GL00919

NEVADA BUREAU OF MINES AND GEOLOGY

UNIVERSITY OF NEVADA RENO

Mail Stop 178
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MEMORANDUM

DATE: April 7, 1994

FROM: Larry Garside

TO: Paul Lineau
Geo-Heat Center
Oregon Institute of Technology
Klamath Falls, OR 97601

SUBJECT: Quarterly Progress Report, Nevada Low-Temperature Geothermal Resources

Progress for the preceding quarter is summarized below; if you have further questions, please contact me.

The selection of records for the spreadsheet for the final report continues. So far, I have marked records for final selection in the northern half of the state. This constitutes about 250 records for over 200 "sites". Most of these records are from GEOTHERM or WATSTORE, but I have had to enter a few from other sources when those sources have the best or only data. I am selecting the sites by comparing 1:1,000,000-scale plots of GEOTHERM, WATSTORE, and the digitized 7.5-minute topographic map data. These were plotted by our GIS lab from the digital longitude and latitude files. The selected records have the best chemical data or best represent the range of chemical data available.

Checking each one of the potential thermal spring and well points has been an eye-opening experience so far. There are numerous errors in the longitude-latitude data, requiring that many erroneous points be checked out (a time-consuming, but necessary, process). Errors occur in both GEOTHERM and WATSTORE with about equal frequency.

I am finding that GEOTHERM has more useable data than WATSTORE; many of Nevada's thermal springs and wells are not represented in WATSTORE. And, if they are, it is not unusual to find that the data is repeated in GEOTHERM (especially for pre-1970's analyses).

I am also finding that quite a number of thermal springs and wells do not have adequate (or even any) analyses. Some of the older analyses do seem quite good, however (based on the ion balance). In some less-populated areas of the state, it appears that there have been no new water chemistry data collected since the late 1970's (when I searched the literature for the data that was published as NBMG Bulletin 91 and eventually entered in GEOTHERM).

Also, there are quite a number of areas where work on the ground needs to be done to figure out just which springs and wells are warm, and which published analyses refer to which localities. I made a brief visit to the Smoke Creek Desert between Reno and Gerlach because of problems with some old location data from Waring (1965). The complete coverage of Nevada with modern 7.5-minute topographic maps has certainly increased our ability to find potential thermal springs and wells. To have a really first-class database of geothermal information, a considerable amount of field work should be done (not just sampling, but surveys of areas known or suspected to have undescribed or poorly known thermal springs and wells). A number of previously unknown geothermal sites have been found during drilling of mineral exploration holes. This source of information, along with the thermal-gradient wells drilled by the geothermal industry in the 60's and 70's, is not readily available and has hardly been researched at all.

The data in WATSTORE has posed some problems that are not completely resolved yet. The bicarbonate and carbonate analyses are represented by several different parameters in the database, requiring quite a bit of extra manipulation. Also, it appears that although boron and iron results are supposed to be reported in ppb, some are in ppm. Hopefully, for those analyses used in the final database, I will resolve these problems.

Over the next 3 months, I plan to complete the selection of records for the final database. These will then be moved from their respective spreadsheets to a final one. The 1:1,000,000-scale map will be easily plotted in the GIS lab from these data.

We continue to add new references to the bibliography from the published, unpublished, and gray literature available in our geothermal files in the NBMG public information office and from my own library. As I mentioned last quarter, the final bibliography will include articles in the GRC Bulletin, the Geo-Heat Center Quarterly Bulletin, and the GRC Transactions.

The article on Nevada geothermal use came out in the last GRC Bulletin. I will be adding a comment in the database on use to those thermal areas mentioned in the article.

Although I am beginning to note quite a number thermal springs and wells that should be sampled to improve the database, I think it is unlikely that I will be able to collect samples from very many of these before July 1. Hopefully, if I am able to collect some of these at a later date, I will be able to apply them to my

10 "free" analyses from UURI. I am hopeful that there will be a continuing DOE low- to moderate temperature geothermal program of data collection and database refinement.

✓cc: Howard Ross, UURI

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Rec 11/15

November 16, 1992

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

Dear Howard:

Please find enclosed the Nevada data for Table 1. There are a lot of caveats for these data. The total database entries are just that, duplicates and all. The YPGA number is GEOTHERM; the 1993 is totals for the three sources I am presently working with. The number of moderate-temperature wells is really a guess, and depends on how you count unutilized exploratory holes. High-Priority resource areas aren't really identified yet, so this too is a guess.

I am enclosing a copy of a letter to Paul concerning an extension of the contract. Also, you might find the Lobster articles from the Reno paper interesting. Please call me if you need anything further.

Sincerely yours,

Larry

Larry Garside
Research Geologist

encl.

1 30 65 40 23 44 202 areas

12/03/93 ~2800 distinct pts.

Table 1. GEOTHERMAL DATABASE SUMMARY

Database Result	State / YPGA	AZ 82	CA 80	CO 80	ID 80	MT 81	NV 83	NM 80	OR 82	UT 80	WA 81
Total Database Entries	1993	___	___	___	___	___	3300 3k	___	___	___	___
(thermal wells, springs)	YPGA	___	___	___	___	___	1376	___	___	___	___
Moderate Temp. Wells	1993	___	___	___	___	___	50	___	___	___	___
(100°C<T< 150°C)	YPGA	___	___	___	___	___	35	___	___	___	___
Low Temp. Wells/Springs	1993	___	___	___	___	___	1000.	___	___	___	___
(20°C<T<100°C)	YPGA	___	___	___	___	___	700.	___	___	___	___
Low Temp. Resource Areas	1993	___	___	___	___	___	400 ok	___	___	___	___
(20°C<Tres.<150°C)	YPGA	___	___	___	___	___	400 200+	___	___	___	___
Direct Heat Utilization	1993	___	___	___	___	___	20	___	___	___	___
(Commercial or district)	YPGA	___	___	___	___	___	8	___	___	___	___
Greenhouses, Aquaculture,	1993	___	___	___	___	___	5	___	___	___	___
Industrial Processes (Number separate businesses)	YPGA	___	___	___	___	___	3	___	___	___	___
Areas, Multiple Residence Heating (not a district)	1993	___	___	___	___	___	2	___	___	___	___
Areas, Potential Near-Term Direct Heat Utilization (Commercial Buildings)	1993	___	___	___	___	___	2	___	___	___	___
Areas, Possible New Binary Power Development (110°C<Tres<150°C)	1993	___	___	___	___	___	2	___	___	___	___
Areas, High Priority Resource Study	1993	___	___	___	___	___	4	___	___	___	___

Comments: YPGA = Year of Previous Geothermal Assessment
Total Database Entries may include several representative wells in a single resource area.
Direct Heat Utilization: Total number of commercial space heating systems, etc.
Areas, Multiple Residence Heating: 1 or more residences
Tres = Estimated reservoir temperature

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June 20, 1994

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

Dear Howard:

I am sending you, under separate cover, a copy of the final report for the Nevada low-temperature project. The enclosed letter and the original report were sent to Paul Lineau at the same time. I did submit a very short paper for the GRC meeting this fall, and I hope to talk a little bit more then about the areal distribution of major and trace elements in Nevada thermal fluids.

Sincerely yours,

Larry

Larry Garside
Research Geologist

encl.

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MEMORANDUM

DATE: June 20, 1994

FROM: Larry Garside *Larry*

TO: Paul Lineau
Geo-Heat Center
Oregon Institute of Technology
Klamath Falls, OR 97601

SUBJECT: Final Report, Nevada Low-Temperature Geothermal Resources

I am sending you under separate cover the final report and 1:1,000,000-scale map showing the geothermal occurrences listed in Appendices 1 and 2. The diskette has the spreadsheet, in Quattro Pro, that produced the two Appendices. The Appendices were just printed from the same spreadsheet by hiding columns not needed for a particular Appendix. The map was produced in ArcInfo here at NBMG, and so it can be modified with relative ease if there are any problems noted. I showed certain geothermal areas with shading surrounded by a line; in these areas, the spring/well locations do not adequately represent, at the map scale, the known area of thermal groundwater (based on all the data examined).

The bibliography is also available as digital data (WordPerfect, ascii, etc.) if you like.

I will be in the field much of the summer, but messages will reach me if they are left at the above telephone/FAX numbers. Please contact me if there are questions or problems with the report, map, and spreadsheet.

cc: Howard Ross

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November 9, 1993

Paul Lienau
Geo-Heat Center
Oregon Institute of Technology
Klamath Falls, OR 97601

Dear Paul:

I received the memo today from you and Howard describing several items concerning the Low-Temperature program. As I have mentioned before, I will need an extension to allow completion of the project tasks; I certainly underestimated the amount of data that is available for Nevada. At present, I am working with about four groups of geothermal analytical+location data (mostly in spreadsheet format). One has over 1,700 records, another (GEOTHERM) over 1,200, and a third has about 350 records. There are a lot of duplicates and incomplete analyses in these sets, although I don't know how many yet. Additionally, our GIS lab has digitized over 2,000 thermal spring/well locations from 7.5-minute topographic maps (combined with GEOTHERM data). I am still trying to get all this data into the same format so that I can select the best records from it. Based on the individual geothermal sites or areas we know of in Nevada, it is certain that there are over 400 locations. There are, for example, 800 locations on the NOAA geothermal map for Nevada. I have included copies of a couple of pages of the spreadsheet data to give you an idea of what it looks like. Also enclosed are copies of some clippings of interest from the Reno Gazette Journal.

I will send a copy of this letter to Howard along with my entries in the Database Summary Table. I believe it would be most efficient for the continuation of the contract here if a no-cost extension was given until June 30, 1994. I expect to deliver most of the data before that date, but extension to that date would allow me to continue to pay for associated expenses as long as possible (for example sample collection and plotting by the GIS lab). If you agree to this extension date, please send me a letter that I can provide to our Grants and Contracts Office.

Thanks for your assistance. Please contact me if I can provide any more information.

Sincerely yours,

Larry

Larry Garside
Research Geologist

cc: Howard Ross

encl.

RENO GAZETTE-JOURNAL

NEVADA

THURSDAY
NOVEMBER 4, 1993 R

PAT HARRISON, CITY EDITOR
PHONE, 788-6397; FAX, 788-6458

AGRICULTURE

Oh, give me a home where 64,000 lobsters roam

■ Hot springs: Douglas County farmers seek permission to cultivate crustaceans.

MINDEN — Cows, alfalfa and sheep production may be on the decline in Douglas County but the number of lobsters on the range could reach 64,000 in the next couple of years.

A California company wants to open an experimental lobster farm on four acres in the Johnson Lane area, making use of natural, geothermal hot springs.

Richard Leudemann, with Lobster's West of Bay Point, is proposing to raise about 64,000 lobsters a year in a metal building equipped with two tanks filled with 17.2 million gallons of water.

The lobsters would be hatched using about 100 female lobsters and would grow to size in larger tanks. The grow-out tanks would be heated by geothermal water that would be injected back into the aquifer.

The experiment would last four years and would employ about three people. Live lobsters would be shipped twice a month to local markets.

The advantages to using geothermal water for the operation, Leudemann wrote in his application, include developing a new use for the resource, promoting aquaculture technology and bringing in economic benefit to the area.

Leudemann and his contractor, Scott Construction Co., will ask the County Commission today for a special use permit to run the lobster farm on the agricultural property.

While other kinds of farming are allowed uses in agriculture zones, aquaculture or lobster farming is not listed.

County planner Paul Patterson also says Leudemann has been having trouble acquiring the appropriate lease from the property owner, the Bureau of Land Management.

In an Oct. 1 letter from BLM, the agency said Leudemann has appealed a notice of lease cancellation, which was based on the fact that he didn't meet regulatory requirements for geothermal development.

Leudemann has appealed the decision. It will take several more months for the process to be completed, state BLM chief Billy Templeton said.

Patterson is recommending approval if Leudemann gets the lease resolved with BLM, gets all permits for raising lobsters for human consumption and makes substantial progress on the project.

He is also asking that Leudemann put in landscaping to screen the farm from an adjacent house and make some road improvements.

Associated Press

B

NEVADA BRIEFING

A daily look at people and events making news in Nevada.

METRO

Trooper says seatbelt might have saved Fernley High pupil

A Fernley High School student killed Thursday in a traffic accident near Fernley might have survived if she had worn a seat belt, an investigator said.

At about 7:10 a.m., Danielle Beaulac, 17, was thrown from her overturning pickup truck on Interstate 80, three miles east of town.

"If people would just wear their seat belts," Nevada Highway Patrol Trooper Dan Bauer said at the scene. "She would have lived."

She was alone driving west in the small truck. On a curve to the left, the truck went straight and off the highway to the right. It went 114 feet into sagebrush, overturning and hurling Beaulac out. There were no witnesses.

A passing doctor and three nurses stopped to try to save her, but couldn't, Bauer said. "She died while I was there."

Wildlife concert tonight

There will be a benefit concert today for Animal Ark, a non-profit nature center and wildlife sanctuary, from 7 to 9 p.m. at Truckee Meadows Community College Auditorium.

The concert will feature the Jan Short Trio, a well-known California group that performed at the Nevada State Fair this year playing all types of music including some jazz and county.

Animal Ark cares for wildlife that can't be released in to the wild, including a black bear, falcons, bobcats and wolves. The animals have been injured or orphaned.

Concert tickets are $5, and are available at the door. Details: The Ark, 969-3111.

Craft fair scheduled for today

The Fourth Annual O'Brien Middle School Holiday Craft Faire has been scheduled from 10 a.m. to 4 p.m. today at 10500 Stead Blvd.

More than 100 crafters invite you to come see their wares. Proceeds from this yearly event support activities like, the RIF program (three free paperbacks for each student), NOVA pharmacy fund, the principal's emergencey fund and a Washoe County dance for disabled adults.

Admission is $1, for which you will receive three raffle tickets. Drawings will be held all day, giving away prizes that include: pizzas, subs, lunches, dinners, hair care, auto care and items donated by the crafters.

Grand prize is a trip for two to Disneyland Knotts Berry Farm, courtesy of Anaheim Holiday Inn and Reno Air.

Potluck marks Community Day

Church Women United of Washoe County will celebrate World Community Day with a potluck lunch today at the Salvation Army, 1925 Sutro St.

All area women are invited to come and bring their favorite dish.

The free event is scheduled to begin at noon and run until about 2 p.m.

Adult hike slated Sunday

For the Love of Hikin' and Bikin' will conduct a hike Sunday along Hunter Creek for adults who enjoy leisurely hiking.

Bring a lunch and water and meet the group at 10 a.m. behind the First Interstate Bank in the Keystone Square Shopping Center.

For more information call 826-5136.

Donate old winter coats

Donate your old winter coats through Nov. 14 at Applegate Video, 520 E. Prater Way.

The first 150 contributors will receive one free video rental for each coat or jacket donated.

All of the winter wraps donated will be given to local needy children and adults by the Salvation Army. Details: **688-4550**.

STATE

Lobster farm project hits snag

MINDEN — Don't tie up those bibs or melt the butter just yet — a proposed lobster farm is on hold because the developer failed to follow the county's noticing requirements.

Richard Leudemann of Bay Point, Calif., sent notices of Thursday's public hearing to only three property owners. Planning staffers said 25 property owners are within 1,350 feet of the 280-acre lobster farm site and all must be notified.

And Chief Deputy District Attorney Robert Storey told county commissioners Leudemann doesn't have a valid lease for the Bureau of Land Management land or a hot springs that would be used to warm lobster-growing ponds.

Without a lease or a letter of intent from the BLM, Storey said the county can't issue a permit. Storey agreed to talk with BLM and, once the noticing requirement is met, reschedule a public hearing on the project.

Leudemann got approval for the lobster farm in 1988 but the permit expired, and now he is seeking a new approval to grow 64,000 three-quarter-pound lobsters a year on the experimental site.

POLICE BLOTTER

SPARKS

Nov. 4

Glendale Avenue, 700 block, Wednesday to Thursday — commercial burglary.

Glendale Avenue, 600 block, Wednesday to Thursday — commercial burglary.

O'Callaghan Drive, 1100 block, 9 a.m. to 3 p.m. — bicycle theft.

RENO

Nov. 5

Idlewild Drive, 2800 block, Monday to Thursday — hospital burglary.

Rainna Court, 1:50 a.m. — burglary and gross lewdness.

Nov. 4

East Second Street, 10 block, 5:02 p.m. — larceny not amounting to robbery.

North Arlington Avenue, 200 block — burglary.

South Virginia Street, 1900 block, 10:30 a.m. — grand larceny.

West Taylor Street, 100 block, Wednesday to Thursday — residential burglary.

WASHOE COUNTY JAIL

- **Inmate population Friday morning:** 742
- **Capacity:** 559
- **Bookings previous 24 hours:** 58

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MEMORANDUM

DATE: September 3, 1993

FROM: Larry Garside *Larry*

TO: Paul Lineau
Geo-Heat Center
Oregon Institute of Technology
Klamath Falls, OR 97601

SUBJECT: Quarterly Progress Report, Nevada Low-Temperature Geothermal Resources

The contract between OIT and the University of Nevada was signed on March 23, 1993, and a quarterly letter report was provided on June 11, 1993. I have briefly summarized the progress to date below. Please contact me if you have further questions. The meeting in July in Salt Lake City was very useful to me, and I now have a much better idea of what is planned for the program, what is expected of the State Teams, and what other State Teams are doing.

1. GEOTHERM - As I reported in June, we have been able to extract the Nevada data and convert it to a format that we can use in dBASE and similar database management systems (PC-FILE). I still have the original tape that UURI supplied, which serves as a backup. I can supply the tape to other State Teams if they need it. I have put the data from GEOTHERM that we all decided was necessary to the program (essentially the columns in Bob Blackett's tables) into Quattro Pro spreadsheets (sample pages enclosed). This data consists of 1368 records for Nevada. Many of these are duplicates, have only temperature data, or have incomplete or otherwise bad analytical data. I have started to filter these out using various methods, including an ion balance calculation, a TDS calculation, and a comparison of Na vs. K and Ca vs. Mg values.

2. WATSTORE - A preliminary search of this database indicates that there are over 900 records for Nevada springs or wells having temperatures greater than 10 °C above mean annual air temperature. We have obtained a CD-ROM from Earthinfo Inc. of the WATSTORE database, and can thus search it as much as necessary "until we get it right". We are in the process of preparing an output file of the pertinent parameters for these 900 or so records in a suitable database/spreadsheet format.

3. USGS Circular 892 data - I received Marshal Reed's letter and diskette with the data from the tables in his report. I have converted it to a spreadsheet to match the anticipated final ones for the project. I still need to compare the records from this with the original GEOTHERM data they were taken from.

4. Other new geothermal data - I have added data to the final spreadsheet format from several new reference sources, including a study of the Moana area (Jacobson and Johnson) and the Great Basin geothermal fluid genesis study by Flynn and Buchanan.

5. Bibliography - The status of the bibliography is about the same as last quarter. It is in digital format (WordPerfect) that includes all references used in NBMG Bulletin 91 plus those additional references in GEOTHERM (listed in the USGS Open-File Report 83-433A), as well as references cited in recent publications on Moana, Beowawe, and the Great Basin. The search for other new references is continuing.

6. Geothermal location data - The program to identify and digitize every Nevada thermal spring shown on the 1:24,000-scale topographic maps is about 80% complete. It appears that this topographic map search has identified at least some thermal springs that are not in the available databases or are incorrectly located. Additionally, we will be able to provide good locations instead of the imprecise ones in GEOTHERM.

7. Timeframe - It seems likely that I will need an extension on the contract to complete all of the tasks. I plan to sample springs in the late fall, but first I need a better idea of what ones are lacking analyses. I should have a better idea of how much more time will be required in a couple of months. Please contact me if you see a problem with this.

P.S. For your information, I have enclosed a copy of a newspaper clipping about the new geothermal vegetable-drying plant under construction in the San Emidio Desert area southwest of Gerlach.

cc: Howard Ross, UURI

C:\ QPRO\ QDATA\ NOHOUSES.WQ1 3 Sep 93

GRECO	TDSc	TDSm	pH	Na	K	Ca	Mg	Fe	SiO2	Cl	B	F	HCO3	CO3	SO4	delD	delO1	cation/anion	Test
GRECO	TDSc	TDSm	pH	Na	K	Ca	Mg	Fe	SiO2	Cl	B	F	HCO3	CO3	SO4	delD	delO1	cation/anion	Test
293	4402		7.56	1450	120	110	6.5	<0.02	85	2400	8.7	4.6	197	<1	120	-125.5	-14.01	0.98	OK
295	3001		7.30	1350	110	100	7	<0.02	72	1150	8.4	4.6	213	<1	94			1.76	OK
577	707		8.00	180	8.7	8.4	<0.1	<0.02	160	48	2.9	7.1	143	2	220	-125.3	-15.26	0.97	OK
579	1063		7.10	330	23	14	0.4	0.08	150	160	7.5	12	497	1	120	-129.2	-14.48	0.99	OK
585	1173		7.30	300	31	75	37		105	27		7.2	1135		32			1.01	OK
587	561		8.50	135	8.9	1	0.03	<0.02	210	23	0.2	17.7	224	15	40	-130.1	-16.09	0.93	OK
589	1254		9.40	250	38	1.3	0.2	<0.02	500	70	2.5	<0.05	667		64	-113.6	-11.07	0.84	OK
591	1990		6.50	540	80	95	26	0.2	150	770	3.8	5.7	545		51	-130	-15.5	1.01	OK
593	589		7.40	160	13	8.8	0.5	<0.02	135	29	1.2	7.8	368		53	-128.6	-15.7	0.93	OK
595	733		8.40	200	18	16	0.9	0.18	125	41	2.6		385		140	-131.4	-15.74	0.97	OK
597	735		7.10	180	20	36	4.4	0.08	110	40	1.9	7.8	375		150	-129.5	-15.58	0.97	OK
599	4256		7.57	1480	42	108	1.7		170	2200	15	5	90	<1	190	-110.2	-12.36	1.05	OK
603	242		9.00						242									ERR	NO
605	1738		7.90	653	71					865	49				100			1.14	NO
607	1106		8.50	277	15	38	0.2		115	46			70		580	-131.5	-16.01	0.99	OK
609	1617		7.40	450	26	44	0.6	<0.02	180	380	2.4	7.9	114	<1	470	-125.8	-13.21	0.99	OK
611	558		7.70	170	8.4	4.8	0.06	<0.02	110	22	0.66	8.9	256	5	102	-130.4	-16.68	1.04	OK
613	270		9.10	81	1	0.2	<0.1	0.03	57	15	0.91	1.7	116	11	45	-124.3	-15.3	0.96	OK
615	312		9.20	88	1.7	3	<0.1		85	10			127		62	-127.1	-16.17	1.10	OK
617	506		8.90	150	4.3	1.8	<0.1	<0.02	85	21	1	8	277	17	82	-128	-16.29	0.86	OK
619	261		8.60	74	1.1	3.1	<0.1	<0.02	63	18	0.64	12	92	3	41	-129.9	-16.56	0.94	OK
621	616		7.90	180	4.5	4.8	0.1	<0.02	105	59	1.8	10	261	2	120	-128.8	-15.93	0.91	OK
623	3215		8.10	1500	20	35	4		120	787			932		290	-122.2	-13.02	1.56	OK
625	997		7.90	340	17	31	4.2	0.13	82	240	1.9	7	464		45	-120.7	-14.72	1.09	OK
627	1264		8.40	463	9.3	25	0.2		85	520			154		86	-124.5	-14.4	1.14	OK
629	284		9.10	75	2.2	1.6	<0.01		83	15	0.47	8.9	108		45	-139	-17.61	0.94	OK
631	631		7.20	120	39	60	15.5	<0.02	65	16	0.7	1.9	488	1	72	-144.7	-15.31	1.04	OK
633	435		7.60	45	16	60	15		70	12			335		52	-132.7	-16.64	0.95	OK
635	1224		7.00	390	41	49	13		84	40	0.77	7.2	1180		18	-134.9	-16.78	1.01	OK
637	910		6.60	230	58	53	35	<0.02	67	1	2.1	6.6	915	<1	7	-136.1	-15.97	1.10	NO
639	403		6.50	44	14	56	12	<0.02	68	12	0.12	2.5	264	<1	64	-129.8	-16.87	0.99	OK
641	777		6.50	200	36	43	9.4	0.06	77	22	2.6	4.7	673		51	-135.8	-16.01	0.97	OK
643	928		8.00	288	33	29	5		80	28			823		60			0.98	OK
645	961		6.50	250	34	45	4.9	0.05	80	29	2.3	4.8	814		110	-131.6	-15.85	0.86	OK
647	900		8.00	296	36	10	8		55	26			881		36	-134.6	-16.44	0.94	OK
649	547		6.50	130	22	33	6.8	0.22	66	18	1.1	1.8	429	1	56	-125.5	-15.65	0.95	OK
651	987		8.10	165	26	110	22		65	75			312		370	-130	-16.24	1.01	OK
653	635		8.60	190	6.5	3.6	0.02	<0.02	115	126	0.89	16	111	11	111	-126.1	-15.89	0.97	OK
655	3892		8.40	1100	160	260	0.1	<0.02	110	1900	6.1	3	26		340	-106.5	-6.33	1.06	OK
657	535		8.70	145	3.6	10	0.01	<0.02	58	44	1.2	4.9	50	9	235	-119.5	-15.55	0.92	OK
659	384		8.70	102	2.5	4.5	0.01	0.06	52	17	0.19	3.1	54	7	169	-123.2	-16.01	0.90	OK

C:\QPRO\QDATA\PA-2.WQ1 27 Aug 93

GRECORD	NAME	COUNT	T	R	SEC	QSECTIONS	LATITUDE	LONGITUDE	TYPE	TEMP	FLOW	DEPTH	H2S	REFERENCE
GRECORD	NAME	COUNT	T	R	SEC	QSECTIONS	LATITUDE	LONGITUDE	TYPE	TEMP	FLOW	DEPTH	H2S	REFERENCE
293	COLADO WELL NO. 1	PE	28N	32E	33	SE	40-14.7 N	119-23.1 W	W	60			1.	*MARINER, R., USGS, MENLO PARK
295	COLADO WELL NO. 2	PE	28N	32E	33	NW SE	40-14.7 N	119-23.1 W	W	61			1.	*MARINER, R., USGS, MENLO PARK
577	BALTAZAR HOT SPRINGS	HU	46N	28E	13	NE SE NW	41-55.21 N	118-42.52 W	S	80	100			MARINER AND OTHERS, 1974B, 1975
579	EAST PINTO HOT SPRING	HU	40N	28E	17	NE SE SE	41-21. N	118-47. W	S	93	500			MARINER AND OTHERS, 1974B, 1975
585	UNNAMED HOT SPRING NEAR WELLS	EL	38N	62E	17	SE NW NE	41-10.91 N	114-59.37 W	S	61				MARINER AND OTHERS, 1974B
587	SULPHUR HOT SPRINGS (HOT SULPHUR SPRINGS)	EL	31N	59E	11	NE NW	40-35.20 N	115-17.08 W	S	93	75			MARINER AND OTHERS, 1974B, 1975
589	BEOWAWE "STEAM WELL"	EU	31N	48E	17	NW	40-33.5 N	116-35.00 W	W					MARINER AND OTHERS, 1974B, 1975
591	KYLE HOT SPRINGS	PE	29N	36E	01	SW	40-24.45 N	117-52.87 W	S	77	20			MARINER AND OTHERS, 1974B, 1975
593	LEACH HOT SPRINGS	PE	32N	38E	36	SE	40-36.22 N	117-38.74 W	S	92	200			MARINER AND OTHERS, 1974B, 1975
595	UNNAMED HOT SPRING	HU	33N	40E	05	SE	40-45.70 N	117-29.53 W	S	85	100			MARINER AND OTHERS, 1974B, 1975
597	JERSEY VALLEY AREA - UNNAMED HOT SPRING	PE	27N	40E	28	SW	40-10.74 N	117-29.40 W	S	29	20			MARINER AND OTHERS, 1974B, 1975
599	FLOWING WELL IN STILLWATER	CH	19N	31E	07	SW	39-31.29 N	118-33.13 W	W	96				MARINER AND OTHERS, 1974B, 1975
603	BRADY HOT SPRINGS	CH	22N	26E	12	NE NE SW	39-47.21 N	119-01.01 W	S	98				OLMSTEAD AND OTHERS, 1975
605	STEAMBOAT SPRINGS - SPRING 8	WA					39-23. N	119-45.00 W	S	89.2				*WHITE, D., USGS, MENLO PARK
607	WABUSKA HOT SPRINGS	LY	15N	25E	16	SE	39-09.69 N	119-10.96 W	S	97				MARINER AND OTHERS, 1974B, 1975
609	LEE HOT SPRINGS	CH	16N	29E	34	SW NW	39-12.55 N	118-43.39 W	S	88	128			MARINER AND OTHERS, 1974B, 1975
611	UNNAMED HOT SPRING	LA	17N	39E	11		39-21. N	117-33.5 W	S	86	75			MARINER AND OTHERS, 1974B, 1975
613	BOG HOT SPRINGS	HU	46N	28E	18	SW NE NW	41-55.37 N	118-48.30 W	W	54	4000			MARINER AND OTHERS, 1974B, 1975
615	HOWARD HOT SPRINGS	HU	44N	31E	04	SE NE NE	41-43.20 N	118-30.20 W	S	56				MARINER AND OTHERS, 1974B, 1975
617	DYKE HOT SPRINGS	HU	43N	30E	25	SE SE	41-34.07 N	118-33.95 W	S	66	100			MARINER AND OTHERS, 1974B, 1975
619	SOLDIERS MEADOW AREA - UNNAMED HOT SPRING	HU	40N	24E	23		41-21.58 N	119-13.08 W	S	54	50			MARINER AND OTHERS, 1974B, 1975
621	DOUBLE HOT SPRING	HU	36N	26E	04	NW SE NW	41-03.03 N	119-01.55 W	S	80	175			MARINER AND OTHERS, 1974B, 1975
623	BLACK ROCK POINT AREA - UNNAMED HOT SPRING	PE					40-57. N	118-58. W	S	90				MARINER AND OTHERS, 1974B, 1975
625	FLY RANCH (WARDS HOT SPRING) - WELL	WA	34N	23E	02		40-51.8 N	119-20.5 W	W	80	500			MARINER AND OTHERS, 1974B, 1975
627	BUTTE SPRINGS (TREGO)	PE					40-46. N	119-07. W	S	86				MARINER AND OTHERS, 1974B, 1975
629	MINERAL HOT SPRINGS	EL	45N	64E	16		41-47.29 N	114-43.76 W	S	60				MARINER AND OTHERS, 1974B, 1975
631	HOT HOLE (ELKO HOT SPRINGS)	EL	34N	55E	21	NE	40-49.11 N	115-46.53 W	S	56	.75			MARINER AND OTHERS, 1974B, 1975
633	UNNAMED SPRINGS NEAR CARLIN	EL	33N	52E	33	SE SW	40-41.83 N	116-08. W	S	79				MARINER AND OTHERS, 1974B, 1975
635	HOT SULPHUR SPRINGS	EL	41N	52E	08	NE	41-28.06 N	116-08.88 W	S	90				MARINER AND OTHERS, 1974B, 1975
637	HOT SPRINGS POINT	EU	29N	48E	11	NE NE	40-24.21 N	116-31.00 W	S	54	125			MARINER AND OTHERS, 1974B, 1975
639	WALTI HOT SPRINGS	EU	24N	48E	33	SW	39-54.1 N	116-35.22 W	S	72	300			MARINER AND OTHERS, 1974B, 1975
641	SPENCER HOT SPRINGS	LA	17N	45E	24	NE NE	39-19.8 N	116-51.4 W	S	72	50			MARINER AND OTHERS, 1974B, 1975
643	HOT POT SPRING	HU	35N	43E	10	NE NE SE	40-55.37 N	117-06.60 W	S	58				MARINER AND OTHERS, 1974B, 1975
645	BUFFALO VALLEY HOT SPRINGS	LA	29N	41E	23	SE	40-22.02 N	117-19.53 W	S	49	10			MARINER AND OTHERS, 1974B, 1975
647	THE HOT SPRING	HU	41N	41E	19	NE NE	41-25.25 N	117-23.2 W	S	58				MARINER AND OTHERS, 1974B, 1975
649	UNNAMED HOT SPRING NEAR GOLCONDA	HU	36N	40E	29	SW SW SE	40-57.66 N	117-29.63 W	S	74	750			MARINER AND OTHERS, 1974B, 1975
651	SOU HOT SPRINGS (GILBERTS HOT SPRINGS)	PE	26N	38E	29	SE	40-05.37 N	117-43.48 W	S	73				MARINER AND OTHERS, 1974B, 1975
653	DIXIE HOT SPRINGS	CH	22N	35E	05	SE	39-47.86 N	118-04.04 W	S	72	200			MARINER AND OTHERS, 1974B, 1975
655	PYRAMID LAKE (THE NEEDLES)	WA					40-08.76 N	119-40.49 W	S	56				MARINER AND OTHERS, 1974B, 1975
657	WALLEYS HOT SPRINGS (GENOA HOT SPRINGS)	DG	13N	19E	22	SW NW NE	38-58.87 N	119-49.95 W	S	61	75			MARINER AND OTHERS, 1974B, 1975
659	NEVADA HOT SPRINGS	LY	12N	23E	16	SE	38-53.97 N	119-24.70 W	S	61	200			MARINER AND OTHERS, 1974B, 1975
663	WARM SPRINGS AREA - UNNAMED WARM SPRING	NY	04N	50E	20	SW	38-11.29 N	116-22.48 W	S	61				MARINER AND OTHERS, 1974B, 1975
665	BARTHOLOMAE HOT SPRINGS	EU	18N	50E	28	SE	39-24.32 N	116-20.78 W	S	54				MARINER AND OTHERS, 1974B, 1975
788	BEOWAWE - MAIN GEYSER	EU	31N	48E	17	N 1/2	40-33.5 N	116-35. W	S					*OESTERLING, W.A., 1959
789	DIANA'S PUNCH BOWL	NY	14N	47E	22	SE	39-01.7 N	116-40.0 W	S	59				MARINER AND OTHERS, 1974B, 1975
790	BEOWAWE HOT SPRING	EU	31N	48E	08	SE	40-34. N	116-34. W	S	98	100			MARINER AND OTHERS, 1974B, 1975
791	WABUSKA HOT SPRINGS	LY	15N	25E	16	SE	39-09.6 N	119-11.0 W	S	97				MARINER AND OTHERS, 1974B, 1975
792	UNNAMED HOT SPRING NEAR FERNLEY	LY	20N	26E	18	SW	39-36.0 N	119-07.0 W	S	86				MARINER AND OTHERS, 1975
793	SODAVILLE SPRINGS, SODA SPRINGS	MN	06N	35E	29	SE	38-20.5 N	118-06.1 W	S	35	100			MARINER AND OTHERS, 1974B, 1975
794	POTT'S RANCH HOT SPRING	NY	14N	47E	02	NE	39-04.7 N	116-38.4 W	S	45	125			MARINER AND OTHERS, 1974B, 1975
795	HOT SPRING NEAR DIANA'S PUNCH BOWL	NY	14N	47E	22	SE	39-01.7 N	116-40.0 W	S	51	200			MARINER AND OTHERS, 1974B, 1975
796	UNNAMED HOT SPRING NEAR TREGO	PE					40-46. N	119-07. W	S	84.5	150		1.0	MARINER AND OTHERS, 1976A
797	UNNAMED HOT SPRING (VALLEY OF THE MOON)	LA	27N	43E	23	NE	40-11.92 N	117-06.05 W	S	53				MARINER AND OTHERS, 1974B, 1975
798	UNNAMED HOT SPRING NEAR GREAT BOILING SPRING	WA	32N	23E	10	SW NW	40-39.9 N	119-22. W	S	89.5	100		0.5	MARINER AND OTHERS, 1976A
799	SAN EMIDIO SPRING	WA	28N	23E	31	NE	40-15.4 N	119-26.1 W	S	15				MARINER AND OTHERS, 1976A

RG-J. 31 Aug 93.

Empire getting a dehydration plant

Integrated Ingredients, part of international food manufacturer Burns Philp, is building an onion and garlic dehydration plant in Empire, to be completed by November.

The facility will open with about 25 jobs, possibly growing to about 65 jobs after 18 months, said Robert Shriver of the Economic Development Authority of Western Nevada.

Empire is located about three miles south of Gerlach on state highway 447 in Washoe County.

The state-of-the-art plant will feature processing and year-round storage of dehydrated onion and garlic products.

Burns Philp is known in the food industry under Integrated Ingredients' brands such as Spice Islands, Durkee-French, Fleischmann's, Dromedary and Blue Ribbon Spice.

Spice Islands operates an herb and spice plant in Sparks on Purina Way.

829-3700

NEVADA BUREAU OF MINES AND GEOLOGY

UNIVERSITY OF NEVADA RENO

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MEMORANDUM

Rec 6/16/93 NK

DATE: June 11, 1993

FROM: Larry Garside

TO: Paul Lineau
Geo-Heat Center
Oregon Institute of Technology
Klamath Falls, OR 97601

SUBJECT: Quarterly Progress Report, Nevada Low-Temperature Geothermal Resources

The contract between OIT and the University of Nevada was signed on March 23, 1993. I have summarized the progress to date below. Please contact me if you have further questions. I anticipate that all the State Teams will have a better understanding of the anticipated final products for the project after our proposed meeting in July in Salt Lake City.

1. GEOTHERM - We have been able to extract the Nevada data and convert it to a format that we can use in dBASE and similar database management systems. I still have the original tape that UURI supplied, which serves as a sort of backup. I can supply the tape to other State Teams if they need it. I have given Les Youngs (California Division of Mines and Geology) a dBASE-format file for California as well. Most of the GEOTHERM records were entered from data-entry forms that I filled out in the late 1970's, and which was eventually published in the table of Nevada Bureau of Mines and Geology Bulletin 91, "Thermal Waters of Nevada". I have already observed that duplicate or near duplicate records are a problem, as are very old analyses. The coordinate location data (longitude-latitude) are also usually not very accurate (but see discission below on geothermal location data). I know some obvious errors in early versions of GEOTHERM were noted and corrected, but I am sure there are many more. However, errors can and will occur whenever data is entered.

2. WATSTORE/NAWDEX - This database has a lot of water quality information in it, and I believe a number of State Teams are using it as a first or second source of data. NAWDEX (National Water Data Exchange) has data from agencies other than the U.S. Geological Survey (which has the WATSTORE database). We have received digital data and a paper copy of a preliminary search of NAWDEX, and I can search it with a word processor

for names, Township and Range numbers, etc. I have a program and other information from Bob Blackett (Utah) concerning the conversion of this data to a dBASE format, but haven't proceeded further as yet. I will need to communicate further with Bob, and I hope to have some discussion with other State Teams about conversion methods and final database/spreadsheet output.

3. Database - At present GEOTHERM is in a rather archaic database management system called INFO (part of the ARCINFO GIS package), but we have put the Nevada portion out to PC File, which is a shareware product of ButtonWare. PC File produces a .dbf file compatible with dBASE and other database programs. I use Quattro Pro to a limited extent, but haven't yet tried to get any of the geochemical data into it. Our plan at present is to produce the final databases and spreadsheet from several digital sources which we are presently collecting data in. I expect that our final product for the contract will only have the best record or few best records for each geothermal site. The location information and some other data on geothermal sites (GEOTHERM record number, for example) will be in ARCINFO, because we are digitizing spring locations from 1:24,000-scale topographic maps into ARCINFO.

4. Chemistry Spreadsheet - The water quality data for this product will come from a variety of sources, including pre-existing databases. I anticipate that the final product will have only the "best" and(or) most complete one or two analyses for each geothermal area. All other incomplete or incorrect analyses will remain in the original source databases at NBMG. I have a copy of Bob Blackett's Pascal program for checking the ion balance, but we haven't tried to apply it to any of our data yet. Other than ion balance, I would like to hear how other State Teams are selecting "best" analyses. Perhaps we can also agree on what elements/ions we want in the final spreadsheet. If someone has written Lotus/Quattro Pro formulas for the geothermometer calculations, I would like these as well. I hope that we can have some discussion on the application of these geothermometers at out July meeting.

5. Bibliography - I have a bibliography in digital format (WordPerfect) that includes all references used in NBMG Bulletin 91 plus those additional references in GEOTHERM (listed in the USGS Open-File Report 83-433A. A search of GEOREF has produced quite a number more, but these haven't been checked or integrated into the overall list as yet. I intend to put together a complete bibliography of Nevada geothermal references, which can then be used, if necessary, to make a list of references for a abbreviated citation list by promising resource areas. The complete bibliography could eventually be an open-file report here at NBMG.

4. Collocation - In early April, I provided Howard Ross with a preliminary list of "population centers" that are collocated

with geothermal resources. I made this list from existing data and personal and local knowledge. It includes some really small towns, but I didn't consider things like mines or other manufacturing sites which might have a use for low-temperature geothermal fluids. Our GIS lab will have to compare the U.S. Census TIGER files of the 1990 census with digital location data on hot springs and wells before we have a good handle on collocation. We have tried this on a preliminary data set for Clark County.

5. Geothermal location data - We have in progress a program to identify and digitize every Nevada thermal spring shown on the 1:24, 000-scale topographic maps. As part of this, we will digitize individual spring locations as well as a central generalized point. I hope this topographic map search will identify thermal springs that are not in the available databases. Additionally, we will be able to provide good locations instead of the imprecise ones in GEOTHERM. When possible, we identify the digitized spring site with the GEOTHERM ID number. We have examined about 45% of the 1:24,000-scale maps to date. Another source of location data is the well files of the Nevada State Engineer's Office. We have a print-out of geothermal wells from them, but the list is apparently mostly high-temperature Industrial- and Commercial- Class wells. Computerization of their files is apparently underway, and they may be available for a selective search.

Sincerely yours,

Larry

Larry Garside
Research Geologist

cc: Howard Ross, UURI

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Rec. 4/9/93
HPR

April 7, 1993

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

Dear Howard:

I will try to respond to your questions and comments in your recent letter. Please note that the mail address label that you used is incorrect; I suspect that it was only delivered to me because of the zip code.

Why wrong? MT had my list

The contract between UNR and OIT was signed some time in March, and our Grants and Contracts Office set up the account on March 21, 1993. We have made a fair amount of progress on some fronts in the last month or two. Thanks for the suggestions on the database recommendations. I have a sample of Bob Blackett's Lotus file for Utah, and we plan to produce something similar. We will create a more complex database or series of databases for our own use and then will extract the simplified database for OIT and UURI. Please keep me informed of any changes in requirements for fields in the database, as it is much better to set up all needed fields at the start.

Thanks for sending the GEOTHERM tape to us. We have been able to extract the Nevada data and convert it to a format that we can use in dBASE and similar database management systems. Please inform me if you need the tape back. I am pretty familiar with this data, because it was entered in GEOTHERM mainly from the table in my Nevada Bureau of Mines and Geology Bulletin on "Thermal Waters of Nevada" (Bulletin 91). We have not checked much of this data yet for accuracy. I also have requested a preliminary search of the USGS WATSTORE database (via NAWDEX), and this should provide up-to-date spring and well data as well as checks on the GEOTHERM data.

I have a bibliography in digital format (WordPerfect) that includes all references used in NBMG Bulletin 91 plus those additional references in GEOTHERM (listed in the USGS Open-File

Report 83-433A. A search of GEOREF has produced quite a number more, but these haven't been checked or integrated into the overall list as yet. I intend to put together a complete bibliography of Nevada geothermal references, which can then be used, if necessary, to make a list of references for a abbreviated citation list by promising resource areas. I assume that the collocation study will be a major factor in the identification and prioritization of promising resource areas.

At the present stage of the Nevada study, I think the only new or significant information developed would be the enclosed preliminary list I have made of "population centers" that are collocated with geothermal resources. I made this list from existing data and personal and local knowledge. Our GIS lab will have to compare the TIGER files of the 1990 census with digital location data on hot springs and wells before we have a good handle on collocation. At present, digital location data for geothermal resources in Nevada consists of the GEOTHERM locations, and a separate digital file of the geothermal locations as shown on the NOAA 1:500,000-scale geothermal resources map. We have just begun to digitize all warm springs and wells shown on the 1:24,000-scale topographic maps for Nevada (this scale of mapping is complete for the state).

The only other item of interest I have is that a mining company has recently encountered very hot ground water at shallow depth in a valley in Nevada. I do not have the location of this discovery yet, but I am told that there are no nearby warm springs known. If this discovery is confirmed, it indicates that there is a high potential for the discovery of more Nevada geothermal resources which have no known surface manifestation.

Sincerely yours,

Larry

Larry Garside
Research Geologist

LJG/hs

Nevada Geothermal Collocation - Preliminary List

Larry J. Garside - March 1993

The towns, cities, urbanized areas, and other population centers listed below as being collocated with geothermal waters were compiled by use of NBMG Bulletin 91, the NOAA 1:500,000 geothermal map of Nevada, the most recent Nevada State Highway map, and a variety of unpublished data and local knowledge. The localities are only in a very general north-to south order. The list is not complete, and is certain to have errors.

1. Gerlach
2. Denio/Denio Junction - Continental Hot Springs; possibly 6 mi from Denio proper.
3. Pyramid - 5 mi. to the Needles; Pyramid Lake Indian Reservation.
4. Warm Springs Valley, northwest of Reno.*
5. Verdi - < 5 mi. to Lawton's Hot Springs; also Mogul and west Reno urbanized area.
6. Flanigan (west Honey Lake Valley) - Fish Spring is 73°F; low population density.*
7. Sutcliff - 5 mi from Anaho Island spring (wildlife reserve) across Pyramid Lake.
8. Reno\Moana area
9. Steamboat, NV - urbanized area nearby including Pleasant Valley, Mount Rose Highway, etc.
10. Washoe City - equidistant from Steamboat Springs and Bowers Mansion Spring (state park).
11. New Washoe City - east of Washoe Lake; Bowers Mansion Spring and warm well (CWRR data).
12. Virginia City - hot water at depth in old mine workings; 5 mi to warm wells in Carson Plains to east near Dayton.
13. Dayton/Stagecoach - warm wells located between these two areas.
14. Silver Springs - 27°C spring nearby.
15. Carson City - Carson Hot Springs
16. New Empire, etc. - east of Carson; Pinyon Hills area.
17. Jacks Valley/north Carson Valley/Johnson Lane - Saratoga and Hobo Hot Springs.*
18. Crystal Bay - Brockway Hot Springs, CA.
19 Minden/Gardnerville/Genoa - Walleys Hot Springs
20. Wellington - warm wells
21. Wabuska - Wabuska Hot Springs; sparsely populated area in north Mason Valley, but Yerington is ~12 mi away.*
22. Hawthorne
23. Hazen
24. Fallon - Soda Lake and Naval Air Station thermal areas.
25. Stillwater
26. Lovelock/Colado
27. McDermitt - thermal wells; Indian Reservation.
28. Winnemucca - 93°F spring, 73°F wells.

29. West Winnemucca - spring at northwest end of East Range, new State prison, potato growing/storage.
30. Paradise Valley - about 10 mi to 135 °F spring.
31. Golconda
32. Battle Mountain - 75 °F spring < 5 mi.
33. Wildhorse - hot spring; only a few homes; cold winters.
34. Mountain City - "warm" spring
35. Crescent Valley - nearby Hot Point Spring.
36. Hadley - < 5 mi from Darroughs Hot Springs; nearby Round Mountain Mine uses geothermal.
37. Contact
38. Wells
39. Warm Springs "siding" north of Ely - is this the second OIT listing? Probably very low population.
40. Sunnyside - any population?
41. Preston/Lund - 70-72 °F.
42. Ely - Lacawana Hot Springs.
43. Warm Springs, Nye County - zero population.
44. Gabbs
45. Duckwater - Indian Reservation; catfish raising.
46. Basalt (Montgomery Pass) - 113 °F well (CWRR data).
47. Mina - < 5 mi from Sodaville.
48. Silver Peak
49. Scotties Junction - few houses? Warm well (72 °F).
50. Tonopah -deep mine workings have lots of hot water.
51. Pahrump - mid- 70's °F water.
52. Beatty
53. Mercury - 84 °F wells at junction with highway; Nevada Test Site Facility.
54. Indian Springs - 79 °F spring; USAF facility; nearby? State prison.
55. Las Vegas - shallow wells have > 75 °F water; resulting from subsurface discharge of 137 °F + water from carbonate aquifer at 5,000 ft. depth.
56. Henderson - adjacent to Las Vegas area wells.
57. Boulder City - Black Canyon Hot Springs (Lake Mead National Recreation Area).
58. Nelson - 81 °F well (CWRR data).
59. Cal Nev Ari - 87 °F well.
60. Laughlin - 81 °F well (CWRR data).
61. Moapa - Springs; Indian Reservation.
62. Logandale/Overton - 70 °F spring, 75 °F well.
63. Mesquite - 70-73 °F wells.
64. Hiko/Ash Springs/Alamo - warm springs and wells.
65. Caliente
66. Panaca

November 23, 1992

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

Dear Paul:

Enclosed please find a letter from Larry Garside, Research Geologist, Nevada Bureau of Mines and Geology, with supporting budget, audit, and resume information for the Nevada Low Temperature subcontract. Larry will be the Principal Investigator for this subcontract. This completes our state teams for the Phase I of this DOE program.

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

Sincerely,

Howard P. Ross
Project Manager

HR/mt
Enclosures

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

October 21, 1992

Dr. Larry J. Garisde
University of Nevada
Nevada Bureau of Mines & Geology
Reno, NV 89557-0088

Dear Larry:

A proposed Statement of Work for participation by your organization in the Department of Energy-Geothermal Division's Low Temperature Geothermal Resources and Technology Transfer Program, was mailed to you on September 28. The funding amount which has been designated for your organization is $55,000 as indicated in Section 6.0 FUNDING.

The proposed Statement of Work is written as an addendum to the OIT Standard Contract Agreement. Upon reaching agreement with the proposed SOW, I will submit the SOW, with any acceptable revisions, to OIT who will initiate the funding process. We have tried to keep the work tasks and deliverable requirements relatively simple, to give the State Teams flexibility in meeting deliverables within the funding available. DOE hopes that additional funding may be available to your effort as a State or Organization cost share, in cost or in kind. The cost share does not have to be specified in your budget.

To expedite the funding process, please prepare a budget and submit it to me for review and forwarding to OIT. The budget should address the available funding amount, and include a detailed breakdown of costs, including salaries and wages by categories, indirect and G & A rates, travel (including estimated mileage, per diem, lodging and conference costs, and probable destinations), supplies, computer costs, reporting, and other costs. Brief resumes (degrees, years of experience, etc) will be required to support the salary schedule, and a reference to indicate organization overhead rates. Budget information will be reviewed by Bob Crowton, EG&G, Idaho, who is the Subcontract Administrator for the OIT-GHC contract. Bob will be glad to respond to questions regarding budget details - his telephone number is (208)-526-7746. Enclosed is a copy of a FAX sent to me by Bob Crowton which indicates the level of detail required for subcontract budgets.

Please call me at (801)-524-3444 with any questions you may have regarding this letter or the enclosures. I look forward to your participation in this DOE-GD program.

Sincerely,

Howard Ross

Howard P. Ross
Project Manager

encl.

EG&G Idaho, Inc.
1955 Fremont Avenue
P. O. Box 1625
Idaho Falls, ID 83415-2082
Procurement
North Holmes Complex 3

	FTS	COMMERCIAL
Ricoh 1000L	583-7743	208-526-7743
Ricoh 4000L	583-7744	208-526-7744
Confirm	583-7746	208-526-7746

TELECOPIER TRANSMITTAL REQUEST

April 28, 1992
Date

Dr. Howard Ross
To

University of Utah - UURI
Organization/Location

FAX No. (801) 524-3453

Bob Crowton
From

EG&G Idaho Subcontracts
Organization/Location

Total Pages
Excluding Cover Page Each

Dr. Ross,

Attached is a copy of the level of detail EG&G Idaho requires in our solicitations. As we discussed, we would also like to see:

* A current copy of the agencies negotiation agreement that addresses indirect rates.

* A copy of the agencies official (typed and formal) travel policy (We would also need to see a very detailed estimate of the point of departure and destination, number of travellers, number of days duration, etc.)

* Resumes of the proposed performers to address education and experience

If you have any questions or concerns (or if there are any questions from your prospective offerers) please call me on (208) 526-7746.

Thanks
Bob

THE PROCUREMENT GROUP OF EG&G IDAHO, INC. HAS UNATTENDED FACSIMILE SERVICE. PLEASE CALL ADDRESSEE WHEN YOU ARE SENDING A MESSAGE, AND FOR CONFIRMATION OF RECEIPT OF FACSIMILE MESSAGES.

2. EG&G Idaho, is a wholly-owned subsidiary of EG&G, Inc., but was organized for the sole purpose of functioning as a Management and Operating (M&O) contractor for the Department of Energy Field Office, Idaho (DOE-ID). EG&G Idaho is not allowed to submit bids in response to non-DOE-ID requests for competitive proposals/bids or quotes. EG&G Idaho is not permitted to divulge to other EG&G affiliates proprietary information received from those submitting proposals in response to EG&G Idaho's request for proposals/bids or quotes.

Explains why

Those proposers who are unwilling or fail to provide detailed pricing data to EG&G Idaho for negotiation purposes and determining cost or price reasonableness (see FAR 15.804) or who restrict access to audit information needed by EG&G Idaho for review, evaluation, and negotiation may have their proposals/bids or quotations deemed to be nonresponsive.

3. COST PROPOSALS must include the following information:

a. The hourly direct labor rate and proposed hours for each person or labor category that will be performing work under the subcontract.

b. Total proposed direct labor cost.

c. Fringe benefit rate.

d. Overhead rate

e. G&A rate.

f. Travel costs (reimbursable in accordance with FAR 31.205-46 and the GSA Federal Travel Register or official agency travel policy).

g. Material and any other miscellaneous costs (itemize).

h. Total estimated cost.

i. Please also include the following information with your cost proposal:

1) State whether your company has been audited by the Defense Contract Audit Agency or by another U. S. Government audit agency.

2) The name and address of the agency which performed the audit and approved your accounting system.

3) The name and telephone number of the auditor who performed the audit.

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

APPENDIX 1

#	NAME	CO	T	R	SC	QSEC	NLAT	WLONG	T	TEMP	FLOW	DEPTH	CDATE	REFERENCE	USE
1	TWIN SPRING, VYA SPRING	W	42N	19E	04	NW	41.5933	119.8650	S	22	715		1952/05/15	WARING, 1965	
2	HILL'S WARM SPRING	W	44N	20E	18	NE SE SW	41.7300	119.7867	S	28			1961/08/08	TREXLER AND OTHERS, 1979	
3	UNNAMED SPRING	W	44N	19E	12		41.7459	119.7919	S	23	19		1946/02/11	SINCLAIR, 1963B	
4	VIRGIN VALLEY RANCH 10	HU					41.7906	119.1075	W	21			1975/08/05	WATSTORE	
5	VIRGIN V CAMP GROUND 1	HU	45N	26E	02		41.8533	119.0008	W	32			1975/08/05	WATSTORE	
6	ROADSIDE REST AREA 3	HU	46N	26E	31	C	41.8753	119.0475	W	18			1975/08/05	WATSTORE	
7	Surprise Valley Hot Spring	WA					41.166	119.978	S	47			1989/	Flynn and Buchanan, 1990	
8	WARM SPRING	W	39N	19E	33		41.2160	119.8627	S	warm				WALL CANYON RESERVOIR 7.5' QUAD	
9	WARM SPRINGS	HU	44N	27E	12	NE SW SW	41.7503	118.8367	S	40			1954/07/27	TREXLER AND OTHERS, 1979	
10	McGEE MOUNTAIN	HU	45N	27E			41.8163	118.8597	S	42.2		61		WENDELL, 1970	
11	BOG HOT WELL	HU	46N	28E	31		41.8783	118.7960	W	hot				BOG HOT SPRINGS 7.5' QUAD	
12	BOG HOT SPRINGS	HU	46N	28E	18	SW NE NW	41.9228	118.8050	S	55.6	3785		1970/09/01	SINCLAIR, 1963B	
13	BALTAZOR HOT SPRING 9	HU	46N	26E	18	B	41.9217	118.7092	S	83			1975/08/05	WATSTORE	
14	SOLDIER MEADOWS AREA HOT SPRING	HU	40N	24E	23		41.3597	119.2180	S	54	68		1974/02/20	GROSE AND KELLER, 1975B	
15	SOLDIERS MEADOW AREA - UNNAMED HOT SPRING	HU	40N	24E	23		41.3597	119.2180	S	54	50		1950/06/13	MARINER AND OTHERS, 1974, 1975	
16	SOLDIER MEADOW AREA HOT SPRING	HU	40N	24E	23		41.3597	119.2180	S	48				GROSE AND KELLER, 1975B	
17	SOLDIER MEADOW 1	HU	40N	24E	23		41.3581	119.2178	S	54			1975/01/01	WATSTORE	
18	CANE SPRING	HU	39N	27E	30	NE	41.2580	118.9362	S	23.3	19			SINCLAIR, 1963A	
19	WEST PINTO HOT SPRING	HU					41.3592	118.8136	S	92			1974/01/01	WATSTORE	
20	EAST PINTO HOT SPRING	HU	40N	28E	17	NE SE SE	41.3625	118.7880	S	94				GROSE AND KELLER, 1975B	
21	WARM SPRING	W	37N	22E	35		41.0397	119.4688	S	warm				LEADVILLE 7.5' QUAD	
22	LEADVILLE SPRINGS	W	37N	23E			41.0827	119.3871	S	warm				SMITH, 1956	
23	CANE SPRINGS	HU	36N	24E	16	A	41.0133	119.2547	S	21			1961/12/12	WATSTORE	
24	WHEELER RANCH WELL	HU	37N	25E	10	SE	41.1150	119.1083	W	36.1			1965/09/21	SINCLAIR, 1963A	
25	DOUBLE HOT SPRING 2	HU	36N	26E	04		41.0492	119.0275	S	68.5			1975/01/01	WATSTORE	
26	UNNAMED SPRING (D.H.-2)	HU	36N	26E	16	SE NE	41.0150	119.0155	S	68.5			1938/08/24	GROSE AND KELLER, 1975B	
27	WW3922T1	HU	37N	24E			41.0733	119.1097	W	24.2	815.0		1979/12/13	WATSTORE	
28	TH SP HARDIN CITY SE QD	HU	37N	26E	10	DCA	41.1156	119.0008	S	50.8	101.9		1980/07/09	WATSTORE	
29	MACFARLANE'S BATH HOUSE SPRING	HU	37N	29E	31		41.0507	118.7188	S	76.5	18.9			SINCLAIR, 1963A	
32	SPRING	HU	42N	30E	12	A	41.5294	118.5686	S	40			1960/10/08	WATSTORE	
33	SPRING	HU	43N	30E	25	D	41.5675	118.5656	S	70			1960/10/08	WATSTORE	
34	UNNAMED SPRING	HU	42N	33E	19	SW SE	41.4922	118.3192	S	21.1	19		1957/05/16	SINCLAIR, 1962C	
35	U.S.G.S. TEST WELL NO. 21	HU	42N	33E	32	SE NE	41.4717	118.2847	W	24.4		27	1972/00/00	MALMBERG AND WORTS, 1966	
36	WELL	HU	42N	31E	11	B	41.5286	118.4769	W	24		107.3	1960/10/08	WATSTORE	
37	HOWARD HOT SPRING	HU	44N	31E	04	SE NE NE	41.7200	118.5033	S	57.8	189		1970/05/05	SINCLAIR, 1962C	
38	FIVE MILE SPRING	HU	45N	33E	21	SE NE SW	41.7625	118.2783	S	27			1975/08/21	TREXLER AND OTHERS, 1979	
39	SPRING	HU	44N	33E	10	BB	41.7053	118.2633	S	26			1959/06/22	WATSTORE	
40	JACKSON WELL	HU	39N	35E	07	DCDA	41.2614	118.0858	W	19.5			1961/02/26	WATSTORE	
41	SOD HOUSE RANCH WELL	HU	41N	35E	20	NE	41.4200	118.0633	W	27		34	1975/08/20	SINCLAIR, 1962A	
42	CORDERO MERCURY MINE, NORTH LOWER WELL	HU	47N	37E			41.9167	117.8000	W	53			1967/11/11	*WHITE, D., USGS, MENLO PARK	
43	MENTABERRYS WELL 1	HU	47N	37E	24	BAB	41.9478	117.7678	W	26.5		61.0	1976/04/23	WATSTORE	
44	NOQUE'S NEVADA WELL	HU	47N	38E	17	NE NE SE	41.9555	117.7200	W	33.3		214	1972/00/00	GARSIDE AND SCHILLING, 1979	
45	THE HOT SPRINGS	HU	41N	41E	19	NE NE	41.4208	117.3867	S	57.2	227			LOELTZ AND OTHERS, 1949	
46	THE HOT SPRING	HU	41N	41E	19	NE NE	41.4208	117.3867	S	58				MARINER AND OTHERS, 1974, 1975	
47	SPRING	HU	41N	43E			41.4364	117.1436	S	hot				WARING, 1965	
48	WELL	HU	37N	39E	03	DC	41.1047	117.5739	W	69		18.6	1962/04/28	WATSTORE	
49	SPRINGS	HU	45N	41E			41.7737	117.3452	S	hot				WARING, 1965	
50	UNNAMED SPRING	HU	36N	41E	02	SW NE NE	41.0300	117.3215	S	21.1	95		1950/00/00	COHEN, 1962	
51	SPRINGS	HU	37N	43E	24		41.0654	117.0762	S	warm	>757			ANCTIL, 1960	
52	WARM SPRING NEAR DEEP CREEK RESERVOIR	EL	43N	55E	19		41.6153	116.2979	S	warm				CORNACOPIA RIDGE 7.5' QUAD	
53	HOT LAKE	EL	38N	46E	25		41.1480	116.7343	S	hot				SQUAW VALLEY RANCH 7.5' QUAD	
54	SPRING	EL	39N	45E	36		41.2137	116.8440	S	hot				WARING, 1965	
55	SPRING, HEAD OF HOT CREEK	EL	38N	48E	11		41.1832	116.5014	S	?				WILLOW CREEK RESERVOIR 7.5' QUAD	
56	UNNAMED HOT SPRING	EL	39N	50E	18		41.2571	116.3666	S	47.2			1972/00/00	HOSE AND TAYLOR, 1974	
57	PETAINI (NIAGARA?) SPRINGS	EL	40N	53E	06		41.3837	116.0587	S	warm	5960			EAKIN, 1962B	
58	ELLISON RANCH SPRING	EL	41N	52E	08	NE	41.4667	116.1533	S	93	3.8		1971/12/30	*WHITE, D., USGS, MENLO PARK, CA	
59	HOT SULPHUR SPRINGS	EL	41N	52E	08	NE	41.4677	116.1480	S	90			1950/05/24	MARINER AND OTHERS, 1974, 1975	
60	UNNAMED HOT SPRING (SSE PATSVILLE)	EL	45N	54E	20		41.7758	115.9207	S	41				MARINER AND OTHERS, 1974, 1975	
61	WILD HORSE HOT SPRING	EL	43N	55E	04	SE SE	41.6472	115.7757	S	54				MARINER AND OTHERS, 1974, 1975	
62	ROWLAND HOT SPRINGS	EL	46N	56E	14	NW SW N	41.8787	115.6260	S	77	114		1957/05/17	*WHITE, D., USGS, MENLO PARK	
63	SPRING	EL	39N	53E	03		41.2980	115.9967	S	warm				MAHALA CREEK WEST 7.5' QUAD	
64	WARM SPRINGS	EL	37N	58E	26		41.0613	115.3936	S	warm				MORGAN HILL 7.5' QUAD	
65	UNNAMED SPRING	EL	38N	59E	14	SE SW SE	41.1800	115.2817	S	36			1962/06/26	TREXLER AND OTHERS, 1979	
66	UNNAMED WELL	EL	38N	59E	11	SW NE SW	41.1950	115.2850	W	30			1947/05/18	TREXLER AND OTHERS, 1979	
67	DEVIL'S PUNCH BOWL	EL	39N	59E	15	SE SW	41.2650	115.3050	S	52			1972/12/13	TREXLER AND OTHERS, 1979	
68	H.D. RANCH SPRING, HOT CREEK SPRINGS	EL	43N	60E	34	SE SW NW	41.5762	115.1808	S	64.4	2271		1946/04/09	WARING, 1965	
69	RAILROAD SPRING	EL	37N	62	29		41.0661	114.9904	S	warm				OESTERLING, 1960	
70	UNNAMED HOT SPRING NEAR WELLS	EL	38N	62E	17	SE NW NE	41.1818	114.9895	S	61				MARINER AND OTHERS, 1974B	HEAT PUMP
71	UNNAMED HOT SP NEAR WELLS	EL	38N	62E	17	A	41.1819	114.9894	S	55			1974/01/01	WATSTORE	

#	NAME	CO	T	R	SC	QSEC	NLAT	WLONG	T	TEMP	FLOW	DEPTH	CDATE	REFERENCE	USE
72	METROPOLIS (TWELVEMILE SPRINGS)	EL	39N	62E	27	NE NE	41.2450	114.9517	S	38.9	3038		1964/04/14	WARING, 1965	
73	WINE CUP RANCH WELL	EL	41N	64E	25	NW SE	41.4092	114.6742	W	58.9		20.7	1946/03/25	RUSH, 1968A	
74	PAN AMERICAN PETROLEUM-COBRE MINERALS WELL	EL	37N	67E	03	SW SE	41.1135	114.3842	W	76.7		1403		*NEVADA BUREAU OF MINES AND GEOLOGY	
75	GAMBLE RANCH WELL NO. 4	EL	40N	69E	16	SW	41.3433	114.1717	W	20		64		RUSH, 1968	
76	THOUSAND SPRINGS (GAMBLE RANCH SPRING)	EL	40N	69E	08	SE NW NW	41.3698	114.1917	S	20.6	5110			MIFFLIN, 1968	
77	HOT SPRING	EL	40N	69E	04		41.3862	114.1644	S	hot				TWELVEMILE RANCH 7.5' QUAD	
78	WELL	EL	45N	64E	20	ACB	41.7731	114.7506	W	54			1979/04/26	WATSTORE	
79	MINERAL HOT SPRINGS	EL	45N	64E	16		41.7882	114.7293	S	60			1966/10/13	MARINER AND OTHERS, 1974, 1975	
80	SAN JACINTO RANCH SPRING	EL	46N	64E	23	NW NW	41.8683	114.6950	S	26			1962/07/26	MOORE AND EAKIN, 1968	
81	MINERAL HOT SPRING	EL	45N	65E	08	BBA	41.7956	114.6258	S	60			1974/01/01	WATSTORE	
82	W.D. RANCHING CO. FLOWING WELL	EL	47N	65E	18	NW SW	41.9653	114.6418	W	37.8		188.4	1979/12/15	MOORE AND EAKIN, 1968	
83	WHEELER (Y3) RANCH WELL	EL	47N	65E	17	CBC	41.9586	114.6344	W	36		382.5	1977/12/07	WATSTORE	
84	WHEELER (Y3) RANCH WELL	EL	47N	65E	15	DCCD	41.9547	114.5856	W	43.5			1981/04/23	WATSTORE	(AQUACULTURE)
85	SHOSHONE WARM SPRINGS	EL	47N	65E	11	NE SW SW	41.9717	114.5783	S	35			1962/06/25	TREXLER AND OTHERS, 1979	
86	UNNAMED HOT SPRING	EL	47N	67E	09	SE NW	41.9800	114.3770	S	30			1960/10/07	HOSE AND TAYLOR, 1974	
87	TROUT CREEK RANCH WELL, GOOSE CREEK AREA	EL	46N	69E	15	NW NE	41.8823	114.1188	W	43.3		75	1912/09/23	MOORE AND EAKIN, 1968	
88	GOOSE CREEK AREA SPRING	EL	46N	69E	10	SE SW SE	41.8867	114.1200	S	33.9			1960/10/07	*WATSTORE	
89	TROUT CREEK RANCH WELL	EL	46N	69E	02	SW SE	41.9027	114.0995	W	21		75	1972/02/13	MOORE AND EAKIN, 1968	
90	NILE SPRING	EL	47N	70E	30	SW SW S	41.9283	114.0687	S	43				MARINER AND OTHERS, 1974, 1975	
91	HOT SPRING	HU	35N	43E	11		40.9202	117.1091	S	hot				HOT POT 7.5' QUAD	
92	NEW SPRING	W	34N	22E	18		40.8317	119.5317	S	29			1952/05/16	GROSE AND KELLER, 1975B	
93	POODLE SPRING	W	34N	22E			40.8244	119.4847	S	29			1975/01/01	WATSTORE	
94	spring	WA					40.6711	119.6174	S	29.4			1975/	LAWRENCE LIVERMORE LABORATORY, 1976	
95	BUFFALO SPRING	W	31N	20E	06		40.5932	119.7742	S	warm				WARING, 1965	
96	BUCKBRUSH SPRING	W	29N	19E	11		40.3960	119.8250	S	warm				WARING, 1965	
97	JACK BONHAM RANCH WELL	W	28N	19E	12	NE	40.3150	119.7933	S	23			1963/04/16	GLANCY AND RUSH, 1968	
98.1	FISH SPRING	W	26N	19E	19	SE SE	40.1008	119.8850	S	23			1952/09/18	RUSH AND GLANCY, 1967	
98.2	Fish Spring	WA					40.1024	119.8836	S	21			1975/	LAWRENCE LIVERMORE LABORATORY, 1976	
99	THE NEEDLES - WESTERN GEOTHERMAL WELL	WA					40.1500	119.6750	W	115.5				*WHITE, D., USGS, MENLO PARK	
100	THE NEEDLES	WA					40.1460	119.6748	S	56				MARINER AND OTHERS, 1974, 1975	
101	SEVENMILE SPRING	W	25N	23E	10	BCD	40.0483	119.3875	S	18			1969/07/30	WATSTORE	
102	SPRING	W	26N	23E	10	DBA	40.1344	119.3789	S	18.5			1969/07/30	WATSTORE	
103	SPRING	W	27N	22E	16	ADA	40.2161	119.5056	S	25			1969/08/22	WATSTORE	
104	LOWER STONEHOUSE SPRING	PE	27N	25E	08	DD	40.2178	119.1997	S	28			1969/09/03	WATSTORE	
105.1	Amor II well 43-21	W	29N	23E	21		40.3692	119.4039	W	135		85.4		*NEVADA BUREAU OF MINES AND GEOLOGY	ELECTRIC POWER
105.2	Amor II well 43-21	W	29N	23E	21		40.3692	119.4039	W	135		85.4		*NEVADA BUREAU OF MINES AND GEOLOGY	ELECTRIC POWER
106	SAN EMIDIO DESERT - UNNAMED HOT SPRING	W	29N	23E	09,16		40.3917	119.4067	S	79	30		1956/02/22	MARINER AND OTHERS, 1976A	VEGETABLE DRYING
107	GERLACH AREA - GREAT BOILING SPRING (GERLACH HOT S	W	32N	23E	15	NW	40.6600	119.3633	S	86				MARINER AND OTHERS, 1974, 1975	SPA
108	UNNAMED HOT SPRING NEAR GREAT BOILING SPRING	W	32N	23E	10	SW NW	40.6650	119.3667	S	89.5	100			MARINER AND OTHERS, 1976A	
109	GREAT BOILING SP ORIF 46	WA					40.6608	119.3650	S	88.6	390.5		1980/01/28	WATSTORE	
110	BOWEN	W	33N	23E	23	C	40.7226	119.3443	S	26			1975/01/01	WATSTORE	
111	GRANITE CREEK RANCH WELL	W	34N	23E	34	A	40.7939	119.3342	W	26			1961/12/13	WATSTORE	
112	WELL	PE	33N	25E	10	B	40.7447	119.1731	W	33.5			1961/06/12	WATSTORE	
113	UNNAMED HOT SPRING NEAR TREGO	PE					40.7667	119.1167	S	84.5	150			MARINER AND OTHERS, 1976A	
114	FLY RANCH (WARDS HOT SPRING) - WELL	W	34N	23E	02		40.8633	119.3417	W	80	500		1968/06/00	MARINER AND OTHERS, 1974, 1975	
115	HUALAPAI FLAT SPRING 16	W	34N	23E	01		40.8606	119.3181	S	94			1975/01/01	WATSTORE	
116	BLACK ROCK HOT SPRINGS	HU	36N	26E	34	NW NW	40.9700	119.0100	S	57.8	715		1972/03/29	SINCLAIR, 1963A	
117	BACH WELL	PE	29N	29E	06	D	40.4056	118.7675	W	20.5			1961/09/14	WATSTORE	
118	PORTER SPRING	PE	29N	28E	05	B	40.4178	118.8678	S	18			1969/11/20	WATSTORE	
119	COLADO WELL NO. 1	PE	28N	32E	33	SE	40.2450	118.3850	W	60			1966/05/23	*MARINER, R., USGS, MENLO PARK	
120	SOUTHWEST DREDGING CO. WELL	PE	29N	34E	34	SE	40.3367	118.1367	W	24	8	42	1957/02/05	LOELTZ AND PHOENIX, 1955	
121	DRILL HOLE	PE	25N	35E	01		40.0613	117.9977	W	hot				GARSIDE AND SCHILLING, 1979	
122	HYDER (HYDRA) HOT SPRINGS	PE	25N	38E	28	SW	40.0033	117.7167	S	78	102		1962/07/31	MARINER AND OTHERS, 1976A	
123	SOU HOT SPRINGS (GILBERTS HOT SPRINGS)	PE	26N	38E	29	SE	40.0895	117.7247	S	73				MARINER AND OTHERS, 1974, 1975	
124	UNNAMED SPRING	PE	25N	39E	19	NW	40.0267	117.6483	S	28	189			COHEN AND EVERETT, 1963	
125	UNNAMED HOT SPRING (LOWER RANCH)	PE	25N	39E	16	NW	40.0350	117.6033	S	40			1952/09/16	MARINER AND OTHERS, 1974B	
126	SPRING, J.S. RANCH (McCOY)	PE	26N	39E	33	SW	40.0767	117.6000	S	48.3	2536		1980/06/04	COHEN AND EVERETT, 1963	
127	JERSEY VALLEY AREA - UNNAMED HOT SPRING	PE	27N	40E	28	SW	40.1790	117.4900	S	29	20		1957/05/13	MARINER AND OTHERS, 1974, 1975	
128	PARIS WELL	PE	27N	38E	02	NW	40.2450	117.6783	W	22	38	116	1963/01/07	COHEN AND EVERETT, 1963	
129	J.S. RANCH WELL	CH	26N	39E	29	D	40.0853	117.6099	W	21		32.6	1963/07/23	WATSTORE	
130	KYLE HOT SPRINGS	PE	29N	36E	12	NW NW	40.4083	117.8850	S	95.6				SANDERS AND MILES, 1974	
131	HOTTEST KYLE HOT SPRINGS	PE	29N	36E	01	C	40.4069	117.8831	S	66			1977/05/08	WATSTORE	
132	COYOTE SPRING	PE	30N	39E	30	DDD	40.4181	117.6397	S	22			1977/01/01	WATSTORE	
133	BUFFALO SPRINGS	PE	29N	41E	06	NE SW NW	40.4172	117.4158	S	65			1963/	WOLLENBERG AND OTHERS, 1977	
134	BUFFALO VALLEY HOT SPRINGS	LA	29N	41E	23	SE	40.3670	117.3255	S	65.5	7.6		1962/03/10	*WHITE, D., USGS, MENLO PARK	
135	QH3D WELL	PE	31N	38E	14	ABC	40.5617	117.6683	W	58.1		409.0	1978/09/15	WATSTORE	
136	SPRING SW GRASS VALLEY	PE	31N	38E	09	B	40.5658	117.7256	S	20			1977/01/01	WATSTORE	
137	LEACH HOT SPRINGS	PE	32N	38E	36	SE	40.6037	117.6457	S	92	200			MARINER AND OTHERS, 1974, 1975	
138	DH 13A ORIFICE	PE	32N	38E	36	DAA	40.6036	117.6456	W	52.5		52.1	1978/08/23	WATSTORE	

#	NAME	CO	T	R	SC	QSEC	NLAT	WLONG	T	TEMP	FLOW	DEPTH	CDATE	REFERENCE	USE
139	NORTHERN EAST RANGE AREA	HU	35N	36E	28	NE NW NE	40.8850	117.9383	S	27.8				COHEN, 1963	
140	SPRING	PE	30N	33E	20		40.4508	118.2934	S	warm				CROFUTT, 1872	
141	HUMBOLDT (RYE PATCH) AREA - PHILLIPS PETROL. CAMPB	PE	31N	33E	21	SE	40.5350	118.2683	W	162.8		565	1970/09/01	GARSIDE AND SCHILLING, 1979	
142	Florida Canyon Mine well	PE	31N	33E	03		40.5833	118.2542	W	114.4				Trexler and others, 1990	HEAP LEACHING
143.1	SPRINGS	PE	33N	35E			40.7050	118.0553	S	warm				WARING, 1965	
143.2	BLUE MOUNTAIN DRILL HOLE	HU	36N	34E	23	C	40.9805	118.1292	W	87.8	227.1	137	1986/	PARR AND PERCIVAL, 1991	
144	CALIFORNIA PACIFIC UTILITIES CO. WELL	HU	36N	38E	30	NE SW SE	40.9600	117.7433	W	22.8		151	1970/10/07	COHEN, 1962	
145	UNNAMED SPRING	HU	36N	37E	13	SE NE SW	40.9928	117.7620	S	33.9			1954/10/05	COHEN, 1962	
146	BLM WELL	HU	36N	38E	26	SW NE SE	40.9642	117.6612	W	22.8		16.8		COHEN, 1962	
147	UNNAMED HOT SPRING NEAR GOLCONDA	HU	36N	40E	29	SW SW SE	40.9610	117.4938	S	74	750			MARINER AND OTHERS, 1974, 1975	
148	GOLCONDA TUNGSTEN MINE DRILL HOLE 302	HU	36N	40E	36	SW	40.9497	117.4238	W	61.7		78.6		GARSIDE AND SCHILLING, 1979	
149	UNNAMED HOT SPRING	HU	33N	40E	05	SE	40.7617	117.4922	S	85	100			MARINER AND OTHERS, 1974, 1975	
150	SULPHUR SPRING	PE	35N	41E	34		40.8643	117.3491	S	hot				KERR, 1940	
151	BROOKS SPRING	HU	34N	41E	13	NE NW NE	40.8317	117.3067	S	34			1962/07/15	TREXLER AND OTHERS, 1979	
152	HOT POT SPRING	HU	35N	43E	10	NE NE SE	40.9228	117.1100	S	58			1912/11/16	MARINER AND OTHERS, 1974, 1975	
153	MOUND SPRING	LA	28N	44E	07		40.3125	117.0695	S	32			1950/01/05	*WHITE, D., USGS, MENLO PARK	
154	UNN HOT SP VLLY OF MOON	LA	27N	43E	23	BCC	40.1911	117.1056	S	53			1974/01/01	WATSTORE	
155	IZZENHOOD RANCH SPRING	LA	35N	45E	10	SW NE NW	40.9287	116.8953	S	31			1962/07/05	TREXLER AND OTHERS, 1979	
156	DEE 3 WELL	EL	36N	49E	03	CDD	41.0194	116.4247	W	45			1990/08/27	WATSTORE	
157	BW2 WELL	EU	36N	50E	19	BCC	40.9831	116.3739	W	51.5		402.3	1990/08/29	WATSTORE	
158	BRAHMA SPRING	EU	35N	51E	30	DDCB	40.8872	116.2794	S	18.5			1990/08/30	WATSTORE	
159	NEWMONT WELL MC2	EU	34N	51E	26	DDD	40.7981	116.2017	W	31.5			1989/04/11	WATSTORE	
160	UNNAMED SPRING	EL	33N	53E	08	NW	40.7642	116.0408	S	64			1970/10/07	TREXLER AND OTHERS, 1979	
161	UNNAMED SPRINGS NEAR CARLIN	EL	33N	52E	33	SE SW	40.6972	116.1333	S	79			1950/05/24	MARINER AND OTHERS, 1974, 1975	(SPACE HEATING)
162	TYROL SPRING	EL	32N	52E	05	CDBA	40.6844	116.1539	S	22			1990/06/13	WATSTORE	
163	SPRING	EU	31N	52E	07		40.5892	116.1515	S	warm				BRADBURY AND ASSOCIATES, 1964	
164	MACK CREEK FARM WELL	EU	33N	49E	10	ACDD	40.7494	116.4283	W	26		172.2	1990/08/24	WATSTORE	
165	WHITE ROCK SPRINGS	LA	33N	47E	08		40.7493	116.7011	S	warm				WARING, 1965	
166	HOT SPRING	LA	32N	46E	06		40.6745	116.8415	S	hot				STONY POINT	
167	BATTLE MOUNTAIN CITY WELL	LA	32N	45E	17	SW SW	40.6463	116.9342	W	23.3	946	221	1970/09/01	SCOTT AND BARKER, 1962	
168	BEOWAWE - SPRING 51	EU	31N	48E	17	N 1/2	40.5583	116.5833	S	96	283.9			*WHITE, DONALD, U.S.G.S.	ELECTRIC POWER
169	BEOWAWE HOT SPRING	EU	31N	48E	08	SE	40.5667	116.5667	S	98	100			MARINER AND OTHERS, 1974B, 1975	
170	HORSESHOE RANCH HOT SPRINGS	EU	32N	49E	33	SW	40.6017	116.4600	S	58	3.8		1967/11/10	ROBERTS AND OTHERS, 1967	
171	HOT SPRINGS POINT	EU	29N	48E	11	NE NE	40.4035	116.5167	S	54	125		1948/10/21	MARINER AND OTHERS, 1974, 1975	
172	HOT SPRINGS POINT	EU	29N	48E	11	NE NE	40.4033	116.5167	S	60			1974/06/05	*WHITE, DONALD, U.S.G.S.	
173	SPRING	EU	28N	49E	10	NW NW N	40.3150	116.4317	S	85.5	9.5		1966/00/00	GARSIDE AND SCHILLING, 1979	
174	CARLOTTI RANCH SPRING, SULFUR SPRING	EL	28N	52E	24	SE	40.2900	116.0500	S	39	378.5			WARING, 1965	
175	HOT CREEK SPRINGS AREA	EU	28N	52E	12	NW	40.3283	116.0717	S	26.1	6000		1972/00/00	MARINER AND OTHERS, 1974B	
176	BRUFFEY'S HOT SPRINGS	EU	27N	52E	14	NE SE	40.2192	116.0683	S	65.5	189		1964/07/16	ROBERTS AND OTHERS, 1967	
177	FLYNN RANCH SPRINGS	EU	25N	53E	06		40.0792	116.0350	S	26	38		1972/00/00	WARING, 1965	
178	Elko Heat Company Well	EL					40.825	115.775	W	80			1989/	Flynn and Buchanan, 1990	SPACE HEATING
179	HOT HOLE (ELKO HOT SPRINGS)	EL	34N	55E	21	NE	40.8185	115.7755	S	56	75		1950/05/24	MARINER AND OTHERS, 1974, 1975	
180	WARM SPRING	EL	34N	59E	31		40.7824	115.3828	S	warm				SOLDIER PEAK 7.5' QUAD	
181	SULPHUR HOT SPRINGS (HOT SULPHUR SPRINGS)	EL	31N	59E	11	NE NW	40.5867	115.2847	S	93	75		1974?	MARINER AND OTHERS, 1974, 1975	
182	UNNAMED HOT SPRING NEAR RUBY MARSH	EL	27N	58E	02	NW	40.2500	115.4010	S	65			1949/09/08	MARINER AND OTHERS, 1974, 1975	
183	UNNAMED SPRING	LA	26N	45E	15	NE	40.1275	116.8853	S	22.2				EVERETT AND RUSH, 1966	
184	UNNAMED HOT SPRING (VALLEY OF THE MOON)	LA	27N	43E	23	NE	40.1987	117.1008	S	53			1980/05/25	MARINER AND OTHERS, 1974, 1975	
185	UNNAMED HOT POOL	LA	27N	45E	25		40.1833	116.8617	S	50			1967/03/10	*WHITE, D., USGS, MENLO PARK	
186	UNNAMED SPRING	LA	27N	46E	28?	NW	40.1867	116.8042	S	22.2			1975/08/00	EVERETT AND RUSH, 1966	
187	Warm spring at Warm Creek Ranch	EL	33N	61E	12		40.7505	115.0354	S	warm	7570			Eakin and others,1951	
188	UNNAMED SPRING NEAR WARM SPRINGS RANCH	EL	35N	64E	04.	NW NE N	40.9517	114.7500	S	30	189		1964/10/23	*WILSON, 1960	
189	JOHNSON RANCH (BIG SPRINGS)	EL	36N	66E	28	SW SW SE	40.9708	114.5067	S	22.7	113.6		1949/10/12	WARING, 1965	
190	COLLAR AND ELBOW SPRING	W	26N	65E	33		40.0835	114.6343	S	22			1940/11/03	*NEVADA BUREAU OF MINES AND GEOLOGY	
191	THE NEEDLE ROCKS - ANAHO ISLAND SPRING	W	24N	22E	16		39.9483	119.5100	W	48.9			1979/10/15	WARING, 1965	
192	THE PYRAMID HOT SPRING	W	24N	22E	03		39.9803	119.5012	S	warm				*GARSIDE, L., NBMG	
193	WARM SPRINGS	W	23N	20E	22		39.8462	119.7161	S	68.3				*GARSIDE, L., NBMG	
194	MCCULLOCH CORP. WELL	W	22N	21E	07	SE NW	39.7900	119.6667	W	43.3			1962/03/21	*DESERT RESEARCH INSTITUTE, 1973	
195	COTTONWOOD SPRING	W	23N	21E	26		39.8327	119.5917	S	warm				WARING, 1965	
196	GEOTHERMAL WELL	CH	23N	26E	13		39.8575	119.0118	W					HOT SPRINGS FLAT 7.5' QUAD	
197	SPRING	CH	22N	26E	11	ADA	39.7883	119.0233	S	58	0.0		1981/02/20	WATSTORE	
198	Bradys Hot Springs	CH					39.787	119.012	W	141			1989/	Flynn and Buchanan, 1990	VEGETABLE DRYING
199	BRADY HOT SPRINGS	CH	22N	26E	12	NE NE SW	39.7883	119.0167	S	94			1966/00/00	*WHITE, D., USGS, MENLO PARK	
200	Eagle Salt Works Spring	CH	22N	36E	35		39.7301	119.0387	S					Adams, 1944	
201	HAZEN AREA (PATUA HOT SPRINGS)	LY	20N	26E	18	SW	39.5967	119.1033	S	86.1			1966/11/12	MARINER AND OTHERS, 1975	
202	Patua Hot Spring	LY					39.597	119.113	S	86			1989/	Flynn and Buchanan, 1990	
203	UNNAMED WELL	W	19N	18E	17		39.5150	119.9850	W	26		10	1978/08/17	DESERT RESEARCH INSTITUTE, 1973	
204	LAWTON HOT SPRINGS	W	19N	18E	13	SW NE	39.5150	119.9017	S	48.9				COHEN AND LOELTZ, 1964	(SPA)
205	MOANA AREA - PEPPER MILL MOTEL	W	19N	19E	24	NE NW	39.5017	119.7983	W	47.2			1957/05/15	BATEMAN AND SCHEIBACH, 1975	SPACE HEATING
206	Warren Estates #1 Well	WA					39.481	119.825	W	88			1989/	Flynn and Buchanan, 1990	SPACE HEATING

#	NAME	CO	T	R	SC	QSEC	NLAT	WLONG	T	TEMP	FLOW	DEPTH	CDATE	REFERENCE	USE
207	MOANA AREA - MOORE WELL	W	19N	19E	26	NE SE	39.4817	119.8100	W	80		60		BATEMAN AND SCHEIBACH, 1975	SPACE HEATING, POOL
208	Steamboat/Ormat Well	WA					39.395	119.715	W	113			1989/	Flynn and Buchanan, 1990	ELECTRIC POWER
209	WELL	W	18N	20E	34		39.3817	119.7233	W	30		36		BATEMAN AND SCHEIBACH, 1975	SPACE HEATING
210	STEAMBOAT SPRINGS - SPRING 25	W	18N	20E	33	NE	39.3833	119.7333	S	94	50		1970/09/01	MARINER AND OTHERS, 1974, 1975	
211	UNNAMED WELL	W	17N	20E	07	SE	39.3500	119.7717	W	24		31		GARSIDE AND SCHILLING, 1979	
212	SPRING 9	ST	18N	21E	15	CABD	39.4258	119.6111	S	19	1.7		1970/10/01	WATSTORE	
213	BOWERS MANSION (FRANKTOWN) HOT SPRING - MAIN SPRIN	W	16N	19E	03	NW	39.2833	119.8367	S	47.2	644		1974/02/04	WHITE AND OTHERS, 1963	SWIMMING POOL
214	UNNAMED WELL	W	16N	20E	06		39.2750	119.7800	W	26		24	1974/00/00	*DESERT RESEARCH INSTITUTE, 1973	
215	COMSTOCK MINING DISTRICT-NEW YELLOW JACKET SHAFT	ST	17N	21E	32	SW SE	39.2900	119.6467	W	76.7		914	1964/06/05	BECKER, 1882	
216	SPRING 6	ST	17N	21E	14	DCBC	39.3342	119.5914	S	21	5.1		1970/09/30	WATSTORE	
217	SUTRO TUNNEL	LY	16N	21E	02	NE NE SE	39.2750	119.5850	S	27.2			1950/04/26	GLANCY AND KATZER, 1975	
218	UNNAMED	LY	16N	22E	07	NW SE NW	39.2683	119.5600	W	26.7		31	1953/05/11	GLANCY AND KATZER, 1975	
219	CARSON CITY WELL NO 7	CC	15N	20E	06	DAAC	39.1925	119.7714	W	28		138.7	1988/05/25	WATSTORE	
220	CARSON CITY WELL NO 4	CC	15N	20E	17	DDDA	39.1592	119.7517	W	27		184.1	1988/09/08	WATSTORE	
221	NOBLE MURRAY WELL	CC	15N	20E	23		39.1433	119.6983	W	41				*NEVADA BUREAU OF MINES AND GEOLOGY	SPACE HEATING
222	CARSON HOT SPRING	CC	15N	20E	05	SE NE	39.1917	119.7517	S	50			1921/11/00	*NEVADA BUREAU OF MINES AND GEOLOGY	SPA, POOL
223	SARATOGA HOT SPRING	CC	14N	20E	21	SW SE	39.0567	119.7400	S	50			1958/01/27	*NEVADA BUREAU OF MINES AND GEOLOGY	
224	WETLANDS, WARM WELL	DG	14N	20E	20	DAA	39.0619	119.7514	W	40		7.9	1983/08/26	WATSTORE	
225	HOBO HOT SPRINGS	DG	14N	19E	23	SE SE	39.0550	119.8083	S	46	473		1929/02/24	GLANCY AND KATZER, 1975	(AQUACULTURE)
226	HASTIE WELL	DG	13N	20E	02	CBB	39.0183	119.7119	W	21		53.6	1986/05/20	WATSTORE	
227	UNNAMED WELL	LY	14N	23E	25		39.0500	119.3667	W	27.7	1533	165	1979/11/15	SCOTT AND BARKER, 1962	
228	NEVADA STATE PRISON SPRING	CC	15N	20E	16	SE SE	39.1600	119.7350	S	24			1967/07/25	*NEVADA BUREAU OF MINES AND GEOLOGY	(AQUACULTRUE)
229	WABUSKA AREA	LY	15N	25E	28	SE NE	39.1367	119.1817	W	30	57	305	1953/05/11	HUXEL, 1969	(ETHANOL PRODUCTION)
230	WABUSKA HOT SPRINGS	LY	15N	25E	16	SE	39.1615	119.1827	S	97			1958/04/25	MARINER AND OTHERS, 1974, 1975	(AQUACULTURE)
231	WABUSKA HOT SPRINGS - MAGMA POWER CO. NO. CB 1 WEL	LY	15N	25E	15	NW SW	39.1617	119.1767	W	97.2	5731	149	1965/11/02	HUXEL, 1969	ELECTRIC POWER
232	DE WELL	CH	22N	27E	21	AACD	39.7642	118.9478	W	163			1987/07/09	WATSTORE	
233	Desert Peak 86-21 Well	CH					39.758	118.946	W	159			1989/	Flynn and Buchanan, 1990	ELECTRIC POWER
234	CHURCHILL DRILLING CORP. TCID No. 1 WELL	CH	22N	30E	15		39.7791	118.6023	W	hot				GARSIDE AND SCHILLING, 1979	
235	USBM HEAT FLOW HOLE	CH	22N	31E	10		39.7918	118.4905	W	25.0		153		OLMSTED AND OTHERS, 1975	
236	DIXIE COMSTOCK MINE	CH	23N	35E	14		39.8661	118.0165	M	hot				VANDERBURG, 1940	
237	DIXIE HOT SPRINGS	CH	22N	35E	05	SE	39.7977	118.0673	S	72	200			MARINER AND OTHERS, 1974, 1975	
238	KENNAMETALS WELL	CH	20N	28E	01	ABB	39.6350	118.7889	W	36		191.1	1978/12/12	WATSTORE	
239	CDDH-48A-USGS	CH	21N	29E	30	DDC	39.6494	118.7603	W	26.3		31.4	1978/11/06	WATSTORE	
240	SHALLOW RESEARCH WELL (SODA LAKE), 4	CH	20N	28E	28	SW	39.5633	118.8533	W	100			1958/05/25	MARINER AND OTHERS, 1975	
241	Soda Lake 33-14 Well	CH					39.564	118.859	W	183			1989/	Flynn and Buchanan, 1990	ELECTRIC POWER
242	CDDH-41A	CH	20N	28E	14	DCC	39.5919	118.8064	W	21		125.0	1976/05/20	WATSTORE	
243	USGS CDR-21	CH	18N	28E	12	ABAC	39.4450	118.7858	W	22.5		4.6	1988/07/12	WATSTORE	
244	INDIAN HEALTH SERVICE WELL	CH	19N	29E	29	BACB	39.4853	118.7603	W	20.5		20.7	1989/03/01	WATSTORE	
245	FLOWING WELL IN STILLWATER	CH	19N	31E	07	SW	39.5215	118.5522	W	96			1967/01/18	MARINER AND OTHERS, 1974, 1975	
246	CDD-117A	CH	19N	31E	07	DCD	39.5211	118.5461	W	67		19.8	1978/04/19	WATSTORE	
247	CDPW-44A	CH	19N	30E	06	BCB	39.5433	118.5547	W	93.7		56.7	1978/04/21	WATSTORE	
248	USFWS WELL 3 NR EAST CAN	CH	20N	32E	20	CAC	39.5825	118.4183	W	25	271.7	213.4	1989/04/03	WATSTORE	
249	DR-SW-LY-9-L1	CH	17N	29E	06	BCAD	39.3686	118.7767	W	25.5		0.6	1985/08/20	WATSTORE	
250	CARSON LAKE CORRAL	CH	16N	30E	07	BACB	39.3561	118.6642	S	77			1987/07/08	WATSTORE	
251	EIGHTMILE FLAT, BORAX SPRING	CH	17N	30E	14	NE	39.3417	118.5783	S	81.1				WARING, 1965	
252	GEOTEHRMAL WELL	CH	17N	30E	36		39.2935	118.5723	W	160.0		2000		EDMISTON AND BENOIT, 1984	
253	SPRING	CH	16N	32E	06		39.2786	118.4332	S	hot				WARING, 1965	
254	LEE HOT SPRINGS	CH	16N	29E	34	SW NW	39.2092	118.7232	S	88	128		1966/11/00	MARINER AND OTHERS, 1974, 1975	
255	E.H. STARK WELL	CH	21N	34E	36	SW	39.6392	118.1083	W	22.8	3785	61	1973/03/00	COHEN AND EVERETT, 1963	
256	HATTON WELL NO. 1	CH	21N	35E	20	NE	39.6767	118.0617	W	21.7	151	49	1971/08/09	SDESERT AT COLD SPRING	
257	Stinking Spring	CH	15N	29	10	SW	39.1739	118.7333	S	28				Katzenstein and Dantl, 1982	
258	Oxbow Geothermal Corp. No. 52-18	CH					39.9537	117.8597	W	231		3007		*NEVADA BUREAU OF MINES AND GEOLOGY	ELECTRIC POWER
259	JAMES LITSTER WELL	LA	24N	43E	27	SW	39.9200	117.1250	W	38.9		4.6	1918/	WARING, 1918	
260	spring	LY	18N	25E	17	NW SE	39.4234	119.1997	S	34	4			*GARSIDE, L., NBMG	
261	TOM ORMECHEA WELL	CH	20N	38E	06	SE	39.6233	117.7400	W	24.4	189	31	1966/11/21	EVERETT, 1964	
262	SMITH CREEK VALLEY WELL	LA	20N	40E	36	NW	39.5588	117.4276	W	29.4			1971/12/00	EVERETT AND RUSH, 1964	
263	UNNAMED HOT SPRING	LA	17N	39E	11		39.3500	117.5583	S	86	75		1969/04/00	MARINER AND OTHERS, 1974, 1975	
264.1	TWIN SPRING	LA	18N	39E	27		39.3961	117.5791	S	warm				WARING, 1965	
264.2	MCLEOD 88 SPRING	NY	14N	43E	34		39.0283	117.1367	S	87.9				*NEVADA BUREAU OF MINES AND GEOLOGY	
265.1	UNNAMED SPRING	LA	17N	39E	25	NE NW N	39.3162	117.5467	S	92			1959/03/15	TREXLER AND OTHERS, 1979	
265.2	LITTLE HOT SPRINGS	LA	23N	47E	02		39.8937	116.6481	S	hot				LITTLE HOT SPRINGS 7.5' QUAD	
266	HOT SPRINGS	LA	24N	47E	15		39.9420	116.6814	S	hot				WARING, 1965	
267	WALTI HOT SPRINGS	EU	24N	48E	33	SW	39.9017	116.5870	S	72	300		1961/08/10	MARINER AND OTHERS, 1974, 1975	
268	SHIPLEY HOT SPRINGS	EU	24N	52E	23	SE	39.9417	116.0733	S	32.2	25500			EAKIN, 1062A	
269.1	SIRI RANCH SPRING, (WATER WELL)	EU	24N	53E	06	SW NE	39.9917	116.0450	W	35			1958/02/11	HARRILL, 1968	
269.2	SULFUR SPRINGS AREA	EU	23N	52E	36	NW	39.8350	116.0662	S	23.3	75.7			WARING, 1965	
270	BARTINE HOT SPRINGS	EU	19N	50E	05	NE NE	39.5583	116.3617	S	44.3			1945/08/24	*NEVADA BUREAU OF MINES AND GEOLOGY	
271	BARTINE RANCH WATER WELL NO. 4	EU	19N	50E	17	NE	39.5233	116.3605	W	46.7	124.9	147.8		GARSIDE AND SCHILLING, 1979	
272	WARM SPRING	EU	19N	50E	18		39.5282	116.3885	S	warm				BEAN FLAT EAST 7.5' QUAD	

#	NAME	CO	T	R	SC	QSEC	NLAT	WLONG	T	TEMP	FLOW	DEPTH	CDATE	REFERENCE	USE
273	BARTHOLOMAE CORP. WATER WELL	EU	18N	51E	18	SW	39.4367	116.2792	W	23.3	53	204	1972/00/00	RUSH AND EVERETT, 1964	
274	BARTHOLOMAE CORP. WATER WELL	EU	18N	51E	30	NW	39.4133	116.2758	W	22.2	757		1972/00/00	RUSH AND EVERETT, 1964	
275	BARTHOLOMAE HOT SPRINGS	EU	18N	50E	28	SE	39.4053	116.3463	S	54			1958/01/27	MARINER AND OTHERS, 1974, 1975	
276	UNNAMED WELL	LA	18N	47E	08	SW	39.4126	116.6960	W	21.7			1975/08/00	RUSH AND EVERETT, 1964	
277	MONITOR VALLEY WELL	LA	18N	47E	20	SE NE	39.3881	116.6894	W	21.7			1973/10/12	RUSH AND EVERETT, 1964	
278	SPENCER HOT SPRINGS	LA	17N	45.5E	11	NE NE	39.3269	116.8567	S	72	50		1962/04/28	MARINER AND OTHERS, 1974, 1975	
279	UNNAMED WELL	LA	16N	44E	24	NW	39.2375	116.9880	W	28.9	22.7	36.6	1971/07/10	FIERO, 1968	
280	POTT'S RANCH HOT SPRING	NY	14N	47E	02	NE	39.0783	116.6400	S	45	125		1972/00/00	MARINER AND OTHERS, 1974, 1975	
281	DIANA'S PUNCH BOWL	NY	14N	47E	22	SE	39.0283	116.6667	S	59			1972/00/00	MARINER AND OTHERS, 1974, 1975	
282	FISH CREEK SPRINGS	EU	16N	53E	08	BCBB	39.2769	116.0383	S	19	15129.0		1981/07/17	WATSTORE	
283	THOMPSON RANCH SPRING	EU	23N	54E	03	DBD	39.9008	115.8678	S	21	3600.0		1981/07/14	WATSTORE	
284	WARM SPRINGS RANCH	W	22N	56E	01	NE NE	39.8117	115.6083	S	22.6			1974/02/20	*NEVADA BUREAU OF MINES AND GEOLOGY	
285	WELL AT ALLIGATOR RIDGE	W	22N	57E	25	CCCC	39.7408	115.5119	W	34		200.9	1984/04/24	WATSTORE	
286	BIG BLUE SPRING	W	14N	56E	23		39.0627	115.6412	S	warm				WARING, 1965	
287	UNN HOT SP CHERRY CREEK	W	23N	63E	06		39.8950	114.8908	S	61			1974/01/01	WATSTORE	
288	SHELL OIL CO. STEPTOE UNIT NO.1 WELL	W	24N	64E	19	NE NE	39.9433	114.7717	W	151.1		2562		GARSIDE AND SCHILLING, 1979	
289	UNNAMED SPRING	W	24N	65E	31	NE	39.9168	114.6600	S	28	1703			SNYDER, 1963	
290	BORCHERT JOHN (WARM) SPRING	WP					39.7778	114.8497	S	18			1978/08/25	WATSTORE	
291	SHELLBOURNE SPRINGS	W	22N	64E	12		39.7933	114.6883	S	24.6			1972/00/00	*NEVADA BUREAU OF MINES AND GEOLOGY	
292	UPPER SHELLBOURNE SPRING	W	22N	65E	08	SE NW	39.8000	114.6550	S	25	1703		1964/06/28	MIFFLIN, 1968	
293	WELL	W	23N	66E	31	AB	39.8303	114.5550	W	28.2			1983/07/27	WATSTORE	
294	MELVIN HOT SPRING (MONTE NEVA)	W	21N	63E	24		39.6667	114.8050	S	79				CLARK AND OTHERS, 1920	
295	SPRING, KERN MOUNTAINS	W	21N	70E			39.6891	114.0809	S	warm				WARING, 1965	
296	STEPTOE WARM SPRING	WP					39.5386	114.9144	S	24			1978/08/25	WATSTORE	
297	MCGILL WARM SPRINGS	W	18N	64E	21	SE NW	39.4150	114.7800	S	29	17034		1945/08/14	CLARK AND OTHERS, 1920	SWIMMING POOL
298	SCHOOLHOUSE SPRING	W	18N	65E	03	DA	39.4537	114.7559	S	26	17320.0		1981/07/15	WATSTORE	
299	ELY-LACKAWANNA ZONE - LACKAWANNA HOT SPRINGS	W	16N	63E	03	NE	39.2850	114.8633	S	35				EAKIN AND OTHERS, 1967	
300	ELY WARM SPRINGS	W	16N	63E	10		39.2683	114.8667	S	29	83		1975/00/00	CLARK AND OTHERS, 1920	
301	WALLEYS HOT SPRINGS (GENOA HOT SPRINGS)	DG	13N	19E	22	SW NW NE	38.9812	119.8325	S	61	75			MARINER AND OTHERS, 1974, 1975	SPA
302	WALLEYS HOT SPRING	DG	13N	19E	22	SW NW NE	38.9812	119.8325	S	63	57		1934/02/07	*WHITE, D., USGS, MENLO PARK	
303	BENSON SPRING - SOUTH OR	DG	12N	19E	26	ACC	38.8747	119.8139	S	22			1981/06/10	WATSTORE	
304	DOUD SPRING	DG	11N	21E	20	SE SW	38.7950	119.6533	S	21.1	681.3		1962/07/23	GLANCY AND KATZER, 1975	
305	NEVADA HOT SPRINGS	LY	12N	23E	16	SE	38.8995	119.4117	S	61	200		1970/07/01	MARINER AND OTHERS, 1974, 1974	
306	AMBASSADOR WELL, ARTESIA LAKE AREA	LY	13N	23E	25	NW SW	38.9567	119.3617	W	27.8		165	1949/08/09	SCOTT AND BARKER, 1962	
307	WELLINGTON WELL	LY	10N	23E	02	NW SE	38.7533	119.3767	W	47.2		61	1912/09/28	LOELTZ AND EAKIN, 1953	
308	WILSON HOT SPRINGS	LY	11N	25E	34		38.7672	119.1732	S	warm	0			GARSIDE AND SCHILLING, 1979	
309	HOT SPRING	LY	12N	25E	34		38.8598	119.1749	S	hot				WILSON CANYON 7.5' QUAD	
310	GRANT VIEW HOT SPRINGS	LY					38.9900	118.9761	S	53			1977/05/11	WATSTORE	
311	DOUBLE SPRING	M	13N	29E	25		38.9647	118.6890	S	warm				WARING, 1965	
312	Deadhorse Wells (dry)	M	12N	32E	21		38.8959	118.3806	W	hot				Miller and others, 1953	
313	WEDELL SPRING NO.1	M	12N	34E	07	SW	38.9191	118.1953	S	62.2	859		1957/05/25	EAKIN, 1962C	
314	hot well	NY					38.9869	118.1783	W	hot				Mount Annie 7.5'	
315	hot drill hole	MN					38.8333	118.2917	W	hot				*GARSIDE, L., NBMG	
316	UNNAMED	LY	07N	27E	04	SW SE	38.4917	118.9650	S	43.3			1966/10/13	DAVIS, 1954; WARING, 1965	
317	CITY OF HAWTHORNE WELL	M	08N	30E	27	SW	38.5200	118.6275	W	26.7		184	1950/04/26	SCOTT AND BARKER, 1962	
318	WELL NO. 3	M	08N	31E	32		38.5067	118.5500	W	34			1971/12/29	*WHITE, D., USGS, MENLO PARK	
319	U. S. BUREAU OF LAND MANAGEMENT WELL	M	05N	31E	19	NE	38.2800	118.5667	W	43.3		105	1974/02/18	EVERETT AND RUSH, 1967	
320	BUREAU OF LAND MANAGEMENT NO. 2 WELL	M	03N	31E	07	NE SW	38.1317	118.5642	W	25.6		20	1953/05/11	VANDENBURGH AND GLANCY, 1970	
321	SODAVILLE SPRINGS, SODA SPRINGS	M	06N	35E	29	SE	38.3417	118.1017	S	35	100		1949/00/00	MARINER AND OTHERS, 1974, 1975	
322	GENE SAWYER WELL	NY	13N	36E	28	NE SW	38.9617	117.9383	W	54		84	1967/10/06	TREXLER AND OTHERS, 1979	
323	GABBS AREA	NY	12N	36E	27	NW	38.8817	117.9200	W	47.8		66	1958/02/11	EAKIN, 1962B	MINERAL EXTRACTION??
324	CHARNOCK (BIG BLUE) SPRINGS	NY	13N	44E	16		38.9914	117.0415	S	26.7	1703		1946/01/30	WARING, 1965	
325	BIG BLUE, CHARNOCK SPRING	NY	13N	44E	32	NE	38.9483	117.0500	S	32			1962/08/18	TREXLER AND OTHERS, 1979	
326	DARROUGH'S WELL	NY	11N	34E	07		38.8200	117.1750	W	90.5		244		*NEVADA BUREAU OF MINES AND GEOLOGY	HEAP LEACHING
327	DARROUGH'S NORTH SPRING	NY	11N	34E	07		38.8250	117.1750	S	71.2			1958/01/27	*NEVADA BUREAU OF MINES AND GEOLOGY	
328	WARM SPRING	NY	08N	38E	12	SW	38.5698	117.6635	S	warm				BLACK SPRINGS 7.5' QUAD	
329	UNNAMED WELL	M	06N	36E			38.3333	117.9667	W	40			1968/06/00	TREXLER AND OTHERS, 1979	
330	hot drill hole	MN					38.2000	117.9700	W	hot				*GARSIDE, L., NBMG	
331	STANLEY A TANNER WELL	NY	07N	40E	28		38.4372	117.4945	W	warm				RUSH AND SCHROER, 1970	
332	INDIAN SPRINGS	NY	07N	42E	34		38.4210	117.2498	S	warm				WARING, 1965	
333	HALL MINE WELL, ANACONDA MOLYBDENUM PROJECT	NY	05N	42E	07		38.3083	117.2917	S	27.7			1954/09/04	*NEVADA BUREAU OF MINES AND GEOLOGY	
334	WELL	NY	02N	43E	01	ACB	38.0650	117.1028	W	28			1967/05/08	WATSTORE	
335.1	WELLS	NY	12N	47E	20		38.8704	116.7034	W	hot				MOSQUITO CREEK 7.5' QUAD	
335.2	BELMONT MINE, 1500 FT LEVEL	NY	03N	42E	36		38.0750	117.2217	W	37.2		457	1964/10/23	BASTIN AND LANEY, 1918	
336	MOSQUITO RANCH SPRINGS	NY	11N	47E	06	SE NE	38.8250	116.7267	S	31.6			1941/07/03	*NEVADA BUREAU OF MINES AND GEOLOGY	
337	SPRING	NY	10N	49E	22	CAA	38.6972	116.4361	S	40			1967/05/10	WATSTORE	
338	TEST HOLE UCE-10	NY	10N	49E	22	CAA	38.6878	116.4625	W	48		903.1	1967/08/03	WATSTORE	
339	SPRING	NY	08N	49E	21	CDC	38.5361	116.4556	S	35			1967/07/31	WATSTORE	
340	OLD DUGAN PLACE HOT SPRING	NY	08N	49E	25	NW NE	38.5300	116.4050	S	36.1			1975/08/20	GARSIDE AND SCHILLING, 1979	

#	NAME	CO	T	R	SC	QSEC	NLAT	WLONG	T	TEMP	FLOW	DEPTH	CDATE	REFERENCE	USE
341	HOT CREEK RANCH SPRING	NY	08N	50E	29	SE SE	38.5200	116.3600	S	62.8	2888		1957/05/13	SANDERS AND MILES, 1974	
342	HOT CREEK VALLEY SPRING	NY	07N	51E	30		38.4367	116.2767	S	61.1				WARING, 1965	
343	WARM SPRING	NY	06N	47E	36	NE NW	38.3383	116.6600	S	26.1	19		1948/01/26	FIERO, 1968	
344	SALISBURY SPRING	NY	05N	46E	28	SW SE	38.2533	116.8267	S	30			1950/01/05	GARSIDE AND SCHILLING, 1979	
345	SPRING	NY	05N	46E	33	CD	38.2389	116.8306	S	21			1967/07/30	WATSTORE	
346	UPPER? MUD SPRING	NY	04N	46E	26	CA	38.1722	116.7917	S	25.5			1967/07/30	WATSTORE	
347	SPRING	NY	04N	47E	29		38.1722	116.7361	S	25			1967/07/27	WATSTORE	
348	SPRING	NY	02N	47E	14	AC	38.0278	116.6806	S	29			1967/07/28	WATSTORE	
349	WARM SPRINGS	NY	04N	50E	20	SW	38.1867	116.3717	S	63	170			*WHITE, D., USGS, MENLO PARK	
350	SPRING	NY	02N	51E	02	D	38.0472	116.1944	S	22			1967/08/03	WATSTORE	
351	SPRING	NY	02N	50E	28	ACC	37.9944	116.3861	S	25			1967/08/02	WATSTORE	
352.1	DUCKWATER AREA	NY	13N	56E	32	NW SE NW	38.9508	115.7000	S	33.9			1950/04/26	GARSIDE AND SCHILLING, 1979	AQUACULTURE
352.2	WILLIAMS HOT SPRINGS	W	13N	60E	33	NE	38.9533	115.2300	S	51.8			1976/11/10	*NEVADA BUREAU OF MINES AND GEOLOGY	
353	PRESTON SPRINGS	W	12N	61E	02	SW NE	38.9308	115.0825	S	22.7			1954/07/31	*NEVADA BUREAU OF MINES AND GEOLOGY	
354	BIG SPRING	NY	08N	55E	15	AC	38.5528	115.2722	S	38			1967/08/07	WATSTORE	
355	BLUE EAGLE SPRINGS	NY	08N	57E	11	DDB	38.5631	115.5275	S	29	7030.0		1981/07/17	WATSTORE	
356	MOORMAN SPRING	NY	09N	61E	32	DABC	38.5947	115.1383	S	37	1294.0		1981/07/18	WATSTORE	
357	EMIGRANT SPRING	W	09N	62E	19	AC	38.6250	115.0478	S	19.5	5247.0		1981/07/18	WATSTORE	
358	FLAG SPRING NO 3	NY	07N	62E	33	BCCC	38.4214	115.0222	S	22.8			1984/01/17	WATSTORE	
359	BUTTERFIELD (FLAG, SUNNYSIDE) SPRINGS	NY	07N	62E	28	NE	38.4450	115.0067	S	23.9	7571		1960/09/26	WARING, 1965; MAXEY AND EAKIN, 1949; ADAMS, 1944	
360	HOT CREEK RANCH SPRINGS	NY	06N	61E	18		38.3817	115.1533	S	26.7			1960/11/08	EAKIN, 1966	
361	MOON RIVER SPRINGS	NY	06N	60E	25	BDAD	38.3517	115.1808	S	32.5			1982/04/27	WATSTORE	
362	Bacon Flat 24-17 oil well	NY	07N	57E	17		38.4600	118.5900	W	113		1653		Hulen and others, 1994	
363	CHIMNEY HOT SPRINGS	NY	07N	55E	16	DC	38.4633	115.7900	S	60			1967/08/07	WATSTORE	
364	SPRING	NY	06N	54E	11	C	38.3889	115.8694	S	45			1967/08/07	WATSTORE	
365	SPRING	NY	06N	54E	24	CA	38.3639	115.8517	S	46			1968/09/12	WATSTORE	
366	GEYSER RANCH SPRINGS	LI	09N	65E	01		38.6750	114.6233	S	18	189		1979/11/15	CARPENTER, 1915	
367	LOWER PONY SPRING	LI	05N	66E	05	CBCC	38.3197	114.6072	S	20			1981/07/23	WATSTORE	
368	HAMMOND RANCH AREA	LI	05N	69E	17		38.2967	114.2733	S	28.9			1967/10/16	CARPENTER, 1915; WARING, 1965	
369	SAND SPRING	ES	01N	34E	27	SE SE	37.9053	118.1732	S	23.3			1965/07/12	RUSH AND KATZER, 1973	
370	FISH LAKE VALLEY	ES	02N	36E	28	SW SW S	37.9931	117.9848	S	27.2	4		1978/08/03	*NEVADA BUREAU OF MINES AND GEOLOGY	
371	GAP SPRING	ES	02N	36E	32	SW SE	37.9797	117.9927	S	23	38		1975/06/00	VANDENBURGH AND GLANCY, 1970	
372	EMIGRANT WELL	ES	01N	38E	06	NW	37.9717	117.8067	W	25			1970/10/07	TREXLER AND OTHERS, 1979	
373	FISH LAKE VALLEY WELL	ES	01N	36E	20	01S	37.9233	118.0058	W	25			1965/07/12	RUSH AND KATZER, 1973	
374	R.G. PENNEBAKER WELL	ES	01S	35E	09	SW SW	37.8640	118.1015	W	23.3		91	1961/12/13	RUSH AND KATZER, 1973	
375	NEVADA OIL AND MINERALS VRS NO. 1 WELL	ES	01S	36E	18	SW NE NE	37.8567	117.9800	W	158.8		2797		GARSIDE AND SCHILLING, 1979	
376	FISH LAKE VALLEY	ES	01S	36E	19	NE	37.8425	118.0150	W	25			1961/07/20	*DESERT RESEARCH INSTITUTE, 1973	
377	FISH SPRING	ES	02S	35E	25	NW SW	37.7425	118.0457	S	24				RUSH AND KATZER, 1973	
378	Gradient well 42-7	ES	01S	36E	07		37.8720	118.0210	W	47.5	757	301		*NEVADA BUREAU OF MINES AND GEOLOGY	
379	SILVER PEAK HOT SPRINGS, WATERWORKS SPRINGS	ES	02S	39E	15	SE SE	37.7600	117.6367	S	34.2	1892			WARING, 1965	
380	PEARL HOT SPRINGS	ES	01S	40E	25	SE NW SW	37.8222	117.4802	S	36.7			1963/04/15	*DESERT RESEARCH INSTITUTE, 1973	
381	ALKALI HOT SPRINGS	ES	01S	41E	26	NE	37.8267	117.3400	S	50.5	95			*WHITE, D., USGS, MENLO PARK	
382	SARCOBATUS FLAT AREA	NY	07S	44E	28	NW SW	37.2967	117.0517	W	22.2		62		MALMBERG AND EAKIN, 1962	
383	NONE GIVEN	ES	11S	43E	06	NW	37.0162	117.2085	S	25				*DESERT RESEARCH INSTITUTE, 1973	
384	FISHLAKE LIVESTOCK Co. WELL	ES	01S	39E	05		37.8767	117.6674	W	hot		50.3		RUSH AND SCHROER, 1970	
385	CEDAR SPRING	NY	02S	51E	21	SE	37.7508	116.2800	S	25	9			VANDENBURGH AND RUSH, 1974	
386	CLIMAX SEEP	NY					37.2244	116.0581	W	41.5			1978/03/07	WATSTORE	
387	TIPPIPAH SPRING NO 2	NY					37.0433	116.2072	S	22			1979/06/19	WATSTORE	
388	YUCCA FLAT TEST WELL 84-69,(TEST WELL E)	NY					37.0550	116.0133	W	42.2		572	1957/09/02	SCHOF F AND MOORE, 1964	
389	YUCCA FLAT WELL 79-69A, TESTWELL C	NY					36.9950	116.0250	W	37.2		519	1916/10/10	SCHOFF AND MOORE, 1964	
390	SARCOBATUS FLAT-BEATTY AREA	NY	09S	46E	35	NE	37.1142	116.7892	W	22.2				MALMBERG AND EAKIN, 1962	
391	SPRING	NY	01N	56E	35	DD	37.8986	115.6453	S	21			1968/09/14	WATSTORE	
392	SAND SPRING	LI	02S	55E	26	NE SE SE	37.7400	115.7517	S	30	1		1927/08/05	VANDENBURGH AND RUSH, 1974	
393	N. J. GUNDERSON WELL	LI	03S	55E	19	SE SE	37.6692	115.8283	W	28.3		73	1946/10/27	VANDENBURGH AND RUSH, 1974	
394	G.C. ENGLEMAN WELL	LI	04S	55E	08		37.6188	115.8217	W	warm		76.3		VAN DENBURGH AND RUSH, 1974	
395	HIKKO SPRING AREA	LI	04S	60E	14		37.5975	115.2117	S	26.7	11167		1950/04/26	EAKIN, 1963B	
396	CRYSTAL SPRINGS AREA	LI	05S	60E	10		37.5300	115.2333	S	27.2			1954/09/04	COHEN, 1966	
397	ASH (ALAMO) SPRINGS AREA	LI	06S	61E	06	NW NW N	37.4600	115.1867	S	31.1	32694		1945/07/30	EAKIN, 1963B	(SPA)
398	LIME SPRING	LI					37.9144	114.5403	S	21			1985/04/07	WATSTORE	
399	FLATNOSE SPRING	LI	01N	69E	35	CC	37.8961	114.2258	S	25			1985/04/08	WATSTORE	
400	DELMUE'S SPRINGS AREA, TWO SPRINGS.	LI	01S	68E	13	NE NW SE	37.8558	114.3217	S	21.1	757			HARDMAN AND MILLER, 1934	
401	PANACA WARM SPRINGS AREA	LI	02S	68E	04		37.8083	114.3800	S	29.5	18472		1949/06/00	RUSH, 1964	
402	BENNETT SPRING	LI	02S	67E	07	CD	37.7842	114.5281	S	24			1985/04/10	WATSTORE	
403	CALIENTE MINERAL SPRING, CALIENTE HOT SPRINGS	LI	04S	67E	08	NE	37.6217	114.5033	S	47.8			1962/07/29	SAND ERSAND MILES, 1974	(SPACE HEATING)
404	AQUA CALIENTE WELL NO. 3	LI	04S	67E	08	NW NW	37.6283	114.5100	W	67	5299	27	1970/10/07	TREXLER AND OTHERS, 1979	SPA
405	HICKS (BURRELL) HOT SPRINGS	NY	11S	37E	21		36.9667	116.7233	S	38	19		1978/08/18	*WHITE, D., USGS, MENLO PARK	
406	BEATTY MINERAL SPRINGS	NY	12S	47E	05	SW	36.9167	116.7500	S	24.4	379			SCOTT AND BARKER, 1962	
407	TW- F WELL	NY	14S	52E			36.7594	116.1164	W	64	883.0	1036.0	1980/03/12	WATSTORE	
408	WELL	NY	15S	50E	25	BD	36.6208	116.4125	W	46		32.0	1973/04/03	WATSTORE	

#	NAME	CO	T	R	SC	QSEC	NLAT	WLONG	T	TEMP	FLOW	DEPTH	CDATE	REFERENCE	USE
409	COOKS EAST WELL	NY	16S	50E	07	CABB	36.5744	116.3964	W	32		91.4	1990/08/25	WATSTORE	
410	FAIRBANKS SPRING	NY	17S	50E	09	SE NE	36.4933	116.3433	S	27.2			1934/02/18	NAFF, 1973	
411	RODGERS SPRINGS	NY	17S	50E	15	NW NE	36.4783	116.3233	S	27.8			1959/10/19	NAFF, 1973	
412	LONGSTREET SPRING	NY	17S	50E	22	NE NW NE	36.4667	116.3250	S	27.8			1980/06/01	DUDLEY AND LARSON, 1976	
413	UNNAMED SPRING	NY	17S	50E	26	SW NE NW	36.4483	116.3133	S	27			1958/06/12	NAFF, 1973	
414	SCRUGGS SPRING	NY	17S	50E	35	SE SW NE	36.4317	116.3067	S	30			1980/06/03	NAFF, 1973	
415	DEVIL'S HOLE	NY	17S	50E	36	SW SE	36.4267	116.2883	S	33			1965/06/17	NAFF, 1973	
416	POINT OF ROCK (KING) SPRING	NY	18S	51E	07	NW SE	36.4017	116.2717	S	32	4399		1964/04/13	HUGHES, 1966; MIFFLIN, 1968	
417	JACK RABBIT SPRING	NY	18S	51E	18	SE NW SE	36.3867	116.2717	S	28			1962/06/28	NAFF, 1973	
418	BIG SPRING; ASH MEADOWS SPRING; DEEP SPRING	NY	18S	51E	19	SW NE	36.3767	116.2717	S	28			1971/02/00	DUDLEY AND LARSON, 1976	
419	CRYSTAL SPRING	NY	18S	50E	03	NE SE NW	36.4183	116.3300	S	30			1979/12/15	NAFF, 1973	
420	USGS TRACER WELL 2	NY	16S	51E	27	NE NE NW	36.5383	116.2317	W	30.6			1968/06/25	DUDLEY AND LARSON, 1976	
421	CHERRY PATCH WELL	NY	17S	52E	08	CDB	36.4914	116.1492	W	27.5		65.5	1990/08/24	WATSTORE	
422	INDIAN SPRING	CL	16S	56E			36.5617	115.6683	S	26.1	5875	1546	1967/11/10	CARPENTER, 1915	
423	MANSE RANCH SPRINGS	NY	21S	54E	03	SE NE	36.1557	115.8886	S	25	4542		1978/08/18	HARDMAN AND MILLER, 1934	
424	PAHRUMP SPRINGS	NY	20S	53E	14	SE SE	36.2075	115.9783	S	25	1840		1960/06/31	HARDMAN AND MILLER, 1934	
425	PAHRUMP COMMUNITY CHURCH WELL	NY					36.2117	115.9883	W	27			1976/01/09	WATSTORE	
426	WHITE ROCK SPRING	CL	20S	58E			36.1742	115.4786	S	25			1985/06/26	WATSTORE	
427	PAGO PAGO BAR WELL	CL					36.2361	115.0531	W	28		61.0	1982/05/18	WATSTORE	
428	Las Vegas Springs	CL	20S	61E	31		36.1645	115.1899	S	26.1	5015			Scott and Barker, 1962	
429	H. NICKERSON WELL	CL	22S	61E	03	NE NE SW	36.0633	115.1458	W	29	644	120	1972/02/13	MAXEY AND JAMESON, 1948	
430	GLADSTONE CORPORATION WELL	CL	22S	61E	10	NE SE NW	36.0600	115.1483	W	33.3	1609	99	1973/00/00	MAXEY AND JAMESON, 1948	
431	T.A. WELLS WELL	CL	22S	62E	01	SW NW S	36.0608	115.0043	W	32.8		346		MAXEY AND JAMESON, 1948	
432	VF-2 WELL	LI	12S	63E	29	DABB	36.8750	114.9456	W	34			1986/02/05	WATSTORE	
433	FUGRO COYOTE V DEEP WELL	CL	13S	63E	23	DD	36.7956	114.8922	W	35.5		203.9	1981/07/22	WATSTORE	
434	USGS-MX CE-DT-6	CL	13S	64E	35	ACAA	36.7678	114.7869	W	33.5		284.7	1986/09/28	WATSTORE	
435	CSV-3	CL	14S	63E	28	ACDC	36.6908	114.9250	W	41		237.7	1987/10/07	WATSTORE	
436	WARM SPRING	CL	14S	65E	16	NW SW NE	36.7222	114.7152	S	32.2	12250		1950/08/27	EAKIN, 1964; MIFFLIN, 1968	
437	IVERSON SPRING	CL	14S	65E	21	NW NE NE	36.7097	114.7142	S	31.6	3840		1958/05/19	EAKIN, 1964	
438	JUANITA SPRING	CL	15S	69E	14	BAA	36.6369	114.2475	S	26			1986/01/25	WATSTORE	
439	DRY LAKE	CL	17S	64E	21	CB	36.4550	114.8439	S	29			1985/07/01	WATSTORE	
440	WATER FOUNTAIN VALLEY OF FIRE, NEV.	CL	17S	67E	30	NW SW	36.4233	114.5483	S	35.1			1971/03/15	SWANBERG AND OTHERS, 1977	
441	BLUE POINT SPRING	CL	18S	68E	06	DCC	36.3897	114.4328	S	29	4075.0		1977/05/04	WATSTORE	
442	ROGERS SPRING	CL	18S	67E	12	DDA	36.3775	114.4433	S	30			1977/05/04	WATSTORE	
443	G.P. APEX WELL	CL	18S	63E	33	DBB	36.3411	114.9267	W	31			1986/09/30	WATSTORE	
444	NAT'L PARK SERVICE, CALLVILLE BAY CAMPGROUND WELL	CL	21S	65E	09	NW SE	36.1442	114.7220	W	28.9	114	61		RUSH, 1968B	
445	HOOVER DAM HOT SPRING	CL	22S	65E	29	SW	36.0100	114.7450	S	42.2			1966/07/27	SWANBERG AND OTHERS, 1977	
446	BLACK CANYON AREA	CL	23S	65E	05	SE NW SW	35.9800	114.7467	S	30	848		1960/00/00	*WATSTORE	
447	BLACK CANYON AREA SPRING	CL	23S	65E	21	NE SW NW	35.9467	114.7333	S	25.6	19		1978/08/18	*WATSTORE	
448	MONITOR WELL 116	CL	32S	66E	14	DBDB	35.1583	114.5864	W	29		91.4	1991/08/06	WATSTORE	
449	SUNDANCE SHORES WELL	CL	32S	66E	24	BBA	35.1497	114.5803	W	32		146.3	1974/08/14	WATSTORE	

APPENDIX 2

#	pH	Na	K	Ca	Mg	Fe	SiO2	B	Li	HCO3	CO3	SO4	Cl	F	TDSm	TDSc	ChgBal	delD	delO18
1									5.8										
2	8.90	58	3.9	5.8	0.34		41			106		23	23			207	1.03		
3																			
4		21	4	3.2	0.3		53	0.08	0.01	50	0	11	5.9	0.6		124	0.96		
5		29	0.4	3.7	0.1		32	0.08	0.03	64	0	12	4.7	1.8		115	0.96		
6		31	2.8	2.1	0.1		57	0.07	0.02	74	0	9	5	0.9		144	0.97		
7	9.1	110	1	4	0		51	1	0	63		119	39	4.6	362	393	1.03	-127	-15.4
8																			
9	7.70	32	6.3	1.4	0.1		67		0.46	68		13	7			160	1.03		
10																			
11																			
12	8.40	78	0.6	0.4			51	0.66		113	6	41	15	2	262	250	1.00		
13		180	8.6	14	0.2		130	2	0.2	163	0	220	48	6.6		690	0.98		
14	8.60	74	1	3.5	1.1		63	0.6	0.667	90	3	35	18	12	275	255	1.02		
15	8.60	74	1.1	3.1	<0.1	<0.02	63	0.64		92	3	41	18	12		261	0.94	-129.9	-16.56
16	7.60	76	1.3	2.6	1.4		65	1		96	N	39	21	10	272	265	1.02		
17	8.5	74	1	4	1		63	0.6		90	3	35	18	12		256	1.02		
18	8.20	55	0.6	6.4	0.2		34	0.32		120	N	15	11	0.3	186	182	1.05		
19	7.65	320	25	4.6	0.1	0.06	160	6.9	0.45	436	2	130	160	14		1038	0.98	-128.2	-14.13
20	7.20	325	26	19	0.3		155	7		500	1	120	160	14		1073	0.99		
21																			
22																			
23		74	10	23	8.4		74	0		107		22	32	0.1	256	296	1.70		
24	7.80	78	11	9.6	2.8		79			165		28	28	1.8		319	1.05		
25	7.1	230	5	17	0.1		130	2.1		280	0	120	110	10		762	1.03		
26	7.60	230	4.5	17	0.1		130	2.1		280	N	120	110	10		761	1.02		
27	8.86	150	8.7	2.7	0.2	0.01	80	0.64	0.03	224	8	49	52	2.3		464	1.05	-123	-15.8
28	8.8	210	4.4	1.5	0.04	0.01	64		0.032	280	9	120	76	0.1		623	0.98	-131	-16.1
29																			
32		210	6.2	3.2	1.5		125	2.9		358	7	67	54	14	660	667	0.98		
33		146	3.7	3.2	0		83	0.41		218	16	76	6	8.9	470	450	1.04		
34	8.10	455	9.9	30	6.3		51	1.3	0.5	948	N	204	69	9.8	1290	1303	0.99		
35		416	11	32	5.2	0.04	39	1.7	0.36	885	N	184	59	0.9	1180	1184	1.02		
36		34	4.8	18	2.4		65	0.11		104		25	15	0.6	244	216	1.01		
37	9.30	91	2	2.4	0.5		84	0.26		52	39	64	14	7.9	324	331	0.97		
38	7.30	28	6.3	14	2.8		53		0.03	94		14	15			179	1.02		
39		27	6.3	25			54	0.1		117		20	22	0.1		212	0.87		
40		146	12	46	9.7		63	0.87		204		94	157	0.3	640	629	1.00		
41	9.00	197	18	2.2	0.8		4.8		1.5	211	36	70	106	1.4	541	540	1.00		
42	7.30	123	3.5	6.4	0.5		65	0.78		182	N	61	27	10	387	387	1.05		
43		89	3.4	7.8	1.8		56	0.35		178		49	19	5.3		319	0.95		
44		58	12	5.8	0.2	N	110	0.37	0.4	119		26	14	2.6	322	288	1.04		
45		334		26	8.5			2.5		920		34	26		930	884	1.00		
46	8.00	296	36	10	8		55			881		36	26			900	0.94	-134.6	-16.44

#	pH	Na	K	Ca	Mg	Fe	SiO2	B	Li	HCO3	CO3	SO4	Cl	F	TDSm	TDSc	ChgBal	delD	delO18
47																			
48		452	26	26	11			1.4		1230		71	16			1209	1.02		
49																			
50	9.20	620	3.5	2	N	N	34	4.6		1080	143	98	46	16	1500	1498	1.02		
51																			
52																			
53																			
54																			
55																			
56									<0.2										
57																			
58	8.10	157	16	13	0.2	N	166	0.81		338	N	75	9	9.4	631	613	1.01		
59	7.00	390	41	49	13		84	0.77		1180		18	40	7.2		1224	1.01	-134.9	-16.78
60	7.40	110	8.3	29	7.7		23	0.22		380		36	4.4	3.4		409	0.97	-140.8	-18.21
61	7.20	130	22	48	12		40	0.67		482		40	14	5.2		549	1.02	-140.2	-17.85
62	7.60	134	4	8.4	N	0.04	96	0.41	N	260	N	46	11	14	442	442	1.01		
63																			
64																			
65	8.00	450	36	3.1	0.45		151			1149		2	31	21		1260	0.99		
66	7.70	358	33	6.5	0.8		132			959		2	25			1029	1.02		
67	6.70	236	43	41	14		38			867		10	20			829	0.97		
68																			
69																			
70	7.30	300	31	75	37		105			1135		32	27	7.2		1173	1.01		
71	6.6	370	46	48	13	0.02	86	0.73	0.72	1135		12	37	7.4		1179	1.02	-136.6	-16.95
72																			
73	8.40			49	17					426	18	69	30			393	0.39		
74																			
75	8.20			74	27					278	N	103	117			458	0.59		
76																			
77																			
78	8.8	78	2.4	2.4	0.6		75	0.53	0.16	78	17	49	11	8.8		283	1.00		
79	9.10	75	2.2	1.6	<0.01		83	0.47		108		45	15	8.9		284	0.94	-139	-17.61
80	8.10	13	3.9	25	8.6	N	18	N		132	N	11	3.9	0.5	149	149	1.04		
81	9.1	75	2.2	1.6	0.01		83	0.47	0.2	108		45	15	8.9		285	0.94	-139	-17.61
82	7.90	17	8.4	37	8.6		20	N	0.205	184	N	20	1.8	0.7	205	204	1.00		
83	7.3	18	8.9	38	9.2		20	0.03	0.06	180	0	22	2.5	0.7		208	1.04		
84	7.8	8	4.8	34	10		20	0	0.02	160	0	23	2.1	0.4		181	0.94		
85	8.00	19	6.6	35	11		21			190		19	2			207	1.02		
86																			
87	8.30	24	5.6	16	5.7	0.18	21			118	1	22	2	0.6	157	156	0.98		
88	7.20	9.6	4.6	29	8.1		23			144	N	13	3.3	0.4	162	162	0.97		
89	7.90	8.5	5.4	30	8	0.06	27			142	N	13	3.5	0.4	166	166	0.98		
90	7.20	10	5.6	40	11.5		31	<0.02		149		37	8.7	0.4		218	1.01	-139.1	-18.24

#	pH	Na	K	Ca	Mg	Fe	SiO2	B	Li	HCO3	CO3	SO4	Cl	F	TDSm	TDSc	ChgBal	delD	delO18
91																			
92	7.80	25	7	32			86		5.7		N		28			178	3.63		
93	7.8	25	7	32	0.2		86			240	0	15	28			311	0.57		
94	8.4	113	N	2						98	24	49	60			296	0.98		
95																			
96																			
97	8.00			37	2.3					155	N	528	849			1493	0.05		
98.1	8.00			3	3				N	179			18			112	0.12		
98.2	9	83	N	3	1	0.004	25			170	48	18	0.01			262	0.81		
99	8.50	1050	29	245	N		97	7.2		11	6	293	1830		3870	3563	1.01		
100	8.40	1100	160	260	0.1	<0.02	110	6.1	0.04	26		340	1900	3		3892	1.06	-106.5	-6.33
101				32	7					200		21	19			177	0.51		
102				6	3					206		18	16			144	0.13		
103				56	22					277		70	34			318	0.66		
104				86	28					286		132	126			513	0.60		
105.1		1400	120	148	0.17	0.34	208	5.85		49	3	220	2320	5.2		4455	1.00		
105.2		1298	110	140	0.17	0.01	203	5.85		22	17	211	2225	5.2		4226	0.97		
106	6.70	1400	110	140	1.5	0.13	240	6.3		92		230	2300	5		4478	0.99	-105.3	-11.54
107	7.20	1400	130	68	1.2	0.02	165	9.9		83	<1	400	2200	4.5		4419	0.94	-100.5	-10.83
108	7.60	1400	86	58	1	<0.02	145	7.1		68		350	2050	4.8		4135	0.99	-106.5	-11.65
109	7.3	1400	120	70	1.1	0.04	210	8.2	1.7	96		380	2100	5.1		4343	0.98	-105	-10.4
110	9.1	152	21	1	4		45	1.8		230	0	52	192			582	0.73		
111	7.5	18	3.5	19	3.8		18	0.1		284	0	9	21	0.1		232	0.39		
112		272	8.4	13	0.6		94			93	0	156	278	2.8		871	1.00		
113	7.90	430	8.6	11	0.2	<0.02	79	5		162		180	500	4.1		1298	0.94	-127.6	-14.87
114	7.90	340	17	31	4.2	0.13	82	1.9		464		45	240	7		997	1.09	-120.7	-14.72
115	7.2	405	17	22	0.2		90	0.5		455	0	205	250			1214	1.02		
116	7.90	486	13	18	1.9		62	2.8		902	N	130	155	8.9	1330	1321	1.01		
117		27	9.8	46	4.1		70	0.1		99		61	38	0.3		305	1.02		
118				24	11					110		26	38			153	0.62		
119	7.56	1450	120	110	6.5	<0.02	85	8.7		197	<1	120	2400	4.6		4402	0.98	-125.5	-14.01
120	7.40	33	1.3	50	9.3	0.05	20	0.18		210		23	29	0.1	271	269	1.00		
121																			
122	6.80	390	20	41	10	<0.02	63	4.1				120	45	8.6		702	4.82		
123	8.10	165	26	110	22		65		0.08	312		370	75			987	1.01	-130	-16.24
124																			
125	8.10	143	12	31	15		42		1.2	456		63	29			559	0.97		
126									0.0574										
127	7.10	180	20	36	4.4	0.08	110	1.9	1.3	375		150	40	7.8		735	0.97	-129.5	-15.58
128	7.90	101	6.4	46	19	0.04	39	0.3		205	N	69	124	0.5	503	506	1.01		
129		182	11	79	17		58	1.1		407		154	127	1.9	826	831	1.00		
130	7.00	518	80	97	20	0.02	155			544	N	48	775	6.3	1968	1967	0.97		
131	6.9	540	82	95	22	0.03	110			490	0	66	790	5.7		1952	1.00		
132	6.97	130	8.2	73	17		40	0.63	0.22	480		65	70	1.4	551	642	0.97		

#	pH	Na	K	Ca	Mg	Fe	SiO2	B	Li	HCO3	CO3	SO4	Cl	F	TDSm	TDSc	ChgBal	delD	delO18
133		277	27	28		<0.25	81						26			439	19.27		
134	7.50	304	33	7.6	20		74	3		818		93	20	5.5		963	0.99		
135	8.1	180	12	13	2.1		8.3	0.54	0.24	457	3	26	23	4.3		497	0.99		
136	7.64	110	4.7	91	32		26	0.36	0.06	180	0	190	180	0.7	734	723	1.00	-124.4	-15.15
137	7.40	160	13	8.8	0.5	<0.02	135	1.2		368		53	29	7.8		589	0.93	-128.6	-15.7
138	8.6	270	14	8.5	2		17	1.8	0.81	365	8	110	140	6.2		758	0.99	-134	-16.4
139	8.30	920	94	17	40	0.01	50	15		1940	41	121	381	12	2650	2645	0.99		
140																			
141																			
142		1350	240	120	4		340			202		18	2250	6	4530	4427	1.05		
143.1																			
143.2																			
144	7.90	60	6.5	56	19	N	51	0.4		260	N	72	58	0.3	452	451	0.96		
145	7.70	74	2	179	58	N	25	0.4		211	N	390	191	0.3	1040	1024	1.00		
146	8.00	42	3.5	102	30	0.04	10	0.1		166	N	85	178	0.3	536	533	0.99		
147	6.50	130	22	33	6.8	0.22	66	1.1	0.08	429	1	56	18	1.8		547	0.95	-125.5	-15.65
148																			
149	8.40	200	18	16	0.9	0.18	125	2.6		385		140	41			733	0.97	-131.4	-15.74
150																			
151	7.00	157	15	58	16		44			533		84	34	1.7		672	0.99		
152	8.00	288	33	29	5		80			823		60	28			928	0.98		
153	7.10	105	28	70	27		40	2	5	507	N	94	17	2.5		635	1.01		
154	8	118	21	20	9		40			333		64	21			457	1.00	-127.8	-16.28
155	7.10	38	5.6	33	4.1		51			136		36	25	1.9		262	1.00		
156	6.4	77	22	100	25	0.18	34		0.33	537		64	14	1.1	582	602	1.04		
157	6.2	80	23	96	22	0.37	41		0.35	548		67	14	1.2	589	615	0.99		
158	6.6	10	2.3	8.5	1.9	0.12	26		0.004	51		5.7	3.9	0.1	96	84	1.01		
159	7.4	39	11	59	20	0.069	28		0.19	318	0	50	14	0.6		378	0.98	-128	-16.9
160	6.90	231	27	15	5.9		52			690		25	10			705	0.99		
161	7.60	45	16	60	15		70			335		52	12			435	0.95	-132.7	-16.64
162	7.51	27	7.6	43	8.8	0.004	67		0.028	180		38	17	0.5		297	1.00		
163																			
164	7.3	47	13	56	11	0.009	51		0.088	234		84	19	0.5	379	397	0.99		
165																			
166																			
167	8.00	50	8	26	5.8	N	85			164	N	37	22	0.4	318	315	1.01		
168	9.50	230	16	0.8	N	0.04	373	2		116	149	89	30	15	1000	962	1.01		
169	8.90	230	16	1	<0.1	<0.02	320	2.1		321	32	130	69	17		975	0.88	-130	-14.76
170	7.00	136	17	22	5.8		58	0.81		378	N	62	27	5	526	520	0.93		
171	6.60	230	58	53	35	<0.02	67	2.1		915	<1	7	1	6.6		910	1.10	-136.1	-15.97
172	6.90	285	56	46	40		70	2.9		949		116	48	7		1138	0.99		
173																			
174																			
175	7.30	10	2.1	46	23.5		20	0.03	0.8	226	1	27	4.6	0.1		246	1.06		

#	pH	Na	K	Ca	Mg	Fe	SiO2	B	Li	HCO3	CO3	SO4	Cl	F	TDSm	TDSc	ChgBal	delD	delO18
176	7.00	39	8.7	52	16		0.58	0.25		287	N	27	14	0.7	380	299	1.02		
177									0.75										
178	6.6	110	35	63	12.3		65	0.9	0.3	493		70	15	2	582	867	0.98	-149	-18.1
179	7.20	120	39	60	15.5	<0.02	65	0.7		488	1	72	16	1.9		631	1.04	-144.7	-15.31
180																			
181	8.50	135	8.9	1	0.03	<0.02	210	0.2		224	15	40	23	17.7		561	0.93	-130.1	-16.09
182	8.00	58	14	45	12		50		1.8	377		24	6.5			395	0.89	-132.8	-16.24
183	7.90			54	18					396	N	95	18			380	0.47		
184	8.00	118	21	20	9	<0.02	40		0.113	333		64	21			457	1.00	-127.8	-16.28
185	7.00	114	22	41	22.4		39	2.4	0.08	443		68	20	4.5		551	0.99		
186	7.80			141	61					540	N	315	332			1115	0.49		
187				52	20		35	0.8		334		39	23	1	398	335	0.61		
188																			
189																			
190	7.74	8.4	4	49	17		24		t	226		20	5.1	0.334		239	1.01		
191									0.1										
192																			
193																			
194	8.90			16	1					56	8	168	114	3	788	338	0.11		
195																			
196																			
197	8.01	780	42	56	2.6	0.037	110	4.3	2	170	1	67	1100	2.9		2251	1.07	-126	-14.3
198	7.2	694	53	35	0.2		210	4.4	1.5	112		323	872	5.5	2120	2311	1.00	-127	-14.2
199	7.10	730	62	22	N	N	226	4.7		67	N	315	910	7.3	2360	2310	1.02		
200				32	2		259			31	19	334	955		2495	1616	0.05		
201	7.10	620	38	70	1.5	0.02	150	5.6		100		400	820	4.2		2159	0.95	-121.5	-13.3
202	7.6	656	52	52	0.6		198	6.1	1.7	93		405	829	4.7	2100	2298	0.97	-121	-12.4
203	7.00												5			5	0.00		
204	9.00	117	5.4	6.2	0.1	N	46	193		12	20	144	57	2.5	361	597	0.99		
205	8.10	139	4.7	5.2	0.3		85	0.76		136		171	20	0.81	567	494	1.01		
206	8.1	277	8	27	0		126	2	0.2	93		528	55	4.1	950	1120	0.95	-126	-15.9
207	7.50	248	7.1	20	0.3		104	1.7		95		419	53	4.9	959	905	1.00		
208	6.3	611	58	15	0.3		278	41.8	6.9	369		120	790	2	2056	2292	0.93	-121	-12.4
209	7.70	679		32	8					361		234	750	1.2	2056	1882	0.99		
210	7.20	680	66	16	0.7	<0.02	270	47		368		73	837	2.1		2173	1.03	-116.7	-12.16
211	8.00	19		24	9					151	N	3	5		211	134	1.03		
212	7.9			37	19					212		47	13	0.1	281	220	0.71		
213	9.30	49	0.4	2.8	1		44	0.2	0.667	34	26	35	5.4			181	1.03		
214	8.40			13		0.27			1.4	120	6		7	7	253	92	0.24		
215																			
216	7.7			47	14					232		5	7	0.1	249	187	0.85		
217	7.60	67	4.6	267	53	3.3	34	0.03		312	N	732	8.2	0.6	1320	1323	1.01		
218	7.70			102	1	0.13			8.4	149	N	192	21		583	389	0.74		
219	8.21	25	1.4	17	0.9	0.003	33	0.04	0.011	107	0	8.6	3	0.3		142	1.01	-109	-14.8

#	pH	Na	K	Ca	Mg	Fe	SiO2	B	Li	HCO3	CO3	SO4	Cl	F	TDSm	TDSc	ChgBal	delD	delO18
220	8.06	28	0.9	15	1.1	0.11	27	0.06	0.004	93	0	16	4.7	0.6		139	1.03	-112	-14.9
221	7.26	173	5.9	270	0.14	0.116	44	1.4			26	843	34	4.1		1402	1.08	-130	-16.2
222	8.84	99	1.6	2.2	<0.05	0.03	60	1.5		57	13	89	27	7.5		329	1.02	-127	-14.9
223	8.55	161	5	166	0.1		33	1.4		4.5	11	617	39	3.3		1039	1.06	-130	-16.2
224	7.3	170	3.9	66	0.74	5.6	35	1		39	0	470	38	5.1	798	815	0.94		
225	8.90	125	1.7	6	0.7	0.03	47	1.5		51	17	109	74	7.1	408	414	0.95		
226	8	58	4.4	9.5	2.9	0.006	78	0.16		140	0	36	9.5	1.6	271	269	0.99		
227	8.50	69	3.4	2	0.2	0.03	36		0.309	146	4	23	6.2	1	244	217	0.99		
228	8.80	82	2	14	0.33		33			48		148	21	5.8		330	0.91		
229	8.20			7.2	1.7				7.1	159		128	29			244	0.08		
230	8.50	277	15	38	0.2		115			70		580	46			1106	0.99	-131.5	-16.01
231	8.60	313	13	40	1	0.06	109	1		52	12	642	49	8.2	1210	1214	0.98		
232	4.83	1200		55	0.07	0.015	190	9.4					2000	0.7		3455	0.97		
233	8	2230	249	87	0.2		319	15.6	3	36		70	3740	4.3	7570	6754	1.00	-114	-,2.1
234																			
235																			
236																			
237	8.60	190	6.5	3.6	0.02	<0.02	115	0.89	0.04	111	11	111	126	16		635	0.97	-126.1	-15.89
238	7.41	1900	120	80	23		83	0.58	1.7	348	0	240	3000	1.3		5621	0.96	-101	-11.5
239	8.1	680	25	11	4.2		49	7.2	0.44	388	2	110	820	0.5		1900	0.98	-110	-13.9
240	7.86	1000	48	82	2.1	0.05	160	5.7	1.5	144		360	1500	0.6		3229	0.94	-109.3	-13.46
241	5.7	2000	232	109	0.4		284	13.4	3.8	108		48	3400	1	6140	6200	1.00	-105	-10.8
242		750	60	18	5		70	5.1	1.1	312	3	39	1300	1.1		2406	0.83	-110.6	-13.3
243	7.34	42	2.8	63	15	0.007	40	0.41	0.055	243	0	65	14	0.5		362	1.09	-95	-11.7
244	9.27	220	7.6	1.7	0.79	0.022	28	1.1	0.012	230	38	89	100	0.8		600	1.02	-111	-14.1
245	7.57	1480	42	108	1.7		170	15		90	<1	190	2200	5		4256	1.05	-110.2	-12.36
246	8.5	1600	57	71	1.1		80	17	2	120	15	180	2300	3.3		4385	1.05		
247	8.2	1700	48	75	0.9		120	17	2.1	140	0	210	2400	5.5		4647	1.06		
248	7.86	3100	45	27	32	0.18	63	13	0.32	839	0	6.8	4700	0.7	8490	8401	0.96	-97	-10.5
249	7.65	370	0.9	33	5.8	0.0055	53	1.5		788		250	15	1.9		1119	0.98		
250	6.56	1400	32	70	2.9	0.054	120	14				62	2200	0.5		3901	1.03	-107	-11.7
251																			
252																			
253																			
254	7.40	450	26	44	0.6	<0.02	180	2.4	0.1	114	<1	470	380	7.9		1617	0.99	-125.8	-13.21
255	7.60	68	3	16	2.2	0.01	54	0.3		86	N	80	26	6	297	298	0.97		
256	8.20	72	2	12	0.9	0.04	63	0.08		98	N	60	21	6.9	287	286	1.01		
257	9.9	4400	87	5.7	6.2	0.25	24	4.8	0.3	575	256	1700	4843	7.8	11919	11618	1.02		
258	8.9	363	34.6	3	1.1		342	7.4		279	13.5	118	321	5.8		1347	1.00		
259				64	5		42			768	N	77	34		863	600	0.24		
260																			
261																			
262	8.40			42	20					180	8	74	19			252	0.71		
263	7.70	170	8.4	4.8	0.06	<0.02	110	0.66	0.04	256	5	102	22	8.9		558	1.04	-130.4	-16.68

#	pH	Na	K	Ca	Mg	Fe	SiO2	B	Li	HCO3	CO3	SO4	Cl	F	TDSm	TDSc	ChgBal	delD	delO18
264.1																			
264.2	8.59	525	38	10	2.5	0.14	107	3.5		1380	40	65	48	12		1530	0.90	-132	-17.7
265.1	7.7	156	8	6.2	0.14		116			243		108	24	8.8		547	0.99		
265.2																			
266																			
267	6.50	44	14	56	12	<0.02	68	0.12		264	<1	64	12	2.5		403	0.99	-129.8	-16.87
268	7.20	29	5.9	57	21	0.01	40	0.26		279	N	35	21	0.2	346	347	1.01		
269.1	8.00	15	3.4	51	20	N	25	N	0.5	255	N	25	10	0.4	276	275	0.99		
269.2																			
270	7.47	37	12	69	17		37			334		25	9	0.889		371	1.07		
271																			
272																			
273									1.2										
274	8.70	36		24	7.8					135	12	28	7			181	1.00		
275	9.30	64	0.7	1	<0.1		85		N	144		18	6.3			246	0.98	-127.9	-16.28
276																			
277	7.80	36		62	12				0.76	160	N	88	43			320	1.00		
278	6.50	200	36	43	9.4	0.06	77	2.6		673		51	22	4.7		777	0.97	-135.8	-16.01
279																			
280	6.60	47	13	52	11	<0.02	36	0.17		249	<1	57	10	2		230	3.58	-127.5	-16.28
281	7.10	55	15	50	11	<0.02	46	0.21		278		59	8	2.8		384	1.00	-124.9	-16.24
282	6.72	27	7.5	65	28	0.01	24	0.1	0.063	370		31	8.3	0.5		374	0.99	-120.5	-15.6
283	6.85	21	4.6	69	22	0.01	21	0.07	0.083	320		53	6.9	0.4		356	0.96	-122	-15.9
284	8.65	18	6.7	42	20		20		0.527	217	6.5	35	6.7	0.319		262	1.00		
285	7.2	19	6.5	60	23	0.006	26		0.083	286		52	6.7	1		335	0.98	-127	-16.6
286																			
287	7.8	150	4.8	12	0.3	0.02	105	0.35	0.65			1	16	1.2		291	13.58	-127.8	-16.2
288																			
289																			
290	7.8	4.8	1	49	21	0.01	11			180	0	17	4	0.1		196	1.29		
291	8.29	4.3	1.4	56	17		23			232		19	3.6	0.265		239	1.02		
292									0.008										
293	8	20	9.5	26	8.7	0.007	71		0.019	130		9	21	0.4		230	1.07	-126	-16.5
294		162		13	1.1	0.12	100			375	7.7	17	17	0.75	518	503	1.07		
295																			
296	7.3	9.3	3.4	51	21	0.01	19			250	0	18	4.4	0.4		250	1.03		
297				54	21	0.1	32			267	N	21	4.3		266	264	0.90		
298	6.8	8.2	2.3	51	16	0.01	21	0.03	0.017	220		19	3.2	0.2		229	1.04	-121.5	-16.2
299	8.00			32	25					148	N	83	10			223	0.82		
300				51	23	0.22	37			222	N	68	7.5	0.67	314	297	0.84		
301	8.70	145	3.6	10	0.01	<0.02	58	1.2		50	9	235	44	4.9		535	0.92	-119.5	-15.55
302	9.10	137	2.9	9.6	0.5	0.01	61			12	24	200	46	5	499	492	0.98		
303													1.2			1	0.00	-116	-15.6
304																			

#	pH	Na	K	Ca	Mg	Fe	SiO2	B	Li	HCO3	CO3	SO4	Cl	F	TDSm	TDSc	ChgBal	delD	delO18
305	8.7	102	2.5	4.5	0.01	0.06	52	0.19	0.07	54	7	169	17	3.1		384	0.90	-123.2	-16.01
306	8.50	69	3.4	2	0.2	0.03	36		7.1	146	4	23	6.2	1		217	0.99		
307							62	1		41	22	157	28	3.5		294	0.00		
308																			
309																			
310	8.5	200	2.2	26	0.1	0.02	34			38	0	380	49	8.4		718	0.97		
311																			
312		70		48	13					88	10	190	43			417	0.94		
313		262		16	N			1.6		210		315	78			776	1.00		
314																			
315																			
316																			
317	7.40	148	6.4	82	14	0.01	25		75	82	N	403	79	0.7	810	798	0.99		
318	8.00	245	10	32	6.1	0.66	54	2.3		118		374	102	6.8	891	891	1.01		
319				6	0.9		37		0.22	47	9	109	64	4.8	370	254	0.07		
320	7.70			26	8				6.1	144	N	23	11			139	0.62		
321	7.60	305	16	40	3.3	0.07	46	2.3		112	<1	597	87	7.4		1159	0.93	-130.3	-16.13
322	8.70	160	2.7	7	<0.25		63			68		238	33	11		548	0.97		
323									0.8										
324									5										
325	7.50	74	13	23	0.95		94		0.18	202		38	12	4		358	1.03		
326	8.77	99	3.3	1.1	<0.05	0.03	122	0.7		119	21	47	12	14		379	0.95	-131	-8.4
327	8.72	94	2.7	1.4	<0.05	0.04	112	0.575		126	17	53	12	14		369	0.88	-130	-6.7
328																			
329	7.60	55	4.8	26	13		28			239		41	1	0.31		287	1.01		
330																			
331																			
332																			
333	8.23	57	13	15	0.924		108			130		44	12	0.738		315	1.06		
334	7.6	43	9	28	4.2	0.02	76	0.18	0.04	147	0	34	21	0.7	300	288	1.03		
335.1																			
335.2		80	5	20	4.4	3	68			51	36	106	35		367	382	0.97		
336	9.12	43	1.9	7.2	0.512		68			83	9.3	18	7.7	0.889		197	1.00		
337	7.9	13	4.2	37	12	0.008	28	0.01	0.01	168	0	36	3.7	0.6	221	217	0.96		
338	7.8	17	5.8	45	11	0.15	31	0.045	0.02	158	0	64	4.8	0.4	269	257	0.99		
339	7.6	38	0.8	4.7	0.1	0.01	46	0.1	0	80	0	19	7	0.4	148	155	1.00		
340	7.70	49	6.8	70	22	0.007	32	0.33	2.1	358	N	55	19	1	444	431	1.00		
341	8.00	197	13	51	15	0.04	135		N	545	N	86	42	8	823	815	1.03		
342																			
343									N										
344	8.10	65	2.5	1.6	0.1	0.014	76	0.16	7.6	132	N	26	10	1.2	229	248	0.98		
345	7.8	66	3.5	25	3.4	0.01	70	0.3	0.03	184	0	42	18	1.2	313	320	1.01		
346	7.4	46	4.4	17	2	0.027	46	0.2	0.04	124	0	27	15	0.5	208	219	1.03		
347	7.4	41	7.9	25	2.6	0.009	72	0.34	0.05	156	0	21	12	0.8	261	259	1.02		

#	pH	Na	K	Ca	Mg	Fe	SiO2	B	Li	HCO3	CO3	SO4	Cl	F	TDSm	TDSc	ChgBal	delD	delO18
348	7.8	276	27	58	18	0.015	25	0.61	0.95	702	0	222	36	6.2	945	1015	0.98		
349	7.20	194	24	76	22		53	0.44		702	N	99	31	3	833	848	1.00		
350	7.7	45	1.1	68	6	0.005	42	0.19	0.03	284	0	31	22	0.2	376	355	0.99		
351	7.7	36	0.3	5.8	1	0.002	40	0.01	0.04	94	0	9.5	6.3	0.3	143	146	1.01		
352.1	8.00	28	6.5	62	22	0.06	25	0.12		321	N	47	8.6	0.6	380	358	0.97		
352.2	9.98	52	1.5	0.723	0.06		70			43	29	14	10	4.8		203	0.94		
353	8.06	12	3.3	40	18		22		1.5	185		38	16	0.22		241	0.95		
354	8.1	54	12	57	17	0.008	32	0.44	0.25	368	0	17	14	2.8	380	388	1.00		
355	6.88	36	5.5	71	23	0.01	24	0.13	0.11	380		29	9.5	0.9		386	1.00	-114	-15
356	7.03	24	5.9	58	19	0.01	27	0.14	0.075	290		47	9.9	1.3		335	0.93	-119	-15.7
357	7.14	5.3	1.6	67	24	0.01	13	0.03	0.018	300		14	2.9	0.2		276	1.05	-108	-14.5
358	7.5	10	3.4	50	21	0.003	26		0.022	270		12	6.6	0.2		262	0.97	-105	-14.3
359				40	23		46		10	178		27	18		283	242	0.98		
360	7.60	24	5.1	60	24	0.01	28	0.1	0.85	300		43	9	1	343	342	1.00		
361	7.38	22	4.4	55	22	0.009	25	0.11	0.053	260	0	44	9.3	1.2		311	1.02	-119.5	-15.8
362	9	1680	18	7.1	5.4		20	18.4	0.95	1590	200	425	937	7.68	4920	4101	1.09		
363	7.8	68	17	56	17	0.008	51	0.4	0.24	350	0	47	26	2	405	457	1.00		
364	8	123	25	91	31	0.1	37	0.8	0.33	698	0	59	9.8	2.4	700	723	1.00		
365	7.6	120	22	100	26	0.002	27	0.62	0.3	673	0	51	15	2.7	732	696	1.02		
366				44	37	0.1	11		0.324	124	N	11	2		132	166	2.26		
367																		-101	-13.2
368																			
369	7.20			1.1	0.6			0.02		50	N	22	2	0.2		51	0.08		
370													578			578	0.00		
371	7.90	792	60	38	38	0.8	23	9.8		720	N	323	860	3.2	2500	2502	0.96		
372	8.40	875	2.5	71	2		48			56		1120	625	5.6		2777	0.99		
373	7.10			48	7.4			1.7		60	N	98	70	4.2		259	0.58		
374	7.90			17	2.7			0.06		128	N	12	3	0.2		98	0.44		
375																			
376	7.00			49	9.6	0.17				614	N	120	74	4.3	940	559	0.22		
377	8.30			13	4			0.42		158	1	38	7	1.5		143	0.26		
378	8.3	430	45	37	4		140	9.4		224	0	80	460	3.1	1494	1319	1.19		
379																			
380																			
381	7.10	334	16	47	2.7	0.12	62	1.4		328	N	487		7	1180	1119	1.10		
382	7.90			48	4.9	N				266		106	54	2.7	560	346	0.34		
383				9.6	2.4				0.65				47			59	0.51		
384																			
385	7.70	47	2.5	62	5.9	0.03	38	0.18		240	N	48	23	0.8	346	345	1.01		
386	7.75	240	0.4	220	0.4		17		0.25	110	0	890	49	0.8	1600	1472	0.99		
387	7.05	49	0.9	21	1.3	0.06	55		0.02	160	0	21	7.8	0.3	229	235	1.00		
388	9.00	81	2.6	1.6	N		61		N	187	N	16	6	0.6	287	261	1.02		
389	7.00	142	15	74	27	1	30			577	N	71	34	0.9	624	679	1.05		
390	8.20			11	5.8	N				155	N	24	55	4.5	427	177	0.21		

#	pH	Na	K	Ca	Mg	Fe	SiO2	B	Li	HCO3	CO3	SO4	Cl	F	TDSm	TDSc	ChgBal	delD	delO18
391	7.7	45	2.8	57	7.7		37		0.05	231	0	48	23	0.6	396	335	1.01		
392	8.00			36	22					357	N	25	5			264	0.55		
393																			
394																			
395	8.00	29	7.2	44	23		33	0.1		260	N	36	11	0.5		312	1.03		
396	8.40	23	5.2	45	23	N	28	0.2	N	272	N	27	8	0.5	295	294	1.00		
397	8.10	32	6.8	39	18		31	0.1	5.6	231	N	34	9.7	0.5	286	285	1.04		
398	8.3	3.8	0.9	55	31	0.006	14		0.013	289		8.9	4.1	0.1		260	1.09	-97	-12.9
399	8	34	5.6	26	3.5	0.009	55		0.057	146		18	10	1.3		225	1.03	-101	-13.4
400																			
401	8.10	38	6.8	31	9.8	N	51	0.1		189		29	15	1.6	271	275	0.99		
402	7.5	6.5	1.5	56	26	0.042	14		0.016			6.9	7.9	0.1		119	14.14	-103	-13.7
403	8.20	46	15	43	6.2	<0.01	91			239	N	42	12	1.4	380	374	0.97		
404	7.20	39	14	34	4.8		106			200		30	8	1.4		336	0.99		
405	7.90	169	3	18	1.5		69	0.4		254		127	45	5	564	563	1.01		
406	8.20	106	5.8	14	1.9	0.12	68			194	N	69	27	4	368	391	1.01		
407	7.35	64	9.7	44	16	0.023	38		0.11			75	20	3	372	270	2.87		
408	8	50	2.2	22	1	0.05	22		0.05	147	0	40	7.6	0.9	210	218	0.97		
409	7.6	120	11	44	16	0.006	28			270		150	27	3.8	537	533	1.06		
410	7.30	71	8	51	18	N	20	0.51		300	N	80	22	2.2	552	420	1.00		
411		69	7.8	47	21		23	0.31	0.11	302	N	78	21	1.5	547	417	1.00		
412		69	7.8	48	19		22	0.26	0.0958	300	N	75	17	1.7	419	407	1.02		
413	7.90	69	6.8	45	20		29		0.6	285	N	81	21	1.3	528	413	1.01		
414	7.60	71	7.8	46	19		28		0.0419	283	N	80	22	1.2	529	414	1.02		
415		65	7.6	50	24	N	22	0.32		310	N	76	20	1.6	555	419	1.02		
416	7.20	69	7.7	49	21	0.02	23	0.1		310		80	21	1.4	425	425	0.99		
417		68	7.8	45	21		22	0.38		300		78	20	1.5	541	411	0.99		
418		97	8.6	44	19		28	0.44		318	N	105	25	1.3	480	485	1.00		
419	7.40	80	8.8	48	20		26		0.0463	311	N	92	32	1.4	593	461	0.97		
420		62	7.8	45	18		22	0.27		284	N	64	21	2.1	400	382	0.99		
421	7.3	300	9.5	76	39	0.006	26			346		500	130	1.7	1260	1252	1.02		
422		21	9.7	48	15	0.16	17			239	N	28	5		330	261	1.03		
423				55	29		18			239	N	42	4.9		268	266	1.04		
424		8.2		50.3	22.2					243.8	N	32.9	0.7		358.1	234	1.00		
425		5.7	1.2	47	23	0.02	13			235		35	4.5	0.2		245	0.96		
426	7.03	8.4	1.8	94	29	0.007	13		0.013	201		180	16	0.2		441	1.00	-91	-12.5
427	7.35	29	3.7	26.7	44.2	0.01	29.1	0.2		280		91	27	0.44	409	389	0.87		
428	7.4	8.1	3.6	48	25	0.05	14			222	0	51	6.5	0.2	266	266	1.00		
429				150	44		21			171	N	453	22		863	774	0.86		
430				155	50		30		1.2	205	N	405	35		857	776	0.93		
431				106	20					84	N	1027	112		1785	1306	0.27		
432	7.4	81	11	47	21	0.006	34		0.11	303		90	34	1.7		469	1.00	-101	-12.95
433	7.15	78	11	46	20	0.01	33	0.31	0.13	300		100	34	1.9		472	0.95	-100	-12.9
434	7.16	88	11	58	25	0.006	30		0.14	272		160	53	2.1		561	0.96	-97	-12.95

#	pH	Na	K	Ca	Mg	Fe	SiO2	B	Li	HCO3	CO3	SO4	Cl	F	TDSm	TDSc	ChgBal	delD	delO18
435	7.35	38	10	51	25	0.01	24		0.11	239		54	26	1.2		347	1.12	-75	-10.35
436		99	10	65	28		31	0.3		288	N	174	60	2.4	614	611	0.99		
437		101	11	70	26		29	0.3	0.6	274	N	179	64	2.3	620	617	1.02		
438	7.3	25	5.3	130	43	0.08	29		0.039			370	15	1		618	1.38	-87	-11.65
439	7.27	120	13	110	48	0.043	21		0.19	210		360	170	2.1		948	0.95	-97.5	-13.3
440	9.60	36	2.7	5	0.7	<0.15	0.64	0.57		37	N	64	8.1	0.1	160	136	0.89		
441	8.1	340	26	500	170	0.01	17	1.3	0.66	160	0	1900	380	1.5		3415	1.03		
442	7.9	300	20	450	140	0.03	17	1.1	0.6	160	0	1600	340	1.4		2949	1.04		
443	6.96	130	13	120	47	0.004	23		0.21	226		380	200	1.4		1026	0.91	-94	-13.45
444	7.00			298	113	N	38			98		1200	1190	1.5	3720	2889	0.40		
445	8.12	271	7.4	62.7	2.7	<0.15	38.94	0.58		113.8	N	431.3	143.6	4.05	1040	1018	1.01		
446	7.90	680	17	290	4.8	0.01	40	1.4		41	N	730	1000	3.9	2790	2787	1.01		
447	7.60	160	3.1	37	6.9	0.01	25	0.7		79	N	180	180	1.4		633	0.93		
448	7.3	350	8.3	220	75	0.02	28	0.82		203		570	600	1	2090	1953	1.01		
449	7.9	160	4	58	16		27			156	0	190	180			712	0.97		

Nevada Geothermal Resource Use — 1993 Update

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Geology

Nevada is well-endowed with both high- and low-temperature geothermal resources. Over 40 percent of the state is believed to have potential for the discovery of high-temperature (>90°C) geothermal resources, and another 50 percent has potential for low- to moderate-temperature (<°90C) resources (see Figure 1). Surface and subsurface indications of these resources are the more than 1,000 thermal springs and wells in the state. Realistically, this number of individual springs and wells represents several hundred resource areas.

Geothermal reservoirs in the northwestern part of the state have generally higher temperatures; these reservoirs are usually interpreted as being related to circulation of groundwater along faults to deep levels in a region of higher-than-average heat flow. In east-central and southern Nevada, the low- to moderate-temperature geothermal resources are generally believed to be related to regional groundwater circulation in fractured carbonate-rock aquifers. Discharge areas (for example, warm springs) may be up to several hundred kilometers from the area of recharge, and the waters may have circulated for dozens to hundreds of years to depths of several kilometers. Maximum temperatures attained during this journey could be 100°C or higher, but spring temperatures at discharge points are generally less than 65°C.

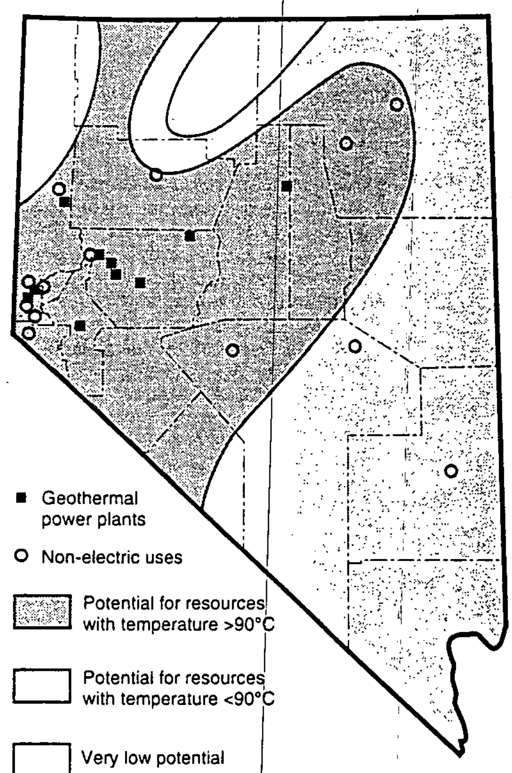

Figure 1. Generalized locations for Nevada's geothermal resources.

Exploration and Development

Two hundred and eighteen geothermal well permits were issued from 1988 through 1993 by the Nevada Division of Minerals. They include 58 industrial-class production wells, 30 domestic class, 88 observation or gradient wells, 10 commercial-class, and 25 injection wells. During this same period 109 geothermal wells are reported to have been drilled, with a total amount drilled of approximately 86,500 m. Forty-five of the wells drilled were production wells, with a total amount drilled of approximately 44,800 m. Figure 2 and Table 1 illustrate the number of power generating wells and pace of drilling since 1980.

From 1989 through 1992 noncompetitive and competitive federal geothermal leases in Nevada generated $1,699,282 in rental fees, $849,641 of which was returned to the State of Nevada. Federal production royalties during the same period generated $7,485,000, of which $3,742,500 was returned to the State. Geothermal lease returns ($849,641) and royalty returns ($3,742,500) to Nevada totaled $4,592,141. By regulation, half of all funds collected by the Bureau of Land Management from federal geothermal leases and production royalties is returned to the state.

Geothermal Electric Power Generation

Electric power is generated using geothermal resources at 10 plants in northern Nevada (Table 2, Figure 1). The state's

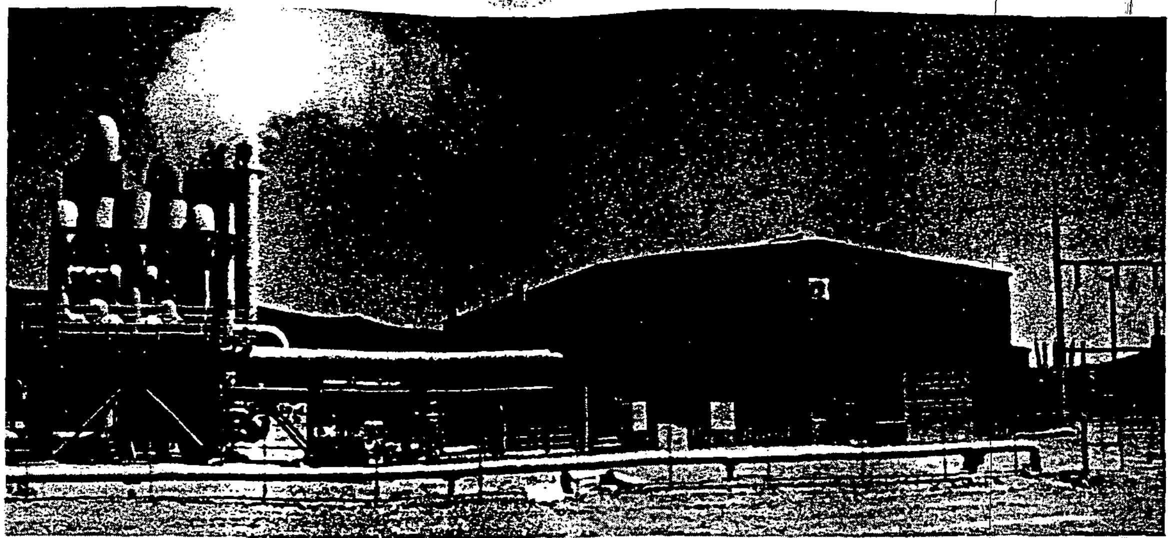

Figure 4. Steam separators and power house at Brady Hot Springs plant (Brady Power Partners), Churchill County, NV. *Larry Green photo.*

Table 2. Total number of all classes of geothermal wells drilled and number of industrial-class geothermal wells drilled by year, 1988 through 1993. *Source:* Hess, 1993; Nevada Division of Minerals, 1993.

Plant name (year on line)	Production capacity[1] (MW)	1992 Production (MWh)		Location	Operator
		Gross	Net (sales)		
Beowawe (1985)	16.0	138,196	104,415	S13,T31N,R47E	Oxbow/Beowawe Geothermal Power Co. P.O. Box 6 Beowawe, NV 89821
Bradys Hot Springs (1992)	21.1	69,999	54,563	S12,T22N,R26E	Oxbow Power Services, Inc. P.O. Box 649 Fernley, NV 89408
Desert Peak (1985)	8.7	85,364	76,906	S21,T22N,R27E	Western States Geothermal Co. P.O. Box 2627 Sparks, NV 89432-2627
Dixie Valley[2] (1988)	66.0	535,220	483,307	S7,T24N,R37E S33,T25N,R37E	Oxbow Geothermal Corp. 5250 South Virginia St. Suite 304 Reno, NV 89502
Empire (1987)	3.6	17,783	12,752	S21,T29N,R23E	OESI/AMOR II P.O. Box 1650 Fallon, NV 89407
Soda Lake No. 1 (1987) and Soda Lake No. 2 (1991)	16.6	107,315	84,419	S33,T20N,R28E	OESI/AMOR III P.O. Box 1650 Fallon, NV 89407
Steamboat I, I-A (1986) and Steamboat II, III (1992)	31.1	104,574	79,790	S29,T18N,R20E	S.B. Geo, Inc. P.O. Box 18087 Reno, NV 89511
Stillwater (1989)	13.0	72,707	59,692	S1,T19N,R30E S6,T19N,R31E	OESI/AMOR IV P.O. Box 1650 Fallon, NV 89407
Wabuska (1984)	1.2	6,262	3,860	S15,16,T15N, R25E	Tad's 10 Julian Lane Yerington, NV 89447
Yankee Caithness (1988)	14.4	82,280	76,096	S5,6,T17N,R20E	Yankee Caithness J.V. L.P. P.O. Box 18160 Reno, NV 89511
TOTAL	191.7	1,219,700	1,035,800		

[1]Production capacity from currently developed geothermal resources.
[2]Gross output of the Dixie Valley plant occasionally exceeds 66 MW.
Source: Hess (1993).

The plant uses 5.4 million pounds of brine per hour produced from six of eight production wells. The production zone is 300 to 425 m deep with a resource temperature of between 172 and 182°C. The wells supply two high pressure turbines and one low pressure turbine in a two stage system that produces 21.1 MW gross output. Geothermal fluids are injected into three of five available injection wells (Ettinger and Brugman, 1992; GRC *BULLETIN*, v. 21, no.1).

Desert Peak

The **Western States Geothermal Co., Desert Peak** plant went online in 1985. It was designed by Phillips Petroleum Co. and uses a biphase turbine built by TransAmerica Corp. Production capacity from the currently developed resource is 8.7 MW. The resource temperature is approximately 205°C and wellhead temperature is 165°C.

Dixie Valley

The largest single geothermal power plant in Nevada, **Oxbow Geothermal Corp. Dixie Valley** plant, came online in 1988 producing 55-59 MW (net). (Gross output sometimes exceeds 66 MW, as listed on Table 2.) The power is produced in a double-flash turbine generator and purchased by Southern California Edison Co. Oxbow estimates a geothermal energy reserve in Dixie Valley sufficient to supply 200 MW for 30 to 60 years (GRC *BULLETIN*, June 1987; *Reno Gazette-Journal*, August 6, 1988).

Empire/San Emidio Desert

The **OESI/AMOR II Empire** plant came online in 1987 and consists of four Ormat Energy Converter Modules with a gross output of 3.6 MW from currently developed geothermal resources. Production is from a liquid-dominated geothermal source at 129 to 137°C. **San Emidio Resources** continued their geothermal program in the **San Emidio Desert** near Gerlach, Nevada. Early in 1991 San Emidio Resources signed a 5 MW, 30-year geothermal power supply contract, effective 1992, and a 20 MW, 30-year geothermal power supply contract, effective 1995, both with Sierra Pacific Power Co. (GRC *BULLETIN*, February 1991). The initial price paid for produced electricity under the long-term contracts is reported to be approximately 5 cents per kWh. At that time plans called for construction of a 6.5 MW binary plant to be online by November 1992. Since then San Emidio Resources requested and was granted a suspension of the 5 MW project in order for Sierra Pacific Power Co. and San Emidio Resources to determine the feasibility of combining the 5 and 20 MW projects into one project. In July 1993, Sierra Pacific Power Co. executed an amendment to the long-term power purchase agreement with San Emidio Resources. The agreement now calls for a 30 MW geothermal power plant to be online by November 1, 1995 (Public Service Commission of Nevada).

Fallon

In early 1992 the **U.S. Navy** issued a request for proposal to construct an 80 to 90 MW geothermal power plant at the Fallon Naval Air Station. If this plant is constructed, it will be Phase I of the Navy's geothermal program. Phase II will consist of a second 80 to 90 MW facility to be constructed within 10 years of completion of the Phase I project. The Navy estimates that the potential geothermal resource in the area will be able to produce 300 to 500 MW. The exploration drilling and reservoir testing performed during the initial phase of this project will be used to better define the geothermal potential of this area. Based on previous exploration information it is expected that the resource will be in the 175 to 205°C range.

Fish Lake Valley

Fish Lake Power Co. continued their extensive drilling efforts to develop a geothermal resource in the Fish Lake Valley area of Esmeralda County. If a geothermal generating facility is built, the electricity would be delivered to California under a Standard Offer No. 4 Contract.

Hot Sulfur Springs

Earth Power Energy and Minerals has requested an avoided-cost purchase contract agreement with Idaho Power Co. If a contract were obtained, a 9.9 MW geothermal power plant could be constructed at Hot Sulfur Springs, Elko County, Nevada (*Reno Gazette-Journal*, October 10, 1993).

Rye Patch

The **Rye Patch Limited Partnership (OESI)** is currently nearing completion of a 12.5 MW binary generating plant at their site near **Rye Patch** reservoir. The company has a signed purchase agreement with Sierra Pacific Power Company with an anticipated plant online date of November 30, 1993. This has been delayed while the company continues to develop sufficient and continuous geothermal resources to fuel the plant.

Soda Lake

On August 19, 1991, the 13 MW **OESI/AMOR III Soda Lake No. 2** geothermal power plant completed commercial operations testing and went online. This plant is adjacent to the 3.6 MW OESI **Soda Lake No. 1** plant that came online during 1987 (GRC *BULLETIN*, October 1991). Both plants are producing from a liquid-dominated geothermal source at 160°C.

Steamboat Springs

Two 12 MW, air-cooled, binary geothermal power plants, **Steamboat II and III**, operated by **S.B. Geo, Inc.**, were brought online in December 1992, adding 24 MW of produc-

tion to the existing 7.1 MW **S.B. Geo Steamboat** plant, for a combined gross production capacity of 31.1 MW.

The geothermal fluid cycle at the new plants is completely contained and the fluids are injected back into the ground (closed binary-cycle system). The existing resource is expected to last 30 years or more and can support an additional 36 MW of production capacity. Based on this, plans are currently being formulated to determine the feasibility of installing an additional 24 MW facility in the near future. In December 1993, S.B.Geo, Inc. received a $7.2 million grant from the U.S. Department of Energy to develop a pilot project known as the Kalina Pilot Plant. The purpose of the project is to increase the efficiency of extracting heat from hot geothermal fluids.

Yankee Caithness J.V.L.P. operates a 14.4 MW (gross) flash turbine system producing from a 170°C resource. The **Yankee Caithness Steamboat** plant came online in 1988, and the produced power is purchased by Sierra Pacific Power Co. on a 30 year contract.

Stillwater

OESI/AMOR IV, Stillwater Geothermal plant came online in April 1989. Total project cost was $36 million. The air-cooled plant consists of 14 Ormat Energy Converters that have a combined gross generating capacity of 13 MW. The plant uses a liquid-dominated geothermal source ranging in temperature from 155 to 170°C. The plant operates on a closed system; all geothermal liquids are injected (Ormat Fact Sheet, 1989; Geo-Heat Center, Fall 1989).

Wabuska

Tad's Wabuska plant came online in 1984. Current production capacity is 1.2 MW produced from two Ormat Energy Converter modules. The plant operates on fluids at 107°C. produced from a depth of 107 m (GRC *BULLETIN*, July, 1987).

Non-Electric Low- and Moderate-Temperature Applications

The majority of Nevada's population is concentrated in two areas, Reno-Carson City and Las Vegas. Many of the state's geothermal resources are remote from any population centers, thus limiting some potential applications. Although 50 or more small-to-large communities are located within 8 km of geothermal resources, only a few of these areas have been able to use these resources effectively. The reasons for this under-utilization are varied. Although some reasons relate to technical and engineering problems (resource size and temperature, heat loss during transport, etc.), many more are economic (high capital outlays, long payout, under-capitalization of projects) and perceptual (unconventional *vs.* conventional technology, short *vs.* long-term cost evaluations, uncertainties about long-term economic risks).

There have been attempts to use Nevada's low- and moderate-temperature geothermal resources in more than 20 areas, mainly in the past 5-10 years. Additionally, economic and/or technical appraisals of more areas have been conducted, but for a variety of reasons projects were not completed.

Moana Geothermal Area

Moana Hot Springs, located in the southwestern part of Reno, have not flowed at the surface for at least 15 years. The springs were the discharge point for an area of thermal groundwater that has been used for a spa, swimming pool, and home heating for nearly 100 years. Recent use for home space heating began in the 1960s. The area today is predominantly residential. We estimate that the area of thermal groundwater encompasses at least 9 km^2. In this area there are more than 300 homes that use geothermal fluids for space heating. One hundred and thirty of these homes are part of a district heating system, while most of the rest use downhole heat exchangers in individual wells. A smaller district heating system has retrofitted 12 homes for geothermal heat, and plans to add another four in the spring of 1994. A large hotel, a motel, about three apartment or townhouse complexes, five churches, and a county swimming pool also use the resource. The Veterans Administration Hospital, located about 2 km northeast of the geothermal area, drilled a deep well several years ago and encountered approximately 43°C water. The well was plugged and abandoned.

Steamboat Hot Springs

The Steamboat geothermal area consists of a deep, high-temperature (215 to 240°C) geothermal system; a shallower, moderate-temperature (160 to180°C) system, and a number of shallow, low-temperature (30 to 80°C) subsystems (Goranson and others, 1991). The higher temperature systems are used for electric-power generation (see the preceding section). A number of low-temperature thermal groundwater anomalies are in an area of approximately 30 km^2 centered on the hot spring area (Goranson and others, 1991), but these thermal areas are not well known and are little used. A few homes in the Steamboat area have used low-temperature fluids for over 40 years, and one or more spas have been active in the springs area since the 1860s. Presently probably less than a dozen homes use the low-temperature geothermal fluids for space heating or domestic hot water (including swimming pools). About one domestic geothermal well permit has been issued per year over the last 5 to 7 years.

Bower's Hot Springs

A large outdoor swimming pool and smaller children's pool at the Washoe County Park at Bower's Mansion (lo-

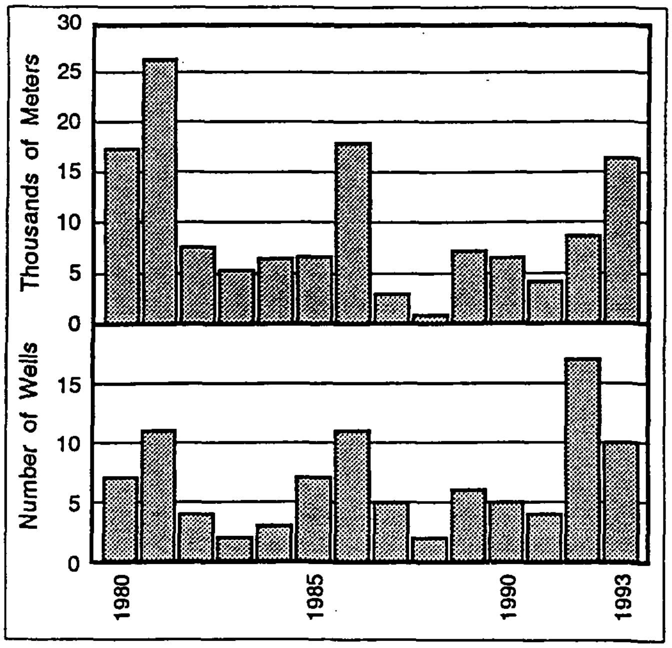

Figure 2. Industrial-class (power generating) wells drilled in Nevada, 1980-1993.

total installed geothermal generating capacity is second only to California.

In 1993 the state-wide peak power demand was 3,755 MW; the total installed generating capacity of Nevada's two major utilities (which supply most of the state's customers) is nearly 2,600 MW (Public Service Commission of Nevada). Thus, geothermal energy provides about 7 percent of the total electricity generated within Nevada (although only about 3 percent of the peak load). Over 40 percent of Nevada's geothermal electric power is exported to California.

From 1989 to 1992, total Nevada geothermal electrical production was 4,076,616 megawatt-hours with an approximate sales value of $307,410,000. Production capacity in 1988 from eight geothermal power plants was 115.8 MW (gross) while current power production from 10 existing geothermal power plants in Nevada is 191.7 MW gross (Table 1). These values represent a 17 percent increase in sales value of the power sold from 1988 to 1992 and an increase in installed gross power production capacity of 60 percent over 1988.

It is important to note that in 1988 Nevada had nearly a threefold increase over 1987 in the amount of online geothermal generating capacity (Figure 3). The primary reason for this increase was the Dixie Valley 60 MW Oxbow Geothermal plant being put online. The OESI plants at Empire (4.8 MW) and Soda Lake No. 1 (3.6 MW) were also brought online during this period.

According to a 1991 Department of Energy estimate, under stable market conditions and with continuing technologic advancements in the geothermal industry, Nevada's projected electrical production capacity from known geothermal resources by the year 2010 should be at least 600 MW (Energy Information Administration, 1991). It is estimated that, for the Basin and Range province as a whole, aggressive exploration activity and continued rapid geothermal technologic advancements could add up to 2,000 MW of production capacity from known resources and new discoveries over the next 10 to 20 years (Wright, 1992). These relatively optimistic future scenarios should be tempered by today's reality of low-priced natural gas, increases in efficiency of fossil fuel generating equipment, and anticipated changes in power sales contracts. The future is bright for Nevada's high-temperature resources, but the pace of development will depend on many factors not related to the viability of the geothermal resource.

Table 1. 1992 directory of Nevada geothermal power plants.

Year	Total # drilled	Total depth(m)	No. Industrial wells drilled	Total depth(m)
1988	11	4,268	3	1,098
1989	15	14,817	6	7,317
1990	12	11,280	5	6,707
1991	14	12,561	4	4,268
1992	36	17,988	17	8,841
1993	21	25,596	10	16,686
TOTAL	109	86,510	45	44,917

Beowawe

The **Oxbow/Beowawe Geothermal Power Co., Beowawe** plant came online in 1988. It is a 16 MW (gross), dual-flash plant, which uses geothermal fluids from three wells with a resource temperature of 221°C.

Brady Hot Springs

The **Brady Hot Springs** geothermal power plant (Figure 4) came online in July 1992. Plant operation and maintenance is being performed by **Oxbow Power Services, Inc.**

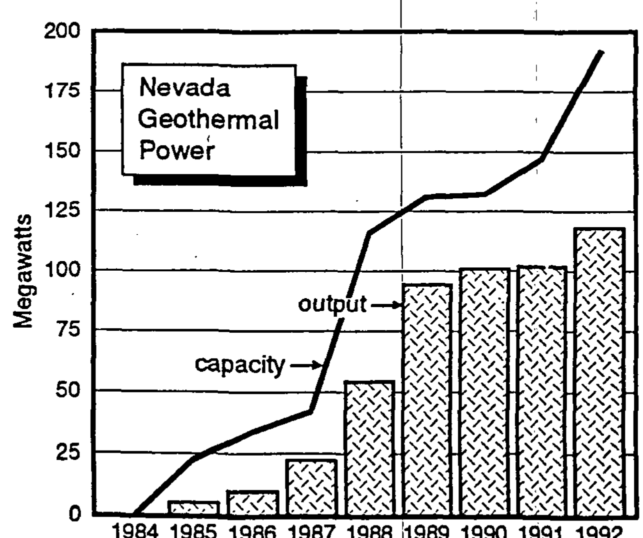

Figure 3. Rated capacity and average net output of Nevada geothermal plants, 1984-1992. Average net output is annual sales in megawatt-hours divided by the number of hours in a year (8,760).

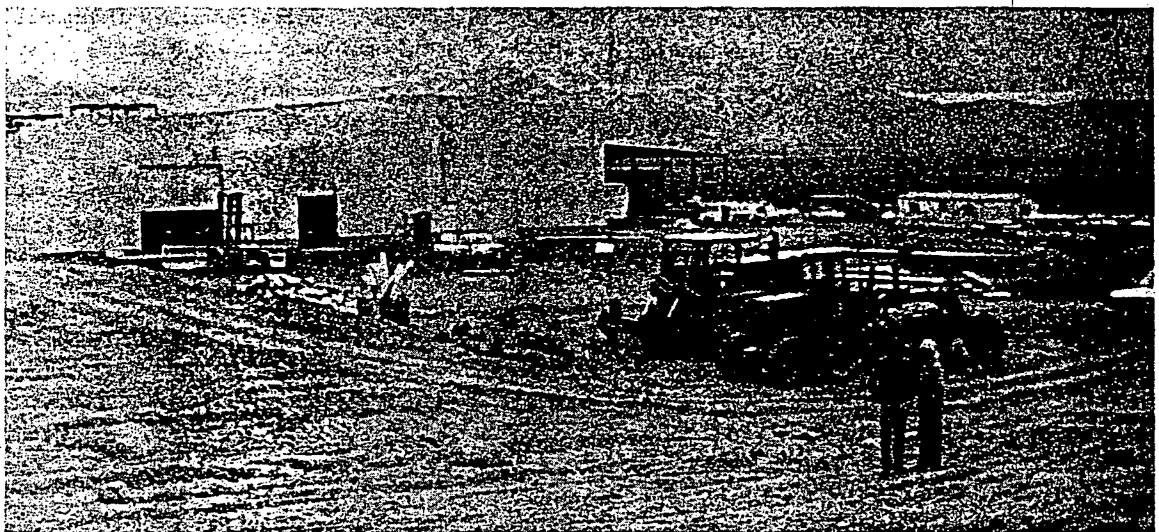

Figure 5. Vegetable-dehydration plant under construction in the San Emidio Desert. *Larry Green photo.*

wells are used in a heat exchanger to transfer heat to cyanide heap-leach solutions (Trexler and others, 1990).

Carlin

Carlin Hot Springs, located near the Humboldt River southwest of the town, have a reported temperature of 80°C (Trexler and others, 1982). The Carlin High School used 31°C geothermal fluid from 280 m well from 1986 to 1992 in a closed-loop space heating system. The well was abandoned in 1992, apparently in part because of scaling problems with iron and manganese.

Elko Area

Hot springs south of the town of Elko were first used in a bath house in the 1860s (Garside and Schilling, 1979). Thermal groundwater was known to exist to the north of the springs under a part of the town, but no use was made of it until the Elko Heat Company began supplying geothermal fluid for space heating to several downtown buildings in 1982 (Rafferty, 1988). The company has continued to grow; in 1993 it served 16 commercial customers and two residential customers (Mike Lattin, oral commun., 1994).

The Elko County School District, in conjunction with the Elko General Hospital, developed a district geothermal heating system in 1986. The system supplies heat to eight buildings (two schools, a municipal swimming pool complex, a gym, a convention center, a hospital, a city hall, and a school administration building). In 1988 the estimated combined savings to all users was $300,000 per year (Rafferty, 1988; Richard Harris, oral communication, 1994).

Jackpot Area

Two wells drilled in 1988 at the Y3 Ranch about 7 km southeast of Jackpot, were used for raising catfish. The maximum reported well temperature was 40°C (Lund and others, 1990). The catfish-raising operation was not active in late 1993, reportedly due to insufficient geothermal fluid.

Wells Area

Warm springs about 1.5 km north of the present town of Wells were referred to by travelers on the emigrant trail in the 1850s as Humboldt Wells (from which the town name is derived). Thermal (32 to 34°C) groundwater is used by an elementary school and the Wells Rural Electric Co. in heat pump applications for space heating.

Duckwater (Big Warm) Springs

A geothermal catfish-growing facility has been operated at this site since 1982. The facility was purchased in 1992 by Robert and Jeff King (Valley Fish) of Preston, Idaho. The facility, located about 110 km west of Ely, produces over 300,000 pounds of prime 8-ounce catfish filets per year that are shipped to Idaho for sale (*Geo-Heat Center Quarterly Bulletin*, December 1992).

Caliente Hot Springs

The town of Caliente in Lincoln County derives its name from the local hot springs. A number of wells in the area have reported temperatures from 40 to 80°C (Garside and Schilling, 1979; Lienau and others, 1988). A motel supplies geothermal well water to bathing pools and individual room whirlpool baths, and a trailer park supplies hot water to individual mobile homes. The Lincoln County Hospital (20 beds) was heated using 39°C water from a well on the site, but reduced temperatures (to 28°C) forced reliance on electric resistance heating. The hospital plans to use the lower-temperature fluids from its well for heating and cooling using heat-pump technology. The city swimming pool used

cated between Reno and Carson City), are supplied with warm water from a geothermal well located near the spring.

Carson City Area

Water from a well at the site of Carson Hot Springs in northern Carson City is used directly in a swimming pool. In southeast Carson City, thermal groundwater is found in the State Prison/Pinyon Hills area. In the past, there have been a few attempts to use the thermal groundwater from domestic wells in that area for space heating. Geothermal space heating has been considered, but not implemented, for at least two schools in the area.

Saratoga Hot Springs

A California company, Lobsters West, has proposed raising lobsters near the warm springs located about 15 km southeast of Carson City. The geothermal fluids would be used to heat tanks in which the lobsters would grow to full size. The experimental study is proposed to last 4 years; live lobsters would be shipped twice a month to local markets (*Reno Gazette-Journal,* November 4, 1993).

Hobo Hot Springs

These hot springs, located about 15 km south of Carson City, were used to raise tropical fish and Malaysian prawns in the late 1980s. Lobster raising was also considered. The water temperature is slightly over 40°C. The site is presently inactive.

Walley's Hot Springs

Walley's Hot Springs, located near Genoa, about 20 km south of Carson City, was the site of a large spa in the late 1800s and early 1900s (Garside and Schilling, 1979). A modern spa was built on the site in the early 1980s. In addition to use of the geothermal fluids for bathing and domestic hot water, the buildings are heated with geothermal energy (Lienau and others, 1988).

Gerlach

Hot springs located just west of the town of Gerlach (Great Boiling Springs) have been used for bathing for many years. The Gerlach General Improvement District built a bath house using geothermal fluids in 1989. The facility was planned for use by tourists and local residents. The facility has been unable to obtain a permit from the health department because sediment from the well plugged water filters. Future plans are for a geothermal heat exchanger system to heat city water for the spa. Geothermal groundwater apparently extends under at least part of the town, as at least two Gerlach homes use geothermal wells for space heating. The water in one well is reported to be 35 to 36°C (unpublished data, Nevada Division of Minerals).

San Emidio Desert

A vegetable dehydration plant is under construction in the San Emidio Desert area southwest of Gerlach (Figure 5). The plant is a few kilometers north of the Empire (OESI/AMOR II) Electric-Power plant. Integrated Ingredients (Spice Islands, Fleischmann's, and other brands), part of international food manufacturer Burns Philp, is contracting for the construction of the facility, which will employ about 25 persons when completed in early 1994. The number of employees may increase to about 65 after 18 months. Onions and garlic will be dehydrated and stored at the plant (*Reno Gazette-Journal,* August 31 1993). The plant will use approximately 150°C geothermal fluid.

Brady Hot Springs

A geothermal vegetable dehydration plant has been operated at this site, about 80 km northeast of Reno, since 1978. The facility uses a moderate-temperature (132°C) geothermal well on site. Since 1993, additional geothermal fluid has been supplied by the nearby Brady Power Partners electric power generation plant, operated by Oxbow Power Services, Inc.

Wabuska Hot Springs

In addition to the rather low-temperature electric-power generation plant operated at Wabuska by Tad's Enterprises, several non-electric applications have been located in the area, but none are active today. A hydroponic geothermal greenhouse operation (tomatoes, cucumbers, etc.) was built on the site in the early 1970s, but few vegetables were grown. Tad's Enterprises has in the past operated a geothermal ethanol facility, a plant to grow algae (*Spirulina*) for human consumption, and facilities to raise Malaysian prawns, catfish, and tropical aquarium fish. Some of these were pilot facilities, rather than actual production facilities.

Rye Patch Geothermal Area

Florida Canyon Mining Co. operates a large open-pit gold mine and heap-leach gold recovery facility about 50 km northeast of Lovelock, and 7 km north of the area presently under development by Rye Patch Limited Partnership for geothermal electric power production. A 180 m well produces fluids at approximately 100°C; these fluids provide makeup water for the cyanide extraction solutions. Heat from heat exchangers is also extracted to heat the solutions. The heating of cyanide solutions aids extraction during cold weather, and may somewhat enhance total gold recovery.

Darrough's Hot Springs Area

Round Mountain Gold Corp. operates a large open-pit gold mine and heap-leach gold recovery facility near the Darrough's Hot Springs geothermal area in Nye County. Geothermal fluids from shallow (approximately 300 m)

geothermal heat in the past, but was damaged during the winter of 1992 and will probably be replaced. The City of Caliente has a grant from the Rural Development Administration to use the local geothermal resources. A nearby perlite processing plant may be the first user of plant process heat. If more funding is found, the city plans to provide heat to the hospital, swimming pool, and eventually an elementary school and youth training facility (Glen Van Roekel, oral communication, 1994).

Ash Springs

Thermal waters (31 to 36°C) at Ash Springs, located about 10 km north of Alamo, in Lincoln County, have been used in the past at a spa on the site. The facility is presently closed.

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NEVADA BUREAU OF MINES AND GEOLOGY

UNIVERSITY OF NEVADA RENO

Mail Stop 178
Reno, Nevada 89557-0088
Telephone: (702) 784-6691
FAX: (702) 784-1709

November 16, 1992

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

Dear Howard:

I have enclosed with this letter a formal proposal for NBMG's Low-Temperature Geothermal Resource Program. I have included my resume, as Principal Investigator, as well as copies of the University's regulations on travel, the motorpool rates for vehicles, and a copy of UNR's negotiated indirect-cost agreement. Please note that the audit agency (Dept. of Health and Human Services), and the representative's name and telephone number are on this document. The Statement of Work that you supplied to me is agreeable to NBMG and the University. I and NBMG will be supplying time and other services to the project that are not accounted for in the budget, and can certainly be considered as cost sharing. I hope that I have supplied enough detail on the budget items; I think they are mostly pretty straightforward.

Please contact me if you need more information. I look forward to working with you and the geothermal research team at UURI.

Sincerely yours,

Larry

Larry Garside
Research Geologist

LJG/hs

encl.

THE BOARD OF REGENTS
UNIVERSITY AND COMMUNITY COLLEGE SYSTEM OF NEVADA
on behalf of the

UNIVERSITY OF NEVADA, RENO

Office of the Associate Vice President for Research
Mail Stop 326, Getchell Library, Reno, Nevada 89557-0035

SPONSORING AGENCY	**Oregon State System of Higher Education** **Oregon Institute of Technology**
TITLE OF PROPOSED PROJECT	**Nevada Low Temperature Geothermal Resources**
PERIOD OF PROPOSED PROJECT	**December 1, 1992 - December 31, 1993**
TOTAL PROPOSED PROJECT	**$55,000**
PRINCIPAL INVESTIGATOR(S)	**Larry J. Garside**
DEPARTMENT/COLLEGE	**Nevada Bureau of Mines and Geology** **Mackay School of Mines**

Administrative representative to be notified upon award/declination.

Kenneth W. Hunter, Jr.
Associate Vice President for Research
Graduate School
Mail Stop 326
University of Nevada, Reno
Reno, NV 89557-0035
(702) 784-4040
FAX: (702) 784-6064

Kenneth W. Hunter, Jr., Sc.D.
Associate Vice President for Research

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 NEVADA BUREAU OF MINES AND GEOLOGY,
THE UNIVERSITY OF NEVADA, RENO

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 Nevada, 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 in support of this study.

2.3 Complete a computer database listing compatible with Lotus 123 or other acceptable 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 Nevada 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 Nevada. 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-GHC quarterly.

4.0 SCHEDULE OF PERFORMANCE AND REPORTING

4.1 The period of performance for this agreement will terminate on December 31, 1993, unless modified by letter agreement and signed by the University of Nevada - Reno, 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 and OIT-GHC not later than December 31, 1993.

5.0 RESPONSIBLE PARTIES

5.1 The Principal Investigator for this agreement will be Larry J. Garside, Nevada Bureau of Mines and Geology, University of Nevada, Reno.

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 $55,000.00 for the completion of all technical tasks and submittal of all required deliverables.

BUDGET
NBMG - LOW TEMPERATURE GEOTHERMAL RESOURCES

Salaries	
Professional ($48.25 x 320 hr)	$15,440
Support Staff ($20.31 x 240 hr)	4,875
Students ($7.00 x 1183 hr)	8,281
	28,596
Other Personnel Expenses	
Fringe benefits (Professional @ 3%)	463
Fringe benefits (Support Staff @35%)	1,706
Fringe benefits (Students @1.2%)	99
	2,268
Other Direct Costs	
Travel	2,307
Conferences (GRC, '93)	200
Supplies, field	586
Supplies, lab and office	2,500
Supplies, computer hardware, software	1,358
Reproductions	300
	7,251
Total Direct Costs	38,115
Indirect Costs @ 44.3%	16,885
Total	$55,000

Distribution by tasks

		Hours	Salary	Travel	Total
Task 1	Resource inventory	1,226	$22,300	$1,300	$22,000
Task 2	Fluid Chemistry	168	2,775	1,000	3,375
Task 3	Review Collocation	133	2,200	-	-
Task 4	Prioritize resources	115	1,900	-	-
		1,642			

Proposed Manpower

	Months(hours)
Professional	1.7 (320)
Support Staff	1.5 (240)
Students	7.1 (1183)

Travel Detail ($2,307)

1) One 3-day trip to OIT (one person): Lodging - $240; Per Diem - $102; Mileage - $195. Total = $377.

2) One 5-day trip for one person to GRC meeting in San Francisco, Oct 3-6: Lodging - 240; Per Diem - $120; Air Fare - $250. Total = $610.

3) Two 5-day trips for one person to various springs in eastern Nevada: Lodging - $340; Per Diem - $240; Mileage - $740. Total = $1,320.

Supplies Detail

2) Supplies, field: Bottles, maps, filters, reagents, film, etc. Total = $586.

3) Supplies, lab and office: Approx. 800 topographic maps @ $2.5 ea. - $2,000; copying, tele., paper, miscl. office supplies. Total = $2,500.

4) Supplies, computer hardware, software: Computer maintenance costs (Sun work station @ $1,000 per month); PC maintenance @ $100 per year; plotter paper, repairs, pens, tape cartridges, RBASE, etc. Total = $1,358.

UNIVERSITY OF NEVADA, RENO
CLARK ADMINISTRATION BUILDING
RENO, NV 89557-0025

DATE: March 20, 1992
FILING REF.: The precec
ing agreement was datec

Feb. 06, 1992 U50228

The rates approved in this Agreement are for use on grants, contracts and other agreements with the Federal Government, subject to the conditions contained in Section II.

SECTION I: RATES

Type	Effective Period From	To	Rate	Location	Applicable To
INDIRECT COST RATES*					
Indirect Cost Rates Applicable to Awards Effective Prior to July 1, 1992:					
Pred.	07/01/92	06/30/93	48.0%	On-Campus	Research
Pred.	07/01/92	06/30/93	29.7%	Off-Campus	Research
Pred.	07/01/92	06/30/93	50.0%	On-Campus	Instruction
Pred.	07/01/92	06/30/93	33.0%	Off-Campus	Instruction
Pred.	07/01/92	06/30/93	24.2%	On-Campus	Other Sponsored A
Pred.	07/01/92	06/30/93	20.1%	Off-Campus	Other Sponsored A
Pred.	07/01/92	06/30/93	16.7%	On-Campus	SNJCC
Indirect Cost Rates Applicable to Awards Effective On or After July 1, 199					
Pred.	07/01/92	06/30/93	44.3%	On-Campus	Research
Pred.	07/01/92	06/30/93	26.0%	Off-Campus	Research
Pred.	07/01/92	06/30/93	50.0%	On-Campus	Instruction
Pred.	07/01/92	06/30/93	26.0%	Off-Campus	Instruction
Pred.	07/01/92	06/30/93	24.2%	On-Campus	Other Sponsored A
Pred.	07/01/92	06/30/93	20.1%	Off-Campus	Other Sponsored A
Pred.	07/01/92	06/30/93	16.7%	On-Campus	SNJCC
Prov.	07/01/93	06/30/95	44.3%	On-Campus	Research
Prov.	07/01/93	06/30/95	26.0%	Off-Campus	Research
Prov.	07/01/93	06/30/95	50.0%	On-Campus	Instruction
Prov.	07/01/93	06/30/95	26.0%	Off-Campus	Instruction
Prov.	07/01/93	06/30/95	24.2%	On-Campus	Other Sponsored A
Prov.	07/01/93	06/30/95	20.1%	Off-Campus	Other Sponsored A
Prov.	07/01/93	06/30/95	16.7%	On-Campus	SNJCC

*BASE: Modified total direct costs consisting of salaries and wages, fring benefits, materials and supplies, services, travel, and subgrant and subcontract up to $25,000 each.

TREATMENT OF PAID ABSENCES
Vacation, holiday, sick leave pay and other paid absences are included in salaries and wages and are charged to Federal projects as part of the norma charge for salaries and wages. Separate charges for the cost of these bsences are not made.

TREATMENT OF OTHER FRINGE BENEFITS

This organization charges the actual cost of each fringe benefit direct to Federal projects. However, it uses a fringe benefit rate which is applied to salaries and wages in budgeting fringe benefit cost under project proposals. The following fringe benefits are treated as direct costs: STATE RETIREMENT, HEALTH INSURANCE, UNEMPLOYMENT COMPENSATION AND NEVADA INDUSTRIAL INSURANCE.

SPECIAL REMARKS

The rates in this agreement have been negotiated or revised, as appropriat to reflect the administrative cap provisions of the revision to OMB Circul A-21 published by the Office of Management and Budget on October 3, 1991. No rate affecting the institution's fiscal periods beginning on or after October 1, 1991 contains total administrative cost components in excess of that 26 per cent cap.

SECTION II: GENERAL

A. LIMITATIONS: The rates in this Agreement are subject to any statutory or administrative limitations and apply to a given grant, contract or other agreement only to the extent that funds are available. Acceptance of the rates is subject to the following conditions: (1) Only costs incurred by the organization were included in its indirect cost pool as finally accepted such costs are legal obligations of the organization and are allowable under the governing cost principles; (2) The same costs that have been treated as indirect costs are not claimed as direct costs; (3) Similar types of costs have been accorded consistent accounting treatment; and (4) The information provided by the organization which was used to establish the rates is not later found to be materially incomplete or inaccurate.

B. ACCOUNTING CHANGES: If a fixed or predetermined rate is in this Agreement, it is based on the accounting system purported by the organization to be in effect during the Agreement period. Changes to the method of accounting for costs which affect the amount of reimbursement resulting from the use of this Agreement require prior approval of the authorized representative of the cognizant agency. Such changes include, but are not limited to changes in the charging of a particular type of cost from indirect to direct. Failure to obtain approval may result in cost disallowances.

C. FIXED RATES: If a fixed rate is in this Agreement, it is based on an estimate of the costs for the period covered by the rate. When the actual costs for this period are determined, an adjustment will be made to a rate of a future year(s) to compensate for the difference between the costs used to establish the fixed rate and actual costs.

D. USE BY OTHER FEDERAL AGENCIES: The rates in this Agreement were approved in accordance with the authority in Office of Management and Budget Circular A-122, A-21 or HHS Hospital Cost Principles, as appropriate, and should be applied to grants, contracts and other agreements covered by the appropriate regulation, subject to any limitations in A above. The organization may provide copies of this Agreement to other Federal Agencies to give them early notification of this Agreement.

BY THE ORGANIZATION	BY THE COGNIZANT AGENCY ON BEHALF OF THE FEDERAL GOVERNMENT DEPARTMENT OF HEALTH AND HUMAN SERVICES
University of Nevada, Reno	
(ORGANIZATION)	(Agency)
[signature]	[signature]
(Signature)	(Signature)
Joseph N. Crowley	David S. Low
(Name)	(Name)
President	Director, Division of Cost Allocation
(Title)	(Title)
4-6-92	March 20, 1992
(Date)	(Date)
	HHS Representative Margo K. Hohulin
P-CU-H)	Telephone: (415) 556-1704

UNIVERSITY OF NEVADA, RENO
INDIRECT COST RATES FOR THE PERIOD
JULY 1, 1992 THROUGH JUNE 30, 1993

EXHIBIT A

	ORGANIZED RESEARCH			INSTRUCTION			OTHER SPON PROJ			
		ON-CAMPUS	OFF-CAMPUS		ON-CAMPUS	OFF-CAMPUS		ON-CAMPUS	OFF-CAMPUS	SNJ
BUILDING AND EQUIPMENT		5.30			3.50			1.40		
OPERATION & MAIN		11.30			7.70			1.60		
GEN ADMIN	7.70			4.90			7.70			7.70
DEPT ADMIN	20.10			14.50			11.20			0.00
SPONSORED PROJ ADMIN	1.90			0.10			1.20			0.00
ADMIN COMPONENTS	29.70	*26.00	26.00	19.50	19.50	26.00	20.10	20.10	20.10	7.70
LIBRARY		1.60			11.60			1.10		
STUDENT SERVICES		0.10			7.70			0.00		
TOTAL		44.30	26.00		50.00	26.00		24.20	20.10	1

THE ABOVE RATES ARE APPLICABLE TO AWARDS EFFECTIVE ON OR AFTER JULY 1, 1992

(*ADMINISTRATIVE COMPONENTS LIMITED TO 26.0% IN ACCORDANCE WITH OMB A-21, DATED OCTOBER 3, 1991.)

CONCUR:

Joseph N. Crowley
(SIGNATURE)

President
TITLE

4-6-92
DATE

DEPARTMENT OF HEALTH & HUMAN SERVICES

Office of the Regional Director

Region IX
50 United Nations Plaza
San Francisco, CA 94102

RECEIVED
APR 2 1992
CONTROLLER'S OFFICE

MAR 31 1992

Thomas L. Judy, Controller
University of Nevada, Reno
Clark Administration Building
Reno, NV 89557-0025

Dear Mr. Judy:

The original and one copy of a revised indirect cost Negotiation Agreement are enclosed. This Agreement reflects an understanding reached between your organization and a member of my staff concerning the rate(s) that may be used to support your claim for indirect costs on grants and contracts with the Federal Government. Please have the original signed by a duly authorized representative of your organization and return it to me, retaining the copy for your files. We will reproduce and distribute the Agreement to the appropriate awarding organizations of the Federal Government for their use.

Sincerely,

David S. Low
Director
Division of Cost Allocation

Enclosures

PLEASE SIGN AND RETURN THE ORIGINAL OF THE NEGOTIATION AGREEMENT.

UNIVERSITY OF NEVADA RENO
Physical Plant Department
Reno, Nevada 89557-0057
(702) 784-6514

MAY 7, 1991

TO: ALL FACULTY AND STAFF

FROM: JIM DUNCAN, FISCAL OFFICER, PHYSICAL PLANT

SUBJECT: REVISED MOTOR POOL RATES

Please be advised that effective July 1, 1991 the rates for the University Motor Pool fleet and services will be as follows:

ASSIGNED VEHICLES

VEHICLE TYPE	RATE	MILEAGE AFTER 400 MILE ALLOWANCE
SEDANS	$185.00/MO.	.23/MI
PICK-UP TRUCKS AND STATION WAGONS	$222.00/MO	.25/MI
FOUR WHEEL DRIVES, SUBURBANS AND VANS	$264.00/MO	.27/MI

DAILY RENTAL

VEHICLE TYPE	RATE	MILEAGE AFTER 40 MILE ALLOWANCE
SEDANS	$15.00/DAY	.23/MI
PICK-UP TRUCKS AND STATION WAGONS	$18.00/DAY	.25/MI
FOUR WHEEL DRIVES, SUBURBANS AND VANS	$20.00/DAY	.27/MI

Applicable Motor Pool labor charges will be $29.00 per hour for University of Nevada, Reno vehicles and $34.00 per hour for all other UNS vehicles.

If you have any questions regarding the Motor Pool Rate or Operational Policies, please feel free to call me at ext. 6514.

TRAVEL

1,401 Out-of-State Travel 1,401

Out-of-State Approval

An Employee's Travel Request form must be forwarded for approval by the appropriately designated vice president, at least ten (10) days prior to an out-of-state trip, except as noted below. In the event it is not possible to submit a travel request ten days prior to the trip, a written explanation must be attached to the request.

Upon approval, the Employee's Travel Request will be sent to the Controller's office for verification of availability of funds and the preparation of an advance check, if requested.

The only exception to the rule as stated is for trips lasting 24 hours or less and for travel of coaches for pre-scheduled intercollegiate athletic events. In such cases, it is not necessary to file an Employee's Travel Request. It is necessary, however, to have advance approval of the department head and dean or director.

Out-of-State Advances

The Employee's Travel Request form provides for the requesting of a travel advance. The ten (10) day requirement noted above will normally provide sufficient time to prepare advance checks, but should the request be late, at least three working days will be required to prepare the advance check. Advances will not be made for less than $50.00. Advances must be cleared within ten days after completion of the trip by filing a Claim for Employee Travel Expense (see section 1,420). An advance will not be made if a previous advance has not been cleared. Advances will be released three working days prior to the trip. No advances will be made for air fare.

Out-of-State Allowable Travel Expenses

Persons on travel status out-of-state shall receive $5.00 for breakfast, $6.00 for lunch, and $13.00 for dinner and lodging up to $60.00 with a receipt, except for New York City and Washington, D.C. and vicinity, which is up to $75.00 with a receipt. A receipt will not be required for out-of-state lodging reimbursement up to the approved lodging rate for in-state travel ($34.00). Receipts are not required for meals. When registration fees provide for meals, employees should not request additional reimbursement for the meal.

All amounts above include tax. Meals exceeding state reimbursement rates will not be allowed as a part of the registration form. Meals served in flight as part of the air fare may not be claimed for reimbursement. Foreign travel per diem is based on federal per diem rates. These rates change quite frequently. Check with the Controller's office for current per diem rates.

TRAVEL

1,401 Out-of-State Travel, Continued 1,401

Exceptions to the maximum out-of-state lodging rates may be approved in advance by the individual authorized to approve such travel. A letter requesting approval of out-of-state lodging rates in excess of currently authorized rates should be submitted with the out-of-state travel request form prior to the trip to the individual authorized to approve such travel.

Time limitations for both in-state and out-of-state travel are as follows:

Must leave before 6:00 a.m. or return after 8:00 a.m. to claim breakfast.
Must leave before 11:00 a.m. or return after 1:00 p.m. to claim lunch.
Must leave before 5:00 p.m. or return after 7:00 p.m. to claim dinner.

Only meals which have been paid for by the traveler may be claimed.

1,402 Number Attending Out-of-State Conferences 1,402

Departments are requested to refrain from scheduling more than three employees to attend the same out-of-state meeting unless it is within 300 miles of the official station or in Los Angeles, San Francisco, Boise or Salt Lake City. Travel to these cities or other relatively nearby areas by two or more employees should be by agency or Motor Pool automobile, unless the total public transportation cost is cheaper. Verification of cost comparisons should be submitted when submitting claims.

1,403 In-State Travel 1,403

In-State Approval

College or departmental regulations must be followed for in-state travel. Notice to the Controller's office is not necessary unless a travel advance is requested.

In-State Advances

If an advance is desired, an Employee Travel Request form must be filed in the Controller's office at least three working days prior to the time the check is needed. Advances will not be made for less than $50.00. Advances must be cleared within ten days after completion of the trip. An advance will not be made if a previous advance has not been cleared. Advances will be released three working days prior to trip. No advances will be made for air fare.

TRAVEL

1,403 In-State Travel, Continued 1,403

In-State Allowable Travel Expenses

Persons traveling in-state shall receive travel reimbursement at a per diem rate of $58.00 per day. The $58.00 is based upon $5.00 for breakfast, $6.00 for lunch, $13.00 for dinner, and $34.00 for lodging. Lodging should only be claimed if the traveler incurred lodging expenses. The allowance for travel by private vehicle is 12¢ per mile, unless use of the private vehicle is required for reasons of university convenience in the transaction of state business, in which case, the allowance would be 24¢ per mile and written justification is required.

Time limitations for both in-state and out-of-state travel are as follows:

Must leave before 6:00 a.m. or return after 8:00 a.m. to claim breakfast.
Must leave before 11:00 a.m. or return after 1:00 p.m. to claim lunch.
Must leave before 5:00 p.m. or return after 7:00 p.m. to claim dinner.

When employees receive free meals or lodging, no reimbursement is allowed; when registration fees provide for meals, no additional reimbursement will be allowed for meals. Meals exceeding the state reimbursement rates will not be allowed as part of the registration fee when listed as an optional item on the registration form. Meals served in flight as part of the air fare may not be claimed for reimbursement.

Exceptions to the approved maximum in-state lodging rates will not be allowed.

1,405 Overnight Lodging Within 50 Miles of Principal Station 1,405

Per diem and overnight lodging in areas less than 50 miles from a principal station must be justified in writing (in advance) and will not be allowed unless:

1. Inclement weather conditions make travel difficult.
2. Late official meetings are required.
3. Individuals involved are conference hosts responsible for meeting arrangements.

Send justification for approval to the individual authorized to approve such travel.

TRAVEL

1,410 Method of Travel 1,410

Advanced planning for travel will allow for the purchase of airline tickets at discount rates. Such rates usually involve a penalty in the event the trip is not taken. Employees may be held responsible for a penalty incurred if a trip is not taken as a result of their own actions. The university will be responsible for determining whether the penalty was incurred as a result of employee action or circumstances beyond the employee's control before submitting the claim for payment.

1,411 Use of Rental Cars 1,411

The motor pool should be used when practicable before rental cars. A rental car may be used in Carson City, Reno, and Las Vegas only when the state motor pool gives written notice that no motor pool car is available. When renting a car in-state, the rental company with whom the state has a contract should be used.

For out-of-state travel, rental cars should be used only when necessary and the rental company should be one with whom the state has a contract.

Avis, Budget, Dollar, Hertz and National have all agreed to provide what the Risk Management Division has determined to be minimum acceptable coverages, and State Purchasing has developed agreements with each of them. Use of any company not authorized by State Purchasing may expose the state to increased liability in the event of an accident, and is prohibited.

All state travelers should consider cost in renting vehicles and utilize those companies offering lower costs when they are located in the destination city and where cars are available. Vehicles must be rented in the name of the individual, and the State of Nevada rental agreement number should be referenced. Always use the state agreement (and price) to obtain insurance coverage. Reservations may be made direct or through your travel agent.

Rate information and rental agreement numbers for each company may be obtained by contacting the Controller's office.

1,412 Additional Insurance Charges to Waive Collision Deductible on Rental Cars 1,412

Additional insurance charges to waive collision deductibles on rental cars are not an approved expenditure. If the individual wishes to purchase the deductible, it will be at the individual's expense. The only exceptions are board or commission members who are not full-time and contractors whose contract allows the use of rental vehicles.

If an employee driving a rental car on state business is involved in a collision, the agency will be responsible for the deductible charges ($50.00 comprehensive, $100.00 collision).

TRAVEL

1,413	Private Automobile Usage	1,413

An employee shall not use a private vehicle for transportation of students on official trips without informing his/her insurance company and to verify that the vehicle is properly covered. In the event of an accident, the private vehicle insurance is primary to all state coverages.

<u>For the Employee's Convenience</u>

If a private car is used for the convenience of the employee, the employee shall be reimbursed 12 ¢ per mile. Air fare in lieu of the 12 ¢ per mile allowance should only be used when it is the least expensive method of travel.

If the city is not serviced by an airline, the employee is entitled to reimbursement of meals en route. If the city is serviced by an airline, the employee must be on either annual or compensatory leave for the extra travel time involved and meals and/or expenses en route will not be reimbursed. The travel claim should indicate that the employee was on annual or compensatory leave or include a statement from the department head or supervisor justifying why the employee was not on annual or compensatory leave.

<u>For the University's Convenience</u>

An employee using his own personal vehicle for the convenience of the university will be allowed reimbursement at the rate of 24 ¢ per mile. Use of a personal vehicle will be considered to be for the convenience of the university when:

1. The vice president or dean approves, in writing, the employee's use of a personal car for the convenience of the university, or

2. The motor pool provides the employee with a slip indicating a motor pool car was unavailable.

The university approval or motor pool slip must be attached to the claim when submitted to the Controller's office. Employees will also be entitled to per diem reimbursement when the president or his designee approves, in writing, the use of a personal car for the convenience of the university.

If two employees travel in a private vehicle on university business, only one employee is entitled to mileage reimbursement.

TRAVEL

1,415 Airlines and Travel Arrangements 1,415

An agreement has been reached with selected local travel agencies in the Reno-Sparks area whose services, lowest-fare guarantees and discounts would be most beneficial to the university. These travel agencies will also provide hotel arrangements.

When making travel arrangements, provide the travel agent with a university account number and a social security number to which travel should be charged. When making lodging reservations or car rental arrangements, do not have the expenses billed directly to the university.

The traveler should pay for the lodging and/or car rental. Then submit the itemized lodging receipt, and/or the itemized car rental agreement for reimbursement on a Claim for Employee Travel form. The airline tickets and the travel itinerary will be delivered directly to the department. Under no circumstances may travel for non-university business be charged to a university account.

1,416 Bonus Flight Coupons 1,416

Several commercial airlines distribute free bonus flight coupons to travelers based on miles flown or as an inducement to schedule travel with that particular airline.

Any such coupons received by university units or employees as a result of the university-paid air travel are considered university property and should be used by the university unit to meet travel needs.

In the event that the university unit cannot use the coupons to meet their intended travel needs, they should forward the coupons to the office of Planning, Budget and Analysis for redistribution to university units on an as-needed, first-come-firstserved basis.

As with other travel regulations, this requirement applies to travel under all funding sources.

1,418 Combining University Business and Personal Travel 1,418

Separating university and personal travel expenses poses certain auditing problems for the travel processor in the Controller's Office. Employees who incorporate private and university travel must demonstrate the costs born by the university are not increased by the personal travel. The employee must clearly delineate the private and university charges when submitting a Claim for Employee Travel Expense. When university and private travel is not clearly delineated, the travel processor will determine the reimbursement due the employee. If in doubt about the calculation of reimbursement, contact the travel processor in the Controller's office.

TRAVEL

1,420 Travel Expense Reimbursement Procedure 1,420

Within ten (10) days after completion of a trip, a Claim for Employee Travel Expense must be filed in the Controller's office. If an advance has been received, indicate the total cost of the trip, amount of advance received, and the amount either due to the traveler or due to the university. The account to be charged must be specified and must agree with the information on the travel request form where used. The Claim for Travel Expense form must be routed through the proper administrative channels. If bus, airplane, or railroad were used, the traveler's portion of the ticket must be attached to the claim form.

If travelers use their personal funds for the purchase of airline tickets or the payment of conference/workshop registration fees, reimbursement cannot be made until completion of the travel and submission of a travel claim to the Controller's office.

An Employee Travel Request should be prepared and submitted whenever airline tickets are ordered from travel agencies or when funds are requested for payment of conference/workshop registration fees to allow the Controller's office to make payment on a timely basis. Special arrangements can be made to pay the travel agency for tickets well in advance of the trip to secure super saver rates. However, the Controller's office must be notified of any cancellations or changes in flight plans.

Conference registration fees must be charged as an operating expense, not travel.

Claims for Employee Travel Expense must be approved by the employee's supervisor, they do not necessarily have to be approved by a dean or vice-president.

1,430 Duplication of Per Diem Items 1,430

Claims for per diem allowance must take into consideration meals or lodging included in conference registration fees and for meals served on public transportation without additional cost to the traveler.

1,440 Parking or Vehicle Storage Fee 1,440

Parking or storage fees will be allowed when considered necessary by the department chair for either university or private cars. Charges should be itemized in the detail column of a Claim for Employee's Travel Expense form and the amount entered in the transportation cost column.

1,445 Commercial Transportation Receipts 1,445

Traveler's portion of bus, taxi, airporter, railroad or airplane tickets must be original and must be attached to the Claim for Employee's Travel Expense if the individual paid for the tickets and is asking reimbursement.

TRAVEL

1,450 Non-Travel Items 1,450

Travel claims filed in conformity with these regulations shall be considered full compensation for all meals and lodging, including tips, and for minor miscellaneous expenses such as local telephone calls from pay booths or hotel rooms. Charges for baggage handling are not reimbursable. Toll calls may be itemized on the Claim for Employee Travel Expense form and reimbursement claimed, but the person and place called must be stated and the claim must be supported by a receipt.

1,460 Travel to Conferences and Meetings 1,460

Staff members attending conferences or meetings may be reimbursed less than the amounts listed if so specified by the dean or President before the trip is undertaken.

1,470 Research, Extension or Public Service Personnel Travel 1,470

Personnel on research, extension, or public service assignments may be reimbursed for travel at rates not to exceed $58.00 per day for in-state and allowed state rates for out-of-state trips, as determined by the dean or director concerned. In these cases, charges for individual meals and lodging may not exceed the limits established.

1,480 Travel Expenses for Applicants for Professional Positions 1,480

Revision to be submitted later.

1,490 Team or Group Travel 1,490

Team travel is defined as any student group travel whose group is a team, class or other organization directly affiliated with and sponsored by the university. Team travel may include travel expense of university employees who are required to accompany the student group and is appropriately chargeable to team travel expense.

Cash advances for team travel may be secured by submission of a Request for Check form at least 72 hours prior to the time the check is required. Within five (5) days after the completion of the trip, an expense report on a Claim for Team Travel Expenses form must be filed in the Controller's office. All items on the expense report must be supported by either a vendor's receipt or Receipt for Team Travel Expenses - List.

TRAVEL

1,490 Team or Group Travel, Continued 1,490

Team or Group Travel Per Diem Rates and Lodging

Expense of meals and lodging may not exceed the amounts prescribed for state employees i.e., $58.00 for a calendar day in-state and allowed state rates for out-of-state; or for less than a full day, $5.00 for breakfast, $6.00 for lunch, $13.00 for dinner, and $34.00 for lodging in-state, and $5.00 for breakfast, $6.00 for lunch, $13.00 for dinner, and up to $60.00 with receipt for lodging for out-of-state ($75.00 is allowed in New York City and Washington, D.C.).

A receipt will not be required for out-of-state lodging for reimbursement up to the approved lodging rate for in-state travel (currently $34.00). Lodging expense over $34.00 submitted will continue to require a receipt in accordance with existing policy.

Exceptions to the maximum out-of-state lodging rates may be approved in advance by the individual authorized to approve such travel. A letter requesting approval of out-of-state lodging rates in excess of currently authorized rates should be submitted prior to the trip with an out-of-state travel request form to the individual authorized to approve such travel.

1,495 Application for Travel Support to Attend Scholarly Meetings 1,495

Faculty at the University of Nevada, Reno may apply to the Graduate School for support of travel expenses to attend national or international meetings for the purpose of presenting scholarly work as senior author or exhibitor.

The Graduate School travel budget for each fiscal year will be divided between the fall and spring semesters, with half the funds available between July 1 and December 31, and the other half available between January 1 and June 30. Applications for fall travel support will be accepted no earlier than May 1 of the preceding fiscal year. Spring travel support can be requested no earlier than November 1 of the present fiscal year.

Faculty holding at least 0.5 FTE appointments can apply for transportation support to one domestic meeting per year, and to one international meeting every third year (in place of that year's domestic trip). A faculty member may elect to apply present year domestic trip dollars toward an international trip without losing entitlement to apply for a full international trip every third year. A cap of $300 will be placed on domestic travel, and $750 on international travel.

Travel funds will be distributed on a first come/first served basis. However, so that faculty who happen to attend late fall or late spring meetings are not penalized, requests for travel support may be submitted prior to acceptance of a research paper. Information about the meeting and the probable title of the paper should be indicated on the travel request form. However, if the Graduate School office does not receive notice of formal acceptance of the research paper by one month prior to the meeting, the earmarked travel funds will be returned to the travel pool.

TRAVEL

1,495 Application for Travel Support to Attend Scholarly Meetings, Continued 1,495

Faculty are encouraged to plan their travel well in advance to obtain discount fares. Under no circumstances will fares other than tourist or coach be allowed.

One copy of the Application for Travel Support (GS-R2) with supporting material should be submitted to the Graduate School in advance of the proposed travel. No retroactive requests will be considered.

Travel papers should be processed through the Graduate School for signature and account number assignment. Upon return from the trip a travel claim form should be submitted. These forms can be obtained from the Controller's office.

UNIVERSITY OF NEVADA-RENO

Thomas L. Judy
Assistant Vice President and Controller

Reno, Nevada 89557-0025
(702) 784-6662
FAX (702) 784-6680

October 11, 1991

MEMORANDUM

TO: Deans, Directors, and Department Chairs

FROM: Tom Judy

SUBJECT: Approval of Hotel Rates

The purpose of this memorandum is to clarify the approval process for hotel rates which exceed the state guidelines.

IN-STATE TRAVEL:

The reimbursement for hotel costs in Nevada may not exceed the state maximum of $34.00.

OUT-OF-STATE TRAVEL:

Approval to exceed the state maximum hotel reimbursement of $60.00, with a receipt, per day ($75.00, with a receipt, in Washington, D.C. and New York City) has been delegated to the Vice Presidents and/or Deans. **Please note that such approval must be given prior to the trip. Approvals given after the trip will not be honored in accordance with state procedures.**

The complete travel rules may be found in the UNR Administrative Manual section 1401-1490.

If you have any questions regarding this subject or others that relate to travel, you may contact the travel desk at x4167 or me.

mk

cc: Vice President Dhingra
Vice President Hoover
Vice President Page
Vice President Miltenberger
Travel Desk

a:travelre.tom

Larry J. Garside

Professional Summary

PERSONAL

Born May 2, 1943, Omaha, Nebraska
Married

Business address: Nevada Bureau of Mines and Geology
Mackay School of Mines
University of Nevada, Reno
Reno, Nevada 89557-0088

Business telephone: (702) 784-6691
FAX: (702) 784-1709

EDUCATION

B.S. Geology, Iowa State University, 1965
M.S. Geology, University of Nevada, Reno, 1968

AREAS OF EXPERTISE

A. Geologic mapping, especially at scales of 1:24,000 - 1:100,000
B. Volcanic geology, especially western Nevada Mesozoic and Tertiary
C. Energy resources geology (uranium, petroleum, geothermal, coal, oil shale)
D. Geology and trace-element geochemistry of metallic ore deposits
E. Volcanism and hydrothermal mineralization
F. Isotopic dating of igneous rocks and mineralization

PROFESSIONAL WORK EXPERIENCE

Economic Geologist, Rank IV
Nevada Bureau of Mines and Geology
University of Nevada, Reno
(1983-present)

Acting Associate Director
Nevada Bureau of Mines and Geology
University of Nevada, Reno, Mackay School of Mines
(1987-1988)

Chief Geologist, Nevada Bureau of Mines and Geology, University of Nevada, Reno, Mackay School of Mines (1986-1987)

Deputy Director for Research, Nevada Bureau of Mines and Geology, University of Nevada, Reno, Mackay School of Mines (1985-1986)

Economic Geologist, Rank III, Nevada Bureau of Mines and Geology, University of Nevada, Reno, Mackay School of Mines (1976-1983)

Economic Geologist, Rank II, Nevada Bureau of Mines and Geology, University of Nevada, Reno, Mackay School of Mines (1971-1976)

Economic Geologist, Rank I, Nevada Bureau of Mines and Geology, University of Nevada, Reno, Mackay School of Mines (1968-1971)

Research Assistant, Nevada Bureau of mines and Geology, University of Nevada, Reno, Mackay School of Mines (1965-1968)

Laboratory Assistant, Iowa State University (summer) (1965)

National Science Foundation grant for undergraduate research (summer 1964)

PROFESSIONAL SOCIETIES

American Association of Petroleum Geologists (Active Member, member Energy Resources Division)
Geological Society of America (Fellow)
Society of Economic Geologists
Association of Exploration Geochemists (Associate Member)

HONOR SOCIETIES

Phi Kappa Phi

Listed in the Twenty-third Edition of Marquis Who's Who in the West
Listed in the Seventeenth Edition (1989-90) of American Men and Women of Science

PUBLICATIONS

Peer-Reviewed Reports Published by Geological Surveys

Hess, R. H., and Garside, L. J., 1990, Geothermal energy, in The Nevada Mineral Industry, 1989: Nevada Bureau of Mines and Geology Special Publication MI-1989, p. 51-55.

Hess, R. H., and Garside, L. J., 1989, Geothermal energy, in The Nevada Mineral Industry, 1988: Nevada Bureau of Mines and Geology Special Publication MI-1988, p. 53-58.

Garside, L. J., Hess, R. H., Fleming, K. L., and Weimer, B. S., 1988, Oil and gas developments in Nevada: Nevada Bureau of Mines and Geology Bulleltin 104, 136 p.

Bell, J. W., and Garside, L. J., 1987, Geologic map of the Verdi quadrangle, Nevada: Nevada Bureau of Mines and Geology Map 4Gg.

Garside, L. J., 1986, Geochemical reconnaissance of the Camp Douglas and Moho Mountain quadrangles, Nevada: Nevada Bureau of Mines and Geology Report 42, 21 p.

Bonham, H. F., Jr. and Garside, L. J., 1982, Geochemical reconnaissance of the Tonopah, Lone Mountain, and northern Mud Lake quadrangles, Nevada: Nevada Bureau of Mines and Geology Bulletin 96, 68 p.

Garside, L. J., 1982, Geologic map of the Moho Mountain quadrangle, Nevada: Nevada Bureau of Mines and Geology Map 74.

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SPECIAL LECTURING, COURSES TAUGHT, AND TESTIMONY

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Testimony, before the Nevada Senate Finance Committee (1987, 1989) and Assembly Ways and Means Committee (1987) on the Mining Cooperative Fund.

OTHER PROFESSIONAL ACTIVITIES

Nevada Oil and Gas Conservation Commission (Exec. Sec., 1974-75)
Geological Society of Nevada (Sec.-Treas., 1969-70; Pres., 1973-74)
Geothermal Resources Council (Pres., local section, 1983-84)
Nevada Petroleum Society (Sec.-Treas., 1986)
Attended numerous local, regional, national, and international professional meetings on general geology, mineral resources, petroleum, and geothermal energy
Served on organizing committees for several professional meetings; acted as session chairman, field trip chairman, field trip leader, etc.
Visited over 150 mining districts in Nevada as well as numerous districts elsewhere in the U.S., Canada, Mexico, Australia, New Zealand, China, and Chile

Acted as reviewer for many NBMG bulletins and reports, proposals to several funding agencies, as well as a number of USGS and other publications on Nevada geology

UNIVERSITY OF NEVADA, RENO COMMITTEES

Served on several University boards and committees, including: Arboretum, Appeals, Wittell, Library, Parking and Traffic (chairman, 1979), Handicap Access, Salary and Benefits, Faculty Senate

Served on numerous College and NBMG committees, including: Museum, Thin Section, Dean evaluation, Bylaws, Personnel, Space, Summer Field Camp

Served on search committees (often chaired) for the following positions: Dean, Field Technician, Editor, Engineering Geologist, Junior Geologist, Computer Geologist, Industrial Minerals Geologist, Economic Geologist, Interim Dean, Dean, Hydrogeologist, Geologic Mapper

RESEARCH SUPPORT

U.S. Geological Survey (Reno Field Office), Account 1-1-330-5300-186, July 1990 to October 1990, $5,000, Mineral resources of the Nevada portion of the Susanville BLM District. (principal investigator)

U.S. Geological Survey (COGEOMAP), Account 1-1-330-5655-663, June 1991 to June 1992, $25,000, Large-Scale Geologic Mapping in the Reno-Carson City area, Nevada. (co-principal investigator)

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September 28, 1992

Dr. Larry J. Garside
University of Nevada
Nevada Bureau of Mines & Geology
Reno, NV 89557-0088

Dear Larry:

Enclosed is a draft copy of the proposal Statement of Work for the Nevada Bureau of Mines and Geology participation in the current Department of Energy - Geothermal Division Low Temperature Geothermal Resource program. The Statement of Work, when finalized, will be an Addendum to a Standard Contract Agreement issued by the Oregon State System of Higher Education.

I understand that you have had some earlier discussions with Marshall Reed (DOE/GD) concerning this program. Please review the attached SOW and let me know if this project is still of interest to the Nevada Bureau of Mines and Geology, if the work can be done in the time described and for the funding available. Also, please inform me of any problems you may have with this SOW.

Sincerely,

Howard Ross

Howard P. Ross
Project Manager

HR/mt
cc: M. J. Reed
P. M. Wright

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 NEVADA BUREAU OF MINES AND GEOLOGY,
THE UNIVERSITY OF NEVADA, RENO

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 Nevada, 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 in support of this study.

2.3 Complete a computer database listing compatible with Lotus 123 or other acceptable 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 Nevada 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 Nevada. 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-GHC quarterly.

4.0 SCHEDULE OF PERFORMANCE AND REPORTING

4.1 The period of performance for this agreement will terminate on December 31, 1993, unless modified by letter agreement and signed by the University of Nevada - Reno, 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 and OIT-GHC not later than December 31, 1993.

5.0 RESPONSIBLE PARTIES

5.1 The Principal Investigator for this agreement will be Larry J. Garside, Nevada Bureau of Mines and Geology, University of Nevada, Reno.

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 $55,000.00 for the completion of all technical tasks and submittal of all required deliverables.

Larry J. Garside

Nevada Bureau of Mines and Geology

EDUCATION

B.S. Geology, Iowa State University, 1965
M.S. Geology, University of Nevada, Reno, 1968

AREAS OF EXPERTISE

A. Geologic mapping, especially at scales of 1:24,000 - 1:100,000
B. Volcanic geology, especially western Nevada Mesozoic and Tertiary
C. Energy resources geology (uranium, petroleum, geothermal, coal, oil shale)
D. Geology and trace-element geochemistry of metallic ore deposits
E. Volcanism and hydrothermal mineralization
F. Isotopic dating of igneous rocks and mineralization

PROFESSIONAL WORK EXPERIENCE

Economic Geologist, Rank IV
Nevada Bureau of Mines and Geology
(1983-present)

Acting Associate Director
Nevada Bureau of Mines and Geology
(1987-1988)

Chief Geologist,
Nevada Bureau of Mines and Geology, (1986-1987)

Deputy Director for Research,
Nevada Bureau of Mines and Geology (1985-1986)

Economic Geologist, Rank III, Nevada Bureau of Mines and Geology,(1976-1983)

Economic Geologist, Rank II, Nevada Bureau of Mines and Geology, (1971-1976)

Economic Geologist, Rank I, Nevada Bureau of Mines and Geology, (1968-1971)

PROFESSIONAL SOCIETIES

American Association of Petroleum Geologists (Active Member, member Energy Resources Divisioo)

Geological Society of America (Fellow)
Society of Economic Geologists
Association of Exploration Geochemists (Associate Member)

HONOR SOCIETIES
Phi Kappa Phi

PUBLICATIONS
About 100 publications, excluding abstracts, predominantly on the geology and mineral resources of Nevada.

OTHER PROFESSIONAL ACTIVITIES
Nevada Oil and Gas Conservation Commission (Exec. Sec., 1974-75)
Geological Society of Nevada (Sec.-Treas., 1969-70; Pres., 1973-74)
Geothermal Resources Council (Charter Member; Pres., local section, 1983-84)
Nevada Petroleum Society (Sec.-Treas., 1986)
Attended numerous local, regional, national, and international professional meetings on general geology, mineral resources, petroleum, and geothermal energy
Served on organizing committees for several professional meetings; acted as session chairman, field trip chairman, field trip leader, etc.
Visited over 150 mining districts in Nevada as well as numerous districts elsewhere in the U.S., Canada, Mexico, Australia, New Zealand, and China
Acted as reviewer for many NBMG bulletins and reports, proposals to several funding agencies, as well as a number of USGS and other publications on Nevada geology
Listed in the Seventeenth Edition (1989-90) of American Men and Women of Science

UNIVERSITY OF NEVADA, RENO COMMITTEES
Served on several University boards and committees, including:
Arboretum, Appeals, Wittell, Library, Parking and Traffic (chairman, 1979), Handicap Access, Salary and Benefits
Served on numerous College and NBMG committees, including:
Museum, Thin Section, Dean evaluation, Bylaws, Personnel
Served on search committees (often chaired) for the following positions: Dean, Field Technician, Editor, Engineering Geologist, Junior Geologist, Computer Geologist, Industrial Minerals Geologist, Economic Geologist, Interim Dean, Dean, Hydrogeologist, Geologic Mapper

RESEARCH SUPPORT
Funded research awards from the U.S. Geological Survey, mining companies, U.S. Department of Energy, Nevada Department of Minerals, U.S. Fish and Wildlife Service, U.S. Corps of Engineers, Washoe County (Nevada),

NEVADA BUREAU OF MINES AND GEOLOGY

UNIVERSITY OF NEVADA RENO

Mail Stop 178
Reno, Nevada 89557-0088
Telephone: (702) 784-6691
FAX: (702) 784-1709

FACSIMILE TRANSMITTAL SHEET

DATE: September 30, 1994

FROM: Larry Garside *Larry*

TO: Howard Ross

FAX NUMBER BEING CALLED: (801) 584-4453

NUMBER OF PAGES (including transmittal sheet): 3

COMMENTS:

Dear Howard:

I have attached to this FAX a two page summary from a longer resume. It's not exactly a paragraph, but was already available. My entire career has been at the Nevada Bureau of Mines and Geology, as you can see. Some of my first research projects were related to Nevada's energy resources, and I have published bulletins on petroleum, geothermal, and uranium. I first started collecting information for a commodity summary bulletin on Nevada geothermal resources (with John Schilling, published as NBMG Bulletin 91) in the mid 1970's. I well remember presenting a state summary of geothermal resources and activity at the first GRC meeting in El Centro during this time.

Please get back to me if you need anything else.

If there are any problems with the reception of this FAX, please notify us at 702/784-6691 or FAX number 702/784-1709. Thank you.

SENT BY: ____________________

TIME: ____________________

NEVADA LOW-TEMPERATURE GEOTHERMAL RESOURCE ASSESSMENT: 1994

By: Larry J. Garside

FINAL REPORT

Prepared for

The Oregon Institute of Technology
GeoHeat Center

Prepared as part of a study of low- to -moderate temperature geothermal resources of Nevada under the U.S. Department of Energy Low-Temperature Geothermal Resources and Technology Transfer Program

CONTENTS

INTRODUCTION

Previous Geothermal Assessments

A statewide inventory of the geology and geochemistry of Nevada's geothermal resources was begun at the Nevada Bureau of Mines and Geology (NBMG) in the late 1970s. NBMG had previously published a 1:1,000,000-scale map of hot springs, sinters, and volcanic cinder cones (Horton, 1964b) and several brief summaries of Nevada's geothermal resources (Horton, 1964a; Garside and Schilling, 1972; Garside, 1974). This inventory, published as NBMG Bulletin 91 (Garside and Schilling, 1979), followed a format used in a number of NBMG publications on mineral commodities of Nevada. The bulletin contained descriptions, by county and hot spring area, of the better known geothermal areas. These descriptions included, where available, maps and other data on the geology, and descriptions of historical and present use. Temperature and water chemistry data were presented in an appendix having about 1,400 individual entries (records). These records commonly included multiple entries for the same or adjacent springs as well as numerous well records from geothermal areas which have a larger areal extent than individual spring sites. A 1:1,000,000-scale map was included in the pocket of NBMG Bulletin 91; nearly 400 geothermal sites (springs, spring groups, well groups, etc.) were included on that map. The lower temperature cut-off for inclusion of data in Bulletin 91 was 70°F (21.1°C).

The location, chemical data, and references for the geothermal springs and wells listed in Bulletin 91 were collected by an extensive and relatively complete search of the available literature. These data were entered by hand on data-collection forms, and these forms were used to typeset the listing of data in the bulletin (Appendix 1). A source of unpublished data was a computer database of water-quality data maintained by the Desert Research Institute at Reno.

GEOTHERM is an acronym for a U.S. Geological Survey (USGS) computerized information system designed to maintain data on the geology, geochemistry, and hydrology of geothermal sites primarily within the United States (Teshin and others, 1979; Bliss, 1983). The system was first proposed in 1974, and was active until 1983. The system utilized a mainframe computer, and most of the data were entered by use of key-punch cards. Key punching was done from a rather extensive data-entry form. When the GEOTHERM database was taken off line, a number of products were published or made available to preserve the data. These include basic data for thermal springs and wells on a state-by-state basis (for Nevada, see Bliss, 1983a) and a listing of each record on a state-by state basis, as microfiche (for Nevada, see Bliss, 1983b). The GEOTHERM database was also filed with the

National Technical Information Service (NTIS) as digital data. A 9-track one-half inch reel-to-reel tape in ASCII format of this GEOTHERM database was provided to NBMG after the start of this project by Howard Ross at the University of Utah Research Institute (UURI). This tape, containing 8,082 records, was originally from NTIS.

GEOTHERM contained 1367 records for Nevada when it was taken off line in 1983; the is the number of Nevada records on the NTIS tape as well. The great majority of these records are from the published sources used to compile Appendix 1 of Bulletin 91. Unpublished site data and analyses from the files of D.E. White (USGS) make up a significant section of the database also. About 75% of this GEOTHERM data was added to the original database during 1978 and 1979 by personnel at NBMG as part of the U.S. Department of Energy State Coupled Program (see Trexler and others, 1979a). In addition to the entry of new data and the editing and verifying of existing data in GEOTHERM, the longitude and latitude locations of springs and wells were determined by plotting them on 1:250,000-scale maps and hand digitization (Trexler and others, 1979a). New analyses were done during this period, and these data were added to GEOTHERM.

The database available in GEOTHERM during the early 1980s was used, along with other data developed from specific geothermal site studies funded by the U.S. Department of Energy (see numerous reports by Trexler and co-workers, 1980-83) to produce two 1:500,000-scale maps illustrating Nevada's geothermal resources (Trexler and others, 1979, 1983). No statewide resource studies were done after the publication of the 1938 NOAA map (Trexler and others, 1983). A nationwide assessment of low-temperature geothermal resources (USGS Circular 892) included data for Nevada, and an open-file report (Reed and others, 1983) included about 350 records for Nevada that were used in that assessment. These records were selected from the GEOTHERM database by use of charge balance determinations and other screening methods (Marshall Reed, written commun., 1993). During this period of time, an increase in exploration for geothermal resources by private industry (mainly for electric-power generation) resulted in the drilling of thousands of gradient and slim holes, and several hundred larger diameter wells for industrial and commercial use (space heating, electric power generation, etc.). Developments in Nevada's geothermal industry are documented in yearly summaries of the Nevada mineral industry, published yearly by NBMG since 1979 (e.g, Hess, 1993). Information that is available on geothermal drilling in Nevada has been summarized by Barton and Purkey (1993).

Need for a New Assessment

Low- and moderate-temperature geothermal resources are widely distributed in the western United States. Although there has been

a substantial increase over the last decade in utilization of these resources in direct-heat applications, the large resource base is greatly underutilized (Ross and others, 1994). Previous studies have demonstrated that Nevada is well endowed with geothermal resources, and much of the state must be considered as having potential for direct use. As Ross and others (1994) describe, the expanded use of low- and moderate-temperature geothermal resources requires, as a start, a current inventory of the resources. Such an inventory, combined with collocation studies (the study of resource location near population centers or areas of potential industrial users), will provide some of the basic information that the potential developers of the geothermal resources need to make sound economic decisions. Collocation factors are of particular significance in Nevada, as well as a number of other western states, because people and most industries are concentrated in a few areas; geothermal resources, on the other hand, are rather widely distributed.

There are many factors that can affect the viability of direct-use geothermal applications. These include not only the suitability of the fluid and the resource for the application (water temperature, chemistry, amount of available heat, etc.) but also the information available to the developer on the technology of the proposed application, and contractual and other economic factors less closely related to the geothermal resource. The collection of data on these geothermal resources and their present uses is only one factor in encouraging their increased use. Other components of the 1992-1993 low-temperature program include development of better techniques to discover and evaluate the resources, and technical assistance to potential developers (Ross and others, 1994).

Nevada Assessment Program

Data compilation for the low-temperature program is being done by State Teams in ten western states. The Nevada program, under the direction of Larry J. Garside at the Nevada Bureau of Mines and Geology at the University of Nevada began data collection in early 1993 (the contract for the research between the University of Nevada and the Oregon Institute of Technology was signed on March 23, 1993). The original contract was to end on December 31, 1993, but was later extended to June 30, 1994. The Technical Project Managers for the agreement were Howard P. Ross (University of Utah Research Institute) and Paul J. Lienau (Oregon Institute of Technology - GeoHeat Center).

The final products of the study include the following: 1) a geothermal database, in hardcopy and as digital data (diskette) listing information on all known low- and moderate-temperature springs and wells in Nevada; 2) a 1:1,000,000-scale map displaying these geothermal localities, and; 3) a bibliography of references on Nevada geothermal resources. The format for

presentation of these data was worked out through discussions among State Teams and the Project Managers during the first half of the contract period; the model for this database has been described by Blackett (1993).

DATA SOURCES

Information on Nevada's geothermal resources is widely distributed in published reports, in unpublished and limited-distribution sources (commonly referred to as "gray literature"), and as digital information in databases such as GEOTHERM and WATSTORE. The sources of data and methods of data manipulation are discussed below, followed by a description of the bibliography.

Preliminary Data Compilation

The Nevada geothermal database (Appendices 1 and 2) includes "records" (that is, single reports of chemistry, temperature, location, etc. that are represented by a single spreadsheet row) for all known (reported or suspected) geothermal sites in the state. A number of preliminary databases and spreadsheets were compiled before selection of records for the final listing (Appendices to this report). To get the data from various sources into a common format for comparison required months of work using a variety of computer hardware and software available at NBMG. In the following paragraphs I have summarized the major sources of information, the techniques used to modify and utilize them effectively, and some of the sources of error and other problems that were encountered.

GEOTHERM

The history of the GEOTHERM database is summarized above under the description of previous assessments. Because the database was taken off line in 1983, it does not contain data collected after that date. A tape GEOTHERM records that was obtained from UURI was read on to a large magnetic disk at NBMG. Information supplied by NTIS with this tape gave the field lengths of each field in the database. With this information, computer database specialists at NBMG were able to design a database having fixed-length fields and read the GEOTHERM ASCII file into that database. The database on tape contained over 8000 records, with approximately 120 fields for each record. The database software used for this database was INFO, a subset of the ARC/INFO software utilized in many GIS (Geographic Information Systems) applications; hardware was a UNIX-based SUN SPARC II workstaion. The database in INFO was nearly 19 MB (megabytes). From this database, the 1367 Nevada records could be exported, by use of PC

ARC/INFO, in a format compatible with modern database-management software (such as dBASE). We used PC-File (a product of ButtonWare, Inc.) as the PC-based database software. The Nevada GEOTHERM database in PC-File is about 3.2 MB, and has a number of problems that make it difficult to use. One of the most notable problem is that in the PC-File format (essentially a dBASE format), most of the numerical data (temperature, water chemistry, etc.) are preceded by a five sided graphic figure which resembles the outline of a small house (or a baseball field "home plate"). This non-ASCII character was apparently a pad character or "punch" symbol in the original database that acted as a space. It can not be searched for, and was only eliminated after a short version of the database was retrieved into spreadsheet software (Quattro Pro, a product of Borland International, Inc.). In addition, some records had data reported in different units from other records (for example ppm or epm); the units used were reported in a separate database field. Fortunately, these problems were overcome in the shortened (spreadsheet) version.

Additionally, a number of other operations were done on a short database of GEOTHERM data that contained only the fields required for this study (Appendix 1). These include: 1) replacing the county name with a two-letter code (abbreviation) for each county, 2) conversion of numerical data from labels to values and insertion by hand of certain qualifiers on some analyses (N for not detected, t for trace, < for less than), 3) addition of calculated columns for ion balance, total calculated dissolved solids, and a major constituents test (is Na>K and Ca>Mg and Cl>F?), 4) rearrangement of columns into final format. Before final column rearrangement, formulas were converted to values, and a fixed number of decimal places was selected for display. About 455 records were finally selected from this spreadsheet to be included in the final tables listed in the Appendix.

WATSTORE

The acronym WATSTORE stands for the National WATer Data STOrage and REtrieval System, a large-scale computerized system developed for the storage and retrieval of water data collected as part of the activities of the USGS, particularly the Water Resources Division (from a 1981 pamphlet, U.S. Government Printing Office: 1981 - 341-618:52). The system was begun in 1971, and contains a very large set of data on surface and groundwater in the U.S. The water-quality file alone is reported to have (in 1991) 34 million observations from over 200,000 stations; 5,000 parameters (major and trace elements, pesticides, organics, etc.) are included. The database contains information on the analyzing and collecting agency, but does not report whether the data has been published or list references. The WATSTORE database can be searched through arrangements with USGS Water Resources district offices or through a national system of water data exchange (NAWDEX);

assistance centers for NAWDEX are also commonly located at USGS Water Resources District Offices. The NAWDEX database also has access to other Federal agency water data, for example the Environmental Protection Agency (EPA), in addition to WATSTORE.

Water quality and other WATSTORE database file information is also available through a commercial outlet, EarthInfo, Inc. of Boulder, Colorado. EarthInfo makes certain data from WATSTORE available on CD-ROMs along with a software retrieval system that can be used by IBM-compatible personal computers. NBMG obtained a CD-ROM that included all Nevada data (current to early 1993) from EarthInfo. Personnel at NBMG (particularly Ron Hess) were able to search the CD-ROM and extract the parameters required for this study (water quality, location, site name, etc.) for all springs and wells having a measured temperature of 18°C or greater. To avoid the combination of parameters (e.g., water chemistry analyses) from different collection dates for the same site, a combination number was created (consisting of the site and collection date numbers) so that a later relational combination of the data would produce records that represent one site visit. These geothermal data were converted to a dBASE format and PC-File was used to eliminate records having temperatures less than 20°C for the area of Nevada south of 38° latitude. At this point, the database consisted of 1,708 records. These records were imported into a spreadsheet format using Quattro Pro software, and a multitude of operations were performed on the data to make it similar to the planned format for the final tables (Appendices 1 and 2). These operations include: 1) conversion of longitude and latitude to decimal degrees, 2) addition of calculated fields for ion balance, total calculated dissolved solids, major constituents test (is Na>K and Ca>Mg and Cl>F?), 3) conversion of depth in feet to meters and flow from cubic feet per second to liters per minute, 4) addition of a reference column for listing of WATSTORE as the reference, 5) convert GW (groundwater) to W (well) and SP to S (spring), 6) conversion of the state-county FIPS code to a two-letter abbreviation (see listing below), 7) conversion of the collection date format to the year/month/ day format, 8) re-arrangement of columns, and 9) a sort of rows (records) by longitude and latitude.

A number of additional operations were later performed on about 140 WATSTORE records selected for the final tables. These include: 1) conversion of Fe, and B from micrograms per liter to milligrams per liter (essentially equivalent to parts per million - ppm), and 2) separation of the site name column into two columns (one for name and one for the legal land location, if reported). Following this, Li, oxygen and hydrogen isotope data, and HCO_3-CO_3 concentrations were added to the short spreadsheet of WATSTORE records. Li, and the ^2H and ^{18}O were inadvertently left out of the first search of the EarthInfo CD-ROM. The search for HCO_3-CO_3 data in WATSTORE presented a more complicated problem, as these constituents are reported as several different

parameters (fields) in the database. A number of the records generated by the first search were lacking data for these constituents; a second search was done for data in all possible related parameters (about eight of them, including bicarbonate and carbonate field results, laboratory results, dissolved, incremental titration, titration to pH 4.5 and pH 8.3, and alkalinity (field and laboratory). The data were entered by hand into the intermediate spreadsheet of WATSTORE records destined for the final tables.

Table 1. County names for Nevada, FIPS (Federal Information Processing Standard) code (32 is Nevada), and abbreviations used in this report.

County Name	FIPS Code	Abbreviation
Churchill	32001	CH
Clark	32003	CL
Douglas	32005	DG
Elko	32007	EL
Esmeralda	32009	ES
Eureka	32011	EU
Humboldt	32013	Hu
Lander	32015	LA
Lincoln	32017	LI
Lyon	32019	LY
Mineral	32021	MN
Nye	32023	NY
Pershing	32027	PE
Story	32029	ST
Washoe	32031	WA
White Pine	32033	WP
Carson City	32510	CC

Topographic Map Digital Data

A complete examination was made by David Davis at NBMG of the approximately 1,900 7.5-minute topographic maps for Nevada. The entire state has this coverage, and a visual examination was made of each map for any mention of hot or warm springs, geothermal wells, etc. In addition, a 1981 version of GEOTHERM was available in paper copy (Jim Bliss, written commun., 1981) and this was used to identify other geothermal spring and well locations on these topographic maps. About 2700 individual points were marked on the maps, and the locations were digitized in the NBMG GIS laboratory using ARC/INFO software, a CalComp 9500 digitizer, and digital map coordinate data (TIC file) from the USGS. A database of the location and other data collected for this part of the project was created, and about a dozen records in the final table were from the spreadsheet equivalent of that database. In general, the records from this database were for locations where

no data were available in other sources. The references are usually the 7.5-minute quadrangle map that the spring or well appears on. Additionally, when more precise longitude and/or latitude locations were required for records taken from any of the other sources used, the appropriate information from this database was entered in intermediate spreadsheets of selected records.

Other Data Sources

During the selection of records for the final database, if water quality or other data in WATSTORE or GEOTHERM was lacking, incomplete, or appeared to be of poor quality, other sources of information were checked for possible inclusion in the database. Some of these sources were originally cited in NBMG Bulletin 91, but no record of a particular site was ever entered in GEOTHERM. A number of such records refer to dubious thermal spring locations, but must be included in any database that is purported to be complete. Other sources used for one or two sites include Hulen and others (1994), Trexler and others (1990), and Lawrence Livermore Laboratory (1976). Unpublished information in NBMG files and field notes of L. Garside for this and previous geothermal studies was also used. In particular, a number of good analyses and locations reported by Flynn and Buchannan (1990) were used. Their Table 3.1 was scanned, imported into Quattro Pro, and parsed into a spreadsheet of similar format to others used during this study. Also available in spreadsheet format to be checked during the data selection process were the analyses reported by Reed and others (1983) from the GEOTHERM database, and digital data on water analyses done in some areas of Nevada for the NURE (National Uranium Resource Evaluation) program (Hoffman and others, 1991).

Selection Criteria

In the early stages of this study, it became apparent that the bulk of the data on Nevada's low- an moderate-temperature geothermal resources was contained in two databases, GEOTHERM and WATSTORE. Usually, for individual thermal springs and wells, the best one or two records available from either WATSTORE or GEOTHERM was selected. If the data in these databases were incomplete or nonexistent, other known sources were checked.

The process of record selection for the final database began with hardcopy printouts of the spreadsheets described above (e.g., GEOTHERM, WATSTORE, and the topographic maps). Digital files of the longitude and latitude information for these three databases were used to plot the geothermal localities on 1:1,000,000-scale maps of Nevada in NBMG's GIS lab, using ARC/INFO software. Each of the points or point groups on these maps was checked in a regular fashion for possible errors of location. The 1:1,000,000-scale maps were examined, on 1° by 1° blocks of latitude-

longitude (about 34 partial or complete blocks for Nevada). Every 7.5-minute topographic map that was shown to have a geothermal locality was re-examined, and the locations displayed on the million-scale maps were compared to those on the 7.5-minute quadrangles. From the available records for a particular spring, the best one, or in a few cases, two records was selected. For groups of springs that are found over several square kilometers, several records were commonly selected to best represent the geographic range and provide a more varied data set of water chemistry. The records selected were numbered, notes were taken on any problems recognized, and the number was written on a million-scale map and on the hardcopy of the appropriate database. This record selection process proceeded from west to east across the state, beginning in northwest Nevada and ending at its southern tip. The selection of the "best" records was somewhat subjective, but generally proceeded as follows. If a point on the maps was determined to be a valid geothermal site, GEOTHERM and WATSTORE records of that site or site area were examined. Selection from one of these databases was generally based on having an ion balance between 0.90 and 1.10, and a check to see if Na>K and Ca>Mg and Cl>F. The ion balance formula used was
Na*0.04350+K*0.02558+Ca*0.04990+Mg*0.08229/Cl*0.02821+F*0.05264+HCO_3*0.01639+CO_3*0.03333+SO_4*0.02082; resulting in a value in milliequivalents per liter, cations/anions. For those records that met these criteria, selection was based on completeness of the other analytical data (temperature, pH, minor constituents. etc.).

During the record selection process, spring and well records that did not meet certain minimum temperature criteria were eliminated from further consideration. According to the statement of work for this project, 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 with depth (for wells). The mean annual air temperature in Nevada varies from somewhat less than 7°C to over 18°C (Houghton and others, 1975, figure 17; see figure 1 below). This variation is an effect of both latitude and elevation; southern Nevada's higher mean annual temperature results from its lower latitude and its lower average elevation (Houghton and others, 1975). Based on this map of mean annual temperature, a lower spring and well temperature limit was set for certain latitude ranges in the state. For springs, the decision whether to include or not was relatively simple - if the spring temperature was at or above the set limit, it was included. For wells, only those were considered for inclusion that fell above a gradient of 25°C per kilometer with a beginning (surface) temperature at or above the minimum selected for that latitude range. The total well depth provided in the database was used to calculate this gradient. The following temperature limits were applied during record selection: 1) north of 39° latitude, 18°C or above; 2) 38° to 39°

latitude, 19°C and above (20°C was used for some sites, mostly wells, in the 38°-38.5° range, 3) 37° to 38° latitude, 20°C or above, and 35° to 37° latitude, 25°C and above. No upper temperature limit was used to restrict inclusion in the final data compilation. The statement of work for this project listed an upper limit of 150°C for occurrences to be included in the compilation. Seven occurrences with temperatures above 150°C were included in the database; mainly for completeness. The only data available for some geothermal occurrences was the analysis and associated location information for the high-temperature fluid. It is obvious that lower temperature geothermal fluids are available at these sites (in peripheral areas or, in the case of electric-power generation areas, as condensed steam or reinjection fluids). Because analyses of these lower temperature fluids were not often available, the high temperature fluid analysis was listed as a substitute.

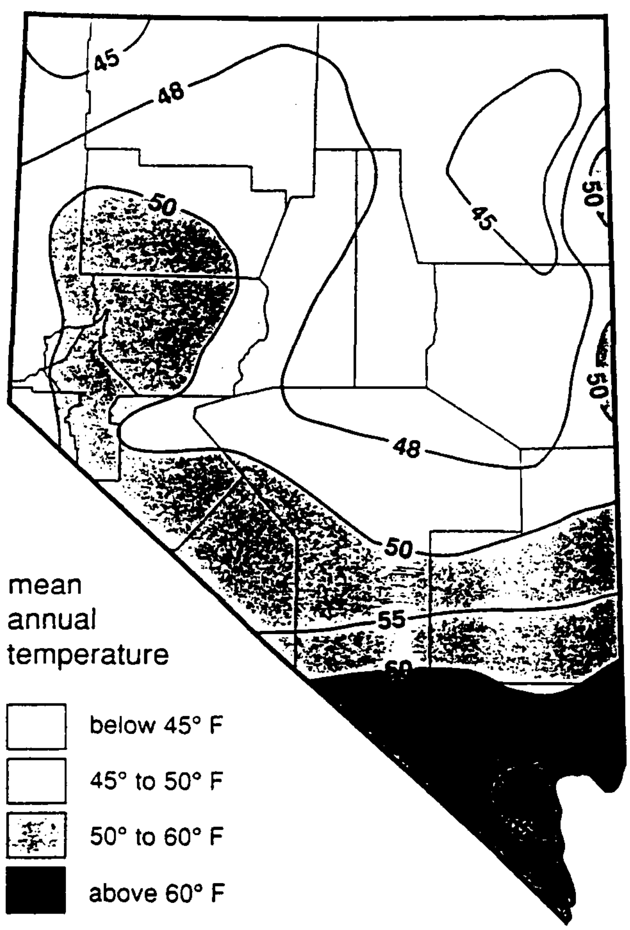

Figure 1. Map of mean annual temperatures in Nevada (from Houghton and others, 1975).

A number of problems were noted for both the GEOTHERM and WATSTORE databases as each plotted point on the million-scale maps was checked to see if it matched a known geothermal site. In quite a number of cases, certain geothermal locations were found

to have an incorrect longitude or latitude or both. These were commonly discovered when the 7.5-minute topographic map was compared to the million-scale plot. In some cases, the legal description (section-township-range) was correct, but the longitude or latitude had an error of, for example, one whole degree or one whole minute. These inaccurate site locations were noted, but not corrected in the individual databases unless the record was needed for the final table.

DATA FORMAT

Data on Nevada's low- to moderate-temperature geothermal resources are presented in Appendices 1 and 2. The data in these tables are in spreadsheet format, and the digital data used to produce them (and provided separately on diskette) can be searched and otherwise manipulated in a great variety of ways utilizing a number of commercially available spreadsheet and database management software packages. Although there are two Appendices, they were printed from a single spreadsheet. The software and data manipulation methods used at NBMG during this study are further described above, under data sources. The format of the tables and, thus, the spreadsheets, in most respects follows rather closely that of Blackett (1993).

The column headings and data in the columns are generally self-explanatory, but a few comments should be made. Each column heading is listed below, with a description of the data and a discussion of format and problems.

The site number is used to identify the site on the 1:1,000,000-scale map. It was added to the record when that record was selected for inclusion in the final database. The process of record selection was done in 1-degree blocks, proceeding from west to east, beginning in northwestern Nevada. Sites added later may not entirely follow this numbering progression, and to prevent renumbering of many of the sites, some added sites use decimal tenths (e.g., 143.1 and 142.2).

NAME The site name is commonly that listed in the source reference. In some cases, corrections, additions, or modifications were made to provide more information.

CO The two-letter abbreviation for one of Nevada's 17 counties is listed here. These abbreviations are listed above, under the Data Sources heading, with their FIPS code.

T, R, SC The legal land description, Township, Range, and Section are listed under these columns. These were commonly taken from the cited source, but some additions and corrections were

made during the data evaluation. Because some of these location data were derived (in the original studies) from maps of varying ages or scales, or by projecting section lines into unsurveyed areas, there is a chance for error. Although some of these errors were noted and corrected, there are certainly many that were not. The best location data for the sites is generally the longitude and latitude; however, if correct, the section-township-range location can be used to confirm a site on topographic maps. Some section locations were determined by use of 1:100,000-scale topographic maps, on which the protracted sections are commonly displayed.

QSEC The data in this column, if present, describe the portion of the section in which the geothermal site is located. The quarter-quarter-quarter system (for example: NE SE NW) indicates an approximately 10 acre parcel in the 1 square mile section (640 acres) that is located in the northeast quarter of the southeast quarter of the northwest quarter. For data from the WATSTORE database, letters are used to indicate (from left to right) the quarter section, quarter-quarter section, and so on; the letters A, B, C, and D designate the northeast, northwest, southwest, and southeast quarters, respectively. Thus, for example, ABC would represent the southeast(C) quarter of the northwest quarter(B) of the northeast(A) quarter. The A-B-C-D system thus lists the largest quarter first, followed by progressively smaller quarters; the NE-NW-SW-SE system lists the smallest quarter section first.

T This column lists the type of occurrence, either spring (S) or well (W). In a few cases, the original listing did not fall into these two categories, and it was modified. For example, a hot pool was listed as a spring, and mine shafts or mineral exploration drill holes were listed as wells.

TEMP The reported temperature of the well or spring is listed, in degrees Celsius, in this column. Many of these reported temperatures were measured and originally reported in degrees Fahrenheit; those converted to °C were rounded to one decimal place after conversion. If the only information reported on temperature is "warm" or "hot" (for example, from a topographic map), this is listed. The reported temperature is that of the cited reference. It is not necessarily the highest temperature reported in all of the available data for a particular spring or well; a particular record may have been selected because of its complete analysis, rather than because it had the highest reported temperature.

FLOW The flow, in liters per minute (L/min) is shown in this column. For wells, this value is commonly the discharge during pumping. Values are reported to one decimal place.

DEPTH For wells, the depth in meters is listed, if available

from the original source.

CDATE The date of collection is listed here, in the format: year/month/day. For many records that list only the year of collection, this was added during this study, based on other information.

pH The reported pH is listed here.

Chemical constituents (Na, Cl, etc.) For most of the chemical constituents, they are listed as reported in the original references or databases. The reporting units are milligrams per liter (mg/L); these are essentially equivalent to parts per million at the concentration levels of the fluids listed in the Appendix. For some analyses, constituent values originally reported in μgm/L (micrograms per liter or parts per billion - ppb) were converted to mg/L. If the original source listed a particular constituent as less than a certain value, this was reported using the symbol "<". Similarly, "t" indicates that a trace amount was detected, and "N" indicates the constituent was analyzed for but not detected. The number of decimal places displayed for each element is generally based on that reported in the sources of data. For most of the reported analyses, bicarbonate (HCO_3) and carbonate (CO_3) are listed as reported in the sources. Carbonate values are usually only found in waters with a pH of 8.2 or greater. A few sources (e.g., Lawrence Livermore Laboratory, 1976) report total alkalinity; these values were recalculated and reported as bicarbonate, as were the values reported in a HCO_3 + CO_3 column of Table 3.1 of Flynn and Buchannan (1990). Some analyses are noted to be relatively complete, but lack Na and K values. Commonly, the reason for this absence is that the original analysis reported Na + K as a single value, and thus, no data was entered in the Na and K fields in databases such as GEOTHERM.

TDSm, TDSc These columns present the total dissolved solids, measured and calculated. The measured value, if present, is from the original data source (presumed to be a residue on evaporation at 105°C). The calculated value was determined by summing the constituents reported. Thus, the TDSc value reported for incomplete analyses only represents a partial sum. A few analyses were summed before Li was added, and may be one to several ppm low. The HCO_3 value was multiplied by 0.492 to make the calculated TSDS values comparable with residue values.

ChgBal The electroneutrality of the analysis was evaluated using a charge (ion) balance formula (described further in the section on selection criteria). No value is reported for records which have no or extremely limited analytical data, as such a calculation would be meaningless. The most common reason for a charge balance that varies considerably from 1.00 is a lack of data for HCO_3. Other missing major ions can also result in a

"poor" charge balance.

delD, delO18 These columns contain isotopic compositions for the stable isotopes ^{18}O and deuterium (^{3}H). Data are reported to zero or one decimal place for ^{18}O and one or two decimal places for deuterium.

REFERENCE The reference citation in this column is that for the source of the data. The records that were taken from the GEOTHERM database include the reference listed therein. The WATSTORE citation is from the database search described above under data sources. An asterisk (*) precedes some citations; this was used in the GEOTHERM database to indicate unpublished data from individuals or agencies (for example, *WHITE, D., USGS, MENLO PARK or *DESERT RESEARCH INSTITUTE, 1973). The *NEVADA BUREAU OF MINES AND GEOLOGY citation includes unpublished data from that agency's files entered into the original GEOTHERM database as well as some entries made during this study. The *WATSTORE reference refers to data from GEOTHERM that originated from a WATSTORE search, probably in the late 1970s.

USE This data category lists the geothermal application for which the thermal water is presently used, or has been used for in the recent past but is not presently (in parentheses). The source of most of this data is Garside and Hess (1994), with some later additions during the later part of this study. Garside and Hess (1994) is reproduced as Appendix 3. No attempt was made to list uses of only the water but not the contained heat (livestock watering, for example). At least a dozen hot spring areas in Nevada have had hotel spas at them; most were built in the late 19th and early 20th Centuries. These were not listed as a past use, but present spas, swimming pools, etc., were reported.

FLUID CHEMISTRY

The geochemistry of thermal water in Nevada (and adjacent areas) has been discussed by a number of authors (e.g., Mariner and others, 1983; Flynn and Buchanan,1990; Welch and Preissler, 1990; Young and Lewis, 1982). A simplification of the pattern of chemistry exhibited by Nevada thermal water is that eastern Nevada geothermal fluids are calcium bicarbonate dominated, central and northern Nevada has mainly sodium bicarbonate type fluids, and the western part of the state has mostly sodium chloride and sodium sulfate types. The reasons for this pattern are, no doubt, relatively complex; however, water-rock interactions are certainly a significant factor. Thus, eastern Nevada calcium bicarbonate geothermal fluids are strongly influenced by the presence of a regional carbonate aquifer. At least some of the sodium bicarbonate geothermal fluids of the central and north-central parts of the state may result from the exchange of sodium (possibly from volcanic rocks) for calcium in

fluids that were originally calcium bicarbonate in character. Western Nevada sodium chloride and sodium sulfate waters may reflect increased water-rock interaction (and thus generally higher temperatures) as well as possible evaporative concentration of fluids prior to deep circulation and/or extraction of salts from Quaternary playa lake deposits.

DISCUSSION

Nevada is well endowed with both high- and low-temperature geothermal resources. Based on a generalized map of known and potential geothermal resource areas of the United States (e.g., Lienau, 1988) over 40% of the state is believed to have potential for the discovery of high-temperature geothermal resources, and another 50% has potential for low -to moderate-temperature resources. This potential is well illustrated by the 1:1,000,000-scale map of geothermal occurrences produced during this study (Plate 1). The database for this study consists of 455 individual records, representing more than 300 resource areas. The geothermal springs and wells are distributed over the entire state, with an increased concentration in the northwestern part of the state (Figure 3). Maximum spring and well temperatures are higher in the north and northwest parts of the state. Geothermal occurrence temperatures greater than 75°C are confined to the northwestern half of the state, a pattern that closely follows that of heat flow (see Sass and others, 1981). The distribution of reported temperature vs. number of occurrences is shown below (Figure 2). About 400 springs and wells plot in 11 temperature ranges; additionally 30 sites are listed as "warm" and 23 as "hot".

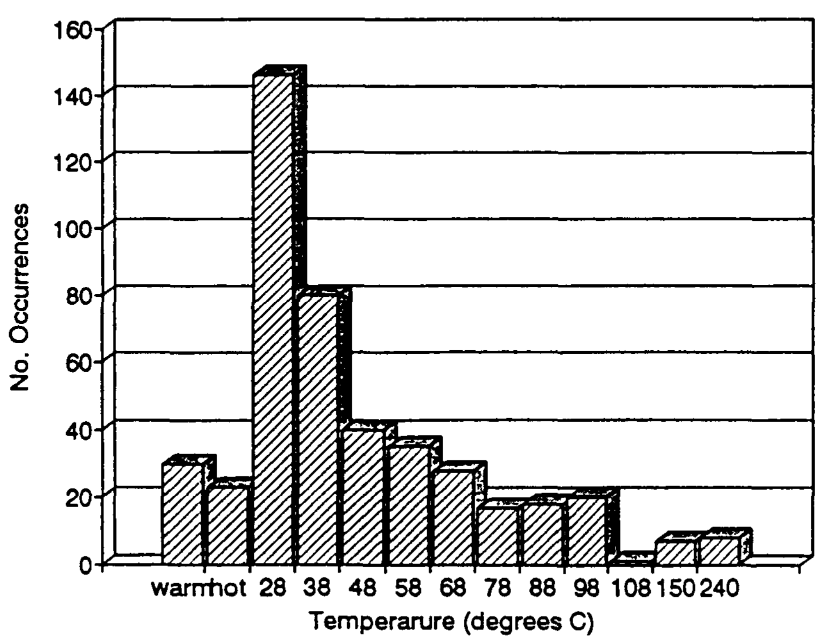

Figure 2. Bar graph of temperature vs. number of geothermal occurrences.

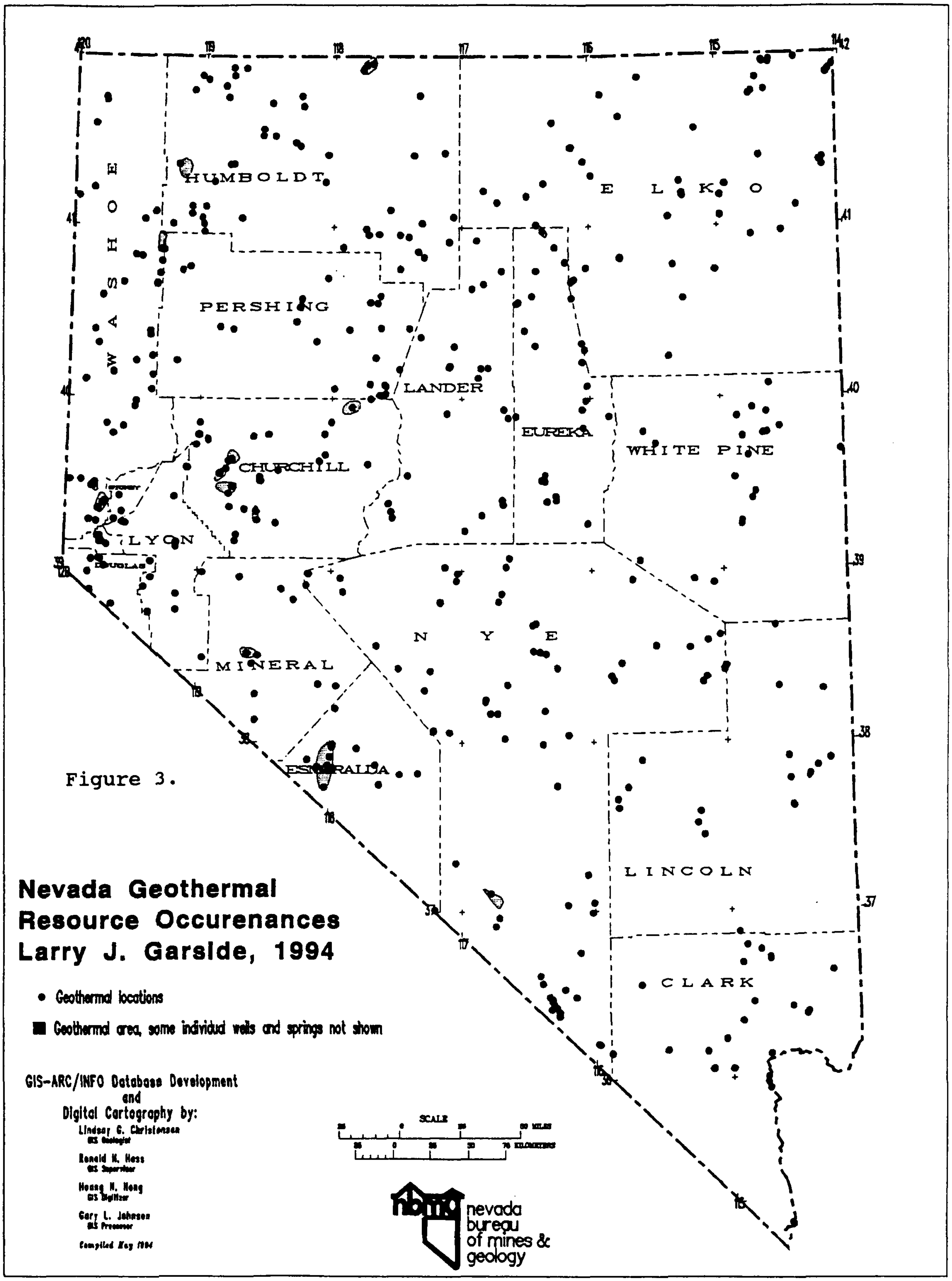

Figure 3.

Nevada Geothermal Resource Occurenances
Larry J. Garside, 1994

Geothermal reservoirs in the northwestern part of the state have generally higher temperatures; these reservoirs are usually interpreted as being related to circulation of ground water to deep levels along faults in a region of higher-than-average heat flow (the Battle Mountain heat flow high). In east-central and southern Nevada, the low- to moderate-temperature geothermal resources are generally believed to be related to regional groundwater circulation in fractured carbonate-rock aquifers. Discharge areas (like warm springs) may be up to several hundred kilometers from the area of recharge, and the waters may have circulated for hundreds to thousands of years to depths of several kilometers. Maximum temperatures attained during this journey could be 100°C or higher, but spring temperatures at discharge points are generally less than 65°C.

The Eureka heat flow low, a region of less than 1.5 HFU (heat flow units; 41.8 milliWatts per square meter, mWm^{-2}) located in eastern Nye and northwestern Lincoln Counties, is centered on the Nevada portion of a large area of Middle Cambrian to Lower Triassic carbonate rocks (the carbonate rock province). This carbonate rock province underlies southern and eastern Nevada and northeastern Utah (Plume and Carlton, 1988). The Eureka Low is most likely a regional-scale hydrologic feature, representing colder groundwater recharge to regional aquifers.

SUMMARY

Nevada is a large state with sparse but locally concentrated population. It has a wide range in average annual temperature, and thus a wide range in the lower limit of temperatures considered anomalous for geothermal fluids. The state's complex pattern of geology and heat flow results in geothermal resource areas of diverse character located throughout the state.

There have been many studies, both general and specific, on Nevada's geothermal resources (see Bibliography). Considerable data are available on specific geothermal spring and well sites but some remote areas are still poorly understood and information on their geothermal resources are incomplete or possibly inaccurate. There are many accurate and complete water analyses and associated location information for well-studied geothermal areas. However, many remote individual springs and wells throughout the state lack complete analyses, and some lack good location information; in some cases, there is uncertainty about the existence of certain springs. For example, Appendix 1 lists over 50 sites for which the only temperature information is "warm" or "hot."

In Nevada, as in many arid areas of the west, most water (whether thermal or nonthermal) has been put to use. Some nonthermal applications actually require cooling before use. Present and

recent past uses of the contained heat of Nevada thermal waters are quite varied (see Appendix 3). However, more such use is feasible if potential developers are well informed and encouraged to be conservative in their use of fossil fuels.

RECOMMENDATIONS

There are many remote geothermal sites for which no complete data set could be found in the sources examined. For completeness, some of these should be visited and sampled but most of them are unlikely to be put to any low-temperature use because of their remoteness. Having a more complete data set would, however, be useful in regional studies, and might result in the discovery of previously unknown higher temperature resources.

No attempt was made during this study to combine trace-element water chemistry data from more than one analysis into a single record. For example, analyses of B, Li, and F may have been reported in a analysis with poor ion balance while the best analysis in terms of major constituents may have been lacking some of the trace-element data. Some of this type of trace-element data could be added to the final database, but it seemed like a poor practice for this original compilation.

Some sources of information on geothermal springs and wells that were not used during this study might be useful to pinpoint previously unknown (especially low-temperature) geothermal sites. However, the mass of data available and its concentration in populated areas (where good information already exists), make searching such data relatively unproductive. Some examples of such available data include the water well records (submitted by well drillers) for the state available from the Nevada Division of Water Resources. These water well records have many errors (especially in location); searching and confirming previously unknown geothermal sites would take considerable effort. Other sources of water data that are likely to have similar potential errors include the analyses of agencies like the Nevada Division of Health, the Nevada Division of Environmental Protection, and the U.S. Environmental Protection Agency. One source of information that might have a higher potential for adding to the geothermal database is the largely confidential files of geothermal exploration companies. Thousands of shallow to moderately deep (100 to 1000 m) geothermal gradient and "slim holes" were drilled in the search for high temperature geothermal resources (for electric power generation) over the last 30 years. This source of geothermal data was suggested by a number of industry representatives at a March 1994 symposium sponsored by the Geothermal Resources Council on the geothermal resources and exploration of the Basin and Range Province. The extent of the data is not presently known.

Finally, increased future use of geothermal energy in low- to moderate-temperature applications will require not only studies that demonstrate the availability of the resource but also dissemination of information (such as case histories) that illustrate the details of these uses. Such case histories should be understandable by the general public, but also make available details of the technical data. Because some uses, such as district heating systems, require considerable front-end investment compared to individual fossil fuel heating units, projects that can bring together several funding sources have a better chance of success.

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One task of the study was the identification of geological, geophysical, geochemical, and hydrologic studies that have been done since the last resource assessment. The bibliography (Appendix 4) is the result of that literature search. There are 907 citations listed in the bibliography; of these, nearly one-half are from the bibliography in Garside and Schilling (1979). This bibliography was nearly exhaustive, at least for published sources, through about 1978. That bibliography was scanned and converted with text-recognition software to a format useable by word-processing software. The references from this 1979 bulletin included general references to the geology of geothermal areas as well as references specific to geothermal resources. The additional references in Appendix 4 were obtained from a variety of sources; most were entered in the document by hand, rather than taken directly from other digital data sources. Several methods were used to find these additional references. The bibliography for GEOTHERM (Bliss, 1983 a) was checked for references not in Garside and Schilling (1979). Additionally, the geothermal files in the Public Information Office of the Nevada Bureau of Mines and Geology were a good source, especially for unpublished reports. My own library of geothermal references was searched, and the CD-ROM for GeoRef (the bibliographic database of the American Geological Institute) was searched for any Nevada geothermal references. A similar search was done of the WolfPAC NALIS library information system (the Northern Nevada Academic Libraries Information System). The Geothermal Resources Council Bulletin and Transactions, and the GeoHeat Center Quarterly Bulletin were also scanned for any Nevada references.

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APPENDIX 1

#	NAME	CO	T	R	SC	QSEC	NLAT	WLONG	T	TEMP	FLOW	DEPTH	CDATE	REFERENCE	USE
1	TWIN SPRING, VYA SPRING	W	42N	19E	04	NW	41.5933	119.8650	S	22	715		1952/05/15	WARING, 1965	
2	HILL'S WARM SPRING	W	44N	20E	18	NE SE SW	41.7300	119.7867	S	26			1961/08/08	TREXLER AND OTHERS, 1979	
3	UNNAMED SPRING	W	44N	19E	12		41.7459	119.7919	S	23	19		1946/02/11	SINCLAIR, 1963B	
4	VIRGIN VALLEY RANCH 10	HU					41.7906	119.1075	W	21			1975/08/05	WATSTORE	
5	VIRGIN V CAMP GROUND 1	HU	45N	26E	02		41.8533	119.0008	W	32			1975/08/05	WATSTORE	
6	ROADSIDE REST AREA 3	HU	46N	26E	31	C	41.8753	119.0475	W	18			1975/08/05	WATSTORE	
7	Surprise Valley Hot Spring	WA					41.166	119.978	S	47			1989/	Flynn and Buchanan, 1990	
8	WARM SPRING	W	39N	19E	33		41.2160	119.8627	S	warm				WALL CANYON RESERVOIR 7.5' QUAD	
9	WARM SPRINGS	HU	44N	27E	12	NE SW SW	41.7503	118.8367	S	40			1954/07/27	TREXLER AND OTHERS, 1979	
10	McGEE MOUNTAIN	HU	45N	27E			41.8163	118.8597	S	42.2		61		WENDELL, 1970	
11	BOG HOT WELL	HU	46N	28E	31		41.8783	118.7960	W	hot				BOG HOT SPRINGS 7.5' QUAD	
12	BOG HOT SPRINGS	HU	46N	28E	18	SW NE NW	41.9226	118.8050	S	55.6	3785		1970/09/01	SINCLAIR, 1963B	
13	BALTAZOR HOT SPRING 9	HU	46N	28E	18	B	41.9217	118.7092	S	63			1975/08/05	WATSTORE	
14	SOLDIER MEADOWS AREA HOT SPRING	HU	40N	24E	23		41.3597	119.2180	S	54	68		1974/02/20	GROSE AND KELLER, 1975B	
15	SOLDIERS MEADOW AREA - UNNAMED HOT SPRING	HU	40N	24E	23		41.3597	119.2180	S	54	50		1950/06/13	MARINER AND OTHERS, 1974, 1975	
16	SOLDIER MEADOW AREA HOT SPRING	HU	40N	24E	23		41.3597	119.2180	S	48				GROSE AND KELLER, 1975B	
17	SOLDIER MEADOW 1	HU	40N	24E	23		41.3581	119.2178	S	54			1975/01/01	WATSTORE	
18	CANE SPRING	HU	39N	27E	30	NE	41.2580	118.9362	S	23.3	19			SINCLAIR, 1963A	
19	WEST PINTO HOT SPRING	HU					41.3592	118.8136	S	92			1974/01/01	WATSTORE	
20	EAST PINTO HOT SPRING	HU	40N	28E	17	NE SE SE	41.3625	118.7680	S	94				GROSE AND KELLER, 1975B	
21	WARM SPRING	W	37N	22E	35		41.0397	119.4688	S	warm				LEADVILLE 7.5' QUAD	
22	LEADVILLE SPRINGS	W	37N	23E			41.0827	119.3871	S	warm				SMITH, 1956	
23	CANE SPRINGS	HU	36N	24E	16	A	41.0133	119.2547	S	21			1961/12/12	WATSTORE	
24	WHEELER RANCH WELL	HU	37N	25E	10	SE	41.1150	119.1083	W	36.1			1965/09/21	SINCLAIR, 1963A	
25	DOUBLE HOT SPRING 2	HU	36N	26E	04		41.0492	119.0275	S	68.5			1975/01/01	WATSTORE	
26	UNNAMED SPRING (D.H.-2)	HU	36N	26E	16	SE NE	41.0150	119.0155	S	68.5			1938/08/24	GROSE AND KELLER, 1975B	
27	WW3922T1	HU	37N	24E			41.0733	119.1097	W	24.2	815.0		1979/12/13	WATSTORE	
28	TH SP HARDIN CITY SE OD	HU	37N	26E	10	DCA	41.1156	119.0008	S	50.8	101.9		1960/07/09	WATSTORE	
29	MACFARLANE'S BATH HOUSE SPRING	HU	37N	29E	31		41.0507	118.7188	S	76.5	18.9			SINCLAIR, 1963A	
32	SPRING	HU	42N	30E	12	A	41.5294	118.5686	S	40			1960/10/06	WATSTORE	
33	SPRING	HU	43N	30E	25	D	41.5675	118.5656	S	70			1960/10/06	WATSTORE	
34	UNNAMED SPRING	HU	42N	33E	19	SW SE	41.4922	118.3192	S	21.1	19		1957/05/16	SINCLAIR, 1962C	
35	U.S.G.S. TEST WELL NO. 21	HU	42N	33E	32	SE NE	41.4717	118.2847	W	24.4		27	1972/00/00	MALMBERG AND WORTS, 1966	
36	WELL	HU	42N	31E	11	B	41.5266	118.4769	W	24		107.3	1960/10/06	WATSTORE	
37	HOWARD HOT SPRING	HU	44N	31E	04	SE NE NE	41.7200	118.5033	S	57.8	189		1970/05/05	SINCLAIR, 1962C	
38	FIVE MILE SPRING	HU	45N	33E	21	SE NE SW	41.7625	118.2783	S	27			1975/08/21	TREXLER AND OTHERS, 1979	
39	SPRING	HU	44N	33E	10	BB	41.7053	118.2633	S	26			1959/06/22	WATSTORE	
40	JACKSON WELL	HU	39N	35E	07	DCDA	41.2614	118.0858	W	19.5			1961/02/26	WATSTORE	
41	SOD HOUSE RANCH WELL	HU	41N	35E	20	NE	41.4200	118.0633	W	27		34	1975/08/20	SINCLAIR, 1962A	
42	CORDERO MERCURY MINE, NORTH LOWER WELL	HU	47N	37E			41.9167	117.8000	W	53			1967/11/11	*WHITE, D., USGS, MENLO PARK	
43	MENTABERRYS WELL 1	HU	47N	37E	24	BAB	41.9478	117.7678	W	26.5		61.0	1976/04/23	WATSTORE	
44	NOQUE'S NEVADA WELL	HU	47N	38E	17	NE NE SE	41.9555	117.7200	W	33.3		214	1972/00/00	GARSIDE AND SCHILLING, 1979	
45	THE HOT SPRINGS	HU	41N	41E	19	NE NE	41.4208	117.3867	S	57.2	227			LOELTZ AND OTHERS, 1949	
46	THE HOT SPRING	HU	41N	41E	19	NE NE	41.4208	117.3867	S	58				MARINER AND OTHERS, 1974, 1975	
47	SPRING	HU	41N	43E			41.4364	117.1436	S	hot				WARING, 1965	
48	WELL	HU	37N	39E	03	DC	41.1047	117.5739	W	69		18.6	1962/04/26	WATSTORE	
49	SPRINGS	HU	45N	41E			41.7737	117.3452	S	hot				WARING, 1965	
50	UNNAMED SPRING	HU	36N	41E	02	SW NE NE	41.0300	117.3215	S	21.1	95		1950/00/00	COHEN, 1962	
51	SPRINGS	HU	37N	43E	24		41.0654	117.0762	S	warm	>757			ANCTIL, 1960	
52	WARM SPRING NEAR DEEP CREEK RESERVOIR	EL	43N	55E	19		41.6153	116.2979	S	warm				CORNACOPIA RIDGE 7.5' QUAD	
53	HOT LAKE	EL	38N	46E	25		41.1480	116.7343	S	hot				SQUAW VALLEY RANCH 7.5' QUAD	
54	SPRING	EL	39N	45E	36		41.2137	116.8440	S	hot				WARING, 1965	
55	SPRING, HEAD OF HOT CREEK	EL	38N	48E	11		41.1832	116.5014	S	?				WILLOW CREEK RESERVOIR 7.5' QUAD	
56	UNNAMED HOT SPRING	EL	39N	50E	18		41.2571	116.3666	S	47.2			1972/00/00	HOSE AND TAYLOR, 1974	
57	PETAINI (NIAGARA?) SPRINGS	EL	40N	53E	08		41.3837	116.0587	S	warm	5960			EAKIN, 1962B	
58	ELLISON RANCH SPRING	EL	41N	52E	08	NE	41.4667	116.1533	S	93	3.8		1971/12/30	*WHITE, D., USGS, MENLO PARK, CA	
59	HOT SULPHUR SPRINGS	EL	41N	52E	08	NE	41.4677	116.1480	S	90			1950/05/24	MARINER AND OTHERS, 1974, 1975	
60	UNNAMED HOT SPRING (SSE PATSVILLE)	EL	45N	54E	20		41.7758	115.9207	S	41				MARINER AND OTHERS, 1974, 1975	
61	WILD HORSE HOT SPRING	EL	43N	55E	04	SE SE	41.6472	115.7757	S	54				MARINER AND OTHERS, 1974, 1975	
62	ROWLAND HOT SPRINGS	EL	46N	56E	14	NW SW N	41.8767	115.6260	S	77	114		1957/05/17	*WHITE, D., USGS, MENLO PARK	
63	SPRING	EL	39N	53E	03		41.2960	115.9967	S	warm				MAHALA CREEK WEST 7.5' QUAD	
64	WARM SPRINGS	EL	37N	58E	26		41.0613	115.3936	S	warm				MORGAN HILL 7.5' QUAD	
65	UNNAMED SPRING	EL	38N	59E	14	SE SW SE	41.1800	115.2817	S	36			1962/06/26	TREXLER AND OTHERS, 1979	
66	UNNAMED WELL	EL	38N	59E	11	SW NE SW	41.1950	115.2850	W	30			1947/05/18	TREXLER AND OTHERS, 1979	
67	DEVIL'S PUNCH BOWL	EL	39N	59E	15	SE SW	41.2650	115.3050	S	52			1972/12/13	TREXLER AND OTHERS, 1979	
68	H.D. RANCH SPRING, HOT CREEK SPRINGS	EL	43N	60E	34	SE SW NW	41.5762	115.1808	S	64.4	2271		1946/04/09	WARING, 1965	
69	RAILROAD SPRING	EL	37N	62	29		41.0661	114.9904	S	warm				OESTERLING, 1960	
70	UNNAMED HOT SPRING NEAR WELLS	EL	38N	62E	17	SE NW NE	41.1818	114.9895	S	61				MARINER AND OTHERS, 1974B	HEAT PUMP
71	UNNAMED HOT SP NEAR WELLS	EL	38N	62E	17	A	41.1819	114.9894	S	55			1974/01/01	WATSTORE	

#	NAME	CO	T	R	SC	QSEC	NLAT	WLONG	T	TEMP	FLOW	DEPTH	CDATE	REFERENCE	USE
72	METROPOLIS (TWELVEMILE SPRINGS)	EL	39N	62E	27	NE NE	41.2450	114.9517	S	38.9	3038		1964/04/14	WARING, 1965	
73	WINE CUP RANCH WELL	EL	41N	64E	25	NW SE	41.4092	114.6742	W	58.9		20.7	1946/03/25	RUSH, 1968A	
74	PAN AMERICAN PETROLEUM-COBRE MINERALS WELL	EL	37N	67E	03	SW SE	41.1135	114.3842	W	76.7		1403		*NEVADA BUREAU OF MINES AND GEOLOGY	
75	GAMBLE RANCH WELL NO. 4	EL	40N	69E	16	SW	41.3433	114.1717	W	20		64		RUSH, 1968	
76	THOUSAND SPRINGS (GAMBLE RANCH SPRING)	EL	40N	69E	08	SE NW NW	41.3698	114.1917	S	20.6	5110			MIFFLIN, 1968	
77	HOT SPRING	EL	40N	69E	04		41.3862	114.1644	S	hot				TWELVEMILE RANCH 7.5' QUAD	
78	WELL	EL	45N	64E	20	ACB	41.7731	114.7506	W	54			1979/04/26	WATSTORE	
79	MINERAL HOT SPRINGS	EL	45N	64E	16		41.7882	114.7293	S	60			1966/10/13	MARINER AND OTHERS, 1974, 1975	
80	SAN JACINTO RANCH SPRING	EL	46N	64E	23	NW NW	41.8683	114.6950	S	26			1962/07/26	MOORE AND EAKIN, 1968	
81	MINERAL HOT SPRING	EL	45N	65E	08	BBA	41.7956	114.6258	S	60			1974/01/01	WATSTORE	
82	W.D. RANCHING CO. FLOWING WELL	EL	47N	65E	18	NW SW	41.9653	114.6418	W	37.8		188.4	1979/12/15	MOORE AND EAKIN, 1968	
83	WHEELER (Y3) RANCH WELL	EL	47N	65E	17	CBC	41.9586	114.6344	W	36		382.5	1977/12/07	WATSTORE	
84	WHEELER (Y3) RANCH WELL	EL	47N	65E	15	DCCD	41.9547	114.5858	W	43.5			1981/04/23	WATSTORE	(AQUACULTURE)
85	SHOSHONE WARM SPRINGS	EL	47N	65E	11	NE SW SW	41.9717	114.5783	S	35			1962/06/25	TREXLER AND OTHERS, 1979	
86	UNNAMED HOT SPRING	EL	47N	67E	09	SE NW	41.9800	114.3770	S	30			1960/10/07	HOSE AND TAYLOR, 1974	
87	TROUT CREEK RANCH WELL, GOOSE CREEK AREA	EL	46N	69E	15	NW NE	41.8823	114.1188	W	43.3		75	1912/09/23	MOORE AND EAKIN, 1968	
88	GOOSE CREEK AREA SPRING	EL	46N	69E	10	SE SW SE	41.8867	114.1200	S	33.9			1960/10/07	*WATSTORE	
89	TROUT CREEK RANCH WELL	EL	46N	69E	02	SW SE	41.9027	114.0995	W	21		75	1972/02/13	MOORE AND EAKIN, 1968	
90	NILE SPRING	EL	47N	70E	30	SW SW S	41.9283	114.0687	S	43				MARINER AND OTHERS, 1974, 1975	
91	HOT SPRING	HU	35N	43E	11		40.9202	117.1091	S	hot				HOT POT 7.5' QUAD	
92	NEW SPRING	W	34N	22E	18		40.8317	119.5317	S	29			1952/05/18	GROSE AND KELLER, 1975B	
93	POODLE SPRING	W	34N	22E			40.8244	119.4847	S	29			1975/01/01	WATSTORE	
94	spring	WA					40.6711	119.8174	S	29.4			1975/	LAWRENCE LIVERMORE LABORATORY, 1976	
95	BUFFALO SPRING	W	31N	20E	06		40.5932	119.7742	S	warm				WARING, 1965	
96	BUCKBRUSH SPRING	W	29N	19E	11		40.3960	119.8250	S	warm				WARING, 1965	
97	JACK BONHAM RANCH WELL	W	28N	19E	12	NE	40.3150	119.7933	S	23			1963/04/16	GLANCY AND RUSH, 1968	
98.1	FISH SPRING	W	26N	19E	19	SE SE	40.1006	119.8850	S	23			1952/09/18	RUSH AND GLANCY, 1967	
98.2	Fish Spring	WA					40.1024	119.8836	S	21			1975/	LAWRENCE LIVERMORE LABORATORY, 1976	
99	THE NEEDLES - WESTERN GEOTHERMAL WELL	WA					40.1500	119.6750	W	115.5				*WHITE, D., USGS, MENLO PARK	
100	THE NEEDLES	WA					40.1460	119.6748	S	56				MARINER AND OTHERS, 1974, 1975	
101	SEVENMILE SPRING	W	25N	23E	10	BCD	40.0483	119.3875	S	18			1969/07/30	WATSTORE	
102	SPRING	W	26N	23E	10	DBA	40.1344	119.3789	S	18.5			1969/07/30	WATSTORE	
103	SPRING	W	27N	22E	16	ADA	40.2161	119.5056	S	25			1969/06/22	WATSTORE	
104	LOWER STONEHOUSE SPRING	PE	27N	25E	08	DD	40.2178	119.1997	S	28			1969/09/03	WATSTORE	
105.1	Amor II well 43-21	W	29N	23E	21		40.3692	119.4039	W	135		85.4		*NEVADA BUREAU OF MINES AND GEOLOGY	ELECTRIC POWER
105.2	Amor II well 43-21	W	29N	23E	21		40.3692	119.4039	W	135		85.4		*NEVADA BUREAU OF MINES AND GEOLOGY	ELECTRIC POWER
106	SAN EMIDIO DESERT - UNNAMED HOT SPRING	W	29N	23E	09,16		40.3917	119.4067	S	79	30		1956/02/22	MARINER AND OTHERS, 1976A	VEGETABLE DRYING
107	GERLACH AREA - GREAT BOILING SPRING (GERLACH HOT S	W	32N	23E	15	NW	40.6600	119.3633	S	86				MARINER AND OTHERS, 1974, 1975	SPA
108	UNNAMED HOT SPRING NEAR GREAT BOILING SPRING	W	32N	23E	10	SW NW	40.6650	119.3667	S	69.5	100			MARINER AND OTHERS, 1976A	
109	GREAT BOILING SP ORIF 46	WA					40.6608	119.3650	S	88.6	390.5		1980/01/28	WATSTORE	
110	BOWEN	W	33N	23E	23	C	40.7226	119.3443	S	26			1975/01/01	WATSTORE	
111	GRANITE CREEK RANCH WELL	W	34N	23E	34	A	40.7939	119.3342	W	26			1961/12/13	WATSTORE	
112	WELL	PE	33N	25E	10	B	40.7447	119.1731	W	33.5			1961/06/12	WATSTORE	
113	UNNAMED HOT SPRING NEAR TREGO	PE					40.7667	119.1167	S	84.5	150			MARINER AND OTHERS, 1976A	
114	FLY RANCH (WARDS HOT SPRING) - WELL	W	34N	23E	02		40.8633	119.3417	W	80	500		1968/06/00	MARINER AND OTHERS, 1974, 1975	
115	HUALAPAI FLAT SPRING 16	W	34N	23E	01		40.8606	119.3181	S	94			1975/01/01	WATSTORE	
116	BLACK ROCK HOT SPRINGS	HU	36N	26E	34	NW NW	40.9700	119.0100	S	57.8	715		1972/03/29	SINCLAIR, 1963A	
117	BACH WELL	PE	29N	29E	08	D	40.4056	118.7675	W	20.5			1961/09/14	WATSTORE	
118	PORTER SPRING	PE	29N	28E	05	B	40.4178	118.8678	S	18			1969/11/20	WATSTORE	
119	COLADO WELL NO. 1	PE	26N	32E	33	SE	40.2450	119.3850	W	80			1966/05/23	*MARINER, R., USGS, MENLO PARK	
120	SOUTHWEST DREDGING CO. WELL	PE	29N	34E	34	SE	40.3367	118.1367	W	24	8	42	1957/02/05	LOELTZ AND PHOENIX, 1955	
121	DRILL HOLE	PE	25N	35E	01		40.0613	117.9977	W	hot				GARSIDE AND SCHILLING, 1979	
122	HYDER (HYDRA) HOT SPRINGS	PE	25N	36E	28	SW	40.0033	117.7167	S	78	102		1962/07/31	MARINER AND OTHERS, 1976A	
123	SOU HOT SPRINGS (GILBERTS HOT SPRINGS)	PE	26N	38E	29	SE	40.0895	117.7247	S	73				MARINER AND OTHERS, 1974, 1975	
124	UNNAMED SPRING	PE	25N	39E	19	NW	40.0287	117.6483	S	28	189			COHEN AND EVERETT, 1963	
125	UNNAMED HOT SPRING (LOWER RANCH)	PE	25N	39E	16	NW	40.0350	117.6033	S	40			1952/09/16	MARINER AND OTHERS, 1974B	
126	SPRING, J.S. RANCH (McCOY)	PE	26N	39E	33	SW	40.0767	117.6000	S	48.3	2536		1960/06/04	COHEN AND EVERETT, 1963	
127	JERSEY VALLEY AREA - UNNAMED HOT SPRING	PE	27N	40E	28	SW	40.1790	117.4900	S	29	20		1957/05/13	MARINER AND OTHERS, 1974, 1975	
128	PARIS WELL	PE	27N	38E	02	NW	40.2450	117.6783	W	22	38	116	1963/01/07	COHEN AND EVERETT, 1963	
129	J.S. RANCH WELL	CH	26N	39E	29	D	40.0853	117.6099	W	21		32.6	1963/07/23	WATSTORE	
130	KYLE HOT SPRINGS	PE	29N	36E	12	NW NW	40.4063	117.8850	S	95.6				SANDERS AND MILES, 1974	
131	HOTTEST KYLE HOT SPRINGS	PE	29N	36E	01	C	40.4069	117.8831	S	66			1977/05/08	WATSTORE	
132	COYOTE SPRING	PE	30N	39E	30	DDD	40.4181	117.6397	S	22			1977/01/01	WATSTORE	
133	BUFFALO SPRINGS	PE	29N	41E	06	NE SW NW	40.4172	117.4158	S	65			1963/	WOLLENBERG AND OTHERS, 1977	
134	BUFFALO VALLEY HOT SPRINGS	LA	29N	41E	23	SE	40.3670	117.3255	S	65.5	7.6		1962/03/10	*WHITE, D., USGS, MENLO PARK	
135	OH3D WELL	PE	31N	38E	14	ABC	40.5617	117.6683	W	58.1		409.0	1976/09/15	WATSTORE	
136	SPRING SW GRASS VALLEY	PE	31N	38E	09	B	40.5658	117.7256	S	20			1977/01/01	WATSTORE	
137	LEACH HOT SPRINGS	PE	32N	38E	36	SE	40.6037	117.6457	S	92	200			MARINER AND OTHERS, 1974, 1975	
138	DH 13A ORIFICE	PE	32N	38E	36	DAA	40.6036	117.6456	W	52.5		52.1	1978/08/23	WATSTORE	

#	NAME	CO	T	R	SC	QSEC	NLAT	WLONG	T	TEMP	FLOW	DEPTH	CDATE	REFERENCE	USE
139	NORTHERN EAST RANGE AREA	HU	35N	36E	26	NE NW NE	40.8850	117.9383	S	27.8				COHEN, 1963	
140	SPRING	PE	30N	33E	20		40.4508	118.2934	S	warm				CROFUTT, 1872	
141	HUMBOLDT (RYE PATCH) AREA - PHILLIPS PETROL. CAMPB	PE	31N	33E	21	SE	40.5350	118.2683	W	162.8		565	1970/09/01	GARSIDE AND SCHILLING, 1979	
142	Florida Canyon Mine well	PE	31N	33E	03		40.5833	118.2542	W	114.4				Trexler and others, 1990	HEAP LEACHING
143.1	SPRINGS	PE	33N	35E			40.7050	118.0553	S	warm				WARING, 1965	
143.2	BLUE MOUNTAIN DRILL HOLE	HU	36N	34E	23	C	40.9805	118.1292	W	87.8	227.1	137	1966/ ,	PARR AND PERCIVAL, 1991	
144	CALIFORNIA PACIFIC UTILITIES CO. WELL	HU	36N	38E	30	NE SW SE	40.9600	117.7433	W	22.8		151	1970/10/07	COHEN, 1962	
145	UNNAMED SPRING	HU	36N	37E	13	SE NE SW	40.9928	117.7620	S	33.9			1954/10/05	COHEN, 1962	
146	BLM WELL	HU	36N	38E	26	SW NE SE	40.9642	117.6612	W	22.8		16.8		COHEN, 1962	
147	UNNAMED HOT SPRING NEAR GOLCONDA	HU	36N	40E	29	SW SW SE	40.9610	117.4938	S	74	750			MARINER AND OTHERS, 1974, 1975	
148	GOLCONDA TUNGSTEN MINE DRILL HOLE 302	HU	36N	40E	36	SW	40.9497	117.4238	W	61.7		78.6		GARSIDE AND SCHILLING, 1979	
149	UNNAMED HOT SPRING	HU	33N	40E	05	SE	40.7617	117.4922	S	65	100			MARINER AND OTHERS, 1974, 1975	
150	SULPHUR SPRING	PE	35N	41E	34		40.8643	117.3491	S	hot				KERR, 1940	
151	BROOKS SPRING	HU	34N	41E	13	NE NW NE	40.8317	117.3067	S	34			1962/07/15	TREXLER AND OTHERS, 1979	
152	HOT POT SPRING	HU	35N	43E	10	NE NE SE	40.9228	117.1100	S	58			1912/11/16	MARINER AND OTHERS, 1974, 1975	
153	MOUND SPRING	LA	28N	44E	07		40.3125	117.0695	S	32			1950/01/05	*WHITE, D., USGS, MENLO PARK	
154	UNN HOT SP VLLY OF MOON	LA	27N	43E	23	BCC	40.1911	117.1056	S	53			1974/01/01	WATSTORE	
155	IZZENHOOD RANCH SPRING	LA	35N	45E	10	SW NE NW	40.9287	116.8953	S	31			1962/07/05	TREXLER AND OTHERS, 1979	
156	DEE 3 WELL	EL	36N	49E	03	CDD	41.0194	116.4247	W	45			1990/06/27	WATSTORE	
157	BW2 WELL	EU	36N	50E	19	BCC	40.9831	116.3739	W	51.5		402.3	1990/06/29	WATSTORE	
158	BRAHMA SPRING	EU	35N	51E	30	DDCB	40.8872	116.2794	S	18.5			1990/06/30	WATSTORE	
159	NEWMONT WELL MC2	EU	34N	51E	26	DDD	40.7981	116.2017	W	31.5			1989/04/11	WATSTORE	
160	UNNAMED SPRING	EL	33N	53E	08	NW	40.7642	116.0408	S	64			1970/10/07	TREXLER AND OTHERS, 1979	
161	UNNAMED SPRINGS NEAR CARLIN	EL	33N	52E	33	SE SW	40.6972	116.1333	S	79			1950/05/24	MARINER AND OTHERS, 1974, 1975	(SPACE HEATING)
162	TYROL SPRING	EL	32N	52E	05	CDBA	40.6844	116.1539	S	22			1990/06/13	WATSTORE	
163	SPRING	EU	31N	52E	07		40.5692	116.1515	S	warm				BRADBURY AND ASSOCIATES, 1964	
164	MACK CREEK FARM WELL	EU	33N	49E	10	ACDD	40.7494	116.4263	W	26		172.2	1990/06/24	WATSTORE	
165	WHITE ROCK SPRINGS	LA	33N	47E	06		40.7493	116.7011	S	warm				WARING, 1965	
166	HOT SPRING	LA	32N	46E	06		40.6745	116.8415	S	hot				STONY POINT	
167	BATTLE MOUNTAIN CITY WELL	LA	32N	45E	17	SW SW	40.6463	116.9342	W	23.3	946	221	1970/09/01	SCOTT AND BARKER, 1962	
168	BEOWAWE - SPRING 51	EU	31N	48E	17	N 1/2	40.5583	116.5833	S	96	263.9			*WHITE, DONALD, U.S.G.S.	ELECTRIC POWER
169	BEOWAWE HOT SPRING	EU	31N	48E	08	SE	40.5667	116.5667	S	98	100			MARINER AND OTHERS, 1974B, 1975	
170	HORSESHOE RANCH HOT SPRINGS	EU	32N	49E	33	SW	40.6017	116.4600	S	58	3.8		1967/11/10	ROBERTS AND OTHERS, 1967	
171	HOT SPRINGS POINT	EU	29N	48E	11	NE NE	40.4035	116.5167	S	54	125		1948/10/21	MARINER AND OTHERS, 1974, 1975	
172	HOT SPRINGS POINT	EU	29N	48E	11	NE NE	40.4033	116.5167	S	60			1974/08/05	*WHITE, DONALD, U.S.G.S.	
173	SPRING	EU	28N	49E	10	NW NW N	40.3150	116.4317	S	85.5	9.5		1968/00/00	GARSIDE AND SCHILLING, 1979	
174	CARLOTTI RANCH SPRING, SULFUR SPRING	EL	28N	52E	24	SE	40.2900	116.0500	S	39	378.5			WARING, 1965	
175	HOT CREEK SPRINGS AREA	EU	28N	52E	12	NW	40.3263	116.0717	S	26.1	6000		1972/00/00	MARINER AND OTHERS, 1974B	
176	BRUFFEY'S HOT SPRINGS	EU	27N	52E	14	NE SE	40.2192	116.0683	S	65.5	189		1964/07/16	ROBERTS AND OTHERS, 1967	
177	FLYNN RANCH SPRINGS	EU	25N	53E	06		40.0792	116.0350	S	26	38		1972/00/00	WARING, 1965	
178	Elko Heat Company Well	EL					40.825	115.775	W	80			1989/	Flynn and Buchanan, 1990	SPACE HEATING
179	HOT HOLE (ELKO HOT SPRINGS)	EL	34N	55E	21	NE	40.8185	115.7755	S	56	75		1950/05/24	MARINER AND OTHERS, 1974, 1975	
180	WARM SPRING	EL	34N	59E	31		40.7624	115.3628	S	warm				SOLDIER PEAK 7.5' QUAD	
181	SULPHUR HOT SPRINGS (HOT SULPHUR SPRINGS)	EL	31N	59E	11	NE NW	40.5867	115.2847	S	93	75		1974?	MARINER AND OTHERS, 1974, 1975	
182	UNNAMED HOT SPRING NEAR RUBY MARSH	EL	27N	58E	02	NW	40.2500	115.4010	S	65			1949/09/08	MARINER AND OTHERS, 1974, 1975	
183	UNNAMED SPRING	LA	26N	45E	15	NE	40.1275	116.8853	S	22.2				EVERETT AND RUSH, 1966	
184	UNNAMED HOT SPRING (VALLEY OF THE MOON)	LA	27N	43E	23	NE	40.1967	117.1008	S	53			1960/05/25	MARINER AND OTHERS, 1974, 1975	
185	UNNAMED HOT POOL	LA	27N	45E	25		40.1833	116.8617	S	50			1967/03/10	*WHITE, D., USGS, MENLO PARK	
186	UNNAMED SPRING	LA	27N	46E	267	NW	40.1667	116.8042	S	22.2			1975/06/00	EVERETT AND RUSH, 1966	
187	Warm spring at Warm Creek Ranch	EL	33N	61E	12		40.7505	115.0354	S	warm	7570			Eakin and others,1951	
188	UNNAMED SPRING NEAR WARM SPRINGS RANCH	EL	35N	64E	04	NW NE N	40.9517	114.7500	S	30	189		1964/10/23	*WILSON, 1960	
189	JOHNSON RANCH (BIG SPRINGS)	EL	36N	66E	26	SW SW SE	40.9708	114.5067	S	22.7	113.6		1949/10/12	WARING, 1965	
190	COLLAR AND ELBOW SPRING	W	26N	65E	33		40.0835	114.6343	S	22			1940/11/03	*NEVADA BUREAU OF MINES AND GEOLOGY	
191	THE NEEDLE ROCKS - ANAHO ISLAND SPRING	W	24N	22E	16		39.9483	119.5100	W	48.9			1979/10/15	WARING, 1965	
192	THE PYRAMID HOT SPRING	W	24N	22E	03		39.9803	119.5012	S	warm				*GARSIDE, L., NBMG	
193	WARM SPRINGS	W	23N	20E	22		39.8462	119.7161	S	66.3				*GARSIDE, L., NBMG	
194	MCCULLOCH CORP. WELL	W	22N	21E	07	SE NW	39.7900	119.6667	W	43.3			1962/03/21	*DESERT RESEARCH INSTITUTE, 1973	
195	COTTONWOOD SPRING	W	23N	21E	26		39.8327	119.5917	S	warm				WARING, 1965	
196	GEOTHERMAL WELL	CH	23N	26E	13		39.8575	119.0118	W					HOT SPRINGS FLAT 7.5' QUAD	
197	SPRING	CH	22N	26E	11	ADA	39.7863	119.0233	S	58	0.0		1961/02/20	WATSTORE	
198	Bradys Hot Springs	CH					39.787	119.012	W	141			1989/	Flynn and Buchanan, 1990	VEGETABLE DRYING
199	BRADY HOT SPRINGS	CH	22N	26E	12	NE NE SW	39.7863	119.0167	S	94			1966/00/00	*WHITE, D., USGS, MENLO PARK	
200	Eagle Salt Works Spring	CH	22N	36E	35		39.7301	119.0367	S					Adams, 1944	
201	HAZEN AREA (PATUA HOT SPRINGS)	LY	20N	26E	16	SW	39.5967	119.1033	S	86.1			1966/11/12	MARINER AND OTHERS, 1975	
202	Patua Hot Spring	LY					39.597	119.113	S	86			1989/	Flynn and Buchanan, 1990	
203	UNNAMED WELL	W	19N	18E	17		39.5150	119.9850	W	26		10	1978/06/17	DESERT RESEARCH INSTITUTE, 1973	
204	LAWTON HOT SPRINGS	W	19N	18E	13	SW NE	39.5150	119.9017	S	48.9				COHEN AND LOELTZ, 1964	(SPA)
205	MOANA AREA - PEPPER MILL MOTEL	W	19N	19E	24	NE NW	39.5017	119.7983	W	47.2			1957/05/15	BATEMAN AND SCHEIBACH, 1975	SPACE HEATING
206	Warren Estates #1 Well	WA					39.481	119.825	W	88			1989/	Flynn and Buchanan, 1990	SPACE HEATING

#	NAME	CO	T	R	SC	QSEC	NLAT	WLONG	T	TEMP	FLOW	DEPTH	CDATE	REFERENCE	USE
207	MOANA AREA - MOORE WELL	W	19N	19E	26	NE SE	39.4817	119.8100	W	60		60		BATEMAN AND SCHEIBACH, 1975	SPACE HEATING, POOL
208	Steamboat/Ormat Well	WA					39.395	119.715	W	113			1989/	Flynn and Buchanan, 1990	ELECTRIC POWER
209	WELL	W	18N	20E	34		39.3817	119.7233	W	30		36		BATEMAN AND SCHEIBACH, 1975	SPACE HEATING
210	STEAMBOAT SPRINGS - SPRING 25	W	18N	20E	33	NE	39.3833	119.7333	S	94	50		1970/09/01	MARINER AND OTHERS, 1974, 1975	
211	UNNAMED WELL	W	17N	20E	07	SE	39.3500	119.7717	W	24		31		GARSIDE AND SCHILLING, 1979	
212	SPRING 9	ST	18N	21E	15	CABD	39.4258	119.6111	S	19	1.7		1970/10/01	WATSTORE	
213	BOWERS MANSION (FRANKTOWN) HOT SPRING - MAIN SPRIN	W	16N	19E	03	NW	39.2833	119.8367	S	47.2	644		1974/02/04	WHITE AND OTHERS, 1963	SWIMMING POOL
214	UNNAMED WELL	W	16N	20E	06		39.2750	119.7600	W	26		24	1974/00/00	*DESTERT RESEARCH INSTITUTE, 1973	
215	COMSTOCK MINING DISTRICT-NEW YELLOW JACKET SHAFT	ST	17N	21E	32	SW SE	39.2900	119.6467	W	76.7		914	1964/06/05	BECKER, 1882	
216	SPRING 6	ST	17N	21E	14	DCBC	39.3342	119.5914	S	21	5.1		1970/09/30	WATSTORE	
217	SUTRO TUNNEL	LY	16N	21E	02	NE NE SE	39.2750	119.5650	S	27.2			1950/04/26	GLANCY AND KATZER, 1975	
218	UNNAMED	LY	16N	22E	07	NW SE NW	39.2683	119.5600	W	26.7		31	1953/05/11	GLANCY AND KATZER, 1975	
219	CARSON CITY WELL NO 7	CC	15N	20E	06	DAAC	39.1925	119.7714	W	28		138.7	1988/05/25	WATSTORE	
220	CARSON CITY WELL NO 4	CC	15N	20E	17	DDDA	39.1592	119.7517	W	27		184.1	1986/09/06	WATSTORE	
221	NOBLE MURRAY WELL	CC	15N	20E	23		39.1433	119.6983	W	41				*NEVADA BUREAU OF MINES AND GEOLOGY	SPACE HEATING
222	CARSON HOT SPRING	CC	15N	20E	05	SE NE	39.1917	119.7517	S	50			1921/11/00	*NEVADA BUREAU OF MINES AND GEOLOGY	SPA, POOL
223	SARATOGA HOT SPRING	CC	14N	20E	21	SW SE	39.0567	119.7400	S	50			1956/01/27	*NEVADA BUREAU OF MINES AND GEOLOGY	
224	WETLANDS, WARM WELL	DG	14N	20E	20	DAA	39.0619	119.7514	W	40		7.9	1983/08/26	WATSTORE	
225	HOBO HOT SPRINGS	DG	14N	19E	23	SE SE	39.0550	119.8083	S	46	473		1929/02/24	GLANCY AND KATZER, 1975	(AQUACULTURE)
226	HASTIE WELL	DG	13N	20E	02	CBB	39.0183	119.7119	W	21		53.6	1986/05/20	WATSTORE	
227	UNNAMED WELL	LY	14N	23E	25		39.0500	119.3667	W	27.7	1533	165	1979/11/15	SCOTT AND BARKER, 1962	
228	NEVADA STATE PRISON SPRING	CC	15N	20E	16	SE SE	39.1600	119.7350	S	24			1967/07/25	*NEVADA BUREAU OF MINES AND GEOLOGY	(AQUACULTRUE)
229	WABUSKA AREA	LY	15N	25E	28	SE NE	39.1367	119.1817	W	30	57	305	1953/05/11	HUXEL, 1969	(ETHANOL PRODUCTION)
230	WABUSKA HOT SPRINGS	LY	15N	25E	16	SE	39.1615	119.1827	S	97			1958/04/25	MARINER AND OTHERS, 1974, 1975	(AQUACULTURE)
231	WABUSKA HOT SPRINGS - MAGMA POWER CO. NO. CB 1 WEL	LY	15N	25E	15	NW SW	39.1617	119.1767	W	97.2	5731	149	1965/11/02	HUXEL, 1969	ELECTRIC POWER
232	DE WELL	CH	22N	27E	21	AACD	39.7642	118.9476	W	163			1987/07/09	WATSTORE	
233	Desert Peak 86-21 Well	CH					39.758	118.946	W	159			1989/	Flynn and Buchanan, 1990	ELECTRIC POWER
234	CHURCHILL DRILLING CORP. TCID No. 1 WELL	CH	22N	30E	15		39.7791	118.6023	W	hot				GARSIDE AND SCHILLING, 1979	
235	USBM HEAT FLOW HOLE	CH	22N	31E	10		39.7916	118.4905	W	25.0		153		OLMSTED AND OTHERS, 1975	
236	DIXIE COMSTOCK MINE	CH	23N	35E	14		39.8661	118.0165	M	hot				VANDERBURG, 1940	
237	DIXIE HOT SPRINGS	CH	22N	35E	05	SE	39.7977	118.0673	S	72	200			MARINER AND OTHERS, 1974, 1975	
238	KENNAMETALS WELL	CH	20N	28E	01	ABB	39.6350	118.7689	W	38		191.1	1978/12/12	WATSTORE	
239	CDDH-48A-USGS	CH	21N	29E	30	DDC	39.6494	118.7603	W	26.3		31.4	1978/11/06	WATSTORE	
240	SHALLOW RESEARCH WELL (SODA LAKE), 4	CH	20N	28E	28	SW	39.5633	118.8533	W	100			1958/05/25	MARINER AND OTHERS, 1975	
241	Soda Lake 33-14 Well	CH					39.564	118.859	W	183			1989/	Flynn and Buchanan, 1990	ELECTRIC POWER
242	CDDH-41A	CH	20N	28E	14	DCC	39.5919	118.8064	W	21		125.0	1976/05/20	WATSTORE	
243	USGS CDR-21	CH	18N	28E	12	ABAC	39.4450	118.7858	W	22.5		4.6	1988/07/12	WATSTORE	
244	INDIAN HEALTH SERVICE WELL	CH	19N	29E	29	BACB	39.4853	118.7603	W	20.5		20.7	1989/03/01	WATSTORE	
245	FLOWING WELL IN STILLWATER	CH	19N	31E	07	SW	39.5215	118.5522	W	96			1967/01/18	MARINER AND OTHERS, 1974, 1975	
246	CDD-117A	CH	19N	31E	07	DCD	39.5211	118.5461	W	67		19.8	1978/04/19	WATSTORE	
247	CDPW-44A	CH	19N	30E	06	BCB	39.5433	118.5547	W	93.7		56.7	1978/04/21	WATSTORE	
248	USFWS WELL 3 NR EAST CAN	CH	20N	32E	20	CAC	39.5825	118.4183	W	25	271.7	213.4	1989/04/03	WATSTORE	
249	DR-SW-LY-9-L1	CH	17N	29E	06	BCAD	39.3686	118.7767	W	25.5		0.6	1985/06/20	WATSTORE	
250	CARSON LAKE CORRAL	CH	16N	30E	07	BACB	39.3561	118.6642	S	77			1987/07/08	WATSTORE	
251	EIGHTMILE FLAT, BORAX SPRING	CH	17N	30E	14	NE	39.3417	118.5783	S	81.1				WARING, 1965	
252	GEOTEHRMAL WELL	CH	17N	30E	36		39.2935	118.5723	W	160.0		2000		EDMISTON AND BENOIT, 1984	
253	SPRING	CH	16N	32E	06		39.2786	118.4332	S	hot				WARING, 1965	
254	LEE HOT SPRINGS	CH	16N	29E	34	SW NW	39.2092	118.7232	S	88	126		1966/11/00	MARINER AND OTHERS, 1974, 1975	
255	E.H. STARK WELL	CH	21N	34E	36	SW	39.6392	118.1063	W	22.8	3785	61	1973/03/00	COHEN AND EVERETT, 1963	
256	HATTON WELL NO. 1	CH	21N	35E	20	NE	39.6767	118.0617	W	21.7	151	49	1971/08/09	SDESERT AT COLD SPRING	
257	Stinking Spring	CH	15N	29	10	SW	39.1739	118.7333	S	26				Katzenstein and Dantl, 1982	
258	Oxbow Geothermal Corp. No. 52-18	CH					39.9537	117.8597	W	231		3007		*NEVADA BUREAU OF MINES AND GEOLOGY	ELECTRIC POWER
259	JAMES LITSTER WELL	LA	24N	43E	27	SW	39.9200	117.1250	W	38.9		4.6	1918/	WARING, 1918	
260	spring	LY	18N	25E	17	NW SE	39.4234	119.1997	S	34	4			*GARSIDE, L., NBMG	
261	TOM ORMECHEA WELL	CH	20N	38E	06	SE	39.6233	117.7400	W	24.4	189	31	1966/11/21	EVERETT, 1964	
262	SMITH CREEK VALLEY WELL	LA	20N	40E	36	NW	39.5586	117.4278	W	29.4			1971/12/00	EVERETT AND RUSH, 1964	
263	UNNAMED HOT SPRING	LA	17N	39E	11		39.3500	117.5583	S	86	75		1969/04/00	MARINER AND OTHERS, 1974, 1975	
264.1	TWIN SPRING	LA	18N	39E	27		39.3961	117.5791	S	warm				WARING, 1965	
264.2	MCLEOD 88 SPRING	NY	14N	43E	34		39.0263	117.1367	S	87.9				*NEVADA BUREAU OF MINES AND GEOLOGY	
265.1	UNNAMED SPRING	LA	17N	39E	25	NE NW N	39.3162	117.5467	S	92			1959/03/15	TREXLER AND OTHERS, 1979	
265.2	LITTLE HOT SPRINGS	LA	23N	47E	02		39.8937	116.6481	S	hot				LITTLE HOT SPRINGS 7.5' QUAD	
266	HOT SPRINGS	LA	24N	47E	15		39.9420	116.6814	S	hot				WARING, 1965	
267	WALTI HOT SPRINGS	EU	24N	48E	33	SW	39.9017	116.5870	S	72	300		1961/06/10	MARINER AND OTHERS, 1974, 1975	
268	SHIPLEY HOT SPRINGS	EU	24N	52E	23	SE	39.9417	116.0733	S	32.2	25500			EAKIN, 1962A	
269.1	SIRI RANCH SPRING, (WATER WELL)	EU	24N	53E	08	SW NE	39.9917	116.0450	W	35			1958/02/11	HARRILL, 1968	
269.2	SULFUR SPRINGS AREA	EU	23N	52E	36	NW	39.8350	116.0662	S	23.3	75.7			WARING, 1965	
270	BARTINE HOT SPRINGS	EU	19N	50E	05	NE NE	39.5583	116.3617	S	44.3			1945/06/24	*NEVADA BUREAU OF MINES AND GEOLOGY	
271	BARTINE RANCH WATER WELL NO. 4	EU	19N	50E	17	NE	39.5233	116.3605	W	46.7	124.9	147.8		GARSIDE AND SCHILLING, 1979	
272	WARM SPRING	EU	19N	50E	18		39.5282	116.3885	S	warm				BEAN FLAT EAST 7.5' QUAD	

#	NAME	CO	T	R	SC	QSEC	NLAT	WLONG	T	TEMP	FLOW	DEPTH	CDATE	REFERENCE	USE
273	BARTHOLOMAE CORP. WATER WELL	EU	18N	51E	18	SW	39.4367	116.2792	W	23.3	53	204	1972/00/00	RUSH AND EVERETT, 1964	
274	BARTHOLOMAE CORP. WATER WELL	EU	18N	51E	30	NW	39.4133	116.2758	W	22.2	757		1972/00/00	RUSH AND EVERETT, 1964	
275	BARTHOLOMAE HOT SPRINGS	EU	18N	50E	28	SE	39.4053	116.3463	S	54			1958/01/27	MARINER AND OTHERS, 1974, 1975	
276	UNNAMED WELL	LA	18N	47E	08	SW	39.4128	116.8960	W	21.7			1975/08/00	RUSH AND EVERETT, 1964	
277	MONITOR VALLEY WELL	LA	18N	47E	20	SE NE	39.3881	116.8894	W	21.7			1973/10/12	RUSH AND EVERETT, 1964	
278	SPENCER HOT SPRINGS	LA	17N	45.5E	11	NE NE	39.3269	116.8567	S	72	50		1962/04/28	MARINER AND OTHERS, 1974, 1975	
279	UNNAMED WELL	LA	16N	44E	24	NW	39.2375	116.9880	W	28.9	22.7	36.6	1971/07/10	FIERO, 1968	
280	POTT'S RANCH HOT SPRING	NY	14N	47E	02	NE	39.0783	116.6400	S	45	125		1972/00/00	MARINER AND OTHERS, 1974, 1975	
281	DIANA'S PUNCH BOWL	NY	14N	47E	22	SE	39.0283	116.6667	S	59			1972/00/00	MARINER AND OTHERS, 1974, 1975	
282	FISH CREEK SPRINGS	EU	16N	53E	08	BCBB	39.2769	116.0383	S	19	15129.0		1981/07/17	WATSTORE	
283	THOMPSON RANCH SPRING	EU	23N	54E	03	DBD	39.9008	115.8678	S	21	3600.0		1981/07/14	WATSTORE	
284	WARM SPRINGS RANCH	W	22N	56E	01	NE NE	39.8117	115.6083	S	22.8			1974/02/20	*NEVADA BUREAU OF MINES AND GEOLOGY	
285	WELL AT ALLIGATOR RIDGE	W	22N	57E	25	CCCC	39.7408	115.5119	W	34		200.9	1984/04/24	WATSTORE	
286	BIG BLUE SPRING	W	14N	56E	23		39.0627	115.6412	S	warm				WARING, 1965	
287	UNN HOT SP CHERRY CREEK	W	23N	63E	06		39.8950	114.8908	S	61			1974/01/01	WATSTORE	
288	SHELL OIL CO. STEPTOE UNIT NO.1 WELL	W	24N	64E	19	NE NE	39.9433	114.7717	W	151.1		2562		GARSIDE AND SCHILLING, 1979	
289	UNNAMED SPRING	W	24N	65E	31	NE	39.9168	114.6600	S	28	1703			SNYDER, 1963	
290	BORCHERT JOHN (WARM) SPRING	WP					39.7778	114.8497	S	18			1978/08/25	WATSTORE	
291	SHELLBOURNE SPRINGS	W	22N	64E	12		39.7933	114.6883	S	24.6			1972/00/00	*NEVADA BUREAU OF MINES AND GEOLOGY	
292	UPPER SHELLBOURNE SPRING	W	22N	65E	08	SE NW	39.8000	114.6550	S	25	1703		1964/06/28	MIFFLIN, 1968	
293	WELL	W	23N	66E	31	AB	39.8303	114.5550	W	28.2			1983/07/27	WATSTORE	
294	MELVIN HOT SPRING (MONTE NEVA)	W	21N	63E	24		39.6667	114.8050	S	79				CLARK AND OTHERS, 1920	
295	SPRING, KERN MOUNTAINS	W	21N	70E			39.6891	114.0809	S	warm				WARING, 1965	
296	STEPTOE WARM SPRING	WP					39.5386	114.9144	S	24			1978/08/25	WATSTORE	
297	MCGILL WARM SPRINGS	W	18N	64E	21	SE NW	39.4150	114.7800	S	29	17034		1945/08/14	CLARK AND OTHERS, 1920	SWIMMING POOL
298	SCHOOLHOUSE SPRING	W	18N	65E	03	DA	39.4537	114.7559	S	26	17320.0		1981/07/15	WATSTORE	
299	ELY-LACKAWANNA ZONE - LACKAWANNA HOT SPRINGS	W	16N	63E	03	NE	39.2850	114.8633	S	35				EAKIN AND OTHERS, 1967	
300	ELY WARM SPRINGS	W	16N	63E	10		39.2683	114.8667	S	29	83		1975/00/00	CLARK AND OTHERS, 1920	
301	WALLEYS HOT SPRINGS (GENOA HOT SPRINGS)	DG	13N	19E	22	SW NW NE	38.9812	119.8325	S	61	75			MARINER AND OTHERS, 1974, 1975	SPA
302	WALLEYS HOT SPRING	DG	13N	19E	22	SW NW NE	38.9812	119.8325	S	63	57		1934/02/07	*WHITE, D., USGS, MENLO PARK	
303	BENSON SPRING - SOUTH OR	DG	12N	19E	28	ACC	38.8747	119.8139	S	22			1981/06/10	WATSTORE	
304	DOUD SPRING	DG	11N	21E	20	SE SW	38.7950	119.6533	S	21.1	681.3		1962/07/23	GLANCY AND KATZER, 1975	
305	NEVADA HOT SPRINGS	LY	12N	23E	16	SE	38.8995	119.4117	S	61	200		1970/07/01	MARINER AND OTHERS, 1974, 1974	
306	AMBASSADOR WELL, ARTESIA LAKE AREA	LY	13N	23E	25	NW SW	38.9567	119.3617	W	27.8		165	1949/08/09	SCOTT AND BARKER, 1962	
307	WELLINGTON WELL	LY	10N	23E	02	NW SE	38.7533	119.3767	W	47.2		61	1912/09/28	LOELTZ AND EAKIN, 1953	
308	WILSON HOT SPRINGS	LY	11N	25E	34		38.7672	119.1732	S	warm	0			GARSIDE AND SCHILLING, 1979	
309	HOT SPRING	LY	12N	25E	34		38.8598	119.1749	S	hot				WILSON CANYON 7.5' QUAD	
310	GRANT VIEW HOT SPRINGS	LY					38.9900	118.9761	S	53			1977/05/11	WATSTORE	
311	DOUBLE SPRING	M	13N	29E	25		38.9647	118.6890	S	warm				WARING, 1965	
312	Deadhorse Wells (dry)	M	12N	32E	21		38.8959	118.3806	W	hot				Miller and others, 1953	
313	WEDELL SPRING NO.1	M	12N	34E	07	SW	38.9191	118.1953	S	62.2	859		1957/05/25	EAKIN, 1962C	
314	hot well	NY					38.9869	118.1783	W	hot				Mount Annie 7.5'	
315	hot drill hole	MN					38.8333	118.2917	W	hot				*GARSIDE, L., NBMG	
316	UNNAMED	LY	07N	27E	04	SW SE	38.4917	118.9650	S	43.3			1966/10/13	DAVIS, 1954; WARING, 1965	
317	CITY OF HAWTHORNE WELL	M	08N	30E	27	SW	38.5200	118.6275	W	26.7		184	1950/04/26	SCOTT AND BARKER, 1962	
318	WELL NO. 3	M	08N	31E	32		38.5067	118.5500	W	34			1971/12/29	*WHITE, D., USGS, MENLO PARK	
319	U. S. BUREAU OF LAND MANAGEMENT WELL	M	05N	31E	19	NE	38.2800	118.5667	W	43.3		105	1974/02/18	EVERETT AND RUSH, 1967	
320	BUREAU OF LAND MANAGEMENT NO. 2 WELL	M	03N	31E	07	NE SW	38.1317	118.5642	W	25.8		20	1953/05/11	VANDENBURGH AND GLANCY, 1970	
321	SODAVILLE SPRINGS, SODA SPRINGS	M	08N	35E	29	SE	38.3417	118.1017	S	35	100		1949/00/00	MARINER AND OTHERS, 1974, 1975	
322	GENE SAWYER WELL	NY	13N	36E	28	NE SW	38.9617	117.9383	W	54		84	1967/10/06	TREXLER AND OTHERS, 1979	
323	GABBS AREA	NY	12N	36E	27	NW	38.8817	117.9200	W	47.8		66	1958/02/11	EAKIN, 1962B	MINERAL EXTRACTION??
324	CHARNOCK (BIG BLUE) SPRINGS	NY	13N	44E	16		38.9914	117.0415	S	26.7	1703		1946/01/30	WARING, 1965	
325	BIG BLUE, CHARNOCK SPRING	NY	13N	44E	32	NE	38.9483	117.0500	S	32			1962/06/18	TREXLER AND OTHERS, 1979	
326	DARROUGH'S WELL	NY	11N	34E	07		38.8200	117.1750	W	90.5		244		*NEVADA BUREAU OF MINES AND GEOLOGY	HEAP LEACHING
327	DARROUGH'S NORTH SPRING	NY	11N	34E	07		38.8250	117.1750	S	71.2			1958/01/27	*NEVADA BUREAU OF MINES AND GEOLOGY	
328	WARM SPRING	NY	08N	38E	12	SW	38.5698	117.6835	S	warm				BLACK SPRINGS 7.5' QUAD	
329	UNNAMED WELL	M	06N	36E			38.3333	117.9667	W	40			1968/06/00	TREXLER AND OTHERS, 1979	
330	hot drill hole	MN					38.2000	117.9700	W	hot				*GARSIDE, L., NBMG	
331	STANLEY A TANNER WELL	NY	07N	40E	28		38.4372	117.4945	W	warm				RUSH AND SCHROER, 1970	
332	INDIAN SPRINGS	NY	07N	42E	34		38.4210	117.2498	S	warm				WARING, 1965	
333	HALL MINE WELL, ANACONDA MOLYBDENUM PROJECT	NY	05N	42E	07		38.3083	117.2917	S	27.7			1954/09/04	*NEVADA BUREAU OF MINES AND GEOLOGY	
334	WELL	NY	02N	43E	01	ACB	38.0650	117.1026	W	28			1967/05/08	WATSTORE	
335.1	WELLS	NY	12N	47E	20		38.8704	116.7034	W	hot				MOSQUITO CREEK 7.5' QUAD	
335.2	BELMONT MINE, 1500 FT LEVEL	NY	03N	42E	36		38.0750	117.2217	W	37.2		457	1964/10/23	BASTIN AND LANEY, 1918	
336	MOSQUITO RANCH SPRINGS	NY	11N	47E	06	SE NE	38.8250	116.7267	S	31.6			1941/07/03	*NEVADA BUREAU OF MINES AND GEOLOGY	
337	SPRING	NY	10N	49E	22	CAA	38.6972	116.4361	S	40			1967/05/10	WATSTORE	
338	TEST HOLE UCE-10	NY	10N	49E	22	CAA	38.6878	116.4625	W	48		903.1	1967/06/03	WATSTORE	
339	SPRING	NY	08N	49E	21	CDC	38.5361	116.4556	S	35			1967/07/31	WATSTORE	
340	OLD DUGAN PLACE HOT SPRING	NY	08N	49E	25	NW NE	38.5300	116.4050	S	36.1			1975/08/20	GARSIDE AND SCHILLING, 1979	

#	NAME	CO	T	R	SC	QSEC	NLAT	WLONG	T	TEMP	FLOW	DEPTH	CDATE	REFERENCE	USE
341	HOT CREEK RANCH SPRING	NY	08N	50E	29	SE SE	38.5200	116.3600	S	62.8	2868		1957/05/13	SANDERS AND MILES, 1974	
342	HOT CREEK VALLEY SPRING	NY	07N	51E	30		38.4367	116.2767	S	61.1				WARING, 1965	
343	WARM SPRING	NY	06N	47E	36	NE NW	38.3383	116.6600	S	26.1	19		1948/01/26	FIERO, 1968	
344	SALISBURY SPRING	NY	05N	46E	26	SW SE	38.2533	116.8267	S	30			1950/01/05	GARSIDE AND SCHILLING, 1979	
345	SPRING	NY	05N	46E	33	CD	38.2389	116.8306	S	21			1967/07/30	WATSTORE	
346	UPPER? MUD SPRING	NY	04N	46E	26	CA	38.1722	116.7917	S	25.5			1967/07/30	WATSTORE	
347	SPRING	NY	04N	47E	29		38.1722	116.7361	S	25			1967/07/27	WATSTORE	
348	SPRING	NY	02N	47E	14	AC	38.0278	116.6806	S	29			1967/07/28	WATSTORE	
349	WARM SPRINGS	NY	04N	50E	20	SW	38.1867	116.3717	S	63	170			*WHITE, D., USGS, MENLO PARK	
350	SPRING	NY	02N	51E	02	D	38.0472	116.1944	S	22			1967/08/03	WATSTORE	
351	SPRING	NY	02N	50E	28	ACC	37.9944	116.3861	S	25			1967/08/02	WATSTORE	
352.1	DUCKWATER AREA	NY	13N	56E	32	NW SE NW	38.9508	115.7000	S	33.9			1950/04/26	GARSIDE AND SCHILLING, 1979	AQUACULTURE
352.2	WILLIAMS HOT SPRINGS	W	13N	60E	33	NE	38.9533	115.2300	S	51.8			1976/11/10	*NEVADA BUREAU OF MINES AND GEOLOGY	
353	PRESTON SPRINGS	W	12N	61E	02	SW NE	38.9306	115.0625	S	22.7			1954/07/31	*NEVADA BUREAU OF MINES AND GEOLOGY	
354	BIG SPRING	NY	08N	55E	15	AC	38.5528	115.2722	S	38			1967/08/07	WATSTORE	
355	BLUE EAGLE SPRINGS	NY	08N	57E	11	DDB	38.5631	115.5275	S	29	7030.0		1981/07/17	WATSTORE	
356	MOORMAN SPRING	NY	09N	61E	32	DABC	38.5947	115.1383	S	37	1294.0		1981/07/18	WATSTORE	
357	EMIGRANT SPRING	W	09N	62E	19	AC	38.6250	115.0478	S	19.5	5247.0		1981/07/18	WATSTORE	
358	FLAG SPRING NO 3	NY	07N	62E	33	BCCC	38.4214	115.0222	S	22.8			1984/01/17	WATSTORE	
359	BUTTERFIELD (FLAG, SUNNYSIDE) SPRINGS	NY	07N	62E	28	NE	38.4450	115.0067	S	23.9	7571		1960/09/26	WARING, 1965; MAXEY AND EAKIN, 1949; ADAMS, 1944	
360	HOT CREEK RANCH SPRINGS	NY	06N	61E	18		38.3817	115.1533	S	26.7			1960/11/08	EAKIN, 1966	
361	MOON RIVER SPRINGS	NY	06N	60E	25	BDAD	38.3517	115.1808	S	32.5			1982/04/27	WATSTORE	
362	Bacon Flat 24-17 oil well	NY	07N	57E	17		38.4600	118.5900	W	113		1653		Hulen and others, 1994	
363	CHIMNEY HOT SPRINGS	NY	07N	55E	18	DC	38.4633	115.7900	S	60			1967/08/07	WATSTORE	
364	SPRING	NY	06N	54E	11	C	38.3889	115.8694	S	45			1967/08/07	WATSTORE	
365	SPRING	NY	06N	54E	24	CA	38.3639	115.8517	S	46			1968/09/12	WATSTORE	
366	GEYSER RANCH SPRINGS	LI	09N	65E	01		38.6750	114.6233	S	18	189		1979/11/15	CARPENTER, 1915	
367	LOWER PONY SPRING	LI	05N	66E	05	CBCC	38.3197	114.6072	S	20			1981/07/23	WATSTORE	
368	HAMMOND RANCH AREA	LI	05N	69E	17		38.2967	114.2733	S	26.9			1967/10/16	CARPENTER, 1915; WARING, 1965	
369	SAND SPRING	ES	01N	34E	27	SE SE	37.9053	118.1732	S	23.3			1965/07/12	RUSH AND KATZER, 1973	
370	FISH LAKE VALLEY	ES	02N	36E	28	SW SW S	37.9931	117.9648	S	27.2	4		1976/08/03	*NEVADA BUREAU OF MINES AND GEOLOGY	
371	GAP SPRING	ES	02N	36E	32	SW SE	37.9797	117.9927	S	23	38		1975/08/00	VANDENBURGH AND GLANCY, 1970	
372	EMIGRANT WELL	ES	01N	38E	06	NW	37.9717	117.8067	W	25			1970/10/07	TREXLER AND OTHERS, 1979	
373	FISH LAKE VALLEY WELL	ES	01N	36E	20	01S	37.9233	118.0058	W	25			1965/07/12	RUSH AND KATZER, 1973	
374	R.G. PENNEBAKER WELL	ES	01S	35E	09	SW SW	37.8640	118.1015	W	23.3		91	1961/12/13	RUSH AND KATZER, 1973	
375	NEVADA OIL AND MINERALS VRS NO. 1 WELL	ES	01S	36E	18	SW NE NE	37.8567	117.9600	W	158.8		2797		GARSIDE AND SCHILLING, 1979	
376	FISH LAKE VALLEY	ES	01S	36E	19	NE	37.8425	118.0150	W	25			1961/07/20	*DESERT RESEARCH INSTITUTE, 1973	
377	FISH SPRING	ES	02S	35E	25	NW SW	37.7425	118.0457	S	24				RUSH AND KATZER, 1973	
378	Gradient well 42-7	ES	01S	36E	07		37.8720	118.0210	W	47.5	757	301		*NEVADA BUREAU OF MINES AND GEOLOGY	
379	SILVER PEAK HOT SPRINGS, WATERWORKS SPRINGS	ES	02S	39E	15	SE SE	37.7600	117.6367	S	34.2	1892			WARING, 1965	
380	PEARL HOT SPRINGS	ES	01S	40E	25	SE NW SW	37.8222	117.4802	S	36.7			1963/04/15	*DESERT RESEARCH INSTITUTE, 1973	
381	ALKALI HOT SPRINGS	ES	01S	41E	26	NE	37.8267	117.3400	S	50.5	95			*WHITE, D., USGS, MENLO PARK	
382	SARCOBATUS FLAT AREA	NY	07S	44E	26	NW SW	37.2967	117.0517	W	22.2		62		MALMBERG AND EAKIN, 1962	
383	NONE GIVEN	ES	11S	43E	06	NW	37.0162	117.2085	S	25				*DESERT RESEARCH INSTITUTE, 1973	
384	FISHLAKE LIVESTOCK Co. WELL	ES	01S	39E	05		37.8767	117.6674	W	hot		50.3		RUSH AND SCHROER, 1970	
385	CEDAR SPRING	NY	02S	51E	21	SE	37.7506	116.2600	S	25	9			VANDENBURGH AND RUSH, 1974	
386	CLIMAX SEEP	NY					37.2244	116.0581	W	41.5			1978/03/07	WATSTORE	
387	TIPPIPAH SPRING NO 2	NY					37.0433	116.2072	S	22			1979/06/19	WATSTORE	
388	YUCCA FLAT TEST WELL 84-69,(TEST WELL E)	NY					37.0550	116.0133	W	42.2		572	1957/09/02	SCHOF F AND MOORE, 1964	
389	YUCCA FLAT WELL 79-69A, TESTWELL C	NY					36.9950	116.0250	W	37.2		519	1918/10/10	SCHOFF AND MOORE, 1964	
390	SARCOBATUS FLAT-BEATTY AREA	NY	09S	46E	35	NE	37.1142	116.7892	W	22.2				MALMBERG AND EAKIN, 1962	
391	SPRING	NY	01N	56E	35	DD	37.8966	115.6453	S	21			1968/09/14	WATSTORE	
392	SAND SPRING	LI	02S	55E	26	NE SE SE	37.7400	115.7517	S	30	1		1927/08/05	VANDENBURGH AND RUSH, 1974	
393	N. J. GUNDERSON WELL	LI	03S	55E	19	SE SE	37.6692	115.8283	W	28.3		73	1946/10/27	VANDENBURGH AND RUSH, 1974	
394	G.C. ENGLEMAN WELL	LI	04S	55E	08		37.6188	115.8217	W	warm		76.3		VAN DENBURGH AND RUSH, 1974	
395	HIKKO SPRING AREA	LI	04S	60E	14		37.5975	115.2117	S	26.7	11167		1950/04/26	EAKIN, 1963B	
396	CRYSTAL SPRINGS AREA	LI	05S	60E	10		37.5300	115.2333	S	27.2			1954/09/04	COHEN, 1966	
397	ASH (ALAMO) SPRINGS AREA	LI	06S	61E	06	NW NW N	37.4600	115.1667	S	31.1	32894		1945/07/30	EAKIN, 1963B	(SPA)
398	LIME SPRING	LI					37.9144	114.5403	S	21			1985/04/07	WATSTORE	
399	FLATNOSE SPRING	LI	01N	69E	35	CC	37.8961	114.2258	S	25			1985/04/06	WATSTORE	
400	DELMUE'S SPRINGS AREA, TWO SPRINGS.	LI	01S	66E	13	NE NW SE	37.8558	114.3217	S	21.1	757			HARDMAN AND MILLER, 1934	
401	PANACA WARM SPRINGS AREA	LI	02S	68E	04		37.8083	114.3600	S	29.5	18472		1949/06/00	RUSH, 1964	
402	BENNETT SPRING	LI	02S	67E	07	CD	37.7842	114.5281	S	24			1965/04/10	WATSTORE	
403	CALIENTE MINERAL SPRING, CALIENTE HOT SPRINGS	LI	04S	67E	08	NE	37.6217	114.5033	S	47.8			1962/07/29	SAND ERSAND MILES, 1974	(SPACE HEATING)
404	AQUA CALIENTE WELL NO. 3	LI	04S	67E	08	NW NW	37.6263	114.5100	W	67	5299	27	1970/10/07	TREXLER AND OTHERS, 1979	SPA
405	HICKS (BURRELL) HOT SPRINGS	NY	11S	37E	21		36.9667	116.7233	S	38	19		1978/08/18	*WHITE, D., USGS, MENLO PARK	
406	BEATTY MINERAL SPRINGS	NY	12S	47E	05	SW	36.9167	116.7500	S	24.4	379			SCOTT AND BARKER, 1962	
407	TW-F WELL	NY	14S	52E			36.7594	116.1164	W	64	883.0	1036.0	1980/03/12	WATSTORE	
408	WELL	NY	15S	50E	25	BD	36.6208	116.4125	W	46		32.0	1973/04/03	WATSTORE	

#	NAME	CO	T	R	SC	QSEC	NLAT	WLONG	T	TEMP	FLOW	DEPTH	CDATE	REFERENCE	USE
409	COOKS EAST WELL	NY	16S	50E	07	CABB	36.5744	116.3964	W	32		91.4	1990/08/25	WATSTORE	
410	FAIRBANKS SPRING	NY	17S	50E	09	SE NE	36.4933	116.3433	S	27.2			1934/02/16	NAFF, 1973	
411	RODGERS SPRINGS	NY	17S	50E	15	NW NE	36.4783	116.3233	S	27.8			1959/10/19	NAFF, 1973	
412	LONGSTREET SPRING	NY	17S	50E	22	NE NW NE	36.4667	116.3250	S	27.8			1980/06/01	DUDLEY AND LARSON, 1976	
413	UNNAMED SPRING	NY	17S	50E	26	SW NE NW	36.4483	116.3133	S	27			1958/06/12	NAFF, 1973	
414	SCRUGGS SPRING	NY	17S	50E	35	SE SW NE	36.4317	116.3067	S	30			1980/06/03	NAFF, 1973	
415	DEVIL'S HOLE	NY	17S	50E	36	SW SE	36.4267	116.2863	S	33			1965/06/17	NAFF, 1973	
416	POINT OF ROCK (KING) SPRING	NY	18S	51E	07	NW SE	36.4017	116.2717	S	32	4399		1964/04/13	HUGHES, 1966; MIFFLIN, 1968	
417	JACK RABBIT SPRING	NY	18S	51E	18	SE NW SE	36.3867	116.2717	S	26			1962/06/28	NAFF, 1973	
418	BIG SPRING; ASH MEADOWS SPRING; DEEP SPRING	NY	18S	51E	19	SW NE	36.3767	116.2717	S	28			1971/02/00	DUDLEY AND LARSON, 1976	
419	CRYSTAL SPRING	NY	18S	50E	03	NE SE NW	36.4183	116.3300	S	30			1979/12/15	NAFF, 1973	
420	USGS TRACER WELL 2	NY	16S	51E	27	NE NE NW	36.5383	116.2317	W	30.6			1968/06/25	DUDLEY AND LARSON, 1976	
421	CHERRY PATCH WELL	NY	17S	52E	06	CDB	36.4914	116.1492	W	27.5		65.5	1990/08/24	WATSTORE	
422	INDIAN SPRING	CL	16S	56E			36.5617	115.6683	S	26.1	5875	1546	1967/11/10	CARPENTER, 1915	
423	MANSE RANCH SPRINGS	NY	21S	54E	03	SE NE	36.1557	115.8886	S	25	4542		1978/06/18	HARDMAN AND MILLER, 1934	
424	PAHRUMP SPRINGS	NY	20S	53E	14	SE SE	36.2075	115.9783	S	25	1840		1960/06/31	HARDMAN AND MILLER, 1934	
425	PAHRUMP COMMUNITY CHURCH WELL	NY					36.2117	115.9883	W	27			1976/01/09	WATSTORE	
426	WHITE ROCK SPRING	CL	20S	58E			36.1742	115.4786	S	25			1985/06/26	WATSTORE	
427	PAGO PAGO BAR WELL	CL					36.2361	115.0531	W	28		61.0	1982/05/18	WATSTORE	
428	Las Vegas Springs	CL	20S	61E	31		36.1645	115.1899	S	26.1	5015			Scott and Barker, 1962	
429	H. NICKERSON WELL	CL	22S	61E	03	NE NE SW	36.0633	115.1458	W	29	644	120	1972/02/13	MAXEY AND JAMESON, 1948	
430	GLADSTONE CORPORATION WELL	CL	22S	61E	10	NE SE NW	36.0600	115.1483	W	33.3	1609	99	1973/00/00	MAXEY AND JAMESON, 1948	
431	T.A. WELLS WELL	CL	22S	62E	01	SW NW S	36.0608	115.0043	W	32.8		346		MAXEY AND JAMESON, 1948	
432	VF-2 WELL	LI	12S	63E	29	DABB	36.8750	114.9456	W	34			1986/02/05	WATSTORE	
433	FUGRO COYOTE V DEEP WELL	CL	13S	63E	23	DD	36.7956	114.8922	W	35.5		203.9	1981/07/22	WATSTORE	
434	USGS-MX CE-DT-6	CL	13S	64E	35	ACAA	36.7678	114.7869	W	33.5		264.7	1986/09/26	WATSTORE	
435	CSV-3	CL	14S	63E	26	ACDC	36.6908	114.9250	W	41		237.7	1987/10/07	WATSTORE	
436	WARM SPRING	CL	14S	65E	16	NW SW NE	36.7222	114.7152	S	32.2	12250		1950/06/27	EAKIN, 1964; MIFFLIN, 1968	
437	IVERSON SPRING	CL	14S	65E	21	NW NE NE	36.7097	114.7142	S	31.6	3840		1958/05/19	EAKIN, 1964	
438	JUANITA SPRING	CL	15S	69E	14	BAA	36.6369	114.2475	S	26			1986/01/25	WATSTORE	
439	DRY LAKE	CL	17S	64E	21	CB	36.4550	114.8439	S	29			1985/07/01	WATSTORE	
440	WATER FOUNTAIN VALLEY OF FIRE, NEV.	CL	17S	67E	30	NW SW	36.4233	114.5483	S	35.1			1971/03/15	SWANBERG AND OTHERS, 1977	
441	BLUE POINT SPRING	CL	18S	68E	06	DCC	36.3897	114.4328	S	29	4075.0		1977/05/04	WATSTORE	
442	ROGERS SPRING	CL	18S	67E	12	DDA	36.3775	114.4433	S	30			1977/05/04	WATSTORE	
443	G.P. APEX WELL	CL	18S	63E	33	DBB	36.3411	114.9267	W	31			1986/09/30	WATSTORE	
444	NAT'L PARK SERVICE, CALLVILLE BAY CAMPGROUND WELL	CL	21S	65E	09	NW SE	36.1442	114.7220	W	28.9	114	61		RUSH, 1968B	
445	HOOVER DAM HOT SPRING	CL	22S	65E	29	SW	36.0100	114.7450	S	42.2			1966/07/27	SWANBERG AND OTHERS, 1977	
446	BLACK CANYON AREA	CL	23S	65E	05	SE NW SW	35.9600	114.7467	S	30	848		1960/00/00	*WATSTORE	
447	BLACK CANYON AREA SPRING	CL	23S	65E	21	NE SW NW	35.9467	114.7333	S	25.6	19		1978/06/18	*WATSTORE	
448	MONITOR WELL 116	CL	32S	66E	14	DBDB	35.1583	114.5864	W	29		91.4	1991/06/06	WATSTORE	
449	SUNDANCE SHORES WELL	CL	32S	66E	24	BBA	35.1497	114.5803	W	32		146.3	1974/06/14	WATSTORE	

APPENDIX 2

#	pH	Na	K	Ca	Mg	Fe	SiO2	B	Li	HCO3	CO3	SO4	Cl	F	TDSm	TDSc	ChgBal	delD	delO18
1									5.8										
2	8.90	58	3.9	5.8	0.34		41			106		23	23			207	1.03		
3																			
4		21	4	3.2	0.3		53	0.08	0.01	50	0	11	5.9	0.6		124	0.96		
5		29	0.4	3.7	0.1		32	0.08	0.03	64	0	12	4.7	1.8		115	0.96		
6		31	2.8	2.1	0.1		57	0.07	0.02	74	0	9	5	0.9		144	0.97		
7	9.1	110	1	4	0		51	1	0	63		119	39	4.6	362	393	1.03	-127	-15.4
8																			
9	7.70	32	6.3	1.4	0.1		67		0.46	68		13	7			160	1.03		
10																			
11																			
12	8.40	78	0.6	0.4			51	0.66		113	6	41	15	2	262	250	1.00		
13		180	8.6	14	0.2		130	2	0.2	163	0	220	48	6.6		690	0.98		
14	8.60	74	1	3.5	1.1		63	0.6	0.667	90	3	35	18	12	275	255	1.02		
15	8.60	74	1.1	3.1	<0.1	<0.02	63	0.64		92	3	41	18	12		261	0.94	-129.9	-16.56
16	7.60	76	1.3	2.6	1.4		65	1		96	N	39	21	10	272	265	1.02		
17	8.5	74	1	4	1		63	0.6		90	3	35	18	12		256	1.02		
18	8.20	55	0.6	6.4	0.2		34	0.32		120	N	15	11	0.3	186	182	1.05		
19	7.65	320	25	4.6	0.1	0.06	160	6.9	0.45	436	2	130	160	14		1038	0.98	-128.2	-14.13
20	7.20	325	26	19	0.3		155	7		500	1	120	160	14		1073	0.99		
21																			
22																			
23		74	10	23	8.4		74	0		107		22	32	0.1	256	296	1.70		
24	7.80	78	11	9.6	2.8		79			165		28	28	1.8		319	1.05		
25	7.1	230	5	17	0.1		130	2.1		280	0	120	110	10		762	1.03		
26	7.60	230	4.5	17	0.1		130	2.1		280	N	120	110	10		761	1.02		
27	8.86	150	8.7	2.7	0.2	0.01	80	0.64	0.03	224	8	49	52	2.3		464	1.05	-123	-15.8
28	8.8	210	4.4	1.5	0.04	0.01	64		0.032	280	9	120	76	0.1		623	0.98	-131	-16.1
29																			
32		210	6.2	3.2	1.5		125	2.9		358	7	67	54	14	660	667	0.98		
33		146	3.7	3.2	0		83	0.41		218	16	76	6	8.9	470	450	1.04		
34	8.10	455	9.9	30	6.3		51	1.3	0.5	948	N	204	69	9.8	1290	1303	0.99		
35		416	11	32	5.2	0.04	39	1.7	0.36	885	N	184	59	0.9	1180	1184	1.02		
36		34	4.8	18	2.4		65	0.11		104		25	15	0.6	244	216	1.01		
37	9.30	91	2	2.4	0.5		84	0.26		52	39	64	14	7.9	324	331	0.97		
38	7.30	28	6.3	14	2.8		53		0.03	94		14	15			179	1.02		
39		27	6.3	25			54	0.1		117		20	22	0.1		212	0.87		
40		146	12	46	9.7		63	0.87		204		94	157	0.3	640	629	1.00		
41	9.00	197	18	2.2	0.8		4.8		1.5	211	36	70	106	1.4	541	540	1.00		
42	7.30	123	3.5	6.4	0.5		65	0.78		182	N	61	27	10	387	387	1.05		
43		89	3.4	7.8	1.8		56	0.35		178		49	19	5.3		319	0.95		
44		58	12	5.8	0.2	N	110	0.37	0.4	119		26	14	2.6	322	288	1.04		
45		334		26	8.5			2.5		920		34	26		930	884	1.00		
46	8.00	296	36	10	8		55			881		36	26			900	0.94	-134.6	-16.44

#	pH	Na	K	Ca	Mg	Fe	SiO2	B	Li	HCO3	CO3	SO4	Cl	F	TDSm	TDSc	ChgBal	delD	delO18
47																			
48		452	26	26	11			1.4		1230		71	16			1209	1.02		
49																			
50	9.20	620	3.5	2	N	N	34	4.6		1080	143	98	46	16	1500	1498	1.02		
51																			
52																			
53																			
54																			
55																			
56									<0.2										
57																			
58	8.10	157	16	13	0.2	N	166	0.81		338	N	75	9	9.4	631	613	1.01		
59	7.00	390	41	49	13		84	0.77		1180		18	40	7.2		1224	1.01	-134.9	-16.78
60	7.40	110	8.3	29	7.7		23	0.22		380		36	4.4	3.4		409	0.97	-140.8	-18.21
61	7.20	130	22	48	12		40	0.67		482		40	14	5.2		549	1.02	-140.2	-17.85
62	7.60	134	4	8.4	N	0.04	96	0.41	N	260	N	46	11	14	442	442	1.01		
63																			
64																			
65	8.00	450	36	3.1	0.45		151			1149		2	31	21		1260	0.99		
66	7.70	358	33	6.5	0.8		132			959		2	25			1029	1.02		
67	6.70	236	43	41	14		38			867		10	20			829	0.97		
68																			
69																			
70	7.30	300	31	75	37		105			1135		32	27	7.2		1173	1.01		
71	6.6	370	46	48	13	0.02	86	0.73	0.72	1135		12	37	7.4		1179	1.02	-136.6	-16.95
72																			
73	8.40			49	17					426	18	69	30			393	0.39		
74																			
75	8.20			74	27					278	N	103	117			458	0.59		
76																			
77																			
78	8.8	78	2.4	2.4	0.6		75	0.53	0.16	78	17	49	11	8.8		283	1.00		
79	9.10	75	2.2	1.6	<0.01		83	0.47		108		45	15	8.9		284	0.94	-139	-17.61
80	8.10	13	3.9	25	8.6	N	18	N		132	N	11	3.9	0.5	149	149	1.04		
81	9.1	75	2.2	1.6	0.01		83	0.47	0.2	108		45	15	8.9		285	0.94	-139	-17.61
82	7.90	17	8.4	37	8.6		20	N	0.205	184	N	20	1.8	0.7	205	204	1.00		
83	7.3	18	8.9	38	9.2		20	0.03	0.06	180	0	22	2.5	0.7		208	1.04		
84	7.8	8	4.8	34	10		20	0	0.02	160	0	23	2.1	0.4		181	0.94		
85	8.00	19	6.6	35	11		21			190		19	2			207	1.02		
86																			
87	8.30	24	5.6	16	5.7	0.18	21			118	1	22	2	0.6	157	156	0.98		
88	7.20	9.6	4.6	29	8.1		23			144	N	13	3.3	0.4	162	162	0.97		
89	7.90	8.5	5.4	30	8	0.06	27			142	N	13	3.5	0.4	166	166	0.98		
90	7.20	10	5.6	40	11.5		31	<0.02		149		37	8.7	0.4		218	1.01	-139.1	-18.24

#	pH	Na	K	Ca	Mg	Fe	SiO2	B	Li	HCO3	CO3	SO4	Cl	F	TDSm	TDSc	ChgBal	delD	delO18
91																			
92	7.80	25	7	32			86		5.7		N		28			178	3.63		
93	7.8	25	7	32	0.2		86			240	0	15	28			311	0.57		
94	8.4	113	N	2						98	24	49	60			296	0.98		
95																			
96																			
97	8.00			37	2.3					155	N	528	849			1493	0.05		
98.1	8.00			3	3				N	179			18			112	0.12		
98.2	9	83	N	3	1	0.004	25			170	48	18	0.01			262	0.81		
99	8.50	1050	29	245	N		97	7.2		11	6	293	1830		3870	3563	1.01		
100	8.40	1100	160	260	0.1	<0.02	110	6.1	0.04	26		340	1900	3		3892	1.06	-106.5	-6.33
101				32	7					200		21	19			177	0.51		
102				6	3					206		18	16			144	0.13		
103				56	22					277		70	34			318	0.66		
104				86	28					286		132	126			513	0.60		
105.1		1400	120	148	0.17	0.34	208	5.85		49	3	220	2320	5.2		4455	1.00		
105.2		1298	110	140	0.17	0.01	203	5.85		22	17	211	2225	5.2		4226	0.97		
106	6.70	1400	110	140	1.5	0.13	240	6.3		92		230	2300	5		4478	0.99	-105.3	-11.54
107	7.20	1400	130	68	1.2	0.02	165	9.9		83	<1	400	2200	4.5		4419	0.94	-100.5	-10.83
108	7.60	1400	86	58	1	<0.02	145	7.1		68		350	2050	4.8		4135	0.99	-106.5	-11.65
109	7.3	1400	120	70	1.1	0.04	210	8.2	1.7	96		380	2100	5.1		4343	0.98	-105	-10.4
110	9.1	152	21	1	4		45	1.8		230	0	52	192			582	0.73		
111	7.5	18	3.5	19	3.8		18	0.1		284	0	9	21	0.1		232	0.39		
112		272	8.4	13	0.6		94			93	0	156	278	2.8		871	1.00		
113	7.90	430	8.6	11	0.2	<0.02	79	5		162		180	500	4.1		1298	0.94	-127.6	-14.87
114	7.90	340	17	31	4.2	0.13	82	1.9		464		45	240	7		997	1.09	-120.7	-14.72
115	7.2	405	17	22	0.2		90	0.5		455	0	205	250			1214	1.02		
116	7.90	486	13	18	1.9		62	2.8		902	N	130	155	8.9	1330	1321	1.01		
117		27	9.8	46	4.1		70	0.1		99		61	38	0.3		305	1.02		
118				24	11					110		26	38			153	0.62		
119	7.56	1450	120	110	6.5	<0.02	85	8.7		197	<1	120	2400	4.6		4402	0.98	-125.5	-14.01
120	7.40	33	1.3	50	9.3	0.05	20	0.18		210		23	29	0.1	271	269	1.00		
121																			
122	6.80	390	20	41	10	<0.02	63	4.1				120	45	8.6		702	4.82		
123	8.10	165	26	110	22		65		0.08	312		370	75			987	1.01	-130	-16.24
124																			
125	8.10	143	12	31	15		42		1.2	456		63	29			559	0.97		
126									0.0574										
127	7.10	180	20	36	4.4	0.08	110	1.9	1.3	375		150	40	7.8		735	0.97	-129.5	-15.58
128	7.90	101	6.4	46	19	0.04	39	0.3		205	N	69	124	0.5	503	506	1.01		
129		182	11	79	17		58	1.1		407		154	127	1.9	826	831	1.00		
130	7.00	518	80	97	20	0.02	155			544	N	48	775	6.3	1968	1967	0.97		
131	6.9	540	82	95	22	0.03	110			490	0	66	790	5.7		1952	1.00		
132	6.97	130	8.2	73	17		40	0.63	0.22	480		65	70	1.4	551	642	0.97		

#	pH	Na	K	Ca	Mg	Fe	SiO2	B	Li	HCO3	CO3	SO4	Cl	F	TDSm	TDSc	ChgBal	delD	delO18
133		277	27	28		<0.25	81						26			439	19.27		
134	7.50	304	33	7.6	20		74	3		818		93	20	5.5		963	0.99		
135	8.1	180	12	13	2.1		8.3	0.54	0.24	457	3	26	23	4.3		497	0.99		
136	7.64	110	4.7	91	32		26	0.36	0.06	180	0	190	180	0.7	734	723	1.00	-124.4	-15.15
137	7.40	160	13	8.8	0.5	<0.02	135	1.2		368		53	29	7.8		589	0.93	-128.6	-15.7
138	8.6	270	14	8.5	2		17	1.8	0.81	365	8	110	140	6.2		758	0.99	-134	-16.4
139	8.30	920	94	17	40	0.01	50	15		1940	41	121	381	12	2650	2645	0.99		
140																			
141																			
142		1350	240	120	4		340			202		18	2250	6	4530	4427	1.05		
143.1																			
143.2																			
144	7.90	60	6.5	56	19	N	51	0.4		260	N	72	58	0.3	452	451	0.96		
145	7.70	74	2	179	58	N	25	0.4		211	N	390	191	0.3	1040	1024	1.00		
146	8.00	42	3.5	102	30	0.04	10	0.1		166	N	85	178	0.3	536	533	0.99		
147	6.50	130	22	33	6.8	0.22	66	1.1	0.08	429	1	56	18	1.8		547	0.95	-125.5	-15.65
148																			
149	8.40	200	18	16	0.9	0.18	125	2.6		385		140	41			733	0.97	-131.4	-15.74
150																			
151	7.00	157	15	58	16		44			533		84	34	1.7		672	0.99		
152	8.00	288	33	29	5		80			823		60	28			928	0.98		
153	7.10	105	28	70	27		40	2	5	507	N	94	17	2.5		635	1.01		
154	8	118	21	20	9		40			333		64	21			457	1.00	-127.8	-16.28
155	7.10	38	5.6	33	4.1		51			136		36	25	1.9		262	1.00		
156	6.4	77	22	100	25	0.18	34		0.33	537		64	14	1.1	582	602	1.04		
157	6.2	80	23	96	22	0.37	41		0.35	548		67	14	1.2	589	615	0.99		
158	6.6	10	2.3	8.5	1.9	0.12	26		0.004	51		5.7	3.9	0.1	96	84	1.01		
159	7.4	39	11	59	20	0.069	28		0.19	318	0	50	14	0.6		378	0.98	-128	-16.9
160	6.90	231	27	15	5.9		52			690		25	10			705	0.99		
161	7.60	45	16	60	15		70			335		52	12			435	0.95	-132.7	-16.64
162	7.51	27	7.6	43	8.8	0.004	67		0.028	180		38	17	0.5		297	1.00		
163																			
164	7.3	47	13	56	11	0.009	51		0.088	234		84	19	0.5	379	397	0.99		
165																			
166																			
167	8.00	50	8	26	5.8	N	85			164	N	37	22	0.4	318	315	1.01		
168	9.50	230	16	0.8	N	0.04	373	2		116	149	89	30	15	1000	962	1.01		
169	8.90	230	16	1	<0.1	<0.02	320	2.1		321	32	130	69	17		975	0.88	-130	-14.76
170	7.00	136	17	22	5.8		58	0.81		378	N	62	27	5	526	520	0.93		
171	6.60	230	58	53	35	<0.02	67	2.1		915	<1	7	1	6.6		910	1.10	-136.1	-15.97
172	6.90	285	56	46	40		70	2.9		949		116	48	7		1138	0.99		
173																			
174																			
175	7.30	10	2.1	46	23.5		20	0.03	0.8	226	1	27	4.6	0.1		246	1.06		

#	pH	Na	K	Ca	Mg	Fe	SiO2	B	Li	HCO3	CO3	SO4	Cl	F	TDSm	TDSc	ChgBal	delD	delO18
176	7.00	39	8.7	52	16		0.58	0.25		287	N	27	14	0.7	380	299	1.02		
177									0.75										
178	6.6	110	35	63	12.3		65	0.9	0.3	493		70	15	2	582	867	0.98	-149	-18.1
179	7.20	120	39	60	15.5	<0.02	65	0.7		488	1	72	16	1.9		631	1.04	-144.7	-15.31
180																			
181	8.50	135	8.9	1	0.03	<0.02	210	0.2		224	15	40	23	17.7		561	0.93	-130.1	-16.09
182	8.00	58	14	45	12		50		1.8	377		24	6.5			395	0.89	-132.8	-16.24
183	7.90			54	18					396	N	95	18			380	0.47		
184	8.00	118	21	20	9	<0.02	40		0.113	333		64	21			457	1.00	-127.8	-16.28
185	7.00	114	22	41	22.4		39	2.4	0.08	443		68	20	4.5		551	0.99		
186	7.80			141	61					540	N	315	332			1115	0.49		
187				52	20		35	0.8		334		39	23	1	398	335	0.61		
188																			
189																			
190	7.74	8.4	4	49	17		24		t	226		20	5.1	0.334		239	1.01		
191									0.1										
192																			
193																			
194	8.90			16	1					56	8	168	114	3	788	338	0.11		
195																			
196																			
197	8.01	780	42	56	2.6	0.037	110	4.3	2	170	1	67	1100	2.9		2251	1.07	-126	-14.3
198	7.2	694	53	35	0.2		210	4.4	1.5	112		323	872	5.5	2120	2311	1.00	-127	-14.2
199	7.10	730	62	22	N	N	226	4.7		67	N	315	910	7.3	2360	2310	1.02		
200				32	2		259			31	19	334	955		2495	1616	0.05		
201	7.10	620	38	70	1.5	0.02	150	5.6		100		400	820	4.2		2159	0.95	-121.5	-13.3
202	7.6	656	52	52	0.6		198	6.1	1.7	93		405	829	4.7	2100	2298	0.97	-121	-12.4
203	7.00												5			5	0.00		
204	9.00	117	5.4	6.2	0.1	N	46	193		12	20	144	57	2.5	361	597	0.99		
205	8.10	139	4.7	5.2	0.3		85	0.76		136		171	20	0.81	567	494	1.01		
206	8.1	277	8	27	0		126	2	0.2	93		528	55	4.1	950	1120	0.95	-126	-15.9
207	7.50	248	7.1	20	0.3		104	1.7		95		419	53	4.9	959	905	1.00		
208	6.3	611	58	15	0.3		278	41.8	6.9	369		120	790	2	2056	2292	0.93	-121	-12.4
209	7.70	679		32	8					361		234	750	1.2	2056	1882	0.99		
210	7.20	680	66	16	0.7	<0.02	270	47		368		73	837	2.1		2173	1.03	-116.7	-12.16
211	8.00	19		24	9					151	N	3	5		211	134	1.03		
212	7.9			37	19					212		47	13	0.1	281	220	0.71		
213	9.30	49	0.4	2.8	1		44	0.2	0.667	34	26	35	5.4			181	1.03		
214	8.40			13		0.27			1.4	120	6		7	7	253	92	0.24		
215																			
216	7.7			47	14					232		5	7	0.1	249	187	0.85		
217	7.60	67	4.6	267	53	3.3	34	0.03		312	N	732	8.2	0.6	1320	1323	1.01		
218	7.70			102	1	0.13			8.4	149	N	192	21		583	389	0.74		
219	8.21	25	1.4	17	0.9	0.003	33	0.04	0.011	107	0	8.6	3	0.3		142	1.01	-109	-14.8

#	pH	Na	K	Ca	Mg	Fe	SiO2	B	Li	HCO3	CO3	SO4	Cl	F	TDSm	TDSc	ChgBal	delD	delO18
220	8.06	28	0.9	15	1.1	0.11	27	0.06	0.004	93	0	16	4.7	0.6		139	1.03	-112	-14.9
221	7.26	173	5.9	270	0.14	0.116	44	1.4			26	843	34	4.1		1402	1.08	-130	-16.2
222	8.84	99	1.6	2.2	<0.05	0.03	60	1.5		57	13	89	27	7.5		329	1.02	-127	-14.9
223	8.55	161	5	166	0.1		33	1.4		4.5	11	617	39	3.3		1039	1.06	-130	-16.2
224	7.3	170	3.9	66	0.74	5.6	35	1		39	0	470	38	5.1	798	815	0.94		
225	8.90	125	1.7	6	0.7	0.03	47	1.5		51	17	109	74	7.1	408	414	0.95		
226	8	58	4.4	9.5	2.9	0.006	78	0.16		140	0	36	9.5	1.6	271	269	0.99		
227	8.50	69	3.4	2	0.2	0.03	36		0.309	146	4	23	6.2	1	244	217	0.99		
228	8.80	82	2	14	0.33		33			48		148	21	5.8		330	0.91		
229	8.20			7.2	1.7				7.1	159		128	29			244	0.08		
230	8.50	277	15	38	0.2		115			70		580	46			1106	0.99	-131.5	-16.01
231	8.60	313	13	40	1	0.06	109	1		52	12	642	49	8.2	1210	1214	0.98		
232	4.83	1200		55	0.07	0.015	190	9.4					2000	0.7		3455	0.97		
233	8	2230	249	87	0.2		319	15.6	3	36		70	3740	4.3	7570	6754	1.00	-114	-,2.1
234																			
235																			
236																			
237	8.60	190	6.5	3.6	0.02	<0.02	115	0.89	0.04	111	11	111	126	16		635	0.97	-126.1	-15.89
238	7.41	1900	120	80	23		83	0.58	1.7	348	0	240	3000	1.3		5621	0.96	-101	-11.5
239	8.1	680	25	11	4.2		49	7.2	0.44	388	2	110	820	0.5		1900	0.98	-110	-13.9
240	7.86	1000	48	82	2.1	0.05	160	5.7	1.5	144		360	1500	0.6		3229	0.94	-109.3	-13.46
241	5.7	2000	232	109	0.4		284	13.4	3.8	108		48	3400	1	6140	6200	1.00	-105	-10.8
242		750	60	18	5		70	5.1	1.1	312	3	39	1300	1.1		2406	0.83	-110.6	-13.3
243	7.34	42	2.8	63	15	0.007	40	0.41	0.055	243	0	65	14	0.5		362	1.09	-95	-11.7
244	9.27	220	7.6	1.7	0.79	0.022	28	1.1	0.012	230	38	89	100	0.8		600	1.02	-111	-14.1
245	7.57	1480	42	108	1.7		170	15		90	<1	190	2200	5		4256	1.05	-110.2	-12.36
246	8.5	1600	57	71	1.1		80	17	2	120	15	180	2300	3.3		4385	1.05		
247	8.2	1700	48	75	0.9		120	17	2.1	140	0	210	2400	5.5		4647	1.06		
248	7.86	3100	45	27	32	0.18	63	13	0.32	839	0	6.8	4700	0.7	8490	8401	0.96	-97	-10.5
249	7.65	370	0.9	33	5.8	0.0055	53	1.5		788		250	15	1.9		1119	0.98		
250	6.56	1400	32	70	2.9	0.054	120	14				62	2200	0.5		3901	1.03	-107	-11.7
251																			
252																			
253																			
254	7.40	450	26	44	0.6	<0.02	180	2.4	0.1	114	<1	470	380	7.9		1617	0.99	-125.8	-13.21
255	7.60	68	3	16	2.2	0.01	54	0.3		86	N	80	26	6	297	298	0.97		
256	8.20	72	2	12	0.9	0.04	63	0.08		98	N	60	21	6.9	287	286	1.01		
257	9.9	4400	87	5.7	6.2	0.25	24	4.8	0.3	575	256	1700	4843	7.8	11919	11618	1.02		
258	8.9	363	34.6	3	1.1		342	7.4		279	13.5	118	321	5.8		1347	1.00		
259				64	5		42			768	N	77	34		863	600	0.24		
260																			
261																			
262	8.40			42	20					180	8	74	19			252	0.71		
263	7.70	170	8.4	4.8	0.06	<0.02	110	0.66	0.04	256	5	102	22	8.9		558	1.04	-130.4	-16.68

#	pH	Na	K	Ca	Mg	Fe	SiO2	B	Li	HCO3	CO3	SO4	Cl	F	TDSm	TDSc	ChgBal	delD	delO18
264.1																			
264.2	8.59	525	38	10	2.5	0.14	107	3.5		1380	40	65	48	12		1530	0.90	-132	-17.7
265.1	7.7	156	8	6.2	0.14		116			243		108	24	8.8		547	0.99		
265.2																			
266																			
267	6.50	44	14	56	12	<0.02	68	0.12		264	<1	64	12	2.5		403	0.99	-129.8	-16.87
268	7.20	29	5.9	57	21	0.01	40	0.26		279	N	35	21	0.2	346	347	1.01		
269.1	8.00	15	3.4	51	20	N	25	N	0.5	255	N	25	10	0.4	276	275	0.99		
269.2																			
270	7.47	37	12	69	17		37			334		25	9	0.889		371	1.07		
271																			
272																			
273									1.2										
274	8.70	36		24	7.8					135	12	28	7			181	1.00		
275	9.30	64	0.7	1	<0.1		85		N	144		18	6.3			246	0.98	-127.9	-16.28
276																			
277	7.80	36		62	12				0.76	160	N	88	43			320	1.00		
278	6.50	200	36	43	9.4	0.06	77	2.6		673		51	22	4.7		777	0.97	-135.8	-16.01
279																			
280	6.60	47	13	52	11	<0.02	36	0.17		249	<1	57	10	2		230	3.58	-127.5	-16.28
281	7.10	55	15	50	11	<0.02	46	0.21		278		59	8	2.8		384	1.00	-124.9	-16.24
282	6.72	27	7.5	65	28	0.01	24	0.1	0.063	370		31	8.3	0.5		374	0.99	-120.5	-15.6
283	6.85	21	4.6	69	22	0.01	21	0.07	0.083	320		53	6.9	0.4		356	0.96	-122	-15.9
284	8.65	18	6.7	42	20		20		0.527	217	6.5	35	6.7	0.319		262	1.00		
285	7.2	19	6.5	60	23	0.006	26		0.083	286		52	6.7	1		335	0.98	-127	-16.6
286																			
287	7.8	150	4.8	12	0.3	0.02	105	0.35	0.65			1	16	1.2		291	13.58	-127.8	-16.2
288																			
289																			
290	7.8	4.8	1	49	21	0.01	11			180	0	17	4	0.1		196	1.29		
291	8.29	4.3	1.4	56	17		23			232		19	3.6	0.265		239	1.02		
292									0.008										
293	8	20	9.5	26	8.7	0.007	71		0.019	130		9	21	0.4		230	1.07	-126	-16.5
294		162		13	1.1	0.12	100			375	7.7	17	17	0.75	518	503	1.07		
295																			
296	7.3	9.3	3.4	51	21	0.01	19			250	0	18	4.4	0.4		250	1.03		
297				54	21	0.1	32			267	N	21	4.3		266	264	0.90		
298	6.8	8.2	2.3	51	16	0.01	21	0.03	0.017	220		19	3.2	0.2		229	1.04	-121.5	-16.2
299	8.00			32	25					148	N	83	10			223	0.82		
300				51	23	0.22	37			222	N	68	7.5	0.67	314	297	0.84		
301	8.70	145	3.6	10	0.01	<0.02	58	1.2		50	9	235	44	4.9		535	0.92	-119.5	-15.55
302	9.10	137	2.9	9.6	0.5	0.01	61			12	24	200	46	5	499	492	0.98		
303													1.2			1	0.00	-116	-15.6
304																			

#	pH	Na	K	Ca	Mg	Fe	SiO2	B	Li	HCO3	CO3	SO4	Cl	F	TDSm	TDSc	ChgBal	delD	delO18
305	8.7	102	2.5	4.5	0.01	0.06	52	0.19	0.07	54	7	169	17	3.1		384	0.90	-123.2	-16.01
306	8.50	69	3.4	2	0.2	0.03	36		7.1	146	4	23	6.2	1		217	0.99		
307							62	1		41	22	157	28	3.5		294	0.00		
308																			
309																			
310	8.5	200	2.2	26	0.1	0.02	34			38	0	380	49	8.4		718	0.97		
311																			
312		70		48	13					88	10	190	43			417	0.94		
313		262		16	N			1.6		210		315	78			776	1.00		
314																			
315																			
316																			
317	7.40	148	6.4	82	14	0.01	25		75	82	N	403	79	0.7	810	798	0.99		
318	8.00	245	10	32	6.1	0.66	54	2.3		118		374	102	6.8	891	891	1.01		
319				6	0.9		37		0.22	47	9	109	64	4.8	370	254	0.07		
320	7.70			26	8				6.1	144	N	23	11			139	0.62		
321	7.60	305	16	40	3.3	0.07	46	2.3		112	<1	597	87	7.4		1159	0.93	-130.3	-16.13
322	8.70	160	2.7	7	<0.25		63			68		238	33	11		548	0.97		
323									0.8										
324									5										
325	7.50	74	13	23	0.95		94		0.18	202		38	12	4		358	1.03		
326	8.77	99	3.3	1.1	<0.05	0.03	122	0.7		119	21	47	12	14		379	0.95	-131	-8.4
327	8.72	94	2.7	1.4	<0.05	0.04	112	0.575		126	17	53	12	14		369	0.88	-130	-6.7
328																			
329	7.60	55	4.8	26	13		28			239		41	1	0.31		287	1.01		
330																			
331																			
332																			
333	8.23	57	13	15	0.924		108			130		44	12	0.738		315	1.06		
334	7.6	43	9	28	4.2	0.02	76	0.18	0.04	147	0	34	21	0.7	300	288	1.03		
335.1																			
335.2		80	5	20	4.4	3	68			51	36	106	35		367	382	0.97		
336	9.12	43	1.9	7.2	0.512		68			83	9.3	18	7.7	0.889		197	1.00		
337	7.9	13	4.2	37	12	0.008	28	0.01	0.01	168	0	36	3.7	0.6	221	217	0.96		
338	7.8	17	5.8	45	11	0.15	31	0.045	0.02	158	0	64	4.8	0.4	269	257	0.99		
339	7.6	38	0.8	4.7	0.1	0.01	46	0.1	0	80	0	19	7	0.4	148	155	1.00		
340	7.70	49	6.8	70	22	0.007	32	0.33	2.1	358	N	55	19	1	444	431	1.00		
341	8.00	197	13	51	15	0.04	135		N	545	N	86	42	8	823	815	1.03		
342																			
343									N										
344	8.10	65	2.5	1.6	0.1	0.014	76	0.16	7.6	132	N	26	10	1.2	229	248	0.98		
345	7.8	66	3.5	25	3.4	0.01	70	0.3	0.03	184	0	42	18	1.2	313	320	1.01		
346	7.4	46	4.4	17	2	0.027	46	0.2	0.04	124	0	27	15	0.5	208	219	1.03		
347	7.4	41	7.9	25	2.6	0.009	72	0.34	0.05	156	0	21	12	0.8	261	259	1.02		

#	pH	Na	K	Ca	Mg	Fe	SiO2	B	Li	HCO3	CO3	SO4	Cl	F	TDSm	TDSc	ChgBal	delD	delO18
348	7.8	276	27	58	18	0.015	25	0.61	0.95	702	0	222	36	6.2	945	1015	0.98		
349	7.20	194	24	76	22		53	0.44		702	N	99	31	3	833	848	1.00		
350	7.7	45	1.1	68	6	0.005	42	0.19	0.03	284	0	31	22	0.2	376	355	0.99		
351	7.7	36	0.3	5.8	1	0.002	40	0.01	0.04	94	0	9.5	6.3	0.3	143	146	1.01		
352.1	8.00	28	6.5	62	22	0.06	25	0.12		321	N	47	8.6	0.6	380	358	0.97		
352.2	9.98	52	1.5	0.723	0.06		70			43	29	14	10	4.8		203	0.94		
353	8.06	12	3.3	40	18		22		1.5	185		38	16	0.22		241	0.95		
354	8.1	54	12	57	17	0.008	32	0.44	0.25	368	0	17	14	2.8	380	388	1.00		
355	6.88	36	5.5	71	23	0.01	24	0.13	0.11	380		29	9.5	0.9		386	1.00	-114	-15
356	7.03	24	5.9	58	19	0.01	27	0.14	0.075	290		47	9.9	1.3		335	0.93	-119	-15.7
357	7.14	5.3	1.6	67	24	0.01	13	0.03	0.018	300		14	2.9	0.2		276	1.05	-108	-14.5
358	7.5	10	3.4	50	21	0.003	26		0.022	270		12	6.6	0.2		262	0.97	-105	-14.3
359				40	23		46		10	178		27	18		283	242	0.98		
360	7.60	24	5.1	60	24	0.01	28	0.1	0.85	300		43	9	1	343	342	1.00		
361	7.38	22	4.4	55	22	0.009	25	0.11	0.053	260	0	44	9.3	1.2		311	1.02	-119.5	-15.8
362	9	1680	18	7.1	5.4		20	18.4	0.95	1590	200	425	937	7.68	4920	4101	1.09		
363	7.8	68	17	56	17	0.008	51	0.4	0.24	350	0	47	26	2	405	457	1.00		
364	8	123	25	91	31	0.1	37	0.8	0.33	698	0	59	9.8	2.4	700	723	1.00		
365	7.6	120	22	100	26	0.002	27	0.62	0.3	673	0	51	15	2.7	732	696	1.02		
366				44	37	0.1	11		0.324	124	N	11	2		132	166	2.26		
367																		-101	-13.2
368																			
369	7.20			1.1	0.6			0.02		50	N	22	2	0.2		51	0.08		
370													578			578	0.00		
371	7.90	792	60	38	38	0.8	23	9.8		720	N	323	860	3.2	2500	2502	0.96		
372	8.40	875	2.5	71	2		48			56		1120	625	5.6		2777	0.99		
373	7.10			48	7.4			1.7		60	N	98	70	4.2		259	0.58		
374	7.90			17	2.7			0.06		128	N	12	3	0.2		98	0.44		
375																			
376	7.00			49	9.6	0.17				614	N	120	74	4.3	940	559	0.22		
377	8.30			13	4			0.42		158	1	38	7	1.5		143	0.26		
378	8.3	430	45	37	4		140	9.4		224	0	80	460	3.1	1494	1319	1.19		
379																			
380																			
381	7.10	334	16	47	2.7	0.12	62	1.4		328	N	487		7	1180	1119	1.10		
382	7.90			48	4.9	N				266		106	54	2.7	560	346	0.34		
383				9.6	2.4				0.65				47			59	0.51		
384																			
385	7.70	47	2.5	62	5.9	0.03	38	0.18		240	N	48	23	0.8	346	345	1.01		
386	7.75	240	0.4	220	0.4		17		0.25	110	0	890	49	0.8	1600	1472	0.99		
387	7.05	49	0.9	21	1.3	0.06	55		0.02	160	0	21	7.8	0.3	229	235	1.00		
388	9.00	81	2.6	1.6	N		61		N	187	N	16	6	0.6	287	261	1.02		
389	7.00	142	15	74	27	1	30			577	N	71	34	0.9	624	679	1.05		
390	8.20			11	5.8	N				155	N	24	55	4.5	427	177	0.21		

#	pH	Na	K	Ca	Mg	Fe	SiO2	B	Li	HCO3	CO3	SO4	Cl	F	TDSm	TDSc	ChgBal	delD	delO18
391	7.7	45	2.8	57	7.7		37		0.05	231	0	48	23	0.6	396	335	1.01		
392	8.00			36	22					357	N	25	5			264	0.55		
393																			
394																			
395	8.00	29	7.2	44	23		33	0.1		260	N	36	11	0.5		312	1.03		
396	8.40	23	5.2	45	23	N	28	0.2	N	272	N	27	8	0.5	295	294	1.00		
397	8.10	32	6.8	39	18		31	0.1	5.6	231	N	34	9.7	0.5	286	285	1.04		
398	8.3	3.8	0.9	55	31	0.006	14		0.013	289		8.9	4.1	0.1		260	1.09	-97	-12.9
399	8	34	5.6	26	3.5	0.009	55		0.057	146		18	10	1.3		225	1.03	-101	-13.4
400																			
401	8.10	38	6.8	31	9.8	N	51	0.1		189		29	15	1.6	271	275	0.99		
402	7.5	6.5	1.5	56	26	0.042	14		0.016			6.9	7.9	0.1		119	14.14	-103	-13.7
403	8.20	46	15	43	6.2	<0.01	91			239	N	42	12	1.4	380	374	0.97		
404	7.20	39	14	34	4.8		106			200		30	8	1.4		336	0.99		
405	7.90	169	3	18	1.5		69	0.4		254		127	45	5	564	563	1.01		
406	8.20	106	5.8	14	1.9	0.12	68			194	N	69	27	4	368	391	1.01		
407	7.35	64	9.7	44	16	0.023	38		0.11			75	20	3	372	270	2.87		
408	8	50	2.2	22	1	0.05	22		0.05	147	0	40	7.6	0.9	210	218	0.97		
409	7.6	120	11	44	16	0.006	28			270		150	27	3.8	537	533	1.06		
410	7.30	71	8	51	18	N	20	0.51		300	N	80	22	2.2	552	420	1.00		
411		69	7.8	47	21		23	0.31	0.11	302	N	78	21	1.5	547	417	1.00		
412		69	7.8	48	19		22	0.26	0.0958	300	N	75	17	1.7	419	407	1.02		
413	7.90	69	6.8	45	20		29		0.6	285	N	81	21	1.3	528	413	1.01		
414	7.60	71	7.8	46	19		28		0.0419	283	N	80	22	1.2	529	414	1.02		
415		65	7.6	50	24	N	22	0.32		310	N	76	20	1.6	555	419	1.02		
416	7.20	69	7.7	49	21	0.02	23	0.1		310		80	21	1.4	425	425	0.99		
417		68	7.8	45	21		22	0.38		300		78	20	1.5	541	411	0.99		
418		97	8.6	44	19		28	0.44		318	N	105	25	1.3	480	485	1.00		
419	7.40	80	8.8	48	20		26		0.0463	311	N	92	32	1.4	593	461	0.97		
420		62	7.8	45	18		22	0.27		284	N	64	21	2.1	400	382	0.99		
421	7.3	300	9.5	76	39	0.006	26			346		500	130	1.7	1260	1252	1.02		
422		21	9.7	48	15	0.16	17			239	N	28	5		330	261	1.03		
423				55	29		18			239	N	42	4.9		268	266	1.04		
424		8.2		50.3	22.2					243.8	N	32.9	0.7		358.1	234	1.00		
425		5.7	1.2	47	23	0.02	13			235		35	4.5	0.2		245	0.96		
426	7.03	8.4	1.8	94	29	0.007	13		0.013	201		180	16	0.2		441	1.00	-91	-12.5
427	7.35	29	3.7	26.7	44.2	0.01	29.1	0.2		280		91	27	0.44	409	389	0.87		
428	7.4	8.1	3.6	48	25	0.05	14			222	0	51	6.5	0.2	266	266	1.00		
429				150	44		21			171	N	453	22		863	774	0.86		
430				155	50		30		1.2	205	N	405	35		857	776	0.93		
431				106	20					84	N	1027	112		1785	1306	0.27		
432	7.4	81	11	47	21	0.006	34		0.11	303		90	34	1.7		469	1.00	-101	-12.95
433	7.15	78	11	46	20	0.01	33	0.31	0.13	300		100	34	1.9		472	0.95	-100	-12.9
434	7.16	88	11	58	25	0.006	30		0.14	272		160	53	2.1		561	0.96	-97	-12.95

#	pH	Na	K	Ca	Mg	Fe	SiO2	B	Li	HCO3	CO3	SO4	Cl	F	TDSm	TDSc	ChgBal	delD	delO18
435	7.35	38	10	51	25	0.01	24		0.11	239		54	26	1.2		347	1.12	-75	-10.35
436		99	10	65	28		31	0.3		288	N	174	60	2.4	614	611	0.99		
437		101	11	70	26		29	0.3	0.6	274	N	179	64	2.3	620	617	1.02		
438	7.3	25	5.3	130	43	0.08	29		0.039			370	15	1		618	1.38	-87	-11.65
439	7.27	120	13	110	48	0.043	21		0.19	210		360	170	2.1		948	0.95	-97.5	-13.3
440	9.60	36	2.7	5	0.7	<0.15	0.64	0.57		37	N	64	8.1	0.1	160	136	0.89		
441	8.1	340	26	500	170	0.01	17	1.3	0.66	160	0	1900	380	1.5		3415	1.03		
442	7.9	300	20	450	140	0.03	17	1.1	0.6	160	0	1600	340	1.4		2949	1.04		
443	6.96	130	13	120	47	0.004	23		0.21	226		380	200	1.4		1026	0.91	-94	-13.45
444	7.00			298	113	N	38			98		1200	1190	1.5	3720	2889	0.40		
445	8.12	271	7.4	62.7	2.7	<0.15	38.94	0.58		113.8	N	431.3	143.6	4.05	1040	1018	1.01		
446	7.90	680	17	290	4.8	0.01	40	1.4		41	N	730	1000	3.9	2790	2787	1.01		
447	7.60	160	3.1	37	6.9	0.01	25	0.7		79	N	180	180	1.4		633	0.93		
448	7.3	350	8.3	220	75	0.02	28	0.82		203		570	600	1	2090	1953	1.01		
449	7.9	160	4	58	16		27			156	0	190	180			712	0.97		

Nevada Geothermal Resource Use — 1993 Update

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Geology

Nevada is well-endowed with both high- and low-temperature geothermal resources. Over 40 percent of the state is believed to have potential for the discovery of high-temperature (>90°C) geothermal resources, and another 50 percent has potential for low- to moderate-temperature (<°90C) resources (see Figure 1). Surface and subsurface indications of these resources are the more than 1,000 thermal springs and wells in the state. Realistically, this number of individual springs and wells represents several hundred resource areas.

Geothermal reservoirs in the northwestern part of the state have generally higher temperatures; these reservoirs are usually interpreted as being related to circulation of groundwater along faults to deep levels in a region of higher-than-average heat flow. In east-central and southern Nevada, the low- to moderate-temperature geothermal resources are generally believed to be related to regional groundwater circulation in fractured carbonate-rock aquifers. Discharge areas (for example, warm springs) may be up to several hundred kilometers from the area of recharge, and the waters may have circulated for dozens to hundreds of years to depths of several kilometers. Maximum temperatures attained during this journey could be 100°C or higher, but spring temperatures at discharge points are generally less than 65°C.

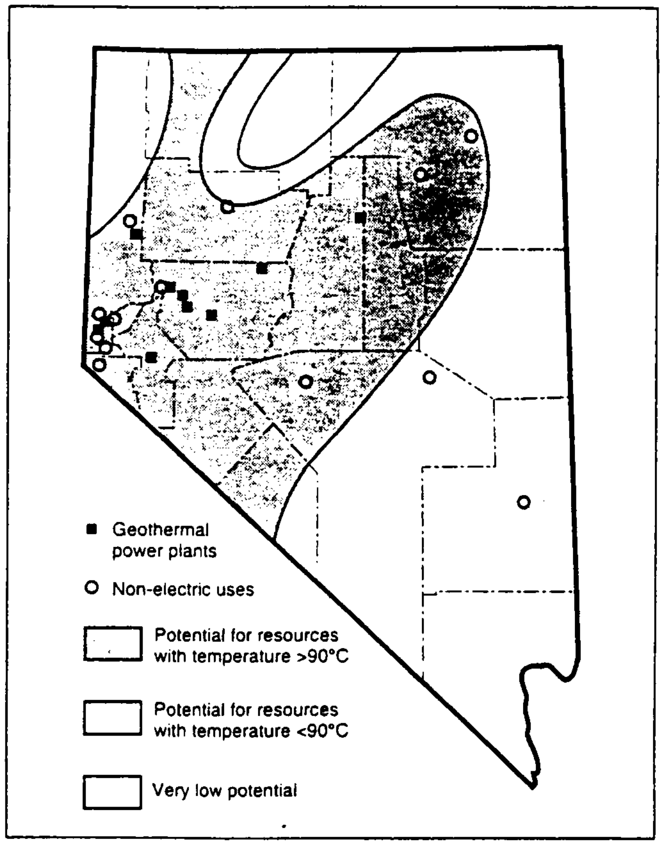

Figure 1. Generalized locations for Nevada's geothermal resources.

Exploration and Development

Two hundred and eighteen geothermal well permits were issued from 1988 through 1993 by the Nevada Division of Minerals. They include 58 industrial-class production wells, 30 domestic class, 88 observation or gradient wells, 10 commercial-class, and 25 injection wells. During this same period 109 geothermal wells are reported to have been drilled, with a total amount drilled of approximately 86,500 m. Forty-five of the wells drilled were production wells, with a total amount drilled of approximately 44,800 m. Figure 2 and Table 1 illustrate the number of power generating wells and pace of drilling since 1980.

From 1989 through 1992 noncompetitive and competitive federal geothermal leases in Nevada generated $1,699,282 in rental fees, $849,641 of which was returned to the State of Nevada. Federal production royalties during the same period generated $7,485,000, of which $3,742,500 was returned to the State. Geothermal lease returns ($849,641) and royalty returns ($3,742,500) to Nevada totaled $4,592,141. By regulation, half of all funds collected by the Bureau of Land Management from federal geothermal leases and production royalties is returned to the state.

Geothermal Electric Power Generation

Electric power is generated using geothermal resources at 10 plants in northern Nevada (Table 2, Figure 1). The state's

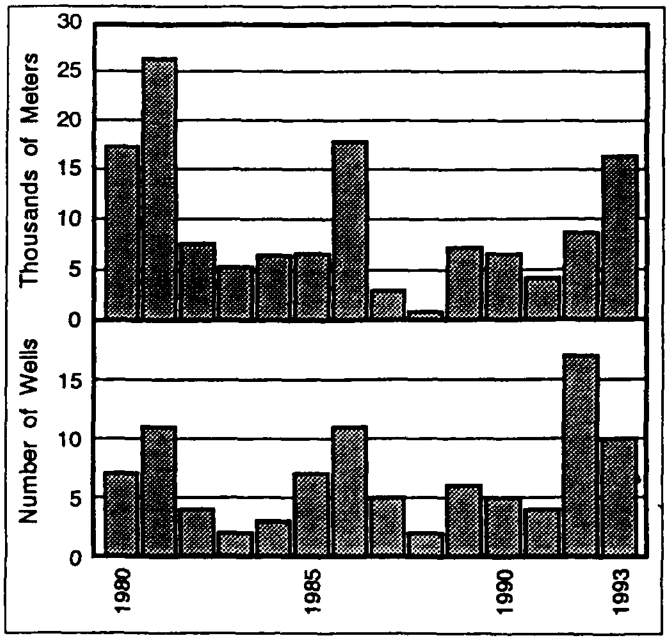

Figure 2. Industrial-class (power generating) wells drilled in Nevada, 1980-1993.

total installed geothermal generating capacity is second only to California.

In 1993 the state-wide peak power demand was 3,755 MW; the total installed generating capacity of Nevada's two major utilities (which supply most of the state's customers) is nearly 2,600 MW (Public Service Commission of Nevada). Thus, geothermal energy provides about 7 percent of the total electricity generated within Nevada (although only about 3 percent of the peak load). Over 40 percent of Nevada's geothermal electric power is exported to California.

From 1989 to 1992, total Nevada geothermal electrical production was 4,076,616 megawatt-hours with an approximate sales value of $307,410,000. Production capacity in 1988 from eight geothermal power plants was 115.8 MW (gross) while current power production from 10 existing geothermal power plants in Nevada is 191.7 MW gross (Table 1). These values represent a 17 percent increase in sales value of the power sold from 1988 to 1992 and an increase in installed gross power production capacity of 60 percent over 1988.

It is important to note that in 1988 Nevada had nearly a threefold increase over 1987 in the amount of online geothermal generating capacity (Figure 3). The primary reason for this increase was the Dixie Valley 60 MW Oxbow Geothermal plant being put online. The OESI plants at Empire (4.8 MW) and Soda Lake No. 1 (3.6 MW) were also brought online during this period.

According to a 1991 Department of Energy estimate, under stable market conditions and with continuing technologic advancements in the geothermal industry, Nevada's projected electrical production capacity from known geothermal resources by the year 2010 should be at least 600 MW (Energy Information Administration, 1991). It is estimated that, for the Basin and Range province as a whole, aggressive exploration activity and continued rapid geothermal technologic advancements could add up to 2,000 MW of production capacity from known resources and new discoveries over the next 10 to 20 years (Wright, 1992). These relatively optimistic future scenarios should be tempered by today's reality of low-priced natural gas, increases in efficiency of fossil fuel generating equipment, and anticipated changes in power sales contracts. The future is bright for Nevada's high-temperature resources, but the pace of development will depend on many factors not related to the viability of the geothermal resource.

Table 1. 1992 directory of Nevada geothermal power plants.

Year	Total # drilled	Total depth(m)	No. industrial wells drilled	Total depth(m)
1988	11	4,268	3	1,098
1989	15	14,817	6	7,317
1990	12	11,280	5	6,707
1991	14	12,561	4	4,268
1992	36	17,988	17	8,841
1993	21	25,596	10	16,686
TOTAL	109	86,510	45	44,917

Beowawe

The **Oxbow/Beowawe Geothermal Power Co., Beowawe** plant came online in 1988. It is a 16 MW (gross), dual-flash plant, which uses geothermal fluids from three wells with a resource temperature of 221°C.

Brady Hot Springs

The **Brady Hot Springs** geothermal power plant (Figure 4) came online in July 1992. Plant operation and maintenance is being performed by **Oxbow Power Services, Inc.**

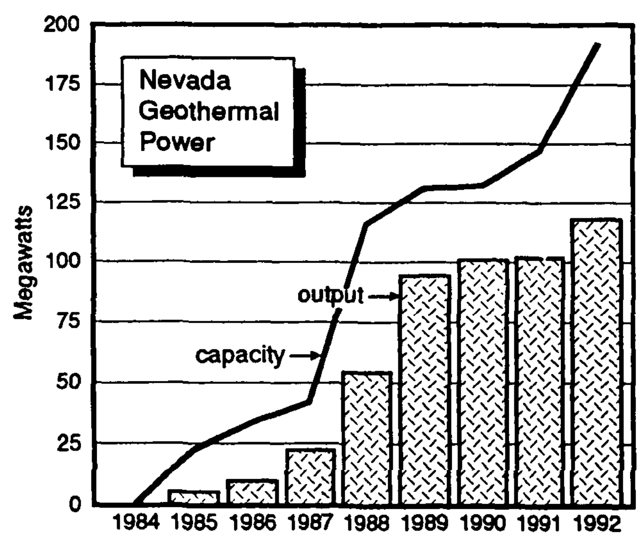

Figure 3. Rated capacity and average net output of Nevada geothermal plants, 1984-1992. Average net output is annual sales in megawatt-hours divided by the number of hours in a year (8,760).

Figure 4. Steam separators and power house at Brady Hot Springs plant (Brady Power Partners), Churchill County, NV. *Larry Green photo.*

Table 2. Total number of all classes of geothermal wells drilled and number of industrial-class geothermal wells drilled by year, 1988 through 1993. Source: Hess, 1993; Nevada Division of Minerals, 1993.

Plant name (year on line)	Production capacity[1] (MW)	1992 Production (MWh)		Location	Operator
		Gross	Net (sales)		
Beowawe (1985)	16.0	138,196	104,415	S13,T31N,R47E	Oxbow/Beowawe Geothermal Power Co. P.O. Box 6 Beowawe, NV 89821
Bradys Hot Springs (1992)	21.1	69,999	54,563	S12,T22N,R26E	Oxbow Power Services, Inc. P.O. Box 649 Fernley, NV 89408
Desert Peak (1985)	8.7	85,364	76,906	S21,T22N,R27E	Western States Geothermal Co. P.O. Box 2627 Sparks, NV 89432-2627
Dixie Valley[2] (1988)	66.0	535,220	483,307	S7,T24N,R37E S33,T25N,R37E	Oxbow Geothermal Corp. 5250 South Virginia St. Suite 304 Reno, NV 89502
Empire (1987)	3.6	17,783	12,752	S21,T29N,R23E	OESI/AMOR II P.O. Box 1650 Fallon, NV 89407
Soda Lake No. 1 (1987) and Soda Lake No. 2 (1991)	16.6	107,315	84,419	S33,T20N,R28E	OESI/AMOR III P.O. Box 1650 Fallon, NV 89407
Steamboat I, I-A (1986) and Steamboat II, III (1992)	31.1	104,574	79,790	S29,T18N,R20E	S.B. Geo, Inc. P.O. Box 18087 Reno, NV 89511
Stillwater (1989)	13.0	72,707	59,692	S1,T19N,R30E S6,T19N,R31E	OESI/AMOR IV P.O. Box 1650 Fallon, NV 89407
Wabuska (1984)	1.2	6,262	3,860	S15,16,T15N, R25E	Tad's 10 Julian Lane Yerington, NV 89447
Yankee Caithness (1988)	14.4	82,280	76,096	S5,6,T17N,R20E	Yankee Caithness J.V.L.P. P.O. Box 18160 Reno, NV 89511
TOTAL	191.7	1,219,700	1,035,800		

[1]Production capacity from currently developed geothermal resources.
[2]Gross output of the Dixie Valley plant occasionally exceeds 66 MW.
Source: Hess (1993).

The plant uses 5.4 million pounds of brine per hour produced from six of eight production wells. The production zone is 300 to 425 m deep with a resource temperature of between 172 and 182°C. The wells supply two high pressure turbines and one low pressure turbine in a two stage system that produces 21.1 MW gross output. Geothermal fluids are injected into three of five available injection wells (Ettinger and Brugman, 1992; GRC *BULLETIN*, v. 21, no.1).

Desert Peak

The **Western States Geothermal Co., Desert Peak** plant went online in 1985. It was designed by Phillips Petroleum Co. and uses a biphase turbine built by TransAmerica Corp. Production capacity from the currently developed resource is 8.7 MW. The resource temperature is approximately 205°C and wellhead temperature is 165°C.

Dixie Valley

The largest single geothermal power plant in Nevada, **Oxbow Geothermal Corp. Dixie Valley** plant, came online in 1988 producing 55-59 MW (net). (Gross output sometimes exceeds 66 MW, as listed on Table 2.) The power is produced in a double-flash turbine generator and purchased by Southern California Edison Co. Oxbow estimates a geothermal energy reserve in Dixie Valley sufficient to supply 200 MW for 30 to 60 years (GRC *BULLETIN*, June 1987; *Reno Gazette-Journal*, August 6, 1988).

Empire/San Emidio Desert

The **OESI/AMOR II Empire** plant came online in 1987 and consists of four Ormat Energy Converter Modules with a gross output of 3.6 MW from currently developed geothermal resources. Production is from a liquid-dominated geothermal source at 129 to 137°C. **San Emidio Resources** continued their geothermal program in the **San Emidio Desert** near Gerlach, Nevada. Early in 1991 San Emidio Resources signed a 5 MW, 30-year geothermal power supply contract, effective 1992, and a 20 MW, 30-year geothermal power supply contract, effective 1995, both with Sierra Pacific Power Co. (GRC *BULLETIN*, February 1991). The initial price paid for produced electricity under the long-term contracts is reported to be approximately 5 cents per kWh. At that time plans called for construction of a 6.5 MW binary plant to be online by November 1992. Since then San Emidio Resources requested and was granted a suspension of the 5 MW project in order for Sierra Pacific Power Co. and San Emidio Resources to determine the feasibility of combining the 5 and 20 MW projects into one project. In July 1993, Sierra Pacific Power Co. executed an amendment to the long-term power purchase agreement with San Emidio Resources. The agreement now calls for a 30 MW geothermal power plant to be online by November 1, 1995 (Public Service Commission of Nevada).

Fallon

In early 1992 the **U.S. Navy** issued a request for proposal to construct an 80 to 90 MW geothermal power plant at the Fallon Naval Air Station. If this plant is constructed, it will be Phase I of the Navy's geothermal program. Phase II will consist of a second 80 to 90 MW facility to be constructed within 10 years of completion of the Phase I project. The Navy estimates that the potential geothermal resource in the area will be able to produce 300 to 500 MW. The exploration drilling and reservoir testing performed during the initial phase of this project will be used to better define the geothermal potential of this area. Based on previous exploration information it is expected that the resource will be in the 175 to 205°C range.

Fish Lake Valley

Fish Lake Power Co. continued their extensive drilling efforts to develop a geothermal resource in the Fish Lake Valley area of Esmeralda County. If a geothermal generating facility is built, the electricity would be delivered to California under a Standard Offer No. 4 Contract.

Hot Sulfur Springs

Earth Power Energy and Minerals has requested an avoided-cost purchase contract agreement with Idaho Power Co. If a contract were obtained, a 9.9 MW geothermal power plant could be constructed at Hot Sulfur Springs, Elko County, Nevada (*Reno Gazette-Journal*, October 10, 1993).

Rye Patch

The **Rye Patch Limited Partnership (OESI)** is currently nearing completion of a 12.5 MW binary generating plant at their site near **Rye Patch** reservoir. The company has a signed purchase agreement with Sierra Pacific Power Company with an anticipated plant online date of November 30, 1993. This has been delayed while the company continues to develop sufficient and continuous geothermal resources to fuel the plant.

Soda Lake

On August 19, 1991, the 13 MW **OESI/AMOR III Soda Lake No. 2** geothermal power plant completed commercial operations testing and went online. This plant is adjacent to the 3.6 MW OESI **Soda Lake No. 1** plant that came online during 1987 (GRC *BULLETIN*, October 1991). Both plants are producing from a liquid-dominated geothermal source at 160°C.

Steamboat Springs

Two 12 MW, air-cooled, binary geothermal power plants, **Steamboat II and III**, operated by **S.B. Geo, Inc.**, were brought online in December 1992, adding 24 MW of produc-

tion to the existing 7.1 MW **S.B. Geo Steamboat** plant, for a combined gross production capacity of 31.1 MW.

The geothermal fluid cycle at the new plants is completely contained and the fluids are injected back into the ground (closed binary-cycle system). The existing resource is expected to last 30 years or more and can support an additional 36 MW of production capacity. Based on this, plans are currently being formulated to determine the feasibility of installing an additional 24 MW facility in the near future. In December 1993, S.B.Geo, Inc. received a $7.2 million grant from the U.S. Department of Energy to develop a pilot project known as the Kalina Pilot Plant. The purpose of the project is to increase the efficiency of extracting heat from hot geothermal fluids.

Yankee Caithness J.V.L.P. operates a 14.4 MW (gross) flash turbine system producing from a 170°C resource. The **Yankee Caithness Steamboat** plant came online in 1988, and the produced power is purchased by Sierra Pacific Power Co. on a 30 year contract.

Stillwater

OESI/AMOR IV, Stillwater Geothermal plant came online in April 1989. Total project cost was $36 million. The air-cooled plant consists of 14 Ormat Energy Converters that have a combined gross generating capacity of 13 MW. The plant uses a liquid-dominated geothermal source ranging in temperature from 155 to 170°C. The plant operates on a closed system; all geothermal liquids are injected (Ormat Fact Sheet, 1989; Geo-Heat Center, Fall 1989).

Wabuska

Tad's Wabuska plant came online in 1984. Current production capacity is 1.2 MW produced from two Ormat Energy Converter modules. The plant operates on fluids at 107°C. produced from a depth of 107 m (GRC *BULLETIN*, July, 1987).

Non-Electric Low- and Moderate-Temperature Applications

The majority of Nevada's population is concentrated in two areas, Reno-Carson City and Las Vegas. Many of the state's geothermal resources are remote from any population centers, thus limiting some potential applications. Although 50 or more small-to-large communities are located within 8 km of geothermal resources, only a few of these areas have been able to use these resources effectively. The reasons for this under-utilization are varied. Although some reasons relate to technical and engineering problems (resource size and temperature, heat loss during transport, etc.), many more are economic (high capital outlays, long payout, under-capitalization of projects) and perceptual (unconventional *vs.* conventional technology, short *vs.* long-term cost evaluations, uncertainties about long-term economic risks).

There have been attempts to use Nevada's low- and moderate-temperature geothermal resources in more than 20 areas, mainly in the past 5-10 years. Additionally, economic and/or technical appraisals of more areas have been conducted, but for a variety of reasons projects were not completed.

Moana Geothermal Area

Moana Hot Springs, located in the southwestern part of Reno, have not flowed at the surface for at least 15 years. The springs were the discharge point for an area of thermal groundwater that has been used for a spa, swimming pool, and home heating for nearly 100 years. Recent use for home space heating began in the 1960s. The area today is predominantly residential. We estimate that the area of thermal groundwater encompasses at least 9 km^2. In this area there are more than 300 homes that use geothermal fluids for space heating. One hundred and thirty of these homes are part of a district heating system, while most of the rest use downhole heat exchangers in individual wells. A smaller district heating system has retrofitted 12 homes for geothermal heat, and plans to add another four in the spring of 1994. A large hotel, a motel, about three apartment or townhouse complexes, five churches, and a county swimming pool also use the resource. The Veterans Administration Hospital, located about 2 km northeast of the geothermal area, drilled a deep well several years ago and encountered approximately 43°C water. The well was plugged and abandoned.

Steamboat Hot Springs

The Steamboat geothermal area consists of a deep, high-temperature (215 to 240°C) geothermal system, a shallower, moderate-temperature (160 to180°C) system, and a number of shallow, low-temperature (30 to 80°C) subsystems (Goranson and others, 1991). The higher temperature systems are used for electric-power generation (see the preceding section). A number of low-temperature thermal groundwater anomalies are in an area of approximately 30 km^2 centered on the hot spring area (Goranson and others, 1991), but these thermal areas are not well known and are little used. A few homes in the Steamboat area have used low-temperature fluids for over 40 years, and one or more spas have been active in the springs area since the 1860s. Presently probably less than a dozen homes use the low-temperature geothermal fluids for space heating or domestic hot water (including swimming pools). About one domestic geothermal well permit has been issued per year over the last 5 to 7 years.

Bower's Hot Springs

A large outdoor swimming pool and smaller children's pool at the Washoe County Park at Bower's Mansion (lo-

cated between Reno and Carson City), are supplied with warm water from a geothermal well located near the spring.

Carson City Area

Water from a well at the site of Carson Hot Springs in northern Carson City is used directly in a swimming pool. In southeast Carson City, thermal groundwater is found in the State Prison/Pinyon Hills area. In the past, there have been a few attempts to use the thermal groundwater from domestic wells in that area for space heating. Geothermal space heating has been considered, but not implemented, for at least two schools in the area.

Saratoga Hot Springs

A California company, Lobsters West, has proposed raising lobsters near the warm springs located about 15 km southeast of Carson City. The geothermal fluids would be used to heat tanks in which the lobsters would grow to full size. The experimental study is proposed to last 4 years; live lobsters would be shipped twice a month to local markets (*Reno Gazette-Journal*, November 4, 1993).

Hobo Hot Springs

These hot springs, located about 15 km south of Carson City, were used to raise tropical fish and Malaysian prawns in the late 1980s. Lobster raising was also considered. The water temperature is slightly over 40°C. The site is presently inactive.

Walley's Hot Springs

Walley's Hot Springs, located near Genoa, about 20 km south of Carson City, was the site of a large spa in the late 1800s and early 1900s (Garside and Schilling, 1979). A modern spa was built on the site in the early 1980s. In addition to use of the geothermal fluids for bathing and domestic hot water, the buildings are heated with geothermal energy (Lienau and others, 1988).

Gerlach

Hot springs located just west of the town of Gerlach (Great Boiling Springs) have been used for bathing for many years. The Gerlach General Improvement District built a bath house using geothermal fluids in 1989. The facility was planned for use by tourists and local residents. The facility has been unable to obtain a permit from the health department because sediment from the well plugged water filters. Future plans are for a geothermal heat exchanger system to heat city water for the spa. Geothermal groundwater apparently extends under at least part of the town, as at least two Gerlach homes use geothermal wells for space heating. The water in one well is reported to be 35 to 36°C (unpublished data, Nevada Division of Minerals).

San Emidio Desert

A vegetable dehydration plant is under construction in the San Emidio Desert area southwest of Gerlach (Figure 5). The plant is a few kilometers north of the Empire (OESI/AMOR II) Electric-Power plant. Integrated Ingredients (Spice Islands, Fleischmann's, and other brands), part of international food manufacturer Burns Philp, is contracting for the construction of the facility, which will employ about 25 persons when completed in early 1994. The number of employees may increase to about 65 after 18 months. Onions and garlic will be dehydrated and stored at the plant (*Reno Gazette-Journal*, August 31 1993). The plant will use approximately 150°C geothermal fluid.

Brady Hot Springs

A geothermal vegetable dehydration plant has been operated at this site, about 80 km northeast of Reno, since 1978. The facility uses a moderate-temperature (132°C) geothermal well on site. Since 1993, additional geothermal fluid has been supplied by the nearby Brady Power Partners electric power generation plant, operated by Oxbow Power Services, Inc.

Wabuska Hot Springs

In addition to the rather low-temperature electric-power generation plant operated at Wabuska by Tad's Enterprises, several non-electric applications have been located in the area, but none are active today. A hydroponic geothermal greenhouse operation (tomatoes, cucumbers, etc.) was built on the site in the early 1970s, but few vegetables were grown. Tad's Enterprises has in the past operated a geothermal ethanol facility, a plant to grow algae (*Spirulina*) for human consumption, and facilities to raise Malaysian prawns, catfish, and tropical aquarium fish. Some of these were pilot facilities, rather than actual production facilities.

Rye Patch Geothermal Area

Florida Canyon Mining Co. operates a large open-pit gold mine and heap-leach gold recovery facility about 50 km northeast of Lovelock, and 7 km north of the area presently under development by Rye Patch Limited Partnership for geothermal electric power production. A 180 m well produces fluids at approximately 100°C; these fluids provide makeup water for the cyanide extraction solutions. Heat from heat exchangers is also extracted to heat the solutions. The heating of cyanide solutions aids extraction during cold weather, and may somewhat enhance total gold recovery.

Darrough's Hot Springs Area

Round Mountain Gold Corp. operates a large open-pit gold mine and heap-leach gold recovery facility near the Darrough's Hot Springs geothermal area in Nye County. Geothermal fluids from shallow (approximately 300 m)

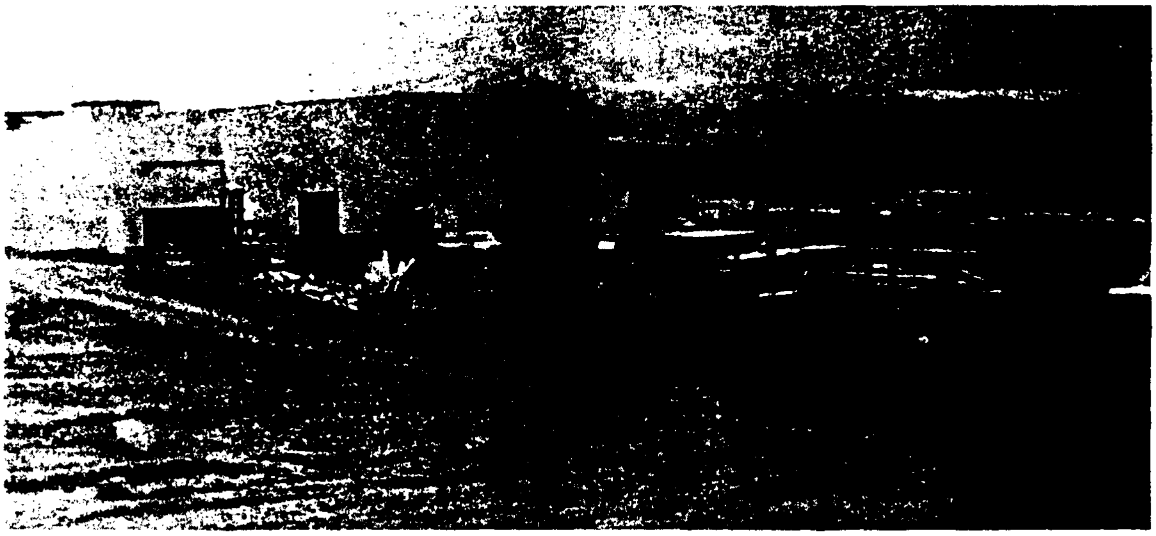

Figure 5. Vegetable-dehydration plant under construction in the San Emidio Desert. *Larry Green photo.*

wells are used in a heat exchanger to transfer heat to cyanide heap-leach solutions (Trexler and others, 1990).

Carlin

Carlin Hot Springs, located near the Humboldt River southwest of the town, have a reported temperature of 80°C (Trexler and others, 1982). The Carlin High School used 31°C geothermal fluid from 280 m well from 1986 to 1992 in a closed-loop space heating system. The well was abandoned in 1992, apparently in part because of scaling problems with iron and manganese.

Elko Area

Hot springs south of the town of Elko were first used in a bath house in the 1860s (Garside and Schilling, 1979). Thermal groundwater was known to exist to the north of the springs under a part of the town, but no use was made of it until the Elko Heat Company began supplying geothermal fluid for space heating to several downtown buildings in 1982 (Rafferty, 1988). The company has continued to grow; in 1993 it served 16 commercial customers and two residential customers (Mike Lattin, oral commun., 1994).

The Elko County School District, in conjunction with the Elko General Hospital, developed a district geothermal heating system in 1986. The system supplies heat to eight buildings (two schools, a municipal swimming pool complex, a gym, a convention center, a hospital, a city hall, and a school administration building). In 1988 the estimated combined savings to all users was $300,000 per year (Rafferty, 1988; Richard Harris, oral communication, 1994).

Jackpot Area

Two wells drilled in 1988 at the Y3 Ranch about 7 km southeast of Jackpot, were used for raising catfish. The maximum reported well temperature was 40°C (Lund and others, 1990). The catfish-raising operation was not active in late 1993, reportedly due to insufficient geothermal fluid.

Wells Area

Warm springs about 1.5 km north of the present town of Wells were referred to by travelers on the emigrant trail in the 1850s as Humboldt Wells (from which the town name is derived). Thermal (32 to 34°C) groundwater is used by an elementary school and the Wells Rural Electric Co. in heat pump applications for space heating.

Duckwater (Big Warm) Springs

A geothermal catfish-growing facility has been operated at this site since 1982. The facility was purchased in 1992 by Robert and Jeff King (Valley Fish) of Preston, Idaho. The facility, located about 110 km west of Ely, produces over 300,000 pounds of prime 8-ounce catfish filets per year that are shipped to Idaho for sale (*Geo-Heat Center Quarterly Bulletin*, December 1992).

Caliente Hot Springs

The town of Caliente in Lincoln County derives its name from the local hot springs. A number of wells in the area have reported temperatures from 40 to 80°C (Garside and Schilling, 1979; Lienau and others, 1988). A motel supplies geothermal well water to bathing pools and individual room whirlpool baths, and a trailer park supplies hot water to individual mobile homes. The Lincoln County Hospital (20 beds) was heated using 39°C water from a well on the site, but reduced temperatures (to 28°C) forced reliance on electric resistance heating. The hospital plans to use the lower-temperature fluids from its well for heating and cooling using heat-pump technology. The city swimming pool used

geothermal heat in the past, but was damaged during the winter of 1992 and will probably be replaced. The City of Caliente has a grant from the Rural Development Administration to use the local geothermal resources. A nearby perlite processing plant may be the first user of plant process heat. If more funding is found, the city plans to provide heat to the hospital, swimming pool, and eventually an elementary school and youth training facility (Glen Van Roekel, oral communication, 1994).

Ash Springs

Thermal waters (31 to 36°C) at Ash Springs, located about 10 km north of Alamo, in Lincoln County, have been used in the past at a spa on the site. The facility is presently closed.

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NEVADA LOW-TEMPERATURE GEOTHERMAL RESOURCE ASSESSMENT: 1994

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FINAL REPORT

Prepared for

The Oregon Institute of Technology
GeoHeat Center

Prepared as part of a study of low- to -moderate temperature geothermal resources of Nevada under the U.S. Department of Energy Low-Temperature Geothermal Resources and Technology Transfer Program

CONTENTS

INTRODUCTION

Previous Geothermal Assessments

A statewide inventory of the geology and geochemistry of Nevada's geothermal resources was begun at the Nevada Bureau of Mines and Geology (NBMG) in the late 1970s. NBMG had previously published a 1:1,000,000-scale map of hot springs, sinters, and volcanic cinder cones (Horton, 1964b) and several brief summaries of Nevada's geothermal resources (Horton, 1964a; Garside and Schilling, 1972; Garside, 1974). This inventory, published as NBMG Bulletin 91 (Garside and Schilling, 1979), followed a format used in a number of NBMG publications on mineral commodities of Nevada. The bulletin contained descriptions, by county and hot spring area, of the better known geothermal areas. These descriptions included, where available, maps and other data on the geology, and descriptions of historical and present use. Temperature and water chemistry data were presented in an appendix having about 1,400 individual entries (records). These records commonly included multiple entries for the same or adjacent springs as well as numerous well records from geothermal areas which have a larger areal extent than individual spring sites. A 1:1,000,000-scale map was included in the pocket of NBMG Bulletin 91; nearly 400 geothermal sites (springs, spring groups, well groups, etc.) were included on that map. The lower temperature cut-off for inclusion of data in Bulletin 91 was 70°F (21.1°C).

The location, chemical data, and references for the geothermal springs and wells listed in Bulletin 91 were collected by an extensive and relatively complete search of the available literature. These data were entered by hand on data-collection forms, and these forms were used to typeset the listing of data in the bulletin (Appendix 1). A source of unpublished data was a computer database of water-quality data maintained by the Desert Research Institute at Reno.

GEOTHERM is an acronym for a U.S. Geological Survey (USGS) computerized information system designed to maintain data on the geology, geochemistry, and hydrology of geothermal sites primarily within the United States (Teshin and others, 1979; Bliss, 1983). The system was first proposed in 1974, and was active until 1983. The system utilized a mainframe computer, and most of the data were entered by use of key-punch cards. Key punching was done from a rather extensive data-entry form. When the GEOTHERM database was taken off line, a number of products were published or made available to preserve the data. These include basic data for thermal springs and wells on a state-by-state basis (for Nevada, see Bliss, 1983a) and a listing of each record on a state-by state basis, as microfiche (for Nevada, see Bliss, 1983b). The GEOTHERM database was also filed with the

National Technical Information Service (NTIS) as digital data. A 9-track one-half inch reel-to-reel tape in ASCII format of this GEOTHERM database was provided to NBMG after the start of this project by Howard Ross at the University of Utah Research Institute (UURI). This tape, containing 8,082 records, was originally from NTIS.

GEOTHERM contained 1367 records for Nevada when it was taken off line in 1983; the is the number of Nevada records on the NTIS tape as well. The great majority of these records are from the published sources used to compile Appendix 1 of Bulletin 91. Unpublished site data and analyses from the files of D.E. White (USGS) make up a significant section of the database also. About 75% of this GEOTHERM data was added to the original database during 1978 and 1979 by personnel at NBMG as part of the U.S. Department of Energy State Coupled Program (see Trexler and others, 1979a). In addition to the entry of new data and the editing and verifying of existing data in GEOTHERM, the longitude and latitude locations of springs and wells were determined by plotting them on 1:250,000-scale maps and hand digitization (Trexler and others, 1979a). New analyses were done during this period, and these data were added to GEOTHERM.

The database available in GEOTHERM during the early 1980s was used, along with other data developed from specific geothermal site studies funded by the U.S. Department of Energy (see numerous reports by Trexler and co-workers, 1980-83) to produce two 1:500,000-scale maps illustrating Nevada's geothermal resources (Trexler and others, 1979, 1983). No statewide resource studies were done after the publication of the 1938 NOAA map (Trexler and others, 1983). A nationwide assessment of low-temperature geothermal resources (USGS Circular 892) included data for Nevada, and an open-file report (Reed and others, 1983) included about 350 records for Nevada that were used in that assessment. These records were selected from the GEOTHERM database by use of charge balance determinations and other screening methods (Marshall Reed, written commun., 1993). During this period of time, an increase in exploration for geothermal resources by private industry (mainly for electric-power generation) resulted in the drilling of thousands of gradient and slim holes, and several hundred larger diameter wells for industrial and commercial use (space heating, electric power generation, etc.). Developments in Nevada's geothermal industry are documented in yearly summaries of the Nevada mineral industry, published yearly by NBMG since 1979 (e.g, Hess, 1993). Information that is available on geothermal drilling in Nevada has been summarized by Barton and Purkey (1993).

Need for a New Assessment

Low- and moderate-temperature geothermal resources are widely distributed in the western United States. Although there has been

a substantial increase over the last decade in utilization of these resources in direct-heat applications, the large resource base is greatly underutilized (Ross and others, 1994). Previous studies have demonstrated that Nevada is well endowed with geothermal resources, and much of the state must be considered as having potential for direct use. As Ross and others (1994) describe, the expanded use of low- and moderate-temperature geothermal resources requires, as a start, a current inventory of the resources. Such an inventory, combined with collocation studies (the study of resource location near population centers or areas of potential industrial users), will provide some of the basic information that the potential developers of the geothermal resources need to make sound economic decisions. Collocation factors are of particular significance in Nevada, as well as a number of other western states, because people and most industries are concentrated in a few areas; geothermal resources, on the other hand, are rather widely distributed.

There are many factors that can affect the viability of direct-use geothermal applications. These include not only the suitability of the fluid and the resource for the application (water temperature, chemistry, amount of available heat, etc.) but also the information available to the developer on the technology of the proposed application, and contractual and other economic factors less closely related to the geothermal resource. The collection of data on these geothermal resources and their present uses is only one factor in encouraging their increased use. Other components of the 1992-1993 low-temperature program include development of better techniques to discover and evaluate the resources, and technical assistance to potential developers (Ross and others, 1994).

Nevada Assessment Program

Data compilation for the low-temperature program is being done by State Teams in ten western states. The Nevada program, under the direction of Larry J. Garside at the Nevada Bureau of Mines and Geology at the University of Nevada began data collection in early 1993 (the contract for the research between the University of Nevada and the Oregon Institute of Technology was signed on March 23, 1993). The original contract was to end on December 31, 1993, but was later extended to June 30, 1994. The Technical Project Managers for the agreement were Howard P. Ross (University of Utah Research Institute) and Paul J. Lienau (Oregon Institute of Technology - GeoHeat Center).

The final products of the study include the following: 1) a geothermal database, in hardcopy and as digital data (diskette) listing information on all known low- and moderate-temperature springs and wells in Nevada; 2) a 1:1,000,000-scale map displaying these geothermal localities, and; 3) a bibliography of references on Nevada geothermal resources. The format for

presentation of these data was worked out through discussions among State Teams and the Project Managers during the first half of the contract period; the model for this database has been described by Blackett (1993).

DATA SOURCES

Information on Nevada's geothermal resources is widely distributed in published reports, in unpublished and limited-distribution sources (commonly referred to as "gray literature"), and as digital information in databases such as GEOTHERM and WATSTORE. The sources of data and methods of data manipulation are discussed below, followed by a description of the bibliography.

Preliminary Data Compilation

The Nevada geothermal database (Appendices 1 and 2) includes "records" (that is, single reports of chemistry, temperature, location, etc. that are represented by a single spreadsheet row) for all known (reported or suspected) geothermal sites in the state. A number of preliminary databases and spreadsheets were compiled before selection of records for the final listing (Appendices to this report). To get the data from various sources into a common format for comparison required months of work using a variety of computer hardware and software available at NBMG. In the following paragraphs I have summarized the major sources of information, the techniques used to modify and utilize them effectively, and some of the sources of error and other problems that were encountered.

GEOTHERM

The history of the GEOTHERM database is summarized above under the description of previous assessments. Because the database was taken off line in 1983, it does not contain data collected after that date. A tape GEOTHERM records that was obtained from UURI was read on to a large magnetic disk at NBMG. Information supplied by NTIS with this tape gave the field lengths of each field in the database. With this information, computer database specialists at NBMG were able to design a database having fixed-length fields and read the GEOTHERM ASCII file into that database. The database on tape contained over 8000 records, with approximately 120 fields for each record. The database software used for this database was INFO, a subset of the ARC/INFO software utilized in many GIS (Geographic Information Systems) applications; hardware was a UNIX-based SUN SPARC II workstaion. The database in INFO was nearly 19 MB (megabytes). From this database, the 1367 Nevada records could be exported, by use of PC

ARC/INFO, in a format compatible with modern database-management software (such as dBASE). We used PC-File (a product of ButtonWare, Inc.) as the PC-based database software. The Nevada GEOTHERM database in PC-File is about 3.2 MB, and has a number of problems that make it difficult to use. One of the most notable problem is that in the PC-File format (essentially a dBASE format), most of the numerical data (temperature, water chemistry, etc.) are preceded by a five sided graphic figure which resembles the outline of a small house (or a baseball field "home plate"). This non-ASCII character was apparently a pad character or "punch" symbol in the original database that acted as a space. It can not be searched for, and was only eliminated after a short version of the database was retrieved into spreadsheet software (Quattro Pro, a product of Borland International, Inc.). In addition, some records had data reported in different units from other records (for example ppm or epm); the units used were reported in a separate database field. Fortunately, these problems were overcome in the shortened (spreadsheet) version.

Additionally, a number of other operations were done on a short database of GEOTHERM data that contained only the fields required for this study (Appendix 1). These include: 1) replacing the county name with a two-letter code (abbreviation) for each county, 2) conversion of numerical data from labels to values and insertion by hand of certain qualifiers on some analyses (N for not detected, t for trace, < for less than), 3) addition of calculated columns for ion balance, total calculated dissolved solids, and a major constituents test (is Na>K and Ca>Mg and Cl>F?), 4) rearrangement of columns into final format. Before final column rearrangement, formulas were converted to values, and a fixed number of decimal places was selected for display. About 455 records were finally selected from this spreadsheet to be included in the final tables listed in the Appendix.

<u>WATSTORE</u>

The acronym WATSTORE stands for the National <u>WAT</u>er Data <u>STO</u>rage and <u>REtrieval</u> System, a large-scale computerized system developed for the storage and retrieval of water data collected as part of the activities of the USGS, particularly the Water Resources Division (from a 1981 pamphlet, U.S. Government Printing Office: 1981 - 341-618:52). The system was begun in 1971, and contains a very large set of data on surface and groundwater in the U.S. The water-quality file alone is reported to have (in 1991) 34 million observations from over 200,000 stations; 5,000 parameters (major and trace elements, pesticides, organics, etc.) are included. The database contains information on the analyzing and collecting agency, but does not report whether the data has been published or list references. The WATSTORE database can be searched through arrangements with USGS Water Resources district offices or through a national system of water data exchange (NAWDEX);

assistance centers for NAWDEX are also commonly located at USGS Water Resources District Offices. The NAWDEX database also has access to other Federal agency water data, for example the Environmental Protection Agency (EPA), in addition to WATSTORE.

Water quality and other WATSTORE database file information is also available through a commercial outlet, EarthInfo, Inc. of Boulder, Colorado. EarthInfo makes certain data from WATSTORE available on CD-ROMs along with a software retrieval system that can be used by IBM-compatible personal computers. NBMG obtained a CD-ROM that included all Nevada data (current to early 1993) from EarthInfo. Personnel at NBMG (particularly Ron Hess) were able to search the CD-ROM and extract the parameters required for this study (water quality, location, site name, etc.) for all springs and wells having a measured temperature of 18°C or greater. To avoid the combination of parameters (e.g., water chemistry analyses) from different collection dates for the same site, a combination number was created (consisting of the site and collection date numbers) so that a later relational combination of the data would produce records that represent one site visit. These geothermal data were converted to a dBASE format and PC-File was used to eliminate records having temperatures less than 20°C for the area of Nevada south of 38° latitude. At this point, the database consisted of 1,708 records. These records were imported into a spreadsheet format using Quattro Pro software, and a multitude of operations were performed on the data to make it similar to the planned format for the final tables (Appendices 1 and 2). These operations include: 1) conversion of longitude and latitude to decimal degrees, 2) addition of calculated fields for ion balance, total calculated dissolved solids, major constituents test (is Na>K and Ca>Mg and Cl>F?), 3) conversion of depth in feet to meters and flow from cubic feet per second to liters per minute, 4) addition of a reference column for listing of WATSTORE as the reference, 5) convert GW (groundwater) to W (well) and SP to S (spring), 6) conversion of the state-county FIPS code to a two-letter abbreviation (see listing below), 7) conversion of the collection date format to the year/month/ day format, 8) re-arrangement of columns, and 9) a sort of rows (records) by longitude and latitude.

A number of additional operations were later performed on about 140 WATSTORE records selected for the final tables. These include: 1) conversion of Fe, and B from micrograms per liter to milligrams per liter (essentially equivalent to parts per million - ppm), and 2) separation of the site name column into two columns (one for name and one for the legal land location, if reported). Following this, Li, oxygen and hydrogen isotope data, and HCO_3-CO_3 concentrations were added to the short spreadsheet of WATSTORE records. Li, and the ^2H and ^{18}O were inadvertently left out of the first search of the EarthInfo CD-ROM. The search for HCO_3-CO_3 data in WATSTORE presented a more complicated problem, as these constituents are reported as several different

parameters (fields) in the database. A number of the records generated by the first search were lacking data for these constituents; a second search was done for data in all possible related parameters (about eight of them, including bicarbonate and carbonate field results, laboratory results, dissolved, incremental titration, titration to pH 4.5 and pH 8.3, and alkalinity (field and laboratory). The data were entered by hand into the intermediate spreadsheet of WATSTORE records destined for the final tables.

Table 1. County names for Nevada, FIPS (Federal Information Processing Standard) code (32 is Nevada), and abbreviations used in this report.

County Name	FIPS Code	Abbreviation
Churchill	32001	CH
Clark	32003	CL
Douglas	32005	DG
Elko	32007	EL
Esmeralda	32009	ES
Eureka	32011	EU
Humboldt	32013	Hu
Lander	32015	LA
Lincoln	32017	LI
Lyon	32019	LY
Mineral	32021	MN
Nye	32023	NY
Pershing	32027	PE
Story	32029	ST
Washoe	32031	WA
White Pine	32033	WP
Carson City	32510	CC

Topographic Map Digital Data

A complete examination was made by David Davis at NBMG of the approximately 1,900 7.5-minute topographic maps for Nevada. The entire state has this coverage, and a visual examination was made of each map for any mention of hot or warm springs, geothermal wells, etc. In addition, a 1981 version of GEOTHERM was available in paper copy (Jim Bliss, written commun., 1981) and this was used to identify other geothermal spring and well locations on these topographic maps. About 2700 individual points were marked on the maps, and the locations were digitized in the NBMG GIS laboratory using ARC/INFO software, a CalComp 9500 digitizer, and digital map coordinate data (TIC file) from the USGS. A database of the location and other data collected for this part of the project was created, and about a dozen records in the final table were from the spreadsheet equivalent of that database. In general, the records from this database were for locations where

no data were available in other sources. The references are usually the 7.5-minute quadrangle map that the spring or well appears on. Additionally, when more precise longitude and/or latitude locations were required for records taken from any of the other sources used, the appropriate information from this database was entered in intermediate spreadsheets of selected records.

Other Data Sources

During the selection of records for the final database, if water quality or other data in WATSTORE or GEOTHERM was lacking, incomplete, or appeared to be of poor quality, other sources of information were checked for possible inclusion in the database. Some of these sources were originally cited in NBMG Bulletin 91, but no record of a particular site was ever entered in GEOTHERM. A number of such records refer to dubious thermal spring locations, but must be included in any database that is purported to be complete. Other sources used for one or two sites include Hulen and others (1994), Trexler and others (1990), and Lawrence Livermore Laboratory (1976). Unpublished information in NBMG files and field notes of L. Garside for this and previous geothermal studies was also used. In particular, a number of good analyses and locations reported by Flynn and Buchannan (1990) were used. Their Table 3.1 was scanned, imported into Quattro Pro, and parsed into a spreadsheet of similar format to others used during this study. Also available in spreadsheet format to be checked during the data selection process were the analyses reported by Reed and others (1983) from the GEOTHERM database, and digital data on water analyses done in some areas of Nevada for the NURE (National Uranium Resource Evaluation) program (Hoffman and others, 1991).

Selection Criteria

In the early stages of this study, it became apparent that the bulk of the data on Nevada's low- an moderate-temperature geothermal resources was contained in two databases, GEOTHERM and WATSTORE. Usually, for individual thermal springs and wells, the best one or two records available from either WATSTORE or GEOTHERM was selected. If the data in these databases were incomplete or nonexistent, other known sources were checked.

The process of record selection for the final database began with hardcopy printouts of the spreadsheets described above (e.g., GEOTHERM, WATSTORE, and the topographic maps). Digital files of the longitude and latitude information for these three databases were used to plot the geothermal localities on 1:1,000,000-scale maps of Nevada in NBMG's GIS lab, using ARC/INFO software. Each of the points or point groups on these maps was checked in a regular fashion for possible errors of location. The 1:1,000,000-scale maps were examined, on 1° by 1° blocks of latitude-

longitude (about 34 partial or complete blocks for Nevada). Every 7.5-minute topographic map that was shown to have a geothermal locality was re-examined, and the locations displayed on the million-scale maps were compared to those on the 7.5-minute quadrangles. From the available records for a particular spring, the best one, or in a few cases, two records was selected. For groups of springs that are found over several square kilometers, several records were commonly selected to best represent the geographic range and provide a more varied data set of water chemistry. The records selected were numbered, notes were taken on any problems recognized, and the number was written on a million-scale map and on the hardcopy of the appropriate database. This record selection process proceeded from west to east across the state, beginning in northwest Nevada and ending at its southern tip. The selection of the "best" records was somewhat subjective, but generally proceeded as follows. If a point on the maps was determined to be a valid geothermal site, GEOTHERM and WATSTORE records of that site or site area were examined. Selection from one of these databases was generally based on having an ion balance between 0.90 and 1.10, and a check to see if Na>K and Ca>Mg and Cl>F. The ion balance formula used was $Na*0.04350+K*0.02558+Ca*0.04990+Mg*0.08229/Cl*0.02821+F*0.05264+HCO_3*0.01639+CO_3*0.03333+SO_4*0.02082$; resulting in a value in milliequivalents per liter, cations/anions. For those records that met these criteria, selection was based on completeness of the other analytical data (temperature, pH, minor constituents. etc.).

During the record selection process, spring and well records that did not meet certain minimum temperature criteria were eliminated from further consideration. According to the statement of work for this project, 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 with depth (for wells). The mean annual air temperature in Nevada varies from somewhat less than 7°C to over 18°C (Houghton and others, 1975, figure 17; see figure 1 below). This variation is an effect of both latitude and elevation; southern Nevada's higher mean annual temperature results from its lower latitude and its lower average elevation (Houghton and others, 1975). Based on this map of mean annual temperature, a lower spring and well temperature limit was set for certain latitude ranges in the state. For springs, the decision whether to include or not was relatively simple - if the spring temperature was at or above the set limit, it was included. For wells, only those were considered for inclusion that fell above a gradient of 25°C per kilometer with a beginning (surface) temperature at or above the minimum selected for that latitude range. The total well depth provided in the database was used to calculate this gradient. The following temperature limits were applied during record selection: 1) north of 39° latitude, 18°C or above; 2) 38° to 39°

latitude, 19°C and above (20°C was used for some sites, mostly wells, in the 38°-38.5° range, 3) 37° to 38° latitude, 20°C or above, and 35° to 37° latitude, 25°C and above. No upper temperature limit was used to restrict inclusion in the final data compilation. The statement of work for this project listed an upper limit of 150°C for occurrences to be included in the compilation. Seven occurrences with temperatures above 150°C were included in the database; mainly for completeness. The only data available for some geothermal occurrences was the analysis and associated location information for the high-temperature fluid. It is obvious that lower temperature geothermal fluids are available at these sites (in peripheral areas or, in the case of electric-power generation areas, as condensed steam or reinjection fluids). Because analyses of these lower temperature fluids were not often available, the high temperature fluid analysis was listed as a substitute.

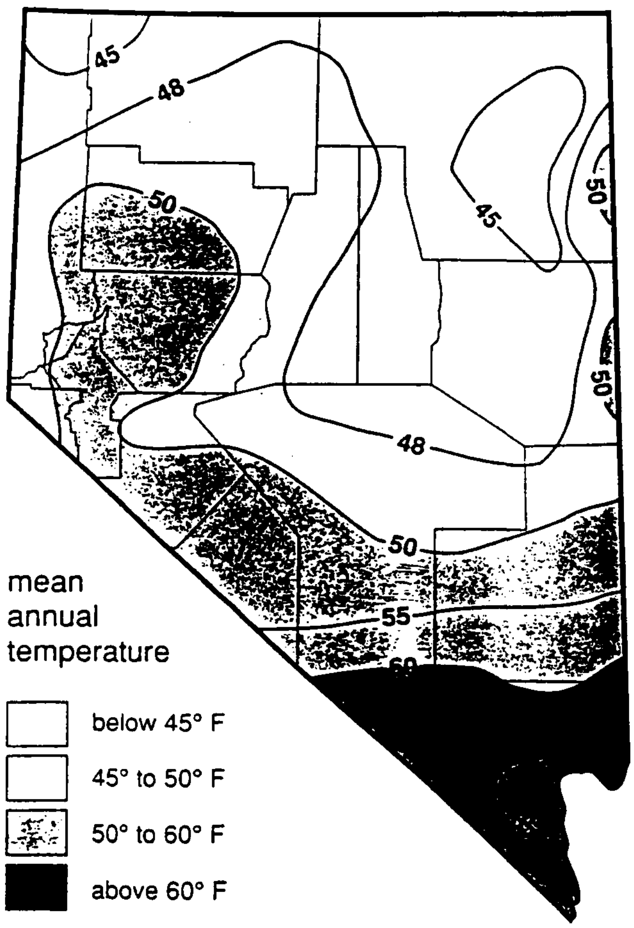

Figure 1. Map of mean annual temperatures in Nevada (from Houghton and others, 1975).

A number of problems were noted for both the GEOTHERM and WATSTORE databases as each plotted point on the million-scale maps was checked to see if it matched a known geothermal site. In quite a number of cases, certain geothermal locations were found

to have an incorrect longitude or latitude or both. These were commonly discovered when the 7.5-minute topographic map was compared to the million-scale plot. In some cases, the legal description (section-township-range) was correct, but the longitude or latitude had an error of, for example, one whole degree or one whole minute. These inaccurate site locations were noted, but not corrected in the individual databases unless the record was needed for the final table.

DATA FORMAT

Data on Nevada's low- to moderate-temperature geothermal resources are presented in Appendices 1 and 2. The data in these tables are in spreadsheet format, and the digital data used to produce them (and provided separately on diskette) can be searched and otherwise manipulated in a great variety of ways utilizing a number of commercially available spreadsheet and database management software packages. Although there are two Appendices, they were printed from a single spreadsheet. The software and data manipulation methods used at NBMG during this study are further described above, under data sources. The format of the tables and, thus, the spreadsheets, in most respects follows rather closely that of Blackett (1993).

The column headings and data in the columns are generally self-explanatory, but a few comments should be made. Each column heading is listed below, with a description of the data and a discussion of format and problems.

The site number is used to identify the site on the 1:1,000,000-scale map. It was added to the record when that record was selected for inclusion in the final database. The process of record selection was done in 1-degree blocks, proceeding from west to east, beginning in northwestern Nevada. Sites added later may not entirely follow this numbering progression, and to prevent renumbering of many of the sites, some added sites use decimal tenths (e.g., 143.1 and 142.2).

NAME The site name is commonly that listed in the source reference. In some cases, corrections, additions, or modifications were made to provide more information.

CO The two-letter abbreviation for one of Nevada's 17 counties is listed here. These abbreviations are listed above, under the Data Sources heading, with their FIPS code.

T, R, SC The legal land description, Township, Range, and Section are listed under these columns. These were commonly taken from the cited source, but some additions and corrections were

made during the data evaluation. Because some of these location data were derived (in the original studies) from maps of varying ages or scales, or by projecting section lines into unsurveyed areas, there is a chance for error. Although some of these errors were noted and corrected, there are certainly many that were not. The best location data for the sites is generally the longitude and latitude; however, if correct, the section-township-range location can be used to confirm a site on topographic maps. Some section locations were determined by use of 1:100,000-scale topographic maps, on which the protracted sections are commonly displayed.

QSEC The data in this column, if present, describe the portion of the section in which the geothermal site is located. The quarter-quarter-quarter system (for example: NE SE NW) indicates an approximately 10 acre parcel in the 1 square mile section (640 acres) that is located in the northeast quarter of the southeast quarter of the northwest quarter. For data from the WATSTORE database, letters are used to indicate (from left to right) the quarter section, quarter-quarter section, and so on; the letters A, B, C, and D designate the northeast, northwest, southwest, and southeast quarters, respectively. Thus, for example, ABC would represent the southeast(C) quarter of the northwest quarter(B) of the northeast(A) quarter. The A-B-C-D system thus lists the largest quarter first, followed by progressively smaller quarters; the NE-NW-SW-SE system lists the smallest quarter section first.

T This column lists the type of occurrence, either spring (S) or well (W). In a few cases, the original listing did not fall into these two categories, and it was modified. For example, a hot pool was listed as a spring, and mine shafts or mineral exploration drill holes were listed as wells.

TEMP The reported temperature of the well or spring is listed, in degrees Celsius, in this column. Many of these reported temperatures were measured and originally reported in degrees Fahrenheit; those converted to °C were rounded to one decimal place after conversion. If the only information reported on temperature is "warm" or "hot" (for example, from a topographic map), this is listed. The reported temperature is that of the cited reference. It is not necessarily the highest temperature reported in all of the available data for a particular spring or well; a particular record may have been selected because of its complete analysis, rather than because it had the highest reported temperature.

FLOW The flow, in liters per minute (L/min) is shown in this column. For wells, this value is commonly the discharge during pumping. Values are reported to one decimal place.

DEPTH For wells, the depth in meters is listed, if available

from the original source.

CDATE The date of collection is listed here, in the format: year/month/day. For many records that list only the year of collection, this was added during this study, based on other information.

pH The reported pH is listed here.

Chemical constituents (Na, Cl, etc.) For most of the chemical constituents, they are listed as reported in the original references or databases. The reporting units are milligrams per liter (mg/L); these are essentially equivalent to parts per million at the concentration levels of the fluids listed in the Appendix. For some analyses, constituent values originally reported in µgm/L (micrograms per liter or parts per billion - ppb) were converted to mg/L. If the original source listed a particular constituent as less than a certain value, this was reported using the symbol "<". Similarly, "t" indicates that a trace amount was detected, and "N" indicates the constituent was analyzed for but not detected. The number of decimal places displayed for each element is generally based on that reported in the sources of data. For most of the reported analyses, bicarbonate (HCO_3) and carbonate (CO_3) are listed as reported in the sources. Carbonate values are usually only found in waters with a pH of 8.2 or greater. A few sources (e.g., Lawrence Livermore Laboratory, 1976) report total alkalinity; these values were recalculated and reported as bicarbonate, as were the values reported in a HCO_3 + CO_3 column of Table 3.1 of Flynn and Buchannan (1990). Some analyses are noted to be relatively complete, but lack Na and K values. Commonly, the reason for this absence is that the original analysis reported Na + K as a single value, and thus, no data was entered in the Na and K fields in databases such as GEOTHERM.

TDSm, TDSc These columns present the total dissolved solids, measured and calculated. The measured value, if present, is from the original data source (presumed to be a residue on evaporation at 105°C). The calculated value was determined by summing the constituents reported. Thus, the TDSc value reported for incomplete analyses only represents a partial sum. A few analyses were summed before Li was added, and may be one to several ppm low. The HCO_3 value was multiplied by 0.492 to make the calculated TSDS values comparable with residue values.

ChgBal The electroneutrality of the analysis was evaluated using a charge (ion) balance formula (described further in the section on selection criteria). No value is reported for records which have no or extremely limited analytical data, as such a calculation would be meaningless. The most common reason for a charge balance that varies considerably from 1.00 is a lack of data for HCO_3. Other missing major ions can also result in a

"poor" charge balance.

delD, delO18 These columns contain isotopic compositions for the stable isotopes ^{18}O and deuterium (^{3}H). Data are reported to zero or one decimal place for ^{18}O and one or two decimal places for deuterium.

REFERENCE The reference citation in this column is that for the source of the data. The records that were taken from the GEOTHERM database include the reference listed therein. The WATSTORE citation is from the database search described above under data sources. An asterisk (*) precedes some citations; this was used in the GEOTHERM database to indicate unpublished data from individuals or agencies (for example, *WHITE, D., USGS, MENLO PARK or *DESERT RESEARCH INSTITUTE, 1973). The *NEVADA BUREAU OF MINES AND GEOLOGY citation includes unpublished data from that agency's files entered into the original GEOTHERM database as well as some entries made during this study. The *WATSTORE reference refers to data from GEOTHERM that originated from a WATSTORE search, probably in the late 1970s.

USE This data category lists the geothermal application for which the thermal water is presently used, or has been used for in the recent past but is not presently (in parentheses). The source of most of this data is Garside and Hess (1994), with some later additions during the later part of this study. Garside and Hess (1994) is reproduced as Appendix 3. No attempt was made to list uses of only the water but not the contained heat (livestock watering, for example). At least a dozen hot spring areas in Nevada have had hotel spas at them; most were built in the late 19th and early 20th Centuries. These were not listed as a past use, but present spas, swimming pools, etc., were reported.

FLUID CHEMISTRY

The geochemistry of thermal water in Nevada (and adjacent areas) has been discussed by a number of authors (e.g., Mariner and others, 1983; Flynn and Buchanan,1990; Welch and Preissler, 1990; Young and Lewis, 1982). A simplification of the pattern of chemistry exhibited by Nevada thermal water is that eastern Nevada geothermal fluids are calcium bicarbonate dominated, central and northern Nevada has mainly sodium bicarbonate type fluids, and the western part of the state has mostly sodium chloride and sodium sulfate types. The reasons for this pattern are, no doubt, relatively complex; however, water-rock interactions are certainly a significant factor. Thus, eastern Nevada calcium bicarbonate geothermal fluids are strongly influenced by the presence of a regional carbonate aquifer. At least some of the sodium bicarbonate geothermal fluids of the central and north-central parts of the state may result from the exchange of sodium (possibly from volcanic rocks) for calcium in

fluids that were originally calcium bicarbonate in character. Western Nevada sodium chloride and sodium sulfate waters may reflect increased water-rock interaction (and thus generally higher temperatures) as well as possible evaporative concentration of fluids prior to deep circulation and/or extraction of salts from Quaternary playa lake deposits.

DISCUSSION

Nevada is well endowed with both high- and low-temperature geothermal resources. Based on a generalized map of known and potential geothermal resource areas of the United States (e.g., Lienau, 1988) over 40% of the state is believed to have potential for the discovery of high-temperature geothermal resources, and another 50% has potential for low -to moderate-temperature resources. This potential is well illustrated by the 1:1,000,000-scale map of geothermal occurrences produced during this study (Plate 1). The database for this study consists of 455 individual records, representing more than 300 resource areas. The geothermal springs and wells are distributed over the entire state, with an increased concentration in the northwestern part of the state (Figure 3). Maximum spring and well temperatures are higher in the north and northwest parts of the state. Geothermal occurrence temperatures greater than 75°C are confined to the northwestern half of the state, a pattern that closely follows that of heat flow (see Sass and others, 1981). The distribution of reported temperature vs. number of occurrences is shown below (Figure 2). About 400 springs and wells plot in 11 temperature ranges; additionally 30 sites are listed as "warm" and 23 as "hot".

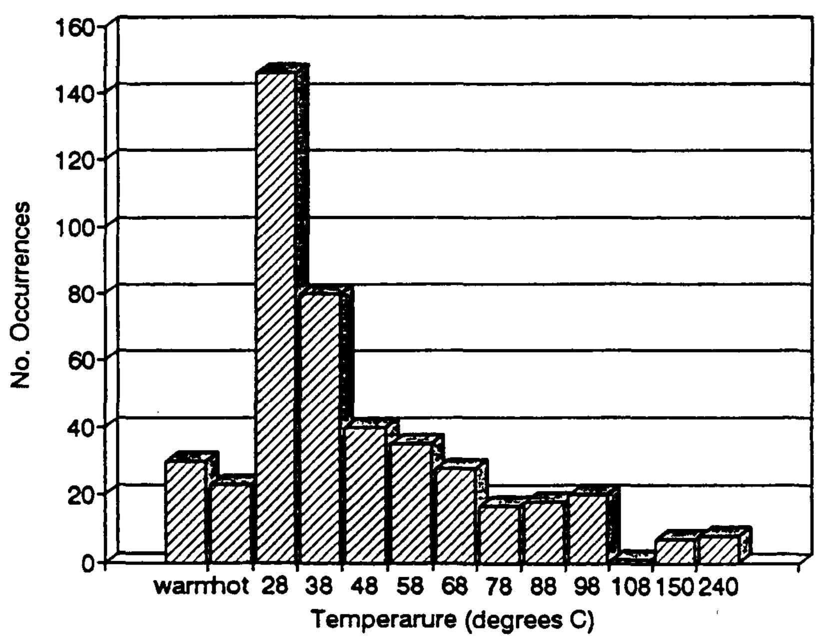

Figure 2. Bar graph of temperature vs. number of geothermal occurrences.

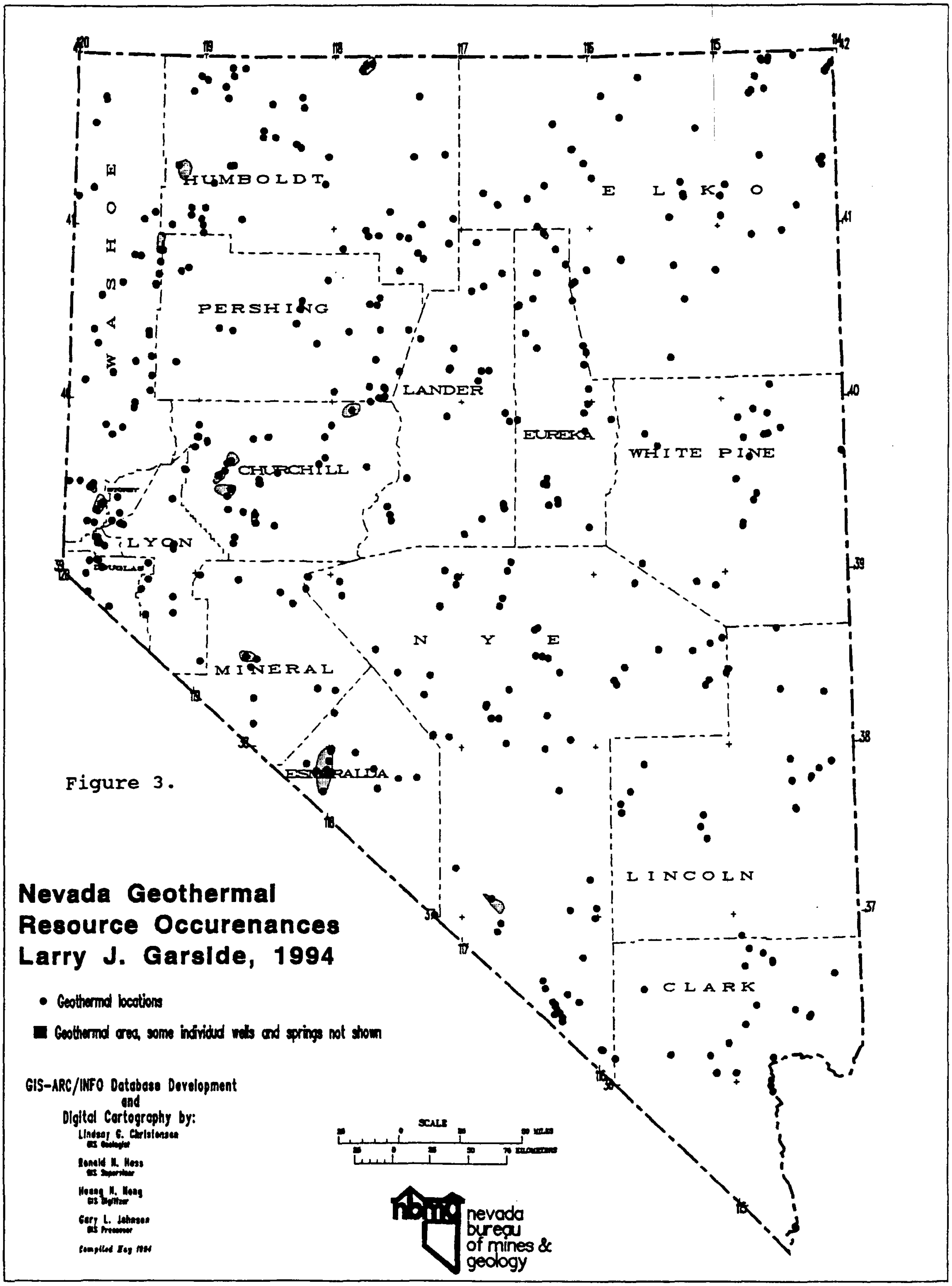
HUMBOLDT
ELKO
WASHOE
PERSHING
LANDER
EUREKA
WHITE PINE
CHURCHILL
LYON
DOUGLAS
NYE
MINERAL
ESMERALDA
LINCOLN
CLARK
Nevada Geothermal
Resource Occurenances
Larry J. Garside, 1994
Geothermal locations
Geothermal area, some individual wells and springs not shown
GIS-ARC/INFO Database Development
and
Digital Cartography by:
Lindsay G. Christensen
GIS Geologist
Ronald H. Hess
GIS Supervisor
Hoang N. Hong
GIS Digitizer
Gary L. Johnson
GIS Processor
Compiled May 1994
SCALE
MILES
KILOMETERS
nbmg
nevada
bureau
of mines &
geology

Figure 3.

Geothermal reservoirs in the northwestern part of the state have generally higher temperatures; these reservoirs are usually interpreted as being related to circulation of ground water to deep levels along faults in a region of higher-than-average heat flow (the Battle Mountain heat flow high). In east-central and southern Nevada, the low- to moderate-temperature geothermal resources are generally believed to be related to regional groundwater circulation in fractured carbonate-rock aquifers. Discharge areas (like warm springs) may be up to several hundred kilometers from the area of recharge, and the waters may have circulated for hundreds to thousands of years to depths of several kilometers. Maximum temperatures attained during this journey could be 100°C or higher, but spring temperatures at discharge points are generally less than 65°C.

The Eureka heat flow low, a region of less than 1.5 HFU (heat flow units; 41.8 milliWatts per square meter, mWm^{-2}) located in eastern Nye and northwestern Lincoln Counties, is centered on the Nevada portion of a large area of Middle Cambrian to Lower Triassic carbonate rocks (the carbonate rock province). This carbonate rock province underlies southern and eastern Nevada and northeastern Utah (Plume and Carlton, 1988). The Eureka Low is most likely a regional-scale hydrologic feature, representing colder groundwater recharge to regional aquifers.

SUMMARY

Nevada is a large state with sparse but locally concentrated population. It has a wide range in average annual temperature, and thus a wide range in the lower limit of temperatures considered anomalous for geothermal fluids. The state's complex pattern of geology and heat flow results in geothermal resource areas of diverse character located throughout the state.

There have been many studies, both general and specific, on Nevada's geothermal resources (see Bibliography). Considerable data are available on specific geothermal spring and well sites but some remote areas are still poorly understood and information on their geothermal resources are incomplete or possibly inaccurate. There are many accurate and complete water analyses and associated location information for well-studied geothermal areas. However, many remote individual springs and wells throughout the state lack complete analyses, and some lack good location information; in some cases, there is uncertainty about the existence of certain springs. For example, Appendix 1 lists over 50 sites for which the only temperature information is "warm" or "hot."

In Nevada, as in many arid areas of the west, most water (whether thermal or nonthermal) has been put to use. Some nonthermal applications actually require cooling before use. Present and

recent past uses of the contained heat of Nevada thermal waters are quite varied (see Appendix 3). However, more such use is feasible if potential developers are well informed and encouraged to be conservative in their use of fossil fuels.

RECOMMENDATIONS

There are many remote geothermal sites for which no complete data set could be found in the sources examined. For completeness, some of these should be visited and sampled but most of them are unlikely to be put to any low-temperature use because of their remoteness. Having a more complete data set would, however, be useful in regional studies, and might result in the discovery of previously unknown higher temperature resources.

No attempt was made during this study to combine trace-element water chemistry data from more than one analysis into a single record. For example, analyses of B, Li, and F may have been reported in a analysis with poor ion balance while the best analysis in terms of major constituents may have been lacking some of the trace-element data. Some of this type of trace-element data could be added to the final database, but it seemed like a poor practice for this original compilation.

Some sources of information on geothermal springs and wells that were not used during this study might be useful to pinpoint previously unknown (especially low-temperature) geothermal sites. However, the mass of data available and its concentration in populated areas (where good information already exists), make searching such data relatively unproductive. Some examples of such available data include the water well records (submitted by well drillers) for the state available from the Nevada Division of Water Resources. These water well records have many errors (especially in location); searching and confirming previously unknown geothermal sites would take considerable effort. Other sources of water data that are likely to have similar potential errors include the analyses of agencies like the Nevada Division of Health, the Nevada Division of Environmental Protection, and the U.S. Environmental Protection Agency. One source of information that might have a higher potential for adding to the geothermal database is the largely confidential files of geothermal exploration companies. Thousands of shallow to moderately deep (100 to 1000 m) geothermal gradient and "slim holes" were drilled in the search for high temperature geothermal resources (for electric power generation) over the last 30 years. This source of geothermal data was suggested by a number of industry representatives at a March 1994 symposium sponsored by the Geothermal Resources Council on the geothermal resources and exploration of the Basin and Range Province. The extent of the data is not presently known.

Finally, increased future use of geothermal energy in low- to moderate-temperature applications will require not only studies that demonstrate the availability of the resource but also dissemination of information (such as case histories) that illustrate the details of these uses. Such case histories should be understandable by the general public, but also make available details of the technical data. Because some uses, such as district heating systems, require considerable front-end investment compared to individual fossil fuel heating units, projects that can bring together several funding sources have a better chance of success.

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One task of the study was the identification of geological, geophysical, geochemical, and hydrologic studies that have been done since the last resource assessment. The bibliography (Appendix 4) is the result of that literature search. There are 907 citations listed in the bibliography; of these, nearly one-half are from the bibliography in Garside and Schilling (1979). This bibliography was nearly exhaustive, at least for published sources, through about 1978. That bibliography was scanned and converted with text-recognition software to a format useable by word-processing software. The references from this 1979 bulletin included general references to the geology of geothermal areas as well as references specific to geothermal resources. The additional references in Appendix 4 were obtained from a variety of sources; most were entered in the document by hand, rather than taken directly from other digital data sources. Several methods were used to find these additional references. The bibliography for GEOTHERM (Bliss, 1983 a) was checked for references not in Garside and Schilling (1979). Additionally, the geothermal files in the Public Information Office of the Nevada Bureau of Mines and Geology were a good source, especially for unpublished reports. My own library of geothermal references was searched, and the CD-ROM for GeoRef (the bibliographic database of the American Geological Institute) was searched for any Nevada geothermal references. A similar search was done of the WolfPAC NALIS library information system (the Northern Nevada Academic Libraries Information System). The Geothermal Resources Council Bulletin and Transactions, and the GeoHeat Center Quarterly Bulletin were also scanned for any Nevada references.

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APPENDIX I

#	NAME	CO	T	R	SC	QSEC	NLAT	WLONG	T	TEMP	FLOW	DEPTH	CDATE	REFERENCE	USE
1	TWIN SPRING, VYA SPRING	W	42N	19E	04	NW	41.5933	119.8650	S	22	715		1952/05/15	WARING, 1965	
2	HILL'S WARM SPRING	W	44N	20E	18	NE SE SW	41.7300	119.7867	S	28			1961/08/08	TREXLER AND OTHERS, 1979	
3	UNNAMED SPRING	W	44N	19E	12		41.7459	119.7919	S	23	19		1946/02/11	SINCLAIR, 1963B	
4	VIRGIN VALLEY RANCH 10	HU					41.7906	119.1075	W	21			1975/08/05	WATSTORE	
5	VIRGIN V CAMP GROUND 1	HU	45N	26E	02		41.8533	119.0006	W	32			1975/08/05	WATSTORE	
6	ROADSIDE REST AREA 3	HU	46N	26E	31	C	41.8753	119.0475	W	18			1975/08/05	WATSTORE	
7	Surprise Valley Hot Spring	WA					41.166	119.978	S	47			1969/	Flynn and Buchanan, 1990	
8	WARM SPRING	W	39N	19E	33		41.2160	119.8627	S	warm				WALL CANYON RESERVOIR 7.5' QUAD	
9	WARM SPRINGS	HU	44N	27E	12	NE SW SW	41.7503	118.8367	S	40			1954/07/27	TREXLER AND OTHERS, 1979	
10	McGEE MOUNTAIN	HU	45N	27E			41.8163	118.8597	S	42.2		61		WENDELL, 1970	
11	BOG HOT WELL	HU	46N	28E	31		41.8783	118.7960	W	hot				BOG HOT SPRINGS 7.5' QUAD	
12	BOG HOT SPRINGS	HU	46N	28E	18	SW NE NW	41.9228	118.8050	S	55.6	3785		1970/09/01	SINCLAIR, 1963B	
13	BALTAZOR HOT SPRING 9	HU	46N	26E	18	B	41.9217	118.7092	S	63			1975/08/05	WATSTORE	
14	SOLDIER MEADOWS AREA HOT SPRING	HU	40N	24E	23		41.3597	119.2180	S	54	66		1974/02/20	GROSE AND KELLER, 1975B	
15	SOLDIERS MEADOW AREA - UNNAMED HOT SPRING	HU	40N	24E	23		41.3597	119.2180	S	54	50		1950/06/13	MARINER AND OTHERS, 1974, 1975	
16	SOLDIER MEADOW AREA HOT SPRING	HU	40N	24E	23		41.3597	119.2180	S	48				GROSE AND KELLER, 1975B	
17	SOLDIER MEADOW 1	HU	40N	24E	23		41.3561	119.2178	S	54			1975/01/01	WATSTORE	
18	CANE SPRING	HU	39N	27E	30	NE	41.2580	118.9362	S	23.3	19			SINCLAIR, 1963A	
19	WEST PINTO HOT SPRING	HU					41.3592	118.8136	S	92			1974/01/01	WATSTORE	
20	EAST PINTO HOT SPRING	HU	40N	28E	17	NE SE SE	41.3625	118.7880	S	94				GROSE AND KELLER, 1975B	
21	WARM SPRING	W	37N	22E	35		41.0397	119.4688	S	warm				LEADVILLE 7.5' QUAD	
22	LEADVILLE SPRINGS	W	37N	23E			41.0827	119.3871	S	warm				SMITH, 1956	
23	CANE SPRINGS	HU	36N	24E	16	A	41.0133	119.2547	S	21			1961/12/12	WATSTORE	
24	WHEELER RANCH WELL	HU	37N	25E	10	SE	41.1150	119.1063	W	36.1			1965/09/21	SINCLAIR, 1963A	
25	DOUBLE HOT SPRING 2	HU	36N	26E	04		41.0492	119.0275	S	68.5			1975/01/01	WATSTORE	
26	UNNAMED SPRING (D.H.-2)	HU	36N	26E	16	SE NE	41.0150	119.0155	S	68.5			1936/06/24	GROSE AND KELLER, 1975B	
27	WW3922T1	HU	37N	24E			41.0733	119.1097	W	24.2	815.0		1979/12/13	WATSTORE	
28	TH SP HARDIN CITY SE QD	HU	37N	26E	10	DCA	41.1156	119.0006	S	50.8	101.9		1960/07/09	WATSTORE	
29	MACFARLANE'S BATH HOUSE SPRING	HU	37N	29E	31		41.0507	118.7188	S	76.5	18.9			SINCLAIR, 1963A	
32	SPRING	HU	42N	30E	12	A	41.5294	118.5686	S	40			1960/10/06	WATSTORE	
33	SPRING	HU	43N	30E	25	D	41.5675	118.5656	S	70			1960/10/08	WATSTORE	
34	UNNAMED SPRING	HU	42N	33E	19	SW SE	41.4922	118.3192	S	21.1	19		1957/05/16	SINCLAIR, 1962C	
35	U.S.G.S. TEST WELL NO. 21	HU	42N	33E	32	SE NE	41.4717	118.2647	W	24.4		27	1972/00/00	MALMBERG AND WORTS, 1966	
36	WELL	HU	42N	31E	11	B	41.5266	118.4769	W	24		107.3	1960/10/06	WATSTORE	
37	HOWARD HOT SPRING	HU	44N	31E	04	SE NE NE	41.7200	118.5033	S	57.8	189		1970/05/05	SINCLAIR, 1962C	
38	FIVE MILE SPRING	HU	45N	33E	21	SE NE SW	41.7625	118.2783	S	27			1975/06/21	TREXLER AND OTHERS, 1979	
39	SPRING	HU	44N	33E	10	BB	41.7053	118.2633	S	26			1959/06/22	WATSTORE	
40	JACKSON WELL	HU	39N	35E	07	DCDA	41.2614	118.0658	W	19.5			1961/02/26	WATSTORE	
41	SOD HOUSE RANCH WELL	HU	41N	35E	20	NE	41.4200	118.0633	W	27		34	1975/08/20	SINCLAIR, 1962A	
42	CORDERO MERCURY MINE, NORTH LOWER WELL	HU	47N	37E			41.9167	117.8000	W	53			1967/11/11	*WHITE, D., USGS, MENLO PARK	
43	MENTABERRYS WELL 1	HU	47N	37E	24	BAB	41.9478	117.7678	W	26.5		61.0	1976/04/23	WATSTORE	
44	NOQUE'S NEVADA WELL	HU	47N	38E	17	NE NE SE	41.9555	117.7200	W	33.3		214	1972/00/00	GARSIDE AND SCHILLING, 1979	
45	THE HOT SPRINGS	HU	41N	41E	19	NE NE	41.4208	117.3867	S	57.2	227			LOELTZ AND OTHERS, 1949	
46	THE HOT SPRING	HU	41N	41E	19	NE NE	41.4208	117.3867	S	58				MARINER AND OTHERS, 1974, 1975	
47	SPRING	HU	41N	43E			41.4364	117.1436	S	hot				WARING, 1965	
48	WELL	HU	37N	39E	03	DC	41.1047	117.5739	W	69		18.6	1962/04/28	WATSTORE	
49	SPRINGS	HU	45N	41E			41.7737	117.3452	S	hot				WARING, 1965	
50	UNNAMED SPRING	HU	36N	41E	02	SW NE NE	41.0300	117.3215	S	21.1	95		1950/00/00	COHEN, 1962	
51	SPRINGS	HU	37N	43E	24		41.0654	117.0762	S	warm	>757			ANCTIL, 1960	
52	WARM SPRING NEAR DEEP CREEK RESERVOIR	EL	43N	55E	19		41.6153	116.2979	S	warm				CORNACOPIA RIDGE 7.5' QUAD	
53	HOT LAKE	EL	38N	46E	25		41.1480	116.7343	S	hot				SQUAW VALLEY RANCH 7.5' QUAD	
54	SPRING	EL	39N	45E	36		41.2137	116.8440	S	hot				WARING, 1965	
55	SPRING, HEAD OF HOT CREEK	EL	38N	48E	11		41.1832	116.5014	S	?				WILLOW CREEK RESERVOIR 7.5' QUAD	
56	UNNAMED HOT SPRING	EL	39N	50E	18		41.2571	116.3666	S	47.2			1972/00/00	HOSE AND TAYLOR, 1974	
57	PETAINI (NIAGARA?) SPRINGS	EL	40N	53E	06		41.3637	116.0587	S	warm	5960			EAKIN, 1962B	
58	ELLISON RANCH SPRING	EL	41N	52E	08	NE	41.4667	116.1533	S	93	3.8		1971/12/30	*WHITE, D., USGS, MENLO PARK, CA	
59	HOT SULPHUR SPRINGS	EL	41N	52E	08	NE	41.4677	116.1480	S	90			1950/05/24	MARINER AND OTHERS, 1974, 1975	
60	UNNAMED HOT SPRING (SSE PATSVILLE)	EL	45N	54E	20		41.7758	115.9207	S	41				MARINER AND OTHERS, 1974, 1975	
61	WILD HORSE HOT SPRING	EL	43N	55E	04	SE SE	41.6472	115.7757	S	54				MARINER AND OTHERS, 1974, 1975	
62	ROWLAND HOT SPRINGS	EL	46N	56E	14	NW SW N	41.8767	115.6260	S	77	114		1957/05/17	*WHITE, D., USGS, MENLO PARK	
63	SPRING	EL	39N	53E	03		41.2960	115.9967	S	warm				MAHALA CREEK WEST 7.5' QUAD	
64	WARM SPRINGS	EL	37N	58E	26		41.0613	115.3936	S	warm				MORGAN HILL 7.5' QUAD	
65	UNNAMED SPRING	EL	38N	59E	14	SE SW SE	41.1800	115.2817	S	36			1962/06/26	TREXLER AND OTHERS, 1979	
66	UNNAMED WELL	EL	38N	59E	11	SW NE SW	41.1950	115.2850	W	30			1947/05/18	TREXLER AND OTHERS, 1979	
67	DEVIL'S PUNCH BOWL	EL	39N	59E	15	SE SW	41.2650	115.3050	S	52			1972/12/13	TREXLER AND OTHERS, 1979	
68	H.D. RANCH SPRING, HOT CREEK SPRINGS	EL	43N	60E	34	SE SW NW	41.5762	115.1808	S	64.4	2271		1946/04/09	WARING, 1965	
69	RAILROAD SPRING	EL	37N	62	29		41.0661	114.9904	S	warm				OESTERLING, 1960	
70	UNNAMED HOT SPRING NEAR WELLS	EL	38N	62E	17	SE NW NE	41.1816	114.9695	S	61				MARINER AND OTHERS, 1974B	HEAT PUMP
71	UNNAMED HOT SP NEAR WELLS	EL	38N	62E	17	A	41.1819	114.9694	S	55			1974/01/01	WATSTORE	

#	NAME	CO	T	R	SC	QSEC	NLAT	WLONG	T	TEMP	FLOW	DEPTH	CDATE	REFERENCE	USE
72	METROPOLIS (TWELVEMILE SPRINGS)	EL	39N	62E	27	NE NE	41.2450	114.9517	S	38.9	3038		1964/04/14	WARING, 1965	
73	WINE CUP RANCH WELL	EL	41N	64E	25	NW SE	41.4092	114.6742	W	58.9		20.7	1946/03/25	RUSH, 1968A	
74	PAN AMERICAN PETROLEUM-COBRE MINERALS WELL	EL	37N	67E	03	SW SE	41.1135	114.3842	W	76.7		1403		*NEVADA BUREAU OF MINES AND GEOLOGY	
75	GAMBLE RANCH WELL NO. 4	EL	40N	69E	16	SW	41.3433	114.1717	W	20		64		RUSH, 1968	
76	THOUSAND SPRINGS (GAMBLE RANCH SPRING)	EL	40N	69E	08	SE NW NW	41.3696	114.1917	S	20.6	5110			MIFFLIN, 1968	
77	HOT SPRING	EL	40N	69E	04		41.3862	114.1644	S	hot				TWELVEMILE RANCH 7.5' QUAD	
78	WELL	EL	45N	64E	20	ACB	41.7731	114.7506	W	54			1979/04/26	WATSTORE	
79	MINERAL HOT SPRINGS	EL	45N	64E	16		41.7862	114.7293	S	60			1966/10/13	MARINER AND OTHERS, 1974, 1975	
80	SAN JACINTO RANCH SPRING	EL	46N	64E	23	NW NW	41.8683	114.6950	S	26			1962/07/26	MOORE AND EAKIN, 1968	
81	MINERAL HOT SPRING	EL	45N	65E	08	BBA	41.7956	114.6258	S	60			1974/01/01	WATSTORE	
82	W.D. RANCHING CO. FLOWING WELL	EL	47N	65E	18	NW SW	41.9653	114.6416	W	37.8		168.4	1979/12/15	MOORE AND EAKIN, 1968	
83	WHEELER (Y3) RANCH WELL	EL	47N	65E	17	CBC	41.9586	114.6344	W	36		362.5	1977/12/07	WATSTORE	
84	WHEELER (Y3) RANCH WELL	EL	47N	65E	15	DCCD	41.9547	114.5856	W	43.5			1961/04/23	WATSTORE	(AQUACULTURE)
85	SHOSHONE WARM SPRINGS	EL	47N	65E	11	NE SW SW	41.9717	114.5783	S	35			1962/06/25	TREXLER AND OTHERS, 1979	
86	UNNAMED HOT SPRING	EL	47N	67E	09	SE NW	41.9600	114.3770	S	30			1960/10/07	HOSE AND TAYLOR, 1974	
87	TROUT CREEK RANCH WELL, GOOSE CREEK AREA	EL	46N	69E	15	NW NE	41.8823	114.1188	W	43.3		75	1912/09/23	MOORE AND EAKIN, 1968	
88	GOOSE CREEK AREA SPRING	EL	46N	69E	10	SE SW SE	41.8867	114.1200	S	33.9			1960/10/07	*WATSTORE	
89	TROUT CREEK RANCH WELL	EL	46N	69E	02	SW SE	41.9027	114.0995	W	21		75	1972/02/13	MOORE AND EAKIN, 1968	
90	NILE SPRING	EL	47N	70E	30	SW SW S	41.9283	114.0687	S	43				MARINER AND OTHERS, 1974, 1975	
91	HOT SPRING	HU	35N	43E	11		40.9202	117.1091	S	hot				HOT POT 7.5' QUAD	
92	NEW SPRING	W	34N	22E	18		40.8317	119.5317	S	29			1952/05/16	GROSE AND KELLER, 1975B	
93	POODLE SPRING	W	34N	22E			40.8244	119.4847	S	29			1975/01/01	WATSTORE	
94	spring	WA					40.6711	119.6174	S	29.4			1975/	LAWRENCE LIVERMORE LABORATORY, 1976	
95	BUFFALO SPRING	W	31N	20E	06		40.5932	119.7742	S	warm				WARING, 1965	
96	BUCKBRUSH SPRING	W	29N	19E	11		40.3960	119.8250	S	warm				WARING, 1965	
97	JACK BONHAM RANCH WELL	W	26N	19E	12	NE	40.3150	119.7933	S	23			1963/04/16	GLANCY AND RUSH, 1968	
98.1	FISH SPRING	W	26N	19E	19	SE SE	40.1006	119.8850	S	23			1952/09/18	RUSH AND GLANCY, 1967	
98.2	Fish Spring	WA					40.1024	119.8836	S	21			1975/	LAWRENCE LIVERMORE LABORATORY, 1976	
99	THE NEEDLES - WESTERN GEOTHERMAL WELL	WA					40.1500	119.6750	W	115.5				*WHITE, D., USGS, MENLO PARK	
100	THE NEEDLES	WA					40.1460	119.6748	S	56				MARINER AND OTHERS, 1974, 1975	
101	SEVENMILE SPRING	W	25N	23E	10	BCD	40.0483	119.3875	S	18			1969/07/30	WATSTORE	
102	SPRING	W	26N	23E	10	DBA	40.1344	119.3789	S	18.5			1969/07/30	WATSTORE	
103	SPRING	W	27N	22E	16	ADA	40.2161	119.5056	S	25			1969/06/22	WATSTORE	
104	LOWER STONEHOUSE SPRING	PE	27N	25E	08	DD	40.2178	119.1997	S	28			1969/09/03	WATSTORE	
105.1	Amor II well 43-21	W	29N	23E	21		40.3692	119.4039	W	135		85.4		*NEVADA BUREAU OF MINES AND GEOLOGY	ELECTRIC POWER
105.2	Amor II well 43-21	W	29N	23E	21		40.3692	119.4039	W	135		85.4		*NEVADA BUREAU OF MINES AND GEOLOGY	ELECTRIC POWER
106	SAN EMIDIO DESERT - UNNAMED HOT SPRING	W	29N	23E	09,16		40.3917	119.4067	S	79	30		1956/02/22	MARINER AND OTHERS, 1976A	VEGETABLE DRYING
107	GERLACH AREA - GREAT BOILING SPRING (GERLACH HOT S	W	32N	23E	15	NW	40.6600	119.3633	S	86				MARINER AND OTHERS, 1974, 1975	SPA
108	UNNAMED HOT SPRING NEAR GREAT BOILING SPRING	W	32N	23E	10	SW NW	40.6650	119.3667	S	89.5	100			MARINER AND OTHERS, 1976A	
109	GREAT BOILING SP ORIF 46	WA					40.6608	119.3650	S	86.6	390.5		1980/01/26	WATSTORE	
110	BOWEN	W	33N	23E	23	C	40.7226	119.3443	S	26			1975/01/01	WATSTORE	
111	GRANITE CREEK RANCH WELL	W	34N	23E	34	A	40.7939	119.3342	W	26			1961/12/13	WATSTORE	
112	WELL	PE	33N	25E	10	B	40.7447	119.1731	W	33.5			1961/06/12	WATSTORE	
113	UNNAMED HOT SPRING NEAR TREGO	PE					40.7667	119.1167	S	84.5	150			MARINER AND OTHERS, 1976A	
114	FLY RANCH (WARDS HOT SPRING) - WELL	W	34N	23E	02		40.8633	119.3417	W	80	500		1968/06/00	MARINER AND OTHERS, 1974, 1975	
115	HUALAPAI FLAT SPRING 16	W	34N	23E	01		40.8606	119.3181	S	94			1975/01/01	WATSTORE	
116	BLACK ROCK HOT SPRINGS	HU	36N	26E	34	NW NW	40.9700	119.0100	S	57.8	715		1972/03/29	SINCLAIR, 1963A	
117	BACH WELL	PE	29N	29E	06	D	40.4056	118.7675	W	20.5			1961/09/14	WATSTORE	
118	PORTER SPRING	PE	29N	28E	05	B	40.4178	118.8678	S	18			1969/11/20	WATSTORE	
119	COLADO WELL NO. 1	PE	26N	32E	33	SE	40.2450	119.3850	W	60			1966/05/23	*MARINER, R., USGS, MENLO PARK	
120	SOUTHWEST DREDGING CO. WELL	PE	29N	34E	34	SE	40.3367	118.1367	W	24	8	42	1957/02/05	LOELTZ AND PHOENIX, 1955	
121	DRILL HOLE	PE	25N	35E	01		40.0613	117.9977	W	hot				GARSIDE AND SCHILLING, 1979	
122	HYDER (HYDRA) HOT SPRINGS	PE	25N	36E	26	SW	40.0033	117.7167	S	78	102		1962/07/31	MARINER AND OTHERS, 1976A	
123	SOU HOT SPRINGS (GILBERTS HOT SPRINGS)	PE	26N	36E	29	SE	40.0695	117.7247	S	73				MARINER AND OTHERS, 1974, 1975	
124	UNNAMED SPRING	PE	25N	39E	19	NW	40.0267	117.6483	S	28	189			COHEN AND EVERETT, 1963	
125	UNNAMED HOT SPRING (LOWER RANCH)	PE	25N	39E	16	NW	40.0350	117.6033	S	40			1952/09/16	MARINER AND OTHERS, 1974B	
126	SPRING, J.S. RANCH (McCOY)	PE	26N	39E	33	SW	40.0767	117.6000	S	48.3	2536		1960/06/04	COHEN AND EVERETT, 1963	
127	JERSEY VALLEY AREA - UNNAMED HOT SPRING	PE	27N	40E	26	SW	40.1790	117.4900	S	29	20		1957/05/13	MARINER AND OTHERS, 1974, 1975	
128	PARIS WELL	PE	27N	38E	02	NW	40.2450	117.6783	W	22	38	116	1963/01/07	COHEN AND EVERETT, 1963	
129	J.S. RANCH WELL	CH	26N	39E	29	D	40.0653	117.6099	W	21		32.6	1963/07/23	WATSTORE	
130	KYLE HOT SPRINGS	PE	29N	36E	12	NW NW	40.4063	117.8850	S	95.6				SANDERS AND MILES, 1974	
131	HOTTEST KYLE HOT SPRINGS	PE	29N	36E	01	C	40.4069	117.8831	S	66			1977/05/06	WATSTORE	
132	COYOTE SPRING	PE	30N	39E	30	DDD	40.4181	117.6397	S	22			1977/01/01	WATSTORE	
133	BUFFALO SPRINGS	PE	29N	41E	06	NE SW NW	40.4172	117.4158	S	65			1963/	WOLLENBERG AND OTHERS, 1977	
134	BUFFALO VALLEY HOT SPRINGS	LA	29N	41E	23	SE	40.3670	117.3255	S	65.5	7.6		1962/03/10	*WHITE, D., USGS, MENLO PARK	
135	QH3D WELL	PE	31N	38E	14	ABC	40.5617	117.6683	W	58.1		409.0	1978/09/15	WATSTORE	
136	SPRING SW GRASS VALLEY	PE	31N	38E	09	B	40.5658	117.7256	S	20			1977/01/01	WATSTORE	
137	LEACH HOT SPRINGS	PE	32N	38E	36	SE	40.6037	117.6457	S	92	200			MARINER AND OTHERS, 1974, 1975	
138	DH 13A ORIFICE	PE	32N	38E	36	DAA	40.6036	117.6456	W	52.5		52.1	1976/06/23	WATSTORE	

#	NAME	CO	T	R	SC	QSEC	NLAT	WLONG	T	TEMP	FLOW	DEPTH	CDATE	REFERENCE	USE
139	NORTHERN EAST RANGE AREA	HU	35N	36E	26	NE NW NE	40.8850	117.9383	S	27.6				COHEN, 1963	
140	SPRING	PE	30N	33E	20		40.4508	118.2934	S	warm				CROFUTT, 1872	
141	HUMBOLDT (RYE PATCH) AREA - PHILLIPS PETROL. CAMPB	PE	31N	33E	21	SE	40.5350	118.2683	W	162.8		565	1970/09/01	GARSIDE AND SCHILLING, 1979	
142	Florida Canyon Mine well	PE	31N	33E	03		40.5833	118.2542	W	114.4				Trexler and others, 1990	HEAP LEACHING
143.1	SPRINGS	PE	33N	35E			40.7050	118.0553	S	warm				WARING, 1965	
143.2	BLUE MOUNTAIN DRILL HOLE	HU	36N	34E	23	C	40.9605	118.1292	W	87.8	227.1	137	1966/ ,	PARR AND PERCIVAL, 1991	
144	CALIFORNIA PACIFIC UTILITIES CO. WELL	HU	36N	36E	30	NE SW SE	40.9600	117.7433	W	22.8		151	1970/10/07	COHEN, 1962	
145	UNNAMED SPRING	HU	36N	37E	13	SE NE SW	40.9928	117.7620	S	33.9			1954/10/05	COHEN, 1962	
146	BLM WELL	HU	36N	38E	26	SW NE SE	40.9642	117.6612	W	22.8		16.8		COHEN, 1962	
147	UNNAMED HOT SPRING NEAR GOLCONDA	HU	36N	40E	29	SW SW SE	40.9610	117.4938	S	74	750			MARINER AND OTHERS, 1974, 1975	
148	GOLCONDA TUNGSTEN MINE DRILL HOLE 302	HU	36N	40E	36	SW	40.9497	117.4238	W	61.7		78.6		GARSIDE AND SCHILLING, 1979	
149	UNNAMED HOT SPRING	HU	33N	40E	05	SE	40.7617	117.4922	S	85	100			MARINER AND OTHERS, 1974, 1975	
150	SULPHUR SPRING	PE	35N	41E	34		40.8643	117.3491	S	hot				KERR, 1940	
151	BROOKS SPRING	HU	34N	41E	13	NE NW NE	40.8317	117.3067	S	34			1962/07/15	TREXLER AND OTHERS, 1979	
152	HOT POT SPRING	HU	35N	43E	10	NE NE SE	40.9228	117.1100	S	58			1912/11/16	MARINER AND OTHERS, 1974, 1975	
153	MOUND SPRING	LA	28N	44E	07		40.3125	117.0695	S	32			1950/01/05	*WHITE, D., USGS, MENLO PARK	
154	UNN HOT SP VLLY OF MOON	LA	27N	43E	23	BCC	40.1911	117.1056	S	53			1974/01/01	WATSTORE	
155	IZZENHOOD RANCH SPRING	LA	35N	45E	10	SW NE NW	40.9267	116.8953	S	31			1962/07/05	TREXLER AND OTHERS, 1979	
156	DEE 3 WELL	EL	36N	49E	03	CDD	41.0194	116.4247	W	45			1990/08/27	WATSTORE	
157	BW2 WELL	EU	36N	50E	19	BCC	40.9831	116.3739	W	51.5		402.3	1990/08/29	WATSTORE	
158	BRAHMA SPRING	EU	35N	51E	30	DDCB	40.8872	116.2794	S	16.5			1990/08/30	WATSTORE	
159	NEWMONT WELL MC2	EU	34N	51E	26	DDD	40.7961	116.2017	W	31.5			1989/04/11	WATSTORE	
160	UNNAMED SPRING	EL	33N	53E	08	NW	40.7642	116.0408	S	64			1970/10/07	TREXLER AND OTHERS, 1979	
161	UNNAMED SPRINGS NEAR CARLIN	EL	33N	52E	33	SE SW	40.6972	116.1333	S	79			1950/05/24	MARINER AND OTHERS, 1974, 1975	(SPACE HEATING)
162	TYROL SPRING	EL	32N	52E	05	CDBA	40.6844	116.1539	S	22			1990/08/13	WATSTORE	
163	SPRING	EU	31N	52E	07		40.5892	116.1515	S	warm				BRADBURY AND ASSOCIATES, 1964	
164	MACK CREEK FARM WELL	EU	33N	49E	10	ACDD	40.7494	116.4283	W	26		172.2	1990/08/24	WATSTORE	
165	WHITE ROCK SPRINGS	LA	33N	47E	08		40.7493	116.7011	S	warm				WARING, 1965	
166	HOT SPRING	LA	32N	46E	06		40.6745	116.8415	S	hot				STONY POINT	
167	BATTLE MOUNTAIN CITY WELL	LA	32N	45E	17	SW SW	40.6463	116.9342	W	23.3	946	221	1970/09/01	SCOTT AND BARKER, 1962	
168	BEOWAWE - SPRING 51	EU	31N	48E	17	N 1/2	40.5583	116.5833	S	96	283.9			*WHITE, DONALD, U.S.G.S.	ELECTRIC POWER
169	BEOWAWE HOT SPRING	EU	31N	48E	08	SE	40.5667	116.5667	S	98	100			MARINER AND OTHERS, 1974B, 1975	
170	HORSESHOE RANCH HOT SPRINGS	EU	32N	49E	33	SW	40.6017	116.4600	S	58	3.8		1967/11/10	ROBERTS AND OTHERS, 1967	
171	HOT SPRINGS POINT	EU	29N	48E	11	NE NE	40.4035	116.5167	S	54	125		1948/10/21	MARINER AND OTHERS, 1974, 1975	
172	HOT SPRINGS POINT	EU	29N	48E	11	NE NE	40.4033	116.5167	S	60			1974/08/05	*WHITE, DONALD, U.S.G.S.	
173	SPRING	EU	28N	49E	10	NW NW N	40.3150	116.4317	S	85.5	9.5		1968/00/00	GARSIDE AND SCHILLING, 1979	
174	CARLOTTI RANCH SPRING, SULFUR SPRING	EL	28N	52E	24	SE	40.2900	116.0500	S	39	378.5			WARING, 1965	
175	HOT CREEK SPRINGS AREA	EU	28N	52E	12	NW	40.3283	116.0717	S	26.1	6000		1972/00/00	MARINER AND OTHERS, 1974B	
176	BRUFFEY'S HOT SPRINGS	EU	27N	52E	14	NE SE	40.2192	116.0683	S	65.5	189		1964/07/16	ROBERTS AND OTHERS, 1967	
177	FLYNN RANCH SPRINGS	EU	25N	53E	06		40.0792	116.0350	S	26	38		1972/00/00	WARING, 1965	
178	Elko Heat Company Well	EL					40.825	115.775	W	80			1989/	Flynn and Buchanan, 1990	SPACE HEATING
179	HOT HOLE (ELKO HOT SPRINGS)	EL	34N	55E	21	NE	40.8185	115.7755	S	56	75		1950/05/24	MARINER AND OTHERS, 1974, 1975	
180	WARM SPRING	EL	34N	59E	31		40.7624	115.3628	S	warm				SOLDIER PEAK 7.5' QUAD	
181	SULPHUR HOT SPRINGS (HOT SULPHUR SPRINGS)	EL	31N	59E	11	NE NW	40.5867	115.2847	S	93	75		1974?	MARINER AND OTHERS, 1974, 1975	
182	UNNAMED HOT SPRING NEAR RUBY MARSH	EL	27N	58E	02	NW	40.2500	115.4010	S	65			1949/09/08	MARINER AND OTHERS, 1974, 1975	
183	UNNAMED SPRING	LA	26N	45E	15	NE	40.1275	116.8853	S	22.2				EVERETT AND RUSH, 1966	
184	UNNAMED HOT SPRING (VALLEY OF THE MOON)	LA	27N	43E	23	NE	40.1967	117.1008	S	53			1960/05/25	MARINER AND OTHERS, 1974, 1975	
185	UNNAMED HOT POOL	LA	27N	45E	25		40.1833	116.8617	S	50			1967/03/10	*WHITE, D., USGS, MENLO PARK	
186	UNNAMED SPRING	LA	27N	46E	287	NW	40.1867	116.8042	S	22.2			1975/06/00	EVERETT AND RUSH, 1966	
187	Warm spring at Warm Creek Ranch	EL	33N	61E	12		40.7505	115.0354	S	warm	7570			Eakin and others,1951	
188	UNNAMED SPRING NEAR WARM SPRINGS RANCH	EL	35N	64E	04	NW NE N	40.9517	114.7500	S	30	189		1964/10/23	*WILSON, 1960	
189	JOHNSON RANCH (BIG SPRINGS)	EL	36N	66E	26	SW SW SE	40.9708	114.5067	S	22.7	113.6		1949/10/12	WARING, 1965	
190	COLLAR AND ELBOW SPRING	W	26N	65E	33		40.0635	114.6343	S	22			1940/11/03	*NEVADA BUREAU OF MINES AND GEOLOGY	
191	THE NEEDLE ROCKS - ANAHO ISLAND SPRING	W	24N	22E	16		39.9483	119.5100	W	46.9			1979/10/15	WARING, 1965	
192	THE PYRAMID HOT SPRING	W	24N	22E	03		39.9603	119.5012	S	warm				*GARSIDE, L., NBMG	
193	WARM SPRINGS	W	23N	20E	22		39.8462	119.7161	S	88.3				*GARSIDE, L., NBMG	
194	MCCULLOCH CORP. WELL	W	22N	21E	07	SE NW	39.7900	119.6667	W	43.3			1962/03/21	*DESERT RESEARCH INSTITUTE, 1973	
195	COTTONWOOD SPRING	W	23N	21E	26		39.8327	119.5917	S	warm				WARING, 1965	
196	GEOTHERMAL WELL	CH	23N	26E	13		39.8575	119.0118	W					HOT SPRINGS FLAT 7.5' QUAD	
197	SPRING	CH	22N	26E	11	ADA	39.7883	119.0233	S	58	0.0		1961/02/20	WATSTORE	
198	Bradys Hot Springs	CH					39.787	119.012	W	141			1989/	Flynn and Buchanan, 1990	VEGETABLE DRYING
199	BRADY HOT SPRINGS	CH	22N	26E	12	NE NE SW	39.7883	119.0167	S	94			1966/00/00	*WHITE, D., USGS, MENLO PARK	
200	Eagle Salt Works Spring	CH	22N	36E	35		39.7301	119.0387	S					Adams, 1944	
201	HAZEN AREA (PATUA HOT SPRINGS)	LY	20N	26E	18	SW	39.5967	119.1033	S	86.1			1966/11/12	MARINER AND OTHERS, 1975	
202	Patua Hot Spring	LY					39.597	119.113	S	86			1989/	Flynn and Buchanan, 1990	
203	UNNAMED WELL	W	19N	18E	17		39.5150	119.9650	W	26		10	1978/06/17	DESERT RESEARCH INSTITUTE, 1973	
204	LAWTON HOT SPRINGS	W	19N	18E	13	SW NE	39.5150	119.9017	S	48.9				COHEN AND LOELTZ, 1964	(SPA)
205	MOANA AREA - PEPPER MILL MOTEL	W	19N	19E	24	NE NW	39.5017	119.7963	W	47.2			1957/05/15	BATEMAN AND SCHEIBACH, 1975	SPACE HEATING
206	Warren Estates #1 Well	WA					39.461	119.825	W	88			1989/	Flynn and Buchanan, 1990	SPACE HEATING

#	NAME	CO	T	R	SC	QSEC	NLAT	WLONG	T	TEMP	FLOW	DEPTH	CDATE	REFERENCE	USE
207	MOANA AREA - MOORE WELL	W	19N	19E	26	NE SE	39.4817	119.8100	W	80		60		BATEMAN AND SCHEIBACH, 1975	SPACE HEATING, POOL
208	Steamboat/Ormat Well	WA					39.395	119.715	W	113			1989/	Flynn and Buchanan, 1990	ELECTRIC POWER
209	WELL	W	18N	20E	34		39.3817	119.7233	W	30		36		BATEMAN AND SCHEIBACH, 1975	SPACE HEATING
210	STEAMBOAT SPRINGS - SPRING 25	W	18N	20E	33	NE	39.3833	119.7333	S	94	50		1970/09/01	MARINER AND OTHERS, 1974, 1975	
211	UNNAMED WELL	W	17N	20E	07	SE	39.3500	119.7717	W	24		31		GARSIDE AND SCHILLING, 1979	
212	SPRING 9	ST	18N	21E	15	CABD	39.4258	119.6111	S	19	1.7		1970/10/01	WATSTORE	
213	BOWERS MANSION (FRANKTOWN) HOT SPRING - MAIN SPRIN	W	16N	19E	03	NW	39.2833	119.8367	S	47.2	644		1974/02/04	WHITE AND OTHERS, 1963	SWIMMING POOL
214	UNNAMED WELL	W	16N	20E	06		39.2750	119.7800	W	28		24	1974/00/00	*DESERT RESEARCH INSTITUTE, 1973	
215	COMSTOCK MINING DISTRICT-NEW YELLOW JACKET SHAFT	ST	17N	21E	32	SW SE	39.2900	119.6467	W	76.7		914	1964/06/05	BECKER, 1882	
216	SPRING 6	ST	17N	21E	14	DCBC	39.3342	119.5914	S	21	5.1		1970/09/30	WATSTORE	
217	SUTRO TUNNEL	LY	16N	21E	02	NE NE SE	39.2750	119.5850	S	27.2			1950/04/26	GLANCY AND KATZER, 1975	
218	UNNAMED	LY	16N	22E	07	NW SE NW	39.2683	119.5600	W	26.7		31	1953/05/11	GLANCY AND KATZER, 1975	
219	CARSON CITY WELL NO 7	CC	15N	20E	06	DAAC	39.1925	119.7714	W	28		138.7	1988/05/25	WATSTORE	
220	CARSON CITY WELL NO 4	CC	15N	20E	17	DDDA	39.1592	119.7517	W	27		184.1	1988/09/08	WATSTORE	
221	NOBLE MURRAY WELL	CC	15N	20E	23		39.1433	119.6983	W	41				*NEVADA BUREAU OF MINES AND GEOLOGY	SPACE HEATING
222	CARSON HOT SPRING	CC	15N	20E	05	SE NE	39.1917	119.7517	S	50			1921/11/00	*NEVADA BUREAU OF MINES AND GEOLOGY	SPA, POOL
223	SARATOGA HOT SPRING	CC	14N	20E	21	SW SE	39.0567	119.7400	S	50			1956/01/27	*NEVADA BUREAU OF MINES AND GEOLOGY	
224	WETLANDS, WARM WELL	DG	14N	20E	20	DAA	39.0619	119.7514	W	40		7.9	1983/08/26	WATSTORE	
225	HOBO HOT SPRINGS	DG	14N	19E	23	SE SE	39.0550	119.8083	S	46	473		1929/02/24	GLANCY AND KATZER, 1975	(AQUACULTURE)
226	HASTIE WELL	DG	13N	20E	02	CBB	39.0183	119.7119	W	21		53.6	1986/05/20	WATSTORE	
227	UNNAMED WELL	LY	14N	23E	25		39.0500	119.3667	W	27.7	1533	165	1979/11/15	SCOTT AND BARKER, 1962	
228	NEVADA STATE PRISON SPRING	CC	15N	20E	16	SE SE	39.1600	119.7350	S	24			1967/07/25	*NEVADA BUREAU OF MINES AND GEOLOGY	(AQUACULTRUE)
229	WABUSKA AREA	LY	15N	25E	28	SE NE	39.1367	119.1617	W	30	57	305	1953/05/11	HUXEL, 1969	(ETHANOL PRODUCTION)
230	WABUSKA HOT SPRINGS	LY	15N	25E	16	SE	39.1615	119.1827	S	97			1958/04/25	MARINER AND OTHERS, 1974, 1975	(AQUACULTURE)
231	WABUSKA HOT SPRINGS - MAGMA POWER CO. NO. CB 1 WEL	LY	15N	25E	15	NW SW	39.1617	119.1767	W	97.2	5731	149	1965/11/02	HUXEL, 1969	ELECTRIC POWER
232	DE WELL	CH	22N	27E	21	AACD	39.7642	118.9478	W	163			1987/07/09	WATSTORE	
233	Desert Peak 86-21 Well	CH					39.758	118.946	W	159			1989/	Flynn and Buchanan, 1990	ELECTRIC POWER
234	CHURCHILL DRILLING CORP. TCID No. 1 WELL	CH	22N	30E	15		39.7791	118.6023	W	hot				GARSIDE AND SCHILLING, 1979	
235	USBM HEAT FLOW HOLE	CH	22N	31E	10		39.7918	118.4905	W	25.0		153		OLMSTED AND OTHERS, 1975	
236	DIXIE COMSTOCK MINE	CH	23N	35E	14		39.8661	118.0165	M	hot				VANDERBURG, 1940	
237	DIXIE HOT SPRINGS	CH	22N	35E	05	SE	39.7977	118.0673	S	72	200			MARINER AND OTHERS, 1974, 1975	
238	KENNAMETALS WELL	CH	20N	28E	01	ABB	39.6350	118.7689	W	36		191.1	1976/12/12	WATSTORE	
239	CDDH-48A-USGS	CH	21N	29E	30	DDC	39.6494	118.7603	W	26.3		31.4	1978/11/06	WATSTORE	
240	SHALLOW RESEARCH WELL (SODA LAKE), 4	CH	20N	28E	28	SW	39.5633	118.8533	W	100			1958/05/25	MARINER AND OTHERS, 1975	
241	Soda Lake 33-14 Well	CH					39.564	118.850	W	183			1989/	Flynn and Buchanan, 1990	ELECTRIC POWER
242	CDDH-41A	CH	20N	28E	14	DCC	39.5919	118.8064	W	21		125.0	1976/05/20	WATSTORE	
243	USGS CDR-21	CH	18N	28E	12	ABAC	39.4450	118.7858	W	22.5		4.8	1988/07/12	WATSTORE	
244	INDIAN HEALTH SERVICE WELL	CH	19N	29E	29	BACB	39.4853	118.7603	W	20.5		20.7	1989/03/01	WATSTORE	
245	FLOWING WELL IN STILLWATER	CH	19N	31E	07	SW	39.5215	118.5522	W	96			1967/01/18	MARINER AND OTHERS, 1974, 1975	
246	CDD-117A	CH	19N	31E	07	DCD	39.5211	118.5461	W	67		19.8	1976/04/19	WATSTORE	
247	CDPW-44A	CH	19N	30E	06	BCB	39.5433	118.5547	W	93.7		56.7	1976/04/21	WATSTORE	
248	USFWS WELL 3 NR EAST CAN	CH	20N	32E	20	CAC	39.5825	118.4183	W	25	271.7	213.4	1989/04/03	WATSTORE	
249	DR-SW-LY-9-L1	CH	17N	29E	06	BCAD	39.3686	118.7767	W	25.5		0.8	1985/06/20	WATSTORE	
250	CARSON LAKE CORRAL	CH	18N	30E	07	BACB	39.3561	118.6642	S	77			1987/07/08	WATSTORE	
251	EIGHTMILE FLAT, BORAX SPRING	CH	17N	30E	14	NE	39.3417	118.5783	S	81.1				WARING, 1965	
252	GEOTEHRMAL WELL	CH	17N	30E	36		39.2935	118.5723	W	160.0		2000		EDMISTON AND BENOIT, 1984	
253	SPRING	CH	16N	32E	06		39.2786	118.4332	S	hot				WARING, 1965	
254	LEE HOT SPRINGS	CH	16N	29E	34	SW NW	39.2092	118.7232	S	88	126		1966/11/00	MARINER AND OTHERS, 1974, 1975	
255	E.H. STARK WELL	CH	21N	34E	36	SW	39.6392	118.1083	W	22.8	3765	61	1973/03/00	COHEN AND EVERETT, 1963	
256	HATTON WELL NO. 1	CH	21N	35E	20	NE	39.6767	118.0617	W	21.7	151	49	1971/08/09	SDESERT AT COLD SPRING	
257	Stinking Spring	CH	15N	29	10	SW	39.1739	118.7333	S	26				Katzenstein and Danti, 1982	
258	Oxbow Geothermal Corp. No. 52-18	CH					39.9537	117.8597	W	231		3007		*NEVADA BUREAU OF MINES AND GEOLOGY	ELECTRIC POWER
259	JAMES LITSTER WELL	LA	24N	43E	27	SW	39.9200	117.1250	W	38.9		4.6	1918/	WARING, 1918	
260	spring	LY	18N	25E	17	NW SE	39.4234	119.1997	S	34	4			*GARSIDE, L., NBMG	
261	TOM ORMECHEA WELL	CH	20N	38E	06	SE	39.6233	117.7400	W	24.4	189	31	1966/11/21	EVERETT, 1964	
262	SMITH CREEK VALLEY WELL	LA	20N	40E	36	NW	39.5588	117.4278	W	29.4			1971/12/00	EVERETT AND RUSH, 1964	
263	UNNAMED HOT SPRING	LA	17N	39E	11		39.3500	117.5583	S	88	75		1969/04/00	MARINER AND OTHERS, 1974, 1975	
264.1	TWIN SPRING	LA	18N	39E	27		39.3961	117.5791	S	warm				WARING, 1965	
264.2	MCLEOD 88 SPRING	NY	14N	43E	34		39.0263	117.1367	S	87.9				*NEVADA BUREAU OF MINES AND GEOLOGY	
265.1	UNNAMED SPRING	LA	17N	39E	25	NE NW N	39.3162	117.5467	S	92			1959/03/15	TREXLER AND OTHERS, 1979	
265.2	LITTLE HOT SPRINGS	LA	23N	47E	02		39.8937	116.6481	S	hot				LITTLE HOT SPRINGS 7.5' QUAD	
266	HOT SPRINGS	LA	24N	47E	15		39.9420	116.6814	S	hot				WARING, 1965	
267	WALTI HOT SPRINGS	EU	24N	48E	33	SW	39.9017	116.5870	S	72	300		1961/08/10	MARINER AND OTHERS, 1974, 1975	
268	SHIPLEY HOT SPRINGS	EU	24N	52E	23	SE	39.9417	116.0733	S	32.2	25500			EAKIN, 1062A	
269.1	SIRI RANCH SPRING, (WATER WELL)	EU	24N	53E	06	SW NE	39.9917	116.0450	W	35			1958/02/11	HARRILL, 1968	
269.2	SULFUR SPRINGS AREA	EU	23N	52E	36	NW	39.8350	116.0662	S	23.3	75.7			WARING, 1965	
270	BARTINE HOT SPRINGS	EU	19N	50E	05	NE NE	39.5583	116.3617	S	44.3			1945/06/24	*NEVADA BUREAU OF MINES AND GEOLOGY	
271	BARTINE RANCH WATER WELL NO. 4	EU	19N	50E	17	NE	39.5233	116.3605	W	46.7	124.9	147.8		GARSIDE AND SCHILLING, 1979	
272	WARM SPRING	PU	19N	50E	16		39.5282	116.3885	S	warm				BEAN FLAT EAST 7.5' QUAD	

#	NAME	CO	T	R	SC	QSEC	NLAT	WLONG	T	TEMP	FLOW	DEPTH	CDATE	REFERENCE	USE
273	BARTHOLOMAE CORP. WATER WELL	EU	18N	51E	18	SW	39.4367	116.2792	W	23.3	53	204	1972/00/00	RUSH AND EVERETT, 1964	
274	BARTHOLOMAE CORP. WATER WELL	EU	18N	51E	30	NW	39.4133	116.2758	W	22.2	757		1972/00/00	RUSH AND EVERETT, 1964	
275	BARTHOLOMAE HOT SPRINGS	EU	18N	50E	28	SE	39.4053	116.3463	S	54			1958/01/27	MARINER AND OTHERS, 1974, 1975	
276	UNNAMED WELL	LA	18N	47E	06	SW	39.4126	116.6960	W	21.7			1975/08/00	RUSH AND EVERETT, 1964	
277	MONITOR VALLEY WELL	LA	18N	47E	20	SE NE	39.3881	116.6894	W	21.7			1973/10/12	RUSH AND EVERETT, 1964	
278	SPENCER HOT SPRINGS	LA	17N	45.5E	11	NE NE	39.3269	116.8567	S	72	50		1962/04/28	MARINER AND OTHERS, 1974, 1975	
279	UNNAMED WELL	LA	16N	44E	24	NW	39.2375	116.9880	W	28.9	22.7	36.6	1971/07/10	FIERO, 1968	
280	POTT'S RANCH HOT SPRING	NY	14N	47E	02	NE	39.0783	116.6400	S	45	125		1972/00/00	MARINER AND OTHERS, 1974, 1975	
281	DIANA'S PUNCH BOWL	NY	14N	47E	22	SE	39.0283	116.6667	S	59			1972/00/00	MARINER AND OTHERS, 1974, 1975	
282	FISH CREEK SPRINGS	EU	16N	53E	08	BCBB	39.2769	116.0383	S	19	15129.0		1981/07/17	WATSTORE	
283	THOMPSON RANCH SPRING	EU	23N	54E	03	DBD	39.9008	115.8678	S	21	3600.0		1981/07/14	WATSTORE	
284	WARM SPRINGS RANCH	W	22N	56E	01	NE NE	39.8117	115.6083	S	22.6			1974/02/20	*NEVADA BUREAU OF MINES AND GEOLOGY	
285	WELL AT ALLIGATOR RIDGE	W	22N	57E	25	CCCC	39.7408	115.5119	W	34		200.9	1984/04/24	WATSTORE	
286	BIG BLUE SPRING	W	14N	56E	23		39.0627	115.6412	S	warm				WARING, 1965	
287	UNN HOT SP CHERRY CREEK	W	23N	63E	06		39.8950	114.8906	S	61			1974/01/01	WATSTORE	
288	SHELL OIL CO. STEPTOE UNIT NO.1 WELL	W	24N	64E	19	NE NE	39.9433	114.7717	W	151.1		2562		GARSIDE AND SCHILLING, 1979	
289	UNNAMED SPRING	W	24N	65E	31	NE	39.9168	114.6600	S	28	1703			SNYDER, 1963	
290	BORCHERT JOHN (WARM) SPRING	WP					39.7778	114.8497	S	18			1978/08/25	WATSTORE	
291	SHELLBOURNE SPRINGS	W	22N	64E	12		39.7933	114.6883	S	24.6			1972/00/00	*NEVADA BUREAU OF MINES AND GEOLOGY	
292	UPPER SHELLBOURNE SPRING	W	22N	65E	08	SE NW	39.8000	114.6550	S	25	1703		1964/06/28	MIFFLIN, 1968	
293	WELL	W	23N	66E	31	AB	39.8303	114.5550	W	28.2			1983/07/27	WATSTORE	
294	MELVIN HOT SPRING (MONTE NEVA)	W	21N	63E	24		39.6667	114.8050	S	79				CLARK AND OTHERS, 1920	
295	SPRING, KERN MOUNTAINS	W	21N	70E			39.6691	114.0809	S	warm				WARING, 1965	
296	STEPTOE WARM SPRING	WP					39.5386	114.9144	S	24			1978/08/25	WATSTORE	
297	MCGILL WARM SPRINGS	W	18N	64E	21	SE NW	39.4150	114.7800	S	29	17034		1945/08/14	CLARK AND OTHERS, 1920	SWIMMING POOL
298	SCHOOLHOUSE SPRING	W	18N	65E	03	DA	39.4537	114.7559	S	28	17320.0		1981/07/15	WATSTORE	
299	ELY-LACKAWANNA ZONE - LACKAWANNA HOT SPRINGS	W	16N	63E	03	NE	39.2850	114.8633	S	35				EAKIN AND OTHERS, 1967	
300	ELY WARM SPRINGS	W	16N	63E	10		39.2683	114.8667	S	29	63		1975/00/00	CLARK AND OTHERS, 1920	
301	WALLEYS HOT SPRINGS (GENOA HOT SPRINGS)	DG	13N	19E	22	SW NW NE	38.9812	119.8325	S	61	75			MARINER AND OTHERS, 1974, 1975	SPA
302	WALLEYS HOT SPRING	DG	13N	19E	22	SW NW NE	38.9812	119.8325	S	63	57		1934/02/07	*WHITE, D., USGS, MENLO PARK	
303	BENSON SPRING - SOUTH OR	DG	12N	19E	28	ACC	38.8747	119.8139	S	22			1981/06/10	WATSTORE	
304	DOUD SPRING	DG	11N	21E	20	SE SW	38.7950	119.6533	S	21.1	681.3		1962/07/23	GLANCY AND KATZER, 1975	
305	NEVADA HOT SPRINGS	LY	12N	23E	16	SE	38.8995	119.4117	S	61	200		1970/07/01	MARINER AND OTHERS, 1974, 1974	
306	AMBASSADOR WELL, ARTESIA LAKE AREA	LY	13N	23E	25	NW SW	38.9567	119.3617	W	27.8		165	1949/08/09	SCOTT AND BARKER, 1962	
307	WELLINGTON WELL	LY	10N	23E	02	NW SE	38.7533	119.3767	W	47.2		61	1912/09/28	LOELTZ AND EAKIN, 1953	
308	WILSON HOT SPRINGS	LY	11N	25E	34		38.7672	119.1732	S	warm	0			GARSIDE AND SCHILLING, 1979	
309	HOT SPRING	LY	12N	25E	34		38.8598	119.1749	S	hot				WILSON CANYON 7.5' QUAD	
310	GRANT VIEW HOT SPRINGS	LY					38.9900	118.9761	S	53			1977/05/11	WATSTORE	
311	DOUBLE SPRING	M	13N	29E	25		38.9647	118.6890	S	warm				WARING, 1965	
312	Deadhorse Wells (dry)	M	12N	32E	21		38.8959	118.3808	W	hot				Miller and others, 1953	
313	WEDELL SPRING NO.1	M	12N	34E	07	SW	38.9191	118.1953	S	62.2	859		1957/05/25	EAKIN, 1962C	
314	hot well	NY					38.9869	118.1783	W	hot				Mount Annie 7.5'	
315	hot drill hole	MN					38.6333	118.2917	W	hot				*GARSIDE, L., NBMG	
316	UNNAMED	LY	07N	27E	04	SW SE	38.4917	118.9650	S	43.3			1966/10/13	DAVIS, 1954; WARING, 1965	
317	CITY OF HAWTHORNE WELL	M	06N	30E	27	SW	38.5200	118.6275	W	28.7		184	1950/04/28	SCOTT AND BARKER, 1962	
318	WELL NO. 3	M	06N	31E	32		38.5067	118.5500	W	34			1971/12/29	*WHITE, D., USGS, MENLO PARK	
319	U. S. BUREAU OF LAND MANAGEMENT WELL	M	05N	31E	19	NE	38.2600	118.5667	W	43.3		105	1974/02/18	EVERETT AND RUSH, 1967	
320	BUREAU OF LAND MANAGEMENT NO. 2 WELL	M	03N	31E	07	NE SW	38.1317	118.5642	W	25.8		20	1953/05/11	VANDENBURGH AND GLANCY, 1970	
321	SODAVILLE SPRINGS, SODA SPRINGS	M	06N	35E	29	SE	38.3417	118.1017	S	35	100		1949/00/00	MARINER AND OTHERS, 1974, 1975	
322	GENE SAWYER WELL	NY	13N	36E	28	NE SW	38.9617	117.9383	W	54		84	1967/10/06	TREXLER AND OTHERS, 1979	
323	GABBS AREA	NY	12N	36E	27	NW	38.8817	117.9200	W	47.8		66	1958/02/11	EAKIN, 1962B	MINERAL EXTRACTION??
324	CHARNOCK (BIG BLUE) SPRINGS	NY	13N	44E	16		38.9914	117.0415	S	28.7	1703		1946/01/30	WARING, 1965	
325	BIG BLUE, CHARNOCK SPRING	NY	13N	44E	32	NE	38.9483	117.0500	S	32			1962/08/18	TREXLER AND OTHERS, 1979	
326	DARROUGH'S WELL	NY	11N	34E	07		38.8200	117.1750	W	90.5		244		*NEVADA BUREAU OF MINES AND GEOLOGY	HEAP LEACHING
327	DARROUGH'S NORTH SPRING	NY	11N	34E	07		38.8250	117.1750	S	71.2			1958/01/27	*NEVADA BUREAU OF MINES AND GEOLOGY	
328	WARM SPRING	NY	08N	38E	12	SW	38.5698	117.6635	S	warm				BLACK SPRINGS 7.5' QUAD	
329	UNNAMED WELL	M	06N	36E			38.3333	117.9667	W	40			1968/06/00	TREXLER AND OTHERS, 1979	
330	hot drill hole	MN					38.2000	117.9700	W	hot				*GARSIDE, L., NBMG	
331	STANLEY A TANNER WELL	NY	07N	40E	28		38.4372	117.4945	W	warm				RUSH AND SCHROER, 1970	
332	INDIAN SPRINGS	NY	07N	42E	34		38.4210	117.2498	S	warm				WARING, 1965	
333	HALL MINE WELL, ANACONDA MOLYBDENUM PROJECT	NY	05N	42E	07		38.3083	117.2917	S	27.7			1954/09/04	*NEVADA BUREAU OF MINES AND GEOLOGY	
334	WELL	NY	02N	43E	01	ACB	38.0650	117.1028	W	28			1967/05/08	WATSTORE	
335.1	WELLS	NY	12N	47E	20		38.8704	116.7034	W	hot				MOSQUITO CREEK 7.5' QUAD	
335.2	BELMONT MINE, 1500 FT LEVEL	NY	03N	42E	36		38.0750	117.2217	W	37.2		457	1964/10/23	BASTIN AND LANEY, 1918	
336	MOSQUITO RANCH SPRINGS	NY	11N	47E	06	SE NE	38.8250	116.7267	S	31.6			1941/07/03	*NEVADA BUREAU OF MINES AND GEOLOGY	
337	SPRING	NY	10N	49E	22	CAA	38.6972	116.4361	S	40			1967/05/10	WATSTORE	
338	TEST HOLE UCE-10	NY	10N	49E	22	CAA	38.6878	116.4625	W	48		903.1	1967/08/03	WATSTORE	
339	SPRING	NY	08N	49E	21	CDC	38.5361	116.4556	S	35			1967/07/31	WATSTORE	
340	OLD DUGAN PLACE HOT SPRING	NY	08N	49E	25	NW NE	38.5300	116.4050	S	36.1			1975/08/20	GARSIDE AND SCHILLING, 1979	

#	NAME	CO	T	R	SC	QSEC	NLAT	WLONG	T	TEMP	FLOW	DEPTH	CDATE	REFERENCE	USE
341	HOT CREEK RANCH SPRING	NY	08N	50E	29	SE SE	38.5200	116.3600	S	62.8	2888		1957/05/13	SANDERS AND MILES, 1974	
342	HOT CREEK VALLEY SPRING	NY	07N	51E	30		38.4367	116.2767	S	61.1				WARING, 1965	
343	WARM SPRING	NY	06N	47E	36	NE NW	38.3383	116.6600	S	26.1	19		1948/01/26	FIERO, 1968	
344	SALISBURY SPRING	NY	05N	46E	28	SW SE	38.2533	116.8267	S	30			1950/01/05	GARSIDE AND SCHILLING, 1979	
345	SPRING	NY	05N	46E	33	CD	38.2369	116.8306	S	21			1967/07/30	WATSTORE	
346	UPPER? MUD SPRING	NY	04N	46E	26	CA	38.1722	116.7917	S	25.5			1967/07/30	WATSTORE	
347	SPRING	NY	04N	47E	29		38.1722	116.7361	S	25			1967/07/27	WATSTORE	
348	SPRING	NY	02N	47E	14	AC	38.0278	116.6806	S	29			1967/07/28	WATSTORE	
349	WARM SPRINGS	NY	04N	50E	20	SW	38.1867	116.3717	S	63	170			*WHITE, D., USGS, MENLO PARK	
350	SPRING	NY	02N	51E	02	D	38.0472	116.1944	S	22			1967/08/03	WATSTORE	
351	SPRING	NY	02N	50E	28	ACC	37.9944	116.3861	S	25			1967/08/02	WATSTORE	
352.1	DUCKWATER AREA	NY	13N	56E	32	NW SE NW	38.9508	115.7000	S	33.9			1950/04/26	GARSIDE AND SCHILLING, 1979	AQUACULTURE
352.2	WILLIAMS HOT SPRINGS	W	13N	60E	33	NE	38.9533	115.2300	S	51.8			1976/11/10	*NEVADA BUREAU OF MINES AND GEOLOGY	
353	PRESTON SPRINGS	W	12N	61E	02	SW NE	38.9308	115.0625	S	22.7			1954/07/31	*NEVADA BUREAU OF MINES AND GEOLOGY	
354	BIG SPRING	NY	08N	55E	15	AC	38.5528	115.2722	S	38			1967/08/07	WATSTORE	
355	BLUE EAGLE SPRINGS	NY	08N	57E	11	DDB	38.5631	115.5275	S	29	7030.0		1981/07/17	WATSTORE	
356	MOORMAN SPRING	NY	09N	61E	32	DABC	38.5947	115.1383	S	37	1294.0		1981/07/18	WATSTORE	
357	EMIGRANT SPRING	W	09N	62E	19	AC	38.6250	115.0478	S	19.5	5247.0		1981/07/18	WATSTORE	
358	FLAG SPRING NO 3	NY	07N	62E	33	BCCC	38.4214	115.0222	S	22.8			1984/01/17	WATSTORE	
359	BUTTERFIELD (FLAG, SUNNYSIDE) SPRINGS	NY	07N	62E	28	NE	38.4450	115.0067	S	23.9	7571		1960/09/26	WARING, 1965; MAXEY AND EAKIN, 1949; ADAMS, 1944	
360	HOT CREEK RANCH SPRINGS	NY	06N	61E	18		38.3817	115.1533	S	26.7			1960/11/08	EAKIN, 1966	
361	MOON RIVER SPRINGS	NY	06N	60E	25	BDAD	38.3517	115.1808	S	32.5			1962/04/27	WATSTORE	
362	Bacon Flat 24-17 oil well	NY	07N	57E	17		38.4600	115.5900	W	113		1653		Hulen and others, 1994	
363	CHIMNEY HOT SPRINGS	NY	07N	55E	16	DC	38.4633	115.7900	S	60			1967/08/07	WATSTORE	
364	SPRING	NY	06N	54E	11	C	38.3889	115.8694	S	45			1967/08/07	WATSTORE	
365	SPRING	NY	06N	54E	24	CA	38.3639	115.8517	S	46			1968/09/12	WATSTORE	
366	GEYSER RANCH SPRINGS	LI	09N	65E	01		38.6750	114.6233	S	18	189		1979/11/15	CARPENTER, 1915	
367	LOWER PONY SPRING	LI	05N	66E	05	CBCC	38.3197	114.6072	S	20			1981/07/23	WATSTORE	
368	HAMMOND RANCH AREA	LI	05N	69E	17		38.2967	114.2733	S	28.9			1967/10/16	CARPENTER, 1915; WARING, 1965	
369	SAND SPRING	ES	01N	34E	27	SE SE	37.9053	118.1732	S	23.3			1965/07/12	RUSH AND KATZER, 1973	
370	FISH LAKE VALLEY	ES	02N	36E	28	SW SW S	37.9931	117.9648	S	27.2	4		1978/08/03	*NEVADA BUREAU OF MINES AND GEOLOGY	
371	GAP SPRING	ES	02N	36E	32	SW SE	37.9797	117.9927	S	23	38		1975/08/00	VANDENBURGH AND GLANCY, 1970	
372	EMIGRANT WELL	ES	01N	38E	08	NW	37.9717	117.8067	W	25			1970/10/07	TREXLER AND OTHERS, 1979	
373	FISH LAKE VALLEY WELL	ES	01N	36E	20	01S	37.9233	118.0058	W	25			1965/07/12	RUSH AND KATZER, 1973	
374	R.G. PENNEBAKER WELL	ES	01S	35E	09	SW SW	37.8640	118.1015	W	23.3		91	1961/12/13	RUSH AND KATZER, 1973	
375	NEVADA OIL AND MINERALS VRS NO. 1 WELL	ES	01S	36E	16	SW NE NE	37.8567	117.9600	W	158.8		2797		GARSIDE AND SCHILLING, 1979	
376	FISH LAKE VALLEY	ES	01S	36E	19	NE	37.8425	118.0150	W	25			1961/07/20	*DESERT RESEARCH INSTITUTE, 1973	
377	FISH SPRING	ES	02S	35E	25	NW SW	37.7425	118.0457	S	24				RUSH AND KATZER, 1973	
378	Gradient well 42-7	ES	01S	36E	07		37.8720	118.0210	W	47.5	757	301		*NEVADA BUREAU OF MINES AND GEOLOGY	
379	SILVER PEAK HOT SPRINGS, WATERWORKS SPRINGS	ES	02S	39E	15	SE SE	37.7600	117.6367	S	34.2	1892			WARING, 1965	
380	PEARL HOT SPRINGS	ES	01S	40E	25	SE NW SW	37.8222	117.4802	S	36.7			1963/04/15	*DESERT RESEARCH INSTITUTE, 1973	
381	ALKALI HOT SPRINGS	ES	01S	41E	28	NE	37.8267	117.3400	S	50.5	95			*WHITE, D., USGS, MENLO PARK	
382	SARCOBATUS FLAT AREA	NY	07S	44E	28	NW SW	37.2967	117.0517	W	22.2		62		MALMBERG AND EAKIN, 1962	
383	NONE GIVEN	ES	11S	43E	06	NW	37.0162	117.2065	S	25				*DESERT RESEARCH INSTITUTE, 1973	
384	FISHLAKE LIVESTOCK Co. WELL	ES	01S	39E	05		37.8767	117.6674	W	hot		50.3		RUSH AND SCHROER, 1970	
385	CEDAR SPRING	NY	02S	51E	21	SE	37.7508	116.2800	S	25	9			VANDENBURGH AND RUSH, 1974	
386	CLIMAX SEEP	NY					37.2244	116.0581	W	41.5			1978/03/07	WATSTORE	
387	TIPPIPAH SPRING NO 2	NY					37.0433	116.2072	S	22			1979/06/19	WATSTORE	
388	YUCCA FLAT TEST WELL 84-69,(TEST WELL E)	NY					37.0550	116.0133	W	42.2		572	1957/09/02	SCHOF F AND MOORE, 1964	
389	YUCCA FLAT WELL 79-69A, TESTWELL C	NY					36.9950	116.0250	W	37.2		519	1916/10/10	SCHOFF AND MOORE, 1964	
390	SARCOBATUS FLAT-BEATTY AREA	NY	09S	46E	35	NE	37.1142	116.7692	W	22.2				MALMBERG AND EAKIN, 1962	
391	SPRING	NY	01N	56E	35	DD	37.8966	115.6453	S	21			1968/09/14	WATSTORE	
392	SAND SPRING	LI	02S	55E	26	NE SE SE	37.7400	115.7517	S	30	1		1927/08/05	VANDENBURGH AND RUSH, 1974	
393	N. J. GUNDERSON WELL	LI	03S	55E	19	SE SE	37.6692	115.8283	W	28.3		73	1946/10/27	VANDENBURGH AND RUSH, 1974	
394	G.C. ENGLEMAN WELL	LI	04S	55E	08		37.6188	115.8217	W	warm		76.3		VAN DENBURGH AND RUSH, 1974	
395	HIKKO SPRING AREA	LI	04S	60E	14		37.5975	115.2117	S	26.7	11167		1950/04/26	EAKIN, 1963B	
396	CRYSTAL SPRINGS AREA	LI	05S	60E	10		37.5300	115.2333	S	27.2			1954/09/04	COHEN, 1966	
397	ASH (ALAMO) SPRINGS AREA	LI	06S	61E	06	NW NW N	37.4600	115.1867	S	31.1	32894		1945/07/30	EAKIN, 1963B	(SPA)
398	LIME SPRING	LI					37.9144	114.5403	S	21			1965/04/07	WATSTORE	
399	FLATNOSE SPRING	LI	01N	69E	35	CC	37.8961	114.2258	S	25			1965/04/08	WATSTORE	
400	DELMUE'S SPRINGS AREA, TWO SPRINGS.	LI	01S	68E	13	NE NW SE	37.8558	114.3217	S	21.1	757			HARDMAN AND MILLER, 1934	
401	PANACA WARM SPRINGS AREA	LI	02S	68E	04		37.8083	114.3600	S	29.5	18472		1949/08/00	RUSH, 1964	
402	BENNETT SPRING	LI	02S	67E	07	CD	37.7842	114.5281	S	24			1965/04/10	WATSTORE	
403	CALIENTE MINERAL SPRING, CALIENTE HOT SPRINGS	LI	04S	67E	08	NE	37.6217	114.5033	S	47.8			1962/07/29	SAND ERSAND MILES, 1974	(SPACE HEATING)
404	AQUA CALIENTE WELL NO. 3	LI	04S	67E	08	NW NW	37.6283	114.5100	W	67	5299	27	1970/10/07	TREXLER AND OTHERS, 1979	SPA
405	HICKS (BURRELL) HOT SPRINGS	NY	11S	37E	21		36.9667	116.7233	S	38	19		1978/08/18	*WHITE, D., USGS, MENLO PARK	
406	BEATTY MINERAL SPRINGS	NY	12S	47E	05	SW	36.9167	116.7500	S	24.4	379			SCOTT AND BARKER, 1962	
407	TW- F WELL	NY	14S	52E			36.7594	116.1164	W	64	883.0	1036.0	1960/03/12	WATSTORE	
408	WELL	NY	15S	50E	25	BD	36.6208	116.4125	W	46		32.0	1973/04/03	WATSTORE	

#	NAME	CO	T	R	SC	QSEC	NLAT	WLONG	T	TEMP	FLOW	DEPTH	CDATE	REFERENCE	USE
409	COOKS EAST WELL	NY	16S	50E	07	CABB	36.5744	116.3964	W	32		91.4	1990/06/25	WATSTORE	
410	FAIRBANKS SPRING	NY	17S	50E	09	SE NE	36.4933	116.3433	S	27.2			1934/02/18	NAFF, 1973	
411	RODGERS SPRINGS	NY	17S	50E	15	NW NE	36.4783	116.3233	S	27.8			1959/10/19	NAFF, 1973	
412	LONGSTREET SPRING	NY	17S	50E	22	NE NW NE	36.4667	116.3250	S	27.8			1960/06/01	DUDLEY AND LARSON, 1976	
413	UNNAMED SPRING	NY	17S	50E	26	SW NE NW	36.4483	116.3133	S	27			1958/06/12	NAFF, 1973	
414	SCRUGGS SPRING	NY	17S	50E	35	SE SW NE	36.4317	116.3067	S	30			1960/06/03	NAFF, 1973	
415	DEVIL'S HOLE	NY	17S	50E	36	SW SE	36.4267	116.2883	S	33			1965/06/17	NAFF, 1973	
416	POINT OF ROCK (KING) SPRING	NY	18S	51E	07	NW SE	36.4017	116.2717	S	32	4399		1964/04/13	HUGHES, 1966; MIFFLIN, 1968	
417	JACK RABBIT SPRING	NY	18S	51E	18	SE NW SE	36.3867	116.2717	S	26			1962/06/28	NAFF, 1973	
418	BIG SPRING; ASH MEADOWS SPRING; DEEP SPRING	NY	18S	51E	19	SW NE	36.3767	116.2717	S	28			1971/02/00	DUDLEY AND LARSON, 1976	
419	CRYSTAL SPRING	NY	18S	50E	03	NE SE NW	36.4183	116.3300	S	30			1979/12/15	NAFF, 1973	
420	USGS TRACER WELL 2	NY	16S	51E	27	NE NE NW	36.5383	116.2317	W	30.6			1968/06/25	DUDLEY AND LARSON, 1976	
421	CHERRY PATCH WELL	NY	17S	52E	06	CDB	36.4914	116.1492	W	27.5		65.5	1990/06/24	WATSTORE	
422	INDIAN SPRING	CL	16S	56E			36.5617	115.6683	S	26.1	5875	1546	1967/11/10	CARPENTER, 1915	
423	MANSE RANCH SPRINGS	NY	21S	54E	03	SE NE	36.1557	115.8886	S	25	4542		1978/06/18	HARDMAN AND MILLER, 1934	
424	PAHRUMP SPRINGS	NY	20S	53E	14	SE SE	36.2075	115.9783	S	25	1840		1960/06/31	HARDMAN AND MILLER, 1934	
425	PAHRUMP COMMUNITY CHURCH WELL	NY					36.2117	115.9883	W	27			1976/01/09	WATSTORE	
426	WHITE ROCK SPRING	CL	20S	58E			36.1742	115.4786	S	25			1965/06/26	WATSTORE	
427	PAGO PAGO BAR WELL	CL					36.2361	115.0531	W	28		61.0	1982/05/18	WATSTORE	
428	Las Vegas Springs	CL	20S	61E	31		36.1645	115.1899	S	26.1	5015			Scott and Barker, 1962	
429	H. NICKERSON WELL	CL	22S	61E	03	NE NE SW	36.0633	115.1458	W	29	644	120	1972/02/13	MAXEY AND JAMESON, 1948	
430	GLADSTONE CORPORATION WELL	CL	22S	61E	10	NE SE NW	36.0600	115.1463	W	33.3	1609	99	1973/00/00	MAXEY AND JAMESON, 1948	
431	T.A. WELLS WELL	CL	22S	62E	01	SW NW S	36.0608	115.0043	W	32.8		346		MAXEY AND JAMESON, 1948	
432	VF-2 WELL	LI	12S	63E	29	DABB	36.8750	114.9456	W	34			1988/02/05	WATSTORE	
433	FUGRO COYOTE V DEEP WELL	CL	13S	63E	23	DD	36.7956	114.8922	W	35.5		203.9	1981/07/22	WATSTORE	
434	USGS-MX CE-DT-6	CL	13S	64E	35	ACAA	36.7678	114.7869	W	33.5		264.7	1986/09/26	WATSTORE	
435	CSV-3	CL	14S	63E	28	ACDC	36.6906	114.9250	W	41		237.7	1987/10/07	WATSTORE	
436	WARM SPRING	CL	14S	65E	16	NW SW NE	36.7222	114.7152	S	32.2	12250		1950/06/27	EAKIN, 1964; MIFFLIN, 1968	
437	IVERSON SPRING	CL	14S	65E	21	NW NE NE	36.7097	114.7142	S	31.6	3840		1958/05/19	EAKIN, 1964	
438	JUANITA SPRING	CL	15S	69E	14	BAA	36.6369	114.2475	S	26			1986/01/25	WATSTORE	
439	DRY LAKE	CL	17S	64E	21	CB	36.4550	114.8439	S	29			1985/07/01	WATSTORE	
440	WATER FOUNTAIN VALLEY OF FIRE, NEV.	CL	17S	67E	30	NW SW	36.4233	114.5463	S	35.1			1971/03/15	SWANBERG AND OTHERS, 1977	
441	BLUE POINT SPRING	CL	18S	68E	06	DCC	36.3897	114.4328	S	29	4075.0		1977/05/04	WATSTORE	
442	ROGERS SPRING	CL	18S	67E	12	DDA	36.3775	114.4433	S	30			1977/05/04	WATSTORE	
443	G.P. APEX WELL	CL	18S	63E	33	DBB	36.3411	114.9267	W	31			1986/09/30	WATSTORE	
444	NAT'L PARK SERVICE, CALLVILLE BAY CAMPGROUND WELL	CL	21S	65E	09	NW SE	36.1442	114.7220	W	26.9	114	61		RUSH, 1968B	
445	HOOVER DAM HOT SPRING	CL	22S	65E	29	SW	36.0100	114.7450	S	42.2			1966/07/27	SWANBERG AND OTHERS, 1977	
446	BLACK CANYON AREA	CL	23S	65E	05	SE NW SW	35.9600	114.7467	S	30	848		1960/00/00	*WATSTORE	
447	BLACK CANYON AREA SPRING	CL	23S	65E	21	NE SW NW	35.9467	114.7333	S	25.6	19		1976/06/18	*WATSTORE	
448	MONITOR WELL 116	CL	32S	66E	14	DBDB	35.1583	114.5864	W	29		91.4	1991/06/06	WATSTORE	
449	SUNDANCE SHORES WELL	CL	32S	66E	24	BBA	35.1497	114.5803	W	32		146.3	1974/06/14	WATSTORE	

APPENDIX 2

#	pH	Na	K	Ca	Mg	Fe	SiO2	B	Li	HCO3	CO3	SO4	Cl	F	TDSm	TDSc	ChgBal	delD	delO18
1									5.8										
2	8.90	58	3.9	5.8	0.34		41			106		23	23			207	1.03		
3																			
4		21	4	3.2	0.3		53	0.08	0.01	50	0	11	5.9	0.6		124	0.96		
5		29	0.4	3.7	0.1		32	0.08	0.03	64	0	12	4.7	1.8		115	0.96		
6		31	2.8	2.1	0.1		57	0.07	0.02	74	0	9	5	0.9		144	0.97		
7	9.1	110	1	4	0		51	1	0	63		119	39	4.6	362	393	1.03	-127	-15.4
8																			
9	7.70	32	6.3	1.4	0.1		67		0.46	68		13	7			160	1.03		
10																			
11																			
12	8.40	78	0.6	0.4			51	0.66		113	6	41	15	2	262	250	1.00		
13		180	8.6	14	0.2		130	2	0.2	163	0	220	48	6.6		690	0.98		
14	8.60	74	1	3.5	1.1		63	0.6	0.667	90	3	35	18	12	275	255	1.02		
15	8.60	74	1.1	3.1	<0.1	<0.02	63	0.64		92	3	41	18	12		261	0.94	-129.9	-16.56
16	7.60	76	1.3	2.6	1.4		65	1		96	N	39	21	10	272	265	1.02		
17	8.5	74	1	4	1		63	0.6		90	3	35	18	12		256	1.02		
18	8.20	55	0.6	6.4	0.2		34	0.32		120	N	15	11	0.3	186	182	1.05		
19	7.65	320	25	4.6	0.1	0.06	160	6.9	0.45	436	2	130	160	14		1038	0.98	-128.2	-14.13
20	7.20	325	26	19	0.3		155	7		500	1	120	160	14		1073	0.99		
21																			
22																			
23		74	10	23	8.4		74	0		107		22	32	0.1	256	296	1.70		
24	7.80	78	11	9.6	2.8		79			165		28	28	1.8		319	1.05		
25	7.1	230	5	17	0.1		130	2.1		280	0	120	110	10		762	1.03		
26	7.60	230	4.5	17	0.1		130	2.1		280	N	120	110	10		761	1.02		
27	8.86	150	8.7	2.7	0.2	0.01	80	0.64	0.03	224	8	49	52	2.3		464	1.05	-123	-15.8
28	8.8	210	4.4	1.5	0.04	0.01	64		0.032	280	9	120	76	0.1		623	0.98	-131	-16.1
29																			
32		210	6.2	3.2	1.5		125	2.9		358	7	67	54	14	660	667	0.98		
33		146	3.7	3.2	0		83	0.41		218	16	76	6	8.9	470	450	1.04		
34	8.10	455	9.9	30	6.3		51	1.3	0.5	948	N	204	69	9.8	1290	1303	0.99		
35		416	11	32	5.2	0.04	39	1.7	0.36	885	N	184	59	0.9	1180	1184	1.02		
36		34	4.8	18	2.4		65	0.11		104		25	15	0.6	244	216	1.01		
37	9.30	91	2	2.4	0.5		84	0.26		52	39	64	14	7.9	324	331	0.97		
38	7.30	28	6.3	14	2.8		53		0.03	94		14	15			179	1.02		
39		27	6.3	25			54	0.1		117		20	22	0.1		212	0.87		
40		146	12	46	9.7		63	0.87		204		94	157	0.3	640	629	1.00		
41	9.00	197	18	2.2	0.8		4.8		1.5	211	36	70	106	1.4	541	540	1.00		
42	7.30	123	3.5	6.4	0.5		65	0.78		182	N	61	27	10	387	387	1.05		
43		89	3.4	7.8	1.8		56	0.35		178		49	19	5.3		319	0.95		
44		58	12	5.8	0.2	N	110	0.37	0.4	119		26	14	2.6	322	288	1.04		
45		334		26	8.5			2.5		920		34	26		930	884	1.00		
~~46~~	~~8.00~~	~~296~~	~~36~~	~~10~~	~~8~~		55			881		36	26			900	0.94	-134.6	-16.44

#	pH	Na	K	Ca	Mg	Fe	SiO2	B	Li	HCO3	CO3	SO4	Cl	F	TDSm	TDSc	ChgBal	delD	delO18
47																			
48		452	26	26	11			1.4		1230		71	16			1209	1.02		
49																			
50	9.20	620	3.5	2	N	N	34	4.6		1080	143	98	46	16	1500	1498	1.02		
51																			
52																			
53																			
54																			
55																			
56									<0.2										
57																			
58	8.10	157	16	13	0.2	N	166	0.81		338	N	75	9	9.4	631	613	1.01		
59	7.00	390	41	49	13		84	0.77		1180		18	40	7.2		1224	1.01	-134.9	-16.78
60	7.40	110	8.3	29	7.7		23	0.22		380		36	4.4	3.4		409	0.97	-140.8	-18.21
61	7.20	130	22	48	12		40	0.67		482		40	14	5.2		549	1.02	-140.2	-17.85
62	7.60	134	4	8.4	N	0.04	96	0.41	N	260	N	46	11	14	442	442	1.01		
63																			
64																			
65	8.00	450	36	3.1	0.45		151			1149		2	31	21		1260	0.99		
66	7.70	358	33	6.5	0.8		132			959		2	25			1029	1.02		
67	6.70	236	43	41	14		38			867		10	20			829	0.97		
68																			
69																			
70	7.30	300	31	75	37		105			1135		32	27	7.2		1173	1.01		
71	6.6	370	46	48	13	0.02	86	0.73	0.72	1135		12	37	7.4		1179	1.02	-136.6	-16.95
72																			
73	8.40			49	17					426	18	69	30			393	0.39		
74																			
75	8.20			74	27					278	N	103	117			458	0.59		
76																			
77																			
78	8.8	78	2.4	2.4	0.6		75	0.53	0.16	78	17	49	11	8.8		283	1.00		
79	9.10	75	2.2	1.6	<0.01		83	0.47		108		45	15	8.9		284	0.94	-139	-17.61
80	8.10	13	3.9	25	8.6	N	18	N		132	N	11	3.9	0.5	149	149	1.04		
81	9.1	75	2.2	1.6	0.01		83	0.47	0.2	108		45	15	8.9		285	0.94	-139	-17.61
82	7.90	17	8.4	37	8.6		20	N	0.205	184	N	20	1.8	0.7	205	204	1.00		
83	7.3	18	8.9	38	9.2		20	0.03	0.06	180	0	22	2.5	0.7		208	1.04		
84	7.8	8	4.8	34	10		20	0	0.02	160	0	23	2.1	0.4		181	0.94		
85	8.00	19	6.6	35	11		21			190		19	2			207	1.02		
86																			
87	8.30	24	5.6	16	5.7	0.18	21			118	1	22	2	0.6	157	156	0.98		
88	7.20	9.6	4.6	29	8.1		23			144	N	13	3.3	0.4	162	162	0.97		
89	7.90	8.5	5.4	30	8	0.06	27			142	N	13	3.5	0.4	166	166	0.98		
90	7.20	10	5.6	40	11.5		31	<0.02		149		37	8.7	0.4		218	1.01	-139.1	-18.24

#	pH	Na	K	Ca	Mg	Fe	SiO2	B	Li	HCO3	CO3	SO4	Cl	F	TDSm	TDSc	ChgBal	delD	delO18
91																			
92	7.80	25	7	32			86		5.7		N		28			178	3.63		
93	7.8	25	7	32	0.2		86			240	0	15	28			311	0.57		
94	8.4	113	N	2						98	24	49	60			296	0.98		
95																			
96																			
97	8.00			37	2.3					155	N	528	849			1493	0.05		
98.1	8.00			3	3				N	179			18			112	0.12		
98.2	9	83	N	3	1	0.004	25			170	48	18	0.01			262	0.81		
99	8.50	1050	29	245	N		97	7.2		11	6	293	1830		3870	3563	1.01		
100	8.40	1100	160	260	0.1	<0.02	110	6.1	0.04	26		340	1900	3		3892	1.06	-106.5	-6.33
101				32	7					200		21	19			177	0.51		
102				6	3					206		18	16			144	0.13		
103				56	22					277		70	34			318	0.66		
104				86	28					286		132	126			513	0.60		
105.1		1400	120	148	0.17	0.34	208	5.85		49	3	220	2320	5.2		4455	1.00		
105.2		1298	110	140	0.17	0.01	203	5.85		22	17	211	2225	5.2		4226	0.97		
106	6.70	1400	110	140	1.5	0.13	240	6.3		92		230	2300	5		4478	0.99	-105.3	-11.54
107	7.20	1400	130	68	1.2	0.02	165	9.9		83	<1	400	2200	4.5		4419	0.94	-100.5	-10.83
108	7.60	1400	86	58	1	<0.02	145	7.1		68		350	2050	4.8		4135	0.99	-106.5	-11.65
109	7.3	1400	120	70	1.1	0.04	210	8.2	1.7	96		380	2100	5.1		4343	0.98	-105	-10.4
110	9.1	152	21	1	4		45	1.8		230	0	52	192			582	0.73		
111	7.5	18	3.5	19	3.8		18	0.1		284	0	9	21	0.1		232	0.39		
112		272	8.4	13	0.6		94			93	0	156	278	2.8		871	1.00		
113	7.90	430	8.6	11	0.2	<0.02	79	5		162		180	500	4.1		1298	0.94	-127.6	-14.87
114	7.90	340	17	31	4.2	0.13	82	1.9		464		45	240	7		997	1.09	-120.7	-14.72
115	7.2	405	17	22	0.2		90	0.5		455	0	205	250			1214	1.02		
116	7.90	486	13	18	1.9		62	2.8		902	N	130	155	8.9	1330	1321	1.01		
117		27	9.8	46	4.1		70	0.1		99		61	38	0.3		305	1.02		
118				24	11					110		26	38			153	0.62		
119	7.56	1450	120	110	6.5	<0.02	85	8.7		197	<1	120	2400	4.6		4402	0.98	-125.5	-14.01
120	7.40	33	1.3	50	9.3	0.05	20	0.18		210		23	29	0.1	271	269	1.00		
121																			
122	6.80	390	20	41	10	<0.02	63	4.1				120	45	8.6		702	4.82		
123	8.10	165	26	110	22		65		0.08	312		370	75			987	1.01	-130	-16.24
124																			
125	8.10	143	12	31	15		42		1.2	456		63	29			559	0.97		
126									0.0574										
127	7.10	180	20	36	4.4	0.08	110	1.9	1.3	375		150	40	7.8		735	0.97	-129.5	-15.58
128	7.90	101	6.4	46	19	0.04	39	0.3		205	N	69	124	0.5	503	506	1.01		
129		182	11	79	17		58	1.1		407		154	127	1.9	826	831	1.00		
130	7.00	518	80	97	20	0.02	155			544	N	48	775	6.3	1968	1967	0.97		
131	6.9	540	82	95	22	0.03	110			490	0	66	790	5.7		1952	1.00		
132	6.97	130	8.2	73	17		40	0.63	0.22	480		65	70	1.4	551	642	0.97		

#	pH	Na	K	Ca	Mg	Fe	SiO2	B	Li	HCO3	CO3	SO4	Cl	F	TDSm	TDSc	ChgBal	delD	delO18
133		277	27	28		<0.25	81						26			439	19.27		
134	7.50	304	33	7.6	20		74	3		818		93	20	5.5		963	0.99		
135	8.1	180	12	13	2.1		8.3	0.54	0.24	457	3	26	23	4.3		497	0.99		
136	7.64	110	4.7	91	32		26	0.36	0.06	180	0	190	180	0.7	734	723	1.00	-124.4	-15.15
137	7.40	160	13	8.8	0.5	<0.02	135	1.2		368		53	29	7.8		589	0.93	-128.6	-15.7
138	8.6	270	14	8.5	2		17	1.8	0.81	365	8	110	140	6.2		758	0.99	-134	-16.4
139	8.30	920	94	17	40	0.01	50	15		1940	41	121	381	12	2650	2645	0.99		
140																			
141																			
142		1350	240	120	4		340			202		18	2250	6	4530	4427	1.05		
143.1																			
143.2																			
144	7.90	60	6.5	56	19	N	51	0.4		260	N	72	58	0.3	452	451	0.96		
145	7.70	74	2	179	58	N	25	0.4		211	N	390	191	0.3	1040	1024	1.00		
146	8.00	42	3.5	102	30	0.04	10	0.1		166	N	85	178	0.3	536	533	0.99		
147	6.50	130	22	33	6.8	0.22	66	1.1	0.08	429	1	56	18	1.8		547	0.95	-125.5	-15.65
148																			
149	8.40	200	18	16	0.9	0.18	125	2.6		385		140	41			733	0.97	-131.4	-15.74
150																			
151	7.00	157	15	58	16		44			533		84	34	1.7		672	0.99		
152	8.00	288	33	29	5		80			823		60	28			928	0.98		
153	7.10	105	28	70	27		40	2	5	507	N	94	17	2.5		635	1.01		
154	8	118	21	20	9		40			333		64	21			457	1.00	-127.8	-16.28
155	7.10	38	5.6	33	4.1		51			136		36	25	1.9		262	1.00		
156	6.4	77	22	100	25	0.18	34		0.33	537		64	14	1.1	582	602	1.04		
157	6.2	80	23	96	22	0.37	41		0.35	548		67	14	1.2	589	615	0.99		
158	6.6	10	2.3	8.5	1.9	0.12	26		0.004	51		5.7	3.9	0.1	96	84	1.01		
159	7.4	39	11	59	20	0.069	28		0.19	318	0	50	14	0.6		378	0.98	-128	-16.9
160	6.90	231	27	15	5.9		52			690		25	10			705	0.99		
161	7.60	45	16	60	15		70			335		52	12			435	0.95	-132.7	-16.64
162	7.51	27	7.6	43	8.8	0.004	67		0.028	180		38	17	0.5		297	1.00		
163																			
164	7.3	47	13	56	11	0.009	51		0.088	234		84	19	0.5	379	397	0.99		
165																			
166																			
167	8.00	50	8	26	5.8	N	85			164	N	37	22	0.4	318	315	1.01		
168	9.50	230	16	0.8	N	0.04	373	2		116	149	89	30	15	1000	962	1.01		
169	8.90	230	16	1	<0.1	<0.02	320	2.1		321	32	130	69	17		975	0.88	-130	-14.76
170	7.00	136	17	22	5.8		58	0.81		378	N	62	27	5	526	520	0.93		
171	6.60	230	58	53	35	<0.02	67	2.1		915	<1	7	1	6.6		910	1.10	-136.1	-15.97
172	6.90	285	56	46	40		70	2.9		949		116	48	7		1138	0.99		
173																			
174																			
175	7.30	10	2.1	46	23.5		20	0.03	0.8	226	1	27	4.6	0.1		246	1.06		

#	pH	Na	K	Ca	Mg	Fe	SiO2	B	Li	HCO3	CO3	SO4	Cl	F	TDSm	TDSc	ChgBal	delD	delO18
176	7.00	39	8.7	52	16		0.58	0.25		287	N	27	14	0.7	380	299	1.02		
177									0.75										
178	6.6	110	35	63	12.3		65	0.9	0.3	493		70	15	2	582	867	0.98	-149	-18.1
179	7.20	120	39	60	15.5	<0.02	65	0.7		488	1	72	16	1.9		631	1.04	-144.7	-15.31
180																			
181	8.50	135	8.9	1	0.03	<0.02	210	0.2		224	15	40	23	17.7		561	0.93	-130.1	-16.09
182	8.00	58	14	45	12		50		1.8	377		24	6.5			395	0.89	-132.8	-16.24
183	7.90			54	18					396	N	95	18			380	0.47		
184	8.00	118	21	20	9	<0.02	40		0.113	333		64	21			457	1.00	-127.8	-16.28
185	7.00	114	22	41	22.4		39	2.4	0.08	443		68	20	4.5		551	0.99		
186	7.80			141	61					540	N	315	332			1115	0.49		
187				52	20		35	0.8		334		39	23	1	398	335	0.61		
188																			
189																			
190	7.74	8.4	4	49	17		24		t	226		20	5.1	0.334		239	1.01		
191									0.1										
192																			
193																			
194	8.90			16	1					56	8	168	114	3	788	338	0.11		
195																			
196																			
197	8.01	780	42	56	2.6	0.037	110	4.3	2	170	1	67	1100	2.9		2251	1.07	-126	-14.3
198	7.2	694	53	35	0.2		210	4.4	1.5	112		323	872	5.5	2120	2311	1.00	-127	-14.2
199	7.10	730	62	22	N	N	226	4.7		67	N	315	910	7.3	2360	2310	1.02		
200				32	2		259			31	19	334	955		2495	1616	0.05		
201	7.10	620	38	70	1.5	0.02	150	5.6		100		400	820	4.2		2159	0.95	-121.5	-13.3
202	7.6	656	52	52	0.6		198	6.1	1.7	93		405	829	4.7	2100	2298	0.97	-121	-12.4
203	7.00												5			5	0.00		
204	9.00	117	5.4	6.2	0.1	N	46	193		12	20	144	57	2.5	361	597	0.99		
205	8.10	139	4.7	5.2	0.3		85	0.76		136		171	20	0.81	567	494	1.01		
206	8.1	277	8	27	0		126	2	0.2	93		528	55	4.1	950	1120	0.95	-126	-15.9
207	7.50	248	7.1	20	0.3		104	1.7		95		419	53	4.9	959	905	1.00		
208	6.3	611	58	15	0.3		278	41.8	6.9	369		120	790	2	2056	2292	0.93	-121	-12.4
209	7.70	679		32	8					361		234	750	1.2	2056	1882	0.99		
210	7.20	680	66	16	0.7	<0.02	270	47		368		73	837	2.1		2173	1.03	-116.7	-12.16
211	8.00	19		24	9					151	N	3	5		211	134	1.03		
212	7.9			37	19					212		47	13	0.1	281	220	0.71		
213	9.30	49	0.4	2.8	1		44	0.2	0.667	34	26	35	5.4			181	1.03		
214	8.40			13		0.27			1.4	120	6		7	7	253	92	0.24		
215																			
216	7.7			47	14					232		5	7	0.1	249	187	0.85		
217	7.60	67	4.6	267	53	3.3	34	0.03		312	N	732	8.2	0.6	1320	1323	1.01		
218	7.70			102	1	0.13			8.4	149	N	192	21		583	389	0.74		
219	8.21	25	1.4	17	0.9	0.003	33	0.04	0.011	107	0	8.6	3	0.3		142	1.01	-109	-14.8

#	pH	Na	K	Ca	Mg	Fe	SiO2	B	Li	HCO3	CO3	SO4	Cl	F	TDSm	TDSc	ChgBal	delD	delO18
220	8.06	28	0.9	15	1.1	0.11	27	0.06	0.004	93	0	16	4.7	0.6		139	1.03	-112	-14.9
221	7.26	173	5.9	270	0.14	0.116	44	1.4			26	843	34	4.1		1402	1.08	-130	-16.2
222	8.84	99	1.6	2.2	<0.05	0.03	60	1.5		57	13	89	27	7.5		329	1.02	-127	-14.9
223	8.55	161	5	166	0.1		33	1.4		4.5	11	617	39	3.3		1039	1.06	-130	-16.2
224	7.3	170	3.9	66	0.74	5.6	35	1		39	0	470	38	5.1	798	815	0.94		
225	8.90	125	1.7	6	0.7	0.03	47	1.5		51	17	109	74	7.1	408	414	0.95		
226	8	58	4.4	9.5	2.9	0.006	78	0.16		140	0	36	9.5	1.6	271	269	0.99		
227	8.50	69	3.4	2	0.2	0.03	36		0.309	146	4	23	6.2	1	244	217	0.99		
228	8.80	82	2	14	0.33		33			48		148	21	5.8		330	0.91		
229	8.20			7.2	1.7				7.1	159		128	29			244	0.08		
230	8.50	277	15	38	0.2		115			70		580	46			1106	0.99	-131.5	-16.01
231	8.60	313	13	40	1	0.06	109	1		52	12	642	49	8.2	1210	1214	0.98		
232	4.83	1200		55	0.07	0.015	190	9.4					2000	0.7		3455	0.97		
233	8	2230	249	87	0.2		319	15.6	3	36		70	3740	4.3	7570	6754	1.00	-114	-,2.1
234																			
235																			
236																			
237	8.60	190	6.5	3.6	0.02	<0.02	115	0.89	0.04	111	11	111	126	16		635	0.97	-126.1	-15.89
238	7.41	1900	120	80	23		83	0.58	1.7	348	0	240	3000	1.3		5621	0.96	-101	-11.5
239	8.1	680	25	11	4.2		49	7.2	0.44	388	2	110	820	0.5		1900	0.98	-110	-13.9
240	7.86	1000	48	82	2.1	0.05	160	5.7	1.5	144		360	1500	0.6		3229	0.94	-109.3	-13.46
241	5.7	2000	232	109	0.4		284	13.4	3.8	108		48	3400	1	6140	6200	1.00	-105	-10.8
242		750	60	18	5		70	5.1	1.1	312	3	39	1300	1.1		2406	0.83	-110.6	-13.3
243	7.34	42	2.8	63	15	0.007	40	0.41	0.055	243	0	65	14	0.5		362	1.09	-95	-11.7
244	9.27	220	7.6	1.7	0.79	0.022	28	1.1	0.012	230	38	89	100	0.8		600	1.02	-111	-14.1
245	7.57	1480	42	108	1.7		170	15		90	<1	190	2200	5		4256	1.05	-110.2	-12.36
246	8.5	1600	57	71	1.1		80	17	2	120	15	180	2300	3.3		4385	1.05		
247	8.2	1700	48	75	0.9		120	17	2.1	140	0	210	2400	5.5		4647	1.06		
248	7.86	3100	45	27	32	0.18	63	13	0.32	839	0	6.8	4700	0.7	8490	8401	0.96	-97	-10.5
249	7.65	370	0.9	33	5.8	0.0055	53	1.5		788		250	15	1.9		1119	0.98		
250	6.56	1400	32	70	2.9	0.054	120	14				62	2200	0.5		3901	1.03	-107	-11.7
251																			
252																			
253																			
254	7.40	450	26	44	0.6	<0.02	180	2.4	0.1	114	<1	470	380	7.9		1617	0.99	-125.8	-13.21
255	7.60	68	3	16	2.2	0.01	54	0.3		86	N	80	26	6	297	298	0.97		
256	8.20	72	2	12	0.9	0.04	63	0.08		98	N	60	21	6.9	287	286	1.01		
257	9.9	4400	87	5.7	6.2	0.25	24	4.8	0.3	575	256	1700	4843	7.8	11919	11618	1.02		
258	8.9	363	34.6	3	1.1		342	7.4		279	13.5	118	321	5.8		1347	1.00		
259				64	5		42			768	N	77	34		863	600	0.24		
260																			
261																			
262	8.40			42	20					180	8	74	19			252	0.71		
263	7.70	170	8.4	4.8	0.06	<0.02	110	0.66	0.04	256	5	102	22	8.9		558	1.04	-130.4	-16.68

#	pH	Na	K	Ca	Mg	Fe	SiO2	B	Li	HCO3	CO3	SO4	Cl	F	TDSm	TDSc	ChgBal	delD	delO18
264.1																			
264.2	8.59	525	38	10	2.5	0.14	107	3.5		1380	40	65	48	12		1530	0.90	-132	-17.7
265.1	7.7	156	8	6.2	0.14		116			243		108	24	8.8		547	0.99		
265.2																			
266																			
267	6.50	44	14	56	12	<0.02	68	0.12		264	<1	64	12	2.5		403	0.99	-129.8	-16.87
268	7.20	29	5.9	57	21	0.01	40	0.26		279	N	35	21	0.2	346	347	1.01		
269.1	8.00	15	3.4	51	20	N	25	N	0.5	255	N	25	10	0.4	276	275	0.99		
269.2																			
270	7.47	37	12	69	17		37			334		25	9	0.889		371	1.07		
271																			
272																			
273									1.2										
274	8.70	36		24	7.8					135	12	28	7			181	1.00		
275	9.30	64	0.7	1	<0.1		85		N	144		18	6.3			246	0.98	-127.9	-16.28
276																			
277	7.80	36		62	12				0.76	160	N	88	43			320	1.00		
278	6.50	200	36	43	9.4	0.06	77	2.6		673		51	22	4.7		777	0.97	-135.8	-16.01
279																			
280	6.60	47	13	52	11	<0.02	36	0.17		249	<1	57	10	2		230	3.58	-127.5	-16.28
281	7.10	55	15	50	11	<0.02	46	0.21		278		59	8	2.8		384	1.00	-124.9	-16.24
282	6.72	27	7.5	65	28	0.01	24	0.1	0.063	370		31	8.3	0.5		374	0.99	-120.5	-15.6
283	6.85	21	4.6	69	22	0.01	21	0.07	0.083	320		53	6.9	0.4		356	0.96	-122	-15.9
284	8.65	18	6.7	42	20		20		0.527	217	6.5	35	6.7	0.319		262	1.00		
285	7.2	19	6.5	60	23	0.006	26		0.083	286		52	6.7	1		335	0.98	-127	-16.6
286																			
287	7.8	150	4.8	12	0.3	0.02	105	0.35	0.65			1	16	1.2		291	13.58	-127.8	-16.2
288																			
289																			
290	7.8	4.8	1	49	21	0.01	11			180	0	17	4	0.1		196	1.29		
291	8.29	4.3	1.4	56	17		23			232		19	3.6	0.265		239	1.02		
292									0.008										
293	8	20	9.5	26	8.7	0.007	71		0.019	130		9	21	0.4		230	1.07	-126	-16.5
294		162		13	1.1	0.12	100			375	7.7	17	17	0.75	518	503	1.07		
295																			
296	7.3	9.3	3.4	51	21	0.01	19			250	0	18	4.4	0.4		250	1.03		
297				54	21	0.1	32			267	N	21	4.3		266	264	0.90		
298	6.8	8.2	2.3	51	16	0.01	21	0.03	0.017	220		19	3.2	0.2		229	1.04	-121.5	-16.2
299	8.00			32	25					148	N	83	10			223	0.82		
300				51	23	0.22	37			222	N	68	7.5	0.67	314	297	0.84		
301	8.70	145	3.6	10	0.01	<0.02	58	1.2		50	9	235	44	4.9		535	0.92	-119.5	-15.55
302	9.10	137	2.9	9.6	0.5	0.01	61			12	24	200	46	5	499	492	0.98		
303													1.2			1	0.00	-116	-15.6
304																			

#	pH	Na	K	Ca	Mg	Fe	SiO2	B	Li	HCO3	CO3	SO4	Cl	F	TDSm	TDSc	ChgBal	delD	delO18
305	8.7	102	2.5	4.5	0.01	0.06	52	0.19	0.07	54	7	169	17	3.1		384	0.90	-123.2	-16.01
306	8.50	69	3.4	2	0.2	0.03	36		7.1	146	4	23	6.2	1		217	0.99		
307							62	1		41	22	157	28	3.5		294	0.00		
308																			
309																			
310	8.5	200	2.2	26	0.1	0.02	34			38	0	380	49	8.4		718	0.97		
311																			
312		70		48	13					88	10	190	43			417	0.94		
313		262		16	N			1.6		210		315	78			776	1.00		
314																			
315																			
316																			
317	7.40	148	6.4	82	14	0.01	25		75	82	N	403	79	0.7	810	798	0.99		
318	8.00	245	10	32	6.1	0.66	54	2.3		118		374	102	6.8	891	891	1.01		
319				6	0.9		37		0.22	47	9	109	64	4.8	370	254	0.07		
320	7.70			26	8				6.1	144	N	23	11			139	0.62		
321	7.60	305	16	40	3.3	0.07	46	2.3		112	<1	597	87	7.4		1159	0.93	-130.3	-16.13
322	8.70	160	2.7	7	<0.25		63			68		238	33	11		548	0.97		
323									0.8										
324									5										
325	7.50	74	13	23	0.95		94		0.18	202		38	12	4		358	1.03		
326	8.77	99	3.3	1.1	<0.05	0.03	122	0.7		119	21	47	12	14		379	0.95	-131	-8.4
327	8.72	94	2.7	1.4	<0.05	0.04	112	0.575		126	17	53	12	14		369	0.88	-130	-6.7
328																			
329	7.60	55	4.8	26	13		28			239		41	1	0.31		287	1.01		
330																			
331																			
332																			
333	8.23	57	13	15	0.924		108			130		44	12	0.738		315	1.06		
334	7.6	43	9	28	4.2	0.02	76	0.18	0.04	147	0	34	21	0.7	300	288	1.03		
335.1																			
335.2		80	5	20	4.4	3	68			51	36	106	35		367	382	0.97		
336	9.12	43	1.9	7.2	0.512		68			83	9.3	18	7.7	0.889		197	1.00		
337	7.9	13	4.2	37	12	0.008	28	0.01	0.01	168	0	36	3.7	0.6	221	217	0.96		
338	7.8	17	5.8	45	11	0.15	31	0.045	0.02	158	0	64	4.8	0.4	269	257	0.99		
339	7.6	38	0.8	4.7	0.1	0.01	46	0.1	0	80	0	19	7	0.4	148	155	1.00		
340	7.70	49	6.8	70	22	0.007	32	0.33	2.1	358	N	55	19	1	444	431	1.00		
341	8.00	197	13	51	15	0.04	135		N	545	N	86	42	8	823	815	1.03		
342																			
343									N										
344	8.10	65	2.5	1.6	0.1	0.014	76	0.16	7.6	132	N	26	10	1.2	229	248	0.98		
345	7.8	66	3.5	25	3.4	0.01	70	0.3	0.03	184	0	42	18	1.2	313	320	1.01		
346	7.4	46	4.4	17	2	0.027	46	0.2	0.04	124	0	27	15	0.5	208	219	1.03		
347	7.4	41	7.9	25	2.6	0.009	72	0.34	0.05	156	0	21	12	0.8	261	259	1.02		

#	pH	Na	K	Ca	Mg	Fe	SiO2	B	Li	HCO3	CO3	SO4	Cl	F	TDSm	TDSc	ChgBal	delD	delO18
348	7.8	276	27	58	18	0.015	25	0.61	0.95	702	0	222	36	6.2	945	1015	0.98		
349	7.20	194	24	76	22		53	0.44		702	N	99	31	3	833	848	1.00		
350	7.7	45	1.1	68	6	0.005	42	0.19	0.03	284	0	31	22	0.2	376	355	0.99		
351	7.7	36	0.3	5.8	1	0.002	40	0.01	0.04	94	0	9.5	6.3	0.3	143	146	1.01		
352.1	8.00	28	6.5	62	22	0.06	25	0.12		321	N	47	8.6	0.6	380	358	0.97		
352.2	9.98	52	1.5	0.723	0.06		70			43	29	14	10	4.8		203	0.94		
353	8.06	12	3.3	40	18		22		1.5	185		38	16	0.22		241	0.95		
354	8.1	54	12	57	17	0.008	32	0.44	0.25	368	0	17	14	2.8	380	388	1.00		
355	6.88	36	5.5	71	23	0.01	24	0.13	0.11	380		29	9.5	0.9		386	1.00	-114	-15
356	7.03	24	5.9	58	19	0.01	27	0.14	0.075	290		47	9.9	1.3		335	0.93	-119	-15.7
357	7.14	5.3	1.6	67	24	0.01	13	0.03	0.018	300		14	2.9	0.2		276	1.05	-108	-14.5
358	7.5	10	3.4	50	21	0.003	26		0.022	270		12	6.6	0.2		262	0.97	-105	-14.3
359				40	23		46		10	178		27	18		283	242	0.98		
360	7.60	24	5.1	60	24	0.01	28	0.1	0.85	300		43	9	1	343	342	1.00		
361	7.38	22	4.4	55	22	0.009	25	0.11	0.053	260	0	44	9.3	1.2		311	1.02	-119.5	-15.8
362	9	1680	18	7.1	5.4		20	18.4	0.95	1590	200	425	937	7.68	4920	4101	1.09		
363	7.8	68	17	56	17	0.008	51	0.4	0.24	350	0	47	26	2	405	457	1.00		
364	8	123	25	91	31	0.1	37	0.8	0.33	698	0	59	9.8	2.4	700	723	1.00		
365	7.6	120	22	100	26	0.002	27	0.62	0.3	673	0	51	15	2.7	732	696	1.02		
366				44	37	0.1	11		0.324	124	N	11	2		132	166	2.26		
367																		-101	-13.2
368																			
369	7.20			1.1	0.6			0.02		50	N	22	2	0.2		51	0.08		
370													578			578	0.00		
371	7.90	792	60	38	38	0.8	23	9.8		720	N	323	860	3.2	2500	2502	0.96		
372	8.40	875	2.5	71	2		48			56		1120	625	5.6		2777	0.99		
373	7.10			48	7.4			1.7		60	N	98	70	4.2		259	0.58		
374	7.90			17	2.7			0.06		128	N	12	3	0.2		98	0.44		
375																			
376	7.00			49	9.6	0.17				614	N	120	74	4.3	940	559	0.22		
377	8.30			13	4			0.42		158	1	38	7	1.5		143	0.26		
378	8.3	430	45	37	4		140	9.4		224	0	80	460	3.1	1494	1319	1.19		
379																			
380																			
381	7.10	334	16	47	2.7	0.12	62	1.4		328	N	487		7	1180	1119	1.10		
382	7.90			48	4.9	N				266		106	54	2.7	560	346	0.34		
383				9.6	2.4				0.65				47			59	0.51		
384																			
385	7.70	47	2.5	62	5.9	0.03	38	0.18		240	N	48	23	0.8	346	345	1.01		
386	7.75	240	0.4	220	0.4		17		0.25	110	0	890	49	0.8	1600	1472	0.99		
387	7.05	49	0.9	21	1.3	0.06	55		0.02	160	0	21	7.8	0.3	229	235	1.00		
388	9.00	81	2.6	1.6	N		61		N	187	N	16	6	0.6	287	261	1.02		
389	7.00	142	15	74	27	1	30			577	N	71	34	0.9	624	679	1.05		
390	8.20			11	5.8	N				155	N	24	55	4.5	427	177	0.21		

#	pH	Na	K	Ca	Mg	Fe	SiO2	B	Li	HCO3	CO3	SO4	Cl	F	TDSm	TDSc	ChgBal	delD	delO18
391	7.7	45	2.8	57	7.7		37		0.05	231	0	48	23	0.6	396	335	1.01		
392	8.00			36	22					357	N	25	5			264	0.55		
393																			
394																			
395	8.00	29	7.2	44	23		33	0.1		260	N	36	11	0.5		312	1.03		
396	8.40	23	5.2	45	23	N	28	0.2	N	272	N	27	8	0.5	295	294	1.00		
397	8.10	32	6.8	39	18		31	0.1	5.6	231	N	34	9.7	0.5	286	285	1.04		
398	8.3	3.8	0.9	55	31	0.006	14		0.013	289		8.9	4.1	0.1		260	1.09	-97	-12.9
399	8	34	5.6	26	3.5	0.009	55		0.057	146		18	10	1.3		225	1.03	-101	-13.4
400																			
401	8.10	38	6.8	31	9.8	N	51	0.1		189		29	15	1.6	271	275	0.99		
402	7.5	6.5	1.5	56	26	0.042	14		0.016			6.9	7.9	0.1		119	14.14	-103	-13.7
403	8.20	46	15	43	6.2	<0.01	91			239	N	42	12	1.4	380	374	0.97		
404	7.20	39	14	34	4.8		106			200		30	8	1.4		336	0.99		
405	7.90	169	3	18	1.5		69	0.4		254		127	45	5	564	563	1.01		
406	8.20	106	5.8	14	1.9	0.12	68			194	N	69	27	4	368	391	1.01		
407	7.35	64	9.7	44	16	0.023	38		0.11			75	20	3	372	270	2.87		
408	8	50	2.2	22	1	0.05	22		0.05	147	0	40	7.6	0.9	210	218	0.97		
409	7.6	120	11	44	16	0.006	28			270		150	27	3.8	537	533	1.06		
410	7.30	71	8	51	18	N	20	0.51		300	N	80	22	2.2	552	420	1.00		
411		69	7.8	47	21		23	0.31	0.11	302	N	78	21	1.5	547	417	1.00		
412		69	7.8	48	19		22	0.26	0.0958	300	N	75	17	1.7	419	407	1.02		
413	7.90	69	6.8	45	20		29		0.6	285	N	81	21	1.3	528	413	1.01		
414	7.60	71	7.8	46	19		28		0.0419	283	N	80	22	1.2	529	414	1.02		
415		65	7.6	50	24	N	22	0.32		310	N	76	20	1.6	555	419	1.02		
416	7.20	69	7.7	49	21	0.02	23	0.1		310		80	21	1.4	425	425	0.99		
417		68	7.8	45	21		22	0.38		300		78	20	1.5	541	411	0.99		
418		97	8.6	44	19		28	0.44		318	N	105	25	1.3	480	485	1.00		
419	7.40	80	8.8	48	20		26		0.0463	311	N	92	32	1.4	593	461	0.97		
420		62	7.8	45	18		22	0.27		284	N	64	21	2.1	400	382	0.99		
421	7.3	300	9.5	76	39	0.006	26			346		500	130	1.7	1260	1252	1.02		
422		21	9.7	48	15	0.16	17			239	N	28	5		330	261	1.03		
423				55	29		18			239	N	42	4.9		268	266	1.04		
424		8.2		50.3	22.2					243.8	N	32.9	0.7		358.1	234	1.00		
425		5.7	1.2	47	23	0.02	13			235		35	4.5	0.2		245	0.96		
426	7.03	8.4	1.8	94	29	0.007	13		0.013	201		180	16	0.2		441	1.00	-91	-12.5
427	7.35	29	3.7	26.7	44.2	0.01	29.1	0.2		280		91	27	0.44	409	389	0.87		
428	7.4	8.1	3.6	48	25	0.05	14			222	0	51	6.5	0.2	266	266	1.00		
429				150	44		21			171	N	453	22		863	774	0.86		
430				155	50		30		1.2	205	N	405	35		857	776	0.93		
431				106	20					84	N	1027	112		1785	1306	0.27		
432	7.4	81	11	47	21	0.006	34		0.11	303		90	34	1.7		469	1.00	-101	-12.95
433	7.15	78	11	46	20	0.01	33	0.31	0.13	300		100	34	1.9		472	0.95	-100	-12.9
434	7.16	88	11	58	25	0.006	30		0.14	272		160	53	2.1		561	0.96	-97	-12.95

#	pH	Na	K	Ca	Mg	Fe	SiO2	B	Li	HCO3	CO3	SO4	Cl	F	TDSm	TDSc	ChgBal	delD	delO18
435	7.35	38	10	51	25	0.01	24		0.11	239		54	26	1.2		347	1.12	-75	-10.35
436		99	10	65	28		31	0.3		288	N	174	60	2.4	614	611	0.99		
437		101	11	70	26		29	0.3	0.6	274	N	179	64	2.3	620	617	1.02		
438	7.3	25	5.3	130	43	0.08	29		0.039			370	15	1		618	1.38	-87	-11.65
439	7.27	120	13	110	48	0.043	21		0.19	210		360	170	2.1		948	0.95	-97.5	-13.3
440	9.60	36	2.7	5	0.7	<0.15	0.64	0.57		37	N	64	8.1	0.1	160	136	0.89		
441	8.1	340	26	500	170	0.01	17	1.3	0.66	160	0	1900	380	1.5		3415	1.03		
442	7.9	300	20	450	140	0.03	17	1.1	0.6	160	0	1600	340	1.4		2949	1.04		
443	6.96	130	13	120	47	0.004	23		0.21	226		380	200	1.4		1026	0.91	-94	-13.45
444	7.00			298	113	N	38			98		1200	1190	1.5	3720	2889	0.40		
445	8.12	271	7.4	62.7	2.7	<0.15	38.94	0.58		113.8	N	431.3	143.6	4.05	1040	1018	1.01		
446	7.90	680	17	290	4.8	0.01	40	1.4		41	N	730	1000	3.9	2790	2787	1.01		
447	7.60	160	3.1	37	6.9	0.01	25	0.7		79	N	180	180	1.4		633	0.93		
448	7.3	350	8.3	220	75	0.02	28	0.82		203		570	600	1	2090	1953	1.01		
449	7.9	160	4	58	16		27			156	0	190	180			712	0.97		

Nevada Geothermal Resource Use — 1993 Update

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Geology

Nevada is well-endowed with both high- and low-temperature geothermal resources. Over 40 percent of the state is believed to have potential for the discovery of high-temperature (>90°C) geothermal resources, and another 50 percent has potential for low- to moderate-temperature (<°90C) resources (see Figure 1). Surface and subsurface indications of these resources are the more than 1,000 thermal springs and wells in the state. Realistically, this number of individual springs and wells represents several hundred resource areas.

Geothermal reservoirs in the northwestern part of the state have generally higher temperatures; these reservoirs are usually interpreted as being related to circulation of groundwater along faults to deep levels in a region of higher-than-average heat flow. In east-central and southern Nevada, the low- to moderate-temperature geothermal resources are generally believed to be related to regional groundwater circulation in fractured carbonate-rock aquifers. Discharge areas (for example, warm springs) may be up to several hundred kilometers from the area of recharge, and the waters may have circulated for dozens to hundreds of years to depths of several kilometers. Maximum temperatures attained during this journey could be 100°C or higher, but spring temperatures at discharge points are generally less than 65°C.

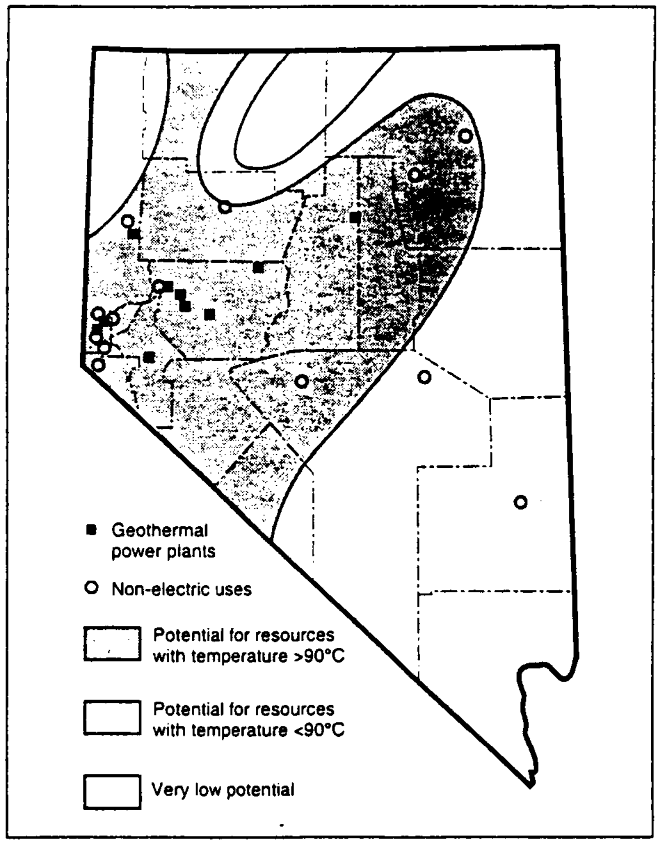

Figure 1. Generalized locations for Nevada's geothermal resources.

Exploration and Development

Two hundred and eighteen geothermal well permits were issued from 1988 through 1993 by the Nevada Division of Minerals. They include 58 industrial-class production wells, 30 domestic class, 88 observation or gradient wells, 10 commercial-class, and 25 injection wells. During this same period 109 geothermal wells are reported to have been drilled, with a total amount drilled of approximately 86,500 m. Forty-five of the wells drilled were production wells, with a total amount drilled of approximately 44,800 m. Figure 2 and Table 1 illustrate the number of power generating wells and pace of drilling since 1980.

From 1989 through 1992 noncompetitive and competitive federal geothermal leases in Nevada generated $1,699,282 in rental fees, $849,641 of which was returned to the State of Nevada. Federal production royalties during the same period generated $7,485,000, of which $3,742,500 was returned to the State. Geothermal lease returns ($849,641) and royalty returns ($3,742,500) to Nevada totaled $4,592,141. By regulation, half of all funds collected by the Bureau of Land Management from federal geothermal leases and production royalties is returned to the state.

Geothermal Electric Power Generation

Electric power is generated using geothermal resources at 10 plants in northern Nevada (Table 2, Figure 1). The state's

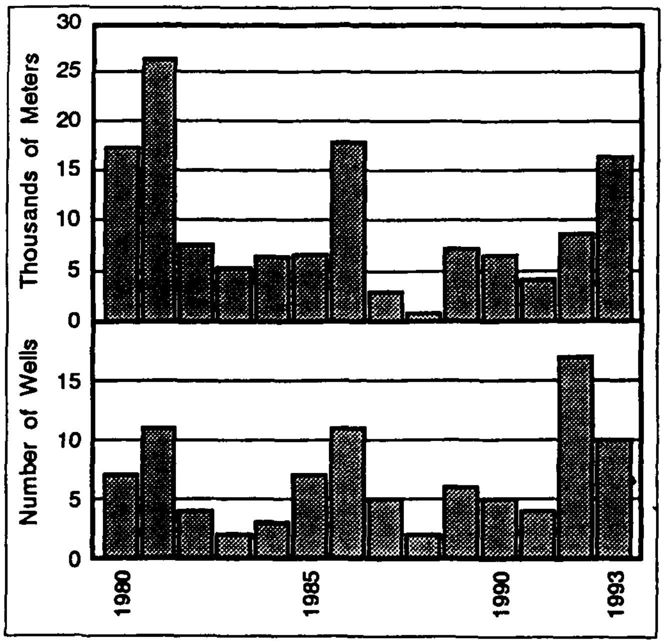

Figure 2. Industrial-class (power generating) wells drilled in Nevada, 1980-1993.

total installed geothermal generating capacity is second only to California.

In 1993 the state-wide peak power demand was 3,755 MW; the total installed generating capacity of Nevada's two major utilities (which supply most of the state's customers) is nearly 2,600 MW (Public Service Commission of Nevada). Thus, geothermal energy provides about 7 percent of the total electricity generated within Nevada (although only about 3 percent of the peak load). Over 40 percent of Nevada's geothermal electric power is exported to California.

From 1989 to 1992, total Nevada geothermal electrical production was 4,076,616 megawatt-hours with an approximate sales value of $307,410,000. Production capacity in 1988 from eight geothermal power plants was 115.8 MW (gross) while current power production from 10 existing geothermal power plants in Nevada is 191.7 MW gross (Table 1). These values represent a 17 percent increase in sales value of the power sold from 1988 to 1992 and an increase in installed gross power production capacity of 60 percent over 1988.

It is important to note that in 1988 Nevada had nearly a threefold increase over 1987 in the amount of online geothermal generating capacity (Figure 3). The primary reason for this increase was the Dixie Valley 60 MW Oxbow Geothermal plant being put online. The OESI plants at Empire (4.8 MW) and Soda Lake No. 1 (3.6 MW) were also brought online during this period.

According to a 1991 Department of Energy estimate, under stable market conditions and with continuing technologic advancements in the geothermal industry, Nevada's projected electrical production capacity from known geothermal resources by the year 2010 should be at least 600 MW (Energy Information Administration, 1991). It is estimated that, for the Basin and Range province as a whole, aggressive exploration activity and continued rapid geothermal technologic advancements could add up to 2,000 MW of production capacity from known resources and new discoveries over the next 10 to 20 years (Wright, 1992). These relatively optimistic future scenarios should be tempered by today's reality of low-priced natural gas, increases in efficiency of fossil fuel generating equipment, and anticipated changes in power sales contracts. The future is bright for Nevada's high-temperature resources, but the pace of development will depend on many factors not related to the viability of the geothermal resource.

Table 1. 1992 directory of Nevada geothermal power plants.

Year	Total # drilled	Total depth(m)	No. industrial wells drilled	Total depth(m)
1988	11	4,268	3	1,098
1989	15	14,817	6	7,317
1990	12	11,280	5	6,707
1991	14	12,561	4	4,268
1992	36	17,988	17	8,841
1993	21	25,596	10	16,686
TOTAL	109	86,510	45	44,917

Beowawe

The **Oxbow/Beowawe Geothermal Power Co., Beowawe** plant came online in 1988. It is a 16 MW (gross), dual-flash plant, which uses geothermal fluids from three wells with a resource temperature of 221°C.

Brady Hot Springs

The **Brady Hot Springs** geothermal power plant (Figure 4) came online in July 1992. Plant operation and maintenance is being performed by **Oxbow Power Services, Inc.**

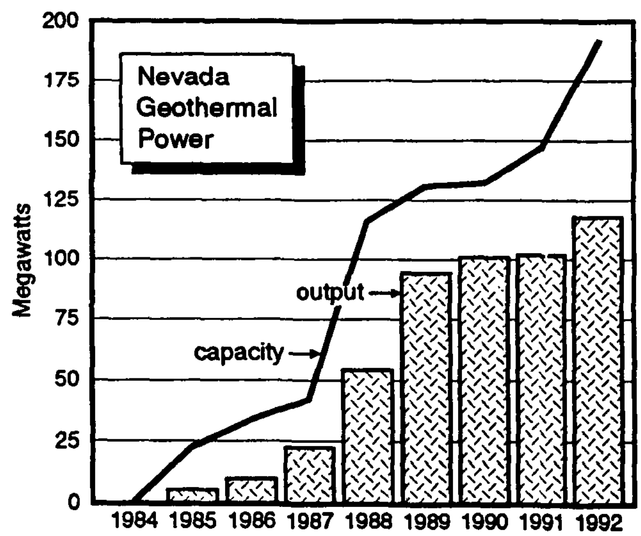

Figure 3. Rated capacity and average net output of Nevada geothermal plants, 1984-1992. Average net output is annual sales in megawatt-hours divided by the number of hours in a year (8,760).

Figure 4. Steam separators and power house at Brady Hot Springs plant (Brady Power Partners), Churchill County, NV. *Larry Green photo.*

Table 2. Total number of all classes of geothermal wells drilled and number of industrial-class geothermal wells drilled by year, 1988 through 1993. Source: Hess, 1993; Nevada Division of Minerals, 1993.

Plant name (year on line)	Production capacity[1] (MW)	1992 Production (MWh) Gross	1992 Production (MWh) Net (sales)	Location	Operator
Beowawe (1985)	16.0	138,196	104,415	S13,T31N,R47E	Oxbow/Beowawe Geothermal Power Co. P.O. Box 6 Beowawe, NV 89821
Bradys Hot Springs (1992)	21.1	69,999	54,563	S12,T22N,R26E	Oxbow Power Services, Inc. P.O. Box 649 Fernley, NV 89408
Desert Peak (1985)	8.7	85,364	76,906	S21,T22N,R27E	Western States Geothermal Co. P.O. Box 2627 Sparks, NV 89432-2627
Dixie Valley[2] (1988)	66.0	535,220	483,307	S7,T24N,R37E S33,T25N,R37E	Oxbow Geothermal Corp. 5250 South Virginia St. Suite 304 Reno, NV 89502
Empire (1987)	3.6	17,783	12,752	S21,T29N,R23E	OESI/AMOR II P.O. Box 1650 Fallon, NV 89407
Soda Lake No. 1 (1987) and Soda Lake No. 2 (1991)	16.6	107,315	84,419	S33,T20N,R28E	OESI/AMOR III P.O. Box 1650 Fallon, NV 89407
Steamboat I, I-A (1986) and Steamboat II, III (1992)	31.1	104,574	79,790	S29,T18N,R20E	S.B. Geo, Inc. P.O. Box 18087 Reno, NV 89511
Stillwater (1989)	13.0	72,707	59,692	S1,T19N,R30E S6,T19N,R31E	OESI/AMOR IV P.O. Box 1650 Fallon, NV 89407
Wabuska (1984)	1.2	6,262	3,860	S15,16,T15N, R25E	Tad's 10 Julian Lane Yerington, NV 89447
Yankee Caithness (1988)	14.4	82,280	76,096	S5,6,T17N,R20E	Yankee Caithness J.V.L.P. P.O. Box 18160 Reno, NV 89511
TOTAL	191.7	1,219,700	1,035,800		

[1]Production capacity from currently developed geothermal resources.
[2]Gross output of the Dixie Valley plant occasionally exceeds 66 MW.
Source: Hess (1993).

The plant uses 5.4 million pounds of brine per hour produced from six of eight production wells. The production zone is 300 to 425 m deep with a resource temperature of between 172 and 182°C. The wells supply two high pressure turbines and one low pressure turbine in a two stage system that produces 21.1 MW gross output. Geothermal fluids are injected into three of five available injection wells (Ettinger and Brugman, 1992; GRC *BULLETIN*, v. 21, no.1).

Desert Peak

The **Western States Geothermal Co., Desert Peak** plant went online in 1985. It was designed by Phillips Petroleum Co. and uses a biphase turbine built by TransAmerica Corp. Production capacity from the currently developed resource is 8.7 MW. The resource temperature is approximately 205°C and wellhead temperature is 165°C.

Dixie Valley

The largest single geothermal power plant in Nevada, **Oxbow Geothermal Corp. Dixie Valley** plant, came online in 1988 producing 55-59 MW (net). (Gross output sometimes exceeds 66 MW, as listed on Table 2.) The power is produced in a double-flash turbine generator and purchased by Southern California Edison Co. Oxbow estimates a geothermal energy reserve in Dixie Valley sufficient to supply 200 MW for 30 to 60 years (GRC *BULLETIN*, June 1987; *Reno Gazette-Journal*, August 6, 1988).

Empire/San Emidio Desert

The **OESI/AMOR II Empire** plant came online in 1987 and consists of four Ormat Energy Converter Modules with a gross output of 3.6 MW from currently developed geothermal resources. Production is from a liquid-dominated geothermal source at 129 to 137°C. **San Emidio Resources** continued their geothermal program in the **San Emidio Desert** near Gerlach, Nevada. Early in 1991 San Emidio Resources signed a 5 MW, 30-year geothermal power supply contract, effective 1992, and a 20 MW, 30-year geothermal power supply contract, effective 1995, both with Sierra Pacific Power Co. (GRC *BULLETIN*, February 1991). The initial price paid for produced electricity under the long-term contracts is reported to be approximately 5 cents per kWh. At that time plans called for construction of a 6.5 MW binary plant to be online by November 1992. Since then San Emidio Resources requested and was granted a suspension of the 5 MW project in order for Sierra Pacific Power Co. and San Emidio Resources to determine the feasibility of combining the 5 and 20 MW projects into one project. In July 1993, Sierra Pacific Power Co. executed an amendment to the long-term power purchase agreement with San Emidio Resources. The agreement now calls for a 30 MW geothermal power plant to be online by November 1, 1995 (Public Service Commission of Nevada).

Fallon

In early 1992 the **U.S. Navy** issued a request for proposal to construct an 80 to 90 MW geothermal power plant at the Fallon Naval Air Station. If this plant is constructed, it will be Phase I of the Navy's geothermal program. Phase II will consist of a second 80 to 90 MW facility to be constructed within 10 years of completion of the Phase I project. The Navy estimates that the potential geothermal resource in the area will be able to produce 300 to 500 MW. The exploration drilling and reservoir testing performed during the initial phase of this project will be used to better define the geothermal potential of this area. Based on previous exploration information it is expected that the resource will be in the 175 to 205°C range.

Fish Lake Valley

Fish Lake Power Co. continued their extensive drilling efforts to develop a geothermal resource in the Fish Lake Valley area of Esmeralda County. If a geothermal generating facility is built, the electricity would be delivered to California under a Standard Offer No. 4 Contract.

Hot Sulfur Springs

Earth Power Energy and Minerals has requested an avoided-cost purchase contract agreement with Idaho Power Co. If a contract were obtained, a 9.9 MW geothermal power plant could be constructed at Hot Sulfur Springs, Elko County, Nevada (*Reno Gazette-Journal*, October 10, 1993).

Rye Patch

The **Rye Patch Limited Partnership (OESI)** is currently nearing completion of a 12.5 MW binary generating plant at their site near **Rye Patch** reservoir. The company has a signed purchase agreement with Sierra Pacific Power Company with an anticipated plant online date of November 30, 1993. This has been delayed while the company continues to develop sufficient and continuous geothermal resources to fuel the plant.

Soda Lake

On August 19, 1991, the 13 MW **OESI/AMOR III Soda Lake No. 2** geothermal power plant completed commercial operations testing and went online. This plant is adjacent to the 3.6 MW OESI **Soda Lake No. 1** plant that came online during 1987 (GRC *BULLETIN*, October 1991). Both plants are producing from a liquid-dominated geothermal source at 160°C.

Steamboat Springs

Two 12 MW, air-cooled, binary geothermal power plants, **Steamboat II and III**, operated by **S.B. Geo, Inc.**, were brought online in December 1992, adding 24 MW of produc-

tion to the existing 7.1 MW **S.B. Geo Steamboat** plant, for a combined gross production capacity of 31.1 MW.

The geothermal fluid cycle at the new plants is completely contained and the fluids are injected back into the ground (closed binary-cycle system). The existing resource is expected to last 30 years or more and can support an additional 36 MW of production capacity. Based on this, plans are currently being formulated to determine the feasibility of installing an additional 24 MW facility in the near future. In December 1993, S.B.Geo, Inc. received a $7.2 million grant from the U.S. Department of Energy to develop a pilot project known as the Kalina Pilot Plant. The purpose of the project is to increase the efficiency of extracting heat from hot geothermal fluids.

Yankee Caithness J.V.L.P. operates a 14.4 MW (gross) flash turbine system producing from a 170°C resource. The **Yankee Caithness Steamboat** plant came online in 1988, and the produced power is purchased by Sierra Pacific Power Co. on a 30 year contract.

Stillwater

OESI/AMOR IV, Stillwater Geothermal plant came online in April 1989. Total project cost was $36 million. The air-cooled plant consists of 14 Ormat Energy Converters that have a combined gross generating capacity of 13 MW. The plant uses a liquid-dominated geothermal source ranging in temperature from 155 to 170°C. The plant operates on a closed system; all geothermal liquids are injected (Ormat Fact Sheet, 1989; Geo-Heat Center, Fall 1989).

Wabuska

Tad's Wabuska plant came online in 1984. Current production capacity is 1.2 MW produced from two Ormat Energy Converter modules. The plant operates on fluids at 107°C. produced from a depth of 107 m (GRC *BULLETIN*, July, 1987).

Non-Electric Low- and Moderate-Temperature Applications

The majority of Nevada's population is concentrated in two areas, Reno-Carson City and Las Vegas. Many of the state's geothermal resources are remote from any population centers, thus limiting some potential applications. Although 50 or more small-to-large communities are located within 8 km of geothermal resources, only a few of these areas have been able to use these resources effectively. The reasons for this under-utilization are varied. Although some reasons relate to technical and engineering problems (resource size and temperature, heat loss during transport, etc.), many more are economic (high capital outlays, long payout, under-capitalization of projects) and perceptual (unconventional *vs.* conventional technology, short *vs.* long-term cost evaluations, uncertainties about long-term economic risks).

There have been attempts to use Nevada's low- and moderate-temperature geothermal resources in more than 20 areas, mainly in the past 5-10 years. Additionally, economic and/or technical appraisals of more areas have been conducted, but for a variety of reasons projects were not completed.

Moana Geothermal Area

Moana Hot Springs, located in the southwestern part of Reno, have not flowed at the surface for at least 15 years. The springs were the discharge point for an area of thermal groundwater that has been used for a spa, swimming pool, and home heating for nearly 100 years. Recent use for home space heating began in the 1960s. The area today is predominantly residential. We estimate that the area of thermal groundwater encompasses at least 9 km^2. In this area there are more than 300 homes that use geothermal fluids for space heating. One hundred and thirty of these homes are part of a district heating system, while most of the rest use downhole heat exchangers in individual wells. A smaller district heating system has retrofitted 12 homes for geothermal heat, and plans to add another four in the spring of 1994. A large hotel, a motel, about three apartment or townhouse complexes, five churches, and a county swimming pool also use the resource. The Veterans Administration Hospital, located about 2 km northeast of the geothermal area, drilled a deep well several years ago and encountered approximately 43°C water. The well was plugged and abandoned.

Steamboat Hot Springs

The Steamboat geothermal area consists of a deep, high-temperature (215 to 240°C) geothermal system, a shallower, moderate-temperature (160 to180°C) system, and a number of shallow, low-temperature (30 to 80°C) subsystems (Goranson and others, 1991). The higher temperature systems are used for electric-power generation (see the preceding section). A number of low-temperature thermal groundwater anomalies are in an area of approximately 30 km^2 centered on the hot spring area (Goranson and others, 1991), but these thermal areas are not well known and are little used. A few homes in the Steamboat area have used low-temperature fluids for over 40 years, and one or more spas have been active in the springs area since the 1860s. Presently probably less than a dozen homes use the low-temperature geothermal fluids for space heating or domestic hot water (including swimming pools). About one domestic geothermal well permit has been issued per year over the last 5 to 7 years.

Bower's Hot Springs

A large outdoor swimming pool and smaller children's pool at the Washoe County Park at Bower's Mansion (lo-

cated between Reno and Carson City), are supplied with warm water from a geothermal well located near the spring.

Carson City Area

Water from a well at the site of Carson Hot Springs in northern Carson City is used directly in a swimming pool. In southeast Carson City, thermal groundwater is found in the State Prison/Pinyon Hills area. In the past, there have been a few attempts to use the thermal groundwater from domestic wells in that area for space heating. Geothermal space heating has been considered, but not implemented, for at least two schools in the area.

Saratoga Hot Springs

A California company, Lobsters West, has proposed raising lobsters near the warm springs located about 15 km southeast of Carson City. The geothermal fluids would be used to heat tanks in which the lobsters would grow to full size. The experimental study is proposed to last 4 years; live lobsters would be shipped twice a month to local markets (*Reno Gazette-Journal*, November 4, 1993).

Hobo Hot Springs

These hot springs, located about 15 km south of Carson City, were used to raise tropical fish and Malaysian prawns in the late 1980s. Lobster raising was also considered. The water temperature is slightly over 40°C. The site is presently inactive.

Walley's Hot Springs

Walley's Hot Springs, located near Genoa, about 20 km south of Carson City, was the site of a large spa in the late 1800s and early 1900s (Garside and Schilling, 1979). A modern spa was built on the site in the early 1980s. In addition to use of the geothermal fluids for bathing and domestic hot water, the buildings are heated with geothermal energy (Lienau and others, 1988).

Gerlach

Hot springs located just west of the town of Gerlach (Great Boiling Springs) have been used for bathing for many years. The Gerlach General Improvement District built a bath house using geothermal fluids in 1989. The facility was planned for use by tourists and local residents. The facility has been unable to obtain a permit from the health department because sediment from the well plugged water filters. Future plans are for a geothermal heat exchanger system to heat city water for the spa. Geothermal groundwater apparently extends under at least part of the town, as at least two Gerlach homes use geothermal wells for space heating. The water in one well is reported to be 35 to 36°C (unpublished data, Nevada Division of Minerals).

San Emidio Desert

A vegetable dehydration plant is under construction in the San Emidio Desert area southwest of Gerlach (Figure 5). The plant is a few kilometers north of the Empire (OESI/AMOR II) Electric-Power plant. Integrated Ingredients (Spice Islands, Fleischmann's, and other brands), part of international food manufacturer Burns Philp, is contracting for the construction of the facility, which will employ about 25 persons when completed in early 1994. The number of employees may increase to about 65 after 18 months. Onions and garlic will be dehydrated and stored at the plant (*Reno Gazette-Journal*, August 31 1993). The plant will use approximately 150°C geothermal fluid.

Brady Hot Springs

A geothermal vegetable dehydration plant has been operated at this site, about 80 km northeast of Reno, since 1978. The facility uses a moderate-temperature (132°C) geothermal well on site. Since 1993, additional geothermal fluid has been supplied by the nearby Brady Power Partners electric power generation plant, operated by Oxbow Power Services, Inc.

Wabuska Hot Springs

In addition to the rather low-temperature electric-power generation plant operated at Wabuska by Tad's Enterprises, several non-electric applications have been located in the area, but none are active today. A hydroponic geothermal greenhouse operation (tomatoes, cucumbers, etc.) was built on the site in the early 1970s, but few vegetables were grown. Tad's Enterprises has in the past operated a geothermal ethanol facility, a plant to grow algae (*Spirulina*) for human consumption, and facilities to raise Malaysian prawns, catfish, and tropical aquarium fish. Some of these were pilot facilities, rather than actual production facilities.

Rye Patch Geothermal Area

Florida Canyon Mining Co. operates a large open-pit gold mine and heap-leach gold recovery facility about 50 km northeast of Lovelock, and 7 km north of the area presently under development by Rye Patch Limited Partnership for geothermal electric power production. A 180 m well produces fluids at approximately 100°C; these fluids provide makeup water for the cyanide extraction solutions. Heat from heat exchangers is also extracted to heat the solutions. The heating of cyanide solutions aids extraction during cold weather, and may somewhat enhance total gold recovery.

Darrough's Hot Springs Area

Round Mountain Gold Corp. operates a large open-pit gold mine and heap-leach gold recovery facility near the Darrough's Hot Springs geothermal area in Nye County. Geothermal fluids from shallow (approximately 300 m)

Figure 5. Vegetable-dehydration plant under construction in the San Emidio Desert. *Larry Green photo.*

wells are used in a heat exchanger to transfer heat to cyanide heap-leach solutions (Trexler and others, 1990).

Carlin

Carlin Hot Springs, located near the Humboldt River southwest of the town, have a reported temperature of 80°C (Trexler and others, 1982). The Carlin High School used 31°C geothermal fluid from 280 m well from 1986 to 1992 in a closed-loop space heating system. The well was abandoned in 1992, apparently in part because of scaling problems with iron and manganese.

Elko Area

Hot springs south of the town of Elko were first used in a bath house in the 1860s (Garside and Schilling, 1979). Thermal groundwater was known to exist to the north of the springs under a part of the town, but no use was made of it until the Elko Heat Company began supplying geothermal fluid for space heating to several downtown buildings in 1982 (Rafferty, 1988). The company has continued to grow; in 1993 it served 16 commercial customers and two residential customers (Mike Lattin, oral commun., 1994).

The Elko County School District, in conjunction with the Elko General Hospital, developed a district geothermal heating system in 1986. The system supplies heat to eight buildings (two schools, a municipal swimming pool complex, a gym, a convention center, a hospital, a city hall, and a school administration building). In 1988 the estimated combined savings to all users was $300,000 per year (Rafferty, 1988; Richard Harris, oral communication, 1994).

Jackpot Area

Two wells drilled in 1988 at the Y3 Ranch about 7 km southeast of Jackpot, were used for raising catfish. The maximum reported well temperature was 40°C (Lund and others, 1990). The catfish-raising operation was not active in late 1993, reportedly due to insufficient geothermal fluid.

Wells Area

Warm springs about 1.5 km north of the present town of Wells were referred to by travelers on the emigrant trail in the 1850s as Humboldt Wells (from which the town name is derived). Thermal (32 to 34°C) groundwater is used by an elementary school and the Wells Rural Electric Co. in heat pump applications for space heating.

Duckwater (Big Warm) Springs

A geothermal catfish-growing facility has been operated at this site since 1982. The facility was purchased in 1992 by Robert and Jeff King (Valley Fish) of Preston, Idaho. The facility, located about 110 km west of Ely, produces over 300,000 pounds of prime 8-ounce catfish filets per year that are shipped to Idaho for sale (*Geo-Heat Center Quarterly Bulletin,* December 1992).

Caliente Hot Springs

The town of Caliente in Lincoln County derives its name from the local hot springs. A number of wells in the area have reported temperatures from 40 to 80°C (Garside and Schilling, 1979; Lienau and others, 1988). A motel supplies geothermal well water to bathing pools and individual room whirlpool baths, and a trailer park supplies hot water to individual mobile homes. The Lincoln County Hospital (20 beds) was heated using 39°C water from a well on the site, but reduced temperatures (to 28°C) forced reliance on electric resistance heating. The hospital plans to use the lower-temperature fluids from its well for heating and cooling using heat-pump technology. The city swimming pool used

geothermal heat in the past, but was damaged during the winter of 1992 and will probably be replaced. The City of Caliente has a grant from the Rural Development Administration to use the local geothermal resources. A nearby perlite processing plant may be the first user of plant process heat. If more funding is found, the city plans to provide heat to the hospital, swimming pool, and eventually an elementary school and youth training facility (Glen Van Roekel, oral communication, 1994).

Ash Springs

Thermal waters (31 to 36°C) at Ash Springs, located about 10 km north of Alamo, in Lincoln County, have been used in the past at a spa on the site. The facility is presently closed.

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Comments

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NEVADA LOW-TEMPERATURE GEOTHERMAL RESOURCE ASSESSMENT: 1994

By

Larry J. Garside

FINAL REPORT

Prepared for

The Oregon Institute of Technology
GeoHeat Center

Prepared as part of a study of low- to -moderate temperature geothermal resources of Nevada under the U.S. Department of Energy Low-Temperature Geothermal Resources and Technology Transfer Program

CONTENTS

INTRODUCTION

Previous Geothermal Assessments

A statewide inventory of the geology and geochemistry of Nevada's geothermal resources was begun at the Nevada Bureau of Mines and Geology (NBMG) in the late 1970s. NBMG had previously published a 1:1,000,000-scale map of hot springs, sinters, and volcanic cinder cones (Horton, 1964b) and several brief summaries of Nevada's geothermal resources (Horton, 1964a; Garside and Schilling, 1972; Garside, 1974). This inventory, published as NBMG Bulletin 91 (Garside and Schilling, 1979), followed a format used in a number of NBMG publications on mineral commodities of Nevada. The bulletin contained descriptions, by county and hot spring area, of the better known geothermal areas. These descriptions included, where available, maps and other data on the geology, and descriptions of historical and present use. Temperature and water chemistry data were presented in an appendix having about 1,400 individual entries (records). These records commonly included multiple entries for the same or adjacent springs as well as numerous well records from geothermal areas which have a larger areal extent than individual spring sites. A 1:1,000,000-scale map was included in the pocket of NBMG Bulletin 91; nearly 400 geothermal sites (springs, spring groups, well groups, etc.) were included on that map. The lower temperature cut-off for inclusion of data in Bulletin 91 was 70°F (21.1°C).

The location, chemical data, and references for the geothermal springs and wells listed in Bulletin 91 were collected by an extensive and relatively complete search of the available literature. These data were entered by hand on data-collection forms, and these forms were used to typeset the listing of data in the bulletin (Appendix 1). A source of unpublished data was a computer database of water-quality data maintained by the Desert Research Institute at Reno.

GEOTHERM is an acronym for a U.S. Geological Survey (USGS) computerized information system designed to maintain data on the geology, geochemistry, and hydrology of geothermal sites primarily within the United States (Teshin and others, 1979; Bliss, 1983). The system was first proposed in 1974, and was active until 1983. The system utilized a mainframe computer, and most of the data were entered by use of key-punch cards. Key punching was done from a rather extensive data-entry form. When the GEOTHERM database was taken off line, a number of products were published or made available to preserve the data. These include basic data for thermal springs and wells on a state-by-state basis (for Nevada, see Bliss, 1983a) and a listing of each record on a state-by state basis, as microfiche (for Nevada, see Bliss, 1983b). The GEOTHERM database was also filed with the

National Technical Information Service (NTIS) as digital data. A 9-track one-half inch reel-to-reel tape in ASCII format of this GEOTHERM database was provided to NBMG after the start of this project by Howard Ross at the University of Utah Research Institute (UURI). This tape, containing 8,082 records, was originally from NTIS.

GEOTHERM contained 1367 records for Nevada when it was taken off line in 1983; the is the number of Nevada records on the NTIS tape as well. The great majority of these records are from the published sources used to compile Appendix 1 of Bulletin 91. Unpublished site data and analyses from the files of D.E. White (USGS) make up a significant section of the database also. About 75% of ~~this~~ these GEOTHERM data ~~was~~ were added to the original database during 1978 and 1979 by personnel at NBMG as part of the U.S. Department of Energy State Coupled Program (see Trexler and others, 1979a). In addition to the entry of new data and the editing and verifying of existing data in GEOTHERM, the longitude and latitude locations of springs and wells were determined by plotting them on 1:250,000-scale maps and hand digitization (Trexler and others, 1979a). New analyses were done during this period, and these data were added to GEOTHERM.

The database available in GEOTHERM during the early 1980s was used, along with other data developed from specific geothermal site studies funded by the U.S. Department of Energy (see numerous reports by Trexler and co-workers, 1980-83) to produce two 1:500,000-scale maps illustrating Nevada's geothermal resources (Trexler and others, 1979, 1983). No statewide resource studies were done after the publication of the 1938 NOAA map (Trexler and others, 1983). A nationwide assessment of low-temperature geothermal resources (USGS Circular 892) included data for Nevada, and an open-file report (Reed and others, 1983) included about 350 records for Nevada that were used in that assessment. These records were selected from the GEOTHERM database by use of charge balance determinations and other screening methods (Marshall Reed, written commun., 1993). During this period of time, an increase in exploration for geothermal resources by private industry (mainly for electric-power generation) resulted in the drilling of thousands of gradient and slim holes, and several hundred larger diameter wells for industrial and commercial use (space heating, electric power generation, etc.). Developments in Nevada's geothermal industry are documented in yearly summaries of the Nevada mineral industry, published yearly by NBMG since 1979 (e.g, Hess, 1993). Information that is available on geothermal drilling in Nevada has been summarized by Barton and Purkey (1993).

Need for a New Assessment

Low- and moderate-temperature geothermal resources are widely distributed in the western United States. Although there has been

a substantial increase over the last decade in utilization of these resources in direct-heat applications, the large resource base is greatly underutilized (Ross and others, 1994). Previous studies have demonstrated that Nevada is well endowed with geothermal resources, and much of the state must be considered as having potential for direct use. As Ross and others (1994) describe, the expanded use of low- and moderate-temperature geothermal resources requires, as a start, a current inventory of the resources. Such an inventory, combined with collocation studies (the study of resource location near population centers or areas of potential industrial users), will provide some of the basic information that the potential developers of the geothermal resources need to make sound economic decisions. Collocation factors are of particular significance in Nevada, as well as a number of other western states, because people and most industries are concentrated in a few areas; geothermal resources, on the other hand, are rather widely distributed.

There are many factors that can affect the viability of direct-use geothermal applications. These include not only the suitability of the fluid and the resource for the application (water temperature, chemistry, amount of available heat, etc.) but also the information available to the developer on the technology of the proposed application, and contractual and other economic factors less closely related to the geothermal resource. The collection of data on these geothermal resources and their present uses is only one factor in encouraging their increased use. Other components of the 1992-1993 low-temperature program include development of better techniques to discover and evaluate the resources, and technical assistance to potential developers (Ross and others, 1994).

Nevada Assessment Program

Data compilation for the low-temperature program is being done by State Teams in ten western states. The Nevada program, under the direction of Larry J. Garside at the Nevada Bureau of Mines and Geology, at the University of Nevada, began data collection in early 1993 (the contract for the research between the University of Nevada and the Oregon Institute of Technology was signed on March 23, 1993). The original contract was to end on December 31, 1993, but was later extended to June 30, 1994. The Technical Project Managers for the agreement were Howard P. Ross (University of Utah Research Institute) and Paul J. Lienau (Oregon Institute of Technology - GeoHeat Center).

The final products of the study include the following: 1) a geothermal database, in hardcopy and as digital data (diskette) listing information on all known low- and moderate-temperature springs and wells in Nevada; 2) a 1:1,000,000-scale map displaying these geothermal localities, and; 3) a bibliography of references on Nevada geothermal resources. The format for

presentation of these data was worked out through discussions among State Teams and the Project Managers during the first half of the contract period; the model for this database has been described by Blackett (1993).

DATA SOURCES

Information on Nevada's geothermal resources is widely distributed in published reports, in unpublished and limited-distribution sources (commonly referred to as "gray literature"), and as digital information in databases such as GEOTHERM and WATSTORE. The sources of data and methods of data manipulation are discussed below, followed by a description of the bibliography.

Preliminary Data Compilation

The Nevada geothermal database (Appendices 1 and 2) includes "records" (that is, single reports of chemistry, temperature, location, etc. that are represented by a single spreadsheet row) for all known (reported or suspected) geothermal sites in the state. A number of preliminary databases and spreadsheets were compiled before selection of records for the final listing (Appendices to this report). To get the data from various sources into a common format for comparison required months of work using a variety of computer hardware and software available at NBMG. In the following paragraphs I have summarized the major sources of information, the techniques used to modify and utilize them effectively, and some of the sources of error and other problems that were encountered.

GEOTHERM

The history of the GEOTHERM database is summarized above under the description of previous assessments. Because the database was taken off line in 1983, it does not contain data collected after that date. A tape of GEOTHERM records that was obtained from UURI was read on to a large magnetic disk at NBMG. Information supplied by NTIS with this tape gave the field lengths of each field in the database. With this information, computer database specialists at NBMG were able to design a database having fixed-length fields and read the GEOTHERM ASCII file into that database. The database on tape contained over 8000 records, with approximately 120 fields for each record. The database software used for this database was INFO, a subset of the ARC/INFO software utilized in many GIS (Geographic Information Systems) applications; hardware was a UNIX-based SUN SPARC II workstaion. The database in INFO was nearly 19 MB (megabytes). From this database, the 1367 Nevada records could be exported, by use of PC

ARC/INFO, in a format compatible with modern database-management software (such as dBASE). We used PC-File (a product of ButtonWare, Inc.) as the PC-based database software. The Nevada GEOTHERM database in PC-File is about 3.2 MB, and has a number of problems that make it difficult to use. One of the most notable problems is that in the PC-File format (essentially a dBASE format), most of the numerical data (temperature, water chemistry, etc.) are preceded by a five sided graphic figure which resembles the outline of a small house (or a baseball field "home plate"). This non-ASCII character was apparently a pad character or "punch" symbol in the original database that acted as a space. It can not be searched for, and was only eliminated after a short version of the database was retrieved into spreadsheet software (Quattro Pro, a product of Borland International, Inc.). In addition, some records had data reported in different units from other records (for example ppm or epm); the units used were reported in a separate database field. Fortunately, these problems were overcome in the shortened (spreadsheet) version.

Additionally, a number of other operations were done on a short database of GEOTHERM data that contained only the fields required for this study (Appendix 1). These include: 1) replacing the county name with a two-letter code (abbreviation) for each county, 2) conversion of numerical data from labels to values and insertion by hand of certain qualifiers on some analyses (N for not detected, t for trace, < for less than), 3) addition of calculated columns for ion balance, total calculated dissolved solids, and a major constituents test (is Na>K and Ca>Mg and Cl>F?), 4) rearrangement of columns into final format. Before final column rearrangement, formulas were converted to values, and a fixed number of decimal places was selected for display. About ???455 records were finally selected from this spreadsheet to be included in the final tables listed in the Appendix.

WATSTORE

The acronym WATSTORE stands for the National WATer Data STOrage and REtrieval System, a large-scale computerized system developed for the storage and retrieval of water data collected as part of the activities of the USGS, particularly the Water Resources Division (from a 1981 pamphlet, U.S. Government Printing Office: 1981 - 341-618:52). The system was begun in 1971, and contains a very large set of data on surface and groundwater in the U.S. The water-quality file alone is reported to have (in 1991) 34 million observations from over 200,000 stations; 5,000 parameters (major and trace elements, pesticides, organics, etc.) are included. The database contains information on the analyzing and collecting agency, but does not report whether the data has been published or list references. The WATSTORE database can be searched through arrangements with USGS Water Resources district offices or through a national system of water data exchange (NAWDEX);

assistance centers for NAWDEX are also commonly located at USGS Water Resources District Offices. The NAWDEX database also has access to other Federal agency water data, for example the Environmental Protection Agency (EPA), in addition to WATSTORE.

Water quality and other WATSTORE database file information is also available through a commercial outlet, EarthInfo, Inc. of Boulder, Colorado. EarthInfo makes certain data from WATSTORE available on CD-ROMs along with a software retrieval system that can be used by IBM-compatible personal computers. NBMG obtained a CD-ROM that included all Nevada data (current to early 1993) from EarthInfo. Personnel at NBMG (particularly Ron Hess) were able to search the CD-ROM and extract the parameters required for this study (water quality, location, site name, etc.) for all springs and wells having a measured temperature of 18°C or greater. To avoid the combination of parameters (e.g., water chemistry analyses) from different collection dates for the same site, a combination number was created (consisting of the site and collection date numbers) so that a later relational combination of the data would produce records that represent one site visit. These geothermal data were converted to a dBASE format and PC-File was used to eliminate records having temperatures less than 20°C for the area of Nevada south of 38° latitude. At this point, the database consisted of 1,708 records. These records were imported into a spreadsheet format using Quattro Pro software, and a multitude of operations were performed on the data to make it similar to the planned format for the final tables (Appendices 1 and 2). These operations include: 1) conversion of longitude and latitude to decimal degrees, 2) addition of calculated fields for ion balance, total calculated dissolved solids, major constituents test (is Na>K and Ca>Mg and Cl>F?), 3) conversion of depth in feet to meters and flow from cubic feet per second to liters per minute, 4) addition of a reference column for listing of WATSTORE as the reference, 5) convert GW (groundwater) to W (well) and SP to S (spring), 6) conversion of the state-county FIPS code to a two-letter abbreviation (see listing below), 7) conversion of the collection date format to the year/month/ day format, 8) re-arrangement of columns, and 9) a sort of rows (records) by longitude and latitude.

A number of additional operations were later performed on about 140 WATSTORE records selected for the final tables. These include: 1) conversion of Fe, and B from micrograms per liter to milligrams per liter (essentially equivalent to parts per million - ppm), and 2) separation of the site name column into two columns (one for name and one for the legal land location, if reported. Following this, Li, oxygen and hydrogen isotope data, and HCO_3-CO_3 concentrations were added to the short spreadsheet of WATSTORE records. Li, and the ^2H and ^{18}O were inadvertently left out of the first search of the EarthInfo CD-ROM. The search for HCO_3-CO_3 data in WATSTORE presented a more complicated problem, as these constituents are reported as several different

parameters (fields) in the database. A number of the records generated by the first search were lacking data for these constituents; a second search was done for data in all possible related parameters (about eight of them, including bicarbonate and carbonate field results, laboratory results, dissolved, incremental titration, titration to pH 4.5 and pH 8.3, and alkalinity (field and laboratory). The data were entered by hand into the intermediate spreadsheet of WATSTORE records destined for the final tables.

Table 1. County names for Nevada, FIPS (Federal Information Processing Standard) code (32 is Nevada), and abbreviations used in this report.

County Name	FIPS Code	Abbreviation
Churchill	32001	CH
Clark	32003	CL
Douglas	32005	DG
Elko	32007	EL
Esmeralda	32009	ES
Eureka	32011	EU
Humboldt	32013	Hu
Lander	32015	LA
Lincoln	32017	LI
Lyon	32019	LY
Mineral	32021	MN
Nye	32023	NY
Pershing	32027	PE
Story	32029	ST
Washoe	32031	WA
White Pine	32033	WP
Carson City	32510	CC

Topographic Map Digital Data

A complete examination was made by David Davis at NBMG of the approximately 1,900 7.5-minute topographic maps for Nevada. The entire state has this coverage, and a visual examination was made of each map for any mention of hot or warm springs, geothermal wells, etc. In addition, a 1981 version of GEOTHERM was available in paper copy (Jim Bliss, written commun., 1981) and this was used to identify other geothermal spring and well locations on these topographic maps. About 2700 individual points were marked on the maps, and the locations were digitized in the NBMG GIS laboratory using ARC/INFO software, a CalComp 9500 digitizer, and digital map coordinate data (TIC file) from the USGS. A database of the location and other data collected for this part of the project was created, and about a dozen records in the final table were from the spreadsheet equivalent of that database. In general, the records from this database were for locations where

no data were available in other sources. The references are usually the 7.5-minute quadrangle map that the spring or well appears on. Additionally, when more precise longitude and/or latitude locations were required for records taken from any of the other sources used, the appropriate information from this database was entered in intermediate spreadsheets of selected records.

Other Data Sources

During the selection of records for the final database, if water quality or other data in WATSTORE or GEOTHERM was lacking, incomplete, or appeared to be of poor quality, other sources of information were checked for possible inclusion in the database. Some of these sources were originally cited in NBMG Bulletin 91, but no record of a particular site was ever entered in GEOTHERM. A number of such records refer to dubious thermal spring locations, but must be included in any database that is purported to be complete. Other sources used for one or two sites include Hulen and others (1994), Trexler and others (1990), and Lawrence Livermore Laboratory (1976). Unpublished information in NBMG files and field notes of L. Garside for this and previous geothermal studies was also used. In particular, a number of good analyses and locations reported by Flynn and Buchannan (1990) were used. Their Table 3.1 was scanned, imported into Quattro Pro, and parsed into a spreadsheet of similar format to others used during this study. Also available in spreadsheet format to be checked during the data selection process were the analyses reported by Reed and others (1983) from the GEOTHERM database, and digital data on water analyses done in some areas of Nevada for the NURE (National Uranium Resource Evaluation) program (Hoffman and others, 1991).

Selection Criteria

In the early stages of this study, it became apparent that the bulk of the data on Nevada's low- an moderate-temperature geothermal resources was contained in two databases, GEOTHERM and WATSTORE. Usually, for individual thermal springs and wells, the best one or two records available from either WATSTORE or GEOTHERM was selected. If the data in these databases were incomplete or nonexistent, other known sources were checked.

The process of record selection for the final database began with hardcopy printouts of the spreadsheets described above (e.g., GEOTHERM, WATSTORE, and the topographic maps). Digital files of the longitude and latitude information for these three databases were used to plot the geothermal localities on 1:1,000,000-scale maps of Nevada in NBMG's GIS lab, using ARC/INFO software. Each of the points or point groups on these maps was checked in a regular fashion for possible errors of location. The 1:1,000,000-scale maps were examined, on 1° by 1° blocks of latitude-

longitude (about 34 partial or complete blocks for Nevada). Every 7.5-minute topographic map that was shown to have a geothermal locality was re-examined, and the locations displayed on the million-scale maps were compared to those on the 7.5-minute quadrangles. From the available records for a particular spring, the best one, or in a few cases, two records was selected. For groups of springs that are found over several square kilometers, several records were commonly selected to best represent the geographic range and provide a more varied data set of water chemistry. The records selected were numbered, notes were taken on any problems recognized, and the number was written on a million-scale map and on the hardcopy of the appropriate database. This record selection process proceeded from west to east across the state, beginning in northwest Nevada and ending at its southern tip. The selection of the "best" records was somewhat subjective, but generally proceeded as follows. If a point on the maps was determined to be a valid geothermal site, GEOTHERM and WATSTORE records of that site or site area were examined. Selection from one of these databases was generally based on having an ion balance between 0.90 and 1.10, and a check to see if Na>K and Ca>Mg and Cl>F. The ion balance formula used was $Na*0.04350+K*0.02558+Ca*0.04990+Mg*0.08229/Cl*0.02821+F*0.05264+HCO_3*0.01639+CO_3*0.03333+SO_4*0.02082$; resulting in a value in milliequivalents per liter, cations/anions. For those records that met these criteria, selection was based on completeness of the other analytical data (temperature, pH, minor constituents. etc.).

During the record selection process, spring and well records that did not meet certain minimum temperature criteria were eliminated from further consideration. According to the statement of work for this project, 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 with depth (for wells). The mean annual air temperature in Nevada varies from somewhat less than 7°C to over 18°C (Houghton and others, 1975, figure 17; see figure 1 below). This variation is an effect of both latitude and elevation; southern Nevada's higher mean annual temperature results from its lower latitude and its lower average elevation (Houghton and others, 1975). Based on this map of mean annual temperature, a lower spring and well temperature limit was set for certain latitude ranges in the state. For springs, the decision whether to include or not was relatively simple - if the spring temperature was at or above the set limit, it was included. For wells, only those were considered for inclusion that fell above a gradient of 25°C per kilometer with a beginning (surface) temperature at or above the minimum selected for that latitude range. The total well depth provided in the database was used to calculate this gradient. The following temperature limits were applied during record selection: 1) north of 39° latitude, 18°C or above; 2) 38° to 39°

latitude, 19°C and above (20°C was used for some sites, mostly wells, in the 38°-38.5° range, 3) 37° to 38° latitude, 20°C or above, and 35° to 37° latitude, 25°C and above. No upper temperature limit was used to restrict inclusion in the final data compilation. The statement of work for this project listed an upper limit of 150°C for occurrences to be included in the compilation. Seven occurrences with temperatures above 150°C were included in the database, mainly for completeness. The only data available for some geothermal occurrences was the analysis and associated location information for the high-temperature fluid. It is obvious that lower temperature geothermal fluids are available at these sites (in peripheral areas or, in the case of electric-power generation areas, as condensed steam or reinjection fluids). Because analyses of these lower temperature fluids were not often available, the high temperature fluid analysis was listed as a substitute.

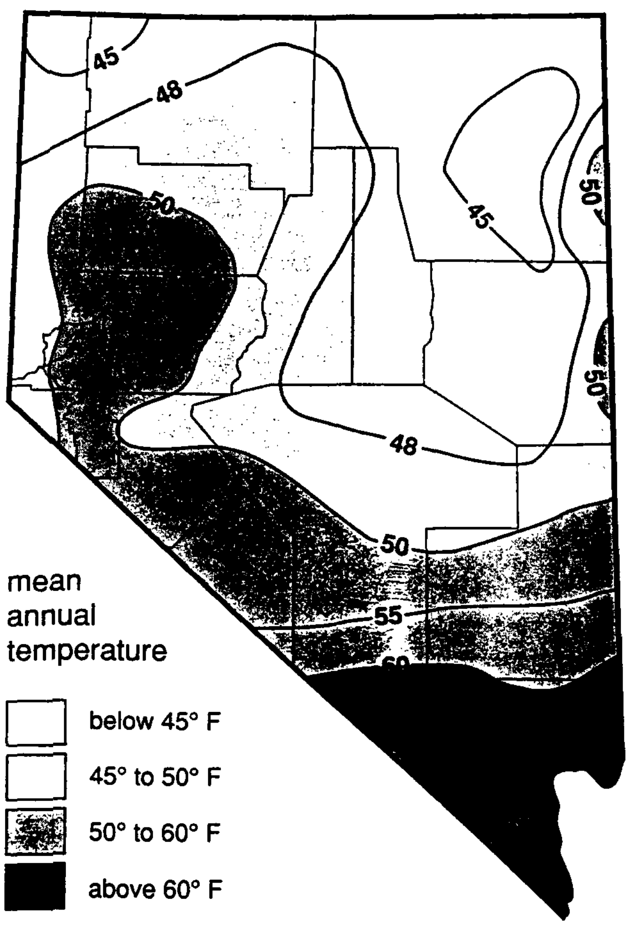


Figure 1. Map of mean annual temperatures in Nevada (from Houghton and others, 1975).

A number of problems were noted for both the GEOTHERM and WATSTORE databases as each plotted point on the million-scale maps was checked to see if it matched a known geothermal site. In quite a number of cases, certain geothermal locations were found

to have an incorrect longitude or latitude or both. These were commonly discovered when the 7.5-minute topographic map was compared to the million-scale plot. In some cases, the legal description (section-township-range) was correct, but the longitude or latitude had an error of, for example, one whole degree or one whole minute. These inaccurate site locations were noted, but not corrected in the individual databases unless the record was needed for the final table.

DATA FORMAT

Data on Nevada's low- to moderate-temperature geothermal resources are presented in Appendices 1 and 2. The data in these tables are in spreadsheet format, and the digital data used to produce them (and provided separately on diskette) can be searched and otherwise manipulated in a great variety of ways utilizing a number of commercially available spreadsheet and database management software packages. Although there are two Appendices, they were printed from a single spreadsheet. The software and data manipulation methods used at NBMG during this study are further described above, under data sources. The format of the tables and, thus, the spreadsheets, in most respects follows rather closely that of Blackett (1993).

The column headings and data in the columns are generally self-explanatory, but a few comments should be made. Each column heading is listed below, with a description of the data and a discussion of format and problems.

The site number is used to identify the site on the 1:1,000,000-scale map. It was added to the record when that record was selected for inclusion in the final database. The process of record selection was done in 1-degree blocks, proceeding from west to east, beginning in northwestern Nevada. Sites added later may not entirely follow this numbering progression, and to prevent renumbering of many of the sites, some added sites use decimal tenths (e.g., 143.1 and 142.2).

NAME The site name is commonly that listed in the source reference. In some cases, corrections, additions, or modifications were made to provide more information.

CO The two-letter abbreviation for one of Nevada's 17 counties is listed here. These abbreviations are listed above, under the Data Sources heading, with their FIPS code.

T, R, SC The legal land description, Township, Range, and Section are listed under these columns. These were commonly taken from the cited source, but some additions and corrections were

made during the data evaluation. Because some of these location data were derived (in the original studies) from maps of varying ages or scales, or by projecting section lines into unsurveyed areas, there is a chance for error. Although some of these errors were noted and corrected, there are certainly many that were not. The best location data for the sites is generally the longitude and latitude; however, if correct, the section-township-range location can be used to confirm a site on topographic maps. Some section locations were determined by use of 1:100,000-scale topographic maps, on which the protracted sections are commonly displayed.

QSEC The data in this column, if present, describe the portion of the section in which the geothermal site is located. The quarter-quarter-quarter system (for example: NE SE NW) indicates an approximately 10 acre parcel in the 1 square mile section (640 acres) that is located in the northeast quarter of the southeast quarter of the northwest quarter. For data from the WATSTORE database, letters are used to indicate (from left to right) the quarter section, quarter-quarter section, and so on; the letters A, B, C, and D designate the northeast, northwest, southwest, and southeast quarters, respectively. Thus, for example, ABC would represent the southeast(C) quarter of the northwest quarter(B) of the northeast(A) quarter. The A-B-C-D system thus lists the largest quarter first, followed by progressively smaller quarters; the NE-NW-SW-SE system lists the smallest quarter section first.

T This column lists the type of occurrence, either spring (S) or well (W). In a few cases, the original listing did not fall into these two categories, and it was modified. For example, a hot pool was listed as a spring, and mine shafts or mineral exploration drill holes were listed as wells.

TEMP The reported temperature of the well or spring is listed, in degrees Celsius, in this column. Many of these reported temperatures were measured and originally reported in degrees Fahrenheit; those converted to °C were rounded to one decimal place after conversion. If the only information reported on temperature is "warm" or "hot" (for example, from a topographic map), this is listed. The reported temperature is that of the cited reference. It is not necessarily the highest temperature reported in all of the available data for a particular spring or well; a particular record may have been selected because of its complete analysis, rather than because it had the highest reported temperature.

FLOW The flow, in liters per minute (L/min) is shown in this column. For wells, this value is commonly the discharge during pumping. Values are reported to one decimal place.

DEPTH For wells, the depth in meters is listed, if available

from the original source.

CDATE The date of collection is listed here, in the format: year/month/day. For many records that list only the year of collection, this was added during this study, based on other information.

pH The reported pH is listed here.

Chemical constituents (Na, Cl, etc.) For most of the chemical constituents, they are listed as reported in the original references or databases. The reporting units are milligrams per liter (mg/L); these are essentially equivalent to parts per million at the concentration levels of the fluids listed in the Appendix. For some analyses, constituent values originally reported in µgm/L (micrograms per liter or parts per billion - ppb) were converted to mg/L. If the original source listed a particular constituent as less than a certain value, this was reported using the symbol "<". Similarly, "t" indicates that a trace amount was detected, and "N" indicates the constituent was analyzed for but not detected. The number of decimal places displayed for each element is generally based on that reported in the sources of data. For most of the reported analyses, bicarbonate (HCO_3) and carbonate (CO_3) are listed as reported in the sources. Carbonate values are usually only found in waters with a pH of 8.2 or greater. A few sources (e.g., Lawrence Livermore Laboratory, 1976) report total alkalinity; these values were recalculated and reported as bicarbonate, as were the values reported in a HCO_3 + CO_3 column of Table 3.1 of Flynn and Buchannan (1990). Some analyses are noted to be relatively complete, but lack Na and K values. Commonly, the reason for this absence is that the original analysis reported Na + K as a single value, and thus, no data was entered in the Na and K fields in databases such as GEOTHERM.

TDSm, TDSc These columns present the total dissolved solids, measured and calculated. The measured value, if present, is from the original data source (presumed to be a residue on evaporation at 105°C). The calculated value was determined by summing the constituents reported. Thus, the TDSc value reported for incomplete analyses only represents a partial sum. A few analyses were summed before Li was added, and may be one to several ppm low. The HCO_3 value was multiplied by 0.492 to make the calculated TSDS values comparable with residue values.

ChgBal The electroneutrality of the analysis was evaluated using a charge (ion) balance formula (described further in the section on selection criteria). No value is reported for records which have no or extremely limited analytical data, as such a calculation would be meaningless. The most common reason for a charge balance that varies considerably from 1.00 is a lack of data for HCO_3. Other missing major ions can also result in a

"poor" charge balance.

delD, del018 These columns contain isotopic compositions for the stable isotopes ^{18}O and deuterium (^{3}H). Data are reported to zero or one decimal place for ^{18}O and one or two decimal places for deuterium.

REFERENCE The reference citation in this column is that for the source of the data. The records that were taken from the GEOTHERM database include the reference listed therein. The WATSTORE citation is from the database search described above under data sources. An asterisk (*) precedes some citations; this was used in the GEOTHERM database to indicate unpublished data from individuals or agencies (for example, *WHITE, D., USGS, MENLO PARK or *DESERT RESEARCH INSTITUTE, 1973). The *NEVADA BUREAU OF MINES AND GEOLOGY citation includes unpublished data from that agency's files entered into the original GEOTHERM database as well as some entries made during this study. The *WATSTORE reference refers to data from GEOTHERM that originated from a WATSTORE search, probably in the late 1970s.

USE This data category lists the geothermal application for which the thermal water is presently used, or has been used for in the recent past but is not presently (in parentheses). The source of most of this data is Garside and Hess (1994), with some later additions during the later part of this study. Garside and Hess (1994) is reproduced as Appendix 3. No attempt was made to list uses of only the water but not the contained heat (livestock watering, for example). At least a dozen hot spring areas in Nevada have had hotel spas at them; most were built in the late 19th and early 20th Centuries. These were not listed as a past use, but present spas, swimming pools, etc., were reported.

FLUID CHEMISTRY

The geochemistry of thermal water in Nevada (and adjacent areas) has been discussed by a number of authors (e.g., Mariner and others, 1983; Flynn and Buchanan,1990; Welch and Preissler, 1990; Young and Lewis, 1982). A simplification of the pattern of chemistry exhibited by Nevada thermal water is that eastern Nevada geothermal fluids are calcium bicarbonate dominated, central and northern Nevada has mainly sodium bicarbonate type fluids, and the western part of the state has mostly sodium chloride and sodium sulfate types. The reasons for this pattern are, no doubt, relatively complex; however, water-rock interactions are certainly a significant factor. Thus, eastern Nevada calcium bicarbonate geothermal fluids are strongly influenced by the presence of a regional carbonate aquifer. At least some of the sodium bicarbonate geothermal fluids of the central and north-central parts of the state may result from the exchange of sodium (possibly from volcanic rocks) for calcium in

fluids that were originally calcium bicarbonate in character. Western Nevada sodium chloride and sodium sulfate waters may reflect increased water-rock interaction (and thus generally higher temperatures) as well as possible evaporative concentration of fluids prior to deep circulation and/or extraction of salts from Quaternary playa lake deposits.

DISCUSSION

Nevada is well endowed with both high- and low-temperature geothermal resources. Based on a generalized map of known and potential geothermal resource areas of the United States (e.g., Lienau, 1988) over 40% of the state is believed to have potential for the discovery of high-temperature geothermal resources, and another 50% has potential for low -to moderate-temperature resources. This potential is well illustrated by the 1:1,000,000-scale map of geothermal occurrences produced during this study (Plate 1). The database for this study consists of 455 individual records, representing more than 300 resource areas. The geothermal springs and wells are distributed over the entire state, with an increased concentration in the northwestern part of the state (Figure 3). Maximum spring and well temperatures are higher in the north and northwest parts of the state. Geothermal occurrence temperatures greater than 75°C are confined to the northwestern half of the state, a pattern that closely follows that of heat flow (see Sass and others, 1981). The distribution of reported temperature vs. number of occurrences is shown below (Figure 2). About 400 springs and wells plot in 11 temperature ranges; additionally 30 sites are listed as "warm" and 23 as "hot".

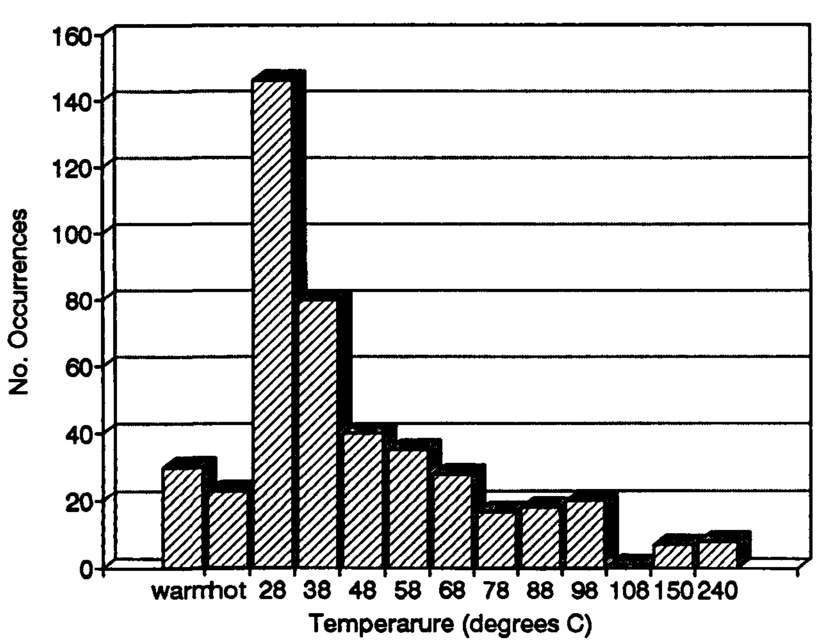
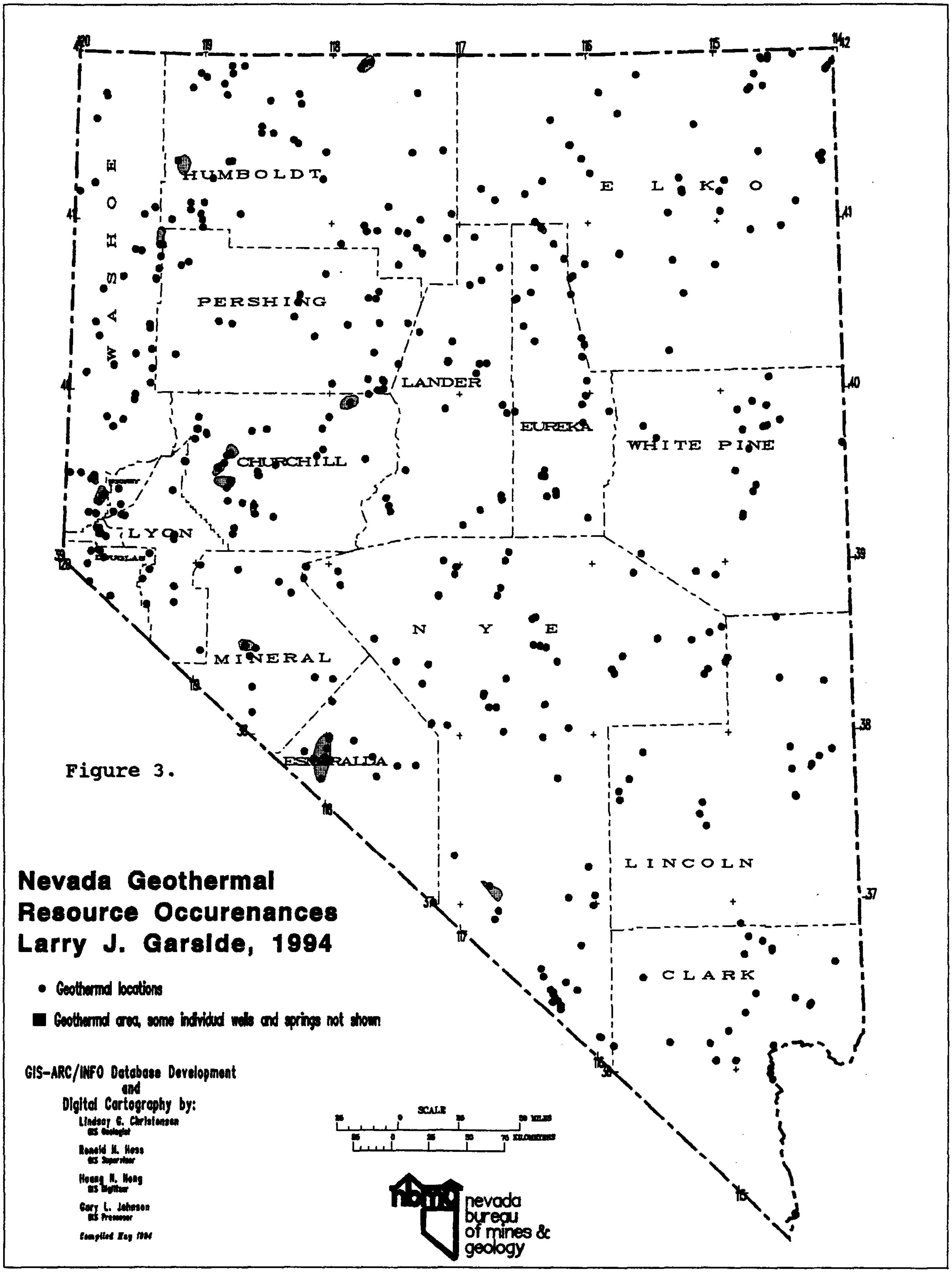


Figure 2. Bar graph of temperature vs. number of geothermal occurrences.


HUMBOLDT
ELKO
WASHOE
PERSHING
LANDER
EUREKA
WHITE PINE
CHURCHILL
LYON
DOUGLAS
MINERAL
NYE
ESMERALDA
LINCOLN
CLARK
Nevada Geothermal
Resource Occurenances
Larry J. Garside, 1994
Geothermal locations
Geothermal area, some individual wells and springs not shown
GIS-ARC/INFO Database Development
and
Digital Cartography by:
Lindsay G. Christensen
Ronald H. Hess
Hoang N. Hong
Gary L. Johnson
SCALE
nevada
bureau
of mines &
geology
Figure 3.

Geothermal reservoirs in the northwestern part of the state have generally higher temperatures; these reservoirs are usually interpreted as being related to circulation of ground water to deep levels along faults in a region of higher-than-average heat flow (the Battle Mountain heat flow high). In east-central and southern Nevada, the low- to moderate-temperature geothermal resources are generally believed to be related to regional groundwater circulation in fractured carbonate-rock aquifers. Discharge areas (like warm springs) may be up to several hundred kilometers from the area of recharge, and the waters may have circulated for hundreds to thousands of years to depths of several kilometers. Maximum temperatures attained during this journey could be 100°C or higher, but spring temperatures at discharge points are generally less than 65°C.

The Eureka heat flow low, a region of less than 1.5 HFU (heat flow units; 41.8 milliWatts per square meter, mWm^{-2}) located in eastern Nye and northwestern Lincoln Counties, is centered on the Nevada portion of a large area of Middle Cambrian to Lower Triassic carbonate rocks (the carbonate rock province). This carbonate rock province underlies southern and eastern Nevada and northeastern Utah (Plume and Carlton, 1988). The Eureka Low is most likely a regional-scale hydrologic feature, representing colder groundwater recharge to regional aquifers.

SUMMARY

Nevada is a large state with sparse but locally concentrated population. It has a wide range in average annual temperature, and thus a wide range in the lower limit of temperatures considered anomalous for geothermal fluids. The state's complex pattern of geology and heat flow results in geothermal resource areas of diverse character located throughout the state.

There have been many studies, both general and specific, on Nevada's geothermal resources (see Bibliography). Considerable data are available on specific geothermal spring and well sites but some remote areas are still poorly understood and information on their geothermal resources are incomplete or possibly inaccurate. There are many accurate and complete water analyses and associated location information for well-studied geothermal areas. However, many remote individual springs and wells throughout the state lack complete analyses, and some lack good location information; in some cases, there is uncertainty about the existence of certain springs. For example, Appendix 1 lists over 50 sites for which the only temperature information is "warm" or "hot."

In Nevada, as in many arid areas of the west, most water (whether thermal or nonthermal) has been put to use. Some nonthermal applications actually require cooling before use. Present and

recent past uses of the contained heat of Nevada thermal waters are quite varied (see Appendix 3). However, more such use is feasible if potential developers are well informed and encouraged to be conservative in their use of fossil fuels.

RECOMMENDATIONS

There are many remote geothermal sites for which no complete data set could be found in the sources examined. For completeness, some of these should be visited and sampled but most of them are unlikely to be put to any low-temperature use because of their remoteness. Having a more complete data set would, however, be useful in regional studies, and might result in the discovery of previously unknown higher temperature resources.

No attempt was made during this study to combine trace-element water chemistry data from more than one analysis into a single record. For example, analyses of B, Li, and F may have been reported in a analysis with poor ion balance while the best analysis in terms of major constituents may have been lacking some of the trace-element data. Some of this type of trace-element data could be added to the final database, but it seemed like a poor practice for this original compilation.

Some sources of information on geothermal springs and wells that were not used during this study might be useful to pinpoint previously unknown (especially low-temperature) geothermal sites. However, the mass of data available and its concentration in populated areas (where good information already exists), make searching such data relatively unproductive. Some examples of such available data include the water well records (submitted by well drillers) for the state available from the Nevada Division of Water Resources. These water well records have many errors (especially in location); searching and confirming previously unknown geothermal sites would take considerable effort. Other sources of water data that are likely to have similar potential errors include the analyses of agencies like the Nevada Division of Health, the Nevada Division of Environmental Protection, and the U.S. Environmental Protection Agency. One source of information that might have a higher potential for adding to the geothermal database is the largely confidential files of geothermal exploration companies. Thousands of shallow to moderately deep (100 to 1000 m) geothermal gradient and "slim holes" were drilled in the search for high temperature geothermal resources (for electric power generation) over the last 30 years. This source of geothermal data was suggested by a number of industry representatives at a March 1994 symposium sponsored by the Geothermal Resources Council on the geothermal resources and exploration of the Basin and Range Province. The extent of the data is not presently known.

Finally, increased future use of geothermal energy in low- to moderate-temperature applications will require not only studies that demonstrate the availability of the resource but also dissemination of information (such as case histories) that illustrate the details of these uses. Such case histories be understandable by the general public, but make available details of the technical data. Because some uses, such as district heating systems, require considerable front-end investment compared to individual fossil fuel heating units, projects that can bring together several funding sources have a better chance of success.

BIBLIOGRAPHY

One task of the study was the identification of geological, geophysical, geochemical, and hydrologic studies that have been done since the last resource assessment. The bibliography (Appendix 4) is the result of that literature search. There are 907 citations listed in the bibliography; of these, nearly one-half are from the bibliography in Garside and Schilling (1979). This bibliography was nearly exhaustive, at least for published sources, through about 1978. That bibliography was scanned and converted with text-recognition software to a format useable by word-processing software. The references from this 1979 bulletin included general references to the geology of geothermal areas as well as references specific to geothermal resources. The additional references in Appendix 4 were obtained from a variety of sources; most were entered in the document by hand, rather than taken directly from other digital data sources. Several methods were used to find these additional references. The bibliography for GEOTHERM (Bliss, 1983 a) was checked for references not in Garside and Schilling (1979). Additionally, the geothermal files in the Public Information Office of the Nevada Bureau of Mines and Geology were a good source, especially for unpublished reports. My own library of geothermal references was searched, and the CD-ROM for GeoRef (the bibliographic database of the American Geological Institute) was searched for any Nevada geothermal references. A similar search was done of the WolfPAC NALIS library information system (the Northern Nevada Academic Libraries Information System). The Geothermal Resources Council Bulletin and Transactions, and the GeoHeat Center Quarterly Bulletin were also scanned for any Nevada references.

NEVADA BUREAU OF MINES AND GEOLOGY

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MEMORANDUM

DATE: January 14, 1994

FROM: Larry Garside *Larry*

TO: Paul Lineau
Geo-Heat Center
Oregon Institute of Technology
Klamath Falls, OR 97601

SUBJECT: Quarterly Progress Report, Nevada Low-Temperature Geothermal Resources

In December the contract between OIT and the University of Nevada, Reno (Nevada Bureau of Mines and Geology) was extended to June 30, 1994. I have briefly summarized the progress for the preceding quarter below; if you have further questions, please contact me. Thank you for your assistance in getting the paperwork signed for the contract extension.

1. GEOTHERM - The 1368 records from GEOTHERM are in Quatro Pro spreadsheets and include the data in the approximate order and format as Bob Blackett illustrated in his Geo-Heat Center Quarterly Bulletin (November) article. The longitude and latitude are as decimal degrees, and can be plotted by the GIS lab (Arc/Info). Selection of the ones to be used in the final data base is continuing.

2. WATSTORE - Over 1700 records have been selected from the WATSTORE database. These include any spring or well records with temperatures over 18°C north of 38°N latitude, and only those over 20°C for the area south of 38°. The pertinent data is in a Quatro Pro spreadsheet in a format similar to the GEOTHERM data described above.

3. NURE water chemistry data - A number of 1° by 2° quadrangles in Nevada were studied for their uranium potential in the 1970s by Bendix Field Engineering for the U.S. Energy Research and Development Administration (now Department of Energy). Water samples of springs and wells were taken and analyzed, including some thermal waters. However, the analyses do not include complete data on major constituents, so the data set is not too useful. However, trace metals

(including arsenic) are reported, and these data may be useful in the future for site specific studies or specific public inquiries. The data is available at NBMG in digital format.

5. Bibliography - We continue to add new references to the bibliography from the published, unpublished, and gray literature available in our geothermal files in the NBMG public information office and from my own library. The search for other new references is continuing, and will include articles in the GRC Bulletin, the Geo-Heat Center Quarterly Bulletin, the GRC Transactions, etc.

6. Geothermal location data - The program to identify and digitize every Nevada thermal spring shown on the 1:24,000-scale topographic maps is complete. We have over 2800 records (some points have more than one record). We have checked the data base for errors, and made corrections. Correlation with locations listed in other data sets is continuing.

7. Use - I have just completed a preliminary survey of the low- to moderate-temperature uses in Nevada. I have summarized this data and described the high-temperature uses (electric power generation) with Ron Hess here at NBMG for an article in an upcoming GRC Bulletin. I have enclosed a manuscript copy of that article for your information.

8. Other items of interest - I have had a couple of contacts in the last several months by individuals interested in low-temperature applications. One individual was interested in information on geothermal sites for an RV park. Also, I had a question from a National Geographic writer about the Fly Geyser area of Washoe County, and a real estate agent asked about an area of thermal ground water in the Saratoga Springs south of Carson City. Additionally, it appears that a mining company has encountered quite hot (almost certainly >90°C) ground water in a somewhat remote area of northern Mineral County. The company has filed for geothermal leases, and there may be potential for high-temperature applications. The nearest known thermal water is a "hot" water well 7 km to the northwest. This discovery points up again the potential for the discovery of blind geothermal reservoirs in the Basin and Range.

✓cc: Howard Ross, UURI

NEVADA GEOTHERMAL RESOURCE USE - 1993 UPDATE

by
Larry J. Garside and Ronald H. Hess

Nevada Bureau of Mines and Geology
University of Nevada, Reno

Geology

Nevada is well endowed with both high- and low-temperature geothermal resources. Over 40% of the state is believed to have potential for the discovery of high-temperature (>90°C) geothermal resources, and another 50% has potential for low -to moderate-temperature (<90°C) resources (see Figure 1). Surface and subsurface indications of these resources are the more than 1000 thermal springs and wells in the state. Realistically, this number of individual springs and wells represents several hundred resource areas.

Geothermal reservoirs in the northwestern part of the state have generally higher temperatures; these reservoirs are usually interpreted as being related to circulation of ground water to deep levels along faults in a region of higher-than-average heat flow. In east-central and southern Nevada, the low- to moderate-temperature geothermal resources are generally believed to be related to regional groundwater circulation in fractured carbonate-rock aquifers. Discharge areas (for example, warm springs) may be up to several hundred kilometers from the area of recharge, and the waters may have circulated for dozens to hundreds of years to depths of several kilometers. Maximum temperatures attained during this journey could be 100°C or higher, but spring temperatures at discharge points are generally less than 65°C.

Exploration and Development

Two hundred and eighteen geothermal well permits were issued from 1988 through 1993 by the Nevada Division of Minerals: they include 58 industrial class production wells, 30 domestic class, 88 observation or gradient wells, 10 commercial class, and 25 injection wells. During this same period 109 geothermal wells are reported to have been drilled with a total amount drilled of approximately 86,500 m. Forty-five of the wells drilled were production wells with a total drilled of approximately 44,800 m. Figure 2 and Table 1 illustrate the number of power generating wells and pace of drilling since 1980.

From 1989 through 1992 noncompetitive and competitive federal geothermal leases in Nevada generated $1,699,282 in rental fees, $849,641 of which was returned to the State of Nevada. Federal production royalties, during the same period, generated $7,485,000 of which $3,742,500 was returned to the State. Geothermal lease returns ($849,641) and royalty returns ($3,742,500) to Nevada totaled $4,592,141. By regulation, half of all funds collected by the Bureau of Land Management from federal geothermal leases and production royalties are returned to the State.

Geothermal Electric Power Generation

Electric power is generated using geothermal resources at 10 plants in northern Nevada (Table 2, Figure 1). The state's total installed geothermal generating capacity is second only to California.

In 1993 the state-wide peak power demand was 3,755 megawatts (MW); the total installed generating capacity of Nevada's two major utilities (who supply most of the state's customers) is nearly 2,600 MW (Public Service Commission of Nevada). Thus, geothermal energy provides about 7% of the total electricity generated within Nevada (although only about 3% of the peak load). Over 40% of Nevada's geothermal electric power is exported to California.

Total Nevada geothermal electrical production 1989-1992 was 4,076,616 megawatt-hours with an approximate sales value of $307,410,000. Production capacity in 1988 from eight geothermal power plants was 115.8 MW gross while current power production from ten existing geothermal power plants in Nevada is 191.7 MW gross (Table 1). These values represent an 17% increase in sales value of the power sold from 1988 to 1992 and an increase in installed gross power production capacity of 60% over 1988.

It is important to note that in 1988 Nevada had nearly a threefold increase over 1987 in the amount of on-line geothermal generating capacity (Figure 3). The primary reason for this increase was the Dixie Valley 60-MW Oxbow Geothermal plant being put on line. The OESI plants at Empire (4.8 MW) and Soda Lake No. 1 (3.6 MW) were also brought on line during this period.

According to a 1991 Department of Energy estimate, under stable market conditions and with continuing technologic advancements in the geothermal industry, Nevada's projected electrical production capacity from known geothermal resources by the year 2010 should be at least 600 MW (Energy Information Administration, 1991). It is estimated, for the Basin and Range province as a whole, that aggressive exploration activity and continued rapid geothermal technologic advancements could add up to 2,000 MW of production capacity from known resources and new discoveries over the next 10 to 20 years (Wright, 1992). These relatively optimistic future scenarios should be tempered by today's reality of low-priced natural gas, increases in efficiency of fossil fuel generating equipment, and anticipated changes in power sales contracts. The future is bright for Nevada's high-temperature resources, but the pace of development will depend on many factors not related to the viability of the geothermal resource.

Beowawe

The **Oxbow/Beowawe Geothermal Power Co., Beowawe** plant came on line in 1988. It is a 16 MW (gross), dual-flash plant, which uses geothermal fluids from three wells with a resource temperature of 221°C.

Brady's Hot Springs

The **Brady Hot Springs** geothermal power plant (Figure 4) came on line in July, 1992. Plant operation and maintenance is being performed by **Oxbow Power Services, Inc.** The plant uses 5.4 million pounds of brine per hour produced from six of eight production wells. The production zone is 300 to 425 m deep with a resource temperature of between 172°C and 182°C. The wells supply two high pressure turbines and one low pressure turbine in a two stage system that produces 21.1 MW gross output. Geothermal fluids are injected into three of five available injection wells. (Ettinger and Brugman, 1992; Geothermal Hot Line, v. 21 no.1)

Desert Peak

The **Western States Geothermal Co., Desert Peak** plant went on line in 1985. It was designed by Phillips Petroleum Co. and uses a biphase turbine built by TransAmerica Corp. Production capacity from the currently developed resource is 8.7 MW. The resource temperature is approximately 205°C and well-head temperature is 165°C.

Dixie Valley

The largest single geothermal power plant in Nevada, **Oxbow Geothermal Corp. Dixie Valley** plant, came on line in 1988 producing 55-59 MW (net). The power is produced in a double-flash turbine generator and purchased by Southern California Edison Co. Oxbow estimates a geothermal energy reserve in Dixie Valley sufficient to supply 200 MW for 30 to 60 years. (GRC Bulletin, June 1987; Reno Gazette-Journal, August 6, 1988)

Empire/San Emidio Desert

The **OESI/AMOR II Empire** plant came on line in 1987 and consists of four Ormat Energy Converter Modules with a gross output of 3.6 MW from currently developed geothermal resources. Production is from a liquid-dominated geothermal source at 129°C to 137°C.**San Emidio Resources** continued their geothermal program in the **San**

Emidio Desert near Gerlach, Nevada. Early in 1991 San Emidio Resources signed a 5-MW, 30-year geothermal power supply contract, effective 1992, and a 20-MW, 30-year geothermal power supply contract, effective 1995, both with Sierra Pacific Power Co. (GRC Bulletin, February 1991) The initial price paid for produced electricity under the long-term contracts is reported to be approximately 5 cents per kWh. At that time plans called for construction of a 6.5 MW binary plant to be on line by November 1992. Since then San Emidio Resources requested and was granted a suspension of the 5-MW project in order for Sierra Pacific Power Co. and San Emidio Resources to determine the feasibility of combining the 5 and 20 MW projects into one project. In July 1993, Sierra Pacific Power Co. executed an amendment to the long-term power purchase agreement with San Emidio Resources. The agreement now calls for a 30-MW geothermal power plant to be on line by November 1, 1995 (Public Service Commission of Nevada).

Fallon

In early 1992 the U.S. Navy issued a request for proposal to construct an 80- to 90-MW geothermal power plant at the Fallon Naval Air Station. If this plant is constructed it will be phase I of the Navy's geothermal program. Phase II will consist of a second 80 to 90 MW facility to be constructed within 10 years of completion of the phase I project. The Navy estimates that the potential geothermal resource in the area will be able to produce 300-500 MW. The exploration drilling and reservoir testing performed during the initial phase of this project will be used to better define the geothermal potential of this area. Based on previous exploration information it is expected that the resource will be in the 175°C to 205°C range.

Fish Lake Valley

Fish Lake Power Co. continued their extensive drilling efforts to develop a geothermal resource in the Fish Lake Valley area of Esmeralda County. If a geothermal generating facility is built, the electricity would be delivered to California under a Standard Offer No. 4 Contract.

Hot Sulfur Springs

Earth Power Energy and Minerals has requested an avoided-cost purchase contract agreement with Idaho Power Co. If a contract were obtained, a 9.9-MW geothermal power plant could be constructed at Hot Sulfur Springs, Elko County, Nevada. (Reno Gazette-Journal, October 10, 1993)

Rye Patch

The **Rye Patch Limited Partnership (OESI)** is currently nearing completion of a 12.5 MW binary generating plant at their site near **Rye Patch** reservoir. The Company has a signed purchase agreement with Sierra Pacific Power Company which had an anticipated plant on-line date of November 30, 1993. This has been delayed while the Company continues to develop a sufficient and continuous geothermal resource that is required to fuel the plant.

Soda Lake

On August 19, 1991 the 13 MW **OESI/AMOR III Soda Lake No. 2** geothermal power plant completed commercial operations testing and went on line. This plant is adjacent to the 3.6 MW OESI **Soda Lake No. 1** plant that came on line during 1987 (GRC Bulletin, October 1991). Both plants are producing from a liquid-dominated geothermal source at 160°C.

Steamboat Springs

Two 12-MW, air-cooled, binary geothermal power plants, Steamboat II and III, operated by **S.B. Geo, Inc.,** were brought on line in December 1992 adding 24 MW of production to the existing 7.1-MW S.B. Geo Steamboat plant for a combined gross production capacity of 31.1 MW.

The geothermal fluid cycle at the new plants is completely contained and the fluids are injected back into the ground (closed binary-cycle system). The existing resource is expected to last 30 years or more and can support an additional 36 MW of production capacity. Based on this, plans are currently being formulated to determine the feasibility of installing an additional 24-MW facility in the near future. In December 1993 S.B.Geo, Inc. received a $7.2 million grant from the U.S. Department of Energy to develop a pilot project known as the Kalina pilot plant. The purpose of the project is to increase the efficiency of extracting heat from hot geothermal fluids.

Yankee Caithness J.V.L.P. operates a 14.4-MW (gross) flash turbine system producing from a 170°C. resource. The Yankee Caithness Steamboat plant came on line in 1988 and the produced power is purchased by Sierra Pacific Power Co. on a 30-year contract.

Stillwater

OESI/AMOR IV, Stillwater Geothermal plant came on line in April 1989. Total project cost was $36 million. The air-cooled plant consists of 14 Ormat Energy Converters that have a combined gross generating capacity of 13 MW. The plant uses a liquid-dominated geothermal source ranging in temperature from 155°C to 170°C. The plant operates on a closed system; all geothermal liquids are reinjected. (Ormat Fact Sheet, 1989; Geo-Heat Center, Fall 1989)

Wabuska

Tad's Wabuska plant came on line in 1984. Current production capacity is 1.2 MW produced from two Ormat Energy Converter modules. The plant operates on fluids at 107°C. produced from a depth of 107 m. (GRC Bulletin, July, 1987).

Non-Electric Low- and Moderate-Temperature Applications

The majority of Nevada's population is concentrated in two areas, Reno-Carson City and Las Vegas. Many of the state's geothermal resources are remote from any population centers, thus limiting some potential applications. Although 50 or more small to large communities are located within 8 km of geothermal resources, only a few of these areas have been able to use these resources effectively. The reasons for this under- utilization are varied. Although some reasons relate to technical and engineering problems (resource size and temperature, heat loss during transport, etc.), many more are economic (high capital outlays, long payout, under-capitalization of projects) and perceptual (unconventional vs. conventional technology, short vs. long term cost evaluations, uncertainties about long-term economic risks).

There have been attempts to use Nevada's low- and moderate-temperature geothermal resources at more than 20 areas, mainly in the past 5-10 years. Additionally, economic and/or technical appraisals of a number more areas have been conducted, but for a variety of reasons projects were not completed.

Moana Geothermal Area

Moana Hot Springs, located in the southwestern part of Reno, have not flowed at the surface for at least 15 years. The springs were the discharge point for an area of thermal groundwater that has been used for a spa, swimming pool, and home heating for nearly 100 years. Recent use for home space heating began in the 1960s. The area today is predominantly residential. We estimate that the area of thermal ground water encompasses at least 9 km^2. In this area there are more than 300 homes that use geothermal fluids for space heating. One hundred and thirty of these homes are part of a district heating system, while most of the rest use down-hole heat exchangers in individual wells. A smaller district heating system has retrofitted 12 homes for geothermal heat, and plans to add another four in the spring of 1994. A large hotel, a motel, about three apartment or townhouse complexes, five churches, and a county swimming pool also use the resource. The Veterans Administration Hospital, located about 2 km northeast of the geothermal area, drilled a deep well several years ago, but encountered only approximately 43°C water. The well was plugged and abandoned.

Steamboat Hot Springs

The Steamboat geothermal area consists of a deep, high-temperature (215-240°C) geothermal system, a shallower, moderate-temperature (160-180°C) system, and a number of shallow, low-temperature (30-80°C) subsystems (Goranson and others, 1991). The higher temperature systems are used for electric-power generation (see the preceding section). A number of low-temperature thermal groundwater anomalies are in an area of approximately 30 km^2 centered on the hot spring area (Goranson and others, 1991), but these thermal areas are not well known and are little used. A few homes in the Steamboat area have used low-temperature fluids for over 40 years, and one or more spas have been active in the springs area since the 1860s. Presently probably less than a dozen homes use the low-temperature geothermal fluids for space heating or domestic hot water (including swimming pools). About one domestic geothermal well permit has been issued per year over the last five to seven years.

Bower's Hot Springs

A large outdoor swimming pool and smaller children's pool at the Washoe County Park at Bower's Mansion (located between Reno and Carson City) are supplied with warm water from a geothermal well located near the spring.

Carson City Area

Water from a well at the site of Carson Hot Springs in northern Carson City is used directly in a swimming pool. In southeast Carson City, thermal groundwater is found in the State Prison/Pinyon Hills area. In the past, there have been a few attempts to use the thermal groundwater from domestic wells in that area for space heating. Geothermal space heating has been considered but not implemented in at least two schools in the area.

Saratoga Hot Springs

A California company, Lobsters West, has proposed to raise lobsters near the warm springs, located about 15 km southeast of Carson City. The geothermal fluids would be used to heat tanks in which the lobsters would grow to full size. The experimental study is proposed to last four years; live lobsters would be shipped twice a month to local markets (Reno Gazette-Journal, November 4, 1993).

Hobo Hot Springs

These hot springs, located about 15 km south of Carson City, were used to raise tropical fish and Malaysian prawns in the late 1980s. Lobster raising was also considered. The water temperature is slightly over 40°C. The site is presently inactive.

Walley's Hot Springs

Walley's Hot Springs, located near Genoa, about 20 km south of Carson City, was the site of a large spa in the late 1800s and early 1900s (Garside and Schilling, 1979). A modern spa was built on the site in the early 1980s. In addition to use of the geothermal fluids for bathing and domestic hot water, the buildings are heated with geothermal energy (Lienau and others, 1988).

Gerlach

Hot springs located just west of the town of Gerlach (Great Boiling Springs) have been used for bathing for many years. The Gerlach General Improvement District built a bath house using geothermal fluids in 1989. The facility was planned for use by tourists and local residents. The facility has been unable to obtain a permit from the health department because of plugging of water filters by sediment from the well. Future plans are for a geothermal heat exchanger system to heat city water for the spa. Geothermal ground water apparently extends under at least part of the town, as at least two Gerlach homes use geothermal wells for space heating. The water in one well is reported to be 35-36°C (unpubl. data, Nevada Division of Minerals).

San Emidio Desert

A vegetable dehydration plant is under construction in the San Emidio Desert area southwest of Gerlach. The plant is a few kilometers north of the Empire (OESI/AMOR II) electric-power plant. Integrated Ingredients (Spice Islands, Fleischmann's, and other brands), part of international food manufacturer Burns Philp, is contracting for the construction of the facility, which will employ about 25 persons when completed in early 1994. The number of employees may increase to about 65 after 18 months. Onions and garlic will be dehydrated and stored at the plant (Reno Gazette-Journal, August 31 1993). The plant will use approximately 150°C geothermal fluid.

Brady's Hot Springs

A geothermal vegetable dehydration plant has been operated at this site, about 80 km northeast of Reno, since 1978. The facility uses a moderate-temperature (132°C) geothermal well on site. Since 1993, additional geothermal fluid has been supplied by the nearby Brady Power Partners electric power generation plant operated by Oxbow Power Services, Inc.

Wabuska Hot Springs

In addition to the rather low-temperature electric-power generation plant operated at Wabuska by Tad's Enterprises, several non-electric applications have been located at the area, but none are active today. A hydroponic geothermal greenhouse operation (tomatoes, cucumbers, etc.) was built on the site in the early 1970s, but few vegetables were grown. Tad's Enterprises has in the past operated a geothermal ethanol facility, a plant to grow algae (Spirulina) for human consumption, and facilities to raise Malaysian prawns, catfish, and tropical aquarium fish. Some of these were pilot facilities, rather than actual production facilities.

Rye Patch Geothermal Area

Florida Canyon Mining Co. operates a large open-pit gold mine and heap-leach gold recovery facility located about 50 km northeast of Lovelock, and 7 km north of the area presently under development by Rye Patch Limited Partnership for geothermal electric power production. A 180-m well produces fluids at approximately 100°C; these fluids provide make-up water for the cyanide extraction solutions and heat is also extracted from via heat exchanger to heat the solutions. The heating of cyanide solutions aids extraction during cold weather, and may enhance total gold recovery somewhat.

Darrough's Hot Springs Area

Round Mountain Gold Corp. operates a large open-pit gold mine and heap-leach gold recovery facility near the Darrough's Hot Springs geothermal area in Nye County. Geothermal fluids from shallow (approx. 300 m) wells are used in a heat exchanger to transfer heat to cyanide heap-leach solutions (Trexler and others, 1990). The heated cyanide solutions increase gold extraction during periods of freezing or near freezing weather; additionally, the heating of solutions may enhance total gold recovery.

Carlin

Carlin Hot Springs, located near the Humboldt River southwest of the town, have a reported temperature of 80°C (Trexler and others, 1982). The Carlin High School used 31°C geothermal fluid from 280-m well from 1986 to 1992 in a closed-loop space heating system. The well was abandoned in 1992, apparently in part because of scaling problems with iron and manganese.

Elko Area

Hot springs south of the town of Elko were first used in a bath house in the 1860s (Garside and Schilling, 1979). Thermal groundwater was known to exist to the north of the springs under a part of the town, but no use was made of it until the Elko Heat Company began supplying geothermal fluid for space heating to several downtown buildings in 1982 (Rafferty, 1988). The company has continued to grow; in 1993 it served 16 commercial customers and 2 residential customers (Mike Lattin, oral commun., 1994).

The Elko County School District, in conjunction with the Elko General Hospital, developed a district geothermal heating system in 1986. The system supplies heat to eight buildings (two schools, a municipal swimming pool complex, a gym, a convention center, a hospital, a city hall, and a school administration building). In 1988 the estimated combined savings to all users was $300,000 per year (Rafferty, 1988; Richard Harris, oral commun., 1994).

Jackpot Area

Two wells drilled in 1988 at the Y3 Ranch about 7 km southeast of Jackpot were used for raising of catfish. The maximum reported well temperature was 40°C (Lund and others, 1990). The catfish-raising operation was not active in late 1993, reportedly due to insufficient enough geothermal fluid.

Wells Area

Warm springs about 1.5 km north of the present town of Wells were referred to by travelers on the emigrant trail in the 1850s as Humboldt Wells (from which the town name is derived). Thermal (32-34°C) groundwater is used by an elementary school and the Wells Rural Electric Co. in heat pump applications for space heating.

Duckwater (Big Warm) Springs

A geothermal catfish-growing facility has been operated at this site since 1982. The facility was purchased in 1992 by Robert and Jeff King (Valley Fish) of Preston, Idaho. The facility, located about 110 km west of Ely, produces over 300,000 pounds of prime 8-ounce catfish filets per year (Geo-Heat Center Quarterly Bulletin, December 1992) that are shipped to Idaho for sale.

Caliente Hot Springs

The town of Caliente in Lincoln County derives its name from the local hot springs. A number of wells in the area have reported temperatures from 40 to 80°C (Garside and Schilling, 1979; Lienau and others, 1988). A motel supplies geothermal water from a well to bathing pools and individual room whirlpool baths, and a trailer park supplies hot water to individual mobile homes. The Lincoln County Hospital (20 beds) was heated using 39°C water from a well on the site, but reduced temperatures (to 28°C) forced reliance on electric resistance heating. The hospital plans to use the lower-temperature fluids from its well for heating and cooling using heat-pump technology. The city swimming pool used geothermal heat in the past, but was damaged during the winter of 1992 and will probably be replaced. The City of Caliente has a grant from the Rural Development Administration to use the local geothermal resources. A nearby perlite processing plant may be the first user, for plant process heat. If more funding is found, the city plans to provide heat to the hospital, swimming pool, and eventually an elementary school and youth training facility (Glen Van Roekel, oral commun., 1994).

Ash Springs

Thermal waters (31-36°C) at Ash Springs, located about 10 km north of Alamo, in Lincoln County, have been used in the past at a spa on the site. The facility was closed during a 1993 visit.

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Figure/Table captions

Figure 1. Generalized Nevada geothermal resources.

Figure 2. Industrial-class (power generating) wells drilled in Nevada, 1980-1993.

Figure 3. Rated capacity and average net output of Nevada geothermal plants, 1984-1992. Average net output is annual sales in megawatt-hours divided by the number of hours in a year (8,760).

Figure 4. Steam separators and power house at Brady's Hot Springs plant (Brady Power Partners), Churchill County, NV. Larry Green photo.

Figure 5. Vegetable-dehydration plant under construction in the San Emidio Desert. Larry Green photo.

Table 1. 1992 directory of Nevada geothermal power plants.

Table 2. Total number of all classes of geothermal wells drilled and number of industrial-class geothermal wells drilled by year, 1988 through 1993. Source: Hess, 1993; Nevada Division of Minerals, 1993.