FEDERAL ASSISTANCE PROGRAM
QUARTERLY PROJECT PROGRESS REPORT

GEOTHERMAL DIRECT-HEAT UTILIZATION ASSISTANCE

GRANT NO. DE-FG07-90ID 12040

REPORTING PERIOD: JULY - SEPTEMBER 1994

PAUL LIENAU, PROJECT DIRECTOR

GEO-HEAT CENTER
OREGON INSTITUTE OF TECHNOLOGY
KLAMATH FALLS, OR 97601

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1.0 **Project Summary: July 1 - September 30, 1994**

1.1 **Technical Assistance.** GHC staff provided assistance to 75 requests during the reporting period from 17 states, Canada, New Zealand, Japan, Italy and Germany. A breakdown of the number of requests according to application are: geothermal heat pumps (14), space heating (13), greenhouses (10), aquaculture (2), resources (16), equipment (10), and other (10).

1.2 **R & D Activities.** Progress is reported on failures of vertical lineshaft turbine in geothermal wells.

1.3 **Technology Transfer.** Work has started on GHC Bulletin, Vol. 16, No. 1, which will feature greenhouses. Five technical reports and papers were prepared, three presentations were given, three computer programs were written or modified, and two tours were provided. A total of 165 publications were distributed on geothermal direct heat utilization. Geothermal Progress Monitor (GPM) reports include: 1) Glass Mountain, 2) California Energy vs. Magma Power, 3) Boise Heating System, 4) School District Reaps Geothermal Benefits, 5) Expanded Low-Temp. Geothermal Database Now Available from DOGAMI, and 6) Milgro Nursery, Inc. Expands to Utah.

1.4 GHC staff that worked on the project during the 4th quarter included: P. Lienau 84%, G. Culver 100%, K. Rafferty 100%, Donna Gibson 95%, and J. Lund 47%.

### 2.0 Technical Assistance

The Geo-Heat Center provides technical assistance on geothermal direct heat applications to developers, consultants and the public which could include: data and information on low-temperature (<150°C) resources, space and district heating, geothermal heat pumps, greenhouses, aquaculture, industrial processes and other technologies. This assistance could include preliminary engineering feasibility studies, review of direct-use project plans, assistance in project material and equipment selection, analysis and solutions of project operating problems, and information on resources and utilization. The following are brief descriptions of technical assistance provided during the third quarter of the program:

<table>
<thead>
<tr>
<th>Name</th>
<th>Nature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr. Janet Valenza</td>
<td>Resource. Discussed geothermal resource potential in Texas. Sent a list of 30 references from the GHC library on geologic studies of geopressured resources in Texas (7-1-94).</td>
</tr>
<tr>
<td>Austin, TX</td>
<td></td>
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<tr>
<td>Harry Will</td>
<td>Equipment. Discussed history of centrifugal equipment. Referred to a reference, &quot;Cameron Hydraulic Data&quot; which contains product information on Ingersol-Rand equipment, which in 1934 manufactured a centrifugal water vapor machine (7-1-94).</td>
</tr>
<tr>
<td>Harry M. Will, Inc.</td>
<td></td>
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<tr>
<td>2700 Lord Baltimore Dr.</td>
<td></td>
</tr>
<tr>
<td>Baltimore, MD 21244</td>
<td></td>
</tr>
<tr>
<td>Troy Groll</td>
<td>Resource. Discussed geothermal resource sites available in the Klamath Basin. Provided information on Klamath Falls district heating system, Oregon resource map, case study and new DOGAMI database (7-5-94).</td>
</tr>
<tr>
<td>City Planning</td>
<td></td>
</tr>
<tr>
<td>K. Falls, OR 97601</td>
<td></td>
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<tr>
<td>Bill Baywell</td>
<td>Greenhouses. Discussed using geothermal energy to heat greenhouses and water quality problems. Suggested that the brown sludge could be iron bacteria and recommended they have it tested. Sent information on economics and referred them to NMSU (7-6-94).</td>
</tr>
<tr>
<td>Geo. Ind. Park</td>
<td></td>
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<tr>
<td>Springhill, Nova Scotia</td>
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<tr>
<td>Ted Hansen</td>
<td>Resource. Discussed monitoring and the effects of the 1986 1.5 km radius ban on the use of geothermal around hot springs. Results are that water levels are up 1.5 m or above 1981 levels. Also discussed K. Falls approach to resource management (7-7-94).</td>
</tr>
<tr>
<td>Rotorua Dist. Council</td>
<td></td>
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<tr>
<td>The-Civic Center</td>
<td></td>
</tr>
<tr>
<td>Private Bag</td>
<td></td>
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<tr>
<td>Rotorua, New Zealand</td>
<td></td>
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</tbody>
</table>
Space Heating. Discussed conversion of 4,000 units--barracks, 4-plexes, etc., to a geothermal heating system. Currently the base is using an outdated steam heating system and a combination of evaporators and package air conditioning units. In 1984, an 1100 ft well drilled, obtained a temperature of 156°F, located about 5 miles south of the base. The resource may extend to the base. Information on geothermal heating systems and economics was sent to aid in a briefing with a General (7-7-94).

Greenhouses. Discussed heat loss from a double-poly roofed greenhouse for various inside design temperatures. Purpose was to determine the number of acres (5.6 acres) that could be heated using effluent from OIT. Sent floppy disk (greenhouse heating system, GHS) that among other things calculates heat loss (7-8-94).

General. Requested information about research institutes that study geothermal energy. Sent information about the GHC and personnel structure (7-11-94).

Greenhouses. Requested assistance in a greenhouse development project. Informed him the GHC efforts would focus on the heating system for the structure and geothermal resources considerations (7-11-94).

Resource. Requested information on resource at Big Bear Lake, California. Sent data on Pan Hot Springs from new database on California, including location, temperature, flow, use status, and chemistry (7-11-94).

GHP. Discussed supply temperature from a DX unit installed in February 1993. A supply temperature of 90°F coming from a ground coil in a pit is dependent on saturation pressure and temperature in the condenser (ground coil). The ground temperature could still be around 60°F with a 90°F supply temperature of the liquid refrigerant. Suggested he contact U.S. Power for saturation pressure and temperature (7-14-94).


GHP. Discussed how to determine the feasibility of using geothermal heat pumps for a large scale residential/multi-family development at Grand Canyon. Provided information on software, life-cycle cost of groundwater vs. ground-coupled systems, contractor list and design guide by S. Kavanaugh (7-14-94).

Space Heating. Discussed space and water heating methods. Owns well in Sparks, Nevada that has a depth of 400 ft at 160°F. Converting three buildings to geothermal space heating - 1500 ft², 1200 ft² and 1000 ft² (7-15-94).

Greenhouses. Discussed well cost, pump casing size for flow requirement, and depth of pump casing based on pumping level (7-15-94).

GHP. Discussed vertical vs. horizontal ground-coupled systems - costs, advantages and disadvantages of both systems (7-18-94).
2.17 Ron Parker
Salt Lake City, UT

Space Heating. Developing good size subdivision northwest of Utah Lake near Saratoga Resort. Resource temperature is 113°F with large number of wells in the area. Discussed low-temp. air distribution system and cost of water distribution. Advised that geothermal development would probably not be economical (7-18-94).

2.18 Randy Kilmer
Beall’s Roses
Seattle, WA

Greenhouses. Discussed how water would be controlled at the heat exchanger - throttling valve responding to hot water return temperature. Also, explained possibility of variable-speed drive for closed loop (greenhouse side) of heat exchanger (7-26-94).

2.19 Jack Thompson
UWC Geothermal Proj.
Armond Hammer United World College
P.O. Box 248
Montezuma, NM 87731

Space Heating. Responded to proposed use of geothermal energy for space heating, greenhouse heating, aquaculture and other demonstration projects with the following summarized comments: 1) If resource is convective, system may be isothermal. If conductive, a hot springs with a temperature of 133°F could produce 150°F from a 800 ft well (assuming 2°F/100 ft); 2) Space heating is probably best use of the resource - terminal units may have to be replaced to accommodate the lower temperature; 3) Large building HVAC system are seldom designed for supply air temperature > 105°F. A well designed fan coil unit can achieve this air temperature with as little as 125°F water. Design for a temperature difference of between 30° and 40°F - this would save considerably on pumping costs (electricity cost) and use less resource; 4) The existing system removes only 4°F from circulating water, thus requiring a large flow rate and cost. Existing system should be able to remove at least 20°F from the water; 5) Cascading projects would make an excellent demonstration, assuming 150°F resource is available; 6) Preservation of the hot springs may be a concern while pumping a nearby well - injection should be required; and 7) HDR to generate power - small scale can be very expensive. A binary power system with cooling towers would be required due to the low supply temperature. The cost is around $2300/kW and $900/kW for wells for < 1.5 MW. Operation, maintenance and annual capital expenditure will vary from 5 to 6 cents/kWh (7-27-94).

2.20 Bill Clark
O’Connel, Robertson & Associates
811 Barton Springs Road
Austin, TX 78784

GHP. Writing paper for ASME conference. Sent information on the Commonwealth Building, Portland, Oregon as an example of an early application of a groundwater heat pump system (7-29-94).

2.21 Jeanne Doney
Dept. of Natural Resources
State of Montana
1520 E. Sixth Avenue
Helena, MT 59620

Space Heating/Greenhouses. GHC evaluated proposal from Jackson Sewer and Water District to Montana DNR. Jackson, Montana has one of the hottest temperatures in southwestern Montana, reported 136°F at the surface and 162°F subsurface. Since a known resource is in town, it is highly recommended that the resource be used as much as possible. The following are specific comments on the proposal: 1) Suggested that $100,000 was not necessary to determine "geophysical characteristics of Jackson Hot Springs." Recommended a competent geologist review literature and do some field work to better delineate the resources ($30,000); 2) Recommended exploratory drilling using slim holes (2 - 4 hole of 500 ft each) to verify areas for development ($50,000); 3) Provide space heating for buildings in town and develop greenhouses using hot springs or one of the slim holes (enlarged) as pilot projects. Another alternative would be to use some of the effluent to heat an aquaculture pond ($30,000); 4) Binary power generation is not viable at the resource temperature, even at estimated subsurface temperatures; and 5) The only significant environmental impact would be the effect on the natural hot springs if wells are drilled and pumped. An injection well would be required to mitigate this impact (8-1-94).

2.22 Brian Widger
1540 Jacqueline Drive
Holt, MI 48842

GHP. Discussed “output” temperature for geothermal heat pumps in the heating mode. This will vary with manufacturer and installation, but is usually in the 90° - 100°F range. This is a few degrees higher than supply air temperatures from most air-source heat pumps due to greater efficiency from the higher source temperature (the ground) used by the system (8-2-94).
2.23 David Hicks  
NREL  
1617 Cole Boulevard  
Golden, CO 80401  

General. Provided information on the direct uses of geothermal for the preparation of a brochure (8-8-94).

2.24 Marge Davenport  
Oregon Scientist  
P.O. Box 230220  
Portland, OR 97281  

General. Provided information on low-temperature utilization of geothermal energy in Oregon. Sent database on current utilization, case study on K. Falls geothermal field, city district heating project and OIT (8-8-94).

2.25 Bruce Jardine  
3700 North Valley Road  
Greenville, CA 95947  

Greenhouses. Economic Development Committee for Greenville is considering obtaining old spa pool area near the hospital for greenhouse development. Discussed resource, marketing, managing, general greenhouse designs and heating systems. Suggested they contact greenhouse operators (8-8-94).

2.26 Steve Hosford  
Morgan, Harder, Swanberg & Daggett  
Las Cruces, NM  

Greenhouses. Discussed action of Burgett Floral vs. BLM, MMS over royalties. Discussion included specifics of metering required by MMS, use of water, etc. They want to prove that power can not be economically generated and sold from the resource. Suggested they talk to several manufacturers of binary equipment about temperature, flow requirements and recent power sales (8-9-94).

2.27 Holly Wilson  
Stillwater/Weider  
K. Falls, OR  

Resource. Sent drillers log on well at 1861 Fremont (8-9-94).

2.28 Matt Freedman  
Public Citizen  
215 Pennsylvania Ave. SE  
Washington, D.C. 20003  

General. Developing a report on state-by-state renewable projects. This will be a layman's summary on what is available for renewable energy. Provided low-temperature state resource assessment summary and database on geothermal direct use (8-9-94).

2.29 Scott Kocker  
Hailey, ID  

Greenhouses. Building a 40 x 100 ft experimental greenhouse using geothermal for heating. Discussed not using a heat exchanger and PVC pipe - expansion problems of pipe which should be buried for restraint. Explained PE piping with caution about fusion. Suggested that corrosion and scaling will not be a problem; however, maintain pressure and try to limit ΔT (8-10-94).

2.30 Mary Dickson  
International Institute for Geothermal Research  
Pisa, Italy  

Resource. Sent resource information on Lithuania (8-8-94).

2.31 John Metesh  
Montana Bureau of Mines & Geology  
Butte, MT 59701  


2.32 Ed Jonas  
Masson Greenhouses  
Radium Springs, NM  

Equipment. Masson's plate heat exchanger is failing after only 2 years of service. The plates are made of 316 stainless steel. Geothermal fluid has 1800 ppm of chloride and 4.4 ppm of fluoride. Suggested the use of titanium due to high Cl concentrations and check with manufacturer about F. Provided names and phone numbers of plate heat exchanger manufacturers (8-15-94).

2.33 Brian Widger  
1540 Jacqueline Drive  
Holt, MI 48842  

GHP. Explained desuperheater: a device that removes heat from hot refrigerant gas as it exits the compressor. The temperature and quantity of heat available are limited, water can only be heated to about 140°F and limited by the fact that heat is being transferred from the refrigerant in a gaseous state. The result is only a small increase in heat pump COP (8-16-94).
<table>
<thead>
<tr>
<th>Name</th>
<th>Address</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kathy Davis</td>
<td>6823 Dunbarton Drive Charlotte, NC 28210</td>
<td>GHP. Building a new home and wanted information on geothermal heat pumps - sent heat pump package (8-16-94).</td>
</tr>
<tr>
<td>Paul Dingman</td>
<td>K. Falls, OR</td>
<td>Space Heating. Geothermal well temperature has increased by 20°F. Discussed neighbor's system, how to hookup air vents, DHE size, how to measure DHE output, etc. (8-17-94).</td>
</tr>
<tr>
<td>David Warner</td>
<td>K. Falls, OR</td>
<td>Space Heating. Tested heating system for air temperature off coil (122°F) from 163°F water. Advised to balance DHW/space heat and throttle back the three other systems on the well (8-22-94).</td>
</tr>
<tr>
<td>Hal Green</td>
<td>K. Falls, OR</td>
<td>Space Heating. Discussed geothermal heating system for modular building - hot water coils, type of pipe, cost differences, etc. (8-22-94).</td>
</tr>
<tr>
<td>Kent Colahan</td>
<td>City K. Falls, OR</td>
<td>Equipment. Provided information on InSitu monitoring instruments for well (8-22-94).</td>
</tr>
<tr>
<td>Dan Warren</td>
<td>K. Falls, OR</td>
<td>Aquaculture. Working with the Klamath Tribe on feasibility studies. Discussed geothermal prospects in Chiloquin and Sprague River areas (small-to-nil), also water rights and water availability related to recent water table problems (8-22-94).</td>
</tr>
<tr>
<td>Lynn Stiles</td>
<td>Stockton College Pomona, NJ 08240</td>
<td>GHP. Discussed monitoring program, HVAC system and well field which was oversized. Talked about an educational program for GSHPs and information dissemination (8-25-94).</td>
</tr>
<tr>
<td>Familian Northwest</td>
<td>Portland, OR</td>
<td>Equipment. Discussed snow melt system for OIT wheelchair ramp - temperature, flows available and weather conditions (8-25-94).</td>
</tr>
<tr>
<td>Elliott Estes</td>
<td>OIT Physical Plant K. Falls, OR</td>
<td>Snow Melt. Designed snow melt system for wheelchair ramp. Design included 600 ft of 5/8 in. diameter tubing laid on 10-in. centers tied to rebar, manifolds, adapters and fittings. In addition to eliminating shoveling and salting, the concrete would last much longer since it wouldn’t be stressed by heat and cold (8-26-94).</td>
</tr>
<tr>
<td>Burkhard Sanner</td>
<td>Institut Für Angwandte Geowissen Schaffen Diezstraße 15, Germany</td>
<td>GHP. The institute in Germany is involved with geothermal heat pump research and wanted to exchange information. Described R&amp;D with horizontal loop, vertical and pit system at OIT (8-29-94).</td>
</tr>
<tr>
<td>Thurmon Blake</td>
<td>Bakersfield, CA</td>
<td>Greenhouses. Interested in putting up geothermal greenhouses, 4 acres, in Kelseyville, California. Discussed resource, irrigation water, ownership, development loans from CEC and geologists familiar with the area (8-30-94).</td>
</tr>
<tr>
<td>Kent Colahan</td>
<td>City K. Falls, OR</td>
<td>Resource. Discussed well tests on city municipal wells in Moana district of Reno, NV. Included length of test, flow, potential for affecting private wells, etc. (8-31-94).</td>
</tr>
<tr>
<td>Rod Friesen</td>
<td>K. Falls, OR</td>
<td>Resource. Discussed well at 1320 Pacific Terrace - DHE out and keeps going out. Provided well log and inspected DHE. Failure is below water line - appears DHE is rubbing against casing (8-31-94).</td>
</tr>
<tr>
<td>Clint Scherf</td>
<td>KCEDA K. Falls, OR</td>
<td>Resources. Discussed potential of geothermal resources in the Klamath Basin. Provided resource data, K. Falls case study and information on GHC programs (9-1-94).</td>
</tr>
</tbody>
</table>
2.48 Bernt Kuhlman  
Dunton Hot Springs  
P.O. Box 11053  
Telluride, CO 81435

Space Heating. Dunton Hot Springs has a water temperature of 105°F and flow of 22 gpm. In addition, a well was drilled to 120 ft, temperature of 100°F and flow of 25 gpm. The spring is used for spas and outdoor swimming pool, piped 150 ft. Discussed space heating for 15 cabins (500 ft² each), 3 homes (1000 ft² each) and saloon/dance hall (4000 ft²). Explained the existing resource does not have enough flow and high enough temperature. Explained radiant floor heating, heat pumps and boiler booster options (9-1-94).

2.49 Bob Griffiths  
Carson City, NV

Space Heating. Wants to use 115 - 120°F well to heat home. Discussed radiant floor system which probably wouldn’t provide enough heat (low temperature). Suggested a hot water coil in duct (9-2-94).

2.50 Cath Read  
1243 Willard Street  
San Francisco, CA 94117

General. British science writer wanted general information on Center - who are we, what we do, etc. Sent brochure and publications list (9-2-94).

2.51 Gene Beeland  
7864 Waverly Mill Court  
Gainsville, VA 22065

General. Sent black and white negatives of Integrated Ingredients dehydration plant for geothermal progress monitor (9-6-94).

2.52 Mary Dickson  
CNR-IIRG  
2 Piazza Solferino  
56126 Pisa, Italy


2.53 Lloyd Frizzell  
Assoc. Geologist  
207 S.W. G Street  
Grants Pass, OR 97526

Resource. Requested Oregon database of thermal wells and springs which contained chemistry. Sent the latest database from the state resource assessment program (9-12-94).

2.54 Pamela Derkey  
USGS  
W. 904 Riverside  
Spokane, WA 99201

Resource. Conducting study on the Columbia River Basin water quality. Wanted databases of thermal wells and springs for Montana, Idaho, Oregon and Washington to determine if any effluent was entering the river bases. Sent Utah assessment as an example (9-13-94).

2.55 Gary Hurst  
342 Pacific Terrace  
K. Falls, OR

Equipment. Replaced DHE pipes six times in the past 10 years. Discussed cathodic protection, sealing well from oxygen and isolation unions. An appliance may be causing the current, sent paper on solution to the problem (9-13-94).

2.56 Paddock Realty  
K. Falls, OR

Resource. Discussed thermal spring reportedly killed by cold water from the Canal back in the 1950s. Wanted to know how to reintroduce the spring. Told them it was a function of the water level; therefore, sent data on wells in the area (9-13-94).

2.57 Dean W. Wilde  
203 W. Bennett  
Saline, MI 48176

GHP. Sent package on geothermal heat pumps (9-13-94).

2.58 Koji Morita  
Geo-Energy Division  
National Inst. of Resource & Environment  
16-3 Onogawa, Tsukuba  
Ibaraki 305, Japan

GHP. Requested information on costs and savings from geothermal heat pumps. Sent database on monitored systems in the U.S. (9-14-94).
2.59 John Hodges
711 Hillside
K. Falls, OR

Equipment. Has 2 DHEs, 1 well supplying 3 homes and 2 swimming pools. From description determined pressure relief valve was leaking, probably corroded valve stem or seat. Recommended new valve. Since DHW is on DHE, its at 50 psi. Can use hot water tank pressure relief valve (9-14-94).

2.60 Tom O'Hare
Pagosa Springs, CO

GHP. Discussed heating of home with a vertical ground-coupled heat pump. Suggested he order S. Kavanaugh's handbook and sent heat pump package (9-15-94).

2.61 Jerry Lehrburger
1639 Jackson Street
Ashland, OR 97520

Resource. Discussed Jackson Hot Springs: \[ T = 44^\circ C \text{ and } f = 1000 \text{ L/min}. \] Wants to expand resort and drill well to obtain more water. Sent report prepared for the city Ashland which contained information on temperature gradient holes in the area. Recommended he contact a geologist in the area - furnished name and phone number (9-15-94).

2.62 Dick O'Donnel
Goulds Pumps

Equipment. Called to discuss pump failure project. Sending information about operating at off design conditions (9-15-94).

2.63 Roy Mink
University of Idaho
Moscow, ID

GHP. Requested information on geothermal heat pump system design. Sent information on IGSHPA horizontal design guidebook, Kavanaugh's vertical design guide and software for designing commercial vertical systems (9-16-94).

2.64 Doug Adkins
Consulting Engineers
2950 Shasta Way
K. Falls, OR 97603

Equipment. Discussed recirculation in centrifugal pumps. Recirculation, which causes pressure pulsations and vibrations, can cause impeller erosion which usually occurs below about 50 - 60% of capacity at best efficiency. With a variable-speed drive, the point of best efficiency varies with speed; but because the head/speed relationship is squared when you have pumping heads, you can reach a no-flow at fairly high speed, and recirculation will occur (9-19-94).

2.65 Dominic Falcone
Creston Financial Group
1800 Harrison Street
Oakland, CA 94612

Tax Credit. Discussed energy tax credits for geothermal development. There is a 10% tax credit on tangible assets (i.e., pipe, casing, pumps, etc.). There is no sunset date on this tax credit. Investment tax credit (ITCs) for exploration, etc., is no longer in effect (9-29-94).

2.66 Andy Parker
P.O. Box 709
Lakeview, OR 97630

Space Heating. Discussed what would be involved with a geothermal district heating feasibility study for Lakeview, Oregon. Wants to use resource of 105°C about 1.5 miles from town. Also discussed franchises and the possibility of the GHC doing the feasibility under the Low-Temp Geothermal Program (9-20-94).

2.67 Earl Kent
B&G Realtors
K. Falls, OR

Resource. Requested information on well at 1330 Pacific Terrace. Provided well log and other information (9-21-94).

2.68 John Siciliani
Solar Energy Ind. Assoc.
122 C Street NW
Washington, D.C. 20001

GHP. Discussed market penetration of geothermal heat pumps. Referred to The News which reported approximately 20,000 units per year manufactured based on an industry survey (9-22-94).

2.69 Kelly Mason
17820 59th Avenue SE
Arlington, WA 98223

Greenhouses. Discussed resource potential between Hunters Hot Springs and Chico Hot Springs in Montana. Also talked about marketing, geothermal design considerations, etc. Sent Guidebook, greenhouse heating systems report and GHC brochure which describes the technical assistance program (9-22-94).

2.70 Matt Freedman
Public Citizen
215 Pennsylvania Ave. SE
Washington, D.C. 20003

General. Discussed current status of geothermal direct heat utilization and geothermal heat pumps. Sent floppy disk with both databases of current uses (9-26-94).
2.71 Jim Ball  
Balzhiser & Hubbard  
Consulting Engineers  
Eugene, OR  
Equipment. Discussed failure of MWMC geothermal well pump and specifications for new pump (9-27-94).

2.72 Steve Drew  
K. Falls, OR  
Equipment. Radiant floor heating system using geothermal is leaking. No temperature stat or crossover valves. Also supplies hot water. Suggested crossover so domestic water stops hot, but floor can be shut off. Repairs will require cutting concrete. Referred to two HVAC contractors (9-27-94).

2.73 Kevin Rupp  
Calpine Corp.  
50 W. San Fernando  
San Jose, CA 95113  
Resource. Discussed 30 MW power development at Glass Mountain. Currently Calpine is drilling temperature gradient holes. Also discussed possibility of investments in direct use industrial projects (9-27-94).

2.74 Kent Brown  
Springfield, MO  
Aquaculture. Discussed an artificial trout stream project. The stream would be 1 mile in length by 50 ft in width with a 1 percent slope to a pond from which the water would be pumped through underground piping to the head of the stream. Question was how much cooling could be expected by the buried pipes to maintain 55° - 65°F for optimal growth. Suggested a spray pond to oxygenate the water then the heat loss in piping would depend on soil characteristics and seasonal temperature fluctuations (9-27-94).

2.75 Ron Hubert, Supt.  
Modoc Joint Unified School District  
906 W. 4th Street  
Alturas, CA 96101  
Space Heating. Received mechanical site plan for new geothermal heating systems for the middle and elementary schools. The plan had pipe sizing, but no flow rates, equipment, equipment requirements, so pipe sizes could not be checked. Expansion loops could not be checked because there were no dimensions, pipe materials or temperature swings (9-29-94).

3.0 R & D Activities.

The direct use research and development program objectives are to aid the industry in resource and technical development problems. To investigate and analyze methods or approaches of reducing the costs of developing, designing and operating low-temperature geothermal projects.

3.1 Geothermal Well Pump Failures

Work on pump failures is continuing on a time available basis. As the draft summary table indicates, early failures appear to be related to variable-speed drives and pumps with extra lateral. Life appears to be only weakly inversely related to geothermal fluid temperature. Further investigation seems to be indicating that life is related to system operation. Pumps in systems that have wide swings in flow rates (i.e., space heating systems where flows are low in summer and high in winter, and which operate a high proportion of the time at relatively low flow rates) seem to have a high proportion of early failures. Pumps for these systems are typically specified for peak a flow rates (in fact, considerably above calculated peak flows as a safety factor); therefore, are operating much of the time at 50% or less of design peak efficiency.

This kind of operation has been related to early failures of large centrifugal pumps, failure being the result of vibrations caused by a phenomenon known as recirculation first documented in the early 1980s and not yet fully understood by pump designers or even known about by many engineers. It has not been documented in smaller (i.e., less than 150 hp) vertical turbine pumps and there is some disagreement among pump designers that it is even possible or likely in smaller vertical turbines.

This leads to a closer investigation into system operation as opposed to investigation of materials and bearing design which was at first suspected.
<table>
<thead>
<tr>
<th>Name</th>
<th>Variable Speed</th>
<th>Extra Lateral</th>
<th>Bearing Material</th>
<th>Pumping Level</th>
<th>Temp. °F</th>
<th>Average Rotating Life/Years</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>OIT #2</td>
<td>Yes</td>
<td>Yes</td>
<td>Brz.</td>
<td>510</td>
<td>192</td>
<td>6+ so far</td>
<td>Operated OK since new (1971) in same water conditions as other OIT pumps.</td>
</tr>
<tr>
<td>OIT #5 (July 1989)</td>
<td>Yes</td>
<td>Yes</td>
<td>Brz.</td>
<td>~100 ft</td>
<td>192</td>
<td>5 1/2 - 6</td>
<td>Bowls have been in service 20+ years. Bearings replaced about every 5 years.</td>
</tr>
<tr>
<td>OIT #5 (August 1994)</td>
<td>Yes</td>
<td>Yes</td>
<td>Brz.</td>
<td>~100 ft</td>
<td>192</td>
<td>2 1/2</td>
<td>Lower 7 bowls and impellers worn beyond repair. Upper bowls and impellers worn. Lower bearing completely gone and shaft worn into bowl bearing housing. Upper bearings still in place but worn.</td>
</tr>
<tr>
<td>OIT #6</td>
<td>Yes</td>
<td>Yes</td>
<td>Brz.</td>
<td>550</td>
<td>192</td>
<td>6+ so far</td>
<td>Bowls in service 23+ years. Bearings and impellers replaced after 17 years.</td>
</tr>
<tr>
<td>Susanville (all in same well)</td>
<td>Yes</td>
<td>No</td>
<td>Brz.</td>
<td>~70 ft</td>
<td>174</td>
<td>5 1/2</td>
<td>Bowls, bearings and impellers looked like new. Rubber bearings had swelled.</td>
</tr>
<tr>
<td>Pump #1</td>
<td>Yes</td>
<td>Yes</td>
<td>Rubber</td>
<td>~70 ft</td>
<td>174</td>
<td>16 mos.</td>
<td>No failure, not inspected. Pump is run at about 2/3 speed all the time during heating season.</td>
</tr>
<tr>
<td>Pump #2</td>
<td>Yes</td>
<td>Yes</td>
<td>Rubber</td>
<td>~70 ft</td>
<td>174</td>
<td>10+ so far</td>
<td>No failure, not inspected. Pump is run at nearly full speed all the time during heating season.</td>
</tr>
<tr>
<td>Pump #3</td>
<td>Yes</td>
<td>Yes</td>
<td>Rubber</td>
<td>~70 ft</td>
<td>174</td>
<td>a few hrs.</td>
<td>No failure, not inspected. Pump is always run at full speed and very near best efficiency.</td>
</tr>
<tr>
<td>Naef</td>
<td>Yes</td>
<td>No</td>
<td>Brz.</td>
<td>150 ft</td>
<td>158</td>
<td>9+ so far</td>
<td>Bearings and impellers worn at 4-year intervals. Bowls sometimes re-machinable.</td>
</tr>
<tr>
<td>Klamath County Shops</td>
<td>Yes</td>
<td>No</td>
<td>Brz.</td>
<td>65+ ft</td>
<td>128</td>
<td>10+ so far</td>
<td>No failure, not inspected. Pump is run at nearly full speed all the time during heating season.</td>
</tr>
<tr>
<td>Wineagle</td>
<td>No</td>
<td>No</td>
<td>Brz.</td>
<td>85+ ft</td>
<td>231</td>
<td>7+ so far</td>
<td>No failure, not inspected. Pump is always run at full speed and very near best efficiency.</td>
</tr>
<tr>
<td>Merle West Medical Center</td>
<td>Yes</td>
<td>Yes</td>
<td>Brz.</td>
<td>300 ft</td>
<td>192</td>
<td>4</td>
<td>Bearings and impellers worn at 4-year intervals. Bowls sometimes re-machinable.</td>
</tr>
<tr>
<td>Modoc High School</td>
<td>Yes</td>
<td>Yes</td>
<td>Brz.</td>
<td>varies</td>
<td>170</td>
<td>2 1/2</td>
<td>Strange wear pattern. Cause unknown. Possible imbalance of impellers.</td>
</tr>
<tr>
<td>Colahan</td>
<td>No</td>
<td>No</td>
<td>Brz.</td>
<td>230</td>
<td>1 - 2</td>
<td></td>
<td>Not good example - poor engineering.</td>
</tr>
<tr>
<td>Bottling</td>
<td>No</td>
<td>No</td>
<td>Brz.</td>
<td>55 ft</td>
<td>249</td>
<td>1 - 3 mos.</td>
<td>Pump ok. Crooked well caused column brg. failure.</td>
</tr>
<tr>
<td>CSI</td>
<td>Yes</td>
<td>No</td>
<td>Brz.</td>
<td>100+ ft</td>
<td>1</td>
<td></td>
<td>Improper alignment of lower column caused pump vibrations and failure. Possible critical speed problems?</td>
</tr>
<tr>
<td>Klamath Union High School</td>
<td>No</td>
<td>No</td>
<td>Brz.</td>
<td>20 ft</td>
<td>165</td>
<td>12+ so far</td>
<td>This pump is in an ex-artesian area and has a shallow (~90 ft) pump setting. The pump is turned on in fall and off in spring. No failure. Not inspected.</td>
</tr>
<tr>
<td>Anonymous (Klamath Falls)</td>
<td>Yes</td>
<td>No</td>
<td>Brz.</td>
<td>90 ft set</td>
<td>172</td>
<td>10 days</td>
<td>Operated in shaft critical speed range.</td>
</tr>
</tbody>
</table>
There is also the possibility that this concept is an artifact of the fact that most direct use pumps are in space heating applications; therefore, there are more failures in pumps with variable-speed drives. Documentation will be nearly impossible since very few systems continuously monitor flow rates and pump rpm. Information will be primarily the recollections and general feelings about system operation by maintenance personnel.

4.0 Technology Transfer.

The Geo-Heat Center prepares and publishes information and educational materials on direct heat applications that includes: a quarterly Bulletin, technical papers, computer programs and progress monitor activities. In addition, resources of a technical library and tours of geothermal facilities in the Klamath Falls area are made available.

4.1 Geo-Heat Center Quarterly Bulletin. Bulletin Vol. 16, No. 1 will feature greenhouses heated by low-temperature geothermal resources. Over the past five years, the use of resources for greenhouse heating was one of three areas of largest growth. A new development, Milgro Inc., in Newcastle, Utah, was visited and will highlight this Bulletin. Significant developments have also taken place in New Mexico.

4.2 Technical Papers, Presentations, Computer Programs and Tours.

1. Technical Report. Reviewed cost components for Seattle Metro effluent pipeline project. These relate to the savings a customer would realize by using the effluent as a heat source (for heat pumps) or a heat sink (in place of a cooling tower).


4. Technical Paper. Worked on development of new terminology for American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) for TC 6.2 - District Energy.


8. Presentation. Participated in meeting with Northwest Power Planning Council (NWPPC) staff to provide information on direct use and GSHP for use in development of the new edition of the Northwest Power Plan. GHC staff will be involved with the Geothermal Comm. for NWPPC in the future.

9. Computer Program. Developed new software on performance of vertical lineshaft vs. submersible well pumps for efficiency and peak power.

10. Computer Program. Modified the calculations of evaporative heat loss in the HEATOOLS program. Existing calculation over estimated evaporative loss due to an error in the equation.
11. Computer Program. Modified the peaking routine on the GHS spreadsheet for general building use. Converted it to a separate stand-alone QPRO spreadsheet. The output now includes a value of the percentage of the building's annual energy which is met by the base load system. For example, the program was used on the Yakima Junior High School heat pump system to prove that the boiler would be required only a few hours per year - saved the PP&L rebate.


4.3 Geothermal Library. During the fourth quarter of 1994, 31 new volumes were added to the library.

4.4 Information Dissemination. During the fourth quarter of 1994, the GHC provided publications to individuals according to the following topics:

<table>
<thead>
<tr>
<th>Topic</th>
<th>No. Publications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geothermal Heat Pumps</td>
<td>107</td>
</tr>
<tr>
<td>Greenhouses</td>
<td>3</td>
</tr>
<tr>
<td>Equipment</td>
<td>5</td>
</tr>
<tr>
<td>Resources/Wells</td>
<td>7</td>
</tr>
<tr>
<td>Other</td>
<td>43</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>165</strong></td>
</tr>
</tbody>
</table>

5.0 Geothermal Progress Monitor

California

5.1 Glass Mountain

Two California companies have announced plans to build a 30-megawatt geothermal power plant on Glass Mountain in northern California on the Modoc National Forest, about 80 km south of Klamath Falls, Oregon. Calpine Corporation of San Jose and Trans-Pacific Geothermal Corporation of Oakland, both independent power companies, will form a partnership to build the plant. The companies plan to begin drilling test wells later this month in the 8,000-ha lease they hold on the forest. The power plant should be online by 1998. Power generated by the plant would go to the Bonneville Power Administration and the Springfield Utility Board of Oregon. Those utilities also hold an option to purchase up to 100 additional megawatts of power. Glass Mountain was one of the three sites in the northwest U.S. selected by the BPA in 1991 for exploratory geothermal power production. Others include Newberry Volcano and Vale in Oregon. California Energy Corporation also holds a contract with BPA to develop geothermal power on Glass Mountain, as well as Newberry Volcano. Glass Mountain has the potential to produce more than 1,000 MW of power. About 20 exploratory wells drilled by various companies on Glass Mountain have produced temperatures of 230 to 260°C. Exploratory wells to be drilled this fall will be up to 1200 m deep. This will be the first geothermal power plant developed in the northwest U.S. (Summary of an article by Todd Keeple in the Herald and News, September 2, 1994).

5.2 California Energy vs. Magma Power

The California Energy Company said they would begin a cash-tender offer in early October worth an estimated $430 million for 51% of the common stock of its rival producer of geothermal power, Magma Power Company, converting an acquisition offer into a hostile takeover bid. This is the first step in Cal Energy’s plan to buy all of Magma’s shares - a transaction valued at $840 million - and gain representation on Magma’s board. This combination would create a company with annual revenues of about $400 million. The companies are two of the U.S.’s largest producers
of geothermal power. Magma, based in San Diego, operates seven geothermal plants in southern California (total of 226 MW) and it holds interests in other projects in California and Nevada. California Energy, Based in Omaha, has six operating sites in the southwest (total of 240 MW). The merger would allow the companies to draw on the engineering expertise of Dow Chemical Company, one of the owners of Magma, and of Peter Kiewit Sons Inc. of Omaha, the largest shareholder of California Energy. (Summarized for an article by Harriet King in the New York Times, October 5, 1994).

Idaho

5.3 Boise Heating System

The city of Boise, Idaho, owns and operates a district heating system which uses geothermal energy. Conceived in the late 1970s and built in the early 1980s (primarily with federal and city funds), the system became fully operational in September 1983. Following an initial surge in connections, customer growth has been slow but steady over the past decade. At present, 42 customers in downtown Boise receive thermal energy from the system. More than 150,000 square meters of floor space in public buildings commercial offices, and other structures use the city’s geothermal energy as their primary source of heat. The geothermal rate varies from $0.214 to $0.1432 per 100 gallons of water used ($0.0566 to $0.0379 per 100 liters) - about 30% less than the prevailing natural gas price. An injection well is being proposed to increase the capacity of the system, which is presently operating at capacity due to depletion of the aquifer. The city is proposing to intercept the spent water from the system before it is discharged into the Boise River, and inject it into the new well. This will help the financial condition of the system due to the decline in geothermal water rates. The proposed budget for the project is around one million dollars.

5.4 School District Reaps Geothermal Benefits

Coeur d’Alene School District 271 is saving energy and money through a comprehensive energy conservation package from Kootenai Electric Cooperative.

The geothermal space heating and cooling system at the new Lake City High School is the heart of the program. Special attention was also given to the school’s windows, lighting and insulation in conjunction with Kootenai Electric Cooperative’s Energy Smart Design Program. ESD projects typically reduce energy consumption by 10 - 30 percent, according to a Kootenai Electric news release detailing the project.

The Lake City system is classified under the broad heading of geothermal heating even through it uses water from the earth at temperatures far cooler than the typical geothermal heating system.

Classic geothermal heating systems use hot water pumped from the earth into pipes which heat a facility. Water temperatures in these systems typically range from about 100°F to 212°F.

The Lake City system uses water at a temperature of about 50 - 55°F. The water is pumped from the aquifer through a heat exchanger where heat is transferred to a closed-loop heat pump system.

A total of 103 individual heat pumps are connected to a closed water loop that runs throughout the building. Heat can be added or removed from the system as needed. Heat removed at one location can be added back to the system for use elsewhere.

Kootenai Electric estimates the annual operating cost for the system is 20 percent less than the yearly operating costs for a gas boiler/cooling system. The school’s system will be one of the most efficient heating and cooling systems of any school in the nation, the utility company predicts.

Additional energy-saving features in the 166,000-square-foot building include low-emissivity glass in all the windows to reduce heat loss. An invisible metallic coating on the glass reflects the heat into the room that would normally be lost out the windows.

Insulation R values exceed what traditionally goes in walls for school buildings. To provide additional insulation, polystyrene inserts were placed in the building’s concrete wall blocks to resist the flow of heat.
T-8 fluorescent lamps were installed throughout the school. The lamps contain better phosphor coatings and use less electricity. Coupled with more efficient electronic ballasts, the fixtures will produce longer lamp life and provide an estimated 20 percent reduction over the lighting energy consumption of conventional fluorescent lighting systems.

An ESD Program rebate of about $140,000 was presented to school district officials from KEC during the school’s opening ceremonies August 31st. As a result of the project, the school will also receive an Energy Edge Award recognizing the building’s superior energy savings.

Oregon

5.4 Expanded Low-Temperature Geothermal Database Now Available From DOGAMI

The Oregon Department of Geology and Mineral Industries (DOGAMI) has produced a digital inventory of Oregon’s low-temperature geothermal resources. This inventory is now available on one computer diskette. It lists 2,193 geothermal wells and springs, more than doubling the number of known geothermal resources in the state over the previous inventory done in 1982.

Low- and moderate-temperature geothermal sites produce water up to 150°C (300°F)—not hot enough to power conventional steam turbines and produce electrical energy; but, sufficient for many economic applications, from greenhouse heating to residential heat pumps to industrial space heating.

The inventory of geothermal sites is part of the nationwide Low-Temperature Geothermal Resource and Technology Transfer Program funded by the U.S. Department of Energy, Geothermal Division. It is administered in Oregon by the Geo-Heat Center at the Oregon Institute of Technology.

The new geothermal database was produced with the Excel program on the DOS platform. It is divided into three files, one for all the counties of Oregon except the area around Klamath Falls, the second for the Klamath Falls area, and the third for chemical data of all those sites from which such data are available.

The database was produced by DOGAMI geologist Gerald L. Black, and is now available to the public as DOGAMI Open-File O-94-9, *Digital Data and Selected Texts from Low-Temperature Geothermal Database for Oregon*. The purchase price for the 3-1/2 inch high-density diskette is $12.

Single paper copies of the report by Black have been placed on open file for library access only in the libraries of DOGAMI’s offices in Baker City, Grants Pass (address below), and Portland as Open File Report O-94-8. This paper version contains the databases, the report text with a slightly extended appendix, and five location maps. Availability is restricted to examination in the library. Photocopies can be obtained at cost.

The new digital report, Open-File O-94-9, is now available over the counter, by mail, FAX, or phone from the Nature of Oregon Information Center, Suite 177, State Office Building, 800 N.E. Oregon Street #5, Portland, OR 97232-2109, phone (503) 731-4444, FAX (503) 731-4066; and the DOGAMI field offices: 1831 First Street, Baker City, OR 97814, phone (503) 523-3133, FAX (503) 523-9088. (Source: Oregonian)

Utah

5.5 Milgro Nursery, Inc. Expands to Utah

Milgro’s new facility near Newcastle, Utah, in the Escalante Desert is an ideal place to grow potted plants, the mainstay crop for the nursery. There are moderate temperatures, high intensity sunlight, good quality irrigation water, an abundant supply of geothermal hot water for greenhouse heating, and it’s all located in a relatively insect- and disease-free region.

The company considered expanding their operation in Oxnard and Santa Barbara, California, which includes over 1.8 million square feet of greenhouse facilities. But expensive land in Ventura County plus the myriad of red tape for any type of development in California discouraged any serious planning.
Most promising about the Newcastle area was a reservoir of naturally hot water. After studying the area for some time, the company located a 290 acre site where 550 ft wells were drilled at opposite ends of the property to tap both the geothermal water and clean irrigation water. The geothermal well produces 1400 - 1500 gpm of 190°F water delivered to two flat plate heat exchangers. The geothermal fluid is disposed of in an injection well. On the heating loop side, 180°F water circulates through 120 miles of tubes at bench level and returns at about 145°F to the heat exchanger. All potted plants are grown on rolling benches and irrigated using a drip system.

The first commercial crop produced at the Newcastle operation - poinsettias - was shipped in time for the 1993 Thanksgiving holiday season. This was only five months after construction of the new facility had started. Other potted plants include mums, geraniums and easter lilies in the 400,000 square foot greenhouse. A third range (200,000 square foot) is under construction, and eventually over 30 acres will be built.