FEDERAL ASSISTANCE PROGRAM
QUARTERLY PROJECT PROGRESS REPORT

GEOTHERMAL DIRECT-HEAT UTILIZATION ASSISTANCE

GRANT NO. DE-FG07-90ID 13040

REPORTING PERIOD: OCTOBER - DECEMBER 1994

PAUL LIENAU, PROJECT DIRECTOR

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

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ABSTRACT

The report summarizes activities of the Geo-Heat Center (GHC) at Oregon Institute of Technology for the first quarter of Fiscal Year 1995. It describes contacts with parties during this period related to assistance with geothermal direct heat projects. Activities include: geothermal heat pumps, space heating, greenhouses, aquaculture, resources and equipment. Research is also being conducted on geothermal energy cost evaluation, low-temperature geothermal resource assessment, use of silica waste from the Cerro Prieto geothermal field as construction materials and geothermal heat pumps. Outreach activities include the publication of a quarterly Bulletin on direct heat applications and dissemination of information on low-temperature geothermal resources and utilization.

1.0 Project Summary: October 1 - December 31, 1994

1.1 Technical Assistance. GHC staff provided assistance to 67 requests during the reporting period from 20 states, Canada and Iceland. A breakdown of the number of requests relative to applications are: geothermal heat pumps (13), space heating (10), greenhouses (6), aquaculture (5), resources (16), equipment (10), and other (7).

1.2 R & D Activities. Progress is reported on: (1) geothermal energy cost evaluation, (2) low-temperature resource assessment, (3) use of silica waste from Cerro Prieto geothermal field as construction material, and (4) geothermal heat pumps.

1.3 Technology Transfer. GHC Quarterly Bulletin Vol. 16, No. 1 was published and sent to 2064 subscribers. 3 technical reports and papers were prepared, 2 presentations were given, and 2 tours were provided. A total of 206 publications were distributed on geothermal direct use. Geothermal progress monitor (GPM) reports include: (1) Army base to retrofit 4000 housing units with geothermal heat pumps, (2) Merle West Medical Center updates geothermal system, and (3) geothermal power on the rise.

1.4 GHC staff that worked on the project included: P. Lienau 89%, G. Culver 100%, K. Rafferty 97%, J. Lund 5%, and D. Gibson 97%.

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>Char Gruessing</td>
<td>GHP. Provide list of geothermal heat pump dealers in the northwest that attended the GHC heat pump seminar in May 1992 (10-5-94).</td>
</tr>
<tr>
<td>WSEO</td>
<td></td>
</tr>
<tr>
<td>Olympia, WA</td>
<td></td>
</tr>
<tr>
<td>Larry Holzgang</td>
<td>Space Heating. Discussed possible use of geothermal energy for a new Shilo Inn, located near OIT, consisting of 145 rooms and 15,000 ft² convention center. Estimated depth and cost of wells (10-7-94).</td>
</tr>
<tr>
<td>Pacific Power</td>
<td></td>
</tr>
<tr>
<td>Klamath Falls, OR</td>
<td></td>
</tr>
<tr>
<td>Kent Banks</td>
<td>Equipment. Provided estimate of cooling for 1 mile of buried pipeline from a collection pond to the head of a trout stream (10-7-94).</td>
</tr>
<tr>
<td>Springfield, MO</td>
<td></td>
</tr>
<tr>
<td>Tom Banks</td>
<td>Equipment. Klamath County Jail heat exchanger appears to be collecting rust from some place in system. In past cleaned at 2-yr intervals, now need to clean in 2 weeks. Material is magnetic, but too light for magnetite. Checked with well driller, no similar material noted in log. Possibly from steel pipes--or outside column or inside casing (10-7-94).</td>
</tr>
<tr>
<td>Klamath County</td>
<td></td>
</tr>
<tr>
<td>Klamath Falls, OR</td>
<td></td>
</tr>
</tbody>
</table>
2.5 Dennis Trexler  
Desert Research Inst.  
Reno, NV  
Resource. Water at San Emidio farms (dehydration plant) is radioactive. Has 101 pcl B and 16 pcl α. Suggested notification of plant personnel about possible danger of opening up system. Radiation probably within health limits when water in pipes—will be checked. Disposal is to injection wells in geothermal with similar but less TDS (10-10-94).

2.6 Lew Pratsch  
DOE  
Washington, D.C.  
Space Cooling. Provided considerations regarding sites for DOD large tonnage ground-water chiller possibilities. The issues included: groundwater, chiller size, building system and utility (10-13-94).

2.7 John Metesh  
Montana Bureau of Mines and Geology  
Butte, MT 59701  
Resource. Discussed proposal for geothermal district heating at Jackson Hot Springs, MT. Suggested the Bureau may want to become involved in resource evaluation (10-13-94).

2.8 Dean Harbaugh  
City Council  
P.O. Box 1956  
Alturas, CA 96101  
District Heating. City is looking into using left over geothermal and effluent from AL1 and AL2 for city buildings. Lefler Engineering gave the following estimates of $168,750 for pool and four buildings at $400,000 including piping, heat exchangers, retrofit, etc. Discussed plan with the CEC—they would rather use effluent than do more geologic work or well drilling. Sent reports and geology information (10-13-94).

2.9 Oregon Water Resources  
Salem, OR  
Resource. Reviewed and commented on proposed well drilling standards. Discussed on phone (10-14-94).

2.10 B. G. Hicks  
Consulting Geologist  
Ashland, OR  
Resource. Discussed geology of the Jackson Hot Springs area—contacts with plutons and dikes in the area. Referred to several reports by DOGAMI (Jerry Black) and the GHC Ashland report (10-14-94).

2.11 Tom O’Hare  
Pagosa Springs, CO  
Resource. General discussion of Pagosa Springs area resource reactions of wells—history of the project, etc. (10-14-94).

2.12 Ward Brown  
Crater Lake Water  
Chiloquin, OR  
Resource. Reviewed geology and description of Klamath Falls site in terms of vertical and horizontal extent. Potential sources of contamination were discussed. Referred to Del Sparks (Water Master) and Fred Lassiner (State Hydrologist) (10-14-94).

2.13 Maria Vicens  
Bill Nye, The Science Guy  
Seattle, WA  
206-624-1834  
General. Provided information on geothermal uses for possible sites to do a show on geothermal energy (10-14-94).

2.14 R. S. Matsamoto  
99-1041 Manako Street  
Aiea, HI 96701  
808-488-7195  
Greenhouses. Discussed the building of a geothermal heated greenhouse on the Big Island. The location is on 100 acres near the HGPA well. A resort/spa would be developed in conjunction with the greenhouse. Sent spa, greenhouse, DHE and equipment information (10-14-94).

2.15 David Hicks  
NREL  
1617 Cole Boulevard  
Golden, CO 80401  
General. NREL is developing and producing a brochure on geothermal direct use. Provided information on history, what it is and how it works, types of resources, and applications. Project illustrations can be highlighted GHC slides (10-18-94).

2.16 Thurmon Blake  
54105 Ave W. Jurez  
LaQuinta, CA 92253  
Resource. Looking for a geothermal site in Lake County, California. Sent database of county and map with locations (10-18-94).
2.17 Mike Young  
**WaterFurnace West**  
2027 Fescue Street  
Albany, OR 97321

GHP. Requested 50 copies of GHC Bulletin on heat pumps for schools. Also sent cost comparison of ground-source heat pump systems (10-19-94).

2.18 Ken Anderson  
**Pacific Power**  
Portland, OR  
503-464-5977

GHP. Monitored ground-source heat pump system for an Ashland, Oregon, residence. Sending report to include in GHP database (10-21-94).

2.19 John Uhl  
**Box Canyon Motel**  
Ouray, CO


2.20 Maria Gunnardottir  
**Samband Hitaveitna**  
Iceland

District Heating. Requested an article on the district heating system in Tanggu, Tianjin, China. Also sent direct use guidebook (10-21-94).

2.21 Bill Sullivan  
**Sandia National Labs**  
Albuquerque, NM

District Heating. Discussed a geothermal district heating system for United World colleges. Exploratory drilling and instrumentation with DOE support were considered (10-21-94).

2.22 Ron Parker  
Salt Lake City, UT

District Heating. A large subdivision is being developed near Saratoga Resort, northwest of Utah Lake. Discussed low temp air distribution and cost of water distribution. Advised the developer using geothermal energy at 113°F is probably not economical (10-21-94).

2.23 Yong Lee  
**Dept. of Political Science**  
Iowa State University  
Ames, IA 50011

General. Requested information on research centers for an NSF directory. Submitted information on GHC including: funding sources, mission, accomplishments and awards.

2.24 Susan Brown  
**Karbate Vicarb, Inc.**  
21945 Drake Road  
Strongsville, OH 44136  
216-572-3600

Equipment. Requested information on geothermal district heating systems. Sent report on 13 systems and informed the company that a Vicarb plate heat exchanger had been installed at the Elko geothermal district heating system (10-26-94).

2.25 Ford Weicht  
1825 Chestnut  
Abilene, TX 79602

GHP. Discussed the pros and cons of ground-coupled vs. direct expansion heat (DX) pump systems. Commented on the importance of a qualified contractor for either type of system, ratings, amount of excavation, efficiency, etc. The major difference is that the ground-coupled system is a single packaged unit sealed at the factory. DX requires field refrigeration work for installation. As a result, this factor strongly favors the ground-coupled approach (10-28-94).

2.26 Dan Warren  
**Fish Pro**  
3030 S.W. Moody Avenue  
Portland, OR 97201  
503-224-0171

Aquaculture. The company is doing a aquaculture feasibility studies for 6 areas in the K. Basin. Provided resource data on the areas from the Oregon database. Referred to the Water Master for the area on regulations (10-28-94).

2.27 Blaine Bellerud  
**Fisheries Biology**  
4132 B. Adelaide  
Klamath Falls, OR 97603  
503-884-5521

Aquaculture. Requested results of OIT research on aquaculture. Discussed resources in K. Basin--considering starting a business based on aquaculture (10-31-94).
2.28 Ron Zech  
2339 Orchard Avenue  
El Cajon, CA

2.29 Jerry Kirkman  
Eagle, ID

2.30 David Tenenbaum  
5741 Bittersweet Place  
Madison, WI 53705  
608-238-2201

2.31 Andy Parker  
Oregon Desert Greenhouses  
Lakeview, OR  
503-947-3923

2.32 Ray Gibson  
OIT  
Klamath Falls, OR

2.33 Clyde Reeves  
31585 Road 68  
Visolia, CA 93291  
800-526-4410

2.34 Neal Odemeyer  
Boise District Heating  
Boise, ID

2.35 Bill Gordon  
Milgro Nursery, Inc.  
Newcastle, UT 84756  
801-439-5285

2.36 Howard Ross  
ESRI  
391 Chipeta Way  
Salt Lake City, UT 84108

2.37 Deborah Page  
1396 S. Hwy 137  
Willow Springs, MO 65793  
417-469-5126

GHP. Discussed resource for residential heat pump installation--70 ft well used for irrigation. Mechanical engineer suggested drilling second well for 2000 ft² home. Sent information on heating pump associations and other contacts (10-31-94).

Equipment. Wanted to know if 2-in. PVC rated at 160 psi could be used to carry 130°F - 140°F at 12 psi. Explained rating is at room temperature and is derated for higher temperatures (10-31-94).

General. Wanted annual energy contribution for geothermal direct use for all countries. Sent table and Reference Book on U.S. use (11-1-94).

District Heating. Discussed the use of existing well at 247°F, 800 gpm drilled to 2000 ft for a geothermal district heating system for downtown Lakeview. Distance is 1.5 mi from downtown--may be able to renew franchise from early 1980s (11-2-94).

Equipment. OIT well pump #5 is making a noise which varies with rpm and pressure. Could not explain the cause (11-3-94).

Greenhouses. Requested information on geothermal resources for Union and Deschutes Counties, Oregon. Sent Oregon database for the counties and information on heating greenhouses with geothermal energy (11-4-94).

District Heating. A moratorium has been established on connecting new customers to the Boise district heating system due to redesign of the delivery and disposal system. The Capital Mall wells will be used for injection in the new design. A new motel complex is evaluating boilers vs. geothermal. Using the HVAC chapter in the GHC Guidebook as background, the developers and contractor were convinced to go ahead with geothermal when the moratorium is lifted. Mr. Odemeyer has asked the GHC to assist with marketing the Boise geothermal system--specifically learning about HVAC systems (11-4-94).

Greenhouses. Requested technical assistance to review geothermal system and suggest improvements. A visit to the facility was established for 7 December 1994. The existing geothermal system is served by a single production well which provides 192°F geothermal fluid to two parallel plate-and-frame heat exchangers. Cooled geothermal fluid (140°F to 150°F at peak) is disposed of in an injection well. The peak flow of 700 gpm with a temperature drop of 42°F is required to meet the load of the 392,400 ft² greenhouses. Milgro estimates a 5 to 1 savings in operation of their Utah facility over their California operation. Milgro specifically requested assistance in reducing geothermal fluid flow requirements for future development (11-7-94).

Resource. Requested information on the potential of low-temp. geothermal resources for direct energy applications. Table I was developed from the cited references to be included in a book on renewable energy being produced by Public Citizen (11-8-94).

Aquaculture. Requested information on Fish Breeders, Inc. of Buhl, Idaho and projects in Montana. Sent paper and brochure on Fish Breeders and Direct Use Reference Book for Montana projects. She is developing a workbook for elementary schools on the use of geothermal energy in the northwest (11-8-94).
### Table 1. Energy for Identified Geothermal Hydrothermal Systems in the U.S.

<table>
<thead>
<tr>
<th>State</th>
<th>Number of Systems</th>
<th>Resource</th>
<th>Number of Systems</th>
<th>Resource</th>
<th>Total Resource</th>
<th>State</th>
<th>Number of Systems</th>
<th>Resource</th>
<th>Number of Systems</th>
<th>Resource</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(10^4 J)</td>
<td>(10^18 J)</td>
<td></td>
<td>(10^18 J)</td>
<td></td>
<td></td>
<td></td>
<td>(10^4 J)</td>
<td></td>
<td>(10^18 J)</td>
</tr>
<tr>
<td>Alaska</td>
<td>33</td>
<td>0.88</td>
<td>25</td>
<td>5.81</td>
<td>6.69</td>
<td>Hawaii</td>
<td>1</td>
<td>0.05</td>
<td></td>
<td>0.05</td>
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<tr>
<td>Arizona</td>
<td>63</td>
<td>3.6</td>
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<td>0.93</td>
<td>4.53</td>
<td>Idaho</td>
<td>171</td>
<td>6.1</td>
<td>34</td>
<td>128.5</td>
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<tr>
<td>Arkansas</td>
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<td></td>
<td>0.092</td>
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<td>3.3</td>
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<td>3.3</td>
</tr>
<tr>
<td>California</td>
<td>203</td>
<td>5.6</td>
<td>24</td>
<td>8.47</td>
<td>14.07</td>
<td>Montana</td>
<td>52</td>
<td>17.3</td>
<td>8</td>
<td>2.71</td>
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<td>Colorado</td>
<td>49</td>
<td>3.8</td>
<td>10</td>
<td>2.4</td>
<td>6</td>
<td>Nebraska</td>
<td>1</td>
<td>3.4</td>
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<td>Georgia</td>
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<td>0.05</td>
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<td></td>
<td>0.05</td>
<td>Nevada</td>
<td>191</td>
<td>5.5</td>
<td>24</td>
<td>8.88</td>
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<tr>
<td>Hawaii</td>
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<td>New Mexico</td>
<td>70</td>
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<tr>
<td>Idaho</td>
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<td>128.5</td>
<td>134.6</td>
<td>New York</td>
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<tr>
<td>Kansas</td>
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<td></td>
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<td>Massachusetts</td>
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<td>North Dakota</td>
<td>12</td>
<td>21.25</td>
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<td>21.25</td>
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<tr>
<td>Montana</td>
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<td>17.3</td>
<td>8</td>
<td>2.71</td>
<td>20.01</td>
<td>Oklahoma</td>
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<td>Oregon</td>
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<td>20</td>
<td>13.54</td>
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<tr>
<td>Nevada</td>
<td>191</td>
<td>5.5</td>
<td>24</td>
<td>8.88</td>
<td>14.38</td>
<td>South Dakota</td>
<td>8</td>
<td>12.52</td>
<td></td>
<td>12.52</td>
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<tr>
<td>New Mexico</td>
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<td>1.32</td>
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<td>1.09</td>
<td>2.41</td>
<td>Texas</td>
<td>17</td>
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<tr>
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<td></td>
<td>0.005</td>
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<td>118</td>
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<tr>
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<td>0.015</td>
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<td>21.25</td>
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<td></td>
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<td>Washington</td>
<td>25</td>
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<tr>
<td>Oklahoma</td>
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<td>West Virginia</td>
<td>5</td>
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<tr>
<td>Oregon</td>
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<td>2.7</td>
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<td>13.54</td>
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<td>Wyoming</td>
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<tr>
<td><strong>Totals</strong></td>
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<td></td>
<td><strong>175.2</strong></td>
<td><strong>280.243</strong></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>

*Resource: energy recoverable at the wellhead (10^18 J = 0.95 Quad)

### REFERENCES


Note: The number of identified geothermal resources for 10 western states has increased substantially as a result of state team efforts in the 1993-94 Low-Temperature Program. Thus the indicated resource (10^18 J) for these states is larger than the calculated value by some unknown amount. In general, most of the larger resources were known to the 1979 and 1983 compilation. (H. Ross and P. Lienau)
2.38 Stuart Simpson  
WSEO  
Olympia, WA  

GHP. Requested a review of a groundwater heat pump system. Discussed storage tank as option, DHW heat pump, variable speed circulating pump and 3-way valve at the heat exchanger. Provided drawing to engineer doing study for groundwater system for elementary school in Moses Lake, WA (11-9-94).

2.39 Bob Sisson  
17325 Germantown Road  
Germantown, MD 20874  

GHP. Wanted unbiased opinion of GSHPs. Discussed ground-coupled systems vs. direct expansion (DX) systems—main concern is field work on refrigeration system. Also discussed vertical and horizontal ground-coupled systems—vertical has a slightly better performance due to more stable ground temperatures (i.e., less seasonal variations) (11-10-94).

2.40 Bruce Durant  
403 Main Street  
Klamath Falls, OR

Resource. Requested report on well test for the Barnes well on Old Fort Road (11-14-94).

2.41 Fredric Steffen  
500 Wall St.  
Seattle, WA 98121  
206-443-1868

Resource. Requested information on Garland Hot Springs, 13 miles north of Index—Temp = 87°F and flow = 100 L/min. Referred to Alex Sifford, ODOE, for a list of hot springs for sale (11-16-94).

2.42 Jo Lansing  
Four Seasons BH&G  
P.O. Box 490  
Pagosa Springs, CO 81147  
303-264-2241


2.43 Tak Yoshida  
1526 S.E. Powell Blvd.  
Portland, OR 97202  
503-238-7117

Resource. Discussed drilling sites for geothermal well to supply resort/spa complex. Sites were discussed relative to fault location and existing thermal springs in the Carson Hot Springs, Wing River Head area (11-17-94).

2.44 James Mooney  
3300 Webster Street  
Oakland, CA 94609

Resource. A residence in Calistoga has an unused geothermal well in the yard. The owner requested information on a downhole heat exchanger. Sent DHE design report, and home heating system guidelines (11-18-94).

2.45 Nikola Janceski  
John F. Kennedy H.S.  
99 Terrace View Avenue  
Bronx, NY 10464


2.46 Ron Zech  
2339 Orchard Avenue  
El Cajon, CA 92019

GHP. Provided information about geothermal heat pumps for a new home—source for a handbook, source of contractors from SW Heat Pump Assoc. and the National Rural Electric Assoc. (11-29-94).

2.47 Philip Ayers  
National Park Service  
P.O. Box 25287  
Denver, CO 80225

Ponds. Requested software HEAToolS used for analysis of heat loss from ponds. Using it for calculation of evaporation for sewage lagoons is outside the application intended. The accuracy of the results would, therefore, be subject to questions. Provided a reference for other software available from FermiLab covering pond thermal calculations (12-1-94).

2.48 Roger Peake  
CEC  
Sacramento, CA 916-654-4607

GHP. Requested comparative monitored data for geothermal heat pump systems from states other than California. Informed him the GHC is developing a database for the U.S. which will be available in the Spring of 1995 (12-6-94).

2.49 Elliott Estes  
OIT Physical Plant Dir.  
Klamath Falls, OR

Equipment. Discussed specifications for a well pump. These include: bearing materials, methods of securing impellers, impeller diameter, flow, head, thrust factor, etc. (12-7-94).
2.50 Peter West  
Renewable NW Project  
1130 S.W. Morrison  
Portland, OR 97205  

Sent several papers on direct use and referred to GRC for power (12-8-94).

2.51 Rita Stewart  
Salt Lake City, UT  
801-654-4226  

Resource. Wants to drill a geothermal well and use a DHE for energy extraction. Discussed drilling, well completion and DHE design (12-8-94).

2.52 Steve Hudson  
Pocohautis, AR  
800-382-3113  

GHP. Discussed monitoring of groundwater heat pump systems. Regulatory people are expressing concern over changes in groundwater temperature (12-8-94).

2.53 Ivar Michelsons  
2433 71st Avenue SE  
Mercer Island, WA 98040  
206-521-4500  

GHP. Provided information package on geothermal heat pumps and a contact for WaterFurnace West in Albany, OR (12-9-94).

2.54 Bruce Cippit  
Caneta Research  
6981 Millcreek Dr., Unit 28  
Missusquah, Ontario  
L5N 6B8 Canada  
905-542-2890  


2.55 Brian Walker  
66172 Oregon Hwy 230  
La Grande, OR 97850  


2.56 Jim Leshuck  
Portland, OR  

Snow Melt. Discussed snow melting wheelchair ramp for 48 unit motel in Government Camp, OR (12-14-94).

2.57 Mike Jones  
Hydro-Temp Corp.  
P.O. Box 566  
Pocahontas, AR 72455  

GHP. Discussed thermal impact of groundwater heat pump systems on aquifers. The most important consideration with regard to thermal impact is that groundwater systems are essentially the same as ground-coupled. The quantity of heat delivered or returned to the ground is determined by the building not the type of system serving it (12-14-94).

2.58 Mike Hastings  
Geothermal Proj. Office  
Naval Air Weapons Station  
China Lake, CA 93555  

Space Heating. Discussed at the GHC resource and project development for primarily a domestic hot water supply for a Marine training center at Fallon, NV (12-12-94).

2.59 Thurmon Blake  
Bakersfield, CA  

Resource. Client is searching for a low-temp geothermal resource site for greenhouse development. Sent study on Clear Lake, CA, by Popadapalus (12-14-94).

2.60 Randy Romang  
726 S. 900 E. C-1  
Salt Lake City, UT 84102  
801-532-5826  

Aquaculture. An aquaculture project near Grantsville, UT, has severe scaling problems. Discussed types of pipes, where scaling occurs, pH changes, etc., as possible solution to the problem (12-28-94).

2.61 Bob Thomasson  
Oxbow Geothermal  
Reno, NV  
702-825-4345  

Equipment. Geothermal well pumps are having bearing problems--using bronze in 230°F fluid with low H2S. Discussed similar temp. uses. Referred to Wineagle and Amity (Jim Osmund) using bronze in similar temperatures. Working with different alloys and bearing clearances (12-14-94).
2.62 Jeremiah Clark  
380 Court Street  
Soda Springs, ID 83276  
Electric Power. Wanted information on generating power using low-temp resources. Referred to three firms that manufacture binary power plants (12-19-94).

2.63 Scott Crocker  
P.O. Box 1326  
Hailey, ID 83333  
Greenhouses. Discussed the use of a 160 ft well producing 400 gpm at 130°F for a greenhouse project. Also considered plastic structures, snow load, heating systems, and insulating a 0.5 mi pipeline (12-20-94).

2.64 Layne Merritt  
Sunrise Engineers  
P.O. Box 678  
Afton, WY 83110  
Greenhouses. Has client interested in drilling geothermal wells for a greenhouse project. Discussed regulation of geothermal, which is primarily a state issue if on private land. Suggested he look at disposal with an environmental agency. Sent information on greenhouses (12-20-94).

2.65 Louie Templeton  
Susanville, CA  
916-257-2174  
Equipment. Problems with Btu meters at the high school. The meters give erratic results; therefore, the city has ceased billing. Recommended a change in the approach to billing (i.e., flat rate based on building size, volume metering, etc.) (12-20-94).

2.66 John Berning  
EPRI  
3412 Hillman Avenue  
Palo Alto, CA 94304  
Greenhouses. Wanted a copy and disk of greenhouse equipment selection spreadsheet (12-20-94).

2.67 Scott Crocker  
P.O. Box 1326  
Hailey, ID 83333  
208-726-9185  
Equipment. Analyzed heat loss from 2500 ft, 6-in. pipeline carrying 400 gpm at 130°F. Resulted in a 5°F temperature loss. Suggested he check the cost of PB, PE and PVC. Line to service greenhouse in Hailey, ID (12-28-94).

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. The following are summaries of activities for the first quarter of Fiscal Year 1995.

3.1 Geothermal Energy Cost Evaluation

In order to be seriously considered as an alternative in any project, an energy source must be easily characterized in terms of cost, both capital and unit energy cost. Historically, this has been a difficult hurdle for geothermal energy. Its costs vary with the depth and character of the resource, number of production and injection wells, and a host of other parameters. As a result, even in cases where developers are interested in using the geothermal, identifying its costs has been a cumbersome process. To address this problem, the Geo-Heat Center is developing a spreadsheet which will allow potential users to quickly evaluate the capital cost and unit energy cost of accessing a geothermal resource.

Using resource, financing and operating inputs, the spreadsheet calculates the capital cost for production well(s), well pump(s), well head equipment, injection well(s), and connecting pipelines. These capital costs are used along with the quantity of annual energy to be supplied and financing information to produce a unit cost of energy. Unit costs for operation (maintenance and electricity) are added to arrive at a total unit cost in $ per million Btu for geothermal heat. To put this value into perspective, similar costs for an equivalently sized gas-boiler plant are also calculated. These values can then be compared to determine the relative economic merit of geothermal for any specific set of circumstances.

Cost data used to develop the spreadsheet is a combination of values from previous projects and data from standard industry construction estimating guides.
3.2 Low-Temperature Resource Assessment

The assessment of low-temperature resources in 10 states has resulted in 8,170 thermal springs and wells to be entered into digital databases (spreadsheet) for each state. This was a 41% increase compared to the previous assessment in 1983, as shown in Figure 1.

Many of these sites also have chemical analysis of the thermal waters included in the databases.

Final reports have been received for seven of the states. Arizona, New Mexico (Jim Withcer, SW Technology Development Institute) and California (Les Youngs, Division of Mines & Geology) have yet to complete their reports and resource maps. The reports will be made available as Open-File Reports from the respective State Departments of Geology.

State Teams presented brief discussions of the priority resource areas they have selected for more detailed study at the October 4, 1994 GRC meeting.

The discussion included:

1. Status of the site in terms of current use and potential for near-term development;

2. Potential for utilization, and what type (space heating/cooling, greenhouses, aquaculture, industrial processes, etc.,);
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<thead>
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<th>STATE</th>
<th>SITE</th>
<th>MEAS. TEMP. (°C)</th>
<th>DEPTH (m)</th>
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* ID 2. There are numerous existing wells suitable for use and there have been numerous studies suggesting economic use—nothing ever happens. Is it political/institutional, lack of understanding, reluctance to change, etc.?
3. Same as above.
4. Same as above.
<table>
<thead>
<tr>
<th>STATE</th>
<th>SITE</th>
<th>MEAS. TEMP. (°C)</th>
<th>DEPTH (m)</th>
<th>FLOW (L/min)</th>
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</table>

* WA 1. Recommendations: 2) match existing thermal wells with proposed new construction or remodeling of public buildings, 2) determine which projects could make advantageous use of geothermal resource, and 3) encourage and facilitate such applications.
2. Recommendations: station an investigator in the Columbia Basin to: 1) measure downhole temp. gradients, 2) obtain well-test data, 3) obtain drill cuttings for measurement of thermal conductivity and geochemistry, and 4) collect water samples for chemical analysis.
3. Recommendations: 1) inform the people of the state about uses low-tempe geothermal resources, 2) work with public policy makers to make certain that legal and institutional framework encourages wise use, and 3) advocate for use of geothermal resources in place of fossil fuels.
3. Need for additional exploration, assessment, confirmation drilling, etc.;

4. Need for preliminary engineering analysis, and

5. Rough estimates of funding requirements.

Table 2 gives a summary of the sites prioritized for each state.

3.3 Use of Silica Waste from the Cerro Prieto Geothermal Field as Construction Material

Background

The Cerro Prieto geothermal field produces approximately 11,000 tonnes of brine per hour that is disposed of in surface ponds. Approximately 1,300 tonnes of silica waste is the residual product from this hourly production of brine. At present, there is no use for this waste silica. Some experimental work has been undertaken by CFE to utilize this waste silica such as for surfacing roads with cement-silica mixture and making bricks with various additives. However, none of this research has been documented.

Objective

Approximately two years ago, a joint USDOE/CFE research project was proposed to investigate the use of the waste silica. The proposal included using the silica mixed with asphalt and cement to produce a suitable road surfacing material, and to combine the silica with various additives to be used as bricks for low-cost housing. It was thought, that the low specific gravity of the silica and the proposed mixtures would give the bricks a high insulating value (low thermal conductivity), thus protecting the residents from high solar heating, typical of Baja California and the area around Mexicali.

Also, since the geothermal fields of the area extend into the Imperial Valley of California, it was hoped that this research would also be applicable to the U.S. side of the border.

Program for 1994

Approximately 35 kg of silica waste was shipped from Cerro Prieto in the summer of 1994 to the Geo-Heat Center. This material was then used in two phases of research work: (1) to form bricks and cubes of various mixtures for strength testing, and (2) to produce asphalt mixtures for testing as pavement material.

Bricks were formed in 7.60 cm wide by 5.10 cm high by 15.2 cm long (2 in. x 3 in. x 6 in.) molds with removable sides. Thee were cured under various conditions of moisture and heat, and then tested in bending (flexure) by three point loading. Cubes were formed in 5.10 cm (2 in.) square molds and then tested in unconfined compression. All mixtures were tested after 7, 14 and 28 days of curing. Three main additives were used to increase the strength of the silica: hydrated lime, portland cement, plastic fibers, and combinations of these three. Samples of all of the bricks were mailed to USGS in Menlo Park for thermal conductivity testing. Finally, all samples were subjected to a simulated weathering test, consisting of a series of wet-dry tests, and then determining the weight loss after 10 cycles.

An asphalt cement (AR-4000) was mixed with the silica and tested by the Marshall stability method to determine if the material was suitable for use as an asphalt concrete structural pavement surfacing material. An emulsified asphalt (CRS-2H) was also mixed with the silica and compacted samples were tested in emersion-compression to determine its suitability for surface treatment of roads in the form of a slurry seal.

Results to Date

1. Silica-lime mixtures have low strength and weather resistance. However, they have high insulating properties, and thus can be used in non-bearing walls to insulate a building. The addition of plastic fibers to the mixture increased the strength and is the recommended mixture.
2. Silica-cement mixtures have high strength and weather resistance. However, they have lower insulating properties. This mixture can be used in bearing walls with relatively light loads (i.e., single story residences) and still provide some insulating properties.

3. Asphalt mixtures are not suitable using silica, and thus should not be considered for any field construction.

4. Silica-cement mixtures also appear to have application as a road surfacing material with the addition of an asphaltic chip seal for erosion protect.

Three projects are proposed for June 1995:

1. To test material from the large disposal pond at Cerro Prieto, as it is only about 70% silica. The 1994 testing used pure silica from one of the silencers.

2. To construct a building of bricks using both lime and cement with fibers as the additive. This building would be tested for thermal conductivity and weather resistance.

3. To construct a road using silica-cement and monitor its resistance to abrasion and weathering, and to determine its load carrying ability.

3.4 Geothermal Heat Pumps

Data on geothermal heat pump installations are being collected on residential, institutional and commercial buildings. The database contains 185 entries of case studies. Information collected mainly consists of what data was monitored, ground system, performance and contacts. Figure 2 is the form that is used for the database.

Plans are to continue the collection of data on which comparative analysis will be performed.

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 was published in November 1994 and distributed to 1760 U.S. and 304 foreign subscribers. Articles included in the issue are:


6. "Low-Temperature Geothermal Database for Oregon" by Gerald Black.

7. "Geothermal Pipeline - Progress and Development Update from the Geothermal Progress Monitor."
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## ADDITIONAL INFORMATION

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Bulletin Vol. 16, No. 2 was prepared during January 1995 and sent to the printer February 2, 1995. Articles include:

4. "Use of Silica Waste from the Cerro Prieto Geothermal Field as a Construction Material" by John W. Lund, Tonya Boyd and David Monnie.
5. "Pavement Snow Melting in Klamath Falls - Rehabilitation of the ODOT Well" by Rachael E. Thurston, Gene Culver and John W. Lund.
6. "Geothermal Pipeline - Progress and Development Update from the Geothermal Progress Monitor."

4.2 Technical Papers, Presentations, Computer Programs and Tours.

3. Databases. Developed energy resource potential for each state (50) in terms of current use, direct use and geothermal potential. Contacts and number of employees were established for each geothermal direct use project (407).
5. Tour. Svend Aaen and Mogens Samer from Denmark of OIT and city geothermal district heating system.
6. Tour. Central Oregon Community College students of OIT geothermal heating system.

4.3 Geothermal Library. During the period of October - December 1994, 25 new volumes were added to the library. The library now has a total of 5066 volumes cataloged.

4.4 Information Dissemination. The GHC provided publications to individuals according to the following topics:

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<td>Resources/Wells</td>
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<td><strong>Total</strong></td>
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5.0 Geothermal Progress Monitor

Louisiana

5.1 Army Base to Retrofit 4000 Housing Units with Geothermal Heat Pumps

Thanks to a shared savings deal, Fort Polk Army Base here expects to reduce electricity consumption by over 32 million kilowatt hours (kWh) a year by retrofitting 4,000 housing units with efficient ground-source heat pumps and implementing other HVAC, lighting, and building envelope upgrades.

The $18 million project, which began in September, is expected to be completed by next October. It is financed and managed by Co-Energy Group, Santa Monica, California, under terms of a 20-year shared energy and maintenance savings agreement, according to Gerald Weber, mechanical branch chief with the Army Corps of Engineers in Huntsville, Alabama.

The multifaceted conservation effort is expected to yield annual electric, natural gas, and maintenance savings totaling $3,310,228. When electricity savings are combined with an anticipated 15,837 million Btu (MMBtu) decline in yearly gas use, annual utility bill savings amount to $1,965,901.

Because the equipment will be owned and maintained by the energy service company for the life of the contract, Weber said maintenance costs will fall by $1,344,327 a year.

Under terms of the deal with Co-Energy, the base gets to keep 22.5 percent, or $744,801, of the annual energy and maintenance savings for 20 years, the branch chief said. Without taking inflation into account, Weber estimated the savings realized by the base will eventually total close to $15 million. After 20 years, Fort Polk will own the equipment.

Shared savings was probably the only way to make the project happen, he continued. "It would have been difficult to get this through the existing procurement channels," Weber admitted, referring to the government's notorious procurement bureaucracy. "There are some who say that shared savings is giving the farm away because we pass up all the savings. But until Congress gives us the money to make these improvements ourselves, we have to find creative ways to make them happen and make our own road."

It cost Fort Polk $125,000 to develop a proposal request that was used to determine the project's feasibility and put the job out for competitive bid. Although the request expressed the base's equipment preferences, it encouraged the idea of partnership and invited prospective bidders to propose additional energy-saving measures and negotiate with vendors, according to Jim Kelley, manager of the engineering and planning division of Fort Polk's directorate of public works.

"The beauty of it all is that the onus to save Btus is on the contractor," he elaborated. "I am a happy camper knowing that I have a single entity that I am going to deal with over the next 20 years, an entity with a profit motivation for saving energy and maintenance dollars."

"We have also formed a bond of partnership in this contract, where the proposers could tell us about a number of ways that we could save energy," Kelley added.

The cornerstone of Fort Polk's energy improvements will involve replacing 4,003 base housing facility heating and air conditioning systems with closed-loop, water-cooled heat pumps. The housing units, which are mostly apartments, two-story townhouses, and duplexes, range from 900 to 1,400 square feet.

Their heating and cooling was accomplished with a patchwork of strategies, including split air conditioning systems, air-to-air heat pumps with auxiliary electric strip heaters, gas-fired furnaces, chilled water, and solar collectors.

David Aldridge, of the Corps of Engineers, told EUN that the existing equipment was near the end of its useful life, and in some cases occupants had also installed window units to compensate for deficiencies. Using original drawing and name-plate data, project engineers estimated the efficiency of existing equipment at about 7-8 SEER, according to Tom White, Co-Energy's president.
Co-Energy selected Climate Master Inc., Oklahoma City, to provide the new heat pumps. Bob Howell, Co-Energy’s site construction manager, told EUN that 13 units were operational as of early October. When the installation is complete, each family unit will be heated and cooled with a Model VZ017, VZ024, or VE030 heat pump. The Climate Master units range from 1.5 to 2.5 tons and have SEER ratings of about 15.5. They will be mounted inside each residence and are charged with HCF-22.

The heat pumps are expected to account for 19,456,001 kWh of the project’s energy savings and virtually all of the 15,451 MMBtu of gas savings.

While said his company worked closely with Climate Master to create a custom design that could be installed with minimum disruption to existing electrical systems and HVAC conduits.

All the major and auxiliary components, such as valves and circulating pumps, are packaged together, he noted.

"All we have to do is hook up power and connect the piping and we are ready to go," Howell observed.

He added that wells for the heat pumps could range from 130 to 325 feet deep, and will be about four inches in diameter. The U-shaped heating and cooling loop will consist of one-inch heavy-duty polyethylene pipe. Average ground temperature was calculated at around 68°F.

About 3,000 of the heat pumps will be equipped with a heat recovery option that will be used to supplement domestic hot water production. This measure is expected to save 3,529,009 kWh. Adding insulation to water heaters and the use of low-flow shower heads will enhance water system efficiency by another 1,425,252 kWh, Howell claimed (Energy User News, November 1994)

Oregon

5.2 Merle West Medical Center Updates Geothermal System

To cut gas consumption for heating this new assisted-living retirement facility installed an Allen-Bradley variable-speed drive and a Trane direct digital control system to increase the capacity of its geothermal heating system which provides space and domestic water heating. The drive varies pump speed in response to demand for heat, while the controls monitor several heat exchangers, help facilities keep the records required by the state’s geothermal regulatory agency, and help with troubleshooting and maintenance scheduling. In addition to saving gas, the project is expected to reduce load on the hospitals main heating system, lowering maintenance costs and improving reliability.

Facility size: 85,000 square feet
Project Cost: $120,000
Annual Cost Savings: $84,000
Payback: 3.5 years
Return on Investment: 23%
Savings per square foot: $0.40
Reduction in annual natural gas use: 6,800 MMBtu

This project was nominated by Trane Oregon for Certificate of Merit (Energy Users News, December 1994).

5.3 Geothermal Power on the Rise

The Newberry Geothermal Pilot Project, the Northwest’s first geothermal project, has cleared another hurdle and should be producing power by late 1997. The 30-MW pilot project, which will use renewable heat from the earth, will provide enough electricity to serve approximately 15,000 households, according to George Darr, geothermal project manager of the Bonneville Power Administration (BPA).

Environmental impact statements have been completed to the Newberry Geothermal Pilot Project. This cleared the way for the BPA to sign contracts with its partners in the project, CE Newberry Inc., a subsidiary of the California Energy Company, and EWEB. The project will be located on the northwest flank of Newberry Volcano, 35 miles (56 km) south of Bend, Oregon, in the Deschutes National Forest.
Under the agreements, BPA will take two-thirds of the project output, and EWEB will take the remaining third. EWEB will receive credits on its BPA bill for developing its own resource rather than drawing on the BPA system. Both BPA and EWEB will pay only for power delivered. CE Newberry, the developer, will assume financing, construction and operation costs.

The pilot project is part of BPA's Resource Supply Expansion Program, which aims at testing and confirming the viability of promising energy resources, both conservation and generation. This is consistent with the Northwest Power Planning Council's power plan, which calls on BPA to test renewable resources. Because it is in a national forest, the Newberry project participants have taken special care to resolve environmental impacts and address citizen concerns. The Forest Service took the lead in the environmental impact studies, working in cooperation with the Bureau of Land Management and BPA. For nearly two years, EWEB and the developer held monthly meetings with central Oregon citizens to address local issues.

The levelized cost of geothermal power is currently under 4 cents a kilo-watt hour, and the price is expected to drop as power managers gain hands-on experience and as economies of scale kick in. "We expect this pilot project to give us important data for improving the technology, helping us resolve land-use issues and other conflicts, and providing environmental information," Darr said. Concerns over limitations on hydropower due to drought and operational changes because of endangered salmon make exploration of this and other renewable resources especially timely, according to Darr (GRC Bulletin, December 1994).