

ELKO, NEVADA, DISTRICT HEATING SYSTEM

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INTRODUCTION

Elko Heat Company has been operating a geothermal district heating system in Elko, Nevada, since December 1982. This system is a direct-use application and serves 17 customers, and conveys approximately 80 million gallons of 178°F geothermal water annually (Table 1). The customers are primarily using the geothermal water for space heating and domestic hot water heating. Two customers are utilizing their return water for winter-time snow and ice melting on walkways, and one is utilizing a heat pump system. The customers are using the geothermal water to heat a controlled loop system via plate-type heat exchangers. Another customer, a commercial laundry, is softening geothermal water, and using it directly for wash and rinse water.

The Elko Heat Company project was funded by the Department of Energy in the late-1970s. The project was to demonstrate the technical and economical feasibility of utilizing low-to-moderate temperature (less than 250°F) geothermal energy in direct-use applications. The project received 100 percent funding to conduct resource exploration; drill, develop and test the geothermal resource; and install the distribution and disposal systems. Each of the customers were responsible for the design and construction of its system retrofit to geothermal heat. The Department of Energy provided an \$827,000.00 grant to Elko Heat Company to complete the system. The Elko Heat Company project was one of 23 projects funded by the Department of Energy under a Program Opportunity Notice (PON) solicitation, 15 of which became operational.

Table 1. Comparative Analysis - Elko Heat Co. Geothermal Well No. 1 - Avg. Elko City Water and Nevada State Drinking Water Standards

Parameter	Elko Heat Co. Geothermal Production Well No. 1*	City of Elko**	State of Nevada Drinking Water Standards***
TDS	605	416	1000
Hardness	214	190	No Limit Set
Calcium	61	56	No Limit Set
Magnesium	12	12	125
Sodium	117	44	No Limit Set
Potassium	47	13	No Limit Set
Sulfate	77	51	500
Chloride	17	33	400
Nitrate (NO ₃)	No Test Data	3	45
Alkalinity	405	145	No Limit Set
Bicarbonate	378	176	No Limit Set
Carbonate	<1	0	No Limit Set
Fluoride	1.9	.25	1.6 - 2.0
Arsenic	.01	.002	.05
Iron	.26	.13	.60
Manganese	No Test Data	.008	.050
pH	6.6	7.74	No Limit Set

* Test samples from artesian flow test Aug. 1981

** Average values from Table VI, Elko Water System Analysis, Chilton Engineering 1980

*** Water Supply Regulations, Part 1, State of Nevada, Oct. 19, 1997

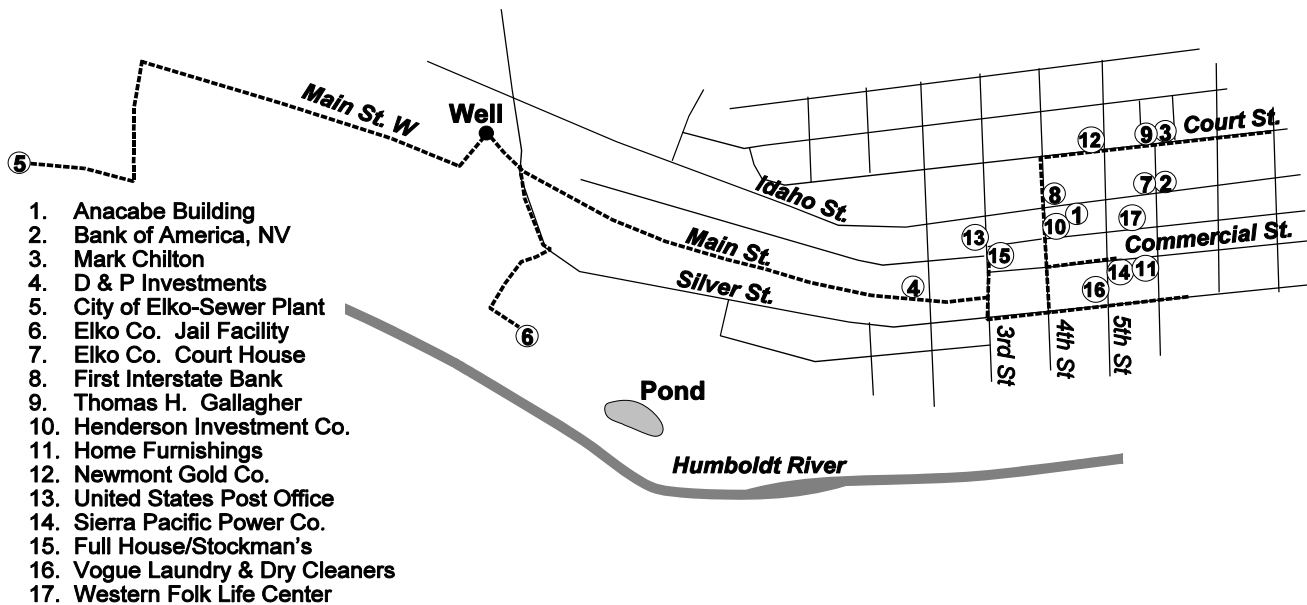


Figure 1. Elko District Heating System.

BACKGROUND

Recognizing the undeveloped potential of the geothermal resource in the Elko area, Elko Heat Company was formed in 1979. The purpose of the company was to develop and utilize the geothermal resource in Elko. Prior to this project, geothermal energy was utilized on a very limited basis in the area. The system was designed by Chilton Engineering of Reno, and then maintained and operated by Elko Heat Company. The initial customer base of three was not large enough to warrant the investment; but, recognizing the potential to expand, the Elko Heat Company was willing to subsidize the system. This approach paid off, as 17 customers are on the system today (Figure 1).

THE SYSTEM

Elko Heat Company has one geothermal production well drilled to a depth of 865 ft. The well is cased with 12-, 8- and 6-inch carbon steel casing. The production zone of the well is the last 65 ft and is not cased (open-hole completion). The well flows approximately 425 gpm under artesian conditions at 178°F. The shut-in pressure of the well is 52 psi. The flow, pressure and temperature have remained unchanged during the 15 years of operation. The well is equipped with a 15-hp lineshaft turbine pump. The pump is used during periods of high flows to boost the system pressure. The wellhead discharge piping is constructed out of Schedule 40 carbon steel pipe (Figures 2 and 3). In 1995, a buried 10-inch elbow failed due to external corrosion and had to be replaced.

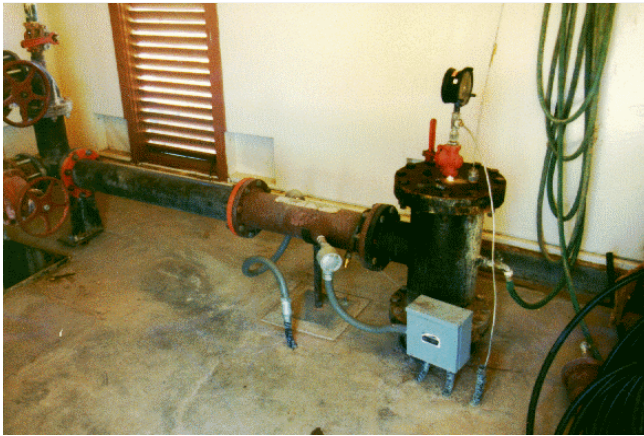


Figure 2. Main production line showing ultra-sonic flow meter.

The piping system consists of a two-pipe system, an insulated supply pipe and an uninsulated return pipe (Figure 4). The majority of the system piping is 8-inch diameter, with some 6-inch and 4-inch diameter pipe. Services to the individual customers are normally 2 inch, and in a few instances are 3 inch and 4 inch for the larger customers. Services were initially constructed out of carbon steel and lasted two to four years before failing due to a combination of internal and external corrosion. Service connection failures occurred at pipe joints, screwed fittings being the first to fail and then Victaulic (grooved-end) followed by welded. It was felt that the stress on the joint area caused by threading, grooving and welding made it susceptible to corrosion.

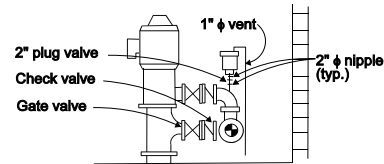
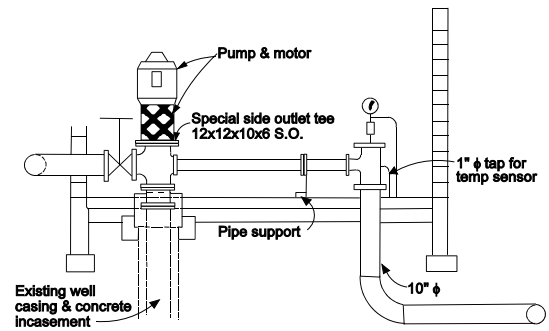
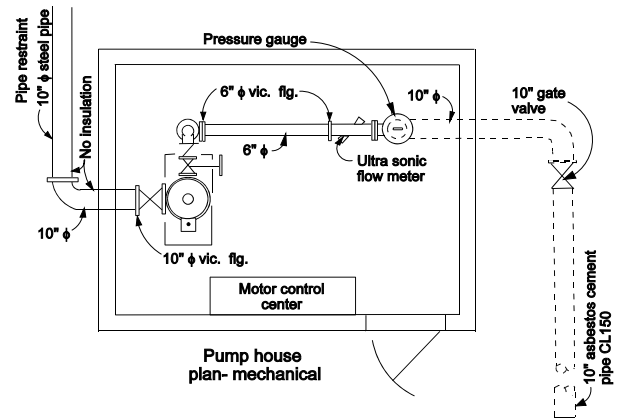


Figure 3. Wellhead equipment and piping.

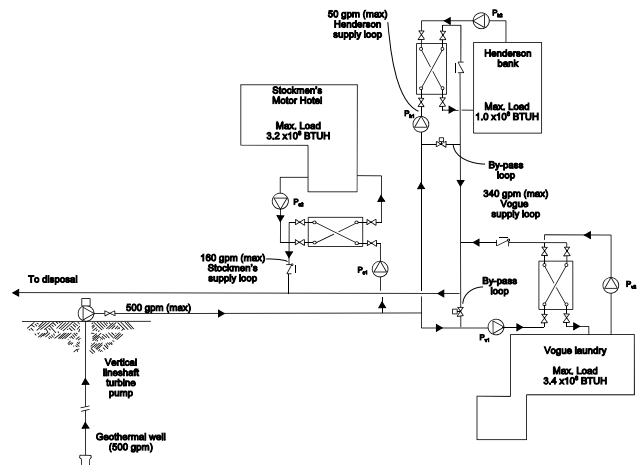


Figure 4. Open-loop distribution system schematic.

Small diameter service piping 4 inches or less was replaced with Type 304L stainless steel, with welded or flanged joints. Stainless steel piping was quite expensive and thus, was then only used on the supply line. High Density Polyethylene (HDPE) pipe was used for the return line piping since it was determined that the HDPE pipe was suitable for use in the relatively low pressure and temperatures encountered in the return piping. HDPE piping is a plastic pipe with thermally fused joints and is relatively inexpensive. This type of pipe is not susceptible to internal and external corrosion; but, its use is limited to temperatures less than 140°F and 50 psi (lower pressures will allow higher temperatures). Valves used on services were stainless steel butterfly valves with gear-type operators and 2-inch operating nuts for buried valves. Each customer's service has a shut-off valve on the supply and return line in close proximity to the customer's building. The customer's geothermal service is charged by the 1000s gallons of supply water. Elko Heat Company initially started charging \$1.25/1000 gallons and in 1992, increased the rates to \$1.38/1000 gallons. It is estimated that this rate for geothermal energy equates to approximately 30 percent of the equivalent rate for natural gas. Flow meters are installed inside the customer's facility and read monthly by Elko Heat Company.

It was found that the resulting 70 percent savings over conventional fuel was not enough to justify customer's investment in system retrofit to geothermal. Elko Heat Company developed the following incentives to make it worthwhile for the customer to retrofit: charging 50 percent of the normal rate for the first three years of the contract, free geothermal use for two years and/or Elko Heat Company paying for the retrofit and the customers pay the rate they were paying for conventional fuel to Elko Heat Company for the next five years. Each of the customer requirements were unique and required special consideration. An existing hydronic system was a relatively easy and inexpensive retrofit; where as, gas-fired air handlers required more complexity and expense. A new building could be designed to utilize geothermal energy at a relatively small additional cost.

In order for geothermal energy to be cost effective, a potential customer has to be in relatively close proximity to the distribution system and be a relatively large energy customer. Individual residences were too small to be cost effective; but, commercial and office complexes exceeding 10,000 sq ft were good candidates for retrofitting.

The main distribution system was installed in city streets along with other utilities, water, sewer, natural gas, telephone, television and electrical. Conflicts with other utilities have not presented nor caused any serious problems. The main problem encountered involves working in streets with traffic and the expense of replacing pavement.

The distribution piping is asbestos-cement (transite) pipe and conveys geothermal energy to each customer. The supply piping is epoxy-lined and coated with polyurethane insulation with an asbestos-cement pipe outer jacket with rubber end seals over the insulation to prevent moisture entry. Jointing of the asbestos-cement pipe is by bell-and-spigot

joints, using EPDM gaskets to withstand the higher temperatures. Manufacturing of this type of pipe (asbestos-cement) was discontinued approximately 10 years ago; so, it is no longer readily available.

The return piping is asbestos-cement with bell-and-spigot joints and EPDM gaskets. At the time, asbestos-cement was considered by the company to be the most cost effective piping material due to materials and installation cost. No problem with corrosion has occurred with the asbestos-cement pipe. If it became necessary to expand the system today, we are unsure of the type of piping material we would select. Alternatives would include: steel (both carbon and stainless), ductile iron, and fiberglass.

Valves and fittings were normal water-work type fittings compatible with the asbestos-cement pipe. These were of the flanged or mechanical-joint type connections, using high-temperature gaskets. Initially, problems were encountered with the flanged fitting; in that no matter how tight the bolts and nuts were tightened, once hot water was circulated through the pipe, the bolts elongated enough that they became loose and had to be re-tightened until the temperature was maximized.

These fittings lasted approximately 15 years in service and failed primarily due to external corrosion, resulting from a combination of soil types, ground moisture, and temperature of the fitting. It was felt that due to the relative low cost of these fittings and ease of installation, that these were the most cost effective, even though they had to be replaced after 15 years of use. The new valves and fittings are being installed with 12# magnesium anodes, in an effort to extend the life expectancy. These valves and fittings are constructed of ductile iron, which exhibited good resistance to internal corrosion, but are susceptible to external corrosion. Hopefully, the anodes will extend the useful life.

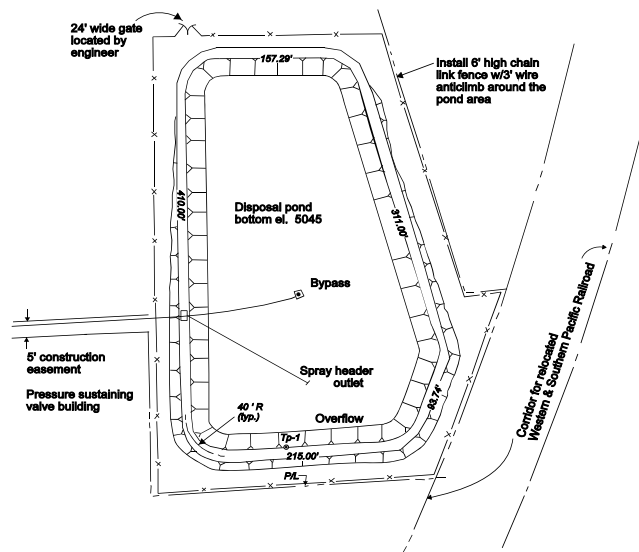


Figure 5. Disposal pond.

Elko Heat Company disposal system consists of a 1-1/2-acre cooling pond followed by discharge on to a wetlands area adjacent to the Humboldt River (see Figure 5). Fortunately, the geothermal fluids are of a good quality and the only treatment requirement is cooling. Occasionally, fog from the cooling pond creates a visibility problem in the area. The same situation occurs at the natural spring sources located in the area.

RECENT MAINTENANCE AND REPAIRS

The existing maintenance problems that are currently being experienced are:

1. External corrosion to ductile iron valves, fittings and steel bolt up hardware,
2. AC piping breaking due to load stresses and deterioration, and
3. Probably external and internal corrosion of wellhead equipment.

Recent repairs include:

1. Replacing a 10-in flange coupling adapter at the production well main line with all stainless steel fittings. The original flange coupling adapter was installed during emergency repairs and, this, was only a temporary solution. The repairs included placing a stainless steel flex coupling along with the flange coupling adapter to provide a connection to the AC main line. A 6-in wide protection wrap was then applied to the stainless steel fittings. This was installed to insure that if future work is required on the fittings, the stainless steel bolts will be protected.
2. Emergency valve replacement at the intersection of 4th and Idaho Streets. The 6-in supply valve was leaking to the surface at this point, and when ex-

posed by excavation, it was externally corroded. New 6-in M.J. Resilient Wedge Gate Valves and 6-in stainless steel flex couples were then installed to replace the old valves. All the fittings were again wrapped and a 17-pound sacrificial anode was installed to protect the ductile iron valves. They were then backfilled with pea gravel and provided with an access riser inside a 6-in PVC pipe.

3. Service valve replacement for the county jail. The valves access box was covered over during a road re-alignment project. When it was uncovered, the valves were inoperable. The shaft seals of both the supply and return valves were leaking. New stainless steel gear-operated butterfly valves with flex couples were then installed. They were wrapped and a PVC pipe was used to protect the valve riser.

CONCLUSION

The Elko Heat Company system has operated successfully for 15 years. There have been few interruptions to the customer's service and no major system failures have occurred to date (this is especially significant, considering there is no backup source of supply). In approximate numbers, the system generates \$110,000 in revenue, with system operational cost approximately \$45,000 per year (management, maintenance, legal and accounting, and permits for licenses). The peak heat use is 6.4 million Btu/hr based on a 30°F temperature drop. If the Department of Energy grant funding, combined with tax and alternative energy credits that we have available to the customer in the early 1980s was not in place at the time, this project would not have been completed. Fortunately for Elko Heat Company, this was not the case, and Elko Heat Company was successful in locating a suitable resource and overcoming technical and other issues to complete the project.