

MEMORANDUM

Date: June 18, 2009
To: Water Right File 37-8205
From: Michele Edl
Re: Proposed Plan for Development

I have been asked to review the Engineering Report for the Clarendon Hot Springs Geothermal Project, Revision B dated 6/8/2009 prepared by Charles G. Brockway for amendment of the above water right permit. This memo summarizes and highlights a few areas of concern that if unaddressed, could impede further processing of this permit.

Brockway Engineering proposes three uses for low-temperature geothermal water: residential space heating, snow-melting and a recreational pool. The warm water will be put to direct use rather than through a heat exchange system. In essence the proposal is for a 'pump and dump' system with contact time in piping imbedded below pavement and/or in a large recreational pool.

Residential Space Heating

Brockway's engineering report used IDWR's guidance to determine heating requirements. The resultant flow rate is reasonable; however, the volume calculated is based on the peak flow requirement for the design temperature and should be adjusted to reflect seasonal needs.

Heating/Snow melting use

I was assisted in my review of the snow-melting use by a recent feasibility study for snow melting in Ketchum, Idaho prepared by the Oregon Institute of Technology's Geo-Heat Center. I have attached a copy of the Phase 1 summary for reference. Snow melting systems are unique to each region because the peak heat energy needed depends on several weather conditions. Because proximity and use are similar to the Brockway proposal, the design parameters should also be comparable. Based on a quick comparison of the two projects, the Brockway snow melting proposal expects to dissipate much more heat than the City of Ketchum's Heritage Corridor. Most snow falls do not happen when the air temperature is coldest, so more justification or a revision should be submitted for the heat load scenario used in the Brockway proposal.

The effluent from snow melting system will "be discharged on the ground surface...where it will infiltrate". At those times when snow melting is needed, the ground is less likely to accept infiltration. In addition, the proposed effluent temperature will be sufficiently higher than the ambient conditions, therefore, the effluent water is more likely to evaporate than to infiltrate. At a minimum, the discharge of effluent should be limited to conditions allowed in the original permit.

Recreational/Pool use

Brockway's engineering report provides estimates for pond heating losses based on the Oregon Institute of Technology's Geo-Heat Center calculation tools. An 80% exceedance level for minimum temperature was used as a basis for calculation. However, the Geo-Heat Center guide suggests that average daily temperatures are realistic values for calculations due to the large thermal mass for open ponds.

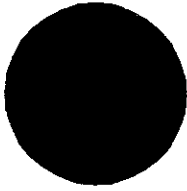
The Geo-Heat Center guide also suggests that if a floating pool cover will not be used to cover an open pool, the value for the cover parameter, k , should be zero. The heat loss summary spreadsheets submitted by Brockway show cover parameter " $k = 0.4 \text{ BTU in/hr sq ft } ^\circ\text{F}$ ", which implies that a cover will be used. However, there is no indication in the report text that the

proposed recreational pool will have a cover. The presence of a non-zero cover parameter in the spreadsheet appears inconsistent with the parameters proposed for wind speed and relative humidity in the pool's "worst case" heat loss scenario.

I was assisted with my review of the recreational pool use by a publicly available back-of-the-envelope calculator provided on the internet http://www.engineeringtoolbox.com/swimming-pool-heating-d_878.html. The recreational pool in this proposal will not require a heater but the heat loss and evaporation parameters needed to size a swimming pool heater are applicable to this project. Even using scenario conditions sympathetic to the permit holder, my application of the Engineering toolbox calculator indicates that more water and heat will be lost to evaporation than has been recognized in this proposal.

Because the proposals are for direct use of a thermal resource with water as the carrier, I believe that these proposed uses will be both heat and water consumptive. The place-of-use for this project is within the Big Wood River GWMA and the Snake River moratorium area and conditions on the permit prohibit consumptive use of water so, the applicant should demonstrate no consumption or should provide mitigation to offset consumption.

In addition to consumptive use concerns, the amendment of a permit cannot result in the diversion and use of more water than the uses originally permitted. The applicant should provide an analysis of the diversion rate and volume anticipated for the original uses and compare them to the expected diversion rate and volume for the proposed uses to demonstrate that the original quantities will not be exceeded.



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FEASIBILITY STUDY FOR A GEOTHERMAL HEAT PUMP SYSTEM FOR SNOW-MELTING AT THE FOURTH STREET HERITAGE CORRIDOR, PHASE 1 – LEADVILLE AVE. TO WALNUT AVE., KETCHUM, ID

Introduction

With the coordinated efforts of the Idaho Energy Division of the Idaho Department of Water Resources (IDWR), the Geo-Heat Center conducted an assessment of the feasibility of a geothermal heat pump system for snow melting of sidewalks along the Fourth Street Heritage Corridor in Ketchum, ID. This feasibility study addresses Phase I of construction, from Leadville Ave. to Walnut, Ave.

The snow melting system is a hydronic type that has been designed by Forsgren Associates, Inc. of Boise, ID, and the tubing installation was completed in the spring of 2007. The tubing spacing is 12-inches, and the heat source is planned to be from two boilers, each installed in an underground vault in two alleys.

Several options for the geothermal energy source were considered, but these options were reduced to one after a site meeting on August 21, 2007. Conveying geothermal water from Guyer Hot Springs was considered, but the availability of the water is questionable and piping costs through city streets would be cost prohibitive. A closed-loop earth coupling for water source heat pumps was considered, but due to the large heating load, there is not nearly enough land area to accommodate the several hundred vertical boreholes that would be required. Other sources of flowing water (i.e. sewers and water mains) were considered as heat sources for water-source heat pumps, but flow rates are questionable during peak snow melting demand times. Use of cold-climate air-source heat pumps was brought up at the site meeting, but currently available units are of small capacity, designed for the residential sector, and thus for snow melting loads, several tens of outdoor condensers would be required. Cold-climate air-source heat pumps may be a viable option if larger units come to the market. Thus, the most viable geothermal option, and the focus of this feasibility study, is water-source heat pumps, with the source being groundwater pumped from a well(s) and injected into a receiving well(s).

Overview of Snow Melting Systems

Snow melting systems are unique in that the peak load may occur under a number of weather conditions. That is, the quantity of energy necessary from a snow melting system depends on the outdoor air temperature, the wind speed, the snowfall rate, and the density of the snow. Most large snow falls occur under milder air temperatures, not at the coldest outdoor design condition.

The American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE, 2003) describes a study that compiled and analyzed 30-years of weather data for several cities to determine

design snow melting loads. For Boise, ID (the closest data set to Ketchum), a heat flux of 146 Btu/hr/ft² is necessary to keep an area snow free 99% of the time, while only 62 Btu/hr/ft² is necessary to melt snow after a certain period of time after accumulating.

Figure 1 is a contour map of snow melting design data taken from the Wirsbo Snow & Ice Melting Manual. A review of these data shows that a supply temperature of 167°F and 100°F would be required in order to keep the sidewalk surface at 35°F under a design heat flux of 146 Btu/hr/ft² and 62 Btu/hr/ft², respectively. These temperatures could easily be supplied by a boiler, but 130°F is the upper limit of fluid temperatures capable of being supplied by water-source heat pumps available today. Therefore, with a supply temperature of 130°F, the available heat output from a water-source heat pump would be unlikely able to keep the area snow free 99% of the time with tubing at 12-inch spacing. However, this situation is still acceptable; it would simply mean that during heavy storms, some snow accumulation would occur on some areas of the sidewalk, while other areas would be kept snow free. After the storm, the system would eventually catch up and melt all the snow.

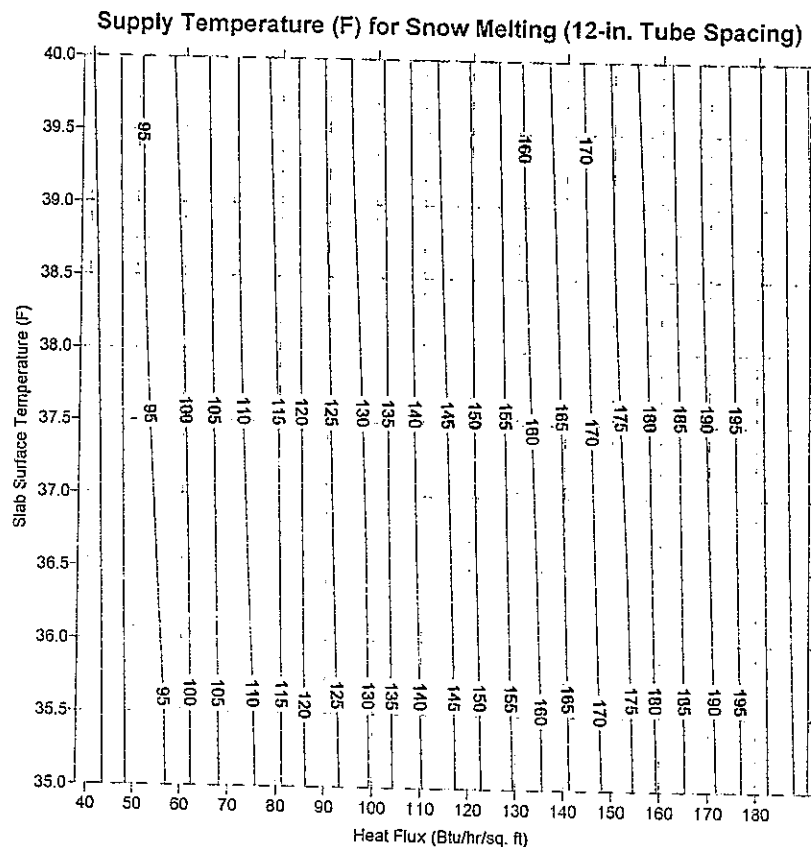


Figure 1. Contour map of fluid supply temperature as a function of slab surface temperature and design heat flux.

Based on an expected heat flux of 100 Btu/hr/ft² on a total snow melting area of 18,000 ft², the peak heating load that water-source heat pumps would be capable of supplying for Phase I is approximately 1.8 million Btu/hr.

Geological Conditions

The geological conditions for an open-loop (well to well) heat source have been evaluated by Kenneth Neely, Technical Hydrogeologist of the Idaho Department of Water Resources. In general the site geology consists of alluvial valley deposits overlying granite basement rocks. Therefore, the alluvial deposits would be the most likely target for the producing aquifer. From well driller's reports, it appears that the alluvial aquifer is less than 200 feet in total thickness in the City Hall/Fourth Street area.

Most wells in the area have yields of less than 50 gallons per minute (gpm), but a couple of wells have yields over 300 gpm. They were drilled for Sun Valley Sewer and Water, and are located northeast of City Hall, according to the well driller's reports. The actual yield of the proposed geothermal heat pump well will be controlled by two factors: the aquifer characteristics at that location and the well construction.

Groundwater temperature is likely in the range of 45-48°F, with no evidence of thermal waters present. Ground water flow is most probably from the northeast to the southwest in the City Hall/ Fourth Street area, so an injection well should be sited in the downgradient direction if possible.

Based on the projected heating load of 1.8 million Btu/hr and the expected groundwater temperature, wells would have to supply groundwater at a total of approximately 275 gallons per minute.

Estimation of Annual Heating Energy Costs

The ASHRAE (2003) handbook (referenced above) also compiled the number of annual snow melting energy per city and the idling energy. Snow melting systems must be "idled" to keep the slab near 32°F prior to a snowfall event. Otherwise, due to the transient nature of these systems, it may require an unacceptable amount of time for the slab to warm up and begin melting snow.

As mentioned above, for a heat pump system supplying 130°F fluid, it is estimated for design purposes that this system will keep the sidewalks 50% snow-free during a peak design snow storm. According to ASHRAE (2003), 2,449 Btu/ft² and 73,015 Btu/ft² are the annual energy fluxes required for snow melting and idling, respectively, for Boise, ID. Thus, the following annual heating costs for snow melting are given below based on the following assumptions: \$1.10/therm for natural gas, \$0.05/kWh for electricity, a boiler efficiency of 0.85, a heat pump coefficient of performance of 2.75 (accounting for well pump electrical energy consumption), and a snow melting area of 18,000 ft². To keep the comparison on equal terms, both the boiler and heat pump systems were assumed to be designed for a snow-free area of 50% during a peak design storm. Slab edge heat losses were not considered.

Heating System	Annual Heating Cost
Geothermal heat pump	\$7,240
Boiler (natural gas)	\$17,600

Estimation of Simple Payback Period Based on Annual Heating Energy Savings

The all-inclusive capital cost of the boiler installation in underground vaults has been roughly estimated by Forsgren Associates, Inc. at \$150,000. This estimated cost is comparable to the installation of water-source heat pumps. Therefore, the incremental cost of a geothermal heat pump system would be the cost of well drilling and testing, well pumps, and horizontal piping from wells to the heat pump vaults.

For cost estimating purposes, it is assumed that one supply and one injection well will be viable in the

given space constraints, giving a total of four wells. Each of these wells are assumed to be drilled to 200 ft deep and finished in a concrete, below-grade well pit. Each of the two supply wells will contain variable-speed submersible pumps. The all-inclusive well installation cost is roughly estimated at \$100,000.

Based on the estimated incremental capital cost of an open-loop geothermal heat pump system, the simple payback on energy savings over a natural gas boiler is on the order of 10 years.

Concluding Summary

The Geo-Heat Center has conducted an assessment of the feasibility of a geothermal heat pump system for snow melting of sidewalks along the Fourth Street Heritage Corridor (from Leadville Ave. to Walnut, Ave.) in Ketchum, ID. This feasibility study has been completed with the coordinated efforts of the Idaho Energy Division of the Idaho Department of Water Resources (IDWR).

The snow melting system is a hydronic type and has been designed by Forsgren Associates, Inc. of Boise, ID. The tubing installation was completed in the spring of 2007, and the heat source was planned to be from two boilers, each installed in an underground vault in each of two alleys.

Some specific conclusions from this study are summarized below:

- The most viable geothermal option was identified to be water-source heat pumps with the source being groundwater pumped from wells and injected into receiving wells. The heat pumps can be placed in underground vaults that are planned for the boiler installation.
- With 12-inch snow-melting tube spacing, it is expected that water source heat pumps can supply a heat flux of about 100 Btu/hr/ft² of snow melt area. Based on Boise, ID weather data, some snow accumulation will occur during a peak design storm, but then the system will eventually catch up and melt all the snow.
- The estimated peak heating load that water-source heat pumps would be capable of supplying for Phase I is approximately 1.8 million Btu/hr.
- A review of water well logs in the downtown Ketchum area by IDWR staff reveals that well yields of up to 300 gallons per minute are possible. Groundwater producing zones are generally less than 200 ft deep, and groundwater temperatures are likely in the range of 45-48°F.
- To meet the projected heating load with the expected groundwater temperatures, wells would have to supply groundwater at a total of approximately 275 gallons per minute. Since two wells are considered for this study, each well would have to supply about 138 gallons per minute.
- Annual heating energy savings with a geothermal heat pump system over a natural gas boiler system is estimated at \$10,360.
- Based on the estimated incremental capital cost of an open-loop geothermal heat pump system, the simple payback on energy savings over a natural gas boiler is on the order of 10 years.
- Before a geothermal heat pump design can proceed, test wells would need to be drilled in the alleys near the proposed locations of the heat pump vaults to insure that adequate groundwater flow rates are available.
- For future snow melting systems, closer tube spacing should be considered, as this allows lower fluid temperatures to be used. In this case for Phase I, 130°F supply water transfers 100 Btu/hr/ft² at 12-inch tubing spacing. At 9-inch tubing spacing and 6-inch tubing spacing, a fluid supply temperature of 112°F and 97°F, respectively, provides the same heat flux.

Sincerely,

Andrew Chiasson, P.E.