

Project No. 337-07-2000

Engineering Report for the Clarendon Hot Springs Geothermal Project

Prepared for:

Sun Valley Land & Minerals

REVISION B
June 8, 2009

For information concerning this report, contact
Charles G. Brockway, Ph.D., P.E.



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2016 NORTH WASHINGTON, SUITE 4
TWIN FALLS, IDAHO 83301

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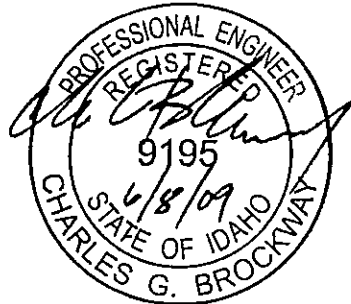
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C. G. Brockway, P.E.

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A. WATER AVAILABILITY

Three wells have been developed and/or rehabilitated to provide geothermal water to the project. A tabulation of pertinent well characteristics is provided in the following table:

	Well #3R	Well #75-1	Well #11
Total depth (ft)	200	185	180
Depth to bottom of water-bearing limestone (ft)	183	177	170?
Artesian pressure above land surface)	1.5	10	Not measured
Artesian flow (gpm)	30	30	100
Maximum pumped capacity (gpm)	200	275	350
Water temperature (°F)	127	127	114

The attached figure shows the well yield curves versus pumping level for "quasi-steady-state" conditions, i.e. after approximately 6 to 8 hours of pumping.

The sum of the individual well capacities is 825 gpm; however, if multiple wells are pumped, interference will occur and the total combined discharge will be less than the sum. An analysis was performed utilizing measured data from the pumping tests and theoretical predictions of well interference to evaluate the likely total yield from the well field. It was estimated that the maximum combined yield will be 765 gpm in order to limit the drawdown to the maximum to keep approximately 10 feet of water over the pump intake (see attached spreadsheet).

The flow split between the wells during maximum pumping would be 21% from Well #3, 33% from Well #75-1, and 46% from Well #3. The weighted-average pumped water temperature using these percentages is 121F.

B. PROPOSED USES

Extensive discussions have been held with IDWR staff, including Director David Tuthill, regarding the nature of beneficial use of geothermal water and whether IDWR would license uses of the heat value of the water that may be considered "non-traditional." No written guidance on this issue exists. It was determined from these discussions that three options are most likely to be licensed by IDWR: 1) utilize the water to heat the existing residences; 2) utilize the water to heat and maintain a recreational pond; and 3) utilize the water in a buried snowmelting system. Other uses such as enhancing trout growth by warming the reservoir water, or keeping the spillways ice-free, did not seem to the Director to be uses that the Department could recognize.

Regarding the recreational pond, the Director indicated that the hot water would need to be used in a manner that clearly provides a recreational beneficial use for human occupants. This may include such amenities as rock lining, concrete walkways, steps into the spa, diving board, railings, etc. In short, the spa must clearly have the purpose of providing beneficial use for recreational purposes. To meet this requirement, it is proposed to modify the upper half of the existing Pond 4 to create a recreational hot water spa and swimming facility.

B.1. Use #1: Residential Heating

Three dwellings currently exist, with a total living area of approximately 3,000 square feet. The spreadsheet used by IDWR to estimate heating requirements was employed in this case to determine peak flow requirement. Standard insulation rating was assumed, the outside temperature was assumed to be -1.7F (see below), and the source temperature was assumed to be an average of 121F. The calculated required flow is 20 gpm (see attached spreadsheet). The calculated temperature drop is 15 degrees, which would leave the water at an adequate temperature to be utilized in the recreational pond.

B.1. Use #2: Recreational Spa and Swimming Facility

The recreational spa will be created within the upper half of the existing lower pond known as Pond 4. The surface area of the proposed spa is 50,170 sq. ft. Geothermal water will be conveyed to the pond from the three wells at an average temperature of 121F. Cold water will be injected via an existing 24" pipeline from the main reservoir (this use is authorized by existing water rights). The hot water for the spa must be first-use water since the effluent temperature from the snowmelting system will be too low for practical use in the spa.

The instantaneous flow rate available from the well sources and the temperature of the geothermal water determine the number of BTU/hr available to meet the maximum heat loss from an outside open water surface of a given size. The design condition for pond heat loss should be a "worst-case" combination of climatic factors affecting heat loss, namely temperature, wind speed, and relative humidity. Since the diversion rate is an instantaneous maximum value, the design condition should reflect a short-term maximum heat requirement, i.e. a daily value rather than monthly or longer term.

There are several approaches and assumptions that could be made to determine the "worst case." One that is believed to be reasonable is presented here.

Temperature

Statistical data regarding temperature which is readily available includes the following statistics for each day of the year for the Hailey 3NNW station: average, average maximum, average minimum, extreme minimum (lowest recorded on that day for the period of record), standard deviation of average maximum, standard deviation of average minimum. This data is available from the Western Regional Climate Center. No additional data was available on the NOAA or NCDC site without significant expense.

The daily minimum temperature is of most interest, because one could envision a scenario where the pond temperature must be maintained for a recreational gathering that may occur in the morning or evening near the minimum temperature point. Using

the extreme minimum would result in an excessive diversion rate requirement and is not warranted. Conversely, using the average minimum is not sufficiently conservative. In these types of engineering design problems, an exceedance level is generally selected such that the design criteria can be met a high percentage of the time, but not 100% of the time, e.g. 80% or 90% is typically used.

Using the average minimum temperature and the standard deviation, and assuming a normal distribution, various exceedance levels can be calculated as shown on the attached plot. Since this is a non-critical application and no safety issues are involved, an 80% exceedance level is reasonable. The minimum daily 80% exceedance level is -1.7 degrees F, which occurs on January 10.

Wind speed

Little data is available regarding wind speed. Monthly average wind speed summaries are readily available at airport observation stations through the AWOS system. At the Hailey airport, the average January wind speed is 4.1 mph. No information on maximums, minimums, or standard deviation is available. Since the wind speed in the Deer Creek valley is likely to be less than at the Hailey airport, 4.1 mph was assumed to be a reasonably conservative value.

Relative humidity

Even less data is available for relative humidity. Average data for large cities is available from the NCDC. For Boise, the average relative humidity for January is 63%, which was assumed to be applicable to the Hailey area.

Heat Load Calculations

Spreadsheet calculation tools from the Oregon Institute of Technology's GeoHeat Center were used to analyze pond head losses. With the climatic inputs described above, two scenarios were evaluated: 1) using all of the well discharge through the spa, and 2) splitting off 416 gpm of the water to meet snow melting demand (see below) prior to entering the spa. The target effluent temperature is 85 degrees F, which is a pleasant temperature for swimming.

With scenario 1, a pond size of 300 ft x 200 ft or 60,000 sq. ft., can be supported with the estimated geothermal flow rate of 765 gpm. This calculation shows that a temperature of 85F can be maintained in the spa under all conditions.

With scenario 2, the estimated geothermal flow rate is 432 gpm (765 gpm minus 333 gpm to snow melting). With this input, a pond size of 250 ft x 125 ft or 31,250 sq. ft., can be supported to maintain an effluent temperature of 85F. With a pond size of 50,170 sq. ft., the effluent temperature would be 76F, which is still a pleasant temperature for swimming. This calculation indicates that the proposed spa can be adequately supported.

Use #3: Roadway Snowmelting

This use will consist of direct use of geothermal water for maintaining snow-free surfaces on the gravel roadways within the project. The system will consist of small-diameter buried polyethylene pipelines, spaced at 16 inches on center and placed 3" to 4" below the road surface. As noted below, this water must be first-use water due to the high source temperature recommended for these types of systems.

The total area of snowmelting would include all existing and proposed roadways. Existing roadway area is estimated to be:

South entry road and access to cabins	24,047 s.f.
Main pond embankment roadway – fire access	7,624 s.f.
TOTAL	31,671 s.f.

Detailed calculation procedures for heat output requirements for buried snowmelting systems have been outlined by Lund (2000) of the OIT GeoHeat Center. This publication also provides several examples of successful snow melting installations. Factors affecting the required road surface heat output include water temperature, air temperature, relative humidity, rate of snowfall, and wind speed. Except for the rate of snowfall, these parameters have been described and quantified above. Rate of snowfall is discussed below.

Rate of Snowfall

The system must be designed to adequately melt snow during a design event consisting of heavy snowfall during a relatively short period. Data on snowfall over periods shorter than one day at the Hailey station is not readily available, but daily data is available for the period 1900 through 1988 from the Idaho State Climatologist. This data was obtained and analyzed to determine frequency characteristics of snowfall depth on days when snowfall occurs. The maximum recorded snowfall was 21 inches, and the mean was 2.89 inches. It was found that an exponential probability distribution fits the data with high accuracy (Chi-Squared = 31.6; $p = 0.00005$) – see attached plot.

Using the fitted exponential distribution, the following data was calculated:

Exceedance Probability	Snowfall Depth (inches)
0.5	2.0
0.8	4.7
0.9	6.7
0.95	8.7
0.99	13.3

For the present case, the design level was selected as 90% since keeping the access roadways clear of snow is a critical application concerning safety, but is likely not a life-threatening concern where a probability level of 95% or 99% might be warranted. The 90% level is 6.7 inches in a 24-hour period. It is reasonable to assume that this snow depth falls within a 4-hour period, which is a typical duration of an event that might be held at the facility. The rate of snowfall is thus 1.68 inches/hour. Assuming a snow density of 0.1, the rate of snowfall may also be expressed as 0.17 inches of water equivalent per hour. This is the value used in the design.

Heat Load Calculations

Applying the calculations from Lund (2000) using the above parameters yields a required heat output at the road surface of 214.5 Btu/hr/ft². This is consistent with “typical” values for various cities given in this publication. The recommended fluid temperature to provide this heat output using ¾” to 1” pipes placed 2 to 3 inches below the road surface

is 140F. Due to the high temperature requirement, the snow melting water must be first-use water rather than effluent from the recreational spa.

Using a resource temperature of 121F and an effluent temperature of 70F, the flow requirement is 333 gpm.

C. EFFLUENT DISPOSAL

During the peak design condition, the effluent stream from the project will consist of 432 gpm of 76F water and 333 gpm of 70F water. At other times of the year, the effluent temperature will be higher but the flow rate will be significantly less. One option is to discharge the effluent directly to Deer Creek. This action could raise water quality issues and claims of injury to fisheries. Deer Creek is not a 303(d) listed stream, but the Big Wood River is listed, and includes temperature as one of the limiting constituents. According to Sonny Buhidar at IDEQ, the critical temperature is 13C for salmonid spawning, and tributaries are regulated according to the water quality limitations on the main stem; however, if Deer Creek does not reach the Big Wood River, it would not necessarily be subject to 303(d) limits. Each year after the runoff hydrograph recedes, Deer Creek becomes "dry" and does not reach the Big Wood River due to natural flow declines and the fact that the water is diverted for irrigation. In a typical year, the creek becomes dry in late June or July and remains so until the next runoff period. Therefore, there is no surface water connection with a 303(d) listed stream during these periods. Mr. Buhidar indicated that IDEQ policy in this case is not entirely clear, but would depend on case-specific evaluation.

To avoid potential issues regarding discharge directly to Deer Creek, the majority of the effluent from the snowmelting system will instead be discharged on the ground surface from the end of each snowmelting zone, where it will infiltrate. The two zones near the main reservoir will discharge directly to that reservoir. The effluent from the recreational spa will proceed to the lower half of Pond 4, where it will be further cooled. As calculated above the effluent temperature from the spa during the design wintertime condition will be 76F. Heat loss calculations indicate that the effluent from the lower Pond 4 to Deer Creek will be 51F or 10.6C. This is below the limit of 13C for salmonid

spawning as regulated by IDEQ for 303(d) listed streams. Also, there will be nearly zero flow in Deer Creek during the winter and no surface connection with the Big Wood River.

During the summer, a smaller amount of geothermal water will be needed to maintain the spa temperature. Cold water has historically been injected during the summertime and this practice will continue in order to maintain adequate water quality and keep the pond temperature comfortable for swimming in hot weather, between 70 and 75 degrees F. It is anticipated that the geothermal water requirement will be low – on the order of 100 gpm – because the temperature of the cold water flow from the main reservoir will likely be about 65F (no temperature data is available, but this is a reasonable assumption based on an inflow temperature at the upper end of the reservoir of 60F). The cold water flow through the pond varies, but is typically at least 2 cfs or 898 gpm. Because of various unknown operational factors, the effluent temperature in the summertime cannot be accurately calculated at this time. A further complication is that no surface connection with the Big Wood River will exist after runoff ceases, typically in June. As a precaution, monitoring of the temperature to ensure that it is no greater than the natural flow from the reservoir is recommended. It should be noted that the natural flow temperature will almost certainly exceed the 13C (55.4F) criteria for salmonid spawning during the summertime.

All ponds in the Clarendon system are covered by a water right and discharge to Deer Creek is authorized under these rights. Further, heated water in the geothermal aquifer system is under artesian pressure in the limestone aquifer and currently discharges via springs to the surface, and to the alluvial aquifer beneath the surface. The alluvial aquifer feeds Deer Creek in some reaches, and also is tributary to the Big Wood River aquifer. Thus, the geothermal water is currently entering the surface stream system, albeit in a more spatially and temporally distributed fashion.

D. SYSTEM LAYOUT AND HYDRAULICS

D.1. Pumps and Pond Supply

Each of the three wells will be fitted with submersible pumps which provide sufficient total dynamic head to overcome pumping lift, head losses in the drop pipe, and provide

at least 5 feet of head above ground surface. This will allow the pumps to discharge to a 4'x4' distribution box to be located just south of Well 75-1. The ground elevation at this point is 5670, which will also be the design water elevation in the box. The box will have an overflow on the south side, where unused water can overflow to the natural spring area above the existing small pond.

Well pump hydraulics calculations are shown on the attached sheet along with the selected pumps. Allowance for motor de-rating due to the water temperature was made according to Franklin Motor recommendations.

The drop pipe will be PVC Schedule 80 pipe to avoid the corrosion potential of standard galvanized pipe. The PVC de-rating factor for water temperature of 130F is 0.30, which still leaves more than adequate working pressure rating. The length elongation for 130F is 0.018 inches/foot, or about 3.2 inches for 180 feet of drop pipe.

To meet water right requirements and for operational purposes, a flow meter must be provided such that the diversion from the wells can be measured. The selected meter is a McCrometer propeller meter, all stainless steel, rated for continuous duty in water temperatures up to 160F. This meter will be located on the discharge pipe from the box, thereby measuring the total diversion without the need for a meter at each wellhead.

The size of the pipe from the distribution box must be 8 inches in order to minimize head loss and provide adequate pressure at the manifold to supply the snowmelting system. The head loss in the 8-inch pipe at the design flow will be 5 feet, making the HGL elevation 5665 at the manifold and the pressure 14.3 psi, which is adequate.

From the manifold to Pond 4, the pipe size will be 6 inches. The capacity of the entire line from the distribution box to the pond, assuming a full pipe, is 2.45 cfs, compared to the design flow of 1.70 cfs. Therefore, the entire flow can be delivered to Pond 4 if needed.

The possibility of the 8" pipe inlet flowing in an undesirable open-channel mode must be evaluated. The open-channel capacity of the 8" pipe at the specified slope is 4.3 cfs,

and assuming orifice flow at the inlet to the 8" pipe, the capacity is 1.6 cfs. Therefore, if the valve at the end of the pipe (at the pond) is not throttled, orifice control will govern and the 8" pipe may begin to flow under open channel conditions. The pond valve must always be throttled in order to keep the pipe full and prevent this condition, and the flow must be regulated only by operating this valve. This is a natural consequence of the large fall in elevation from the wells to the pond.

D.3. Snowmelting System

The snowmelting system will consist of 3/4-inch or 1/2-inch buried polyethylene pipes placed 3 inches below the roadway surface at a spacing of 16 inches. These pipes will act as radiators, conducting heat through the roadway material to prevent snow from accumulating or melt existing snow. The total design flow is 333 gpm to meet the peak roadway heat output requirement. The proposed areas of snow making include the entrance roads, driveways, and roadway across the main dam. These four areas will be served from the junction point, and valves will allow isolation of each area. After passing through the radiators, effluent will occur to the lake system from the west and south systems. The effluent from the north and south systems will be discharged to the ground surface and will sink. Each effluent pipe will be fitted with a valve to maintain pressure in the radiators and regulate the flow.

A hydraulic analysis was performed on the snowmelting system in order to size the feeder pipes and radiators and analyze the pressure distribution in the system. It was determined that 14 parallel radiators, 3/4" diameter, will be required to deliver the required flow to each zone. The exceptions are Zones 3B (1/2" diameter) and Zone 2 (12 pipes, 3/4"). With this configuration it was determined that the system can deliver by gravity more than the required flow with the valves wide open. Therefore, no additional booster pumps will be required and the valves at the end of each zone must be set partially closed in order to properly regulate the flow.

D.4. Pipeline Material

Based on cost, availability, and ease of installation, PVC pipe is usually the preferred material for water systems. It also has the benefit of being nearly impervious to

corrosion, which is an important consideration for geothermal installations, where metallic pipe tends to deteriorate at an accelerated rate. However, PVC is significantly affected by temperature, and this fact requires careful evaluation for geothermal systems. PVC is rated for operating temperature up to 140F. The maximum temperature in the Clarendon system will be 127F. As noted above with respect to the well pump drop pipe, the pipe working pressure rating must be de-rated for temperatures above 73F. For 130F water, the working pressure will be 30% of the cold-water rating. The maximum pressure in the system will occur at the lower end of the snowmaking system, and will not exceed 26 psi. Therefore, standard Class 200 pipe can be used. 200 psi x 30% is 60 psi, which is more than adequate. The small-diameter laterals for the snowmaking system can be Class 200 poly pipe.

One important factor to be accounted for is the elongation of PVC as temperature increases. The maximum expected elongation based on the thermal expansion coefficients for PVC will be 0.018 inches/foot, or 1.8 inches for every 100 feet of pipe. The pipe must be allowed to expand and contract longitudinally, and therefore gasketed connections should not be used to avoid the potential for unseating the gasket and causing leakage. Instead, solvent-weld connections should be used, with provisions to allow expansion and contraction, e.g. flexible expansion fittings or expansion loops. If the pipe is not allowed to move, it may become overstressed and break.

As an alternative to PVC, ductile iron pipe with flanged fittings would be suitable and could be used. However, PVC will likely be the most economical.

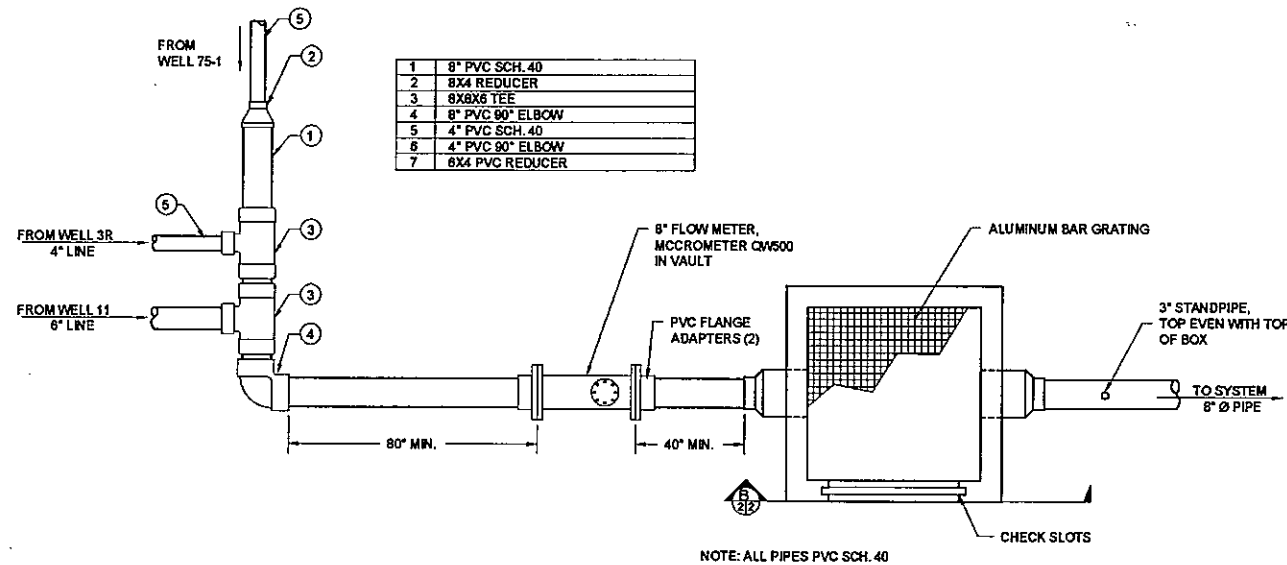
D. ELECTRICAL POWER REQUIREMENTS

The nominal horsepower and the actual maximum power draw of the well pumps will be as follows:

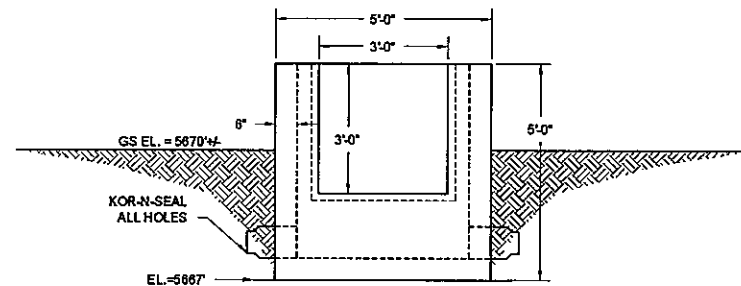
Well	Max Req'd HP	Nominal HP
Well #3	12.6	15
Well 75-1	17.9	20
Well #11	19.3	20
TOTAL	48.0	55

The motor horsepower was selected by applying a de-rating factor based on water temperature to the maximum required horsepower of 1.32 for Well #3 and Well #75-1, and 1.14 for Well #11. The nominal horsepower is the motor with a service factor horsepower equal or greater than the de-rated horsepower (service factor of 1.15). This procedure follows the guidelines provided by Franklin Motors. The de-rating is required not because hot water will cause additional electrical draw, but because an oversized motor will run cooler.

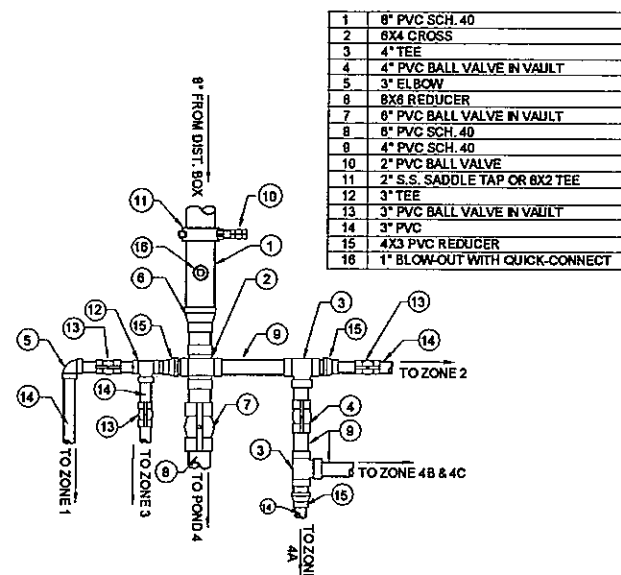
Idaho Power has been contacted regarding the proposed power requirements and has approved a 65HP load with no inrush limitations. Three-phase power is not available at the site. Therefore, a variable-speed drive and phase converter will be required for each well pump, and Idaho Power will need to perform a study to determine the level of electrical filtration needed to ensure no adverse transients are introduced into the system. A service request has been submitted and two site meetings held, during which the location of all Idaho Power-owned and customer-owned facilities was determined.



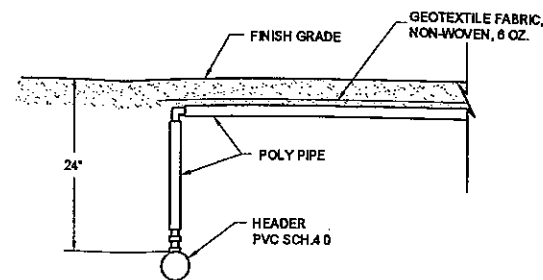
1 DISTRIBUTION BOX
SCALE 1/2"=1'



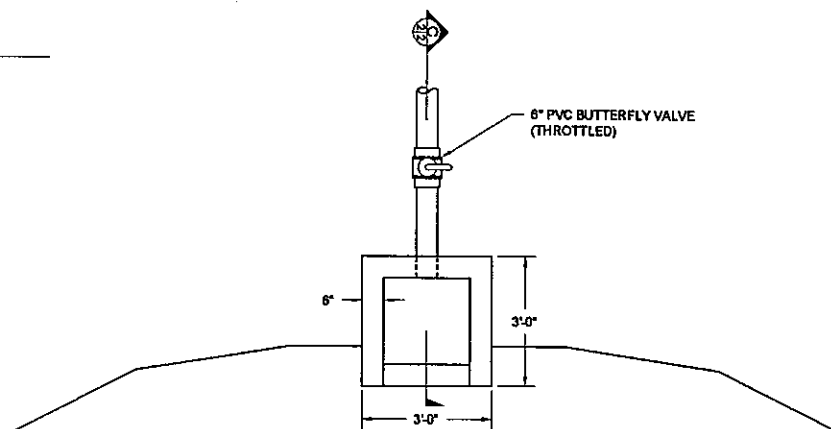
B DISTRIBUTION BOX
SCALE: 1"=4'



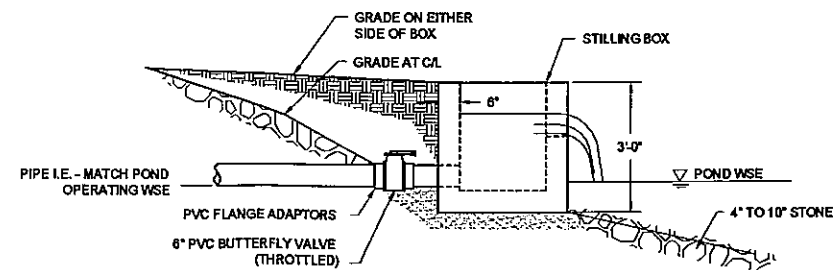
2 DISTRIBUTION VALVE DETAIL (TYP.)
SCALE 1/2"=1'



3 HEADER & TAILPIPE MANIFOLD SECTION (TYP.)
SCALE 1"=1'

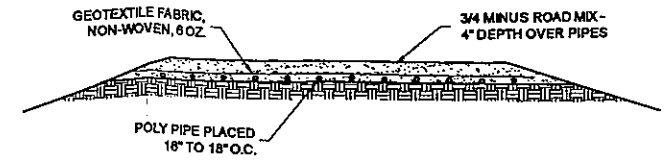


4 POND INLET
SCALE 1/2"=1'

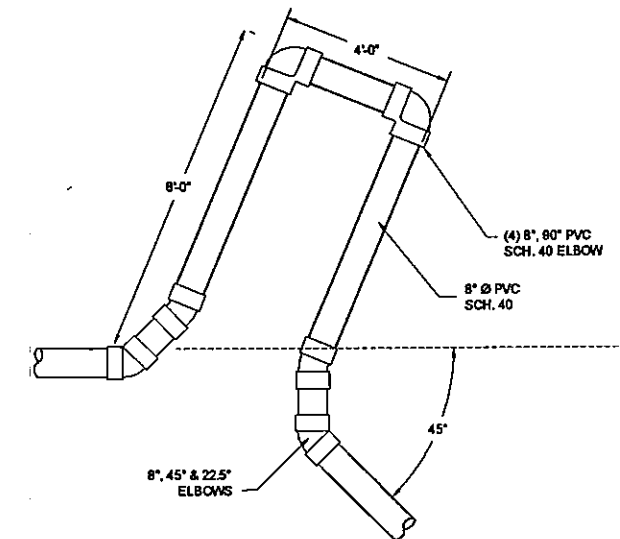


C POND INLET
SCALE: 1"=4'

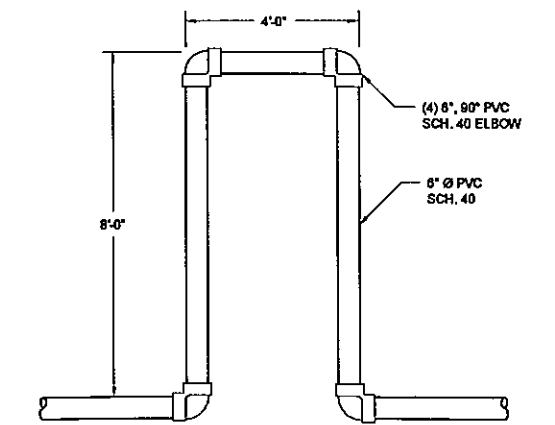
RADIATOR PIPE SCHEDULE		
ZONE	NO. PIPES	SIZE
1	14	3/4"
2	12	3/4"
3A	14	3/4"
3B	14	3/4"
4A	14	3/4"
4B	14	3/4"
4C	14	3/4"



A SNOWMELTING RADIATORS
SCALE: 1"=4'



4 EXPANSION LOOP 45° BEND
SCALE 1/2"=1'



5 EXPANSION LOOP - STRAIGHT THROUGH
SCALE 1/2"=1'

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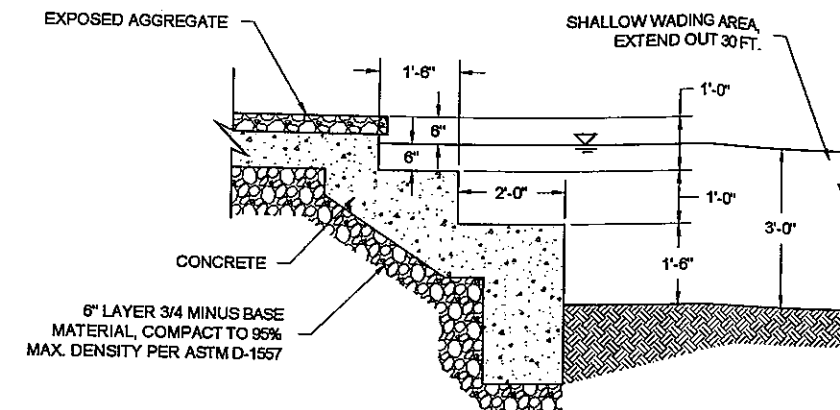
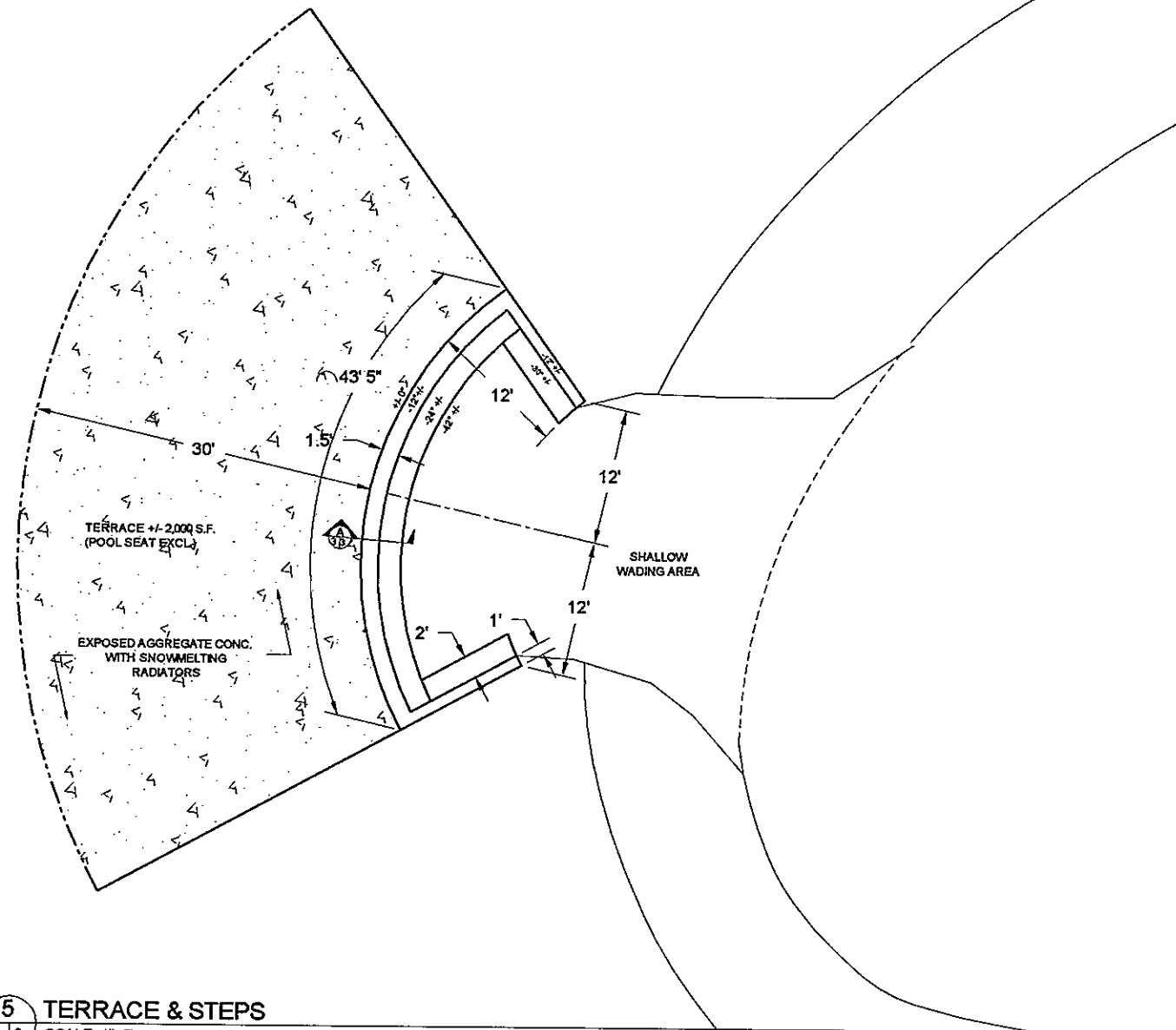
REV	DESCRIPTION	DATE	APPD.	REFERENCE DRAWINGS
B	ISSUE FOR REVIEW	6/8/09		
A	ISSUE FOR REVIEW	4/7/09		

DESIGNED BY CCB
DRAFTED BY ALR
SCALE: AS NOTED (11 X 36 DWG ONLY)

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2016 NORTH WASHINGTON, SUITE 4
TWIN FALLS, ID. 83301
(208) 736-8543

CLARENDON
GEOTHERMAL DEVELOPMENT
DETAILS & SECTIONS

PROJECT #
337-08-2009
DWG #
2
REV
B



A SECTION
3 | 3 SCALE: 1/2"=1'

5 TERRACE & STEPS
1 | 3 SCALE: 1"=5'

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REV	DESCRIPTION	DATE	APPD.	REFERENCE DRAWINGS
B	ISSUE FOR REVIEW	6/8/09		
A	ISSUE FOR REVIEW	4/7/09		

DESIGNED BY
CGB
DRAFTED BY
ALR
SCALE: AS NOTED
(24 X 36 DWG ONLY)

BROCKWAY ENGINEERING, PLLC.
HYDRAULICS - HYDROLOGY - WATER RESOURCES
2016 NORTH WASHINGTON, SUITE 4
TWIN FALLS, ID. 83301
(208) 736-8543

**CLARENDON
GEOTHERMAL DEVELOPMENT**
DETAILS & SECTIONS II

PROJECT #
337-08-2009
DWG #
3
REV
B

Appendix A
Well Information

CLARENDON**ESTIMATION OF COMBINED YIELD OF WELL FIELD**

Based on pumping tests completed 12/08 and 3/09

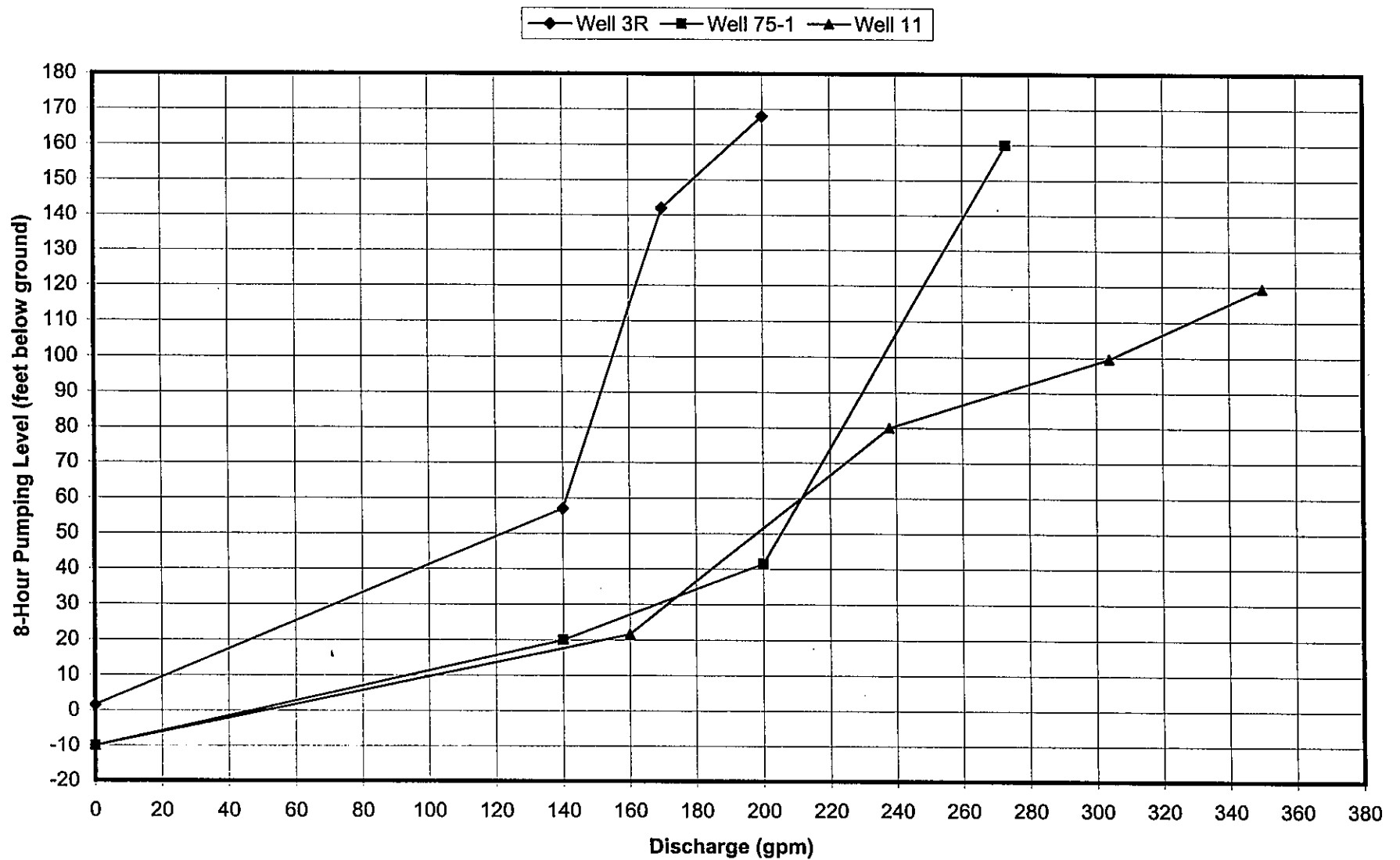
C. G. Brockway, P.E. 3/11/09

Discharge in gpm, levels in feet

Quasi-steady-state conditions, i.e. after pumping 6 to 8 hours

	SWL below top casing	Discharge	Pumping level, no interference	Additional drawdown (interference) due to:			Combined Pumping level
				Well #3	Well #75-1	Well #11	
Well #3R	1.6	160	114	--	31.0	19.7	165
Well #75-1	-10	255	131	19.5	--	20.2	171
Well #11	-10	350	119	13.7	18.3	--	151
	TOTAL	765					

Clarendon Geothermal Wells: Quasi-Steady State Yield-Pumping Level Curves



Appendix B

Residential Space Heating Requirements

RESIDENTIAL SPACE HEATING/COOLING REQUIREMENTS FOR COLD OR GEOTHERMAL SOURCES

Worksheet created by Cindy Hodges, 11/93.

Project: CLARENDON -- FUTURE NEW RESIDENCES IN DEVELOPMENT

Data entered by: C. G. Brockway

Exam Date: n/a House 3000 sq ft

File No: House 0 sq ft

Computations for: Heating Employee hc 0 sq ft

Bathhouse 0 sq ft

Other 0 sq ft

REQUIRED DATA: Total 3000 sq ft

Area of livable floor space, ft2 (A) 3000

2 story? (N=1, Y=2) 1

House efficiency factor (e) * 0.67

Inside design temperature (Ti) 72

Average outside temperature (To) ** -1.7

Source temperature, degrees F (S) 121

Heating/cooling days per season (D) 303

Hours/day system operates (H) 24

CALCULATED DATA:

DESIGN HEAT LOAD (BTU/hr required)

Formula: $E = [e \times (T_i - T_o)] A$

Applies factor of 0.8 for two-story dwelling

$E = 148,137 \text{ BTU/hour}$

TEMPERATURE DROP ACROSS SYSTEM

Formula: $T_s = 0.3 \times [S - T_i]$

$T_s = 14.7 \text{ degrees F}$

FLOW RATE REQUIRED (at given source temperature)

Formula: $Q = E / (500 \times T_s) \times 448.8$

$Q = 0.04 \text{ cfs}$
 20.2 gpm

DIVERTED VOLUME OVER SEASON

Formula: $V_{div} = Q \times D \times H / 24 \times 1.9835$

$V_{div} = 27.0 \text{ AFA}$

* e values are as follows:

0.28 Best energy efficiency - extra insulation, caulked and weatherstripped, with storm windows and doors

0.44 Better energy efficiency - standard insulation, caulked and weatherstripped, with storm windows and/or doors

0.67 Average residence - standard insulation, no weatherproofing but with storm windows or double panes

1.11 Poor energy efficiency - minimal insulation, no weatherproofing or storm windows (older homes, shops or greenhouses)

** Suggested average outside temperatures:

WINTER

4 deg F Boise

6 deg F Grand View

-8 deg F Cascade

SUMMER

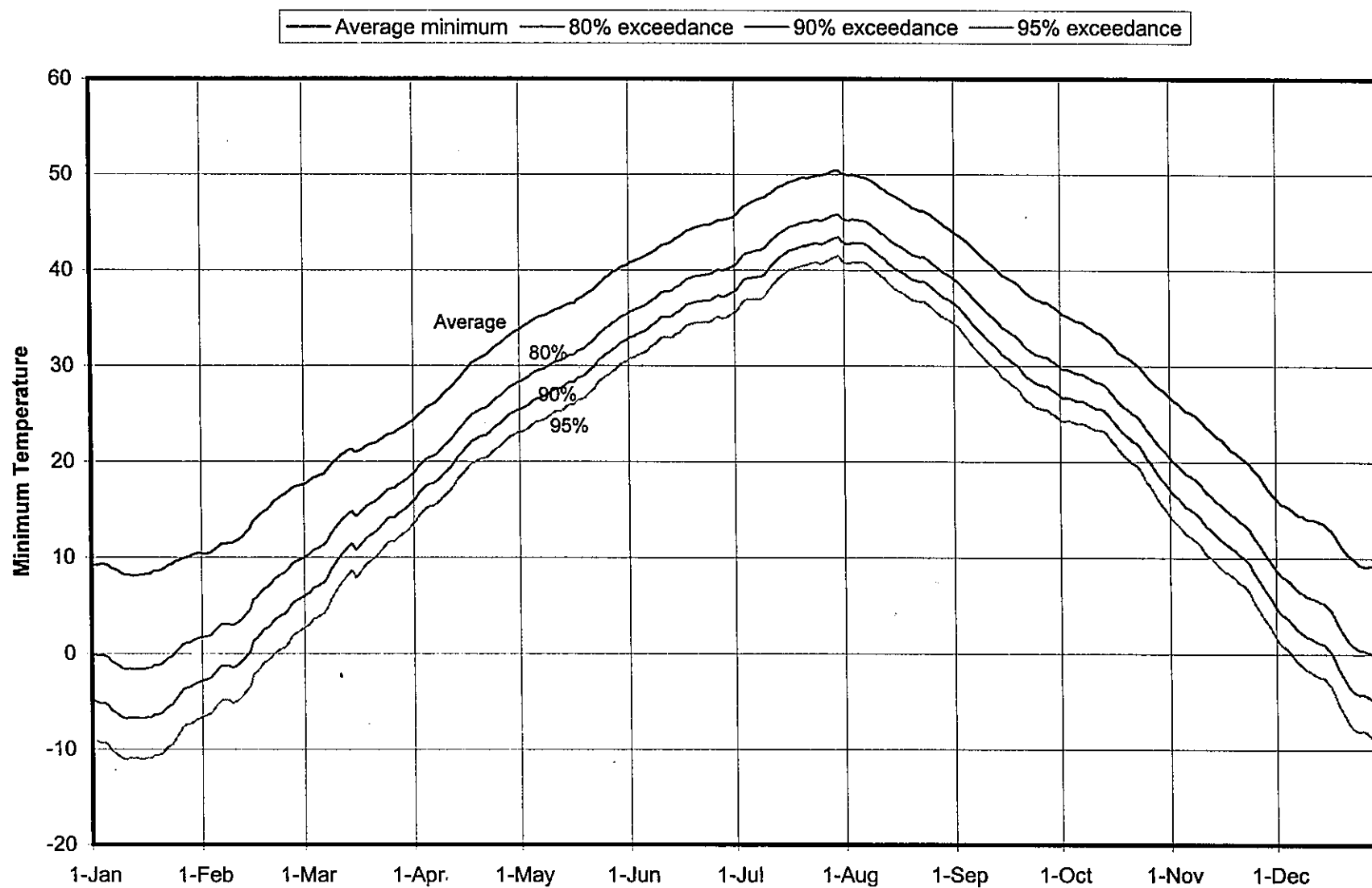
80 deg F Boise

90 deg F Grand View

70 deg F Cascade

Appendix C
Pond Heat Loss Analysis

Daily Minimum Temperature at Hailey 3NNW, 1971-1990 NCDC



CLARENDON -- OPEN POND HEAT LOSS CALCULATION

OIT Geoheat Center Tools

CGB 7/9/08

NEW RECREATIONAL POND

Available discharge from 3 wells	765 gpm
Split off for snowmelting	0 gpm
Remainder to pond	765 gpm

PRELIMINARY UNTIL PUMP TEST ON
WELL #11 IS COMPLETED

Parameter	Value	Units	Assumptions / Remarks
1. Resource temp	121	F	Well #75-1, #3, and #11 average
2. Length	300	ft	Pond length
3. Width	200	ft	Pond width
4. Water temp in pond	85	F	Pleasant temperature for bathing/swimming
5. Wind velocity	4.1	mph	Average January wind speed at Hailey
6. Air temp	-1.7	F	80% exceedance minimum temp at Hailey
7. Cover thickness	0	in	
8. Cover "k"	0.4	btu in/hr sqft F	
9. Relative humidity	63	%	
10. Calculated water vap pres	0.589	psia	
1. Evaporative Loss	4946457	btu/hr	82.4 btu/hr sqft
2. Convective Loss	4398428	btu/hr	73.3 btu/hr sqft
3. Radiant Loss	4282487	btu/hr	71.4 btu/hr sqft
4. Conductive Loss	157740	btu/hr	2.6 btu/hr sqft
5. Total Loss	13785112	btu/hr	229.8 btu/hr sqft
6. Required flow rate	765.8	gpm	

ha	0.845526	Pond surface area	60000 ft2
x/k	0		
p. press	0.019		
area	60000		
surf temp	85		
U	0.845526		

CLARENDON RESORT
OPEN POND HEAT LOSS CALCULATION
 OIT Geoheat Center Tools
 CGB 7/9/08

NEW RECREATIONAL POND

Available discharge from 3 wells	765 gpm
Split off for snowmelting	333 gpm
Remainder to pond	432 gpm

**PRELIMINARY UNTIL PUMP TEST ON
WELL #11 IS COMPLETED**

Parameter	Value	Units
1. Resource temp	121	F
2. Length	250	ft
3. Width	125	ft
4. Water temp in pond	85	F
5. Wind velocity	4.1	mph
6. Air temp	-1.7	F
7. Cover thickness	0	in
8. Cover "k"	0.4	btu in/hr sqft F
9. Relative humidity	63	%
10. Calculated water vap pres	0.589	psia

Assumptions / Remarks
 Well #75-1, #3, and #11 average
 Pond length
 Pond width
 Pleasant temperature for bathing/swimming
 Average January wind speed at Hailey
 80% exceedance minimum temp at Hailey

1. Evaporative Loss	2830199	btu/hr	90.6	btu/hr sqft
2. Convective Loss	2516635	btu/hr	80.5	btu/hr sqft
3. Radiant Loss	2230462	btu/hr	71.4	btu/hr sqft
4. Conductive Loss	98588	btu/hr	3.2	btu/hr sqft
5. Total Loss	7675884	btu/hr	245.6	btu/hr sqft
6. Required flow rate	426.4	gpm		

ha	0.928862	Pond surface area	31250	ft2
x/k	0			
p. press	0.019			
area	31250			
surf temp	85			
U	0.928862			

CLARENDON RESORT
OPEN POND HEAT LOSS CALCULATION
 OIT Geoheat Center Tools
 CGB 7/9/08

NEW RECREATIONAL POND - ACTUAL SIZE

Available discharge from 3 wells	765 gpm
Split off for snowmelting	333 gpm
Remainder to pond	432 gpm

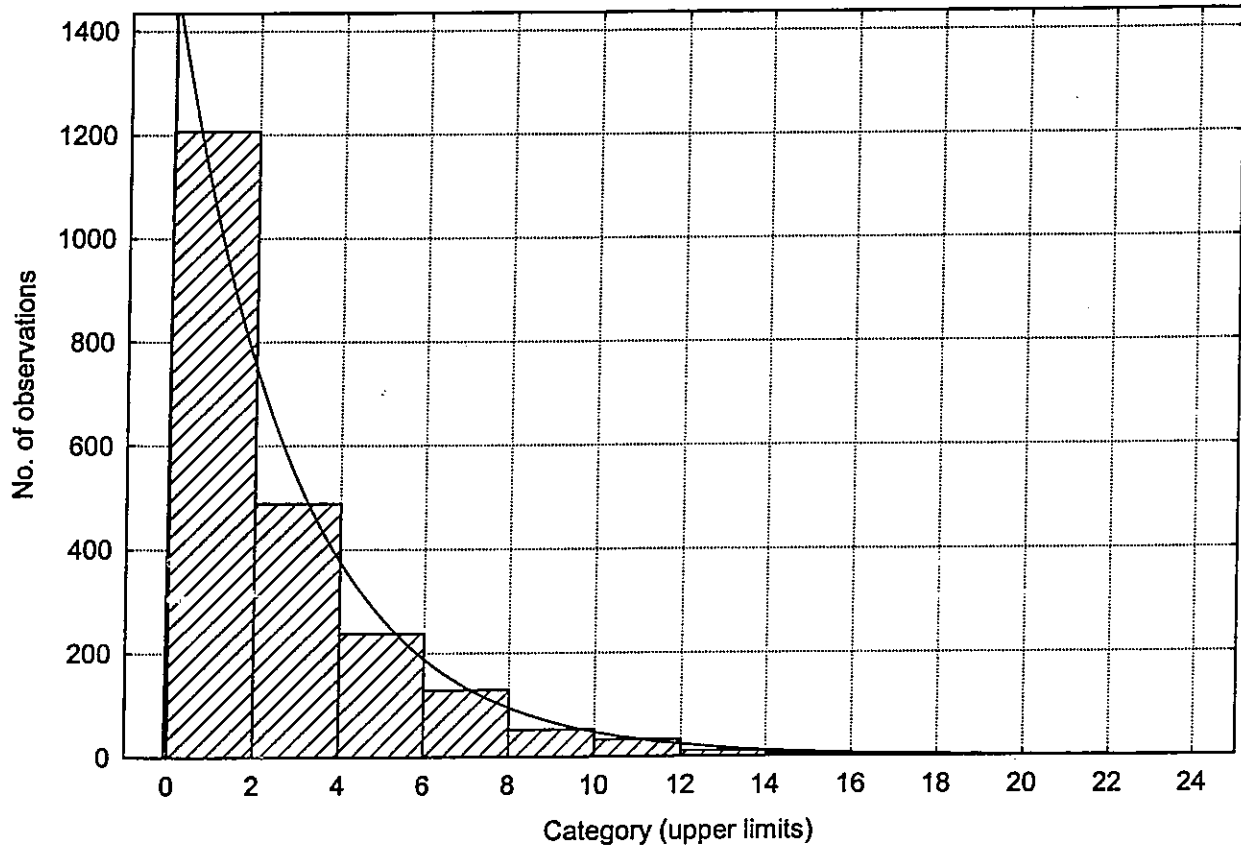
**PRELIMINARY UNTIL PUMP TEST ON
WELL #11 IS COMPLETED**

Parameter	Value	Units	Assumptions / Remarks
1. Resource temp	121	F	Well #75-1, #3, and #11 average
2. Length	224	ft	Pond length
3. Width	224	ft	Pond width
4. Water temp in pond	76	F	Pleasant temperature for bathing/swimming
5. Wind velocity	4.1	mph	Average January wind speed at Hailey
6. Air temp	-1.7	F	80% exceedance minimum temp at Hailey
7. Cover thickness	0	in	
8. Cover "k"	0.4	btu in/hr sqft F	
9. Relative humidity	63	%	
10. Calculated water vap pres	0.433	psia	
1. Evaporative Loss	2988852	btu/hr	59.6 btu/hr sqft
2. Convective Loss	3222557	btu/hr	64.2 btu/hr sqft
3. Radiant Loss	3119720	btu/hr	62.2 btu/hr sqft
4. Conductive Loss	119100	btu/hr	2.4 btu/hr sqft
5. Total Loss	9450229	btu/hr	188.3 btu/hr sqft
6. Required flow rate	420.0	gpm	

ha	0.826577	Pond surface area	50176 ft2
x/k	0		
p. press	0.019		
area	50176		
surf temp	76		
U	0.826577		

Appendix D
Snowmelting Water Requirement

Variable: DailySnow, Distribution: Exponential
 Chi-Square test = 31.62249, df = 7 (adjusted), p = 0.00005



$$\bar{x} = 2.887$$

$$\lambda = \frac{1}{\bar{x}} = 0.346$$

$$F(x) = 1 - e^{-\lambda x}$$

<u>F(x)</u>	<u>x</u>
0.5	2.0
0.8	4.7
0.9	6.7
0.95	8.7
0.99	13.3

Upper Boundary	Variable: DailySnow, Distribution: Exponential (Spreadsheet1) Chi-Square = 31.62249, df = 7 (adjusted) , p = 0.00005						
	Observed Frequency	Cumulative Observed	Percent Observed	Cumul. % Observed	Expected Frequency	Cumulative Expected	Percent Expected
<= 2.00000	1207	1207	55.62212	55.6221	1084.459	1084.459	2.302999
4.00000	489	1696	22.53456	78.1567	542.500	1626.959	1.152073
6.00000	238	1934	10.96774	89.1244	271.385	1898.344	0.576324
8.00000	129	2063	5.94470	95.0691	135.760	2034.104	0.288305
10.00000	52	2115	2.39631	97.4654	67.914	2102.018	0.144225
12.00000	33	2148	1.52074	98.9862	33.974	2135.992	0.072148
14.00000	11	2159	0.50691	99.4931	16.995	2152.988	0.036092
16.00000	6	2165	0.27650	99.7696	8.502	2161.490	0.018055
18.00000	4	2169	0.18433	99.9539	4.253	2165.743	0.009032
20.00000	0	2169	0.00000	99.9539	2.128	2167.870	0.004518
22.00000	1	2170	0.04608	100.0000	1.064	2168.935	0.002260
< Infinity	0	2170	0.00000	100.0000	1.065	2170.000	0.002263

CLARENDON RESORT ROADWAY SNOW MELTING WITH GEOTHERMAL WATER

Lund, John W. (2000). Pavement Snow Melting. Geo-Heat Center Bulletin.
Assumes direct-use hydronic method, buried pipelines

SCENARIO: FIRST USE OF WELL DISCHARGE

DESIGN CONDITION

Parameter	Value	Units
Total area	31,671	ft ²
Rate of snowfall	0.17	inches of water equivalent per hour
Air temperature	-1.6	F
Wind speed	4.1	mph
Water film temperature	33	F
Ratio of snow-free area to total	1	
Resource temperature	121	F
Effluent temperature	70	F
Road pavement heat loss	20%	

CALCULATIONS

Vapor pressure of air	0.06	in Hg
Heat of vaporization at film temp	1075.5	Btu/lb
Sensible heat	14.8512	Btu/hr/ft ²
Heat of fusion	126.82	Btu/hr/ft ²
Heat of evaporation	18.6393	Btu/hr/ft ²
Heat transfer (conv. & radiation)	54.2	Btu/hr/ft ²
Unit heat required at road surface	214.5	Btu/hr/ft ²
Unit heat required from pipes	268.1	Btu/hr/ft ²
Total heat required	8492202	Btu/hr
Flow rate required	333	gpm

Appendix E

Hydraulic Analysis

CLARENDON HOT SPRINGS WELLS - FINAL DESIGN

BASED ON PUMPING TESTS COMPLETED 12/08 and 2/09

CGB 3/11/09

Included hot water de-rating factor based on technical guidance for Franklin motors

	Well #3R	Well 75-1	Well #11	Total
Design flow (gpm)	200	275	350	825
(cfs)	0.45	0.61	0.78	
Design pumping level (ft)	168	165	119	
Pump intake setting (ft)	180	175	170	
Column diam (ft)	0.33	0.33	0.33	
Column velocity (ft/s)	5.21	7.16	9.12	
Reynolds number	1.41E+05	1.94E+05	2.47E+05	
Friction factor	0.0166	0.0156	0.0149	
Minor loss coefficient	4.3	4.3	4.3	
Column loss (ft)	5.6	10.0	15.5	
Check valves:				
No. of units	1	1	1	
Head loss per unit (from manuf.)	3.5	6.0	6.0	
Total loss for check valves	3.5	6.0	6.0	
7" flow sleeve head loss (manuf.)	1.0	2.0	No sleeve	
Required pressure at wellhead (psi)	2	2	2	
TDH of pump (ft)	183.2	188.4	146.4	
Pump efficiency	0.72	0.73	0.67	
HP required	12.9	17.9	19.3	
Hot water multiplier (Franklin motor)	1.32	1.32	1.14	
Motor HP required (upsized)	17.0	23.7	22.0	
Motor HP nominal (SFHP > required)	15	20	20	
GS elevation at wellhead (NGVD29)	5680.0	5672.0	5666	
HGL at wellhead	5685	5677	5671	
Selected pump	Goulds 250L15	Goulds 320L20	Goulds 320L20	

Design notes:

Assume all wells will eventually discharge to a common sump and water will be boosted from there. Well pumps sized for individual well maximum yield and drawdown. Total combined yield from all three wells will be less than the total due to well interference.

For standard motor, need sleeve to achieve 3 ft/s flow around motor: 7" sleeve for Well #3R, 8" sleeve for others. Sleeve head loss: 6" motor with 7" sleeve, 0.5' at 200 gpm. 6" motor with 8" sleeve, 0.3' at 350 gpm. No consequence.

CLARENDON PROJECT
SNOWMELTING NETWORK HYDRAULICS

C. G. Brockway, P.E. 3/18/09 REV. 4/3/09

Valves at junction will be adjusted to achieve the desired flow in each leg,
and the desired total flow (target 333 gpm peak)

			Area (ft ²)	Flow (gpm)
Distribution box WSE	5670	Zone 1	6592	69
Pond 3 WSE	5625	Zone 2	3532	37
Pond 4 WSE	5610	Zone 3	7624	80
Snowmelting flow total	333 gpm	Zone 4	13923	146
		TOTAL	31671	333

Pipe - Box to junction

Discharge	765 gpm (TOTAL flow - including to pond)
Length	417 feet
Diam	8 inches
f	0.015
Cm	3.6
Velocity	4.88 ft/s
Head loss	4.81 feet
HGL at end	5665.19 feet

Zone 3A - Dam embankment north

Discharge	53 gpm
Length	270 feet
Diam (equivalent)	1.81 inches (14 - 3/4" pipes)
f	0.014
Cm	1.6
Velocity	6.66 ft/s
Head loss	18.40 feet
HGL at end	5646.79 feet > GS and Pond 3 WSE

Pipe - Zone 3A header to Zone 3B header

Discharge	27 gpm
Length	280 feet
Diam	2 inches
f	0.014
Cm	1.6
Velocity	2.73 ft/s
Head loss	2.91 feet
HGL at end	5662.28 feet

Zone 3B - Dam embankment south

Discharge	27 gpm
Length	140 feet
Diam (equivalent)	1.21 inches (14 - 1/2" pipes)
f	0.014
Cm	1.6
Velocity	7.46 ft/s
Head loss	18.18 feet
HGL at end	5644.10 feet > GS and Pond 3 WSE

Zone 1 - Junction to west end

Discharge	70 gpm **manually reduced to avoid 1" pipes
Length	260 feet
Diam (equivalent)	1.81 inches (14 - 3/4" pipes)

f	0.014
Cm	1.6
Velocity	8.73 ft/s
Head loss	30.47 feet
HGL at end	5634.71 feet > GS and Pond 3 WSE

Zone 2 - Junction to north

Discharge	37 gpm
Length	176 feet
Diam (equivalent)	1.72 inches (12 - 3/4" pipes)
f	0.014
Cm	1.6
Velocity	5.13 ft/s
Head loss	7.68 feet
HGL at end	5657.51 feet > Existing pond WSE

Zone 4A - Main entrance road west

Discharge	49 gpm
Length	267 feet
Diam (equivalent)	1.81 inches (14 - 3/4" pipes)
f	0.014
Cm	1.6
Velocity	6.08 ft/s
Head loss	15.18 feet
HGL at end	5650.01 feet > GS and Pond 4 WSE

Pipe - Zone 4A header to Zone 4B header

Discharge	98 gpm
Length	267 feet
Diam	3 inches
f	0.014
Cm	1.6
Velocity	4.43 ft/s
Head loss	5.05 feet
HGL at end	5660.14 feet

Zone 4B - Main entrance road middle

Discharge	49 gpm
Length	267 feet
Diam (equivalent)	1.81 inches (14 - 3/4" pipes)
f	0.014
Cm	1.6
Velocity	6.08 ft/s
Head loss	15.18 feet
HGL at end	5644.96 feet > GS and Pond 4 WSE

Pipe - Zone 4B header to Zone 4C header

Discharge	49 gpm
Length	267 feet
Diam	3 inches
f	0.014
Cm	1.6
Velocity	2.21 ft/s
Head loss	1.26 feet
HGL at end	5658.88 feet

Zone 4C - Main entrance road east

Discharge	49 gpm
Length	267 feet
Diam (equivalent)	1.81 inches (14 - 3/4" pipes)
f	0.014
Cm	1.6
Velocity	6.08 ft/s
Head loss	15.18 feet
HGL at end	5643.70 feet > GS and Pond 4 WSE

Pipe 5 - East end return to Pond 4

Discharge	49 gpm - same as Pipe 4
Length	450 feet
Diam	4 inches
f	0.014
Cm	1.6
Velocity	1.25 ft/s
Head loss	0.49 feet
HGL at end	5649.51 feet >> Pond 4 WSE