

STATE OF IDAHO  
DEPARTMENT OF WATER RESOURCES  
**BENEFICIAL USE FIELD REPORT**

**A. GENERAL INFORMATION**

Permit No: 43-7308

Exam Date: 3/6/2000

Re-Exam: 2/1/2013

1. Current Owner: PETER J GRUSH And SYLVIA T GRUSH  
2218 E PIERCE LN  
MALTA ID 83342  
(208)645-2361

And

NORTHWEST FARM CREDIT SERVICES FLCA  
1408 POMERELLE AVE STE B  
BURLEY ID 83318  
(208)678-6650

2. Accompanied by: Peter Grush

Phone No: (208)645-2361

3. **SOURCE**

GROUND WATER

**B. OVERLAP REVIEW**

1. Other water rights with the same place of use: 43-13540, 43-2580B, 43-13206, and 43-13209  
2. Other water rights with the same point of diversion: None

**C. DIVERSION AND DELIVERY SYSTEM**1. **LOCATION OF POINT(S) OF DIVERSION:**

GROUND WATER

SE1/4NW1/4

Sec. 1, Twp 14S, Rge 26E, B.M.

CASSIA County

Method of Determination: GPS 42 14.155/113 22.024

2. **PLACE OF USE:**

|             |     |    | COMMERCIAL |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |               |  |
|-------------|-----|----|------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|---------------|--|
| Twp Rge Sec |     |    | NE         |           |           |           | NW        |           |           |           | SW        |           |           |           | SE        |           |           |           |               |  |
|             |     |    | <u>NE</u>  | <u>NW</u> | <u>SW</u> | <u>SE</u> | <u>NE</u> | <u>NW</u> | <u>SW</u> | <u>SE</u> | <u>NE</u> | <u>NW</u> | <u>SW</u> | <u>SE</u> | <u>NE</u> | <u>NW</u> | <u>SW</u> | <u>SE</u> | <u>Totals</u> |  |
| 13S         | 26E | 36 |            |           |           |           |           |           |           |           | X         | X         | X         | X         |           |           |           |           |               |  |
| 14S         | 26E | 1  |            | X         |           |           | X         | X         | X         | X         |           |           |           |           |           |           |           |           |               |  |
|             |     |    |            | L 2       |           |           |           | L 3       | L 4       |           |           |           |           |           |           |           |           |           |               |  |

**PLACE OF USE:**

|             |     |   | HEATING   |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |               |  |
|-------------|-----|---|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|---------------|--|
| Twp Rge Sec |     |   | NE        |           |           |           | NW        |           |           |           | SW        |           |           |           | SE        |           |           |           |               |  |
|             |     |   | <u>NE</u> | <u>NW</u> | <u>SW</u> | <u>SE</u> | <u>NE</u> | <u>NW</u> | <u>SW</u> | <u>SE</u> | <u>NE</u> | <u>NW</u> | <u>SW</u> | <u>SE</u> | <u>NE</u> | <u>NW</u> | <u>SW</u> | <u>SE</u> | <u>Totals</u> |  |
| 14S         | 26E | 1 |           | X         | X         |           |           | X         | X         | X         |           |           |           |           |           |           |           |           |               |  |
|             |     |   |           | L 2       |           |           |           | L 4       |           |           |           |           |           |           |           |           |           |           |               |  |

**PLACE OF USE:**

|             |     |   | RECREATION |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |               |  |
|-------------|-----|---|------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|---------------|--|
| Twp Rge Sec |     |   | NE         |           |           |           | NW        |           |           |           | SW        |           |           |           | SE        |           |           |           |               |  |
|             |     |   | <u>NE</u>  | <u>NW</u> | <u>SW</u> | <u>SE</u> | <u>NE</u> | <u>NW</u> | <u>SW</u> | <u>SE</u> | <u>NE</u> | <u>NW</u> | <u>SW</u> | <u>SE</u> | <u>NE</u> | <u>NW</u> | <u>SW</u> | <u>SE</u> | <u>Totals</u> |  |
| 14S         | 26E | 1 |            | X         |           |           |           |           |           |           |           |           |           |           |           |           |           |           |               |  |
|             |     |   |            | L         |           |           |           |           |           |           |           |           |           |           |           |           |           |           |               |  |

## Method of Determination:

3. ☒ Delivery System Diagram Attached (required). Indicate all major components and distances between components. Indicate weir size/pipe as applicable.
- ☒ Map Attached Showing Location(s) of point(s) of diversion and place(s) of use (required). Scale must be 1:24,000 or greater.
- ☒ Aerial Photo Attached (required for irrigation of 10+ acres).
- ☒ Photo of Diversion and System Attached

4.

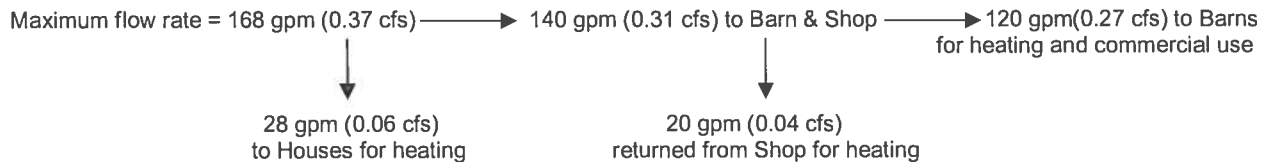
Well or Diversion

Well – 15 hp submersible pump installed by Pump Service (Burley) pump capacity is approximately 160 gpm (per conversation with Steve Baker, Pump Service 6/7/2013).

**D. FLOW MEASUREMENTS**

Flow measurement taken on 2/27/2013 with a Polysonic flow meter (Panametrics PT878) by Jana Reader. See attachment 1 for details on measurements taken and diagram showing pipes.

Maximum flow rate measured = 168 gpm = 0.37 cfs  
 Flow rate to Barns and Shop = 140 gpm = 0.31 cfs  
 Flow rate returning from Shop = 20 gpm = 0.04 cfs

**E. FLOW CALCULATIONS**

Commercial – Maximum flow to barns = **0.27 cfs**  
 Heating – All buildings included heating = **0.37 cfs**  
 Recreation – Swimming pool 5 gpm = **0.01 cfs**  
 Total Flow = **0.37 cfs**

**F. VOLUME CALCULATIONS (see attachment 2)****Heating Use**

House = 3.5 af  
 Pasteurizer = 14.9 af  
 Shop = 5.2 af  
 Barn 1 = 11.8 af  
 Barn 2 = 2.5 af  
**Total = 37.9 af**

**Commercial Use**

Barn 1 = 14.5 af  
 Barn 2 = 30.2 af  
**Total = 44.7 af**

**Recreation use**

Swimming Pool = **3.4 af**

**G. NARRATIVE/REMARKS/COMMENTS**

This permit is currently under the ownership of Peter and Sylvia Grush for the use of a hot water well for commercial, heating, and recreation use associated with a dairy and home. The permit was originally filed by Melrose Edmond Burgess and indicates the well is 12 inches in diameter with a depth of 6,787 feet; however there is no record of who drilled the well other than that it was for exploratory purposes. There are indications in the file that the temperature of the well was 190 degrees Fahrenheit, however during the field exam the highest temperature recorded was 150 degrees Fahrenheit. The hot water use on the dairy does overlap with several cold water rights (43-13540, 43-2580B, 43-13206, and 43-13209) used for commercial and stock water.

The commercial portion is used in the dairy for washing down the facility and sprinklers for washing the cows. The water is collected in storage tanks; water for the sprinklers is mixed with cold water to achieve a usable temperature. Some of the water supplied to the dairy barns is for heating and discharged into the waste pond, none of the water that is supplied to the dairy is returned to the well for re-injection. Once all the waste water is collected to the pond it is applied to either a field near the dairy or other farmland with irrigation water rights. The field near the dairy is included on this water rights commercial place of use and other associated cold water rights with the dairy. The recreation use is for a swimming pool that is located by Peter Grush's personal home. The water in the pool is used only during the summer months and is discharged in a seepage pit north of the home.

The heating use is for Peter Grush's home, shop, two dairy barns, and for use in the pasteurizer. All of the uses except for the two dairy barns extract only the heat value through a closed loop system and return the water back to the source well. Currently there is not a permit for the water to be re-injected; the owner has filed with the Department for an injection permit.

The proof of beneficial use was filed in 1998 at which point it appears that the dairy was established and Peter Grush's home and swimming pool. Since 1998 the dairy has undergone improvements and an additional home was constructed and several apartments. It is recommended that the uses for the dairy and the use for the first home and swimming pool can reasonably be licensed under this permit. The additional use for the home constructed after 1998 and the three apartments should be licensed under a new permit (43-13723).

This permit will also need to be amended to represent what was actually developed and to correct the point of diversion. When the permit was originally filed the point of diversion was correct and the place of use was only within the 40-acre tract where the POD was located. In November of 1995 an amendment was filed that changed the POD and

increased the size of the POU. An amendment will now need to be filed that will return the POD back to where it previously had been correctly identified and also change the POU to cover all of the locations that have commercial and heating use. Additionally the amendment will add recreation as a use to better represent the swimming pool on the water right.

It is my recommendation this water right be licensed for a total flow rate of 0.37 cfs and an annual volume of 86.0 af. The individual amounts for each of the uses, commercial, heating, and recreation are explained in the calculations section. As previously mentioned a new permit (43-13723) has been filed that will allow for the use of heating in an additional home and three apartments. This additional permit will not increase the 0.37 cfs capacity of the well, but will only increase the volume of water that is pumped from the well. However the new permit will be considered as non-consumptive since all the heating use will be injected back into the well.

Have conditions of permit approval been met? ☒ Yes ☐ No

#### H. RECOMMENDATIONS

##### 1. Recommended Amounts

| <u>BENEFICIAL USE</u> | <u>PERIOD OF USE</u> | <u>DIVERSION RATE</u> | <u>ANNUAL VOLUME</u> |
|-----------------------|----------------------|-----------------------|----------------------|
| COMMERCIAL            | 01/01 to 12/31       | 0.270 CFS             | 44.7 AF              |
| HEATING               | 01/01 to 12/31       | 0.370 CFS             | 37.9 AF              |
| RECREATION            | 01/01 to 12/31       | 0.010 CFS             | 3.4 AF               |
| <u>Totals:</u>        |                      | 0.370 CFS             | 86.0 AF              |

##### 2. Recommended Amendments

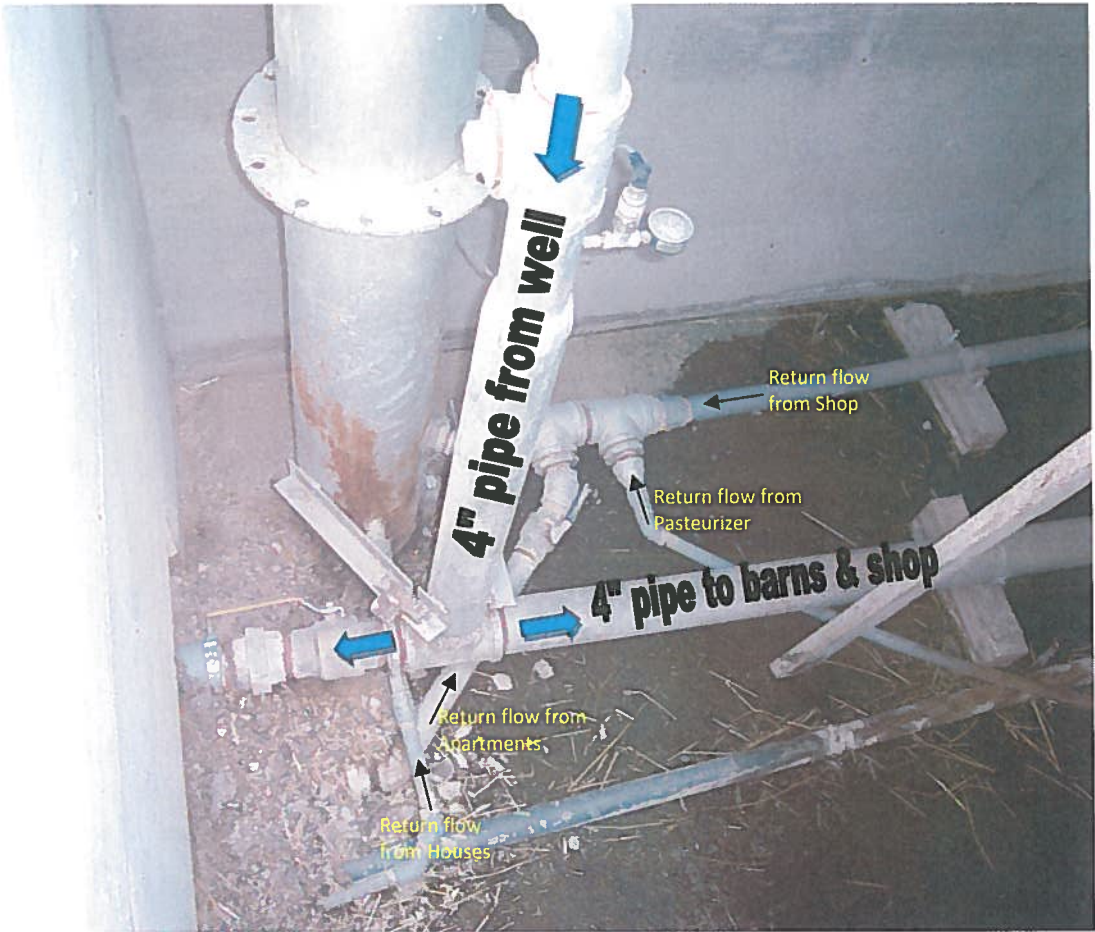
☒ Change P.D. as reflected above ☐ Add P.D. as reflected above ☐ None

☒ Change P.U. as reflected above ☐ Add P.U. as reflected above ☒ Other (add Recreation use)

#### I. AUTHENTICATION

Field Examiner's Name Nathan Erickson Date 4/21/14  
Reviewer A. J. Mervin Date 6/6/14

Attachment 1



4" PIPE WITH ALL FLOW FROM WELL

Log Name G2.LOG  
 Log Title G2.LOG  
 Start Time 2/27/2013 10:23  
 End Time 2/27/2013 10:34  
 Records 3  
 Interval 60  
 Error Flags 8208  
 Cyclic Flags 2

WALL THICKNESS = 0.235 IN  
 PIPE DIAMETER = 4.53 IN  
 WATER TEMP  $\approx$  170°F  
 SPEED OF SOUND = 5,122  
 SPACING OF PROBES = 4.56

MAX FLOW = 168 GPM

| Item # | Label    | UnitType | Symbol    | Comport |
|--------|----------|----------|-----------|---------|
| 0      | Velocity |          | 578 ft/s  | 0       |
| 1      | (+)Total |          | 1160 gal  | 0       |
| 2      | Volume   |          | 846 gal/m | 0       |

| Date/Time          | Velocity (ft/s) | Volume (gal/m) | (+)Total (gal) |
|--------------------|-----------------|----------------|----------------|
| 2/27/2013 10:23:05 | 3.557678287     | 143.558575     | 2556.699245    |
| 2/27/2013 10:24:05 | 3.483813002     | 140.5779808    | 2690.898279    |
| 2/27/2013 10:25:06 | 3.476016898     | 140.2633943    | 2826.573828    |
| 2/27/2013 10:26:07 | 3.586788274     | 144.7332142    | 2977.60837     |
| 2/27/2013 10:27:05 | 3.736166714     | 150.7608969    | 3123.658963    |
| 2/27/2013 10:28:05 | 3.927874408     | 158.4966395    | 3267.450486    |
| 2/27/2013 10:29:07 | 3.933263227     | 158.7140878    | 3442.479971    |
| 2/27/2013 10:30:05 | 4.015422475     | 162.0293579    | 3594.483069    |
| 2/27/2013 10:31:06 | 3.80922432      | 153.7088997    | 3763.151968    |
| 2/27/2013 10:32:06 | 3.62489545      | 146.2709057    | 3910.377103    |
| 2/27/2013 10:33:06 | 3.705227852     | 149.5124594    | 4051.124391    |

1494.425146  
 149.4 GPM

FLOW TO BARNS & SHOP (EVERY THING BUT HOUSES)

Log Name G3.LOG  
Log Title G3.LOG  
Start Time 2/27/2013 10:41  
End Time 2/27/2013 10:52  
Records 3  
Interval 60  
Error Flags 8208  
Cyclic Flags 2

PIPE DIAMETER = 4.55 IN  
WALL THICKNESS = .235  
WATER TEMP  $\approx$  170°F  
SPEED OF SOUND = 5,063 FT/S

MAX FLOW = 140 GPM

| Item # | Label    | Symbol | UnitType | Channel |
|--------|----------|--------|----------|---------|
| 0      | Velocity | ft/s   | 578      | 0       |
| 1      | Volume   | gal/m  | 846      | 0       |
| 2      | (+)Total | gal    | 1160     | 0       |

| Date/Time          | Velocity (ft/s) | Volume (gal/m) | (+)Total (gal) | Error # |
|--------------------|-----------------|----------------|----------------|---------|
| 2/27/2013 10:41:06 | 3.30429723      | 133.3342038    | 4866.949415    | 0       |
| 2/27/2013 10:42:07 | 3.194841917     | 128.9174894    | 5000.671474    | 0       |
| 2/27/2013 10:43:07 | 3.332522332     | 134.4731363    | 5123.461023    | 0       |
| 2/27/2013 10:44:07 | 2.800536344     | 113.0065662    | 5252.701327    | 0       |
| 2/27/2013 10:45:06 | 2.816470053     | 113.6495193    | 5364.421375    | 0       |
| 2/27/2013 10:46:06 | 0.103780904     | 4.187741971    | 5458.398699    | 0       |
| 2/27/2013 10:47:08 | 2.788430842     | 112.5180879    | 5540.758727    | 0       |
| 2/27/2013 10:48:07 | 3.235587596     | 130.5616492    | 5653.066516    | 0       |
| 2/27/2013 10:49:06 | 3.239219683     | 130.7082103    | 5786.47181     | 0       |
| 2/27/2013 10:50:06 | 3.180836674     | 128.3523532    | 5922.550115    | 0       |
| 2/27/2013 10:51:06 | 3.170590194     | 127.9388898    | 6019.114232    | 0       |

1152.164817  
115.2 GPM

Log Name                      Return Line    FROM SHOP  
Log Title                      G4.LOG  
Start Time                      2/27/2013 11:13  
End Time                        2/27/2013 23:24  
Records                                3  
Interval                                60  
Error Flags                            8208  
Cyclic Flags                            2

WALL THICKNESS = 0.33 IN  
PIPE DIAMETER = 2.4 IN  
WATER TEMP  $\approx$  150°F  
SPACING OF PROBES = 2.76

MAX FLOW = 20 GPM

| Item # | Label    | Symbol | UnitType | Channel |
|--------|----------|--------|----------|---------|
| 0      | Velocity | ft/s   | 578      | 0       |
| 1      | Volume   | gal/m  | 846      | 0       |
| 2      | (+)Total | gal    | 1160     | 0       |

| Date/Time          | Velocity (ft/s) | Volume (gal/m) | (+)Total (gal) | Error # |
|--------------------|-----------------|----------------|----------------|---------|
| 2/27/2013 11:13:22 | 2.640506761     | 19.5702398     | 6835.718037    | 0       |
| 2/27/2013 11:14:23 | 2.636203851     | 19.53834859    | 6855.596595    | 0       |
| 2/27/2013 11:15:23 | 2.622200883     | 19.43456494    | 6875.391877    | 0       |
| 2/27/2013 11:16:21 | 2.661661387     | 19.72702831    | 6894.156146    | 0       |
| 2/27/2013 11:17:22 | 2.630222918     | 19.49402062    | 6914.024885    | 0       |
| 2/27/2013 11:18:21 | 2.638057338     | 19.55208579    | 6933.076281    | 0       |
| 2/27/2013 11:19:21 | 2.649745602     | 19.63871391    | 6952.785325    | 0       |
| 2/27/2013 11:20:22 | 2.609640648     | 19.34147416    | 6972.565478    | 0       |
| 2/27/2013 11:21:22 | 2.627723266     | 19.47549433    | 6992.404081    | 0       |
| 2/27/2013 11:22:21 | 2.616143455     | 19.38967002    | 7011.276992    | 0       |
| 2/27/2013 11:23:21 | 2.652892658     | 19.66203846    | 7031.108178    | 0       |

195.3901414  
19.5 GPM

**House –**

Heating - see pages 2&3 of attachment 2 = **3.5 af**

**Swimming Pool -**

Pool dimensions are 30ft x 40ft with a depth of 3ft to 8ft (5.5 ft average depth)

$$A = 30' \times 40' = 1200 \text{ ft}^2$$

$$V = 1200 \text{ ft}^2 \times 5.5 \text{ ft} = 6600 \text{ ft}^3 \times 7.48 \text{ gal/ft}^3 = 49,368 \text{ gallons}$$

Pool is managed with a constant flow of 5 gpm during the summer (May – September(153 days)) and is not used during the winter. The waste water from the pool is discharged into a drainage pit just north of the homes.

$$\text{Annual Volume} = 5 \text{ gpm} \times 60 \text{ min/hr} \times 24 \text{ hr/day} \times 153 \text{ days} = 1,101,600 \text{ gallons} / 325,850 \text{ gallons/af} = \mathbf{3.4 \text{ af}}$$

The uses in the barns are for heating, washing, and sprinklers. Per the owner Peter Grush, washing water is all hot water and the water used in the sprinklers on average would be 1/3 cold water. Based on this information the volume of sprinkler water for this water right will be reduced by 1/3. Note that the water for the sprinklers and washing is put into storage tanks until used so that the increase flow rate is possible.

**Barn 1 –**

Heating – see pages 4&5 of attachment 2 = **11.8 af**

Wash up – 150 gal x 6 per/day = 900 gal/day x 365 days/year = 328,500 gal / 325,850 gal/af = **1 af**

Sprinklers – 300 gpm x 5 groups x 4 per/day x 3 min = (18,000 gal x 365 days) / 325,850 gal/ft = 20.2 af x (2/3) = **13.5 af**

**Barn 2 –**

Heating – see pages 6&7 of attachment 2 = **2.5 af**

Wash up – 300 gal x 6 per/day = 1,800 gal/day x 365 days/year = 657,000 gal / 325,850 gal/af = **2 af**

Sprinklers – 600 gpm x 7 groups x 3 per/day x 3 min = (37,800 gal x 365 days) / 325,850 gal/ft = 42.3 af x (2/3) = **28.2 af**

**Pasteurizer –**

The pasteurizer is used to pasteurize milk and is used for 6 hours per day. Flow is through a 1" pipe and is assumed to have a flow of 37 gpm. Water is looped through the pasteurizer unit for its heat value and is re-injected back into the source well.

$$6 \text{ hours/day} \times 37 \text{ gpm} \times 60 \text{ min/hr} \times 365 \text{ days/yr} = 4,861,800 \text{ gal} / 325,850 \text{ gal/af} = \mathbf{14.9 \text{ af}}$$

**Shop –**

Heating – see pages 8&9 of attachment 2 = **5.2 af**

## Volume calculation WR 43-7308 Home (5,612 ft<sup>2</sup>)

The annual volume requirement was calculated using a Memorandum from Rick Sterling to Terry Blau dated March 25, 1988 and Administrative Memorandum from Norm Young dated September 28, 1992 titled Rate of flow for heating use. The memorandums contain equations for calculating the annual water requirements for geothermal heating. The equations are listed below with an explanation of the variables; data was taken from the field exam and the National Oceanic and Atmospheric Administration (NOAA).

### Explanation of values used in calculations:

The Home has a total of 5,612 ft<sup>2</sup>, the efficiency factor was assumed to have a *best energy efficiency* or 0.28 BTU/hr ft<sup>2</sup> °F. The Design temperature difference for the area is 73 °F. The temperature of the geothermal source was reported to be 130 °F. The temperature in the 2 story home is expected to be 70 °F. The annual heating degree days were taken from the Malta 2E weather station because it is closest in elevation and proximity.

**Design Heat Load Calculation:**  $E = [e \times \Delta t_1] 0.8 \times A$

Where:

$E$  = BTU/hr required

$e$  = House efficiency factor

$\Delta t_1$  = Design temperature difference

0.8 = Adjustment factor for two story homes

$A$  = Area of heated space

Values used:

$$\begin{aligned} e &= 0.28 \text{ BTU/hr ft}^2 \text{ °F} \\ \Delta t_1 &= 73 \text{ °F} \\ A &= 5,612 \text{ ft}^2 \end{aligned}$$

$$E = [e \times \Delta t_1] 0.8 \times A = \boxed{91,767} \text{ BTU/hr}$$

**Temperature Drop Across System Calculation:**  $\Delta T_s = 0.3(S - T)$

Where:

$\Delta T_s$  = Temperature drop across system

$S$  = Geothermal source temperature

$T$  = Temperature required by system

Values used:

$$\begin{aligned} S &= 130 \text{ °F} \\ T &= 70 \text{ °F} \end{aligned}$$

$$\Delta T_s = 0.3(S - T) = \boxed{18.0} \text{ °F}$$

**Volume Calculation:**

$$V = \frac{HL \times DD \times 24 \times C_D}{\Delta t_1 \times k \times C \times \Delta t_2}$$

Where:

$V$  = Annual volume of geothermal water required

$HL$  = Peak heating load in BTU/hr

$DD$  = Annual heating degree-days

$24$  = 24 hrs/day

$C_D$  = Empirical correction factor for heating effect vs. 65 °F degree-days

$\Delta t_1$  = Design temperature difference

$k$  = Correction factor to account for losses, use 0.90

$C$  = Constant to correct for desired units,  $2.72 \times 10^6$  BTU/AF-°F

$\Delta t_2 = \Delta T_s$  = Temperature drop across system (calculated above)

Values used:

$HL$  = 91,767 BTU/hr

$DD$  = 7,807 °F

$24$  = 24 hrs/day

$C_D$  = 0.65

$\Delta t_1$  = 73 °F

$k$  = 0.9

$C$  = 2,720,000 BTU/AF-°F

$\Delta t_2$  = 18 °F

$$V = \frac{HL \times DD \times 24 \times C_D}{\Delta t_1 \times k \times C \times \Delta t_2} = \boxed{3.5} \text{ afa}$$

**Volume calculation WR 43-7308 Barn 1 (5,150 ft<sup>2</sup>)**

The annual volume requirement was calculated using a Memorandum from Rick Sterling to Terry Blau dated March 25, 1988 and Administrative Memorandum from Norm Young dated September 28, 1992 titled Rate of flow for heating use. The memorandums contain equations for calculating the annual water requirements for geothermal heating. The equations are listed below with an explanation of the variables; data was taken from the field exam and the National Oceanic and Atmospheric Administration (NOAA).

**Explanation of values used in calculations:**

The Barn has a total of 5,150 ft<sup>2</sup> that is heated, the efficiency factor was assumed to have a *poor energy efficiency* or 1.11 BTU/hr ft<sup>2</sup> °F. The Design temperature difference for the area is 73 °F. The temperature of the geothermal source was reported to be 140 °F. The temperature in the barn is expected to be 60 °F. The annual heating degree days were taken from the Malta 2E weather station because it is closest in elevation and proximity.

**Design Heat Load Calculation:**  $E = [e \times \Delta t_1] A$

Where:

$E$  = BTU/hr required

$e$  = House efficiency factor

$\Delta t_1$  = Design temperature difference

$A$  = Area of heated space

Values used:

$$\begin{aligned} e &= 1.11 \text{ BTU/hr ft}^2 \text{ °F} \\ \Delta t_1 &= 73 \text{ °F} \\ A &= 5,150 \text{ ft}^2 \end{aligned}$$

$$E = [e \times \Delta t_1] A = \boxed{417,305} \text{ BTU/hr}$$

**Temperature Drop Across System Calculation:**  $\Delta T_s = 0.3(S - T)$

Where:

$\Delta T_s$  = Temperature drop across system

$S$  = Geothermal source temperature

$T$  = Temperature required by system

Values used:

$$\begin{aligned} S &= 140 \text{ °F} \\ T &= 60 \text{ °F} \end{aligned}$$

$$\Delta T_s = 0.3(S - T) = \boxed{24.0} \text{ °F}$$

**Volume Calculation:**

$$V = \frac{HL \times DD \times 24 \times C_D}{\Delta t_1 \times k \times C \times \Delta t_2}$$

Where:

$V$  = Annual volume of geothermal water required

$HL$  = Peak heating load in BTU/hr

$DD$  = Annual heating degree-days

$24$  = 24 hrs/day

$C_D$  = Empirical correction factor for heating effect vs. 65 °F degree-days

$\Delta t_1$  = Design temperature difference

$k$  = Correction factor to account for losses, use 0.90

$C$  = Constant to correct for desired units,  $2.72 \times 10^6$  BTU/AF-°F

$\Delta t_2 = \Delta T_s$  = Temperature drop across system (calculated above)

Values used:

$$HL = 417,305 \text{ BTU/hr}$$

$$DD = 7,807 \text{ °F}$$

$$24 = 24 \text{ hrs/day}$$

$$C_D = 0.65$$

$$\Delta t_1 = 73 \text{ °F}$$

$$k = 0.9$$

$$C = 2,720,000 \text{ BTU/AF-°F}$$

$$\Delta t_2 = 24 \text{ °F}$$

$$V = \frac{HL \times DD \times 24 \times C_D}{\Delta t_1 \times k \times C \times \Delta t_2} = \boxed{11.8} \text{ afa}$$

**Volume calculation WR 43-7308 Barn 2 (1,090 ft<sup>2</sup>)**

The annual volume requirement was calculated using a Memorandum from Rick Sterling to Terry Blau dated March 25, 1988 and Administrative Memorandum from Norm Young dated September 28, 1992 titled Rate of flow for heating use. The memorandums contain equations for calculating the annual water requirements for geothermal heating. The equations are listed below with an explanation of the variables; data was taken from the field exam and the National Oceanic and Atmospheric Administration (NOAA).

**Explanation of values used in calculations:**

The Barn has a total of 1,090 ft<sup>2</sup> that is heated, the efficiency factor was assumed to have a *poor energy efficiency* or 1.11 BTU/hr ft<sup>2</sup> °F. The Design temperature difference for the area is 73 °F. The temperature of the geothermal source was reported to be 140 °F. The temperature in the barn is expected to be 60 °F. The annual heating degree days were taken from the Malta 2E weather station because it is closest in elevation and proximity.

**Design Heat Load Calculation:**  $E = [e \times \Delta t_1] A$

Where:

$E$  = BTU/hr required

$e$  = House efficiency factor

$\Delta t_1$  = Design temperature difference

$A$  = Area of heated space

Values used:

$$e = 1.11 \text{ BTU/hr ft}^2 \text{ °F}$$

$$\Delta t_1 = 73 \text{ °F}$$

$$A = 1,090 \text{ ft}^2$$

$$E = [e \times \Delta t_1] A = \boxed{88,323} \text{ BTU/hr}$$

**Temperature Drop Across System Calculation:**  $\Delta T_s = 0.3(S - T)$

Where:

$\Delta T_s$  = Temperature drop across system

$S$  = Geothermal source temperature

$T$  = Temperature required by system

Values used:

$$S = 140 \text{ °F}$$

$$T = 60 \text{ °F}$$

$$\Delta T_s = 0.3(S - T) = \boxed{24.0} \text{ °F}$$

**Volume Calculation:**

$$V = \frac{HL \times DD \times 24 \times C_D}{\Delta t_1 \times k \times C \times \Delta t_2}$$

Where:

$V$  = Annual volume of geothermal water required

$HL$  = Peak heating load in BTU/hr

$DD$  = Annual heating degree-days

24 = 24 hrs/day

$C_D$  = Empirical correction factor for heating effect vs. 65 °F degree-days

$\Delta t_1$  = Design temperature difference

$k$  = Correction factor to account for losses, use 0.90

$C$  = Constant to correct for desired units,  $2.72 \times 10^6$  BTU/AF-°F

$\Delta t_2 = \Delta T_s$  = Temperature drop across system (calculated above)

Values used:

$HL$  = 88,323 BTU/hr

$DD$  = 7,807 °F

24 = 24 hrs/day

$C_D$  = 0.65

$\Delta t_1$  = 73 °F

$k$  = 0.9

$C$  = 2,720,000 BTU/AF-°F

$\Delta t_2$  = 24 °F

$$V = \frac{HL \times DD \times 24 \times C_D}{\Delta t_1 \times k \times C \times \Delta t_2} = \boxed{2.5} \text{ afa}$$

**Volume calculation WR 43-7308 Shop (3,750 ft<sup>2</sup>)**

The annual volume requirement was calculated using a Memorandum from Rick Sterling to Terry Blau dated March 25, 1988 and Administrative Memorandum from Norm Young dated September 28, 1992 titled Rate of flow for heating use. The memorandums contain equations for calculating the annual water requirements for geothermal heating. The equations are listed below with an explanation of the variables; data was taken from the field exam and the National Oceanic and Atmospheric Administration (NOAA).

**Explanation of values used in calculations:**

The shop has a total of 3,750 ft<sup>2</sup>, the efficiency factor was assumed to have a *average energy efficiency* or 0.67 BTU/hr ft<sup>2</sup> °F. The Design temperature difference for the area is 73 °F. The temperature of the geothermal source was reported to be 140 °F. The temperature in the shop is expected to be 60 °F. The annual heating degree days were taken from the Malta 2E weather station because it is closest in elevation and proximity.

**Design Heat Load Calculation:**  $E = [e \times \Delta t_1] A$

Where:

$E$  = BTU/hr required

$e$  = House efficiency factor

$\Delta t_1$  = Design temperature difference

$A$  = Area of heated space

Values used:

$$e = 0.67 \text{ BTU/hr ft}^2 \text{ °F}$$

$$\Delta t_1 = 73 \text{ °F}$$

$$A = 3,750 \text{ ft}^2$$

$$E = [e \times \Delta t_1] A = \boxed{183,413} \text{ BTU/hr}$$

**Temperature Drop Across System Calculation:**  $\Delta T_s = 0.3(S - T)$

Where:

$\Delta T_s$  = Temperature drop across system

$S$  = Geothermal source temperature

$T$  = Temperature required by system

Values used:

$$S = 140 \text{ °F}$$

$$T = 60 \text{ °F}$$

$$\Delta T_s = 0.3(S - T) = \boxed{24.0} \text{ °F}$$

**Volume Calculation:**

$$V = \frac{HL \times DD \times 24 \times C_D}{\Delta t_1 \times k \times C \times \Delta t_2}$$

Where:

$V$  = Annual volume of geothermal water required

$HL$  = Peak heating load in BTU/hr

$DD$  = Annual heating degree-days

$24$  = 24 hrs/day

$C_D$  = Empirical correction factor for heating effect vs. 65 °F degree-days

$\Delta t_1$  = Design temperature difference

$k$  = Correction factor to account for losses, use 0.90

$C$  = Constant to correct for desired units,  $2.72 \times 10^6$  BTU/AF-°F

$\Delta t_2 = \Delta T_s$  = Temperature drop across system (calculated above)

Values used:

$HL$  = 183,413 BTU/hr

$DD$  = 7,807 °F

$24$  = 24 hrs/day

$C_D$  = 0.65

$\Delta t_1$  = 73 °F

$k$  = 0.9

$C$  = 2,720,000 BTU/AF-°F

$\Delta t_2$  = 24 °F

$$V = \frac{HL \times DD \times 24 \times C_D}{\Delta t_1 \times k \times C \times \Delta t_2} = \boxed{5.2} \text{ afa}$$

# Permit 43-7308 Peter and Sylvia Grush

