



GEO-HEAT CENTER

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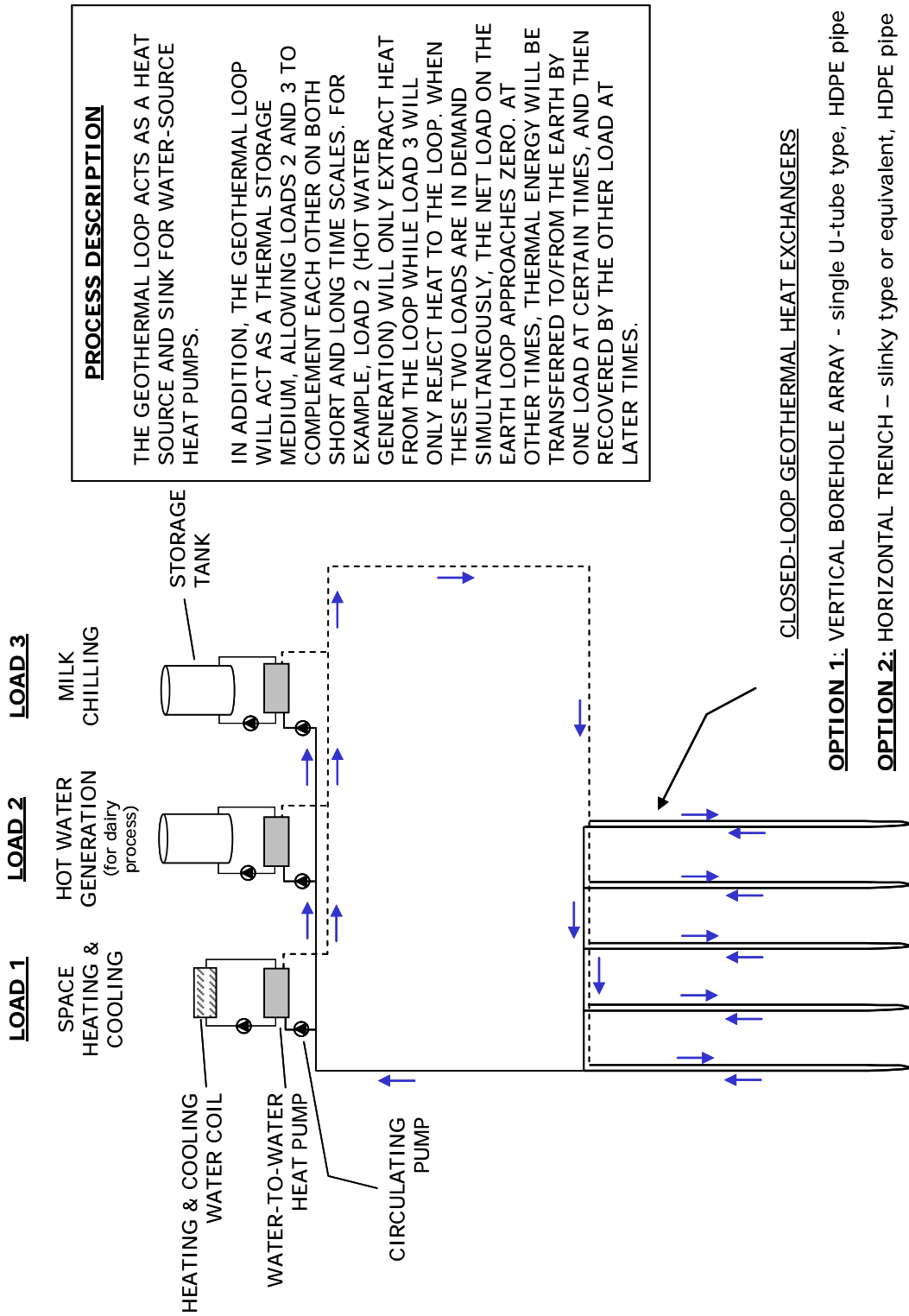
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KLDJ-5-55052-04: Task 2 – Farm Bill Geothermal Heat Pump Template – Appendix A

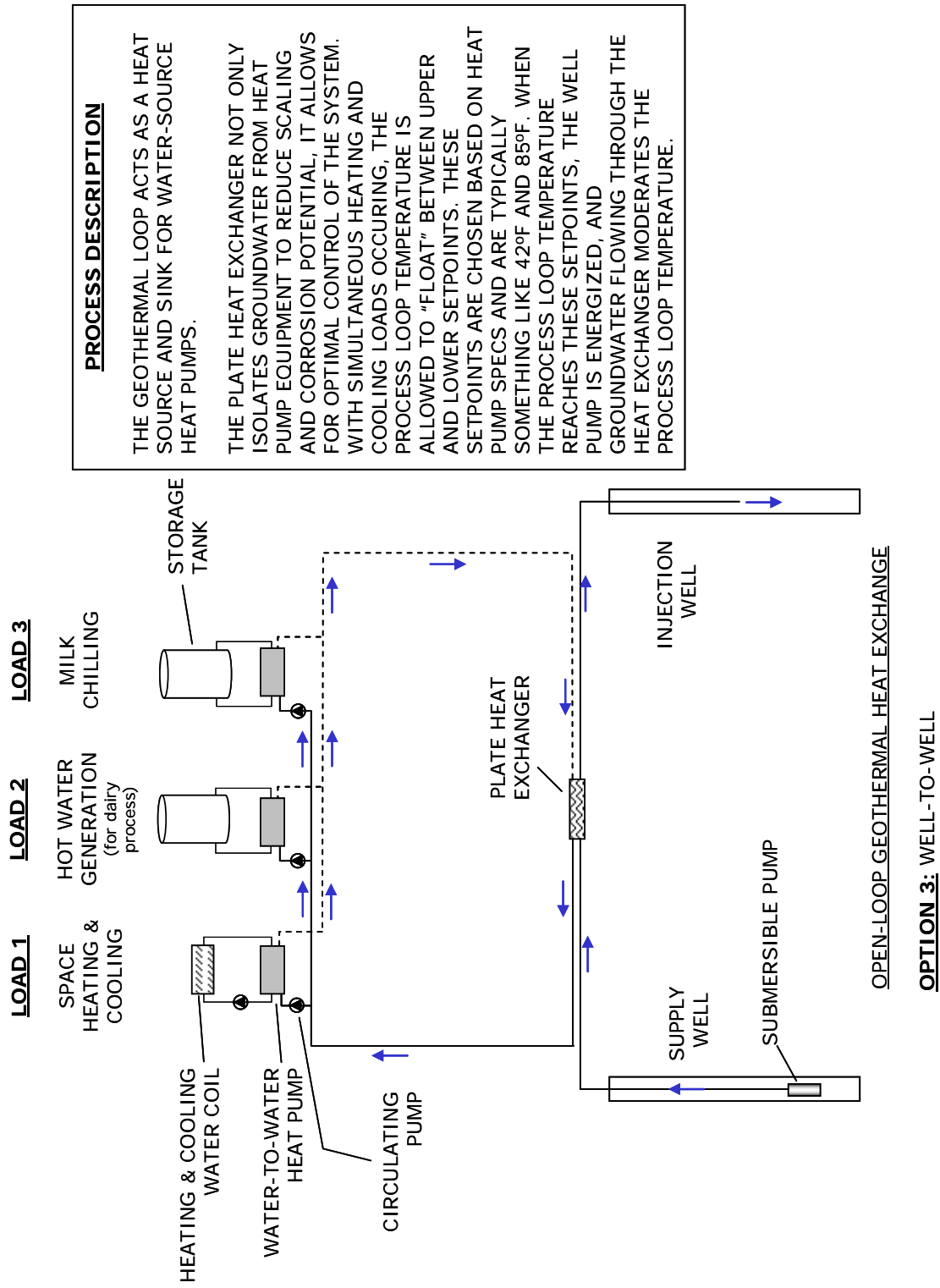
Appendix A – Engineering Design

- **Process Diagrams**
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- **Heating Loads Summary**
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Appendix A: Process Diagram (Closed-Loop Geothermal Options 1 and 2)



Appendix A: Process Diagram (Open-Loop Geothermal Option 3)



Appendix A: Design and Engineering Heating Loads Summary

Values in red are computed from input data.

Space Heating Loads

Load 1: Milk Barn

Floor space	1,220	ft ²
Design outdoor air temperature:	-6	°F
Design indoor air temperature:	70	°F
Annual heating degree days	7,100	
Heat loss at design condition	55	Btu/hr-ft ²
Peak heating Load	67,100	Btu/hr
Annual heating energy required	150	million Btu

Load 2: Bulk Tank Room

Floor space	576	ft ²
Design outdoor air temperature:	-6	°F
Design indoor air temperature:	70	°F
Annual heating degree days	7,100	
Heat loss at design condition	55	Btu/hr-ft ²
Peak heating Load	31,680	Btu/hr
Annual heating energy required	71	million Btu

Hot Water Heating Loads

Load 1: Cow Washing

Gallons per day required	600	gpd
Number of events per day	2	
Minimum storage required	300	gal
Recovery time	4	hr
Peak flow rate	1.3	gpm
Inlet water temperature	50	°F
Desired outlet water temperature	110	°F
Peak Heating Load	37,500	Btu/hr
Annual heating energy required	110	million Btu

Load 2: Cow Udders & Milk Barn Floors

Gallons per day required	520	gpd
Number of events per day	2	
Minimum storage required	260	gal
Recovery time	4	hr
Peak flow rate	1.1	gpm
Inlet water temperature	50	°F
Desired outlet water temperature	110	°F
Peak Heating Load	32,500	Btu/hr
Annual heating energy required	95	million Btu

Total Heating Load

Peak hourly	168,780	Btu/hr
Annual	426	million Btu

**Appendix A: Design and Engineering
Cooling/Refrigeration Loads
Summary**

Values in red are computed from input data.

Space Cooling Loads

Load 1: **Milk Barn**

Floor space	<u>1,220</u>	ft ²
Cooling load per sq. ft	<u>250</u>	ft ² /ton
Annual equivalent full load hours	<u>1,000</u>	hr
Peak cooling Load	<u>58,560</u>	Btu/hr
Annual cooling energy required	<u>59</u>	million Btu

Load 2: **Bulk Tank Room**

Floor space	<u>576</u>	ft ²
Cooling load per sq. ft	<u>250</u>	ft ² /ton
Annual equivalent full load hours	<u>1,000</u>	hr
Peak cooling Load	<u>27,648</u>	Btu/hr
Annual cooling energy required	<u>28</u>	million Btu

Process Cooling Loads

Load 1: **Milk Chilling**

Gallons per day produced	<u>2,340</u>	gpd
Starting milk temperature	<u>90</u>	°F
Chilled milk temperature	<u>34</u>	°F
Cooling Load (on storage tank)	<u>45,549</u>	Btu/hr
Annual cooling energy required	<u>40</u>	million Btu

Total Cooling Load

Peak hourly	<u>131,757</u>	Btu/hr
	<u>11.0</u>	tons
Annual	<u>126</u>	million Btu

Appendix A: Design and Engineering Construction Cost Estimate

Construction Cost Estimate	Quantity	Units	Unit Cost	Sub Total	Totals
<u>GEOHERMAL RESOURCE</u>					
<u>OPTION 1 - VERTICAL CLOSED-LOOP SYSTEM</u>					
Vertical borehole, single U-tube*					
All labor & materials to drill, install U-tube heat exchangers, grout boreholes, and bring piping into buildings; flush, purge, and pressure test loop.	12	ton	\$2,000	\$24,000	\$24,000
<u>GEOHERMAL ENERGY UTILIZATTION</u>					
Space Heating Load 1 - Milk Barn					
Retrofit from existing boiler					
Wall cut, piping, fittings	1	lump	\$1,750	\$1,750	
Heat pump (water-to-water)	6	ton	\$1,500	\$9,000	
Circulating pump, controls	2	lump	\$500	\$1,000	\$11,750
Space Heating Load 2 - Bulk Tank Room					
Retrofit from existing boiler					
Wall cut, piping, fittings	1	lump	\$1,750	\$1,750	
Heat pump (water-to-water)	3	ton	\$1,500	\$4,500	
Circulating pump, controls	2	lump	\$500	\$1,000	\$7,250
Hot Water Load 1 - Cow Washing					
Wall cut, piping, fittings	1	lump	\$1,750	\$1,750	
Heat pump (water-to-water)	3.5	ton	\$1,500	\$5,250	
Hot water storage tank (w. backup)	300	gal	\$12	\$3,600	
Circulating pump, controls	2	lump	\$500	\$1,000	\$11,600
Hot Water Load 2 - Floors, Udders					
Wall cut, piping, fittings	1	lump	\$1,750	\$1,750	
Heat pump (water-to-water)	3	ton	\$1,500	\$4,500	
Hot water storage tank (w. backup)	260	gal	\$12	\$3,120	
Circulating pump, controls	2	lump	\$500	\$1,000	\$10,370
Milk Chilling					
Wall cut, piping, fittings	1	lump	\$1,750	\$1,750	
Heat pump (water-to-water)	4	ton	\$1,500	\$6,000	
Storage tank (assume existing already)	0	gal	\$0	\$0	
Circulating pump, controls	2	lump	\$500	\$1,000	\$8,750
CONSTRUCTION GRAND TOTAL					\$73,720
* NOTE: The geoexchange loop should be installed by a certified contractor. Final loop design should follow accepted standards and practices.					

Appendix A: Design and Engineering Construction Cost Estimate

Construction Cost Estimate	Quantity	Units	Unit Cost	Sub Total	Totals
<u>GEOTHERMAL RESOURCE</u>					
<u>OPTION 2 - HORIZONTAL CLOSED-LOOP SYSTEM</u>					
Slinky Loop (or equivalent)*					
All labor & materials to excavate and install the loop and bring piping into buildings; flush, purge, and pressure test loop.	12	ton	\$1,500	\$18,000	\$18,000
<u>GEOTHERMAL ENERGY UTILIZATION</u>					
Space Heating Load 1 - Milk Barn					
Retrofit from existing boiler					
Wall cut, piping, fittings	1	lump	\$1,750	\$1,750	
Heat pump (water-to-water)	6	ton	\$1,500	\$9,000	
Circulating pump, controls	2	lump	\$500	\$1,000	\$11,750
Space Heating Load 2 - Bulk Tank Room					
Retrofit from existing boiler					
Wall cut, piping, fittings	1	lump	\$1,750	\$1,750	
Heat pump (water-to-water)	3	ton	\$1,500	\$4,500	
Circulating pump, controls	2	lump	\$500	\$1,000	\$7,250
Hot Water Load 1 - Cow Washing					
Wall cut, piping, fittings	1	lump	\$1,750	\$1,750	
Heat pump (water-to-water)	3.5	ton	\$1,500	\$5,250	
Hot water storage tank (w. backup)	300	gal	\$12	\$3,600	
Circulating pump, controls	2	lump	\$500	\$1,000	\$11,600
Hot Water Load 2 - Floors, Udders					
Wall cut, piping, fittings	1	lump	\$1,750	\$1,750	
Heat pump (water-to-water)	3	ton	\$1,500	\$4,500	
Hot water storage tank (w. backup)	260	gal	\$12	\$3,120	
Circulating pump, controls	2	lump	\$500	\$1,000	\$10,370
Milk Chilling					
Wall cut, piping, fittings	1	lump	\$1,750	\$1,750	
Heat pump (water-to-water)	4	ton	\$1,500	\$6,000	
Storage tank (assume existing already)	0	gal	\$0	\$0	
Circulating pump, controls	2	lump	\$500	\$1,000	\$8,750
CONSTRUCTION GRAND TOTAL					\$67,720
* NOTE: The geoexchange loop should be installed by a certified contractor. Final loop design should follow accepted standards and practices.					

Appendix A: Design and Engineering Construction Cost Estimate

Construction Cost Estimate	Quantity	Units	Unit Cost	Sub Total	Totals
<u>GEOTHERMAL RESOURCE</u>					
<u>OPTION 3 - OPEN-LOOP SYSTEM (WELL-TO-WELL)</u>					
Production Well					
Drilling & materials	250	ft	\$30	\$7,500	
Well pump, pressure tank, controls	1	lump	\$2,000	\$2,000	
Injection Well					
Drilling & materials	250	ft	\$30	\$7,500	
Distribution Piping					
PVC pipe, trench & backfill, pipe bedding, associated fittings & valves	200	ft	\$20	\$4,000	\$21,000
<u>GEOTHERMAL ENERGY UTILIZATION</u>					
Main Heat Exchanger (plate type)	12	ton	\$50	\$600	\$600
Space Heating Load 1 - Milk Barn					
Retrofit from existing boiler					
Wall cut, piping, fittings	1	lump	\$1,750	\$1,750	
Heat pump (water-to-water)	6	ton	\$1,500	\$9,000	
Circulating pump, controls	2	lump	\$500	\$1,000	\$11,750
Space Heating Load 2 - Bulk Tank Room					
Retrofit from existing boiler					
Wall cut, piping, fittings	1	lump	\$1,750	\$1,750	
Heat pump (water-to-water)	3	ton	\$1,500	\$4,500	
Circulating pump, controls	2	lump	\$500	\$1,000	\$7,250
Hot Water Load 1 - Cow Washing					
Wall cut, piping, fittings	1	lump	\$1,750	\$1,750	
Heat pump (water-to-water)	3.5	ton	\$1,500	\$5,250	
Hot water storage tank (w. backup)	300	gal	\$12	\$3,600	
Circulating pump, controls	2	lump	\$500	\$1,000	\$11,600
Hot Water Load 2 - Floors, Udders					
Wall cut, piping, fittings	1	lump	\$1,750	\$1,750	
Heat pump (water-to-water)	3	ton	\$1,500	\$4,500	
Hot water storage tank (w. backup)	260	gal	\$12	\$3,120	
Circulating pump, controls	2	lump	\$500	\$1,000	\$10,370
Milk Chilling					
Wall cut, piping, fittings	1	lump	\$1,750	\$1,750	
Heat pump (water-to-water)	4	ton	\$1,500	\$6,000	
Storage tank (assume existing already)	0	gal	\$0	\$0	
Circulating pump, controls	2	lump	\$500	\$1,000	\$8,750
CONSTRUCTION GRAND TOTAL					\$71,320