WILDERS GROVE SOLID WASTE SERVICES CENTER

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GROUND SOURCE HEAT PUMPS

Project Overview – Executive Summary

- New 24,000 sq. ft. administrative service facility for Solid Waste Services Department.

- Demonstration project for City of Raleigh to meet stated objectives of:
  - Contribute to 20% reduction in City's use of fossil fuels.
  - Meet LEED Silver or better. (project goal is LEED Gold).
  - Achieve Minimum Energy Savings of 30%.
  - Take a leadership role in developing green facilities and promoting renewable energy project development.
  - Provide comfortable work environment for City Employees.

Project Overview – Timeline

- Project will be accomplished in three phases – Design, Construction and Post Construction Monitoring.
  - Phase 1 - Design
    - Building and Loop System completed March 2010.
    - Design enhancements March 2010 through July 2010.
  - Phase 2 - Construction
    - March 2010 through July 2011.
    - Groundbreaking 4/7/2010.
    - Construction Began March 30, 2010.
  - Phase 3 – Post Construction Monitoring
    - Begin July 2011 through July 2016.
    - FMCS will monitor the system continuously in real time over the Internet using a standard Web browser.
    - Report temperature trends on a quarterly basis.

Project Overview – Budget

- Overall SWS Facility Project Budget - $21 MD
- Total Geothermal System Budget - $2.6 MD
  - Geothermal System Design - $225,000
  - Geothermal System Construction - $1.9 MD
  - Construction Monitoring and Commissioning - $101,000
  - Post Construction Monitoring and Modeling - $250,000
  - Project Management and Reporting - $114,000
- DOE Share - $1.3 MD
- City of Raleigh Share - $1.3 MD
- Grant Award – January 29, 2010
- Funding Received for 2009 - $0
- Funding for 2010 - $112,500 to date

Project Overview – Barriers and Partners

- Barriers
  - Viability of Geothermal Systems for cooling dominated loads typical in the Southern United States.
  - "Right Sizing" of well fields based upon thermal characteristics of the ground reservoir.
  - Initial System Cost.
  - Operational Lifetime of Ground Loop System.

- Partners
  - **Owner: City of Raleigh.**
  - **Engineering: Hazen and Sawyer, P.C., HIPP Engineering, Inc.**
  - **Enhanced Commissioning: Jacobs Engineering.**
  - **Contractor: TA Loving Company.**

Project Objectives

- Provide demonstration of Geothermal Heat Pumps viability on energy usage for future Service Centers planned by the City of Raleigh and other similar facilities in the southeast.
- Reuse rejected heat from Heat Pumps to reduce return water heat content to well field:
  - Generate hot water for domestic use.
  - Exhaust air energy recovery.
  - Other applications identified during design phase.
    - Pre-heat water for use with vehicle washing.
    - Evaporative cooling system.
- Prove viability for high demand, sporadic cooling loads throughout the year, without significantly raising the temperature of the well field to the point of lost viability.
- Provide means to monitor temperature trends of heat pump system, excess heat rejection systems, and well field through FMCS.

Scientific/Technical Approach

- Designed system with monitoring points that will allow detailed analysis of well field performance.
  - Monitor Heat Pump Water Discharge Temperature.
  - Monitor Water Discharge temperature from Domestic Hot Water Storage Tank.
  - Monitor Water temperature entering well field.
  - Monitor Water Temperature exiting well field.
  - Monitor Affect of loop system on rock formation temperature.
- Minimize temperature of water entering well field to prolong well field viability.
  - Provide flexibility to incorporate future devices to remove excess heat for beneficial use.
- Milestones to be established.

Accomplishments, Expected Outcomes and Progress

- Accomplishments:
  - Geothermal Heat Pump System has been designed and modeled and is expected to provide a minimum energy savings of 30% compared to conventional HVAC system.
  - Hot Water system has been designed and modeled to provide an additional 20% energy savings.
  - Nine Year payback period anticipated for Geothermal System.
- Planned Activities 2010:
  - Analysis and design of systems to remove excess heat for beneficial use.
  - Design final well field monitoring system.
  - Drill conductivity test wells to verify well field design.
  - Construct building systems.

Project Management/Coordination

- Scope, Schedule and Staffing Management

  Scope -The scope of the Wilders Grove project was presented to City Council as part of the City's Remote Operations Facility Network plan to decentralize various City departments and operations into high growth areas of the City to provide services at a lower cost. The Wilders Grove project is the first phase of the Remote Operations Network that is being constructed and has been approved by the City Council.

  Schedule - Completion of Construction is Scheduled for July, 2011.

  Staffing Management – No changes in the current City staffing structure and firms currently under contract are anticipated.

  Spending – FY 2010 Contract Payments Estimated at $1.6 MD.

Project Management/Coordination

- Projected Annual Grant Obligations (Total Geothermal Energy System Project Costs)
  - 2010 - $1,653,588
  - 2011 - $ 727,919
  - 2012 - $ 70,776
  - 2013 - $ 71,910
  - 2014 - $ 73,058
- City of Raleigh Share Fully Funded
  - City has approved award and funding of design, commissioning, construction administration and construction contracts for the Wilders Grove Solid Waste Service Center Project.

Future Directions

- The first critical construction milestone will be to determine the conductivity of wells (May 2010).
  - Two wells will be drilled in May and conductivity determined in early June. This will allow fine tuning of well field size.
- July and August 2010 milestones will be to finish design of passive heat rejection strategies prior to circulating loop water.
  - Review possibility of providing heated wash water.
  - Review possibility of evaporative cooler.
  - Decisions will be based on potential impact on well field, maintenance cost, and capital cost.
- Review shop drawings for geothermal equipment, piping materials and grouting.
- Finalize monitoring and reporting strategies.

Summary Project Goals

- Validate the effectiveness of geothermal heat pump system when facility HVAC is cooling dominated such as in the southeast.
- Evaluate use of heat sinks such as coolers and water tanks to reduce temperature of water returning to well field, thus increasing system efficiency and longevity.
- Demonstrate that monitoring throughout the process can determine more efficient design and operation of future City of Raleigh and similar Operation Centers.
- Demonstrate significant reduction in energy use and in operations and maintenance costs.

Supplemental Slides

Energy Model Results

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

LEED NC 2.2 EA Credit 1 Summary Report

208077 Wilders Grove Final Load Calc — 04/28/2010 09:56AM

General Information

Simulation Program Name and Version	**Hourly Analysis Program v4.40**	
Simulation Weather File Name	**Raleigh/Durham, North Carolina (TM2)**	
Total Conditioned Floor Area	**26,994**	ft²
Total Floor Area	**26,994**	ft²

Building Designations

Proposed Building	**[P] Ground Source Heat Pumps**
Baseline - 0 degrees	**[B000] Base Line**
Baseline - 90 degrees	**[B090] Base Line**
Baseline - 180 degrees	**[B180] Base Line**
Baseline - 270 degrees	**[B270] Base Line**

Window-to-Wall Ratios

	Proposed Design	Baseline
Window to Wall Ratio	11 %	11 %
Gross Wall Area (ft²)	16,584	16,584
Vertical Window Area (ft²)	1,754	1,754

Advisory Messages

	Proposed Building	Baseline Building (0 deg. rotation)	Difference
Number of hours heating loads not met	0	0	0
Number of hours cooling loads not met	27	818	-791

Table 1.5. Energy Type Summary

Energy Type	Utility Rate Description	Units of Energy	Units of Demand
Electric	SGS-TOU-10B	kWh	kW
Natural Gas	PSNC RATE 125	Therm	MBH

Energy Units:
1 kBTU = 1,000 BTU
1 kWh = 3.412 kBTU
1 Therm = 100.000 kBTU

Demand Units:
1 MBH = 1,000 BTU/h
1 kW = 3.412 MBH

Energy Model Results, cont'd

Table 1.8.1. Baseline Performance - Performance Rating Method Compliance

End Use	Process	Baseline Design Energy Type	Units of Annual Energy & Peak Demand	Baseline (0 deg rotation)	Baseline (90 deg rotation)	Baseline (180 deg rotation)	Baseline (270 deg rotation)	Baseline Design
Interior Lighting	No	Electric	Energy kWh	49,743	49,743	49,743	49,743	49,743
			Demand kW	19.1	19.1	19.1	19.1	19.1
Space Heating	No	Electric	Energy kWh	127,534	128,260	125,824	127,713	127,333
			Demand kW	222.5	222.3	220.6	222.8	222.1
Space Cooling	No	Electric	Energy kWh	76,943	77,514	75,624	77,670	76,938
			Demand kW	115.8	116.2	113.6	116.1	115.4
Pumps	No	Electric	Energy kWh	0	0	0	0	0
			Demand kW	0.0	0.0	0.0	0.0	0.0
Heat Rejection	No	Electric	Energy kWh	0	0	0	0	0
			Demand kW	0.0	0.0	0.0	0.0	0.0
Fans - Interior	No	Electric	Energy kWh	204,612	204,522	203,190	204,495	204,205
			Demand kW	49.8	49.7	49.3	49.8	49.7
Receptacle Equipment	Yes	Electric	Energy kWh	62,269	62,269	62,269	62,269	62,269
			Demand kW	26.8	26.8	26.8	26.8	26.8
Water Heater	Yes	Electric	Energy kWh	228,588	228,588	228,588	228,588	228,588
			Demand kW	300.0	300.0	300.0	300.0	300.0
Ice Machine	Yes	Electric	Energy kWh	18,421	18,421	18,421	18,421	18,421
			Demand kW	3.9	3.9	3.9	3.9	3.9
Mechanical Room	Yes	Electric	Energy kWh	131,400	131,400	131,400	131,400	131,400
			Demand kW	15.0	15.0	15.0	15.0	15.0
Electrical	Yes	Electric	Energy kWh	1,752	1,752	1,752	1,752	1,752
			Demand kW	0.2	0.2	0.2	0.2	0.2
Controls	Yes	Electric	Energy kWh	1,752	1,752	1,752	1,752	1,752
			Demand kW	0.2	0.2	0.2	0.2	0.2
Baseline Energy Totals	Total Annual Energy Use kBTU			3,081,084	3,085,202	3,065,895	3,083,776	3,078,989
	Annual Process Energy kBTU							1,515,549

Process Cost accounts for 49% of Baseline Performance. Process cost must equal at least 25% of Baseline Performance or the narrative at the end of this form must document why this building's process costs are less than 25%.

Energy Model Results, cont'd

Table 1.8.1(b). Baseline Energy Costs

Energy Type	Baseline Cost (0 deg rotation) ($)	Baseline Cost (90 deg rotation) ($)	Baseline Cost (180 deg rotation) ($)	Baseline Cost (270 deg rotation) ($)	Baseline Building Performance ($)
Electric	90,291	90,254	89,826	90,250	90,155
Natural Gas	0	0	0	0	0
Total Baseline Costs	**90,291**	**90,254**	**89,826**	**90,250**	**90,155**

Table 1.8.2. Performance Rating Table - Performance Rating Method Compliance

End Use	Process	Proposed Design Energy Type	Proposed Design Units	Proposed Building Results	Baseline Building Units	Baseline Building Results	Percent Savings
Interior Lighting	No	Electric	Energy kWh	49,743	Energy kWh	49,743	0 %
			Demand kW	19.1	Demand kW	19.1	0 %
Space Heating	No	Electric	Energy kWh	21,765	Energy kWh	127,333	83 %
			Demand kW	42.7	Demand kW	222.1	81 %
Space Cooling	No	Electric	Energy kWh	79,800	Energy kWh	76,938	-4 %
			Demand kW	53.8	Demand kW	115.4	53 %
Pumps	No	Electric	Energy kWh	19,452	Energy kWh	0	n/a
			Demand kW	3.6	Demand kW	0.0	n/a
Heat Rejection	No	Electric	Energy kWh	0	Energy kWh	0	n/a
			Demand kW	0.0	Demand kW	0.0	n/a
Fans - Interior	No	Electric	Energy kWh	42,779	Energy kWh	204,205	79 %
			Demand kW	18.3	Demand kW	49.7	63 %
Receptacle Equipment	Yes	Electric	Energy kWh	62,269	Energy kWh	62,269	0 %
			Demand kW	26.8	Demand kW	26.8	0 %
Water Heater	Yes	Electric	Energy kWh	86,466	Energy kWh	228,588	62 %
			Demand kW	40.0	Demand kW	300.0	87 %
Ice Machine	Yes	Electric	Energy kWh	18,421	Energy kWh	18,421	0 %
			Demand kW	3.9	Demand kW	3.9	0 %
Mechanical Room	Yes	Electric	Energy kWh	131,400	Energy kWh	131,400	0 %
			Demand kW	15.0	Demand kW	15.0	0 %
Electrical	Yes	Electric	Energy kWh	1,752	Energy kWh	1,752	0 %
			Demand kW	0.2	Demand kW	0.2	0 %
Controls	Yes	Electric	Energy kWh	1,752	Energy kWh	1,752	0 %
			Demand kW	0.2	Demand kW	0.2	0 %
Energy Totals			Total Annual Energy Use kBTU	1,759,226		3,078,989	43 %
			Annual Process Energy kBTU	1,030,629		1,515,549	32 %

Energy Model Results, cont'd

Table 1.8.2(b). Energy Cost and Consumption by Energy Type - Performance Rating Method Compliance

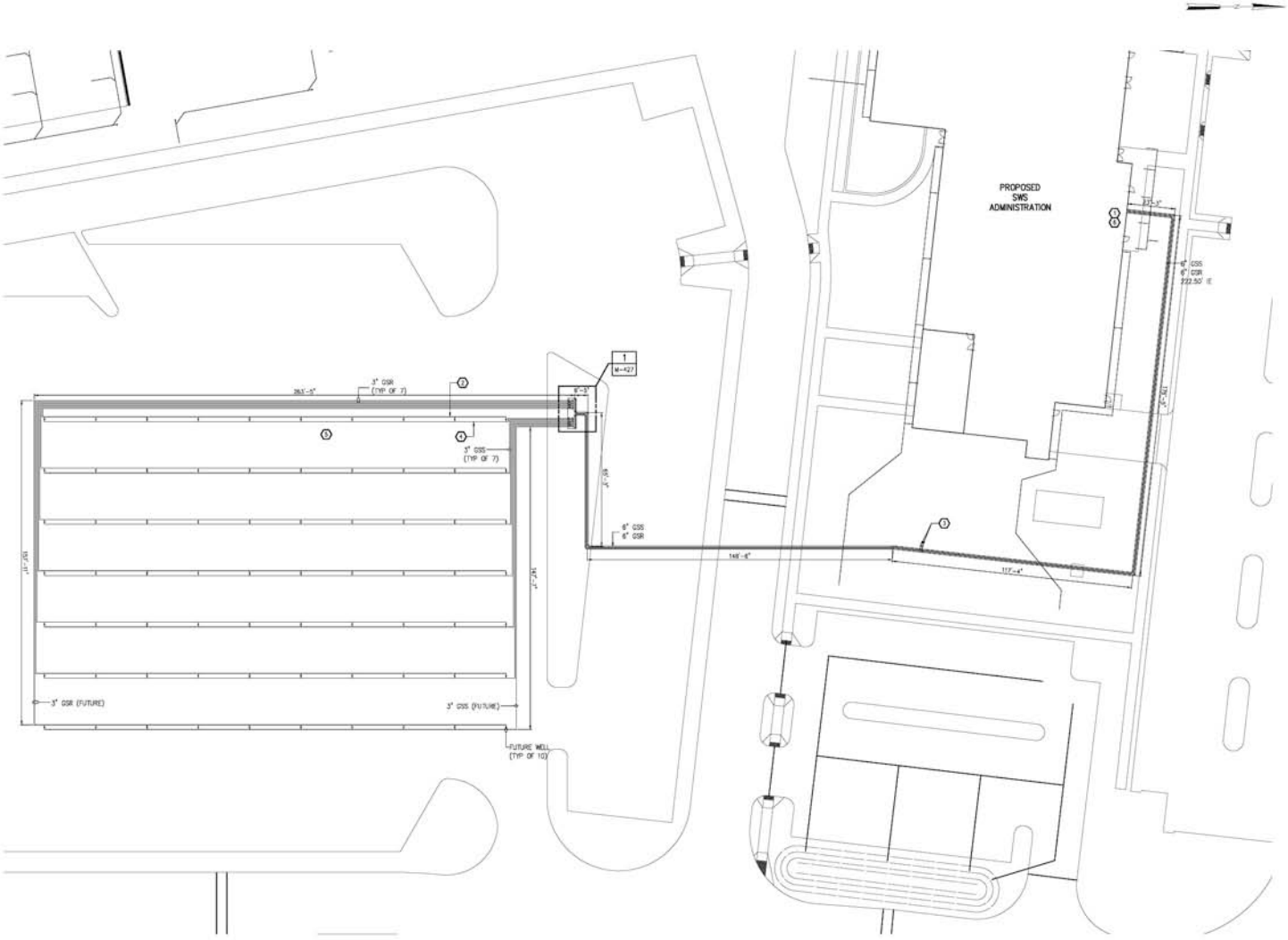
	Proposed Design		Baseline Design		Percent Savings	
Energy Type	**Energy Use**	**Cost ($)**	**Energy Use**	**Cost ($)**	**Energy Use**	**Cost**
Electric	515,600 kWh	38,312	902,400 kWh	90,155	42.9 %	57.5 %
Natural Gas	0 Therm	0	0 Therm	0	n/a	n/a
Subtotal (Model Outputs)	**1,759,226 kBTU**	**38,312**	**3,078,989 kBTU**	**90,155**	**42.9 %**	**57.5 %**
On Site Renewable Energy	**Energy Generated**	**Renewable Energy Cost**				
Exceptional Calculations	**Energy Savings**	**Cost Savings**				
	Proposed Design	**Proposed Design**	**Baseline Design**	**Baseline Design**	**Percent Savings**	**Percent Savings**
	Energy Use	**Cost ($)**	**Energy Use**	**Cost ($)**	**Energy**	**Cost**
Total:	kBTU		kBTU		%	%

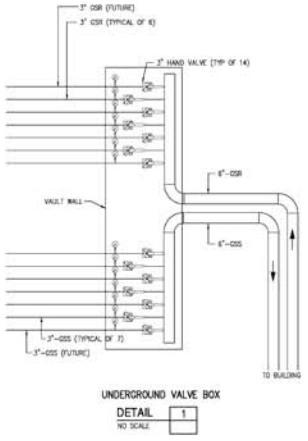
Note: In Table 1.8.2(b), On-Site Renewable, Exceptional Calculation and amended total results at bottom of table are to be filled in manually if these separate calculations were performed.

LEED NC 2.2 EA Credit 1 Points Reference Table

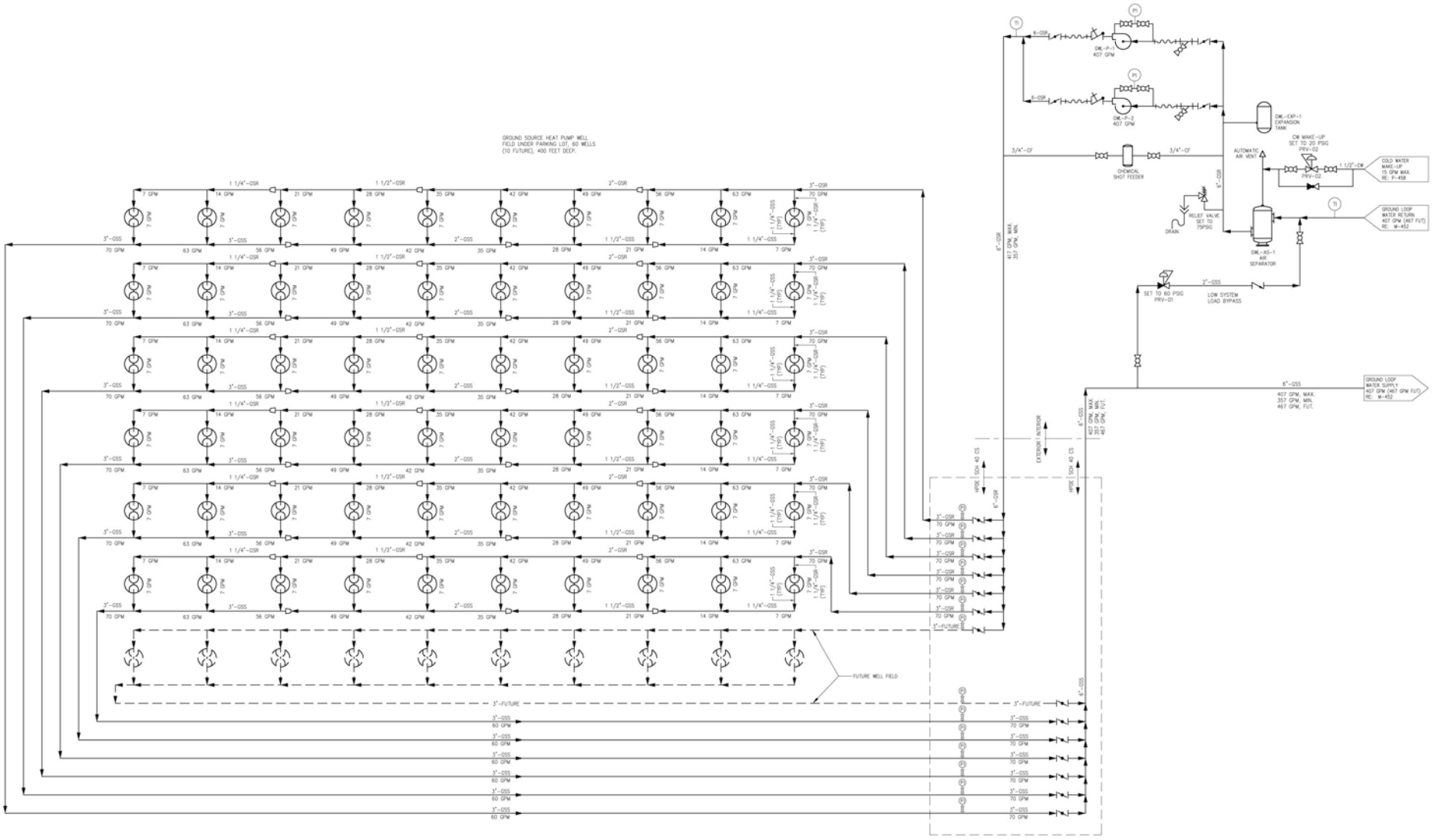
New Construction % Cost Savings	Existing Building Renovations % Cost Savings	LEED NC 2.2 Points Awarded
10.5 %	3.5 %	1 pt
14.0 %	7.0 %	2 pts
17.5 %	10.5 %	3 pts
21.0 %	14.0 %	4 pts
24.5 %	17.5 %	5 pts
28.0 %	21.0 %	6 pts
31.5 %	24.5 %	7 pts
35.0 %	28.0 %	8 pts
38.5 %	31.5 %	9 pts
42.0 %	35.0 %	**10 pts**

Ground Loop System Well Layout





Ground Loop System P&ID



Geothermal System Hot Water Storage Tank P&ID

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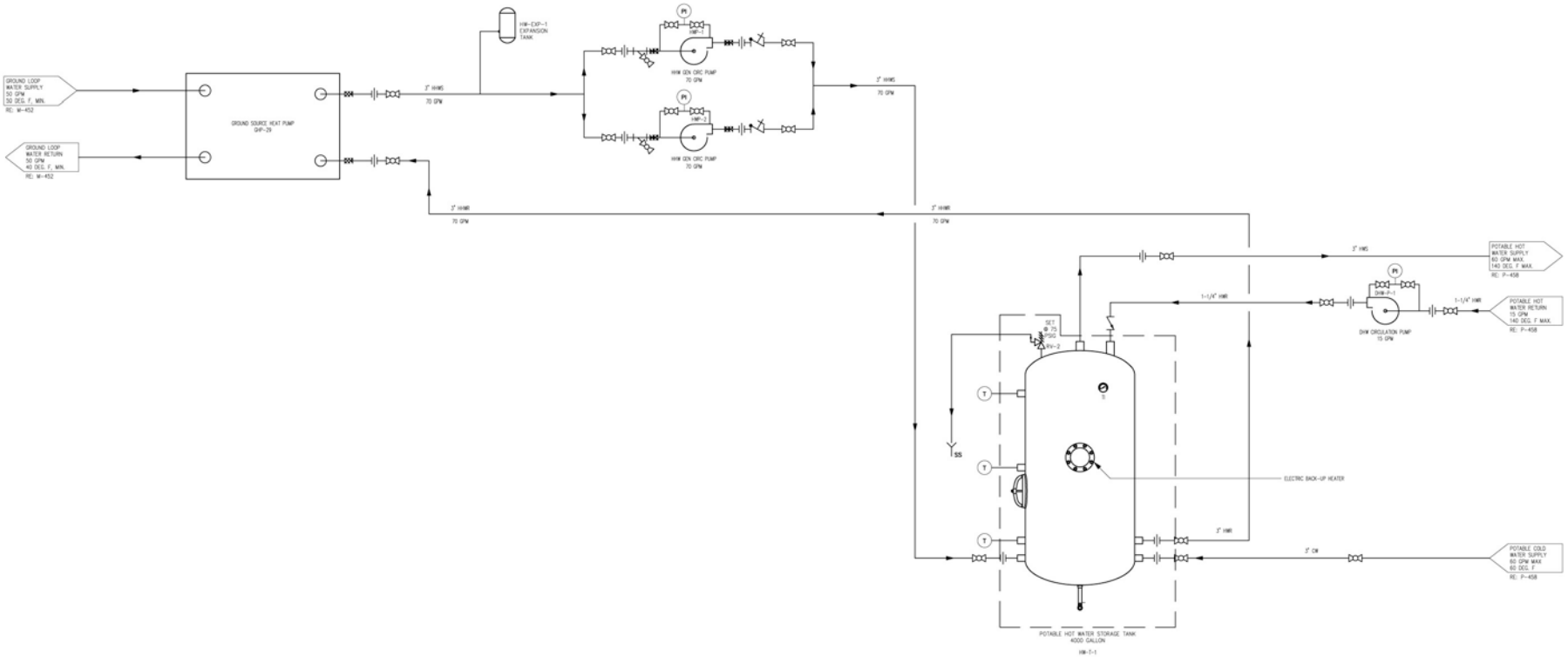
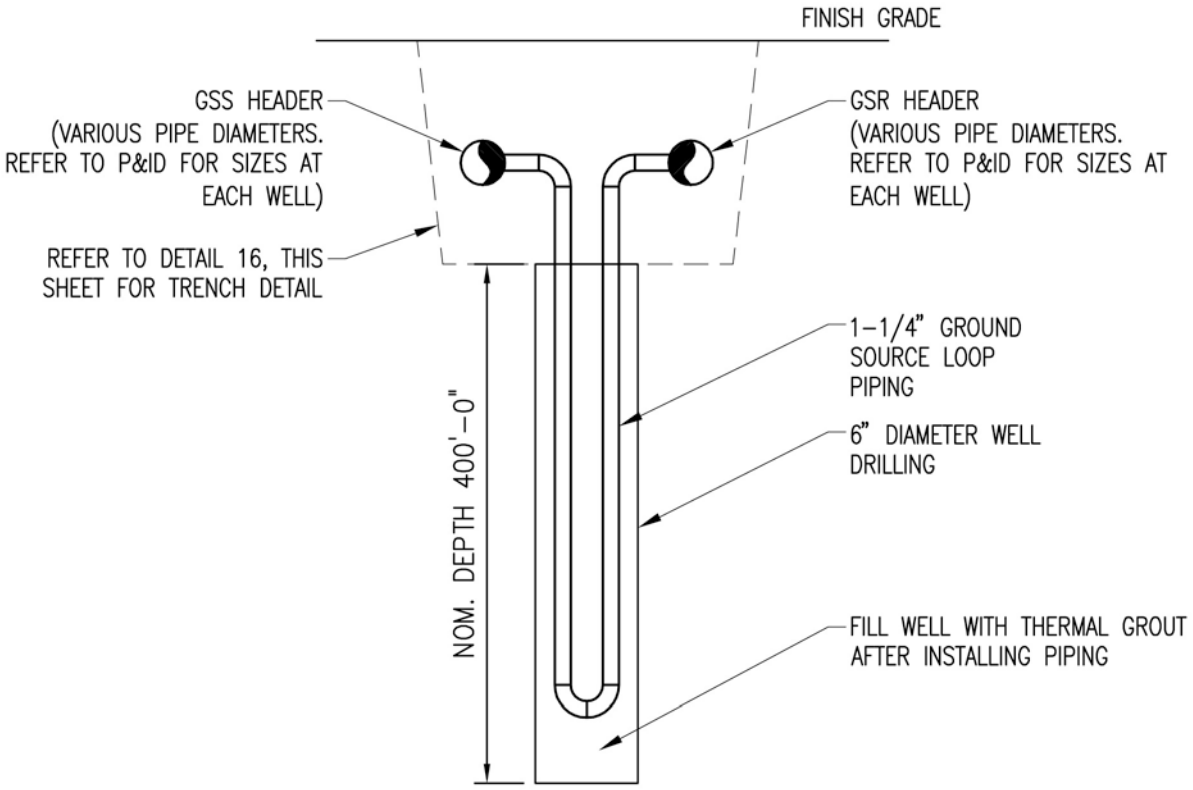


Typical Ground Loop Well Detail



TYPICAL WELL DETAIL