

Introduction to Geothermal Systems

05 June 2018

**Information compiled and presented by
Franklin H. Holcomb**

Information Sources

U.S. Department of Energy

https://www.youtube.com/watch?v=y_ZGBhy48YI

Geothermal Alliance of Illinois (GAOI)

www.gaoi.org/

<https://www.gaoi.org/wp-content/uploads/2013/11/Introduction-to-Geothermal-Comfort-Systems-Dave-Buss-GAOI-Northern-Meeting-10-30-13.pptx>

Professor Scott Willenbrock (UIUC)

<https://physics.illinois.edu/outreach/zero-net-energy-house/geothermal>

U.S. Department of Defense

<https://www.serdp-estcp.org/News-and-Events/Blog/Coupling-Geothermal-Heat-Pumps-with-Underground-Thermal-Energy-Storage-EW-201135>



Introduction to Geothermal Comfort Systems

Heat Pumps

- Heat pumps “move” energy from one location to another, instead of creating heat by burning fossil fuels, such as a gas furnace does. -- (like your refrigerator).
- Geothermal Heat Pumps use the earth or well water to provide heating, cooling and hot water for your home.
- A geothermal heat pump “moves” energy to/from the ground, eliminating the outdoor equipment associated with ordinary heat pumps or air conditioners.



The Basic Ground Source Heat Pump System

- The earth loop is placed in the ground either horizontally or vertically, or it can be placed in a pond.
- Water and anti-freeze is circulated through the pipe, transporting heat to the heat pump during the heating mode and away from the heat pump during the cooling mode.
- The heat transfer takes place inside the heat pump in a water-to-refrigerant heat exchanger.

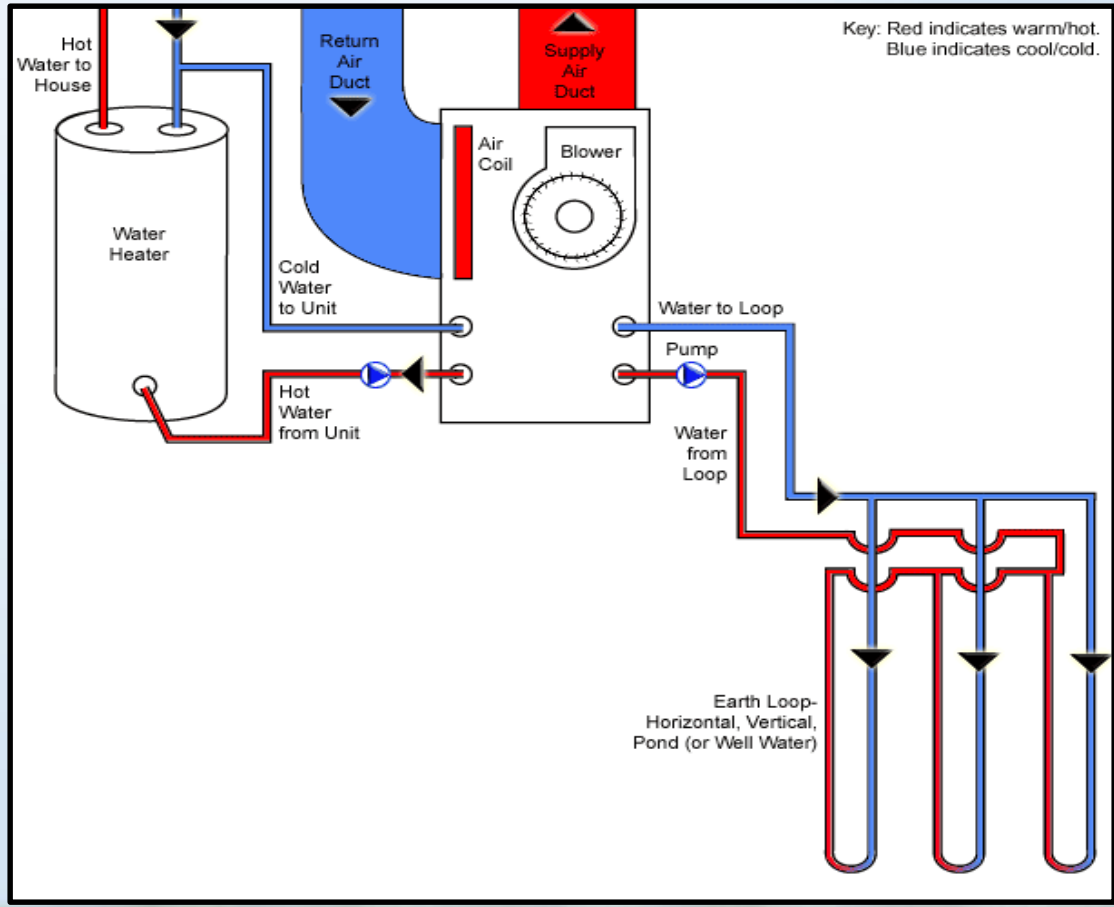


Energy Source

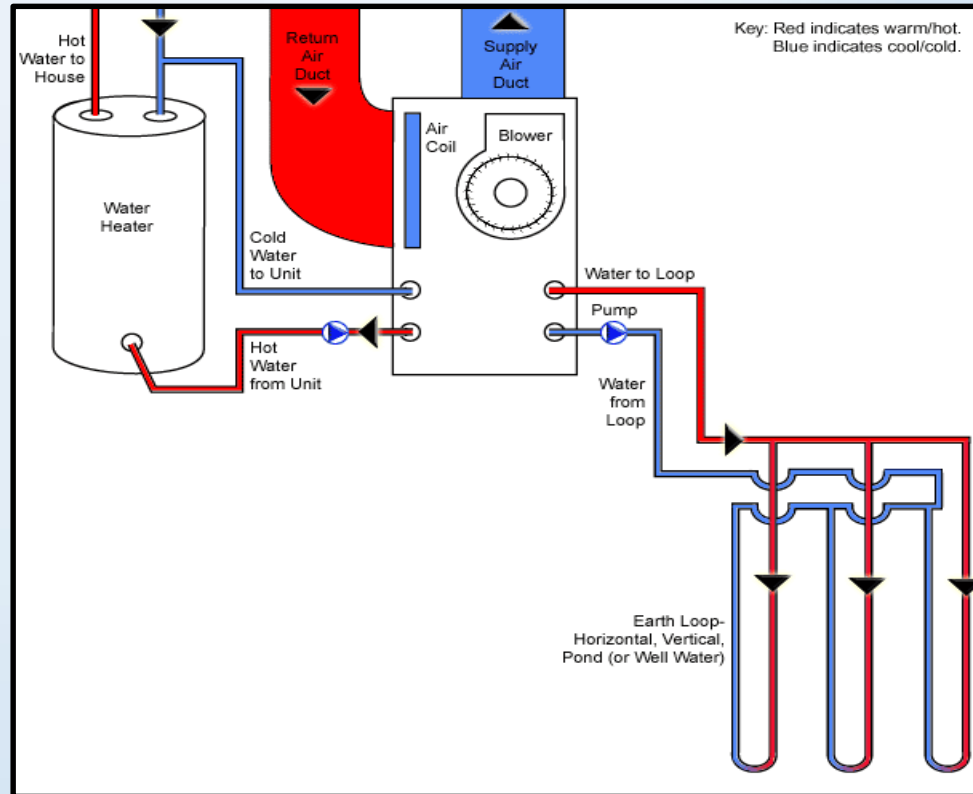
- During the heating season, the earth serves as a heat source. (HE - Heat of extraction)
- During the cooling season, the earth serves as a heat sink. (HR - Heat of rejection)



Heating Mode Operation

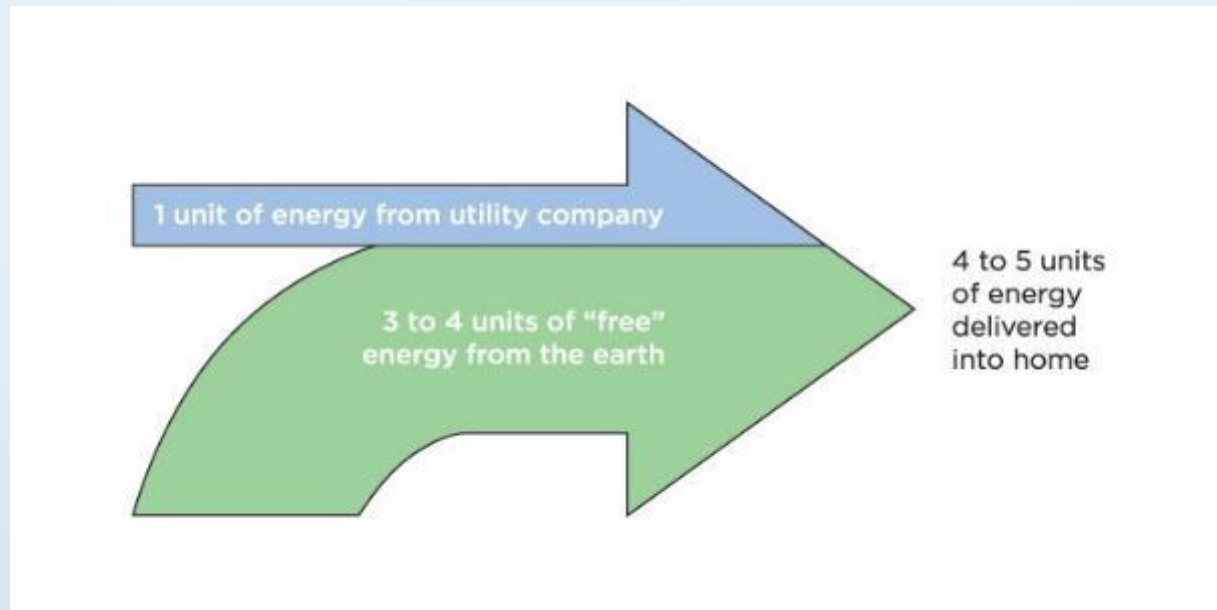


Cooling Mode Operation



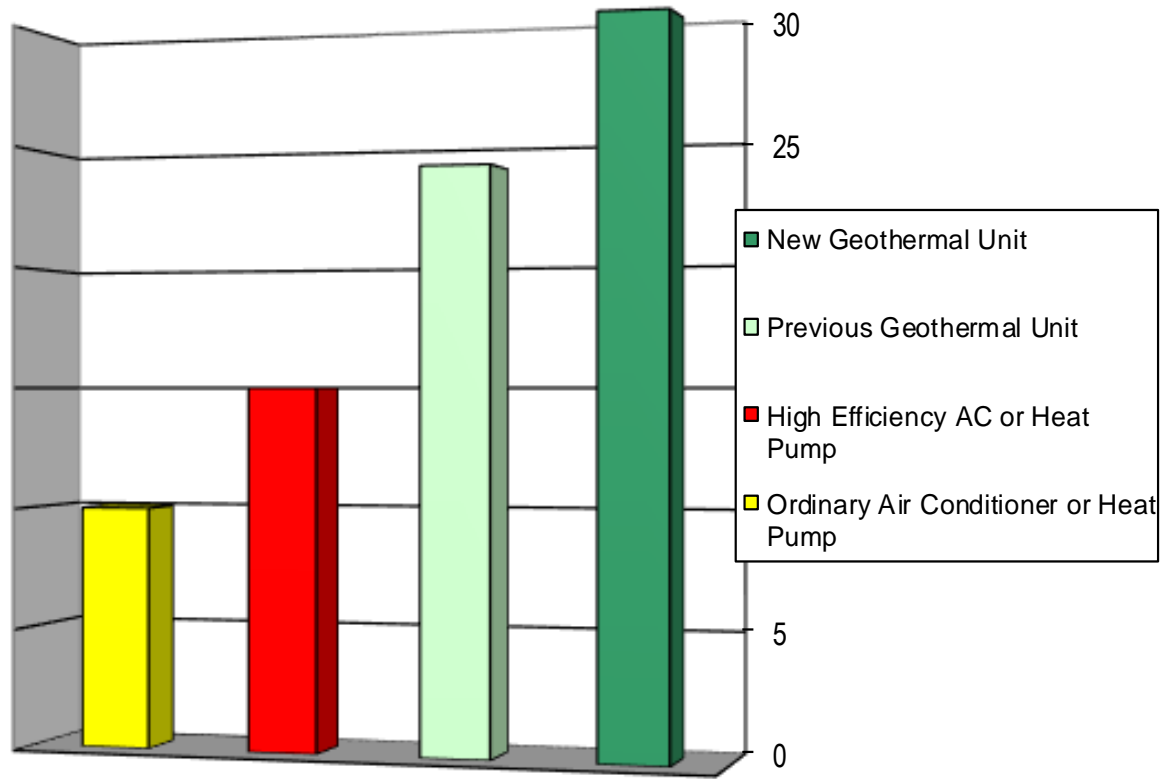
Free Energy

- Geothermal Heat Pumps use only a small amount of energy to capture a large amount of FREE energy from the earth.



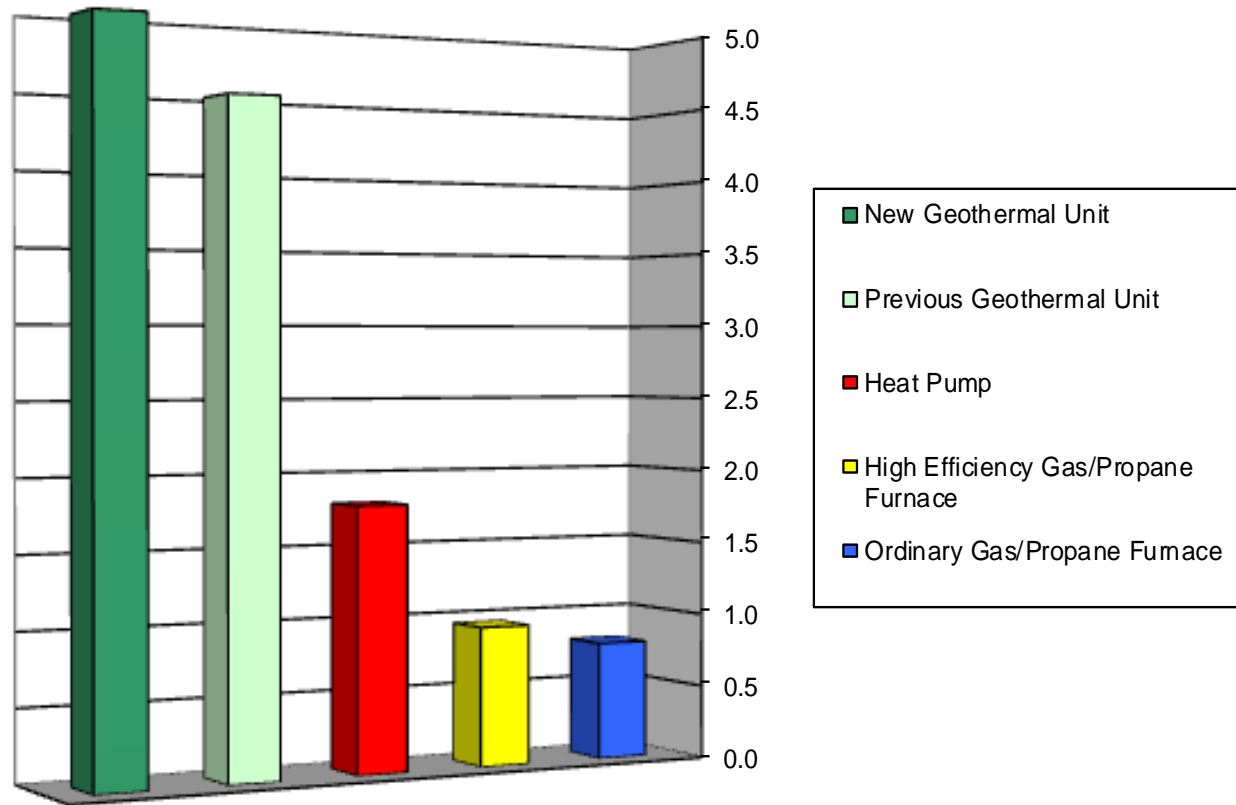
Geothermal Performance Comparison

Cooling Efficiency (EER)



Geothermal Performance Comparison

Heating Efficiency (COP)



Operating Cost Comparison

- Annual Heating, Cooling & Hot Water costs for typical 2,500 sq. ft. home, local weather, local fuel rates (computer analysis results)
 - Geothermal \$ 780
 - High Efficiency Nat. Gas & A.C. \$ 1,497
 - Air Source Heat Pump \$ 1,608
 - High Efficiency Propane & A.C \$ 2,305



30% Tax Credit*

The Bipartisan Budget Act of 2018, signed in February 2018, reinstated the tax credit for fuel cells, small wind, and geothermal heat pumps. The tax credit for all technologies now features a gradual step down in the credit value.

Geothermal heat pumps

- 30% for systems placed in service by 12/31/2019
- 26% for systems placed in service after 12/31/2019 and before 01/01/2021
- 22% for systems placed in service after 12/31/2020 and before 01/01/2022
- There is no maximum credit for systems placed in service after 2008.
- Systems must be placed in service on or after January 1, 2008, and on or before December 31, 2021
- The geothermal heat pump must meet federal Energy Star criteria
- The home served by the system does not have to be the taxpayer's principal residence

*Source: <http://programs.dsireusa.org/system/program/detail/1235>

Return on Investment (Due to Energy Savings)

- New Homes: Typically positive cash flow from “day one”.
 - Added cost in mortgage is offset by reduced monthly operating cost.
- Existing Homes: Additional cost of geothermal system is usually recovered in about 5 years.




Environmental Aspects

- Geothermal generally more efficient, but may use more electricity
- Carbon offsets dependent upon application and regional “mix” of generation¹
- Geothermal may increase emissions in some cases

AVERAGE AMOUNT OF EMISSIONS and AMOUNTS OF NUCLEAR WASTE per 1000 kilowatt-hours (kWhs) PRODUCED from KNOWN sources for the 12 months ending June 30, 2017	
Carbon Dioxide	1,374 lbs
Nitrogen Oxides	0.73 lbs
Sulfur Dioxide	1.51 lbs
High-Level Nuclear Waste	0.0009 lbs
Low-Level Nuclear Waste	0.0002 ft ³

The disclosure of this information is required under Section 16-127 of the Electric Service Customer Choice and Rate Relief Law of 1997 and the rules of the Illinois Commerce Commission, 83 Ill. Adm. Code 421.


ELECTRICITY
SOURCES
AND
EMISSIONS
FOR 12 MONTHS ENDING
JUNE 30, 2017

¹e.g. Frank’s 90% furnace and natural gas use ~ 15,400 lbs CO₂/year, and total household electric use ~ 13,500 lbs CO₂ /year

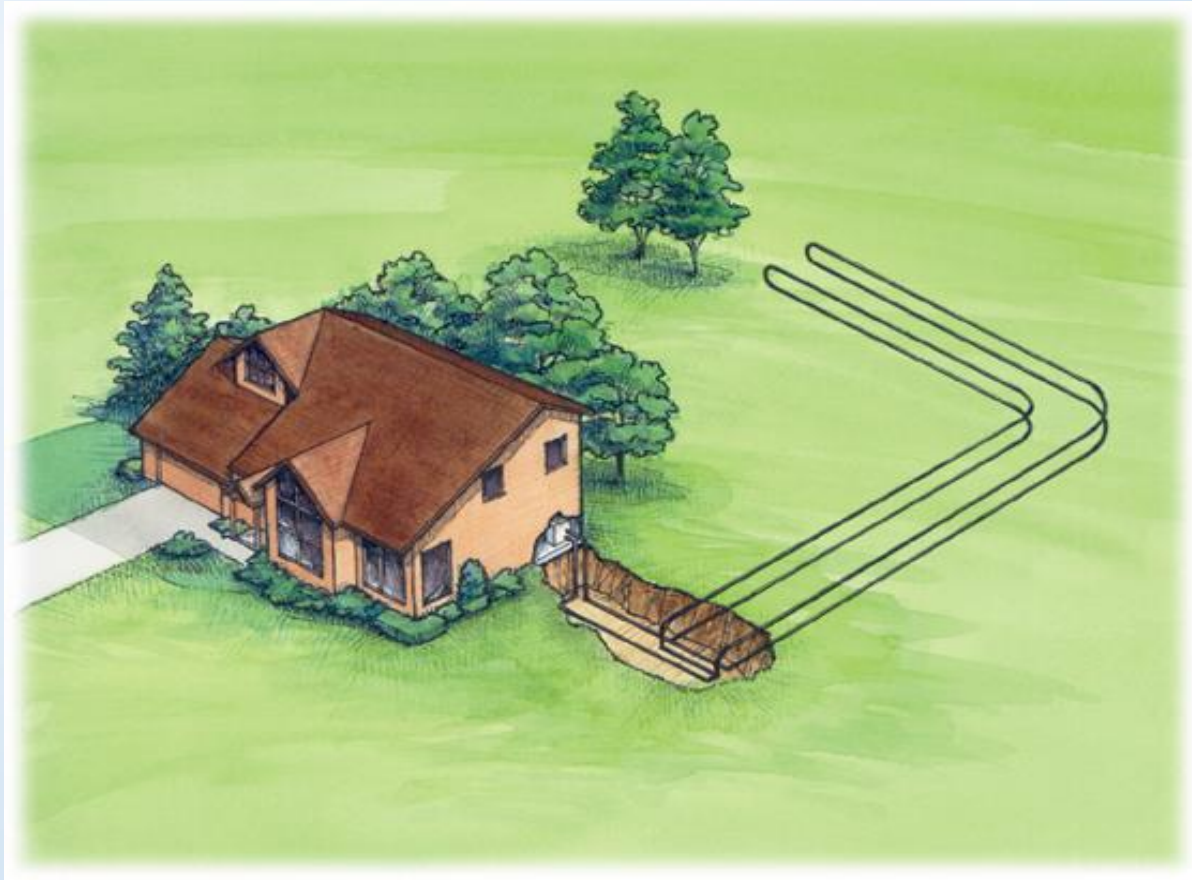
Need to do the calculations to determine if geothermal will decrease or increase CO₂ emissions

Loop Types

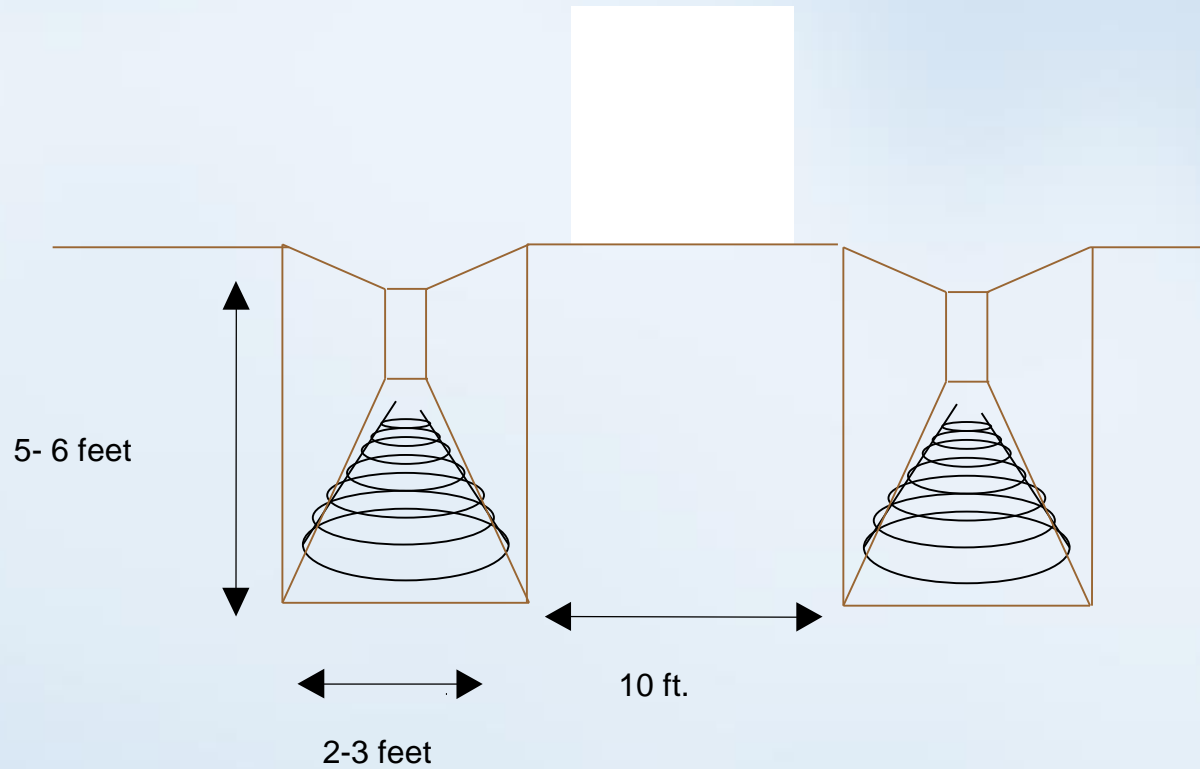
- Closed Loop (w/ antifreeze)
 - Horizontal
 - Vertical
 - Pond
- Open Loop
 - Well Water



Horizontal Loop



Slinky



Typically 3 or 4 trenches, 100-150 feet long each

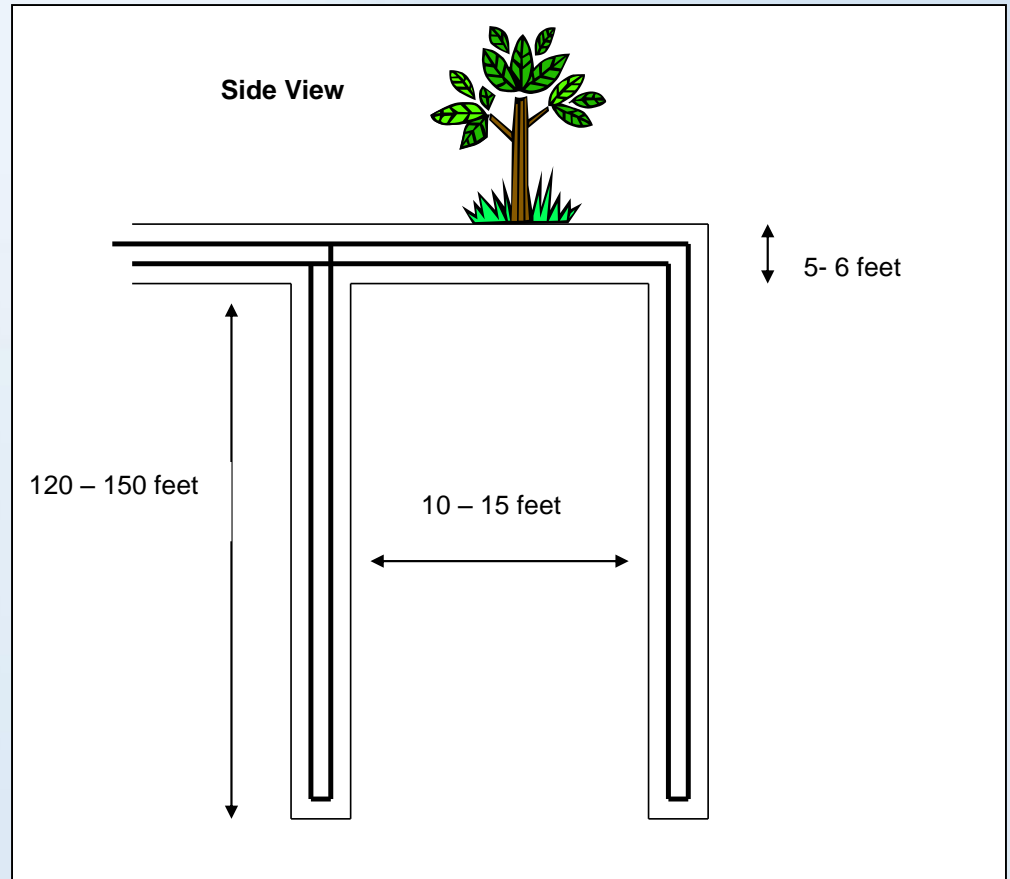


Horizontal Slinky Loops



Vertical Loop

Typically 3 to 5 bore holes, 130 feet deep each

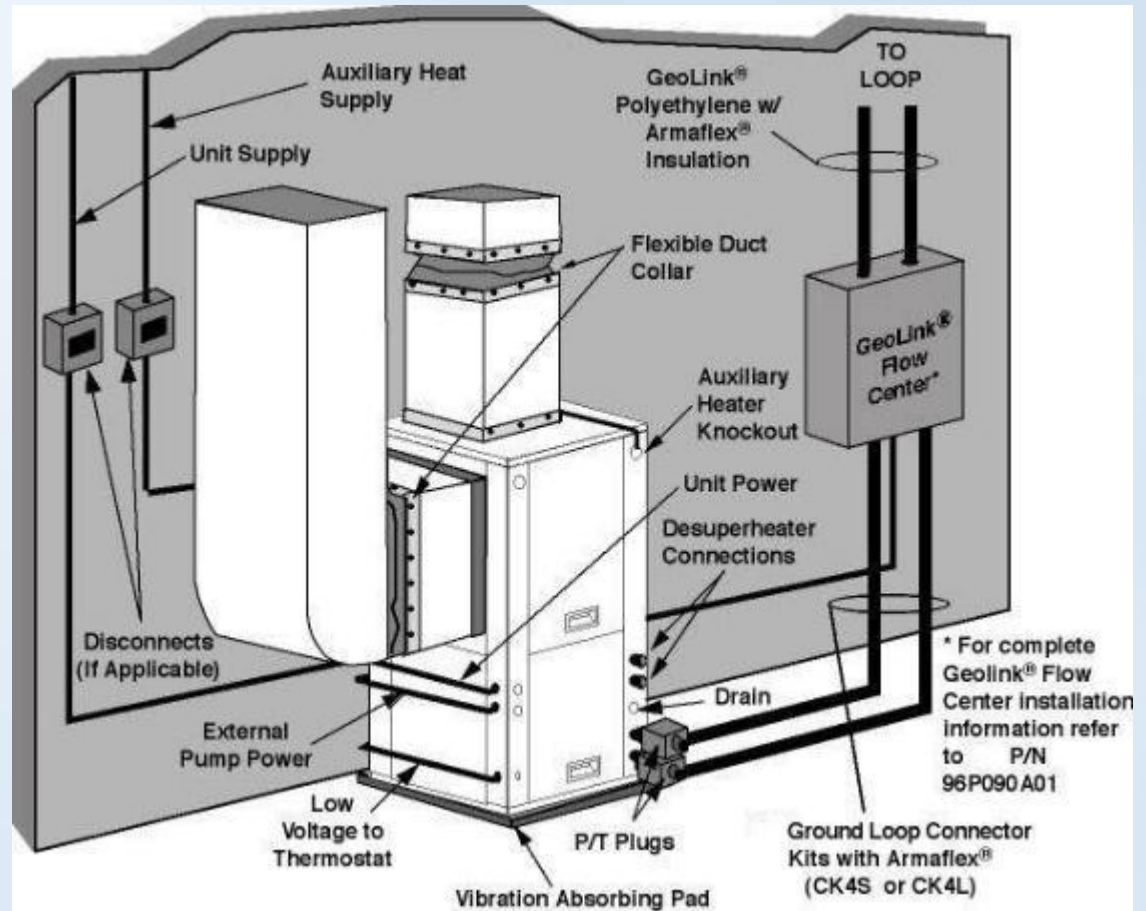


Vertical Loop Drilling

Use drilling rig like ones used for water well drilling.



Typical Closed Loop Equipment and Accessories



Typical Installation



Questions?

