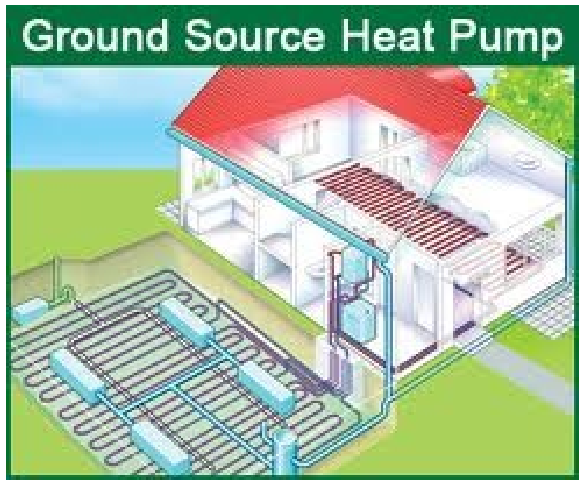
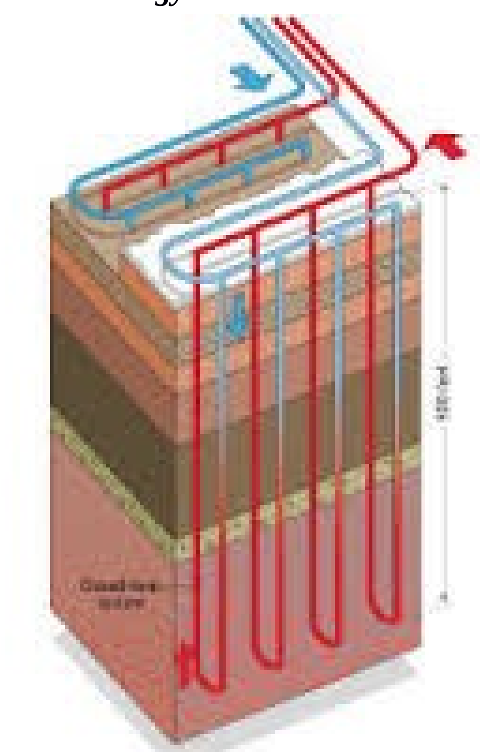
CHAPTER 2. Implementation of *Ground Source Thermal Technology*

Acknowledgement to DOE, Regional & State Agencies for some of data and concepts herein

Unfortunately Ground Source Thermal Technology is imprecisely and inappropriately sometimes called “Geothermal Heat Pump”. This is incorrect because by both definition and general usage <u>geothermal</u> means active energy from the earth. A proper analysis of GSTT technology shows that it uses the inactive stable near-surface temperature as a source or sink. The image to the right which probably originated from DOE sources, uses the term “Ground Source”, to describe a source/sink in a geo-inactive region. Thus a fitting and valid term could be “Ground Source”. Thus throughout this & related presentations, the term **GSTT** will be used to mean “***Ground Source Thermal Technology***.





GSTT uses the sub-surface ground temperature of the earth as the source/sink, i.e., “Ground Source”, for heating and\or cooling of above surface structures. As demonstrated in other parts of this presentation, the subsurface (< ~100 feet) temperature in geo-inactive regions remain constant throughout the year and have a small seasonal variation at depths as shallow as ~10 feet. Depending on the latitude, the variation at this depth is about 45°F to 75°F.

An analogy to the above is a cave. The cave temperature is warmer than the surface air during winter and cooler than the surface air in the summer Because of the mass of its walls, it is thus usable as a heat source for heating firing the winter and as a heat sink for cooling during the summer.

How *Ground Source Thermal Technology* Accomplishes the Above for Heating/Cooling of Target Surface Structure(s) hereafter referred to as simply "Structure"

Pumps move fluid from the "Ground Source" to the Structure being heated and/or cooled thus transferring thermal energy between the two. When the temperature of the structure is sufficiently lower than the "Ground Source", the fluid is pumped from the "ground Source" to the Structure as shown in the Winter Heating (right side of) picture below. In the summertime the flow is reversed as shown in the left picture.

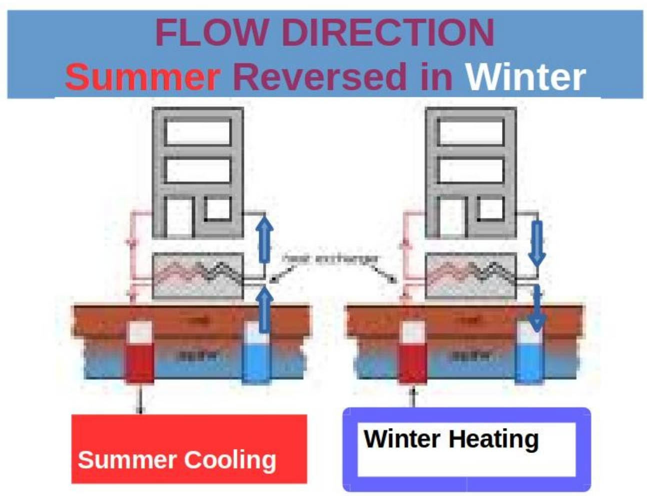


Figure 4. Multiple “slinky” pipe system.

Note the trencher in the background.

Figure 5. Single “slinky” pipe system

GSTT systems are able to heat, cool, and, if so equipped, supply homes and buildings with hot water. A GSTT system consists of a system of pipes buried in the “Ground Source” (Figs 4 & 5), a pumpl, for delivering fluid from the “Ground Source” to the above ground structure, an entry (Fig 6) into the structure

Figure 6. “Ground Source” fluid entry into Structure

and an air delivery system for exchanging the delivered fluid thermal content with the structure. Generally this is a Carrier Corporation system which is discussed below after description of the basic system types.

To access the "Ground Source", it is necessary to dig trenches as show in Figs 4 & 5, or drill holes. Clearly a location specific cost.

As shown in Figure 7, economy can be achieved by directional trenching or drilling. in this case horizontally. Directional drilling is effective when used vertically.

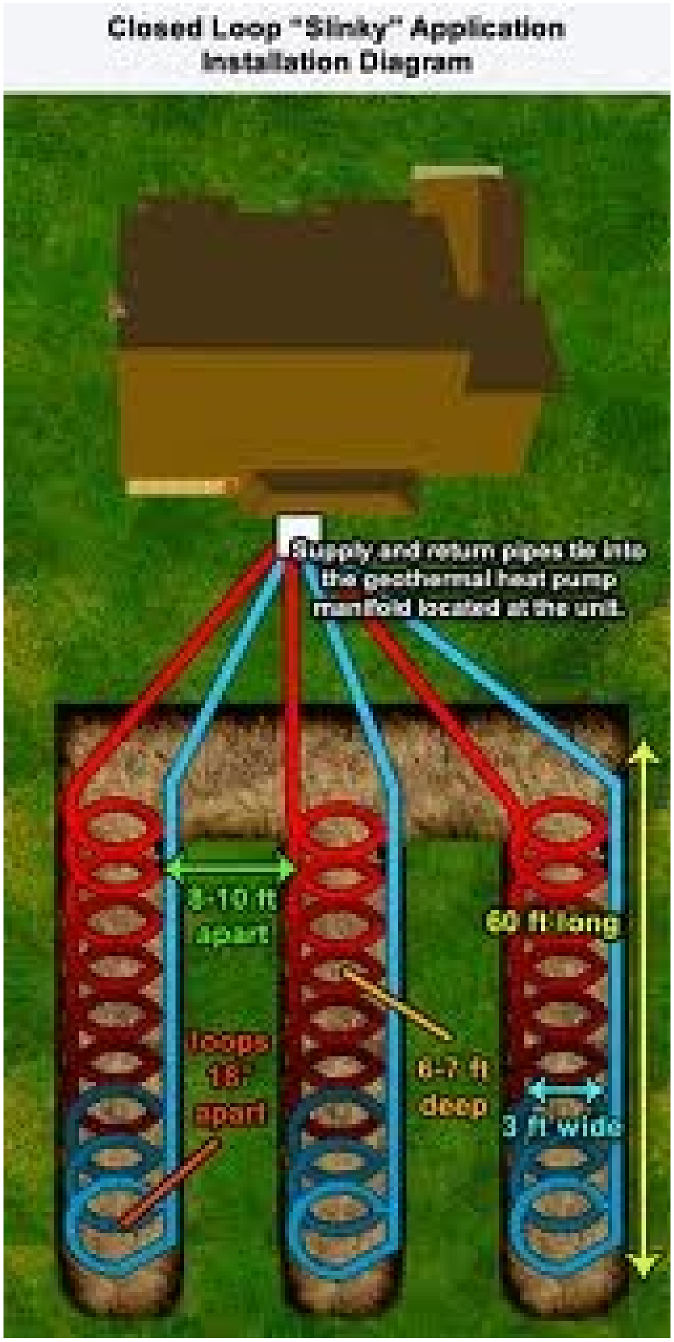


Figure 7. Directional trenching. Details of a typical "slinky" installation, showing dimensions .

Putting the above “Ground Source” system together with a Structure will give an exterior system that might look like that shown in Fig. 8. for a Vertical Closed Loop System (see System Types Below).

In the summer, the process is reversed, and the "Ground Source" pump moves heat from the indoor air into the heat exchanger. The heat removed from the indoor air during the summer can also be used to provide a free source of hot water.

Figure 8. “Ground Source” system showing entry to Structure for a vertical closed loop systems .

TYPES OF GSTT "*Ground Source Thermal Technology*" PUMP SYSTEMS

There are four general types of GSTT heat pump systems, Fig. 9. Three of these:
1) horizontal, 2) vertical, and 3) pond/lake, are closed-loop systems. The fourth type is open-loop. Of course there are many combinations of these, as well as others which are not mentioned, but can be invented for the particular location. As an example of an inventive and site specific application, see "Appendix; A Final Note "at the end of this document. As mentioned above, this applies to any structure on the surface. Which system is best depends on the climatic conditions above the surface, local sub-surface temperature, geology, soil conditions, available land, local installation costs at a particular site, and any unique features of the specific structure and its immediate local.

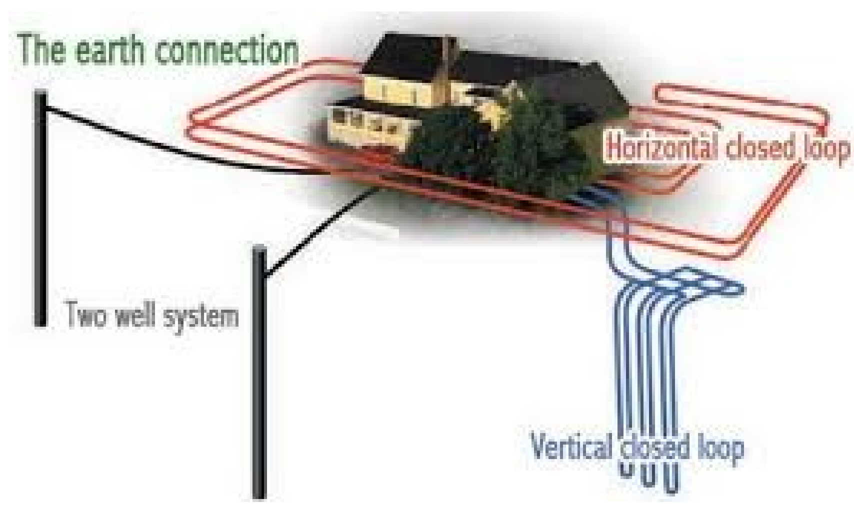
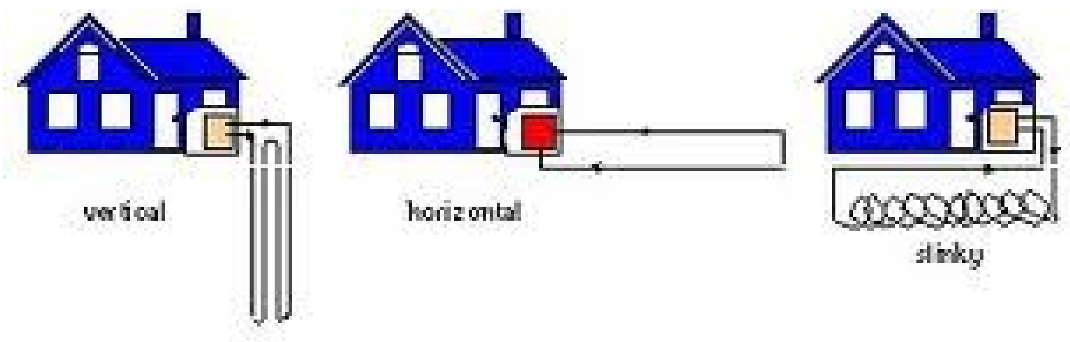


Figure 9. Open, closed- vertical & horizontal "Ground Source" loop systems

CLOSED-LOOP **SYSTEMS**

Small Structure Horizontal and Vertical Closed-Loop Systems

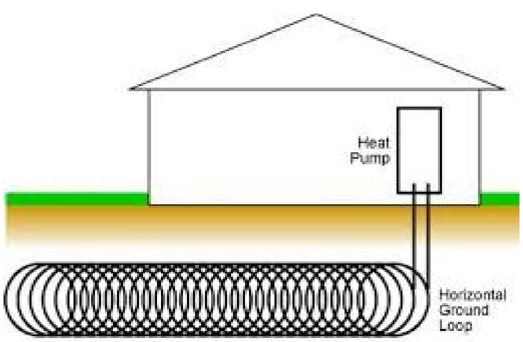


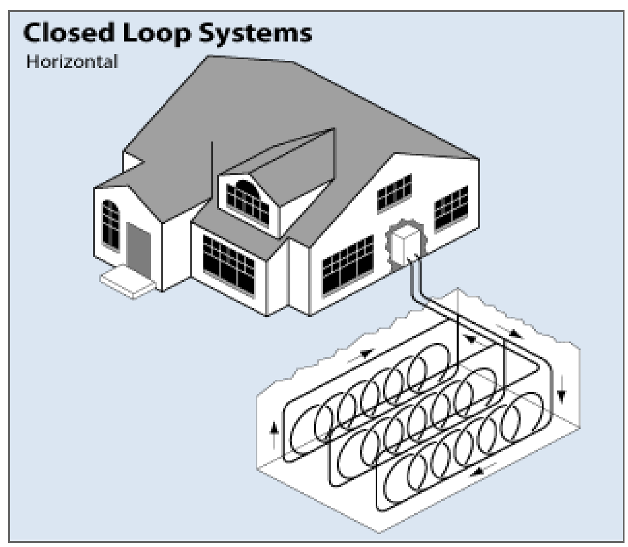
Type 1 HORIZONTAL Closed-loop System

This type of GSTT system is generally most cost-effective for residential or other small structure installations, particularly for new construction where sufficient land is available. Common layouts use buried pipes below surface at a depth, x+ feet, depending on the local geology and climate a) two pipes, one buried at 6+ feet and the other at 4+ feet, or b) two pipes placed side-by-side at 5+ feet in the ground in a 2-foot-wide trench. The number and length of pipe will vary with the HDD and CDD and the size of the structure.

The Slinky method of looping pipe allows more pipe in a shorter trench, which may be economically advantageous for certain applications. This is because it may get more transfer area in the "Ground Source" than other methods.

Figure 11. a) (left) Small structure b) (right) larger structure and more loops.

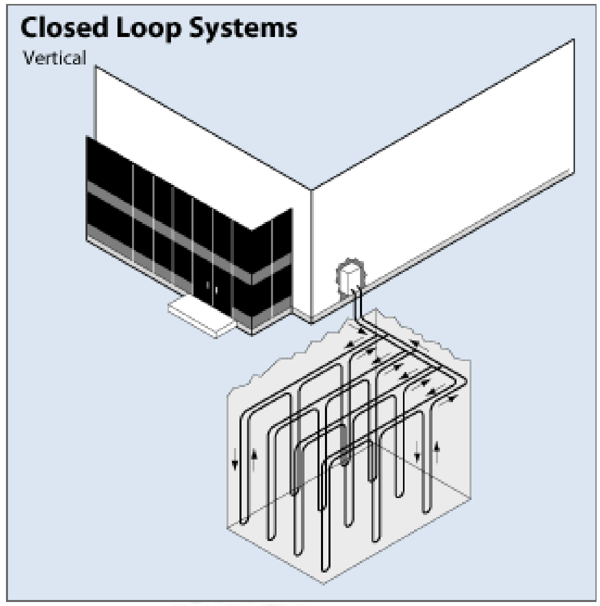




Type 2 VERTICAL Closed-loop System

Large commercial and public buildings, as well as small local district heating systems often use vertical systems, Fig. 12, because it is more economic than for horizontal systems. Vertical loops are also used where the soil is too shallow for trenching, and they minimize the disturbance to existing landscaping. See Figure 8 for a large small structure such as a large residence.

For a vertical system, holes (approximately 4 inches in diameter) are drilled about 20 feet apart and 100 to 400 feet deep. Into these holes go two pipes that are connected at the bottom with a U-bend to form a loop. The vertical loops are connected with horizontal pipe (i.e., manifold), placed in trenches, and connected to the Thermal in the building.



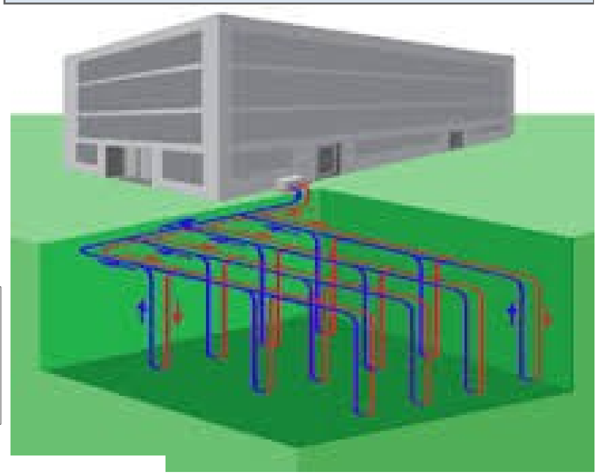


Figure 12. c (below) Vertical closed-loop "Ground Source" system for a small district heating/cooling system.

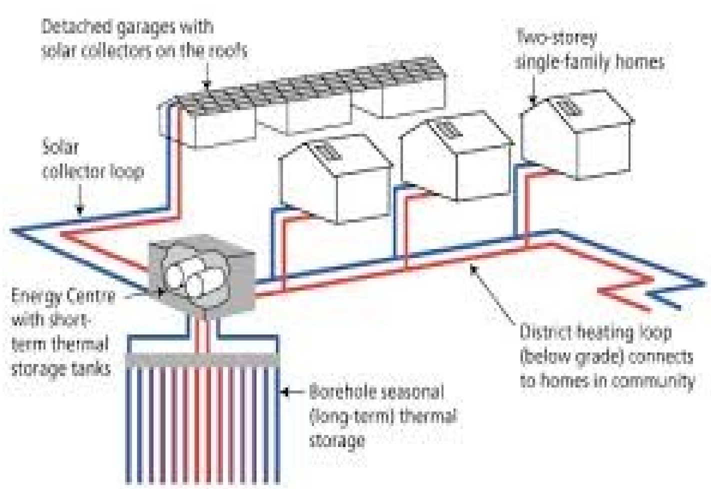


Figure 12. a & b Vertical closed-loop "Ground Source" system for larger structures.

Type 3 PONDS or LAKES, Closed-loop Systems

Note: ponds, lakes, rivers and similar water-sources can be used advantageously as open-loop or closed-loop systems.

If a site has an adequate body of water, a water-source GSTT system may be the lowest-cost option. A supply line pipe is run underground from the building to the water and coiled into circles or other suitable form for the location. For example a flowing river, often available, would require a simpler heat exchange piping arrangement. If there is danger of freezing, the piping should be at a sufficient depth and as necessary otherwise protected. The coils should be placed in a water source that meets minimum volume, depth, and quality criteria.

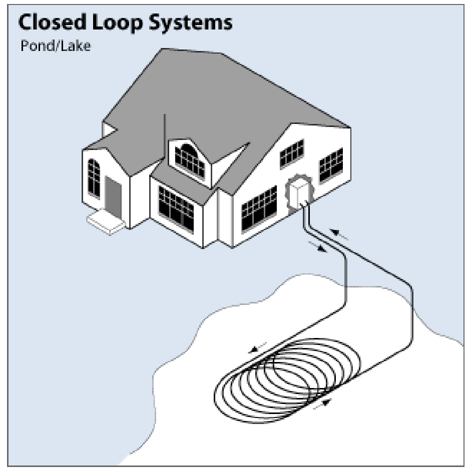
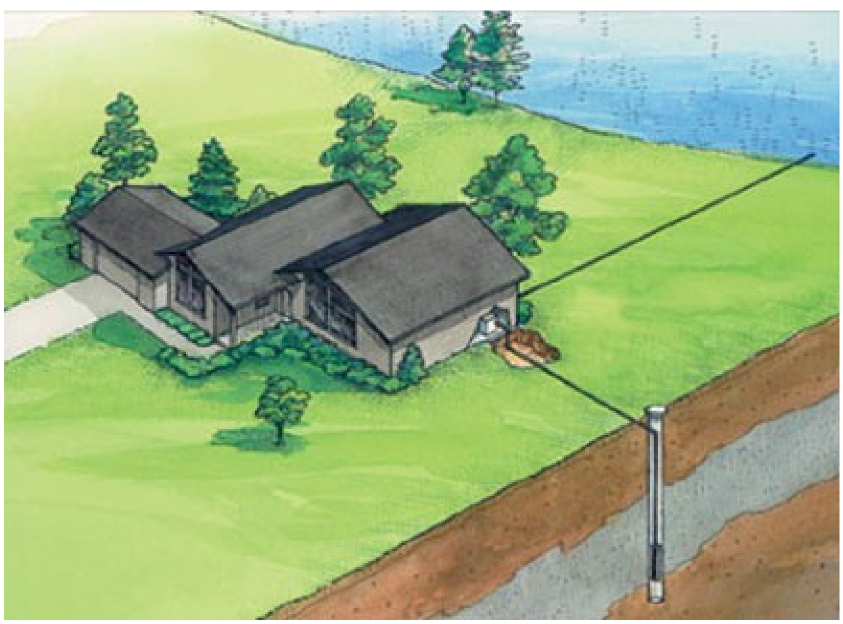


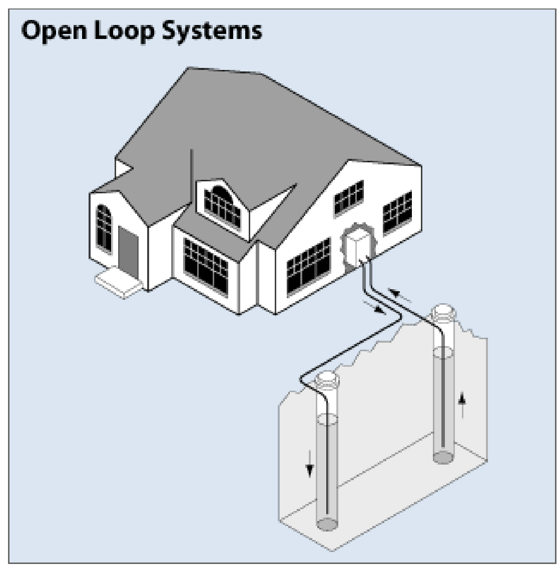
Figure 13. Closed-loop surface water "Ground Source" systems: a(above) pond or small lake, & b (below) a large lake or river



Type 4. OPEN LOOP Systems

This type of system uses well or surface body water as the heat exchange fluid that circulates directly through the Thermal system. Once it has circulated through the system, the water returns to the ground through the well, a recharge well, or surface discharge. This option is practical only where there is an adequate supply of relatively clean water and all local codes and regulations regarding groundwater discharge can be met.

Figure 14. Open loop "Ground Source" systems: a(right) using local wells; b) using large lake or river as in Fig. 13b



Carrier Corporation System Components for
Ground Source Thermal Technology

Carrier Corporation provides system components and specifications for their equipment to be used for Ground Source Thermal Technology, particularly to the "structure" interior liquid and air handling system.

In the winter, the Carrier recirculating unit (Fig C1) takes in the cooler building air, heats it, and then pumps the heated air into the building. In the summertime, it cools the inlet air, discharging cooled air to the building.

Figure C1. Air recirculating unit

Figure C2. Resource to building heat exchange unit.

Figure C3. Air circulating unit.

Appendix: A FINAL NOTE

Economics are a function of Geographic Location, Local climatic conditions, distance from a geothermal source, if any in vicinity, geology of the crustal surface down to about 200 feet, and particularly dependent on the structure, the unique characteristics of the structure, and the unique local conditions.

See the Fig A-1, an inventive application exemplifying consideration of these factors.

Figure A-1. An inventive unique site specific application.