Checklist of Requirements
Designing Closed Loop Ground Heat Exchangers for Commercial GSHP Systems

The worst enemy against GSHP installations is the use of rule-of-thumb assumptions. As the size and scope of a project increases, the more this is true. For example, a 100 ton peak cooling load for a church and office building, located next to one another and using the same exact mechanical equipment with the same geology and climate, could have vastly different loop sizes. The church could for example end up with a ground loop with 50' of borehole per peak equipment ton, and the office building could require 300'+ of borehole per peak ton. It boils down to determining how long does the peak ton run. The bottom line is that rule-of-thumb assumptions have no place for finalizing GSHP system parameters, in particular closed loop ground heat exchangers.

To make your GSHP system a success, and help your client realize the least installation, operating and maintenance costs with the greatest reliability, there is no substitute for complete system evaluation (which should be done for a conventional mechanical system as well).

A brief summary checklist for designing a commercial GSHP system includes the following:

1. Site Plan
    a. Properly scaled with scale bar, not just numeric scale description
    b. Geographic location
    c. Includes building footprint with mechanical room location
2. Plans
    a. Compass orientation of building
    b. Elevations of whole building and individual rooms
    c. Sufficiently detailed to include insulation, window, lighting and other schedules affecting the cooling and heating loads
    d. Conditioned space by GSHP system in square feet – for reality check
3. Annual Energy Loads & Peak Loads
4. Complete GSHP Mechanical Schedule
5. Thermal Conductivity Test – Parameters for testing are determined by the design team **AFTER** the loop is pre-designed based on items 1. and 2.

Once these variables are known, the final closed loop parameters can be determined. Items 1. through 4. add no more stress or cost to a project than those required for a life cycle and operating cost estimate for any commercial building.

Site Plan

A scaled site plan with geographic location including the building footprint is necessary for the design team to account for available area to install the ground loop, reference local geology and determine the best field configuration that meets the needs of the project. With some projects it might be determined that a horizontal loop is viable, while with others the loop configuration may be limited to only a vertical (drilled) system due to space constraints. The building footprint must note the location(s) where the header piping connecting the ground loop to the mechanical room may be sited. The site plan should also note those areas where a ground loop can be installed, and just as importantly, where it cannot go.

Annual Energy Loads & Peak Loads

The building loads are interpreted from the building plans, scheduling and occupancy of the building. In addition to the peak loads necessary for equipment sizing, annual energy loads must be determined for any project where the loads are not purely climate driven. This allows us to model the actual durations and heating/cooling needs against the geology. Common software tools for determining these loads include Trane's Trace 700, Carrier's HAP, etc. We need a load profile that can be summarized as follows:

Example load profile	TOTAL COOLING mbtu	PEAK COOLING mbtuh	TOTAL HEATING mbtu	PEAK HEATING mbtuh
January	59263	353.1	41995	473.9
February	57123	344.4	29175	388.1
March	78363	543.9	13948	295.0
April	99462	611.9	4314	168.7
May	121687	670.8	816	32.5
June	150577	785.1	241	23.0
July	192414	798.7	1	1.0
August	173835	870.2	2	0.5
September	138296	786.3	261	10.6
October	101040	594.4	4287	164.0
November	54736	391.5	18673	249.1
December	57011	348.1	36538	423.2

Please note the Total columns are in cumulative monthly btu units, not btu units per hour.

Complete GSHP Mechanical Schedule

This cannot be determined until the peak loads, ventilation requirements, etc., have been accounted for. Equipment efficiency and flow rate required will have a significant impact on number of ground loop circuits, spacing, depth and geometry. Even the type of delivery system and controls will impact the overall mechanical schedule.

Thermal Conductivity Test

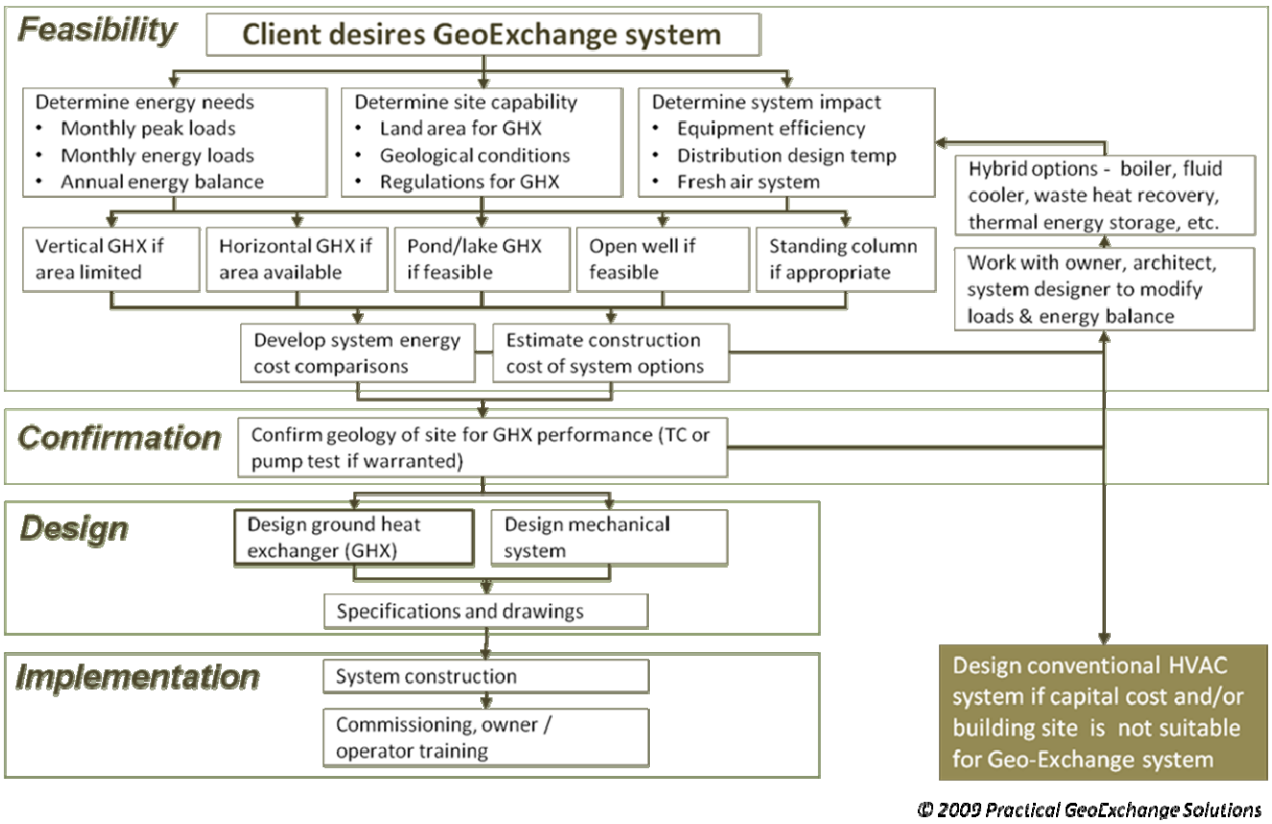
A thermal conductivity (TC) test should not be confirmed and run until **AFTER** the system has been pre-designed to determine optimum parameters. The system cannot be pre-designed until the annual energy loads and heat pump equipment schedule are known.

Many projects start with a TC test before a mechanical design is even accounted for, forcing the design to follow the test parameters. For example, one project started with a TC test using a vertical borehole of 300' without benefit of a pre-design; due to site constraints the project required a 500' deep hole – the test values for one depth cannot be guaranteed to be the same for another. Remember, the ground loop is a major part of the mechanical system. The TC test parameters should only be selected and approved by those responsible for the design, operation and performance of the mechanical system.

TC tests may be used for both vertical and horizontal ground loop options, but the testing methodology for each is different.

Design Process

The design process for a closed loop ground heat exchanger is a methodical procedure that merely accounts for the needs of the building, its mechanical system and host conditions for the ground loop. Please note that a TC test should not be commissioned until after the building requirements are determined in sufficient detail and site variables have been accounted for by an experienced designer (see *Confirmation* section of flow chart below).



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Following this design process reduces the potential for conflicts and issues with the costing, installation and operation of the project's mechanical system by eliminating the influence of inaccurate estimates and rule-of-thumb assumptions.

Please call us should you have any questions about your commercial GSHP project at 303-424-1622.

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