

CONSTRUCTION MANAGEMENT

INTRODUCTION:

This study continues the research of heat pumps to determine the feasibility of changing from a constant volume four pipe system served by a central chiller and boiler to a geothermal system in construction. This study will compare the current system with both vertical and horizontal geothermal heat pump systems to determine the site implications and the difference in project cost and overall project schedule.

PROPOSED SYSTEM REVISIONS:

As previously described in the Mechanical section of this report, the proposed system revisions consist of changing from a four pipe hot water heating and chilled water cooling system to a two pipe water to water heat pump system. The alternate system replaces the existing fan coils with water source heat pumps and eliminates the need for an air cooled chiller and hot water boiler along with one set of pipes.

RESEARCH ON GEOTHERMAL HEAT PUMPS:

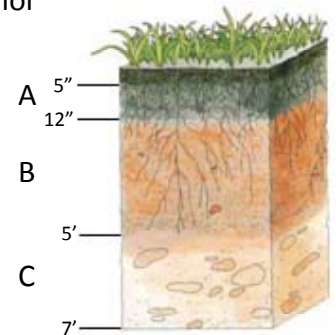
Geothermal heat pumps or geo exchange systems utilize the earth's ability to maintain a constant temperature throughout all the seasons. There are two main configurations of closed loop geothermal heat pump systems; horizontal and vertical. The two options will be reviewed for application on this project.

SITE IMPLICATIONS:

Preliminary research shows that the site is located in the Warrior Basin District and based upon the geological region has a Pottsville Formation. This Pottsville Formation consists of beds of sandstone and shale. Upon exploration of the site, The subsurface report shows that the soil conditions found at St. Francis Friary are as follows:

- A. 5-12 inches of topsoil
- B. Residual sandy clay soils
- C. Weathered rock

The weathered rock found below the residual soils was tested And results conclude that the weathered rock will not prohibit the auger from boring beyond this point.



HORIZONTAL PIPING

Horizontal systems are installed in a trench 4-6 feet deep. Horizontal piping configurations require a field large enough to accommodate the length of piping necessary which as a rule of thumb and as suggested by a contractor in the Cullman county are is 400-600 feet of piping per ton of heating and cooling. Based upon the 84 ton system in the St. Francis Friary, the area necessary for a horizontal system would need to be adequate for 42,000 feet of piping spaced 10 feet apart.

CONSTRUCTION MANAGEMENT

Advantages of a Horizontal System:

- Lower installation cost
- Easy to access for maintenance purposes

Disadvantages of a Horizontal System:

- Maintenance is needed more frequently due to damage from sharp rocks below the surface
- Temperature varies due to close proximity to surface



VERTICAL PIPING

Vertical systems require deep holes to be bored to allow for piping to be configured in a vertical pattern. Bore holes are generally 150 to 450 feet deep depending on the geographic location. As suggested by contractors in the Cullman county area, 250 feet is necessary per hole, each hole serving one ton of heating and cooling. The holes must be spaced at a minimum of 10 feet apart. Based upon the 84 ton heating and cooling system of the St. Francis Friary, the area necessary for a vertical system would need to be adequate to hold 84 holes spaced at 10 feet apart.



Advantages of a Vertical System

- Less piping required
- Temperature more stable
- More efficient
- *Recommended by contractors in Cullman district

Disadvantages of a Vertical System

- Higher installation cost

FINAL PIPING ARRANGEMENT SELECTION

While both options are valid for this site, the decision was made to use vertical piping because it requires less piping, is more appropriate for the existing soil conditions and disrupts less of the site allowing for potential future expansion.

SITE

The position of the vertical boring well field on the site can be found in the Construction Management Appendix.

CONSTRUCTION MANAGEMENT

PROJECT COST

Multiple prices were received for the entire project. Based on a cost estimate from one contractor, the premium for the heat pump system is estimated to be approximately 10%. This yields a cost increase between \$70,000 and \$110,000. For the purposes of this analysis, an average of the two will be used (\$90,000).

Based on the initial cost increase and the projected annual energy savings of 116,000 kwh/yr the simple payback for this additional investment is approximately nine years.

PROJECT SCHEDULE

A review of the proposed construction schedule indicates that the mechanical systems are not on the critical path. The proposed system is actually less complicated to install because it utilizes less equipment and dramatically reduced piping throughout the building. A complete set of piping runs, two pumps, a chiller and a boiler are no longer required. While the costs are slightly higher, the overall installation is less time consuming. The wells associated with the heat pumps can be drilled simultaneously with the general building construction. Though they will take approximately 3 months to complete, they have no impact on the critical path and the remaining installation can follow the previously defined schedule for interior piping, electrical and mechanical system installation. An argument could be made that this system could reduce the overall construction period and therefore also reduce the cost of general conditions associated with the construction period; however, it is not significant enough to use in justifying the use of this system.

CONCLUSION

The analysis of the overall construction management yielded the following recommendations:

- Incorporate the following changes into the construction documents
 - Geothermal heat pumps
 - Revised lighting layout
- Utilize horizontal piping to minimize site disturbance and maintain a maximum amount of the site for future expansion.
- Because the overall project cost is currently over budget and the documents are essentially complete, continue to utilize the design bid build approach to provide a known price and allow time to seek additional funding to support a more energy efficient option
- Incorporate a bid alternative in the bid documents to consider the use of aluminum conductors as a potential cost cutting measure

While the change to a heat pump system has an increased first cost, it has a very short payback, a lower net present value and does not impact the critical path for construction.