CASE STUDY

Modern Storage Facility

New Construction Self Storage Facility in Chelmsford, MA

THE PROJECT

This GSHP supports a 150,000 sq. ft. newly constructed self-storage facility. The building consists of five floors of steel frame and block wall construction. Self-storage facilities can be very efficient buildings. Heating and cooling loads for were evaluated using ACCA Manual N and the design temperatures appropriate to the nearest weather station. The peak heating load and cooling loads were found to be 630,812 Btu/hr. and 315,240 Btu/hr., respectively.

As part of the new building construction, the following energy efficiency measures were implemented:

- Heating and cooling via GSHP
- An LED lighting system with occupancy sensors/ timers.
- Upgraded insulation and air sealing.
- An ERV to provide required fresh air with improved thermal efficiency.
- Infrastructure for future installation of a Solar PV.

THE RESULTS

The GSHP system was designed to utilize a Vertical Closed-Loop (VCL) system consisting of 18 vertical borings with variable-speed loop circulation.

Achieve designed the VCL system to be efficient and compact by reducing barriers to heat transfer. An In Situ Formation Thermal Conductivity Test yielded a result of 1.73 Btu/hr-ft-°F. With this FTC and 1.25" ID HDPE u-bends, the loop can maintain a minimum Entering Water Temperature of 32 F or higher with 18 borings drilled to a depth of 420 feet. This design relies on using a graphite grout mixed for a thermal conductivity of 1.6 Btu/hr-ft-°F. Lower grout TC results in a need for more/deeper borings.

Quality Assurance and Quality Control ended up being very important to a successful project. When designing a VCL with some parameters at the limit of commercially practicality, significant reductions in performance can result from 'field variation'.

- During drilling, Achieve's Geologist confirmed the bedrock type matched that of the FTC test boring. Because of the importance of the thermal conductivity of the grout material, Achieve collected field samples during installation so that the TC could be verified.
- Two samples were collected from the FTC test boring. Results were 1.511 and 1.606 Btu/hr-ft-°F.
- Four samples were collected during installation of the 18 borings with results of 1.066, 1.020, 0.650, and 0.709 Btu/hr-ft-°F. This averages 0.861, which is well below the 1.6 target and identified a significant problem.
- Additional modeling was conducted.
- Achieve concluded that two additional borings to 420 feet (a new total of 20) would compensate. Testing the grout in the additional borings resulted in 1.634 Btu/hr-ft-°F.
- Average Grout TC achieved was 0.969. The use of borehole QA/QC was key to successful completion this project.

Achieve located all of the borings via both Total Station survey and drone video and still photographs.

After installation of the VCL, the site excavation contractor damaged the VCL installation by excavating where they should not have. Achieve provided the survey and drone photography and the loop was damaged a second time. In both cases, Achieve utilized our location information to diagnosis and guide repair of the damage.

Further excavation in the area paid attention to our location information and proceeded without incident.

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