

CASE STUDY

The Trojans of Whitmore Lake High School build an "edifice to be envied" with new geexchange system

The sign in the Whitmore Lake High School gymnasium says "The Home of the Trojans." Just like the Trojans of Homer's *Iliad*, these Trojans of Michigan have constructed an edifice to be envied. The new 150,000-square-foot high school, which opened in August 2006, is one of the first high schools in Michigan to achieve LEED® Silver certification. Among its many sustainable features, a geexchange system for heating, ventilating and air conditioning (HVAC) includes 67 McQuay water source heat pumps. The 430-ton HVAC system delivers conditioned air to classrooms and other spaces, helping to reduce energy costs by an estimated 35 percent compared to a conventional system.

A need to distinguish

Whitmore Lake High School, the only high school in the school district located near Ann Arbor, serves about 420 students in grades nine through 12. One of the project goals was to build an exceptional school that would stand out in the community. "There are several private schools in the area that local students could choose to attend," said Tom Dekeyser, principal of Whitmore Lake High School. "Plus, Ann Arbor public school students can choose to attend Whitmore Lake because we're so close. So we wanted to put our best foot forward and show that Whitmore Lake can make a difference.



Achieving LEED certification was one way to distinguish ourselves, and we decided we wouldn't settle for anything less than LEED Silver. In fact, it was non-negotiable."

Going green to save green

In addition to being a community icon, school officials wanted to minimize operating costs – especially as the cost of natural gas began to rise during the planning stages. The school board recognized that any additional first costs for the geexchange system would be offset by the savings in energy costs. As a result of their foresight, the school anticipates saving about \$80,000 per year. In the first year alone, that's more than double the added cost to

construct the geexchange system versus a conventional HVAC system.

Geexchange systems can reduce energy consumption – and corresponding emissions – by as much as 40 percent compared to electric resistance heating and standard air-conditioning equipment. Their simplicity further reduces costs. Geexchange systems do not require chillers, cooling towers, or boilers, and the closed loop water circulating system requires very little maintenance. During cold months, heat is transferred from the ground via the closed loop circulating system to individual McQuay water source heat pumps. During warm months, heat is transferred out of the school and rejected into the ground.

Combination pond and horizontal loop system improves heat transfer

Although geexchange systems reduce energy costs compared to traditional systems, Whitmore Lake's geexchange system goes even farther by combining a horizontal loop and pond system. Approximately 47 miles of pipe were laid in a horizontal field and in a 15-acre pond. The system has two horizontal layers of piping trenches dug eight feet deep. The top pipe is six feet below the surface and loops back with the second pipe two feet below that.

"We could have put the whole pipe system in one horizontal field, and still had an efficient system," said Bob Roop, mechanical engineer with Peter Basso & Associates. "We had plenty of real estate. But we had to create the pond to provide storm water retention and a fire protection water supply. The water in the pond is a better heat transfer media than the soil, so we took advantage of what we had to construct anyway to further improve the efficiency of the geexchange system."

Energy recovery systems are key to supplying heat on cold winter days

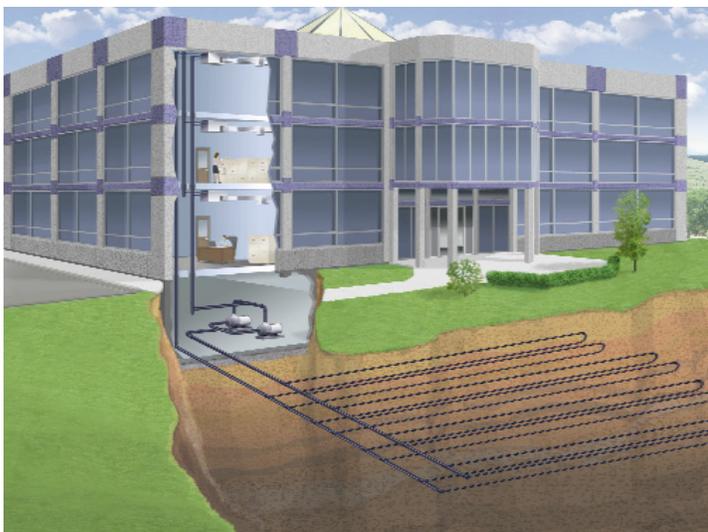
The Whitmore Lake project is the first school project Roop and his firm have designed utilizing a geexchange system. "We have quite a bit of experience with heat pumps on closed-loop boiler tower systems, and we've been using them successfully in schools for more than 10 years," he said. "When Whitmore Lake told us they wanted LEED certification, we did some comparative cost information and came back with some favorable numbers for a geexchange system. Our boiler tower systems consume about 28 percent less energy than traditional systems; we expect Whitmore Lake, with its geexchange system, to be about 33 percent less in energy consumption compared to a conventional building. Those numbers, combined with the ample real estate available, convinced school officials to go ahead with the system."

All of the McQuay geexchange heat pumps, located throughout the school, are fed a pre-treated, measured amount of outside air from one of two

pre-packaged energy recovery units. "All of the relief air from the building goes through the energy recovery unit," said Roop. "It has a plate-type heat exchanger and pre-treats all the outside air. It maintains a discharge air temperature in winter of 60 degrees, so all of the outside air is pre-treated to 60 degrees."

The plate-type energy recovery device is 70 percent efficient. For example, if the outside temperature is 0 degrees Fahrenheit, and the inside temperature is 70 degrees, the recovery units capture 70 percent of that 70 degree air. "That's about 54 degrees just by going through the energy recovery device without spending any more energy," said Roop. "The water source heat pump then brings the air temperature from that temperature up to 60 degrees."

"That means that the 67 individual water source heat pumps are basically responsible for space tempering, and do not have to deal with the outside air load. We've found this to be very successful for supplying heat in a northern climate in the dead of winter."



Example of a horizontal loop system



Example of a pond loop system



Enfinity™ high efficiency vertical water source heat pump with HFC-410A refrigerant

This is integral to all of our designs for the past 10 years; it's a keystone for making these systems more energy efficient."

McQuay water source heat pumps help meet LEED® requirements

Working with Thermal-Netics, the McQuay representative firm, Roop and his team chose McQuay Enfinity™ water source heat pumps to help meet the requirements for efficient, reliable operation. Each McQuay unit responds only to the heating or cooling load of the individual zone it serves, whether it's a classroom or the natatorium. This provides excellent comfort levels for occupants, better control of energy use and lower seasonal operating costs. To help meet heating loads in the winter, a coaxial heat exchanger is designed for maximum heat transfer

with minimum pressure drop. A high-efficiency motor and low-speed blower further reduce energy consumption. High energy-efficiency ratios (EER) and non-ozone-depleting R-410A refrigerant also helped to meet LEED requirements.

A more comfortable learning environment

The geexchange HVAC system also uses demand control ventilation to further increase energy efficiency. "The ventilation rate, calculated through ASHRAE Standard 62, is based on a rise in CO2 levels in the space using CO2 as a predictor of occupancy. When people aren't in the building, we bring in a minimum amount of outside air. When the building is occupied, and the air becomes concentrated with CO2, we bring in more outside air."

While the main job of a school is to provide a safe and comfortable learning environment for students, Whitmore Lake sets a new standard. "We wanted to bring the outside in, while providing the best learning environment we could," said Dekeyser. Other amenities include a commons area with a large skylight for natural lighting. Street lamps and trees promote the outdoors theme. "One of the most interesting innovations of the school is the adjustable auditorium," said Dekeyser. "The auditorium features a full stage and 200 permanent seats. Removable bleachers provide seating for another

450 spectators. When the bleachers are not in use, they are collapsed and stored in the cafeteria. The adjustable seating decreased the footprint required and reduces the heating and cooling costs." The school includes two levels of academic spaces, a large gymnasium, an auxiliary gym, and a six-lane competition pool (which includes an energy-recovery-based dehumidification unit). In addition, waterless urinals and touchless faucets reduce water consumption by 20 percent; biodegradable materials are used throughout the building and locally-produced products and green cleaning all contributed to the LEED Silver certification.

With a specific goal in mind, the backing of the community, and an efficient HVAC system, Whitmore Lake has built its dream school. The school serves as a flagship for a growing community and a testament to their environmental mindset. Much like the Trojans of Homer's *Iliad*, the Trojans of Whitmore Lake have an edifice worthy of an epic.

"Now that we've earned our LEED certification, the new school has created a buzz in the community; it has people excited," said Dekeyser. "Everyone from members of the community to prospective students and visiting sports teams are witnessing what Whitmore Lake has to offer. We're very pleased with the result."

