Plastics Pipe Institute
BUILDING & CONSTRUCTION

Case Study – Project in Action

CANADA'S LARGEST GEOTHERMAL PROJECT READY TO GO

Vancouver International Airport
Undertaking Wins
Industry Award

VANCOUVER, British Columbia – Vancouver International Airport (YVR) is the largest building in British Columbia and requires a lot of heating and cooling -- needs that will be increased by a $300-million expansion that will add 300,000 square feet (27,880 square meters) to the terminal complex's more than 1.25 million square feet (116,170 square meters).

To meet those demands, and to also substantially limit its environmental footprint, the airport chose an eco-friendly geoexchange (ground source geothermal) system for heating and cooling the expanded facility. The new Central Utilities Building, still under construction, will improve efficiency by centralizing all of the equipment needed to meet the airport's heating, cooling and electricity demands.

As Canada's second largest and busiest airport, Vancouver International Airport (YVR) welcomed 25 million people in 2018, facilitated 338,073 aircraft take-offs and landings, and handled over 372,500 tons (338,000 tonnes) of cargo. Currently 56 airlines serve YVR, connecting people and businesses to 125 non-stop destinations in Canada, the U.S. and around the world.

In 2019, YVR was voted Best Airport in North America by the Skytrax World Airport Awards - the only airport to have received this honor for 10 consecutive years. The year before, ground was broken on a number of capital construction projects - part of YVR's multi-year expansion plan that will see the airport complete 75 major projects, totaling $9.1 billion during 20 years.

One of those projects, the airport's geothermal exchange system, was awarded Building & Construction Project of the Year by the Plastics Pipe Institute, Inc. (PPI). The honor went to PPI member and Canadian pipe manufacturer VERSAPROFILES (Saint-Lazare-de Bellechasse, QC, CANADA), which provided the pipe for the YVR Airport geothermal exchange system. PPI is the major North American trade association representing the plastic pipe industry.

The system's design required hundreds of vertical boreholes to provide sustainable heating and cooling for the terminal and is one of the largest geothermal energy projects in Canadian history.

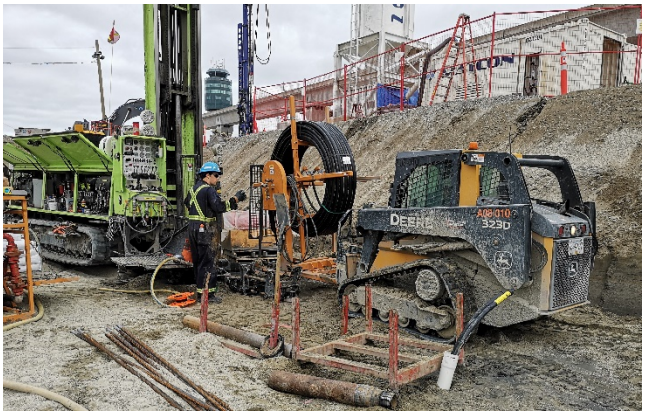
Borehole drilling and installation of the geothermal loops and headers is complete, and the 67,000 square foot (6,230 square meter) Central Utilities Building (CUB) is expected to be operational by 2022.

This system is a massive undertaking that is crucial to Vancouver International Airport's objective to reduce greenhouse gas emissions. At an estimated total installed cost of $350 million, including the new CUB, the system is the most expensive of the airport's expansion projects.

Case Study – Project in Action

It is expected to substantially reduce CO_2 emissions from heating and cooling demands by 30 to 35 percent. By using the earth as a renewable energy source, heat pump-based geoexchange systems are able to significantly flatten the electricity grid's energy demand curve.

They also greatly reduce dependence on fossil fuel usage for heating and cooling requirements, and are becoming a leading technology in the electrification of governmental and commercial building infrastructure. According to the U.S. Environmental Protection Agency, a geothermal system is the most energy-efficient means to heat and cool a building.



"PPI and our members promote the adoption of geothermal technologies to help reduce energy consumption for heating and cooling buildings, saving owners money," stated Lance MacNevin, P. Eng., director of engineering for PPI's Building and Construction Division. "Other benefits of ground source systems are better reliability and building resiliency, with no exposed outdoor components.

Also, water-to-water heat pumps are a perfect match for hydronic heating and cooling distribution systems, which are comfortable and efficient technologies for use in residential and high-performance commercial construction." MacNevin's group has established a Geothermal Steering Committee to focus support specifically on the geothermal industry.

In 2019, VERSAPROFILES signed an agreement with Ground Source Energy, an Alberta-based geothermal contractor, to manufacture and supply the high-density polyethylene (HDPE) geothermal piping loops to the construction site at YVR.

For VERSAPROFILES, the pipe manufacturer in Quebec, Canada, one of the main challenges of the project was to ship the geothermal piping loops almost 3,000 miles (4,800 km) across Canada. A total of 17 containers of pipes left the production facility, first by truck, then by train to Vancouver. VERSAPROFILES was chosen as the piping supplier based not only on competitive pricing but also on its capacity to deliver a quality and factory pressure-tested product, with full customer support, under a Just-In-Time (JIT) delivery protocol.

VERSAPROFILES contribution to the project was 841 VERTICALOOP™ single u-bend geothermal loops, each 1,000 feet (305 m) long with a molded and heat-fused U-bend installed at the mid-point, for a total of 841,000 feet (256,000 m) of HDPE geothermal piping. The job used about 280,000 pounds (127,000 kg) of resin and required the equivalent of 35 days of production capacity for the Saint-Lazare-de Bellechasse, QC facility. The first geothermal loops were installed in April 2019.

The project had two major components to it - drilling and geothermal loop installation - and relied heavily on HDPE plastic piping - material that is robust and reliable, with more than 50 years of a proven track record in geoexchange systems.

According to Tony Mooney, project manager at Ground Source Energy, one of the most important considerations of geothermal energy installations is ground conditions. "The lithology, or rock characteristics, needs to be of a high enough thermal conductivity to move energy through the earth. In this case, the soft glacial till overburden provided wet soil conditions that are suitable for heat transfer to occur.

Case Study – Project in Action

"The glacial till affects the thermal conductivity of the ground, which affects the size of the system they need to get the energy, and our drilling methodology," Mooney explained. "We still put the HDPE loop in the same way we do into bedrock or for any other application or system. How we make the hole and how many holes needed depends on how the earth varies.

"So, if it's sand, you typically don't even put geo where there's sand, but if you're in bedrock, heat moves well. If you're in wet soil, the thermal conductivity moves well, wherever heat can transfer, and that determines how many holes you need. So, if it was more sandy and dry, it would be less conductive, and you'd need more holes and more loops to get the same amount of energy out of the ground.

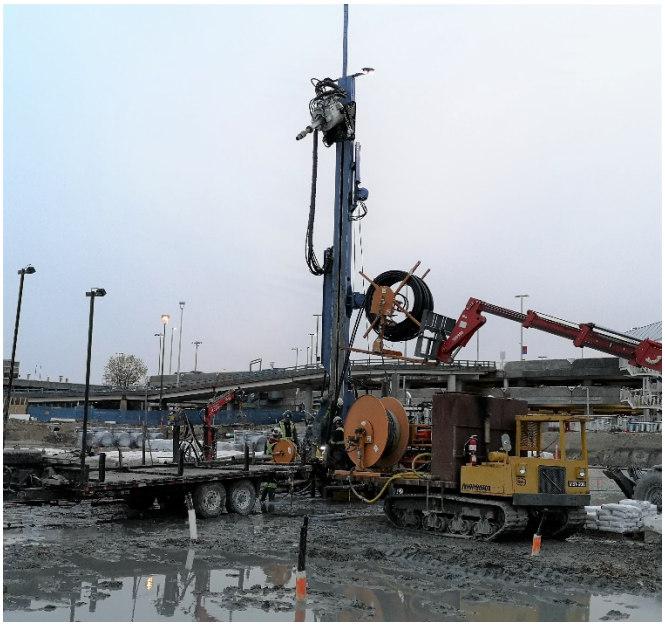
"The only problem with glacial till is that it isn't bedrock. That means drilling with the casing in each hole to keep the hole from collapsing on itself. The pipe is then fed into the hole from a spool.

"Because it's glacial till, we used sonic drilling and drilled with the casing, because you can't use air rotary or other methodologies because there is no bedrock to keep the hole open, so you have to have casing all the way down so the hole stays open, so you can put the loop in.

"We put the loop in within the casing and then we grout. We end up with a loop in the ground surrounded with thermally-enhanced grout, and just normal earth," he said.

"The piping material is critical to the overall success of geothermal systems," stated David Fink, president of PPI "and must provide corrosion and chemical resistance, flexibility, long term toughness (impact resistance), pressure capability, and temperature resistance. HDPE pipe is often specified for this type of project because of its proven durability. Those attributes were called on for this extreme endeavor and it was a pleasure to honor it with the Project of the Year award."

Vertical piping loops are connected to larger diameter headers that run horizontally through the pipe field. Heat exchange fluid enters the HDPE pipe at one end of the vertical loop, travels to the bottom of the pipe where there is a U-bend, then heads back up to the surface.

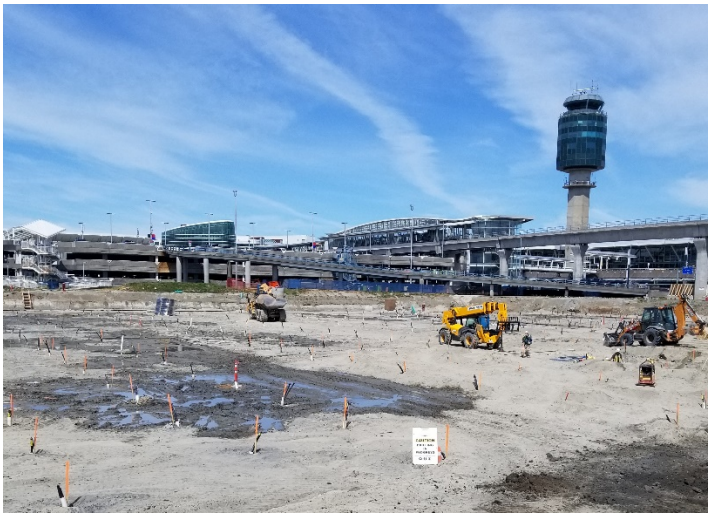


Within this closed-loop system, heat is exchanged with the earth, and no fluid leaves the system. The pipe loop, or ground-coupled heat exchanger, is the thermal energy source during heating cycles and the thermal sink during cooling cycles.

Geothermal fluid transfers from the borefield to the central energy plant, which exchanges heat with a district energy system which will ring the terminal with a network of heavy-duty 10- to 24-inch diameter HDPE pipes.

Mooney said at YVR, because of the mild West Coast climate, most of the time heat will be drawn from airport buildings, extracted through heat pumps in the Central Utilities Building, and pumped into the ground. To heat buildings, thermal energy will be transferred back into the geothermal fluid as it travels through the borefield.

Case Study – Project in Action



Each 500-foot borehole contains 1,000 feet of 1 1/4-inch PE4710 HDPE pipe. These pipes link to lateral headers that carry the fluid to the Central Utilities Building. The headers feed into manifolds that tie into heat pumps, which distribute the geothermal energy to and from airport buildings. Ground Source Energy used 16,800 feet (5,120 m) of 1 1/4-inch PE4710 HDPE header pipes to complete the geoexchange system. "There's pipe everywhere," said Mooney.

Future phases will see the geoexchange piping energy distribution system made of 10- to 24-inch PE4710 HDPE pipe. According to PPI, PE4710 is the highest performance classification of HDPE piping material for fluid applications. PE4710 compounds offer a high level of performance with increased flow capacities plus increased resistance to surge pressure, fatigue, and slow crack growth.

"All the parties involved were grateful to have completed this large-scale commercial project ahead of schedule," offered MacNevin. "Drilling was a team effort, with three companies collaborating to achieve success. Given the high-profile nature of the Vancouver International Airport geothermal exchange system, the drilling firms were under 24/7 oversight by Ground Source Energy to ensure all boreholes were drilled to target depth and pipes were subjected to post-installation pressure testing to ensure integrity.

"The expected performance of the Vancouver International Airport Central Utilities Building geoexchange system will certainly show how plastic pipe can be part of the sustainable solutions to save our planet. This has to be good news to all of us," concluded MacNevin.

More information can be found at https://plasticpipe.org/building-construction

# # #

Plastics Pipe Institute
The Voice of an Industry.

About PPI:
The Plastics Pipe Institute, Inc. (PPI) is the major North American trade association representing the plastic pipe industry and is dedicated to promoting plastic as the materials of choice for pipe and conduit applications. PPI is the premier technical, engineering and industry knowledge resource publishing data for use in the development and design of plastic pipe and conduit systems. Additionally, PPI collaborates with industry organizations that set standards for manufacturing practices and installation methods.

A Pipe Performance Report from the Field