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# Standing column wells in cold climates: a case study in a highly productive aquifer

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Standing column wells (SCW) are ground heat exchangers that recirculate groundwater in a deep uncased borehole and “bleed” only a fraction of the pumped water during peak demand periods to boost advective heat transfer. While operational feedback collected from numerous systems in the northeastern United States is available and provides general design guidelines (Orio et al., 2005; 2006), practitioners have been slow to embrace SCWs outside their area of emergence. This reluctance can be explained in part by a lack of awareness, as well as lingering concerns about groundwater chemistry and the reliability of these systems in diverse climatic and geological settings. In this context, the present work presents a case study of a demonstration SCW system that was retrofitted in a school near Montreal, Québec, Canada, with the aim of sharing the knowledge gained during the design and commissioning phases.

The demonstration system’s design relied on an early exploratory phase, which included an exploratory drilling, a thermal response test, a pumping test, and groundwater analyses. These field operations first uncovered the presence of a highly productive sandstone aquifer, which 1) halted drilling early at 133 m due to the elevated water pressure, and 2) had a strong influence on the thermal response test’s results due to the high efficiency of advective heat transfer, even in the absence of bleed. Accordingly, the development and calibration of an advanced coupled thermo-hydrogeological numerical model was deemed necessary to evaluate the proper sizing of the ground heat exchanger.

Following design and construction, a review of the available data was conducted to evaluate the SCW system’s general performance metrics. This exercise first demonstrated its overall efficiency, which reduced drilling lengths by approximately 73%, construction time by 52%, and initial costs by 37% compared to conventional closed-loop boreholes. It was also found that the SCWs were able to sustain building loads over 200 W/m and to reduce peak electrical power demand by 71% compared to electric resistance heating, this on the coldest winter day when the air temperature was -26 °C. Monitoring of the pressure losses through the plate heat exchanger and step-drawdown tests did not indicate any immediate groundwater quality concerns. On the other hand, the elevated energy consumption of the pumping equipment affected the system’s seasonal performance factor, and a few operational issues related to corroded probes and inefficient control sequences compromised energy and financial savings and had to be resolved.

In conclusion, the results of this case study demonstrate the strong potential of SCWs for reducing the environmental and economic costs of heating operations in cold climates. The importance of conducting an early exploratory phase was emphasized, as well as the potentially significant impact of productive aquifers and groundwater flow on field testing, design studies and overall performance metrics. Lastly, it also became evident that careful selection of the pumping equipment and control sequences, as well as post-commissioning efforts, were necessary to ensure the optimal operation of this innovative technology.