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Delineation of the thermal plume associated with a standing column well system

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Due to their potential for reducing energy consumption and greenhouse gas emissions, ground heat exchangers (GHE) coupled with heat pumps are now more commonplace. In urban areas, interference between neighboring GHEs can be a cause for concern, as it can affect average ground temperature and the long-term efficiency of heat pumps. Standing column wells, which use groundwater as a heat transfer fluid, are particularly suited to urban contexts as they do not require a productive aquifer or large areas of land. Unlike open-loop systems, groundwater is mainly recirculated in SCWs. However, to improve their performance, a fraction of the recirculation flow can be diverted to an injection well (IW), enabling the development of a thermal plume around the SCW and IW. Therefore, the delineation of the thermal plume for SCW systems is important to prevent environmental disturbances and maintain their thermal efficiency. A case study is conducted on a real system consisting of five SCWs and one IW installed in a productive fractured aquifer in the city of Mirabel, Canada. Using a 25-day hydraulic tomography, geophysical logs, drilling reports and thermal profiles, a 3D numerical model coupling heat transfer and groundwater flow was developed and calibrated. Using this calibrated model, numerical simulations were used to generate a 3D thermal plume and assess the environmental impact of the SCW system. The results indicate that the impact of SCW on this particular aquifer is limited, and that the system alone can be operated for 10 years without significant loss of efficiency or environmental impact.