



## **Assessing Risk in Open-Loop Heat Pump Systems**

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Open-loop heat pumps systems can offer numerous advantages over closed-loop alternatives, mainly due to reduction in drilling costs. However, due to high level of heterogeneity in subsurface hydraulic parameters relative to thermal parameters, there is considerably more risk of failure in open-loop systems. Possible difficulties include finding insufficient permeability in one or more wells or premature thermal breakthrough due to preferential fluid flow through fractures or high permeability strata. Here drilling records are examined for a carbonate aquifer in Manitoba, Canada to assess probability of finding insufficient permeability in at least one well in an open-loop heat pump project and operational records are examined to determine thermal breakthrough times. Stochastic models using demonstrate that it is possible to determine this risk if adequate geostatistical information is available.