

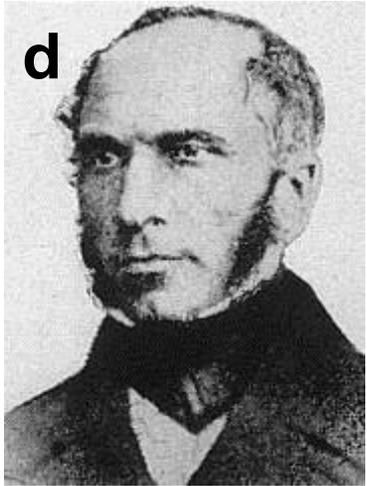
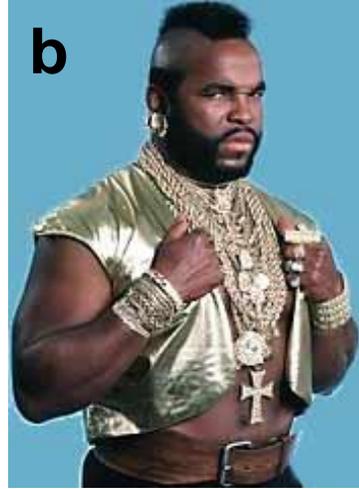
Ground Source Heat Pump Association Webinar Series 2020

#2 NUMERICAL MODELLING OF OPEN LOOP GSHP SYSTEMS

Huw Williams

Agua Enodo

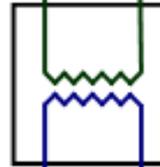
26 November 2020



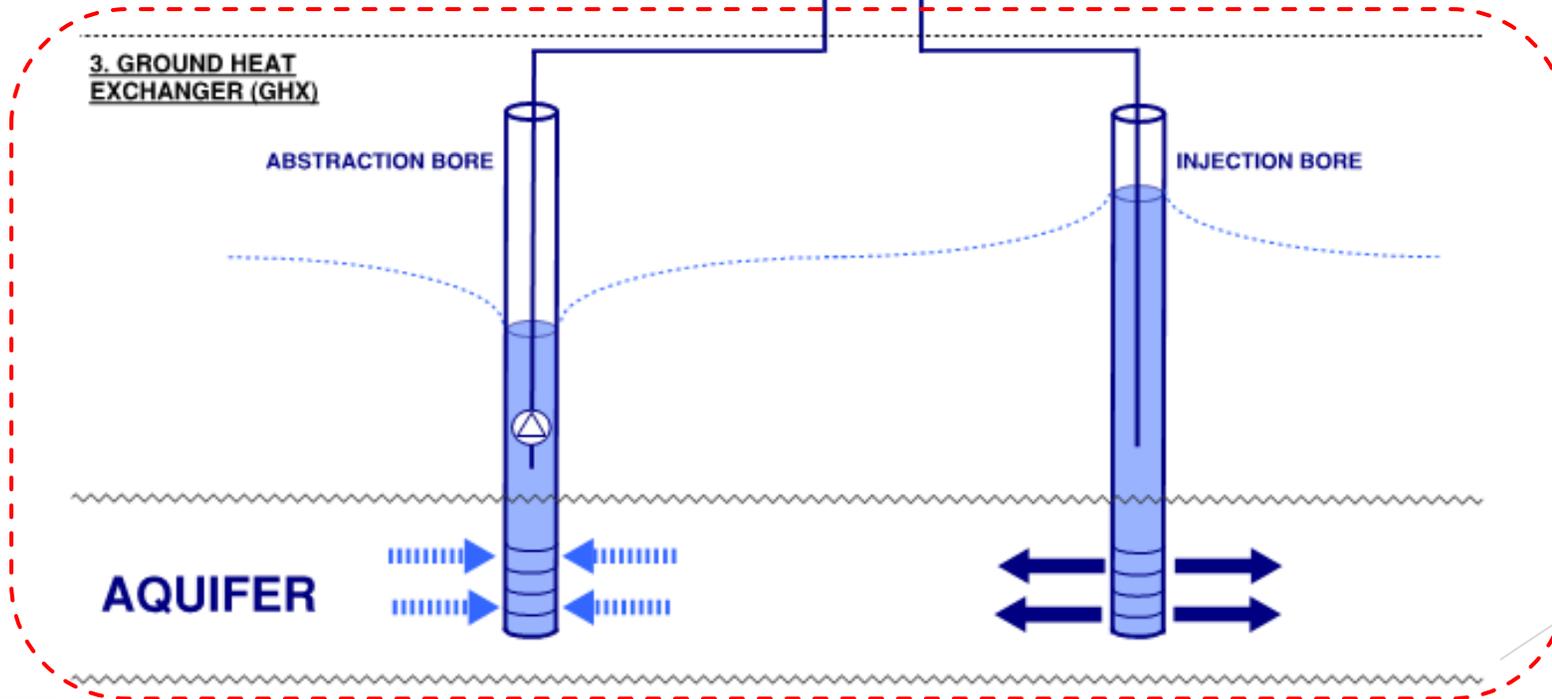
1. THERMAL LOADS AND HVAC DISTRIBUTION SYSTEM

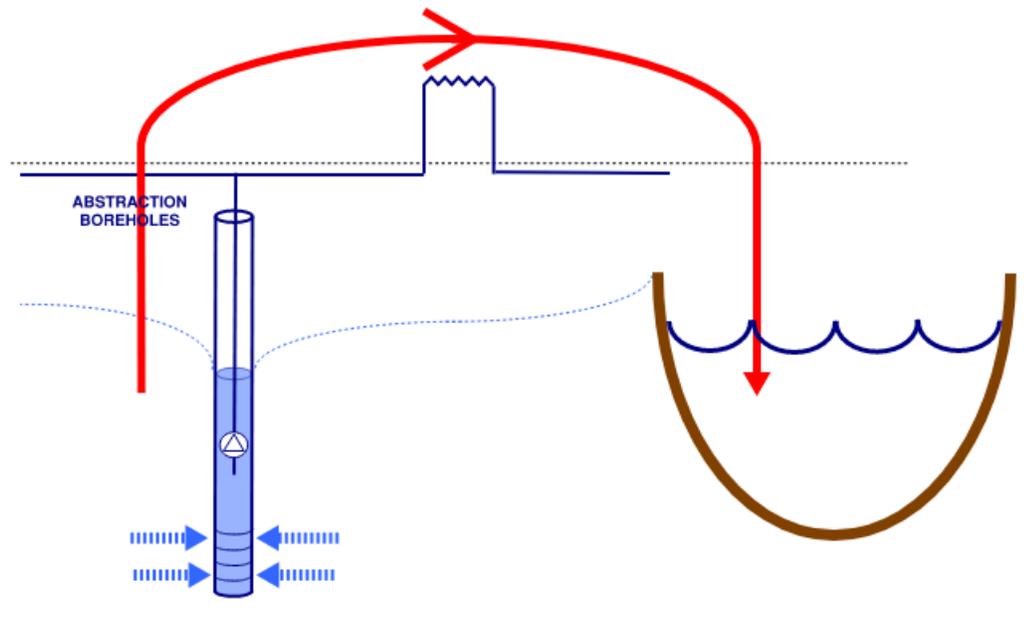
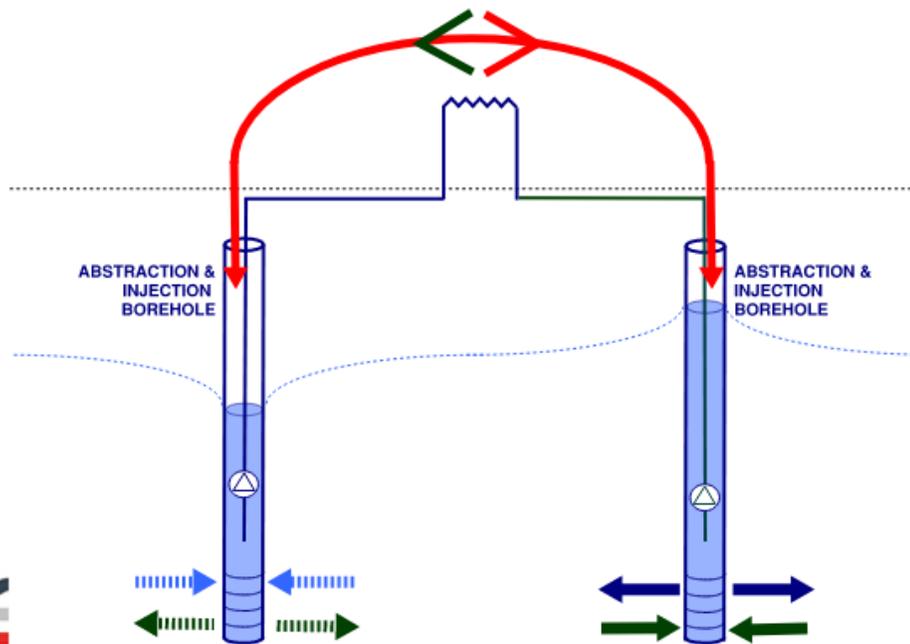
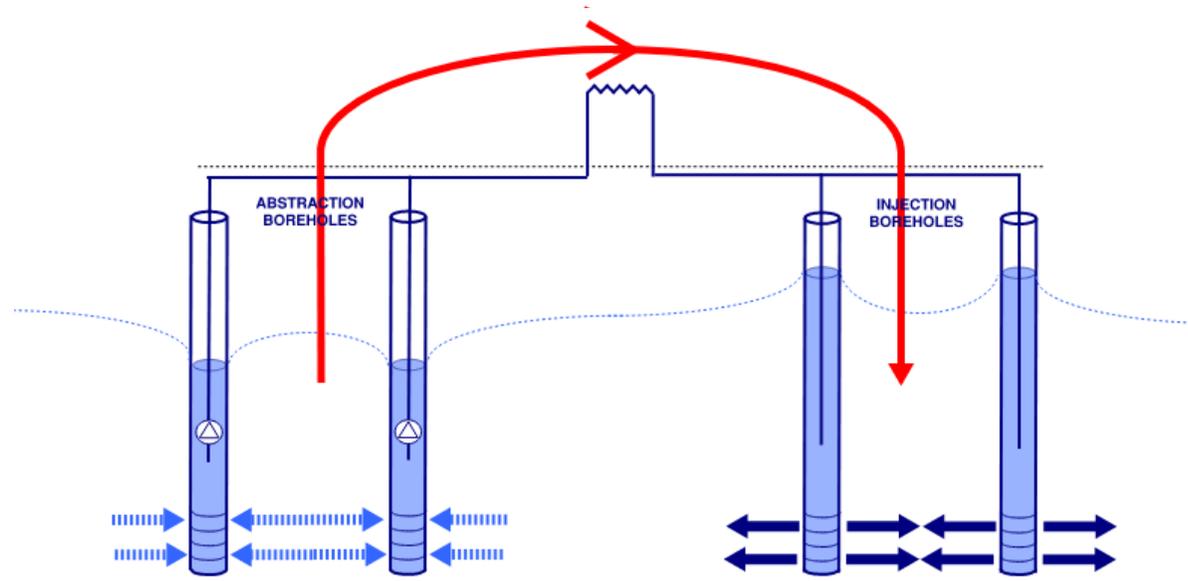


2. GROUND SOURCE HEAT PUMP (GSHP) PLANT

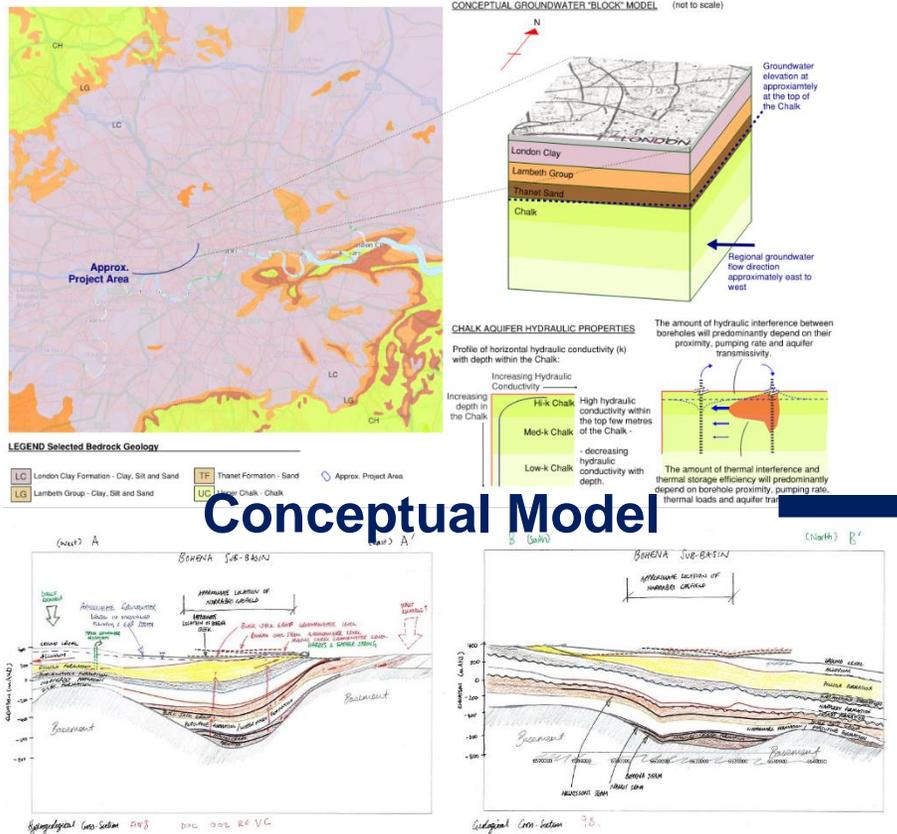


3. GROUND HEAT EXCHANGER (GHX)

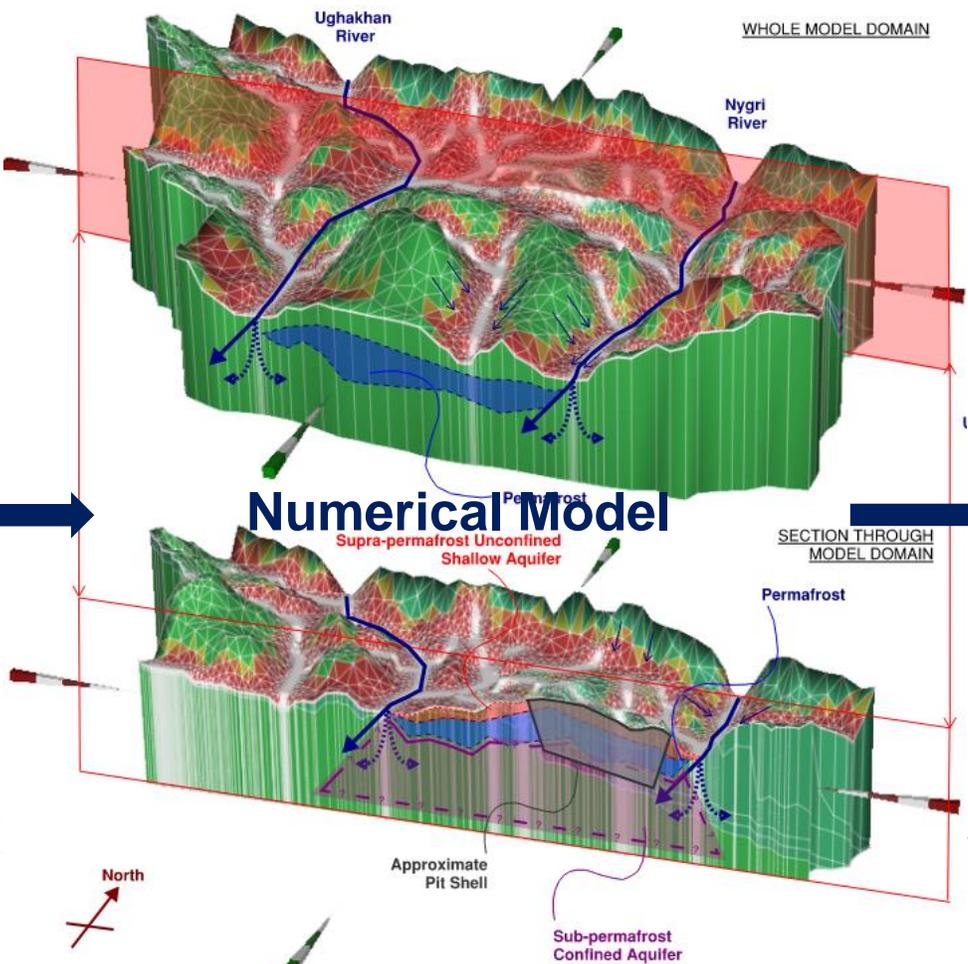




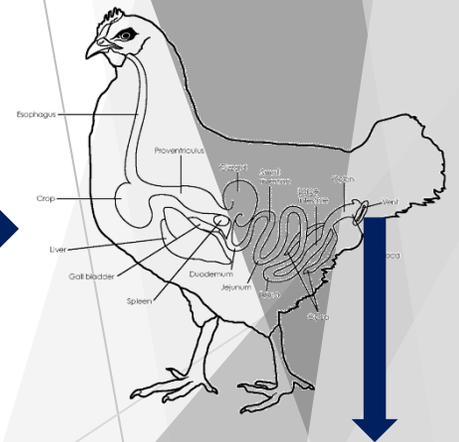
What does our groundwater model look like?



Conceptual Model

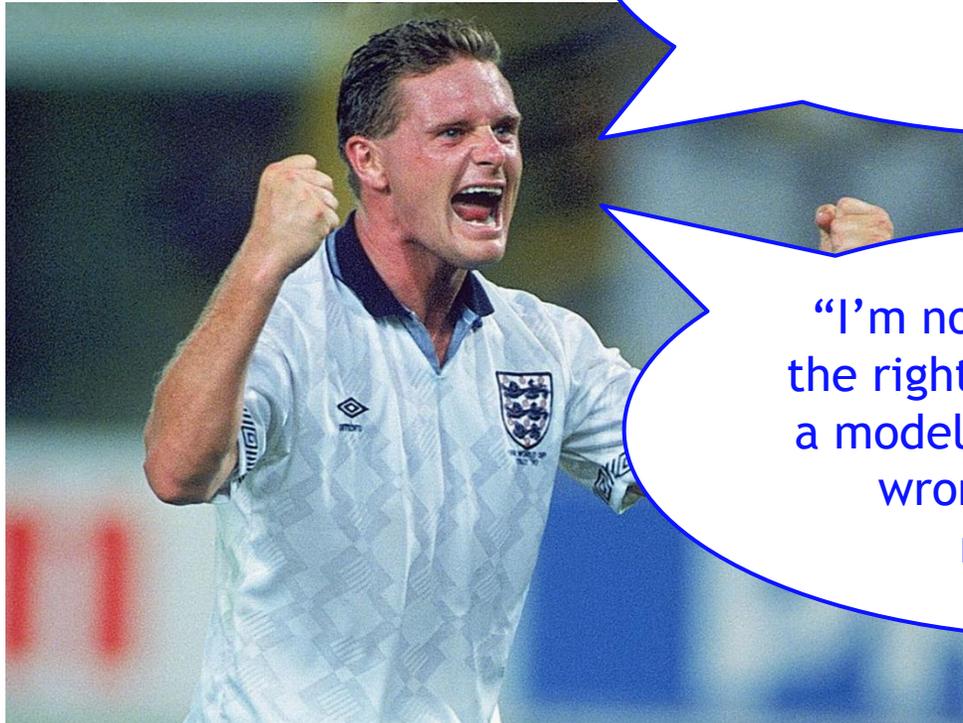


Numerical Model



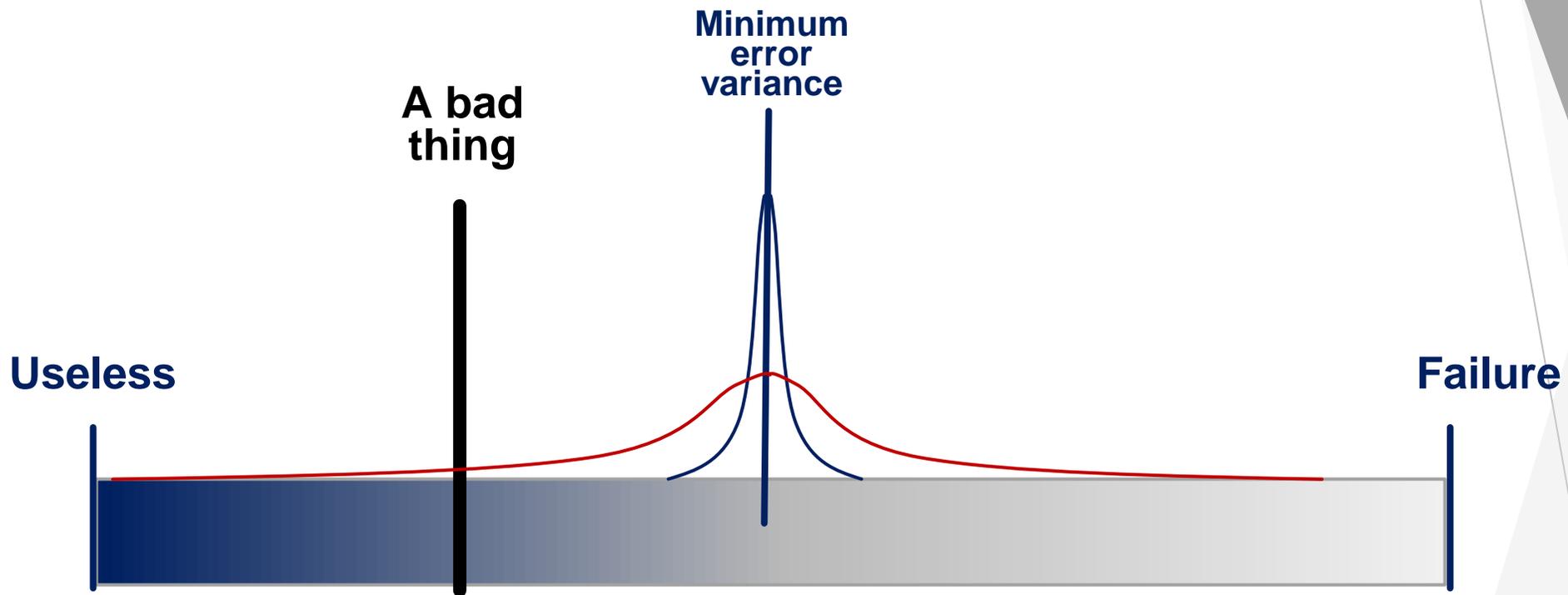
Predictive Modelling for:

- An answer ?
- The Results ?



“I don’t make predictions.....
and never will”

“I’m not going to give you
the right answer, but here is
a model who’s potential for
wrongness has been
minimised.”

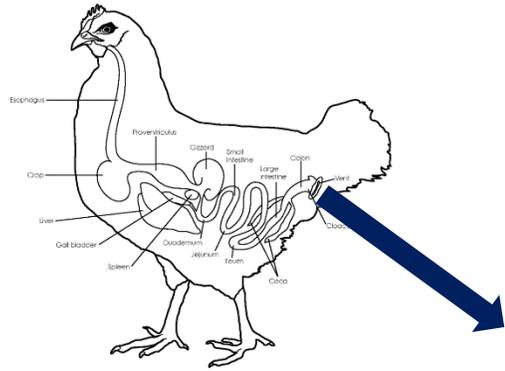


The groundwater modelling spectrum

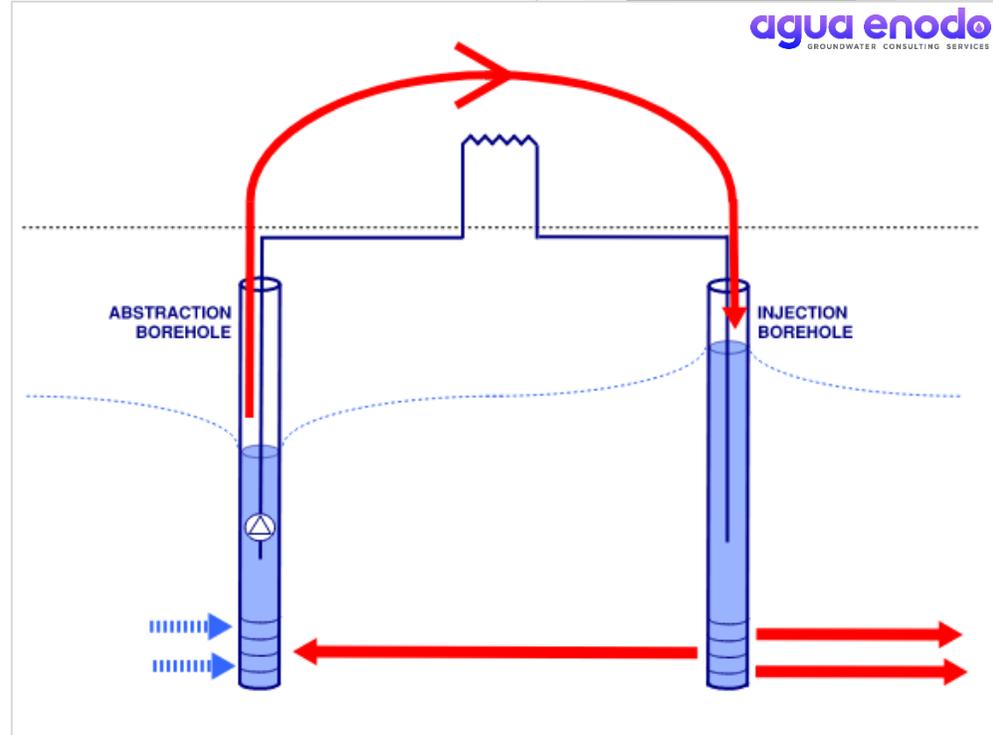
What decisions can our groundwater model help us with?

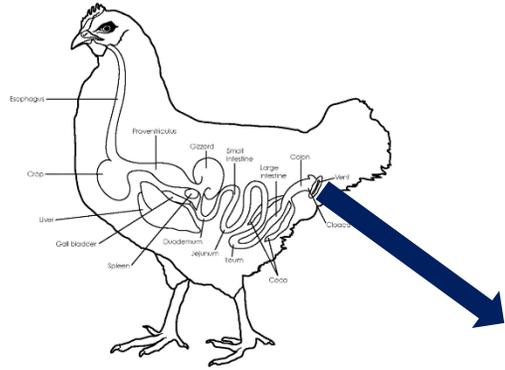
	In the On-Site Boreholes	In the Off-Site Environment
Thermal Impact	Abstraction and Injection Temperatures	Thermal plume moving off-site
Hydraulic Impact	Abstraction and Injection groundwater levels / pressures	Change in groundwater levels and pressures
Of interest to..	The designer and operator	The Regulator

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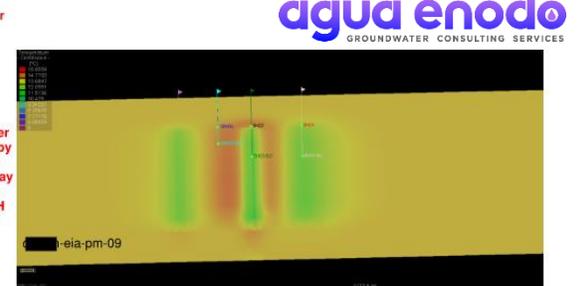
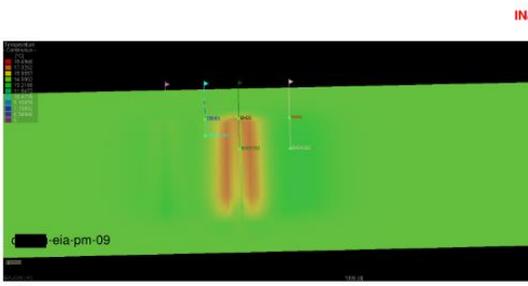
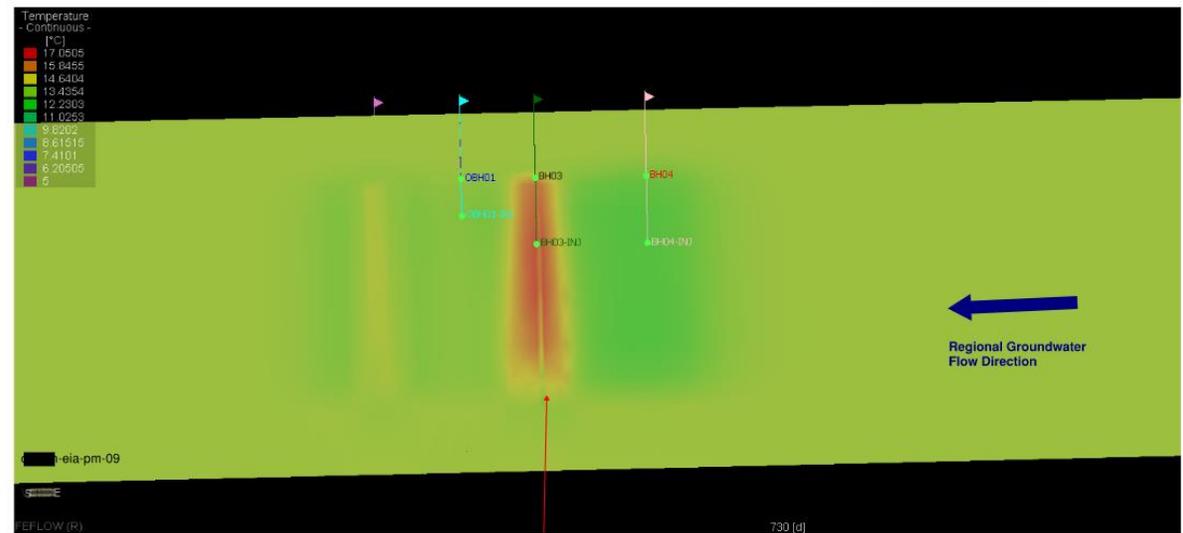
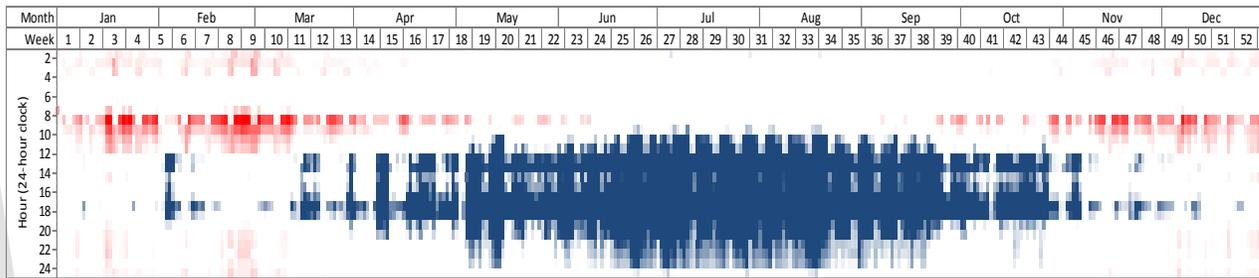
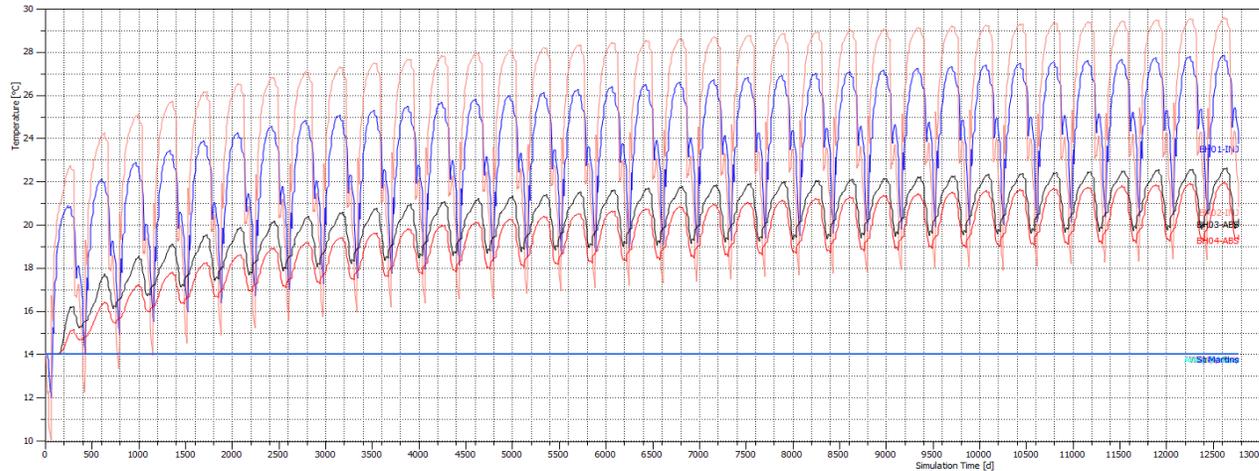


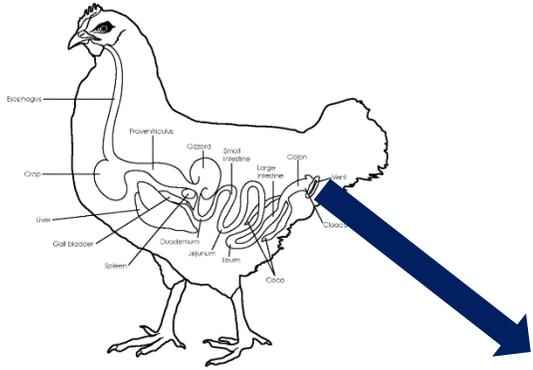
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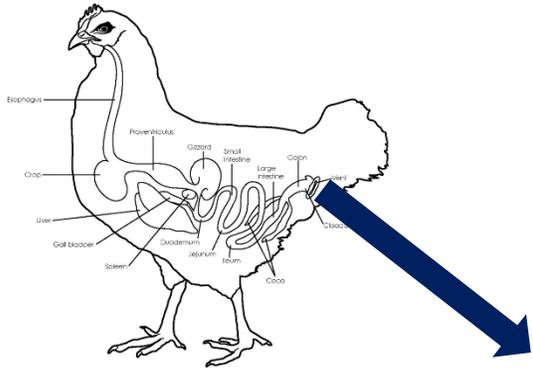
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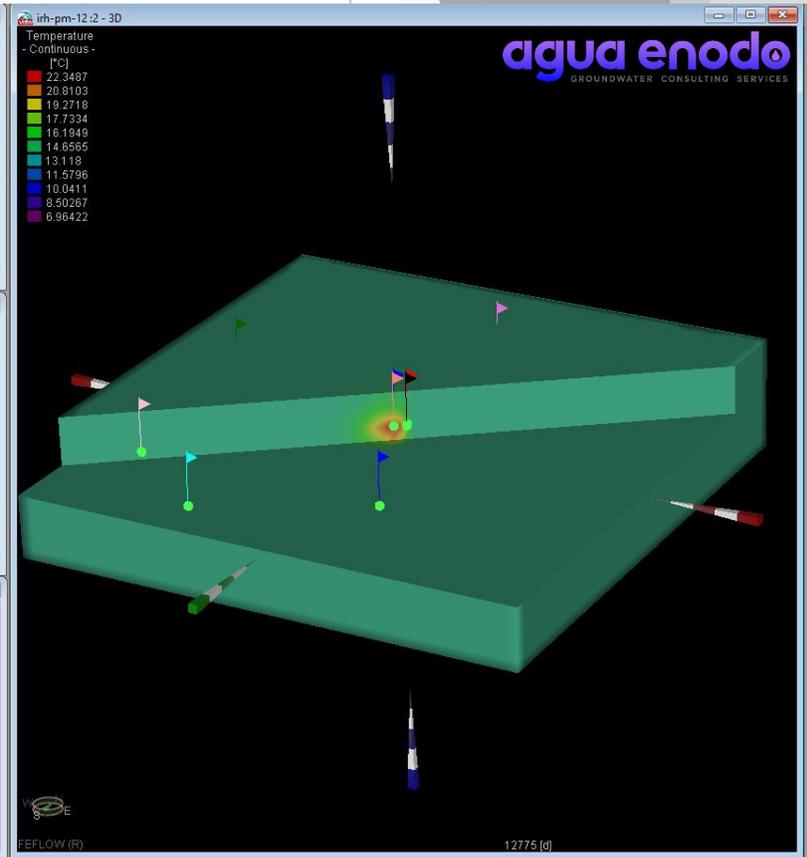
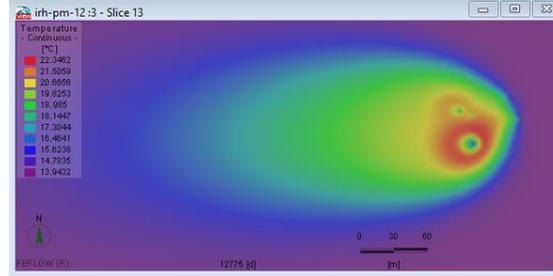
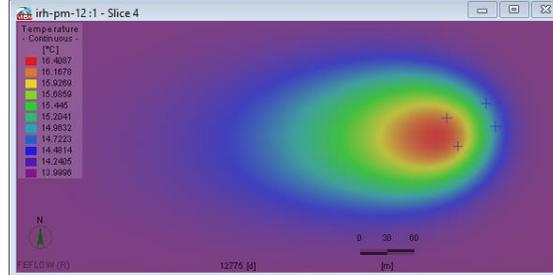
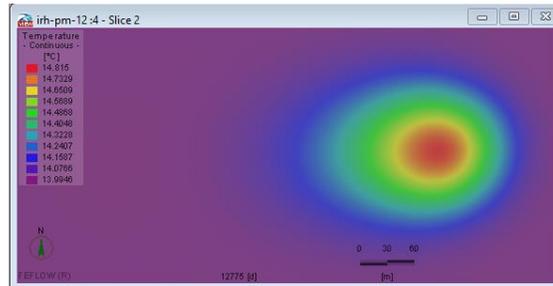
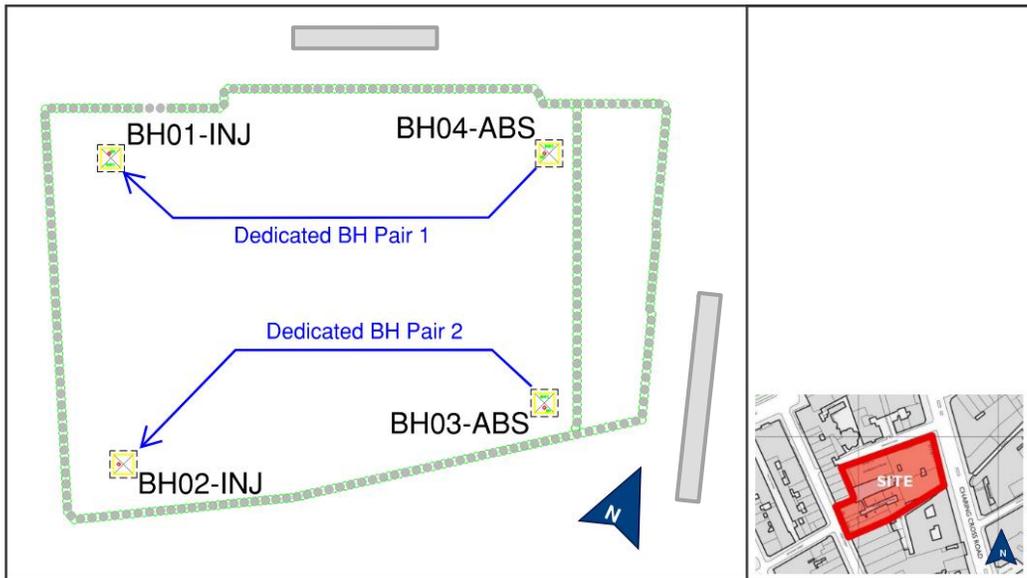


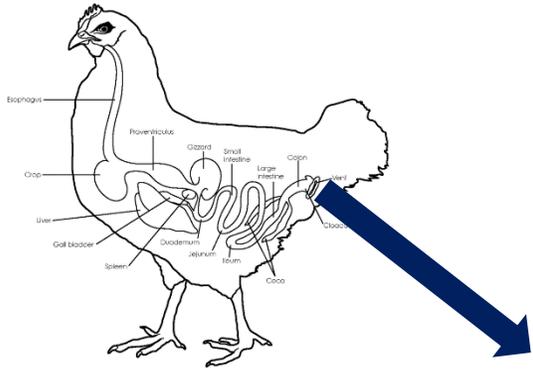
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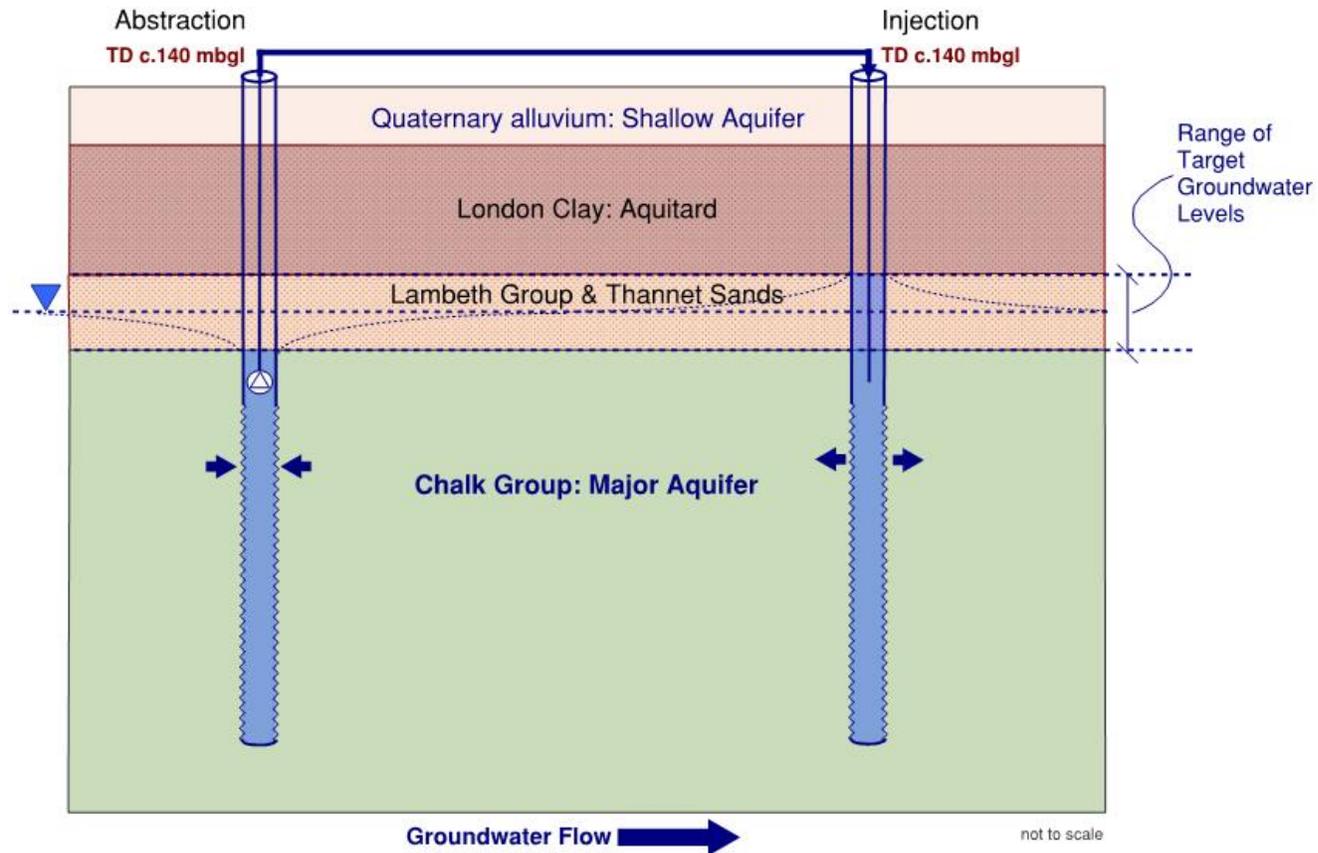


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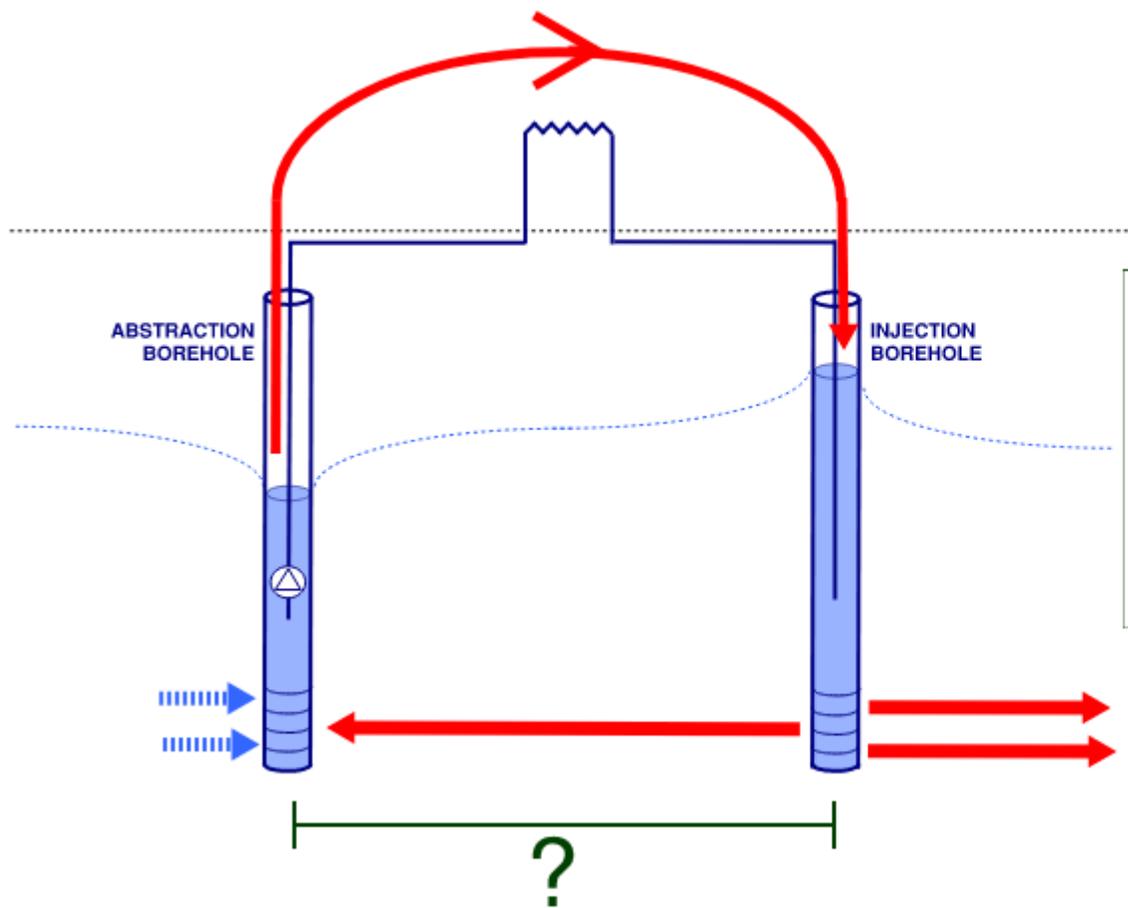
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 Increasing Severity

Increasing Likelihood

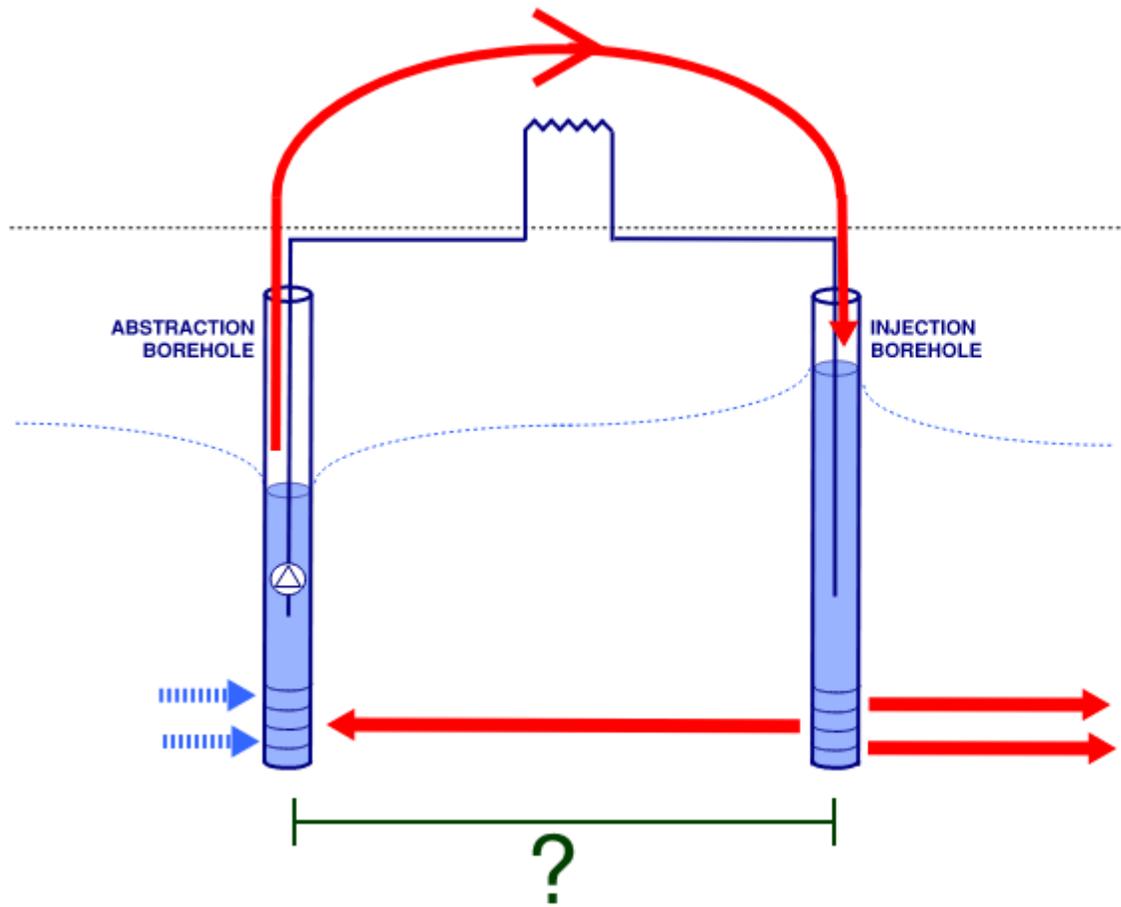
		Consequence		
		Low Risk: Minimal impact to objectives / low cost to make good	Medium Risk: Tolerable impact to objectives / moderate cost to make good	High Risk: Significant impact to objectives / high cost to make good
Likelihood	Likely	2	3	Risk Taking Clients
	Possible	Risk Adverse Clients	2	
	Unlikely		1	2
	Remote	1	2	



What's the minimum distance between boreholes

How big is your site?
 How much flow is required?
 What's the thermal imbalance over a year?
 What's the groundwater flow mechanism?
 What's the groundwater through-flow?
 Are there any temperature sensitive features in the vicinity of the site?

Better ask an experienced open loop designer



When do we need a groundwater model

How big is your site?
 How much flow is required?
 What's the thermal imbalance over a year?
 What's the groundwater flow mechanism?
 What's the groundwater through-flow?
 Are there any temperature sensitive features in the vicinity of the site?

Better ask an experienced open loop designer

Questions.....

and thank you
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