Investigating the Impacts of Hydrogeological Parameters on DSI Efficiency through Numerical Simulation

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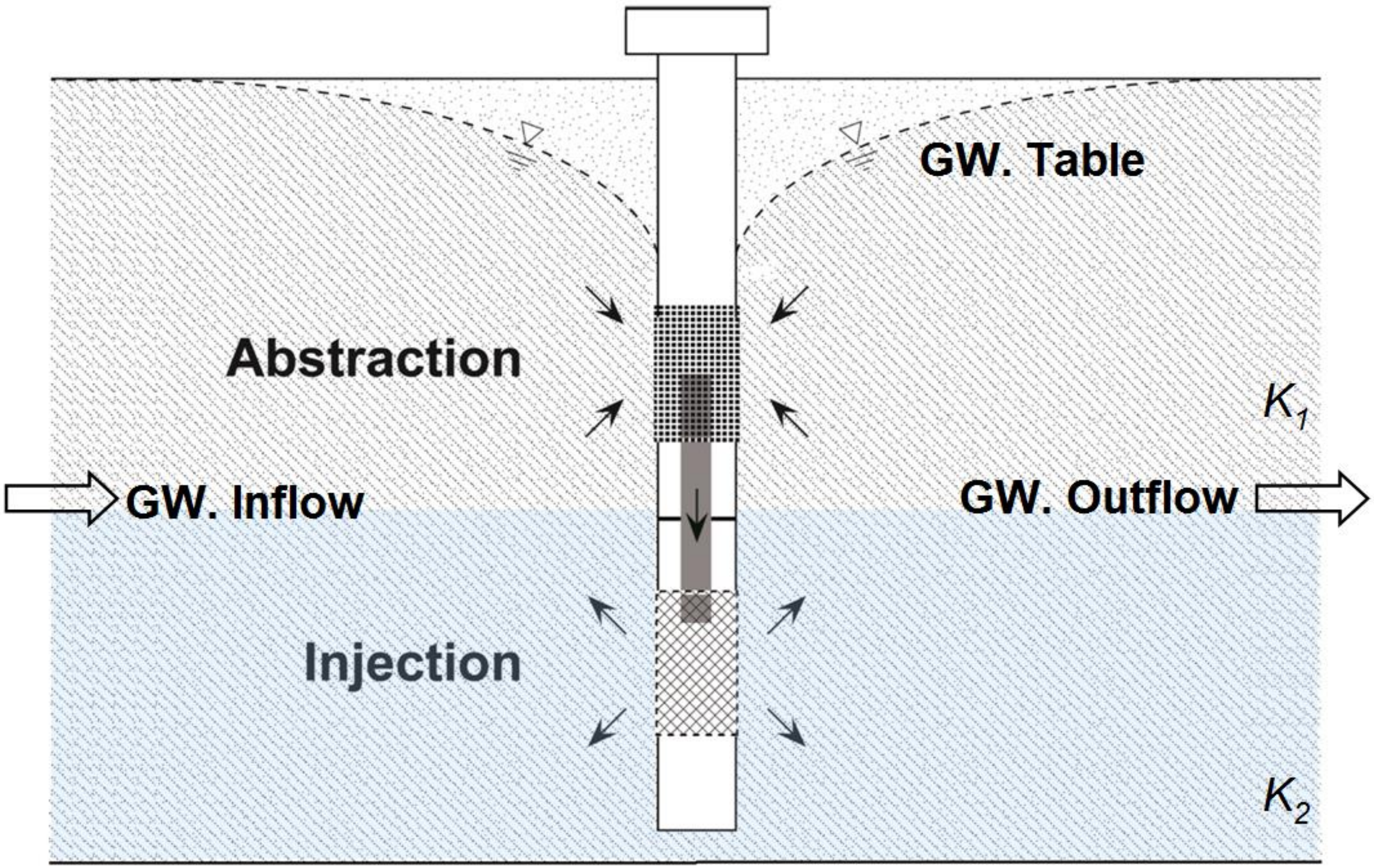
Content

- Concepts of Düsensauginfiltration (DSI) method
- Numerical model set-up
- Model validation
- Influence of hydrogeological parameters on DSI

What is DSI?



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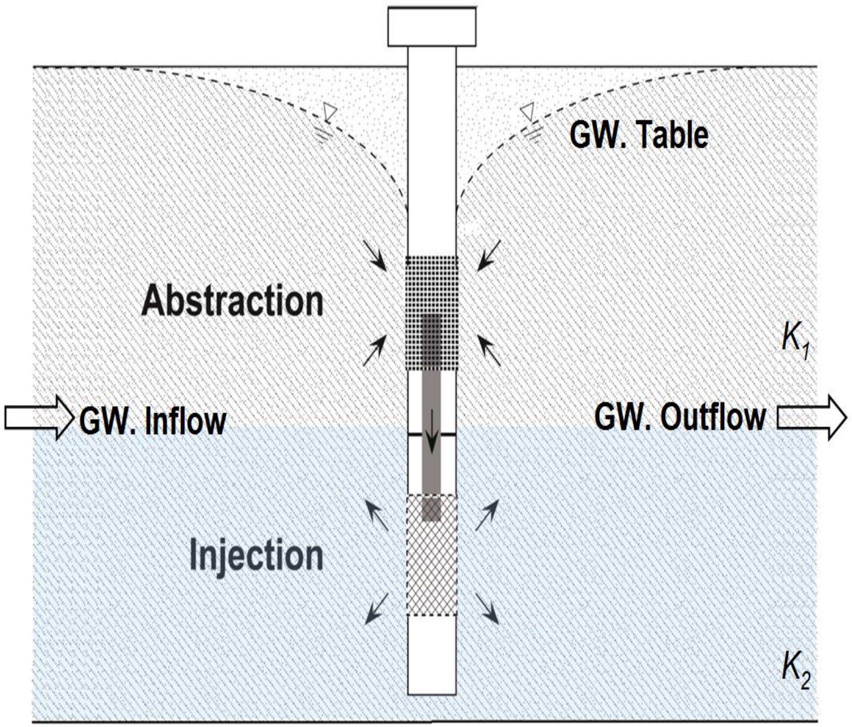
Application of DSI method



Eco-compatibility & Affordability:

- Dewatering is achieved without water abstraction from an aquifer.
- Prevent spreading water contaminants caused by water conveyance.
- Avoid costs generated by water conveyance, water treatment etc.

[1] Holzbecher E., Jin Y., Ebneth S., Borehole pump & inject: an environmentally sound new method for groundwater lowering, International Journal of Environmental Protection (IJEP), Vol. 1, No. 4, 2011.

[2] Jin, Y., Holzbecher, E. Oberdorfer, P.: Simulation of a novel groundwater lowering technique using arbitrary Lagrangian-Eulerian method, COMSOL Conference, Stuttgart (Germany), 2011.

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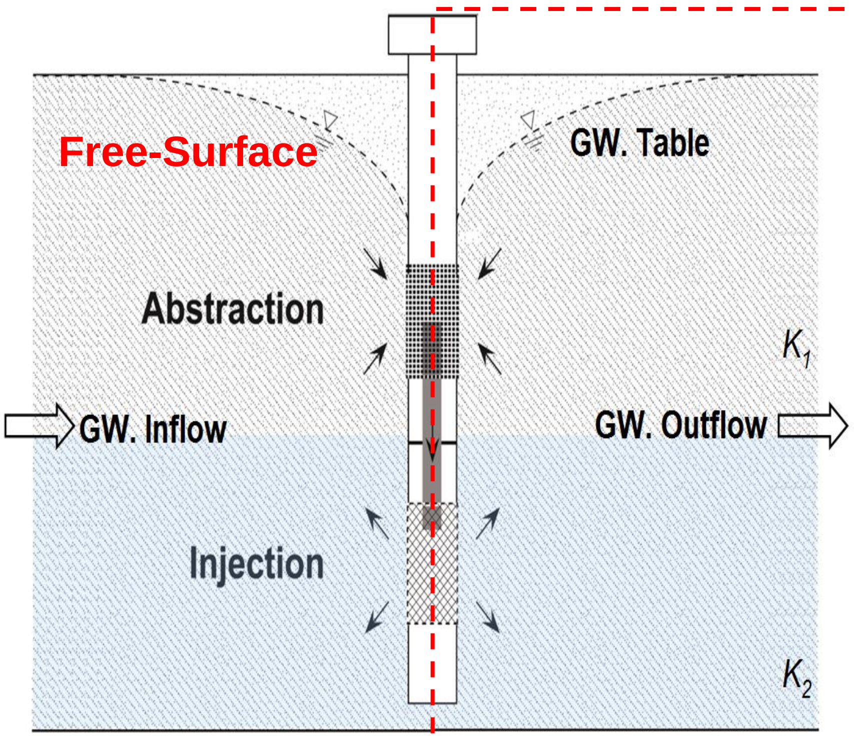
Numerical model set-up

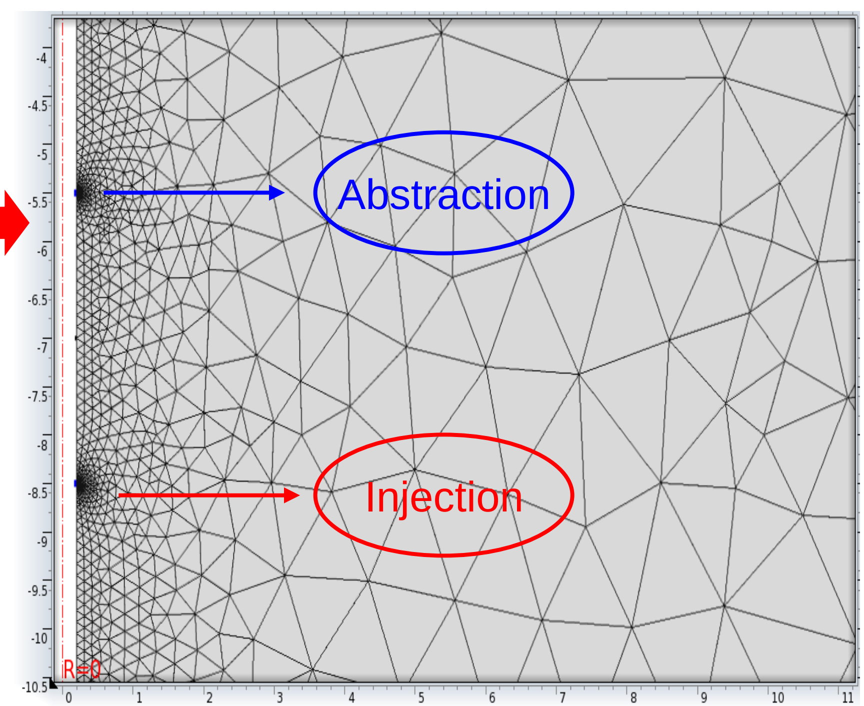
- *Darcy's Law*

$$(\alpha+\varphi\beta)\frac{\partial p}{\partial t}-q=\nabla\cdot\frac{\mathbf{k}}{\mu}\nabla(p+\rho g z)$$

α: porous medium compressibility
φ: porosity
p: pressure
q: source / sink
κ : permeability
β, ρ, μ : fluid compressibility, density, viscosity

- *Arbitrary Lagrangian-Eulerian (ALE) method*

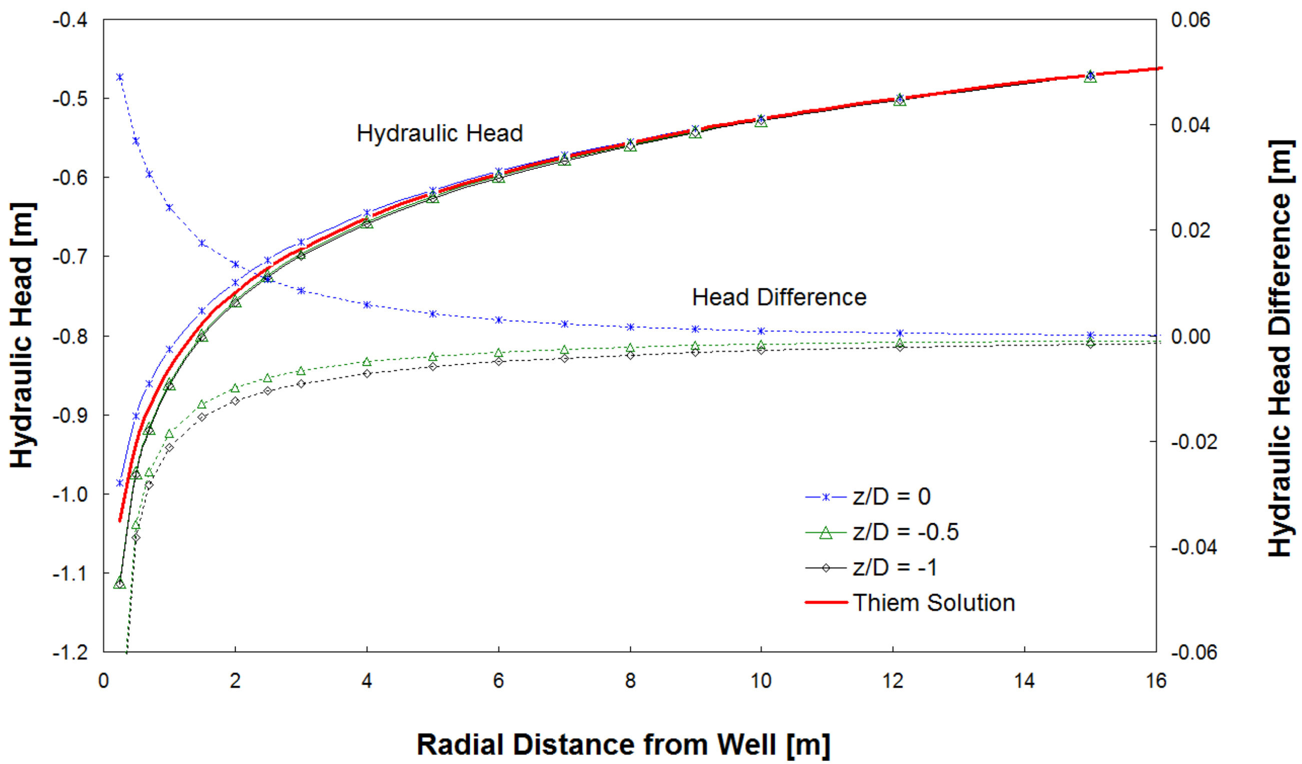




2D Model Region

Model validation

- In comparison with the analytical solution of the pumping test



[3] Jin Y., Holzbecher E., Sauter M., A novel modeling approach using arbitrary Lagrangian-Eulerian(ALE) method for the flow simulation in unconfined aquifer, *in press*: Computer & Geosciences, 2013.

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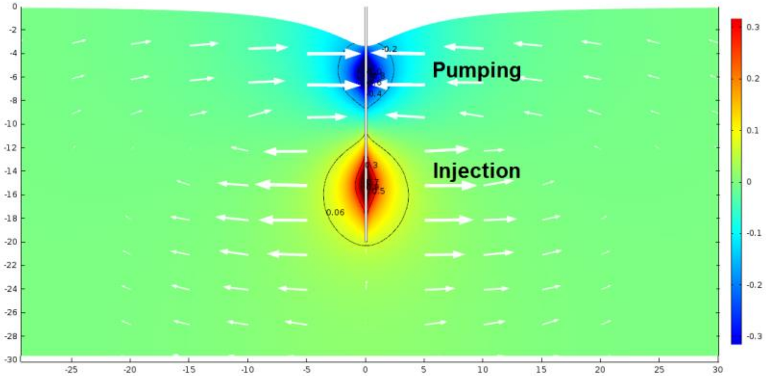
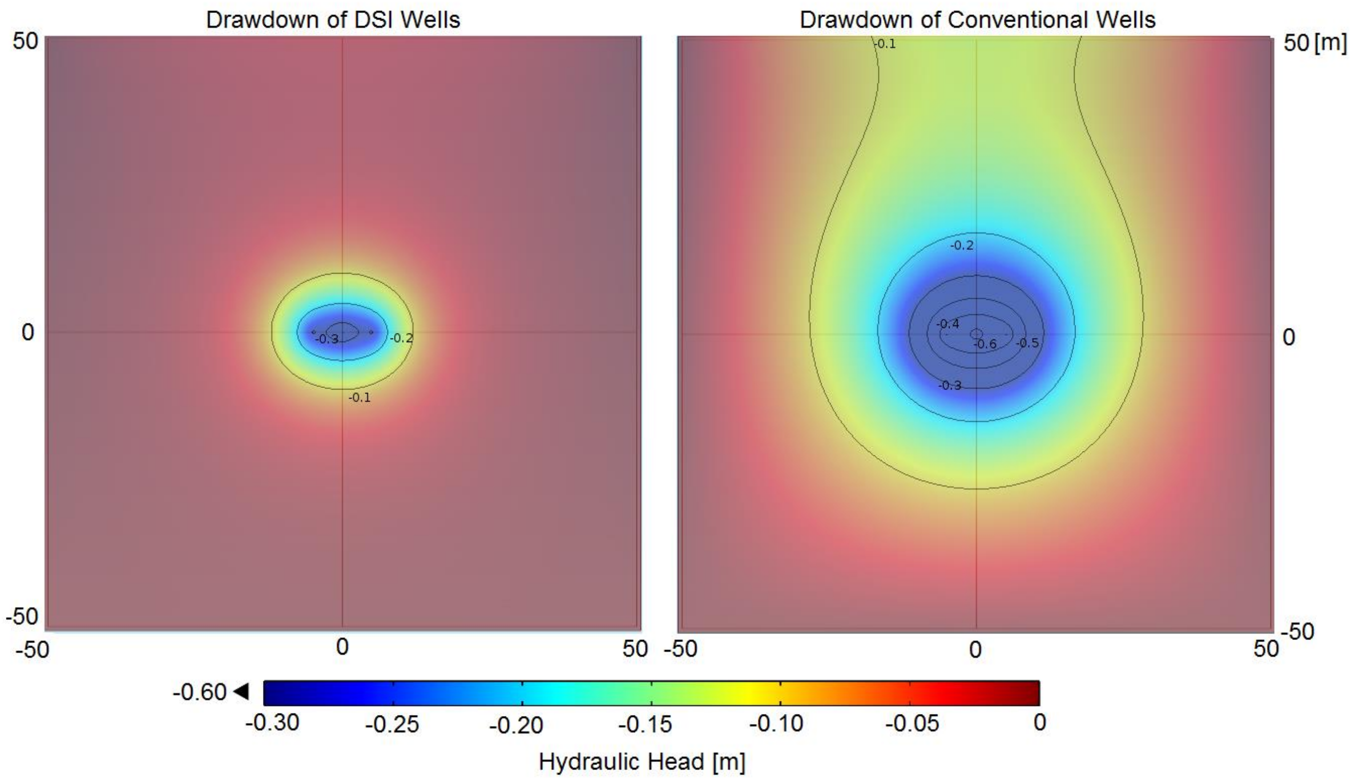
Simulation results



DSI well vertical cross-cut section

Top-Down View



Influence of the selected parameters on DSI

DSI-well setting

- Injection depth
- Pumping/injection rate

Homogeneous aquifer

- Anisotropy
- Hydraulic conductivity

Heterogeneous aquifer

- Layered

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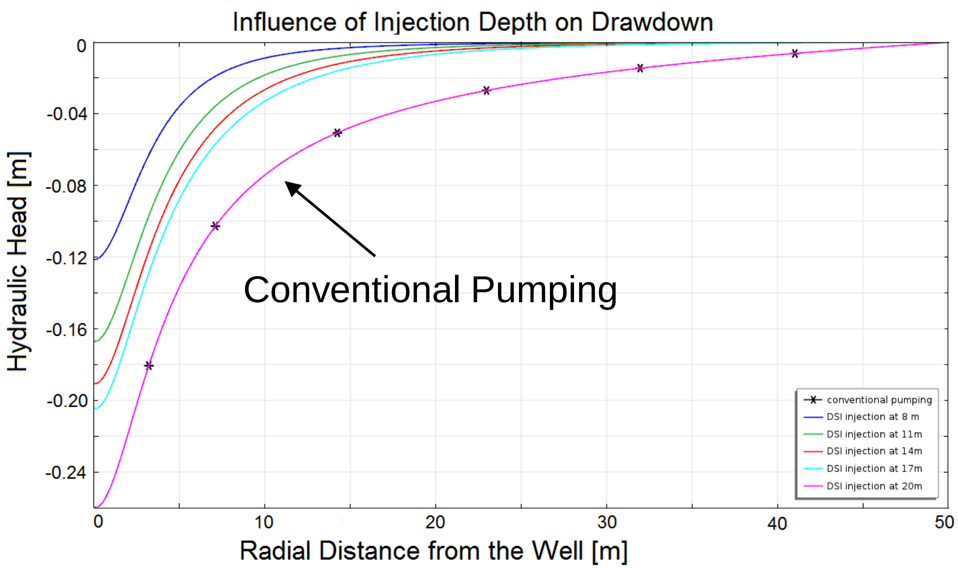
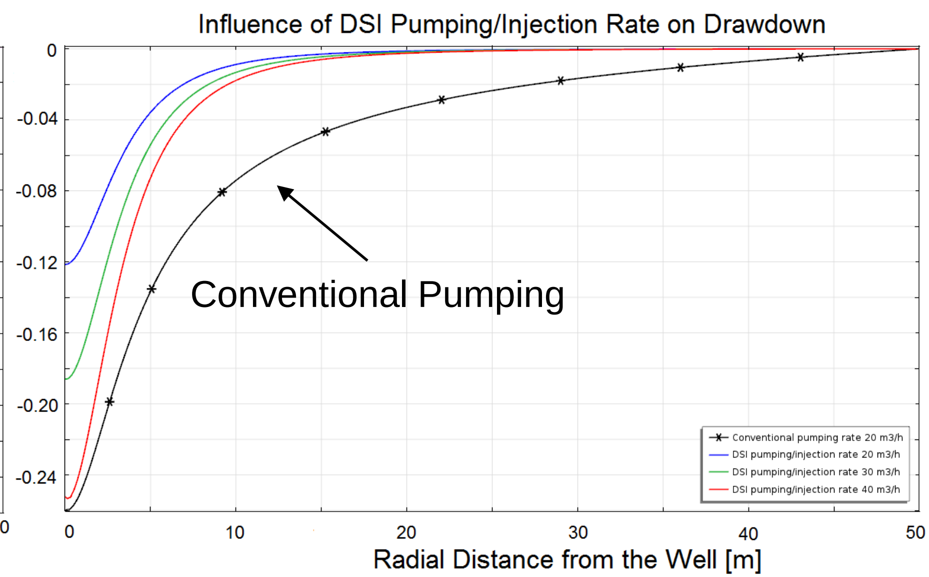
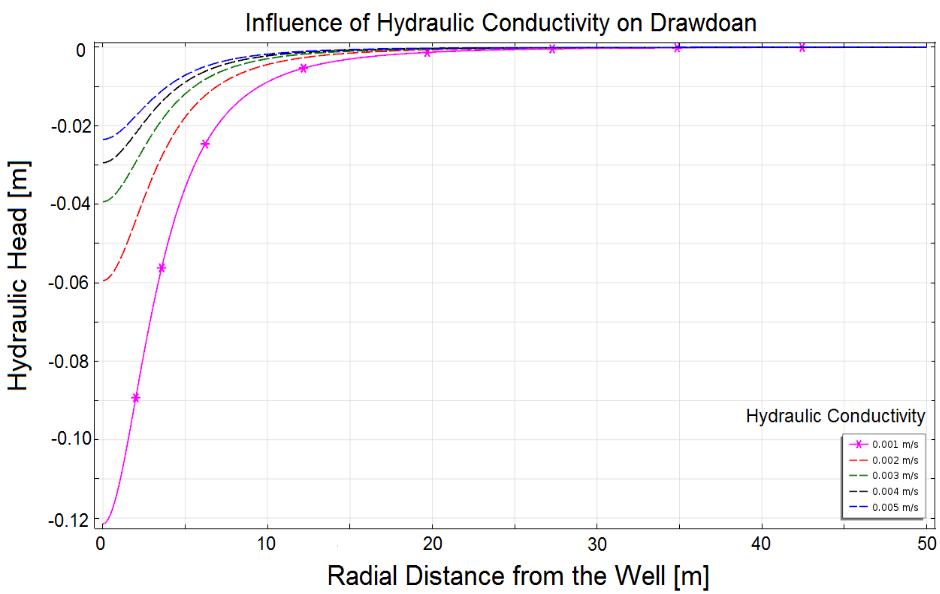
Influence of DSI-well setting on DSI efficiency

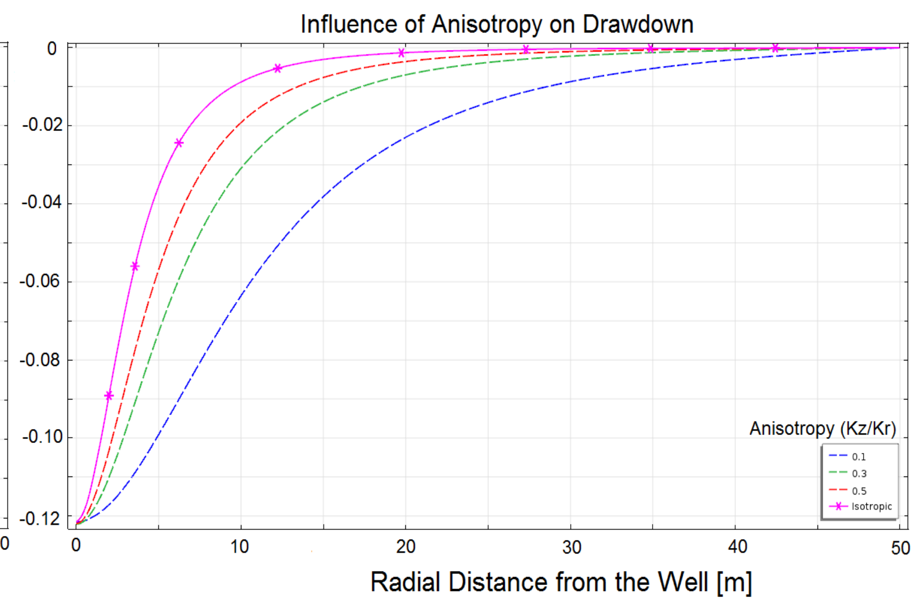




- Deeper injection depths result in larger and deeper drawdown.
- Higher pumping and injection rate of DSI installation results in deeper drawdown.

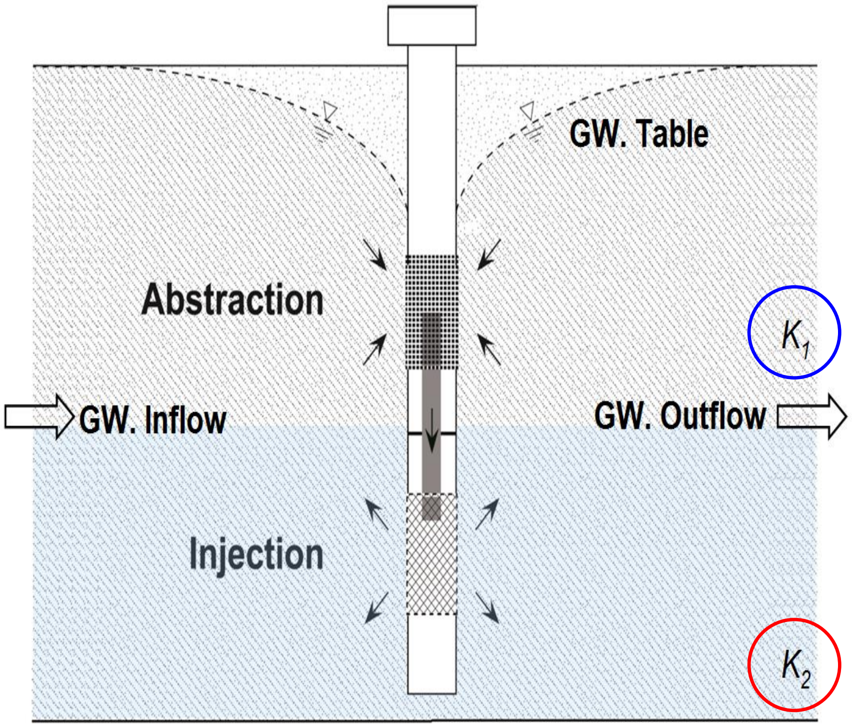
Influence of hydrogeological parameters

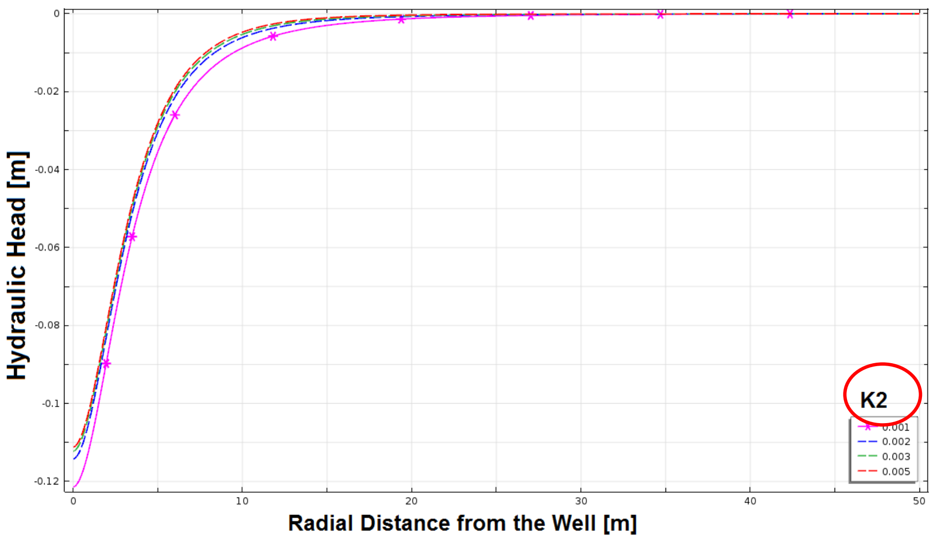




- Lower hydraulic conductivity results deeper and larger drawdown.
- Lower vertical anisotropy ratio yields in larger drawdown.

Heterogeneous Aquifer: Layered aquifer





- Lower hydraulic conductivity in injection layer results deeper and larger drawdown. (K_1=1×10^{-3}m/s, constant)

Conclusion

- Groundwater flow in unconfined aquifer (free-surface problem) is practically solved by implementing ALE method.
- The conventional dewatering results in larger influenced area than DSI method.
- Deeper injection section, higher pumping/injection rate yield in larger and deeper drawdown.
- Lower hydraulic conductivity, anisotropy ratio contribute to larger and deeper drawdown.
- Lower hydraulic conductivity of injection layer results in slightly deeper and larger dewatered area. Nevertheless, high hydraulic conductivity is required for injection.

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Thank You for Your Attention!

We appreciate the support of

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