What happens below construction pits? The long-term erosion of temporary barriers to groundwater flow#

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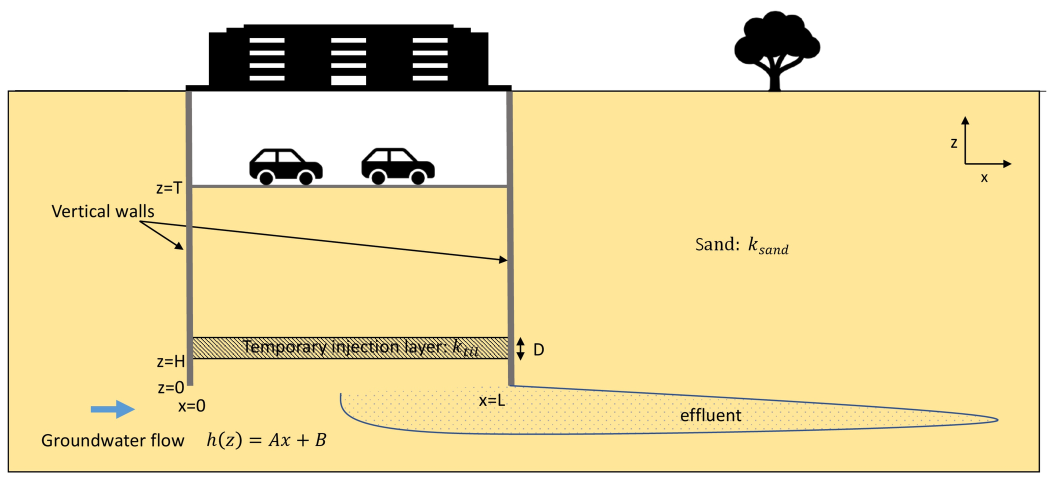
Background & Objective



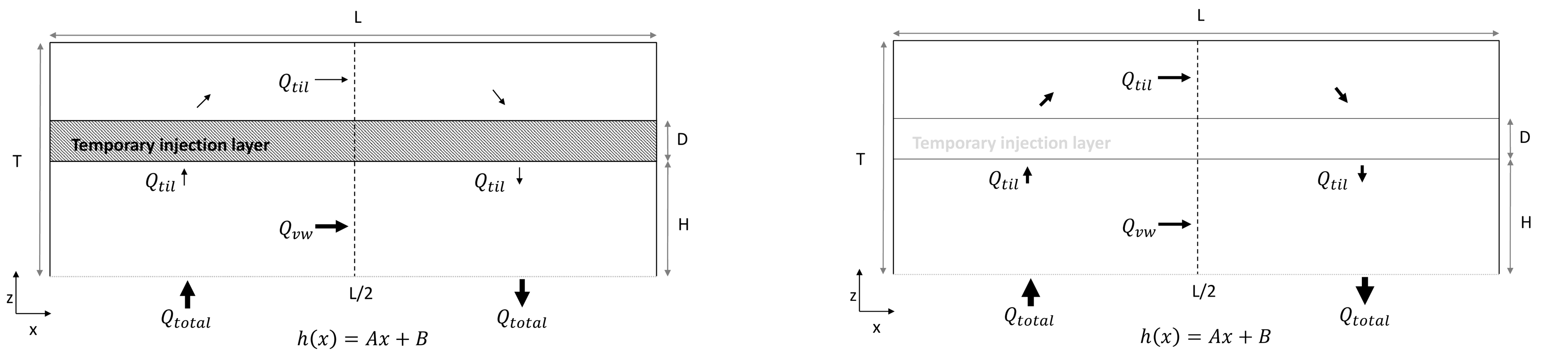
Scheme of a construction site.

Grout material ("waterglass") is widely used to create a temporary vertical flow barrier for dewatering construction sites. It is slowly dissolved after construction is finished. Since dissolved waterglass causes a potential risk to groundwater quality, it is critical to know concentrations in the effluent.

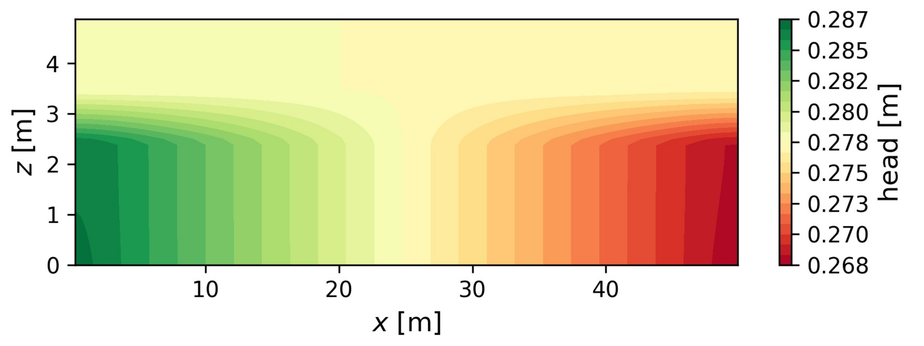
• We investigate the long-term erosion of the grout layer as function of the groundwater fluxes in the pit.

• We study characteristics of flow within the domain by means of numerical simulations mathematical analysis.

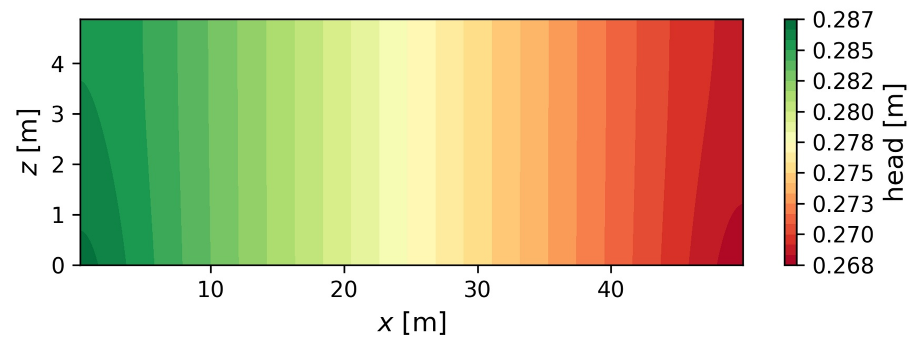
• We specify the impact of site settings.



*Top: **Fluxes** within construction pit: Q_{total} is total flux into and out of the domain; Q_{til} is flux through and Q_{vw} is flux below the temporary injection layer. Bottom: Hydraulic **head** distribution.*



*Flow situation **before erosion** (directly after construction finished).*



*Flow situation at the **end of erosion**.*

Grout Erosion & Transport

• erosion changes the hydraulic conductivity of the injection layer k_{til}

• fluxes Q change in time; higher total outflow Q_{total} with ongoing erosion

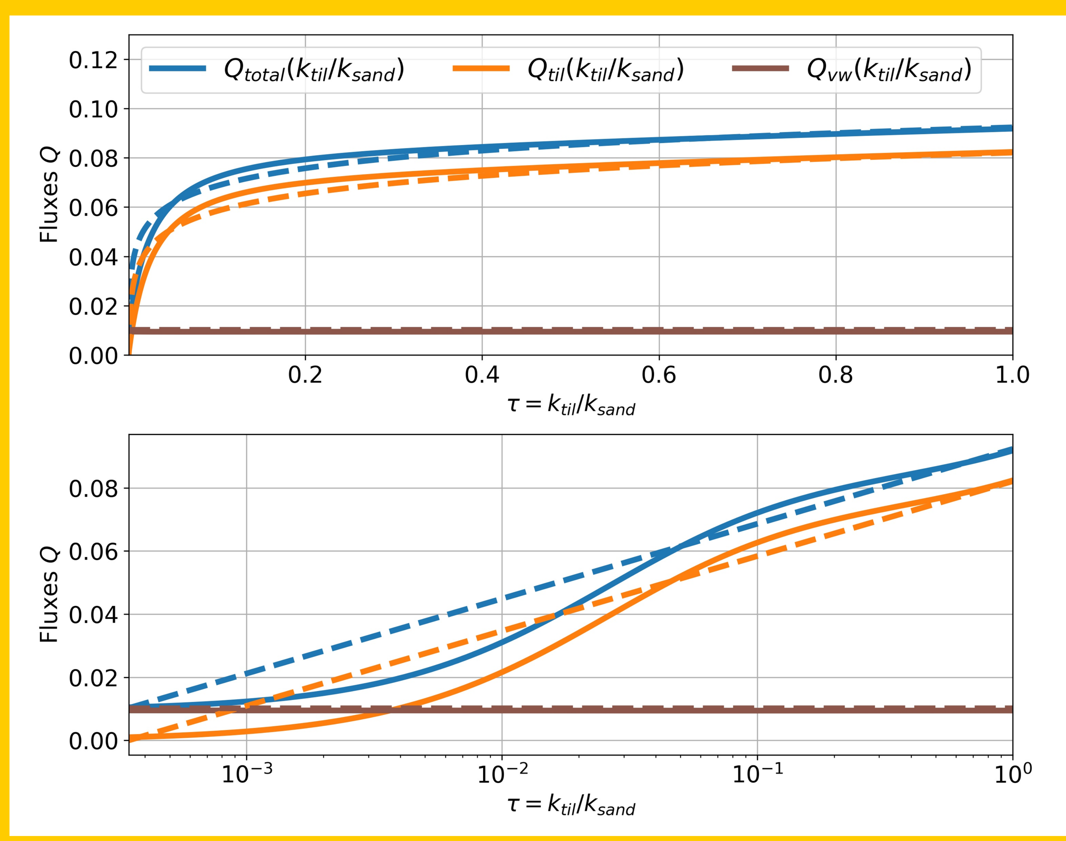
• time proxi: ratio of conductivities of injection layer and aquifer: $\tau = k_{til}/k_{sand}$ ("erosion stage")

• Numerical groundwater flow simulations provide inside to temporal evolution

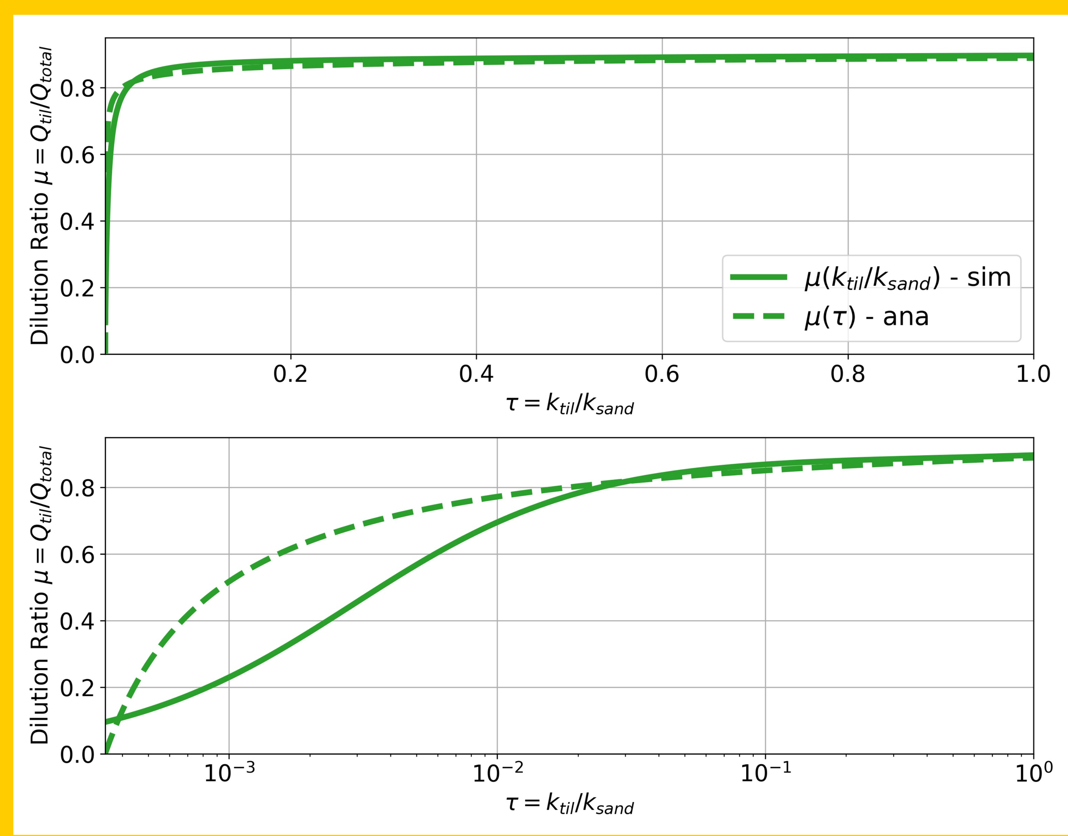
• Approximation with analytical expressions: log-linear relation for Q_{total} and Q_{til}

• dilution ratio μ relates flux out of the construction site to flux through the layer

• fluxes are sensitive to domain settings: depth to length ratio of the pit and depth of injection layer

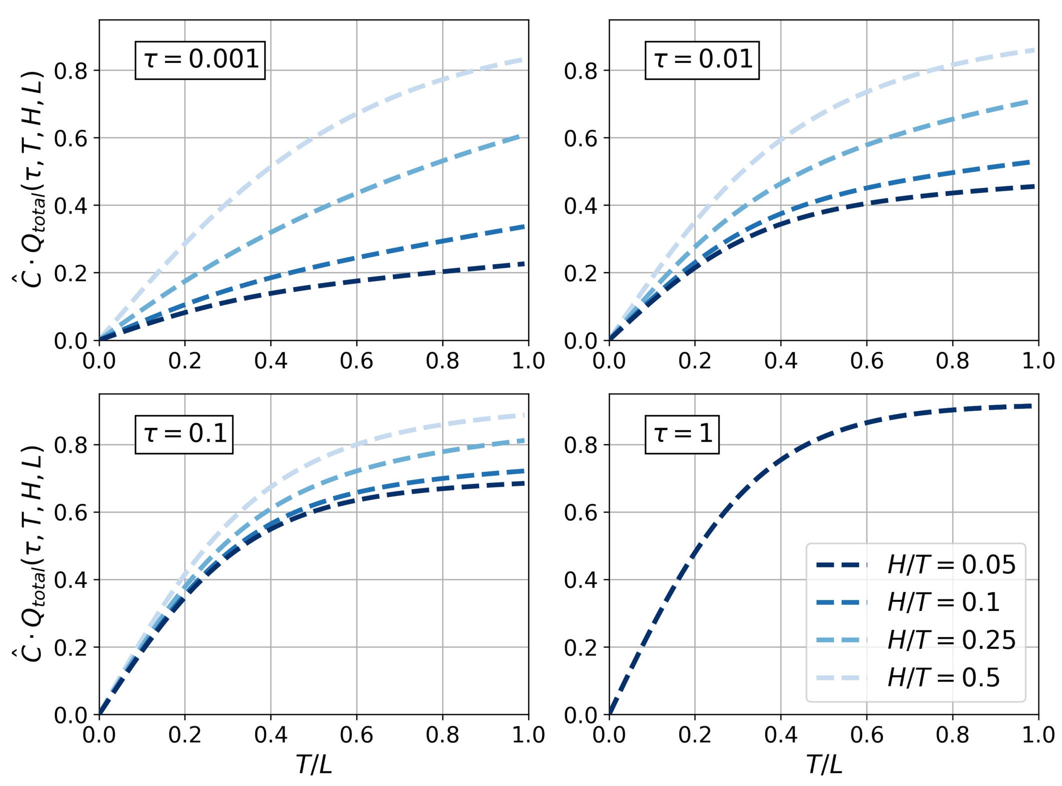


***Fluxes** through the domain as function of erosion stage $\tau = k_{til}/k_{sand}$ at linear (top) and semi-log (bottom) scale. Solid line show numerical results; dashed lines show the analytical approximations.*

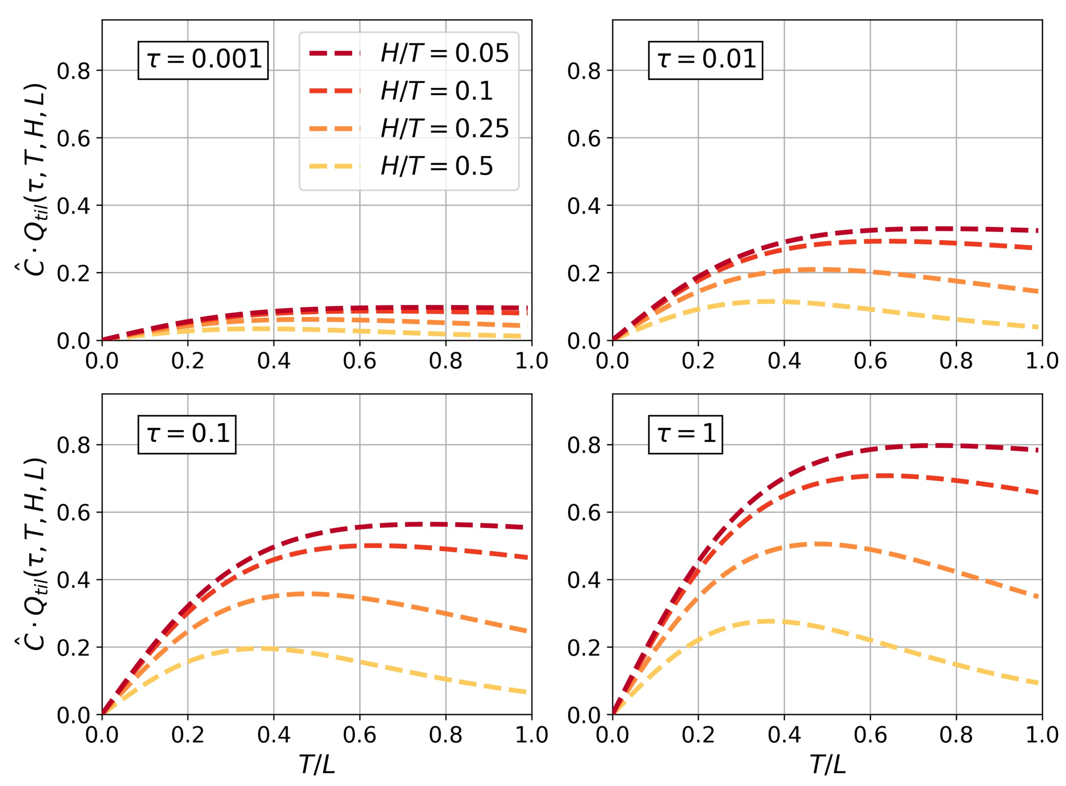


***Dilution ratio** $\mu(\tau)$=Qtil/Qtotal.*

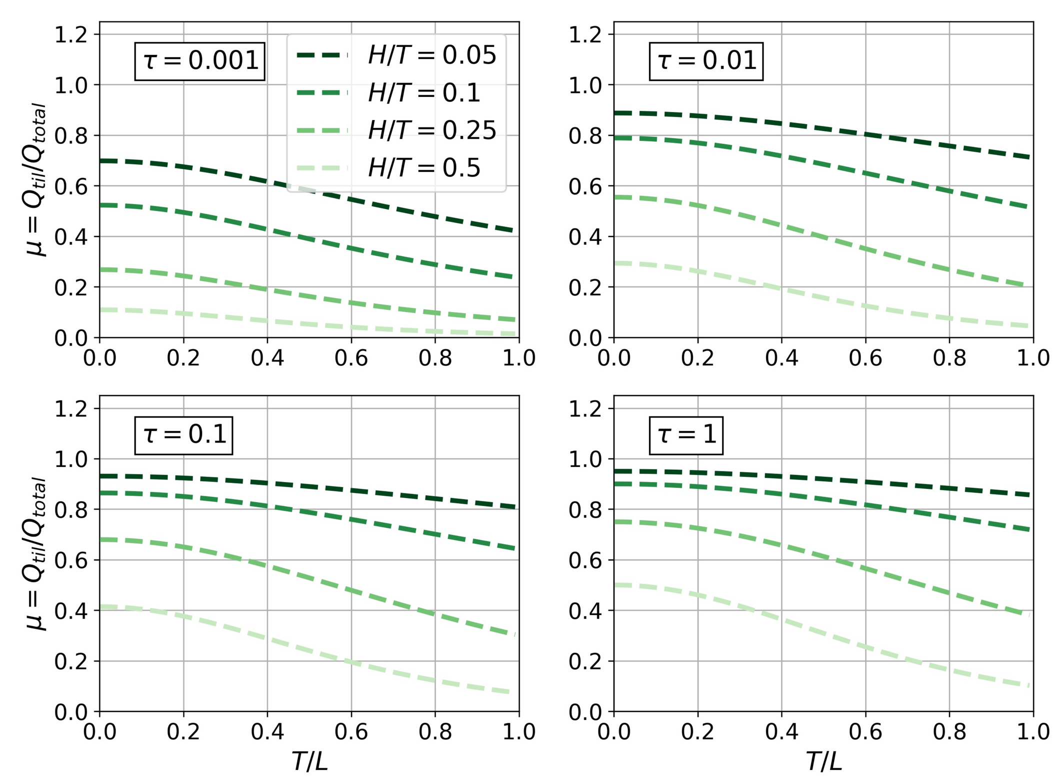
Sensitivity of Fluxes to Site Settings



***Total flux Q_{total}** as function of depth to length ratio T/L for different erosion stages $\tau = k_{til}/k_{sand}$. H/L denotes the ratio of injection layer depth H to domain depth T.*



Flux through the injection layer Q_{til}.



Dilution ratio μ.

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#Corresponding Paper: *Groundwater Flow below Construction Pits and the Erosion Behavior of Horizontal Grout Barriers*; J. M. Dekker, T. Sweijen, A. Zech; 2020; submitted to Hydrogeology Journal

Conclusions

• Fluxes into the construction pit show a log-linear relation to the conductivity ratio of the injection layer and the aquifer material.

• Erosion is initially slow and accelerates until the temporary injection layer is completely gone.

• An analytical expression allows to predict the transport behavior out of a construction site with arbitrary site settings.

• Potentially negative effects of waterglass on groundwater quality have the largest effect long time after construction ceased.

• A parameter sensitivity study showed that waterglas mass flux can be reduced by (i) increasing the distance between the bottom of the pit and the injection layer; (ii) reducing the thickness of the temporary injection layer.