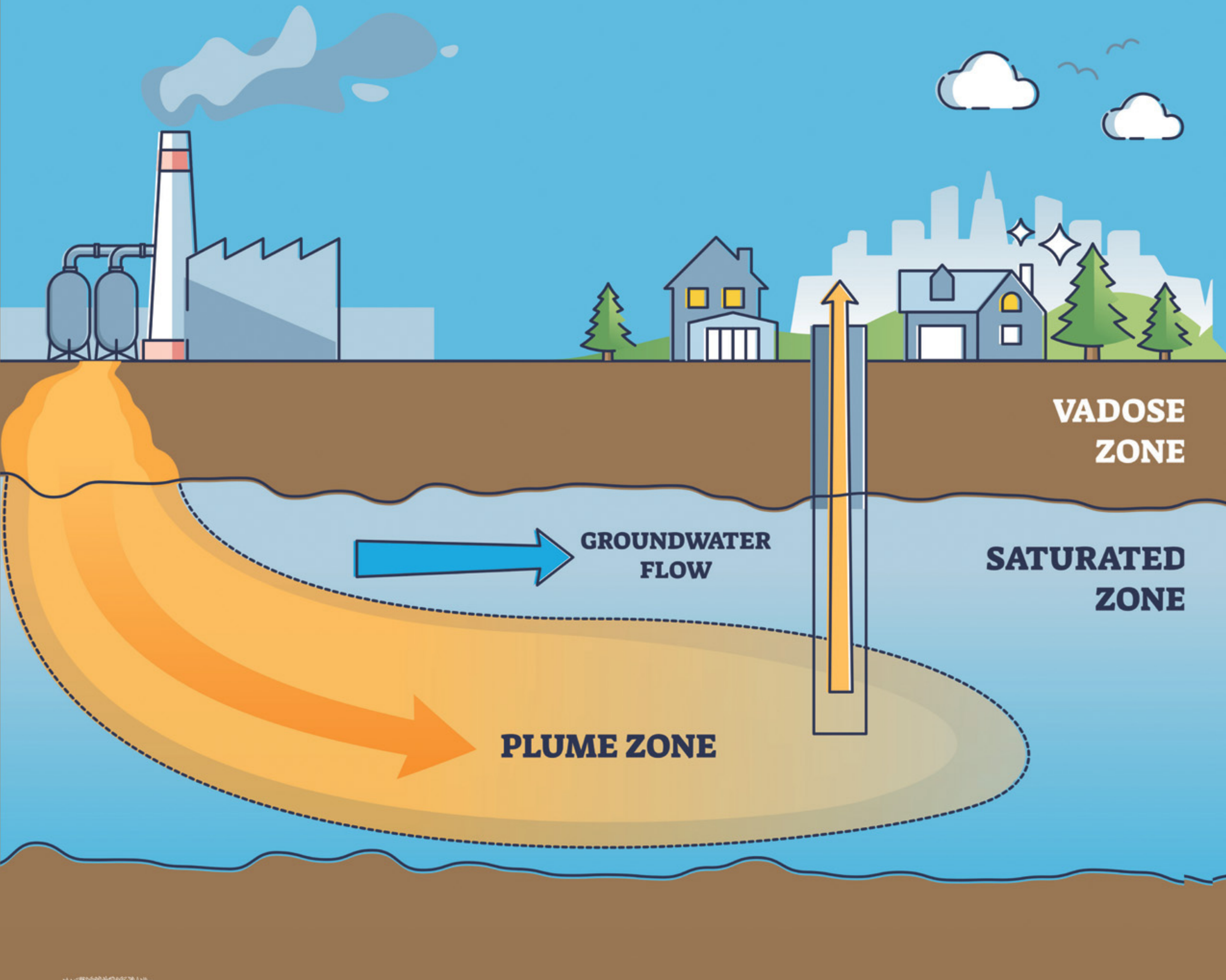
Decontamination of Subsurface Water Resources System Using Contemporary Technologies



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Chapter 4

Research on migration characteristics of CML colloid cotransported carcinogenic Cr(VI) in a two-phase porous medium incorporating a probabilistic human health risk assessment

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4.1 Introduction

Colloids existing in the subsurface ecosystem, that is, unsaturated vadose zone and saturated aquifer system, are recognized as significant contaminant carriers that enhance the mobilization of colloid-cotransported pollutants significantly (Katzourakis & Chrysikopoulos, 2015; Xu et al., 2022). Commonly present colloids in the subsurface environment are suspended clay minerals, viruses, humic elements, metal oxides, and microorganisms (Šimůnek et al., 2013). The size range of various organic, inorganic, and biological colloids present in the subsurface environment is 10 nm to 10 μm (Bradford et al., 2002). The microscopic size of colloids enables strong adsorbing tendencies to attach various contaminants such as pesticides, radionuclides, and heavy metals along the movement of colloidal particles through the interconnecting pore structure of the aquifer system (Tang et al., 2012). The cotransport of the contaminants with microscopic colloidal particles possesses the potential risk of contamination in the unsaturated zone and groundwater resources (DeNovio et al., 2004).

Over the last few decades, research studies on the investigation of mobilization and retention characteristics of colloidal particles in the heterogeneous subsurface environment have grown significantly under both laboratory-scale and pore-scale networks (Lin et al., 2021). In general, advection, molecular diffusion, and mechanical dispersion are the governing mechanisms that are involved in solute transport processes (Wang et al., 2015). Apart from these mechanisms, attachment−detachment and straining mechanisms are the two prime mechanisms that impart distinct complexity to analyze the transport behavior of colloids (Šimůnek et al., 2006). Colloidal particles are trapped during straining at particle-to-particle contact sites, areas of surface roughness, and in downgradient pore networks that are tiny for allowing particle passage (Majumdar & Dagaonkar, 2015). Experimental investigation on the mobilization of colloidal particles in a one-dimensional column signifies that the peaks of the effluent concentrations of colloids significantly reduced with increasing the size of colloids, and thus the fraction of retained colloid mass enhanced (Li et al., 2013). The blocking of particles during the mobilization through the interconnecting pore structure of the aquifer system is significantly affected by the diameter of the colloidal particles and the particle size of the porous medium under consideration (Deb & Chakma, 2022). However, thorough experimental research is required to analyze the impact of the straining mechanism on the colloid migration and retention under the porous medium of different median grain sizes. In addition, the strong adsorbing characteristic of colloidal particles enables higher reaction time between colloids and the existing contaminants in the groundwater system (Bradford et al., 2002). Several heavy metals present in the saturated aquifer environment are attached to the surface of microscopic colloids and are mobilized with them also (Liang et al., 2013). The colloids having microscopic size, migrate at a faster rate through the pore matrix of the aquifer medium and carry heavy

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