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Simulation Study for the Application of Permeable Reactive Barrier for Aquifer Remediation in the Proximity of Indian Landfill Site

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The generation of landfill leachate from huge open dumpsites has become a serious cause of concern worldwide and especially in developing countries like India. India is facing numerous problem related to groundwater contamination from the landfill leachates at various places. Therefore, applications of efficient groundwater remediation technologies could be very effective solutions for better managing and significantly reducing their extremely negative impact on adjacent receptors, or even thoroughly cleaning up contaminated groundwater to the adjacent of such contaminated sites. In this study, a groundwater flow and solute transport model are analysed followed by a virtual reactive barrier model to remove chromium (Cr (VI)) and iron (Fe (II)) simultaneously, generated from the leachate of the Bhalswa landfill, Delhi, India. The analysis is focused on two major factors of virtual PRB modelling: a) selection of an appropriate PRB design type such as a continuous reactive barrier (CRB), a funnel and gate (F&G) or a drain and gate (D&G) PRB for a particular landfill site; b) analysis of different barrier and aquifer hydraulic conductivity ratio variations and impact on the removal efficacy of virtual PRB system with time. A mixture of activated carbon (AC) and electrolytic iron powder (EIP) is used as a reactive material for the barrier. The flow model is developed using MODFLOW followed by the multi-solute transport model using MT3DMS for the same aquifer. The results of the simulation study show that the F&G is performing better than the CRB design type for the landfill site. However, for the highly populated, space constraint and resource crunched region such as Delhi, D&G systems could be better solutions compared to the other two, that is, CRB and F&G PRBs. Furthermore, simulation results strongly suggest that the ratio of barrier and aquifer hydraulic conductivity highly affects the removal efficacy of the barrier. Higher the ratio, larger the plume contaminant passes through the aquifer which leads to an increase in overall removal efficiency of the PRB. Therefore, the simulation results of the flow and solute transport model pave the way for opting a PRB as a prominent solution for aquifer remediation, within the standard permissible limit (Bureau of Indian Standards (BIS)), in the proximity of the landfill leachate area.