Ground Water, Surface Water, and Leachate

Ground Water Pumping/Pump and Treat

Introduction/Description:

Ground water pumping is one of the most regularly utilised ground water remediation technologies. The objective of the process is to removal dissolved contaminants from the subsurface, and the containment of contaminated ground water to stop its migration.

The initial step of a remediation project is the defining of remedial objectives that need to be achieved at the site. This involves background site information and field data in order to determine if cleanup or containment is the most viable option. If cleanup is chosen, the level of cleanup must be determined and for containment, ground water pumping acts as a hydraulic barrier to prevent the migration of contaminant plumes off site.

Designing and implementation of ground water pumping is based on data assessed in deciding overall objectives. The well design, pumping system, and treatment are dependent on the sites characteristics and the type of contaminant. Eventual treatment may comprise of a train of processes for instance gravity separation and air strippers. An additional consideration for ground water extraction is the need for a ground water monitoring program in order to verify its efficiency. Monitoring the progression of remediation through the use of wells and piezometers means the operator can make appropriate adjustments to the system in response to any potential changes in the subsurface conditions.

Although pumping is not an actual treatment process, treatments below typically follow:

Bioreators:

Extracted ground water is placed in contact with microorganisms in and attached or suspended growth biological reactor. In suspended systems, such as activated sludge, contaminated ground water is circulated in an aeration basin. In attached systems, such as trickling filters, microorganisms are established on an inert support matrix. Contaminants are degraded by the microorganicms.

Constructed-Wetlands:

Constructed wetlands utilise geochemical and biological processes of an artificial wetland ecosystem in order to concentrate and remove contaminants from the water.

Adsorption/Absorption:

For liquid adsorption, the solutes are concentrated at the surface of a sorbent, therefore reducing their concentration in the bulk liquid phase. The most commonly used adsorbent is granulated activated carbon (GAC), whilst other natural and synthetic adsorbents suitable are lignin adsorption, sorption clays and synthetic resins.

Air Stripping:

By enhancing the surface area of the contaminated water that is exposed to air, volatile organics are partitioned. Examples of aeration processes are diffused aeration, tray aeration, and spray aeration.

Granulated Activated Carbon (GAC)/Liquid Phase Carbon Adsorption:

Ground water is pumped through a number of columns that are packed with activated carbon, which adsorbs organic contaminants. Regular replacement or regeneration of saturated carbon is needed.

Ion-Exchange:

Ion exchange removes ions from the aqueous phase by means of exchanging cations or anions between contaminants and the exchange medium. Ion exchange materials can involve resins comprising of synthetic organic materials that contain ionic functional groups that exchangeable ions are attached to. They may also be inorganic and natural polymeric materials. After the resin capacity is exhausted, resins should be regenerated for re-use in order to maintain efficiency of the process.

Precipitation/Coagulation/Flocculation:

Dissolved contaminants are changed into insoluble solids, enabling the contaminant's subsequent removal from the liquid phase through the process of sedimentation or filtration. Typically pH adjustment is undertaken in addition to the use of a chemical precipitant, and flocculation.

Separation:

Separation removed contaminants from the matrix such as water, soil or sediment. *Ex situ* separation of waste can be undertaken by distillation, filtration, freeze crystallisation and reverse osmosis.

Sprinkler-Irrigation:

Wastewater is trickled over a filter bed and microorganisms attached to the filter medium breakdown the organic contaminants in waste.

Surfactant Enhanced Recovery:

The use of surfactants can facilitate the ground water pumping process through increasing the mobility and solubility of the contaminants sorbed to the soil matrix. The implementation of surfactant-enhanced recovery involves the injection of surfactants into the contaminated aquifer. Standard systems use a pump to remove ground water at a distance away from the injection point. The extracted water is then treated *ex situ* to separate the surfactant from the contaminants and ground water. The design of the surfactant-enhanced recovery system is vital to ensuring that the process is cost effective. After the surfactants have been separated from the ground water they may be re-injected into the subsurface. Contaminants must be separated from the ground water and treated before being discharged.

Drawdown Pumping:

Drawdown non-aqueous-phase liquid (NAPL) recovery systems pump NAPL and ground water from wells or trenches. The pumping extracts water and decreases the water table to create a cone of depression which generates a gravity head that pushes the flow of NAPL towards the extraction well and increases the thickness of the NAPL layer in the well. In most cases, the cone of depression increases the recovery rates of NAPLs. Pumping can be undertaken with one or two pumps. In a single-pump situation, one pump withdraws both the water and NAPL. In a dual-pump setup, one pump located below the water table removes the water and the second pump located in the NAPL layer recovers the NAPL. Although a single-pump system lowers the capital and operating costs and is also a simpler system to operate, the stream of mixed water and NAPL requires separation after removal.

Dual phase extraction process for undissolved liquid-phase organics is used in situations where a fuel hydrocarbon lens of more than 20 centimetres (8 inches) thick is present on the surface of the water table. The free product is drawn to the surface through the pumping system. After recovery, it can be disposed of or purified before being re-used. The dual phase extraction process is a full-scale technology.

Applicability:

Site characteristics, including hydraulic conductivity, determine the range of remediation options that are possible at a site. Chemical properties of the site and plume also require determining in order characterise the transport of the contaminant and assess the feasibility of ground water pumping. The history of the contamination event, properties of the subsurface, and the biological/chemical characteristics of the contaminant are also important considerations. Surfactant-enhanced recovery is most suited to sites impacted with dense non-aqueous-phase liquids (DNAPLs).

Drawdown pumping is efficient for the recovery of NAPLs when the aquifer has moderate to high hydraulic conductivity and a thick layer of low-viscosity NAPL. An aquifer with high hydraulic conductivity generates a lower flow resistance of NAPL into the well. This option is commercially available and can be easily implemented with standard pumps. Installation costs are moderate, with the cost per amount of NAPL recovered differing vastly.

Limitations:

- System designs fail to contain the contaminant as predicted, allowing the plume to migrate and failure of the pumping equipment.
- Residual saturation of the contaminant in the soil pores cannot be removed by ground water pumping. Contaminants tend to be sorbed in the soil matrix. Ground water pumping is not applicable to contaminants with high residual saturation, contaminants with high sorption capabilities, and homogeneous aquifers with hydraulic conductivity less than 10-5 cm/sec.
- The cost of permitting procuring and operating treatment systems is high. Additional cost may also be attributed to the disposal of spend carbon and other treatment residuals and wastes.
- Subsurface heterogeneities, as with most ground water remediation technologies, present challenges to the successful implementation of surfactant-enhanced recovery
- Potential toxic effects of residual surfactants in the subsurface
- Off-site migration of contaminants is possible due to the increase in solubility achieved with surfactant injection. Obtaining regulatory approval to inject surfactants into an aquifer is needed.
- A cone depression in the water table can smear the free product or trap the fuel in the saturated zone when the water table returns to its original level.

Performance Data:

Numerous pump and treat technologies for hazardous waste removal have been tested over the years.

Cost:

Cost is based on site-specific conditions.