Ground Water, Surface Water, and Leachate

Phytoremediation

Introduction:

Phytoremediation utilises plants in order to transfer, stabilise and eliminate organic/inorganic contamination in ground water, surface water, and leachate.

Description:

Mechanisms of phytoremediation take in enhanced rhizosphere biodegradation, hydraulic control, phytodegradation and phytovolatilisation.

Enhanced Rhizosphere Biodegradation:

Enhanced rhizosphere biodegradation takes place in the soil directly adjacent to plant roots. Natural substances released by plant roots provide nutrients to microorganisms, which improves their biological performance. Plant roots in addition loosen the soil and then die, leaving paths for the transportation of water and air. The process pulls water to the surface zone and dries the lower saturated zones.

Hydraulic Control:

Depending on tree species, climate and season, trees may operate as an organic pump through their roots reaching down to the water table and creating a dense root mass that takes up large quantities of water.

Phytodegradation:

Phytodegradation is the metabolism of contaminants in plant tissues. Plants generate enzymes, for instance dehalogenase and oxygenase, that assist catalyse degradation.

Phytovolatilisation:

Phytovolatilisation comes about as plants take up water containing organic contaminants and release the contaminants into the air via the leaves.

Applicability:

Phytoremediation can be used to treat organic contaminants that may be present in surface water, ground water, leachate, and municipal and industrial wastewater.

Limitations:

- Limited to shallow soils, streams, and ground water.
- High concentrations of hazardous materials can be toxic to plants.
- It involves the same mass transfer limitations as other bio-treatments.
- Climatic or seasonal conditions may interfere or inhibit plant growth, thus slowing the remediation efforts, or increasing the length of the treatment time.
- It can transfer contamination across media, e.g. from soil to air.
- Phytoremediation will likely require a large surface area of land.
- The toxicity and bioavailability of biodegradation products is not always known.

More research is necessary to establish the fate of a variety of compounds in the plant metabolic cycle to make certain that plant droppings and products manufactured by plants do not contribute toxic or harmful chemicals into the food chain or amplify risk exposure to the public.

Data Needs:

Water movement, oxygen concentrations, root growth, and root structure all can have an impact upon the growth of plants and must be taken into account when considering the use of phytoremediation.

Performance Data:

In Iowa, the EPA established the use of phytoremediation via the planting of poplar trees between a cornfield and a stream. The trees operated as natural pumps to prevent toxic herbicides, pesticides, and fertilisers out of the stream and ground water. After three years, while the nitrate concentration in ground water at the edge of the cornfield was measured at 150 mg/L, ground water amongst the poplar trees along the stream bank had nitrate concentration of only 3 mg/L.

Cost:

The area of contamination is a major cost driver, as is the density of sampling, which could be driven by regulatory desires. Tree size (maturity) can also have an impact.