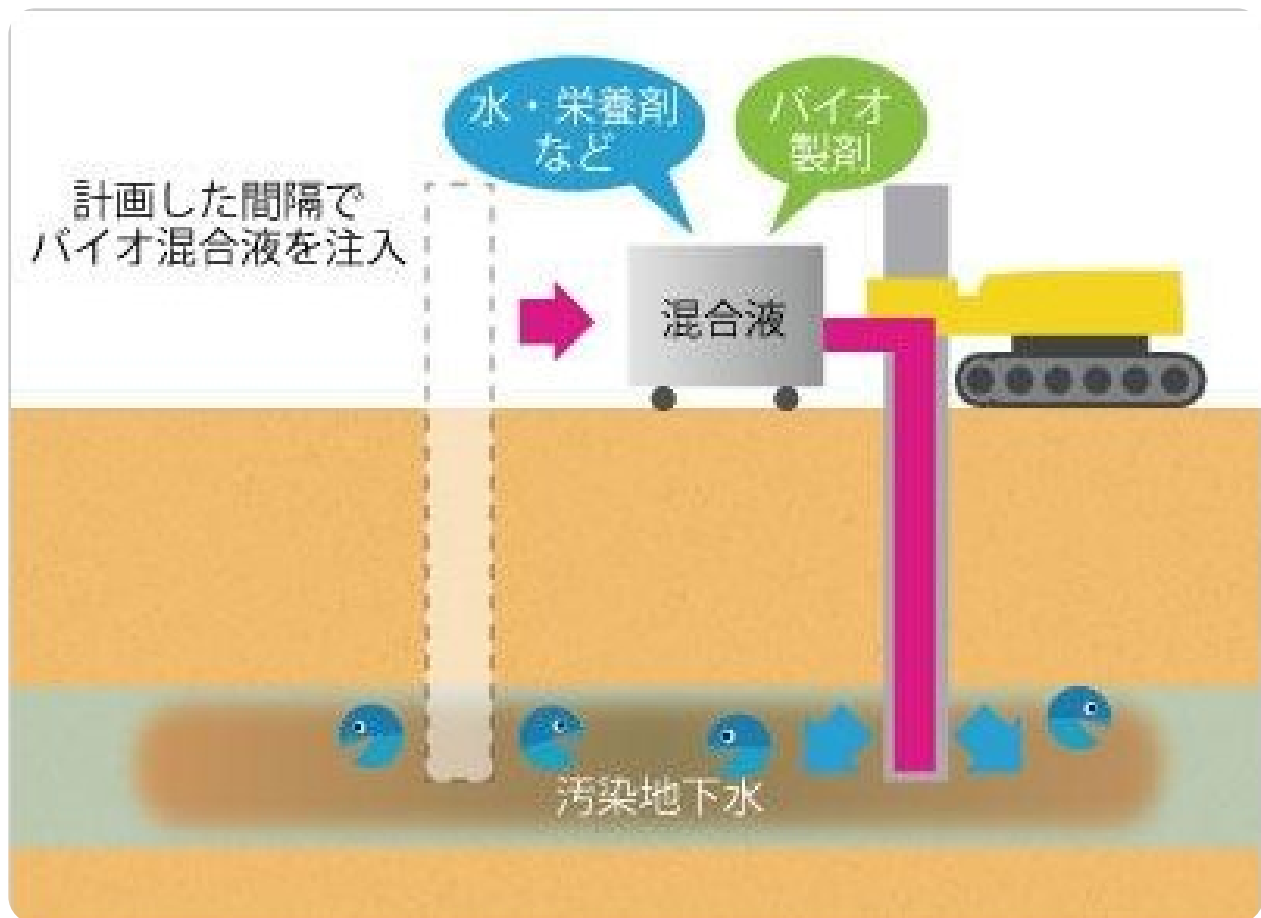


Remediating Groundwater Oil Contamination with Bioremediation

From investigation to completed remediation—the workflow and methods for cleaning up groundwater oil contamination with microbes



BioRangers

Overview

Bioremediation is a method that uses the power of microbes to break down oil and remediate contamination. It places little burden on the environment and can also address groundwater contamination that has spread over a wide area. Here we explain the workflow from investigating groundwater contamination through to completed remediation, along with the on-site injection methods.

Target Groundwater contaminated by oil	Principle Microbial breakdown of oil (aerobic oxidative degradation)
Main methods Rod injection (direct push) / well injection	Strengths Low environmental burden; suited to wide areas

Investigating Groundwater Contamination

When oil contaminates soil, the contamination may remain confined to the soil, but the oil can also penetrate deep underground and reach the groundwater. Whether it has reached the groundwater is confirmed by a boring survey.

Once oil reaches the groundwater, it can spread laterally across the water table, allowing the contamination to extend over a wide area. Furthermore, when the groundwater level rises and falls with seasonal variation, the oil moves up and down with it, expanding the contaminated area. Wells are installed to sample the groundwater and check the oil (TPH) concentration, oil odour, and oil sheen.

Remediation Planning and Treatability Testing

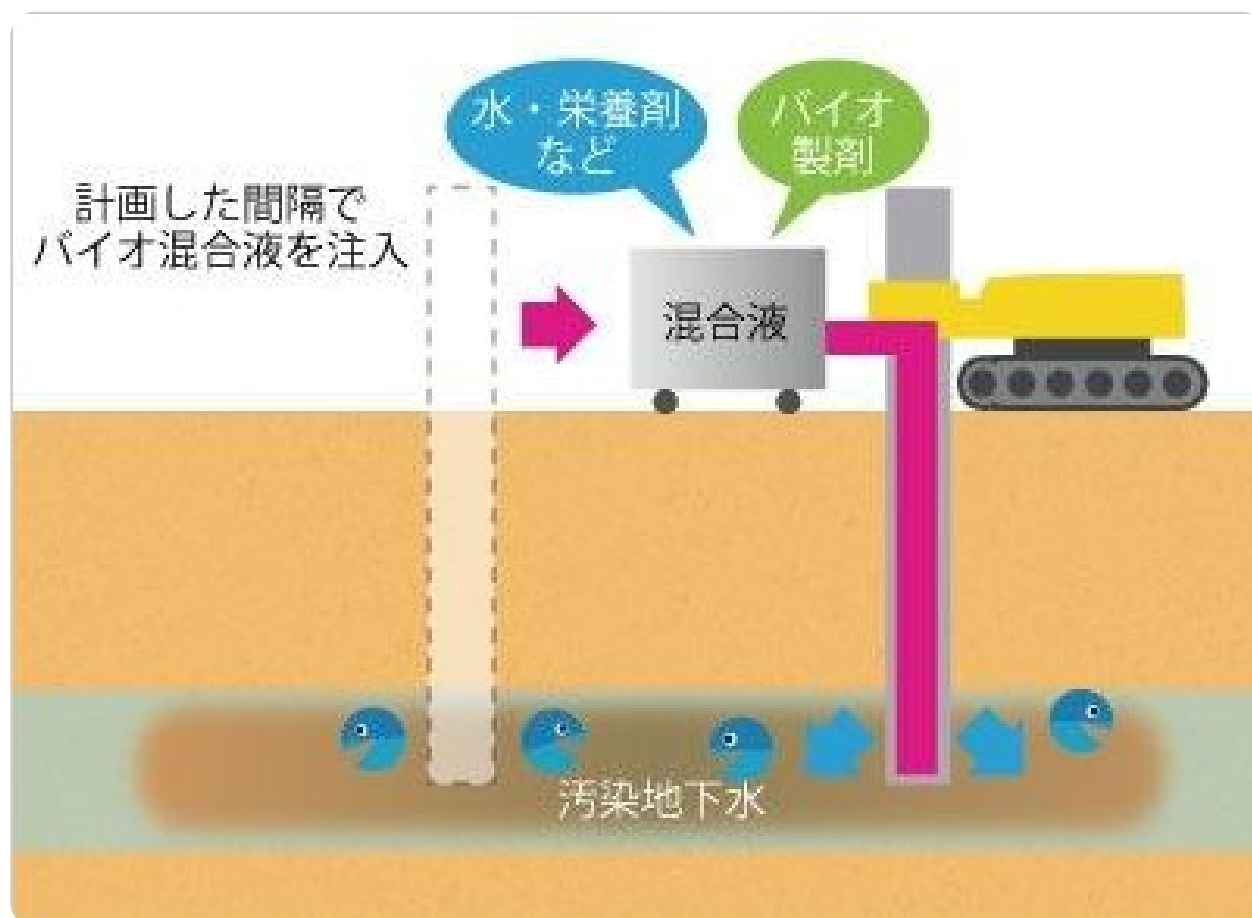
After the investigation, a remediation plan is drawn up based on the investigation report. When bioremediation is adopted, the dosage of the agent, the injection spacing, and the injection method are determined at this planning stage. Clients often consult us at the point when this investigation report has been issued, and we provide our estimate based on the report.

Whether remediation is feasible depends on site-specific conditions such as the type of oil, the oil (TPH) concentration, and water quality. We therefore ask clients to send us a sample of the oil-contaminated groundwater so that we can confirm the remediation effect in advance through a treatability test. The test takes about one to two weeks, and once we judge that remediation is feasible, we begin preparing for the on-site remediation work.

- Rod injection

Rod Injection (Direct Push)

A rod is inserted into the ground with a boring machine and, as it is withdrawn, the bio-mixture is injected at each depth. After injection, extraction wells and injection wells are installed, and circulating the groundwater by pumping promotes remediation. Oil breaks down faster under aerobic conditions, so circulation can supply oxygen and is also expected to help disperse the injected bio-mixture uniformly.



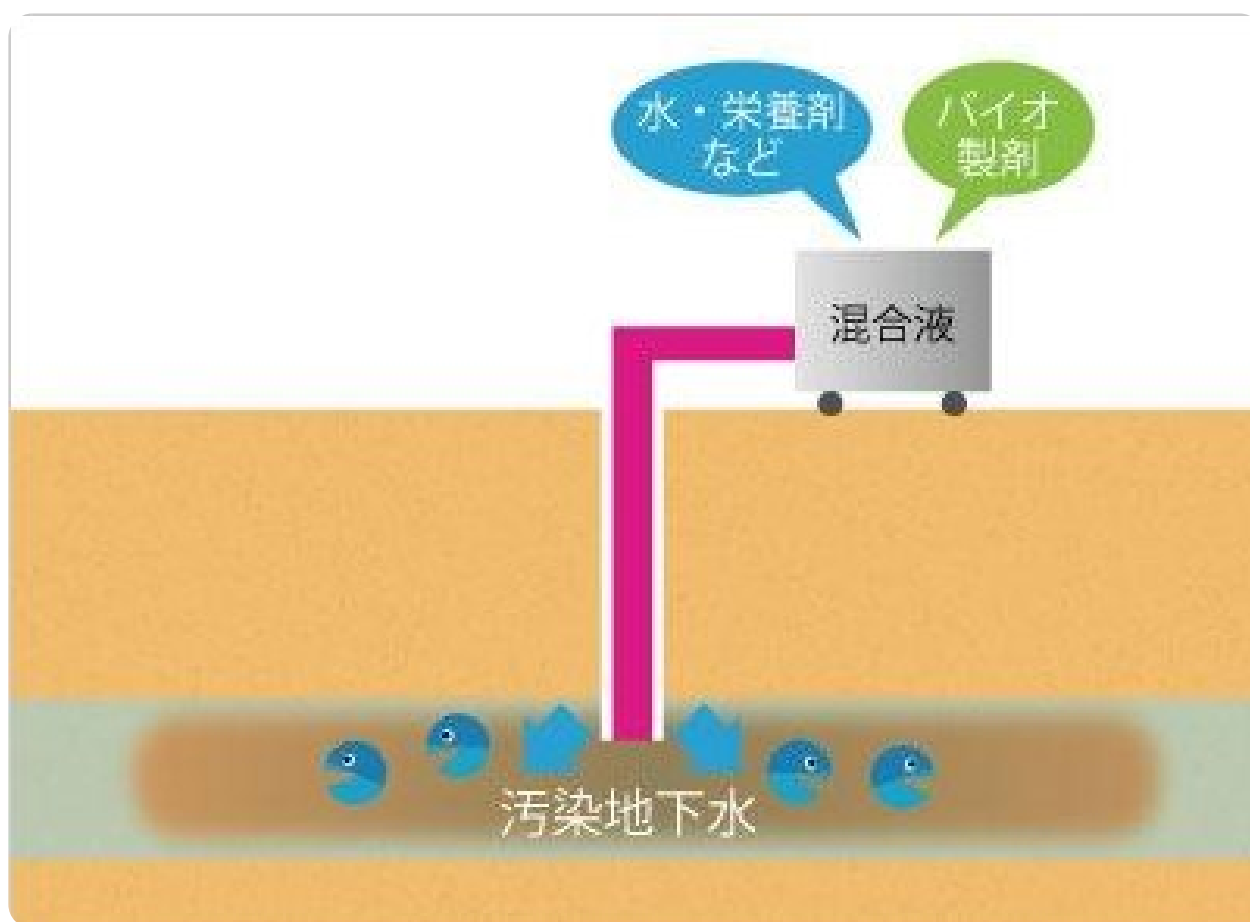
Rod injection: the bio-mixture is injected at each depth at the planned spacing

The pumped groundwater is used not only for circulation but also for monitoring remediation progress. Monitoring checks TPH, oil odour and oil sheen, pH, nitrogen and phosphorus concentrations, the total microbial count, and more. On site, it is also important to check the groundwater level, DO (dissolved oxygen), and ORP (oxidation-reduction potential).

- Well injection

Well Injection

This method installs a well of about $\phi 50\text{mm}$ and injects the bio-mixture from the well. There are two approaches: gravity infiltration, in which the pressure from the height difference lets the mixture seep down slowly from above, and pressure injection, in which the well is capped and pressure is applied. Gravity infiltration is possible where the layer is highly permeable.



Well injection: the bio-mixture is injected from the well and made to infiltrate the contaminated groundwater

A well that has finished injection can, like in rod injection, be used for pumping circulation, and it is important to monitor remediation progress. A zone is considered remediated once it has met the remediation target.