No. PREX-GEN101007

In-situ Remediation of Contaminated Soil and Groundwater using the Power of Mother Nature

Bioremediation Product Series

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About EcoCycle Corporation

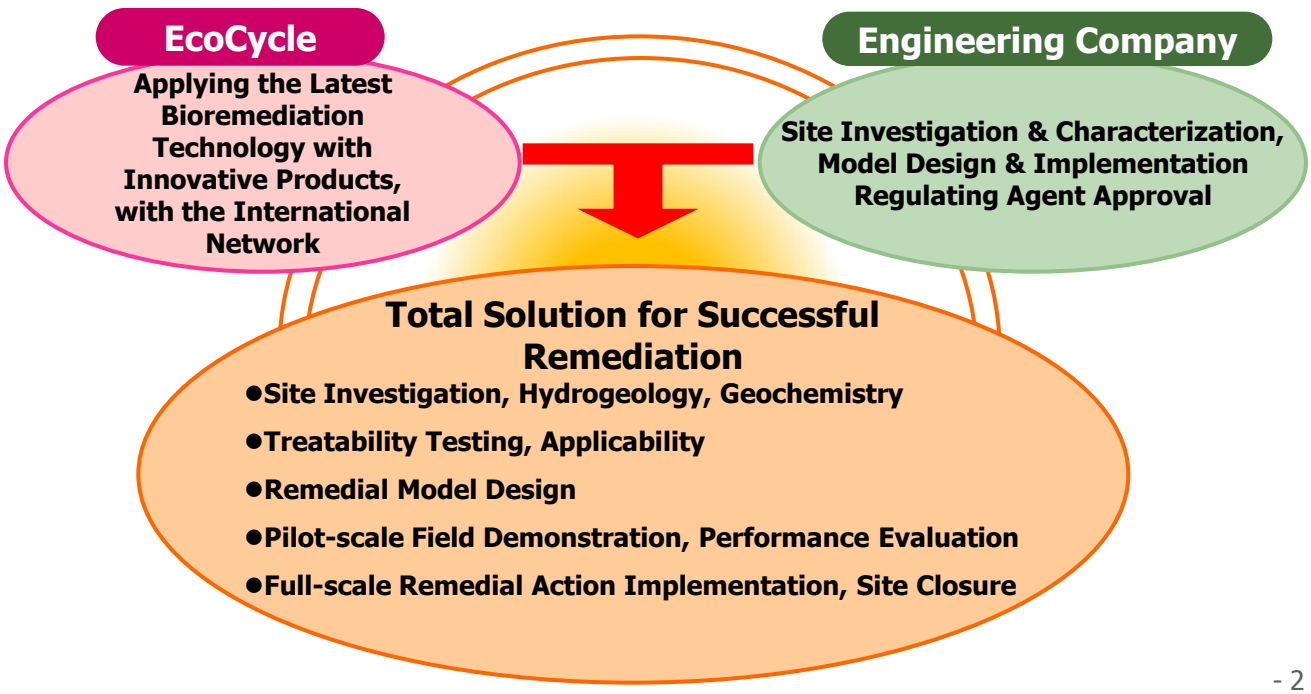
The Organization

EcoCycle Corporation is a Japanese company focused on developing ***cutting-edge technologies*** for various environmental problems the world is facing today. We have in-house ***dedicated team of engineers and scientists***. We also sponsor research and technology development at various universities and institutes who have world-class research facilities. We are involved in environmental remediation business, recycling of industrial effluents, and developing environmentally friendly biofertilizer business.

Capabilities and Experience

- **Our Products:** Our bioremediation products have been successfully applied for cleaning of over 150 sites contaminated with chlorinated solvents, chromium (VI), petroleum hydrocarbons and cyanide in Japan, the US and other Asian countries. We are looking for vendors/partners for marketing our products in some Asian, European and North American countries.
- **Technical capabilities:** We have developed technical partnership with many leading Japanese and American companies specialized in contaminated site investigation and remediation. With the help of their inter-disciplinary technical team consisting of hydrogeologists, environmental engineers, chemical engineers, environmental microbiologists, civil engineers and others we can provide tailor-made solutions to the clients worldwide.
- **Knowing the problem:** As a team, we can successfully implement site-investigation program to understand the extent of contamination, make risk assessment, develop remedial action plan, implement the plan, close the site and deal with the regulating agencies.
- **The solution:** Though we are specialized in bioremediation, depending on the problem and available budget, the team is capable of implementing various remediation options such as pump and treat, zero-valent iron treatment, chemical oxidation, soil gas vapor extraction, etc.

Business Plan for Supporting the Client



Selection of Biostimulants for Various Contaminants of Concern

A Summary of Bioremediation Nutrients with Respect to Contaminant Concern

Contaminants of Concern	Circumstances & Conditions	Biostimulants
Chlorinated Volatile Organic Compounds (VOCs) Tetrachloroethylene, Trichloroethylene, Trichloroethane, Carbon tetrachloride, etc. & Dichlroethylene, dichloroethane Dichloromethane, Vinyl chloride, etc.	Anaerobic Degradation	EcoClean + EcoClean-E
Chlorinated Volatile Organic Compounds (VOCs)	The barrier is made for degradation of contaminants in the inflow by the native microbes in the reactive zone & clean, de-contaminated groundwater flows down gradient of the bio-barrier	EcoClean + EcoClean-E + EcoClean-B
Chlorinated Volatile Organic Compounds (VOCs) ≤2 chlorine atoms only Dichloroethylene, dichloroethane Dichloromethane, Vinyl chloride, etc.	Aerobic Degradation	Green Clean-CL
Hexavalent Chromium		EcoClean-M
Hexavalent Chromium	The barrier is made for degradation of contaminants in the inflow by the native microbes in the reactive zone & clean, de-contaminated groundwater flows down gradient of the bio-barrier	EcoClean-M + EcoClean-E + EcoClean-B
Benzene, Toluene, Xylene **Light oil** (gasoline, kerosene, etc.)		Green Clean-PH
Petroleum hydrocarbons	*Ex-situ* soil treatment such as land farming, biopiles	Green Clean-BP
Cyanide Compounds		Green Clean-CN

Contaminants of concern other than above mentioned target substances

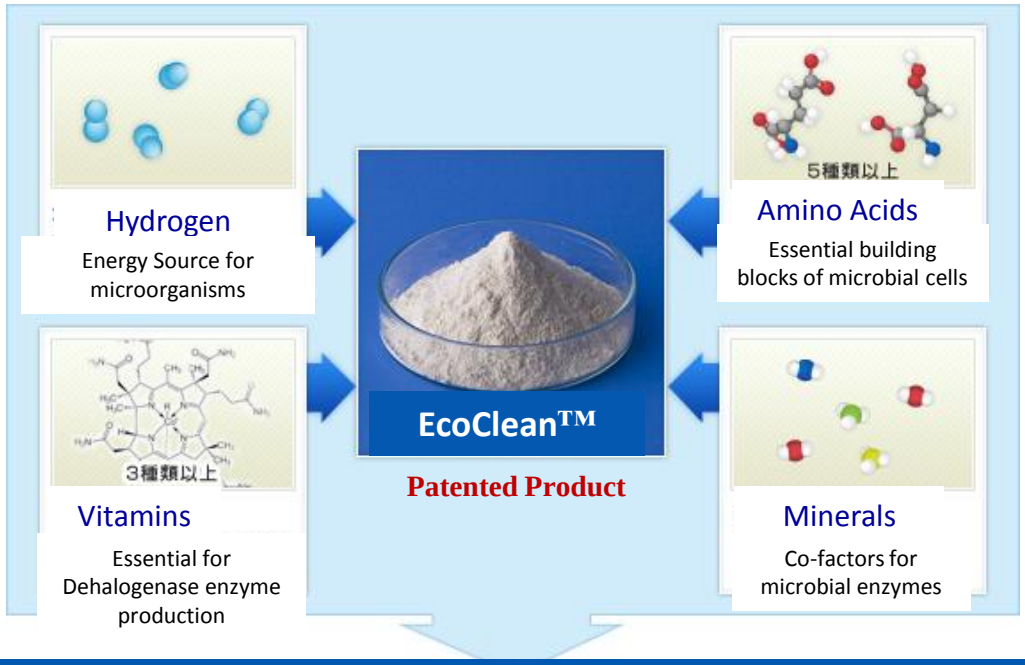
We also manufacture custom-made bioremediation agents for a wide range of contaminants. Please contact EcoCycle Corporation for further information.

An example of contamination concern	Custom-made nutrients
Chlorobenzenes (dichlorobenzene, etc.), hexachlorobutadiene Chlorophenols (pentachlorophenols, etc.), BCEE, Toxaphene Trinitrotoluene, Trinitrobenzene, perchlorate, chlorinated agricultural chemicals & pesticides.	EcoClean-X
Polyaromatic hydrocarbons (PAHs ,naphthalene, benzopyrene, etc.) Dioxanes, MTBE, methyl ethyl ketone, dicyclopentadiene, etc. Agricultural Chemicals (Simazine, Thiobencarb, Thiram, etc.)	Green Clean-X
Heavy metals of lead, arsenic, cadmium, selenium, copper, cobalt, zinc, & nickel ※ Water soluble contaminants are biologically stabilized	EcoClean-MX

Concern of complex contamination

Please contact EcoCycle if the contaminants & groups are multiple.
Combination of nutrients are applied and/or new nutrients are designed & manufactured.

EcoClean for Bioremediation of Chlorinated Solvents



Effective microbial consortium responsible for VOCs degradation is stimulated resulting in faster and complete contaminant degradation

EcoClean-E for Long-Term Bioremediation

Effective in low K soil, to degrade DNAPL and for coastal area groundwater with high salt concentration.

Advantages of EcoClean based Bioremediation

① **Short time:** Usually bioremediation takes 1-3 years to clean the sites. However our product EcoClean & EcoClean-E can do the same job within 3-12 months.

② **Contamination concentration:** We have successfully degraded contamination (>150mg/L of groundwater) at many sites with DNAPLs (Dense Non-aqueous phase Liquids).

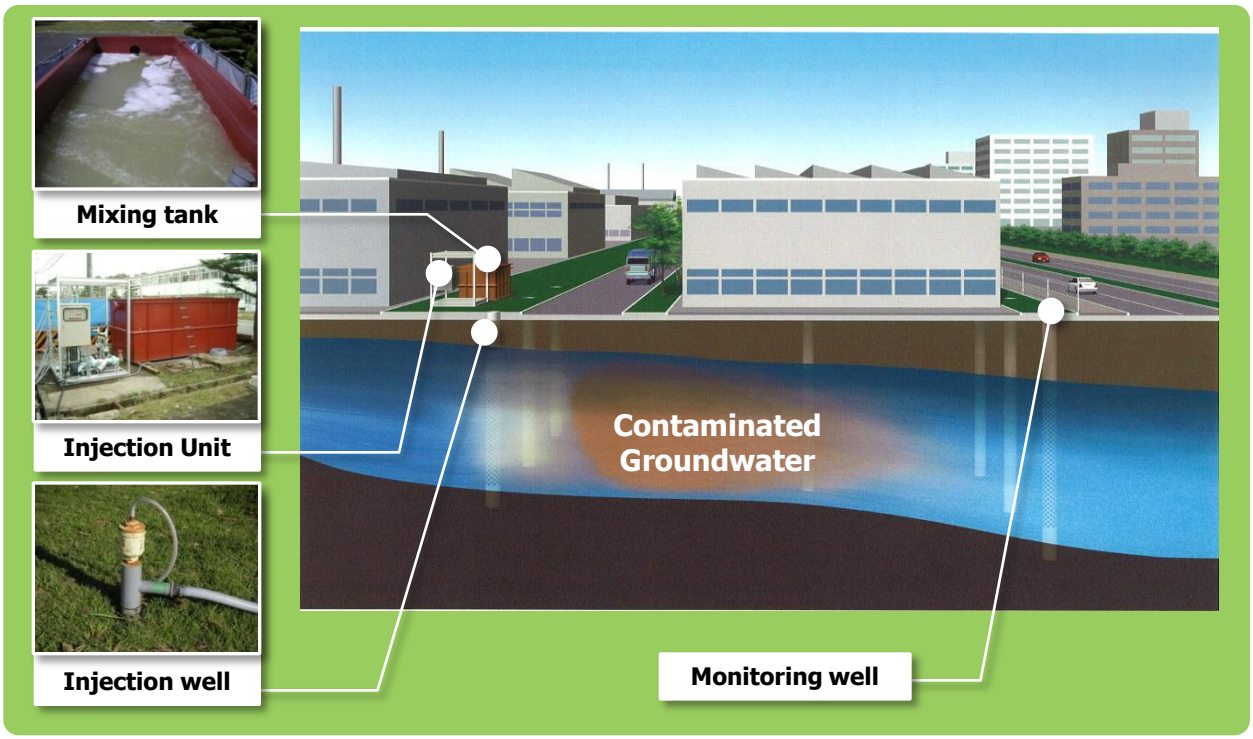
③ **Ultra-Low energy:** Unlike some technologies such as pump and treat, bioremediation has ultra low energy requirement.

④ **Low cost:** Compare to many other remediation methods such as dig and haul, EcoClean based bioremediation costs less than 1/3.

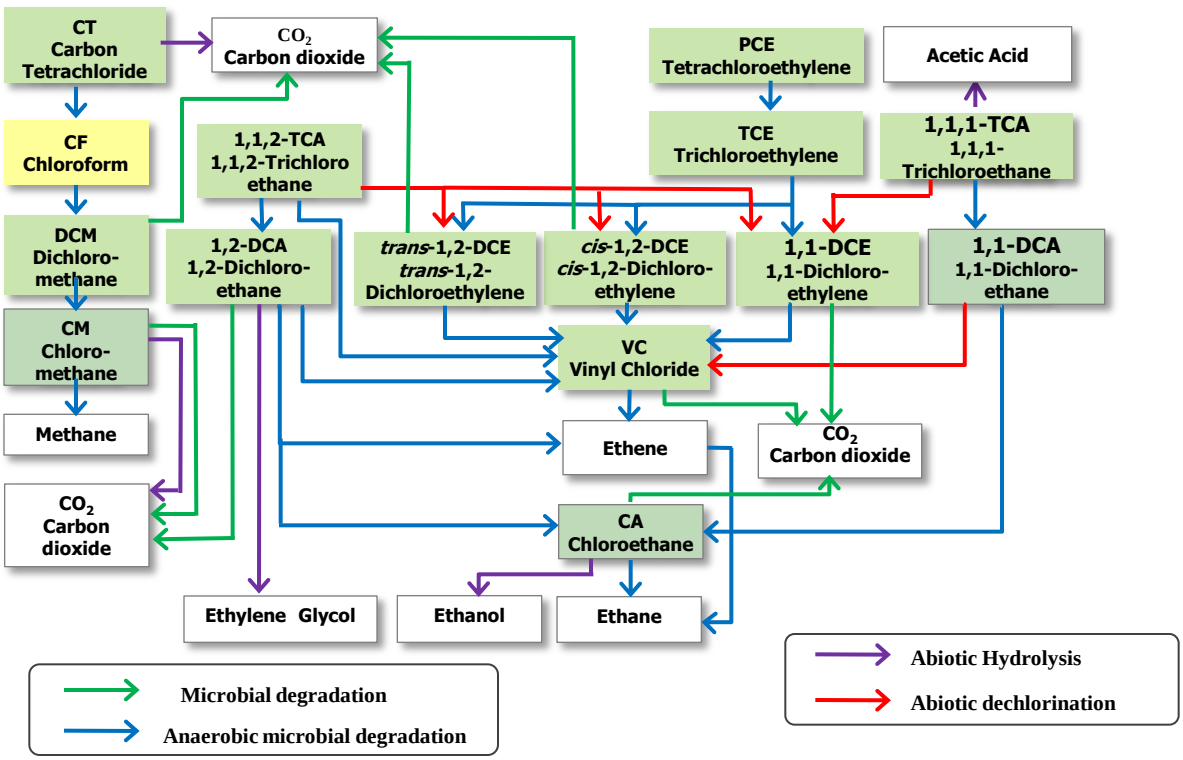
⑤ **Safety:** Like all of our products EcoClean & EcoClean-E are made of food grade raw materials and are degraded completely when applied to the soil or groundwater by the native microorganisms.

How to Use

As shown in the picture below, the bioremediation nutrients are dissolved in water and injected subsurface to stimulate the native microorganism capable of degrading the toxic pollutants.



Various Chlorinated Solvents and Their Decomposition Pathways



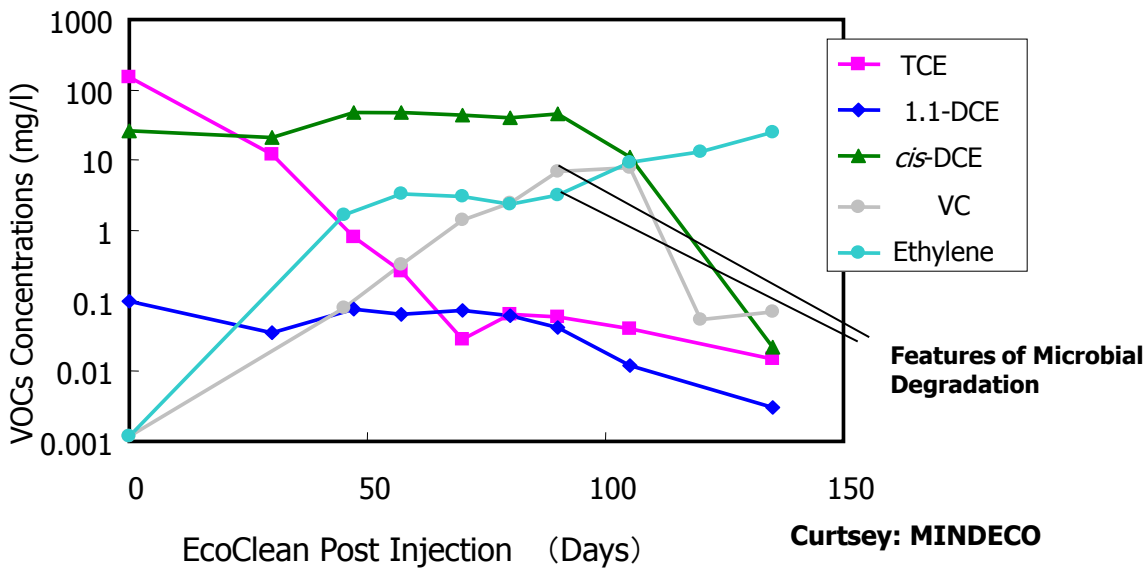
Chlorinated solvents are degraded by microorganism with EcoClean/EcoClean-E. The resulted end products of the whole process would be non-toxic ethylene, inorganic chlorides, carbon dioxide and water.

Field Results of EcoClean Series Application

EcoClean-series have been widely applied on more than 150 sites in Japan, the US, and other Asian countries.

EcoClean Field Result

The graph shows degradation of chlorinated solvents as the result of EcoClean application. Even in the presence of residual DNAPL contamination in the groundwater was degraded below regulatory standard within 150 days. The same results are difficult to achieve by extracting the groundwater even for more than 10 years.



Curtsey: MINDECO

EcoClean-M for Bioremediation of Hexavalent Chromium

EcoClean-M is a bioremediation agent for remediation of soil and groundwater contaminated with hexavalent chromium (VI) by utilizing natural microorganisms.
It is a mixture of well-balanced nutrients, energy for microbes capable of respiring Cr(VI).
In this process the water soluble, highly toxic Cr(VI) is reduced to non-soluble and stable chromium (III).

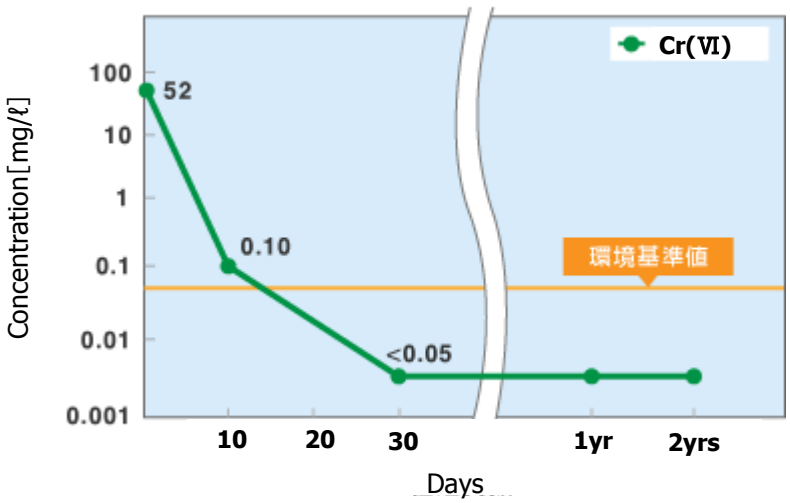
EcoClean-M™
Patented Product

Advantages of EcoClean-M based Bioremediation

- EcoClean-M is the unique combination of various nutrients for microorganisms that are capable of detoxifying Cr(VI).
- Complete remediation of highly contaminated media is possible in a matter of a few weeks to months.
- The cost is cheaper than any other technologies available.
- The product is made of food grade raw materials & therefore safe to use.

EcoClean-M Field Result

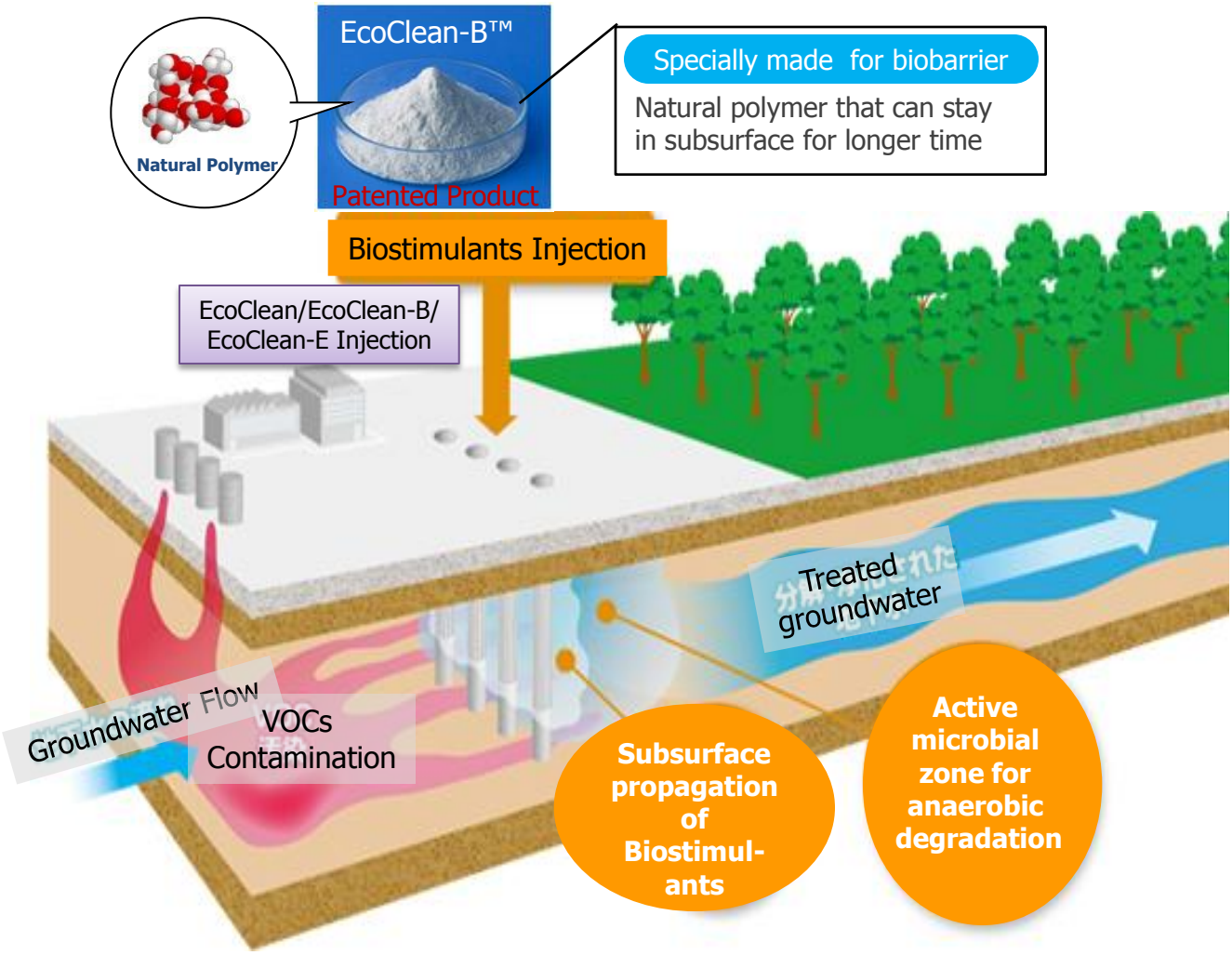
After dissolving EcoClean-M in water and injecting into the aquifer the concentration of Cr(VI) reduced from 52 mg/l of initial concentration to below detection limit (0.05 mg/L) in 30 days.



※ The groundwater has been monitored continuously for two years and there is no sign of contamination rebound.

Permeable Reactive Barriers

EcoClean-B along with other biostimulants are injected to create an active, subsurface zone of permeable reactive barrier. The contaminants in the inflow are degraded by the native microbes in the reactive zone and clean, de-contaminated groundwater flows down gradient of the bio-barrier.



Merits of EcoClean Series Biobarrier Over the Conventional Methods

Comparison of Pump & Treat !

- Running cost (electricity; carbon filters; stripper maintenance etc.) is considerable
- Accelerated groundwater flow due to extraction may result in spread of the contamination from the source

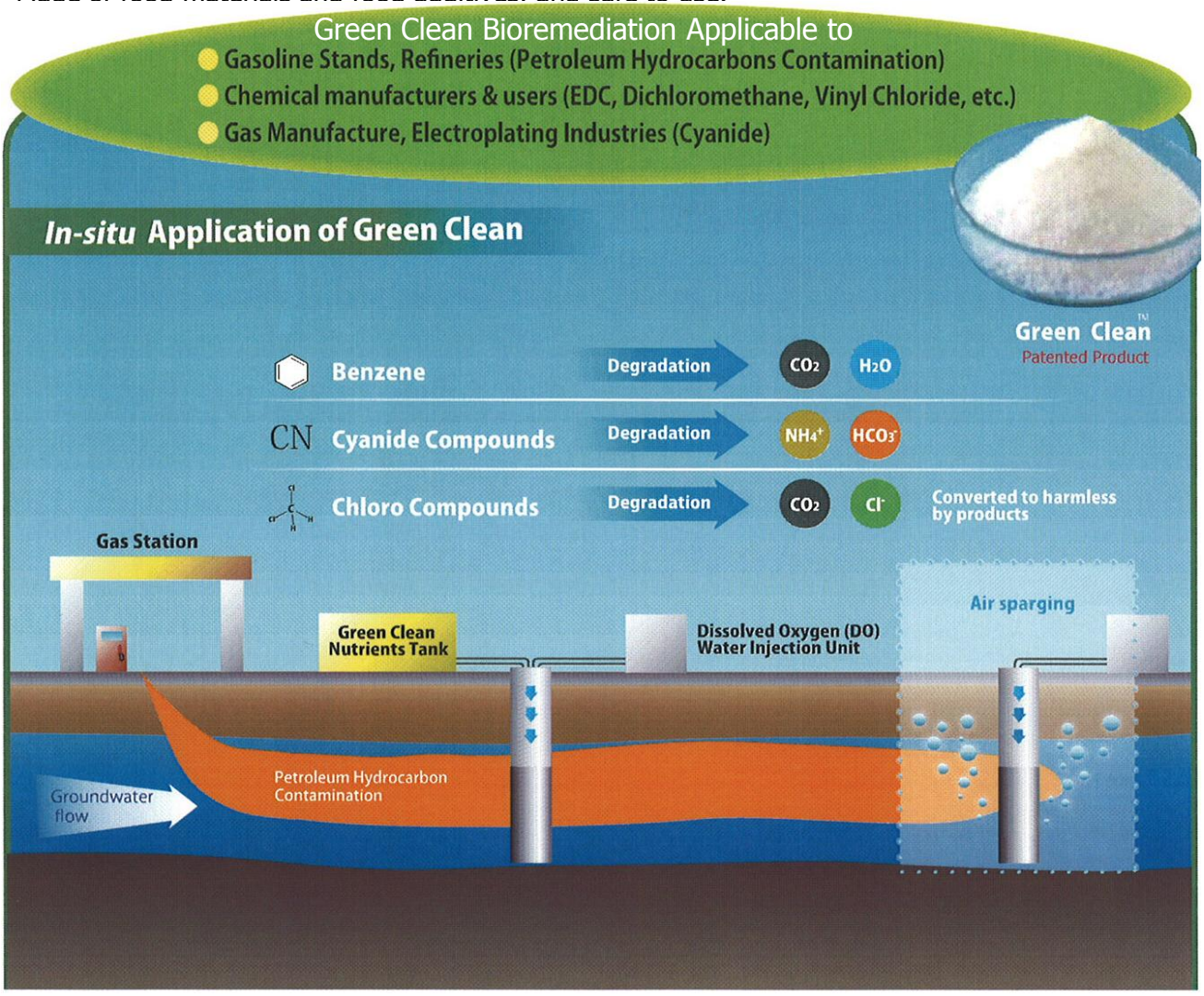
Comparison with Zerovalent Iron barrier !

- Cost: Around 1/3 of ZVI barrier.
- Large augur is used to mix ZVI into the soil that consumes large working space and limits operation in active facilities
- ZVI oxidizes resulting rusty groundwater down gradient to ZVI barrier .

EcoClean Series biobarrier application method is low cost, environmental friendly, & almost no maintenance.

Green Clean for High Performance Aerobic Remediation

- Green Clean biostimulants are optimal nutritional source for aerobic microorganisms capable of biodegradation of petroleum hydrocarbons (BTEX, light oils, etc.) cyanide compounds, and chlorinated hydrocarbons.
- Green Clean is dissolved in water containing high concentration of oxygen & injected to subsurface.
- Made of food materials and food additives, and safe to use.



Green Clean-BP for Onsite or Off-site Treatment of Soil Contaminated with Petroleum Hydrocarbons

Ex-situ Application

- ***BIOTHERMOPILE*** is useful for treating aerobically degradable contaminants.
- Green Clean-BP is efficient to degrade various petroleum hydrocarbons of high concentrations in short times.
- Soil contaminated with petroleum hydrocarbons is made into a pile & Green Clean-BP is mixed to stimulate natural microorganisms that degrade contaminants
- Low cost, easy to apply and there is no environmental burden.

BIOTHERMOPILE Image