



# OilCure

INNOVATIVE ENVIRONMENTAL REMEDIATION

## OIL DIGESTER

### Hydrocarbon BioRemediation Program



[www.allcure.co.za](http://www.allcure.co.za)  
Tel: 061 469 8370  
Francois Viljoen  
Mobile: 082 805 0405  
Email: [cois@allcure.co.za](mailto:cois@allcure.co.za)



## AllCure

*Think beyond green!*

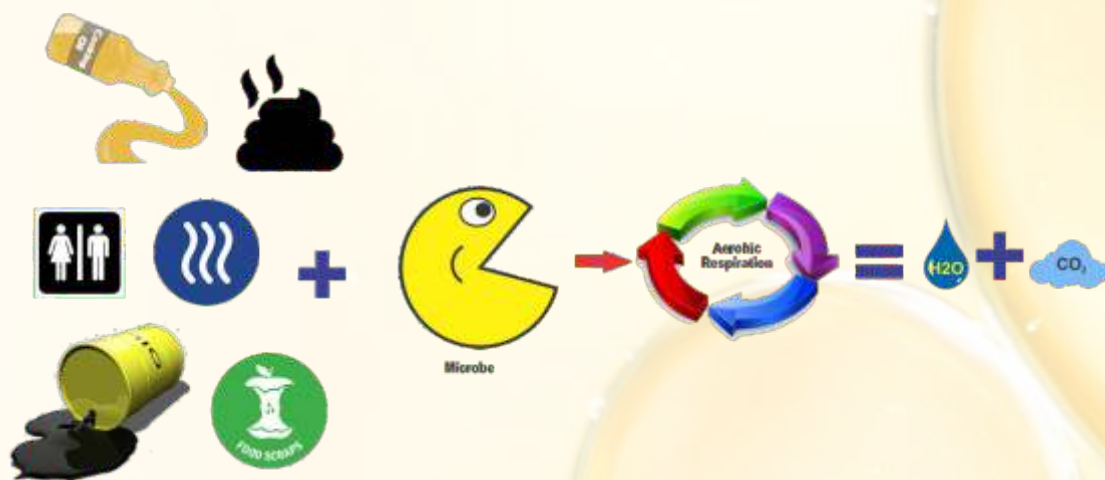
## Products

- ⌚ We offer a comprehensive range of bioremediation products for petroleum hydrocarbons contamination groundwater, surface water, soil and excavation projects.
- ⌚ Conventional mechanical methods(booms, skimmers, vactrucks) and chemical methods(dispersants, degreasers, surface collection agents) are limited:
- ⌚ Conventional technologies are capable of recovering no more than 10-15% of the oil contamination in surface waters.
- ⌚ Pump-and-treat groundwater remediation cannot be relied upon to bring contaminant levels down to environmentally-accepted standards. (Hanson, EPA).

## BioRemediation Advantages

- ⌚ Generally 60-70% less costly than conventional technologies.
- ⌚ On-site treatment eliminates need to transport soil or water as hazardous waste and the associated permits.
- ⌚ Eliminates air quality and air pollution from evaporation.
- ⌚ Continual process (24/7) with low energy cost.
- ⌚ Enhances conventional technologies such as oxygen sparge and SVE systems.
- ⌚ A non-invasive treatment not requiring extensive infrastructure.
- ⌚ Used to remediate areas that are not easily accessible or are inaccessible to other technologies.

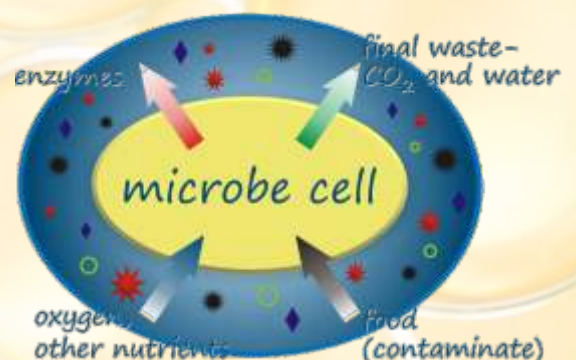
## Kreb's Cycle



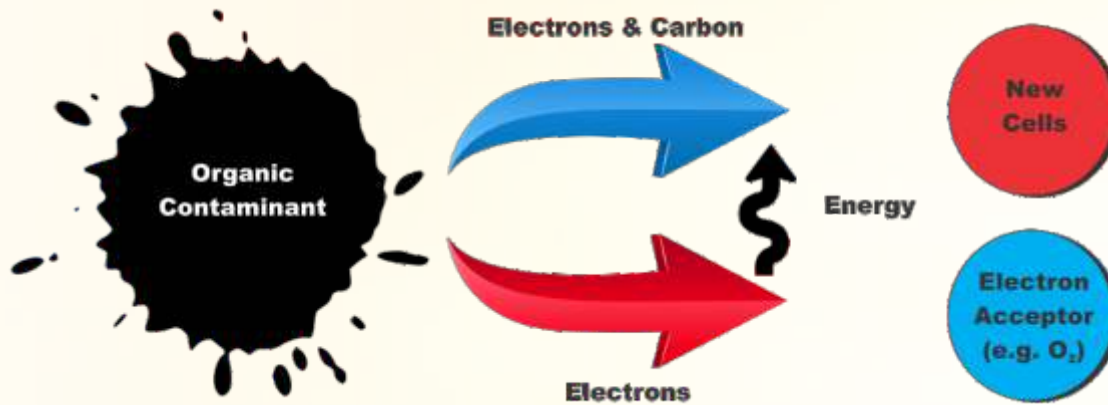
- ⌚ The Krebs cycle, citric acid cycle or tricarboxylic acid ("TCA") cycle is a series of chemical reactions used by all aerobic organisms to release stored energy through the oxidation of acetyl-CoA derived from contaminants into carbon dioxide and energy.
- ⌚ The cycle consumes acetate (in the form of acetyl-CoA) and produces carbon dioxide and water as waste byproducts.

## BioRemediation Technology

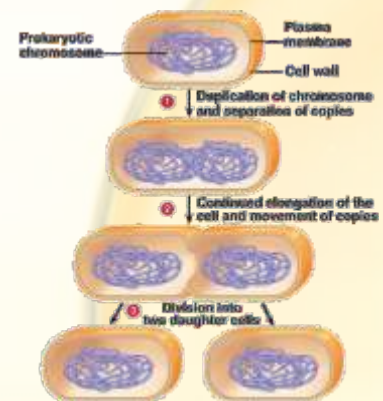
- ⌚ Microbes have the capability to biodegrade almost all organic contaminants, including petroleum hydrocarbons, fats, oils and greases ("FOG"), odors, soils and other organic matter.
- ⌚ Organic contaminants serve two purposes for the organisms:
- ⌚ A source of carbon, which is one of the basic building blocks of new cells;
- ⌚ Electrons, which the microbes extract to obtain energy.



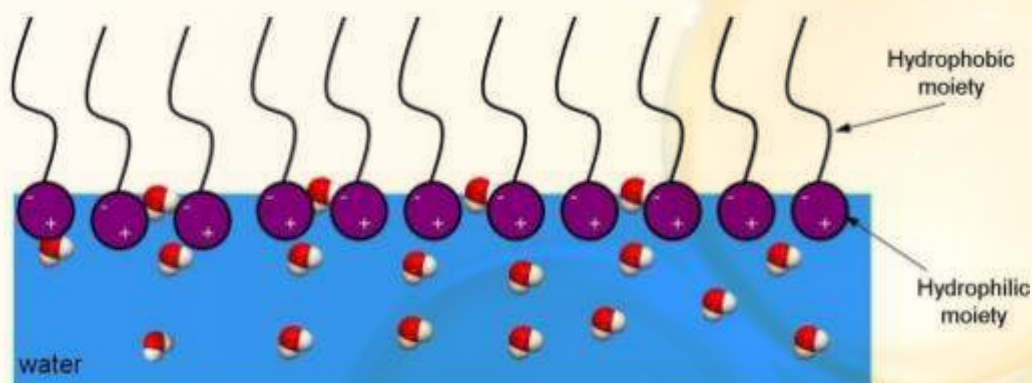
# BioRemediation Technology



- Microbes gain energy by catalyzing energy-producing chemical reactions that involve breaking chemical bonds and transferring electrons away from the contaminant.
- The type of chemical reaction is called oxidation-reduction:
- The organic contaminant is oxidized,
- The compound that gains the electrons is reduced.
- The contaminant is called the electron donor, while the electron recipient is called the electron acceptor.
- Microbes reproduce by the process of binary fission (one cell asexually splitting into two).
- Microbe cells are about one micron wide and 2 microns long (1 micron is 0.00004 inches or 1/1,000,000 meters).
- One single microbial cell with a 20-minute generation time, would increase over 1 millionfold in 6 hours.



## Role of Bio-Surfactants



- Bio-surfactants are natural biologically structurally diverse group of surface active agents secreted by the microbes and excreted into the surrounding environment.
- Bio-surfactants consist of two parts—a polar (hydrophilic) moiety and non-polar (hydrophobic) group..



Without Bio-Surfactants

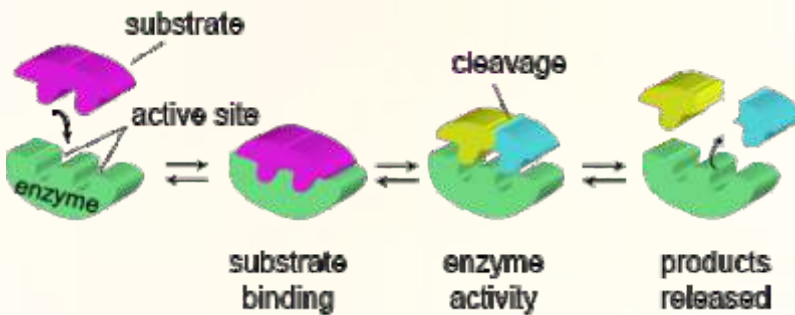


With Bio-Surfactants



- ④ Bio-surfactants reduce surface tensions of hydrophobic waterinsoluble contaminants, thereby increasing the surface area of insoluble contaminants, leading to increased mobility and bioavailability.
- ④ The bio-surfactants enable the microbes to enzymatically attack the hydrocarbon on all 8 sides providing a 3-dimensional treatment.

## Role of Enzymes

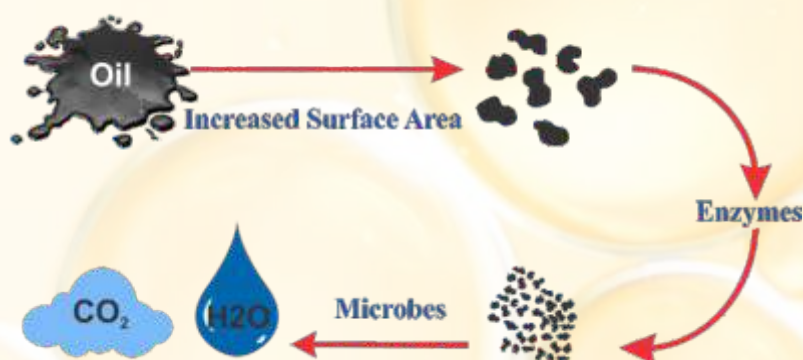


- ④ It is not uncommon for the terms "microbe" and "enzyme" to be used synonymously. However, they are not the same. Microbes are millions of tiny living "enzyme factories."
- ④ An enzyme is a complex protein which encourages a biochemical reaction by acting as a catalyst.
- ④ Microbes continuously produce a complete "team" of fresh enzymes and multiple "teams" at the same time.
- ④ The type of containment determines the type of enzymes produced, in what sequence, at what concentration and for what duration.

## Aerobic & Anaerobic

- ④ Microbes use molecular oxygen ( $O_2$ ) as the electron acceptor. The process of destroying organic compounds with the aid of oxygen is called aerobic respiration. In aerobic respiration, microbes use oxygen to oxidize part of the carbon in the contaminant to carbon dioxide ( $CO_2$ ), with the rest of the carbon used to produce new cell mass. In the process, the oxygen gets reduced thereby producing water.
- ④ Many microbes can exist without oxygen, using a process called anaerobic respiration. In anaerobic respiration, nitrate ( $NO_3^-$ ), sulfate ( $SO_4^{2-}$ ), metals such as iron ( $Fe^{3+}$ ) and manganese ( $Mn^{4+}$ ), or even  $CO_2$  can play the role of oxygen, accepting electrons from the degraded contaminant. The byproducts of anaerobic respiration may include nitrogen gas ( $N_2$ ), hydrogen sulfide ( $H_2S$ ), reduced forms of metals, and methane ( $CH_4$ ), depending on the electron acceptor.

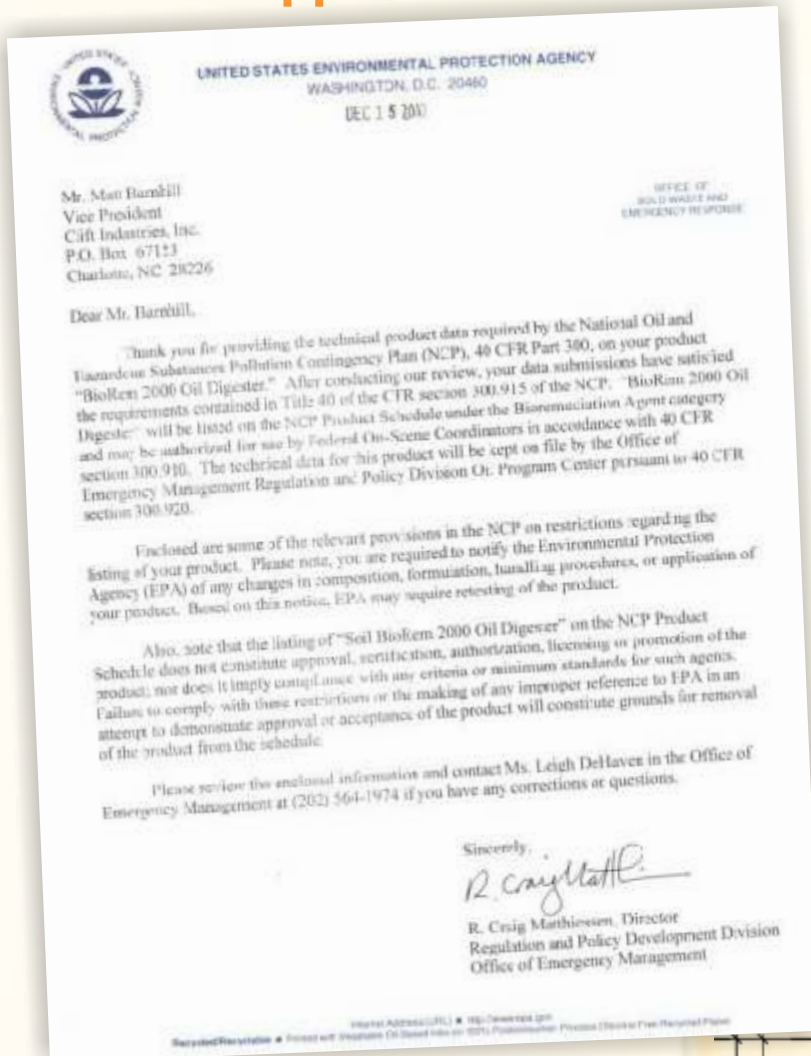
## Petroleum Hydrocarbons



- ④ Biodispersion – The microbes produce bio-surfactants, converting the hydrophobic water-insoluble petroleum hydrocarbons to hydrophilic.
- ④ Solubilization – The bio-surfactants increase the surface area of the hydrocarbons breaking it down from macro to micro-sized molecules.
- ④ Assimilation – The microbes secrete enzymes performs the process of cleavage, chopping the long chains of the solubilized hydrocarbons into two carbon units.
- ④ Mineralization – The microbes convert the carbon units into carbon dioxide and water as a source of food for growth.

- ⦿ A complex consortium of microbes, enzymes and nutrients designed to bioremediate hydrocarbons.
- ⦿ Effective over a wide range of hydrocarbons (DRO, GRO), freeproduct, NAPL and weathered oils.
- ⦿ Concentrated liquid formula provides the maximum microbial activity.
- ⦿ Does not require special mixing or an acclimatization period.
- ⦿ Listed on the EPA's National Contingency Plan Product Schedule as a bioremediation agent.
- ⦿ Low toxicity and designed for ecologically fragile areas.
- ⦿ 2-year shelf life.

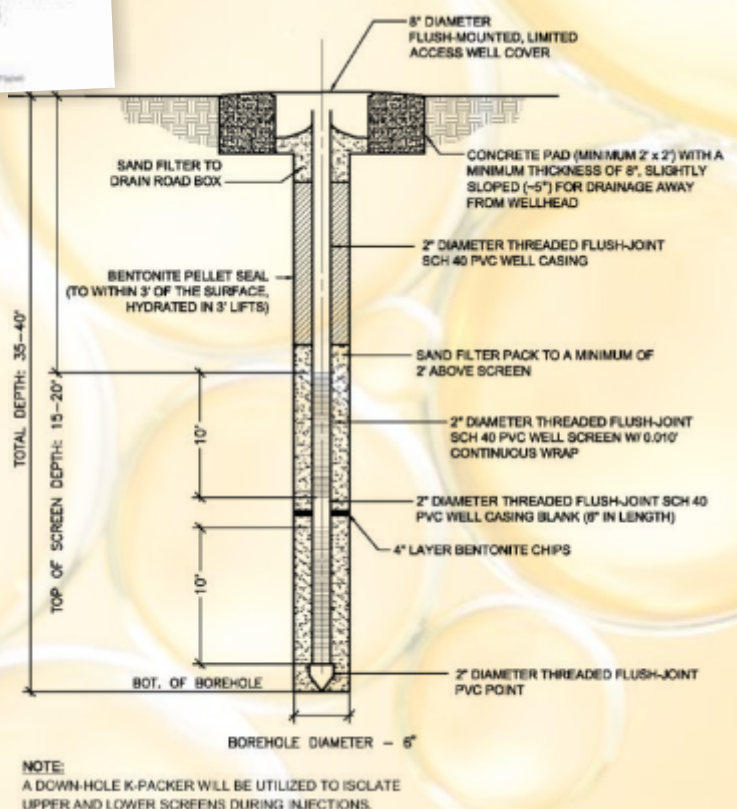
## EPA NCP Approval



- ⦿ The test was conducted as per protocol documented in CFR 40 Part 300.
- ⦿ Crude oil was heated to 541 F° to remove all low boiling point fractions.
- ⦿ Data shows 85.2% reduction of Alkanes and 11% in Aromatics in 7 days.
- ⦿ 28 day results of 99.8% reduction of Alkanes and 71% in Aromatics.

## Case Study Results

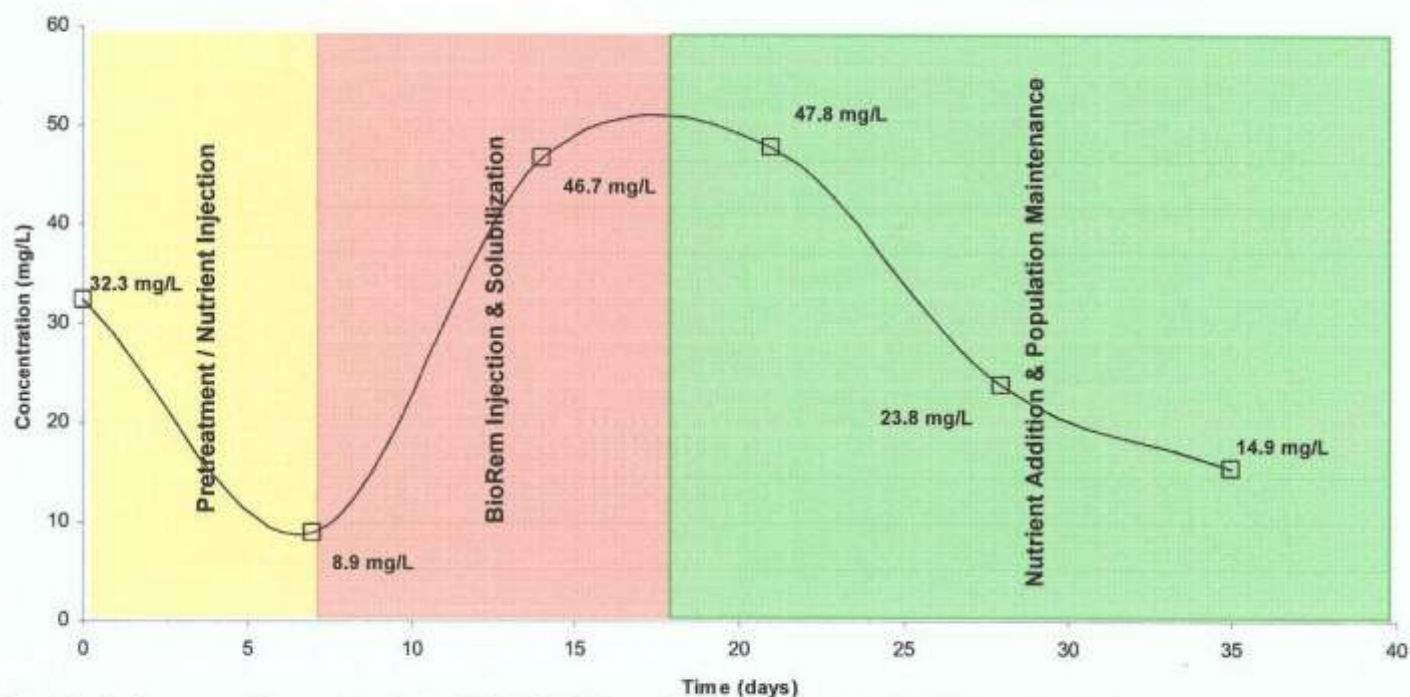
- ⦿ Initial calculations indicated 50.3 kg TPH-DRO in the dissolved phase.
- ⦿ 188.1 kg TPH-DRO was calculated as removed.
- ⦿ This indicates a mass balance of 137.8 kg TPH-DRO was removed from the NAPL phase both as measurable free product or residuals from the smear zone.
- ⦿ "This removal was accomplished in situ without long-term energy expenditures and without disposal costs."





## Case Study Results

Pilot Test Study Wells Average TPH-DRO vs Time



Graph 1: Average Concentration of TPH-DRO vs. Time across the Pilot Test Study Area

DRO Concentrations (mg/l) September 10, 2009  
contour interval = 10 mg/l

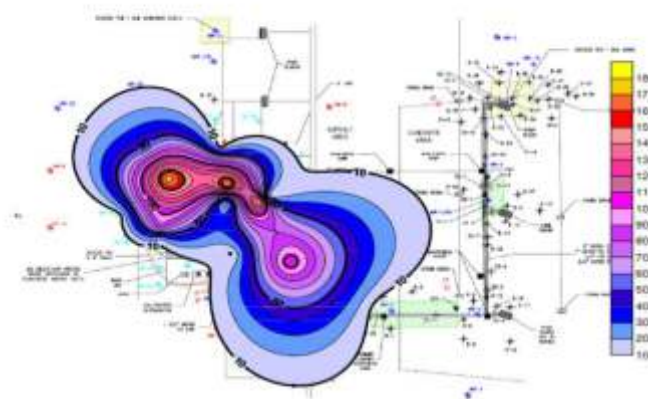


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES.

DRO WITH SILICA GEL Concentrations (mg/l) April 8, 2011  
contour interval = 10 mg/l

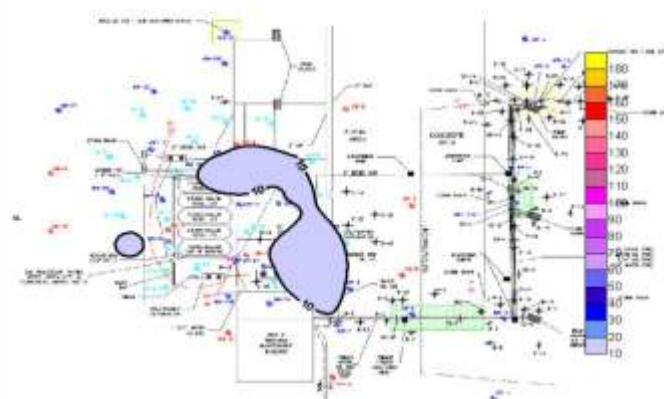


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES.

## Soil Remediation

- ⦿ Works ex-situ or in-situ with soil and sediment projects.
- ⦿ Can be applied topically or injected on open land or under buildings, UST sites, pavement, train tracks and tank farms.
- ⦿ Replaces costly Dig-and-Haul.
- ⦿ Effective soil management includes maintaining appropriate soil pH, moisture and consistently tilling.
- ⦿ Tilling maximizes pore space oxygen content to maintain its aerobic condition and ensures complete mixing.
- ⦿ Bulking agents (wood chips, palm husks, straw, hay) provide an increase in pore space, water retention and temperature.



## Excavation

- ⦿ Underground storage tanks (UST), accounts for more than half of groundwater contamination.
- ⦿ The size of excavations are typically smaller than the size of the plume.
- ⦿ Physical limitations to excavation: utilities, buildings, roads, bedrock are common.
- ⦿ Applied to open excavation pits to eliminate residual contaminants in minutes so the excavated area can be backfilled immediately.
- ⦿ Easily broadcasted using a traditional liquid spraying equipment.





## Surface Water

- Outperforms conventional remediation technologies.
- Successfully treats insoluble, soluble and weathered hydrocarbons.
- Uses: Shoreline clean-up, remediation of sheen in ports, contained open water spills, containment and storm water retention ponds.
- Easily dispersed using traditional liquid spraying equipment.
- Oil Digester will not disperse in the water column attaching to the hydrocarbons on the surface in an aerobic environment.



## Spill Control

<b>Railroads</b>	<ul style="list-style-type: none"><li>• Spills on tracks and in Ballast</li><li>• Transformer leak clean up</li></ul>
<b>Airports</b>	<ul style="list-style-type: none"><li>• Jet Fuel Spills</li><li>• Oil and Fuel spills around equipment</li></ul>
<b>Oil Refineries</b>	<ul style="list-style-type: none"><li>• Preventative maintenance</li><li>• Leak and spill clean ups</li><li>• Sheen clean up from loading and unloading barges</li><li>• RipRap Clean up</li></ul>
<b>Terminals</b>	<ul style="list-style-type: none"><li>• Spill and leak clean up</li><li>• Stormwater runoff management</li></ul>
<b>Filling Stations</b>	<ul style="list-style-type: none"><li>• “LUST” Gas and Oil tank removal</li><li>• Groundwater Remediation</li><li>• Surface spills around dispensing</li></ul>
<b>Dredging</b>	<ul style="list-style-type: none"><li>• Surface waste sheen control</li></ul>
<b>Highways</b>	<ul style="list-style-type: none"><li>• Accidental Fuel and Oil clean ups</li></ul>



## Role of Nutrients

- ⦿ Sometimes called bio-catalysts or bio-stimulants and include ingredients for the stimulation, growth, and reproduction of microbes.
- ⦿ Nutrient injection may be necessary if the groundwater and/or soil contains inadequate amounts of nitrogen and phosphorus.
- ⦿ The ideal nutrient balance (pathway) required for hydrocarbon remediation is carbon; nitrogen; phosphorus equals 100:10:4.
- ⦿ It is critical to control the inorganic nutrients in order to accelerate microbial metabolism.
- ⦿ BioRem-2000 Nutrient Blend<sup>TM</sup> is a superior, slow release nutrient source, stimulant, and accelerant which produces excellent plate counts.



**www.allcure.co.za**  
Tel: 061 469 8370  
Francois Viljoen  
Mobile: 082 805 0405  
Email: cois@allcure.co.za



**AllCure**  
*Think beyond green!*