

Treatment of polluted water

By- Dr. Ekta Khare

Department of Microbiology,

Chhatrapati Shahu Ji Maharaj University, Kanpur

What Is Water Pollution?

- Water pollution occurs when harmful substances—often chemicals or microorganisms—contaminate a stream, river, lake, ocean, aquifer, or other body of water, degrading water quality and rendering it toxic to humans or the environment.

Categories of Water Pollution

Groundwater

- Groundwater gets polluted when contaminants—from pesticides and fertilizers to waste leached from landfills and septic systems—make their way into an aquifer, rendering it unsafe for human use.
- Ridding groundwater of contaminants can be difficult to impossible, as well as costly.
- Once polluted, an aquifer may be unusable for decades, or even thousands of years.
- Groundwater can also spread contamination far from the original polluting source as it seeps into streams, lakes, and oceans.

... Categories of Water Pollution

Surface water

- Covering about 70% of the earth, surface water is what fills our oceans, lakes, rivers, and all those other blue bits on the world map.
- Nutrient pollution, which includes nitrates and phosphates, is the leading type of contamination in these freshwater sources.
- While plants and animals need these nutrients to grow, they have become a major pollutant due to farm waste and fertilizer runoff.
- Municipal and industrial waste discharges contribute their fair share of toxins as well.
- There's also all the random junk that industry and individuals dump directly into waterways.
- Eighty percent of ocean pollution (also called marine pollution) originates on land—whether along the coast or far inland.
- Contaminants such as chemicals, nutrients, and heavy metals are carried from farms, factories, and cities by streams and rivers into bays and estuaries; from there they travel out to sea.

Treatment of ground water

- There are a number of ways in which this can be accomplished, the most effective being the protection of water sources against future contamination, while allowing natural biological, chemical and physical processes to break down existing contaminants.

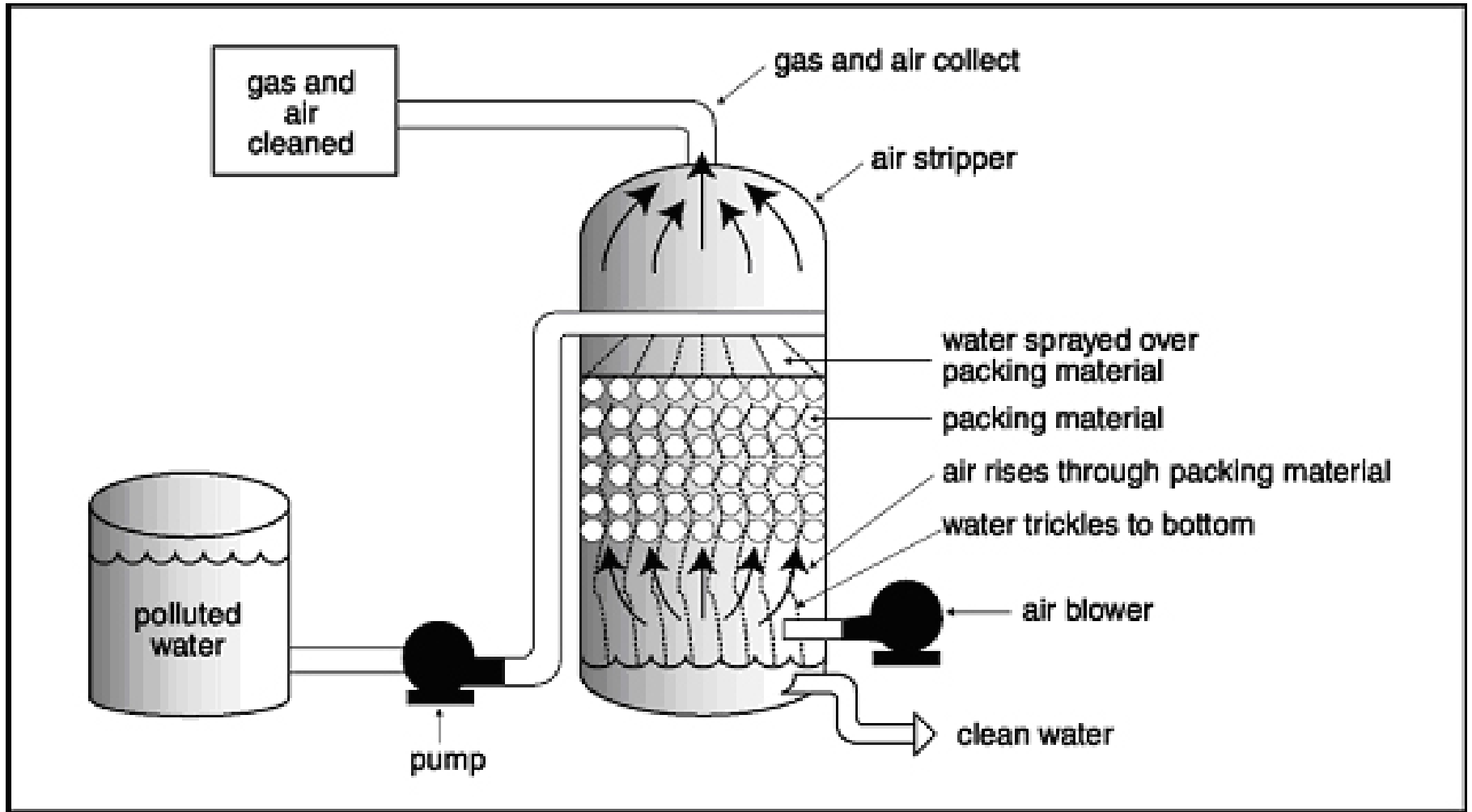
PUMP AND TREAT

- In this conventional type of groundwater treatment, pumps are used to bring polluted water to the surface, where it can be more easily treated.
- Sometimes, treatment can be applied at the site of contamination, and at other times, the water must be transported, treated and then returned to the source or another location.
- This process typically takes between **five and ten years** to remediate a water source, but it is not unusual for the process to go on for decades.
- The following three treatment processes, **air stripping, activated carbon filtering and bioremediation**, are often used as a part of the pump and treat method of remediating a region.
- **Chemical oxidation** is another method of ground water treatment

AIR STRIPPING

- This process can effectively remove chemicals that evaporate easily, including fuels and solvents.
- Contaminated water is pumped through a large chamber, where it is sprayed over packing material.
- The packing material allows the water to slowly trickle to the bottom of the tank.
- At the same time, a fan blows air upwards, which causes the chemicals to evaporate out of the water.
- The chemicals are collected at the top of the tank, and treated, so that they cannot cause further pollution.
- Air strippers can be brought to the site of contamination, to reduce transportation costs.
- Usually takes many years to clean up a site.

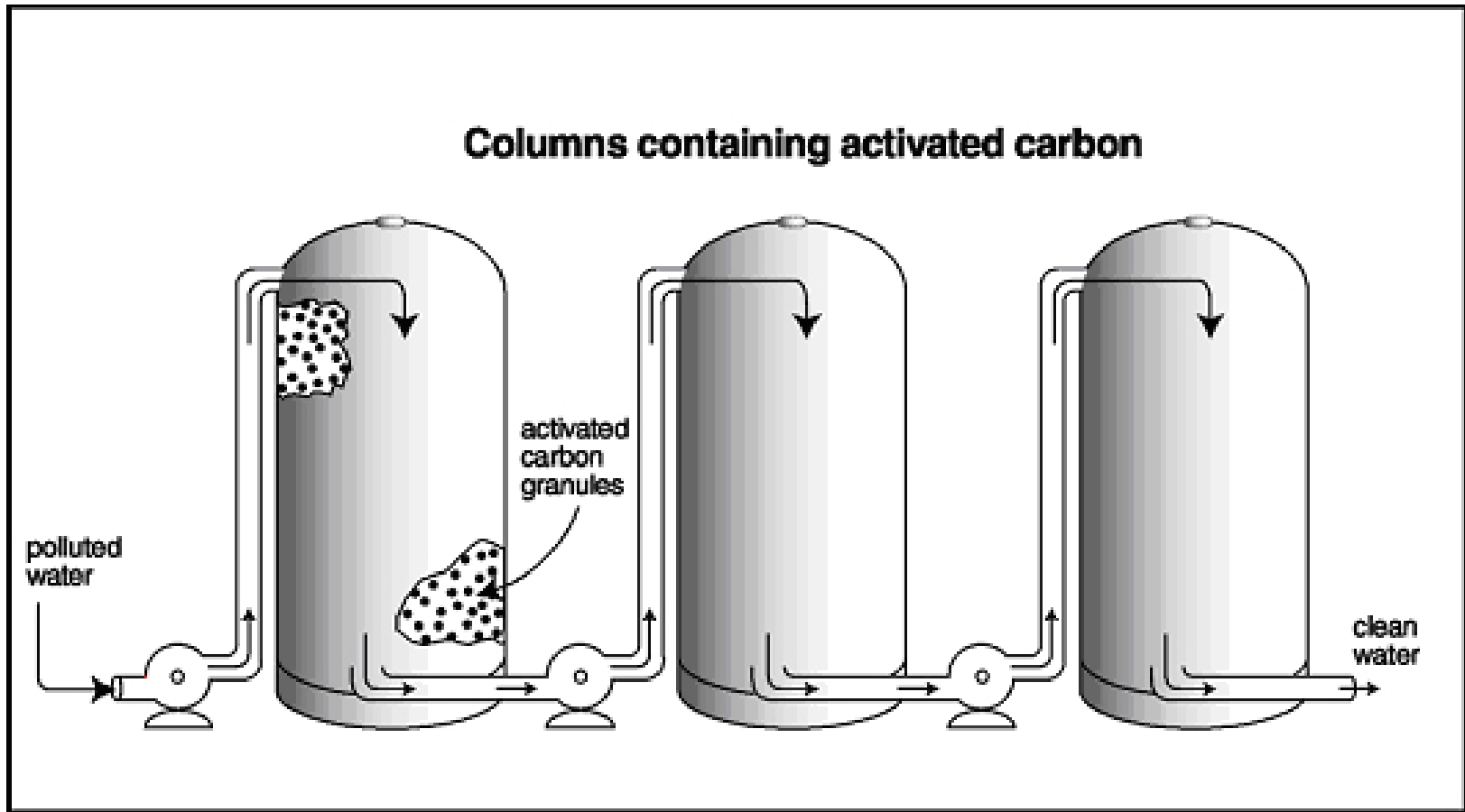
... AIR STRIPPING



Activated Carbon Filtration Process

- This method can **remove fuel, PCBs, dioxins and radioactive wastes**.
- The polluted water is sent through columns of activated carbon, to the surface and within the pores of the granules, and the clean water flows through.
- When the filters become fouled, or blocked with contaminants, they must be cleaned or replaced.
- One disadvantage of using activated carbon filtration is that it does **not break down the contaminants**, such as some of the other methods, such as bioremediation, do.
- To clean an activated carbon filter, the carbon is heated and air is pumped through the columns to loosen the contaminants from the carbon.
- The contaminants are then disposed in landfills or destroyed with other methods.
- Activated carbon filters are generally used in addition to another process, because excessively polluted water can foul the filters quite quickly.
- The time required to clean up a groundwater source ranges from a few days to years, depending on the rate and success of other treatment methods.
- These processes are extremely expensive.

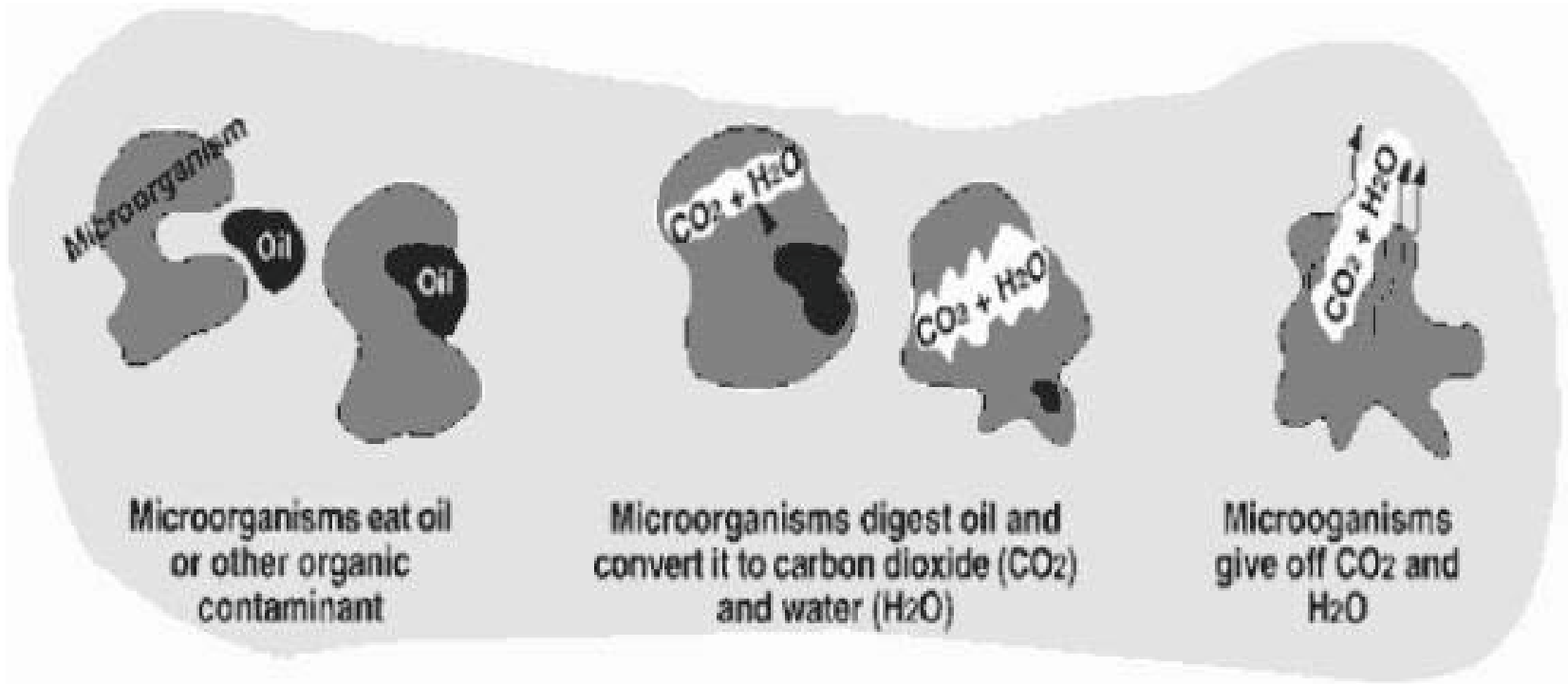
... Activated Carbon Filtration Process



Bioremediation

- Bioremediation is a process that uses microorganisms that are naturally found, to digest contaminants in soil and water, including the chemicals that are found in gas and oil spills.
- When this process occurs in nature, it is called **natural attenuation**, and generally occurs at a slow rate.
- The rate of digestion can be increased with the addition of air and nutrients, which allow the microorganisms to grow and multiply.
- However, mixing with air can cause chemicals to evaporate before they can be digested, so mixing is often done in enclosed tank, so that chemicals cannot escape.
- The water is pumped up through a well and enters a holding tank.
- Once in the tank, nutrients are added and the water is aerated, to provide optimal conditions for the microorganisms.
- After enough of the chemicals removed, the water is pumped back into the aquifer.
- Bioremediation can take anywhere from a few months to a few years to remove contaminants, but it is an effective and natural treatment process that does not require the use of chemicals or disinfectants.

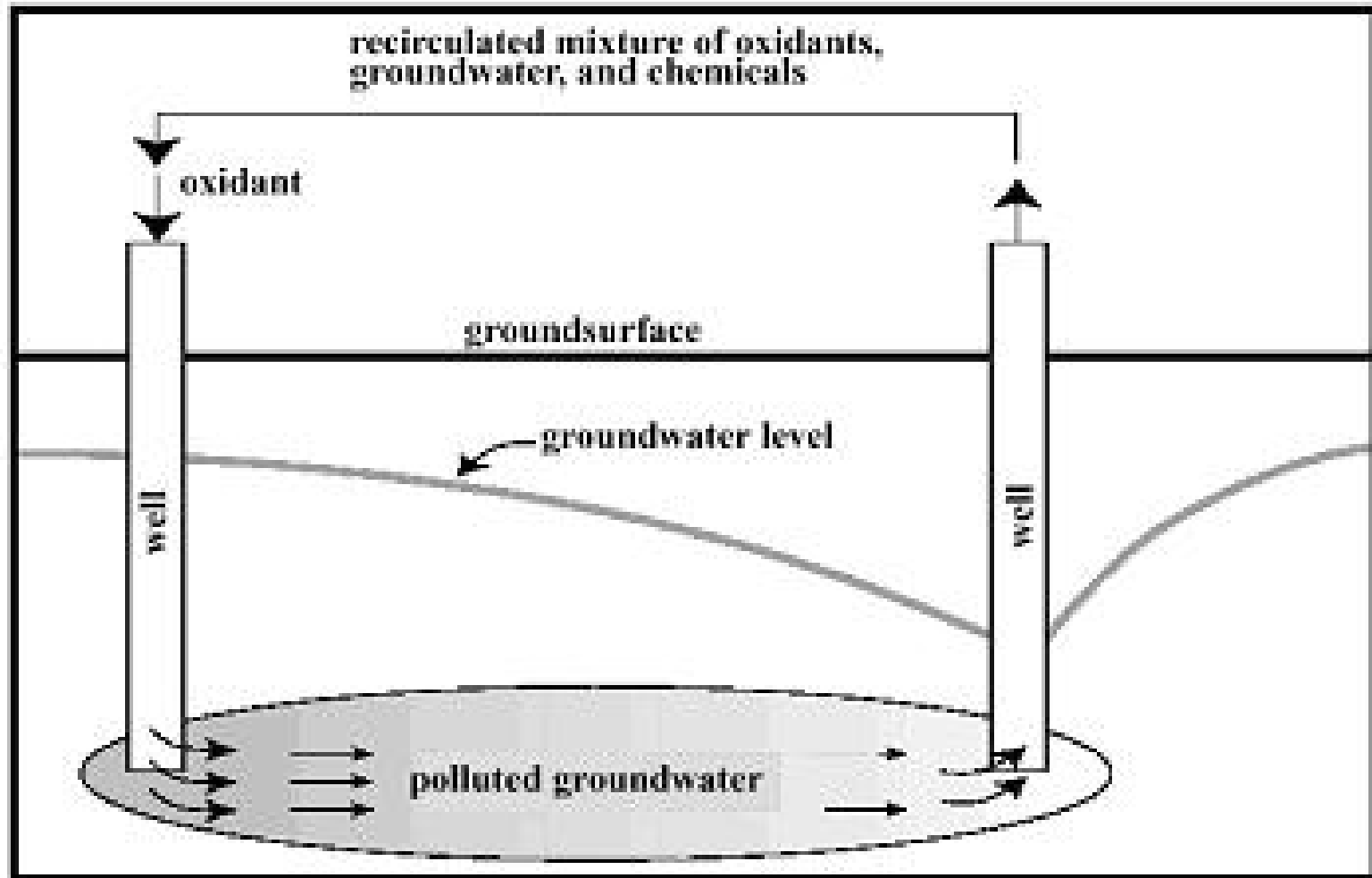
...Bioremediation



Chemical oxidation

- Chemical oxidation is a process that uses oxidants to convert harmful chemicals, such as fuels, solvents and pesticides, into less harmful chemicals, even water and CO₂.
- The most commonly used oxidants are H₂O₂, KMnO₄, O₃.
- To groundwater source, wells are drilled and the oxidant is pumped in.
- Often, two wells are dug, so that the water can be circulated, as is shown in the diagram to the right.
- This ensures that the oxidant is able to be evenly mixed in the water, and remove the majority of the contaminants.
- When the oxidant is added, heat is produced; in fact, enough heat to boil water.
- This causes the chemicals to evaporate from the water and travel upwards through soil.
- The contaminants are captured above ground, where they can be safely treated and disposed of.
- Chemical oxidation is an expensive treatment process, but in comparison to bioremediation and phytoremediation, it is a fast process.
- It generally takes between several months and one year to finish removing the contaminants from a polluted area with oxidation.

...Chemical oxidation



Surface water treatment

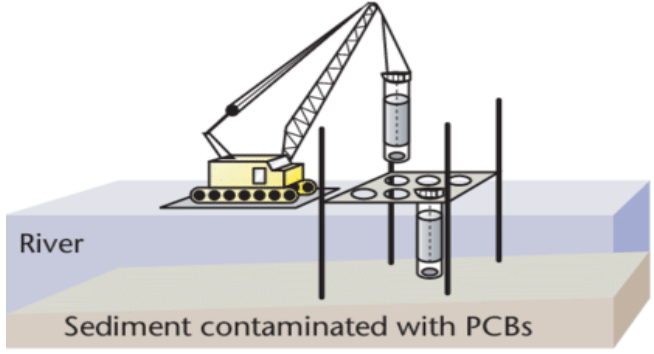
- Deep assessment of the [River](#) conditions.
- Analysis for the River water and the bed of [sludge](#).
- Tailor the best optimal solution and required equipment for the cleaning of the River sludge.
- Organizing and mobilization of the dredging and screening equipment to one or more sites along the River.
- Organizing several sludge storages along the River.
- Establishing pollution to water (P2W) treatment plants to treat the sludge and the water (eg. Composting, incineration).
- If necessary, mineral extraction plants from the sludge are established too.

... Surface water treatment

- Many of the aromatic compounds of concern have functional groups such as halogen-, nitro- and azo-groups, making them less susceptible to oxygenases.
- In these cases, initial reductive attack is more effective.
- For example, some halogenated aromatics, such as higher molecular weight congeners of polychlorinated biphenyls (PCBs) are susceptible to reductive dehalogenation.
- Anaerobic metabolism therefore is initially used for the bioremediation of PCB-contaminated soils.
- A subsequent switch to aerobic conditions would then allow attack by oxygenases.
- This approach has been demonstrated for the bioremediation of PCB-contaminated sediments of the Hudson river in New York, Sheboygan river in Wisconsin.
- Similar approach was followed for treatment of polluted Nainital Lake.

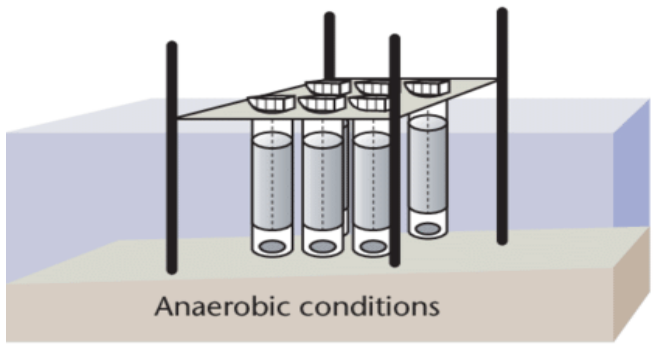
Bioremediation of polychlorinated biphenyl (PCB)-contaminated river sediments.

(a) Placement of steel caissons into sediments



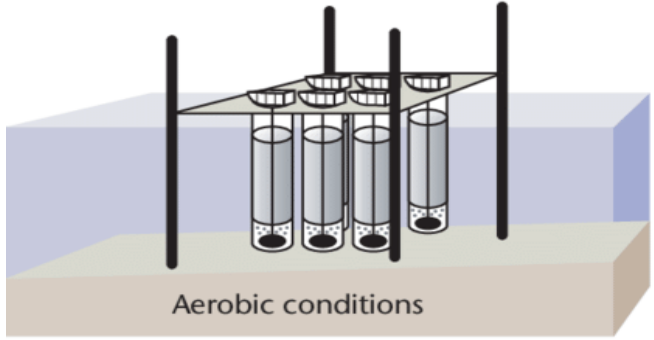
(a)

(b) Nutrients added to sealed caissons lead to creation of anaerobic conditions: anaerobic dehalogenation converts higher molecular weight congeners to ones with fewer chlorines;

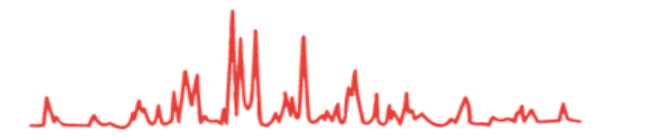
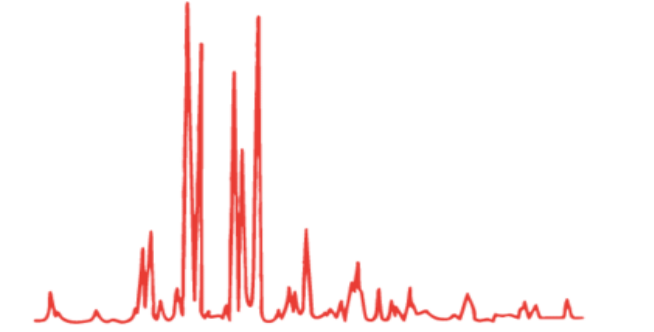
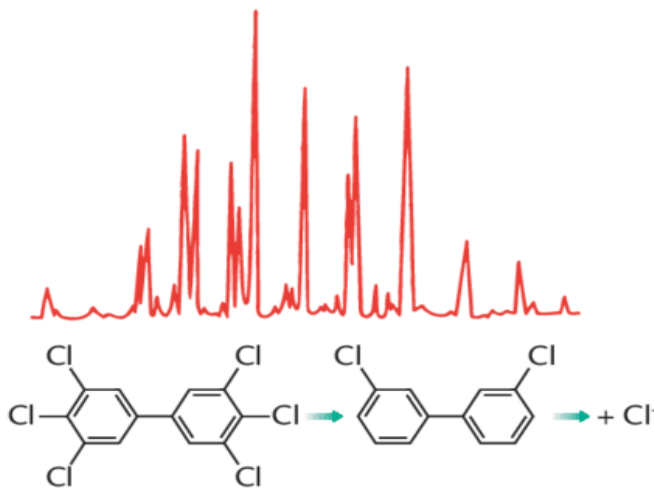


(b)

(c) Forced aeration and stirring create aerobic conditions; biodegradation of lower molecular weight congeners leads to cleaner sediments.



(c)



Questions

- Which condition of water is comes under category of water pollution? Write an essay on different method of polluted water treatment.
- Write short note on:
 - Ground water treatment
 - Surface water treatment