

2006 National Faculty Leadership Conference

The Two Tasks: Redeeming the Soul, Redeeming the Mind

**Healing the Land:
Engineering to Remediate our Environment**

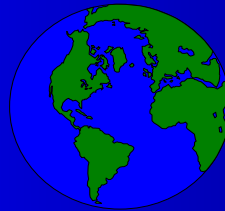
**Clayton J. Clark II, Ph.D.
Civil & Coastal Engineering
University of Florida**

Role of Engineering in Response to mandate of Gen 1:28?

And God blessed them, and God said unto them, Be fruitful, and multiply, and replenish the earth, and subdue it: and have dominion over the fish of the sea, and over the fowl of the air, and over every living thing that moveth upon the earth.

Genesis 1:28 KJV

Our Dominion over the world and all things in it.



Mankind was given dominion or responsibility over all the Earth by God.

BUT, dominion or stewardship demands responsibility.

This responsibility includes:

- ✚ development of strategies to conserve and maximize resources
- ✚ development of methods to counteract the negative impacts man has had on the Earth and its resources



Knowledge From God for a Purpose

.... He giveth wisdom unto the wise, and knowledge to them that know understanding:

He revealeth the deep and secret things: he knoweth what *is* in the darkness, and the light dwelleth with him.

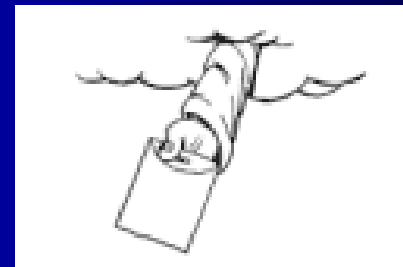
I thank thee, and praise thee, O thou God of my fathers, who hast given me wisdom and might, and hast made known unto me now what we desired of thee...

-Daniel says of the Lord, Daniel 2:21-23

*God is the giver of all wisdom and knowledge; therefore, we should seek His direction when we desire them.

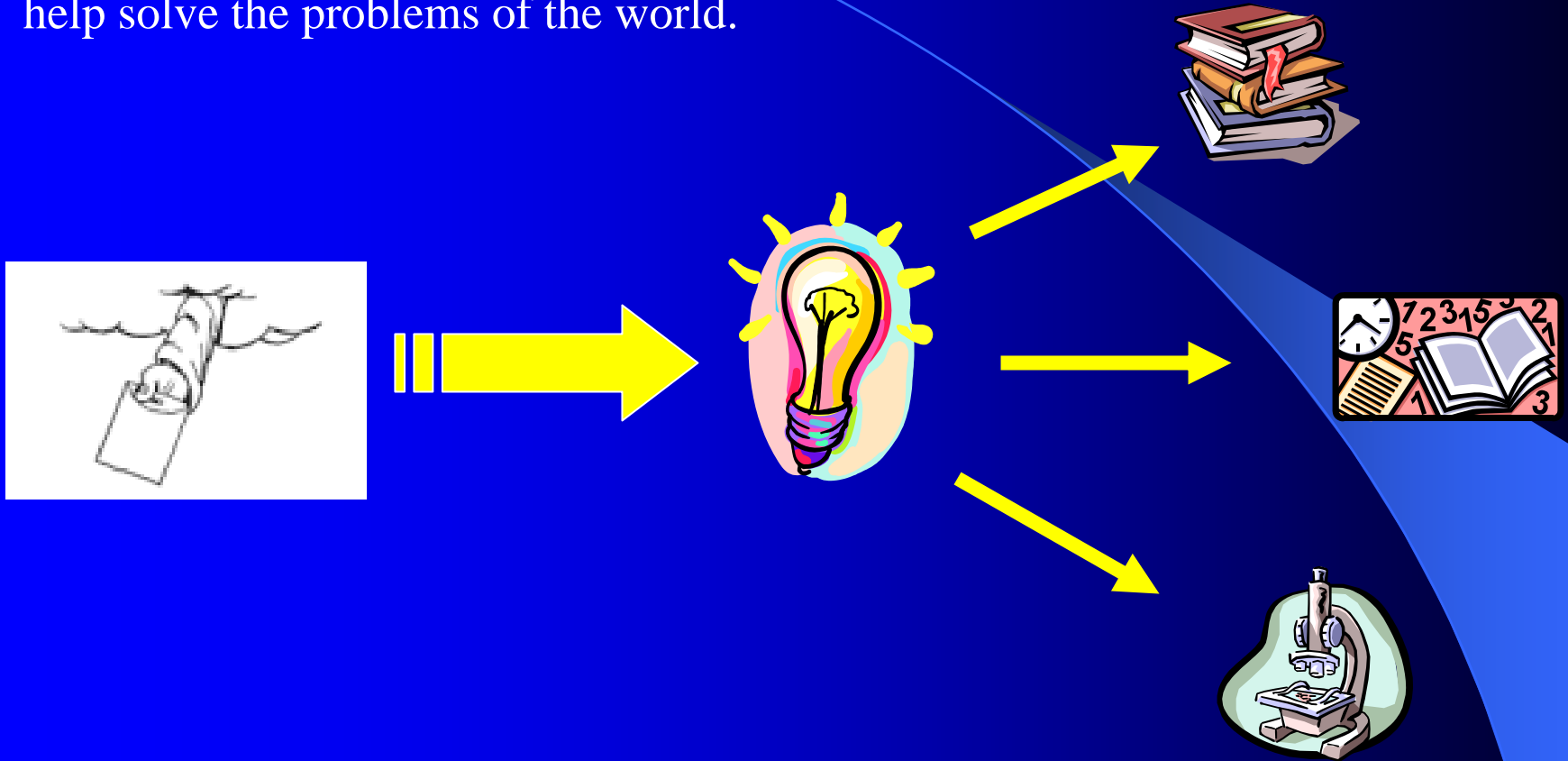
If any of you lack wisdom, let him ask of God, that giveth to all *men* liberally, and upbraideth not; and it shall be given him.

-James 1:5



Knowledge From God for a Purpose

*Through wisdom, He reveals to us strategies, sciences, and technologies to use to help solve the problems of the world.



And I have filled him with the spirit of God, in wisdom, and in understanding, and in knowledge, and in all manner of workmanship,

-The Lord to Moses, Exodus 31: 3

Knowledge From God for a Purpose

Problems and concerns of people, concern the Father.

Examples of His provision of knowledge for those who seek Him:

- * Pharaoh in Joseph's time
- * Engineered rebuilding of Jerusalem's walls in Nehemiah's time.
- * Numerous discoveries of George Washington Carver

Is Technology Good or Evil?



For the love of money is the root of all evil: which while some coveted after, they have erred from the faith, and pierced themselves through with many sorrows.

1Timothy 6:10 KJV



Money is not in itself evil, however the love of it, or anything greater than our love and obedience and utter dependence on the Lord God is.

Engineering and Technology, like money, is only a tool to be used to improve our lives and the lives of others.

However, like money, Technology has become worshipped in place of the Creator.

Is Technology Good or Evil?

The Tower of Babel was a remarkable engineering achievement, but its purpose was to glorify man and not God.

The Tower and the technology itself was not evil, the tool can only be used for evil if the users' motive is for evil.



-Conversely-

King Solomon's temple and the walls of Jerusalem were also engineering feats, however, they were used to glorify the Father and help people.

Motivation and use of the tools are determined by the seeker.



Manifestation of Biblical Worldview in Life of an Engineer/ Engineering Professor

Worldview of Engineering should parallel a *Biblical Worldview of Life* itself:

Research should go beyond benefiting only ourselves, but should also be seen in a lesser parallel to what Jesus spoke at the well:

But whosoever drinketh of the water that I shall give him shall never thirst; but the water that I shall give him shall be in him a well of water springing up into everlasting life.

-Jesus, John 4:14

The “well experience” benefits or blesses one person or only those in one central area.

Generally, engineering advances will provide advantages to those who develop technology, and those who can afford it.

But, a true Christian worldview looks for a further application of his/her resources to help others, known as a:

“River experience”.

Manifestation of Biblical Worldview in Life of an Engineer/ Engineering Professor

Worldview of Engineering as “River Experience”:

He that believeth on me, as the scripture hath said, out of his belly shall flow rivers of living water.

-Jesus, John 7:38

Rivers benefit many along the path of its course, as should Engineering and Technology.



Engineering technologies have to be implemented for all who may be in need, not only to those from which it may bring the largest profit.

As a river flows, so should necessary technology from one place to another.

This worldview seeks the best for all, not only the few or privileged.



Manifestation of Biblical Worldview in Life of an Engineer/ Engineering Professor

Responsibility of Engineering Professor:



23 Moreover as for me, God forbid that I should sin against the LORD in ceasing to pray for you:
but I will teach you the good and the right way:

24 Only fear the LORD, and serve him in truth with all your heart: for consider how great *things* he hath done for you.

-I Samuel 12:23-24

*Teach the “Good and Right Way” = Encompasses *Engineering Ethics*

*Be an example and pray for those you instruct

*Do not forget His benefits for you (Psalm 103:2), so you may benefit others



Healing the Land: Purpose of Environmental Engineering

If my people, which are called by my name, shall humble themselves, and pray, and seek my face, and turn from their wicked ways; then will I hear from heaven, and will forgive their sin, and will heal their land.

-II Chron 7:14

Healing the land can not only be spiritual, but also literally the removing pollution or “*disease*” from the Earth’s environment.

Engineering and Technology can be used in man’s stewardship of the Earth to aid in his keeping and maintaining of the planet and its resources.



And the LORD God took the man, and put him into the garden of Eden to dress it and to keep it.

Genesis 2:15 KJV

Environmental Engineering

Major Aspects of Environmental Engineering¹:

- Provision of safe, adequate water supplies
- Proper disposal of or recycle of wastewater and solid wastes
- Adequate drainage for proper sanitation
- Control of water, soil, and atmospheric pollution
- Remediation of contaminated environmental resources*

¹Davis and Cornwell, Intro to Environmental Engineering, 1991

Healing the Land: Environmental Engineering

As physicians “heal” patients, Environmental Engineers may “heal” the land and its resources.



Environmental Engineers modify the surroundings to facilitate the inherent capacity of resident environmental systems to remove or degrade undesired contaminants.

These modifications generally occur in two ways:



Removal of a majority of harmful contaminants to allow resident biological agents to take over.



Addition of chemicals to enhance the natural remedial abilities of the resident biological agents.

Remediation of Contaminated Environmental Resources

- Air and Atmospheric Resources
- Soil and Sediments
- Surface water and Groundwater Resources

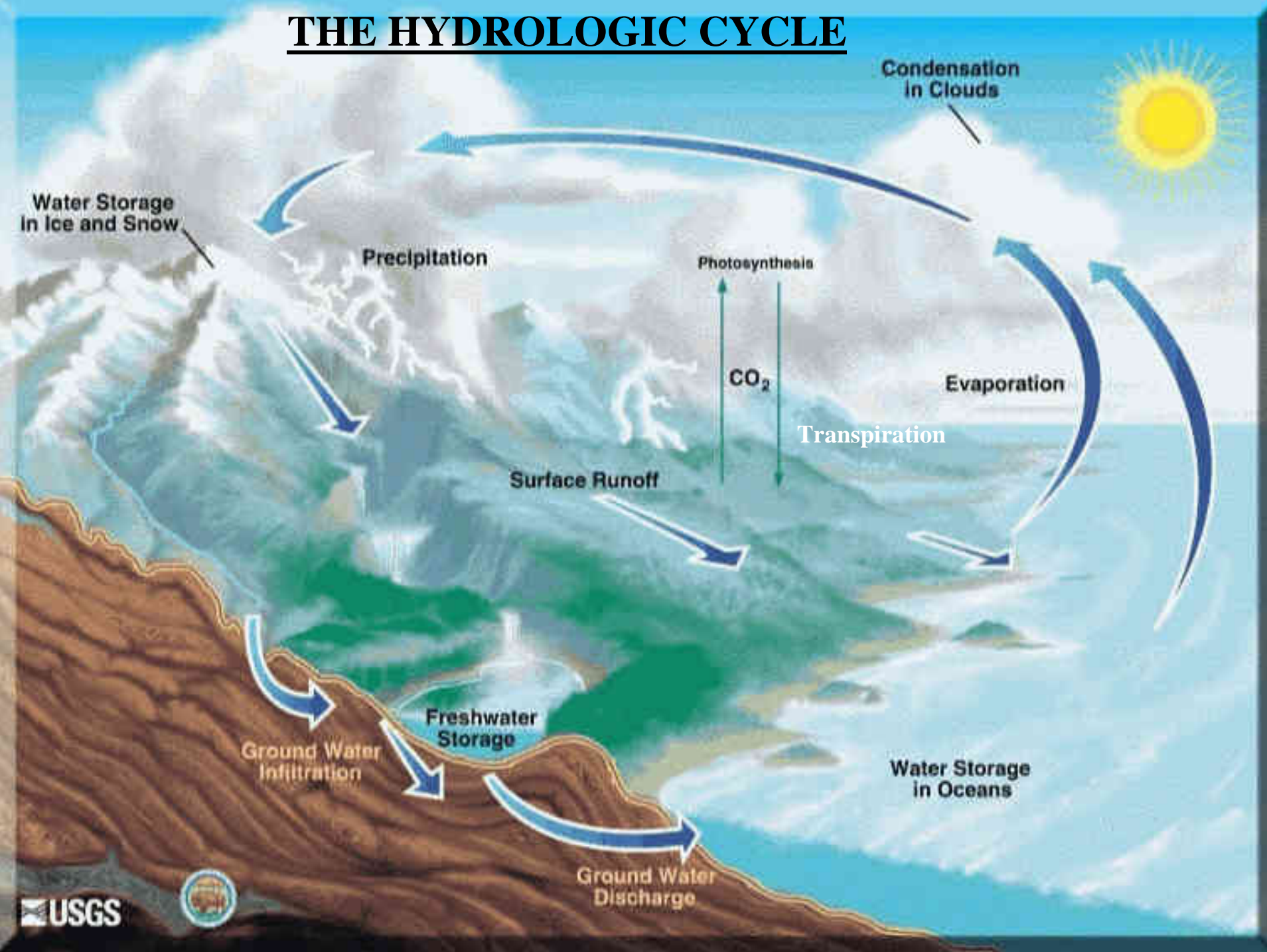
Engineering and technology focused on remediation of the above natural resources has evolved into the discipline referred to as Remediation Engineering.

Remediation Engineering

:the development and implementation of strategies to clean up (remediate) the environment by removing the hazardous contamination disposed in properties since the beginning of the industrial revolution².

²Sutherson, Remediation Engineering, 1997

THE HYDROLOGIC CYCLE



HYDROLOGIC CYCLE

The pathway of water as it moves in its various phases through the atmosphere, to the earth, over and through the land, to the ocean, and back to the atmosphere.

National Research Council, 1991

All the rivers run into the sea; yet the sea is not full; unto the place from whence the rivers come, thither they return again.

King Solomon, Ecclesiastes 1:7

Remediation Engineering



Uncontaminated Site

Contaminated with



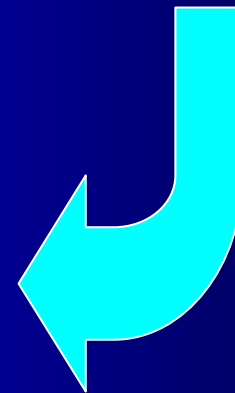
**Hazardous Waste
(Pesticides)**



Contaminated Area



Site after Remediation



**Application of
Remedial Engineering
Measures**

Remediation Engineering

Biological Processes

Enhanced Bioremediation

a process in which **indigenous or inoculated** micro-organisms (e.g., fungi, bacteria, and other microbes) degrade (metabolize) organic contaminants found in soil and/or ground water, converting them to innocuous end products.

Nutrients, oxygen, or other amendments may be used to enhance bioremediation and contaminant desorption from subsurface materials.

Remediation Engineering

Biological Processes

Bioreactor Landfill

operates to rapidly transform and degrade organic waste through the addition of liquid and air to enhance microbial processes.

Three Types:

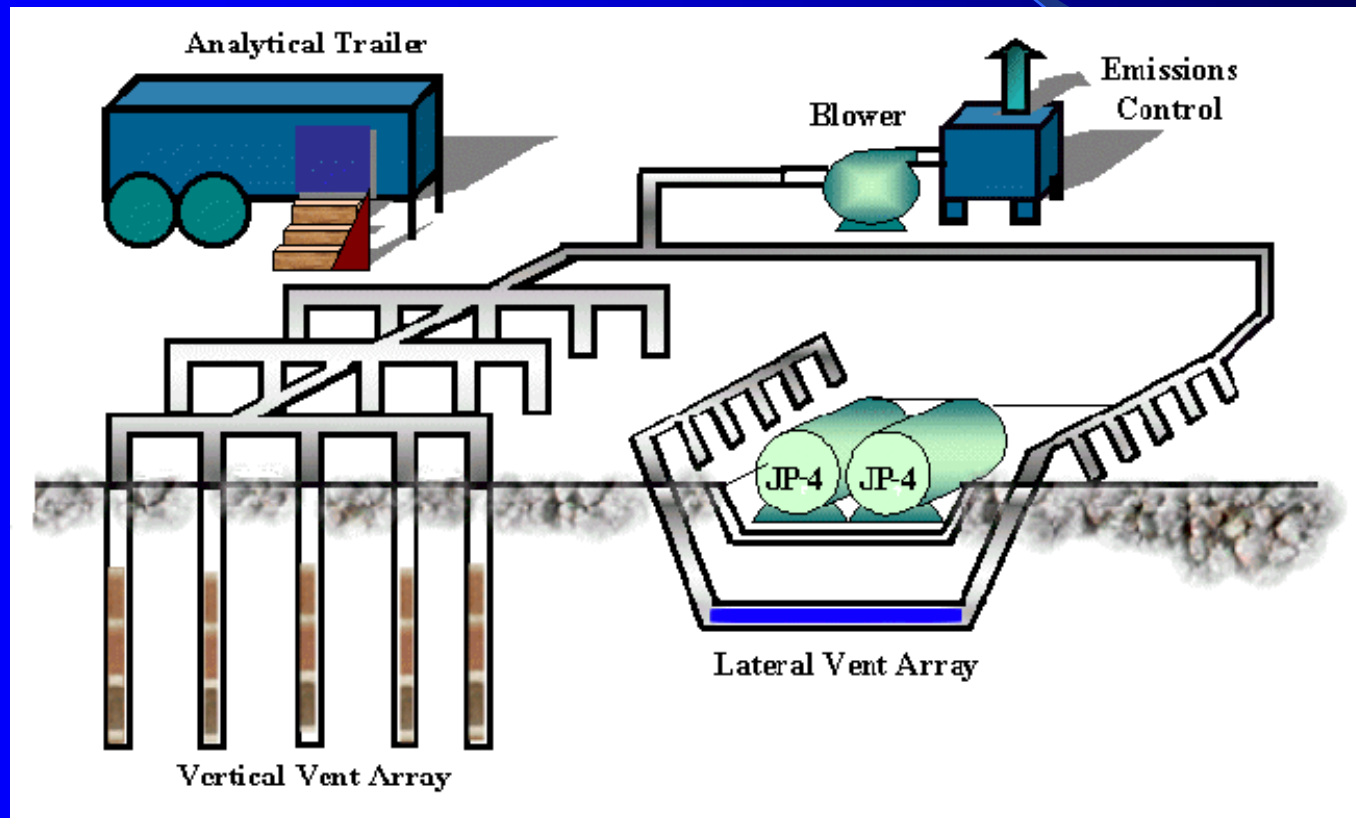
- 1. Aerobic** - Leachate is removed from the bottom layer and recirculated into the landfill in a controlled manner.
Air is injected using vertical or horizontal wells, to promote aerobic activity and accelerate waste stabilization.
- 2. Anaerobic** - Moisture is added as recirculated leachate and to obtain optimal moisture levels. Biodegradation occurs in the absence of oxygen (anaerobically) and produces landfill gas (primarily methane).
- 3. Hybrid (Aerobic-Anaerobic)** - Accelerates waste degradation by employing a sequential aerobic-anaerobic treatment to rapidly degrade organics in the upper sections of the landfill and collect gas from lower sections.

Remediation Engineering

Biological Processes

Bioventing

Oxygen is delivered to contaminated unsaturated soils by forced air movement, either by Extraction or injection of air, to increase oxygen concentrations and stimulate biodegradation⁴.



⁴FRTR, Remediation Technologies Screening Matrix and Reference Guide, Version 4.0

Remediation Engineering

Chemical Modification

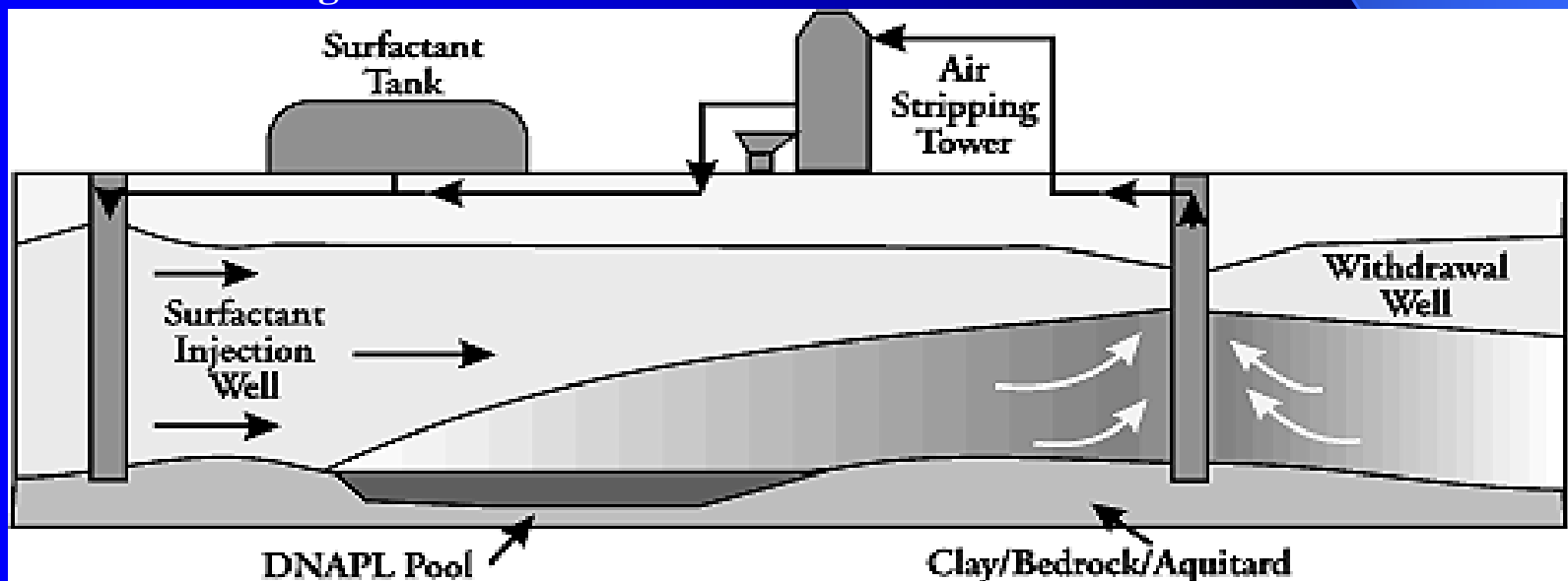
In Situ Flushing

Water, or water containing an additive to enhance contaminant solubility, is applied to the soil or injected into the ground water to raise the water table into the contaminated soil zone.

Contaminants are leached into the ground water, which is then extracted and treated.

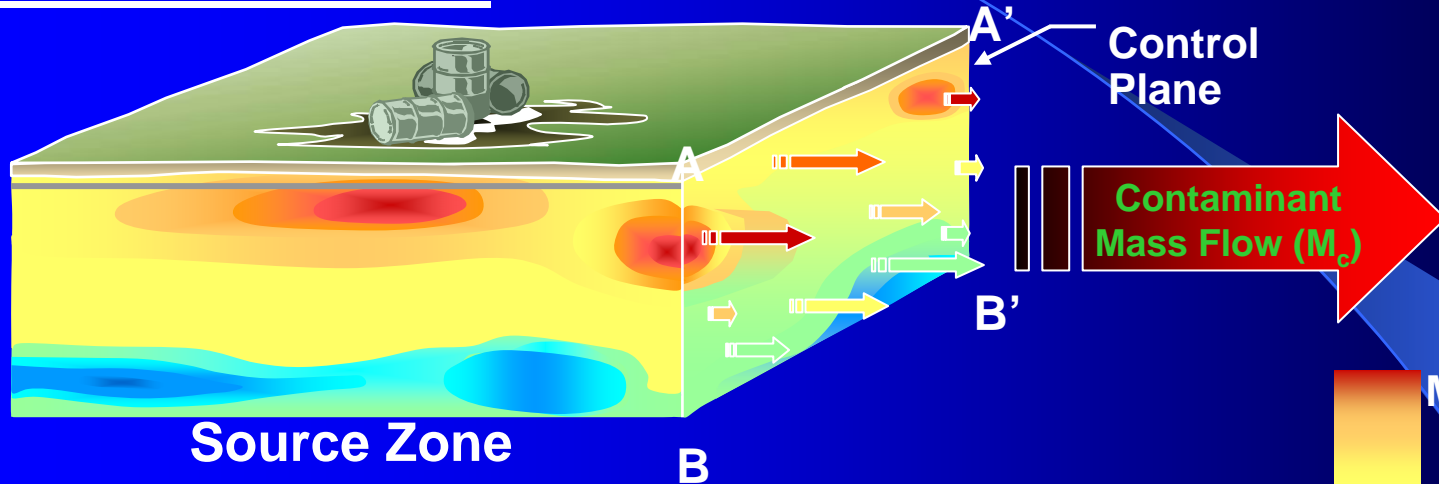
In situ soil flushing is the extraction of contaminants from the soil with water or other suitable aqueous solutions. Soil flushing is accomplished by passing the extraction fluid through in-place soils using an injection or infiltration process. Extraction fluids must be recovered from the underlying aquifer and, when possible, they are recycled.

Surfactant Flushing Schematic

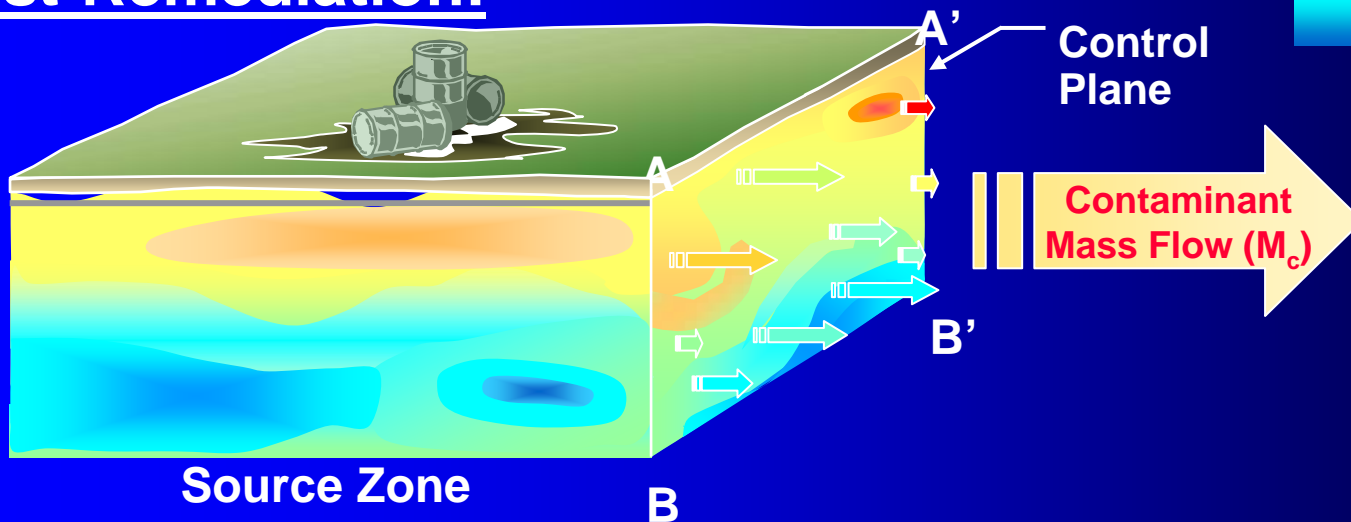


Remediation Effects on Contaminated Area

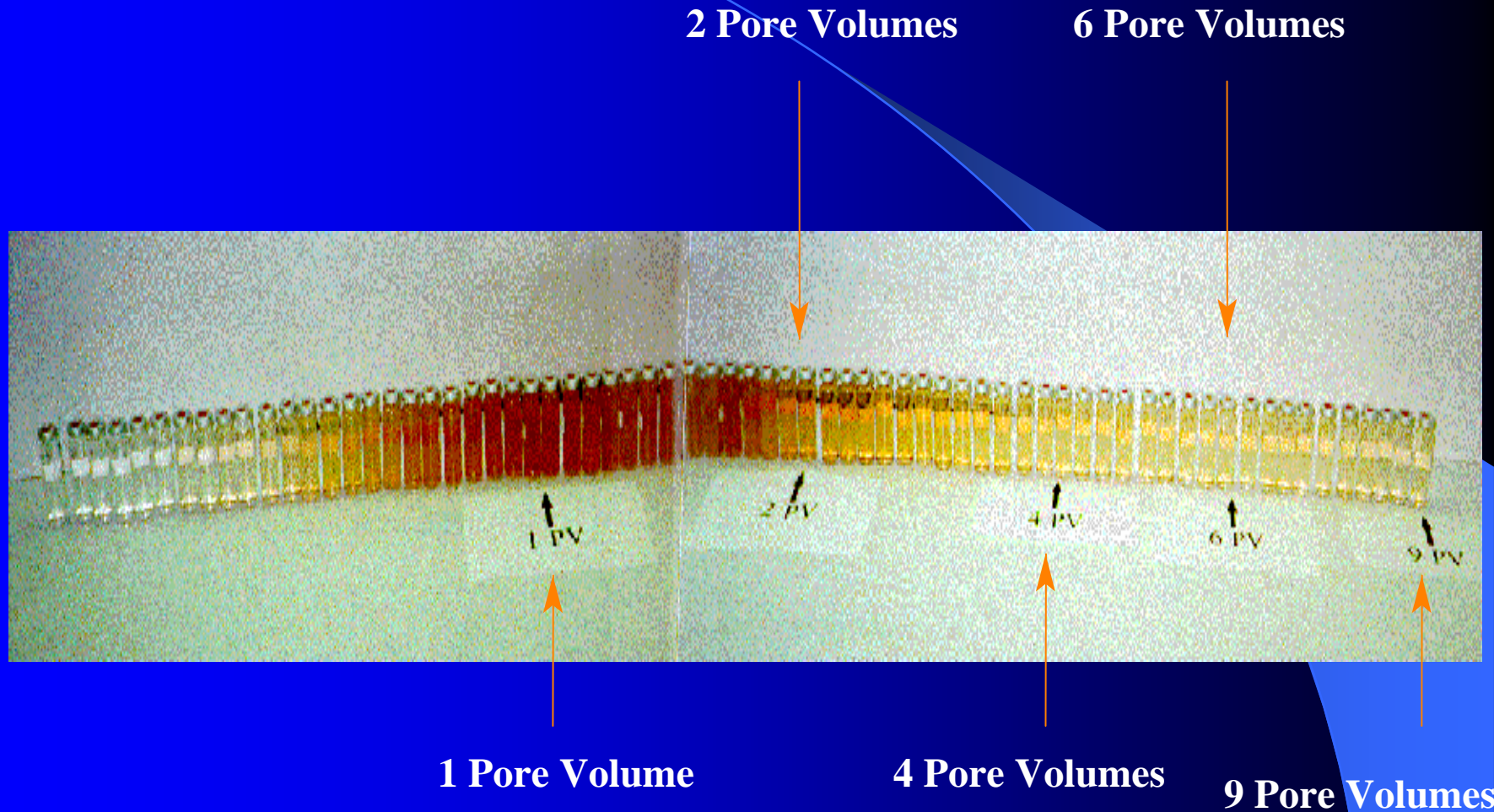
Pre-Remediation:



Post-Remediation:



SPME Flushing Effluent Samples



Remediation Engineering

Natural Attenuation

Relies on natural processes to clean up or attenuate pollution in soil and groundwater. Although it occurs at most polluted sites, the right conditions must exist underground to clean sites properly. If not, cleanup will not be quick enough or complete enough.

Nature can work in four ways to remediate contamination³:

1. Microbes indigenous in soil and groundwater use some chemicals for food. When they completely digest the chemicals, they can change them into water and harmless gases.
2. Chemicals can sorb to soil, which stabilizes their movement. This does not clean up the chemicals, but it can keep them from polluting groundwater and leaving the site.
3. As pollution moves through soil and groundwater, it can mix with clean water. This reduces or dilutes the pollution.
4. Some chemicals, like oil and solvents, can evaporate, which means they change from liquids to gases within the soil. If these gases escape to the air at the ground surface, sunlight may destroy them.

Remediation Engineering Developments Needed

National Priorities List (NPL)

is the list of national priorities among the known releases or threatened releases of hazardous substances, pollutants, or contaminants throughout the United States and its territories set up by the Superfund Federal Regulation. The NPL is intended primarily to guide the EPA in determining which sites warrant further investigation.



Over **1550** sites presently listed, with more being added than removed every year.

Remediation Engineering

As the number of contaminated sites continues to grow, so does the need to develop strategies to effectively remediate them.

God can reveal these strategies using Engineering as a tool.

Because, He never intended for us to remove contamination **THIS** way:





Thank You!

