

Bio-piling Remediation Technology for Hydrocarbon Contaminated Soil

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Agenda

- ▶ Soil pollution in Kuwait
- ▶ Hazardous effects of oil contaminated soil
- ▶ Introduction to bio-piling
- ▶ Criteria for evaluating bio-pile effectiveness
- ▶ Site requirements and system design
- ▶ Operating, monitoring and maintenance
- ▶ System advantages



Soil pollution in Kuwait

Historical factors that caused the Kuwaiti soil pollution:

- ▶ **Aftermath of Iraqi Invasion**
 - 700 oil wells set on fire/7 months
 - Oil lakes/ 40 Million tons of contaminated soil
- ▶ **Years of controlled activities within Oil Industry**
 - Underground storage tanks
 - Pipeline leaks
 - Spills and accidents

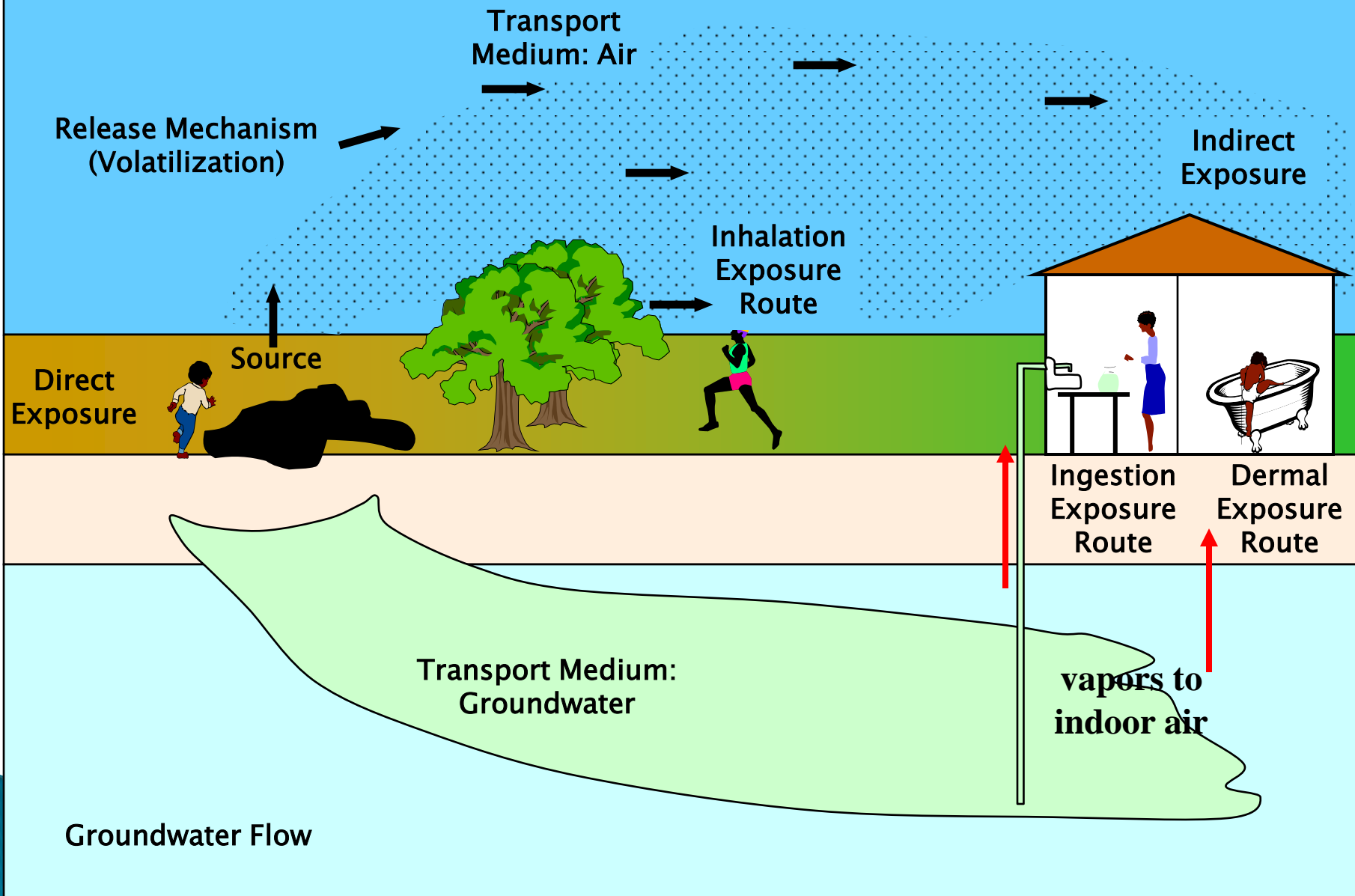


Hazardous effects of oil contaminated soil

- ▶ Health effects
 - Chronic health and respiratory problems
 - Cancer
 - Disorder of central nervous system
 - Gene deformities
- ▶ Ecosystem effects
 - Flora
 - Fauna



CONCEPTUAL EXPOSURE SCENARIOS



Introduction to bio-piling

- ▶ An environmental cleanup technology that uses microorganisms that naturally occur in soil, to destroy organic contaminants into CO₂ and H₂O
- ▶ Involves heaping contaminated soils into piles (or cells) and stimulating aerobic microbial activity within the soil through aeration and addition of nutrients and moisture
- ▶ Widely used in US and Europe



Introduction to Bio-piling

- ▶ **Applicability:**
 - Low molecular weight hydrocarbons
 - Heavy Chain Hydrocarbons
 - Gasoline
 - Diesel and heating Fuel
 - Generally, all constituents in petroleum products
- ▶ Treatment time typically 3–6 months



Introduction to Bio-piling

- ▶ How effective is Bio-piling?
 - Effective in cleaning petroleum contaminant in soil for concentrations as low as 1 ppm and as high as 50,000 ppm
 - If petroleum concentrations are higher than 50,000 ppm then dilution by blending is necessary
- ▶ Reduction in TPH concentration up to 95%



Criteria for evaluating bio-pile effectiveness – Treatability study

Treatability study purpose:

- ▶ Determine if contaminant in soil can be degraded to acceptable levels by indigenous microorganisms and existing soil and environmental conditions
- ▶ Compare to acceptable ranges
- ▶ Establish new conditions that would maintain and enhance the health of the indigenous microorganisms



Criteria for evaluating bio-pile effectiveness – Treatability study

Parameters used to evaluate the effectiveness of bio-piling system:

- ▶ 1. Soil characteristics
 - Microbial population density
 - Soil pH
 - Soil Moisture Content
 - Soil temperature
 - Nutrient concentrations
 - Soil texture



Criteria for evaluating bio-pile effectiveness – Treatability study

- ▶ 2. Petroleum Contaminant Characteristics
 - Volatility
 - Chemical structure
 - Concentration and toxicity

- ▶ 3. Environmental conditions
 - Ambient temperature
 - Rainfall
 - wind



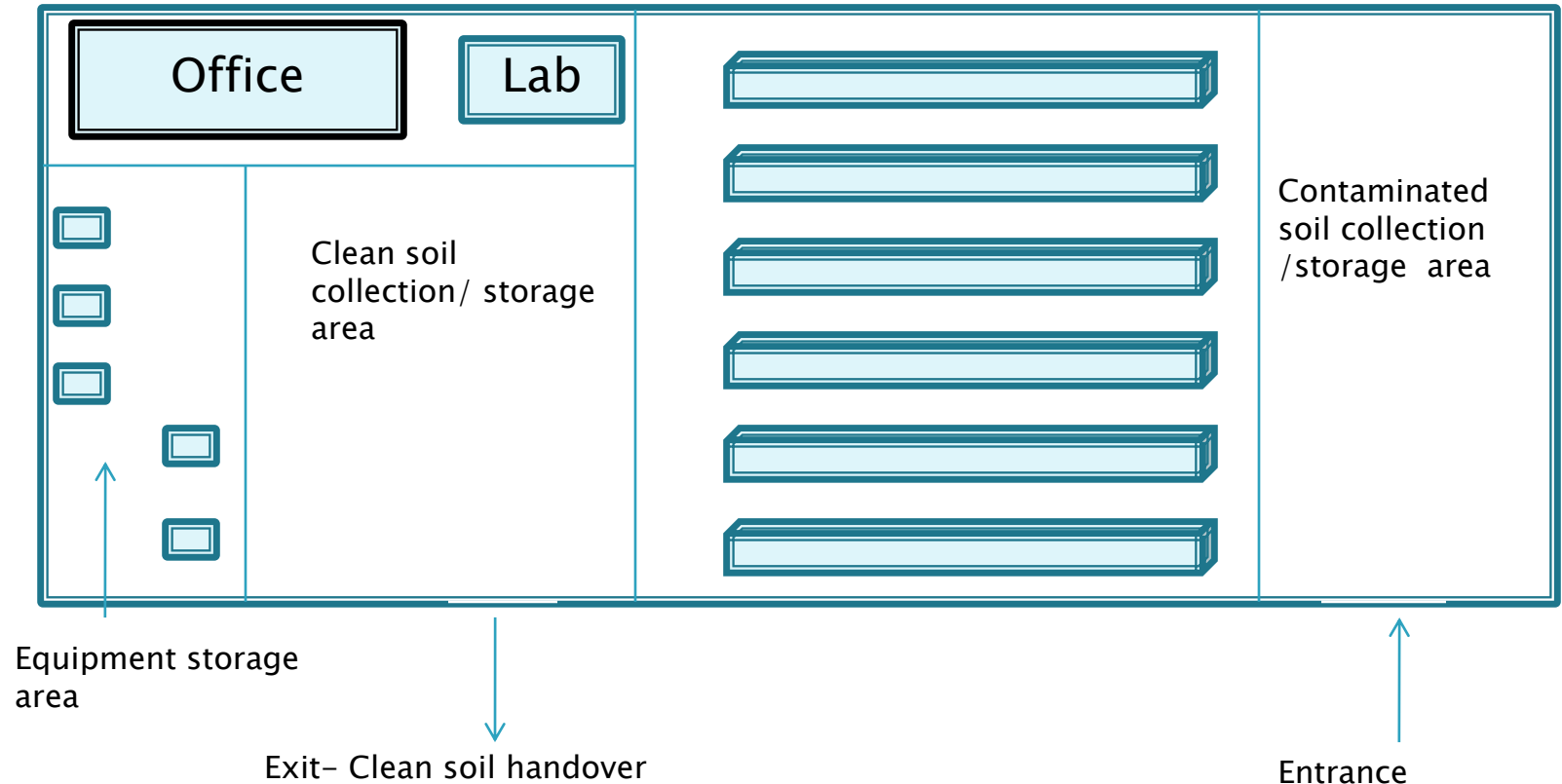
Site requirements and system design

- ▶ Site selection
 - Secured area
 - Outside of residential areas
 - Solid and flat ground
 - Close to utilities (water and electricity)

- ▶ Typical bio-piling facility include:
 - Bio-piles
 - Contaminated soil and clean soil storage/receiving areas
 - Offices and laboratory space
 - Equipment holding zone



Site requirements and system design



Site requirements and system design

- ▶ Height of bio-piles varies between 1m–3m
- ▶ System size example: 1.5m x 4m x L
- ▶ Additional land area around the bio-pile is required for access



Site requirements and system design

- ▶ Onsite operation will require a limited yet diverse group of specialists:
 - Onsite workers
 - Office workers
 - Field supervisor
 - Field technician
 - Remediation engineer



Site requirements and system design

- ▶ **Base Construction**
 - Cleared and graded land
 - Clay or asphalt foundation
 - Geo-textile liner at base
 - Leachate collection system/ berm
 - Clean sand base



Site requirements and system design

- ▶ Moisture and Nutrients System
 - Nutrient mixing tank
 - Mechanical mixer
 - Nutrient amendment piping (drip-line irrigation)
 - Delivery pump
 - Flow meter



Site requirements and system design

▶ Aeration System

- Air compressor
- Air flow instrumentation
- Air distribution piping
- Air liquid separator
- Vacuum blower
- Valves at the manifold branch points

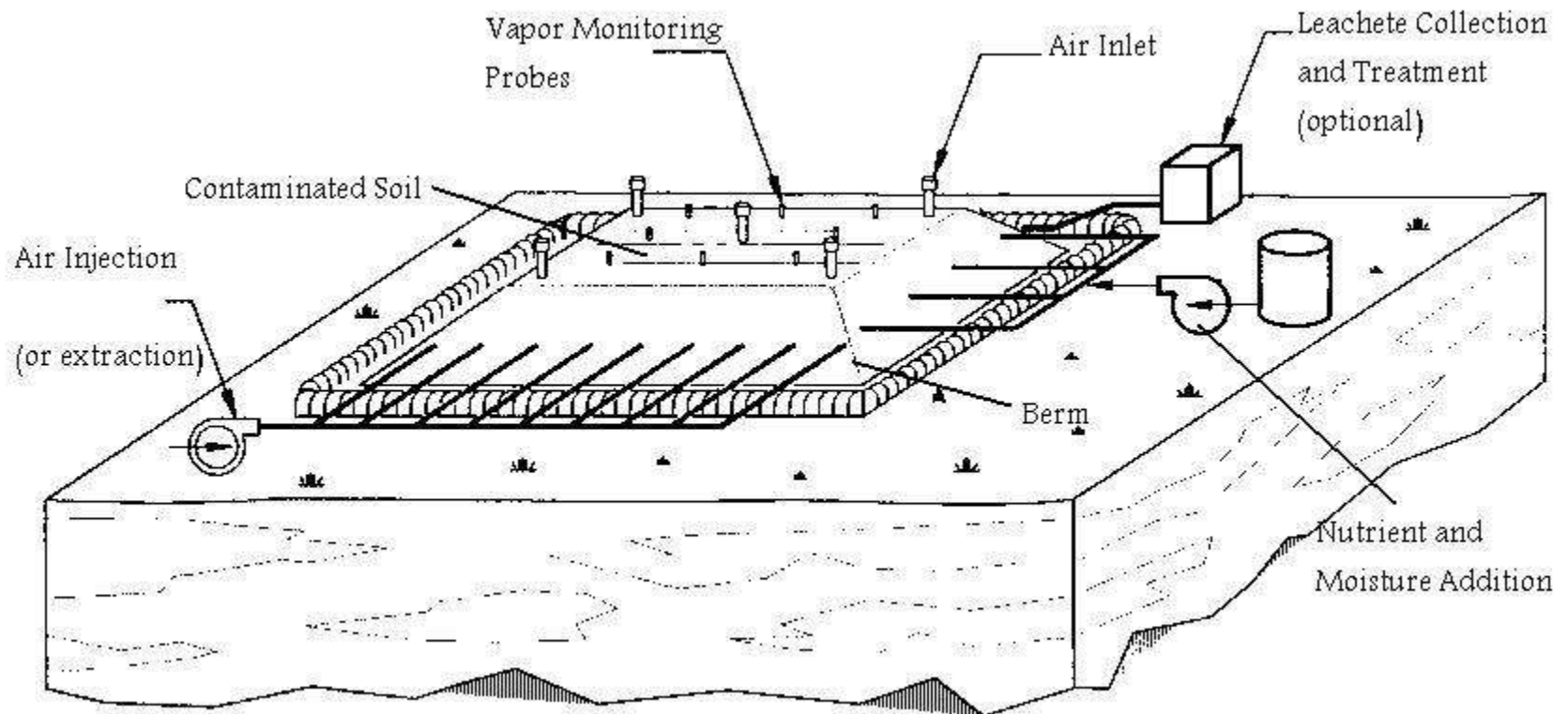


Site requirements and system design

- ▶ Bio-pile formation
 - Installing soil/gas monitoring points
 - Time zero sampling
 - Cover bio-pile



Site requirements and system design



Monitoring, operation and maintenance

Monitoring plan:

- ▶ Sampling events and intervals are according to schedule
- ▶ To ensure optimization of biodegradation rates and track constituent concentration reductions
- ▶ Monitor GW, emissions and runoff



Monitoring, operation and maintenance

Operation plan:

- ▶ A flexible operation plan that is modified based on the results of regular monitoring involve:
 - Frequency of air injection rate
 - Nutrient application rate
 - Moisture addition frequency



Monitoring, operation and maintenance

Maintenance plan:

- ▶ Aeration system maintenance
- ▶ Moisture and nutrient system maintenance
- ▶ Bio-pile cover repair
- ▶ Security/ vandalism checkup
- ▶ Piping repair



System advantages

- ▶ Save money and effort
- ▶ Use less energy
- ▶ Enhance company reputation
- ▶ Remediated soil safely reused
- ▶ No residuals or by products
- ▶ Reduce human exposure/onsite disaster risk
- ▶ **Lower stress on the environment**



Thank you

Any Questions?