

AIR-BASED REMEDIATION TECHNOLOGY SELECTION LOGIC



Air-Based Remediation Technologies

Overview

- Identify important site/project parameters
- Present general decision logic to select potentially applicable air-based remediation technologies
- Apply to example sites



Air-Based Remediation Technologies

Important Site/Project Parameters

- Media to be remediated (soil, groundwater, both soil and groundwater)
- Contaminant type
 - Low molecular-weight (MW) hydrocarbons
 - Medium/high-MW hydrocarbons
 - Chlorinated solvents
- Site hydrogeology
 - Homogeneous or heterogeneous subsurface materials
 - Sand/gravel or Silts/clays
- Time and funding available for project completion



Air-Based Remediation Technologies

General Approach

- Identify media to be treated
- Go to appropriate slide
 - Slide 5 for soil only
 - Slide 9 for groundwater only
 - Slide 15 for both soil and groundwater
- Follow logic shown on the slides to identify applicable air-based technologies
- Possible non-air-based technologies noted (in parentheses)



Air-Based Remediation Technologies

Treat Unsaturated Soil

- Low-MW Petroleum Hydrocarbons
 - If homogeneous sand/gravel:
 - SVE (if rapid restoration is required), possibly transitioning to BV;
 - BV if more time available and immiscible fuel not present in large quantities
 - If heterogeneous mix of sand/silt/clay:
 - SVE, with potential enhancements such as soil fracturing, long restoration times possible;
 - BV, long restoration times likely
 - ISTR, if shorter restoration times desired, higher costs



Air-Based Remediation Technologies

Treat Unsaturated Soil, Continued

- Low-MW Hydrocarbons, Continued
 - If predominantly silt/clay:
 - SVE, low flow rates with enhancements such as hot dry air injection and/or fracturing
 - ISTR (ERH, TCH, steam)
 - (Natural attenuation)



Air-Based Remediation Technologies

Treat Unsaturated Soil, Continued

- High-MW Petroleum Hydrocarbons
 - If homogeneous sand/gravel:
 - BV, possibly with early SVE phase, long restoration times possible
 - ISTR (ERH, steam, TCH) if quick restoration necessary
 - If mixture of sand/silt/clay:
 - BV (or SVE followed by BV), long restoration times likely, some residual low-solubility/mobility/toxicity hydrocarbons will remain
 - ISTR (steam, TCH, ERH) if quick restoration necessary
 - If predominantly silt/clay:
 - ISTR (ERH, TCH)
 - (Natural attenuation)



Air-Based Remediation Technologies

Treat Unsaturated Soil, Continued

- Chlorinated Solvents
 - If homogeneous sand/gravel:
 - SVE
 - Cometabolic BV, if little immiscible solvent present
 - Ozone oxidation possible alternative
 - If heterogeneous mix of sand/silt/clay:
 - SVE, longer restoration times possible, enhancements such as soil fracturing may be needed
 - Cometabolic BV, if little immiscible solvent present, long restoration times likely
 - If predominantly silt/clay:
 - ISTR (ERH, TCH)



Air-Based Remediation Technologies

Treat Groundwater

- Low-MW Hydrocarbons
 - If homogeneous sand/gravel
 - Air sparging, if little or no floating fuel, rapid restoration desirable, SVE may be necessary to capture vapors
 - Biosparging, if no floating fuel, short restoration time not needed
 - Product skimming, dual extraction, if floating fuels present
 - If heterogeneous mix of sand/silt/clay
 - Biosparging, if no floating fuel, long restoration times likely
 - Product skimming if goal is only to remove mobile product
 - TPE (particularly if floating fuel present) or DPE
 - Ground water circulation wells, if dissolved contaminant
 - ISTR (ERH, steam, TCH) if rapid restoration and/or very low concentrations desired
 - (In-situ chemical oxidation, bioremediation)



Air-Based Remediation Technologies

Treat Groundwater, Continued

- Low-MW Petroleum Hydrocarbons, Continued
 - If predominantly silt/clay:
 - High-vacuum two-phase extraction (if mostly silt)
 - ISTR (ERH, TCH)
 - (Natural attenuation)



Air-Based Remediation Technologies

Treat Groundwater, Continued

- High-MW Petroleum Hydrocarbons
 - If homogeneous sand/gravel:
 - Air sparging transitioning to biosparging if little floating fuel
 - Biosparging, if no floating fuel, short restoration time not needed
 - Product skimming, dual extraction, if floating fuels present
 - If heterogeneous mix of sand/silt/clay:
 - Biosparging, if no floating fuel, long restoration times likely
 - Product skimming if goal is only to remove mobile product
 - TPE (particularly if floating fuel present) or DPE, residual hydrocarbons likely following treatment
 - ISTR (ERH, steam, TCH) if rapid restoration and/or low concentrations desired
 - (In-situ chemical oxidation, bioremediation)



Air-Based Remediation Technologies

Treat Groundwater, Continued

- High-MW Petroleum Hydrocarbons, Continued
 - If predominantly silt/clay:
 - High-vacuum TPE (if mostly silt), significant residual low solubility/mobility/toxicity hydrocarbon will remain
 - ISTR (ERH, TCH)
 - (Natural attenuation?)



Air-Based Remediation Technologies

Treat Groundwater, Continued

- Chlorinated Solvents
 - If homogeneous sand/gravel:
 - Air sparging, if contaminant is primarily concentrated near water table; SVE may be necessary for vapors
 - Cometabolic air sparging (for chlorinated ethenes)
 - Product removal, if immiscible product (DNAPL) present, incomplete removal is highly likely
 - DPE if no immiscible product
 - ISTR if immiscible product (DNAPL) present and low residual concentrations required
 - If heterogeneous mix of sand/silt/clay:
 - DPE, TPE
 - Groundwater Circulation Wells, no immiscible product
 - ISTR (ERH, steam, TCH) if rapid restoration and/or low concentrations desired
 - (In-situ chemical oxidation, enhanced bioremediation)



Air-Based Remediation Technologies

Treat Groundwater, Continued

- Chlorinated Solvents, Continued
 - If predominantly silt/clay:
 - High-vacuum TPE (if mostly silt)
 - ISTR (ERH, TCH)



Air-Based Remediation Technologies

Treat Soil and Groundwater

- Low-MW Hydrocarbons
 - If homogeneous sand/gravel:
 - SVE and Air sparging, if little or no floating fuel, rapid restoration desirable, possibly transitioning to bioventing/biosparging
 - Bioventing and biosparging, if no floating fuel, short restoration time not needed
 - SVE and product skimming or dual extraction, if floating fuels present



Air-Based Remediation Technologies

Treat Soil and Groundwater, Continued

- Low-MW Petroleum Hydrocarbons, Continued
 - If heterogeneous mix of sand/silt/clay:
 - SVE (and/or bioventing) with biosparging, if no floating fuel, long restoration times likely, enhancements such as soil fracturing may be necessary above water table
 - SVE (and/or bioventing) and product skimming if goal for water is only to remove mobile product
 - TPE (particularly if floating fuel present) or DPE
 - Ground water circulation wells, if dissolved contaminant
 - ISTR (ERH, steam, TCH) if rapid restoration and/or very low concentrations desired
 - If predominantly silt/clay:
 - High-vacuum TPE (if mostly silt)
 - ISTR (ERH, TCH)
 - (Natural attenuation)



Air-Based Remediation Technologies

Treat Soil and Groundwater, Continued

- High-MW Petroleum Hydrocarbons
 - If homogeneous sand/gravel:
 - SVE and air sparging transitioning to bioventing and biosparging if little floating fuel
 - Bioventing and biosparging, if no floating fuel, short restoration time not needed, residual contaminants likely
 - SVE and product skimming or dual extraction, if floating fuels present, residual contaminants likely



Air-Based Remediation Technologies

Treat Soil and Groundwater, Continued

- High-MW Petroleum Hydrocarbons, Continued
 - If heterogeneous mix of sand/silt/clay:
 - Bioventing and biosparging, if no floating fuel, long restoration times likely
 - Bioventing and product skimming if goal for water is only to remove mobile product, residual hydrocarbons likely
 - TPE (particularly if floating fuel present) or DPE, residual hydrocarbons likely
 - ISTR (ERH, steam, TCH) if rapid restoration desired
 - (In-situ chemical oxidation, bioremediation)
 - If predominantly silt/clay:
 - High-vacuum TPE (if mostly silt)
 - ISTR (ERH, TCH)
 - (Natural attenuation)



Air-Based Remediation Technologies

Treat Soil and Groundwater, Continued

- Chlorinated Solvents
 - If homogeneous sand/gravel:
 - SVE and air sparging, if contaminant is primarily concentrated near water table
 - Cometabolic bioventing and air sparging (for dissolved chlorinated ethenes)
 - SVE and product removal, if immiscible product (DNAPL) present, incomplete removal is likely
 - DPE if no immiscible product
 - ISTR if immiscible product (DNAPL) present and low residual concentrations required



Air-Based Remediation Technologies

Treat Soil and Groundwater, Continued

- Chlorinated Solvents, Continued
 - If heterogeneous mix of sand/silt/clay:
 - DPE, TPE
 - Groundwater Circulation Wells, no immiscible product
 - ISTR (ERH, steam, TCH) if rapid restoration and/or low concentrations desired
 - SVE or cometabolic bioventing, possibly with enhancements (e.g., soil fracturing), with cometabolic biosparging, risk of incomplete treatment
 - (In-situ chemical oxidation, enhanced bioremediation)
 - If predominantly silt/clay:
 - High-vacuum TPE (if mostly silt)
 - ISTR (ERH, TCH)



Air-Based Remediation Technologies

Example Application 1

- Hypothetical Site
 - Underground storage tank that leaked diesel fuel over past 20 years
 - Geology: interbedded fine sands and silts
 - Groundwater is deep (~30 m), contamination extends only to ~20 m
 - Site is soon to be developed for residential use



Air-Based Remediation Technologies

Example Application 1, Continued

- Decision logic
 - Soil only
 - High-MW Petroleum Hydrocarbons
 - Mixture of sands/silts
 - Options:
 - SVE followed by BV (or BV) – slow but low cost
 - ISTR, if want to attain low concentrations – fast, but more costly
 - Too deep for practical excavation



Air-Based Remediation Technologies

Example Application 2

- Hypothetical Site
 - Trichloroethene-contaminated sump water discharged to on-site ditch
 - Geology: thin (1-2 m) silt-rich layer over fine to medium grained sands, impermeable bedrock at 25 m
 - Groundwater is shallow (7 m), contamination (up to 700 ug/L) extends only to ~15 m, no immiscible product suspected
 - Site is and will be used for industrial purposes



Air-Based Remediation Technologies

Example Application 2, Continued

- Decision logic
 - Soil and groundwater to be treated
 - Chlorinated solvents
 - Homogeneous sands
 - Options:
 - SVE and air sparging
 - Cometabolic bioventing and air sparging
 - DPE
 - SVE and simple ground water pumping another option, if containment of plume required
 - (In-situ chemical oxidation)



Air-Based Remediation Technologies

Example Applications

- Students' Projects
 - Media to be treated
 - Contaminant(s)
 - Geology
 - Constraints on goals, schedules, funding



Air-Based Remediation Technologies