Table A-14.A. Bioventing/Biosparging

Technology	Bioventing/ Biosparging	Bioventing, a process closely related to SVE, is an aerobic process by which air is injected and sometimes extracted to enhance biodegradation of petroleum in the unsaturated zone. Biosparging, a process closely related to air sparging, involves air sparging for the primary purpose of adding oxygen to stimulate biodegradation in groundwater. Bioventing and biosparging are potentially applicable to any biodegradable material found in sufficiently permeable material to allow air flow.	
Remediation process	Physical mass recovery	Limited	Bioventing and Biosparging are both in situ destruction technologies, some mass removal my occur if extraction is used.
	Phase change	Yes	Some lighter hydrocarbons may volatize and either biodegrade along the flow path or be extracted, if extraction is used.
	In situ destruction	Yes	Air is injected/extracted to enhance in situ aerobic biodegradation.
	Stabilization/ binding	Limited	Treatment often selectively removes lighter hydrocarbon fractions more rapidly, this results in increased viscosity lowering LNAPL transmissivity.
Objective applicability	LNAPL saturation	Yes	Bioventing reduces LNAPL mass and LNAPL saturation. This mass reduction reduces measurable free product as a result of upward "wicking" of deeper LNAPL as LNAPL and water table fluctuations expose deeper LNAPL to treatment.
	LNAPL composition	Yes	Lighter and more volatile LNAPL components are removed more rapidly than heavier. Typically BTEX and MTBE are more rapidly removed than alkanes or heavier hydrocarbons.
		Example performance metrics	LNAPL composition change, soil/groundwater VOC concentrations to below regulatory standard.
Applicable LNAPL type	Applicable to any biodegradable petroleum hydrocarbon. Typically light- to middle distillate LNAPL (e.g., gasoline, diesel fuel) is treated more rapidly than heavier (e.g., some diesel and heating fuels, and lubricating oils). However, the process has been used for crude oil and heavy hydrocarbons such as Bunker C.		
Geologic factors	Unsaturated zone	Permeability	Bioventing may be effective in any material that will allow sufficient air flow.
		Grain size	Fine-grained soil may not allow sufficient air flow, field testing may be necessary to make this determination.
		Heterogeneity	Heterogeneity is an important consideration, air will selectively flow in more permeable channels, treatment in low permeability material may be limited to diffusion effects (note that diffusion rates in unsaturated soils (bioventing) may be orders of magnitude greater than in saturated (biosparging)). Stratification can increase the radius of influence and reduce the number of wells required.
		Consolidation	Not typically a factor. A compacted surface layer can serve as a cap increasing ROI.
	Saturated zone	Permeability	Biosparging may be effective in any material with sufficient permeability to allow air flow.
		Grain size	Fine-grained soil may not allow sufficient air flow, field testing may be necessary to make this determination.

		Heterogeneity	Heterogeneity is of greater concern than for bioventing. Air flow channels form and their formation is very much controlled by even small heterogeneities. For hydrocarbons to be treated they must be in or close to an air channel, diffusion is a much weaker process than in the vadose zone. At times, lower permeability layers can spread air channels and increase the area of influence.
		Consolidation	Not typically a factor.