Table A-17.A. Natural source zone depletion

Technology	Natural source zone depletion	LNAPL mass reduction via naturally occurring volatilization, aqueous dissolution, and aerobic/anaerobic biodegradation across both the unsaturated and saturated zones; site-specific LNAPL mass loss rates can be quantified.	
Remediation process	Physical mass recovery	No	N/A
	Phase change	Yes	Volatile LNAPL fractions volatilize naturally to the gas phase in unsaturated soils; soluble LNAPL fractions dissolve to groundwater in the saturated zone. Additionally, microbes directly solubilize hydrocarbons from the LNAPL source or adhere to LNAPL at LNAPL-water interfaces and utilize intracellular diffusion techniques to assimilate LNAPL. LNAPL constituents in both the vadose (unsaturated) and saturated zones subsequently biodegrade via aerobic and anaerobic processes.
	In situ destruction	Yes	In situ biodegradation processes destroy LNAPL constituents in both the saturated and unsaturated zone.
	Stabilization/binding	No	N/A
Objective applicability	LNAPL saturation	Yes	Over the long term, the collective processes of NSZD reduce LNAPL mass and saturations
		Example performance metrics	Reduced LNAPL transmissivity, direct analysis of soil to measure changes in LNAPL saturation, presence/absence of in-well LNAPL, sustained effective NSZD rates
	LNAPL composition	Yes	NSZD changes the LNAPL composition; current research suggests that individual hydrocarbons degrade in a sequential process: toluene, followed by benzene, ethylbenzene, and xylenes, then short chain and long chain alkanes, and finally non-volatile hydrocarbons. The summation of the individual rates yields an overall quasi-zero-order degradation rate.
		Example performance metrics	Stable or reducing dissolved-phase plume and/or center of mass, LNAPL composition change, soil VOC concentrations to below regulatory standard, soil vapor levels to regulatory standard.
Applicable LNAPL type	All types of petroleum hydrocarbons. LNAPLs containing higher proportions of more soluble, volatile, and/or bioavailable hydrocarbon fractions may deplete more efficiently.		
Geologic factors	Unsaturated zone	Permeability	Unsaturated zone permeability, grain size, heterogeneity, consolidation, and soil moisture affect the effective diffusivity of volatilized LNAPL and biogenic gases. These conditions may change where aerobic or anaerobic degradation processes dominate and influences the LNAPL mass loss rate.
		Grain size	
		Heterogeneity	
		Soil moisture	
		Consolidation	Not typically a factor.
	Saturated zone	Permeability	No correlation between saturated zone hydraulic properties and NSZD rates has been consistently observed. Hydraulic properties that lead to higher groundwater velocities may result in higher LNAPL dissolution and aqueous phase-related mass loss rates; lower groundwater velocities may limit the dissolution rate, but may also result in deeply methanogenic conditions and elevated NSZD rates.
		Grain size	
		Heterogeneity	
		Consolidation	