

APPENDIX B

INDEX

Activated carbonSee Carbon Adsorption

Adsorption2-39, 5-69, 6-4

Advection4-1

Air

- emission calculation7-17
- extraction 5-7, 5-8, 5-9, 5-56
- injection3-45
- moisture separator See separator, moisture
- permeability 2-15, 2-17, 2-33, 3-4, 3-6, 3-34, 5-4, 5-9
- saturation See saturation, air
- sparging 1-1, 2-20, 3-45

Air saturationSee saturation, air

Airflow

- blocking of 2-27, 2-29, 2-33, 2-35
- in laboratory testing3-48
- in layered soils 2-35, 2-36
- in SVE3-45
- initiation of 3-8, 4-31. See also Priming
- measurement 4-7, 4-8, 4-9, 5-61, 7-12
- modeling See Modeling
- preferential See Preferential flow
- rates 3-45, 5-5, 5-7, 5-9, 5-18, 7-9, 7-12
- related to biodegradation2-39
- required to lift liquid 2-27, 2-28, 2-34, 3-41

Air-liquid separatorSee Separator, gas-liquid

Anemometer4-7, 7-12, 7-13, 7-27

Anisotropy2-22, 3-7

BacteriaSee Microorganisms

Barometric pressure4-8

Biodegradation

- aerobic 1-3, 2-12, 2-40, 3-32, 3-45, 4-6
- applicability of 3-31, 3-32, 3-33, 3-45
- description of2-39
- factors influencing 3-31, 3-32, 3-33, 3-34
- modeling See Modeling
- monitoring 3-33, 7-2, 7-4, 7-11
- potential 3-4, 3-31, 3-32, 3-33
- rates 3-33, 4-26

Biofiltration5-69

Bioslurping See also Two-phase extraction

- applicability of 3-2, 7-23
- description 1-3, 2-3, 2-4
- monitoring 4-13, 4-14
- performance 4-29, 4-30
- pilot testing 4-1, 4-17, 4-18, 4-24, 4-26
- processes of 2-37, 7-12, 7-17

Bioventing	
background	1-2, 1-4, 1-5, 2-5, 2-20
factors influencing	7-4. See also Biodegradation
feasibility	3-3, 4-29, 4-31
implementation	3-45, 5-6, 5-19, 7-19, 7-23, 7-24, 7-29
modeling	See Modeling
zone of influence	4-8, 5-11
Blower	
area	See Variable speed drive
associated piping	5-37, 5-40, 5-41
curve	4-7, 7-12
design	5-49, 5-57
liquid ring pump	5-49, 5-50
maintenance	7-25
maximum lift	5-59
monitoring performance	4-7, 7-16, 7-27
protection	5-65, 7-23. See also Filter, particulate
regenerative	5-50, 5-54
rotary lobe	5-50, 5-54
rotary piston pump	5-50, 5-54
rotary vane pump	5-50, 5-53
selection/sizing	4-7, 5-7, 5-18, 5-55, 5-56
shakedown	7-6
start-up	7-9, 7-10
temperature	5-40, 5-63, 7-14
troubleshooting	7-20, 7-23
use in DPE	2-1, 3-39, 3-40, 4-5
use in TPE	2-1, 4-5
Boiling point	3-4, 3-47, 5-47
Boring log	3-6, 5-31
Bulk density	2-13, 3-4, 3-6, 4-12
Bulletin Board Systems	1-4, 1-5
Capillary	
barrier	2-29, 2-35
break	2-35
forces	1-3, 2-5, 2-15, 3-11, 5-13
fringe	2-5, 2-18, 2-33, 2-34, 3-8, 4-11, 5-12, 5-30
model	2-14
pressure (head)	2-13, 2-16, 2-23, 2-33, 4-9
pressure-saturation curve	2-17, 2-32, 2-34, 3-4, 3-6, 3-8, 4-12
pressure-saturation relationship	2-14, 4-9, 5-7
rise	2-14, 2-15
Carbon adsorption	
aqueous treatment	3-46, 4-6, 5-5, 5-47, 5-69, 6-4
operation	7-11, 7-20, 7-23
use in sampling devices	7-13
vapor treatment	4-6, 5-69, 6-4, 7-19
Carbon dioxide	3-26, 3-33, 4-14, 7-11, 7-28
Catalytic oxidation	
operation	7-19, 7-23
selection	5-69, 5-70
CERCLA	3-47, 8-3
Closure	1-4, 7-5, 7-23, 8-1, 8-2, 8-3
Commissioning Checklist	See Pre-Commissioning Checklist

Condensate	
control/separation	5-45, 7-20, 7-23
monitoring	7-10
Contaminant	
concentration	3-18, 4-2, 7-14, 8-3
removal	1-2, 1-3, 3-31, 3-46, 3-47, 7-15
short-circuiting	3-9
Contamination	
cross-	4-8, 5-33
extent	1-2, 2-5, 2-12, 2-18, 2-19, 3-1, 3-16, 3-30, 3-32, 5-6, 7-14
locating by geophysical methods	3-15
Contract Issues	7-7, 7-15, 7-29, 7-30, 7-31, 9-2, 9-4
Cost	
capital	3-40, 3-43, 3-44, 5-6, 5-37, 5-47, 5-48, 5-49, 5-53, 5-64, 5-67, 5-68, 5-69, 7-19, 7-20, 7-29, 7-30
documenting	7-29
estimating	3-35, 3-47, 3-48, 4-2, 5-70
operating	3-35, 5-64, 5-67, 5-68, 5-69, 7-15, 7-19, 7-27, 7-28, 7-29, 7-30, 8-4
Cover	See Surface cover
Darcy's Law	2-18, 2-20, 2-21, 2-22, 2-23
Darcy-Weisbach equation	5-39
Data	
acquisition	3-1, 3-4, 3-33, 3-34, 4-13, 4-19, 4-28, 5-64, 7-1, 7-2, 7-3, 7-26
analysis	2-26, 3-8, 4-12, 4-17, 4-18, 4-22, 4-23, 5-56, 7-3, 7-13, 7-27, 8-2
collection sheet	4-14
loggers	7-11
management	5-68, 7-4, 7-8, 7-15, 7-27, 7-29
quality control/objectives	3-22, 6-2, 7-5, 7-25, 7-26
validation	7-26
Database	1-4, 1-5, 7-29
Decontamination	7-5, 8-1, 8-4
Density	
air	2-24, 4-12
bulk	See Bulk density
fluid	2-13, 2-23, 2-24, 3-4, 3-14, 3-16, 5-26, 5-39, 7-2, 9-4
particle	3-6
water	2-24
Desiccation	2-15, 4-9
Design	
parameters	4-13
Diffusion	
-limited mass transfer	2-35, 2-36, 2-39, 3-21, 3-45, 4-1, 7-23
Dissolution	2-39, 3-33, 3-46

Drop tube	2-1, 2-27, 2-28, 2-32, 2-33, 2-34, 3-7, 3-40, 4-13, 5-5, 5-30, 5-39, 7-1, 7-9, 7-18, 7-23, 7-28, 9-2
Dual-phase extraction	
background/description	1-3, 2-1, 3-39
data collection	4-13
liquid-only pump use	5-55
typical system layout	3-40
well	4-10
Electrical systems	
area classification	5-60, 5-67
electrostatic charge considerations	5-48
requirements	5-64
Electron acceptors	3-29, 3-31, 3-32
Excavation	3-35
Explosion hazard	5-49, 5-62, 5-65, 5-66, 7-24
Filter	
bio-	See Biofiltration
particulate	5-55, 7-11, 7-23
Fire protection	5-64
Fracturing	
hydraulic	3-44
pneumatic	3-44
Friction loss	5-39, 5-40
across valves	5-44
in piping	5-56
Gradient	
gravitational	2-21, 3-38, 4-13
hydraulic	2-6, 3-6, 3-7
pressure	2-3, 2-21, 2-26, 7-19
Granular activated carbon	See Carbon adsorption
Groundwater	
contamination	2-4, 2-5, 5-69, 7-3, 7-14
elevation	2-26, 3-6, 3-34, 4-16, 7-3
hydrology	2-21
pump-and-treat	1-2, 2-3, 3-43, 3-46
sampling	3-9, 3-27, 8-1
treatment methods	5-69
yield	3-8, 5-13
Half-life	See Biodegradation rates
Hazen and Williams formula	5-39
Head loss	
description	5-39
determining	5-39
Health and Safety	5-64, 7-4, 9-4
Heating (in-situ)	3-47
Henry's Law	2-5, 2-24, 2-38, 3-4
Heterogeneity	2-19, 3-4, 3-6, 3-9, 5-4, 7-19
Humidity	See Relative humidity

Hydraulic conductivity	2-22, 3-7, 3-8, 3-10, 4-13, 4-27, 4-32, 5-7, 5-10, 5-17, 5-26, 5-49, 5-52
In situ respirometry	
method	3-33
use in monitoring	3-4, 3-33, 3-34
Incompressible flow assumption	2-22
Injection	
air	See Air: injection
steam	3-47
surfactant	3-46
Instrumentation	5-60, 5-67, 7-6, 7-13
Laminar flow	2-20
Liquid ring pump	See Blower
Manifold	5-41, 5-42, 5-43
Manometer	5-62
Microorganism	
biotransformation	3-31
co-metabolic degradation	3-32
enumeration studies	3-33
nutrient needs	3-29
population	3-31, 3-33
Modeling	
airflow	5-26, 5-27
contaminant transport	3-7, 5-26
DNAPL	5-27
fundamentals	2-20, 5-20
groundwater	5-26, 5-27
LNAPL recovery	5-16, 5-17
use in design	1-5, 5-13, 5-18
use in evaluating system performance	5-27
Models	
classification of	5-24, 5-25
development of	5-26
numerical	5-27
selection criteria	5-24
summary of available software	5-21
Modifications	7-29
Moisture content	See Saturation, water
Mole fraction	3-17
Monitoring	4-6, 5-43, 5-60, 7-10, 7-11, 7-17, 7-24, 7-25, 7-26, 7-27, 7-28, 8-4
Monitoring points	4-6, 4-9, 5-34, 7-2, 7-9
Nitrogen	3-21, 3-27, 3-29, 3-32, 3-34, 7-2

Non-aqueous phase liquids (NAPL)	
dense non-aqueous phase liquids (DNAPL)	2-24, 3-16, 3-20, 5-27
emulsions	5-70
light non-aqueous phase liquids (LNAPL)	2-4, 2-24, 3-10
movement	2-18, 2-20
recovery	2-3, 2-5, 2-7, 2-8, 3-2, 3-35, 3-36, 3-37, 3-38, 4-8, 5-15
saturation	See Saturation, NAPL
spatial distribution	2-5, 2-37
storage	5-70, 7-19
-water separation	5-45, 5-46, 5-47
Nutrients	3-32, 3-33, 3-34, 7-2, 7-28
Octanol-water partitioning coefficient	2-39
Off-gas treatment	
implications for design	5-55, 5-56
operation	5-63
selection	5-69
Oil-water separator	See Separator, NAPL-water
Operation and maintenance	
monitoring	7-10, 7-11
performance	7-15
start-up	7-9
strategy	7-18, 7-22, 7-23, 7-24
troubleshooting	7-20
Organic vapor analyzer	5-62
Organically activated clay	5-47
Oxygen	
dissolved	3-27, 3-30
monitoring/sampling	3-26, 4-13, 7-28
supplying	3-45
uptake	3-33
Particulate filter	See Filters
Partitioning	
air-NAPL	2-5
air-soil	2-12
air-water	3-45
coefficients	2-39
octanol-water	2-5
soil-NAPL	2-5
soil-water	2-5, 3-34
Patent issues	9-1
Permeability	
air	See Air permeability
intrinsic	2-20, 2-22, 3-34
relationship to hydraulic conductivity	2-22
relative	2-20, 2-21
Permitting	4-1, 4-2, 5-34, 9-1
pH	3-4, 3-21, 3-30, 3-32, 3-34, 5-47, 7-2
Phosphorus	3-21, 3-27, 3-30, 3-32, 3-34, 7-2
Piezometer	See Monitoring points
Piezometric surface	2-29, 4-10

Pilot test	
evaluation	4-26
limitations	4-2
monitoring	4-6
objectives	4-1
reports	See Reports
Piping	5-37
Pitot tube	See Aiflow measurement
Plate count	See Microorganisms, enumeration
Pneumatic analysis	5-39
Pore volume	
exchange rate	5-6, 5-8
selection of exchange rate	3-46, 5-19
Pore water	2-5, 2-12, 3-31, 3-32, 3-33
Porosity	
air filled	2-29, 5-7, 5-8
use in determining moisture content	2-13
Potential	
biodegradation	See Biodegradation, potential
redox	3-27, 3-30, 7-2, 7-11
Pre-Commissioning Checklist	7-6, 7-7
Preferential flow	2-19, 4-31, 5-4, 5-7, 5-20, 7-19, 7-22.
See also Short-circuiting	
Pressure	
absolute	5-59
air emergence	2-15, 2-30, 2-31, 2-34, 3-8
air entry	2-29, 2-30, 2-31
atmospheric	2-19, 2-29, 4-10
barometric	See Barometric pressure
capillary	See Capillary pressure (head)
control devices	5-63
distribution	7-2, 7-27
drop across valves	See Friction loss
gauge	2-19, 4-8, 5-61, 5-62
gradient	See Gradient, pressure
head	2-21
inflection	See Pressure, air emergence
limitations on piping	5-40
loss in piping	See Friction loss
monitoring in the subsurface	7-11
standard	2-24, 4-7, 7-13
testing of monitoring points	4-9
vapor	See Vapor pressure
wetting	2-29
Pressure-saturation	See Capillary pressure-saturation
Presumptive remedies	1-3
Priming	2-34, 2-35, 7-23, 9-2
Process controls	5-60, 5-63
Product	See Non-aqueous phase liquids (NAPL)

Project team	5-3
Pulsed extraction	7-19, 7-28
Pump curve	See Blower curve
Quality assurance	7-5, 7-26
See also Sampling and Analysis Plan	
Quality assurance requirements	See Data
Radius of influence	
radius of pressure influence	4-8
zone of effective air exchange	4-8, 4-31
Raoult's Law	3-17
Rebound	8-1, 8-3
Recordkeeping	7-29
References	1-1, 1-4
Regenerative blower	See Blower
Regulatory issues	3-5, 8-1, 9-1
Relative humidity	4-7, 7-11, 9-4
Remedy selection	3-1
Reports	
design	6-1
feasibility study	3-48
pilot test	4-12
start-up	7-15
Residual NAPL saturation	2-18, 3-14
Resource Conservation and Recovery Act (RCRA)	3-47, 9-1
Respirometry	See In situ respirometry
Rotary lobe blower	See Blower
Rotary vane pump	See Blower
Safety	See Health and Safety
Sampling	
air	3-26, 7-14
closure	8-1
DNAPL	3-18
field methods	7-5, 7-25
groundwater	See Groundwater sampling
in long-term monitoring	7-25
intact soil cores	3-10
LNAPL	3-15
soil	3-8, 3-21, 3-34, 5-32, 5-36
soil gas	3-23, 3-26, 7-13
VOC decision tree	3-24, 3-25
Sampling and Analysis Plan	3-1, 3-21, 7-3, 7-25, 7-27
Saturated zone	2-4, 2-33, 3-7

Saturation	
air	2-13, 2-15
monitoring	4-10
NAPL	2-5, 2-12, 2-18, 2-36, 3-44
residual	3-14
vapor	3-17
water	2-12, 2-15, 2-34
Semi-volatile organic compounds (SVOC)	2-12, 3-21, 3-30, 3-47, 7-4
Separator	
gas-liquid	2-1, 4-5, 5-45
NAPL-water	2-1, 4-5, 5-46, 5-47, 7-1, 7-9
Short-circuiting	4-31, 5-71. See also Preferential flow
Shutdown	
guidance	8-4
strategy	8-1
Site characterization	3-1, 3-4, 3-34
Slurp tube	See Drop Tube
Soil	
cores	2-18, 3-8, 3-10
moisture	See Saturation, water
porosity	See Porosity
probes	See Monitoring points
properties	3-4, 3-6, 3-34, 4-1, 5-17, 7-3
sampling	See Sampling, soil
texture	2-6, 2-12, 2-15
Soil gas survey	3-23
Soil vapor extraction	
background	1-1
combining with groundwater extraction/NAPL recovery	3-46
Engineer Manual	1-5
wells	5-28
Solubility	
approximation of	3-17
of various compounds	2-24, 3-18
Solvent	1-3, 2-4, 3-15, 3-18, 4-3, 5-41
Start-up	
checklist	7-6, 7-7, 7-9
monitoring	7-9
objectives	7-8
overview	7-7
report	See Reports, start-up
strategy	7-7
Stratigraphy	3-6, 7-3
Structural considerations	6-2
Substrate	3-31, 3-32
Suction	2-26, 3-7, 5-53, 5-59. See also Capillary pressure
Suction tube	See Drop tube
Superfund	See CERCLA
Superposition, principle of	2-11, 5-12

Surface cover	5-36, 5-71, 6-1, 7-22, 7-23, 7-29
Tanks	5-2, 5-63
Technology screening	2-39, 3-1, 3-2, 3-3, 3-4
Temperature	
effects on chemical properties	2-24
instrumentation	5-62, 7-6
limitations	3-2, 3-3, 5-40, 5-63
measurement of	3-27, 3-30, 4-12, 5-39, 7-10
operating	5-38, 5-58
standard	2-24, 4-7, 7-13
Tension	See Capillary pressure
Texture	See Soil, texture
Thermal oxidation	
operation	7-8
selection	5-69, 5-70
Tracer gas	4-12
Trench/drain systems	3-36, 3-37
Trenches	5-28, 5-35, 7-6, 7-18
Troubleshooting	See Operation and maintenance, troubleshooting
Two-phase extraction	See also Bioslurping
background/description	1-3, 2-1, 3-40
data collection	4-7
limitations of	2-32, 3-2, 3-3, 3-6, 3-7, 3-8, 4-6, 5-41
typical system layout	2-2
Unsaturated zone	1-3, 2-5, 2-18, 3-14, 4-8
Upwelling	
causes of	2-27
concept	2-26, 2-27, 2-29, 4-10
measurement of	4-9, 4-10
of DNAPL	3-44
Vacuum	2-11, 2-26, 2-37, 4-6, 4-8, 5-40, 5-63, 7-2, 7-11, 7-27
Vacuum pump	See Blower
Vadose zone	See Unsaturated zone
Valves	
ball	5-44
butterfly	5-44
diaphragm	5-44
foot	5-45
gate	5-44
globe	5-44
needle	5-44
plug	5-45
Vapor concentration	
measurement	5-60, 5-62
trends	2-39, 5-48, 7-19, 7-23
Vapor pressure	2-38, 3-4, 3-47, 5-58, 5-59
Variable speed drive	5-55
Viscosity	2-21, 2-24, 3-14, 3-16, 7-2

Volatile organic compounds (VOC)	
gaseous phase	2-20, 7-13
liquid phase	2-5
methods of analysis	3-22
partitioning	2-5, 4-26
residual phase	2-5
Volatilization	2-38
Water saturation	See Saturation, water
Water table	See Groundwater level
Wells	
design	5-29
filter pack	2-32, 5-30, 5-32, 7-20
horizontal	5-28, 5-34
installation	5-28, 5-31
maintenance	7-20, 7-23, 7-28
screen placement	5-30, 5-32
Wetting phase	2-13, 2-14, 2-17, 2-29, 2-36
Work Plan	4-2, 6-2, 8-1