TABLE 2-1. CONTAMINANTS OF CONCERN FOR GROUNDWATER
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Groundwater COCs	Groundwater Cleanup Level (mg/l)
Arsenic	0.01
Benzene	0.005
Chlorobenzene	0.1
Ethylbenzene	0.7
Lead	0.015
Toluene	1
Xylenes (Total)	10

TABLE 3-1. PERIMETER PLUME MONITORING WELLS
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

General Plume Monitoring Wells
MW-26R
MW-33
MW-48S
MW-85S
MW-94S
MW-95S
MW-100S
MW-104S
MW-115S
Sentinel Monitoring Wells
MW-35
MW-131
MW-132
POC Monitoring Wells
MW-37
MW-120
MW-133
MW-134

TABLE 3-2. INTERIOR PLUME MONITORING WELLS
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Interior Plume Monitoring Wells
MW-10
MW-17
MW-18R
MW-20S
MW-22
MW-58S
MW-81S
MW-85D
MW-88
MW-93S
MW-96S

TABLE 3-3. LABORATORY ANALYSIS AND FIELD PARAMETERS FOR MONITORED NATURAL ATTENUATION (MNA) TRACKING CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Laboratory Analysis	Field Parameters
Alkalinity, Calcium, Chemical Oxygen Demand, Chloride, Iron (II) and Iron (III), Dissolved and Total Manganese, Methane, Nitrate, Nitrite, and Ammonia as Nitrogen, Total Kjeldahl Nitrogen, Potassium, Sodium, Sulfate, Sulfide, Total Organic Carbon	Dissolved Oxygen, Oxidation-Reduction Potential, pH, Specific Electrical Conductance, Temperature, Turbidity

TABLE 3-4. DATA USES OF INDICATOR PARAMETERS FOR MONITORED NATURAL ATTENUATION (MNA) PROGRAM CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Data Uses of Indicator Parameters		
Parameter	**Data Use**	**References**
Alkalinity (CO_2, HCO_3^-,CO_3^{-2})	Used for *charge balance* during major ion analysis	b, c
	Changes in alkalinity can result from biological activity in ground water through production of carbon dioxide (CO_2).	a, h
	A measure of the *buffering capacity* of ground water to pH changes	a,b,d
Arsenic (As^{+3}, As^{+5})	To determine if anaerobic microbiological activity is dissolving arsenic from aquifer matrix material. May require determination of the *speciation* of arsenic.	a
Calcium (Ca^{+2})	Used for *charge balance* during major ion analysis	b, c
Carbon Dioxide(CO_2)	Can act as an electron acceptor for anaerobic microorganisms.	a
	By product of some degradation pathways.	a
Chloride (Cl^-)	Used for *charge balance* during major ion analysis.	b, c
	Chloride can be from other sources such as road salt, general waste, etc.	b
	Dechlorination processes (se *reductive dehalogenation)* from chlorinated compounds may result in increases in chloride.	a,h
	Can be used as a conservative tracer to determine ground-water flow rates.	a
Iron (II) (Fe^{+2})	May indicate an anaerobic degradation process that transforms vinyl chloride, or BTEX compounds.	a, d, h
Hydrogen , Dissolved (H_2)	Dissolved hydrogen is an electron donor. May indicate the potential for reductive dechlorination to occur. Dissolved hydrogen concentrations indicate ambient redox conditions	a, h
Magnesium (Mg^{+2})	Used for *charge balance* during major ion analysis.	b, c

TABLE 3-4. DATA USES OF INDICATOR PARAMETERS FOR MONITORED NATURAL ATTENUATION (MNA) PROGRAM CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Data Uses of Indicator Parameters		
Parameter	**Data Use**	**References**
Manganese (Mn^{+2}), Mn^{+3}, Mn^{+4})	To determine if anaerobic biological activity is dissolving manganese from aquifer matrix material.	a, d, h
Methane (CH_4)	Methane is a by-product of methanogenesis.	a, h
	Associated with conditions that promote reductive dechlorination.	a,h
Nitrate (NO_3^-)	Nitrate may act as a medium for growth of microorganisms for anaerobic degradation, if oxygen is deplete. Nitrate inhibits reductive dechlorination	a, h
Nitrites (NO_2^-)	Is an intermediate during the denitrification processes. Product of ammonia oxidation by aerobic microorganisms. Toxic by-product of denitrification of nitrate.	d
Oxidation –Reduction Potential (ORP or sometimes Eh)	Used as stabilization parameter during ground-water sampling.	f
	Used for determining the presence of oxygen in ground water (Oxidation state).	b, h
	Frequently, the electrode potentials measured in the field must be corrected to standard conditions.	a
Oxygen, Dissolved (O_2)	Used as stabilization parameter during ground-water sampling and aids in determining the redox regime.	f
	Used for determining the concentration of oxygen in ground water.	a,h
Partition coefficient (also known as a Distribution Coefficient or K_d)[1]	Used for determining the relative mobility of contaminant. Direct measure of the partitioning of a contaminant between the formation materials and ground water.	g
pH	Used for *charge balance* during major ion analysis.	b, c
	Used as stabilization parameter during ground-water sampling.	f
	Chemical and biological reactions are pH dependent.	h

TABLE 3-4. DATA USES OF INDICATOR PARAMETERS FOR MONITORED NATURAL ATTENUATION (MNA) PROGRAM CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Data Uses of Indicator Parameters		
Parameter	**Data Use**	**References**
Potassium (K^+)	Used for *charge balance* during major ion analysis.	b, c
Specific Electrical Conductance (SEC) (also commonly referred to as Conductivity or Specific Conductance)	Used for *charge balance* during major ion analysis.	b, c
	Used as an estimate of Total Dissolved Solids	e
	used as a stabilization parameter during ground-water sampling.	f
	Directly related to ion concentration in solution and therefore may indicate total number of ions.	a
Sodium (Na^+)	Used for *charge balance* during major ion analysis.	b, c
Sulfate (SO_4^{-2})	Used for *charge balance* during major ion analysis.	b, c
	Sulfate may act as an electron acceptor for anaerobic degradation.	a, h
Sulfide (S^{-2})	Sulfide may be produced by sulfate reduction by sulfate-reducing bacteria, primarily in the form of hydrogen sulfide (H_2S). Tests are typically for H_2S. the presence of sulfide is a good indication that sulfate reduction is on-going.	d, h
Temperature	Used t o support the evaluation of charge balance during major ion analysis.	b, c
	Used as stabilization parameter during ground-water sampling.	f
	Chemical and biological reactions are temperature dependent.	a, h
	Affects the solubility of dissolved gases.	a
Total Dissolved Solids (TDS)	Used with Total Suspended Solids to determine fraction of particulates that are able to pass a specified filter size. The particulates can be mobile in ground water and may provide a mechanism for facilitated transport for compounds that otherwise would not be mobile.	

TABLE 3-4. DATA USES OF INDICATOR PARAMETERS FOR MONITORED NATURAL ATTENUATION (MNA) PROGRAM CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Data Uses of Indicator Parameters		
Parameter	**Data Use**	**References**
Total Inorganic Carbon (CO_2, HCO_3^-, CO_3^{-2})[2]	Used for *charge balance* during major ion analysis.	b, c
	Changes in alkalinity can result from biological activity in ground water through production of carbon dioxide (CO2).	a, h
	A measure of the buffering capacity of ground water of pH changes.	a,b,d
Total Organic Carbon (TOC)	Used to classify plume and to determine if reductive	a
Total Suspended Solids (TSS)	Used with Total Dissolved Solids. TSS is the total fraction of particulates.	
Turbidity	Used as stabilization parameter during ground-water sampling.	f
	Represents fine particles suspended in water, which can be correlated to TDS and TSS.	f
Biologically Available Iron (III) (Fe^{+3})	Iron (III) may serve as the terminal electron acceptor for the destruction of fuel hydrocarbons and vinyl chloride.	a
Cation Exchange Capacity (CEC)	Measure of the capacity of formation materials to sorb metals. Composed of sorption sites on both clay and organic matter.	d, g
Grain Size	Size of grains control some sorption ad precipitation properties.	h, i
Clay content	Clay provides sorptive sites for metals, organics and radio-nuclides. Different clay mineralogical types may also affect sorption. May be completed via x-ray analysis for mineralogy determination, via sieve analysis, or via natural=gamma geophysical logs for relative difference in clay content. Also, sorption is pH dependent.	d, g, i

TABLE 3-4. DATA USES OF INDICATOR PARAMETERS FOR MONITORED NATURAL ATTENUATION (MNA) PROGRAM CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Data Uses of Indicator Parameters		
Parameter	**Data Use**	**References**
Total Organic Carbon (TOC)	The rate of migration of various contaminants in ground water is dependent upon the amount of TOC in the aquifer matrix.	a, d
	May also preferentially sorb some metals, organics and radio-nuclides.	d, g, h
	TOC may reduce Chromium (VI) to Chromium (III), making it less mobile and less toxic.	j

1998 and/or the Standard Methods for the examination of Water and Wastewater, 18th edition, 1992.

[1]Methods for determining partition coefficients are presented in USEPA, 1999b, with the general recommendation that in-situ test be performed.

[2]Total Inorganic Carbon can be determined by calculation r\or by modification of TOC methoc

References:

a) United States Environmental Protection Agency, 1998
b) Hem, 1985
c) Hounslow, 1995
d) Deutsch, 1997
e) Wiedemeier, Rifai, Newell and Wilson, 1999
f) Puls and Barcelona, 1996
g) United States Environmental Protection Agency, 1999b
h) Azadpour-Keeley, Russell and Sewell, 1999
i) Piwoni and Keeley, 1990
j) Palmer and Puls, 1994

TABLE 3-5. DECISION RULES FOR GEOTECHNICAL PARAMETERS FOR MONITORED NATURAL ATTENUATION CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Parameter	Decision Rule
Alkalinity (CO_2, HCO_3^-, CO_3^{-2})	Used for charge balance: if charges do not balance then this indicates at least one of the ions was measured incorrectly, or a major ion was not included in the analyte list.
	Increasing alkalinity from up-gradient to within smear zone indicates biodegradation processes.
Ammonia as Nitrogen	Increasing Ammonia from up-gradient to within the smear zone indicates anaerobic biodegradation via nitrate reduction.
Calcium (Ca^{+2})	Used for charge balance: if charges do not balance then this indicates at least one of the ions was measured incorrectly, or a major ion was not included in the analyte list.
Chloride (Cl^-)	Used for charge balance: if charges do not balance then this indicates at least one of the ions was measured incorrectly, or a major ion was not included in the analyte list.
Iron (II) (Fe^{+2})	Increasing Iron (II) from up-gradient to within smear zone indicates anaerobic biodegradation via iron reduction.
Magnesium (Mg^{+2})	Used for charge balance: if charges do not balance then this indicates at least one of the ions was measured incorrectly, or a major ion was not included in the analyte list.
Manganese (Mn^{+2})	Increasing Mn (II) from up-gradient to within smear zone indicates anaerobic biodegradation via manganese reduction.
Methane (CH_4)	Increasing Methane from up-gradient to within smear zone indicates anaerobic biodegradation.
Nitrate (NO_3^-)	Decreasing Nitrate from up-gradient to within smear zone indicates anaerobic biodegradation via nitrate reduction.
Nitrites (NO_2^-)	Increasing Nitrite from up-gradient to within smear zone indicates anaerobic biodegradation via nitrate reduction.
Oxidation-Reduction Potential (ORP).	If ORP is not reasonably correlated with dissolved oxygen concentrations, then this may indicate that one or both of these parameters is measured incorrectly.
Oxygen, Dissolved (O_2)	Decreasing Oxygen from up-gradient to within the smear zone indicates aerobic biodegradation via oxygen reduction.
pH	Used for charge balance: if charges do not balance then this indicates at least one of the ions was measured incorrectly, or a major ion was not included in the analyte list.
Potassium (K^+)	Used for charge balance: if charges do not balance then this indicates at least one of the ions was measured incorrectly, or a major ion was not included in the analyte list.

TABLE 3-5. DECISION RULES FOR GEOTECHNICAL PARAMETERS FOR MONITORED NATURAL ATTENUATION CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Parameter	Decision Rule
Sodium (Na^{+})	Used for charge balance: if charges do not balance then this indicates at least one of the ions was measured incorrectly, or a major ion was not included in the analyte list.
Specific Electrical Conductance	Used as indicator of TDS. No specific decision rule for this analyte.
Sulfate (SO_4^{-2})	Used for charge balance: if charges do not balance then this indicates at least one of the ions was measured incorrectly, or a major ion was not included in the analyte list.
	Decreasing Sulfate from u-gradient to within the smear zone indicates anaerobic biodegradation via sulfate reduction.
Sulfide (S^{-2})	Increasing Sulfide from u-gradient to within the smear zone indicates anaerobic biodegradation via sulfate reduction.
Temperature	Groundwater temperatures within the general range of 10 to 35^{o}C are optimum for biodegradation (Wilson et al., 1996). Temperatures outside of this range would indicate biodegradation is possible but the rates may be lower than within the optimum range.
Total Kjeldahl Nitrogen	Used for estimating speciation of nitrogen. No specific decision rule for this analyte; used in conjunction with the other nitrogen analyses.
Turbidity	Used to calibrate any field colorimetric tests. No specific decision rule for this analyte.

Wilson, B.H., Wilson, J.T., Luce, D. 1996. Design and interpretation of microcosm studies for chlorinated compounds. *Symposium on Natural Attenuation of Chlorinated Organics in Groundwater* , pp.21-28. EPA/540/R-96/509.

TABLE 3-6. MONITORED NATURAL ATTENUATION (MNA) MONITORING WELLS
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

MNA Monitoring Wells
L-1RR
MW-18R
MW-20S
MW-33
MW-35
MW-38
MW-51
MW-81S
MW-85S
MW-96S
MW-100S
MW-112
MW-114
MW-115S

TABLE 3-7. SUPPLEMENTAL DISSOLVED-PHASE MONITORING WELLS
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Supplemental Dissolved-Phase Monitoring Wells
L-1RR
L-3R
MW-21
MW-33
MW-51
MW-64
MW-80
MW-99

TABLE 3-8. GROUPED MEDIA SAMPLE LOCATION DESIGNATIONS
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Grouped Media Sample Location Designations
Group 21
Group 18
Group 20
Group 93

TABLE 3-9. NESTED VAPOR WELLS FOR VAPOR PROFILING
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Nested Vapor Monitoring Wells
VW-18 (proposed)
VW-20 (proposed)
VW-21 (proposed)
VW-93

TABLE 3-10. NESTED GROUNDWATER MONITORING WELLS
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Nested Groundwater Monitoring Wells
NW-18 (proposed)
NW-20 (proposed)
NW-21 (proposed)
NW-93 (proposed)

TABLE 3-11. TRANSDUCER MONITORING WELLS FOR PLUME MONITORING
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Transducer Monitoring Wells
MW-19
MW-20S
MW-26R
MW-35
MW-48S
MW-79
MW-85S
MW-94S
MW-96S
MW-100S
MW-104S
MW-112
MW-131
MW-132

TABLE 3-12. MANUAL FLUID GAUGING WELLS FOR PLUME MONITORING
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Manual Fluid Gauging Wells for Plume Monitoring				
GPW-2S	MW-119	MW-23	MW-55	MW-9
GPW-3S	MW-12	MW-24	MW-56	MW-92S
GPW-4S	MW-120	MW-26R	MW-57	MW-93S
GPW-5S	MW-124	MW-28S	MW-58S	MW-94S
L-1RR	MW-125	MW-33	MW-59S	MW-95S
L-2R	MW-128	MW-35	MW-6	MW-96S
L-3R	MW-129	MW-38	MW-60S	MW-98S
L-4R	MW-130	MW-4	MW-62	MW-99S
L-5R	MW-131	MW-40	MW-64	PROD_12
L-7	MW-132	MW-41	MW-65S	PROD_15
MW-10	MW-133	MW-42S	MW-7	PROD_19
MW-100S	MW-134	MW-44S	MW-78	PROD_20
MW-101S	MW-14	MW-45	MW-79	PROD_21
MW-103S	MW-16	MW-47S	MW-8	PROD_23
MW-104S	MW-17	MW-48S	MW-81S	PROD_24
MW-105S	MW-18R	MW-49	MW-84S	RBGP-44
MW-107S	MW-19	MW-5	MW-85S	T-3
MW-109S	MW-1R	MW-50	MW-86	T-5
MW-11	MW-20S	MW-51	MW-87S	TH-1S
MW-111S	MW-21	MW-52	MW-88	TH-2
MW-112	MW-22	MW-53	MW-89	TH-3
MW-113				

TABLE 3-13. WELLS AND PIEZOMETERS FOR INTERIM MONITORING ALONG THE GREAT MIAMI RIVER CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Interim River Monitoring Wells
MW-26R
MW-44S
MW-48S
MW-85S
MW-104S
RGBP-44

TABLE 4-1. HIGH GRADE TRIGGER LEVELS FOR 2007
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Monitoring Well	Historical Low Groundwater Elevation (feet MSL)	Date of Historical Low Groundwater Elevation	Drawdown 2005 (Production Well PROD_20)	Drawdown 2006 (Production Well PROD_19)	Pumping Trigger (feet MSL)
MW-20S	461.2	11/1/1999	3.6	4.2	464.8
MW-24	461.7	11/22/1999	4	no data	465.6
MW-93S	462.4	1/22/2001	3.9	1.3	466.2
MW-96S	462.3	9/24/1999	3.6	2.4	465.9
MW-99S	462.1	9/24/2002	3.4	3.5	465.5

Note: Pumping Trigger = Historical low groundwater elevation + 2005 drawdown

TABLE 4-2. KEY AND SELECT TRANSDUCER MONITORING WELLS FOR PROD_19
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Key Transducer Monitoring Wells
MW-20S
MW-96S
MW-99S
MW-112
PROD_19
Select Transducer Monitoring Wells
MW-4
MW-10
MW-17
MW-20D
MW-44S
MW-81S
MW-93S
RBGP-44

TABLE 4-3. KEY AND SELECT FLUID MONITORING WELLS FOR PROD_19
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Key Fluid Monitoring Wells
MW-20S
MW-85S
MW-96S
MW-99S
PROD_19
Select Fluid Monitoring Wells
L-7
MW-1R
MW-4
MW-10
MW-17
MW-20D
MW-44S
MW-62
MW-81S
MW-88
MW-92S
MW-93S
MW-100S
MW-101
MW-112
MW-121
MW-126
MW-128
MW-129
RBGP-44

TABLE 7-1. NESTED VAPOR MONITORING WELLS
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Nested Vapor Monitoring Wells
VW-93
VW-96
VW-99
VW-128
VW-129

TABLE 7-2. CONTAMINANTS OF CONCERN FOR SOIL VAPOR
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Soil Vapor COCs
Benzene
n-Butylbenzene
sec- Butylbenzene
Ethylbenzene
n-Hexane
Isopropylbenzene
Napthalene
n-propylbenzene
1,2,4 trimethylbenzene
1,3,5 trimethylbenzene
2,2,4 trimethylpentane
Toluene
Xylene

TABLE 8-1. GULF PARK SYSTEM MONITORING WELLS
GULF COMMUNITY PARK, CLEVES, OHIO

Gulf Park System Monitoring Wells
GPW-1S
GPW-1I
GPW-2S
GPW-2I
GPW-3S
GPW-3I
GPW-4S
GPW-5S
TH-1S
TH-1I
TH-2
TH-3