

# Hydrograph Controlled Release Lagoons Update For A Promising Technology

## VOLUME 2

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APPENDIX 3.1  
LAGOON DESIGN AND GROUND-WATER PROTECTION PRACTICES

APPENDIX 3.1

TABLE 3.1-1  
WASTEWATER LAGOONS: USES AND SIZING

Lagoon Type	Application	Typical Loading Parameters <sup>a</sup>	Typical Detention Times, Days	Typical Depths <sup>a</sup>	Comments
Facultative	<ul style="list-style-type: none"> <li>o Raw municipal wastewater</li> <li>o Effluent from primary treatment, trickling filters, aerated ponds, or anaerobic ponds</li> </ul>	22-67 kg BOD <sub>5</sub> /ha/d	25-180	1.2-2.5 m deep (approximately 4 - 8 ft) <sup>b</sup>	Most commonly used type of lagoon. May be aerobic through entire depth if lightly loaded.
Aerated	<ul style="list-style-type: none"> <li>o Industrial wastes</li> <li>o Overloaded facultative ponds</li> <li>o Situations where limited land area is available</li> </ul>	8-320 kg BOD <sub>5</sub> /1000 m <sup>3</sup> /d	7-20	2-6 m deep (approximately 6 - 20 ft) <sup>b</sup>	Uses may range from a supplement of photosynthesis to an extended aeration activated sludge process. Requires less land area than facultative lagoons.
Aerobic	<ul style="list-style-type: none"> <li>o Generally used to treat effluent from other processes. Produces effluent low in soluble BOD<sub>5</sub> and high in algal solids</li> </ul>	85-170 kg BOD <sub>5</sub> /ha/d	10-40	30-45 cm deep (approximately 1 - 1.5 ft) <sup>b</sup>	Application limited because of effluent quality. Maximizes algae production and (if algae are harvested) nutrient removal. High loadings reduce land requirements.
Anaerobic	<ul style="list-style-type: none"> <li>o Industrial wastes</li> </ul>	160-800 kg BOD <sub>5</sub> /1000 m <sup>3</sup> /d	20-50	2.5-5 m deep (approximately 8 - 16 ft) <sup>b</sup>	Odor production usually a problem. Subsequent treatment normally required.

Source: Reference 1

<sup>a</sup>Metric Units: kg = kilogram; ha = hectare; d = day; m = meter; m<sup>3</sup> = cubic meter; cm = centimeter

<sup>b</sup>English units: ft = feet

## APPENDIX 3.1

TABLE 3.1-2

STATE REQUIREMENTS FOR GROUND-WATER  
PROTECTION AT MUNICIPAL WASTEWATER LAGOONS

State	Lining Requirements	Seepage or Permeability Limitations	Monitoring Requirements and Remarks
Alabama	Liners required. Lagoon impoundment guidelines state that earthen materials used as liners must be at least 2 feet thick.	Permeability of earthen materials = $1 \times 10^{-7}$ cm/sec. Permeability of synthetic materials = $1 \times 10^{-3}$ cm/sec.	Monitoring wells required. Monitoring can be required if geological evaluation by the State shows that there is potential for contamination of drinking wells.
Alaska	No specific lining requirements.	No specific allowable seepage rate or permeability. Decided on case-by-case basis.	Monitoring wells not required. Sites evaluated on a case-by-case basis.
Arkansas	No specific lining requirements.	Ten-State Standards (Recommended Standards for Sewage Works by Committee of Great Lakes-Upper Mississippi River Board of State Sanitary Engineers, 1978) are followed. Standards call for percolation rate of 500 gallons/acre/day or less.	Monitoring wells not required.
Arizona	No specific lining requirements.	No specific allowable seepage rate or permeability.	Monitoring wells required on a case-by-case basis. Lagoon requirements depend on location, depth to ground water, distance from water supply wells, and any unusual conditions.
California	Need for liners evaluated on a case-by-case basis. Depth to ground water is an important consideration.	No specific allowable seepage rate or permeability. Decided on a case-by-case basis.	Monitoring wells required on a case-by-case basis.
Colorado	Lining required. No restrictions on type of liner.	Design criteria call for a maximum allowable seepage rate of 1/32 in/day.	Monitoring wells are not required.
Connecticut	No specific lining requirements.	No specific allowable seepage rate or permeability. Decided on a case-by-case basis.	Need for monitoring wells evaluated on a case-by-case basis. No treatment lagoons in the State. (There are septic lagoons in the State.)
Delaware	Lining generally required. Some older facilities may not be lined.	Ten-State Standards followed (maximum percolation rate of 500 gallons/acre/day).	Monitoring wells not required unless lagoon is unlined.
Florida	No specific lining requirements.	No specific allowable seepage rate or permeability.	Lagoons may not be used for primary treatment, but they may be used for secondary treatment. Three monitoring wells required for unlined lagoons (1 upgradient and 2 downgradient).

## APPENDIX 3.1

TABLE 3.1-2, Continued

## STATE REQUIREMENTS FOR GROUND-WATER PROTECTION AT MUNICIPAL WASTEWATER LAGOONS

State	Lining Requirements	Seepage or Permeability Limitations	Monitoring Requirements and Remarks
Georgia	No specific lining requirements.	Maximum allowable seepage rate of 1/8 in/day.	Monitoring wells not required. Guidelines for lagoon construction are being developed; the requirement of monitoring wells is being considered.
Hawaii	No specific lining requirements.	No specific allowable seepage rate or permeability.	Monitoring wells not required. Lagoon requirements handled on a case-by-case basis. (Hawaii has only 1 or 2 municipal wastewater treatment lagoons.)
Idaho	No specific lining requirements; however, very few lagoons in the State do not have liners.	Maximum allowable seepage rate is 1/4 in/day, less in some cases as determined by case-by-case review. Higher allowable seepage rate if not primary treatment lagoon.	Monitoring wells not required. Idaho follows Ten-State Standards.
Illinois	No specific lining requirements.	No specific allowable seepage rate or permeability.	Monitoring wells not required. Illinois has many areas with dense, compacted soils. Lagoon requirements handled on a case-by-case basis.
Indiana	Lining required to meet seepage limitations. Liners can be constructed of clay, bentonite or synthetic materials.	Maximum allowable permeability of $1 \times 10^{-7}$ cm/sec.	Monitoring wells not required. Indiana follows Ten-State Standards.
Iowa	No specific lining requirements.	Design standards for new construction require that seepage be less than 1/16 in/day with lagoon filled to 6 feet (adopted 1979).	Monitoring wells not required. Some older lagoons do not meet 1/16 in/day seepage rate.
Kansas	No specific lining requirements.	Maximum allowable seepage rate of 1/4 in/day.	Monitoring wells required on a case-by-case basis.
Kentucky	No specific lining requirements.	No specified allowable seepage rate or permeability. Kentucky follows Ten-State Standards percolation rate of 500 gallons/acre/day or less.	Monitoring wells not required. Not many lagoons in state; last one approved was 6 or 7 years ago. Ground-water Section of Department of Environmental Protection formed within past 6 months.
Louisiana	No specific lining requirements.	No specific allowable seepage rate or permeability.	No monitoring wells required unless lagoon receives industrial waste. Each lagoon proposal reviewed on its individual merits.

## APPENDIX 3.1

TABLE 3.1-2, Continued

**STATE REQUIREMENTS FOR GROUND-WATER  
PROTECTION AT MUNICIPAL WASTEWATER LAGOONS**

State	Lining Requirements	Seepage or Permeability Limitations	Monitoring Requirements and Remarks
Maine	No specific lining requirements.	500 gallon/acre/day percolation rate used as guideline.	Monitoring wells required on a case-by-case basis.
Maryland	Lining required to meet permeability limitations.	Maximum permeability of $1 \times 10^{-8}$ cm/sec.	Monitoring wells not required.
Massachusetts	No specific regulations or guidelines for liners. Most lagoons in the State are lined with either natural or synthetic materials.	No specific allowable seepage rate or permeability.	Monitoring wells not required. Lagoon designs approved on a case-by-case basis.
Michigan	Liners required to meet seepage limitations.	Maximum allowable seepage rate is 1/8 in/day.	Need for monitoring wells evaluated on a site-by-site basis.
Minnesota	Lining required. Two 6-inch lifts of compacted clay is an acceptable lining for most sites.	Maximum percolation rate of 500 gallons/acre/day (equivalent to a seepage of 1/64 in/day). Prior to July 1977, maximum percolation rate was 3,500 gallons/acre/day via compaction of clay materials.	Monitoring not normally required.
Mississippi	No specific lining requirements. Lining requirements determined on a case-by-case basis.	Ten-State Standards followed (maximum allowable percolation rate of 500 gallons/acre/day).	Monitoring wells not required. Municipalities are not required to prove that they are within the limits of the Ten-State Standards. Groundwater Quality Branch recently developed by Mississippi Bureau of Pollution Control.
Missouri	Lagoons must be lined or sealed to meet maximum percolation rates.	Lagoons which have flows of less than 22,500 gallons/day may have a maximum percolation rate of 0.25 in/day. Lagoons which have flows greater than 22,500 gallons/day may have a maximum percolation rate of 1/16 in/day.	Monitoring wells not normally required. Missouri could require wells if lagoon is located in an area with a severe potential to contaminate ground water (as determined by geological study).
Montana	Lining required to meet allowable seepage rate.	Ten-State Standards followed (maximum percolation rate of 500 gallons/acre/day).	Monitoring wells not required.
Nebraska	No specific lining requirements.	Seepage of up to 6 in/year allowed for primary cells; 15 in/year for secondary cells. Guideline for allowable seepage is 1/8 in/day for design and 1/4 in/day in use.	Monitoring wells not generally required.

## APPENDIX 3.1

TABLE 3.1-2. Continued

## STATE REQUIREMENTS FOR GROUND-WATER PROTECTION AT MUNICIPAL WASTEWATER LAGOONS

State	Lining Requirements	Seepage or Permeability Limitations	Monitoring Requirements and Remarks
Nevada	No specific lining requirements. Generally primary cells are required to be lined.	No specific allowable seepage rate or permeability. Decided on a case-by-case basis.	Monitoring wells may be required by permit. Nevada has no written regulations. All lagoons must receive a ground-water discharge permit.
New Hampshire	Liners required. Most liners currently in use are synthetic.	Maximum allowable percolation rate is 500 gallons/acre/day.	New lagoons must be monitored. No existing lagoons in the State are being monitored. Several systems under construction will require monitoring wells.
New Jersey	Liners required. All types of lining materials are acceptable.	Permeability of $1 \times 10^{-7}$ cm/sec for the material being contained.	Three monitoring wells are required for all surface impoundments (including lagoons). Monitoring plan is site-specific and must be approved by the New Jersey Department of Environmental Protection.
New Mexico	No specific lining requirements. Lining requirements determined on a case-by-case basis.	Site-specific. Must demonstrate that ground water will not be contaminated.	Monitoring wells not required. In some areas of the State the ground-water table is 800 feet below the lagoon bottom (no lining would be required by the state).
New York	No specific lining requirements.	Ten-State Standards are followed (maximum percolation rate of 500 gallons/acre/day).	Monitoring wells not required.
North Carolina	Case-by-case review. Water quality Branch, which issues permits, almost always recommends liners.	On-site soils allowed as liners if 1 foot of the compacted soil has a permeability of $1 \times 10^{-6}$ cm/sec.	Monitoring wells may be required for new lagoons on a case-by-case basis. Existing lagoons may be required to install monitoring wells upon permit reissue.
North Dakota	Lining required. Clay liners are usually used.	Guidelines require allowable seepage rate of 1/16 in./day for design and 1/8 in./day in use. A percolation test is required.	Monitoring wells are not usually required. More stringent requirements could be imposed if impact of ground-water contamination is serious. Land damage to crops from horizontal seepage is occasionally a problem.
Ohio	No specific lining requirements. Lining is often required as part of a case-by-case review.	Ten-State Standards are followed (maximum percolation rate of 500 gallons/acre/day).	Monitoring wells not required.
Oklahoma	Lining required. Acceptable liners include a 12-inch layer of clay, a 4-inch layer of bentonite, or a vinyl liner.	Permeability shall not exceed $1 \times 10^{-7}$ cm/sec.	Monitoring wells not normally required.

## APPENDIX 3.1

TABLE 3.1-2, Continued

## STATE REQUIREMENTS FOR GROUND-WATER PROTECTION AT MUNICIPAL WASTEWATER LAGOONS

State	Lining Requirements	Seepage or Permeability Limitations	Monitoring Requirements and Remarks
Oregon	Liners required to meet seepage rates. Most liners in the State are bentonite; there are a few synthetic liners in use.	Maximum allowable seepage rate is 1/4 in/day.	Monitoring wells not required.
Pennsylvania	Lagoons must be lined or sealed to meet permeability requirements. Synthetic liners shall have a minimum thickness of .030 inches (.30 mils).	Permeability may not exceed $1 \times 10^{-7}$ cm/sec.	One groundwater observation point required - may be new or existing wells, springs, well points or lysimeters, or rocklined test pits or trenches. Underdrains or use of leak detection techniques are alternatives to monitoring.
Rhode Island	Not applicable.	Not applicable.	Construction of wastewater treatment lagoons not approved or allowed. No municipal wastewater treatment lagoons in the State.
South Carolina	All new lagoons must be lined. Areas which are classified as critical must have synthetic liners; non-critical areas may have bentonite liners.	Ten-State Standards followed (maximum percolation rate of 500 gallons/acre/day).	Three monitoring wells sometimes required for older lagoon systems.
South Dakota	Liners required.	Maximum allowable seepage rate is 1/16 in/day (may be 1/8 in/day on secondary lagoons).	Monitoring wells not required.
Tennessee	No specific lining requirements.	No specific allowable seepage rate or permeability.	Monitoring wells not required. Most lagoons are in the western part of the State, where the ground-water table is often 100 feet from the lagoon bottom.
Texas	No specific lining requirements. Lining required on a case-by-case basis. Synthetic liners must be at 20 mils thick.	Soil parameters for in-situ or placed and compacted clay - more than 30 percent must pass No. 200 sieve, liquid limit must be greater than 30 percent, plasticity index must exceed 15, and the minimum thickness is 2 feet.	Monitoring wells not required.
Utah	Lining required. If no natural materials nearby, synthetic liners may be used.	Maximum allowable seepage rates: for deslyn, 1/8 in/day; in use, 1/4 in/day.	Monitoring wells have not been required in the past. State is developing standards for monitoring of lagoons in areas where ground-water is used as drinking water.
Vermont	Lining required. In most cases synthetic; if conditions are good, clay or bentonite may be used.	No specific allowable seepage rate or permeability. Determined on a case-by-case basis.	Monitoring wells not required.

## APPENDIX 3.1

TABLE 3.1-2, Continued

STATE REQUIREMENTS FOR GROUND-WATER  
PROTECTION AT MUNICIPAL WASTEWATER LAGOONS

State	Lining Requirements	Seepage or Permeability Limitations	Monitoring Requirements and Remarks
Virginia	Lining required to meet permeability requirements. Liner thickness shall be no less than .020 inches (20 mils) for synthetic liners.	Permeability shall not exceed $1 \times 10^{-6}$ cm/sec.	Monitoring wells required on a case-by-case basis.
Washington	Liners may be required to meet seepage rates.	Maximum allowable seepage rate is 1/4 in/day; designed for no leakage.	Monitoring wells required for unlined lagoons and lined lagoons where aquifer of special importance exists.
West Virginia	Liners required in some cases (determined on a case-by-case basis).	No specific allowable seepage rate or permeability.	Monitoring wells not required.
Wisconsin	Lining required to meet allowable seepage rates. Synthetic liners must be at least 30 mils thick.	Maximum percolation rate of 1,000 gallons/acre/day. The permeability of soil or bentonite liners shall not exceed $1 \times 10^{-7}$ cm/sec.	Monitoring wells not required.
Wyoming	Lining required on a case-by-case basis. Minimum thickness of synthetic liner is 30 mils.	Maximum allowable seepage rate is 1/8 in/day.	Monitoring wells sometimes required on a case-by-case basis.

Data collected in mid-1985.

## APPENDIX 3.1

TABLE 3.1-3

SEEPAGE RATES FOR VARIOUS LINER MATERIALS<sup>a</sup>

Material	Thickness (inches)	Minimum Expected Seepage Rate Assuming a 20-foot Water Column after 1 Year of Service (inches/day)
Open sand and gravel	-	96
Loose earth	-	48
Loose earth plus chemical treatment*	-	12
Loose earth plus bentonite	-	10
Earth in cut	-	12
Soil cement (continuously wetted)	4	4
Gunit	1.5	3
Asphalt concrete	4	1.5
Unreinforced concrete	4	1.5
Compacted earth	36	0.3
Exposed prefabricated asphalt panels	0.5	0.03
Exposed synthetic membranes	0.045	0.001

<sup>a</sup>The data are based on actual installation experience. The chemical and bentonite treatments "(\*)" depend on pretreatment seepage rates. (Values are assumed for loose, uncompacted earth.)

Source: Reference 2.

## APPENDIX 3.1

TABLE 3.1-4

SUMMARY OF STATE GROUND-WATER MONITORING  
REQUIREMENTS FOR MUNICIPAL WASTEWATER LAGOONS

State	<u>Minimum Number of Wells</u>		<u>Sampling Frequency</u> (times per year)		Monitoring Parameters
	Upgradient	Downgradient	First Year	Thereafter	
Arizona	- <sup>a</sup>	- <sup>a</sup>	- <sup>a</sup>	- <sup>a</sup>	- <sup>a</sup>
California	1	1	2-4	2-4	NO <sub>3</sub> -N, total N, Cl, TDS, Na
Connecticut	1	2	4-12	4-12	NO <sub>3</sub> -N, NH <sub>3</sub> -N, TKN, Cl, Total P, fecal coliform
Florida	1	1	4	4	Drinking water standards, toxics, others
Kansas	1	- <sup>a</sup>	2-4	2-4	NO <sub>3</sub> -N, NH <sub>3</sub> -N, Total P or PO <sub>4</sub> , SO <sub>4</sub>
Maine	1	3	- <sup>b</sup>	- <sup>b</sup>	pH, BOD, SS, NO <sub>3</sub> -N, NH <sub>3</sub> -N, TKN
Michigan	- <sup>a</sup>	- <sup>a</sup>	- <sup>a</sup>	- <sup>a</sup>	- <sup>a</sup>
Minnesota	- <sup>a</sup>	- <sup>a</sup>	- <sup>a</sup>	- <sup>a</sup>	NO <sub>3</sub> -N, NH <sub>3</sub> -N, TKN, Cl, EC, pH
Nevada	- <sup>a</sup>	- <sup>a</sup>	- <sup>a</sup>	- <sup>a</sup>	- <sup>a</sup>
New Hampshire	- <sup>a</sup>	- <sup>a</sup>	- <sup>a</sup>	- <sup>a</sup>	NO <sub>3</sub> -N, pH, Total P, BOD or COD, metals, EC
New Jersey	1	2	4	4	NH <sub>3</sub> -N, NO <sub>3</sub> -N, TKN, pH, TDS
New Mexico	- <sup>a</sup>	- <sup>a</sup>	3	3	Total N, NO <sub>3</sub> -N, Cl, TDS, fecal coliform
North Carolina	1	1	3	3	NO <sub>3</sub> -N, NH <sub>3</sub> -N, TDS, Cl, Total coliforms, pH, EC, water level

## APPENDIX 3.1

TABLE 3.1-4, Continued

SUMMARY OF STATE GROUND-WATER MONITORING  
REQUIREMENTS FOR LAGOONS

State	<u>Minimum Number of Wells</u>		<u>Sampling Frequency</u> (times per year)		Monitoring Parameters
	Upgradient	Downgradient	First Year	Thereafter	
Pennsylvania	- <sup>a</sup>	1	- <sup>a</sup>	- <sup>a</sup>	- <sup>a</sup>
South Carolina	1	2	4	2	$\text{NO}_3\text{-N}$ , $\text{NH}_3\text{-N}$ , Total P, pH, Cl, Na, TDS, TOC, fecal coliform, alkalinity
Virginia	1	2	12	- <sup>c</sup>	$\text{NO}_3\text{-N}$ , Cl, TOC, pH, Total P, hardness, alkalinity, EC, total coliform, others on a case-by-case basis
Washington	1	1	- <sup>b</sup>	- <sup>b</sup>	$\text{NO}_3\text{-N}$ , total coliform
Wyoming	1	2	1	1	$\text{NH}_3\text{-N}$ , $\text{NO}_3\text{-N}$ , pH, Cl, TDS, boron, selenium

<sup>a</sup>Site-specific.<sup>b</sup>Depends on flow rate.<sup>c</sup>Data not available.

Source: Reference 3.

APPENDIX 3.2  
LAGOON INVENTORY DATA

## DESIGN AND FLOW CHARACTERISTICS OF MUNICIPAL WASTE-WATER LAGOONS IN THE UNITED STATES

USEPA REGION/STATE	DESIGN FLOW < 0.1 MGD			DESIGN FLOW 0.1 - 0.49 MGD			DESIGN FLOW 0.5 - 1.0 MGD			DESIGN FLOW > 1.0 MGD		
	# OF FAC	FLOW, MGD DCMES	FLOW, MGD INDUS	TOTAL FLOW, MGD	# OF FAC	FLOW, MGD DOMES	FLOW, MGD INDUS	TOTAL FLOW, MGD	# OF FAC	FLOW, MGD DOMES	FLOW, MGD INDUS	TOTAL FLOW, MGD
CONNECTICUT	0	0.00	0.00	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0.00
CONNECTICUT	1	0.06	0.02	0.09	0	0.00	0.00	0.00	0	0.00	0.00	0.00
MAINE	1	0.09	0.00	0.09	2	0.35	0.00	0.35	1	0.74	0.00	0.74
MASSACHUSETTS	2	0.04	0.07	0.12	0	0.00	0.00	0.00	1	0.49	0.00	0.49
NEW HAMPSHIRE	5	0.22	0.00	0.22	14	3.39	0.17	3.57	4	1.42	1.37	2.80
VERMONT	8	0.47	0.01	0.49	9	2.05	0.05	2.11	4	2.31	0.19	2.51
REGION 1	17	0.00	0.12	1.05	25	292.85	0.23	6.03	19	0.00	0.00	823.67
NEW JERSEY	0	0.00	0.00	0.00	1	0.19	0.00	0.19	0	0.00	0.00	0.00
NEW YORK	3	0.15	0.00	0.15	5	1.13	0.33	1.47	2	0.69	0.09	0.99
REGION 2	3	0.15	0.00	0.15	6	1.33	0.33	1.67	2	0.89	0.09	0.99
DELAWARE	0	0.00	0.00	0.00	0	0.00	0.00	0.00	3	1.25	0.70	1.95
MARYLAND	12	0.59	0.00	0.59	14	3.12	0.15	3.28	2	1.57	0.00	1.57
PENNSYLVANIA	11	1.39	0.00	1.39	5	0.87	0.00	0.87	0	0.00	0.00	0.00
VIRGINIA	21	0.98	0.00	0.98	20	4.48	0.00	4.48	1	0.75	0.00	0.75
WEST VIRGINIA	8	0.52	0.00	0.52	11	2.63	0.17	2.81	4	2.31	0.00	2.31
REGION 3	52	3.50	0.00	3.50	50	11.12	0.33	11.46	10	5.90	0.70	6.61
ALABAMA	7	0.42	0.00	0.42	44	10.41	0.25	10.67	14	6.55	0.13	6.69
FLORIDA	1	0.06	0.00	0.06	3	0.90	0.00	0.90	1	0.62	0.00	0.62
GEORGIA	49	2.82	0.09	2.92	46	9.80	0.13	9.94	5	1.85	0.00	1.85
KENTUCKY	1	0.15	0.00	0.15	6	0.82	0.00	0.82	2	1.49	0.00	1.49
MISSISSIPPI	68	4.31	0.06	4.37	106	21.91	0.52	22.43	25	15.10	1.50	16.60
NORTH CAROLIN	17	1.07	0.00	1.08	15	2.76	0.18	2.95	2	1.05	0.00	1.05
SOUTH CAROLIN	18	0.90	0.07	0.97	38	9.01	0.06	9.08	12	6.68	0.98	7.67
TENNESSEE	9	0.44	0.02	0.47	15	3.19	0.03	3.23	2	1.08	0.21	1.30
REGION 4	170	10.22	0.27	10.50	273	58.85	1.20	60.06	63	36.47	2.84	39.31
ILLINOIS	121	7.85	0.03	7.89	123	23.91	0.37	24.28	10	5.35	0.09	5.45
INDIANA	17	1.23	0.00	1.23	22	4.23	0.10	4.34	5	3.14	0.00	3.14
MICHIGAN	58	4.08	0.00	4.08	104	19.56	0.37	19.93	19	11.80	1.01	12.81
MINNESOTA	161	7.77	0.05	7.82	78	14.08	1.77	15.86	6	2.83	0.62	3.46
OHIO	5	0.30	0.00	0.30	28	5.54	0.24	5.79	5	3.07	0.00	3.07
WISCONSIN	144	6.83	0.15	6.98	47	8.06	0.06	8.93	9	5.32	0.55	5.87
REGION 5	506	28.08	0.24	28.32	402	75.41	3.74	79.16	54	31.54	2.29	33.64

DESIGN AND FLOW CHARACTERISTICS OF MUNICIPAL WASTE-WATER LAGOONS IN THE UNITED STATES

USEPA REGION/STATE	DESIGN FLOW < 0.1 MGD			DESIGN FLOW 0.1 - 0.49 MGD			DESIGN FLOW 0.5 - 1.0 MGD			DESIGN FLOW > 1.0 MGD		
	# OF FAC	FLOW, MGD DOMES	FLOW, MGD INDUS	# OF FAC	FLOW, MGD DOMES	FLOW, MGD INDUS	TOTAL FAC	DOMES	INDUS	TOTAL FAC	DOMES	INDUS
ARKANSAS	61	4.09	0.00	4.09	88	18.25	0.19	18.45	22	14.86	0.30	15.16
LOUISIANA	36	2.29	0.01	2.31	68	16.14	0.05	16.20	26	17.72	1.13	18.86
NEW MEXICO	32	1.48	0.00	1.48	13	2.86	0.00	2.86	4	1.98	0.00	1.98
OKLAHOMA	220	11.55	0.03	11.58	85	16.68	0.11	16.79	14	8.58	0.31	8.90
TEXAS	113	78.64	0.00	78.64	92	29.15	0.03	29.19	10	6.40	0.46	6.87
REGION 6	462	98.07	0.04	98.12	346	83.11	0.40	83.52	76	49.57	2.22	51.79
IOWA	296	18.82	0.12	18.95	88	14.98	0.14	15.13	3	1.85	0.00	1.85
KANSAS	266	11.16	0.00	11.16	83	17.49	0.29	17.79	4	2.64	0.00	2.65
MISSOURI	182	9.19	0.02	9.22	97	19.55	0.92	20.47	24	15.30	1.04	16.34
NEBRASKA	224	7.02	0.00	7.02	35	8.47	0.26	8.73	2	1.24	0.00	1.24
REGION 7	968	46.20	0.15	46.35	303	60.50	1.63	62.13	33	21.06	1.05	22.11
COLORADO	85	4.61	0.00	4.61	51	11.80	0.11	11.92	16	12.30	0.39	12.70
MONTANA	74	3.08	0.00	3.08	42	9.36	0.00	9.36	10	6.18	0.00	6.18
NORTH DAKOTA	227	6.71	0.00	6.72	37	6.88	0.04	6.93	4	2.73	0.00	2.73
SOUTH DAKOTA	173	6.94	0.00	6.95	50	9.23	0.38	9.62	4	2.29	0.00	2.29
UTAH	23	1.18	0.00	1.18	29	7.10	0.18	7.29	4	2.68	0.00	2.68
WYOMING	50	1.68	0.00	1.68	22	4.89	0.00	4.89	0	0.00	0.00	0.00
REGION 8	632	24.24	0.01	24.25	231	49.28	0.75	50.04	38	26.21	0.39	26.61
ARIZONA	27	1.24	0.00	1.25	24	5.80	0.00	5.80	15	10.03	0.09	10.13
CALIFORNIA	74	19.58	0.00	19.58	76	15.99	0.49	16.48	30	16.88	2.35	19.24
HAWAII	1	0.04	0.00	0.04	0	0.00	0.00	0.00	0	0.00	0.00	0.00
NEVADA	20	0.98	0.00	0.98	9	1.82	0.00	1.82	6	2.99	0.00	2.99
AMERICAN SAMO	0	0.00	0.00	0.00	0	0.00	0.00	0.00	1	0.64	0.00	0.64
GUAM	0	0.00	0.00	0.00	1	0.11	0.00	0.11	1	0.78	0.00	0.78
PAC. TR. TERR	1	0.09	0.00	0.09	0	0.00	0.00	0.00	0	0.00	0.00	0.00
REGION 9	123	21.96	0.00	21.96	110	23.74	0.49	24.24	53	31.35	2.45	33.80
ALASKA	9	0.25	0.00	0.25	3	0.69	0.00	0.69	0	0.00	0.00	0.00
IDAHO	59	2.85	0.00	2.85	26	9.80	0.18	9.99	5	3.42	0.00	3.42
OREGON	30	10.00	0.00	10.00	29	6.00	0.00	6.00	7	4.88	0.00	4.88
REGION 10	133	15.04	0.00	15.04	83	24.42	0.23	24.66	23	15.38	1.05	16.44
US TOTALS:	3066	248.43	0.67	249.30	1829	393.61	9.64	403.00	362	223.39	14.95	238.09
											219	489.61
												217.88
												707.25

DESIGN FLOW > 1.0 MGD

APPENDIX 3.3  
CONVERSION OF FLOW RATES TO AREAS

APPENDIX 3.3  
CONVERSION OF LAGOON FLOW RATES  
TO AREAS

For use in this study, the flow rate distribution in Table 3-1 of the text has been converted to an area distribution using the equation below:

$$A = 3.0334 (t/d)(Q)$$

where 3.0334 is a factor for converting the units of the right hand side (mgd, feet and days) into units of acres, and

A = lagoon area (acres)

t = hydraulic retention time (days)

d = lagoon depth (feet)

Q = design flow (mgd)

Values for hydraulic retention time and depth were assumed based on typical ranges for facultative lagoons (25-180 days and 4-8 feet, respectively) obtained from the USEPA's Design Manual for Municipal Wastewater Stabilization Ponds (1). For median values of 102.5 days and 6 feet, the above equation becomes:

$$A = 51.82(Q)$$

APPENDIX 3.4  
WASTEWATER CHARACTERISTICS

## APPENDIX 3.4

TABLE 3.4-1

## TYPICAL COMPOSITION OF UNTREATED DOMESTIC WASTEWATER

Pollutant or Pollutant Parameter	Concentration (mg/l)		
	Strong	Medium	Weak
Solids, total:			
Dissolved, total	1,200	720	350
Fixed	850	500	250
Volatile	525	300	145
Suspended, total	325	200	105
Fixed	350	220	100
Volatile	75	55	20
Settleable solids, mL/L	275	165	80
Biochemical oxygen demand, 5-day, 20°C (BOD <sub>5</sub> , 20°C)	20	10	5
Total organic carbon (TOC)	400	220	110
Chemical oxygen demand (COD)	290	160	80
Nitrogen (total as N):	1,000	500	250
Organic	85	40	20
Free ammonia	35	15	8
Nitrites	50	25	12
Nitrates	0	0	0
Phosphorus (total as P):	15	8	4
Organic	5	3	1
Inorganic	10	5	3
Chlorides <sup>a</sup>	100	50	30
Alkalinity (as CaCO <sub>3</sub> ) <sup>a</sup>	200	100	50
Grease	150	100	50

Source: Reference 5.

<sup>a</sup>Values for alkalinity and chlorides will be increased by the amount found in the domestic water supply.

## APPENDIX 3.4

TABLE 3.4-2

EPA'S TOXIC (PRIORITY) POLLUTANTS<sup>a</sup>Class/PollutantVOLATILE ORGANIC COMPOUNDS

Acrolein	1,2-Dichloropropane
Acrylonitrile	1,3-Dichloropropene
Benzene	Methylene Chloride
Toluene	Methyl Chloride
Ethylbenzene	Methyl Bromide
Carbon Tetrachloride	Bromoform
Chlorobenzene	Dichlorobromomethane
1,2-Dichloroethane	Chlorodibromomethane
1,1,1-Trichloroethane	Tetrachloroethylene
1,1-Dichloroethane	Trichloroethylene
1,1-Dichloroethylene	Vinyl Chloride
1,1,2-Trichloroethane	1,2-trans-Dichloroethylene
1,1,2,2-Tetrachloroethane	
Chloroethane	
2-Chloroethyl Vinyl Ether	
Chloroform	

ACID EXTRACTABLE ORGANIC COMPOUNDS

Phenol	p-Chloro-m-cresol
2-Nitrophenol	2-Chlorophenol
2,4-Dichlorophenol	2,4-Dinitrophenol
4-Nitrophenol	2,4,6-Trichlorophenol
2,4-Dimethylphenol	4,6-Dinitro-o-cresol
Pentachlorophenol	

26 PESTICIDES/PCBs

alpha-Endosulfan	Heptachlor
beta-Endosulfan	Heptachlor Epoxide
Endosulfan Sulfate	Chlordane
alpha-BHC	Toxaphene
beta-BHC	Aroclor 1016
gamma-BHC (Lindane)	Aroclor 1221
delta-BHC	Aroclor 1232
Aldrin	Aroclor 1242
Dieldrin	Aroclor 1248
4,4'-DDE	Aroclor 1254
4,4'-DDD	Aroclor 1260
4,4'-DDT	2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)
Endrin	
Endrin Aldehyde	

## APPENDIX 3.4

TABLE 3.4-2, Continued  
EPA'S TOXIC (PRIORITY) POLLUTANTS<sup>a</sup>Class/PollutantBASE/NEUTRAL EXTRACTABLE ORGANIC COMPOUNDS

1,2-Dichlorobenzene	Fluorene
1,3-Dichlorobenzene	Fluoranthene
1,4-Dichlorobenzene	Chrysene
Hexachloroethane	Pyrene
Hexachlorobutadiene	Phenanthrene
Hexachlorobenzene	Benzo(a)anthracene
1,2,4-Trichlorobenzene	Benzo(b)fluoranthene
bis(2-Chloroethoxy)methane	Benzo(k)fluoranthene
Naphthalene	Benzo(a)pyrene
2-Chloronaphthalene	Indeno(1,2,3-c,d)pyrene
Isophorone	Dibenzo(a,h)anthracene
Nitrobenzene	Benzo(g,h,i)perylene
2,4-Dinitrotoluene	4-Chlorophenyl Phenyl Ether
2,6-Dinitrotoluene	3,3'-Dichlorobenzidine
4-Bromophenyl Phenyl Ether	Benzidine
bis(2-Ethylhexyl)phthalate	bis(2-Chloroethyl)ether
Di-n-octyl Phthalate	1,2-Diphenylhydrazine
Dimethyl Phthalate	Hexachlorocyclopentadiene
Diethyl Phthalate	N-Nitrosodiphenylamine
Di-n-butyl Phthalate	N-Nitrosodimethylamine
Acenaphthylene	N-Nitrosodi-n-propylamine
Acenaphthene	bis(2-Chloroisopropyl)ether
Butyl Benzyl Phthalate	Anthracene

13 METALS

Antimony	Mercury
Arsenic	Nickel
Beryllium	Selenium
Cadmium	Silver
Chromium	Thallium
Copper	Zinc
Lead	

OTHER

Total Cyanides	Asbestos (fibrous)
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<sup>a</sup> Designated pursuant to Section 307(a)(1) of the Clean Water Act.

## APPENDIX 3.4

TABLE 3.4-3

## COMMON CONSUMER PRODUCTS AND THEIR HOUSEHOLD SOURCES

Household Source	Consumer Product
Automatic Dishwasher Waste	Detergents Silver polish
Bath and Shower Waste	Soaps (perfumed) Medicinal ointments Shampoo Disinfectants Cosmetics (makeup, antiperspirant, hair dyes)
Bathroom Sink Waste	Medicine Soaps Disinfectants Cosmetics Shampoo Cleaner
Garbage Disposal	Pesticides (from washing produce) Deoderizer
Kitchen Sink	Hand soaps and cleaners Polish Pesticides Cosmetics Cleaners
Laundry Waste	Polish (laundered clothes soiled with polish) Fabric adhesives Dyes and textile coatings Medicinal ointments Laundry products Pesticides and insecticides Disinfectants Bleach and starch
Toilet Flush Waste	Medicinal ointments Disinfectants Deoderizer Cleaner
Utility Sink Waste	Preservatives and dyes Polish Photographic products Paint products Pesticides Cleaners Bleach

Source: Reference 6

## APPENDIX 3.4

TABLE 3.4-4

## PRIORITY POLLUTANTS IN HOUSEHOLD WASTES

Household Source	Priority Pollutant
Automatic Dishwasher Waste	Phenol* Benzene* Toluene* 2,4,6-Trichlorophenol* Silver*
Bath and Shower Waste	Phenol* Benzene* Naphthalene* 1,2-Dichloroethylene Diethylphthalate* Dimethylphthalate* Toluene* 2,4,6-Trichlorophenol* 2-Chlorophenol* 2,4-Dimethylphenol Fluoranthene PAHs 2,4-Dichlorophenol Antimony* Cadmium* Copper* Lead* Mercury* Nickel* Selenium Silver* Zinc*
Bathroom Sink Waste	Phenol* Toluene* Benzene* 2,4,6-Trichlorophenol* 2-Chlorophenol* p-Chloro-m-cresol 2,4-Dimethylphenol Fluoranthene Naphthalene* PAHs Diethylphthalate* Dimethylphthalate* Antimony* Cadmium* Copper* Lead* Mercury* Silver* Zinc* Arsenic*

## APPENDIX 3.4

TABLE 3.4-4, Continued

## PRIORITY POLLUTANTS IN HOUSEHOLD WASTES

Household Source	Priority Pollutant
Garbage Disposal Waste	1,4-Dichlorobenzene* Aldrin* Dieldrin* Chlordane Arsenic* Cadmium* Chromium* Copper* Lead* Mercury* Zinc*
Kitchen Sink Waste	Phenol* Toluene* 1,2-Dichlorobenzene* Tetrachloroethylene 1,2-Dichloroethylene Diethylphthalate* Dimethylphthalate* 1,2-Dichloroethane 1,1,2,2-Tetrachloroethane 1,2-Dichloropropane 1,2-Dichloropropylene Isophorone Trichloroethylene* Carbon Tetrachloride Arsenic* Cadmium* Chromium* Copper* Lead* Mercury* Zinc* Antimony* Nickel* Silver*
Laundry Waste	2,4,6-Trichlorophenol 1,2-Dichlorobenzene* Benzene* Phenol* 1,4-Dichlorobenzene* 2,4-Dimethylphenol Naphthalene* 1,1,1-Trichloroethane* 1,1,2,2-Tetrachloroethane 1,3-Dichlorobenzene

## APPENDIX 3.4

TABLE 3.4-4, Continued

## PRIORITY POLLUTANTS IN HOUSEHOLD WASTES

Household Source	Priority Pollutant
Laundry Waste, Continued	Nitrobenzene Tetrachloroethylene* Diethylphthalate* Dimethylphthalate* Chlorophenol* Arsenic* Cadmium* Chromium* Copper* Lead* Mercury* Zinc*
Toilet Flush Waste	Benzene* Phenol* 2,4,6-Trichlorophenol* 2-Chlorophenol* 1,2-Dichlorobenzene* 1,3-Dichlorobenzene 1,4-Dichlorobenzene* 1,1,1-Trichloroethane* 1,1,2-Trichloroethane Naphthalene* Trichloroethylene* 1,2-Dichloroethane Antimony* Copper* Mercury* Zinc* Chromium*
Utility Sink Waste	1,1,1-Trichloroethane* 1,1,2-Trichloroethane 1,2-Dichlorobenzene* 2,4,6-Trichlorophenol* Antimony* Arsenic* Cadmium* Copper* Lead* Mercury* Nickel* Scandium* Zinc* Silver*

Source: Reference 6

\*Most commonly found (14 organics, 9 metals).

APPENDIX 3.5  
LAGOON SAMPLING PROGRAM

ATTACHMENT B  
LAGOON SAMPLING AND ANALYTICAL PROCEDURES

The Publicly Owned Treatment Works (POTW) Lagoon Study sampling program was conducted at nine domestic lagoon and 12 municipal lagoon systems as identified in the final letter report.<sup>a</sup> Priority pollutants<sup>b</sup> and selected nonconventional water quality parameters (total organic carbon, ammonia nitrogen, oxidized nitrogen, total solids (sludges), and chloride) were sampled at each site. U.S. Environmental Protection Agency (EPA), Brown and Caldwell (BC) and Robert E. Lee and Associates, Inc. (REL) personnel participated in the sampling program. Analytical work was performed at EPA laboratories in Annapolis, Maryland (Central Regional Laboratory) and Athens, Georgia, (Environmental Services Division Laboratory) and the Robert E. Lee and Associates, Inc. Analytical Laboratory in Green Bay, Wisconsin. A site sampling and analysis summary is presented in Table 1.

Sampling Procedures

Sampling of the 21 facilities was performed during two periods. The nine domestic lagoon systems (plus the Mandan, ND municipal/industrial lagoon system<sup>c</sup>) were sampled by EPA Regions III and IV between August and November, 1985. The 11 other municipal/industrial lagoons were sampled by EPA Region IV, REL and BC during July and August, 1986.

The domestic sampling program was developed by EPA Headquarters in Washington and concentrated on lagoon systems with monitoring wells. Based on information gained by BC from observations of sampling activities performed by Region IV at three Michigan sites typical sampling procedures used for the domestic lagoon study are presented below.

Influent automatic composite samplers were used to obtain 6 to 24 hour composites of all contaminants except volatile organics, cyanide and total phenolics. Grab samples were collected for these contaminants. Volatile organic influent samples were collected in triplicate. Lagoon liquid, effluent, sludge and monitoring well grab

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<sup>a</sup>In addition, data from the Everett, WA and Muskegon, MI municipal/industrial lagoon systems are used in the study.

<sup>b</sup>Except dioxin.

<sup>c</sup>The Mandan, ND lagoon system was initially classified as a domestic lagoon.

samples were also collected. Typically, one upgradient and three down gradient monitoring wells were sampled. Sampling procedures used (e.g., minimizing aeration of volatile organics and flushing monitoring wells three times prior to sampling) were based on standard EPA sampling protocol. If a monitoring well dried up during baling operations the well was allowed to recover overnight prior to sampling. Teflon balers were used for baling and sample collection. Field and equipment blanks were collected at each site.

For the municipal/industrial lagoon sampling program, samples obtained by REL and BC at nine sites were collected in accordance with procedures specified in the Quality Assurance Project Plan submitted to EPA as part of the Revised Work Plan for Work Assignment 2-7 dated July 30, 1986.

For the two municipal/industrial lagoons sampled by EPA Region IX, sampling activities were conducted in accordance with the Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual, U.S. Environmental Protection Agency, Region IV, Environmental Services Division, dated April 1, 1986.

#### Analytical Procedures

Analytical methods and quality assurance procedures used during the study are documented as follows:

1. EPA Central Regional Laboratory--memo from Joseph L. Slayton, CRL Chemist to Water Gilbert, EPA Headquarters dated January 28, 1986.
2. REL Analytical Laboratory--Quality Assurance Project Plan for Work Assignment 2-7 (submitted to EPA with Revised Work Plan dated July 30, 1986).
3. EPA Environmental Services Division Laboratory--EPA Region IV Analytical Support Branch Operations and Quality Control Manual, dated June 1985.

Table 2 summarizes analytical detection limits for both liquid and sludge samples from the three laboratories participating in the sampling program and for the independent data collected from the Muskegon, MI and Everett, WA facilities. Detection limit ranges shown in Table 2 represent both variances in specific contaminants within the identified contaminant category and variances between samples. Typically, for the majority of contaminants, detection limits were near the lower limit of the range. Table 3 identifies detection limits for each contaminant analyzed by REL. There was greater variance in detection limits for individual compounds sampled by EPA. The respective EPA laboratories supplied detection limits for the contaminants as part of raw data sheets for each site transmitted to EPA headquarters.

Analytical methods<sup>1,2,3,4</sup> were similar at all laboratories except those for volatile (purgeable) and extractable organics. The EPA laboratories used gas chromatograph/mass spectrometer (GC/MS) methods, EPA Method 624 for volatile and Method 625 for extractable organics. The REL laboratory used principally GC and liquid chromatography (LC) methods with specific detectors in accordance with EPA Methods 601, 602, 603, 604, 605, 606, 607, 609, 610, 611 and 612.

Metals concentrations were measured with element specific spectroscopic analytical methods. Cyanide was analyzed spectrophotometrically, while total phenols were determined via distillation and colorimetric methods.

Quality control and assurance procedures used during the study included spike samples, duplicates and participation in external performance audit sample surveys with EPA Cincinnati. Summary data used in the study were corrected for water and equipment blank contamination.<sup>5</sup>

#### REFERENCES

1. "Standard Methods for the Examination of Water and Wastewater," APHA-AWWA-WPCF, 16th Edition, 1985.
2. "Test Methods for Evaluating Solid Waste--Physical/Chemical Methods," EPA/SW-846, United States Environmental Protection Agency, 2nd Edition, revised 1985.
3. "Methods for the Chemical Analysis of Water and Wastes," EPA-600/4-79-020, United States Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Cincinnati, Ohio, 1979.
4. "Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater," EPA-600/4-82-047, United States Environmental Protection Agency, July 1982.
5. "Handbook for Analytical Quality Control in Water and Wastewater Laboratories," EPA-600/4-79-019, United States Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Cincinnati, Ohio, 1979.

Table 1 PONW Lagoon Study Sample Collection and Analyses Summary

Site	Lagoon category	Influent	Samples collected			Sample collection	Chemical analysis
			Effluent	Lagoon liquid	Monitoring wells		
Honeybrook, PA	Domestic	x	x	x	x	x	EPA CM <sup>a</sup>
Britten Village, MI	Domestic	x	x	x	x	x	EPA CM <sup>a</sup>
Potterville, MI	Domestic	x	x	x	x	x	EPA CM <sup>a</sup>
Standish, MI	Domestic	x	x	x	x	x	EPA CM <sup>a</sup>
Minot, ND	Domestic	x	x	x	x	x	EPA CR <sup>b</sup>
McVille, ND	Domestic	x	x	x	x	x	EPA CR <sup>b</sup>
Laramie, WY	Domestic	x	x	x	x	x	EPA CR <sup>b</sup>
Lander, WY	Domestic	x	x	x	x	x	EPA CR <sup>b</sup>
Buffalo, WY	Domestic	x	x	x	x	x	EPA CR <sup>b</sup>
Mandan, ND	Municipal/industrial	x	x	x	x	x	EPA CR <sup>b</sup>
Hebron, IL	Municipal/industrial	x	x	x	x	x	REL <sup>b</sup>
Dexter, MI	Municipal/industrial	x	x	x	x	x	REL
Atkins, AK	Municipal/industrial	x	x	x	x	x	REL
Harrisburg, MD <sup>c</sup>	Municipal/industrial	x	x	x	x	x	REL
Alexandria, LA	Municipal/industrial	x	x	x	x	x	REL
Glendive, MT	Municipal/industrial	x	x	x	x	x	REL
Scottsbluff, NE	Municipal/industrial	x	x	x	x	x	REL
Manong, WI	Municipal/industrial	x	x	x	x	x	REL
Ridgecrest, CA	Municipal/industrial	x	x	x	x	BC <sup>c</sup>	REL
Andrews, SC	Municipal/industrial	x	x	x	x	EPA Region IV	EPA Athens, GA <sup>d</sup>
Pickens, SC	Municipal/industrial	x	x	x	x	EPA Region IV	EPA Athens, GA

<sup>a</sup>EPA Central Regional Laboratory-Annapolis, MD.

<sup>b</sup>Robert E. Lee and Associates.

<sup>c</sup>Brown and Caldwell.

<sup>d</sup>EPA Environmental Science Division Laboratory, Athens, GA.

Table 2 Summary of Analytical Detection Limits

Contaminant category	Anapolis, MD Laboratory	Athens, GA Laboratory	REF, Inc. Laboratory	Muskegon, MI	Everett, WA
	Liquid, ug/l	Sludge, mg/kg <sup>a</sup>	Liquid, ug/l	Sludge, ug/kg <sup>b</sup>	Liquid, ug/l
Organics					
Volatile	1	0.005-0.01	5	0.03-0.3	0.1-1.8
Extractable	10-200	10-31.3	50-100	46-250	1-10
Pesticides/PCBs <sup>c</sup>	0.002-0.15	0.02-1.5	0.03-27	0.06-7.7	0.003-0.083
Total phenolics	10	-	-	-	5
Inorganics					
Metals	0.2-5.0	0.01-10	10-200	3-12	0.05-8
Cyanide	20	-	-	-	3
TOC	1,000	-	-	-	100
NH <sub>3</sub> -N	40	-	0.10	-	50
NO <sub>x</sub> -N	40	-	0.05	-	5
Chloride	-	-	45	-	100

<sup>a</sup>Net weight basis.

<sup>b</sup>Dry weight basis.

<sup>c</sup>Sludge detections limits approximately 20 times greater than liquid limits (expressed as ug/kg--dry weight basis).

<sup>d</sup>Only metals analyzed in sludge, detection limits were approximately 2 ug/kg.

KUBIKI E. LEE & ASSOCIATES  
USERA WASTEWATER SAMPLING PROJECT  
Job Number: Y00007  
DETECTION LIMITS

Table 3. REL Analytical Detection Limit Summary

PARAMETER <sup>a</sup>	CONCENTRATION (UG/L)	PARAMETER	CONCENTRATION (UG/L)	PARAMETER	CONCENTRATION (UG/L)
TOTAL ORGANIC CHLORINE	<100	4-CHLORO-3-METHYLPHENOL	<0.36	1,2-DICHLOROBENZENE	<1.14
AMMONIUM-N	<50	2-CHLOROPHENOL	<0.31	1,3-DICHLOROBENZENE	<1.19
NITRITE/NITRATE-N	<5	2,4-DICHLOROPHENOL	<0.39	1,4-DICHLOROBENZENE	<1.34
CHLORIDE	<100	2,4-DIMETHYLPHENOL	<0.32	HEMICHLOROQUATROENE	<0.03
METALOGY	<0.06	2,4-DINITROPHENOL	<13	HEMICHLOROCYCLOPENTADIENE	<0.34
HISTERIC	<8	2-NEUTRAL-4,6-DINITROPHENOL	<16	HEXACHLOROCYCLOPENTADIENE	<0.34
BHKLUN	<3	2-NITROPHENOL	<0.45	HEXAFLUOROPHENYL ETHER	<0.03
CHUNLUN	<3	4-NITROPHENOL	<2.8	1,2,4-TRICHLOROBENZENE	<0.03
CHUNLUN	<3	PHENYLCHLOROPHENOL	<7.4	1,2-DIMETHYL HYDROXYLINE	<0.03
CURTER	<3	PHENOL	<0.14	HALKIN	<0.001
LEHO	<3	2,4,6-TRICHLOROPHENOL	<0.64	A-BHC	<0.003
REKLEM	<0.2	BIS(2-ETHYLHEXYL) PHthalate	<2.0	B-BHC	<0.006
NICKEL	<3	Butyl BENZYL PHthalate	<0.34	S-BHC	<0.003
SELMILUN	<0.2	O,N-BUTYL PHthalate	<0.36	G-BHC	<0.004
SILVEK	<5	O,N-ETHYL PHthalate	<0.29	CHLORDRANE	<0.012
THIRLUN	<8	O,N-OCTYL PHthalate	<3.0	1,4-ODQ	<0.012
ZINC	<0.1	BENZODIENE	<1.4	1,4-ODE	<0.004
CYNamide	<5	3,3'-DICHLOROBENZIDINE	<0.13	DIELORIN	<0.002
TOTAL PHENOLICS	<5	N-MITROSODIMETHYLNITRILE	<0.16	ENDOSULFAN I	<0.014
BROMODICHLOROETHANE	<0.10	N-MITROSODIPHENYLNITRILE	<0.61	ENDOSULFAN II	<0.004
BROMOFURAN	<0.20	N-MITROSODI-N-PROPYLNITRILE	<0.16	ENDOSULFAN SULFATE	<0.006
BROMOETHANE	<1.18	2,4-DINITROTOLUENE	<0.02	ENDOKIN ALDEHYDE	<0.003
CHLORINE TETRACHLOROURE	<0.12	2,6-DINITROTOLUENE	<0.01	HEPTACHLOR EPoxide	<0.003
CHLOROBYKENE	<0.26	1,5-PHENOXINE	<3.7	TOXINPHENE	<0.003
CHLOROETHANE	<0.92	4,4'-(M)TROBENZENE	<3.6	PCB-AU6	<0.003
2-CHLOROETHYL VINYL ETHER	<0.13	4,4'EPOXYBENZENE	<1.9	PCB-1221	<0.003
CHLOROFURAN	<0.05	4,4'EPOXYBENZENE	<2.3	PCB-1232	<0.003
CHLORONEPHINE	<0.06	4,4'EPOXYBENZENE	<0.60	PCB-1242	<0.003
1,2-BIS(2-CHLOROETHYL)FURANE	<1.91	4,4'EPOXYBENZENE	<0.03	PCB-1248	<0.003
1,1,2-TRICHLOROETHANE	<0.07	1-BENZO (A) ANTHRAKENE	<0.023	PCB-1254	<0.003
1,2-DICHLOROETHANE	<0.03	1-BENZO (A) PYRENE	<0.018	PCB-1260	<0.003
1,1-DICHLOROETHANE	<0.13	1-BENZO (A) PYROKUMARENE	<0.076		
TAHES-1,2-DICHLOROETHANE	<0.10	1-BENZO (A) PYRENE	<0.017		
1,2-DICHLOROPHENOL	<0.04	1-BENZO (A) FLUORANTHENE	<0.15		
CIS-1,3-DICHLOROPHENOL	<0.20	1-CYANENE	<0.03		
THRES-1,3-DICHLOROPHENOL	<0.34	1-BENZO (A) ANTHRAKENE	<0.21		
NEPHYLENE CHLORIDE	<0.25	FLUORANTHENE	<0.21		
1,1,2,2-TETRACHLOROETHANE	<0.03	FLUORANTHENE	<0.043		
1,1,1,1-TETRACHLOROETHANE	<0.03	INDENO (1,2,3-CD) PHENOL	<1.6		
1,1,2,2-TETRACHLOROETHANE	<0.03	INDENYL FURANE	<0.64		
VINYL CHLORIDE	<0.16	INDENYL VINYL CHLORIDE	<0.27		
BENZENE	<0.2	BIS (C2-CHLOROETHYL) ETHER	<0.3		
EINYL BENZENE	<0.2	BIS (C2-CHLOROETHYL) NEPTHENE	<0.5		
TOLUENE	<0.2	BIS (C2-CHLOROETHYL) SUPHONYL ETHER	<0.8		
MCOLEIN	<0.6	4-BROMOPHENYL PHENYL ETHER	<2.3		
ACKLONICLIMIDE		4-CHLOROPHENYL PHENYL ETHER	<3.9		
		2-CHLORONAPHTHALENE	<0.94		

<sup>a</sup> MULTIPLE PEAK RESPONSE-DETECTION LIMIT APPROXIMATELY 0.1 PPM

<sup>b</sup>Liquid detection limits--Sludge detection limits approximately 20 times greater, expressed as ug/Kg (dry weight basis)



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION III  
CENTRAL REGIONAL LABORATORY  
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FTS 922-3752

DATE : January 28, 1986

SUBJECT: Central Regional Laboratory Quality Assurance Procedures Employed During the Analysis of Construction Grants Samples

FROM : Joseph L. Slayton (3ES21) *JS*  
Chemist

TO : Walter Gilbert (WH-595)

The quality assurance procedures employed during the analysis of the Construction Grants samples have been summarized by parameter group.

General

The Central Regional Laboratory participates each year in four external performance audit sample surveys. These include unknown audit samples for the SDWA; NPDES; Superfund and RCRA programs. The laboratory has a full time quality assurance officer and technician. Quarterly performance checks are routinely performed to assure adequate operational of balances; spectrophotometers; pH meters and other critical instrumentation.

Phenol

A duplicate (precision) and spike (accuracy) sample were analyzed every tenth sample. A check standard was analyzed in the middle and end of each set of samples analyzed. An audit sample (EPA-Cincinnati provided external standard) was analyzed at the beginning of each set of samples analyzed. The calibration curve consisted of six standards.

Cyanide

A duplicate (precision) and spike (recovery) sample were analyzed after every tenth sample. A check standard was analyzed after every three or four samples. An audit (EPA-Cincinnati) was analyzed at the beginning of each analysis set. The calibration curve consisted of six standards and was prepared for each set of samples analyzed.

Total Carbon

A duplicate (precision) and spike (recovery) sample were analyzed after every tenth sample. A check standard was analyzed after every tenth sample. An audit (EPA-Cincinnati) sample was analyzed after every tenth sample. The calibration curve consisted of seven standards.

### Nitrite, Nitrate, Ammonia

A duplicate (precision) and spike (recovery) sample were analyzed after every tenth sample. This was followed directly by a check standard. An audit sample (EPA-Cincinnati) was analyzed at the beginning of each set of analysis. The calibration curve consisted of seven standards.

### Chloride

A duplicate (precision) and spike (recovery) sample were analyzed after every tenth sample. A check standard on audit sample (EPA-Cincinnati) was analyzed at the beginning of each analysis. The calibration curve consisted of at least seven standards.

### Mercury

A duplicate (precision), a digestion duplicate, a check standard and a spiked sample (recovery) were analyzed after every tenth sample. An audit sample (EPA-Cincinnati) was analyzed at the beginning of each set of samples analyzed, for each type of matrix. The calibration curve consisted of at least six standards.

### Metals

A standard curve composed of five or six standards for each metal was analyzed to calibrate the instruments. In addition, the instrument was previously autozeroed. After the standardization, a performance audit sample (EPA provided external standard) was routinely analyzed to confirm the accuracy of the instrument ( $\pm 10\%$  required audit performance). This performance check was followed by the analysis of a reagent blank, a digestion blank and corresponding field blanks. Ten percent of the samples were analyzed in duplicate. Also a check standard was analyzed every ten samples with the required limits of  $\pm 10\%$ . For samples analyzed by the furance technique every sample was spiked at least once. If this single spike result was not found to give 85-115% recovery, then the Method of Standard Additions was employed using two additional spikes.

### Extractables Organic Compounds GC/MS

Before acquisition of any samples the mass spectrometer was calibrated using FC43. The calibration was verified by obtaining the spectra of a known compound (DFTPP). All mass assignments and relative abundances were found to be in acceptable ranges or the instrument was adjusted until suitable spectra of the known were obtained. Immediately before analysis each sample was spiked with an internal standards mixture containing six compounds including D10-phenanthrene. All quantitation or estimates of concentration were made in comparison to the nearest internal standards. Mixed standards of extractable priority pollutants and Hazardous Compound List Substances (EPA-RTP provided) were analyzed at multiple concentration levels before each group of samples. The relative response of each compound versus the nearest internal standard was determined for use in quantitation. For each group of samples extracted (<20 samples) a method blank was prepared and examined for laboratory introduced contamination. In addition, field blanks were

### Extractables Organics (GC/MS) (Con't)

analyzed and all sample values were corrected for any blank contamination. Each sample was spiked with a mixture of surrogate compounds (six) prior to extraction and analysis. The recovery for each was determined to check for matrix effect. For each group of samples extracted (<20), an aliquot of sample was spiked with a priority pollutant cocktail containing twelve representative target compounds and carried through the extraction and GC/MS analysis. The recovery for each compound was determined to check for matrix effect.

### Pesticides

The instruments are calibrated before each set of samples with varified standards (EPA-Cincinnati or proven equivalent). The samples are spiked with EPA reference PCB/chlordane mixtures). A duplicate sample is analyzed with each set of samples. A degradation check standard for Endrin and DDT was analyzed with each set of samples to assure satisfactory column performance. Field and reagent blanks were analyzed to varify the absence of pesticide contamination.

### Volatile Organic Compounds GC/MS

The QA procedures included on a daily basis an initial instrument blank followed by a method blank and standards (EPA or EPA varified).

Incorporated in the first method blank was the analysis of 4-Bromo-1-Fluorobenzene (BFB) as a Mass Spectral Criteria Compound. If the spectra of BFB did not meet the criteria specified in Method 624 the Mass Spectrometer would be recalibrated using Perfluorotributylamine (FC43) until the criteria was met.

The analysis of field blanks and additional method blanks followed the analysis of standards.

The following additional QA procedures were employed: At least one duplicate analysis was performed for each batch of samples. At least one matrix spike was performed for each batch of samples. In addition, samples that had high contamination were followed by method blanks.

JLS:ad

APPENDIX 3.5

TABLE 3.5-1

## SUMMARY OF DOMESTIC LAGOON SAMPLING RESULTS

Pollutant Category / Pollutant	Lagoon Influent Min	Lagoon Influent Max	Lagoon Effluent Min	Lagoon Effluent Max	Lagoon Sludge Min	Lagoon Sludge Max	Monitoring Wells Min	Monitoring Wells Max
<u>VOLATILES</u>								
Benzene	<1	14	-c	-	-	-	2.3d	-
Ethylbenzene	4.2	380	-	2.5d	-	0.005	-	-
Chloroform	1.1	20	<1	2.3	-	4.2	-	15
Bromodichloromethane	-	-	-	-	-	-	7.2	-
Dibromochloromethane	-	-	-	-	-	-	2.6	-
Tetrachloroethylene	<1	78	1.2	1.4	-	-	<1	-
Toluene	<1	280	2.1	9.6	0.006	0.036e	-	-
1,1-Dichloroethane	-	1.5	-	-	-	-	1.4	-
1,1,1-Trichloroethane	<1	22	<1	1	-	-	-	-
Trichloroethylene	1.7	110	<1	1.7	-	-	<1	-
Methylene Chloride	10	40	-	-	-	-	8	8.1
<u>EXTRACTABLE ORGANICS</u>								
Phenol	3.5	61	-	5.1	-	-	4.2	4.8
Naphthalene	-	58	-	5.1	-	5.8	-	2.8
Phenanthrene	-	-	-	-	-	1.9	-	-
Butyl-benzyl-phthalate	-	9	0.1	0.3	-	-	-	0.4
Di-n-octyl Phthalate	-	-	-	-	-	-	<1	-
Diethyl Phthalate	10	52	-	-	-	-	-	-
Bis(2-ethylhexyl) Phthalate	-	-	-	-	-	-	1.5	7.2
1,4-Dichlorobenzene	4	53	-	-	-	-	-	-
1,2-Dichlorobenzene	-	7	-	-	-	-	0.8	0.4

## APPENDIX 3.5

TABLE 3.5-1, Continued  
SUMMARY OF DOMESTIC LAGOON SAMPLING RESULTS

Pollutant Category/ Pollutant	Lagoon Influent		Lagoon Effluent <sup>a</sup>		Lagoon Sludge <sup>b</sup>		Monitoring Wells	
	Min	Max	Min	Max	Min	Max	Min	Max
<u>PCBS/PESTICIDES</u>								
Aroclor 1254 (PCB 1254)	-	-	ug/l	ug/l	ug/g	ug/g	ug/l	ug/l
Lindane (gamma BHC)	-	-	-	-	-	-	-	-
<u>METALS</u>								
Antimony	-	-	ug/l	ug/l	ug/g	ug/g	ug/l	ug/l
Arsenic <sup>f</sup>	-	5.1	-	-	11	0.8	2.8	-
Barium	85	135	51	83	2.1	15.4	6.3	28
Cadmium	-	6.4	-	-	26.0	1,482	8.9	300
Chromium	-	5.6	77	-	0.7	17.6	6	8
Copper	27.5	173	27	67	7.0	54	5.8	63
Lead	6.9	174	5.7	13	3.0	574	0.31	740
Mercury	0.2	3	-	-	0.2	29.6	0.2	0.4
Nickel	-	-	-	-	8.7	39	53	342
Selenium	-	-	5.2	7.8	1.3	22	7.4	14
Silver	13	22	-	-	1.2	95	-	-
Thallium	3.4	3.7	3.5	3.9	-	-	2.4	5.7
Zinc	41	228	24	117	25.0	1,340	18	10,600
<u>OTHER</u>								
Cyanide	-	-	ug/l	ug/l	ug/g	ug/g	ug/l	ug/l
Total Phenols <sup>f</sup>	18.5	238	43	13.3	63	-9	-	-
					78.8	-9	-	10.4
						-	-	45.3

## APPENDIX 3.5

TABLE 3.5-1, Continued

## SUMMARY OF DOMESTIC LAGOON SAMPLING RESULTS

Pollutant Category/ Pollutant	Lagoon Min	Influent Max	Lagoon Min	Effluent <sup>a</sup> Max	Lagoon Min	Sludge <sup>b</sup> Max	Monitoring Wells Min	Monitoring Wells Max
<u>NON-CONVENTIONAL POLLUTANTS</u>								
TOC (Total) carbon <sup>c</sup>	35.6	141	8.6	58.4	-	-	1.1	78.4
Chloride	14.5	776	15.7	453	-	-	2.4	382
NH <sub>3</sub> - N (ammonia) <sup>f</sup>	2.76	28.65	0.066	28.3	-	-	0.042	26.1
NO <sub>2</sub> /NO <sub>3</sub> - N	0.042	1.72	0.043	2.29	-	-	0.050	7.25

## Notes:

<sup>a</sup> Includes lagoon wastewater samples.<sup>b</sup> Wet weight basis.<sup>c</sup> "-" indicates all measured values were below detection limits.<sup>d</sup> Single value based on one data point.<sup>e</sup> Also detected in two sludges at 5 and 80 ug/l.<sup>f</sup> Not a priority pollutant.

g Sludge not analyzed for this pollutant.

## APPENDIX 3.5

TABLE 3.5-2  
POLLUTANT FREQUENCY OF OCCURRENCE: DOMESTIC LAGOONS

Pollutant Category/ Pollutant	Lagoon Influent		Lagoon Effluent <sup>a</sup>		Lagoon Sludge		Total Source <sup>b</sup>		Monitoring Wells	
	No. of Samples	No. of Times Detected	No. of Samples Detected	No. of Times Detected						
Volatiles	26	15	7	0	48	9	37	19	1	1
Benzene	9	0	1	1	0	8	8	17	0	0
Ethybenzene	6	1	4	0	0	28	28	58	1	1
Chloroform	24	4	0	0	0	0	0	0	0	0
Bromodichloromethane	0	0	0	0	0	0	0	0	0	1
Vibromochloromethane	0	0	0	0	0	0	0	0	0	1
Tetrachloroethylene	10	2	2	0	0	12	25	25	2	2
Toluene	20	2	3	3	3	25	52	52	0	0
1,1-Dichloroethane	1	0	0	0	0	1	2	2	2	2
1,1,1-Trichloroethane	7	1	0	0	0	8	17	17	0	0
Trichloroethylene	8	2	0	0	0	10	21	21	3	3
Methylene Chloride	2	0	0	0	2	4	4	4	3	3
Extractable Organics	7	14	8	0	29	4	37	14	4	4
Phenol	3	1	0	0	0	3	10	10	1	1
Naphthalene	1	1	1	1	1	1	3	3	0	0
Phenanthrene	0	0	0	0	0	0	0	0	0	0
Butyl-benzyl-phthalate	1	1	1	1	0	2	2	2	1	1
Di-n-octyl phthalate	0	0	0	0	0	0	0	0	1	1
Diethyl Phthalate	3	0	0	0	0	3	10	10	0	0
Bis (2-ethylhexyl)										
Phthalate	1	0	0	0	0	1	3	3	3	3
1,4-Dichlorobenzene	2	0	0	0	1	3	10	10	1	1
1,2-Dichlorobenzene	0	0	1	1	1	1	3	3	0	0
PCBs/Pesticides	9	15	7	1	31	1	38	1	3	0
Aroclor 1254 (PCB 1254)	0	0	0	0	0	0	0	0	0	0
Lindane (gamma BHC)	0	1	0	0	1	1	3	3	0	0

## APPENDIX 3:5

TABLE 3.5-2, Continued

## POLLUTANT FREQUENCY OF OCCURRENCE: DOMESTIC LAGOONS

Pollutant Category/ Pollutant	Lagoon Influent		Lagoon Effluent <sup>a</sup>		Lagoon Sludge		Total Source <sup>b</sup>		Monitoring Wells	
	No. of Samples	No. of Times Detected	No. of Samples	No. of Times Detected	No. of Samples	No. of Times Detected	No. of Samples	Total Times Detected	Percent Detected	No. of Samples Detected
<b>Metals</b>										
Antimony	0	0	0	0	5	5	5	16	0	0
Arsenic <sup>c</sup>	1	2	2	2	7	7	10	31	2	2
Barium <sup>c</sup>	5	4	4	4	6	6	15	47	14	14
Beryllium	0	0	0	0	0	0	0	0	0	0
Cadmium	1	0	0	0	7	7	8	25	8	8
Chromium	2	0	0	0	8	8	10	31	5	5
Copper	9	2	2	2	8	8	19	59	4	4
Lead	8	4	4	4	8	8	20	63	24	24
Mercury	6	0	0	0	7	7	13	41	3	3
Nickel	0	0	0	0	8	8	8	25	1	1
Selenium	0	3	3	3	5	5	8	25	2	2
Silver	2	0	0	0	6	6	8	25	0	0
Thallium	2	2	2	0	0	0	4	13	13	13
Zinc	9	5	5	8	8	8	22	69	25	25
Other	9	15	0	0	24	24	38	0	0	0
Cyanide	0	2	2	2	2	2	8	0	0	0
Total Phenols <sup>c</sup>	9	9	7	7	16	16	67	11	11	11
<b>Non-Conventional</b>										
Constituents	9	15	0	0	24	24	38	38	38	38
TOT (total) organic	9	9	15	15	24	24	100	34	34	34
carbon <sup>c</sup>	9	9	15	15	24	24	100	37	37	37
Chloride <sup>c</sup>	8	14	14	22	22	22	92	28	28	28
NH <sub>3</sub> -N (ammonia) <sup>c</sup>	8	10	10	16	16	16	67	18	18	18
NO <sub>2</sub> /NO <sub>3</sub> -N	6									

<sup>a</sup>Includes lagoon wastewater samples.<sup>b</sup>Lagoon influent, effluent and sludge are all considered potential sources of pollutants in lagoon seepage.<sup>c</sup>Not a priority pollutant.

TABLE S 1 -- LARAMIE, WYOMING LAGOON SYSTEM CONTAMINANT SUMMARY

DATA COLLECTED AUGUST 1985

CONTAMINANT CATEGORY / contaminant	SAMPLE LOCATION and CONCENTRATION				WASTEWATER INFLUENT	TREATED WASTEWATER LAGOON LIQUID EFFLUENT	LAGOON SLUDGE CONCENTRATION wet weight basis, ug/g
	Up gradient MW1	MW2	Down gradient MW3	MW4			
VOLATILES - STANDARD EQUATABLE							
benzene	ug/l				2.3	7-14	
chloroform	ug/l					9-21	
ethylbenzene	ug/l					4.2-360	
tetrachloroethylene	ug/l					13-63	
toluene	ug/l					9.8-280	
1,1,1-trichloroethane	ug/l					(1-15)	
trichloroethylene	ug/l					3.5-11	5.1 ug/l
EXTRACTABLE ORGANICS							
phenol	ug/l						
naonthalene	ug/l					5.1	
PCBs/ PESTICIDES							
lindane	ug/l					6.3	
METALS							
antimony	ug/l						
arsenic	ug/l						2.2
barium	ug/l						5.2
beryllium	ug/l						656
cadmium	ug/l						17.5
chromium	ug/l						54
copper	ug/l						818
lead	ug/l						224
mercury	ug/l						10
nickel	ug/l						16.4
selenium	ug/l						11
silver	ug/l						8.8
thallium	ug/l						
zinc	ug/l						882
OTHER PRIORITY POLLUTANTS							
Cyanide, ug/l						61	
Total phenolics, ug/l						73.0	23.7
CONVENTIONAL CONTAMINANTS, ug/l							
Total Organic Carbon		7.6	9.4	11.7	7.1	80.4	26.4
CHLORIDE		46.7	96.9	159	111	60.6	91.6
NH3 - N (ammonia)		2.79	2.76	2.76	2.76	8.82	8.75
NO2/NO3 - N			.054	.081	.44	1.77	2.29

a — value may be high, BLANK (850809-01) concentration = 13 ug/l

! — ESTIMATED CONCENTRATION, detected @ concentration below accurate quantification.

- not analyzed

NOTES:

Trace concentrations (( 1 ug/l) set equal to 1 ug/l, blank indicates value below detectable limit.

TABLE 5.2 -- LANDER, WYOMING LAGOON SYSTEM CONTAMINANT SUMMARY

DATA COLLECTED AUGUST 1985

CONTAMINANT CATEGORY / contaminant	SAMPLE LOCATION and CONCENTRATION							
	MONITORING WELLS				WASTEWATER INFILUENT	TREATED WASTEWATER		LAGOON SLUDGE CONCENTRATION wet weight basis, ug/g
	Up MW1	MW2	Down gradient MW3	MW4		LAGOON LIQUID	LAGOON EFFLUENT	
<b>VOLATILES - STANDARD EQUATABLE</b>								
chloroform	ug/l				12-15			
tetrachloroethylene	ug/l				47-50			
toluene	ug/l							
trichloroethylene	ug/l				1.7-6			
		1						80 ug/l
<b>EXTRACTABLE ORGANICS</b>								
phenol	ug/l	4.5j						
naanthalene	ug/l		4.8j	4.2j				
			2.8j					
<b>PCBs/ PESTICIDES, ug/l</b>								
none detected								
<b>METALS</b>								
antimony	ug/l							
arsenic	ug/l							2.8
barium	ug/l	143						4.7
cadmium	ug/l		6.5					1482
chromium	ug/l							15.3
coppper	ug/l							48.2
lead	ug/l							891
mercury	ug/l		11					574
nickel	ug/l							10.4
seleinium	ug/l							27.3
silver	ug/l							6.4
thallium	ug/l	2.9	2.7	2.4	3.0	13		4.4
zinc	ug/l				28	3.4		1185
						48		
						26		
<b>OTHER PRIORITY POLLUTANTS</b>								
CYANIDE								
Total phenolics, ug/l					15.6	26.8	48.5	-
<b>CONVENTIONAL CONTAMINANTS, mg/l</b>								
Total Organic Carbon					12.0			
CHLORIDE		4.1			5.88	4.22	14.5	
NH3 - N (ammonia)					1.15	.042	2.76	
NO2/NO3 - N						.24a	.056a	

a — equipment blank ( 850609-14 ) contained 0.052 ug/l NO2/NO3-n

j — ESTIMATED CONCENTRATION; detected @ concentration below accurate quantification.

— not analyzed

## NOTES:

Trace concentrations (( 1 ug/l) set equal to 1 ug/l, blank indicates value below detectable limit.

TABLE S 3 -- BUFFALO, WYOMING LAGOON SYSTEM CONTAMINANT SUMMARY

DATA COLLECTED AUGUST 1985

CONTAMINANT CATEGORY / contaminant	SAMPLE LOCATION and CONCENTRATION							
	MONITORING WELLS				WASTEWATER INFILTRATE	TREATED		LAGOON SLUDGE CONCENTRATION wet weight basis, ug/g
	Up MW1	MW2	Down gradient MW3	MW4		LAGOON LIQUID	LADDOON LIQUID	
VOLATILES - STANDARD EQUATABLE								
chloroform ug/l					8.0-20	2.3		
toluene ug/l					4.1-5.1	9.6		
1,1,1-trichloroethane ug/l					1			
methylene chloride ug/l			8.1	8.0				
EXTRACTABLE ORGANICS, ug/l								
PCBs/ PESTICIDES, ug/l								
none detected								
METALS								
antimony ug/l								.8
arsenic ug/l								
barium ug/l	163	68	88.5	118	59		748	
beryllium ug/l		6.3	7.5	5.5				6.4
cadmium ug/l								9.3
chromium ug/l								627
copper ug/l						173	67	216
lead ug/l		8.6a	6.2a			13		4.3
mercury ug/l								18.2
nickel ug/l								
selenium ug/l								9.2
silver ug/l								
thallium ug/l	2.4	2.4	2.9	2.8				
zinc ug/l	271b	202b	644b	114b	150	59		596
OTHER PRIORITY POLLUTANTS								
CYANIDE								
Total phenolics, ug/l					128			-
CONVENTIONAL CONTAMINANTS, mg/l								
Total Organic Carbon	18.8	13.1	78.4	43.5	71.7	58.4		-
CHLORIDE	7.06	5.87	17.4	15.0	34.2	33.9		-
NH3 - N (ammonia)		.075	.81	.076	7.61	7.63		-
NO2/NO3 - N	.072		.078	.075				

a = equipment blank ( 850809-27 ) contained 34 ug/l lead

b = equipment blanks ( 850809-27, -31 ) contained 45 ug/l and 66 ug/l zinc respectively

- not analyzed

## NOTES:

Trace concentrations (&lt; 1 ug/l) set equal to 1 ug/l, blank indicates value below detectable limit.

TABLE S 4 -- HONEY BROOK, PA LAGOON SYSTEM CONTAMINANT SUMMARY SAMPLES COLLECTED JULY 1985

CONTAMINANT CATEGORY / contaminant	SAMPLE LOCATION and CONCENTRATION				
	MONITORING WELLS		WASTEWATER INFLUENT	TREATED LAGOON LIQUID	LAGOON SLUDGE CONCENTRATION wet weight basis, ug/g
Up gradient : ug/l	Down gradient : ug/l				
VOLATILES - STANDARD EQUATABLE					
chloroform			2.2-4.7		
toluene			1		
EXTRACTABLE ORGANICS, ug/l					
phenol			61j,a		
naphthalene			58j,a		
phenanthrene					5.8j
1,2- dichlorobenzene					1.9j
1,4- dichlorobenzene					0.4j
diethyl-phthalate			52j,a		1.5j
PCBs/ PESTICIDES, ug/l					
Arochlor 1254					.5
METALS					
antimony					1.8
arsenic					15.4
barium		87	61	71	345
cadmium					16
chromium					48
copper				143	944
lead				18	166
mercury		.3	.2	.4	9.2
nickel					39
selenium					1.3
silver					1.2
zinc		18	63	123	1096
OTHER PRIORITY POLLUTANTS					
Cyanide, ug/l				43	-
Total phenolics, ug/l			61.9	13.1	-
CONVENTIONAL CONTAMINANTS, mg/l					
Total Organic Carbon	1.1		87.6	29.4	-
CHLORIDE	14.7	7.16	51	53.7	-
NH3 - N (ammonia)			4.17	5.23	-
NO2/NO3 - N	6.3b	2.58	.042	1.07	-

a -- actual detection limit = 100 ug/l for this sample

b -- value may be high, up gradient MW equipment blank (850725-09) contained 2.1 mg/l NO2/NO3-N

Field blank (850725-01) contained 6.9j ug/l bis(2-ethylhexyl)-phthalate and 4.4j ug/l di-n-butyl-phthalate

j -- ESTIMATED CONCENTRATION, detected @ concentration below accurate quantification.

- not analyzed

## NOTES:

Trace concentrations (&lt; 1 ug/l) set equal to 1 ug/l, blank indicates values below detectable limit.

TABLE S 6 -- MINOT, ND LAGOON SYSTEM CONTAMINANT SUMMARY

DATA COLLECTED SEPTEMBER 1985

CONTAMINANT CATEGORY / contaminant	SAMPLE LOCATION and CONCENTRATION							
	MONITORING WELLS				WASTEWATER INFILTRATE	TREATED WASTEWATER		LAGOON SLUDGE CONCENTRATION wet weight basis, ug/g
	Up MW1	MW2	Down gradient MW3	MW4		LAGOON LIQUID	LAGOON EFFLUENT	
VOLATILES - STANDARD EQUATABLE								
1,1-dichloroethane	ug/l					1.5		
chloroform	ug/l					9.4-10		
bromodichloromethane	ug/l					7.2		
dibromo-chloromethane	ug/l					2.6		
tetrachloroethylene	ug/l					2-5		
toluene	ug/l					2.6-4.7		
1,1,1-trichloroethane	ug/l					7-22		
trichloroethylene	ug/l					12-110	1	
methylene chloride	ug/l					10-40		
EXTRACTABLE ORGANICS, ug/l								
butyl-benzyl-phthalate		0.4j				9j,b	0.1j	
di-n-octyl phthalate		0.9j						
diethyl phthalate						10j,b		
bis(2-ethylhexyl)- phthalate		16	7.2	9.7		53j,b		
1,4-dichlorobenzene						7j,b		
PCBs/ PESTICIDES, ug/l								
none detected								
METALS								
antimony	ug/l							
arsenic	ug/l	6.3				5.1	11	4.6
barium	ug/l							
beryllium	ug/l							
cadmium	ug/l							
chromium	ug/l	16	31	11	5.8	6.4		5.4
copper	ug/l	36		44		24		33
lead	ug/l	15	10	28		97		233
mercury	ug/l					174	7.4	215
nickel	ug/l					.6		4.8
selenium	ug/l							18
silver	ug/l					22		4.2
thallium	ug/l							23
zinc	ug/l	151	54	151	58	228		507
OTHER PRIORITY POLLUTANTS								
CYANIDE								
Total phenolics, ug/l		12.8	45.3		10.4	84.0	36.8	17.8
CONVENTIONAL CONTAMINANTS, mg/l								
Total Organic Carbon		6.6	7.2	13.4	9.0	35.6	29.3	20.6
CHLORIDE		10.5	115	153	135	188	126	166
NH3 - N (ammonia)		.104	.057	.043	.376		14.46	.066
NO2/NO3 - N		.321		.065		.042	.043	-

a -- analyzed as liquid

b -- actual detection limit = 10 x MDL for this sample

j -- ESTIMATED CONCENTRATION, detected &amp; concentration below accurate quantification

- not analyzed

## NOTES:

Trace concentrations (&lt; 1 ug/l) set equal to 1 ug/l, blank indicates value below detectable limit.

TABLE S 7 -- MCVILLE, ND LAGOON SYSTEM CONTAMINANT SUMMARY

DATA COLLECTED SEPTEMBER 1985

CONTAMINANT CATEGORY / contaminant	SAMPLE LOCATION and CONCENTRATION						
	MONITORING WELLS			WASTEWATER INFILLET	TREATED LAGOON LIQUID	LAGOON SLUDGE CONCENTRATION wet weight basis, ug/g	
	Up MW1	MW2	Down gradient MW3 MW4				
<b>VOLATILES - STANDARD EQUATABLE</b>							
1,1-dichloroethane ug/l			1.4	1	1.1-2.7		
chloroform ug/l							
ethylbenzene ug/l							.005
toluene ug/l					9.6-11		.006
trichloroethylene ug/l				1			
<b>EXTRACTABLE ORGANICS, ug/l</b>							
phenol					10j,a		
diethyl phthalate					11j,a		
1,4-dichlorobenzene			0.8j		4j,a		
<b>PCBs/ PESTICIDES, ug/l</b>							
none detected							
<b>METALS</b>							
antimony ug/l							1.8
arsenic ug/l			17	28			5.5
barium ug/l							
beryllium ug/l				6.6			5.7
cadmium ug/l							36
chromium ug/l							
cooper ug/l				90	26	164	2100
lead ug/l	16		16	88	14	18	223
mercury ug/l						3.0	29.6
nickel ug/l							23
selenium ug/l							22
silver ug/l							95
thallium ug/l							
zinc ug/l	30			47	27	131	1340
<b>OTHER PRIORITY POLLUTANTS</b>							
<b>CYANIDE</b>							
Total phenolics, ug/l	10.4		16.6		10.4	137	18.6
<b>CONVENTIONAL CONTAMINANTS, mg/l</b>							
Total Organic Carbon	5.5		13.8	8.7	4.8	110	32.4
CHLORIDE	3.11		229	212	220	776	258
NH3 - N (ammonia)			18.28		26.1b	25.4	11.07
NO2/NO3 - N	7.25		.089	.081	.145		

a -- actual detection limit = 10xNDL

b -- equipment blank ( 850927-32 ) contained 26.8 mg/l NH3-N

j -- ESTIMATED CONCENTRATION, detected @ concentration below accurate quantification

- not analyzed

## NOTES:

Trace concentrations (( 1 ug/l) set equal to 1 ug/l, blank indicates value below detectable limit.

TABLE S 8 -- BRITTON VILLAGE, MI LAGOON SYSTEM CONTAMINANT SUMMARY DATA COLLECTED NOVEMBER 1985

CONTAMINANT CATEGORY / contaminant	SAMPLE LOCATION and CONCENTRATION							
	MONITORING WELLS				WASTEWATER INFLUENT	TREATED WASTEWATER		LAGOON SLUDGE CONCENTRATION wet weight basis, ug/g
	Up MW1	MW2	Down gradient MW3	MW4		LAGOON LIQUID	LAGOON EFFLUENT	
VOLATILES - STANDARD EQUATABLE								
chloroform toluene (see note a), ug/l					4			
EXTRACTABLE ORGANICS, ug/l								
phenol bis(2-ethylhexyl) phthalate ( see note c)					3.5; b			
PCBs/ PESTICIDES, ug/l								
none detected								
METALS								
antimony ug/l								
arsenic ug/l						11		6.8
barium ug/l					135			118
beryllium ug/l								.7
cadmium ug/l								14.5
chromium ug/l								38.7
copper ug/l					89			9.5
lead ug/l	5.5	8.7	11.5	6.5	11	13		.2
mercury ug/l					.2			26
nickel ug/l								
selenium ug/l								
silver ug/l								
thallium ug/l								
zinc ug/l	746e	1040e	2230e	701e	115	117		97
OTHER PRIORITY POLLUTANTS								
CYANIDE								
Total phenolics, ug/l					82.2			-
CONVENTIONAL CONTAMINANTS, ug/l								
Total Organic Carbon	12.8	7.8	16.2	6.6	102	31.4	25.9	-
CHLORIDE	15.9	15.3	9.3	23.0	160	146	140	-
NH3 - N (ammonia)	.071		.077		20.4	1.25		-
NO2/NO3 - N						1.23		

a -- blanks (851120-20/21) contaminated w/ &gt;60 ug/l toluene, no valid results for this contaminant

b -- actual detection limit = 10x NDL for this sample

c -- blanks (851120-20/21) contaminated w/ 31,3.0 ug/l, respectively of this contaminant

e -- value may be high, blank (851120-20) contained 4120 ug/l zinc

! -- ESTIMATED CONCENTRATION, detected # concentration below accurate quantification

? -- not analyzed

## NOTES:

Trace concentrations (&lt; 1 ug/l) set equal to 1 ug/l, blank indicates value below detectable limit.

TABLE S 9 -- POTTERVILLE, MI LAGOON SYSTEM CONTAMINANT SUMMARY

DATA COLLECTED NOVEMBER 1985

CONTAMINANT CATEGORY / contaminant	Up MW1	MW2	Down gradient MW3	MW4	SAMPLE LOCATION and CONCENTRATION				LAGOON SLUDGE CONCENTRATION wet weight basis, ug/g	
					MONITORING WELLS		WASTEWATER INFILTRATE	TREATED WASTEWATER		
								LAGOON LIQUID	LAGOON EFFLUENT	
VOLATILES - STANDARD EQUATABLE, ug/l ( holding time ) 7 days										1M
chloroform										1M
ethylbenzene										1M
benzene										1M
toluene										1M
tetrachloroethylene										1M
										1M
EXTRACTABLE ORGANICS, ug/l										1M
bis(2-ethylhexyl) phthalate ( see note a )										1M
PCBs/ PESTICIDES, ug/l										1M
none detected										1M
METALS										1M
antimony ug/l										1M
arsenic ug/l										1M
barium ug/l			190	300	120					2.1
beryllium ug/l										25
cadmium ug/l										1M
chromium ug/l										1M
copper ug/l										7.0
lead ug/l	149		22	27	34		44			11
mercury ug/l							6.9			3.0
nickel ug/l										8.7
silver ug/l										1M
thallium ug/l										1M
zinc ug/l	4460		10600	3370	5340		73			25
OTHER PRIORITY POLLUTANTS										1M
CYANIDE										1M
Total phenolics, ug/l			12.9	17.0	14.8		33.5	13.3		-
CONVENTIONAL CONTAMINANTS, mg/l										1M
Total Organic Carbon	3.8		5.1	4.2	6.4		59.5	26.2	20.2	1M
CHLORIDE	3.0		382	254			155	380	453	1M
NH3 - N (ammonia)			.125	.053	.105		13.55	1.77	5.95	1M
NO2/NO3 - N	5.38			.156			1.72	.239		1M

a -- blanks (851121-28) contaminated w/ 3.2j ug/l of this contaminant

- not analyzed

NOTES:

Trace concentrations (&lt; 1 ug/l) set equal to 1 ug/l, blank indicates value below detectable limit.

TABLE S 10 — STANDISH, MI LAGOON SYSTEM CONTAMINANT SUMMARY

DATA COLLECTED NOVEMBER 1985

CONTAMINANT CATEGORY / contaminant	Uo MW1	SAMPLE LOCATION and CONCENTRATION				TREATED WASTEWATER		
		MONITORING WELLS				WASTEWATER INFLOW	LAGOON LIQUID	
		MW2	Down gradient MW3	MW4			LAGOON EFFLUENT	
VOLATILES - STANDARD EQUATABLE, ug/l ( holding time ) 7 days )								
chloroform					8		1	
1,1,1-trichloroethane					1		1	
benzene								
toluene					2-3			
tetrachloroethylene					1			
EXTRACTABLE ORGANICS, ug/l								
PCBs/ PESTICIDES, ug/l								
none detected								
METALS								
antimony	ug/l							
arsenic	ug/l							
barium	ug/l							
beryllium	ug/l							
cadmium	ug/l							
chromium	ug/l							
copper	ug/l							
lead	ug/l		0.31a		7.2a		9.3a	
mercury	ug/l							
nickel	ug/l							
selenium	ug/l							
silver	ug/l							
thallium	ug/l							
zinc	ug/l					41		
OTHER PRIORITY POLLUTANTS								
CYANIDE								
Total phenolics, ug/l						18.5		
CONVENTIONAL CONTAMINANTS, ug/l								
Total Organic Carbon	4.2	1.8	8.0	6.6	40.9	19.8	22.7	
CHLORIDE	2.4	3.1	3.3	2.6	68.4	92.8	111	
NH3 - N (ammonia)	.203	.27	.358	.26	3.76	5.48	1.84	
NO2/NO3 - N					.709	.207	.674	

a = blank (851125-45) contaminated w/ 19 ug/l of lead, duplicate (851125-43) contained 31 ug/l lead

- not analyzed

## NOTES:

Trace concentrations (&lt; 1 ug/l) set equal to 1 ug/l, blank indicates value below detectable limit.

## APPENDIX 3.5

TABLE 3.5-3

## SUMMARY OF DOMESTIC/INDUSTRIAL LAGOON SAMPLING RESULTS

Pollutant Category/ Pollutant	Lagoon Min	Influent Max	Lagoon Min	Effluent <sup>a</sup> Max	Lagoon Min	Sludge <sup>b</sup> Max
<b>VOLATILES</b>						
Acrolein	13.4	63.8	2.3	3.5	58.2	58.2
Acrylonitrile	1.7	83.8	2.1	4.4	86	86.7
Benzene	1	153	0.99	11	99	99
Ethylbenzene	0.6	17.8	0.4	0.99	4	130
Carbon Tetrachloride	0.13	0.13	- <sup>c</sup>	-	-	-
Chloroform	0.21	747	0.06	86	2.61	2.61
Chlorobenzene	0.66	61.8	0.99	0.99	20.7	3,700
Chloroethane	0.26	80.3	12.1	12.1	0.58	3.59
Bromodichloromethane	1	2	-	-	-	-
Tetrachloroethylene	0.71	361	3	31	-	-
Toluene	1	1,964	1	34	2.5	3,300
Trans-1,2-dichloro- ethylene	6	6	0.99	0.99	80	80
1,1-Dichloroethane	0.14	3	0.99	0.99	-	-
1,1-Dichloroethylene	0.99	0.99	-	-	-	-
1,2-Dichloroethane	730	730	1.17	164	0.06	0.06
1,2-Dichloropropane	3.84	3.84	5.46	5.46	0.22	0.22
1,1,1-Trichloroethane	1.06	93	0.99	9	0.25	40
1,1,2-Trichloroethane	0.09	99.2	4.15	4.15	19.8	19.8
1,1,2,2-Tetrachloroethane	6.4	17	-	-	-	-
Trichloroethylene	0.73	56.7	0.4	2	-	-
Methyl Chloride	0.99	0.99	5	5	-	-
Methylene Chloride	5.2	340	0.49	280	0.34	0.34
Vinyl Chloride	0.62	11.6	1.9	1.9	50	50
<b>EXTRACTABLE ORGANICS</b>						
<u>Acid</u>						
Phenol	1.72	233	0.71	44	10	26,500
2-Chlorophenol	2	742	0.99	90	26.6	3,560
2,4-Dichlorophenol	2	164	0.41	10.6	123	32,500
2,4-Dimethylphenol	0.6	273	0.98	35.3	128	20,000
4-Chloro-3-Methylphenol	0.85	113	0.36	40.4	26.4	124,000
2-Methyl-4,6-Dini- trophenol	5.2	578	-	-	775	34,200
2-Nitrophenol	3.81	491	0.85	96.9	19	61,500
4-Nitrophenol	4.91	527	6.96	824	193	23,000
2,4-Dinitrophenol	7.42	553	320	320	243	45,300
Pentachlorophenol	0.99	828	5.44	416	61	126,000
2,4,6-Trichlorophenol	0.71	289	0.64	47.8	117	132,000

## APPENDIX 3.5

TABLE 3.5-3, Continued

SUMMARY OF DOMESTIC/INDUSTRIAL LAGOON SAMPLING RESULTS

Pollutant Category/ Pollutant	Lagoon Min	Influent Max	Lagoon Min	Effluent <sup>a</sup> Max	Lagoon Sludge <sup>b</sup> Min	Lagoon Sludge <sup>b</sup> Max
<b>EXTRACTABLE ORGANICS, continued</b>						
<u>Base/Neutral</u>	<u>ug/l</u>	<u>ug/l</u>	<u>ug/l</u>	<u>ug/l</u>	<u>ug/kg</u>	<u>ug/kg</u>
Acenaphthene	0.99	110	7.1	7.72	22.5	1,530
Acenaphthylene	0.99	4.24	2.68	2.68	6,300	6,300
Anthracene	0.91	12	1.49	1.49	11.5	6,100
Benzidine	1.11	0.15	0.12	0.84	1.14	2.25
Benzo (a) Anthracene	0.12	0.99	-	-	0.35	1,590
Benzo (a) Pyrene	0.05	0.99	0.09	0.09	0.13	0.13
Benzo (b) Fluoranthene	0.44	0.44	0.28	0.28	42.4	344
Benzo (ghi) Perylene	0.2	12.5	-	-	-	-
Benzo (k) Fluoranthene	0.32	0.59	1.24	1.24	21.2	1,110
Dibenzo (a,h) Anthracene	0.1	1.9	0.58	1	103	1,410
2-Chloronaphthalene	0.1	165	8.4	173	1.81	10,900
Chrysene	0.99	30.3	0.99	4.2	2.81	15,000
n-Nitrosodimethylamine	0.24	9.34	2.66	2.66	36.6	713
n-Nitrosodiphenylamine	0.28	1.45	0.14	123	14.3	282
n-Nitrosodi-n-propylamine	-	-	0.16	3.6	0.83	2,120
3,3'-Dichlorobenzidine	0.69	23	0.99	6	4,000	44,000
Dimethyl Phthalate	0.94	118	3.25	78.7	430	240,000
Fluoranthene	0.8	18	0.32	0.99	38.1	1,260
Fluorene	0.99	37.4	0.92	1.1	40	389
Indeno (1,2,3-cd) Pyrene	0.05	19.1	0.19	0.19	20.6	529
Pyrene	0.54	3.2	0.95	1.61	29	8,320
1,2,4-Trichlorobenzene	0.99	0.99	-	-	-	-
Naphthalene	4	130	0.99	0.99	50	580
Phenanthrene	0.91	2.6	0.99	0.99	29.1	1,560
Di-n-butyl Phthalate	0.11	4.68	0.99	5.17	4.42	964
Butyl-benzyl-phthalate	0.75	1	0.2	22.93	0	280
Di-n-octyl Phthalate	0.14	5.75	0.6	0.6	0.54	171
Diethyl Phthalate	0.99	0.99	-	-	-	-
Bis(2-ethylhexyl) Phthalate	0.23	0.23	0.63	80	10.7	11,700
1,2-Dichlorobenzene	1.4	31.9	0.7	6.2	101	7,560
1,4-Dichlorobenzene	1	23.2	1.05	8.7	200	4,030
1,3-Dichlorobenzene	1.8	22.9	0.6	27.6	153	4,880
2,4-Dinitrotoluene	0.63	36.9	4.1	42.6	0.43	194,000
2,6-Dinitrotoluene	0.15	109	0.27	32.8	0.22	35,600
Isophorone	1.06	30.1	-	-	251	5,100

## APPENDIX 3.5

TABLE 3.5-3, Continued

SUMMARY OF DOMESTIC/INDUSTRIAL LAGOON SAMPLING RESULTS

Pollutant Category/ Pollutant	Lagoon Min	Influent Max	Lagoon Min	Effluent <sup>a</sup> Max	Lagoon Min	Sludge <sup>b</sup> Max
<u>Base/Neutral, continued</u>						
Nitrobenzene	ug/l 5.47	ug/l 48.9	ug/l -	ug/l -	ug/kg 189	ug/kg 189
Bis (2-chloroethyl) Ether	2.1	202	1.3	3.9	90.5	4,420
Bis (2-chloroethoxy) Methane	3.6	448	4.7	15.7	115	8,560
Bis (2-chloroisopropyl) Ether	0.4	1,430	2.5	60	1.06	9,140
4-Bromophenyl Phenyl Ether	6.5	89.1	0.25	9	9.17	13,200
4-Chlorophenyl Phenyl Ether	0.99	288	1.4	32.9	73	42,500
Hexachlorobenzene	0.13	326	0.15	32	17.7	58,000
Hexachlorobutadiene	0.3	5.43	0.2	0.2	1.83	274
Hexachloroethane	0.19	11.5	0.2	235	15.8	36,100
<u>PCBs/PESTICIDES</u>	ug/l	ug/l	ug/l	ug/l	ug/kg	ug/kg
Lindane (gamma BHC)	0.1	0.1	0.1	0.1	-	-
Dieldrin	-	-	0.031	0.031	-	-
<u>OTHER</u>	ug/l	ug/l	ug/l	ug/l	ug/kg	ug/kg
Cyanide	4	23	0.1	3.5	95.1	9,000
Total Phenolics <sup>d</sup>	5.7	260	1.4	204	142	20,700
<u>METALS</u>	ug/l	ug/l	ug/l	ug/l	ug/g	ug/g
Antimony	5.3	7	2.3	105	0.09	2.2
Arsenic	2.4	77.7	0.5	88.4	0.55	24
Barium <sup>d</sup>	22.8	58.2	12.55	47.1	0.66	240
Beryllium	1.4	15.2	0.7	7.4	0.17	20
Cadmium	1	2.7	0.3	7.4	0.009	37
Chromium	4.6	78	2.2	35.2	4.79	208
Copper	28.8	330	5.6	55	4.87	1,034
Lead	1.7	200	1	16.7	7.6	999
Mercury	0.3	0.7	0.4	0.4	0.01	11.4
Nickel	6.9	45	3.8	5,103.6	3.5	221
Selenium	27.7	118	27.7	208	0.36	9.6
Silver	1.1	10.9	1	4	0.04	81
Thallium	14	17.7	17.7	17.7	0.04	0.18
Zinc	155	4,670	22	535.5	0.36	1,176

## APPENDIX 3.5

TABLE 3.5-3, Continued

## SUMMARY OF DOMESTIC/INDUSTRIAL LAGOON SAMPLING RESULTS

Pollutant Category/ Pollutant	Lagoon Min	Influent Max	Lagoon Effluent <sup>a</sup> Min	Lagoon Effluent <sup>a</sup> Max	Lagoon Sludge <sup>b</sup> Min	Lagoon Sludge <sup>b</sup> Max
<b>NON-CONVENTIONAL</b>						
<b>POLLUTANTS</b>		mg/l	mg/l	mg/l	ug/g	ug/g
Total Organic Carbon <sup>d</sup>	66.1	248	16.4	144	34,000	90,000
Chloride <sup>d</sup>	21.1	1,200	17.6	630	1.53	720
NH <sub>3</sub> - N (ammonia) <sup>d</sup>	6.7	28.05	0.44	73.2	110	3,480
NO <sub>2</sub> /NO <sub>3</sub> - N <sup>d</sup>	0.105	11.5	0.1	7.32	-	-
Total Solids, percent <sup>d</sup>	-	-	-	-	4.8	37

<sup>a</sup> Includes lagoon wastewater samples.<sup>b</sup> Dry weight basis.<sup>c</sup>"-" indicates all values below detection limits.<sup>d</sup> Not a priority pollutant.

APPENDIX 3.5

TABLE 3.5-4  
POLLUTANT FREQUENCY OF OCCURRENCE: DOMESTIC/INDUSTRIAL LAGOONS

Pollutant Category/ Pollutant	Lagoon Influent		Lagoon Effluent <sup>a</sup>		Lagoon Sludge		Total Samples	Source <sup>b</sup> Percent Detected
	No. of Samples	No. of Times Detected	No. of Samples Detected	No. of Times Detected	No. of Samples Detected	No. of Times Detected		
<b>VOLATILES</b>								
Acetone	15	4	17	2	16	1	48	7 15
Acrylonitrile		4		2		2		8 17
Benzene	6	6	6	1	5	1	13	13 27
Ethybenzene	6	2	2	5	5	13	13	27
Carbon Tetrachloride	1	0	0	0	0	1	1	2
Chloroform	9	6	1	1	1	16	16	33
Chlorobenzene	8	1	1	3	3	12	12	25
Chloroethane	5	1	1	2	2	8	8	17
Bromochloromethane	2	0	0	0	0	2	2	4
Tetrachloroethylene	9	3	3	0	0	12	12	25
Toluene	5	2	8	8	8	15	15	31
Trans-1,2-dichloroethylene	1	1	1	1	1	3	3	6
1,1-Dichloroethane	2	1	1	0	0	3	3	6
1,1-Bis(chloroethyl)ene	1	0	0	0	0	1	1	2
1,2-Dichloroethane	1	0	0	1	1	5	5	10
1,2-Dichloropropane	1	3	1	1	1	3	3	6
1,1,1-Trichloroethane	2	3	2	2	2	7	7	15
1,1,2-Trichloroethane	4	1	1	1	1	6	6	13
1,1,2,2-Tetrachloroethane	2	0	0	0	0	2	2	4
Trichloroethylene	5	4	4	0	0	9	9	19
Methyl Chloride	1	1	1	0	0	2	2	4
Methylene Chloride	5	4	1	1	1	10	10	21
Vinyl Chloride	4	1	1	1	1	6	6	13
<b>EXTRACTABLE ORGANICS</b>								
Acid	15	17	16			48		
Phenol	13	10	9				32	67
2-Chlorophenol	7	4	4				15	31
2,4-Dichlorophenol	10	7	5				22	46
2,4-Dimethylphenol	11	6	4				21	44
4-Chloro-3-Methylphenol	10	4	8				22	46
2-Methyl-1,4-bis(methylphenol)	5	0	6				11	23
2-Nitrophenol	8	6	4				18	38
4-Nitrophenol	9	6	5				20	42
2,4-Dinitrophenol	4	1	3				8	17
Pentachlorophenol	10	5	7				22	46
2,4,6-Trichlorophenol	10	8	8				26	54

## APPENDIX 3.b

TABLE 3.b-4

## POLLUTANT FREQUENCY OF OCCURRENCE: DOMESTIC/INDUSTRIAL LAGOONS

Pollutant Category/ Pollutant	Lagoon Influent No. of Samples Detected	Lagoon Effluent <sup>a</sup> No. of Samples Detected		Lagoon Sludge No. of Samples Detected		Total Source <sup>b</sup> No. of Samples Detected	
		No. of Times Detected	% Detected	No. of Times Detected	% Detected	No. of Times Detected	% Detected
<b>EXTRAC TABLE ORGANICS, continued</b>							
Base Neutral	15	16	17	3	4	48	11
-Aceanaphthalene		4	23	1	4	4	8
Anthracene		2	10	1	4	10	21
Benzidine		5	15	2	7	7	15
Benzo (a) Anthracene		2	15	0	4	7	15
Benzo (a) Pyrene		3	15	1	1	4	8
Benzo (b) Fluoranthene		2	15	1	2	4	8
Benzo (g,h) Perylene		1	15	0	0	2	4
Benzo (k) Fluoranthene		2	15	0	0	2	4
Dibenz (a,h) Anthracene		2	15	1	3	6	13
2-Chloronaphthalene		6	15	2	3	7	15
Chrysene		7	15	5	7	18	38
n-Nitrosodimethylamine		3	15	1	8	18	38
n-Nitrosodiphenylamine		4	15	3	3	7	15
n-Nitrosodiphenylamine		0	0	5	6	15	31
3,3'-Bichlorobenzidine		2	15	2	3	5	10
Dimethyl Phthalate	10	8	15	9	10	27	56
Fluoranthene		4	15	3	5	12	25
Fluorene		5	15	2	4	11	23
Indeno (1,2,3-cd) Pyrene		2	15	1	2	5	10
Pyrene		7	15	3	5	15	31
1,2,4-Trichlorobenzene		1	15	0	0	1	2
Naphthalene		3	15	1	4	8	17
Phenanthrene		3	15	1	4	10	21
Di-n-butyl phthalate	10	8	15	11	12	29	60
Butyl-benzyl-phthalate		2	15	6	6	14	29
Di-n-octyl Phthalate		2	15	1	5	8	17
Diethyl Phthalate		2	15	0	0	2	4
Bis (2-ethylhexyl) Phthalate	7	8	15	10	12	52	52
1,2-Dichlorobenzene		8	15	7	7	24	50
1,4-Dichlorobenzene		7	15	4	4	20	42
1,3-Dichlorobenzene		7	15	5	5	20	42
2,4-Dinitrotoluene		4	15	7	7	15	31
2,6-Dinitrotoluene		5	15	5	5	33	33
Isophorone		5	15	0	0	7	15

## APPENDIX 3.5

TABLE 3.5-4

## POLLUTANT FREQUENCY OF OCCURRENCE: DOMESTIC/INDUSTRIAL LAGOONS

Pollutant Category/ Pollutant	Lagoon Influent		Lagoon Effluent <sup>a</sup>		Lagoon Sludge		Total Source <sup>b</sup>	
	No. of Samples	No. of Times Detected	No. of Samples Detected	No. of Times Detected	No. of Samples Detected	No. of Times Detected	No. of Samples Detected	Percent Detected
<u>Base Neutral, continued</u>								
Nitrobenzene	15	5	17	0	16	1	48	6
Bis (2-chloroethyl) Ether		9		4		5		13
Bis (2-chloroethoxy) Ether		5		3		4		18
Bis (2-chloroisopropyl) Ether		9		6		7		38
4-Bromophenyl Phenyl Ether		7		3		4		12
4-Chlorophenyl Phenyl Ether		9		5		8		25
Hexachlorobenzene		7		6		8		22
Hexachlorobutadiene		5		2		7		46
Hexachloroethane		7		4		7		21
PCBs/PESTICIDES								44
Lindane (gamma HxC) Dieldrin	15	1	16	1	12	0	43	14
OTHER	12	0	15	1	0	0	2	29
Cyanide		3		2		6		38
Total phenolics <sup>c</sup>	10		11		6		27	38
<u>METALS</u>								
Antimony			17	3	7	7		17
Arsenic		2		9		8		26
Barium		9		11		11		57
Beryllium		11		10		10		33
Cadmium		10		10		10		72
Chromium		10		9		13		30
Chromium		13		9		13		65
Copper		14		12		14		32
Lead		13		13		14		70
Mercury		13		1		11		39
Nickel		12		13		13		85
Selenium		8		6		9		41
Silver		11		9		13		89
Thallium		2		1		4		41
Zinc		15		14		14		89

## APPENDIX 3.5

TABLE 3.5-4  
POLLUTANT FREQUENCY OF OCCURRENCE: DOMESTIC/INDUSTRIAL LAGOONS

Pollutant Category/ Pollutant	Lagoon Influent		Lagoon Effluent <sup>a</sup>		Lagoon Sludge		Total Source <sup>b</sup>	
	No. of Samples Detected	No. of Times						
<u>NON-CONVENTIONAL POLLUTANTS</u>								
Total Organic Carbon <sup>c</sup>	13	10	15	11	12	9	40	30
Chloride	10	13	11	15	9	10	30	30
NH <sub>3</sub> - N (ammonia) <sup>c</sup>	13	13	9	9	11	11	33	38
NO <sub>3</sub> /NO <sub>2</sub> - N <sup>c</sup>	7	4	4	0	0	0	11	83
Total Solids, percent					14	14	14	28
								100

<sup>a</sup> Includes lagoon wastewater samples.<sup>b</sup> Lagoon influent, effluent and sludge are all considered potential sources of pollutants in lagoon seepage.<sup>c</sup> Not a priority pollutant.

TABLE A Demographic Influences on Characterization of MUNICIPAL / INDUSTRIAL LEGACIES





TABLE 6 Wastewater Effluent Characterization of MUNICIPAL/INDUSTRIAL LOADS (continued)

CONTAMINANT CATEGORY / CONTAMINANT	CURRENT FLOW AND PERCENT INDUSTRIAL	EXTRACTABLE ORGANICS, ug/l										DETECTION SUMMARY										
		M	N	O	P	LID	EFF	HEIRON	WETTER	ATKINS, ROAD 2 POND 4	DIVE	BLUFF	MINING	W	W	W	W	W	W	SC	MINIMUM/MAXIMUM	NUMBER OF SAMPLES
ACID																						
phenol	.5	.21	.99																			
2-chlorophenol	.99	.99																				
2,4-dichlorophenol																						
2,4-dimethylphenol																						
4-nitrophenol																						
2-methyl-1,5-dinitrophenol																						
4-nitrophenol																						
2,4-dinitrophenol																						
pentachlorophenol																						
2,4,6-trichlorophenoxy	1	.99																				
BASE / NEUTRAL																						
anisole																						
anisophenone																						
anisophthalic acid																						
anthracene																						
anthracene																						
benzo (a) anthracene																						
benzene																						
benzo (a) pyrene																						
benzo (b) fluoranthene																						
benzo (b) phenanthrene																						
benzo (k) fluoranthene																						
benzyl chloride																						
benzyl phenol																						
benzyl phenyl ether																						
benzyl phthalate																						
benzyl phenyl phthalate																						
bis(2-ethylhexyl) phthalate																						
1,2-dichlorobenzene																						
1,4-dichlorobenzene																						
2,3-dichlorobenzene																						
2,4-dichlorobenzene																						
2,5-dinitrofuran																						
isophorone																						
nitrobenzene																						
o-phenanthroline																						
o-phenyl phthalate																						
o-phenylphenol																						
o-phenylphenyl ether																						
2,4,4,4-tetrachlorobiphenyl																						
4-chlorophenyl phenol ether																						
4-chlorophenyl phenyl ether																						
hexachlorobutene																						
hexachlorocetane																						

\* -- non-priority pollutant  
All samples 24 hr composites except as noted below

a -- Average 1980(B) data

b -- 81 Dec. 19, 1980(B) 24 hr composite

c -- Grab sample

d -- Sample not analyzed for this contaminant category

TAG C Sludge Characterization of MUNICIPAL/INDUSTRIAL LABORATORIES

Table F-C Sludge Characterization of MUNICIPAL/INDUSTRIAL LEGODS (continued)

CONTAMINANT CATEGORY / contaminant	CURRENT FLO. (kg PERCENT INDUSTRIAL)	MUNICIPAL/INDUSTRIAL LEGODS										DETECTION SUMMARY	
		NEW YORK, NJ CELL II EAST (kg)			NEW YORK, NJ CELL II WEST (kg)			NEW YORK, NJ CELL III (kg)			NEW YORK, NJ CELL IV (kg)		
		PERCENT INDUSTRIAL	PERCENT INDUSTRIAL	PERCENT INDUSTRIAL	PERCENT INDUSTRIAL	PERCENT INDUSTRIAL	PERCENT INDUSTRIAL	PERCENT INDUSTRIAL	PERCENT INDUSTRIAL	PERCENT INDUSTRIAL	PERCENT INDUSTRIAL	PERCENT INDUSTRIAL	
<b>EXTRACTABLE ORGANICS, ug/kg</b>													
o-xylene	240												
2,4-dichlorophenol		26,500	9400										
2,4,4-trichlorobenzenol		1500	3200	56,40	26,000			26,6	34,6	191			
2,4-dimethylphenol		27,30	22,30	141,00	14,600			144	121			26,6	
4-entero-3-methyl(pienol)				34,200	2460			26,4	23,1	1390		12,5	
2-methyl-4,6-dinitrophenol						61,500		775	3000	5,60	5,60	1250	
2-nitrophenol							61,500		251	300	5,60	2,000	
4-nitrophenol								470		350	191	61500	
2,4-dinitrophenol									300	3,60		191	
2,4-dinitrophenol										300		2,000	
o,p-dichlorophenol										520	2,000	4,516	
p,p'-trichlorophenol										61	2,000	6	
o,p-dichlorophenol										10,300	3,500	111	
o,p-dichlorophenol											10,300	132,000	
benzene													
acetylphtalate													
acrylonitrile													
aromatic													
benzo (a) anthracene	60												
benzo (a) pyrene													
benzo (b) fluoranthene													
benzo (g,h,i) perylene													
benzo (k) fluoranthene													
dibenz (a,n) anthracene													
2-methoxyphthalene													
chloroform													
o-nitrosodimethylamine													
o-nitrosod-p-propylamine													
3,3'-dichlorobenzidine													
diethyl phthalate													
fluoranthene													
fluorene													
isopropo, (1,2,3-cd) pyrene													
pyrene													
1,2,3-trichlorobenzene													
naphthalene													
phthalic anhydride													
o-n-butyl phthalate													
o,p-nonyl phthalate													
o-p-nonyl phthalate													
diethyl phthalate													
o-n-butyl phthalate													
diethyl phthalate													
2-chlorophenol													
isobutylene													
nitrilene													
bis (2-chloroethyl) ether													
bis (2-chloroisopropyl) ether													
4-(2-chloroethyl) phenol ether													
4-(trifluoromethyl) phenol ether													
benzyl chloride													
hexachlorobutane													
hexaforbenane													
<b>* non-priority pollutant</b>													
<b>† sample are grab samples, values based on dry weight of sludge</b>													
<b>‡ Average 1980/81 data</b>													
<b>§ Concentration in east and west storage lagoon sludge, 1980.</b>													
<b>¶ Average of E - grab samples, metals, cyanide, PCB's.</b>													
<b>** N/A - not analyzed for this contaminant category</b>													

\* -- non-priority pollutant  
 † sample are grab samples, values based on dry weight of sludge

‡ -- Average 1980/81 data

§ Concentration in east and west storage lagoon sludge, 1980.

¶ Average of E - grab samples, metals, cyanide, PCB's.

\*\* N/A - not analyzed for this contaminant category

APPENDIX 3.6  
APPENDIX 3 REFERENCES

APPENDIX 3.6  
APPENDIX 3 REFERENCES

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APPENDIX 4.1  
ASSESSMENT METHODOLOGY

## APPENDIX 4.1

### ASSESSMENT METHODOLOGY

#### 4.1.1 SELECTION OF POLLUTANTS OF CONCERN AND EXPOSURE POINT THRESHOLD CONCENTRATIONS

The first step in the assessment process was the selection of pollutants of concern and determination of their human health-based thresholds (MCLs and RSD/RfD-based concentrations, as described in Chapter 2 of the text). To this end, sampling data from the domestic and domestic/industrial lagoons were examined separately to identify any significant differences in the types and concentrations of pollutants detected. Lagoon wastewater and effluent data were expected to most closely approximate concentrations found in the lagoon (see Chapter 3 in the text), and therefore were used in this analysis.

Those pollutants most likely to be of concern in ground water were identified by comparing maximum lagoon effluent concentrations to human health-based threshold concentrations based on RSD and RfD values. (Because MCLs reflect economic and technological feasibility, they were not used for this initial screening process.) Although use of median effluent concentrations would have been more realistic than maximums, that approach was not possible because few pollutants had median concentrations above their health threshold concentrations, (in some cases, median concentrations did not even exceed analytical detection limits). Additionally, as data are available for only 23 of 5,476 lagoons, a median value would not be statistically significant.

The actual selection process was based primarily on the magnitude of the ratio of effluent concentration to the human health-based threshold for a given pollutant. Whenever this ratio was less than one (i.e., when the maximum effluent concentration was less than the corresponding threshold concentration), that pollutant was considered unlikely to cause a risk to human health via drinking water and was eliminated from further consideration.

##### 4.1.1.1 Domestic Lagoons

Only three of the pollutants found in the effluent of domestic lagoons exceeded their respective health thresholds (see Table 4.1-1). Therefore, all three were identified as pollutants of concern for this study. It should be noted that, although the maximum effluent concentration for arsenic is only 11 ug/l, the health threshold is so low that it is exceeded by a factor of 4,721.

##### 4.1.1.2 Domestic/Industrial Lagoons

In contrast to domestic lagoons, 21 compounds found in the effluent of domestic/industrial lagoons exceeded their respective health thresholds (see Table 4.1-2). Because the number of computer runs conducted had to be kept to a manageable number, this list of 21 chemicals was condensed. The criteria used in this selection process were:

TABLE 4.1-1  
POLLUTANTS OF CONCERN (DOMESTIC LAGOONS)

Pollutant	Maximum Effluent Concentration (ug/l) <sup>a</sup>	Health Threshold <sup>b</sup> (ug/l)	Ratio <sup>c</sup>	Mobility <sup>d</sup>	Frequency of Detection <sup>e</sup>
Arsenic	11	0.00233 <sup>e</sup>	4,721	High	2/15
Chloroform	2.3	0.430 <sup>e</sup>	5.35	High	4/15
Tetrachloroethylene	1.4	0.676 <sup>e</sup>	2.07	High	2/15

<sup>a</sup>From Appendix 3.5 (Table 3.5-1).

<sup>b</sup>Based on RSD/RfD Values.

<sup>c</sup>Maximum Effluent Concentration: Health Threshold.

<sup>d</sup>Organic carbon partition coefficient ( $K_{OC}$ ) less than 2,000 l/kg (Source: Reference 1).

<sup>e</sup>From Appendix 3.5 (Table 3.5-2). Includes lagoon wastewater and effluent

<sup>f</sup>Risk specific dose (carcinogen).

TABLE 4.1-2  
POLLUTANTS OF CONCERN (DOMESTIC/INDUSTRIAL LAGOONS)

Pollutant	Maximum Effluent Concentration <sup>a</sup> (ug/l)	Health Threshold <sup>b</sup> (ug/l)	Ratio <sup>c</sup>	Mobility <sup>d</sup>	Frequency of Detection <sup>e</sup>
Arsenic	88.4	0.00233 <sup>e</sup>	37.939	High	9/17
Benzidine	0.84	0.00015 <sup>e</sup>	5,600	Low	3/17
n-Nitrosodimethylamine	2.66	0.00135 <sup>e</sup>	1,970	Low	9/17
Hexachlorobenzene	32	0.021 <sup>e</sup>	1,524	Low	6/17
2,4-Dinitrotoluene	42.6	0.113 <sup>e</sup>	377	High	4/17
3,3'-Dichlorobenzidine	6	0.021 <sup>e</sup>	286	Low	2/17
Chloroform	86	0.430 <sup>e</sup>	200	High	6/17
Vinyl chloride	1.9	0.015 <sup>e</sup>	127	High	1/17
Bis(2-chloroethyl)ether	3.9	0.031 <sup>e</sup>	126	Low	4/17
Methylene chloride	280	2.50 <sup>e</sup>	112	High	4/17
Acrylonitrile	4.4	0.067 <sup>e</sup>	65.7	High	2/17
Tetrachloroethylene	31	0.676 <sup>e</sup>	45.9	High	3/17
Benzo(a)pyrene	0.09	0.003 <sup>e</sup>	30.0	Low	1/17
2,4,6-Trichlorophenol	47.8	1.75 <sup>e</sup>	27.3	Low	8/17
Bis(2-ethylhexyl)phthalate	80	3.85 <sup>e</sup>	20.8	Low	8/17
Benzene	11	0.663 <sup>e</sup>	16.6	High	6/17
1,1,2-Trichloroethane	4.15	0.614 <sup>e</sup>	6.76	High	1/17
2,4-Dinitrophenol	320	70 <sup>f</sup>	4.57	Low	1/17
Nitrate	7,320	3450 <sup>f</sup>	2.12	High	4/17
Selenium	208	195.4 <sup>f</sup>	1.97	NA <sup>g</sup>	6/17
Thallium	17.7	14.0 <sup>f</sup>	1.26	High	1/17

<sup>a</sup>Based on RSD/RfD Values.

<sup>b</sup>From Appendix 3.b (Table 3.5-3).

<sup>c</sup>Maximum Effluent Concentration: Health Threshold.

<sup>d</sup>K<sub>D</sub> less than 2000 l/kg (Source: Reference 1).

<sup>e</sup>RfDm Appendix 3.5 (Table 3.5-4). Includes lagoon wastewater and effluent risk specific dose (carcinogen).

<sup>f</sup>Reference dose (non-carcinogen).

<sup>g</sup>Not available.

- o Degree of threshold exceedence (high ratio);
- o Frequency of detection;
- o Degree of mobility (not significant for steady-state models, but useful if transient analyses are conducted); and
- o Persistence in the environment.

The four pollutants selected on the basis of these criteria are shown in Table 4.1-3, along with the three domestic lagoon pollutants (Table 4.1-1) and nitrates (included to illustrate the effects of anaerobic biodegradation).

#### 4.1.2 EPACMS COMPUTER MODEL

The procedure used in this study for assessing the extent of potential ground-water contamination necessarily involves definition of a human health-based risk threshold concentration for each pollutant at the exposure point, back-calculation along the migration pathway to determine the corresponding source concentration which yields the threshold concentration at the exposure point, and comparison of the calculated source concentration with the known or likely source concentration. EPACMS is a two-dimensional composite numerical/analytical solution model designed to evaluate the migration of dissolved pollutants from a surface impoundment to points of interest in an underlying water-table aquifer (Figure 4.1-1). The cross-sectional model considers spatial variability of the flow field induced by mounding beneath the surface impoundment and important attenuation mechanisms such as dispersion, adsorption, first-order decay (including anaerobic, but not aerobic, biodegradation) and dilution due to recharge in the fully saturated zone. The model can also assess adsorption and first-order decay in the unsaturated zone, if desired. This option was not selected for the national assessment, as the major decay process in the unsaturated zone would be that of biodegradation, for which rate constants were not generally available (see Section 4.1.3.4).

##### 4.1.2.1 Code Features and Applicability

EPACMS, a composite model, comprises four major components including:

- o A one-dimensional finite-element code designed to simulate steady-state moisture movement through the unsaturated zone;
- o A one-dimensional analytical solution for advective transport of dissolved contaminants through the unsaturated zone;
- o A one-dimensional cross-sectional analytical solution for steady-state saturated ground-water flow in an anisotropic homogeneous aquifer subject to leakage from above; and
- o A one-dimensional cross-sectional analytical solution for advective-dispersive transport in an aquifer subject to a variable flow field.

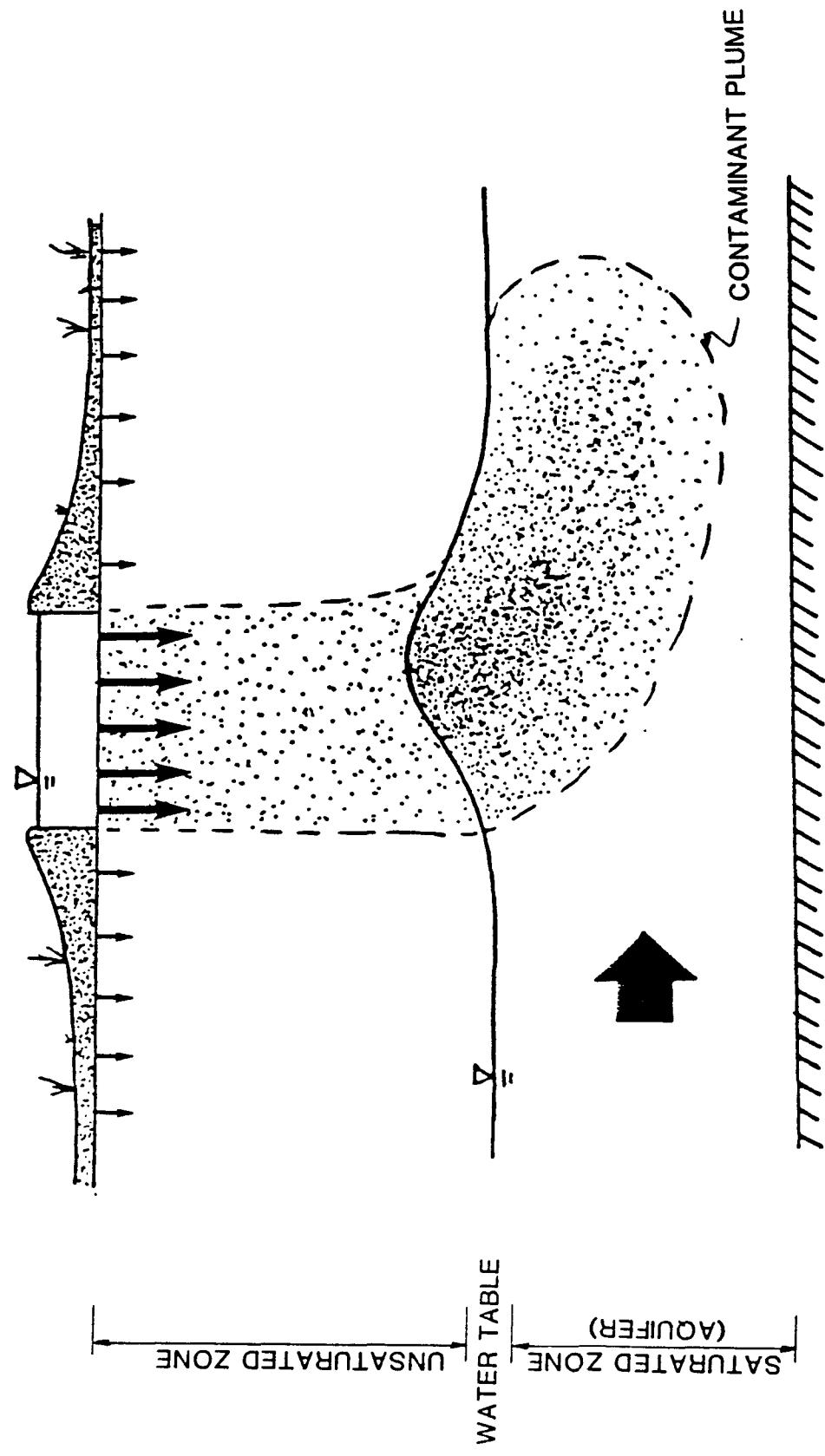
The four modules are designed to be utilized together to simulate the movement of pollutants from a surface impoundment (i.e., lagoon) through the unsaturated zone to the water table and finally through the saturated zone. The modules can also be used in pairs to evaluate either vertical ground-water

TABLE 4.1-3  
POLLUTANTS SELECTED FOR COMPUTER MODELLING

Pollutant	Rationale
Arsenic	<ul style="list-style-type: none"> <li>o Highest ratio of lagoon effluent concentration to human health-based threshold concentration for both domestic and domestic/industrial lagoons</li> <li>o Found in domestic lagoon monitoring wells with maximum ratio of 12,017 (ground-water concentration: threshold)</li> <li>o Detected in 64% of domestic/industrial lagoons sampled</li> <li>o Persistent</li> <li>o Highly mobile</li> </ul>
Benzene	<ul style="list-style-type: none"> <li>o Retained for possible comparison with earlier, site-specific modelling (SWIFT Model)</li> </ul>
Chloroform	<ul style="list-style-type: none"> <li>o Organic with highest ratio for domestic lagoons (seventh for domestic/industrial lagoons)</li> <li>o Detected in almost one-third of domestic lagoons sampled</li> <li>o Relatively persistent</li> <li>o Highly mobile</li> </ul>
2,4-Dinitrotoluene	<ul style="list-style-type: none"> <li>o High ratio for domestic/industrial lagoons</li> <li>o Persistent</li> <li>o Highly mobile</li> </ul>
Hexachlorobenzene	<ul style="list-style-type: none"> <li>o High ratio for domestic/industrial lagoons</li> <li>o Detected in over one-third of domestic/ industrial lagoons sampled</li> <li>o Persistent</li> <li>o Highly immobile</li> </ul>
Nitrate	<ul style="list-style-type: none"> <li>o Anaerobic biodegradation coefficients are available for use in computer model</li> </ul>
Tetrachloroethylene	<ul style="list-style-type: none"> <li>o Ratio exceeds 1.0 for domestic lagoons</li> <li>o Moderately mobile</li> </ul>

FIGURE 4.1-1

SCHEMATIC DESCRIPTION OF LAGOON  
AND HYDROGEOLOGIC REGIME



flow and contaminant transport in the unsaturated zone or cross-sectional ground-water flow and contaminant transport in the saturated zone, or they can be used as individual components.

#### 4.1.2.2 Model Description

The surface impoundment model is comprised of four modules including:

- o A one-dimensional unsaturated flow finite-element module;
- o An analytical model for advective transport of dissolved contaminants migrating from the surface impoundment to the saturated zone;
- o An analytical solution for ground-water flow in the saturated zone; and
- o A semi-analytical model for transport of dissolved contaminants in the saturated zone.

Each module can be used as a stand-alone code or the four modules can be run sequentially to evaluate the migration of contaminants from the surface impoundment and through the saturated zone. In addition, full analysis can be performed for the unsaturated zone or the saturated zone.

When EPACMS is used in the composite mode, the evaluation is initiated by the simulation of moisture movement through the unsaturated zone. The simulation results in a moisture profile which is used to derive the seepage velocity field in the unsaturated zone. The seepage velocity field is then utilized as input for an analytical solution describing steady-state advective transport through a multilayered system (Figure 4.1-2). For the unsaturated zone transport simulation, the variable seepage velocity field derived from the unsaturated zone flow simulation is approximated by taking the average saturation in a series of zones. Vertical transport through the unsaturated zone is then simulated with results determined at the water table. The generated value of concentration at the water table is then used as a boundary condition for the saturated-zone advective-dispersive transport solution. The derived concentration is applied as a patch source of constant concentration boundary of the top of the saturated zone (Figure 4.1-3). After flow and transport are evaluated in the unsaturated zone, a similar analysis is performed for the saturated zone. First, the ground-water velocity field in the saturated zone, which is a product of the regional gradient fluid flux from the impoundment, and any infiltration from precipitation, is generated using an analytical solution. These velocities are then used as input to the saturated zone transport module. The transport module is then used to evaluate advective-dispersive transport of dissolved contaminants in the saturated zone. The final result is a dimensionless concentration,  $C_D$ , defined as:

$$C_D = \frac{C_{\text{well}}}{C_{\text{source}}}$$

FIGURE 4.1-2  
SCHEMATIC OF LAYERED ANALYTICAL SOLUTION  
FOR TRANSPORT IN THE UNSATURATED ZONE

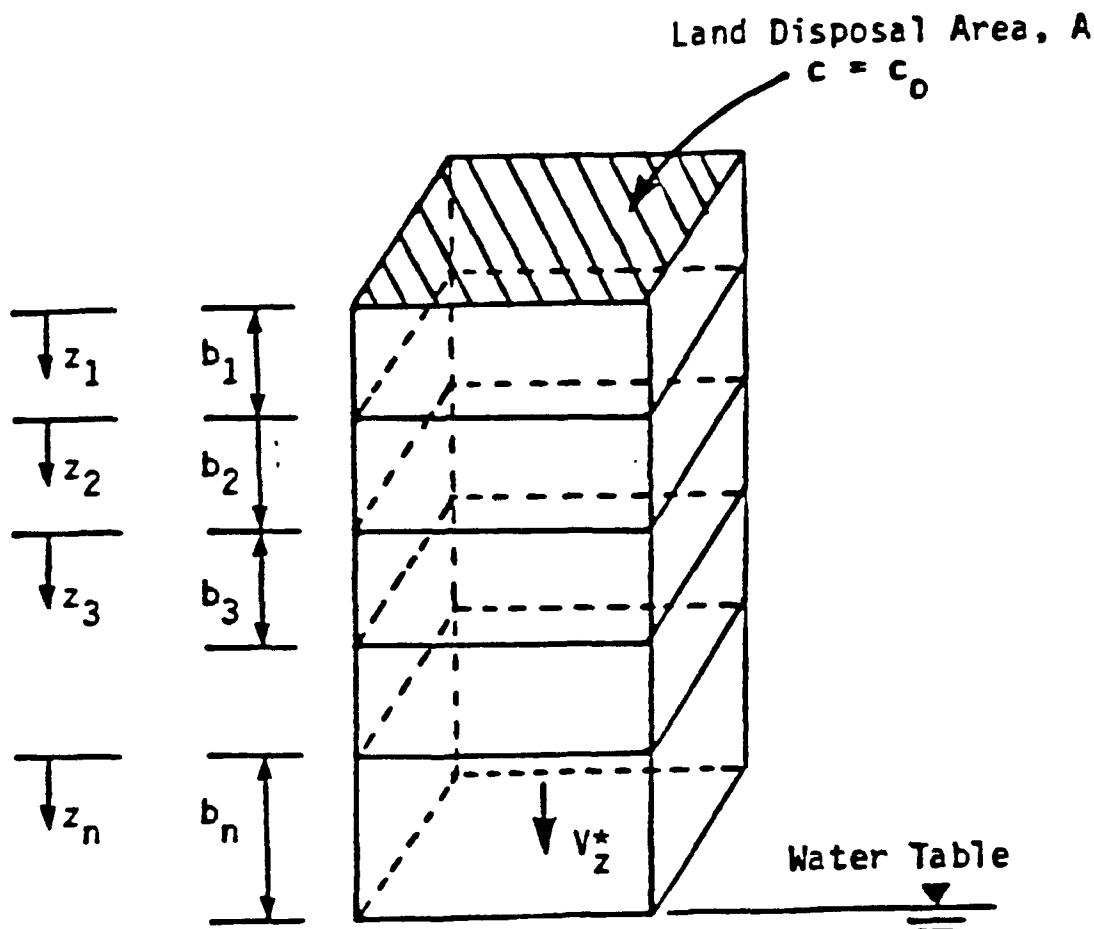
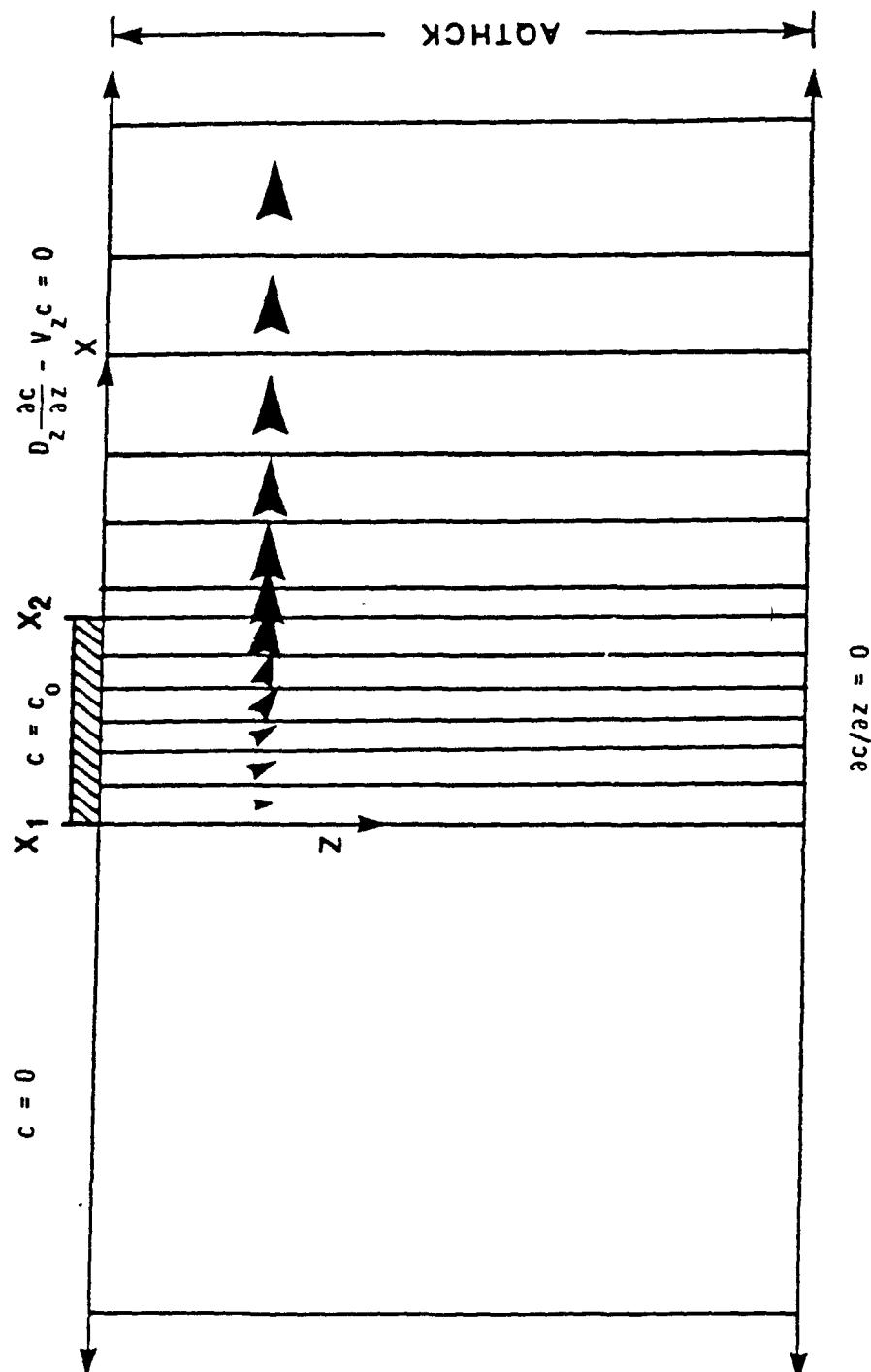


FIGURE 4.1-3  
SCHEMATIC DESCRIPTION OF  
SATURATED ZONE TRANSPORT MODEL



where:

$C_D$  = dimensionless concentration  
 $C_{well}$  = concentration at the exposure point (e.g., water supply well)  
 $C_{source}$  = concentration at the source.

Therefore, for a given maximum permissible concentration at the exposure point or well, the corresponding maximum allowable lagoon seepage concentration is:

$$C_{source} = \frac{C_{well}}{C_D}$$

For purposes of the national assessment, a Monte Carlo driver was added to the process, enabling a wide variety of input parameters to be taken into consideration for a given hydrogeologic region. The resulting output,  $C_D$ , is in probabilistic form. By assuming a maximum acceptable well concentration, this output was transformed (using the above equation) to reflect maximum permissible source (i.e., lagoon seepage) concentrations.

#### 4.1.2.3 Model Assumptions

The major assumptions upon which the flow module is based include:

- o Flow of the fluid phase is considered isothermal and governed by Darcy's Law;
- o The fluid considered is slightly compressible and homogeneous;
- o Hysteresis effects in the constitutive relationships of relative permeability versus water saturation, and water saturation versus capillary pressure head, are assumed to be negligible; and
- o The simultaneous flow of a second phase (i.e., air) can be disregarded.

The simplifying assumptions upon which the solutions for advective solute transport in a multilayered porous medium are based are as follows:

- o The flow field is at steady state;
- o The seepage velocity is uniform in each layer;
- o The rate of adsorption by the solid matrix is related to concentration levels in the ground water and matrix by a linear isotherm;
- o The influence of longitudinal and transverse dispersion is negligible; and
- o The source is constant.

The saturated zone analytical solution for ground-water flow is based on a number of simplifying assumptions pertaining to the geometry and material properties of the saturated zone. The key assumptions are as follows:

- o The saturated thickness of the aquifer remains constant despite the fact that mounding occurs;
- o The aquifer is homogeneous;
- o Ground-water flow is steady;
- o Flow is isothermal and governed by Darcy's Law; and
- o The fluid is slightly compressible and homogeneous.

The major simplifying assumptions upon which the solutions for advective-dispersive solute transport used in the saturated zone analysis are based include:

- o The flow field is at steady state;
- o The seepage velocity is uniform in each set-up;
- o The rate of adsorption by the solid matrix is related to concentration levels in the ground-water matrix by a linear isotherm;
- o The source is constant;
- o Each strip is homogeneous and isotropic;
- o Each strip is approximated as infinite in horizontal length and therefore the ratio of horizontal dispersivity to strip width for cases where horizontal flow is dominant should be  $\gg 1$ ; and
- o For the constant concentration boundary condition, the amount of mass entering the system via vertical dispersion is much smaller than by advection. (This assumption may be invalid for cases where the ratio of horizontal to vertical velocity is large).

#### 4.1.3 DETERMINATION OF MODEL INPUT DATA

As shown in Figure 2-1 of the text, the first step in the Monte Carlo method is generation of a problem set, or assembly of a complete set of input parameter values. Individual values are selected at random based on their frequency distributions and interrelationships. Table 4.1-4 lists the required input parameters and their distribution type, as selected for this study. In applying the EPACMS model to the municipal lagoon study, certain modifications to the general input structure were needed to represent the nature of the data available and the problems and issues specific to lagoon systems. The approaches used to identify and define these values are discussed below.

TABLE 4.1-4  
SUMMARY OF EPACMS INPUT DATA  
(Saturated Zone)

Parameter (units)	Symbol	Distribution Type
Mean particle diameter of the aquifer medium (cm)	d	$\log_{10}$ uniform
Hydraulic gradient (%)	s	Exponential
Thickness of the saturated zone (m)	B	Exponential
Ground-water pH (standard units)	pH	Normal
Ground-water temperature ( $^{\circ}\text{C}$ )	T	Normal
Net infiltration (m/yr)	FLUXI	Uniform
Lagoon seepage rate (m/yr)	q	Uniform
Fractional organic carbon content of subsurface environment	$f_{\text{OC}}$	"Johnson SB Distribution"
Hydrolysis constants Acid-catalyzed ( $\text{mole}^{-1}\text{hr}^{-1}$ )	$K_a$	Single value, chemical-specific
Neutral ( $\text{hr}^{-1}$ )	$K_n$	Single value, chemical-specific
Base-catalyzed ( $\text{mole}^{-1}\text{hr}^{-1}$ )	$K_b$	Single value, chemical-specific
Anaerobic biodegradation constant (second $^{-1}$ )	-	Single value, chemical-specific
Normalized distribution coefficient for organic carbon (mg/l)	K	Single value, chemical-specific
Lagoon area ( $\text{m}^2$ )	A	Non-standard distribution (see Section 6.4.3)
Distance to exposure point, measured from downgradient edge of lagoon (m)	X	Non-standard distribution (see Section 6.4.3)
Longitudinal dispersivity (m)	$\alpha_L$	Defined as a function of distance to the exposure point: $\alpha_L = 0.1(X)$
Vertical dispersivity (m)	$\alpha_Z$	Defined as a function of $\alpha_L$ : $\alpha_Z = c \alpha_L$ where $0.025 \leq c \leq 0.10$

#### 4.1.3.1 Hydrogeologic Parameters

The vulnerability of each hydrogeologic setting region and subregion of the DRASTIC System (Chapter 2 of the text) to ground-water pollution is indexed by key factors controlling the migration of pollutants from the land surface to the ground-water table. The acronym DRASTIC was formed from the following key factors:

D = Depth to water  
R = Recharge (net)  
A = Aquifer media  
S = Soil media  
T = Topography (slope)  
I = Impact of vadose zone  
C = Conductivity (hydraulic) to the aquifer

Each factor is weighted for its relative importance with respect to other factors and rated by its likely effect on ground-water pollution potential. The product of the weight and rating for each factor is then added to generate the DRASTIC index for a specific setting. Thus, the higher the DRASTIC index, the higher the ground-water pollution potential (or the increase in ease with which the pollutant on the land surface reaches the ground-water table). The DRASTIC index does not provide the impact of ground-water pollution directly. The impact of ground-water pollution could be indexed to key risk factors as given by the acronym IMPACT.

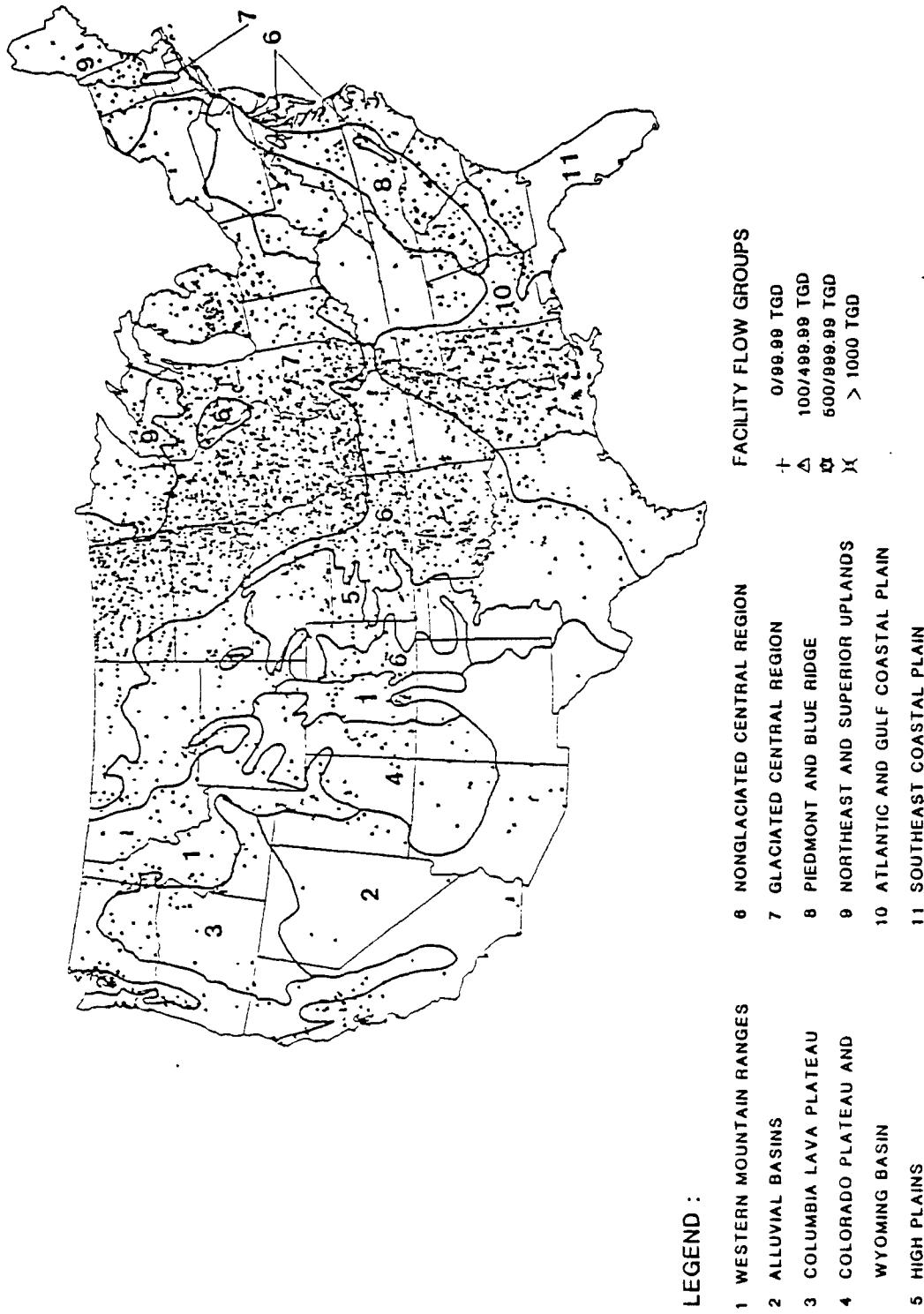
I = Inclination of the water table (gradient)  
M = Measured horizontal distance to the exposure point  
P = Population exposed  
A = Application rate of pollutants  
C = Concentration of pollutants  
T = Toxicity of pollutants

The IMPACT factors are site and facility-specific and therefore are not provided in the DRASTIC system. (See Reference 2 for a further description of the DRASTIC system.)

Although the DRASTIC system does not provide sufficient information for the evaluation of the potential impact of ground-water contamination in terms of human health risk, selected parameters from DRASTIC (notably aquifer and hydraulic conductivity), combined with general knowledge of topography and assumptions regarding regional hydraulic gradients (which control the velocity of ground-water flow), can be used as key inputs for the lagoon study. In addition, the DRASTIC classification of the entire nation into unique hydrogeologic settings can be compared with the actual lagoon population within each setting, leading to a systematic national assessment as well as to the identification of potential problematic situations.

In an effort to concentrate the hydrogeologic scope of this project on those areas with significant lagoon populations, the DRASTIC map was superimposed on a lagoon distribution map, thus identifying the DRASTIC regions with high lagoon populations (see Figure 4.1-4). As a result, seven major

**FIGURE 4.1-4**  
**LAGOON POPULATION WITH DRASIC GROUNDWATER REGIONS**



DRASTIC regions with high lagoon concentrations were selected for evaluation. These major DRASTIC regions are mainly in the central United States, but several regions extend to encompass areas of lower lagoon density. The 15 DRASTIC regions, including the seven selected regions, are listed in Table 4.1-5.

Each DRASTIC region is divided into subregions which represent the various hydrogeologic settings typically found in the region. For example, DRASTIC Region 5 consists of hydrogeologic settings 5A (Ogallala), 5B (Alluvium), 5C (Sand Dunes), 5D (Playa Lakes), and 5E (Braided River Deposits). These hydrogeologic settings were individually analyzed to characterize them by their hydraulic conductivity range, aquifer media, and geomorphological features. Once this analysis was accomplished, those settings with similar characteristics were regrouped into nine larger categories containing comparable ranges of hydrogeologic parameters. Table 4.1-6 lists the new categories and their associated settings.

Next, the hydrogeologic data for each category were compiled for input to EPACMS. These parameters include (see Table 4.1-4).

- o mean particle diameter of the aquifer medium
- o hydraulic gradient (slope of the water table)
- o thickness of the saturated zone
- o net infiltration (net precipitation recharge)

Estimated ground-water velocities for the nine categories are presented in Table 4.1-7.

Other subsurface parameters listed in Table 4.1-4 (e.g., ground-water pH and temperature, subsurface fractional organic carbon content, etc.) were the same for all hydrogeologic categories.

A third class of parameters, longitudinal and vertical dispersivities, was originally defined as functions of distance to the exposure point (see Table 4.1-4). For this study, the definition of the two parameters was modified to reflect more accurately realistic situations.

This modification involved the division of dispersivity into two categories: under the source (i.e., lagoon) and outside the source (i.e., downgradient from the lagoon). To ensure a constant rate of mass (i.e., pollutant) entering the aquifer from the source with each Monte Carlo iteration, dispersivity was held constant underneath the source. This was accomplished by defining longitudinal dispersivity under the source as a function of lagoon area:

$$\alpha_L = 0.5 (\bar{A})$$

The definition of longitudinal dispersivity downgradient from the source was left unchanged, except for the specification of a maximum value of 60 meters, corresponding to commonly encountered regional values (3). As a result of these modifications, the corresponding values of vertical dispersivities ( $\alpha_z$ ) changed, although the definition of  $\alpha_z$  remained the same.

TABLE 4.1-5  
DRASTIC REGIONS

Region Number	Region Name
1	Western Mountain Ranges
2*	Alluvial Basins
3	Columbia Lava Plateau
4	Colorado Plateau and Wyoming Basin
5*	High Plains
6*	Nonglaciated Central Region
7*	Glaciated Central Region
8*	Piedmont and Blue Ridge
9*	Northeast and Superior Uplands
10*	Atlantic and Gulf-Coastal Plain
11	Southeast Coastal Plain
12	Alluvial Valleys
13	Hawaiian Islands
14	Alaska
15	Puerto Rico and Virgin Islands

Source: Reference 2

\* Regions selected for the municipal lagoon study based on lagoon population.

TABLE 4.1-6  
HYDROGEOLOGIC CATEGORIES AND SETTINGS

Category	Setting Number	Setting Name
1	2E	Playa Lakes
	5A	Ogallala
	5D	Playa Lakes
	6B	Alluvial Mountain Valleys
	7Ea	River Alluvium with Overbank Deposit
	7Eb	River Alluvium without Overbank Deposit
	9B	Alluvial Mountain Valleys
	9F	Moraine
	10Ab	Shallow Surficial Aquifers
	10Ba	River Alluvium with Overbank Deposit
2	2B	Alluvial Mountain Valleys
	2C	Alluvial Fans
	2D	Alluvial Basins (Internal Drainage)
	5B	Alluvium
	7C	Moraine
	8B	Alluvial Mountain Valleys
	10Aa	Confined Regional Aquifers
3	5C	Sand Dunes
4	5E	Braided River Deposits
	6Fa	River Alluvium with Overbank
	6Fb	River Alluvium without Overbank
	6G	Braided River Deposits
	7Ab	Glacial Till over Outwash
	7Ba	Outwash
	7D	Buried Valley
	7H	Beaches, Beach Ridges, and Sand Dunes
	8E	River Alluvium
	9Db	Glacial Till over Outwash
	9E	Outwash
	9Ga	River Alluvium with Overbank
	9Gb	River Alluvium without Overbank
	10Bb	River Alluvium without Overbank Deposit
	10C	Swamp
5	7Aa	Glacial Till over Bedded Sedimentary Rocks
	7Bb	Outwash over Bedded Sedimentary Rocks
	7F	Glacial Lake Deposits
	7G	Thin Till over Bedded Sedimentary Rocks
	8C	Mountain Flanks
	9C	Mountain Flanks
6	6A	Mountain Slopes
	6C	Mountain Flanks
	6Da	Alternating Sandstone, Limestone, and Shale-thin Soil
	6Db	Alternating Sandstone, Limestone, and Shale-deep Regolith
7	6H	Triassic Basins
8	7Ad	Glacial Till over Sandstone
9	7Ae	Glacial Till over Shale

TABLE 4.1-7  
ESTIMATED GROUND-WATER VELOCITY FOR  
THE NINE HYDROGEOLOGIC CATEGORIES

Category	Estimated Ground-Water Velocity (m/yr) <sup>a</sup>	
1	25	- 364
2	10	- 251
3	76	- 760
4	36	- 760
5	32	- 203
6	0.3	- 64
7	0.1	- 48
8	51	- 376
9	0.1	- 48

<sup>a</sup>Estimated on the basis of hydraulic conductivity and hydraulic gradient.

#### 4.1.3.2 Lagoon Seepage Rates

An assessment of potential seepage rates from lagoon systems was made to establish a range of hydraulic loadings for input into the EPACMS model. This assessment focuses on seepage from lagoons through permeable liners and unlined lagoons. The effects of accumulated sludge and self-sealing are also addressed. (Synthetic liners are considered to be essentially impermeable and are therefore not included in this analysis).

4.1.3.2.1 Theoretical Calculation of Seepage Rates. The rate of seepage from lagoons is dependent on the water depth, liner hydraulic conductivity and liner thickness and can be calculated from the rate of flow in saturated media using Darcy's Law (4):

$$v = K (dh/dl)$$

where

$$\begin{aligned} v &= \text{Darcy's velocity (length/time)} \\ K &= \text{hydraulic conductivity coefficient (length/time)} \\ dh/dl &= \text{hydraulic gradient} \end{aligned}$$

Figure 4.1-5 presents a schematic of a lagoon system with water depth ( $D$ ) and a liner of known hydraulic conductivity ( $K$ ) and thickness ( $t$ ). Assuming: (1) the liner is completely saturated; (2) the underlying aquifer has an hydraulic conductivity greater than that of the liner; (3) the ground-water table is below the liner; and (4) accumulated sludge does not affect seepage, then the seepage equation developed from Darcy's law is:

$$S = \frac{K(D+t)}{t}$$

For seepage,  $S$ , in inches per day (in/day),  $K$  in centimeters per second (cm/sec), and  $D$ ,  $t$  in feet (ft), the seepage equation becomes:

$$S = 3.4 \times 10^4 K \frac{(D+t)}{t}$$

Figure 4.1-6 presents a summary of seepage rates for various water depths and liner characteristics based on this seepage equation. To illustrate, a lagoon having a 10-foot water depth would seep at 0.04 in/day through a 1-foot thick clay liner having  $K = 10^{-7}$  cm/sec. However, for a 3-foot compacted earth liner with  $K = 10^{-5}$  cm/sec, the seepage rate would be 1.47 inches per day at a 10-foot water depth. If the water table is above the bottom of the liner, seepage would be reduced proportionally to the change in head between the water table and water surface elevation in the lagoon. Therefore, for the identified liner characteristics, Figure 4.1-6 represents maximum expected seepage rates from a lagoon system. Typical permeabilities for various liners are presented in Table 4.1-8 (5).

FIGURE 4.1-5  
SCHEMATIC OF SEEPAGE THROUGH  
A LAGOON LINER

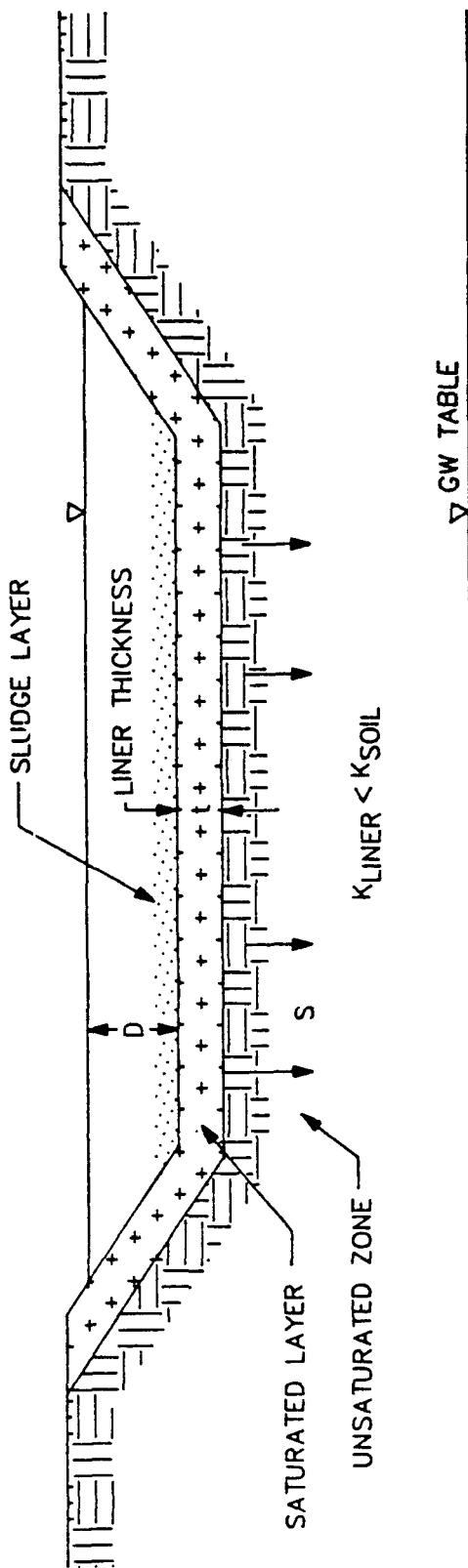


FIGURE 4.1-6  
SEEPAGE AS FUNCTION OF WATER DEPTH  
AND LINER CHARACTERISTICS

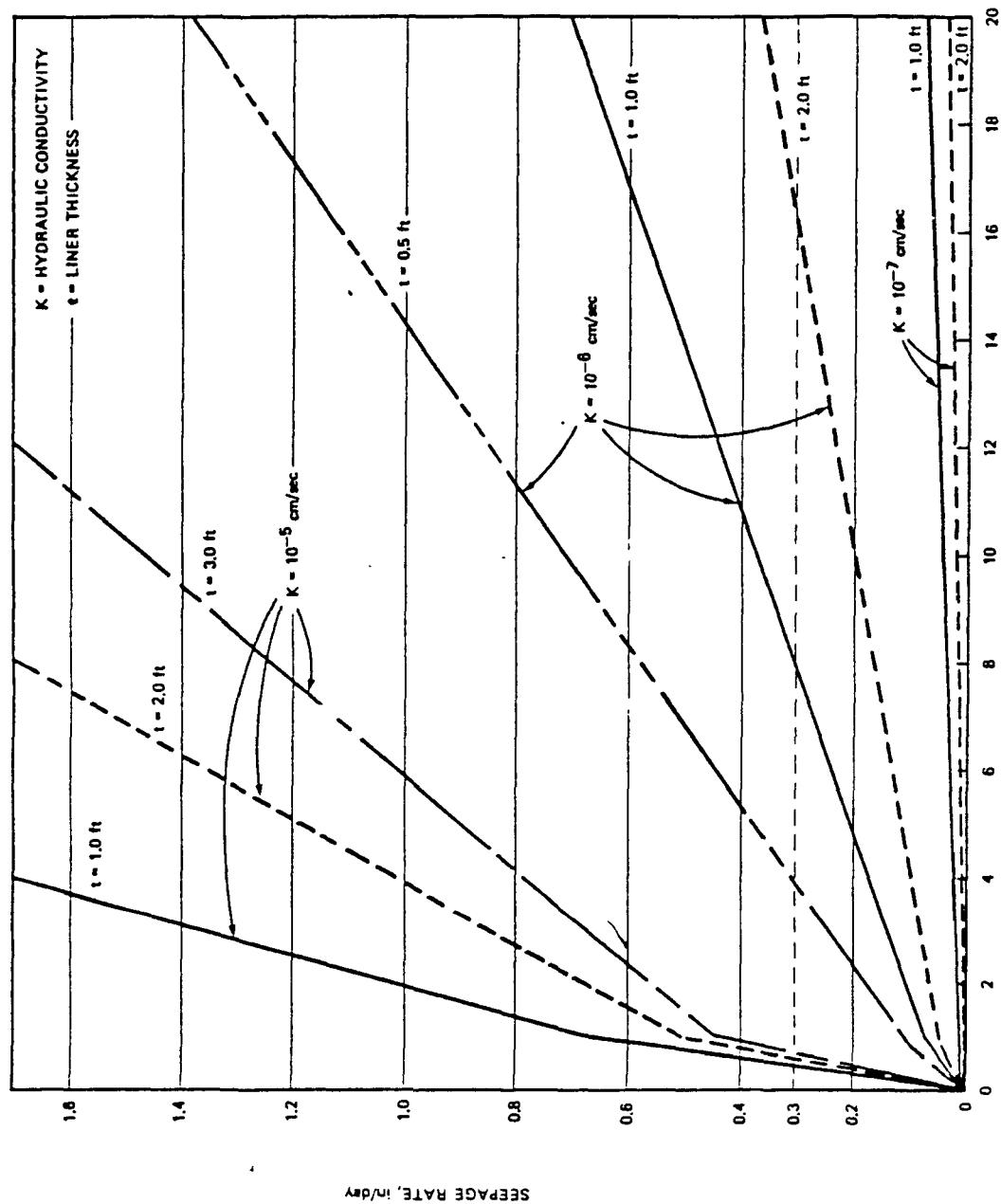


TABLE 4.1-8  
PERMEABILITY OF VARIOUS LINERS AND GEOLOGIC MATERIALS

Material	Permeability (cm/s)
<u>Liner</u>	
Soil cement	$10^{-6}$
Gunite	$10^{-7}$
Compacted clay	$10^{-6}$ to $10^{-10}$
Compacted bentonite plus earth	$10^{-6}$ to $10^{-8}$
Asphalt concrete	$10^{-7}$
Unreinforced concrete	$10^{-6}$
<u>Geologic Material</u>	
Glacial till	$10^{-4}$ to $10^{-10}$
Clay	$10^{-6}$ to $10^{-10}$
Silt, loose	$10^{-3}$ to $10^{-7}$
Silt sand	$10^{-1}$ to $10^{-5}$
Clean sand	$1$ to $10^{-4}$
Gravel	$10^2$ to $10^{-1}$

Source: References 4 and 5.

Application of the permeabilities in Table 4.1-8 to Figure 4.1-6 for the range of water depths typical of lagoon systems (4 to 20 ft) indicates that for readily available liner materials ( $K = 10^{-6}$  to  $10^{-7}$  cm/sec), seepage rates can vary from less than 0.01 in/day to 1.4 in/day. This represents a variation of over two orders of magnitude. However, the maximum seepage rate can be reduced to less than 0.1 in/day by a liner with  $K = 10^{-7}$  cm/sec and a thickness of one foot. This is representative of a typical bentonite clay liner design.

For unlined lagoons, seepage rates are dependent on the hydraulic conductivity of the native soil (excluding the effects of an overlying sludge layer). Freeze and Cherry (4) have compiled ranges for various consolidated geologic deposits (shown in Table 4.1-8). Assuming that a compacted native earth liner decreases the hydraulic conductivity 1 to 2 orders of magnitude, seepage rates determined from Figure 4.1-6 would be in excess of 2 in/day for gravelly, sand and silt aquifers (depending also on the depth of water in the lagoon and thickness of the compacted earth layer).

**4.1.3.2.2 Effects of the Sludge Layer.** Table 4.1-9 presents a summary of measured seepage rates from unlined municipal lagoon systems which are known to have a sludge layer. These data indicate the relative impact of a sludge layer on lagoon seepage caused by self-sealing mechanisms, such as physical, chemical and biological clogging. Seepage rates range from 0.04 to 1.3 inches per day (1,000 to 35,300 gallons per day per acre, yd<sup>3</sup>/ac) and reflect hydraulic characteristics of both the sludge layer and underlying soils.

The thickness of the sludge layer, sludge/soil hydraulic conductivity, and location of the water table were not measured for the lagoon systems referenced in Table 4.1-9. However, the data in Table 4.1-9 indicate the presence of a sludge layer that significantly reduces the expected rate of seepage. In four studies of lagoon systems located in sandy soils, expected seepage rates greater than 2 in/day were reduced to values of 0.35, 0.34, 0.18, and 0.12 in/day, respectively, presumably due to the effect of a sludge layer. In more permeable silt, sands, and gravels, seepage rates of 0.61 to 1.3 in/day occurred through the sludge layer. These data suggest that the degree of self-sealing is dependent on the underlying geologic media.

Intensive studies of seepage from lagoons in Minnesota suggest that the hydraulic conductivity of permeable soils may be decreased one to two orders of magnitude by the accumulation of a sludge layer. However, fluctuations in the water table above the bottom of the lagoon system may also be the cause of the reduced seepage as noted in these studies (6). The measured soil/sludge hydraulic conductivity was approximately  $10^{-6}$  cm/sec. Therefore, for a 1-foot sludge/soil liner, the seepage rate would be 0.37 in/day at a 10-foot water depth (see Figure 4.1-6).

The rate and extent of sludge deposition significantly affects seepage from unlined lagoon systems. For at least three cases (multiple cell systems, lagoons receiving primary effluent, and intermittently used lagoons) the degree of sealing will vary widely. Thus there is much uncertainty in applying seepage rates to the total area of a lagoon system, or even a single lagoon, as sludge may settle out near the influent pipe. Data on berm and/or

TABLE 4.1-9  
SUMMARY OF MEASURED SEEPAGE RATES FROM  
MUNICIPAL LAGOON SYSTEMS

Water depth (feet)	Lagoon Type	Underlying Soil	Seepage Rate		Reference
			in/day	gpd/ac	
5	Facultative	Heavy silty clay	0.3	8,200	7
6	Facultative	Light silty clay	0.29	7,900	7
5	Facultative	Alkaline silt	0.65	17,700	7
6	Facultative	Fine sand	1.2	32,600	7
6	Facultative	Gravel and silt	1.3	35,300	7
-	-	Sandy soil	0.35	9,500	8
-	-	Sand and gravel	0.61 <sup>a</sup>	16,600	8
-	-	Sandy soil	0.34	9,300	8
-	-	Clay loam and shale	0.3	8,200	8
-	Maturation	Mica and schist	0.06-0.23	1,700-6,300	8
5	Facultative	Silt, sand, marl	0.18	5,000	9
5	Facultative <sup>b</sup>	Sand, silt, marl	1.07	29,000	9
5	Evaporation <sup>c</sup>	Sand, silt, marl	0.04-0.11	1,000-3,000	10
-	Facultative	Sandy soil	0.12	3,400	10

Source: References 7, 8, 9, and 10.

<sup>a</sup>Includes net precipitation/evaporation.

<sup>b</sup>Used intermittently.

<sup>c</sup>Sealed with bentonite and soda ash.

liner compaction specifications and actual construction practices collected during the lagoon sampling program were very limited. In many cases, it appears that only berm compaction (for structural stability) was provided. Compaction of lagoon bottoms to prevent seepage apparently was not always required.

**4.1.3.2.3 Selection of Lagoon Seepage Rates for the National Assessment.** Of the 23 municipal lagoons investigated as part of this assignment, 8 had liners, 2 had compacted native clay liners, and 13 were unlined or consisted of compacted native soils (see Tables 3-3 and 3-4 in the text). Table 4.1-10 presents an hydraulic balance for each of the nine domestic lagoons sampled (and Mandan, ND) based on hydrogeologic, liner, and flow information obtained during the field investigation. The resulting seepage rates estimated for these ten systems vary between 0.03 and 1.2 in/day (excluding the percolation beds at the Laramie, WY site), and represent 5 to 48 percent of the influent hydraulic load. (Honeybrook, PA experienced an increase in discharge caused by positive net precipitation, resulting in an effective seepage rate of 1% of the influent loading.)

Table 4.1-11 presents a summary of State seepage and permeability limitations for lagoon systems. Thirty-four States have limitations; 24 States designate allowable seepage rates, 8 States limit maximum hydraulic conductivities, and two States, Washington and Virginia, regulate both seepage and liner permeability. Eleven States follow the "Ten State Standards" seepage rate of 500 gpd/ac (0.02 in/day), based on a 6-foot water depth (11). Conversion of these conditions to a 20-foot water column would result in a seepage rate of 0.06 in/day. Allowable seepage rates vary between 0.02 and 0.25 in/day (1/64 to 1/4 in/day) or 500 to 6,800 gpd/ac. Allowable liner permeabilities vary between  $10^{-6}$  and  $10^{-8}$  cm/sec (Alabama requires  $10^{-12}$  cm/sec for synthetic liners), with 7 States requiring  $10^{-7}$  cm/sec. Many of these limitations have only recently been enacted. In 1978, only 16 States limited seepage from lagoon systems (5), and the Ten States Standard of 500 gpd/ac was just then implemented.

Based on the assessment of potential seepage rates from lagoon systems (Tables 4.1-9 and 4.1-10), a range of seepage rates, from 0.1 to 0.3 in/day, uniformly distributed, was selected for use in computer modelling. While the low end of state seepage limitations, 0.02 in/day for a 6-foot water column (corresponding to 0.06 in/day for a 20-foot water column), is achievable with standard materials and construction practices currently available, it is not likely that a high proportion of existing lagoons conforms to this value. Below these values, synthetic liners would result in virtual impermeability (less than 0.001 in/day).

The 0.3 in/day value is at the upper limit of State limitations (0.25 in/day) and represents a reasonable sludge-layer limiting value for unlined lagoons under many geologic conditions. For the majority of lagoon systems, values greater than 0.3 in/day would result in the majority of the influent wastewater being disposed of via seepage. Therefore, use of seepage rates greater than 0.3 in/day for computer modelling would simulate estimated upper bound worst-case conditions for domestic and domestic/industrial lagoon scenarios, beyond the range of reasonable values.

TABLE 4.1-10  
 ESTIMATED SEEPAGE RATES AND HYDRAULIC  
 BALANCES AT 10 LAGOONS  
 (9 Domestic, 1 Domestic/Industrial)

Site/Liner Type	Influent Flow, $Q_i$			Seepage Rate			Net P/E <sup>a</sup> in/day	Effluent Flow, $Q_e$ % $Q_i$
	mgd	in/day	in/day	gpd/acre	% $Q_i$			
Laramie, WY								
Bentonite sealer	4.2	8.6	1.2	32,600	14	-0.08	85	
Percolation beds	3.6	3.6	3.6	97,800	100	-0.08	0	
Honeybrook, PA								
Double bentonite	0.6	2.33	0.024	650	1	+0.04	101	
Potterville, MI								
2-ft clay seal	0.45	0.58	0.027	750	5	0	95	
Standish, MI								
Compacted clay soil	0.3	0.34	0.125	3,400	37	0	63	
Britton Village, MI								
Compacted clay soil	0.19	0.35	0.17	4,600	48	+0.01	54	
Buffalo, WY								
Bentonite	1.3	1.37	0.032	850	2	-0.07	93	
Lander, WY								
Bentonite	2.0	1.05	0.034	900	3	-0.06	91	
Mandan, ND								
Compacted earth	1.5	1.94	0.37	10,050	19	-0.05	78	
Minot, ND								
Bentonite (assumed)	3.5	0.18	0.03	800	17	-0.05	55	
McVille, ND								
Compacted earth	0.06	0.74	0.3	8,150	41	-0.02	57	
Unlined/sand	0.036	0.42	>0.5	>13,600	100	-0.02	0	

<sup>a</sup>Daily net Precipitation (+)/Evaporation (-) based on annual average (P-E).  
<sup>b</sup>Includes effect of percolation and net P/E.

TABLE 4.1-11  
SUMMARY OF STATE SEEPAGE AND PERMEABILITY  
LIMITATIONS FOR LAGOON SYSTEMS

State	Permeability K (cm/sec)	Seepage in/day	Seepage gpd/acre
Alabama	$10^{-7}$ (Earthen liner) $10^{-12}$ (Synthetic liner)		
Arkansas		0.02	500 <sup>a</sup>
Colorado		0.03	850
Delaware		0.02	500 <sup>a</sup>
Georgia		0.12	3,400
Idaho		0.25	6,800
Indiana	$10^{-7}$		
Iowa		0.06 <sup>b</sup>	1,700
Kansas		0.25	6,800
Kentucky		0.02	500 <sup>a</sup>
Maine		0.02	500 <sup>a</sup>
Maryland	$10^{-8}$		
Michigan		0.12	3,400 <sup>a</sup>
Minnesota		0.02	500 <sup>a</sup>
Mississippi		0.02	500 <sup>a</sup>
Missouri		0.25	6,800
Montana			
Primary		0.02	500 <sup>a</sup>
Secondary		0.04	1,200
Nebraska		0.25	6,800
New Hampshire		0.02	500
New Jersey	$10^{-7}$		
New York		0.02	500 <sup>a</sup>
North Carolina	$10^{-6}$ <sup>c</sup>		
North Dakota		0.12	3,400 <sup>a</sup>
Ohio		0.02	500 <sup>a</sup>
Oklahoma	$10^{-7}$		
Oregon		0.25	6,800
Pennsylvania	$10^{-7}$		
South Carolina		0.02	500 <sup>a</sup>
South Dakota			
Primary		0.06	1,700
Secondary		0.12	3,400
Utah		0.25	6,800
Virginia	$10^{-6}$		
Washington	$10^{-7}$	0.25	6,800
Wisconsin	$10^{-7}$ (Soil and bentonite liners)	0.04	1,000
Wyoming		0.12	3,400

<sup>a</sup>Ten State Standard based on 6-foot water depth (11).

<sup>b</sup>Based on 6-foot thickness.

<sup>c</sup>Minimum 1-foot thickness, compacted on-site soils.

#### 4.1.3.3 Lagoon Area and Exposure Distance

In the original use of EPACMS and preceding models, both lagoon area and distance to the nearest exposure point were entered as single values. For this project, a Monte Carlo approach was selected to reflect more accurately the realistic variation of those two parameters. To this end, data on both lagoon area and exposure distance were obtained from sample populations and compiled to yield frequency distributions, which were then subjected to curve-fitting procedures to determine the most representative probability distributions.

For lagoon area, data were compiled from Table 3-1 (in the text) for domestic lagoons. Data for domestic/industrial lagoons (Table 3-2, text) were not included as they could not be readily combined with domestic lagoon data.

Data for the exposure distance distribution were obtained by selecting a sample lagoon population of 220 lagoons and conducting an exposure mapping exercise to identify distributions of downgradient receptors. This mapping technique is discussed below.

For each lagoon, the distance to the closest downgradient well within 2000 meters was determined from USGS 7.5-minute maps. In measuring the distance to the closest well, both private residential wells and public water supplies were considered, as was the potential for ground-water interception by surface water. Wells located downgradient from a stream that was likely to intercept the contaminant plume from the lagoon were not included. However, in cases where the stream might not intercept all of the plume, wells beyond the stream were included. For the facilities without a potentially affected well within 2,000 meters, exposure was assumed to occur in the 2,000 meters to infinite distance range.

These data are summarized in Table 4.1-12, which gives the probability and cumulative probability distributions for the distance to the closest well at municipal wastewater treatment facilities, based on survey data from 220 facilities. The distribution provides probabilities that a well will be located within one of eight exposure ranges.

As both lagoon area and exposure distance data are reported in incremental terms, an equal probability of occurrence must be assumed within a given range. The distributions determined on the basis of this assumption are:

##### Lagoon Area (square meters, m<sup>2</sup>)

$$P(X) = 2.36 \times 10^4 (X^{-2.103})$$

$$10,522 \leq X \leq 943,760$$

##### Exposure Distance (meters, m)

$$P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$$

$$35 \leq X \leq 2000$$

TABLE 4.1-12  
DISTANCE TO NEAREST WELL

Distance Range, X (meters)		Number of Wells within Distance Range	Probability of Exposure	Cumulative Probability
Lower	Upper			
0	35	4	0.0182	0.0182
36	130	18	0.0818	0.1000
131	300	28	0.1273	0.2273
301	500	35	0.1591	0.3864
501	800	35	0.1591	0.5455
801	1,250	25	0.1136	0.6591
1,251	2,000	17	0.0773	0.7364
2,001	Infinite	58	0.2636	1.0000
		TOTAL: 220	1.0000	

Source: ICF, Inc., 1987

These distributions represent the probability of lagoon area or exposure distance equaling a specific value within the defined range. Details of the distribution derivation are presented in Appendix 4.2.

#### 4.1.3.4 Chemical Constants

The preliminary results of a literature search for values of hydrolysis and other chemical constants required as input to EPACMS are presented as Appendix 4.3. (It should be noted that these values are subject to change, as additional experimental data become available). Because of the large and sometimes diverse number of values obtained for a particular constant, it was necessary to formulate a basis for the selection of a corresponding single value. In general, values of dubious validity (e.g., "estimated from values which were themselves estimated") were discarded and the remaining values averaged. This process is outlined in more detailed form in Appendix 4.3. Table 4.1-13 presents the final values used in the EPACMS computer runs.

Table 4.1-13 shows that none of the pollutants investigated in this study had values for all five constants. In one case, arsenic, no data were available. Although biodegradation is known to occur for some of the other pollutants (e.g., tetrachloroethylene), reliable rate constants were not identified in time for inclusion in the Report to Congress. Where constants were not available or a reaction was considered insignificant, a default value was assumed, indicating no attenuation due to that particular process. The net result of this assumption was the underestimation of retardation or degradation for a particular pollutant.

#### 4.1.4 SELECTION OF GENERIC MODELLING SCENARIOS

As discussed in Sections 4.1.3 and 4.1.1 of this Appendix, nine hydrogeologic categories and seven pollutants were selected for the national assessment. If all combinations were to be investigated using the EPACMS model, a total of 63 runs would be required, covering approximately 90% of the nation's 5,476 lagoons, as shown in Table 4.1-14. The remaining 10% of the lagoons are scattered throughout the Northwest, the Rocky Mountains and Florida (see Table 4.1-5 and Figure 4.1-4 of this Appendix).

TABLE 4.1-13  
CHEMICAL CONSTANTS USED IN EPACMS RUNS

Pollutant	$K_{OC}$ (ml/g)	$K_a$ (mole $^{-1}$ hour $^{-1}$ )	$K_n$ (hr $^{-1}$ )	$K_b$ (mole $^{-1}$ hour $^{-1}$ )	Anaerobic Biodegradation (sec $^{-1}$ )
Arsenic	NA <sup>a</sup>	NA	NA	NA	NA
Benzene	59	- <sup>b</sup>	- <sup>b</sup>	- <sup>b</sup>	NA
Beryllium	NA	NA	NA	NA	NA
Chloroform	31	0	$3 \times 10^{-9}$	0.23	NA
2,4-Dinitrotoluene	76	- <sup>b</sup>	- <sup>b</sup>	- <sup>b</sup>	NA
Hexachlorobenzene	$1.5 \times 10^5$	- <sup>b</sup>	- <sup>b</sup>	- <sup>b</sup>	NA
Nitrate	NA	NA	NA	NA	$3.2 \times 10^{-6}$
Tetrachloroethylene	209	- <sup>b</sup>	- <sup>b</sup>	- <sup>b</sup>	NA

Source: Appendix 4.3

<sup>a</sup>Not available.

<sup>b</sup>Hydrolysis not significant.

TABLE 4.1-14  
NUMBER OF LAGOONS PER HYDROGEOLOGIC CATEGORY<sup>a</sup>

Category	Number of Small Lagoons <sup>b</sup>	Number of Large Lagoons <sup>c</sup>	Number of Total Lagoons
1	894	123	1,017
2	555	99	654
3	23	1	24
4	1,766	149	1,915
5	376	25	401
6	319	26	345
7	255	21	276
8	116	7	123
9	<u>132</u>	<u>8</u>	<u>140</u>
TOTAL	4,436	459	4,895
% OF TOTAL	90.6	9.4	

<sup>a</sup>Because only seven of the 15 DRASTIC regions were included in the study, not all of the nation's 5,476 lagoons are represented in this table.

<sup>b</sup>Flow rates less than 0.5 mgd.

<sup>c</sup>Flow rates greater than or equal to 0.5 mgd.

APPENDIX 4.2

DETERMINATION OF PROBABILITY DISTRIBUTIONS  
FOR LAGOON AREA AND EXPOSURE DISTANCE

## APPENDIX 4.2

### DETERMINATION OF PROBABILITY DISTRIBUTIONS FOR LAGOON AREA AND EXPOSURE DISTANCE

#### A. General Procedure

- (1) Take probability of being within a given range and divide it by the size of the range itself. For example, take exposure distances between 0 and 35 meters:
  - (a)  $0 \leq X \leq 35$ ; probability = 0.0182
  - (b)  $(0.0182)/(35-0) = 0.000520$
- (2) Do this for all intervals
- (3) Plot the resulting data as a step function (e.g., all unit values from 1 to 35 are 0.000520) of probability versus distance
- (4) Fit a curve to the endpoints or midpoints of the steps
  - (a) Use step endpoint for exposure distance, as lagoons in the 0-35 range are likely to be closer to 35 (also, since there is no upper limit on distances greater than 2000m, it is not possible to define a discrete "step" and assign probabilities to each unit value as done in Item (1) above).
  - (b) Use step midpoint for area, as approximately 60% of the lagoons are in the first increment (0 to 5.2 acres)

#### B. Lagoon Area

- (1) Form of equation:  $P = AX^B$
- (2) Correlation coefficient:  $R^2 = 0.97$  (see graph)
- (3) Limits are step midpoints:  $10,522 \leq X \leq 943,760$
- (4) Equation:  $P = 2.36 \times 10^4 (X^{-2.103})$

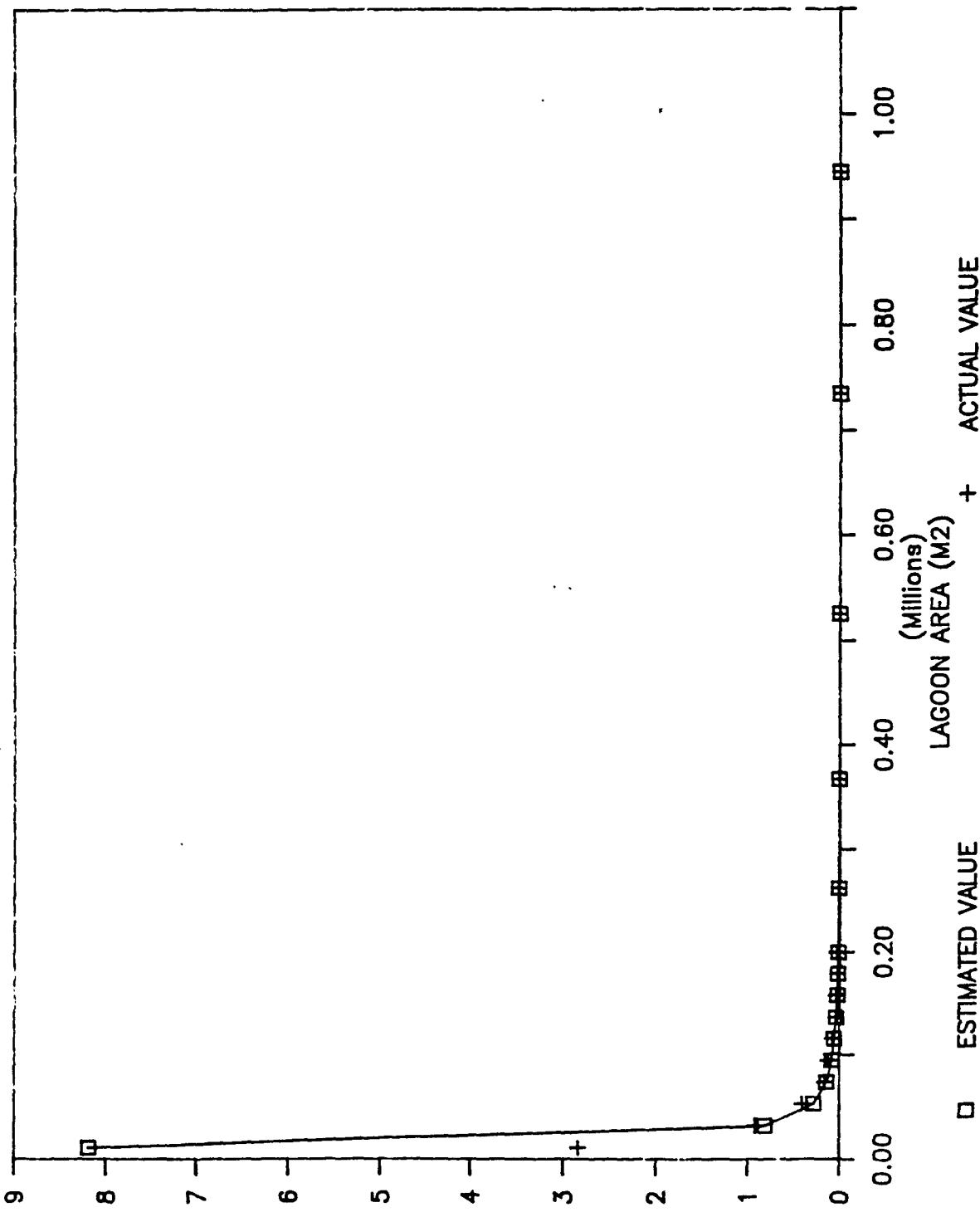
#### C. Exposure Distance

- (1) Form of equation:  $P = AX^3 + BX^2 + CX + D$
- (2) Correlation coefficient:  $R^2 = 0.91$  (see graph)
- (3) Limits are step endpoints (the step above 2000 has no endpoint):  
 $35 \leq X \leq 2000$
- (4) Equation:  
$$P = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9}(X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$$

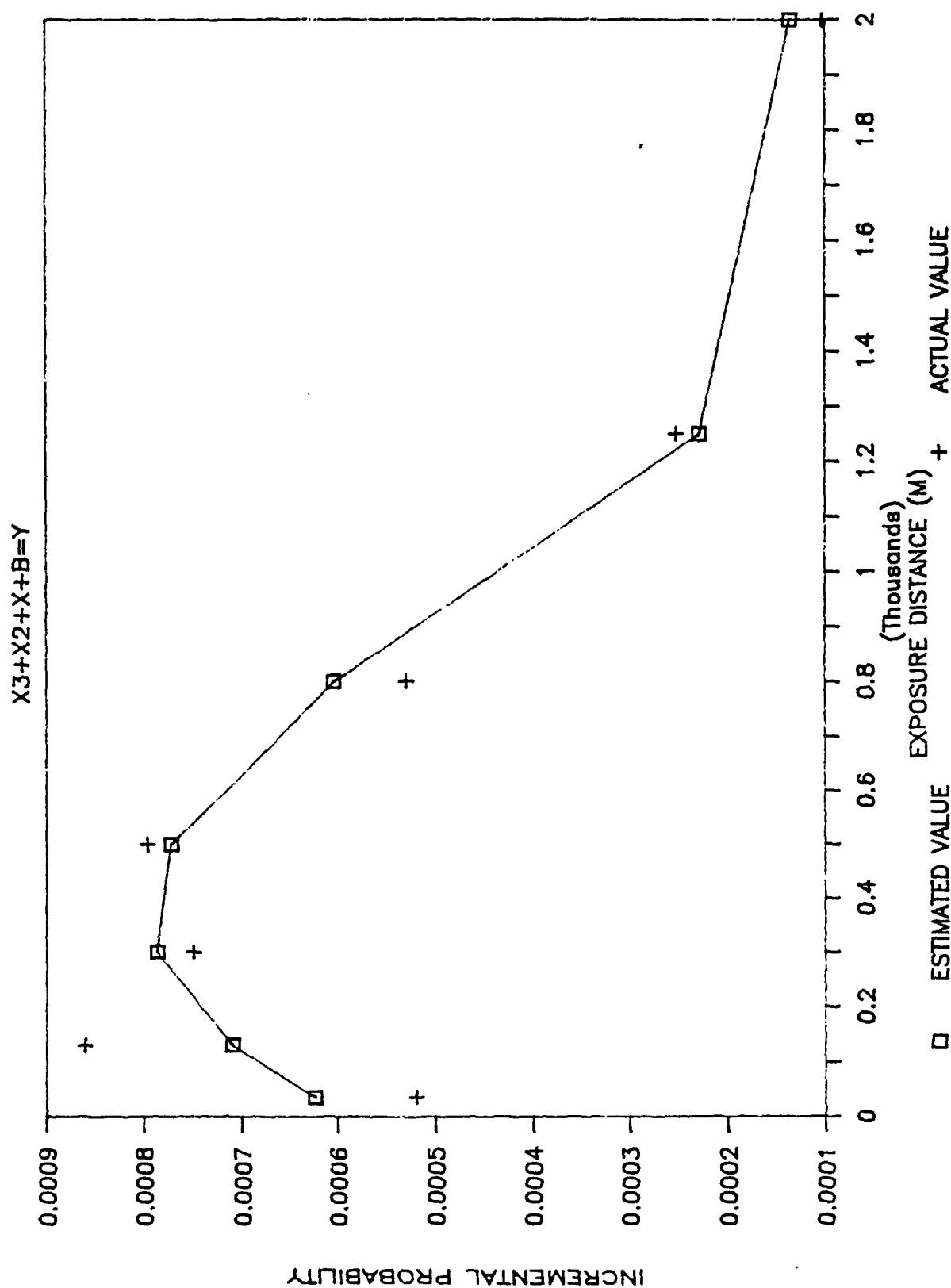
# LAGOON AREA, M2 (LN,LN)

P=AX~B; BASED ON INTERVAL MDPT

INCREMENTAL PROBABILITY  
(Times 10E-5)



# EXPOSURE DISTANCE, POLYNOMIAL



APPENDIX 4.3  
SELECTION OF CHEMICAL CONSTANTS

## APPENDIX 4.3

SELECTION OF CHEMICAL CONSTANTS BASED ON  
DATA COMPILED BY OSW

## CHEMICAL CONSTANTS USED IN EPACMS RUNS

Pollutant	$K_{oc}$ (ml/g)	$K_a$ (mole $^{-1}$ hour $^{-1}$ )	$K_n$ (hr $^{-1}$ )	$K_b$ (mole $^{-1}$ hour $^{-1}$ )	Anaerobic Biodegradation (sec $^{-1}$ )
Arsenic	NA <sup>a</sup>	NA	NA	NA	NA
Benzene	59	- <sup>b</sup>	- <sup>b</sup>	- <sup>b</sup>	NA
Beryllium	NA	NA	NA	NA	NA
Chloroform	31	0	$3 \times 10^{-9}$	0.23	NA
2,4-Dinitrotoluene	76	- <sup>b</sup>	- <sup>b</sup>	- <sup>b</sup>	NA
Hexachlorobenzene	$1.5 \times 10^5$	- <sup>b</sup>	- <sup>b</sup>	- <sup>b</sup>	NA
Nitrate	NA	NA	NA	NA	$3.2 \times 10^{-6}$
Tetrachloroethylene	209	- <sup>b</sup>	- <sup>b</sup>	- <sup>b</sup>	NA

<sup>a</sup>Not available.<sup>b</sup>Hydrolysis not significant.

Note 1: Benzene

Organic Carbon Partition Coefficient,  $K_{OC}$

	<u>Value</u>	<u>Source</u>
(a)	93	Estimated from measured data
(b)	920	Experimentally measured for aqueous estuarine colloids
(c)	27.8	Unknown
(d)	65	Estimated from estimated data

- Discard (b) as not relevant to subsurface regime
- Could select (a) only, but it is the highest value and thus the least conservative
- Average (a), (c) and (d)
- Result is 59

Note 2: Chloroform

Organic Carbon Partition Coefficient,  $K_{OC}$

	<u>Value</u>	<u>Source</u>
(a)	31	Estimated from measured data
(b)	34	Estimated from measured data
(c)	44	Estimated from estimated data

- Discard (c)
- Could average (a) and (B), but (a) is found in Superfund Public Health Evaluation Manual and was the only value originally reported for use in initial runs
- Therefore, pick 31

### Neutral Hydrolysis Constant, $k_n$

	<u>Value</u>	<u>Source</u>
(a)	$3 \times 10^{-9}$	Experimentally measured
(b)	$2.5 \times 10^{-9}$	Estimated from measured data

- Pick  $3 \times 10^{-9}$  as more reliable (also, only value reported for use in initial runs)

### Note 3: 2,4-Dinitrotoluene

#### Organic Carbon Partition Coefficient, $K_{OC}$

	<u>Value</u>	<u>Source</u>
(a)	45	Estimated from estimated values
(b)	107.2	Unknown

- Average (a) and (b)
- Result is 76

### Note 4: Hexachlorobenzene

#### Organic Carbon Partition Coefficient, $K_{OC}$

	<u>Value</u>	<u>Source</u>
(a)	3900	Estimated from measured data
(b)	$10^4$ - $10^5$	Estimated from measured data
(c)	0.00175	Unknown
(d)	$3.954 \times 10^5$	Unknown
(e)	$1.2 \times 10^6$	Estimated from estimated data

- Discard (c) as being suspect
- Discard (e), which is "estimated from estimated data"
- Take median ( $5 \times 10^4$ ) of the range in (b)
- Average (a), (d) and  $5 \times 10^4$
- Result is  $1.5 \times 10^5$

Note 5: Nitrate

Anaerobic Biodegradation Rate Constant

Given the variety of constants compiled (different depths, incubation times, and initial concentrations), it was decided to pick a constant corresponding to the greatest depth and longest incubation time. Three values,  $15.6 \times 10^6$ ,  $4.5 \times 10^{-6}$ , and  $3.2 \times 10^{-6}$  second<sup>-1</sup> fit these criteria. The latter value,  $3.2 \times 10^{-6}$ , was selected to reflect a more conservative approach (All data were experimentally measured).

Note 6: Tetrachloroethylene

Organic Carbon Partition Coefficient, K<sub>OC</sub>

	<u>Value</u>	<u>Source</u>
(a)	209	Estimated from measured data
(b)	229	Estimated from estimated data
(c)	245	Estimated from estimated data
(d)	$3.5 \times 10^{-4}$	Estimated from estimated data expressed in dimensionless units
(e)	166	Source unknown
(f)	364	Estimated from estimated data

- Discard (d) as being noncomparable
- Discard (b), (c) and (f) which are "estimated from estimated values"
- Discard (e) as being unknown
- Choose (a), 209 as being "estimated from measured data." (This value is the second most conservative.)

JW List Parameters Draft Copy

CAS NUMBER	NAME	Vapor Pressure (mmHg)	Henry's Constant (M/M)	Hydrolysis			
				Ref.	Rate Constant Ref. (M <sup>-1</sup> /s)	Ref.	Rate Constant (M <sub>a</sub> , k <sub>b</sub> , k <sub>r</sub> )
67-66-3	Chloroform	151		8*	3.40x10 <sup>-3</sup> à 25C 1.1*	7*	k <sub>a</sub> =0.23 à 25C 1.0*
		160 à 10.4C		5*	3.19x10 <sup>-3</sup> à 25C	11*	k <sub>a</sub> =0 1.0
		160 à 20C		1*	2.88x10 <sup>-3</sup> à 20C 1.1*	13*	k <sub>a</sub> =3x10 <sup>-3</sup> 1.0
		245 à 30C		1*	3.58x10 <sup>-3</sup> à 25C	7*	k <sub>a</sub> =2.5x10 <sup>-3</sup> 1.0
		150.5 à 20C		42*			k=2.96x10 <sup>-3</sup> 1.0
		194.8 à 25C		2*			
71-43-2	Benzene	95.2 à 20-30C		8*	5.55x10 <sup>-3</sup> à 25C 2.3*	7*	NHFG 2.3*
		60 à 15C		1*	5.49x10 <sup>-3</sup> 2.2*	29*	NHFG 2.3*
		76 à 20C		1*	5.55x10 <sup>-3</sup> 2.2*	29*	
		100 à 26.1C		5*	0.227	20*	
		95.19 à 25C 2.22		27*	5.51x10 <sup>-3</sup> à 25C 2.37	13*	
		182.86 à 40C 2.23		27*			
95-32-5		95 à 25C 2.27		28*			
		74 à 20C 2.24		28*			
		95 à 25C		19*			
		118 à 30C		1*			
118-16-4	Hexachlorobenzene	1.09x10 <sup>-3</sup>		8*	1.75x10 <sup>-3</sup> à 25C	7*	NHES 3.2*
		1.9x10 <sup>-3</sup> à 25C		19*	0.03-0.07 à 20C	12*	
		0.420x10 <sup>-3</sup> à 15C 3.17		9*	0.07	20*	
		0.581x10 <sup>-3</sup> à 15C 3.18		9*	6.8x10 <sup>-4</sup> à 25C 3.23	13*	
		1.73x10 <sup>-3</sup> à 25C 3.17		9*	-----3.12	47*	
		2.16x10 <sup>-3</sup> à 25C 3.18		9*			
127-16-4	Tetrachloroethylene	6.48x10 <sup>-3</sup> à 15C 3.17		9*			
		6.97x10 <sup>-3</sup> à 35C 3.18		9*			
		22.4x10 <sup>-3</sup> à 45C 3.17		9*			
		21.5x10 <sup>-3</sup> à 45C 3.18		9*			
		0.396±0.024x10 <sup>-3</sup> à 25C 3.1*		9*			
		1.91±0.20x10 <sup>-3</sup> à 25C 3.1*		9*			
20.948.89x10 <sup>-3</sup> à 35C 3.1*		6.40±0.35x10 <sup>-3</sup> à 35C 3.1*		9*			
		20.948.89x10 <sup>-3</sup> à 35C 3.1*		9*			
		17.8		8*	2.59x10 <sup>-2</sup>	8*	k <sub>a</sub> =k <sub>b</sub> =k <sub>r</sub> =0 4.18
		18.47 à 25C		2*	2.87x10 <sup>-2</sup>	7*	-----NR 4.12
		20 à 25C		19*	2.10 <sup>-2</sup> 4.14	36*	
		14 à 20C		42*	1.174	20*	0.0153

\* = experimentally measured value

b = estimated by extrapolation or interpolation from measured data

c = estimated using molecular structure

d = estimated from values which were themselves estimated

e = unknown data type

f = primary reference has not been checked are designated as 'b'.

NOTE: Values for which the

## DS List Parameters - aft (apv)

CAS NUMBER	NAME	Hydrolysis				Ref.
		Vapor Pressure (atm)	Henry's Constant (atm-L <sup>-2</sup> /M)	Rate Constant (hr.L.M <sup>-1</sup> )	Ref.	
121-14-2	2,4-Dinitrotoluene	5.10x10 <sup>-3</sup> @ 20°C 1.3x10 <sup>-3</sup> @ 59°C 7.6x10 <sup>-3</sup> @ 25°C 1.23x10 <sup>-3</sup> @ 4°C 2.85x10 <sup>-3</sup> @ 10°C 1.32x10 <sup>-3</sup> @ 20°C	13 <sup>a</sup> 10 <sup>b</sup> 19 <sup>c</sup> 15 <sup>d</sup> 15 <sup>e</sup>	4.07x10 <sup>-4</sup> @ 25°C <sup>a</sup> 1x10 <sup>-3</sup> to 1x10 <sup>-4</sup> 5.09x10 <sup>-4</sup> 20-30°C <sup>a</sup>	7 <sup>a</sup> 10 <sup>a</sup> 15 <sup>a</sup>	HRES 0.2
7440-38-2	Arsenic and Compounds					13 <sup>c</sup>
1303-28-2	Arsenious Acid <sup>0.1,0.7</sup> (H <sub>3</sub> AsO <sub>3</sub> )					NOTE: Values for which the primary reference has not been checked are designated as '0'.
1327-53-3	Arsenic Acid <sup>0.1</sup> (H <sub>3</sub> AsO <sub>4</sub> )					
7440-41-7	Beryllium [Be(OH) <sub>2</sub> ]					6 <sup>a</sup>
14797-55-8	Nitrates NaNO <sub>3</sub> KNO <sub>3</sub>					
14797-65-8	Nitrites NaNO <sub>2</sub> KNO <sub>2</sub>					

<sup>a</sup> = experimentally measured value  
<sup>b</sup> = estimated by extrapolation or interpolation from measured data  
<sup>c</sup> = estimated using molecular structure  
<sup>d</sup> = estimated from values which were themselves estimated  
<sup>e</sup> = unknown data type

NOTE: Values for which the primary reference has not been checked are designated as '0'.

JW List Parameters - 1st Copy

EIS NUMBER	NAME	Octanol/Water Partition Coefficient <u>log K<sub>ow</sub></u>	Ref.	Organic Carbon Coefficient <u>K<sub>oc</sub></u>	Ref.	Solubility <u>mg/L</u>	Ref.	Activity Coefficient	Ref.	Kef.
o7-66-3	Chlorofor <sub>a</sub>	1.97 1.95 1.3 1.97	8 <sup>a</sup> 13 <sup>a</sup> 10 <sup>a</sup>	31 1.13 34 44 1.12	8 <sup>a</sup> 14 <sup>a</sup> 15 <sup>a</sup>	8.20x10 <sup>3</sup> @ 26-30C 6000 @ 20C 9300 @ 25C	8 <sup>a</sup> 1 <sup>a</sup> 1 <sup>a</sup>	-----	-----	-----
71-43-2	benzene	2.12 2.13 2.13 2.1 2.25 2.2 2.13 2.7 2.32 2.13 2.38	8 <sup>a</sup> 1 <sup>a</sup> 21 <sup>a</sup> 21 <sup>a</sup> 24 <sup>a</sup> 20 <sup>a</sup> 19 <sup>a</sup>	63 920 2. 2.78x10 <sup>1</sup> 652 2. 1780 2. 10000 @ 15C	8 <sup>a</sup> 23 <sup>a</sup> 19 <sup>a</sup> 13 <sup>a</sup>	1.75x10 <sup>3</sup> 1780 @ 20C 820 2. 1780 2. 8.20x10 <sup>2</sup> @ 25C	8 <sup>a</sup> 1 <sup>a</sup> 2.2x10 <sup>3</sup> 2. 1 <sup>a</sup>	2.1x10 <sup>3</sup> 2. 2.2x10 <sup>3</sup> 2. 23 <sup>a</sup> 29 <sup>a</sup> 20 <sup>a</sup> 19 <sup>a</sup>	27 <sup>a</sup> 27 <sup>a</sup>	-----
110-18-4	Hexachlorobenzene	5.25 6.2 5.2 8.0 6.915 2. 6.18	8 <sup>a</sup> 1 <sup>a</sup> 20 <sup>a</sup> 19 <sup>a</sup> 13 <sup>a</sup> 24 <sup>a</sup>	3900 10 <sup>4</sup> -10 <sup>5</sup> 0.00175 3.95x10 <sup>8</sup> 1.2x10 <sup>8</sup> 2. 1.2x10 <sup>8</sup>	8 <sup>a</sup> 16 <sup>a</sup> 20 <sup>a</sup> 19 <sup>a</sup> 13 <sup>a</sup> 2.12x10 <sup>-3</sup>	6.0x10 <sup>-3</sup> 0.11 @ 24C 6x10 <sup>-3</sup> @ 25C 6.6x10 <sup>-3</sup> 2. 6.2x10 <sup>-3</sup> 2. 2.12x10 <sup>-3</sup>	8 <sup>a</sup> 1 <sup>a</sup> 19 <sup>a</sup> 47 <sup>a</sup> 10 <sup>a</sup>	9.77x10 <sup>8</sup> 2. 1 <sup>a</sup> 19 <sup>a</sup> 9 <sup>a</sup>	7 <sup>a</sup>	-----
127-18-4	tetrachloroethylene	2.6 2.88 2.60 2. 2.6 3.1 2.9	8 <sup>a</sup> 10 <sup>a</sup> 4 <sup>a</sup> 20 <sup>a</sup> 19 <sup>a</sup> 13 <sup>a</sup>	209 4. 229 4. 245 4. 3.5x10 <sup>-4</sup> 4. 166 3.64x10 <sup>20</sup>	34 <sup>a</sup> 34 <sup>a</sup> 34 <sup>a</sup> 36 <sup>a</sup> 13 <sup>a</sup>	1.36x10 <sup>2</sup> 150-200 @ 20C 241.8 1.5x10 <sup>2</sup> @ 25C 19 <sup>a</sup>	8 <sup>a</sup> 10 <sup>a</sup> 20 <sup>a</sup> 19 <sup>a</sup>	-----	-----	-----
121-14-2	2,4-Dinitrotoluene	2 2.01 3. 3.14	8 <sup>a</sup> 10 <sup>a</sup> 19 <sup>a</sup>	45 3. 1.072x10 <sup>2</sup>	13 <sup>a</sup> 19 <sup>a</sup>	2.40x10 <sup>2</sup> 270 @ 22C 3x10 <sup>2</sup> @ 25C	8 <sup>a</sup> 10 <sup>a</sup> 19 <sup>a</sup>	-----	-----	-----
7440-38-2	Arsenic and Compounds	-----	-----	-----	-----	3.70x10 <sup>4</sup> @ 20C -----	3.70x10 <sup>4</sup> @ 20C -----	6 <sup>a</sup>	-----	-----
1303-28-2	Arsenious Acid <sup>a</sup> , <sup>b</sup> , <sup>c</sup> , <sup>d</sup>	-----	-----	-----	-----	1.5x10 <sup>6</sup> @ 16C 7. -----	1.5x10 <sup>6</sup> @ 16C 7. -----	6 <sup>a</sup>	-----	-----
1327-53-3	Arsenic Acid <sup>d</sup> , <sup>e</sup>	-----	-----	-----	-----	-----	-----	46 <sup>a</sup>	-----	-----

## DW List Parameters Brett Lapp

<u>CAS NUMBER</u>	<u>NAME</u>	<u>Octanol/Water Partition Coefficient (log K<sub>ow</sub>)</u>	<u>Ref.</u>	<u>Organic Carbon Coefficient (log K<sub>oc</sub>)</u>	<u>Ref.</u>	<u>Solubility (mg/l)</u>	<u>Ref.</u>	<u>Activity Coefficient</u>	<u>Ref.</u>
7440-41-7	Berry juice (Fe(OH) <sub>2</sub> )	-----	-----	-----	-----	-----	-----	-----	-----
14797-55-8	Nitrates	-----	-----	-----	-----	9.2x10 <sup>-3</sup> @ 25C	5*	-----	-----
	NaNO <sub>3</sub>	-----	-----	-----	-----	1.35x10 <sup>-3</sup> @ 0C	6*	-----	-----
	KNO <sub>3</sub>	-----	-----	-----	-----	-----	-----	-----	-----
14797-65-8	Nitrites	-----	-----	-----	-----	-----	-----	-----	-----
	NaNO <sub>2</sub>	1.39	19*	1.67x10 <sup>-1</sup>	19*	0.15x10 <sup>-3</sup> @ 15C	5*	-----	-----
	KNO <sub>2</sub>	-----	-----	-----	-----	8.15x10 <sup>-3</sup> @ 25C	19*	-----	-----
						2.80x10 <sup>-3</sup> @ 0C	6*	-----	-----

## DN List Parameter Alt Copy

CAS NUMBER	NAME	Log Equilibrium Constant				Photolysis Rate Constant			
		Viscosity (cP)	Ref.	Density (g/cm <sup>3</sup> )	Ref.	pK <sub>1,2,3,4</sub>	Ref.	p (hr <sup>-1</sup> )	Ref.
67-66-3	Chloroform	0.596 @ 15C	2*	1.489 @ 20C <sup>1.14</sup>	1*	NEK 1.12	13e	PNEK 1.13	13e
		0.514 @ 30C	2*	1.49885 @ 15C	5*				
		0.529 1.1 @ 25C	43*	1.4832 @ 20C <sup>1.10</sup>	6*				
71-43-2	Benzene	0.6407 @ 20C	2*	0.9786 @ 20C <sup>2.33</sup>	1*	---	---		
		0.6028 @ 25C	2*	0.9794 @ 20C	5*				
		0.5621 @ 30C	2*	0.9791 2.3	22*				
		0.65001 @ 20C <sup>2.3</sup> 22*	0.9737 2.5		22*				
		0.64983 @ 20C <sup>2.4</sup> 22*	0.977		19*				
		0.60345	0.9765 @ 20C		6*				
		0.5932 3.3 @ 25C	43*						
110-18-4	Hexachlorobenzene	---	---	2.044 @ 23C	4*	---	0.000014 3.7	47a	
		1.57	5*				0.000666 3.11	47a	
		2.044	19*				---	3.10	47a*
		1.5691	6*				---	3.4	48*
							---	3.5	48*
127-18-4	Tetrachloroethylene	0.932 @ 15C	2*	1.6227 @ 20C	6*	---	0.57 6.0 <sup>-1</sup> 4.3	32a	
		0.798 @ 30C	2*	1.6311 @ 15C	3*		0.078 6.0 <sup>-1</sup> 4.4	32a	
		0.844 1.1 @ 20C	43*	1.623 @ 25C	19*		---	4.11	35a*
							---	4.17	36c
121-14-2	2,4-Dinitrotoluene	---	---	1.3208 @ 71C	6*	---	1.6x10 <sup>-2</sup> 5.3	13*	
		1.320	19*						
7440-38-2	Arsenic and Compounds	---	---	7.738 6.3	6*	pK <sub>1</sub> 5.9x10 <sup>-10</sup> @ 25C 6.0	6*	---	
1303-28-2	Arsenious Acid 4.1,2,7 (H <sub>3</sub> AsO <sub>3</sub> )	---	4.4	---	---	pK <sub>2</sub> 9.23 @ 25C 6.0	6*	---	
		---	6.3	---	---	pK <sub>3</sub> 12.13 @ 25C 6.12	46b	---	
		---	4.4	---	---	pK <sub>3</sub> 12.71 @ 25C 6.10	46b	---	
		---	6.3	---	---	pK <sub>2</sub> 9.79 6.11	46b	---	
		---	4.4	---	---	pK <sub>2</sub> 9.294	18*	---	
		---	6.3	---	---				

## DN List Parameters Draft Copy

<u>CAS Number</u>	<u>Name</u>	<u>Viscosity</u>	<u>Density</u>	<u>log</u>	<u>Photolysis</u>
		<u>(cp)</u>	<u>Ref.</u> <u>[g/cm<sup>3</sup>]</u>	<u>Ref.</u> <u>[K, pK<sub>1</sub>, pK<sub>2</sub>]</u>	<u>Equilibrium Constant</u>
1327-53-3	Arsenic Acid <sup>7,8</sup> (H <sub>3</sub> AsO <sub>4</sub> )	----	4.32	6*	pK <sub>1</sub> , 2.3 @ 25°C 7.0 pK <sub>2</sub> , 6.8 @ 25°C 7.7 pK <sub>3</sub> , 11.5 @ 25°C 8 pK <sub>4</sub> , 2.24 25°C 7.6 pK <sub>2</sub> , 6.94 25°C 7.7 pK <sub>3</sub> , 11.50 25°C 7.0 pK <sub>1</sub> , 2.19 pK <sub>2</sub> , 6.94 pK <sub>3</sub> , 11.50
7440-41-7	Beryllium (Be(OH) <sub>2</sub> )	----	1.92	3*	pK <sub>2</sub> = 11.3
14797-55-8	Nitrates	----	----	6*	----
					3.3 x 10 <sup>-5</sup> sec <sup>-1</sup> 9.4
					----- 9.7
					----- 9.10
					10 <sup>-4</sup> sec <sup>-1</sup> 9.11
					----- 9.12
					40 <sup>a</sup>
					0.041 obsr <sup>-1</sup> 9.0
					0.0608 sec <sup>-1</sup> 9.0
14797-65-8	Nitrites	----	----	5*	----
					2.168
					2.170
					1.915
					5*

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<u>CAS NUMBER</u>	<u>NAME</u>	<u>BIODEGRADATION</u>			<u>SORPTION</u>		
		<u>RATE CONSTANT (AERONIC)</u>	<u>RATE CONSTANT (MALEICIC)</u>	<u>REF</u>	<u>MOLECULAR DIFFUSIVITY [cm<sup>2</sup>/s]</u>	<u>COEFFICIENT (K<sub>a</sub>)</u>	<u>REF</u>
67-66-3	Chlorofor <sup>m</sup>	----	----	----	0.06681 <sup>m</sup> @ 25C	44 <sup>m</sup>	----
71-43-2	Benzene	2. <sup>a</sup>	25 <sup>a</sup>	----	0.09322-30 @ 25C	44 <sup>a</sup>	-----2.29
		2. <sup>a</sup>	25 <sup>a</sup>	----		2.4 2.14	26 <sup>a</sup>
		2. <sup>a</sup>	25 <sup>a</sup>	----		1.8 2.17	26 <sup>a</sup>
		2. <sup>a</sup>	25 <sup>a</sup>	----		30.9 2.18	26 <sup>a</sup>
		2. <sup>a</sup>	25 <sup>a</sup>	----		4.4 2.19	26 <sup>a</sup>
		2. <sup>a</sup>	25 <sup>a</sup>	----			
		2. <sup>a</sup>	25 <sup>a</sup>	----			
		2. <sup>a</sup>	25 <sup>a</sup>	----			
110-16-4	Hexachlorobenzene	----	----	----	0.0593-2 @ 25C	45 <sup>c</sup>	2627 3. <sup>v</sup>
					1.6x10 <sup>-6</sup> cm <sup>2</sup> /day 3.16	9 <sup>a</sup>	-----3.0
							4.193 3.13 ng/g
							276 3.14 ng/g
							136 3.16 ng/g
							16 <sup>a</sup>
127-18-4	Tetrachloroethylene	4. <sup>a</sup>	31 <sup>a</sup>	----NAD 4.1	30 <sup>a</sup>	0 <sup>a</sup> / 0 <sup>a</sup> = 0.5 4.19	36 <sup>a</sup>
		4. <sup>a</sup>	33 <sup>a</sup>	----NAD 4.1		0 <sup>a</sup> / 0 <sup>a</sup> = 0.30 4.16	36 <sup>a</sup>
		4. <sup>a</sup>	30 <sup>a</sup>	----		0.0797 <sup>a</sup> @ 25C	45 <sup>a</sup>
121-14-2	2,4-Dinitrotoluene	----	----	----	----	----	----
7440-39-2	Arsenical Compounds	----	----	----	----	----	----
1303-28-2	Arenous Acid <sup>d</sup> , <sup>e</sup> , <sup>f</sup> , <sup>g</sup> (H <sub>3</sub> AsO <sub>3</sub> )	----	----	----	----	----	----
1327-53-3	Arsenic Acid <sup>d</sup> , <sup>i</sup> (H <sub>3</sub> AsO <sub>4</sub> )	----	7.3	----	----	----	----
7440-41-7	Beryllium [Be(OH) <sub>2</sub> ]	----	----	----	----	----	----

## DW List Parameters t\_Copy

<u>CAS NUMBER</u>	<u>NAME</u>	<u>BIODEGRADATION</u>		<u>MOLECULAR</u>		<u>SORPTION</u>	
		<u>RATE CONSTANT (AEROBIC)</u>	<u>REF</u>	<u>DIFFUSIVITY (ANNEOBATIC)</u>	<u>REF</u>	<u>EFFECTIVE COEFFICIENT (K<sub>a</sub>)</u>	<u>REF</u>
14797-55-8	Nitrates	----- <sup>-9.2</sup>	41*	----- <sup>-9.2</sup>	41*	10 <sup>-4</sup> Ca <sub>25-1</sub> *. <sup>3</sup>	41*
	NaNO <sub>3</sub>			13.6x10 <sup>-4</sup> s <sup>-1</sup> *. <sup>13</sup>	41*	1.8x10 <sup>3</sup> Ca <sub>25-1</sub> *. <sup>4</sup>	41*
	KNO <sub>3</sub>			15.6x10 <sup>-4</sup> s <sup>-1</sup> *. <sup>14</sup>	41*		
				1.9x10 <sup>-4</sup> s <sup>-1</sup> *. <sup>15</sup>	41*		
				3.2x10 <sup>-4</sup> s <sup>-1</sup> *. <sup>16</sup>	41*		
				13.2x10 <sup>-4</sup> s <sup>-1</sup> *. <sup>17</sup>	41*		
				9.5x10 <sup>-4</sup> s <sup>-1</sup> *. <sup>18</sup>	41*		
				4.7x10 <sup>-4</sup> *. <sup>19</sup>	41*		
				4.5x10 <sup>-4</sup> *. <sup>20</sup>	41*		
				0.8x10 <sup>-4</sup> *. <sup>21</sup>	41*		
				0.6x10 <sup>-4</sup> *. <sup>22</sup>	41*		
				0.5x10 <sup>-4</sup> *. <sup>23</sup>	41*		
				0.6x10 <sup>-4</sup> *. <sup>24</sup>	41*		
				1.0x10 <sup>-4</sup> *. <sup>25</sup>	41*		
				0.8x10 <sup>-4</sup> *. <sup>26</sup>	41*		
				1.0x10 <sup>-4</sup> *. <sup>27</sup>	41*		
				1.3x10 <sup>-4</sup> *. <sup>28</sup>	41*		
				1.2x10 <sup>-4</sup> *. <sup>29</sup>	41*		
				2.9x10 <sup>-4</sup> *. <sup>32</sup>	41*		
				2.7x10 <sup>-4</sup> *. <sup>33</sup>	41*		
				8.8x10 <sup>-4</sup> *. <sup>34</sup>	41*		
14797-55-8	Nitrates	-----	41	-----	41	-----	41
	NaNO <sub>3</sub>						
	KNO <sub>3</sub>						

- 1.1 Viscosity unit is "mPa-s"
- 1.2 Value of  $K_{oc}$  was calculated from the  $K_{ow}$  value using the equation  
 $K_{oc}=0.48K_{ow}$ .
- 1.3 Value of  $K_{ow}$  was obtained by computer calculation, using FRAGMENT calculation procedure.
- 1.4 In  $hr^{-1}$ . Estimated for pH7 and 25C from data (Radding, et al.) extrapolated from 100-150C. Corresponds to "a first order rate constant for hydrolysis of  $6.9 \times 10^{-12} \text{ sec}^{-1}$ ". The "validity of the extrapolation method has not been established". This value is "in sharp contrast" to the first-order rate constant of 0.045 month $^{-1}$  (Dillinger, et.al.) reflecting a "primarily ionic" mechanism. Discrepancies exist for other halomethanes.
- 1.5 Diffusivity in air in  $\text{cm}^2 \text{ s}^{-1}$
- 1.6 In  $\text{M}^{-1} \text{ hr}^{-1}$ .
- 1.7 In  $hr^{-1}$ : at 25C.
- 1.8  $k_a=0$  "No acid catalyzed mechanism".
- 1.9 In  $hr^{-1}$ .
- 1.10 Specific gravity; relative to water at 4X.
- 1.11 Calculated from vapor pressure and solubility at 20C.
- 1.12 NER = pK "not environmentally relevant".
- 1.13 PNER = "photolysis not environmentally relevant".
- 1.14 Specific gravity.
- 1.15  $K_{oc}$  in ml/g.
- 1.16 Level of confidence = error = greater than one order of magnitude (Note: this reference contains many values for  $H_c$ ; all approximately the same value).
- 2.1 Observed [from A. Leo, Hansch, and Elkins; Chem Rev 71,525(1971) and C. Hansch and A. Leo "Substituent Constants for Correlation Analysis in Chemistry and Biology" John Wiley & Sons, N.Y., 1979]
- 2.2 Log  $K_{ow}$  calculated as function of solubility.
- 2.3 Experimentally determined from Kinematic viscosity at 20C 99.7% pure,  $\nu=0.73952 \text{ mm}^2/\text{s}$  and density  $d=0.8791 \text{ g/cm}^3$ .
- 2.4 Experimentally determined from Kinematic viscosity at 20C, 99% pure  $\nu=0.73920 \text{ mm}^2/\text{s}$ , and d as in footnote 2.3.

- 2.5 Experimentally determined from kinematic viscosity  $\nu=0.69068$  at 25C, 99.7% pure, density  $d=0.8737$ .
- 2.6 Aqueous solubility; determined on estuarine colloids; organic carbon = 42.0mg/l.
- 2.7 Associated with value for  $K_p$ , correlated experimentally with GLC retention time.
- 2.8 100% degradation; benzene at 5ug/L; third subculture; representing biota of domestic sewer sludge. 1st subculture 49% biodegradation.
- 2.9 66% removal; biological treatment system; 8.8ug/L influent level; by municipal activated sludge.
- 2.10 92% removal; 7.7 ug/L influent level; municipal activated sludge.
- 2.11 90-100% removal; industrial activated sludge.
- 2.12 96% removal; aerated lagoon; 6.53ug/L influent level.
- 2.13 99% removed; 160ug/L influent level; activated sludge with powdered activated carbon added.
- 2.14 >60% removed; 10,250ug/L influent level. Industrial activated sludge.
- 2.15 >84% removed; 46.9ug/L influent level; Industrial activated sludge.
- 2.16  $K_d=2.4$ , Hastings silty clay loam.
- 2.17  $K_d=1.8$  Overton silty clay loam.
- 2.18  $K_d=3.09$  Al-saturated montmorillonite.
- 2.19  $K_d=4.4$  Ca-saturated montmorillonite.
- 2.20 At 25C; corresponds with vapor pressure value of 95.19mmHg. Concentrations in water at equilibrium with threshold value = 0.15mg/L.
- 2.21 At 40C; corresponds with vapor pressure of 182.86mmHg. Concentration in water at equilibrium with threshold value = 0.08mg/L.
- 2.22 At 25C; see footnote 2.20.
- 2.23 At 40C; see footnote 2.21.
- 2.24 Saturation vapor pressure; determined in conjunction with  $K_d$  (see footnote 2.25).

- 2.25 At 23.8C Uptake of benzene vapors by dry woodburn O relative humidity soil: ~30mg/g at P/P =1; 13mg/g at P/P =0.85; ~11mg/g at P/P =0.8; ~7.5mg/g at P/P =0.35.  
At 20C uptake at 50% relative humidity; ~8mg/g at P/P =0.6; ~5mg/g at P/P =0.4; (linear relationship).  
At 90% relative humidity ~4mg/g at P/P =0.6; ~2mg/g at P/P =0.5.  
P/P = relative vapor concentration; P = equilibrium partial pressure; DO = saturation vapor pressure.
- 2.26 At 25C [given as 1,789gm-3]  
from McAuliff C., J. Phys Chem 70, 1267(1966)
- 2.27 From Zwolinski, Wilhoit, "Handbook of Vapor pressures and Heats of Vaporization of Hydrocarbons and Related Compounds" API, 44-TRC-Publ. in Sci and Eng., 1971.
- 2.28 Calculated from measured values.
- 2.29 Experimentally determined.
- 2.30 Diffusivity in air.
- 2.31 Hydrolysis not significant.
- 2.32 NHFG = "No hydrolyzable functional group".
- 2.33 Viscosity unit is "mPa-s"
- 2.34 Value of Koc was calculated from the Kow value (135), using the equation  $K_{oc} = 0.48K_{ow}$ . (See footnote 2.38.)
- 2.35 Specific gravity; relative to water at 4C.
- 2.36 Error (level of confidence) =  $\pm 30\%$ .
- 2.37 Calculated from vapor pressure and solubility at 25C.
- 2.38 Calculated by computer calculation (FRAGMENT).
- 3.1 Value of koc was calculated from the kow value using the equation  $k_{oc} = 0.48k_{ow}$ .
- 3.2 Value of kow was obtained by computer calculation, using FRAGMENT calculation procedure.
- 3.3 Diffusivity in air calculated using F,S and G method (Lyman, 1982).
- 3.4 Photolysis of solid hexachlorobenzene on silica gel "extremely slow":. Sample irradiated for 4.5h in sunlight "extremely small amounts of photoproducts". Crystalline hexachlorobenzene exposed

- 5 months to "sun lamp or laboratory illumination" had no detectable photoproducts as determined by (by GLC or HPLC).
- 3.5 After 15 days irradiation in sunlight; 38% recovered from hexachlorobenzene in methanol.
- 3.6 From Callahan, Slimak, and Gabel, et al. Water Related Environmental Fate of 129 Priority Pollutants. EPA 440/4-79-0296, US EPA; Washington, DC. (ref 13)
- 3.7 Calculated from experimental data and from empirical relationship;  $K_p$  for pure water (see footnote 3.10).
- 3.8  $K_{sorp}$  = rate constant for sorption by sediment (0.13mL/cm<sup>2</sup>hr).  $k_{desorp}$  = rate constnt for desorption from sediment; 0.00067 hr<sup>-1</sup>.
- 3.9 Experimentally determined; pond sediment
- 3.10 Quantum yeild = 0.00603 at 313nm in distilled water.
- 3.11 Photolysis rate constant calculated for 40 north latitude at noon in the fall, in hr<sup>-1</sup>.
- 3.12 Volatization rate constant 2.76 cm/hr.
- 3.13 Soil: Houghton Mock (16.81% organic carbon). Freundlich, K; units ng/g. Experimental absorption of C-hexachlorobenzene by soils from aqueous solution. Data plotted according to Freundlich adsorption equation (from a Adamson, 1967)  $x/m = KC^{-n}$ . x = ug (or ng) of compound sorbed. m = weight of adsorbent in g. c = equilibrium concentration of solution (in ug or ng/l).
- 3.14 Catlin silt loam; 4.73% organic carbon;  $1/2 = 0.99$  (see footnote 3.13).
- 3.15 Ava silty clay loam; 1.18% organic carbon;  $1/n = 0.93$  (see footnote 3.13).
- 3.16  $D_o$  = vapor diffusion coefficient in air (in cm<sup>2</sup>/day). Experimentally determined utilizing Fick's first law:  $J = D_s(c_2 - c_s)/L$  and equation (developed from Millington and Quirk, 1961)  $D_s = D_s(p_a 10/3/Pt^2)$  where J = vapor flux through soil (in ug cm<sup>-2</sup> day<sup>-1</sup>);  $D_s$  = apparent steady-state diffusion coeffient ( in cm<sup>2</sup>/day);  $c_s$  = concentration or vapor density of volatile substance in air at soil surface (in mg/liter);  $c_2$  = concentration in air at bottom of soil layer (in mg/liter); L = soil depth (in cm),  $p_a$  = soil air-filled porosity (in cm<sup>3</sup>/cm<sup>3</sup>); and Pt = total soil porosity (in cm<sup>3</sup>/cm<sup>3</sup>).
- 3.17 Vapor pressure calculated from  $\log p = 12.94 - (5279/T)$ .
- 3.18 Literature values "extrapolated from the data of Sears and Hopke (1949).

- 3.19 Experimentally determined; calculated from vapor density (wt/vol) by  $\rho = (\text{wt/vol}) (RT/M)$ .
- 3.20 From unpublished data M. Yang and W.J. Farmer.
- 3.21 At infinite dilution.
- 3.22 Solubility 2.22 ppb in creek water (C. Griffin and Chou, 1980).
- 3.23 Henry's law constant calculated from vapor pressure and solubility at 25°C.
- 3.24 HNES = "Hydrolysis not significant".
- 4.1 N.A.D "No Appreciable Degradation" in aerobic or anaerobic condition.
- 4.2 No observable biodegradation.
- 4.3 Photolysis in purified water. The rate of substrate disappearance is represented by the linear combination of four contributing processes; purging, photolysis ozonization, and photolytic oxidation. Data refers to photolysis process only.
- 4.4 In lake water. See footnote 4.3.
- 4.5 No degradation observed in live or dead culture.
- 4.6 From Chiou, Peters, Freed; Science 1979, 206, 831.
- 4.7 From  $\log K_{oc} = 0.72 \log K_{ow} + 0.49$ .
- 4.8 From  $\log K_{oc}=1.00 \log K_{ow}-0.21$  (Karichkhoff, Brown, Scott, Water Res 1979, 13, 241).
- 4.9 From Chiou, Schmedding, Kohnert, Env. Sci. Tech. 1977, 11, 475.
- 4.10 From average of six measurement b (extrapolated) from measured.
- 4.11 Measured half-lives ( $t_{1/2}$ ): 14.2h for tetrachloroethylene at 10 ppm, no 5ppm; 1 atm, 27 $\pm$ 1°C, 9.58L UV cutoff 290nm; I=2.6x natural sunlight/noon (summer (Texas)) 35-40% relative humidity (94 uLH2O)  
a/measured  $t_{1/2}$  = 12.5 hr; same conditions;  
b extrapolated  $t_{1/2}$  : 83hr CC12=CC12 10ppm; NO2 16.8 ppm from measured  
a meas  $t_{1/2}$  7.0hr; as above  
b extrap from meas  $t_{1/2}$  : 11.2hr CC12=CC12 10ppm; 5ppm NO  
a meas  $t_{1/2}$  6.5hr; as above

- a meas t<sub>1/2</sub> 7.0hr CC<sub>12</sub>=CC<sub>12</sub>=40ppm ND; 20ppm
- a meas t<sub>1/2</sub> 3.8hr CC<sub>12</sub>=CC<sub>12</sub>=100ppm ND; 50ppm
- 4.12 Hydrolysis "not relevant"
- 4.13 Calculated from Kow f(oc)(s) Koc = K<sub>p</sub>(s)<sup>2</sup> × b<sub>x</sub>(Kow)a in units of m<sup>3</sup> m<sup>3</sup> g<sup>-1</sup> oc (not a dimensionless ratio).
- 4.14 Calculated; empirical relationship.
- 4.15 Calculated ratio of molecular diffusivity of perchloroethylene in aqueous solution to diffusivity of oxygen in aqueous solution. Dimensionless, individual diffusivity terms in area (m<sup>2</sup>) per time (hr).
- 4.16 Calucated ratio of molecular diffusivity of perchloroethylene in air to that of water in air from D<sub>g</sub>/D<sub>wg</sub>=85(1/m<sup>2</sup>+0.0347)<sup>1/2</sup> × ((E<sub>V2</sub>)<sup>1/3</sup>+2.72)<sup>1/2</sup>
- 4.17 Photolysis not relevant.
- 4.18 Hydrolysis rate is not environmentally significant.
- 4.19 Vicosity unit is "mPa-s".
- 4.20 Value of Koc was calculated from the Kow value using the equation Koc=0.48Kow.
- 4.21 Diffusivity in air calculated using F,S and G method (Lyman, 1982).
- 5.1 Henry's law constant calculated by (Vapor Pressure) (MW)/(Solubility).
- 5.2 HNES - "Hydrolysis not environmentally significant".
- 5.3 Photolysis rate constant calculated for summer at 40° latitude.
- 5.4 Henry's law constant calculated from vapor pressure and solubiity. Level of confidence (error) ±1 order of magnitude.
- 5.5 Calculated by the method Tute 1971.
- 5.6 Calculated from Koc = 0.48 Kow.
- 6.1 Arsenious acid; the acid that corresponds to arsenite salts. Does not exist in solid, free state; exists in solution as arsenite anion.
- Arsenious acid is Oxyanion of Arsenic III; subject to oxidation reactions (i.e. reducing agent) yeilding AsIV (arsenate).

Predominant species in reduced conditions; unstable in oxidized conditions where eV=0.

Various formulas exist for the acid (which is hypothetical entity); H<sub>3</sub>AsO<sub>3</sub> or HAsO<sub>2</sub>. Usually considered indentical; but data exists differentiating between the two (see reference 46).

6.2 Water solubility of arsenious acid is not applicable, since solid arsenious acid does not exist outside of solution. Solubility is defined for arsenite anions as specific salts.

6.3 Vapor pressure of Arsenious acid not applicable since solid compound does not exist in free state.

6.4 Viscosity for this parameter is not applicable since it is not a fluid.

6.5 Density - this parameter not applicable to arsenious acid; since pure compound does not exist. Paramter is relevant for; compounds of arsenious acid (ex: salts), and solutions of organites (arsenous acid salts).

6.6 Values for this parameter are applicable only to a stable solution containing arsenite anion. The solution species that exists is a function of pH and electrochemical potential (eV).

6.7 The following equations describe the oxidation-reduction of [(arsenious acid/arsenites) and oxides]. [These equilibria are related to pKa.] K calculated by

6.8 For H<sub>3</sub>AsO<sub>3</sub><--->H<sub>2</sub>AsO<sub>3</sub><sup>-</sup> +H<sup>+</sup>

6.9 For H<sub>2</sub>AsO<sub>3</sub><--->HAsO<sub>3</sub><sup>-2</sup> +H<sup>+</sup>

6.10 For HAsO<sub>3</sub><sup>-2</sup><--->AsO<sub>3</sub><sup>-3</sup> +H<sup>+</sup>

6.11 For HAsO<sub>2</sub><--->AsO<sub>2</sub><sup>-</sup> +H<sup>+</sup>

6.12 For H<sub>2</sub>AsO<sub>3</sub><--->HAsO<sub>3</sub><sup>-</sup> +H<sup>+</sup>

7.1 Arsenic Acid. Arsenic acid exists as H<sub>3</sub>AsO<sub>4</sub> only in pure solid phase. Arsenic acid in natural ground water systems exists as a solution that is dissociated to an extent controlled by pH. In solution H<sub>3</sub>AsO<sub>4</sub>, H<sub>2</sub>AsO<sub>4</sub><sup>-2</sup>, HAsO<sub>4</sub><sup>-3</sup>, and AsO<sub>4</sub><sup>-4</sup> occur. H<sub>3</sub>AsO<sub>4</sub> exists as main species in acidic environment (pH<pKa), AsO<sub>4</sub><sup>-2</sup> exists as main species in alkaline environment. At pH 4-9, HAsO<sub>4</sub><sup>-2</sup> and H<sub>2</sub>AsO<sub>4</sub><sup>-</sup> predominate.

Arsenic acid is a special case of arsenate, (i.e. "hydrogen arsenate"). In any natural environmental situation, the species that exists are arsenates of metal cations. Arsenic acid (arsenates) are also formed by dissolution of arsenic trioxide and pentoxide (As<sub>2</sub>O<sub>3</sub> and As<sub>2</sub>O<sub>5</sub>); and oxidation-reduction reactions of arsenites (arsenous acid).

7.2 The solubility of arsenates is controlled by the metal ions present. Any dissolved arsenic acid species will precipitate out of solution when dissolved metals are present, and arsenites will redissolve when the concentration of metal cations in the aqueous environment is less than the concentration of metal cations in the solubility product constant ( $K_{sp}$ ).

Arsenic acid is formed from dissolved  $As_2O_5$  in water or  $As_2O_3$  (depending on pH, eV).

Arsenic acid (arsenate) is interconvertable to arsenite by reduction. Wide application of this redox ( $As^{III} + 2e^- \rightarrow As^V$ ) is employed in chemistry. The lower valence states of many metals, inorganic anions, etc., participate in redox reactions; i.e.  $Fe^{+2}$ ;  $Cu^{+1}$ ;  $Cr^{+3}$ , etc.

7.3 Arsenic acid is subject reduction by biodegradation to arsine ( $AsH_3$ ), a volatile gas, and to methyl and dimethyl arsine.

7.4 Does not exist in gaseous state " $2H_3AsO_4 \rightarrow 3H_2O + As_2O_5$ "

7.5 Not applicable; a solid.

7.6 Calculated for  $H_3AsO_4 \rightarrow H_2AsO_4^- + H^+$

7.7 For  $H_2AsO_4 \rightarrow HAsO_4^- + H^+$

7.8 For  $HAsO_4^- \rightarrow AsO_4^{3-} + H^+$

7.9 The following equations describe the solubility of arsenic acid (arsenate) with cations in solution (see footnote 6.8).  $K = K_{sp}$  solubility is a function of pH.

$AsS(\text{realger}) + 8H_2O \rightleftharpoons HAsO_4^{3-} + SO_4^{2-} + 11H^+ - 83.13$
$As_2S_3(\text{Orpiment}) + 16H_2O \rightleftharpoons 2HAsO_4^{3-} + 2SO_4^{2-} + 22H^+ - 180.42$
$As_2S_3(c) + 20H_2O \rightleftharpoons 2HA_3O_4^{3-} + 3SO_4^{2-} + 30H^+ - 219.14$
$AlAsO_4(c) + H^+ \rightleftharpoons Al^3+ + HAsO_4^{3-} - 4.70$
$Ca_3(AsO_4)_2(c) + 2H^+ \rightleftharpoons 3Ca^{2+} + 2HAsO_4^{3-} - 1.91$
$Cd_3(AsO_4)_2(c) + 2H^+ \rightleftharpoons 3Cd^{2+} + 2HAsO_4^{3-} - 8.97$
$Cu_3(AsO_4)_2(c) + 2H^+ \rightleftharpoons 3Cu^{2+} + 2HAsO_4^{3-} - 14.97$
$FeAsO_4(c) + H^+ \rightleftharpoons Fe^{3+} + HAsO_4^{3-} - 8.59$
$Mn_3(AsO_4)_2(c) + 2H^+ \rightleftharpoons 3Mn^{2+} + 2HAsO_4^{3-} - 8.51$
$Ni_3(AsO_4)_2(c) + 2H^+ \rightleftharpoons 3Ni^{2+} + 2HAsO_4^{3-} - 2.71$
$Pb_3(AsO_4)_2(c) + 2H^+ \rightleftharpoons 3Pb^{2+} + 2HAsO_4^{3-} - 9.07$
$Zn_3(AsO_4)_2(c) + 2H^+ \rightleftharpoons 3Zn^{2+} + 2HAsO_4^{3-} - 8.20$

The following reaction describes the solubility of arsenic pentoxide in water to form arsenic acid.

7.10 The following equations describe the oxidation-reduction reactions of Arsenite-Arsenate (Arsenious acid-Arsenic Acid). (See footnote 7.8.) These values describe the relationship of the equilibrium constant (acid dissociation constant and oxidation-reduction.

9.1 Nitrates ( $\text{NO}_3^-$ ) do not exist as stable species per se, but as the anionic portion of a solid; crystalline ionic species, occurring with a cation, forming a neutral molecule. (The ionic character of these crystals exists in degrees depending on the metal.) It is in the form that nitrates enter the environment - as dissolved salts (or less frequently, from dissolved nitrogen oxides).

Nitrogen oxides dissolved in water form nitric acid (nitrates), nitrous acid (nitrites, etc.). The many varieties of nitrogen oxides are in equilibrium with each other via oxidation-reduction, photolysis, evaporation, dissolution etc., in complex interrelationships that also include molecular nitrogen ( $\text{N}_2$ ) and ammonia ( $\text{NH}_3$ ). Nitrates dissolved in water in varying amounts depending on the cation-forming "free" nitrate anions. Nitric acid is special case of nitrates (hydrogen nitrate).

Nitrates and other species of nitrogen are involved in biodegradation/biotransformation.

9.2 Overall disappearance of nitrate by "biodegradation" =  $K = \text{denitrification} + \text{reduction to ammonia}$ .  $K = KD + KA$ .  $KA = \text{rate constant for nitrate reduction, approximated as 1st order}$ .  $KD = \text{denitrification} = 1 \times 10^{-6} \text{ s}^{-1}$ .  $KA = 2 \times 10^{-6} \text{ to } 8 \times 10^{-6}$ ; average  $5 \times 10^{-6}$ .

9.3 Mass transfer coefficient; estimated  $10^{-4} \text{ cm}^2 \text{ s}^{-1}$  (from Vanderborgh).

9.4 Diffusion coefficient for nitrate in pure water  $1.8 \times 10^{-5} \text{ cm}^2 \text{ s}^{-1}$  (Handbook Chemistry and Physics, 1969).

9.5 Nitrates are salts of nitric acid;  $\text{HNO}_3$  [strong acid], ~ completely dissociated "nitric acid" would be present in nitrate solutions from many processes including:

- a) Hydrolysis of water by cation  $M_m\text{H}_2\text{O} \rightarrow M_{(m-1)}^{+} + (\text{OH}^-)_m + \text{H}^+$
- b) photolysis of  $\text{NO}_3^-$  yielding nitrite and peroxy nitrite
- c) oxidation-reduction of nitrate and derivatives of nitrate
- d) solution-gas phase equilibration of nitrogen oxides ( $\text{N}_2\text{O}$ ,  $\text{NO}$ ,  $\text{NO}_2$ ,  $\text{N}_2\text{O}_3$ ,  $\text{N}_2\text{O}_4$ ,  $\text{N}_2\text{O}_5$ ) anions and radicals
- e) biodegradations.

9.6  $k_p 1$  for (see original article) formation of nitrates under  $\text{NO}_2 + \text{NO}_2 \rightarrow \text{NO}_3^- + \text{NO}$ .  $P = 0.40 \text{ torr}$ ; 2%  $\text{NO}_2$  in  $\text{CO}_2$ . Wavelengths 4131-5309A

Measured from slope of graph of values of photolysis of 2M1 Molar  $\text{NO}_3^-$  at 254nm alkaline (pH 12) solution: for reaction  $(\text{NO}_3^-) * \rightarrow \text{NO}_2 + \text{O}$  (presented as rate of formation of nitrate per time.) Yield varies linearly with time.  $8 \times 10^{-4} \times (\text{NO}_2\text{-yield})/\text{mole} = 25 \times 10^{-4} \text{ time(sec)}$ : reaction inhibited by presence of added nitrate.  $\text{NO}_2^-$

- is not an inhibitor in alkaline photolysis, but absorbs energy.
- 9.7 kp2 for CO<sub>3</sub>-+NO<sub>2</sub> NO<sub>3</sub>-+CO<sub>2</sub> formation of nitrate same parameters as above.
- Reaction in acidic solutions involves protonation of (NO<sub>3</sub>-)\*; and self inhibited reaction.
- In acidic solution; (pH2.8) 254nm, 293K, irradiated 3,600s; presence of NaASO<sub>2</sub> increases quantum yield by factor of ~30, lesser degrees of increase observed for reaction in presence of stand, allyl alcohol, and sodium bromide.
- 9.8 kp3 for NO<sub>3</sub>-+H<sub>2</sub>O+CO<sub>2</sub> NO<sub>3</sub>-+H<sub>2</sub>O+CO<sub>2</sub> formation of isomer of nitrate (probably OONO-) from nitrate same parameters as above.
- Photolysis rate constant for crystalline NaNO<sub>3</sub> at 203±5K P=3x10<sup>-7</sup> Pa (1Torr=133.3Pa) radiation 1254cv (1.60x10<sup>-19</sup> J=lev)
- 9.9 Photolysis rate constant for crystalline KNO<sub>3</sub>. See footnote 9.7 for values of parameters.
- 9.10 Photolysis of sodium nitrate solutions (3.6.5 mole l-1) at pH12 by UV light at 25C.
- 9.11 Photolysis rate of reaction of Ethanol with NO<sub>3</sub> radical. C<sub>2</sub>H<sub>5</sub>OH+NO<sub>3</sub> C<sub>2</sub>H<sub>3</sub>OH+NO<sub>2</sub>+H<sub>2</sub>O rate (for production of nitrite from nitrate) than without ethanol; at given pH value; "apparently due to the acceptor properties of ethanol with respect to the NO<sub>3</sub>. (NO<sub>3</sub> oxidized form of NO<sub>3</sub>-; nitrate).
- 9.12 Photoecomposition of nitrate to nitrite in alkaline solutions: in conditions of continuous irradiation NO<sub>3</sub>- (excited anions) "remains constant and low", relative to nitrate ions.
- 9.13 Denitrification rate; 10C; 3-10cm depth; 10/5/22hr incubation time; location areassp; 77.
- 9.14 As in note 9.13, 46 hr incubation time.
- 9.15 as above; 24 hr incubation time (10/19/77)
- 9.16 as above; 46 hr incubation time.
- 9.17 as above 12C 0-3 cm depth; sampled 9/28/77 Norway 22 hr incubation time.
- 9.18 as above; 47 hr incubation time
- 9.19 as above, 3-10cm depth: 22hr incubation time.
- 9.20 as above; 47 hr incubation time.
- 9.21 3-10cm depth, initial NO<sub>3</sub>-N (Nitrate nitrogen) 0.8mg l<sup>-1</sup> (sampled

5/17/71)

- 9.22 as above; NO<sub>3</sub>-N 4.8 mg l<sup>-1</sup>
- 9.23 3-10cm depth; NO<sub>3</sub>-N 1.2mg l<sup>-1</sup> (6/1/77)
- 9.24 as above; NO<sub>3</sub>-N 7.2 mg l<sup>-1</sup>
- 9.25 3-10cm; NO<sub>3</sub>-N 8.1mg l<sup>-1</sup>; (6/29/77)
- 9.26 as above; NO<sub>3</sub>-N 8.1mg l<sup>-1</sup>
- 9.27 0-3cm depth; NO<sub>3</sub>-N 0.8mg l<sup>-1</sup>; (7/14/77)
- 9.28 as above; NO<sub>3</sub>-N 3.8mg l<sup>-1</sup>
- 9.29 3-10cm depth; NO<sub>3</sub>-N 0.5mg l<sup>-1</sup>
- 9.30 as above; NO<sub>3</sub>-N 2.4mg l<sup>-1</sup>
- 9.31 0-3cm; NO<sub>3</sub>-N 0.6mg l<sup>-1</sup> (7/27/77)
- 9.32 as above; NO<sub>3</sub>-N 3.1 mg l<sup>-1</sup>
- 9.33 3-10cm; NO<sub>3</sub>-N 0.4mg l<sup>-1</sup>
- 9.34 as above, NO<sub>3</sub>-N 2.1mg l<sup>-1</sup>

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APPENDIX 4.4  
INPUT DATA FOR GENERIC RUNS

GENERIC RUN 1  
 HYDROGEOLOGIC CATEGORY: 4  
 CHEMICAL: CHLOROFORM

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	--	0.0282	--	0.0226	0.0351
S	%	Exponential	--	0.295	--	0.1	1
B	m	Exponential	--	45	--	37	59
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m³/yr	Uniform	--	0.2	--	0.1	0.3
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0.23	--	--	--	--
K <sub>n</sub>	hr <sup>-1</sup>	--	3 x 10 <sup>-9</sup>	--	--	--	--
K <sub>o,c</sub>	ml/g	--	31	--	--	--	--
"ADI"	mg/l	--	4.3 x 10 <sup>-4</sup>	--	--	--	--
Anaerobic biodegradation	s <sup>-1</sup>	--	0	--	--	--	--
q	m³/yr	Uniform	--	2	--	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	--	--	--	--	--
$\alpha_L$ outside the source	m	Derived from X: 0.1 X	--	--	--	0	60

GENERIC RUN 1  
 HYDROGEOLOGIC CATEGORY: 4  
 CHEMICAL: CHLOROFORM

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = \alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{oc}$	--	As defined by the CORR program

GENERIC RUN 2  
 HYDROGEOLOGIC CATEGORY: 4  
 CHEMICAL: HEXACHLOROBENZENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	—	0.0282	—	0.0226	0.0351
S	%	Exponential	—	0.295	—	0.1	1
B	m	Exponential	—	45	—	37	59
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.2	—	0.1	0.3
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>n</sub>	hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>c,c</sub>	ml/g	—	1.5 x 10 <sup>5</sup>	—	—	—	—
"ADI"	mg/l	—	2.1 x 10 <sup>-5</sup>	—	—	—	—
Anaerobic biodegradation	s <sup>-1</sup>	—	—	—	—	—	—
q	m/yr	Uniform	0	—	—	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\int A$ )	—	—	—	—	—
$\alpha_L$ outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 2  
 HYDROGEOLOGIC CATEGORY: 4  
 CHEMICAL: Hexachlorobenzene

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is a uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is a uniform distribution over the range 0.025 to 0.10
$f_{oc}$	—	As defined by the CORR program

GENERIC RUN 3  
 HYDROGEOLOGIC CATEGORY: 4  
 CHEMICAL: TETRACHLOROETHYLENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	--	0.0282	--	0.0226	0.0351
S	%	Exponential	--	0.295	--	0.1	1
B	m	Exponential	--	45	--	37	59
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.2	--	0.1	0.3
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>n</sub>	hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>o,c</sub>	mL/g	--	209	--	--	--	--
"ADI"	mg/l	--	6.76 x 10 <sup>-4</sup>	--	--	--	--
Anaerobic degradation							
q	s <sup>-1</sup>	--	0	--	--	--	--
$\alpha_L$ under the source	m/yr	Uniform	--	2	--	1	5.5
		Derived from A:					
		0.05 ( $\nabla A$ )	--	--	--	--	--
Derived from X:							
$\alpha_L$ outside the source	m	0.1 X	--	--	--	0	60

GENERIC RUN 3  
 HYDROGEOLOGIC CATEGORY: 4  
 CHEMICAL: TETRACHLOROETHYLENE

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{oc}$	--	As defined by the CORR program

GENERIC RUN 4  
 HYDROGEOLOGIC CATEGORY: 4  
 CHEMICAL: BENZENE

Parameter	Units	Distribution	Single Value		Standard Deviation	Minimum	Maximum
			Mean	—			
d	cm	Log <sub>10</sub> uniform	—	0.0282	—	0.0226	0.0351
S	%	Exponential	—	0.295	—	0.1	1
B	m	Exponential	—	45	—	37	59
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.2	—	0.1	0.3
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>n</sub>	hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>o</sub> c	mL/g	—	59	—	—	—	—
"ADI"	mg/l	—	6.63 x 10 <sup>-4</sup>	—	—	—	—
Anaerobic biodegradation	s <sup>-1</sup>	—	0	—	—	—	—
q	m/yr	Uniform	0	—	—	1	3
α <sub>L</sub> under the source	m	Derived from A: 0.05 (f/A)	—	—	—	—	—
α <sub>L</sub> outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 4  
 HYDROGEOLOGIC CATEGORY: 4  
 CHEMICAL: BENZENE

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{o,c}$	--	As defined by the CORR program

GENERIC RUN 5  
 HYDROGEOLOGIC CATEGORY: 4  
 CHEMICAL: 2,4 - DINITROTOLUENE

Parameter	Units	Distribution	Single	Mean	Standard Deviation	Minimum	Maximum
			Value				
d	cm	Log <sub>10</sub> uniform	--	0.0282	--	0.0226	0.0351
S	%	Exponential	--	0.295	--	0.1	1
B	m	Exponential	--	45	--	37	59
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.2	--	0.1	0.3
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>n</sub>	hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>o_c</sub>	mL/g	--	76	--	--	--	--
"ADI"	mg/l	--	1.13 x 10 <sup>-4</sup>	--	--	--	--
Anaerobic biodegradation	s <sup>-1</sup>	--	0	--	--	--	--
q	m/yr	Uniform	--	2	--	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\int A$ )	--	--	--	--	--
$\sigma_L$ outside the source	m	Derived from X: 0.1 x	--	--	--	0	60

GENERIC RUN 5  
 HYDROGEOLIC CATEGORY: 4  
 CHEMICAL: 2,4 - DINITROTOLUENE

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where $c$ is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where $c$ is an uniform distribution over the range 0.025 to 0.10
$f_{oc}$	--	As defined by the CORR program

GENERIC RUN 6  
 HYDROGEOLOGIC CATEGORY: 4  
 CHEMICAL: ARSENIC\*

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	--	0.0282	--	0.0226	0.0351
S	%	Exponential	--	0.295	--	0.1	1
B	m	Exponential	--	45	--	37	59
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.2	--	0.1	0.3
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>n</sub>	hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>o,c</sub>	mL/g	--	0	--	--	--	--
"ADI"	mg/l	--	2.33 x 10 <sup>-6</sup>	--	--	--	--
Anaerobic biodegradation	s <sup>-1</sup>	--	0	--	--	--	--
q	m/yr	Uniform	--	2	--	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	--	--	--	--	--
$\alpha_L$ outside the source	m	Derived from X: 0.1 X	--	--	--	0	60

GENERIC RUN 6  
 HYDROGEOLOGIC CATEGORY: 4  
 CHEMICAL: ARSENIC\*

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha'_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{oc}$	--	As defined by the CORR program

- \* Note that, since all chemical and biological decay constants are zero for both arsenic and beryllium, one run will cover both chemicals up to the post-processing step (conversion of  $C_D$  to concentration at the source).

GENERIC RUN 8  
 HYDROGEOLOGIC CATEGORY: 4  
 CHEMICAL: NITRATE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	—	0.0282	—	0.0226	0.0351
S	%	Exponential	—	0.295	—	0.1	1
B	m	Exponential	—	45	—	37	59
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.2	—	0.1	0.3
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>n</sub>	hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>o,c</sub>	ml/g	—	0	—	—	—	—
"ADI"	mg/l	—	3.45	—	—	—	—
Anaerobic biodegradation	s <sup>-1</sup>	—	3.2 x 10 <sup>-6</sup>	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\tilde{f}_A$ )	—	—	—	—	—
$\alpha_L$ outside the source	m	Derived from X: 0.1 x	—	—	—	0	60

GENERIC RUN 8  
 HYDROGEOLOGIC CATEGORY: 4  
 CHEMICAL: NITRATE

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{oc}$	--	As defined by the CORR program

GENERIC RUN 9  
 HYDROGEOLOGIC CATEGORY: 5  
 CHEMICAL: CHLOROFORM

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	—	0.0076	—	0.0054	0.0106
S	%	Exponential	—	1.217	—	1	2
B	m	Exponential	—	31	—	28	35
pH	°C	Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/Yr	Uniform	—	0.18	—	0.05	0.30
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	—	0.23	—	—	—	—
K <sub>n</sub>	hr <sup>-1</sup>	—	3 x 10 <sup>-9</sup>	—	—	—	—
K <sub>o_c</sub>	ml/g	—	31	—	—	—	—
"ADI"	mg/l	—	4.3 x 10 <sup>-4</sup>	—	—	—	—
Anaerobic biodegradation	s <sup>-1</sup>	—	0	—	—	—	—
q <sub>L</sub> under the source	m/Yr	Uniform	—	2	—	1	3
Derived from A: 0.05 ( $\sqrt{A}$ )		—	—	—	—	—	—
$\mathcal{A}_L$ outside the source		Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 9  
 HYDROGEOLOGIC CATEGORY: 5  
 CHEMICAL: CHLOROFORM

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^{-4} (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c \alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c \alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{oc}$	—	As defined by the CORR program

GENERIC RUN 10  
 HYDROGEOLOGIC CATEGORY: 5  
 CHEMICAL: HEXACHLOROBENZENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	—	0.0076	—	0.0054	0.0106
S	%	Exponential	—	1.217	—	1	2
B.	m	Exponential	—	31	—	28	35
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.18	—	0.05	0.30
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>n</sub>	hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>oc</sub>	mL/g	—	1.5 × 10 <sup>5</sup>	—	—	—	—
"ADI"	mg/l	—	2.1 × 10 <sup>-5</sup>	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
Anaerobic biodegradation	s <sup>-1</sup>	—	0	—	—	—	—
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	—	—	—	—	—
$\alpha_L$ outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 10  
 HYDROGEOLOGIC CATEGORY: 5  
 CHEMICAL: HEXACHLOROBENZENE

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c \alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c \alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{oc}$	--	As defined by the CORR program

GENERIC RUN 11  
 HYDROGEOLOGIC CATEGORY: 5  
 CHEMICAL: TETRACHLOROETHYLENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	--	0.0076	--	0.0054	0.0106
S	%	Exponential	--	1.217	--	1	2
B	m	Exponential	--	31	--	28	35
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.18	--	0.05	0.30
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>n</sub>	hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>o,c</sub>	ml/g	--	209	--	--	--	--
"ADI"	mg/l	--	6.76 x 10 <sup>-4</sup>	--	--	--	--
Anaerobic biodegradation	s <sup>-1</sup>	--	0	--	--	--	--
q	m/yr	Uniform	--	2	--	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	--	--	--	--	--
$\alpha_L$ outside the source	m	Derived from X: 0.1 X	--	--	--	0	60

GENERIC RUN 11  
 HYDROGEOLOGIC CATEGORY: 5  
 CHEMICAL: TETRACHLOROETHYLENE

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{o_c}$	--	As defined by the CORR program

GENERIC RUN 12  
 HYDROGEOLOGIC CATEGORY: 5  
 CHEMICAL: BENZENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	--	0.0076	--	0.0054	0.0106
S	%	Exponential	--	1.217	--	1	2
B	m	Exponential	--	31	--	28	35
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.18	--	0.05	0.30
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>n</sub>	hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>o,c</sub>	mL/g	--	59	--	--	--	--
"ADI"	mg/l	--	6.63 x 10 <sup>-4</sup>	--	--	--	--
Anaerobic biodegradation	s <sup>-1</sup>	--	0	--	--	--	--
q	m/yr	Uniform	--	2	--	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\int A$ )	--	--	--	--	--
$\sigma_L$ outside the source	m	Derived from X: 0.1 X	--	--	--	0	0

GENERIC RUN 12  
 HYDROGEOLOGIC CATEGORY: 5  
 CHEMICAL: BENZENE

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{oc}$	--	As defined by the CORR program

GENERIC RUN 13  
 HYDROGEOLOGIC CATEGORY: 5  
 CHEMICAL: 2,4 - DINITROTOLUENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	—	0.0076	—	0.0054	0.0106
S	%	Exponential	—	1.217	—	1	2
B	m	Exponential	—	31	—	28	35
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.18	—	0.05	0.30
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>n</sub>	hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>o<sub>c</sub></sub>	ml/g	—	76	—	—	—	—
"ADI"	mg/l	—	1.13 x 10 <sup>-4</sup>	—	—	—	—
Anaerobic biodegradation	s <sup>-1</sup>	—	—	—	—	—	—
q	m/yr	Uniform	0	—	—	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	—	—	—	—	—
$\alpha_L$ outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 13  
 HYDROGEOLOGIC CATEGORY: 5  
 CHEMICAL: 2,4 - DINITROTOLUENE

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{oc}$	--	As defined by the CORR program

GENERIC RUN 14  
 HYDROGEOLOGIC CATEGORY: 5  
 CHEMICAL: ARSENIC\*

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	--	0.0076	--	0.0054	0.0106
S	%	Exponential	--	1.217	--	1	2
B	m	Exponential	--	31	--	28	35
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/Yr	Uniform	--	0.18	--	0.05	0.30
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>n</sub>	hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>o,c</sub>	mL/g	--	0	--	--	--	--
"ADI"	mg/l	--	2.33 x 10 <sup>-6</sup>	--	--	--	--
Anaerobic biodegradation	s <sup>-1</sup>	--	0	--	--	--	--
q	m/Yr	Uniform	2	--	1	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	--	--	--	--	--
$\phi_L$ outside the source		Derived from X: 0.1 X	--	--	--	0	60

GENERIC RUN 14  
 HYDROGEOLOGIC CATEGORY: 5  
 CHEMICAL: ARSENIC\*

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-1.3} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{oc}$	--	As defined by the CORR program

- \* Note that, since all chemical and biological decay constants are zero for both arsenic and beryllium, one run will cover both chemicals up to the post-processing step (conversion of  $C_D$  to concentration at the source).

GENERIC RUN 16  
 HYDROGEOLOGIC CATEGORY: 5  
 CHEMICAL: NITRATE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	--	0.0076	--	0.0054	0.0106
S	%	Exponential	--	1.217	--	1	2
B	m	Exponential	--	31	--	28	35
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.18	--	0.05	0.30
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>n</sub>	hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>c</sub>	mL/g	--	0	--	--	--	--
"ADI"	mg/l	--	3.45	--	--	--	--
Anaerobic biodegradation	s <sup>-1</sup>	--	3.2 x 10 <sup>-6</sup>	--	--	1	3
q	m/yr	Uniform	--	2	--	--	--
$\sigma_L$ under the source	m	Derived from A: 0.05 ( $f_A$ )	--	--	--	--	--
$\sigma_L$ outside the source	m	Derived from X: 0.1 X	--	--	--	0	60

GENERIC RUN 16  
 HYDROGEOLOGIC CATEGORY: 5  
 CHEMICAL: NITRATE

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^{-4} (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{oc}$	--	As defined by the CORR program

GENERIC RUN 17  
 HYDROGEOLOGIC CATEGORY: 1  
 CHEMICAL: CHLOROFORM

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	--	0.0203	--	0.0183	0.0226
S	%	Exponential	--	0.295	--	0.1	1
B	m	Exponential	--	28	--	14	53
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/Yr	Uniform	--	0.15	--	0	0.30
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0.23	--	--	--	--
K <sub>n</sub>	hr <sup>-1</sup>	--	3 x 10 <sup>-9</sup>	--	--	--	--
K <sub>o,c</sub>	ml/g	--	31	--	--	--	--
"ADI"	mg/l	--	4.3 x 10 <sup>-4</sup>	--	--	--	--
Anaerobic biodegradation	s <sup>-1</sup>	--	0	--	--	--	--
q	m/Yr	Uniform	--	2	--	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	--	--	--	--	--
$\alpha_L$ outside the source	m	Derived from X: 0.1 X	--	--	--	0	60

GENERIC RUN 17  
 HYDROGEOLOGIC CATEGORY: 1  
 CHEMICAL: CHLOROFORM

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m .	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{oc}$	--	As defined by the CORR program

GENERIC RUN 18  
 HYDROGEOLOGIC CATEGORY: 1  
 CHEMICAL: HEXACHLOROBENZENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	--	0.0203	--	0.0183	0.0226
S	%	Exponential	--	0.295	--	0.1	1
B	m	Exponential	--	28	--	14	53
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.15	--	0	0.30
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>n</sub>	hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>o,c</sub>	ml/g	--	1.5 x 10 <sup>5</sup>	--	--	--	--
"ADI"	mg/l	--	2.1 x 10 <sup>-5</sup>	--	--	--	--
Anaerobic biodegradation	s <sup>-1</sup>	--	0	--	--	--	--
q	m/yr	Uniform	--	2	--	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	--	--	--	--	--
$\alpha_L$ outside the source	m	Derived from X: 0.1 X	--	--	--	0	60

GENERIC RUN 18  
 HYDROGEOLOGIC CATEGORY: 1  
 CHEMICAL: HEXACHLOROBENZENE

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{oc}$	--	As defined by the CORR program

GENERIC RUN 19  
 HYDROGEOLOGIC CATEGORY: 1  
 CHEMICAL: TETRACHLOROETHYLENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	--	0.0203	--	0.0183	0.0226
S	%	Exponential	--	0.295	--	0.1	1
B	m	Exponential	--	28	--	14	53
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.15	--	0	0.30
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>n</sub>	hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>o,c</sub>	mL/g	--	209	--	--	--	--
"ADI"	mg/l	--	6.76 × 10 <sup>-4</sup>	--	--	--	--
Anaerobic biodegradation	s <sup>-1</sup>	--	0	--	--	--	--
q	m/yr	Uniform	--	2	--	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	--	--	--	--	--
$\alpha_L$ outside the source	m	Derived from X: 0.1 X	--	--	--	0	60

GENERIC RUN 1.9  
 HYDROGEOLOGIC CATEGORY: 1  
 CHEMICAL: TETRACHLOROETHYLENE

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{oc}$	—	As defined by the CORR program

GENERIC RUN 20  
 HYDROGEOLOGIC CATEGORY: 1  
 CHEMICAL: BENZENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm.	Log <sub>10</sub> uniform	--	0.0203	--	0.0183	0.0226
S	%	Exponential	--	0.295	--	0.1	1
B	m	Exponential	--	28	--	14	53
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/Yr	Uniform	--	0.15	--	0	0.30
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>n</sub>	hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>o,c</sub>	ml/g	--	59	--	--	--	--
"ADI"	mg/l	--	6.63 x 10 <sup>-4</sup>	--	--	--	--
Anaerobic biodegradation	s <sup>-1</sup>	--	0	--	--	--	--
q	m/Yr	Uniform	--	2	--	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	--	--	--	--	--
$\alpha_L$ outside the source	m	Derived from X: 0.1 X	--	--	--	0	60

GENERIC RUN 20  
 HYDROGEOLOGIC CATEGORY: 1  
 CHEMICAL: BENZENE

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{oc}$	—	As defined by the CORR program

GENERIC RUN 21  
 HYDROGEOLOGIC CATEGORY: 1  
 CHEMICAL: 2,4 - DINITROTOLUENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	—	0.0203	—	0.0183	0.0226
S	%	Exponential	—	0.295	—	0.1	1
B	m	Exponential	—	28	—	14	53
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.15	—	0	0.30
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>n</sub>	hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>o_c</sub>	ml/g	—	76	—	—	—	—
"ADI"	mg/l	—	1.13 x 10 <sup>-4</sup>	—	—	—	—
Anaerobic biodegradation	s <sup>-1</sup>	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α <sub>L</sub> under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	—	—	—	—	—
α <sub>L</sub> outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 21  
 HYDROGEOLOGIC CATEGORY: 1  
 CHEMICAL: 2,4 - DINITROTOLUENE

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{oc}$	--	As defined by the CORR program

GENERIC RUN 22  
 HYDROGEOLOGIC CATEGORY: 1  
 CHEMICAL: ARSENIC\*

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	--	0.0203	--	0.0183	0.0226
S	%	Exponential	--	0.295	--	0.1	1
B	m	Exponential	--	28	--	14	53
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.15	--	0	0.30
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>n</sub>	hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>o,c</sub>	ml/g	--	0	--	--	--	--
"ADI"	mg/l	--	2.33 × 10 <sup>-6</sup>	--	--	--	--
Anaerobic biodegradation	s <sup>-1</sup>	--	0	--	--	--	--
q	m/yr	Uniform	--	2	--	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	--	--	--	--	--
$\alpha_L$ outside the source	m	Derived from X: 0.1 X	--	--	--	0	60

GENERIC RUN 22  
 HYDROGEOLOGIC CATEGORY: 1  
 CHEMICAL:  
 ARSENIC\*

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{o_c}$	--	As defined by the CORR program

- \* Note that, since all chemical and biological decay constants are zero for both arsenic and beryllium, one run will cover both chemicals up to the post-processing step (conversion of  $C_D$  to concentration at the source).

GENERIC RUN 24  
 HYDROGEOLOGIC CATEGORY: 1  
 CHEMICAL: NITRATE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	--	0.0203	--	0.0183	0.0226
S	%	Exponential	--	0.295	--	0.1	1
B	m	Exponential	--	28	--	14	53
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.15	--	0	0.30
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>n</sub>	hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>o,c</sub>	mL/g	--	0	--	--	--	--
"ADI"	mg/l	--	3.45	--	--	--	--
Anaerobic biodegradation	s <sup>-1</sup>	--	3.2 x 10 <sup>-6</sup>	--	--	--	--
q	m/yr	Uniform	--	2	--	1	3
$\sigma_L$ under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	--	--	--	--	--
$\sigma_L$ outside the source	m	Derived from X: 0.1 X	--	--	--	0	60

GENERIC RUN 24  
 HYDROGEOLOGIC CATEGORY: 1  
 CHEMICAL: NITRATE

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-1.3} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{oc}$	--	As defined by the CORR program

GENERIC RUN 25  
 HYDROGEOLOGIC CATEGORY: 2  
 CHEMICAL: CHLOROFORM

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	—	0.0139	—	0.0106	0.0183
S	%	Exponential	—	0.295	—	0.1	1
B	m	Exponential	—	31	—	20	55
pH	—	Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.025	—	0	0.05
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	—	0.23	—	—	—	—
K <sub>n</sub>	hr <sup>-1</sup>	—	3 x 10 <sup>-9</sup>	—	—	—	—
K <sub>o,c</sub>	mL/g	—	31	—	—	—	—
"ADI"	mg/l	—	4.3 x 10 <sup>-4</sup>	—	—	—	—
Anaerobic biodegradation	s <sup>-1</sup>	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	—	—	—	—	—
$\alpha$ outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 25  
 HYDROGEOLOGIC CATEGORY: 2  
 CHEMICAL: CHLOROFORM

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$F_{oc}$	--	As defined by the CORR program

GENERIC RUN 26  
 HYDROGEOLOGIC CATEGORY: 2  
 CHEMICAL: HEXACHLOROBENZENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	--	0.0139	--	0.0106	0.0183
S	%	Exponential	--	0.295	--	0.1	1
B	m	Exponential	--	31	--	20	55
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/Yr	Uniform	--	0.025	--	0	0.05
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>n</sub>	hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>o c</sub>	mL/g	--	1.5 x 10 <sup>5</sup>	--	--	--	--
"ADI"	mg/l	--	2.1 x 10 <sup>-5</sup>	--	--	--	--
Anaerobic biodegradation	s <sup>-1</sup>	--	0	--	--	--	--
q	m/Yr	Uniform	--	2	--	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	--	--	--	--	--
$\alpha_L$ outside the source	m	Derived from X: 0.1 x	--	--	--	0	60

GENERIC RUN 26  
 HYDROGEOLOGIC CATEGORY: 2  
 CHEMICAL: HEXACHLOROBENZENE

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{oc}$	--	As defined by the CORR program

GENERIC RUN 27  
 HYDROGEOLOGIC CATEGORY: 2  
 CHEMICAL: TETRACHLOROETHYLENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	--	0.0139	--	0.0106	0.0183
S	%	Exponential	--	0.295	--	0.1	1
B	m	Exponential	--	31	--	20	55
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.025	--	0	0.05
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>n</sub>	hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>o,c</sub>	ml/g	--	209	--	--	--	--
"ADI"	mg/l	--	6.76 × 10 <sup>-4</sup>	--	--	--	--
Anaerobic biodegradation	s <sup>-1</sup>	--	0	--	--	--	--
q	m/yr	Uniform	--	2	--	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	--	--	--	--	--
$\alpha_L$ outside the source	m	Derived from X: 0.1 X	--	--	--	0	60

GENERIC RUN 27  
 HYDROGEOLOGIC CATEGORY: 2  
 CHEMICAL: TETRACHLOROETHYLENE

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{oc}$	—	As defined by the CORR program

GENERIC RUN 28  
 HYDROGEOLOGIC CATEGORY: 2  
 CHEMICAL: BENZENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	--	0.0139	--	0.0106	0.0183
S	%	Exponential	--	0.295	--	0.1	1
B	m	Exponential	--	31	--	20	55
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.025	--	0	0.05
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>n</sub>	hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>o,c</sub>	mL/g	--	59	--	--	--	--
"ADI"	mg/l	--	6.63 x 10 <sup>-4</sup>	--	--	--	--
Anaerobic biodegradation	s <sup>-1</sup>	--	0	--	--	--	--
q	m/yr	Uniform	--	2	--	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	--	--	--	--	--
$\alpha_L$ outside the source	m	Derived from X: 0.1 X	--	--	--	0	60

CENERIC RUN 28  
 HYDROGEOLOGIC CATEGORY: 2  
 CHEMICAL: BENZENE

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c \alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c \alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{oc}$	--	As defined by the CORR program

GENERIC RUN 29  
 HYDROGEOLOGIC CATEGORY: 2  
 CHEMICAL: 2,4 - DINITROTOLUENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	--	0.0139	--	0.0106	0.0183
S	%	Exponential	--	0.295	--	0.1	1
B	m	Exponential	--	31	--	20	55
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.025	--	0	0.05
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>n</sub>	hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>o,c</sub>	ml/g	--	76	--	--	--	--
"ADI"	mg/l	--	1.13 x 10 <sup>-4</sup>	--	--	--	--
Anaerobic biodegradation	s <sup>-1</sup>	--	0	--	--	--	--
q	m/yr	Uniform Derived from A: 0.05 ( $\sqrt{A}$ )	--	2	--	1	3
$\alpha_L$ under the source	m		--	--	--	--	--
$\alpha_L$ outside the source	m	Derived from X: 0.1 X	--	--	--	0	60

GENERIC RUN 29  
 HYDROGEOLOGIC CATEGORY: 2  
 CHEMICAL: 2,4 - DINITROTOLUENE

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{oc}$	--	As defined by the CORR program

GENERIC RUN 30  
 HYDROGEOLOGIC CATEGORY: 2  
 CHEMICAL: ARSENIC\*

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	--	0.0139	--	0.0106	0.0183
S	%	Exponential	--	0.295	--	0.1	1
B	m	Exponential	--	31	--	20	55
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/Yr	Uniform	--	0.025	--	0	0.05
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>n</sub>	hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>o,c</sub>	mL/g	--	0	--	--	--	--
"ADI"	mg/l	--	2.33 x 10 <sup>-6</sup>	--	--	--	--
Anaerobic biodegradation	s <sup>-1</sup>	--	0	--	--	--	--
q	m/yr	Uniform	--	2	--	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	--	--	--	--	--
$\alpha_L$ outside the source	m	Derived from X: 0.1 X	--	--	--	0	60

GENERIC RUN 30  
 HYDROGEOLOGIC CATEGORY: 2  
 CHEMICAL:  
 ARSENIC\*

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-1.3} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{oc}$	—	As defined by the CORR program

- \* Note that, since all chemical and biological decay constants are zero for both arsenic and beryllium, one run will cover both chemicals up to the post-processing step (conversion of  $C_D$  to concentration at the source).

GENERIC RUN 32  
 HYDROGEOLOGIC CATEGORY: 2  
 CHEMICAL: NITRATE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	—	0.0139	—	0.0106	0.0183
S	%	Exponential	—	0.295	—	0.1	1
B	m	Exponential	—	31	—	20	55
pH	—	Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.025	—	0	0.05
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>n</sub>	hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>o<sub>c</sub></sub>	mL/g	—	0	—	—	—	—
"ADI"	mg/l	—	3.45	—	—	—	—
Anaerobic biodegradation	s <sup>-1</sup>	—	3.2 x 10 <sup>-6</sup>	—	—	—	—
q	m/yr	Uniform	—	—	—	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 (VA)	—	—	—	—	—
$\alpha_L$ outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 32  
 HYDROGEOLOGIC CATEGORY: 2  
 CHEMICAL: NITRATE

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
f <sub>oc</sub>	--	As defined by the CORR program

GENERIC RUN 33  
 HYDROGEOLOGIC CATEGORY: 3  
 CHEMICAL: CHLOROFORM

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	--	0.0351	--	0.0351	0.0351
S	%	Exponential	--	0.295	--	0.1	1
B	m	Exponential	--	33	--	33	33
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.025	--	0	0.05
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0.23	--	--	--	--
K <sub>n</sub>	hr <sup>-1</sup>	--	3 x 10 <sup>-9</sup>	--	--	--	--
K <sub>o,c</sub>	ml/g	--	31	--	--	--	--
"ADI"	mg/l	--	4.3 x 10 <sup>-4</sup>	--	--	--	--
Anaerobic biodegradation	s <sup>-1</sup>	--	0	--	--	--	--
q	m/yr	Uniform	--	2	--	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	--	--	--	--	--
$\alpha_L$ outside the source	m	Derived from X: 0.1 X	--	--	--	0	60

GENERIC RUN 33  
 HYDROGEOLOGIC CATEGORY: 3  
 CHEMICAL: CHLOROFORM

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by P(A) = $2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by P(X) = $6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
f <sub>oc</sub>	—	As defined by the CORR program

GENERIC RUN 34  
 HYDROGEOLOGIC CATEGORY: 3  
 CHEMICAL: HEXACHLOROBENZENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	—	0.0351	—	0.0351	0.0351
S	%	Exponential	—	0.295	—	0.1	1
B	m	Exponential	—	33	—	33	33
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.025	—	0	0.05
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>n</sub>	hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>o,c</sub>	ml/g	—	1.5 x 10 <sup>5</sup>	—	—	—	—
"ADI"	mg/l	—	2.1 x 10 <sup>-5</sup>	—	—	—	—
Anaerobic biodegradation	s <sup>-1</sup>	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	—	—	—	—	—
$\alpha_L$ outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 34  
 HYDROGEOLOGIC CATEGORY: 3  
 CHEMICAL: HEXACHLOROBENZENE

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{oc}$	--	As defined by the CORR program

GENERIC RUN 35  
 HYDROGEOLOGIC CATEGORY: 3  
 CHEMICAL: TETRACHLOROETHYLENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	--	0.0351	--	0.0351	0.0351
S	%	Exponential	--	0.295	--	0.1	1
B	m	Exponential	--	33	--	33	33
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.025	--	0	0.05
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>n</sub>	hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>o,c</sub>	ml/g	--	209	--	--	--	--
"ADI"	mg/l	--	6.76 x 10 <sup>-4</sup>	--	--	--	--
Anaerobic biodegradation	s <sup>-1</sup>	--	0	--	--	--	--
q	m/yr	Uniform	--	2	--	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 (f <sub>A</sub> )	--	--	--	--	--
$\alpha_L$ outside the source	m	Derived from X: 0.1 X	--	--	--	0	60

GENERIC RUN 35  
 HYDROGEOLOGIC CATEGORY: 3  
 CHEMICAL: TETRACHLOROETHYLENE

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^{-4} (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{\alpha_c}$	--	As defined by the CORR program

GENERIC RUN 36  
 HYDROGEOLOGIC CATEGORY: 3  
 CHEMICAL: BENZENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	--	0.0351	--	0.0351	0.0351
S	%	Exponential	--	0.295	--	0.1	1
B	m	Exponential	--	33	--	33	33
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.025	--	0	0.05
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>n</sub>	hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>o,c</sub>	mL/g	--	59	--	--	--	--
"ADI"	mg/l	--	6.63 x 10 <sup>-4</sup>	--	--	--	--
Anaerobic biodegradation	s <sup>-1</sup>	--	0	--	--	--	--
q	m/yr	Uniform	--	2	--	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	--	--	--	--	--
$\alpha_L$ outside the source	m	Derived from X: 0.1 X	--	--	--	0	60

GENERIC RUN 36  
 HYDROGEOLOGIC CATEGORY: 3  
 CHEMICAL: BENZENE

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{oc}$	--	As defined by the CORR program

GENERIC RUN 37  
HYDROGEOLOGIC CATEGORY: 3  
CHEMICAL: 2,4 - DINITROTOLUENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	—	0.0351	—	0.0351	0.0351
S	g/m <sup>3</sup>	Exponential	—	0.295	—	0.1	1
B	m	Exponential	—	33	—	33	33
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m <sup>2</sup> /yr	Uniform	—	0.025	—	0	0.05
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>n</sub>	hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>o,c</sub>	mL/g	—	76	—	—	—	—
"ADI"	mg/l	—	1.13 x 10 <sup>-4</sup>	—	—	—	—
Anaerobic biodegradation	s <sup>-1</sup>	—	—	—	—	—	—
q	m <sup>2</sup> /yr	Uniform	0	—	2	—	1
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	—	—	—	—	—
$\alpha_L$ outside the source	m	Derived from X: 0.1 X	—	—	—	—	0

GENERIC RUN 37  
 HYDROGEOLOGIC CATEGORY: 3  
 CHEMICAL: 2,4 - DINITROTOLUENE

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2+10^3})$ ; minimum = 10,522; maximum = 943,760
X	m.	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
f <sub>oc</sub>	--	As defined by the CORR program

GENERIC RUN 38  
 HYDROGEOLOGIC CATEGORY: 3  
 CHEMICAL: ARSENIC\*

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	—	0.0351	—	0.0351	0.0351
S	%	Exponential	—	0.295	—	0.1	1
B	m	Exponential	—	33	—	33	33
pH	—	Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.025	—	0	0.05
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>n</sub>	hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>o,c</sub>	ml/g	—	0	—	—	—	—
"ADI"	mg/l	—	2.33 x 10 <sup>-6</sup>	—	—	—	—
Anaerobic biodegradation	s <sup>-1</sup>	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	—	—	—	—	—
$\sigma_L$ outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 38  
 HYDROGEOLOGIC CATEGORY: 3  
 CHEMICAL: ARSENIC\*

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{oc}$	--	As defined by the CORR program

- \* Note that, since all chemical and biological decay constants are zero for both arsenic and beryllium, one run will cover both chemicals up to the post-processing step (conversion of  $C_D$  to concentration at the source).

GENERIC RUN 40  
 HYDROGEOLOGIC CATEGORY: 3  
 CHEMICAL: NITRATE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	--	0.0351	--	0.0351	0.0351
S	%	Exponential	--	0.295	--	0.1	1
B	m	Exponential	--	33	--	33	33
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.025	--	0	0.05
K <sub>a</sub>	moles <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>b</sub>	moles <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>n</sub>	hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>o<sub>c</sub></sub>	mL/g	--	0	--	--	--	--
"ADI"	mg/l	--	3.45	--	--	--	--
Anaerobic biodegradation	s <sup>-1</sup>	--	3.2 x 10 <sup>-6</sup>	--	--	--	--
q	m/yr	Uniform	--	2	--	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	--	--	--	--	--
$\alpha_L$ outside the source	m	Derived from X: 0.1 X	--	--	--	0	60

GENERIC RUN 40  
 HYDROGEOLOGIC CATEGORY: 3  
 CHEMICAL: NITRATE

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{oc}$	--	As defined by the CORR program

GENERIC RUN 41  
 HYDROGEOLOGIC CATEGORY: 6  
 CHEMICAL: CHLOROFORM

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	--	0.0013	--	0.0003	0.0054
S	%*	Exponential	--	1.217	--	1	2
B	m	Exponential	--	58	--	33	100
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.09	--	0	0.18
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0.23	--	--	--	--
K <sub>n</sub>	hr <sup>-1</sup>	--	3 x 10 <sup>-9</sup>	--	--	--	--
K <sub>o<sub>c</sub></sub>	ml/g	--	31	--	--	--	--
"ADI"	mg/l	--	4.3 x 10 <sup>-4</sup>	--	--	--	--
Anaerobic biodegradation	s <sup>-1</sup>	--	0	--	--	--	--
q	m/yr	Uniform	--	2	--	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	--	--	--	--	--
$\alpha_L$ outside the source	m	Derived from X: 0.1 X	--	--	--	0	60

GENERIC RUN 41  
 HYDROGEOLOGIC CATEGORY: 6  
 CHEMICAL: CHLOROFORM

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c \alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c \alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{\alpha_c}$	—	As defined by the CORR program

GENERIC RUN 42  
 HYDROGEOLOGIC CATEGORY: 6  
 CHEMICAL: HEXACHLOROBENZENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	—	0.0013	—	0.0003	0.0054
S	%	Exponential	—	1.217	—	1	2
B	m	Exponential	—	58	—	33	100
pH	—	Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.09	—	0	0.18
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>n</sub>	hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>o,c</sub>	ml/g	—	1.5 x 10 <sup>5</sup>	—	—	—	—
"ADI"	mg/l	—	2.1 x 10 <sup>-5</sup>	—	—	—	—
Anaerobic biodegradation	s <sup>-1</sup>	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	—	—	—	—	—
$\alpha_L$ outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 42  
 HYDROGEOLOGIC CATEGORY: 6  
 CHEMICAL: HEXACHLOROBENZENE

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by P(A) = $2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m.	Defined by P(X) = $6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
f <sub>oc</sub>	--	As defined by the CORR program

GENERIC RUN 43  
 HYDROGEOLOGIC CATEGORY: 6  
 CHEMICAL: TETRACHLOROETHYLENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	--	0.0013	--	0.0003	0.0054
S	%	Exponential	--	1.217	--	1	2
B	m	Exponential	--	58	--	33	100
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.09	--	0	0.18
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>n</sub>	· hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>o<sub>c</sub></sub>	mL/g	--	209	--	--	--	--
"ADI"	mg/l	--	6.76 × 10 <sup>-4</sup>	--	--	--	--
Anaerobic biodegradation	s <sup>-1</sup>	--	0	--	--	--	--
q	m/yr	Uniform	0	--	--	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 (fA)	--	--	--	--	--
$\alpha_L$ outside the source	m	Derived from X: 0.1 X	--	--	--	0	60

GENERIC RUN 43  
 HYDROGEOLOGIC CATEGORY: 6  
 CHEMICAL: TETRACHLOROETHYLENE

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{oc}$	—	As defined by the CORR program

GENERIC RUN 44  
 HYDROGEOLOGIC CATEGORY: 6  
 CHEMICAL: BENZENE

Parameter	Units	Distribution	Single value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	--	0.0013	--	0.0003	0.0054
S	%	Exponential	--	1.217	--	1	2
B	m	Exponential	--	58	--	33	100
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.09	--	0	0.18
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>n</sub>	hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>o,c</sub>	ml/g	--	59	--	--	--	--
"ADI"	mg/l	--	6.63 x 10 <sup>-4</sup>	--	--	--	--
Anaerobic biodegradation	s <sup>-1</sup>	--	0	--	--	--	--
q	m/yr	Uniform	--	2	--	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	--	--	--	--	--
$\alpha_L$ outside the source	m	Derived from X: 0.1 x	--	--	--	0	60

GENERIC RUN 44  
 HYDROGEOLOGIC CATEGORY: 6  
 CHEMICAL: BENZENE

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{oc}$	—	As defined by the CORR program

GENERIC RUN 45  
 HYDROGEOLOGIC CATEGORY: 6  
 CHEMICAL: 2,4-DINITROTOLUENE

Parameter	Units	Distribution	Single	Mean	Standard	Minimum	Maximum
			Value	Deviation			
d	cm	Log <sub>10</sub> uniform	--	0.0013	--	0.0003	0.0054
S	%	Exponential	--	1.217	--	1	2
B	m	Exponential	--	58	--	33	100
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.09	--	0	0.18
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>n</sub>	hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>o,c</sub>	mL/g	--	76	--	--	--	--
"ADI"	mg/l	--	1.13 x 10 <sup>-4</sup>	--	--	--	--
Anaerobic biodegradation	s <sup>-1</sup>	--	0	--	--	--	--
q	m/yr	Uniform	--	2	--	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	--	--	--	--	--
$\alpha_L$ outside the source	m	Derived from X: 0.1 X	--	--	--	0	60

GENERIC RUN 45  
 HYDROGEOLOGIC CATEGORY: 6  
 CHEMICAL: 2,4-DINITROTOLUENE

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{oc}$	--	As defined by the CORR program

GENERIC RUN 46  
 HYDROGEOLOGIC CATEGORY: 6  
 CHEMICAL: ARSENIC.

Parameter	Units	Distribution	Single Value		Standard Deviation	Minimum	Maximum
			Mean	—			
d	cm	Log <sub>10</sub> uniform	—	0.0013	—	0.0003	0.0054
S	%	Exponential	—	1.217	—	1	2
B	m	Exponential	—	58	—	33	100
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.09	—	0	0.18
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>n</sub>	hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>o,c</sub>	ml/g	—	0	—	—	—	—
"ADI"	mg/l	—	2.33 x 10 <sup>-6</sup>	—	—	—	—
Anaerobic biodegradation	s <sup>-1</sup>	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α <sub>L</sub> under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	—	—	—	—	—
α <sub>L</sub> outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 46  
 HYDROGEOLOGIC CATEGORY: 6  
 CHEMICAL: ARSENIC

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m*	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{oc}$	--	As defined by the CORR program

- \* Note that, since all chemical and biological decay constants are zero for both arsenic and beryllium, one run will cover both chemicals up to the post-processing step (conversion of  $C_D$  to concentration at the source).

GENERIC RUN 48  
 HYDROGEOLOGIC CATEGORY: 6  
 CHEMICAL: NITRATE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	—	0.0013	—	0.0003	0.0054
S	%	Exponential	—	1.217	—	1	2
B	m	Exponential	—	58	—	33	100
pH	—	Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.09	—	0	0.18
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>n</sub>	hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>o,c</sub>	mL/g	—	0	—	—	—	—
"ADI"	mg/l	—	3.45	—	—	—	—
Anaerobic biodegradation	s <sup>-1</sup>	—	3.2 x 10 <sup>-6</sup>	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	—	—	—	—	—
$\alpha_L$ outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 48  
 HYDROGEOLOGIC CATEGORY: 6  
 CHEMICAL: NITRATE

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{oc}$	--	As defined by the CORR program

GENERIC RUN 49  
 HYDROGEOLOGIC CATEGORY: 7  
 CHEMICAL: CHLOROFORM

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	--	0.0013	--	0.0003	0.0054
S	%	Exponential	--	0.717	--	0.5	1.5
B	m	Exponential	--	58	--	33	100
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.14	--	0.10	0.18
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0.23	--	--	--	--
K <sub>n</sub>	hr <sup>-1</sup>	--	3 x 10 <sup>-9</sup>	--	--	--	--
K <sub>o,c</sub>	ml/g	--	31	--	--	--	--
"ADI"	mg/l	--	4.3 x 10 <sup>-4</sup>	--	--	--	--
Anaerobic biodegradation	s <sup>-1</sup>	--	0	--	--	--	--
q	m/yr	Uniform	--	2	--	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	--	--	--	--	--
$\alpha_L$ outside the source	m	Derived from X: 0.1 X	--	--	--	0	60

GENERIC RUN 49  
 HYDROGEOLOGIC CATEGORY: 7  
 CHEMICAL: CHLOROFORM

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-1.3} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{oc}$	--	As defined by the CORR program

GENERIC RUN 50  
 HYDROGEOLOGIC CATEGORY: 7  
 CHEMICAL: HEXACHLOROBENZENE

Parameter	Units	Distribution	Single Value		Standard Deviation	Minimum	Maximum
			Mean	Standard Deviation			
d	cm	Log <sub>10</sub> uniform	—	0.0013	—	0.0003	0.0054
S	%	Exponential	—	0.717	—	0.5	1.5
B	m	Exponential	—	58	—	33	100
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.14	—	0.10	0.18
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>n</sub>	hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>c,c</sub>	ml/g	—	1.5 x 10 <sup>5</sup>	—	—	—	—
"ADI"	mg/l	—	2.1 x 10 <sup>-5</sup>	—	—	—	—
Anaerobic biodegradation	s <sup>-1</sup>	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	—	—	—	—	—
$\alpha_L$ outside the source	m	Derived from X: 0.1 x	—	—	—	0	60

GENERIC RUN 50  
 HYDROGEOLOGIC CATEGORY: 7  
 CHEMICAL: HEXACHLOROBENZENE

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c \alpha_L$ ; where c is a uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c \alpha_L$ ; where c is a uniform distribution over the range 0.025 to 0.10
$f_{oc}$	--	As defined by the CORR program

GENERIC RUN 51  
 HYDROGEOLOGIC CATEGORY: 7  
 CHEMICAL: TETRACHLOROETHYLENE

Parameter	Units	Distribution	Single Value		Standard Deviation	Minimum	Maximum
			Mean	Standard Deviation			
d	cm	Log <sub>10</sub> uniform	--	0.0013	--	0.0003	0.0054
S	%	Exponential	--	0.717	--	0.5	1.5
B	m	Exponential	--	58	--	33	100
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/Yr	Uniform	--	0.14	--	0.10	0.18
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>n</sub>	hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>o,c</sub>	mL/g	--	209	--	--	--	--
"ADI"	mg/l	--	6.76 x 10 <sup>-4</sup>	--	--	--	--
Anaerobic biodegradation	s <sup>-1</sup>	--	0	--	--	--	--
q	m/Yr	Uniform	--	2	--	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	--	--	--	--	--
$\alpha_L$ outside the source	m	Derived from X: 0.1 X	--	--	--	0	60

GENERIC RUN 51  
 HYDROGEOLOGIC CATEGORY: 7  
 CHEMICAL: TETRACHLOROETHYLENE

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) \approx 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{o,c}$	--	As defined by the CORR program

GENERIC RUN 52  
 HYDROGEOLOGIC CATEGORY: 7  
 CHEMICAL: BENZENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	—	0.0013	—	0.0003	0.0054
S	%	Exponential	—	0.717	—	0.5	1.5
B	m	Exponential	—	58	—	33	100
pH	—	Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.14	—	0.10	0.18
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>n</sub>	hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>o,c</sub>	mL/g	—	59	—	—	—	—
"ADI"	mg/l	—	6.63 x 10 <sup>-4</sup>	—	—	—	—
Anaerobic biodegradation	s <sup>-1</sup>	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	—	—	—	—	—
$\alpha_L$ outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 52  
 HYDROGEOLOGIC CATEGORY: 7  
 CHEMICAL: BENZENE

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$F_{oc}$	--	As defined by the CORR program

GENERIC RUN 53  
 HYDROGEOLOGIC CATEGORY: 7  
 CHEMICAL: 2,4 - DINITROTOLUENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	--	0.0013	--	0.0003	0.0054
S	%	Exponential	--	0.717	--	0.5	1.5
B	m	Exponential	--	58	--	33	100
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.14	--	0.10	0.18
K <sub>a</sub>	mol·e <sup>-1</sup> ·hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>b</sub>	mol·e <sup>-1</sup> ·hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>n</sub>	hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>o,c</sub>	ml/g	--	76	--	--	--	--
"ADI"	mg/l	--	1.13 x 10 <sup>-4</sup>	--	--	--	--
Anaerobic biodegradation	s <sup>-1</sup>	--	0	--	--	--	--
q	m/yr	Uniform	--	2	--	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	--	--	--	--	--
$\alpha_L$ outside the source	m	Derived from X: 0.1 X	--	--	--	0	60

GENERIC RUN 53  
 HYDROGEOLOGIC CATEGORY: 7  
 CHEMICAL: 2,4 - DINITROTOLUENE

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{oc}$	—	As defined by the CORR program

GENERIC RUN 54  
 HYDROGEOLOGIC CATEGORY: 7  
 CHEMICAL: ARSENIC\*

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	--	0.0013	--	0.0003	0.0054
S	%	Exponential	--	0.717	--	0.5	1.5
B	m	Exponential	--	58	--	33	100
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.14	--	0.10	0.18
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>n</sub>	hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>o,c</sub>	mL/g	--	0	--	--	--	--
"ADI"	mg/l	--	2.33 x 10 <sup>-6</sup>	--	--	--	--
Anaerobic biodegradation	s <sup>-1</sup>	--	0	--	--	--	--
q	m/yr	Uniform	--	2	--	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	--	--	--	--	--
$\alpha_L$ outside the source	m	Derived from X: 0.1 X	--	--	--	0	60

GENERIC RUN 54  
 HYDROGEOLOGIC CATEGORY: 7  
 CHEMICAL: ARSENIC\*

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{oc}$	--	As defined by the CORR program

- \* Note that, since all chemical and biological decay constants are zero for both arsenic and beryllium, one run will cover both chemicals up to the post-processing step (conversion of  $C_D$  to concentration at the source).

GENERIC RUN 56  
 HYDROGEOLOGIC CATEGORY: 7  
 CHEMICAL: NITRATE

Parameter	Units	Distribution	Single value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	--	0.0013	--	0.0003	0.0054
S	%	Exponential	--	0.717	--	0.5	1.5
B	m	Exponential	--	58	--	33	100
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.14	--	0.10	0.18
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>n</sub>	hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>o c</sub>	ml/g	--	0	--	--	--	--
"ADI"	mg/l	--	3.45	--	--	--	--
Anaerobic biodegradation	s <sup>-1</sup>	--	3.2 x 10 <sup>-6</sup>	--	--	--	--
q	m/yr	Uniform	--	2	--	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	--	--	--	--	--
$\alpha_L$ outside the source	m	Derived from X: 0.1 X	--	--	--	0	60

GENERIC RUN 56  
 HYDROGEOLOGIC CATEGORY: 7  
 CHEMICAL: NITRATE

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{\alpha_c}$	--	As defined by the CORR

GENERIC RUN 57  
 HYDROGEOLOGIC CATEGORY: 8  
 CHEMICAL: CHLOROFORM

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	--	0.0139	--	0.0106	0.0183
S	%	Exponential	--	0.717	--	0.5	1.5
B	m	Exponential	--	18	--	7	50
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/Yr	Uniform	--	0.14	--	0.10	0.18
K <sub>s</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0.23	--	--	--	--
K <sub>n</sub>	hr <sup>-1</sup>	--	3 x 10 <sup>-9</sup>	--	--	--	--
K <sub>o c</sub>	mL/g	--	31	--	--	--	--
"ADI"	mg/l	--	4.3 x 10 <sup>-4</sup>	--	--	--	--
Anaerobic biodegradation	s <sup>-1</sup>	--	0	--	--	--	--
q	m/Yr	Uniform	--	2	--	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	--	--	--	--	--
$\alpha_L$ outside the source	m	Derived from X: 0.1 X	--	--	--	0	60

GENERIC RUN 57  
 HYDROGEOLeGIC CATEGORY: 8  
 CHEMICAL: CHLORoFORM

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{oc}$	—	As defined by the CORR program

GENERIC RUN 58  
 HYDROGEOLOGIC CATEGORY: 8  
 CHEMICAL: HEXACHLOROBENZENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	--	0.0139	--	0.0106	0.0183
S	%	Exponential	--	0.717	--	0.5	1.5
B	m	Exponential	--	18	--	7	50
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.14	--	0.10	0.18
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>n</sub>	hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>o_c</sub>	mL/g	--	1.5 x 10 <sup>5</sup>	--	--	--	--
"ADI"	mg/l	--	2.1 x 10 <sup>-5</sup>	--	--	--	--
Anaerobic biodegradation	s <sup>-1</sup>	--	0	--	--	--	--
q	m/yr	Uniform	--	2	--	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	--	--	--	--	--
$\alpha_L$ outside the source	m	Derived from X: 0.1 X	--	--	--	0	60

GENERIC RUN 58  
 HYDROGEOLOGIC CATEGORY: 8  
 CHEMICAL: HEXACHLOROBENZENE

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{oc}$	--	As defined by the CORR program

GENERIC RUN 59  
 HYDROGEOLOGIC CATEGORY: 8  
 CHEMICAL: TETRACHLOROETHYLENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	--	0.0139	--	0.0106	0.0183
S	%	Exponential	--	0.717	--	0.5	1.5
B	m	Exponential	--	18	--	7	50
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.14	--	0.10	0.18
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	mole <sup>-1</sup> hr <sup>-1</sup>	0	--	--	--	--
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	mole <sup>-1</sup> hr <sup>-1</sup>	0	--	--	--	--
K <sub>n</sub>	hr <sup>-1</sup>	hr <sup>-1</sup>	0	--	--	--	--
K <sub>o,c</sub>	ml/g	ml/g	209	--	--	--	--
"ADI"	mg/l	mg/l	6.76 x 10 <sup>-4</sup>	--	--	--	--
Anaerobic biodegradation	s <sup>-1</sup>	--	0	--	--	--	--
q	m/yr	Uniform	--	2	--	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 (V/A)	--	--	--	--	--
$\alpha_L$ outside the source	m	Derived from X: 0.1 X	--	--	--	0	60

GENERIC RUN 59  
 HYDROGEOLIC CATEGORY: 8  
 CHEMICAL: TETRACHLOROETHYLENE

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{oc}$	--	As defined by the CORR program

GENERIC RUN 60  
 HYDROGEOLOGIC CATEGORY: 8  
 CHEMICAL: BENZENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	—	0.0139	—	0.0106	0.0183
S	%	Exponential	—	0.717	—	0.5	1.5
B	m	Exponential	—	18	—	7	50
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.14	—	0.10	0.18
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>n</sub>	hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>o,c</sub>	ml/g	—	59	—	—	—	—
"ADI"	mg/l	—	6.63 × 10 <sup>-4</sup>	—	—	—	—
Anaerobic biodegradation	s <sup>-1</sup>	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α <sub>L</sub> under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	—	—	—	—	—
α <sub>L</sub> outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 60  
 HYDROGEOLOGIC CATEGORY: 8  
 CHEMICAL: BENZENE

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{oc}$	--	As defined by the CORR program

GENERIC RUN 61  
HYDROGEOLOGIC CATEGORY: 8  
CHEMICAL: 2,4 - DINITROTOLUENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	--	0.0139	--	0.0106	0.0183
S	%	Exponential	--	0.717	--	0.5	1.5
B	m	Exponential	--	18	--	7	50
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.14	--	0.10	0.18
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>n</sub>	hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>o_c</sub>	mL/g	--	76	--	--	--	--
"ADI"	mg/l	--	1.13 x 10 <sup>-4</sup>	--	--	--	--
Anaerobic biodegradation	s <sup>-1</sup>	--	0	--	--	--	--
q	m/yr	Uniform	--	2	--	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	--	--	--	--	--
$\alpha_L$ outside the source	m	Derived from X: 0.1 X	--	--	--	--	0

GENERIC RUN 61  
 HYDROGEOLOGIC CATEGORY: 8  
 CHEMICAL: 2,4 - DINITROTOLUENE

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = \infty_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
f <sub>oc</sub>	--	As defined by the CORR program

GENERIC RUN 62  
 HYDROGEOLOGIC CATEGORY: 8  
 CHEMICAL: ARSENIC\*

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	—	0.0139	—	0.0106	0.0183
S	%	Exponential	—	0.717	—	0.5	1.5
B	m	Exponential	—	18	—	7	50
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/Yr	Uniform	—	0.14	—	0.10	0.18
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>n</sub>	hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>o,c</sub>	mL/g	—	0	—	—	—	—
"ADI"	mg/l	—	2.33 × 10 <sup>-6</sup>	—	—	—	—
Anaerobic biodegradation	s <sup>-1</sup>	—	0	—	—	—	—
q	m/Yr	Uniform	—	2	—	1	3
α <sub>L</sub> under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	—	—	—	—	—
σ <sub>L</sub> outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 62  
 HYDROGEOLOGIC CATEGORY: 8  
 CHEMICAL: ARSENIC\*

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{o,c}$	--	As defined by the CORR program

- \* Note that, since all chemical and biological decay constants are zero for both arsenic and beryllium, one run will cover both chemicals up to the post-processing step (conversion of  $C_D$  to concentration at the source).

GENERIC RUN 64  
 HYDROGEOLOGIC CATEGORY: 8  
 CHEMICAL: NITRATE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	—	0.0139	—	0.0106	0.0183
S	%	Exponential	—	0.717	—	0.5	1.5
B	m	Exponential	—	18	—	7	50
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.14	—	0.10	0.18
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>n</sub>	hr <sup>-1</sup>	—	0	—	—	—	—
K <sub>o,c</sub>	ml/g	—	0	—	—	—	—
"ADI"	mg/l	—	3.45	—	—	—	—
Anaerobic biodegradation	s <sup>-1</sup>	—	3.2 x 10 <sup>-6</sup>	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	—	—	—	—	—
$\alpha_L$ outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 64  
 HYDROGEOLOGIC CATEGORY: 8  
 CHEMICAL: NITRATE

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{oc}$	--	As defined by the CORR program

GENERIC RUN 65  
 HYDROGEOLOGIC CATEGORY: 9  
 CHEMICAL: CHLOROFORM

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	--	0.0013	--	0.0003	0.0054
S	%	Exponential	--	0.717	--	0.5	1.5
B	m	Exponential	--	18	--	7	50
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/y <sup>r</sup>	Uniform	--	0.14	--	0.10	0.18
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0.23	--	--	--	--
K <sub>n</sub>	hr <sup>-1</sup>	--	3 x 10 <sup>-9</sup>	--	--	--	--
K <sub>o<sup>c</sup></sub>	ml/g	--	31	--	--	--	--
"ADI"	mg/l	--	4.3 x 10 <sup>-4</sup>	--	--	--	--
Anaerobic biodegradation	s <sup>-1</sup>	--	0	--	--	--	--
q	m/y <sup>r</sup>	Uniform	--	2	--	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	--	--	--	--	--
$\alpha_L$ outside the source	m	Derived from X: 0.1 x	--	--	--	0	60

GENERIC RUN 65  
 HYDROGEOLOGIC CATEGORY: 9  
 CHEMICAL: CHLOROFORM

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\phi_L$ under the source: $\alpha_z = c \phi_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\phi_L$ outside the source: $\alpha_z = c \phi_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{oc}$	--	As defined by the CORR program

GENERIC RUN 66  
 HYDROGEOLOGIC CATEGORY: 9  
 CHEMICAL: HEXACHLOROBENZENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	--	0.0013	--	0.0003	0.0054
S	%	Exponential	--	0.717	--	0.5	1.5
B	m	Exponential	--	18	--	7	50
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.14	--	0.10	0.18
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>n</sub>	hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>o,c</sub>	ml/g	--	1.5 x 10 <sup>5</sup>	--	--	--	--
"ADI"	mg/l	--	2.1 x 10 <sup>-5</sup>	--	--	--	--
Anaerobic biodegradation	s <sup>-1</sup>	--	0	--	--	--	--
q	m/yr	Uniform	--	2	--	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	--	--	--	--	--
$\alpha_L$ outside the source	m	Derived from X: 0.1 X	--	--	--	0	60

GENERIC RUN 66  
 HYDROGEOLOGIC CATEGORY: 9  
 CHEMICAL: HEXACHLOROBENZENE

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{oc}$	--	As defined by the CORR program

GENERIC RUN 67  
 HYDROGEOLOGIC CATEGORY: 9  
 CHEMICAL: TETRACHLOROETHYLENE

Parameter	Units	Distribution	Single	Mean	Standard	Minimum	Maximum
			Value		Deviation		
d	cm	Log <sub>10</sub> uniform	--	0.0013	--	0.0003	0.0054
S	%	Exponential	--	0.717	--	0.5	1.5
B	m	Exponential	--	18	--	7	50
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.14	--	0.10	0.18
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>n</sub>	hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>o,c</sub>	ml/g	--	209	--	--	--	--
"ADI"	mg/l	--	6.76 x 10 <sup>-4</sup>	--	--	--	--
Anaerobic biodegradation	s <sup>-1</sup>	--	0	--	--	--	--
q	m/yr	Uniform	--	2	--	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\int A$ )	--	--	--	--	--
$\alpha_L$ outside the source	m	Derived from X: 0.1 x	--	--	--	0	60

GENERIC RUN 67  
 HYDROGEOLOGIC CATEGORY: 9  
 CHEMICAL: TETRACHLOROETHYLENE

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is a uniform distribution over the range of 0.325 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is a uniform distribution over the range 0.025 to 0.10
$f_{oc}$	--	As defined by the CORR program

GENERIC RUN 68  
 HYDROGEOLOGIC CATEGORY: 9  
 CHEMICAL: BENZENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	--	0.0013	--	0.0003	0.0054
S	%	Exponential	--	0.717	--	0.5	1.5
B	m	Exponential	--	18	--	7	50
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.14	--	0.10	0.18
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>n</sub>	hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>o,c</sub>	mL/g	--	59	--	--	--	--
"ADI"	mg/l	--	6.63 x 10 <sup>-4</sup>	--	--	--	--
Anaerobic biodegradation	s <sup>-1</sup>	--	0	--	--	--	--
q	m/yr	Uniform	--	2	--	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	--	--	--	--	--
$\alpha_L$ outside the source	m	Derived from X: 0.1 X	--	--	--	0	60

GENERIC RUN 68  
 HYDROGEOLOGIC CATEGORY: 9  
 CHEMICAL: BENZENE

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m.	Defined by $P(X) = 6.4 \times 10^{-1.3} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{oc}$	—	As defined by the CORR program

GENERIC RUN 69  
 HYDROGEOLOGIC CATEGORY: 9  
 CHEMICAL: 2,4 - DINITROTOLUENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	--	0.0013	--	0.0003	0.0054
S	g ·	Exponential	--	0.717	--	0.5	1.5
B	m	Exponential	--	18	--	7	50
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.14	--	0.10	0.18
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>n</sub>	hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>o,c</sub>	ml/g	--	76	--	--	--	--
"ADI"	mg/l	--	1.13 x 10 <sup>-4</sup>	--	--	--	--
Anaerobic biodegradation	s <sup>-1</sup>	--	0	--	--	--	--
q	m/yr	Uniform	--	2	--	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	--	--	--	--	--
$\alpha_L$ outside the source	m	Derived from X: 0.1 X	--	--	--	0	60

GENERIC RUN 69  
 HYDROGEOLOGIC CATEGORY: 9  
 CHEMICAL: 2,4 - DINITRONTOLUENE

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m*	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{oc}$	--	As defined by the CORR program

GENERIC RUN 70  
 HYDROGEOLOGIC CATEGORY: 9  
 CHEMICAL: ARSENIC\*

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log <sub>10</sub> uniform	--	0.0013	--	0.0003	0.0054
S	%	Exponential	--	0.717	--	0.5	1.5
B	m	Exponential	--	18	--	7	50
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.14	--	0.10	0.18
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>n</sub>	hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>o,c</sub>	ml/g	--	0	--	--	--	--
"ADI"	mg/l	--	2.33 x 10 <sup>-6</sup>	--	--	--	--
Anaerobic biodegradation	s <sup>-1</sup>	--	0	--	--	--	--
q	m/yr	Uniform	--	2	--	1	3
$\alpha_L$ under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	--	--	--	--	--
$\alpha_L$ outside the source	m	Derived from X: 0.1 X	--	--	--	0	60

GENERIC RUN 70  
 HYDROGEOLOGIC CATEGORY: 9  
 CHEMICAL: ARSENIC\*

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
F <sub>oc</sub>	--	As defined by the CORR program

- \* Note that, since all chemical and biological decay constants are zero for both arsenic and beryllium, one run will cover both chemicals up to the post-processing step (conversion of C<sub>b</sub> to concentration at the source).

GENERIC RUN 72  
 HYDROGEOLOGIC CATEGORY: 9  
 CHEMICAL: NITRATE

Parameter	Units	Distribution	Single	Mean	Standard	Minimum	Maximum
			Value	Deviation			
d	cm	Log <sub>10</sub> uniform	--	0.0013	--	0.0003	0.0054
S	%	Exponential	--	0.717	--	0.5	1.5
B	m	Exponential	--	18	--	7	50
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.14	--	0.10	0.18
K <sub>a</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>b</sub>	mole <sup>-1</sup> hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>n</sub>	hr <sup>-1</sup>	--	0	--	--	--	--
K <sub>c c</sub>	mL/g	--	0	--	--	--	--
"ADI"	mg/l	--	3.45	--	--	--	--
Anaerobic biodegradation	s <sup>-1</sup>	--	3.2 x 10 <sup>-2</sup>	--	--	--	--
q	m/yr	Uniform	--	2	--	1	3
α <sub>L</sub> under the source	m	Derived from A: 0.05 ( $\sqrt{A}$ )	--	--	--	--	--
α <sub>L</sub> outside the source	m	Derived from X: 0.1 X	--	--	--	0	60

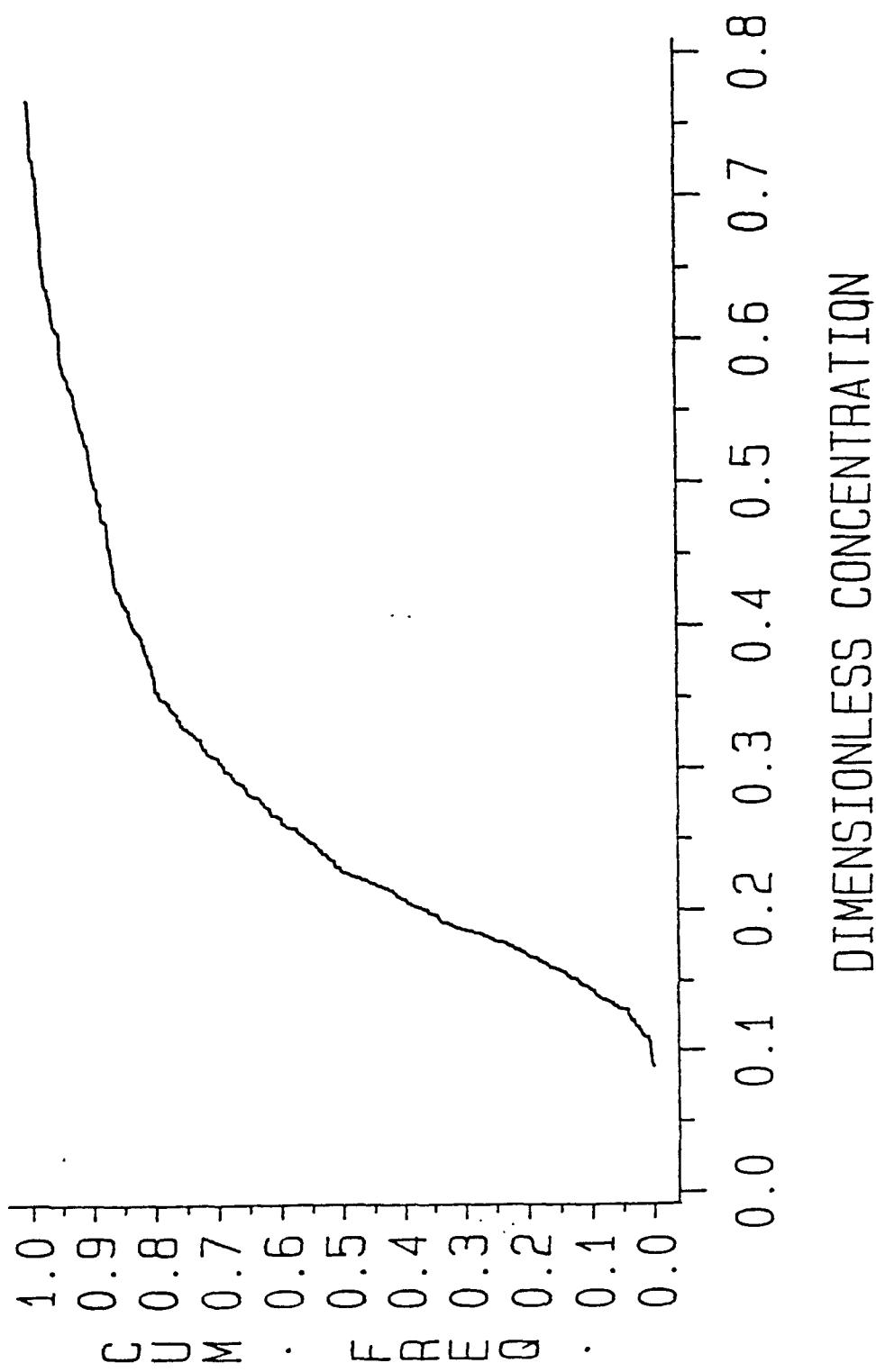
GENERIC RUN 72  
 HYDROGEOLOGIC CATEGORY: 9  
 CHEMICAL: NITRATE

Parameter	Units	Distribution
A	m <sup>2</sup>	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$ ; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$ ; minimum = 35; maximum = 2000
$\alpha_z$ under the source	m	Derived from $\alpha_L$ under the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range of 0.025 to 0.10
$\alpha_z$ outside the source	m	Derived from $\alpha_L$ outside the source: $\alpha_z = c\alpha_L$ ; where c is an uniform distribution over the range 0.025 to 0.10
$f_{oc}$	--	As defined by the CORR program

APPENDIX 4.5  
RESULTS OF GENERIC RUNS: DIMENSIONLESS CONCENTRATIONS

RUN 1

CHLOROFORM - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 4



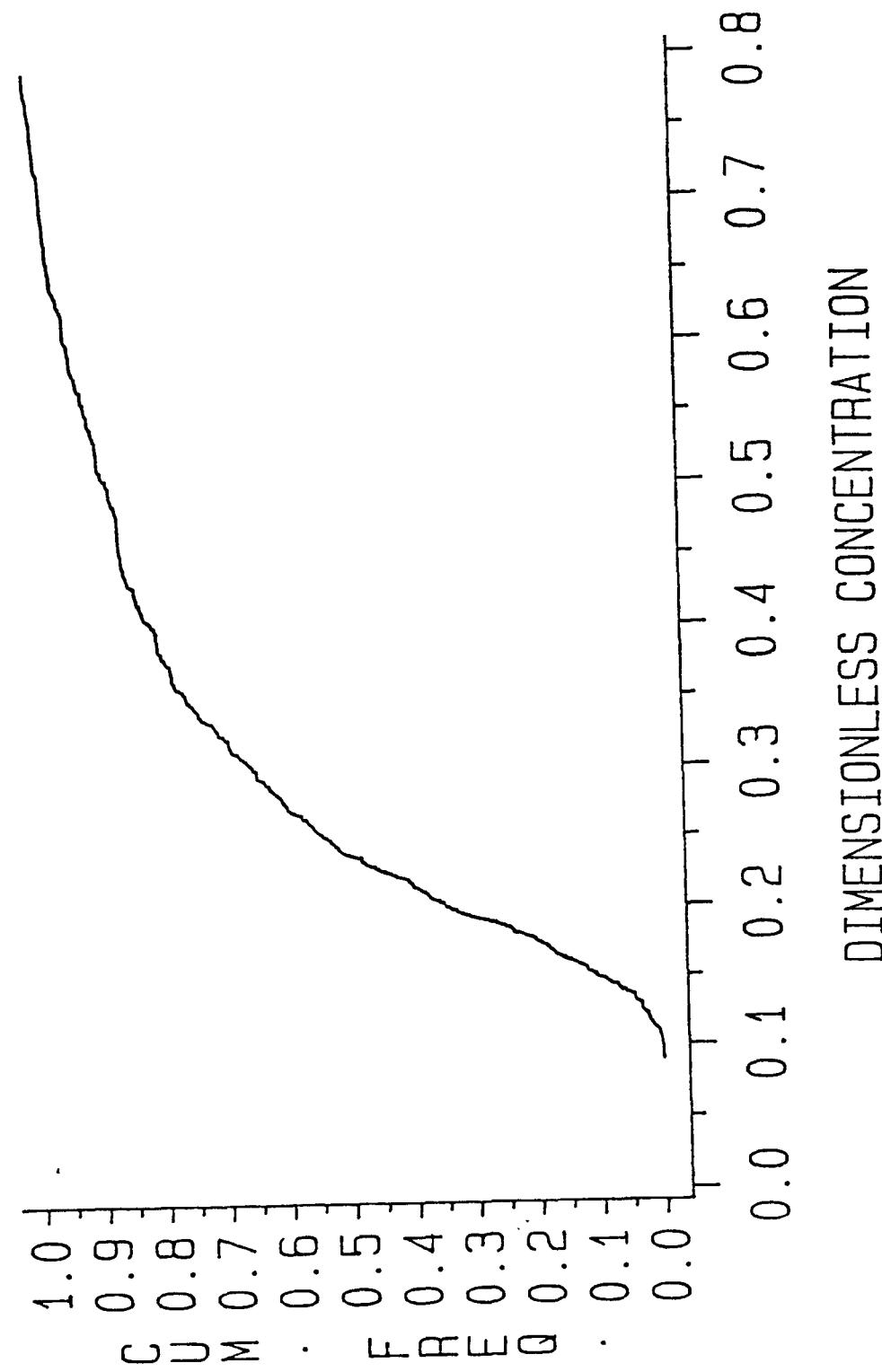
## RUNS 2-6

HEXACHLOROBENZENE, TETRACHLOROETHYLENE, BENZENE, 2,4-DINITROTOLUENE AND ARSENIC

SATURATED ZONE ONLY

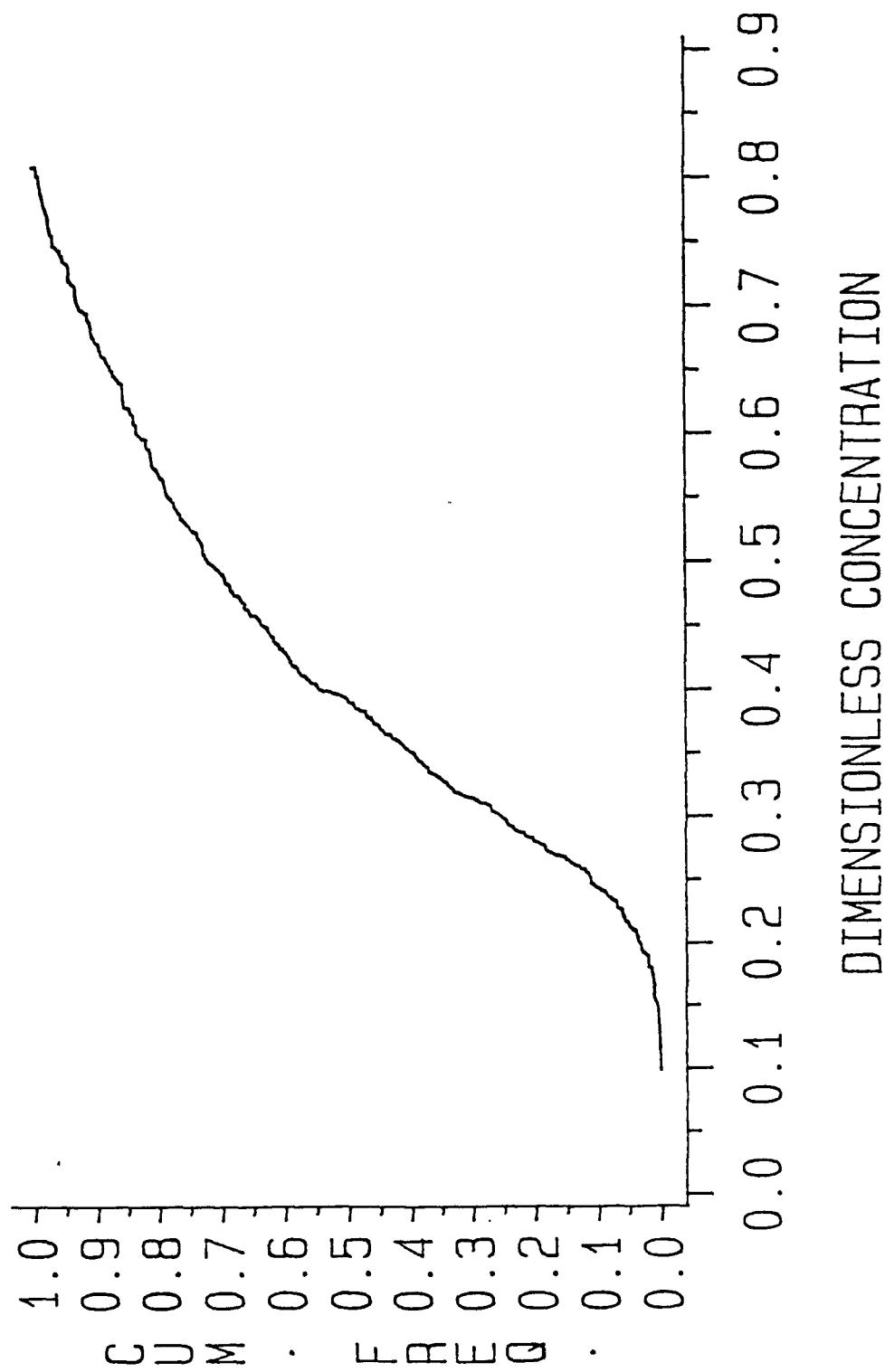
500 ITERATIONS

HYDROGEOLOGIC CATEGORY - 4



RUN 9

CHLOROFORM - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 5



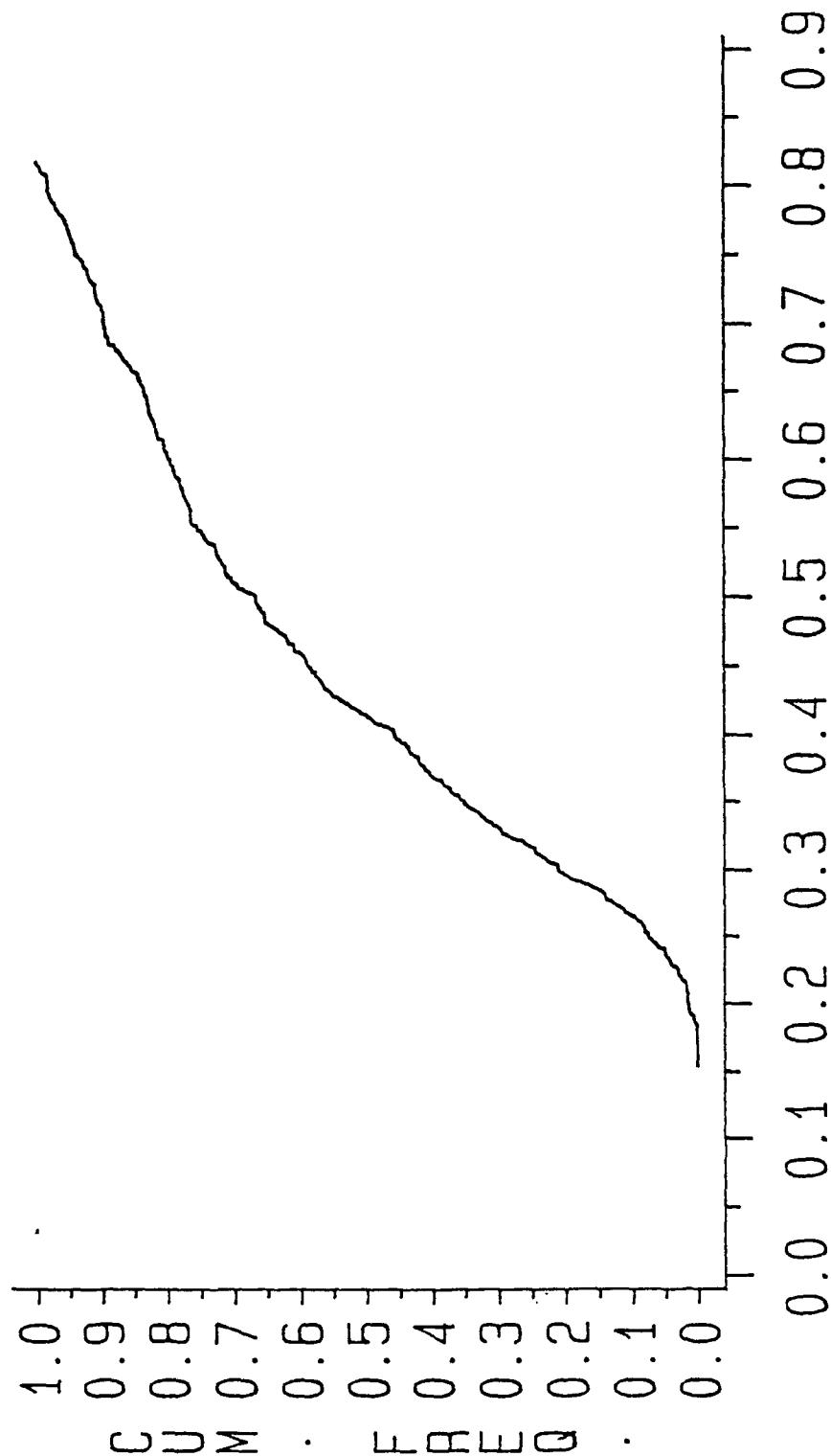
## RUNS 10-14

HEXACHLOROBENZENE, TETRACHLOROETHYLENE, BENZENE, 2,4-DINITROTOLUENE AND ARSENIC

SATURATED ZONE ONLY

500 ITERATIONS

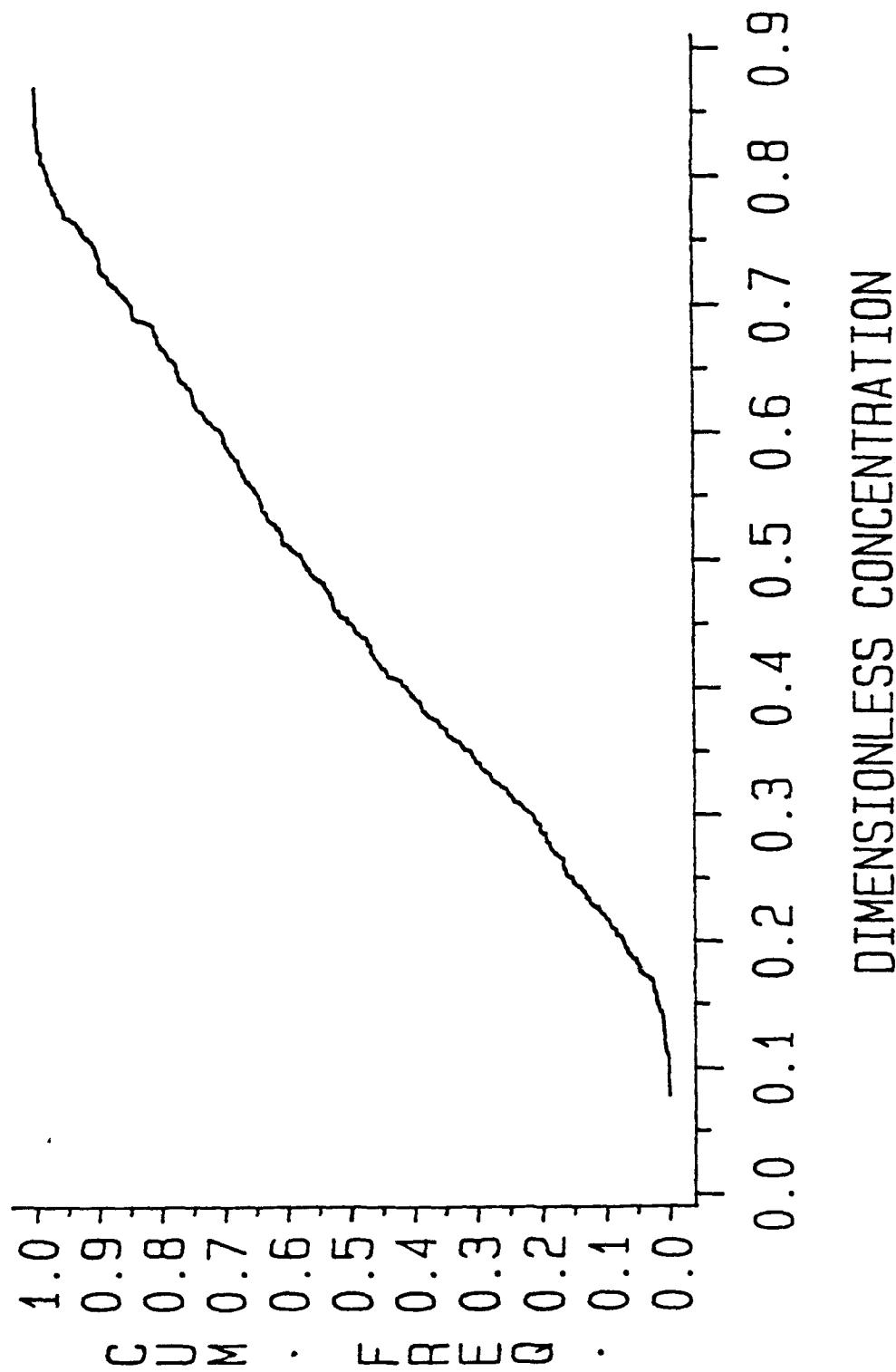
HYDROGEOLOGIC CATEGORY - 5



DIMENSIONLESS CONCENTRATION

RUN 17

CHLOROFORM - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 1

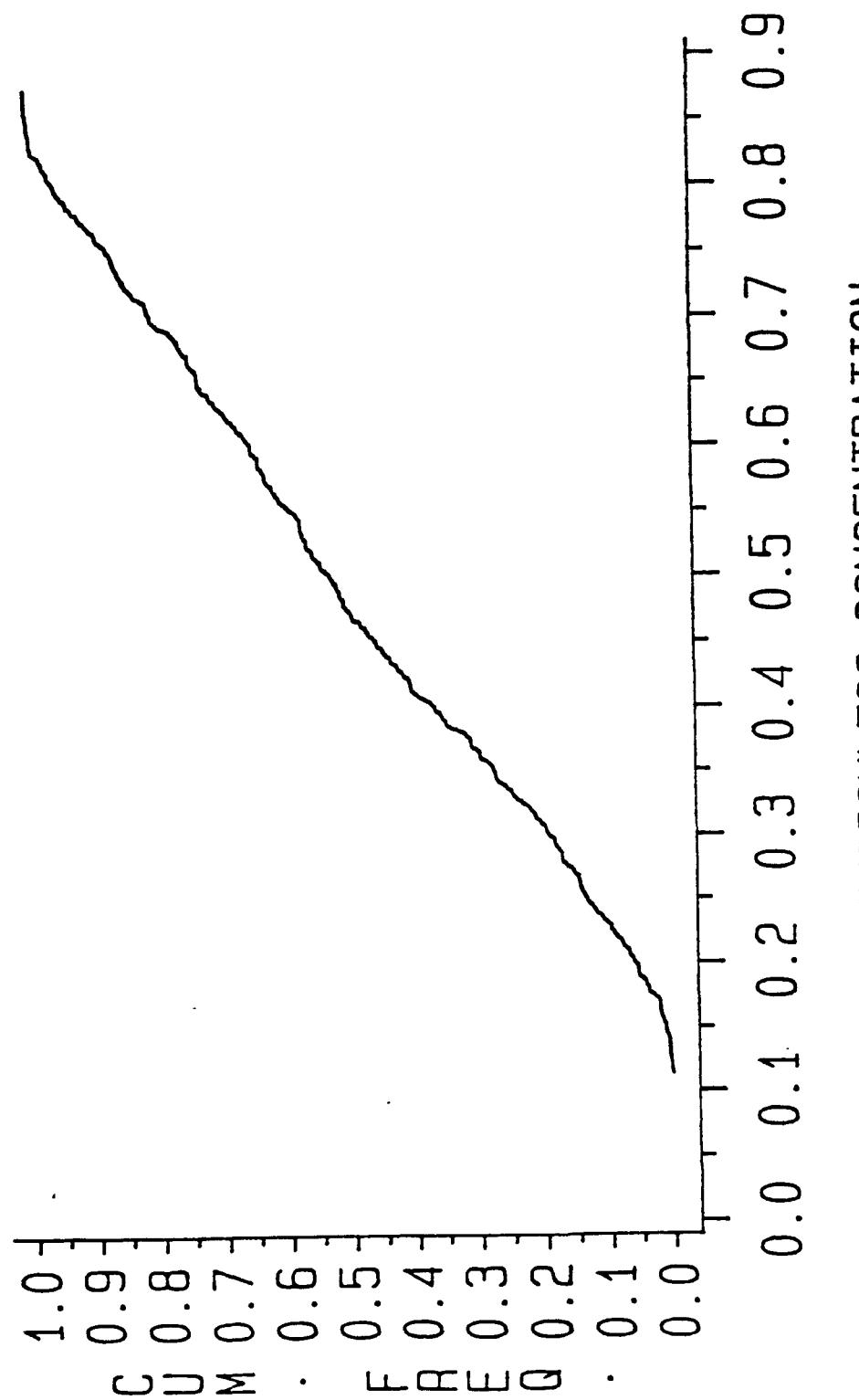


## RUNS 18-22

HEXACHLOROBENZENE, TETRACHLOROETHYLENE, BENZENE, 2,4-DINITROTOLUENE AND ARSENIC

SATURATED ZONE ONLY

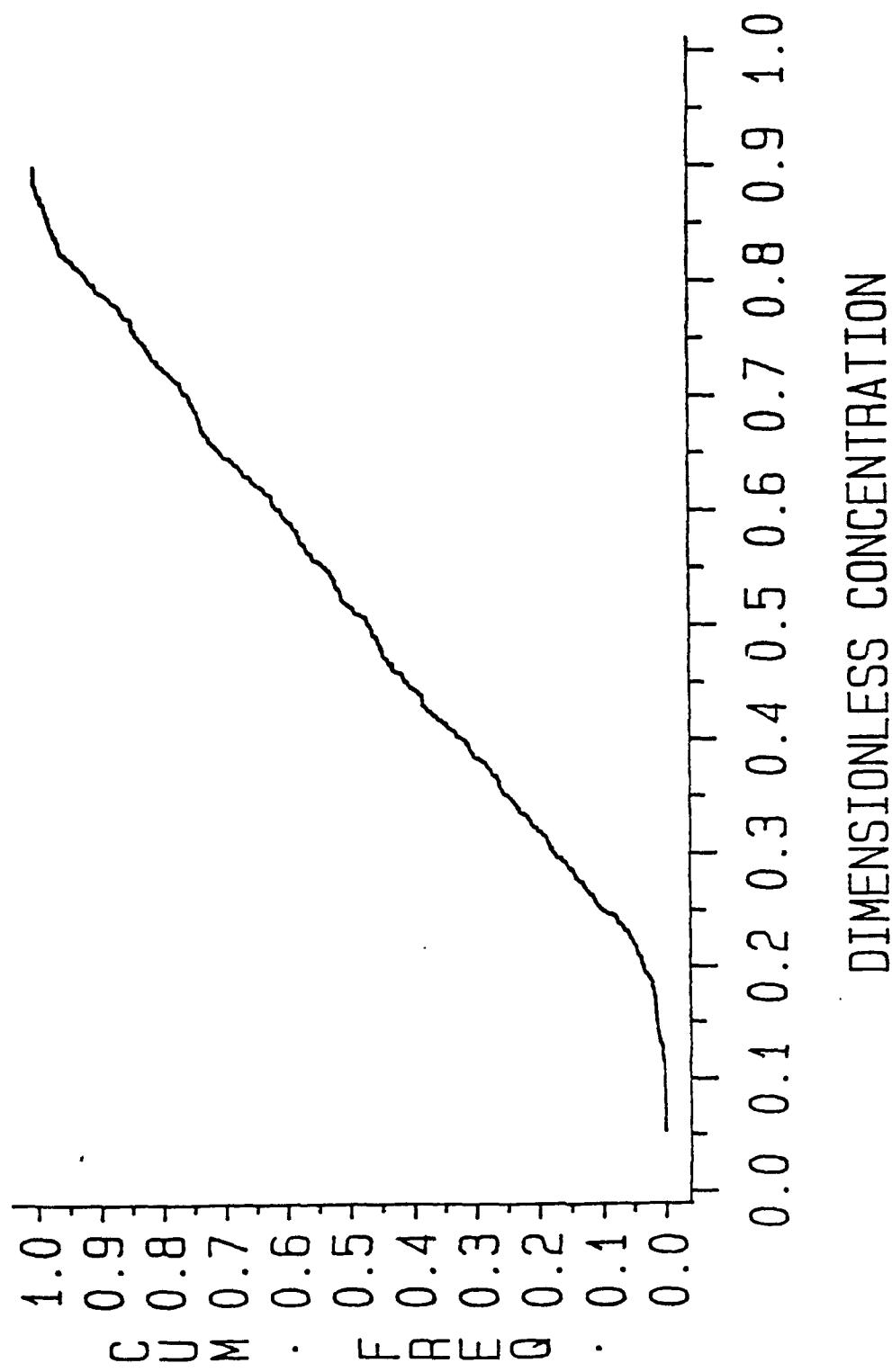
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 1



DIMENSIONLESS CONCENTRATION

RUN 25

CHLOROFORM - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 2



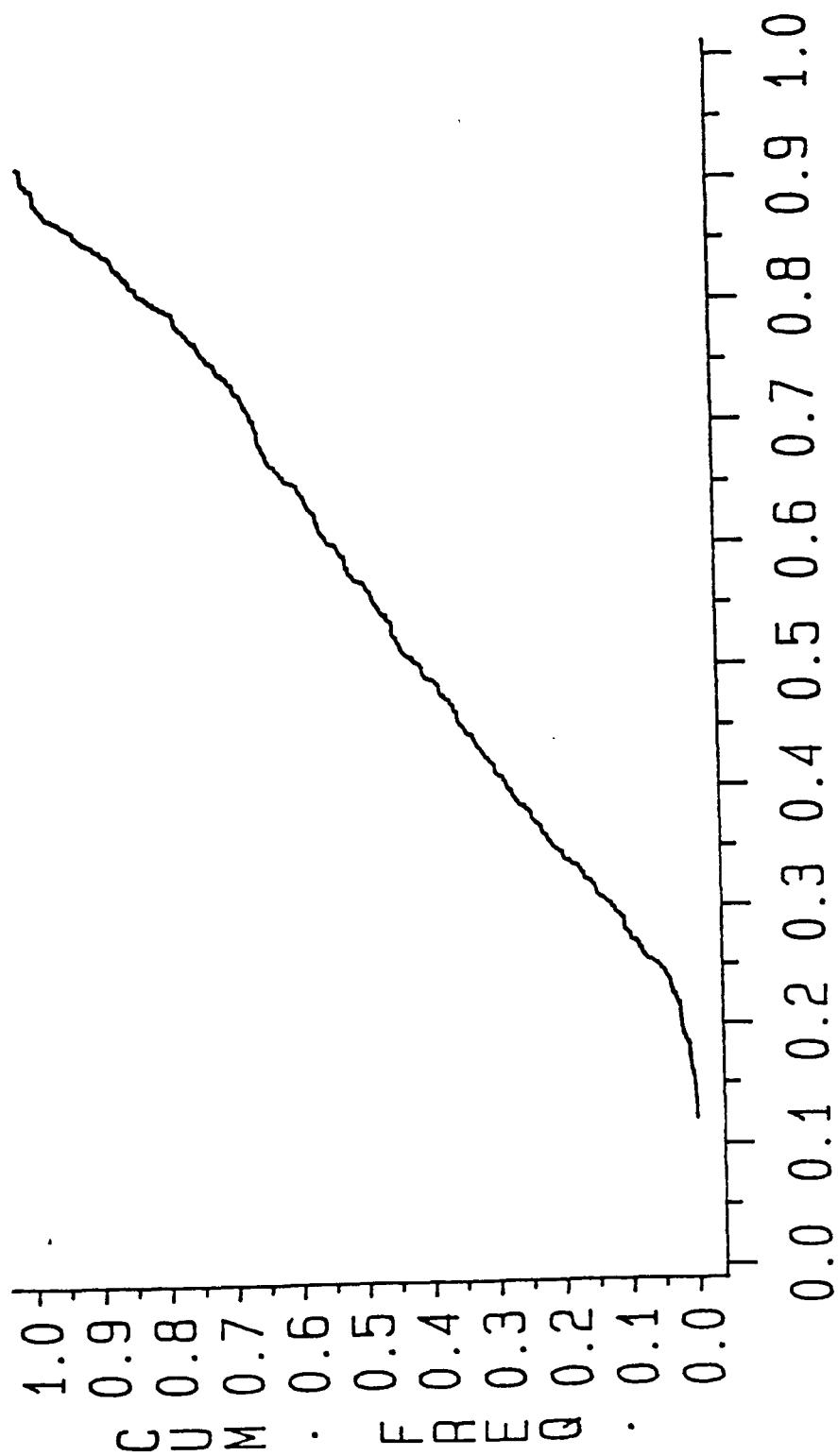
## RUNS 26-30

HEXACHLOROBENZENE, TETRACHLOROETHYLENE, BENZENE, 2,4-DINITROTOLUENE AND ARSENIC.

SATURATED ZONE ONLY

500 ITERATIONS

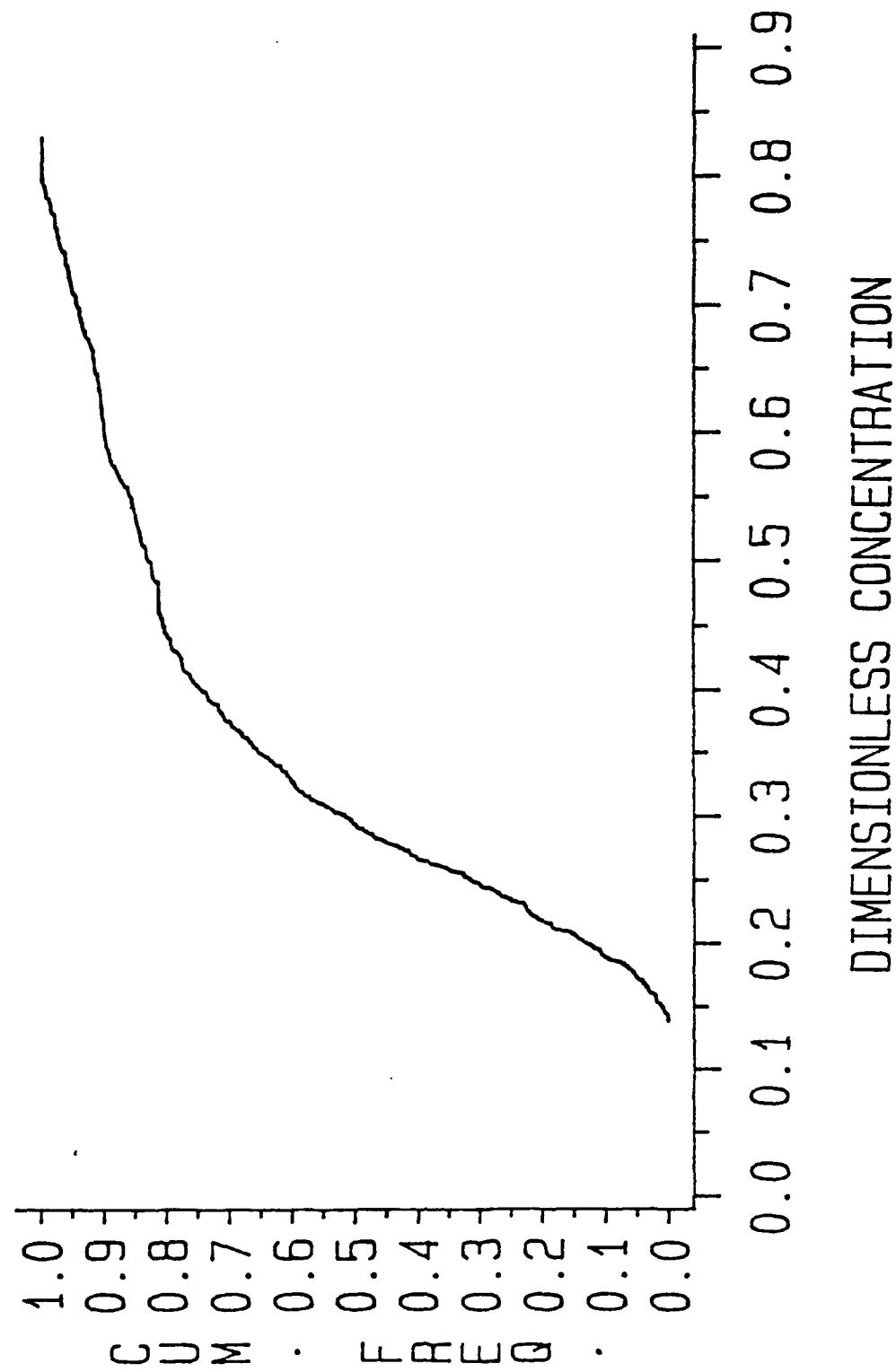
HYDROGEOLOGIC CATEGORY - 2



DIMENSIONLESS CONCENTRATION

RUN 33

CHLOROFORM - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 3



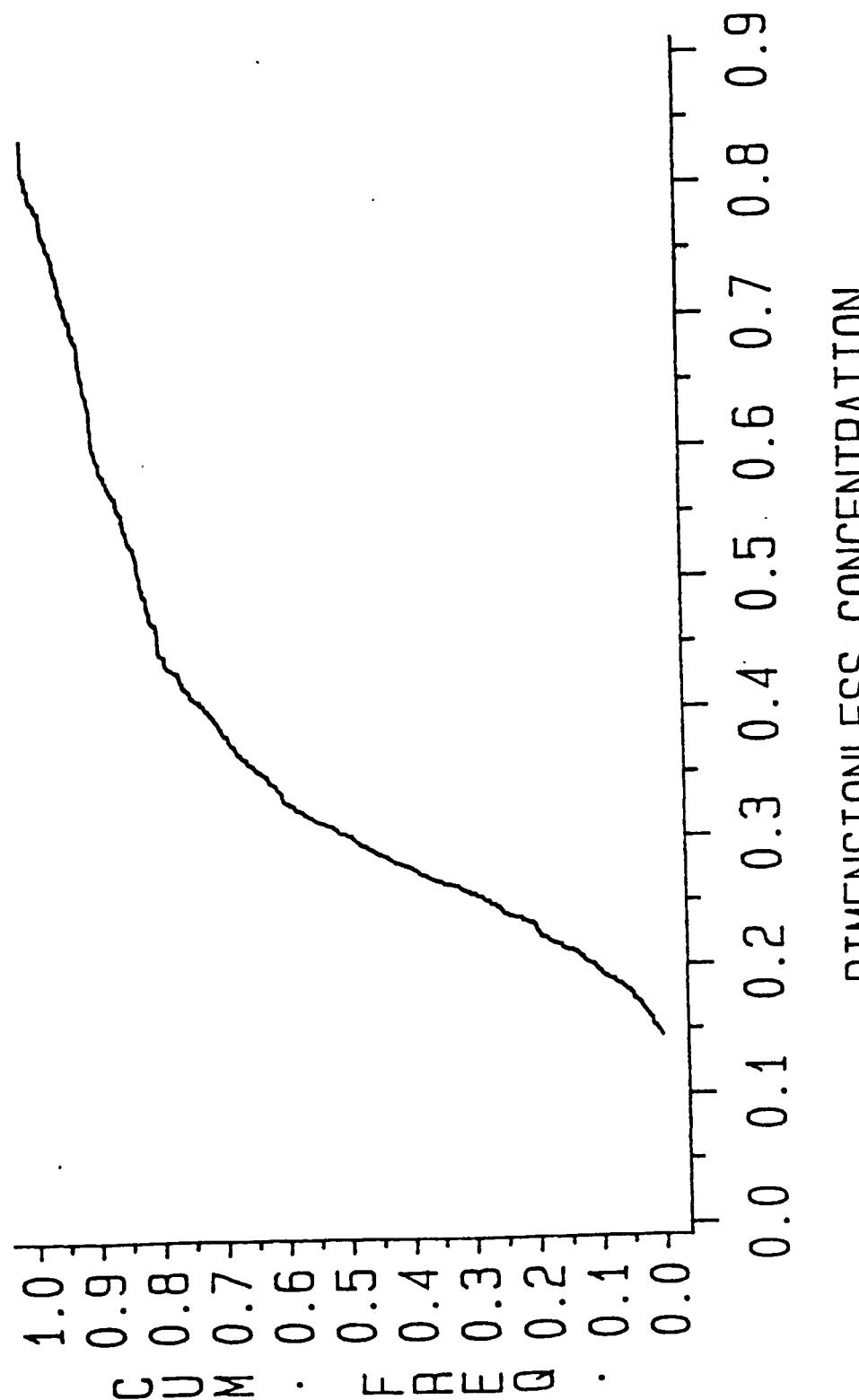
# RUNS 34-38

HEXACHLOROBENZENE, TETRACHLOROETHYLENE, BENZENE, 2,4-DINITROTOLUENE AND ARSENIC

SATURATED ZONE ONLY

500 ITERATIONS

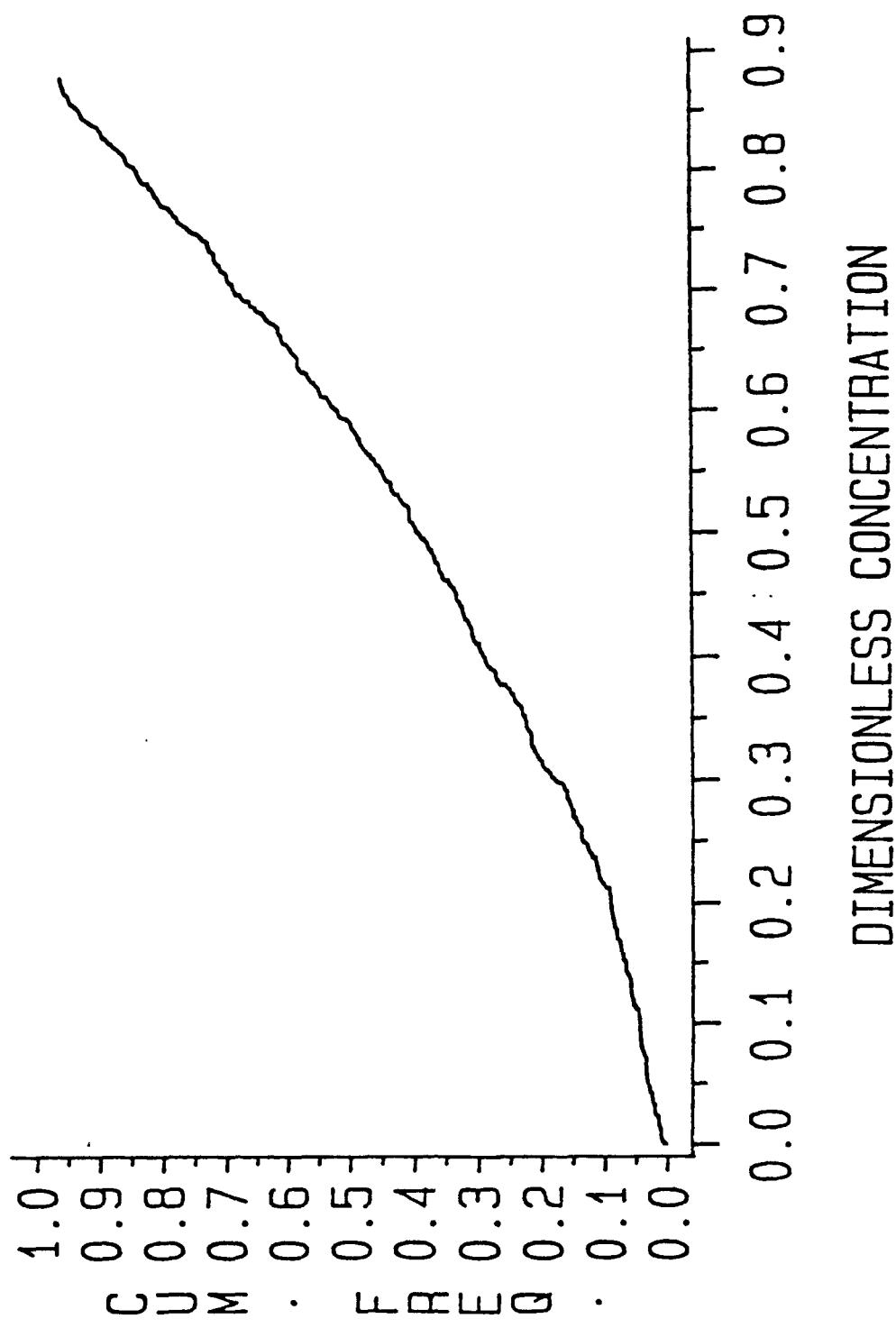
HYDROGEOLOGIC CATEGORY - 3



DIMENSIONLESS CONCENTRATION

RUN 41

CHLOROFORM - SATURATED ZONE ONLY  
493 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 6

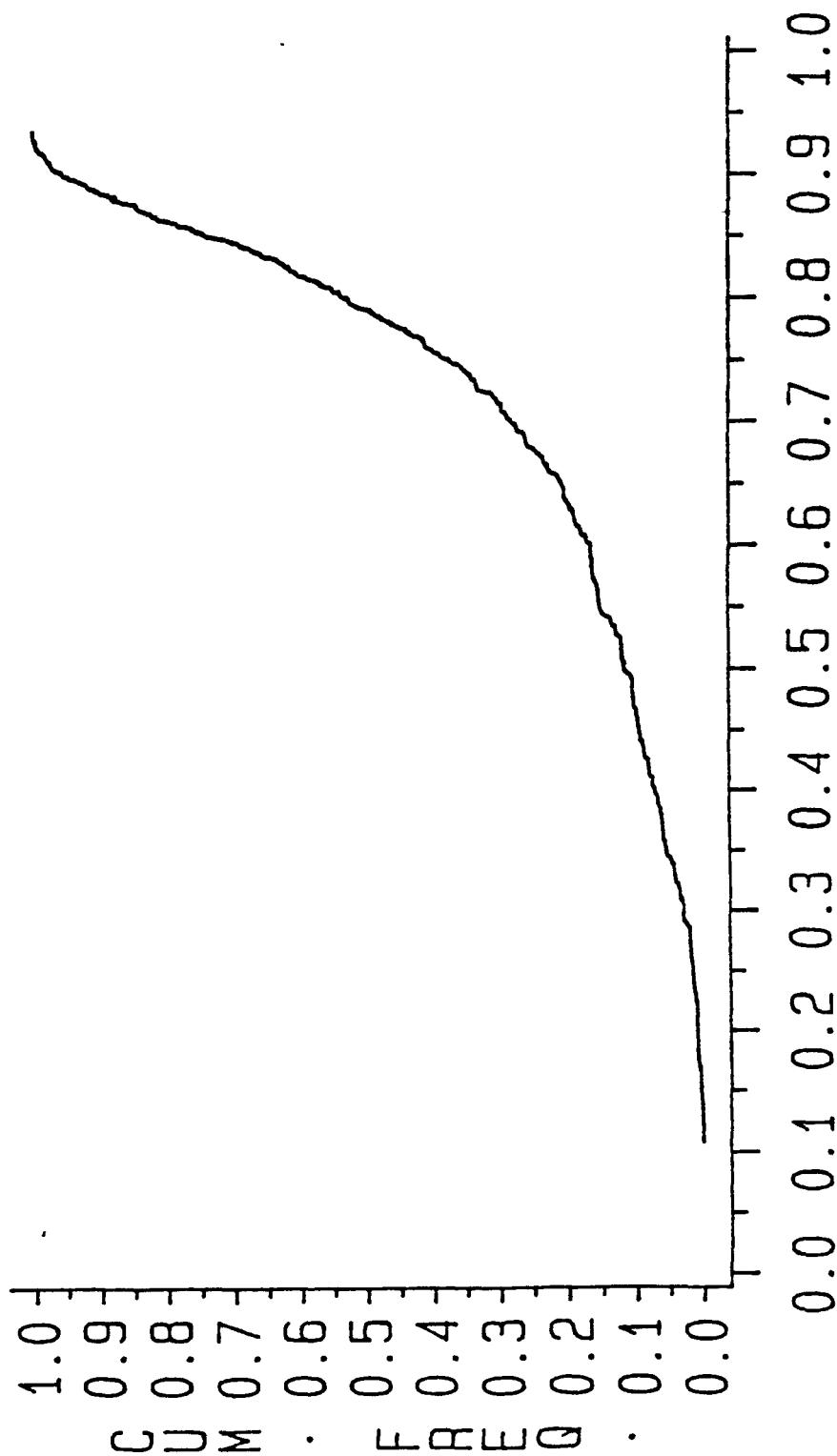


## RUNS 42-46

HEXACHLOROBENZENE, TETRACHLOROETHYLENE, BENZENE, 2,4-DINITROTOLUENE AND ARSENIC

SATURATED ZONE ONLY

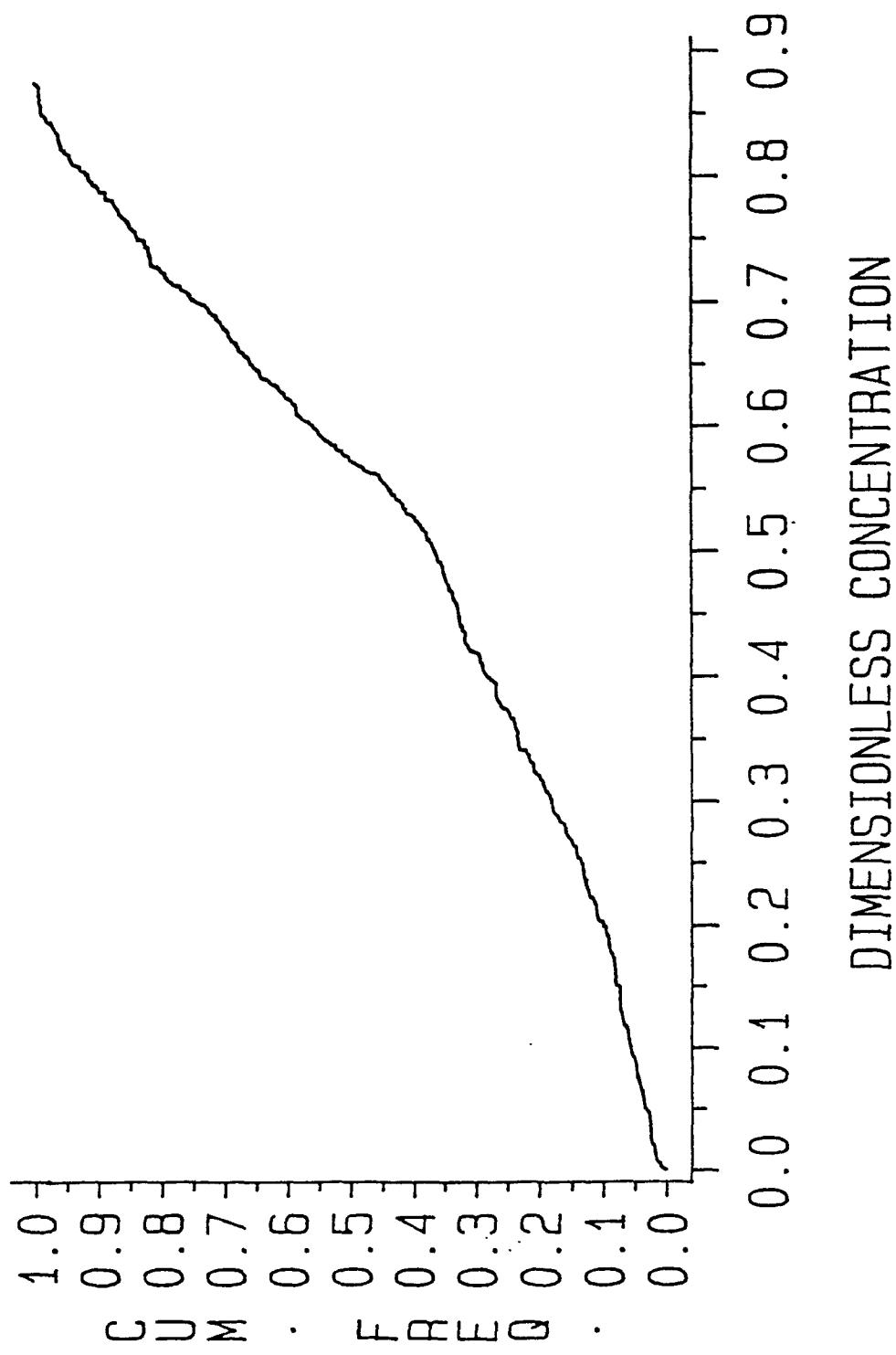
493 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 6



DIMENSIONLESS CONCENTRATION

RUN 49

CHLOROFORM - SATURATED ZONE ONLY  
497 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 7

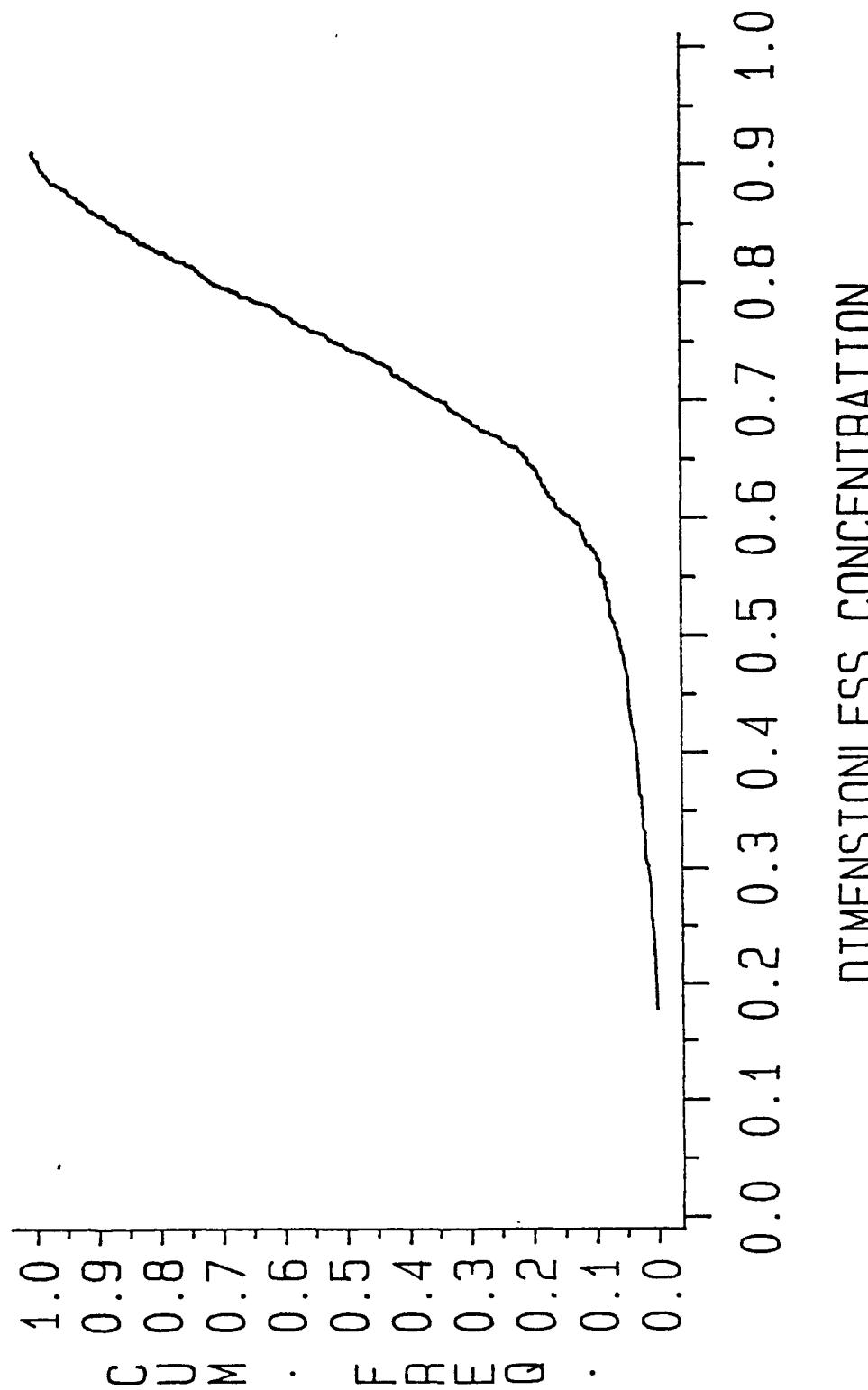


# RUNS 50-54

HEXACHLOROBENZENE, TETRACHLOROETHYLENE, BENZENE, 2,4-DINITROTOLUENE AND ARSENIC

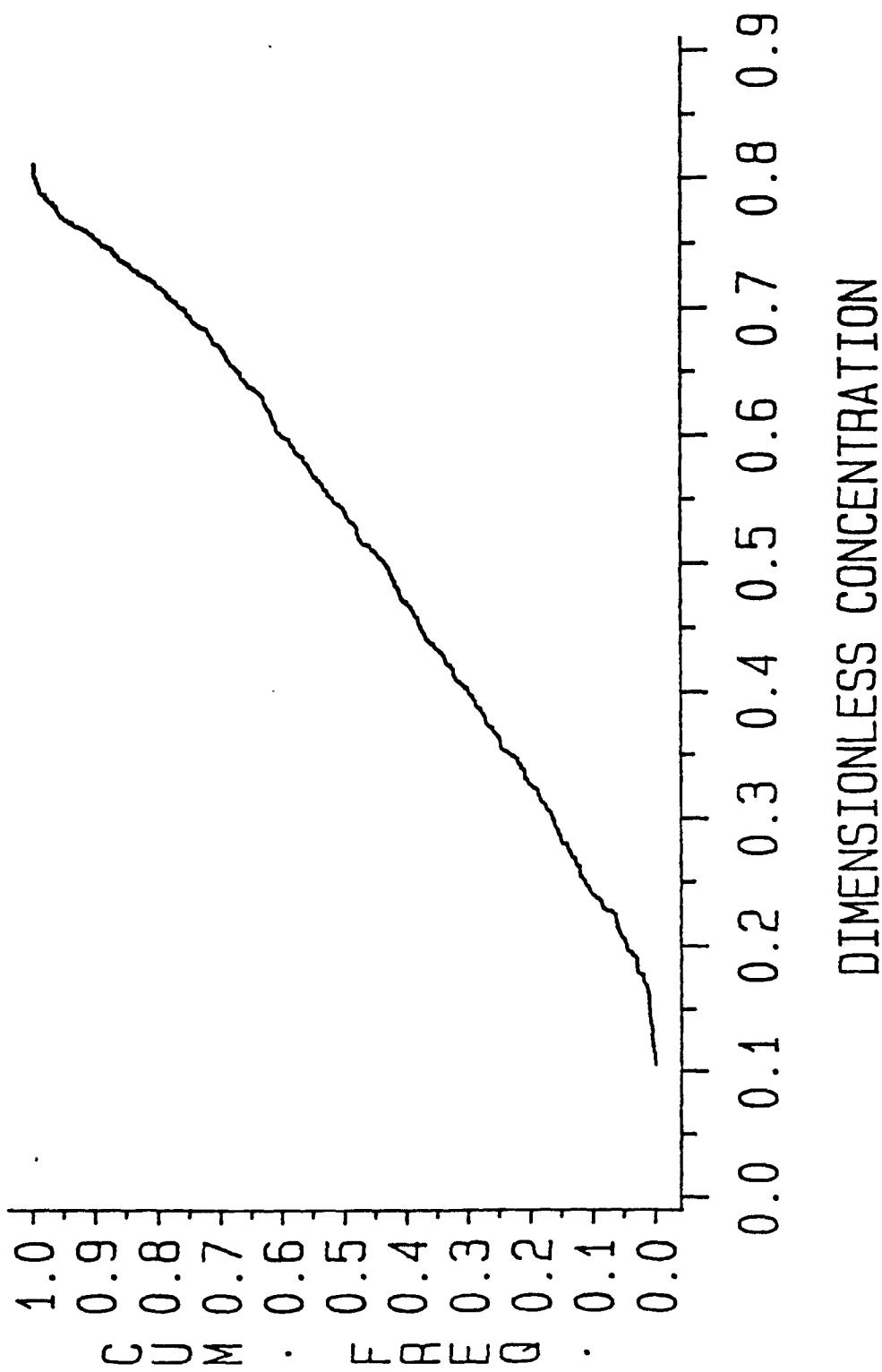
SATURATED ZONE ONLY

497 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 7



RUN 57

CHLOROFORM - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 8

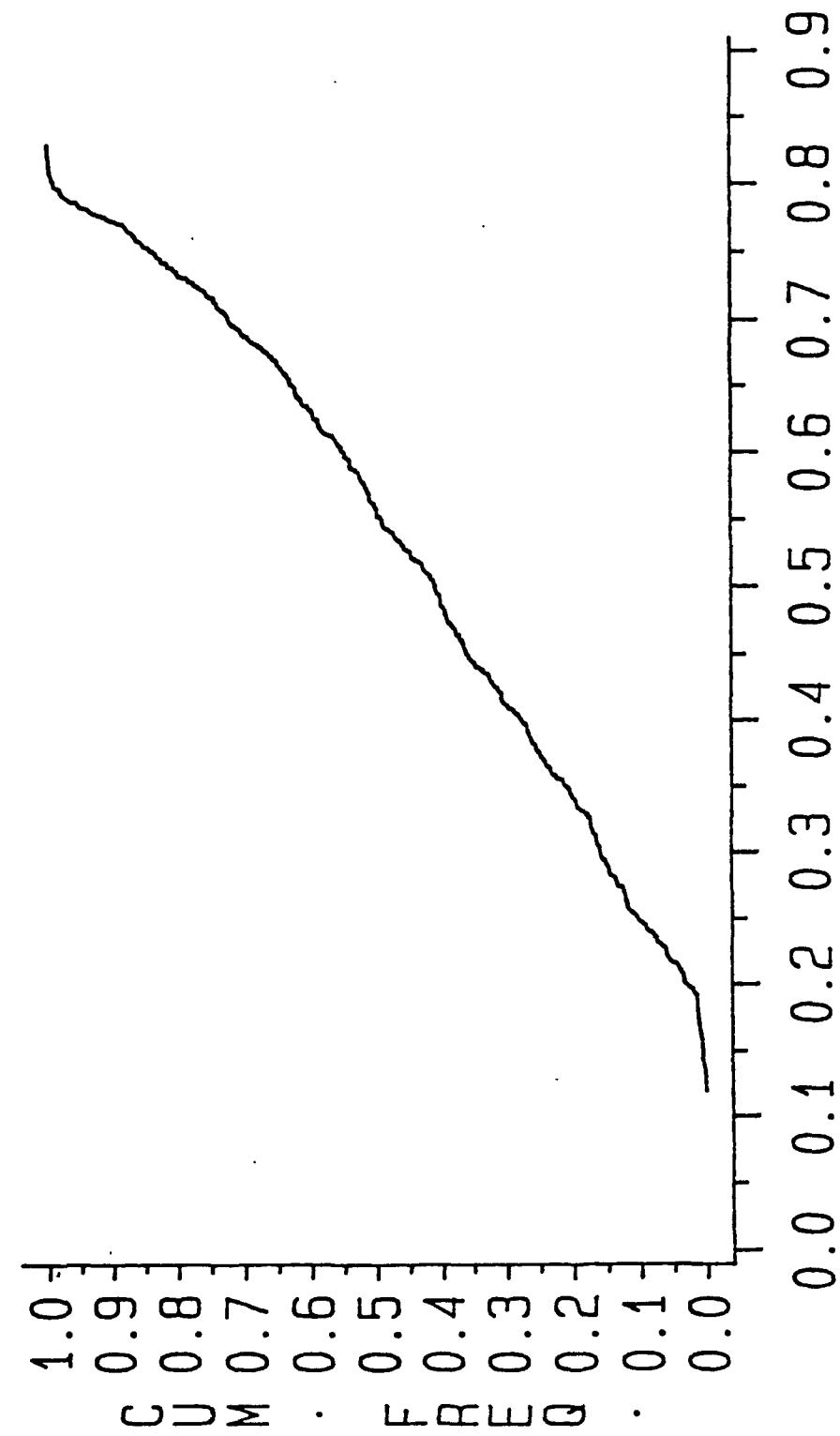


## RUNS 58-62

HEXACHLOROBENZENE, TETRACHLOROETHYLENE, BENZENE, 2,4-DINITROTOLUENE AND ARSENIC

SATURATED ZONE ONLY

500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 8



DIMENSIONLESS CONCENTRATION

RUN 65

CHLOROFORM - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 9



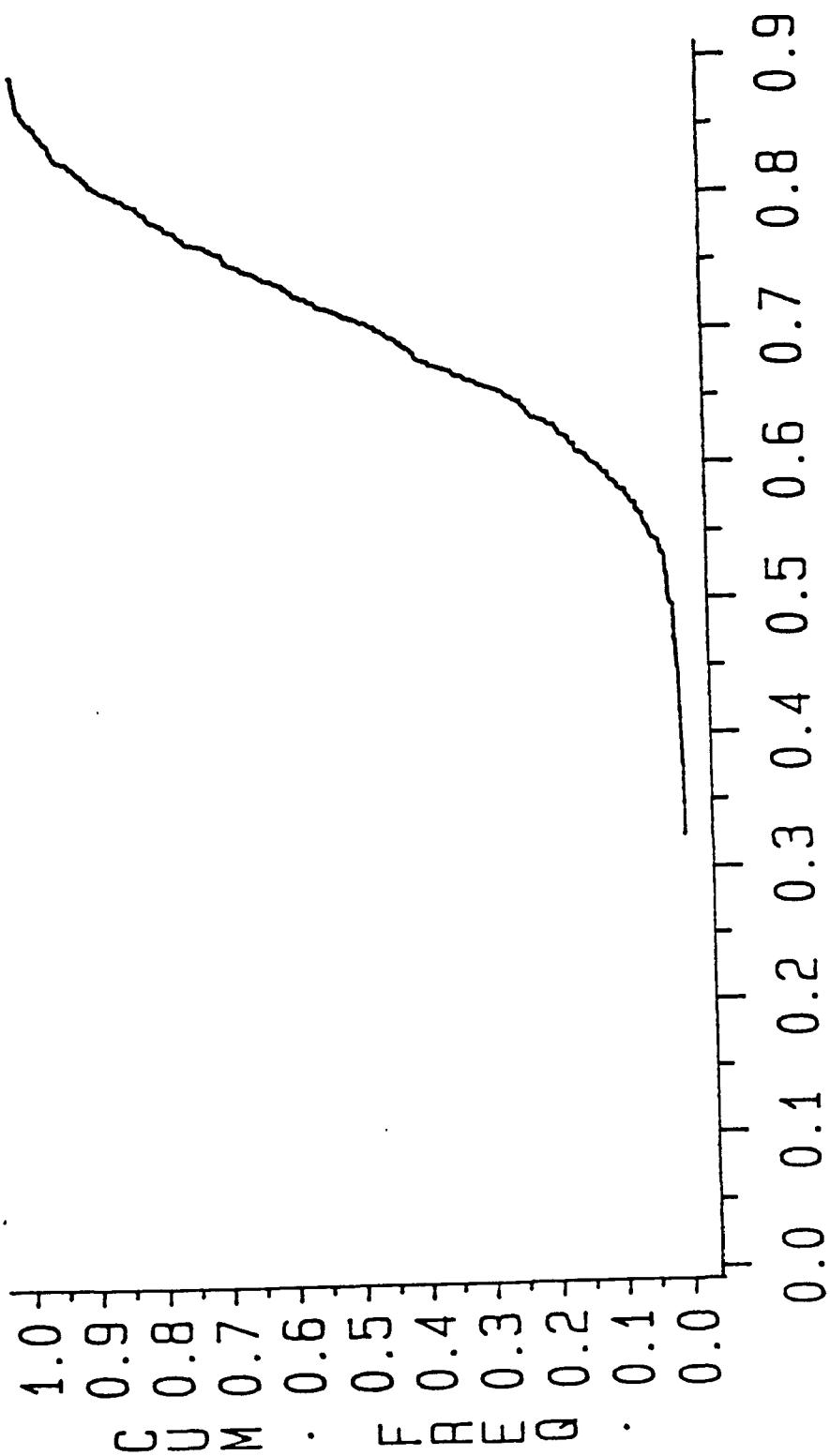
# RUNS 66-70

HEXACHLOROBENZENE, TETRACHLOROETHYLENE, BENZENE, 2,4-DINITROTOLUENE AND ARSENIC

SATURATED ZONE ONLY

500 ITERATIONS

HYDROGEOLOGIC CATEGORY - 9



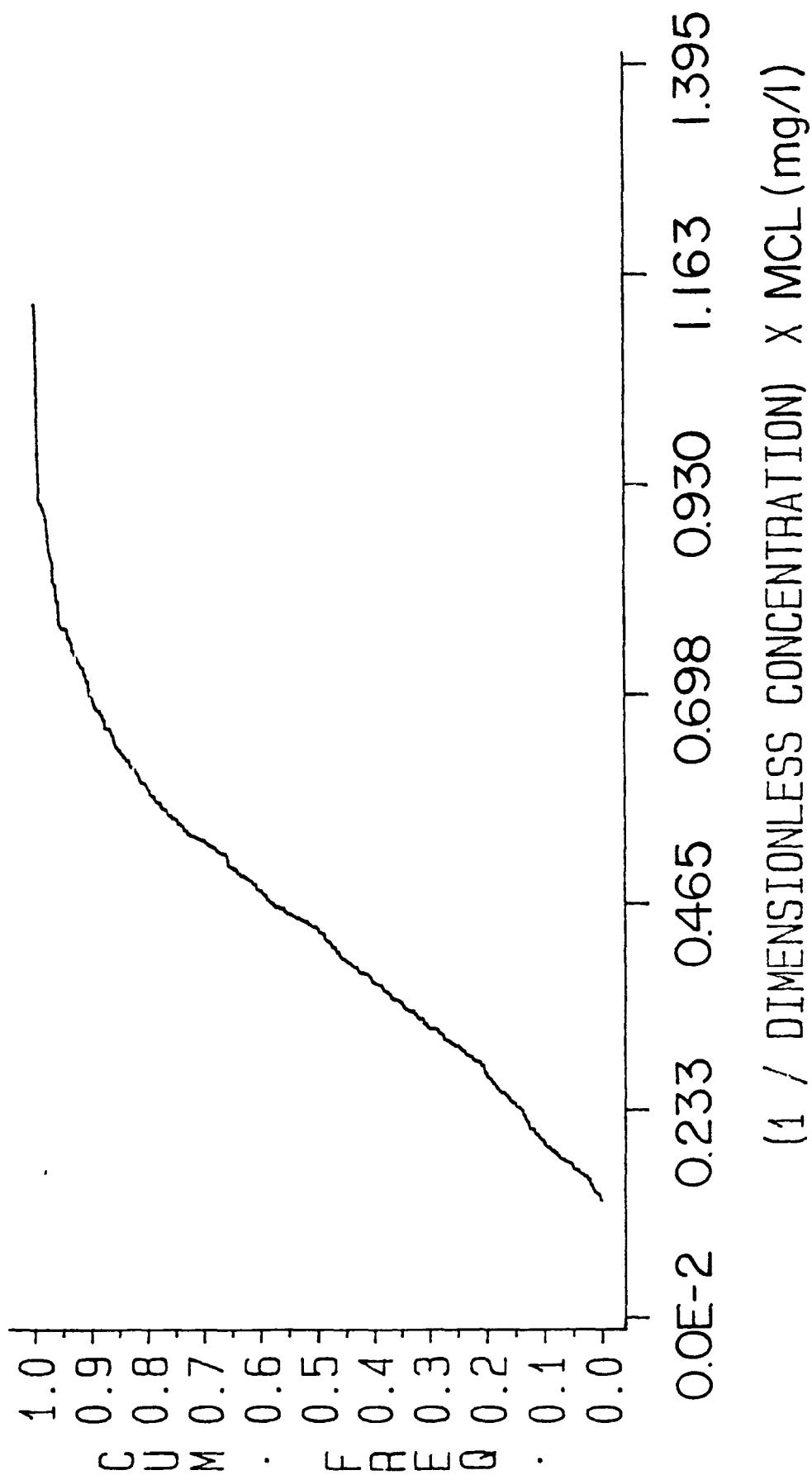
DIMENSIONLESS CONCENTRATION

APPENDIX 4.6

RESULTS OF GENERIC RUNS: TARGET LAGOON CONCENTRATIONS  
BASED ON HUMAN HEALTH THRESHOLDS

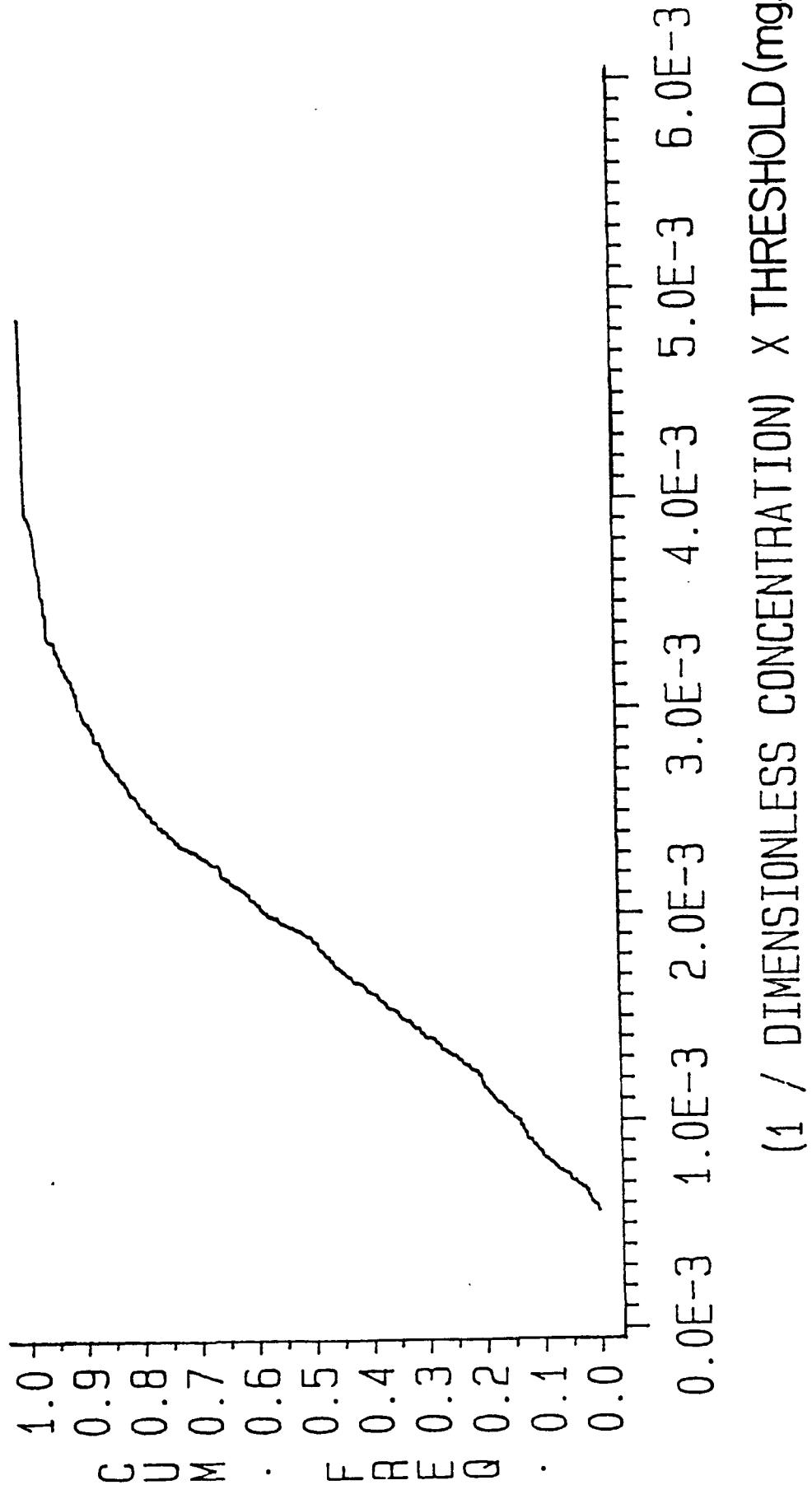
RUN 1A

CHLOROFORM - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 4



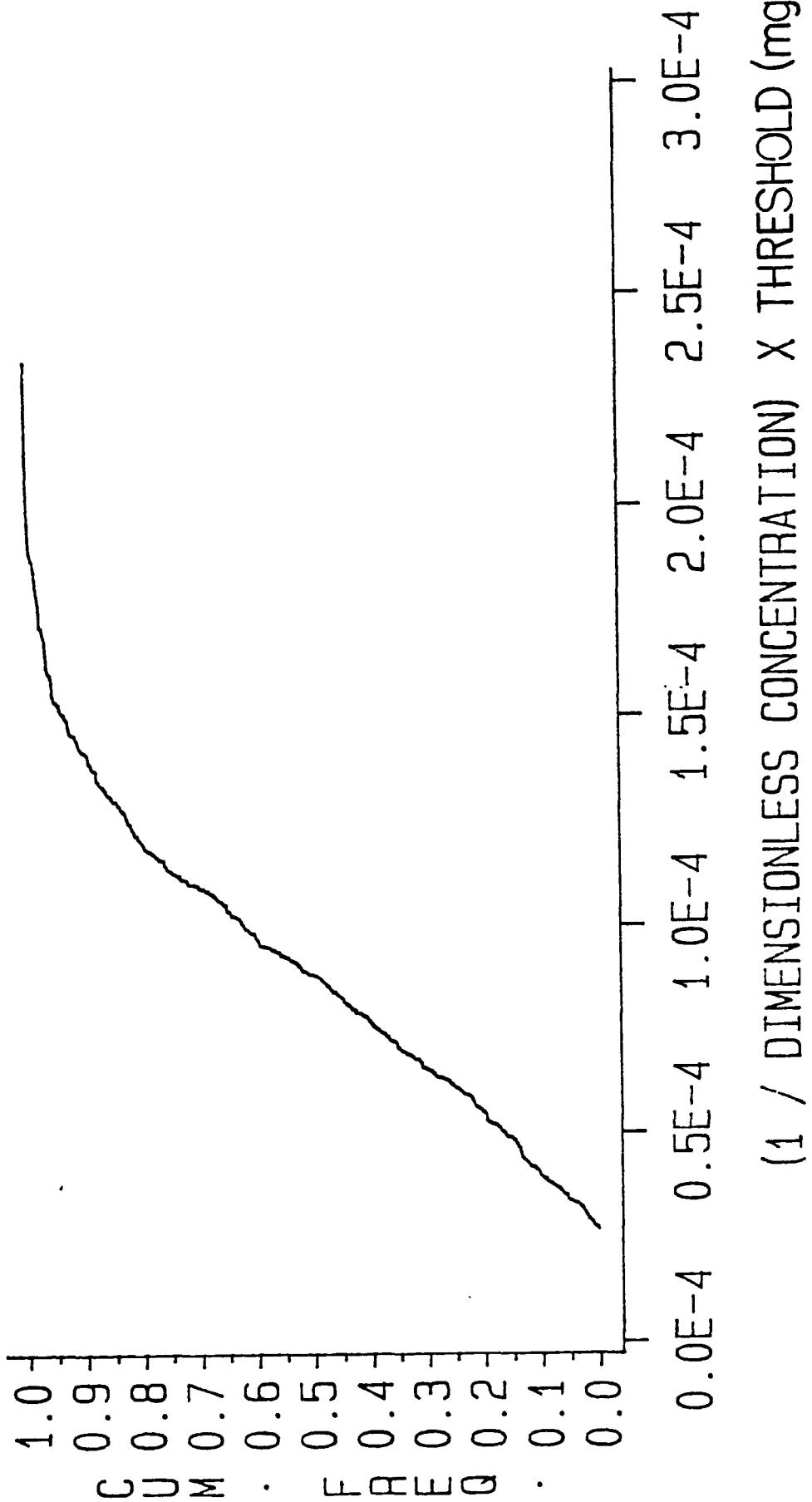
RUN 1B

CHLOROFORM - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 4



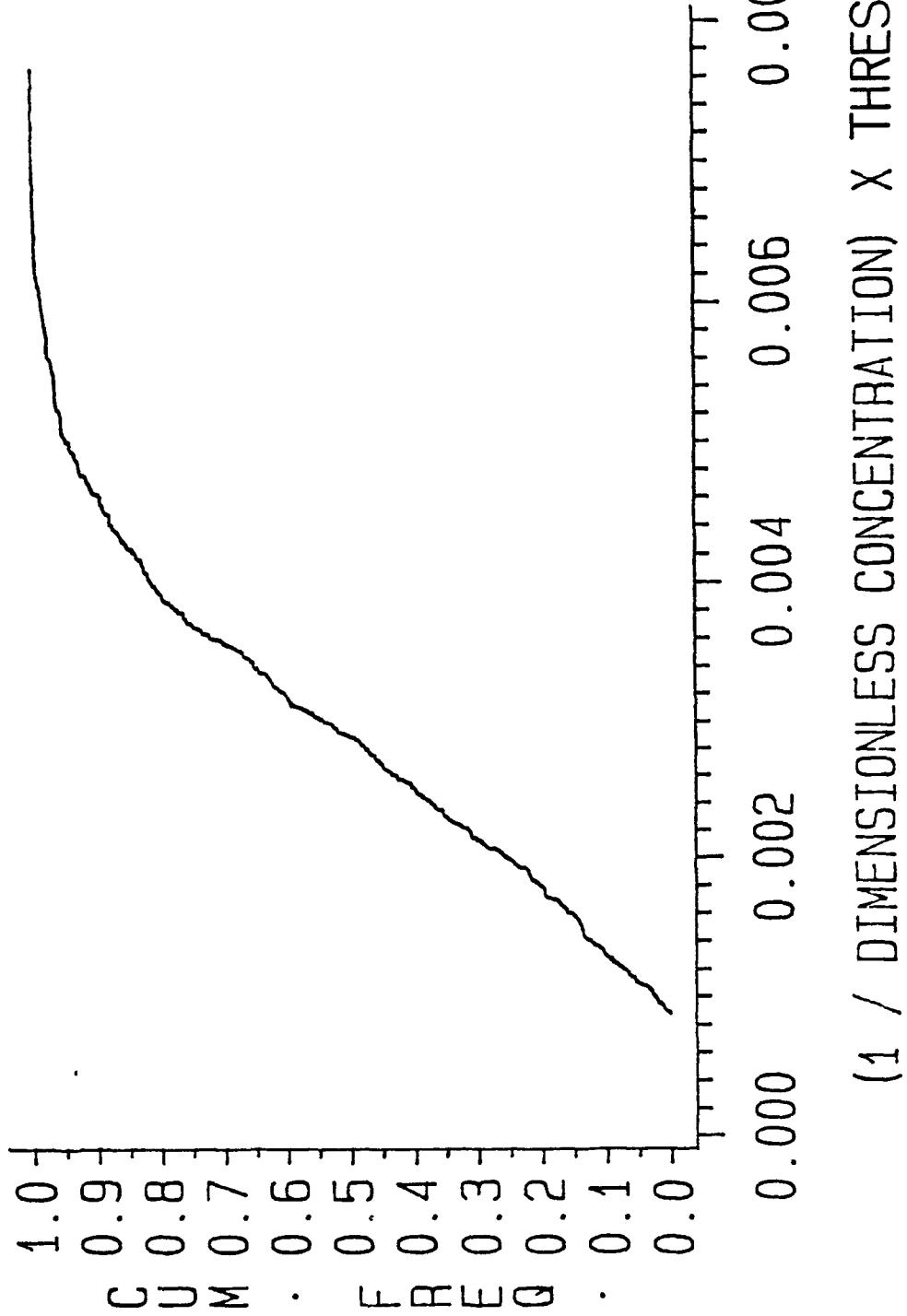
## RUN 2

HEXACHLOROBENZENE - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 4



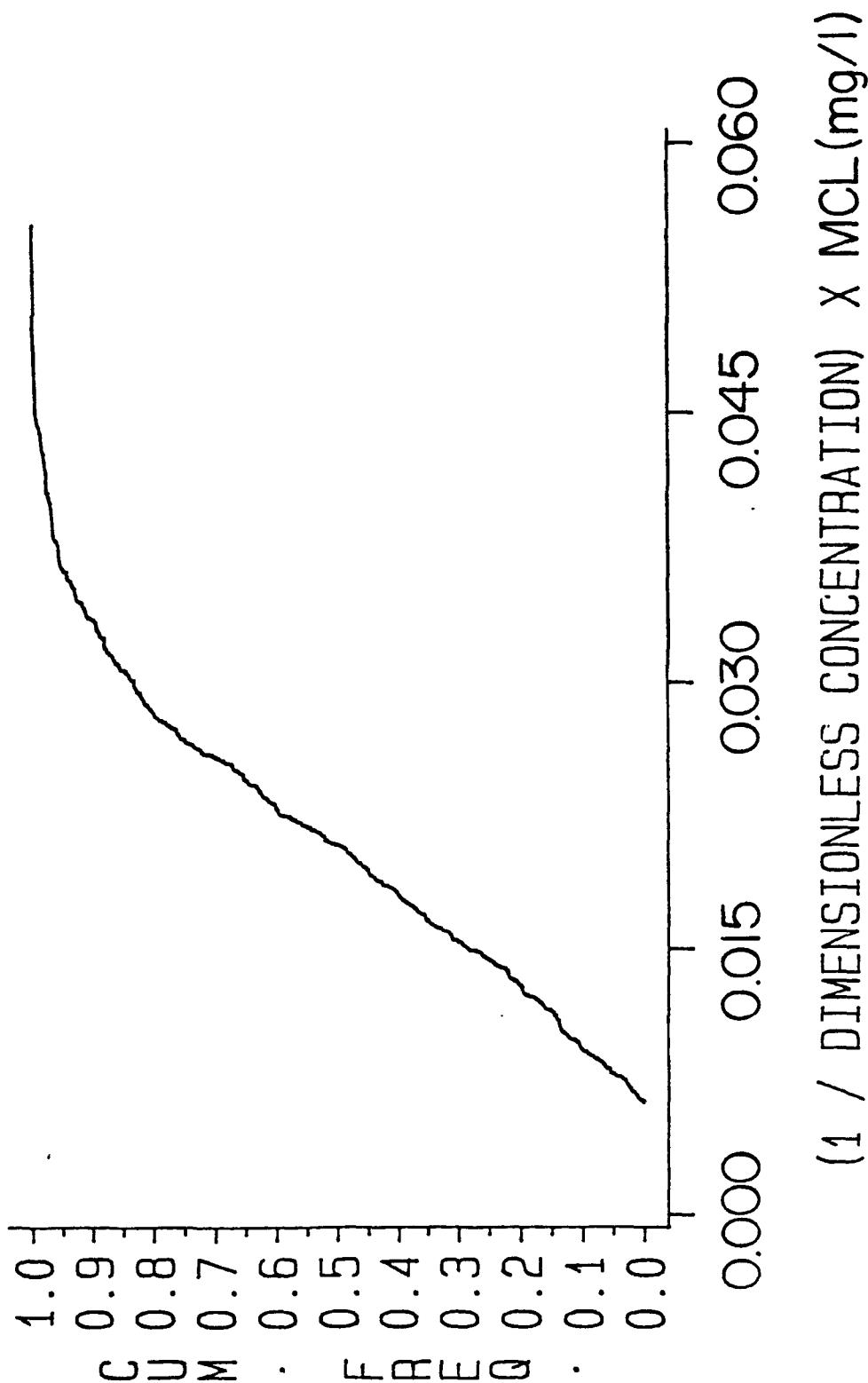
RUN 3

TETRACHLOROETHYLENE - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 4



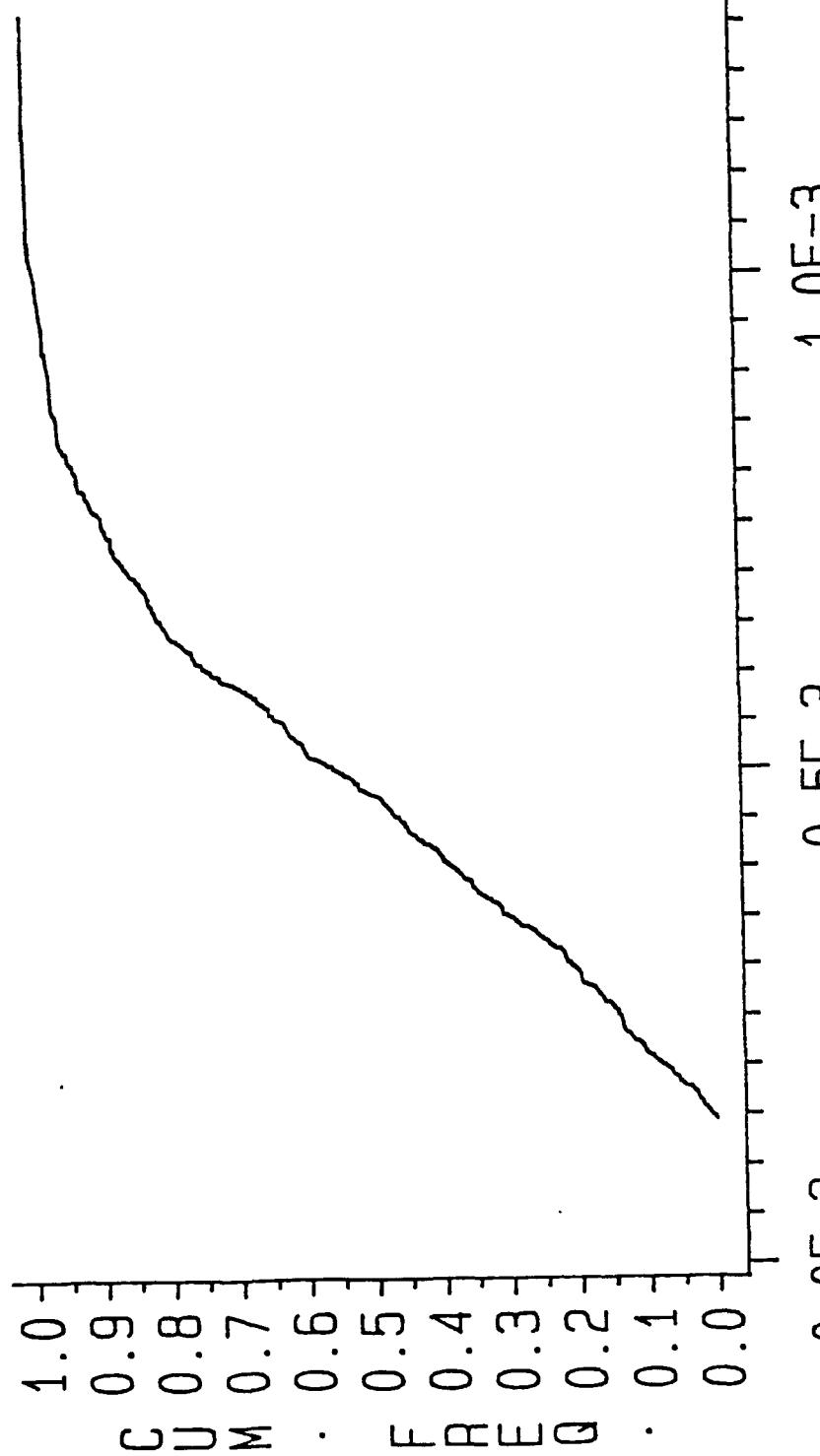
RUN 4

BENZENE - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 4



RUN 5

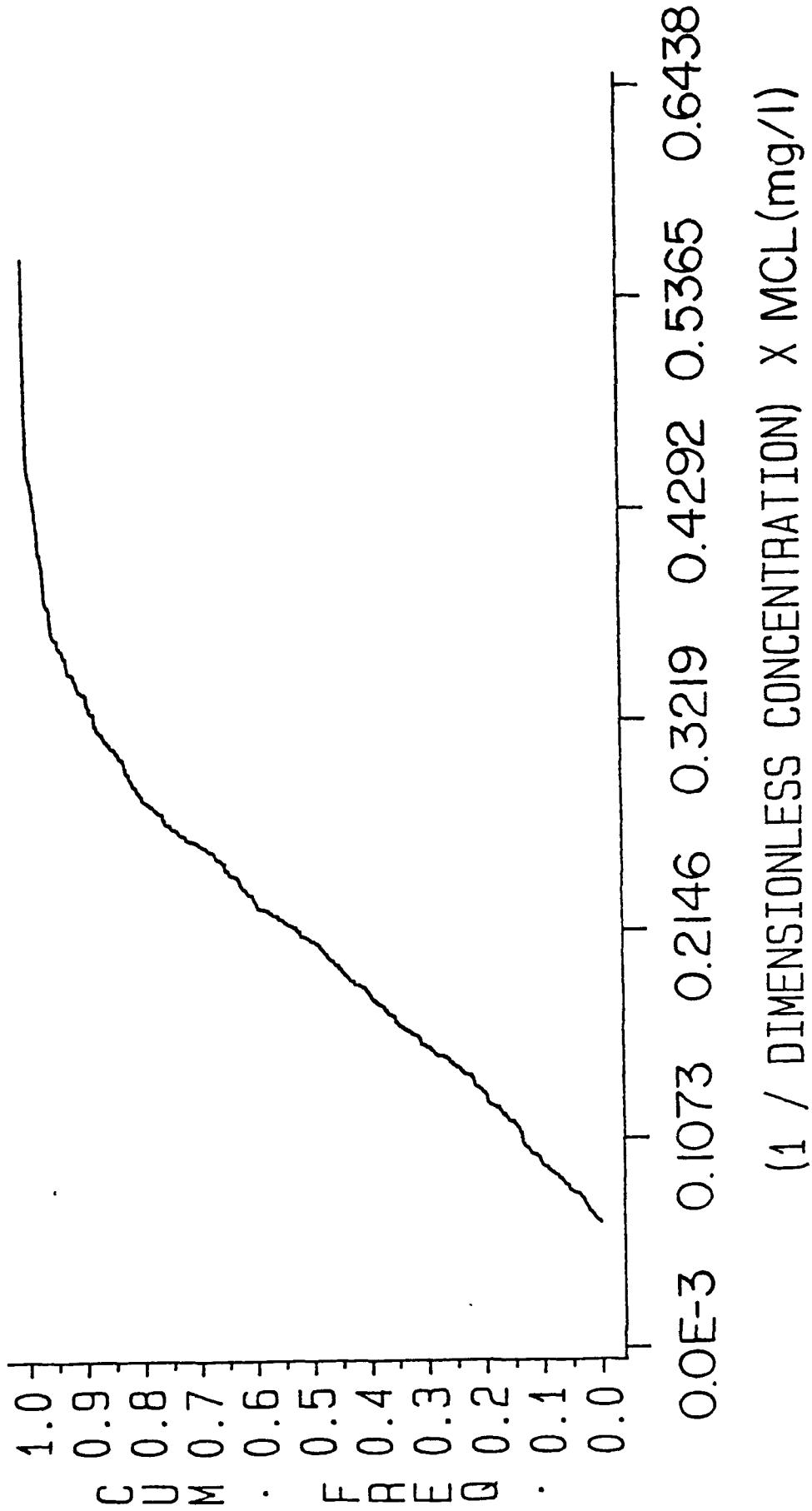
2,4-DINITROTOLUENE - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 4



(1 / DIMENSIONLESS CONCENTRATION) X THRESHOLD (mg/l)

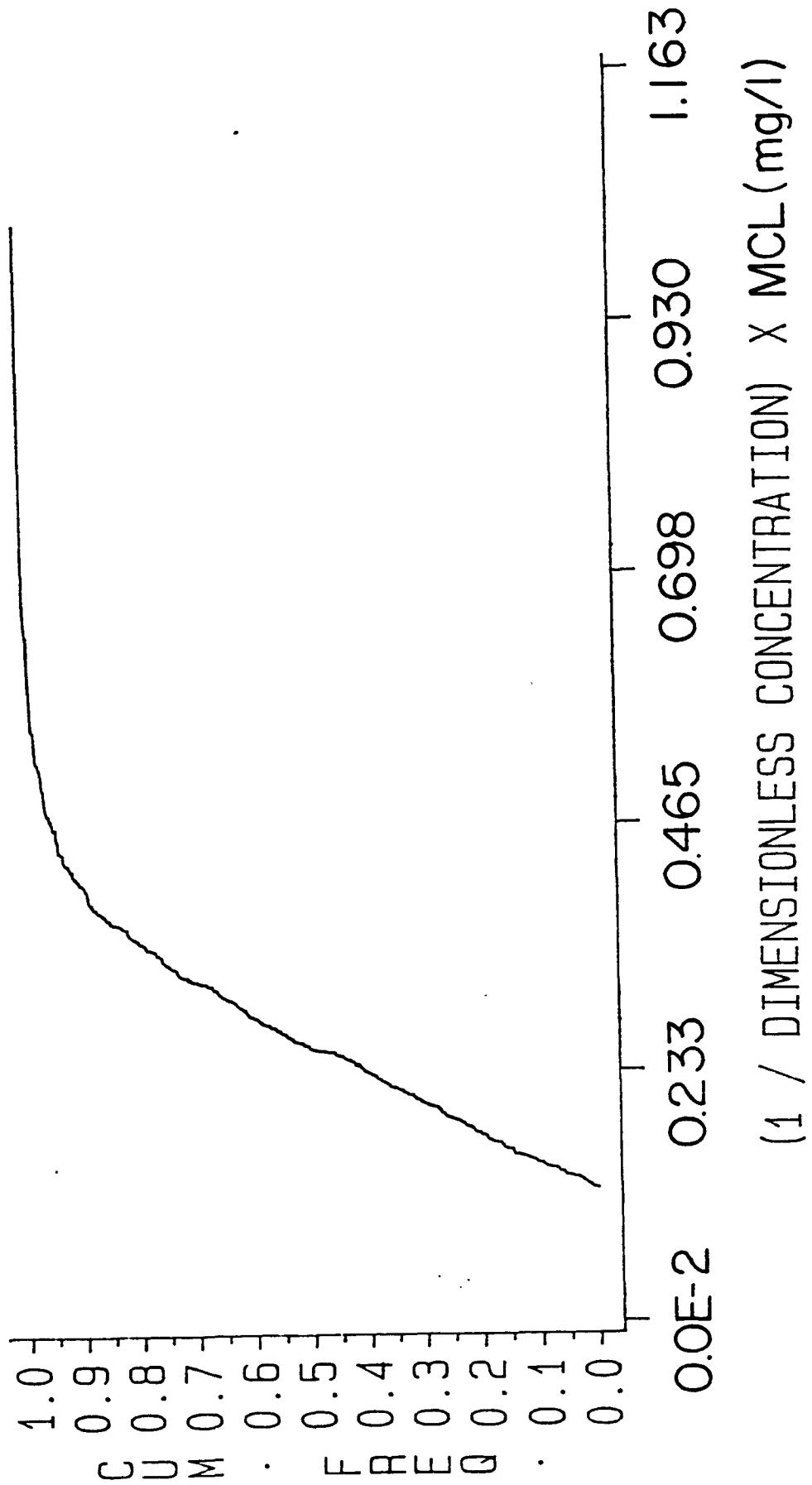
RUN 6

ARSENIC - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 4



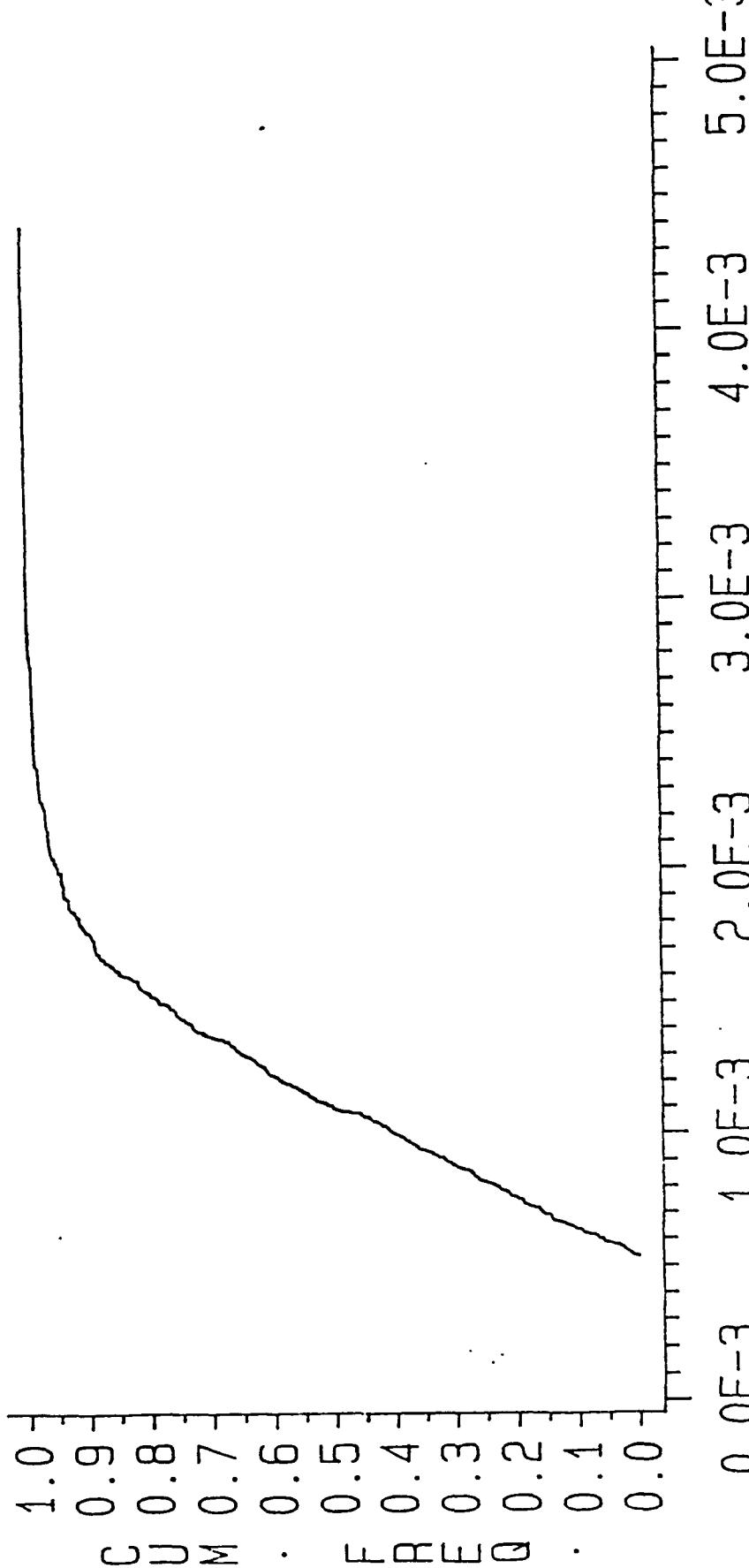
RUN 9A

CHLOROFORM - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 5



RUN 9B

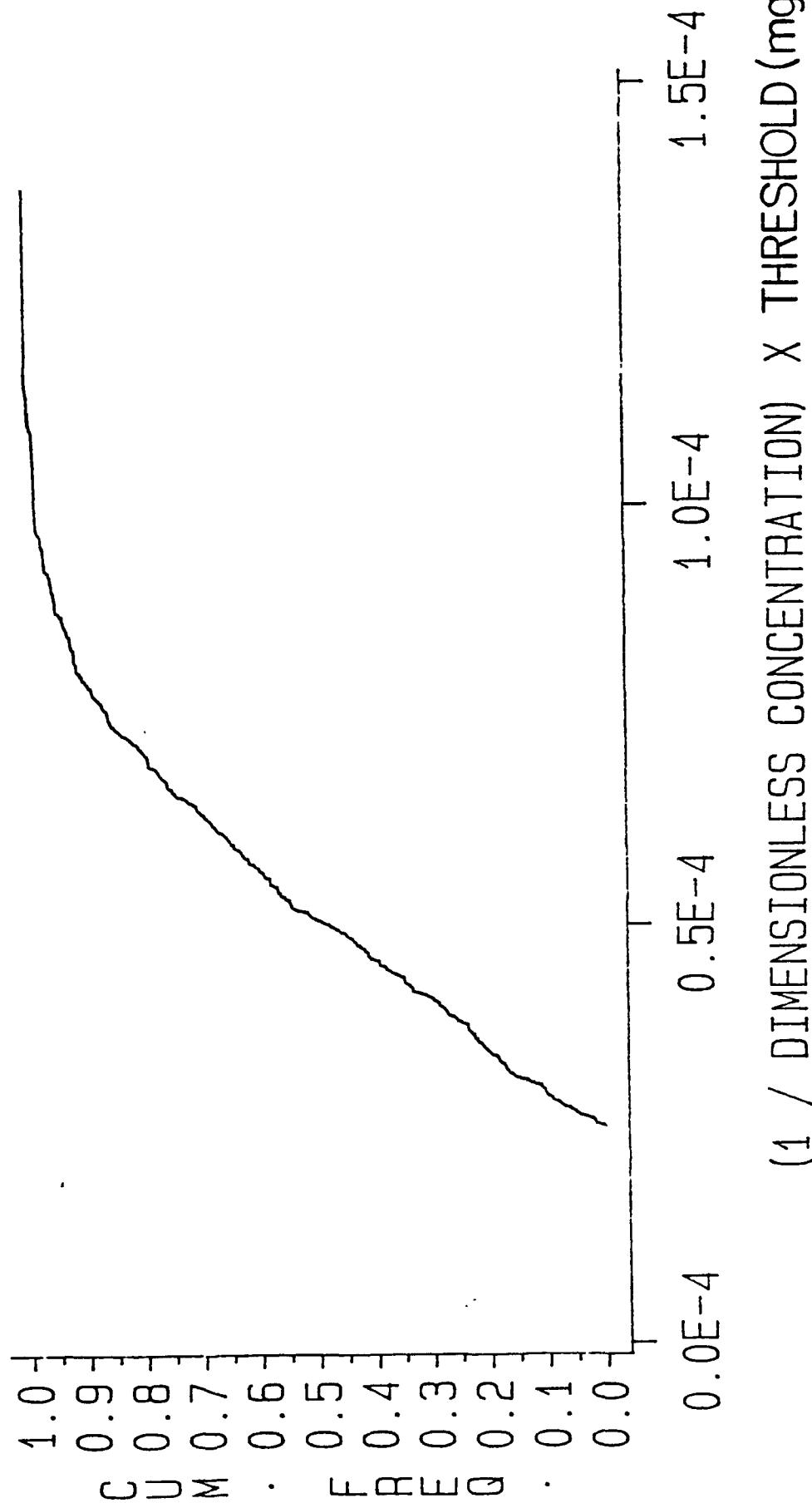
CHLOROFORM - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 5



(1 / DIMENSIONLESS CONCENTRATION) X THRESHOLD (mg/l)

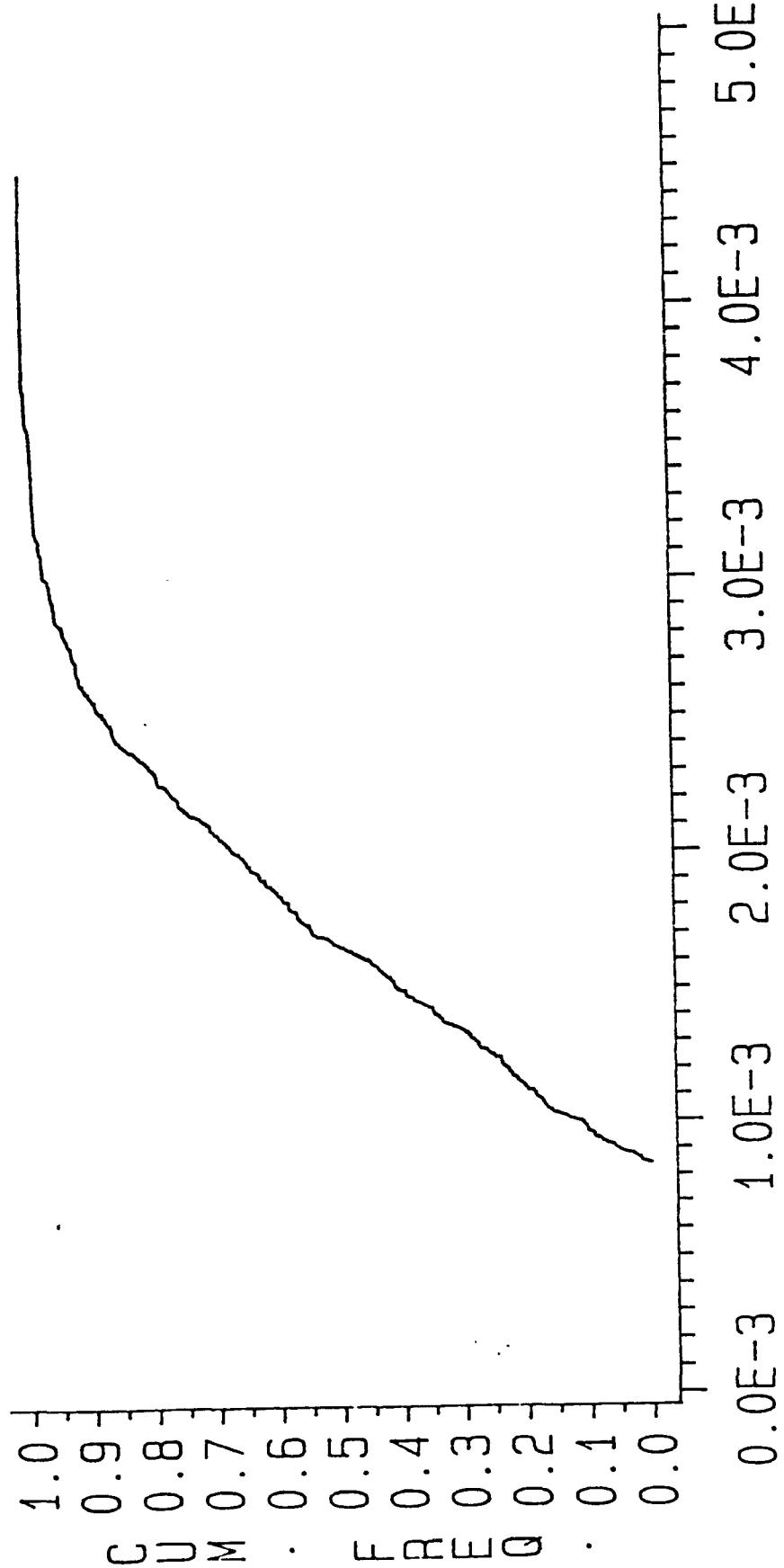
RUN 10

HEXACHLOROBENZENE - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 5



RUN 11

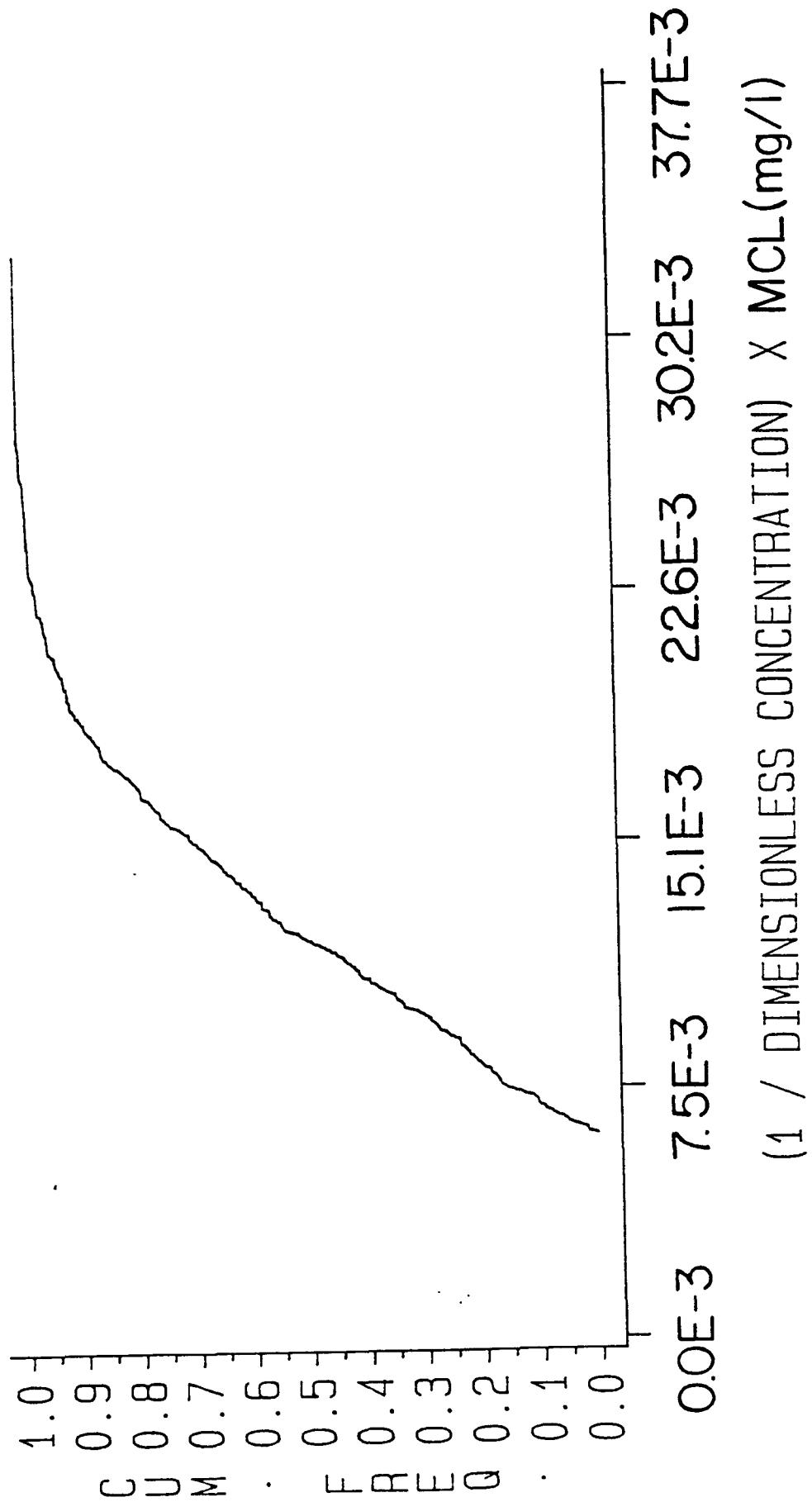
TETRACHLOROETHYLENE - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 5



(1 / DIMENSIONLESS CONCENTRATION) X THRESHOLD (mg/l)

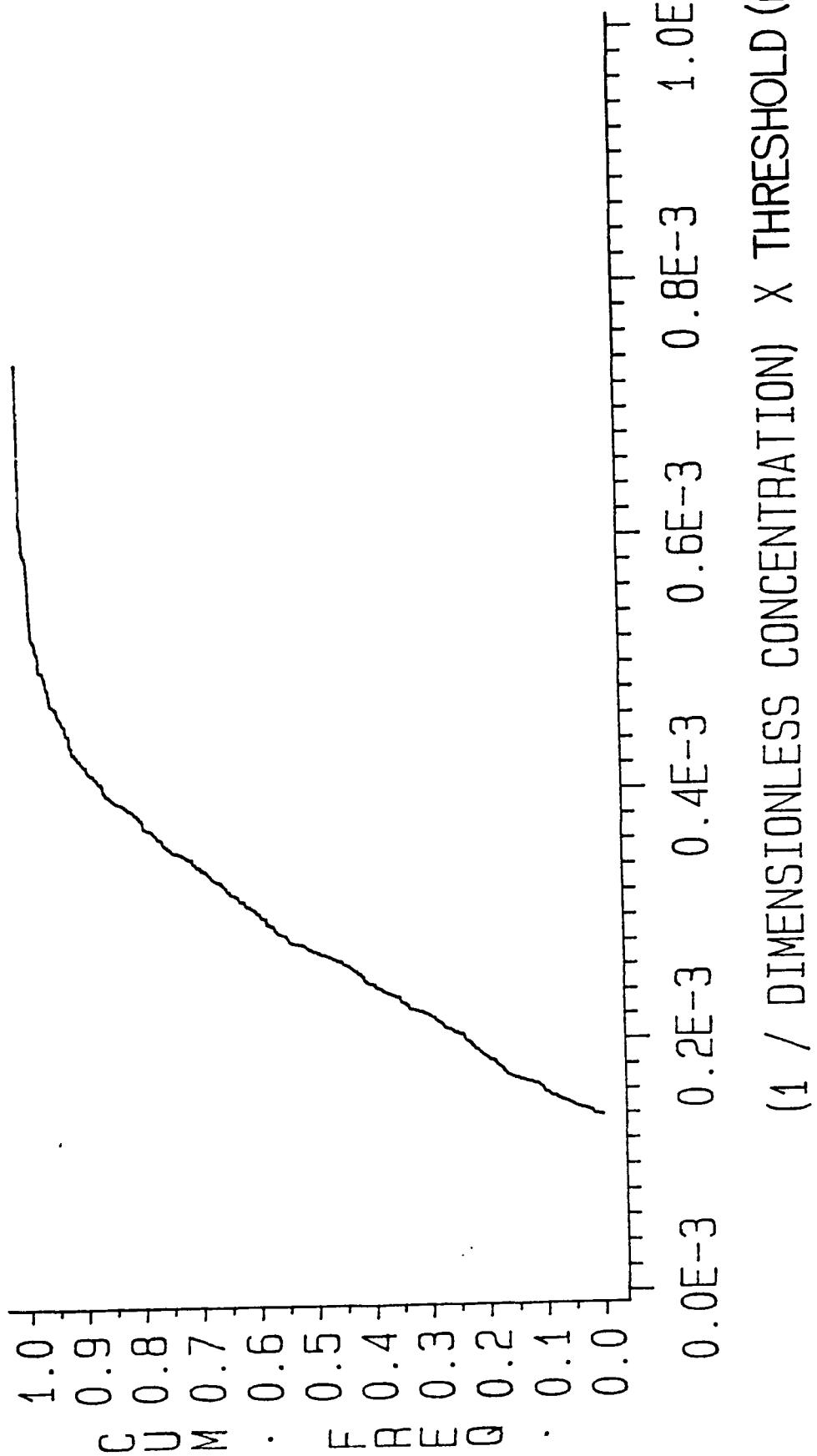
## RUN 12

BENZENE - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 5



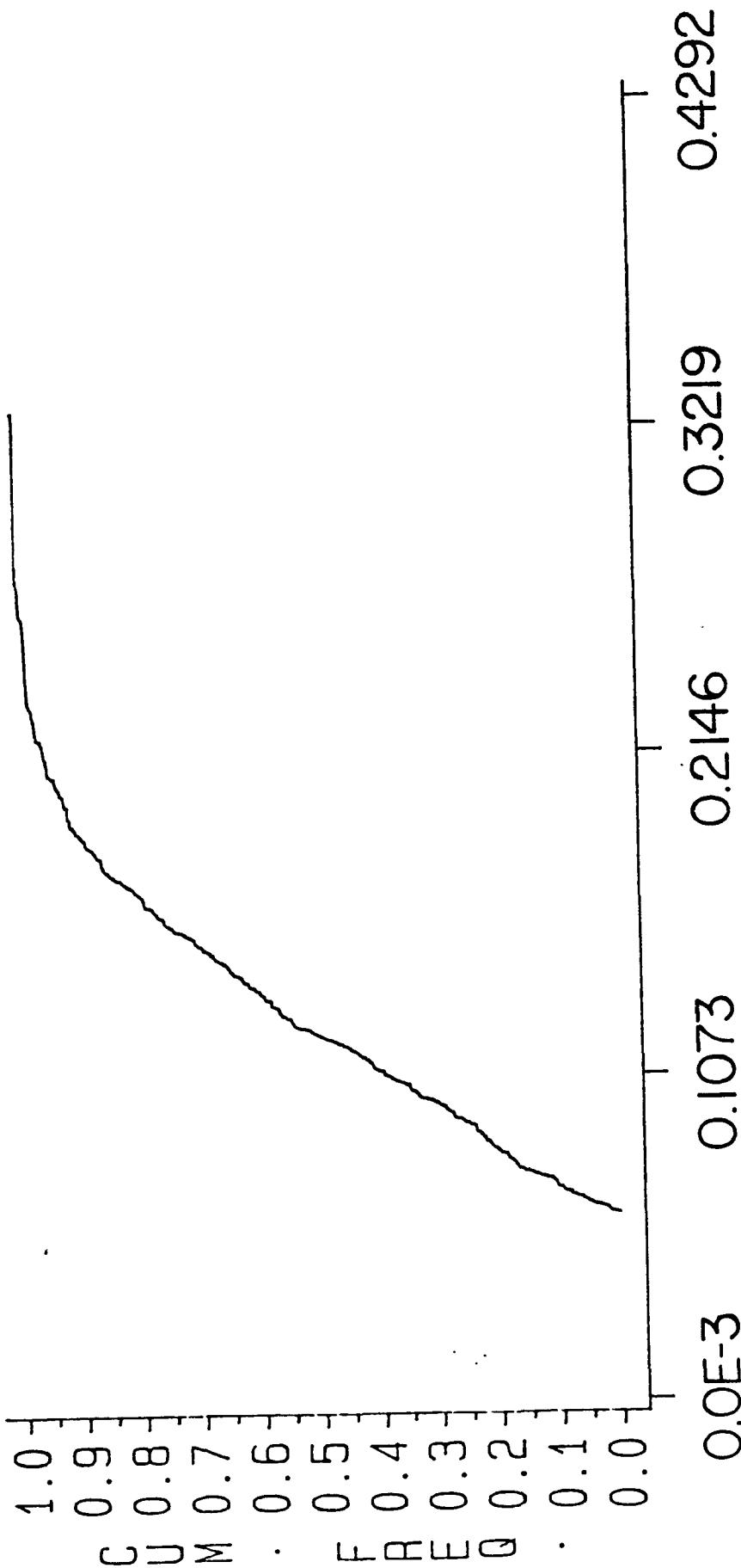
## RUN 13

2,4-DINITROTOLUENE - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 5



RUN 14

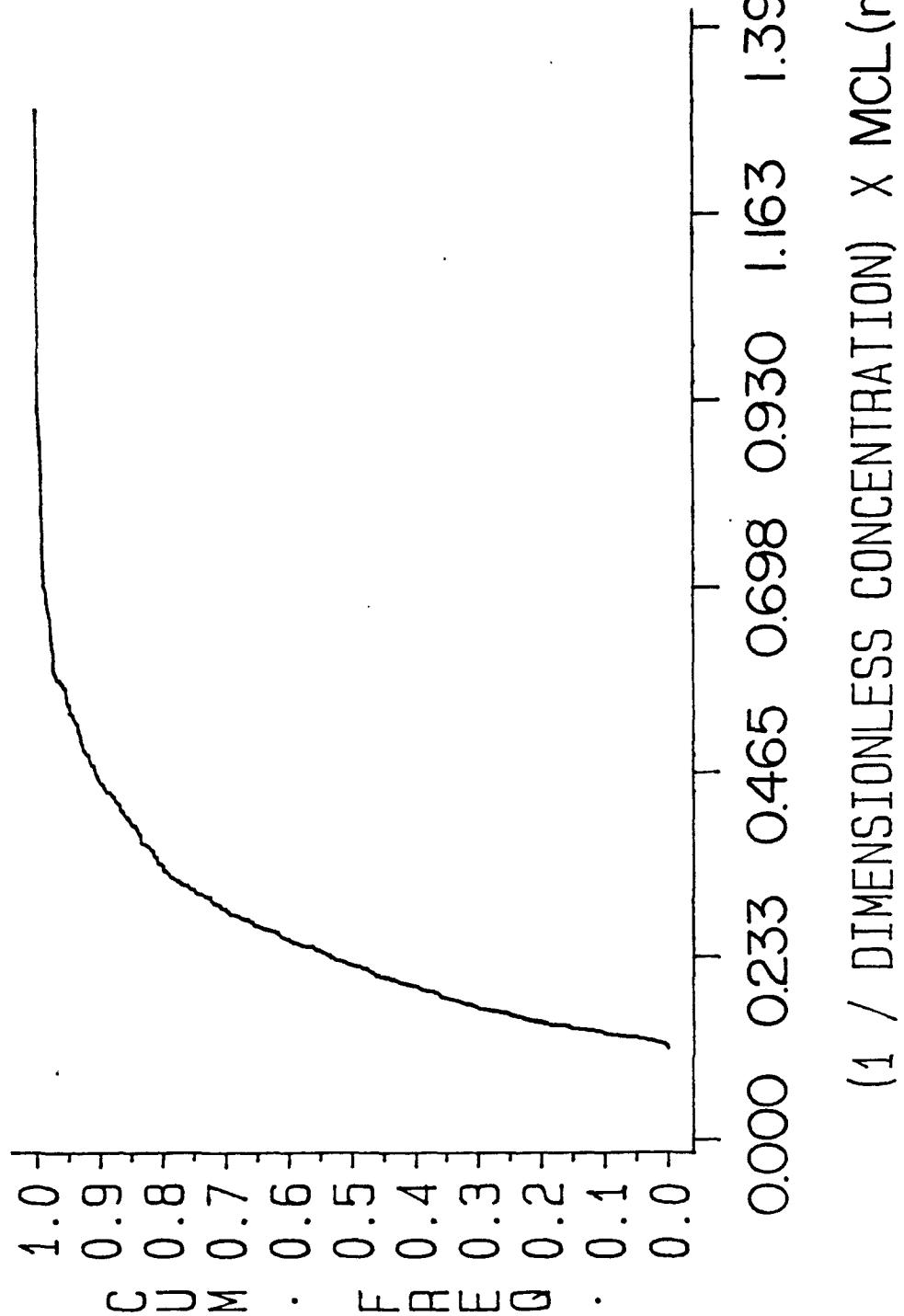
ARSENIC - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 5



(1 / DIMENSIONLESS CONCENTRATION)  $\times$  MCL (mg/l)

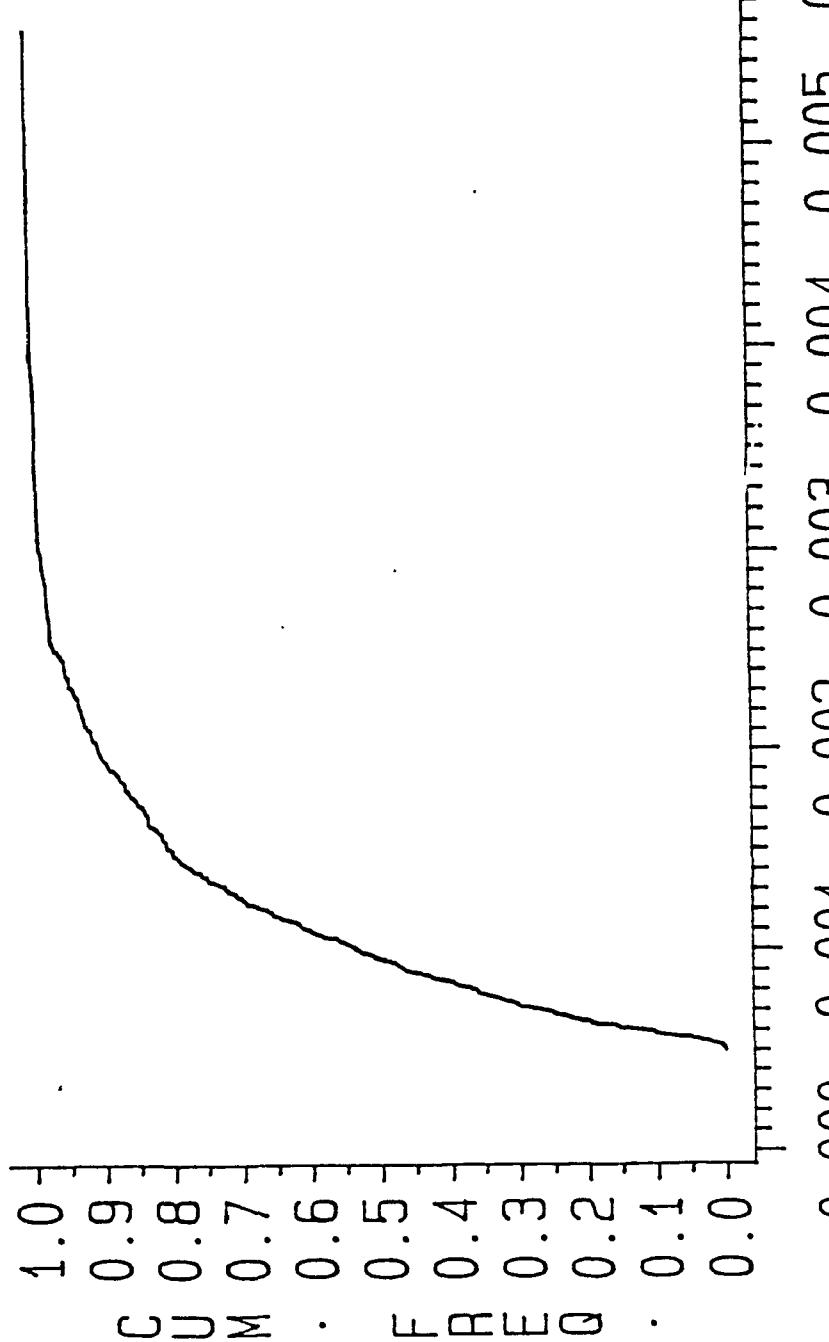
RUN 17A

CHLOROFORM - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 1



RUN 17B

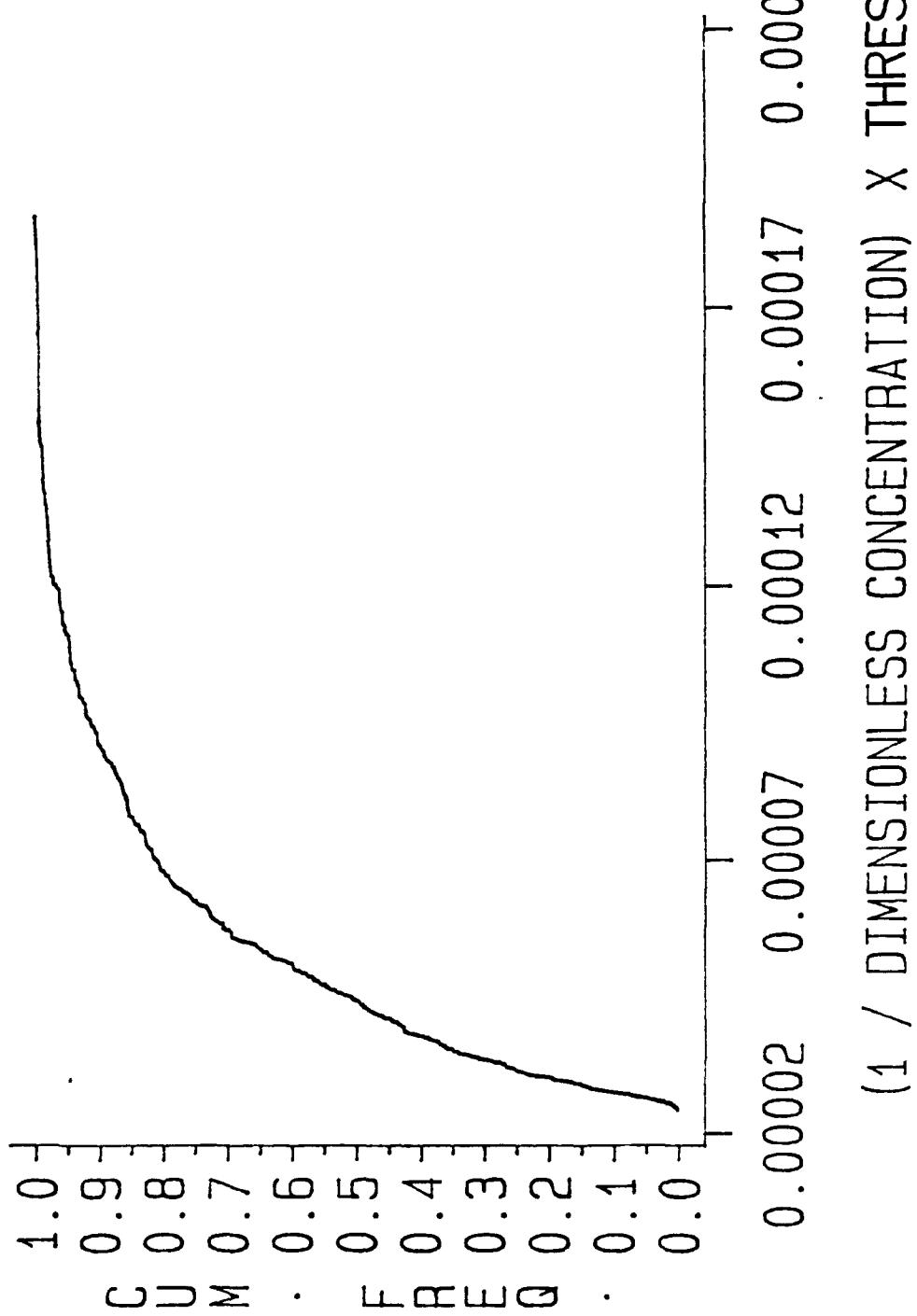
CHLOROFORM - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 1



(1 / DIMENSIONLESS CONCENTRATION) X THRESHOLD (mg/l)

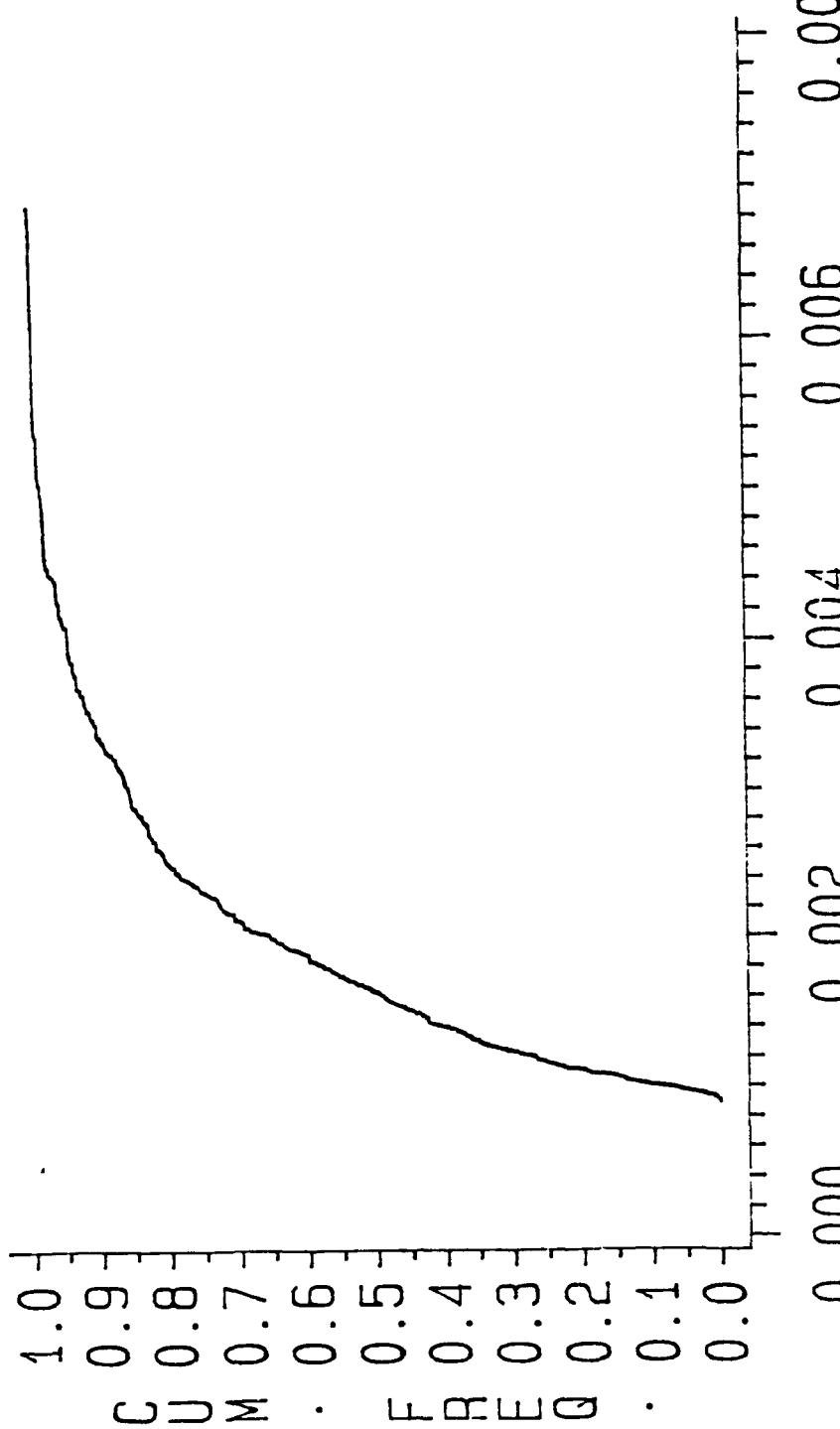
RUN 18

HEXACHLOROBENZENE - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 1



RUN 19

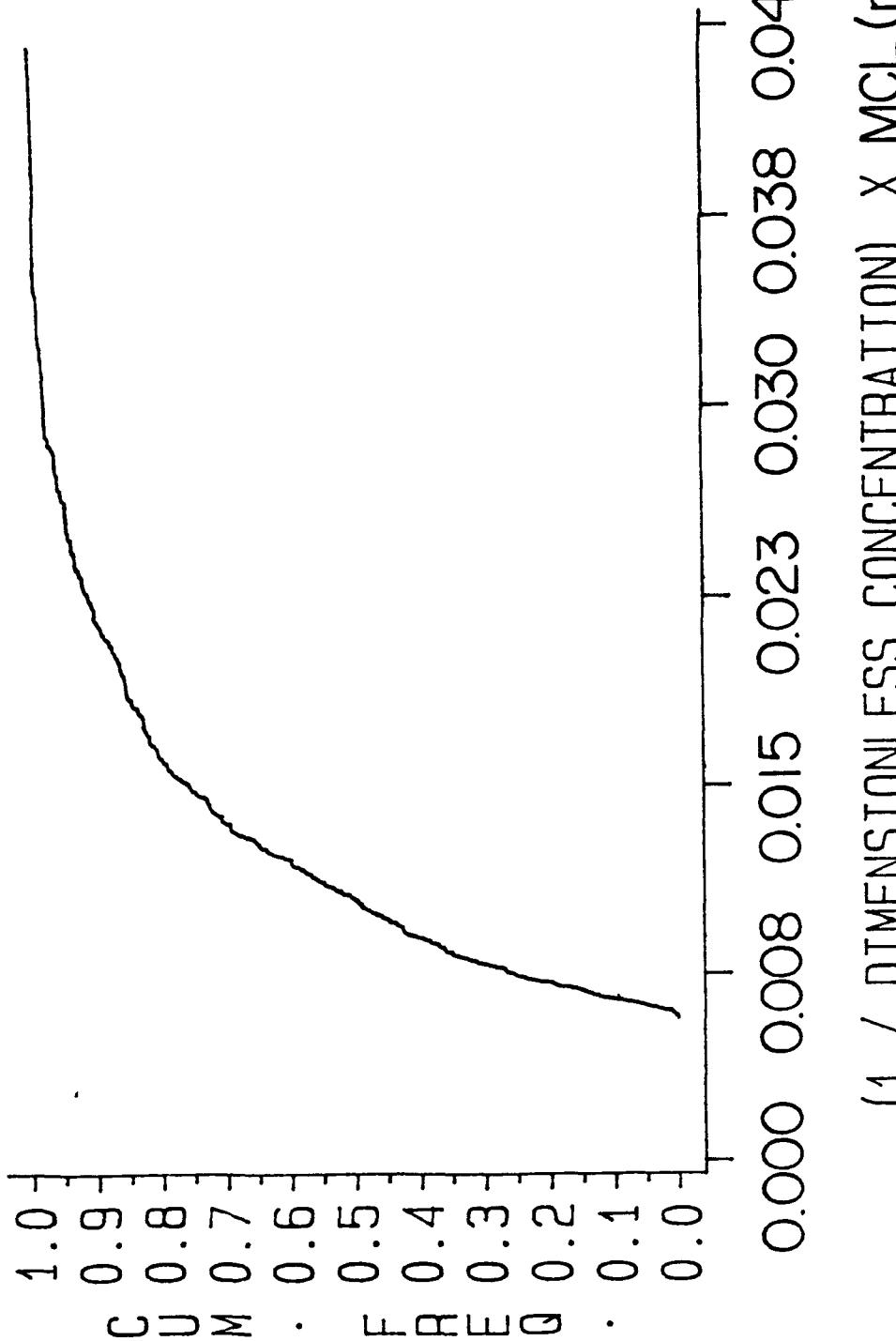
TETRACHLOROETHYLENE - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 1



(1 / DIMENSIONLESS CONCENTRATION) X THRESHOLD (mg/l)

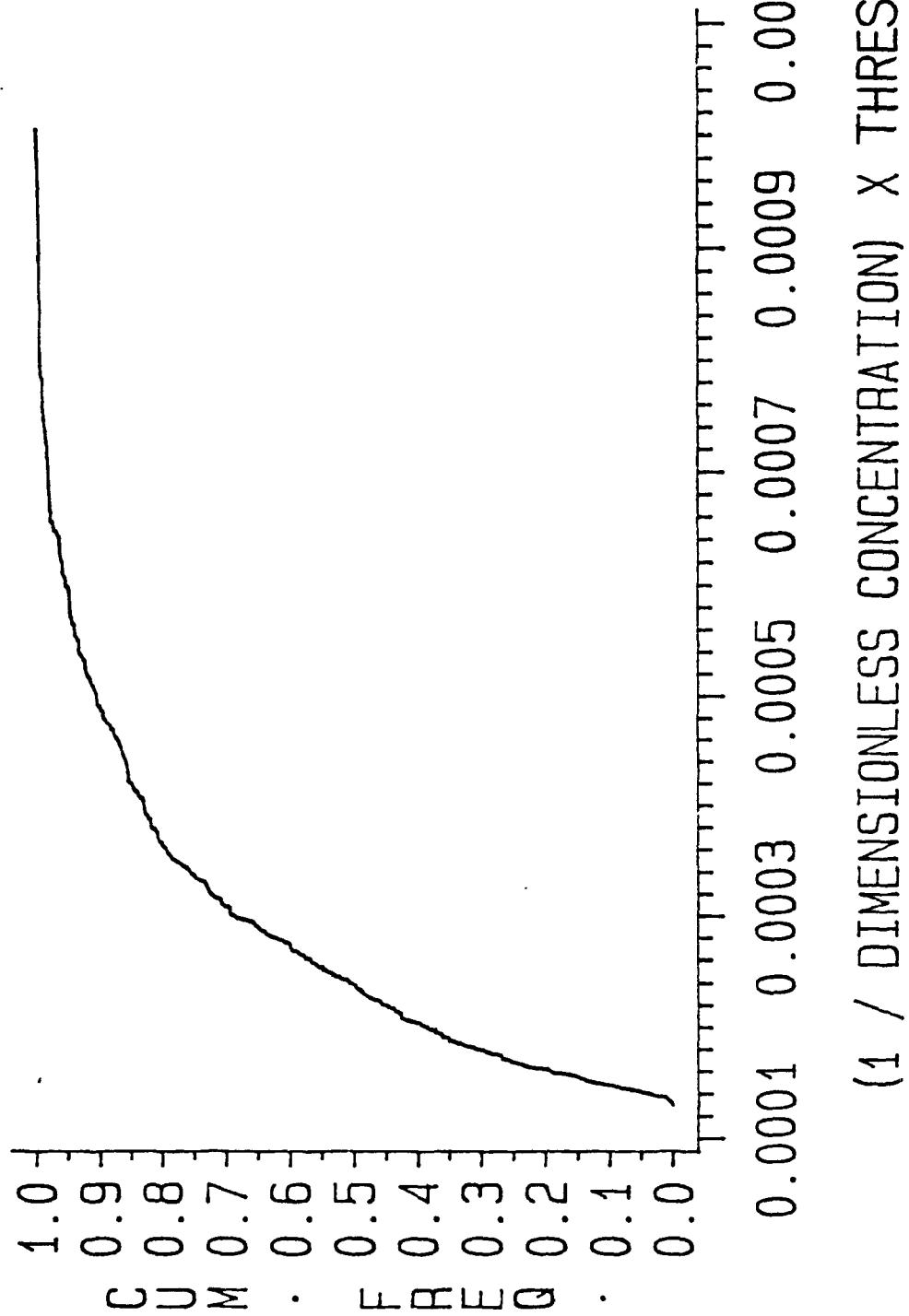
RUN 20

BENZENE - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 1



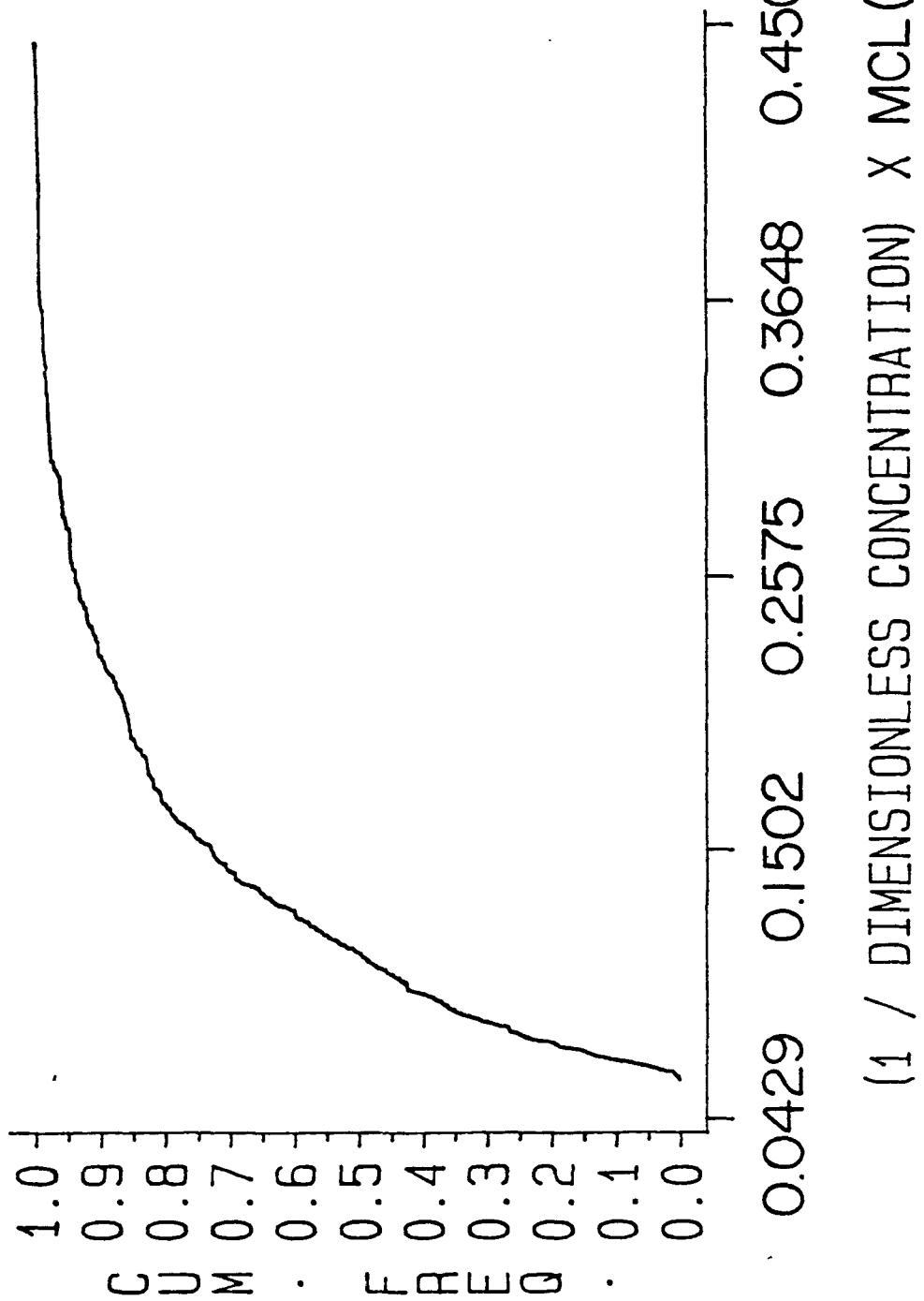
RUN 21

2,4-DINITROTOLUENE - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 1



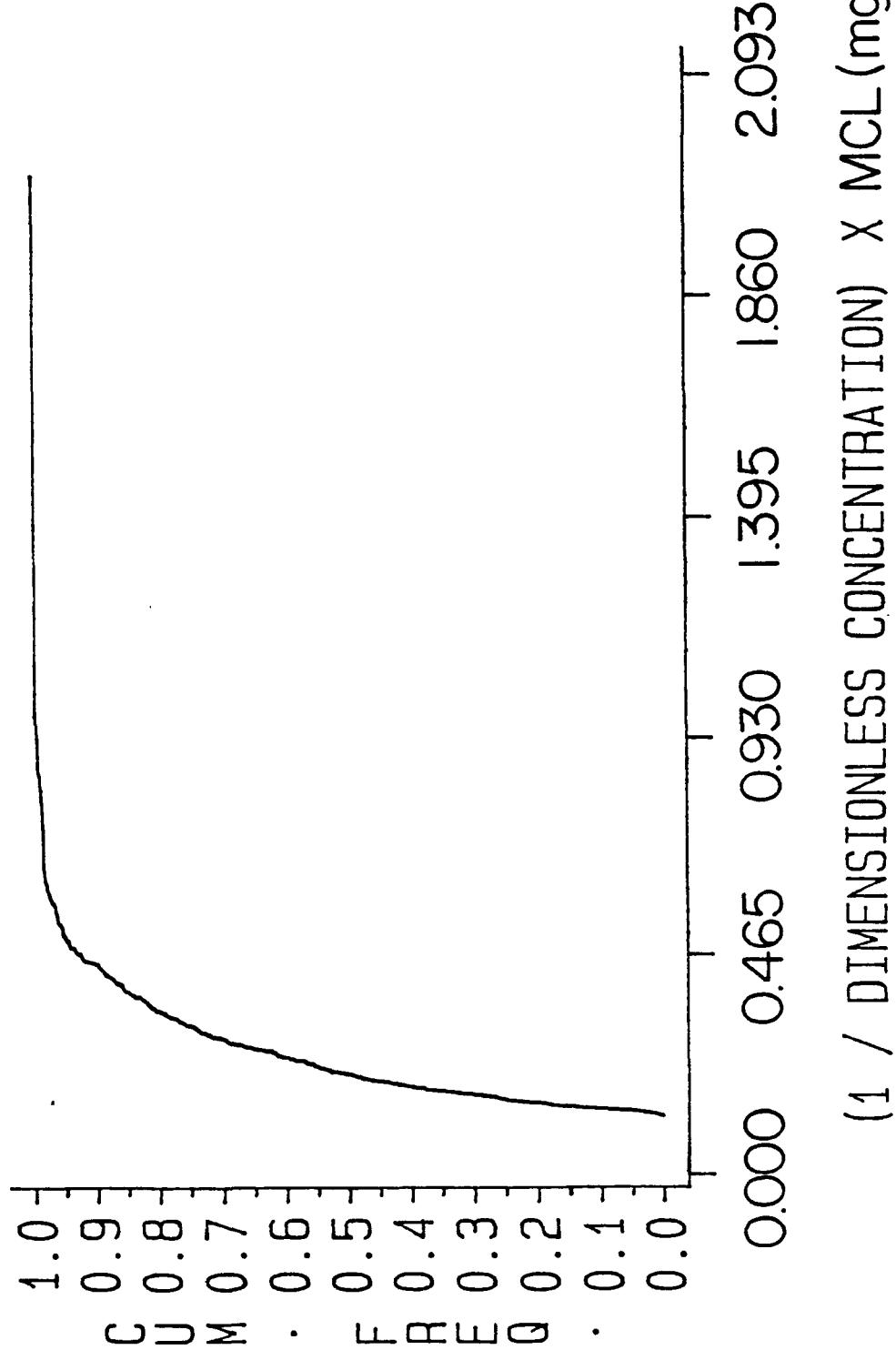
RUN 22

ARSENIC - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 1



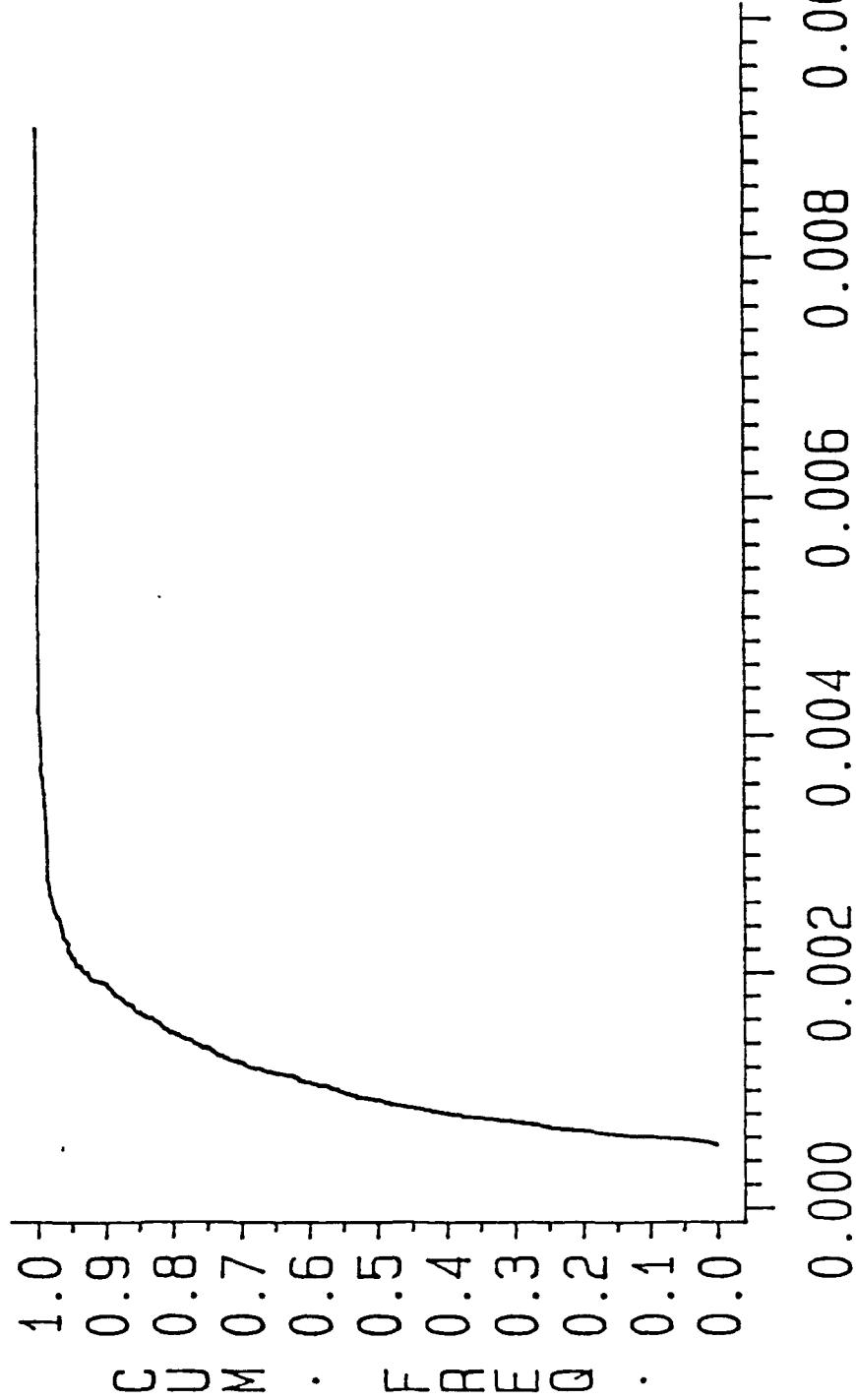
RUN 25A

CHLOROFORM - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 2



RUN 25B

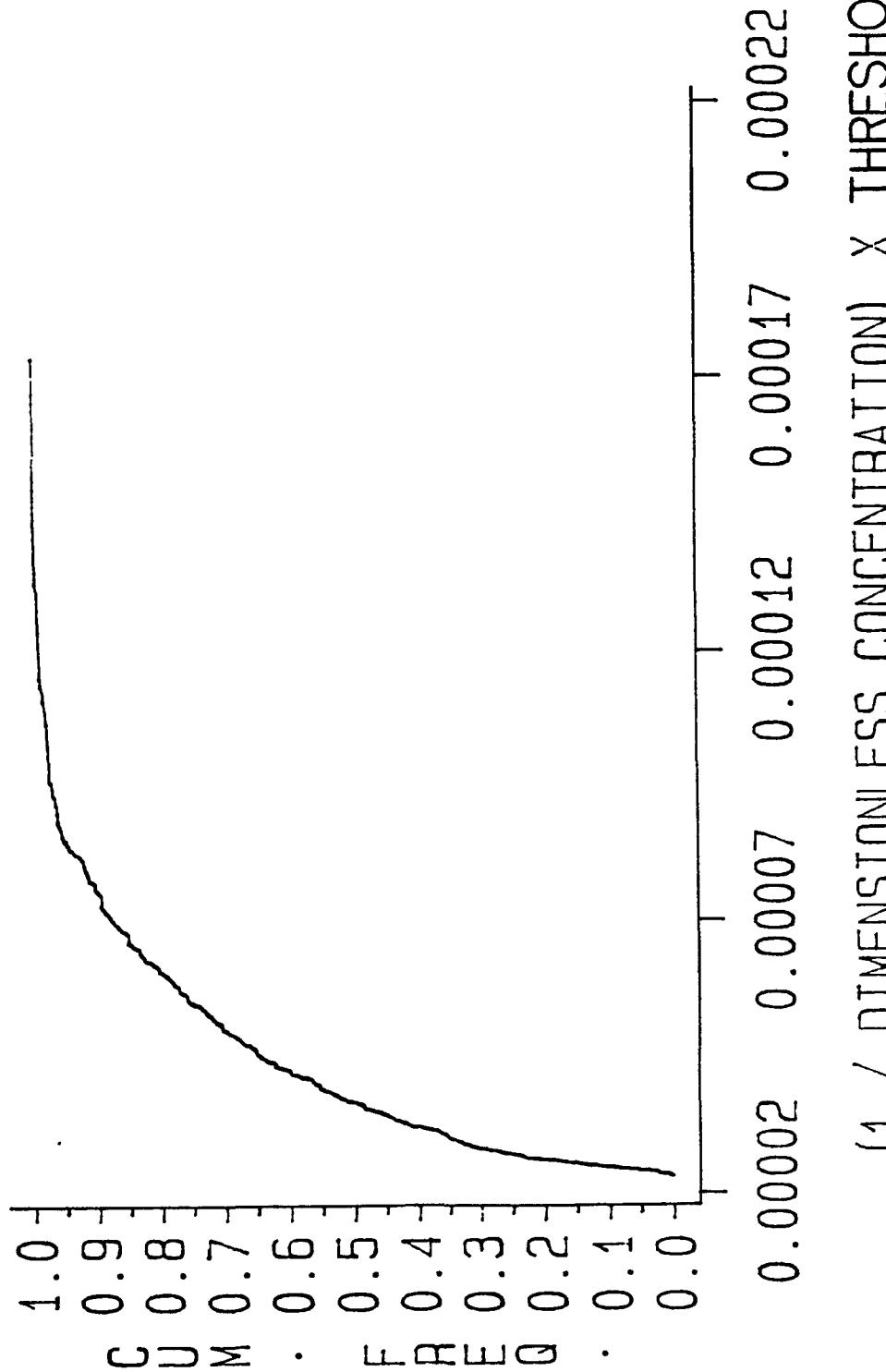
CHLOROFORM - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 2



(1 / DIMENSIONLESS CONCENTRATION) X THRESHOLD (mg/l)

RUN 26

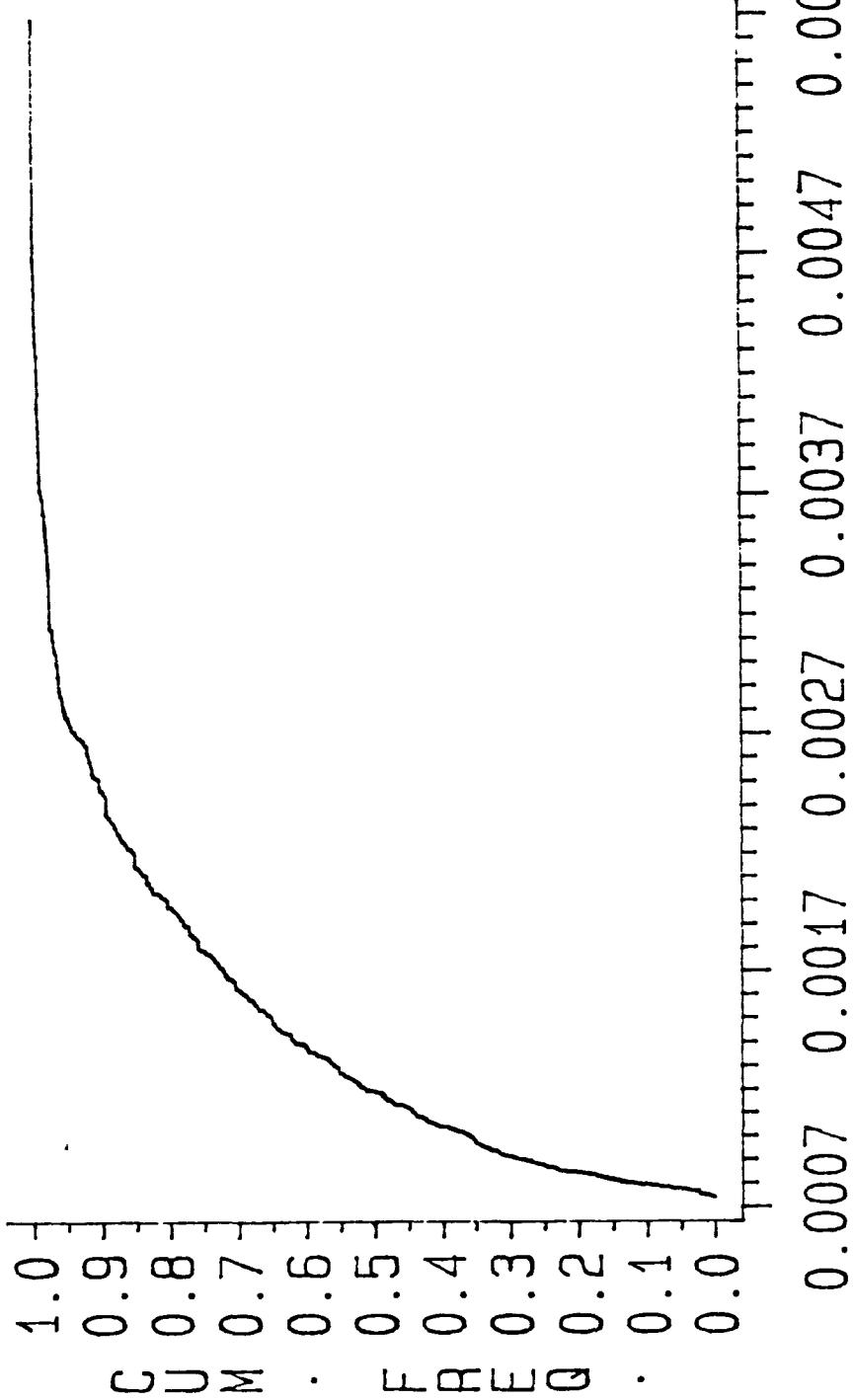
HEXACHLOROBENZENE - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 2



(1 / DIMENSIONLESS CONCENTRATION) X THRESHOLD (mg/l)

RUN 27

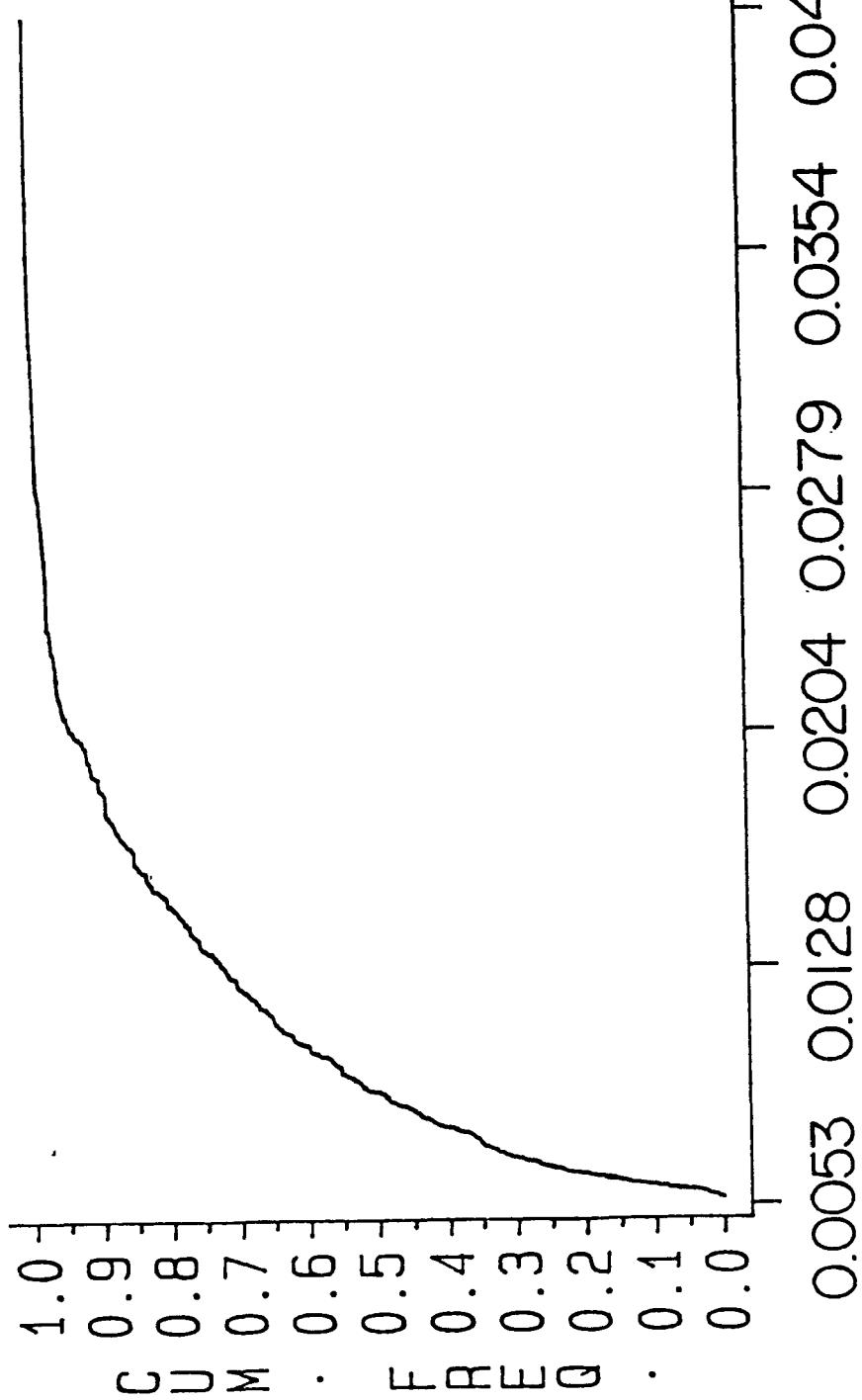
TETRACHLOROETHYLENE - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 2



(1 / DIMENSIONLESS CONCENTRATION)  $\times$  THRESHOLD (mg/l)

RUN 28

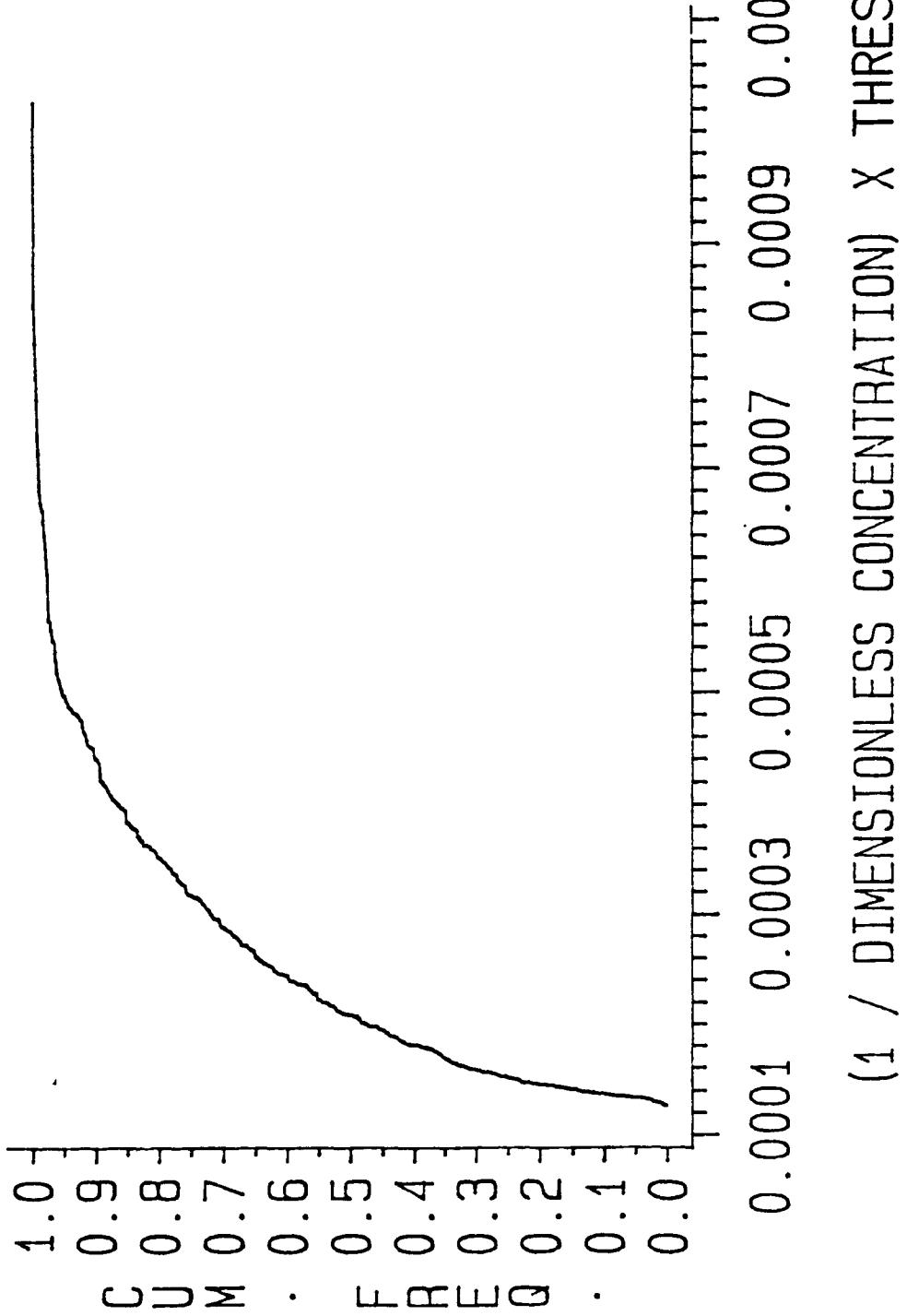
BENZENE - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 2



(1 / DIMENSIONLESS CONCENTRATION) X MCL (mg/l)

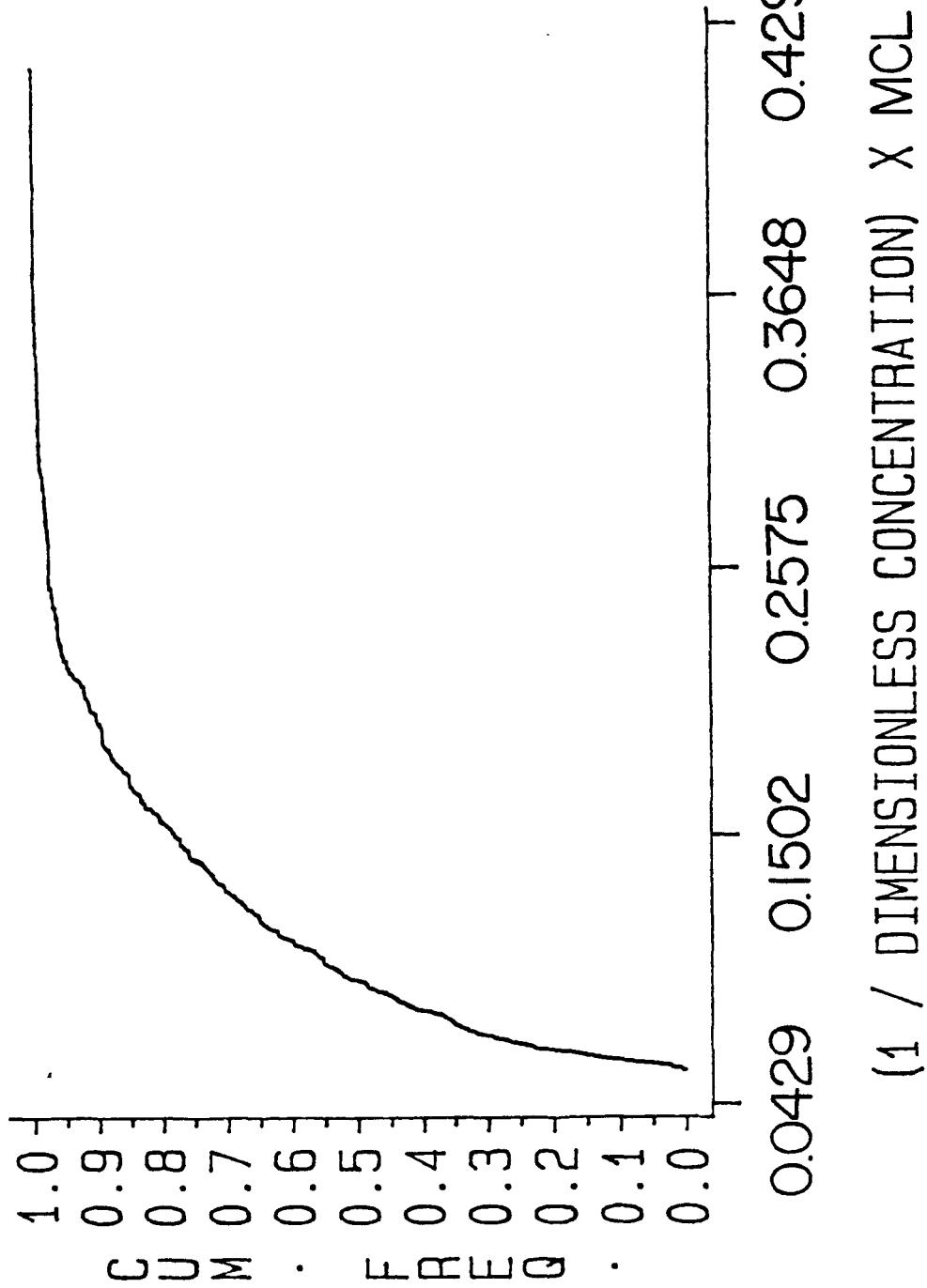
RUN 29

2,4-DINITROTOLUENE - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 2



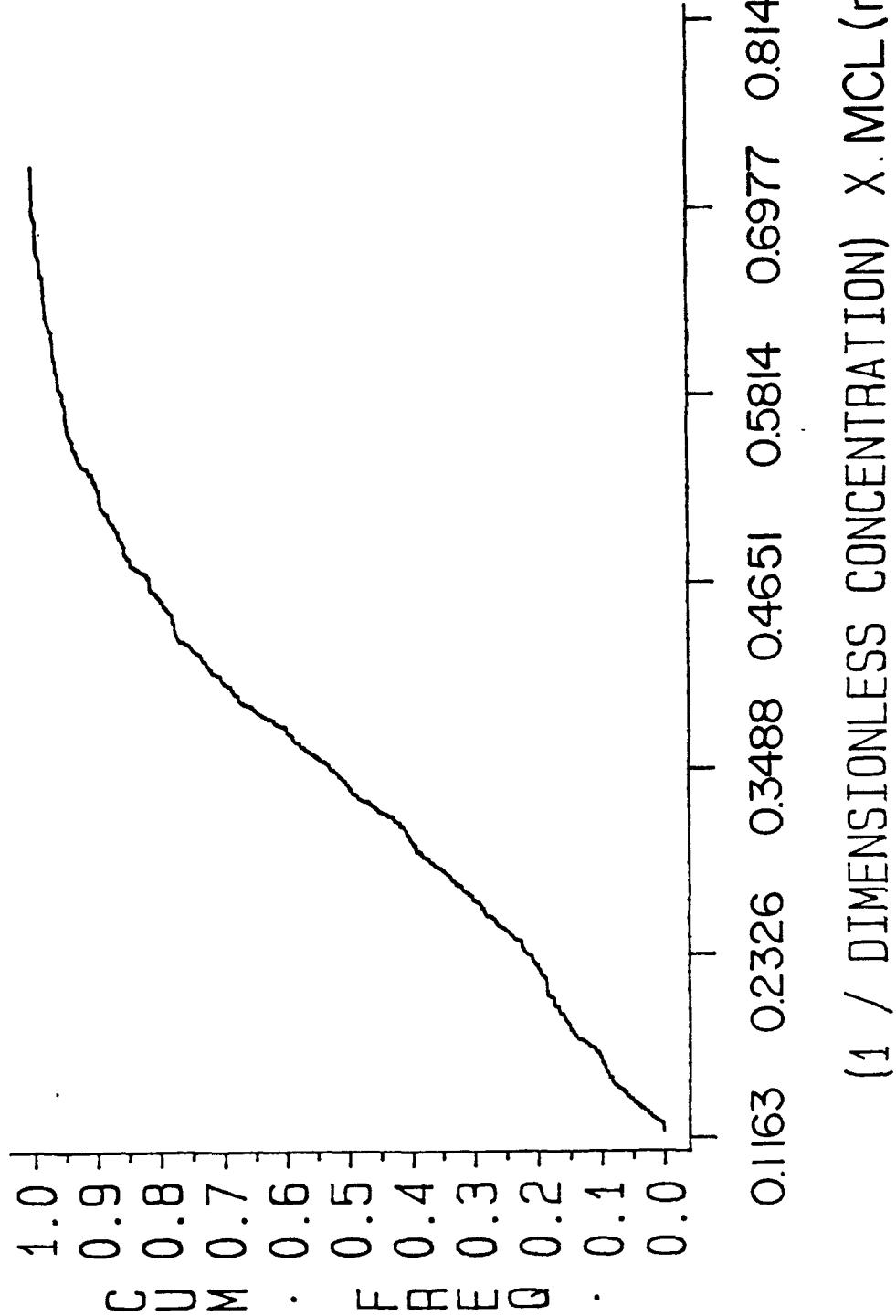
RUN 30

ARSENIC - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 2



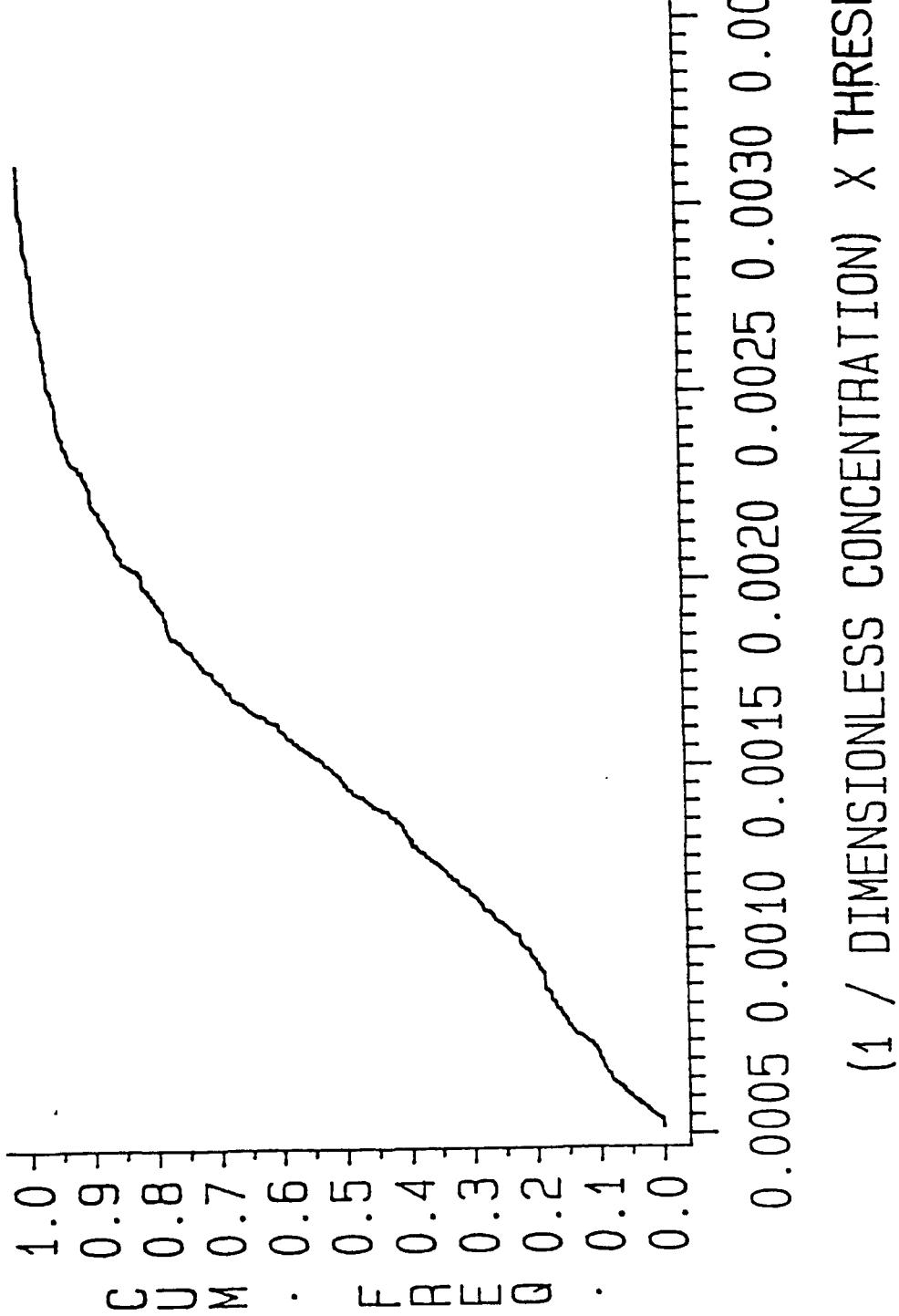
RUN 33A

CHLOROFORM - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 3



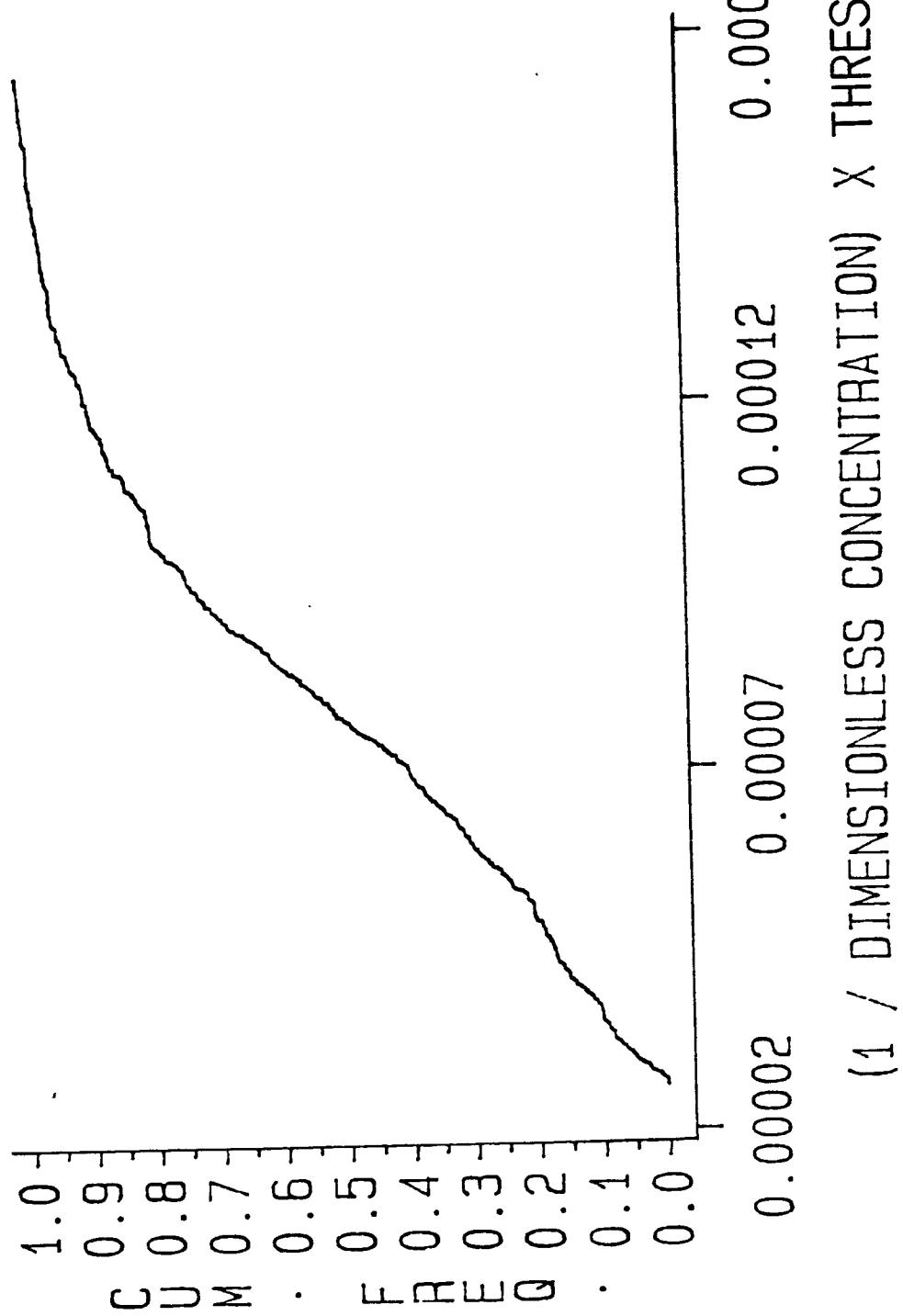
RUN 33B

CHLOROFORM - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 3



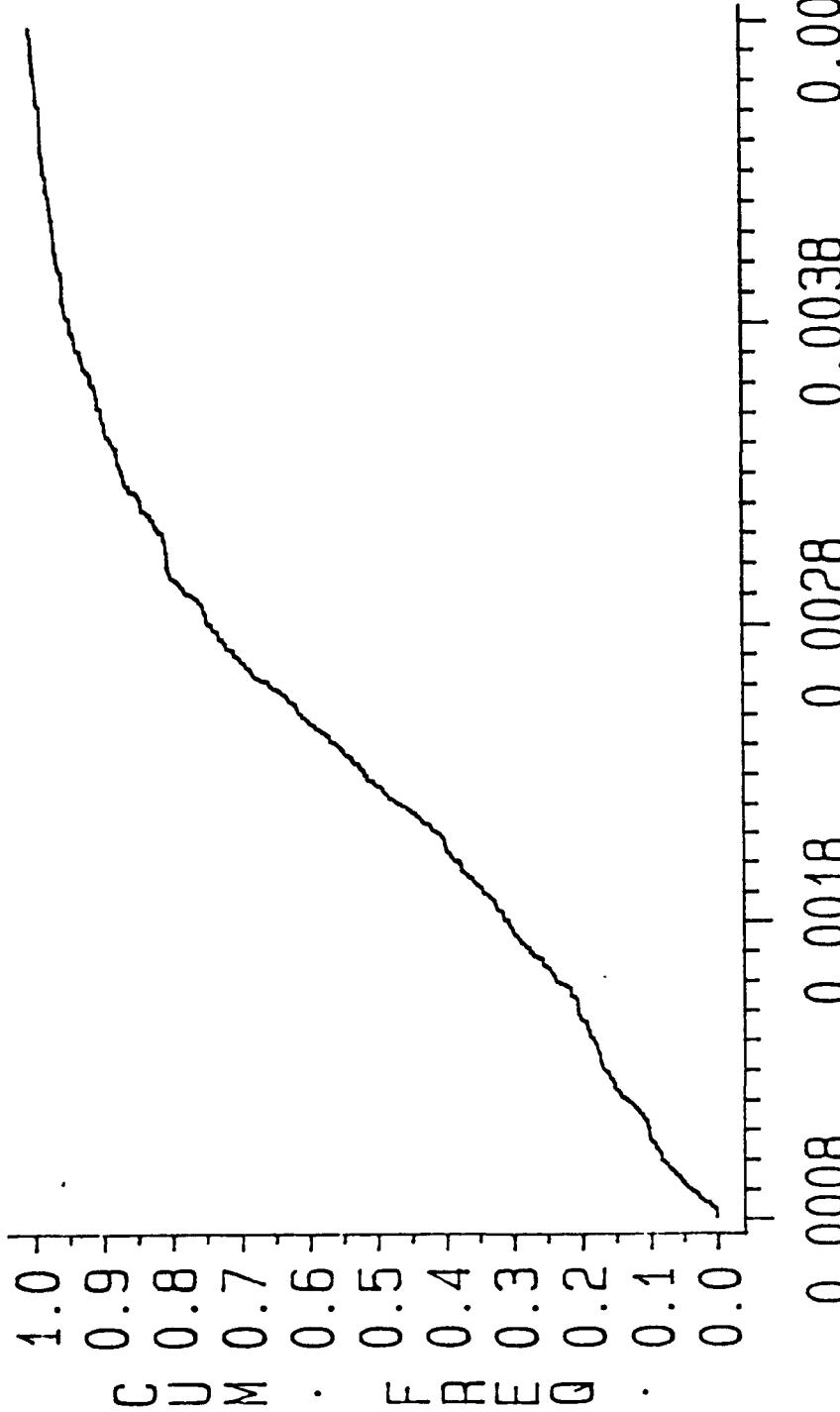
RUN 34

HEXACHLOROBENZENE - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 3



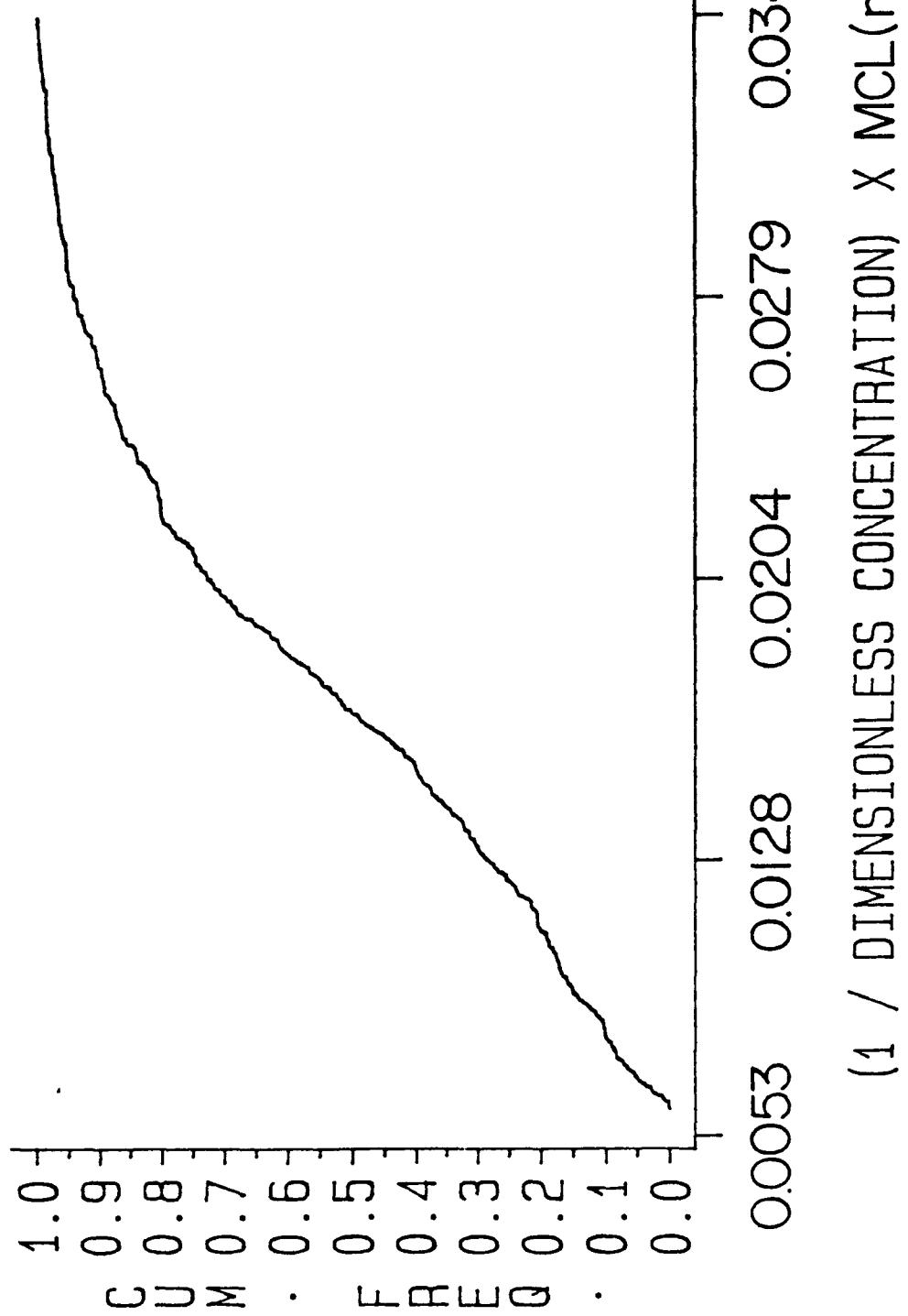
RUN 35

TETRACHLOROETHYLENE - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 3



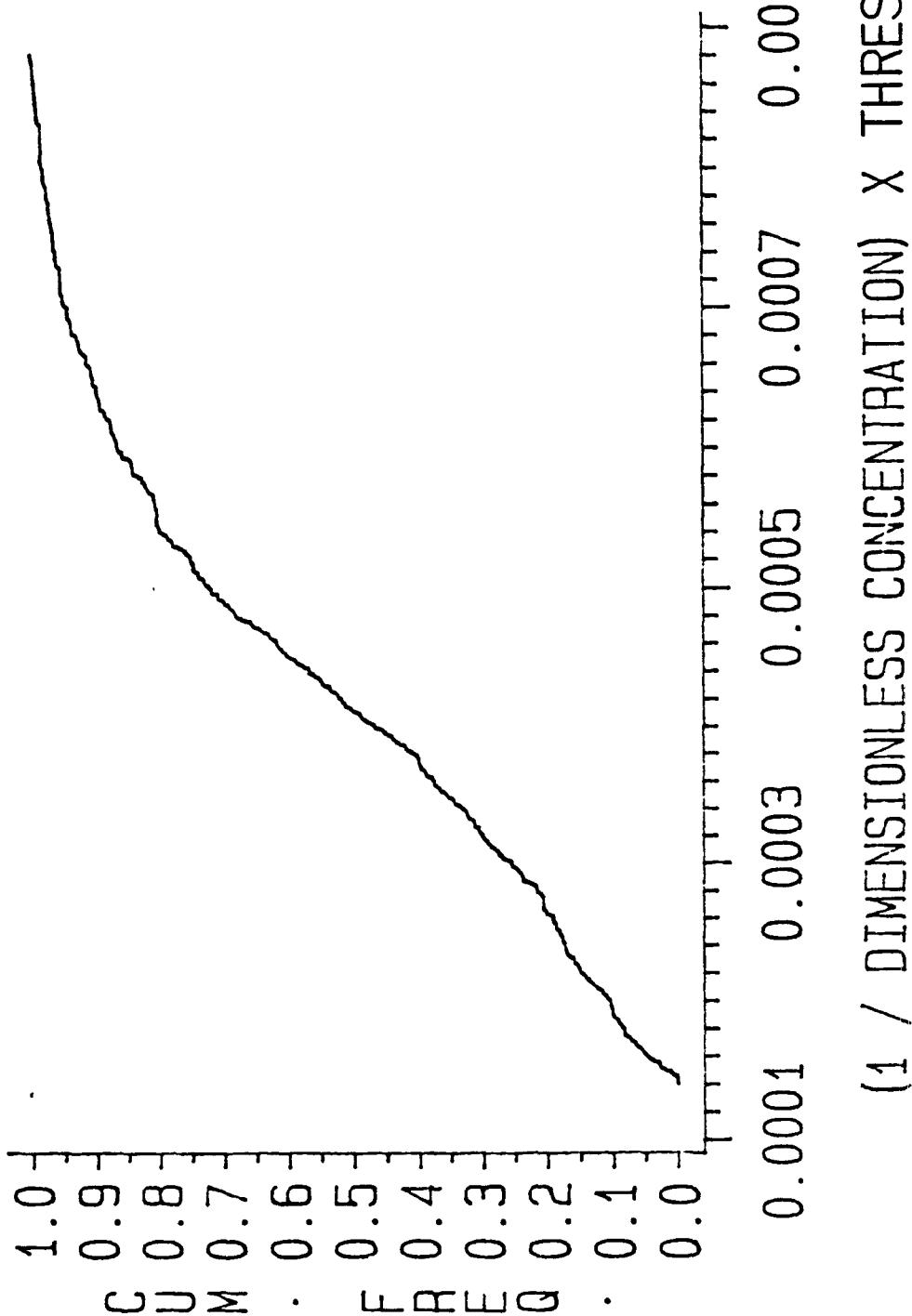
RUN 36

BENZENE - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 3



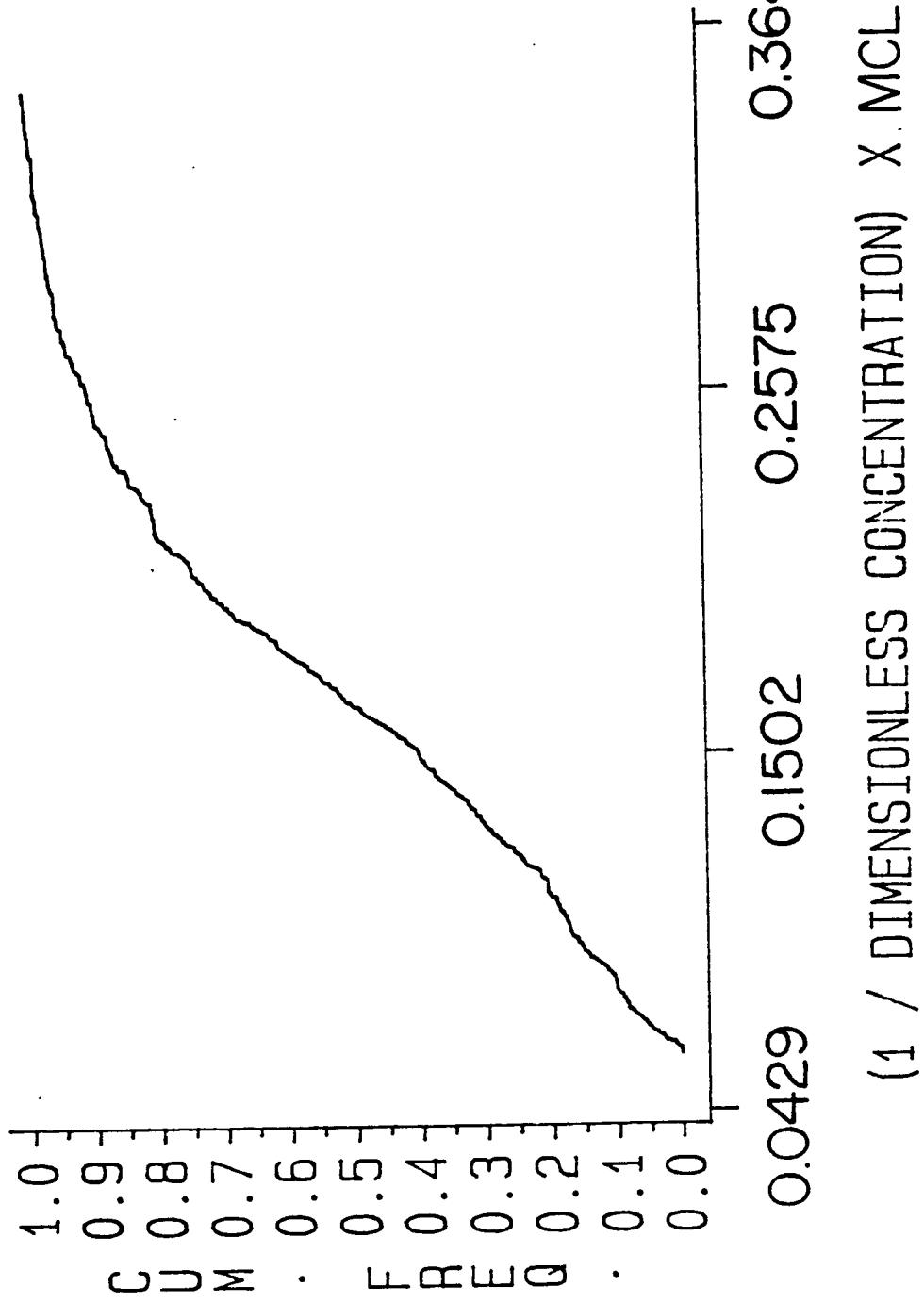
RUN 37

2,4-DINITROTOLUENE - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 3



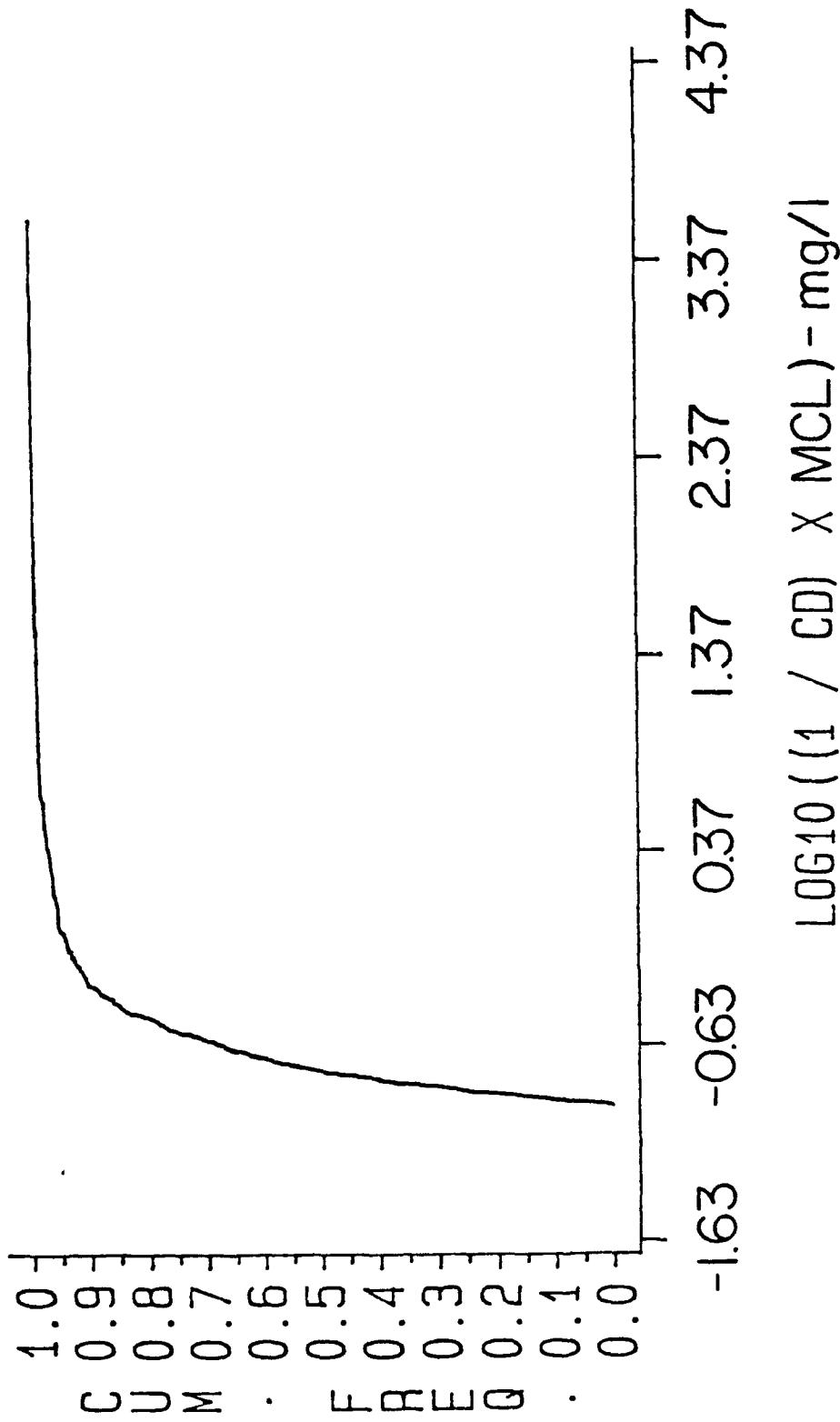
RUN 38

ARSENIC - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 3



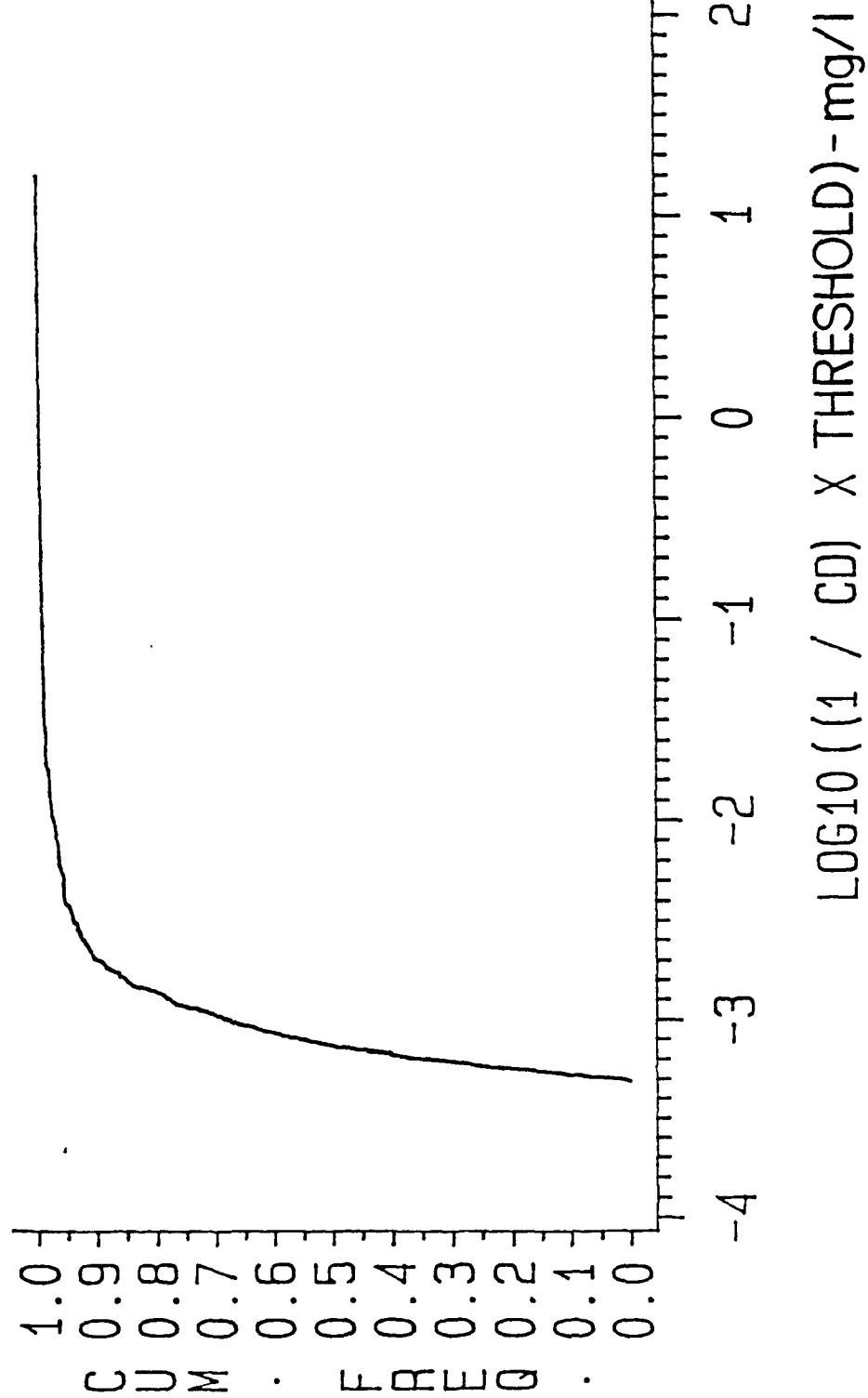
RUN 41A

CHLOROFORM - SATURATED ZONE ONLY  
493 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 6



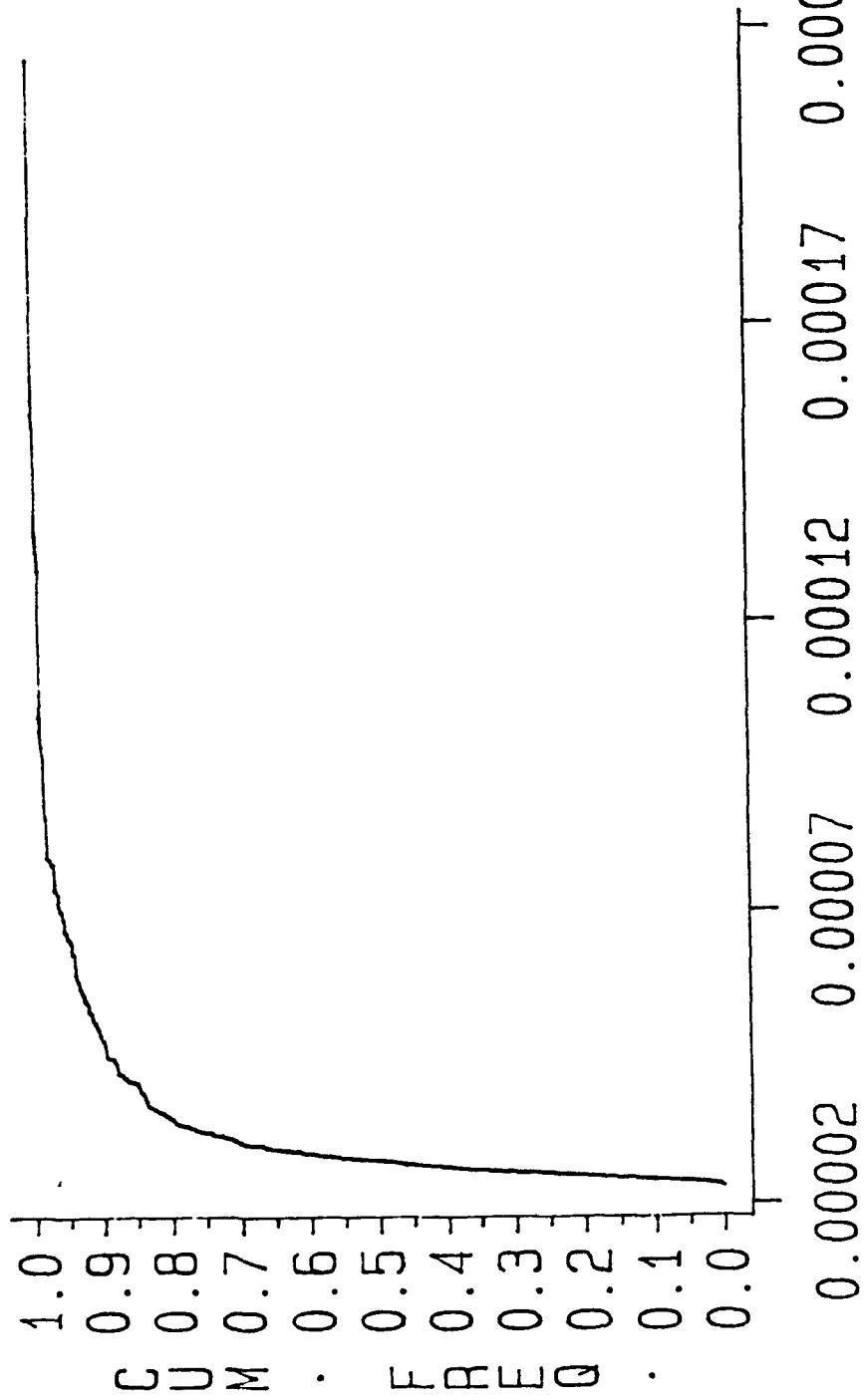
RUN 41B

CHLOROFORM - SATURATED ZONE ONLY  
493 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 6



RUN 42

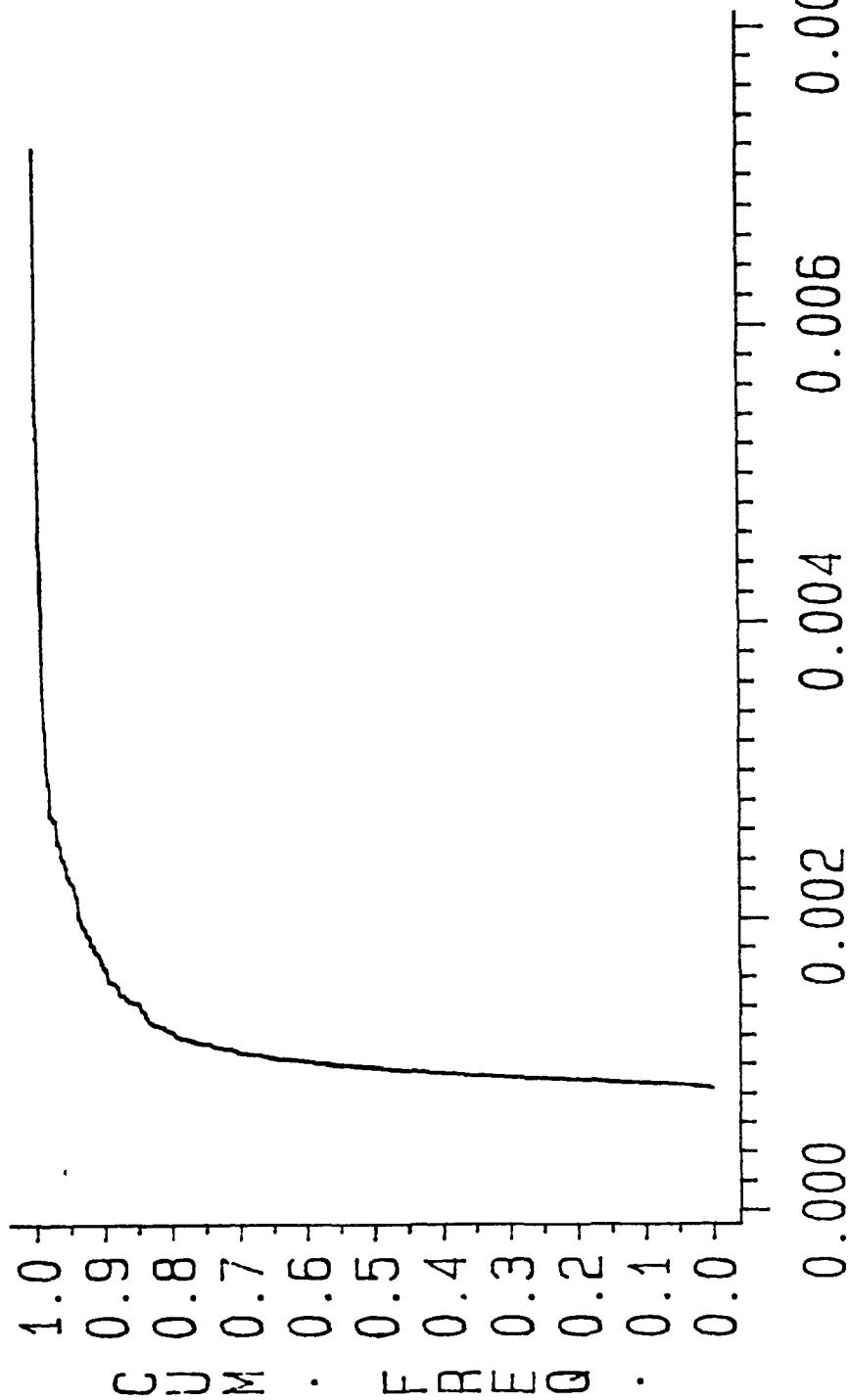
HEXACHLOROBENZENE - SATURATED ZONE ONLY  
493 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 6



(1 / DIMENSIONLESS CONCENTRATION)  $\times$  THRESHOLD (mg/l)

RUN 43

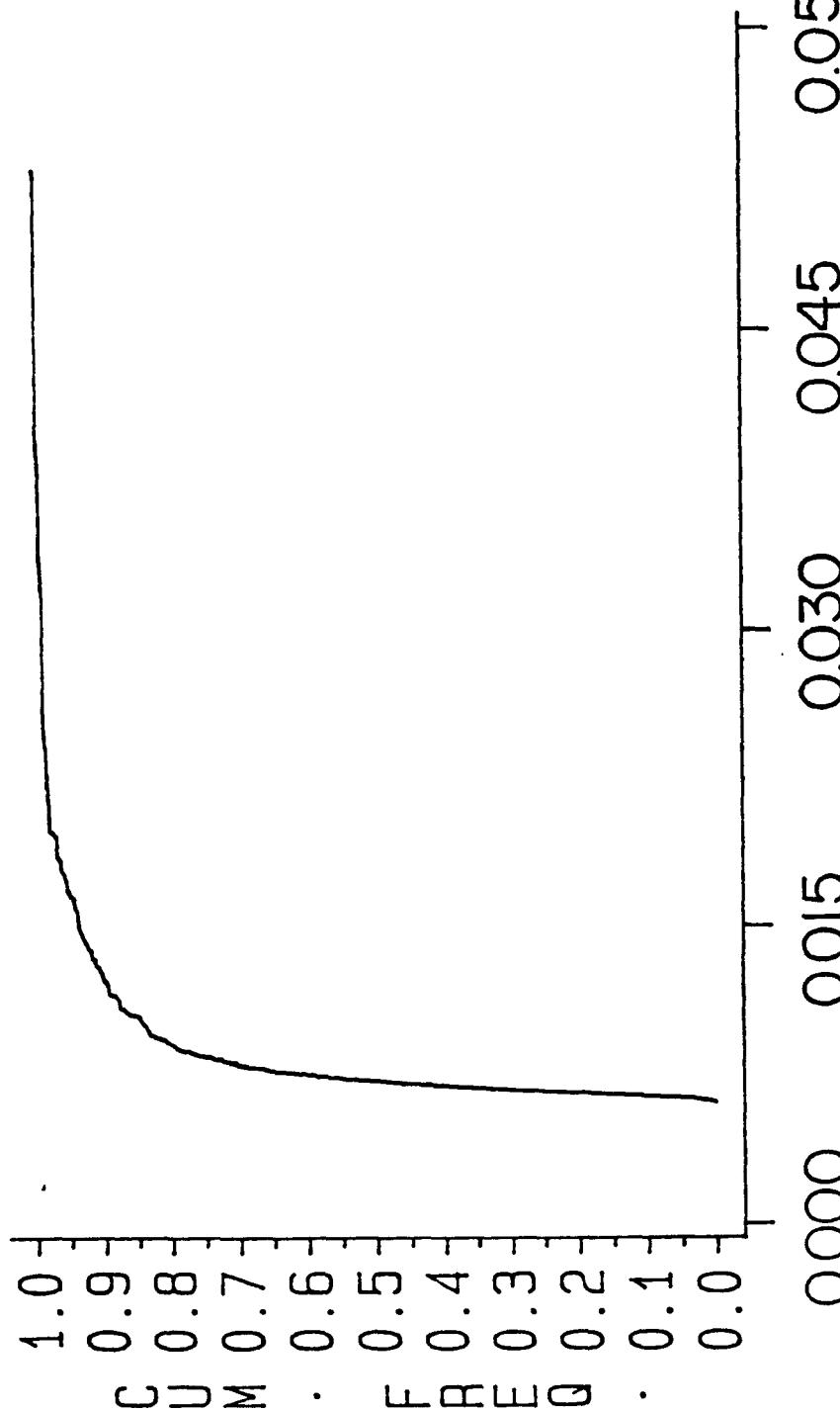
TETRACHLOROETHYLENE - SATURATED ZONE ONLY  
493 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 6



( $l$  / DIMENSIONLESS CONCENTRATION) X THRESHOLD (mg/l)

RUN 44

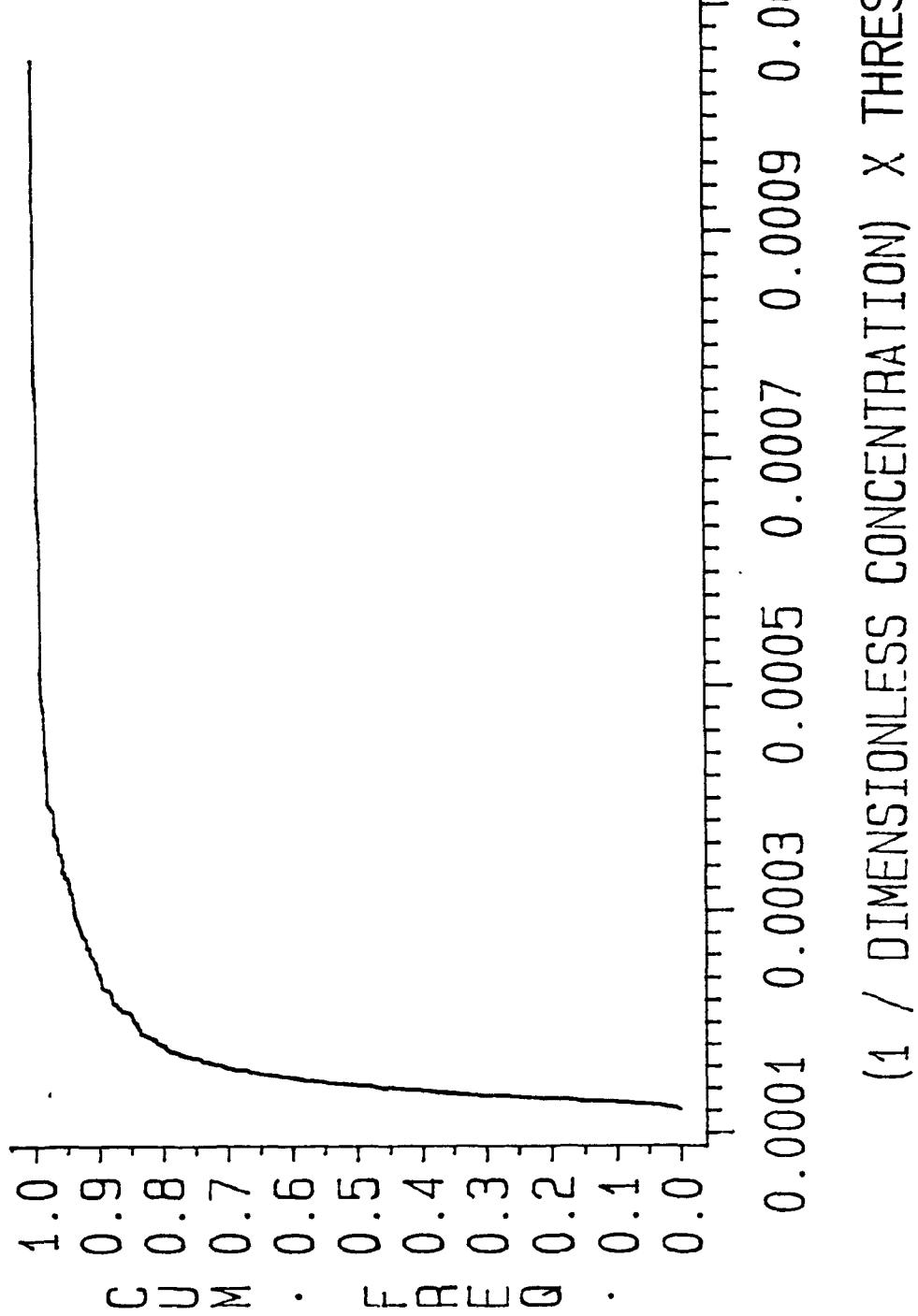
BENZENE - SATURATED ZONE ONLY  
493 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 6



(1 / DIMENSIONLESS CONCENTRATION) X MCL (mg/l)

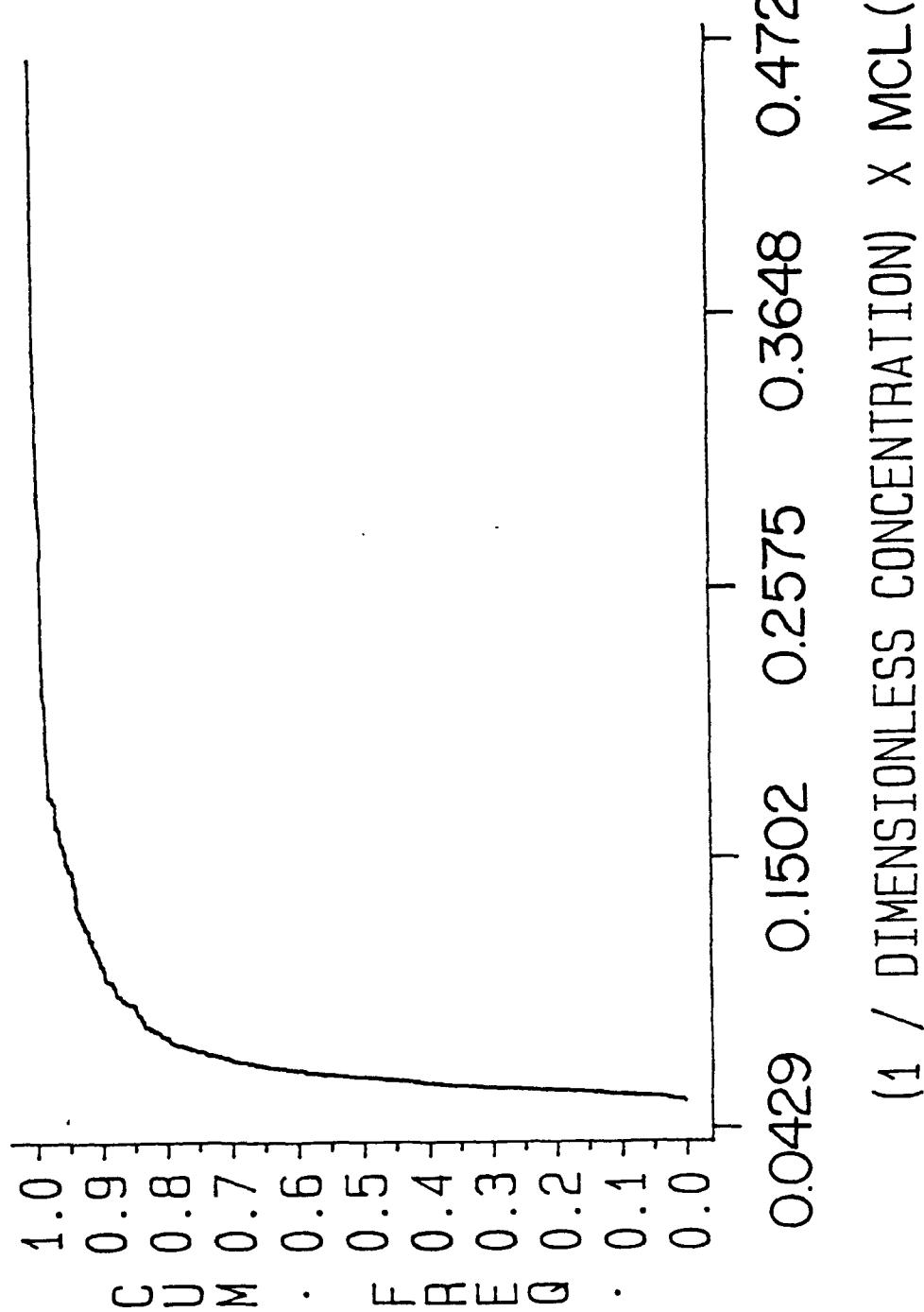
RUN 45

2,4-DINITROTOLUENE - SATURATED ZONE ONLY  
493 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 6



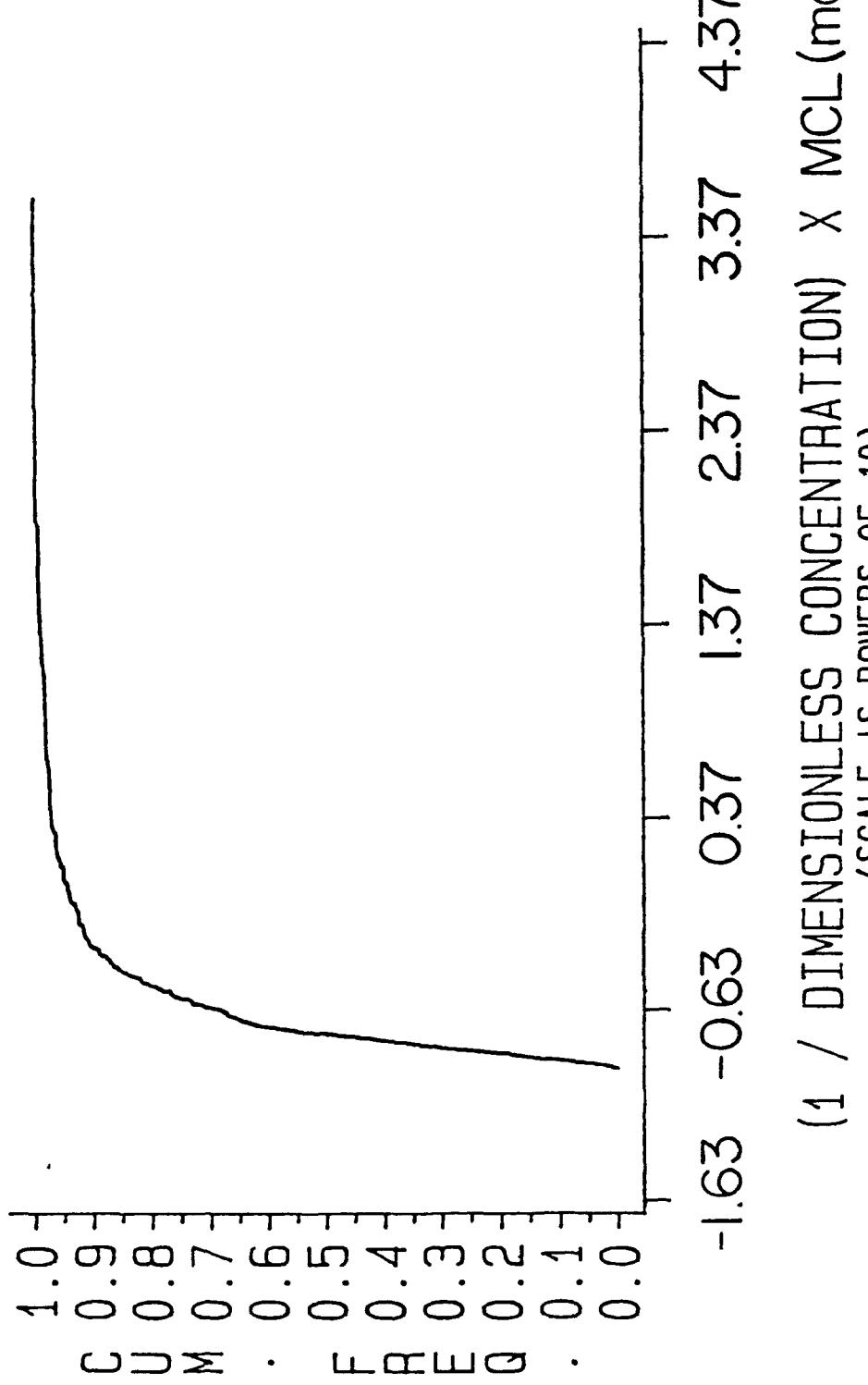
RUN 46

ARSENIC - SATURATED ZONE ONLY  
493 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 6



RUN 49A

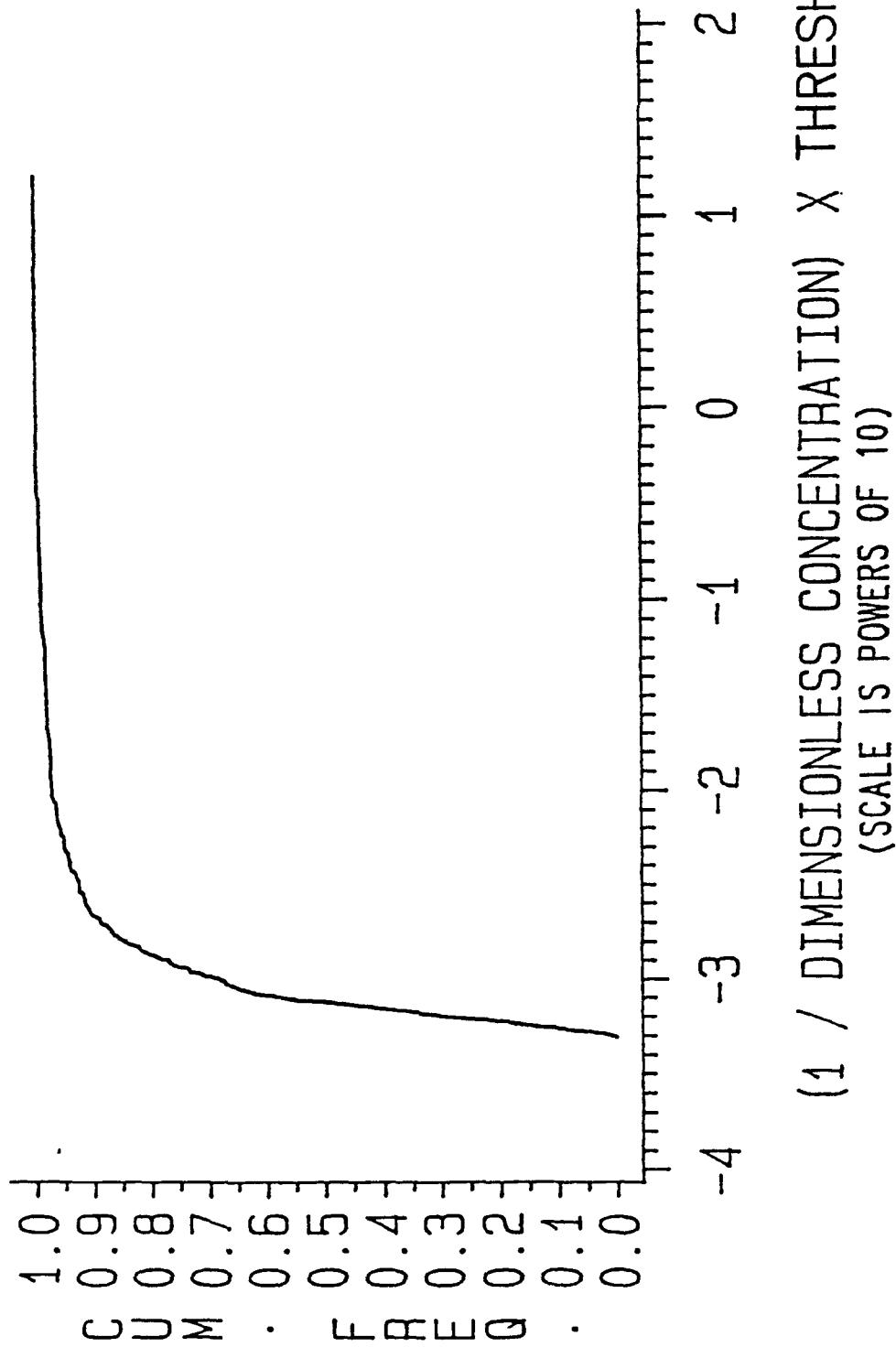
CHLOROFORM - SATURATED ZONE ONLY  
497 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 7



(1 / DIMENSIONLESS CONCENTRATION)  $\times$  MCL (mg/l)  
(SCALE IS POWERS OF 10)

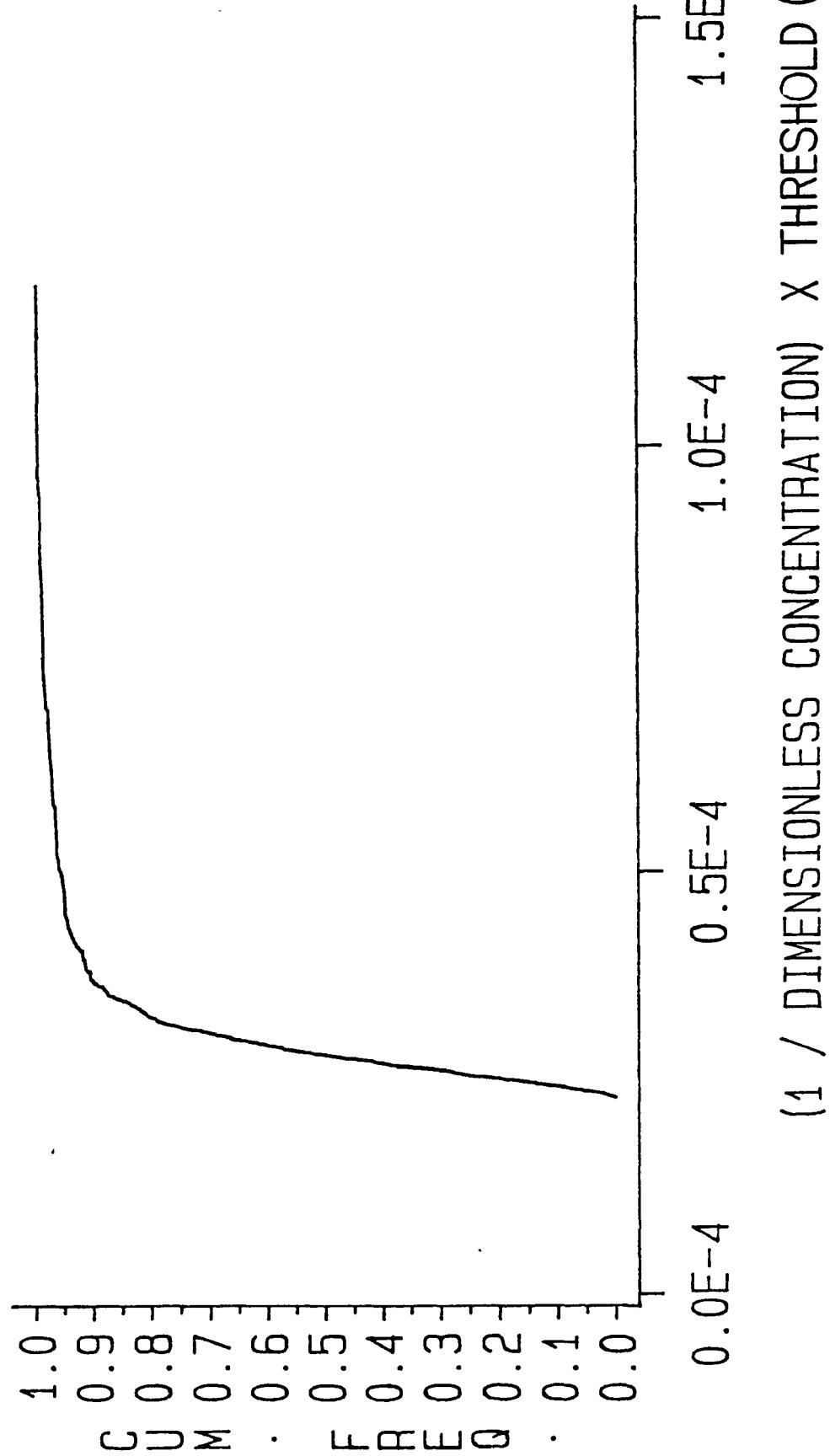
RUN 49B

CHLOROFORM - SATURATED ZONE ONLY  
497 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 7



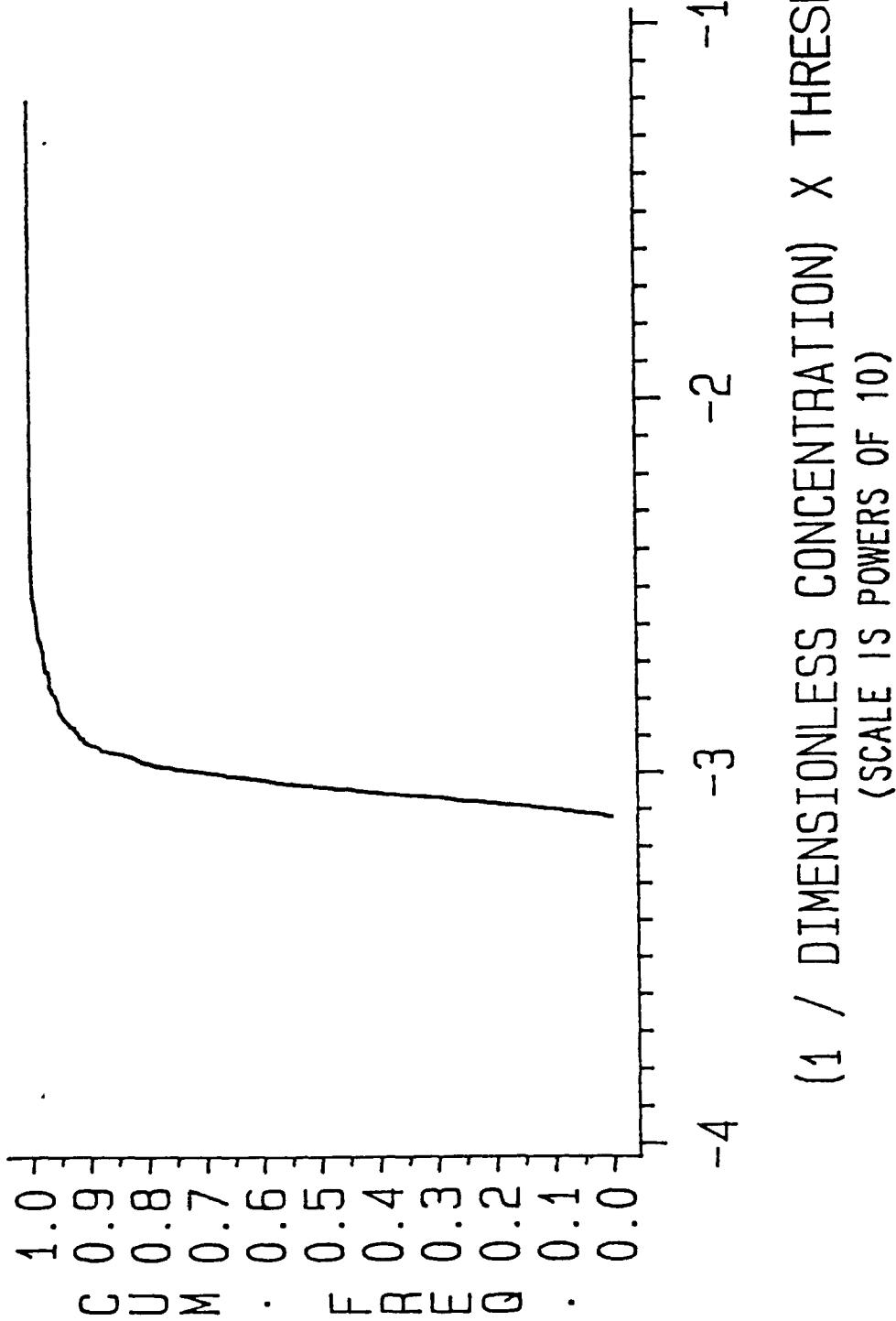
RUN 50

HEXACHLOROBENZENE - SATURATED ZONE ONLY  
497 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 7



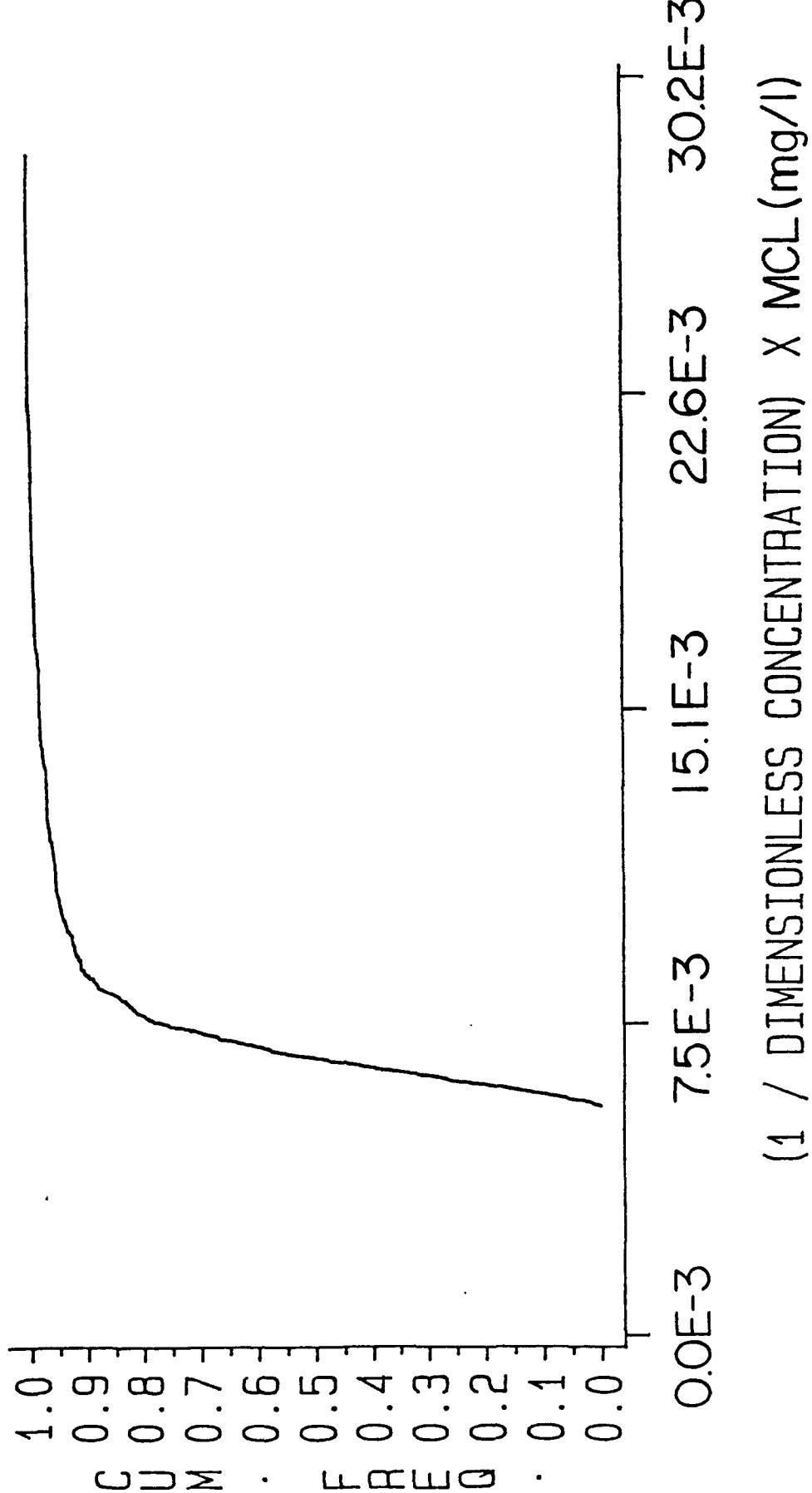
RUN 51

TETRACHLOROETHYLENE - SATURATED ZONE ONLY  
498 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 7



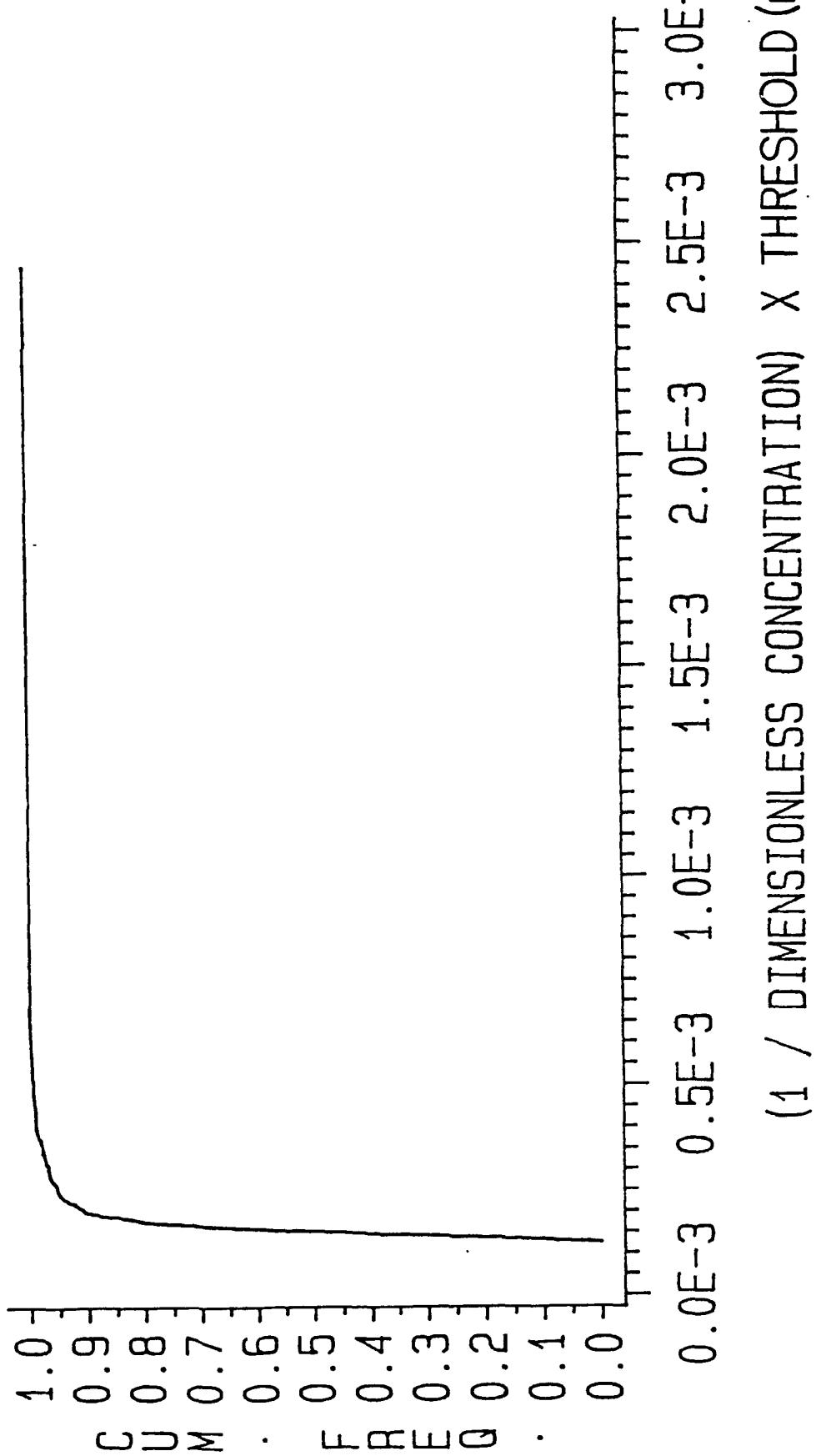
RUN 52

BENZENE - SATURATED ZONE ONLY  
497 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 7



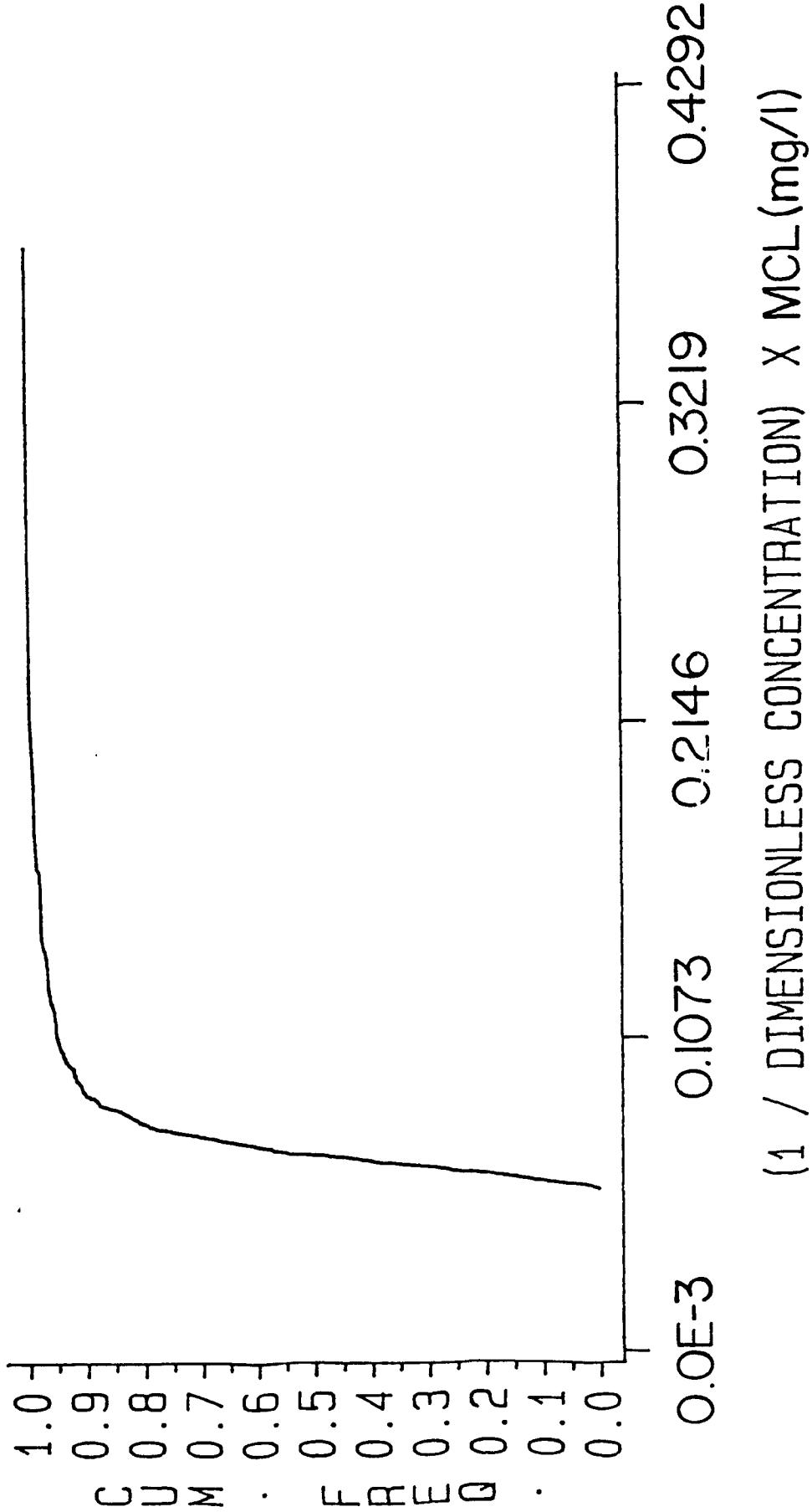
RUN 53

2,4-DINTROTOLUENE - SATURATED ZONE ONLY  
498 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 7



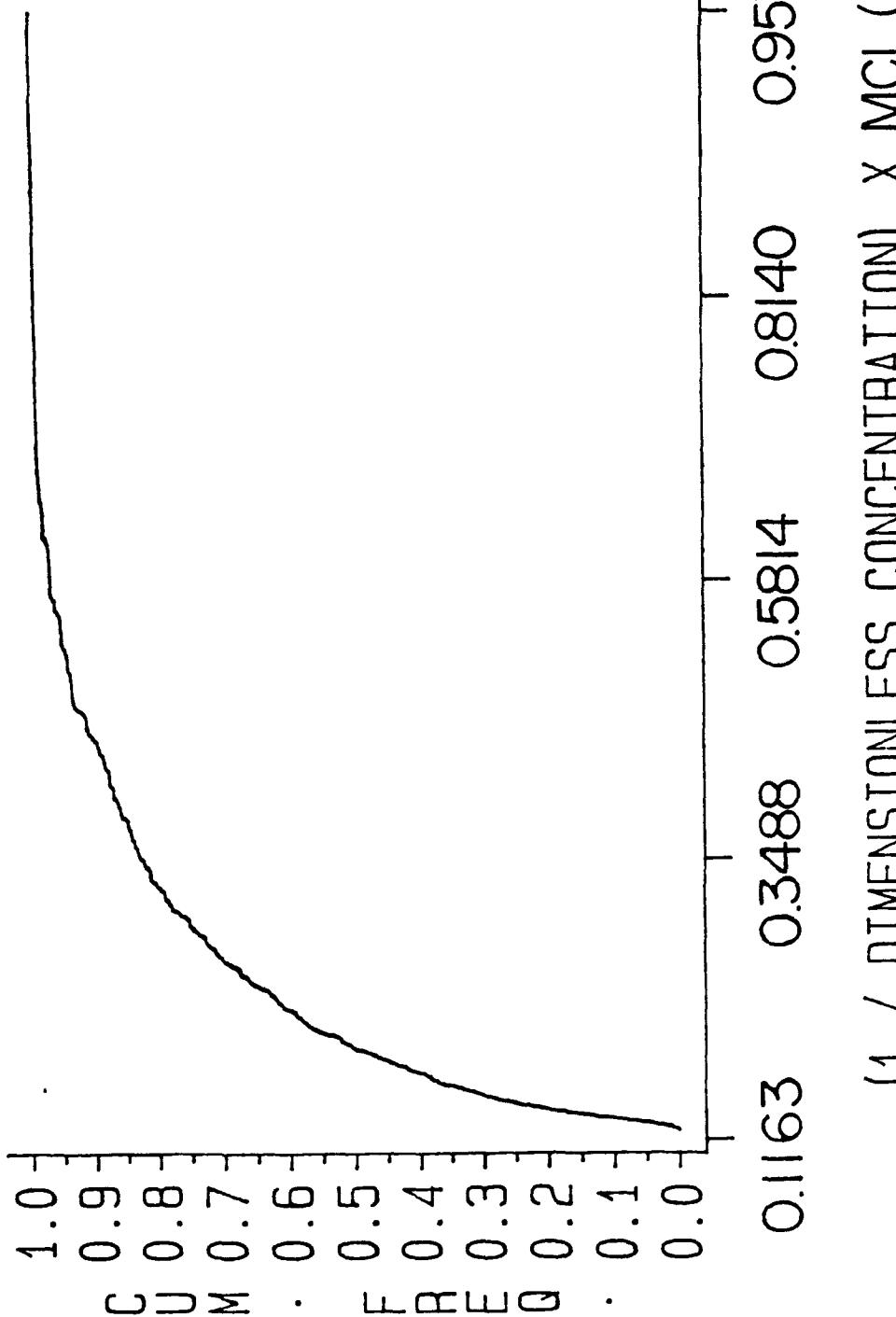
RUN 54

ARSENIC - SATURATED ZONE ONLY  
498 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 7



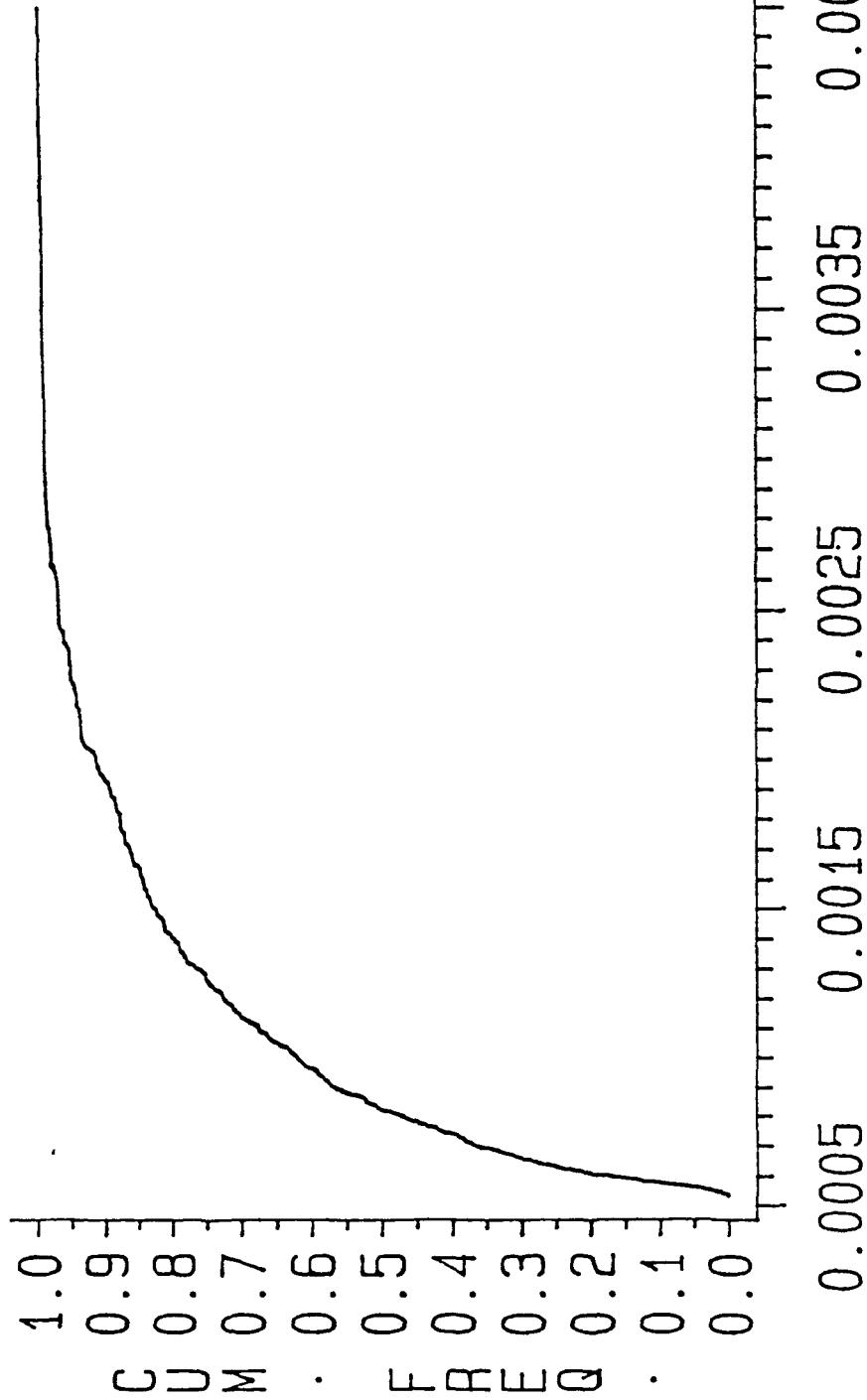
RUN 57A

CHLOROFORM - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 8



RUN 57B

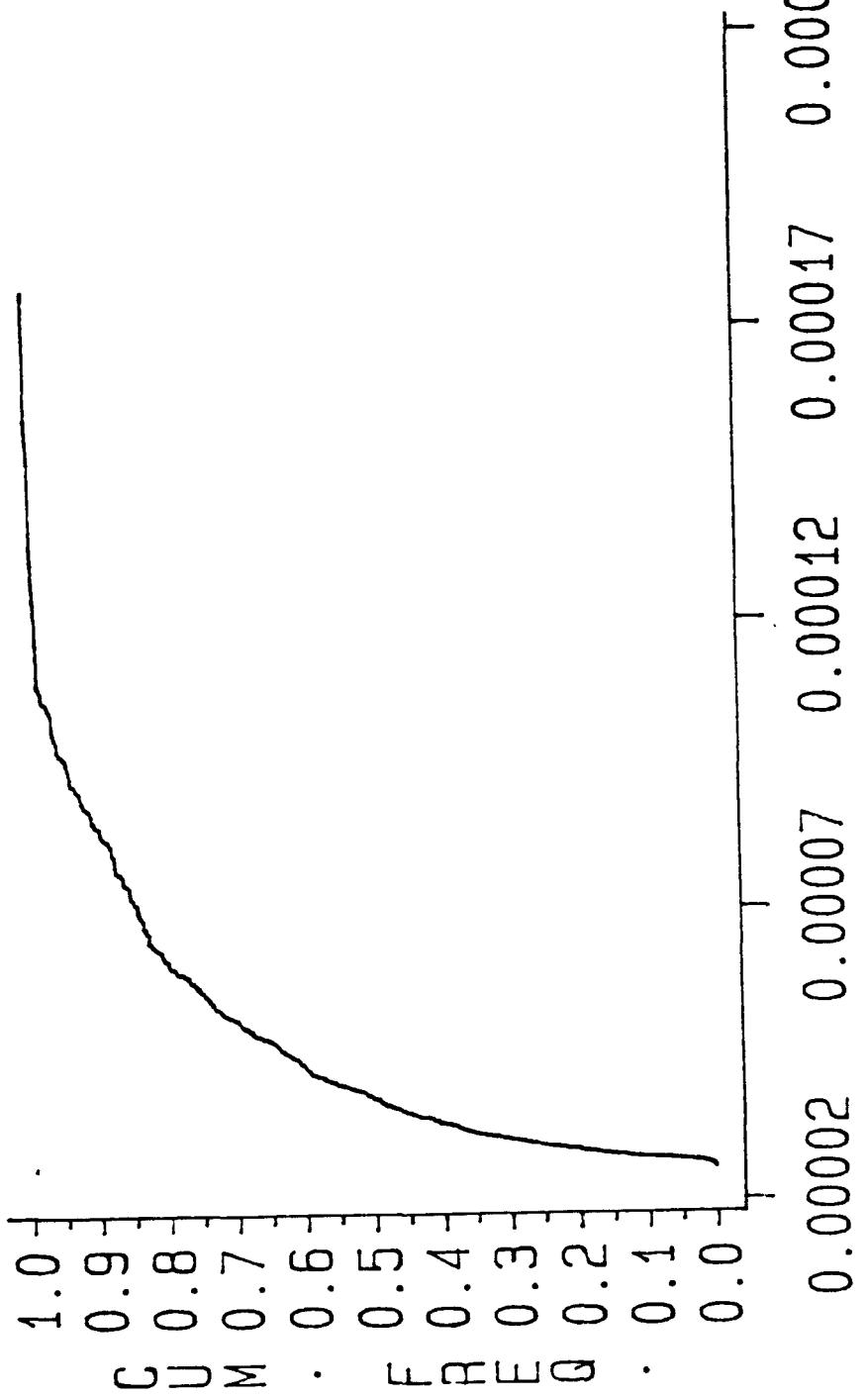
CHLOROFORM - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 8



(1 / DIMENSIONLESS CONCENTRATION)  $\times$  THRESHOLD (mg/l)

RUN 58

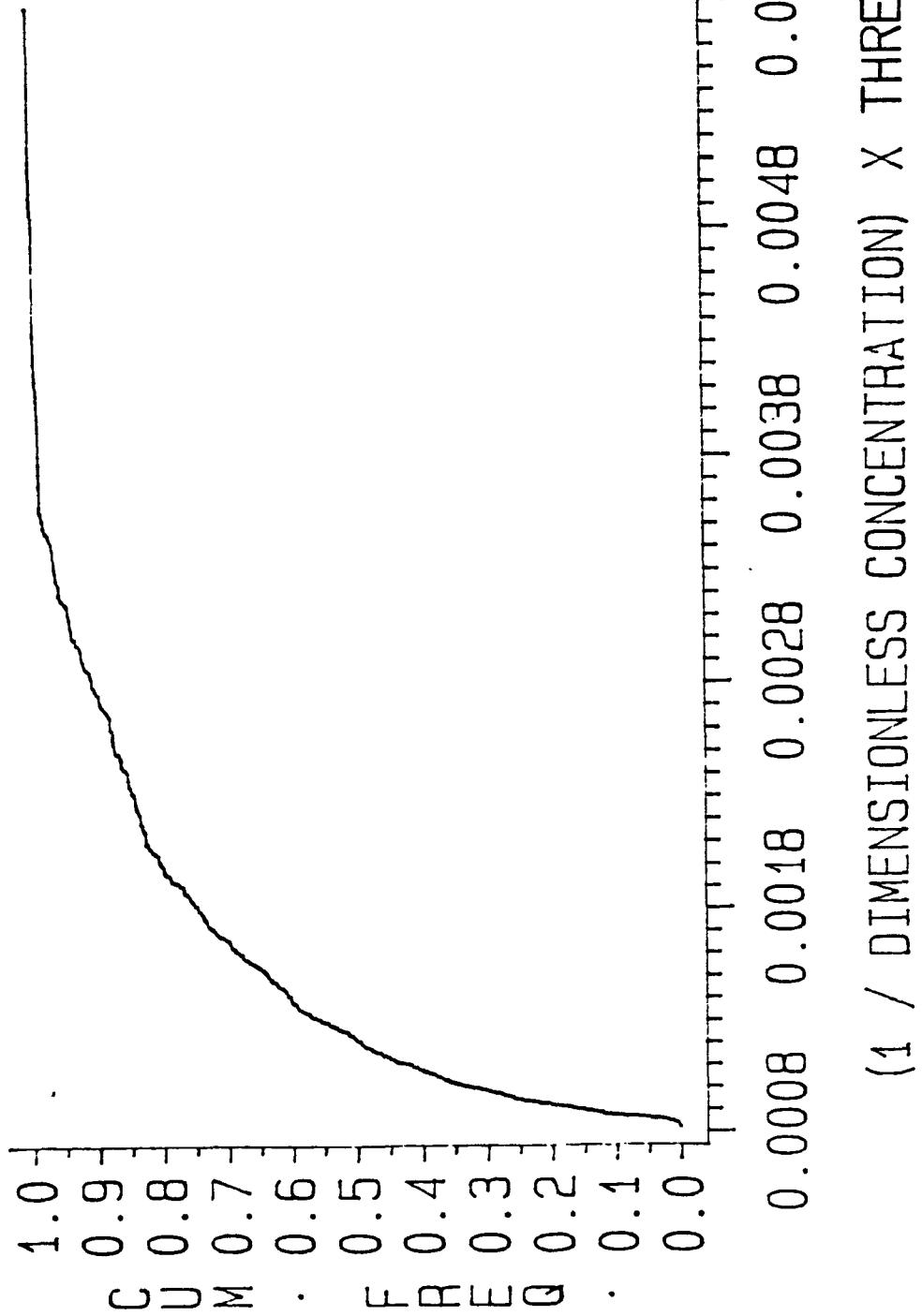
HEXACHLOROBENZENE - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 8



(1 / DIMENSIONLESS CONCENTRATION) X THRESHOLD (mg/l)

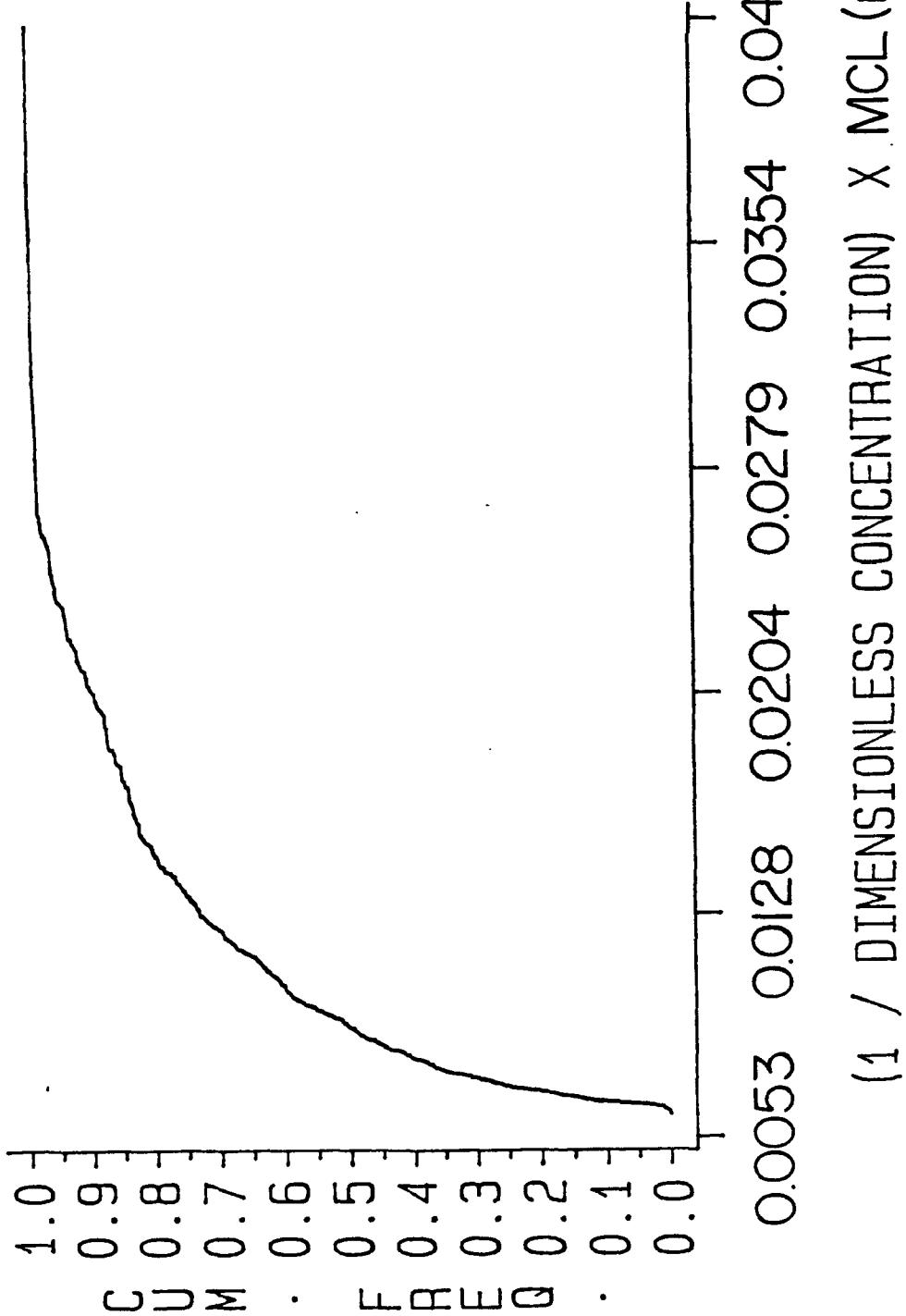
RUN 59

TETRACHLOROETHYLENE - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 8



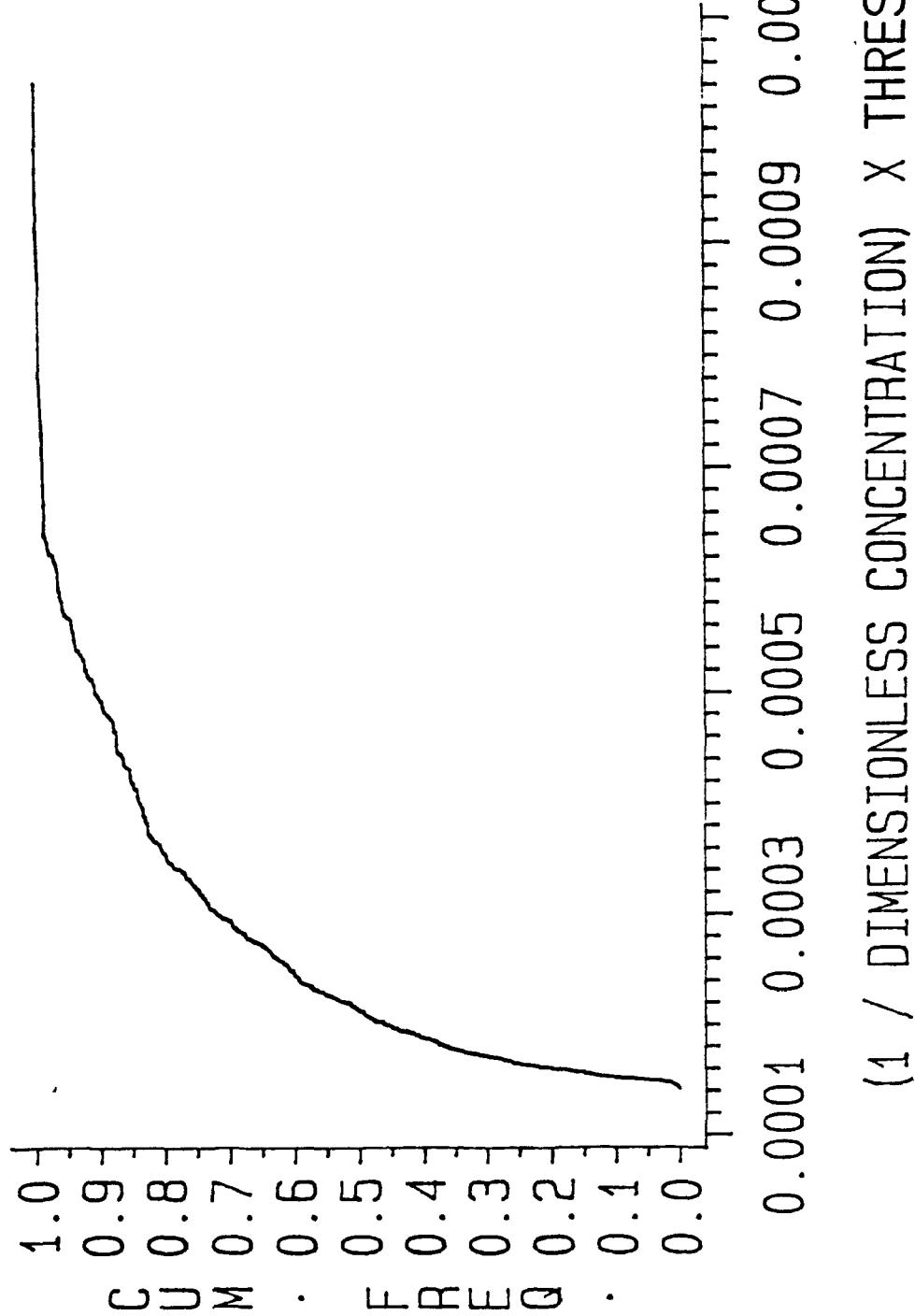
RUN 60

BENZENE - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 8



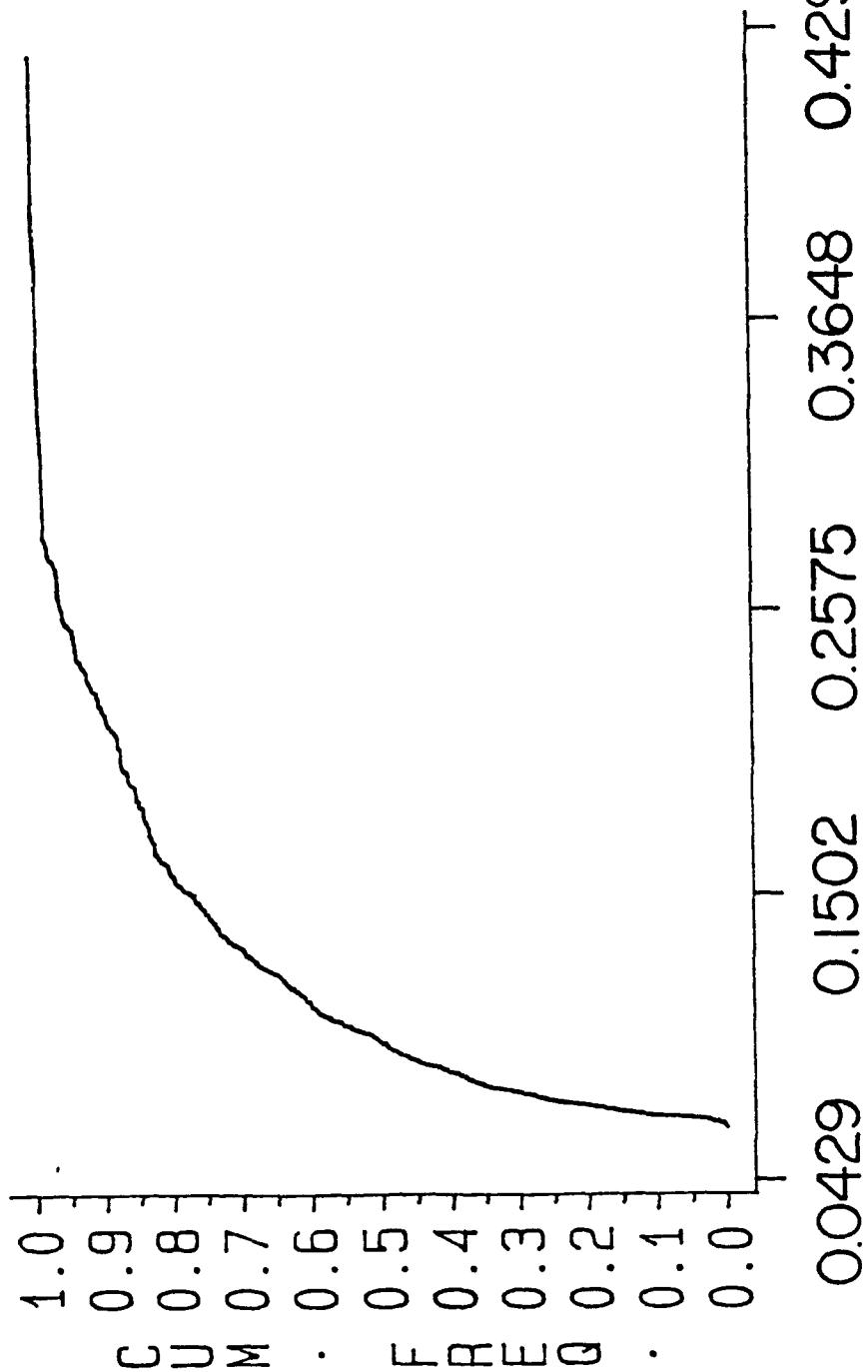
RUN 61

2,4-DINITROTOLUENE - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 8



RUN 62

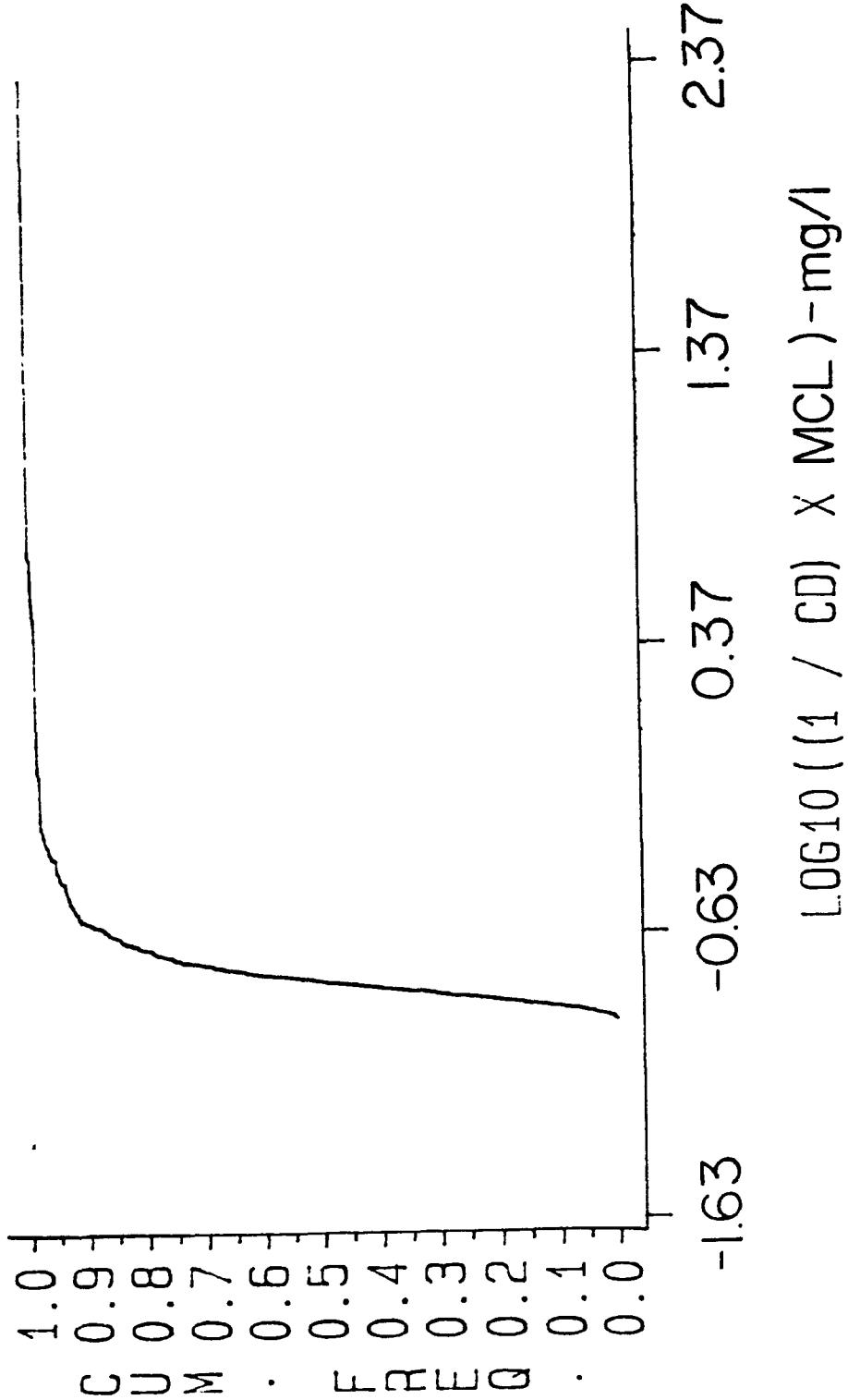
ARSENIC - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 8



(1 / DIMENSIONLESS CONCENTRATION) X MCL (mg/l)

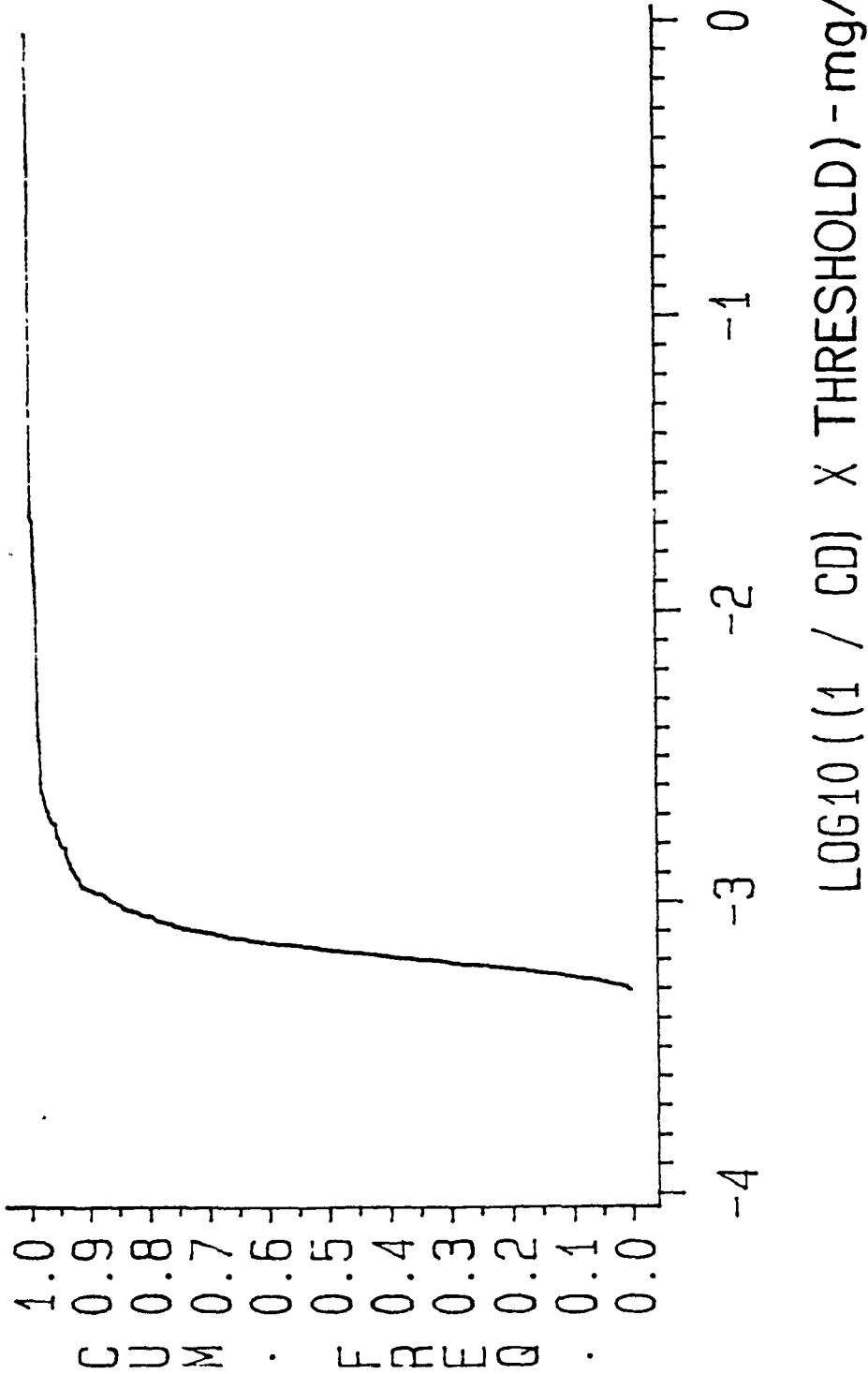
RUN 65A

CHLOROFORM - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 9



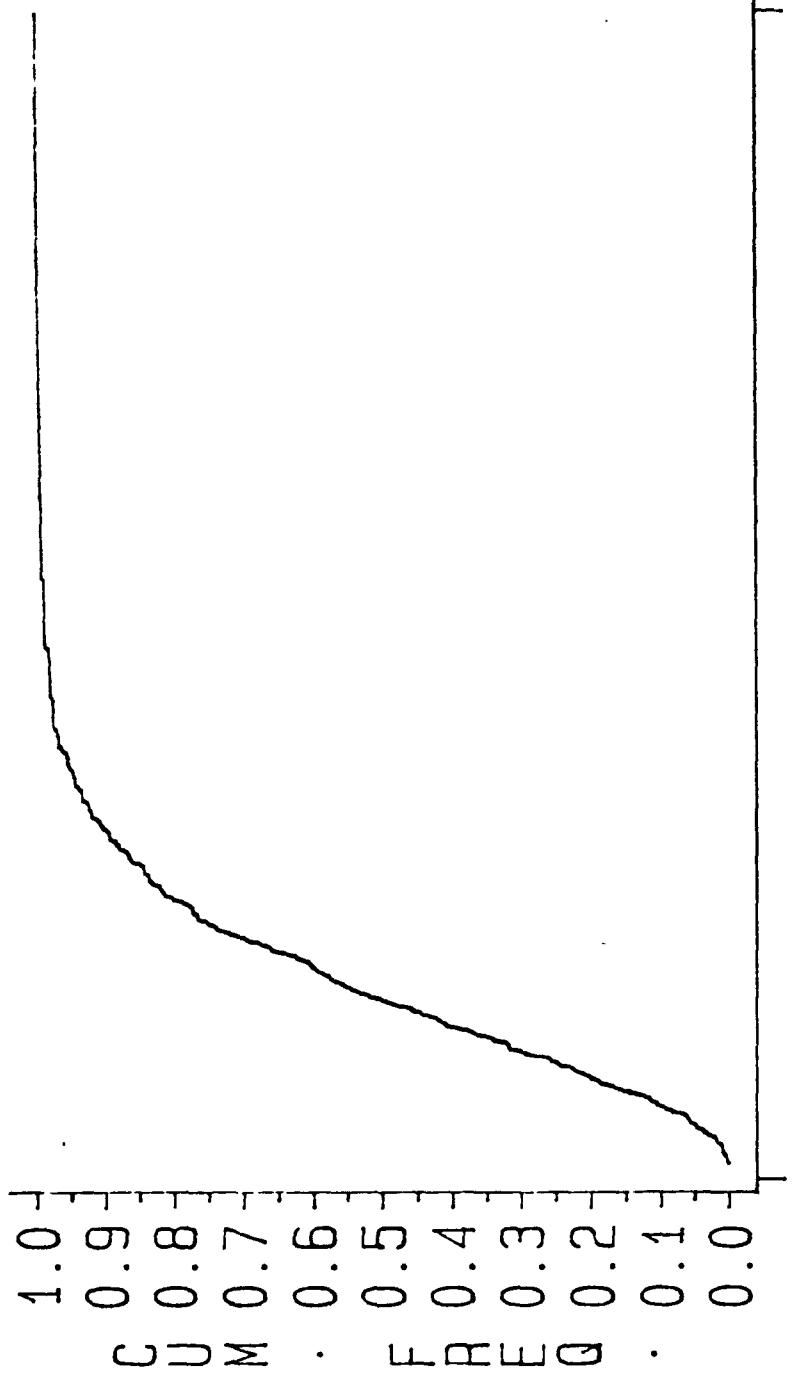
RUN 65B

CHLOROFORM - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 9



RUN 66

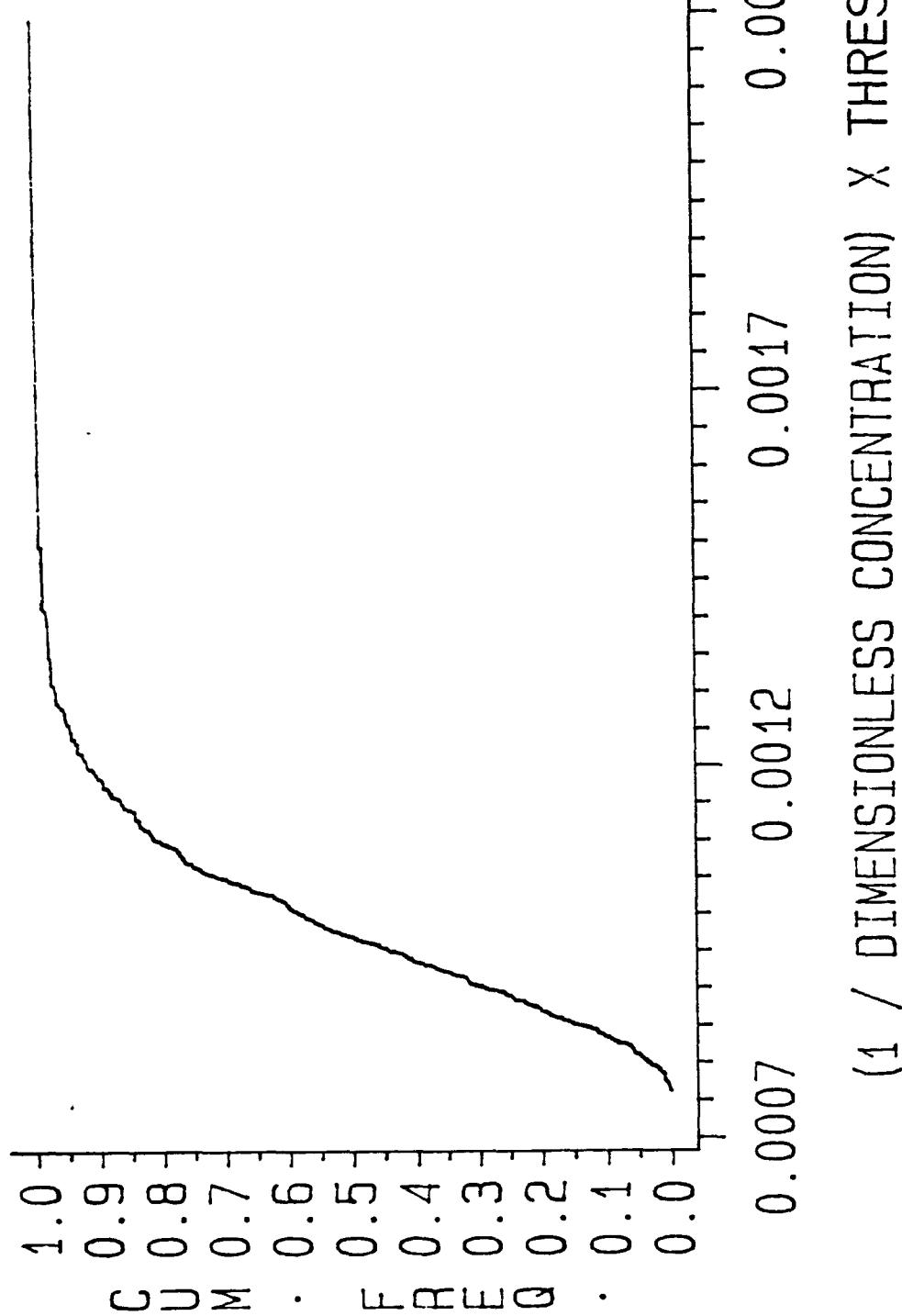
HEXACHLOROBENZENE - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 9



(1 / DIMENSIONLESS CONCENTRATION) X THRESHOLD (mg/l)

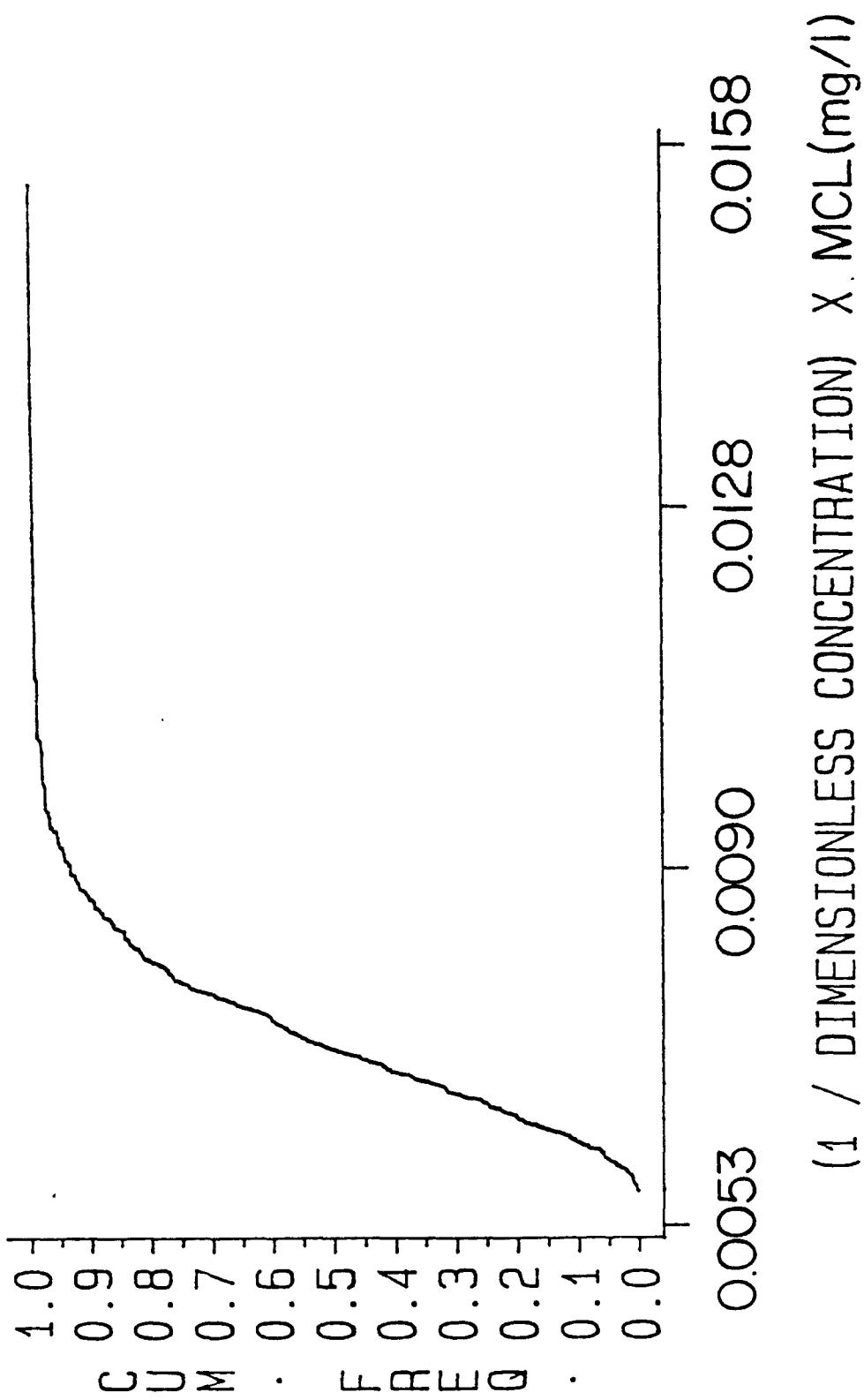
RUN 67

TETRACHLOROETHYLENE - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 9



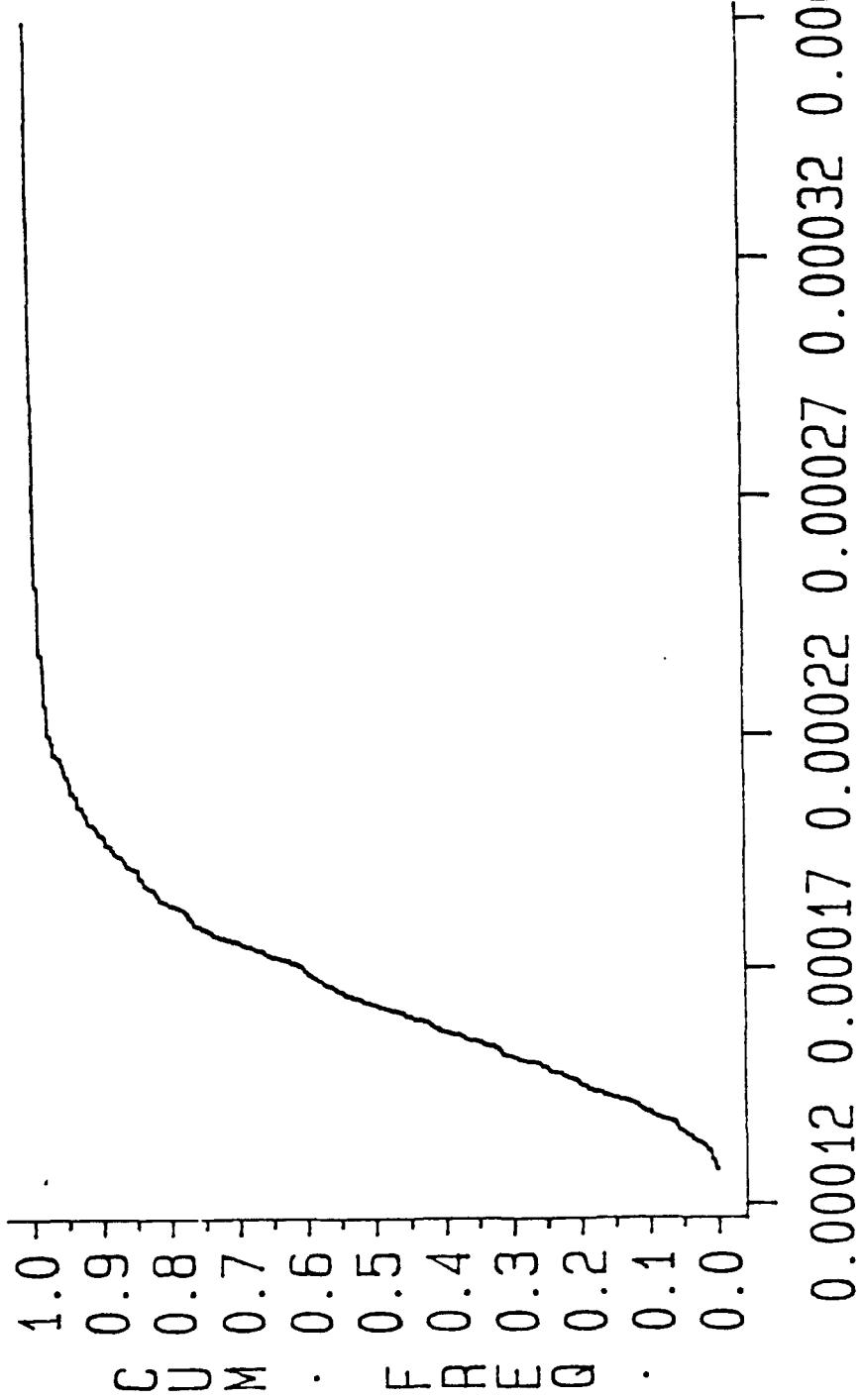
RUN 68

BENZENE - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 9



RUN 69

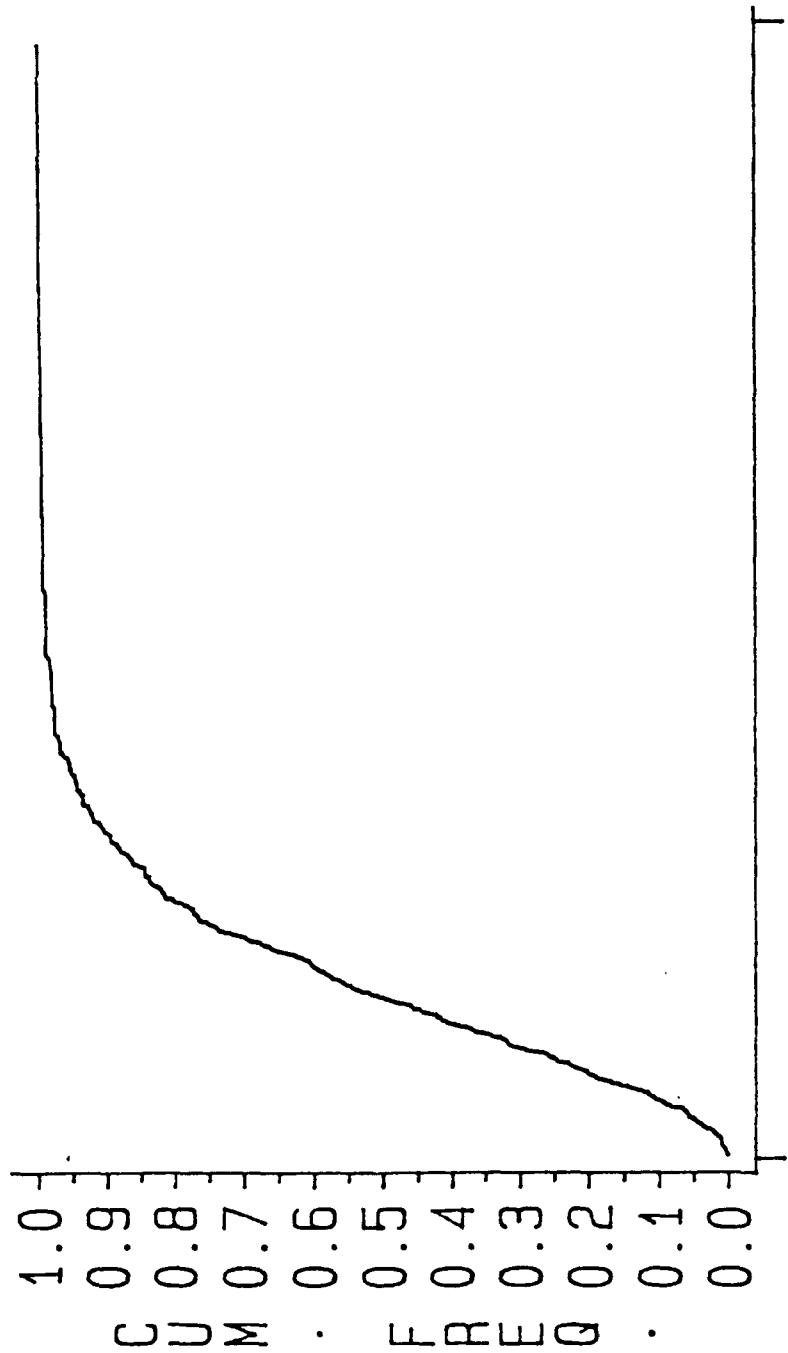
2,4-DINITROTOLUENE - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 9



(1 / DIMENSIONLESS CONCENTRATION) X THRESHOLD (mg/l)

RUN 70

ARSENIC - SATURATED ZONE ONLY  
500 ITERATIONS  
HYDROGEOLOGIC CATEGORY - 9



(1 / DIMENSIONLESS CONCENTRATION) X MCL (mg/l)

0.0558

0.1567

APPENDIX 4.7

APPENDIX 4 REFERENCES

## APPENDIX 4.7

### APPENDIX 4 REFERENCES

1. U.S. Environmental Protection Agency. 1986. Liner Location, Risk and Cost Analysis Model, Phase II Report (Draft). USEPA, Office of Solid Waste.
2. National Water Well Association (NWWA), 1985. DRASTIC: A Standardized System for Evaluating Ground Water Pollution Potential Using Hydrogeologic Settings. EPA-600/2-85-018. National Technical Information Service, Springfield, VA.
3. Anderson, M.P., 1979. "Using Models to Simulate the Movement of Contaminants through Ground Water Flow Systems". Critical Reviews in Environmental Control. 9(2):97-156
4. Freeze, R.A. and J.A. Cherry, 1979. Groundwater, Prentice-Hall.
5. U.S. Environmental Protection Agency. Wastewater Stabilization Pond Linings. MCD-54, November 1984.
6. Hannaman, M.C., E.J. Johnson, and M.A. Zagar, 1978. Effects of Wastewater Stabilization Pond Seepage on Groundwater Quality. Prepared by Eugene A. Hickok and Associates, Wayzata, Minnesota for Minnesota Pollution Control Agency, Roseville, Minnesota.
7. Oswald, W.J., 1983. Unpublished Manuscript, Lecture Notes, University of California, Berkeley.
8. Middlebrooks, E.J., C.H. Middlebrooks, J.H. Reynolds, G.Z. Waters, S.C. Reed, and D.B. George, 1982. Wastewater Stabilization Lagoon Design, Performance, and Upgrading. MacMillan Publishing Company.
9. Letter to R.C. Hampson, Lahontan (CA) Regional Water Quality Control Board from the City of Ridgecrest, dated July 30, 1985.
10. Preul, H.C., 1968. "Contaminants in Groundwater Near Waste Stabilization Ponds." Journal of the Water Pollution Control Federation, Volume 40, p. 659.
11. Great Lakes--Upper Mississippi River Board of State Sanitary Engineers. Recommended Standards for Sewage Works. Health Education Service, Albany, New York.

APPENDIX 5.1  
MODEL LAGOON LEACHATE CONCENTRATIONS

APPENDIX 5.1

MODEL LAGOON LEACHATE CONCENTRATIONS

	Concentration	
	Median	Maximum
<b>Metals, ug/l</b>		
Arsenic	0.2 <sup>a</sup>	88
<b>Conventional, mg/l</b>		
NO <sub>2</sub> /NO <sub>3</sub> -N	0.005 <sup>a</sup>	7.3
<b>Volatiles, ug/l</b>		
Benzene	1 <sup>a</sup>	11
Chloroform	0.05 <sup>a</sup>	86
Tetrachloroethylene	0.01 <sup>a</sup>	31
<b>Organics, base-neutral, ug/l</b>		
2,4-Dinitrotoluene	0.02 <sup>a</sup>	43
Hexachlorobenzene	1	32

<sup>a</sup> Median calculated using the analytical detection limit value for non-detect values resulted in the detection limit being the median.

Source: See Appendix 3.5

**APPENDIX 5.2**

**NINETIETH PERCENTILE HEALTH RISKS BY SETTING**

Appendix

Distribution of Risks Across Hydrogeologic Settings

Constituent (Leachate Conc.) \*

Ninetieth Percentile Health Risks by Hydrogeologic Setting

	1	2	3	4	5	6	7	8	9
Arsenic	(Median) 6.7E - 07 3.7E - 05	7.4E - 07 4.1E - 05	5.6E - 07 3.1E - 05	4.7E - 07 2.6E - 05	6.2E - 07 3.4E - 05	7.7E - 07 4.2E - 05	7.5E - 07 4.1E - 05	6.7E - 07 3.7E - 05	7.1E - 07 3.9E - 05
Benzene	(Median) 1.2E - 06 1.3E - 05	1.3E - 06 1.4E - 05	9.7E - 07 1.1E - 05	8.1E - 07 9.0E - 06	1.1E - 06 1.2E - 05	1.3E - 06 1.5E - 05	1.3E - 06 1.4E - 05	1.2E - 06 1.3E - 05	1.2E - 06 1.4E - 05
Chloroform	(Median) 8.8E - 08 1.5E - 04	9.4E - 08 1.6E - 04	7.2E - 08 1.2E - 04	6.2E - 08 1.1E - 04	7.9E - 08 1.4E - 04	9.7E - 08 1.7E - 04	9.3E - 08 1.6E - 04	8.9E - 08 1.5E - 04	9.2E - 08 1.6E - 04
2, 4 - Dinitrotoluene	(Median) 1.4E - 07 2.9E - 04	1.5E - 07 3.3E - 04	1.1E - 07 2.4E - 04	9.2E - 08 2.1E - 04	1.3E - 07 2.7E - 04	1.6E - 07 3.4E - 04	1.5E - 07 3.3E - 04	1.4E - 07 3.0E - 04	1.5E - 07 3.1E - 04
Hexachlorobenzene	(Median) 3.8 - 05 1.2E - 03	4.2E - 05 1.3E - 03	3.1E - 05 1.0E - 03	2.6E - 05 8.5E - 04	3.5E - 05 1.1E - 03	4.3E - 05 1.4E - 03	4.2E - 05 1.3E - 03	3.8E - 05 1.2E - 03	4.0E - 05 1.3E - 03
Tetrachloroethylene	(Median) 1.1E - 08 3.5E - 05	1.3E - 08 3.9E - 05	9.5E - 09 2.9E - 05	8.0E - 09 2.5E - 05	1.1E - 08 3.3E - 05	1.3E - 08 4.1E - 05	1.3E - 08 3.9E - 05	1.1E - 08 3.5E - 05	1.2E - 08 3.8E - 05
Nitrate or Nitrite**	(Median) 0.0 0.0	0.0 0.0	0.0 1.1E - 10	0.0 3.5E - 12	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0

\* Median refers to Lagoon leachate median concentration value;

Maximum to lagoon leachate maximum concentration.

\*\* Represents a ratio of well concentration to the reference dose and is not a risk value.

**APPENDIX 5.3**  
**DESCRIPTION OF MAPPING SURVEY**

TABLE 5.3-1  
TOTAL EXPOSED POPULATION DISTRIBUTION

Distance to Well (m)		Population Exposed	Probability	Cumulative Probability
Lower	Upper			
0	35	10	0.0001	0.0001
35	130	92.5	0.0011	0.0012
130	300	1,781.5	0.0207	0.0219
300	500	4,722	0.0549	0.0768
500	800	61,042.5	0.7093	0.7861
800	1,250	5,520	0.0641	0.8502
1,250	2,000	12,892	0.1498	1.0000

**APPENDIX 5.4**  
**CALCULATION OF HEALTH RISKS FROM WELL**  
**CONCENTRATIONS**

## APPENDIX 5.4

### CALCULATION OF HEALTH RISKS FROM WELL CONCENTRATIONS

Post-processing software developed for EPACMS takes the dimensionless concentration values produced by EPACMS and transforms these values into risk or hazard values. Carcinogenic and noncarcinogenic risks are calculated separately based upon carcinogenic potency values and noncarcinogenic reference values. Cancer and noncancer health effects are estimated with the following equations:

#### Carcinogenic Risk:

$$R = (C \times F) \times P, \text{ where:}$$

R = Risk (dimensionless)

C = Ground-water contaminant concentration (mg/L)

P = Potency factor (see Table 3-7) (mg/kg/day)-1

F = 0.029 (this is a conversion factor to account for ingestion assumptions).

#### Noncarcinogenic Hazard:

$$H = (C \times F)/RfD, \text{ where:}$$

H = Noncarcinogenic hazard index (dimensionless)

C = Ground-water contaminant concentration (mg/L)

RfD = reference dose (see Table 3-7) (mg/kg/day)-1

F = 0.029 (this is a conversion factor to account for ingestion assumptions).

**APPENDIX 5.5**  
**DESCRIPTION OF COMPUTER RUNS**

## APPENDIX 5.5

### DESCRIPTION OF COMPUTER RUNS

One set of EPACMS runs was done to estimate the maximally exposed individual (MEI) risks. This set of runs examined seven pollutants and nine hydrogeologic settings resulting in a total of sixty-three computer runs. Each run consisted of 500 iterations of the Monte Carlo simulator. The model generates a ratio between an estimated well concentration and the leachate concentration (this ratio is called a dimensionless concentration). This ratio is multiplied by the leachate concentration and a ingestion conversion factor. For carcinogenic risk, the result is multiplied by a risk potency factor, P. For noncarcinogenic hazard, the result is divided by a reference dose, RFD.

A post-processing software package was developed to allow these computer runs to be examined in several ways. The computer runs describe the distribution of risks to individuals in a single hydrogeologic setting caused by exposure to a single pollutant. With the post-processing package, analyzing the total risks within each hydrogeologic setting after summing the carcinogenic risks can be done. This allows relatively vulnerable hydrogeologic settings to be identified. The post-processing package also enables aggregation of risks across all environments in order to determine the overall magnitude of the risks posed nationwide by municipal lagoons.

Tables of the input parameters are presented in Appendix 4.4.

**APPENDIX 5.6**  
**DATA FROM MODEL OUTPUT**

## APPENDIX 5.6

### DATA FROM MODEL OUTPUT

The attached tables present the outputs of the EPACMS model and the post-processing software. The tables present two sets of outputs corresponding to runs using median well concentrations as input and runs using maximum well concentrations as input. Nine hydrogeologic settings were examined for each concentration input.

Please Note: The data output contains a typographical error. Data for tetrachlorethylene are incorrectly labeled as "tetrachloroethane."

Wert der gesuchten Risiken ist die Summe aller Risiken mit dem entsprechenden Gewicht.

Risikosumme = Summe aller Risiken mit dem entsprechenden Gewicht

Risiko	Gewicht	Risikowert
1. Risiko	0.1	100
2. Risiko	0.2	200
3. Risiko	0.3	300
4. Risiko	0.4	400

Abbildung 1: CARCINOIDEN RISIKO = SUMME DER RISIKOSUMMEN FÜR CARCINOIDEN RISIKO FÜR JEDE RISIKOART. Beispiele: 1. RISIKOART: CARCINOIDEN RISIKO = 100 \* 0.1 + 200 \* 0.2 + 300 \* 0.3 + 400 \* 0.4 = 300

Risiko	Gewicht	Risikowert
1. Risiko	0.1	100
2. Risiko	0.2	200
3. Risiko	0.3	300
4. Risiko	0.4	400

N = 500  
PERCENTILE: 100%  
RISK: 3.4E-06

$\text{CHLORFORM: RISK} = (\text{MEDIAN WELL CONCENTRATION IN } \mu\text{g/L} \times 0.029) \times 0.1 \times 10^{-2}$

N = 500  
PERCENTILE: 100%  
RISK: 4.0E-06

BENZENE: RISK = (MEDIAN WELL CONCENTRATION IN  $\mu\text{g/L} \times 0.029) \times 5.2 \times 10^{-2}$

N = 500  
PERCENTILE: 100%  
RISK: 4.7E-06

HEXACHLOROBENZENE: RISK = (MEDIAN WELL CONCENTRATION IN  $\mu\text{g/L} \times 0.029) \times 1.69$

N = 500  
PERCENTILE: 100%  
RISK: 5.5E-07

HEPTAFLUOROPENTANE: RISK = (MEDIAN WELL CONCENTRATION IN  $\mu\text{g/L} \times 0.029) \times 1.69$

N = 500  
PERCENTILE: 100%  
RISK: 6.3E-07

HEPTACHLOROETHANE: RISK = (MEDIAN WELL CONCENTRATION IN  $\mu\text{g/L} \times 0.029) \times 1.69$

N = 500  
PERCENTILE: 100%  
RISK: 7.2E-07

HEPTACHLOROTOLUENE: RISK = (MEDIAN WELL CONCENTRATION IN  $\mu\text{g/L} \times 0.029) \times 5.1 \times 10^{-2}$

N = 500  
PERCENTILE: 100%  
RISK: 8.1E-07

HEPTACHLOROETHANE: RISK = (MEDIAN WELL CONCENTRATION IN  $\mu\text{g/L} \times 0.029) \times 1.0E-2$

N = 500  
PERCENTILE: 100%  
RISK: 9.0E-07

HEPTACHLOROTOLUENE: RISK = (MEDIAN WELL CONCENTRATION IN  $\mu\text{g/L} \times 0.029) \times 1.0E-2$

N = 500  
PERCENTILE: 100%  
RISK: 1.0E-07

HEPTACHLOROETHANE: RISK = (MEDIAN WELL CONCENTRATION IN  $\mu\text{g/L} \times 0.029) \times 1.0E-2$

N = 500  
PERCENTILE: 100%  
RISK: 1.1E-07

HEPTACHLOROTOLUENE: RISK = (MEDIAN WELL CONCENTRATION IN  $\mu\text{g/L} \times 0.029) \times 1.0E-2$

N = 500  
PERCENTILE: 100%  
RISK: 1.2E-07

HEPTACHLOROETHANE: RISK = (MEDIAN WELL CONCENTRATION IN  $\mu\text{g/L} \times 0.029) \times 1.0E-2$

N = 500  
PERCENTILE: 100%  
RISK: 1.3E-07

HEPTACHLOROTOLUENE: RISK = (MEDIAN WELL CONCENTRATION IN  $\mu\text{g/L} \times 0.029) \times 1.0E-2$

N = 500  
PERCENTILE: 100%  
RISK: 1.4E-07

HEPTACHLOROETHANE: RISK = (MEDIAN WELL CONCENTRATION IN  $\mu\text{g/L} \times 0.029) \times 1.0E-2$

N = 500  
PERCENTILE: 100%  
RISK: 1.5E-07

HEPTACHLOROTOLUENE: RISK = (MEDIAN WELL CONCENTRATION IN  $\mu\text{g/L} \times 0.029) \times 1.0E-2$

N = 500  
PERCENTILE: 100%  
RISK: 1.6E-07

HEPTACHLOROETHANE: RISK = (MEDIAN WELL CONCENTRATION IN  $\mu\text{g/L} \times 0.029) \times 1.0E-2$

N = 500  
PERCENTILE: 100%  
RISK: 1.7E-07

HEPTACHLOROTOLUENE: RISK = (MEDIAN WELL CONCENTRATION IN  $\mu\text{g/L} \times 0.029) \times 1.0E-2$

N = 500  
PERCENTILE: 100%  
RISK: 1.8E-07

HEPTACHLOROETHANE: RISK = (MEDIAN WELL CONCENTRATION IN  $\mu\text{g/L} \times 0.029) \times 1.0E-2$

N = 500  
PERCENTILE: 100%  
RISK: 1.9E-07

HEPTACHLOROTOLUENE: RISK = (MEDIAN WELL CONCENTRATION IN  $\mu\text{g/L} \times 0.029) \times 1.0E-2$

N = 500  
PERCENTILE: 100%  
RISK: 2.0E-07

HEPTACHLOROETHANE: RISK = (MEDIAN WELL CONCENTRATION IN  $\mu\text{g/L} \times 0.029) \times 1.0E-2$

N = 500  
PERCENTILE: 100%  
RISK: 2.1E-07

HEPTACHLOROTOLUENE: RISK = (MEDIAN WELL CONCENTRATION IN  $\mu\text{g/L} \times 0.029) \times 1.0E-2$

N = 500  
PERCENTILE: 100%  
RISK: 2.2E-07

HEPTACHLOROETHANE: RISK = (MEDIAN WELL CONCENTRATION IN  $\mu\text{g/L} \times 0.029) \times 1.0E-2$

N = 500  
PERCENTILE: 100%  
RISK: 2.3E-07

HEPTACHLOROTOLUENE: RISK = (MEDIAN WELL CONCENTRATION IN  $\mu\text{g/L} \times 0.029) \times 1.0E-2$

N = 500  
PERCENTILE: 100%  
RISK: 2.4E-07

MEDIAN AGGREGATE CARCINOGEN RISK TÜ M1 - CATEGORY 1

AGGREGATE RISK = SUM OF RISKS FROM THE FOLLOWING CONSTITUENTS:  
CHLOROFORM, BENZENE, HEXACHLOROBENZENE, HEXACHLOROTOLUENE, 1,4-DINITROBENZENE

N = 500  
PERCENTILE: 100%  
RISK: 1.6E-05

NITRATE: HAZARD = (MEDIAN WELL CONCENTRATION IN  $\mu\text{g/L} \times 0.029) / 1.0 \times 10^{-1}$

N = 500  
PERCENTILE: 100%  
RISK: 2.0E-05

NITRATE: HAZARD = (MEDIAN WELL CONCENTRATION IN  $\mu\text{g/L} \times 0.029) / 1.0 \times 10^{-1}$

N = 500  
PERCENTILE: 100%  
RISK: 2.4E-05

MEDIAN RISK FOR HAZARD TO SITE IN CATEGORY 2

CUMULATIVE: RISK = MEDIAN WELL CONCENTRATION IN mg/L X Q.029 X 0.1 X 10E-2  
 N = 500  
 PERCENTILE: 10TH 20TH 30TH 40TH 50TH 60TH 70TH 80TH 90TH  
 RISK: 3. 10E-03 3. 10E-03 4. 50E-03 5. 14E-03 6. 19E-03 7. 64E-03 8. 55E-03 9. 36E-03 1. 06E-02

FRACTION: RISK = MEDIAN WELL CONCENTRATION IN mg/L X Q.029 X 5.2 X 10E-2  
 N = 500  
 PERCENTILE: 10TH 20TH 30TH 40TH 50TH 60TH 70TH 80TH 90TH  
 RISK: 5. 24E-07 5. 24E-07 6. 35E-07 7. 56E-07 8. 66E-07 9. 85E-07 1. 11E-06 1. 21E-06 1. 26E-06 1. 38E-06

HEXAFLUOROPRANE: RISK = MEDIAN WELL CONCENTRATION IN mg/L X Q.029 X 1.69  
 N = 500  
 PERCENTILE: 10TH 20TH 30TH 40TH 50TH 60TH 70TH 80TH 90TH  
 RISK: 1. 17E-05 1. 70E-05 2. 06E-05 2. 44E-05 2. 80E-05 3. 20E-05 3. 64E-05 3. 93E-05 4. 18E-05 4. 48E-05

ETHERCHLOROETHANE: RISK = MEDIAN WELL CONCENTRATION IN mg/L X Q.029 X 5.1 X 10E-2  
 N = 500  
 PERCENTILE: 10TH 20TH 30TH 40TH 50TH 60TH 70TH 80TH 90TH  
 RISK: 5. 14E-03 6. 23E-03 7. 37E-03 8. 46E-03 9. 66E-03 1. 10E-02 1. 19E-02 1. 26E-02 1. 35E-02

DINITRODIBENZENE: RISK = MEDIAN WELL CONCENTRATION IN mg/L X Q.029 X 3.1 X 10E-1  
 N = 500  
 PERCENTILE: 10TH 20TH 30TH 40TH 50TH 60TH 70TH 80TH 90TH  
 RISK: 5. 06E-06 6. 15E-06 7. 57E-06 8. 96E-06 1. 03E-05 1. 17E-05 1. 33E-05 1. 44E-05 1. 53E-05 1. 64E-05

ANISINI: RISK = MEDIAN WELL CONCENTRATION IN mg/L X Q.029 X 1.5 X 10E-1  
 N = 500  
 PERCENTILE: 10TH 20TH 30TH 40TH 50TH 60TH 70TH 80TH 90TH  
 RISK: 5. 45E-07 3. 66E-07 4. 34E-07 4. 97E-07 5. 68E-07 6. 46E-07 6. 38E-07 7. 41E-07 7. 95E-07

NITROBENZENE: RISK = MEDIAN WELL CONCENTRATION IN mg/L X Q.029 / 1.0 X 10E-1  
 N = 500  
 PERCENTILE: 10TH 20TH 30TH 40TH 50TH 60TH 70TH 80TH 90TH  
 RISK: 0. 10E+00 0. 10E+00

MEDIAN AGGREGATE FRACTION RISK TO SITE - CATEGORY 2  
 AGGREGATE RISK = SUM OF RISKS FROM THE FOLLOWING CONSTITUENTS:  
 CUMULATIVE, BENZENE, HEXACHLOROPRANE, TRICHLOROURETHANE, 4-DINITRODIBENZENE  
 N = 500  
 PERCENTILE: 10TH 20TH 30TH 40TH 50TH 60TH 70TH 80TH 90TH  
 RISK: 1. 01E-05 1. 01E-05 1. 16E-05 1. 36E-05 1. 56E-05 1. 82E-05 2. 16E-05 4. 15E-05 4. 72E-05

### MEDIAN RISK FOR HAZARD TO MAN IN CATEGORY 3

$N = 5000$   
 PERCENTILE: 10TH  
 RISK: 1.0E-08

$N = 5000$   
 PERCENTILE: 10TH  
 RISK: 2.91E-08

$\text{CHLORFORM: RISK} = (\text{MEDIAN WELL CONCENTRATION IN MG/L} \times 0.059) \times 6.1 \times 10^{15} \times$

$40TH \quad 50TH \quad 60TH \quad 70TH \quad 80TH \quad 90TH \quad 95TH \quad 100TH$   
 $3.51E-07 \quad 3.88E-07 \quad 4.19E-07 \quad 4.58E-07 \quad 5.07E-07 \quad 5.88E-07 \quad 7.03E-07 \quad 9.66E-07 \quad 1.56E-06$

$\text{BENZENE: RISK} = (\text{MEDIAN WELL CONCENTRATION IN MG/L} \times 0.059) \times 5.2 \times 10^{15} \times$

$40TH \quad 50TH \quad 60TH \quad 70TH \quad 80TH \quad 90TH \quad 95TH \quad 100TH$   
 $3.51E-07 \quad 3.88E-07 \quad 4.19E-07 \quad 4.58E-07 \quad 5.07E-07 \quad 5.88E-07 \quad 7.03E-07 \quad 9.66E-07 \quad 1.56E-06$

$\text{HEXACHLOROBENZENE: RISK} = (\text{MEDIAN WELL CONCENTRATION IN MG/L} \times 0.059) \times 1.69$

$40TH \quad 50TH \quad 60TH \quad 70TH \quad 80TH \quad 90TH \quad 95TH \quad 100TH$   
 $1.14E-05 \quad 1.26E-05 \quad 1.36E-05 \quad 1.49E-05 \quad 1.65E-05 \quad 1.91E-05 \quad 2.29E-05 \quad 3.14E-05 \quad 4.10E-05$

$\text{TETRACHLOROETHANE: RISK} = (\text{MEDIAN WELL CONCENTRATION IN MG/L} \times 0.059) \times 1.69 \times$

$40TH \quad 50TH \quad 60TH \quad 70TH \quad 80TH \quad 90TH \quad 95TH \quad 100TH$   
 $3.45E-09 \quad 3.80E-09 \quad 4.11E-09 \quad 4.49E-09 \quad 4.97E-09 \quad 5.77E-09 \quad 6.90E-09 \quad 9.47E-09 \quad 1.24E-08$

$\text{2,4-DINITROTOLUENE: RISK} = (\text{MEDIAN WELL CONCENTRATION IN MG/L} \times 0.059) \times 3.1 \times 10^{15} \times$

$40TH \quad 50TH \quad 60TH \quad 70TH \quad 80TH \quad 90TH \quad 95TH \quad 100TH$   
 $1.72E-07 \quad 2.03E-07 \quad 2.44E-07 \quad 2.64E-07 \quad 3.39E-07 \quad 4.06E-07 \quad 5.57E-07 \quad 7.23E-07$

$\text{ARSENIC: RISK} = (\text{MEDIAN WELL CONCENTRATION IN MG/L} \times 0.059) \times 1.5 \times 10^{15} \times$

$40TH \quad 50TH \quad 60TH \quad 70TH \quad 80TH \quad 90TH \quad 95TH \quad 100TH$   
 $2.44E-07 \quad 2.64E-07 \quad 3.39E-07 \quad 4.06E-07 \quad 5.57E-07 \quad 7.23E-07$

$\text{NITRATES: HAZARD} = (\text{MEDIAN WELL CONCENTRATION IN MG/L} \times 0.059) / 1.0 \times 10^{15} \times$

$40TH \quad 50TH \quad 60TH \quad 70TH \quad 80TH \quad 90TH \quad 95TH \quad 100TH$   
 $0.00E+00 \quad 0.00E+00 \quad 5.50E-08$

$\text{MEDIAN AGGREGATE CHART INDOGEN RISK TO MAN - CATEGORY 3}$

$\text{AGGREGATE RISK} = \text{SUM OF RISKS FROM THE FOLLOWING CONSTITUENTS:}$

$\text{CHLORIDIC ACID, BENZENE, CHLOROURENE, TRICHLOROETHANE, 2,4-DINITROTOLUENE}$   
 $\text{PERCENTILE: 10TH} \quad 2.91E-08 \quad 1.03E-05 \quad 1.44E-05 \quad 1.57E-05 \quad 1.74E-05 \quad 2.01E-05 \quad 2.31E-05 \quad 4.32E-05$   
 $\text{RISK: } 1.0E-08 \quad 2.91E-08 \quad 1.03E-05 \quad 1.44E-05 \quad 1.57E-05 \quad 1.74E-05 \quad 2.01E-05 \quad 2.31E-05 \quad 4.32E-05$

MEDIAN RISK, OR HAZARD TO MEI IN UNITARY 4

CHLORFORM: RISK = (MEDIAN ME-1 CONCENTRATION IN MG/L X 0.023) X 0.1 X 10<sup>-4</sup>  
N = 500  
PERCENTILE: 100%  
RISK: 1.73E-008 1.73E-008 2.20E-008 2.20E-008 2.45E-008 2.45E-008 2.80E-008 2.80E-008 3.14E-008 3.14E-008 3.63E-008 3.63E-008 4.35E-008 4.35E-008 6.16E-008 6.16E-008 9.03E-008 9.03E-008

HEPTENE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.023) X 5.2 X 10<sup>-2</sup>  
N = 500  
PERCENTILE: 100%  
RISK: 1.14E-007 1.14E-007 1.20E-007 1.20E-007 1.26E-007 1.26E-007 1.39E-007 1.39E-007 1.59E-007 1.59E-007 4.16E-007 4.16E-007 5.85E-007 5.85E-007 8.15E-007 8.15E-007 1.15E-007 1.15E-007

HEXACHLOROBENZENE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.023) X 1.69  
N = 500  
PERCENTILE: 100%  
RISK: 7.53E-006 8.66E-006 9.45E-006 1.07E-005 1.17E-005 1.35E-005 1.53E-005 1.70E-005 1.90E-005 1.90E-005 2.65E-005 3.07E-005 3.07E-005 3.07E-005 3.07E-005 3.07E-005 3.07E-005 3.07E-005 3.07E-005

TETRACHLOROETHANE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.023) X 5.1 X 10<sup>-2</sup>  
N = 500  
PERCENTILE: 100%  
RISK: 1.61E-009 2.61E-009 3.21E-009 3.52E-009 3.85E-009 4.08E-009 4.78E-009 5.78E-009 6.00E-009 6.17E-009

C, 4-DINITRODOLUENE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.023) X 3.1 X 10<sup>-1</sup>  
N = 500  
PERCENTILE: 100%  
RISK: 1.67E-008 3.18E-008 3.47E-008 3.91E-008 4.28E-008 4.56E-008 5.08E-008 5.61E-008 6.37E-008 6.97E-008 9.73E-008 1.42E-008

ARSENIC: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.023) X 1.5 X 10<sup>-1</sup>  
N = 500  
PERCENTILE: 100%  
RISK: 1.29E-007 1.54E-007 1.66E-007 1.85E-007 2.05E+000 2.25E+000 2.45E+000 2.65E+000 2.85E+000 3.05E+000 3.37E-007 4.70E-007 6.87E-007

NITRATE: HAZARD = (MEDIAN WELL CONCENTRATION IN MG/L X 0.023) / 1.0 X 10<sup>-1</sup>  
N = 500  
PERCENTILE: 100%  
RISK: 2.10E+000 2.10E+000

MEDIAN AGGREGATE CARCINOGEN RISK TO MEI - CATEGORY 4  
AGGREGATE RISK = SUM OF RISKS FROM THE FOLLOWING CONSTITUENTS:  
Chloroform, Benzene, n-hexylbenzene, 1,4-dinitrobenzene.  
N = 500  
PERCENTILE: 100%  
RISK: 7.12E-006 9.14E-006 9.37E-006 1.15E-005 1.23E-005 1.42E-005 1.67E-005 1.83E-005 2.00E-005 2.17E-005 2.34E-005 2.51E-005 2.68E-005 2.85E-005 3.02E-005 3.19E-005 3.36E-005 3.53E-005 3.70E-005

## ANALYSIS OF THE RISKS IN THE ENVIRONMENT

N = 5000  
ΣΕΧΤΙΚΟ ΣΗΜΕΙΟ: 1.011  
ΡΙΣΚΟΥ: 2.0E-05 3.7E-05 4.14E-05 4.6E-06 5.0E-06 5.7E-06 3.51E-06

N = 5000  
ΣΕΧΤΙΚΟ ΣΗΜΕΙΟ: 1.011  
ΡΙΣΚΟΥ: 4.0E-07 5.0E-07 5.6E-07 6.2E-07 6.9E-07 7.75E-07 9.20E-07 1.00E-06

N = 5000  
ΣΕΧΤΙΚΟ ΣΗΜΕΙΟ: 1.011  
ΡΙΣΚΟΥ: 4.0E-07 4.6E-05 1.6E-05 1.4E-05 1.8E-05 2.0E-05 2.25E-05 2.5E-05 3.50E-05 4.00E-05

N = 5000  
ΣΕΧΤΙΚΟ ΣΗΜΕΙΟ: 1.011  
ΡΙΣΚΟΥ: 3.5E-03 4.0E-03 4.30E-03 4.40E-03 5.45E-03 6.13E-03 6.80E-03 7.60E-03 9.00E-03 1.00E-02

N = 5000  
ΣΕΧΤΙΚΟ ΣΗΜΕΙΟ: 1.011  
ΡΙΣΚΟΥ: 4.0E-08 5.34E-08 6.66E-08 7.46E-08 8.27E-08 9.24E-08 1.10E-07 1.28E-07 1.47E-07 1.67E-07

N = 5000  
ΣΕΧΤΙΚΟ ΣΗΜΕΙΟ: 1.011  
ΡΙΣΚΟΥ: 2.5E-07 2.0E-07 3.23E-07 3.61E-07 4.00E-07 4.47E-07 5.31E-07 6.21E-07 7.10E-07 1.00E-01

N = 5000  
ΣΕΧΤΙΚΟ ΣΗΜΕΙΟ: 1.011  
ΡΙΣΚΟΥ: 2.0E+00 2.0E+00 2.0E+00 2.0E+00 2.0E+00 2.0E+00 2.0E+00 2.0E+00 2.0E+00 1.20E-11

MEDIAN AGGREGATE CHLORINE RISK TO MR. I - CATEGORY 5  
AGGREGATE RISK = SUM OF RISKS FROM THE FOLLOWING CONSTITUENTS:  
CHLOROFORM, BENZENE, HEXACHLOROBENZENE, TETRACHLOROBENZENE, 2,4-DINITROTOLUENE

N = 5000  
ΣΕΧΤΙΚΟ ΣΗΜΕΙΟ: 1.011  
ΡΙΣΚΟΥ: 1.54E-05 1.71E-05 1.96E-05 2.11E-05 2.36E-05 2.66E-05 3.15E-05 4.00E-05 1.00E-05

WELL IN CHLORINE

CHLORINE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 0.1 X 10E-2

N = 492	PERCENTILE: 10TH	20TH	30TH	40TH	50TH	60TH	70TH	80TH	90TH	100TH
RISK:	2.3E-06	4.0E-06	5.3E-06	6.6E-06	7.6E-06	8.2E-06	8.9E-06	9.4E-06	9.6E-06	9.8E-06

PERCENTILE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 5.2 X 10E-2

N = 492	PERCENTILE: 10TH	20TH	30TH	40TH	50TH	60TH	70TH	80TH	90TH	100TH
RISK:	7.05E-07	9.59E-07	1.08E-06	1.14E-06	1.15E-06	1.24E-06	1.28E-06	1.30E-06	1.34E-06	1.41E-06

PERCENTILE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 1.69

N = 492	PERCENTILE: 10TH	20TH	30TH	40TH	50TH	60TH	70TH	80TH	90TH	100TH
RISK:	2.9E-05	3.12E-05	3.52E-05	3.72E-05	3.88E-05	4.03E-05	4.15E-05	4.23E-05	4.35E-05	4.59E-05

PERCENTILE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 5.1 X 10E-2

N = 492	PERCENTILE: 10TH	20TH	30TH	40TH	50TH	60TH	70TH	80TH	90TH	100TH
RISK:	3.9E-07	4.06E-07	1.066E-06	1.12E-06	1.17E-06	1.21E-06	1.25E-06	1.28E-06	1.31E-06	1.38E-06

PERCENTILE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 3.1 X 10E-1

N = 492	PERCENTILE: 10TH	20TH	30TH	40TH	50TH	60TH	70TH	80TH	90TH	100TH
RISK:	6.40E-03	1.14E-02	1.29E-02	1.36E-02	1.42E-02	1.48E-02	1.54E-02	1.55E-02	1.60E-02	1.65E-02

PERCENTILE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 1.5 X 10E-1

N = 492	PERCENTILE: 10TH	20TH	30TH	40TH	50TH	60TH	70TH	80TH	90TH	100TH
RISK:	4.07E-07	5.53E-07	6.25E-07	6.60E-07	6.83E-07	7.14E-07	7.37E-07	7.52E-07	7.73E-07	8.14E-07

PERCENTILE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 1.0 X 10E-1

N = 492	PERCENTILE: 10TH	20TH	30TH	40TH	50TH	60TH	70TH	80TH	90TH	100TH
RISK:	2.04E+00	2.04E+00	2.04E+00	2.04E+00	2.04E+00	2.04E+00	2.04E+00	2.04E+00	2.04E+00	2.04E+00

MEDIAN AGGREGATE CARCINOGEN RISK TO MEI - CATEGORY 6

AGGREGATE RISK = SUM OF RISKS FROM THE FOLLOWING CONSTITUENTS: CHLOROFORM, BENZENE, CHLOROCHLOROBENZENE, TETRACHLOROETHANE.

N = 493	PERCENTILE: 10TH	20TH	30TH	40TH	50TH	60TH	70TH	80TH	90TH	100TH
RISK:	1.41E-05	2.0E-05	3.71E-05	5.92E-05	9.3E-05	1.24E-05	1.58E-05	1.92E-05	2.46E-05	3.0E-05

MEDIAN RISK OF HAZARD TO M.L IN CATEGORY 7

N = 497 PERCENTILE: 10TH RISK:	1.1E-06 3.77E-08 4.93E-08 6.11E-08 6.76E-08 7.34E-08 8.01E-08 8.55E-08 9.32E-08 1.03E-07	20TH 30TH 40TH 50TH 60TH 70TH 80TH 90TH 95TH 100TH	2.1E-06 3.1E-08 4.2E-08 5.3E-08 6.4E-08 7.5E-08 8.6E-08 9.7E-08 1.08E-08 1.19E-08	1.0E-06 1.4E-08 1.8E-08 2.2E-08 2.6E-08 3.0E-08 3.4E-08 3.8E-08 4.2E-08 4.6E-08	1.0E-06 1.4E-08 1.8E-08 2.2E-08 2.6E-08 3.0E-08 3.4E-08 3.8E-08 4.2E-08 4.6E-08
N = 497 PERCENTILE: 10TH RISK:	1.01H 3.72E-07 9.72E-07	20TH 30TH 40TH 50TH 60TH 70TH 80TH 90TH 95TH 100TH	2.01H 3.01H 4.01H 5.01H 6.01H 7.01H 8.01H 9.01H 9.51H 1001H	1.01H 1.43E-06 1.83E-06 2.11E-06 2.39E-06 2.67E-06 2.95E-06 3.23E-06 3.51E-06 3.79E-06	1.01H 1.43E-06 1.83E-06 2.11E-06 2.39E-06 2.67E-06 2.95E-06 3.23E-06 3.51E-06 3.79E-06
N = 497 PERCENTILE: 10TH RISK:	1.01H 3.16E-05 9.53E-09	20TH 30TH 40TH 50TH 60TH 70TH 80TH 90TH 95TH 100TH	2.01H 3.01H 4.01H 5.01H 6.01H 7.01H 8.01H 9.01H 9.51H 1001H	1.01H 1.08E-05 3.35E-05 3.51E-05 3.66E-05 3.80E-05 3.91E-05 3.98E-05 4.05E-05 4.12E-05	1.01H 1.43E-06 1.83E-06 2.11E-06 2.39E-06 2.67E-06 2.95E-06 3.23E-06 3.51E-06 3.79E-06
N = 497 PERCENTILE: 10TH RISK:	1.01H 8.48E-09	20TH 30TH 40TH 50TH 60TH 70TH 80TH 90TH 95TH 100TH	2.01H 3.01H 4.01H 5.01H 6.01H 7.01H 8.01H 9.01H 9.51H 1001H	1.01H 1.01E-08 1.06E-08 1.11E-08 1.16E-08 1.21E-08 1.26E-08 1.31E-08 1.36E-08 1.41E-08	1.01H 1.43E-06 1.83E-06 2.11E-06 2.39E-06 2.67E-06 2.95E-06 3.23E-06 3.51E-06 3.79E-06
N = 497 PERCENTILE: 10TH RISK:	1.01H 5.61E-07	20TH 30TH 40TH 50TH 60TH 70TH 80TH 90TH 95TH 100TH	2.01H 3.01H 4.01H 5.01H 6.01H 7.01H 8.01H 9.01H 9.51H 1001H	1.01H 1.16E-07 1.23E-07 1.29E-07 1.34E-07 1.39E-07 1.44E-07 1.49E-07 1.54E-07 1.59E-07	1.01H 1.43E-06 1.83E-06 2.11E-06 2.39E-06 2.67E-06 2.95E-06 3.23E-06 3.51E-06 3.79E-06
N = 497 PERCENTILE: 10TH RISK:	1.01H 4.99E-07	20TH 30TH 40TH 50TH 60TH 70TH 80TH 90TH 95TH 100TH	2.01H 3.01H 4.01H 5.01H 6.01H 7.01H 8.01H 9.01H 9.51H 1001H	1.01H 1.03E-07 5.95E-07 6.24E-07 6.53E-07 6.82E-07 6.93E-07 6.98E-07 7.03E-07 7.08E-07	1.01H 1.43E-06 1.83E-06 2.11E-06 2.39E-06 2.67E-06 2.95E-06 3.23E-06 3.51E-06 3.79E-06
N = 497 PERCENTILE: 10TH RISK:	1.01H 3.35E-05	20TH 30TH 40TH 50TH 60TH 70TH 80TH 90TH 95TH 100TH	2.01H 3.01H 4.01H 5.01H 6.01H 7.01H 8.01H 9.01H 9.51H 1001H	1.01H 1.30E+00 2.00E+00 2.70E+00 3.40E+00 4.10E+00 4.80E+00 5.50E+00 6.20E+00 6.90E+00	1.01H 1.43E-05 4.00E-05 4.13E-05 4.27E-05 4.44E-05 4.71E-05

MEDIAN AGGREGATE EXPOSURE RISKS TO M.L - CATEGORY 7  
 AGGREGATE RISK = SUM OF RISKS FROM THE FOLLOWING CONSTITUENTS:  
 CHLOROFORM, BENZENE, TETRACHLOROETHANE, TETRACHLOROUREA, 2,4-DINITROTOLUENE

N = 497 PERCENTILE: 10TH RISK:	1.01H 3.35E-05	20TH 30TH 40TH 50TH 60TH 70TH 80TH 90TH 95TH 100TH	2.01H 3.01H 4.01H 5.01H 6.01H 7.01H 8.01H 9.01H 9.51H 1001H	1.01H 1.43E-05 4.00E-05 4.13E-05 4.27E-05 4.44E-05 4.71E-05
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RISK, IN RISKS, OF HAZARD IN CHLORINE

$\text{RISK}_{\text{CHLORINE}} = (\text{MEDIAN WELL CONCENTRATION IN } \mu\text{g/L} \times 0.001) \times 5.1 \times 10^{-2}$

N = 500	PERCENTILE: 10TH	20TH	30TH	40TH	50TH	60TH	70TH	80TH	90TH	95TH
RISK:	3.05E-06	4.73E-06	5.56E-06	6.39E-06	7.27E-06	8.15E-06	9.04E-06	9.93E-06	1.08E-05	1.17E-05

$\text{RISK}_{\text{BENZENE}} = (\text{MEDIAN WELL CONCENTRATION IN } \mu\text{g/L} \times 0.001) \times 5.2 \times 10^{-2}$

N = 500	PERCENTILE: 10TH	20TH	30TH	40TH	50TH	60TH	70TH	80TH	90TH	95TH
RISK:	3.76E-07	5.23E-07	6.73E-07	7.45E-07	8.47E-07	9.57E-07	1.04E-06	1.11E-06	1.17E-06	1.25E-06

$\text{RISK}_{\text{HEXACHLOROBENZENE}} = (\text{MEDIAN WELL CONCENTRATION IN } \mu\text{g/L} \times 0.001) \times 5.3 \times 10^{-2}$

N = 500	PERCENTILE: 10TH	20TH	30TH	40TH	50TH	60TH	70TH	80TH	90TH	95TH
RISK:	1.03E-05	1.69E-05	2.03E-05	2.42E-05	2.75E-05	3.11E-05	3.39E-05	3.61E-05	3.79E-05	4.06E-05

$\text{RISK}_{\text{TETRACHLOROETHANE}} = (\text{MEDIAN WELL CONCENTRATION IN } \mu\text{g/L} \times 0.001) \times 5.1 \times 10^{-2}$

N = 500	PERCENTILE: 10TH	20TH	30TH	40TH	50TH	60TH	70TH	80TH	90TH	95TH
RISK:	3.10E-07	5.11E-07	6.11E-07	7.30E-07	8.31E-07	9.33E-07	1.03E-06	1.09E-06	1.14E-06	1.23E-06

$\text{RISK}_{\text{2,4-DINITROTOLUENE}} = (\text{MEDIAN WELL CONCENTRATION IN } \mu\text{g/L} \times 0.001) \times 5.1 \times 10^{-1}$

N = 500	PERCENTILE: 10TH	20TH	30TH	40TH	50TH	60TH	70TH	80TH	90TH	95TH
RISK:	4.46E-08	6.20E-08	7.43E-08	8.68E-08	1.01E-07	1.14E-07	1.24E-07	1.32E-07	1.39E-07	1.49E-07

$\text{RISK}_{\text{ARSENIC}} = (\text{MEDIAN WELL CONCENTRATION IN } \mu\text{g/L} \times 0.001) \times 1.5 \times 10^{-1}$

N = 500	PERCENTILE: 10TH	20TH	30TH	40TH	50TH	60TH	70TH	80TH	90TH	95TH
RISK:	2.17E-07	3.00E-07	3.60E-07	4.30E-07	4.89E-07	5.52E-07	6.01E-07	6.40E-07	6.73E-07	7.21E-07

$\text{RISK}_{\text{NITRATE}} = (\text{MEDIAN WELL CONCENTRATION IN } \mu\text{g/L} \times 0.001) / 1.0 \times 10^{-1}$

N = 500	PERCENTILE: 10TH	20TH	30TH	40TH	50TH	60TH	70TH	80TH	90TH	95TH
RISK:	1.76E-05	2.14E-05	2.55E-05	2.90E-05	3.26E-05	3.57E-05	3.88E-05	4.19E-05	4.49E-05	4.79E-05

MEDIAN AGGREGATE CHLORINE RISK TO MEI - CATEGORY B  
AGGREGATE RISK = SUM OF RISKS FROM THE FOLLOWING CONSTITUENTS:

$\text{RISK}_{\text{CHLORINE, BENZENE, TETRACHLOROBENZENE, T-TRICHLOROETHANE, 2,4-DINITROTOLUENE}}$

N = 500	PERCENTILE: 10TH	20TH	30TH	40TH	50TH	60TH	70TH	80TH	90TH	95TH
RISK:	1.73E-05	1.76E-05	2.14E-05	2.55E-05	2.90E-05	3.26E-05	3.57E-05	3.88E-05	4.19E-05	4.49E-05

## η DÍTAN RISK ÓF HAZARD IN THE WATER SUPPLY

CALCULATION: RISK = MEDIAN WELL CONCENTRATION IN µg/L X Q.029 X 8.1 X 10E-2									
<b>N = 500</b>									
PERCENTILE: 10%:	1011.	ΣΩΤΗ	4ΩΤΗ	5ΩΤΗ	6ΩΤΗ	7ΩΤΗ	8ΩΤΗ	9ΩΤΗ	1ΩΩΤΗ
RISK:	4.13E-03	5.73E-03	6.52E-03	7.04E-03	7.45E-03	7.87E-03	8.23E-03	8.67E-03	9.23E-03
<b>N = 5000</b>									
PERCENTILE: 10%:	1011.	ΣΩΤΗ	4ΩΤΗ	5ΩΤΗ	6ΩΤΗ	7ΩΤΗ	8ΩΤΗ	9ΩΤΗ	1ΩΩΤΗ
RISK:	0.07E-07	9.56E-07	1.03E-06	1.07E-06	1.11E-06	1.15E-06	1.19E-06	1.24E-06	1.34E-06
<b>HEXACHLOROBENZENE: RISK = MEDIAN WELL CONCENTRATION IN µg/L X Q.029 X 5.2 X 10E-2</b>									
N = 500	ΣΩΤΗ								
PERCENTILE: 10%:	1011.	ΣΩΤΗ	4ΩΤΗ	5ΩΤΗ	6ΩΤΗ	7ΩΤΗ	8ΩΤΗ	9ΩΤΗ	1ΩΩΤΗ
RISK:	2.05E-05	3.10E-05	3.24E-05	3.36E-05	3.43E-05	3.61E-05	3.73E-05	3.87E-05	4.02E-05
<b>HEXAACHLOROBENZENE: RISK = MEDIAN WELL CONCENTRATION IN µg/L X Q.029 X 1.69</b>									
N = 5000	ΣΩΤΗ								
PERCENTILE: 10%:	1011.	ΣΩΤΗ	4ΩΤΗ	5ΩΤΗ	6ΩΤΗ	7ΩΤΗ	8ΩΤΗ	9ΩΤΗ	1ΩΩΤΗ
RISK:	0.06E-07	9.26E-07	9.56E-07	9.86E-07	1.03E-06	1.07E-06	1.11E-06	1.15E-06	1.19E-06
<b>TETRACHLOROETHANE: RISK = MEDIAN WELL CONCENTRATION IN µg/L X Q.029 X 5.1 X 10E-2</b>									
N = 500	ΣΩΤΗ								
PERCENTILE: 10%:	1011.	ΣΩΤΗ	4ΩΤΗ	5ΩΤΗ	6ΩΤΗ	7ΩΤΗ	8ΩΤΗ	9ΩΤΗ	1ΩΩΤΗ
RISK:	8.72E-03	9.26E-03	9.77E-03	1.02E-02	1.05E-02	1.09E-02	1.13E-02	1.17E-02	1.21E-02
<b>2,4-DINITROTOLUENE: RISK = MEDIAN WELL CONCENTRATION IN µg/L X Q.029 X 3.1 X 10E-1</b>									
N = 5000	ΣΩΤΗ								
PERCENTILE: 10%:	1011.	ΣΩΤΗ	4ΩΤΗ	5ΩΤΗ	6ΩΤΗ	7ΩΤΗ	8ΩΤΗ	9ΩΤΗ	1ΩΩΤΗ
RISK:	1.10E-07	1.14E-07	1.19E-07	1.23E-07	1.28E-07	1.33E-07	1.37E-07	1.42E-07	1.47E-07
<b>NITRALE: RAZARD = MEDIAN WELL CONCENTRATION IN µg/L X Q.029 X 1.5 X 10E-1</b>									
N = 5000	ΣΩΤΗ								
PERCENTILE: 10%:	1011.	ΣΩΤΗ	4ΩΤΗ	5ΩΤΗ	6ΩΤΗ	7ΩΤΗ	8ΩΤΗ	9ΩΤΗ	1ΩΩΤΗ
RISK:	0.11E-07	0.12E-07	0.13E-07	0.14E-07	0.15E-07	0.16E-07	0.17E-07	0.18E-07	0.19E-07
<b>CHLORFORM: RAZARD = SUM OF RISKS FROM THE FOLLOWING CONSTITUENTS:</b>									
N = 5000	ΣΩΤΗ								
PERCENTILE: 10%:	1011.	ΣΩΤΗ	4ΩΤΗ	5ΩΤΗ	6ΩΤΗ	7ΩΤΗ	8ΩΤΗ	9ΩΤΗ	1ΩΩΤΗ
RISK:	3.04E-05	3.27E-05	3.41E-05	3.54E-05	3.68E-05	3.82E-05	3.95E-05	4.08E-05	4.24E-05

MEDIAN ADDITIVE CHLORINE RISK TO MITI - CATEGORY 9

AGGREGATE RISK = SUM OF RISKS FROM THE FOLLOWING CONSTITUENTS:  
CHLORFORM, B. NITRENE, Σ-ACETOCHLOROETHANE, T. TRICHLOROETHANE, Σ-4-DINITROTOLUENE

N = 5000	ΣΩΤΗ	ΣΩΤΗ	ΣΩΤΗ	ΣΩΤΗ	ΣΩΤΗ	ΣΩΤΗ	ΣΩΤΗ	ΣΩΤΗ	ΣΩΤΗ
PERCENTILE: 10%:	1011.	ΣΩΤΗ	4ΩΤΗ	5ΩΤΗ	6ΩΤΗ	7ΩΤΗ	8ΩΤΗ	9ΩΤΗ	1ΩΩΤΗ

$N = 1000$   
 $\text{PERCENTILE: } 1.0E-01$   
 $\text{RISK: } 3.9E-05$

$N = 5000$   
 $\text{PERCENTILE: } 1.0E-01$   
 $\text{RISK: } 3.6E-06$

$N = 5000$   
 $\text{PERCENTILE: } 1.0E-04$   
 $\text{RISK: } 5.2E-06$

$N = 5000$   
 $\text{PERCENTILE: } 1.0E-05$   
 $\text{RISK: } 1.0E-05$

$N = 5000$   
 $\text{PERCENTILE: } 1.0E-05$   
 $\text{RISK: } 6.3E-06$

$N = 5000$   
 $\text{PERCENTILE: } 1.0E-04$   
 $\text{RISK: } 6.3E-06$

$N = 5000$   
 $\text{PERCENTILE: } 1.0E-05$   
 $\text{RISK: } 7.0E-06$

$N = 5000$   
 $\text{PERCENTILE: } 1.0E-05$   
 $\text{RISK: } 7.0E-06$

$N = 5000$   
 $\text{PERCENTILE: } 1.0E-04$   
 $\text{RISK: } 7.0E-06$

$N = 5000$   
 $\text{PERCENTILE: } 1.0E-05$   
 $\text{RISK: } 7.0E-06$

L - OBLIGATION: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X Q. Q25) X 0.1 X 10E-02  
 $3.9E-05 \quad 3.0E-01 \quad 4.0E-01 \quad 5.0E-01 \quad 6.0E-01 \quad 7.0E-01 \quad 8.0E-01 \quad 9.0E-01 \quad 1.0E-01$

PERCENTILE: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X Q. Q25) X 0.2 X 10E-02  
 $3.6E-06 \quad 5.2E-01 \quad 6.1E-01 \quad 6.5E-01 \quad 6.9E-01 \quad 7.3E-01 \quad 7.7E-01 \quad 8.1E-01 \quad 8.5E-01$

PERCENTILE: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X Q. Q25) X 0.3 X 10E-02  
 $5.2E-06 \quad 4.0E-01 \quad 5.0E-01 \quad 5.5E-01 \quad 6.0E-01 \quad 6.5E-01 \quad 7.0E-01 \quad 7.5E-01 \quad 8.0E-01$

PERCENTILE: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X Q. Q25) X 0.4 X 10E-02  
 $1.0E-05 \quad 1.0E-01 \quad 1.4E-01 \quad 1.8E-01 \quad 2.2E-01 \quad 2.6E-01 \quad 3.0E-01 \quad 3.4E-01 \quad 3.8E-01$

PERCENTILE: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X Q. Q25) X 0.5 X 10E-02  
 $6.3E-06 \quad 2.0E-01 \quad 2.4E-01 \quad 2.8E-01 \quad 3.2E-01 \quad 3.6E-01 \quad 4.0E-01 \quad 4.4E-01 \quad 4.8E-01$

PERCENTILE: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X Q. Q25) X 0.6 X 10E-02  
 $7.0E-06 \quad 2.4E-01 \quad 2.8E-01 \quad 3.2E-01 \quad 3.6E-01 \quad 4.0E-01 \quad 4.4E-01 \quad 4.8E-01 \quad 5.2E-01$

PERCENTILE: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X Q. Q25) X 0.7 X 10E-02  
 $7.0E-06 \quad 2.4E-01 \quad 2.8E-01 \quad 3.2E-01 \quad 3.6E-01 \quad 4.0E-01 \quad 4.4E-01 \quad 4.8E-01 \quad 5.2E-01$

PERCENTILE: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X Q. Q25) X 0.8 X 10E-02  
 $7.0E-06 \quad 2.4E-01 \quad 2.8E-01 \quad 3.2E-01 \quad 3.6E-01 \quad 4.0E-01 \quad 4.4E-01 \quad 4.8E-01 \quad 5.2E-01$

PERCENTILE: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X Q. Q25) X 0.9 X 10E-02  
 $7.0E-06 \quad 2.4E-01 \quad 2.8E-01 \quad 3.2E-01 \quad 3.6E-01 \quad 4.0E-01 \quad 4.4E-01 \quad 4.8E-01 \quad 5.2E-01$

PERCENTILE: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X Q. Q25) X 1.0 X 10E-02  
 $7.0E-06 \quad 2.4E-01 \quad 2.8E-01 \quad 3.2E-01 \quad 3.6E-01 \quad 4.0E-01 \quad 4.4E-01 \quad 4.8E-01 \quad 5.2E-01$

## MAXIMUM RISK DUE TO ZINC IN THE MUD IN THE ENVIRONMENT

**N = 5000**  
**PERCENTILE: 100.000**  
**RISK: 7.83E-05 3.01E-04 1.05E-04 1.31E-04 1.61E-04 1.83E-04**

**N = 50000**  
**PERCENTILE: 100.000**  
**RISK: 5.77E-06 2.16E-06 8.16E-06 9.40E-06 1.06E-05 1.23E-05 1.33E-05 1.41E-05 1.51E-05**

**N = 500000**  
**PERCENTILE: 100.000**  
**RISK: 3.45E-04 1.37E-04 6.60E-04 7.83E-04 8.97E-04 1.00E-03 1.16E-03 1.26E-03 1.34E-03 1.43E-03**

**N = 5000000**  
**PERCENTILE: 100.000**  
**RISK: 1.53E-05 1.93E-05 2.29E-05 2.66E-05 3.00E-05 3.40E-05 3.84E-05 3.68E-05 3.91E-05 4.19E-05**

**N = 50000000**  
**PERCENTILE: 100.000**  
**RISK: 1.07E-04 1.33E-04 1.61E-04 1.91E-04 2.39E-05 2.70E-05 3.19E-05 3.50E-05 3.84E-05 4.37E-05**

**N = 500000000**  
**PERCENTILE: 100.000**  
**RISK: 1.34E-05 1.66E-05 1.98E-05 2.30E-05 2.62E-05 3.04E-05 3.45E-05 3.85E-05 4.26E-05 4.67E-05**

**N = 5000000000**  
**PERCENTILE: 100.000**  
**RISK: 8.20E-06 1.02E-06 1.23E-06 1.43E-06 1.63E-06 1.83E-06 2.03E-06 2.23E-06 2.43E-06 2.63E-06**

**MÁXIMUM RISICO DE CINCO MILÍGRIAS EN EL AGUA DE CONCENTRACIÓN EN MUG/L X Q. Q. E. 99 X 1.0E-02**  
**AGREGADO RISICO = SUMA DE RISCOS PARA LOS FIVE MILLONES DE CONCENTRACIONES:**  
**EN UNIFORME, EN NUEVE, EN EXPONENCIAL, EN UNIFORME, EN UNIFORME, EN UNIFORME.**  
**N = 5000000000**  
**PERCENTILE: 100.000**  
**RISK: 7.83E-04 3.01E-04 1.05E-04 1.31E-04 1.61E-04 1.83E-04**

**MÁXIMUM RISICO DE CINCO MILÍGRIAS EN EL AGUA DE CONCENTRACIÓN EN MUG/L X Q. Q. E. 99 X 1.0E-01**

**AGREGADO RISICO = SUMA DE RISCOS PARA LOS FIVE MILLONES DE CONCENTRACIONES:**

**EN UNIFORME, EN NUEVE, EN EXPONENCIAL, EN UNIFORME, EN UNIFORME, EN UNIFORME.**

## MÄXIMUM RISIK UND MAXIMUM WELL DÜNNENFRÄTUN IN MÖ/L X Ø. ØEØ X H. J. A. K. -

N = 500  
PERCENTILE: 10TH 20TH 30TH 40TH 50TH 60TH 70TH 80TH 90TH  
RISK: 3.84E-05 4.45E-05 5.05E-05 5.65E-05 6.25E-05 6.85E-05 7.45E-05 8.05E-05 8.65E-05

N = 500  
PERCENTILE: 10TH 20TH 30TH 40TH 50TH 60TH 70TH 80TH 90TH  
RISK: 3.26E-06 3.87E-06 4.48E-06 5.09E-06 5.69E-06 6.29E-06 6.89E-06 7.49E-06 8.09E-06

N = 500  
PERCENTILE: 10TH 20TH 30TH 40TH 50TH 60TH 70TH 80TH 90TH  
RISK: 3.10E-04 3.65E-04 4.05E-04 4.35E-04 4.77E-04 5.25E-04 5.75E-04 6.25E-04 6.75E-04

N = 500  
PERCENTILE: 10TH 20TH 30TH 40TH 50TH 60TH 70TH 80TH 90TH  
RISK: 9.47E-05 1.07E-05 1.18E-05 1.29E-05 1.39E-05 1.54E-05 1.69E-05 1.84E-05 1.99E-05

N = 500  
PERCENTILE: 10TH 20TH 30TH 40TH 50TH 60TH 70TH 80TH 90TH  
RISK: 7.57E-05 8.95E-05 9.85E-05 1.07E-04 1.16E-04 1.25E-04 1.35E-04 1.45E-04 1.55E-04

N = 500  
PERCENTILE: 10TH 20TH 30TH 40TH 50TH 60TH 70TH 80TH 90TH  
RISK: 9.46E-06 1.12E-05 1.23E-05 1.34E-05 1.45E-05 1.61E-05 1.87E-05 2.13E-05 2.49E-05

N = 500  
PERCENTILE: 10TH 20TH 30TH 40TH 50TH 60TH 70TH 80TH 90TH  
RISK: 2.08E+00 2.10E+00 2.12E+00 2.14E+00 2.16E+00 2.18E+00 2.20E+00 2.22E+00 2.24E+00

N = 500  
PERCENTILE: 10TH 20TH 30TH 40TH 50TH 60TH 70TH 80TH 90TH  
RISK: 4.47E-04 5.01E-04 5.55E-04 6.09E-04 6.63E-04 7.17E-04 7.71E-04 8.25E-04 8.79E-04

N = 500  
PERCENTILE: 10TH 20TH 30TH 40TH 50TH 60TH 70TH 80TH 90TH  
RISK: 1.01E-04 1.02E-04 1.03E-04 1.04E-04 1.05E-04 1.06E-04 1.07E-04 1.08E-04 1.09E-04

1.  $\text{H}_2\text{O}$  +  $\text{Na}_2\text{S}_2\text{O}_3$   $\rightarrow$   $\text{Na}_2\text{SO}_4$  +  $\text{H}_2\text{S}$   
 $\text{H}_2\text{S} + \text{CuSO}_4 \rightarrow \text{CuS} + \text{H}_2\text{SO}_4$

DEFINITION: RISER = MAXIMUM WELL CIRCUMFERENCE IN MILLS X 0.0254 X 10<sup>-3</sup>

**MAXIMUM RISK:** RISK = (MAXIMUM WEI. CONCENTRATION IN MG/L X 0.009) X 1.69

CH <sub>4</sub> CONCENTRATION (PPM)	CH <sub>4</sub> EMISSIONS (G/HA)	CH <sub>4</sub> EMISSIONS (%)	CH <sub>4</sub> EMISSIONS (G/HA)	CH <sub>4</sub> EMISSIONS (%)
1000	1000	1000	1000	1000
1000	1000	1000	1000	1000
1000	1000	1000	1000	1000
1000	1000	1000	1000	1000

*2.4. Dose-response: FIGE = (MAXIMUM WELL CONCENTRATION IN MG/L X % DEG) X 2.1 X 10<sup>-4</sup>*

4. *Geometric function theory* = *Geometrische Funktionentheorie* = *Geometrische Funktionentheorie* = *Geometrische Funktionentheorie*

وَالْمُؤْمِنُونَ هُمُ الْأَوَّلُونَ مَنْ يَعْمَلُ مِنْ حَسَنَاتِهِ فَلَا يُؤْتَهُ إِنْ يَعْلَمُ

وَالْمُؤْمِنُونَ الْمُؤْمِنُونَ الْمُؤْمِنُونَ الْمُؤْمِنُونَ الْمُؤْمِنُونَ

1.  $\frac{d}{dt} \ln \rho = \frac{1}{\rho} \frac{d\rho}{dt}$   
2.  $\frac{d}{dt} \ln \rho = \frac{1}{\rho} \frac{d\rho}{dt} = \frac{1}{\rho} \frac{d}{dt} (\rho^2) = \frac{2}{\rho} \frac{d\rho}{dt}$

## MÍXJAHUM RÍSKUR ÓF MÍXJAHUM TÚ MEL IN VÍTÍSÚRY

N = 500  
PERCENTILE: 10TH 2.011 3.011 4.011 5.011 6.011 7.011 8.011 9.011  
RISK: 4.93E-05 5.71E-05 6.38E-05 7.11E-05 8.75E-05 9.71E-05 1.01E-04 1.11E-04 1.21E-04

N = 500  
PERCENTILE: 10TH 2.011 3.011 4.011 5.011 6.011 7.011 8.011 9.011  
RISK: 4.41E-06 4.93E-06 5.46E-06 6.01E-06 6.58E-06 7.11E-06 7.68E-06 8.25E-06 8.82E-06

N = 500  
PERCENTILE: 10TH 2.011 3.011 4.011 5.011 6.011 7.011 8.011 9.011  
RISK: 4.17E-04 4.66E-04 5.23E-04 5.83E-04 6.43E-04 7.03E-04 7.63E-04 8.23E-04 8.83E-04

N = 500  
PERCENTILE: 10TH 2.011 3.011 4.011 5.011 6.011 7.011 8.011 9.011  
RISK: 1.21E-05 1.56E-05 1.92E-05 2.28E-05 2.64E-05 3.01E-05 3.37E-05 3.73E-05 4.09E-05

N = 500  
PERCENTILE: 10TH 2.011 3.011 4.011 5.011 6.011 7.011 8.011 9.011  
RISK: 1.01E-04 1.27E-04 1.43E-04 1.59E-04 1.75E-04 1.91E-04 2.07E-04 2.23E-04 2.39E-04

N = 500  
PERCENTILE: 10TH 2.011 3.011 4.011 5.011 6.011 7.011 8.011 9.011  
RISK: 1.27E-05 1.43E-05 1.59E-05 1.75E-05 1.91E-05 2.07E-05 2.23E-05 2.39E-05 2.55E-05

N = 500  
PERCENTILE: 10TH 2.011 3.011 4.011 5.011 6.011 7.011 8.011 9.011  
RISK: 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00

MÍXJAHUM RÍSKUR = MÍXJAHUM MEL CÍNCENTRÍTUN IN MÍSL X 0.001  
MÍXJAHUM RÍSKUR = SUM ÚF RÍSKS FRUM THÉ FÚL ÜMLING LUNG 1.74E-04  
LÍMI ÚRÚ ÖRT, EINZI NE, RE ÁRHULÖRKHLÍZEN, LÍTRÍCHHLÍZEN, HÍMLI, 0.001 X 0.001  
N = 500  
PERCENTILE: 10TH 2.011 3.011 4.011 5.011 6.011 7.011 8.011 9.011  
RISK: 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00

MÄXIMALER RISIKO UND MAXIMALE FÜR MEL IN CONCENTRATION.

N = 493  
PERCENTILE: 10TH 2.0TH 3.0TH 4.0TH 5.0TH 6.0TH 7.0TH 8.0TH 9.0TH 10TH  
RISK: 4.35E-05 6.37E-05 8.27E-05 1.05E-04 1.16E-04 1.31E-04 1.44E-04 1.54E-04 1.65E-04 1.78E-04

N = 493  
PERCENTILE: 10TH 2.0TH 3.0TH 4.0TH 5.0TH 6.0TH 7.0TH 8.0TH 9.0TH 10TH  
RISK: 7.75E-06 1.05E-05 1.35E-05 1.65E-05 1.95E-05 2.25E-05 2.55E-05 2.85E-05 3.15E-05 3.45E-05

N = 493  
PERCENTILE: 10TH 2.0TH 3.0TH 4.0TH 5.0TH 6.0TH 7.0TH 8.0TH 9.0TH 10TH  
RISK: 9.93E-04 1.33E-04 1.73E-04 2.13E-04 2.53E-04 2.93E-04 3.33E-04 3.73E-04 4.13E-04 4.53E-04

N = 493  
PERCENTILE: 10TH 2.0TH 3.0TH 4.0TH 5.0TH 6.0TH 7.0TH 8.0TH 9.0TH 10TH  
RISK: 1.14E-05 1.33E-05 1.53E-05 1.73E-05 1.93E-05 2.13E-05 2.33E-05 2.53E-05 2.73E-05 2.93E-05

N = 493  
PERCENTILE: 10TH 2.0TH 3.0TH 4.0TH 5.0TH 6.0TH 7.0TH 8.0TH 9.0TH 10TH  
RISK: 1.79E-04 2.43E-04 3.07E-04 3.72E-04 4.37E-04 5.02E-04 5.67E-04 6.32E-04 6.97E-04 7.62E-04

N = 493  
PERCENTILE: 10TH 2.0TH 3.0TH 4.0TH 5.0TH 6.0TH 7.0TH 8.0TH 9.0TH 10TH  
RISK: 2.24E-05 3.04E-05 3.44E-05 3.63E-05 3.73E-05 3.83E-05 3.93E-05 4.03E-05 4.13E-05 4.23E-05

N = 494  
PERCENTILE: 10TH 2.0TH 3.0TH 4.0TH 5.0TH 6.0TH 7.0TH 8.0TH 9.0TH 10TH  
RISK: 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00

MAXIMUM AUSWIRKUNGEN RISIKO TU MEL IN CONCENTRATION.  
AUSWIRKUNG RISIKO = SUMM OF RISKS FROM THE FOLLOWING CONDITIONS. E.G. DUE TO THE VARIOUS  
CHLORINE-URID, BENZENE, MAXIMUM CONCENTRATION, STRACHCLORIDE INHIBITION, ETC.  
N = 493  
PERCENTILE: 10TH 2.0TH 3.0TH 4.0TH 5.0TH 6.0TH 7.0TH 8.0TH 9.0TH 10TH  
RISK: 1.04E-05 1.40E-05 1.55E-05 1.65E-05 1.74E-05 1.84E-05 1.94E-05 2.04E-05 2.14E-05 2.24E-05

MAXIMUM RISIK ÜBERZEUGEND ÜBER MEI IN ERNSTIGER?

N = 497  
PERCENTILE: 10TH  
RISK: 4.11E-05  
  
CITLÜRKÜF ÜBER: RISK = MAXIMUM WELT CONCENTRATION IN µM/L X 0.001 X 0.1 X 1000  
2.01H  
6.43E-05 6.43E-05 6.43E-05 6.43E-05 6.43E-05 6.43E-05 6.43E-05 6.43E-05 6.43E-05 6.43E-05

N = 497  
PERCENTILE: 10TH  
RISK: 9.51E-06  
  
BLNÉNE: RISK = MAXIMUM WELT CONCENTRATION IN µM/L X 0.001 X 0.1 X 1000  
2.01H  
1.07E-05 1.07E-05 1.07E-05 1.07E-05 1.07E-05 1.07E-05 1.07E-05 1.07E-05 1.07E-05 1.07E-05

N = 497  
PERCENTILE: 10TH  
RISK: 6.99E-04  
  
HEXACHLOROBENZENE: RISK = MAXIMUM WELT CONCENTRATION IN µM/L X 0.001 X 0.1 X 1000  
2.01H  
1.01E-03 1.01E-03 1.01E-03 1.01E-03 1.01E-03 1.01E-03 1.01E-03 1.01E-03 1.01E-03 1.01E-03

N = 497  
PERCENTILE: 10TH  
RISK: 2.63E-05  
  
TETRACHLOROETHANE: RISK = MAXIMUM WELT CONCENTRATION IN µM/L X 0.001 X 0.1 X 1000  
2.01H  
2.95E-05 2.95E-05 2.95E-05 2.95E-05 2.95E-05 2.95E-05 2.95E-05 2.95E-05 2.95E-05 2.95E-05

N = 497  
PERCENTILE: 10TH  
RISK: 2.40E-04  
  
2,4-DINITROTOLUENE: RISK = MAXIMUM WELT CONCENTRATION IN µM/L X 0.001 X 0.1 X 1000  
2.01H  
2.43E-04 2.43E-04 2.43E-04 2.43E-04 2.43E-04 2.43E-04 2.43E-04 2.43E-04 2.43E-04 2.43E-04

N = 497  
PERCENTILE: 10TH  
RISK: 2.74E-05  
  
ARSENIC: RISK = MAXIMUM WELT CONCENTRATION IN µM/L X 0.001 X 0.1 X 1000  
2.01H  
2.08E-05 2.08E-05 2.08E-05 2.08E-05 2.08E-05 2.08E-05 2.08E-05 2.08E-05 2.08E-05 2.08E-05

N = 493  
PERCENTILE: 10TH  
RISK: 0.00E+00  
  
NITRATO: NITRATO = MAXIMUM WELT CONCENTRATION IN µM/L X 0.001 X 0.1 X 1000  
2.01H  
0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00

N = 497  
PERCENTILE: 10TH  
RISK: 1.36E-03  
  
MAXIMUM RISIK ÜBERZÜGE LÄHLINGEN RISK TU MEL LÄHLING  
ABGRENZTE RISK = SUMM OF RISKS FROM THE FOLLOWING CONSTITUENTS:  
CITLÜRKÜF, B-KATINE, HEXAHLOROBENZENE, TETRAHALOCHLOROBENZENE, C-4 DINITROTOLUENE,  
1.36E-03 1.36E-03 1.36E-03 1.36E-03 1.36E-03 1.36E-03 1.36E-03 1.36E-03 1.36E-03 1.36E-03

MAXIMUM RISK FOR HAZARD 1 IN CHLORINE

N = 500  
 PERCENTILE: 10TH 20TH 30TH 40TH 50TH 60TH 70TH 80TH 90TH  
 RISK: 4.6E-05 6.6E-05 8.1E-05 9.4E-05 1.10E-04 1.25E-04 1.36E-04 1.46E-04 1.53E-04 1.65E-04

N = 500  
 PERCENTILE: 10TH 20TH 30TH 40TH 50TH 60TH 70TH 80TH 90TH  
 RISK: 4.1E-06 5.7E-06 6.9E-06 8.1E-06 9.3E-06 1.05E-05 1.15E-05 1.22E-05 1.28E-05 1.36E-05

N = 500  
 PERCENTILE: 10TH 20TH 30TH 40TH 50TH 60TH 70TH 80TH 90TH  
 RISK: 3.9E-04 5.4E-04 6.48E-04 7.75E-04 8.81E-04 9.93E-04 1.08E-03 1.15E-03 1.21E-03 1.30E-03

N = 500  
 PERCENTILE: 10TH 20TH 30TH 40TH 50TH 60TH 70TH 80TH 90TH  
 RISK: 1.14E-05 1.58E-05 1.89E-05 2.26E-05 2.58E-05 2.91E-05 3.17E-05 3.37E-05 3.55E-05 3.80E-05

N = 500  
 PERCENTILE: 10TH 20TH 30TH 40TH 50TH 60TH 70TH 80TH 90TH  
 RISK: 9.54E-05 1.32E-04 1.58E-04 1.83E-04 2.15E-04 2.43E-04 2.65E-04 2.82E-04 2.98E-04 3.10E-04

N = 500  
 PERCENTILE: 10TH 20TH 30TH 40TH 50TH 60TH 70TH 80TH 90TH  
 RISK: 1.13E-05 1.65E-05 2.36E-05 2.69E-05 3.04E-05 3.31E-05 3.52E-05 3.70E-05 3.97E-05

N = 500  
 PERCENTILE: 10TH 20TH 30TH 40TH 50TH 60TH 70TH 80TH 90TH  
 RISK: 8.10E+00 8.10E+00 8.10E+00 8.10E+00 8.10E+00 8.10E+00 8.10E+00 8.10E+00 8.10E+00 8.10E+00

N = 500  
 PERCENTILE: 10TH 20TH 30TH 40TH 50TH 60TH 70TH 80TH 90TH  
 RISK: 3.64E-04 7.80E-04 3.34E-04 1.34E-03 1.12E-03 1.27E-03 1.42E-03 1.56E-03 1.75E-03 1.87E-03

MAXIMUM AGGREGATE CARCINOGEN RISK TO ME - CATEGORY 6  
 AGGREGATE RISK = SUM OF RISKS FROM THE FOLLOWING CONSTITUENTS:  
 C-LÖRÖFÖRM, BENZENI, MONOCHLOROBENZENE, T, TRICHLOROETHANE, 2,4-DINITROFLUOROBENZENE

MAXIMUM RISK: USE OF CHLORINE IN THE PLANT

N = 500  
 PERCENTILE: 1.01E-01  
 RISK: 7.37E-05 9.65E-05 1.13E-04 1.24E-04 1.28E-04 1.32E-04 1.35E-04 1.42E-04 1.45E-04 1.59E-04 1.76E-04

N = 500  
 PERCENTILE: 1.01E-01  
 RISK: 9.75E-06 1.05E-05 1.10E-05 1.14E-05 1.16E-05 1.21E-05 1.25E-05 1.28E-05 1.32E-05 1.36E-05 1.48E-05

N = 500  
 PERCENTILE: 1.01E-01  
 RISK: 9.23E-04 9.93E-05 3.93E-05 1.04E-03 1.07E-03 1.12E-03 1.15E-03 1.19E-03 1.24E-03 1.29E-03 1.40E-03

N = 500  
 PERCENTILE: 1.01E-01  
 RISK: 2.70E-05 3.50E-05 3.80E-05 3.14E-05 3.26E-05 3.37E-05 3.49E-05 3.62E-05 3.76E-05 3.92E-05 4.09E-05

N = 500  
 PERCENTILE: 1.01E-01  
 RISK: 2.45E-04 2.45E-04 2.53E-04 2.63E-04 2.73E-04 2.83E-04 2.93E-04 3.03E-04 3.13E-04 3.23E-04 3.33E-04

N = 500  
 PERCENTILE: 1.01E-01  
 RISK: 2.81E-05 3.81E-05 3.95E-05 3.41E-05 3.51E-05 3.51E-05 3.64E-05 3.75E-05 3.92E-05 4.27E-05

N = 500  
 PERCENTILE: 1.01E-01  
 RISK: 2.00E+00 2.00E+00

N = 500  
 PERCENTILE: 1.01E-01  
 RISK: 1.40E-03 1.40E-03 1.47E-03 1.53E-03 1.59E-03 1.65E-03 1.70E-03 1.77E-03 1.84E-03 1.91E-03

RISK = SUM OF RISKS FROM THE FOLLOWING CONSTITUENTS:  
 CHLORINE, HYDROGEN, HYDROCHLORIC ACID, HYDROCHLORIDE, HYDROGEN SULFIDE, 4-DINITROTOLUENE

N = 500  
 PERCENTILE: 1.01E-01  
 RISK: 1.01E-03 1.01E-03 1.07E-03 1.13E-03 1.19E-03 1.25E-03 1.31E-03 1.37E-03 1.43E-03 1.49E-03

APPENDIX 6.1  
LINER MATERIAL SELECTION AND DESIGN CONSIDERATION

## APPENDIX 6.1

### LINER MATERIAL SELECTION AND DESIGN CONSIDERATIONS

Earthen, asphalt and concrete liners are some of the earliest types of lagoon sealers employed. While some of the rigid linings in this group have not enjoyed good reputations as hydraulic linings, they have a definite place in the technology. The structural stability of rigid linings complements the flexible systems which do not rate well in this respect. However, rigid systems cannot elongate to accommodate subgrade deformation as easily. Under certain conditions, some rigid systems may serve well as protective devices over other, more fragile, lining systems; in this application they have been most efficiently used.

Disadvantages of this category include sensitivity to low temperatures and frost penetration. Some admixed materials perform best when applied during periods of moderate temperatures, while asphalt concrete liners degrade when exposed to excessive heating conditions.

Soil-bentonite liners are easiest and least costly to repair when the breach can be identified and is relatively small. Because bentonite can absorb 5 times its weight in water and swell to 12-15 times its dry volume at maximum saturation, it is often used for filling voids in soil or repairing leaks. Draining of the liners requires dry conditions for proper adherence of the repaired section; however, repair of these materials is often more effective than repair of synthetic liners. Table 6.6-1 summarizes some of the basic characteristics of selected liners in this category (1,2,3,4,5,6 and 7).

Use of synthetic and rubber liners came into practice in the 1960s, and they have become increasingly popular in applications requiring essentially zero permeability. Table 6.1-2 lists some of the more common liners in this category together with their general characteristics. These materials are economical, resistant to most chemicals if selected and installed properly, available in large sheets simplifying installation, and essentially impermeable. As discharge standards continue to become more stringent, the application of plastic and elastomeric (the general name given to butyl rubber, neoprene and EPDM) membranes as lagoon liners will increase because of the need to guarantee protection against seepage. This is particularly true in the sealing of lagoons containing potentially toxic wastewaters.

Selection criteria for synthetic liners include the following:

- o Chemical compatibility with lagoon waters. Wastewaters that are treated in municipal lagoons usually contain very dilute quantities of substances which may degrade liner materials. It has been found that, in cases where industrial wastes are accepted into an impoundment, aggressive chemicals can come into contact with and adversely affect some liners. Compatibility testing of expected wastewater compositions and proposed liner materials must be conducted to ensure successful containment conditions.

Table 6.1-1  
GENERAL CHARACTERISTICS OF SELECTED EARTHEN, ASPHALT AND CEMENT LINERS

Type of liner	Favorable Characteristics	Unfavorable Characteristics
Compacted soil	<ul style="list-style-type: none"> <li>Longest record of successful performance.</li> <li>Economical.</li> <li>Flexibility provides resistance to normal subgrade settlement and minor seismic activity.</li> </ul>	<ul style="list-style-type: none"> <li>Controlled seepage.</li> <li>Variable soil characteristics affect construction practices.</li> <li>Interaction with certain wastes can affect properties.</li> <li>May be affected by freezing, thawing, drying, and wetting.</li> </ul>
Concrete, unreinforced	<ul style="list-style-type: none"> <li>Hard working surface which is easy to clean.</li> <li>Durable and resistant to freezing, thawing, wetting and drying.</li> </ul>	<ul style="list-style-type: none"> <li>Construction joints present leakage problems, field applied concrete membranes have widely varying degrees of permeability, and waterproofing categories tend to degrade with time.</li> <li>Vulnerable to actions of frost, swelling, and shrinkage within the soils on which they rest.</li> </ul>
Gunite	<ul style="list-style-type: none"> <li>Sprayed onto vertical surfaces without need for using forms, thus reducing cost.</li> <li>Application equipment is mobile, so inaccessible sites may be treated.</li> <li>Almost no demand as to the texture required in the subgrade.</li> </ul>	<ul style="list-style-type: none"> <li>Cracking during curing process and foundation settlement.</li> <li>A certain amount of seepage occurs due to cracks and porosity.</li> <li>Difficult to patch.</li> </ul>
Asphalt concrete	<ul style="list-style-type: none"> <li>May be used for the entire lining structure, or a principal part of a more complex lining.</li> <li>Depending on the mix, it may serve as an impermeable layer or as a porous layer.</li> </ul>	<ul style="list-style-type: none"> <li>Requires stable substrate.</li> <li>Subject to damage due to icing conditions.</li> <li>Interaction with certain wastes can affect properties.</li> <li>Can not be used on vertical slope work; use restricted to maximum slope of 2:1.</li> </ul>
Prefabricated asphalt panels	<ul style="list-style-type: none"> <li>Flexible, continuous, impervious, rugged in nature and resists vandalism.</li> <li>Generally tolerant to water solutions of most chemicals.</li> <li>Ability to form tough, long-lasting seals to concrete structures.</li> </ul>	<ul style="list-style-type: none"> <li>Panels are heavy and costs are fairly high.</li> <li>Panels exhibit flow properties on steep slopes in hot weather during their early life.</li> <li>Do not age well in desert areas of the country.</li> <li>Panels deteriorate on exposed berm areas.</li> </ul>

SOURCE: References 2, 8, 9 and 10

Table 6.1-2  
GENERAL CHARACTERISTICS OF SELECTED SYNTHETIC AND RUBBER LINERS

Type of liner	Favorable Characteristics	Unfavorable Characteristics
Polyvinyl chloride (PVC)	Most widely used liner material due to low initial cost and tolerance to a wide range of chemicals, oils, greases, and solvents. High strength-to-weight ratio and good resistance to puncture, abrasion, and microbiological activity.	Should be covered with soil because it is not as resistant to ozone, ultraviolet radiation, and weather deterioration as some of the other liners. Exposure to heat causes undesirable deterioration in presence of some chemicals. Becomes stiff at low temperatures, making installation and maintenance more difficult in cold weather.
Chlorinated polyethylene (CPE)	Not susceptible to ozone attack, and excellent resistance. Excellent resistance to atmospheric deterioration. Because it can be compounded with other plastics, it is a feasible base material for a broad spectrum of liners designed for specific applications.	Rather limited range of tolerance for chemicals, oils, and acids.
Hypalon (synthetic rubber)	Widely used and provides exceptional resistance to weather, ozone, and sunlight. Will not crack or fail at temperature extremes or from weathering. Highly resistant to a wide range of chemicals, acids, and alkalis. Moderate resistance to oils and growth of mold, mildew, fungi, and bacteria.	Relatively high cost and low tensile strength.
Ethylene propylene rubber (EPDM)	High strength, flexible compound. Highly impermeable, excellent resistance to weather and sunlight; resists abrasion tear and has a good tolerance for extremes of temperature. Resistant to dilute concentrations of acids, alkalis, silicates, phosphates, and brine.	Not recommended for hydrocarbons or for aromatic or halogenated solvents.
Neoprene (synthetic rubber)	Excellent resistance to oils, weathering and sunlight. Extremely resistant to puncture, abrasion, and mechanical damage. Resists hydrocarbons and acids. Primarily used for containment of wastewater and other liquid containing traces of hydrocarbons.	Expensive compared with other flexible liners. Difficult to seam and repair in the field.
Butyl (synthetic rubber)	Highly reliable with over 25 years of service in storage of potable water. Good resistance to sunlight and ozone, extremely impermeable to water, retains flexibility, and high tolerance for temperature extremes. Good tear strength and resistance to puncture.	Low resistance to hydrocarbons and aromatic and halogenated solvents. Poor workability and seamability.

Table 6.1-2 , Continued  
 GENERAL CHARACTERISTICS OF SELECTED SYNTHETIC AND RUBBER LINERS

Type of liner	Favorable Characteristics	Unfavorable Characteristics
Polyethylene	Tough, highly flexible, and inert to solvents. Excellent low temperature qualities. Initial cost is relatively low.	Poor puncture resistance and weatherability; if not formulated correctly, protective soil covering may be necessary. Difficult to place and seam in the field.
Polypropylene	Tolerant to many chemicals and extremes of temperatures. Good tensile strength and low permeability to water.	Low resistance to sunlight if not formulated correctly. Difficult to seam in the field. Not recommended for containment of oxidizing solvents.
Elastomeric Polyolefins	Resistant to weathering. Resistant to alkalis and acids.	Not resistant to oils. Not good in low temperature; is affected by wind. Difficult to seam and repair in the field.
Epichlorohydrin Rubbers	Resists hydrocarbon solvents, fuels, oils. Resists ozone and weathering. Low gas/vapor permeability. Exhibits thermal stability. Good tensile and tear strength. Retains flexibility.	
Nitrile Rubber	Resistant to oils Can be seamed and repaired in the field.	When compounded with plasticizers, becomes difficult to seam and repair in the field.
Chlorosulfonated Polyethylene	Resistant to ozone, UV light, heat, corrosive chemicals, mold, mildew, fungi, bacteria.	Thermoplastic type is sensitive to high temperatures. Hardens with age and is not resistant to oils. Unreinforced - low tensile strength, shrinks in heat. Mend to repair.

Source: References 1, 2, 8, 9, 10 and 11

- o Resistance to extreme temperatures. In general, flexible membrane liners require mild temperatures for seaming, and some liners (e.g., polyvinyl chloride based liners) degrade when exposed to excessive heating conditions. If such conditions are expected, consideration should be given to selecting another liner (e.g., Hypalon) that is better able to withstand extreme temperatures.
- o Resistance to ultraviolet light. Exposure of some flexible membrane pond linings to sunlight can cause degradation due to the effects of ultraviolet light. Polyvinyl chloride, polyethylene and polypropylene based liners are among those not recommended for use when the liner may be exposed to the weather for a long period of time before filling. Dike slopes and other exposed areas should be protected by a soil cover to reduce the effects of sunlight on ultraviolet-sensitive materials. Exposable materials include the synthetic rubbers (butyl, EPDM, Hypalon and neoprene).
- o High tensile strength, flexibility, and the ability to conform to minor subgrade deformations without failure. While flexible membrane liners can offer significant advantages with regard to flexibility and relative impermeability, they are relatively fragile when compared to the more rigid admixed materials.
- o Resistance to abrasion, puncture, bacterial and fungal attack. The minimum recommended thickness is 20 mils. The material should exhibit good weatherability, with a manufacturer's guarantee of long life (20-30 years). The life expectancy of the liner system of a surface impoundment is extremely dependent on design, construction quality and consistent maintenance.
- o Specific gravity greater than 1.0. If a liner material does not meet this criterion, it will not be held in place by the weight of lagoon liquids.
- o Ease of installation. Liner installation must be evaluated on a case-by-case basis. The relative ease of installation will depend on such factors as design (above-grade, below-grade, or combination); the availability of usable low-permeability materials for the subgrade and/or liner; seaming requirements; and weather.
- o Ease of repair. Flexible membrane liners are not as easily repaired as soil-bentonite liners. At the very least, the pond will require draining prior to effecting the repair and may require replacement of a panel or the entire liner.
- o Relative cost and availability. Transportation and delivery costs must be taken into account in any comparison of liner material, particularly when choosing between admixed and synthetic liners. For example, clay may appear cheaper than a given synthetic liner on the basis of material costs; however, transport costs for the former may tip the balance in favor of the synthetic liner.

In addition to use of admixed and synthetic/rubber liners, ponds can be sealed, either separately or in combination, by natural means or by chemical treatment (2). Natural sealing of ponds has been found to occur from three mechanisms: (1) physical clogging of soil pores by settled solids; (2) chemical clogging of soil pores by ionic exchange; and (3) biological and organic clogging caused by microbial growth at the pond lining. The dominant mechanism of the three depends on the characteristics of the wastewater being treated. Chemical treatment changes the nature of the bottom soil to ensure sealing.

Chemicals have also been used for some time as a means of stabilizing soils. Although these techniques are aimed at reducing porosity, their primary objective has been to increase soil stability and/or bearing capacity. Sealants used include: (1) polymer-diesel mixtures; (2) petroleum-based emulsions; (3) powdered polymers which form a gel after application; and (4) monovalent cationic salts. These agents can be water-borne, spray-applied, mixed in place, or injected below the ground surface (1). There is little information in the literature regarding the use of chemicals for reduction of seepage. Among the several reasons for the lack of popularity of chemical treatments as linings, three are important: (1) they are not 100 percent effective and often are not effective at all; (2) they are complex and not well understood; and (3) usually they are expensive, although there are a few exceptions (8).

Each lining material discussed in this section has certain advantages and disadvantages. No single liner has all the attributes that would make it the ideal material. The concept of combination liners makes use of various combinations that would place each component in the location where its desirable properties could be used most efficiently (8).

The best example of a combination liner that has been widely used in the past is that of a continuous impervious lining overlaid with a concrete, gunite, or asphalt concrete topping. Although this liner combination is effective, it is rather costly, and consequently it has given way in recent years to other combinations.

A second general type of combination system that has been used in the lining field involves the use of a combination of flexible liner materials. For example, the exposed portion of a liner (i.e., berms, embankments) could be fabricated of a highly weather-resistant, and possibly less expensive, material.

Combination systems also have involved continuous membranes in combination with low permeability clays. In this application, the lining often serves a dual role of seepage control and wave erosion control.

APPENDIX 6.2  
LAGOON CONSTRUCTION

## APPENDIX 6.2

### LAGOON CONSTRUCTION

#### 6.2.1 SUBGRADE PREPARATION

The compaction of soil is an essential step in the construction of all types of liners whether it is soil for a soil-clay liner or for a subgrade upon which admixed or flexible membrane liners will be installed. The equipment, depth, number of lifts, and degree of compaction will be specified by engineering design. The soil type and moisture content will be tested to determine the methods of achieving the desired permeability. The installation of both admixed and synthetic liners can be quite sensitive to small deformations in the subgrade. The liner should be emplaced before the subgrade can be damaged by wind or rainfall, particularly if a synthetic liner will be used. In general, the smoother the surface of the impoundment prior to liner placement, the greater the potential for successful lagoon performance (1, 2, 4, 5, 6 and 7).

#### 6.2.2 LINER INSTALLATION

Installation procedures for admixed material liners are site and material-specific. In general, in-situ soils are mixed with the liner material and applied to the lagoon surface in a continuous or overlapping manner. Soil cement and asphalt cement may be placed by road paving equipment; hot asphalt is spray-applied, and concrete and gunite are placed using a slip or screen. Bentonite is mixed with soil, spread and compacted. Variations in materials and application methods are numerous and new technologies are regularly being introduced (1,2,4,5 and 6).

Synthetic liner panels are delivered to the lagoon site either folded or in rolls. Depending on the specific liner material, seams are sealed using adhesive(s) solvent(s), bodied solvents, heat guns, and other thermal techniques, cements, or tape. Quality control during seaming is vital to ensure adequate strength and permeability of the seal. All inlets, outlets and other penetrations must be sealed to prevent leakage. Past experience indicates that it is very difficult to be sure that all seams are sealed properly to assure long-term integrity of the liner system.

Protective soil covers are provided in many cases to anchor and protect the synthetic liner from degradation. Ultraviolet light and ozone are damaging to some liners (e.g., polyvinyl chloride) and the effects of excessive heat or cold can cause others to become brittle or to lose their impermeability. Soil covers are recommended for dike slopes to aid in resisting mechanical damage and slippage.

Proper anchoring of the liner around the impoundment perimeter as well as conscientious tailoring and sealing of the liner around penetrating structures is essential to satisfactory liner performance. The most common anchoring method for the perimeter is "trench-and-backfill." A trench is excavated along the top of the dike or beam and the liner edges are emplaced. After seaming has been completed and the panel is properly spread and smoothed, the trench is then backfilled to secure the liner (1,3 and 7).

APPENDIX 6.3

COSTS

## LAGOONS, AERATED

## FACT SHEET 2.1.11

Description - Aerated lagoons are medium-depth basins designed for the biological treatment of wastewater on a continuous basis. In contrast to stabilization ponds, which obtain oxygen from photosynthesis and surface re-aeration, they employ aeration devices which supply supplemental oxygen to the system. The aeration devices may be mechanical (i.e., surface aerator), or diffused air systems. Surface aerators are divided into two types: cage aerators and the more common turbine and vertical shaft aerators. The many diffused air systems utilized in lagoons consist of plastic pipes supported near the bottom of the cells with regularly spaced sparger holes drilled in the tops of the pipes. Because aerated lagoons are normally designed to achieve partial mixing only, aerobic-anaerobic stratification will occur, and a large fraction of the incoming solids and a large fraction of the biological solids produced from waste conversion settle to the bottom of the lagoon cells. As the solids begin to build up, a portion will undergo anaerobic decomposition. Volatile toxics can potentially be removed by the aeration process, and incidental removal of other toxics can be expected to be similar to an activated sludge system. Several smaller aerated lagoon cells in series are more effective than one large cell. Tapering aeration intensity downward in the direction of flow promotes settling out of solids in the last cell. A non-aerated polishing cell following the last aerated cell is an optional, but recommended, design technique to enhance suspended solids removal prior to discharge.

Common Modifications - The lagoons may be lined with concrete or an impervious flexible lining, depending on soil conditions and environmental regulations. Use of various types of aeration. When high-intensity aeration produces completely mixed (all aerobic) conditions, a final settling tank is required. Solids are recycled to maintain about 800 mg/l MLVSS in this mode.

Technology Status - While not as widely used when compared with the large number of stabilization ponds in common use throughout the U. S., it has been fully demonstrated, and used for years.

Applications - Used for domestic and industrial wastewater of low and medium strength. Commonly used where land is inexpensive and costs and operational control are to be minimized. It is relatively simple to upgrade existing oxidation ponds, lagoons, and natural bodies of water to this type of treatment. Aeration increases the oxidation capacity of the pond and is useful in overloaded ponds that generate odors. Useful when supplemental oxygen requirements are high or when the requirements are either seasonal or intermittent.

Limitations - In very cold climates aerated lagoons may experience reduced biological activity and treatment efficiency, and the formation of ice.

Typical Equipment/No. Mfrs. (23) - Lining systems/6; Aerators/30; Hydraulic Controls/29

Performance

	Influent	% Removed
BOD	200 - 500 mg/l	60 - 90
COD	-	70 - 90
TSS	200 - 500 mg/l	70 - 90

Residuals - Settled solids on pond bottom may require clean-out every 10 to 20 years, or possibly more often if a polishing pond is used behind the aerated pond.

Design Criteria (12, 67)

Operation: One or more aerated cells, followed by a settling (unaerated) cell  
 Detention time: 3 to 10 days  
 Depth, ft: 6 to 20  
 pH: 6.5 to 8.0

Water Temperature range: 0 to 40°C  
 Optimum Water Temperature: 20°C  
 Oxygen requirement: 0.7 to 1.4 times the amount of BOD<sub>5</sub> removed  
 Organic Loading: 10 to 300 lb BOD<sub>5</sub>/acre/d

Energy requirements:

For aeration: 6 to 10 hp/million gallons capacity  
 To maintain all solids in suspension: 60 to 100 hp/million gallons capacity  
 To maintain some solids in suspension: 30 to 40 hp/million gallons capacity

Process Reliability - The service life of a lagoon is estimated at 30 years or more. The reliability of equipment and the process is high. Little operator expertise is required.

Environmental Impacts - There is opportunity for volatile organic material and pathogens in aerated lagoons to enter the air as with any aerated wastewater treatment process. This opportunity depends on air/water contact afforded by the aeration system. There is potential for seepage of wastewater into ground water unless a lagoon is lined. Compared to other secondary treatment processes, aerated lagoons generate less solid residue.

Toxics - Volatile toxics will be removed, and incidental removal of other toxics can be expected to be similar to an activated sludge system.

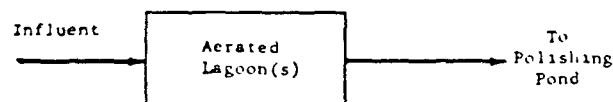
References - 7, 12, 13, 18, 23, 67

Source: Reference 12

## LAGOONS, AERATED

## FACT SHEET 2.1.11

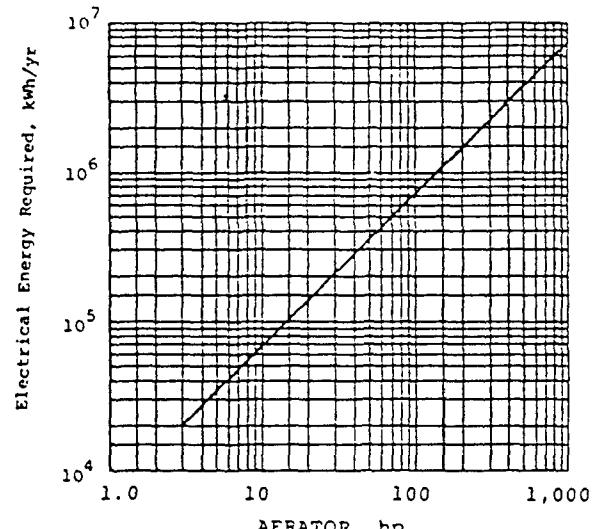
## FLOW DIAGRAM -



## ENERGY NOTES (4) -

Low speed mechanical surface aerators; motor efficiency = 90%; aerator efficiency = 1.8 lb O<sub>2</sub>/hph (wire to water); head loss negligible. Type of energy required: electrical

For additional information on energy requirements and transfer efficiency of selected aeration devices, refer to Table D-1.



## COSTS (3) - Assumptions:

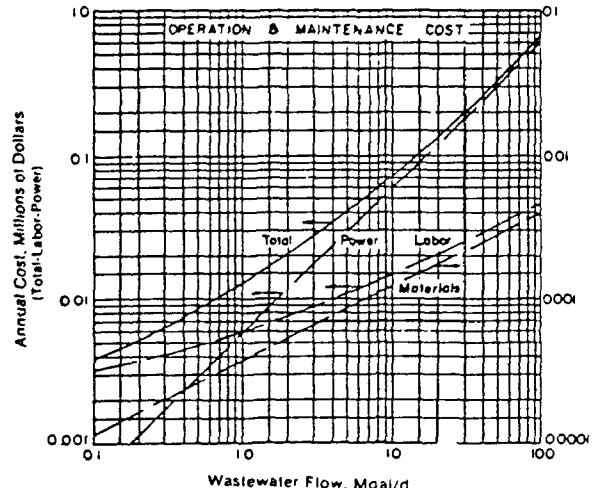
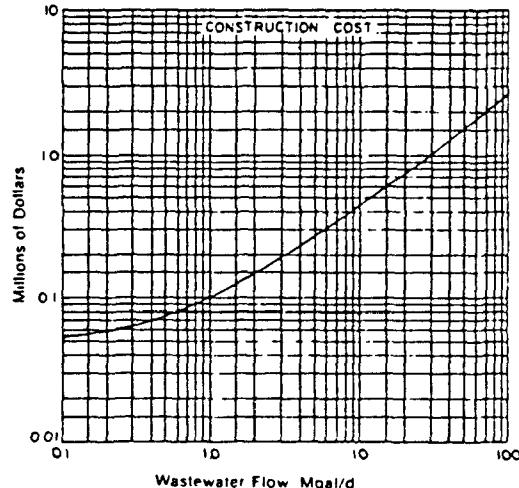
1. Service life, 30 years; ENR Index = 2475
2. Theoretical detention time = 7 d; 15-ft water depth; floating mechanical aerators;
3. Horsepower required = 36 hp/Mgal of capacity; power @ 5.02/kWh;
4. Construction cost includes excavation, embankment, and seeding of lagoon/slopes (3 cells); service road and fencing; riprap embankment protection; hydraulic control works; aeration equipment and electrical equipment.

## Wastewater Characteristics:

	In	Out
BOD <sub>5</sub> , mg/l	210	25
COD <sub>5</sub> , mg/l	400	50
TSS, mg/l	230	40
Total-P, mg/l	11	8
NH <sub>3</sub> -N, mg/l	20	18

To adjust construction cost for detention time other than above, enter curve at effective flow ( $Q_E$ )

$$Q_E = Q_{DESIGN} \times \frac{\text{New Design Detention Time}}{7 \text{ days}}$$



## REFERENCES - 3, 4

\*To convert construction cost to capital cost see Table A-2.

Source: Reference 12

## LAGOONS, FACULTATIVE

### .FACT SHEET 2.1.13

Description - Facultative lagoons are intermediate depth (3 to 8 feet) ponds in which the wastewater is stratified into three zones. These zones consist of an anaerobic bottom layer, an aerobic surface layer, and an intermediate zone. Stratification is a result of solids settling and temperature-water density variations. Oxygen in the surface stabilization zone is provided by reaeration and photosynthesis. This is in contrast to aerated lagoons in which mechanical aeration is used to create aerobic surface conditions. In general, the aerobic surface layer serves to reduce odors while providing treatment of soluble organic by-products of the anaerobic processes operating at the bottom.

Sludge at the bottom of facultative lagoons will undergo anaerobic digestion producing carbon dioxide, methane and cells. The photosynthetic activity at the lagoon surface produces oxygen diurnally, increasing the dissolved oxygen during daylight hours, while surface oxygen is depleted at night.

Facultative lagoons are often and for optimum performance should be operated in series. When three or more cells are linked, the effluent from either the second or third cell may be recirculated to the first. Recirculation rates of 0.5 to 2.0 times the plant flow have been used to improve overall performance.

Common Modifications - Facultative lagoons are customarily contained within earthen dikes. Depending on soil characteristics, lining with various impervious materials such as rubber, plastic or clay may be necessary. Use of supplemental top layer aeration can improve overall treatment capacity, particularly in northern climates where icing over of facultative lagoons is common in the winter.

Technology Status - Fully demonstrated and in moderate use especially for treatment of relatively weak municipal wastewater in areas where real estate costs are not a restricting factor.

Applications - Used for treating raw, screened, or primary settled domestic wastewaters and weak biodegradable industrial wastewaters. Most applicable when land costs are low and operation and maintenance costs are to be minimized.

Limitations - In very cold climates, facultative lagoons may experience reduced biological activity and treatment efficiency. Ice formation can also hamper operations. In overloading situations, odors can be a problem.

Typical Equipment/No. of Mfrs. (23) - Lining systems/6; Hydraulic controls/29.

Performance -  $BOD_5$  reductions of 75 to 95 percent have been reported. Effluent suspended solids concentrations of 20 to 150 mg/l can be expected, depending on the degree of algae separation achieved in the last cell. Efficiencies are strongly related to pond depth, detention time and temperature.

Chemicals Required - If wastewater is nutrient deficient, a source of supplemental nitrogen or phosphorus may be needed. No other chemicals are required.

Residuals - Settled solids may require clean out and removal once every 10 to 20 years.

Design Criteria -

Operation: At least three cells in series. Parallel trains of cells may be used for larger systems.

Detention time: 20 to 180 days.

Depth, ft: 3 to 8, although a portion of the anaerobic zone of the first cell may be up to 12 ft deep to accommodate large initial solids deposition.

pH: 6.5 to 9.0

Water temperature range: 35 to 90°F for municipal applications

Optimum water temperature: 68°F

Organic loading: 10 to 100 lb  $BOD_5$ /acre/d

Process Reliability - The service life of the lagoon is estimated to be 50 years. Little operator expertise is required. Overall, the system is highly reliable.

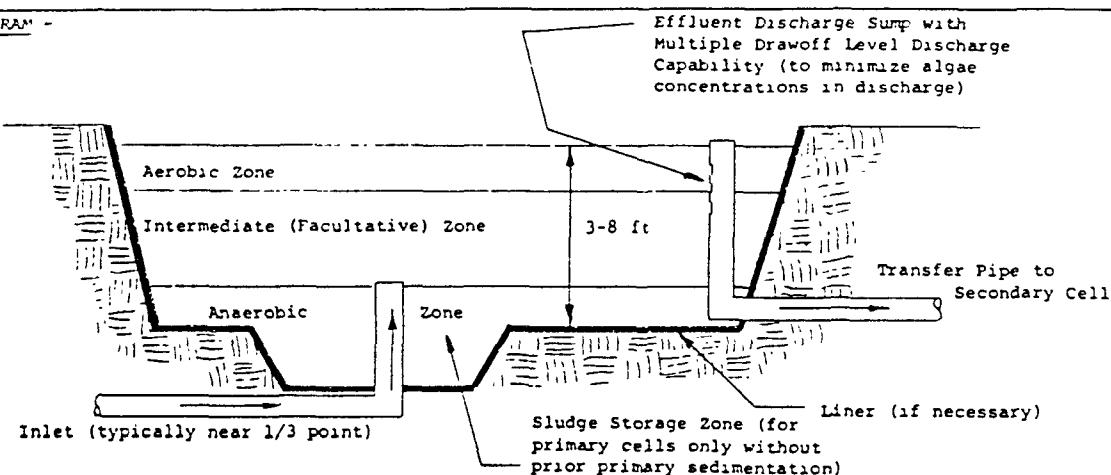
Environmental Impact - There is potential for seepage of wastewater into ground water unless lagoon is lined. Compared to other secondary processes, relatively small quantities of sludge are produced.

References - 3, 7, 18, 23, 67, 109, 110

## LAGOONS, FACULTATIVE

## FACT SHEET 2.1.13

## FLOW DIAGRAM -



**ENERGY NOTES** - Facultative lagoons are operated by gravity and therefore have no energy requirements other than any pumping that may be necessary to lift the influent wastewater into the lagoons.

**COSTS** \*Assumptions:

1. Warm climate - lagoon loading = 40 lb BOD<sub>5</sub>/acre/d.
2. Cool climate (northern U.S.) - lagoon loading = 20 lb BOD<sub>5</sub>/acre/d.
3. Water depth = 4 ft.
4. Construction cost includes excavating, grading, and other earthwork required for normal subgrade preparation and service roads. Costs do not include land and pumping.
5. Process performance:

Wastewater Characteristics

	In	Out
BOD <sub>5</sub> , mg/l	210	30
COD, mg/l	400	100
TSS, mg/l	230	60
Total-P, mg/l	11	8
NH <sub>3</sub> -N, mg/l	20	15 (cool climate) 1 (warm climate)

6. No liner included in cost estimate.
7. ENR Index = 2475

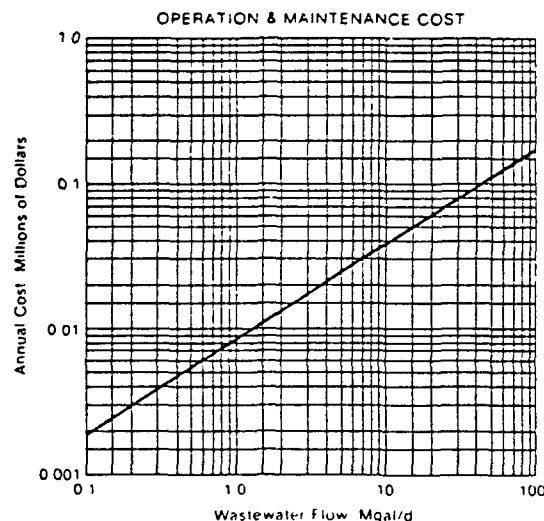
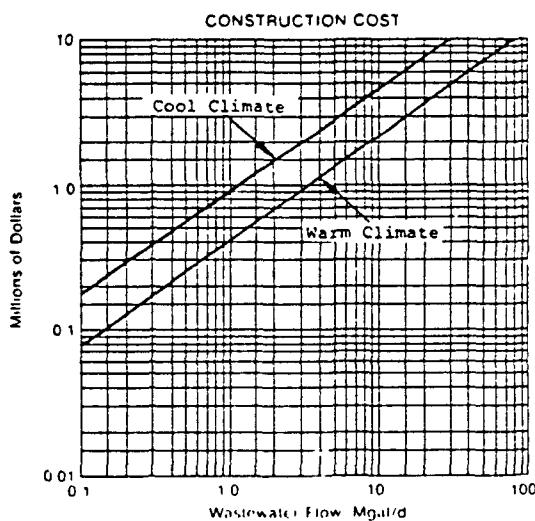
Adjustment Factor: To adjust costs for loadings other than those above, enter curve at effective flow ( $Q_E$ ).

Warm Climates  

$$Q_E = Q_{DESIGN} \times \frac{40 \text{ lb BOD}_5/\text{acre/day}}{\text{New Design Loading}}$$

Cool Climates  

$$Q_E = Q_{DESIGN} \times \frac{20 \text{ lb BOD}_5/\text{acre/day}}{\text{New Design Loading}}$$

**REFERENCE** - 3

\*To convert construction cost to capital cost see Table A-2.

Source: Reference 12

## LAGOONS, ANAEROBIC

## FACT SHEET 2.1.12

Description - Anaerobic lagoons are relatively deep (up to 20 ft) ponds with steep sidewalls in which anaerobic conditions are maintained by keeping loading so high that complete deoxygenation is prevalent. Although some oxygenation is possible in a shallow surface zone, once greases form an impervious surface layer, complete anaerobic conditions develop. Treatment or stabilization results from thermophilic anaerobic digestion of organic wastes. The treatment process is analogous to that occurring in single stage untreated anaerobic digestion of sludge in which acid forming bacteria break down organics. The resultant acids are then converted to carbon dioxide, methane, cells and other end products.

In the typical anaerobic lagoon, raw wastewater enters near the bottom of the pond (often at the center) and mixes with the active microbial mass in the sludge blanket, which is usually about 6 ft deep. The discharge is located near one of the sides of the pond, submerged below the liquid surface. Excess undigested grease floats to the top, forming a heat retaining and relatively air tight cover. Wastewater flow equalization and heating are generally not practiced. Excess sludge is washed out with the effluent. Recirculation of waste sludge is not required.

Anaerobic lagoons are capable of providing treatment of high strength wastewaters and are resistant to shock loads.

Common Modifications- Anaerobic lagoons are customarily contained within earthen dikes. Depending on soil characteristics, lining with various impervious materials such as rubber, plastic or clay may be necessary. Pond geometry may vary, but surface area to volume ratios are minimized to enhance heat retention.

Technology Status - Although anaerobic processes are common for sludge digestion, anaerobic lagoons for wastewater treatment have found only limited application. The process is well demonstrated for stabilization of highly concentrated organic wastes.

Typical Equipment/No.of Mfrs. (23) -

Lining Systems/6; Hydraulic controls/29

Applications - Typically used in series with aerobic or facultative lagoons. Anaerobic lagoons are effective as roughing units prior to aerobic treatment of high strength wastes.

Limitations - May generate odors. Requires relatively large land area. For efficient operation, water temperatures above 75°F should be maintained.

Performance - $BOD_5$  removals of 50 to 70 percent are achievable depending on loading and temperature conditions. TSS concentrations may increase, especially if the influent  $BOD_5$  is primarily dissolved. Generally does not produce an effluent suitable for direct discharge to receiving waters.

Residuals Generated - In anaerobic lagoons excess sludge is usually washed out in the effluent. Since anaerobic lagoons are often used for preliminary treatment recirculation or removal of sludge not generally required.

Chemicals Required - Nutrients as needed to make up deficiencies in raw wastewater. No other chemicals required.

Design Criteria -

Operation: Parallel or series

Detention Time: 20 to 50 d

Depth, ft: 8 to 20

pH: 6.8 to 7.2

Water Temperature Range: 35 to 120°F

Optimum Water Temperature: 86°F

Organic loading: 200 to 2200 lb  $BOD_5$ /acre/d

Unit Process Reliability - Generally resistant to upsets. Highly reliable if pH in the relatively narrow optimum range is maintained.

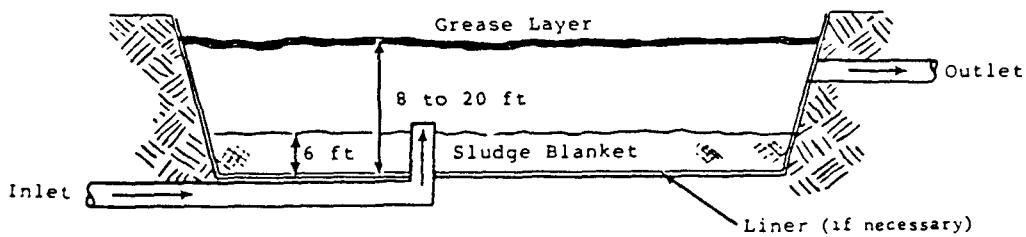
Environmental Impact - May create odors. Have relatively high land requirements. There is potential for seepage of wastewater into groundwater unless lagoon is lined.

Joint Treatment Potential - Valuable as a preliminary treatment process for combined industrial and municipal wastes containing high concentrations of organic materials. Can be used preceding most standard biological treatment processes.

References - 7, 16, 18, 20, 23, 67, 107, 110

## LAGOONS, ANAEROBIC

## FACT SHEET 2.1.12

FLOW DIAGRAM -

ENERGY NOTES - Anaerobic lagoons are operated by gravity flow and therefore have no energy requirements other than any pumping that may be necessary to lift the influent wastewater into the lagoons.

COSTS\* - Assumptions: January 1979 dollars; ENR Index = 2872.

Service Life: 50 years

Average detention time = 35 days; depth = 10 ft;  $BOD_5$  loading = 466 lb/acre/d. Construction cost includes excavating, grading and other earthwork and service roads. Costs do not include land and pumping. Liner cost not included in estimate. Operation and maintenance costs consist of labor and material.

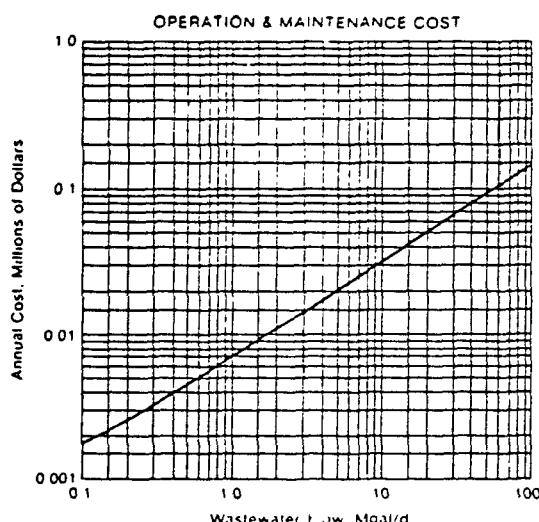
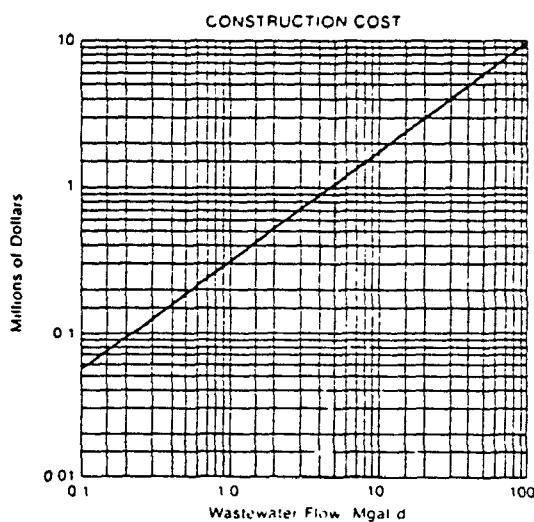
Wastewater Characteristics

Influent, mg/l  
600

Effluent, mg/l  
240

To adjust costs for other  $BOD_5$  loadings and/or detention times, enter curve at effective flow ( $Q_E$ ):

$$Q_E = Q_{DESIGN} \times \frac{(466 \text{ lb/acre/d}) (\text{New detention time})}{(\text{New Design Loading}) (35 \text{ days})}$$



REFERENCE - Curves derived from reference 3.

\*To convert construction cost to capital cost see Table A-2.

Source: Reference 12

TABLE 6.3-1  
DEVELOPMENT OF CAPITAL COSTS

Category	Cost <sup>a</sup>	
	Warm Climate <sup>b</sup>	Cool Climate <sup>c</sup>
Component Installed Construction Costs	\$142,000	\$319,000
Subtotal 1	142,000	319,000
Non-Component Construction Costs		
Piping @ 10%	14,000	32,000
Electrical @ 8%	11,000	26,000
Instrumentation @ 5%	7,000	16,000
Site Preparation @ 5%	7,000	16,000
Subtotal 2	39,000	90,000
Non-Construction Costs		
Engineering and Construction		
Supervision @ 15%	27,000	61,000
Contingencies @ 15%	27,000	61,000
Subtotal 3	54,000	122,000
TOTAL CAPITAL COST	\$235,000	\$531,000

SOURCE: After Reference 12

<sup>a</sup> June 1987 dollars; ENR Index 4386.80

<sup>b</sup> Surface loading rate in warm climate is assumed to be 40 lb BOD<sub>5</sub>/acre/day for facultative lagoons

<sup>c</sup> Surface loading rate in cool climate is assumed to be 20 lb BOD<sub>5</sub>/acre/day for facultative lagoons

TABLE 6.3-2  
COSTS OF SELECTED FLEXIBLE MEMBRANE LINERS

Material	Nominal Thickness (mils)	Relative Cost <sup>b</sup>	Price (\$/yd <sup>2</sup> ) <sup>a</sup>	Installed Cost <sup>c</sup>
Butyl Rubber	30	M	6.68-7.99 <sup>d,e</sup>	
Chlorinated Polyethylene (CPE)	30	M	7.31-12.60 <sup>d,e</sup>	
Chlorosulfonated Polyethylene (CSPE)	30	M	7.31-12.60 <sup>d,e</sup>	
Elasticized Polyolefins (ELPO)	20	-	3.52-3.83	
Ethylene Propylene Rubber	30	M	6.68-7.99 <sup>d,e</sup>	
Neoprene	30	H	9.95-11.48 <sup>e</sup>	
High Density Polyethylene (HDPE)	60	M-H <sup>f</sup>	8.17 <sup>d</sup>	
	80		9.07-9.64 <sup>d</sup>	
Epichlorohydrin Rubbers	-	H	8.48-12.72	
Polyvinyl Chloride (PVC)	20	L	2.45-3.37	
	30		3.06-4.17	

Source: References 1 and 13

<sup>a</sup>June 1987 dollars; ENR Index of 4386.80

<sup>b</sup>L=low; M=moderate; H=high

<sup>c</sup>Installed cost is highly dependent on the area being lined.

<sup>d</sup>Includes subgrade preparation

<sup>e</sup>Includes fabric reinforcement

<sup>f</sup>Depends on thickness

TABLE 6.3-3  
COSTS OF SELECTED EARTHEN AND ADMIXED LINERS

Material	Installed Cost (\$/yd <sup>2</sup> ) <sup>a,b,c</sup>
Soil and Bentonite (9 lb/yd <sup>2</sup> )	1.72
Bentonite	1.53 ~ 3.52
Soil Cement (6 inches plus 2 coats sealer)	2.97
Gunite	6.12 ~ 22.95
Soil Asphalt (6 inches plus 2 coats sealer)	2.97
Asphalt Panels	9.79 ~ 16.37
Hydraulic Asphalt Concrete (hot mix, 4 inches)	7.15 ~ 10.02

Source: References 1 and 2

<sup>a</sup>June 1987 dollars; ENR Index of 4386.80

<sup>b</sup>Does not include subgrade preparation

<sup>c</sup>Transportation costs will vary depending on distance of site from material source

## APPENDIX 6.3

TABLE 6.3-4

## COSTS FOR A FOUR-WELL GROUND-WATER MONITORING SYSTEM

Item	Cost Per Well	System Cost
<b>INSTALLATION AND DEVELOPMENT COSTS (exclusive of supervisory personnel)</b>		
<b><u>Mobilization/Demobilization</u></b>		
	\$125.00	\$500.00
<b><u>Drilling</u></b>		
- 10-inch hollow stem auger @ \$20.00/ft and 40 ft.	800.00	3,200.00
- Split-spoon sampling @ \$75.00/sample and 5-ft. intervals	675.00	2,700.00
<b><u>Well Installation (4-inch Schedule 80 PVC pipe)</u></b>		
- Well casing (blank) @ \$11.00/ft and 35 ft	385.00	1,540.00
- Well screen @ \$20.00/ft and 10 ft	200.00	800.00
- Backfill (clean sand filter pack, bentonite seal, grout and cement) @ \$14.00/ft	560.00	2,240.00
- Protective locking well cover	300.00	1,200.00
- Equipment decontamination (one hour)	150.00	600.00
<b><u>Well Development</u></b>		
@\$150.00/hr and 1 hr/well	150.00	600.00
<b>TOTAL</b>	<b>\$3,345.00</b>	<b>\$13,380.00</b>

## APPENDIX 6.3

TABLE 6.3-4 (Continued)

COSTS FOR A FOUR-WELL GROUND-WATER MONITORING SYSTEM

Item	Cost Per Well	System Cost
<u>SUPERVISORY COSTS (during well installation)</u>		
<u>Supervisory Personnel</u>		
- Geologist @\$40.00/hr and 8-12 hr/well	400.00	1,600.00
- Rental Car @\$50.00/day	50.00	200.00
- Per diem @\$75.00/day	75.00	300.00
TOTAL	<u>525.00</u>	<u>2,100.00</u>
<u>SAMPLING AND ANALYSIS COSTS</u>		
<u>Sampling (2 people)</u>		
- Pre-sample purge @\$30.00/manhour and 1-2 hrs/well	90.00	360.00
- Sampling equipment, containers, protective clothing (Level D), field instrument rental, sample shipment costs	80.00	320.00
- Rental car @\$50.00/day	50.00	50.00
- Per diem @\$75.00/manday	150.00	150.00
<u>Analysis</u>		
- Priority pollutant scan @\$2,000.00/sample	2,000.00	8,000.00
- QA/QC (field blank, wash blank) <sup>a</sup>	2,000.00	2,000.00
TOTAL (per sampling event)	<u>\$4,370.00</u>	<u>\$10,880.00</u>

<sup>a</sup>One QA/QC sample per sampling event, whether one or four wells.

APPENDIX 6.4  
PRETREATMENT

## APPENDIX 6.4

TABLE 6.4-1  
ESTABLISHED PRETREATMENT PROCESSES

Process <sup>a</sup>	TYPES OF WASTES TREATED						Poly-nuclear Organics	Volatile Organics
	Amines	Cyanide	Ethers	(Non-Volatile)	Metals	Phenols	Phthalates	
Adsorption	X	X	X	-	X	X	X	X
Evaporation	X	0	X	-	X	-	-	-
Filtration	-	-	-	-	X	-	-	-
Flocculation	-	-	-	-	X	-	-	-
Neutralization	-	-	-	-	X	-	-	-
Precipitation	-	0	-	-	X	-	X	0
Sedimentation	-	-	X	-	X	-	-	-
Stripping	-	0	-	-	0	X	-	-
Aerobic Bio Treatment <sup>b</sup>	X	-	X	-	-	X	X	X
Anaerobic Bio Treatment <sup>b</sup>	X	-	X	-	-	X	X	X

<sup>a</sup>Because these processes would be used to treat industrial wastewater prior to discharge to the POTW, costs will vary significantly depending upon: (1) the particular chemical(s) to be removed from the industrial wastewater; (2) the magnitude of flow to be treated; and (3) the particular discharge limits to be met.

<sup>b</sup>Should only be used as a general guide. Specific compounds may or may not be biodegradable depending upon concentration and environmental conditions such as the presence of toxic substances.

X: Compounds amenable to treatment.

0: Compounds not amenable to treatment.

-: Information not available.

Source: References 14, 15 and 16

APPENDIX 6.5  
LAGOON REMEDIATION

APPENDIX 6.5

TABLE 6.5-1

GENERAL TYPES OF RESPONSE ALTERNATIVES  
APPLICABLE TO MUNICIPAL LAGOONS

ACTION
No action (periodic monitoring)
Construction of alternate water supply (in response to a short-term health threat)
Source Control <ul style="list-style-type: none"><li>o Retrofit/repair lagoon to eliminate pollutant source</li><li>o Clean closure (removal of waste)</li><li>o Closure with waste in place</li></ul>
Landfill of excavated material
Incineration of excavated material
Control of contaminant plume <ul style="list-style-type: none"><li>o Ground-water extraction and treatment</li><li>o Ground-water diversion</li><li>o In-situ treatment (innovative)</li><li>o Allow natural attenuation through dilution, sorption and degradation</li></ul>

## APPENDIX 6.5

## TABLE 6.5-2

## REMEDIAL TECHNOLOGIES

Remedial Technology	Comments
Removal of wastewater	<ul style="list-style-type: none"> <li>o Necessary for all alternatives except no action and bentonite liner repair.</li> </ul>
Mechanical dewatering of excavated sediments/sludges	<ul style="list-style-type: none"> <li>o Gravity sedimentation yields lowest solids and requires greatest area.</li> <li>o Centrifuges and filtration units are available in mobile systems.</li> <li>o All processes generate an effluent which requires proper treatment/disposal.</li> </ul>
Excavation of sludge and soil (Backfill, compaction/grading and revegetation).	<ul style="list-style-type: none"> <li>o If contamination is deep, the resulting depth of excavation may be such as to require significant bracing and dewatering (and potential treatment of extracted water).</li> </ul>
Landfill of excavated materials	<ul style="list-style-type: none"> <li>o Landfill is generally cheaper than incineration.</li> <li>o On-site landfill must be permitted or otherwise approved by regulatory authorities, and may require long-term monitoring and maintenance. (However, liability is contained on site.)</li> <li>o Off-site landfill requires transport and extends potential liability.</li> </ul>
Incineration of excavated materials	<ul style="list-style-type: none"> <li>o More expensive than landfill.</li> <li>o Off-site incineration requires transport.</li> <li>o On-site incineration requires permitting and is cost-effective only for large quantities.</li> </ul>
Site capping, grading and revegetation	<ul style="list-style-type: none"> <li>o Designed to minimize infiltration and leachate generation when waste (e.g., contaminated soil) is left in place.</li> <li>o Wastewater must be removed.</li> <li>o Requires long-term maintenance to ensure integrity.</li> <li>o Major disadvantages of a surface cap are its uncertain design life and the need to monitor ground water.</li> <li>o Capping is usually less expensive than excavation.</li> </ul>
Surface water diversion and collection	<ul style="list-style-type: none"> <li>o Can be used temporarily to divert surface water around a site during excavation or other remedial activity.</li> <li>o Some types of diversion structures (e.g., sodded or stone waterways) are permanent.</li> <li>o Requires inspection and maintenance.</li> </ul>
Ground-water Extraction – Subsurface Drainage Systems	<ul style="list-style-type: none"> <li>o Less expensive than pumping if contamination is shallow and hydraulic conductivities are variable or low.</li> <li>o In general, O&amp;M costs are lower than for pumping, and system is easier to operate.</li> <li>o Limited to shallow depths.</li> <li>o Can clog in the presence of reactive or viscous chemicals.</li> <li>o Construction/installation (i.e., excavation) costs are greater than for pumping. Installation period is longer and thus the system is not appropriate for immediate remediation.</li> <li>o Costly to repair.</li> </ul>
Ground-water Extraction – Wells	<ul style="list-style-type: none"> <li>o Better than subsurface drainage systems when contaminants are miscible and move readily with ground water, the hydraulic gradient is steep, and the hydraulic conductivity is high.</li> <li>o Can be used in combination with slurry walls (slurry wall can divert uncontaminated ground water around the site, thus minimizing the amount to be extracted).</li> <li>o High O&amp;M costs.</li> <li>o Requires facilities for storage, treatment and/or disposal of extracted ground water.</li> </ul>

TABLE 6.5-2, Continued  
REMEDIAL TECHNOLOGIES

Remedial Technology	Comments
Ground-water Injection	<ul style="list-style-type: none"> <li>o Injection wells can be used to direct contaminants toward extraction wells (useful when quick removal is desired and hydraulic gradient is relatively low).</li> <li>o Requires frequent maintenance and well rehabilitation.</li> <li>o Can help redirect plume away from an exposure point.</li> </ul>
Ground-water barriers - Slurry wall (soil-bentonite, cement-bentonite, or diaphragm walls)	<ul style="list-style-type: none"> <li>o Requires little or no maintenance.</li> <li>o Less expensive than grouting.</li> <li>o Easy to construct.</li> <li>o Results in immediate control of ground-water levels if properly designed and installed.</li> <li>o When combined with extraction wells, can be used to maintain an inward hydraulic gradient.</li> <li>o Can be susceptible to tunneling as a result of cation exchange with calcium-rich ground water.</li> </ul>
Ground-water barriers - Rock grouting and grout curtains (Portland cement and clay are the two most common grouts)	<ul style="list-style-type: none"> <li>o Better than slurry for sealing voids in rock.</li> <li>o Minimal O&amp;M.</li> <li>o More expensive than slurry walls.</li> <li>o Cannot achieve uniformly low permeability in unconsolidated materials.</li> <li>o Requires specialized equipment, resulting in a large mobilization cost.</li> </ul>
Ground-water barriers - Sheet piling	<ul style="list-style-type: none"> <li>o Used for temporary dewatering during other construction/excavation or as erosion protection for another barrier.</li> <li>o Little maintenance.</li> <li>o Subject to corrosion unless protected.</li> <li>o Can be damaged during installation.</li> </ul>
Ground-water treatment	<ul style="list-style-type: none"> <li>o Can be done on site with both fixed and mobile systems.</li> <li>o See Table 6.3-3 for individual processes.</li> </ul>

Source: References 13 and 15.

## APPENDIX 6.5

TABLE 6.5-3

## COMMON GROUND-WATER TREATMENT PROCESSES

Treatment Process	Comments
Activated Carbon	<ul style="list-style-type: none"> <li>o Well-suited for the removal of mixed organics, especially if they are hydrophobic and nonpolar. Can also remove some metal and inorganic species.</li> <li>o If fulvic or humic acids are present, they will preferentially adsorb and result in rapid carbon exhaustion.</li> <li>o Requires pretreatment for oil and grease and suspended solids.</li> <li>o Often used following air stripping.</li> <li>o Mobile systems are commercially available, easy to start up and shut down, and require minimal space.</li> <li>o Not affected by toxic compounds.</li> <li>o High capital and operating costs can be reduced by pretreatment (e.g., sedimentation, biological treatment, and/or air stripping).</li> </ul>
Biological Treatment (suspended growth and fixed-film systems)	<ul style="list-style-type: none"> <li>o Degrades soluble organics more readily than insoluble organics.</li> <li>o Halogenated and nitro-substituted compounds are generally more refractory than other materials.</li> <li>o Bacteria can be inhibited by toxic compounds (e.g., metals) and shock loadings.</li> <li>o Pretreatment (usually neutralization and/or sedimentation) is sometimes required.</li> <li>o Sludge must be properly disposed.</li> </ul>
Filtration	<ul style="list-style-type: none"> <li>o Good for removal of low levels of solids.</li> <li>o Equipment is readily available; easy to operate and control.</li> <li>o Process is easily integrated into overall treatment scheme.</li> <li>o Mobile systems are commercially available.</li> <li>o Backwash water will contain high concentrations of contaminants and must be treated.</li> </ul>
Precipitation/Flocculation	<ul style="list-style-type: none"> <li>o Removes metals and certain anionic species.</li> <li>o Can be used in situ in lagoon wastewater before it is removed.</li> <li>o Equipment is readily available and easy to operate.</li> <li>o Process is easily integrated into overall treatment scheme.</li> <li>o Sludge must be properly disposed.</li> </ul>
Sedimentation	<ul style="list-style-type: none"> <li>o Used as pretreatment for activated carbon adsorption, ion exchange, air stripping, biological treatment, reverse osmosis and filtration.</li> <li>o Sludge must be properly disposed.</li> </ul>

## APPENDIX 6.5

TABLE 6.5-3

COMMON GROUND-WATER TREATMENT PROCESSES, Continued

Treatment Process	Comments
Ion Exchange	<ul style="list-style-type: none"> <li>o Removes metals, inorganic anions, and ionized and organic acids.</li> <li>o Rapidly exhausted at high concentrations (2500-4000 mg/l)</li> <li>o Suspended solids greater than 50 mg/l can plug the resin.</li> <li>o Units are commercially available and can be used in mobile treatment systems.</li> <li>o Regenerant solution must be properly disposed.</li> </ul>
Neutralization	<ul style="list-style-type: none"> <li>o Often used to adjust pH prior to biological and other treatment processes.</li> <li>o Relatively simple process.</li> </ul>
Air Stripping	<ul style="list-style-type: none"> <li>o Used to remove volatile compounds.</li> <li>o Less volatile compounds are not removed and must be subjected to other treatment such as carbon adsorption or biological degradation.</li> <li>o Often used upstream of carbon adsorption to reduce the frequency and expense of carbon regeneration.</li> <li>o High energy cost (air flow).</li> </ul>
Resin Adsorption	<ul style="list-style-type: none"> <li>o Very cost-effective for removal of low concentrations of volatile organics.</li> <li>o System is modular and easy to establish on site.</li> <li>o Off-gas may require collection and treatment.</li> <li>o Can remove a wide range of polar and nonpolar organics.</li> <li>o Can tolerate high levels of dissolved inorganics.</li> <li>o Spent regenerant must be properly disposed.</li> </ul>
Chemical Oxidation	<ul style="list-style-type: none"> <li>o Can partially oxidize specific refractory and/or toxic wastes prior to biological treatment (cyanides, phenols, mercaptans and pesticides).</li> <li>o Equipment is readily available but application is complex.</li> <li>o Reagents are hazardous.</li> </ul>
Chemical Reduction	<ul style="list-style-type: none"> <li>o Used primarily for the reduction of hexavalent chromium, mercury and lead.</li> <li>o Equipment is readily available and process is easy to implement.</li> <li>o Capital and operating costs are low.</li> </ul>

## APPENDIX 6.5

TABLE 6.5-3

COMMON GROUND-WATER TREATMENT PROCESSES, Continued

Treatment Process	Comments
In-Situ Treatment	<ul style="list-style-type: none"> <li>o Applicability must be determined on site-specific basis using laboratory and pilot-scale testing.</li> </ul>
o Bioreclamation	<ul style="list-style-type: none"> <li>o Aerobic conditions are usually required (except for halogenated lower molecular weight hydrocarbons).</li> <li>o More soluble compounds are more readily available for degradation.</li> <li>o Other conditions (pH, micronutrients, temperature, etc.) must be suitable.</li> <li>o Hydraulic conductivity must be adequate to maintain a supply of oxygen and nutrients throughout the treatment zone.</li> <li>o Can degrade organics that are sorbed to soils which can not be removed by groundwater extraction.</li> </ul>
o Chemical Treatment	<ul style="list-style-type: none"> <li>o Still in developmental stage.</li> <li>o Groundwater to be treated and the injected reagents must be contained within the treatment zone.</li> <li>o Types of chemical treatment include immobilization, soil flushing, and detoxification.</li> <li>o Soil flushing with water surfactants appears to be relatively feasible and cost-effective for organics. Inorganics can be flushed with dilute acids or chelating agents.</li> </ul>
o Physical Treatment	<ul style="list-style-type: none"> <li>o Still in developmental stages.</li> <li>o Types of physical treatment include in-situ heating, vitrification and ground freezing to immobilize or detoxify contaminants.</li> </ul>

Source: References 13, 14, 17, 18, 19 and 20.

APPENDIX 6.6

APPENDIX 6 REFERENCES

APPENDIX 6.6  
APPENDIX 6 REFERENCES

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