

Homework 5 Question 1

a. Gradient from MW-2 to MW-8 = $\frac{848.55 - 843.13}{2900}$
= 0.002

Gradient from 848-ft contour to 845-ft contour
= $\frac{848 - 845}{1000}$
= 0.003

Note the near-site gradient is directed to the southwest and not directly toward the municipal wells.

Gradient is in the range 0.002 to 0.003

b. In fractured limestone bedrock with negligible organic content, there is little to no adsorption. Thus, $R_d \approx 1$

c. A consultant working for the chemical company used the default dispersivity values and came up with these coefficient values:

$$\begin{array}{ll} \text{TCA} \rightarrow \text{DCA} & \lambda = 11.55 \text{ /yr} \\ \text{DCA} \rightarrow \text{CA} & \lambda = 693 \text{ /yr} \\ \text{CA} \rightarrow \text{Ethane} & \lambda = 0.693 \text{ /yr} \end{array}$$

$$\begin{array}{ll} \text{PCE} \rightarrow \text{TCE} & \lambda = 8.66 \text{ /yr} \\ \text{TCE} \rightarrow \text{DCE} & \lambda = 30.13 \text{ /yr} \\ \text{DCE} \rightarrow \text{VC} & \lambda = 17.33 \text{ /yr} \\ \text{VC} \rightarrow \text{Eth} & \lambda = 693 \text{ /yr} \end{array}$$

They also "improved" their fit by assuming a source concentration ten times higher than the concentration observed in well MW-7A. Even with this, the match was not all that great.

BIOCHLOR Natural Attenuation Decision Support System

Version 1.1

Cape Canaveral
Fire Training Area
Run Name

Data Input Instructions:

1. Enter value directly....or
 2. Calculate by filling in gray cells. Press Enter, then
- (To restore formulas, hit "Restore Formulas" button)
- Variable* — Data used directly in model.

TYPE OF CHLORINATED SOLVENT:

Ethenes
Ethanes

1. ADVECTION

Seepage Velocity* Vs (ft/yr)

Hydraulic Conductivity K (cm/sec)

Hydraulic Gradient i (ft/ft)

Effective Porosity n (-)

2. DISPERSION

Alpha x Calc. Method (-) (-)

(Alpha y) / (Alpha x)

(Alpha z) / (Alpha x)

Change Alpha x Calc. Method

3. ADSORPTION

Retardation Factor* R

Soil Bulk Density, rho (kg/L)

Fraction Organic Carbon, foc (-)

Partition Coefficient Koc

PCE (L/kg) (-)

TCE (L/kg) (-)

DCE (L/kg) (-)

VC (L/kg) (-)

ETH (L/kg) (-)

Common R (used in model)* =

4. BIOTRANSFORMATION

Zone 1

Zone 2

-1st Order Decay Coef*

λ (1/yr)	half-life (yrs)	Yield*
8.660	0.06	0.79
30.13	0.00	0.74
17.330	1.00	0.64
		0.45

5. GENERAL

Simulation Time* (yr)

Modeled Area Width* (ft)

Modeled Area Length* (ft)

Zone 1 Length* (ft)

Zone 2 Length* (ft)

Zone 2 = L - Zone 1

6. SOURCE DATA

Source Options

TYPE: Single Planar

Source Thickness in Sat. Zone* (ft)

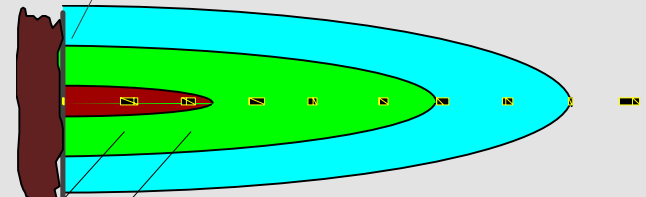
Width* (ft)

Conc. (mg/L)* C1

PCE	39.9
TCE	139.0
DCE	10.0
VC	
ETH	

Test if Biotransformation is Occurring Natural Attenuation Screening Protocol

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

Conc. (mg/L)	0	200	1300	2350						
PCE Conc. (mg/L)	3.99	1.67	.612	.001						
TCE Conc. (mg/L)	13.9	1.16	.037	.001						
DCE Conc. (mg/L)	1.0	5.18	.039	.001						
VC Conc. (mg/L)										
ETH Conc. (mg/L)										
Dist. from Source (ft)	0	200	1300	2350						

8. CHOOSE TYPE OF OUTPUT TO SEE:

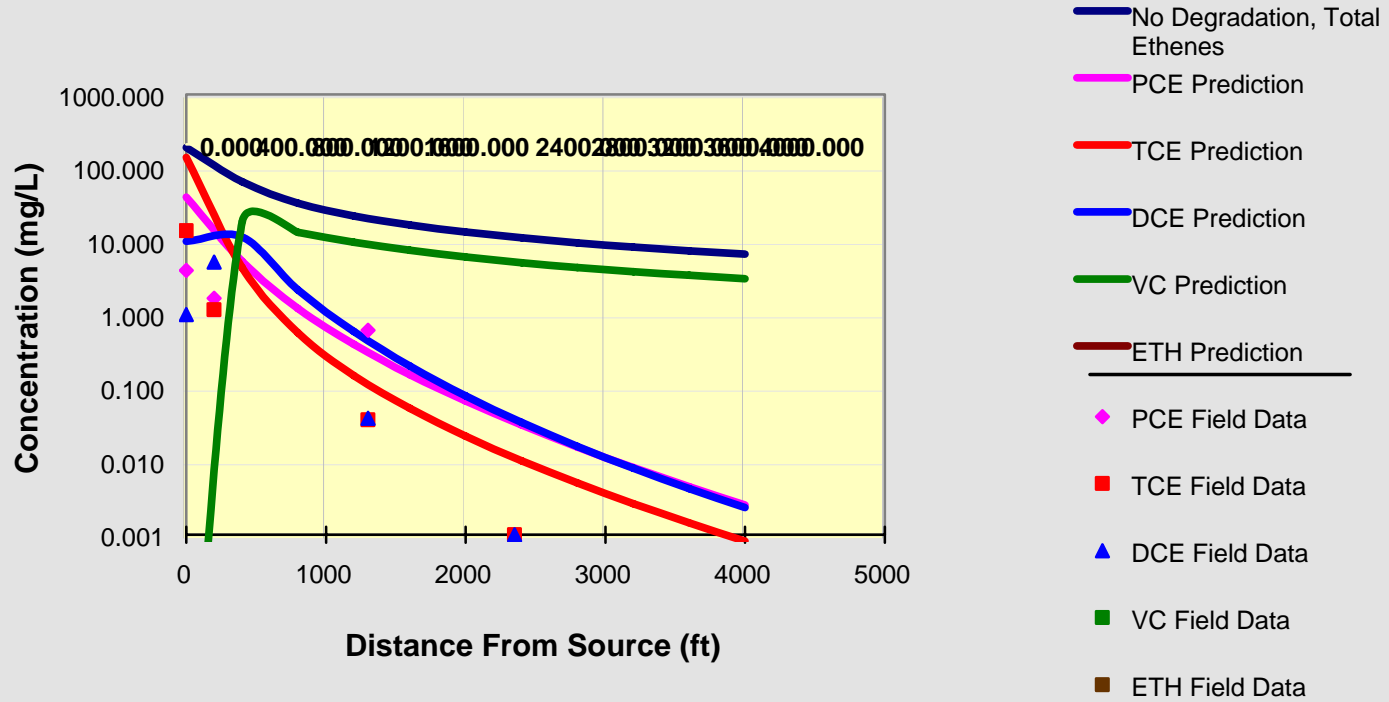
RUN CENTERLINE

RUN ARRAY

Help Restore Formulas RESET

SEE OUTPUT Paste Example

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE



Log Linear

Time:

To Input

To Individual Compounds

BIOCHLOR Natural Attenuation Decision Support System

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Cape Canaveral
Fire Training Area
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Test if
Biotransformation
is Occurring

Natural Attenuation
Screening Protocol

TYPE OF CHLORINATED SOLVENT:

Ethenes
Ethanes

1. ADVECTION

Seepage Velocity* Vs (ft/yr)

Hydraulic Conductivity K (cm/sec)

Hydraulic Gradient i (ft/ft)

Effective Porosity n (-)

2. DISPERSION

Alpha x Calc. Method (-)

(Alpha y) / (Alpha x) (-)

(Alpha z) / (Alpha x) (-)

Change Alpha x
Calc. Method

3. ADSORPTION

Retardation Factor* R

Soil Bulk Density, rho (kg/L)

Fraction Organic Carbon, foc (-)

Partition Coefficient Koc (L/kg)


TCA (L/kg) (-)

DCA (L/kg) (-)

CA (L/kg) (-)

Common R (used in model)* =

4. BIOTRANSFORMATION

Zone 1  -1st Order Decay Coef* (1/yr) half-life (yrs) Yield*

TCA (1/yr) (yrs)

DCA (1/yr) (yrs)

CA (1/yr) (yrs)

Zone 2

TCA (1/yr) (yrs)

DCA (1/yr) (yrs)

CA (1/yr) (yrs)

5. GENERAL

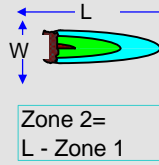
Simulation Time* (yr)

Modeled Area Width* (ft)

Modeled Area Length* (ft)

Zone 1 Length* (ft)

Zone 2 Length* (ft)



6. SOURCE DATA

Source Options

TYPE: Single Planar

Source Thickness in Sat. Zone* (ft)

Width* (ft)

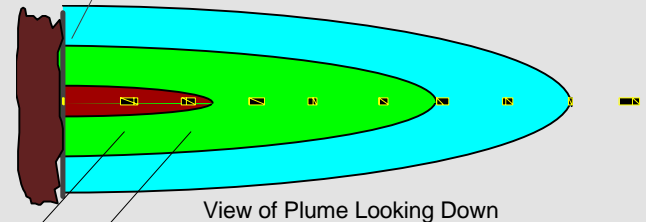
Conc. (mg/L)* C1

TCA

DCA

CA

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

TCA Conc. (mg/L)	185.0	40.9	.612	.001									
DCA Conc. (mg/L)	1.0	.565	.009	.001									
CA Conc. (mg/L)	.001	.001	.001	.001									

Dist. from Source (ft)	0	200	1300	2350									
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8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE

RUN ARRAY

Help

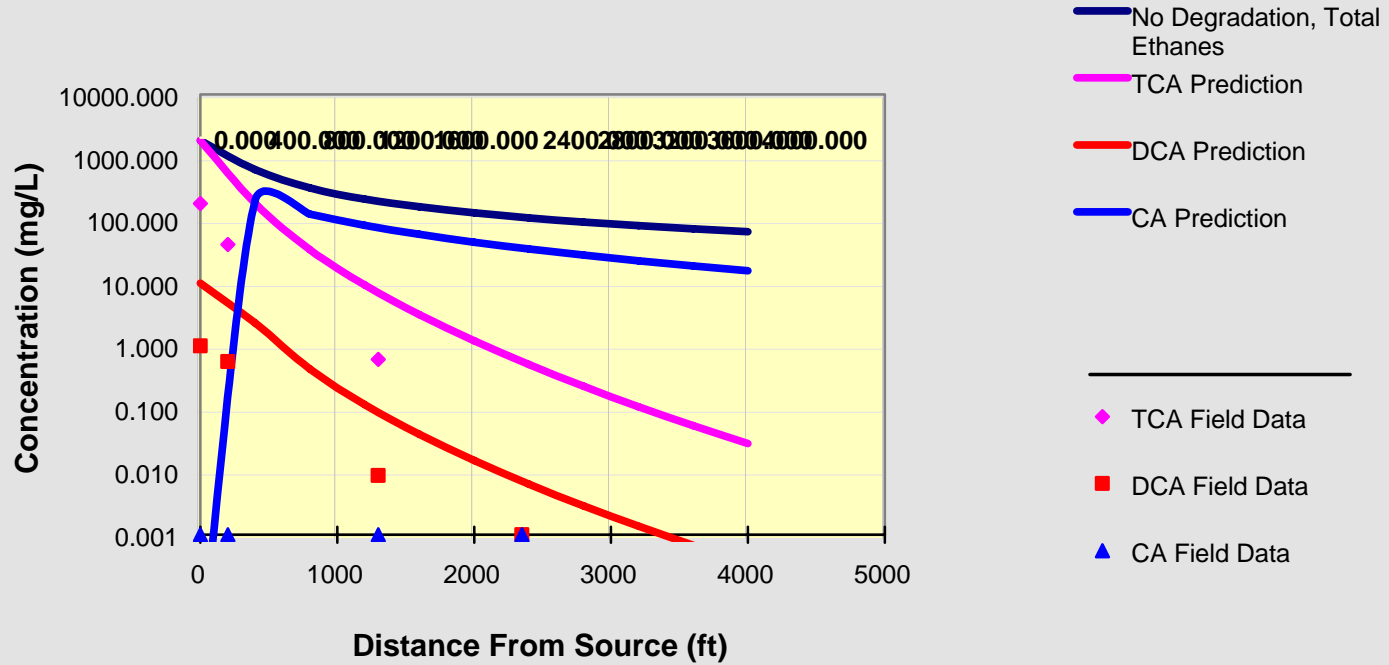
Restore Formulas

RESET

SEE OUTPUT

Paste Example

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE



Log Linear

Time:

To Input

To Individual Compounds

HOMWORK 5 SOLUTION

Question 1, Part d

A conceptual model for this site is that a variety of organic chemicals were released at the site, including benzene, toluene, ethylbenzene, and xylene (BTEX); methyl ethyl ketone (MEK); and chlorinated organic solvents including tetrachloroethylene (PCE), trichloroethylene (TCE), and 1,1,1-trichloroethene (1,1,1-TCA).

The primary source area is the former tank containment area indicated in Figure 1. The high concentrations near the source indicate that nonaqueous phase liquids are present. The concentrations of TCE and 1,1,1-TCA both exceed 10,000 µg/L, which is an indicator of the presence of DNAPL. (This observation was worth 2 points.)

Near the source, readily biodegradable chemicals such as BTEX and MEK were biodegraded aerobically. Because these chemicals are present in high concentrations, their biodegradation depleted the oxygen in the ground water, creating anaerobic conditions within a zone downgradient of the source. This then created the conditions for anaerobic degradation of the chlorinated organic chemicals. (This general conceptual model was worth 10 points.) The presence of cis-1,2-DCE indicates that TCE is being biodegraded at this site. (This observation was worth 2 points.)

In addition, 1,1,1-TCA is being degraded by abiotic hydrolysis, creating 1,1-DCE. (This observation was worth 2 points.)

The concentrations and compounds present at monitoring wells MW-7A and MW-3B are distinctly different from those at monitoring wells MW-6B and MW-8C. Therefore, the near-source zone ends someplace between MW-3B and MW-6B. (This observation was worth 2 points.) Note that BTEX and MEK are not necessarily absent at MW-7A. However, the high concentration of 1,1,1-TCA raises the detection limit for other compounds to high levels.

The low-level hits of benzene and toluene at well MW-8C are probably from other sources. These compounds are absent from MW-6B, which is nearer the chemical company. This and the highly biodegradable character of BTEX indicates these chemicals are unlikely to have traveled as far as MW-8C. However, this is a developed area, there are other industrial operations (Power Engineering and Peavey Company) as well as residential development around. Thus, there are plenty of potential places using gasoline, fuel oil, or other materials that contain BTEX. (This observation was worth 2 points.)

The threat to the public wells is uncertain. The persistence of chlorinated organic chemicals in aerobic ground water implies that these chemicals could travel a long distance if they are not fully degraded near the source. However, the hydraulic gradient near the site (see Figure 1) is not in the direction of the supply wells but rather in the direction of MW-6B, as indicated by the presence of contaminants at MW-6B. My evaluation is that contamination of the public wells by this particular source is possible but not likely.