

Nevada Division of Environmental Protection

Bureau of Corrective Actions CEM Workshop for
Remediation and Leaking Underground Storage Tank
Cases

April 22 and 24, 2025

Presented by

**The NDEP Bureau of Corrective
Actions**



NEVADA DIVISION OF
**ENVIRONMENTAL
PROTECTION**

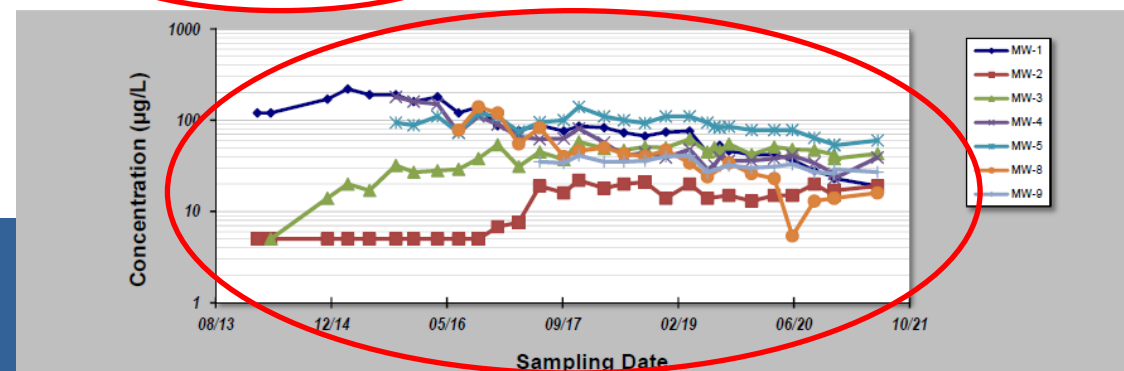


Mann- Kendall Tool Highlights

- NDEP preferred terminology: “Increasing” or “Decreasing” not expanding or contracting

GSI MANN-KENDALL TOOLKIT for Constituent Trend Analysis

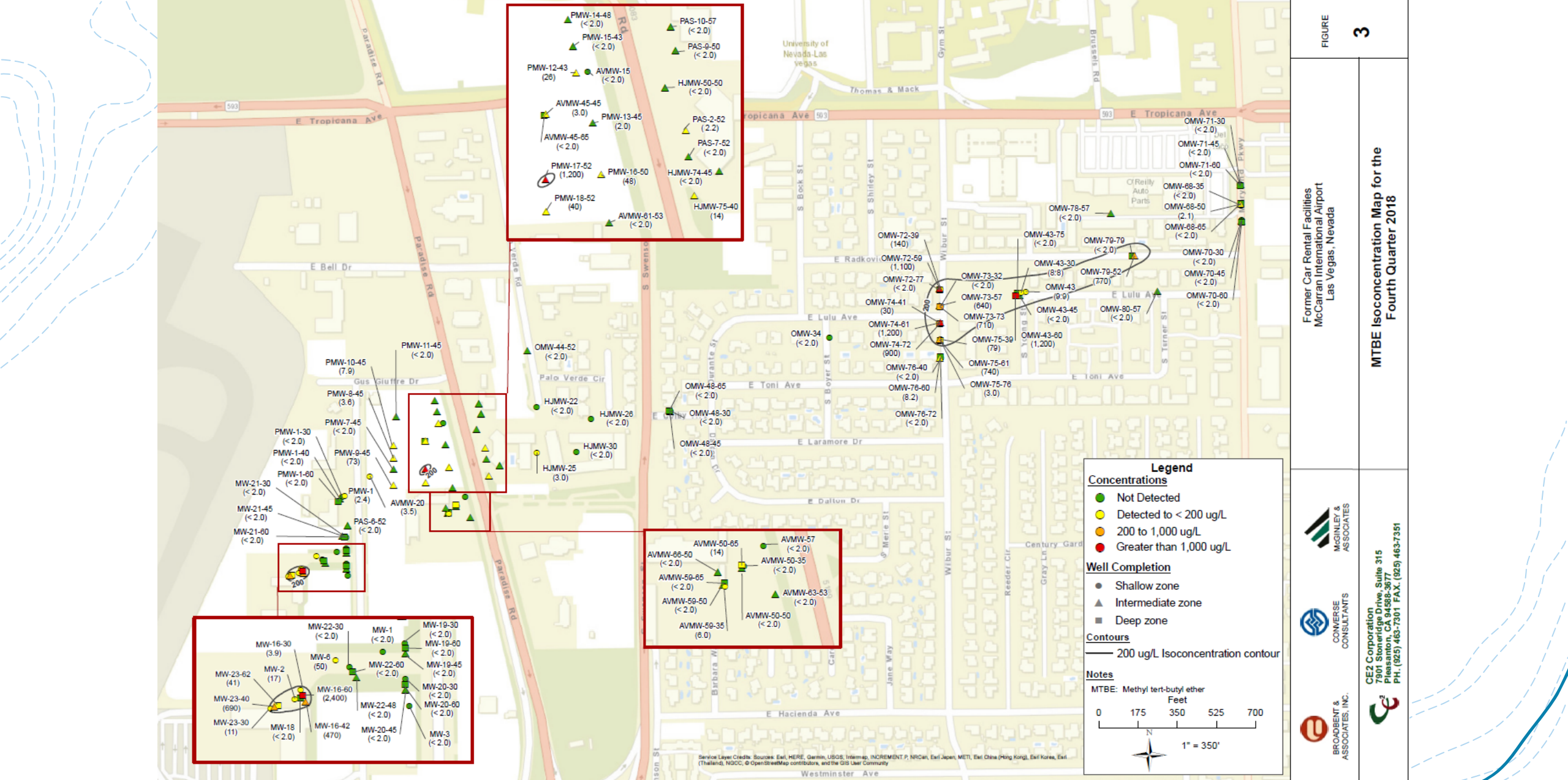
		Constituent: PCE						
		Concentration Units: µg/L						
Sampling Point ID:		MW-1	MW-2	MW-3	MW-4	MW-5	MW-8	MW-9
Sampling Event	Sampling Date	PCE CONCENTRATION (µg/L)						
1	2/10/2014	120	5					
2	4/9/2014	120	5	5				
3	12/10/2014	170	5	14				
4	3/8/2015	220	5	20				
5	6/10/2015	190	5	17				
6	10/2/2015	190	5	32	180	94		
7	12/18/2015	160	5	27	160	88		
8	3/30/2016	180	5	28	150	110		
9	6/29/2016	120	5	29	73	73	78	
10	9/23/2016	140	5	38	110	120	140	
11	12/15/2016	87	6.8	54	90	110	120	
12	3/16/2017	77	7.6	31	66	75	55	
13	6/15/2017	88	19	45	62	95	83	35
14	9/27/2017	76	16	37	63	100	40	34
15	12/1/2017	86	22	58	81	140	46	41
16	3/20/2018	83	18	49	57	110	50	35
17	6/14/2018	73	20	47	41	100	43	35
18	9/13/2018	67	21	51	44	93	40	36
19	12/12/2018	74	14	50	39	110	47	40
20	3/25/2019	76	20	62	48	110	34	41
21	6/10/2019	44	14	45	29	94	24	27
22	7/10/2019	49		50	32	85		
23	8/2/2019	53		46	39	83		
24	9/11/2019	46	15	55	36	85	34	32
25	12/17/2019				36		26	30
26	12/18/2019	42	13	42		78		
27	3/25/2020	42	15	51	38	78	23	31
28	6/11/2020	37	15	48	41	78	5.4	33
29	9/14/2020	28	20	47	34	64	13	27
30	12/8/2020							26
31	12/9/2020	24	15	42	26	54	14	
32	12/9/2020	23	17	38	23	53	14	29
33	6/14/2021				39		16	27
34	6/15/2021	19	19	43		60		
35								
Coefficient of Variation:		0.02	0.51	0.34	0.68	0.23	0.77	0.15
Mann-Kendall Statistic (S):		-389	204	181	-242	-155	-161	-67
Confidence Factor:		>99.9%	>99.9%	100.0%	>99.9%	>99.9%	>99.9%	99.8%
Concentration Trend:		Decreasing	Increasing	Increasing	Decreasing	Decreasing	Decreasing	Decreasing

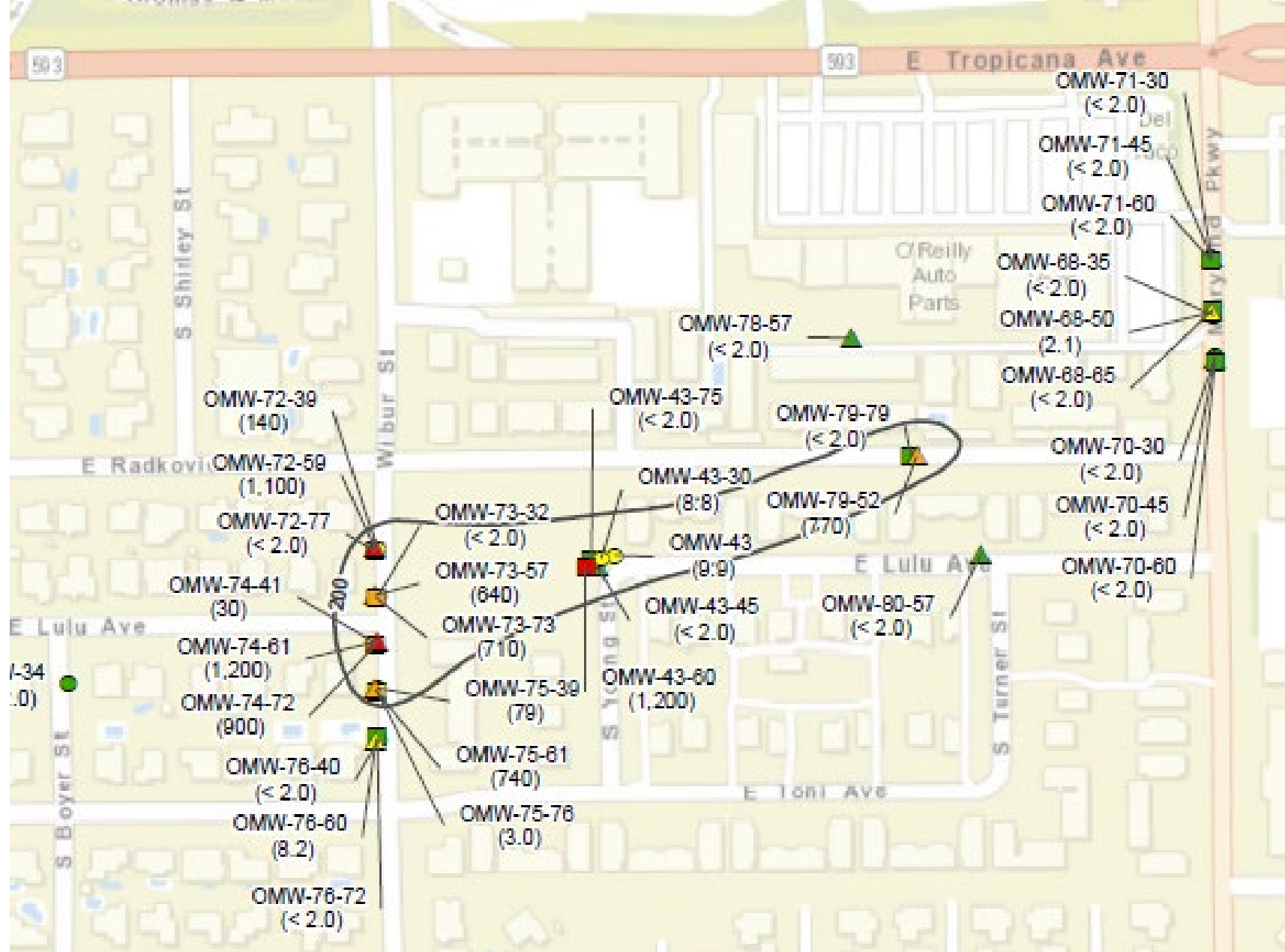


BIOSCREEN Case Study

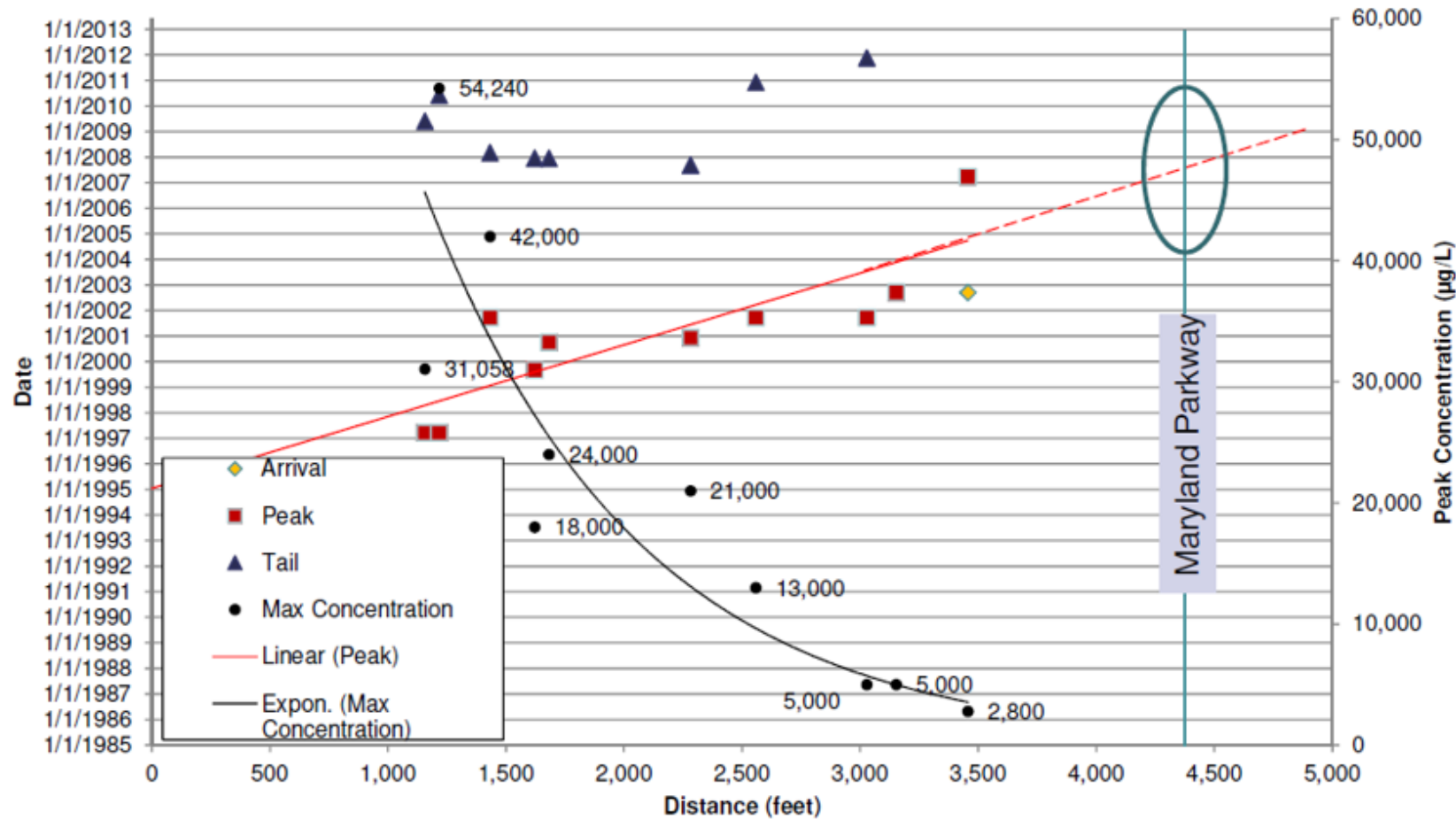
McCarran RAC Facilities Commingled MTBE Plume







Upper HSU: MTBE Arrival Times and Concentration-Distance Curve



Shallow wells
velocity ~ 350 feet
per year

Max
concentrations
decrease
exponentially
down-gradient
from source

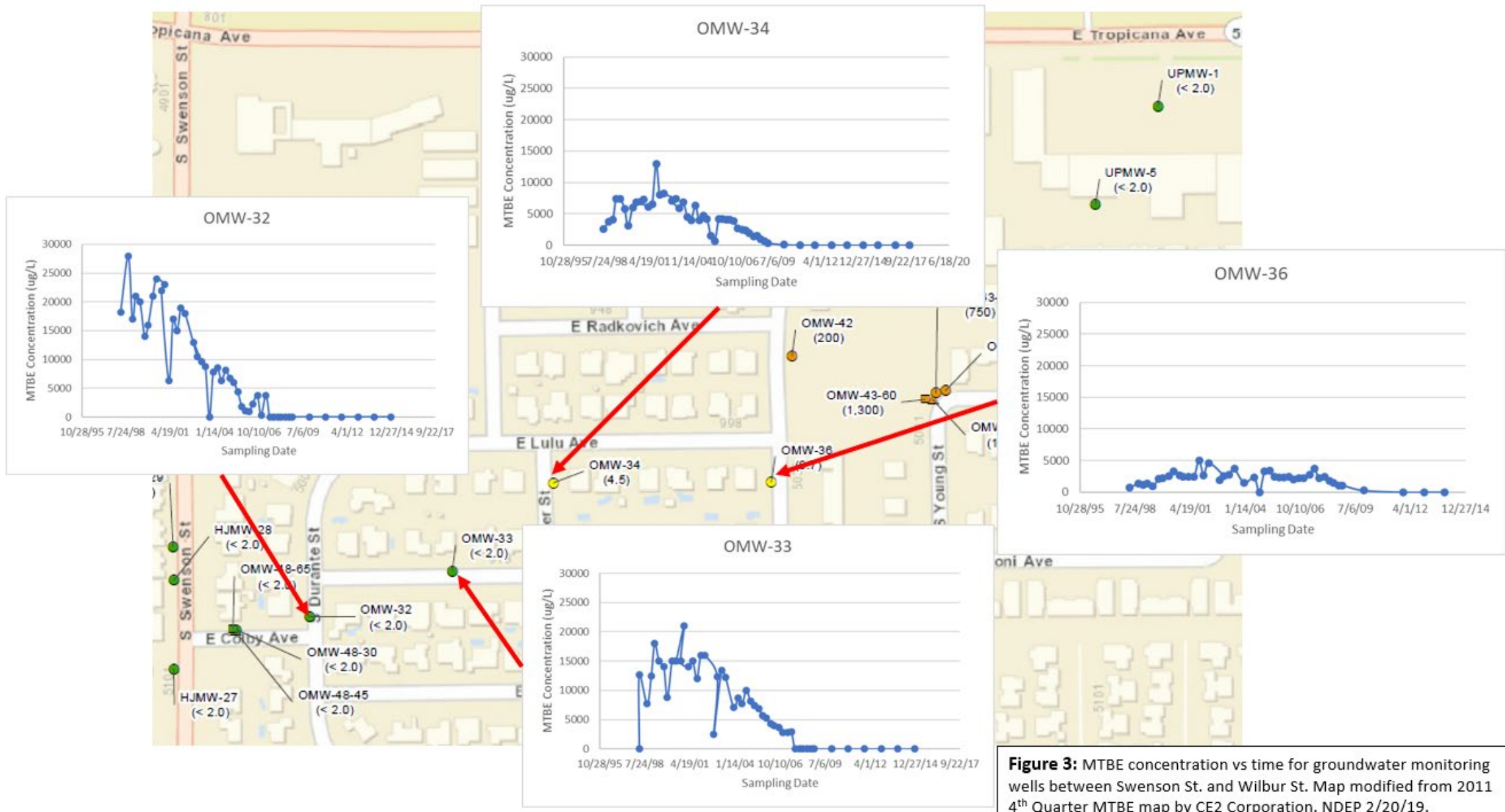


Figure 3: MTBE concentration vs time for groundwater monitoring wells between Swenson St. and Wilbur St. Map modified from 2011 4th Quarter MTBE map by CE2 Corporation. NDEP 2/20/19.

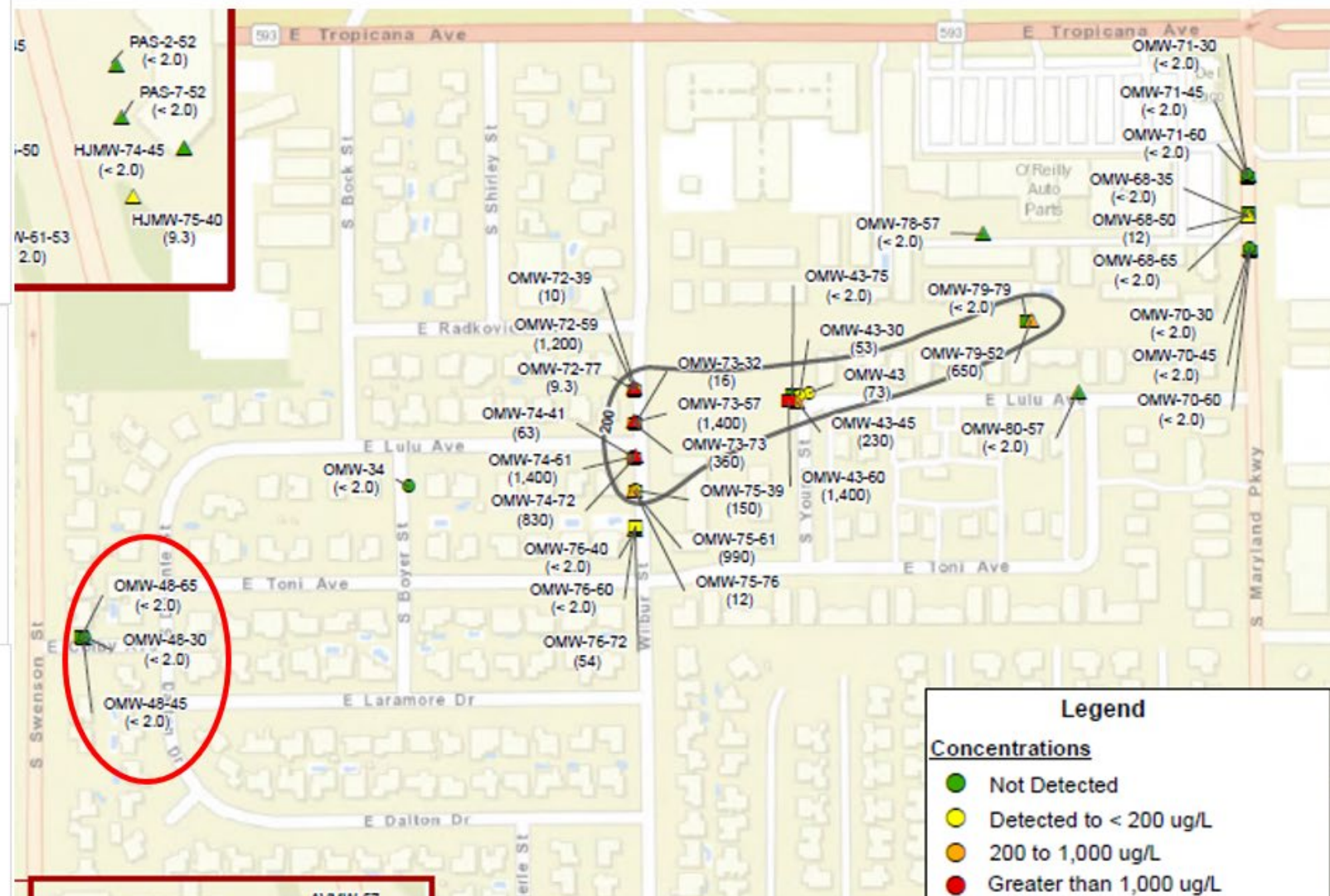
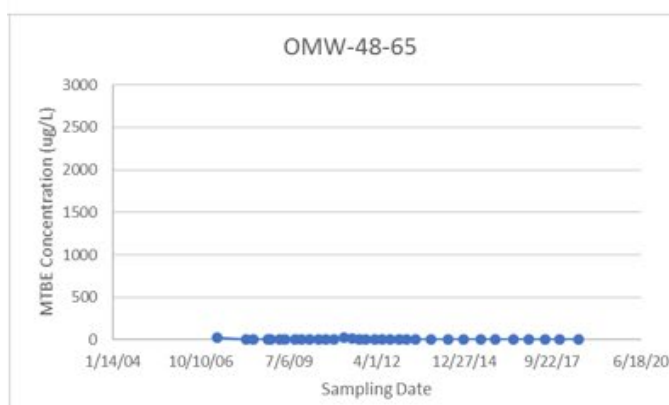
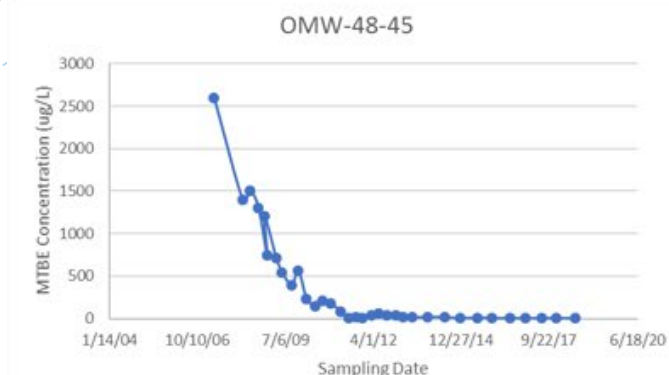
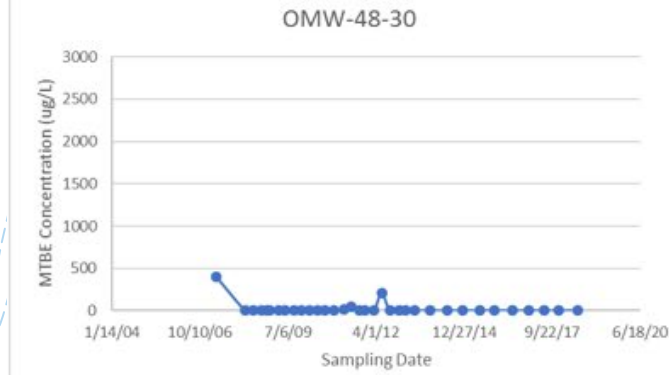
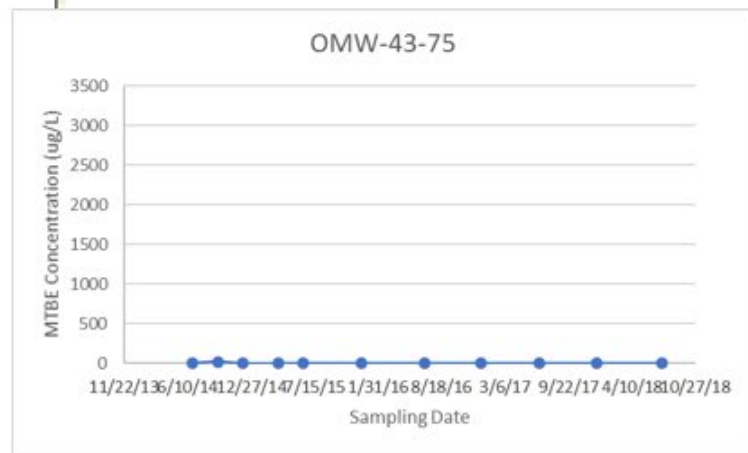
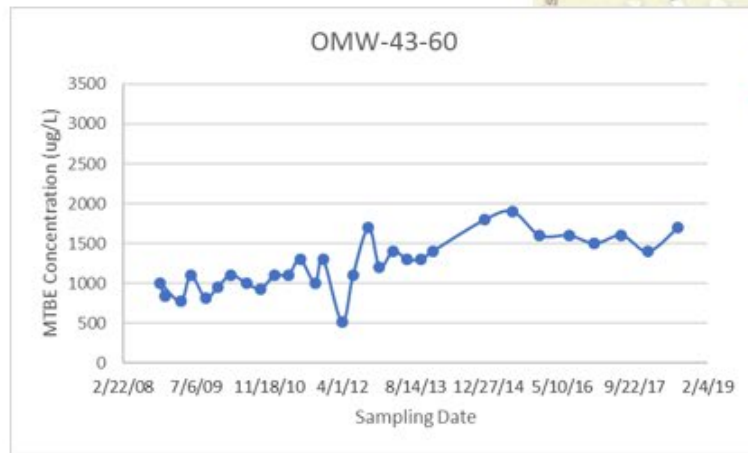
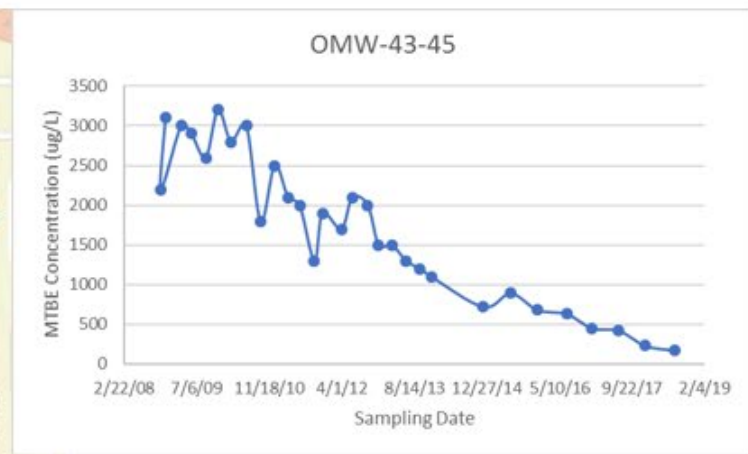
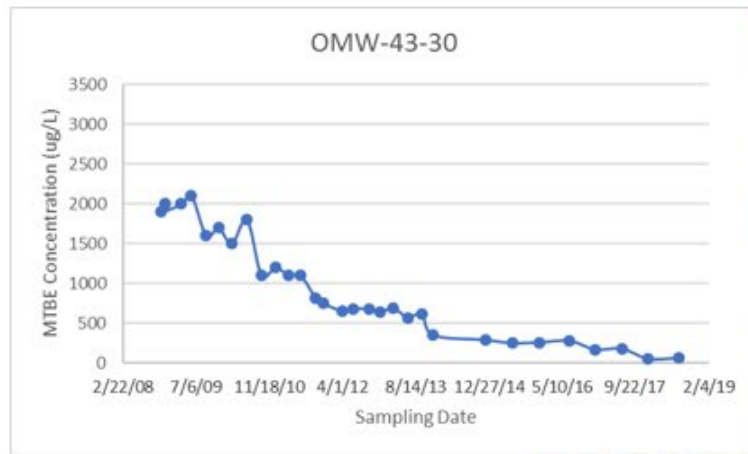


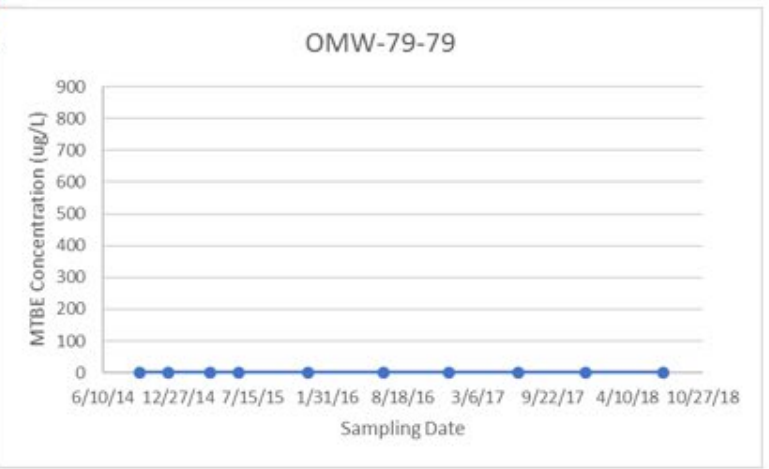
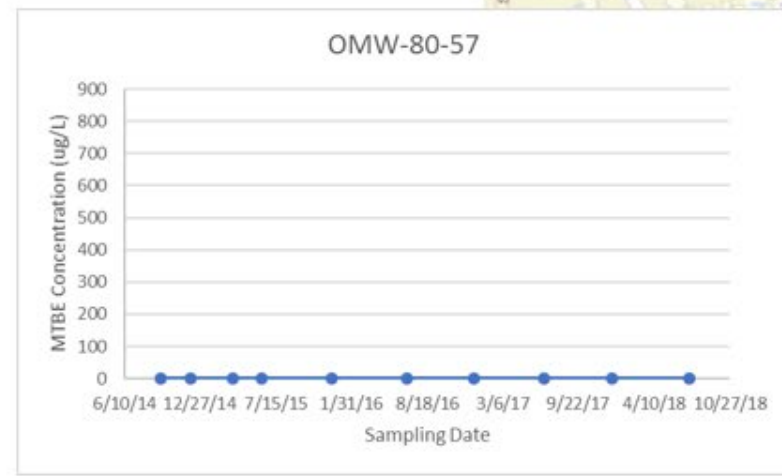
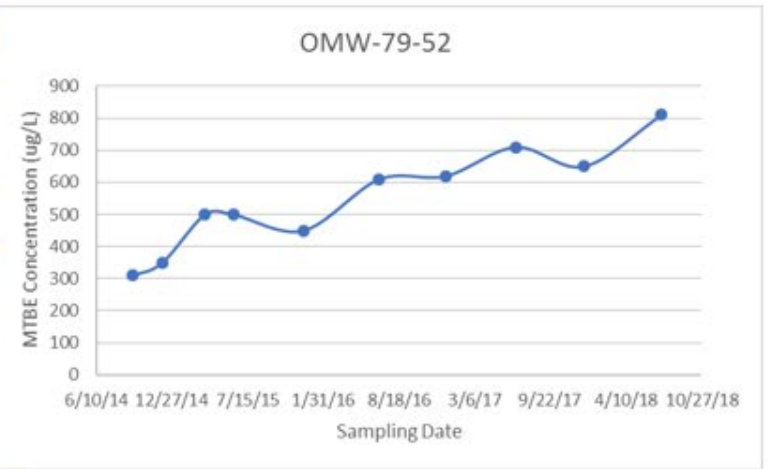
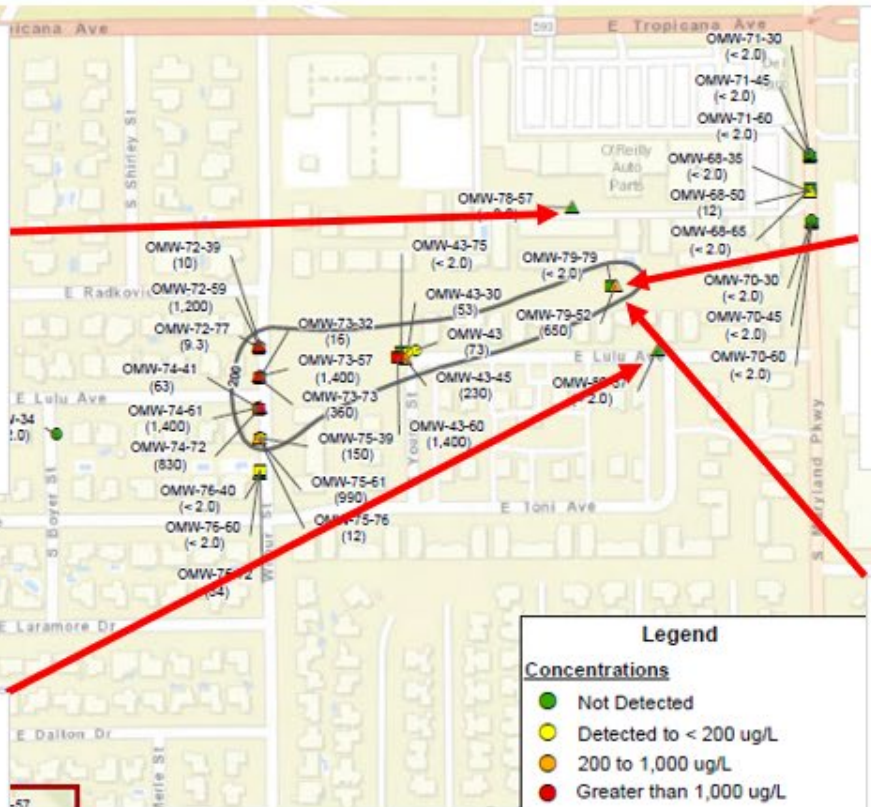
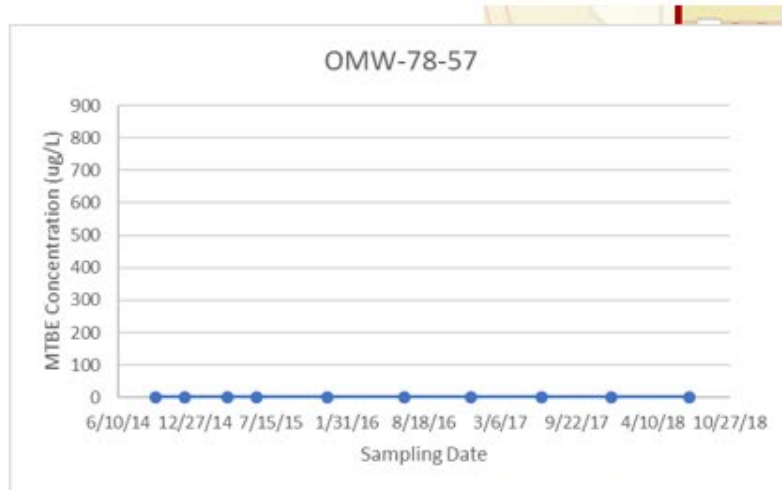
Figure 4: MTBE concentration vs time for monitoring well cluster OMW-48 upgradient of the current Off-site Plume. Map modified from 2017 4th Quarter MTBE map by CE2 Corporation, NDEP 2/20/19.

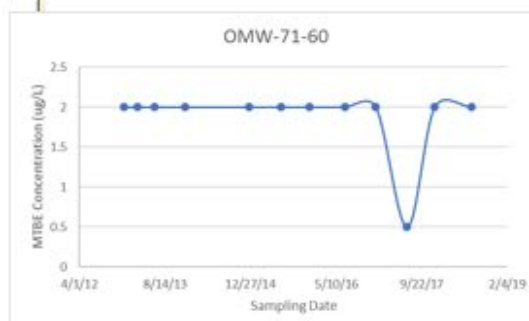
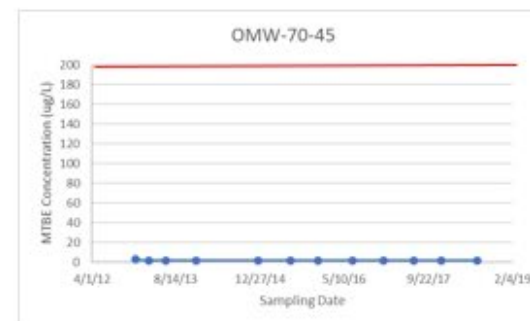
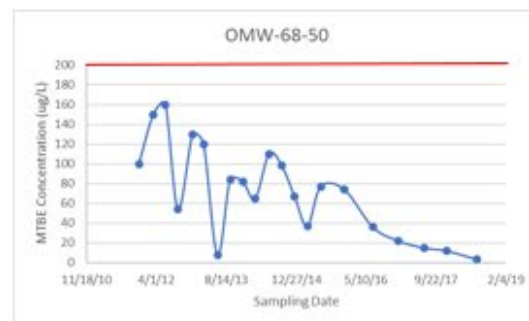
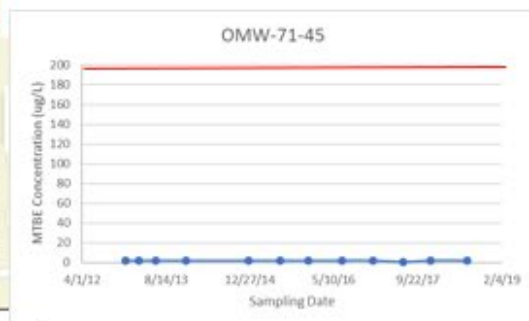
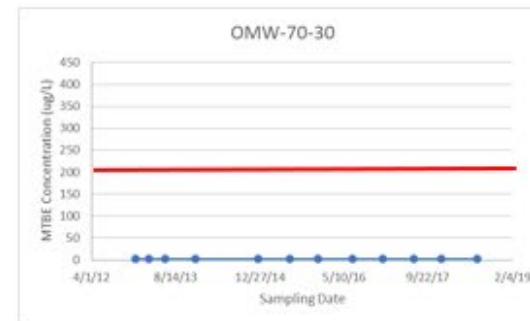
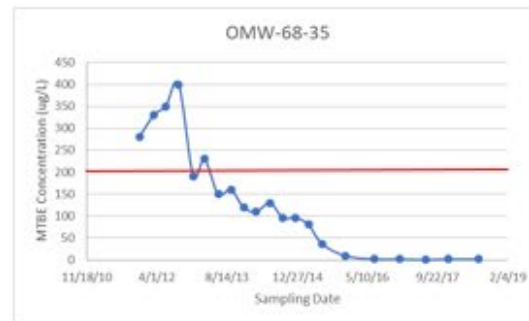
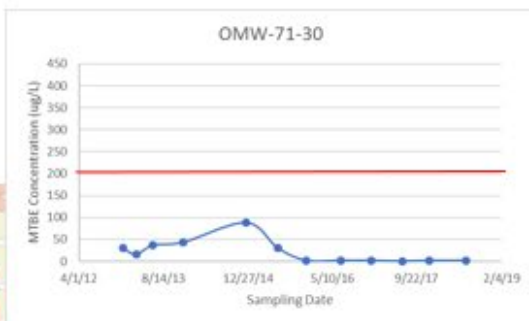


Figure 5: MTBE concentration vs time for monitoring well clusters along the Wilbur transect, near the trailing edge of the current Off-site Plume. Map modified from 2017 4th Quarter MTBE map by CE2 Corporation. The top row graphs are for shallow wells, the middle row graphs are for intermediate wells and the bottom row graphs are for deeper wells. NDEP 2/20/19.









BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Offsite Plume

MTBE

Run Name

Data Input Instructions:

1. Enter value directly....or
2. Calculate by filling in grey cells below. (To restore formulas, hit button below).
- Variable* → Data used directly in model.
20 → Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	139.7	(ft/yr)
or			
Hydraulic Conductivity	K	3.0E-03	(cm/sec)
Hydraulic Gradient	i	0.009	(ft/ft)
Porosity	n	0.2	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	32.3	(ft)
Transverse Dispersivity*	alpha y	3.2	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or			
Estimated Plume Length	Lp	2000	(ft)

3. ADSORPTION

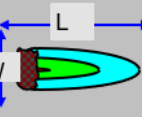
Retardation Factor*	R	1.1	(-)
or			
Soil Bulk Density	rho	1.7	(kg/l)
Partition Coefficient	Koc	11	(L/kg)
Fraction Organic Carbon	foc	3.0E-3	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	1.7E-1	(per yr)
or			
Solute Half-Life	t-half	4.00	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	2000	(ft)
Modeled Area Width*	400	(ft)
Simulation Time*	11	(yr)



6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

Source Zones:

Width* (ft)	Conc. (mg/L)*
0	0
0	0
300	2.15
0	0
0	0

Source Halflife (see Help): 90 4 (yr)

Inst. React. 1st Order

Soluble Mass 1000 (Kg)

In Source NAPL, Soil

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3

View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	2.15		1.8			.35			.067		
Dist. from Source (ft)	0	200	400	600	800	1000	1200	1400	1600	1800	2000

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE **RUN ARRAY**

View Output **View Output**

Help **Recalculate**

Paste Example Dataset

Restore Formulas for Vs,

Input Parameters

1. Seepage Velocity

-From field values for K, i, and n

2. Dispersion

-From estimated plume length

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Offsite Plume

MTBE

Run Name

Data Input Instructions:

115 or 0.02
1. Enter value directly....or
2. Calculate by filling in grey cells below. (To restore formulas, hit button below).
Variable* → Data used directly in model.
20 → Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity* Vs 139.7 (ft/yr)
or
Hydraulic Conductivity K 3.0E-03 (cm/sec)
Hydraulic Gradient i 0.009 (ft/ft)
Porosity n 0.2 (-)

2. DISPERSION

Longitudinal Dispersivity* alpha x 32.3 (ft)
Transverse Dispersivity* alpha y 3.2 (ft)
Vertical Dispersivity* alpha z 0.0 (ft)
or
Estimated Plume Length Lp 2000 (ft)

3. ADSORPTION

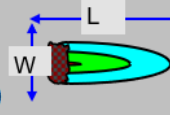
Retardation Factor* R 1.1 (-)
or
Soil Bulk Density rho 1.7 (kg/l)
Partition Coefficient Koc 11 (L/kg)
Fraction Organic Carbon foc 3.0E-3 (-)

4. BIODEGRADATION

1st Order Decay Coeff* lambda 1.7E-1 (per yr)
or
Solute Half-Life t-half 4.00 (year)
or Instantaneous Reaction Model
Delta Oxygen* DO (mg/L)
Delta Nitrate* NO3 (mg/L)
Observed Ferrous Iron* Fe2+ (mg/L)
Delta Sulfate* SO4 (mg/L)
Observed Methane* CH4 (mg/L)

5. GENERAL

Modeled Area Length* 2000 (ft)
Modeled Area Width* 400 (ft)
Simulation Time* 11 (yr)



6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

Source Zones:

Width* (ft)	Conc. (mg/L)*
0	0
0	0
300	2.15
0	0
0	0

Source Halflife (see Help):

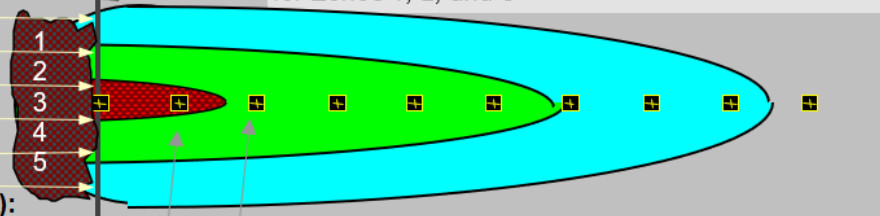
90 4 (yr)

Inst. React. 1st Order

Soluble Mass 1000 (Kg)

In Source NAPL, Soil

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	2.15		1.8			.35			.067		
Dist. from Source (ft)	0	200	400	600	800	1000	1200	1400	1600	1800	2000

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN
CENTERLINE

RUN ARRAY

View Output

View Output

Help

Recalculate

Paste Example Dataset

Restore Formulas for Vs,

Input Parameters

3.Retardation Factor

-Typically 1.1 for MTBE and PCE, 1.3 for benzene

4. Solute Half-Life

-Start with educated guess, vary in calibration

	Average Annual MTBE Concentration (ug/L)					
Year	OMW-72-59	OMW-73-57	OMW-74-61	OMW-75-61		
2014	2,200	2,200	2,100	1,400		
2015	2,150	2,100	1,130	1,250		
2016	1,550	1,105	1,600	1,015		
2017	1,300	1,450	1,105	1,045		
2018	1,100	970	880	485		
4-year	50%	56%	58%	65%	57%	average

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Offsite Plume

MTBE

Run Name

Data Input Instructions:

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- Variable* → Data used directly in model.
20 → Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	139.7	(ft/yr)
or			
Hydraulic Conductivity	K	3.0E-03	(cm/sec)
Hydraulic Gradient	i	0.009	(ft/ft)
Porosity	n	0.2	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	32.3	(ft)
Transverse Dispersivity*	alpha y	3.2	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or			
Estimated Plume Length	Lp	2000	(ft)

3. ADSORPTION

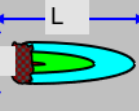
Retardation Factor*	R	1.1	(-)
or			
Soil Bulk Density	rho	1.7	(kg/l)
Partition Coefficient	Koc	11	(L/kg)
Fraction Organic Carbon	foc	3.0E-3	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	1.7E-1	(per yr)
or			
Solute Half-Life	t-half	4.00	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	2000	(ft)
Modeled Area Width*	400	(ft)
Simulation Time*	11	(yr)



6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

Source Zones:

Width* (ft)	Conc. (mg/L)*
0	0
0	0
300	2.15
0	0
0	0

Source Halflife (see Help):

90 4 (yr)

Inst. React. 1st Order

Soluble Mass 1000 (Kg)

In Source NAPL, Soil

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	2.15	1.8	.35	.067							
Dist. from Source (ft)	0	200	400	600	800	1000	1200	1400	1600	1800	2000

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN
CENTERLINE

RUN ARRAY

Help

Recalculate

View Output

View Output

Paste Example Dataset

Restore Formulas for Vs,

Input Parameters

5. Modeled Length

-Longer than
current plume

Width

-Based on field
data

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Offsite Plume

MTBE

Run Name

Data Input Instructions:

1. Enter value directly....or
2. Calculate by filling in grey cells below. (To restore formulas, hit button below).
- Variable* → Data used directly in model.
20 → Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	139.7	(ft/yr)
or			
Hydraulic Conductivity	K	3.0E-03	(cm/sec)
Hydraulic Gradient	i	0.009	(ft/ft)
Porosity	n	0.2	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	32.3	(ft)
Transverse Dispersivity*	alpha y	3.2	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or			
Estimated Plume Length	Lp	2000	(ft)

3. ADSORPTION

Retardation Factor*	R	1.1	(-)
or			
Soil Bulk Density	rho	1.7	(kg/l)
Partition Coefficient	Koc	11	(L/kg)
Fraction Organic Carbon	foc	3.0E-3	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	1.7E-1	(per yr)
or			
Solute Half-Life	t-half	4.00	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	2000	(ft)
Modeled Area Width*	400	(ft)
Simulation Time*	11	(yr)

6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

Source Zones:

Width* (ft)	Conc. (mg/L)*
0	0
0	0
300	2.15
0	0
0	0

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3

Source Halflife (see Help):	
90	4 (yr)
Inst. React.	1st Order
Soluble Mass	1000 (Kg)
In Source NAPL, Soil	

View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	2.15		1.8			.35			.067		
Dist. from Source (ft)	0	200	400	600	800	1000	1200	1400	1600	1800	2000

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE	RUN ARRAY	Help	Recalculate
View Output	View Output	Paste Example Dataset	
		Restore Formulas for Vs,	

Input Parameters

5.Simulation Time

- For calibration, should be the time between the release and a known snapshot later on
- Should not be so short that groundwater can't get to wells

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Offsite Plume

MTBE

Run Name

Data Input Instructions:

1. Enter value directly....or
2. Calculate by filling in grey cells below. (To restore formulas, hit button below).
- Variable* → Data used directly in model.
20 → Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	139.7	(ft/yr)
or			
Hydraulic Conductivity	K	3.0E-03	(cm/sec)
Hydraulic Gradient	i	0.009	(ft/ft)
Porosity	n	0.2	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	32.3	(ft)
Transverse Dispersivity*	alpha y	3.2	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or			
Estimated Plume Length	Lp	2000	(ft)

3. ADSORPTION

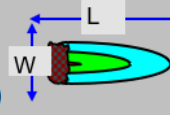
Retardation Factor*	R	1.1	(-)
or			
Soil Bulk Density	rho	1.7	(kg/l)
Partition Coefficient	Koc	11	(L/kg)
Fraction Organic Carbon	foc	3.0E-3	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	1.7E-1	(per yr)
or			
Solute Half-Life	t-half	4.00	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	2000	(ft)
Modeled Area Width*	400	(ft)
Simulation Time*	11	(yr)



6. SOURCE DATA

Source Thickness in Sat. Zone* 15 (ft)

Source Zones:

Width* (ft)	Conc. (mg/L)*
0	0
0	0
300	2.15
0	0
0	0

Source Halflife (see Help):

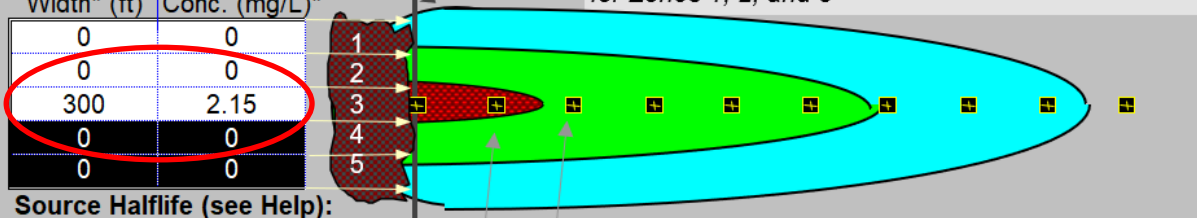
90 4 (yr)

Inst. React. 1st Order

Soluble Mass 1000 (Kg)

In Source NAPL, Soil

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	2.15		1.8			.35			.067		
Dist. from Source (ft)	0	200	400	600	800	1000	1200	1400	1600	1800	2000

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN
CENTERLINE

RUN ARRAY

View Output

View Output

Help

Recalculate

Paste Example Dataset

Restore Formulas for Vs,

Input Parameters

6. Thickness

- Based on field data

Source zone concentration

- Well closest to source

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Offsite Plume

MTBE

Run Name

Data Input Instructions:

1. Enter value directly....or
2. Calculate by filling in grey cells below. (To restore formulas, hit button below).
- Variable* → Data used directly in model.
20 → Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	139.7	(ft/yr)
or			
Hydraulic Conductivity	K	3.0E-03	(cm/sec)
Hydraulic Gradient	i	0.009	(ft/ft)
Porosity	n	0.2	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	32.3	(ft)
Transverse Dispersivity*	alpha y	3.2	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or			
Estimated Plume Length	Lp	2000	(ft)

3. ADSORPTION

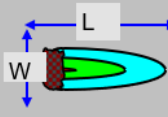
Retardation Factor*	R	1.1	(-)
or			
Soil Bulk Density	rho	1.7	(kg/l)
Partition Coefficient	Koc	11	(L/kg)
Fraction Organic Carbon	foc	3.0E-3	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	1.7E-1	(per yr)
or			
Solute Half-Life	t-half	4.00	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	2000	(ft)
Modeled Area Width*	400	(ft)
Simulation Time*	11	(yr)



6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

Source Zones:

Width* (ft)	Conc. (mg/L)*
0	0
0	0
300	2.15
0	0
0	0

Source Halflife (see Help):

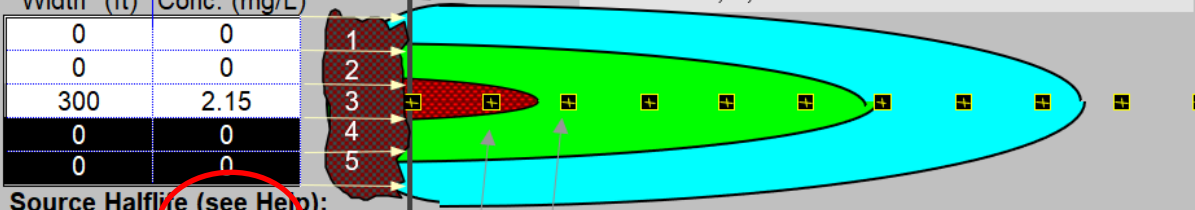
90 4 (yr)

Inst. React. 1st Order

Soluble Mass 1000 (Kg)

In Source NAPL, Soil

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	2.15		1.8			.35			.067		
Dist. from Source (ft)	0	200	400	600	800	1000	1200	1400	1600	1800	2000

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN
CENTERLINE

RUN ARRAY

View Output

View Output

Help

Recalculate

Paste Example Dataset

Restore Formulas for Vs,

Input Parameters

6. Source half life and soluble mass

- Vary during calibration

- Typically don't use
Instantaneous
Reaction

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Offsite Plume

MTBE

Run Name

Data Input Instructions:

1. Enter value directly....or
2. Calculate by filling in grey cells below. (To restore formulas, hit button below).
- Variable* → Data used directly in model.
20 → Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	139.7	(ft/yr)
or			
Hydraulic Conductivity	K	3.0E-03	(cm/sec)
Hydraulic Gradient	i	0.009	(ft/ft)
Porosity	n	0.2	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	32.3	(ft)
Transverse Dispersivity*	alpha y	3.2	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or			
Estimated Plume Length	Lp	2000	(ft)

3. ADSORPTION

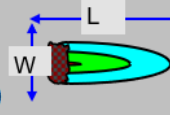
Retardation Factor*	R	1.1	(-)
or			
Soil Bulk Density	rho	1.7	(kg/l)
Partition Coefficient	Koc	11	(L/kg)
Fraction Organic Carbon	foc	3.0E-3	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	1.7E-1	(per yr)
or			
Solute Half-Life	t-half	4.00	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	2000	(ft)
Modeled Area Width*	400	(ft)
Simulation Time*	11	(yr)



6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

Source Zones:

Width* (ft)	Conc. (mg/L)*
0	0
0	0
300	2.15
0	0
0	0

Source Halflife (see Help):

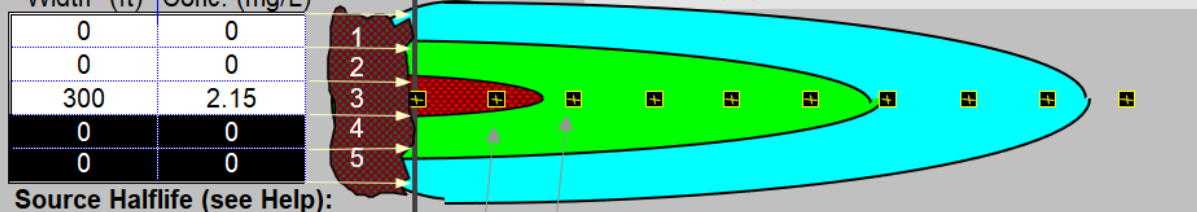
90 4 (yr)

Inst. React. 1st Order

Soluble Mass 1000 (Kg)

In Source NAPL, Soil

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	2.15		1.8			.35			.067		
Dist. from Source (ft)	0	200	400	600	800	1000	1200	1400	1600	1800	2000

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN
CENTERLINE

RUN ARRAY

Help

Recalculate

View Output

View Output

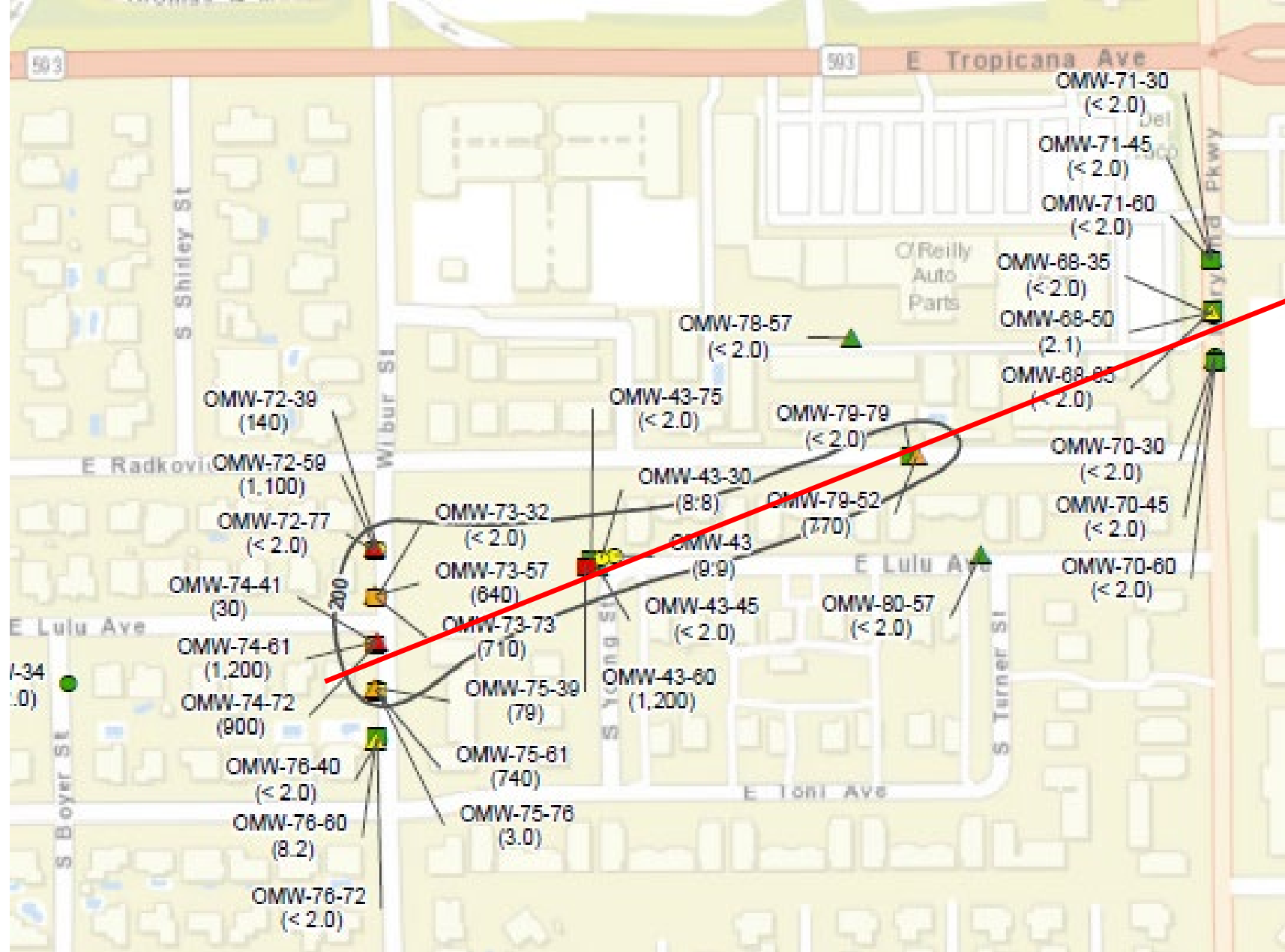
Paste Example Dataset

Restore Formulas for Vs,

Input Parameters

7. Field Data for Comparison

- Critical for calibration
- Wells near center line
- More wells are better



BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Offsite Plume

MTBE

Run Name

Data Input Instructions:

1. Enter value directly....or
2. Calculate by filling in grey cells below. (To restore formulas, hit button below).
- Variable* → Data used directly in model.
20 → Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	139.7	(ft/yr)
or			
Hydraulic Conductivity	K	3.0E-03	(cm/sec)
Hydraulic Gradient	i	0.009	(ft/ft)
Porosity	n	0.2	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	32.3	(ft)
Transverse Dispersivity*	alpha y	3.2	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or			
Estimated Plume Length	Lp	2000	(ft)

3. ADSORPTION

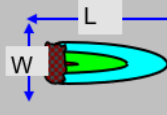
Retardation Factor*	R	1.1	(-)
or			
Soil Bulk Density	rho	1.7	(kg/l)
Partition Coefficient	Koc	11	(L/kg)
Fraction Organic Carbon	foc	3.0E-3	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	1.7E-1	(per yr)
or			
Solute Half-Life	t-half	4.00	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	2000	(ft)
Modeled Area Width*	400	(ft)
Simulation Time*	11	(yr)



6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

Source Zones:

Width* (ft)	Conc. (mg/L)*
0	0
0	0
300	2.15
0	0
0	0

Source Halflife (see Help):

90 4 (yr)

Inst. React. 1st Order

Soluble Mass 1000 (Kg)

In Source NAPL, Soil

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	2.15		1.8			.35			.067		
Dist. from Source (ft)	0	200	400	600	800	1000	1200	1400	1600	1800	2000

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE **RUN ARRAY**

View Output **View Output**

Help **Recalculate**

Paste Example Dataset

Restore Formulas for Vs,

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3

View of Plume Looking Down

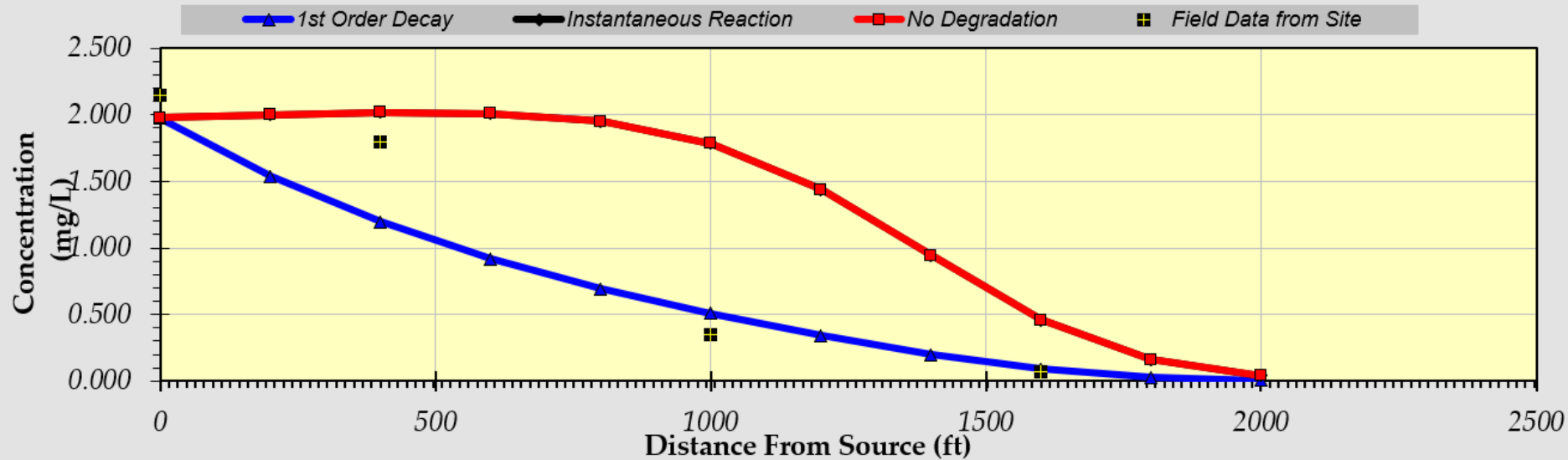
Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

Calibration

- Run model
- Adjust half-life for section 4 until curve matches field data
- Adjust source mass and half life as needed
- Only adjust seepage velocity as last resort

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

	Distance from Source (ft)											
TYPE OF MODEL	0	200	400	600	800	1000	1200	1400	1600	1800	2000	
No Degradation	1.977	2.000	2.017	2.009	1.951	1.786	1.441	0.944	0.461	0.161	0.039	
1st Order Decay	1.977	1.540	1.195	0.918	0.695	0.509	0.343	0.198	0.088	0.029	0.007	
Inst. Reaction	1.977	2.000	2.017	2.009	1.951	1.786	1.441	0.944	0.461	0.161	0.039	
Field Data from Site	2.150		1.800			0.350			0.067			



Calculate Animation

Time:

11 Years

Return to

Recalculate This

Calibration

- Never a perfect fit
- Balance between over and underprediction
- Favor down-gradient wells

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Offsite Plume
MTBE
Run Name

Data Input Instructions:

115 or 0.02
1. Enter value directly....or
2. Calculate by filling in grey cells below. (To restore formulas, hit button below).
Variable* → Data used directly in model.
20 → Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity* Vs 139.7 (ft/yr)
or
Hydraulic Conductivity K 3.0E-03 (cm/sec)
Hydraulic Gradient i 0.009 (ft/ft)
Porosity n 0.2 (-)

2. DISPERSION

Longitudinal Dispersivity* alpha x 32.3 (ft)
Transverse Dispersivity* alpha y 3.2 (ft)
Vertical Dispersivity* alpha z 0.0 (ft)
or
Estimated Plume Length Lp 2000 (ft)

3. ADSORPTION

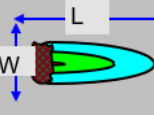
Retardation Factor* R 1.1 (-)
or
Soil Bulk Density rho 1.7 (kg/l)
Partition Coefficient Koc 11 (L/kg)
Fraction Organic Carbon foc 3.0E-3 (-)

4. BIODEGRADATION

1st Order Decay Coeff* lambda 1.7E-1 (per yr)
or
Solute Half-Life t-half 4.00 (year)
or Instantaneous Reaction Model
Delta Oxygen* DO (mg/L)
Delta Nitrate* NO3 (mg/L)
Observed Ferrous Iron* Fe2+ (mg/L)
Delta Sulfate* SO4 (mg/L)
Observed Methane* CH4 (mg/L)

5. GENERAL

Modeled Area Length* 2000 (ft)
Modeled Area Width* 400 (ft)
Simulation Time* 11 (yr)



6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

Source Zones:

Width* (ft)	Conc. (mg/L)*
0	0
0	0
300	2.15
0	0
0	0

Source Halflife (see Help):

90 4 (yr)

Inst. React. 1st Order

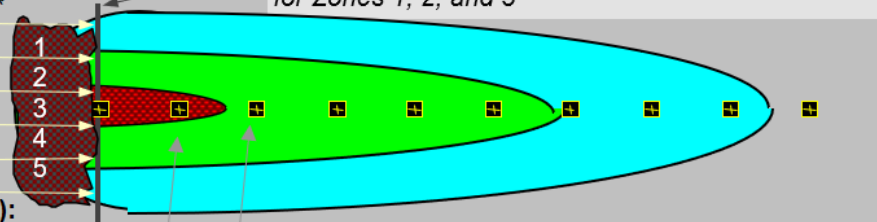
Soluble Mass 1000 (Kg)

In Source NAPL, Soil

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	2.15		1.8			.35			.067		
Dist. from Source (ft)	0	200	400	600	800	1000	1200	1400	1600	1800	2000

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE **RUN ARRAY** **Help** **Recalculate**
View Output **View Output**
Paste Example Dataset
Restore Formulas for Vs,

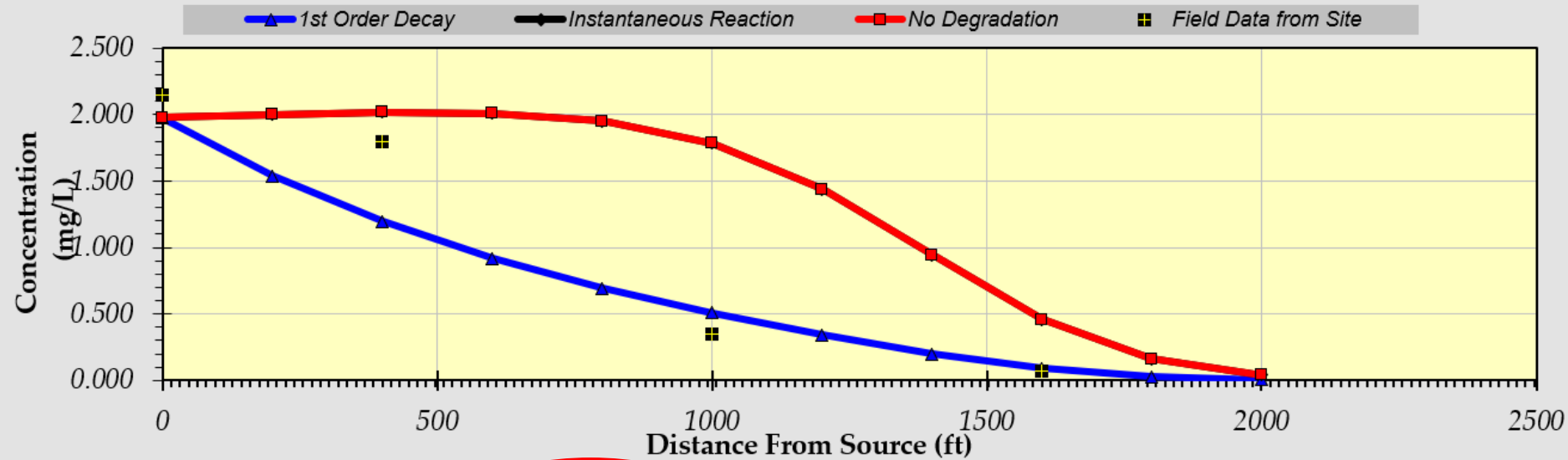
Once calibrated

- Can run a check or secondary calibration on later data, if available
- Run model at increasing simulation times
- Don't make other changes
- Focus on action level and distance



DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

	Distance from Source (ft)											
TYPE OF MODEL	0	200	400	600	800	1000	1200	1400	1600	1800	2000	
No Degradation	1.977	2.000	2.017	2.009	1.951	1.786	1.441	0.944	0.461	0.161	0.039	
1st Order Decay	1.977	1.540	1.195	0.918	0.695	0.509	0.343	0.198	0.088	0.029	0.007	
Inst. Reaction	1.977	2.000	2.017	2.009	1.951	1.786	1.441	0.944	0.461	0.161	0.039	
Field Data from Site	2.150		1.800			0.350			0.067			



Calculate Animation

Time:

11 Years

Return to

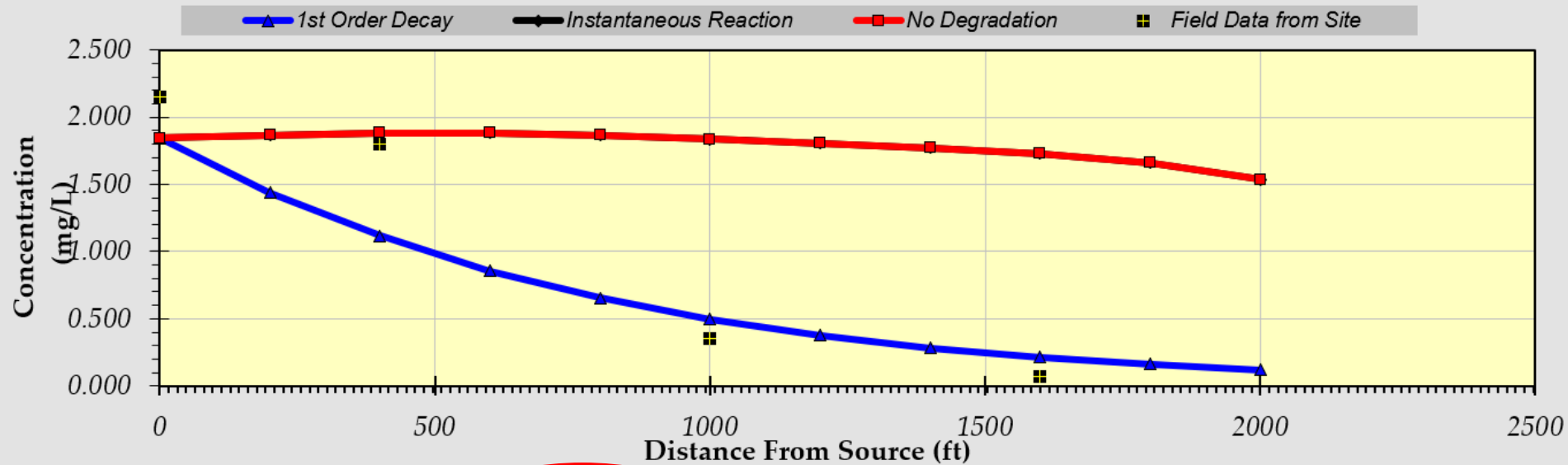
Recalculate This

At 11 years, plume is 1,400 feet long

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

	Distance from Source (ft)										
TYPE OF MODEL	0	200	400	600	800	1000	1200	1400	1600	1800	2000
No Degradation	1.845	1.867	1.884	1.882	1.865	1.838	1.807	1.773	1.730	1.661	1.538
1st Order Decay	1.845	1.437	1.116	0.858	0.654	0.496	0.376	0.284	0.215	0.161	0.120
Inst. Reaction	1.845	1.867	1.884	1.882	1.865	1.838	1.807	1.773	1.730	1.661	1.538
Field Data from Site	2.150		1.800			0.350			0.067		

At 20 years,
plume is 1,600
feet long



Calculate
Animation

Time:

20 Years

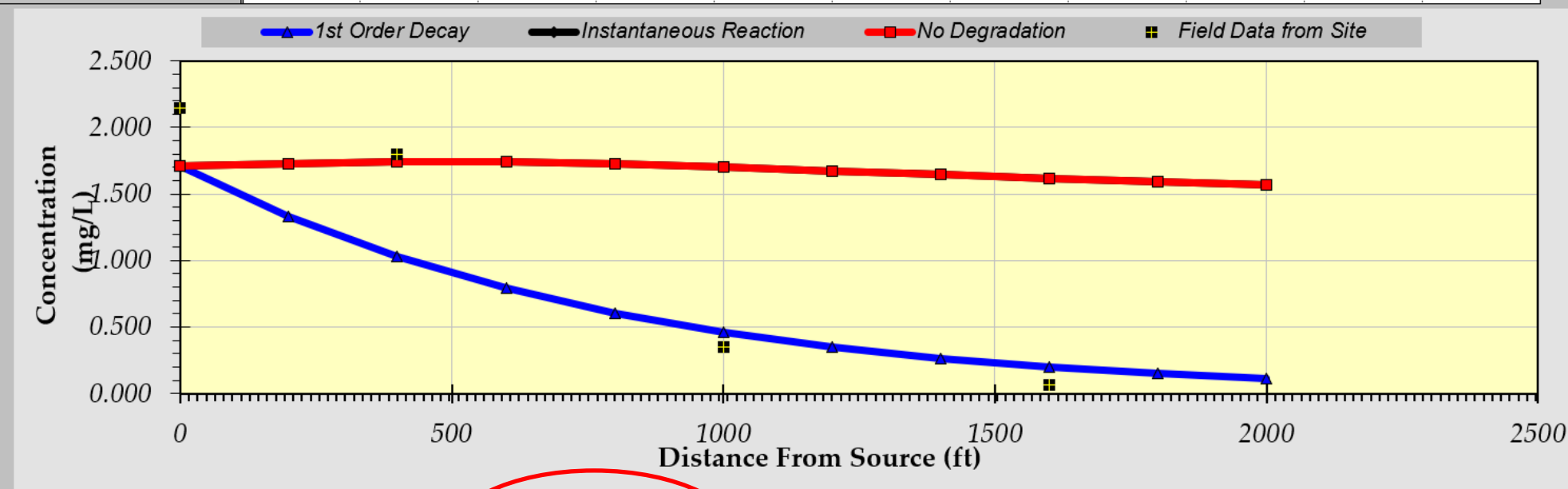
Return to

Recalculate This

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

	Distance from Source (ft)										
TYPE OF MODEL	0	200	400	600	800	1000	1200	1400	1600	1800	2000
No Degradation	1.709	1.730	1.745	1.744	1.727	1.703	1.675	1.647	1.619	1.592	1.568
1st Order Decay	1.709	1.331	1.034	0.795	0.606	0.460	0.348	0.263	0.199	0.151	0.114
Inst. Reaction	1.709	1.730	1.745	1.744	1.727	1.703	1.675	1.647	1.619	1.592	1.568
Field Data from Site	2.150		1.800			0.350			0.067		

At 30 years,
plume is 1,600
feet long



Calculate
Animation

Time:

30 Years

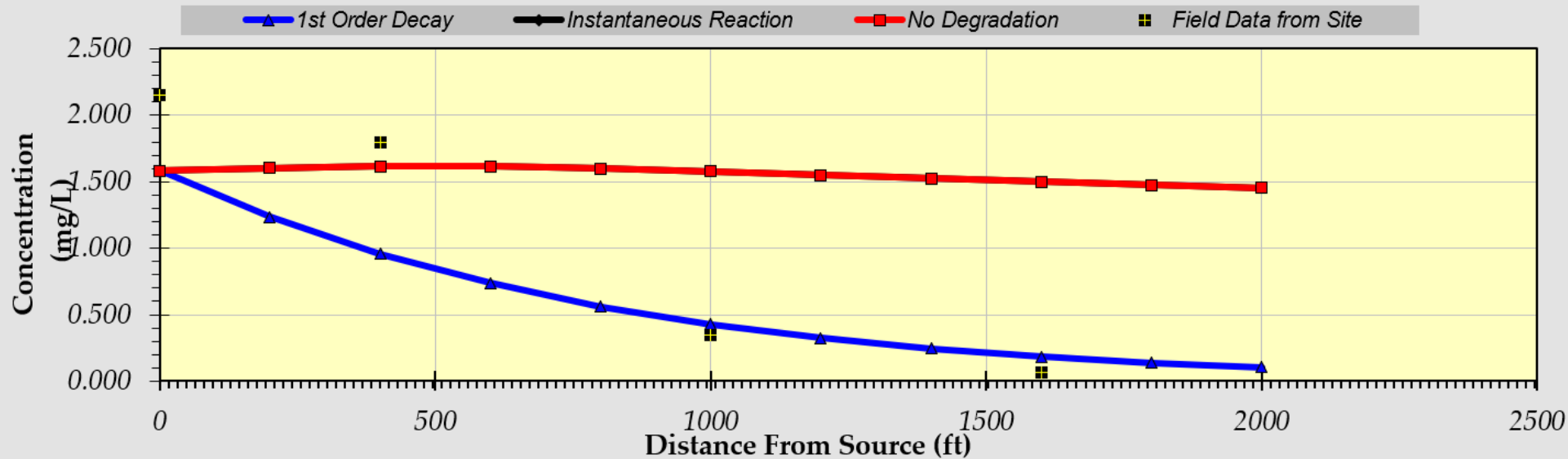
Return to

Recalculate This

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

	Distance from Source (ft)										
TYPE OF MODEL	0	200	400	600	800	1000	1200	1400	1600	1800	2000
No Degradation	1.583	1.602	1.617	1.615	1.600	1.578	1.552	1.525	1.500	1.475	1.452
1st Order Decay	1.583	1.233	0.958	0.736	0.562	0.426	0.323	0.244	0.185	0.140	0.106
Inst. Reaction	1.583	1.602	1.617	1.615	1.600	1.578	1.552	1.525	1.500	1.475	1.452
Field Data from Site	2.150		1.800			0.350			0.067		

by 40 years,
plume is
diminishing



Calculate
Animation

Time:

40 Years

Return to

Recalculate This

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Vogue
F&T Data
Run Name

TYPE OF CHLORINATED SOLVENT:

Ethenes ☒
Ethanes ☐

1. ADVECTION

Seepage Velocity* Vs 151.7 (ft/yr) **C**
or
Hydraulic Conductivity K 8.4E-03 (cm/sec)
Hydraulic Gradient i 0.007 (ft/ft)
Effective Porosity n 0.401 (-)



2. DISPERSION

Alpha x* 32.945 (ft)
(Alpha y) / (Alpha x)* 0.33 (-)
(Alpha z) / (Alpha x)* 1.E-01 (-)
Calc. Alpha x

3. ADSORPTION

Retardation Factor* R **C**
or
Soil Bulk Density, rho 1.62 (kg/L)
Fraction Organic Carbon, foc 2.0E-3 (-)
Partition Coefficient Koc
PCE 95 (L/kg) 1.77 (-)
TCE 61 (L/kg) 1.49 (-)
DCE 40 (L/kg) 1.32 (-)
VC 30 (L/kg) (-)
ETH 302 (L/kg) (-)
Common R (used in model)* = 1.49

4. BIOTRANSFORMATION

Zone 1 
PCE → TCE 0.030 (1/yr) ← 23.10 (yrs) 0.79
TCE → DCE 0.020 (1/yr) ← 34.65 (yrs) 0.74
DCE → VC 0.010 (1/yr) ← 69.30 (yrs) 0.64
VC → ETH 0.090 (1/yr) ← 7.70 (yrs) 0.45
Zone 2 
PCE → TCE 0.000 (1/yr) ←
TCE → DCE 0.000 (1/yr) ←
DCE → VC 0.000 (1/yr) ←
VC → ETH 0.000 (1/yr) ←
λ HELP

5. GENERAL

Simulation Time* 19 (yr)
Modeled Area Width* 500 (ft)
Modeled Area Length* 2000 (ft)
Zone 1 Length* 2000 (ft)
Zone 2 Length* 0 (ft)
Zone 2 = L - Zone 1

6. SOURCE DATA

Source Options
TYPE: Decaying Single Planar
Source Thickness in Sat. Zone* 25 (ft)
Width* (ft) 75
Conc. (mg/L)* C1
PCE 5.65
TCE .082
DCE .005
VC
ETH
k_s* (1/yr)
0
0
0
0
0
0

7. FIELD DATA FOR COMPARISON

PCE Conc. (mg/L)	1.295	1.03	2.3	.685	.005	.005				
TCE Conc. (mg/L)										
DCE Conc. (mg/L)										
VC Conc. (mg/L)										
ETH Conc. (mg/L)										
Distance from Source (ft)	0	150	275	440	700	1180	1875			
Date Data Collected	2024									

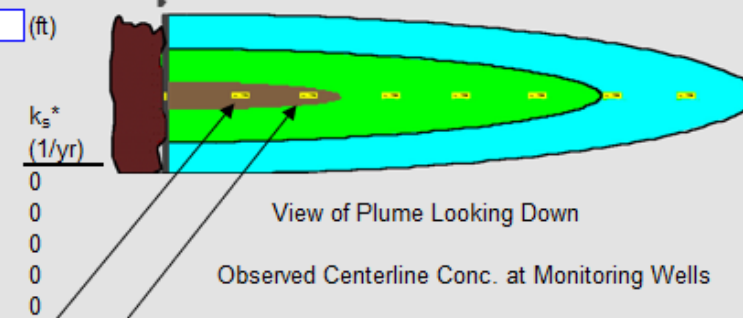
8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE **RUN ARRAY** **Help** Restore RESET
SEE OUTPUT Paste Unprotect

Data Input Instructions:

115 → 1. Enter value directly....or
↑ or 0.02 → 2. Calculate by filling in gray cells. Press Enter, then **C**
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.
Test if Biotransformation is Occurring → Natural Attenuation

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



BIOCHLOR

- Similar to BIOSCREEN
- Can estimate half life based on PCE daughter product concentrations
- NDEP will accept either model for chlorinated sites



Results Communication

Submit report to NDEP

At a minimum:

- Explain selection of each input parameter
 - Can use defaults or model recommended when site-specific data are lacking
- Briefly describe calibration procedure
 - Assumptions regarding timeframe for source release
 - Calibrated model output screenshots and comparison to field data
- Run future simulations
 - Output screenshots
- Predict ultimate length ($>$ action level) and time for entire plume to diminish to $<$ action level

Thank You! Questions?

Contact information:

Ben Moan: bmoan@ndep.nv.gov – 775-687-9396

