RESPONSE TO EPD
DECEMBER 28, 2016 AND MARCH 10, 2017 COMMENTS

CSX Transportation – Powell Duffryn

Hutchinson Island

Savannah, Chatham County, Georgia

HSI Site No. 10101

Prepared by:
Amec Foster Wheeler Environment & Infrastructure, Inc.
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May 10, 2017

Project No. 6-4300-5247

May 10, 2017 CSX-RPI Project No. 9415575

Mr. David Hayes
Georgia Environmental Protection Division
Hazardous Site Response Program
205 Butler Street, Floyd Towers East
Atlanta, Georgia 30334

Subject: **Response to EPD December 28, 2016 and March 10, 2017 Comments**
CSX Transportation- Powell Duffryn
Hutchinson Island, Savannah, Chatham County, Georgia
HSI Site No. 10101

Dear Mr. Hayes:

On behalf of CSX Real Property, Inc. (CSX-RPI) Amec Foster Wheeler Environment & Infrastructure, Inc. (Amec Foster Wheeler) has prepared this response to comments by the GA-EPD regarding the Voluntary Remediation Program Compliance Status Report (CSR) dated August 1, 2016 for the referenced site. The EPD issued a series of comments via email on December 28, 2016 and in a letter dated March 10, 2017. Responses were requested by May 10, 2017.

This letter responds to the comments presented by GA-EPD. Please contact us if further information or clarification is necessary.

Sincerely,

Amec Foster Wheeler Environment & Infrastructure, Inc.

Stephen R. Foley, P.G.
Senior Geologist

Charles T. Ferry, P.E.
Senior Principal

With permission by: TC

Attachments

cc: Mr. Coley Campbell, P.E., CSX Real Property, Inc.
Mr. Matthew Grostick, P.E., Amec Foster Wheeler

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RESPONSE TO DECEMBER 2016 COMMENTS

EPD's comments and our responses to them are discussed in the order in which they appeared in EPD's email dated December 28, 2016.

Comment 1. EPD provided several comments on groundwater modeling via email on December 28, 2016.

1. Table C-1 of the CSR is not adequate to address Comment #1.a. in EPD's February 26, 2016 letter addressed to CSX c/o Mr. Samuel Ross.

   a. Sources of several input values are not sufficiently detailed enough as follows:

   Hydraulic Conductivity and Gradient: Please provide the range (maximum and minimum) of site specific values acquired from field observations at the site for comparison with the final value input into the calibrated model. EPD acknowledges that Section 10.2.7 of the CSR indicates average hydraulic conductivity values from slug tests were used in the "calibration run" of the model, but the table should indicate this as well. Furthermore, it may be more appropriate to use an average of historically measured hydraulic gradient values rather than a value representing data acquired on a single day.

   ii. Effective Porosity, Aquifer Matrix Bulk Density, and Koc: Please provide the bibliographic literature reference used to estimate the input values used and provide the published range if available for comparison with the final value input into the calibrated model.

   iii. First Order Decay Coefficient: Please provide the range of published values from your literature source for comparison with the final value input into the calibrated model. Furthermore, first order decay coefficients used for "degradation products" should be included on the table.

   iv. Source Decay Constant: Please add this input value to the table and indicate the value calculated from site-specific data if the value in the model was manipulated.

   v. Biotransformation yields: Please include the values used in the model along with the source of the values on a revised input table. Furthermore, graphs and/or calculations used to determine them should also be provided as backup documentation.

   vi. Source Concentrations: Please include the source concentrations used for ammonia and its "degradation" products in the model on the referenced table. Furthermore, the table indicates that the initial source concentration for the southern lobe of the groundwater contaminant was estimated based on current concentration and estimated release date. Please include a note that includes the maximum concentrations of the contaminants of concern detected at that source location.

   vii. Several model input values (hydraulic gradients, dispersion factors, etc.) posted on Table C-1 are not the same as those shown on the paper printouts of the model input sheets or the digital copies of the modeling runs provided in

Appendix C of the CSR. EPD recommends that the referenced table be revised to include the actual input values used to "calibrate" the model with comments providing the ranges of field measured and/or literature values. Please see the example table below, which does not include all model input parameters:

b. Please provide copies of graphs and calculations used to determine the base value for the source decay constant, before manipulation, during calibration referenced in Section 10.2.6 of the CSR and as requested in Comment No. 1 e. of the February 26, 2016 EPD letter referenced above. These must be provided as justification for the source decay constant used in the model, even if the calculated value was manipulated during model calibration.

Response to Comment 1: The requested reference information and ranges of values, where appropriate, have been input into the attached Table C-1. Table C-1 has also been corrected to be consistent with the model calibration input values.

Comment 2. The model has not been validated in the CSR as requested in Comment #2 of the referenced February 2016 EPD letter. The "calibration run" predictions were compared to the data set used to "calibrate" the model in Table C-4 of the CSR, but comparison of additional data sets vs predicted values was not provided to validate the model as requested. Please revise Table C-4 using a minimum of one data set collected prior to the 2015 data set used in the initial "calibration run". Note that validation should be conducted prior to the extended model runs predicting contaminant plume behavior into the future as provided in the CSR, and requested in Comment #3.a. of the February 2016 EPD letter.

Response to Comment 2: Validation runs were completed using data from the December 2014 sampling event for the northern plume and the December 2013 sampling event for the southern plume. Note that the Point of Demonstration (POD) wells utilized for the northern plume were not installed until 2014; therefore, earlier data was not available to compare the predicted results with field data in the area downgradient of the source well TMW-1. Further, the 2013 data utilized for the southern plume selected as earlier sampling data in the area, downgradient of the source area well EW-1, did not include analysis of all ammonia degradation products. In both instances, analyses included only ammonia and nitrate in the source area and downgradient wells. Nitrite analysis was not requested by EPD until the 2015 sampling events.

Comment 3. Please respond to Comment #3.b. of the February 2016 EPD letter after validating the model results as referenced in Comment #2 above.

Response to Comment 3: Model validation has not affected the predicted maximum extent or maximum acceptable concentrations as previously documented in the CSR. The applicable Biochlor output sheets are attached herein.

Comment 4. Comment #4 of the February 2016 EPD letter has not been adequately addressed. Please see Comment #1.a.v. above.

Response to Comment 4: The biotransformation yield represents the ratio of the molecular weight of the daughter product to the molecular weight of the parent compound. These values have been input into the revised model as illustrated on the attached Biochlor output sheets.

RESPONSE TO MARCH 2017 COMMENTS

The following comments and our responses to them are discussed in the order in which they appeared in EPD's letter dated March 10, 2017.

Comment 1: EPD provided several comments on groundwater modeling via email on December 28, 2016.

Response to Comment 1: See above discussion.

Comment 2. On Figures 12 and 13, the isoconcentration lines for naphthalene and benzene are shown in the legend as having units of milligrams per liter (mg/L). However, groundwater concentrations in Table 5 indicate that the isoconcentration lines should have units of micrograms per liter (ug/L). Please verify the correct units and update these figures accordingly.

Response to Comment 2: The figures have been corrected and are included herein.

Comment 3. The vapor intrusion pathway has not been sufficiently evaluated for future buildings. The generally shallow depths to impacted groundwater (less than 5 feet) along with the historical presence of petroleum source material and light non-aqueous phase liquid indicate that the potential for vapor intrusion should be evaluated based on soil gas sampling. Although this pathway is currently incomplete because there are no buildings present, it must be evaluated prior to future building construction. At a minimum, soil gas should be sampled for ammonia and volatile organic compounds. The pathway evaluation should be based on the United States Environmental Protection Agency (USEPA) *Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air* dated June 2015.

Response to Comment 3: A preliminary vapor intrusion risk evaluation was completed in June 2016 for ammonia, benzene, naphthalene, and xylenes for the CSXT parcel based on one line of evidence (i.e. groundwater data). The evaluation indicated the potential for unacceptable risk to future residents and future site workers if future buildings are constructed over an area of groundwater impact. As such, a Uniform Environmental Covenant (UEC) has been drafted for the site that includes the evaluation of potential risk and/or hazardous for intrusion of vapors prior to building any residential structure on the property and, if warranted, installation of a mitigation system.

Comment 4. In Section 10.2, the CSR states that groundwater concentrations are below risk reduction standards for construction and utility workers. However, an evaluation of the groundwater exposure scenario for construction and utility workers was not presented. Please present an evaluation of this exposure scenario and/or include appropriate controls (e.g., digging restrictions) in the Uniform Environmental Covenant (UEC). Management of excavation dewatering should also be considered.

Response to Comment 4: Groundwater is shallow in depth and dewatering of construction trenches would be necessary. Precautions during construction regarding direct contact with groundwater or working in a trench is included in the draft UEC.

Comment 5. Section 8.2.4 of the CSR states that soil containing petroleum source material was left in place around four (4) utility poles to provide structural support. Leaving this source

material in place requires the use of Type 5 risk reduction standards. The certification of compliance with risk reduction standards should be updated accordingly. Please verify that the petroleum source material is not present from 0–2 feet below the ground surface. The locations of petroleum source material remaining in place should be clearly identified in the UEC. A monitoring and maintenance plan should provide for periodic evaluation of these areas and annual reporting to EPD.

Response to Comment 5: As part of planned upcoming site closure activities, CSXT is contemplating the removal and proper disposal of the impacted soil remaining around the four utility poles, followed by submittal of a report to EPD. Should this plan change, a figure documenting the location of the impacted material will be included in the UEC along with a land use restriction.

Comment 6. In accordance with §12-8-107(f) of the Voluntary Remediation Program Act and §391-3-19-.06(5) of the Rules for Hazardous Site Response, please provide copies of the CSR public notice published in the local legal organ and provided to the local city and county governments.

Response to Comment 6: Copies of the public notifications are included herein.

ATTACHMENTS

BIOCHLOR DATA TABLES AND OUTPUT SHEETS

Table C-1 – Summary of Biochlor Input Parameters

Parameter	Input Value Used with Units		Range of Observed or Published Values		Bibliographic Reference
	Northern Plume	Southern Plume	Northern Plume	Southern Plume	
Hydraulic Conductivity	7.8 x 10^{-4} cm/sec	3 x 10^{-3} cm/sec	9.2 x 10^{-5} cm/sec - 2.0 x 10^{-3} cm/sec	8.53x 10^{-4} cm/sec - 7.01x 10^{-3} cm/sec	Average of slug test results from the northern and southern plume areas, AMEC Modified Corrective Action Plan, dated June 6, 2009.
Hydraulic Gradient	0.0069	0.0015	0.01 – 0.021	0.001 - 0.005	Average of gradients calculated along flow paths from source area wells TMW-1 and EW-1 during semi-annual static water level measurements between December 2013 and December 2016
Effective Porosity	0.25	0.25	0.16– 0.46	0.16 – 0.46	Groundwater Hydrology and Hydraulics, McWorter and Sunada, 1977
Longitudinal Dispersivity Transverse Dispersivity Vertical Dispersivity	30 0.1 1x10^{-99}	60 0.1 1x10^{-99}			10% of estimated plume length 0.1 x longitudinal dispersivity Biochlor recommended value
Retardation Factor	4	2			Initially calculated from $R=1+K_{oc} \times f_{oc} \times \rho/n$, then adjusted for effect related to clay content of soil based on comparison with field data
Aquifer Matrix Density	1.7 gm/cm^3	1.7 gm/cm^3	1.55 – 1.80	1.55 – 1.80	General Guide for Estimating Moist Bulk Density, Natural Resources Conservation Service
Foc	0.001	0.001			Biochlor default value
Koc Ammonia Nitrite Nitrate	 14 NA 0.01	 14 NA 0.01			 Toxicological Profile for Ammonia, Agency for Toxic Substances and Disease Registry, September 2004. GSI Environmental Chemical Database.
Source Concentrations, mg/L Ammonia Nitrite Nitrate	 18,000 0.19 250	 1,100 <0.05 0.29	 330-18,000 <0.05 - 0.19 100 - 250	 2.5 – 1,100 <0.05 – 0.081 <0.05 – 0.29	For both the northern and Southern plumes, the highest ammonia and nitrate concentrations detected to data were utilized as source area concentrations.
Source Decay Constant	0.04	0.035			Ks = the slope of the semi-log plot of the ammonia concentration in the source area well, TMW-1. The calculated value was modified to match observed field conditions.
Biotransformation Rate Coefficient Ammonia – Nitrite Nitrite - Nitrate	 0.533 0.693	 0.533 0.693	 0.116 - 0.693	 0.116 - 0.693	Based on calibration to field data using 40-year simulation time (release of ammonia assumed in the 1970s). Started with literature values (Buss, S.R., Herbert, A.W., Morgan, P., & Thornton, S.F., 2003) and adjusted model to fit field data.
Biotransformation Yields Ammonia – Nitrite Nitrite - Nitrate	 2.75 1.35	 2.75 1.35			Biochlor calculated value equal to the ratio of the molecular weight of the daughter product to the molecular weight of the parent compound.
Plume Length	200	540			Northern plume modeled from TMW-1 to PDMW-49, located adjacent to drainage canal. Southern plume modeled from EW-1 to PDMW-30P.
Plume Width	300	180			Modeled area widths were estimated based on location of 100 mg/L isopleth.
Simulation Time	150	150			Simulation time from estimated release to point at which ammonia plume begins to recede.
Source Thickness, ft.	10	10			From monitoring well boring logs.
Source Width, ft.	300	100			Modeled as a single-plane source based on location of 100 mg/L isopleth.
Source Concentrations, mg/L	18000	5000			TW-1 data represents the highest concentration detected to date. EW-1 initial concentration estimated based on current concentration and estimated release date.

Table C-2 - Model Sensitivity Analysis; Calculated for May 2015 at PDMW-49

Hydraulic Conductivity (Baseline = 7.8 x 10^{-4} cm/sec)				
Constituent	Concentrations (mg/L)			
	2x Baseline	Baseline	0.5xBaseline	Observed
NH_3	296	10.7	0.001	0.63
Hydraulic Gradient (Baseline = 0.005)				
Constituent	Concentrations (mg/L)			
	2x Baseline	Baseline	0.5x Baseline	Observed
NH_3	296	10.7	0.001	0.63
Effective Porosity (Baseline = 0.25)				
Constituent	Concentrations (mg/L)			
	1.2x Baseline	Baseline	0.8x Baseline	Observed
NH_3	1.85	10.7	49.8	0.63
Longitudinal Dispersivity (Baseline = 30 feet)				
Constituent	Concentrations (mg/L)			
	1.5x Baseline	Baseline	0.5x Baseline	Observed
NH_3	22.7	10.7	2.3	0.63
Transverse Dispersivity (Baseline = 0.1 x Longitudinal Dispersivity)				
Constituent	Concentrations (mg/L)			
	2x Baseline	Baseline	0.5x Baseline	Observed
NH_3	10.7	10.7	10.7	0.63
Retardation Factor (Baseline = 4.0)				
Constituent	Concentrations (mg/L)			
	1.5x Baseline	Baseline	0.5x Baseline	Observed
NH_3	0.5	10.7	14.1	0.63
Aquifer Matrix Density (Baseline = 1.7 gm/cm^3)				
Constituent	Concentrations (mg/L)			
	1.2x Baseline	Baseline	0.90x Baseline	Observed
NH_3	10.6	10.7	10.7	0.63
Foc (Baseline = 0.001)				
Constituent	Concentrations (mg/L)			
	1.5x Baseline	Baseline	0.85x Baseline	Observed
NH_3	10.7	10.7	10.7	0.63
Koc (Baseline = 14)				
Constituent	Concentrations (mg/L)			
	1.5x Baseline	Baseline	0.5x Baseline	Observed
NH_3	10.7	10.7	0.03	0.63
Biotransformation Rate Constant (Baseline = 0.533)				
Constituent	Concentrations (mg/L)			
	1.5x Baseline	Baseline	0.5x Baseline	Observed
NH_3	3.0	10.7	114	0.63
First Order Decay Constant **(Baseline = 0.04)**				
Constituent	Concentrations (mg/L)			
	1.5x Baseline	Baseline	0.5x Baseline	Observed
NH_3	1,632	3,634	8,087	3,600
Source Width (Baseline = 300 Ft)				
Constituent	Concentrations (mg/L)			
	1.5x Baseline	Baseline	0.85x Baseline	Observed
NH_3	10.7	10.7	10.7	0.63

Table C-3 - Model sensitivity analysis; calculated for May 2015 at PDMW-30P

Hydraulic Conductivity (Baseline = 3.0 x 10^{-3} cm/sec)				
Constituent	Concentrations (mg/L)			
	2x Baseline	Baseline	0.5xBaseline*	Observed
NH_3	38.8	6.3	0.2	1.1
Hydraulic Gradient (Baseline = 0.00153)				
Constituent	Concentrations (mg/L)			
	2x Baseline	Baseline	0.5x Baseline	Observed
NH_3	38.8	6.3	0.2	1.1
Effective Porosity (Baseline = 0.25)				
Constituent	Concentrations (mg/L)			
	1.2x Baseline	Baseline	0.8x Baseline	Observed
NH_3	3.12	6.3	12.8	1.1
Longitudinal Dispersivity (Baseline = 10 feet)				
Constituent	Concentrations (mg/L)			
	1.5x Baseline	Baseline	0.5x Baseline	Observed
NH_3	5.5	6.3	7.7	1.1
Transverse Dispersivity (Baseline = 0.1 x Longitudinal Dispersivity)				
Constituent	Concentrations (mg/L)			
	2x Baseline	Baseline	0.5x Baseline	Observed
NH_3	6.3	6.3	6.3	1.1
Retardation Factor (Baseline = 2.0)				
Constituent	Concentrations (mg/L)			
	1.5x Baseline	Baseline	0.5x Baseline	Observed
NH_3	4.8	6.3	9.9	1.1
Aquifer Matrix Density (Baseline = 1.7 gm/cm^3)				
Constituent	Concentrations (mg/L)			
	1.2x Baseline	Baseline	0.90x Baseline	Observed
NH_3	6.3	6.3	6.4	1.1
Foc (Baseline = 0.001)				
Constituent	Concentrations (mg/L)			
	1.5x Baseline	Baseline	0.85x Baseline	Observed
NH_3	6.3	6.3	6.3	1.1
Koc (Baseline = 14)				
Constituent	Concentrations (mg/L)			
	1.5x Baseline	Baseline	0.5x Baseline	Observed
NH_3	3.0	6.3	2.8	1.1
Biotransformation Rate Constant (Baseline = 0.693)				
Constituent	Concentrations (mg/L)			
	1.5x Baseline	Baseline	0.5x Baseline	Observed
NH_3	0.9	6.3	51.6	1.1
First Order Decay Constant (Baseline = 0.04)				
Constituent	Concentrations (mg/L)			
	1.5x Baseline	Baseline	0.5x Baseline	Observed
NH_3	4.0	271	557	270
Source Width (Baseline = 300 Ft)				
Constituent	Concentrations (mg/L)			
	1.5x Baseline	Baseline	0.5x Baseline	Observed
NH_3	6.3	6.3	6.2	1.1

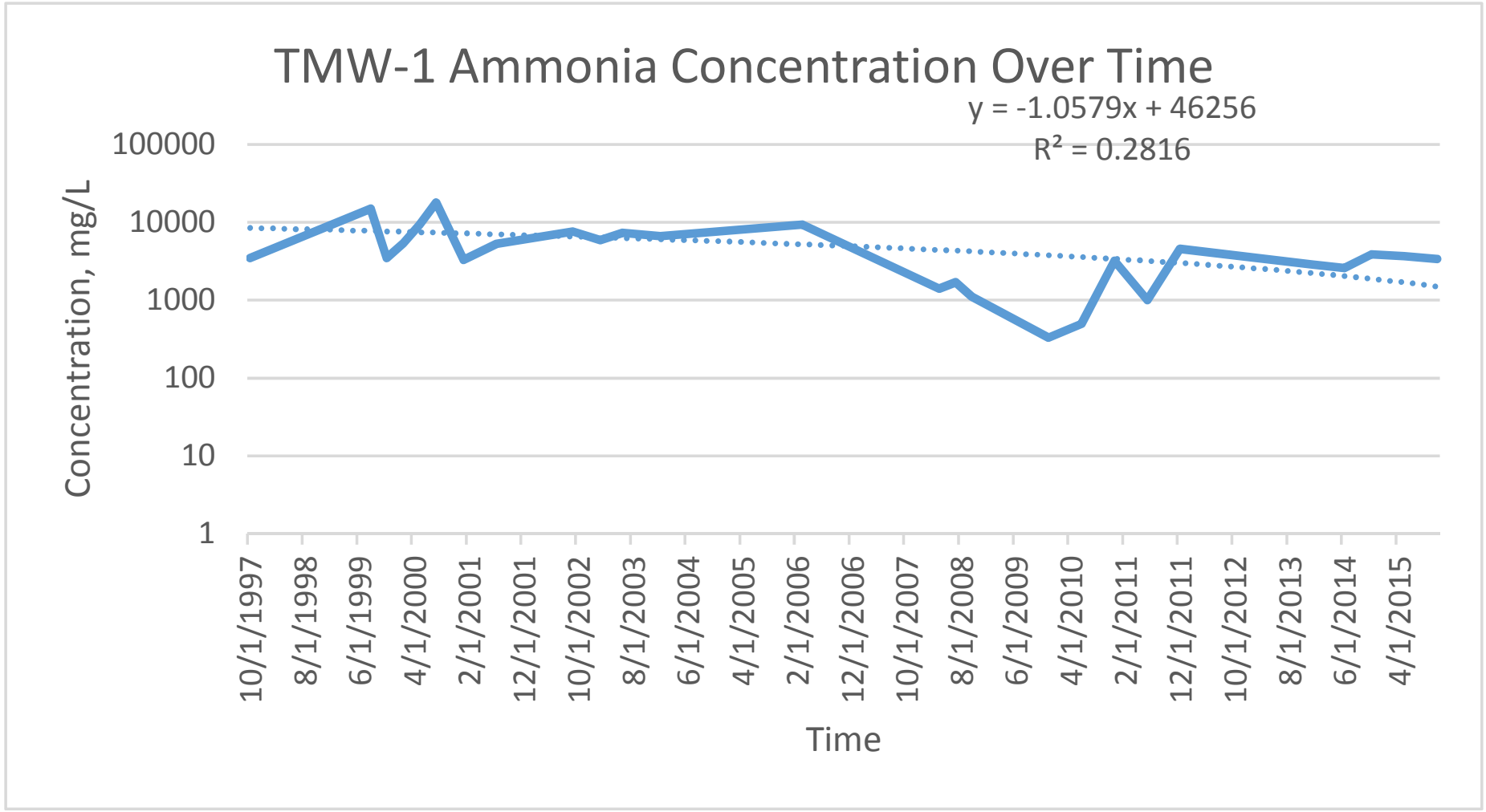
CSXT-Hutchinson Island

Savannah, Georgia

Table C-4 – Summary of Predicted vs. Observed COC Concentrations

Location	Sampling Date*	Ammonia		Nitrite		Nitrate		Comments
		Predicted	Observed	Predicted	Observed	Predicted	Observed	
TMW-1	11/2015	3,634	3,600	0.04	<10	56.5	250	Source Area Well
PDMW-48	11/2015	557	28	0.09	0.11	133	0.11	
PDMW-49	11/2015	10.6	0.63	0.015	<0.05	21.5	<0.05	POD Well
TMW-1	6/2014	3,782	2,600	0.04	NT	58.8	170	Source Area Well
PDMW-48	6/2014	580	27	0.09	NT	136	<0.05	
PDMW-49	6/2014	9.69	0.42	0.12	NT	17.8	<0.05	POD Well
EW-1	11/2015	271.3	270	0.0	<0.05	0.07	<0.05	Source Area Well
PDMW-10R	11/2015	87.7	7.9	0.0	<0.05	0.086	<0.05	
PDMW-46	11/2015	6.3	1.1	0.0	<0.05	0.13	0.073	POD Well
EW-1	12/2013	290	160	0.02	NT	0.08	0.44	Source Area Well
PDMW-10R	12/2013	29.5	11	0.03	NT	0.12	<0.05	
PDMW-46	12/2013	0.132	1.7	0.01	NT	0.05	<0.5	POD Well

*The June 2014 data is the earliest for the POD wells as they were installed during the June 2014 sampling event. The November 2015 data is the latest data available for the POD wells.


TMW-1 Ammonia Concentration Over Time
y = -1.0579x + 46256
R² = 0.2816
Concentration, mg/L
100000
10000
1000
100
10
1
10/1/1997
8/1/1998
6/1/1999
4/1/2000
2/1/2001
12/1/2001
10/1/2002
8/1/2003
6/1/2004
4/1/2005
2/1/2006
12/1/2006
10/1/2007
8/1/2008
6/1/2009
4/1/2010
2/1/2011
12/1/2011
10/1/2012
8/1/2013
6/1/2014
4/1/2015
Time

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

TMW-1 - PDMW-49 Validation
Run Name

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 Screening Protocol

TYPE OF CONSTITUENT: Ammonia ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	22.3	(ft/yr)
or			
Hydraulic Conductivity	K	7.8E-04	(cm/sec)
Hydraulic Gradient	i	0.0069	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Alpha x*	32	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc. Alpha x

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho	1.7	(kg/L)		
FractionOrganicCarbon, foc	1.0E-3	(-)		
Partition Coefficient	Koc			
Ammonia	14	(L/kg)	1.10	(-)
Nitrite	0	(L/kg)	1.00	(-)
Nitrate	0	(L/kg)	1.00	(-)
		(L/kg)	1.00	(-)
		(L/kg)	1.00	(-)
Common R (used in model)* =			**4.00**	

4. BIOTRANSFORMATION

-1st Order Decay Coefficient*

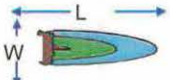
	λ (1/yr)		half-life (yrs)	Yield
Zone 1				
NH3 → Nitrite	0.533	←	1.30	2.75
Nitrite → Nitrate	0.693	←	1.00	1.35
→	0.000	←		
→	0.000	←		
Zone 2	λ (1/yr)		half-life (yrs)	
→	0.000	←		
→	0.000	←		
→	0.000	←		
→	0.000	←		

λ HELP

5. GENERAL

Simulation Time*	39	(yr)
Modeled Area Width*	300	(ft)
Modeled Area Length*	320	(ft)
Zone 1 Length*	320	(ft)
Zone 2 Length*		(ft)

Zone 2= L - Zone 1



6. SOURCE DATA

TYPE: Decaying Single Planar

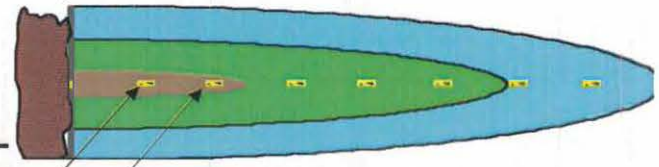
Source Options

Source Thickness in Sat. Zone* 10 (ft)

Width* (ft) Y1: 300

Conc. (mg/L)*	C1	k_s* (1/yr)
Ammonia	18000.0	0.04
Nitrite	.19	0.04
Nitrate	280.0	0.04
		0.04
		0.04

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

Ammonia Conc. (mg/L)	2600.0	27.0	.42
Nitrite Conc. (mg/L)	NT	NT	NT
Nitrate Conc. (mg/L)	170.0	<0.05	<0.05
Distance from Source (ft)	0	120	320
Date Data Collected	2014		

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore | RESET | SEE OUTPUT | Paste

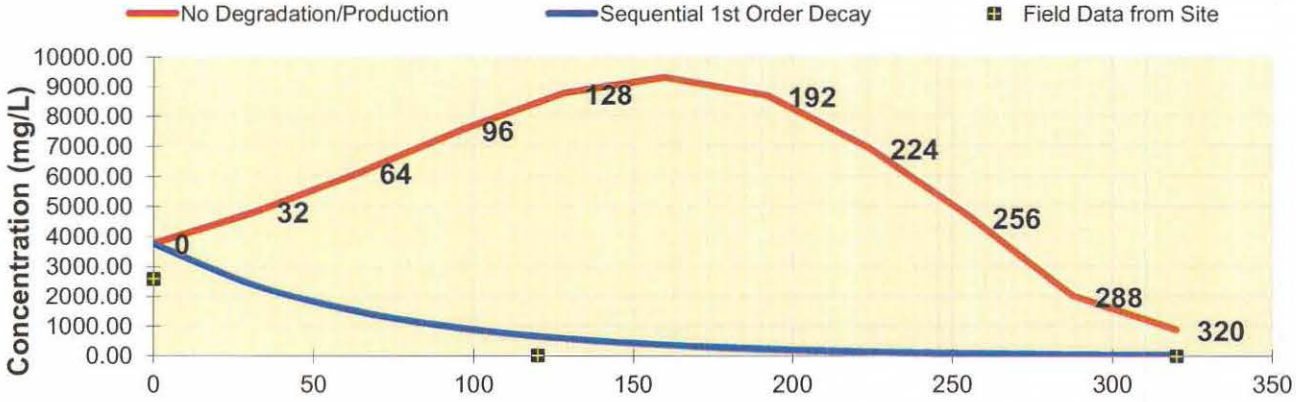
AMMONIA CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

Distance from Source (ft)

Ammonia	0	32	64	96	128	160	192	224	256	288	320
No Degradation	3782.450	4839.982	6129.611	7548.213	8780.553	9312.132	8695.728	6944.878	4640.850	2001.312	871.744
Biotransformation	3782.4487	2369.579	1484.249	928.890	579.144	356.737	213.297	120.384	61.438	25.613	9.693

Monitoring Well Locations (ft)

	TMW-1	PDMW-48	PDMW-49								
Field Data from Site	2600.000	27.000	0.420								



See PCE

See TCE

See DCE

Prepare Animation

Time:

39.0 Years

Log ⟺ Linear

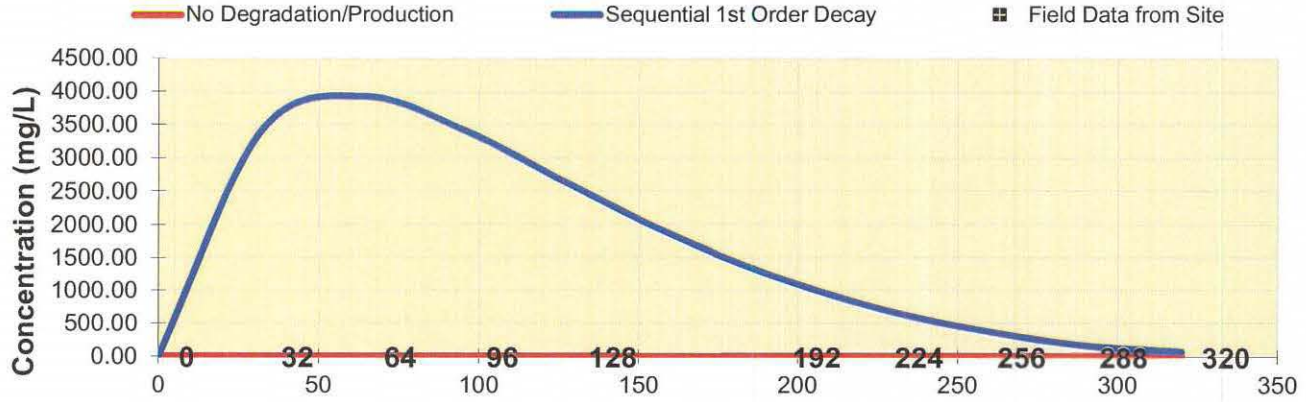
Return to Input

To All

To Array

NITRITE CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

Nitrite	Distance from Source (ft)										
	0	32	64	96	128	160	192	224	256	288	320
No Degradation	0.040	0.051	0.065	0.080	0.093	0.098	0.092	0.073	0.049	0.027	0.012
Biotransformation	0.0418	3409.161	3934.652	3408.790	2616.837	1858.713	1227.210	741.995	402.412	168.846	65.258
	Monitoring Well Locations (ft)										
	TMW-1	PDMW-48	PDMW-49								
Field Data from Site	NT	NT	NT								



See PCE

See TCE

See DCE

Prepare Animation

Time:

39.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

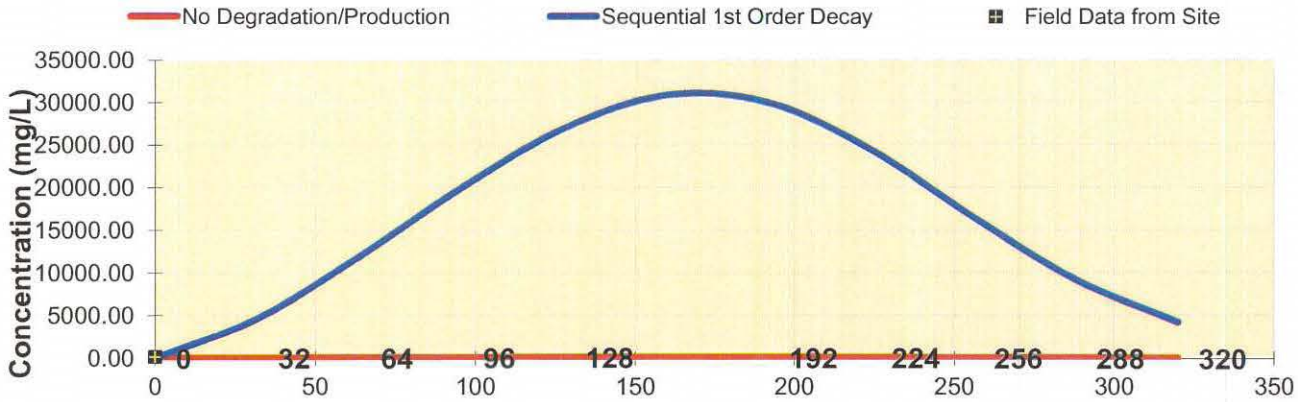
NITRATE CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

Distance from Source (ft)

Nitrate	0	32	64	96	128	160	192	224	256	288	320
No Degradation	58.838	75.289	95.350	117.417	136.586	144.855	135.267	108.031	72.191	39.736	17.825
Biotransformation	58.8387	4644.364	12029.561	20089.893	27051.711	30882.628	29969.681	24442.370	16530.068	9200.244	4147.854

Monitoring Well Locations (ft)

	TMW-1	PDMW-48	PDMW-49								
Field Data from Site	170.000	<0.05	<0.05								



See PCE

See TCE

See DCE

Prepare Animation

Time:

39.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

EW-1 - PDMW-30P
Validation
Run Name

Data Input Instructions:
115 → 1. Enter value directly....or
↑ or → 2. Calculate by filling in gray
0.02 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 Screening Protocol

TYPE OF CONSTITUENT: Ammonia ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	18.6	(ft/yr)
or			
Hydraulic Conductivity	K	3.0E-03	(cm/sec)
Hydraulic Gradient	i	0.0015	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Alpha x*	54	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc. Alpha x

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho	1.7	(kg/L)		
FractionOrganicCarbon, foc	1.0E-3	(-)		
Partition Coefficient	Koc			
Ammonia	14	(L/kg)	1.10	(-)
Nitrite	0	(L/kg)	1.00	(-)
Nitrate	0	(L/kg)	1.00	(-)
		(L/kg)	1.00	(-)
		(L/kg)	1.00	(-)
Common R (used in model)* =			**2.00**	

4. BIOTRANSFORMATION

-1st Order Decay Coefficient*

	λ (1/yr)		half-life (yrs)	Yield
Zone 1				
NH3 → Nitrite	0.533	←	1.30	2.75
Nitrite → Nitrate	0.693	←	1.00	1.35
→	0.000	←		
→	0.000	←		
Zone 2	λ (1/yr)		half-life (yrs)	
→	0.000	←		
→	0.000	←		
→	0.000	←		
→	0.000	←		

λ HELP

5. GENERAL

Simulation Time*	38	(yr)
Modeled Area Width*	300	(ft)
Modeled Area Length*	540	(ft)
Zone 1 Length*	540	(ft)
Zone 2 Length*	0	(ft)

L, W

Zone 2= L - Zone 1

6. SOURCE DATA

TYPE: Decaying Single Planar

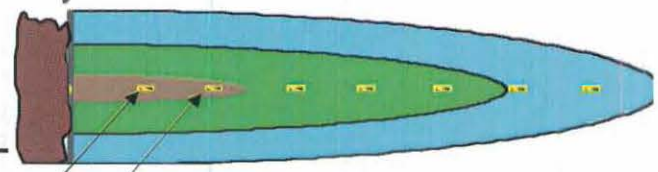
Source Options

Source Thickness in Sat. Zone* 10 (ft)

Y1
Width* (ft) 300

Conc. (mg/L)*	C1	k_s* (1/yr)
Ammonia	1100.0	0.035
Nitrite	.081	0.035
Nitrate	.29	0.035
		0.035
		0.035

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

Ammonia Conc. (mg/L)	160.0	11.0	1.7								
Nitrite Conc. (mg/L)	NT	NT	NT								
Nitrate Conc. (mg/L)	.044	<0.05	<0.05								
Distance from Source (ft)	0	160	500								
Date Data Collected	2013	2013									

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore | RESET | SEE OUTPUT | Paste

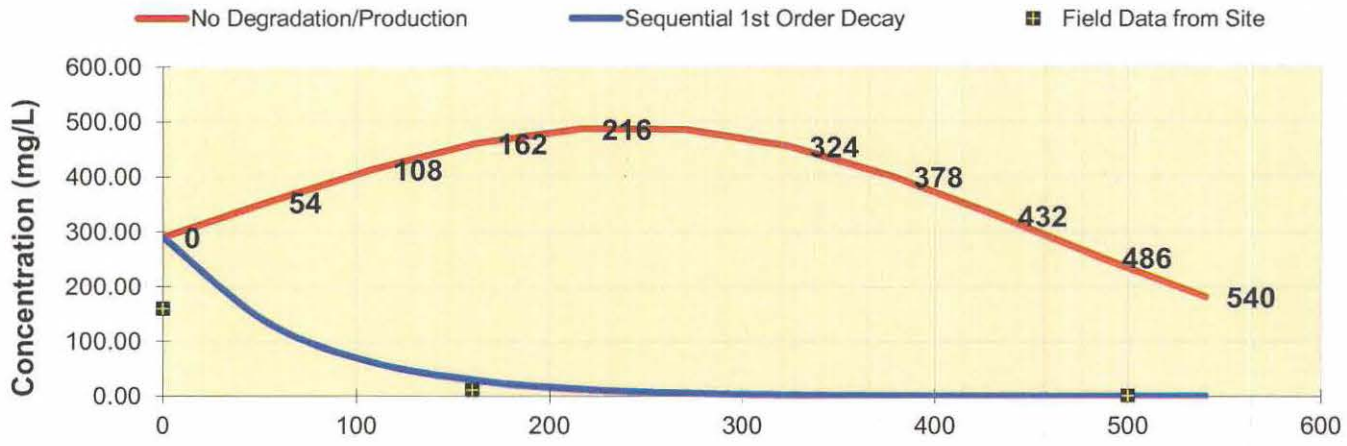
AMMONIA CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

Distance from Source (ft)

Ammonia	0	54	108	162	216	270	324	378	432	486	540
No Degradation	290.925	354.162	413.848	461.308	487.603	486.316	456.026	401.029	330.116	254.003	182.472
Biotransformation	290.9249	135.780	63.370	29.566	13.776	6.405	2.970	1.374	0.633	0.290	0.132

Monitoring Well Locations (ft)

	EW-1	PDMW-10R	PDMW-30P								
Field Data from Site	160.000	11.000	1.700								



Distance From Source (ft.)

See PCE

See TCE

See DCE

Prepare Animation

Time:

38.0 Years

Log ⟺ Linear

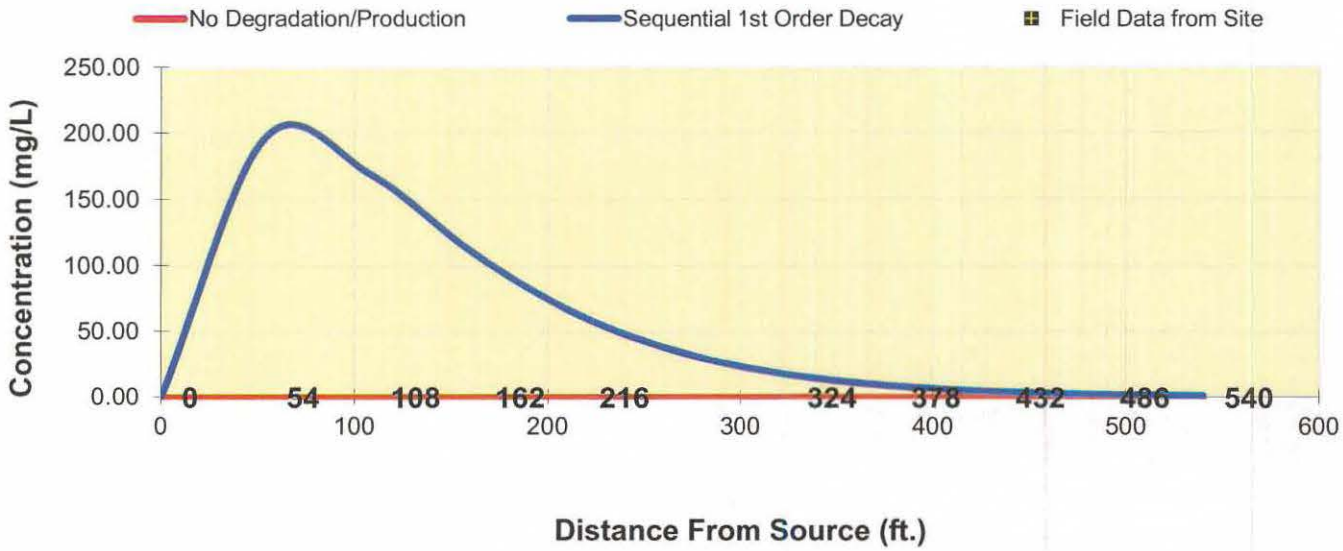
Return to Input

To All

To Array

NITRITE CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

Nitrite	Distance from Source (ft)										
	0	54	108	162	216	270	324	378	432	486	540
No Degradation	0.021	0.026	0.030	0.034	0.036	0.036	0.034	0.030	0.024	0.019	0.013
Biotransformation	0.0215	196.682	169.077	109.242	62.810	33.862	17.520	8.806	4.330	2.090	0.991
	Monitoring Well Locations (ft)										
	EW-1	PDMW-10R	PDMW-30P								
Field Data from Site	NT	NT	NT								



See PCE

See TCE

See DCE

Prepare Animation

Time:

38.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

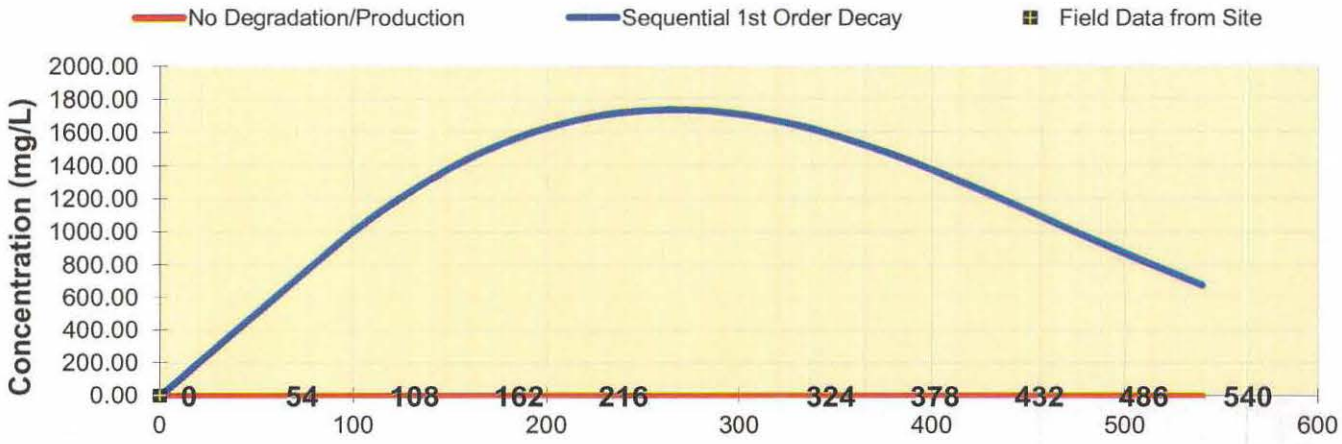
NITRATE CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

Distance from Source (ft)

Nitrate	0	54	108	162	216	270	324	378	432	486	540
No Degradation	0.077	0.093	0.109	0.122	0.129	0.128	0.120	0.106	0.087	0.067	0.048
Biotransformation	0.0768	545.349	1073.045	1455.534	1674.465	1736.130	1658.482	1471.977	1217.479	939.178	675.666

Monitoring Well Locations (ft)

	EW-1	PDMW-10R	PDMW-30P								
Field Data from Site	0.044	<0.05	<0.05								



See PCE

See TCE

See DCE

Prepare Animation

Time:

38.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

TMW-1 - PDMW-49 Calibration
Run Name

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 Screening Protocol

TYPE OF CONSTITUENT: Ammonia (◉) Ethanes (○)

1. ADVECTION

Seepage Velocity*	Vs	22.3	(ft/yr)
or			
Hydraulic Conductivity	K	7.8E-04	(cm/sec)
Hydraulic Gradient	i	0.0069	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Alpha x*	10	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc. Alpha x

3. ADSORPTION

Retardation Factor* → R
or

Soil Bulk Density, rho	1.7	(kg/L)		
FractionOrganicCarbon, foc	1.0E-3	(-)		
Partition Coefficient	Koc			
Ammonia	14	(L/kg)	1.10	(-)
Nitrite	0	(L/kg)	1.00	(-)
Nitrate	0	(L/kg)	1.00	(-)
		(L/kg)	1.00	(-)
		(L/kg)	1.00	(-)
Common R (used in model)* =			**4.00**	

4. BIOTRANSFORMATION

-1st Order Decay Coefficient*

		λ (1/yr)	half-life (yrs)	Yield
Zone 1				
NH3 →	Nitrite	0.533	1.30	2.75
Nitrite →	Nitrate	0.693	1.00	1.35
→		0.000		
→		0.000		
Zone 2		λ (1/yr)	half-life (yrs)	
→		0.000		
→		0.000		
→		0.000		
→		0.000		

λ HELP

5. GENERAL

Simulation Time*	40	(yr)
Modeled Area Width*	300	(ft)
Modeled Area Length*	320	(ft)
Zone 1 Length*	320	(ft)
Zone 2 Length*		(ft)

L, W

Zone 2= L - Zone 1

6. SOURCE DATA

TYPE: Decaying Single Planar

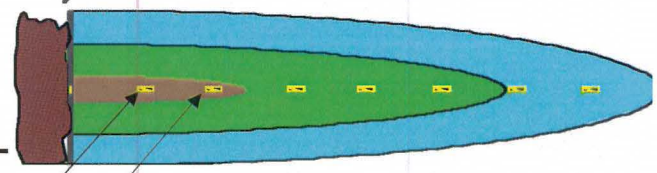
Source Options

Source Thickness in Sat. Zone* 10 (ft)

Y1
Width* (ft) 300

Conc. (mg/L)*	C1	k_s* (1/yr)
Ammonia	18000.0	0.04
Nitrite	.19	0.04
Nitrate	280.0	0.04
		0.04
		0.04

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

Ammonia Conc. (mg/L)	3600.0	28.0	.63								
Nitrite Conc. (mg/L)	.05	.11	<0.05								
Nitrate Conc. (mg/L)	250.0	.11	<0.05								
Distance from Source (ft)	0	120	320								
Date Data Collected	2015	2013	?								

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore | RESET | SEE OUTPUT | Paste

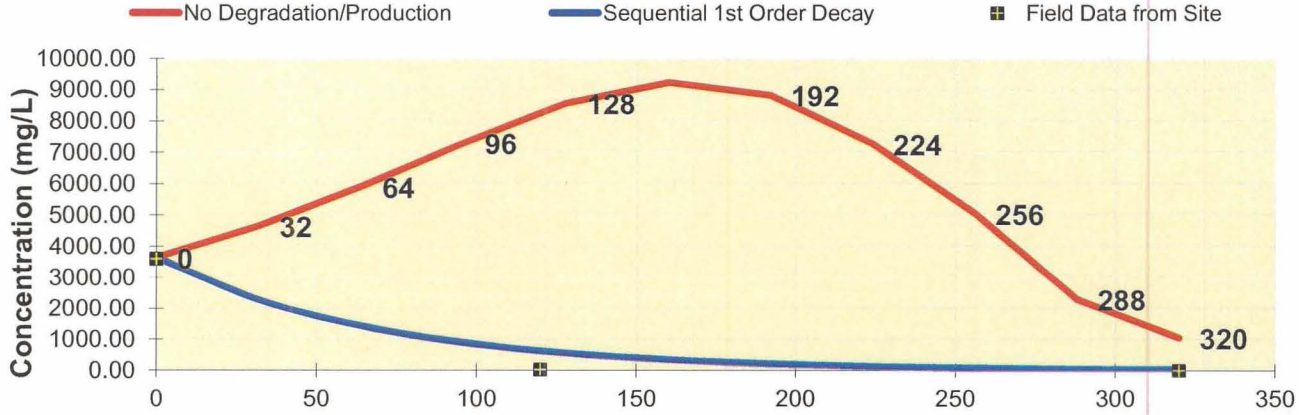
AMMONIA CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

Distance from Source (ft)

Ammonia	0	32	64	96	128	160	192	224	256	288	320
No Degradation	3634.138	4651.756	5900.108	7297.250	8567.835	9232.710	8826.700	7273.109	5052.096	2298.801	1055.458
Biotransformation	3634.1368	2276.674	1426.107	892.701	557.117	344.230	207.378	118.792	62.268	26.958	10.659

Monitoring Well Locations (ft)

	TMW-1	PDMW-48	PDMW-49								
Field Data from Site	3600.000	28.000	0.630								



Distance From Source (ft.)

See PCE

See TCE

See DCE

Prepare Animation

Time:

40.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

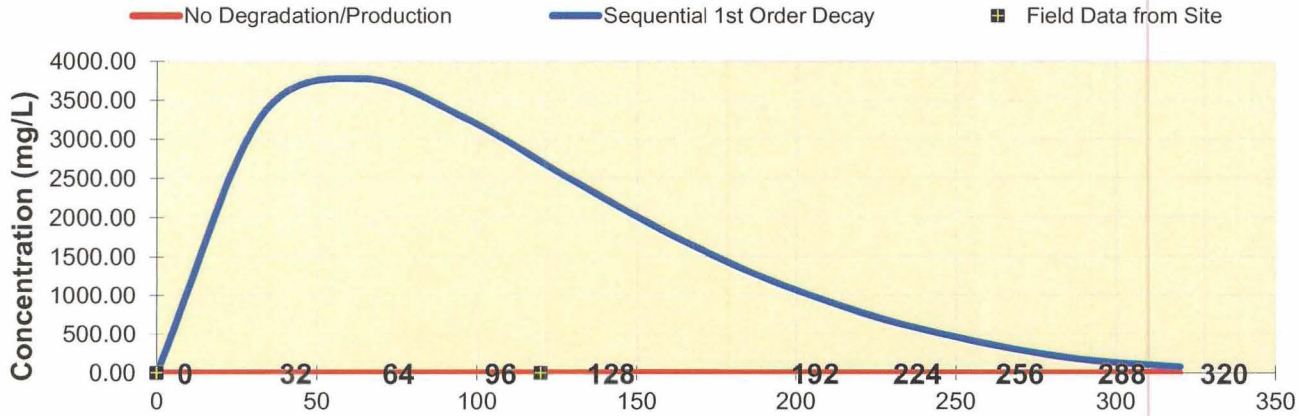
NITRITE CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

Distance from Source (ft)

Nitrite	0	32	64	96	128	160	192	224	256	288	320
No Degradation	0.038	0.049	0.062	0.077	0.090	0.097	0.093	0.077	0.053	0.031	0.015
Biotransformation	0.0401	3275.545	3780.781	3276.827	2519.191	1796.603	1196.879	735.462	409.935	179.135	72.392

Monitoring Well Locations (ft)

	TMW-1	PDMW-48	PDMW-49								
Field Data from Site	0.050	0.110	<0.05								



See PCE

See TCE

See DCE

Prepare Animation

Time:

40.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

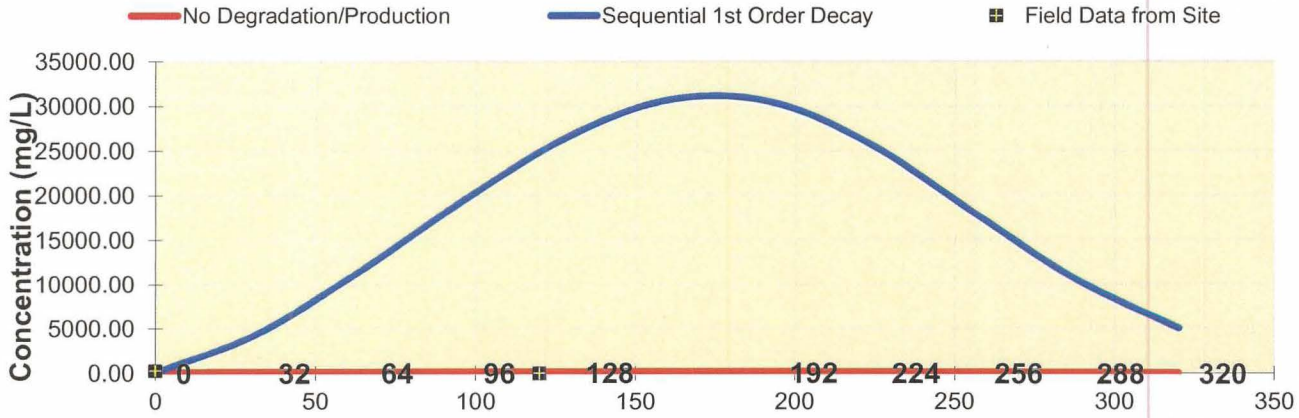
NITRATE CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

Distance from Source (ft)

Nitrate	0	32	64	96	128	160	192	224	256	288	320
No Degradation	56.531	72.361	91.779	113.513	133.277	143.620	137.304	113.137	78.588	45.289	21.417
Biotransformation	56.5316	4467.933	11597.535	19466.786	26472.280	30716.822	30520.873	25680.770	18049.985	10512.056	4995.486

Monitoring Well Locations (ft)

	TMW-1	PDMW-48	PDMW-49								
Field Data from Site	250.000	0.110	<0.05								



See PCE

See TCE

See DCE

Prepare Animation

Time:

40.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

TMW-1 - PDMW-49
Maximum Extent of Plume
Run Name

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 Screening Protocol

TYPE OF CONSTITUENT: Ammonia (●) Ethanes (○)

1. ADVECTION

Seepage Velocity*	Vs	22.3	(ft/yr)
or			
Hydraulic Conductivity	K	7.8E-04	(cm/sec)
Hydraulic Gradient	i	0.0069	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Alpha x*	10	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc. Alpha x

3. ADSORPTION

Retardation Factor* → R
or

Soil Bulk Density, rho	1.7	(kg/L)		
FractionOrganicCarbon, foc	1.0E-3	(-)		
Partition Coefficient	Koc			
Ammonia	14	(L/kg)	1.10	(-)
Nitrite	0	(L/kg)	1.00	(-)
Nitrate	0	(L/kg)	1.00	(-)
		(L/kg)	1.00	(-)
		(L/kg)	1.00	(-)
Common R (used in model)* =			**4.00**	

4. BIOTRANSFORMATION

-1st Order Decay Coefficient*

Zone 1

		λ (1/yr)	half-life (yrs)	Yield
NH3	Nitrite	0.533	1.30	2.75
Nitrite	Nitrate	0.693	1.00	1.35
		0.000		
		0.000		

Zone 2

	λ (1/yr)	half-life (yrs)
	0.000	
	0.000	
	0.000	
	0.000	

λ HELP

5. GENERAL

Simulation Time*	120	(yr)
Modeled Area Width*	300	(ft)
Modeled Area Length*	1000	(ft)
Zone 1 Length*	1000	(ft)
Zone 2 Length*		(ft)

L, W

Zone 2= L - Zone 1

6. SOURCE DATA

TYPE: Decaying Single Planar

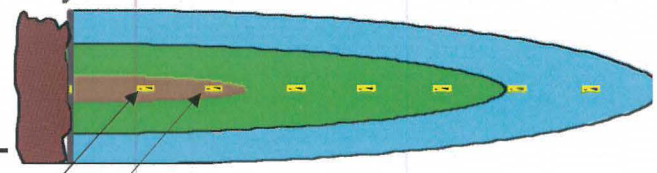
Source Options

Source Thickness in Sat. Zone* 10 (ft)

Y1
Width* (ft) 300

Conc. (mg/L)*	C1	k_s* (1/yr)
Ammonia	18000.0	0.04
Nitrite	.19	0.04
Nitrate	280.0	0.04
		0.04
		0.04

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

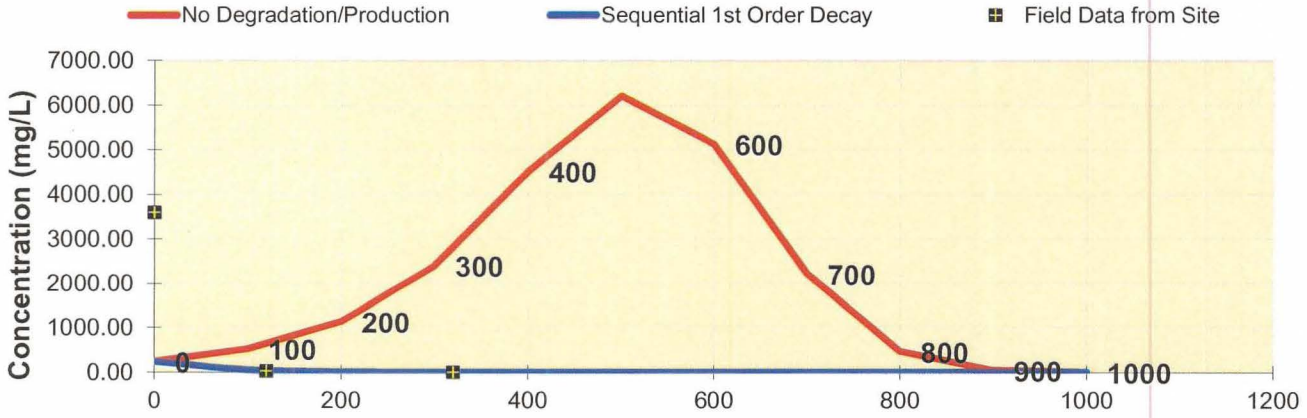
Ammonia Conc. (mg/L)	3600.0	28.0	.63
Nitrite Conc. (mg/L)	.05	.11	<0.05
Nitrate Conc. (mg/L)	250.0	.11	<0.05
Distance from Source (ft)	0	120	320
Date Data Collected	2015	2013	2

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore | RESET | SEE OUTPUT | Paste

AMMONIA CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

	Distance from Source (ft)										
Ammonia	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	239.398	521.711	1134.161	2405.761	4519.696	6213.587	5129.378	2222.368	468.455	46.100	2.069
Biotransformation	239.3979	55.520	12.876	2.986	0.692	0.160	0.035	0.007	0.001	0.000	0.000
	Monitoring Well Locations (ft)										
Field Data from Site											



See PCE

See TCE

See DCE

Replay

Time:

108.0 Years

Log ⟺ Linear

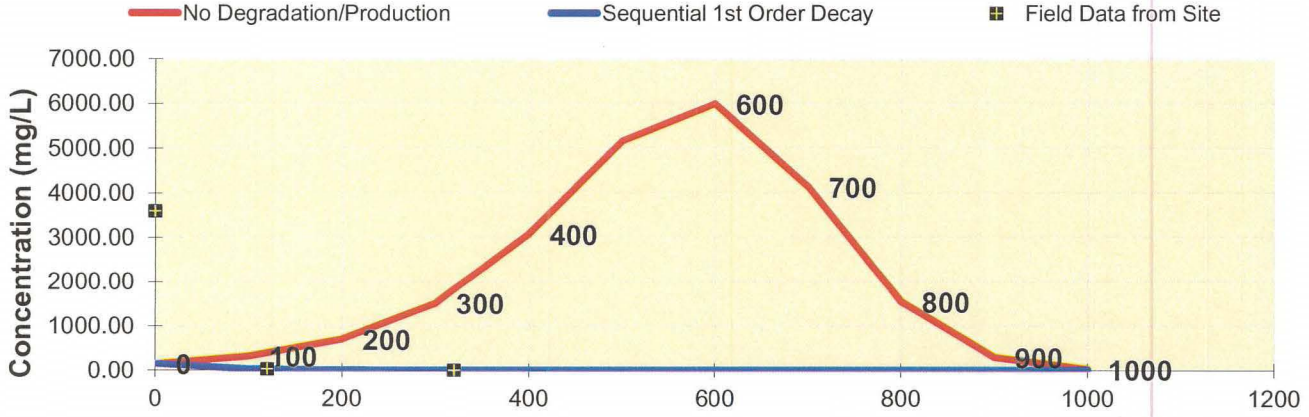
Return to Input

To All

To Array

AMMONIA CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

Ammonia	Distance from Source (ft)										
	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	148.135	322.833	702.992	1516.179	3081.370	5173.337	6000.513	4146.588	1556.151	300.987	29.131
Biotransformation	148.1354	34.355	7.967	1.848	0.429	0.099	0.023	0.005	0.001	0.000	0.000
	Monitoring Well Locations (ft)										
Field Data from Site											



See PCE

See TCE

See DCE

Time:

120.0 Years

Log ⟺ Linear

Replay

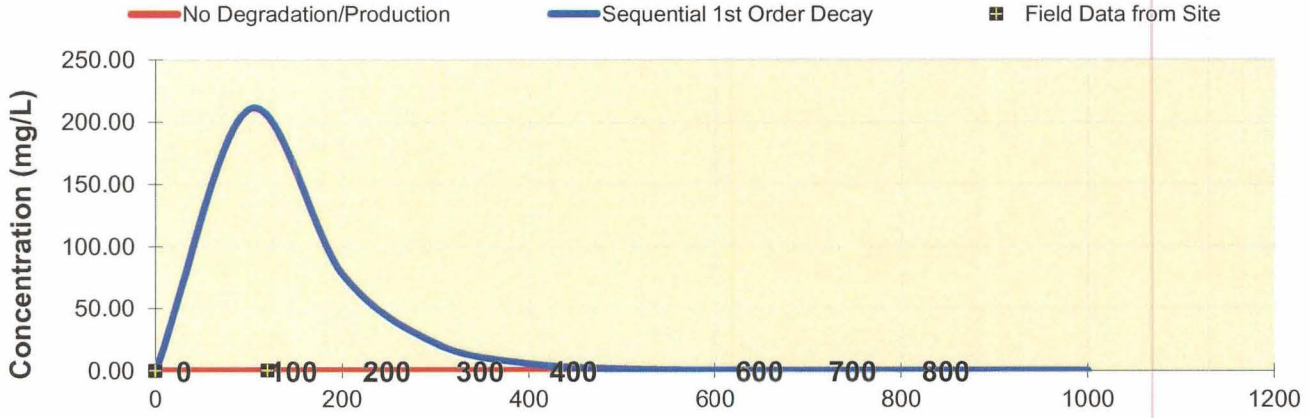
Return to Input

To All

To Array

NITRITE CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

Nitrite	Distance from Source (ft)										
	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	0.003	0.006	0.012	0.026	0.049	0.066	0.054	0.023	0.005	0.000	0.000
Biotransformation	0.0026	210.438	77.427	21.850	5.595	1.362	0.310	0.058	0.007	0.001	0.000
	Monitoring Well Locations (ft)										
Field Data from Site											



See PCE

See TCE

See DCE

Time:

108.0 Years

Log ⟺ Linear

Replay

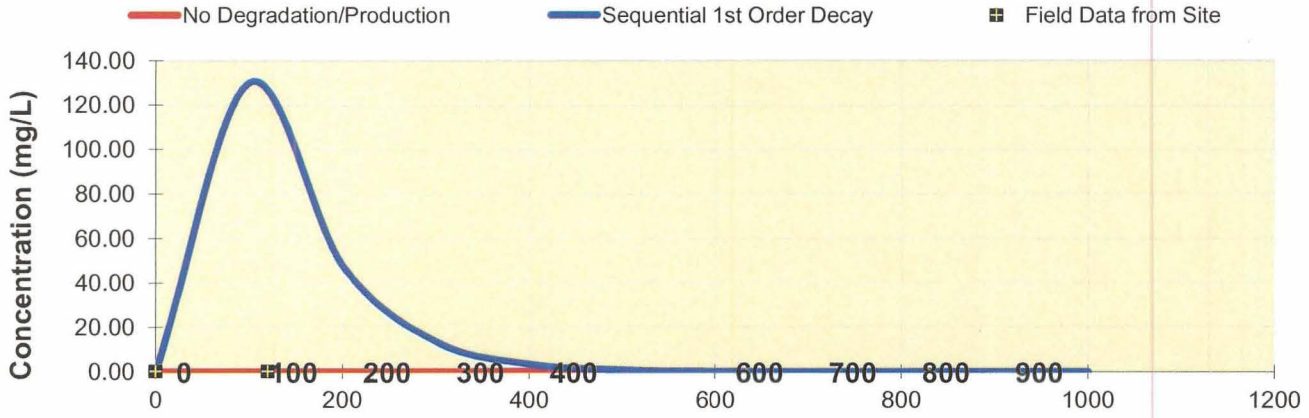
Return to Input

To All

To Array

NITRITE CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

	Distance from Source (ft)										
Nitrite	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	0.002	0.003	0.007	0.016	0.033	0.055	0.063	0.044	0.016	0.003	0.000
Biotransformation	0.0016	130.216	47.911	13.520	3.463	0.847	0.200	0.044	0.008	0.001	0.000
	Monitoring Well Locations (ft)										
Field Data from Site											



See PCE

See TCE

See DCE

Time:

120.0 Years

Log ⟺ Linear

Replay

Return to Input

To All

To Array

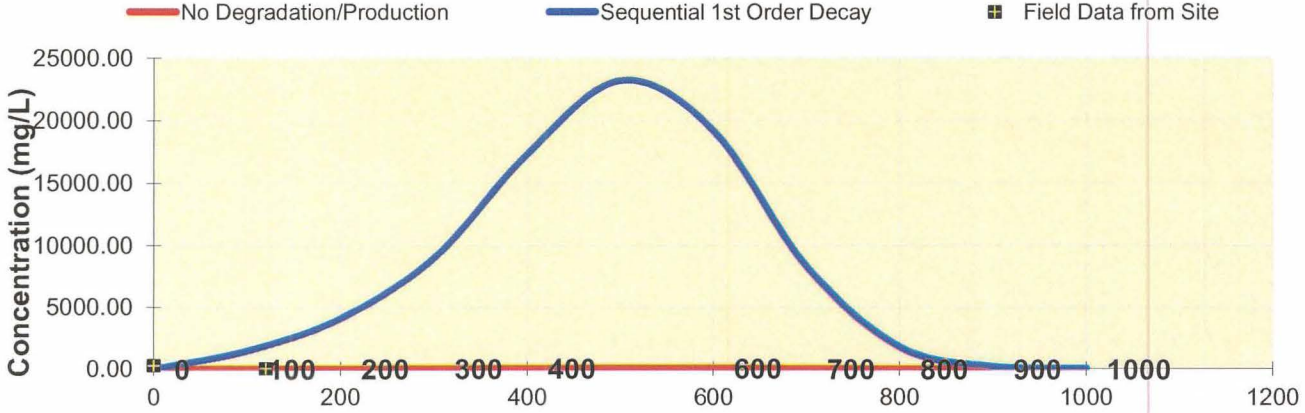
NITRATE CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

Distance from Source (ft)

Nitrate	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	3.724	8.116	17.663	37.764	72.463	96.656	79.790	34.570	7.287	0.717	0.032
Biotransformation	3.7240	1454.767	4080.908	9010.103	17356.596	23162.257	19122.130	8285.038	1746.418	171.865	7.715

Monitoring Well Locations (ft)

Field Data from Site											



See PCE

See TCE

See DCE

Time:

108.0 Years

Log ⟺ Linear

Replay

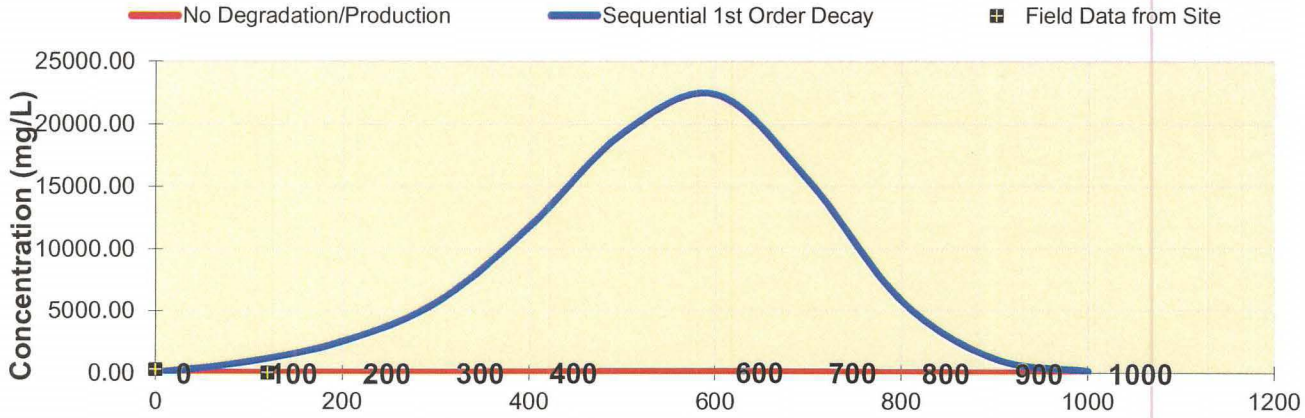
Return to Input

To All

To Array

NITRATE CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

	Distance from Source (ft)										
Nitrate	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	2.304	5.022	10.940	23.677	49.267	80.474	93.341	64.502	24.207	4.682	0.453
Biotransformation	2.3044	900.213	2527.631	5649.372	11801.193	19285.048	22369.975	15458.693	5801.426	1122.099	108.601
	Monitoring Well Locations (ft)										
Field Data from Site											



See PCE

See TCE

See DCE

Time:

120.0 Years

Log ⟺ Linear

Replay

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

TMW-1 - PDMW-49
Maximum NH3 Concentration
Run Name

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 Screening Protocol

TYPE OF CONSTITUENT: Ammonia (◉) Ethanes (○)

1. ADVECTION

Seepage Velocity*	Vs	22.3	(ft/yr)
or			
Hydraulic Conductivity	K	7.8E-04	(cm/sec)
Hydraulic Gradient	i	0.0069	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Alpha x*	10	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc. Alpha x

3. ADSORPTION

Retardation Factor* → R
or

Soil Bulk Density, rho	1.7	(kg/L)		
FractionOrganicCarbon, foc	1.0E-3	(-)		
Partition Coefficient	Koc			
Ammonia	14	(L/kg)	1.10	(-)
Nitrite	0	(L/kg)	1.00	(-)
Nitrate	0	(L/kg)	1.00	(-)
		(L/kg)	1.00	(-)
		(L/kg)	1.00	(-)
Common R (used in model)* =			**4.00**	

4. BIOTRANSFORMATION

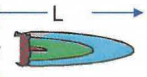
-1st Order Decay Coefficient*

	λ (1/yr)		half-life (yrs)	Yield
Zone 1				
NH3 → Nitrite	0.533	←	1.30	2.75
Nitrite → Nitrate	0.693	←	1.00	1.35
→	0.000	←		
→	0.000	←		
Zone 2	λ (1/yr)		half-life (yrs)	
→	0.000	←		
→	0.000	←		
→	0.000	←		
→	0.000	←		

λ HELP

5. GENERAL

Simulation Time*	60	(yr)
Modeled Area Width*	300	(ft)
Modeled Area Length*	320	(ft)
Zone 1 Length*	320	(ft)
Zone 2 Length*		(ft)



Zone 2= L - Zone 1

6. SOURCE DATA

TYPE: Decaying Single Planar

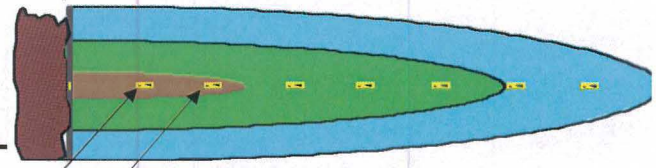
Source Options

Source Thickness in Sat. Zone* 10 (ft)

Width* (ft): Y1 = 300

Conc. (mg/L)*	C1	k_s* (1/yr)
Ammonia	35000.0	0.04
Nitrite	.19	0.04
Nitrate	280.0	0.04
		0.04
		0.04

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

Ammonia Conc. (mg/L)	3600.0	28.0	.63								
Nitrite Conc. (mg/L)	.05	.11	<0.05								
Nitrate Conc. (mg/L)	250.0	.11	<0.05								
Distance from Source (ft)	0	120	320								
Date Data Collected	2015	2013	2								

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore | RESET | SEE OUTPUT | Paste

Exceedance of Ammonia RRS at PDMW-49

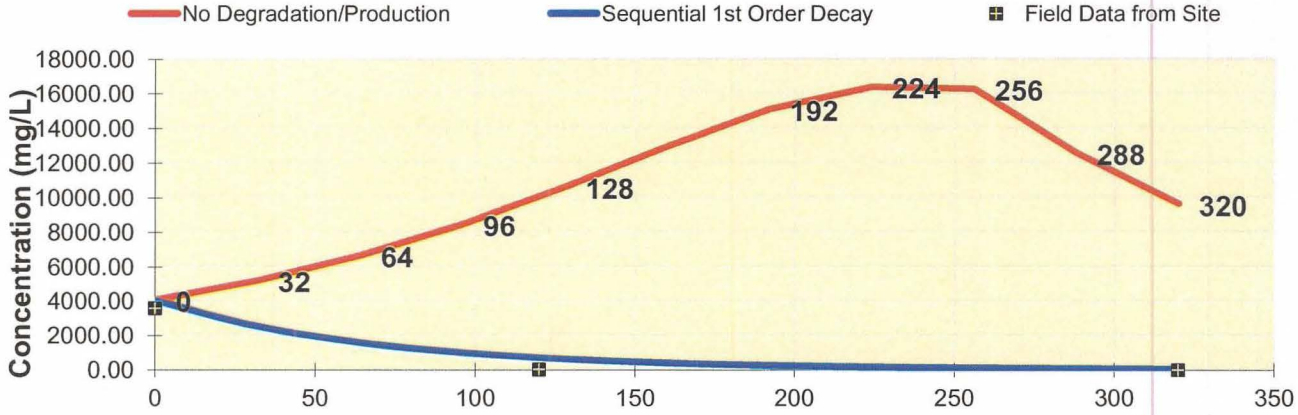
AMMONIA CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

Distance from Source (ft)

Ammonia	0	32	64	96	128	160	192	224	256	288	320
No Degradation	4036.380	5176.958	6628.305	8439.385	10597.125	12938.772	15067.535	16374.485	16258.965	12550.057	9609.353
Biotransformation	4036.3786	2528.695	1584.162	992.413	621.629	389.163	243.159	151.077	92.827	54.159	30.512

Monitoring Well Locations (ft)

Field Data from Site											



Distance From Source (ft.)

See PCE

See TCE

See DCE

Replay

Time:

54.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

EW-1 - PDMW-46 Calibration
Run Name

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 Screening Protocol

TYPE OF CONSTITUENT: Ammonia ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	62.1	(ft/yr)
or			
Hydraulic Conductivity	K	3.0E-03	(cm/sec)
Hydraulic Gradient	i	0.005	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Alpha x*	10	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc. Alpha x

3. ADSORPTION

Retardation Factor* → R
or
Soil Bulk Density, rho: 1.7 (kg/L)
FractionOrganicCarbon, foc: 1.0E-3 (-)

Partition Coefficient	Koc		R	
Ammonia	14	(L/kg)	1.10	(-)
Nitrite	0	(L/kg)	1.00	(-)
Nitrate	0	(L/kg)	1.00	(-)
		(L/kg)	1.00	(-)
		(L/kg)	1.00	(-)

Common R (used in model)* = 2.00

4. BIOTRANSFORMATION

-1st Order Decay Coefficient*

Zone 1

		λ (1/yr)	half-life (yrs)	Yield
NH3	Nitrite	0.533	1.30	2.75
Nitrite	Nitrate	0.693	1.00	1.35
		0.000		
		0.000		

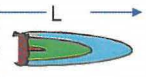
Zone 2

λ (1/yr)	half-life (yrs)
0.000	
0.000	
0.000	
0.000	

λ HELP

5. GENERAL

Simulation Time*	40	(yr)
Modeled Area Width*	300	(ft)
Modeled Area Length*	540	(ft)
Zone 1 Length*	540	(ft)
Zone 2 Length*	0	(ft)



Zone 2= L - Zone 1

6. SOURCE DATA

TYPE: Decaying Single Planar

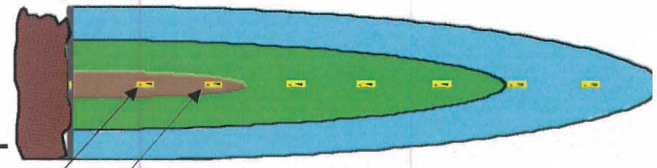
Source Options

Source Thickness in Sat. Zone* 10 (ft)

Width* (ft) Y1: 300

Conc. (mg/L)*	C1	k_s* (1/yr)
Ammonia	1100.0	0.035
Nitrite		0.035
Nitrate	.29	0.035
		0.035
		0.035

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

Ammonia Conc. (mg/L)	270.0	7.9	1.1
Nitrite Conc. (mg/L)	<0.05	<0.05	<0.05
Nitrate Conc. (mg/L)	<0.05	<0.05	<0.05
Distance from Source (ft)	0	160	500
Date Data Collected	2015	2013	2

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore | RESET | SEE OUTPUT | Paste

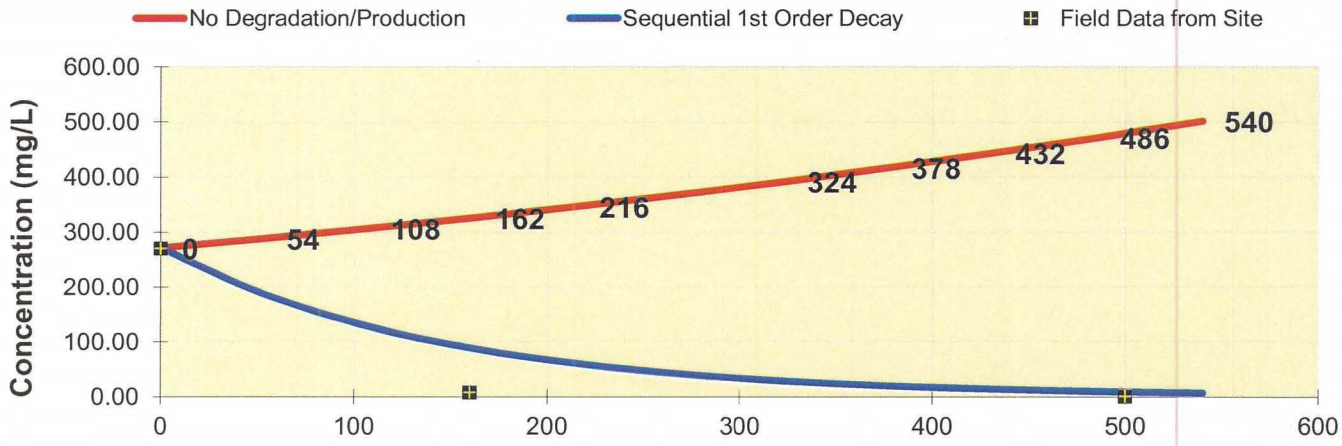
AMMONIA CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

Distance from Source (ft)

Ammonia	0	54	108	162	216	270	324	378	432	486	540
No Degradation	271.257	288.489	306.817	326.309	347.039	369.086	392.534	417.471	443.993	472.198	502.191
Biotransformation	271.2566	186.142	127.735	87.654	60.150	41.276	28.325	19.437	13.338	9.153	6.281

Monitoring Well Locations (ft)

	EW-1	PDMW-10R	PDMW-46								
Field Data from Site	270.000	7.900	1.100								



Distance From Source (ft.)

See PCE

See TCE

See DCE

Prepare Animation

Time:

40.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

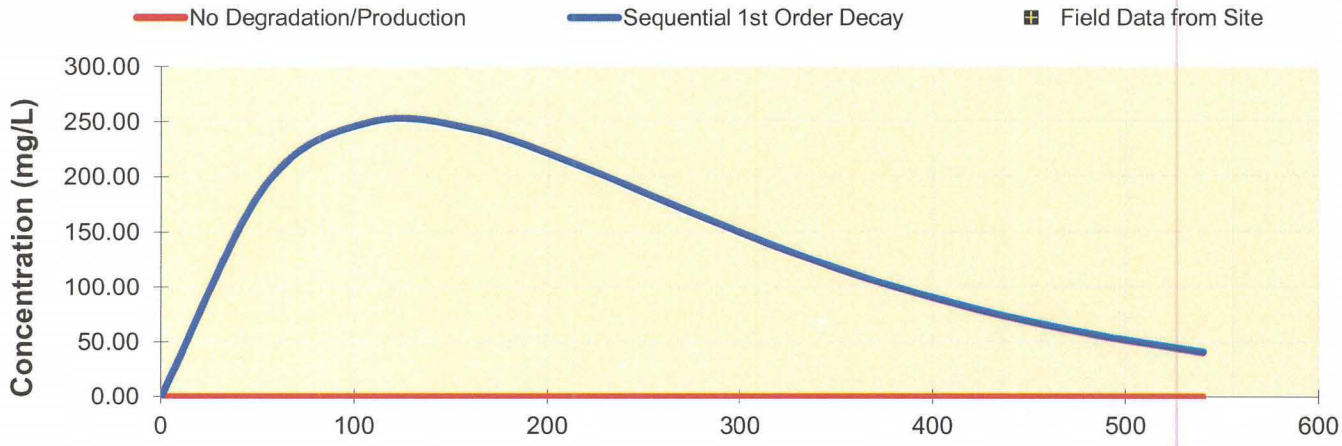
NITRITE CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

Distance from Source (ft)

Nitrite	0	54	108	162	216	270	324	378	432	486	540
No Degradation	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biotransformation	0.0001	192.575	249.384	242.502	209.858	170.459	133.074	101.121	75.359	55.346	40.191

Monitoring Well Locations (ft)

	EW-1	PDMW-10R	PDMW-46								
Field Data from Site	<0.05	<0.05	<0.05								



See PCE

See TCE

See DCE

Prepare Animation

Time:

40.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

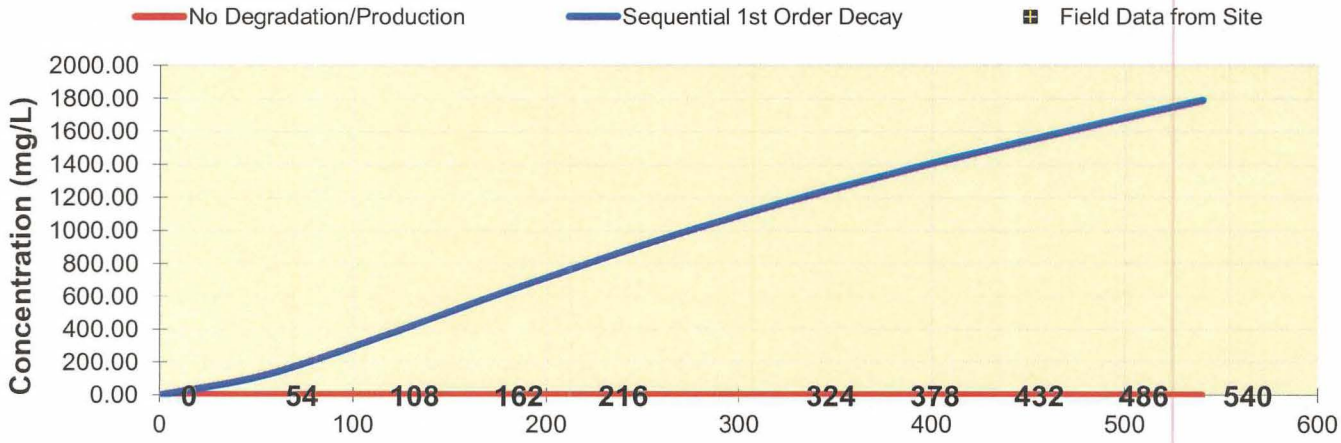
NITRATE CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

Distance from Source (ft)

Nitrate	0	54	108	162	216	270	324	378	432	486	540
No Degradation	0.072	0.076	0.081	0.086	0.091	0.097	0.103	0.110	0.117	0.124	0.132
Biotransformation	0.0715	120.064	328.255	558.714	781.858	986.972	1172.580	1341.299	1497.188	1644.463	1786.941

Monitoring Well Locations (ft)

	EW-1	PDMW-10R	PDMW-46								
Field Data from Site	<0.05	<0.05	<0.05								



See PCE

See TCE

See DCE

Prepare Animation

Time:

40.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

EW-1 - PDMW-46
Maximum Extent of Plume
Run Name

Data Input Instructions:
115 → 1. Enter value directly....or
↑ or 2. Calculate by filling in gray
0.02 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 Screening Protocol

TYPE OF CONSTITUENT: Ammonia ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	62.1	(ft/yr)
or			
Hydraulic Conductivity	K	3.0E-03	(cm/sec)
Hydraulic Gradient	i	0.005	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Alpha x*	10	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc. Alpha x

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho	1.7	(kg/L)		
FractionOrganicCarbon, foc	1.0E-3	(-)		
Partition Coefficient	Koc			
Ammonia	14	(L/kg)	1.10	(-)
Nitrite	0	(L/kg)	1.00	(-)
Nitrate	0	(L/kg)	1.00	(-)
		(L/kg)	1.00	(-)
		(L/kg)	1.00	(-)
Common R (used in model)* =			**2.00**	

4. BIOTRANSFORMATION -1st Order Decay Coefficient*

Zone 1

		λ (1/yr)	half-life (yrs)	Yield
NH3	Nitrite	0.533	1.30	2.75
Nitrite	Nitrate	0.693	1.00	1.35
		0.000		
		0.000		

Zone 2

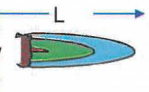
λ (1/yr)	half-life (yrs)
0.000	
0.000	
0.000	
0.000	

λ HELP

5. GENERAL

Simulation Time*	60	(yr)
Modeled Area Width*	300	(ft)
Modeled Area Length*	1200	(ft)
Zone 1 Length*	1200	(ft)
Zone 2 Length*		(ft)

Zone 2= L - Zone 1



6. SOURCE DATA TYPE: Decaying, Single Planar

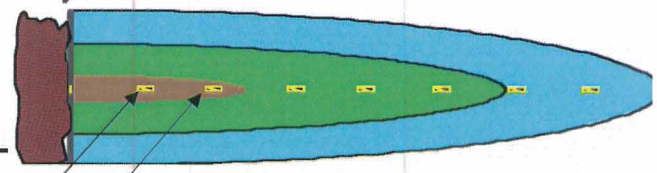
Source Options

Source Thickness in Sat. Zone* 10 (ft)

Y1
Width* (ft) 300

Conc. (mg/L)*	C1	k_s* (1/yr)
Ammonia	1100.0	0.035
Nitrite		0.035
Nitrate	.29	0.035
		0.035
		0.035

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

Ammonia Conc. (mg/L)	270.0	7.9	1.1
Nitrite Conc. (mg/L)	<0.05	<0.05	<0.05
Nitrate Conc. (mg/L)	<0.05	<0.05	<0.05
Distance from Source (ft)	0	160	500
Date Data Collected	2015	2013	2

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore | RESET | SEE OUTPUT | Paste

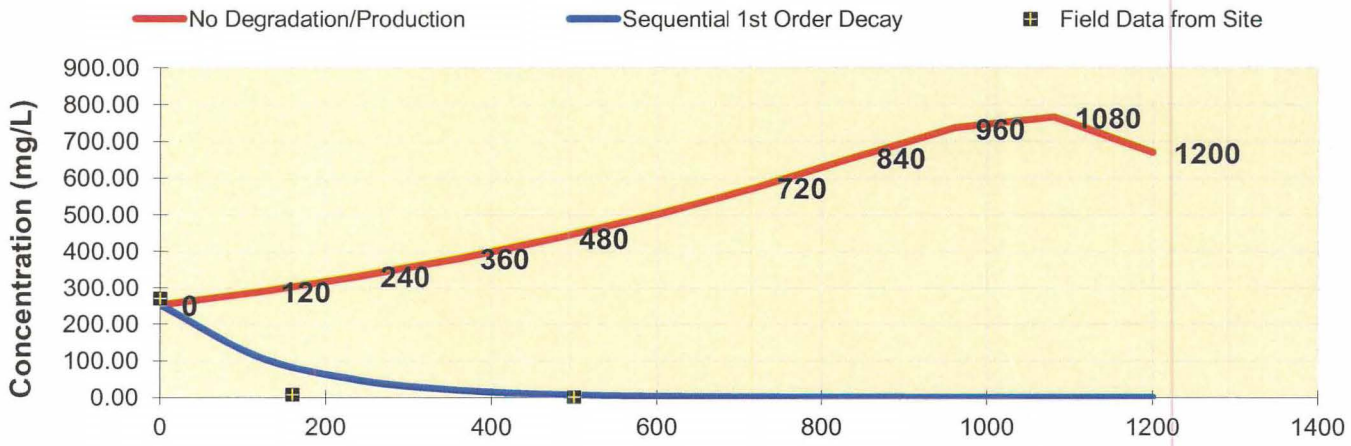
AMMONIA CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

Distance from Source (ft)

Ammonia	0	120	240	360	480	600	720	840	960	1080	1200
No Degradation	252.918	290.017	332.557	381.338	437.273	501.399	574.745	656.759	735.939	766.343	670.939
Biotransformation	252.9180	109.538	47.441	20.547	8.899	3.854	1.669	0.723	0.313	0.135	0.056

Monitoring Well Locations (ft)

	EW-1	PDMW-10R	PDMW-46								
Field Data from Site	270.000	7.900	1.100								



Distance From Source (ft.)

See PCE

See TCE

See DCE

Replay

Time:

42.0 Years

Log ⟺ Linear

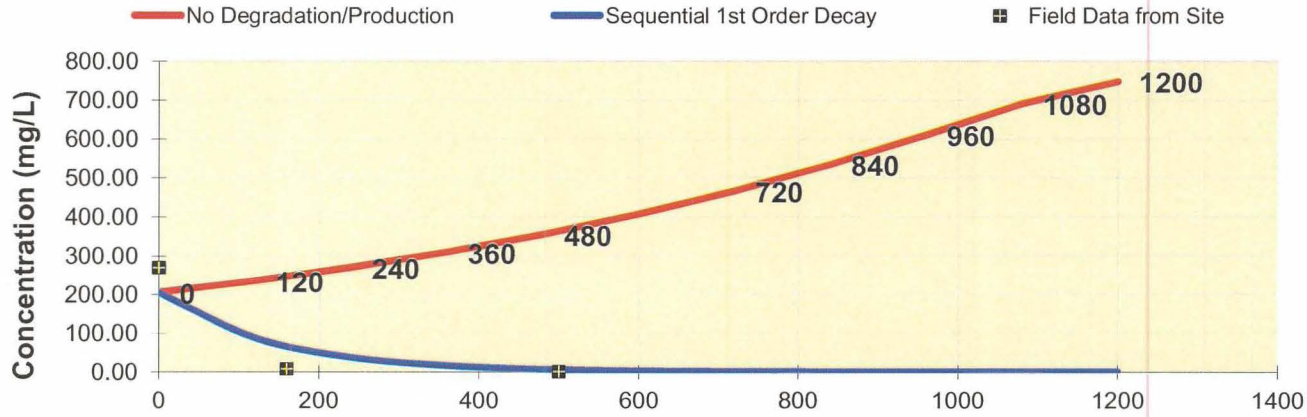
Return to Input

To All

To Array

AMMONIA CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

	Distance from Source (ft)										
Ammonia	0	120	240	360	480	600	720	840	960	1080	1200
No Degradation	205.011	235.083	269.566	309.106	354.446	406.432	466.015	534.187	611.183	691.490	748.433
Biotransformation	205.0114	88.790	38.455	16.655	7.213	3.124	1.353	0.586	0.254	0.110	0.047
	Monitoring Well Locations (ft)										
Field Data from Site											



See PCE

See TCE

See DCE

Time:

48.0 Years

Log ⟺ Linear

Replay

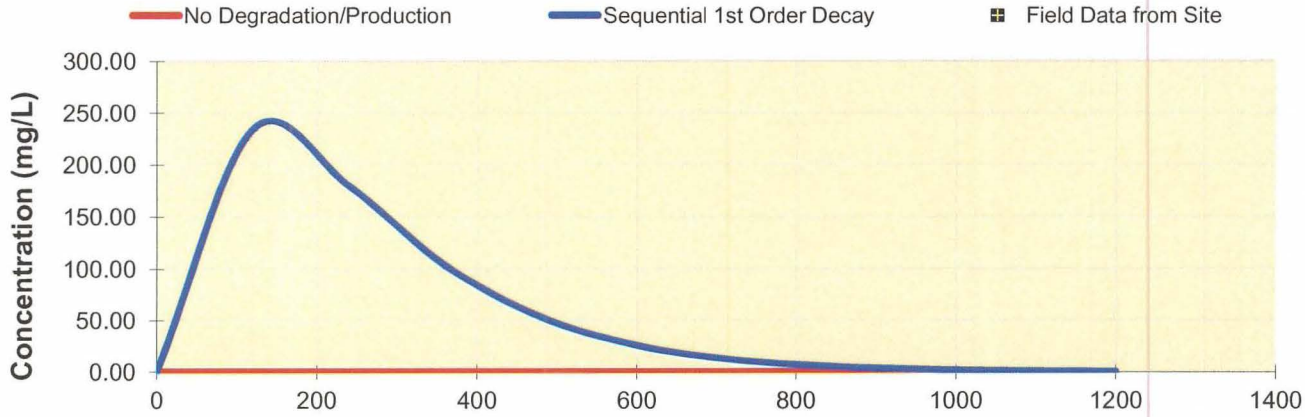
Return to Input

To All

To Array

NITRITE CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

Nitrite	Distance from Source (ft)										
	0	120	240	360	480	600	720	840	960	1080	1200
No Degradation	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biotransformation	0.0001	234.611	179.478	103.577	53.437	25.990	12.200	5.596	2.525	1.121	0.480
	Monitoring Well Locations (ft)										
Field Data from Site											



See PCE

See TCE

See DCE

Time:

42.0 Years

Log ⟺ Linear

Replay

Return to Input

To All

To Array

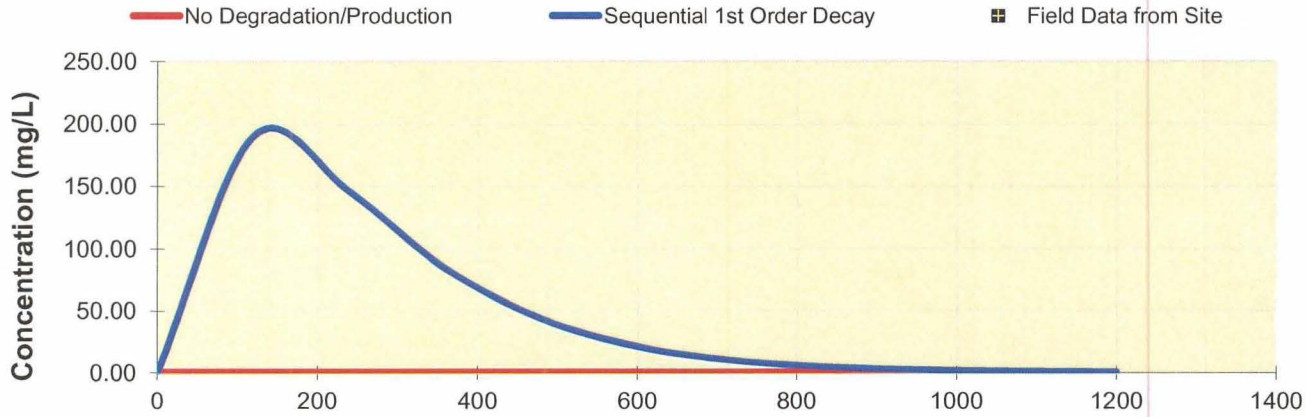
NITRITE CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

Distance from Source (ft)

Nitrite	0	120	240	360	480	600	720	840	960	1080	1200
No Degradation	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biotransformation	0.0000	190.172	145.482	83.958	43.315	21.067	9.890	4.537	2.048	0.914	0.404

Monitoring Well Locations (ft)

Field Data from Site											



See PCE

See TCE

See DCE

Time:

48.0 Years

Log ⟺ Linear

Replay

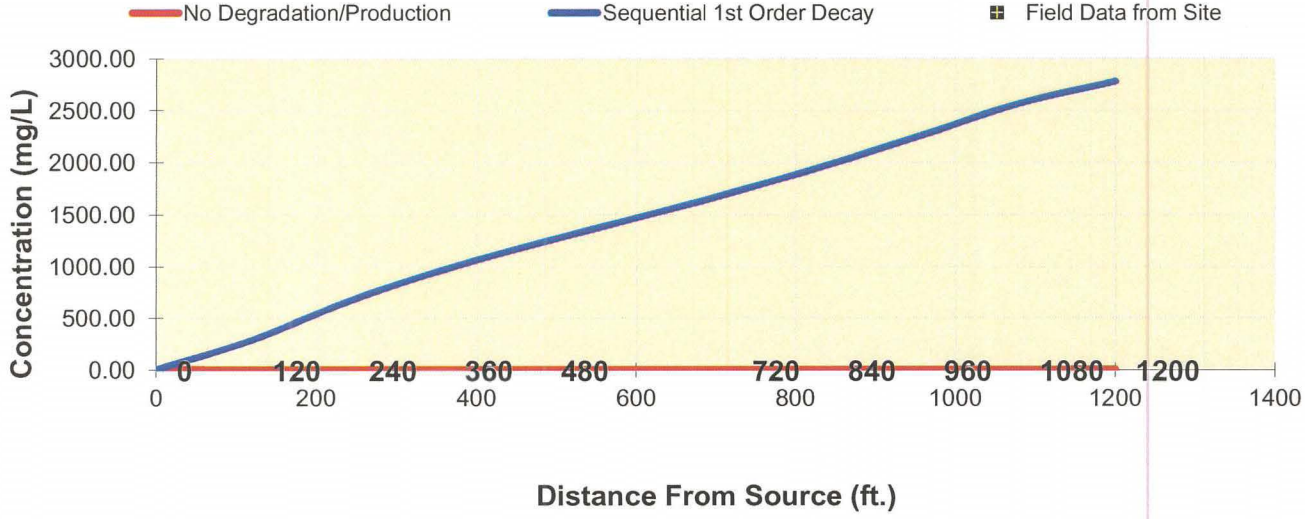
Return to Input

To All

To Array

NITRATE CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

Nitrate	Distance from Source (ft) 0	120	240	360	480	600	720	840	960	1080	1200
No Degradation	0.054	0.062	0.071	0.081	0.093	0.107	0.123	0.141	0.161	0.182	0.197
Biotransformation	0.0541	286.442	661.669	972.465	1230.721	1468.947	1711.829	1975.010	2265.470	2565.696	2778.034
	Monitoring Well Locations (ft)										
Field Data from Site											



See PCE

See TCE

See DCE

Time:

48.0 Years

Log ⟺ Linear

Replay

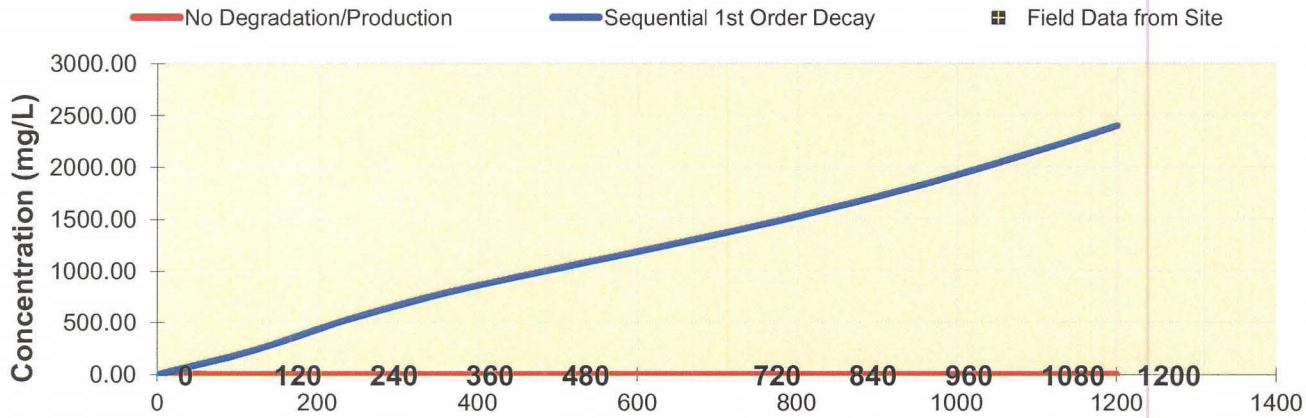
Return to Input

To All

To Array

NITRATE CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

Nitrate	Distance from Source (ft)										
	0	120	240	360	480	600	720	840	960	1080	1200
No Degradation	0.044	0.050	0.058	0.066	0.076	0.087	0.100	0.114	0.131	0.150	0.170
Biotransformation	0.0438	232.185	536.338	788.265	997.603	1190.706	1387.596	1601.190	1839.907	2108.356	2398.757
	Monitoring Well Locations (ft)										
Field Data from Site											



See PCE

See TCE

See DCE

Time:

54.0 Years

Log ⟺ Linear

Replay

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

EW-1 - PDMW-46
Run Name

Maximum NH3 Concentration
115 or 0.02

Data Input Instructions:
1. Enter value directly....or
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 Screening Protocol

TYPE OF CONSTITUENT: Ammonia ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	62.1	(ft/yr)
or			
Hydraulic Conductivity	K	3.0E-03	(cm/sec)
Hydraulic Gradient	i	0.005	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Alpha x*	10	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc. Alpha x

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho	1.7	(kg/L)		
FractionOrganicCarbon, foc	1.0E-3	(-)		
Partition Coefficient	Koc			
Ammonia	14	(L/kg)	1.10	(-)
Nitrite	0	(L/kg)	1.00	(-)
Nitrate	0	(L/kg)	1.00	(-)
		(L/kg)	1.00	(-)
		(L/kg)	1.00	(-)
Common R (used in model)* =			**2.00**	

4. BIOTRANSFORMATION

-1st Order Decay Coefficient*

Zone 1

		λ (1/yr)	half-life (yrs)	Yield
NH3	Nitrite	0.533	1.30	2.75
Nitrite	Nitrate	0.693	1.00	1.35
		0.000		
		0.000		

Zone 2

λ (1/yr)	half-life (yrs)
0.000	
0.000	
0.000	
0.000	

λ HELP

5. GENERAL

Simulation Time*	45	(yr)
Modeled Area Width*	300	(ft)
Modeled Area Length*	1200	(ft)
Zone 1 Length*	1200	(ft)
Zone 2 Length*		(ft)

L, W

Zone 2= L - Zone 1

6. SOURCE DATA

TYPE: Decaying
Single Planar

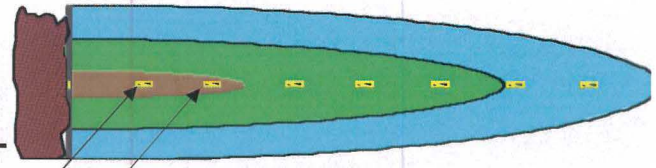
Source Options

Source Thickness in Sat. Zone* 10 (ft)

Y1
Width* (ft) 300

Conc. (mg/L)*	C1	k_s* (1/yr)
Ammonia	580000.0	0.035
Nitrite		0.035
Nitrate	.29	0.035
		0.035
		0.035

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

Ammonia Conc. (mg/L)	270.0	7.9	1.1
Nitrite Conc. (mg/L)	<0.05	<0.05	<0.05
Nitrate Conc. (mg/L)	<0.05	<0.05	<0.05
Distance from Source (ft)	0	160	500
Date Data Collected	2015	2013	2

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore | RESET | SEE OUTPUT | Paste

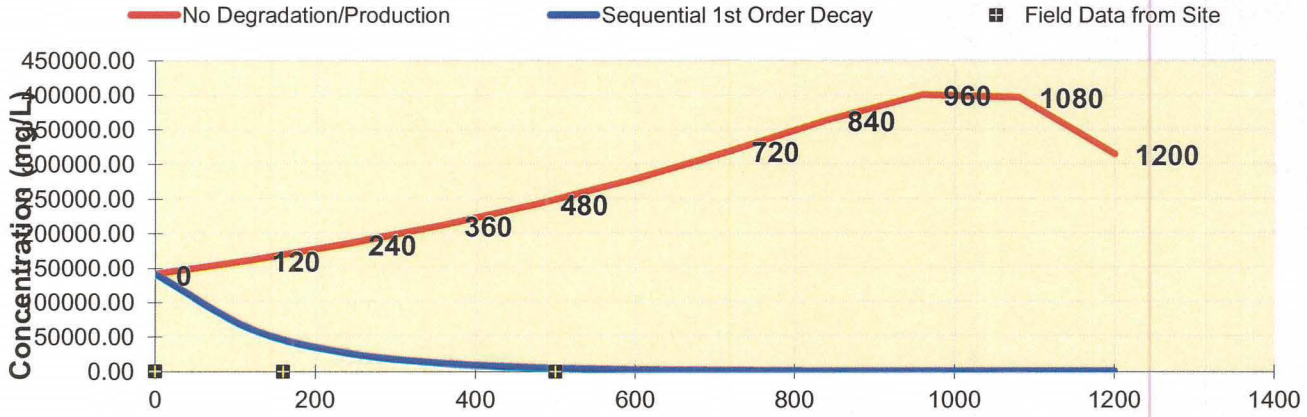
AMMONIA CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

Distance from Source (ft)

Ammonia	0	120	240	360	480	600	720	840	960	1080	1200
No Degradation	########	########	########	########	########	########	########	########	########	########	########
Biotransformation	########	60869.878	26362.664	11417.635	4944.956	2141.625	927.474	401.581	173.626	74.271	30.240

Monitoring Well Locations (ft)

Field Data from Site											



Distance From Source (ft.)

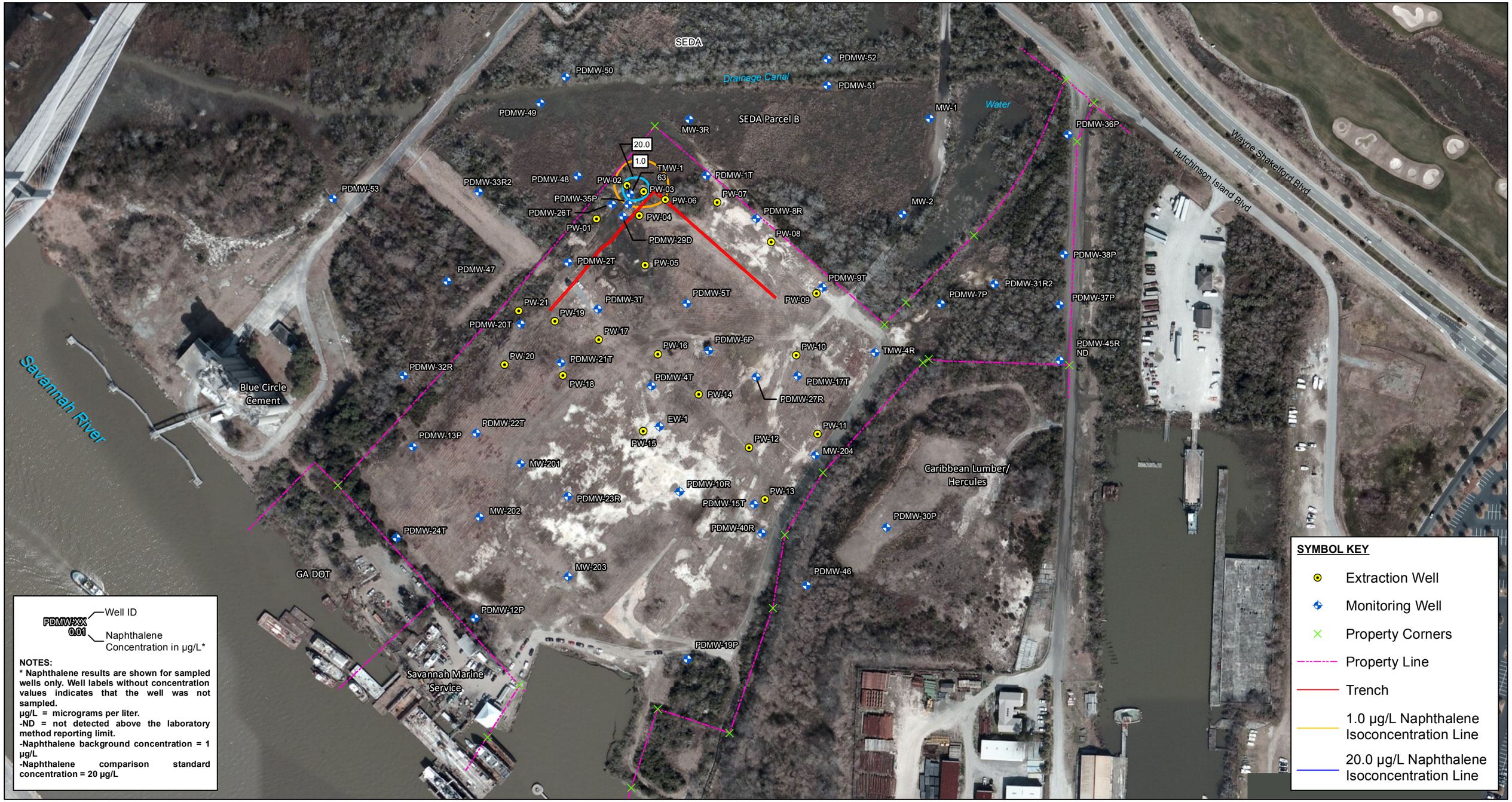
See PCE | See TCE | See DCE

Time: 40.5 Years

Log ⟺ Linear

Replay | Return to Input | To All | To Array

FIGURES



NOTES:
* Naphthalene results are shown for sampled wells only. Well labels without concentration values indicates that the well was not sampled.
µg/L = micrograms per liter.
-ND = not detected above the laboratory method reporting limit.
-Naphthalene background concentration = 1 µg/L
-Naphthalene comparison standard concentration = 20 µg/L

Amec Foster Wheeler
Environment & Infrastructure
2677 Buford Highway
Atlanta, Georgia 30324

amec foster wheeler

N

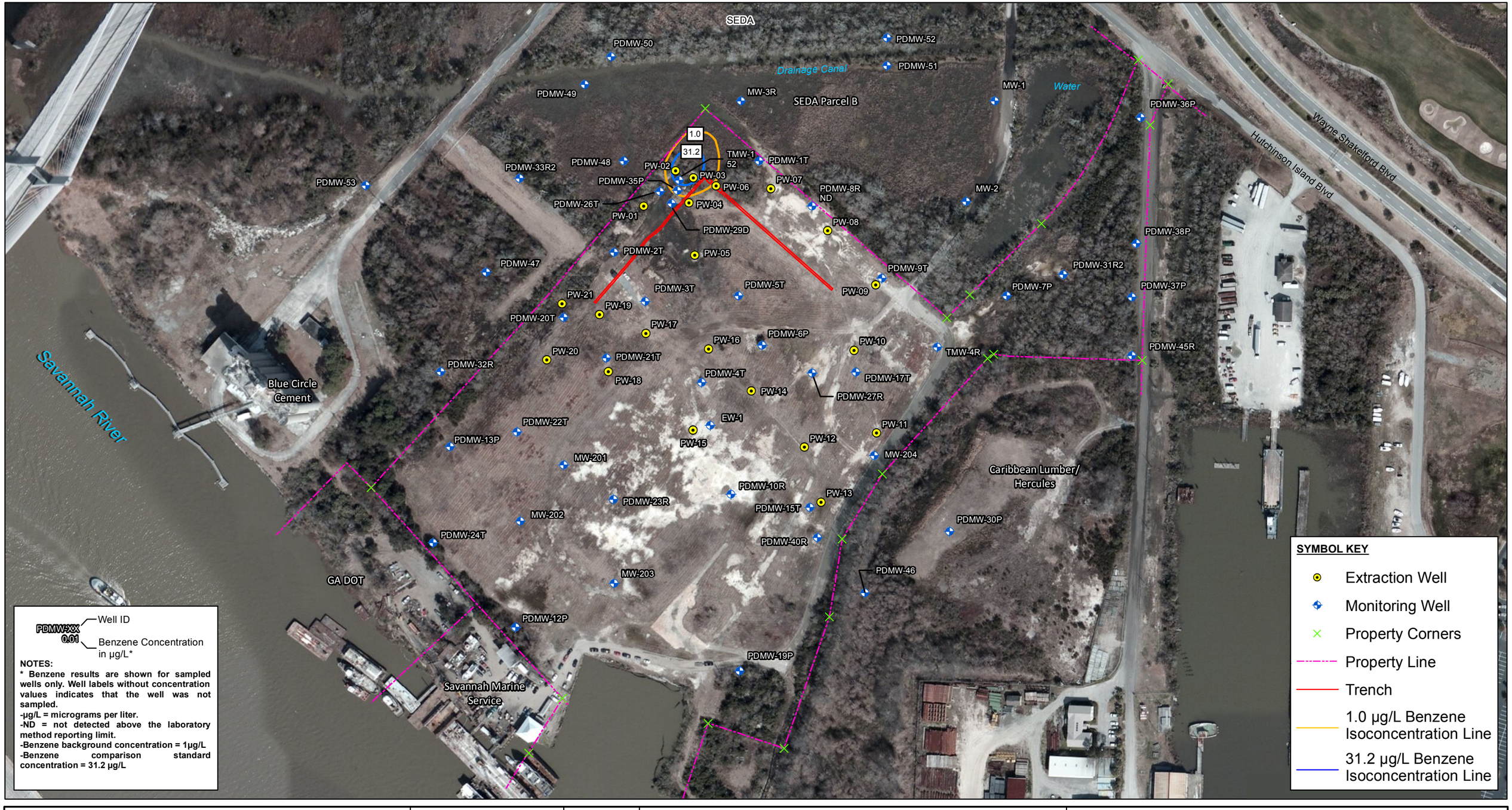
CSX Transportation, Inc.

FIGURE 12

Naphthalene Isoconcentration Map - November 2015
Hutchinson Island HSI - 10101 - Savannah, Georgia

0 200 400 800 1,200 1,600 Feet

05/02/2017	REV:	File: P:\ENV\643005246-CSX Hutchinson Island\GIS\2016VRP\CSXT_Hutch_IS_Naphthalene_Conc_Nov2015.mxd
Drawn: TDN	PROJ: 6-4300-5247	Aerial data source: Obtained through ESRI online services, 2015 Parcel Data Source: Savannah Area GIS (SAGIS)



Amec Foster Wheeler
Environment & Infrastructure
2677 Buford Highway
Atlanta, Georgia 30324

amec foster wheeler

N

CSX Transportation, Inc.

FIGURE 13

Benzene Isoconcentration Map - November 2015
Hutchinson Island HSI - 10101 - Savannah, Georgia

0 200 400 800 1,200 1,600 Feet

07/20/2016	REV:	File: P:\ENV\643005246-CSX Hutchinson Island\GIS\2016VRP\CSXT_Hutch_IS_Benzene_Conc_Nov2015.mxd
Drawn: TDN	PROJ: 6-4300-5247	Aerial data source: Obtained through ESRI online services, 2015 Parcel Data Source: Savannah Area GIS (SAGIS)

PUBLIC NOTICE DOCUMENTATION

March 8, 2017

Mr. Eddie DeLoach
Mayor, City of Savannah
P.O. Box 1027
Savannah, Georgia 31402

Dear Mr. DeLoach:

This is to inform you that the Georgia Environmental Protection Division, Department of Natural Resources, State of Georgia (EPD) has placed this site on the Hazardous Site Inventory pursuant to its authority under the Hazardous Site Response Act and Rules promulgated thereunder. As required by the Rules for Hazardous Site Response, the responsible party for this site was require to investigate the site and submit a compliance status report to EPD summarizing the results of that investigation. EPD is currently reviewing the compliance status report to determine if additional corrective action is needed. The public has the opportunity to review the compliance status report and provide comments to EPD about the report.

32.91-Acre CSXT Parcel
00 Hutchinson Island
Savannah, Georgia 31421
HSI Site No. 10101

A copy of the report may be viewed and copied at the Bull Street Branch Library, 2002 Bull Street, Savannah, Georgia 31401.

Designated Contact:
Chuck Ferry
Amec Foster Wheeler Environment & Infrastructure, Inc.
Atlanta, Georgia 30324
(404) 873-4761

The 30-day public comment period begins on March 13, 2017. Written or oral comments may be submitted to:

Larry Kloet
Georgia Department of Natural Resources
Environmental Protection Division
2 Martin Luther King Jr. Drive
Suite 1054, East Tower
Atlanta, GA 30334
(404) 657-8600

Sincerely,
Amec Foster Wheeler Environment & Infrastructure, Inc.

Stephen R. Foley
Senior Geologist

Amec Foster Wheeler Environment & Infrastructure, Inc.
2677 Buford Highway, Atlanta, Georgia 30324
Tel: (404) 873 4761
Fax: (404) 817 0183

March 8, 2017

Mr. Lee Smith
Chatham County Manager
P.O. Box 8161
Savannah, Georgia 31412

Dear Mr. Smith:

This is to inform you that the Georgia Environmental Protection Division, Department of Natural Resources, State of Georgia (EPD) has placed this site on the Hazardous Site Inventory pursuant to its authority under the Hazardous Site Response Act and Rules promulgated thereunder. As required by the Rules for Hazardous Site Response, the responsible party for this site was require to investigate the site and submit a compliance status report to EPD summarizing the results of that investigation. EPD is currently reviewing the compliance status report to determine if additional corrective action is needed. The public has the opportunity to review the compliance status report and provide comments to EPD about the report.

32.91-Acre CSXT Parcel
00 Hutchinson Island
Savannah, Georgia 31421
HSI Site No. 10101

A copy of the report may be viewed and copied at the Bull Street Branch Library, 2002 Bull Street, Savannah, Georgia 31401.

Designated Contact:
Chuck Ferry
Amec Foster Wheeler Environment & Infrastructure, Inc.
Atlanta, Georgia 30324
(404) 873-4761

The 30-day public comment period begins on March 13, 2017. Written or oral comments may be submitted to:

Larry Kloet
Georgia Department of Natural Resources
Environmental Protection Division
2 Martin Luther King Jr. Drive
Suite 1054, East Tower
Atlanta, GA 30334
(404) 657-8600

Sincerely,
Amec Foster Wheeler Environment & Infrastructure, Inc.

Stephen R. Foley
Senior Geologist

Amec Foster Wheeler Environment & Infrastructure, Inc.
2677 Buford Highway, Atlanta, Georgia 30324
Tel: (404) 873 4761
Fax: (404) 817 0183

AFFIDAVIT OF PUBLICATION
SAVANNAH MORNING NEWS

STATE OF GEORGIA
COUNTY OF CHATHAM

Personally appeared before me, Alaina Fincher, to me known, who being sworn, deposes and says:

That he/she is the authorized agent of Southeastern Newspapers Company, LLC d.b.a. Savannah Morning News, a Georgia corporation, doing business in Chatham County, Georgia as a daily newspaper published in said county;

That he/she is authorized to make affidavits of publication on behalf of said company;

That said newspaper is of general circulation in said county and in the area adjacent thereto;

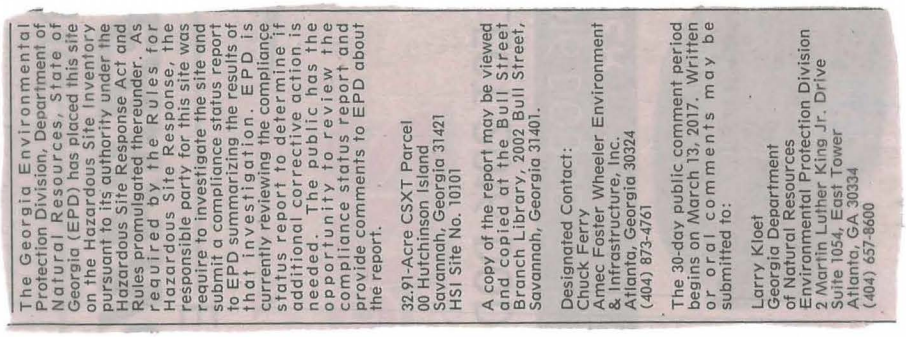
That said newspaper is the legal organ for publication in Chatham County, Georgia

That he/she has reviewed the regular editions of the Savannah Morning News, published on:

March 11, 2017 _____, 2017,

_____, 2017, _____, 2017,

and finds that the following advertisement, to-wit:



The Georgia Environmental Protection Division, Department of Natural Resources, State of Georgia (EPD) has placed this site on the Hazardous Site Inventory pursuant to its authority under the Hazardous Site Response Act and Rules promulgated thereunder. As required by the Rules for Hazardous Site Response, the responsible party for this site was require to investigate the site and submit a compliance status report to EPD summarizing the results of that investigation. EPD is currently reviewing the compliance status report to determine if additional corrective action is needed. The public has the opportunity to review the compliance status report and provide comments to EPD about the report.

32.91-Acre CSXT Parcel
00 Hutchinson Island
Savannah, Georgia 31421
HSI Site No. 10101

A copy of the report may be viewed and copied at the Bull Street Branch Library, 2002 Bull Street, Savannah, Georgia 31401.

Designated Contact:
Chuck Ferry
Amec Foster Wheeler Environment & Infrastructure, Inc.
Atlanta, Georgia 30324
(404) 873-4761

The 30-day public comment period begins on March 13, 2017. Written or oral comments may be submitted to:

Larry Kloet
Georgia Department of Natural Resources
Environmental Protection Division
2 Martin Luther King Jr. Drive
Suite 1054, East Tower
Atlanta, GA 30334
(404) 657-8600

Alaina Fincher

appeared in each of said editions. (Deponent)
Sworn to and subscribed before me

This 14 day of March 2017 Eugene J Cronk
Notary Public; Chatham County, Ga.

EUGENE J. CRONK
Notary Public, Chatham County GA
My Commission Expires Jan. 24, 2018