November 29, 1995

Mr. Lynn Walker
Shell Oil Products Company
P.O. Box 4023
Concord, California 94524

RE: **Corrective Action Plan - Addendum**
Former Shell Service Station
15275 Washington Avenue
San Leandro, California
WIC #204-6852-1108

Dear Mr. Walker:

Enviros, Inc. (Enviros) has prepared this Corrective Action Plan (CAP) Addendum to address questions raised by Mr. Scott Seery of the Alameda County Health Care Services Agency (ACHCSA) during review of the original CAP, dated April 17, 1995. The site location and plan are presented on Plates 1 and 2.

Fate and Transport Modeling

As previously described, FATE2 is the fate and transport model chosen to predict the migration of petroleum hydrocarbon contaminants and determine whether migration to target receptors will occur. The wells used to evaluate the plume attenuation in the CAP were wells SR-1, S-8, and S-10. ACHCSA requested that the following combinations of wells also be evaluated with the model:

S-3, S-8, S-10
S-3, S-9, S-18
S-5, S-8, S-10
S-5, S-9, S-18

The FATE2 model parameter inputs and outputs for these well combinations are the same as those used for the SR-1, S-8, S-10 well combination in the CAP. A summary of these inputs is as follows:

Soil Porosity, n ($ft.^3/ft.^3$): Porosity is percent void space in the soil. Typical values range from 20% to 50%. A soil porosity of 35% was used in this model as it is a common clay porosity value.

Hydraulic Conductivity, K (ft./day): Hydraulic Conductivity is a measure of the capacity of the aquifer to transmit water. Typical values range from 1.00E-04 to 1.00E+02 (ft./day). Based on site geology and prior aquifer testing, a Hydraulic Conductivity of 3 ft./day was used in this model.

Hydraulic Gradient, i (ft./ft.): Hydraulic Gradient is the change in hydraulic head per unit of horizontal distance measured in the downgradient direction. Typical values range from 0.001 to 0.1 ft./ft. 0.005 ft./ft. was used in this model based upon past quarterly groundwater monitoring data.

Source Concentration, Cs (mg/l): The source concentration is the concentration of the contaminants of concern (in this case benzene and TPH-G) in groundwater at the downgradient edge of the source. For use in this model, it has been estimated by calculating the effective solubility of benzene in groundwater by the following equation:

$$Cs = Si * Xi$$

where Si is the solubility limit of the pure compound in water and Xi is the mole fraction of the compound in a hydrocarbon mixture (as it is applied to the groundwater). In this case, Si = 1780 mg/l and Xi = 0.0205. Thus 36.5 mg/l was used in this model as Cs for benzene. It should be noted that this represents a worst case source concentration as Si represents the solubility limit.

The Cs for TPH-G used in this model was 140 mg/l, which represents the high end of the range of solubility for TPH-G in water.

Source Width, Y (ft.): The source width is the maximum distance in feet perpendicular to the direction of groundwater flow in the saturated zone impacted by the source area. In this case, the width of the former UST area perpendicular the direction of groundwater flow was approximately 40 feet.

Source Thickness, Z (ft.): Source thickness reflects the height of the groundwater column in the source area that contains solubilized petroleum hydrocarbons. Groundwater depths fluctuate from approximately 6 to 9 fbg seasonally. Assuming the total depth of the tank excavation (source area) was 13 fbg, it is estimated that the maximum height of the groundwater column in contact with the former tank excavation is 7 feet, which was thus selected as the source thickness for this model.

Receptor Distance, R (ft.): The receptor distance is the distance in feet from the downgradient edge of the source to the selected receptor location. As mentioned in the text above, three irrigation wells are listed within a 1/4-mile radius of the subject property in the downgradient direction. Based on the size of the groundwater plume as it is presently delineated, these wells are at least 1/8-mile from the distal edge of the groundwater plume (i.e. ND perimeter monitoring wells). Although the wells are located an even greater distance from the downgradient edge of the source, the more conservative 1/8 mile (660-feet) distance (the distance from current ND monitoring wells) was used in this model as the receptor distance.

Target Concentration, C^* (mg/l): The target concentration is the selected target exposure point concentration which must be met at the receptor location. In this case the California Department of Health Services Primary MCL of 0.001 mg/l was selected as the target concentration for benzene. No MCL has been established for TPH-G. The analytical method detection limit of 0.050 mg/l was selected as the target concentration for TPH-G.

Attenuation Coefficient, λ (1/day): The attenuation coefficient is a measure of the rate at which a compound is lost from a solute plume due to the combined mechanisms of biodegradation, volatilization, and chemical transformation. For aromatic hydrocarbons, such as benzene, aerobic biodegradation is often the dominant mechanism and attenuation rates of 0.001 to 0.01/day are reported for sites where dissolved oxygen concentrations are sufficient to support aerobic biodegradation. In this case 0.0025/day for benzene and 0.0015/day for TPH-G, near the lower end of the attenuation coefficient range, were selected based on existing monitoring well data.

dissolved O2 conc.

Dispersivity Coefficients, x, y, and z directions (α_x, α_y, α_z): Dispersivity is a measure of the plumes tendency to spread horizontally in the direction of groundwater flow (x direction), horizontally perpendicular to the direction of groundwater flow (y direction), and vertically (z direction). The values used for these input variables (dispersivity multipliers) are those provided by the USEPA Office of Solid Waste *Background Document for the Groundwater Screening Procedure to support 40 CFR Part 268 Land Disposal Restrictions*, 1985. These values are $\alpha_x = 0.1x$ (where x is the downgradient distance from the source), $\alpha_y = \alpha_x/3$, and $\alpha_z = 0.05 * \alpha_x$.

Monitoring Point Data: FATE2 is designed for input of data for up to three monitoring point locations. These monitoring points should be located as close to the centerline of the dissolved plume as possible and should span the full length of the dissolved phase plume if possible. The monitoring point data input to FATE2 is the concentration of the contaminants (benzene and TPH-G) and the distance from the source. As requested by ACHCSA, the model was run four additional times, using the well combinations described above. Concentrations of benzene and TPH-G used for the model were the maximum concentrations which had been detected in these wells. The following tables summarize the input parameters for each well combination.

Wells S-3, S-8, S-10

Well ID	TPH-G (ppm)	Benzene (ppm)	Distance (feet)
S-3	140	36	20
S-8	1.1	0.65	90
S-10	0.59	0.0024	155

Wells S-3, S-9, S-18

Well ID	TPH-G (ppm)	Benzene (ppm)	Distance (feet)
S-3	140	36	20
S-9	19	2.4	70
S-18	0.05	0.001	195

Wells S-5, S-8, S-10

Well ID	TPH-G (ppm)	Benzene (ppm)	Distance (feet)
S-5	54	4.8	20
S-8	1.1	0.65	90
S-10	0.59	0.0024	155

Wells S-5, S-9, S-18

Well ID	TPH-G (ppm)	Benzene (ppm)	Distance (feet)
S-5	54	4.8	20
S-9	19	2.4	70
S-18	0.05	0.001	195

Wells SR-1, S-8, S-10 (done in CAP)

Well ID	TPH-G (ppm)	Benzene (ppm)	Distance (feet)
SR-1	140	36	25
S-8	1.1	0.65	90
S-10	0.59	0.0024	155

Parameters returned by FATE2 based on input data are as follows:

Attenuation Factor AF: The attenuation factor, AF, is equal the groundwater concentration at a given distance divided by the source concentration and ranges in value from zero to unity. Since the AF varies with distance from the source, the AF output is provided in the form of a plot where AF is plotted versus distance from the source area. This plot also includes the site monitoring input data, receptor distance, and location of plume attenuation length (see below). Therefore, model output can be compared with site monitoring data from selected well points to support model results.

Receptor Attenuation Factor AFr: The receptor attenuation factor, AFr, is equal the groundwater concentration at the receptor distance divided by the source concentration.

Plume Attenuation Length, PAL (ft.): The plume attenuation length or PAL is the distance away from the source in the direction of groundwater flow at which the groundwater concentration equals the target concentration, C^*.

Max Source Concentration, C_S^*: The maximum source concentration that is protective of a receptor is returned based upon the target concentration and the receptor attenuation factor.

FATE2 Model Results

The FATE2 input parameters, output data, and plots are presented in Appendix A. Results of the modeling are as follows:

Plume Attenuation Length: The PAL returned by FATE2 for each of the combinations is shown in the table below. It shows that the worst case PAL for benzene is a distance of 338 feet using well combinations S-5, S-9, and S-18, or SR-1, S-8, and S-10. For TPH-G the worst case PAL is 260 feet, using well combination S-3, S-9, S-18. In each case the PALs represent only half or less than half the distance to the nearest receptor.

Well Combination	TPH-G PAL (ft.)	Benzene PAL (ft.)
S-3, S-8, S-10	232	202
S-3, S-9, S-18	260	290
S-5, S-8, S-10	255	232
S-5, S-9, S-18	220	338
SR-1, S-8, S-10	217	338

Max Source Concentration, C_S^*: The maximum source concentration is returned as >S for both benzene and TPH-G in all combinations. This indicates that the calculated maximum source concentration exceeds the solubility limit for benzene and TPH-G.

Receptor Attenuation Factor Afr: Since the calculated maximum source concentration exceeds the solubility limits for benzene and TPH-G, Afr values are extremely low; on the order of 10^{-6} to 10^{-9}.

FATE2 Model Results Discussion

Running the FATE2 model using the requested well combinations resulted in similar results as were found using the well combination in the CAP. Based on these inputs, model results indicate that natural attenuation will degrade hydrocarbons to target levels at distances from the source considerably less than the distance to the nearest receptor (660 feet).

Evaluation of Vacuum Enhanced Pump and Treat

An evaluation of vacuum enhanced pump and treat cleanup methods was requested by ACHCSA as part of the remedial alternatives evaluation presented in the CAP.

Vacuum enhanced pump and treat is an in-situ remedial method whereby both groundwater and soil vapors are extracted simultaneously from the subsurface. Application of a vacuum is beneficial in increasing groundwater extraction rates in low permeability soils. Hydrocarbons are removed from the subsurface in both extracted groundwater and soil vapors. Extracted water and vapor are then treated at the surface prior to discharge through

conventional treatment methods such as activated carbon and air stripping for groundwater, and thermal or catalytic oxidation for soil vapor.

Soils at this site are of a low permeability nature, and pump and treat techniques would likely be more effective when enhanced by vacuum extraction. However, due to the limited use of groundwater in the vicinity of the subject site and the location of potential receptors, active remediation is not warranted at this site. Natural attenuation is the most cost-effective alternative and has been selected to remediate petroleum hydrocarbons present in soil and groundwater.

Receptors
① mobil homes
② future business at site
③ current business at site

Route
① inhalation of vapors from GW to air

Summary

Modeling using the requested well combinations demonstrates that natural attenuation will be effective in remediating petroleum hydrocarbons identified in groundwater prior to their migration to potential receptors.

If you have any questions regarding the contents of this document, please call.

Sincerely,

Enviros, Inc.

for Jeffrey L. Peterson
Hydrogeologist

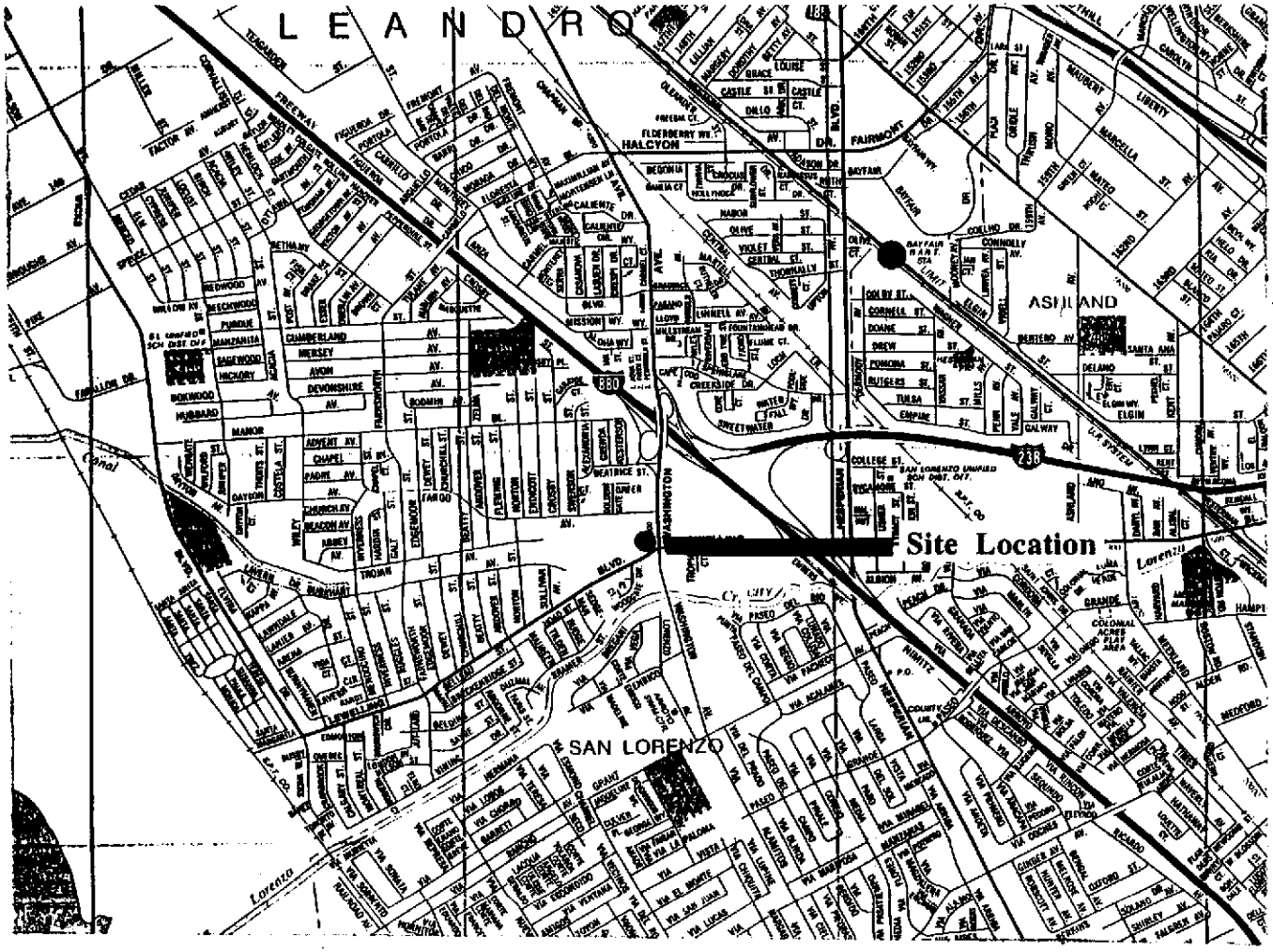
Diane M. Lundquist, P.E.
Senior Engineer
C46725

REGISTERED PROFESSIONAL ENGINEER
DIANE M. LUNDQUIST
NO. C46725
CIVIL
STATE OF CALIFORNIA

Plate 1 - Vicinity Map
Plate 2 - Site Plan

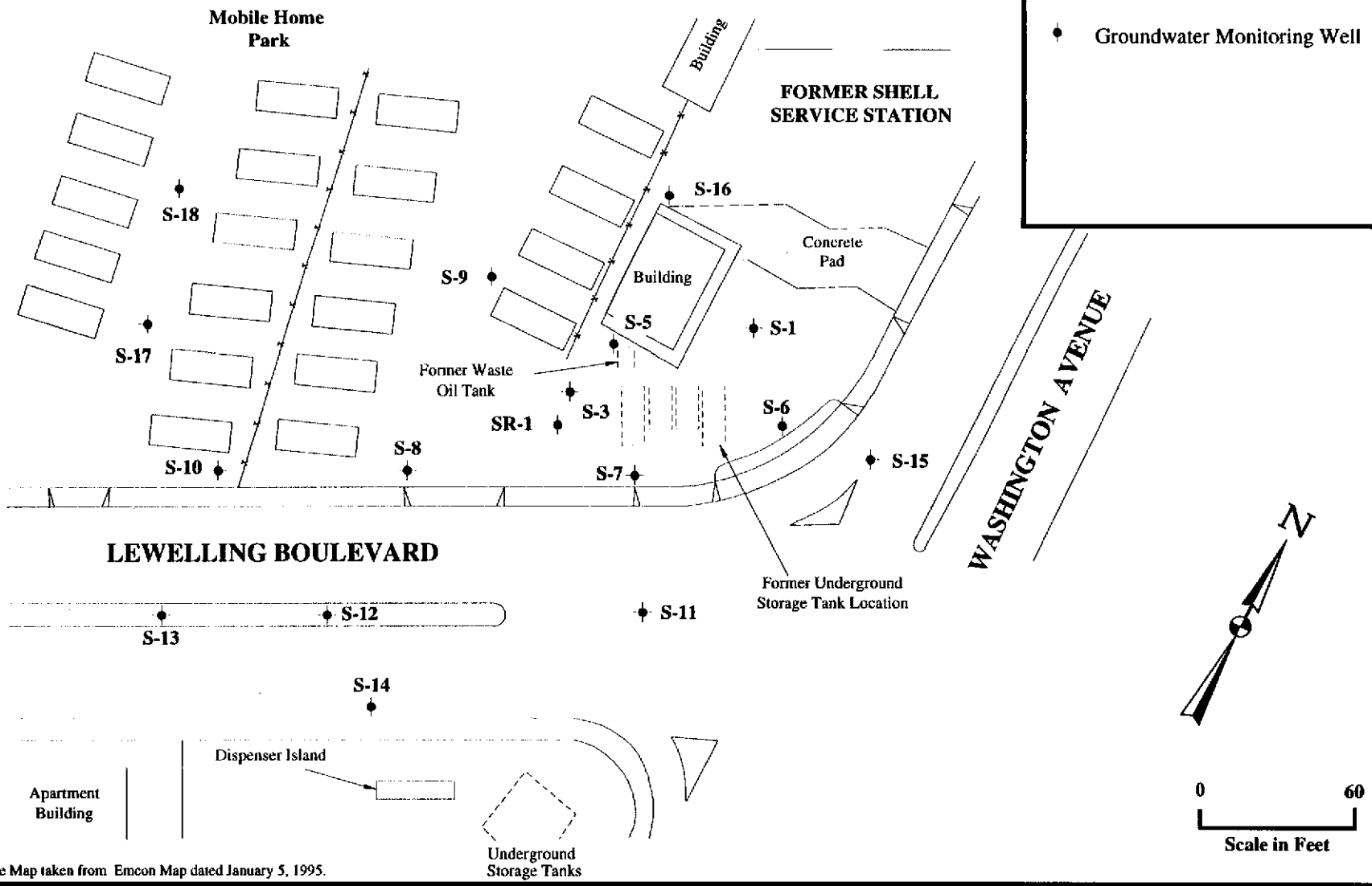
Appendix A: FATE2 Model Parameters

cc: Mr. Scott Seery, Alameda County Health Care Services, Environmental Protection Division
Mr. Rich Hiett, Regional Water Quality Control Board, San Francisco Bay Region
Mr. Mike Bakaldin, San Leandro Fire Department



Note: Vicinity Map taken from California State Automobile Association Map.

PLATE	SITE VICINITY MAP	
1	Shell Oil Company 15275 Washington Avenue San Leandro, California	enviros® 95276.01
Drawn By: JLP	Date: 3-23-95	Approved By: _____ Date: 11-28-95



Base Map taken from Emcon Map dated January 5, 1995.

PLATE 2

SITE PLAN
Shell Oil Company
15275 Washington Avenue
San Leandro, California

enviros ®
95276

Drawn By: JLP Date: 4-3-95

Approved By: _____ Date: 11-28-95

APPENDIX A

FATE2 Model Parameters

Plume Attenuation Model: FATE2

MODEL PARAMETER INPUT

1) Input Flow Model Parameters:	Input	Min	Max
n - Porosity [ft^3/ft^3]	**0.35**	0.25	0.6
K - Hydraulic Conductivity [ft/day]	**3**	0.0001	100
i - Groundwater Gradient [ft/ft]	**0.005**	0.001	0.01
lamda - attenuation rate [1/day]	**0.0012**	0.001	0.01
Mx - multiplier for longitudinal dispersivity [alpha-x = Mx*x]	**0.1**	0.05	0.2
My - multiplier for transverse dispersivity [alpha-y = My*alpha-x]	**0.33**	0.1	0.3333
Mz - multiplier for vertical dispersivity [alpha-z = Mz*alpha-x]	**0.05**	0.0125	0.1

2) Input Source Data:	
Cs - Source Concentration [mg/l]	**140**
Y - source width perpendicular to groundwater flow [ft]	**40**
Z - source depth below water table [ft]	**7**
L - farthest distance to be evaluated from source [ft]	**660**

3) Input Monitoring Point Data:			
Monitoring Point	**1**	**2**	**3**
Cm - concentration at monitoring locations [mg/l]	**140**	**1.1**	**0.59**
M - Distance to Monitoring Locations [ft]	**20**	**90**	**155**

4) Input Receptor Data:	
R - Distance to Nearest Receptor Location [ft]	**660**
Cgw* - Target Concentration [mg/l]	**0.05**

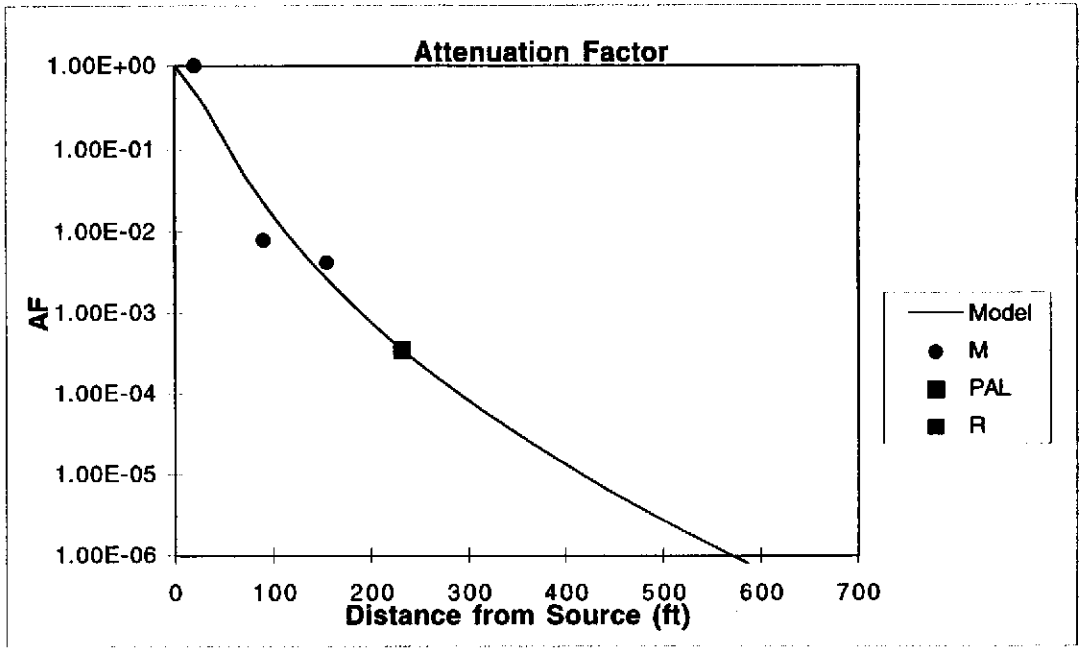
MODEL CALIBRATION

Plume Attenuation Model: FATE2

5) Run Calibration Macros

lamda - attenuation rate [1/day] (.001 - .01)	0.0012	(from cell B8)
Mx - multiplier for longitudinal dispersivity [alpha-x = Mx*x] (0.1)	0.1000	(from cell B9)

AFm - attenuation factor at location m	1.00E+00	7.86E-03	4.21E-03
AFm* - modeled attenuation factor at location m	5.40E-01	2.31E-02	2.61E-03
(1-AFm*/AFm)^2	2.11E-01	3.74E+00	1.45E-01
Sum of Squares (1-AFm*/AFm)^2	4.10E+00		



MODEL OUTPUT

6) Run Plume Attenuation Length Macro "PAL"

Plume Attenuation Model: FATE2

Cgw*/Cs - attenuation factor at target concentration	3.57E-04
(Cgw*/Cs - AFpal)/(Cgw*/Cs)	1.10E-05

PAL - Plume Attenuation Length [ft]	232
PAL/L - Scaled Plume Attenuation Length	0.35
R - Distance to Nearest Receptor Location [ft]	660

7) Receptor Attenuation

AFr - Attenuation Factor at Receptor	3.02E-07
Cr - Concentration at Receptor [mg/l]	4.23E-05
Cgw* - Target Concentration [mg/l]	0.05

8) Input Contaminant Data

S - Solubility Limit of Contaminant (mg/l)	**140.5** Gasoline

9) Target Source Concetration

Cs* - Maximum Source Concentration [mg/l]	>S
Cs - Source Concentration [mg/l]	140

Plume Attenuation Model: FATE2

MODEL PARAMETER INPUT

1) Input Flow Model Parameters:	Input		Min	Max
n - Porosity [ft^3/ft^3]	0.35		0.25	0.6
K - Hydraulic Conductivity [ft/day]	3		0.0001	100
i - Groundwater Gradient [ft/ft]	0.005		0.001	0.01
lamda - attenuation rate [1/day]	0.0025		0.001	0.01
Mx - multiplier for longitudinal dispersivity [alpha-x = Mx*x]	0.1		0.05	0.2
My - multiplier for transverse dispersivity [alpha-y = My*alpha-x]	0.3333		0.1	0.3333
Mz - multiplier for vertical dispersivity [alpha-z = Mz*alpha-x]	0.1	Max	0.0125	0.1

2) Input Source Data:	
Cs - Source Concentration [mg/l]	36
Y - source width perpendicular to groundwater flow [ft]	40
Z - source depth below water table [ft]	7
L - farthest distance to be evaluated from source [ft]	660

3) Input Monitoring Point Data:			
Monitoring Point	1	2	3
Cm - concentration at monitoring locations [mg/l]	36	0.65	0.0024
M - Distance to Monitoring Locations [ft]	20	90	155

4) Input Receptor Data:	
R - Distance to Nearest Receptor Location [ft]	660
Cgw* - Target Concentration [mg/l]	0.001

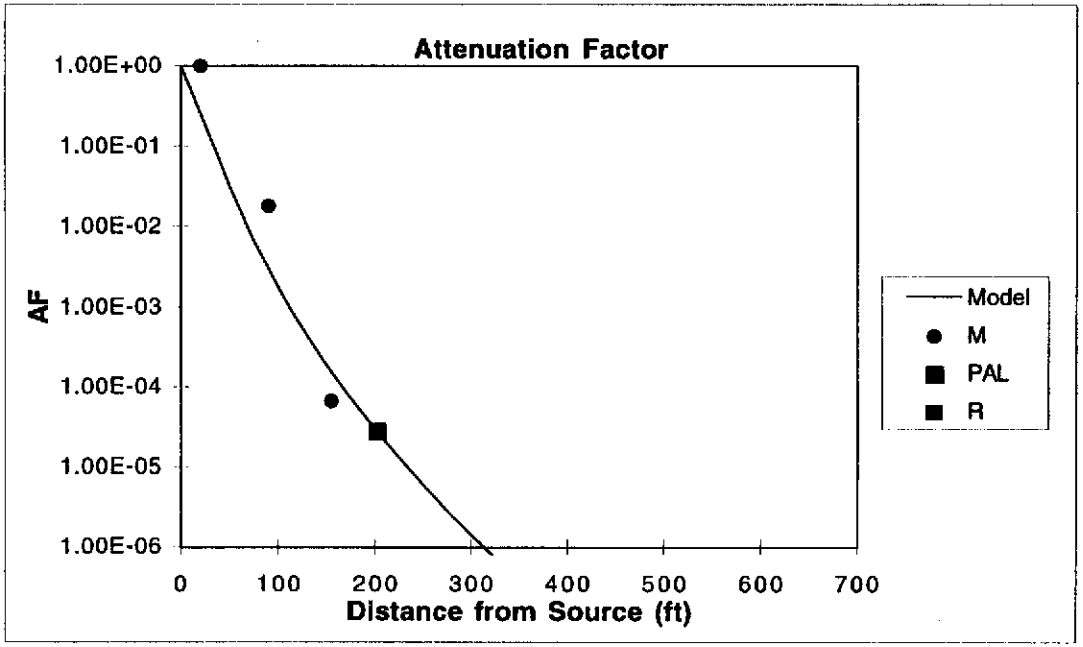
MODEL CALIBRATION

Plume Attenuation Model: FATE2

5) Run Calibration Macros

lamda - attenuation rate [1/day] (.001 - .01)	0.0025	(from cell B8)
Mx - multiplier for longitudinal dispersivity [alpha-x = Mx*x] (0.1)	0.1000	(from cell B9)

AFm - attenuation factor at location m	1.00E+00	1.81E-02	6.67E-05
AFm* - modeled attenuation factor at location m	2.73E-01	2.95E-03	1.56E-04
(1-AFm*/AFm)^2	5.29E-01	7.00E-01	1.78E+00
Sum of Squares (1-AFm*/AFm)^2	3.01E+00		



MODEL OUTPUT

6) Run Plume Attenuation Length Macro "PAL"

Plume Attenuation Model: FATE2

Cgw*/Cs - attenuation factor at target concentration	2.78E-05
(Cgw*/Cs - AFpal)/(Cgw*/Cs)	4.60E-05

PAL - Plume Attenuation Length [ft]	202
PAL/L - Scaled Plume Attenuation Length	0.31
R - Distance to Nearest Receptor Location [ft]	660

7) Receptor Attenuation

AFr - Attenuation Factor at Receptor	6.67E-10
Cr - Concentration at Receptor [mg/l]	2.40E-08
Cgw* - Target Concentration [mg/l]	0.001

8) Input Contaminant Data

S - Solubility Limit of Contaminant (mg/l) **36.48** Benzene in Gasoline

9) Target Source Concentration

Cs* - Maximum Source Concentration [mg/l]	>S
Cs - Source Concentration [mg/l]	36

Plume Attenuation Model: FATE2

MODEL PARAMETER INPUT

1) Input Flow Model Parameters:	Input		Min	Max
n - Porosity [ft^3/ft^3]	0.35		0.25	0.6
K - Hydraulic Conductivity [ft/day]	3		0.0001	100
i - Groundwater Gradient [ft/ft]	0.005		0.001	0.01
lamda - attenuation rate [1/day]	0.001	Min	0.001	0.01
Mx - multiplier for longitudinal dispersivity [alpha-x = Mx*x]	0.1		0.05	0.2
My - multiplier for transverse dispersivity [alpha-y = My*alpha-x]	0.33		0.1	0.3333
Mz - multiplier for vertical dispersivity [alpha-z = Mz*alpha-x]	0.05		0.0125	0.1

2) Input Source Data:	
Cs - Source Concentration [mg/l]	140
Y - source width perpendicular to groundwater flow [ft]	40
Z - source depth below water table [ft]	7
L - farthest distance to be evaluated from source [ft]	660

3) Input Monitoring Point Data:			
Monitoring Point	1	2	3
Cm - concentration at monitoring locations [mg/l]	140	19	0.05
M - Distance to Monitoring Locations [ft]	20	70	195

4) Input Receptor Data:	
R - Distance to Nearest Receptor Location [ft]	660
Cgw* - Target Concentration [mg/l]	0.05

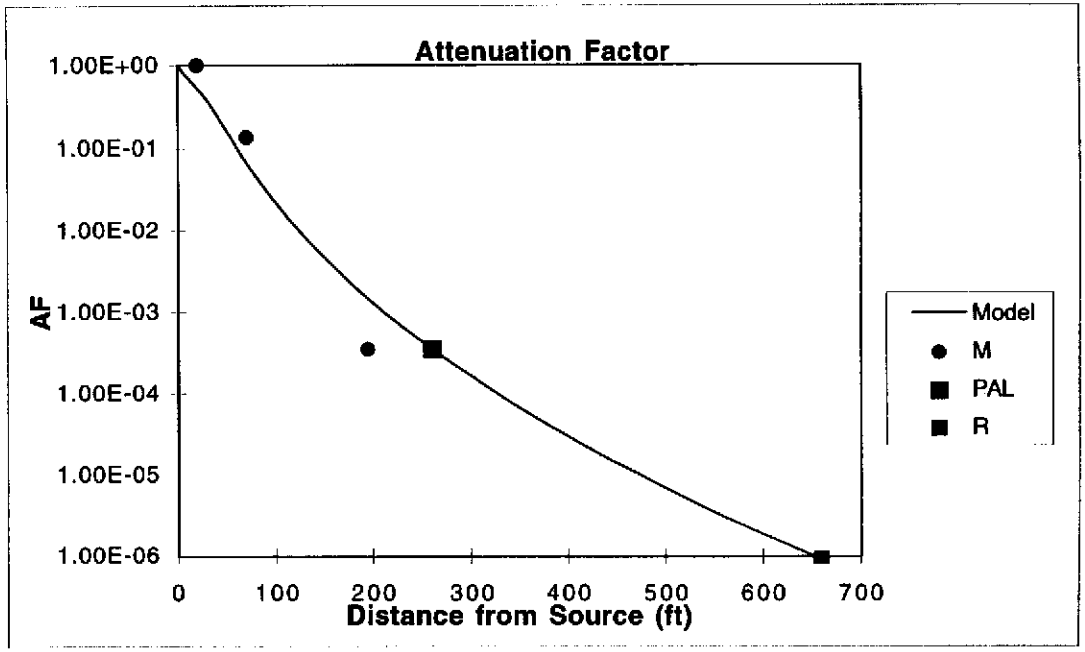
MODEL CALIBRATION

Plume Attenuation Model: FATE2

5) Run Calibration Macros

lamda - attenuation rate [1/day] (.001 - .01)	0.0010	**Min**	(from cell B8)
Mx - multiplier for longitudinal dispersivity [alpha-x = Mx*x] (0.1)	0.1000		(from cell B9)

AFm - attenuation factor at location m	1.00E+00	1.36E-01	3.57E-04
AFm* - modeled attenuation factor at location m	5.88E-01	6.73E-02	1.48E-03
(1-AFm*/AFm)^2	1.69E-01	2.54E-01	9.89E+00
Sum of Squares (1-AFm*/AFm)^2	1.03E+01		



MODEL OUTPUT

6) Run Plume Attenuation Length Macro "PAL"

Plume Attenuation Model: FATE2

Cgw*/Cs - attenuation factor at target concentration	3.57E-04
(Cgw*/Cs - AFpal)/(Cgw*/Cs)	6.57E-04
PAL - Plume Attenuation Length [ft]	260
PAL/L - Scaled Plume Attenuation Length	0.39
R - Distance to Nearest Receptor Location [ft]	660

7) Receptor Attenuation

AFr - Attenuation Factor at Receptor	9.12E-07
Cr - Concentration at Receptor [mg/l]	1.28E-04
Cgw* - Target Concentration [mg/l]	0.05

8) Input Contaminant Data

S - Solubility Limit of Contaminant (mg/l)	**140.5** Gasoline

9) Target Source Concetration

Cs* - Maximum Source Concentration [mg/l]	>S
Cs - Source Concentration [mg/l]	140

Plume Attenuation Model: FATE2

MODEL PARAMETER INPUT

1) Input Flow Model Parameters:	Input		Min	Max
n - Porosity [ft^3/ft^3]	0.35		0.25	0.6
K - Hydraulic Conductivity [ft/day]	3		0.0001	100
i - Groundwater Gradient [ft/ft]	0.005		0.001	0.01
lamda - attenuation rate [1/day]	0.0015		0.001	0.01
Mx - multiplier for longitudinal dispersivity [alpha-x = Mx*x]	0.1		0.05	0.2
My - multiplier for transverse dispersivity [alpha-y = My*alpha-x]	0.3333		0.1	0.3333
Mz - multiplier for vertical dispersivity [alpha-z = Mz*alpha-x]	0.1	Max	0.0125	0.1

2) Input Source Data:	
Cs - Source Concentration [mg/l]	36
Y - source width perpendicular to groundwater flow [ft]	40
Z - source depth below water table [ft]	7
L - farthest distance to be evaluated from source [ft]	660

3) Input Monitoring Point Data:			
Monitoring Point	1	2	3
Cm - concentration at monitoring locations [mg/l]	36	2.4	0.001
M - Distance to Monitoring Locations [ft]	20	70	195

4) Input Receptor Data:	
R - Distance to Nearest Receptor Location [ft]	660
Cgw* - Target Concentration [mg/l]	0.001

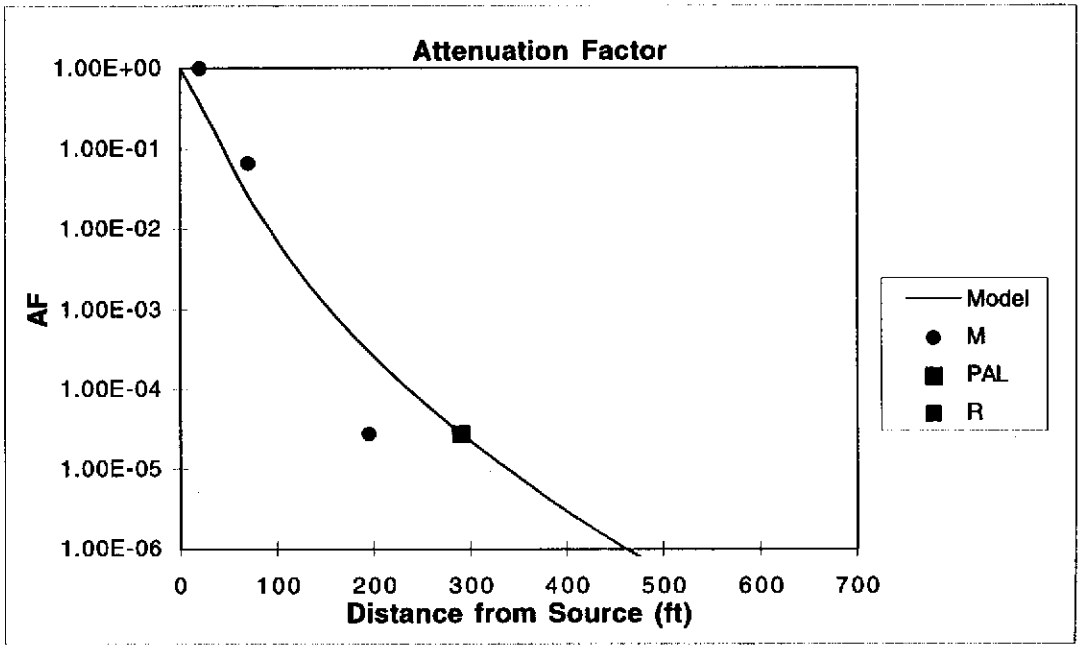
MODEL CALIBRATION

Plume Attenuation Model: FATE2

5) Run Calibration Macros

lamda - attenuation rate [1/day] (.001 - .01)	0.0015	(from cell B8)
Mx - multiplier for longitudinal dispersivity [alpha-x = Mx*x] (0.1)	0.1000	(from cell B9)

AFm - attenuation factor at location m	1.00E+00	6.67E-02	2.78E-05
AFm* - modeled attenuation factor at location m	4.06E-01	2.64E-02	2.96E-04
(1-AFm*/AFm)^2	3.52E-01	3.65E-01	9.34E+01
Sum of Squares (1-AFm*/AFm)^2	9.41E+01		



MODEL OUTPUT

6) Run Plume Attenuation Length Macro "PAL"

Plume Attenuation Model: FATE2

Cgw*/Cs - attenuation factor at target concentration	2.78E-05
(Cgw*/Cs - AFpal)/(Cgw*/Cs)	-2.37E-04

PAL - Plume Attenuation Length [ft]	290
PAL/L - Scaled Plume Attenuation Length	0.44
R - Distance to Nearest Receptor Location [ft]	660

7) Receptor Attenuation

AFr - Attenuation Factor at Receptor	4.67E-08
Cr - Concentration at Receptor [mg/l]	1.68E-06
Cgw* - Target Concentration [mg/l]	0.001

8) Input Contaminant Data

S - Solubility Limit of Contaminant (mg/l)	**36.48** Benzene in Gasoline

9) Target Source Concentration

Cs* - Maximum Source Concentration [mg/l]	>S
Cs - Source Concentration [mg/l]	36

Plume Attenuation Model: FATE2

MODEL PARAMETER INPUT

1) Input Flow Model Parameters:	Input		Min	Max
n - Porosity [ft^3/ft^3]	0.35		0.25	0.6
K - Hydraulic Conductivity [ft/day]	3		0.0001	100
i - Groundwater Gradient [ft/ft]	0.005		0.001	0.01
lamda - attenuation rate [1/day]	0.0018		0.001	0.01
Mx - multiplier for longitudinal dispersivity [alpha-x = Mx*x]	0.1		0.05	0.2
My - multiplier for transverse dispersivity [alpha-y = My*alpha-x]	0.3333		0.1	0.3333
Mz - multiplier for vertical dispersivity [alpha-z = Mz*alpha-x]	0.1	Max	0.0125	0.1

2) Input Source Data:	
Cs - Source Concentration [mg/l]	36
Y - source width perpendicular to groundwater flow [ft]	40
Z - source depth below water table [ft]	7
L - farthest distance to be evaluated from source [ft]	660

3) Input Monitoring Point Data:			
Monitoring Point	1	2	3
Cm - concentration at monitoring locations [mg/l]	4.8	0.65	0.0024
M - Distance to Monitoring Locations [ft]	20	90	155

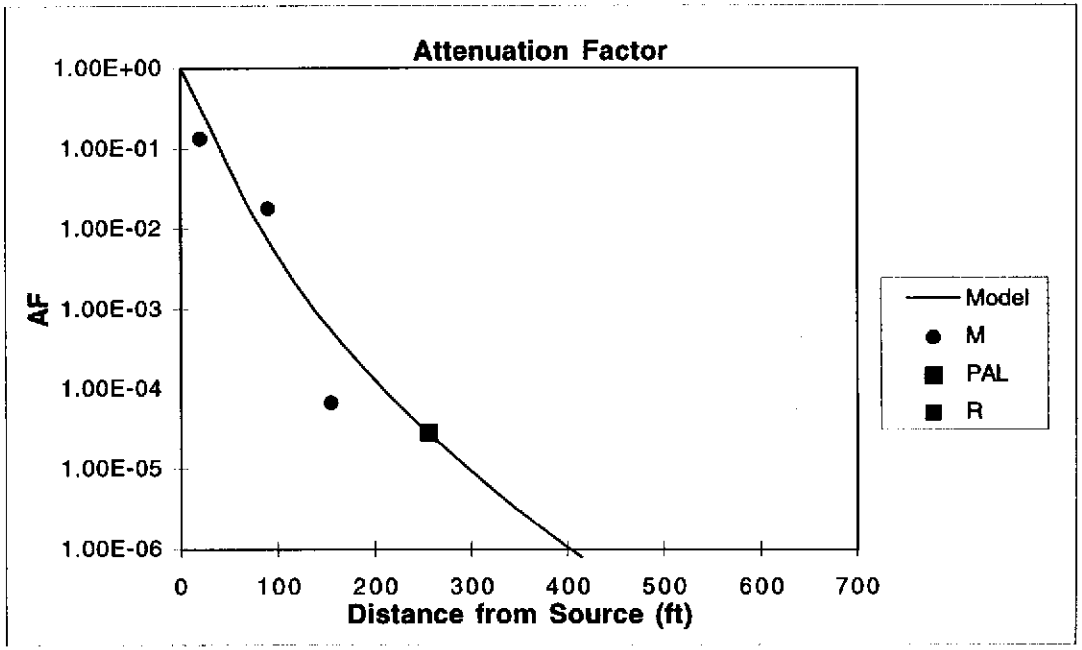
4) Input Receptor Data:	
R - Distance to Nearest Receptor Location [ft]	660
Cgw* - Target Concentration [mg/l]	0.001

MODEL CALIBRATION

Plume Attenuation Model: FATE2

5) Run Calibration Macros

lamda - attenuation rate [1/day] (.001 - .01)	0.0018		(from cell B8)
Mx - multiplier for longitudinal dispersivity [alpha-x = Mx*x] (0.1)	0.1000		(from cell B9)
AFm - attenuation factor at location m	1.33E-01	1.81E-02	6.67E-05
AFm* - modeled attenuation factor at location m	3.60E-01	7.10E-03	5.44E-04
(1-AFm*/AFm)^2	2.88E+00	3.68E-01	5.12E+01
Sum of Squares (1-AFm*/AFm)^2	5.44E+01		



MODEL OUTPUT

6) Run Plume Attenuation Length Macro "PAL"

Plume Attenuation Model: FATE2

Cgw*/Cs - attenuation factor at target concentration	2.78E-05
(Cgw*/Cs - AFpal)/(Cgw*/Cs)	-4.69E-05

PAL - Plume Attenuation Length [ft]	255
PAL/L - Scaled Plume Attenuation Length	0.39
R - Distance to Nearest Receptor Location [ft]	660

7) Receptor Attenuation

AFr - Attenuation Factor at Receptor	1.17E-08
Cr - Concentration at Receptor [mg/l]	4.21E-07
Cgw* - Target Concentration [mg/l]	0.001

8) Input Contaminant Data

S - Solubility Limit of Contaminant (mg/l)	**36.48**	Benzene in Gasoline

9) Target Source Concentration

Cs* - Maximum Source Concentration [mg/l]	>S
Cs - Source Concentration [mg/l]	36

Plume Attenuation Model: FATE2

MODEL PARAMETER INPUT

1) Input Flow Model Parameters:	Input	Min	Max
n - Porosity [ft^3/ft^3]	0.35	0.25	0.6
K - Hydraulic Conductivity [ft/day]	3	0.0001	100
i - Groundwater Gradient [ft/ft]	0.005	0.001	0.01
lamda - attenuation rate [1/day]	0.0012	0.001	0.01
Mx - multiplier for longitudinal dispersivity [alpha-x = Mx*x]	0.1	0.05	0.2
My - multiplier for transverse dispersivity [alpha-y = My*alpha-x]	0.33	0.1	0.3333
Mz - multiplier for vertical dispersivity [alpha-z = Mz*alpha-x]	0.05	0.0125	0.1

2) Input Source Data:	
Cs - Source Concentration [mg/l]	140
Y - source width perpendicular to groundwater flow [ft]	40
Z - source depth below water table [ft]	7
L - farthest distance to be evaluated from source [ft]	660

3) Input Monitoring Point Data:			
Monitoring Point	1	2	3
Cm - concentration at monitoring locations [mg/l]	54	1.1	0.59
M - Distance to Monitoring Locations [ft]	20	90	155

4) Input Receptor Data:	
R - Distance to Nearest Receptor Location [ft]	660
Cgw* - Target Concentration [mg/l]	0.05

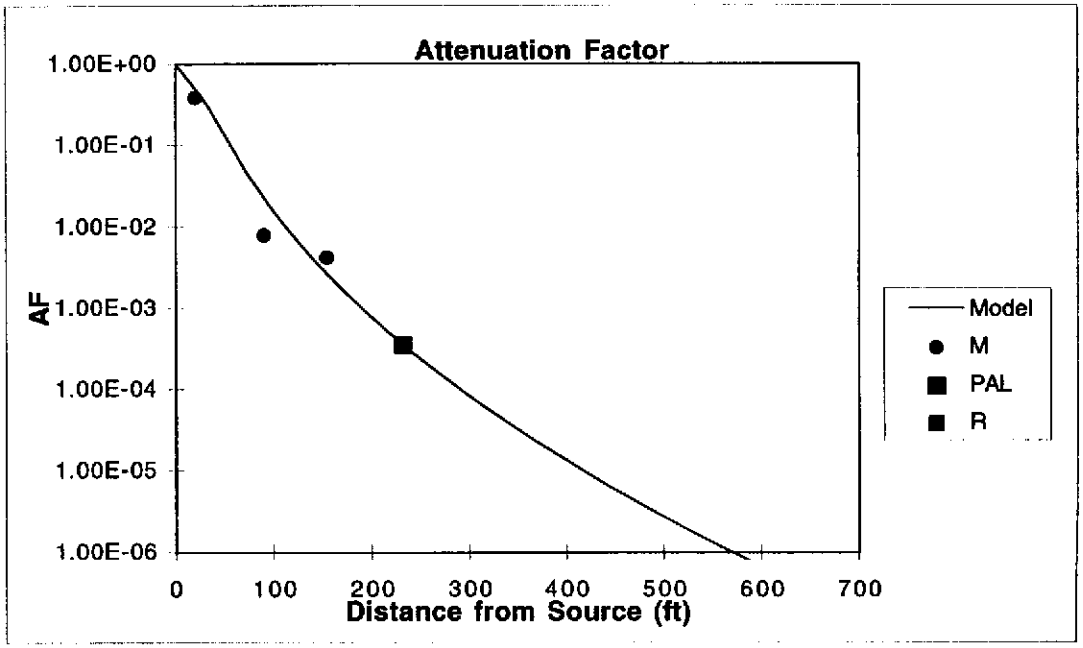
MODEL CALIBRATION

Plume Attenuation Model: FATE2

5) Run Calibration Macros

lamda - attenuation rate [1/day] (.001 - .01)	0.0012	(from cell B8)
Mx - multiplier for longitudinal dispersivity [alpha-x = Mx*x] (0.1)	0.1000	(from cell B9)

AFm - attenuation factor at location m	3.86E-01	7.86E-03	4.21E-03
AFm* - modeled attenuation factor at location m	5.40E-01	2.31E-02	2.61E-03
(1-AFm*/AFm)^2	1.61E-01	3.74E+00	1.45E-01
Sum of Squares (1-AFm*/AFm)^2	4.05E+00		



MODEL OUTPUT

6) Run Plume Attenuation Length Macro "PAL"

Plume Attenuation Model: FATE2

Cgw*/Cs - attenuation factor at target concentration	3.57E-04
(Cgw*/Cs - AFpal)/(Cgw*/Cs)	5.33E-04

PAL - Plume Attenuation Length [ft]	232
PAL/L - Scaled Plume Attenuation Length	0.35
R - Distance to Nearest Receptor Location [ft]	660

7) Receptor Attenuation

AFr - Attenuation Factor at Receptor	3.02E-07
Cr - Concentration at Receptor [mg/l]	4.23E-05
Cgw* - Target Concentration [mg/l]	0.05

8) Input Contaminant Data

S - Solubility Limit of Contaminant (mg/l)	**140.5** Gasoline

9) Target Source Concetration

Cs* - Maximum Source Concentration [mg/l]	>S
Cs - Source Concentration [mg/l]	140

Plume Attenuation Model: FATE2

MODEL PARAMETER INPUT

1) Input Flow Model Parameters:	Input	Min	Max
n - Porosity [ft^3/ft^3]	0.35	0.25	0.6
K - Hydraulic Conductivity [ft/day]	3	0.0001	100
i - Groundwater Gradient [ft/ft]	0.005	0.001	0.01
lamda - attenuation rate [1/day]	0.0013	0.001	0.01
Mx - multiplier for longitudinal dispersivity [alpha-x = Mx*x]	0.1	0.05	0.2
My - multiplier for transverse dispersivity [alpha-y = My*alpha-x]	0.33	0.1	0.3333
Mz - multiplier for vertical dispersivity [alpha-z = Mz*alpha-x]	0.05	0.0125	0.1

2) Input Source Data:	
Cs - Source Concentration [mg/l]	140
Y - source width perpendicular to groundwater flow [ft]	40
Z - source depth below water table [ft]	7
L - farthest distance to be evaluated from source [ft]	660

3) Input Monitoring Point Data:			
Monitoring Point	1	2	3
Cm - concentration at monitoring locations [mg/l]	54	19	0.05
M - Distance to Monitoring Locations [ft]	20	70	195

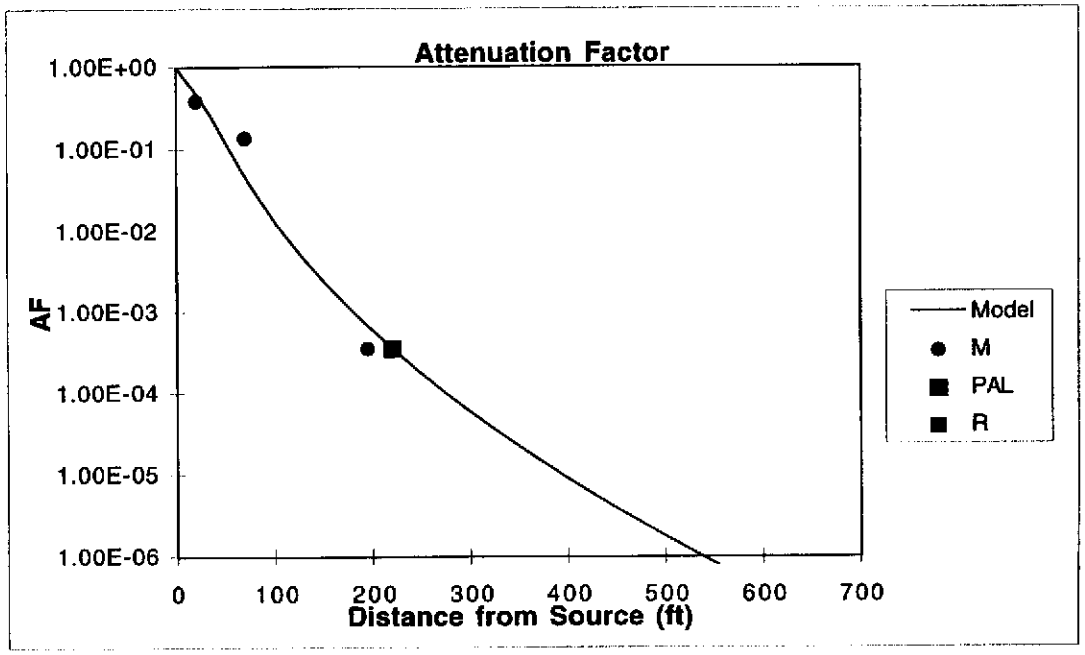
4) Input Receptor Data:	
R - Distance to Nearest Receptor Location [ft]	660
Cgw* - Target Concentration [mg/l]	0.05

MODEL CALIBRATION

Plume Attenuation Model: FATE2

5) Run Calibration Macros

lamda - attenuation rate [1/day] (.001 - .01)	0.0013		(from cell B8)
Mx - multiplier for longitudinal dispersivity [alpha-x = Mx*x] (0.1)	0.1000		(from cell B9)
AFm - attenuation factor at location m	3.86E-01	1.36E-01	3.57E-04
AFm* - modeled attenuation factor at location m	5.18E-01	4.65E-02	6.81E-04
(1-AFm*/AFm)^2	1.18E-01	4.32E-01	8.21E-01
Sum of Squares (1-AFm*/AFm)^2	1.37E+00		



MODEL OUTPUT

6) Run Plume Attenuation Length Macro "PAL"

Plume Attenuation Model: FATE2

Cgw*/Cs - attenuation factor at target concentration	3.57E-04
(Cgw*/Cs - AFpal)/(Cgw*/Cs)	-3.39E-05

PAL - Plume Attenuation Length [ft]	220
PAL/L - Scaled Plume Attenuation Length	0.33
R - Distance to Nearest Receptor Location [ft]	660

7) Receptor Attenuation

AFr - Attenuation Factor at Receptor	1.79E-07
Cr - Concentration at Receptor [mg/l]	2.51E-05
Cgw* - Target Concentration [mg/l]	0.05

8) Input Contaminant Data

S - Solubility Limit of Contaminant (mg/l)	**140.5** Gasoline

9) Target Source Concetration

Cs* - Maximum Source Concentration [mg/l]	>S
Cs - Source Concentration [mg/l]	140

Plume Attenuation Model: FATE2

MODEL PARAMETER INPUT

1) Input Flow Model Parameters:	Input		Min	Max
n - Porosity [ft^3/ft^3]	**0.35**		0.25	0.6
K - Hydraulic Conductivity [ft/day]	**3**		0.0001	100
i - Groundwater Gradient [ft/ft]	**0.005**		0.001	0.01
lamda - attenuation rate [1/day]	**0.0012**		0.001	0.01
Mx - multiplier for longitudinal dispersivity [alpha-x = Mx*x]	**0.1**		0.05	0.2
My - multiplier for transverse dispersivity [alpha-y = My*alpha-x]	**0.3333**		0.1	0.3333
Mz - multiplier for vertical dispersivity [alpha-z = Mz*alpha-x]	**0.1**	**Max**	0.0125	0.1

2) Input Source Data:	
Cs - Source Concentration [mg/l]	**36**
Y - source width perpendicular to groundwater flow [ft]	**40**
Z - source depth below water table [ft]	**7**
L - farthest distance to be evaluated from source [ft]	**660**

3) Input Monitoring Point Data:			
Monitoring Point	**1**	**2**	**3**
Cm - concentration at monitoring locations [mg/l]	**4.8**	**2.4**	**0.001**
M - Distance to Monitoring Locations [ft]	**20**	**70**	**195**

4) Input Receptor Data:	
R - Distance to Nearest Receptor Location [ft]	**660**
Cgw* - Target Concentration [mg/l]	**0.001**

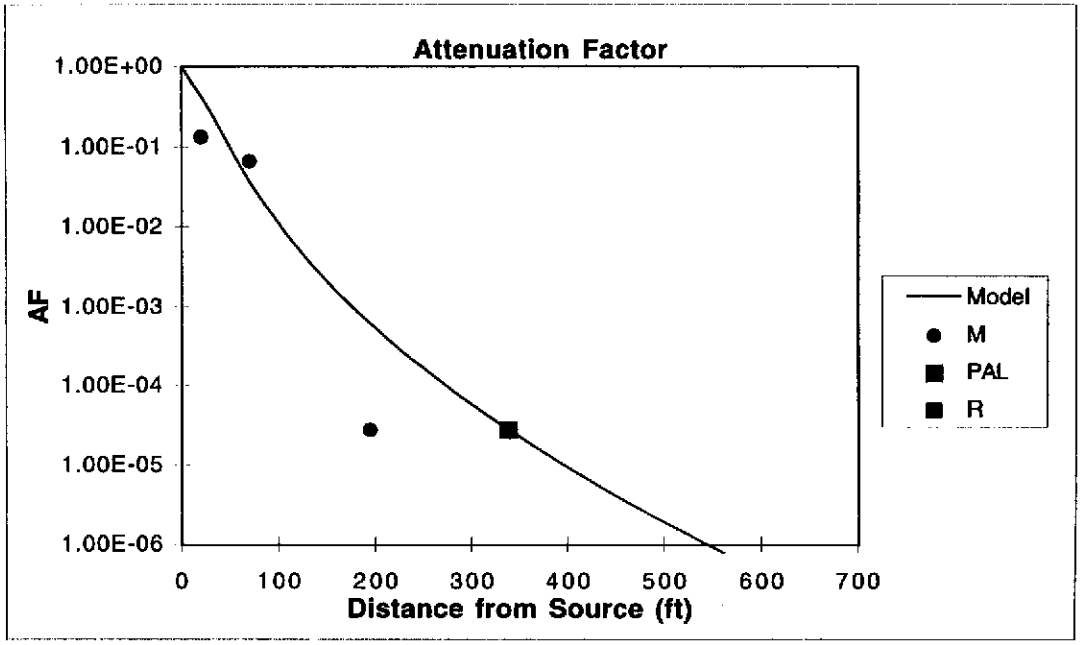
MODEL CALIBRATION

Plume Attenuation Model: FATE2

5) Run Calibration Macros

lamda - attenuation rate [1/day] (.001 - .01)	0.0012	(from cell B8)
Mx - multiplier for longitudinal dispersivity [alpha-x = Mx*x] (0.1)	0.1000	(from cell B9)

AFm - attenuation factor at location m	1.33E-01	6.67E-02	2.78E-05
AFm* - modeled attenuation factor at location m	4.61E-01	3.77E-02	6.18E-04
(1-AFm*/AFm)^2	6.03E+00	1.88E-01	4.51E+02
Sum of Squares (1-AFm*/AFm)^2	4.57E+02		



MODEL OUTPUT

6) Run Plume Attenuation Length Macro "PAL"

Plume Attenuation Model: FATE2

Cgw*/Cs - attenuation factor at target concentration	2.78E-05
(Cgw*/Cs - AFpal)/(Cgw*/Cs)	-1.61E-05

PAL - Plume Attenuation Length [ft]	338
PAL/L - Scaled Plume Attenuation Length	0.51
R - Distance to Nearest Receptor Location [ft]	660

7) Receptor Attenuation

AFr - Attenuation Factor at Receptor	2.12E-07
Cr - Concentration at Receptor [mg/l]	7.65E-06
Cgw* - Target Concentration [mg/l]	0.001

8) Input Contaminant Data

S - Solubility Limit of Contaminant (mg/l)	**36.48** Benzene in Gasoline

9) Target Source Concentration

Cs* - Maximum Source Concentration [mg/l]	>S
Cs - Source Concentration [mg/l]	36

Plume Attenuation Model: FATE2

MODEL PARAMETER INPUT

1) Input Flow Model Parameters:	Input		Min	Max
n - Porosity [ft^3/ft^3]	0.35		0.25	0.6
K - Hydraulic Conductivity [ft/day]	3		0.0001	100
i - Groundwater Gradient [ft/ft]	0.005		0.001	0.01
lamda - attenuation rate [1/day]	0.0012		0.001	0.01
Mx - multiplier for longitudinal dispersivity [alpha-x = Mx*x]	0.1		0.05	0.2
My - multiplier for transverse dispersivity [alpha-y = My*alpha-x]	0.3333		0.1	0.3333
Mz - multiplier for vertical dispersivity [alpha-z = Mz*alpha-x]	0.1	Max	0.0125	0.1

2) Input Source Data:	
Cs - Source Concentration [mg/l]	36
Y - source width perpendicular to groundwater flow [ft]	40
Z - source depth below water table [ft]	7
L - farthest distance to be evaluated from source [ft]	660

3) Input Monitoring Point Data:			
Monitoring Point	1	2	3
Cm - concentration at monitoring locations [mg/l]	36	0.65	0.0024
M - Distance to Monitoring Locations [ft]	25	90	155

4) Input Receptor Data:	
R - Distance to Nearest Receptor Location [ft]	660
Cgw* - Target Concentration [mg/l]	0.001

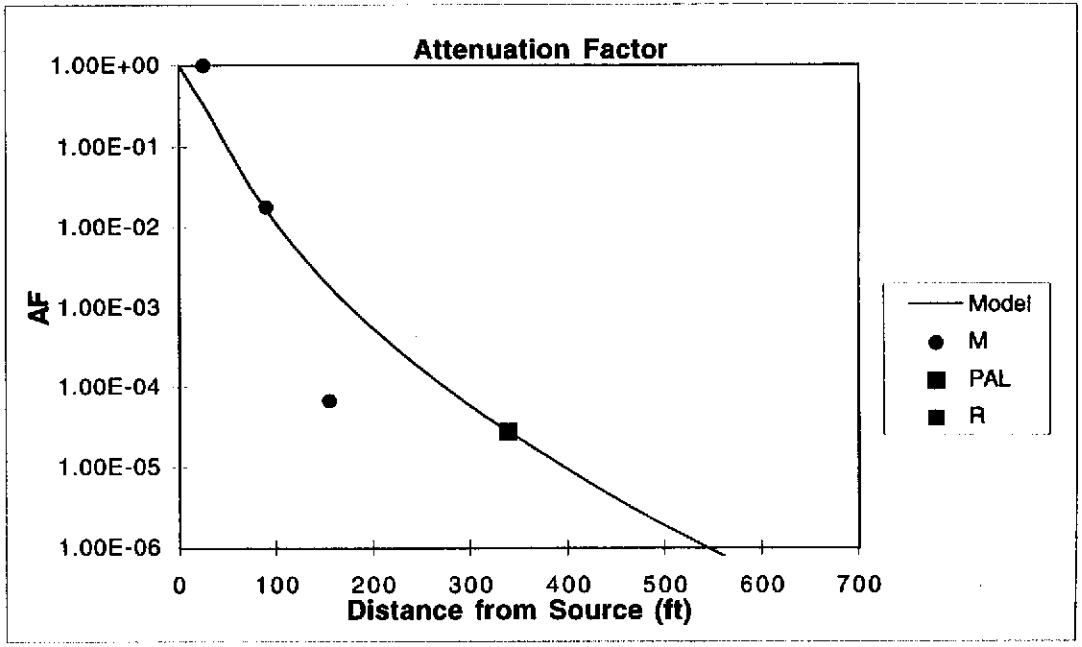
MODEL CALIBRATION

Plume Attenuation Model: FATE2

5) Run Calibration Macros

lamda - attenuation rate [1/day] (.001 - .01)	0.0012	(from cell B8)
Mx - multiplier for longitudinal dispersivity [alpha-x = Mx*x] (0.1)	0.1000	(from cell B9)

AFm - attenuation factor at location m	1.00E+00	1.81E-02	6.67E-05
AFm* - modeled attenuation factor at location m	3.51E-01	1.64E-02	1.84E-03
(1-AFm*/AFm)^2	4.22E-01	7.98E-03	7.11E+02
Sum of Squares (1-AFm*/AFm)^2	7.12E+02		



MODEL OUTPUT

6) Run Plume Attenuation Length Macro "PAL"

Plume Attenuation Model: FATE2

Cgw*/Cs - attenuation factor at target concentration	2.78E-05
(Cgw*/Cs - AFpal)/(Cgw*/Cs)	-7.92E-05

PAL - Plume Attenuation Length [ft]	338
PAL/L - Scaled Plume Attenuation Length	0.51
R - Distance to Nearest Receptor Location [ft]	660

7) Receptor Attenuation

AFr - Attenuation Factor at Receptor	2.12E-07
Cr - Concentration at Receptor [mg/l]	7.65E-06
Cgw* - Target Concentration [mg/l]	0.001

8) Input Contaminant Data

S - Solubility Limit of Contaminant (mg/l) **36.48** Benzene in Gasoline

9) Target Source Concentration

Cs* - Maximum Source Concentration [mg/l]	>S
Cs - Source Concentration [mg/l]	36

Plume Attenuation Model: FATE2

MODEL PARAMETER INPUT

1) Input Flow Model Parameters:	Input		Min	Max
n - Porosity [ft^3/ft^3]	**0.35**		0.25	0.6
K - Hydraulic Conductivity [ft/day]	**3**		0.0001	100
i - Groundwater Gradient [ft/ft]	**0.005**		0.001	0.01
lamda - attenuation rate [1/day]	**0.0012**		0.001	0.01
Mx - multiplier for longitudinal dispersivity [alpha-x = Mx*x]	**0.1**		0.05	0.2
My - multiplier for transverse dispersivity [alpha-y = My*alpha-x]	**0.3333**		0.1	0.3333
Mz - multiplier for vertical dispersivity [alpha-z = Mz*alpha-x]	**0.1**	**Max**	0.0125	0.1

2) Input Source Data:	
Cs - Source Concentration [mg/l]	**140**
Y - source width perpendicular to groundwater flow [ft]	**40**
Z - source depth below water table [ft]	**7**
L - farthest distance to be evaluated from source [ft]	**660**

3) Input Monitoring Point Data:			
Monitoring Point	**1**	**2**	**3**
Cm - concentration at monitoring locations [mg/l]	**140**	**1.1**	**0.59**
M - Distance to Monitoring Locations [ft]	**25**	**90**	**155**

4) Input Receptor Data:	
R - Distance to Nearest Receptor Location [ft]	**660**
Cgw* - Target Concentration [mg/l]	**0.05**

MODEL CALIBRATION

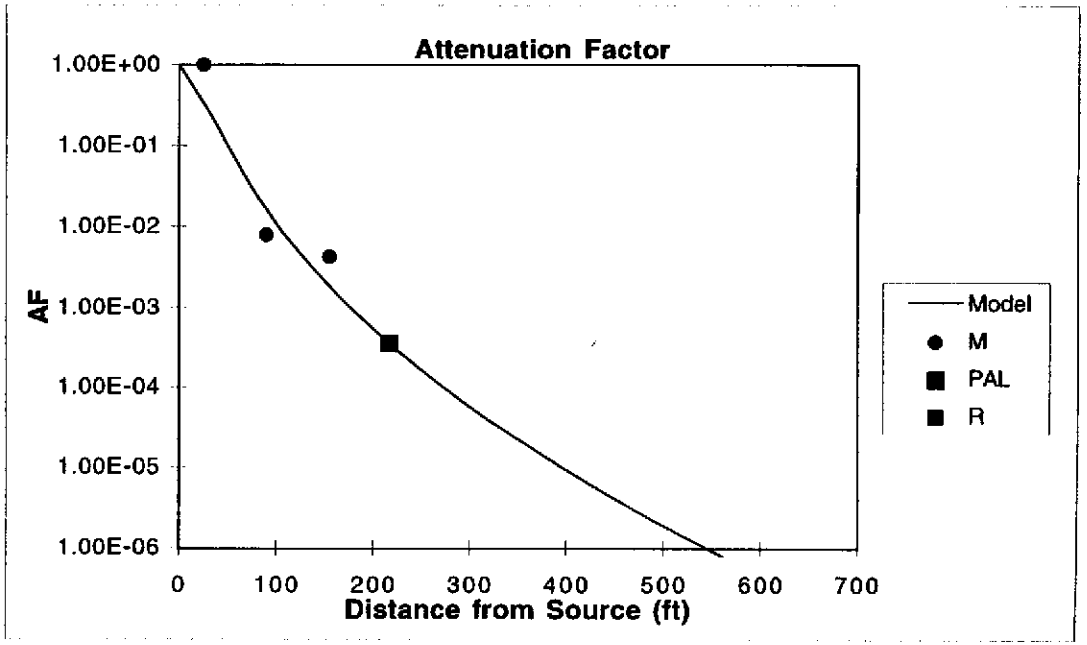
Shell Development Company J.B. Gustafson

Plume Attenuation Model: FATE2

5) Run Calibration Macros

lamda - attenuation rate [1/day] (.001 - .01)	0.0012	(from cell B8)
Mx - multiplier for longitudinal dispersivity [alpha-x = Mx*x] (0.1)	0.1000	(from cell B9)

AFm - attenuation factor at location m	1.00E+00	7.86E-03	4.21E-03
AFm* - modeled attenuation factor at location m	3.51E-01	1.64E-02	1.84E-03
(1-AFm*/AFm)^2	4.22E-01	1.19E+00	3.16E-01
Sum of Squares (1-AFm*/AFm)^2	1.93E+00		



MODEL OUTPUT

6) Run Plume Attenuation Length Macro "PAL"