REPORT

BIOSCREEN MODELING RESULTS AND LONG-TERM GROUNDWATER MONITORING FREQUENCY

Submitted To: Landsburg Mine Site PLP Group

Submitted By: Golder Associates Inc.
18300 NE Union Hill Road, Suite 200
Redmond, WA 98052 USA

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Executive summary

The purpose of this groundwater modeling study was to use the transport of potential constituents disposed at the Landsburg Mine Site to determine a protective long-term groundwater monitoring frequency(ies) for the Draft Cleanup Action Plan. Long-term groundwater monitoring refers to the scope and frequency of groundwater monitoring that occurs in the future ten (10) years after completion of the Cleanup Action Plan for the site. This report presents the results of the transport modeling, arrival times at specific locations, and evaluates the long-term groundwater monitoring frequency resulting from the modeling results.

Conservativeness Built into the Analyses:

To be protective, only the most mobile organic compounds (methylene chloride, vinyl chloride, and 1,2-dioxane) and most mobile metal (arsenic) were used in the modeling effort. In addition, the model transport input parameters that would result in conservative results (defined as more frequent monitoring frequencies) were modeled in this study. The input parameters were proposed by the City of Kent and The Landsburg Mine Site PLP Group (Group) to the Washington Department of Ecology. The Washington Department of Ecology selected either the ultra conservative input parameter proposed or selected a range of conservative values (Ecology 2009).

Because several Ecology-selected input parameters had a range of conservative values (i.e., high, medium and low), our modeling effort focused on three conditions or cases designated as follows:

1. Ultra Conservative Case
2. Medium Conservative Case
3. Baseline Conservative Case

The conservative input parameters also assumed high source concentrations. Unlike most modeling efforts, the only possible model calibration is the absence of detections or the minimum time of a potential arrival for these mobile constituents at particular well locations. The modeling results presented in this report indicate that all of the modeled constituents should have been detected in the north compliance wells, and methylene chloride, vinyl chloride and 1,4-dioxane (although 1,4-dioxane has not been an analyte for analysis in past Site groundwater samples) should have been detected in the south sentinel wells or the south compliance wells. Therefore, travel times estimated by the modeling effort may be unrealistically short and indicate too frequent groundwater monitoring frequencies than are needed to be protective.

Results of the Analyses:

The modeling results indicate that the protective long-term groundwater monitoring frequency at the proposed south compliance boundary is between once every year and once every 1 year and 6 months for the three conservative cases. While at the proposed north compliance boundary the modeling results indicate that the protective long-term groundwater monitoring frequency is between once every 3 months and once every 7 months for the three conservative cases. However, the BIOSCREEN modeling efforts also indicate to the PLP Group that earlier detection may be a far greater advantage for protection of human health and the environment at the site.

Sentinel Wells Being Considered:

To achieve earlier detection and in keeping with the conservative approach in modeling, the PLP Group is now considering the use of sentinel wells for both the south and north compliance boundaries. Sentinel wells will require additional costs to enhance the well network, but the advantages of an earlier detection to achieve increased response time may be a wise investment.

For the south compliance boundary, BIOSCREEN results indicate that if sentinel wells (LMW-9 and LMW-11 locations) are included, the ability to respond to a detection is improved indicating that the protective long-term groundwater monitoring is between once every 10 years and 2 months to once every 14 years and 11 months. For the north compliance boundary, this same approach finds that if sentinel wells (at the north portal location) are included, the protective long-term groundwater monitoring frequency is between once every 2 years and 7 months to once every 5 years and 9 months.

Based on the results of the BIOSCREEN modeling study and to achieve earlier detection through the use of sentinel wells, for the south compliance boundary the Group recommends a long-term groundwater monitoring frequency for be once every 5 years for volatile organic compounds using EPA Method 8260 and once every 10 years for all other potential contaminants, including metals, PCBs, pesticides, and semi-volatile organic compounds (including 1,4-dioxane). For the north compliance boundary utilizing sentinel wells, the Group recommends a long-term groundwater monitoring frequency for the north compliance boundary be once every 2.5 years for volatile organic compounds using EPA Method 8260 and once every 5 years for all other potential contaminants, including metals, PCBs, pesticides, and semi-volatile organic compounds (including 1,4-dioxane).

1.0 INTRODUCTION

The Landsburg PLP Group (Group)/Golder Associates Inc. (Golder) respectively submits our BIOSCREEN modeling results to the State of Washington, Department of Ecology (Ecology) for the MTCA Landsburg Mine Site (see Figures 1 and 2). Ecology decided that the long-term groundwater monitoring frequency that is protective of human health and the environment should be determined through groundwater fate and transport modeling (Ecology Letter dated February 3, 2009 provided in Appendix A). During an Ecology meeting on April 14, 2009 with the City of Kent and the Group, the decision was made to use the BIOSCREEN Model (U.S. EPA 1997) for the groundwater fate and transport modeling effort. The input parameters used in the BIOSCREEN modeling effort were selected by Ecology in their letter dated August 7, 2009 (Ecology 2009), which is provided in Appendix B. Because several Ecology-selected input parameters had a range of values (i.e., high, medium and low), our modeling effort focused on three conditions or cases designated as follows, each of which are designed using conservative assumptions:

4. Ultra Conservative Case: The input parameters to the model would result in the more rapid migration of potential contaminants requiring more frequent long-term groundwater monitoring to be protective.
5. Medium Conservative Case: For input parameters that had an associated range selected by Ecology, medium values were used.
6. Baseline Conservative Case: The input values to the model would result in the baseline contaminant migration requiring less frequent long-term groundwater monitoring to be protective.

All three cases are designated as "conservative". The fixed input parameters for all runs were conservative. For example, the groundwater velocities were fixed at the highest velocity value suggested by the City of Kent/Aspect or the Group/Golder rather than an average (if these values were different). For organic compounds, no biological or chemical degradation was allowed, although all organic compounds degrade with time. The lowest source concentrations used in the model were actually high concentrations that are rarely observed at sites. The algorithm (Domenico 1987) used in the BIOSCREEN Model results in a concentration along the centerline of the plume and represents a point concentration instead of an average concentration for the discharging groundwater from the mine. In addition, the retardation factors for organic compounds were based on the lowest suggested organic carbon levels (F_{oc}) that result in more rapid migration of each organic compound in groundwater. These conservative fixed inputs produce conservative results for all cases.

This report presents the modeling results for each case. The specific input parameter values for each case and each run are provided in Appendices C, D, and E, for the Ultra Conservative Case, Medium Conservative Case, and the Baseline Conservative Case, respectively. Since groundwater from the Roger's Coal Mine of the Landsburg Mine site discharges both toward the north and towards the south, each case is modeled for groundwater migrating toward the north and south separately.

2.0 STUDY OBJECTIVES AND APPROACH

2.1 Objectives

The objective of this modeling study is to determine the long-term groundwater monitoring frequency that is protective of human health and the environment in accordance with MTCA. More specifically, the monitoring frequency shall be frequent enough to detect the arrival of a potential contaminant at the points of compliance before its concentration exceeds MTCA cleanup Levels. To be protective implies that upon detection at the points of compliance there is adequate time to implement remedial actions to prevent the potential contaminants (above the MTCA Cleanup Levels) emanating from the Landsburg Mine Site (specifically the Rogers Coal Mine) from migrating past the points of compliance. The use of sentinel wells adds an additional layer of protection because potential contaminants can be detected at a much earlier time during their migration toward compliance boundaries. Since groundwater from the Rogers Coal Mine discharges to the north and south, this modeling study focused on contaminant migration toward the south and north compliance boundaries that have been proposed in the Draft Cleanup Action Plan (Golder 2002).

2.2 Approach

The time for a potential contaminant to arrive at a particular location (either at some point within the mine or at a compliance boundary) is determined by the BIOSCREEN Model and also by the analytical detection limit for a potential contaminant. The laboratory has two types of detection limits. One is the practical quantification limits (PQL) or Reporting Limit {RLs}), which is the lowest concentration in which the laboratory can achieve actual quantification within analytical method quality assurance requirements. The method detection levels (MDLs) are the lowest concentration that is detectable, but cannot be quantified at the analytical method quality assurance requirements. MDLs are documented and tested on a routine basis at a laboratory. MDL detections are given a "j" qualifier. Both the PQL and MDL are available for analyses if requested. The PQL (or RL) and the MDL for the laboratory Golder uses for the Landsburg Mine site has the following for each mobile organic compound:

- Methylene chloride: RL = 0.2 µg/L; MDL = 0.07 µg/L
- Vinyl chloride: RL = 0.1 µg/L; MDL = 0.05 µg/L
- Metals (arsenic, selenium, and cadmium): generally RL= 2 to 3 µg/L; MDL =1 µg/L or less

California typically is requiring 1,4-dioxane to be analyzed when 1,1,1-trichloroethane and/or trichloroethene are contaminants of concern. The typical PQL (or RL) and MDL are:

- 1,4-dioxane: RL = 2.0 µg/L; MDL = 0.3 µg/L

The MDL is a true detection and is used for determining time of arrival and detection at a specific location for the model runs.

As stated previously, for a monitoring frequency to be protective the detection at the points of compliance must provide adequate time to implement remedial actions to prevent potential contaminants from exceeding the MTCA Cleanup Levels. As an initial consideration, one-half of the MTCA Cleanup levels at the respective points of compliance are used as a trigger for remedial actions. The time for potential contaminants to increase from one-half to the full MTCA Cleanup Level at each point of compliance represents the time available to implement remedial actions.

This report presents the modeling results for each case. The specific input parameter values for each case and each run are provided in Appendices C, D, and E, for the Ultra Conservative Case, Medium Conservative Case, and the Baseline Conservative Case, respectively. BIOSCREEN modeling runs were not conducted for selenium and cadmium, because their mobility is less than arsenic's mobility; therefore arsenic modeling results can be used as a protective surrogate for these metals.

3.0 ULTRA CONSERVATIVE CASE

3.1 Results Summary

Appendix C provides the BIOSCREEN Model inputs and output results using Ecology selected input values that would result in the most rapid contaminant migration, requiring the most frequent long-term groundwater monitoring. Appendix C-1 is a compilation of the BIOSCREEN runs for groundwater migrating toward the south from Rogers Coal Mine (Portal # 3) and Appendix C-2 for groundwater migrating toward the north (Portal #2) from the Rogers Coal Mine.

The source concentrations for this case used methylene chloride at 13,000 mg/L (the solubility limit), vinyl chloride at 1530 mg/L (>0.5 solubility limit), 1,4-dioxane at 148.9 mg/L, and the metals arsenic, selenium and cadmium at 1000 mg/L. The lowest values for dynamic dispersivity were used to create a steeper plume concentration leading edge that would result in concentrations increasing more quickly at any given location upon plume arrival. For groundwater migrating toward the north compliance boundary, this case used the shortest distance from the source to the compliance boundary selected by Ecology.

3.2 Groundwater Monitoring Frequency

Tables 1 and 2 summarize the arrival times of each potential contaminant migrating toward the south and north compliance boundaries, respectively. The tables present times that a potential contaminant would arrive and be detected at specific locations. The locations include potential sentinel well locations and monitoring wells representing both points of compliance.

The south compliance boundary monitoring wells include LMW-3, LMW-5 and LMW-8 although the proposed south compliance boundary is actually the Palmer Coking Coal property boundary several hundred feet further to the south (see Figure 3). The sentinel well is a location that can be used for early detection of contaminants migrating toward a compliance boundary, before the contaminant arrives at detectable levels. The sentinel wells for the south compliance boundary are assumed to be LMW-9 and LMW-11 that are about 700 feet north of the south Portal #3 and monitoring well LMW-8 (see Figure 3). The potential contaminant that requires the most frequent long-term groundwater monitoring is vinyl chloride. Table 1 indicates that the arrival of detectable potential contaminants to the south compliance wells could occur in 22 years and 8 months (for methylene chloride). The most protective monitoring frequency for the south compliance boundary would be monitoring once every year (controlled by vinyl chloride from the time of detection to the time to increase to 0.5 MTCA Cleanup Levels at the south compliance wells), if sentinel wells are not used (only monitoring LMW-3, LMW-5, and LMW-8). If sentinel wells (LMW-9 and LMW-11) are used in long-term groundwater monitoring, the monitoring frequency that would be protective can be once every 10 years, 2 months (controlled by methylene chloride). The remedial action time represents the time for the south compliance wells to have a potential contaminant increase from half to full MTCA Cleanup Levels and is the time necessary to implement remedial actions. The most restrictive (shortest) time is 7 months controlled by methylene chloride.

The north groundwater compliance boundary is represented by monitoring wells LMW-2 and LMW-4 that are just south of the proposed north compliance boundary Palmer Coking Coal property boundary at the Summit Landsburg road (see Figure 3). The sentinel well for the north compliance boundary is assumed to be the Portal #2 area that is about 300 feet south of LMW-2 and LMW-4 wells (see Figure 3). As indicated from Table 2, the arrival of detectable levels of a potential contaminant to the north compliance wells could be as soon as 3 years and 3 months (for methylene chloride), and ranges from 5 years up to 19 years and 10 months for the other modeled potential contaminants. The monitoring frequency that is protective is once every three months (controlled by vinyl chloride from the time of detection to the time to increase to 0.5 MTCA Cleanup Levels at the north compliance wells), if sentinel monitoring is not conducted. If sentinel monitoring is conducted, the monitoring frequency that is protective increases to once every 2 years and 7 months controlled by methylene chloride. The corresponding most restrictive remedial action time frame is 2 months for methylene chloride, vinyl chloride and 1,4 dioxane.

4.0 MEDIUM CONSERVATIVE CASE

4.1 Results Summary

Appendix D provides the BIOSCREEN Model inputs and output results using Ecology selected input values that would result in medium conservative level of contaminant migration and less frequent long-term groundwater monitoring than the "Ultra Conservative Case" would require. Appendix D-1 compile the BIOSCREEN runs for groundwater migrating toward the south end (Portal # 3) and Appendix D-2 for groundwater migrating toward the north end (Portal #2) of the Rogers Coal Mine.

The source concentrations for this case used methylene chloride at 685.1 mg/L, vinyl chloride at 620.3 mg/L, 1,4-dioxane at 24.48 mg/L, and the metal arsenic at 10 mg/L. The medium values for dynamic dispersivity were used to create a moderate slope of the plume concentration along the leading edge that would result in concentrations increasing moderately at any given location once the plume reached that location. For groundwater migrating toward the north compliance boundary, this case used the medium distance from the source to the compliance boundary selected by Ecology.

4.2 Groundwater Monitoring Frequency

Tables 3 and 4 summarize the medium conservative arrival times of each potential contaminant migrating toward the south and north compliance boundaries, respectively. The tables present times that a potential contaminant would arrive and be detected at specific locations. The locations include potential sentinel well locations and monitoring wells representing both points of compliance.

Table 3 indicates that the arrival of detectable potential contaminants to the south compliance wells could occur in 23 years and 1 month (for methylene chloride). The most protective monitoring frequency for the south compliance boundary would be once every 1 year and 1 month (controlled by vinyl chloride from the time of detection to the time to increase to half the MTCA Cleanup Levels at the south compliance wells), if sentinel wells are not used (only monitoring LMW-3, LMW-5, and LMW-8). If sentinel wells (LMW-9 and LMW-11) are used in long-term groundwater monitoring, the monitoring frequency that would be protective can be once every 11 years and 2 months (controlled by methylene chloride). The remedial action time represents the time for the south compliance wells to have a potential contaminant increase from half to full MTCA Cleanup Levels and is the time necessary to implement remedial actions. The most restrictive (shortest) time is 10 months controlled by methylene chloride.

As indicated from Table 4, the arrival of detectable levels of a potential contaminant to the north compliance wells would be 4 years and nine months (for methylene chloride), and ranges from 7 years and 4 months up to 34 years and 4 months for the other modeled potential contaminants. The monitoring frequency that is protective is every five months (controlled by vinyl chloride from the time of detection to the time to increase to 0.5 MTCA Cleanup Levels at the north compliance wells), if sentinel monitoring is not conducted. If sentinel monitoring is conducted, the monitoring frequency that is protective increases to once every 3 years and 4 months (controlled by methylene chloride). The corresponding most restrictive remedial action time is 2 months for methylene chloride.

5.0 BASELINE CONSERVATIVE CASE

5.1 Results Summary

Appendix E provides the BIOSCREEN Model inputs and output using Ecology selected input values that would result in the baseline conservative rate of contaminant migration and require the least frequent groundwater monitoring of the three cases. Appendix E-1 compile the BIOSCREEN runs for groundwater migrating toward the south from Rogers Coal Mine (Portal #3) and Appendix E-2 for groundwater migrating toward the north (Portal #2) from the Rogers Coal Mine.

The source concentrations for this case used methylene chloride at 10 mg/L, vinyl chloride at 28 mg/L, 1,4-dioxane at 10 mg/L, and the metal arsenic at 0.8914 mg/L. The highest values for dynamic dispersivity were used to create a longer plume concentration leading edge that would result in concentrations increasing less rapidly at any given location once the plume reached that location. For groundwater migrating toward the north compliance boundary, this case used the longest distance from the source to the compliance boundary selected by Ecology.

5.2 Groundwater Monitoring Frequency

Tables 5 and 6 summarize the arrival times of each potential contaminant migrating toward the south and north compliance boundaries, respectively, for the Baseline Conservative Case. The tables present times that a potential contaminant would arrive and be detected at specific locations. The locations include potential sentinel well locations and monitoring wells representing both points of compliance.

Table 5 indicates that the arrival of detectable potential contaminants to the south compliance wells could occur in 26 years and 1 month (for methylene chloride). The most protective monitoring frequency for the south compliance boundary would be once every 1 year and 6 months (controlled by vinyl chloride from the time of detection to the time to increase to half MTCA Cleanup Levels at the south compliance wells), if sentinel wells are not used (only monitoring LMW-3, LMW-5, and LMW-8). If sentinel wells (LMW-9 and LMW-11) are used in long-term groundwater monitoring, the monitoring frequency that would be protective can be once every 14 years and 11 months (controlled by methylene chloride). The remedial action time represents the time for the south compliance wells to have a potential contaminant increase from 0.5 to full MTCA Cleanup Levels and is the time necessary to implement remedial actions. The most restrictive (shortest) time is 1 year and 8 months controlled by methylene chloride.

As indicated from Table 6, the arrival of detectable levels of a potential contaminant to the north compliance wells could be as low as 9 years and 4 months (for methylene chloride), and ranges from 17 years and 11 months up to 68 years for the other modeled potential organic contaminants. The monitoring frequency that is protective is once every 7 months (controlled by vinyl chloride from the time of detection to the time to increase to half MTCA Cleanup Levels at the north compliance wells), if sentinel monitoring is not conducted. If sentinel monitoring is conducted, the monitoring frequency that is protective increases to once every 5 years, 9 months (controlled by methylene chloride) The corresponding most restrictive remedial action time is 8 months for methylene chloride and vinyl chloride.

6.0 UNCERTAINTY ASSESSMENT

All modeling efforts need to be calibrated with actual site results. The usual manner of calibrating a model is to vary (within reasonable ranges) the input values as to simulate the actual monitored conditions. The monitored conditions could be the groundwater hydraulic head distributions and the extent of the contaminant plume. Adequate calibration is achieved when the model results emulate the monitored conditions over a given time period. Calibration provides confidence that the model is adequately simulating the hydrologic system and contaminant behavior. Without calibration, there is no confidence that the model is simulating the hydrologic system and contaminant behavior, whereby predictions based on uncalibrated model projections may be unduly biased.

The modeling effort used in the study is difficult to calibrate. The BIOSCREEN model is an analog solution and does not result in a hydraulic head distribution that can be calibrated with observed hydraulic heads. The observed hydraulic gradient and hydraulic conductivity is entered and assumed to be correct with time regardless of changes that take place to the system. For this modeling effort, the observed variations in hydraulic head toward the south were dismissed and a broad assumption was selected to always have a gradient for groundwater flow to the mine's south end from the waste disposal area. This deviation from standard modeling practice is by itself conservatively biased for potential flows to the south.

There is some calibration based on contaminant behavior that can be incorporated into the model. Waste disposal occurred almost 40 years ago. Groundwater has been monitored periodically over the last 15 years at both ends of the mine. Since contaminants have not been detected in groundwater from the monitoring wells, the modeling results should be consistent with these observations. The modeling results presented in Tables 1 through 6 indicate that all the modeled organic compounds (if they existed in the mine site at the selected source concentrations) should have been detected in the north compliance wells and methylene chloride and 1,4-dioxane should have been detected in the south compliance wells. Past and recent groundwater monitoring did not have 1,4-dioxane as an analyte, therefore, monitored data is not useful for any calibration of the modeled 1,4-dioxane results. The BIOSCREEN Model predicts using the inputted parameters that vinyl chloride should have migrated 1700 feet from the waste disposal area toward the south and be detectable in monitoring wells at that location.

Since the modeling results are not consistent with the monitoring results, this may indicate the following:

- The source concentration selected for these organic compounds are very high and may be unrealistic given that they are a daughter compound or an impurity of something else. The wastes disposed at the Rogers Coal Mine contain the organic compounds. Methylene chloride was detected in the source area as was trichloroethylene (TCE). TCE is a potential source of 1,4-dioxane and although not analyzed, is expected to have been present in the waste disposed at the site. TCE can also eventually degrade to vinyl chloride. The dechlorination of TCE is probable given the groundwater conditions; therefore vinyl chloride is also expected to be present at some time in the wastes or impacted groundwater at the Site.

- The model input parameters are not representative of the hydrologic system or of the contaminant behavior. The modeling required that organic compounds will not be assumed to degrade as solutes or source in the model which could make the modeling results unrepresentative, if degradation is occurring relatively rapidly. All organic compounds degrade with time, but the rate of degradation of specific organic compounds is unknown at the Site. Other selected parameters such as groundwater velocity may not be representative.

Since the modeling results are not consistent with monitoring results, this modeling study using the Ecology selected input parameters is considered conservatively biased for all three cases presented above.

7.0 CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

The modeling study evaluated the travel times for potential contaminants to arrive at specific locations within and from the Rogers Coal Mine of the MTCA Landsburg Site. The results are considered conservative, because the model predictions are not consistent with monitored data. The arrival times of potential contaminants that emanate from the waste disposal area in the mine is used to evaluate the long-term groundwater monitoring frequency that will be protective of human health and the environment. To be protective, the monitoring frequency must be able to detect a contaminant before it reaches a compliance boundary and have sufficient time to implement temporary or permanent remedial actions.

This modeling study identifies that the monitoring frequency is very dependent on the relative mobility of a potential contaminant. The "retardation factor" distinguishes a potential contaminant mobility in a given groundwater flow system. Because of the uncertainty of the constituents and their quantity that are in the disposed waste at the Site, this modeling study used the most mobile hazardous constituents that may be present at the Site. The input parameters and source concentrations were selected by Ecology and are conservative. Therefore, the long-term groundwater monitoring frequency resulting from this study should be considered conservative and protective.

This study determined that a protective groundwater monitoring program will be more frequent for the north compliance boundary than for the south compliance boundary. This study has also determined the monitoring frequency using sentinel wells hydraulically up-gradient of the compliance boundaries will allow added protection, because sentinel well monitoring provides early detection of a potential contaminant at a sentinel well before it reaches a compliance boundary.

7.2 Recommendations

The Group recommends that modifications be made to the Draft Cleanup Action Plan (DCAP) for the long-term groundwater monitoring frequency based on these BIOSCREEN modeling results. The last version of the DCAP (Golder 2002) defines that long-term groundwater monitoring to start ten years after the cover soils, low permeability cap, and surface water diversion systems are installed and completed. Groundwater monitoring immediately after remediation is completed to ten years after remediation will be conducted at a more frequent time intervals as specified in the 2002 DCAP. Long-tem groundwater monitoring will be conducted in perpetuity or until impacted media in the Roger's Coal Mine is below MTCA Cleanup Levels.

The Group is considering the use sentinel wells for additional protection and early detection that a contaminant is migrating toward each compliance boundary. For the south compliance boundary, LMW-11 and LMW-9 will be the sentinel wells, and for the north compliance boundary Portal #2 and two additional groundwater monitoring wells will be installed as sentinel wells that monitor different depths of the Roger's Coal Mine workings near the Portal #2 location.

The Group recommends that the results of the Medium Conservative Case be the basis for determining the long-term groundwater monitoring frequency using sentinel wells for the reasons presented in Section 6 above. As shown in Tables 3 and 4, BIOSCREEN modeling results indicate that protective long-term groundwater monitoring for the most mobile potential contaminant is once every 11 years, 2 months for the south compliance boundary and once every 3 years, 4 months for the north compliance boundary. The frequency for long-term groundwater monitoring for metals and potential organics not modeled, but having a retardation factor for the mine aquifer of greater than 50 could be less frequent than once every 30 years and 10 years for the south and north compliance boundaries, respectively, to be protective.

Based on the results of the BIOSCREEN modeling study and the use of sentinel wells, the Group recommends a long-term groundwater monitoring frequency for the south compliance boundary be once every 5 years for volatile organic compounds using EPA Method 8260 and once every 10 years for all other potential contaminants, including metals, PCBs, pesticides, and semi-volatile organic compounds (including 1,4-dioxane).

Based on the results of the BIOSCREEN modeling study and the use of sentinel wells, the Group recommends a long-term groundwater monitoring frequency for the north compliance boundary be once every 2.5 years for volatile organic compounds using EPA Method 8260 and once every 5 years for all other potential contaminants, including metals, PCBs, pesticides, and semi-volatile organic compounds (including 1,4-dioxane).

8.0 REFERENCES

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9.0 CLOSING

GOLDER ASSOCIATES INC.

Douglas J. Morell, Ph.D., L.G., L.HG.
Principal

Kirsi Longley
Environmental Scientist

DJM/KL/ngs

TABLES

TABLE 1

ULTRA CONSERVATIVE CASE-TRAVEL TIMES, MONITORING FREQUENCIES, AND REMEDIAL ACTION TIME FRAMES FOR THE SOUTH COMPLIANCE BOUNDARY AT LANDSBURG MINE

Analyte	Method Detection Limit (µg/L)	MTCA Cleanup Level (µg/L)	LMW-9/LMW-11 Time for Detection from Source	LMW-3/ LMW-5/ LMW-8 Compliance Boundary Time for Detection	LMW-3/ LMW-5/ LMW-8 Compliance Boundary Time for 0.5 MTCA Cleanup Levels	LMW-3/ LMW-5/ LMW-8 Compliance Boundary Time for Full MTCA Cleanup Levels	Monitoring Frequency without Sentinel Wells		Monitoring Frequency with Sentinel Wells (LMW-9 and LMW-11)		Remedial Action Time Between 0.5 MTCA and Full MTCA Cleanup Levels
							0.5 MTCA Cleanup Level	Full MTCA Cleanup Level	0.5 MTCA Cleanup Level	Full MTCA Cleanup Level	
Methylene Chloride	0.07	5.0	15 years, 1 month	22 years, 8 months	25 years, 3 months	25years, 10 months	2 years, 7 months	3 years, 2 month	10 years, 2 months	10 years, 9 months	7 months
Vinyl Chloride	0.05	0.2	33 years, 1 month	49 years, 7 months	50 years, 7 months	51 years, 10 months	1 year, 0 months	2 years, 3 months	17 years, 6 months	18 years, 9 months	1 year, 3 months
1,4-Dioxane	0.3	4.0	22 years, 8 months	33 years, 4 months	35 years, 11 months	37 years, 0 months	2 years, 7 months	3 years, 8 months	13 years, 3 months	14 years, 4 months	1 year, 1 month
Arsenic	1.0	5.0	91 years	134 years	138 years	142 years	4 years	8 years	47 years	51 years	4 years

TABLE 2

ULTRA CONSERVATIVE CASE-TRAVEL TIMES, MONITORING FREQUENCIES, AND REMEDIAL ACTION TIME FRAMES FOR THE NORTH COMPLIANCE BOUNDARY AT LANDSBURG MINE

Analyte	Analytical Method Detection Limit (µg/L)	MTCA Cleanup Level (µg/L)	North Portal #2 Area Time for Detection from Source	LMW-2/ LMW-4 Compliance Boundary Time for Detection	LMW-2/ LMW-4 Compliance Boundary Time for 0.5 MTCA Cleanup Levels	LMW-2/ LMW-4 Compliance Boundary Time for Full MTCA Cleanup Levels	Monitoring Frequency without Sentinel Wells		Monitoring Frequency with Sentinel Wells (North Portal #2 Area)		Remedial Action Time Between 0.5 MTCA and Full MTCA Cleanup Levels
							0.5 MTCA Cleanup Level	Full MTCA Cleanup Level	0.5 MTCA Cleanup Level	Full MTCA Cleanup Level	
Methylene Chloride	0.07	5.0	1 year, 1 month	3 years, 3 months	3 years, 8 months	3 years, 10 months	5 months	7 months	2 years, 7 months	2 years, 9 months	2 months
Vinyl Chloride	0.05	0.2	2 years, 4 months	7 years, 1 month	7 years, 4 months	7 years, 6 months	3 months	5 months	5 years, 0 months	5 years, 2 months	2 months
1,4-Dioxane	0.3	4.0	1 year, 9 months	5 years, 0 months	5 years, 6 months	5 years, 8 months	6 months	8 months	3 years, 9 months	3 years, 11 months	2 months
Arsenic	1.0	5.0	6 years, 10 months	19 years, 10 months	20 years, 8 months	21 years, 5 months	10 months	1 year, 7 months	13 years, 10 months	14 years, 7 months	9 months

TABLE 3

MEDIUM CONSERVATIVE CASE-TRAVEL TIMES, MONITORING FREQUENCIES, AND REMEDIAL ACTION TIME FRAMES FOR THE SOUTH COMPLIANCE BOUNDARY AT LANDSBURG MINE

Analyte	Analytical Method Detection Limit (μg/L)	MTCA Cleanup Level (μg/L)	LMW-9/LMW-11 Time for Detection from Source	LMW-3/ LMW-5/ LMW-8 Compliance Boundary Time for Detection	LMW-3/ LMW-5/ LMW-8 Compliance Boundary Time for 0.5 MTCA Cleanup Levels	LMW-3/ LMW-5/ LMW-8 Compliance Boundary Time for Full MTCA Cleanup Levels	Monitoring Frequency without Sentinel Wells		Monitoring Frequency with Sentinel Wells (LMW-9 and LMW-11)		Remedial Action Time Between 0.5 MTCA and Full MTCA Cleanup Levels
							0.5 MTCA Cleanup Level	Full MTCA Cleanup Level	0.5 MTCA Cleanup Level	Full MTCA Cleanup Level	
Methylene Chloride	0.07	5.0	15 years, 5 months	23 years, 1 month	26 years, 7 months	27 years, 5 months	3 years, 6 months	4 years, 4 months	11 years, 2 months	12 years, 0 months	10 months
Vinyl Chloride	0.05	0.2	31 years, 6 months	47 years, 6 months	48 years, 7 months	49 years, 11 months	1 year, 1 month	2 years, 5 months	17 years, 1 month	18 years, 5 months	1 year, 4 months
1,4-Dioxane	0.3	4.0	23 years, 3 months	34 years, 1 month	37 years, 8 months	39 years, 3 months	3 years, 7 months	5 years, 2 months	14 years, 5 months	16 years, 0 months	1 year, 7 months
Arsenic	1.0	5.0	109 years	157 years	166 years	174 years	9 years	17 years	57 years	65 years	8 years

TABLE 4

MEDIUM CONSERVATIVE CASE-TRAVEL TIMES, MONITORING FREQUENCIES, AND REMEDIAL ACTION TIME FRAMES FOR THE NORTH COMPLIANCE BOUNDARY AT LANDSBURG MINE

Analyte	Analytical Method Detection Limit (µg/L)	MTCA Cleanup Level (µg/L)	North Portal #2 Area Time for Detection from Source	LMW-2/ LMW-4 Compliance Boundary Time for Detection	LMW-2/ LMW-4 Compliance Boundary Time for 0.5 MTCA Cleanup Levels	LMW-2/ LMW-4 Compliance Boundary Time for Full MTCA Cleanup Levels	Monitoring Frequency without Sentinel Wells		Monitoring Frequency with Sentinel Wells (North Portal #2 Area)		Remedial Action Time Between 0.5 MTCA and Full MTCA Cleanup Levels
							0.5 MTCA Cleanup Level	Full MTCA Cleanup Level	0.5 MTCA Cleanup Level	Full MTCA Cleanup Level	
Methylene Chloride	0.07	5.0	2 years, 4 months	4 years, 9 months	5 years, 8 months	5 years, 10 months	11 months	1 year, 1 month	3 years, 4 months	3 years, 6 months	2 months
Vinyl Chloride	0.05	0.2	4 years, 8 months	9 years, 8 months	10 years, 1 month	10 years, 4 months	5 months	8 months	5 years, 5 months	5 years 8 months	3 months
1,4-Dioxane	0.3	4.0	3 years, 8 months	7 years, 4 months	8 years, 3 months	8 years, 8 months	11 months	1 year, 4 months	4 years, 7 months	5 years, 0 months	5 months
Arsenic	1.0	5.0	17 years, 6 months	34 years, 4 months	36 years, 8 months	38 years, 10 months	2 years, 4 months	4 years, 6 months	19 years, 2 months	21 years, 4 months	2 years, 2 months

TABLE 5

BASELINE CONSERVATIVE CASE-TRAVEL TIMES, MONITORING FREQUENCIES, AND REMEDIAL ACTION TIME FRAMES FOR THE SOUTH COMPLIANCE BOUNDARY AT LANDSBURG MINE

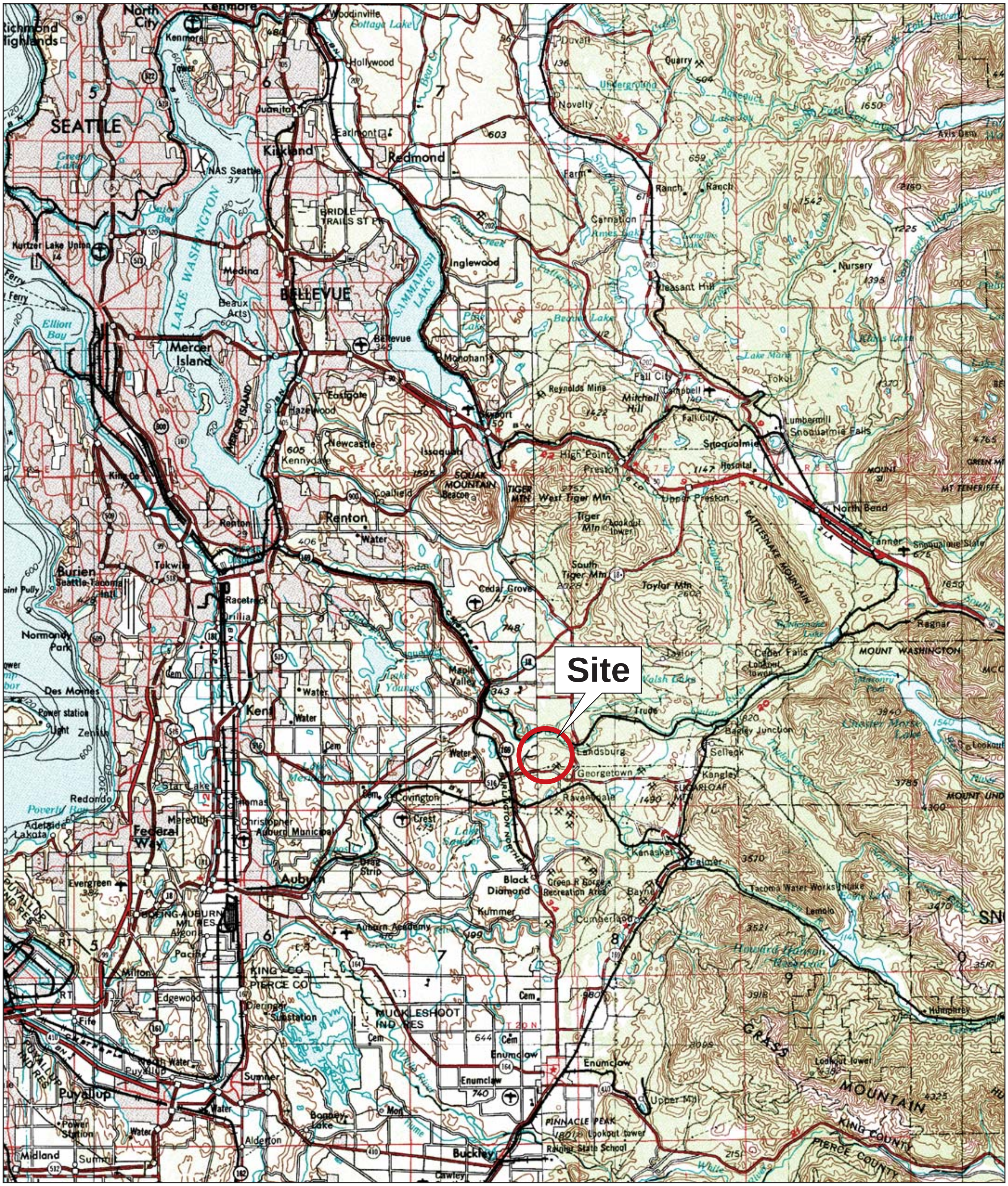
Analyte	Analytical Method Detection Limit (µg/L)	MTCA Cleanup Level (µg/L)	LMW-9/LMW-11 Time for Detection from Source	LMW-3/ LMW-5/ LMW-8 Compliance Boundary Time for Detection	LMW-3/ LMW-5/ LMW-8 Compliance Boundary Time for 0.5 MTCA Cleanup Levels	LMW-3/ LMW-5/ LMW-8 Compliance Boundary Time for Full MTCA Cleanup Levels	Monitoring Frequency without Sentinel Wells		Monitoring Frequency with Sentinel Wells (LMW-9 and LMW-11)		Remedial Action Time Between 0.5 MTCA and Full MTCA Cleanup Levels
							0.5 MTCA Cleanup Level	Full MTCA Cleanup Level	0.5 MTCA Cleanup Level	Full MTCA Cleanup Level	
Methylene Chloride	0.07	5.0	17 years, 7 months	26 years, 1 month	32 years, 6 months	34 years, 3 months	6 years, 5 months	8 years, 2 months	14 years, 11 months	16 years, 8 months	1 year, 8 months
Vinyl Chloride	0.05	0.2	34 years, 0 months	51 years, 0 months	52 years, 6 months	54 years, 4 months	1 year, 6 months	3 years, 4 months	18 years, 6 months	20 years, 4 months	1 year, 10 months
1,4-Dioxane	0.3	4.0	23 years, 5 months	34 years, 5 months	38 years, 10 months	40 years, 11 months	4 years, 5 months	6 years, 6 months	15 years, 5 months	17 years 6 months	2 years, 1 month
Arsenic	1.0	5.0	129 years	185 years	205 years	227 years	20 years	42 years	76 years	98 years	22 years

TABLE 6

BASELINE CONSERVATIVE CASE-TRAVEL TIMES, MONITORING FREQUENCIES, AND REMEDIAL ACTION TIME FRAMES FOR THE NORTH COMPLIANCE BOUNDARY AT LANDSBURG MINE

Analyte	Analytical Method Detection Limit (µg/L)	MTCA Cleanup Level (µg/L)	North Portal #2 Area Time for Detection from Source	LMW-2/ LMW-4 Compliance Boundary Time for Detection	LMW-2/ LMW-4 Compliance Boundary Time for 0.5 MTCA Cleanup Levels	LMW-2/ LMW-4 Compliance Boundary Time for Full MTCA Cleanup Levels	Monitoring Frequency without Sentinel Wells		Monitoring Frequency with Sentinel Wells (North Portal #2 Area)		Remedial Action Time Between 0.5 MTCA and Full MTCA Cleanup Levels
							0.5 MTCA Cleanup Level	Full MTCA Cleanup Level	0.5 MTCA Cleanup Level	Full MTCA Cleanup Level	
Methylene Chloride	0.07	5.0	6 years, 1 month	9 years, 4 months	11 years, 10 months	12 years, 6 months	2 years, 6 months	3 years, 2 months	5 years, 9 months	6 years, 5 months	8 months
Vinyl Chloride	0.05	0.2	11 years, 7 months	17 years, 11 months	18 years, 6 months	19 years, 2 months	7 months	1 year, 3 months	6 years, 11 months	7 years, 7 months	8 months
1,4-Dioxane	0.3	4.0	8 years, 2 months	12 years, 4 months	14 years, 0 months	14 years, 11 months	1 years, 8 months	2 years, 7 months	5 years, 10 months	6 years, 9 months	11 months
Arsenic	1.0	5.0	47 years	68 years	75 years	83 years	7 years	15 years	28 years	36 years	8 years

FIGURES



0 5

SCALE IN MILES

Source: USGS 1:250,000 sheets "Seattle" and "Wenatchee".

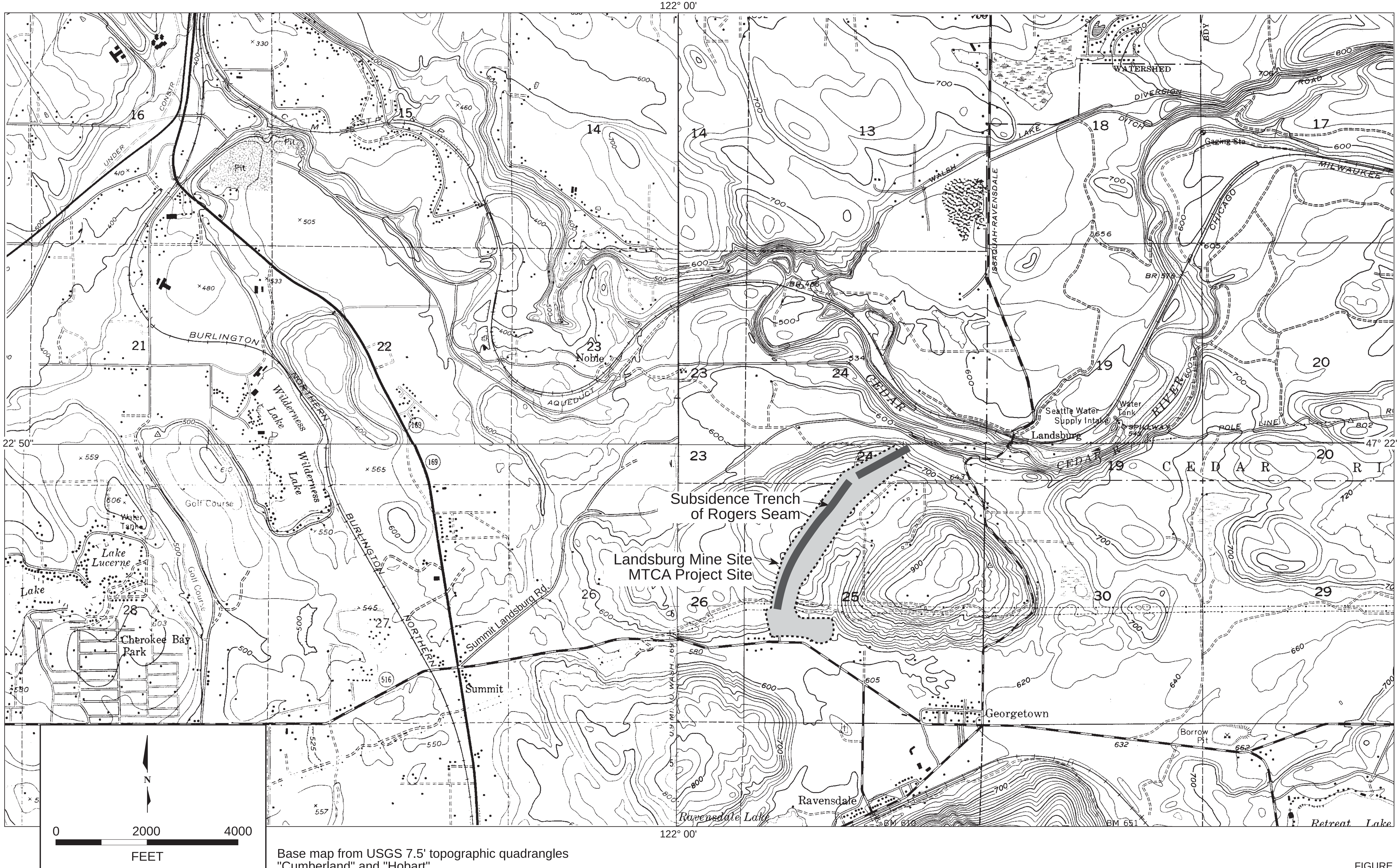
FIGURE 1

LANDSBURG SITE LOCATION

PALMER/LANDSBURG MINE/WA

923100002R300fig01.ai | Mod: 09/14/09 | AMP

Golder Associates



Base map from USGS 7.5' topographic quadrangles "Cumberland" and "Hobart".

FIGURE 2
LANDSBURG PROJECT SITE BOUNDARIES
PALMER/LANDSBURG MINE/WA

Golder Associates

923100002R300fig02.ai | Mod: 09/14/09 | AMP

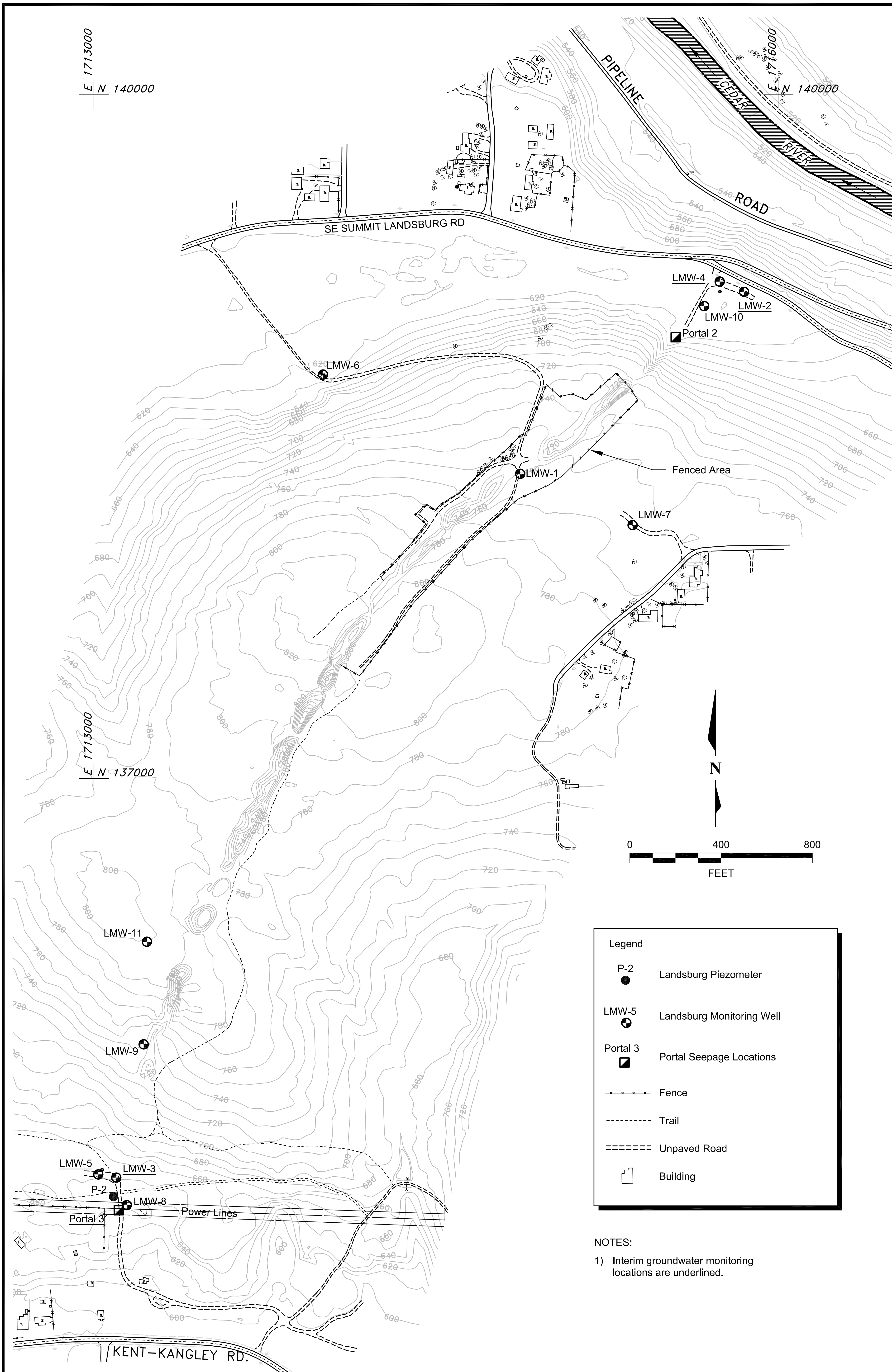


FIGURE 3
GROUNDWATER MONITORING LOCATIONS
PALMER/LANDSBURG MINE/WA

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Golder Associates

APPENDIX A

ECOLOGY LETTER DATED FEBRUARY 3, 2009

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
Northwest Regional Office • 3190 160th Avenue SE • Bellevue, Washington 98008-5452 • (425) 649-7000

February 3, 2009

Mr. Larry Blanchard
Public Works Director
City of Kent Public Works Department
400 West Gowe
Kent, WA 98032

Dear Mr. Blanchard:

Re: Landsburg Mine site long term monitoring evaluation

I am in receipt of your letter dated January 29, 2009 that provided the City of Kent's response to one proposal that I made in a meeting held last January 6, 2009 to adopt annual long term "in perpetuity" monitoring at the site.

The intention of this proposal was to use a justifiably stringent monitoring frequency that was reasonable given that no groundwater impacts have been measured at this site for over 25 years. This would have avoided some of the shortcomings inherent in a modeling approach, and potentially avoided large expense in time, money and staffing. Various safeguards would have been instituted, such as periodic five year reviews, to re-evaluate this frequency, and this plan would not prevent the City from doing their own monitoring had it felt to do so.

The travel time calculation provided in your letter is a simple calculation for advective velocity, that is, the velocity of ground water flow. This is not the same as the velocities exhibited by contaminants in ground water under real conditions. Contaminants experience retardation due to processes such as adsorption, precipitation, dilution, dispersion, and natural degradation. Furthermore, this calculation was only for groundwater travel through the outwash deposits of Rock Creek and did not take into account the pathway within the mine itself. Actually, due to the distance from the north trench area where the wastes were disposed, the overall inclination of the water table in the mine northward away from the south portal and/or the groundwater divide at the south portal area, Clark Springs and Rock Creek are most likely at less risk than the north portal due to these site conditions. Thus, the calculation provided would tend to exaggerate the speed of a potential contaminant and does not reflect actual contaminant behavior commonly measured at contaminated sites where actual groundwater impacts have occurred, unlike this site.

Given the City's preference to move forward with a modeling approach to determining the long-term monitoring frequency of potential groundwater contaminants at the site, Ecology will proceed to plan for groundwater/contaminant transport and fate model to implement and collaboratively review. Ecology will contact Kelly Peterson in the near future to propose or discuss the model approach to adopt, whether it will involve review of the existing travel time memo that uses the semi-analytical BIOSCREEN model, or possibly a numerical transport and fate model such as MODFLOW-MT3D.

The modeling approach will be used to determine a scientifically based travel time for potential contaminants that may come from the site along the groundwater flow pathway. From these results, a monitoring frequency will be established that is designed to detect the contaminant at site wells, thus allowing the implementation of contingency measures to prevent its spread from the site through the capture, treatment, and safe disposal of the treated water.

I have assembled a team of TCP hydrogeologists and environmental engineers to assist me in the modeling and monitoring frequency evaluations and decision-making.

If you would like to further discuss with me your concerns or to share any questions or comments, please don't hesitate to contact me at (425) 649-7094.

Sincerely,

Jerome B. Cruz

Jerome B. Cruz, Ph.D., L.G., L.H.G.
Toxics Cleanup Program

jc/kp

cc: Robert Warren, TCP-NWRO, Department of Ecology
Ching-Pi Wang, TCP-NWRO, Department of Ecology

APPENDIX B

ECOLOGY LETTER DATED AUGUST 7, 2009

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
Northwest Regional Office • 3190 160th Avenue SE • Bellevue, Washington 98008-5452 • (425) 649-7000

August 7, 2009

Dr. Douglas Morell
Golder Associates Inc
18300 NE Union Hill Road Suite 200
Redmond WA 98052-3333

Dear Dr. Morell:

Re: BIOSCREEN modeling of hypothetical contaminant travel times and recommended long term monitoring frequencies at Landsburg Mine site in Ravensdale, Washington

Please find attached the input parameters, simulation methodology, and model outputs decided upon by Ecology for this site.

Please implement the model simulations outlined in the accompanying document and present the results to Ecology to use for a final decision.

Please don't hesitate to contact me if you have any questions or comments.

Thank you,

Jerome B. Cruz, Ph.D., L.G., L.H.G.
Toxics Cleanup Program

JBC

Attachments

cc: William Kombol, Palmer Coking Coal Co.
Mike Mactutis, City of Kent Public Works
Robert F. Bakemeier, Bakemeier Law Firm (Bakemeier, P.C.)
Elliot Furst, Assistant Attorney General, Ecology Division
Robert Warren, WA State Department of Ecology
Ching-Pi Wang, WA State Department of Ecology
Ronald W. Timm, WA State Department of Ecology

BIOSCREEN MODELING OF HYPOTHETICAL CONTAMINANT TRAVEL TIMES AT THE LANDSBURG MINE SITE, RAVENSDALE, WASHINGTON

FLOW DISTANCE L

Two directions of flow simulations will be done: northward (from waste area at the northern subsidence trench area to the north portal) and southward (from waste area at the northern subsidence trench area to southern mine interior wells LMW-11 and LMW-9, and to the south portal wells).

The following table shows the recommended distances (in feet) by Golder Associates (representing the PLP Group), and Aspect Consulting (representing the City of Kent):

Table 1.

Flow Direction	Golder Associates	Aspect Consulting
Northward	700-800	600, 1200
Southward	1800, 2400	1700, 2300, 2900, 3500

In order to assume conservative (i.e., more protective) input values for the models, Ecology directs the PLP to use the following:

Northward flow: **600 feet (low range),**
800 feet (primary value)
1200 feet (high range)

Southward flow: **1400 feet (edge of trench area 7 to LMW-11)**
1700 feet (low range - edge of waste area to LMW-11 to LMW-9)
2300 feet (edge of waste area to LMW-11 to LMW-9 to portal wells LMW-3 and LMW-5). Primary distance is 2300 feet (waste edge to portal wells)
Option is left open to plug in longer distances of 2900 and 3500 feet for their own use.

The travel times between wells along these paths will also be a critical component of the modeling.

MODELED CONTAMINANTS

Golder Associates and Aspect Consulting recommended the following contaminants for the simulations:
1,4-dioxane (Kent)
Vinyl Chloride (Kent)
Methylene Chloride (PLPs)
Arsenic (PLPs and Kent)
Selenium (PLPs and Kent)
Cadmium (PLPs)

Ecology requests the modeling of all the recommended contaminants. Since biodegradation will not be considered in the simulations, the relevant major parameter that distinguishes the transport behavior in these choices of contaminants will be adsorption/retardation. However, including all the contaminants may lead to calculating a wider range of travel times, source concentrations, dispersivities and transport behavior that aid in making conservative evaluations of long-term monitoring frequencies.

BIOSCREEN INPUT PARAMETERS

The following is a summary table (adapted from the original BIOSCREEN interface) showing the suggested input values and Ecology chosen values:

Table 2.

			Kent's values	PLP's values	Final Chosen Values	COMMENTS
1. HYDROGEOLOGY						
Seepage Velocity*	*Vs (ft/yr)*	**North** **South**	830.0 664	750.0 250	**830** **664**	**conservative**
or						Golder's Vs does not calculate from Vs=KI/n; Derives from assumed Q after remediation
Hydraulic Conductivity	*K (cm/sec)*		8.5E-01	8.0E-01		
Hydraulic Gradient	*I (ft/ft)*	**North** **South**	3.6E-04 2.9E-04	5.00E-03 1.0E-04		
Porosity	*n*		0.38	0.25		
2a. DISPERSION	**North**	**600 ft**				**Model a range of dispersivities**
*Longitudinal Dispersivity**	*alpha x (ft)*		6	22.0	**15.6 low** **19.5** **23.4 high**	**Use alpha x +/- 20%**
*Transverse Dispersivity**	*alpha y (ft)*		0.6	0.1	**1.6 low** **2.0** **2.4 high**	**Use alpha y +/- 20%**
*Vertical Dispersivity**	*alpha z (ft)*		0.06	0.0	**0.16 low** **0.2** **0.24 high**	**Use alpha z +/- 20%**
or						
Estimated Plume Length	*Lp (ft)*				**600 ft**	
2b. DISPERSION	**North**	**800 ft**				
*Longitudinal Dispersivity**	*alpha x (ft)*		8	22.0	**17.76 low** **22.2** **26.64 high**	**Use alpha x +/- 20%**
*Transverse Dispersivity**	*alpha y (ft)*		0.8	0.1	**1.76 low** **2.2** **2.64 high**	**Use alpha y +/- 20%**
*Vertical Dispersivity**	*alpha z (ft)*		0.08	0.0	**0.176 low** **0.22** **0.264 high**	**Use alpha z +/- 20%**
or						
Estimated Plume Length	*Lp (ft)*				**800 ft**	
2c. DISPERSION	**North**	**1200 ft**				

			Kent's values	PLP's values	Final Chosen Values	COMMENTS
*Longitudinal Dispersivity**	*alpha x (ft)*		12	22.0	31.12 low 26.4 31.68 high	Use alpha x +/- 20%
*Transverse Dispersivity**	*alpha y (ft)*		1.2	0.1	2.08 low 2.6 3.12 high	Use alpha y +/- 20%
*Vertical Dispersivity**	*alpha z (ft)*		0.12	0.0	0.208 low 0.26 0.312 high	Use alpha z +/- 20%
or						
Estimated Plume Length	*Lp (ft)*				**1200 ft**	
2d. DISPERSION	**South**	**1400 ft**				
*Longitudinal Dispersivity**	*alpha x (ft)*		14	34.5	22.48 low 28.1 33.72 high	Use alpha x +/- 20%
*Transverse Dispersivity**	*alpha y (ft)*		1.4	0.1	2.24 low 2.8 3.36 high	Use alpha y +/- 20%
*Vertical Dispersivity**	*alpha z (ft)*		0.14	0.0	0.16 low 0.2 0.24 high	Use alpha z +/- 20%
or						
Estimated Plume Length	*Lp (ft)*				**1400 ft**	
2e. DISPERSION	**South**	**1700 ft**				
*Longitudinal Dispersivity**	*alpha x (ft)*		17	34.5	24.24 low 30.3 36.36 high	Use alpha x +/- 20%
*Transverse Dispersivity**	*alpha y (ft)*		1.7	0.1	2.4 low 3.0 3.6 high	Use alpha y +/- 20%
*Vertical Dispersivity**	*alpha z (ft)*		0.17	0.0	0.16 low 0.2 0.24 high	Use alpha z +/- 20%
or						
Estimated Plume Length	*Lp (ft)*				**1700 ft**	
2f. DISPERSION	**South**	**2300 ft**				
*Longitudinal Dispersivity**	*alpha x (ft)*		23	34.5	27.2 low 34.0 40.8 high	Use alpha x +/- 20%
*Transverse Dispersivity**	*alpha y (ft)*		2.3	0.1	2.72 low 3.4 4.08 high	Use alpha y +/- 20%
*Vertical Dispersivity**	*alpha z (ft)*		0.23	0.0	0.16 low 0.2 0.24 high	Use alpha z +/- 20%
or						
Estimated Plume Length	*Lp (ft)*				**2300 ft**	

		Kent's values	PLP's values	Final Chosen Values	COMMENTS
3a. ADSORPTION	**1,4-DIOXANE**				
Retardation Factor*	*R*	32.0 north 17 south		**17**	
or		↑ or	↑ or		
Soil Bulk Density	*rho (kg/l)*	1.5			
Distribution Coefficient	*Kd*	8 north 4 south			Estimate for north and south portions
Partition Coefficient	*Koc (L/kg)*	17			
FractionOrganicCarbon	*foc*	0.46 north 0.24 south			Estimate for north and south portions
3b. ADSORPTION	**VINYL CHLORIDE**				
Retardation Factor*	*R*	55.5 north 29 south		**29**	
or		↑ or	↑ or		
Soil Bulk Density	*rho (kg/l)*	1.5	1.4		
Distribution Coefficient	*Kd*	14 north 7 south			Estimate for north and south portions
Partition Coefficient	*Koc (L/kg)*	30			
FractionOrganicCarbon	*foc*	0.46 north 0.24 south	2.3E-1		Estimate for north and south portions
3c. ADSORPTION	**METHYLENE CHLORIDE**				
Retardation Factor*	*R*		13.9	**14**	
or		↑ or	↑ or		
Soil Bulk Density	*rho (kg/l)*		1.4		
Distribution Coefficient	*Kd*		2.3		**Calculated**
Partition Coefficient	*Koc (L/kg)*		10		
FractionOrganicCarbon	*foc*		2.3E-1		
3d. ADSORPTION	**ARSENIC**				
Retardation Factor*	*R*	70.0	163.4	**70**	**Calculated**
or		↑ or	↑ or		
Soil Bulk Density	*rho (kg/l)*	1.5	1.4		
Distribution Coefficient	*Kd*	17	29		
Partition Coefficient	*Koc (L/kg)*				
FractionOrganicCarbon	*foc*		2.3E-1		
3e. ADSORPTION	**SELENIUM**				
Retardation Factor*	*R*	114.0	387.4	**114**	**Calculated**
or		↑ or	↑ or		
Soil Bulk Density	*rho (kg/l)*	1.5	1.4		

		Kent's values	PLP's values	Final Chosen Values	COMMENTS
Distribution Coefficient	*Kd*	29	69		
Partition Coefficient	*Koc (L/kg)*				
FractionOrganicCarbon	*foc*		2.3E-1		
3f. ADSORPTION	**CADMIUM**				
Retardation Factor*	*R*		314.6	**315**	
or		↑ or	↑ or		
Soil Bulk Density	*rho (kg/l)*		1.4		
Distribution Coefficient	*Kd*		56		
Partition Coefficient	*Koc (L/kg)*				
FractionOrganicCarbon	*foc*				
5. GENERAL					
Modeled Area Length*		Variable	Variable	**see Table 1**	
Modeled Area Width*		16	15	**15**	
Simulation Time*		80		**Variable**	**Adjust time to get CUL at POC (breakthrough)**
6a. SOURCE DATA	**1,4-DIOXANE**				**NOTE: No source half life**
	Source Thickness in Sat.Zone*	16	15	**15**	
Source Zones:					
Width* (ft)	Conc. (mg/L)*			**Use 3 values:**	
3		24.81		**10 low 24.48 148.9 high**	**Aspect uses 3% TCA and 1% TCE from sludge characterization**
3		24.81		**10 low 24.48 148.9 high**	**High value is estimated effective solubility**
3		24.81		**10 low 24.48 148.9 high**	**Low value is adopted from Golder Associates**
6b. SOURCE DATA	**VINYL CHLORIDE**				
	Source Thickness in Sat.Zone*	16	15	**15**	
Source Zones:					

			Kent's values	PLP's values	Final Chosen Values	COMMENTS
Width* (ft)	Conc. (mg/L)*				Use 3 values:	
3			1530		28 low 620.3 1530 high	Middle value is predicted from sludge data
3			1530		28 low 620.3 1530 high	High value is maximum TCE in sludge
3			1530		28 low 620.3 1530 high	Low value is 1% of solubility

6c. SOURCE DATA METHYLENE CHLORIDE

	Kent's values	PLP's values	Final Chosen Values
Source Thickness in Sat.Zone*	16	15	15

Source Zones:

Width* (ft)	Conc. (mg/L)*	Kent's values	PLP's values	Final Chosen Values	COMMENTS
				Use 3 values:	
3			10	10 low 685.1 13000 high	Middle value is predicted from sludge data
3			10	10 low 685.1 13000 high	High value is maximum TCE in sludge
3			10	10 low 685.1 13000 high	Low value is 1% of solubility

6d. SOURCE DATA ARSENIC

	Kent's values	PLP's values	Final Chosen Values
Source Thickness in Sat.Zone*	16	15	15

Source Zones:

Width* (ft)	Conc. (mg/L)*	Kent's values	PLP's values	Final Chosen Values	COMMENTS
				Use 3 values:	
3		1000	10	0.8914 low 10 1000 high	Middle value is from Golder Associates
3		1000	10	0.8914 low 10 1000 high	High value is from Kent & originally Golder
3		1000	10	0.8914 low 10 1000 high	Low value is predicted from portal soils (Table 5-12)

	Kent's values	PLP's values	Final Chosen Values	COMMENTS

[redacted]

6e. SOURCE DATA SELENIUM

	Kent's values	PLP's values	Final Chosen Values
Source Thickness in Sat.Zone*	16	15	**15**

Source Zones:

Width* (ft)	Conc. (mg/L)*	Kent's values	PLP's values	Use 3 values:	Comments
3		1000	10	0.3871 low 10 1000 high	Middle value is from Golder Associates
3		1000	10	0.3871 low 10 1000 high	Low value is predicted from Table 5-9 Trench soils
3		1000	10	0.3871 low 10 1000 high	High value is from Kent & originally Golder

[redacted]

6f. SOURCE DATA CADMIUM

	Kent's values	PLP's values	Final Chosen Values
Source Thickness in Sat.Zone*	16	15	**15**

Source Zones:

Width* (ft)	Conc. (mg/L)*	Kent's values	PLP's values	Use 3 values:	Comments
3			10	3.2 low 10 1000 high	Middle value is from Golder Associates
3			10	3.2 low 10 1000 high	Low value is predicted from Table 5-9 Trench soils
3			10	3.2 low 10 1000 high	High value is from Kent & originally Golder

[redacted]

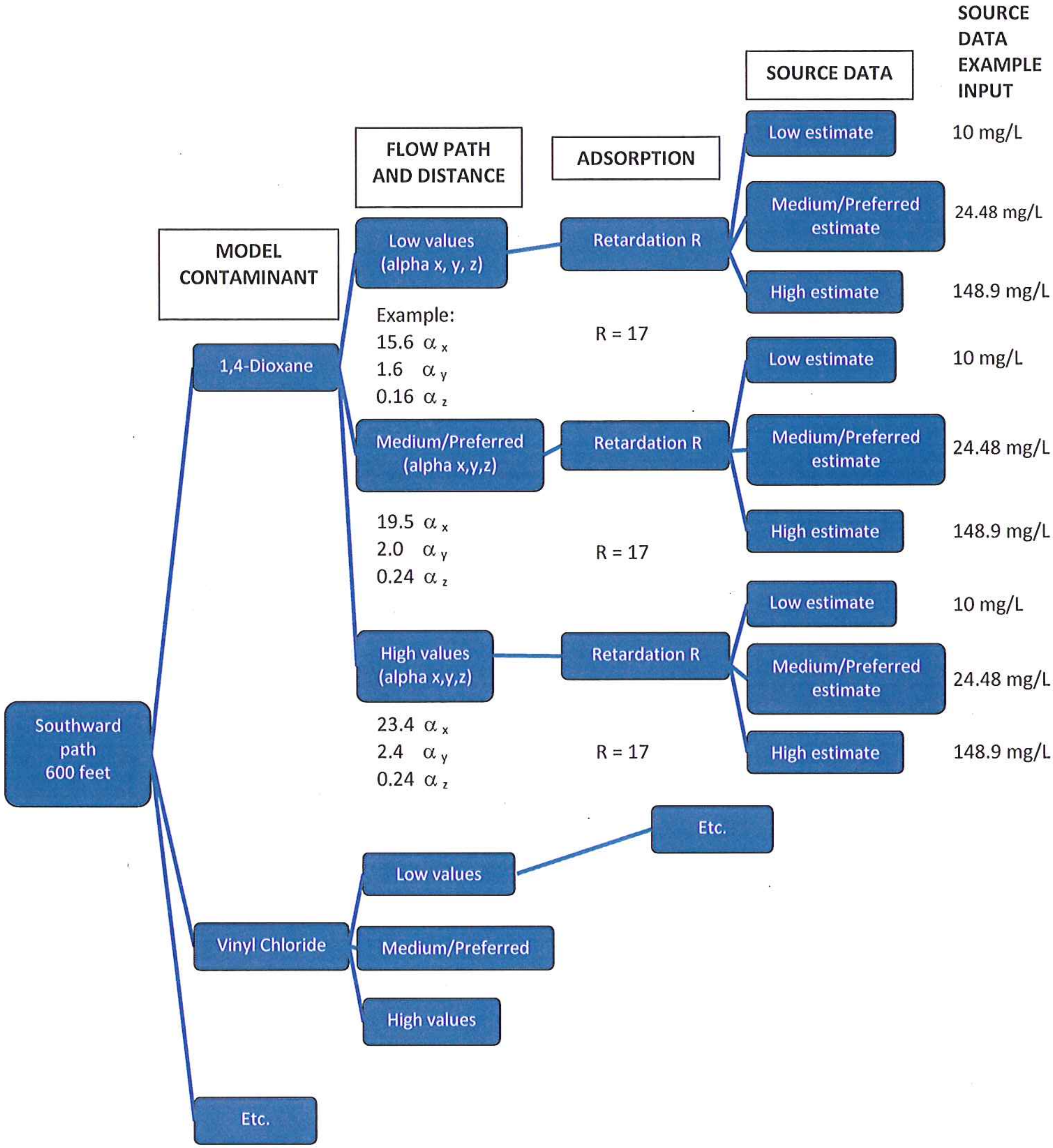


Figure 1. Example process chart for travel time simulation using BIOSCREEN Input Parameters.

The following are the recommended outputs for the simulation results:

<u>NORTHWARD FLOW</u>

600 feet
(to LMW-2/4)

1,4-dioxane
Vinyl Chloride
Methylene Chloride
Arsenic
Selenium
Cadmium

800 feet
(to LMW-2/4)

1,4-dioxane
Vinyl Chloride
Methylene Chloride
Arsenic
Selenium
Cadmium

1200 feet
(to LMW-2/4)

1,4-dioxane
Vinyl Chloride
Methylene Chloride
Arsenic
Selenium
Cadmium

<u>For each simulation*</u>

- Breakthrough times:
  - **Method Detection Limit (MDL)**
  - **Method B CUL**
  - **50% of Method B CUL**

- Breakthrough times including between portal and wells along path
- Peak concentration
- Translated recommended monitoring frequency
- Summary Table for each contaminant

SOUTHWARD FLOW

1400 feet
(to LMW-11)

- 1,4-dioxane
- Vinyl Chloride
- Methylene Chloride
- Arsenic
- Selenium
- Cadmium

1700 feet
(to LMW-9)

- 1,4-dioxane
- Vinyl Chloride
- Methylene Chloride
- Arsenic
- Selenium
- Cadmium

2300 feet
(to LMW-3/5)

- 1,4-dioxane
- Vinyl Chloride
- Methylene Chloride
- Arsenic
- Selenium
- Cadmium

For each simulation*

- Breakthrough times:

Method Detection Limit (MDL)

Method B CUL

50% of Method B CUL

- Breakthrough times between wells along path

- Peak concentration

- Translated recommended monitoring frequency

- Summary Table for each contaminant

* See Figure 1 for simulation methodology.

APPENDIX C
ULTRA CONSERVATIVE CASE

ULTRA CONSERVATIVE CASE TO SOUTH

APPENDIX C-1

SOUTH COMPLIANCE BOUNDARY

METHYLENE CHLORIDE

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Landsburg Mine
Ultra Conservative Case
Methylene Chloride to South

Data Input Instructions:

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

1. HYDROGEOLOGY

Seepage Velocity*	Vs	664.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	8.5E-01	(cm/sec)
Hydraulic Gradient	i	0.00029	(ft/ft)
Porosity	n	0.31	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	27.2	(ft)
Transverse Dispersivity*	alpha y	2.72	`
Vertical Dispersivity*	alpha z	0.16	(ft)
or		or	
Estimated Plume Length	Lp	2300	(ft)

3. ADSORPTION

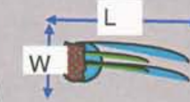
Retardation Factor*	R	14.0	(-)
or		or	
Soil Bulk Density	rho	1.4	(kg/l)
Partition Coefficient	Koc	10	(L/kg)
FractionOrganicCarbon	foc	2.3E-1	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-8	(per yr)
or		or	
Solute Half-Life	t-half	#######	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	2870	(ft)
Modeled Area Width*	15	(ft)
Simulation Time*	15.10	(yr)



6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

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

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	13000
3	13000
3	13000
3	13000
3	13000

Source Halflife (see Help):

	Infinite	Infinite	(yr)
	Inst. React.	1st Order	
Soluble Mass	infinite		(Kg)

In Source NAPL, Soil

View of Plume Looking Down

1200

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

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	287	574	861	1148	1435	1722	2009	2296	2583	2870

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE

View Output

RUN ARRAY

View Output

Help

Recalculate This Sheet

Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED METHYLENE CHLORIDE CONCENTRATION ALONG PLUME CENTERLINE TO SOUTH (13,000 mg/L at Z=0)

TYPE OF MODEL	Distance from Source (ft) 0	287	574	861	1148	1435	1722	2009	2296	2583	2870
No Degradation	13000.000	1701.408	776.148	166.494	7.982	0.061	0.00007	0.000	0.000	0.000	0.000
1st Order Decay	13000.000	1701.407	776.148	166.494	7.982	0.061	0.00007	0.000	0.000	0.000	0.000
Inst. Reaction	13000.000	1701.408	776.148	166.494	7.982	0.061	0.00007	0.000	0.000	0.000	0.000
Field Data from Site											

Calculate Animation

Time: 15.10 Years

Return to Input

Recalculate This Sheet

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Landsburg Mine
Ultra Conservative Case
Methylene Chloride to South

Data Input Instructions:

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

1. HYDROGEOLOGY

Seepage Velocity*	Vs	664.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	8.5E-01	(cm/sec)
Hydraulic Gradient	i	0.00029	(ft/ft)
Porosity	n	0.31	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	27.2	(ft)
Transverse Dispersivity*	alpha y	2.72	`
Vertical Dispersivity*	alpha z	0.16	(ft)
or		or	
Estimated Plume Length	Lp	2300	(ft)

3. ADSORPTION

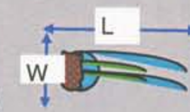
Retardation Factor*	R	14.0	(-)
or		or	
Soil Bulk Density	rho	1.4	(kg/l)
Partition Coefficient	Koc	10	(L/kg)
FractionOrganicCarbon	foc	2.3E-1	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-8	(per yr)
or		or	
Solute Half-Life	t-half	#######	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	2870	(ft)
Modeled Area Width*	15	(ft)
Simulation Time*	22.70	(yr)



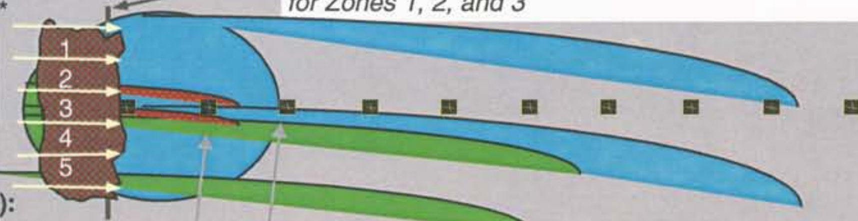
6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

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

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	13000
3	13000
3	13000
3	13000
3	13000



Source Halflife (see Help):

Infinite	Infinite	(yr)
Inst. React.	1st Order	
Soluble Mass	infinite	(Kg)
In Source NAPL, Soil		

1200

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

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	287	574	861	1148	1435	1722	2009	2296	2583	2870

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE

View Output

RUN ARRAY

View Output

Help

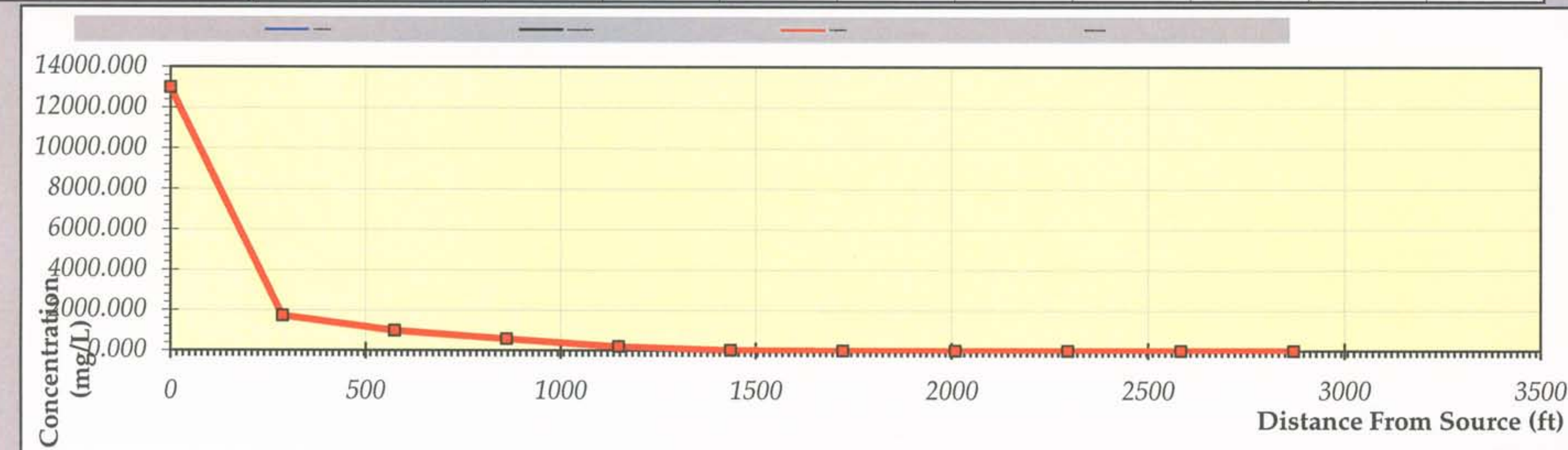
Recalculate This Sheet

Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED METHYLENE CHLORIDE CONCENTRATION ALONG PLUME CENTERLINE TO SOUTH (13,000 mg/L at Z=0)

TYPE OF MODEL	Distance from Source (ft) 0	287	574	861	1148	1435	1722	2009	2296	2583	2870
No Degradation	13000.000	1726.086	996.271	584.961	213.706	31.464	1.467	0.019	0.00007	0.000	0.000
1st Order Decay	13000.000	1726.085	996.270	584.960	213.705	31.464	1.467	0.019	0.00007	0.000	0.000
Inst. Reaction	13000.000	1726.086	996.271	584.961	213.706	31.464	1.467	0.019	0.00007	0.000	0.000
Field Data from Site											



Calculate Animation

Time: 22.70 Years

Return to Input

Recalculate This Sheet

VINYL CHLORIDE

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Landsburg Mine
Ultra Conservative Case
Vinyl Chloride to South

Data Input Instructions:

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

1. HYDROGEOLOGY

Seepage Velocity*	*Vs*	664.0	*(ft/yr)*
or		↑ *or*	
Hydraulic Conductivity	*K*	8.5E-01	*(cm/sec)*
Hydraulic Gradient	*i*	0.00029	*(ft/ft)*
Porosity	*n*	0.31	*(-)*

2. DISPERSION

Longitudinal Dispersivity*	*alpha x*	27.2	*(ft)*
Transverse Dispersivity*	*alpha y*	2.72	
Vertical Dispersivity*	*alpha z*	0.16	*(ft)*
or		↑ *or*	
Estimated Plume Length	*Lp*	2300	*(ft)*

3. ADSORPTION

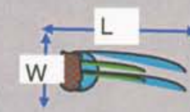
Retardation Factor*	*R*	29.0	*(-)*
or		↑ *or*	
Soil Bulk Density	*rho*	1.4	*(kg/l)*
Partition Coefficient	*Koc*	30	*(L/kg)*
FractionOrganicCarbon	*foc*	2.3E-1	*(-)*

4. BIODEGRADATION

1st Order Decay Coeff*	*lambda*	6.9E-8	*(per yr)*
or		↑ *or*	
Solute Half-Life	*t-half*	#######	*(year)*
or Instantaneous Reaction Model			
Delta Oxygen*	*DO*		*(mg/L)*
Delta Nitrate*	*NO3*		*(mg/L)*
Observed Ferrous Iron*	*Fe2+*		*(mg/L)*
Delta Sulfate*	*SO4*		*(mg/L)*
Observed Methane*	*CH4*		*(mg/L)*

5. GENERAL

Modeled Area Length*	2870	*(ft)*
Modeled Area Width*	15	*(ft)*
Simulation Time*	33.10	*(yr)*



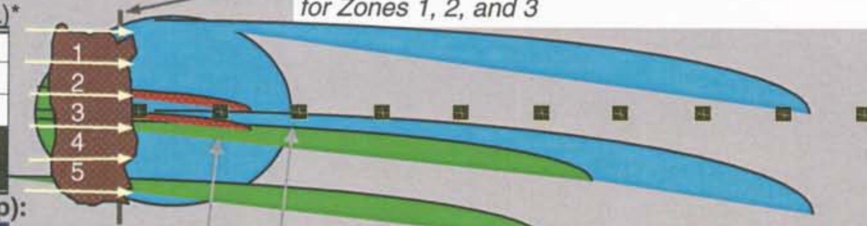
6. SOURCE DATA

Source Thickness in Sat.Zone* 15 *(ft)*

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

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	1530
3	1530
3	1530
3	1530
3	1530



View of Plume Looking Down

Source Halflife (see Help):

Infinite	Infinite	*(yr)*
Inst. React. ↑	↑ 1st Order	
Soluble Mass	infinite	*(Kg)*
In Source NAPL, Soil		

1200

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

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	287	574	861	1148	1435	1722	2009	2296	2583	2870

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE

View Output

RUN ARRAY

View Output

Help

Recalculate This Sheet

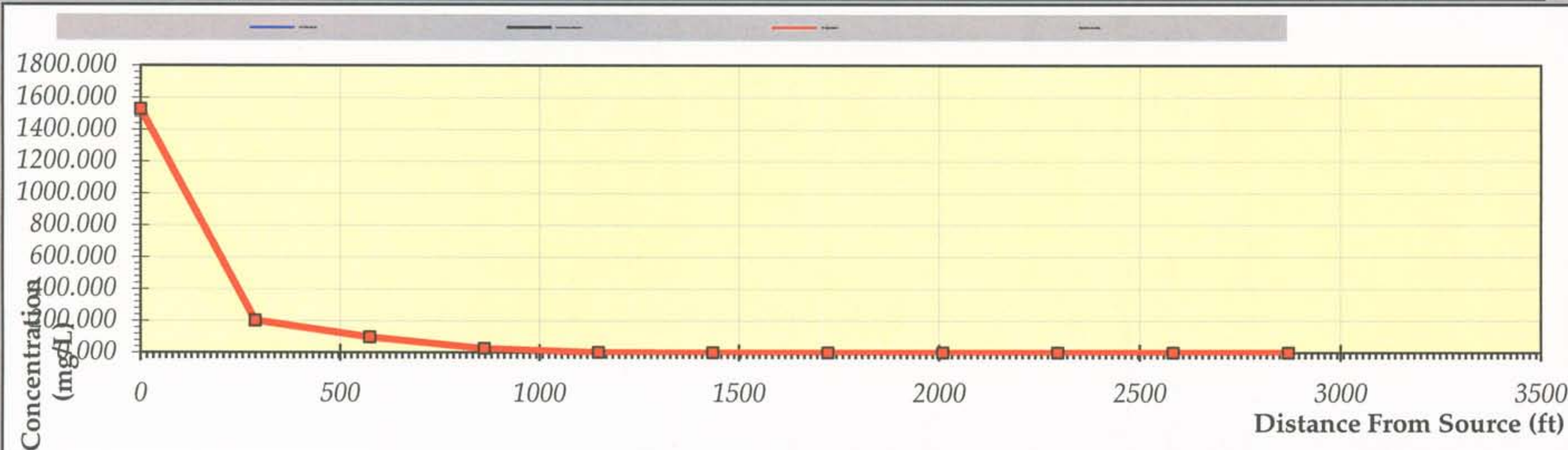
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED VINYL CHLORIDE CONCENTRATION ALONG PLUME CENTERLINE TO SOUTH (1530 mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	287	574	861	1148	1435	1722	2009	2296	2583	2870
No Degradation	1530.000	201.187	97.692	25.876	1.791	0.023	0.00005	0.000	0.000	0.000	0.000
1st Order Decay	1530.000	201.186	97.692	25.876	1.791	0.023	0.00005	0.000	0.000	0.000	0.000
Inst. Reaction	1530.000	201.187	97.692	25.876	1.791	0.023	0.00005	0.000	0.000	0.000	0.000
Field Data from Site											



Calculate Animation

Time:

33.10 Years

Return to Input

Recalculate This Sheet

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Landsburg Mine
Ultra Conservative Case
Vinyl Chloride to South

Data Input Instructions:

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

1. HYDROGEOLOGY

Seepage Velocity*	Vs	664.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	8.5E-01	(cm/sec)
Hydraulic Gradient	i	0.00029	(ft/ft)
Porosity	n	0.31	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	27.2	(ft)
Transverse Dispersivity*	alpha y	2.72	`
Vertical Dispersivity*	alpha z	0.16	(ft)
or		or	
Estimated Plume Length	Lp	2300	(ft)

3. ADSORPTION

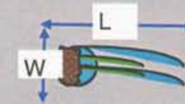
Retardation Factor*	R	29.0	(-)
or		or	
Soil Bulk Density	rho	1.4	(kg/l)
Partition Coefficient	Koc	30	(L/kg)
FractionOrganicCarbon	foc	2.3E-1	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-8	(per yr)
or		or	
Solute Half-Life	t-half	#######	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	2870	(ft)
Modeled Area Width*	15	(ft)
Simulation Time*	49.60	(yr)



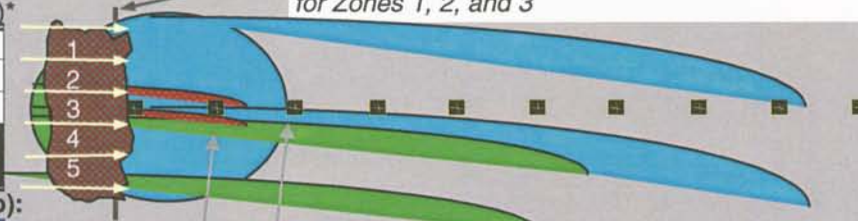
6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

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

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	1530
3	1530
3	1530
3	1530
3	1530



View of Plume Looking Down

Source Halflife (see Help):

Infinite	Infinite	(yr)
Inst. React.	1st Order	
Soluble Mass	infinite	(Kg)
In Source NAPL, Soil		

1200

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

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	287	574	861	1148	1435	1722	2009	2296	2583	2870

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | **View Output**

RUN ARRAY | **View Output**

Help | Recalculate This Sheet

Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED VINYL CHLORIDE CONCENTRATION ALONG PLUME CENTERLINE TO SOUTH (1530 mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	287	574	861	1148	1435	1722	2009	2296	2583	2870
No Degradation	1530.000	203.194	118.088	73.237	31.451	6.102	0.413	0.009	0.00005	0.000	0.000
1st Order Decay	1530.000	203.194	118.088	73.237	31.451	6.102	0.413	0.009	0.00005	0.000	0.000
Inst. Reaction	1530.000	203.194	118.088	73.237	31.451	6.102	0.413	0.009	0.00005	0.000	0.000
Field Data from Site											

Calculate Animation

Time:

49.60 Years

Return to Input

Recalculate This Sheet

1,4-DIOXANE

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Landsburg Mine
Ultra Conservative Case
1,4-Dioxane to South

Data Input Instructions:

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

1. HYDROGEOLOGY

Seepage Velocity*	Vs	664.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	8.5E-01	(cm/sec)
Hydraulic Gradient	i	0.00029	(ft/ft)
Porosity	n	0.31	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	27.2	(ft)
Transverse Dispersivity*	alpha y	2.72	
Vertical Dispersivity*	alpha z	0.16	(ft)
or		or	
Estimated Plume Length	Lp	2300	(ft)

3. ADSORPTION

Retardation Factor*	R	17.0	(-)
or		or	
Soil Bulk Density	rho	1.4	(kg/l)
Partition Coefficient	Koc	17	(L/kg)
FractionOrganicCarbon	foc	2.3E-1	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-8	(per yr)
or		or	
Solute Half-Life	t-half	#######	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	2870	(ft)
Modeled Area Width*	15	(ft)
Simulation Time*	22.70	(yr)

L W

6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

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

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	148.9
3	148.9
3	148.9
3	148.9
3	148.9

View of Plume Looking Down

Source Halflife (see Help):

Infinite	Infinite	(yr)
Inst. React.	1st Order	
Soluble Mass	infinite	(Kg)
In Source NAPL, Soil		

1200

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

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	287	574	861	1148	1435	1722	2009	2296	2583	2870

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE

View Output

RUN ARRAY

View Output

Help

Recalculate This Sheet

Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED 1,4-DIOXANE CONCENTRATION ALONG PLUME CENTERLINE TO SOUTH (148.9 mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	287	574	861	1148	1435	1722	2009	2296	2583	2870
No Degradation	148.900	19.719	10.732	4.501	0.746	0.033	0.00031	0.000	0.000	0.000	0.000
1st Order Decay	148.900	19.719	10.732	4.501	0.746	0.033	0.00031	0.000	0.000	0.000	0.000
Inst. Reaction	148.900	19.719	10.732	4.501	0.746	0.033	0.00031	0.000	0.000	0.000	0.000
Field Data from Site											

Calculate Animation

Time: 22.70 Years

Return to Input

Recalculate This Sheet

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Landsburg Mine
Ultra Conservative Case
1,4-Dioxane to South

Data Input Instructions:

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

1. HYDROGEOLOGY

Seepage Velocity*	Vs	664.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	8.5E-01	(cm/sec)
Hydraulic Gradient	i	0.00029	(ft/ft)
Porosity	n	0.31	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	27.2	(ft)
Transverse Dispersivity*	alpha y	2.72	
Vertical Dispersivity*	alpha z	0.16	(ft)
or		or	
Estimated Plume Length	Lp	2300	(ft)

3. ADSORPTION

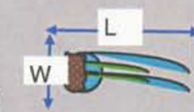
Retardation Factor*	R	17.0	(-)
or		or	
Soil Bulk Density	rho	1.4	(kg/l)
Partition Coefficient	Koc	17	(L/kg)
FractionOrganicCarbon	foc	2.3E-1	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-8	(per yr)
or		or	
Solute Half-Life	t-half	#######	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	2870	(ft)
Modeled Area Width*	15	(ft)
Simulation Time*	33.30	(yr)



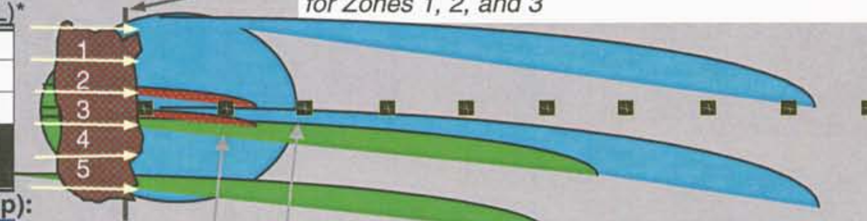
6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	148.9
3	148.9
3	148.9
3	148.9
3	148.9

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



View of Plume Looking Down

Source Halflife (see Help):

Infinite	Infinite	(yr)
Inst. React.	1st Order	
Soluble Mass	infinite	(Kg)
In Source NAPL, Soil		

1200

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

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	287	574	861	1148	1435	1722	2009	2296	2583	2870

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | **View Output**

RUN ARRAY | **View Output**

Help

Recalculate This Sheet

Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED 1,4-DIOXANE CONCENTRATION ALONG PLUME CENTERLINE TO SOUTH (148.9 mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	287	574	861	1148	1435	1722	2009	2296	2583	2870
No Degradation	148.900	19.780	11.594	7.831	4.570	1.595	0.248	0.015	0.0003	0.000	0.000
1st Order Decay	148.900	19.780	11.594	7.831	4.570	1.595	0.248	0.015	0.0003	0.000	0.000
Inst. Reaction	148.900	19.780	11.594	7.831	4.570	1.595	0.248	0.015	0.0003	0.000	0.000
Field Data from Site											

Calculate Animation

Time:

33.30 Years

Return to Input

Recalculate This Sheet

ARSENIC

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence *Version 1.4*

Landsburg Mine
Ultra Conservative Case
Arsenic to South

Data Input Instructions:

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

1. HYDROGEOLOGY

Seepage Velocity*	Vs	664.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	8.5E-01	(cm/sec)
Hydraulic Gradient	i	0.00029	(ft/ft)
Porosity	n	0.31	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	27.2	(ft)
Transverse Dispersivity*	alpha y	2.72	
Vertical Dispersivity*	alpha z	0.16	(ft)
or		or	
Estimated Plume Length	Lp	2300	(ft)

3. ADSORPTION

Retardation Factor*	R	70.0	(-)
or		or	
Soil Bulk Density	rho	1.4	(kg/l)
Partition Coefficient	Koc	NA	(L/kg)
FractionOrganicCarbon	foc	2.3E-1	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-8	(per yr)
or		or	
Solute Half-Life	t-half	#######	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	2870	(ft)
Modeled Area Width*	15	(ft)
Simulation Time*	91.00	(yr)

6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

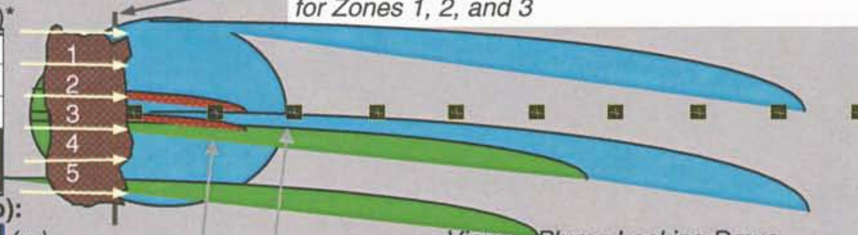
Source Zones:

Width* (ft)	Conc. (mg/L)*
3	1000
3	1000
3	1000
3	1000
3	1000

Source Halflife (see Help):

Infinite	Infinite	(yr)
Inst. React.	1st Order	
Soluble Mass	infinite	(Kg)
In Source NAPL, Soil		

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



View of Plume Looking Down

1200

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

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	287	574	861	1148	1435	1722	2009	2296	2583	2870

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | View Output

RUN ARRAY | View Output

Help | Recalculate This Sheet

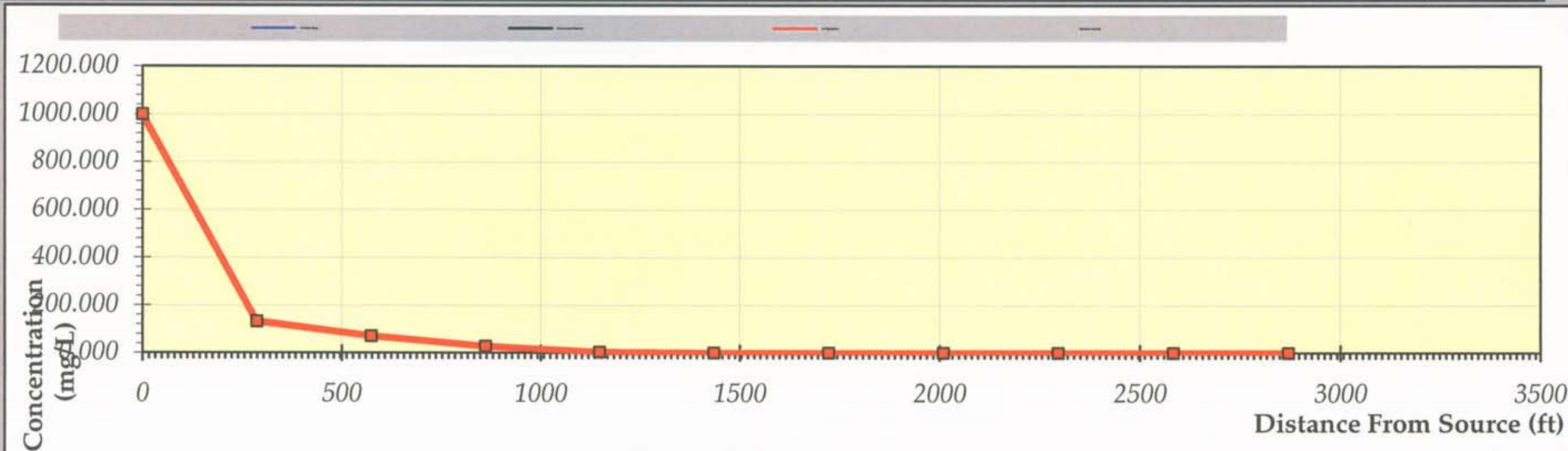
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED ARSENIC CONCENTRATION ALONG PLUME CENTERLINE TO SOUTH (1000 mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	287	574	861	1148	1435	1722	2009	2296	2583	2870
No Degradation	1000.000	132.328	71.004	27.879	4.040	0.145	0.0011	0.000	0.000	0.000	0.000
1st Order Decay	1000.000	132.328	71.004	27.879	4.040	0.145	0.0011	0.000	0.000	0.000	0.000
Inst. Reaction	1000.000	132.328	71.004	27.879	4.040	0.145	0.0011	0.000	0.000	0.000	0.000
Field Data from Site											



Calculate Animation

Time:

91.00 Years

Return to Input

Recalculate This Sheet

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Landsburg Mine
Ultra Conservative Case
Arsenic to South

Data Input Instructions:

115 — 1. Enter value directly....or
or — 2. Calculate by filling in grey
0.02 — cells below. (To restore formulas, hit button below).

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

1. HYDROGEOLOGY

Seepage Velocity*	*Vs*	664.0	*(ft/yr)*
or		or	
Hydraulic Conductivity	*K*	8.5E-01	*(cm/sec)*
Hydraulic Gradient	*i*	0.00029	*(ft/ft)*
Porosity	*n*	0.31	*(-)*

2. DISPERSION

Longitudinal Dispersivity*	*alpha x*	27.2	*(ft)*
Transverse Dispersivity*	*alpha y*	2.72	
Vertical Dispersivity*	*alpha z*	0.16	*(ft)*
or		or	
Estimated Plume Length	*Lp*	2300	*(ft)*

3. ADSORPTION

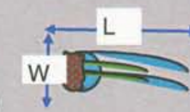
Retardation Factor*	*R*	70.0	*(-)*
or		or	
Soil Bulk Density	*rho*	1.4	*(kg/l)*
Partition Coefficient	*Koc*	NA	*(L/kg)*
FractionOrganicCarbon	*foc*	2.3E-1	*(-)*

4. BIODEGRADATION

1st Order Decay Coeff*	*lambda*	6.9E-8	*(per yr)*
or		or	
Solute Half-Life	*t-half*	#######	*(year)*
or Instantaneous Reaction Model			
Delta Oxygen*	*DO*		*(mg/L)*
Delta Nitrate*	*NO3*		*(mg/L)*
Observed Ferrous Iron*	*Fe2+*		*(mg/L)*
Delta Sulfate*	*SO4*		*(mg/L)*
Observed Methane*	*CH4*		*(mg/L)*

5. GENERAL

Modeled Area Length*	2870	*(ft)*
Modeled Area Width*	15	*(ft)*
Simulation Time*	134.00	*(yr)*



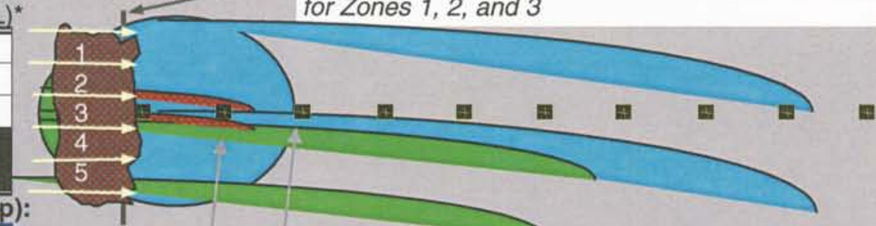
6. SOURCE DATA

Source Thickness in Sat.Zone* 15 *(ft)*

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

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	1000
3	1000
3	1000
3	1000
3	1000



Source Halflife (see Help):

	Infinite	Infinite	*(yr)*
	Inst. React.	1st Order	
Soluble Mass		infinite	*(Kg)*
In Source NAPL, Soil			

View of Plume Looking Down

1200

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

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	287	574	861	1148	1435	1722	2009	2296	2583	2870

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE

View Output

RUN ARRAY

View Output

Help

Recalculate This Sheet

Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED ARSENIC CONCENTRATION ALONG PLUME CENTERLINE TO SOUTH (1000 mg/L at Z=0)

	Distance from Source (ft)										
TYPE OF MODEL	0	287	574	861	1148	1435	1722	2009	2296	2583	2870
No Degradation	1000.000	132.837	77.799	52.023	29.114	9.305	1.273	0.064	0.0011	0.000	0.000
1st Order Decay	1000.000	132.837	77.799	52.023	29.114	9.305	1.273	0.064	0.0011	0.000	0.000
Inst. Reaction	1000.000	132.837	77.799	52.023	29.114	9.305	1.273	0.064	0.0011	0.000	0.000
Field Data from Site											

Calculate Animation

Time:

134.00 Years

Return to Input

Recalculate This Sheet

APPENDIX C-2

NORTH COMPLIANCE BOUNDARY

METHYLENE CHLORIDE

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence — *Version 1.4*

Landsburg Mine
Ultra Conservative Case
Methylene Chloride To North

Data Input Instructions:

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

1. HYDROGEOLOGY

Seepage Velocity*	*Vs*	830.0	(ft/yr)
or		or	
Hydraulic Conductivity	*K*	8.5E-01	(cm/sec)
Hydraulic Gradient	*i*	0.00036	(ft/ft)
Porosity	*n*	0.31	(-)

2. DISPERSION

Longitudinal Dispersivity*	*alpha x*	15.6	(ft)
Transverse Dispersivity*	*alpha y*	1.60	
Vertical Dispersivity*	*alpha z*	0.16	(ft)
or		or	
Estimated Plume Length	*Lp*	600	(ft)

3. ADSORPTION

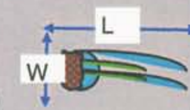
Retardation Factor*	*R*	14.0	(-)
or		or	
Soil Bulk Density	*rho*	1.4	(kg/l)
Partition Coefficient	*Koc*	10	(L/kg)
FractionOrganicCarbon	*foc*	4.6E-1	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	*lambda*	6.9E-8	(per yr)
or		or	
Solute Half-Life	*t-half*	#######	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	*DO*		(mg/L)
Delta Nitrate*	*NO3*		(mg/L)
Observed Ferrous Iron*	*Fe2+*		(mg/L)
Delta Sulfate*	*SO4*		(mg/L)
Observed Methane*	*CH4*		(mg/L)

5. GENERAL

Modeled Area Length*	1000	(ft)
Modeled Area Width*	15	(ft)
Simulation Time*	1.05	(yr)



6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

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

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	13000
3	13000
3	13000
3	13000
3	13000

Source Halflife (see Help):

Infinite	Infinite	(yr)	
Inst. React.	1st Order		
Soluble Mass	infinite	(Kg)	
In Source NAPL, Soil			

View of Plume Looking Down

1200

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

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	100	200	300	400	500	600	700	800	900	1000

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help

Recalculate This Sheet

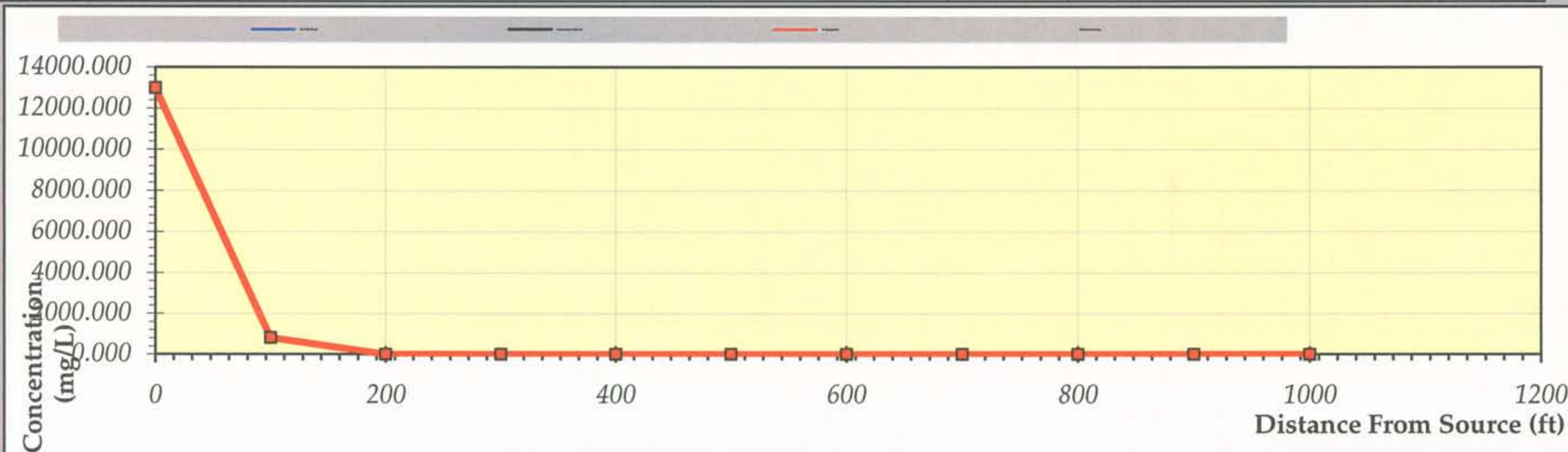
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED METHYLENE CHLORIDE CONCENTRATION ALONG PLUME CENTERLINE TO NORTH (13,000 mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	13000.000	820.725	2.525	0.00007	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1st Order Decay	13000.000	820.725	2.525	0.00007	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	13000.000	820.725	2.525	0.00007	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site											



Calculate Animation

Time:

1.05 Years

Return to Input

Recalculate This Sheet

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Landsburg Mine
Ultra Conservative Case
Methylene Chloride To North

Data Input Instructions:

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

1. HYDROGEOLOGY

Seepage Velocity*	Vs	830.0	(ft/yr)
or		↑ or	
Hydraulic Conductivity	K	8.5E-01	(cm/sec)
Hydraulic Gradient	i	0.00036	(ft/ft)
Porosity	n	0.31	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	15.6	(ft)
Transverse Dispersivity*	alpha y	1.60	
Vertical Dispersivity*	alpha z	0.16	(ft)
or		↑ or	
Estimated Plume Length	Lp	600	(ft)

3. ADSORPTION

Retardation Factor*	R	14.0	(-)
or		↑ or	
Soil Bulk Density	rho	1.4	(kg/l)
Partition Coefficient	Koc	10	(L/kg)
FractionOrganicCarbon	foc	4.6E-1	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-8	(per yr)
or		↑ or	
Solute Half-Life	t-half	#######	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	1000	(ft)
Modeled Area Width*	15	(ft)
Simulation Time*	3.22	(yr)

L
W

6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

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

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	13000
3	13000
3	13000
3	13000
3	13000

Source Halflife (see Help):

	Infinite	Infinite	(yr)
	Inst. React. ↑	↑ 1st Order	
Soluble Mass	infinite		(Kg)
In Source NAPL, Soil			

View of Plume Looking Down

1200

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

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	100	200	300	400	500	600	700	800	900	1000

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE

View Output

RUN ARRAY

View Output

Help

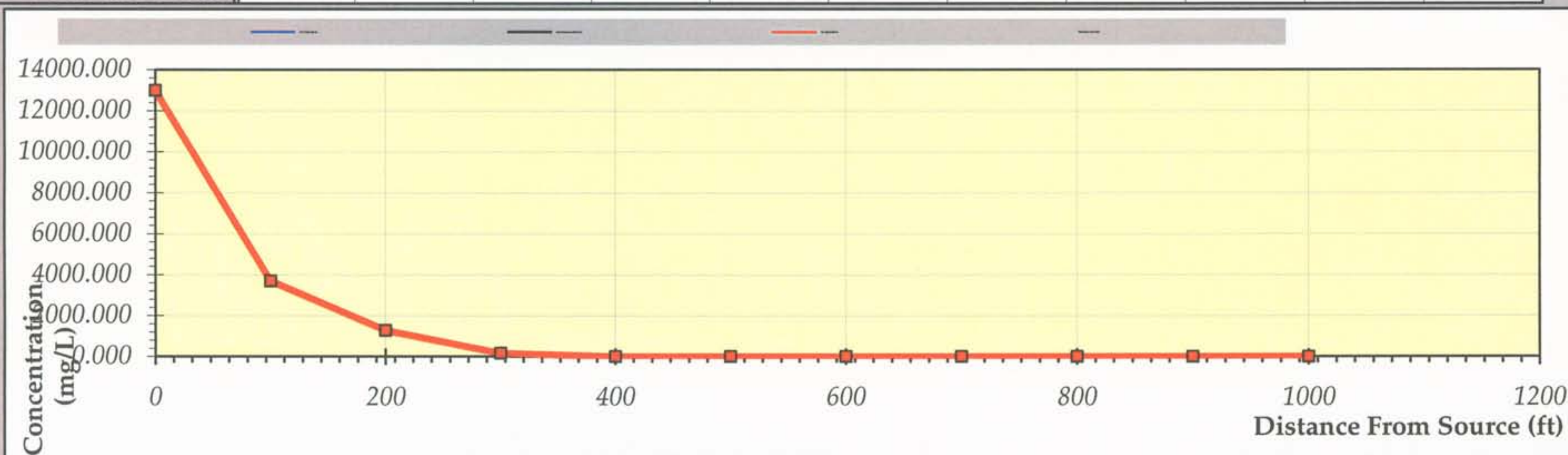
Recalculate This Sheet

Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED METHYLENE CHLORIDE CONCENTRATION ALONG PLUME CENTERLINE TO NORTH (13,000 mg/L at Z=0)

	Distance from Source (ft)										
TYPE OF MODEL	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	13000.000	3690.327	1289.601	171.139	5.930	0.046	0.00007	0.000	0.000	0.000	0.000
1st Order Decay	13000.000	3690.327	1289.600	171.139	5.930	0.046	0.00007	0.000	0.000	0.000	0.000
Inst. Reaction	13000.000	3690.327	1289.601	171.139	5.930	0.046	0.00007	0.000	0.000	0.000	0.000
Field Data from Site											



Calculate Animation

Time:

3.22 Years

Return to Input

Recalculate This Sheet

VINYL CHLORIDE

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Landsburg Mine
Ultra Conservative Case
Vinyl Chloride To North

Data Input Instructions:

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

1. HYDROGEOLOGY

Seepage Velocity*	Vs	830.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	8.5E-01	(cm/sec)
Hydraulic Gradient	i	0.00036	(ft/ft)
Porosity	n	0.31	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	15.6	(ft)
Transverse Dispersivity*	alpha y	1.60	`
Vertical Dispersivity*	alpha z	0.16	(ft)
or		or	
Estimated Plume Length	Lp	600	(ft)

3. ADSORPTION

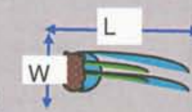
Retardation Factor*	R	29.0	(-)
or		or	
Soil Bulk Density	rho	1.4	(kg/l)
Partition Coefficient	Koc	30	(L/kg)
FractionOrganicCarbon	foc	4.6E-1	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-8	(per yr)
or		or	
Solute Half-Life	t-half	#######	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	1000	(ft)
Modeled Area Width*	15	(ft)
Simulation Time*	2.35	(yr)



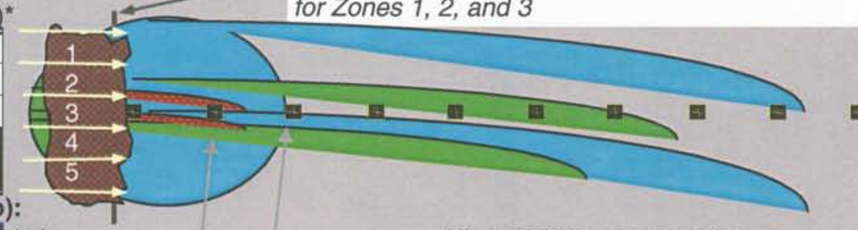
6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	1530
3	1530
3	1530
3	1530
3	1530

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



View of Plume Looking Down

1200

Source Halflife (see Help):

Infinite	Infinite	(yr)
Inst. React.	1st Order	
Soluble Mass	infinite	(Kg)
In Source NAPL, Soil		

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

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	100	200	300	400	500	600	700	800	900	1000

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | **View Output**

RUN ARRAY | **View Output**

Help

Recalculate This Sheet

Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED VINYL CHLORIDE CONCENTRATION ALONG PLUME CENTERLINE TO NORTH (1,530 mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	1530.000	117.086	0.630	0.00005	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1st Order Decay	1530.000	117.086	0.630	0.00005	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	1530.000	117.086	0.630	0.00005	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site											

Calculate Animation

Time:

2.35 Years

Return to Input

Recalculate This Sheet

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence — *Version 1.4*

Landsburg Mine
Ultra Conservative Case
Vinyl Chloride To North

Data Input Instructions:

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

1. HYDROGEOLOGY

Seepage Velocity*	Vs	830.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	8.5E-01	(cm/sec)
Hydraulic Gradient	i	0.00036	(ft/ft)
Porosity	n	0.31	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	15.6	(ft)
Transverse Dispersivity*	alpha y	1.60	
Vertical Dispersivity*	alpha z	0.16	(ft)
or		or	
Estimated Plume Length	Lp	600	(ft)

3. ADSORPTION

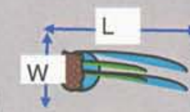
Retardation Factor*	R	29.0	(-)
or		or	
Soil Bulk Density	rho	1.4	(kg/l)
Partition Coefficient	Koc	30	(L/kg)
FractionOrganicCarbon	foc	4.6E-1	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-8	(per yr)
or		or	
Solute Half-Life	t-half	#######	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	1000	(ft)
Modeled Area Width*	15	(ft)
Simulation Time*	7.10	(yr)



6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	1530
3	1530
3	1530
3	1530
3	1530

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

Source Halflife (see Help):

Infinite	Infinite	(yr)
Inst. React.	1st Order	
Soluble Mass	infinite	(Kg)

In Source NAPL, Soil

View of Plume Looking Down

1200

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

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	100	200	300	400	500	600	700	800	900	1000

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — View Output

RUN ARRAY — View Output

Help

Recalculate This Sheet

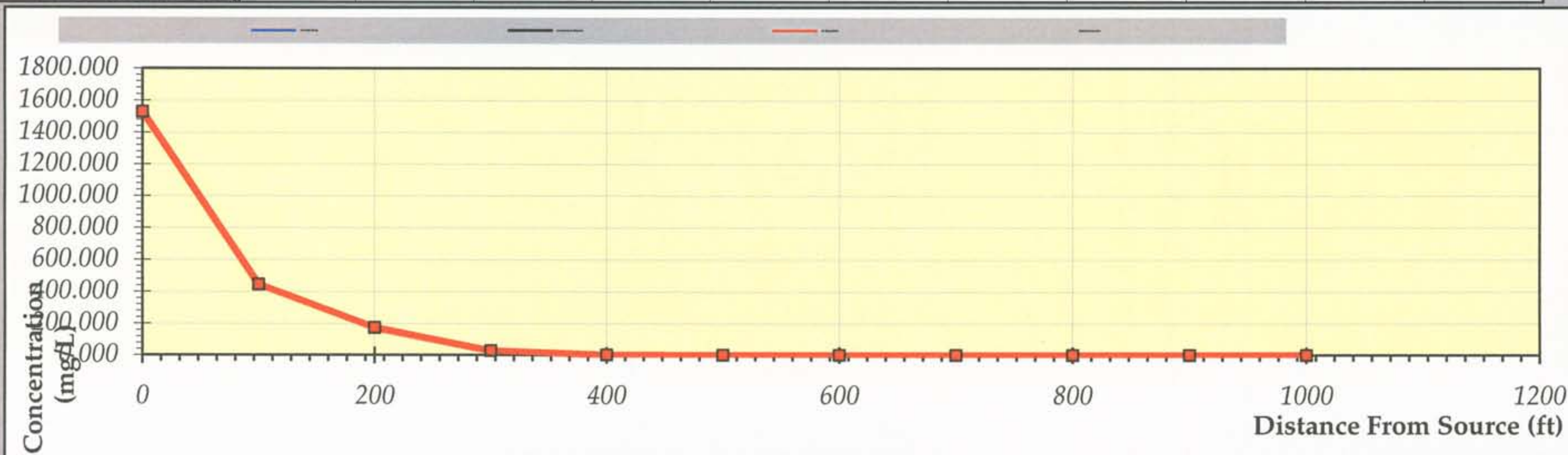
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED VINYL CHLORIDE CONCENTRATION ALONG PLUME CENTERLINE TO NORTH (1,530 mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	1530.000	445.161	172.879	28.669	1.393	0.017	0.00005	0.000	0.000	0.000	0.000
1st Order Decay	1530.000	445.161	172.879	28.669	1.393	0.017	0.00005	0.000	0.000	0.000	0.000
Inst. Reaction	1530.000	445.161	172.879	28.669	1.393	0.017	0.00005	0.000	0.000	0.000	0.000
Field Data from Site											



Calculate Animation

Time:
7.10 Years

Return to Input

Recalculate This Sheet

1,4-DIOXANE

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Landsburg Mine
Ultra Conservative Case
1,4-Dioxane To North

Data Input Instructions:

115 — 1. Enter value directly....or
or — 2. Calculate by filling in grey
0.02 — cells below. (To restore formulas, hit button below).

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

1. HYDROGEOLOGY

Seepage Velocity*	Vs	830.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	8.5E-01	(cm/sec)
Hydraulic Gradient	i	0.00036	(ft/ft)
Porosity	n	0.31	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	15.6	(ft)
Transverse Dispersivity*	alpha y	1.60	
Vertical Dispersivity*	alpha z	0.16	(ft)
or		or	
Estimated Plume Length	Lp	600	(ft)

3. ADSORPTION

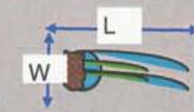
Retardation Factor*	R	17.0	(-)
or		or	
Soil Bulk Density	rho	1.4	(kg/l)
Partition Coefficient	Koc	17	(L/kg)
FractionOrganicCarbon	foc	4.6E-1	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-8	(per yr)
or		or	
Solute Half-Life	t-half	#######	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	1000	(ft)
Modeled Area Width*	15	(ft)
Simulation Time*	1.72	(yr)



6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	148.9
3	148.9
3	148.9
3	148.9
3	148.9

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

View of Plume Looking Down

Source Halflife (see Help):

	Infinite	Infinite	(yr)
	Inst. React.	1st Order	
Soluble Mass		infinite	(Kg)
In Source NAPL, Soil			

1200

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

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	100	200	300	400	500	600	700	800	900	1000

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE

View Output

RUN ARRAY

View Output

Help

Recalculate This Sheet

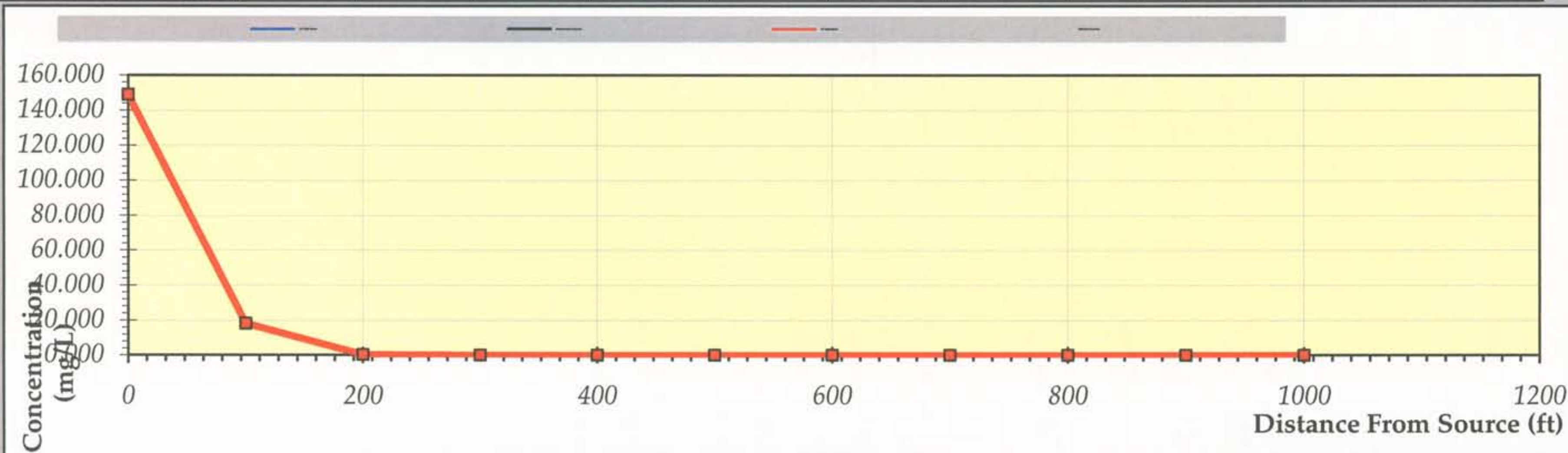
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED 1,4-DIOXANE CONCENTRATION ALONG PLUME CENTERLINE TO NORTH (148.9 mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	148.900	18.102	0.382	0.0003	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1st Order Decay	148.900	18.102	0.382	0.0003	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	148.900	18.102	0.382	0.0003	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site											



Calculate Animation

Time:
1.72 Years

Return to Input

Recalculate This Sheet

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence *Version 1.4*

Landsburg Mine
Ultra Conservative Case
1,4-Dioxane To North

Data Input Instructions:

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

1. HYDROGEOLOGY

Seepage Velocity*	*Vs*	830.0	*(ft/yr)*
or		or	
Hydraulic Conductivity	*K*	8.5E-01	*(cm/sec)*
Hydraulic Gradient	*i*	0.00036	*(ft/ft)*
Porosity	*n*	0.31	*(-)*

2. DISPERSION

Longitudinal Dispersivity*	*alpha x*	15.6	*(ft)*
Transverse Dispersivity*	*alpha y*	1.60	
Vertical Dispersivity*	*alpha z*	0.16	*(ft)*
or		or	
Estimated Plume Length	*Lp*	600	*(ft)*

3. ADSORPTION

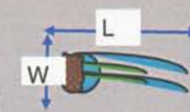
Retardation Factor*	*R*	17.0	*(-)*
or		or	
Soil Bulk Density	*rho*	1.4	*(kg/l)*
Partition Coefficient	*Koc*	17	*(L/kg)*
FractionOrganicCarbon	*foc*	4.6E-1	*(-)*

4. BIODEGRADATION

1st Order Decay Coeff*	*lambda*	6.9E-8	*(per yr)*
or		or	
Solute Half-Life	*t-half*	#######	*(year)*
or Instantaneous Reaction Model			
Delta Oxygen*	*DO*		*(mg/L)*
Delta Nitrate*	*NO3*		*(mg/L)*
Observed Ferrous Iron*	*Fe2+*		*(mg/L)*
Delta Sulfate*	*SO4*		*(mg/L)*
Observed Methane*	*CH4*		*(mg/L)*

5. GENERAL

Modeled Area Length*	1000	*(ft)*
Modeled Area Width*	15	*(ft)*
Simulation Time*	5.00	*(yr)*



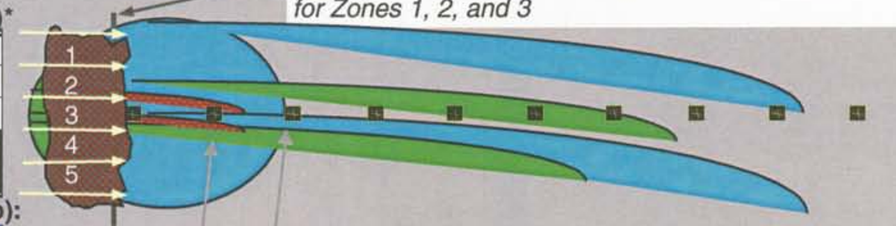
6. SOURCE DATA

Source Thickness in Sat.Zone* 15 *(ft)*

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	148.9
3	148.9
3	148.9
3	148.9
3	148.9

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



View of Plume Looking Down

1200

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

Source Halflife (see Help):

Infinite	Infinite	*(yr)*
Inst. React.	1st Order	
Soluble Mass	infinite	*(Kg)*
In Source NAPL, Soil		

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	*0*	*100*	*200*	*300*	*400*	*500*	*600*	*700*	*800*	*900*	*1000*

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE

View Output

RUN ARRAY

View Output

Help

Recalculate This Sheet

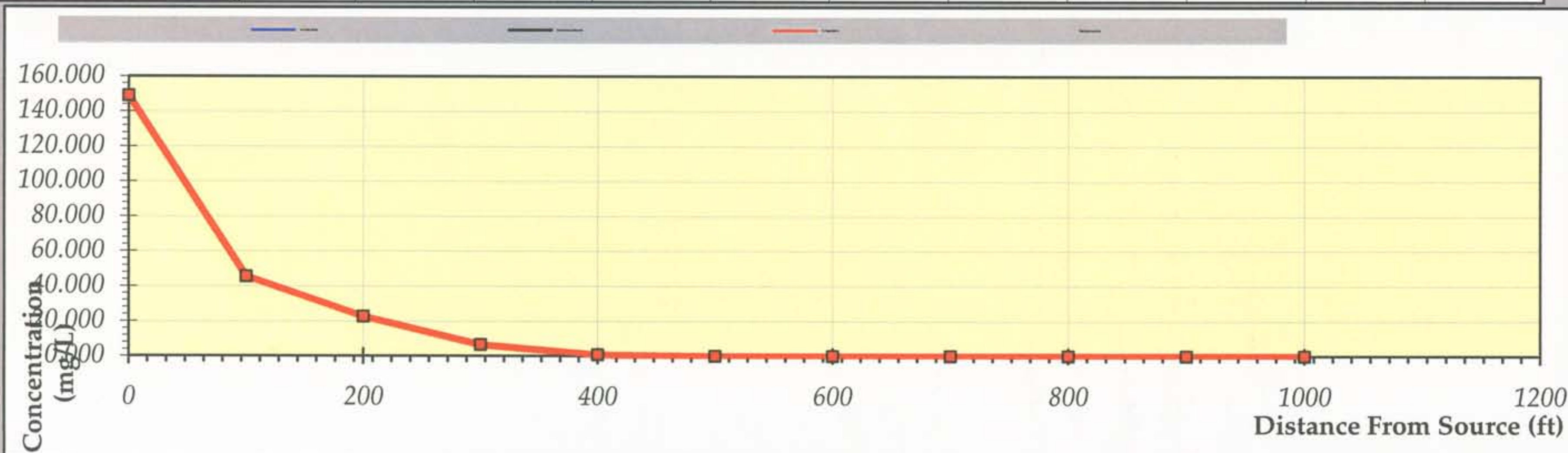
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED 1,4-DIOXANE CONCENTRATION ALONG PLUME CENTERLINE TO NORTH (148.9 mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	148.900	45.633	22.606	6.498	0.746	0.029	0.0003	0.000	0.000	0.000	0.000
1st Order Decay	148.900	45.633	22.606	6.498	0.746	0.029	0.0003	0.000	0.000	0.000	0.000
Inst. Reaction	148.900	45.633	22.606	6.498	0.746	0.029	0.0003	0.000	0.000	0.000	0.000
Field Data from Site											



Calculate Animation

Time:

5.00 Years

Return to Input

Recalculate This Sheet

ARSENIC

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

~~Landsburg Mine~~
Ultra Conservative Case
Arsenic To North

Data Input Instructions:

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

1. HYDROGEOLOGY

Seepage Velocity*	Vs	830.0	(ft/yr)
or			
Hydraulic Conductivity	K	8.5E-01	(cm/sec)
Hydraulic Gradient	i	0.00036	(ft/ft)
Porosity	n	0.31	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	15.6	(ft)
Transverse Dispersivity*	alpha y	1.60	
Vertical Dispersivity*	alpha z	0.16	(ft)
or			
Estimated Plume Length	Lp	600	(ft)

3. ADSORPTION

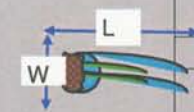
Retardation Factor*	R	70.0	(-)
or			
Soil Bulk Density	rho	1.4	(kg/l)
Partition Coefficient	Koc	NA	(L/kg)
FractionOrganicCarbon	foc	4.6E-1	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-8	(per yr)
or			
Solute Half-Life	t-half	#######	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	1000	(ft)
Modeled Area Width*	15	(ft)
Simulation Time*	6.80	(yr)



6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

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

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	1000
3	1000
3	1000
3	1000
3	1000

Source Halflife (see Help):

Infinite	Infinite	(yr)
Inst. React.	1st Order	
Soluble Mass	infinite	(Kg)
In Source NAPL, Soil		

View of Plume Looking Down

1200

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

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	100	200	300	400	500	600	700	800	900	1000

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE

View Output

RUN ARRAY

View Output

Help

Recalculate This Sheet

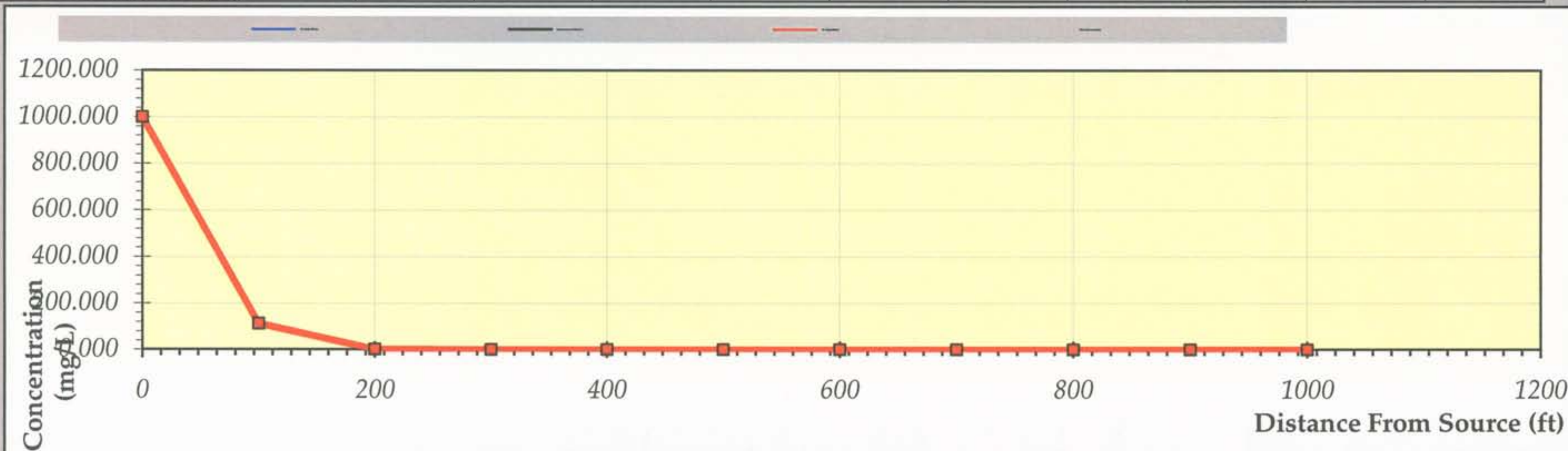
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED ARSENIC CONCENTRATION ALONG PLUME CENTERLINE TO NORTH (1,000 mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	1000.000	112.723	1.895	0.0010	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1st Order Decay	1000.000	112.723	1.895	0.0010	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	1000.000	112.723	1.895	0.0010	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site											



Calculate Animation

Time:

6.80 Years

Return to Input

Recalculate This Sheet

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

~~Landsburg Mine~~

Ultra Conservative Case

Arsenic To North

Data Input Instructions:

115	*1. Enter value directly....or*
0.~~02~~ or	*2. Calculate by filling in grey cells below. (To restore formulas, hit button below).*
Variable*	*Data used directly in model.*
20	*Value calculated by model. (Don't enter any data).*

1. HYDROGEOLOGY

Seepage Velocity*	*Vs*	830.0	*(ft/yr)*
or			
Hydraulic Conductivity	*K*	8.5E-01 or	*(cm/sec)*
Hydraulic Gradient	*i*	0.00036	*(ft/ft)*
Porosity	*n*	0.31	*(-)*

2. DISPERSION

Longitudinal Dispersivity*	*alpha x*	15.6	*(ft)*
Transverse Dispersivity*	*alpha y*	1.60	
Vertical Dispersivity*	*alpha z*	0.16	*(ft)*
or			
Estimated Plume Length	*Lp*	600 or	*(ft)*

3. ADSORPTION

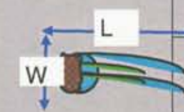
Retardation Factor*	*R*	70.0	*(-)*
or			
Soil Bulk Density	*rho*	1.4 or	*(kg/l)*
Partition Coefficient	*Koc*	NA	*(L/kg)*
FractionOrganicCarbon	*foc*	4.6E-1	*(-)*

4. BIODEGRADATION

1st Order Decay Coeff*	*lambda*	6.9E-8	*(per yr)*
or			
Solute Half-Life	*t-half*	####### or	*(year)*
or Instantaneous Reaction Model			
Delta Oxygen*	*DO*		*(mg/L)*
Delta Nitrate*	*NO3*		*(mg/L)*
Observed Ferrous Iron*	*Fe2+*		*(mg/L)*
Delta Sulfate*	*SO4*		*(mg/L)*
Observed Methane*	*CH4*		*(mg/L)*

5. GENERAL

Modeled Area Length*	1000	*(ft)*
Modeled Area Width*	15	*(ft)*
Simulation Time*	19.80	*(yr)*



6. SOURCE DATA

Source Thickness in Sat.Zone* 15 *(ft)*

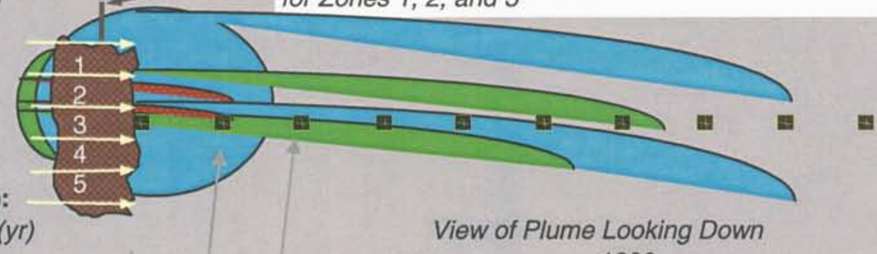
Source Zones:

Width* (ft)	Conc. (mg/L)*
3	1000
3	1000
3	1000
3	1000
3	1000

Source Halflife (see Help):

Infinite	Infinite	*(yr)*
Inst. React.	1st Order	
Soluble Mass	infinite	*(Kg)*
In Source NAPL, Soil		

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



View of Plume Looking Down

1200

Observed Centerline Concentrations at Monitoring Wells

If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	*0*	*100*	*200*	*300*	*400*	*500*	*600*	*700*	*800*	*900*	*1000*

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE

View Output

RUN ARRAY

View Output

Help

Recalculate This Sheet

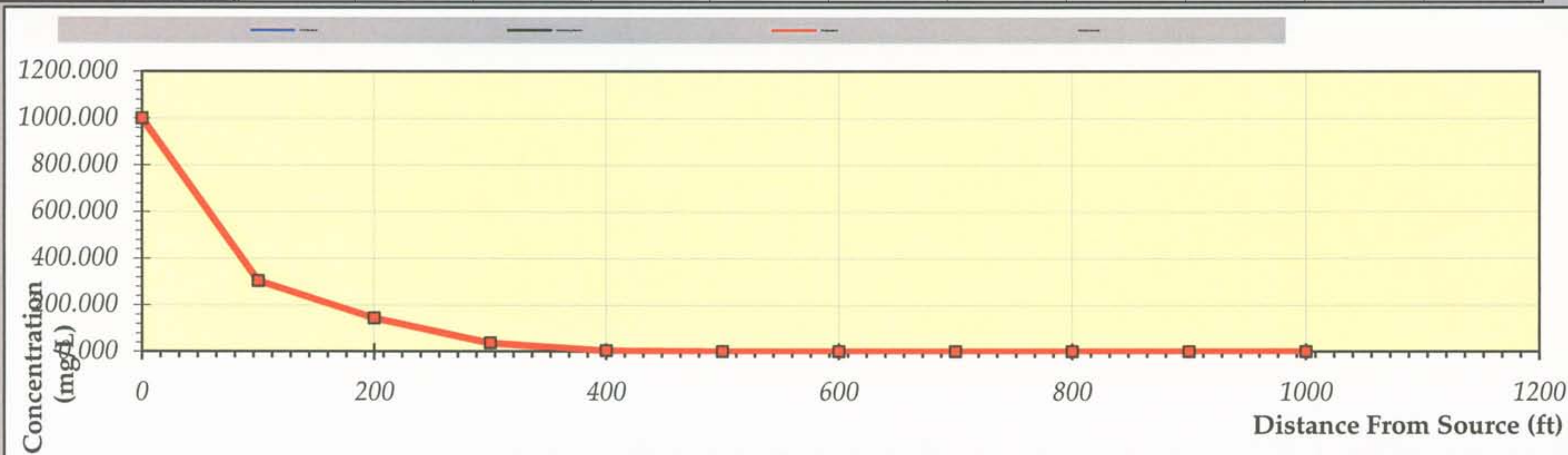
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED ARSENIC CONCENTRATION ALONG PLUME CENTERLINE TO NORTH (1,000 mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	1000.000	303.784	144.011	37.285	3.623	0.110	0.0010	0.000	0.000	0.000	0.000
1st Order Decay	1000.000	303.784	144.011	37.285	3.623	0.110	0.0010	0.000	0.000	0.000	0.000
Inst. Reaction	1000.000	303.784	144.011	37.285	3.623	0.110	0.0010	0.000	0.000	0.000	0.000
Field Data from Site											



Calculate Animation

Time: 19.80 Years

Return to Input

Recalculate This Sheet

APPENDIX D

MEDIUM CONSERVATIVE CASE

MEDIUM CONSERVATIVE CASE TO SOUTH

APPENDIX D-1

SOUTH COMPLIANCE BOUNDARY

METHYLENE CHLORIDE

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence *Version 1.4*

Landsburg Mine
Medium Conservative Case
Methylene Chloride To South

Data Input Instructions:

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

1. HYDROGEOLOGY

Seepage Velocity*	Vs	664.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	8.5E-01	(cm/sec)
Hydraulic Gradient	i	0.00029	(ft/ft)
Porosity	n	0.31	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	34.0	(ft)
Transverse Dispersivity*	alpha y	3.40	
Vertical Dispersivity*	alpha z	0.20	(ft)
or		or	
Estimated Plume Length	Lp	800	(ft)

3. ADSORPTION

Retardation Factor*	R	14.0	(-)
or		or	
Soil Bulk Density	rho	1.4	(kg/l)
Partition Coefficient	Koc	10	(L/kg)
FractionOrganicCarbon	foc	2.3E+0	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-8	(per yr)
or		or	
Solute Half-Life	t-half	#######	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	2870	(ft)
Modeled Area Width*	15	(ft)
Simulation Time*	15.40	(yr)

L
W

6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	685.1
3	685.1
3	685.1
3	685.1
3	685.1

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

View of Plume Looking Down

1200

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

Source Halflife (see Help):

Infinite	Infinite	(yr)
Inst. React.	1st Order	
Soluble Mass	infinite	(Kg)
In Source NAPL, Soil		

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	287	574	861	1148	1435	1722	2009	2296	2583	2870

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help

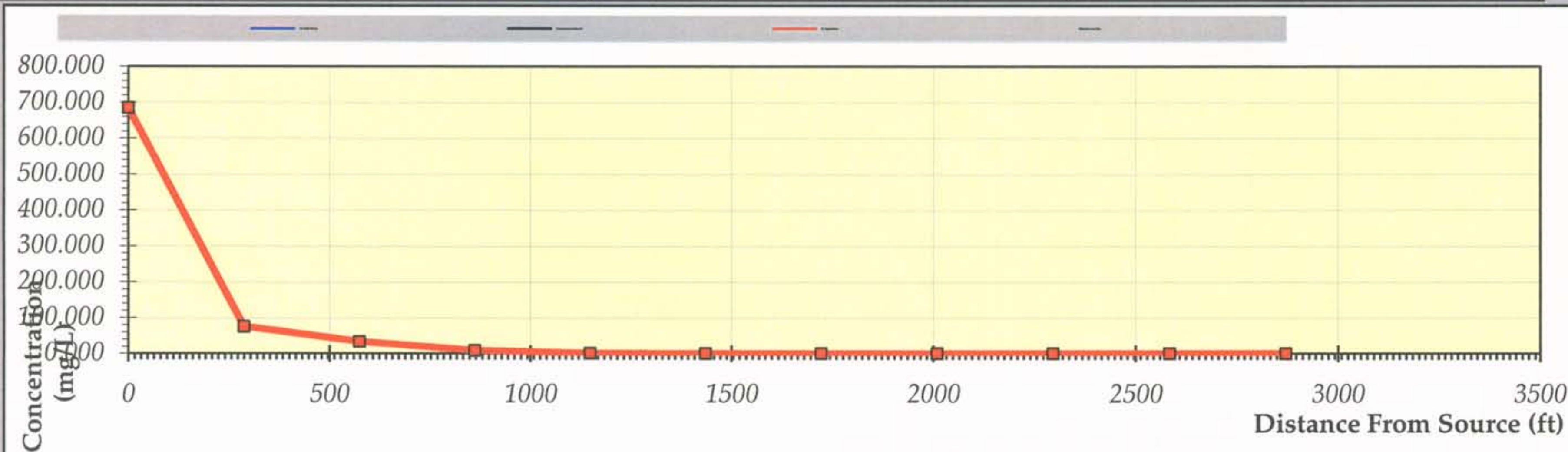
Recalculate This Sheet

Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED METHYLENE CHLORIDE CONCENTRATION ALONG PLUME CENTERLINE TO SOUTH (685.1 mg/L at Z=0)

TYPE OF MODEL	Distance from Source (ft) 0	287	574	861	1148	1435	1722	2009	2296	2583	2870
No Degradation	685.100	75.635	33.660	8.670	0.729	0.015	0.00007	0.000	0.000	0.000	0.000
1st Order Decay	685.100	75.635	33.660	8.670	0.729	0.015	0.00007	0.000	0.000	0.000	0.000
Inst. Reaction	685.100	75.635	33.660	8.670	0.729	0.015	0.00007	0.000	0.000	0.000	0.000
Field Data from Site											



Calculate Animation

Time:

15.40 Years

Return to Input

Recalculate This Sheet

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Landsburg Mine
Medium Conservative Case
Methylene Chloride To South

Data Input Instructions:

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

1. HYDROGEOLOGY

Seepage Velocity*	Vs	664.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	8.5E-01	(cm/sec)
Hydraulic Gradient	i	0.00029	(ft/ft)
Porosity	n	0.31	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	34.0	(ft)
Transverse Dispersivity*	alpha y	3.40	
Vertical Dispersivity*	alpha z	0.20	(ft)
or		or	
Estimated Plume Length	Lp	800	(ft)

3. ADSORPTION

Retardation Factor*	R	14.0	(-)
or		or	
Soil Bulk Density	rho	1.4	(kg/l)
Partition Coefficient	Koc	10	(L/kg)
FractionOrganicCarbon	foc	2.3E+0	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-8	(per yr)
or		or	
Solute Half-Life	t-half	#######	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	2870	(ft)
Modeled Area Width*	15	(ft)
Simulation Time*	23.10	(yr)

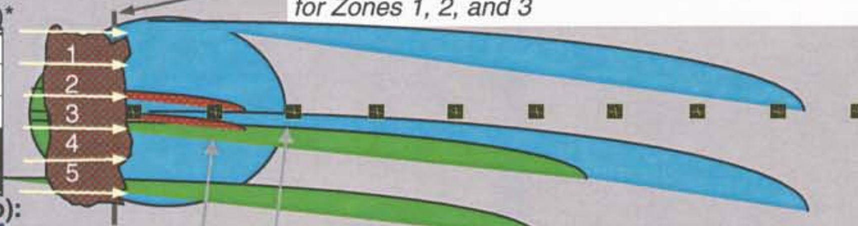
6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	685.1
3	685.1
3	685.1
3	685.1
3	685.1

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



View of Plume Looking Down

1200

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

Source Halflife (see Help):

Infinite	Infinite	(yr)
Inst. React.	1st Order	
Soluble Mass	infinite	(Kg)
In Source NAPL, Soil		

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	287	574	861	1148	1435	1722	2009	2296	2583	2870

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | View Output

RUN ARRAY | View Output

Help | Recalculate This Sheet

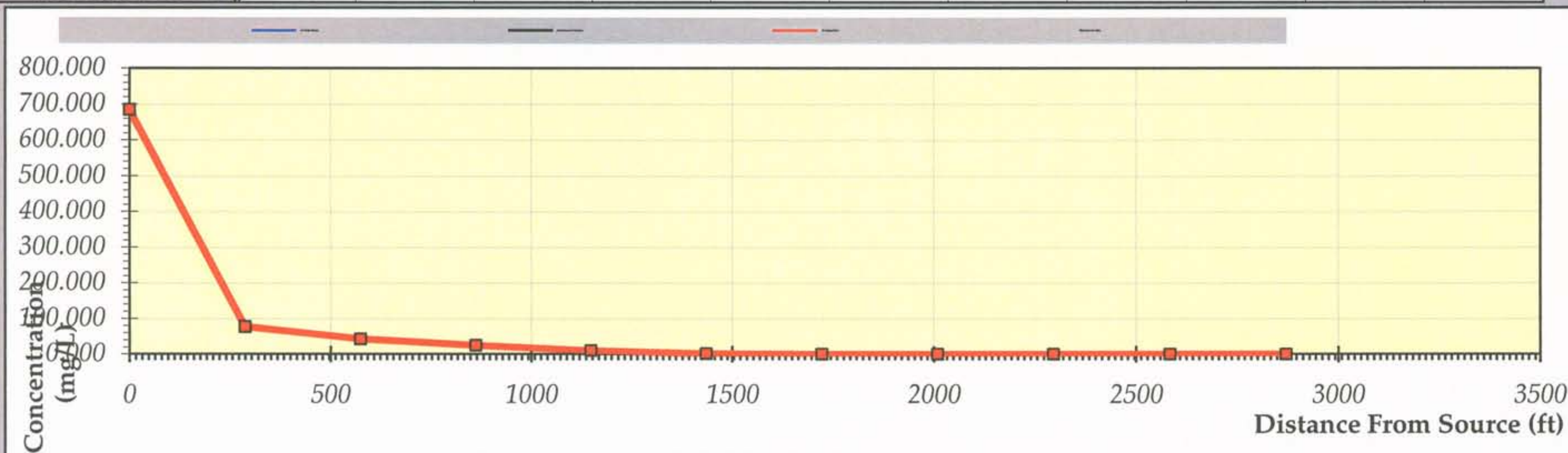
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED METHYLENE CHLORIDE CONCENTRATION ALONG PLUME CENTERLINE TO SOUTH (685.1 mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	287	574	861	1148	1435	1722	2009	2296	2583	2870
No Degradation	685.100	77.323	43.129	25.021	10.138	2.077	0.178	0.006	0.00007	0.000	0.000
1st Order Decay	685.100	77.323	43.128	25.021	10.138	2.077	0.178	0.006	0.00007	0.000	0.000
Inst. Reaction	685.100	77.323	43.129	25.021	10.138	2.077	0.178	0.006	0.00007	0.000	0.000
Field Data from Site											



Calculate Animation

Time:

23.10 Years

Return to Input

Recalculate This Sheet

VINYL CHLORIDE

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Landsburg Mine
Medium Conservative Case
Vinyl Chloride To South

Data Input Instructions:

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

1. HYDROGEOLOGY

Seepage Velocity*	*Vs*	664.0	*(ft/yr)*
or		or	
Hydraulic Conductivity	*K*	8.5E-01	*(cm/sec)*
Hydraulic Gradient	*i*	0.00029	*(ft/ft)*
Porosity	*n*	0.31	*(-)*

2. DISPERSION

Longitudinal Dispersivity*	*alpha x*	34.0	*(ft)*
Transverse Dispersivity*	*alpha y*	3.40	
Vertical Dispersivity*	*alpha z*	0.20	*(ft)*
or		or	
Estimated Plume Length	*Lp*	800	*(ft)*

3. ADSORPTION

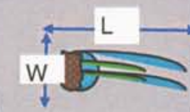
Retardation Factor*	*R*	29.0	*(-)*
or		or	
Soil Bulk Density	*rho*	1.4	*(kg/l)*
Partition Coefficient	*Koc*	30	*(L/kg)*
FractionOrganicCarbon	*foc*	2.3E-1	*(-)*

4. BIODEGRADATION

1st Order Decay Coeff*	*lambda*	6.9E-8	*(per yr)*
or		or	
Solute Half-Life	*t-half*	#######	*(year)*
or Instantaneous Reaction Model			
Delta Oxygen*	*DO*		*(mg/L)*
Delta Nitrate*	*NO3*		*(mg/L)*
Observed Ferrous Iron*	*Fe2+*		*(mg/L)*
Delta Sulfate*	*SO4*		*(mg/L)*
Observed Methane*	*CH4*		*(mg/L)*

5. GENERAL

Modeled Area Length*	2870	*(ft)*
Modeled Area Width*	15	*(ft)*
Simulation Time*	31.50	*(yr)*



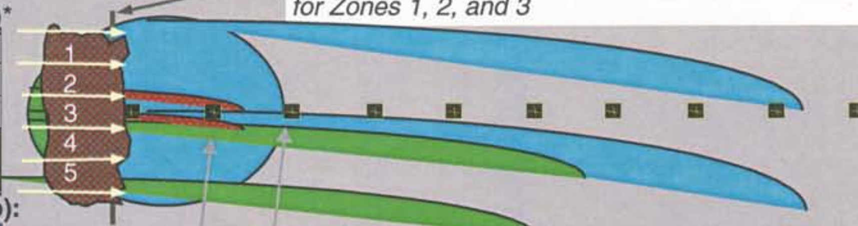
6. SOURCE DATA

Source Thickness in Sat.Zone* 15 *(ft)*

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

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	620.3
3	620.3
3	620.3
3	620.3
3	620.3



View of Plume Looking Down

Source Halflife (see Help):

	Infinite	Infinite	*(yr)*
Inst. React.		1st Order	
Soluble Mass	infinite		*(Kg)*
In Source NAPL, Soil			

1200

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

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	287	574	861	1148	1435	1722	2009	2296	2583	2870

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE

View Output

RUN ARRAY

View Output

Help

Recalculate This Sheet

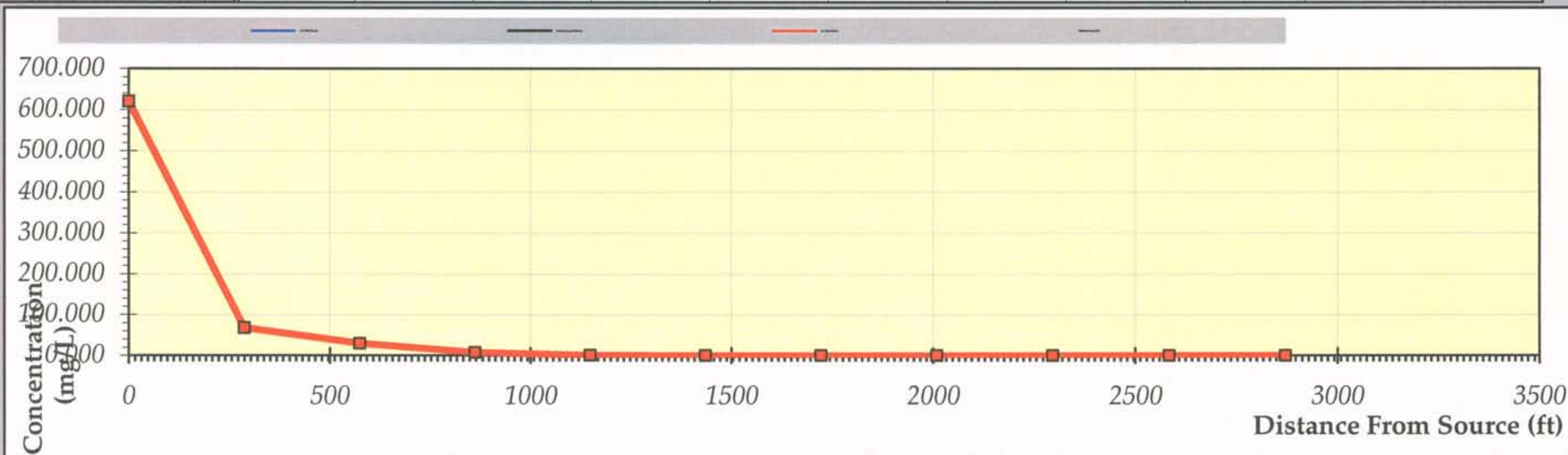
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED VINYL CHLORIDE CONCENTRATION ALONG PLUME CENTERLINE TO SOUTH (620.3 mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	287	574	861	1148	1435	1722	2009	2296	2583	2870
No Degradation	620.300	68.367	30.007	7.430	0.584	0.011	0.00005	0.000	0.000	0.000	0.000
1st Order Decay	620.300	68.367	30.007	7.430	0.584	0.011	0.00005	0.000	0.000	0.000	0.000
Inst. Reaction	620.300	68.367	30.007	7.430	0.584	0.011	0.00005	0.000	0.000	0.000	0.000
Field Data from Site											



Calculate Animation

Time:

31.50 Years

Return to Input

Recalculate This Sheet

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Landsburg Mine
Medium Conservative Case
Vinyl Chloride To South

Data Input Instructions:

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

1. HYDROGEOLOGY

Seepage Velocity*	Vs	664.0	(ft/yr)
or		↑ or	
Hydraulic Conductivity	K	8.5E-01	(cm/sec)
Hydraulic Gradient	i	0.00029	(ft/ft)
Porosity	n	0.31	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	34.0	(ft)
Transverse Dispersivity*	alpha y	3.40	
Vertical Dispersivity*	alpha z	0.20	(ft)
or		↑ or	
Estimated Plume Length	Lp	800	(ft)

3. ADSORPTION

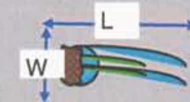
Retardation Factor*	R	29.0	(-)
or		↑ or	
Soil Bulk Density	rho	1.4	(kg/l)
Partition Coefficient	Koc	30	(L/kg)
FractionOrganicCarbon	foc	2.3E-1	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-8	(per yr)
or		↑ or	
Solute Half-Life	t-half	#######	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	2870	(ft)
Modeled Area Width*	15	(ft)
Simulation Time*	47.50	(yr)



6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	620.3
3	620.3
3	620.3
3	620.3
3	620.3

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

Source Halflife (see Help):

Infinite	Infinite	(yr)
Inst. React.	↑ 1st Order	
Soluble Mass	infinite	(Kg)
In Source NAPL, Soil		

View of Plume Looking Down

1200

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

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	287	574	861	1148	1435	1722	2009	2296	2583	2870

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE

View Output

RUN ARRAY

View Output

Help

Recalculate This Sheet

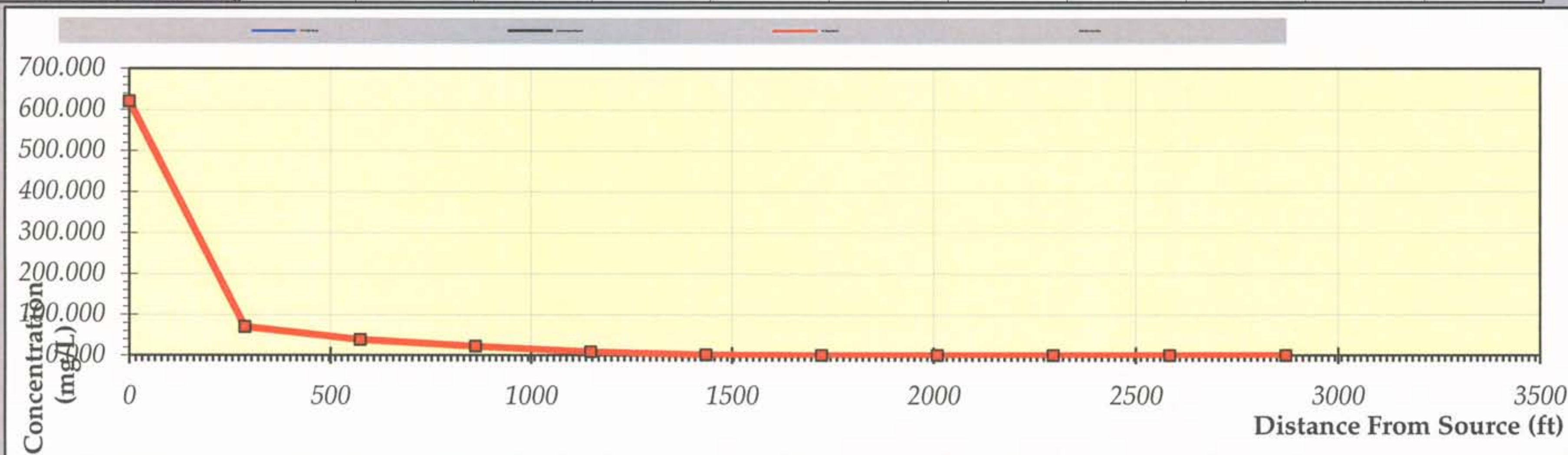
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED VINYL CHLORIDE CONCENTRATION ALONG PLUME CENTERLINE TO SOUTH (620.3 mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	287	574	861	1148	1435	1722	2009	2296	2583	2870
No Degradation	620.300	70.002	38.990	22.448	8.924	1.772	0.146	0.005	0.00005	0.000	0.000
1st Order Decay	620.300	70.002	38.990	22.448	8.924	1.772	0.146	0.005	0.00005	0.000	0.000
Inst. Reaction	620.300	70.002	38.990	22.448	8.924	1.772	0.146	0.005	0.00005	0.000	0.000
Field Data from Site											



Calculate Animation

Time:

47.50 Years

Return to Input

Recalculate This Sheet

1,4-DIOXANE

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence *Version 1.4*

Landsburg Mine
Medium Conservative Case
1,4-Dioxane To South

Data Input Instructions:

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

1. HYDROGEOLOGY

Seepage Velocity*	Vs	664.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	8.5E-01	(cm/sec)
Hydraulic Gradient	i	0.00029	(ft/ft)
Porosity	n	0.31	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	34.0	(ft)
Transverse Dispersivity*	alpha y	3.40	`
Vertical Dispersivity*	alpha z	0.20	(ft)
or		or	
Estimated Plume Length	Lp	800	(ft)

3. ADSORPTION

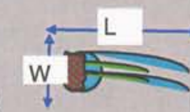
Retardation Factor*	R	17.0	(-)
or		or	
Soil Bulk Density	rho	1.4	(kg/l)
Partition Coefficient	Koc	17	(L/kg)
FractionOrganicCarbon	foc	2.3E-1	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-8	(per yr)
or		or	
Solute Half-Life	t-half	#######	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	2870	(ft)
Modeled Area Width*	15	(ft)
Simulation Time*	23.20	(yr)



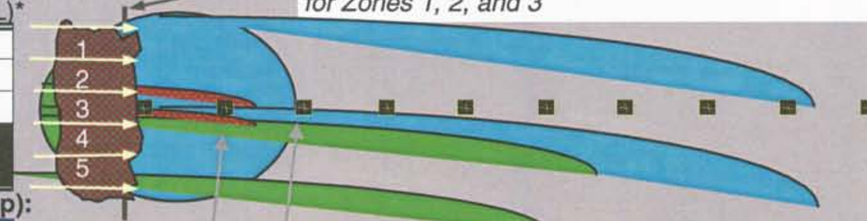
6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	24.48
3	24.48
3	24.48
3	24.48
3	24.48

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



View of Plume Looking Down

1200

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

Source Halflife (see Help):

Infinite	Infinite	(yr)
Inst. React.	1st Order	
Soluble Mass	infinite	(Kg)
In Source NAPL, Soil		

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	287	574	861	1148	1435	1722	2009	2296	2583	2870

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE

View Output

RUN ARRAY

View Output

Help

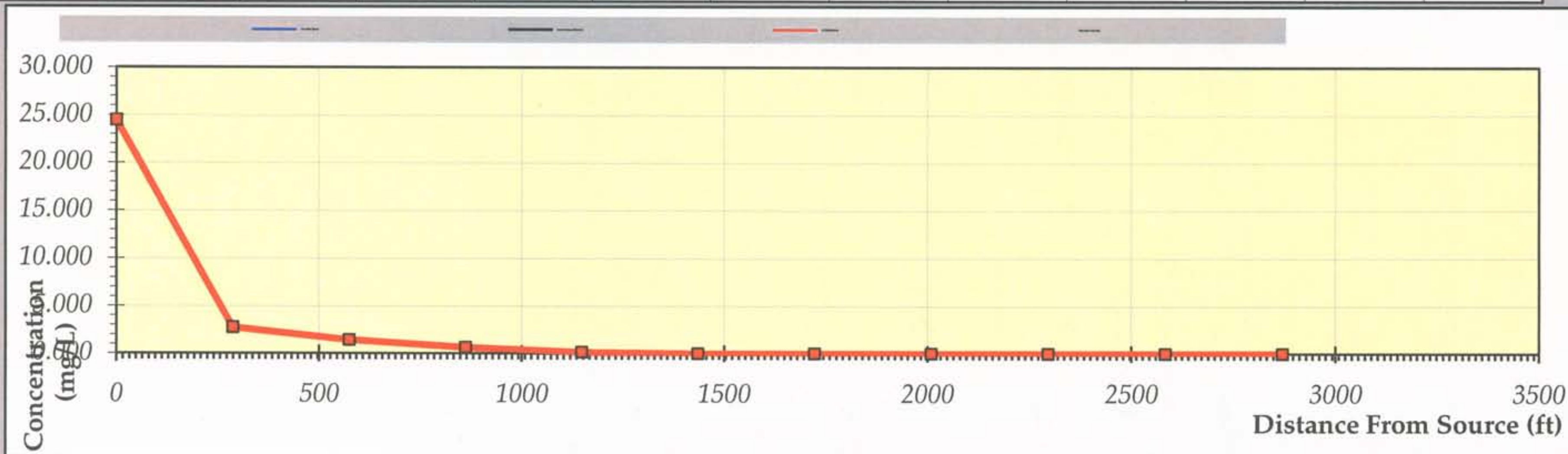
Recalculate This Sheet

Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED 1,4-DIOXANE CONCENTRATION ALONG PLUME CENTERLINE TO SOUTH (24.48 mg/L at Z=0)

	Distance from Source (ft)										
TYPE OF MODEL	0	287	574	861	1148	1435	1722	2009	2296	2583	2870
No Degradation	24.480	2.750	1.442	0.636	0.141	0.012	0.00030	0.000	0.000	0.000	0.000
1st Order Decay	24.480	2.750	1.442	0.636	0.141	0.012	0.00030	0.000	0.000	0.000	0.000
Inst. Reaction	24.480	2.750	1.442	0.636	0.141	0.012	0.00030	0.000	0.000	0.000	0.000
Field Data from Site											



Calculate Animation

Time:

23.20 Years

Return to Input

Recalculate This Sheet

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence — *Version 1.4*

Landsburg Mine
Medium Conservative Case
1,4-Dioxane To South

Data Input Instructions:

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

1. HYDROGEOLOGY

Seepage Velocity*	*Vs*	664.0	*(ft/yr)*
or		↑ *or*	
Hydraulic Conductivity	*K*	8.5E-01	*(cm/sec)*
Hydraulic Gradient	*i*	0.00029	*(ft/ft)*
Porosity	*n*	0.31	*(-)*

2. DISPERSION

Longitudinal Dispersivity*	*alpha x*	34.0	*(ft)*
Transverse Dispersivity*	*alpha y*	3.40	
Vertical Dispersivity*	*alpha z*	0.20	*(ft)*
or		↑ *or*	
Estimated Plume Length	*Lp*	800	*(ft)*

3. ADSORPTION

Retardation Factor*	*R*	17.0	*(-)*
or		↑ *or*	
Soil Bulk Density	*rho*	1.4	*(kg/l)*
Partition Coefficient	*Koc*	17	*(L/kg)*
FractionOrganicCarbon	*foc*	2.3E-1	*(-)*

4. BIODEGRADATION

1st Order Decay Coeff*	*lambda*	6.9E-8	*(per yr)*
or		↑ *or*	
Solute Half-Life	*t-half*	#######	*(year)*
or Instantaneous Reaction Model			
Delta Oxygen*	*DO*		*(mg/L)*
Delta Nitrate*	*NO3*		*(mg/L)*
Observed Ferrous Iron*	*Fe2+*		*(mg/L)*
Delta Sulfate*	*SO4*		*(mg/L)*
Observed Methane*	*CH4*		*(mg/L)*

5. GENERAL

Modeled Area Length*	2870	*(ft)*
Modeled Area Width*	15	*(ft)*
Simulation Time*	34.10	*(yr)*

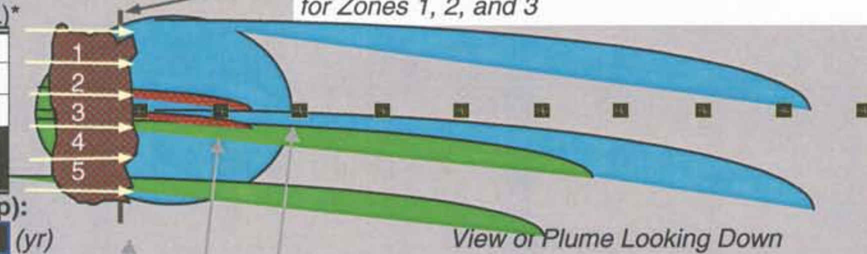
6. SOURCE DATA

Source Thickness in Sat.Zone* 15 *(ft)*

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

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	24.48
3	24.48
3	24.48
3	24.48
3	24.48



Source Halflife (see Help):

Infinite	Infinite	*(yr)*
Inst. React.	1st Order	
Soluble Mass	infinite	*(Kg)*
In Source NAPL, Soil		

1200

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

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	287	574	861	1148	1435	1722	2009	2296	2583	2870

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help — Recalculate This Sheet

Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED 1,4-DIOXANE CONCENTRATION ALONG PLUME CENTERLINE TO SOUTH (24.48 mg/L at Z=0)

TYPE OF MODEL	0	287	574	861	1148	1435	1722	2009	2296	2583	2870
No Degradation	24.480	2.766	1.576	1.045	0.623	0.254	0.057	0.006	0.00030	0.000	0.000
1st Order Decay	24.480	2.766	1.576	1.045	0.623	0.254	0.057	0.006	0.00030	0.000	0.000
Inst. Reaction	24.480	2.766	1.576	1.045	0.623	0.254	0.057	0.006	0.00030	0.000	0.000
Field Data from Site											

Distance from Source (ft)

Calculate Animation

Time:

34.10 Years

Return to Input

Recalculate This Sheet

ARSENIC

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence *Version 1.4*

Landsburg Mine
Medium Conservative Case
Arsenic To South

Data Input Instructions:

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

1. HYDROGEOLOGY

Seepage Velocity*	Vs	664.0	(ft/yr)
or		↑ or	
Hydraulic Conductivity	K	8.5E-01	(cm/sec)
Hydraulic Gradient	i	0.00029	(ft/ft)
Porosity	n	0.31	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	34.0	(ft)
Transverse Dispersivity*	alpha y	3.40	
Vertical Dispersivity*	alpha z	0.20	(ft)
or		↑ or	
Estimated Plume Length	Lp	800	(ft)

3. ADSORPTION

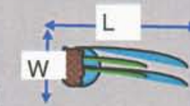
Retardation Factor*	R	70.0	(-)
or		↑ or	
Soil Bulk Density	rho	1.4	(kg/l)
Partition Coefficient	Koc	NA	(L/kg)
FractionOrganicCarbon	foc	2.3E+0	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-8	(per yr)
or		↑ or	
Solute Half-Life	t-half	#######	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	2870	(ft)
Modeled Area Width*	15	(ft)
Simulation Time*	109.00	(yr)



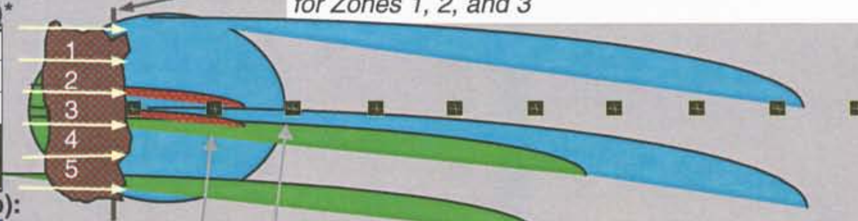
6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

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

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	10
3	10
3	10
3	10
3	10



Source Halflife (see Help):

Infinite	Infinite	(yr)
Inst. React.	↑↑ 1st Order	
Soluble Mass	infinite	(Kg)
In Source NAPL, Soil		

1200

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

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	287	574	861	1148	1435	1722	2009	2296	2583	2870

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | **View Output**

RUN ARRAY | **View Output**

Help

Recalculate This Sheet

Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED ARSENIC CONCENTRATION ALONG PLUME CENTERLINE TO SOUTH (10 mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	287	574	861	1148	1435	1722	2009	2296	2583	2870
No Degradation	10.000	1.128	0.621	0.337	0.116	0.018	0.0011	0.000	0.000	0.000	0.000
1st Order Decay	10.000	1.128	0.621	0.337	0.116	0.018	0.0011	0.000	0.000	0.000	0.000
Inst. Reaction	10.000	1.128	0.621	0.337	0.116	0.018	0.0011	0.000	0.000	0.000	0.000
Field Data from Site											

Calculate Animation

Time:

109.00 Years

Return to Input

Recalculate This Sheet

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence — *Version 1.4*

Landsburg Mine
Medium Conservative Case
Arsenic To South

Data Input Instructions:

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

1. HYDROGEOLOGY

Seepage Velocity*	Vs	664.0	(ft/yr)
or		↑ or	
Hydraulic Conductivity	K	8.5E-01	(cm/sec)
Hydraulic Gradient	i	0.00029	(ft/ft)
Porosity	n	0.31	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	34.0	(ft)
Transverse Dispersivity*	alpha y	3.40	
Vertical Dispersivity*	alpha z	0.20	(ft)
or		↑ or	
Estimated Plume Length	Lp	800	(ft)

3. ADSORPTION

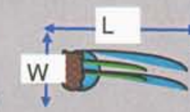
Retardation Factor*	R	70.0	(-)
or		↑ or	
Soil Bulk Density	rho	1.4	(kg/l)
Partition Coefficient	Koc	NA	(L/kg)
FractionOrganicCarbon	foc	2.3E+0	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-8	(per yr)
or		↑ or	
Solute Half-Life	t-half	#######	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	2870	(ft)
Modeled Area Width*	15	(ft)
Simulation Time*	157.00	(yr)



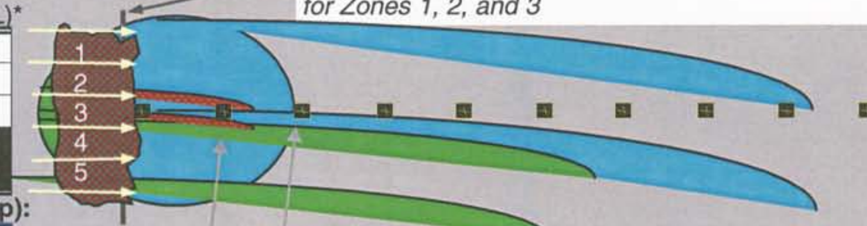
6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

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

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	10
3	10
3	10
3	10
3	10



Source Halflife (see Help):

Infinite	Infinite	(yr)
Inst. React.	1st Order	
Soluble Mass	infinite	(Kg)
In Source NAPL, Soil		

1200

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

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	287	574	861	1148	1435	1722	2009	2296	2583	2870

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help

Recalculate This Sheet

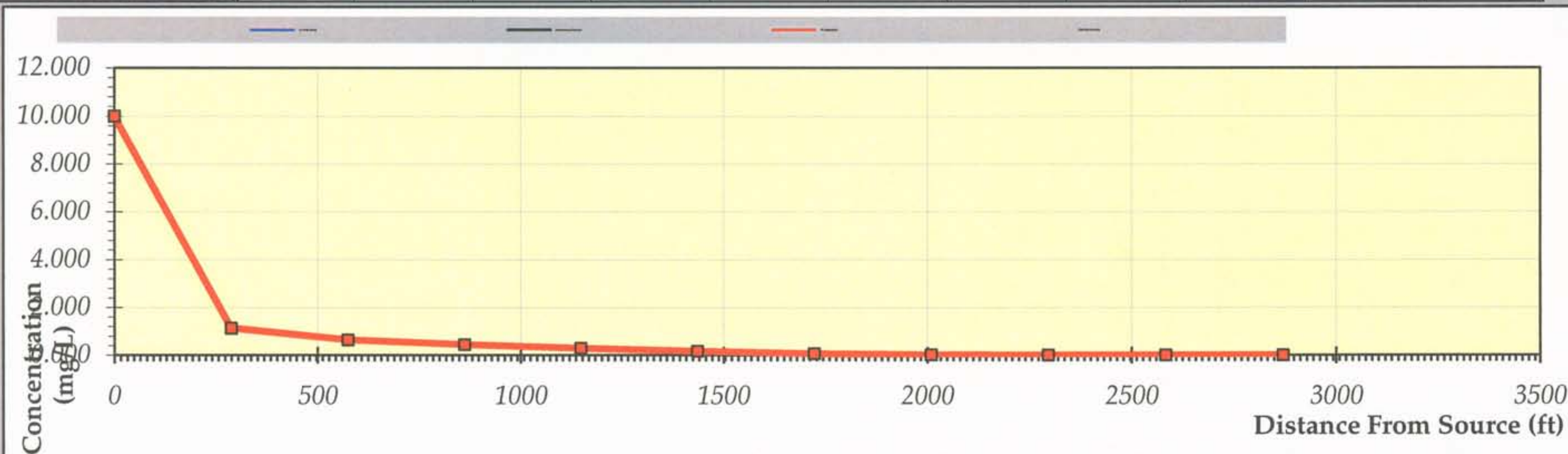
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED ARSENIC CONCENTRATION ALONG PLUME CENTERLINE TO SOUTH (10 mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	287	574	861	1148	1435	1722	2009	2296	2583	2870
No Degradation	10.000	1.130	0.646	0.443	0.300	0.161	0.055	0.011	0.0010	0.000	0.000
1st Order Decay	10.000	1.130	0.646	0.443	0.300	0.161	0.055	0.011	0.0010	0.000	0.000
Inst. Reaction	10.000	1.130	0.646	0.443	0.300	0.161	0.055	0.011	0.0010	0.000	0.000
Field Data from Site											



Calculate Animation

Time:

157.00 Years

Return to Input

Recalculate This Sheet

APPENDIX D-2

NORTH COMPLIANCE BOUNDARY

METHYLENE CHLORIDE

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Landsburg Mine
Medium Conservative Case
Methylene Chloride To North

Data Input Instructions:

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

1. HYDROGEOLOGY

Seepage Velocity*	*Vs*	830.0	*(ft/yr)*
or		or	
Hydraulic Conductivity	*K*	8.5E-01	*(cm/sec)*
Hydraulic Gradient	*i*	0.00036	*(ft/ft)*
Porosity	*n*	0.31	*(-)*

2. DISPERSION

Longitudinal Dispersivity*	*alpha x*	22.2	*(ft)*
Transverse Dispersivity*	*alpha y*	2.20	
Vertical Dispersivity*	*alpha z*	0.22	*(ft)*
or		or	
Estimated Plume Length	*Lp*	800	*(ft)*

3. ADSORPTION

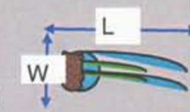
Retardation Factor*	*R*	14.0	*(-)*
or		or	
Soil Bulk Density	*rho*	1.4	*(kg/l)*
Partition Coefficient	*Koc*	10	*(L/kg)*
FractionOrganicCarbon	*foc*	4.6E-1	*(-)*

4. BIODEGRADATION

1st Order Decay Coeff*	*lambda*	6.9E-8	*(per yr)*
or		or	
Solute Half-Life	*t-half*	#######	*(year)*
or Instantaneous Reaction Model			
Delta Oxygen*	*DO*		*(mg/L)*
Delta Nitrate*	*NO3*		*(mg/L)*
Observed Ferrous Iron*	*Fe2+*		*(mg/L)*
Delta Sulfate*	*SO4*		*(mg/L)*
Observed Methane*	*CH4*		*(mg/L)*

5. GENERAL

Modeled Area Length*	1000	*(ft)*
Modeled Area Width*	15	*(ft)*
Simulation Time*	2.30	*(yr)*



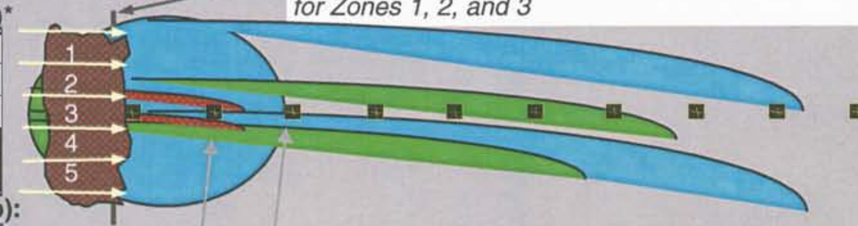
6. SOURCE DATA

Source Thickness in Sat.Zone* 15 *(ft)*

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

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	685.1
3	685.1
3	685.1
3	685.1
3	685.1



View of Plume Looking Down

Source Halflife (see Help):

Infinite	Infinite	*(yr)*
Inst. React.	1st Order	
Soluble Mass	infinite	*(Kg)*

In Source NAPL, Soil

1200

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

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	100	200	300	400	500	600	700	800	900	1000

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | **View Output**

RUN ARRAY | **View Output**

Help

Recalculate This Sheet

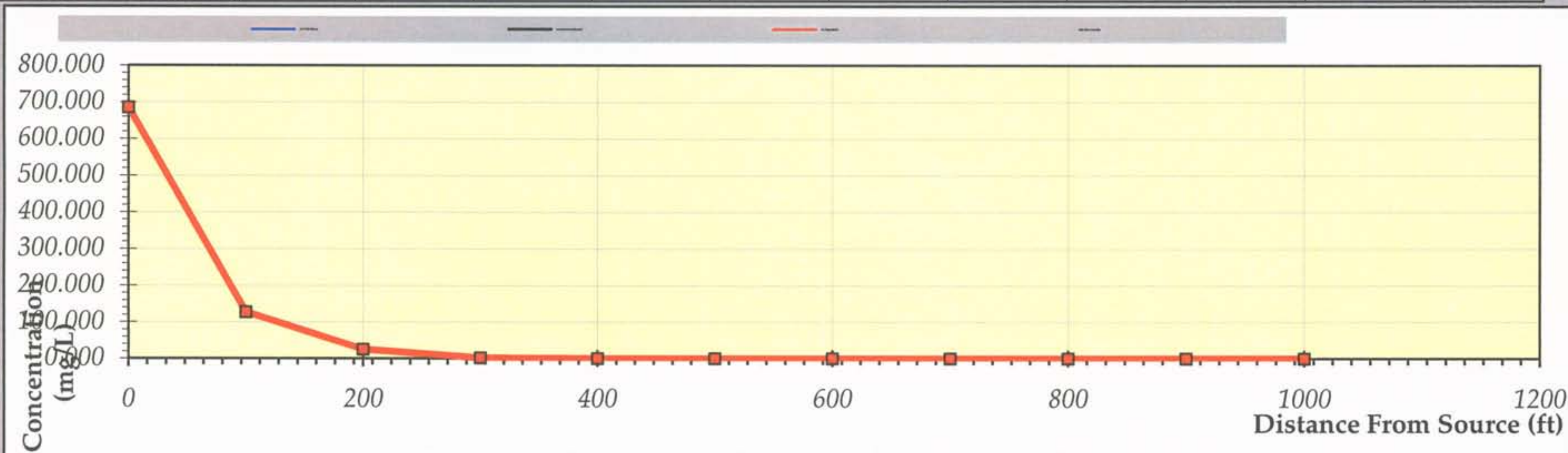
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED METHYLENE CHLORIDE CONCENTRATION ALONG PLUME CENTERLINE TO NORTH (685.1 mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	685.100	127.007	25.160	1.605	0.025	0.00009	0.000	0.000	0.000	0.000	0.000
1st Order Decay	685.100	127.007	25.160	1.605	0.025	0.00009	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	685.100	127.007	25.160	1.605	0.025	0.00009	0.000	0.000	0.000	0.000	0.000
Field Data from Site											



Calculate Animation

Time:

2.30 Years

Return to Input

Recalculate This Sheet

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Landsburg Mine

Medium Conservative Case

Methylene Chloride To North

Data Input Instructions:

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

1. HYDROGEOLOGY

Seepage Velocity*	Vs	830.0	(ft/yr)
or		↑ or	
Hydraulic Conductivity	K	8.5E-01	(cm/sec)
Hydraulic Gradient	i	0.00036	(ft/ft)
Porosity	n	0.31	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	22.2	(ft)
Transverse Dispersivity*	alpha y	2.20	
Vertical Dispersivity*	alpha z	0.22	(ft)
or		↑ or	
Estimated Plume Length	Lp	800	(ft)

3. ADSORPTION

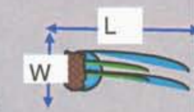
Retardation Factor*	R	14.0	(-)
or		↑ or	
Soil Bulk Density	rho	1.4	(kg/l)
Partition Coefficient	Koc	10	(L/kg)
FractionOrganicCarbon	foc	4.6E-1	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-8	(per yr)
or		↑ or	
Solute Half-Life	t-half	#######	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	1000	(ft)
Modeled Area Width*	15	(ft)
Simulation Time*	4.75	(yr)



6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	685.1
3	685.1
3	685.1
3	685.1
3	685.1

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

Source Halflife (see Help):

Infinite	Infinite	(yr)
Inst. React. ↑	↑ 1st Order	
Soluble Mass	infinite	(Kg)

In Source NAPL, Soil

View of Plume Looking Down

1200

Observed Centerline Concentrations at Monitoring Wells

If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	100	200	300	400	500	600	700	800	900	1000

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE

View Output

RUN ARRAY

View Output

Help

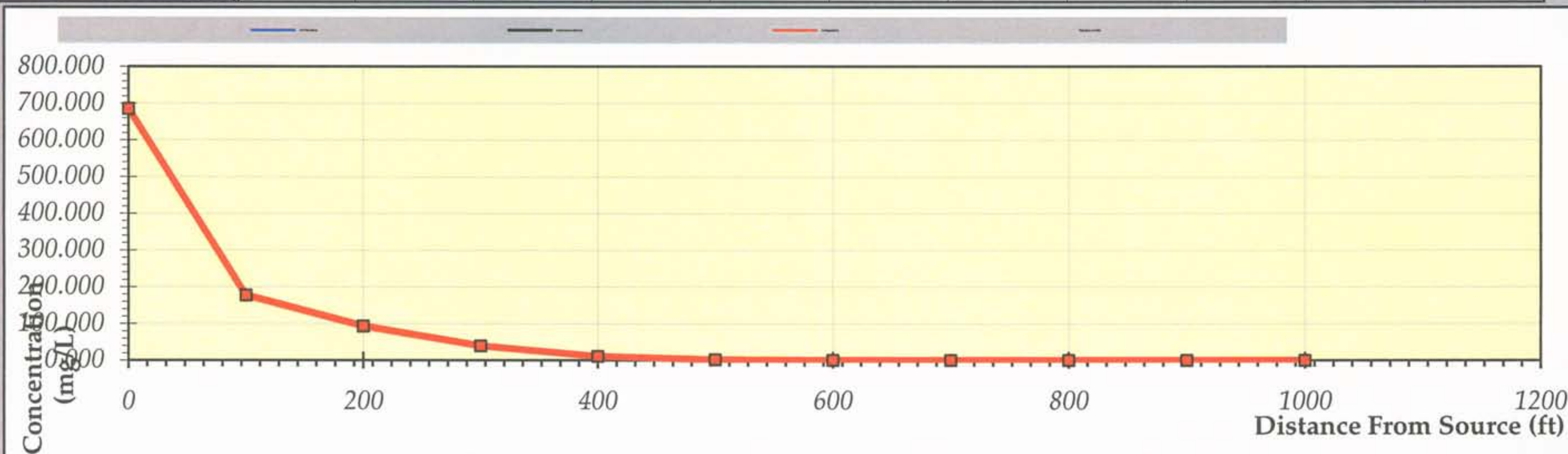
Recalculate This Sheet

Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED METHYLENE CHLORIDE CONCENTRATION ALONG PLUME CENTERLINE TO NORTH (685.1 mg/L at Z=0)

TYPE OF MODEL	Distance from Source (ft) 0	100	200	300	400	500	600	700	800	900	1000
No Degradation	685.100	177.071	93.395	39.367	10.445	1.521	0.113	0.004	0.00007	0.000	0.000
1st Order Decay	685.100	177.071	93.395	39.367	10.445	1.521	0.113	0.004	0.00007	0.000	0.000
Inst. Reaction	685.100	177.071	93.395	39.367	10.445	1.521	0.113	0.004	0.00007	0.000	0.000
Field Data from Site											



Calculate Animation

Time:

4.75 Years

Return to Input

Recalculate This Sheet

VINYL CHLORIDE

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Landsburg Mine
Medium Conservative Case
Vinyl Chloride To North

Data Input Instructions:

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

1. HYDROGEOLOGY

Seepage Velocity*	Vs	830.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	8.5E-01	(cm/sec)
Hydraulic Gradient	i	0.00036	(ft/ft)
Porosity	n	0.31	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	22.2	(ft)
Transverse Dispersivity*	alpha y	2.20	
Vertical Dispersivity*	alpha z	0.22	(ft)
or		or	
Estimated Plume Length	Lp	800	(ft)

3. ADSORPTION

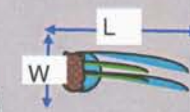
Retardation Factor*	R	29.0	(-)
or		or	
Soil Bulk Density	rho	1.4	(kg/l)
Partition Coefficient	Koc	30	(L/kg)
FractionOrganicCarbon	foc	4.6E-1	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-8	(per yr)
or		or	
Solute Half-Life	t-half	#######	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	1000	(ft)
Modeled Area Width*	15	(ft)
Simulation Time*	4.70	(yr)



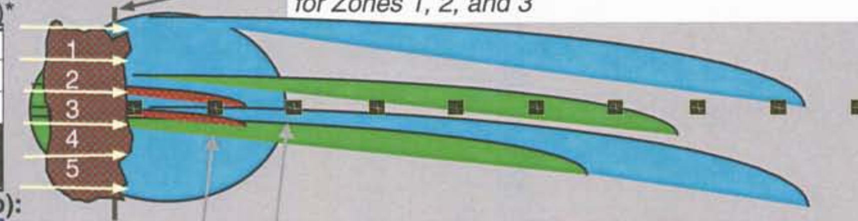
6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	620.3
3	620.3
3	620.3
3	620.3
3	620.3

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



Source Halflife (see Help):

Infinite	Infinite	(yr)
Inst. React.	1st Order	

Soluble Mass infinite (Kg)

In Source NAPL, Soil

View of Plume Looking Down

1200

Observed Centerline Concentrations at Monitoring Wells

If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	100	200	300	400	500	600	700	800	900	1000

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | View Output

RUN ARRAY | View Output

Help

Recalculate This Sheet

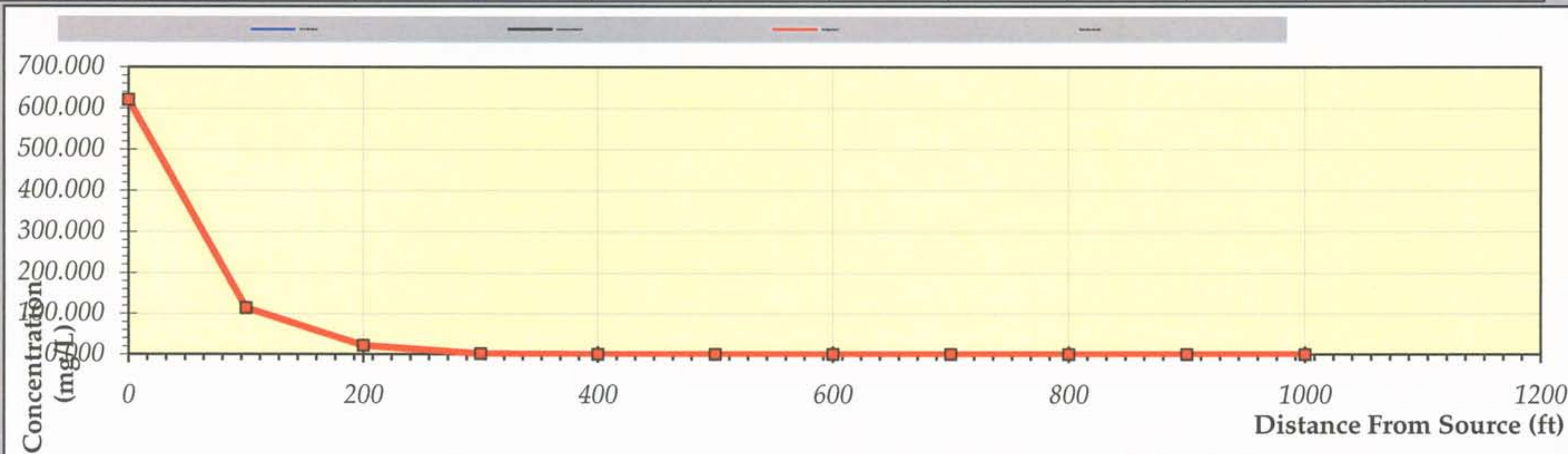
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED VINYL CHLORIDE CONCENTRATION ALONG PLUME CENTERLINE TO NORTH (620.3 mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	620.300	113.741	21.867	1.322	0.019	0.00006	0.000	0.000	0.000	0.000	0.000
1st Order Decay	620.300	113.741	21.867	1.322	0.019	0.00006	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	620.300	113.741	21.867	1.322	0.019	0.00006	0.000	0.000	0.000	0.000	0.000
Field Data from Site											



Calculate Animation

Time:

4.70 Years

Return to Input

Recalculate This Sheet

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence — *Version 1.4*

Landsburg Mine
Medium Conservative Case
Vinyl Chloride To North

Data Input Instructions:

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

1. HYDROGEOLOGY

Seepage Velocity*	Vs	830.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	8.5E-01	(cm/sec)
Hydraulic Gradient	i	0.00036	(ft/ft)
Porosity	n	0.31	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	22.2	(ft)
Transverse Dispersivity*	alpha y	2.20	
Vertical Dispersivity*	alpha z	0.22	(ft)
or		or	
Estimated Plume Length	Lp	800	(ft)

3. ADSORPTION

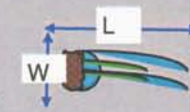
Retardation Factor*	R	29.0	(-)
or		or	
Soil Bulk Density	rho	1.4	(kg/l)
Partition Coefficient	Koc	30	(L/kg)
FractionOrganicCarbon	foc	4.6E-1	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-8	(per yr)
or		or	
Solute Half-Life	t-half	#######	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	1000	(ft)
Modeled Area Width*	15	(ft)
Simulation Time*	9.70	(yr)



6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

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

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	620.3
3	620.3
3	620.3
3	620.3
3	620.3

Source Halflife (see Help):

Infinite	Infinite	(yr)
Inst. React.	1st Order	
Soluble Mass	infinite	(Kg)
In Source NAPL, Soil		

View of Plume Looking Down

1200

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

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	100	200	300	400	500	600	700	800	900	1000

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — View Output

RUN ARRAY — View Output

Help

Recalculate This Sheet

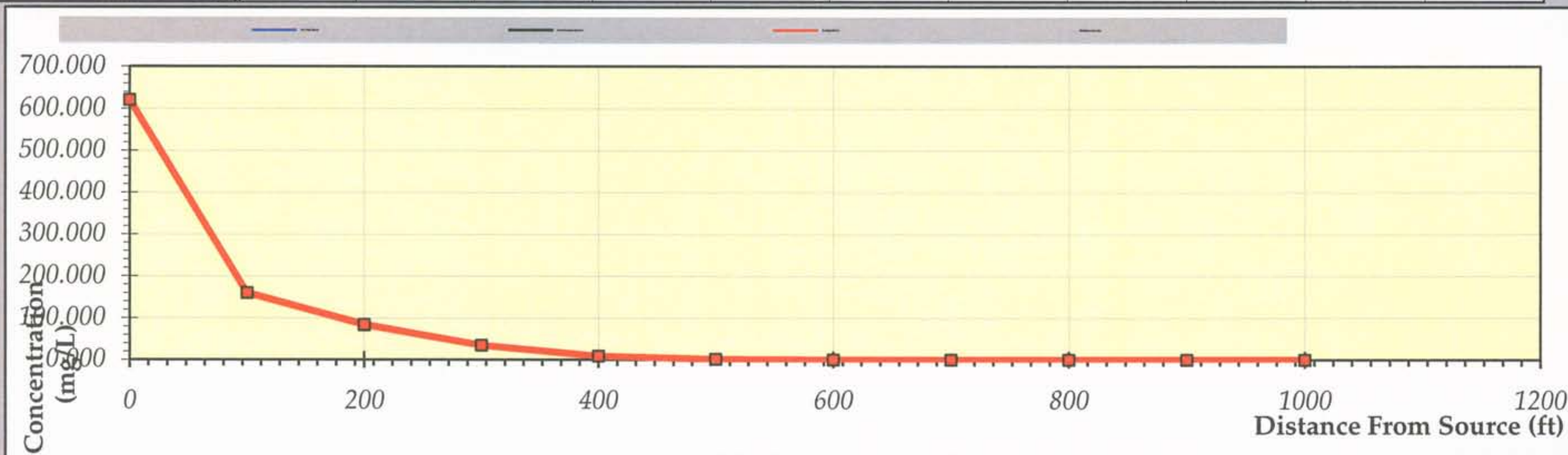
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED VINYL CHLORIDE CONCENTRATION ALONG PLUME CENTERLINE TO NORTH (620.3 mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	620.300	159.876	83.516	34.450	8.825	1.225	0.085	0.003	0.00005	0.000	0.000
1st Order Decay	620.300	159.876	83.516	34.450	8.825	1.225	0.085	0.003	0.00005	0.000	0.000
Inst. Reaction	620.300	159.876	83.516	34.450	8.825	1.225	0.085	0.003	0.00005	0.000	0.000
Field Data from Site											



Calculate Animation

Time:

9.70 Years

Return to Input

Recalculate This Sheet

1,4-DIOXANE

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Landsburg Mine
Medium Conservative Case
1,4-Dioxane To North

Data Input Instructions:

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

1. HYDROGEOLOGY

Seepage Velocity*	Vs	830.0	(ft/yr)
or		↑ or	
Hydraulic Conductivity	K	8.5E-01	(cm/sec)
Hydraulic Gradient	i	0.00036	(ft/ft)
Porosity	n	0.31	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	22.2	(ft)
Transverse Dispersivity*	alpha y	2.20	
Vertical Dispersivity*	alpha z	0.22	(ft)
or		↑ or	
Estimated Plume Length	Lp	800	(ft)

3. ADSORPTION

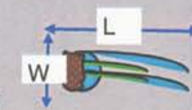
Retardation Factor*	R	17.0	(-)
or		↑ or	
Soil Bulk Density	rho	1.4	(kg/l)
Partition Coefficient	Koc	17	(L/kg)
FractionOrganicCarbon	foc	4.6E-1	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-8	(per yr)
or		↑ or	
Solute Half-Life	t-half	#######	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	1000	(ft)
Modeled Area Width*	15	(ft)
Simulation Time*	3.70	(yr)



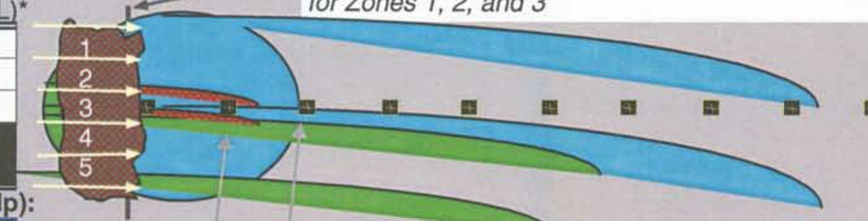
6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	24.48
3	24.48
3	24.48
3	24.48
3	24.48

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



View of Plume Looking Down

Source Halflife (see Help):

Infinite	Infinite	(yr)
Inst. React. ↑	↑ 1st Order	
Soluble Mass	infinite	(Kg)
In Source NAPL, Soil		

1200

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

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	100	200	300	400	500	600	700	800	900	1000

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | View Output

RUN ARRAY | View Output

Help | Recalculate This Sheet

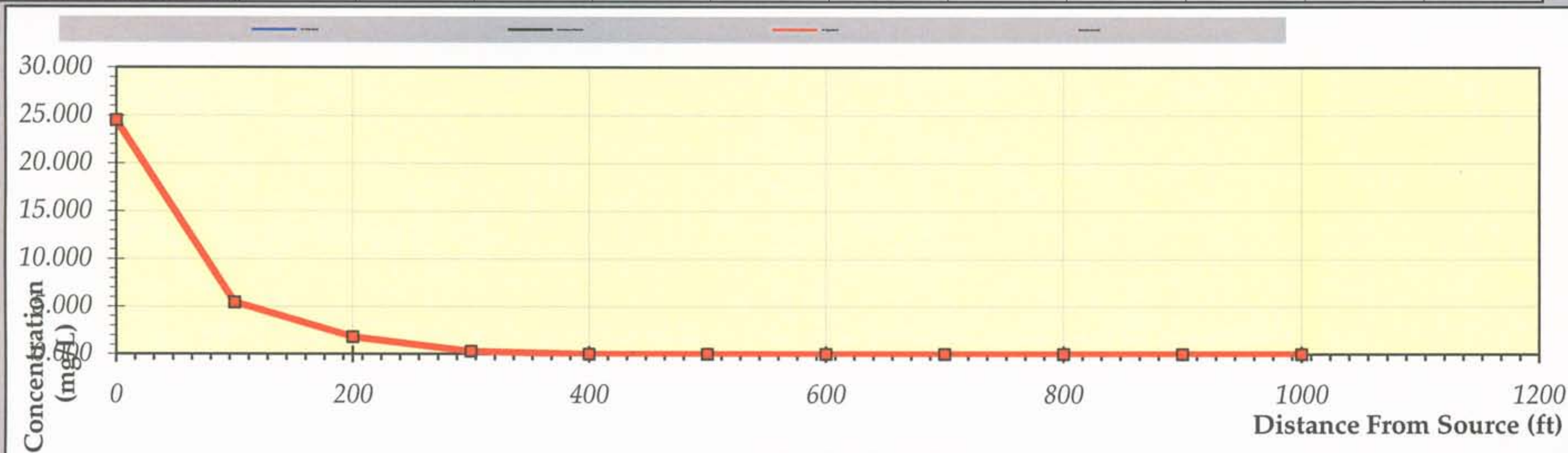
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED 1,4-DIOXANE CONCENTRATION ALONG PLUME CENTERLINE TO NORTH (24.48 mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	24.480	5.448	1.803	0.296	0.018	0.00039	0.000	0.000	0.000	0.000	0.000
1st Order Decay	24.480	5.448	1.803	0.296	0.018	0.00039	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	24.480	5.448	1.803	0.296	0.018	0.00039	0.000	0.000	0.000	0.000	0.000
Field Data from Site											



Calculate Animation

Time:

3.70 Years

Return to Input

Recalculate This Sheet

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Landsburg Mine
Medium Conservative Case
1,4-Dioxane To North

Data Input Instructions:

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

1. HYDROGEOLOGY

Seepage Velocity*	Vs	830.0	(ft/yr)
or		↑ or	
Hydraulic Conductivity	K	8.5E-01	(cm/sec)
Hydraulic Gradient	i	0.00036	(ft/ft)
Porosity	n	0.31	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	22.2	(ft)
Transverse Dispersivity*	alpha y	2.20	
Vertical Dispersivity*	alpha z	0.22	(ft)
or		↑ or	
Estimated Plume Length	Lp	800	(ft)

3. ADSORPTION

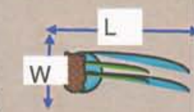
Retardation Factor*	R	17.0	(-)
or		↑ or	
Soil Bulk Density	rho	1.4	(kg/l)
Partition Coefficient	Koc	17	(L/kg)
FractionOrganicCarbon	foc	4.6E-1	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-8	(per yr)
or		↑ or	
Solute Half-Life	t-half	#######	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	1000	(ft)
Modeled Area Width*	15	(ft)
Simulation Time*	7.30	(yr)



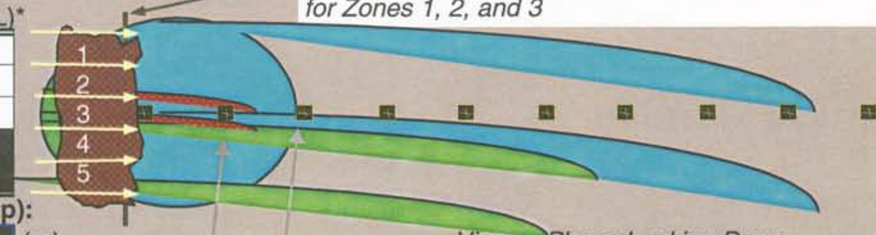
6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

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

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	24.48
3	24.48
3	24.48
3	24.48
3	24.48



Source Halflife (see Help):

Infinite	Infinite	(yr)
Inst. React. ↑	↑ 1st Order	
Soluble Mass	infinite	(Kg)
In Source NAPL, Soil		

View of Plume Looking Down

1200

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

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	100	200	300	400	500	600	700	800	900	1000

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE

View Output

RUN ARRAY

View Output

Help

Recalculate This Sheet

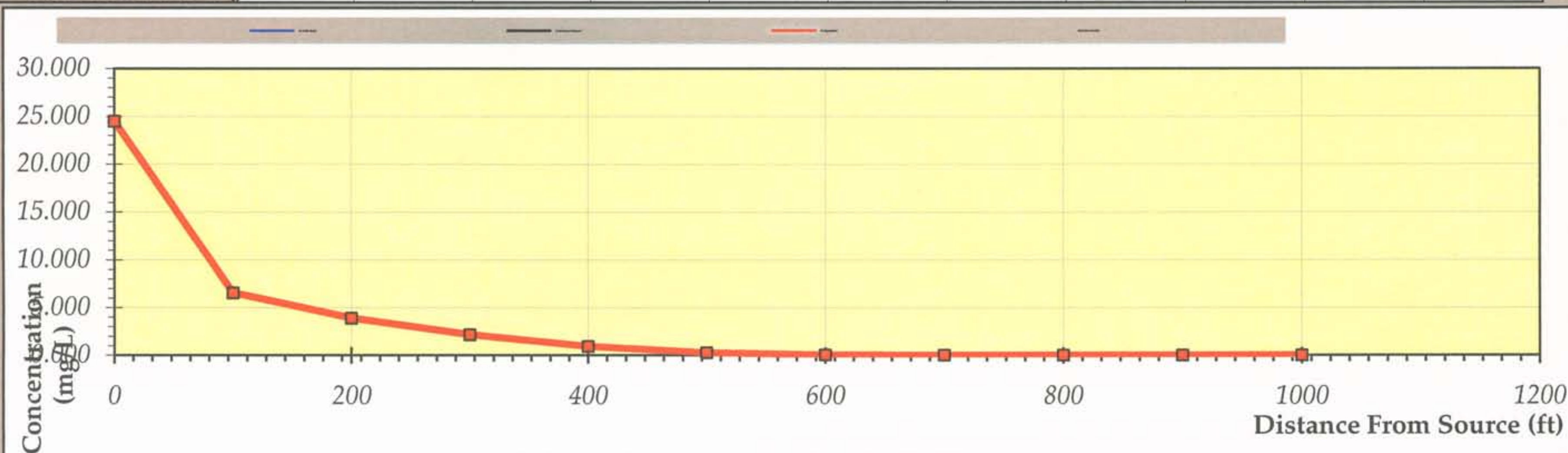
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED 1,4-DIOXANE CONCENTRATION ALONG PLUME CENTERLINE TO NORTH (24.48 mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	24.480	6.537	3.885	2.178	0.939	0.271	0.048	0.005	0.00030	0.000	0.000
1st Order Decay	24.480	6.537	3.885	2.178	0.939	0.271	0.048	0.005	0.00030	0.000	0.000
Inst. Reaction	24.480	6.537	3.885	2.178	0.939	0.271	0.048	0.005	0.00030	0.000	0.000
Field Data from Site											



Calculate Animation

Time:

7.30 Years

Return to Input

Recalculate This Sheet

ARSENIC

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Landsburg Mine
Medium Conservative Case
Arsenic To North

Data Input Instructions:

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

1. HYDROGEOLOGY

Seepage Velocity*	Vs	830.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	8.5E-01	(cm/sec)
Hydraulic Gradient	i	0.00036	(ft/ft)
Porosity	n	0.31	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	22.2	(ft)
Transverse Dispersivity*	alpha y	2.20	
Vertical Dispersivity*	alpha z	0.22	(ft)
or		or	
Estimated Plume Length	Lp	800	(ft)

3. ADSORPTION

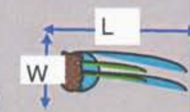
Retardation Factor*	R	70.0	(-)
or		or	
Soil Bulk Density	rho	1.4	(kg/l)
Partition Coefficient	Koc	NA	(L/kg)
FractionOrganicCarbon	foc	4.6E-1	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-8	(per yr)
or		or	
Solute Half-Life	t-half	#######	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	1000	(ft)
Modeled Area Width*	15	(ft)
Simulation Time*	17.50	(yr)



6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	10
3	10
3	10
3	10
3	10

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

View of Plume Looking Down

1200

Source Halflife (see Help):

Infinite	Infinite	(yr)
Inst. React.	1st Order	
Soluble Mass	infinite	(Kg)
In Source NAPL, Soil		

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

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	100	200	300	400	500	600	700	800	900	1000

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE

View Output

RUN ARRAY

View Output

Help

Recalculate This Sheet

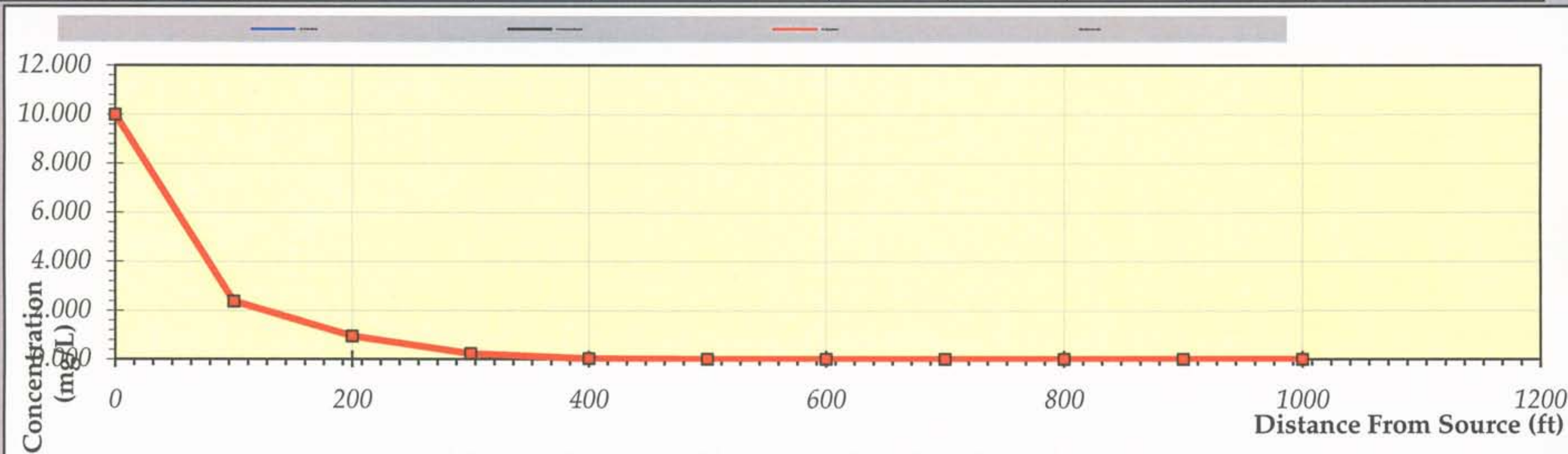
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED ARSENIC CONCENTRATION ALONG PLUME CENTERLINE TO NORTH (10 mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	10.000	2.369	0.944	0.222	0.024	0.0010	0.000	0.000	0.000	0.000	0.000
1st Order Decay	10.000	2.369	0.944	0.222	0.024	0.0010	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	10.000	2.369	0.944	0.222	0.024	0.0010	0.000	0.000	0.000	0.000	0.000
Field Data from Site											



Calculate Animation

Time:

17.50 Years

Return to Input

Recalculate This Sheet

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence *Version 1.4*

Landsburg Mine
Medium Conservative Case
Arsenic To North

Data Input Instructions:

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

1. HYDROGEOLOGY

Seepage Velocity*	Vs	830.0	(ft/yr)
or		↑ or	
Hydraulic Conductivity	K	8.5E-01	(cm/sec)
Hydraulic Gradient	i	0.00036	(ft/ft)
Porosity	n	0.31	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	22.2	(ft)
Transverse Dispersivity*	alpha y	2.20	
Vertical Dispersivity*	alpha z	0.22	(ft)
or		↑ or	
Estimated Plume Length	Lp	800	(ft)

3. ADSORPTION

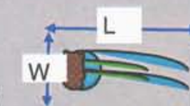
Retardation Factor*	R	70.0	(-)
or		↑ or	
Soil Bulk Density	rho	1.4	(kg/l)
Partition Coefficient	Koc	NA	(L/kg)
FractionOrganicCarbon	foc	4.6E-1	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-8	(per yr)
or		↑ or	
Solute Half-Life	t-half	#######	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	1000	(ft)
Modeled Area Width*	15	(ft)
Simulation Time*	34.30	(yr)



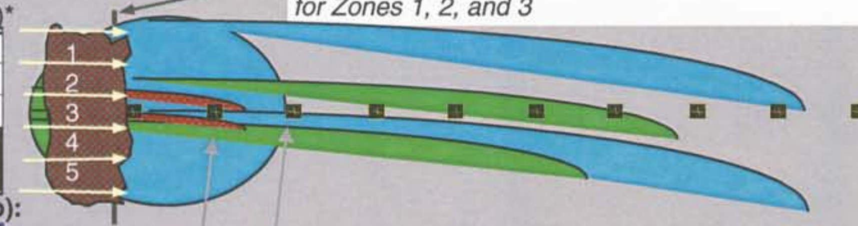
6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	10
3	10
3	10
3	10
3	10

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



Source Halflife (see Help):

Infinite	Infinite	(yr)
Inst. React.	↑ ↑ 1st Order	
Soluble Mass	infinite	(Kg)
In Source NAPL, Soil		

View of Plume Looking Down

1200

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

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	100	200	300	400	500	600	700	800	900	1000

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | View Output

RUN ARRAY | View Output

Help | Recalculate This Sheet

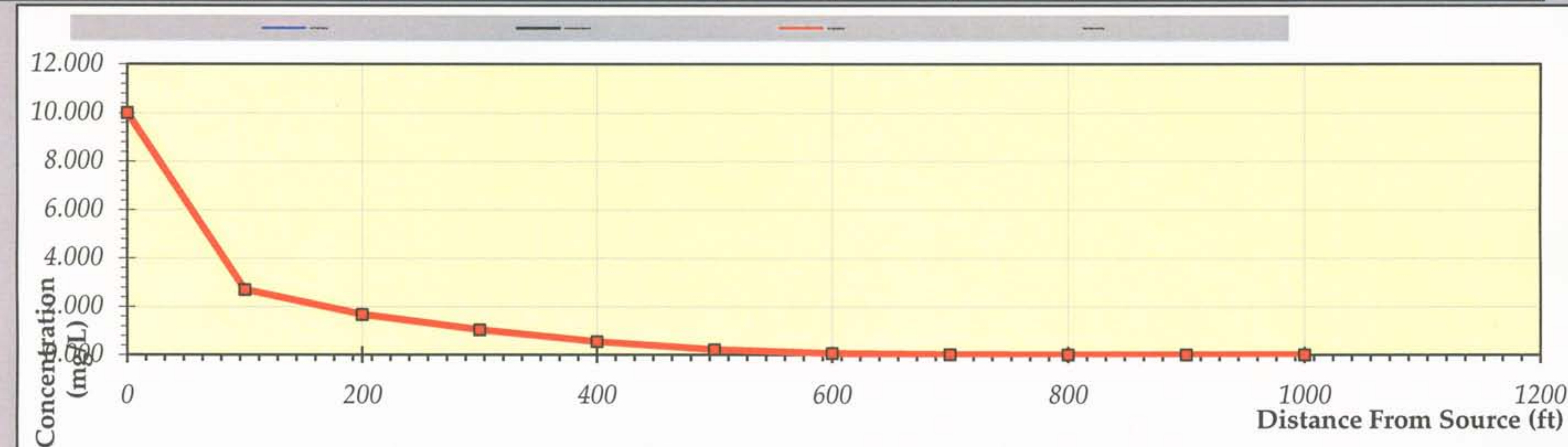
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED ARSENIC CONCENTRATION ALONG PLUME CENTERLINE TO NORTH (10 mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	10.000	2.696	1.667	1.040	0.547	0.213	0.056	0.009	0.0010	0.000	0.000
1st Order Decay	10.000	2.696	1.667	1.040	0.547	0.213	0.056	0.009	0.0010	0.000	0.000
Inst. Reaction	10.000	2.696	1.667	1.040	0.547	0.213	0.056	0.009	0.0010	0.000	0.000
Field Data from Site											



Calculate Animation

Time:
34.30 Years

Return to Input

Recalculate This Sheet

APPENDIX E

BASELINE CONSERVATIVE CASE

BASELINE CONSERVATIVE CASE TO SOUTH

APPENDIX E-1

SOUTH COMPLIANCE BOUNDARY

METHYLENE CHLORIDE

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Landsburg Mine
Baseline Conservative Case
Methylene Chloride To South

Data Input Instructions:

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

1. HYDROGEOLOGY

Seepage Velocity*	Vs	664.0	(ft/yr)
or		↑ or	
Hydraulic Conductivity	K	8.5E-01	(cm/sec)
Hydraulic Gradient	i	0.00029	(ft/ft)
Porosity	n	0.31	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	40.8	(ft)
Transverse Dispersivity*	alpha y	4.08	
Vertical Dispersivity*	alpha z	0.24	(ft)
or		↑ or	
Estimated Plume Length	Lp	800	(ft)

3. ADSORPTION

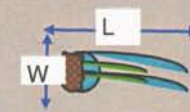
Retardation Factor*	R	14.0	(-)
or		↑ or	
Soil Bulk Density	rho	1.4	(kg/l)
Partition Coefficient	Koc	10	(L/kg)
FractionOrganicCarbon	foc	2.3E+0	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-8	(per yr)
or		↑ or	
Solute Half-Life	t-half	#######	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	2870	(ft)
Modeled Area Width*	15	(ft)
Simulation Time*	17.60	(yr)



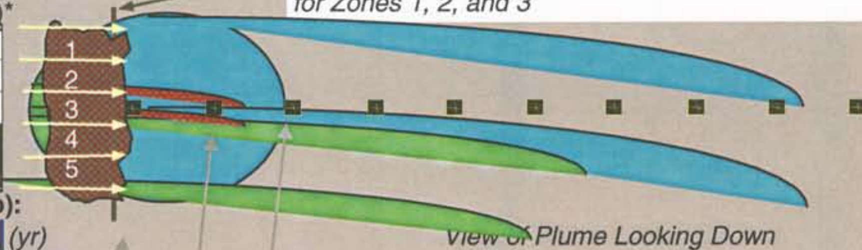
6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	10
3	10
3	10
3	10
3	10

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



View of Plume Looking Down

1200

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

Source Halflife (see Help):

Infinite	Infinite	(yr)
Inst. React.	1st Order	
Soluble Mass	infinite	(Kg)
In Source NAPL, Soil		

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	287	574	861	1148	1435	1722	2009	2296	2583	2870

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE

View Output

RUN ARRAY

View Output

Help

Recalculate This Sheet

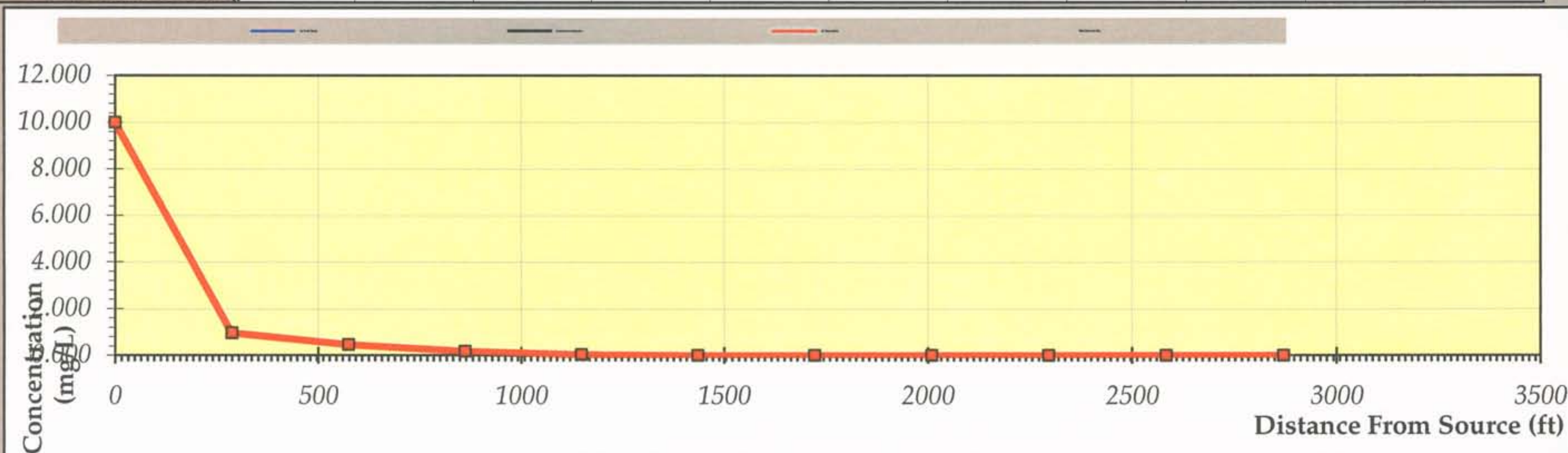
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED METHYLENE CHLORIDE CONCENTRATION ALONG PLUME CENTERLINE TO SOUTH (10 mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	287	574	861	1148	1435	1722	2009	2296	2583	2870
No Degradation	10.000	0.966	0.465	0.177	0.034	0.003	0.00007	0.000	0.000	0.000	0.000
1st Order Decay	10.000	0.966	0.465	0.177	0.034	0.003	0.00007	0.000	0.000	0.000	0.000
Inst. Reaction	10.000	0.966	0.465	0.177	0.034	0.003	0.00007	0.000	0.000	0.000	0.000
Field Data from Site											



Calculate Animation

Time:

17.60 Years

Return to Input

Recalculate This Sheet

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Landsburg Mine
Baseline Conservative Case
Methylene Chloride To South

Data Input Instructions:

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

1. HYDROGEOLOGY

Seepage Velocity*	Vs	664.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	8.5E-01	(cm/sec)
Hydraulic Gradient	i	0.00029	(ft/ft)
Porosity	n	0.31	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	40.8	(ft)
Transverse Dispersivity*	alpha y	4.08	`
Vertical Dispersivity*	alpha z	0.24	(ft)
or		or	
Estimated Plume Length	Lp	800	(ft)

3. ADSORPTION

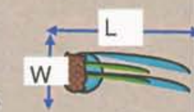
Retardation Factor*	R	14.0	(-)
or		or	
Soil Bulk Density	rho	1.4	(kg/l)
Partition Coefficient	Koc	10	(L/kg)
FractionOrganicCarbon	foc	2.3E+0	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-8	(per yr)
or		or	
Solute Half-Life	t-half	#######	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	2870	(ft)
Modeled Area Width*	15	(ft)
Simulation Time*	26.10	(yr)



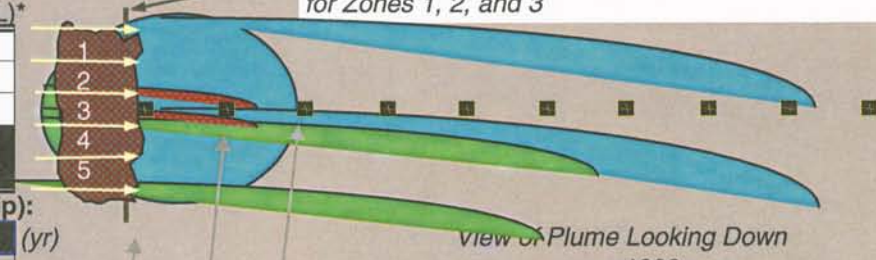
6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

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

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	10
3	10
3	10
3	10
3	10



Source Halflife (see Help):

Infinite	Infinite	(yr)
Inst. React.	1st Order	
Soluble Mass	infinite	(Kg)
In Source NAPL, Soil		

1200

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

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	287	574	861	1148	1435	1722	2009	2296	2583	2870

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE

View Output

RUN ARRAY

View Output

Help

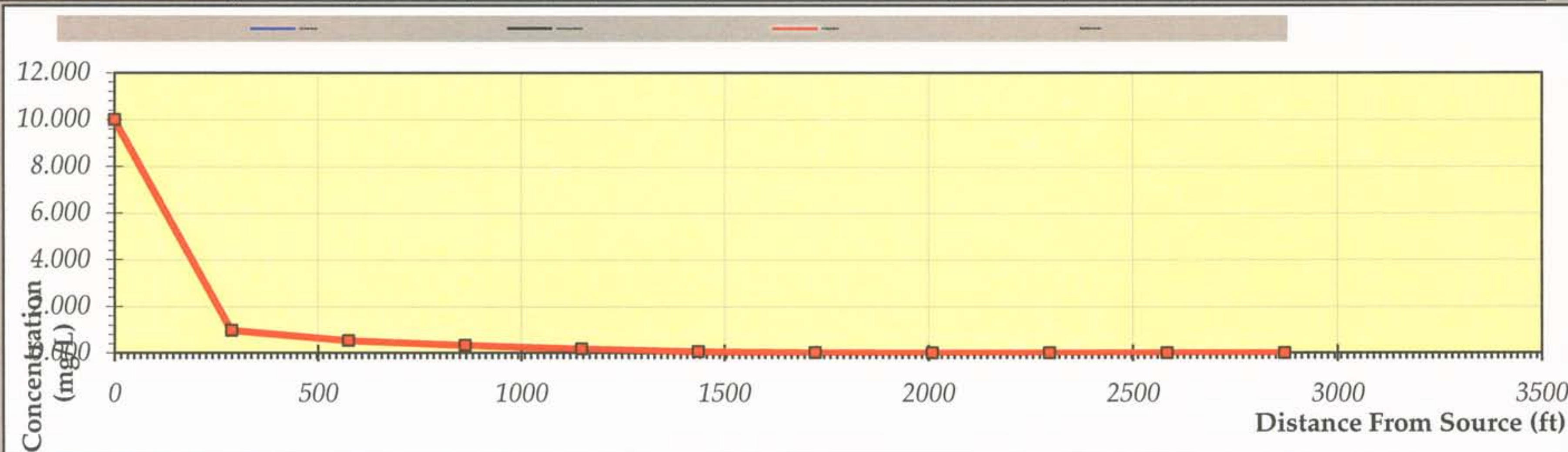
Recalculate This Sheet

Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED METHYLENE CHLORIDE CONCENTRATION ALONG PLUME CENTERLINE TO SOUTH (10 mg/L at Z=0)

TYPE OF MODEL	Distance from Source (ft) 0	287	574	861	1148	1435	1722	2009	2296	2583	2870
No Degradation	10.000	0.982	0.543	0.339	0.180	0.064	0.013	0.001	0.00007	0.000	0.000
1st Order Decay	10.000	0.982	0.543	0.339	0.180	0.064	0.013	0.001	0.00007	0.000	0.000
Inst. Reaction	10.000	0.982	0.543	0.339	0.180	0.064	0.013	0.001	0.00007	0.000	0.000
Field Data from Site											



Calculate Animation

Time:

26.10 Years

Return to Input

Recalculate This Sheet

VINYL CHLORIDE

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Landsburg Mine
Baseline Conservative Case
Vinyl Chloride To South

Data Input Instructions:

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

1. HYDROGEOLOGY

Seepage Velocity*	Vs	664.0	(ft/yr)
or		↑ or	
Hydraulic Conductivity	K	8.5E-01	(cm/sec)
Hydraulic Gradient	i	0.00029	(ft/ft)
Porosity	n	0.31	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	40.8	(ft)
Transverse Dispersivity*	alpha y	4.08	`
Vertical Dispersivity*	alpha z	0.24	(ft)
or		↑ or	
Estimated Plume Length	Lp	800	(ft)

3. ADSORPTION

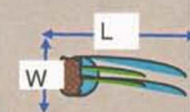
Retardation Factor*	R	29.0	(-)
or		↑ or	
Soil Bulk Density	rho	1.4	(kg/l)
Partition Coefficient	Koc	30	(L/kg)
FractionOrganicCarbon	foc	2.3E+0	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-8	(per yr)
or		↑ or	
Solute Half-Life	t-half	#######	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	2870	(ft)
Modeled Area Width*	15	(ft)
Simulation Time*	34.00	(yr)



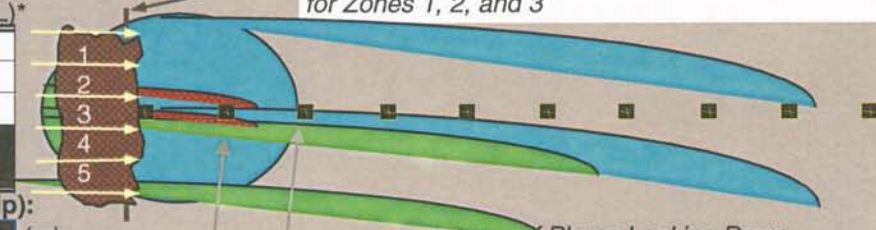
6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

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

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	28
3	28
3	28
3	28
3	28



Source Halflife (see Help):

Infinite	Infinite	(yr)
Inst. React. ↑	↑ 1st Order	
Soluble Mass	infinite	(Kg)
In Source NAPL, Soil		

1200

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

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	287	574	861	1148	1435	1722	2009	2296	2583	2870

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE

View Output

RUN ARRAY

View Output

Help

Recalculate This Sheet

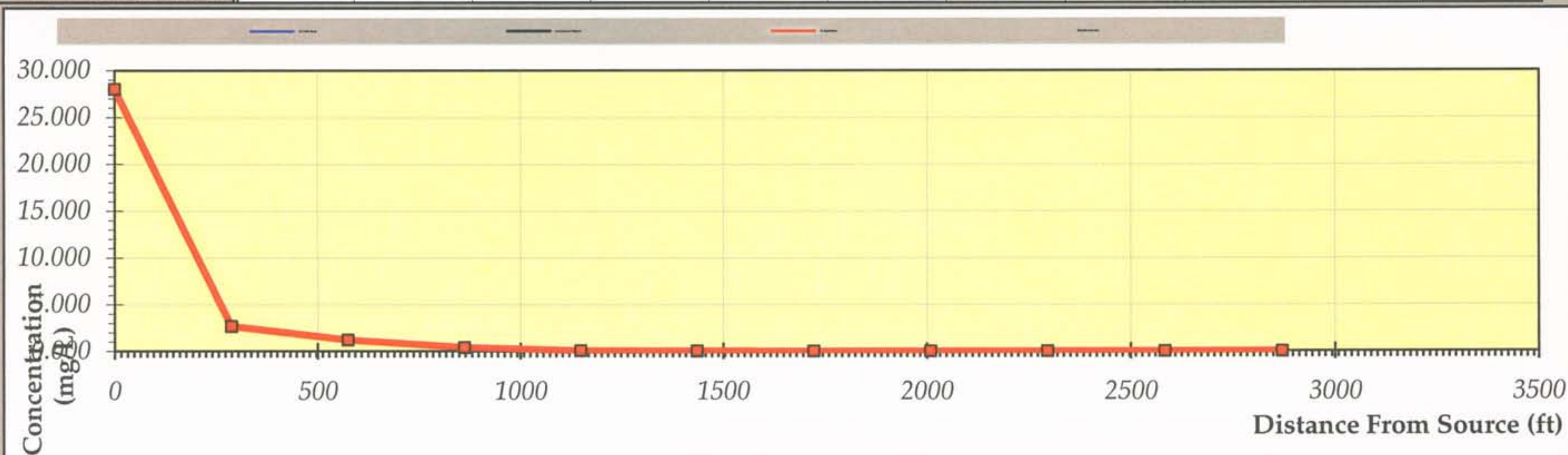
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED VINYL CHLORIDE CONCENTRATION ALONG PLUME CENTERLINE TO SOUTH (28 mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	287	574	861	1148	1435	1722	2009	2296	2583	2870
No Degradation	28.000	2.684	1.226	0.400	0.059	0.003	0.00005	0.000	0.000	0.000	0.000
1st Order Decay	28.000	2.684	1.226	0.400	0.059	0.003	0.00005	0.000	0.000	0.000	0.000
Inst. Reaction	28.000	2.684	1.226	0.400	0.059	0.003	0.00005	0.000	0.000	0.000	0.000
Field Data from Site											



Calculate Animation

Time:

34.00 Years

Return to Input

Recalculate This Sheet

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Landsburg Mine

Baseline Conservative Case

Vinyl Chloride To South

Data Input Instructions:

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

1. HYDROGEOLOGY

Seepage Velocity*	Vs	664.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	8.5E-01	(cm/sec)
Hydraulic Gradient	i	0.00029	(ft/ft)
Porosity	n	0.31	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	40.8	(ft)
Transverse Dispersivity*	alpha y	4.08	
Vertical Dispersivity*	alpha z	0.24	(ft)
or		or	
Estimated Plume Length	Lp	800	(ft)

3. ADSORPTION

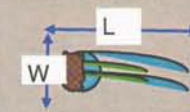
Retardation Factor*	R	29.0	(-)
or		or	
Soil Bulk Density	rho	1.4	(kg/l)
Partition Coefficient	Koc	30	(L/kg)
FractionOrganicCarbon	foc	2.3E+0	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-8	(per yr)
or		or	
Solute Half-Life	t-half	#######	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	2870	(ft)
Modeled Area Width*	15	(ft)
Simulation Time*	51.00	(yr)



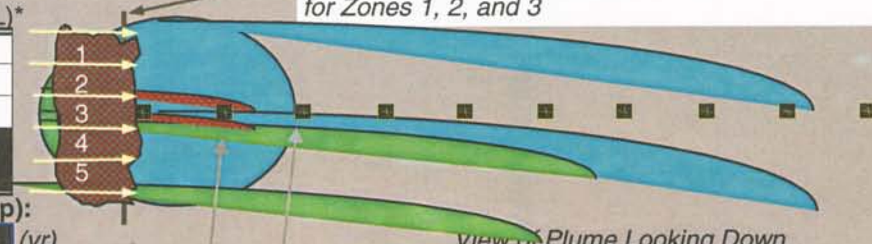
6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	28
3	28
3	28
3	28
3	28

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



View of Plume Looking Down

1200

Observed Centerline Concentrations at Monitoring Wells

If No Data Leave Blank or Enter "0"

Source Halflife (see Help):

Infinite	Infinite	(yr)
Inst. React.	1st Order	
Soluble Mass	infinite	(Kg)
In Source NAPL, Soil		

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	287	574	861	1148	1435	1722	2009	2296	2583	2870

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE

View Output

RUN ARRAY

View Output

Help

Recalculate This Sheet

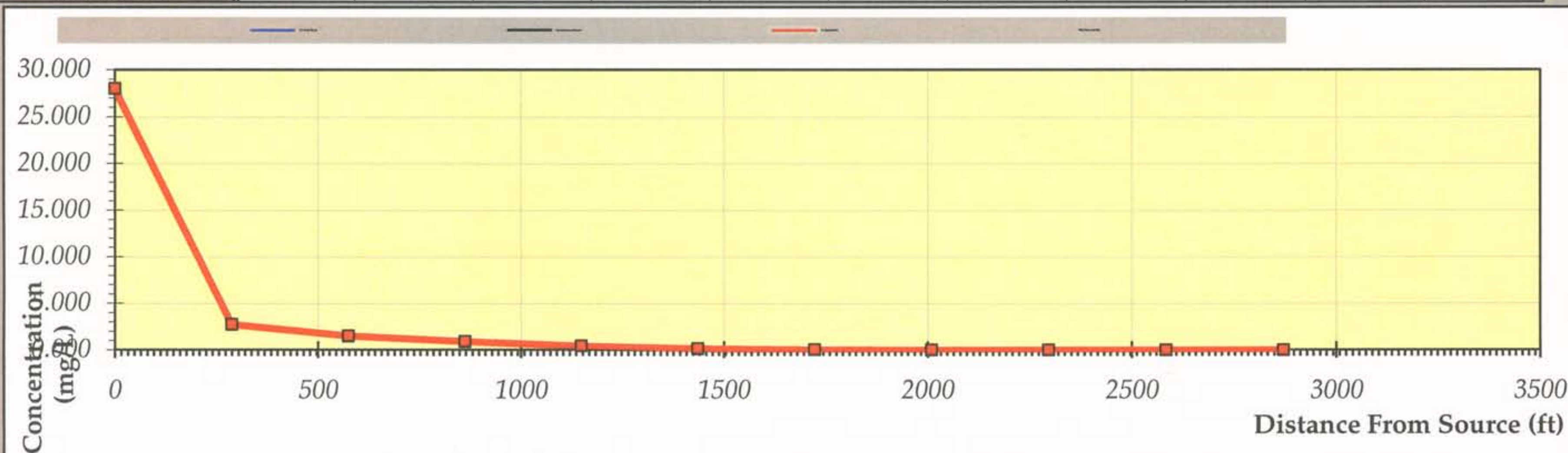
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED VINYL CHLORIDE CONCENTRATION ALONG PLUME CENTERLINE TO SOUTH (28 mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	287	574	861	1148	1435	1722	2009	2296	2583	2870
No Degradation	28.000	2.749	1.507	0.904	0.434	0.129	0.020	0.002	0.00005	0.000	0.000
1st Order Decay	28.000	2.749	1.507	0.904	0.434	0.129	0.020	0.002	0.00005	0.000	0.000
Inst. Reaction	28.000	2.749	1.507	0.904	0.434	0.129	0.020	0.002	0.00005	0.000	0.000
Field Data from Site											



Calculate Animation

Time:

51.00 Years

Return to Input

Recalculate This Sheet

1,4-DIOXANE

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Landsburg Mine
Baseline Conservative Case
1,4-Doixane To South

Data Input Instructions:

115 — 1. *Enter value directly....or*
↑ *or* 2. *Calculate by filling in grey*
0.02 *cells below. (To restore formulas, hit button below).*

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

1. HYDROGEOLOGY

Seepage Velocity*	*Vs*	664.0	*(ft/yr)*
or		↑ *or*	
Hydraulic Conductivity	*K*	8.5E-01	*(cm/sec)*
Hydraulic Gradient	*i*	0.00029	*(ft/ft)*
Porosity	*n*	0.31	*(-)*

2. DISPERSION

Longitudinal Dispersivity*	*alpha x*	40.8	*(ft)*
Transverse Dispersivity*	*alpha y*	4.08	`
Vertical Dispersivity*	*alpha z*	0.24	*(ft)*
or		↑ *or*	
Estimated Plume Length	*Lp*	800	*(ft)*

3. ADSORPTION

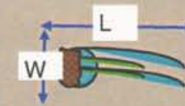
Retardation Factor*	*R*	17.0	*(-)*
or		↑ *or*	
Soil Bulk Density	*rho*	1.4	*(kg/l)*
Partition Coefficient	*Koc*	17	*(L/kg)*
FractionOrganicCarbon	*foc*	2.3E+0	*(-)*

4. BIODEGRADATION

1st Order Decay Coeff*	*lambda*	6.9E-8	*(per yr)*
or		↑ *or*	
Solute Half-Life	*t-half*	#######	*(year)*
or Instantaneous Reaction Model			
Delta Oxygen*	*DO*		*(mg/L)*
Delta Nitrate*	*NO3*		*(mg/L)*
Observed Ferrous Iron*	*Fe2+*		*(mg/L)*
Delta Sulfate*	*SO4*		*(mg/L)*
Observed Methane*	*CH4*		*(mg/L)*

5. GENERAL

Modeled Area Length*	2870	*(ft)*
Modeled Area Width*	15	*(ft)*
Simulation Time*	23.40	*(yr)*



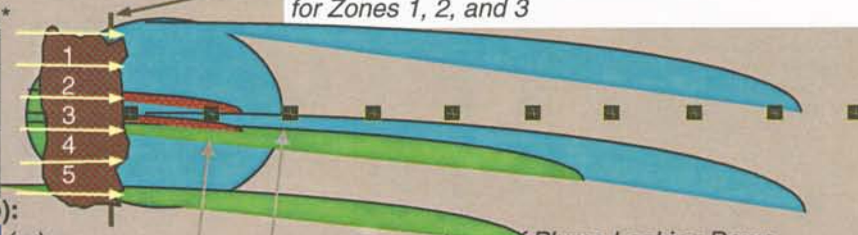
6. SOURCE DATA

Source Thickness in Sat.Zone* 15 *(ft)*

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	10
3	10
3	10
3	10
3	10

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



Source Halflife (see Help):

Infinite	Infinite	*(yr)*
Inst. React. ↑	↑ 1st Order	
Soluble Mass	infinite	*(Kg)*
In Source NAPL, Soil		

View of Plume Looking Down

1200

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

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	*0*	*287*	*574*	*861*	*1148*	*1435*	*1722*	*2009*	*2296*	*2583*	*2870*

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE

View Output

RUN ARRAY

View Output

Help

Recalculate This Sheet

Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED 1,4-DIOXANE CONCENTRATION ALONG PLUME CENTERLINE TO SOUTH (10 mg/L at Z=0)

	Distance from Source (ft)										
TYPE OF MODEL	0	287	574	861	1148	1435	1722	2009	2296	2583	2870
No Degradation	10.000	0.973	0.494	0.222	0.058	0.007	0.00031	0.000	0.000	0.000	0.000
1st Order Decay	10.000	0.973	0.494	0.222	0.058	0.007	0.00031	0.000	0.000	0.000	0.000
Inst. Reaction	10.000	0.973	0.494	0.222	0.058	0.007	0.00031	0.000	0.000	0.000	0.000
Field Data from Site											

Calculate Animation

Time: 23.40 Years

Return to Input

Recalculate This Sheet

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Landsburg Mine
Baseline Conservative Case
1,4-Dioxane To South

Data Input Instructions:

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

1. HYDROGEOLOGY

Seepage Velocity*	Vs	664.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	8.5E-01	(cm/sec)
Hydraulic Gradient	i	0.00029	(ft/ft)
Porosity	n	0.31	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	40.8	(ft)
Transverse Dispersivity*	alpha y	4.08	
Vertical Dispersivity*	alpha z	0.24	(ft)
or		or	
Estimated Plume Length	Lp	800	(ft)

3. ADSORPTION

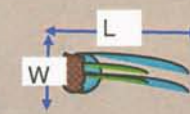
Retardation Factor*	R	17.0	(-)
or		or	
Soil Bulk Density	rho	1.4	(kg/l)
Partition Coefficient	Koc	17	(L/kg)
FractionOrganicCarbon	foc	2.3E+0	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-8	(per yr)
or		or	
Solute Half-Life	t-half	#######	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	2870	(ft)
Modeled Area Width*	15	(ft)
Simulation Time*	34.40	(yr)



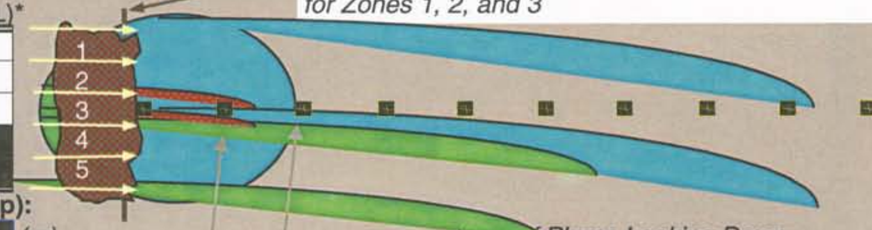
6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

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

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	10
3	10
3	10
3	10
3	10



Source Halflife (see Help):

Infinite	Infinite	(yr)
Inst. React.	1st Order	
Soluble Mass	infinite	(Kg)
In Source NAPL, Soil		

1200

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

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	287	574	861	1148	1435	1722	2009	2296	2583	2870

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE

View Output

RUN ARRAY

View Output

Help

Recalculate This Sheet

Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED 1,4-DIOXANE CONCENTRATION ALONG PLUME CENTERLINE TO SOUTH (10 mg/L at Z=0)

	Distance from Source (ft)										
TYPE OF MODEL	0	287	574	861	1148	1435	1722	2009	2296	2583	2870
No Degradation	10.000	0.983	0.548	0.357	0.213	0.093	0.025	0.004	0.00031	0.000	0.000
1st Order Decay	10.000	0.983	0.548	0.357	0.213	0.093	0.025	0.004	0.00031	0.000	0.000
Inst. Reaction	10.000	0.983	0.548	0.357	0.213	0.093	0.025	0.004	0.00031	0.000	0.000
Field Data from Site											

Calculate Animation

Time:
34.40 Years

Return to Input

Recalculate This Sheet

ARSENIC

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence *Version 1.4*

Landsburg Mine
Baseline Conservative Case
Arsenic To South

Data Input Instructions:

115 — 1. Enter value directly....or
or — 2. Calculate by filling in grey
0.02 — cells below. (To restore formulas, hit button below).

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

1. HYDROGEOLOGY

Seepage Velocity*	Vs	664.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	8.5E-01	(cm/sec)
Hydraulic Gradient	i	0.00029	(ft/ft)
Porosity	n	0.31	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	40.8	(ft)
Transverse Dispersivity*	alpha y	4.08	
Vertical Dispersivity*	alpha z	0.24	(ft)
or		or	
Estimated Plume Length	Lp	800	(ft)

3. ADSORPTION

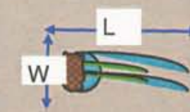
Retardation Factor*	R	70.0	(-)
or		or	
Soil Bulk Density	rho	1.4	(kg/l)
Partition Coefficient	Koc	NA	(L/kg)
FractionOrganicCarbon	foc	2.3E+0	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-8	(per yr)
or		or	
Solute Half-Life	t-half	#######	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	2870	(ft)
Modeled Area Width*	15	(ft)
Simulation Time*	129.00	(yr)



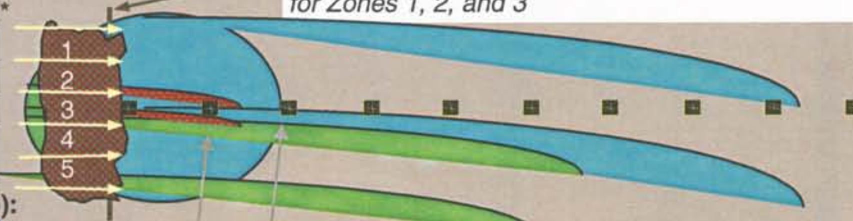
6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	0.8914
3	0.8914
3	0.8914
3	0.8914
3	0.8914

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



View of Plume Looking Down

1200

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

Source Halflife (see Help):

Infinite	Infinite	(yr)
Inst. React.	1st Order	
Soluble Mass	infinite	(Kg)
In Source NAPL, Soil		

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	287	574	861	1148	1435	1722	2009	2296	2583	2870

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | View Output

RUN ARRAY | View Output

Help

Recalculate This Sheet

Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED ARSENIC CONCENTRATION ALONG PLUME CENTERLINE TO SOUTH (0.8914 mg/L at Z=0)

TYPE OF MODEL	0	287	574	861	1148	1435	1722	2009	2296	2583	2870
	Distance from Source (ft)										
No Degradation	0.891	0.088	0.048	0.030	0.016	0.005	0.0010	0.000	0.000	0.000	0.000
1st Order Decay	0.891	0.088	0.048	0.030	0.016	0.005	0.0010	0.000	0.000	0.000	0.000
Inst. Reaction	0.891	0.088	0.048	0.030	0.016	0.005	0.0010	0.000	0.000	0.000	0.000
Field Data from Site											

Calculate Animation

Time:

129.00 Years

Return to Input

Recalculate This Sheet

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence — *Version 1.4*

Landsburg Mine
Baseline Conservative Case
Arsenic To South

Data Input Instructions:

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

1. HYDROGEOLOGY

Seepage Velocity*	Vs	664.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	8.5E-01	(cm/sec)
Hydraulic Gradient	i	0.00029	(ft/ft)
Porosity	n	0.31	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	40.8	(ft)
Transverse Dispersivity*	alpha y	4.08	
Vertical Dispersivity*	alpha z	0.24	(ft)
or		or	
Estimated Plume Length	Lp	800	(ft)

3. ADSORPTION

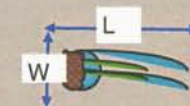
Retardation Factor*	R	70.0	(-)
or		or	
Soil Bulk Density	rho	1.4	(kg/l)
Partition Coefficient	Koc	NA	(L/kg)
FractionOrganicCarbon	foc	2.3E+0	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-8	(per yr)
or		or	
Solute Half-Life	t-half	#######	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	2870	(ft)
Modeled Area Width*	15	(ft)
Simulation Time*	185.00	(yr)



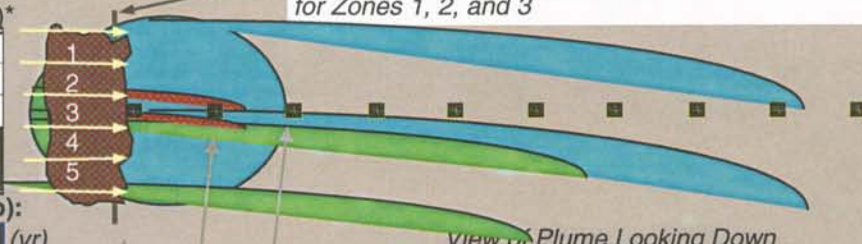
6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

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

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	0.8914
3	0.8914
3	0.8914
3	0.8914
3	0.8914



Source Halflife (see Help):

	Infinite	Infinite	(yr)
Inst. React.		1st Order	
Soluble Mass		infinite	(Kg)
In Source NAPL, Soil			

1200

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

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	287	574	861	1148	1435	1722	2009	2296	2583	2870

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — View Output

RUN ARRAY — View Output

Help

Recalculate This Sheet

Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED ARSENIC CONCENTRATION ALONG PLUME CENTERLINE TO SOUTH (0.8914 mg/L at Z=0)

TYPE OF MODEL	Distance from Source (ft)										
	0	287	574	861	1148	1435	1722	2009	2296	2583	2870
No Degradation	0.891	0.088	0.049	0.034	0.025	0.017	0.010	0.004	0.0010	0.000	0.000
1st Order Decay	0.891	0.088	0.049	0.034	0.025	0.017	0.010	0.004	0.0010	0.000	0.000
Inst. Reaction	0.891	0.088	0.049	0.034	0.025	0.017	0.010	0.004	0.0010	0.000	0.000
Field Data from Site											

Calculate Animation

Time:

185.00 Years

Return to Input

Recalculate This Sheet

APPENDIX E-2

NORTH COMPLIANCE BOUNDARY

METHYLENE CHLORIDE

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence *Version 1.4*

Landsburg Mine
Baseline Conservative Case
Methylene Chloride To North

Data Input Instructions:

115 — 1. Enter value directly....or
or — 2. Calculate by filling in grey cells below. (To restore formulas, hit button below).
0.02

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

1. HYDROGEOLOGY

Seepage Velocity*	Vs	830.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	8.5E-01	(cm/sec)
Hydraulic Gradient	i	0.00036	(ft/ft)
Porosity	n	0.31	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	31.7	(ft)
Transverse Dispersivity*	alpha y	3.12	
Vertical Dispersivity*	alpha z	0.31	(ft)
or		or	
Estimated Plume Length	Lp	1200	(ft)

3. ADSORPTION

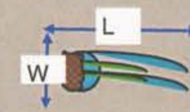
Retardation Factor*	R	14.0	(-)
or		or	
Soil Bulk Density	rho	1.4	(kg/l)
Partition Coefficient	Koc	10	(L/kg)
FractionOrganicCarbon	foc	4.6E-1	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-8	(per yr)
or		or	
Solute Half-Life	t-half	#######	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	1500	(ft)
Modeled Area Width*	15	(ft)
Simulation Time*	6.10	(yr)



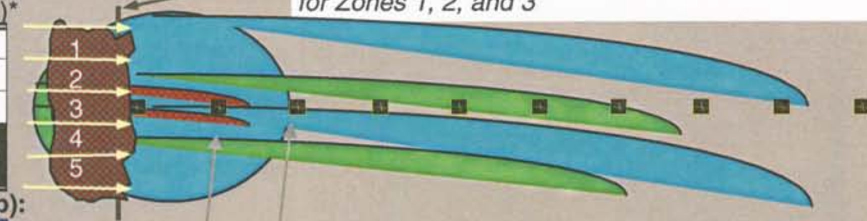
6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	10
3	10
3	10
3	10
3	10

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



Source Halflife (see Help):

Infinite	Infinite	(yr)
Inst. React.	1st Order	
Soluble Mass	infinite	(Kg)

In Source NAPL, Soil

View of Plume Looking Down

1200

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

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	150	300	450	600	750	900	1050	1200	1350	1500

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — View Output

RUN ARRAY — View Output

Help

Recalculate This Sheet

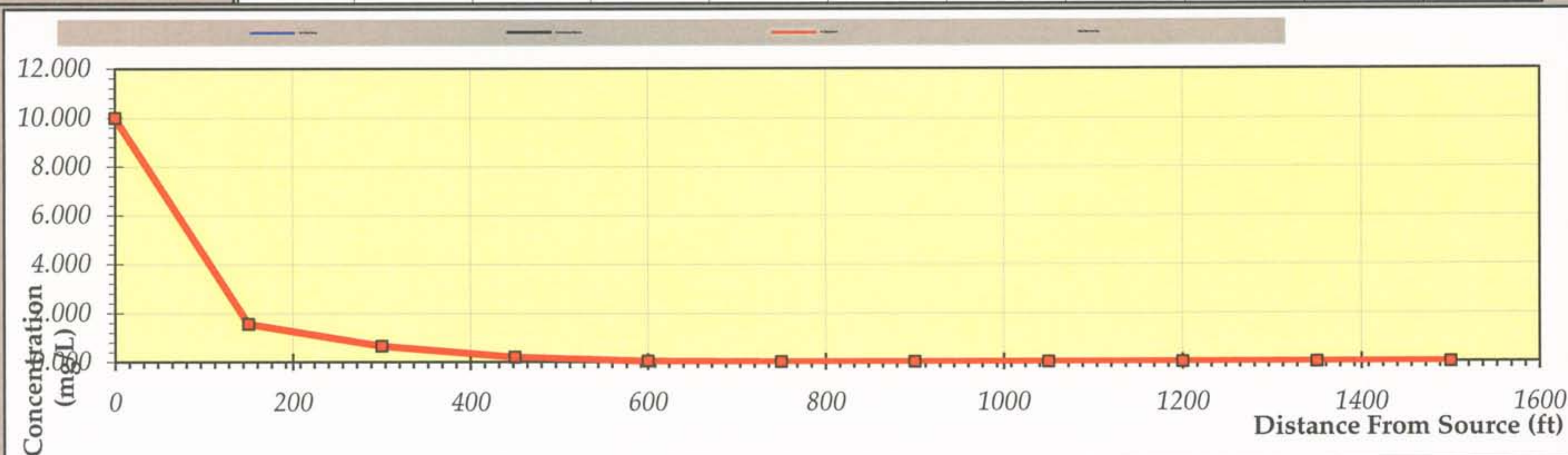
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED METHYLENE CHLORIDE CONCENTRATION ALONG PLUME CENTERLINE TO NORTH (10 mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	150	300	450	600	750	900	1050	1200	1350	1500
No Degradation	10.000	1.564	0.658	0.198	0.032	0.002	0.00007	0.000	0.000	0.000	0.000
1st Order Decay	10.000	1.564	0.658	0.198	0.032	0.002	0.00007	0.000	0.000	0.000	0.000
Inst. Reaction	10.000	1.564	0.658	0.198	0.032	0.002	0.00007	0.000	0.000	0.000	0.000
Field Data from Site											



Calculate Animation

Time:

6.10 Years

Return to Input

Recalculate This Sheet

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence *Version 1.4*

Landsburg Mine

Baseline Conservative Case

Methylene Chloride To North

Data Input Instructions:

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

1. HYDROGEOLOGY

Seepage Velocity*	Vs	830.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	8.5E-01	(cm/sec)
Hydraulic Gradient	i	0.00036	(ft/ft)
Porosity	n	0.31	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	31.7	(ft)
Transverse Dispersivity*	alpha y	3.12	
Vertical Dispersivity*	alpha z	0.31	(ft)
or		or	
Estimated Plume Length	Lp	1200	(ft)

3. ADSORPTION

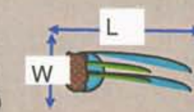
Retardation Factor*	R	14.0	(-)
or		or	
Soil Bulk Density	rho	1.4	(kg/l)
Partition Coefficient	Koc	10	(L/kg)
FractionOrganicCarbon	foc	4.6E-1	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-8	(per yr)
or		or	
Solute Half-Life	t-half	#######	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	1500	(ft)
Modeled Area Width*	15	(ft)
Simulation Time*	9.30	(yr)



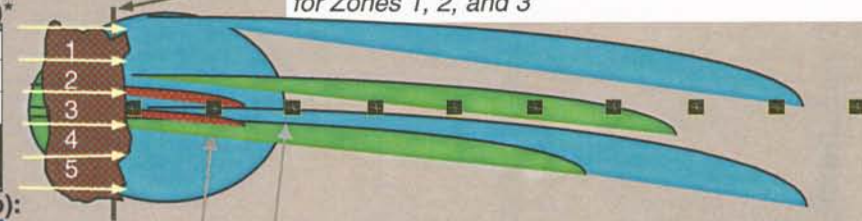
6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

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

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	10
3	10
3	10
3	10
3	10



Source Halflife (see Help):

Infinite	Infinite	(yr)
Inst. React.	1st Order	
Soluble Mass	infinite	(Kg)
In Source NAPL, Soil		

View of Plume Looking Down

1200

Observed Centerline Concentrations at Monitoring Wells

If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	150	300	450	600	750	900	1050	1200	1350	1500

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE

View Output

RUN ARRAY

View Output

Help

Recalculate This Sheet

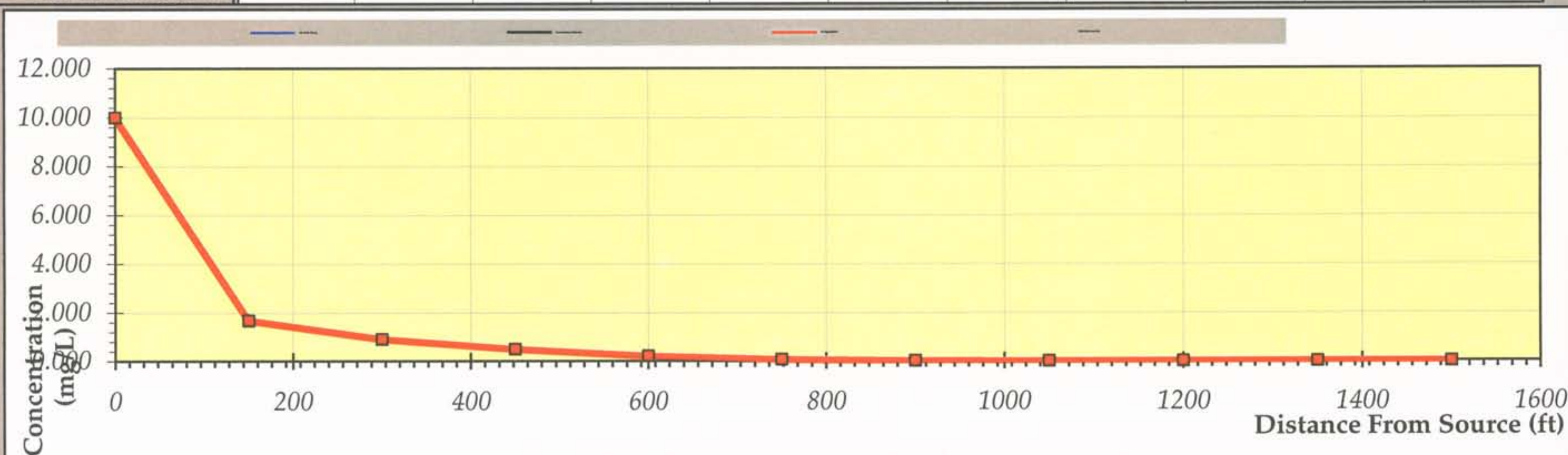
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED METHYLENE CHLORIDE CONCENTRATION ALONG PLUME CENTERLINE TO NORTH (10 mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	150	300	450	600	750	900	1050	1200	1350	1500
No Degradation	10.000	1.675	0.911	0.500	0.218	0.064	0.012	0.001	0.00007	0.000	0.000
1st Order Decay	10.000	1.675	0.911	0.500	0.218	0.064	0.012	0.001	0.00007	0.000	0.000
Inst. Reaction	10.000	1.675	0.911	0.500	0.218	0.064	0.012	0.001	0.00007	0.000	0.000
Field Data from Site											



Calculate Animation

Time:

9.30 Years

Return to Input

Recalculate This Sheet

VINYL CHLORIDE

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence *Version 1.4*

Landsburg Mine
Baseline Conservative Case
Vinyl Chloride To North

Data Input Instructions:

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

1. HYDROGEOLOGY

Seepage Velocity*	Vs	830.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	8.5E-01	(cm/sec)
Hydraulic Gradient	i	0.00036	(ft/ft)
Porosity	n	0.31	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	31.7	(ft)
Transverse Dispersivity*	alpha y	3.12	
Vertical Dispersivity*	alpha z	0.31	(ft)
or		or	
Estimated Plume Length	Lp	1200	(ft)

3. ADSORPTION

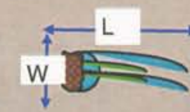
Retardation Factor*	R	29.0	(-)
or		or	
Soil Bulk Density	rho	1.4	(kg/l)
Partition Coefficient	Koc	30	(L/kg)
FractionOrganicCarbon	foc	4.6E-1	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-8	(per yr)
or		or	
Solute Half-Life	t-half	#######	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	1500	(ft)
Modeled Area Width*	15	(ft)
Simulation Time*	11.60	(yr)



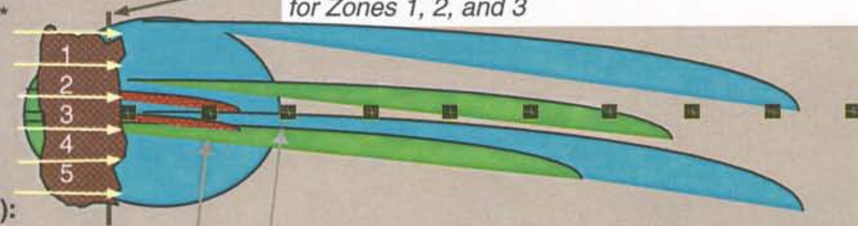
6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

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

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	28
3	28
3	28
3	28
3	28



Source Halflife (see Help):

Infinite	Infinite	(yr)
Inst. React.	1st Order	
Soluble Mass	infinite	(Kg)

In Source NAPL, Soil

View of Plume Looking Down

1200

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

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	150	300	450	600	750	900	1050	1200	1350	1500

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE

View Output

RUN ARRAY

View Output

Help

Recalculate This Sheet

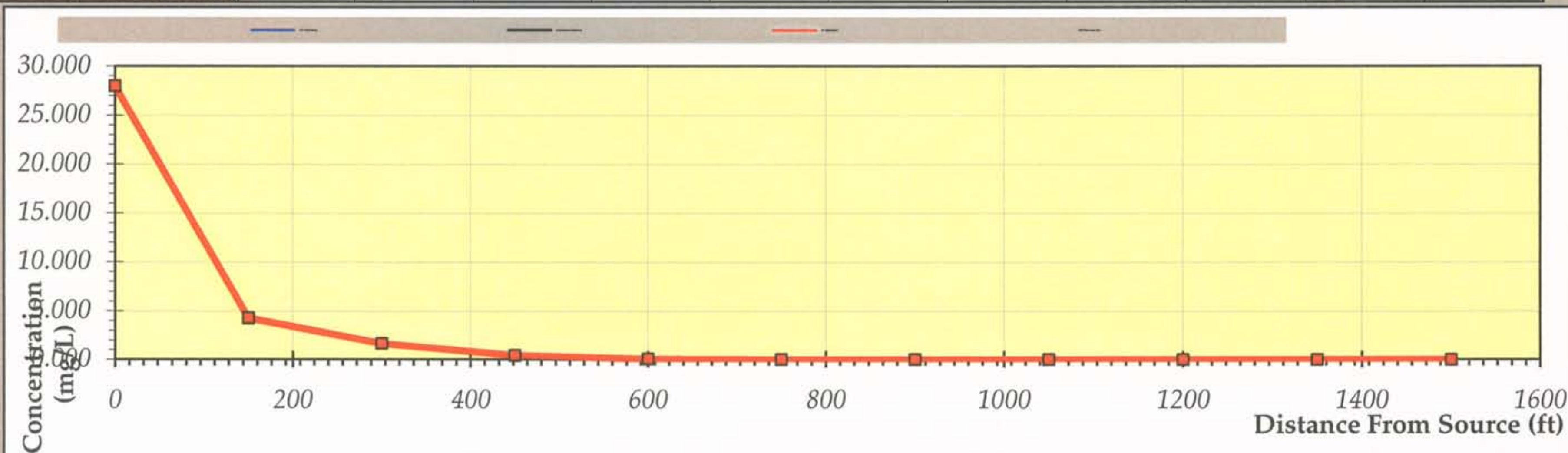
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED VINYL CHLORIDE CONCENTRATION ALONG PLUME CENTERLINE TO NORTH (28 mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	150	300	450	600	750	900	1050	1200	1350	1500
No Degradation	28.000	4.267	1.645	0.412	0.050	0.002	0.00005	0.000	0.000	0.000	0.000
1st Order Decay	28.000	4.267	1.645	0.412	0.050	0.002	0.00005	0.000	0.000	0.000	0.000
Inst. Reaction	28.000	4.267	1.645	0.412	0.050	0.002	0.00005	0.000	0.000	0.000	0.000
Field Data from Site											



Calculate Animation

Time:

11.60 Years

Return to Input

Recalculate This Sheet

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence | *Version 1.4*

Landsburg Mine
Baseline Conservative Case
Vinyl Chloride To North

Data Input Instructions:

115 — 1. Enter value directly....or
or — 2. Calculate by filling in grey
0.02 — cells below. (To restore formulas, hit button below).

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

1. HYDROGEOLOGY

Seepage Velocity*	Vs	830.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	8.5E-01	(cm/sec)
Hydraulic Gradient	i	0.00036	(ft/ft)
Porosity	n	0.31	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	31.7	(ft)
Transverse Dispersivity*	alpha y	3.12	`
Vertical Dispersivity*	alpha z	0.31	(ft)
or		or	
Estimated Plume Length	Lp	1200	(ft)

3. ADSORPTION

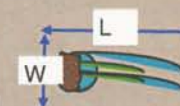
Retardation Factor*	R	29.0	(-)
or		or	
Soil Bulk Density	rho	1.4	(kg/l)
Partition Coefficient	Koc	30	(L/kg)
FractionOrganicCarbon	foc	4.6E-1	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-8	(per yr)
or		or	
Solute Half-Life	t-half	#######	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	1500	(ft)
Modeled Area Width*	15	(ft)
Simulation Time*	17.90	(yr)



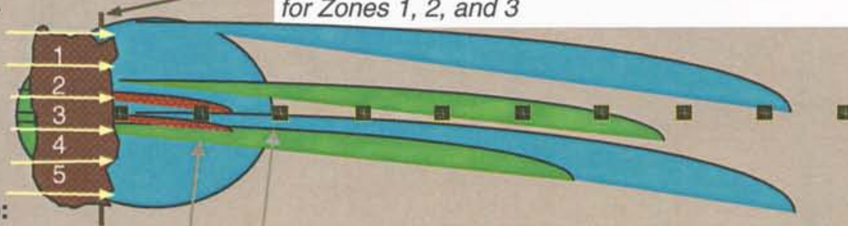
6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

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

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	28
3	28
3	28
3	28
3	28



Source Halflife (see Help):

Infinite	Infinite	(yr)
Inst. React.	1st Order	
Soluble Mass	infinite	(Kg)
In Source NAPL, Soil		

View of Plume Looking Down

1200

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

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	150	300	450	600	750	900	1050	1200	1350	1500

8. CHOOSE TYPE OF OUTPUT TO SEE:

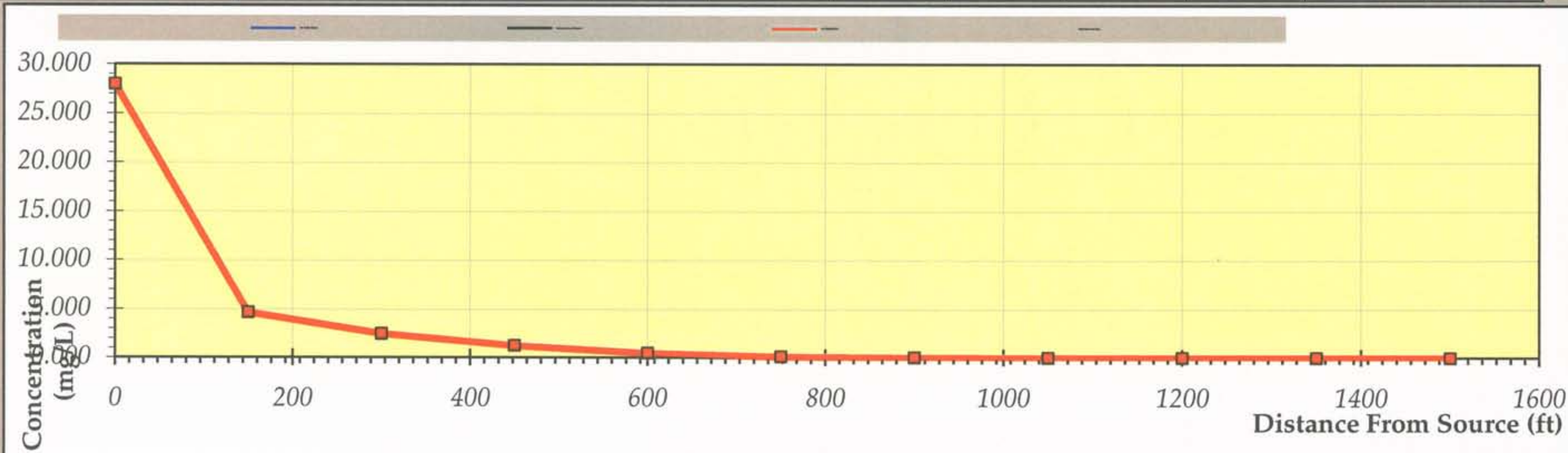
RUN CENTERLINE | **RUN ARRAY** | *Help* | Recalculate This Sheet

View Output | **View Output** | Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED VINYL CHLORIDE CONCENTRATION ALONG PLUME CENTERLINE TO NORTH (28 mg/L at Z=0)

TYPE OF MODEL	Distance from Source (ft)										
	0	150	300	450	600	750	900	1050	1200	1350	1500
No Degradation	28.000	4.660	2.467	1.260	0.481	0.117	0.017	0.001	0.00005	0.000	0.000
1st Order Decay	28.000	4.660	2.467	1.260	0.481	0.117	0.017	0.001	0.00005	0.000	0.000
Inst. Reaction	28.000	4.660	2.467	1.260	0.481	0.117	0.017	0.001	0.00005	0.000	0.000
Field Data from Site											



Calculate Animation

Time:

17.90 Years

Return to Input

Recalculate This Sheet

1,4-DIOXANE

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Landsburg Mine
Baseline Conservative Case
1,4-Dioxane To North

Data Input Instructions:

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

1. HYDROGEOLOGY

Seepage Velocity*	Vs	830.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	8.5E-01	(cm/sec)
Hydraulic Gradient	i	0.00036	(ft/ft)
Porosity	n	0.31	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	31.7	(ft)
Transverse Dispersivity*	alpha y	3.12	
Vertical Dispersivity*	alpha z	0.31	(ft)
or		or	
Estimated Plume Length	Lp	1200	(ft)

3. ADSORPTION

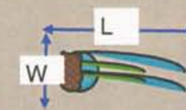
Retardation Factor*	R	17.0	(-)
or		or	
Soil Bulk Density	rho	1.4	(kg/l)
Partition Coefficient	Koc	17	(L/kg)
FractionOrganicCarbon	foc	4.6E-1	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-8	(per yr)
or		or	
Solute Half-Life	t-half	#######	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	1500	(ft)
Modeled Area Width*	15	(ft)
Simulation Time*	8.20	(yr)



6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	10
3	10
3	10
3	10
3	10

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

View of Plume Looking Down

Source Halflife (see Help):

Infinite	Infinite	(yr)
Inst. React.	1st Order	
Soluble Mass	infinite	(Kg)
In Source NAPL, Soil		

1200

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

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	150	300	450	600	750	900	1050	1200	1350	1500

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | **View Output**

RUN ARRAY | **View Output**

Help

Recalculate This Sheet

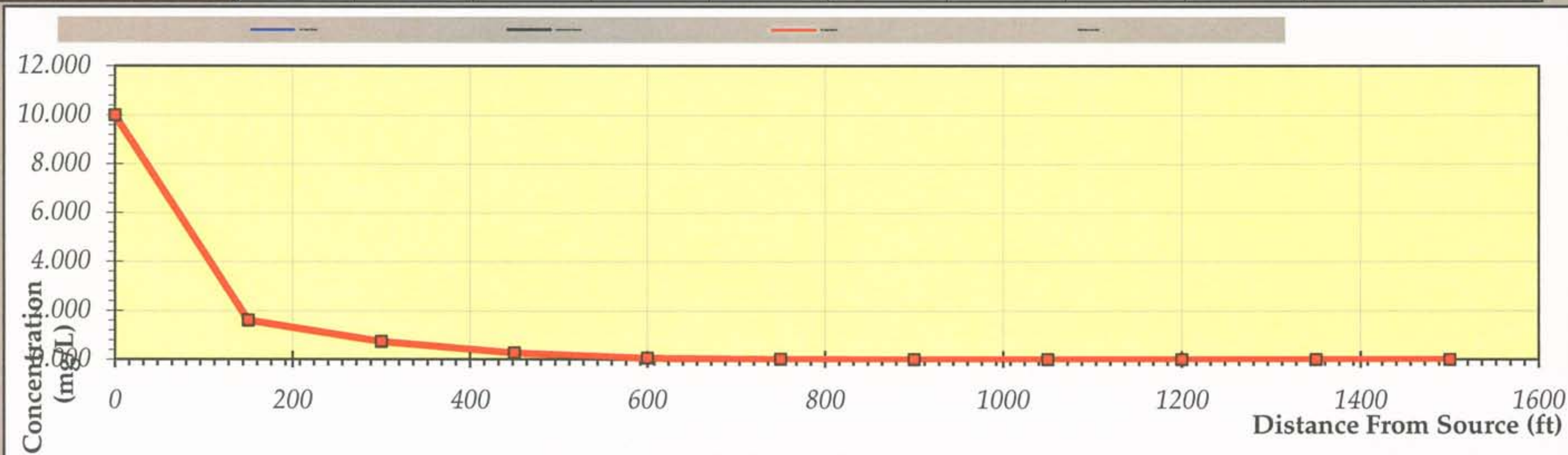
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED 1,4-DIOXANE CONCENTRATION ALONG PLUME CENTERLINE TO NORTH (10 mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	150	300	450	600	750	900	1050	1200	1350	1500
No Degradation	10.000	1.603	0.736	0.267	0.058	0.006	0.00032	0.000	0.000	0.000	0.000
1st Order Decay	10.000	1.603	0.736	0.267	0.058	0.006	0.00032	0.000	0.000	0.000	0.000
Inst. Reaction	10.000	1.603	0.736	0.267	0.058	0.006	0.00032	0.000	0.000	0.000	0.000
Field Data from Site											



Calculate Animation

Time:

8.20 Years

Return to Input

Recalculate This Sheet

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Landsburg Mine
Baseline Conservative Case
1,4-Dioxane To North

Data Input Instructions:

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

1. HYDROGEOLOGY

Seepage Velocity*	Vs	830.0	(ft/yr)
or		↑ or	
Hydraulic Conductivity	K	8.5E-01	(cm/sec)
Hydraulic Gradient	i	0.00036	(ft/ft)
Porosity	n	0.31	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	31.7	(ft)
Transverse Dispersivity*	alpha y	3.12	`
Vertical Dispersivity*	alpha z	0.31	(ft)
or		↑ or	
Estimated Plume Length	Lp	1200	(ft)

3. ADSORPTION

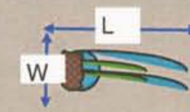
Retardation Factor*	R	17.0	(-)
or		↑ or	
Soil Bulk Density	rho	1.4	(kg/l)
Partition Coefficient	Koc	17	(L/kg)
FractionOrganicCarbon	foc	4.6E-1	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-8	(per yr)
or		↑ or	
Solute Half-Life	t-half	#######	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	1500	(ft)
Modeled Area Width*	15	(ft)
Simulation Time*	12.30	(yr)



6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

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

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	10
3	10
3	10
3	10
3	10

Source Halflife (see Help):

	Infinite	Infinite	(yr)
	Inst. React. ↑	↑ 1st Order	
Soluble Mass		infinite	(Kg)
In Source NAPL, Soil			

View of Plume Looking Down

1200

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

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	150	300	450	600	750	900	1050	1200	1350	1500

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE

View Output

RUN ARRAY

View Output

Help

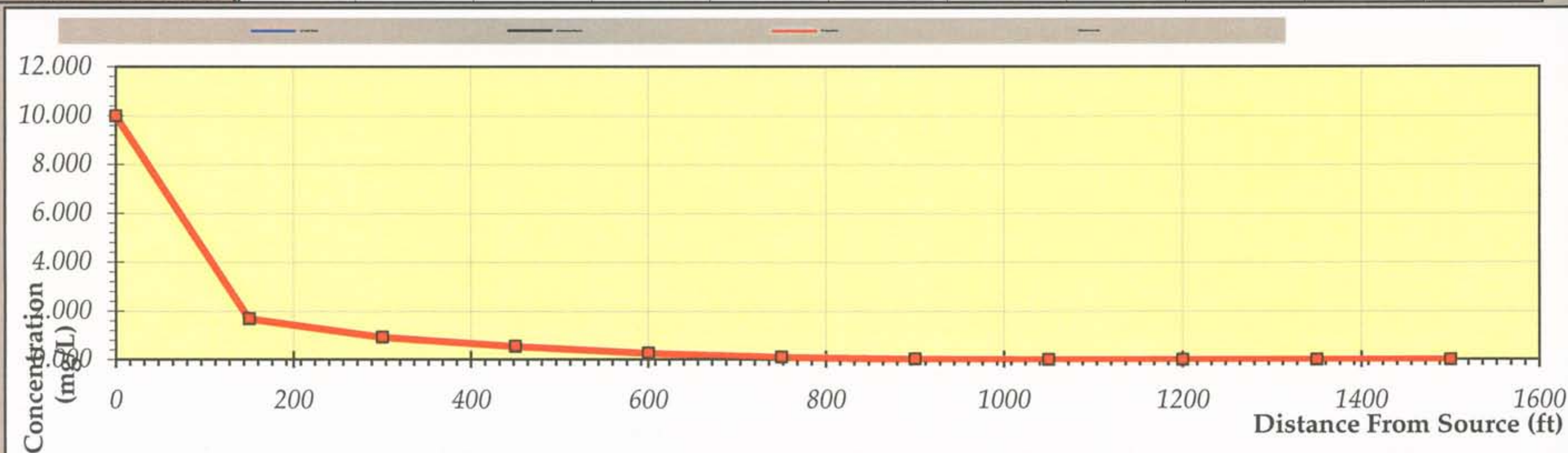
Recalculate This Sheet

Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED 1,4-DIOXANE CONCENTRATION ALONG PLUME CENTERLINE TO NORTH (10 mg/L at Z=0)

TYPE OF MODEL	Distance from Source (ft) 0	150	300	450	600	750	900	1050	1200	1350	1500
No Degradation	10.000	1.684	0.939	0.552	0.275	0.099	0.024	0.003	0.00030	0.000	0.000
1st Order Decay	10.000	1.684	0.939	0.552	0.275	0.099	0.024	0.003	0.00030	0.000	0.000
Inst. Reaction	10.000	1.684	0.939	0.552	0.275	0.099	0.024	0.003	0.00030	0.000	0.000
Field Data from Site											



Calculate Animation

Time:

12.30 Years

Return to Input

Recalculate This Sheet

ARSENIC

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Landsburg Mine
Baseline Conservative Case
Arsenic To North

Data Input Instructions:

115 — 1. Enter value directly....or
or — 2. Calculate by filling in grey
0.02 — cells below. (To restore formulas, hit button below).

Variable* — Data used directly in model.

20 — Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	830.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	8.5E-01	(cm/sec)
Hydraulic Gradient	i	0.00036	(ft/ft)
Porosity	n	0.31	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	31.7	(ft)
Transverse Dispersivity*	alpha y	3.12	
Vertical Dispersivity*	alpha z	0.31	(ft)
or		or	
Estimated Plume Length	Lp	1200	(ft)

3. ADSORPTION

Retardation Factor*	R	70.0	(-)
or		or	
Soil Bulk Density	rho	1.4	(kg/l)
Partition Coefficient	Koc	NA	(L/kg)
FractionOrganicCarbon	foc	4.6E-1	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-8	(per yr)
or		or	
Solute Half-Life	t-half	#######	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	1500	(ft)
Modeled Area Width*	15	(ft)
Simulation Time*	47.00	(yr)

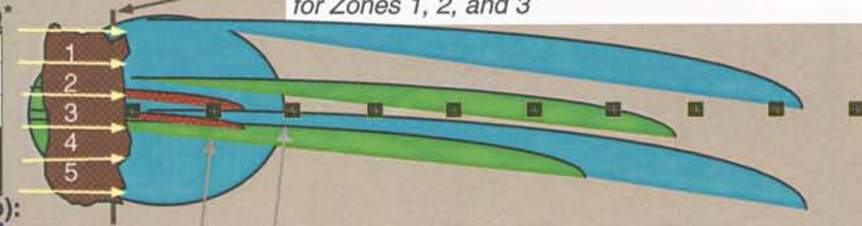
6. SOURCE DATA

Source Thickness in Sat.Zone* 15 (ft)

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

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	0.8914
3	0.8914
3	0.8914
3	0.8914
3	0.8914



Source Halflife (see Help):

Infinite	Infinite	(yr)
Inst. React.	1st Order	
Soluble Mass	infinite	(Kg)

In Source NAPL, Soil

View of Plume Looking Down

1200

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

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	150	300	450	600	750	900	1050	1200	1350	1500

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — View Output

RUN ARRAY — View Output

Help

Recalculate This Sheet

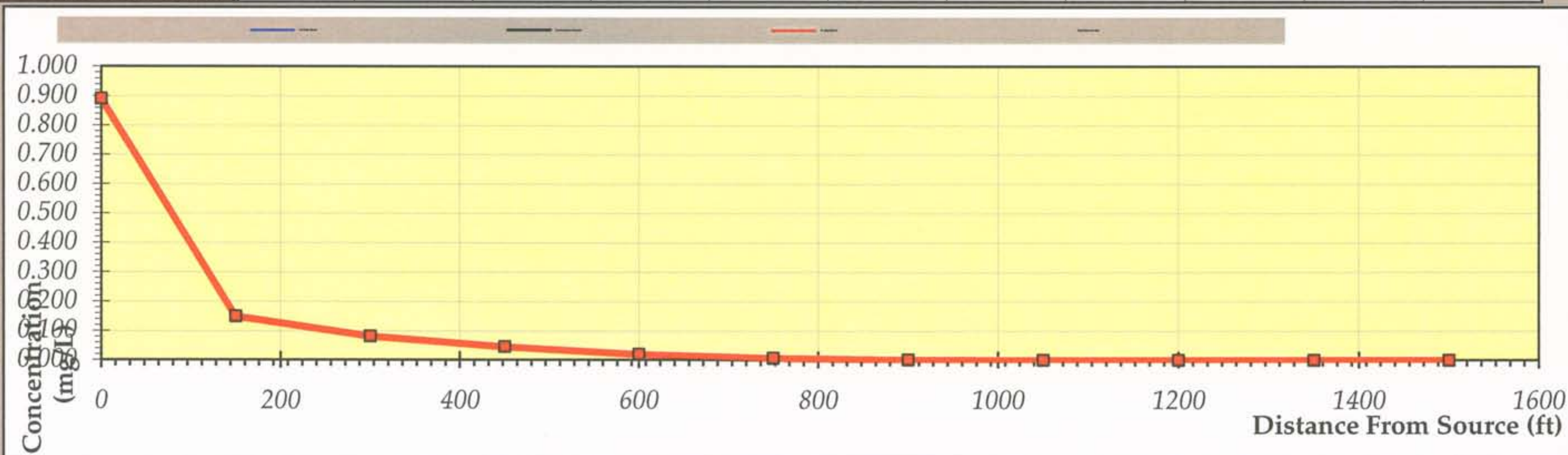
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED ARSENIC CONCENTRATION ALONG PLUME CENTERLINE TO NORTH (0.89 mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	150	300	450	600	750	900	1050	1200	1350	1500
No Degradation	0.891	0.149	0.082	0.045	0.020	0.006	0.0011	0.000	0.000	0.000	0.000
1st Order Decay	0.891	0.149	0.082	0.045	0.020	0.006	0.0011	0.000	0.000	0.000	0.000
Inst. Reaction	0.891	0.149	0.082	0.045	0.020	0.006	0.0011	0.000	0.000	0.000	0.000
Field Data from Site											



Calculate Animation

Time:

47.00 Years

Return to Input

Recalculate This Sheet

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Landsburg Mine

Baseline Conservative Case

Arsenic To North

Data Input Instructions:

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

1. HYDROGEOLOGY

Seepage Velocity*	*Vs*	830.0	*(ft/yr)*
or		↑ or	
Hydraulic Conductivity	*K*	8.5E-01	*(cm/sec)*
Hydraulic Gradient	*i*	0.00036	*(ft/ft)*
Porosity	*n*	0.31	*(-)*

2. DISPERSION

Longitudinal Dispersivity*	*alpha x*	31.7	*(ft)*
Transverse Dispersivity*	*alpha y*	3.12	
Vertical Dispersivity*	*alpha z*	0.31	*(ft)*
or		↑ or	
Estimated Plume Length	*Lp*	1200	*(ft)*

3. ADSORPTION

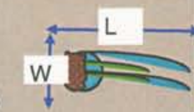
Retardation Factor*	*R*	70.0	*(-)*
or		↑ or	
Soil Bulk Density	*rho*	1.4	*(kg/l)*
Partition Coefficient	*Koc*	NA	*(L/kg)*
FractionOrganicCarbon	*foc*	4.6E-1	*(-)*

4. BIODEGRADATION

1st Order Decay Coeff*	*lambda*	6.9E-8	*(per yr)*
or		↑ or	
Solute Half-Life	*t-half*	#######	*(year)*
or Instantaneous Reaction Model			
Delta Oxygen*	*DO*		*(mg/L)*
Delta Nitrate*	*NO3*		*(mg/L)*
Observed Ferrous Iron*	*Fe2+*		*(mg/L)*
Delta Sulfate*	*SO4*		*(mg/L)*
Observed Methane*	*CH4*		*(mg/L)*

5. GENERAL

Modeled Area Length*	1500	*(ft)*
Modeled Area Width*	15	*(ft)*
Simulation Time*	68.00	*(yr)*



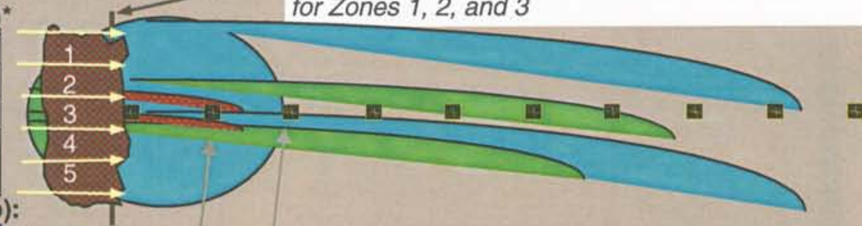
6. SOURCE DATA

Source Thickness in Sat.Zone* 15 *(ft)*

Source Zones:

Width* (ft)	Conc. (mg/L)*
3	0.8914
3	0.8914
3	0.8914
3	0.8914
3	0.8914

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



View of Plume Looking Down

1200

Observed Centerline Concentrations at Monitoring Wells

If No Data Leave Blank or Enter "0"

Source Halflife (see Help):

Infinite	Infinite	*(yr)*
Inst. React. ↑	↑ 1st Order	
Soluble Mass	infinite	*(Kg)*

In Source NAPL, Soil

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	150	300	450	600	750	900	1050	1200	1350	1500

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE

View Output

RUN ARRAY

View Output

Help

Recalculate This Sheet

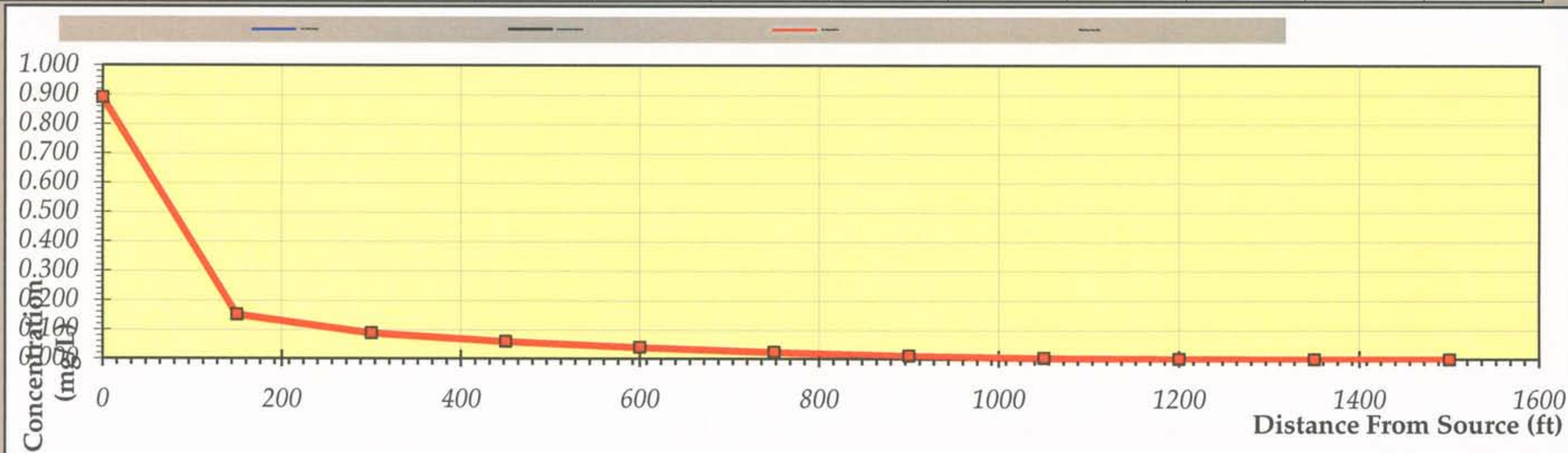
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED ARSENIC CONCENTRATION ALONG PLUME CENTERLINE TO NORTH (0.89 mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	150	300	450	600	750	900	1050	1200	1350	1500
No Degradation	0.891	0.151	0.088	0.060	0.040	0.024	0.011	0.004	0.001	0.000	0.000
1st Order Decay	0.891	0.151	0.088	0.060	0.040	0.024	0.011	0.004	0.001	0.000	0.000
Inst. Reaction	0.891	0.151	0.088	0.060	0.040	0.024	0.011	0.004	0.001	0.000	0.000
Field Data from Site											



Calculate Animation

Time:

68.00 Years

Return to Input

Recalculate This Sheet