Lab 7 Modeling a Super Fund Site *Franz Helfenstein* NAME

An old mine contaminated Clear Lake for years before the EPA stepped in and shut it down and began an intensive cleanup operation. This table represents some water quality readings for Clear Lake. The data collection began shortly before the mine ceased operation. When the mine ceased operation the EPA initiated an aggressive project to clean up some of the pollution. Eventually, the EPA finished their aggressive cleanup efforts and let the remaining pollution dissipate naturally. Thus, there are three distinct phases: (a) Mine in operation, (b) Active cleanup of pollution, (c) Natural dissipation of pollution.

Mine in Operation		
t	**Date**	**ppb**
0	Jan-2000	6988
1	Feb-2000	7112
2	Mar-2000	7205
3	Apr-2000	7298
4	May-2000	7404
5	Jun-2000	7523

Active Cleanup		
t	**Date**	**ppb**
5	Jun-2000	7523
6	Jul-2000	6652
7	Aug-2000	5589
8	Sep-2000	4689
9	Oct-2000	3725
10	Nov-2000	2809

Nature's Course		
t	**Date**	**ppb**
10	Nov-2000	2809
11	Dec-2000	2530
12	Jan-2001	2275
13	Feb-2001	2050
14	Mar-2001	1840
15	Apr-2001	1660

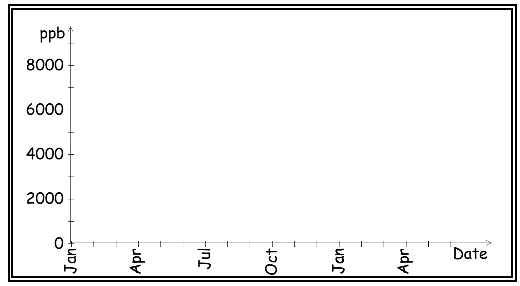
Divide the sketch into three phases using a vertical dashed line.

Enter the data in your TI and plot it.

(a) Mine in operation (I); Use L_1 & L_2

(b) Active cleanup (II); Use L_3 & L_4

(c) Natural dissipation (III); Use L_5 & L_6



Sketch your results here →

1a) Find the average rate of change (m) of pollution level for Phase I from t = 0 to t = 5.

m =

1b) Use t = 0 to find b and write the average function that models Phase 1. Store that function in Y_1.

Y_1 =

1c) If the mine had continued in operation at that average, how long until the pollution level reached 10,000 ppb?

2) Use linear regression, find the best-fit line for Phase II. Be sure to store the full equation in Y_2 for accuracy but write the line's equation here in slope-intercept form using just 3 significant digits.

Y_2 =

3) If the EPA were to continue cleaning up the pollution at the same rate when would the pollution be gone?

4) Using exponential regression, find the best-fit exponential for Phase III. Be sure to store the full equation in Y_3 for accuracy but write an abbreviated version here using 3 significant digits and using base 'e'. i.e $y = a e^{kt}$.

Y_3 =

5) Using Y_3, find the predicted pollution level June, 2002 (t = 29)

6) (a) Using Y_3 determine the year when Clear Lake will have acceptable water quality which is less than 10 ppb.

(b) Under the exponential model, will the pollution level ever reach zero? Why/why not?

7) Write a piecewise function that most closely represents this data. Be sure to include domain restrictions.

COST OF CLEANUP

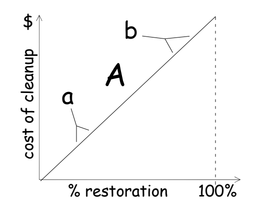
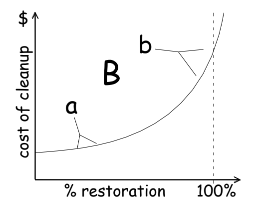
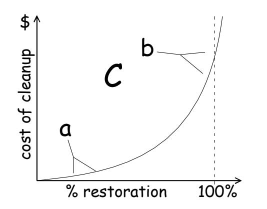
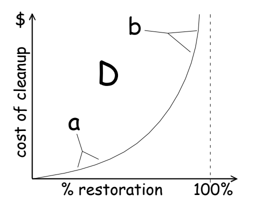
8) Below are 4 possible scenarios for the cost of cleaning up pollution. From this list of possible cost functions match the function with the most likely graph by writing the function below the graph.

$y = \frac{a\,x}{1 - x}$

$y = a\,x^2$

$y = m\,x$

$y = a\,e^{+kx}$

9) Consider the following: What should be the cost of cleaning up zero pollution? What should happen to the cost as the percentage gets closer to 100%? What can you say about the cost of cleanup at 'a' versus the cost of cleanup at 'b'? Which of the above models is the most realistic for cost of cleanup? Justify your answer.

10) Although the EPA can remove much of the pollution, it is probably impossible to remove it all. The cost should be zero if none is cleaned up and increase dramatically as the percentage approaches 100%.

$C = \frac{a\,x}{1 - x}$ models this scenario. C = cost, x = percentage cleaned up, a = parameter determined by actual data.

Use this function and the following data to determine 'a'. It costs $14,000,000 to clean up the first 50% of the pollution.

a = _______________

Now use your model to determine the cost to clean up 80% of the pollution. C(80%) = ____________

BONUS

Suppose there is an overhead cost of $4,500,000 before cleanup starts. Then we could use $C = \frac{a\,x + b}{1 - x}$ to model this scenario.

C = cost, x = percentage cleaned up, a & b = parameters determined by actual data. Under this scenario, what are a & b? What will it cost to clean up 80% of the pollution?

a = ____________ b = ____________ C(80%) = ______________