APPENDIX 20

SAMPLE STATION 20

SUBSURFACE MONITORING ZONE - 210' FT. BIG BERTHA ARTESIAN WELL

PA STATE GAME LANDS #95

PROJECT SL-110-7-101.5

MONITORING POINT 20

The discussion of this monitoring point will be divided into four (4) phases as outlined below:

1. General Conditions
2. Pre Closure Analysis
3. Post Closure Analysis
4. Summary of Analysis

1. General Conditions

The data and associated graphical materials relevant to and utilized in describing the relationships at this monitoring location are outlined below:

Sheet 7 - Relationship of Geophysical Parameters
Sheet 8 - Geologic Cross Sections
Sheet 19 - Relationship of Hydrologic Parameters
Appendix 20 - Subsurface Monitoring Zone
Narrative exhibits contained on the following pages.

This monitoring point is 210 ' below the surface of the artesian well (Big Bertha), as shown on Sheets 7 and 8.

The flow relationships of the artesian well at this monitoring zone are given below:

a. Velocity - the average velocity of water at this monitoring zone was l.03 ft/min upward.

b. Cumulative Quantity - the cumulative quantity of water contributed by this flow system was 2.7 gal/min

c. Flow System Quantity - the average quantity of water contributed by this flow system was 2.7 gal/min. (.01c.f.s)

This monitoring point is representative of conditions in flow. system B6. This monitoring point shows the water quality at the base of the Connoquenessing sandstone and was the deepest sample obtainable after construction.

2. Pre Closure Analysis (Monitoring Point 20)

The reviewer is directed to refer to the following materials during the discussion of the chemical analyses and trends at this monitoring point.:

a. Sheet 19 - which shows the sample data plotted using a time reference basis.

b. The corresponding graphs (on the 6 pages immediately following the pre closure analysis) which show the data, the regression mean line, and the field of variance.

c. Appendix 20 - which contains the raw sample data during pre closure which was utilized to develop the means, ranges, and regression analysis results.

1. pH Relationship
The pH at this monitoring point varied from 6.34 - 6.49 the mean value being 6.44. An extremely weak relationship exists.

2. Specific Conductance Relationship
The specific conductance at this monitoring point varied from 2000 - 2150; the mean value calculated as 2050.

3. Acidity/Alkalinity Balance (mg/l)
The alkalinity varied from 139 - 176 ; the mean value was 163 Regression analysis of the alkalinity values showed: A very weak relationship exists where alkalinity concentrations decreased as conductance increased. The acidity varied from 0 - 0; the mean value was N.A. Regression analysis of the sulphate values showed: No relationship was possible as no acidity was measured.

4. Sulphate Relationship (mg/l)
The sulphates varied from 354- 466; the mean value was 412 Regression analysis of the sulphate values showed: An extremely weak relationship exists where sulphate concentrations decreased as conductance increased.

5. Total Iron Relationship (mg/l)
The total iron varied from 56 - 550 ; the mean value was 201 Regression analysis of the ferrous iron values showed: A weak relationship exists where total iron concentrations increased as conductance increased.

6. Ferrous Iron Relationship (mg/l)
The ferrous iron varied from 55- 538 ; the mean value was 196 Regression analysis of the ferrous iron values showed: A weak relationship exists where ferrous iron concentration increased as conductance increased.

7. Ferric Iron Relationship (mg/l)
The ferric iron varied from 0.l - 12.0; the mean value was 5 Regression analysis of the ferric iron values showed: An extremely weak relationship exists where ferric iron concentration increased as conductance increased.

3. Post Closure Analysis

The reviewer is referred to sheet 19 which shows the post-closure data plotted using a time reference basis with pre-closure data for comparative purposes.

Closure depressed the specific conductance, however, the zone recorded rapidly after the well was reopened.

pH was also depressed as a result of closure, but the pH also recovered rapidly after the well was opened.

This zone was alkaline prior to closure, and closure caused a reduction in the concentration of alkalinity and a short term presence of acidity was observed in a zone where acidity was not previously found. However, the acidity was not present except in the initial sampling and the alkalinity recovered quickly.

There was a marked increase in sulphate concentration which recovered to pre closure levels in a short period of time.

The results for the total iron and the ferrous component were inconclusive for this zone due to the high variation in pre-closure levels; while ferric iron showed little or no response to the effects of closure.

4. Summary of Monitoring Point 20 Analysis

Closure allowed a free mixing of the flow systems between the lower zones and the upper zones (with higher permeabilities, higher recharge capacities and poorer quality). The upper zones dominated the lower zones and caused a depression in the water quality of the lower zones. However, post closure analysis shows a rapid recovery to near pre closure values, indicating only a local effect.

SAMPLE 20   PROJECT SL110-7--101.5:BIG BERTHA

DATE	SPEC COND UMHOS/CM	DISCHARGE C.F.S.	PH SU	ALKALINITY MG/L	ACIDITY MG/L	SULPHATES MG/L	TOTAL IRON MG/L	FERROUS IRON MG/L	FERRIC IRON MG/L	REC #
030783	2150	.01	6.48	175	00	374	61.0	59.0	2.0	1
033183	2000	.01	6.49	171	00	354	56.0	55.1	.1	2
041383	2000	.01	6.42	176	00	453	123.0	115.0	8.0	3
042083	2000	.01	6.47	152	00	416	214.0	211.0	3.0	4
042683	2100	.01	6.34	139	00	466	550.0	538.0	12.0	5

COEFFICIENT MATRIX AND AUGMENTED MATRIX
                                          1025   32.2000
                  1025   2103249   66005.9375
REGRESSION COEFFICIENTS OF NORMAL EQUATION
          6.849995613098
   ---   0.000199999995

ORIGINAL X - Y PAIRS		PREDICTED VALUES	DEVIATION
2150.0000	6.4800	6.4200	0.0600
2000.0000	6.4900	6.4500	0.0400
2000.0000	6.4200	6.4500	0.0300
2000.0000	6.4700	6.4500	0.0200
2100.0000	6.3400	6.4300	0.0900

STATISTICAL ANALYSIS WITH ORDER OF EQUATION= 1
NUMBER OF X - Y PAIRS= 5
TOTAL SUMS OF SQUARE= .01564
SUMS OF SQUARES DUE TO REGRESSION= 1.144409E-3
SUMS OF SQUARES DUE TO DEVIATION= .014496
GOODNESS OF FIT= .073171
MULTIPLE CORRELATION COEFFICIENT   0.27050
STANDARD DEVIATION .060199

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE
LIN. REGRESSION	.00	1	.00
DEVIATION	.01	3	.00
TOTAL VARIATION	.02	4	

F-TEST FOR EQUALITY OF SAMPLE/REGRESSION VARIANCE
F TEST - SIGNIFICANCE OF REGRESSION =   0.24
     LEVEL .05% - CRITICAL VALUE = 4.28

COEFFICIENT MATRIX AND AUGMENTED MATRIX
                                                        1025   813.0000
                        1025   2103249   1666150.0000
REGRESSION COEFFICIENTS OF NORMAL EQUATION
   213.747482299805
                0.024949997663
      ORIGINAL X - Y PAIRS   PREDICTED VALUES   DEVIATION
       2150.0000   175.0000   160.1050   14.8950
       2000.0000   171.0000   163.8475   7.1525
       2000.0000   176.0000   163.8475   12.1525
       2000.0000   152.0000   163.8475   11.8475
       2100.0000   139.0000   161.3525   22.3525

STATISTICAL ANALYSIS WITH ORDER OF EQUATION= 1
NUMBER OF X - Y PAIRS= 5
TOTAL SUMS OF SQUARE= 1074
SUMS OF SQUARES DUE TO REGRESSION= 13.125
SUMS OF SQUARES DUE TO DEVIATION= 1060.875
GOODNESS OF FIT= .012221
MULTIPLE CORRELATION COEFFICIENT   0.11055
STANDARD DEVIATION 16.28553

                    ANALYSIS OF VARIANCE
        SOURCE OF   SUM OF   DEGREES OF   MEAN
        VARIATION   SQUARES   FREEDOM   SQUARE
LIN. REGRESSION   13.13   1   13.13
DEVIATION   1060.88   3   353.63
TOTAL VARIATION   1074.00   4

F-TEST FOR EQUALITY OF SAMPLE/REGRESSION VARIANCE
F TEST - SIGNIFICANCE OF REGRESSION =   0.04
     LEVEL .05% - CRITICAL VALUE = 4.28
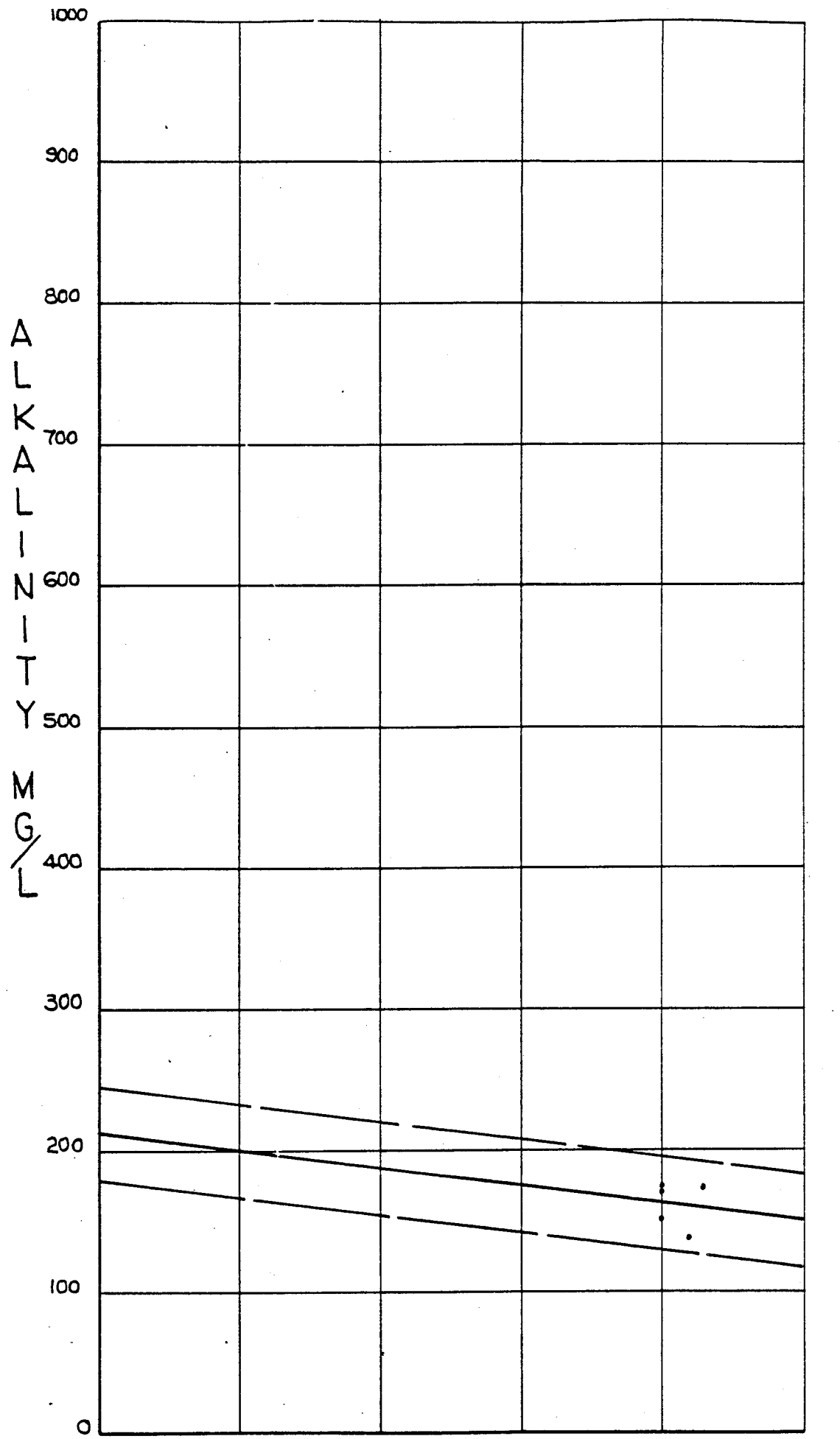
SPECIFIC CONDUCTANCE (umhos/cm)
BIG BERTHA - SAMPLE ZONE 20

COEFFICIENT MATRIX AND AUGMENTED MATRIX

|		1025	0.0000
	1025	2103249	0.0000

REGRESSION COEFFICIENTS OF NORMAL EQUATION

0.000000000000
0.000000000000

ORIGINAL X – Y PAIRS		PREDICTED VALUES	DEVIATION
2150.0000	0.0000	0.0000	0.0000
2000.0000	0.0000	0.0000	0.0000
2000.0000	0.0000	0.0000	0.0000
2000.0000	0.0000	0.0000	0.0000
2100.0000	0.0000	0.0000	0.0000

STATISTICAL ANALYSIS WITH ORDER OF EQUATION= 1
NUMBER OF X – Y PAIRS= 5
TOTAL SUMS OF SQUARE= 0
SUMS OF SQUARES DUE TO REGRESSION= 0
SUMS OF SQUARES DUE TO DEVIATION= 0
GOODNESS OF FIT= 0
MULTIPLE CORRELATION COEFFICIENT   0.00000
STANDARD DEVIATION 0

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE
LIN. REGRESSION	.00	1	.00
DEVIATION	.00	3	.00
TOTAL VARIATION	.00	4	

F-TEST FOR EQUALITY OF SAMPLE/REGRESSION VARIANCE
F TEST – SIGNIFICANCE OF REGRESSION =   0.00
      LEVEL .05% – CRITICAL VALUE = 4.28
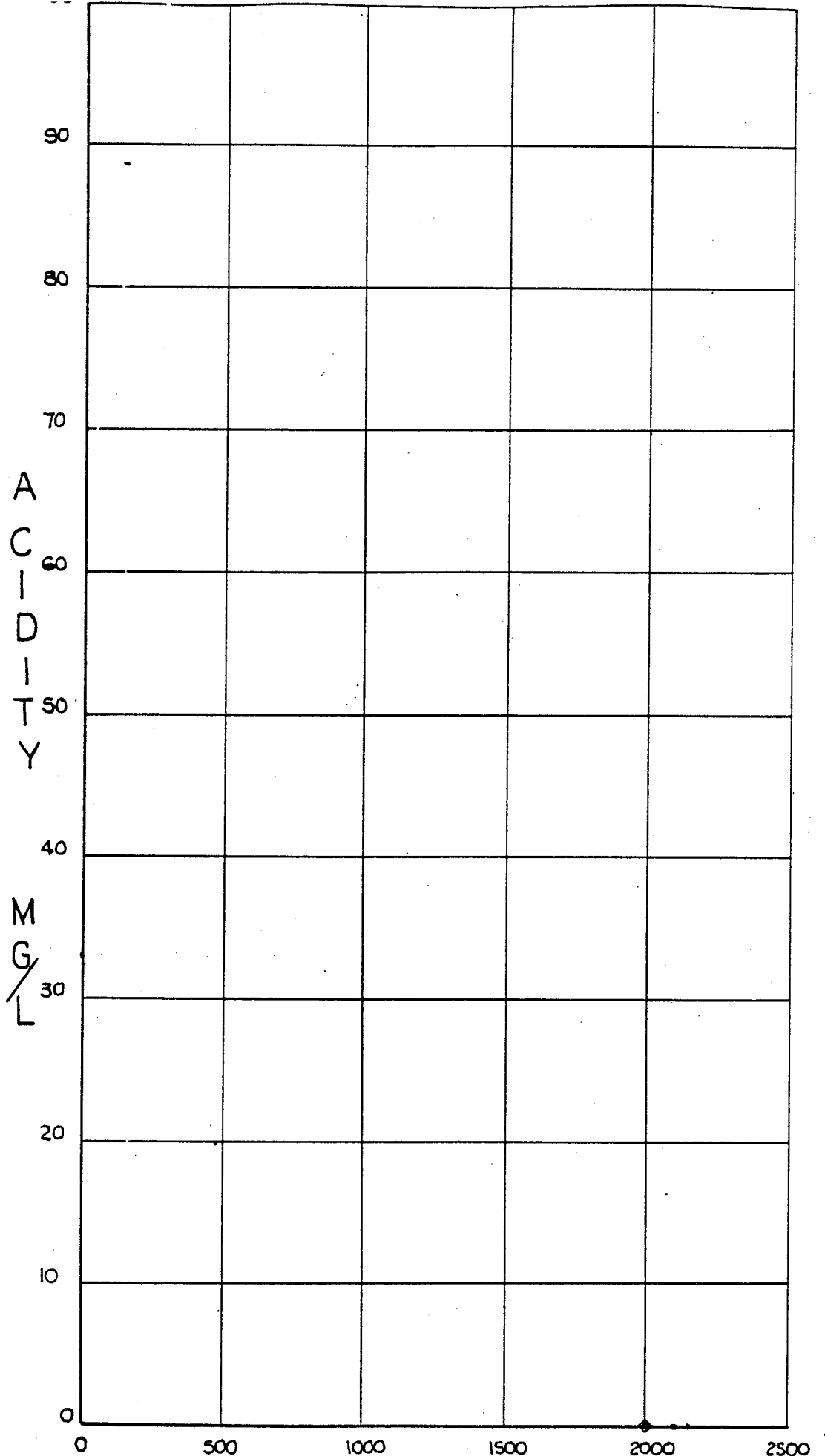
SPECIFIC CONDUCTANCE (umhos/cm)
BIG BERTHA - SAMPLE ZONE 20

COEFFICIENT MATRIX AND AUGMENTED MATRIX
                                              1025   2063.0000
   1025   2103249   4228700.0000
REGRESSION COEFFICIENTS OF NORMAL EQUATION
          456.159912109375
            0.021249998361

ORIGINAL X - Y PAIRS		PREDICTED VALUES	DEVIATION
2150.0000	374.0000	410.4724	36.4724
2000.0000	354.0000	413.6599	59.6599
2000.0000	453.0000	413.6599	39.3401
2000.0000	416.0000	413.6599	2.3401
2100.0000	466.0000	411.5349	54.4651

STATISTICAL ANALYSIS WITH ORDER OF EQUATION= 1
NUMBER OF X - Y PAIRS= 5
TOTAL SUMS OF SQUARE= 9419.25
SUMS OF SQUARES DUE TO REGRESSION= 9
SUMS OF SQUARES DUE TO DEVIATION= 9410.25
GOODNESS OF FIT= 9.554885E-4
MULTIPLE CORRELATION COEFFICIENT   0.03091
STANDARD DEVIATION 48.50322

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE
LIN. REGRESSION	9.00	1	9.00
DEVIATION	9410.25	3	3136.75
TOTAL VARIATION	9419.25	4	

F-TEST FOR EQUALITY OF SAMPLE/REGRESSION VARIANCE
F TEST - SIGNIFICANCE OF REGRESSION =   0.00
     LEVEL .05% - CRITICAL VALUE = 4.28
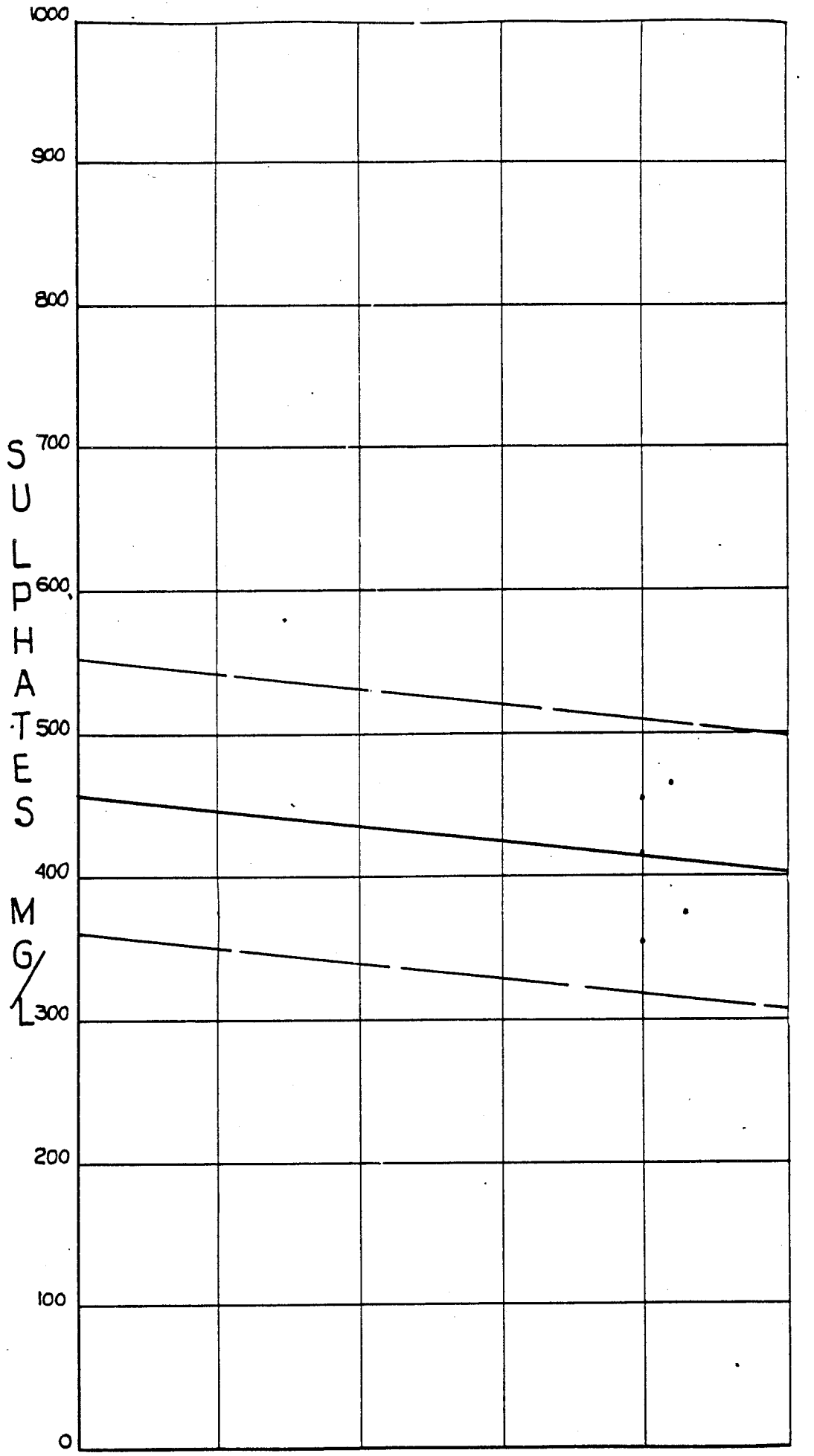
SPECIFIC CONDUCTANCE (umhos/cm)

BIG BERTHA - SAMPLE ZONE 20

COEFFICIENT MATRIX AND AUGMENTED MATRIX
                                                1025   1004.0000
                        1025   2103249   2072150.0000
REGRESSION COEFFICIENTS OF NORMAL EQUATION
—   1229.177246093750
              0.697549998760

ORIGINAL X — Y PAIRS		PREDICTED VALUES	DEVIATION
2150.0000	61.0000	270.5552	209.5552
2000.0000	56.0000	165.9226	109.9226
2000.0000	123.0000	165.9226	42.9226
2000.0000	214.0000	165.9226	48.0774
2100.0000	550.0000	235.6777	314.3223

STATISTICAL ANALYSIS WITH ORDER OF EQUATION= 1
NUMBER OF X — Y PAIRS= 5
TOTAL SUMS OF SQUARE= 168679
SUMS OF SQUARES DUE TO REGRESSION= 9731.75
SUMS OF SQUARES DUE TO DEVIATION= 158947.2
GOODNESS OF FIT= .057694
MULTIPLE CORRELATION COEFFICIENT   0.24020
STANDARD DEVIATION 199.3409

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE
LIN. REGRESSION	9731.75	1	9731.75
DEVIATION	158947.25	3	52982.41
TOTAL VARIATION	168679.00	4	

F-TEST FOR EQUALITY OF SAMPLE/REGRESSION VARIANCE
F TEST — SIGNIFICANCE OF REGRESSION =   0.18
      LEVEL .05% — CRITICAL VALUE = 4.28
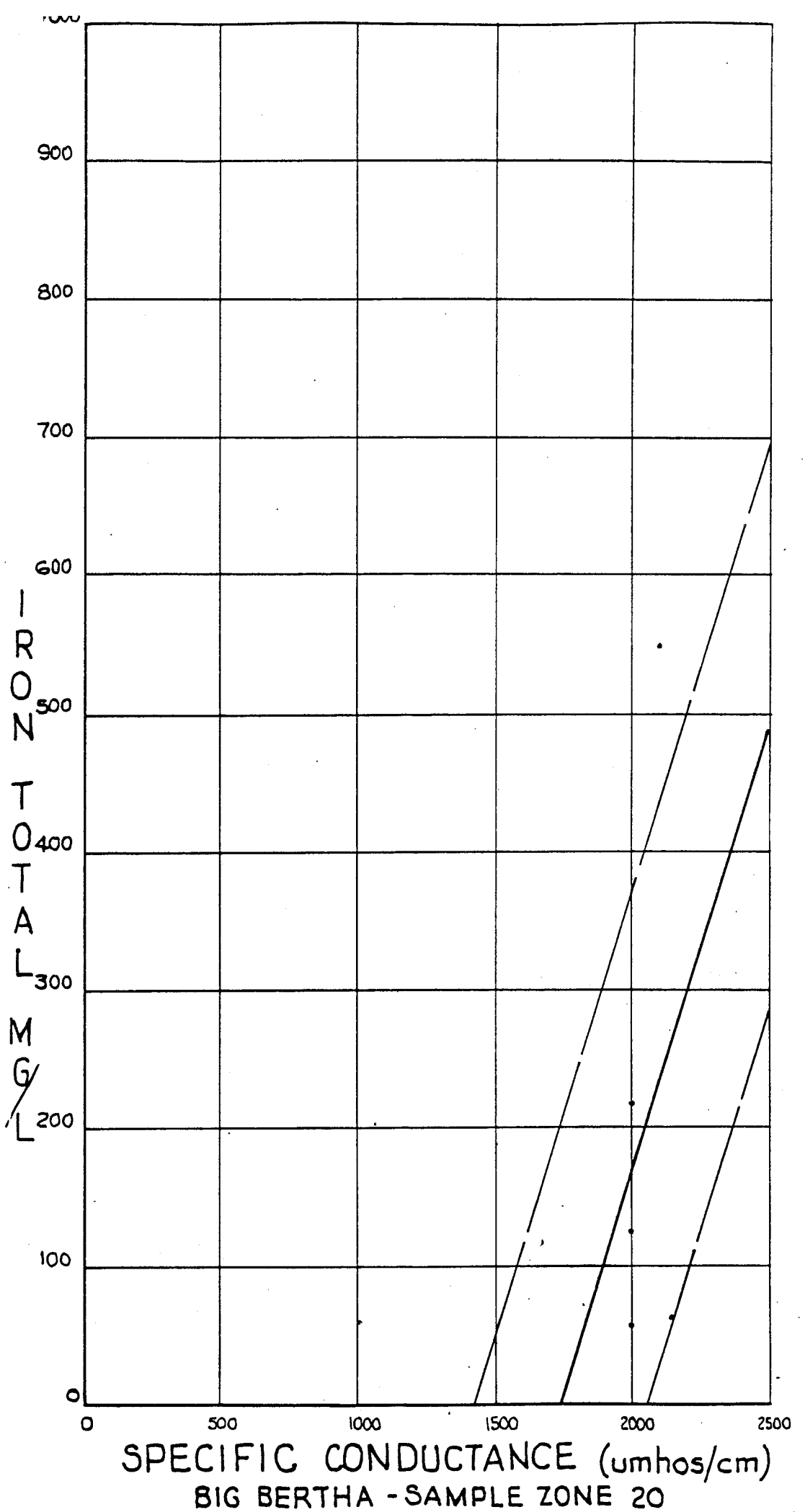
SPECIFIC CONDUCTANCE (umhos/cm)
BIG BERTHA - SAMPLE ZONE 20

COEFFICIENT MATRIX AND AUGMENTED MATRIX

		1025	978.0999
	1025	2103249	2018850.0000

REGRESSION COEFFICIENTS OF NORMAL EQUATION
-       1213.344726562500
            0.687299966812

ORIGINAL X - Y PAIRS		PREDICTED VALUES	DEVIATION
2150.0000	59.0000	264.3501	205.3501
2000.0000	55.1000	161.2551	106.1551
2000.0000	115.0000	161.2551	46.2551
2000.0000	211.0000	161.2551	49.7449
2100.0000	538.0000	229.9851	308.0149

STATISTICAL ANALYSIS WITH ORDER OF EQUATION= 1
NUMBER OF X - Y PAIRS= 5
TOTAL SUMS OF SQUARE= 162372
SUMS OF SQUARES DUE TO REGRESSION= 9447.625
SUMS OF SQUARES DUE TO DEVIATION= 152924.3
GOODNESS OF FIT= .058185
MULTIPLE CORRELATION COEFFICIENT   0.24122
STANDARD DEVIATION 195.5277

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE
LIN. REGRESSION	9447.62	1	9447.62
DEVIATION	152924.38	3	50974.79
TOTAL VARIATION	162372.00	4	

F-TEST FOR EQUALITY OF SAMPLE/REGRESSION VARIANCE
F TEST - SIGNIFICANCE OF REGRESSION =   0.19
     LEVEL .05% - CRITICAL VALUE = 4.28
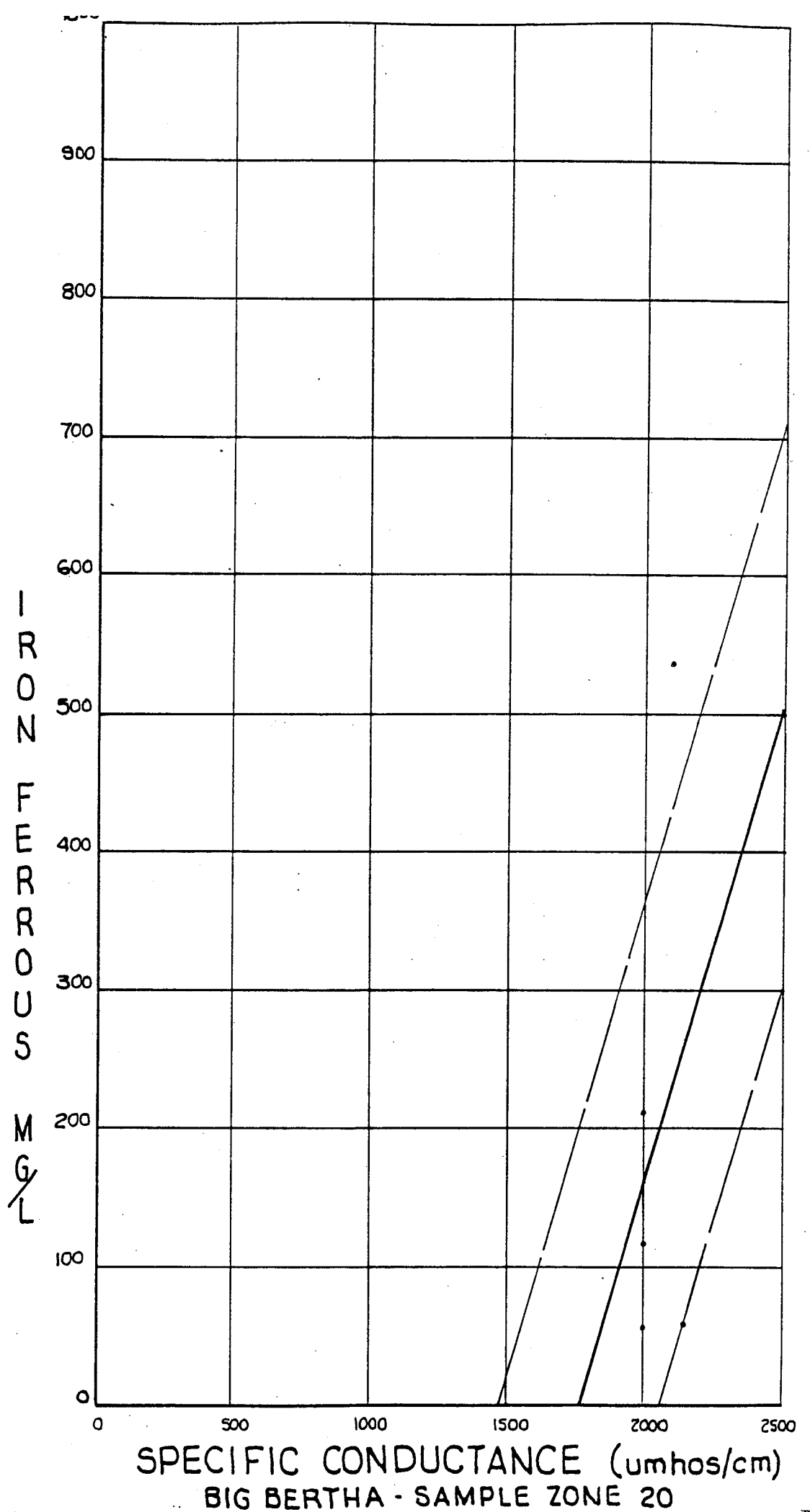
SPECIFIC CONDUCTANCE (umhos/cm)
BIG BERTHA - SAMPLE ZONE 20

COEFFICIENT MATRIX AND AUGMENTED MATRIX

```
                                        1025                        25.1000
                    1025              2103249                  51700.0000
REGRESSION COEFFICIENTS OF NORMAL EQUATION
--        20.095184326172
           0.012251317501
     ORIGINAL X - Y PAIRS      PREDICTED VALUES      DEVIATION
     2150.0000    2.0000           6.2451            4.2451
     2000.0000    0.1000           4.4074            4.3074
     2000.0000    8.0000           4.4074            3.5926
     2000.0000    3.0000           4.4074            1.4074
     2100.0000   12.0000           5.6326            6.3674
```

STATISTICAL ANALYSIS WITH ORDER OF EQUATION= 1
NUMBER OF X - Y PAIRS= 5
TOTAL SUMS OF SQUARE= 95.0081
SUMS OF SQUARES DUE TO REGRESSION= 3.001907
SUMS OF SQUARES DUE TO DEVIATION= 92.00619
GOODNESS OF FIT= .031596
MULTIPLE CORRELATION COEFFICIENT   0.17775
STANDARD DEVIATION 4.795983

```
                    ANALYSIS OF VARIANCE
       SOURCE OF      SUM  OF      DEGREES OF     MEAN
       VARIATION      SQUARES      FREEDOM        SQUARE
LIN. REGRESSION        3.00           1            3.00
DEVIATION             92.01           3           30.67
TOTAL VARIATION       95.01           4
```

F-TEST FOR EQUALITY OF SAMPLE/REGRESSION VARIANCE
F TEST - SIGNIFICANCE OF REGRESSION =   0.10
     LEVEL .05% - CRITICAL VALUE = 4.28

SPECIFIC CONDUCTANCE (umhos/cm)
BIG BERTHA - SAMPLE ZONE 20
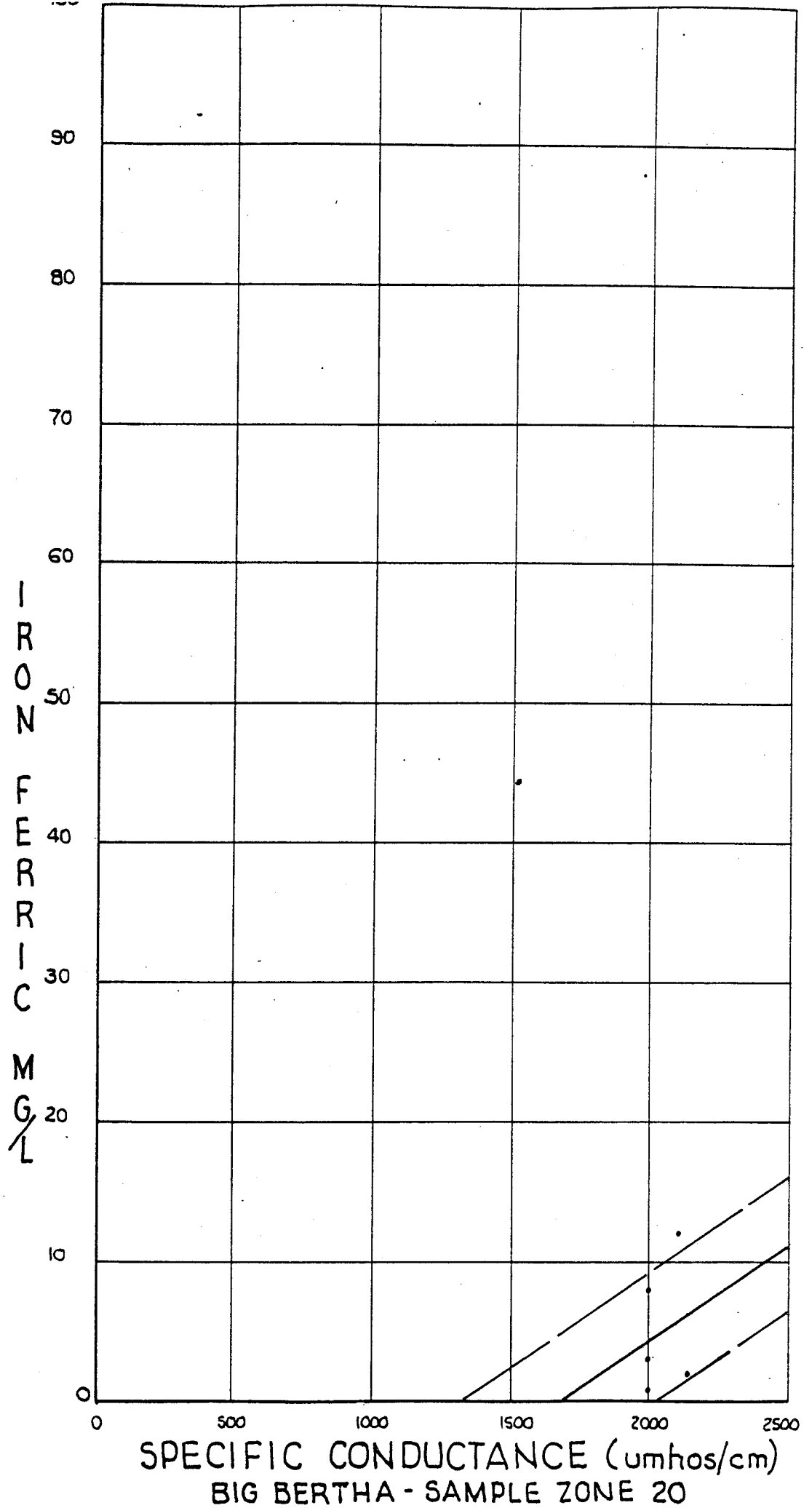
POST CLOSURE DATA LISTING *

SAMPLE TWENTY

DATE	SPEC. COND.	DISCHARGE	pH	ALKALINITY	ACIDITY	SULPHATES	TOTAL IRON	FERROUS IRON	FERRIC IRON
6/12	1900	.006	5.54	22	202	831	227.0	200.0	27.0
6/16	1900	.006	5.86	60	0	668	75.8	67.3	8.5
6/21	1800	.006	6.23	102	0	560	88.4	87.0	1.4
6/29	1800	.006	6.41	96	0	390	56.5	48.9	7.6
7/10	2200	.006	6.25	105	0	310	54.5	53.0	1.5
7/26	2000	.006	6.03	67	0	410	62.0	55.0	7.0
8/6	2000	.006	6.55	151	0	514	89.8	87.0	2.8
8/21	1700	.006	6.18	62	0	317	84.8	80.8	4.0

* Units are as follows:

specific conductance	–	umhos/cm
discharge	–	c.f.s.
pH	–	standard units
all others	–	mg/L