APPENDIX 17

SAMPLE STATION 17

SUBSURFACE MONITORING ZONE - 120' FT.

BIG BERTHA ARTESIAN WELL

PA STATE GAME LANDS #95 PROJECT SL-110-7-101.5

MONITORING POINT 17

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 22 - Relationship of Hydrologic Parameters
Appendix 17 - Subsurface Monitoring Zone

Narrative exhibits contained on the following pages.

This monitoring point is 120' 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 2.78ft/min upward.

b. Cumulative Quantity - the cumulative quantity of water contributed by this flow system was 7.2 gal/min

c. Flow System Quantity - the average quantity of water contributed by this flow system was 4.4 gal/min. (.01c.f.s)

This monitoring point is representative of conditions in flow system B5. This sample is at the top of the flow system representing fully mixed conditions.

2. Pre Closure Analysis Monitoring Point 17

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 22 - which shows the sample data plotted using a <u>time</u> 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. <u>Appendix</u> 17 - 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 6.32 - 6.41; the mean value being 6.37. An extremely strong relationship exists.

2. Specific Conductance Relationship
The specific conductance at this monitoring point varied from 1200 - 1300; the mean value calculated as 1271.

3. Acidity/Alkalinity Balance (mg/l)
The alkalinity varied from 84 - 133 ; the mean value was 116. Regression analysis of the alkalinity values showed: A moderate relationship exists where alkalinity concentrations increased as conductance increased. The acidity varied from 00- 00; the mean value was N.A. Regression analysis of the sulphate values showed: No relationship is possible as no acidity was measured.

4. Sulphate Relationship (mg/l)
The sulphates varied from 307 - 416 ; the mean value was 376. Regression analysis of the sulphate values showed: An extremely weak relationship exists where sulphate concentrations increased as conductance increases.

5. Total Iron Relationship (mg/l)
The total iron varied from 30 - 41; the mean value was 36. Regression analysis of the ferrous iron values showed: An extremely strong relationship exists where total iron concentrations decreased as conductance increased.

6. Ferrous Iron Relationship (mg/l)
The ferrous iron varied from 29 - 40; the mean value was 34. Regression analysis of the ferrous iron values showed: A strong relationship exists where ferrous iron concentration decreased as conductance increased.

7. Ferric Iron Relationship (mg/l)
The ferric iron varied from 0.4 - 3.5 ; the mean value was 2. Regression analysis of the ferric iron values showed: A weak relationship exists where ferric iron concentrations decreased as conductance increased.

3. Post Closure Analysis

The reviewer is referred to sheet 22 which shows the post-closure data plotted using a time reference basis with pre-closure data for comparative purposes.

Closure substantially increased the specific conductance, however, post closure analysis shows a rapid return to values similar to pre closure tendencies.

pH values were depressed due to closure, however post closure values rapidly returned to near pre closure conditions.

This zone was alkaline prior to closure, however, post closure analysis shows a reduction in the concentration of alkalinity. Acidity was not . present prior to closure. Closure introduced a short term presence of acidity which quickly dissipated during post closure to levels similar to those occurring prior to closure (non acidic conditions).

Closure caused a significant increase in concentration of sulphate which quickly returned to pre closure values.

Total iron concentrations showed a dramatic increase due to closure. Post closure analysis shows a rapid recovery to pre closure concentration levels.

Ferrous iron concentrations also showed a dramatic increase due to closure. Post closure analysis showed a rapid recovery to pre closure concentration levels.

Ferric iron concentrations showed little or no response to closure activities.

4. Summary of Monitoring Point 17   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.

This zone was affected by upper zones during closure but rapidly returned to concentrations and conditions similar to pre closure values. This indicates a short term or local effect due to closure.

SAMPLE 17   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 #
022883	1300	.02	6.37	133	00	369	32.5	29.5	3.0	1
030783	1300	.02	6.40	118	00	394	30.2	29.2	1.0	2
031483	1300	.02	6.41	127	00	416	33.6	33.2	.4	3
040783	1200	.02	6.32	121	00	416	41.5	39.0	2.5	4
041383	1300	.02	6.40	132	00	396	34.0	31.5	2.5	5
042083	1250	.02	6.36	95	00	307	41.6	40.8	.8	6
042683	1250	.02	6.34	84	00	334	36.5	33.0	3.5	7

COEFFICIENT MATRIX AND AUGMENTED MATRIX

```
                                          890                        44.6000
              890                      1132500                    56713.0000
REGRESSION COEFFICIENTS OF NORMAL EQUATION
          5.373846153846
          0.000784615385
     ORIGINAL X - Y PAIRS        PREDICTED VALUES      DEVIATION
     1300.0000     6.3700           6.3938               0.0238
     1300.0000     6.4000           6.3938               0.0062
     1300.0000     6.4100           6.3938               0.0162
     1200.0000     6.3200           6.3154               0.0046
     1300.0000     6.4000           6.3938               0.0062
     1250.0000     6.3600           6.3546               0.0054
     1250.0000     6.3400           6.3546               0.0146
```

STATISTICAL ANALYSIS WITH ORDER OF EQUATION= 1
NUMBER OF X - Y PAIRS= 7
TOTAL SUMS OF SQUARE= 6.885714E-3
SUMS OF SQUARES DUE TO REGRESSION= 5.716484E-3
SUMS OF SQUARES DUE TO DEVIATION= 1.169231E-3
GOODNESS OF FIT= .830195
MULTIPLE CORRELATION COEFFICIENT   0.91115
STANDARD DEVIATION .01396

```
                    ANALYSIS OF VARIANCE
        SOURCE OF      SUM  OF      DEGREES OF      MEAN
        VARIATION      SQUARES       FREEDOM       SQUARE
LIN. REGRESSION          .01            1            .01
DEVIATION                .00            5            .00
TOTAL VARIATION          .01            6
```

F-TEST FOR EQUALITY OF SAMPLE/REGRESSION VARIANCE
F TEST - SIGNIFICANCE OF REGRESSION =   24.45
     LEVEL .05% - CRITICAL VALUE = 6.61

COEFFICIENT MATRIX AND AUGMENTED MATRIX
```
                                    890                    810.0000
                890                1132500.            1031950.0000
```
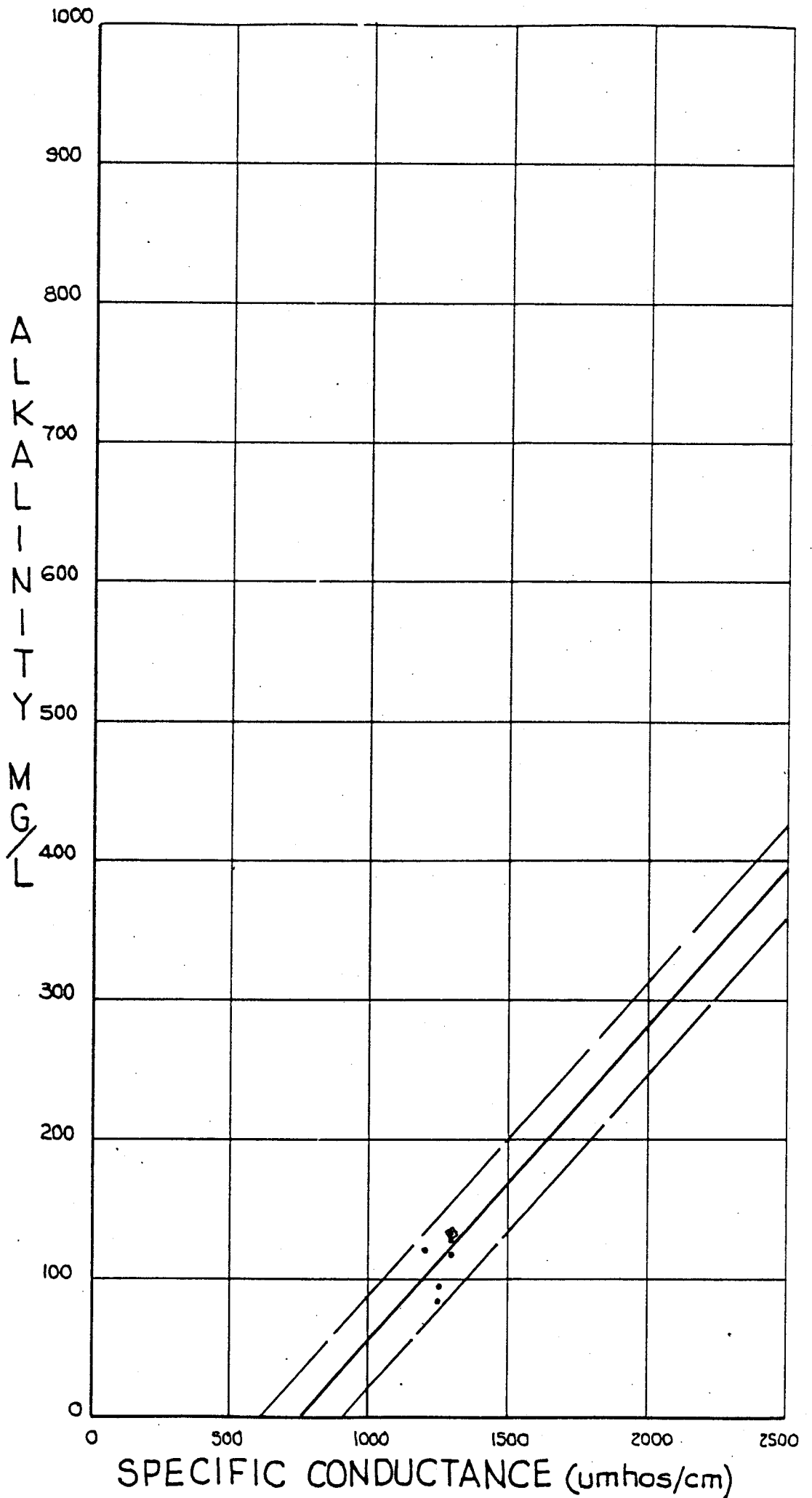REGRESSION COEFFICIENTS OF NORMAL EQUATION
```
-         170.846153846143
            0.225384615385
   ORIGINAL X - Y PAIRS      PREDICTED VALUES      DEVIATION
   1300.0000    133.0000         122.1538          10.8462
   1300.0000    118.0000         122.1538           4.1538
   1300.0000    127.0000         122.1538           4.8462
   1200.0000    121.0000          99.6154          21.3846
   1300.0000    132.0000         122.1538           9.8462
   1250.0000     95.0000         110.8846          15.8846
   1250.0000     84.0000         110.8846          26.8846
```

STATISTICAL ANALYSIS WITH ORDER OF EQUATION= 1
NUMBER OF X - Y PAIRS= 7
TOTAL SUMS OF SQUARE= 2159.428571
SUMS OF SQUARES DUE TO REGRESSION= 471.697802
SUMS OF SQUARES DUE TO DEVIATION= 1687.730769
GOODNESS OF FIT= .218436
MULTIPLE CORRELATION COEFFICIENT   0.46737
STANDARD DEVIATION 16.771656

```
                 ANALYSIS OF VARIANCE
     SOURCE OF      SUM  OF      DEGREES OF      MEAN
     VARIATION      SQUARES       FREEDOM       SQUARE
LIN. REGRESSION      471.70          1          471.70
DEVIATION           1687.73          5          337.55
TOTAL VARIATION     2159.43          6
```

F-TEST FOR EQUALITY OF SAMPLE/REGRESSION VARIANCE
F TEST - SIGNIFICANCE OF REGRESSION =   1.40
     LEVEL .05% - CRITICAL VALUE = 6.61

Y-axis: ALKALINITY MG/L

X-axis: SPECIFIC CONDUCTANCE (umhos/cm)

COEFFICIENT MATRIX AND AUGMENTED MATRIX

	890	0.0000
890	1132500	0.0000

REGRESSION COEFFICIENTS OF NORMAL EQUATION
            0.000000000000
            0.000000000000

ORIGINAL X - Y PAIRS		PREDICTED VALUES	DEVIATION
1300.0000	0.0000	0.0000	0.0000
1300.0000	0.0000	0.0000	0.0000
1300.0000	0.0000	0.0000	0.0000
1200.0000	0.0000	0.0000	0.0000
1300.0000	0.0000	0.0000	0.0000
1250.0000	0.0000	0.0000	0.0000
1250.0000	0.0000	0.0000	0.0000

STATISTICAL ANALYSIS WITH ORDER OF EQUATION= 1
NUMBER OF X - Y PAIRS= 7
TOTAL SUMS OF SQUARE= 0
SUMS OF SQUARES DUE TO REGRESSION= 0
SUMS OF SQUARES DUE TO DEVIATION= 0
GOODNESS OF FIT= 0
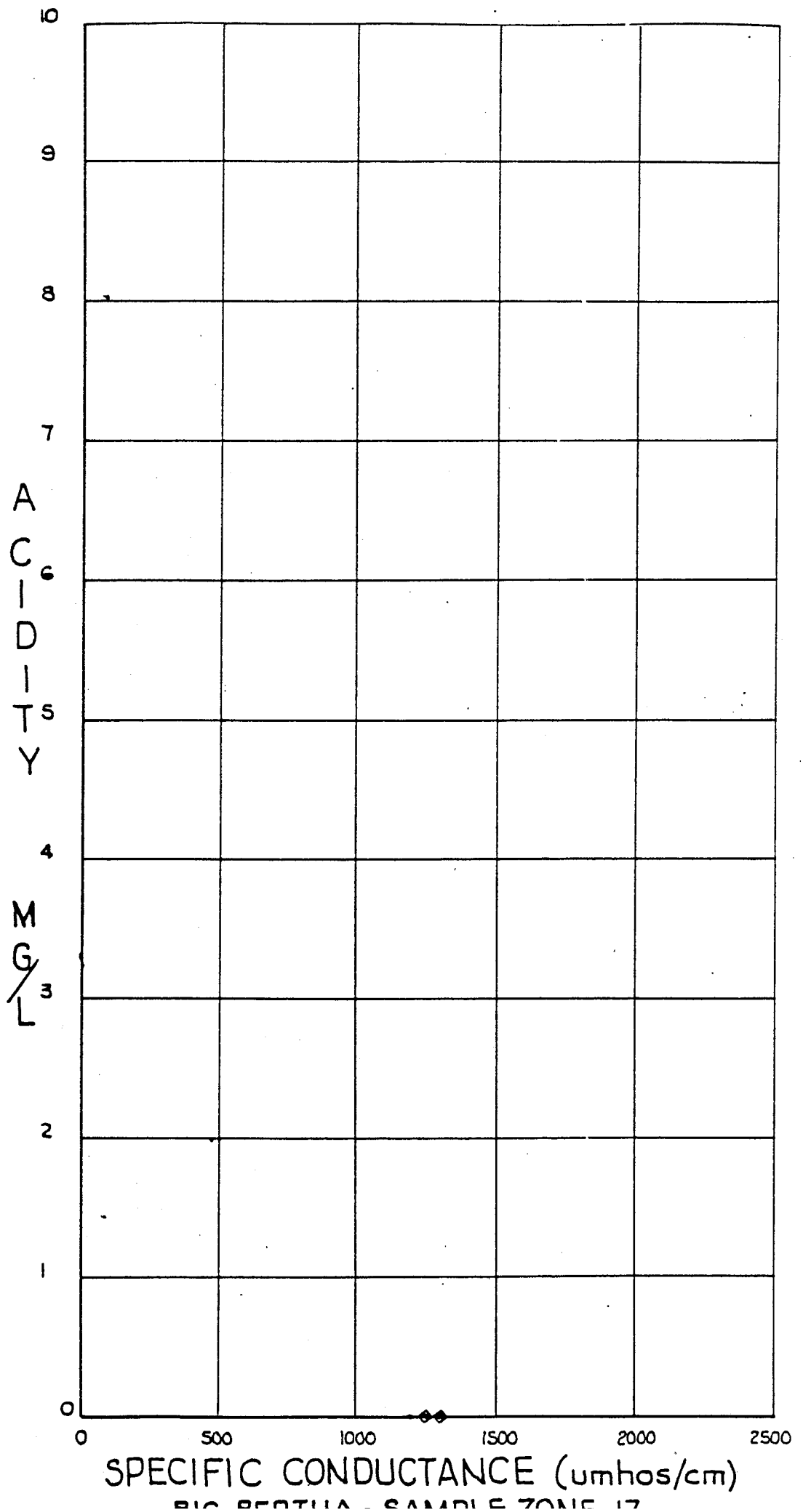MULTIPLE CORRELATION COEFFICIENT   0.00000
STANDARD DEVIATION 0

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE
LIN. REGRESSION	.00	1	.00
DEVIATION	.00	5	.00
TOTAL VARIATION	.00	6	

F-TEST FOR EQUALITY OF SAMPLE/REGRESSION VARIANCE
F TEST - SIGNIFICANCE OF REGRESSION =   0.00
    LEVEL .05% - CRITICAL VALUE = 6.61

SPECIFIC CONDUCTANCE (umhos/cm)

COEFFICIENT MATRIX AND AUGMENTED MATRIX
```
                                         890                    2632.0000
                  890               1132500            3347950.0000
```
REGRESSION COEFFICIENTS OF NORMAL EQUATION
```
          163.769230769242
            0.166923076923
   ORIGINAL X - Y PAIRS      PREDICTED VALUES      DEVIATION
   1300.0000    369.0000         380.7692          11.7692
   1300.0000    394.0000         380.7692          13.2308
   1300.0000    416.0000         380.7692          35.2308
   1200.0000    416.0000         364.0769          51.9231
   1300.0000    396.0000         380.7692          15.2308
   1250.0000    307.0000         372.4231          65.4231
   1250.0000    334.0000         372.4231          38.4231
```

STATISTICAL ANALYSIS WITH ORDER OF EQUATION= 1
NUMBER OF X - Y PAIRS= 7
TOTAL SUMS OF SQUARE= 10498
SUMS OF SQUARES DUE TO REGRESSION= 258.730769
SUMS OF SQUARES DUE TO DEVIATION= 10239.269231
GOODNESS OF FIT= .024646
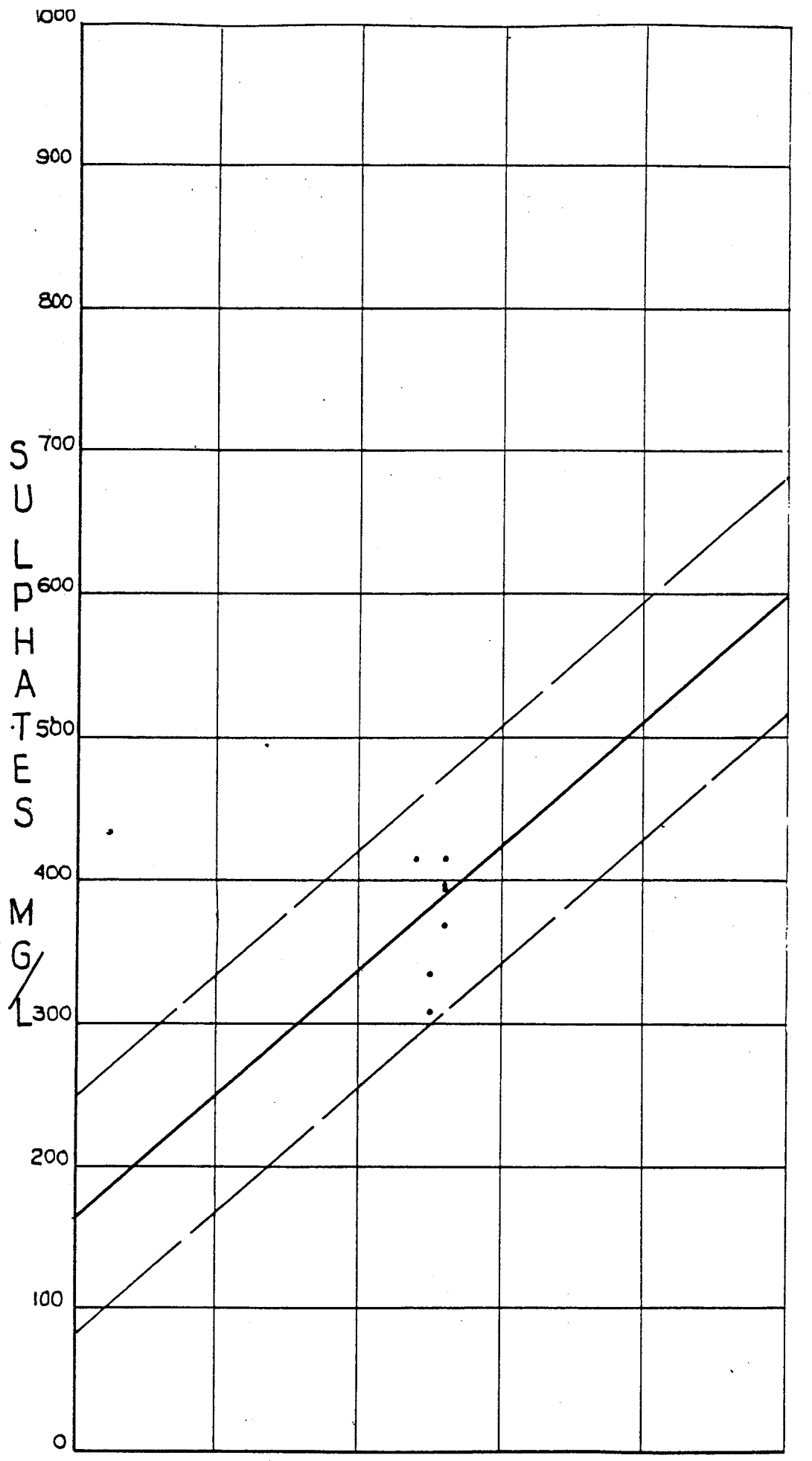MULTIPLE CORRELATION COEFFICIENT   0.15699
STANDARD DEVIATION 41.310348

                 ANALYSIS OF VARIANCE
     SOURCE OF   SUM OF   DEGREES OF   MEAN
     VARIATION   SQUARES   FREEDOM   SQUARE
LIN. REGRESSION   258.73   1   258.73
DEVIATION   10239.27   5   2047.85
TOTAL VARIATION   10498.00   6

F-TEST FOR EQUALITY OF SAMPLE/REGRESSION VARIANCE
F TEST - SIGNIFICANCE OF REGRESSION =   0.13
     LEVEL .05% - CRITICAL VALUE = 6.61

SPECIFIC CONDUCTANCE (umhos/cm)
BIG BERTHA - SAMPLE ZONE 17

COEFFICIENT MATRIX AND AUGMENTED MATRIX

```
                                            890                      249.9000
                   890                    1132500                  316815.0000
```
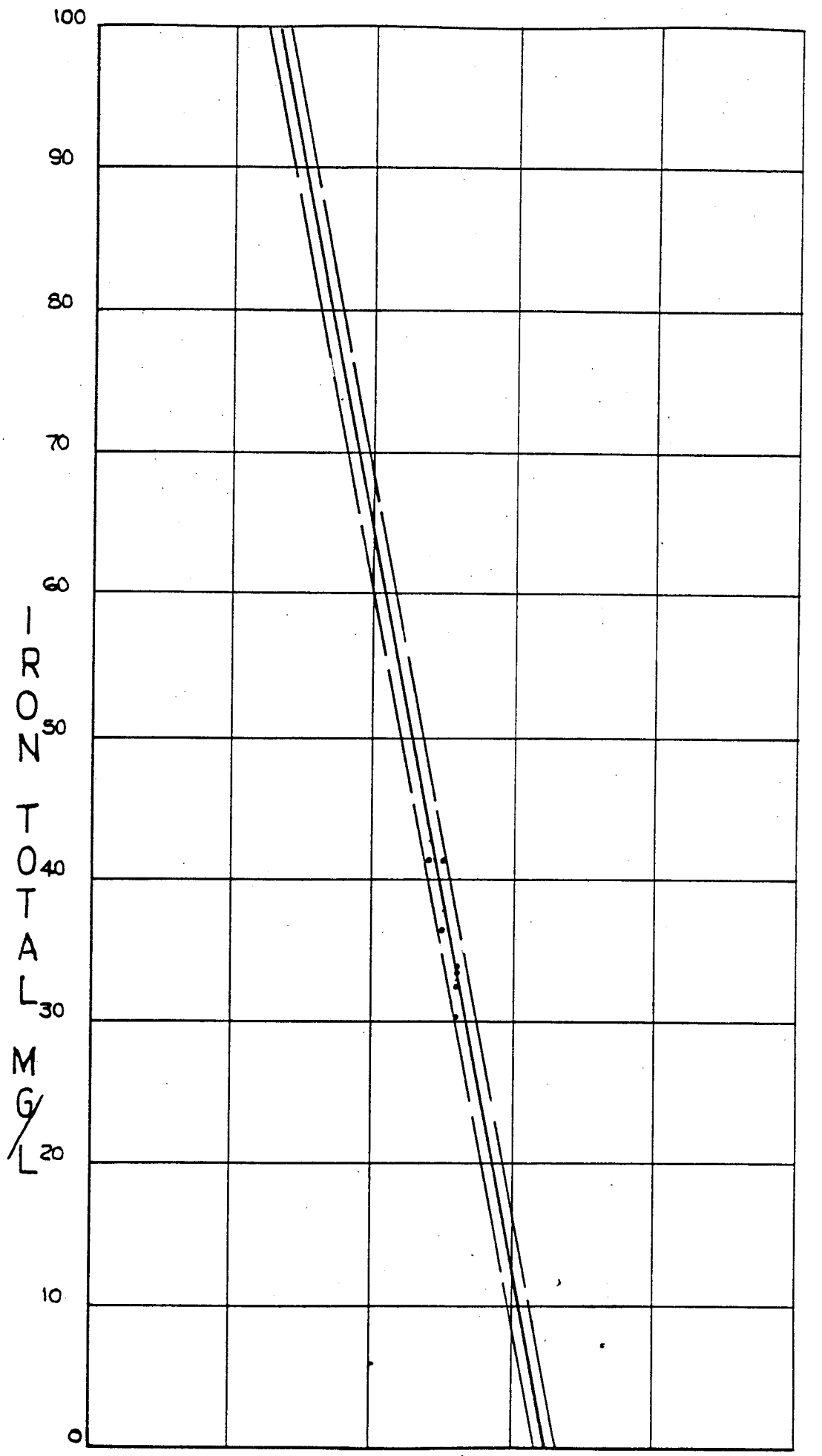
REGRESSION COEFFICIENTS OF NORMAL EQUATION
```
          160.984615384613
      -     0.098538461538
```

ORIGINAL X - Y PAIRS		PREDICTED VALUES	DEVIATION
1300.0000	32.5000	32.8846	0.3846
1300.0000	30.2000	32.8846	2.6846
1300.0000	33.6000	32.8846	0.7154
1200.0000	41.5000	42.7385	1.2385
1300.0000	34.0000	32.8846	1.1154
1250.0000	41.6000	37.8115	3.7885
1250.0000	36.5000	37.8115	1.3115

STATISTICAL ANALYSIS WITH ORDER OF EQUATION= 1
NUMBER OF X - Y PAIRS= 7
TOTAL SUMS OF SQUARE= 116.88
SUMS OF SQUARES DUE TO REGRESSION= 90.162692
SUMS OF SQUARES DUE TO DEVIATION= 26.717308
GOODNESS OF FIT= .771412
MULTIPLE CORRELATION COEFFICIENT   0.87830
STANDARD DEVIATION 2.110186

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE
LIN. REGRESSION	90.16	1	90.16
DEVIATION	26.72	5	5.34
TOTAL VARIATION	116.88	6	

F-TEST FOR EQUALITY OF SAMPLE/REGRESSION VARIANCE
F TEST - SIGNIFICANCE OF REGRESSION =   16.87
     LEVEL .05% - CRITICAL VALUE = 6.61

SPECIFIC CONDUCTANCE (umhos/cm)
BIG BERTHA - SAMPLE ZONE 17

COEFFICIENT MATRIX AND AUGMENTED MATRIX
```
                                        890                      236.2000
                  890              1132500               299470.0000
```
REGRESSION COEFFICIENTS OF NORMAL EQUATION
```
          148.953846153841
            0.090615384615
```

ORIGINAL X - Y PAIRS		PREDICTED VALUES	DEVIATION
1300.0000	29.5000	31.1538	1.6538
1300.0000	29.2000	31.1538	1.9538
1300.0000	33.2000	31.1538	2.0462
1200.0000	39.0000	40.2154	1.2154
1300.0000	31.5000	31.1538	0.3462
1250.0000	40.8000	35.6846	5.1154
1250.0000	33.0000	35.6846	2.6846

STATISTICAL ANALYSIS WITH ORDER OF EQUATION= 1
NUMBER OF X - Y PAIRS= 7
TOTAL SUMS OF SQUARE= 121.957143
SUMS OF SQUARES DUE TO REGRESSION= 76.246374
SUMS OF SQUARES DUE TO DEVIATION= 45.710769
GOODNESS OF FIT= .62519
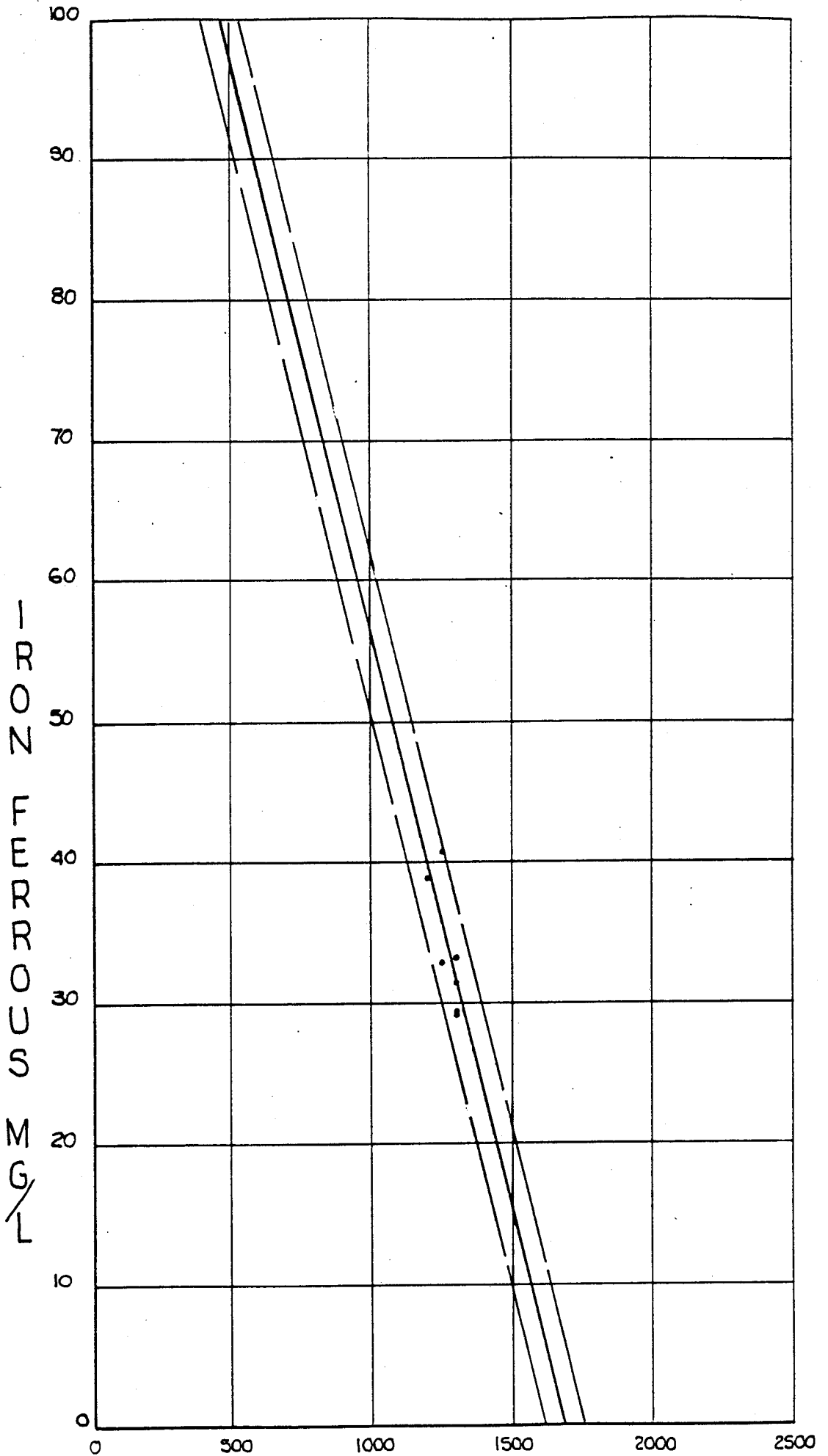MULTIPLE CORRELATION COEFFICIENT   0.79069
STANDARD DEVIATION 2.760156

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE
LIN. REGRESSION	76.25	1	76.25
DEVIATION	45.71	5	9.14
TOTAL VARIATION	121.96	6	

F-TEST FOR EQUALITY OF SAMPLE/REGRESSION VARIANCE
F TEST - SIGNIFICANCE OF REGRESSION =   8.34
     LEVEL .05% - CRITICAL VALUE = 6.61

IRON FERROUS MG/L vs. SPECIFIC CONDUCTANCE (umhos/cm)

BIG BERTHA - SAMPLE ZONE 17

```
SAMPLE.SEVNTEEN               SPECIFIC CONDUCTANCE VS. FERRIC IRON

COEFFICIENT MATRIX AND AUGMENTED MATRIX
                                     890                    13.7000
                    890             1132500           17345.0000
REGRESSION COEFFICIENTS OF NORMAL EQUATION
            12.030769230769
  -          0.007923076923
   ORIGINAL X - Y PAIRS      PREDICTED VALUES      DEVIATION
   1300.0000      3.0000         1.7308              1.2692
   1300.0000      1.0000         1.7308              0.7308
   1300.0000      0.4000         1.7308              1.3303
   1200.0000      2.5000         2.5231              0.0231
   1300.0000      2.5000         1.7308              0.7692
   1250.0000      0.8000         2.1269              1.3269
   1250.0000      3.5000         2.1269              1.3731

STATISTICAL ANALYSIS WITH ORDER OF EQUATION= 1
NUMBER OF X - Y PAIRS= 7
TOTAL SUMS OF SQUARE= 8.737143
SUMS OF SQUARES DUE TO REGRESSION= .582912
SUMS OF SQUARES DUE TO DEVIATION= 8.154231
GOODNESS OF FIT= .066717
MULTIPLE CORRELATION COEFFICIENT          0.25830
STANDARD DEVIATION 1.165778


                    ANALYSIS OF VARIANCE
        SOURCE OF      SUM  OF      DEGREES OF      MEAN
        VARIATION      SQUARES      FREEDOM        SQUARE
LIN. REGRESSION          .58           1            .58
DEVIATION               8.15           5           1.63
TOTAL VARIATION         8.74           6

F-TEST FOR EQUALITY OF SAMPLE/REGRESSION VARIANCE
F TEST - SIGNIFICANCE OF REGRESSION =           0.36
     LEVEL .05% - CRITICAL VALUE = 6.61
```
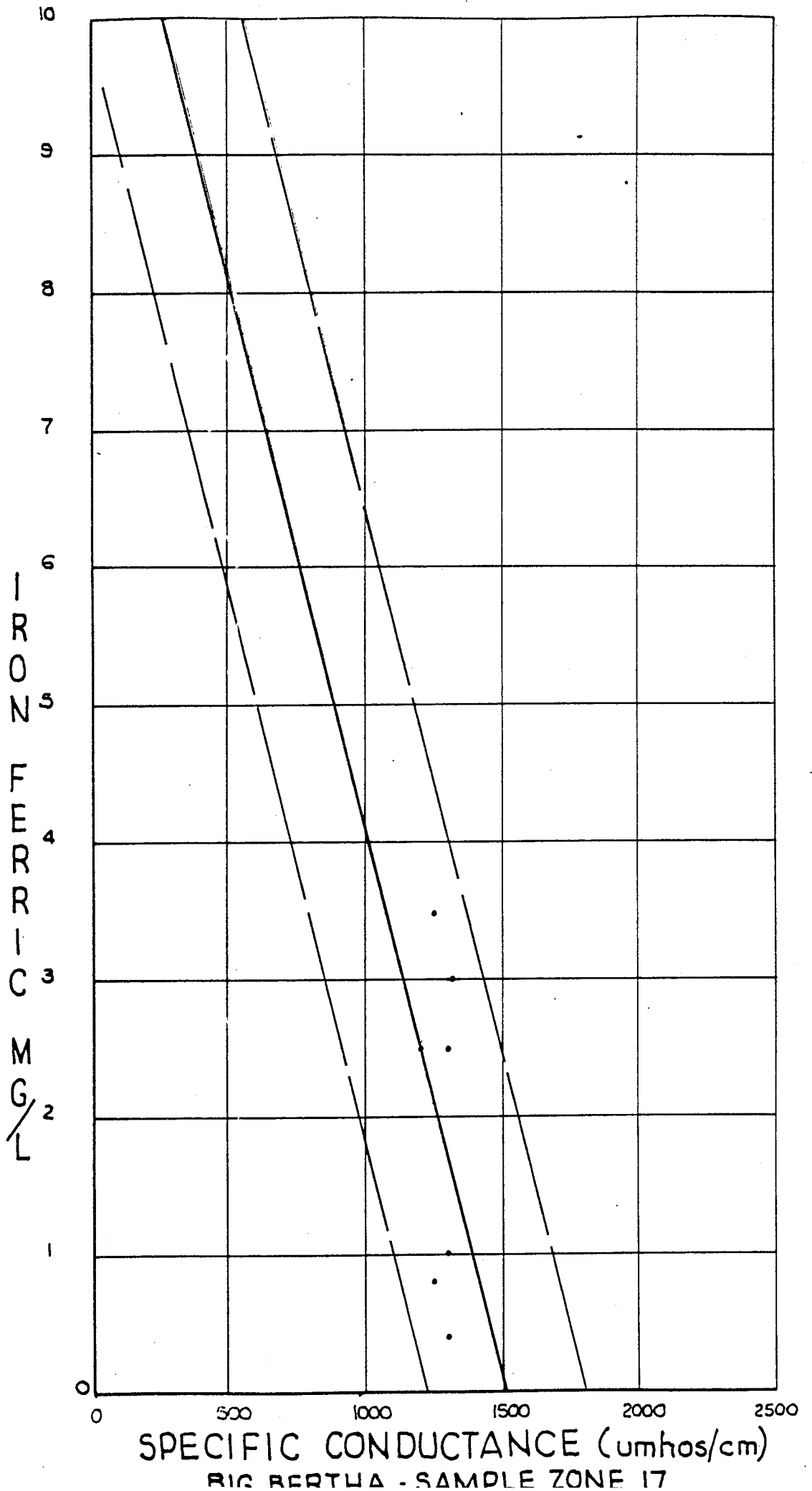
IRON FERRIC MG/L

SPECIFIC CONDUCTANCE (umhos/cm)

BIG BERTHA - SAMPLE ZONE 17

POST CLOSURE DATA LISTING *

SAMPLE SEVENTEEN

DATE	SPEC. COND.	DISCHARGE	pH	ALKALINITY	ACIDITY	SULPHATES	TOTAL IRON	FERROUS IRON	FERRIC IRON
6/12	2100	.016	5.57	22	341	395	189.0	188.0	1.0
6/16	1700	.016	5.37	14	292	1142	156.0	154.0	2.0
6/21	1400	.016	6.02	50	4	556	62.2	59.6	2.6
7/10	1600	.016	5.94	42	31	422	47.6	46.8	0.8
7/26	1400	.016	6.18	56	0	253	39.1	39.0	0.1
8/21	1200	.016	6.15	40	10	171	78.0	78.0	0.0

* Units are as follows:

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