METALLURGY -BIO-OXIDATION TEST

BIO-OX OF SULFER WEEKLY-BROHM REPORTING -
BY LAURA DAMON

Post-It™ brand fax transmittal memo 7671

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Sulfide

MEMORANDUM

DATE: March 8, 1996

TO: Jim Thompson

FROM: Laura Damon

RE: Broken Sulfide Neutralization Schedule

C: Troy Fierro
John Trimble

A neutralization schedule of four months was calculated last fall for Troy's budgeting purposes on a proposed 400,000 tons of broken sulfides (original amount to be crushed) on cells 1-4 with an estimated 600gpm of detox solution going over the ore.

In reality, the tonnage to be neutralized has been increased to 638,960 tons with an actual 572,490 tons of broken sulfides being crushed and the decision to neutralize 46,430 tons of cell #5 ore and an estimated 20,000 tons of cell #6 ore.

This additional tonnage calculates to a best case neutralization schedule scenario of about six months provided 600gpm of solution actually going over the ore can be consistently maintained throughout the neutralization period. So far, due to recirculating solution, only about 75gpm per cell is being applied on cells 2-4. At this rate the neutralization schedule will be increased to about 10 months for each cell, pushing back the offloading of cells 1-5 to January 1997. Even if flows of 100gpm per cell are maintained it will take an estimated 7 months (or October) before offload will be possible.

You may want to consider maximizing flow on a couple of cells at a time to rinse them more quickly and provide space for Anchor Hill crushed ore. If 200gpm per cell (of actual solution going over the heap) can be maintained, a single cell heap should be rinsed in about four months providing pad space sometime in July. If you recall, this is the schedule that was discussed for cells 3 & 4 during the January 26, 1996 Staff Meeting.

MEMORANDUM

DATE: April 10, 1996

TO: Jim Thompson

FROM: Laura Damon

RE: Broken Sulfide Neutralization Rate

C: John Trimble

After review of various cyanide neutralization (rinsing) techniques (Hydrogen peroxide, Caro,s acid, Hypochlorite,), the neutralization rate dilemma regresses to the situation studied in depth in 1989-1990.

The problem is not chemical in nature but physical. The cyanide is sufficiently and efficiently detoxified by hydrogen peroxide. Once the cyanide is rinsed to compliance concentration (2 ppm), the other parameters (with the exception of TDS) have been within compliance off-loading criteria. (Note that either a method to lower TDS levels or a variance for compliance limits must be achieved before off-loading.)

In my opinion it would do no good to put elevated concentrations of hydrogen peroxide into the heaps. Evidence has shown that the peroxide decomposes from contact with the ore before it gets very far into the heap and therefore is a waste of peroxide and money. Applying hypochlorite directly into the heap could cause chloride concentrations in excess of compliance limits. Caro's acid has the same problem with sulfate levels as it is made with sulfuric acid. There is no evidence that direct application of these chemicals would do any good anyway or that they would permeate the heaps any better than water.

The solution to pollution is dilution. The heaps must be **RINSED**! in order to get the contaminants out of the spent ore and meet off-loaded criteria. The only way to achieve this is to get more flow through the heaps.

Use of surfactants (Nalco, Drew, Union Carbide, Exxon, DuPont) in the rinse solution for increased "wetability" or flow was studied in detail in 1989. No increase in the

neutralization rate was shown from any of these many tests. That's when the "Geochemical Study of Leach Pad Cyanide Neutralization" was implemented. I've attached a copy of the paper for your review.

Various ideas for increased permeability come to mind, feasible or not.

- Rip the tops of the heaps periodically and re-pipe. (Lay the emitters on top of the ore and cover with bird netting so they can be reused.)

- Rip, neutralize and off-load the heaps in lifts. (This may work if the impermeability is from truck traffic when loading on each lift.)

- Drill holes into the heaps and force pressured water through them. (If the impermeability is distributed through out the heap, this would not work.)

- Put small explosives charges in the heaps and "fluff" the ore.

Somehow, someway rinse water flow must be increased through the heaps in order to achieve a faster neutralization rate.

GEOCHEMICAL STUDY OF LEACH PAD CYANIDE NEUTRALIZATION BROHM MINING CORPORATION, SOUTH DAKOTA

Laura L. Damon, Adrian Smith, and Terry Mudder

ABSTRACT

A geochemical study of cyanide neutralization processes was conducted at Brohm Mining Corporation to gain a better understanding of the leach pad behavior and to develop a simplified procedure to quantify the attainment of compliance with permitted cyanide neutralization criteria. Such attainment is a prerequisite for off-loading spent ore from the leach pad at the "load/unload" gold heap leach operation.

The geochemical study program consisted of size fraction analyses and weak acid dissociable (wad) cyanide analyses for various sections of the spent ore from the actual leach pad. Further testwork included size fraction analyses and wad cyanide analyses on the ore from four 29 foot laboratory test columns which were leached and neutralized with different neutralization treatments in parallel with an actual active leach pad. Wad cyanide was analyzed daily on the neutralizing columns and various parameters were monitored weekly on the influents and effluents during the leach cycle and neutralization period. A comparison was made of neutralized effluent chemistry and porewater extraction fluids, as well as an analysis of the selective adsorption of cyanide on various particle size fractions.

INTRODUCTION

In a "load/unload" gold heap leach operation, the time that a heap[1] is on the reusable leach pad is of critical economic importance. The turnover of heaps must flow in a consistent and cyclic manner in order to leach the gold bearing ore in an economically feasible manner. The process cycle is time dependent on two main stages, leaching and neutralizing. During the leaching stage, an alkaline solution containing cyanide is sprayed over a heap to extract the precious metals from the ore. After the precious metals have been extracted from the ore, the remaining cyanide must be rinsed from the heap in a neutralization phase. The cyanide is rinsed from the ore and detoxified with hydrogen peroxide using copper sulfate as a catalyst for the reaction. A prolonged neutralization stage interrupts the continuity of the process cycle and becomes the limiting factor in heap turnover time. Therefore, an understanding of the neutralization processes can be beneficial

[1] a Brohm heap contains approximately 65,000 tons of ore

in expediting neutralization, while ensuring an environmentally safe level of weak acid dissociable (wad) cyanide prior to the unloading of spent ore.

The South Dakota treatment standard for off-loading a heap requires <0.5mg/l wad cyanide in the heap effluent[2]. Other species are regulated using a solid sample extraction test on the spent ore. During the testing to assess the effectiveness of rinsing the spent ore, it was found that compliance for wad cyanide was met more rapidly in the porewater[3] from the spent ore than in the heap effluent. The neutralization period required to meet the treatment standard in the heap effluent required an average 80 days per heap, close to the time allotted for the entire process cycle. Compliance for wad cyanide was achieved in the porewater after about 30 days. Because of the difficulty in meeting the process cycle time requirement and due to the observations from the solid sample testing, Brohm Mining Corporation (BMC) requested a Technical Revision from the South Dakota Department of Water and Natural Resources (DWNR) to off-load spent ore using the porewater test.

After review of the existing data, the DWNR allowed the off-loading of spent ore at a heap effluent wad cyanide level of 2 mg/l providing the spent ore porewater sampling met the unload criteria of <0.5 mg/l wad cyanide. Spent ore could be off-loaded using this criteria for an interim period. During this time BMC agreed to conduct an Interim Neutralization Study to gain a better understanding of the leach pad behavior. The program consisted of size fraction analyses and wad cyanide analyses for various sections of the spent ore from the actual leach pad. Further testwork included size fraction analyses and wad cyanide analyses on the ore from four 29 ft laboratory test columns which were leached and neutralized with different neutralization treatments. A comparison was made of neutralized effluent chemistry and porewater extraction fluids, as well as an analysis of the selective adsorption of cyanide on various particle size fractions.

METHODS AND MATERIALS

Leach Pad Heap Tests

During the off-loading of an actual leach pad, spent ore samples were collected from 5 ft sections extending from 5 to 30 feet, and from 1 ft sections extending from the base of the heap up to 5 feet. The five uppermost samples were collected by first exposing a 5 ft bench in the spent ore and then removing a vertical composite from the exposed bench. Vertical control was maintained by using a level and tape. The bottom 5 ft section of the heap was sampled by first exposing the 5 ft bench and then collecting successive 1 ft thick shelves of material. Care was taken not to allow slumping material from the already

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[2] heap effluent: solution collected from the toe of the heap

[3] porewater (synonym: pore fluid): the water that exists in the voids between the rock particles in the spent ore, i.e., the interstitial water

sampled sections to mix with samples being collected. The bottommost sample (0-1 ft) included the material directly on top of the asphalt surface underlying the heap. All samples contained over 250 lb (114 kg) of spent ore, were placed in plastic lined 55 gal barrels and were immediately closed and sealed leaving minimal air retention.

The samples were prepared for analyses by mixing the sample which was then coned and quartered. In addition to the above sample preparation procedure, subsampling was conducted on the samples from 25-30 ft, 10-15 ft, and 1-2 ft, as a quality assurance measure on wad cyanide volatilization during mixing.

The sample to be analyzed for size gradation and moisture was placed in a tared container, weighed, and dried at 100°C. After drying, the sample was again weighed and the moisture content calculated. The dried sample was screened yielding size fractions of plus 2 1/2, 2, 1 1/2, 1, 3/4, 1/2, 1/4, and minus 1/4 inch. The "fines" were washed off the individual size fractions and combined with the minus 1/4 inch material. The individual size fractions were re-dried and weighed. The minus 1/4 inch material was wet screened yielding plus 4, 8, 14, 28, 48, 100, 200, and minus 200 mesh (Tyler) sieve fractions. The individual sieve fractions were filtered through a pressure filter pot, dried and weighed.

Batch tests[4] were run on samples from each section of the heap as well as on the various subsamples. The batch tests were run at a 2:1 solution to dry ore weight ratio, using U.S. EPA Method 1312 Extraction Solution #1[5] for the liquid phase. The solution and ore were placed in a bottle with zero headspace, rolled on a bottle rolling device for 23 3/4 hr, and allowed to settle for 15 min. The solution was decanted into a pressure filter pot and filtered. The solid sample equilibrated solution[6] was collected and immediately tested for sulfides and oxidants. Two splits were made from the filtered solution. One split was refrigerated, nonpreserved, and analyzed within 24 hr for wad cyanide and thiocyanate (SCN). The second split was preserved with 5 molar (M) sodium hydroxide (NaOH), refrigerated, and analyzed within a week of collection for wad cyanide.

Column Tests

Four 29 ft (8.839 m) long, 10 inch (0.254 m) diameter columns were constructed from white PVC pipe and connected with 12 bolt PVC flanges with rubber gaskets. The bottom section had a 12 inch sight glass and two screens on the bottom, a 1 inch heavy screen covered with a 40 mesh screen. The columns sat on a metal plate, six inches off the floor.

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[4] batch test: bottle roll for solid sample extraction

[5] EPA Method 1312 Extraction Solution #1: deionized water pH adjusted to 4.2 with a 60:40% mixture of sulfuric and nitric acids

[6] solid sample equilibrated solution: the liquid portion derived from a solid sample extraction or leaching test

A 1 inch black steel pipe, with a 3/8 inch reducer and ball valve, extended from the bottom of the column. Tygon tubing connected the pipe to a 7 gal (26.5 L) covered collection vessel. The collection vessel held a bottle for the assay sample collection. The influent solutions were delivered by metering pumps. A 125 gal storage tank, with continuous feed from the process plant barren line, was used for the leach cycle influent. An 1100 gal tank was used for neutralization solution collection and storage during the neutralization period.

Approximately 12 tons of ore was collected by random sampling of the crushed ore stockpile. The ore was collected in the bucket of a front-end loader and transferred to the crusher bin. The ore was passed through the crusher to ensure 80-90 percent less than 1 inch material and to blend the ore into a homogeneous sample.

The columns were loaded with ore sequentially by 5 ft sections. The ore was loaded by random shoveling of the "stockpile" into a tared funnel bucket containing a slide gate. The loaded funnel bucket was weighed and hoisted above the column section and the material was allowed to fall into the section. The top two sections were loaded by tared and weighed 5 gal buckets.

The ore density was calculated for each column. The loaded columns were then filled with water. The water was allowed to saturate the ore and the columns were drained slowly. The amount of drained water was measured for each column, giving the pore volume[7].

The ore in each column was leached for 60 days, the average of actual operating conditions, with 0.5 lb per ton sodium cyanide (NaCN) barren solution at an application rate of 0.0040 gpm per sq ft (0.159 L per min per sq m), to mimic field conditions. The columns were run concurrently with Cell #5, a heap containing the same ore type as the columns. A 15 inch phreatic head was maintained in the base of the leaching ore simulating actual heap conditions. The effluent was collected daily in the collection vessel. Tygon tubing went to the bottom of the collection bottle and as the bottle filled it displaced the solution making it overflow into the tank resulting in a positive discharge system. The column effluent was weighed daily. Gold (Au), silver (Ag), NaCN and pH were analyzed daily on the column effluents, Cell #5 effluent and the barren solution. Iron (Fe), copper (Cu), zinc (Zn), total hardness, alkalinity, conductivity, wad cyanide and thiocyanate (SCN) were analyzed on a weekly basis for the above solutions.

After leaching and a two day drain period were completed, the columns were neutralized at an application rate of 0.0043 gpm per sq ft (0.171 L per min per sq m), equivalent to the average of actual operating conditions. The process neutralization solution contained 0.2 mg/l wad cyanide. Each of the four columns had a different neutralization treatment. Column A was neutralized with neutralization solution to a wad cyanide value

[7] pore volume: the volume of solution that will just saturate a fully drained (under gravity) volume of rock

of 2 mg/l as was Cell #5. Column B was neutralized with neutralization solution until a wad cyanide equilibrium was reached. Column C was neutralized with neutralization solution to 2 mg/l wad cyanide followed by one pore volume groundwater rinse. Column D was neutralized with neutralization solution to 2 mg/l wad cyanide followed by one pore volume deionized water rinse. A 15 inch phreatic head was maintained in the base of the neutralizing ore. Effluent sample collection was the same as in the leach cycle. Wad cyanide was analyzed daily on the column effluents and Cell #5 effluent. Cu, Fe, Zn, manganese (Mn), nickel (Ni), calcium (Ca), magnesium (Mg), sodium (Na), chloride (Cl), sulfate (SO_4), ammonia (NH_3), SCN, total hardness, conductivity, alkalinity and pH were analyzed on a weekly basis. The neutralization solution, groundwater and deionized water were analyzed on collection and at the end of their use. All samples were refrigerated, analyzed within 48 hr of collection, and not preserved, excluding the samples analyzed for dissolved metals. These samples were preserved with nitric acid to pH <2. Ten percent of all samples generated were sent to outside laboratories for quality assurance purposes.

The columns were allowed to drain for three days at the end of the neutralization period and then were unloaded a section at a time. Samples were removed from each section with a post hole digger and collected in plastic lined 5 gal buckets. For sections 2-6, the second bucket of material (from the top of each section) was removed and saved for size fraction and moisture analyses. The third bucket of material was removed and saved for batch test analyses. The second and fourth buckets of material were saved for size fraction and moisture analyses from section 1 and the first, third and fifth buckets of material were saved for batch test analyses.

The samples collected for size gradation were prepared by dumping the material from the bucket onto a clean tarp and rolling the ore until uniform. The sample was then coned and quartered and two opposite quarters analyzed for size gradation and moisture content in the same manner as the "Leach Pad Heap Tests".

Batch testing was done on the various sections collected from the column spent ore. Column A and Column D batch tests were run at a 1:1, 2:1 and 4:1 solution to dry ore weight ratio to compare the wad cyanide concentrations to the various ratios. Column B and Column C batch tests were run at a 2:1 ratio. If wad cyanide was detected in the 2:1 ratio batch test then 1:1 and 4:1 batch tests were run using U.S. EPA Method 1312 Extraction Solution #1 for the liquid phase. The batch testing was conducted in the same manner as the "Leach Pad Heap Tests" procedure except no preserved splits were made. The solid sample equilibrated solution was analyzed within 48 hr for wad cyanide and SCN. Ten percent of all samples generated were sent to outside laboratories as a quality assurance measure.

Cell #5 was off-loaded using the same criteria set forth in the sampling of the actual leach pad heap in the "Leach Pad Heap Tests". Cell #5 had a HDPE liner instead of asphalt on the bottom of the cell. To protect the liner, a one foot layer of fines (minus 1/4 inch material) was put directly on top of a geotextile covering (0-1 ft). A one foot layer

of course material (plus 1/4 inch) covered the layer of fines (1-2 ft). This was the only difference between this heap and the heap in the "Leach Pad Heap Tests". Size gradation and batch tests were done in the same way as the "Leach Pad Heap Tests". In addition, batch tests were run at a 1:1 and 4:1 ratio if wad cyanide was detected in the 2:1 batch test.

RESULTS AND DISCUSSION

Leach Cycle

Table 1 shows the comparison between operating parameters during the leach cycle. Each column and Cell #5 were leached for 61 days at a constant flow rate. The pH of the columns was consistently lower than that of Cell #5 presumably due to the amount of lime in the original crushed ore. The NaCN (lb per ton) levels also stayed consistently lower for the columns compared to Cell #5 probably due to increased cyanide volatilization.

Neutralization Period

Table 2 shows various data comparisons during the neutralization period. The flow rates were relatively constant for all of the columns and Cell #5. All columns took about the same amount of time to reach 2 mg/l wad cyanide. Cell #5 took approximately twice as long to reach this same wad cyanide concentration. Column C and Column D both had water rinses after the 2 mg/l wad cyanide level was reached. These columns took about the same amount of time to go from 2 mg/l to 0.5 mg/l wad cyanide. Column B had continued neutralization solution application, shown in Table 2, and lagged behind Column C and D.

Column A and Cell #5 were both neutralized to 2 mg/l wad cyanide with neutralization solution and unloaded. Figure 1 shows that the rinse of Column A was more efficient than the rinse of Cell #5. Cell #5 took about twice the amount of solution to ore ratio as Column A.

Column C and Column D were neutralized to 2 mg/l wad cyanide with neutralization solution and then given one pore volume water rinses. Column C had a local groundwater rinse to determine if the removal of wad cyanide from 2 mg/l to 0.5 mg/l would improve significantly with the fresh water rinse. Column D had a deionized water rinse to compare the wad cyanide extraction efficiency between the groundwater and deionized water. As seen in Figure 2, the columns track almost identically to 2 mg/l wad cyanide. The columns also show the same slope from 2 mg/l to the end of rinsing indicating that both rinsing methods behave in the same manner.

Column B was rinsed with neutralization solution for its entire duration under neutralization. Figure 3 shows a comparison between Column C, having a groundwater rinse once it reached 2 mg/l wad cyanide, and Column B. Again the two columns track almost identically to 2 mg/l wad cyanide. However, comparing the slopes as the wad

Table 1: Leach Cycle Data Comparison

Sample I.D.	Column A	Column B	Column C	Column D	Cell #5
Days on Leach	61	61	61	61	61
Avg gpm/sq ft	246	249	263	249	222
Final pH	8.25	8.31	8.18	8.12	10.4
Final NaCN lb/ton	0.28	0.29	0.28	0.28	0.45
Final Wad Cyanide (mg/l)	207	210	210	210	200

Table 2: Neutralization Period Data Comparison

Sample I.D.	Column A	Column B	Column C	Column D	Cell #5
Days to ~2 mg/l Wad Cyanide	20	23	22	22	42
Actual Wad Cyanide Value	(2.00 mg/l)	(1.68 mg/l)	(1.85 mg/l)	(1.60 mg/l)	(2.00 mg/l)
Avg gpm/sq ft	280	287	280	283	287
Days to 0.5 mg/l Wad Cyanide	---	34	31	30	---

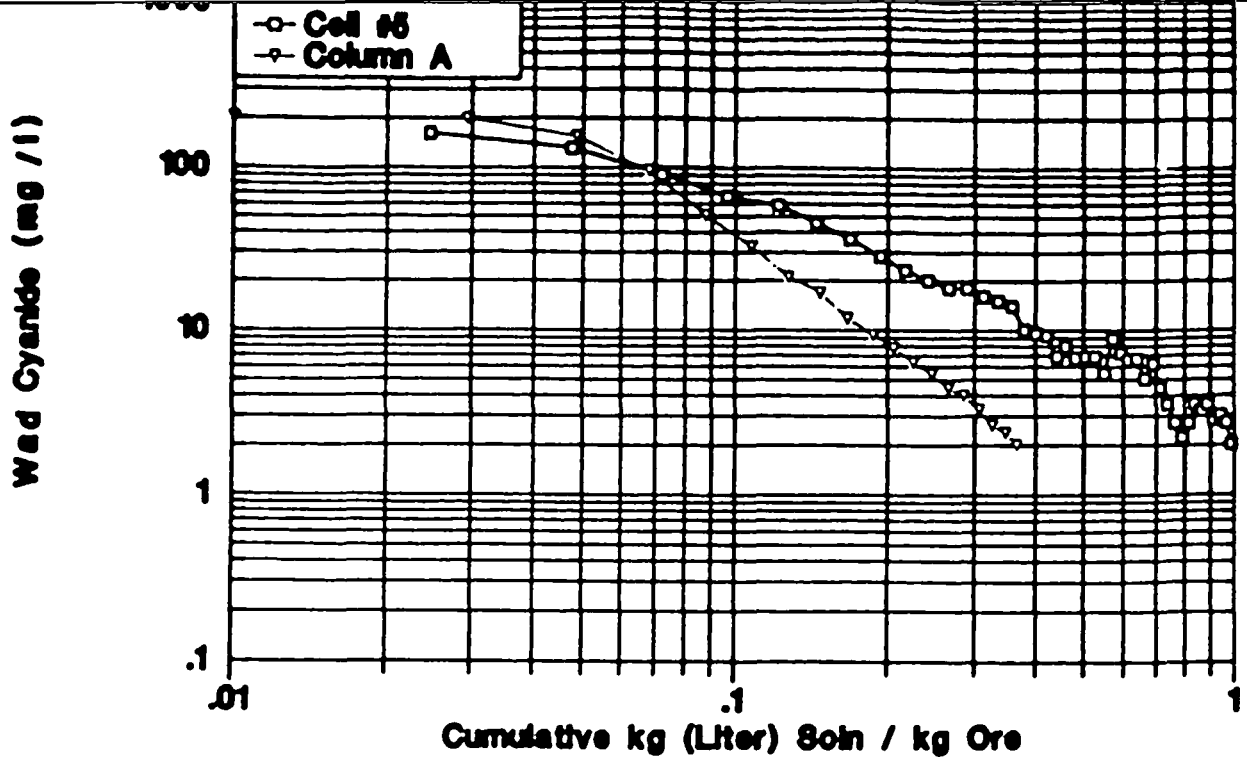

Figure 1. Wad Cyanide Concentration versus Kg Solution per Kg Ore for Cell #5 and Column A (Both neutralized to 2 mg/l wad cyanide with neutralization solution).

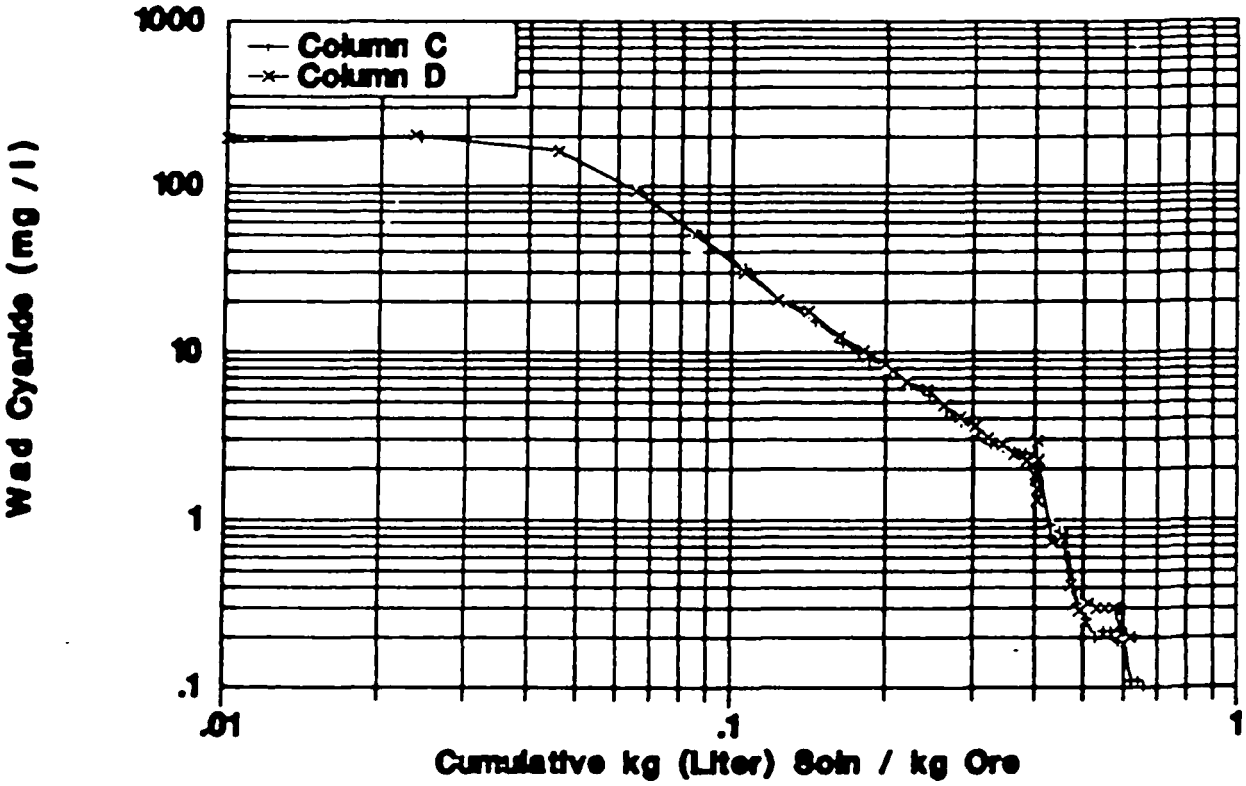

Figure 2. Wad Cyanide Concentration versus Kg Solution per Kg Ore for Column C and Column D (both neutralized to 2 mg/l wad cyanide with neutralization solution and given 1 pore volume water rinses).

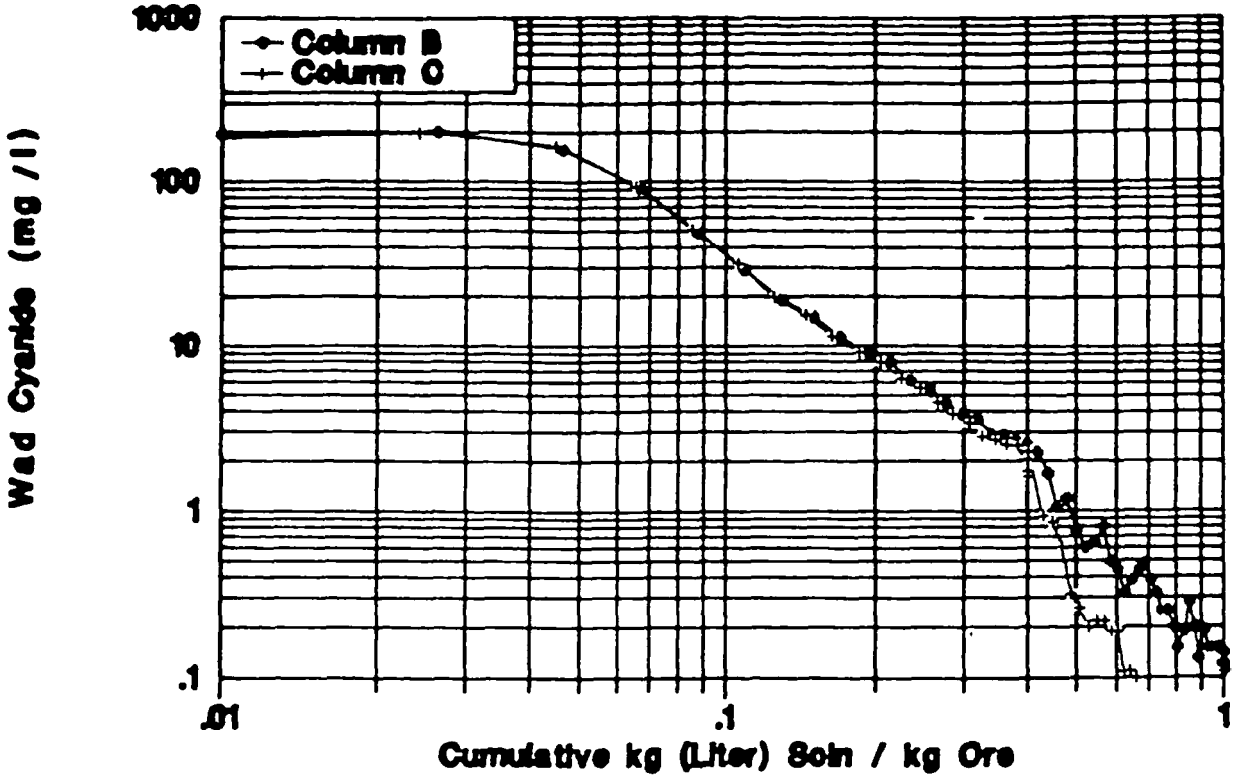

Figure 3. Wad Cyanide Concentration versus Kg Solution per Kg Ore for Column B and Column C (both neutralized to 2 mg/l wad cyanide with neutralization solution, Column B continued neutralization solution rinse and Column C local groundwater rinse).

Table 3: Linear Regression Equation and Correlation Coefficient for Wad Cyanide Concentration vs Cumulative Effluent

	Day 5 to 2 mg/l Wad Cyanide	
	Linear Regression Equation	Correlation Coefficient
Cell #5	C = 10^(-1.504594*log(Veff) + 12.171820)	.957563
Column A	C = 10^(-2.236485*log(Veff) + 5.559605)	.998542
Column B	C = 10^(-1.997499*log(Veff) + 5.090031)	.995512
Column C	C = 10^(-2.089519*log(Veff) + 5.261638)	.996854
Column D	C = 10^(-2.089597*log(Veff) + 5.257948)	.996905

cyanide concentration decreases from 2 mg/l, it can be seen that Column C has a steeper slope than Column B indicating that the neutralization solution rinse is less efficient than the groundwater rinse at lower concentrations of wad cyanide. The concentration gradient between the neutralization solution (0.16 mg/l wad cyanide) and the column effluent is less than the concentration gradient between the groundwater (<0.1 mg/l wad cyanide) and the column effluent. This may contribute to the neutralization solution rinse being less efficient than the groundwater rinse. The lower pH in the groundwater (pH = 5.6) versus the neutralization solution (pH = 8.6) may also be a factor in the differences between the two rinse procedures as cyanide volatilization will be enhanced at the lower pH.

A kilogram of solution (equivalent to 1 liter) per kilogram of ore ratio has been used for comparison to the wad cyanide concentration. This ratio has been used in the past at BMC to track the neutralization progress of heaps. A definite trend was observed from heap to heap. The consistency in the amount of solution per amount of ore between the heaps enabled the prediction of the readiness of heaps, within a few days, for compliance testing.

From Figure 1-3 it appears that about five days (fifth character on the illustration) are required to reach equilibrium. Table 3 shows the linear regression equations and correlation coefficients for each column and Cell #5 from Day 5 to 2 mg/l wad cyanide. The data for the four columns fit an equation of the form logC = mlogV+constant where C is the wad cyanide concentration, V is the cumulative volume of effluent, in liters, and m is the slope, or (C = 10^(mlogV+constant)) with the coefficient of correlation (r^2) > 0.996. Cell #5 shows a similar fit, but at a lower r^2 value of 0.958 which may be due to its not being as controlled in the experiment, i.e.,the amount of effluent was not measured exactly, the tons of ore on the cell were measured by truck loads, and there is more variance in sample collection.

Displacement, Dilution, and Diffusion

Displacement appears to play a part in the rinsing of a heap or column. If the mechanism of rinsing were strict displacement, the cyanide concentration in the effluent would remain constant until the cyanide was displaced and the concentration decreased to zero. However the cyanide concentration decreases steadily from the beginning of the neutralization period, indicating that dilution is taking place.

The decrease in cyanide concentration occurs more slowly during the first four or five days of the neutralization period than in the subsequent days. Dilution seems to be the main controlling factor in the decrease of cyanide from the beginning of the neutralization period. However, the cyanide concentration decrease is slower than what can be accounted for by strict dilution. For example, the wad cyanide concentration for Column A at 0.01 kg solution per kg ore is 200 mg/l. At 0.1 kg solution per kg ore the wad cyanide concentration is about 40 mg/l. If the cyanide removal mechanism were strict dilution then at ten times the amount of solution, i.e. 0.1 kg solution per kg ore the wad cyanide concen-

tration should be ten times less, i.e. 20 mg/l. This is not the case. Therefore, the neutralization processes in the columns seem to be a combination of displacement and dilution. The wad cyanide concentration for Cell #5 decreases more slowly than the columns. The heap could be showing lateral displacement due to the construction of the heap itself while there is probably an edge effect in the columns where the solution is confined by the walls, giving a more efficient use of the neutralization solution.

Along with displacement and dilution, diffusion could also play a part in the rinse processes. Cyanide held in the pore space in the spent ore could diffuse into solution more slowly than by dilution. The slope from the Column B data does not support this theory since the slope of the rinse curve is steeper from 2 mg/l wad cyanide to <0.5mg/l than at the higher concentrations. It would appear that if diffusion played a part in the neutralization of the columns, it would be more pronounced at the lower concentrations. However, channeling of solution in the actual heaps, due to the flow characteristics of the ore, could create a diffusion effect in the heaps. A higher concentration of cyanide in the less effectively rinsed nonchanneled areas may be diffusing into the stream of channeling solution.

The neutralization history of the actual heaps showed that it took almost as long to get from 2 mg/l to 0.5 mg/l wad cyanide as from Day 1 to 2 mg/l wad cyanide. Cell #5 took 42 days to reach 2 mg/l wad cyanide. At twice the time, neutralization would take 84 days to reach 0.5 mg/l wad cyanide for Cell #5. This is in agreement with the average time (80 days) of rinsing required to reach 0.5 mg/l wad cyanide before the Interim Neutralization Study was started.

Table 4 shows the wad cyanide concentrations during draindown of the columns and Cell #5 and the amount of drain effluent from each draindown day for the columns. Generally the cyanide concentration increases slightly as the solution volume decreases, indicating that the mechanism of cyanide removal is dilution.

Screen Analysis and Batch Tests

Figure 4 illustrates the size gradation distributions for the Leach Pad Heap, Column A, and Cell #5. While the heaps do not have the same mean particle size (d_{50}), nonetheless they are distributed similarly around the mean as evidenced by the similar slopes. Column A shows a different distribution although the overall mean particle size is very similar to the heaps.

Table 5 shows a summary of the batch test results. There is no appreciable amount of residual wad cyanide in the ore from the upper sections (10-30 ft) of the heaps. Cell #5 shows no appreciable amount of wad cyanide in any ore above the very bottom section (0-1 ft). At the 0-1 ft section from Cell #5, the wad cyanide concentration is 2.6 mg/l. The "Leach Pad Heap" shows a wad cyanide concentration of 0.5 mg/l in the 5-10 ft section. There is an average of 1.7 mg/l wad cyanide in the bottom 5 feet of the heap.

Table 4: Neutralization Period Data Comparison During Draindown

Sample I.D.	Column A	Column B	-Column C - 1st	-Column C - 2nd	-Column D - 1st	-Column D - 2nd	Cell #5
Final Wad Cyanide Level in Effluent	2.00	.12	1.85	.10	1.60	.20	1.8
<u>Draindown Day 1</u>							
Effluent Return (Liter)	10	9	10	6	10	11	---
Wad Cyanide (mg/l)	1.9	.10	1.8	.05	1.5	.21	1.9
<u>Day 2</u>							
Effluent Return (Liter)	9	3	9	9	9	4	---
Wad Cyanide (mg/l)	2.0	.13	1.6	.10	1.3	.53	3.0
<u>Day 3</u>							
Effluent Return (Liter)	2	8	3	2	2	8	---
Wad Cyanide (mg/l)	2.2	.10	2.1	.18	2.9	.57	3.9

(Each column avg 11-12 liter effluent return per day throughout neutralization period.)

Table 5: Batch Test Summary - Columns A-D, Cell #5, and Leach Pad Heap

	Wad Cyanide (mg/l)					
Section Depth	Column A	Column B	Column C	Column D	Cell #5	Leach Pad Heap
25' - 30'	.02	.02	.01	.04	.01	.04
20' - 25'	.08	.08	.01	.01	.01	.11
15' - 20'	.02	.01	.01	.01	.02	.03
10' - 15'	.03	.02	.01	.05	.01	.02
5' - 10'	.01	.01	.01	.01	.01	.48
4' - 5'	.01	.01	.01	.01	.01	1.52
3' - 4'	---	---	---	---	.01	1.92
2' - 3'	.01	.01	.02	.01	.01	2.26
1' - 2'	---	---	---	---	.01	1.47
0' - 1'	.02	.01	.01	.02	2.58	1.15

(All Batch Test Comparisons 2:1 liquid to solid ratio)

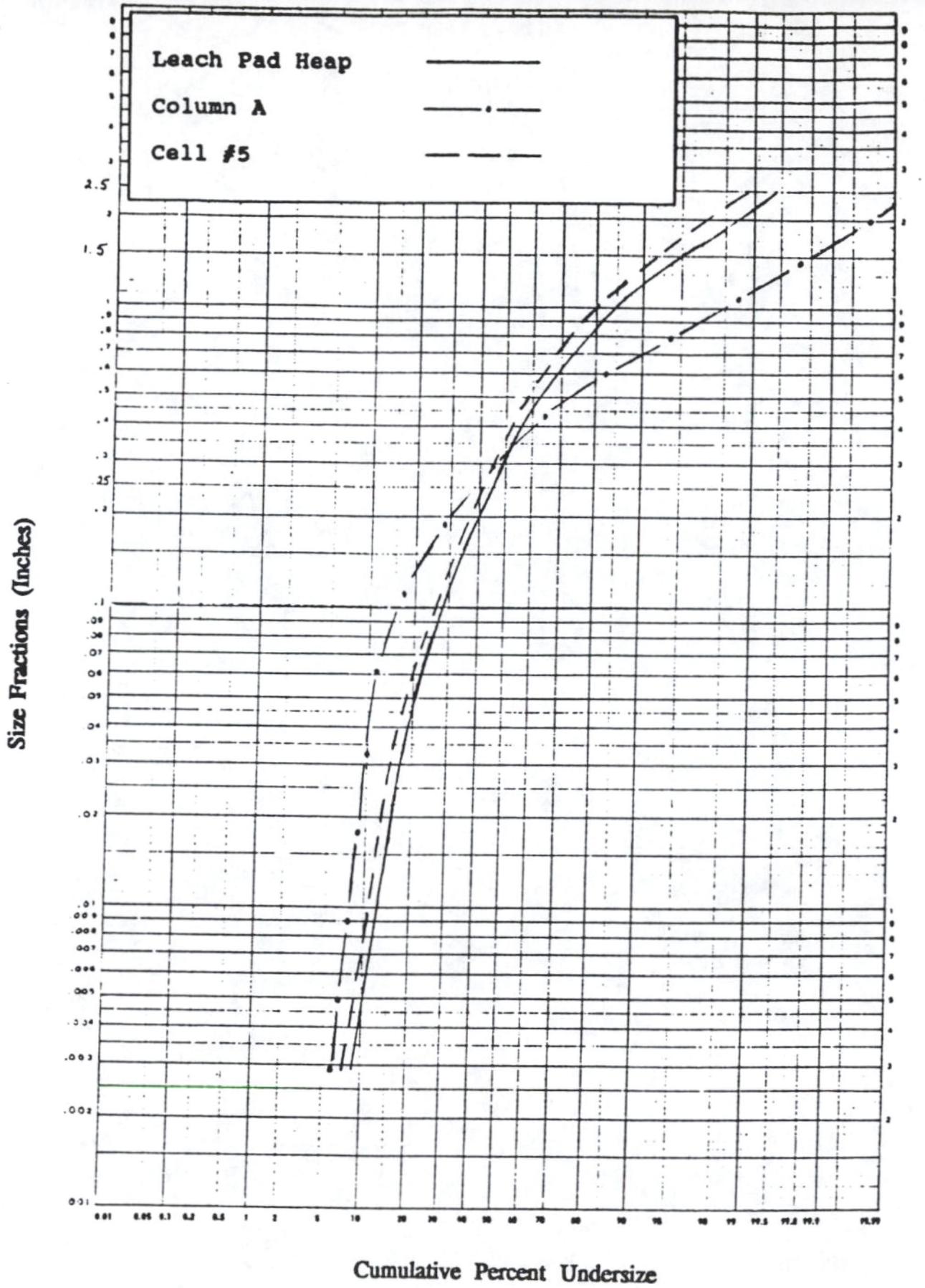

Figure 4: Size Gradation Distribution for Leach Pad Heap, Column A and Cell #5.

The difference in the heaps can be explained from the difference in their neutralization treatments. The "Leach Pad Heap" was neutralized in the winter months with spray wobblers covered with cups. The cups cause direct channeling into the heap and do not allow even coverage of the surface of the heap. Cell #5 was neutralized in the summer months having no such cups on the wobblers. The heap was more efficiently covered with neutralization solution and therefore more thoroughly rinsed. There is no appreciable amount of residual wad cyanide in the column ore in any section.

In addition to the batch tests using U.S. EPA Method 1312 Solution #1, two batch test samples were run using extraction solution with the pH adjusted to pH >12 with 1.25 M NaOH. This was requested by the DWNR to assess whether the pH of the extraction solution affected the final wad cyanide results.

The results were as follows:

Sample #1:	1312, pH 4.2 solution	0.01 mg/l wad cyanide
	NaOH, pH >12 solution	0.02 mg/l wad cyanide
Sample #2:	1312, pH 4.2 solution	2.58 mg/l wad cyanide
	NaOH, pH >12 solution	2.60 mg/l wad cyanide

The U.S. EPA Method 1312 Solution #1 is a poorly buffered fluid. When it encounters the ore, the solution is buffered by the spent ore itself at a higher pH (in this case, pH values about 9). As the above data indicates, the initial pH of the extraction solution for the Brohm spent ore is essentially irrelevant to the final wad cyanide result.

Wad cyanide was detected in the material on the geotextile filters that covered the screens at the bottom of the columns to avoid the loss of fine particulate material during the leach and neutralization cycles. Approximately 20 grams of fines adhered to each of the saturated filters. The filters were bottle rolled in the same manner as the batch test procedure using 1 liter U.S. EPA Method 1312 Extraction #1. Table 6 shows the amount of wad cyanide in each of the filters. Column A, having the least amount of wash solution shows the highest wad cyanide level. Column B, having the greatest amount of was solution shows the lowest wad cyanide level. Column C and Column D having one pore volume water rinses, fall in between Column A and Column B.

Also shown in Table 6 are the dissolved trace metals associated with wad cyanide for each of the column filters and the various sections from Cell #5. The cyanide appears to be in the form of wad copper cyanide complexes. Cell #5 shows wad cyanide enrichment only in the lowest (0'-1'), fines-bearing layer.

Even though migration of fines does not appear to be an appreciable factor from the screen gradation data, the fines in the very lowest part of the column or heap appear to be contributing to the elevated wad cyanide values in the effluent. The filter and trace metal

Table 6: Wad Cyanide and Metals Comparison from Column Filters and Cell #5 Batch Tests

Sample I.D.	Column A* Filter	Column B* Filter	Column C* Filter	Column D* Filter	---Cell #5**--- 1'-25'	0'-1'
Wad Cyanide (mg/l)	8.80	.36	2.05	1.60	<.01	2.3
Copper (mg/l)	>6.6	.31	1.3	.47	<.05	2.5
Iron (mg/l)	.2	.2	1.1	2.3	<.01	.2
Manganese (mg/l)	.04	.03	.04	.03	<.05	<.05
Nickel (mg/l)	.03	.02	.04	.04	<.05	<.05
Zinc (mg/l)	.03	.01	<.01	.01	<.05	<.05

(Dissolved metals)

* ±20 g filter solids in 1 liter of extractant (50:1 liquid to solid ratio)
** 2:1 liquid to solid ratio

Table 7: Liquid to Solid Ratio Comparison for Cell #5 - Section 10

Sample I.D.	Liquid to Solid Ratio	Wad Cyanide mg/l	mg Wad Cyanide Kg Ore
(10) 0'-1' Sample #2	2:1	2.58	1.4
(10) 0'-1' Subsample A	2:1	2.39	1.3
(10) 0'-1' Subsample B	2:1	2.23	1.2
(10) 0'-1' Sample #2	1:1	4.75	1.5
(10) 0'-1' Sample #2	2:1	2.28	1.2
(10) 0'-1' Sample #2	4:1	1.18	1.2
(10) 0'-1' Subsample A	1:1	4.67	1.5
(10) 0'-1' Subsample A	2:1	2.23	1.2
(10) 0'-1' Subsample A	4:1	1.14	1.1
(10) 0'-1' Subsample B	1:1	4.39	1.4
(10) 0'-1' Subsample B	2:1	2.21	1.2
(10) 0'-1' Subsample B	4:1	1.08	1.1

data indicate that fines are collecting at the base of the columns (and most likely the heaps) and holding the enhanced levels of wad cyanide.

Table 7 shows a comparison of the various liquid to solid ratios used in the batch tests for Cell #5 - section 10. There is no effect in the variation of liquid to solid ratio indicating that there is a linear relationship between the ratios tested. The 4:1 ratio is 25% of the 1:1 ratio and 2:1 ratio is 50% of the 1:1 ratio for wad cyanide in mg/l. Also shown is the calculated concentration in mg wad cyanide per kg ore. This shows that basically the same amount of wad cyanide is leached out of the ore whether a 4:1 or 1:1 liquid to solid ratio is used.

SUMMARY AND CONCLUSIONS

Solid sampling is more indicative of heap neutralization than effluent sampling at BMC. The bottom layer of ore, in the case of the columns of the geotextile filter, is continuously saturated with relatively high concentrations of cyanide bearing solution. It appears that fines collect in this bottom layer. Having continuous contact with the cyanide solution, the fines may indeed adsorb cyanide on their high surface area. The cyanide slowly diffuses from this saturated zone, never being thoroughly flushed, and causes elevated cyanide levels in the effluent, but is not indicative of the porewater in the neutralized spent ore above this layer. The enhanced cyanide levels during draindown appear to be coming from these cyanide enriched fines, the cyanide being in the form of wad copper cyanide complexes.

Neutralization seems to be dependent on a combination of displacement, dilution and possibly diffusion mechanisms. It takes longer to rinse wad cyanide from leach pad heaps than from column ore presumably due to different flow characteristics within the heap and the columns. A water rinse after initial neutralization, does decrease the amount of time to rinse ore from 2 mg/l to 0.5 mg/l wad cyanide but not significantly. Groundwater and deionized water rinses behave in the same manner.

Batch tests on spent ore solids are an acceptable simplified procedure to quantify the attainment of compliance with permitted neutralization criteria. As shown from the subsampling protocol, no cyanide volatilization occurs during mixing of the samples for homogeneity. The pH of the extraction solution, as applied to Brohm spent ore, does not influence the final wad cyanide result.

It has been shown that the spent ore above the bottom one foot layer is sufficiently rinsed at BMC to remove most cyanide species. The bottom three feet of ore is left in place when off-loading the spent ore to protect the liner. Therefore, as shown in this Interim Neutralization Study, the spent ore at Brohm Mining Corporation passes state compliance (wad cyanide <0.5 mg/l) when the heap effluent is at 2 mg/l wad cyanide.

ACKNOWLEDGEMENTS

- Ray Brosnahan, Steve Gross, and the many Brohm employees who helped build, load and monitor the columns.

- The Brohm lab technicians: Bill Atkinson, Valerie Dierks, Ryan Frederickson, Kim Ware, and Martha Wierzbicki, whose conscientious sample collection and analyses made this a worthwhile study.

MEMORANDUM

DATE: MARCH 29, 1995
TO: JIM THOMPSON
FROM: LAURA DAMON
SUBJECT: BIOOXIDATION BULK TEST (BBT) SUMMARY (WEEKS 28-34)

The BBT has been on the biooxidation cycle for thirty-four weeks. OFF solution is still being discharged from the circuit with the total gallons having decreased to less than 100 gallons per day. Fresh water application to the top of the heap ceased on February 22nd due to puddling on the heap and elevated sulfate concentrations in the process solution. A total of 54,392 gallons of fresh water were applied from December 16th through February 21st. 58,465 gallons of OFF solution have been discharged since November 23rd. As of March 22nd, 722 lb of copper, 8319 lb of iron and 14,256 lb SO4 as sulfur have been removed from the heap in the discharge solution. The heap remains stable and intact.

Attached are extraction rate graphs for iron and sulfate as sulfur from the weekly BBT data. The log-log graphs have two sets of data points. One set is the percent extraction calculated from the total iron or sulfate discharged in the OFF solution and neutralization circuit. The other set consists of the extraction calculated from the amount of water soluble iron (2.0%) or sulfate (2.75%) which was fresh water rinsed from a column of nonbiooxidized ore subtracted from the total iron or sulfate (first set). It is probably erroneous to assume that the water soluble iron and sulfate will rinse out of the ore before biooxidation occurs. Therefore, an average of the two data point sets were averaged to try to account for both ions from biooxidation and ions being naturally washed out of the ore. The iron extraction rates are drawn through the data points which are believed to reflect the most accurate percent extractions when water was being applied in a consistent manner. The data points which are below the rate of extraction are believed to be low because there is no flushing mechanism to transport the ions out of the heap. (It is thought that the ion concentrations are actually higher in the heap, i.e. stuck to the particles). As of week 34, the average iron extraction, if the rate line is used, is on the order of 10-11%. The average sulfate as sulfur extraction is around 14%. Notice on these graphs that to obtain 20-30% biooxidation, (which is in the ballpark of what has been suggested the Gilt Edge sulfidic ore needs to be biooxidized to before sufficient economic gold extraction occurs), it will take on the order of a year to a year and a half. This supports the estimated time of biooxidation for euhedral pyrite mineralogy as discussed in the "TMS Biooxidation Short Course" memo of 03-16-95 to Martin Quick.

BBT heap ore was collected from twenty-one auger drill holes (auger drill-9) on January 31st. Four five foot by ten inch test columns containing this ore, were put on acid (biooxidation) leach on

February 8th. The rate of biooxidation is being investigated comparing recirculated OFF solution, neutralized solution and fresh water rinses with continuous and controlled air supply. Attached is a summary of the test column data. So far the columns have not started biooxidizing as evidenced by the low eh values (iron predominantly in the ferrous state). The ON solution pH's have been lowered to 1.4 to try to lower the column ore pH's and "kick start" the bacteria. In the last two weeks this approach has failed to lower the pH in the column ore. It has been surmised that cyanide toxicity may be responsible for the lack of bacterial activity. If these columns do not respond favorably within the next few weeks, they will be aborted. Two columns will be rerun with off-loaded BBT ore to compare the ore's biooxidation rate with recirculated ON solution and fresh water ON solution (inhibitory substance theory). Notice the dissolved oxygen (DO) values in the data summary between the recirculated and fresh water ON solutions. The recirc DO shows values below 1 ppm since the second week on leach while the fresh water DO is consistently above 8 ppm. It was said in the TMS course that the bacteria could not use oxygen from solutions with DO's less than 2 ppm. Could this be related to the "inhibitory substance" theory?

A gold extraction graph is attached comparing the various auger drill samples collected during the course of the test. The auger drill-9 curve is based on the fire assay head while the other samples are based on the calculated head. Although the data suggest that as the ore's percent biooxidization increases the gold extraction rate increases, the overall extraction does not increase accordingly. The percent biooxidation has been in question for each of these individual auger drill samples, but the auger drill-9 sample should be fairly representative of the heap since much more sample was collected. The auger drill-9 calculated head should be done within the next couple of weeks to ascertain how much the gold extraction has increased over the control sample. An auger drill-10 sample will be collected next week and analyzed for gold extraction. Within the next 4-6 weeks it is expected that the BBT will be off-loaded. We will then be able to compare the heap head sample with the heap tail sample for the best comparative results of biooxidation and gold extraction.

It is time to put together an off-load plan for sampling and final testwork protocol. Geobiotics has suggested setting up two large (6'x6') columns with the off-loaded ore. One column will be a continuation of the heap and one column is proposed to hold a concentrate of the ore agglomerated on to some larger material. (This is along the same line of thought as was suggested by Jody Kelso). These columns would be run in conjunction with two smaller columns set-up to investigate the inhibitory substance theory.

The final gold extraction values will be analyzed in the heap tail sample to compare with the head (control) sample. Therefore a very representative sample needs to be collected during off-loading. Although the bottle roll gold extraction data support the corresponding column extraction data, the difference in gold

extraction between water rinsed ore and non-rinsed ore (which takes about 30 lb/ton lime for pH control) should be investigated. The high amount of lime in the ore may be forming gypsum and blinding off the ore particles causing low gold extraction values. We should also be thinking on the lines of any testwork needed for estimating the feasibility of using biooxidation on a production scale basis (i.e. how much water will it take to sufficiently rinse the ore and how does this affect the large scale water balance).

Finally, for the record, Herb said during a recent discussion that so far there has been no success with agglomeration of the neut sludge and the bioox ore (McClelland Labs). The results have, however, been improving during the course of the test work.

c: Rod MacLeod
Martin Quick
Herb Osborne

BIOOXIDATION BULK TEST SOLUTION SAMPLING

OFF SOLUTION - DISCARDED FROM HEAP

	Fresh H2O ON	Day	Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)
	0	217	COMP	3/ 1/95	225	53075	1.92	460.0	1510	22900	5600	17300	85541	112545
	0	218	COMP	3/ 2/95	200	53275	1.88	467.3	1540	21600	4600	17000	-	112422
	0	219	COMP	3/ 3/95	185	53460	1.88	485.3	1440	19600	2600	17000	-	106887
	0	220	COMP	3/ 4/95	150	53610	1.94	474.3	1350	18500	3400	15100	-	-
	0	221	COMP	3/ 5/95	150	53760	1.90	472.4	1540	19800	4000	15800	-	112298
	0	222	COMP	3/ 6/95	0	53760	1.85	486.7	1530	20500	2600	17900	-	114623
	0	223	COMP	3/ 7/95	200	53960	1.90	469.9	1560	21600	4400	17200	-	117113
	0	224	COMP	3/ 8/95	0	53960	1.88	506.5	1650	18400	1300	17100	-	108739
	0	225	COMP	3/ 9/95	200	54160	2.02	496.6	1220	14900	1020	13880	-	85139
	0	226	COMP	3/10/95	248	54408	2.17	525.6	880	10000	400	9600	-	58742
	0	227	COMP	3/11/95	390	54798	2.01	562.9	1190	15300	340	14960	-	87259
	1500	228	COMP	3/12/95	440	55238	1.93	572.7	1110	14200	300	13900	-	83144
North Blower ON →	0	229	COMP	3/13/95	800	56038	2.10	543.8	740	8300	250	8050	-	51417
	0	230	COMP	3/14/95	468	56506	2.10	570.6	820	8600	190	8410	-	56808
	0	231	COMP	3/15/95	0	56506	2.11	571.9	640	6300	140	6160	32719	43208
	0	232	COMP	3/16/95	515	57021	2.06	576.4	670	6000	150	5850	-	43619
	0	233	COMP	3/17/95	516	57537	2.11	561.7	610	4900	140	4760	-	38681
	0	234	COMP	3/18/95	395	57932	2.08	559.6	690	5400	160	5240	-	42775
	0	235	COMP	3/19/95	137	58069	2.00	562.5	850	7500	200	7300	-	63433
	0	236	COMP	3/20/95	200	58269	2.01	562.6	880	8300	130	8170	-	71375
	0	237	COMP	3/21/95	118	58387	1.99	560.3	1020	9300	250	9050	-	71375
	0	238	COMP	3/22/95	78	58465	1.96	564.5	930	8100	200	7900	44413	61293

BIOOXIDATION BULK TEST THERMOCOUPLE DATA

Date	West 1	West 2	West 3	West 4	West 5	Mid 6	Mid 7	Mid 8	East 9	East 10	East 11	East 12	AMBIENT 1-6	AMBIENT 7-12
03/01/95	-	26.4	48.8	16.7	-	26.6	52.6	-	47.4	52.4	52.7	31.3	-19.2	-19.6
03/02/95	-	26.1	49.2	16.1	-	26.8	52.5	-	47.1	52.4	52.9	31.0	-13.5	-10.7
03/03/95	-	26.3	49.8	15.7	-	26.5	53.6	-	47.4	52.8	53.1	30.8	-6.1	-5.2
03/04/95	-	25.7	49.8	15.1	-	26.4	53.4	-	46.8	52.4	52.5	30.6	-13.2	-13.6
03/05/95	-	25.1	49.6	14.5	-	25.9	53.8	-	46.9	52.6	52.5	30.3	-12.8	-10.3
03/06/95	-	24.5	49.3	13.7	-	25.2	53.6	-	46.6	52.6	52.4	30.3	-18.3	-18.6
03/07/95	-	23.8	49.0	12.9	-	24.5	54.9	-	47.5	53.6	53.2	31.0	-14.1	-14.9
03/08/95	-	23.6	49.0	13.0	-	25.2	54.8	-	47.3	53.7	53.2	30.9	1.5	1.3
03/09/95	-	24.0	49.4	13.2	-	25.4	55.0	-	47.1	53.8	53.0	29.7	4.8	4.4
03/10/95	-	23.9	49.2	13.3	-	25.5	55.2	-	47.1	54.0	53.2	28.9	9.9	9.8
03/11/95	-	23.6	48.9	13.3	-	25.2	55.3	-	46.8	54.1	53.2	27.8	11.0	10.8
03/12/95	-	-	-	-	-	-	-	-	-	-	-	-	-	-
03/13/95	-	22.6	47.7	13.3	-	24.4	55.0	-	47.0	54.2	53.1	27.0	2.8	3.4
03/14/95	-	21.7	47.2	13.8	-	25.5	56.1	-	48.0	55.1	53.7	27.7	10.8	10.7
03/15/95	-	22.1	47.3	13.6	-	24.7	54.5	-	46.8	54.2	52.8	26.4	14.3	13.7
03/16/95	-	21.6	46.7	13.4	-	24.7	54.6	-	47.0	54.4	52.9	26.3	.1	.3
03/17/95	-	21.3	46.4	13.5	-	24.6	54.5	-	47.1	54.6	52.8	26.5	.7	1.3
03/18/95	-	20.6	45.5	12.8	-	23.7	54.1	-	46.8	54.4	52.6	26.6	8.2	9.0
03/19/95	-	20.9	45.6	13.4	-	24.5	54.2	-	47.1	54.8	52.9	26.6	2.7	2.5
03/20/95	-	20.7	45.3	13.4	-	24.3	53.7	-	47.0	54.9	52.8	26.8	2.3	2.0
03/21/95	-	20.3	44.8	13.2	-	24.2	53.5	-	46.8	54.9	52.5	26.1	13.4	11.2
03/22/95	-	20.2	44.5	13.1	-	24.1	53.5	-	47.0	55.3	52.8	26.6	5.1	4.6
03/23/95	-	19.6	43.9	12.9	-	23.6	53.0	-	46.9	55.2	52.7	26.6	4.0	3.2
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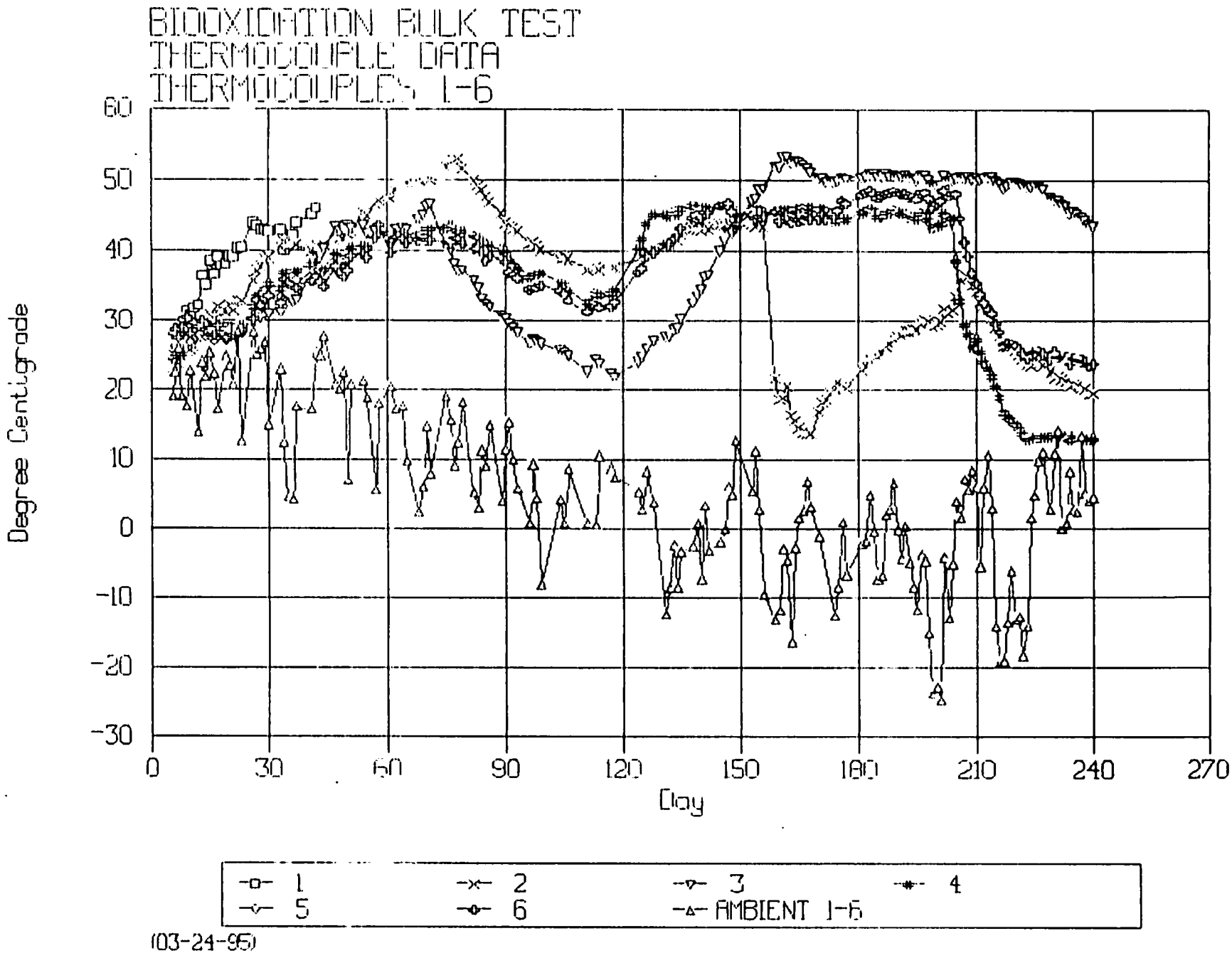
BIOOXIDATION BULK TEST
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THERMOCOUPLES 1-6
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40
30
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-30
0
30
60
90
120
150
180
210
240
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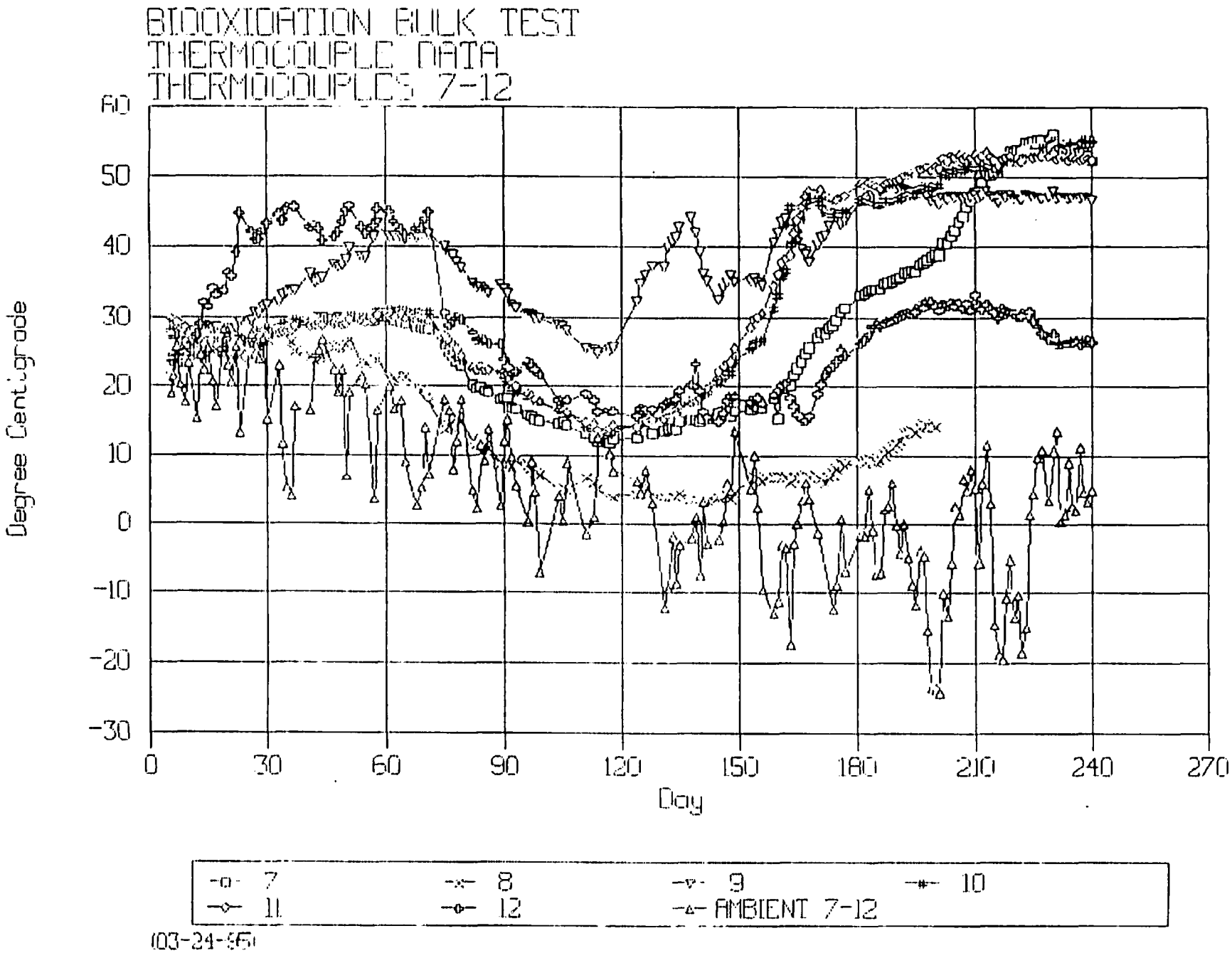
Day
1
2
3
4
5
6
AMBIENT 1-6
(03-24-95)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THERMOCOUPLE DATA
THERMOCOUPLES 7-12
Degree Centigrade
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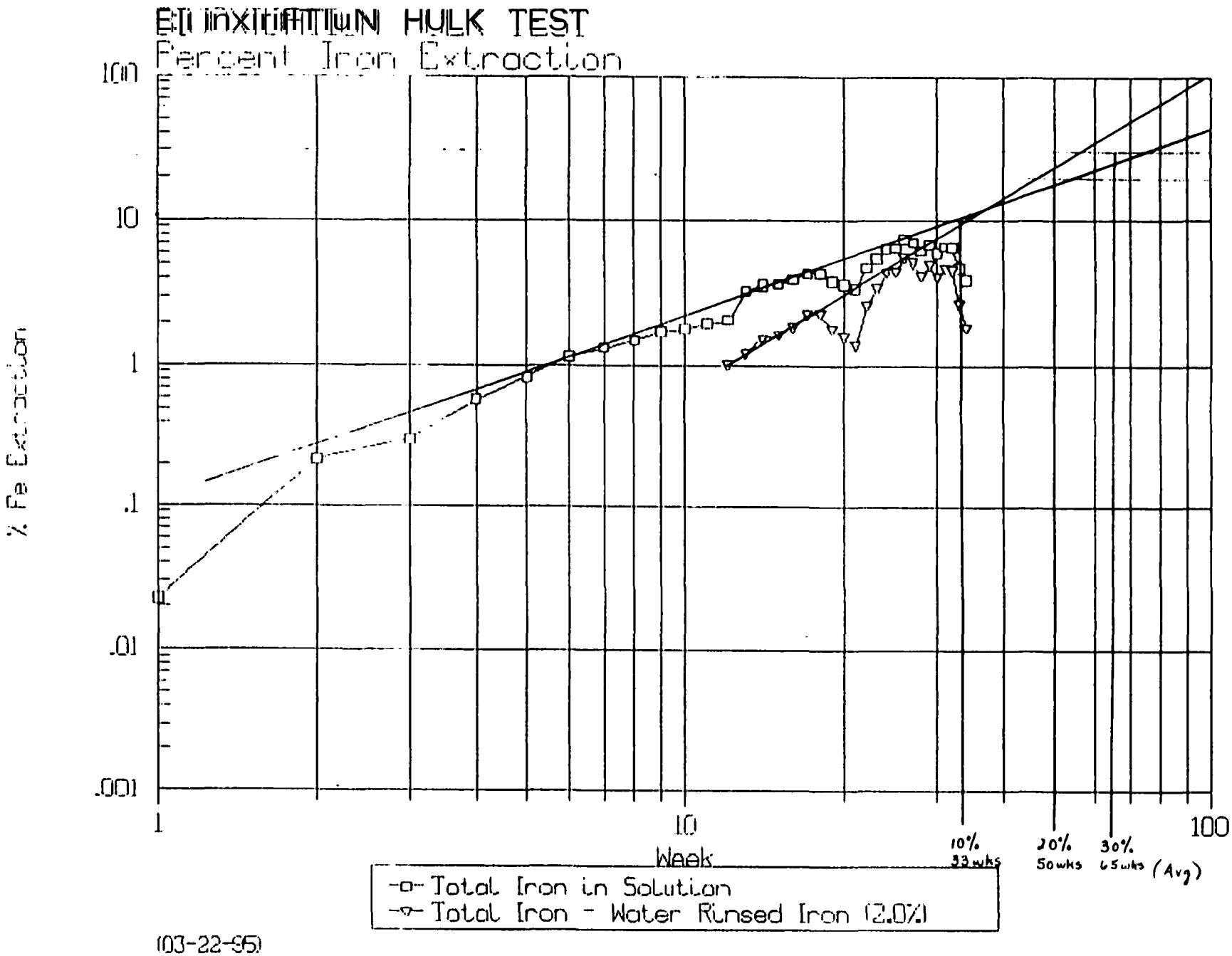
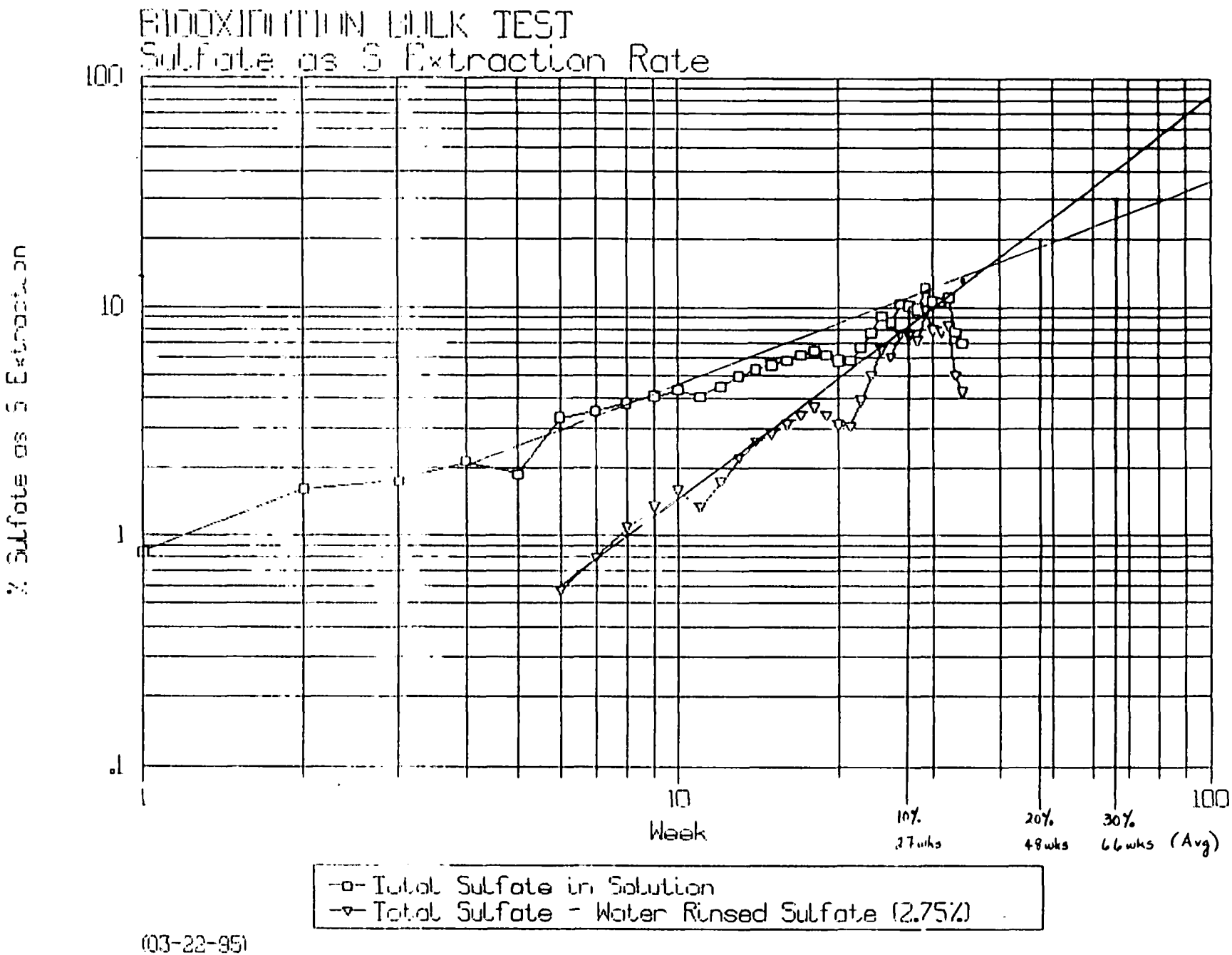
12
AMBIENT 7-12
(03-24-95)


EXTRACTION HULK TEST
Percent Iron Extraction
% Fe Extraction
100
10
1
.1
.01
.001
1
10
100
Week
10%
33 wks
20%
50 wks
30%
65 wks
(Avg)
Total Iron in Solution
Total Iron - Water Rinsed Iron (2.0%)

(03-22-95)


BIOOXIDATION BULK TEST
Sulfate as S Extraction Rate
% Sulfate as S Extraction
100
10
1
.1
1
10
100
Week
10%
27 wks
20%
48 wks
30%
66 wks (Avg)
Total Sulfate in Solution
Total Sulfate - Water Rinsed Sulfate (2.75%)
(03-22-95)

COLUMN 3 - CONTINUOUS AIR
BBT TEST COLUMN - RECIRCULATING SOLUTION

Day	Sample ID	Date	Liters	Cum Liters	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	ON DO (ppm)	OFF DO (ppm)
	ON SOLN	02/08/95	-	-	1.89	585.5	1510	21800	440	21360	82913	107196	2.2	-
3	24 HR COMP	02/10/95	1.50	1.50	2.23	390.5	630	24600	23000	1600	-	109459	-	-
4	24 HR COMP	02/11/95	2.55	4.05	2.30	378.3	510	26800	29000	0	81862	113718	-	-
5	24 HR COMP	02/12/95	3.03	7.08	2.46	350.0	350	29600	34000	0	-	111558	5.5	5.2
6	24 HR COMP	02/13/95	2.71	9.79	2.85	293.9	167	31200	36000	0	80548	108862	3.6	1.4
7	24 HR COMP	02/14/95	2.80	12.60	3.05	269.8	164	30700	34000	0	-	110879	1.6	2.0
8	24 HR COMP	02/15/95	2.89	15.48	3.05	256.6	131	31100	36000	0	78052	110755	2.3	1.9
9	24 HR COMP	02/16/95	3.34	18.82	3.17	251.1	-	-	-	-	-	-	2.1	1.3
	ON SOLN	02/16/95	-	18.82	1.86	446.0	1360	24600	8900	15700	92374	120570	2.3	-
15	WEEKLY COMP	02/22/95	17.86	36.69	3.32	230.0	104	34800	34800	0	-	118924	2.3	1.9
22	WEEKLY COMP	03/01/95	21.43	58.12	2.99	269.1	92	39000	39000	0	94214	136351	.8	1.6
28	WEEKLY COMP	03/07/95	18.49	76.61	1.97	317.5	142	41200	41200	0	99470	145260	.4	1.2
36	WEEKLY COMP	03/15/95	24.71	101.32	2.63	297.1	151	43100	43100	0	97630	144663	.4	1.7
43	WEEKLY COMP	03/22/95	21.40	122.72	3.15	267.0	83	44000	44000	0	100390	147008	.7	1.5
50	WEEKLY COMP	03/29/95	22.22	144.94	3.17	254.8	85	43400	43400	0	101047	151144	-	-

COLUMN 4 - CONTINUOUS AIR
BBT TEST COLUMN - NEUTRALIZED SOLUTION

Day	Sample ID	Date	Liters	Cum Liters	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	ON DO (ppm)	OFF DO (ppm)
1	ON SOLN	02/08/95	-	-	1.90	610.2	227	3500	70	3430	13850	18394	6.3	-
3	24 HR COMP	02/10/95	1.92	1.92	2.36	355.3	360	28800	31000	0	-	112422	-	-
4	24 HR COMP	02/11/95	1.12	3.04	3.24	267.1	145	22900	30000	0	69773	97772	-	-
5	24 HR COMP	02/12/95	2.49	5.53	2.83	312.6	176	17500	21000	0	-	75202	7.7	3.8
6	24 HR COMP	02/13/95	2.63	8.16	2.41	351.4	172	15900	21100	0	43099	59688	7.7	1.9
7	24 HR COMP	02/14/95	1.30	9.46	2.53	361.6	174	13400	14200	0	-	51252	7.9	2.1
8	24 HR COMP	02/15/95	2.59	12.05	2.42	366.8	141	12000	10500	1500	33638	46438	6.9	1.5
9	24 HR COMP	02/16/95	2.52	14.57	2.61	372.3		-	-	-	-	-	7.3	1.5
15	WEEKLY COMP	02/22/95	15.26	29.83	2.62	373.1	119	9500	9500	0	-	36356	7.5	2.0
22	WEEKLY COMP	03/01/95	17.74	47.57	2.16	367.2	91	10400	10400	0	27988	37138	7.5	1.7
28	WEEKLY COMP	03/07/95	15.32	62.89	1.69	333.5	50	10900	10900	0	29302	40080	7.7	1.6
36	WEEKLY COMP	03/15/95	19.37	82.25	1.87	325.7	47	8400	8400	0	24835	31747	6.8	2.3
43	WEEKLY COMP	03/22/95	17.96	100.21	2.26	329.5	39	6960	6960	0	18396	27344	6.2	2.2
50	WEEKLY COMP	03/29/95	17.33	117.54	2.34	338.1	47	7540	7540	0	20039	30739	-	-

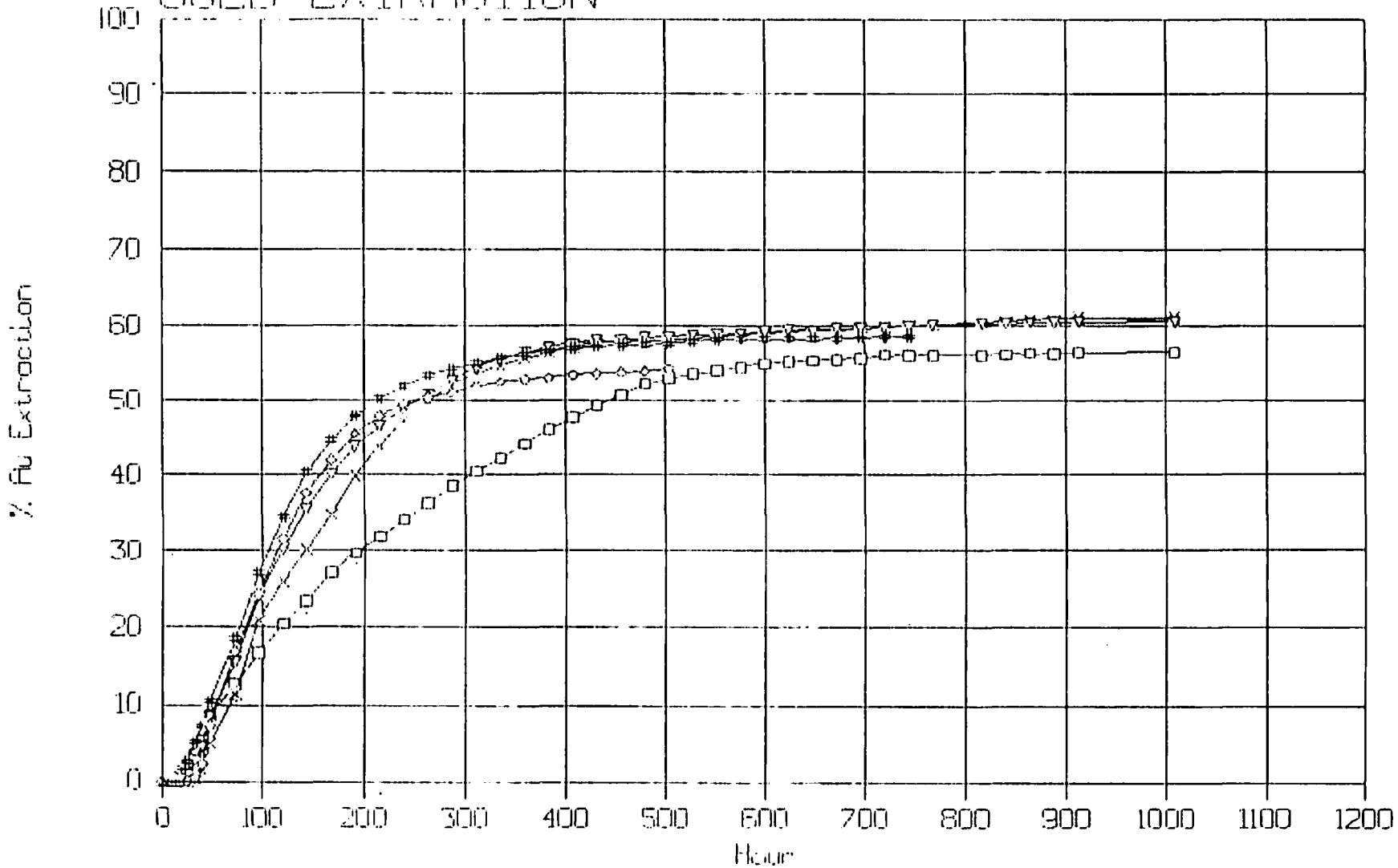
COLUMN 5 CONTINUOUS AIR
BBT TEST COLUMN FRESH H2O

Day	Sample ID	Date	Liters	Cum Liters	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	ON DO (ppm)	OFF DO (ppm)
1	ON SOLN	02/08/95			1.82	-		-	-	-	-	-	8.7	-
3	24 HR COMP	02/10/95	2.79	2.79	2.44	354.5	320	22600	30000	0	-	94871	-	-
4	24 HR COMP	02/11/95	1.04	3.82	3.17	274.3	112	17500	22000	0	55582	78350	-	-
5	24 HR COMP	02/12/95	2.66	6.48	2.73	334.6	139	12400	16000	0	-	58454	8.8	3.9
6	24 HR COMP	02/13/95	2.78	9.26	2.44	361.5	138	11800	13100	0	35084	45142	8.7	1.9
7	24 HR COMP	02/14/95	2.53	11.79	2.63	362.3	125	9300	10500	0	-	37673	8.5	2.1
8	24 HR COMP	02/15/95	2.77	14.56	2.58	363.4	89	7500	8400	0	20958	29690	8.1	1.4
9	24 HR COMP	02/16/95	2.63	17.19	2.80	360.9		-	-	-	-	-	8.2	1.8
15	WEEKLY COMP	02/22/95	16.38	33.57	2.88	363.0	48	3600	3600	0	-	14300	8.1	2.7
22	WEEKLY COMP	03/01/95	19.76	53.33	2.47	372.8	21	3600	3600	0	8015	10864	8.6	2.3
28	WEEKLY COMP	03/07/95	17.11	70.43	1.89	365.2	13	3000	3000	0	8475	11543	8.6	1.7
36	WEEKLY COMP	03/15/95	22.95	93.38	2.04	351.9	5	1650	1650	0	3778	5946	8.1	3.0
43	WEEKLY COMP	03/22/95	20.82	114.20	2.29	348.7	5	1440	1440	0	3088	4691	8.2	2.2
50	WEEKLY COMP	03/29/95	15.26	129.46	2.19	349.4	4	1780	1780	0	3679	6304	-	-

COLUMN 6 CONTROLLED AIR
BBT TEST COLUMN FRESH H2O

Day	Sample ID	Date	Liters	Cum Liters	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	ON DO (ppm)	OFF DO (ppm)
1	ON SOLN	02/08/95			1.82			-	-	-	-	-	8.7	-
3	24 HR COMP	02/10/95	2.14	2.14	2.54	351.5	370	22700	29000	0	-	96558	-	-
4	24 HR COMP	02/11/95	2.99	5.14	3.05	281.0	139	15100	20000	0	48092	68700	-	
5	24 HR COMP	02/12/95	2.76	7.90	3.42	260.9	83	10600	15000	0	-	48125	8.8	3.5
6	24 HR COMP	02/13/95	2.76	10.66	3.92	314.0	67	9500	11400	0	24572	35245	8.7	1.6
7	24 HR COMP	02/14/95	2.65	13.32	2.85	341.1	86	7300	8600	0	-	27961	8.5	2.2
8	24 HR COMP	02/15/95	2.82	16.13	2.66	353.7	62	5800	6700	0	15571	22139	8.1	1.5
9	24 HR COMP	02/16/95	2.65	18.78	2.82	354.9		-	-	-	-	-	8.2	2.1
15	WEEKLY COMP	02/22/95	15.76	34.54	2.94	352.8	36	3700	3700	0	-	12383	8.1	3.0
22	WEEKLY COMP	03/01/95	19.13	53.67	3.35	358.9	25	3900	3900	0	8935	11892	8.6	2.4
28	WEEKLY COMP	03/07/95	16.58	70.24	3.04	356.0	13	3400	3400	0	8607	12016	8.6	2.0
36	WEEKLY COMP	03/15/95	22.39	92.64	2.28	329.3	5	1720	1720	0	3975	5802	8.1	2.9
43	WEEKLY COMP	03/22/95	20.84	113.48	2.55	310.2	4	1400	1400	0	2825	4329	8.2	2.6
50	WEEKLY COMP	03/29/95	21.78	135.26	2.18	326.1	4	1200	1200	0	2957	5037		-

BBT - COLUMN COMPARISON
GOLD EXTRACTION



03/23/94

* Calculated Head Basis

MEMORANDUM

DATE: FEBRUARY 9, 1995
TO: JIM THOMPSON
FROM: LAURA DAMON
SUBJECT: BIOOXIDATION BULK TEST (BBT) SUMMARY (WEEKS 22-27)

The BBT has been on the biooxidation cycle for twenty-seven weeks. OFF solution is still being discharged from the circuit. The total gallons have decreased to about 200-300 gal/day with larger amounts flushing through periodically from the addition of fresh water to the top of the heap. 39,463 gallons of fresh water have been applied since December 16th and 41,494 gallons of OFF solution have been discharged since November 23rd. As of February 1st, 549 lb of copper, 6036 lb of iron and 9947 lb SO4 as sulfur have been removed from the heap in the discharge solution. The discharged solution started puddling on top of Cell #6 last week so holes were drilled in the center of Cells #6-#7 to discharge the solution directly into the heaps. Some of the drill holes overflowed indicating that the plugging problen is precipitation oriented and not caused by frozen ground. The heap remains stable and intact.

Extraction rate graphs have been produced for copper, iron and sulfate as sulfur from the weekly BBT data. As of week 27, the iron extraction rate semi-log graph shows the rate staying fairly consistent although it is dependent on the amount of rinse water being flushed through the heap. The iron extraction to date is on the order of 7-8%. The sulfate as sulfur extraction rate graph shows an increase in the slope after fresh water addition was started on week 21. The total extraction calculated by SO4 as sulfur is over 10%. The copper extraction rate graph shows that the majority of copper is extracted by week 13 and then holds fairly steady at about 80%.

A copper gradation study was done on auger drill samples collected from one foot sections in the center of the heap. The data are shown in the attached table. The 0'-1' section has never really had solution applied to it since most of the drip lines are buried beneath it. The data reflect this. The average of the 1'-5' interval has a pH of 2.6 and corresponding heap copper concentration of 600 ppm. The average of the 5'-10' interval has a pH of 2.7 and corresponding heap copper concentration of 900 ppm. The average of the 10'-15' interval has a pH of 2.8 and a corresponding heap copper concentration of 1100 ppm. These copper values and pH's support a pug flow theory of heap rinsing with fresh water (displacement). The 14'-15' section has a corresponding heap copper concentration of 1297 ppm which matches very well with the OFF solution copper concentration of 1280 ppm. The data suggest that the heap is rinsing from the top down and the lower pH in the top region (1' to 5' = 2.6) indicates that a higher level of bioactivity is taking place in the top five feet of the heap. It has been calculated that it will take about 750,000 gallons of fresh water to rinse or dilute the copper concentration to acceptable levels (if the inhibitory substance

theory is viable) but, with about 18 loads of water (50,000 gallons) the top 5′ section of the heap should be rinsed to adequate copper concentrations. Therefore, we should keep adding fresh water, as weather permits, until we have reached a goal of 50,000 gallons and then re-evaluate the copper, iron, sulfide and gold extraction values to see if indeed the lower copper values are assisting in higher rates of biooxidation.

Four five foot by ten inch test columns were put on acid (biooxidation) leach to investigate the rate of biooxidation comparing recirculated OFF solution, neutralized solution and fresh water rinses with continuous and controlled air supply. BBT heap ore was collected from twenty-one auger drill holes on January 31st. Seven holes were drilled in each of the west, mid and east regions of the heap and the ore from each region was composited by 5 foot sections (1′-5′; 5′-10′; 10′-15′). Sulfur, iron, copper digestions and gold extraction bottle rolls will be run on each of the nine regions of ore. All the ore, about 1500 lb, from the nine regions was composited. This composite was used for the test columns and also for an auger drill-9 gold extraction column. Gold extraction bottle rolls and sulfur, iron and copper digestions will also be run on this composite.

Attached is a summary of thermocouple data with and without air injection. One blower was put on the #4 south perforated pipe on November 23rd or day 120. On December 10th, day 136, the blower was moved to the #4 north perforated pipe. On December 30th, day 156, four blowers were placed at #2 and #4 perforated pipes on both the south and north sides of the heap. Apparently the blowers kicked off on January 13th, day 170, but were restarted on January 18th, day 175. On January 20th, day 177, the blowers completely failed and the heap has had no air injection since this time.

Also attached are the gold extraction results to date. Auger drill-3 and 5 show comparative final gold extraction values, however the gold is leaching more quickly in each succesive column leach. Auger drill-7 data should be available within the next couple of weeks.

c: Rod MacLeod
Martin Quick
Herb Osborne

01/25/95 BBT COPPER GRADATION

200 g Sample	pH	1000 ml Rinse Cu (ppm)	Corresponding Heap* Cu (ppm)	Residual Cu (ppm)	(Fe not w/DI Rinse Water?) 1000 ml Rinse Fe (ppm)	Corresponding Heap* Fe (ppm)	Residual Fe (ppm)
0'-1'	2.61	23	1066	169	220	10193	46420
1'-2'	2.53	12	556	151	196	9081	43703
2'-3'	2.54	11	510	132	181	8386	52535
3'-4'	2.57	14	649	142	191	8850	54882
4'-5'	2.71	14	649	169	157	7274	61151
5'-6'	2.60	19	880	154	204	9452	58765
6'-7'	2.63	21	973	167	202	9359	63475
7'-8'	2.65	20	927	159	197	9128	56275
8'-9'	2.69	20	927	166	182	8433	61085
9'-10'	2.75	19	880	157	160	7413	56417
10'-11'	2.71	24	1112	135	192	8896	57210
11'-12'	2.80	20	927	167	144	6672	58551
12'-13'	2.82	24	1112	165	147	6811	57102
13'-14'	2.84	22	1019	180	128	5931	58703
14'-15'	2.79	28	1297	152	155	7182	55622
Actual from Heap OFF Soln:			1280			22400	

* 200 gram ore: 1000 ml H2O = 4.88 Ton Soln/Ton Ore
4749 Ton Heap x 4.88 TS/TO x 240 gal/ton = 5,560,000 gallons
Heap @ 10.5% moisture = 120,000 gallons

Rinse ppm x 5,560,000 = 120,000 x Heap ppm

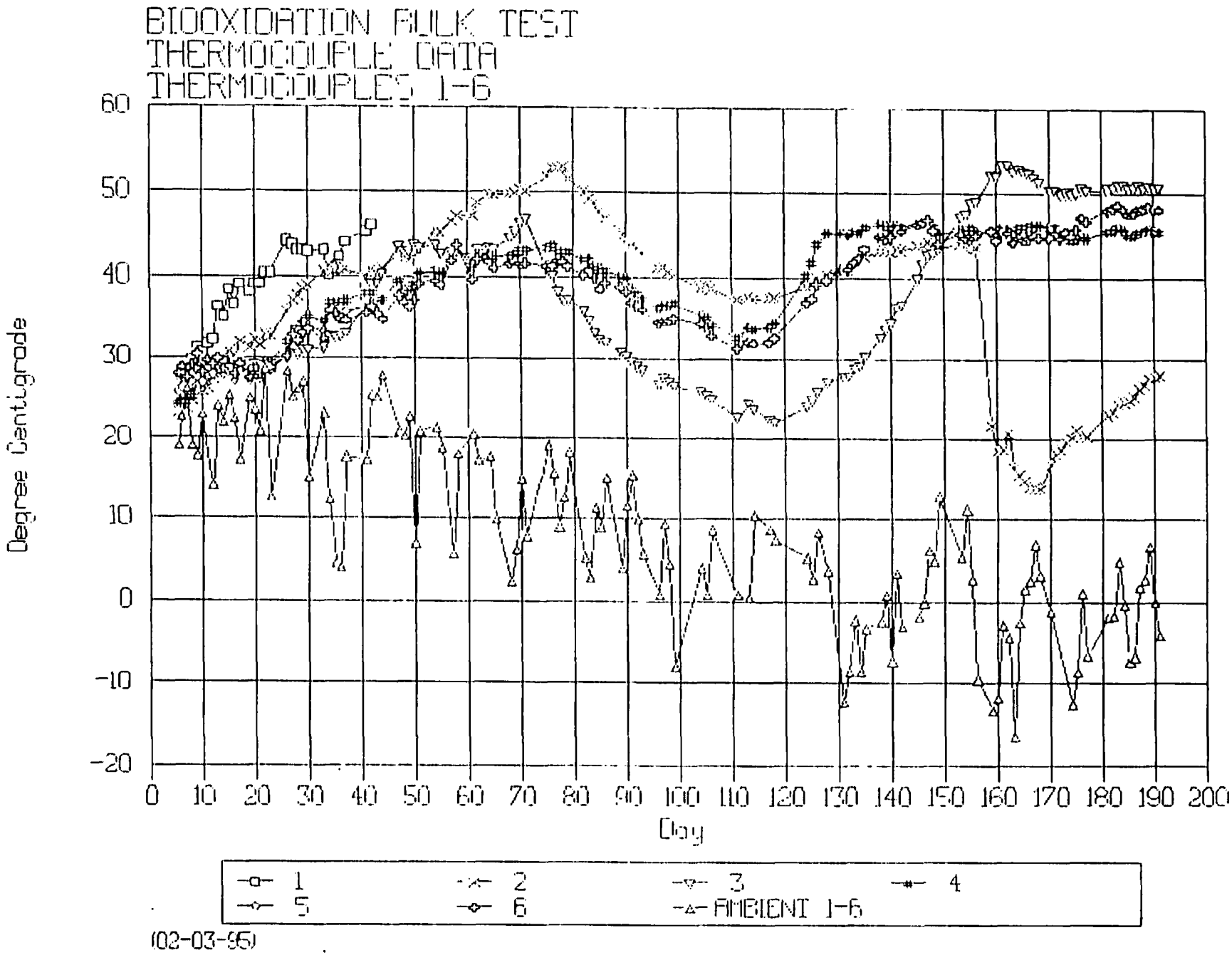
BIOOXIDATION BULK TEST SOLUTION SAMPLING

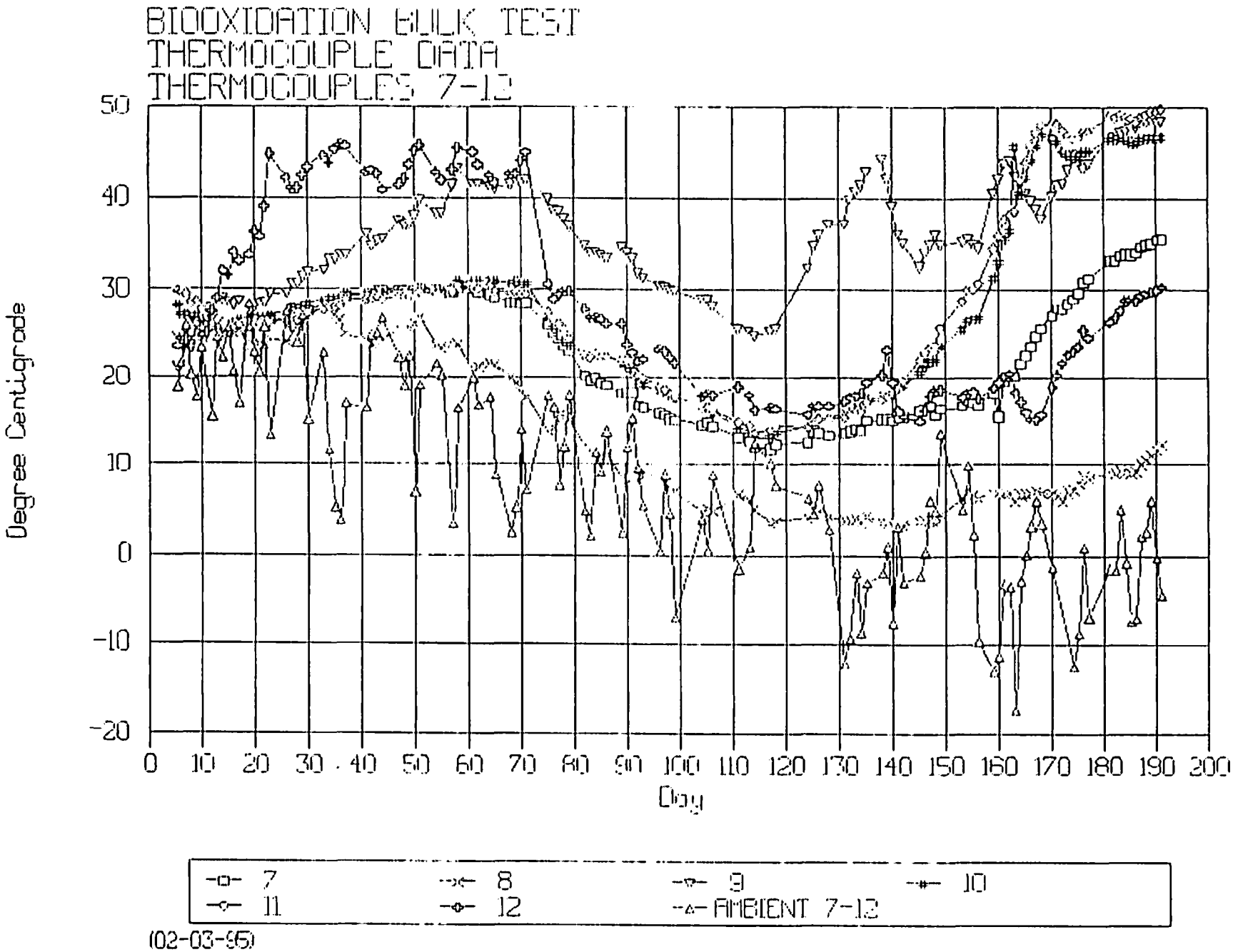
OFF SOLUTION - DISCARDED FROM HEAP

	Day	Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	DO (ppm)
0	158	COMP	1/ 1/95	330	29137	1.74	581.3	1580	19600	430	19170	75356	99192	-
0	159	COMP	1/ 2/95	287	29424	1.88	575.7	1640	21200	440	20760	-	101229	-
0	160	COMP	1/ 3/95	287	29711	1.79	567.7	1650	22500	460	22040	-	104418	-
0	161	COMP	1/ 4/95	304	30015	1.84	567.9	1710	22700	480	22220	81906	109912	-
0	162	COMP	1/ 5/95	223	30238	1.82	573.6	1760	23800	490	23310	-	113389	-
0	163	COMP	1/ 6/95	223	30461	1.85	591.1	1730	24900	460	24440	-	114191	-
0	164	COMP	1/ 7/95	128	30589	1.85	588.6	1740	23100	480	22620	-	114274	-
0	165	COMP	1/ 8/95	190	30779	1.83	569.4	1770	23500	510	22990	85804	114582	-
0	166	COMP	1/ 9/95	121	30900	1.96	571.6	1720	28800	480	28320	-	112175	-
2932	167	COMP	1/10/95	217	31117	2.00	588.2	1530	22500	400	22100	-	101188	-
3028	168	COMP	1/11/95	620	31737	1.97	581.6	1380	20600	400	20200	-	92382	-
0	169	COMP	1/12/95	619	32356	2.00	571.8	1310	20500	400	20100	-	84892	-
2837	170	COMP	1/13/95	530	32886	1.88	592.1	1160	18300	360	17940	-	81868	-
2967	171	COMP	1/14/95	907	33793	1.86	573.3	1060	19000	400	18600	-	80140	-
0	172	COMP	1/15/95	961	34754	1.85	568.0	1380	22200	490	21710	73847	96929	-
0	173	COMP	1/16/95	633	35387	1.82	566.3	1490	28000	540	27460	-	107443	-
0	174	COMP	1/17/95	540	35927	1.80	561.5	1520	28200	580	27620	-	110961	-
0	175	COMP	1/18/95	452	36379	1.83	567.4	1460	27200	580	26620	90338	117915	-
0	176	COMP	1/19/95	295	36674	1.77	567.3	1620	30700	610	30090	-	120055	-
0	177	COMP	1/20/95	284	36958	1.81	577.6	1520	30400	220	30180	-	113574	-
0	178	COMP	1/21/95	212	37170	1.81	576.1	1650	28200	560	27640	-	119356	-
0	179	COMP	1/22/95	194	37364	1.84	589.9	1630	26400	540	25860	95528	117915	-
0	180	COMP	1/23/95	181	37545	1.68	572.9	1820	30300	600	29700	-	126289	-
2951	181	COMP	1/24/95	223	37768	1.69	599.1	1570	23100	490	22610	-	112422	-
2987	182	COMP	1/25/95	483	38251	1.69	576.8	1280	22400	460	21940	75621	96229	-
3014	183	COMP	1/26/95	747	38998	1.88	689.6	1190	20800	430	20370	-	90489	-
0	184	COMP	1/27/95	704	39702	1.82	573.5	1330	24700	560	24140	-	104686	-
0	185	COMP	1/28/95	506	40208	1.83	576.5	1330	26100	600	25500	-	106620	-
0	186	COMP	1/29/95	439	40647	1.83	567.2	1480	25900	650	25250	89089	114438	-
0	187	COMP	1/30/95	288	40935	1.74	572.8	1420	25000	540	24460	-	110179	-
0	188	COMP	1/31/95	302	41237	1.74	570.6	1460	23400	510	22890	-	105179	-
0	189	COMP	2/ 1/95	257	41494	1.74	558.3	1560	27200	580	26620	88498	111146	-

BIOOXIDATION BULK TEST THERMOCOUPLE DATA

Date	West 1	West 2	West 3	West 4	West 5	Mid 6	Mid 7	Mid 8	East 9	East 10	East 11	East 12	AMBIENT 1-6	AMBIENT 7-12
01/01/95	-	-	-	-	-	-	-	-	-	-	-	-	-	-
01/02/95	-	21.7	52.1	45.5	-	45.6	18.3	6.9	40.6	31.3	34.5	18.8	-13.2	-13.0
01/03/95	-	18.6	52.0	44.7	-	44.3	15.5	6.9	42.1	33.1	36.0	19.5	-11.7	-11.2
01/04/95	-	18.8	53.3	45.9	-	45.5	19.7	6.9	43.7	35.6	37.7	20.2	-2.8	-3.1
01/05/95	-	20.6	53.2	45.8	-	45.3	20.1	6.9	44.0	36.5	38.3	20.5	-4.4	-3.4
01/06/95	-	16.5	52.5	45.2	-	44.2	20.2	6.1	42.4	45.6	38.7	18.3	-16.4	-17.3
01/07/95	-	15.6	52.8	45.9	-	44.7	21.7	6.7	41.5	40.6	42.0	17.2	-2.6	-2.8
01/08/95	-	14.7	52.6	46.0		44.5	22.6	6.8	40.6	42.3	43.9	16.0	1.6	.1
01/09/95	-	14.1	52.2	46.1	-	44.6	23.6	6.9	39.6	44.1	45.7	15.3	2.5	3.3
01/10/95	-	13.9	51.9	46.3	-	44.9	24.7	7.1	38.8	45.7	47.2	15.2	6.9	6.0
01/11/95	-	13.8	51.3	46.2	-	44.7	25.6	6.9	37.8	46.9	48.0	15.7	3.2	3.6
01/12/95	-	-	-	-	-	-	-	-	-	-	-	-	-	-
01/13/95	-	16.8	50.4	45.9	-	44.7	27.1	6.9	40.2	46.6	48.2	18.9	-1.1	-1.2
01/14/95	-	18.2	50.4	46.0	-	45.3	27.9	6.6	41.3	46.1	48.2	20.4	-	-
01/15/95	-	18.7	49.8	44.9	-	44.6	27.8	6.1	41.6	45.1	47.4	21.7	-	-
01/16/95	-	19.6	50.0	44.9	-	45.4	28.5	7.0	43.0	44.7	46.9	22.7	-	-
01/17/95	-	20.2	49.8	44.4	-	44.9	29.0	7.3	44.5	44.5	46.6	23.0	-12.5	-12.4
01/18/95	-	21.2	50.0	44.4	-	45.7	29.7	8.0	44.9	44.5	46.6	23.6	-8.5	-8.8
01/19/95	-	20.4	50.5	44.9	-	47.2	30.9	8.7	43.2	45.1	47.3	23.4	1.0	.8
01/20/95	-	20.3	50.3	44.6	-	46.7	31.3	8.5	43.8	45.1	47.3	24.5	-6.6	-6.9
01/21/95	-	-	-	-	-	-	-	-	-	-	-	-	-	-
01/22/95	-	-	-	-	-	-	-	-	-	-	-	-	-	-
01/23/95	-	-	-	-	-	-	-	-	-	-	-	-	-	-
01/24/95	-	23.0	50.5	45.5	-	48.0	33.2	9.2	46.4	46.5	49.0	26.3	-2.0	-1.5
01/25/95	-	23.5	50.6	45.6	-	48.3	33.3	9.1	46.7	46.4	48.9	26.8	-1.6	-1.6
01/26/95	-	24.4	51.0	46.0	-	48.6	33.8	9.5	47.1	46.6	49.2	27.7	4.9	5.1
01/27/95	-	24.7	51.0	45.7	-	48.2	33.9	9.3	47.4	46.4	48.9	28.8	-.4	-.8
01/28/95	-	24.9	50.6	45.0	-	47.6	33.9	9.1	47.7	46.1	48.7	28.9	-7.2	-7.3
01/29/95	-	25.3	50.6	45.0	-	47.7	34.0	9.3	47.8	46.0	48.3	28.8	-6.7	-7.0
01/30/95	-	26.3	51.0	45.5	-	48.2	34.7	10.1	48.3	46.5	49.0	29.3	1.9	2.2
01/31/95	-	26.8	50.7	45.5	-	48.3	34.9	10.6	48.4	46.5	49.2	29.6	2.7	2.6
02/01/95	-	27.6	50.9	45.8	-	48.5	35.1	11.2	48.5	46.6	49.5	29.8	6.7	6.0
02/02/95	-	27.8	50.7	45.6	-	48.2	35.4	11.7	48.3	46.6	49.6	30.0	.0	-.2
02/03/95	-	28.0	50.6	45.4	-	48.1	35.6	12.3	48.4	46.7	49.8	30.4	-4.2	-4.3


BIOOXIDATION BULK TEST
THERMOCOUPLE DATA
THERMOCOUPLES 1-6
Degree Centigrade
60
50
40
30
20
10
0
-10
-20
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
Day
1
2
3
4
5
6
AMBIENT 1-6
(02-03-95)


BIOOXIDATION BULK TEST
THERMOCOUPLE DATA
THERMOCOUPLES 7-12
Degree Centigrade
50
40
30
20
10
0
-10
-20
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
Day
7
8
9
10
11
12
AMBIENT 7-12
(02-03-95)

Overall heat up from not adding water

#4 South Blower ON → #4 South Blower OFF (~~10~~ 15 days)

11/23

Day 120 - 12/9 ~~136~~ 135

#2 - gradual increase	+4.9			
#3 - steady increase	+8.4	+	~~0'~~ ? -10' west (3	
#4 - sharp increase 1/2 ; level out 1/2	+11.5	++	~~0'~~ west (2)	
#6 - steady increase	+10.7	++	~~0'~~ west (1)	
#7 - gradual increase	+2.6			
#8 - level	+0.6			
#9 - sharp increase	+17.3	+++	~~0'~~ straight	
#10 - gradual increase	+3.9			
#11 - gradual increase	+2.8			
#12 - gradual increase	+3.0			
ambient 1-6 steady 1/2 ; sharp ↓ ; steady 1/2	-10.7			
Ambient 7-12 " " "	-10.7			

12/10 - Day 136 - 12/29 155

#4 North Blower ON → 4 Blowers ON (~~20~~ 19 days)

#2 level	+1.6			
#3 steady increase	+15.5	+++	~~0'~~ ? -10' south west (3)	
#4 level	~~0~~			
#6 gradual increase	+1.7			
#7 gradual increase	+2.1			
#8 level 2/3 → increase 1/3	+2.3			
#9 sharp decrease 1/3 ; level 2/3	-8.0	--	0' west (1)	
#10 steady increase	+9.0	++	10' west (1)	
#11 steady increase	+13.0	++	10' straight	
#12 sharp increase 1/4 ; sharp decrease 1/8 , grad increase 1/8 , level 1/2	-1.0			
ambient 1-6	+6.0			
ambient 7-12	+5.3			

	# 2 + # 4 SOUTH and NORTH (4 blowers ON)					
12/30 - 156	#2	sharp decrease (1/4); steady decrease (3/4)	30.3	---	0'	west
1/13 - 170	#3	gradual increase (1/4); grad decrease (3/4)	+2.5			
(1/11 - 168)	#4	level	+0.3			
	#6	level	-0.3			
	#7	steady increase	+8.5	+	10'	center 4 blowers
	#8	level	+0.2			
	#9	sharp increase (1/2); sharp decrease (1/2)	+2.9			
	#10	steady increase	+20.3	+++	10'	straight
	#11	steady increase	+17.8	+++	10'	straight
	#12	grad increase (1/3); sharp decrease (1/3); grad increase (1/3)	-2.7			
	ambient 1-6	very cold temps	+0.5			
	ambient 7-12	first Do 1/2	+1.3			
(1/11 - 168)						
1/13 170	Blowers Off					
1/18 175	#2	steady increase	+7.4	+	0'	
	#3	immediate decrease → level	-1.3			
	#4	steady decrease	-1.8			
	#6	steady increase	+1.0			
	#7	steady increase	+4.1		10'	
	#9	immediate decrease → increase	+1.1			
	#9	~~sharp~~ steady increase	+7.1	+	0'	
	#10	steady decrease	-2.4			
	#11	steady decrease	-1.4			
	#12	steady increase	+7.9	+	0'	
	ambient 1-6		-11.7			
	ambient 7-12		-12.4			

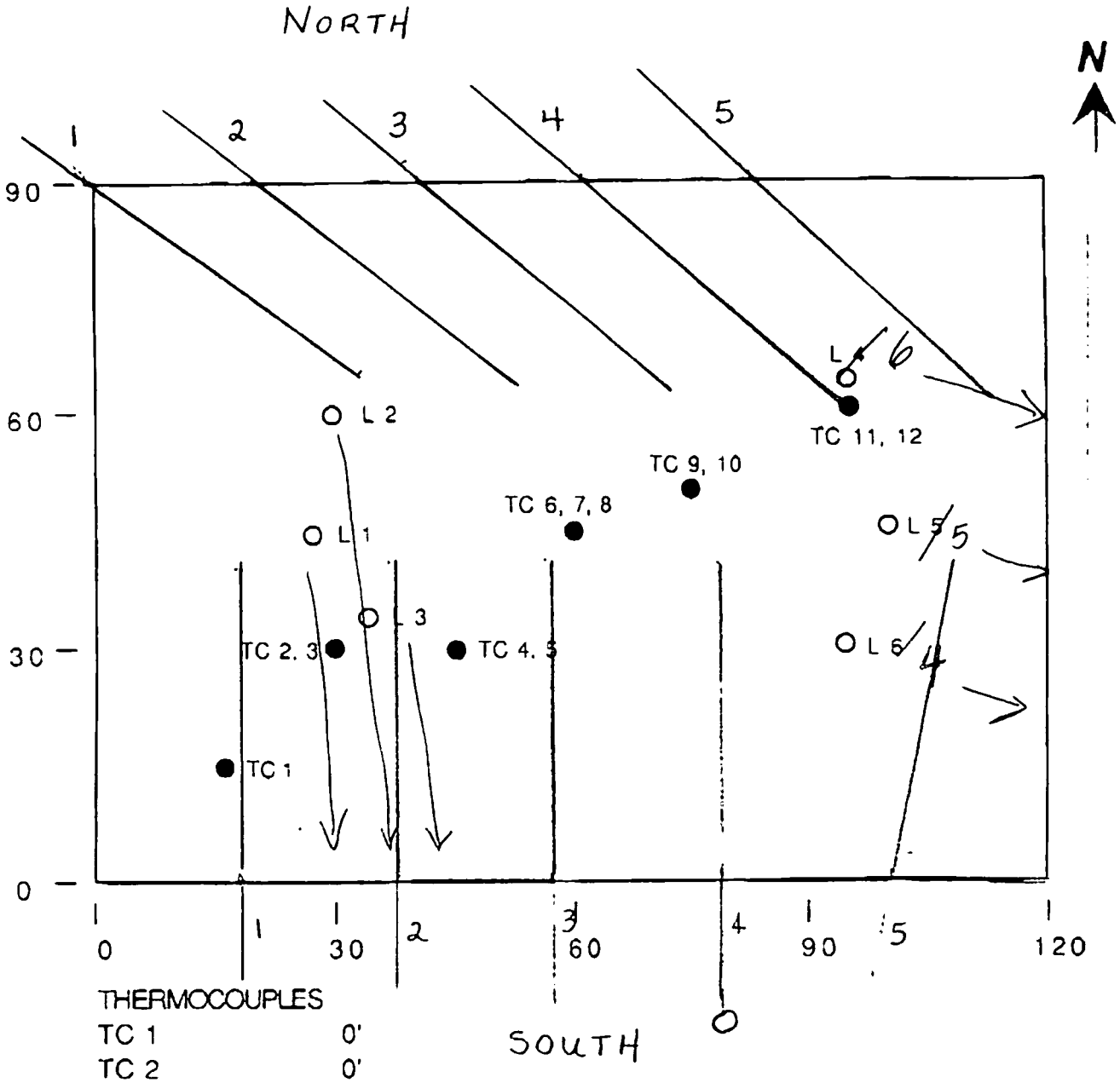
		Blowers ON		
1/18	175	#2	-0.9	
1/20	177	#3	+0.3	
		#4	+0.2	
		#6	+1.0	
		#7	+1.6	
		#8	+0.5	
		#9	-1.1	
		#10	+0.6	
		#11	+0.7	
		#12	+0.9	
		Ambient 1-6	+1.9	
		Ambient 7-12	+1.9	
		Blowers Off		
1/20	177	#2	+9.8	++ 0' West
2/9	197	#3	+0.5	
		#4	+0.7	
		#6	+1.6	
		#7	+6.4	+ 10' Center
		#8	+6.1	+ 17' Center
		#9	+3.8	
		#10	+3.5	
		#11	+4.2	
		#12	+7.0	+ 0' East
		Ambient 1-6	+2.0	
		Ambient 7-12	+2.2	

Conclusions: Thermocouple Blowers

Warmer ambient temps ⇒ 0' heat up
Colder ambient temps ⇒ 0' level or cool
but 10' increase temp

Air → increase bioactivity

2/9 East side consistently higher temps
8 - 17' Center increased
dramatically over last few weeks
Biooxidation ↑ in top level of ~~pile~~ heap?



THERMOCOUPLES

TC 1	0'	
TC 2	0'	
TC 3	?'	Somewhere beteen 0 and 10'
TC 4	0'	
TC 5	20'	
TC 6	0'	
TC 7	10'	
TC 8	17'	3' below top
TC 9	0'	
TC 10	10'	
TC 11	10'	
TC 12	0'	

Heap Height
W = 18.5'
E 18.1'

LYSIMETERS

L 1	6'
L 2	1'
L 3	1'
L 4	1'
L 5	6'
L 6	1'

Version ~~3~~ 4 dp
8/24/94

BROHM BBT BOTTLE ROLL GOLD EXTRACTION DATA			
	% Fe Oxidation	% $S^{=}$ Oxidation	% Au Extraction*
Auger Drill-2 West 1'-15'	4.4	3.3	62.4
Auger Drill-2 Mid 1'-15'	5.8	2.5	57.5
Auger Drill-3 West 10'-15'	4.5	10.3	56.6
Auger Drill-3 Mid 10'-15'	-1.3	-15.2	56.5
Auger Drill-3 East 10'-15'	1.0	1.2	59.2
Auger Drill-4 West 1'-5'	0.3	3.5	54.6
Auger Drill-4 Mid 1'-5'	5.0	15.1	58.5
Auger Drill-4 East 1'-5'	2.7	12.1	57.5
Auger Drill-6 West 10'-15'	14.3	4.2	54.5
Auger Drill-6 Mid 10'-15'	12.9	2.8	56.7
Auger Drill-6 East 10'-15'	13.9	2.0	59.5

* Gold Extraction percentages based on calculated head.

Oxidation percentages based on difference between Auger Drill-1 and Auger Drill-x iron and sulfide values. It was assumed that no appreciable oxidation had taken place when Auger Drill-1 samples were collected on 08-23-94.

BROHM BBT COMPOSITE BOTTLE ROLL GOLD EXTRACTION DATA			
	% Fe Oxidation	% $S^{=}$ Oxidation	% Au Extraction*
SP2 Control	0	0	52.3 3x avg
Auger Drill-3 10/24/94	6.2	-1.5	57.1 1x
Auger Drill-5 12/01/94	10.7	2.2	58.2 2x avg
Auger Drill-7 12/28/94	4.6	1.1	57.0 2x avg
Auger Drill-9			

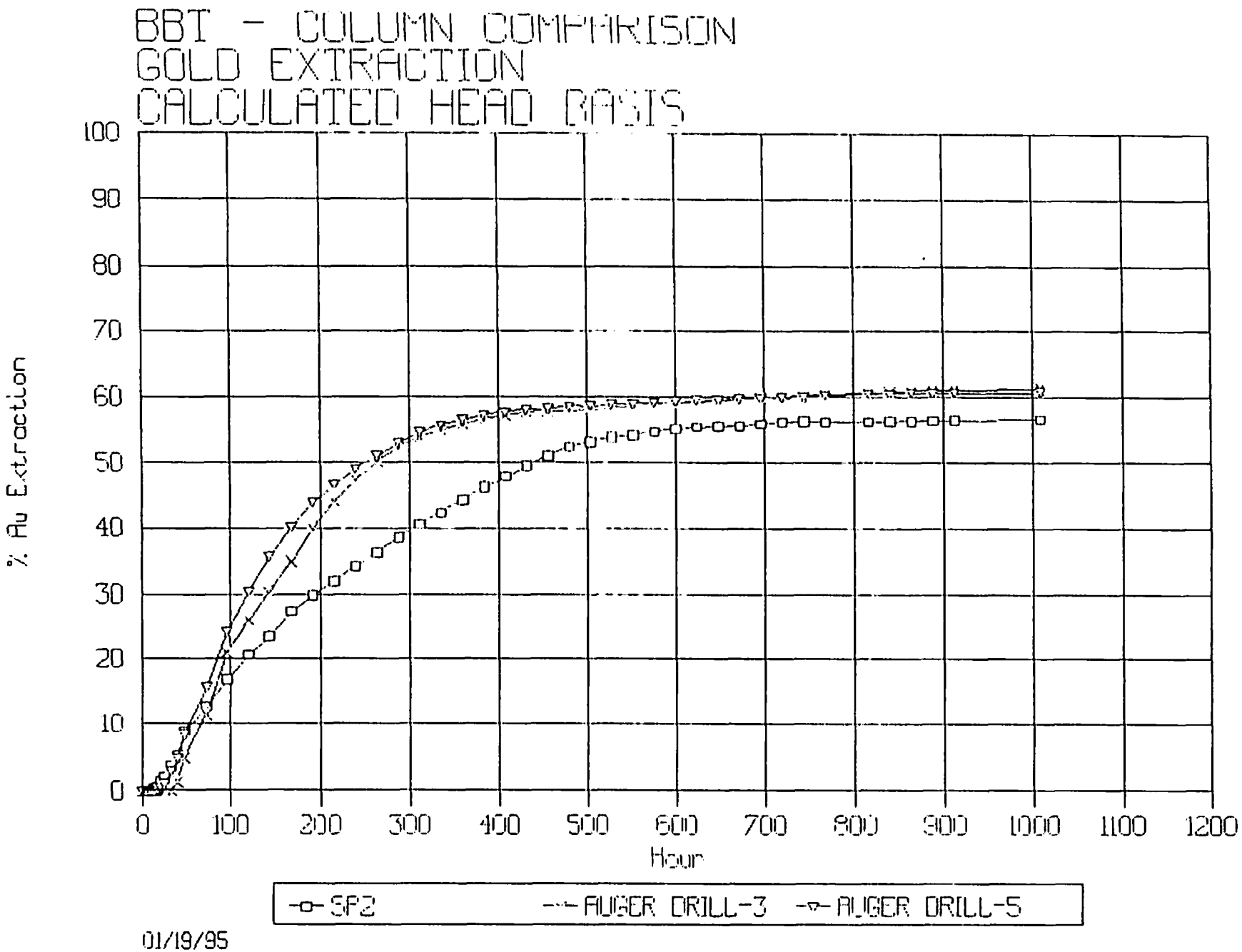
* Gold Extraction percentages based on calculated head.

Oxidation percentages based on difference between Auger Drill-1 and Auger Drill-x iron and sulfide values. It was assumed that no appreciable oxidation had taken place when Auger Drill-1 samples were collected on 08-23-94.

BROHM BBT COLUMN GOLD EXTRACTION DATA			
	% Fe Oxidation	% $S^{=}$ Oxidation	% Au Extraction*
SP2 Control	0	0	56.7
Auger Drill-3 10/24/94	6.2	-1.5	61.3
Auger Drill-5 12/01/94	10.7	2.2	60.7
Auger Drill-7 12/28/94	4.6	1.1	
Auger Drill-9			

* Gold Extraction percentages based on calculated head.

Oxidation percentages based on difference between Auger Drill-1 and Auger Drill-x iron and sulfide values. It was assumed that no appreciable oxidation had taken place when Auger Drill-1 samples were collected on 08-23-94.


BBT - COLUMN COMPARISON
GOLD EXTRACTION
CALCULATED HEAD BASIS
% Au Extraction
100
90
80
70
60
50
40
30
20
10
0
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
Hour
SP2
AUGER DRILL-3
AUGER DRILL-5
01/19/95

MEMORANDUM

DATE: JANUARY 16, 1995
TO: MARTIN QUICK and HERB OSBORNE
FROM: LAURA DAMON
SUBJECT: BIOOXIDATION BULK TEST (BBT) DATA INTERPRETATION

Attached are iron and sulfate extraction graphs which I believe simply show that when fresh water is added to the BBT heap the heap is flushing rather than exhibiting an increase in the rate of biooxidation due to the removal of a bacterial inhibitory substance. I interpret the graphs as showing that the heap's iron and sulfate extractions are following, to date, a rather linear extraction rate.

As seen in the iron extraction graph, it may be that the iron extraction rate is somewhat lower than the predicted rate during weeks 3-10 due to precipitation on the drainrock and in the screwfeeder solids. Also the amount of iron in the neutralization sludge may be somewhat low due to estimating the amount of sludge that was being discarded. Heavy rains diluted the iron concentration during the weeks of 11-12 as shown by the significant increase of the OFF solution's average gpm. During weeks 13-17, when the OFF solution's average gpm stayed fairly consistent, the rate of extraction follows the drawn line well. The rate of extraction dropped during weeks 18-21 when circulation of solution was stopped and the soluble consistuents had no means of transport out of the heap. Biooxidation continued at the predicted rate in the heap and when fresh water was added during week 21 the soluble iron simply was flushed from the heap. The true test is to see if, with the continued addition of fresh water, the extraction rate follows the predicted rate of extraction or starts to climb dramatically. I think we should be able to see this within the next few weeks.

Likewise, in the sulfate extraction graph, the same sort of arguments can be made although the solubility or precipitaion of the sulfate behaves somewhat differently than the iron. The big difference is in week 24 when the sulfate extraction continues to climb. From what I've seen of the week 25 data, I think the extraction will come back down closer to the predicted rate. We will have that data by the time we meet on Friday.

Also attached are the spreadsheets showing how I calculated the extractions, the latest thermocouple and OFF solution data, recent memos from John Shield, the final auger drill-3 gold extraction column curve and auger drill-6 bottle roll data.

Please review this data and give me a call to critique my flush theory. ALL observations are welcomed!

I will continue to update these graphs as data becomes available. I also plan to work on a gold extraction summary this week and try to estimate the amount of sulfate that was discarded during neutralization. Finally, I am also working on a copper extraction curve to go with the iron and sulfate curves.

I look forward to your comments.

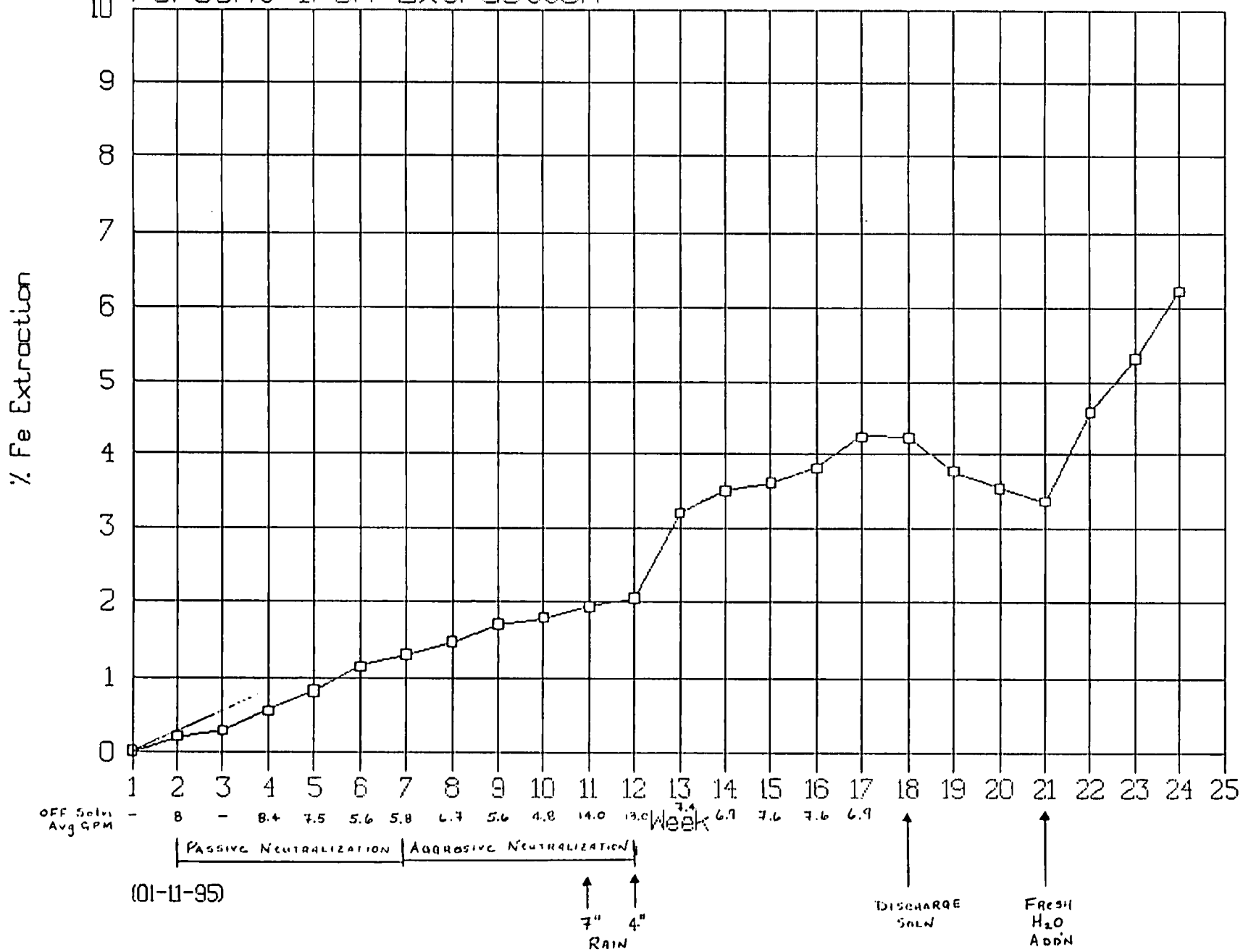
Laura

Laura

/

c: Jim Thompson
Rod MacLeod

BIOOXIDATION BULK TEST
Percent Iron Extraction



9BT FE EXTRACTION

Total lb Fe in Heap = 559432

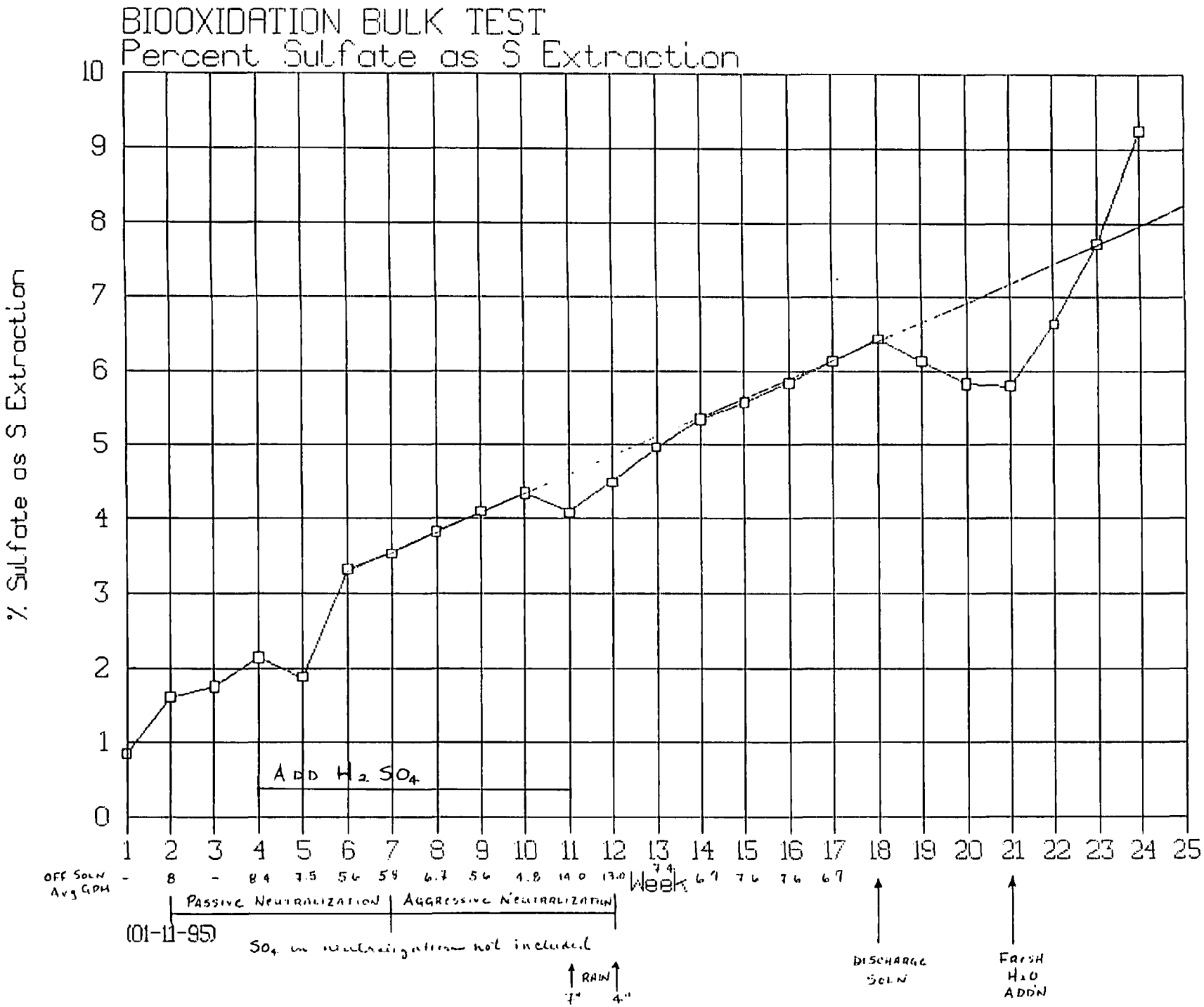
Date	Week	On Soln gal	Cum On Soln gal	Discharge Soln gal	Cum Discharge Soln gal	Neut & Soln Discharge lb Fe	Cum Discharge lb Fe	Avg Weekly Total Fe ppm	Fe contained In Circuit lb	Circuit Fe + Cum Discharge lb	Cum % Fe Ext	Cum % Fe Ext - Soluble Fe (2% from H2O Rinse)
7/28-8/3	1							110	124	124	.0	
8/4-8/10	2					21	21	1057	1190	1211	.2	
8/11-8/17	3					132	153	1361	1532	1685	.3	
8/18-8/24	4						153	2701	3040	3193	.6	
8/25-8/31	5						153	3983	4483	4636	.8	
9/1-9/7	6					163	316	5467	6153	6469	1.2	
9/8-9/14	7						316	6237	7020	7336	1.3	
9/15-9/21	8						316	7100	7991	8307	1.5	
9/22-9/28	9					925	1241	7410	8340	9581	1.7	
9/29-10/5	10					110	1351	7700	8666	10017	1.8	
10/6-10/12	11					757	2108	7817	8798	10906	1.9	
10/13-10/19	12						2108	8333	9379	11487	2.1	1.0
10/20-10/26	13					3231	5339	11175	12577	17916	3.2	1.2
10/27-11/2	14						5339	12771	14374	19713	3.5	1.5
11/3-11/9	15						5339	13267	14932	20271	3.6	1.6
11/10-11/16	16						5339	14300	16095	21434	3.8	1.8
11/17-11/23	17						5339	16371	18425	23764	4.2	2.2
11/23-11/30	18			10697	10697	1446	6785	16362	16956	23741	4.2	2.2
12/1-12/7	19			5036	15733	587	7372	13857	13778	21150	3.8	1.8
12/8-12/14	20			2542	18275	268	7640	12614	12275	19915	3.6	1.6
12/15-12/21	21	10458	10458	3263	21538	286	7926	10543	10892	18818	3.4	1.4
12/22-12/28	22	5345	15803	5181	26719	694	8620	16500	17069	25689	4.6	2.6
12/29-1/4	23	2944	18747	3296	30015	463	9083	20117	20752	29835	5.3	3.3
1/5-1/11	24	5960	24707	1722	31737	328	9411	23886	25484	34895	6.2	4.2
1/12-1/18	25											

1. Weeks 1-17: Extraction assumes 11% moisture in saturated heap (Auger Drill-3 data).
   4749 Tons x 0.11 x 240 gal/ton = 125,377 gallons contained in heap
   + 10,000 gallons in tankage
   = approximately 135,000 gallons in circuit

2. Weeks 18-24: 135,000 - Cum Discharge + Cum Fresh Water = gallons in circuit.

3. Extraction does not include any Fe ppt on drainrock or in screwfeeder solids.

4. Extraction does include water and acid soluble Fe.


BIOOXIDATION BULK TEST
Percent Sulfate as S Extraction
% Sulfate as S Extraction
0
1
2
3
4
5
6
7
8
9
10
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Week
OFF SOLN Avg GPM
- 8 - 8.4 7.5 5.6 5.9 6.7 5.6 4.8 14.0 13.0 7.4 6.7 7.6 7.6 6.7
ADD H_2SO_4
PASSIVE NEUTRALIZATION
AGGRESSIVE NEUTRALIZATION
(01-11-95)
SO_4 in neutralization not included
RAIN
7" 4"
DISCHARGE SOLN
FRESH H_2O ADD'N

PBT SO4 EXTRACTION

Total Sulfide in Heap = 466352
Total Sulfur in Heap = 496745 as S
Total lb SO4 in Heap = 90231 30394

Date	Week	On Soln gal	Cum On Soln gal	Discharge Soln gal	Cum Discharge Soln gal	Neut & Soln Discharge lb SO4 as S	Cum Discharge lb SO4 as S	Avg Weekly SO4 ppm	SO4 as S contained In Circuit lb	Circuit SO4 as S + Cum Discharge lb	Cum x SO4 as S Ext	Cum x SO4 as S - Soluble Sulfate (2.75x from H2O Rinse Column
7/28-8/3	1							11192	4199	4199	.8	
8/4-8/10	2							21327	8001	8001	1.6	
8/11-8/17	3							23139	8681	8681	1.7	
8/18-8/24	4							28250	10598	10598	2.1	
8/25-8/31	5							24788	9300	9300	1.9	
9/1-9/7	6							43992	16504	16504	3.3	.6
9/8-9/14	7							46884	17589	17589	3.5	.8
9/15-9/21	8							50667	19008	19008	3.8	1.1
9/22-9/28	9							54071	20285	20285	4.1	1.3
9/29-10/5	10							57303	21498	21498	4.3	1.6
10/6-10/12	11							53983	20252	20252	4.1	1.3
10/13-10/19	12							59349	22265	22265	4.5	1.7
10/20-10/26	13							65671	24637	24637	5.0	2.2
10/27-11/2	14							70723	26533	26533	5.3	2.6
11/3-11/9	15							73809	27690	27690	5.6	2.8
11/10-11/16	16							77329	29011	29011	5.8	3.1
11/17-11/23	17							81120	30433	30433	6.1	3.4
11/23-11/30	18			10697	10697	2509	2509	85242	29446	31955	6.4	3.7
12/1-12/7	19			5036	15733	1130	3639	80842	26794	30433	6.1	3.4
12/8-12/14	20			2542	18275	539	4178	76242	24731	28909	5.8	3.1
12/15-12/21	21	10458	10458	3263	21538	619	4797	69682	23996	28793	5.8	3.0
12/22-12/28	22	5345	15803	5181	26719	1103	5900	78497	27068	32968	6.6	3.9
12/29-1/4	23	2944	18747	3296	30015	793	6693	92182	31697	38390	7.7	5.0
1/5-1/11	25	5960	24707	1722	31737	500	7193	108883	38722	45915	9.2	6.5

1. Weeks 1-17: Extraction assumes 11% moisture in saturated heap (Auger Drill-3 data).
   4749 Tons x 0.11 x 240 gal/ton = 125,377 gallons contained in heap
   + 10,000 gallons in tankage
   = approximately 135,000 gallons in circuit

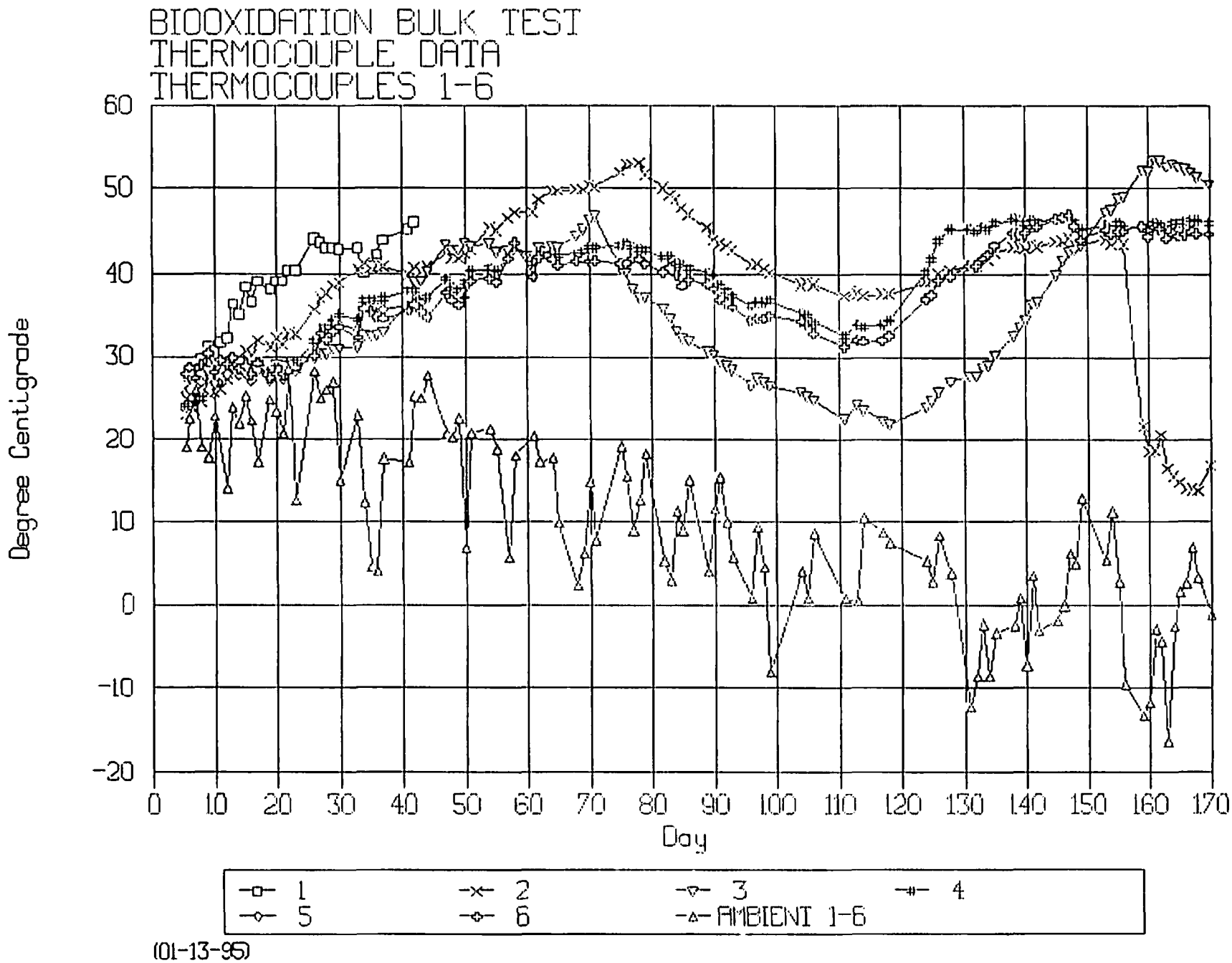
2. Weeks 18-24: 135,000 - Cum Discharge + Cum Fresh Water = gallons in circuit.

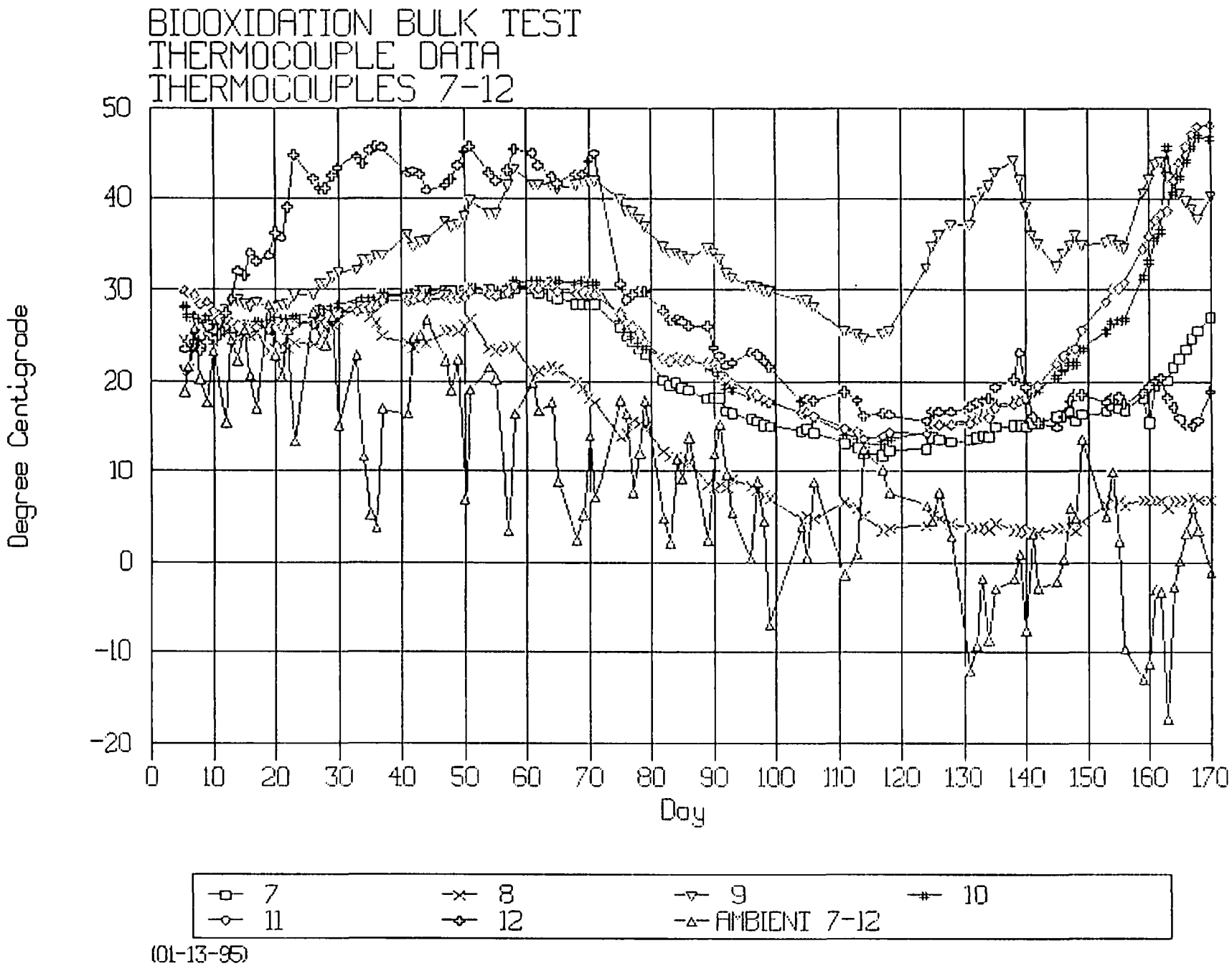
3. Extraction does not include any SO4 ppt on drainrock, in neut sludge and discard or screwfeeder solids.

4. Extraction does include water soluble SO4.

BIOOXIDATION BULK TEST THERMOCOUPLE DATA

Date	West 1	West 2	West 3	West 4	West 5	Mid 6	Mid 7	Mid 8	East 9	East 10	East 11	East 12	AMBIENT 1-6	AMBIENT 7-12
11/28/94	-	39.0	24.0	40.2	-	37.0	12.6	4.2	32.4	14.4	14.3	15.7	5.3	6.3
11/29/94	-	39.2	24.7	41.7	-	37.5	13.8	5.1	34.8	15.5	15.4	16.8	2.7	4.5
11/30/94	-	40.1	25.9	43.9	-	39.2	13.6	4.9	36.0	15.4	15.3	16.7	8.3	7.8
12/01/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12/02/94	-	40.4	27.1	45.2	-	39.7	13.3	4.3	37.2	15.4	15.3	16.7	3.7	2.9
12/03/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12/04/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12/05/94	-	40.9	27.7	45.2	-	41.0	13.6	3.9	37.1	15.8	15.5	17.3	-12.3	-12.1
12/06/94	-	41.0	27.8	45.0	-	40.9	13.8	3.9	39.8	16.1	15.9	17.8	-8.5	-9.3
12/07/94	-	41.8	28.8	45.4	-	41.8	14.1	4.0	40.7	16.5	16.2	18.0	-2.3	-1.9
12/08/94	-	41.6	29.0	45.3	-	42.3	13.9	3.7	41.3	16.5	16.1	18.2	-8.5	-8.6
12/09/94	-	42.5	30.3	45.9	-	43.3	15.0	4.4	42.9	17.6	17.2	19.4	-3.3	-3.0
12/10/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12/11/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12/12/94	-	43.2	32.6	46.4	-	44.8	15.2	3.6	44.2	17.9	17.6	20.3	-2.5	-2.0
12/13/94	-	43.2	33.6	46.2	-	44.6	15.2	3.6	42.0	18.1	17.9	23.2	.8	1.0
12/14/94	-	43.0	34.5	45.9	-	44.8	15.1	3.4	39.1	18.1	18.3	19.4	-7.2	-7.5
12/15/94	-	43.4	36.4	46.2	-	45.5	15.5	3.4	36.1	18.9	19.3	16.3	3.4	3.1
12/16/94	-	43.2	36.6	46.0	-	45.5	15.5	3.3	35.1	19.1	19.7	15.5	-3.1	-2.9
12/17/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12/18/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12/19/94	-	43.8	39.9	46.5	-	46.4	16.2	3.8	32.5	20.6	22.1	15.0	-1.9	-2.3
12/20/94	-	43.9	41.5	46.5	-	46.6	16.4	3.9	34.1	21.3	22.9	16.2	-.1	.3
12/21/94	-	44.2	42.6	46.7	-	46.8	16.8	4.1	35.0	22.0	23.5	17.9	6.2	6.0
12/22/94	-	43.5	42.7	46.0	-	45.6	15.7	3.5	36.0	22.0	23.6	18.6	4.9	4.8
12/23/94	-	43.3	43.3	45.2	-	44.0	16.4	4.5	35.0	23.6	25.6	18.6	12.8	13.6
12/24/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12/25/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12/26/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12/27/94	-	44.0	47.1	45.7	-	45.1	16.7	6.3	35.2	25.5	28.7	17.8	5.4	5.1
12/28/94	-	43.6	47.4	45.4	-	44.7	17.4	6.9	35.6	26.5	30.1	18.3	11.2	10.0
12/29/94	-	44.1	48.8	45.9	-	45.0	17.1	6.7	34.9	26.6	30.2	18.4	2.7	2.3
12/30/94	-	43.6	48.9	45.4	-	45.0	16.8	6.3	34.5	26.8	30.7	17.6	-9.4	-9.5
12/31/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
01/01/95	-	-	-	-	-	-	-	-	-	-	-	-	-	-
01/02/95	-	21.7	52.1	45.5	-	45.6	18.3	6.9	40.6	31.3	34.5	18.8	-13.2	-13.0
01/03/95	-	18.6	52.0	44.7	-	44.3	15.5	6.9	42.1	33.1	36.0	19.5	-11.7	-11.2
01/04/95	-	18.8	53.3	45.9	-	45.5	19.7	6.9	43.7	35.6	37.7	20.2	-2.8	-3.1
01/05/95	-	20.6	53.2	45.8	-	45.3	20.1	6.9	44.0	36.5	38.3	20.5	-4.4	-3.4
01/06/95	-	16.5	52.5	45.2	-	44.2	20.2	6.1	42.4	45.6	38.7	18.3	-16.4	-17.3
01/07/95	-	15.6	52.8	45.9	-	44.7	21.7	6.7	41.5	40.6	42.0	17.2	-2.6	-2.8
01/08/95	-	14.7	52.6	46.0	-	44.5	22.6	6.8	40.6	42.3	43.9	16.0	1.6	.1
01/09/95	-	14.1	52.2	46.1	-	44.6	23.6	6.9	39.6	44.1	45.7	15.3	2.5	3.3
01/10/95	-	13.9	51.9	46.3	-	44.9	24.7	7.1	38.8	45.7	47.2	15.2	6.9	6.0
01/11/95	-	13.8	51.3	46.2	-	44.7	25.6	6.9	37.8	46.9	48.0	15.7	3.2	3.6
01/12/95	-	-	-	-	-	-	-	-	-	-	-	-	-	-
01/13/95	-	16.8	50.4	45.9	-	44.7	27.1	6.9	40.2	46.6	48.2	18.9	-1.1	-1.2


BIOOXIDATION BULK TEST
THERMOCOUPLE DATA
THERMOCOUPLES 1-6
Degree Centigrade
60
50
40
30
20
10
0
-10
-20
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
Day
1
2
3
4
5
6
AMBIENT 1-6
(01-13-95)


BIOOXIDATION BULK TEST
THERMOCOUPLE DATA
THERMOCOUPLES 7-12
Degree Centigrade
50
40
30
20
10
0
-10
-20
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
Day
7
8
9
10
11
12
AMBIENT 7-12
(01-13-95)

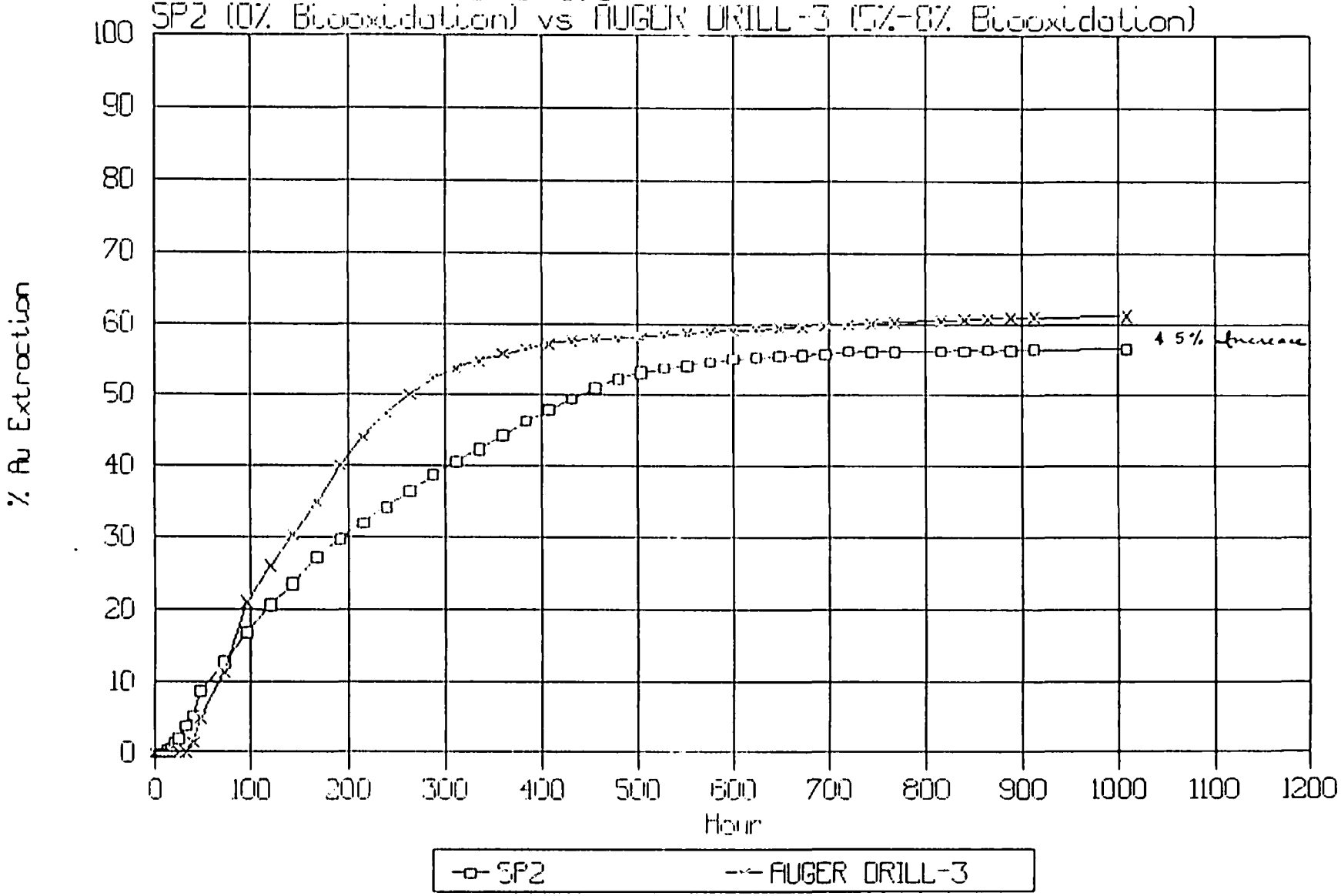
BIOOXIDATION BULK TEST SOLUTION SAMPLING

OFF SOLUTION - DISCARDED FROM HEAP

	Day	Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	DO (ppm)
	119	COMP	11/23/94	3865	3865	1.70	549.5	1690	15900	410	15490	-	82053	-
	120	COMP	11/24/94	2518	6383	1.81	564.3	1730	16400	380	16020	64266	85489	-
	121	COMP	11/25/94	924	7307	1.80	685.7	1770	16800	340	16460	-	86106	-
	122	COMP	11/26/94	1207	8514	1.83	688.2	1770	16200	340	15860	-	86086	-
	123	COMP	11/27/94	944	9458	1.82	607.8	1760	16000	340	15660	63748	85818	-
	124	COMP	11/28/94	494	9952	1.94	608.4	1820	17200	330	16870	-	86744	5.0
	125	COMP	11/29/94	424	10376	1.91	688.7	1870	17000	310	16690	65304	85613	-
	126	COMP	11/30/94	321	10697	2.04	573.0	1850	15400	270	15130	-	84028	-
	127	COMP	12/ 1/94	807	11504	1.92	636.6	1840	15600	290	15310	59662	82979	-
	128	COMP	12/ 2/94	968	12472	1.96	629.3	1760	14600	300	14300	-	79522	-
	129	COMP	12/ 3/94	840	13312	2.03	579.4	1770	14200	300	13900	-	79749	-
	130	COMP	12/ 4/94	687	13999	2.01	577.2	1820	14400	330	14070	58884	81991	-
	131	COMP	12/ 5/94	638	14637	1.93	587.2	1680	11400	260	11140	-	75922	-
	132	COMP	12/ 6/94	583	15220	2.02	634.1	1860	13600	290	13310	57781	83390	-
	133	COMP	12/ 7/94	513	15733	2.06	590.9	1840	13200	290	12910	-	82341	-
	134	COMP	12/ 8/94	428	16161	1.94	614.4	1840	12800	260	12540	58235	81724	-
	135	COMP	12/ 9/94	344	16505	1.94	574.5	1920	13400	360	13040	-	76930	-
	136	COMP	12/10/94	355	16860	1.94	601.8	1860	12600	310	12290	-	74728	-
	137	COMP	12/11/94	416	17276	1.96	608.9	1850	12600	310	12290	57781	74132	-
	138	COMP	12/12/94	342	17618	2.00	585.1	1920	12900	270	12630	-	72115	-
	139	COMP	12/13/94	356	17974	1.96	569.6	1870	12100	270	11830	57392	72836	-
	140	COMP	12/14/94	301	18275	2.01	583.5	1790	11900	230	11670	-	81230	-
ON	141	COMP	12/15/94	276	18551	2.03	585.9	1890	11000	230	10770	57327	83864	-
2469	142	COMP	12/16/94	218	18769	1.99	566.8	1780	11300	270	11030	-	71354	-
2500	143	COMP	12/17/94	391	19160	1.99	600.8	1670	10400	250	10150	-	69976	-
0	144	COMP	12/18/94	677	19837	2.03	561.1	1510	9400	250	9150	47859	63536	-
0	145	COMP	12/19/94	282	20119	2.03	599.7	1500	10300	230	10070	-	65552	-
2832	146	COMP	12/20/94	493	20612	2.05	587.0	1480	10000	220	9780	47665	65223	-
2657	147	COMP	12/21/94	926	21538	1.96	581.1	1360	11400	230	11170	-	68268	-
2500	148	COMP	12/22/94	1293	22831	1.87	530.2	1380	15400	400	15000	-	70840	-
0	149	COMP	12/23/94	1075	23906	1.79	541.1	1420	16100	380	15720	58624	72877	-
0	150	COMP	12/24/94	762	24668	1.81	548.0	1430	16200	410	15790	-	76621	-
0	151	COMP	12/25/94	634	25302	1.78	558.7	1500	11000	400	10600	-	79358	-
0	152	COMP	12/26/94	515	25817	1.80	563.2	1560	19200	410	18790	68352	83637	-
0	153	COMP	12/27/94	440	26257	1.70	566.9	1590	18000	400	17600	-	82979	-
2845	154	COMP	12/28/94	462	26719	1.79	573.5	1560	19600	410	19190	-	83164	-
2944	155	COMP	12/29/94	700	27419	1.73	575.4	1190	8300	360	7940	64202	70984	-
0	156	COMP	12/30/94	849	28268	1.74	578.2	1400	16100	400	15700	-	79543	-
0	157	COMP	12/31/94	539	28807	1.74	579.2	1580	18600	380	18220	-	79996	-
0	158	COMP	1/ 1/95	330	29137	1.74	581.3	1580	19600	430	19170	75356	99192	-
0	159	COMP	1/ 2/95	287	29424	1.88	575.7	1640	21200	440	20760	-	101229	-
0	160	COMP	1/ 3/95	287	29711	1.79	567.7	1650	22500	460	22040	-	104418	-
0	161	COMP	1/ 4/95	304	30015	1.84	567.9	1710	22700	480	22220	81906	109912	-
0	162	COMP	1/ 5/95	223	30238	1.82	573.6	1760	23800	490	23310	-	113389	-
0	163	COMP	1/ 6/95	223	30461	1.85	591.1	1730	24900	460	24440	-	114191	-
0	164	COMP	1/ 7/95	128	30589	1.85	588.6	1740	23100	480	22620	-	114274	-
0	165	COMP	1/ 8/95	190	30779	1.83	569.4	1770	23500	510	22990	85804	114582	-
0	166	COMP	1/ 9/95	121	30900	1.96	571.6	1720	28800	480	28320	-	112175	-
2932	167	COMP	1/10/95	217	31117	2.00	588.2	1530	22500	400	22100	-	101188	-
3028	168	COMP	1/11/95	620	31737	1.97	581.6	1380	20600	400	20200	-	92382	-
0	169	COMP	1/12/95	619	32356	2.00	571.8	1310	20500	400	20100	-	84892	-

BBT - COLUMN COMPARISON
GOLD EXTRACTION
CALCULATED HCNO BASIS
SP2 (0% Bioxidation) vs AUGER DRILL-3 (6%-8% Bioxidation)

~4% Week 13



01/06/94

BBT BOTTLE ROLL EXTRACTION

Sample I.D.		AUGER DRILL-6 WEST 10'-15' Interval 35 lb/T CaO 5 lb/T NaCN 50% Solids	
Date		12/15/94	
FA Tail	Au (opt)	.0264	
AA Soln	Au (opt)	.0316	96 hr
Calc Head	Au (opt)	.0580	
NaCN (lb/ton) final		2.20	
NaCN Consumption (lb/ton)		2.80	
pH (initial)		11.57	
pH (final)		11.46	
% Extraction Au (AA Soln/Calc Head)		54.5	

BBT BOTTLE ROLL EXTRACTION

Sample I.D.		AUGER DRILL-6 MID 10'-15' Interval 35 lb/T CaO 5 lb/T NaCN 50% Solids	
Date		12/15/94	
FA Tail	Au (opt)	.0248	
AA Soln	Au (opt)	.0325	96 hr
Calc Head	Au (opt)	.0573	
NaCN (lb/ton) final		2.02	
NaCN Consumption (lb/ton)		2.98	
pH (initial)		11.60	
pH (final)		11.54	
% Extraction Au (AA Soln/Calc Head)		56.7	

BBT BOTTLE ROLL EXTRACTION

Sample I.D.		AUGER DRILL-6 EAST 10'-15' Interval 37 lb/T CaO 5 lb/T NaCN 50% Solids	
Date		12/15/94	
FA Tail	Au (opt)	.0236	
AA Soln	Au (opt)	.0347	96 hr
Calc Head	Au (opt)	.0583	
NaCN (lb/ton) final		2.83	
NaCN Consumption (lb/ton)		2.17	
pH (initial)		11.74	
pH (final)		11.42	
% Extraction Au (AA Soln/Calc Head)		59.5	

Note: East and Mid Fire Assay Tail Samples weighed less than they should have and West Sample weighed more than it should have. It appears that some of East and Mid Sample Pulp was put into West Pan.

Average of three % Au Ext = 56.9

Avg of East and Mid = 58.1

	AUGER DRILL - 3 10/24/94 Comp 1'-15' Unrinsed	AUGER DRILL - 3 10/24/94 Comp 1'-15' Rinsed	AUGER DRILL - 3 10/24/94 West 10'-15'	10/24/94 Mid 10'-15'	10/24/94 East 10'-15'	% Fe Extraction and % Sulfide Oxidation Auger 3 vs Auger 1 West 10'-15'	Mid 10'-15'	East 10'-15'
Fe	57159	59928	58215	62219	59037	4.5	-1.3	1.0
Cu	312	145	140	227	184			
% Sulfur	5.67	5.78	5.24	6.59	5.31			
% SO4	1.46	.88	.86	.93	.99			
% Sulfide	5.18	5.49	4.95	6.28	4.97	10.3	-15.2	1.2

	AUGER DRILL-2 09/27/94 AUGER West 10'-15'	09/27/94 AUGER Mid 10'-15'	09/27/94 AUGER East 10'-15'	% Fe Extraction and % Sulfide Oxidation Auger 2 vs Auger 1 West 10'-15'	Mid 10'-15'	East 10'-15'
Fe	58029	60927	58302	4.8	.8	2.3
Cu	172	220	184			
% Sulfur	5.26	5.71	5.34			
% SO4	.73	.70	.80			
% Sulfide	5.01	5.47	5.07	9.2	-.4	-.8

	CONTROL BBT-SP2COLCOMP Average 7/5-7/18 Unrinsed	BR Split 10% HCl Rinsed	AUGER DRILL-1 08/23/94 AUGER West 10'-15'	08/23/94 AUGER Mid 10'-15'	08/23/94 AUGER East 10'-15'	AUGER DRILL-6 12/15/94 AUGER West 10'-15'	12/15/94 AUGER Mid 10'-15'	12/15/94 AUGER East 10'-15'
Fe	58851	50792	60945	61439	59661	52228(14.3)	53495(12.9)	51365(13.9)
Cu	504	222	195	170	117	147	132	127
% Sulfur	5.23	4.65	5.71	5.63	5.22	5.63	5.61	5.23
% SO4	.95	.65	.57	.53	.58	1.00	.94	.90
% Sulfide	4.91	4.44	5.52	5.45	5.03	5.29(4.2)	5.30(2.8)	4.93(2.0)

1/3/95 Bill K John S. Jim Whitbeck

General comments

(1) With water addition

A. pH general drop followed by increase

B. Cu flushed then elevated concentration returns

C. Fe^{++} iron generally elevated

D. Sh follows dilution pattern

THESE ARE A FEW ERRATIC DATA POINTS WHICH I BELIVE ARE THE RESULT OF DILUTION PATTERNS CAUSED BY RINSE WATER

E. ACIDITY shows current increase AFTER DROP DURING flush

G. Sulfates demonstrate RINSE pattern

-Ysimiter #3 has yet to show SAME Metals concentration recovery following RINSE WATER

Thermocouples

(1) #9 Follows Blower Movement pattern

(2) #2 Shows influence of AMBIENT Temperature

(3) 4, 6, 7 8 Rel. Stable 3 9, 10, 11 elevated

GEOBIOTICS, INC.

3505 Breakwater Avenue
Hayward, CA 94545

510 783-9060
Fax 510 783-9059

CC TO: HERB O.

January 6, 1995

To: Bill Kohr, Geobiotics
Rich Crowell, Geobiotics
Jim Whitlock, Geobiotics
Omar Muhtadi, Geobiotics
Laura Damon, Brohm Mining

Post-it® Fax Note 7671	Date 1/6/95	# of pages ▶ 2
To LAURA DAMON	From	
Co./Dept. BROHM	Co.	
Phone # 605	Phone #	
Fax # 578 1709	Fax #	

From: John Shield, Geobiotics

Re: Improvement in Heap Biooxidation with Additional Rinse Water

As you know, the operations personnel at Gilt Edge where asked to add fresh water to the biooxidation test heap as weather conditions permitted. The addition of fresh water is expected to flush out some of the inhibitory and toxic components in the ore and consequently speed up biooxidation. Between December 16 and December 29, 1994, 18,750 gallons of fresh water were added to the heap.

There are several ways to monitor heap biooxidation, including: effluent pH, acidity, sulfate concentration, and iron concentration as well as internal heap temperatures.

With the addition of water, the effluent pH dropped from an average of 1.99 for the week prior to water addition to 1.74 in days after the last water addition. The decrease in pH is a definite indication of biooxidation, as sulfides have been converted to sulfuric acid. The decreased pH corresponds to an increase in the acidity of the effluent solution which has increased from 57,000 to 75,000 mg $CaCO_3$ required to neutralize 1 liter of solution.

The amount of dissolved iron in the effluent solution also increased as a result of the addition of fresh water. Prior to the water addition the iron concentration was hovering between 11,500 and 14,000 ppm. After the water flush the iron level increased to over 18,000 ppm.

These effluent pH values are the lowest and the acidity and dissolved iron values the highest measured to date in the biooxidation heap, indicating that biooxidation has again been accelerated.

The increased acidity and iron levels are more significant considering that addition of fresh water would be expected to dilute dissolved components in the effluent solution. In fact, initial dilution was seen with the iron levels. Dilution was also seen with the sulfate and copper levels. The copper values dropped from around 1850 ppm to 1580 ppm. From our laboratory experimentation, we know that the measured copper level is an indication of the concentration of inhibitory components. Consequently, this decrease in copper correlates with a decrease in the inhibitory components which contributes to the observed increase in biooxidation rate.

Since the addition of fresh water was started, the temperature from every thermocouple

has increased, indicating that the rate of biooxidation has increased. These temperature increases have been measured during very cold ambient conditions and despite mechanical introduction of cold air into the heap via the air distribution piping. Half of the thermocouples read internal heap temperatures in excess of 40°C, and the coldest thermocouple buried 3 feet below the surface of the heap is reading 20°C hotter than ambient.

The additional effluent as a result of the fresh water addition has been discharged from the heap. To date, approximately 30% of the copper has been removed from the heap. From our laboratory observations, the inhibitory components appear to be removed when over 80% of the copper has been removed. As copper removal corresponds with inhibitory component removal, the fresh water addition has flushed out some more of the inhibitory components and has positively impacted the rate of biooxidation within the heap. The adding of this dilution water has improved the rate of biooxidation as evidenced by the drop in the copper levels and the increase in dissolved iron levels in the effluent. Furthermore, the drop in effluent pH is another indication that the biooxidation rate is increasing.

Additional fresh water addition would be expected to further dilute and remove inhibitory components and continue to improve the biooxidation rate. As weather conditions permit, additional fresh water should be added to the biooxidation test heap and the resulting effluent discharged.

GEOBIOTICS, INC.

3505 Breakwater Avenue
Hayward, CA 94545

Co./Dept. BROKM	Co.
Phone # 60	Phone #
Fax # 605 578 1709	Fax # 510 783 5059

Fax 510 783-5059

January 11, 1995

To: Laura Damon
From: John Shield
Re: Estimate of Quantity of Removed Iron and Sulfur

Yesterday, in our conversation with you and Jim Whitlock, you mentioned that you have been examining the increase in solubilized iron and sulfate levels as a means to estimate the extent of biooxidation. As you pointed out, these calculations of the extent of biooxidation will represent a lower bound, because they will not include any removal or iron or sulfur due to precipation, sludge removal or solution discharge.

As the level of toxic/inhibitory components in the biooxidation test heap is important, I have been tracking the amount of copper that has been solubilized and removed. I have tried to account for copper removed via sludge removal and solution discharge.

Since our converstation, I have expanded my calculations to include iron and sulfur that has been removed via sludge or solution discharge. Please find enclosed the results of these calculations, that you may be able to incorporate with your determinations of the extent of biooxidation to perhaps give a closer approximation of the extent of biooxidation.

I look forward to discussing with you and Jim if the incorporation of the amount of iron and sulfur discharged impacts upon your calculations regarding the extent of biooxidation.

CALCULATIONS and ASSUMPTIONS

Given the amount of Copper discharged in neutralization sludge, Calculate the amount of iron discharged and the amount of Sulfur discharged.

	Sludge	Sump Pond
Assume that sludge is 15% solids.	Avg 17.3%	43.5%
Assume that the copper content of the solids is 2%.	Avg 3.6%	0.2%
Assume that the iron content of the solids is 10%	Avg 7.0%	17.0%

? Assume that the remainder of the solids is $CaSO_4$.
? Assuem the copper is in the form of $CuSO_4$. (Cu(OH)) *
Assume that the iron is in the form of $Fe(OH)_2$.

Molecular Weights

Cu	63.5
S	32
SO_4	96
Ca	40

C: Jim Whitlock

Fe 56
$(OH)_2$ 34

Calculate Fraction of ~~Ca~~Cu SO_4 in solids.

Cu content is 2%

$CuSO_4$ content is:

2% * (96+63.5)/63.5 = 5% $CuSO_4$

Fe content is 10%

$Fe(OH)_2$ content is:

10% * (56+34)/56 = 16% $Fe(OH)_2$

? $CaSO_4$ content is remainder:

100% - 5% - 16% = 79%

$Cu(OH)_2$

3.6

$Cu(OH)_2$

3.6% (34+63.5)/63.5 = 5.5% $Cu(OH)_2$

7% (56+34)/56 = 11% $Fe(OH)_2$

90% - 5.5 - 11% = 73.5%

Calcuate amount of S in sludge per pound of Cu.

S comes from $CuSO_4$ and $CaSO_4$.

? For 1 lb of Cu there will be 1 * (63.5÷96)/63.5 = 2.5 lb $CuSO_4$

2.5 lb of $CuSO_4$ has 2.5 * 32/(63.5+96) = 0.51 lb of S

73.5/5.5 = 13.4

For 1 lb of Cu there will be 1 * 79%/5% = 15.8 lb of $CaSO_4$

15.8 lb of $CaSO_4$ has 15.8 * 32/136 = 3.72 lb of S

13.4 13.4 * 32/136 = 3.2 lb S

Then there is 0.51 + 3.72 = 4.23 lb of S per lb of Cu removed in sludge.

Calculate amount of Fe in sludge per pound of Fe.

For 1 lb of Cu there is 1 * 10%/2% = 5 lb of Fe

7/3.6 = 2 lb

The factor 4.2 and 5 were used in the accompaning speadsheet.

In the spreadsheet I have been keeping track of the copper removed in the sludge (Column 1), so now I can estimate the sulfur and iron removed. The sulfur (Column 2) is 4.35 * the copper. The cumulative amount of S in the sludge is in Column 3.

I also have calculated the amount of S removed when water was drained from the pad. This is the product of the amount of water drained (Column 0) and the concentration of S in the water (Column 4) giving the pounds of S (Column 5) and the cumulative pounds of S (Column 6).

Similarily, I have lb of Fe from sludge (Column 9) and the cumulative Fe in sludge (Column 10). Also the lb of Fe discharged with water (Column 7) and the Cumulative Fe lb discharged with water (Column 8).

Date	Day	0 H2O Drained	1 Cu lb in Sludge	Cu lb in Drained Solution	Cum Cu lb in Drained	Cum Cu in Sludge	2 lb S from Sludge	3 Cum lb S from Sludge	4 Sulfate ppm OFF	S ppm OFF	lb S OFF Solution	5 lb S Drained	6 Cum lb S Drained	ppm Fe OFF	lb Fe OFF Solution	7 lb Fe Drained	8 Cum lb Fe Drained	9 lb Fe in Sludge	10 lb Fe Cum in Sludge
07/26	1						0							0.27	0.2			0	0
07/27	2				0		0	0						0.2	0.2		0	0	0
07/28	3				0		0	0	4411	1470	1324		0.0	0.55	0.5		0	0	0
07/29	4				0		0	0	5094	1698	1529		0.0	13	11.7		0	0	0
07/30	5				0		0	0	7913	2637	2376		0.0	14	12.6		0	0	0
07/31	6				0		0	0	9835	3278	2953		0.0	11	9.9		0	0	0
08/01	7				0		0	0	11106	3702	3334		0.0	39	35.1		0	0	0
08/02	8				0		0	0	18304	6101	5495		0.0	172	154.9		0	0	0
08/03	9				0		0	0	21678	7225	6508		0.0	520	468.4		0	0	0
08/04	10				0		0	0	18731	6243	5623		0.0	500	450.4		0	0	0
08/05	11				0		0	0	20711	6903	6218		0.0	480	432.3		0	0	0
08/06	12				0		0	0	23591	7863	7082		0.0	1530	1378.1		0	0	0
08/07	13				0		0	0	20727	6908	6222		0.0	1110	999.8		0	0	0
08/08	14		20.2		0	20	85	85	22299	7432	6694		0.0	1390	1252.0		0	101	101
08/09	15				0	20	0	85	21180	7059	6358		0.0	1070	963.8		0	0	101
08/10	16				0	20	0	85	22052	7350	6620		0.0	1320	1189		0	0	101
08/11	17				0	20	0	85	21764	7254	6534		0.0	1290	1162		0	0	101
08/12	18				0	20	0	85	22729	7576	6823		0.0	1520	1369		0	0	101
08/13	19				0	20	0	85	22995	7664	6903		0.0	1420	1279		0	0	101
08/14	20				0	20	0	85	23456	7818	7042		0.0	1490	1342		0	0	101
08/15	21		188		0	208	795	881	23381	7793	7019		0.0	1110	1000		0	840	1041
08/16	22				0	208	0	881	23933	7977	7185		0.0	1640	1387		0	0	1041
08/17	23				0	208	0	881	23711	7903	7118		0.0	1160	1045		0	0	1041
08/18	24				0	208	0	881	25735	8577	7726		0.0	1100	991		0	0	1041
08/19	25				0	208	0	881	27554	9184	8272		0.0	2450	2207		0	0	1041
08/20	26				0	208	0	881	27464	9154	8245		0.0	2550	2297		0	0	1041
08/21	27				0	208	0	881	29200	9732	8766		0.0	2900	2612		0	0	1041
08/22	28				0	208	0	881	30249	10082	9081		0.0	3160	2846		0	0	1041
08/23	29				0	208	0	881	31299	10432	9396		0.0	3210	2891		0	0	1041
08/24	30				0	208	0	881	32348	10782	9711		0.0	3540	3189		0	0	1041
08/25	31				0	208	0	881	33471	11156	10048		0.0	3640	3279		0	0	1041
08/26	32				0	208	0	881	34443	11480	10340		0.0	3860	3477		0	0	1041
08/27	33				0	208	0	881	35035	11677	10518		0.0	4000	3603		0	0	1041
08/28	34				0	208	0	881	35858	11951	10765		0.0	4000	3603		0	0	1041
08/29	35				0	208	0	881	35858	11951	10765		0.0	4370	3936		0	0	1041
08/30	36				0	208	0	881	35134	11710	10548		0.0	4030	3630		0	0	1041
08/31	37				0	208	0	881	35134	11710	10548		0.0	4435	3995		0	0	1041
09/01	38		310.85		0	519	1315	2196	39562	13186	11877		0.0	4840	4359		0	1554	2595
09/02	39				0	519	0	2196	41456	13817	12446		0.0	5017	4519		0	0	2595
09/03	40				0	519	0	2196	43351	14449	13014		0.0	5195	4679		0	0	2595
09/04	41				0	519	0	2196	45246	15080	13583		0.0	5372	4839		0	0	2595
09/05	42				0	519	0	2196	47141	15712	14152		0.0	5550	4999		0	0	2595
09/06	43				0	519	0	2196	45273	15089	13591		0.0	6010	5413		0	0	2595
09/07	44		93.3		0	612	395	2590	45697	15231	13719		0.0	6010	5413		0	467	3062
09/08	45				0	612	0	2590	46121	15372	13846		0.0	6010	5413		0	0	3062
09/09	46		82.9		0	695	351	2941	46206	15400	13872		0.0	6040	5440		0	415	3476
09/10	47				0	695	0	2941	46291	15429	13897		0.0	6070	5467		0	0	3476
09/11	48				0	695	0	2941	46376	15457	13923		0.0	6100	5494		0	0	3476
09/12	49				0	695	0	2941	47265	15753	14189		0.0	6300	5675		0	0	3476
09/13	50				0	695	0	2941	48154	16050	14456		0.0	6600	5945		0	0	3476
09/14	51				0	695	0	2941	48763	16253	14639		0.0	6800	6125		0	0	3476
09/15	52				0	695	0	2941	49372	16456	14822		0.0	7000	6305		0	0	3476
09/16	53				0	695	0	2941	50036	16677	15021		0.0	7100	6395		0	0	3476
09/17	54				0	695	0	2941	50699	16898	15220		0.0	7200	6485		0	0	3476

Date	Day	H2O Drained	Cu lb in Sludge	Cu lb in Drained Solution	Cum Cu lb in Drained	Cum Cu in Sludge	lb S from Sludge	Cum lb S from Sludge	Sulfate ppm OFF	S ppm OFF	lb S OFF Solution	lb S Drained	Cum lb S Drained	ppm Fe OFF	lb Fe OFF Solution	lb Fe Drained	Cum lb Fe Drained	lb Fe in Sludge	lb Fe Cum in Sludge
09/18	55				0	695	0	2941	51369	17119	16420		0.0	7300	6575		0	0	3476
09/19	56		18		0	713	76	3017	51314	17103	16405		0.0	7150	6440		0	90	3566
09/20	57		18		0	731	76	3093	51265	17087	15390		0.0	7000	6305		0	90	3656
09/21	58		18		0	749	76	3169	51821	17272	15557		0.0	6900	6215		0	90	3746
09/22	59		18		0	767	76	3245	52376	17457	15724		0.0	6800	6125		0	90	3836
09/23	60		18		0	785	76	3322	52949	17648	15896		0.0	7110	6404		0	90	3926
09/24	61				0	785	0	3322	53523	17839	16068		0.0	7420	6683		0	0	3926
09/25	62				0	785	0	3322	54096	18030	16240		0.0	7730	6963		0	0	3926
09/26	63		18		0	803	76	3398	54645	18213	16405		0.0	7720	6954		0	90	4016
09/27	64		18		0	821	76	3474	55193	18396	16569		0.0	7710	6945		0	90	4106
09/28	65		18		0	839	76	3550	55742	18579	16734		0.0	7700	6936		0	90	4196
09/29	66		18		0	857	76	3626	55898	18631	16781		0.0	7900	7116		0	90	4286
09/30	67				0	857	0	3626	56312	18769	16905		0.0	7633	6875		0	0	4286
10/01	68				0	857	0	3626	56725	18906	17029		0.0	7367	6636		0	0	4286
10/02	69				0	857	0	3626	57552	19182	17278		0.0	7100	6395		0	0	4286
10/03	70				0	857	0	3626	58005	19333	17414		0.0	7600	6846		0	0	4286
10/04	71				0	857	0	3626	58458	19484	17550		0.0	8100	7296		0	0	4286
10/05	72				0	857	0	3626	51195	17063	15369		0.0	7275	6553		0	0	4286
10/06	73				0	857	0	3626	43932	14643	17585		0.0	6550	7866		0	0	4286
10/07	74				0	857	0	3626	48681	16225	19486		0.0	7233	8687		0	0	4286
10/08	75		93		0	950	393	4020	53429	17808	21387		0.0	7917	9508		0	465	4751
10/09	76		144		0	1094	609	4629	58178	19391	23287		0.0	8600	10328		0	720	5471
10/10	77				0	1094	0	4629	59013	19669	23622		0.0	8450	10148		0	0	5471
10/11	78				0	1094	0	4629	59840	19945	23953		0.0	8300	9968		0	0	5471
10/12	79				0	1094	0	4629	60124	20039	24066		0.0	8500	10208		0	0	5471
10/13	80				0	1094	0	4629	60408	20134	24180		0.0	8700	10448		0	0	5471
10/14	81				0	1094	0	4629	59563	19852	23842		0.0	8000	9608		0	0	5471
10/15	82				0	1094	0	4629	58718	19571	23504		0.0	7300	8767		0	0	5471
10/16	83				0	1094	0	4629	57873	19289	23165		0.0	6600	7926		0	0	5471
10/17	84				0	1094	0	4629	58820	19605	23544		0.0	8150	9788		0	0	5471
10/18	85				0	1094	0	4629	59766	19920	23923		0.0	9700	11649		0	0	5471
10/19	86				0	1094	0	4629	61252	20415	24518		0.0	10050	12070		0	0	5471
10/20	87		17		0	1111	72	4701	62737	20910	25112		0.0	10400	12490		0	85	5556
10/21	88				0	1111	0	4701	63716	21237	25604		0.0	10600	12730		0	0	5556
10/22	89		1743 lb Cu		0	1111	0	4701	64896	21563	25897		0.0	10850	13030	53391b Fe	0	0	5556
10/23	90		(Broken)		0	1111	0	4701	65675	21889	28288		0.0	11100	13331	(Broken)	0	0	5556
10/24	91				0	1111	0	4701	66400	22131	26579		0.0	11300	13571		0	0	5556
10/25	92				0	1111	0	4701	66992	22328	26816		0.0	11500	13811		0	0	5556
10/26	93				0	1111	0	4701	67280	22424	26931		0.0	11700	14051		0	0	5556
10/27	94				0	1111	0	4701	68663	22885	27484		0.0	12500	15012		0	0	5556
10/28	95				0	1111	0	4701	68992	22995	27616		0.0	12000	14412		0	0	5556
10/29	96				0	1111	0	4701	69362	23118	27764		0.0	12300	14772		0	0	5556
10/30	97				0	1111	0	4701	70367	23453	28167		0.0	12600	15132		0	0	5556
10/31	98				0	1111	0	4701	71099	23697	28460		0.0	12800	15372		0	0	5556
11/01	99				0	1111	0	4701	71354	23782	28562		0.0	13300	15973		0	0	5556
11/02	100				0	1111	0	4701	75222	25071	30110		0.0	13900	16693		0	0	5556
11/03	101				0	1111	0	4701	73008	24334	29224		0.0	13300	15973		0	0	5556
11/04	102				0	1111	0	4701	73527	24507	29431		0.0	13500	16213		0	0	5556
11/05	103				0	1111	0	4701	73870	24621	29569		0.0	13200	15853		0	0	5556
11/06	104				0	1111	0	4701	74235	24743	29715		0.0	12900	15492		0	0	5556
11/07	105				0	1111	0	4701	73165	24386	29286		0.0	13900	16693		0	0	5556
11/08	106				0	1111	0	4701	73593	24529	29458		0.0	13100	15733		0	0	5556
11/09	107				0	1111	0	4701	75329	25107	30153		0.0	12900	15492		0	0	5556
11/10	108				0	1111	0	4701	76457	25483	30604		0.0	12600	15132		0	0	5556
11/11	109				0	1111	0	4701	76648	25548	30680		0.0	15000	18014		0	0	5556
11/12	110				0	1111	0	4701	76720	25571	30709		0.0	15200	18255		0	0	5556

Date Day	H2O Drained	Cu lb in Sludge	Cu lb in Drained Solution	Cum Cu lb in Drained	Cum Cu in Sludge	lb S from Sludge	Cum lb S from Sludge	Sulfate ppm OFF	S ppm OFF	lb S OFF Solution	lb S Drained	Cum lb S Drained	ppm Fe OFF	lb Fe OFF Solution	lb Fe Drained	Cum lb Fe Drained	lb Fe in Sludge	lb Fe Cum in Sludge
11/13111				0	1111	0	4701	81057	27016	32445		0.0	14300	17174		0	0	5558
11/14112				0	1111	0	4701	73765	24586	29527		0.0	12300	14772		0	0	5556
11/15113				0	1111	0	4701	79329	26440	31754		0.0	14800	17774		0	0	5556
11/16114				0	1111	0	4701	79897	26630	31981		0.0	15900	19095		0	0	5556
11/17115				0	1111	0	4701	80300	26764	32142		0.0	17400	20897		0	0	5556
11/18116				0	1111	0	4701	80850	26947	32363		0.0	16600	19936		0	0	5556
11/19117				0	1111	0	4701	81461	27151	32607		0.0	15800	18975		0	0	5556
11/20118				0	1111	0	4701	77675	25889	31092		0.0	15200	18255		0	0	5556
11/21119				0	1111	0	4701	82934	27642	33197		0.0	17500	21017		0	0	5556
11/22120				0	1111	0	4701	82349	27447	32963	0.0	0.0	17000	20416	0	0	0	5556
11/23121	3865		54.5	54	1111	0	4701	82053	27348	31963	881.5	0.0	15900	18583	513	513	0	5556
11/24122	2518		36.3	91	1111	0	4701	85489	28493	32703	698.4	881.5	16400	18823	344	857	0	5556
11/25123	924		13.6	104	1111	0	4701	86106	28699	32718	221.2	1479.9	16800	19152	129	988	0	5556
11/26124	1207		17.8	122	1111	0	4701	86086	28692	32421	288.8	1701.1	16200	18305	163	1149	0	5556
11/27125	944		13.9	136	1111	0	4701	85818	28603	32095	225.2	1989.9	16000	17953	126	1275	0	5556
11/28126	494		7.5	144	1111	0	4701	86744	28912	32322	119.1	2215.1	17200	19229	71	1346	0	5556
11/29127	424		6.6	150	1111	0	4701	85613	28535	31800	100.9	2334.2	17000	18945	60	1406	0	5556
11/30128	321		5.0	155	1111	0	4701	84028	28007	31136	75.0	2435.1	15400	17121	41	1448	0	5556
12/01129	807		12.4	168	1111	0	4701	82979	27657	30561	186.1	2510.1	15600	17238	105	1553	0	5556
12/02130	968		14.2	182	1111	0	4701	79522	26505	29074	214.0	2696.2	14600	16015	118	1670	0	5556
12/03131	840		12.4	194	1111	0	4701	79749	26680	28971	186.2	2910.2	14200	15477	99	1770	0	5556
12/04132	687		10.4	205	1111	0	4701	81991	27328	29629	156.6	3096.4	14400	15613	83	1852	0	5556
12/05133	638		8.9	214	1111	0	4701	75922	25305	27301	134.8	3253.0	11400	12299	61	1913	0	5556
12/06134	583		9.0	223	1111	0	4701	83390	27794	29851	135.1	3387.6	13600	14607	66	1979	0	5556
12/07135	513		7.9	230	1111	0	4701	82341	27444	29358	117.4	3522.8	13200	14121	56	2036	0	5556
12/08136	428		6.6	237	1111	0	4701	81724	27239	29041	97.2	3640.2	12800	13647	46	2081	0	5556
12/09137	344		5.5	243	1111	0	4701	76960	25651	27275	73.6	3737.4	13400	14248	38	2120	0	5556
12/10138	355		5.5	248	1111	0	4701	74728	24907	26410	73.7	3811.0	12600	13360	37	2157	0	5556
12/11139	416		6.4	254	1111	0	4701	74132	24708	26114	85.7	3884.8	12600	13317	44	2201	0	5556
12/12140	342		5.5	260	1111	0	4701	72115	24036	25334	68.6	3970.5	12900	13597	37	2238	0	5556
12/13141	358		5.5	265	1111	0	4701	72836	24276	25516	72.1	4039.0	12100	12718	36	2274	0	5556
12/14142	301		4.6	270	1111	0	4701	81230	27074	28388	68.0	4111.1	11900	12478	30	2303	0	5556
12/15143	276		4.4	274	1111	0	4701	83864	27952	29244	64.3	4179.1	11000	11509	25	2329	0	5556
12/16144	218		3.4	278	1111	0	4701	71354	23782	25329	43.2	4243.4	11300	12035	21	2349	0	5556
12/17145	391		5.8	284	1111	0	4701	69976	23323	25250	78.1	4286.7	10400	11259	34	2383	0	5556
12/18146	677		10.7	294	1111	0	4701	63536	21177	22806	119.6	4362.7	9400	10123	53	2436	0	5556
12/19147	282		4.2	299	1111	0	4701	65552	21848	23479	51.4	4482.3	10300	11068	24	2461	0	5556
12/20148	493		6.9	305	1111	0	4701	65223	21739	23785	89.4	4533.7	10000	10941	41	2502	0	5556
12/21149	926		11.7	317	1111	0	4701	68268	22754	25224	175.7	4623.0	11400	12638	88	2590	0	5556
12/22150	1293		16.2	333	1111	0	4701	70840	23611	26412	254.6	4798.8	15400	17227	186	2756	0	5556
12/23151	1075		13.3	347	1111	0	4701	72877	24290	26953	217.8	5063.4	16100	17865	144	2900	0	5556
12/24152	762		8.8	355	1111	0	4701	78621	25538	28176	162.3	5271.2	16200	17873	103	3003	0	5556
12/25153	634		7.3	362	1111	0	4701	79358	26450	29042	139.9	5433.5	11000	12078	58	3061	0	5556
12/26154	515		6.1	369	1111	0	4701	83637	27876	30489	119.7	5573.3	19200	20999	82	3144	0	5556
12/27155	440		5.2	374	1111	0	4701	82979	27657	30147	101.5	5693.0	18000	19621	66	3210	0	5556
12/28156	462		5.8	380	1111	0	4701	83164	27719	30765	106.8	5794.5	19600	21754	76	3286	0	5556
12/29157	700		9.1	389	1111	0	4701	70984	23659	26702	138.1	5901.3	8300	9368	48	3334	0	5556
12/30158	849		11.3	400	1111	0	4701	79543	26512	29734	187.7	6039.5	16100	18057	114	3448	0	5556
12/31159	639		7.0	407	1111	0	4701	79996	26663	29784	119.9	6227.2	18600	20777	84	3531	0	5556
01/01 60	330		3.3	410	1111	0	4701	79996	26663	29710	73.4	6347.0	19600	21840	54	3585	0	5556
				4.02 Bi	1733		5546					6693 (Bi				3581 (Bi		533 (Bi

TOTAL P.05

MEMORANDUM

DATE: DECEMBER 20, 1994
TO: JIM THOMPSON
FROM: LAURA DAMON
SUBJECT: BIOOXIDATION BULK TEST (BBT) WEEKLY UPDATE (20-21)

The BBT has been on the biooxidation cycle for twenty-one weeks. OFF solution is still being discharged from the circuit. The total gallons have decreased to about 300 gal/day. Fresh water is being added to the top of the heap, one load a day, as weather permits. 5000 gallons were added on Friday and Saturday, December 16th-17th. Another 2500-3000 gallons are being added today. So far we have not seen any increased discharge from the heap. The heap remains stable and intact.

The air blower was moved on Monday, December 12th from the center of the heap to the northeast corner. It is now being injected through perforated PVC pipe under Thermocouples 10-12. The thermocouple temperatures have risen in #10 and #11 and dropped in the thermocouples that had previously risen. This indicates that the air is having a positive effect on biooxidation.

Thermocouple #	Before Air Week 0 12/12	After Air Week 1 12/20	+ Change in degree C
2	37.6	39.2	0.7
3	21.9	24.7	8.9
4	34.4	41.7	0.1
6	32.6	37.5	1.8
7	12.4	13.8	1.2
8	3.8	5.1	0.3
9	25.6	34.8	-10.1
10	13.7	15.5	3.4
11	14.4	15.4	5.3
12	16.4	16.8	-4.1

The auger drill-3 column was unloaded last week. We are waiting for tail assays before the final percent gold extraction can be calculated. These should be available after the first of the year.

An auger drill-5 composite sample was bottle rolled for gold extraction data this week. The average of duplicate assays showed 58.2% gold extraction.

Auger drill-6 samples were collected on Thursday, December 15th. Samples from the 10'-15' intervals are being bottle rolled for gold extraction percentages.

c: Rod MacLeod
Martin Quick
Herb Osborne

	CONTROL BBT-SP2COLCOMP			AUGER DRILL - 5 12/01/94	12/01/94	AUGER DRILL - 3 10/24/94	10/24/94	
	Average 7/5-7/18 Unrinsed	BR Split 10% HCl Rinsed	BR-2 10% HCl Rinsed	Comp 1'-15' Unrinsed	Comp 1'-15' Rinsed	Comp 1'-15' Unrinsed	Comp 1'-15' Rinsed	% Fe Extraction and % Sulfide Oxidation Auger 5 vs Auger 3 Rinsed
Fe	58851	50792	52687	56252	54380	59928	57159	4.9
Cu	504	222	217	289	97	312	145	
% Sulfur	5.23	4.65	4.73	5.76	5.58	5.67	5.78	
% SO4	.95	.65	.75	1.76	.85	1.46	.88	
% Sulfide	4.91	4.44	4.48	5.18	5.29	5.18	5.49	3.6

9BT BOTTLE ROLL EXTRACTION

Sample I.D.		AUGER DRILL-5 COMP 1 40 lb/T CaO 5 lb/T NaCN 50% Solids	
Date		12/01/94	
FA Tail	Au (opt)	.0252	
AA Soln	Au (opt)	.0339	96 hr
Calc Head	Au (opt)	.0591	
NaCN (lb/ton) final		3.2	
NaCN Consumption (lb/ton)		1.8	
pH (initial)		12.6	
pH (final)		12.2	
% Extraction Au (AA Soln/Calc Head)		57.4	

8BT BOTTLE ROLL EXTRACTION

Sample I.D.		AUGER DRILL-5 COMP 2 40 lb/T CaO 5 lb/T NaCN 50% Solids	
Date		12/01/94	
FA Tail	Au (opt)	.0233	
AA Soln	Au (opt)	.0334	96 hr
Calc Head	Au (opt)	.0567	
NaCN (lb/ton) final		3.2	
NaCN Consumption (lb/ton)		1.8	
pH (initial)		12.5	
pH (final)		12.2	
% Extraction Au (AA Soln/Calc Head)		58.9	

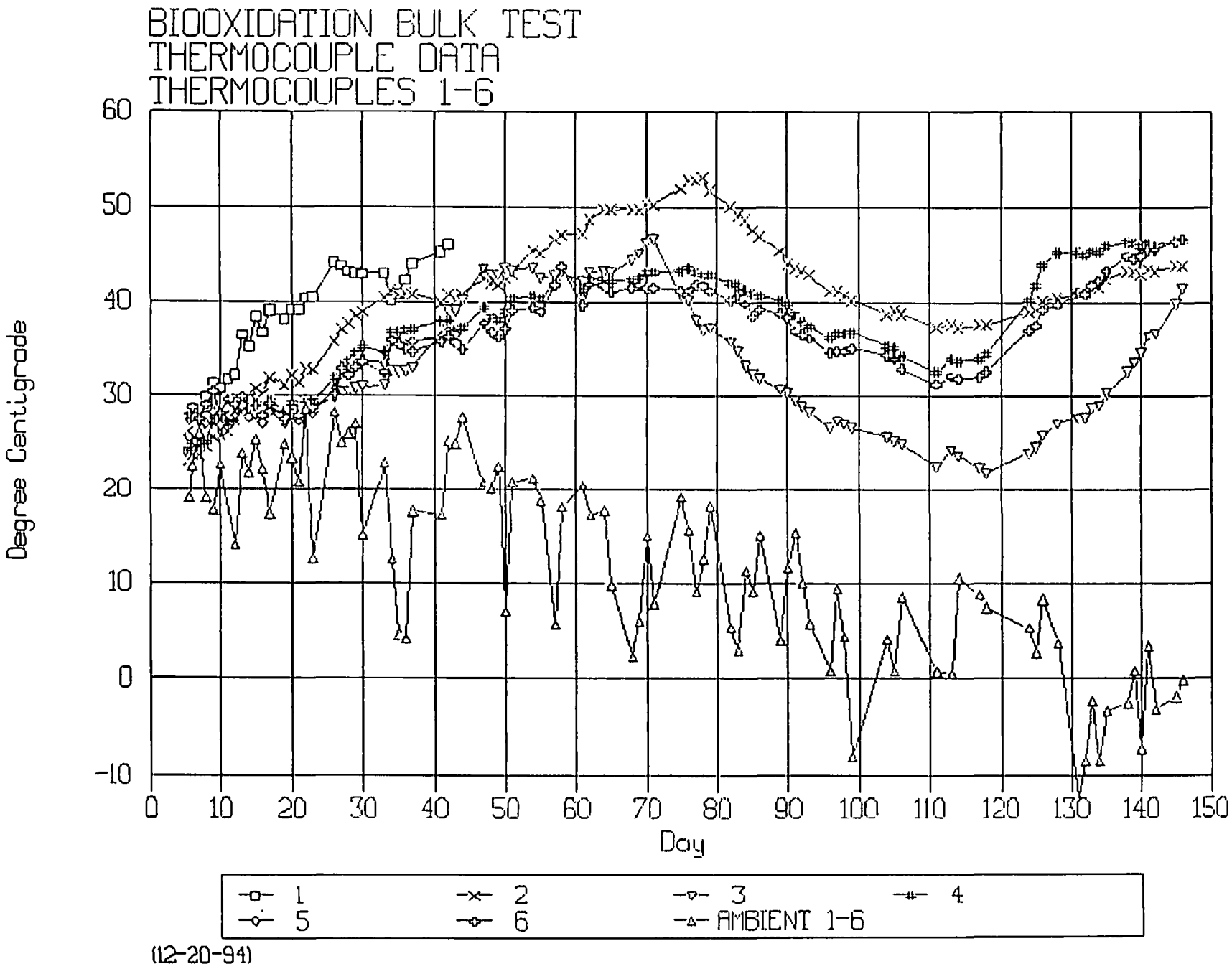
BIOOXIDATION BULK TEST SOLUTION SAMPLING

OFF SOLUTION - DISCARDED FROM HEAP

Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	DO (ppm)
COMP	11/23/94	3865	3865	1.70	549.5	1690	15900	410	15490	-	82053	-
COMP	11/24/94	2518	6383	1.81	564.3	1730	16400	380	16020	64266	85489	-
COMP	11/25/94	924	7307	1.80	685.7	1770	16800	340	16460	-	86106	-
COMP	11/26/94	1207	8514	1.83	688.2	1770	16200	340	15860	-	86086	-
COMP	11/27/94	944	9458	1.82	607.8	1760	16000	340	15660	63748	85818	-
COMP	11/28/94	494	9952	1.94	608.4	1820	17200	330	16870	-	86744	5.0
COMP	11/29/94	424	10376	1.91	688.7	1870	17000	310	16690	65304	85613	-
COMP	11/30/94	321	10697	2.04	573	1850	15400	270	15130	-	84028	-
COMP	12/ 1/94	807	11504	1.92	636.6	1840	15600	290	15310	59662	82979	-
COMP	12/ 2/94	968	12472	1.96	629.3	1760	14600	300	14300	-	79522	-
COMP	12/ 3/94	840	13312	2.03	579.4	1770	14200	300	13900	-	79749	-
COMP	12/ 4/94	687	13999	2.01	577.2	1820	14400	330	14070	58884	81991	-
COMP	12/ 5/94	638	14637	1.93	587.2	1680	11400	260	11140	-	75922	-
COMP	12/ 6/94	583	15220	2.02	634.1	1860	13600	290	13310	57781	83390	-
COMP	12/ 7/94	513	15733	2.06	590.9	1840	13200	290	12910	-	82341	-
COMP	12/ 8/94	428	16161	1.94	614.4	1840	12800	260	12540	58235	81724	-
COMP	12/ 9/94	344	16505	1.94	574.5	1920	13400	360	13040	-	76930	-
COMP	12/10/94	355	16860	1.94	601.8	1860	12600	310	12290	-	74728	-
COMP	12/11/94	416	17276	1.96	608.9	1850	12600	310	12290	57781	74132	-
COMP	12/12/94	342	17618	2.00	585.1	1920	12900	270	12630	-	72115	-
COMP	12/13/94	356	17974	1.96	569.6	1870	12100	270	11830	57392	72836	-
COMP	12/14/94	301	18275	2.01	583.5	1790	11900	230	11670	-	81230	-
COMP	12/15/94	276	18551	2.03	585.9	1890	11000	230	10770	57327		
COMP	12/16/94	218	18769	1.99	566.8	1780	11300	270	11030	-		
COMP	12/17/94	391	19160	1.99	600.8	1670	10400	250	10150	-		
COMP	12/18/94	677	19837	2.03	561.1	1510	9400	250	9150	47859		

BIOOXIDATION BULK TEST THERMOCOUPLE DATA

Date	West 1	West 2	West 3	West 4	West 5	Mid 6	Mid 7	Mid 8	East 9	East 10	East 11	East 12	AMBIENT 1-6	AMBIENT 7-12
11/28/94	-	39.0	24.0	40.2	-	37.0	12.6	4.2	32.4	14.4	14.3	15.7	5.3	6.3
11/29/94	-	39.2	24.7	41.7	-	37.5	13.8	5.1	34.8	15.5	15.4	16.8	2.7	4.5
11/30/94	-	40.1	25.9	43.9	-	39.2	13.6	4.9	36.0	15.4	15.3	16.7	8.3	7.8
12/01/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12/02/94	-	40.4	27.1	45.2	-	39.7	13.3	4.3	37.2	15.4	15.3	16.7	3.7	2.9
12/03/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12/04/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12/05/94	-	40.9	27.7	45.2	-	41.0	13.6	3.9	37.1	15.8	15.5	17.3	-12.3	-12.1
12/06/94	-	41.0	27.8	45.0	-	40.9	13.8	3.9	39.8	16.1	15.9	17.8	-8.5	-9.3
12/07/94	-	41.8	28.8	45.4	-	41.8	14.1	4.0	40.7	16.5	16.2	18.0	-2.3	-1.9
12/08/94	-	41.6	29.0	45.3	-	42.3	13.9	3.7	41.3	16.5	16.1	18.2	-8.5	-8.6
12/09/94	-	42.5	30.3	45.9	-	43.3	15.0	4.4	42.9	17.6	17.2	19.4	-3.3	-3.0
12/10/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12/11/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12/12/94	-	43.2	32.6	46.4	-	44.8	15.2	3.6	44.2	17.9	17.6	20.3	-2.5	-2.0
12/13/94	-	43.2	33.6	46.2	-	44.6	15.2	3.6	42.0	18.1	17.9	23.2	.8	1.0
12/14/94	-	43.0	34.5	45.9	-	44.8	15.1	3.4	39.1	18.1	18.3	19.4	-7.2	-7.5
12/15/94	-	43.4	36.4	46.2	-	45.5	15.5	3.4	36.1	18.9	19.3	16.3	3.4	3.1
12/16/94	-	43.2	36.6	46.0	-	45.5	15.5	3.3	35.1	19.1	19.7	15.5	-3.1	-2.9
12/17/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12/18/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12/19/94	-	43.8	39.9	46.5	-	46.4	16.2	3.8	32.5	20.6	22.1	15.0	-1.9	-2.3
12/20/94	-	43.9	41.5	46.5	-	46.6	16.4	3.9	34.1	21.3	22.9	16.2	-.1	.3


BIOOXIDATION BULK TEST
THERMOCOUPLE DATA
THERMOCOUPLES 1-6
Degree Centigrade
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30
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0
-10
0
10
20
30
40
50
60
70
80
90
100
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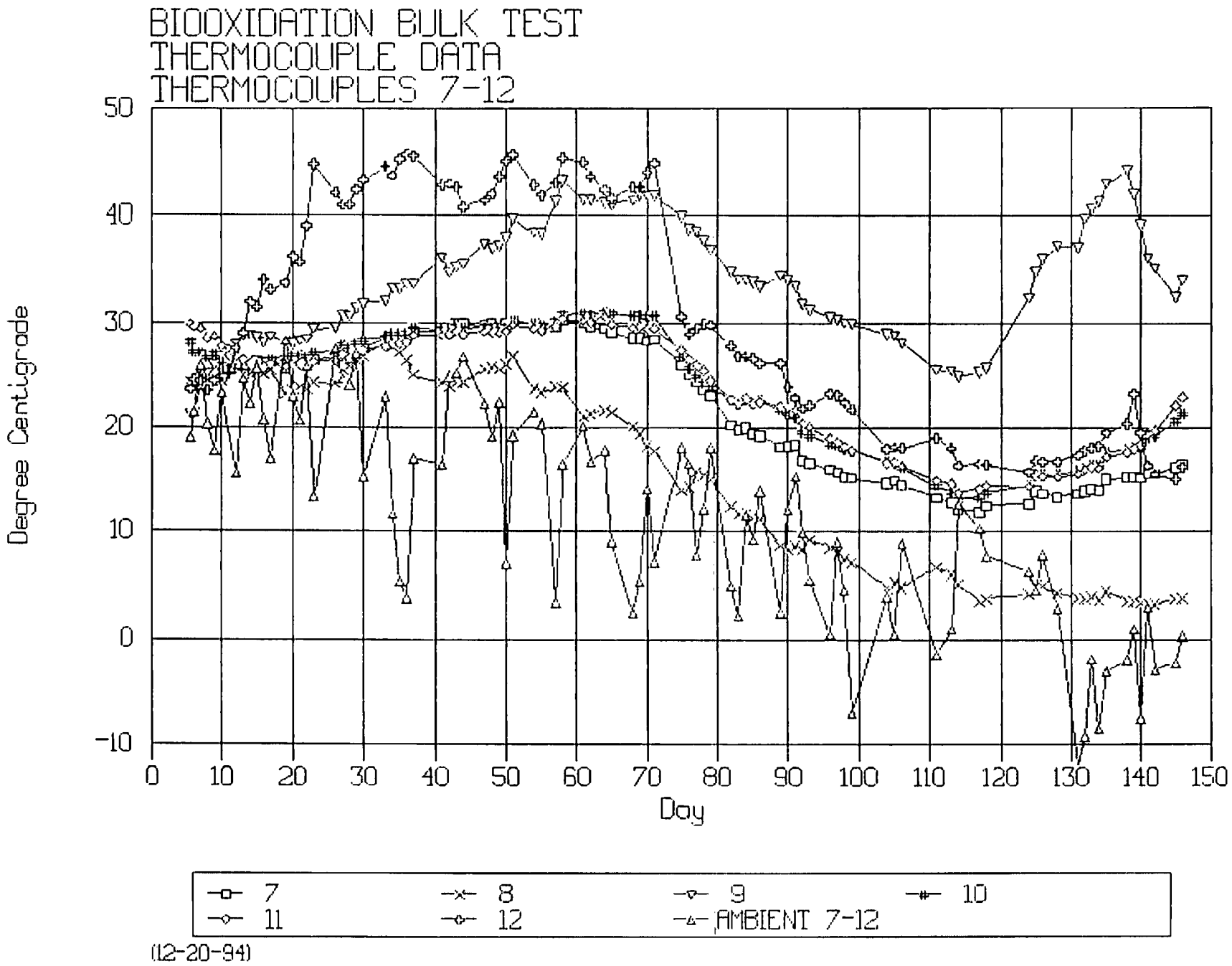
120
130
140
150
Day
1
2
3
4
5
6
AMBIENT 1-6
(12-20-94)


BIOOXIDATION BULK TEST
THERMOCOUPLE DATA
THERMOCOUPLES 7-12
Degree Centigrade
50
40
30
20
10
0
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
Day
7
8
9
10
11
12
AMBIENT 7-12
(12-20-94)

MEMORANDUM

DATE: DECEMBER 8, 1994
TO: JIM THOMPSON
FROM: LAURA DAMON
SUBJECT: BIOOXIDATION BULK TEST (BBT) WEEKLY UPDATE (19)

The BBT has been on the biooxidation cycle for nineteen weeks now. OFF solution is still being discharged from the circuit however the total gallons have decreased from around 1000 gal/day to about 500 gal/day. 14,637 gallons, containing 1911 lbs of iron and 212 lbs of copper, have been discharged as of December 5th. The heap remains stable and intact.

Air is still being injected through perforated PVC pipe under the center of the heap (under Lysimeter #3). The thermocouple temperatures have continued to rise, especially #4, #6 and #9 which are located at the 0' level in the center of the heap. This indicates that the air is having a positive effect on biooxidation.

Thermocouple #	Before Air Week 0 11/22	After Air Week 1 11/29	After Air Week 2 12/6	+ Change in degree C
2	37.6	39.2	41.0	3.4
3	21.9	24.7	27.8	5.9
4	34.4	41.7	45.0	10.6
6	32.6	37.5	40.9	8.3
7	12.4	13.8	13.8	1.4
8	3.8	5.1	3.9	0.1
9	25.6	34.8	39.8	14.2
10	13.7	15.5	16.1	2.4
11	14.4	15.4	15.9	1.5
12	16.4	16.8	17.8	1.4

Bottle roll results were obtained from McClelland Labs for the SP2 control sample (see attached memo). Their original % gold extraction results averaged 51.9% for triplicate analyses. Their triplicate sample was re-assayed resulting in an average 51.1% gold extraction for the three samples. Brohm also analyzed two more SP2 control samples by bottle roll (one sample was run in August). Brohm's average of the three samples was 52.3% gold extraction (see attached report). These averages match fairly well. Therefore it can be concluded that the control sample, with zero percent biooxidation, will attain between 51% and 52% gold extraction.

Attached is the auger drill-3 column (est. 5-8% biooxidized) vs the control column (0% biooxidized) gold extraction curves. The control column curve is based on a final 56.6% gold extraction derived from the calculated head (Calc Head = 0.0471 opt Au; Direct Fire Assay Head = 0.0457 opt). The auger drill-3 column curve is based on the direct fire assay head of 0.0522 opt Au. After 37 days on leach the auger drill-3 column shows 60.4% gold extraction vs 56.5% for the control column during the same time period. This is an increase of 3.9%. The auger drill-3 column will be unloaded next week and the final gold extraction, based on the calculated head, will be figured after the tail is assayed.

An auger drill-5 composite sample is being bottle rolled for gold extraction data this week. Also a column of the same ore is being leached. No data is available at this time.

Auger drill-6 samples are scheduled for collection during the week of December 12th. Auger drill-7 samples are scheduled for collection during the week of December 26th.

c: Rod MacLeod
Martin Quick
Herb Osborne

GEOBIOTICS, INC.

3505 Breakwater Avenue
Hayward, CA 94545

510 783-9060
Fax 510 783-9059

December 7, 1994

To: Bill, Rich, Jim - Geobiotics
Laura Damon - Brohm
From: John Shield

Re: SP2 Bottle Roll Extraction Results from McClelland Laboratories

When McClelland ran the triplicate SP2 bottle roll they noticed some potential problems with the analytical results from the triplicate, and chose to rerun all the solution and tail assays.

The original results were:

SAMPLE	Tail Assay Au/Ag	Tail Assay Au/Ag	Tail Assay Au/Ag	Au Extracted opt	Ag Extracted opt
SP2 Initial	0.026/<0.05	0.020/<0.05	0.023/<0.05	0.022	0.06
SP2 Duplicate	0.023/<0.05	0.024/<0.05	0.030/<0.05	0.026	0.06
SP2 Triplicate	0.018/0.08	0.019/0.07	0.021/0.06	0.025	0.06

The results from rerunning the SP2 triplicate sample analytical are:

SP2 Triplicate	0.022/<0.05	0.019/<0.05	0.021/<0.05	0.025	0.06

Using the second set of tail fire assays slightly changes the calculated head values and the recovery. The original results were:

SP2 Initial	48.9%	
SP2 Duplicate	50.0%	
SP2 Triplicate	56.8%	Average 51.9 %

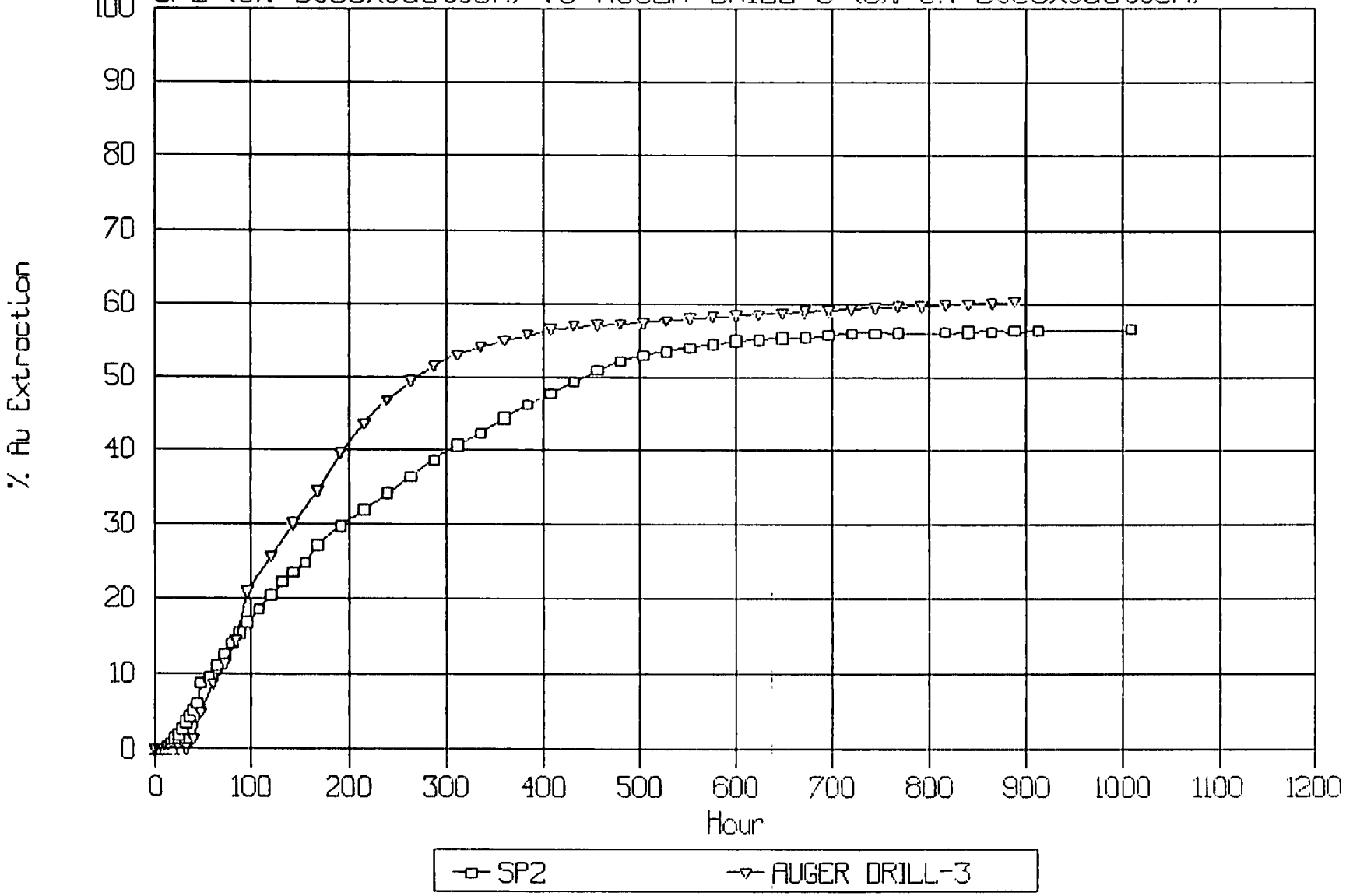
The rerun SP2 triplicate results calculate to:

SP2 Triplicate Rerun 54.3%

Consequently, the average of the three SP2 bottle roll cyanide extraction tests is:
Average 51.1%

BBT - COLUMN COMPARISON
GOLD EXTRACTION

SP2 (0% Biooxidation) vs AUGER DRILL-3 (5%-8% Biooxidation)



12/07/94

BBT BOTTLE ROLL EXTRACTION

Sample I.D.		SP2 - COMP 2 20 lb/T CaO 5 lb/T NaCN 50% Solids	
Date		11/29/94	
FA Tail	Au (opt)	.0257	
AA Soln	Au (opt)	.0281	96 hr
Calc Head	Au (opt)	.0538	
NaCN (lb/ton) final		2.1	
NaCN Consumption (lb/ton)		2.9	
pH (initial)		11.8	
pH (final)		11.3	
% Extraction Au (AA Soln/Calc Head)		52.2	

BBT BOTTLE ROLL EXTRACTION

Sample I.D.		SP2 - COMP 3 19 lb/T CaO 5 lb/T NaCN 50% Solids	
Date		11/29/94	
FA Tail	Au (opt)	.0253	
AA Soln	Au (opt)	.0251	96 hr
Calc Head	Au (opt)	.0504	
NaCN (lb/ton) final		2.0	
NaCN Consumption (lb/ton)		3.0	
pH (initial)		11.5	
pH (final)		11.4	
% Extraction Au (AA Soln/Calc Head)		49.8	

BBT BOTTLE ROLL EXTRACTION

Sample I.D.		SP2 - COMP 1 18 lb/T CaO 5 lb/T NaCN 50% Solids	
Date		08/02/94	
FA Tail	Au (opt)	.0234	
AA Soln	Au (opt)	.0284	96 hr
Calc Head	Au (opt)	.0518	
NaCN (lb/ton) final		3.0	
NaCN Consumption (lb/ton)		2.1	
pH (initial)		12.1	
pH (final)		11.2	
% Extraction Au (AA Soln/Calc Head)		54.8	

Average of 3 % Au Extractions = 52.3 Avg. 3 McClelland SP2 = 51.9%

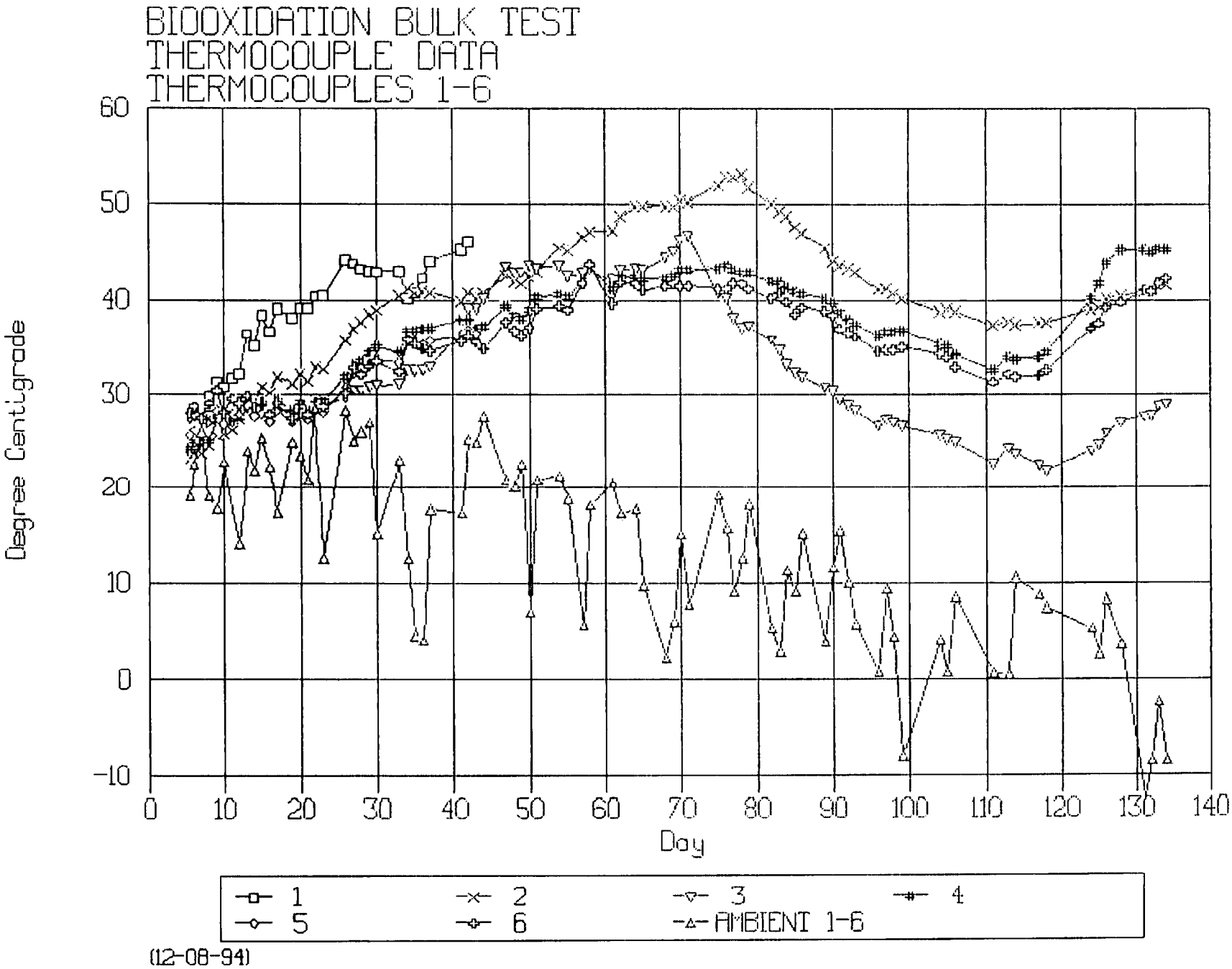
BIOOXIDATION BULK TEST SOLUTION SAMPLING

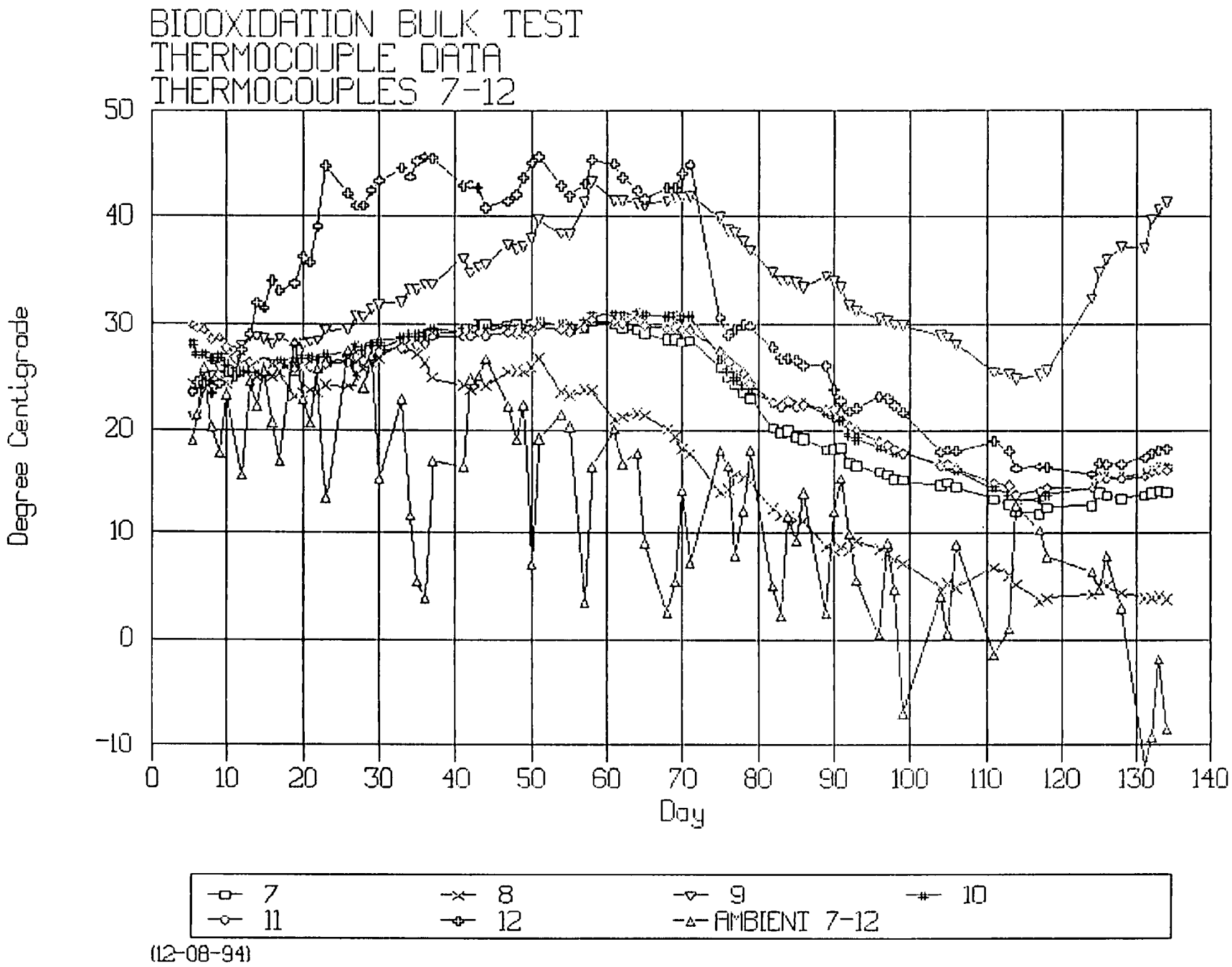
OFF SOLUTION - DISCARDED FROM HEAP

Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	DO (ppm)
COMP	11/23/94	3865	3865	1.70	549.5	1690	15900	410	15490	-	82053	-
COMP	11/24/94	2518	6383	1.81	564.3	1730	16400	380	16020	64266	85489	-
COMP	11/25/94	924	7307	1.80	685.7	1770	16800	340	16460	-	86106	-
COMP	11/26/94	1207	8514	1.83	688.2	1770	16200	340	15860	-	86086	-
COMP	11/27/94	944	9458	1.82	607.8	1760	16000	340	15660	63748	85818	-
COMP	11/28/94	494	9952	1.94	608.4	1820	17200	330	16870	-	86744	5.0
COMP	11/29/94	424	10376	1.91	688.7	1870	17000	310	16690	65304	85613	-
COMP	11/30/94	321	10697	2.04	573	1850	15400	270	15130	-	84028	-
COMP	12/ 1/94	807	11504	1.92	636.6	1840	15600	290	15310	59662	82979	-
COMP	12/ 2/94	968	12472	1.96	629.3	1760	14600	300	14300	-	79522	-
COMP	12/ 3/94	840	13312	2.03	579.4	1770	14200	300	13900	-	79749	-
COMP	12/ 4/94	687	13999	2.01	577.2	1820	14400	330	14070	58884	81991	-
COMP	12/ 5/94	638	14637	1.93	587.2	1680	11400	260	11140	-		-

BIOOXIDATION BULK TEST THERMOCOUPLE DATA

Date	West 1	West 2	West 3	West 4	West 5	Mid 6	Mid 7	Mid 8	East 9	East 10	East 11	East 12	AMBIENT 1-6	AMBIENT 7-12
11/28/94	-	39.0	24.0	40.2	-	37.0	12.6	4.2	32.4	14.4	14.3	15.7	5.3	6.3
11/29/94	-	39.2	24.7	41.7	-	37.5	13.8	5.1	34.8	15.5	15.4	16.8	2.7	4.5
11/30/94	-	40.1	25.9	43.9	-	39.2	13.6	4.9	36.0	15.4	15.3	16.7	8.3	7.8
12/01/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12/02/94	-	40.4	27.1	45.2	-	39.7	13.3	4.3	37.2	15.4	15.3	16.7	3.7	2.9
12/03/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12/04/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12/05/94	-	40.9	27.7	45.2	-	41.0	13.6	3.9	37.1	15.8	15.5	17.3	-12.3	-12.1
12/06/94	-	41.0	27.8	45.0	-	40.9	13.8	3.9	39.8	16.1	15.9	17.8	-8.5	-9.3
12/07/94	-	41.8	28.8	45.4	-	41.8	14.1	4.0	40.7	16.5	16.2	18.0	-2.3	-1.9
12/08/94	-	41.6	29.0	45.3	-	42.3	13.9	3.7	41.3	16.5	16.1	18.2	-8.5	-8.6


BIOOXIDATION BULK TEST
THERMOCOUPLE DATA
THERMOCOUPLES 1-6
Degree Centigrade
60
50
40
30
20
10
0
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
Day
1
2
3
4
5
6
AMBIENT 1-6
(12-08-94)


BIOOXIDATION BULK TEST
THERMOCOUPLE DATA
THERMOCOUPLES 7-12
Degree Centigrade
50
40
30
20
10
0
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
Day
7
8
9
10
11
12
AMBIENT 7-12
(12-08-94)

FeS_2

MEMORANDUM

DATE: NOVEMBER 19, 1994
TO: MARTIN QUICK
FROM: LAURA DAMON
SUBJECT: BIOOXIDATION BULK TEST (BBT) DATA SUMMARY OBSERVATIONS

Dear Martin,

I want to voice some observations from the BBT Data Summary Memo of 11/17/94 in hopes of clarifying some of the information.

FAXED 11/17 Thurs ~~OT~~ ~~TRT~~

First, I've included all technical information from Geobiotics regarding the original testwork leading up to the BBT and that of the BBT with the exception of John Shield's memos of 10/31/94 and 11/14/94 which are included in Weekly Reports #14 and #16. I am not faxing this information today as you should receive it on Monday attached to the hard copy of this fax. If you do not receive it Monday or desire the information sooner, please give me a call.

Included in the Geobiotics technical data are:

Cu

1) A prediction graph for the BBT biooxidation rate based on Column 11 (Geobiotics) results. This prediction came from Bill Kohr before the commencement of the BBT. 30% Fe leach → Bill
30% Fe oxid. = 60% Sulfer — John says no should be same

2) Data From Columns 11 and 12 (Geobiotics) including % Fe/day vs time in days; % Fe leach vs time in days; raw column data; assay data; and Bill Kohr's recovery calculations.

3) McClelland bottle roll data (which was included in the Geobiotics Phase 1 Report of March 1994).

4) Two sets of data from BBT SP2 heap ore columns set up at Geobiotics. These columns consisted of 3-5' columns set up in series to represent a 15' heap. Geobiotics has tried to make predictions for the BBT from this column testwork. They neutralized (metal precipitation) the recirculating solution for this column which is why they have always thought that we needed to neutralize the solution for the BBT to rid the substance inhibiting the bacteria. (The actual field biooxidation rate is not mimicking the test column biooxidation rate.)

5) Thermocouple data analysis by John Shield 9/8/94.

The John Shield memos of 10/31/94 and 11/14/94 (Weekly Report #14 and #16) concern calculations estimating the % biooxidation of the BBT. At week 14 he estimates the % biooxidation to be between 3.7% and 6.2%. At week 16 he estimates the % biooxidation to be about 8%. I have checked his calculations and they look sound. As he says in his memos, these estimates represent the lower bound % biooxidation as they do not account for any iron or sulfate precipitated in the drain rock or the screw feeder solids. One

assumption in his calculations is that there are about 120,000 gallons of solution in the system (4749 tons x 240 gal/ton x 10% moisture). We will be discharging the solution over the next week and will be able to check, with some certainty, this assumption.

So, on 10/31, day 96, John estimates % biooxidation to be between 3.7% and 6.2%. Bill Kohr predicted the BBT to be over 21% biooxidized. On 11/14, day 110, John estimates 8% biooxidation. Bill Kohr predicted upwards of 25% biooxidation. The test heap is clearly not living up to the predicted biooxidation rate. In fact, the actual rate of biooxidation is only about one-third of predicted. Geobiotics claims this is because of neutralization of metals problems, the inhibiting substance of the bacteria (something which was not foreseen up front - the neutralization system was designed for acidity control). There was evidence that the BBT's biooxidation rate took off after the 7" rainstorm but that could have just been a flushing of the system. Although the biooxidation rate seems somewhat elevated after the rainstorm, this could be due to ferric iron oxidation, not necessarily biooxidation. Another possibility is that the BBT is just biooxidizing at its field rate and will <u>NEVER</u> mimic the biooxidation rate of the lab columns.

Now to correlate % biooxidation to % gold extraction. The BBT prediction chart shows the % gold extraction to be 60% (Brohm) at 12% oxidation. The Brohm control, at 0% oxidation, showed 54.8% gold extraction (which by the way correlates rather well with the STH gold extractions). <u>If</u> the gold extraction is linear, which may or may not be true, then at 8% oxidation the gold extraction should be about 58% ((8/12 x (60-54.8)) + 54.8).

Looking at Auger Drill-3 gold extraction data, the Brohm bottle roll result for the composite sample is 57%. This is fairly close (within analytical error) of the predicted 58%. John Shield's memo of 11/14/94 (Weekly Report #16) shows a comparison of bottle roll data between McClelland, Geobiotics and Brohm. Geobiotics results are quite a bit lower than either Brohm or McClelland results. Geobiotics is re-assessing their bottle roll procedure as it deviates quite a bit from the Brohm and McClelland procedures. Brohm results are on the whole slightly higher than those of McClelland but in my opinion correlate fairly well given the diversity of the ore and the small variations in the bottle roll procedures.

I hesitate to say, at this point, the % gold extraction vs the % biooxidation is not living up to its expectations. However, the rate of biooxidation is obviously disappointing.

It must also be noted that using the auger drill data as concrete values rather than indicators is not possible. I believe the heap is biooxidizing at different rates throughout the heap (i.e. hot spots and cold spots) and unless the same sample is removed by auger drill every time (which is obviously not possible), we are

comparing apples and oranges (or at least golden delicious and McIntosh). Therefore, a true answer will not be possible until the off-loading of the heap, which will be sampled in the same manner as when it was loaded. This way we will be comparing the **ENTIRE** heap "tail" with the **ENTIRE** heap "head".

It is important to leave the BBT in place as long as operationally possible to get the best answers to our questions. After all the time, energy and money spent on this project, I think we are all committed to this notion.

As for one more concern, I have no reservations about the intelligence, specialization and aptitude of Geobiotics as far as cultivating bacteria to high densities. I do have reservations about Geobiotics thinking they have something ultimately special in operationally applying this technique and the ability to grow bacteria in the first place (i.e. indications that the process is **ALL** their baby). There are numerous published papers on growing Thiobacillus ferrooxidans and what nutrients to use. We grew Tf successfully 8 years ago at Asamera. Bacterial dump leaching has been done for years in the copper industry. I'm also not so sure how well these high density cultures actually work in the field. As I've discussed with Herb, it appears that the heap must first come to its own equilibrium and therfore the high density bacterial culture may not be of much consequence.

I hope this helps clarify some of the information available to date. If you have any further questions, please call. If not, I'm looking forward to your call on Tuesday.

Best regards,

Laura

c: Jim Thompson
Rod MacLeod
Herb Osborne

MEMORANDUM

DATE: NOVEMBER 17, 1994
TO: JIM THOMPSON
FROM: LAURA DAMON
SUBJECT: BIOOXIDATION BULK TEST (BBT) DATA SUMMARY

The following is an attempt to summarize any test data, leading up to and including the biooxidation test heap. It will mainly focus on percent biooxidation vs percent gold extraction.

Preliminary bottle roll and column testwork was performed by Geobiotics and McClelland Laboratories. The ore for this testwork was not collected from the same sulfide ore stockpile as for the BBT. Therefore an ore chart, to identify the various ores tested, is delineated below.

TEST	SIZE	DAKOTA MAID SULFIDE (Trachyte Porphry)	SUNDAY PIT SULFIDE (Quartz Trachyte)
Sulfide Test Heap	-1/4"	85%-90%	10%-15%
GEM 2	-3/8"	0%	100%
BBT	-3/8"	100%	0%

GEM 2 ore was collected for testwork with instructions to collect sulfide ore. This ore was collected from the same stockpile as the ore that went to Homestake for testing. The Sulfide Test Heap ore was collected carefully with the intentions to represent the sulfide resource as closely as possible. The BBT ore was collected to also more closely represent the sulfide resource.

GEM 2 BOTTLE ROLL RESULTS - 1*	
% Fe Oxidation	% Gold Extraction (McClelland)
0	51.4
5	67.4
10	67.8
20	60.7

* The ore was biooxidized in a column with ore being removed from the top at various biooxidized percentages predicted from solution analyses. Approximately 525 grams of non-rinsed material was bottle rolled by McClelland Laboratories.

GEM 2 BOTTLE ROLL RESULTS - 2 (COLUMN 11)**			
	% Au Extraction		
% Fe Oxidation	McClelland	Geobiotics	Brohm
4	67	47	-
9	68	39	-
19	61	78	-
25	-	78	-
30	-	82	78

** The ore was biooxidized in Column 11 (Geobiotics) with o r e being removed from the top at various biooxidized percentages predicted from solution analyses. Non-rinsed material was bottle rolled by McClelland Laboratories, Geobiotics, and a final sample by Brohm.

PREDICTED BBT* % Fe OXIDATION vs TIME IN DAYS			
		% Au Extraction	
Day	% Fe Oxidation	Geobiotics	Brohm
30	2	-	-
60	12	62[1]	60[4]
90	21	70[2]	66[4]
120	27	78[3]	74[4]
150	30	82[5]	78[5]

* Predicted by Bill Kohr (Geobiotics) from Column 11 GEM 2 bottle roll results above. (See attached graph).

1) Estimated from GEM 2 BR Results - 2, McClelland bottle roll data @ 9% and 19% Oxidation.

2) Estimated from GEM 2 BR Results - 2, average of McClelland and Geobiotics bottle roll data @ 19% Oxidation.

3) Geobiotics bottle roll data from GEM 2 BR Results - 2, @ 25% Oxidation.

4) 95% Brohm Factor applied to Geobiotics % Au Extraction. Calculated from actual bottle roll results (78% / 82%).

5) Actual bottle roll results.

BROHM BBT GOLD EXTRACTION DATA			
	% Fe Oxidation	% $S^{=}$ Oxidation	% Au Extraction*
SP2 Comp Column	0	0	56.6
SP2 Comp BR	0	0	54.8
Auger Drill-2 West 1'-15' BR	4.4[1)]	3.3[1)]	62.4
Auger Drill-2 Mid 1'-15' BR	5.8[1)]	2.5[1)]	57.5
Auger Drill-3 West 10'-15' BR	4.5[2)]	10.3[2)]	56.6
Auger Drill-3 Mid 10'-15' BR	-1.3[2)]	-15.2[2)]	56.5
Auger Drill-3 East 10'-15' BR	1.0[2)]	1.2[2)]	59.2
Auger Drill-3 West, Mid, East 1'-15' Comp BR	1.6[2)]	-1.5[2)]	57.1

* Gold Extraction percentages based on calculated head.

1) Oxidation percentages based on difference between Auger Drill-1 and Auger Drill-2 iron and sulfide values. It was assumed that no appreciable oxidation had taken place when Auger Drill-1 samples were collected on 08-23-94.

2) Oxidation percentages based on difference between Auger Drill-1 and Auger Drill-3 iron and sulfide values.

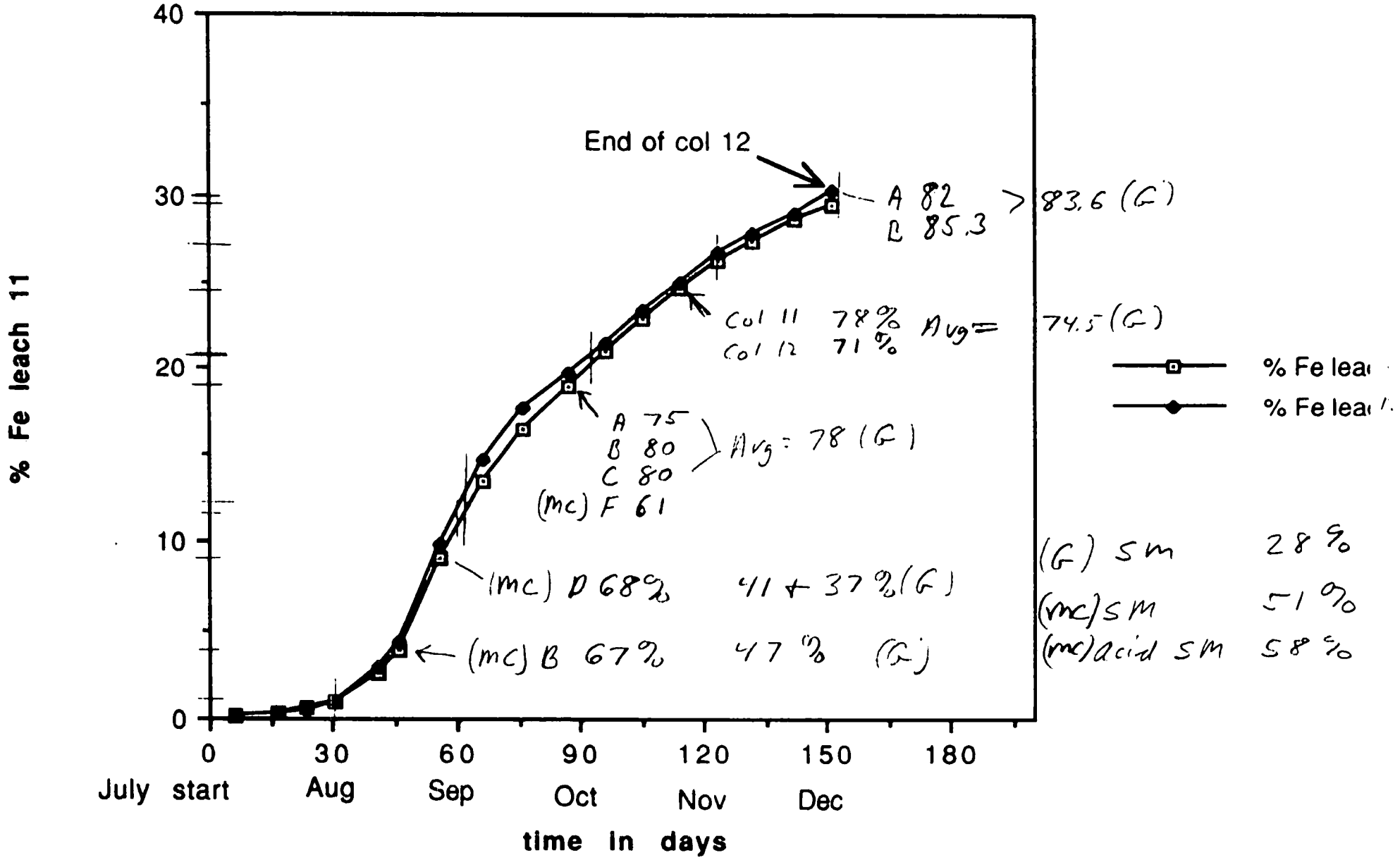
The following shows the comparison in bottle roll procedures for McClelland Laboratories, Geobiotics and Brohm.

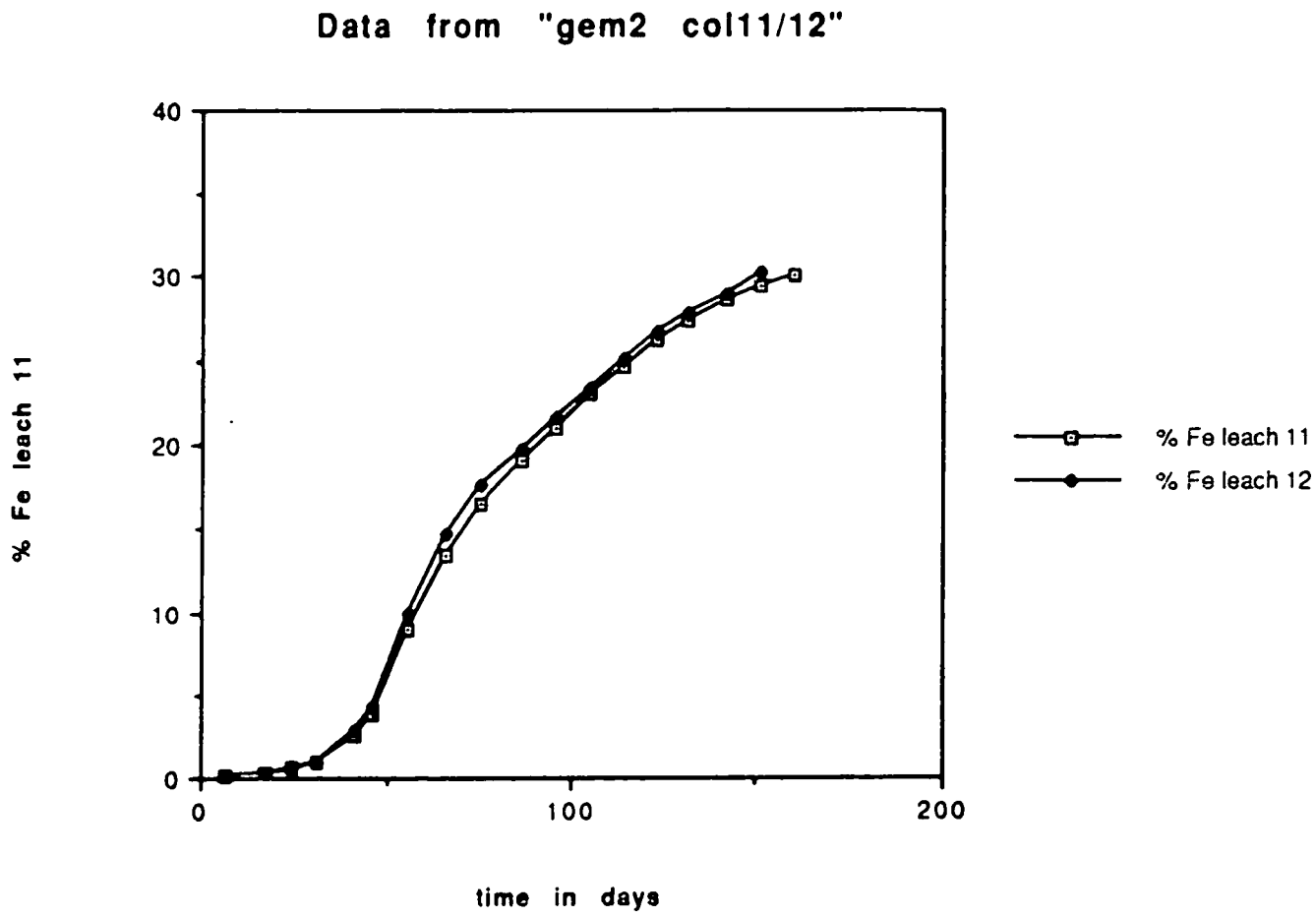
	McClelland	Geobiotics	Brohm
Duration (hrs)	96	96	96
% Solids	40	40	50
pH	11 w/CaO	11 w/NaOH	11-12 w/CaO
NaCN (lb/ton)	2	2	5
Sample Size	1500g	500g	1500g
Interval Soln Sampling	Yes 2,6,12,24,48, 72 hours	No	No
AA Final Soln	Yes	No	Yes
Carbon Absorb Final Soln	No	Yes	No
Fire Assay Tail	3X	Entire Sample	10X

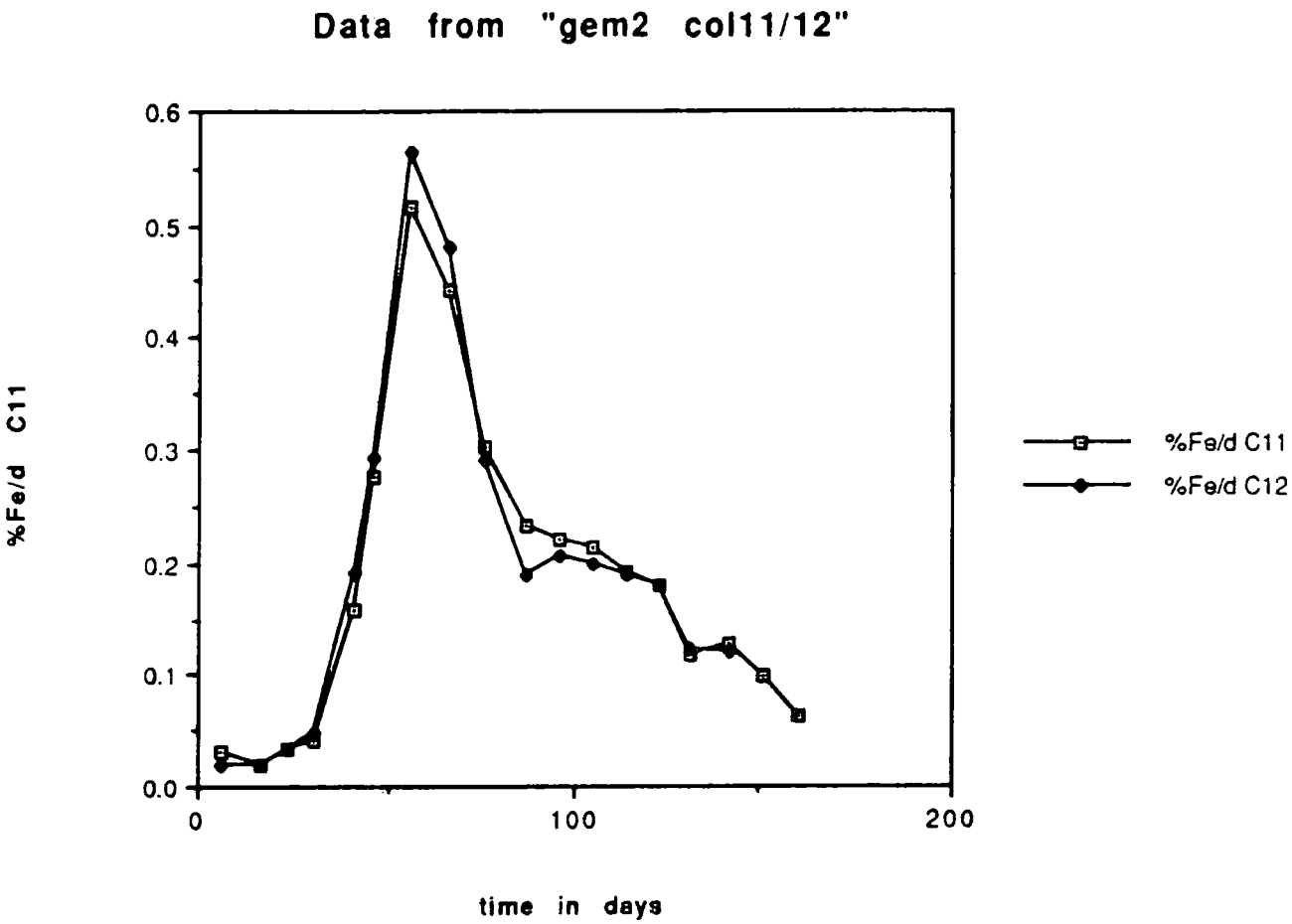
Attached to this memo are all data memo's received from Geobiotics since commencement of the biooxidation test heap and also Geobiotics testwork data received directly from Bill Kohr.

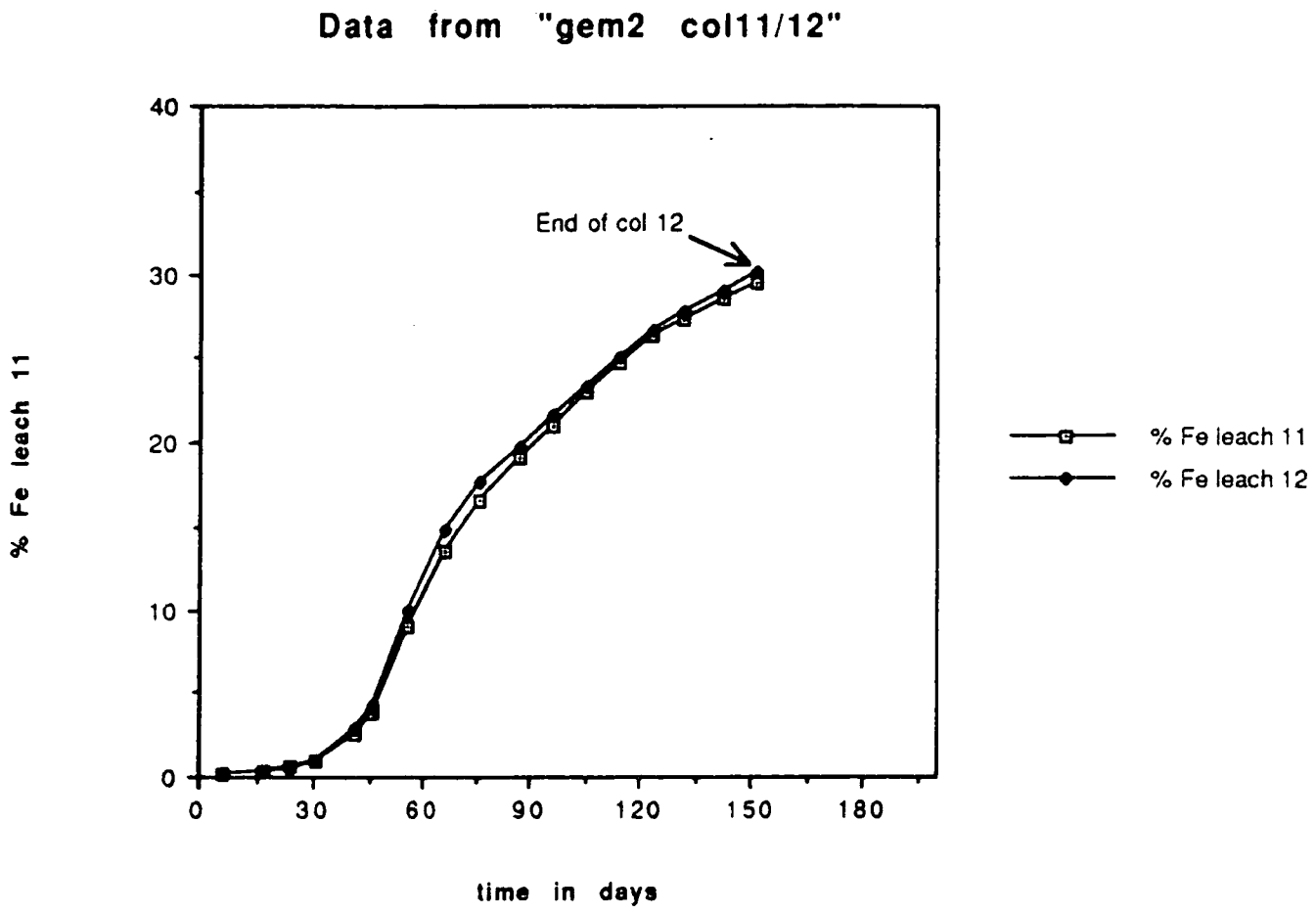
c: Rod MacLeod
Martin Quick
Herb Osborne

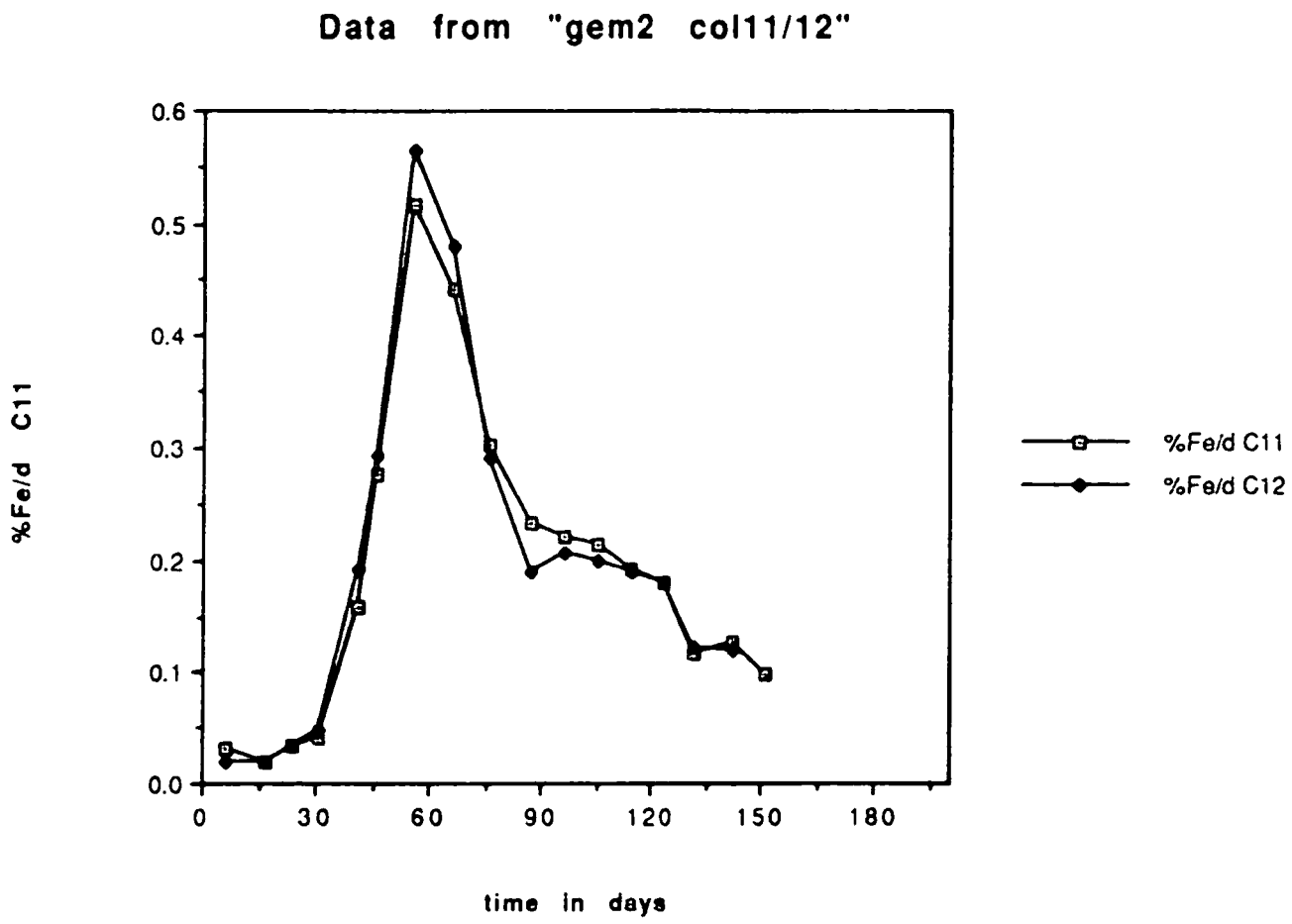
Prediction of test heap biooxidation




Data from "gem2 col11/12"
40
30
20
10
0
% Fe leach 11
0
100
200
time in days
% Fe leach 11
% Fe leach 12


Data from "gem2 col11/12"
0.6
0.5
0.4
0.3
0.2
0.1
0.0
%Fe/d C11
0
100
200
time in days
%Fe/d C11
%Fe/d C12


Data from "gem2 col11/12"
End of col 12
% Fe leach 11
% Fe leach 12
time in days
0
10
20
30
40
0
30
60
90
120
150
180


Data from "gem2 col11/12"
0.6
0.5
0.4
0.3
0.2
0.1
0.0
%Fe/d C11
0
30
60
90
120
150
180
time in days
%Fe/d C11
%Fe/d C12

gem2 col11/12 Fri, Jul 1, 1994 2:00 PM

	time in days	pH col 11	pH col 12	Eh col 11	Eh col 12	liq l 11	liq l 12
1	6	1.330	1.450	0.478	0.475	0.825	0.835
2	17	1.590	1.770	0.454	0.461	1.440	2.055
3	24	1.980	2.010	0.577	0.571	2.095	2.375
4	31	1.920	1.940	0.646	0.653	1.770	1.990
5	41	1.670	1.530	0.676	0.663	2.640	2.840
6	46	1.670	1.660	0.698	0.692	1.340	1.450
7	56	1.530	1.500	0.718	0.688	4.090	4.320
8	66	1.540	1.560	0.719	0.712	6.080	5.945
9	76	1.140	1.180	0.718	0.689	6.024	5.985
10	87	1.160	1.210	0.720	0.721	5.280	4.860
11	96	1.500	1.480	0.735	0.735	3.775	3.665
12	105	1.520	1.570	0.739	0.735	4.200	4.520
13	114	1.620	1.590	0.740	0.737	4.035	4.400
14	123	1.540	1.370	0.732	0.717	5.105	5.640
15	132	1.330	1.310	0.737	0.726	3.380	4.440
16	142	1.590	1.570	0.704	0.699	4.620	5.140
17	151	1.450		0.717		3.648	23.000
18	160	1.5		.710		4.130	

	Fe g C11	Fe g C12	% Fe/p 11	%Fe/p 12	% Fe leach 11	% Fe leach 12	vol/d 11
1	4.049	2.670	0.190	0.110	0.190	0.110	0.140
2	5.031	5.367	0.200	0.200	0.390	0.310	0.130
3	3.620	3.809	0.230	0.240	0.620	0.550	0.300
4	4.549	5.238	0.290	0.340	0.910	0.890	0.250
5	24.795	30.285	1.580	1.930	2.490	2.820	0.260
6	12.585	15.462	1.377	1.467	3.870	4.290	0.270
7	80.098	87.575	5.170	5.650	9.037	9.940	0.410
8	67.707	72.861	4.417	4.793	13.454	14.733	0.608
9	46.144	43.691	3.032	2.897	16.486	17.630	0.602
10	39.135	31.823	2.554	2.090	19.040	19.720 —	0.480
11	29.566	27.340	1.990	1.860	21.030	21.580	0.420
12	28.795	26.686	1.930	1.800	22.960	23.380	0.467
13	25.840	25.133	1.730	1.710	24.690 ←	25.090	0.448
14	23.279	23.350	1.610	1.630	26.300	26.720 ←	0.567
15	13.479	15.718	1.050	1.100	27.350	27.820	0.375
16	18.535	17.373	1.270	1.210	28.620	29.030	0.462
17.	12.841	15.088	0.890	1.180	29.510	30.210	0.405
	8,177		.56		30.07		.459

gem2 col11/12 Fri, Jul 1, 1994 2:00 PM

	vol/d C12	gFe/d C11	gFe/d C12	gCu C11	gCu C12	gCu/d C11	gCu/d C12
1	0.140	0.675	0.445	1.238	1.039	0.206	0.173
2	0.190	0.457	0.488	2.074	2.417	0.188	0.220
3	0.340	0.517	0.544	1.973	2.147	0.282	0.307
4	0.280	0.649	0.748	1.674	1.827	0.239	0.261
5	0.280	2.480	3.028	3.527	3.783	0.353	0.378
6	0.290	2.517	3.092	3.801	3.396	0.760	0.679
7	0.430	8.010	8.758	2.814	2.454	0.281	0.245
8	0.594	6.770	7.286	0.900	0.927	0.090	0.093
9	0.598	4.614	4.369	0.381	0.390	0.038	0.039
10	0.442	3.560	3.182	0.258	0.223	0.023	0.020
11	0.407	3.280	3.038	0.159	0.165	0.018	0.018
12	0.502	3.200	2.960	0.139	0.138	0.015	0.015
13	0.488	2.871	2.792	0.121	0.119	0.013	0.013
14	0.627	2.586	2.594	0.131	0.106	0.015	0.012
15	0.493	1.498	1.746				
16	0.514	1.854	1.737				
17		1.427					
		.908					

	%Fe/d C11	%Fe/d C12	Fe ppm C 11	Fe ppm C12	date
1	0.0317	0.0183	4908	3198	1/27/94
2	0.0182	0.0182	3494	2612	2/7/94
3	0.0328	0.0343	1728	1604	2/14/94
4	0.0414	0.0486	2570	2632	2/21/94
5	0.1580	0.1930	9392	10664	3/3/94
6	0.2754	0.2934	16096	15840	3/8/94
7	0.5170	0.5650	19584	20272	3/18/94
8	0.4417	0.4793	11136	12256	3/28/94
9	0.3032	0.2897	7660	7300	4/7/94
10	0.2322	0.1900	7412	6548	4/18/94
11	0.2211	0.2067	7832	7460	4/27/94
12	0.2144	0.2000	6856	5904	5/6/94
13	0.1922	0.1900	6404	5712	5/16/94 ←
14	0.1790	0.1811	4560	4140	5/25/94
15	0.1167	0.1222	3988	3540	6/3/94
16	0.1270	0.1210	4012	3380	6/13/94
17	0.0989		3520		6/22/94
18.	0.0622		1980		7/1/94

roll bottle test.

Taken 5/16

TF leach/CIL III

	A	B	C	D	E	F	G	H	I	J
1	Sample	Au ug/ml	Blank	vol.(ml)	Au ug	dry wt. (g)	Au ug/g	Head conc.ug/	%Au extracted	% Fe leached
2	C1 5/19 tail	0.282			28.20	100	0.28	1.11	74.69	46.54
3	" Ca	2.17	0.09	40	83.2					
4	Sample	Au ug/ml	Blank	vol.(ml)	Au ug	dry wt. (g)	Au ug/g	Head conc.ug/	%Au extracted	% Fe leached
5	C4 5/19 tail	0.165			16.50	100	0.17	0.69	76.05	39.76
6	" Ca	1.39	0.08	40	52.4					
7	Sample	Au ug/ml	Blank	vol.(ml)	Au ug	dry wt. (g)	Au ug/g	Head conc.ug/	%Au extracted	% Fe leached
8	C6 5/19 tail	0.221			66.30	300	0.22	0.59	62.73	23.73
9	" Ca	2.88	0.09	40	111.6					
10	Sample	Au ug/ml	Blank	vol.(ml)	Au ug	dry wt. (g)	Au ug/g	Head conc.ug/	%Au extracted	% Fe leached
11	C8 5/19 tail	0.22			22.00	100	0.22	1.41	84.42	53.44
12	" Ca	3.07	0.09	40	119.2					
13	Sample	Au ug/ml	Blank	vol.(ml)	Au ug	dry wt. (g)	Au ug/g	Head conc.ug/	%Au extracted	% Fe leached
14	C11 5/19 tail	0.358			179.00	500	0.36	1.58	78.30	26.82
15	" Ca 1	3.1	0.04	200	612					
16	" Ca 2	1.88	0.18	20	34					
17	Sample	Au ug/ml	Blank	vol.(ml)	Au ug	dry wt. (g)	Au ug/g	Head conc.ug/	%Au extracted	% Fe leached
18	C12+18mesh	0.323			161.50	500	0.32	0.86	62.57	27.69
19	" Ca	6.83	0.08	40	270					
20	Sample	Au ug/ml	Blank	vol.(ml)	Au ug	dry wt. (g)	Au ug/g	Head conc.ug/	%Au extracted	% Fe leached
21	C12-18mesh	0.8			80.00	100	0.80	3.44	76.72	27.69
22	" Ca	6.67	0.08	40	263.6					

-10

-1/8

-1/4

-16

total recovery for column # 12

-18	76.7%	× 60.2 Au%	=	46.17
+18	62.6%	× 39.8 Au%	=	24.91
				71.08

Low recovery -18	72.5	× 60.2 Au%	=	43.6
Low recovery +18	59.8	× 39.8 Au%	=	23.8
				67.4 - 3.7

High recovery -18	79.3	× 60.2 Au%	=	47.7
Low recovery +18	59.8	× 39.8 Au%	=	23.8
				71.5

High recovery -18	79.3	× 60.2 Au%	=	47.7
~~Low~~ High recovery +18	70.1	× 39.8 Au%	=	27.9
				75.6 + 4.3

Column 12 Avg recovery 71.1% ± 4%

Column 11 Avg recovery 78.3% ± 10%

range from 71.7 to 88.4

Column 11

% leached 26.3 (123 days)

500g test 96 hr test 500ppm NaCN

Au on Carbon (absorbed after roll bottle test)

1st 612 ug 2nd 34 ug = 646 ug total

Tail 16 samples for fire assay 480g total out of 500gm from test

3 of 16 were very fine material were analysed along with other 13 sample of tail which were split as uniformly as possible.

Sample #	oz/ton			
1	.155 ppm	.0045	14	.650
2	.155		15	.120
3	.160		16	.250
4	.510			
5	.510			
6	.310			
7	.430			
8	.310			
9	.280			
10	.485			
11	.360			
12	.390			
13	[illegible]			

fine sample

remain part of tail that settled out quickly

				% recovery					
Highest	1	.720	(c) 170	64.2	- 14.1				
	2	.650	80.5	66.5	- 11.8				
	3	.510	42	71.7	- 6.6				
	4	.510	42	71.7	- 6.6				
	5	.485	35	72.7	- 5.6				
	6	.430	19.4	75.0	- 3.3	±3	±6	±9	±
	7	.390	8.3	76.8	- 1.5				
	8	.360	.59	78.2	- .1	4	8	10	
	9	.310	-13.9	80.6	+ 2.3				
	10	.310	-13.9	80.6	+ 2.3				
	11	.280	-22	82.2	+ 3.9				
	12	.250	-30	83.8	5.5				
	13	.170	-53	88.4	10.7				
	14	.160	(f) -55	89.0	10.7				
	15	.155	(f) 57%	89.3	11				
Lowest	16	.155	(f) 57	89.3	11				

Mead .360

Avg .358

Chemex Labs Ltd.
Analytical Chemists * Geochemists * Registered Assayers
994 West Glendale Ave., Suite 7, Sparks,
Nevada, U.S.A. 89431
PHONE: 702-356-5395

To: GEOBIOTICS

3505 BREAKWATER AVE
HAYWARD, CALIFORNIA
94545

Project: 01-016
Comments: ATTN. CHRIS JOHANSSON

Page Number 1
Total Pages 1
Certificate Date 7-JUL-94
Invoice No I-9419728
P.O. Number R70794CJ
Account

Gen 2 - 4/12 6/22 Tail 500g

CERTIFICATE OF ANALYSIS A9419728

SAMPLE DESCRIPTION	PREP CODE		Au ppb RUSH
001	217	--	210
002	217	--	190
003	217	--	215
004	217	--	260
005	217	--	165
006	217	--	155
007	217	--	290
008	217	--	370
009	217	--	180
010	217	--	240
011	217	--	180
012	217	--	230
013	217	--	210
014	217	--	235
015	217	--	220
016	217	--	275

3625 ÷ 16 = .227 ppm. (.0066)

85.3% Au recov.

Chemex Labs Ltd.
Analytical Chemists * Geochemists * Registered Assayers
994 West Glendale Ave., Suite 7, Sparks,
Nevada, U.S.A. 89431
PHONE: 702-356-5395

To: GEOBIOTICS

3505 BREAKWATER AVE
HAYWARD, CALIFORNIA
94545

Project : N1-N16
Comments ATTN: CHRIS JOHANSSON

Certificate Date 8-JUL-94
Invoice No I-9419727
P O Number R70694CJ
Account

Gem 2 - C/12 - 6/22 Tail 500g

CERTIFICATE OF ANALYSIS A9419727

SAMPLE DESCRIPTION	PREP CODE		Au ppb RUSH
M01	217	--	205
M02	217	--	235
M03	217	--	190
M04	217	--	185
M05	217	--	485
M06	217	--	185
M07	217	--	210
M08	217	--	255
M09	217	--	315
M10	217	--	205
M11	217	--	225
M12	217	--	265
M13	217	--	215
M14	217	--	200
M15	217	--	245
M16	217	--	230

3850 = .241 ave. (.007 OZ/t

82% Av Recov.

Chemex Labs Inc.
Analytical Chemists * Geochemists * Registered Assayers
994 West Glendale Ave., Suite 7, Sparks,
Nevada, U.S.A. 89431
PHONE: 702-356-5395

To GEOBIOTICS

3505 BREAKWATER AVE
HAYWARD, CALIFORNIA
94545

Project K7-K8
Comments: ATTN CHRIS JOHANSSON

Page Number 1
Total Pages 1
Certificate Date 04 JUL 94
Invoice No : 19418968
P O Number : R62494CJ
Account : JIE

CERTIFICATE OF ANALYSIS A9418968

SAMPLE	PREP CODE		Au ppb RUSH	Cu %	Ni %	Co %	S % (Leco)	Fe %	As %	Fe left.		
K7 [illegible] 3 1/12 [illegible]	248	260	1480	0.02	< 0.02	< 0.01	1.38	2.5	< 0.01	55% left	avg. 64% left	
K8 " "	248	260	1360	0.02	< 0.02	0.01	— 1.53	3.3	< 0.01	73% left		
			Av 1420							5% left.		
Starting material 1/27/94	248		1390	.06	< 0.02	< 0.01	3.47	45	0.01	40% left av. 42% 44% left		
	tail		.485 / .185	Av .241		1 − .241/1.42 = 83%				1 − (.485/1.36) = 64%		
	tail		.370 / .165	Av .227		1 − .227/1.42 = 84%				1 − (.37/1.36) = 73%		

CERTIFICATION: [signature]

GEOBIOTICS, INC.

3505 Breakwater Avenue
Hayward, CA 94545

510 783-9060
Fax 510 783 9059

FAX COVER

FROM:

SENDER: Bill Kohr

DATE: 5-17-94

FROM FAX: 510 783-9059

PHONE: 510 783-9060 EXT. 30

PAGES: 5
(including this cover)

TO:

RECIPIENT: Omar Muhtadi

COMPANY:

AT FAX: 702-358-5759

notes: Sample E - 5% oxidation
C - 10% oxidation
F = 20% oxidation

Table . - Overall Metallurgical Results,
Bottle Roll Tests, As Received Feed Size (Nominal 1/4")

Metallurgical Results	Sample A (8% Fraction Remit)		Sample B (5% Oxidation)		Sample C (0% Oxidation - Control)	
Extraction: pct of total	Au	Ag	Au	Ag	Au	Ag
in 2 hours	27.6		30.4		20.0	
in 6 hours	42.1		43.9		30.0	
in 24 hours	60.8		62.6		46.9	
in 48 hours	63.4		65.4		51.1	
in 72 hours	64.5		66.9		51.4	
in 96 hours	68.4		67.4		51.4	
Extracted, oz/ton of feed	0.026		0.031		0.018	
Tail Assay, oz/ton[1)]	0.012		0.015		0.017	
Calc'd Head, oz/ton of feed	0.038		0.046		0.035	
Cyanide Cons., lb/ton of feed	1.35		1.18		2.66	
Lime Added, lb/ton of feed	15.3		32.8		14.1	
Final Solution pH	11.1		11.1		10.9	
Natural pH (40% solids)	3.2		2.3		3.9	
Ag Extracted, oz/ton of feed[2)]	0.08		0.09		0.08	

1) Average of triplicate tail assays.
2) Ag tail assay results are pending.

Table 1. - Overall Metallurgical Results, Bottle Roll Test, As Received Feeds, (Nominal 1/4")

Metallurgical Results	Sample D 10% Oxidation		Sample E	
Extraction: pct. of total	Au	Ag	Au	Ag
in 2 hours	27.5	43.8	21.5	28.6
in 6 hours	41.9	48.1	31.2	35.9
in 24 hours	59.2	52.7	48.0	45.1
in 48 hours	64.9	55.2	52.9	46.7
in 72 hours	66.3	58.8	56.1	46.7
in 96 hours	67.8	58.8	58.5	46.7
Extracted, oz/ton ore	0.040	0.10	0.024	0.07
Tail Assay, oz/ton*	0.019	0.07	0.017	0.08
Calculated Head, oz/ton ore	0.059	0.17	0.041	0.15
Cyanide Consumed, lb/ton ore	1.37		2.71	
Lime Added, lb/ton ore	31.4		36.1	
Final Solution pH	10.8		11.0	
Natural pH (40% solids)	2.3		2.4	

* Average of all tail assays.

Table 3. - Direct Tail Assay Results, Bottle Leached Residues

Determination	Tail Grade, oz/ton D Au	D Ag	E Au	E Ag
Direct Assay, 1	0.014	0.06	0.019	0.08
Direct Assay, 2	0.020	0.07	0.018	0.08
Direct Assay, 3	0.022	0.08	0.014	0.08
Direct Assay, 4	0.010		0.015	
Direct Assay, 5	0.038		0.019	
Direct Assay, 6	0.015		0.013	
Direct Assay, 7	0.011		0.018	
Direct Assay, 8	0.025		0.019	
Direct Assay, 9	0.018		0.015	
Average	0.019	0.07	0.017	0.08

Note without #5 Average = 0.0169

Table 1. - Overall Metallurgical Results, Bottle Roll Test, As Received Feed, (Nominal 1/4")

Metallurgical Results	Sample F 20% oxidation Au	Ag
Extraction: pct. of total		
in 2 hours	25.0	55.4
in 6 hours	36.8	56.9
in 24 hours	54.3	59.2
in 48 hours	59.3	59.3
in 72 hours	59.5	61.1
in 96 hours	60.7	64.7
Extracted, oz/ton ore	0.034	0.11
Tail Assay, oz/ton*	0.022	0.06
Calculated Head, oz/ton ore	0.056	0.17
Cyanide Consumed, lb/ton ore	2.53	
Lime Added, lb/ton ore	28.3	
Final Solution pH	11.0	
Natural pH (40% solids)	2.7	

*Average of triplicate tail assays.

Table 2. - Triplicate Tail Assay Results, Bottle Leached Residue

Determination	Sample, oz/ton F Au	Ag
Initial	0.021	0.06
Duplicate	0.023	0.06
Triplicate	0.023	0.06
Average	0.022	0.06

Chemex Labs Ltd.

Analytical Chemists * Geochemists * Registered Assayers
994 West Glendale Ave., Suite 7 Sparks
Nevada, U S A 89431
PHONE: 702-356-5395

To GEOBIOTICS

3505 BREAKWATER AVE
HAYWARD, CALIFORNIA
94545

Project : X6 -> X14
Comments ATTN CHRIS JOHANSSON

Page Number 1
Total Pages 1
Certificate Date 29-APR-94
Invoice No I-9415335
P O Number R42094CJ
Account

CERTIFICATE OF ANALYSIS A9415335

SAMPLE DESCRIPTION	PREP CODE		Au ppb BUSH									
X06	217	--	415	Gem 2 4/18 Sample		A (14)	4/18 Sample					
X07	217	--	440									
X08	217	--	125									
X09	217	--	295									
X10	217	--	295	"	"	"	B(15)					
X11	217	--	270									
X12	217	--	395	"	"	"	C (16)					
X13	217	--	530									
X14	217	--	415									

TF leach/CIL II

	A	B	C	D	E	F	G	H	I	J	
423	GEM4/18Biox	Au ug/ml	Blank	vol.(ml)	Au ug	dry wt. (g)	Au ug/Sample	% Fe oxidized	%Au extracted	mg. CN/96hr.	
424	Tail(Chemx)	0.4			40.00	100		20.93		75	A
425	Ca	5.84	0.07	20	119.59		159.59		74.94		
426	solution	0.469	0.078	285	111.44		151.44		73.59		
427	GEM4/18Biox	Au ug/ml	Blank	vol.(ml)	Au ug	dry wt. (g)	Au ug/Sample	% Fe oxidized	%Au extracted	mg. CN/96hr.	
428	Tail(Chemx)	0.287			28.70	100		20.93		75	B
429	Ca	5.54	0.1	20	113.22		141.92		79.78		
430	solution	0.493	0.075	259	108.26		136.96		79.05		
431	GEM4/18Biox	Au ug/ml	Blank	vol.(ml)	Au ug	dry wt. (g)	Au ug/Sample	% Fe oxidized	%Au extracted	mg. CN/96hr.	
432	Tail(Chemx)	0.453			45.30	100		20.93		75	C
433	Ca	8.92	0.06	20	183.82		229.12		80.23		
434	solution	0.728	0.083	280	180.60		225.90		79.95		

Same sample as given to McClelland (Sample F)
Note 3 samples of 30g each out of 100g
were sent to Chemex for fire assay.

GEOBIOTICS, INC.

3505 Breakwater Avenue
Hayward, CA 94545

510 783-9060
Fax 510 783 9059

FAX COVER

FROM:

SENDER: Bill Kohr

DATE: 9-8-94

FROM FAX: 510 783-9059

PHONE: 510 783-9060 EXT. 30

PAGES: 4
(including this cover)

TO:

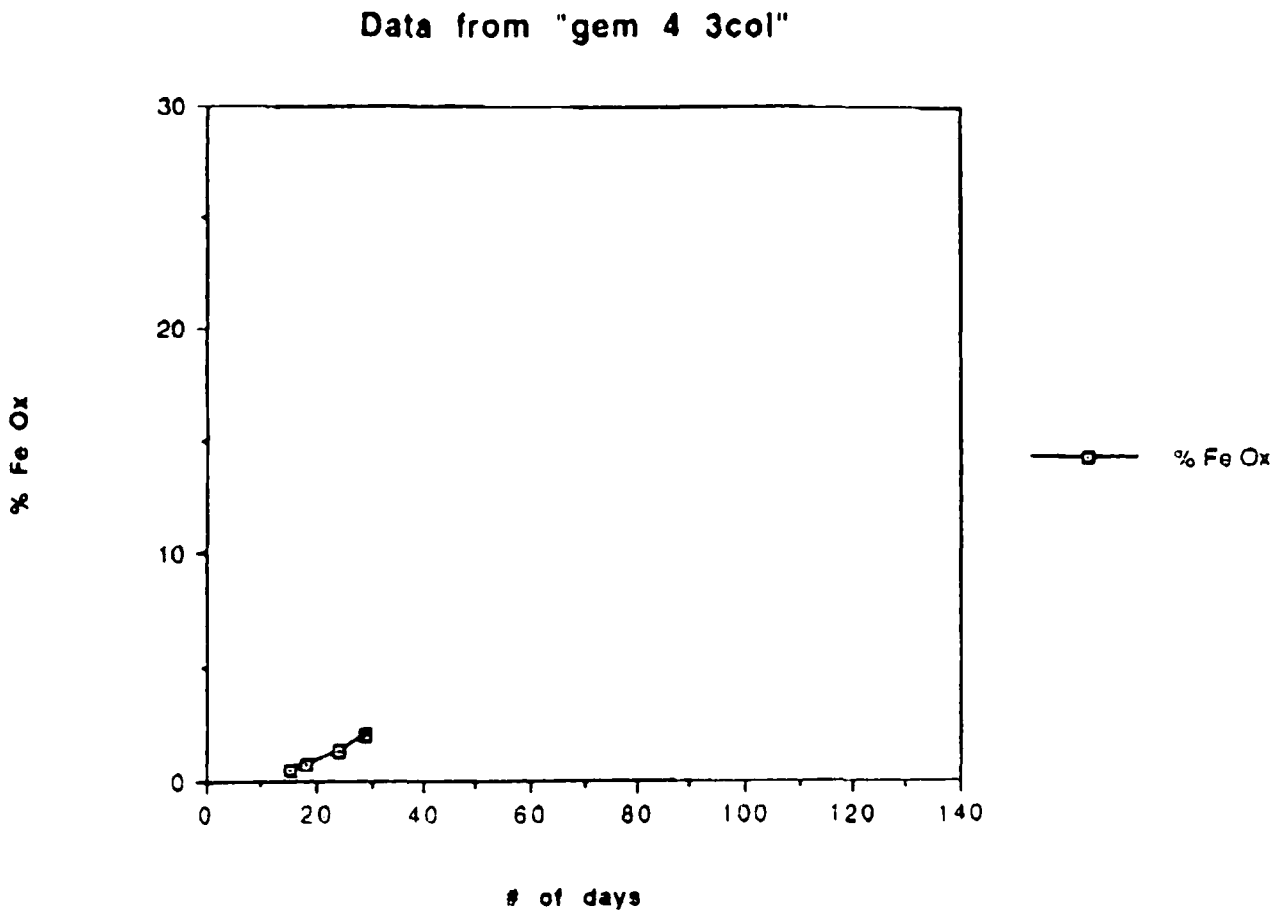
RECIPIENT: Jim Whitlock, Rod MacLeod

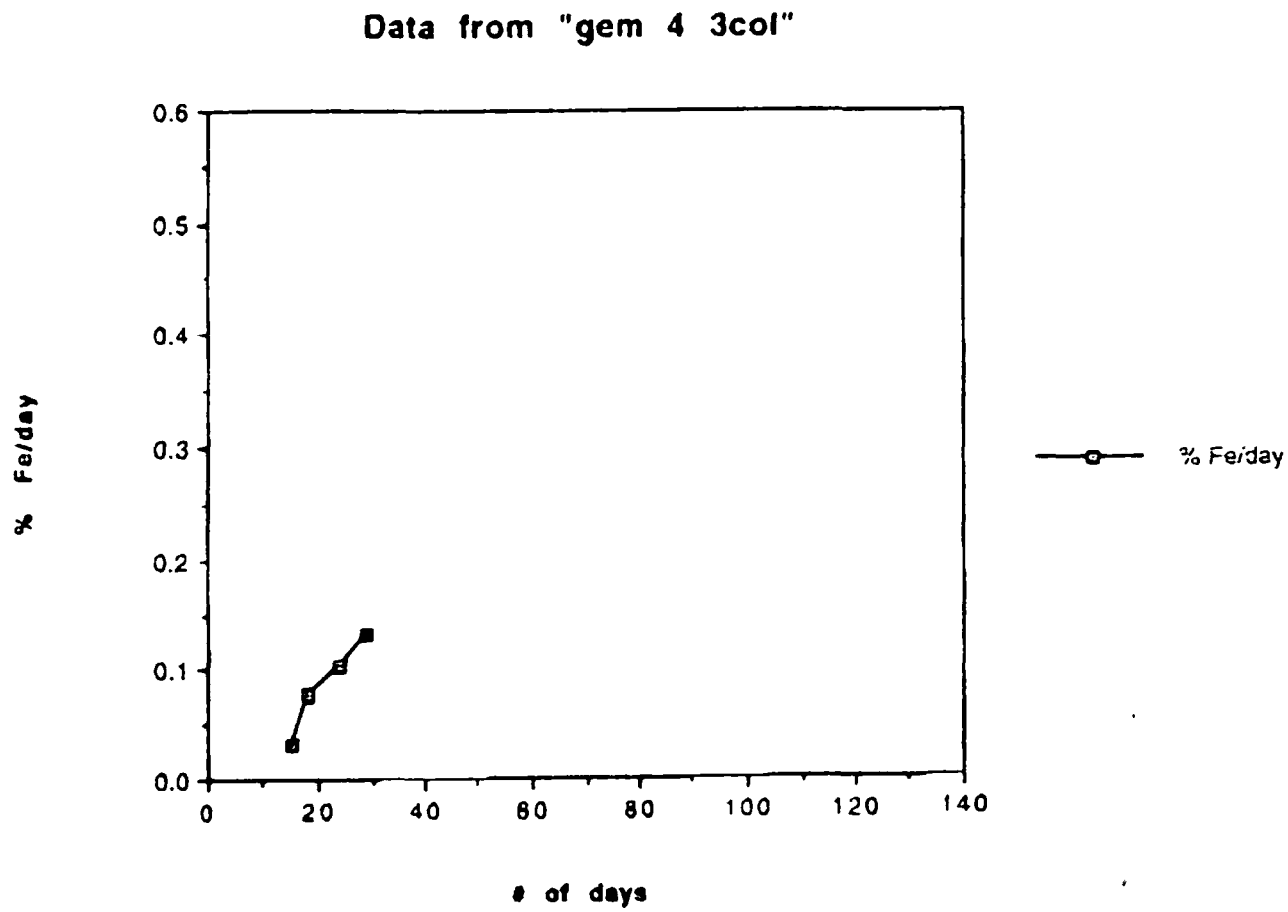
COMPANY: Jim Thompson, Laura Damon

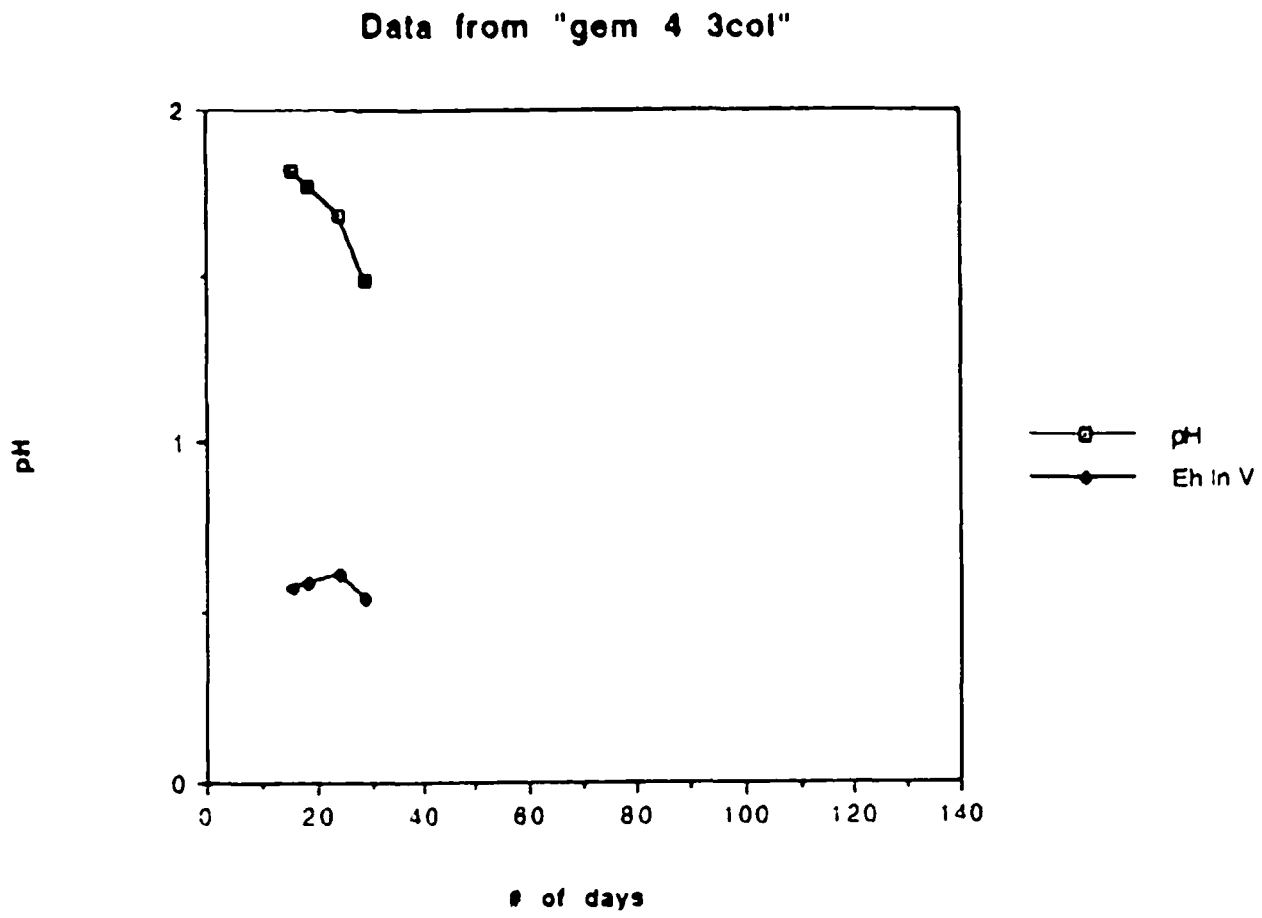
AT FAX: 1-605-578-1703

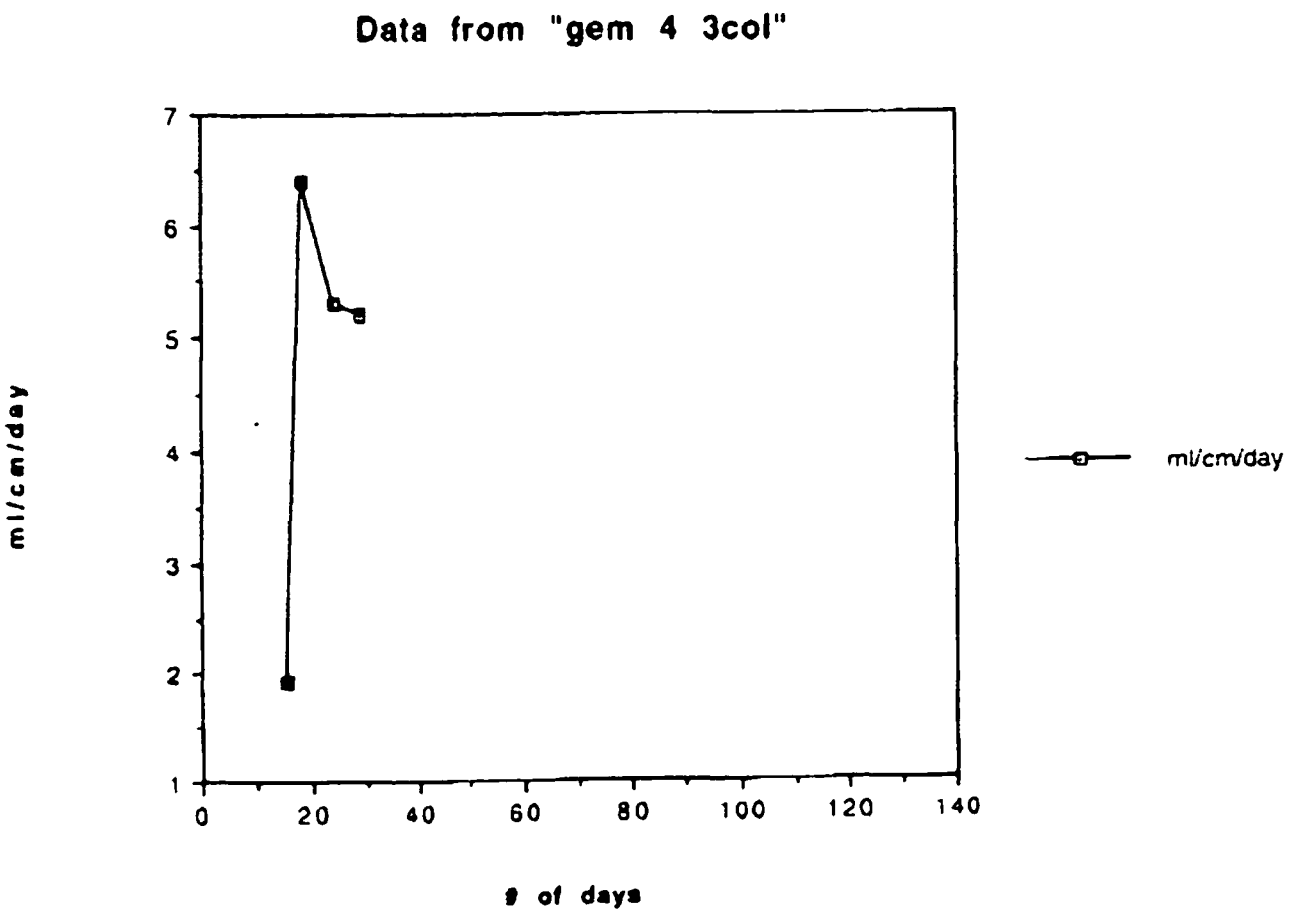
notes: Results from three column system set up using one from the heap (SP-2). It's just it takes about 10 days for the liquid to move through the columns. Application of recycled solution was started on 8/26.

3-5' columns in succession (15')

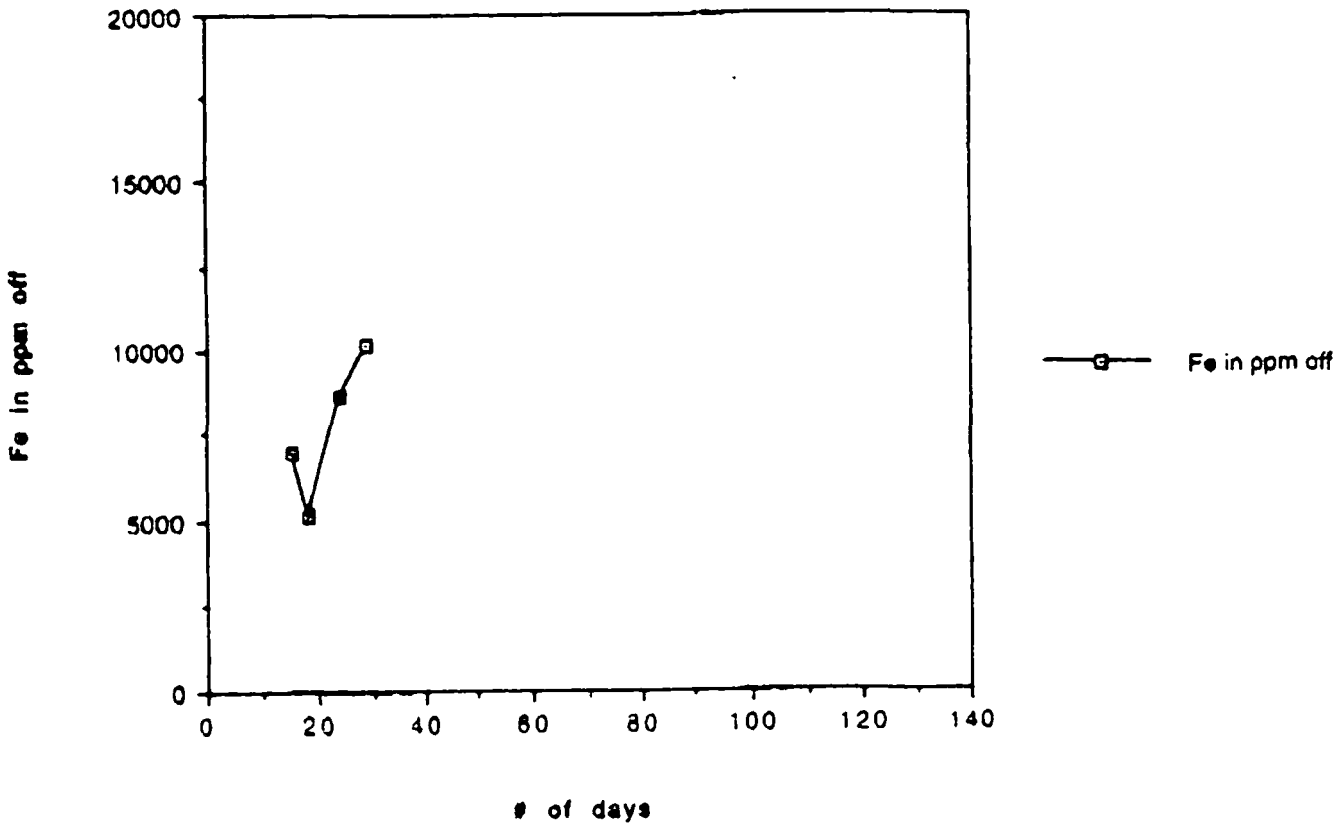

Data from "gem 4 3col"
30
20
10
0
% Fe Ox
0
20
40
60
80
100
120
140
# of days
% Fe Ox


Data from "gem 4 3col"
0.6
0.5
0.4
0.3
0.2
0.1
0.0
% Fe/day
0
20
40
60
80
100
120
140
# of days
% Fe/day


Data from "gem 4 3col"
pH
2
1
0
0
20
40
60
80
100
120
140
# of days
pH
Eh in V


Data from "gem 4 3col"
ml/cm/day
7
6
5
4
3
2
1
0
20
40
60
80
100
120
140
# of days
ml/cm/day

Data from "gem 4 3col"



gem 4 3col

Thu. Sep 8, 1994 9:08 AM

	date	# of days	pH	Eh in V	vol rem.	vol r. /day	ml/cm/day
1	8/23/94	15	1.820	0.576	1160	74	1.900
2	8/26/94	18	1.770	0.590	740	247	6.400
3	9/1/94	24	1.680	0.614	1220	203	5.300
4	9/6/94	29	1.480	0.640	1000	200	5.200
				0.540?			

gem 4 3col

Thu. Sep 8, 1994 9:08 AM

	g Fe rem.	% Fe Ox	% Fe/day	Fe in ppm off	gal/ft/min
1	8.038	0.470	0.031	6928	0.00023
2	3.785	0.700	0.077	5116	0.00078
3	10.541	1.320	0.103	8640	0.00065
4	10.136	1.980	0.132	10136	0.00063

3505 Breakwater Avenue
Hayward, CA 94545

510 783-9060
Fax 510 783 9059

FAX COVER

FROM:

SENDER: Bill Kohr

DATE: 9-30-94

FROM FAX: 510 783-9059

PHONE: 510 783-9060 EXT. 30

PAGES: 4
(including this cover)

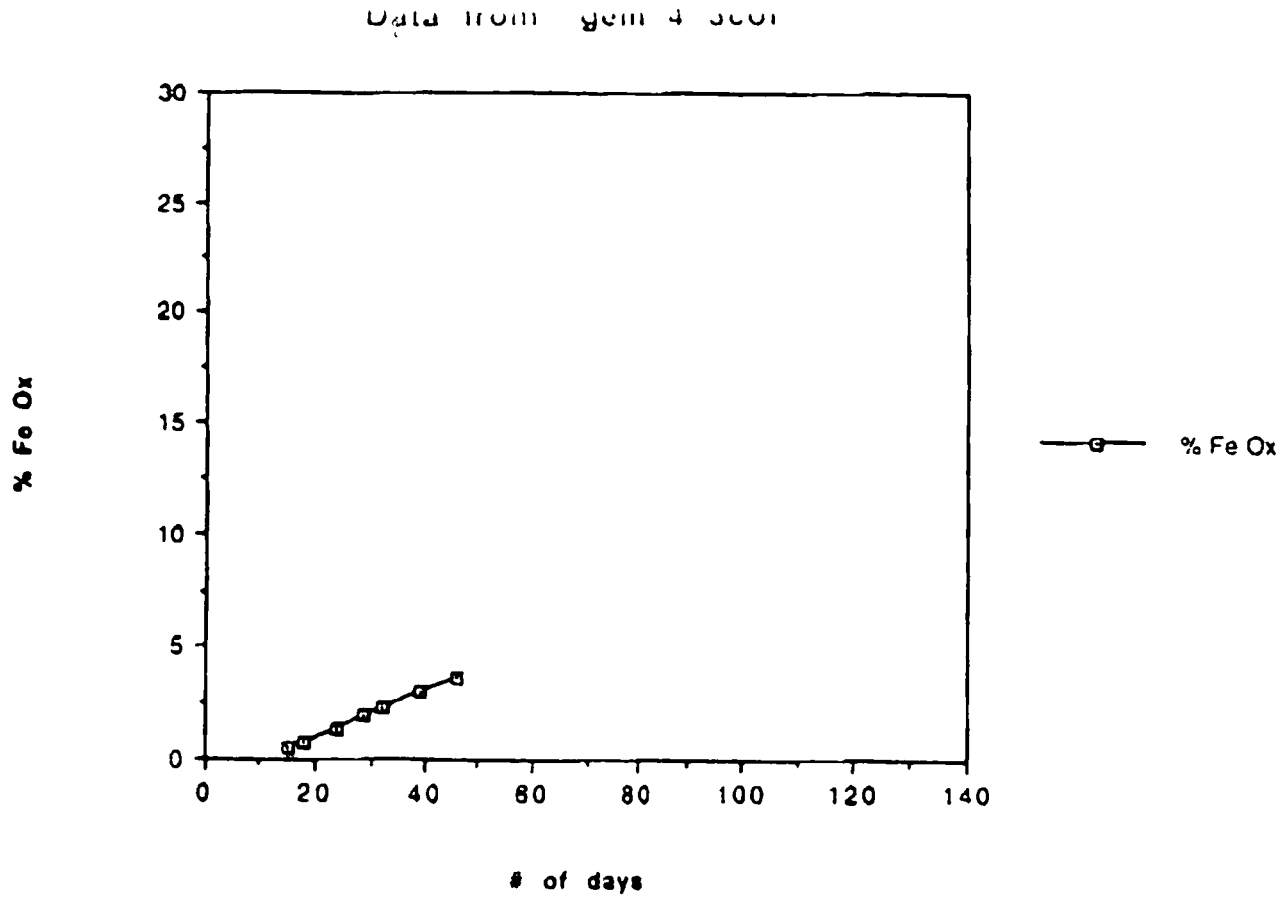
TO:

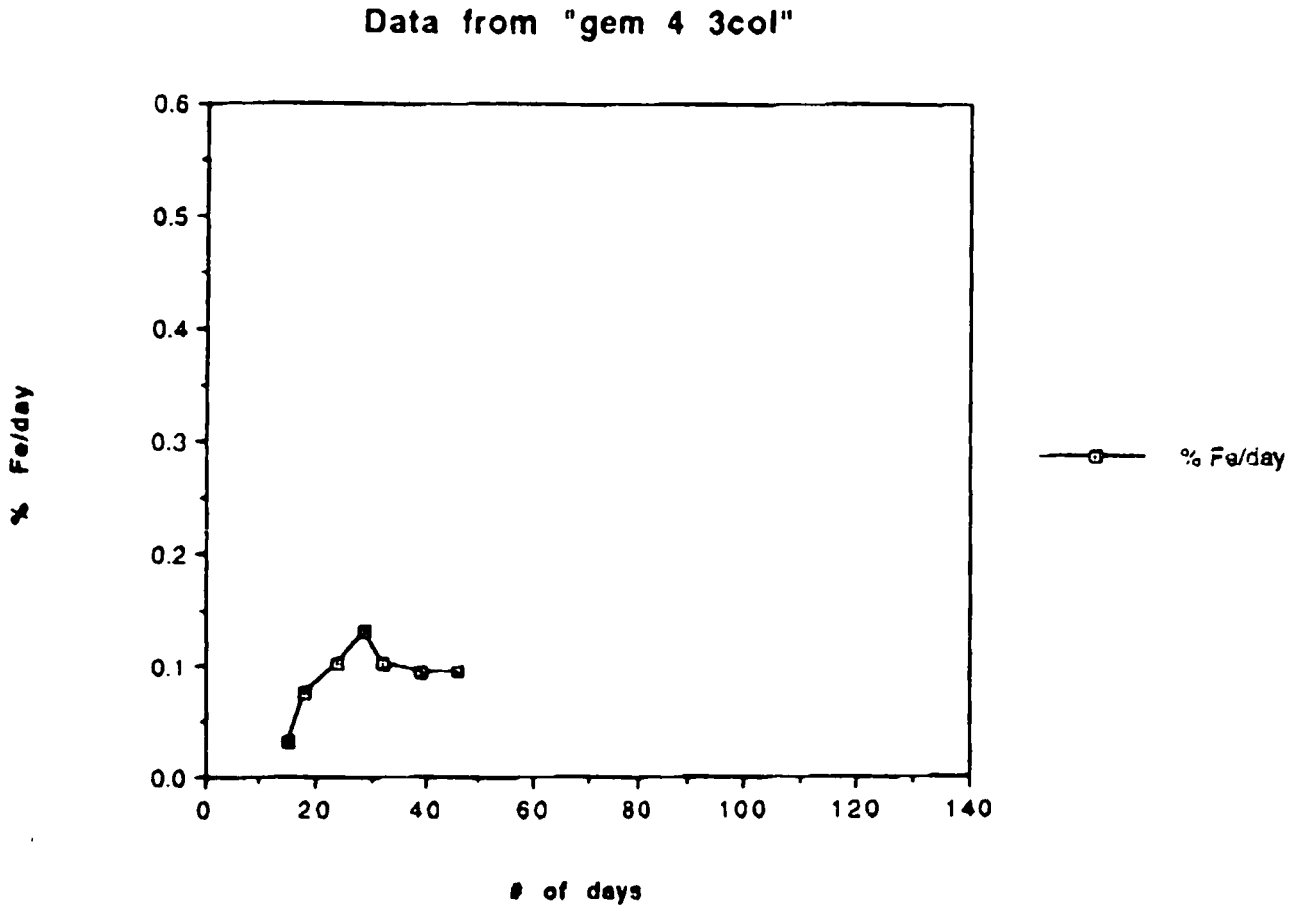
RECIPIENT: Jim Whitlock, Rod MacLeod

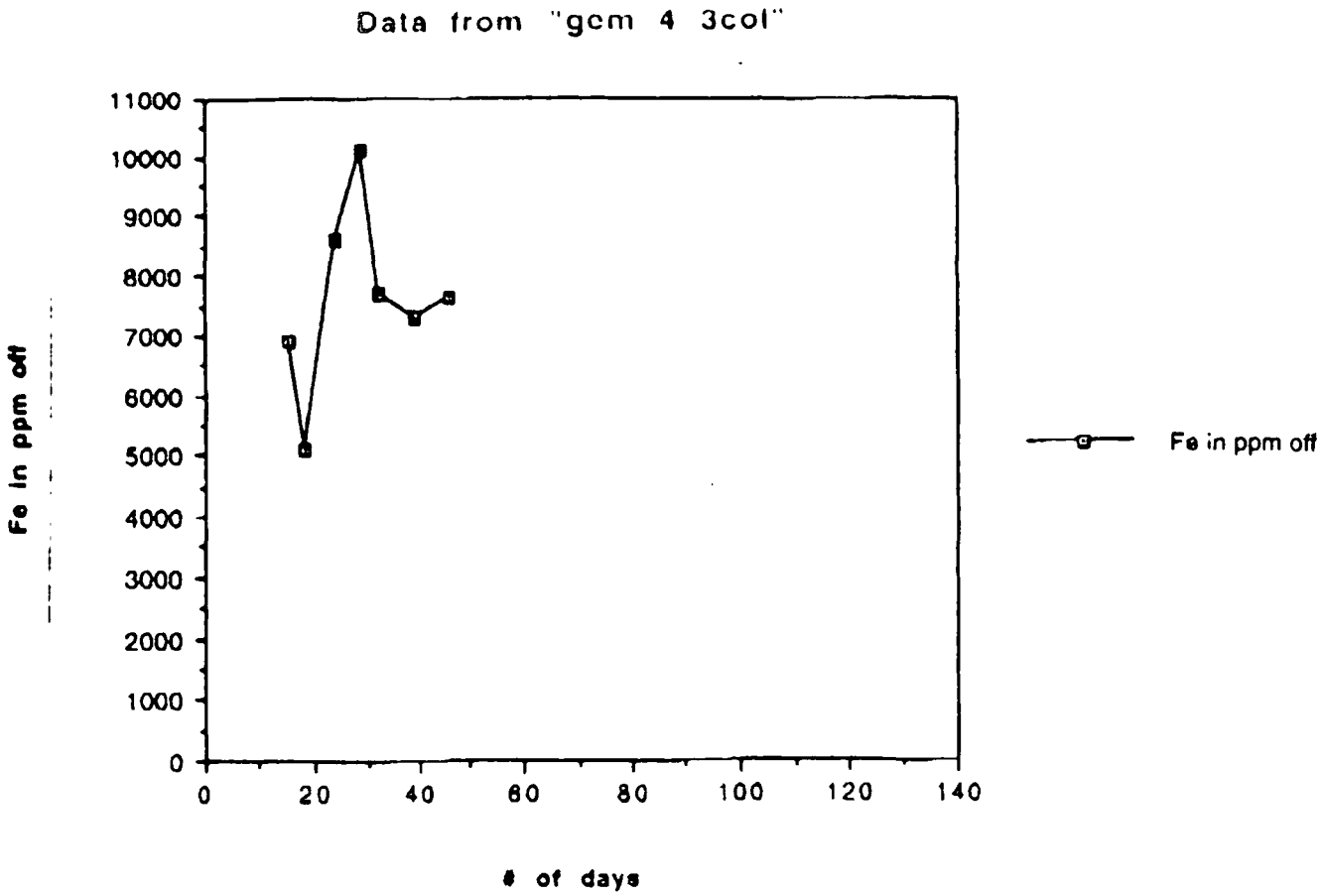
COMPANY: Jim Thompson, Laura Damon

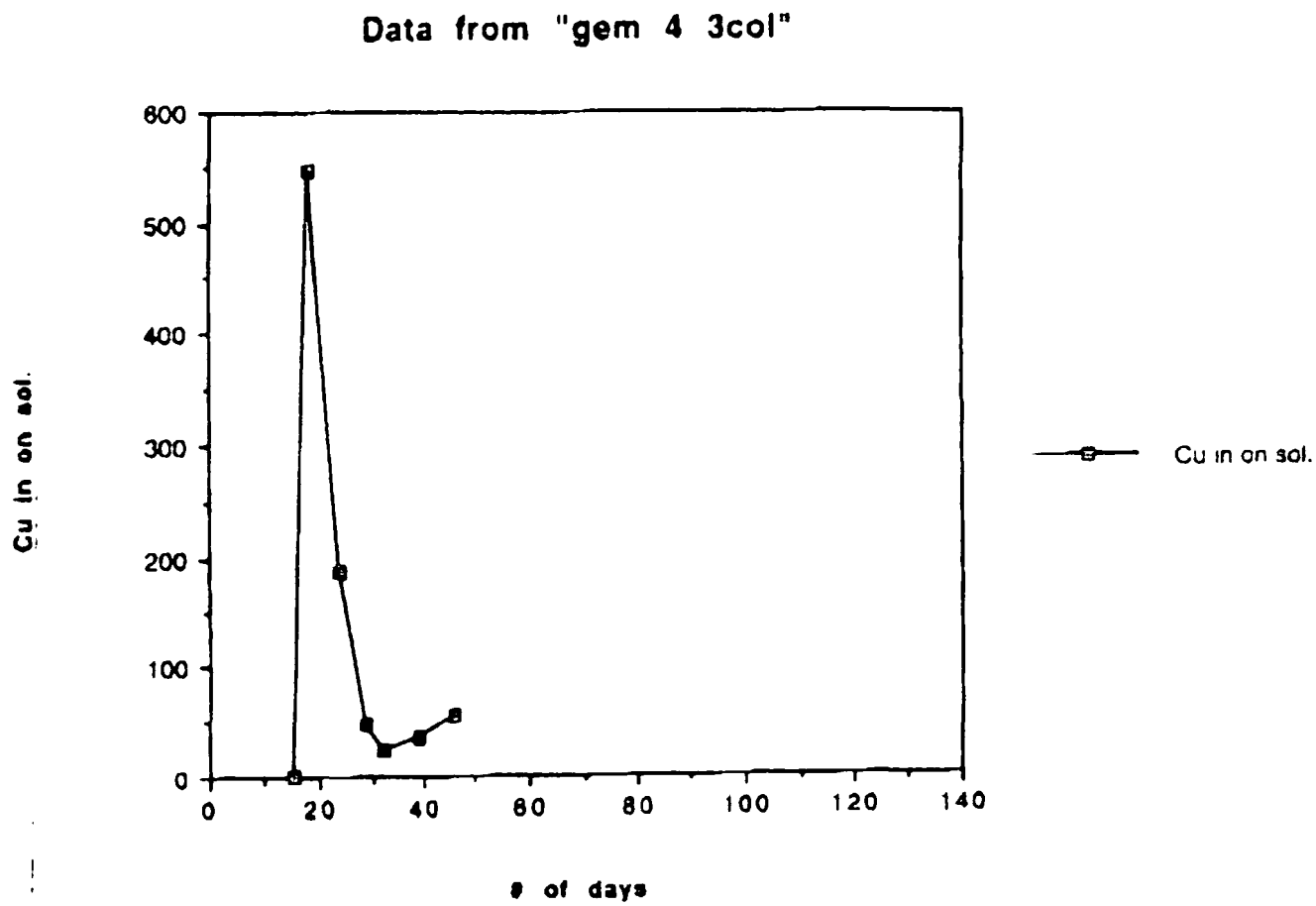
AT FAX: 1-605-578-1709

notes: Results as of 9-23 from the three column system. Note drop in rate about 10 days after start of recycled solution (8/26/94). Note last 2 columns do not have air. Rate goal is 0.1 %/day.


Data from "gem 4 3col"
% Fe Ox
# of days
% Fe Ox
0
5
10
15
20
25
30
0
20
40
60
80
100
120
140


Data from "gem 4 3col"
% Fe/day
# of days
% Fe/day
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0
20
40
60
80
100
120
140


Data from "gem 4 3col"
Fe in ppm off
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
0
20
40
60
80
100
120
140
# of days
Fe in ppm off


Data from "gem 4 3col"
Cu in on sol.
600
500
400
300
200
100
0
0
20
40
60
80
100
120
140
# of days
Cu in on sol.

	date	# of days	pH	Eh in V	vol rem.	vol r. /day	ml/cm/day
1	8/23/94	15	1.820	0.576	1160	74	1 900
2	8/26/94	18	1.770	0.590	740	247	6.400
3	9/1/94	24	1.680	0.614	1220	203	5 300
4	9/6/94	29	1.480	0.540	1000	200	5.200
5	9/9/94	32	1.490	0.507	640	213	5.600
6	9/16/94	39	1.600	0.542	1500	214	5.600
7	9/23/94	46	1.490	0.491	1330	190	5.000

	g Fe rem.	% Fe Ox	% Fe/day	Fe in ppm off	gal/ft/min	Cu in on sol.
1	8.036	0.470	0.0310	6928	0.00023	0.0
2	3.785	0.700	0.0770	5116	0.00078	548.0
3	10.541	1.320	0.1030	8640	0.00065	188.0
4	10.136	1.980	0.1320	10136	0.00063	47.8
5	4.935	2.290	0.1030	7712	0.00069	24.4
6	10.968	2.960	0.0957	7312	0.00069	36.8
7	10.182	3.620	0.0943	7656	0.00063	55.0

Note solution applied is 85% pH 5.5 limestone treated off solution plus 15% untreated off solution. First column has air other two do not. Eh of first column is running around 700 last column around 500. Expect rate of oxidation per day to increase in next few weeks.

GEOBIOTICS, INC.

3406 Breakwater Avenue
Hayward, CA 94545

510 783-9060
Fax 510 783-9069

September 8, 1994

To: Jim Whitlock
From: John Shield

Re: Thermocouple Data

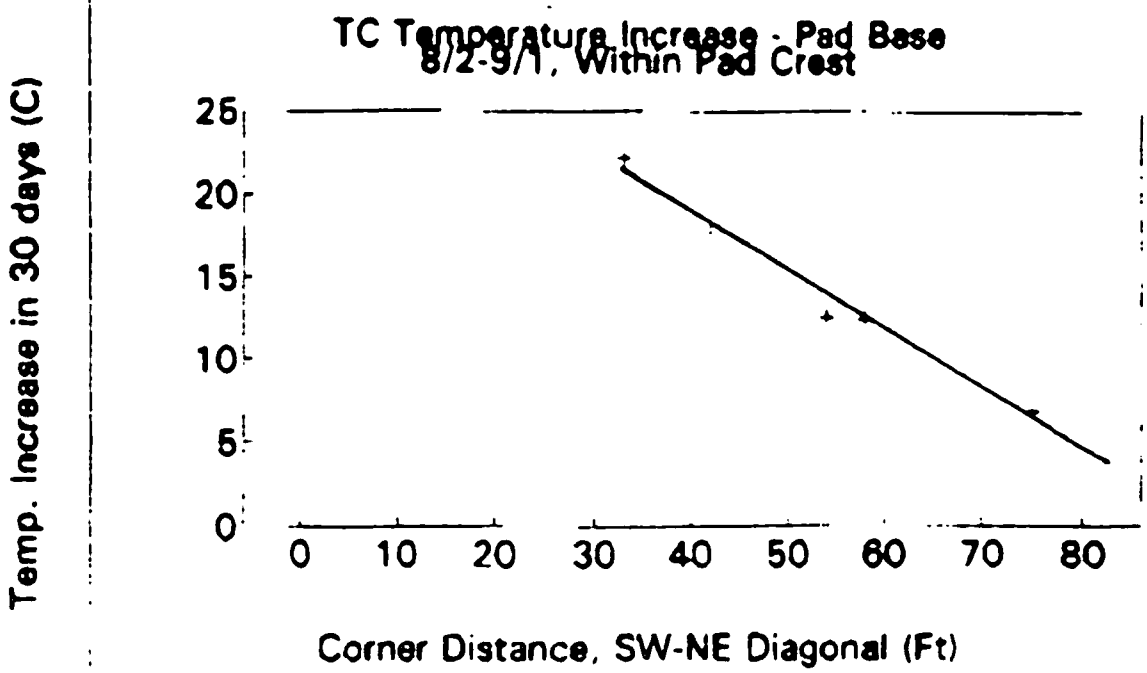
Enclosed are some plots of the increase in the temperatures at various thermocouples versus the location of the thermocouple within the heap.

In all these plots, the increase in temperature at a specific thermocouple is calculated as the difference between the temperature measured on 8/2 and 9/1/94. No corrections have been made.

Plot 1 examines the thermocouples that were placed at the base of the heap and are located within the pad base (i.e. not including the thermocouples under the slope of the heap). The greatest temperature increases are seen furthest from the center of the heap.

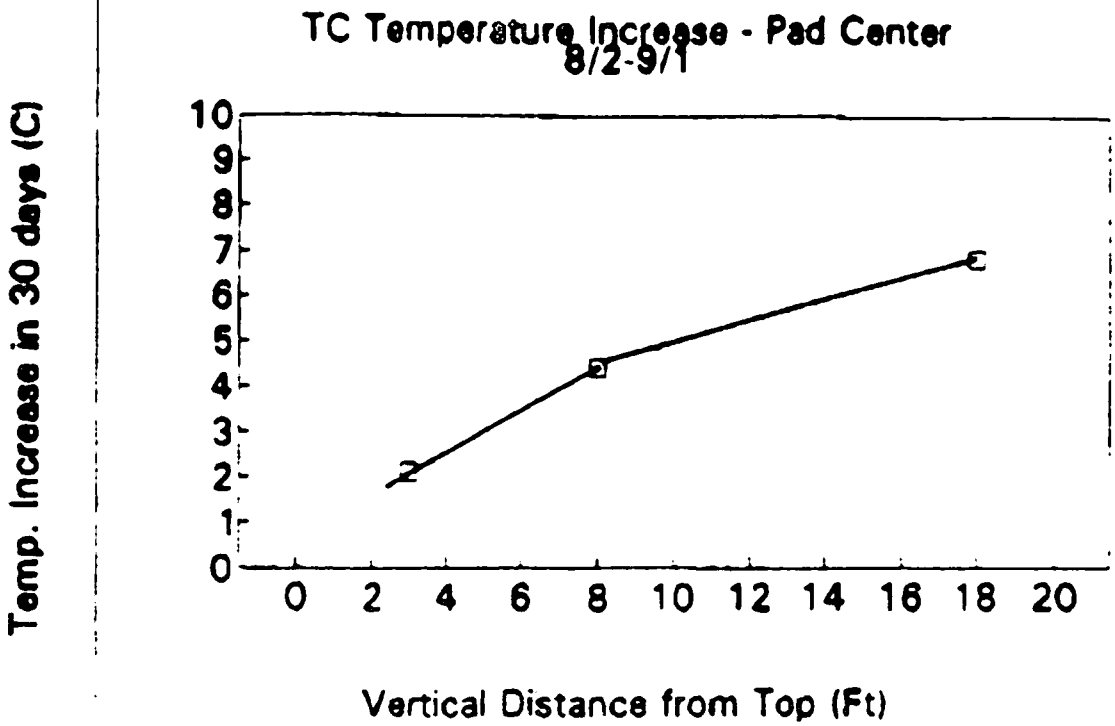
Plot 2 shows the changes in temperature vertically in the center of the pad. As depth into the pad increases, the temperature rise also increases. The same phenomena is seen for all the other thermocouples that were placed atop of one another vertically These are shown in plots 3 - 6.

Please share these plots with Jim Thompson and Laura Damon at Brohm. Thanks.

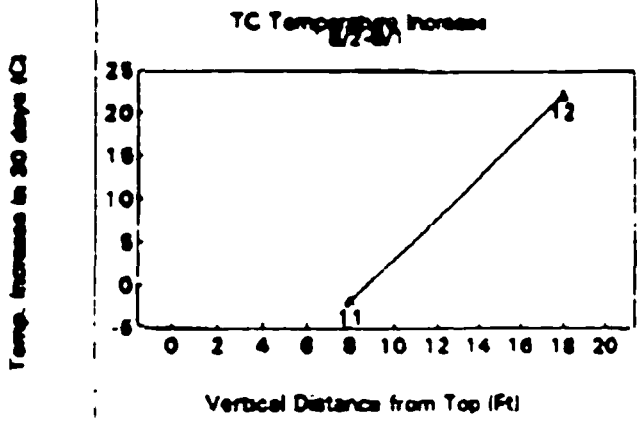

TC Temperature Increase - Pad Base
8/2-9/1, Within Pad Crest
Temp. Increase in 30 days (C)
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80
Corner Distance, SW-NE Diagonal (Ft)

1

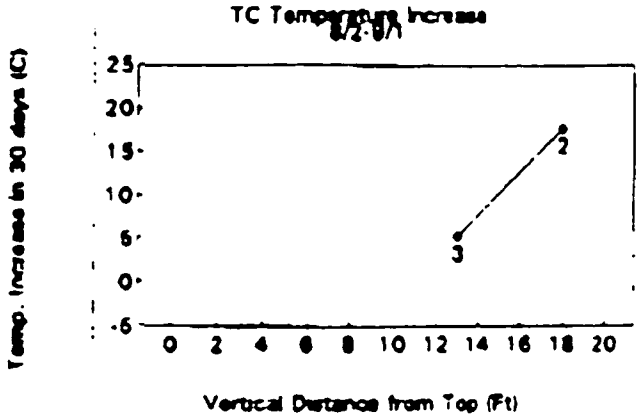
STOPPED


TC Temperature Increase - Pad Center
8/2-9/1
Temp. Increase in 30 days (C)
10
9
8
7
6
5
4
3
2
1
0
0
2
4
6
8
10
12
14
16
18
20
Vertical Distance from Top (Ft)

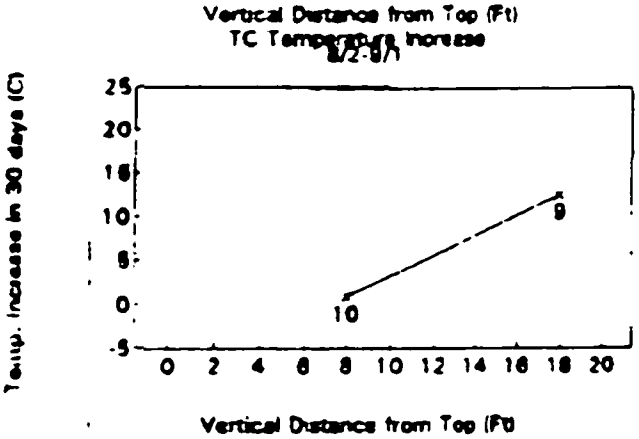
2


TC Temperature Increase
Temp. Increase in 30 days (C)
Vertical Distance from Top (Ft)

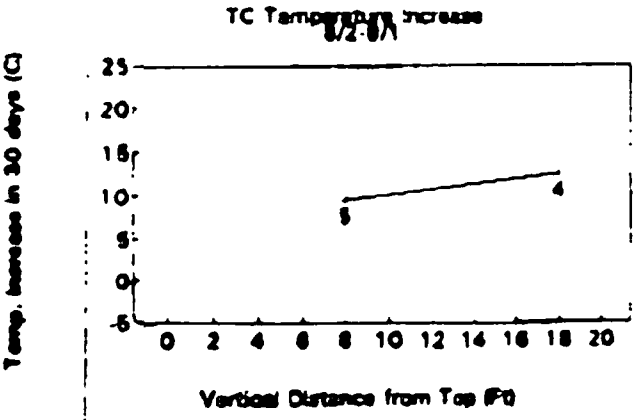
3


TC Temperature Increase
Temp. Increase in 30 days (C)
Vertical Distance from Top (Ft)

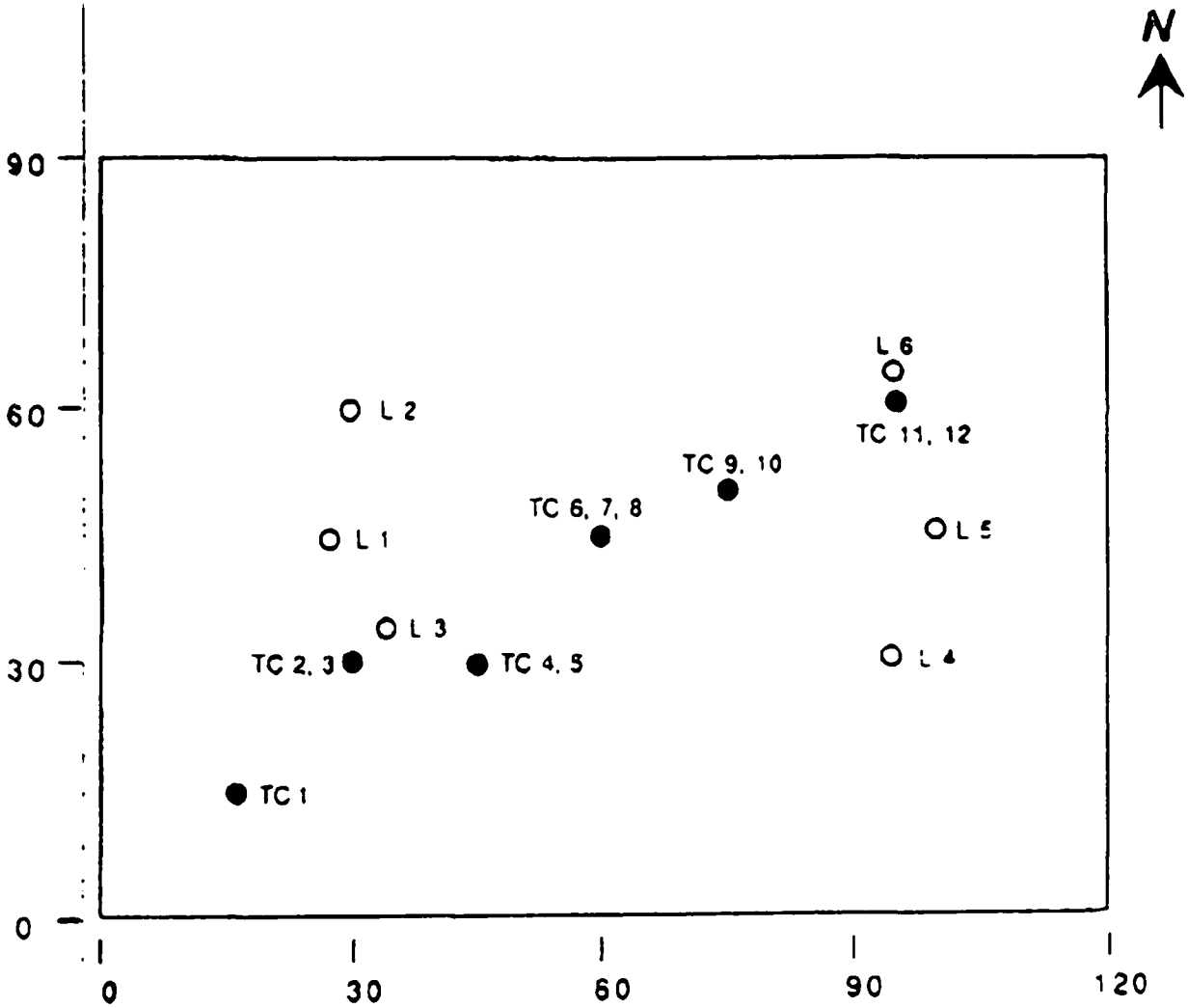
4


TC Temperature Increase
Temp. Increase in 30 days (C)
Vertical Distance from Top (Ft)

5


TC Temperature Increase
Temp. Increase in 30 days (C)
Vertical Distance from Top (Ft)

6



THERMOCOUPLES

TC 1	0'
TC 2	0'
TC 3	? Somewhere beteen 0 and 10'
TC 4	0'
TC 5	20'
TC 6	0'
TC 7	10'
TC 8	17' 3' below top
TC 9	0'
TC 10	10'
TC 11	10'
TC 12	0'

LYSIMETERS

L 1	6'
L 2	1'
L 3	1'
L 4	1'
L 5	6'
L 6	1'

Version 4
8/25/94

MEMORANDUM

DATE: NOVEMBER 18, 1994
TO: JIM THOMPSON
FROM: LAURA DAMON
SUBJECT: BIOOXIDATION BULK TEST (BBT) WEEKLY UPDATE (16)

The BBT has been on the biooxidation cycle for sixteen weeks now. Both the west and east sides are on simultaneous solution application. The OFF solution continues to flow into the sump area and is then pumped to a 300 gallon tank holding the ON solution pump. A flow meter is located after the ON solution pump. 11,000 gallons per day totalization was again used in the daily log sheet this week since the flow meter readings were questionable. The heap remains stable and intact.

A conference call was held between Brohm and Geobiotics personnel on Tuesday, November 15th. It was decided to discharge all solution from the test heap as soon as possible and let any precipitation rinse the heap. Bill Kohr feels that the ferric iron levels may be inhibiting the bacteria. (5,000-10,000 ppm being the optimal concentration of Fe^{3+}.) Gallons of solution discharged will be kept track of and composite samples will be collected for assay purposes. Geobiotics personnel are re-running 9 bottle roll samples (Auger Drill-3) that had a wide variability in gold extraction results (See attached memo). A SP2 Composite control sample split was sent to McClelland for a Geobiotics bottle roll. We will rerun the sample to compare gold extraction percentages.

The total iron concentration rose to 15,000+ ppm this week. The iron continues to be predominantly in the form of ferric iron. The copper values have stabilized in the 1700 ppm range. The pH of the OFF solution is in the 1.8 range and the oxidation/reduction potential has an eh range of 550+. The sulfate concentration has risen this week as has the acidity.

Auger drill-4 samples were collected on Thursday, November 10th. The samples are being bottle rolled this week for gold extraction. Splits of the samples were sent to Geobiotics and McClelland Labs for comparison bottle rolls.

c: Rod MacLeod
Martin Quick
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November 14, 1994

FAX Transmittal Cover Page

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Number of Pages (including cover page): 3

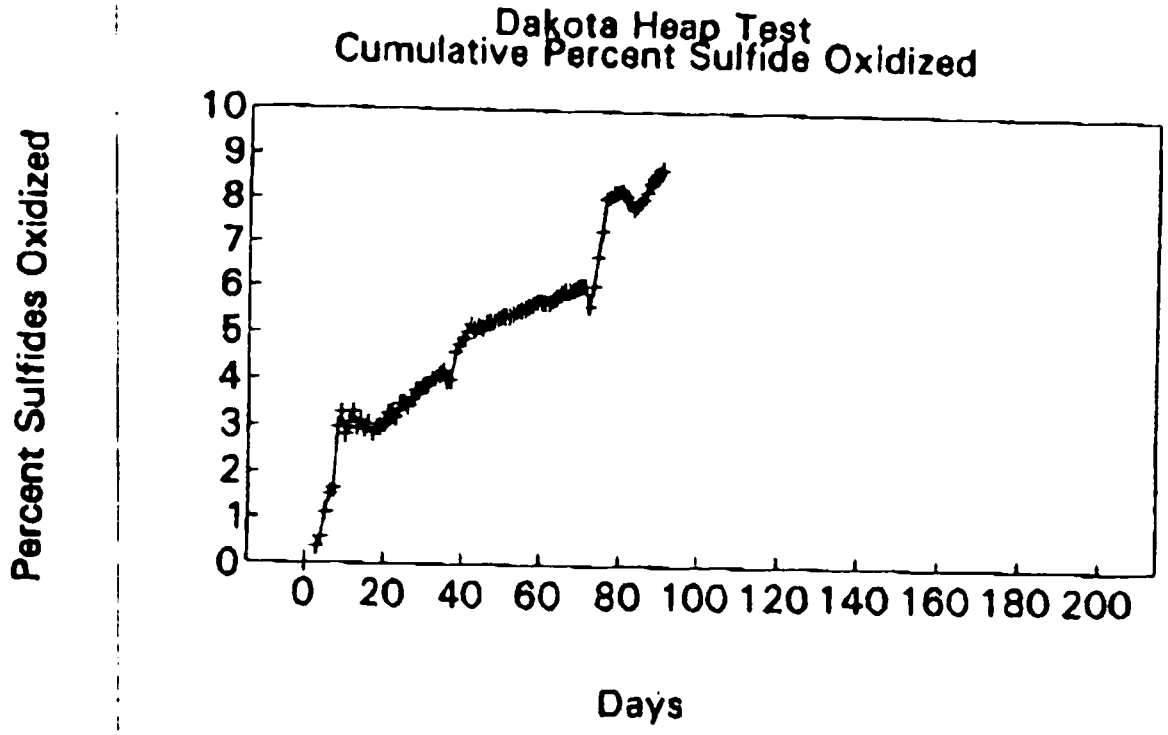
As you know the % sulfide numbers in the SP2 sample and the various core samples have been scattered. So, I have been working on calculating the extent of biooxidation by looking at the amount of sulfates generated. For all practical purposes, all the sulfates have been caused by the oxidation of sulfides. Sulfates that have been generated are either in the circulating solution or have been removed as $CaSO_4$ (gypsum) during neutralization. Any gypsum that has been formed within the heap cannot be measured now, consequently a extent of biooxidation calculation using sulfate generation will be low.

I calculated amounts of sulfates generated by taking the ppm of the sulfates in the circulating solution and multiplying by an estimate of the number of gallons circulating within the heap. This estimate has been on the order of 110 to 140 thousand gallons of water.

My calculation for the amount of sulfates removed during neutralization is more convoluted. I have been keeping a good track of the amount of copper removed. I used the lab result that 25 g of $CaCO_3$ was used for each liter of water neutralized. I used 1500 ppm as the average copper level in the water before treated. Knowing how much copper has been removed and using the 1500 ppm Cu per liter I can calculate the number of liters of water that has been treated. Knowing the number of liters, I can calculate the grams of $CaCO_3$ consumed. Then I assumed that each mole of Ca precipitated a mole of SO_4. Summing the amount of sulfates in solution and the sulfates precipitated gives the total sulfates removed.

To figure extent biooxidation, I used 4780 tons of ore at 5.23% S as the starting level for sulfur. The calculation is shown in the first graph. It appears as though we are about 8% biooxidized.

Going back to our shake flask results from the spring, an 8% biooxidation should add about 10 points to recovery.


Dakota Heap Test
Cumulative Percent Sulfide Oxidized
Percent Sulfides Oxidized
0
1
2
3
4
5
6
7
8
9
10
0
20
40
60
80
100
120
140
160
180
200
Days

The variability that we are seeing between samples, and the inconsistencies in recovery and sulfide levels points to some problem in our analytical approach. Ore heterogeneity is one possible explanation. The variability in fire assay and the resulting influence on recovery calculation is another possibility. Another possibility is gypsum formation in the bottle roll sample. We know that biooxidation produces passage ways within pyrite crystals, usually along weaknesses caused by impurities (like Au) in the pyrite crystal. In a biooxidized sample, there is probably a lot of sulfate ions and when the sample is treated with lime the resulting $CaSO_4$ may precipitate out and prevent CN access to the exposed Au.

Anyway here are the McClelland and GBI bottle roll results:

Sample		Extraction McClelland	Extraction GBI	Extraction Brohm	Mc-GBI Delta	Br-GBI Delta	Br-McC Delta
W 1-5	1	53.7	55.6		-1.9		
W 5-10	2	51	51.5		-0.5		
W 10-15	3	50	46.9	56.6	3.1	9.7	6.6
M 1-5	4	61.4	48.3		13.1		
M 5-10	5	55.4	57.6		-2.2		
M 10-15	6	52.8	48.8	56.5	4	7.7	3.7
E 1-5	7	57.4	47.8		9.6		
E 5-10	8	54.9	49.6		5.3		
E 10-15	9	61	51.5	59.2	9.5	7.7	-1.8
AVG West	10	51.6	51.3		0.23		
AVG Mid	11	56.5	51.6		4.97		
AVG East	12	57.8	49.6		8.13		
AVG 1-5'	13	57.5	50.6		6.93		
AVG 5-10'	14	53.8	52.9		0.87		
AVG 10-15'	15	54.6	49.1		5.53		
Total AVG	16	55.3	50.8	57.4	4.44	6.6	2.1
Composite	17			57.1			

Let us try to get together on the phone at 1 PM your time (12 noon) Pacific time.

11/15/94 Geobiotics re-do 9 BR with 500g Washed Ore Variability makes hard to make any determinations.

JT
JW
LLD
OM
BK
JS
RC

* Send SP2 Split to McClelland (SP2 Comp Bulk Density)

5,000-10,000 ppm Fe^{3+} optimum;

Discard solution and let any precipitation rinse.

* Compare BR Procedures Brohm and McClelland

BIOOXIDATION BULK TEST SOLUTION SAMPLING

OFF SOLUTION

Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	DO (ppm)
SUMP-GRAB	07/26/94	1200	1200	7.22	-	.84	.27	-	-	-	-	-
GRAB-1530	07/27/94	1750	2950	7.53	305.4	.89	.20	-	-	-	-	-
COMP	07/28/94	3000	5950	5.93	353.6	83	.55	-	-	83	4411	-
COMP	07/29/94	3293	9243	5.49	282.1	255	13	-	-	362	5094	-
COMP	07/30/94	4419	13662	5.11	285.7	654	14	-	-	994	7913	-
COMP	07/31/94	2688	16350	5.18	318.8	960	11	-	-	956	9835	-
COMP	08/01/94	7822	24172	4.20	332.3	990	39	1	38	2438	11106	-
COMP	08/02/94	21836	46008	3.39	429.6	1930	172	2	170	8960	18304	-
COMP	08/03/94	14710	60718	3.43	360.1	2050	520	260	260	10520	21678	-
COMP	08/04/94	7500	68218	3.36	344.2	1750	500	410	90	8967	18731	-
COMP	08/05/94	6821	75039	2.50	503.7	1870	480	40	440	11633	20711	-
COMP	08/06/94	21396	96436	2.45	465.2	1940	1530	200	1330	14570	23591	-
COMP	08/07/94	21396	117832	2.63	435.8	1770	1110	190	920	12617	20727	-
COMP	08/08/94	18698	136530	2.40	484.6	1800	1390	160	1230	13259	22299	-
COMP	08/09/94	21118	157648	2.36	557.4	1690	1070	36	1034	11904	21180	-
COMP	08/10/94	16419	174067	2.31	491.4	1760	1320	220	1100	12958	22052	-
COMP	08/11/94	16500	190567	2.29	524.4	1580	1290	86	1204	12958	21764	-
COMP	08/12/94	18213	208780	2.28	523.1	1630	1520	56	1464	13452	22729	1.3
COMP	08/13/94	18585	227365	2.34	500.2	1630	1420	240	1180	13361	22995	1.3
COMP	08/14/94	16646	244011	2.29	472.4	1680	1490	380	1110	13608	23458	-
COMP	08/15/94	13559	257570	2.31	522.4	1700	1110	84	1026	13179	23381	-
COMP	08/16/94	12267	269837	2.36	496.4	1670	1540	196	1344	14831	23933	1.4
COMP	08/17/94	7697	277534	2.49	481.4	1600	1160	43	1117	13309	23711	2.2
COMP	08/18/94	7136	284670	2.39	650.1	1790	1100	480	620	13839	25735	1.7
COMP	08/19/94	13078	297748	2.13	663.0	1680	2450	690	1760	16703	27554	-
COMP	08/20/94	14479	312227	2.02	672.0	1620	2550	670	1880	16716	27464	-
COMP	08/21/94	14213	326440	2.18	678.3	1660	2900	770	2130	18024	29200	-
COMP	08/22/94	14246	340686	2.16	631.0	1800	3160	75	3085	-	-	-
COMP	08/23/94	13868	354554	2.11	671.3	1740	3210	73	3137	19568	31299	-
COMP	08/24/94	12742	367296	2.09	604.1	1760	3540	82	3458	-	-	.7
COMP	08/25/94	11741	379037	2.11	646.9	1730	3640	86	3554	20823	33471	5.5?
COMP	08/26/94	12505	391542	2.19	687.1	1810	3860	86	3774	22006	34443	OFL
COMP	08/27/94	11272	402814	2.27	689.5	1770	4000	94	3906	22374	35035	-
COMP	08/28/94	9000	411814	2.21	688.0	1800	4000	82	3918	23319	35858	-
COMP	08/29/94	9000	420814	2.10	688.2	1860	4370	86	4284	-	-	OFL
COMP	08/30/94	11403	432217	2.17	685.5	1710	4030	84	3946	22242	35134	13.5?
COMP	08/31/94	10726	442943	-	-	-	-	-	-	-	-	OFL
COMP	09/01/94	10299	453242	1.94	669.9	1710	4840	89	4751	25577	39562	OFL
COMP	09/02/94	9075	462317	-	-	-	-	-	-	-	-	3.9
COMP	09/03/94	8149	470466	-	-	-	-	-	-	-	-	-
COMP	09/04/94	7612	478078	-	-	-	-	-	-	-	-	-
COMP	09/05/94	7357	485435	2.11	663.7	1870	5550	120	5430	29017	47141	-
COMP	09/06/94	6870	492305	2.09	682.9	1870	6010	151	5859	29543	45273	3.5
COMP	09/07/94	6503	498808	-	-	-	-	-	-	-	-	6.2
COMP	09/08/94	10447	509255	2.00	693.8	1760	6010	117	5893	30304	46121	5.5
COMP	09/09/94	8553	517808	-	-	-	-	-	-	-	-	5.5
COMP	09/10/94	8424	526232	-	-	-	-	-	-	-	-	-
COMP	09/11/94	8424	534656	2.01	677.7	1800	6100	114	5986	31157	46376	-
COMP	09/12/94	7258	541914	-	-	-	-	-	-	-	-	-
COMP	09/13/94	6630	548544	2.08	683.7	1800	6600	151	6449	32657	48154	2.8
COMP	09/14/94	7479	556023	-	-	-	-	-	-	-	-	2.6
COMP	09/15/94	11492	567515	1.97	685.6	1740	7000	142	6858	33989	49372	4.6
COMP	09/16/94	11244	578759	-	-	-	-	-	-	-	-	2.8
COMP	09/17/94	11287	590046	-	-	-	-	-	-	-	-	-
COMP	09/18/94	10435	600481	2.03	684.0	1760	7300	134	7166	35825	51363	-
COMP	09/19/94	9531	610012	-	-	-	-	-	-	-	-	2.5
COMP	09/20/94	6175	616187	2.01	593.5	1820	7000	134	6866	34241	51265	2.8

BIOOXIDATION BULK TEST SOLUTION SAMPLING

OFF SOLUTION

Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	DO (ppm)
COMP	09/22/94	5238	626486	1.95	576.7	1800	6800	171	6629	36579	52376	3.5
COMP	09/23/94	6073	632559	-	-	-	-	-	-	-	-	3.2
COMP	09/24/94	9286	641845	-	-	-	-	-	-	-	-	-
COMP	09/25/94	9592	651437	1.91	552.0	1650	7730	250	7480	38565	54096	-
COMP	09/26/94	7385	658822	-	-	-	-	-	-	-	-	2.8
COMP	09/27/94	9119	667941	-	-	-	-	-	-	-	-	3.5
COMP	09/28/94	7789	675730	1.93	571.8	1730	7700	230	7470	38690	55742	-
COMP	09/29/94	7387	683117	1.85	547.2	1720	7900	270	7630	40150	55898	-
COMP	09/30/94	7807	690924	-	-	-	-	-	-	-	-	3.2
COMP	10/01/94	6502	697426	-	-	-	-	-	-	-	-	-
COMP	10/02/94	6502	703928	1.92	560.7	1730	7100	210	6890	40202	57552	-
COMP	10/03/94	6231	710159	-	-	-	-	-	-	-	-	4.2
COMP	10/04/94	6834	716993	1.80	591.1	1700	8100	210	7890	40383	58458	4.5
COMP	10/05/94	6911	723904	-	-	-	-	-	-	-	-	4.5
COMP	10/06/94	28493	752396	1.99	557.3	1270	6550	170	6380	30663	43932	5.7
COMP	10/07/94	22817	775213	-	-	-	-	-	-	-	-	-
COMP	10/08/94	19403	794616	-	-	-	-	-	-	-	-	-
COMP	10/09/94	21196	815812	1.90	501.8	1710	8600	610	7990	41883	58178	-
COMP	10/10/94	17200	833012	-	-	-	-	-	-	-	-	2.8
COMP	10/11/94	11500	844512	1.90	492.7	1710	8300	890	7410	43442	59840	2.4
COMP	10/12/94	17000	861512	-	-	-	-	-	-	-	-	-
COMP	10/13/94	18300	879812	1.85	515.7	1720	8700	460	8240	44220	60408	2.1
COMP	10/14/94	15800	895612	-	-	-	-	-	-	-	-	2.0
COMP	10/15/94	16500	912112	-	-	-	-	-	-	-	-	-
COMP	10/16/94	20700	932812	1.79	520.7	1580	6600	300	6300	42146	57873	-
COMP	10/17/94	24500	957312	-	-	-	-	-	-	-	-	2.1
COMP	10/18/94	20500	977812	1.70	514.3	1620	9700	410	9290	44826	59766	2.2
COMP	10/19/94	14300	992112	-	-	-	-	-	-	-	-	2.0
COMP	10/20/94	7750	999862	1.73	493.7	1700	10400	630	9770	47772	62737	2.4
COMP	10/21/94	11600	1011462	-	-	-	-	-	-	-	-	2.5
COMP	10/22/94	9400	1020862	-	-	-	-	-	-	-	-	-
COMP	10/23/94	10000	1030862	1.92	569.0	1770	11100	260	10840	46976	65675	-
COMP	10/24/94	13030	1043892	-	-	-	-	-	-	-	-	2.7
COMP	10/25/94	14262	1058154	1.84	536.9	1750	11500	370	11130	49948	66992	2.2
COMP	10/26/94	14397	1072551	1.82	528.8	1660	11700	430	11270	-	67280	2.4
COMP	10/27/94	11874	1084425	1.82	527.6	1710	12500	430	12070	51833	68663	2.4
COMP	10/28/94	11000	1095425	1.86	522.4	1750	12000	430	11570	-	68992	2.8
COMP	10/29/94	10207	1105632	1.83	521.9	1770	12300	430	11870	-	69362	-
COMP	10/30/94	11000	1116632	1.88	559.8	1720	12600	290	12310	51344	70367	-
COMP	10/31/94	11000	1127632	1.90	555.7	1780	12800	310	12490	50208	71099	3.6
COMP	11/ 1/94	11000	1138632	1.83	647.6	1760	13300	260	13040	51667	71354	3.2
COMP	11/ 2/94	11000	1149632	1.85	569.8	1620	13900	300	13600	-	75222	-
COMP	11/ 3/94	11000	1160632	1.83	579.3	1700	13300	260	13040	53189	73008	3.0
COMP	11/ 4/94	10589	1171221	1.80	608.0	1750	13500	260	13240	-	73527	-
COMP	11/ 5/94	10589	1181810	-	-	-	-	-	-	-	-	-
COMP	11/ 6/94	11000	1192810	1.79	544.0	1720	12900	360	12540	55114	74235	-
COMP	11/ 7/94	11000	1203810	1.8	595.1	1710	13900	310	13590	-	73165	-
COMP	11/ 8/94	11000	1214810	1.79	695.8	1730	13100	360	12740	54027	73593	2.9
COMP	11/ 9/94	11539	1226349	1.84	540.8	1730	12900	380	12520	-	75329	2.9
COMP	11/10/94	11167	1237516	1.78	559.2	1780	12600	360	12240	57375	76457	2.8
COMP	11/11/94	11000	1248516	1.87	550.4	1770	15000	360	14640	-	76646	-
COMP	11/12/94	11000	1259516	1.88	544.6	1740	15200	380	14820	-	76720	-
COMP	11/13/94	11000	1270516	1.93	579.4	1300	14300	250	14050	65861	81057	-
COMP	11/14/94	11000	1281516	1.95	578.2	1220	12300	210	12090	-	73765	-
COMP	11/15/94	11000	1292516	1.77	570.8	1740	14800	340	14460	59030	79329	3.3

BIOOXIDATION BULK TEST SOLUTION SAMPLING

PAN LYSIMETER 3

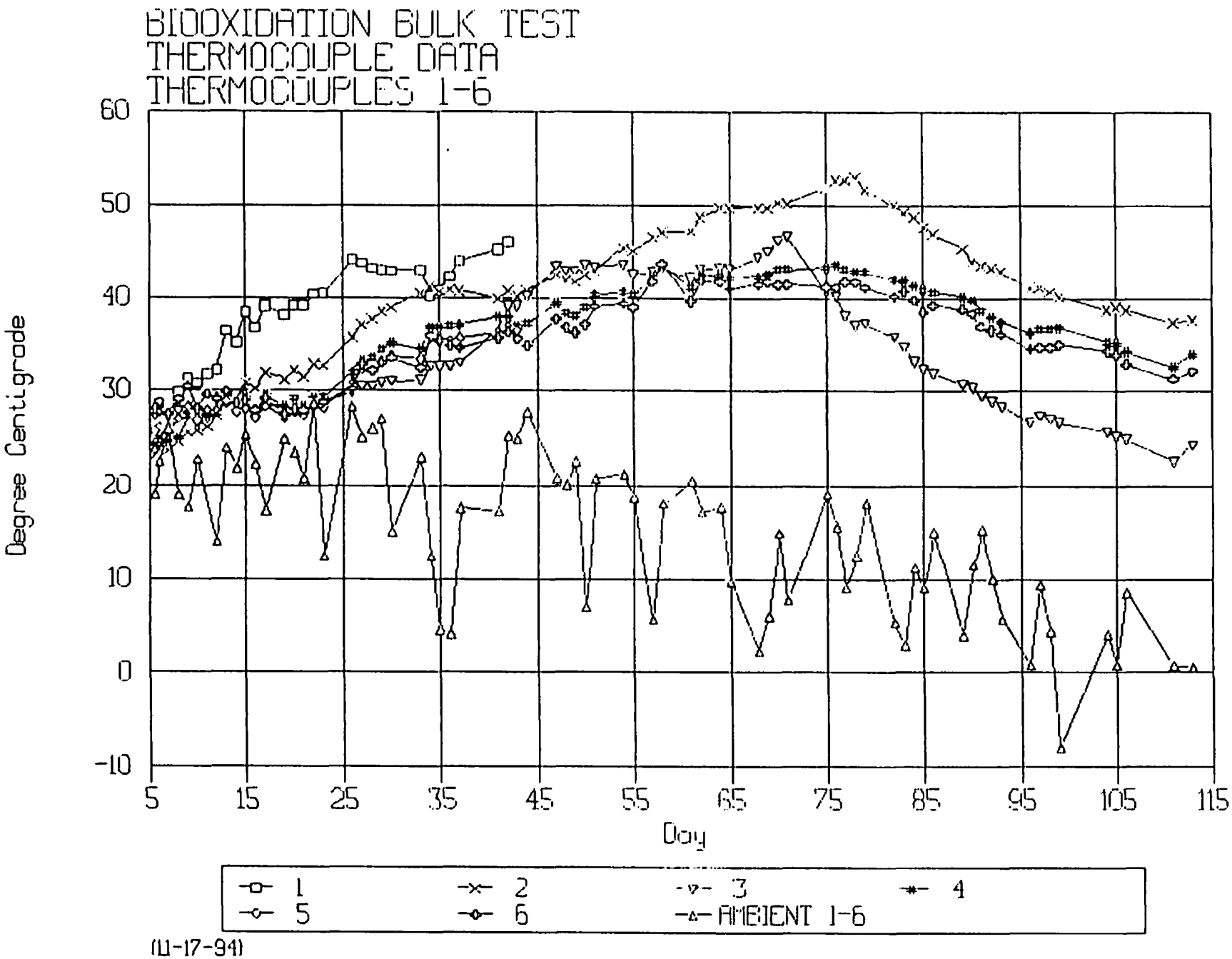
Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO (ppm)
GRAB	08/03/94	1.93	488.4	1540	4640	1200	3440	20005	23896	-	
GRAB	08/11/94	1.52	496.1	3200	8700	2900	5800	-	-	Brown/Murky	
GRAB	08/12/94	1.89	450.4	2200	3900	2100	1800	-	27461	Lt Brown	1.5
GRAB	08/15/94	1.92	459.5	2170	3920	1270	2650	15417	27625	Med Brown	1.7
GRAB	08/17/94	1.97	462.7	1940	3220	560	2660	19502	25159	Med Brown	2.4
GRAB	08/19/94	2.00	458.4	1850	2300	1400	900	17828	23604	-	-
GRAB	08/22/94	1.90	464.0	1760	2300	360	1940	16677	23744	Grw/Br Ti	1.9
GRAB	08/24/94	2.04	468.5	1780	2680	770	1910	16795	23028	Green	.9
GRAB	08/26/94	2.05	479.6	1730	2700	690	2010	17030	24320	Br-Yel	4.5?
GRAB	08/29/94	2.08	472.8	1770	2760	360	2400	17936	25167	Yel-Br	OFL
GRAB	09/01/94	1.79	472.3	1870	2730	730	2000	19039	26822	Green	OFL
GRAB	09/06/94	1.83	492.1	1940	2620	210	2410	19748	30237	Lt Green	2.5
GRAB	09/08/94	1.80	488.8	1980	2870	300	2570	21454	30435	Dk Green	4.3
GRAB	09/13/94	1.68	499.7	2040	3310	510	2800	22662	32648	Gr;cldy	0.9
GRAB	09/20/94	1.66	494.8	2000	3930	300	3630	24512	33471	Lt Green	1.4
GRAB	09/22/94	1.56	481.2	1980	4250	770	3480	26724	34796	Gr-Br	1.6
GRAB	09/27/94	1.66	487.7	1920	3820	460	3360	24512	34253	Gr;cldy	1.8
GRAB	09/29/94	1.73	498.0	2070	3820	460	3360	25972	37735	Green	2.3
GRAB	10/04/94	1.63	504.6	2320	3710	330	3380	30067	42385	Gr;cldy	2.9
GRAB	10/06/94	1.66	496.1	2500	3880	440	3440	32530	46919	Gr;cldy	4.9
GRAB	10/11/94	1.63	508.9	2550	5630	430	5200	39606	54458	Br;cldy	3.9
GRAB	10/13/94	1.49	485.7	2400	6370	1020	5350	43658	57709	Gr-Brown	1.9
GRAB	10/18/94	1.52	469.2	2180	7050	1660	5390	43101	47232	Gr-Brown	2.8
GRAB	10/20/94	1.59	478.9	1940	7650	1230	6420	43738	59454	Br;cldy	3.4
GRAB	10/25/94	1.89	556.7	1800	11500	270	11230	50081	67083	Dk Br;ppt	2.1
GRAB	10/27/94	1.82	532.0	1710	11500	380	11120	50161	67486	Br;cldy	2.3
GRAB	11/01/94	1.79	489.8	1790	11100	960	10140	48749	68860	Milky Br	2.0
GRAB	11/03/94	1.67	479.7	1730	11400	1510	9890	50028	68605	Br;cldy	1.5
GRAB	11/08/94	1.74	498.1	1750	12700	860	11840	50518	70087	Br;cldy	2.2
GRAB	11/10/94	1.80	487.7	1710	10500	1270	9230	50891	70613	Br;cldy	1.8
GRAB	11/15/94	1.83	499.0	1700	13100	800	12300	53732	73379	Br;cldy	2.2

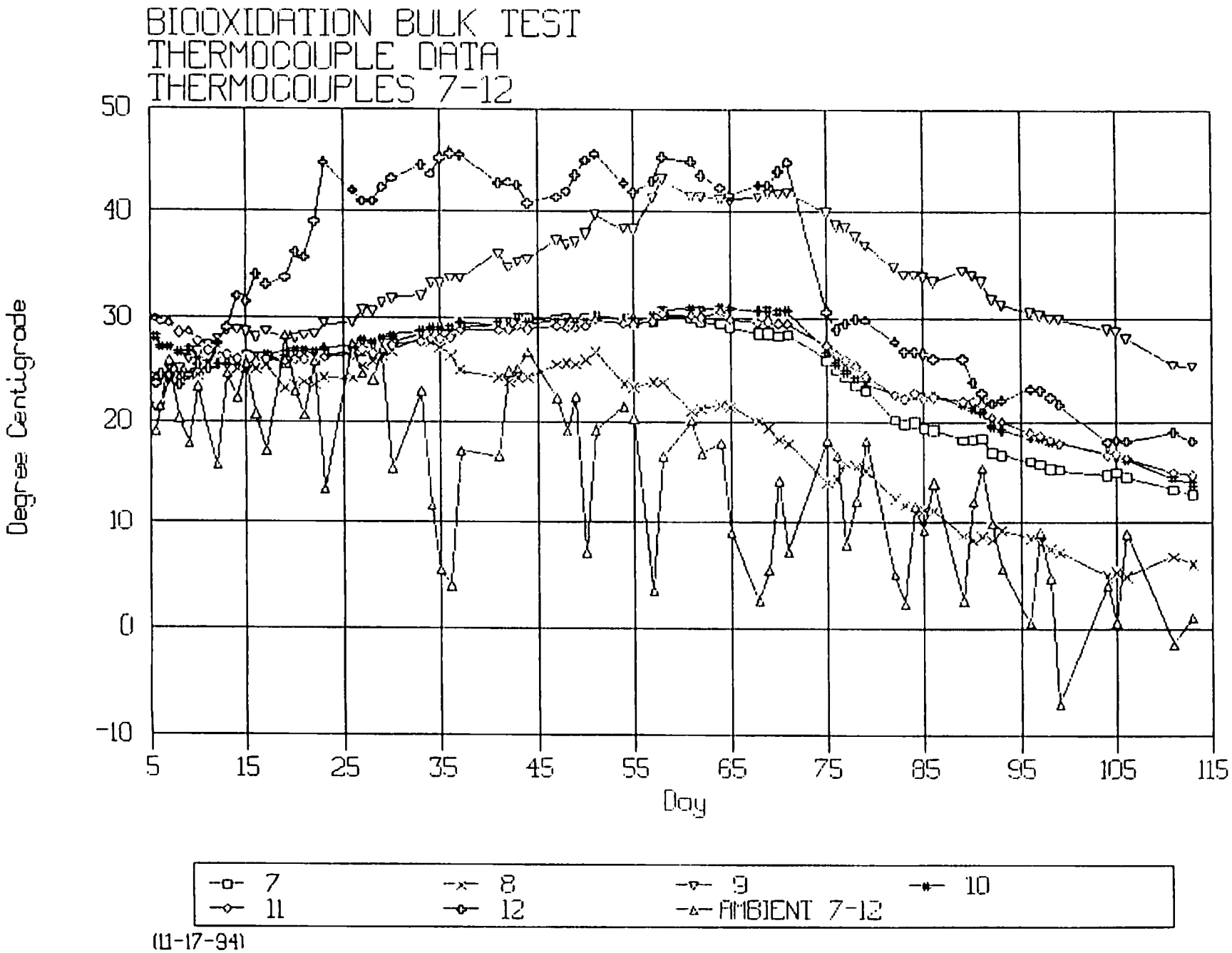
BIOOXIDATION BULK TEST THERMOCOUPLE DATA

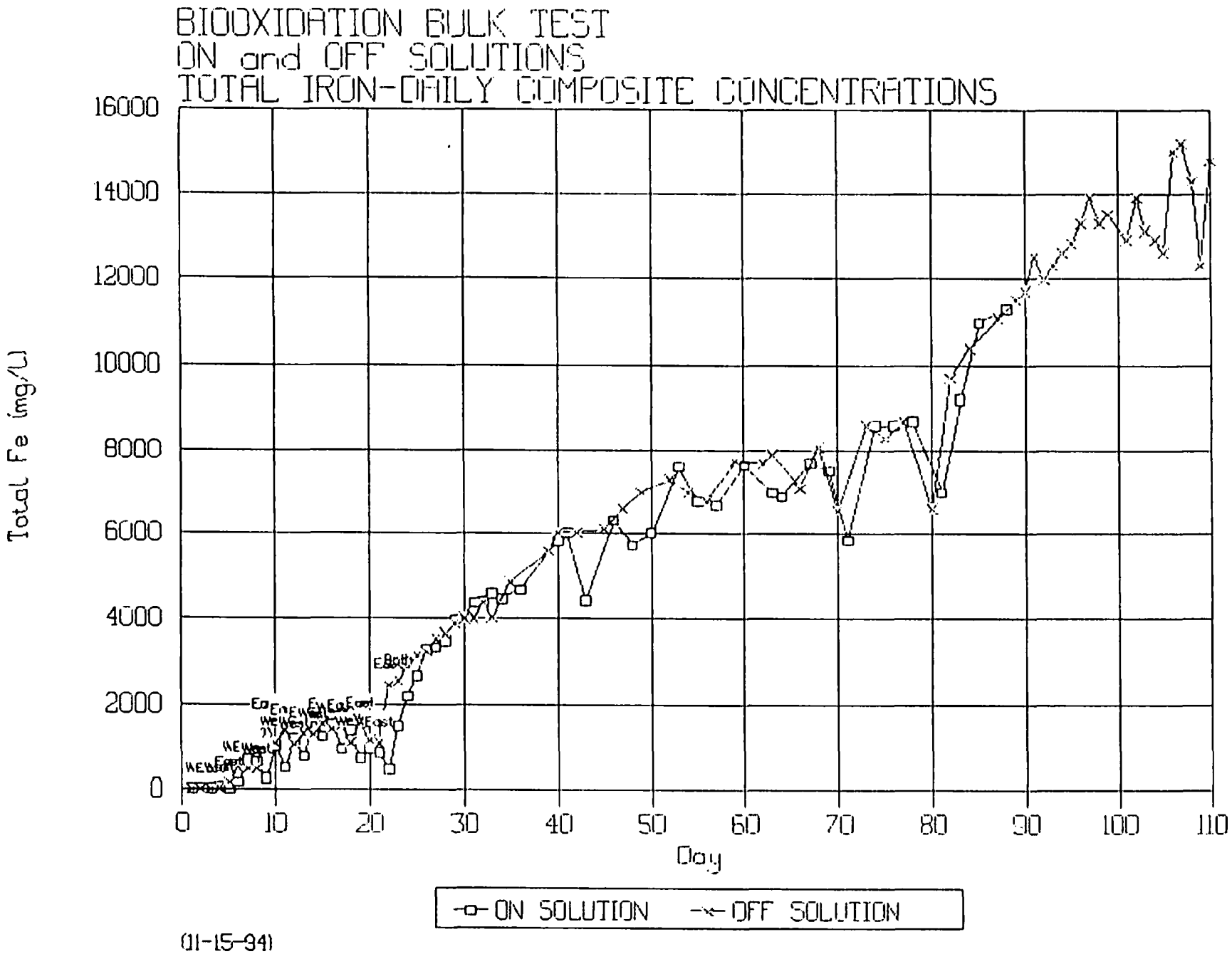
Date	West 1	West 2	West 3	West 4	West 5	Mid 6	Mid 7	Mid 8	East 9	East 10	East 11	East 12	AMBIENT 1-6	AMBIENT 7-12
08/02/94	27.8	23.2	27.4	24.3	25.7	28.0	24.3	24.3	21.2	28.1	29.8	23.5	19.0	18.9
08/02/94	28.2	23.8	27.6	25.0	26.2	28.7	24.3	24.5	21.3	27.1	29.6	24.4	22.6	21.5
08/03/94	27.2	23.7	27.2	24.6	25.6	27.5	24.5	24.8	24.0	27.1	29.4	24.3	26.0	25.8
08/04/94	29.7	24.7	27.8	25.0	27.0	29.0	24.2	24.4	25.1	26.6	28.5	23.4	19.0	20.3
08/05/94	31.3	25.6	28.2	27.3	28.3	30.4	25.5	24.6	25.9	26.9	28.6	24.3	17.7	17.7
08/06/94	30.7	25.8	27.7	26.6	26.9	28.1	24.8	24.4	26.6	25.9	27.7	25.4	22.8	23.3
08/07/94	31.8	26.2	27.1	27.4	27.9	29.6	25.4	25.5	27.3	25.5	26.8	25.0	-	-
08/08/94	32.2	27.3	27.9	27.6	27.9	29.1	25.5	25.7	27.9	25.3	26.8	27.5	14.0	15.5
08/09/94	36.4	28.9	28.6	29.3	28.9	29.9	25.7	24.9	28.7	25.4	26.4	29.0	24.0	24.5
08/10/94	35.1	28.8	28.0	28.3	27.8	28.6	25.8	25.0	28.8	25.5	26.0	32.0	21.9	22.3
08/11/94	38.4	30.8	28.5	29.2	28.1	28.9	26.2	25.1	28.5	25.6	25.8	31.5	25.4	25.6
08/12/94	36.6	30.2	27.7	27.8	27.2	27.9	26.1	25.0	28.1	26.0	25.6	34.0	22.3	20.7
08/13/94	39.0	31.9	28.6	29.4	28.3	29.2	26.3	25.3	28.6	26.4	25.9	33.1	17.3	17.0
08/14/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/15/94	38.1	31.2	28.2	28.3	27.1	27.5	25.6	23.2	28.2	26.5	25.7	33.7	24.9	28.3
08/16/94	39.1	32.2	29.0	28.8	27.6	28.0	26.2	23.5	28.0	26.8	25.9	36.2	23.5	22.9
08/17/94	39.1	31.4	28.3	28.3	27.4	27.9	26.3	23.7	28.3	26.8	26.0	35.7	20.8	20.6
08/18/94	40.3	32.8	29.4	29.2	28.3	28.6	26.1	23.5	28.4	26.7	25.9	39.0	28.6	25.7
08/19/94	40.4	32.7	28.8	29.3	28.2	28.7	26.4	24.2	29.4	27.0	26.2	44.8	12.6	13.3
08/20/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/21/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/22/94	44.1	35.7	29.8	31.9	30.7	30.2	26.5	24.1	29.5	27.4	26.3	42.1	28.3	27.5
08/23/94	43.7	37.1	30.4	33.3	32.3	32.8	26.7	25.3	30.7	27.9	26.9	41.0	25.1	24.5
08/24/94	43.1	37.7	30.4	33.5	32.2	32.1	26.8	25.7	30.6	27.6	26.5	41.0	26.0	24.0
08/25/94	43.0	38.5	30.9	34.4	33.2	33.0	27.3	26.3	31.4	28.0	27.0	42.4	27.0	27.0
08/26/94	42.9	38.9	31.0	35.1	33.8	33.5	27.5	26.8	31.8	28.3	27.3	43.3	15.0	15.2
08/27/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/28/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/29/94	43.0	40.5	31.1	34.5	33.4	32.4	28.3	27.9	32.1	28.7	27.7	44.6	23.0	22.9
08/30/94	40.1	41.2	32.6	36.8	35.7	35.8	28.6	27.7	33.2	28.9	28.0	43.7	12.4	11.6
08/31/94	40.8	40.6	32.5	36.8	35.7	35.4	28.6	27.1	33.3	28.9	28.0	45.3	4.6	5.3
09/01/94	42.3	40.9	32.6	36.9	35.3	34.8	28.7	26.4	33.7	29.0	28.1	45.7	4.1	3.9
09/02/94	44.0	40.8	33.0	37.0	35.7	34.6	29.1	24.9	33.7	29.5	28.8	45.6	17.6	17.0
09/03/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/04/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/05/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/06/94	45.2	39.9	36.4	37.9	36.3	35.6	29.4	24.2	36.1	29.4	28.8	42.8	17.2	16.4
09/07/94	46.1	40.7	39.0	37.9	36.8	36.3	29.2	23.7	34.7	29.3	28.9	42.9	25.3	24.8
09/08/94	-	40.2	39.0	36.9	36.4	35.5	29.9	24.2	35.3	29.7	29.2	42.6	25.0	25.1
09/09/94	-	40.8	40.2	37.2	-	34.8	29.9	24.2	35.5	29.5	28.9	40.8	27.8	26.7
09/10/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/11/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/12/94	-	42.5	43.4	39.4	-	37.7	29.8	25.5	37.4	29.6	29.2	41.4	20.8	22.3
09/13/94	-	41.9	42.8	38.3	-	36.8	29.9	25.6	37.0	29.6	29.1	42.0	20.1	19.0
09/14/94	-	41.7	42.8	38.0	-	36.2	29.6	25.5	37.2	29.4	29.0	43.6	22.6	22.4
09/15/94	-	42.5	43.6	38.9	-	37.1	29.9	26.0	37.9	29.6	29.2	45.1	7.0	7.0
09/16/94	-	42.9	43.2	40.3	-	39.1	30.2	26.8	39.7	30.1	29.8	45.7	20.8	19.1
09/17/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/18/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/19/94	-	45.4	43.6	40.6	-	39.4	30.0	23.6	38.4	29.9	29.5	42.8	21.3	21.5
09/20/94	-	45.1	42.5	40.3	-	38.9	29.5	23.3	38.3	29.8	29.3	41.9	18.8	20.3
09/21/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/22/94	-	46.5	42.8	42.1	-	41.8	29.6	23.8	41.3	30.2	29.7	43.0	5.6	3.5
09/23/94	-	47.1	43.1	43.5	-	43.7	30.2	23.7	43.2	30.8	30.4	45.4	18.0	16.4
09/24/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/25/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/26/94	-	47.2	42.1	41.2	-	39.6	30.1	21.0	41.5	30.9	30.2	45.0	20.5	20.0
09/27/94	-	48.7	43.1	42.4	-	41.9	29.6	21.2	41.5	30.8	30.1	43.6	17.2	16.7
09/28/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/29/94	-	49.7	43.2	42.5	-	41.7	29.4	21.6	41.2	31.0	30.6	42.4	17.7	17.8

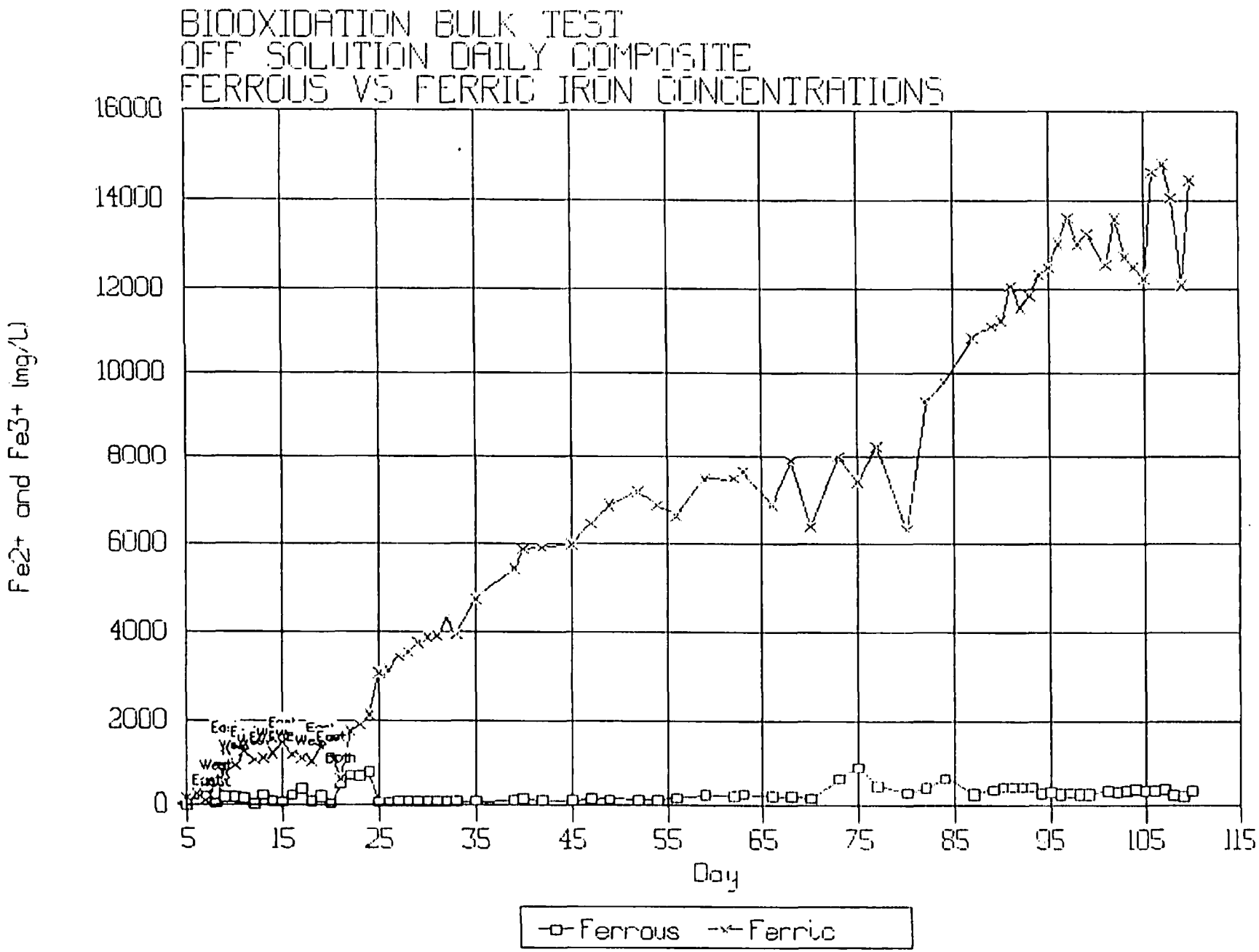
9100XIDATION BULK TEST THERMOCOUPLE DATA

Date	West 1	West 2	West 3	West 4	West 5	Mid 6	Mid 7	Mid 8	East 9	East 10	East 11	East 12	AMBIENT 1-6	AMBIENT 7-12
09/30/94	-	49.7	43.1	42.1	-	41.0	29.1	21.4	41.0	30.9	29.9	41.6	9.8	9.0
10/01/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/02/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/03/94	-	49.8	44.4	42.3	-	41.5	28.5	20.0	41.4	30.7	29.6	42.6	2.3	2.5
10/04/94	-	49.8	45.1	42.6	-	41.7	28.5	19.3	41.9	30.8	29.7	42.6	6.1	5.3
10/05/94	-	50.3	46.3	43.1	-	41.5	28.3	18.2	41.8	30.6	29.5	44.0	14.9	14.0
10/06/94	-	50.2	46.7	43.1	-	41.5	28.4	17.7	41.9	30.7	29.5	44.9	7.8	7.2
10/07/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/08/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/09/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/10/94	-	51.9	40.7	43.3	-	41.2	25.9	13.9	39.9	26.9	27.4	30.6	19.1	18.0
10/11/94	-	52.9	40.1	43.6	-	41.1	24.9	14.2	38.7	25.6	26.5	28.9	15.6	16.5
10/12/94	-	52.9	38.1	43.1	-	41.8	24.4	15.7	38.5	24.8	26.0	29.5	9.0	7.8
10/13/94	-	53.1	37.1	42.9	-	41.7	23.5	15.4	37.8	24.1	25.4	29.9	12.5	12.1
10/14/94	-	51.7	37.2	42.8	-	41.1	23.0	15.0	36.9	23.7	24.4	29.8	18.2	18.0
10/15/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/16/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/17/94	-	50.0	35.8	42.0	-	40.2	20.2	12.3	34.8	22.6	22.6	27.8	5.3	4.9
10/18/94	-	49.2	34.7	41.9	-	40.7	19.7	11.7	34.1	22.3	22.3	26.8	2.9	2.2
10/19/94	-	48.7	33.1	41.3	-	39.8	19.9	11.6	34.1	22.7	22.8	26.8	11.3	11.5
10/20/94	-	47.6	32.3	40.9	-	38.5	19.3	11.2	33.8	22.4	22.3	26.6	9.0	9.2
10/21/94	-	46.9	31.9	40.6	-	39.2	19.1	11.1	33.4	22.5	22.4	26.1	15.0	13.8
10/22/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/23/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/24/94	-	45.4	30.7	40.1	-	38.8	18.1	8.7	34.5	21.7	22.0	26.1	4.0	2.5
10/25/94	-	44.0	30.3	39.8	-	38.3	18.2	8.3	34.0	21.3	22.0	23.8	11.5	12.0
10/26/94	-	43.5	29.5	38.6	-	36.9	18.3	8.6	33.4	20.9	21.7	22.8	15.4	15.3
10/27/94	-	43.3	28.9	37.9	-	36.5	16.8	8.3	31.8	19.5	20.4	21.8	10.0	9.8
10/28/94	-	42.8	28.4	37.4	-	36.1	16.6	9.2	31.3	19.1	20.0	22.1	5.8	5.5
10/29/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/30/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/31/94	-	41.1	26.7	36.2	-	34.5	15.9	8.5	30.5	18.4	18.9	23.2	.8	.4
11/01/94	-	41.2	27.4	36.6	-	34.7	15.7	8.0	30.3	18.3	18.6	23.1	9.3	9.0
11/02/94	-	40.6	27.0	36.6	-	34.7	15.2	7.4	30.0	17.9	18.1	22.4	4.4	4.6
11/03/94	-	40.1	26.6	36.8	-	35.0	15.1	7.1	29.9	17.8	17.8	21.7	-8.0	-7.0
11/04/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11/05/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11/06/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11/07/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11/08/94	-	38.7	25.7	35.3	-	34.3	14.6	4.8	28.9	16.7	16.6	17.9	4.1	4.0
11/09/94	-	39.0	25.3	35.1	-	33.9	14.9	5.2	28.8	16.6	16.7	18.1	.8	.5
11/10/94	-	38.7	24.9	34.2	-	32.9	14.4	4.8	28.1	16.1	16.3	18.0	8.6	8.9
11/11/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11/12/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11/13/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11/14/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11/15/94	-	37.3	22.6	32.6	-	31.3	13.2	6.7	25.5	14.3	14.9	18.9	.7	-1.5
11/16/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11/17/94	-	37.7	24.3	33.9	-	32.1	12.7	6.0	25.3	13.8	14.6	18.0	.6	1.0

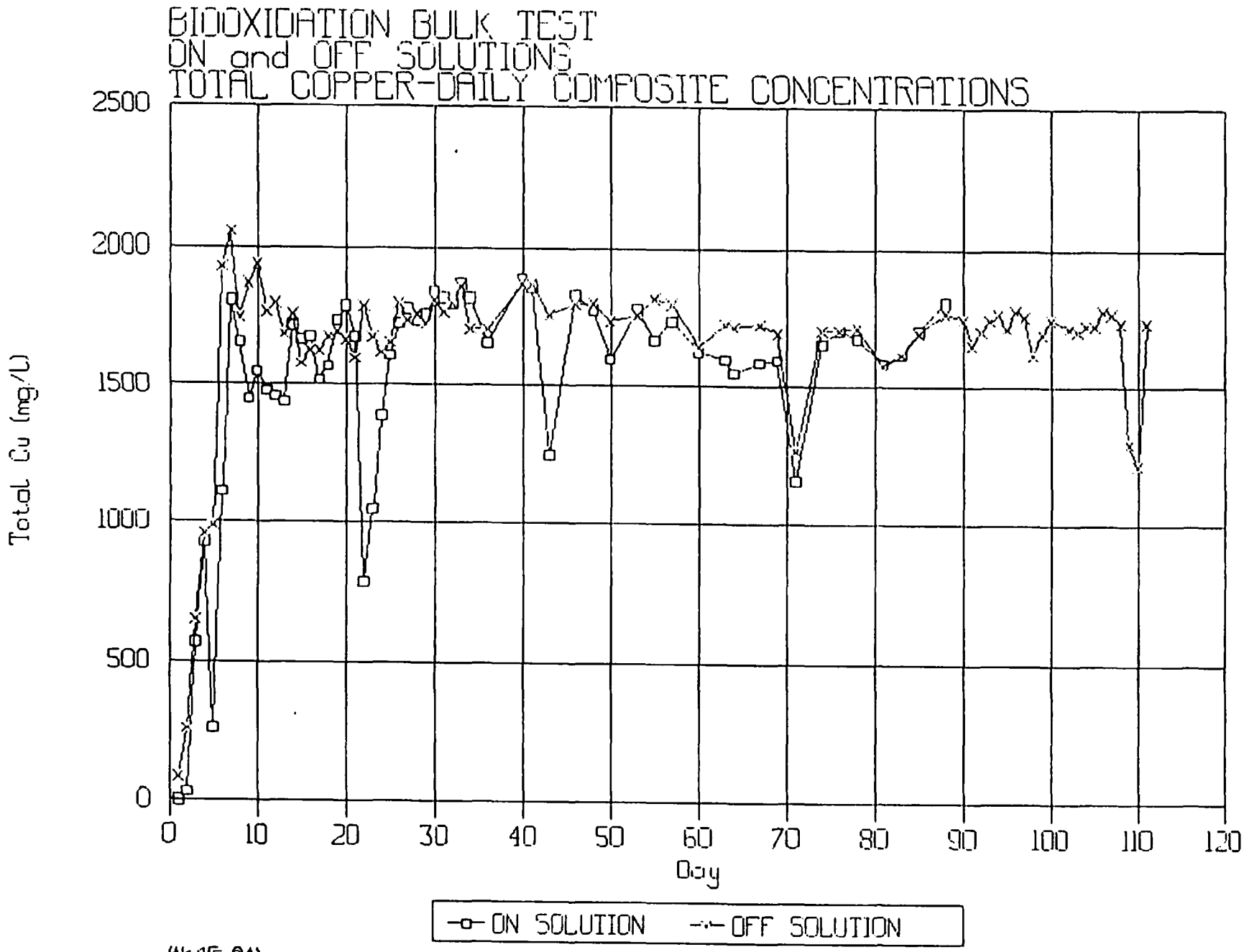

BIOOXIDATION BULK TEST
THERMOCOUPLE DATA
THERMOCOUPLES 1-6
Degree Centigrade
60
50
40
30
20
10
0
-10
5
15
25
35
45
55
65
75
85
95
105
115
Day
1
2
3
4
5
6
AMBIENT 1-6
(11-17-94)


BIOOXIDATION BULK TEST
THERMOCOUPLE DATA
THERMOCOUPLES 7-12
Degree Centigrade
50
40
30
20
10
0
-10
5
15
25
35
45
55
65
75
85
95
105
115
Day
7
8
9
10
11
12
AMBIENT 7-12
(11-17-94)

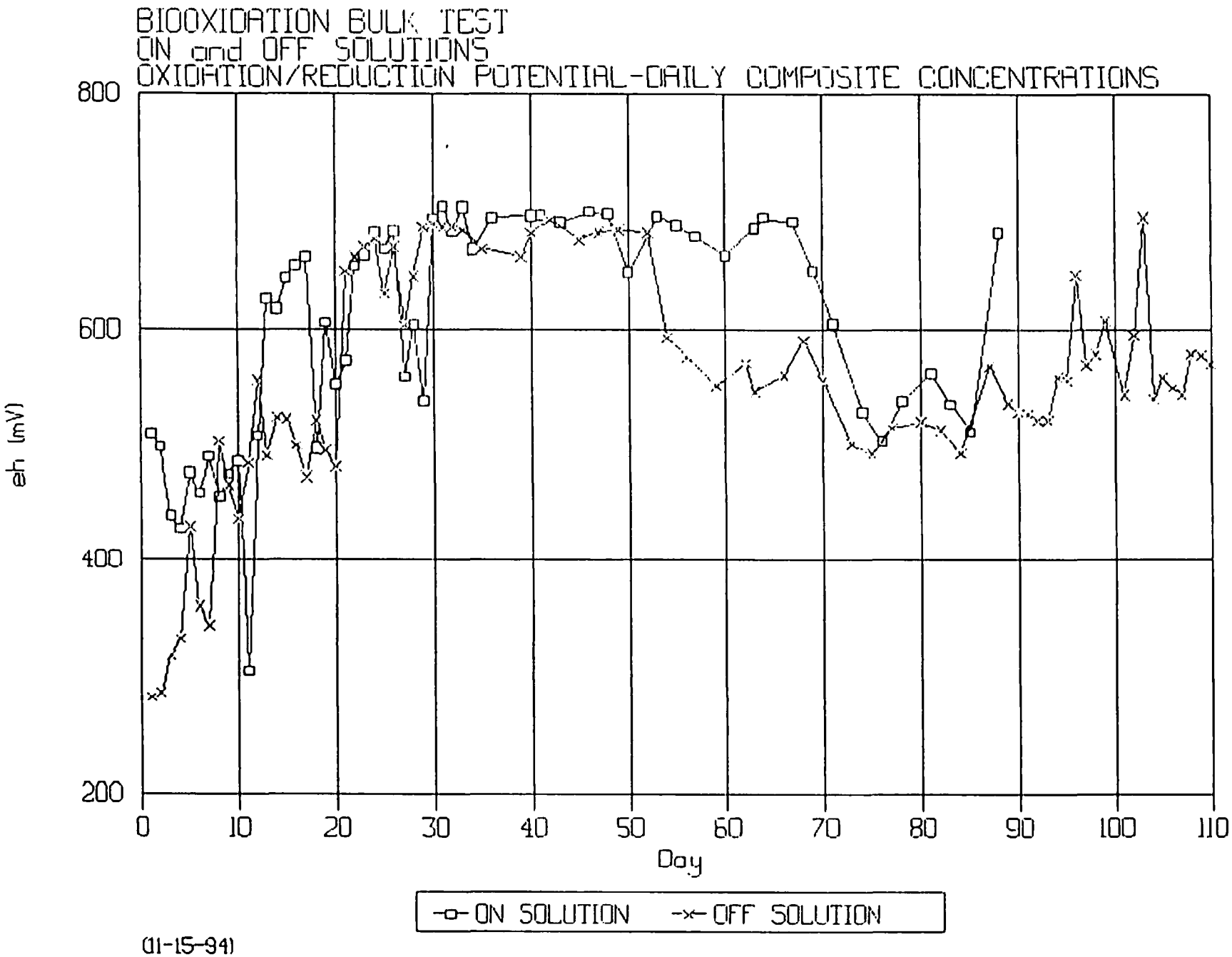

BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
TOTAL IRON-DAILY COMPOSITE CONCENTRATIONS
Total Fe (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
0
10
20
30
40
50
60
70
80
90
100
110
Day
ON SOLUTION
OFF SOLUTION
(01-15-94)


BIOOXIDATION BULK TEST
OFF SOLUTION DAILY COMPOSITE
FERROUS VS FERRIC IRON CONCENTRATIONS
Fe2+ and Fe3+ (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
5
15
25
35
45
55
65
75
85
95
105
115
Day
Ferrous
Ferric

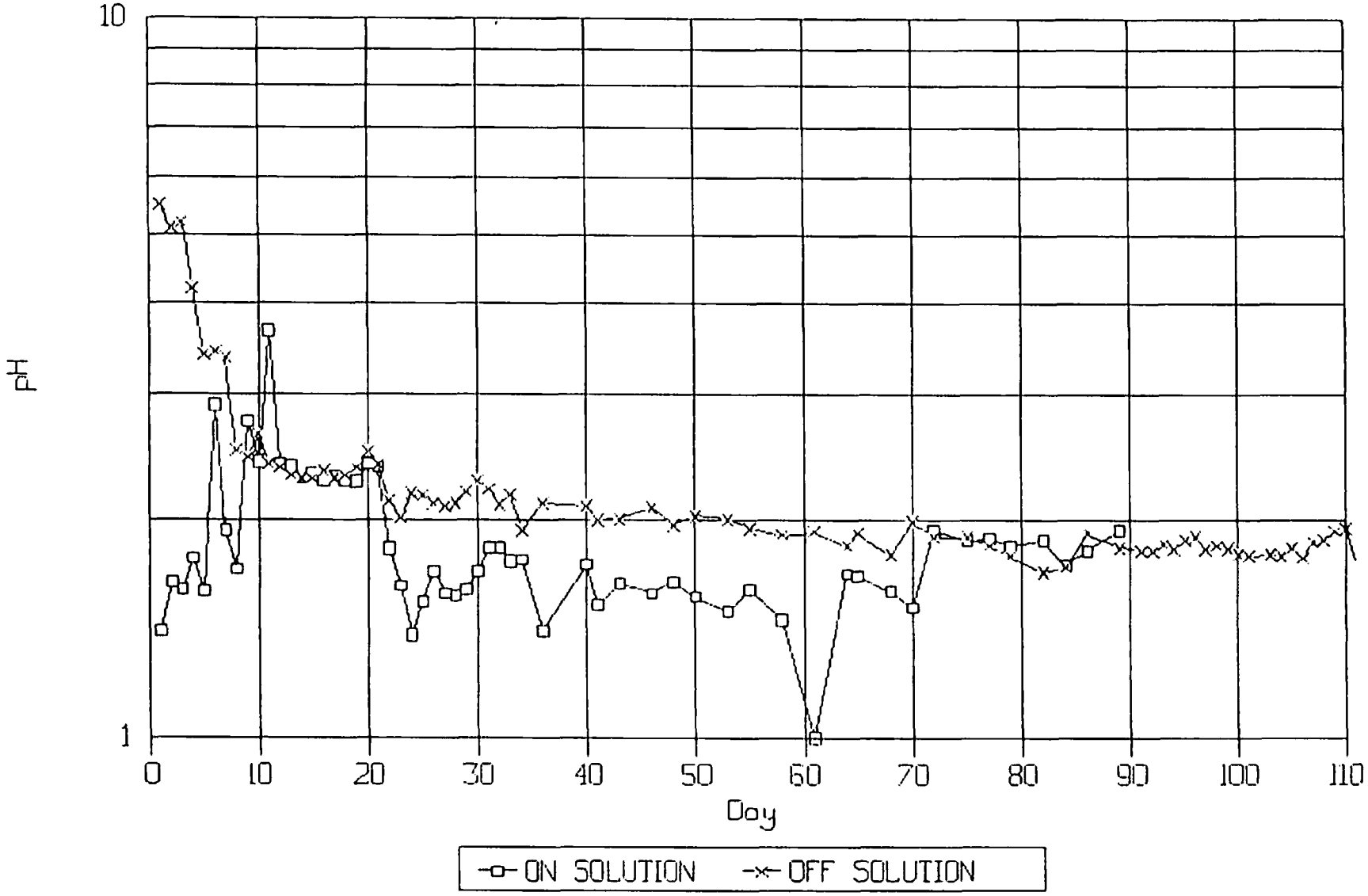
(11-15-94)


BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
TOTAL COPPER-DAILY COMPOSITE CONCENTRATIONS
Total Cu (mg/L)
2500
2000
1500
1000
500
0
0
10
20
30
40
50
60
70
80
90
100
110
120
Day
ON SOLUTION
OFF SOLUTION

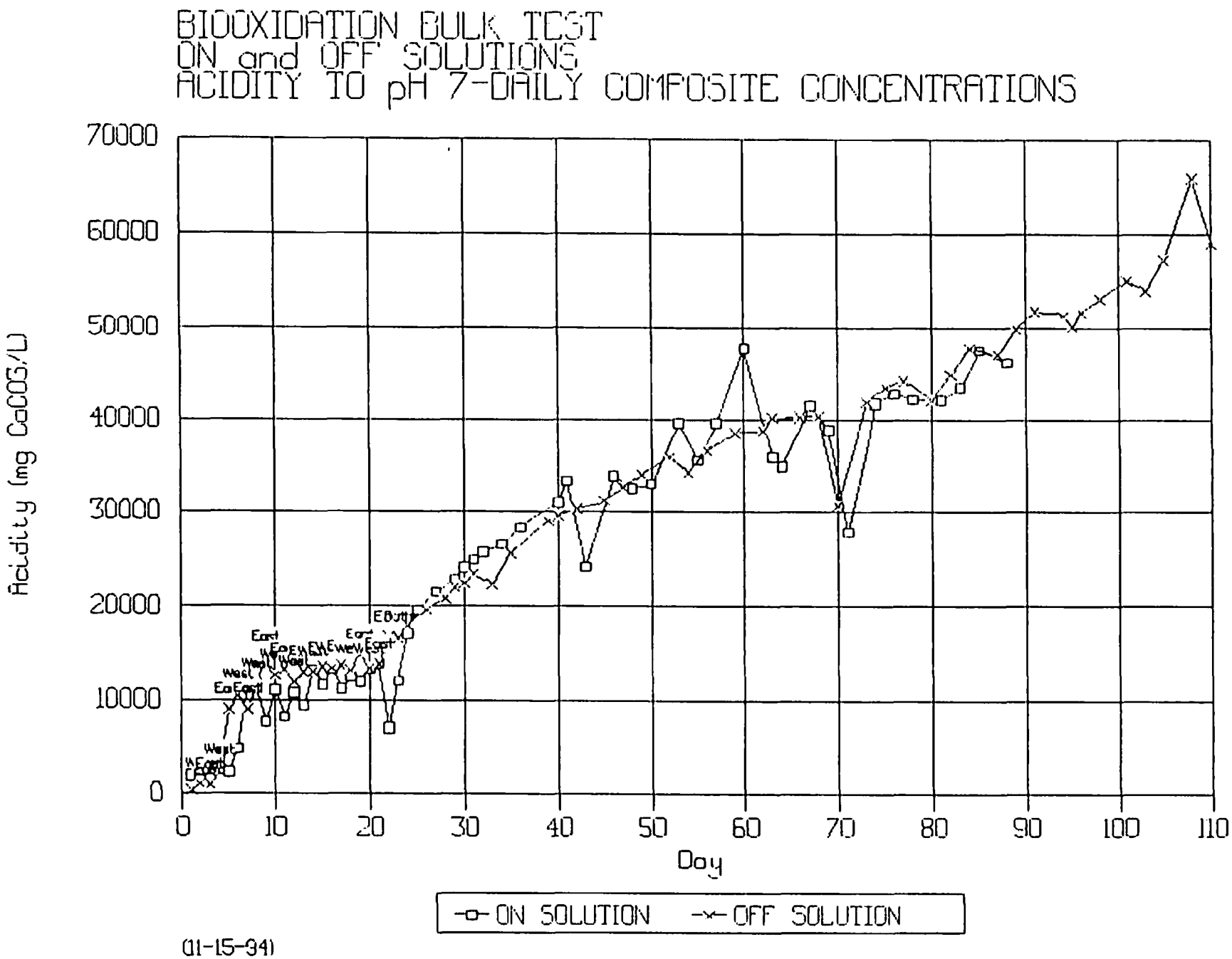
(11-15-94)

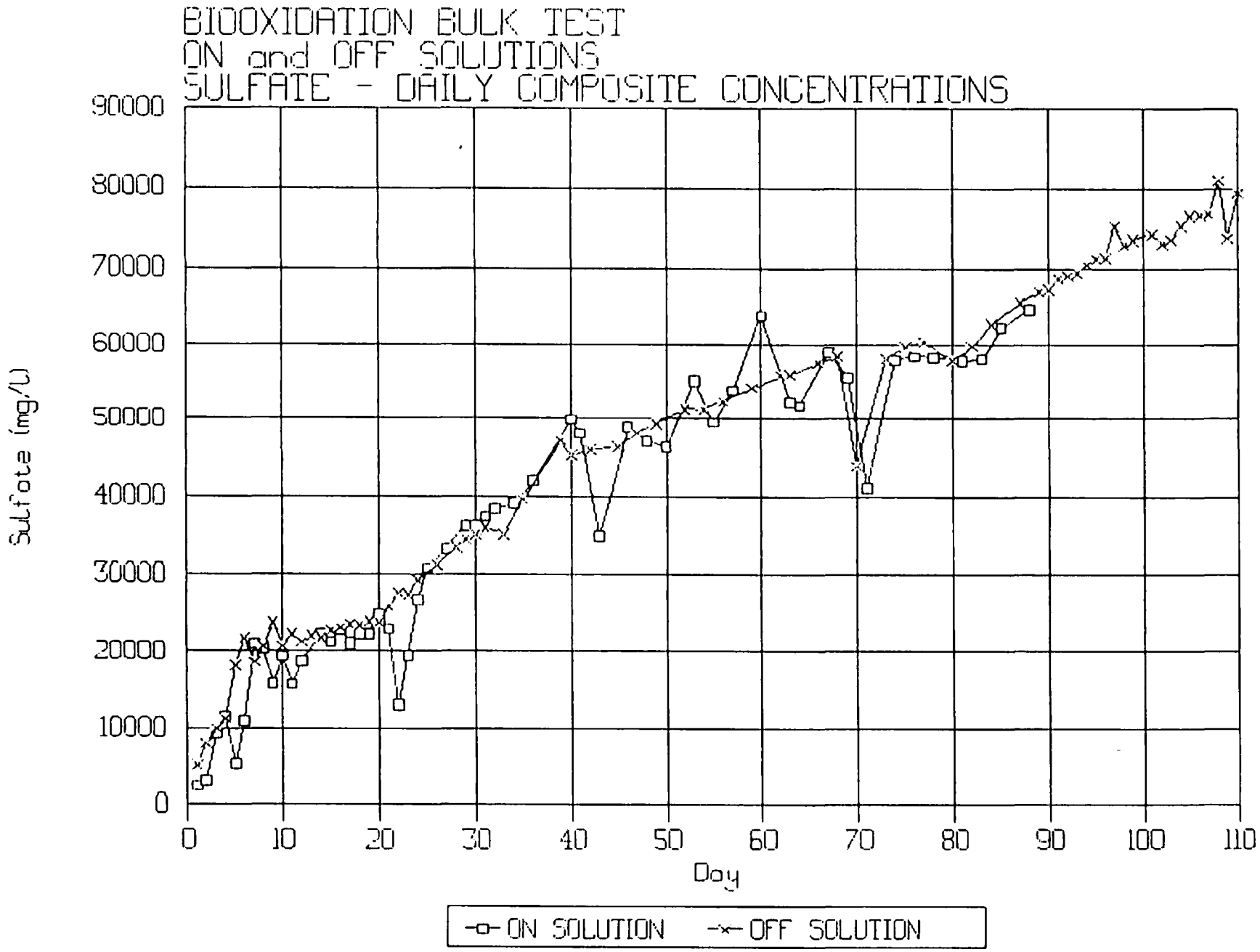

BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
OXIDATION/REDUCTION POTENTIAL-DAILY COMPOSITE CONCENTRATIONS
800
600
400
200
eh (mV)
0
10
20
30
40
50
60
70
80
90
100
110
Day
ON SOLUTION
OFF SOLUTION
(11-15-94)

BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
pH - DAILY COMPOSITE



(11-15-94)


BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
ACIDITY TO pH 7-DAILY COMPOSITE CONCENTRATIONS
Acidity (mg CaCO3/L)
70000
60000
50000
40000
30000
20000
10000
0
0
10
20
30
40
50
60
70
80
90
100
110
Day
ON SOLUTION
OFF SOLUTION
(01-15-94)


BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
SULFATE - DAILY COMPOSITE CONCENTRATIONS
Sulfate (mg/L)
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
0
10
20
30
40
50
60
70
80
90
100
110
Day
ON SOLUTION
OFF SOLUTION

(01-15-94)

MEMORANDUM

DATE: NOVEMBER 11, 1994
TO: JIM THOMPSON
FROM: LAURA DAMON
SUBJECT: BIOOXIDATION BULK TEST (BBT) WEEKLY UPDATE (15)

The BBT has been on the biooxidation cycle for fifteen weeks now. Both the west and east sides are on simultaneous solution application. The OFF solution continues to flow into the sump area and is then pumped to a 300 gallon tank holding the ON solution pump. A flow meter is located after the ON solution pump. There's now two weeks of evidence that the solution flow meter is not reading correctly. The totalizations have ranged from 3400 to 11,000+ gallons per day. The average of the totalizations that appear correct for the two week period (10,000+ gallons) were averaged. The average was 11,000 gallons. This average totalization was used in the daily log sheet for any readings which were out of the range of 11,000 gallons ± 1,000. This may answer the question last week of, "Where's the solution going?" although the circuit has still lost about 3000 gallons since the rainstorm. The heap remains stable and intact.

The total iron concentration has stayed in the 13,000 ppm range this week. The iron continues to be predominantly in the form of ferric iron. The copper values have stabilized in the 1700 ppm range. The pH of the OFF solution is in the 1.8 range and the oxidation/reduction potential has an eh range of 500-550. The sulfate concentration has risen this week as has the acidity.

Four auger drill-3 bottle rolls (west 10'-15'; mid 10'-15'; east 10'-15'; west, mid, east 1'-15' composite) were assayed this week. Attached is a table comparing the iron extraction and sulfide oxidation to the previous auger drill holes. The comparisons are non-conclusive and indicate that we are comparing apples and oranges as far as predicting the percent oxidation at individual intervals. The average interval hole results seem to give better correlations. Also attached are the corresponding gold extraction data for each bottle roll. The extractions were rather disappointing for these particular intervals showing gold extraction percentages only a few points higher (avg 57.4%) than the control sample (54.8%). These particular samples used an average of 33 lb/ton CaO vs 18 lb/ton CaO for the control sample but the average NaCN consumption dropped to 1.9 lb/ton from 2.1 lb/ton on the control. We are waiting for Geobiotics and McClelland bottle roll results on the same samples.

Auger drill-4 samples were collected on Thursday, November 10th. The samples will be bottle rolled next week for gold extraction data. Splits of the samples are being sent to Geobiotics and McClelland Labs for comparison bottle rolls.

c: Rod MacLeod
Martin Quick
Herb Osborne

BBT BOTTLE ROLL EXTRACTION

Sample I.D.	AUGER DRILL-3 WEST 10' - 15' Interval 33 lb/T CaO 5 lb/T NaCN 50% Solids	
Date	10/24/94	
FA Tail Au (opt)	.0242	
AA Soln Au (opt)	.0315	96 hr
Calc Head Au (opt)	.0557	
NaCN (lb/ton) final	3.34	
NaCN Consumption (lb/ton)	1.7	
pH (initial)	11.88	
pH (final)	11.35	
% Extraction Au (AA Soln/Calc Head)	56.6	

BBT BOTTLE ROLL EXTRACTION

Sample I.D.	AUGER DRILL-3 MID 10' - 15' Interval 32 lb/T CaO 5 lb/T NaCN 50% Solids	
Date	10/24/94	
FA Tail Au (opt)	.0262	
AA Soln Au (opt)	.0340	96 hr
Calc Head Au (opt)	.0602	
NaCN (lb/ton) final	2.82	
NaCN Consumption (lb/ton)	2.2	
pH (initial)	11.91	
pH (final)	11.32	
% Extraction Au (AA Soln/Calc Head)	56.5	

BBT BOTTLE ROLL EXTRACTION

Sample I.D.	AUGER DRILL-3 EAST 10' - 15' Interval 33 lb/T CaO 5 lb/T NaCN 50% Solids	
Date	10/24/94	
FA Tail Au (opt)	.0226	
AA Soln Au (opt)	.0328	96 hr
Calc Head Au (opt)	.0554	
NaCN (lb/ton) final	3.14	
NaCN Consumption (lb/ton)	1.9	
pH (initial)	11.67	
pH (final)	11.42	
% Extraction Au (AA Soln/Calc Head)	59.2	

BBT BOTTLE ROLL EXTRACTION

Sample I.D.	AUGER DRILL-3 COMP 1'-15' West;Mid;East 32 lb/T CaO 5 lb/T NaCN 50% Solids	
Date	10/24/94	
FA Tail Au (opt)	.0231	
AA Soln Au (opt)	.0307	96 hr
Calc Head Au (opt)	.0538	
NaCN (lb/ton) final	3.28	
NaCN Consumption (lb/ton)	1.7	
pH (initial)	12.36	
pH (final)	11.46	
% Extraction Au (AA Soln/Calc Head)	57.1	

	AUGER DRILL - 3 10/24/94 Comp 1'-15' Unrinsed	AUGER DRILL - 3 10/24/94 Comp 1'-15' Rinsed	AUGER DRILL - 3 10/24/94 West 10'-15'	10/24/94 Mid 10'-15'	10/24/94 East 10'-15'	% Fe Extraction and % Sulfide Oxidation Auger 3 vs Auger 1 West 10'-15'	Mid 10'-15'	East 10'-15'
Fe	57159	59928	58215	62219	59037	4.5	-1.3	1.0
Cu	312	145	140	227	184			
% Sulfur	5.67	5.78	5.24	6.59	5.31			
% SO4	1.46	.88	.86	.93	.99			
% Sulfide	5.18	5.49	4.95	6.28	4.97	10.3	-15.2	1.2

	AUGER DRILL-2 09/27/94 AUGER West 10'-15'	09/27/94 AUGER Mid 10'-15'	09/27/94 AUGER East 10'-15'	% Fe Extraction and % Sulfide Oxidation Auger 2 vs Auger 1 West 10'-15'	Mid 10'-15'	East 10'-15'
Fe	58029	60927	58302	4.8	.8	2.3
Cu	172	220	184			
% Sulfur	5.26	5.71	5.34			
% SO4	.73	.70	.80			
% Sulfide	5.01	5.47	5.07	9.2	-.4	-.8

	CONTROL BBT-SP2COLCOMP Average 7/5-7/18 Unrinsed	BR Split 10% HCl Rinsed	AUGER DRILL-1 08/23/94 AUGER West 10'-15'	08/23/94 AUGER Mid 10'-15'	08/23/94 AUGER East 10'-15'
Fe	58851	50792	60945	61439	59661
Cu	504	222	195	170	117
% Sulfur	5.23	4.65	5.71	5.63	5.22
% SO4	.95	.65	.57	.53	.58
% Sulfide	4.91	4.44	5.52	5.45	5.03

* All intervals are measured from the TOP of the heap.

BIOOXIDATION BULK TEST SOLUTION SAMPLING

OFF SOLUTION

Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	DO (ppm)
SUMP-GRAB	07/26/94	1200	1200	7.22	-	.84	.27	-	-	-	-	-
GRAB-1530	07/27/94	1750	2950	7.53	305.4	.89	.20	-	-	-	-	-
COMP	07/28/94	3000	5950	5.93	353.6	83	.55	-	-	83	4411	-
COMP	07/29/94	3293	9243	5.49	282.1	255	13	-	-	362	5094	-
COMP	07/30/94	4419	13662	5.11	285.7	654	14	-	-	994	7913	-
COMP	07/31/94	2688	16350	5.18	318.8	960	11	-	-	956	9835	-
COMP	08/01/94	7822	24172	4.20	332.3	990	39	1	38	2438	11106	-
COMP	08/02/94	21836	46008	3.39	429.6	1930	172	2	170	8960	18304	-
COMP	08/03/94	14710	60718	3.43	360.1	2050	520	260	260	10520	21678	-
COMP	08/04/94	7500	68218	3.36	344.2	1750	500	410	90	8967	18731	-
COMP	08/05/94	6821	75039	2.50	503.7	1870	480	40	440	11633	20711	-
COMP	08/06/94	21396	96436	2.45	465.2	1940	1530	200	1330	14570	23591	-
COMP	08/07/94	21396	117832	2.63	435.8	1770	1110	190	920	12617	20727	-
COMP	08/08/94	18698	136530	2.40	484.6	1800	1390	160	1230	13259	22299	-
COMP	08/09/94	21118	157648	2.36	557.4	1690	1070	36	1034	11904	21180	-
COMP	08/10/94	16419	174067	2.31	491.4	1760	1320	220	1100	12958	22052	-
COMP	08/11/94	16500	190567	2.29	524.4	1580	1290	86	1204	12958	21764	-
COMP	08/12/94	18213	208780	2.28	523.1	1630	1520	56	1464	13452	22729	1.3
COMP	08/13/94	18585	227365	2.34	500.2	1630	1420	240	1180	13361	22995	1.3
COMP	08/14/94	16646	244011	2.29	472.4	1680	1490	380	1110	13608	23458	-
COMP	08/15/94	13559	257570	2.31	522.4	1700	1110	84	1026	13179	23381	-
COMP	08/16/94	12267	269837	2.36	496.4	1670	1540	196	1344	14831	23933	1.4
COMP	08/17/94	7697	277534	2.49	481.4	1600	1160	43	1117	13309	23711	2.2
COMP	08/18/94	7136	284670	2.39	650.1	1790	1100	480	620	13839	25735	1.7
COMP	08/19/94	13078	297748	2.13	663.0	1680	2450	690	1760	16703	27554	-
COMP	08/20/94	14479	312227	2.02	672.0	1620	2550	670	1880	16716	27464	-
COMP	08/21/94	14213	326440	2.18	678.3	1660	2900	770	2130	18024	29200	-
COMP	08/22/94	14246	340686	2.16	631.0	1800	3160	75	3085	-	-	-
COMP	08/23/94	13868	354554	2.11	671.3	1740	3210	73	3137	19568	31299	-
COMP	08/24/94	12742	367296	2.09	604.1	1760	3540	82	3458	-	-	.7
COMP	08/25/94	11741	379037	2.11	646.9	1730	3640	86	3554	20823	33471	5.5?
COMP	08/26/94	12505	391542	2.19	687.1	1810	3860	86	3774	22006	34443	OFL
COMP	08/27/94	11272	402814	2.27	689.5	1770	4000	94	3906	22374	35035	-
COMP	08/28/94	9000	411814	2.21	688.0	1800	4000	82	3918	23319	35858	-
COMP	08/29/94	9000	420814	2.10	688.2	1860	4370	86	4284	-	-	OFL
COMP	08/30/94	11403	432217	2.17	685.5	1710	4030	84	3946	22242	35134	13.5?
COMP	08/31/94	10726	442943	-	-	-	-	-	-	-	-	OFL
COMP	09/01/94	10299	453242	1.94	669.9	1710	4840	89	4751	25577	39562	OFL
COMP	09/02/94	9075	462317	-	-	-	-	-	-	-	-	3.9
COMP	09/03/94	8149	470466	-	-	-	-	-	-	-	-	-
COMP	09/04/94	7612	478078	-	-	-	-	-	-	-	-	-
COMP	09/05/94	7357	485435	2.11	663.7	1870	5550	120	5430	29017	47141	-
COMP	09/06/94	6870	492305	2.09	682.9	1870	6010	151	5859	29543	45273	3.5
COMP	09/07/94	6503	498808	-	-	-	-	-	-	-	-	6.2
COMP	09/08/94	10447	509255	2.00	693.8	1760	6010	117	5893	30304	46121	5.5
COMP	09/09/94	8553	517808	-	-	-	-	-	-	/-	-	5.5
COMP	09/10/94	8424	526232	-	-	-	-	-	-	-	-	-
COMP	09/11/94	8424	534656	2.01	677.7	1800	6100	114	5986	31157	46376	-
COMP	09/12/94	7258	541914	-	-	-	-	-	-	-	-	-
COMP	09/13/94	6630	548544	2.08	683.7	1800	6600	151	6449	32657	48154	2.8
COMP	09/14/94	7479	556023	-	-	-	-	-	-	-	-	2.6
COMP	09/15/94	11492	567515	1.97	685.6	1740	7000	142	6858	33989	49372	4.6
COMP	09/16/94	11244	578759	-	-	-	-	-	-	-	-	2.8
COMP	09/17/94	11287	590046	-	-	-	-	-	-	-	-	-
COMP	09/18/94	10435	600481	2.03	684.0	1760	7300	134	7166	35825	51363	-
COMP	09/19/94	9531	610012	-	-	-	-	-	-	-	-	2.5
COMP	09/20/94	6175	616187	2.01	593.5	1820	7000	134	6866	34241	51265	2.8
COMP	09/21/94	5061	621248	-	-	-	-	-	-	-	-	-

9100XIDATION BULK TEST SOLUTION SAMPLING

OFF SOLUTION

Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	DO (ppm)
COMP	09/22/94	5238	626486	1.95	576.7	1800	6800	171	6629	36579	52376	3.5
COMP	09/23/94	6073	632559	-	-	-	-	-	-	-	-	3.2
COMP	09/24/94	9286	641845	-	-	-	-	-	-	-	-	-
COMP	09/25/94	9592	651437	1.91	552.0	1650	7730	250	7480	38565	54096	-
COMP	09/26/94	7385	658822	-	-	-	-	-	-	-	-	2.8
COMP	09/27/94	9119	667941	-	-	-	-	-	-	-	-	3.5
COMP	09/28/94	7789	675730	1.93	571.8	1730	7700	230	7470	38690	55742	-
COMP	09/29/94	7387	683117	1.85	547.2	1720	7900	270	7630	40150	55898	-
COMP	09/30/94	7807	690924	-	-	-	-	-	-	-	-	3.2
COMP	10/01/94	6502	697426	-	-	-	-	-	-	-	-	-
COMP	10/02/94	6502	703928	1.92	560.7	1730	7100	210	6890	40202	57552	-
COMP	10/03/94	6231	710159	-	-	-	-	-	-	-	-	4.2
COMP	10/04/94	6834	716993	1.80	591.1	1700	8100	210	7890	40383	58458	4.5
COMP	10/05/94	6911	723904	-	-	-	-	-	-	-	-	4.5
COMP	10/06/94	28493	752396	1.99	557.3	1270	6550	170	6380	30663	43932	5.7
COMP	10/07/94	22817	775213	-	-	-	-	-	-	-	-	-
COMP	10/08/94	19403	794616	-	-	-	-	-	-	-	-	-
COMP	10/09/94	21196	815812	1.90	501.8	1710	8600	610	7990	41883	58178	-
COMP	10/10/94	17200	833012	-	-	-	-	-	-	-	-	2.8
COMP	10/11/94	11500	844512	1.90	492.7	1710	8300	890	7410	43442	59840	2.4
COMP	10/12/94	17000	861512	-	-	-	-	-	-	-	-	-
COMP	10/13/94	18300	879812	1.85	515.7	1720	8700	460	8240	44220	60408	2.1
COMP	10/14/94	15800	895612	-	-	-	-	-	-	-	-	2.0
COMP	10/15/94	16500	912112	-	-	-	-	-	-	-	-	-
COMP	10/16/94	20700	932812	1.79	520.7	1580	6600	300	6300	42146	57873	-
COMP	10/17/94	24500	957312	-	-	-	-	-	-	-	-	2.1
COMP	10/18/94	20500	977812	1.70	514.3	1620	9700	410	9290	44826	59766	2.2
COMP	10/19/94	14300	992112	-	-	-	-	-	-	-	-	2.0
COMP	10/20/94	7750	999862	1.73	493.7	1700	10400	630	9770	47772	62737	2.4
COMP	10/21/94	11600	1011462	-	-	-	-	-	-	-	-	2.5
COMP	10/22/94	9400	1020862	-	-	-	-	-	-	-	-	-
COMP	10/23/94	10000	1030862	1.92	569.0	1770	11100	260	10840	46976	65675	-
COMP	10/24/94	13030	1043892	-	-	-	-	-	-	-	-	2.7
COMP	10/25/94	14262	1058154	1.84	536.9	1750	11500	370	11130	49948	66992	2.2
COMP	10/26/94	14397	1072551	1.82	528.8	1660	11700	430	11270	-	67280	2.4
COMP	10/27/94	11874	1084425	1.82	527.6	1710	12500	430	12070	51833	68663	2.4
COMP	10/28/94	11000	1095425	1.86	522.4	1750	12000	430	11570	-	68992	2.8
COMP	10/29/94	10207	1105632	1.83	521.9	1770	12300	430	11870	-	69362	-
COMP	10/30/94	11000	1116632	1.88	559.8	1720	12600	290	12310	51344	70367	-
COMP	10/31/94	11000	1127632	1.90	555.7	1780	12800	310	12490	50208	71099	3.6
COMP	11/ 1/94	11000	1138632	1.83	647.6	1760	13300	260	13040	51667	71354	3.2
COMP	11/ 2/94	11000	1149632	1.85	569.8	1620	13900	300	13600	-	75222	-
COMP	11/ 3/94	11000	1160632	1.83	579.3	1700	13300	260	13040	53189	73008	3.0
COMP	11/ 4/94	10589	1171221	1.80	608.0	1750	13500	260	13240	-	73527	-
COMP	11/ 5/94	10589	1181810	-	-	-	-	-	-	-	-	-
COMP	11/ 6/94	11000	1192810	1.79	544.0	1720	12900	360	12540	55114	74235	-
COMP	11/ 7/94	11000	1203810	1.8	595.1	1710	13900	310	13590	-	73165	-
COMP	11/ 8/94	11000	1214810	1.79	695.8	1730	13100	360	12740	54027	73593	2.9
COMP	11/ 9/94	11539	1226349	1.84	540.8	1730	12900	380	12520	-	75329	2.9

* Note: There's now 2 weeks of evidence that the solution flow meter is not reading correctly (Total gallons from 3400-11,000+ per day). The average of the totalizations for the 2 week period that appear to be correct (10,000+) were averaged. The average was 11,000 gal and used for any readings out of the range 11,000 ± 1,000.

BIOOXIDATION BULK TEST SOLUTION SAMPLING

PAN LYSIMETER 3

Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO (ppm)
GRAB	08/03/94	1.93	488.4	1540	4640	1200	3440	20005	23896	-	
GRAB	08/11/94	1.52	496.1	3200	8700	2900	5800	-	-	Brown/Murky	
GRAB	08/12/94	1.89	450.4	2200	3900	2100	1800	-	27461	Lt Brown	1.5
GRAB	08/15/94	1.92	459.5	2170	3920	1270	2650	15417	27625	Med Brown	1.7
GRAB	08/17/94	1.97	462.7	1940	3220	560	2660	19502	25159	Med Brown	2.4
GRAB	08/19/94	2.00	458.4	1850	2300	1400	900	17828	23604	-	-
GRAB	08/22/94	1.90	464.0	1760	2300	360	1940	16677	23744	Grw/Br Ti	1.9
GRAB	08/24/94	2.04	468.5	1780	2680	770	1910	16795	23028	Green	.9
GRAB	08/26/94	2.05	479.6	1730	2700	690	2010	17030	24320	Br-Yel	4.5?
GRAB	08/29/94	2.08	472.8	1770	2760	360	2400	17936	25167	Yel-Br	OFL
GRAB	09/01/94	1.79	472.3	1870	2730	730	2000	19039	26822	Green	OFL
GRAB	09/06/94	1.83	492.1	1940	2620	210	2410	19748	30237	Lt Green	2.5
GRAB	09/08/94	1.80	488.8	1980	2870	300	2570	21454	30435	Dk Green	4.3
GRAB	09/13/94	1.68	499.7	2040	3310	510	2800	22662	32648	Gr;cldy	0.9
GRAB	09/20/94	1.66	494.8	2000	3930	300	3630	24512	33471	Lt Green	1.4
GRAB	09/22/94	1.56	481.2	1980	4250	770	3480	26724	34796	Gr-Br	1.6
GRAB	09/27/94	1.66	487.7	1920	3820	460	3360	24512	34253	Gr;cldy	1.8
GRAB	09/29/94	1.73	498.0	2070	3820	460	3360	25972	37735	Green	2.3
GRAB	10/04/94	1.63	504.6	2320	3710	330	3380	30067	42385	Gr;cldy	2.9
GRAB	10/06/94	1.66	496.1	2500	3880	440	3440	32530	46919	Gr;cldy	4.9
GRAB	10/11/94	1.63	508.9	2550	5630	430	5200	39606	54458	Br;cldy	3.9
GRAB	10/13/94	1.49	485.7	2400	6370	1020	5350	43658	57709	Gr-Brown	1.9
GRAB	10/18/94	1.52	469.2	2180	7050	1660	5390	43101	47232	Gr-Brown	2.8
GRAB	10/20/94	1.59	478.9	1940	7650	1230	6420	43738	59454	Br;cldy	3.4
GRAB	10/25/94	1.89	556.7	1800	11500	270	11230	50081	67083	Dk Br;ppt	2.1
GRAB	10/27/94	1.82	532.0	1710	11500	380	11120	50161	67486	Br;cldy	2.3
GRAB	11/01/94	1.79	489.8	1790	11100	960	10140	48749	68860	Milky Br	2.0
GRAB	11/03/94	1.67	479.7	1730	11400	1510	9890	50028	68605	Br;cldy	1.5
GRAB	11/08/94	1.74	498.1	1750	12700	860	11840	50518	70087	Br;cldy	2.2
GRAB	11/10/94	1.80	487.7	1710	10500	1270	9230	50891	70613	Br;cldy	1.8

BIOOXIDATION BULK TEST SOLUTION SAMPLING

PAN LYSIMETER 5

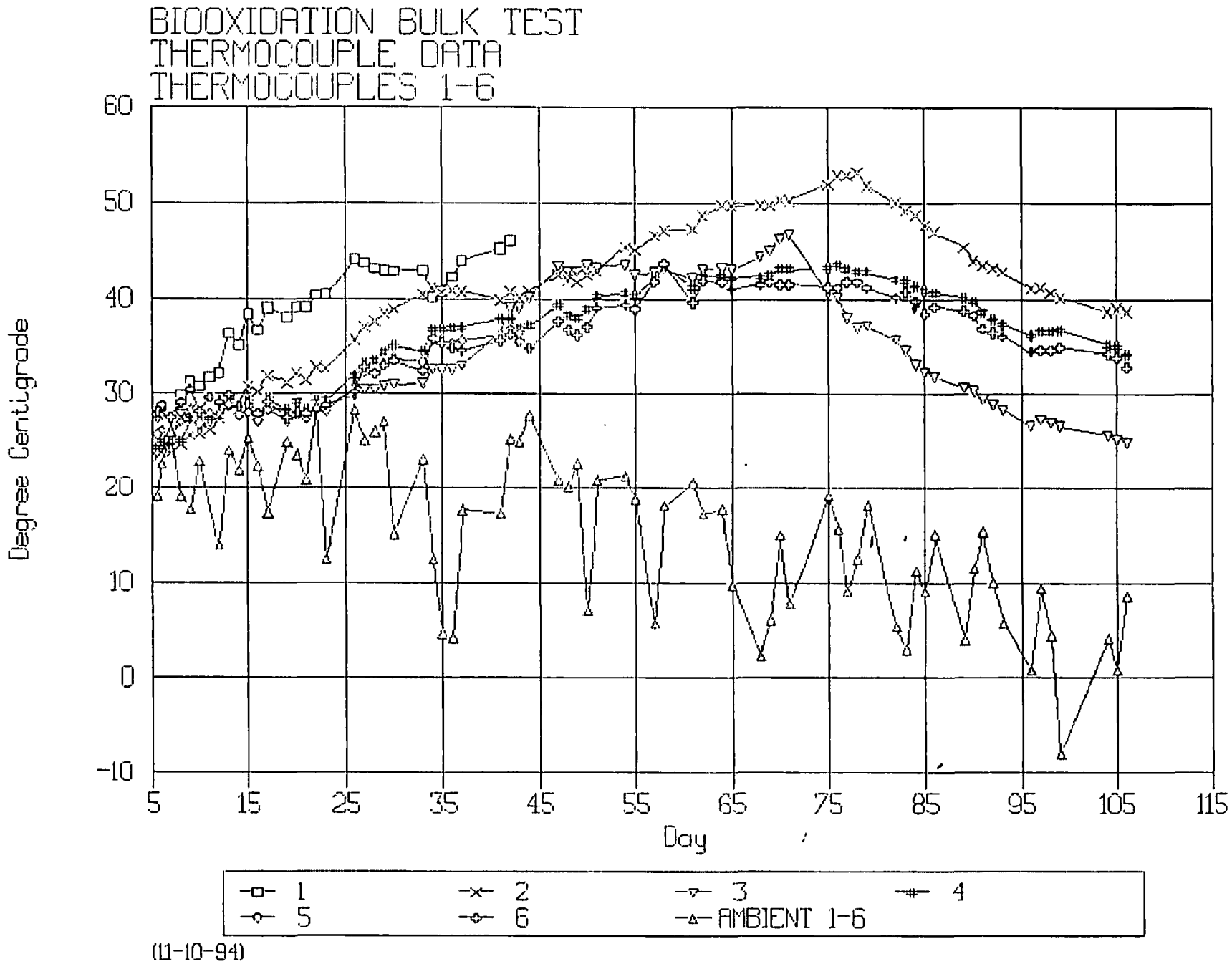
Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO (ppm)
GRAB	08/03/94	1.49	515.6	3690	17700	2100	15600	57687	66622	Dark Brown	-
GRAB	08/04/94	1.32	511.1	3930	14100	1600	12500	60119	67556	Dark Brown	-
GRAB	08/09/94	1.70	484.5	2600	4500	1400	3100	28440	38389	Dark Brown	-
GRAB	08/10/94	2.37	574.1	1740	990	36	954	11468	23641	Off Soln Flush	
GRAB	08/11/94	1.72	431.8	2000	3700	3400	300	-	-	Green Color	-
GRAB	08/12/94	1.80	439.7	2000	3900	2900	1000	20048	24627	Lt Green	3.7
GRAB	08/15/94	1.88	361.1	1940	3940	2200	1740	20543	24800	Green	2.6
GRAB	08/17/94	1.88	415.7	2030	4800	3700	1100	23073	27307	Green	2.7
GRAB	08/19/94	1.87	418.5	2170	4100	4000	100	21647	27324	-	-
GRAB	08/22/94	2.26	437.3	1920	2800	2300	500	18260	24542	Yel-Br	2.1
GRAB	08/24/94	2.12	385.4	1880	3250	2900	350	17056	25184	Lt Gr/Blue	OFL
GRAB	08/26/94	2.39	414.8	1780	3270	2290	980	16428	24641	Yel-Gr;odor	OFL
GRAB	08/29/94	2.47	402.7	1730	3260	2110	1150	16623	24698	Lt Green	OFL
GRAB	09/01/94	2.28	492.3	1700	2600	480	2120	16360	24254	Yel-Br;odor	OFL
GRAB	09/06/94	2.30	386.7	1520	3010	1830	1180	16097	25933	Bl-Gr;odor	2.5
GRAB	09/08/94	2.36	465.2	1480	2490	430	2060	16202	24534	Lt Br;ppt	4.3
GRAB	09/13/94	2.32	389.7	1170	3250	3700	-450	16019	25019	Lt Green	0.9
GRAB	09/20/94	2.30	386.7	1110	2470	2600	-130	15185	23797	Lt Green	1.8
GRAB	09/22/94	2.23	417.6	1110	2320	2000	320	15888	24163	Lt Green	2.8
GRAB	09/27/94	2.17	563.9	1110	1650	700	950	16416	24270	Lt Brown	2.8
GRAB	09/29/94	2.19	500.5	1280	1950	200	1750	13841	25834	Brown	2.8
GRAB	10/04/94	2.07	473.2	1240	1760	410	1350	16978	25776	Yel-Lt Br	3.0
GRAB	10/06/94	2.21	576.0	1290	1630	80	1550	16265	25390	Lt Brown	6.0
GRAB	10/11/94	2.17	637.1	1360	1740	690	1050	18274	29389	Gr-Yellow	5.0
GRAB	10/13/94	1.99	567.5	1500	1970	60	1910	21497	32739	Yel-Lt Br	4.0
GRAB	10/18/94	1.96	514.8	1760	2380	177	2203	24019	36517	Green	3.5
GRAB	10/20/94	1.85	514.6	2020	2600	171	2429	25983	38648	Green	3.2
GRAB	10/25/94	2.08	460.3	2720	4530	1340	3190	38987	56425	Dk Gr-Br	1.4
GRAB	10/27/94	1.93	405.0	2480	5690	5300	390	39093	55289	Lt Green	1.8
GRAB	11/01/94	2.11	379.2	2800	7080	7500	-420	39471	58375	Aqua Green	1.8
GRAB	11/03/94	2.23	407.1	2610	6640	530	6110	39048	55166	Gr-Br;ppt	2.7
GRAB	11/08/94	1.88	430.9	2810	6590	3700	2890	40893	58384	Dk Green	2.5
GRAB	11/10/94	2.02	414.0	2930	6800	4600	2200	42911	59536	Green	3.0

BIOOXIDATION BULK TEST THERMOCOUPLE DATA

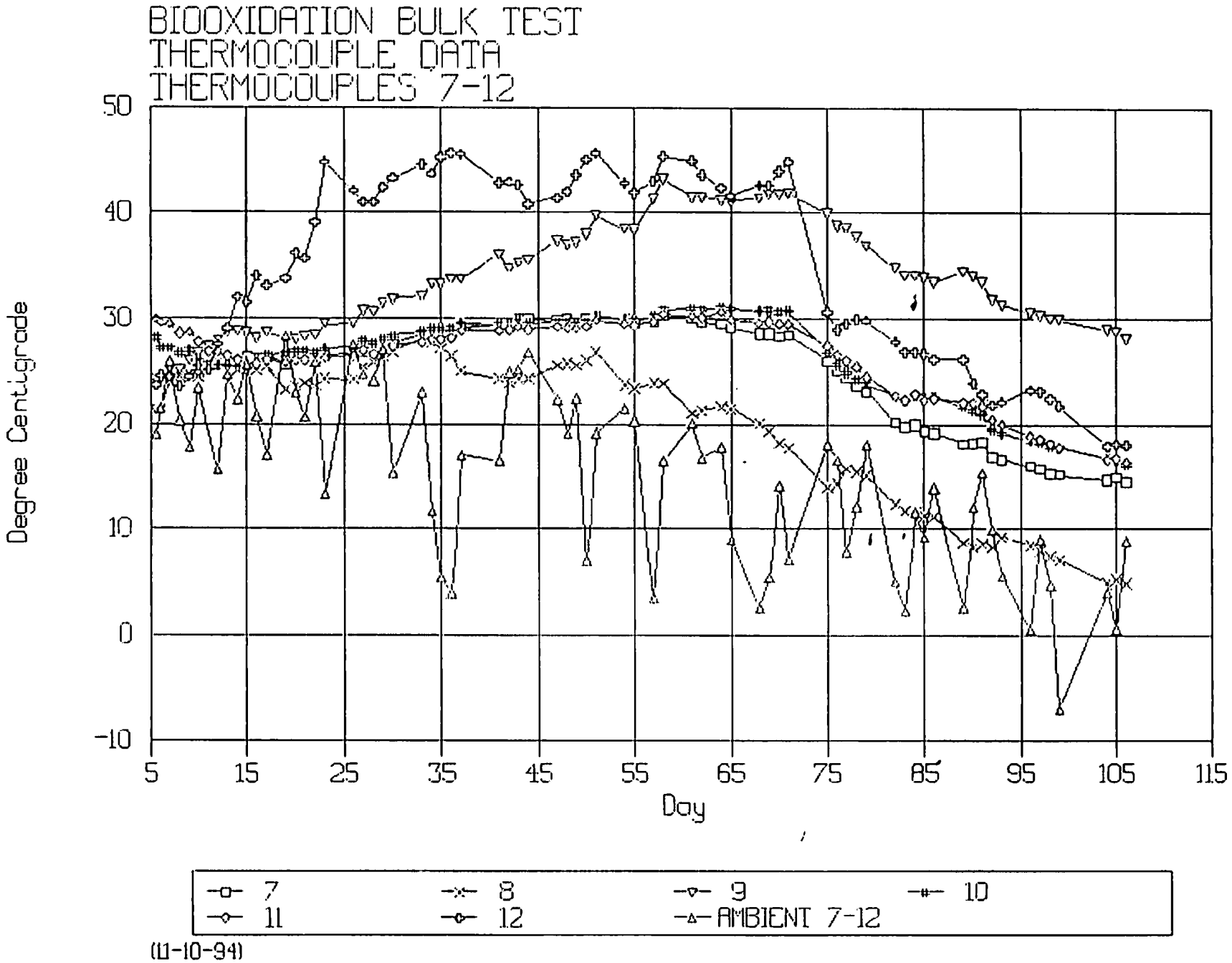
Date	West 1	West 2	West 3	West 4	West 5	Mid 6	Mid 7	Mid 8	East 9	East 10	East 11	East 12	AMBIENT 1-6	AMBIENT 7-12
08/02/94	27.8	23.2	27.4	24.3	25.7	28.0	24.3	24.3	21.2	28.1	29.8	23.5	19.0	18.9
08/02/94	28.2	23.8	27.6	25.0	26.2	28.7	24.3	24.5	21.3	27.1	29.6	24.4	22.6	21.5
08/03/94	27.2	23.7	27.2	24.6	25.6	27.5	24.5	24.8	24.0	27.1	29.4	24.3	26.0	25.8
08/04/94	29.7	24.7	27.8	25.0	27.0	29.0	24.2	24.4	25.1	26.6	28.5	23.4	19.0	20.3
08/05/94	31.3	25.6	28.2	27.3	28.3	30.4	25.5	24.6	25.9	26.9	28.6	24.3	17.7	17.7
08/06/94	30.7	25.8	27.7	26.6	26.9	28.1	24.8	24.4	26.6	25.9	27.7	25.4	22.8	23.3
08/07/94	31.8	26.2	27.1	27.4	27.9	29.6	25.4	25.5	27.3	25.5	26.8	25.0	-	-
08/08/94	32.2	27.3	27.9	27.6	27.9	29.1	25.5	25.7	27.9	25.3	26.8	27.5	14.0	15.5
08/09/94	36.4	28.9	28.6	29.3	28.9	29.9	25.7	24.9	28.7	25.4	26.4	29.0	24.0	24.5
08/10/94	35.1	28.8	28.0	28.3	27.8	28.6	25.8	25.0	28.8	25.5	26.0	32.0	21.9	22.3
08/11/94	38.4	30.8	28.5	29.2	28.1	28.9	26.2	25.1	28.5	25.6	25.8	31.5	25.4	25.6
08/12/94	36.6	30.2	27.7	27.8	27.2	27.9	26.1	25.0	28.1	26.0	25.6	34.0	22.3	20.7
08/13/94	39.0	31.9	28.6	29.4	28.3	29.2	26.3	25.3	28.6	26.4	25.9	33.1	17.3	17.0
08/14/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/15/94	38.1	31.2	28.2	28.3	27.1	27.5	25.6	23.2	28.2	26.5	25.7	33.7	24.9	28.3
08/16/94	39.1	32.2	29.0	28.8	27.6	28.0	26.2	23.5	28.0	26.8	25.9	36.2	23.5	22.9
08/17/94	39.1	31.4	28.3	28.3	27.4	27.9	26.3	23.7	28.3	26.8	26.0	35.7	20.8	20.6
08/18/94	40.3	32.8	29.4	29.2	28.3	28.6	26.1	23.5	28.4	26.7	25.9	39.0	28.6	25.7
08/19/94	40.4	32.7	28.8	29.3	28.2	28.7	26.4	24.2	29.4	27.0	26.2	44.8	12.6	13.3
08/20/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/21/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/22/94	44.1	35.7	29.8	31.9	30.7	30.2	26.5	24.1	29.5	27.4	26.3	42.1	28.3	27.5
08/23/94	43.7	37.1	30.4	33.3	32.3	32.8	26.7	25.3	30.7	27.9	26.9	41.0	25.1	24.5
08/24/94	43.1	37.7	30.4	33.5	32.2	32.1	26.8	25.7	30.6	27.6	26.5	41.0	26.0	24.0
08/25/94	43.0	38.5	30.9	34.4	33.2	33.0	27.3	26.3	31.4	28.0	27.0	42.4	27.0	27.0
08/26/94	42.9	38.9	31.0	35.1	33.8	33.5	27.5	26.8	31.8	28.3	27.3	43.3	15.0	15.2
08/27/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/28/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/29/94	43.0	40.5	31.1	34.5	33.4	32.4	28.3	27.9	32.1	28.7	27.7	44.6	23.0	22.9
08/30/94	40.1	41.2	32.6	36.8	35.7	35.8	28.6	27.7	33.2	28.9	28.0	43.7	12.4	11.6
08/31/94	40.8	40.6	32.5	36.8	35.7	35.4	28.6	27.1	33.3	28.9	28.0	45.3	4.6	5.3
09/01/94	42.3	40.9	32.6	36.9	35.3	34.8	28.7	26.4	33.7	29.0	28.1	45.7	4.1	3.9
09/02/94	44.0	40.8	33.0	37.0	35.7	34.6	29.1	24.9	33.7	29.5	28.8	45.6	17.6	17.0
09/03/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/04/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/05/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/06/94	45.2	39.9	36.4	37.9	36.3	35.6	29.4	24.2	36.1	29.4	28.8	42.8	17.2	16.4
09/07/94	46.1	40.7	39.0	37.9	36.8	36.3	29.2	23.7	34.7	29.3	28.9	42.9	25.3	24.8
09/08/94	-	40.2	39.0	36.9	36.4	35.5	29.9	24.2	35.3	29.7	29.2	42.6	25.0	25.1
09/09/94	-	40.8	40.2	37.2	-	34.8	29.9	24.2	35.5	29.5	28.9	40.8	27.8	26.7
09/10/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/11/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/12/94	-	42.5	43.4	39.4	-	37.7	29.8	25.5	37.4	29.6	29.2	41.4	20.8	22.3
09/13/94	-	41.9	42.8	38.3	-	36.8	29.9	25.6	37.0	29.6	29.1	42.0	20.1	19.0
09/14/94	-	41.7	42.8	38.0	-	36.2	29.6	25.5	37.2	29.4	29.0	43.6	22.6	22.4
09/15/94	-	42.5	43.6	38.9	-	37.1	29.9	26.0	37.9	29.6	29.2	45.1	7.0	7.0
09/16/94	-	42.9	43.2	40.3	-	39.1	30.2	26.8	39.7	30.1	29.8	45.7	20.8	19.1
09/17/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/18/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/19/94	-	45.4	43.6	40.6	-	39.4	30.0	23.6	38.4	29.9	29.5	42.8	21.3	21.5
09/20/94	-	45.1	42.5	40.3	-	38.9	29.5	23.3	38.3	29.8	29.3	41.9	18.8	20.3
09/21/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/22/94	-	46.5	42.8	42.1	-	41.8	29.6	23.8	41.3	30.2	29.7	43.0	5.6	3.5
09/23/94	-	47.1	43.1	43.5	-	43.7	30.2	23.7	43.2	30.8	30.4	45.4	18.0	16.4
09/24/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/25/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/26/94	-	47.2	42.1	41.2	-	39.6	30.1	21.0	41.5	30.9	30.2	45.0	20.5	20.0
09/27/94	-	48.7	43.1	42.4	-	41.9	29.6	21.2	41.5	30.8	30.1	43.6	17.2	16.7
09/28/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/29/94	-	49.7	43.2	42.5	-	41.7	29.4	21.6	41.2	31.0	30.6	42.4	17.7	17.8

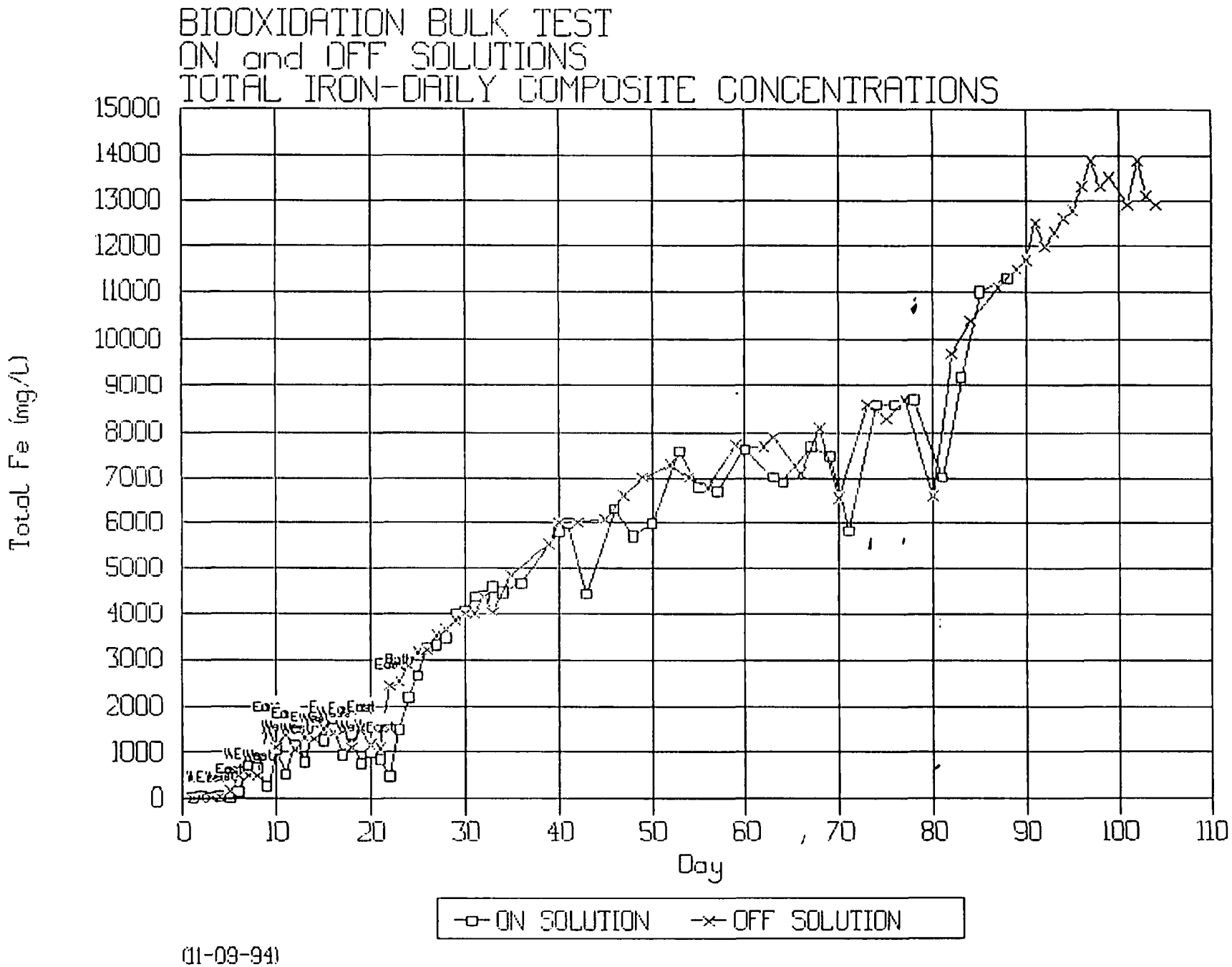
BIOOXIDATION BULK TEST THERMOCOUPLE DATA

Date	West 1	West 2	West 3	West 4	West 5	Mid 6	Mid 7	Mid 8	East 9	East 10	East 11	East 12	AMBIENT 1-6	AMBIENT 7-12
09/30/94	-	49.7	43.1	42.1	-	41.0	29.1	21.4	41.0	30.9	29.9	41.6	9.8	9.0
10/01/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/02/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/03/94	-	49.8	44.4	42.3	-	41.5	28.5	20.0	41.4	30.7	29.6	42.6	2.3	2.5
10/04/94	-	49.8	45.1	42.6	-	41.7	28.5	19.3	41.9	30.8	29.7	42.6	6.1	5.3
10/05/94	-	50.3	46.3	43.1	-	41.5	28.3	18.2	41.8	30.6	29.5	44.0	14.9	14.0
10/06/94	-	50.2	46.7	43.1	-	41.5	28.4	17.7	41.9	30.7	29.5	44.9	7.8	7.2
10/07/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/08/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/09/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/10/94	-	51.9	40.7	43.3	-	41.2	25.9	13.9	39.9	26.9	27.4	30.6	19.1	18.0
10/11/94	-	52.9	40.1	43.6	-	41.1	24.9	14.2	38.7	25.6	26.5	28.9	15.6	16.5
10/12/94	-	52.9	38.1	43.1	-	41.8	24.4	15.7	38.5	24.8	26.0	29.5	9.0	7.8
10/13/94	-	53.1	37.1	42.9	-	41.7	23.5	15.4	37.8	24.1	25.4	29.9	12.5	12.1
10/14/94	-	51.7	37.2	42.8	-	41.1	23.0	15.0	36.9	23.7	24.4	29.8	18.2	18.0
10/15/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/16/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/17/94	-	50.0	35.8	42.0	-	40.2	20.2	12.3	34.8	22.6	22.6	27.8	5.3	4.9
10/18/94	-	49.2	34.7	41.9	-	40.7	19.7	11.7	34.1	22.3	22.3	26.8	2.9	2.2
10/19/94	-	48.7	33.1	41.3	-	39.8	19.9	11.6	34.1	22.7	22.8	26.8	11.3	11.5
10/20/94	-	47.6	32.3	40.9	-	38.5	19.3	11.2	33.8	22.4	22.3	26.6	9.0	9.2
10/21/94	-	46.9	31.9	40.6	-	39.2	19.1	11.1	33.4	22.5	22.4	26.1	15.0	13.8
10/22/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/23/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/24/94	-	45.4	30.7	40.1	-	38.8	18.1	8.7	34.5	21.7	22.0	26.1	4.0	2.5
10/25/94	-	44.0	30.3	39.8	-	38.3	18.2	8.3	34.0	21.3	22.0	23.8	11.5	12.0
10/26/94	-	43.5	29.5	38.6	-	36.9	18.3	8.6	33.4	20.9	21.7	22.8	15.4	15.3
10/27/94	-	43.3	28.9	37.9	-	36.5	16.8	8.3	31.8	19.5	20.4	21.8	10.0	9.8
10/28/94	-	42.8	28.4	37.4	-	36.1	16.6	9.2	31.3	19.1	20.0	22.1	5.8	5.5
10/29/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/30/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/31/94	-	41.1	26.7	36.2	-	34.5	15.9	8.5	30.5	18.4	18.9	23.2	.8	.4
11/01/94	-	41.2	27.4	36.6	-	34.7	15.7	8.0	30.3	18.3	18.6	23.1	9.3	9.0
11/02/94	-	40.6	27.0	36.6	-	34.7	15.2	7.4	30.0	17.9	18.1	22.4	4.4	4.6
11/03/94	-	40.1	26.6	36.8	-	35.0	15.1	7.1	29.9	17.8	17.8	21.7	-8.0	-7.0
11/04/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11/05/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11/06/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11/07/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11/08/94	-	38.7	25.7	35.3	-	34.3	14.6	4.8	28.9	16.7	16.6	17.9	4.1	4.0
11/09/94	-	39.0	25.3	35.1	-	33.9	14.9	5.2	28.8	16.6	16.7	18.1	.8	.5
11/10/94	-	38.7	24.9	34.2	-	32.9	14.4	4.8	28.1	16.1	16.3	18.0	8.6	8.9

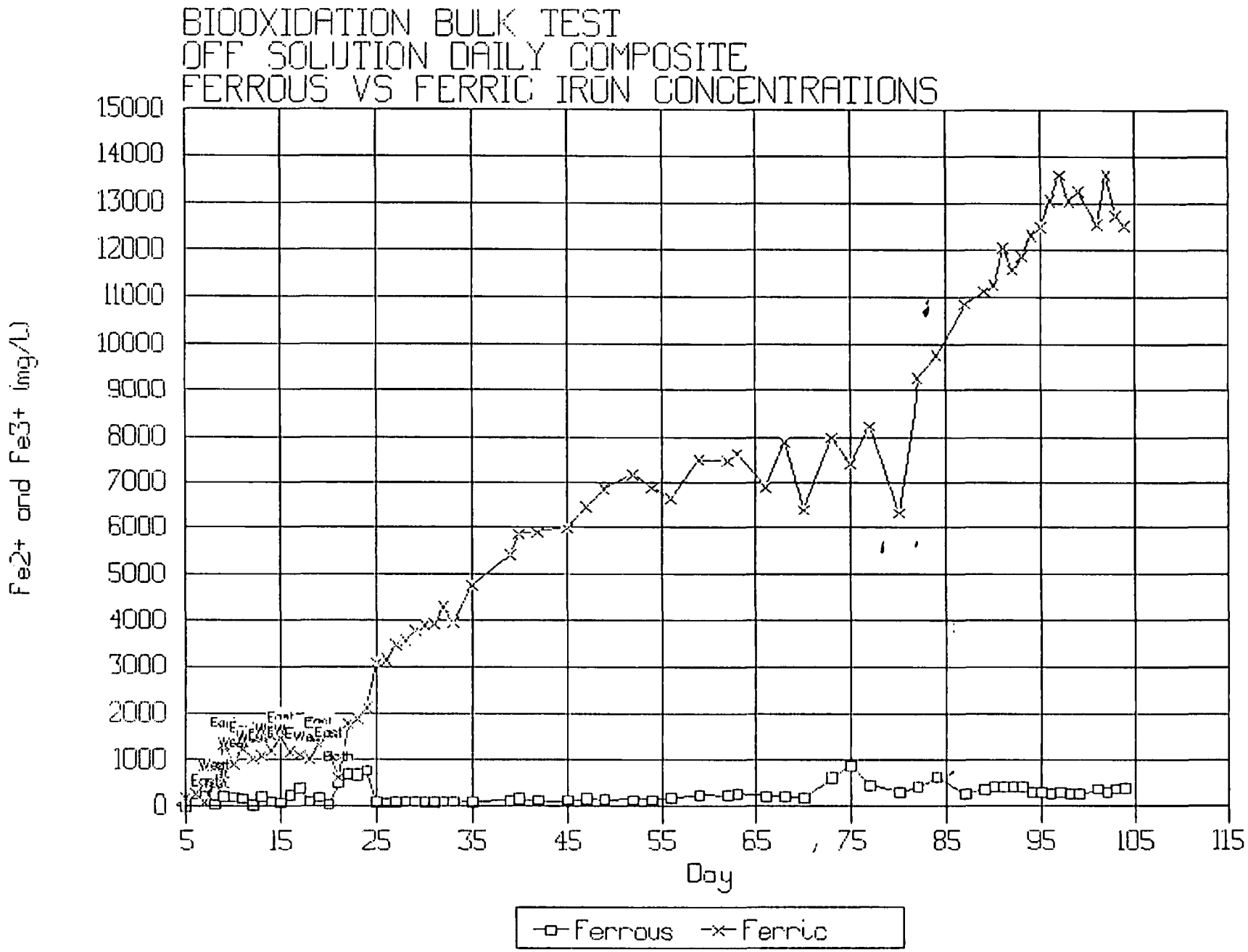

BIOOXIDATION BULK TEST
THERMOCOUPLE DATA
THERMOCOUPLES 1-6
Degree Centigrade
60
50
40
30
20
10
0
-10
5
15
25
35
45
55
65
75
85
95
105
115
Day
1
2
3
4
5
6
AMBIENT 1-6

(11-10-94)

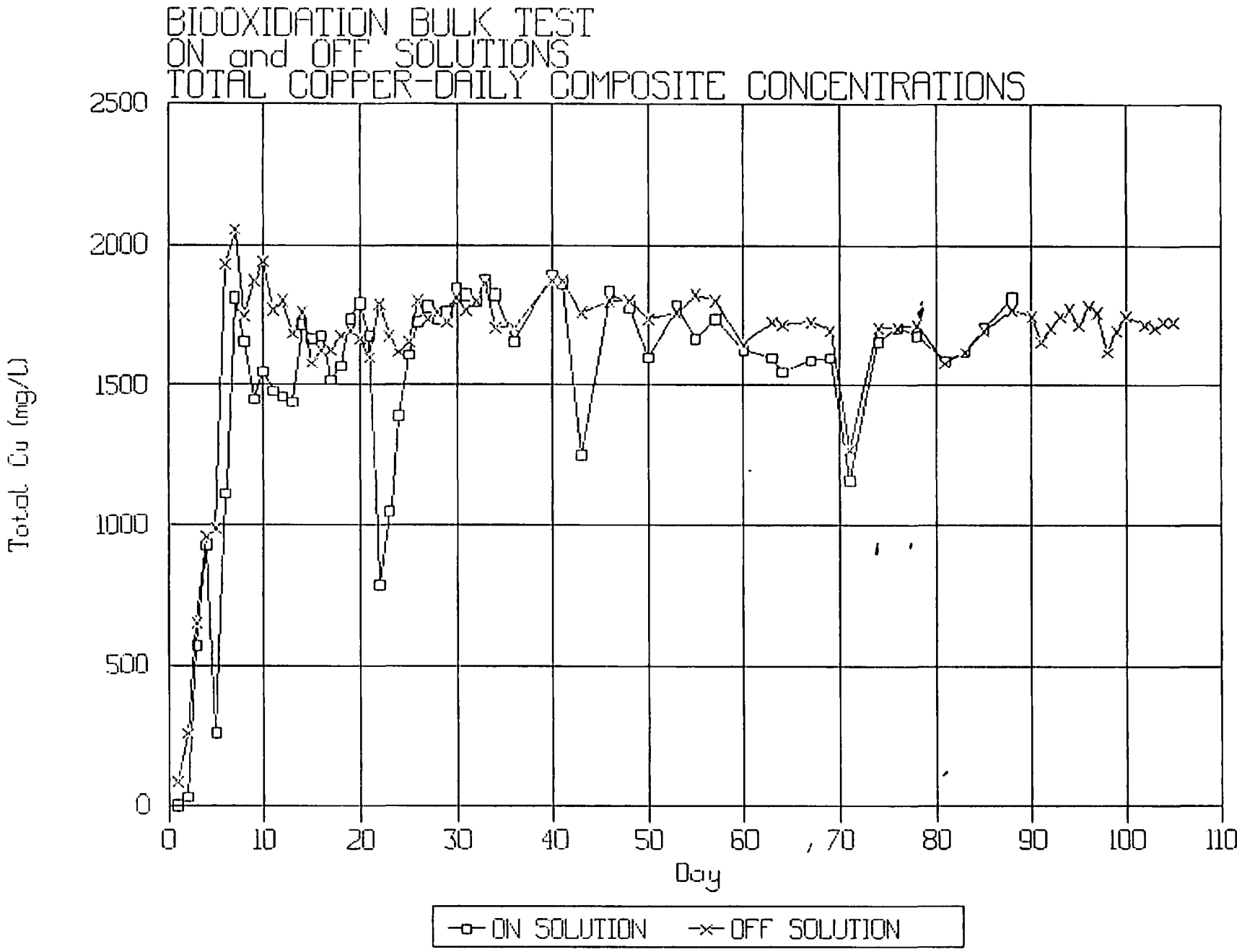

BIOOXIDATION BULK TEST
THERMOCOUPLE DATA
THERMOCOUPLES 7-12
Degree Centigrade
50
40
30
20
10
0
-10
5
15
25
35
45
55
65
75
85
95
105
115
Day
7
8
9
10
11
12
AMBIENT 7-12
(11-10-94)


BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
TOTAL IRON-DAILY COMPOSITE CONCENTRATIONS
Total Fe (mg/L)
15000
14000
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
0
10
20
30
40
50
60
70
80
90
100
110
Day
ON SOLUTION
OFF SOLUTION

(11-09-94)

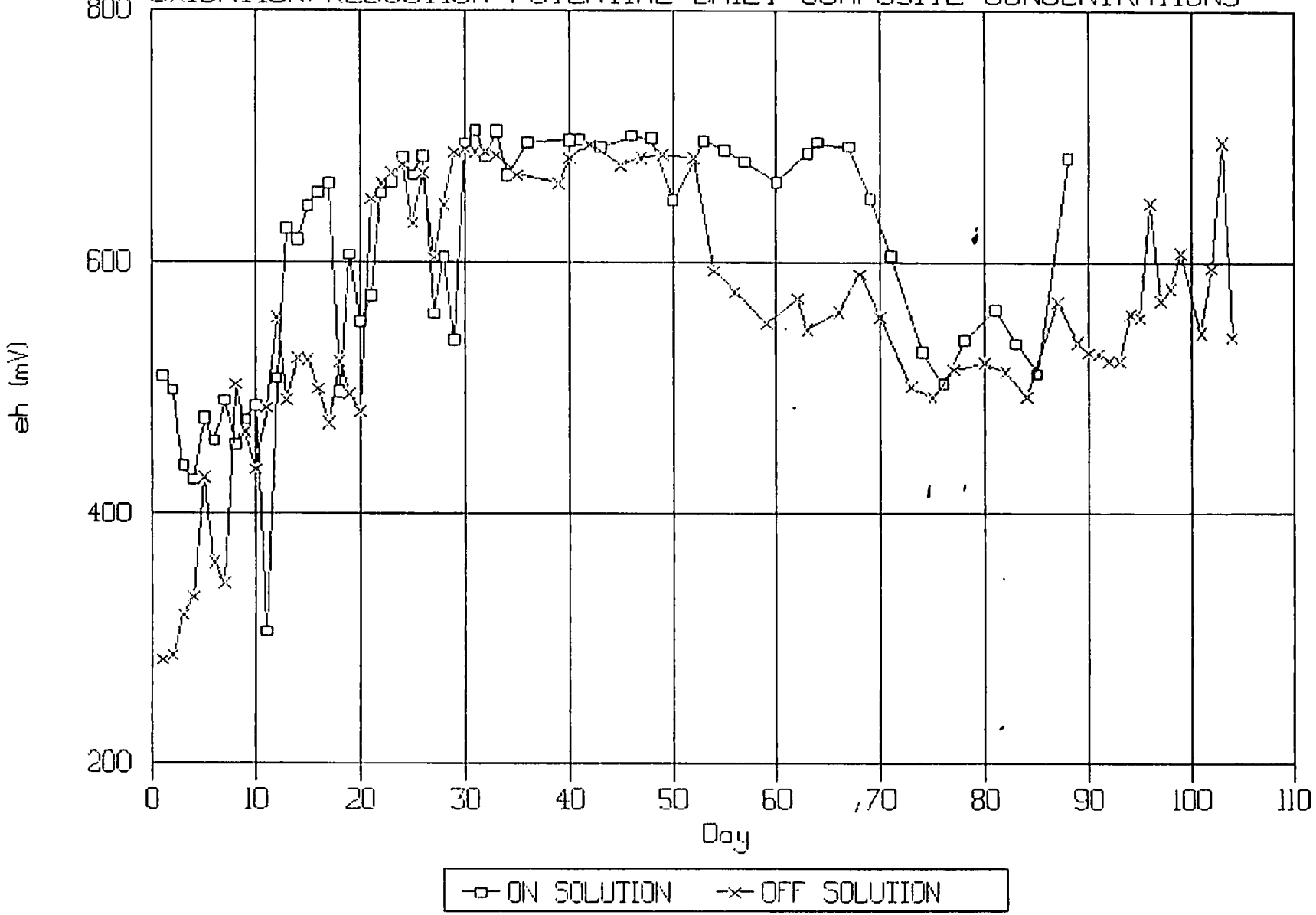

BIOOXIDATION BULK TEST
OFF SOLUTION DAILY COMPOSITE
FERROUS VS FERRIC IRON CONCENTRATIONS
Fe2+ and Fe3+ (mg/L)
15000
14000
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
5
15
25
35
45
55
65
75
85
95
105
115
Day
Ferrous
Ferric

(11-09-94)


BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
TOTAL COPPER-DAILY COMPOSITE CONCENTRATIONS
Total Cu (mg/L)
2500
2000
1500
1000
500
0
0
10
20
30
40
50
60
70
80
90
100
110
Day
ON SOLUTION
OFF SOLUTION

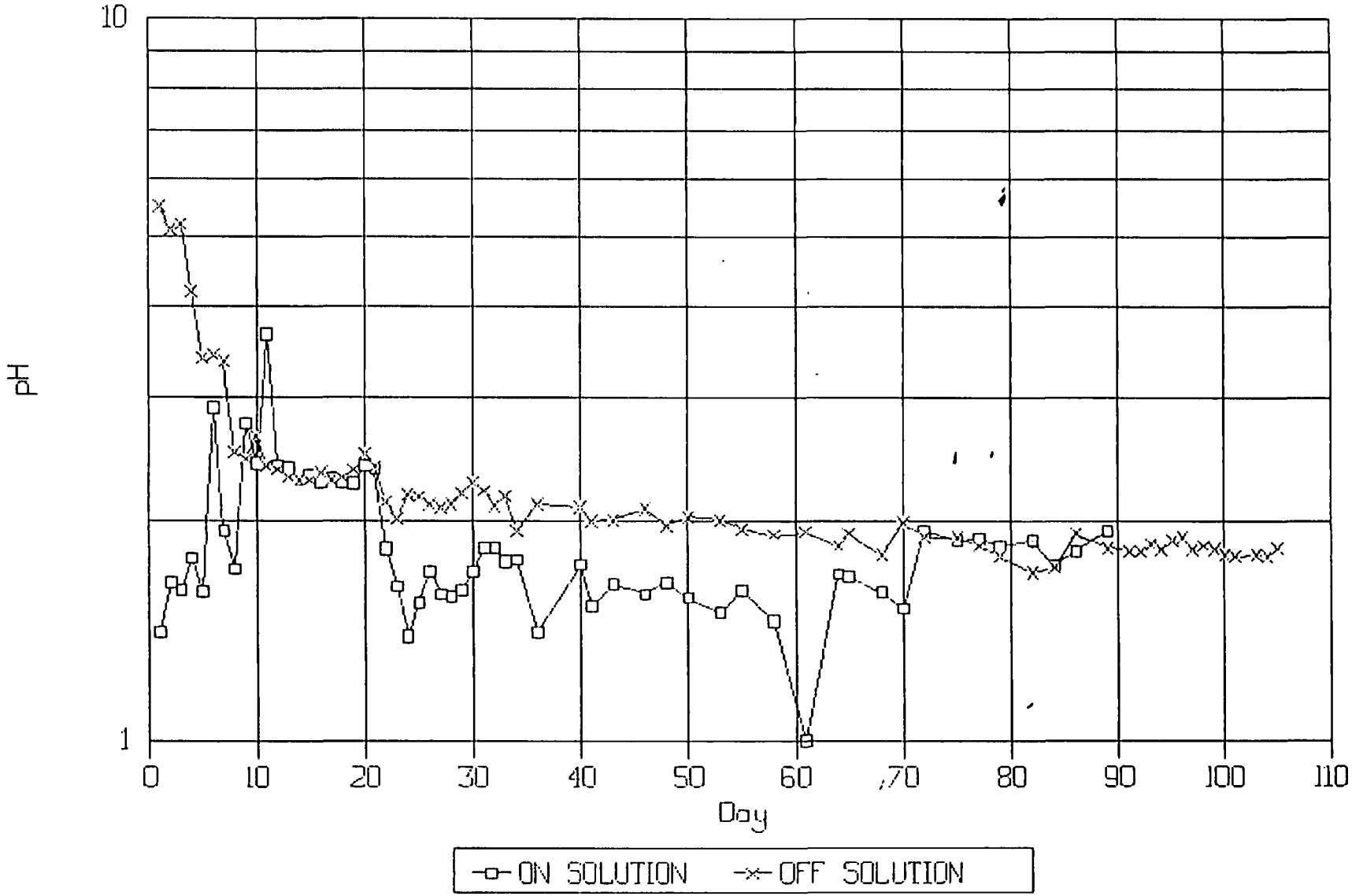
(11-08-94)

BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
OXIDATION/REDUCTION POTENTIAL-DAILY COMPOSITE CONCENTRATIONS

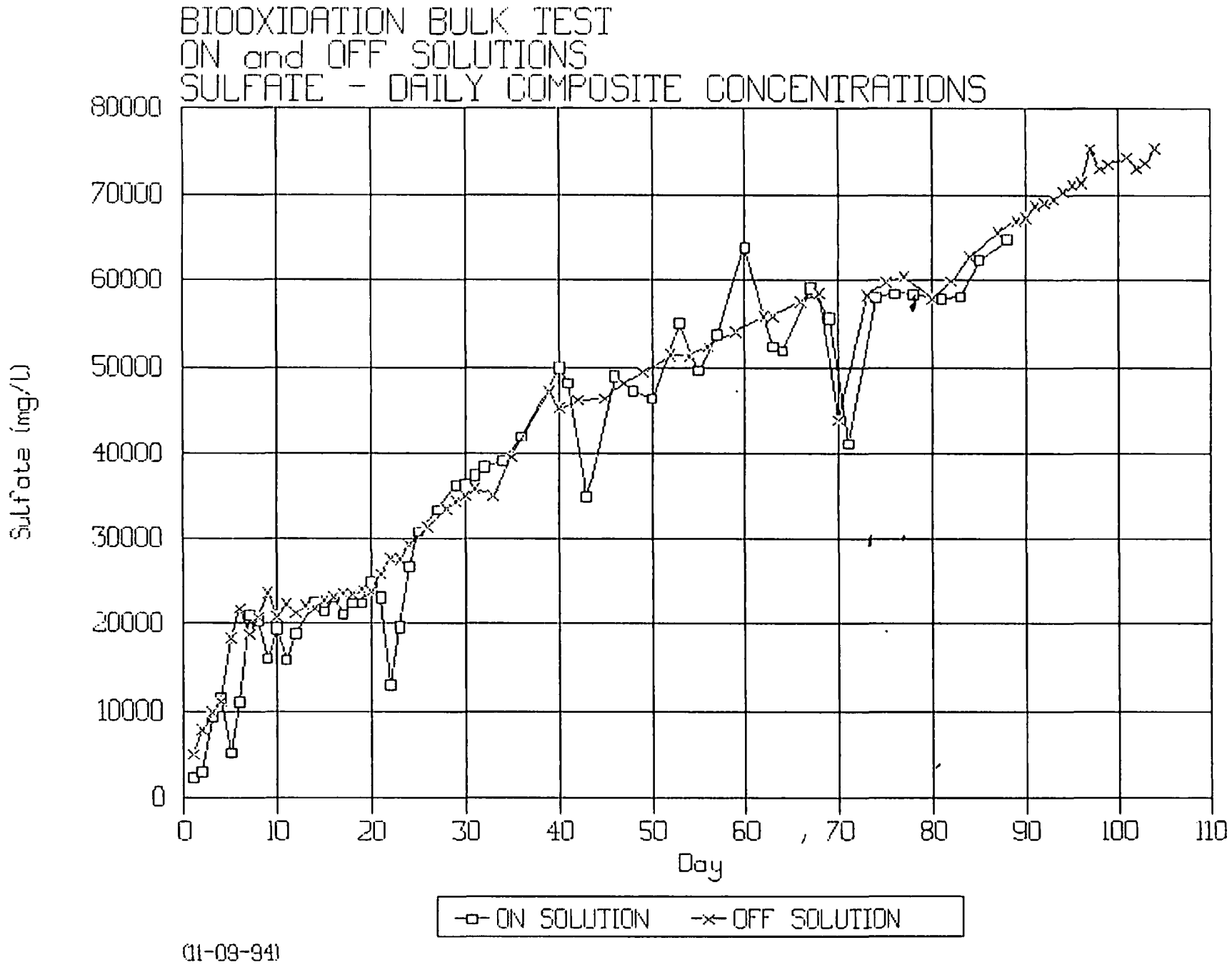


(11-09-94)

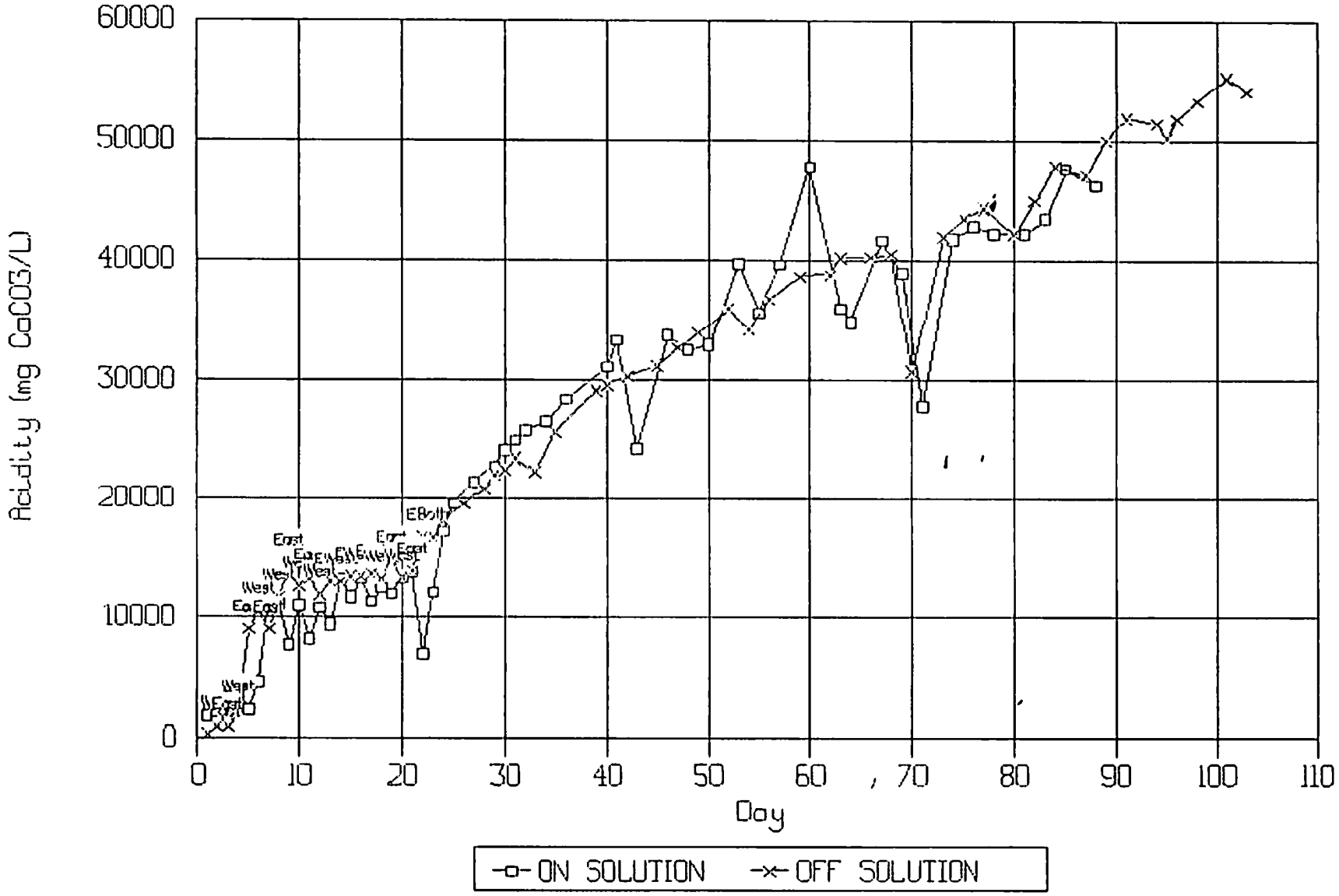
BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
pH - DAILY COMPOSITE



(11-09-94)


BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
SULFATE - DAILY COMPOSITE CONCENTRATIONS
Sulfate (mg/L)
80000
70000
60000
50000
40000
30000
20000
10000
0
0
10
20
30
40
50
60
70
80
90
100
110
Day
ON SOLUTION
OFF SOLUTION
(11-09-94)

BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
ACIDITY TO pH 7-DAILY COMPOSITE CONCENTRATIONS



(11-09-94)

MEMORANDUM

DATE: NOVEMBER 4, 1994
TO: JIM THOMPSON
FROM: LAURA DAMON
SUBJECT: BIOOXIDATION BULK TEST (BBT) WEEKLY UPDATE (14)

The BBT has been on the biooxidation cycle for fourteen weeks now. Both the west and east sides are on simultaneous solution application. The OFF solution continues to flow into the sump area and is then pumped to a 300 gallon tank holding the ON solution pump. A flow meter is located after the ON solution pump. The flow has averaged 6.1 gpm this week. The total solution has fallen from about 14,000 gallon per day to about 8500 gallon per day over the past couple of weeks. An obvious question is: "Where's the water going?". Some may be lost to evaporation but again there's the question of the integrity of the liner. This question may be able to be answered when the heap is off-loaded. The heap remains stable and intact.

Another question to be answered is: "Where's the iron going?". On October 26th there was a calculated 1404 lb iron in the OFF solution. On November 2nd the calculated iron had dropped to 919 lbs. The solution data based on ppm still indicate that the BBT continues to biooxidize. The total iron concentration is up close to 14,000 ppm this week and the slope has stayed at a steepened incline. The iron continues to be predominantly in the form of ferric iron. The drop in lbs of iron suggest either the flow meter isn't working properly or we are possibly losing water through a hole in the liner.

The copper values have stabilized in the 1700 ppm range. The pH of the OFF solution is in the 1.8 range and the oxidation/reduction potential has an eh range of 500-550. The sulfate concentration has risen this week as has the acidity.

Four auger drill-3 bottle rolls (west 10'-15'; mid 10'-15'; east 10'-15'; west, mid, east 1'-15' composite) and a composite column of ore were leached this week. Results should be available by next week.

Attached is a memo from John Shield, Geobiotics, conservatively estimating the extent of biooxidation to be between 3.7 and 6.2% at present. This correlates well with an attached memo on the auger drill-2 gold extraction results which show percent biooxidation to be between 2.5 and 5.8% a month ago.

c: Rod MacLeod
Martin Quick
Herb Osborne

LD

GEOBIOTICS, INC.

3505 Breakwater Avenue
Hayward, CA 94545

510 783-9060
Fax 510 783-9069

October 31, 1994

To: Jim Whitlock
From: John Shield

Re: **Gilt Edge Biooxidation Test Progress**

Measurement of the iron and sulfate content in the effluent solution is an indication of how the biooxidation is progressing in the test heap. Additionally, the copper level in the effluent is an indication of the extent of inhibitory components removal. Using the analytical data supplied by Laura Damon, I have been calculating the rate and extent of biooxidation as evidenced by these values. The rate of biooxidation can be reported as the % of sulfides biooxidized per day.

In the days immediately following the rain storms of 10/6 and 10/15-10/18 there were significant increases in the sulfate and iron levels in the effluent solution, indicating that the dilution and flushing caused by the rain increased the solubilization rates. Additionally, the rate of biooxidation after the rain storms seems to have stabilized at a higher rate than was seen earlier in the test.

Average rate of biooxidation by iron entire test	0.033 % / day
Average rate of biooxidation by iron before rain	0.026 % / day
Rate of biooxidation by iron 10/7 - 10/9	0.31 % / day
Rate of biooxidation by iron 10/17 - 10/18	0.25 % / day
Average rate of biooxidation by iron 10/19 - 10/26	0.040 % / day
Average rate of biooxidation by sulfate entire test	0.066 % / day
Average rate of biooxidation by sulfate before rain	0.064 % / day
Rate of biooxidation by sulfate 10/7 - 10/9	0.11 % / day
Rate of biooxidation by sulfate 10/17 - 10/18	0.10 % / day
Average rate of biooxidation by sulfate 10/19 - 10/23	0.078 % / day

Also the amount of copper in the system is an indication of the level of inhibitory metals. About 3200 lbs of copper have been removed from the test material, or about two thirds of the original amount. Of this about 800 lbs were removed since the rain. These data again confirm our laboratory observations that removing the inhibitory components is critical in the biooxidation of this ore.

These iron and sulfate calculations provide a lower bound for the amount of biooxidation that has occurred, because they do not account for any iron or sulfates that were removed from the test heap by neutralization, sludge removal or excess solution removal.

Using the total amount or iron and sulfate solubilized, the extent of biooxidation is between 3.7 and 6.2%. Again these numbers represent a lower bound; the actual extent of biooxidation is higher.

Could you please share these observations with the folks at the mine?

MEMORANDUM

DATE: NOVEMBER 1, 1994
TO: JIM THOMPSON
FROM: LAURA DAMON
SUBJECT: BIOOXIDATION BULK TEST (BBT) GOLD EXTRACTION COMPARISONS

The following table summarizes the BBT gold extraction data to date. Also included are NaCN consumption and CaO addition.

	SP2 Composite Control Column	SP2 Composite Control Bottle Roll	Auger Drill 2 West Bottle Roll	Auger Drill 2 Mid Bottle Roll
% Oxidation	0%	0%	5.8%[1)]	2.5%[1)]
% Au Extraction	56.6%[2)]	54.8%[2)]	62.4%[2)]	57.5%[2)]
NaCN Consumption (lb/ton ore)	2.1	2.1	2.0	2.6
CaO Addition (lb/ton ore)	12	18	26	27
Initial pH	11.5	12.1	11.8	12.0
Final pH	10.8	11.2	10.9	10.9

1) Oxidation percentages based on difference between Auger Drill-1 and Auger Drill-2 percent sulfide. It was assumed that no appreciable oxidation had taken place when Auger Drill-1 Samples were collected on 08-23-94.

2) Gold Extraction percentages based on the calculated head.

c: Rod MacLeod
Martin Quick
Herb Osborne

BIOOXIDATION BULK TEST SOLUTION SAMPLING

OFF SOLUTION

Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	DO (ppm)
SUMP-GRAB	07/26/94	1200	1200	7.22	-	.84	.27	-	-	-	-	-
GRAB-1530	07/27/94	1750	2950	7.53	305.4	.89	.20	-	-	-	-	-
COMP	07/28/94	3000	5950	5.93	353.6	83	.55	-	-	83	4411	-
COMP	07/29/94	3293	9243	5.49	282.1	255	13	-	-	362	5094	-
COMP	07/30/94	4419	13662	5.11	285.7	654	14	-	-	994	7913	-
COMP	07/31/94	2688	16350	5.18	318.8	960	11	-	-	956	9835	-
COMP	08/01/94	7822	24172	4.20	332.3	990	39	1	38	2438	11106	-
COMP	08/02/94	21836	46008	3.39	429.6	1930	172	2	170	8960	18304	-
COMP	08/03/94	14710	60718	3.43	360.1	2050	520	260	260	10520	21678	-
COMP	08/04/94	7500	68218	3.36	344.2	1750	500	410	90	8967	18731	-
COMP	08/05/94	6821	75039	2.50	503.7	1870	480	40	440	11633	20711	-
COMP	08/06/94	21396	96436	2.45	465.2	1940	1530	200	1330	14570	23591	-
COMP	08/07/94	21396	117832	2.63	435.8	1770	1110	190	920	12617	20727	-
COMP	08/08/94	18698	136530	2.40	484.6	1800	1390	160	1230	13259	22299	-
COMP	08/09/94	21118	157648	2.36	557.4	1690	1070	36	1034	11904	21180	-
COMP	08/10/94	16419	174067	2.31	491.4	1760	1320	220	1100	12958	22052	-
COMP	08/11/94	16500	190567	2.29	524.4	1580	1290	86	1204	12958	21764	-
COMP	08/12/94	18213	208780	2.28	523.1	1630	1520	56	1464	13452	22729	1.3
COMP	08/13/94	18585	227365	2.34	500.2	1630	1420	240	1180	13361	22995	1.3
COMP	08/14/94	16646	244011	2.29	472.4	1680	1490	380	1110	13608	23458	-
COMP	08/15/94	13559	257570	2.31	522.4	1700	1110	84	1026	13179	23381	-
COMP	08/16/94	12267	269837	2.36	496.4	1670	1540	196	1344	14831	23933	1.4
COMP	08/17/94	7697	277534	2.49	481.4	1600	1160	43	1117	13309	23711	2.2
COMP	08/18/94	7136	284670	2.39	650.1	1790	1100	480	620	13839	25735	1.7
COMP	08/19/94	13078	297748	2.13	663.0	1680	2450	690	1760	16703	27554	-
COMP	08/20/94	14479	312227	2.02	672.0	1620	2550	670	1880	16716	27464	-
COMP	08/21/94	14213	326440	2.18	678.3	1660	2900	770	2130	18024	29200	-
COMP	08/22/94	14246	340686	2.16	631.0	1800	3160	75	3085	-	-	-
COMP	08/23/94	13868	354554	2.11	671.3	1740	3210	73	3137	19568	31299	-
COMP	08/24/94	12742	367296	2.09	604.1	1760	3540	82	3458	-	-	.7
COMP	08/25/94	11741	379037	2.11	646.9	1730	3640	86	3554	20823	33471	5.5?
COMP	08/26/94	12505	391542	2.19	687.1	1810	3860	86	3774	22006	34443	OFL
COMP	08/27/94	11272	402814	2.27	689.5	1770	4000	94	3906	22374	35035	-
COMP	08/28/94	9000	411814	2.21	688.0	1800	4000	82	3918	23319	35858	-
COMP	08/29/94	9000	420814	2.10	688.2	1860	4370	86	4284	-	-	OFL
COMP	08/30/94	11403	432217	2.17	685.5	1710	4030	84	3946	22242	35134	13.5?
COMP	08/31/94	10726	442943	-	-	-	-	-	-	-	-	OFL
COMP	09/01/94	10299	453242	1.94	669.9	1710	4840	89	4751	25577	39562	OFL
COMP	09/02/94	9075	462317	-	-	-	-	-	-	-	-	3.9
COMP	09/03/94	8149	470466	-	-	-	-	-	-	-	-	-
COMP	09/04/94	7612	478078	-	-	-	-	-	-	-	-	-
COMP	09/05/94	7357	485435	2.11	663.7	1870	5550	120	5430	29017	47141	-
COMP	09/06/94	6870	492305	2.09	682.9	1870	6010	151	5859	29543	45273	3.5
COMP	09/07/94	6503	498808	-	-	-	-	-	-	-	-	6.2
COMP	09/08/94	10447	509255	2.00	693.8	1760	6010	117	5893	30304	46121	5.5
COMP	09/09/94	8553	517808	-	-	-	-	-	-	-	-	5.5
COMP	09/10/94	8424	526232	-	-	-	-	-	-	-	-	-
COMP	09/11/94	8424	534656	2.01	677.7	1800	6100	114	5986	31157	46376	-
COMP	09/12/94	7258	541914	-	-	-	-	-	-	-	-	-
COMP	09/13/94	6630	548544	2.08	683.7	1800	6600	151	6449	32657	48154	2.8
COMP	09/14/94	7479	556023	-	-	-	-	-	-	-	-	2.6
COMP	09/15/94	11492	567515	1.97	685.6	1740	7000	142	6858	33989	49372	4.6
COMP	09/16/94	11244	578759	-	-	-	-	-	-	-	-	2.8
COMP	09/17/94	11287	590046	-	-	-	-	-	-	-	-	-
COMP	09/18/94	10435	600481	2.03	684.0	1760	7300	134	7166	35825	51363	-
COMP	09/19/94	9531	610012	-	-	-	-	-	-	-	-	2.5
COMP	09/20/94	6175	616187	2.01	593.5	1820	7000	134	6866	34241	51265	2.8

BIOOXIDATION BULK TEST SOLUTION SAMPLING

OFF SOLUTION

Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	DO (ppm)
COMP	09/22/94	5238	626486	1.95	576.7	1800	6800	171	6629	36579	52376	3.5
COMP	09/23/94	6073	632559	-	-	-	-	-	-	-	-	3.2
COMP	09/24/94	9286	641845	-	-	-	-	-	-	-	-	-
COMP	09/25/94	9592	651437	1.91	552.0	1650	7730	250	7480	38565	54096	-
COMP	09/26/94	7385	658822	-	-	-	-	-	-	-	-	2.8
COMP	09/27/94	9119	667941	-	-	-	-	-	-	-	-	3.5
COMP	09/28/94	7789	675730	1.93	571.8	1730	7700	230	7470	38690	55742	-
COMP	09/29/94	7387	683117	1.85	547.2	1720	7900	270	7630	40150	55898	-
COMP	09/30/94	7807	690924	-	-	-	-	-	-	-	-	3.2
COMP	10/01/94	6502	697426	-	-	-	-	-	-	-	-	-
COMP	10/02/94	6502	703928	1.92	560.7	1730	7100	210	6890	40202	57552	-
COMP	10/03/94	6231	710159	-	-	-	-	-	-	-	-	4.2
COMP	10/04/94	6834	716993	1.80	591.1	1700	8100	210	7890	40383	58458	4.5
COMP	10/05/94	6911	723904	-	-	-	-	-	-	-	-	4.5
COMP	10/06/94	28493	752396	1.99	557.3	1270	6550	170	6380	30663	43932	3.7
COMP	10/07/94	22817	775213	-	-	-	-	-	-	-	-	-
COMP	10/08/94	19403	794616	-	-	-	-	-	-	-	-	-
COMP	10/09/94	21196	815812	1.90	501.8	1710	8600	610	7990	41883	58178	-
COMP	10/10/94	17200	833012	-	-	-	-	-	-	-	-	2.8
COMP	10/11/94	11500	844512	1.90	492.7	1710	8300	890	7410	43442	59840	2.4
COMP	10/12/94	17000	861512	-	-	-	-	-	-	-	-	-
COMP	10/13/94	18300	879812	1.85	515.7	1720	8700	460	8240	44220	60408	2.1
COMP	10/14/94	15800	895612	-	-	-	-	-	-	-	-	2.0
COMP	10/15/94	16500	912112	-	-	-	-	-	-	-	-	-
COMP	10/16/94	20700	932812	1.79	520.7	1580	6600	300	6300	42146	57873	-
COMP	10/17/94	24500	957312	-	-	-	-	-	-	-	-	2.1
COMP	10/18/94	20500	977812	1.70	514.3	1620	9700	410	9290	44826	59766	2.2
COMP	10/19/94	14300	992112	-	-	-	-	-	-	-	-	2.0
COMP	10/20/94	7750	999862	1.73	493.7	1700	10400	630	9770	47772	62737	2.4
COMP	10/21/94	11600	1011462	-	-	-	-	-	-	-	-	2.5
COMP	10/22/94	9400	1020862	-	-	-	-	-	-	-	-	-
COMP	10/23/94	10000	1030862	1.92	569.0	1770	11100	260	10840	46976	65675	-
COMP	10/24/94	13030	1043892	-	-	-	-	-	-	-	-	2.7
COMP	10/25/94	14262	1058154	1.84	536.9	1750	11500	370	11130	49948	66992	2.2
COMP	10/26/94	14397	1072551	1.82	528.8	1660	11700	430	11270	-	67280	2.4
COMP	10/27/94	11874	1084425	1.82	527.6	1710	12500	430	12070	51833	68663	2.4
COMP	10/28/94	8026	1092451	1.86	522.4	1750	12000	430	11570	-	68992	2.8
COMP	10/29/94	10207	1102658	1.83	521.9	1770	12300	430	11870	-	69362	-
COMP	10/30/94	7615	1110273	1.88	559.8	1720	12600	290	12310	51344	70367	-
COMP	10/31/94	7157	1117430	1.90	555.7	1780	12800	310	12490	50208	71099	3.6
COMP	11/ 1/94	8767	1126197	1.83	647.6	1760	13300	260	13040	51667	71354	3.2
COMP	11/ 2/94	7936	1134133	1.85	569.8	1620	13900	300	13600	-		-

Note: Flow meter may have been intermittently plugged on readings from 10/28 - 11/2. This may account for lower flows.

I would guestimate the total to be around 10,000 gal/day.

** After checking with the operators, the reported flows may be correct. The flow meter readings have gone from 10gpm → 6+gpm.

BIOOXIDATION BULK TEST SOLUTION SAMPLING

PAN LYSIMETER 3

Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO (ppm)
GRAB	08/03/94	1.93	488.4	1540	4640	1200	3440	20005	23896	-	
GRAB	08/11/94	1.52	496.1	3200	8700	2900	5800	-	-	Brown/Murky	
GRAB	08/12/94	1.89	450.4	2200	3900	2100	1800	-	27461	Lt Brown	1.5
GRAB	08/15/94	1.92	459.5	2170	3920	1270	2650	15417	27625	Med Brown	1.7
GRAB	08/17/94	1.97	462.7	1940	3220	560	2660	19502	25159	Med Brown	2.4
GRAB	08/19/94	2.00	458.4	1850	2300	1400	900	17828	23604	-	-
GRAB	08/22/94	1.90	464.0	1760	2300	360	1940	16677	23744	Grw/Br Ti	1.9
GRAB	08/24/94	2.04	468.5	1780	2680	770	1910	16795	23028	Green	.9
GRAB	08/26/94	2.05	479.6	1730	2700	690	2010	17030	24320	Br-Yel	4.5?
GRAB	08/29/94	2.08	472.8	1770	2760	360	2400	17936	25167	Yel-Br	OFL
GRAB	09/01/94	1.79	472.3	1870	2730	730	2000	19039	26822	Green	OFL
GRAB	09/06/94	1.83	492.1	1940	2620	210	2410	19748	30237	Lt Green	2.5
GRAB	09/08/94	1.80	488.8	1980	2870	300	2570	21454	30435	Dk Green	4.3
GRAB	09/13/94	1.68	499.7	2040	3310	510	2800	22662	32648	Gr;cldy	0.9
GRAB	09/20/94	1.66	494.8	2000	3930	300	3630	24512	33471	Lt Green	1.4
GRAB	09/22/94	1.56	481.2	1980	4250	770	3480	26724	34796	Gr-Br	1.6
GRAB	09/27/94	1.66	487.7	1920	3820	460	3360	24512	34253	Gr;cldy	1.8
GRAB	09/29/94	1.73	498.0	2070	3820	460	3360	25972	37735	Green	2.3
GRAB	10/04/94	1.63	504.6	2320	3710	330	3380	30067	42385	Gr;cldy	2.9
GRAB	10/06/94	1.66	496.1	2500	3880	440	3440	32530	46919	Gr;cldy	4.9
GRAB	10/11/94	1.63	508.9	2550	5630	430	5200	39606	54458	Br;cldy	3.9
GRAB	10/13/94	1.49	485.7	2400	6370	1020	5350	43658	57709	Gr-Brown	1.9
GRAB	10/18/94	1.52	469.2	2180	7050	1660	5390	43101	47232	Gr-Brown	2.8
GRAB	10/20/94	1.59	478.9	1940	7650	1230	6420	43738	59454	Br;cldy	3.4
GRAB	10/25/94	1.89	556.7	1800	11500	270	11230	50081	67083	Dk Br;ppt	2.1
GRAB	10/27/94	1.82	532.0	1710	11500	380	11120	50161	67486	Br;cldy	2.3
GRAB	11/01/94	1.79	489.8	1790	11100	960	10140	48749	68860	Milky Br	2.0
GRAB	11/03/94	1.67	479.7	1730	11400	1510	9890	50028		Br;cldy	1.5

BIOOXIDATION BULK TEST SOLUTION SAMPLING

PAN LYSIMETER 5

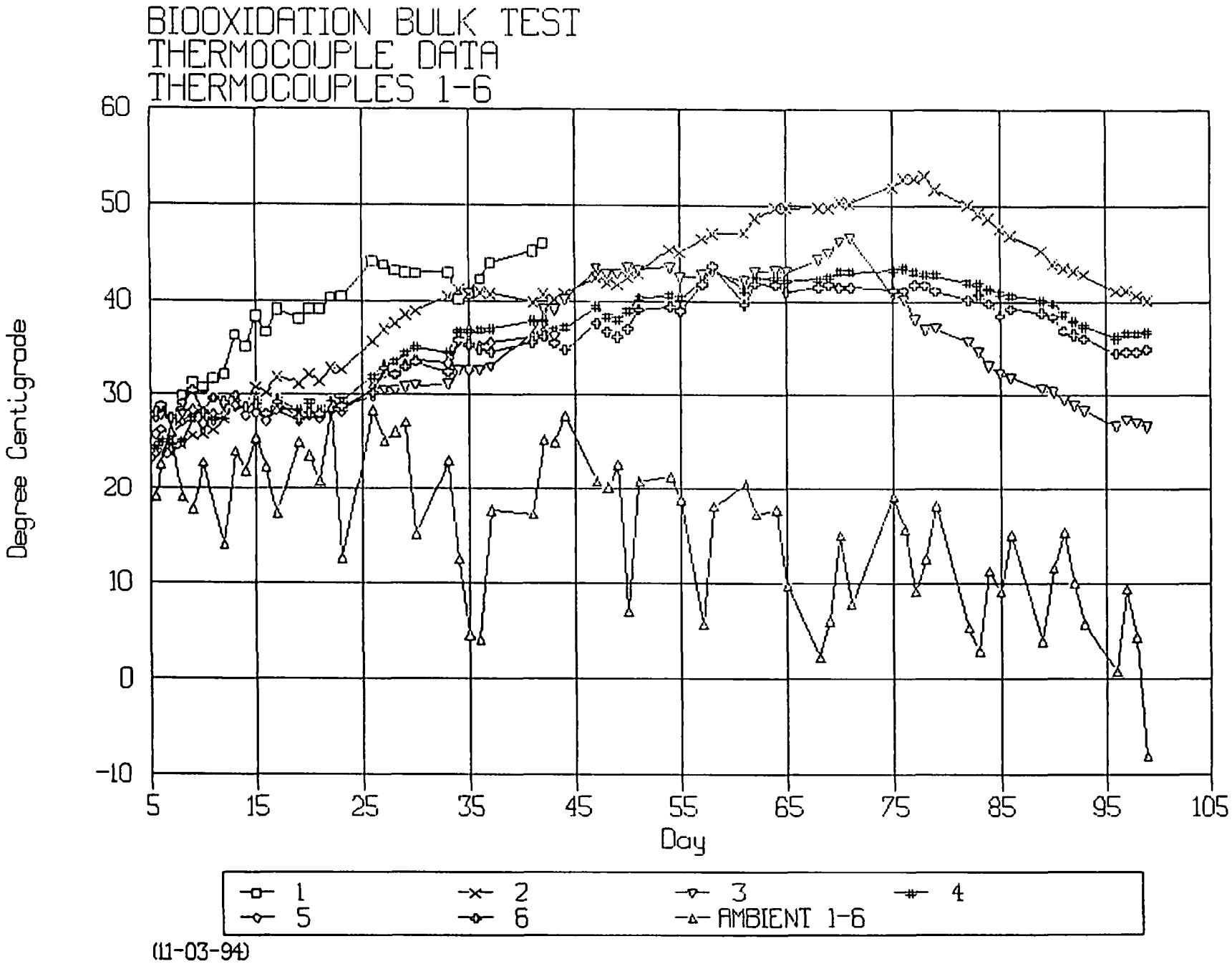
Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO (ppm)
GRAB	08/03/94	1.49	515.6	3690	17700	2100	15600	57687	66622	Dark Brown	-
GRAB	08/04/94	1.32	511.1	3930	14100	1600	12500	60119	67556	Dark Brown	-
GRAB	08/09/94	1.70	484.5	2600	4500	1400	3100	28440	38389	Dark Brown	-
GRAB	08/10/94	2.37	574.1	1740	990	36	954	11468	23641	Off Soln Flush	
GRAB	08/11/94	1.72	431.8	2000	3700	3400	300	-	-	Green Color	-
GRAB	08/12/94	1.80	439.7	2000	3900	2900	1000	20048	24627	Lt Green	3.7
GRAB	08/15/94	1.88	361.1	1940	3940	2200	1740	20543	24800	Green	2.6
GRAB	08/17/94	1.88	415.7	2030	4800	3700	1100	23073	27307	Green	2.7
GRAB	08/19/94	1.87	418.5	2170	4100	4000	100	21647	27324	-	-
GRAB	08/22/94	2.26	437.3	1920	2800	2300	500	18260	24542	Yel-Br	2.1
GRAB	08/24/94	2.12	385.4	1880	3250	2900	350	17056	25184	Lt Gr/Blue	OFL
GRAB	08/26/94	2.39	414.8	1780	3270	2290	980	16428	24641	Yel-Gr;odor	OFL
GRAB	08/29/94	2.47	402.7	1730	3260	2110	1150	16623	24698	Lt Green	OFL
GRAB	09/01/94	2.28	492.3	1700	2600	480	2120	16360	24254	Yel-Br;odor	OFL
GRAB	09/06/94	2.30	386.7	1520	3010	1830	1180	16097	25933	Bl-Gr;odor	2.5
GRAB	09/08/94	2.36	465.2	1480	2490	430	2060	16202	24534	Lt Br;ppt	4.3
GRAB	09/13/94	2.32	389.7	1170	3250	3700	-450	16019	25019	Lt Green	0.9
GRAB	09/20/94	2.30	386.7	1110	2470	2600	-130	15185	23797	Lt Green	1.8
GRAB	09/22/94	2.23	417.6	1110	2320	2000	320	15888	24163	Lt Green	2.8
GRAB	09/27/94	2.17	563.9	1110	1650	700	950	16416	24270	Lt Brown	2.8
GRAB	09/29/94	2.19	500.5	1280	1950	200	1750	13841	25834	Brown	2.8
GRAB	10/04/94	2.07	473.2	1240	1760	410	1350	16978	25776	Yel-Lt Br	3.0
GRAB	10/06/94	2.21	576.0	1290	1630	80	1550	16265	25390	Lt Brown	6.0
GRAB	10/11/94	2.17	637.1	1360	1740	690	1050	18274	29389	Gr-Yellow	5.0
GRAB	10/13/94	1.99	567.5	1500	1970	60	1910	21497	32739	Yel-Lt Br	4.0
GRAB	10/18/94	1.96	514.8	1760	2380	177	2203	24019	36517	Green	3.5
GRAB	10/20/94	1.85	514.6	2020	2600	171	2429	25983	38648	Green	3.2
GRAB	10/25/94	2.08	460.3	2720	4530	1340	3190	38987	56425	Dk Gr-Br	1.4
GRAB	10/27/94	1.93	405.0	2480	5690	5300	390	39093	55289	Lt Green	1.8
GRAB	11/01/94	2.11	379.2	2800	7080	7500	-420	39471	58375	Aqua Green	1.8
GRAB	11/03/94	2.23	407.1	2610	6640	530	6110	39048		Gr-Br;ppt	2.7

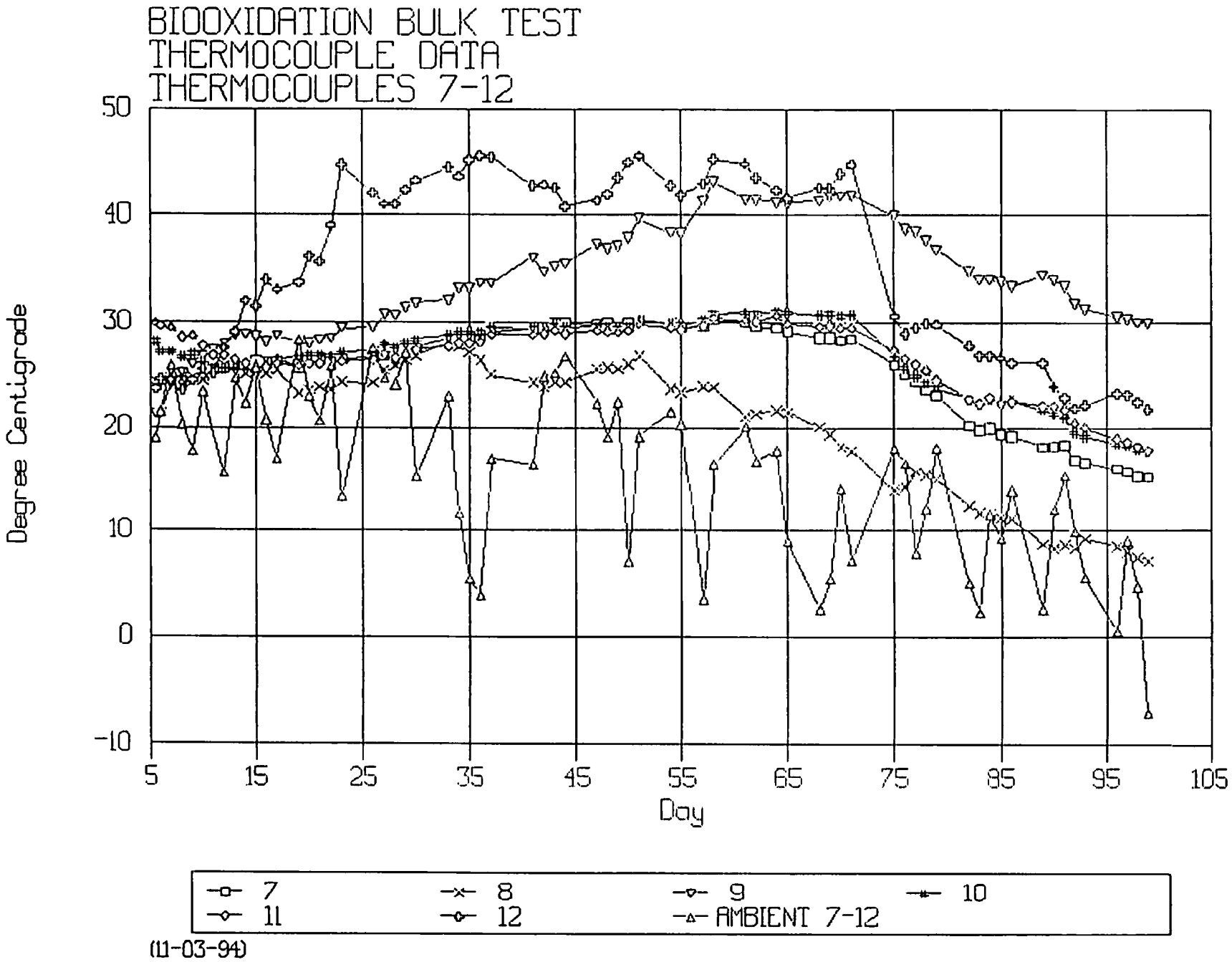
BIOOXIDATION BULK TEST THERMOCOUPLE DATA

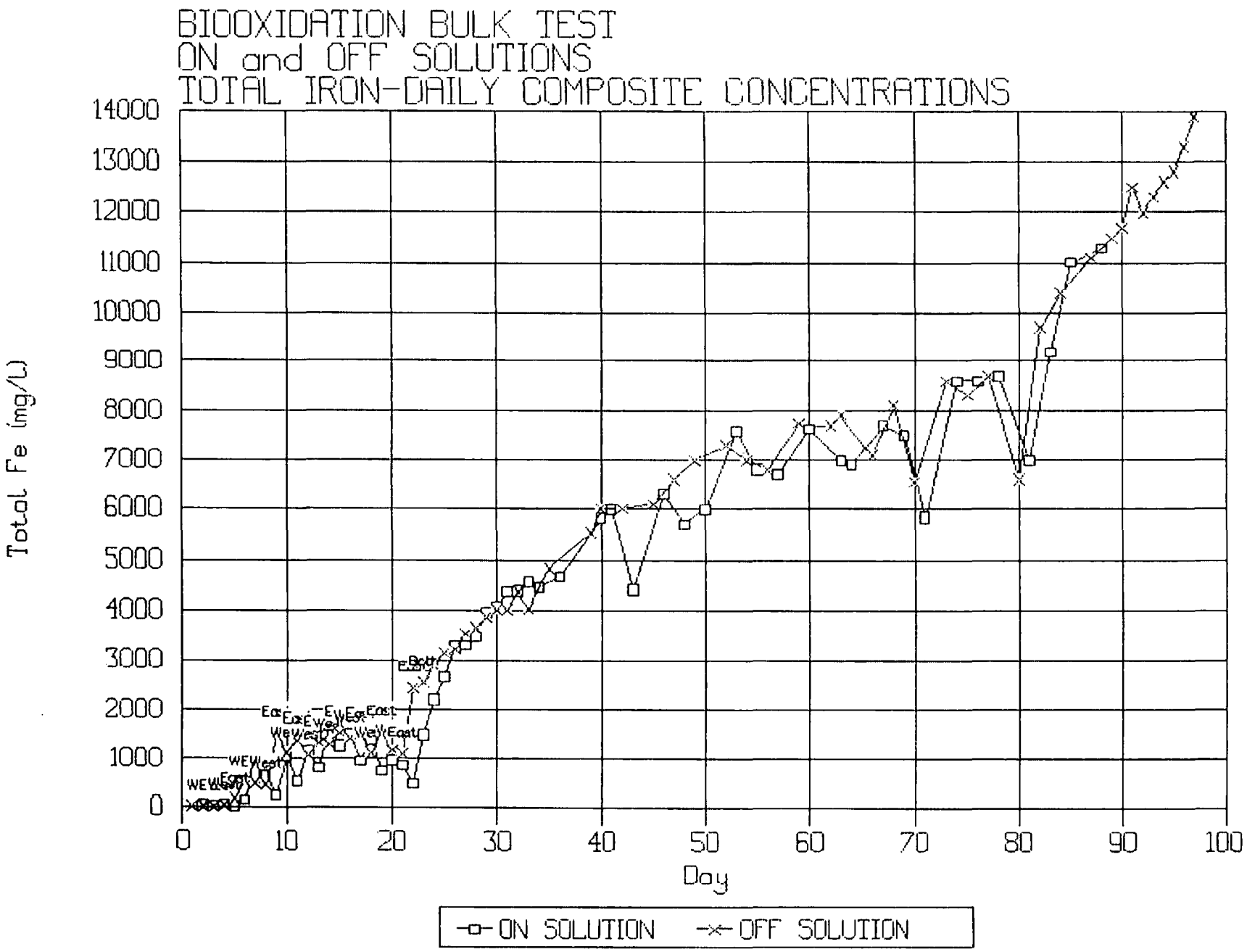
Date	West 1	West 2	West 3	West 4	West 5	Mid 6	Mid 7	Mid 8	East 9	East 10	East 11	East 12	AMBIENT 1-6	AMBIENT 7-12
08/02/94	27.8	23.2	27.4	24.3	25.7	28.0	24.3	24.3	21.2	28.1	29.8	23.5	19.0	18.9
08/02/94	28.2	23.8	27.6	25.0	26.2	28.7	24.3	24.5	21.3	27.1	29.6	24.4	22.6	21.5
08/03/94	27.2	23.7	27.2	24.6	25.6	27.5	24.5	24.8	24.0	27.1	29.4	24.3	26.0	25.8
08/04/94	29.7	24.7	27.8	25.0	27.0	29.0	24.2	24.4	25.1	26.6	28.5	23.4	19.0	20.3
08/05/94	31.3	25.6	28.2	27.3	28.3	30.4	25.5	24.6	25.9	26.9	28.6	24.3	17.7	17.7
08/06/94	30.7	25.8	27.7	26.6	26.9	28.1	24.8	24.4	26.6	25.9	27.7	25.4	22.8	23.3
08/07/94	31.8	26.2	27.1	27.4	27.9	29.6	25.4	25.5	27.3	25.5	26.8	25.0	-	-
08/08/94	32.2	27.3	27.9	27.6	27.9	29.1	25.5	25.7	27.9	25.3	26.8	27.5	14.0	15.5
08/09/94	36.4	28.9	28.6	29.3	28.9	29.9	25.7	24.9	28.7	25.4	26.4	29.0	24.0	24.5
08/10/94	35.1	28.8	28.0	28.3	27.8	28.6	25.8	25.0	28.8	25.5	26.0	32.0	21.9	22.3
08/11/94	38.4	30.8	28.5	29.2	28.1	28.9	26.2	25.1	28.5	25.6	25.8	31.5	25.4	25.6
08/12/94	36.6	30.2	27.7	27.8	27.2	27.9	26.1	25.0	28.1	26.0	25.6	34.0	22.3	20.7
08/13/94	39.0	31.9	28.6	29.4	28.3	29.2	26.3	25.3	28.6	26.4	25.9	33.1	17.3	17.0
08/14/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/15/94	38.1	31.2	28.2	28.3	27.1	27.5	25.6	23.2	28.2	26.5	25.7	33.7	24.9	28.3
08/16/94	39.1	32.2	29.0	28.8	27.6	28.0	26.2	23.5	28.0	26.8	25.9	36.2	23.5	22.9
08/17/94	39.1	31.4	28.3	28.3	27.4	27.9	26.3	23.7	28.3	26.8	26.0	35.7	20.8	20.6
08/18/94	40.3	32.8	29.4	29.2	28.3	28.6	26.1	23.5	28.4	26.7	25.9	39.0	28.6	25.7
08/19/94	40.4	32.7	28.8	29.3	28.2	28.7	26.4	24.2	29.4	27.0	26.2	44.8	12.6	13.3
08/20/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/21/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/22/94	44.1	35.7	29.8	31.9	30.7	30.2	26.5	24.1	29.5	27.4	26.3	42.1	28.3	27.5
08/23/94	43.7	37.1	30.4	33.3	32.3	32.8	26.7	25.3	30.7	27.9	26.9	41.0	25.1	24.5
08/24/94	43.1	37.7	30.4	33.5	32.2	32.1	26.8	25.7	30.6	27.6	26.5	41.0	26.0	24.0
08/25/94	43.0	38.5	30.9	34.4	33.2	33.0	27.3	26.3	31.4	28.0	27.0	42.4	27.0	27.0
08/26/94	42.9	38.9	31.0	35.1	33.8	33.5	27.5	26.8	31.8	28.3	27.3	43.3	15.0	15.2
08/27/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/28/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/29/94	43.0	40.5	31.1	34.5	33.4	32.4	28.3	27.9	32.1	28.7	27.7	44.6	23.0	22.9
08/30/94	40.1	41.2	32.6	36.8	35.7	35.8	28.6	27.7	33.2	28.9	28.0	43.7	12.4	11.6
08/31/94	40.8	40.6	32.5	36.8	35.7	35.4	28.6	27.1	33.3	28.9	28.0	45.3	4.6	5.3
09/01/94	42.3	40.9	32.6	36.9	35.3	34.8	28.7	26.4	33.7	29.0	28.1	45.7	4.1	3.9
09/02/94	44.0	40.8	33.0	37.0	35.7	34.6	29.1	24.9	33.7	29.5	28.8	45.6	17.6	17.0
09/03/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/04/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/05/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/06/94	45.2	39.9	36.4	37.9	36.3	35.6	29.4	24.2	36.1	29.4	28.8	42.8	17.2	16.4
09/07/94	46.1	40.7	39.0	37.9	36.8	36.3	29.2	23.7	34.7	29.3	28.9	42.9	25.3	24.8
09/08/94	-	40.2	39.0	36.9	36.4	35.5	29.9	24.2	35.3	29.7	29.2	42.6	25.0	25.1
09/09/94	-	40.8	40.2	37.2	-	34.8	29.9	24.2	35.5	29.5	28.9	40.8	27.8	26.7
09/10/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/11/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/12/94	-	42.5	43.4	39.4	-	37.7	29.8	25.5	37.4	29.6	29.2	41.4	20.8	22.3
09/13/94	-	41.9	42.8	38.3	-	36.8	29.9	25.6	37.0	29.6	29.1	42.0	20.1	19.0
09/14/94	-	41.7	42.8	38.0	-	36.2	29.6	25.5	37.2	29.4	29.0	43.6	22.6	22.4
09/15/94	-	42.5	43.6	38.9	-	37.1	29.9	26.0	37.9	29.6	29.2	45.1	7.0	7.0
09/16/94	-	42.9	43.2	40.3	-	39.1	30.2	26.8	39.7	30.1	29.8	45.7	20.8	19.1
09/17/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/18/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/19/94	-	45.4	43.6	40.6	-	39.4	30.0	23.6	38.4	29.9	29.5	42.8	21.3	21.5
09/20/94	-	45.1	42.5	40.3	-	38.9	29.5	23.3	38.3	29.8	29.3	41.9	18.8	20.3
09/21/94	-	-	-	-	-	-	-	..	-	-	-	-	-	-
09/22/94	-	46.5	42.8	42.1	-	41.8	29.6	23.8	41.3	30.2	29.7	43.0	5.6	3.5
09/23/94	-	47.1	43.1	43.5	-	43.7	30.2	23.7	43.2	30.8	30.4	45.4	18.0	16.4
09/24/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/25/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/26/94	-	47.2	42.1	41.2	-	39.6	30.1	21.0	41.5	30.9	30.2	45.0	20.5	20.0
09/27/94	-	48.7	43.1	42.4	-	41.9	29.6	21.2	41.5	30.8	30.1	43.6	17.2	16.7
09/28/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/29/94	-	49.7	43.2	42.5	-	41.7	29.4	21.6	41.2	31.0	30.6	42.4	17.7	17.8

BIOOXIDATION BULK TEST THERMOCOUPLE DATA

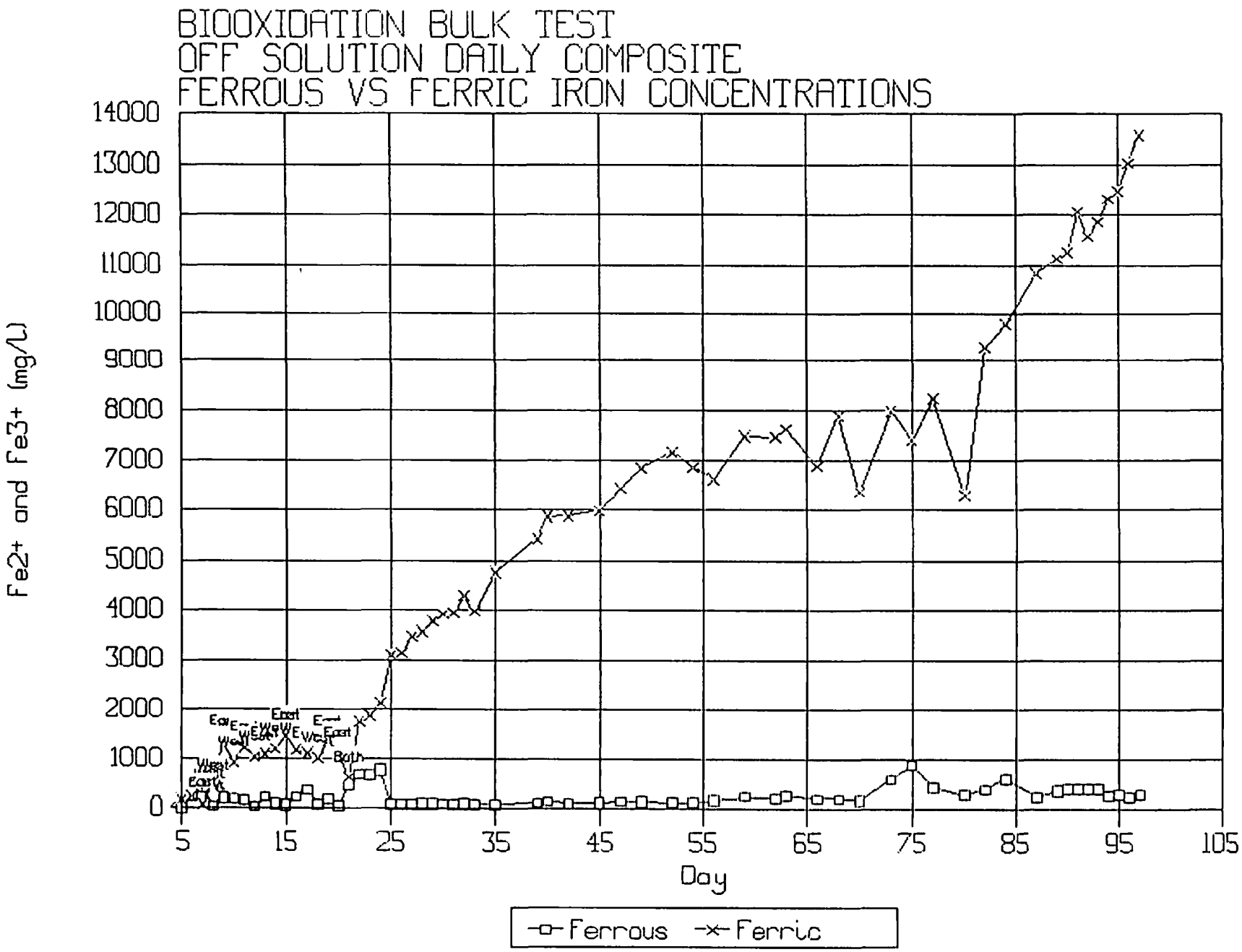
Date	West 1	West 2	West 3	West 4	West 5	Mid 6	Mid 7	Mid 8	East 9	East 10	East 11	East 12	AMBIENT 1-6	AMBIENT 7-12
09/30/94	-	49.7	43.1	42.1	-	41.0	29.1	21.4	41.0	30.9	29.9	41.6	9.8	9.0
10/01/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/02/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/03/94	-	49.8	44.4	42.3	-	41.5	28.5	20.0	41.4	30.7	29.6	42.6	2.3	2.5
10/04/94	-	49.8	45.1	42.6	-	41.7	28.5	19.3	41.9	30.8	29.7	42.6	6.1	5.3
10/05/94	-	50.3	46.3	43.1	-	41.5	28.3	18.2	41.8	30.6	29.5	44.0	14.9	14.0
10/06/94	-	50.2	46.7	43.1	-	41.5	28.4	17.7	41.9	30.7	29.5	44.9	7.8	7.2
10/07/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/08/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/09/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/10/94	-	51.9	40.7	43.3	-	41.2	25.9	13.9	39.9	26.9	27.4	30.6	19.1	18.0
10/11/94	-	52.9	40.1	43.6	-	41.1	24.9	14.2	38.7	25.6	26.5	28.9	15.6	16.5
10/12/94	-	52.9	38.1	43.1	-	41.8	24.4	15.7	38.5	24.8	26.0	29.5	9.0	7.8
10/13/94	-	53.1	37.1	42.9	-	41.7	23.5	15.4	37.8	24.1	25.4	29.9	12.5	12.1
10/14/94	-	51.7	37.2	42.8	-	41.1	23.0	15.0	36.9	23.7	24.4	29.8	18.2	18.0
10/15/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/16/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/17/94	-	50.0	35.8	42.0	-	40.2	20.2	12.3	34.8	22.6	22.6	27.8	5.3	4.9
10/18/94	-	49.2	34.7	41.9	-	40.7	19.7	11.7	34.1	22.3	22.3	26.8	2.9	2.2
10/19/94	-	48.7	33.1	41.3	-	39.8	19.9	11.6	34.1	22.7	22.8	26.8	11.3	11.5
10/20/94	-	47.6	32.3	40.9	-	38.5	19.3	11.2	33.8	22.4	22.3	26.6	9.0	9.2
10/21/94	-	46.9	31.9	40.6	-	39.2	19.1	11.1	33.4	22.5	22.4	26.1	15.0	13.8
10/22/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/23/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/24/94	-	45.4	30.7	40.1	-	38.8	18.1	8.7	34.5	21.7	22.0	26.1	4.0	2.5
10/25/94	-	44.0	30.3	39.8	-	38.3	18.2	8.3	34.0	21.3	22.0	23.8	11.5	12.0
10/26/94	-	43.5	29.5	38.6	-	36.9	18.3	8.6	33.4	20.9	21.7	22.8	15.4	15.3
10/27/94	-	43.3	28.9	37.9	-	36.5	16.8	8.3	31.8	19.5	20.4	21.8	10.0	9.8
10/28/94	-	42.8	28.4	37.4	-	36.1	16.6	9.2	31.3	19.1	20.0	22.1	5.8	5.5
10/29/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/30/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/31/94	-	41.1	26.7	36.2	-	34.5	15.9	8.5	30.5	18.4	18.9	23.2	.8	.4
11/01/94	-	41.2	27.4	36.6	-	34.7	15.7	8.0	30.3	18.3	18.6	23.1	9.3	9.0
11/02/94	-	40.6	27.0	36.6	-	34.7	15.2	7.4	30.0	17.9	18.1	22.4	4.4	4.6
11/03/94	-	40.1	26.6	36.8	-	35.0	15.1	7.1	29.9	17.8	17.8	21.7	-8.0	-7.0


BIOOXIDATION BULK TEST
THERMOCOUPLE DATA
THERMOCOUPLES 1-6
Degree Centigrade
60
50
40
30
20
10
0
-10
5
15
25
35
45
55
65
75
85
95
105
Day
1
2
3
4
5
6
AMBIENT 1-6
(11-03-94)

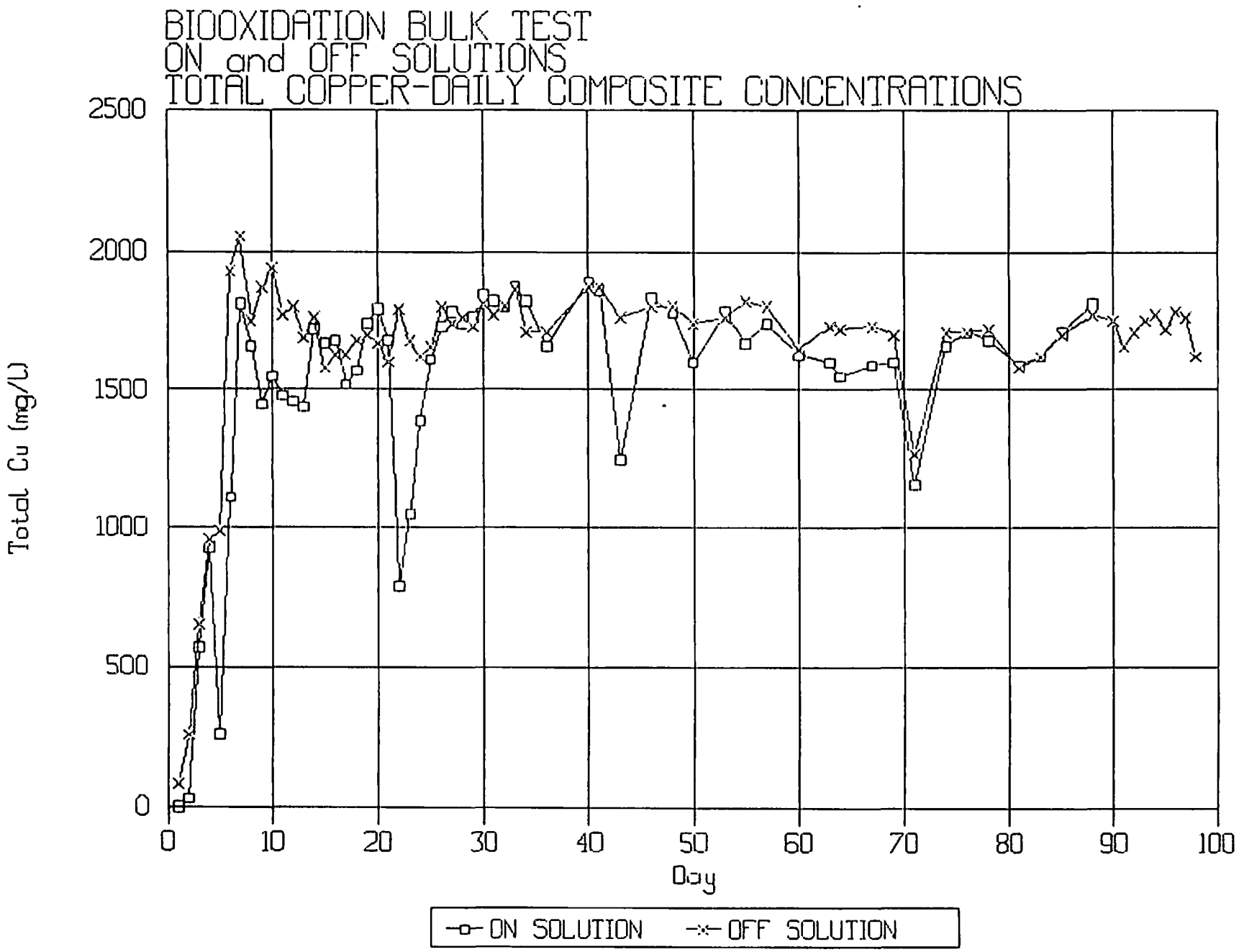

BIOOXIDATION BULK TEST
THERMOCOUPLE DATA
THERMOCOUPLES 7-12
Degree Centigrade
50
40
30
20
10
0
-10
5
15
25
35
45
55
65
75
85
95
105
Day
7
8
9
10
11
12
AMBIENT 7-12
(11-03-94)


BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
TOTAL IRON-DAILY COMPOSITE CONCENTRATIONS
Total Fe (mg/L)
14000
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
0
10
20
30
40
50
60
70
80
90
100
Day
ON SOLUTION
OFF SOLUTION

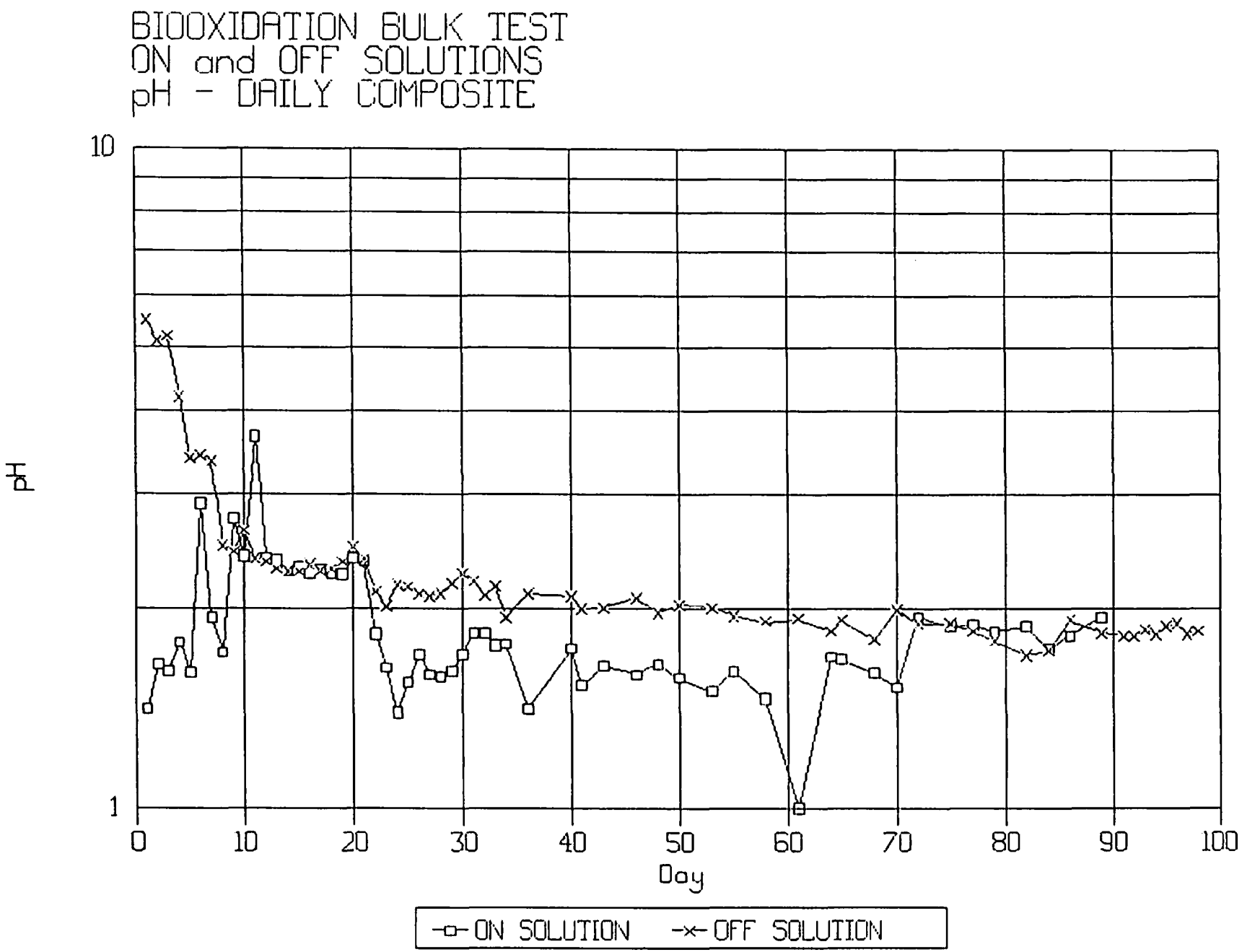
(11-02-94)


BIOOXIDATION BULK TEST
OFF SOLUTION DAILY COMPOSITE
FERROUS VS FERRIC IRON CONCENTRATIONS
Fe2+ and Fe3+ (mg/L)
14000
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
5
15
25
35
45
55
65
75
85
95
105
Day
East
West
Both
Ferrous
Ferric

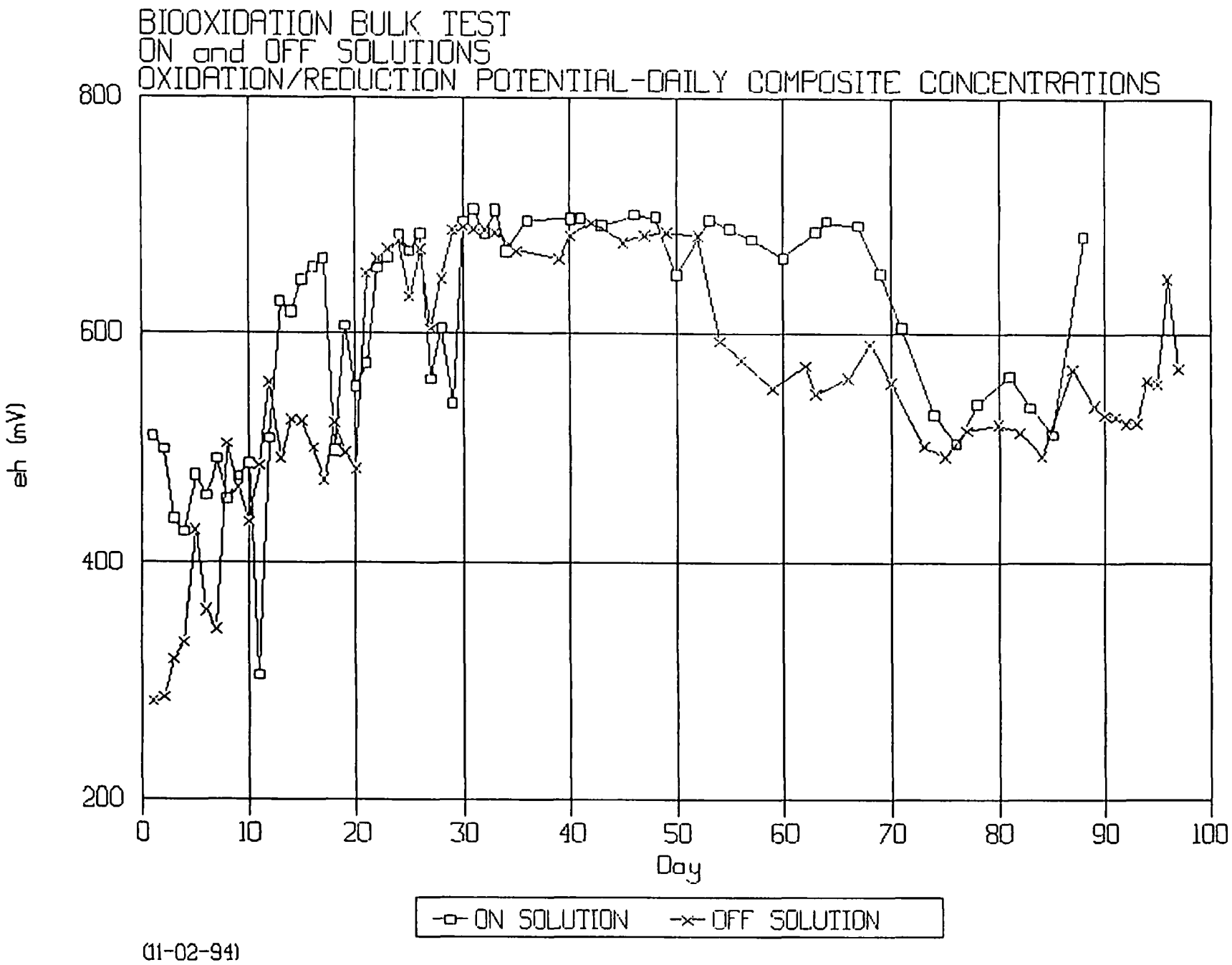
(11-02-94)

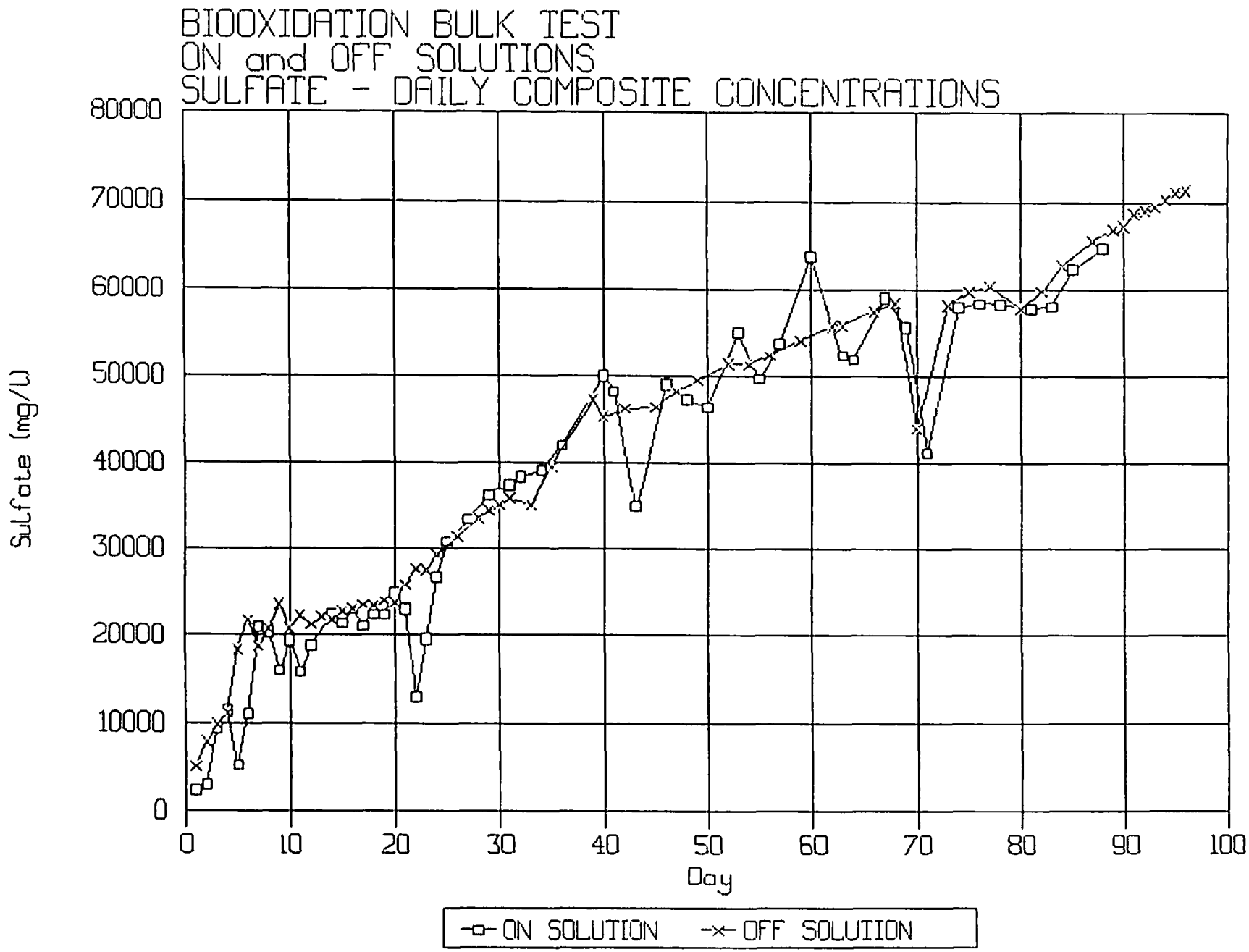

BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
TOTAL COPPER-DAILY COMPOSITE CONCENTRATIONS
Total Cu (mg/L)
2500
2000
1500
1000
500
0
0
10
20
30
40
50
60
70
80
90
100
Day
ON SOLUTION
OFF SOLUTION

(11-02-94)

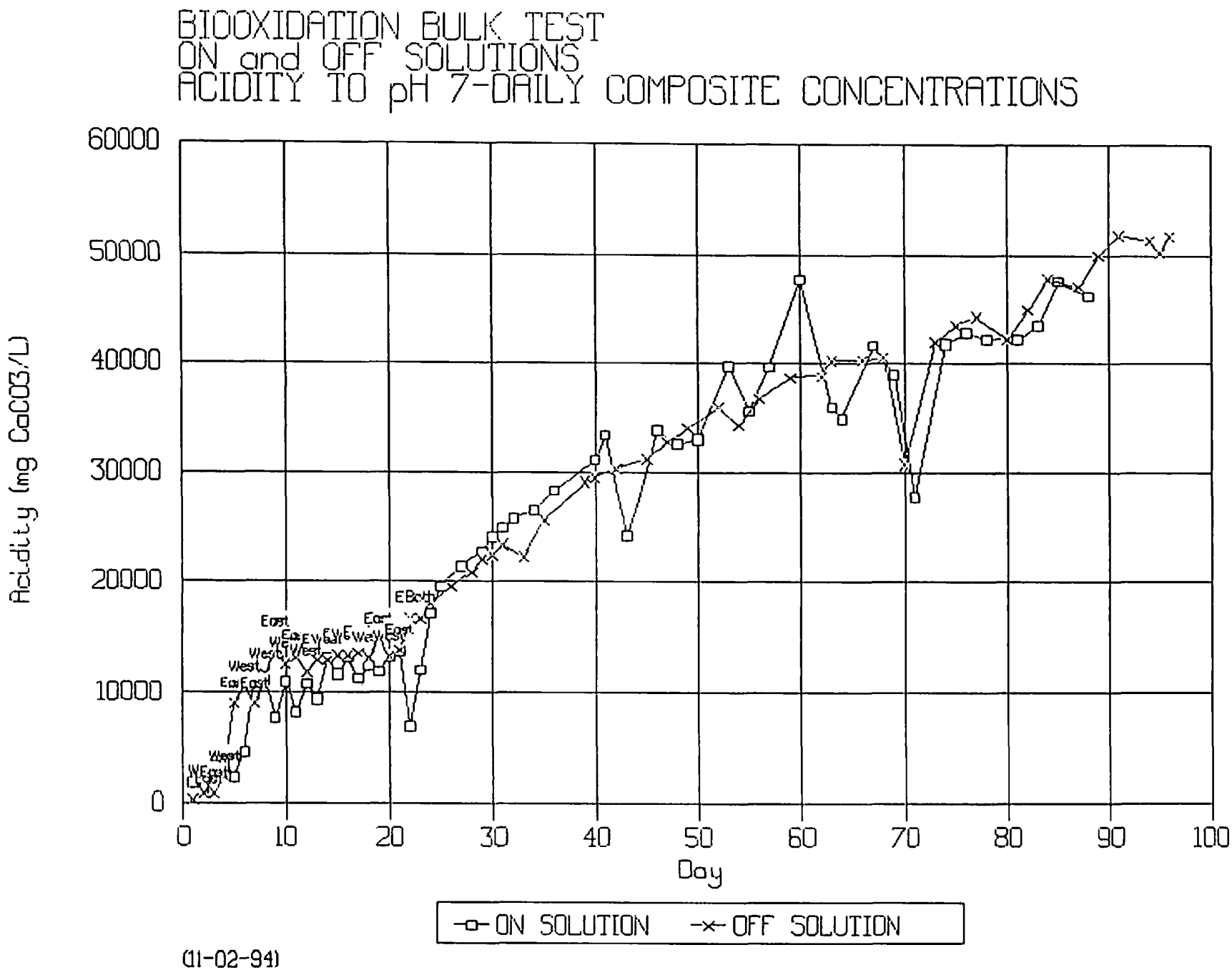

BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
pH - DAILY COMPOSITE
10
1
pH
0
10
20
30
40
50
60
70
80
90
100
Day
ON SOLUTION
OFF SOLUTION

(11-02-94)


BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
OXIDATION/REDUCTION POTENTIAL-DAILY COMPOSITE CONCENTRATIONS
800
600
400
200
eh (mV)
0
10
20
30
40
50
60
70
80
90
100
Day
ON SOLUTION
OFF SOLUTION
(11-02-94)


BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
SULFATE - DAILY COMPOSITE CONCENTRATIONS
Sulfate (mg/L)
80000
70000
60000
50000
40000
30000
20000
10000
0
0
10
20
30
40
50
60
70
80
90
100
Day
ON SOLUTION
OFF SOLUTION

(11-01-94)


BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
ACIDITY TO pH 7-DAILY COMPOSITE CONCENTRATIONS
Acidity (mg CaCO3/L)
60000
50000
40000
30000
20000
10000
0
0
10
20
30
40
50
60
70
80
90
100
Day
ON SOLUTION
OFF SOLUTION
(11-02-94)

MEMORANDUM

DATE: NOVEMBER 1, 1994
TO: JIM THOMPSON
FROM: LAURA DAMON
SUBJECT: BIOOXIDATION BULK TEST (BBT) GOLD EXTRACTION COMPARISONS

The following table summarizes the BBT gold extraction data to date. Also included are NaCN consumption and CaO addition.

	SP2 Composite Control Column	SP2 Composite Control Bottle Roll	Auger Drill 2 West Bottle Roll	Auger Drill 2 Mid Bottle Roll
% Oxidation	0%	0%	5.8%[1)]	2.5%[1)]
% Au Extraction	56.6%[2)]	54.8%[2)]	62.4%[2)]	57.5%[2)]
NaCN Consumption (lb/ton ore)	2.1	2.1	2.0	2.6
CaO Addition (lb/ton ore)	12	18	26	27
Initial pH	11.5	12.1	11.8	12.0
Final pH	10.8	11.2	10.9	10.9

1) Oxidation percentages based on difference between Auger Drill-1 and Auger Drill-2 percent sulfide. It was assumed that no appreciable oxidation had taken place when Auger Drill-1 Samples were collected on 08-23-94.

2) Gold Extraction percentages based on the calculated head.

c: Rod MacLeod
Martin Quick
Herb Osborne

MEMORANDUM

DATE: NOVEMBER 1, 1994
TO: JIM THOMPSON
FROM: LAURA DAMON
SUBJECT: BIOOXIDATION BULK TEST (BBT) GOLD EXTRACTION COMPARISONS

The following table summarizes the BBT gold extraction data to date. Also included are NaCN consumption and CaO addition.

	SP2 Composite Control Column	SP2 Composite Control Bottle Roll	Auger Drill 2 West Bottle Roll	Auger Drill 2 Mid Bottle Roll
% Oxidation	0%	0%	5.8%[1)]	2.5%[1)]
% Au Extraction	56.6%[2)]	54.8%[2)]	62.4%[2)]	57.5%[2)]
NaCN Consumption (lb/ton ore)	2.1	2.1	2.0	2.6
CaO Addition (lb/ton ore)	12	18	26	27
Initial pH	11.5	12.1	11.8	12.0
Final pH	10.8	11.2	10.9	10.9

1) Oxidation percentages based on difference between Auger Drill-1 and Auger Drill-2 percent sulfide. It was assumed that no appreciable oxidation had taken place when Auger Drill-1 Samples were collected on 08-23-94.

2) Gold Extraction percentages based on the calculated head.

c: Rod MacLeod
Martin Quick
Herb Osborne

MEMORANDUM

DATE: NOVEMBER 1, 1994
TO: JIM THOMPSON
FROM: LAURA DAMON
SUBJECT: BIOOXIDATION BULK TEST (BBT) GOLD EXTRACTION COMPARISONS
(on 96 hour bottle rolls)

96 hour

The following table summarizes the BBT gold extraction data to date. Also included are NaCN consumption and CaO addition.

	SP2 Composite Control Column	SP2 Composite Control Bottle Roll	Auger Drill 2 West Bottle Roll	Auger Drill 2 Mid Bottle Roll
% Oxidation	0%	0%	5.8%[1)]	2.5%[1)]
% Au Extraction	56.6%[2)]	54.8%[2)]	62.4%[2)]	57.5%[2)]
NaCN Consumption (lb/ton ore)	2.1	2.1	2.0	2.6
CaO Addition (lb/ton ore)	12	18	26	27
Initial pH	11.5	12.1	11.8	12.0
Final pH	10.8	11.2	10.9	10.9

1) Oxidation percentages based on difference between Auger Drill-1 and Auger Drill-2 percent sulfide. It was assumed that no appreciable oxidation had taken place when Auger Drill-1 Samples were collected on 08-23-94.

2) Gold Extraction percentages based on the calculated head.

c: Rod MacLeod
Martin Quick
Herb Osborne

MEMORANDUM

DATE: OCTOBER 28, 1994
TO: JIM THOMPSON
FROM: LAURA DAMON
SUBJECT: BIOOXIDATION BULK TEST (BBT) WEEKLY UPDATE (13)

The BBT has been on the biooxidation cycle for thirteen weeks now. Both the west and east sides are on simultaneous solution application. The ON solution pump was moved to a 300 gallon tank inside the berm to allow for continued solution application while the holding tanks and piping outside the berm are being dismantled. The OFF solution continues to flow into the sump area and is then pumped to the 300 gallon tank holding the ON solution pump. A flow meter is located after the ON solution pump. The flow has averaged 7.4 gpm this week. 100 gallons of neutralization slurry was removed from the circuit this week containing 17 lb of copper and 63 lb of iron. The heap still remains intact and stable.

The total iron concentration is up close to 12,000 ppm this week. The slope has stayed at a steepened incline. The iron continues to be predominantly in the form of ferric iron. The copper values seem to have stabilized in the 1700 ppm range. The pH of the OFF solution is in the 1.8 range and the oxidation/reduction potential has an eh range of 500-550. The sulfate concentration has risen this week as has the acidity. These analyses indicate that the BBT continues to biooxidize at an increased rate.

Air was injected into the heap under Thermocouples 4 and 6 starting October 20th to see if the added air supply had any effect in raising the temperatures. The power was cut to the air compressor October 25th so air was only added for about 5 days. No results were seen from the air addition.

Corrected results from gold extraction bottle rolls on the auger drill-2 samples are attached. The data was re-calculated showing the percent solids were 47.4% rather than the reported 50%. The sulfide analyses indicated that these samples are about 5% biooxidized in comparison to the auger drill-1 samples. The corrected gold extraction percentage is 60.0% with 26 lb/ton CaO addition and NaCN consumption at 2.2 lb/ton. These results are based on the average of the west and mid auger drill-2 composites. The gold extraction increased 5.2% in comparison to the control SP-2 composite bottle rolls. The control samples, with zero percent biooxidation, had 54.8% gold extraction with 18 lb/ton CaO addition and NaCN consumption at 2.1 lb/ton.

Auger drill-3 samples were collected and prepped this week. Bottle rolls and a column of ore will be analyzed for gold extraction.

c: Rod MacLeod
Martin Quick
Herb Osborne

BIOOXIDATION BULK TEST SOLUTION SAMPLING

ON SOLUTION

Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)
Orofino	7/21-9/29		(91000)	7.91	337.4	.01	1.35	-	-	-	107
	7/21-7/28	19741	19741								
GRAB-1530	07/27/94	?	19741	1.94	516.2	1.26	3.0	-	-	-	-
GRAB	07/28/94	?	19741	1.20	555.3	.16	7.8	-	-	3042	3411
COMP	07/28/94	?	19741	1.41	510.8	.10	21.6	-	-	1924	2420
COMP	07/29/94	9542	29283	1.65	498.3	29	45.0	4.1	40.9	1416	3012
COMP	07/30/94	5504	34787	1.61	438.4	574	38.0	2.2	35.8	3442	9230
COMP	07/31/94	975	35762	1.78	426.7	930	51.0	2.3	48.7	3823	11575
COMP	08/01/94	21302	57063	1.60	475.9	260	33.0	1.3	31.7	2394	5238
COMP	08/02/94	18970	76034	2.89	458.4	1110	155	71	84	4705	10999
COMP	08/03/94	16238	92272	1.94	490.0	1810	710	130	580	11581	20982
COMP	08/04/94	12021	104293	1.72	455.8	1660	660	340	320	11167	20349
COMP	08/05/94	16734	121027	2.75	475.1	1450	260	40	220	7673	15888
COMP	08/06/94	16466	137492	2.41	486.8	1550	1030	60	970	11012	19332
COMP	08/07/94	16466	153958	3.66	304.8	1480	530	60	470	8191	15810
COMP	08/08/94	16502	170460	2.40	507.9	1460	1170	110	1060	10820	18867
COMP	08/09/94	16103	186563	2.38	627.5	1440	790	25	765	9380	-
COMP	08/10/94	15624	202187	2.28	618.1	1720	1680	63	1617	13218	22369
COMP	08/11/94	16113	218300	2.33	645.4	1670	1250	33	1217	11657	21262
COMP	08/12/94	14762	233062	2.27	656.2	1680	1510	146	1364	13205	22874
COMP	08/13/94	13785	246847	2.30	663.0	1520	950	41	909	11254	21036
COMP	08/14/94	10979	257826	2.27	497.5	1570	1380	229	1151	12451	22331
COMP	08/15/94	10129	267955	2.26	606.6	1740	750	53	697	11956	22333
COMP	08/16/94	6178	274133	2.40	553.1	1790	970	51	919	13257	24698
COMP	08/17/94	6444	280577	2.36	573.3	1680	860	171	689	13713	22929
COMP	08/18/94	7205	287782	1.83	655.6	790	490	170	320	6959	12987
COMP	08/19/94	12447	300229	1.63	664.1	1050	1480	440	1040	12007	19505
COMP	08/20/94	15338	315567	1.39	683.9	1390	2190	610	1580	17135	26608
COMP	08/21/94	12497	328064	1.55	669.8	1610	2660	710	1950	19555	30681
COMP	08/22/94	11793	339857	1.71	684.8	1730	3270	75	3195	-	-
COMP	08/23/94	12099	351956	1.59	560.0	1780	3310	123	3187	21399	33274
COMP	08/24/94	11183	363139	1.58	604.9	1740	3480	82	3398	-	-
COMP	08/25/94	11114	374253	1.61	538.6	1760	3960	230	3730	22733	36228
COMP	08/26/94	9502	383755	1.71	694.7	1840	4040	94	3946	24028	36237
COMP	08/27/94	9144	392899	1.84	705.2	1820	4370	99	4271	24868	37372
COMP	08/28/94	8493	401392	1.84	684.4	1800	4380	99	4281	25735	38352
COMP	08/29/94	8859	410251	1.76	704.1	1870	4570	86	4484	-	-
COMP	08/30/94	7349	417600	1.77	669.5	1820	4450	84	4366	26418	39084
COMP	08/31/94	8940	426540	-	-	-	-	-	0	-	-
COMP	09/01/94	8784	435324	1.41	695.6	1660	4660	94	4566	28282	41981
COMP	09/02/94	5757	441081	-	-	-	-	-	0	-	-
COMP	09/03/94	7779	448860	-	-	-	-	-	0	-	-
COMP	09/04/94	7563	456423	-	-	-	-	-	0	-	-
COMP	09/05/94	6512	462935	1.74	697.0	1890	5820	127	5693	31066	49890
COMP	09/06/94	5907	468842	1.53	698.3	1860	6000	138	5862	33298	48170
COMP	09/07/94	6074	474916	-	-	-	-	-	0	-	-
COMP	09/08/94	8632	483548	1.64	691.8	1250	4410	86	4324	24133	34862
COMP	09/09/94	9369	492917	-	-	-	-	-	0	-	-
COMP	09/10/94	6460	499377	-	-	-	-	-	0	-	-
COMP	09/11/94	6460	505837	1.59	700.2	1830	6300	114	6186	33773	48927
COMP	09/12/94	6004	511841	-	-	-	-	-	0	-	-
COMP	09/13/94	7143	518984	1.65	698.8	1780	5700	127	5573	32506	47216
COMP	09/14/94	8045	527029	-	-	-	-	-	0	-	-
COMP	09/15/94	10057	537086	1.57	649.7	1600	6000	117	5883	32933	46360
COMP	09/16/94	10719	547805	-	-	-	-	-	0	-	-
COMP	09/17/94	9886	557691	-	-	-	-	-	0	-	-
COMP	09/18/94	8902	566593	1.50	697.1	1780	7600	102	7498	39646	55042
COMP	09/19/94	5547	572140	-	-	-	-	-	0	-	-

BIOOXIDATION BULK TEST SOLUTION SAMPLING

ON SOLUTION

Sample ID	Date	Gal/ .Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)
COMP	09/20/94	3226	575366	1.61	689.3	1670	6800	138	6662	35523	49528
COMP	09/21/94	4164	579530	-	-	-	-	-	0	-	-
COMP	09/22/94	3296	582826	1.46	680.5	1740	6700	151	6549	39570	53734
COMP	09/23/94	6300	589126	-	-	-	-	-	0	-	-
COMP	09/24/94	8519	597645	-	-	-	-	-	0	-	-
COMP	09/25/94	7928	605573	1.00	664.8	1630	7630	146	7484	47665	63889
COMP	09/26/94	6189	611762	-	-	-	-	-	0	-	-
COMP	09/27/94	6154	617916	-	-	-	-	-	0	-	-
COMP	09/28/94	5684	623600	1.69	686.9	1600	7000	138	6862	35900	52293
COMP	09/29/94	7387	630987	1.68	695.5	1550	6900	120	6780	34862	51808
COMP	09/30/94	5875	636862	-	-	-	-	-	0	-	-
COMP	10/01/94	4570	641431	-	-	-	-	-	0	-	-
COMP	10/02/94	4570	646001	1.60	691.9	1590	7700	171	7529	41524	58993
COMP	10/03/94	5786	651787	-	-	-	-	-	0	-	-
COMP	10/04/94	2417	654204	1.52	650.9	1600	7500	156	7344	38828	55577
COMP	10/05/94	5927	660131	-	-	-	-	-	0	-	-
COMP	10/06/94	9778	669909	1.94	605.5	1160	5830	123	5707	27760	41183
COMP	10/07/94	14172	684081	-	-	-	-	-	0	-	-
COMP	10/08/94	16206	700287	-	-	-	-	-	0	-	-
COMP	10/09/94	14417	714704	1.88	529.8	1660	8600	300	8300	41682	57947
COMP	10/10/94	14429	729133	-	-	-	-	-	0	-	-
COMP	10/11/94	15560	744693	1.89	504.1	1710	8600	610	7990	42768	58417
COMP	10/12/94	15734	760427	-	-	-	-	-	0	-	-
COMP	10/13/94	13780	774207	1.85	538.7	1680	8700	260	8440	42172	58326
COMP	10/14/94	13162	787369	-	-	-	-	-	0	-	-
COMP	10/15/94	13628	800997	-	-	-	-	-	0	-	-
COMP	10/16/94	16462	817459	1.88	563	1590	7000	200	6800	42146	57791
COMP	10/17/94	17251	834710	-	-	-	-	-	0	-	-
COMP	10/18/94	16440	851150	1.74	536.2	1620	9200	310	8890	43393	58079
COMP	10/19/94	11241	862391	-	-	-	-	-	-	-	-
COMP	10/20/94	8925	871316	1.82	512.2	1710	11000	430	10570	47480	62350
COMP	10/21/94	9548	880864	-	-	-	-	-	-	-	-
COMP	10/22/94	7915	888779	-	-	-	-	-	-	-	-
COMP	10/23/94	10527	899306	1.94	683.4	1810	11300	250	11050	46153	64770
	10/24/94			Recirculating Sump Solution - See OFF Solution Sample Data							

BIOOXIDATION BULK TEST SOLUTION SAMPLING

OFF SOLUTION

Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	DO (ppm)
SUMP-GRAB	07/26/94	1200	1200	7.22	-	.84	.27	-	-	-	-	-
GRAB-1530	07/27/94	1750	2950	7.53	305.4	.89	.20	-	-	-	-	-
COMP	07/28/94	3000	5950	5.93	353.6	83	.55	-	-	83	4411	-
COMP	07/29/94	3293	9243	5.49	282.1	255	13	-	-	362	5094	-
COMP	07/30/94	4419	13662	5.11	285.7	654	14	-	-	994	7913	-
COMP	07/31/94	2688	16350	5.18	318.8	960	11	-	-	956	9835	-
COMP	08/01/94	7822	24172	4.20	332.3	990	39	1	38	2438	11106	-
COMP	08/02/94	21836	46008	3.39	429.6	1930	172	2	170	8960	18304	-
COMP	08/03/94	14710	60718	3.43	360.1	2050	520	260	260	10520	21678	-
COMP	08/04/94	7500	68218	3.36	344.2	1750	500	410	90	8967	18731	-
COMP	08/05/94	6821	75039	2.50	503.7	1870	480	40	440	11633	20711	-
COMP	08/06/94	21396	96436	2.45	465.2	1940	1530	200	1330	14570	23591	-
COMP	08/07/94	21396	117832	2.63	435.8	1770	1110	190	920	12617	20727	-
COMP	08/08/94	18698	136530	2.40	484.6	1800	1390	160	1230	13259	22299	-
COMP	08/09/94	21118	157648	2.36	557.4	1690	1070	36	1034	11904	21180	-
COMP	08/10/94	16419	174067	2.31	491.4	1760	1320	220	1100	12958	22052	-
COMP	08/11/94	16500	190567	2.29	524.4	1580	1290	86	1204	12958	21764	-
COMP	08/12/94	18213	208780	2.28	523.1	1630	1520	56	1464	13452	22729	1.3
COMP	08/13/94	18585	227365	2.34	500.2	1630	1420	240	1180	13361	22995	1.3
COMP	08/14/94	16646	244011	2.29	472.4	1680	1490	380	1110	13608	23458	-
COMP	08/15/94	13559	257570	2.31	522.4	1700	1110	84	1026	13179	23381	-
COMP	08/16/94	12267	269837	2.36	496.4	1670	1540	196	1344	14831	23933	1.4
COMP	08/17/94	7697	277534	2.49	481.4	1600	1160	43	1117	13309	23711	2.2
COMP	08/18/94	7136	284670	2.39	650.1	1790	1100	480	620	13839	25735	1.7
COMP	08/19/94	13078	297748	2.13	663.0	1680	2450	690	1760	16703	27554	-
COMP	08/20/94	14479	312227	2.02	672.0	1620	2550	670	1880	16716	27464	-
COMP	08/21/94	14213	326440	2.18	678.3	1660	2900	770	2130	18024	29200	-
COMP	08/22/94	14246	340686	2.16	631.0	1800	3160	75	3085	-	-	-
COMP	08/23/94	13868	354554	2.11	671.3	1740	3210	73	3137	19568	31299	-
COMP	08/24/94	12742	367296	2.09	604.1	1760	3540	82	3458	-	-	.7
COMP	08/25/94	11741	379037	2.11	646.9	1730	3640	86	3554	20823	33471	5.5?
COMP	08/26/94	12505	391542	2.19	687.1	1810	3860	86	3774	22006	34443	OFL
COMP	08/27/94	11272	402814	2.27	689.5	1770	4000	94	3906	22374	35035	-
COMP	08/28/94	9000	411814	2.21	688.0	1800	4000	82	3918	23319	35858	-
COMP	08/29/94	9000	420814	2.10	688.2	1860	4370	86	4284	-	-	OFL
COMP	08/30/94	11403	432217	2.17	685.5	1710	4030	84	3946	22242	35134	13.5?
COMP	08/31/94	10726	442943	-	-	-	-	-	-	-	-	OFL
COMP	09/01/94	10299	453242	1.94	669.9	1710	4840	89	4751	25577	39562	OFL
COMP	09/02/94	9075	462317	-	-	-	-	-	-	-	-	3.9
COMP	09/03/94	8149	470466	-	-	-	-	-	-	-	-	-
COMP	09/04/94	7612	478078	-	-	-	-	-	-	-	-	-
COMP	09/05/94	7357	485435	2.11	663.7	1870	5550	120	5430	29017	47141	-
COMP	09/06/94	6870	492305	2.09	682.9	1870	6010	151	5859	29543	45273	3.5
COMP	09/07/94	6503	498808	-	-	-	-	-	-	-	-	6.2
COMP	09/08/94	10447	509255	2.00	693.8	1760	6010	117	5893	30304	46121	5.5
COMP	09/09/94	8553	517808	-	-	-	-	-	-	-	-	5.5
COMP	09/10/94	8424	526232	-	-	-	-	-	-	-	-	-
COMP	09/11/94	8424	534656	2.01	677.7	1800	6100	114	5986	31157	46376	-
COMP	09/12/94	7258	541914	-	-	-	-	-	-	-	-	-
COMP	09/13/94	6630	548544	2.08	683.7	1800	6600	151	6449	32657	48154	2.8
COMP	09/14/94	7479	556023	-	-	-	-	-	-	-	-	2.6
COMP	09/15/94	11492	567515	1.97	685.6	1740	7000	142	6858	33989	49372	4.6
COMP	09/16/94	11244	578759	-	-	-	-	-	-	-	-	2.8
COMP	09/17/94	11287	590046	-	-	-	-	-	-	-	-	-
COMP	09/18/94	10435	600481	2.03	684.0	1760	7300	134	7166	35825	51363	-
COMP	09/19/94	9531	610012	-	-	-	-	-	-	-	-	2.5
COMP	09/20/94	6175	616187	2.01	593.5	1820	7000	134	6866	34241	51265	2.8
COMP	09/21/94	5061	621248	-	-	-	-	-	-	-	-	-

BIOOXIDATION BULK TEST SOLUTION SAMPLING

OFF SOLUTION

Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	DO (ppm)
COMP	09/22/94	5238	626486	1.95	576.7	1800	6800	171	6629	36579	52376	3.5
COMP	09/23/94	6073	632559	-	-	-	-	-	-	-	-	3.2
COMP	09/24/94	9286	641845	-	-	-	-	-	-	-	-	-
COMP	09/25/94	9592	651437	1.91	552.0	1650	7730	250	7480	38565	54096	-
COMP	09/26/94	7385	658822	-	-	-	-	-	-	-	-	2.8
COMP	09/27/94	9119	667941	-	-	-	-	-	-	-	-	3.5
COMP	09/28/94	7789	675730	1.93	571.8	1730	7700	230	7470	38690	55742	-
COMP	09/29/94	7387	683117	1.85	547.2	1720	7900	270	7630	40150	55898	-
COMP	09/30/94	7807	690924	-	-	-	-	-	-	-	-	3.2
COMP	10/01/94	6502	697426	-	-	-	-	-	-	-	-	-
COMP	10/02/94	6502	703928	1.92	560.7	1730	7100	210	6890	40202	57552	-
COMP	10/03/94	6231	710159	-	-	-	-	-	-	-	-	4.2
COMP	10/04/94	6834	716993	1.80	591.1	1700	8100	210	7890	40383	58458	4.5
COMP	10/05/94	6911	723904	-	-	-	-	-	-	-	-	4.5
COMP	10/06/94	28493	752396	1.99	557.3	1270	6550	170	6380	30663	43932	5.7
COMP	10/07/94	22817	775213	-	-	-	-	-	-	-	-	-
COMP	10/08/94	19403	794616	-	-	-	-	-	-	-	-	-
COMP	10/09/94	21196	815812	1.90	501.8	1710	8600	610	7990	41883	58178	-
COMP	10/10/94	17200	833012	-	-	-	-	-	-	-	-	2.8
COMP	10/11/94	11500	844512	1.90	492.7	1710	8300	890	7410	43442	59840	2.4
COMP	10/12/94	17000	861512	-	-	-	-	-	-	-	-	-
COMP	10/13/94	18300	879812	1.85	515.7	1720	8700	460	8240	44220	60408	2.1
COMP	10/14/94	15800	895612	-	-	-	-	-	-	-	-	2.0
COMP	10/15/94	16500	912112	-	-	-	-	-	-	-	-	-
COMP	10/16/94	20700	932812	1.79	520.7	1580	6600	300	6300	42146	57873	-
COMP	10/17/94	24500	957312	-	-	-	-	-	-	-	-	2.1
COMP	10/18/94	20500	977812	1.70	514.3	1620	9700	410	9290	44826	59766	2.2
COMP	10/19/94	14300	992112	-	-	-	-	-	-	-	-	2.0
COMP	10/20/94	7750	999862	1.73	493.7	1700	10400	630	9770	47772	62737	2.4
COMP	10/21/94	11600	1011462	-	-	-	-	-	-	-	-	2.5
COMP	10/22/94	9400	1020862	-	-	-	-	-	-	-	-	-
COMP	10/23/94	10000	1030862	1.92	569.0	1770	11100	260	10840	46976	65675	-
COMP	10/24/94	13030	1043892	-	-	-	-	-	-	-	-	2.7
COMP	10/25/94	14262	1058154	1.84	536.9	1750	11500	370	11130	49948		2.2
COMP	10/26/94	14397	1072551	1.82	528.8	1660	11700	430	11270	-	-	2.4

BIOOXIDATION BULK TEST SOLUTION SAMPLING

PAN LYSIMETER 3

Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO (ppm)
GRAB	08/03/94	1.93	488.4	1540	4640	1200	3440	20005	23896	-	
GRAB	08/11/94	1.52	496.1	3200	8700	2900	5800	-	-	Brown/Murky	
GRAB	08/12/94	1.89	450.4	2200	3900	2100	1800	-	27461	Lt Brown	1.5
GRAB	08/15/94	1.92	459.5	2170	3920	1270	2650	15417	27625	Med Brown	1.7
GRAB	08/17/94	1.97	462.7	1940	3220	560	2660	19502	25159	Med Brown	2.4
GRAB	08/19/94	2.00	458.4	1850	2300	1400	900	17828	23604	-	-
GRAB	08/22/94	1.90	464.0	1760	2300	360	1940	16677	23744	Grw/Br Ti	1.9
GRAB	08/24/94	2.04	468.5	1780	2680	770	1910	16795	23028	Green	.9
GRAB	08/26/94	2.05	479.6	1730	2700	690	2010	17030	24320	Br-Yel	4.5?
GRAB	08/29/94	2.08	472.8	1770	2760	360	2400	17936	25167	Yel-Br	OFL
GRAB	09/01/94	1.79	472.3	1870	2730	730	2000	19039	26822	Green	OFL
GRAB	09/06/94	1.83	492.1	1940	2620	210	2410	19748	30237	Lt Green	2.5
GRAB	09/08/94	1.80	488.8	1980	2870	300	2570	21454	30435	Dk Green	4.3
GRAB	09/13/94	1.68	499.7	2040	3310	510	2800	22662	32648	Gr;cldy	0.9
GRAB	09/20/94	1.66	494.8	2000	3930	300	3630	24512	33471	Lt Green	1.4
GRAB	09/22/94	1.56	481.2	1980	4250	770	3480	26724	34796	Gr-Br	1.6
GRAB	09/27/94	1.66	487.7	1920	3820	460	3360	24512	34253	Gr;cldy	1.8
GRAB	09/29/94	1.73	498.0	2070	3820	460	3360	25972	37735	Green	2.3
GRAB	10/04/94	1.63	504.6	2320	3710	330	3380	30067	42385	Gr;cldy	2.9
GRAB	10/06/94	1.66	496.1	2500	3880	440	3440	32530	46919	Gr;cldy	4.9
GRAB	10/11/94	1.63	508.9	2550	5630	430	5200	39606	54458	Br;cldy	3.9
GRAB	10/13/94	1.49	485.7	2400	6370	1020	5350	43658	57709	Gr-Brown	1.9
GRAB	10/18/94	1.52	469.2	2180	7050	1660	5390	43101	47232	Gr-Brown	2.8
GRAB	10/20/94	1.59	478.9	1940	7650	1230	6420	43738	59454	Br;cldy	3.4
GRAB	10/25/94	1.89	556.7	1800	11500	270	11230	50081	67083	Dk Br;ppt	2.1
GRAB	10/27/94	1.82	532.0	1710	11500	380	11120	50161		Br;cldy	2.3

BIOOXIDATION BULK TEST SOLUTION SAMPLING

PAN LYSIMETER 5

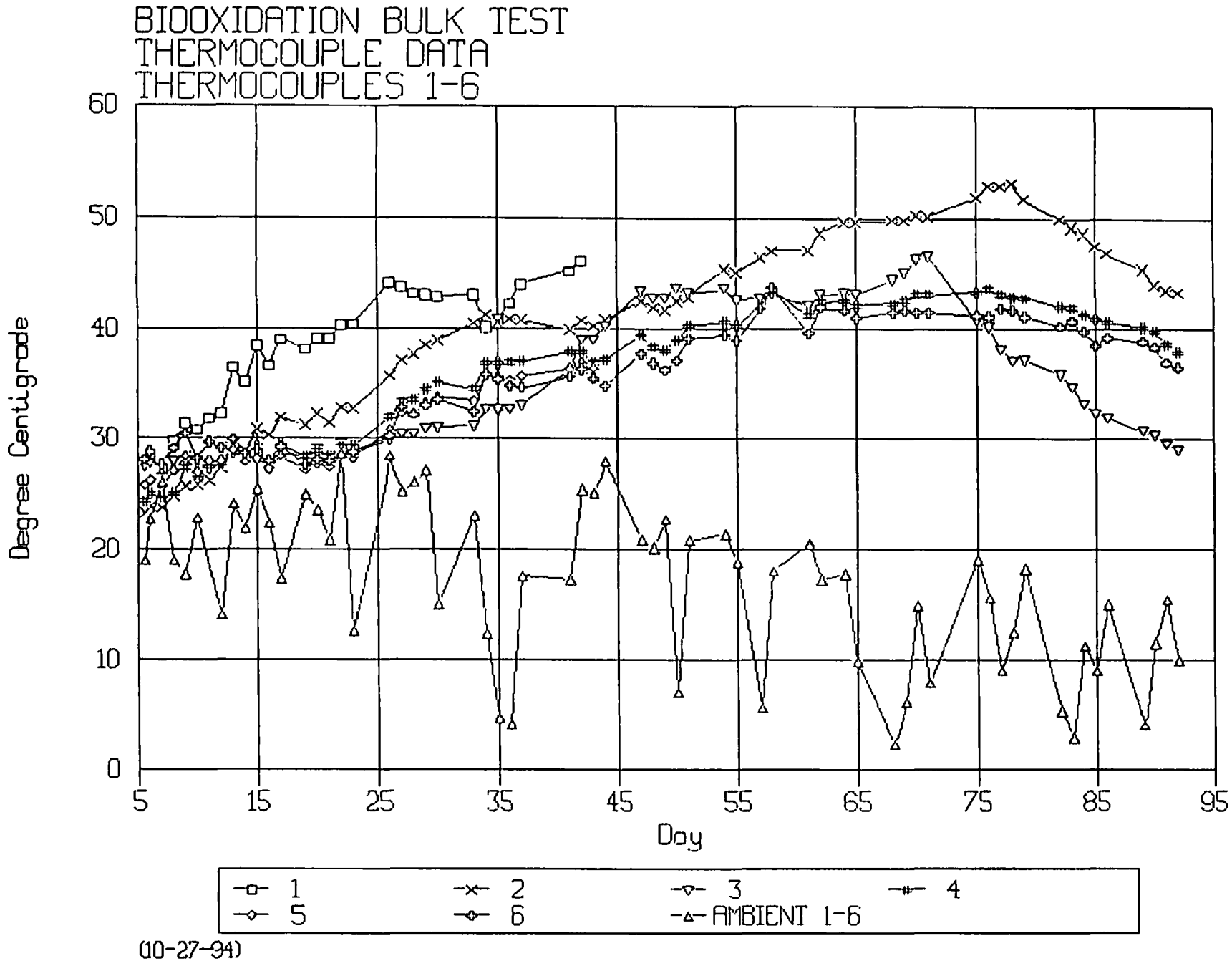
Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS
GRAB	08/03/94	1.49	515.6	3690	17700	2100	15600	57687	66622	Dark Brown
GRAB	08/04/94	1.32	511.1	3930	14100	1600	12500	60119	67556	Dark Brown
GRAB	08/09/94	1.70	484.5	2600	4500	1400	3100	28440	38389	Dark Brown
GRAB	08/10/94	2.37	574.1	1740	990	36	954	11468	23641	Off Soln Flu
GRAB	08/11/94	1.72	431.8	2000	3700	3400	300	-	-	Green Color
GRAB	08/12/94	1.80	439.7	2000	3900	2900	1000	20048	24627	Lt Green
GRAB	08/15/94	1.88	361.1	1940	3940	2200	1740	20543	24800	Green .
GRAB	08/17/94	1.88	415.7	2030	4800	3700	1100	23073	27307	Green
GRAB	08/19/94	1.87	418.5	2170	4100	4000	100	21647	27324	-
GRAB	08/22/94	2.26	437.3	1920	2800	2300	500	18260	24542	Yel-Br
GRAB	08/24/94	2.12	385.4	1880	3250	2900	350	17056	25184	Lt Gr/Blue
GRAB	08/26/94	2.39	414.8	1780	3270	2290	980	16428	24641	Yel-Gr;odor
GRAB	08/29/94	2.47	402.7	1730	3260	2110	1150	16623	24698	Lt Green
GRAB	09/01/94	2.28	492.3	1700	2600	480	2120	16360	24254	Yel-Br;odor
GRAB	09/06/94	2.30	386.7	1520	3010	1830	1180	16097	25933	Bl-Gr;odor
GRAB	09/08/94	2.36	465.2	1480	2490	430	2060	16202	24534	Lt Br;ppt
GRAB	09/13/94	2.32	389.7	1170	3250	3700	-450	16019	25019	Lt Green
GRAB	09/20/94	2.30	386.7	1110	2470	2600	-130	15185	23797	Lt Green
GRAB	09/22/94	2.23	417.6	1110	2320	2000	320	15888	24163	Lt Green
GRAB	09/27/94	2.17	563.9	1110	1650	700	950	16416	24270	Lt Brown
GRAB	09/29/94	2.19	500.5	1280	1950	200	1750	13841	25834	Brown
GRAB	10/04/94	2.07	473.2	1240	1760	410	1350	16978	25776	Yel-Lt Br
GRAB	10/06/94	2.21	576.0	1290	1630	80	1550	16265	25390	Lt Brown
GRAB	10/11/94	2.17	637.1	1360	1740	690	1050	18274	29389	Gr-Yellow
GRAB	10/13/94	1.99	567.5	1500	1970	60	1910	21497	32739	Yel-Lt Br
GRAB	10/18/94	1.96	514.8	1760	2380	177	2203	24019	36517	Green
GRAB	10/20/94	1.85	514.6	2020	2600	171	2429	25983	38648	Green
GRAB	10/25/94	2.08	460.3	2720	4530	1340	3190	38987	56425	Dk Gr-Br
GRAB	10/27/94	1.93	405.0	2480	5690	5300	390	39093		Lt Green

BIOOXIDATION BULK TEST THERMOCOUPLE DATA

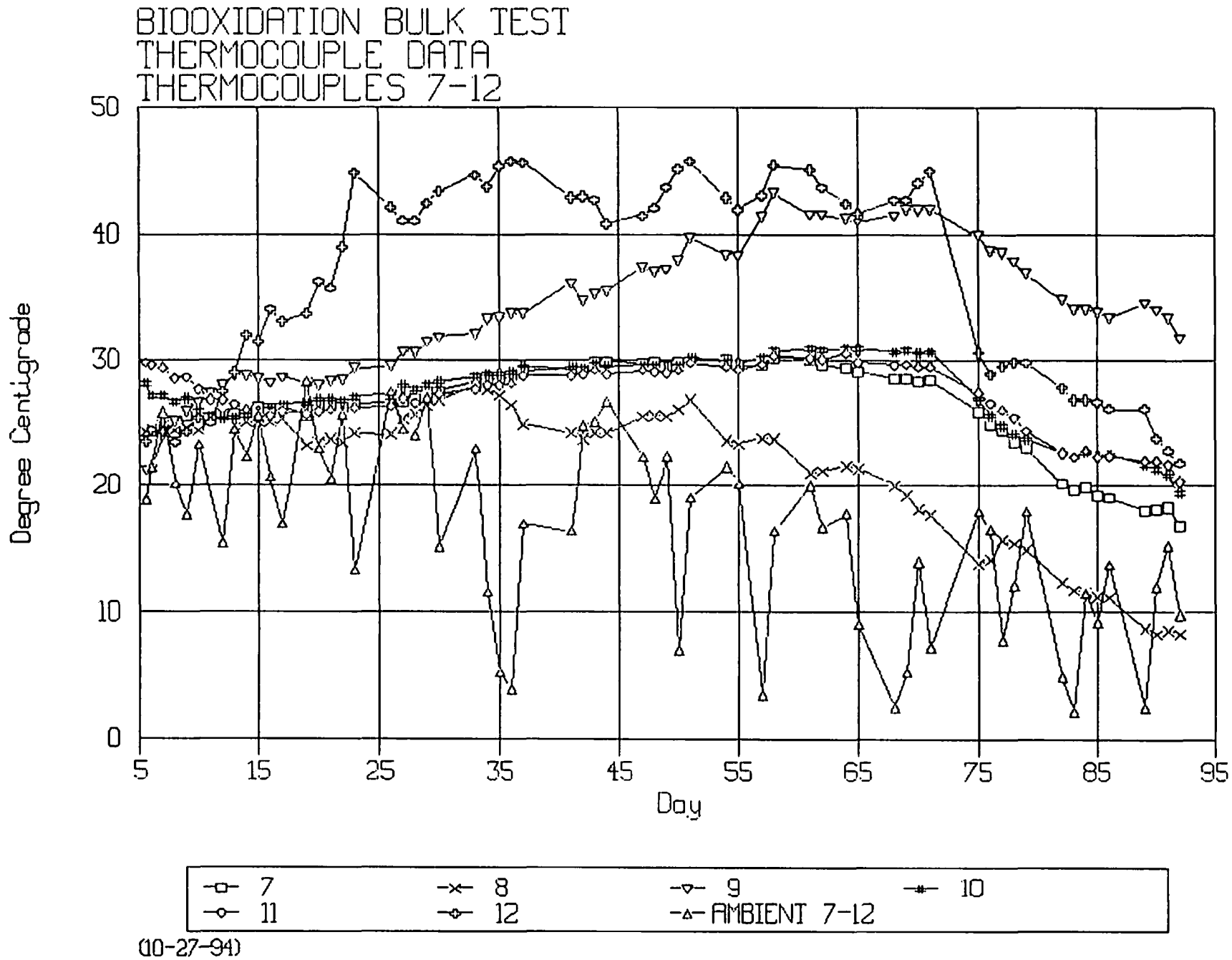
Date	West 1	West 2	West 3	West 4	West 5	Mid 6	Mid 7	Mid 8	East 9	East 10	East 11	East 12	AMBIENT 1-6	AMBIENT 7-12
08/02/94	27.8	23.2	27.4	24.3	25.7	28.0	24.3	24.3	21.2	28.1	29.8	23.5	19.0	18.9
08/02/94	28.2	23.8	27.6	25.0	26.2	28.7	24.3	24.5	21.3	27.1	29.6	24.4	22.6	21.5
08/03/94	27.2	23.7	27.2	24.6	25.6	27.5	24.5	24.8	24.0	27.1	29.4	24.3	26.0	25.8
08/04/94	29.7	24.7	27.8	25.0	27.0	29.0	24.2	24.4	25.1	26.6	28.5	23.4	19.0	20.3
08/05/94	31.3	25.6	28.2	27.3	28.3	30.4	25.5	24.6	25.9	26.9	28.6	24.3	17.7	17.7
08/06/94	30.7	25.8	27.7	26.6	26.9	28.1	24.8	24.4	26.6	25.9	27.7	25.4	22.8	23.3
08/07/94	31.8	26.2	27.1	27.4	27.9	29.6	25.4	25.5	27.3	25.5	26.8	25.0	-	-
08/08/94	32.2	27.3	27.9	27.6	27.9	29.1	25.5	25.7	27.9	25.3	26.8	27.5	14.0	15.5
08/09/94	36.4	28.9	28.6	29.3	28.9	29.9	25.7	24.9	28.7	25.4	26.4	29.0	24.0	24.5
08/10/94	35.1	28.8	28.0	28.3	27.8	28.6	25.8	25.0	28.8	25.5	26.0	32.0	21.9	22.3
08/11/94	38.4	30.8	28.5	29.2	28.1	28.9	26.2	25.1	28.5	25.6	25.8	31.5	25.4	25.6
08/12/94	36.6	30.2	27.7	27.8	27.2	27.9	26.1	25.0	28.1	26.0	25.6	34.0	22.3	20.7
08/13/94	39.0	31.9	28.6	29.4	28.3	29.2	26.3	25.3	28.6	26.4	25.9	33.1	17.3	17.0
08/14/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/15/94	38.1	31.2	28.2	28.3	27.1	27.5	25.6	23.2	28.2	26.5	25.7	33.7	24.9	28.3
08/16/94	39.1	32.2	29.0	28.8	27.6	28.0	26.2	23.5	28.0	26.8	25.9	36.2	23.5	22.9
08/17/94	39.1	31.4	28.3	28.3	27.4	27.9	26.3	23.7	28.3	26.8	26.0	35.7	20.8	20.6
08/18/94	40.3	32.8	29.4	29.2	28.3	28.6	26.1	23.5	28.4	26.7	25.9	39.0	28.6	25.7
08/19/94	40.4	32.7	28.8	29.3	28.2	28.7	26.4	24.2	29.4	27.0	26.2	44.8	12.6	13.3
08/20/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/21/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/22/94	44.1	35.7	29.8	31.9	30.7	30.2	26.5	24.1	29.5	27.4	26.3	42.1	28.3	27.5
08/23/94	43.7	37.1	30.4	33.3	32.3	32.8	26.7	25.3	30.7	27.9	26.9	41.0	25.1	24.5
08/24/94	43.1	37.7	30.4	33.5	32.2	32.1	26.8	25.7	30.6	27.6	26.5	41.0	26.0	24.0
08/25/94	43.0	38.5	30.9	34.4	33.2	33.0	27.3	26.3	31.4	28.0	27.0	42.4	27.0	27.0
08/26/94	42.9	38.9	31.0	35.1	33.8	33.5	27.5	26.8	31.8	28.3	27.3	43.3	15.0	15.2
08/27/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/28/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/29/94	43.0	40.5	31.1	34.5	33.4	32.4	28.3	27.9	32.1	28.7	27.7	44.6	23.0	22.9
08/30/94	40.1	41.2	32.6	36.8	35.7	35.8	28.6	27.7	33.2	28.9	28.0	43.7	12.4	11.6
08/31/94	40.8	40.6	32.5	36.8	35.7	35.4	28.6	27.1	33.3	28.9	28.0	45.3	4.6	5.3
09/01/94	42.3	40.9	32.6	36.9	35.3	34.8	28.7	26.4	33.7	29.0	28.1	45.7	4.1	3.9
09/02/94	44.0	40.8	33.0	37.0	35.7	34.6	29.1	24.9	33.7	29.5	28.8	45.6	17.6	17.0
09/03/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/04/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/05/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/06/94	45.2	39.9	36.4	37.9	36.3	35.6	29.4	24.2	36.1	29.4	28.8	42.8	17.2	16.4
09/07/94	46.1	40.7	39.0	37.9	36.8	36.3	29.2	23.7	34.7	29.3	28.9	42.9	25.3	24.8
09/08/94	-	40.2	39.0	36.9	36.4	35.5	29.9	24.2	35.3	29.7	29.2	42.6	25.0	25.1
09/09/94	-	40.8	40.2	37.2	-	34.8	29.9	24.2	35.5	29.5	28.9	40.8	27.8	26.7
09/10/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/11/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/12/94	-	42.5	43.4	39.4	-	37.7	29.8	25.5	37.4	29.6	29.2	41.4	20.8	22.3
09/13/94	-	41.9	42.8	38.3	-	36.8	29.9	25.6	37.0	29.6	29.1	42.0	20.1	19.0
09/14/94	-	41.7	42.8	38.0	-	36.2	29.6	25.5	37.2	29.4	29.0	43.6	22.6	22.4
09/15/94	-	42.5	43.6	38.9	-	37.1	29.9	26.0	37.9	29.6	29.2	45.1	7.0	7.0
09/16/94	-	42.9	43.2	40.3	-	39.1	30.2	26.8	39.7	30.1	29.8	45.7	20.8	19.1
09/17/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/18/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/19/94	-	45.4	43.6	40.6	-	39.4	30.0	23.6	38.4	29.9	29.5	42.8	21.3	21.5
09/20/94	-	45.1	42.5	40.3	-	38.9	29.5	23.3	38.3	29.8	29.3	41.9	18.8	20.3
09/21/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/22/94	-	46.5	42.8	42.1	-	41.8	29.6	23.8	41.3	30.2	29.7	43.0	5.6	3.5
09/23/94	-	47.1	43.1	43.5	-	43.7	30.2	23.7	43.2	30.8	30.4	45.4	18.0	16.4
09/24/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/25/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/26/94	-	47.2	42.1	41.2	-	39.6	30.1	21.0	41.5	30.9	30.2	45.0	20.5	20.0
09/27/94	-	48.7	43.1	42.4	-	41.9	29.6	21.2	41.5	30.8	30.1	43.6	17.2	16.7
09/28/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/29/94	-	49.7	43.2	42.5	-	41.7	29.4	21.6	41.2	31.0	30.6	42.4	17.7	17.8

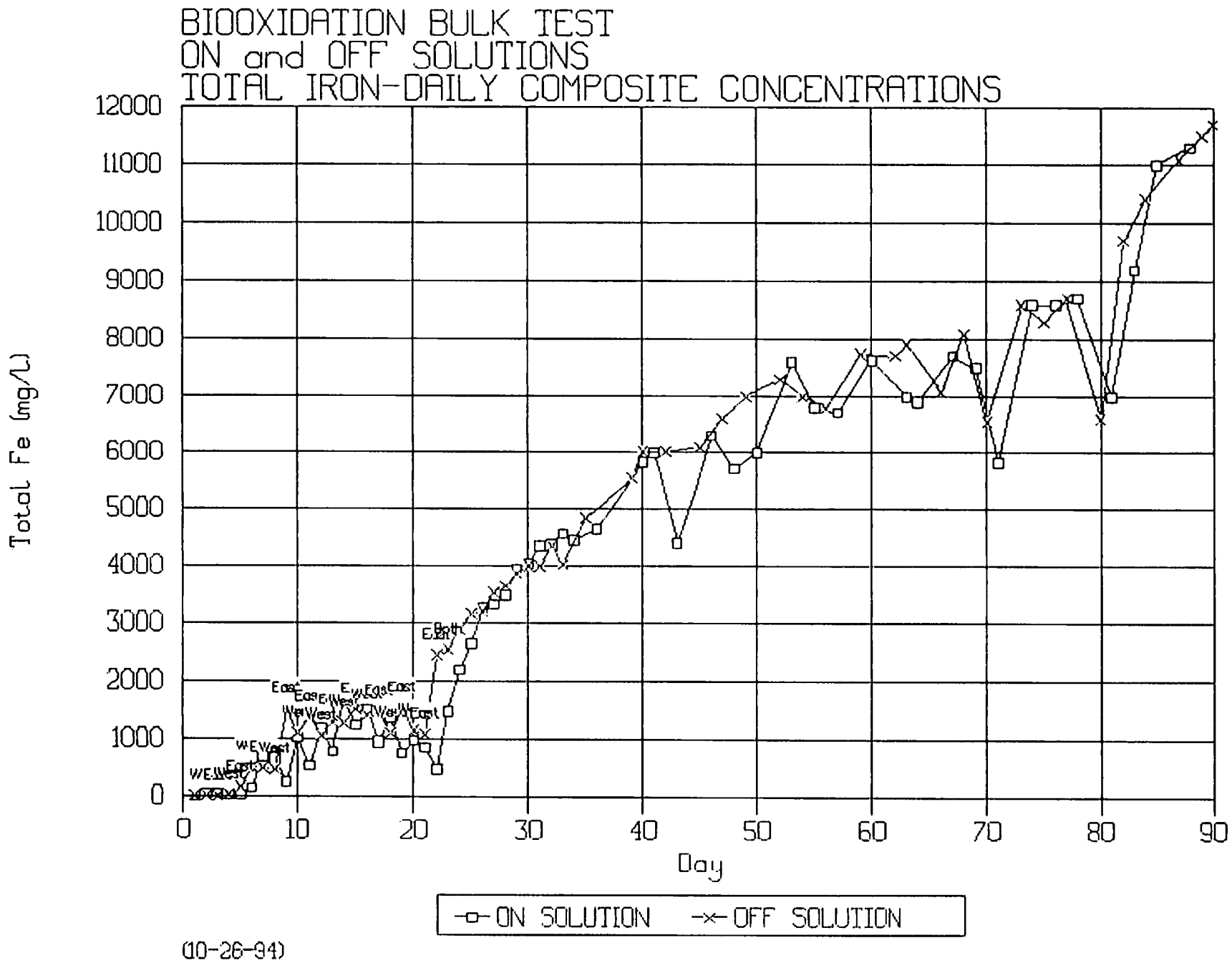
BIOOXIDATION BULK TEST THERMOCOUPLE DATA

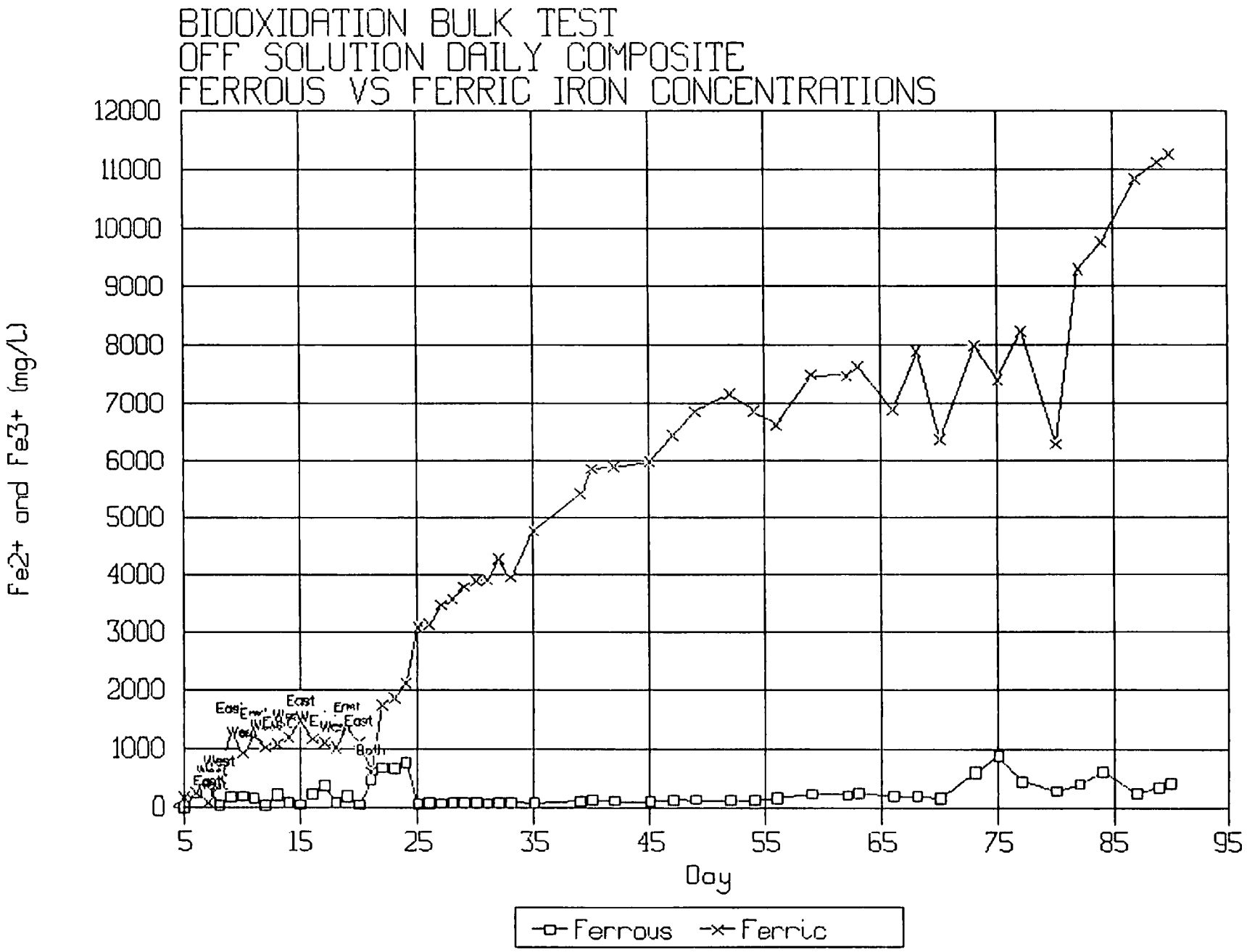
Date	West 1	West 2	West 3	West 4	West 5	Mid 6	Mid 7	Mid 8	East 9	East 10	East 11	East 12	AMBIENT 1-6	AMBIENT 7-12
09/30/94	-	49.7	43.1	42.1	-	41.0	29.1	21.4	41.0	30.9	29.9	41.6	9.8	9.0
10/01/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/02/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/03/94	-	49.8	44.4	42.3	-	41.5	28.5	20.0	41.4	30.7	29.6	42.6	2.3	2.5
10/04/94	-	49.8	45.1	42.6	-	41.7	28.5	19.3	41.9	30.8	29.7	42.6	6.1	5.3
10/05/94	-	50.3	46.3	43.1	-	41.5	28.3	18.2	41.8	30.6	29.5	44.0	14.9	14.0
10/06/94	-	50.2	46.7	43.1	-	41.5	28.4	17.7	41.9	30.7	29.5	44.9	7.8	7.2
10/07/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/08/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/09/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/10/94	-	51.9	40.7	43.3	-	41.2	25.9	13.9	39.9	26.9	27.4	30.6	19.1	18.0
10/11/94	-	52.9	40.1	43.6	-	41.1	24.9	14.2	38.7	25.6	26.5	28.9	15.6	16.5
10/12/94	-	52.9	38.1	43.1	-	41.8	24.4	15.7	38.5	24.8	26.0	29.5	9.0	7.8
10/13/94	-	53.1	37.1	42.9	-	41.7	23.5	15.4	37.8	24.1	25.4	29.9	12.5	12.1
10/14/94	-	51.7	37.2	42.8	-	41.1	23.0	15.0	36.9	23.7	24.4	29.8	18.2	18.0
10/15/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/16/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/17/94	-	50.0	35.8	42.0	-	40.2	20.2	12.3	34.8	22.6	22.6	27.8	5.3	4.9
10/18/94	-	49.2	34.7	41.9	-	40.7	19.7	11.7	34.1	22.3	22.3	26.8	2.9	2.2
10/19/94	-	48.7	33.1	41.3	-	39.8	19.9	11.6	34.1	22.7	22.8	26.8	11.3	11.5
10/20/94	-	47.6	32.3	40.9	-	38.5	19.3	11.2	33.8	22.4	22.3	26.6	9.0	9.2
10/21/94	-	46.9	31.9	40.6	-	39.2	19.1	11.1	33.4	22.5	22.4	26.1	15.0	13.8
10/22/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/23/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/24/94	-	45.4	30.7	40.1	-	38.8	18.1	8.7	34.5	21.7	22.0	26.1	4.0	2.5
10/25/94	-	44.0	30.3	39.8	-	38.3	18.2	8.3	34.0	21.3	22.0	23.8	11.5	12.0
10/26/94	-	43.5	29.5	38.6	-	36.9	18.3	8.6	33.4	20.9	21.7	22.8	15.4	15.3
10/27/94	-	43.3	28.9	37.9	-	36.5	16.8	8.3	31.8	19.5	20.4	21.8	10.0	9.8


BIOOXIDATION BULK TEST
THERMOCOUPLE DATA
THERMOCOUPLES 1-6
Degree Centigrade
60
50
40
30
20
10
0
5
15
25
35
45
55
65
75
85
95
Day
1
2
3
4
5
6
AMBIENT 1-6

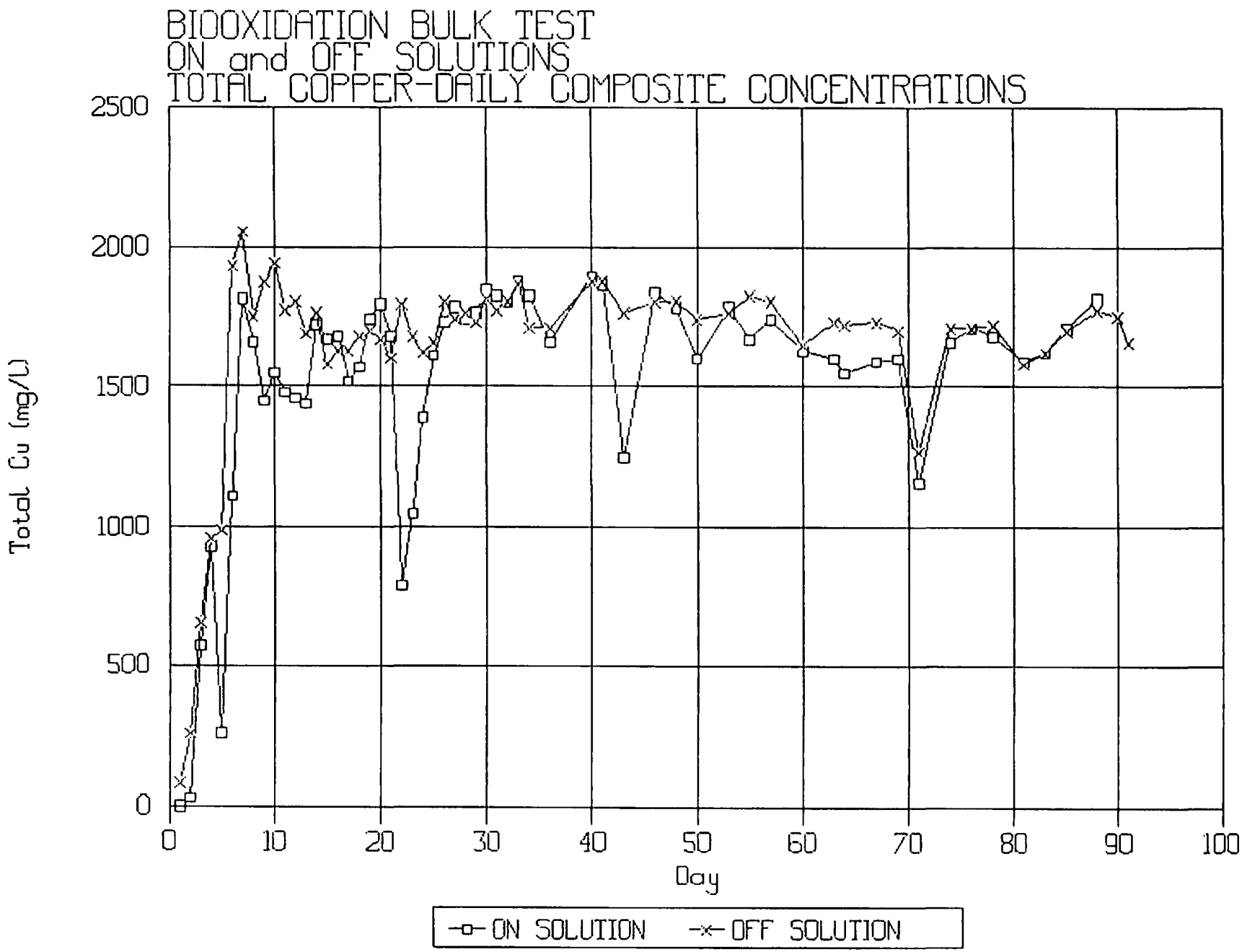
(10-27-94)


BIOOXIDATION BULK TEST
THERMOCOUPLE DATA
THERMOCOUPLES 7-12
Degree Centigrade
50
40
30
20
10
0
5
15
25
35
45
55
65
75
85
95
Day
7
8
9
10
11
12
AMBIENT 7-12
(10-27-94)


BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
TOTAL IRON-DAILY COMPOSITE CONCENTRATIONS
Total Fe (mg/L)
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
0
10
20
30
40
50
60
70
80
90
Day
ON SOLUTION
OFF SOLUTION
(10-26-94)

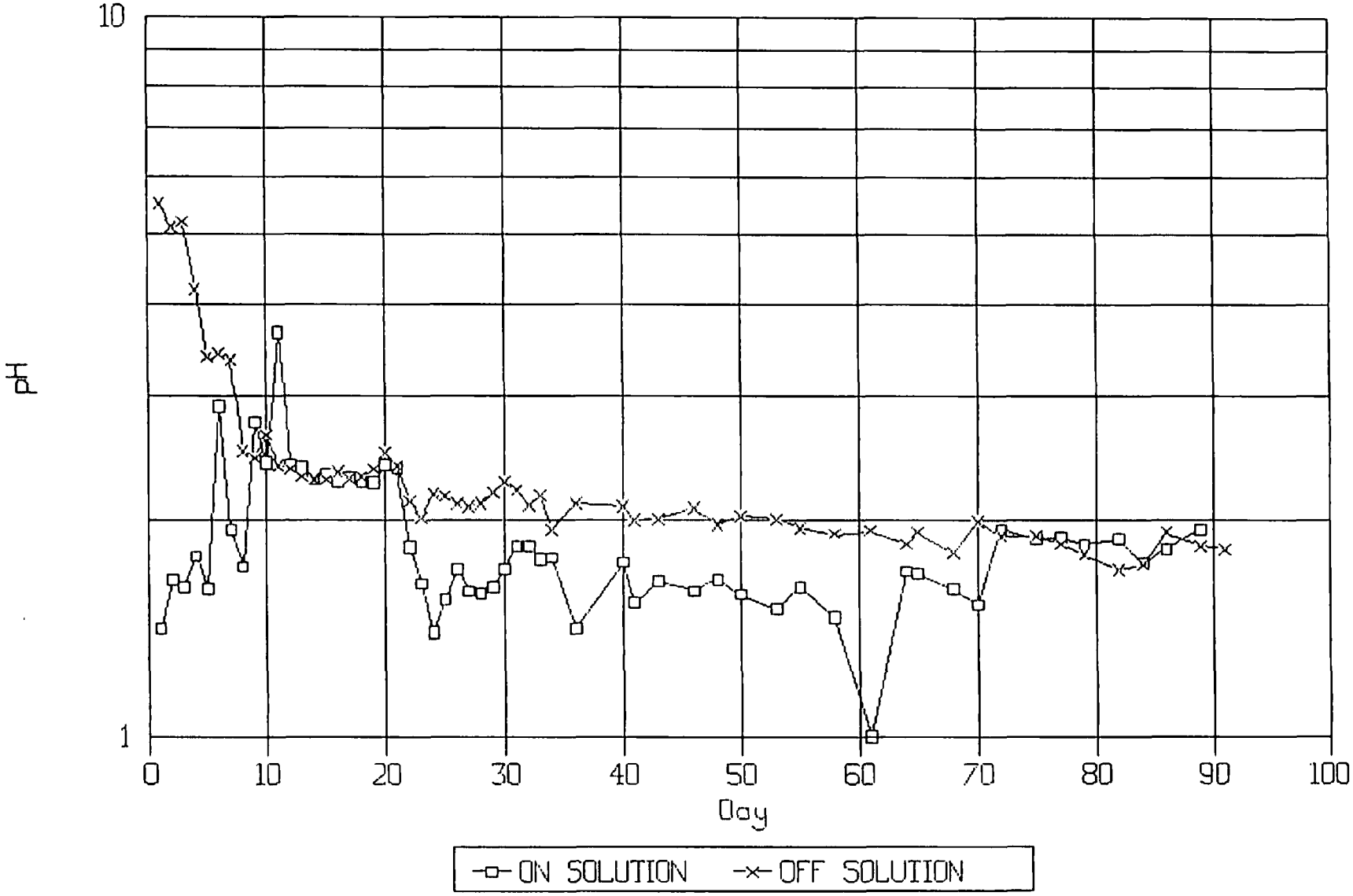

BIOOXIDATION BULK TEST
OFF SOLUTION DAILY COMPOSITE
FERROUS VS FERRIC IRON CONCENTRATIONS
Fe2+ and Fe3+ (mg/L)
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
5
15
25
35
45
55
65
75
85
95
Day
Ferrous
Ferric

(10-26-94)

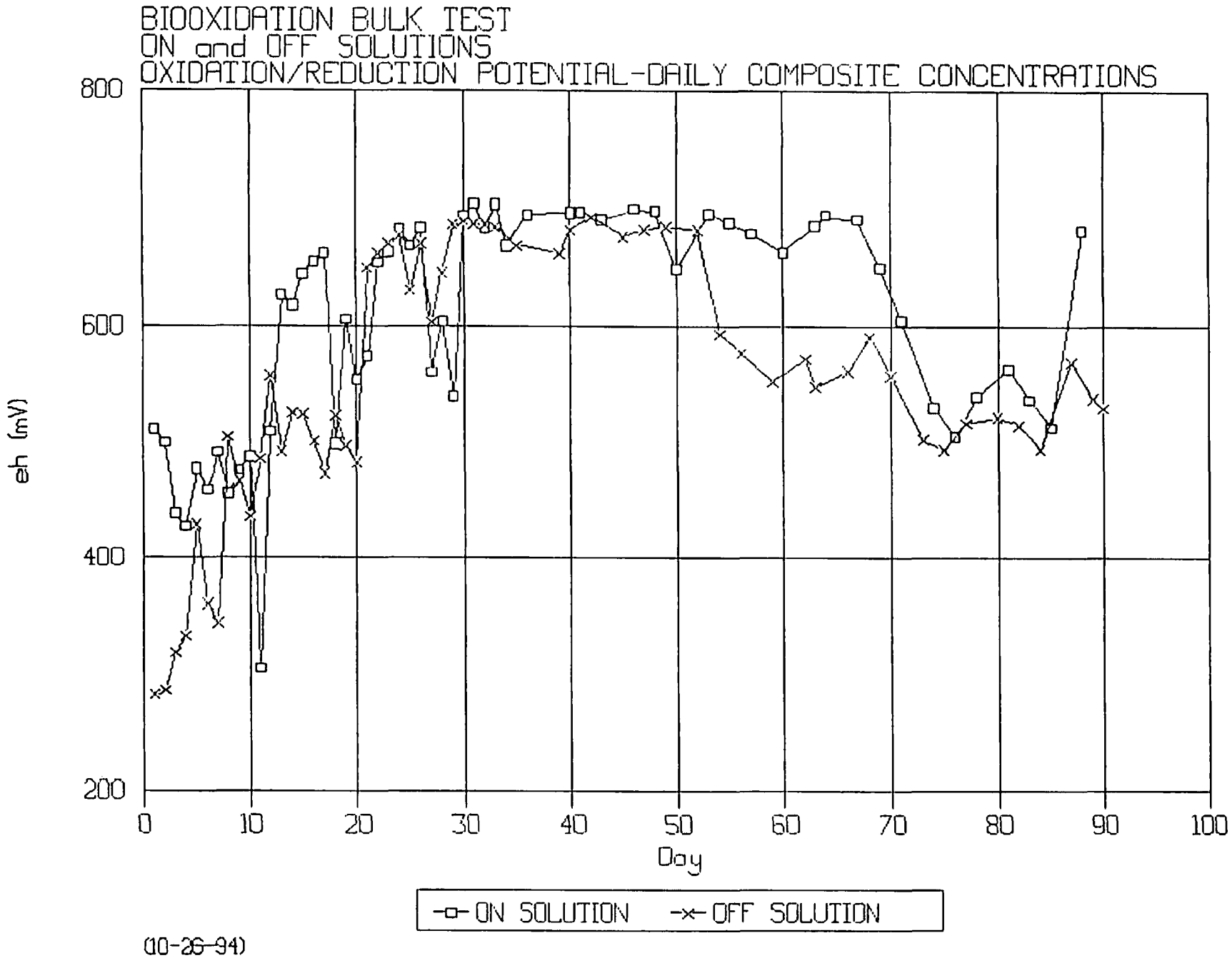

BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
TOTAL COPPER-DAILY COMPOSITE CONCENTRATIONS
Total Cu (mg/L)
2500
2000
1500
1000
500
0
0
10
20
30
40
50
60
70
80
90
100
Day
ON SOLUTION
OFF SOLUTION

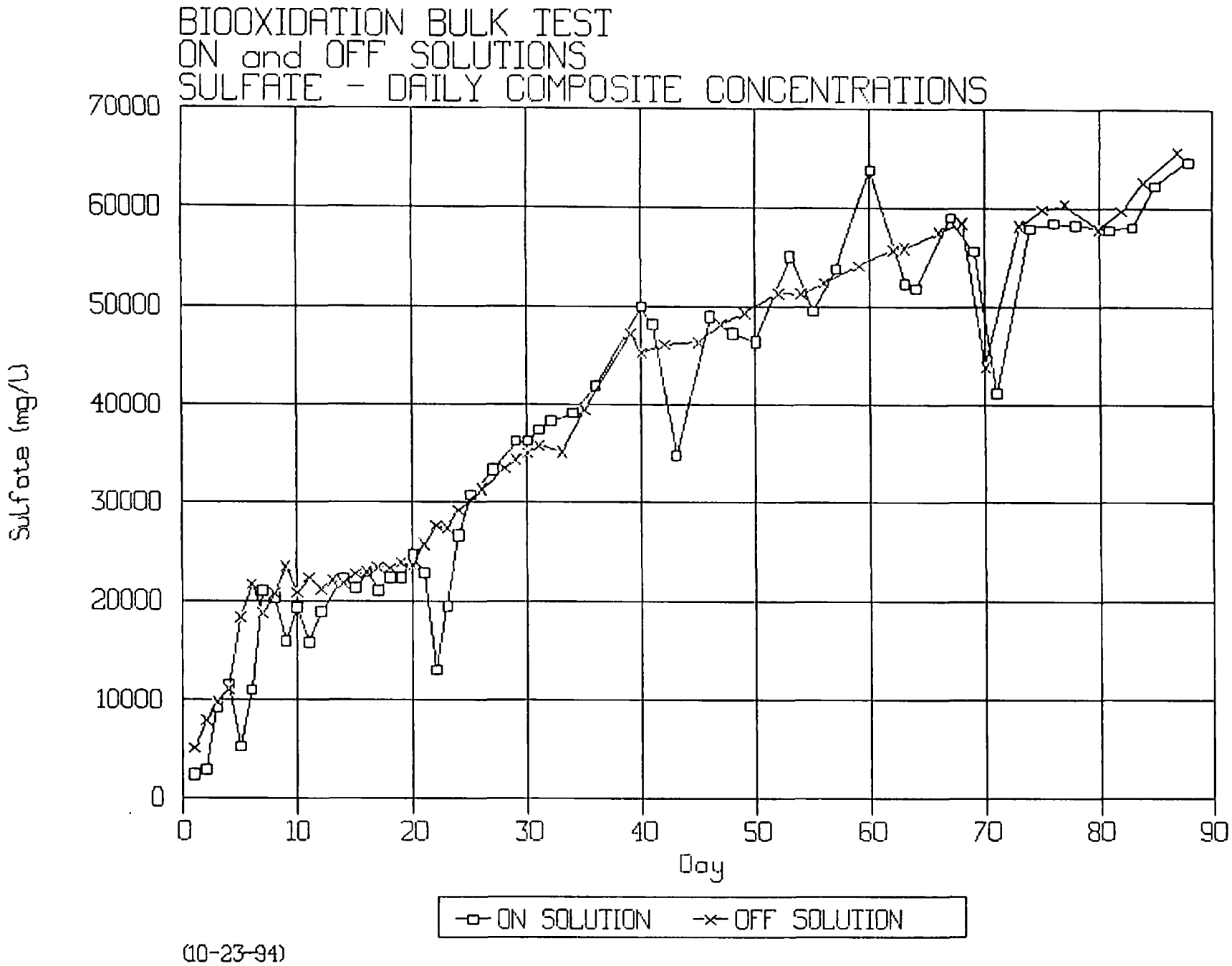
(10-26-94)

BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
pH - DAILY COMPOSITE

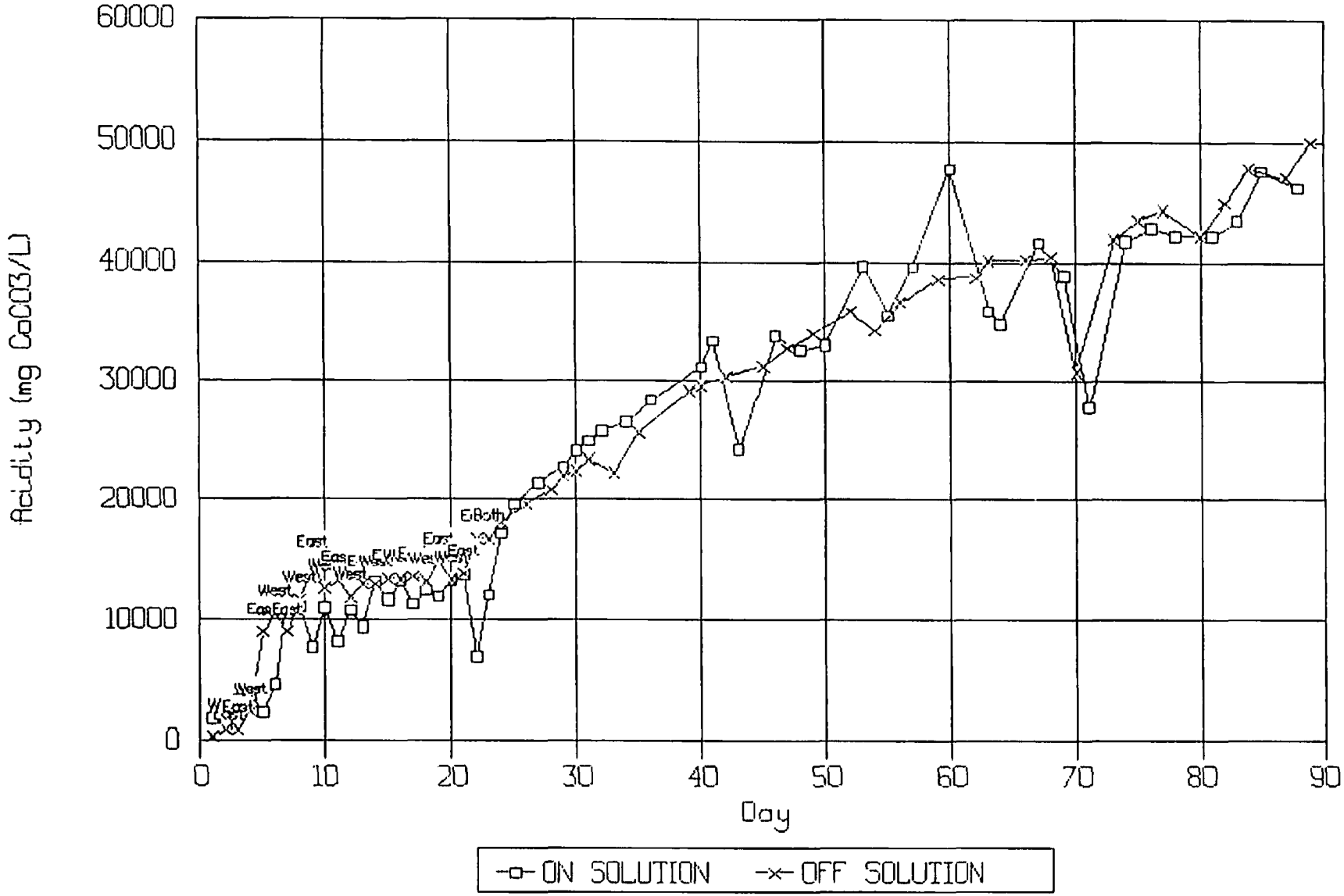


(10-26-94)


BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
OXIDATION/REDUCTION POTENTIAL-DAILY COMPOSITE CONCENTRATIONS
800
600
400
200
eh (mV)
0
10
20
30
40
50
60
70
80
90
100
Day
ON SOLUTION
OFF SOLUTION
(10-26-94)


BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
SULFATE - DAILY COMPOSITE CONCENTRATIONS
Sulfate (mg/L)
70000
60000
50000
40000
30000
20000
10000
0
0
10
20
30
40
50
60
70
80
90
Day
ON SOLUTION
OFF SOLUTION
(10-23-94)

BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
ACIDITY TO pH 7-DAILY COMPOSITE CONCENTRATIONS



(10-25-94)

BBT BOTTLE ROLL EXTRACTION

Sample I.D.	AUGER DRILL-2 WEST 26 lb/T CaO 5.55 lb/T NaCN 47.4% Solids	
Date	09/27/94	
FA Tail Au (opt)	.0227	
AA Soln Au (opt)	.0377	96 hr
Calc Head Au (opt)	.0604	
NaCN (lb/ton) final	3.57	
NaCN Consumption (lb/ton)	2.0	
pH (initial)	11.82	
pH (final)	10.87	
% Extraction Au (AA Soln/Calc Head)	62.4	

BBT BOTTLE ROLL EXTRACTION

Sample I.D.	AUGER DRILL-2 MID 27 lb/T CaO 5.56 lb/T NaCN 47.4% Solids	
Date	09/27/94	
FA Tail Au (opt)	.0226	
AA Soln Au (opt)	.0306	96 hr
Calc Head Au (opt)	.0532	
NaCN (lb/ton) final	2.97	
NaCN Consumption (lb/ton)	2.6	
pH (initial)	11.96	
pH (final)	10.91	
% Extraction Au (AA Soln/Calc Head)	57.5	

BBT BOTTLE ROLL EXTRACTION

Sample I.D.	AUGER DRILL-2 EAST 25 lb/T CaO 5.55 lb/T NaCN 47.4% Solids	
Date	09/27/94	
FA Tail Au (opt)	.1196	Contamination?
AA Soln Au (opt)	.0335	96 hr
Calc Head Au (opt)	.1531	
NaCN (lb/ton) final	3.49	
NaCN Consumption (lb/ton)	2.1	
pH (initial)	11.76	
pH (final)	10.94	
% Extraction Au (AA Soln/Calc Head)	21.9	

AUGER DRILL-2 = 5% Bioxidation by Sulfur

AVERAGE WEST and MID
% Extraction Gold = 60.0%

SP2 COMP (CONTROL)
% Extraction Gold = 54.8%
Calc Head Au = 0.0518 opt
18 lb/ton CaO
2.1 lb/ton NaCN Consumption

MEMORANDUM

DATE: OCTOBER 21, 1994
TO: JIM THOMPSON
FROM: LAURA DAMON
SUBJECT: BIOOXIDATION BULK TEST (BBT) WEEKLY UPDATE (12)

The BBT has been on the biooxidation cycle for twelve weeks now. Both the west and east sides are on simultaneous solution application. The ON solution application rate has averaged 10.1 gpm this week while the OFF solution return rate has averaged 13.0 gpm. Some discrepancy in flows of the ON and OFF solutions this week is due to a 2-3 inch rainstorm Saturday, October 15th through Tuesday, October 18th. It is estimated that the biooxidation solution circuit gained another 5,000 to 10,000 gallons of rain water. 18,700 gallons, 5100 gallons of pool solution and 13,600 gallons of OFF solution, were discharged on to Cell #7. The discharged gallons contained 1016 lb of iron and 189 lb of copper. Another 2152 lb of iron and 66 lb of copper is in the swimming pool sediment. The heap still remains intact and stable.

The neutralization circuit is no longer adequate for solution neutralization. The limestone in the swimming pool has blinded off decreasing flow capacity from 30 gpm to 3 gpm. Without the aid of the limestone pre-treatment, the screw feeder system cannot perform neutralization on the solution. It is estimated that we have come very close to reaching our neutralization treatment goal of 100,000 total gallons if the 35,000 to 40,000 gallons of rain water is included in the neutralization treatment total.

The rain water rinse seems to have helped the BBT's rate of biooxidation. The total iron concentration is up close to 10,000 ppm this week. The total iron graph shows two low data points (from the days with the heaviest rainfall) but then the slope starts to steepen. The total iron concentration in the OFF solution has risen from an average 1417 lb to 1658 lb over the last week. The iron continues to be predominantly in the form of ferric iron. It has been calculated that 5276 lb of iron has been removed from the BBT either in neutralization or from the release of OFF solution. It has been further calculated that there is 7920 lb of iron in the circulating solution load (assuming 100,000 total gallons of solution). Thus, 13,196 lb of iron has been removed from the BBT (not taking into account any iron deposited in the limestone screw feeder precipitate or iron deposited on the limestone in the drain rock). With a total 541,386 lb of iron in the heap, the percent iron oxidation to date is at least 2.4%. This corresponds well with the reported 5% sulfur oxidation from the auger drill-2 samples.

The copper values seem to be slowly decreasing, most likely due to dilution from the rain water. This decrease suggests, however, that most of the leachable copper has been removed from the ore and is merely recirculating in the solution now. It has been calculated that 1716 lb of copper has been removed from the BBT either in neutralization or from the release of OFF solution. It has also been calculated that there is 1351 lb of copper in the circulating solution load. Thus, 3067 lb of copper has been removed from the BBT. With a total of 4559 lb copper in the heap, it is calculated that only about 30% of the copper remains in the ore.

The pH of the OFF solution is slowly decreasing and staying lower than the ON solution pH. The oxidation/reduction potential continues to stay at an eh range of 500. Although the sulfate concentration seems to have levelled off somewhat, the dilution factor must be considered. The acidity continues to rise in comparison with the lower pH. These analyses indicate that the BBT is biooxidizing at an increased rate.

The thermocouple readings have consistently tapered off over the last couple of weeks but the ambient temperatures have been lower too. Also the cool rain water rinse may have affected the thermocouple temperatures. It takes many calories to raise the temperature of the added solution. Air started being injected into the heap under Thermocouples 4 and 6 to see if this added air supply has any effect in raising the temperatures.

Results from gold extraction bottle rolls on the auger drill-2 samples are attached. The sulfide analyses indicated that these samples are about 5% biooxidized in comparison to the auger drill-1 samples. The gold extraction percentage was 57.5% with 26 lb/ton CaO addition and NaCN consumption at 2.1 lb/ton. These results are based on the average of the west and mid auger drill-2 composites. The gold extraction increased 2.7% in comparison to the control SP-2 composite bottle rolls. The control samples, with zero percent biooxidation, had 54.8% gold extraction with 18 lb/ton CaO addition and NaCN consumption at 2.1 lb/ton.

Auger drill-3 samples will be collected next week with bottle rolls and a column of ore analyzed for gold extraction. Splits from the nine samples (West, Mid, East; 1'-5', 5'-10' and 10'-15' intervals) will be sent to McClelland Laboratories, at the request of Geobiotics, for bottle roll analyses.

c: Rod MacLeod
Martin Quick
Herb Osborne

BIOOXIDATION BULK TEST SOLUTION SAMPLING

ON SOLUTION

Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)
Orofino	7/21-9/29		(91000)	7.91	337.4	.01	1.35	-	-	-	107
	7/21-7/28	19741	19741								
GRAB-1530	07/27/94	?	19741	1.94	516.2	1.26	3.0	-	-	-	-
GRAB	07/28/94	?	19741	1.20	555.3	.16	7.8	-	-	3042	3411
COMP	07/28/94	?	19741	1.41	510.8	.10	21.6	-	-	1924	2420
COMP	07/29/94	9542	29283	1.65	498.3	29	45.0	4.1	40.9	1416	3012
COMP	07/30/94	5504	34787	1.61	438.4	574	38.0	2.2	35.8	3442	9230
COMP	07/31/94	975	35762	1.78	426.7	930	51.0	2.3	48.7	3823	11575
COMP	08/01/94	21302	57063	1.60	475.9	260	33.0	1.3	31.7	2394	5238
COMP	08/02/94	18970	76034	2.89	458.4	1110	155	71	84	4705	10999
COMP	08/03/94	16238	92272	1.94	490.0	1810	710	130	580	11581	20982
COMP	08/04/94	12021	104293	1.72	455.8	1660	660	340	320	11167	20349
COMP	08/05/94	16734	121027	2.75	475.1	1450	260	40	220	7673	15888
COMP	08/06/94	16466	137492	2.41	486.8	1550	1030	60	970	11012	19332
COMP	08/07/94	16466	153958	3.66	304.8	1480	530	60	470	8191	15810
COMP	08/08/94	16502	170460	2.40	507.9	1460	1170	110	1060	10820	18867
COMP	08/09/94	16103	186563	2.38	627.5	1440	790	25	765	9380	-
COMP	08/10/94	15624	202187	2.28	618.1	1720	1680	63	1617	13218	22369
COMP	08/11/94	16113	218300	2.33	645.4	1670	1250	33	1217	11657	21262
COMP	08/12/94	14762	233062	2.27	656.2	1680	1510	146	1364	13205	22874
COMP	08/13/94	13785	246847	2.30	663.0	1520	950	41	909	11254	21036
COMP	08/14/94	10979	257826	2.27	497.5	1570	1380	229	1151	12451	22331
COMP	08/15/94	10129	267955	2.26	606.6	1740	750	53	697	11956	22333
COMP	08/16/94	6178	274133	2.40	553.1	1790	970	51	919	13257	24698
COMP	08/17/94	6444	280577	2.36	573.3	1680	860	171	689	13713	22929
COMP	08/18/94	7205	287782	1.83	655.6	790	490	170	320	6959	12987
COMP	08/19/94	12447	300229	1.63	664.1	1050	1480	440	1040	12007	19505
COMP	08/20/94	15338	315567	1.39	683.9	1390	2190	610	1580	17135	26608
COMP	08/21/94	12497	328064	1.55	669.8	1610	2660	710	1950	19555	30681
COMP	08/22/94	11793	339857	1.71	684.8	1730	3270	75	3195	-	-
COMP	08/23/94	12099	351956	1.59	560.0	1780	3310	123	3187	21399	33274
COMP	08/24/94	11183	363139	1.58	604.9	1740	3480	82	3398	-	-
COMP	08/25/94	11114	374253	1.61	538.6	1760	3960	230	3730	22733	36228
COMP	08/26/94	9502	383755	1.71	694.7	1840	4040	94	3946	24028	36237
COMP	08/27/94	9144	392899	1.84	705.2	1820	4370	99	4271	24868	37372
COMP	08/28/94	8493	401392	1.84	684.4	1800	4380	99	4281	25735	38352
COMP	08/29/94	8859	410251	1.76	704.1	1870	4570	86	4484	-	-
COMP	08/30/94	7349	417600	1.77	669.5	1820	4450	84	4366	26418	39084
COMP	08/31/94	8940	426540	-	-	-	-	-	0	-	-
COMP	09/01/94	8784	435324	1.41	695.6	1660	4660	94	4566	28282	41981
COMP	09/02/94	5757	441081	-	-	-	-	-	0	-	-
COMP	09/03/94	7779	448860	-	-	-	-	-	0	-	-
COMP	09/04/94	7563	456423	-	-	-	-	-	0	-	-
COMP	09/05/94	6512	462935	1.74	697.0	1890	5820	127	5693	31066	49890
COMP	09/06/94	5907	468842	1.53	698.3	1860	6000	138	5862	33298	48170
COMP	09/07/94	6074	474916	-	-	-	-	-	0	-	-
COMP	09/08/94	8632	483548	1.64	691.8	1250	4410	86	4324	24133	34862
COMP	09/09/94	9369	492917	-	-	-	-	-	0	-	-
COMP	09/10/94	6460	499377	-	-	-	-	-	0	-	-
COMP	09/11/94	6460	505837	1.59	700.2	1830	6300	114	6186	33773	48927
COMP	09/12/94	6004	511841	-	-	-	-	-	0	-	-
COMP	09/13/94	7143	518984	1.65	698.8	1780	5700	127	5573	32506	47216
COMP	09/14/94	8045	527029	-	-	-	-	-	0	-	-
COMP	09/15/94	10057	537086	1.57	649.7	1600	6000	117	5883	32933	46360
COMP	09/16/94	10719	547805	-	-	-	-	-	0	-	-
COMP	09/17/94	9886	557691	-	-	-	-	-	0	-	-
COMP	09/18/94	8902	566593	1.50	697.1	1780	7600	102	7498	39646	55042

BIOOXIDATION BULK TEST SOLUTION SAMPLING

ON SOLUTION

Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)
COMP	09/20/94	3226	575366	1.61	689.3	1670	6800	138	6662	35523	49528
COMP	09/21/94	4164	579530	-	-	-	-	-	0	-	-
COMP	09/22/94	3296	582826	1.46	680.5	1740	6700	151	6549	39570	53734
COMP	09/23/94	6300	589126	-	-	-	-	-	0	-	-
COMP	09/24/94	8519	597645	-	-	-	-	-	0	-	-
COMP	09/25/94	7928	605573	1.00	664.8	1630	7630	146	7484	47665	63889
COMP	09/26/94	6189	611762	-	-	-	-	-	0	-	-
COMP	09/27/94	6154	617916	-	-	-	-	-	0	-	-
COMP	09/28/94	5684	623600	1.69	686.9	1600	7000	138	6862	35900	52293
COMP	09/29/94	7387	630987	1.68	695.5	1550	6900	120	6780	34862	51808
COMP	09/30/94	5875	636862	-	-	-	-	-	0	-	-
COMP	10/01/94	4570	641431	-	-	-	-	-	0	-	-
COMP	10/02/94	4570	646001	1.60	691.9	1590	7700	171	7529	41524	58993
COMP	10/03/94	5786	651787	-	-	-	-	-	0	-	-
COMP	10/04/94	2417	654204	1.52	650.9	1600	7500	156	7344	38828	55577
COMP	10/05/94	5927	660131	-	-	-	-	-	0	-	-
COMP	10/06/94	9778	669909	1.94	605.5	1160	5830	123	5707	27760	41183
COMP	10/07/94	14172	684081	-	-	-	-	-	0	-	-
COMP	10/08/94	16206	700287	-	-	-	-	-	0	-	-
COMP	10/09/94	14417	714704	1.88	529.8	1660	8600	300	8300	41682	57947
COMP	10/10/94	14429	729133	-	-	-	-	-	0	-	-
COMP	10/11/94	15560	744693	1.89	504.1	1710	8600	610	7990	42768	58417
COMP	10/12/94	15734	760427	-	-	-	-	-	0	-	-
COMP	10/13/94	13780	774207	1.85	538.7	1680	8700	260	8440	42172	58326
COMP	10/14/94	13162	787369	-	-	-	-	-	0	-	-
COMP	10/15/94	13628	800997	-	-	-	-	-	0	-	-
COMP	10/16/94	16462	817459	1.88	563	1590	7000	200	6800	42146	57791
COMP	10/17/94	17251	834710	-	-	-	-	-	0	-	-
COMP	10/18/94	16440	851150	1.74	536.2	1620	9200	310	8890	43393	58079
COMP	10/19/94	11241	862391	-	-	-	-	-	0	-	-

BIOOXIDATION BULK TEST SOLUTION SAMPLING

OFF SOLUTION

Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	DO (ppm)
SUMP-GRAB	07/26/94	1200	1200	7.22	-	.84	.27	-	-	-	-	-
GRAB-1530	07/27/94	1750	2950	7.53	305.4	.89	.20	-	-	-	-	-
COMP	07/28/94	3000	5950	5.93	353.6	83	.55	-	-	83	4411	-
COMP	07/29/94	3293	9243	5.49	282.1	255	13	-	-	362	5094	-
COMP	07/30/94	4419	13662	5.11	285.7	654	14	-	-	994	7913	-
COMP	07/31/94	2688	16350	5.18	318.8	960	11	-	-	956	9835	-
COMP	08/01/94	7822	24172	4.20	332.3	990	39	1	38	2438	11106	-
COMP	08/02/94	21836	46008	3.39	429.6	1930	172	2	170	8960	18304	-
COMP	08/03/94	14710	60718	3.43	360.1	2050	520	260	260	10520	21678	-
COMP	08/04/94	7500	68218	3.36	344.2	1750	500	410	90	8967	18731	-
COMP	08/05/94	6821	75039	2.50	503.7	1870	480	40	440	11633	20711	-
COMP	08/06/94	21396	96436	2.45	465.2	1940	1530	200	1330	14570	23591	-
COMP	08/07/94	21396	117832	2.63	435.8	1770	1110	190	920	12617	20727	-
COMP	08/08/94	18698	136530	2.40	484.6	1800	1390	160	1230	13259	22299	-
COMP	08/09/94	21118	157648	2.36	557.4	1690	1070	36	1034	11904	21180	-
COMP	08/10/94	16419	174067	2.31	491.4	1760	1320	220	1100	12958	22052	-
COMP	08/11/94	16500	190567	2.29	524.4	1580	1290	86	1204	12958	21764	-
COMP	08/12/94	18213	208780	2.28	523.1	1630	1520	56	1464	13452	22729	1.3
COMP	08/13/94	18585	227365	2.34	500.2	1630	1420	240	1180	13361	22995	1.3
COMP	08/14/94	16646	244011	2.29	472.4	1680	1490	380	1110	13608	23458	-
COMP	08/15/94	13559	257570	2.31	522.4	1700	1110	84	1026	13179	23381	-
COMP	08/16/94	12267	269837	2.36	496.4	1670	1540	196	1344	14831	23933	1.4
COMP	08/17/94	7697	277534	2.49	481.4	1600	1160	43	1117	13309	23711	2.2
COMP	08/18/94	7136	284670	2.39	650.1	1790	1100	480	620	13839	25735	1.7
COMP	08/19/94	13078	297748	2.13	663.0	1680	2450	690	1760	16703	27554	-
COMP	08/20/94	14479	312227	2.02	672.0	1620	2550	670	1880	16716	27464	-
COMP	08/21/94	14213	326440	2.18	678.3	1660	2900	770	2130	18024	29200	-
COMP	08/22/94	14246	340686	2.16	631.0	1800	3160	75	3085	-	-	-
COMP	08/23/94	13868	354554	2.11	671.3	1740	3210	73	3137	19568	31299	-
COMP	08/24/94	12742	367296	2.09	604.1	1760	3540	82	3458	-	-	.7
COMP	08/25/94	11741	379037	2.11	646.9	1730	3640	86	3554	20823	33471	5.5?
COMP	08/26/94	12505	391542	2.19	687.1	1810	3860	86	3774	22006	34443	OFL
COMP	08/27/94	11272	402814	2.27	689.5	1770	4000	94	3906	22374	35035	-
COMP	08/28/94	9000	411814	2.21	688.0	1800	4000	82	3918	23319	35858	-
COMP	08/29/94	9000	420814	2.10	688.2	1860	4370	86	4284	-	-	OFL
COMP	08/30/94	11403	432217	2.17	685.5	1710	4030	84	3946	22242	35134	13.5?
COMP	08/31/94	10726	442943	-	-	-	-	-	-	-	-	OFL
COMP	09/01/94	10299	453242	1.94	669.9	1710	4840	89	4751	25577	39562	OFL
COMP	09/02/94	9075	462317	-	-	-	-	-	-	-	-	3.9
COMP	09/03/94	8149	470466	-	-	-	-	-	-	-	-	-
COMP	09/04/94	7612	478078	-	-	-	-	-	-	-	-	-
COMP	09/05/94	7357	485435	2.11	663.7	1870	5550	120	5430	29017	47141	-
COMP	09/06/94	6870	492305	2.09	682.9	1870	6010	151	5859	29543	45273	3.5
COMP	09/07/94	6503	498808	-	-	-	-	-	-	-	-	6.2
COMP	09/08/94	10447	509255	2.00	693.8	1760	6010	117	5893	30304	46121	5.5
COMP	09/09/94	8553	517808	-	-	-	-	-	-	-	-	5.5
COMP	09/10/94	8424	526232	-	-	-	-	-	-	-	-	-
COMP	09/11/94	8424	534656	2.01	677.7	1800	6100	114	5986	31157	46376	-
COMP	09/12/94	7258	541914	-	-	-	-	-	-	-	-	-
COMP	09/13/94	6630	548544	2.08	683.7	1800	6600	151	6449	32657	48154	2.8
COMP	09/14/94	7479	556023	-	-	-	-	-	-	-	-	2.6
COMP	09/15/94	11492	567515	1.97	685.6	1740	7000	142	6858	33989	49372	4.6
COMP	09/16/94	11244	578759	-	-	-	-	-	-	-	-	2.8
COMP	09/17/94	11287	590046	-	-	-	-	-	-	-	-	-
COMP	09/18/94	10435	600481	2.03	684.0	1760	7300	134	7166	35825	51363	-
COMP	09/19/94	9531	610012	-	-	-	-	-	-	-	-	2.5
COMP	09/20/94	6175	616187	2.01	593.5	1820	7000	134	6866	34241	51265	2.8
COMP	[illegible]	[illegible]	[illegible]									

BIOOXIDATION BULK TEST SOLUTION SAMPLING

OFF SOLUTION

Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	DO (ppm)
COMP	09/22/94	5238	626486	1.95	576.7	1800	6800	171	6629	36579	52376	3.5
COMP	09/23/94	6073	632559	-	-	-	-	-	-	-	-	3.2
COMP	09/24/94	9286	641845	-	-	-	-	-	-	-	-	-
COMP	09/25/94	9592	651437	1.91	552.0	1650	7730	250	7480	38565	54096	-
COMP	09/26/94	7385	658822	-	-	-	-	-	-	-	-	2.8
COMP	09/27/94	9119	667941	-	-	-	-	-	-	-	-	3.5
COMP	09/28/94	7789	675730	1.93	571.8	1730	7700	230	7470	38690	55742	-
COMP	09/29/94	7387	683117	1.85	547.2	1720	7900	270	7630	40150	55898	-
COMP	09/30/94	7807	690924	-	-	-	-	-	-	-	-	3.2
COMP	10/01/94	6502	697426	-	-	-	-	-	-	-	-	-
COMP	10/02/94	6502	703928	1.92	560.7	1730	7100	210	6890	40202	57552	-
COMP	10/03/94	6231	710159	-	-	-	-	-	-	-	-	4.2
COMP	10/04/94	6834	716993	1.80	591.1	1700	8100	210	7890	40383	58458	4.5
COMP	10/05/94	6911	723904	-	-	-	-	-	-	-	-	4.5
COMP	10/06/94	28493	752396	1.99	557.3	1270	6550	170	6380	30663	43932	5.7
COMP	10/07/94	22817	775213	-	-	-	-	-	-	-	-	-
COMP	10/08/94	19403	794616	-	-	-	-	-	-	-	-	-
COMP	10/09/94	21196	815812	1.90	501.8	1710	8600	610	7990	41883	58178	-
COMP	10/10/94	17200	833012	-	-	-	-	-	-	-	-	2.8
COMP	10/11/94	11500	844512	1.90	492.7	1710	8300	890	7410	43442	59840	2.4
COMP	10/12/94	17000	861512	-	-	-	-	-	-	-	-	-
COMP	10/13/94	18300	879812	1.85	515.7	1720	8700	460	8240	44220	60408	2.1
COMP	10/14/94	15800	895612	-	-	-	-	-	-	-	-	2.0
COMP	10/15/94	16500	912112	-	-	-	-	-	-	-	-	-
COMP	10/16/94	20700	932812	1.79	520.7	1580	6600	300	6300	42146	57873	-
COMP	10/17/94	24500	957312	-	-	-	-	-	-	-	-	2.1
COMP	10/18/94	20500	977812	1.7	514.3	1620	9700	410	9290	44826	59766	2.2
COMP	10/19/94	14300	992112	-	-	-	-	-	-	-	-	2.0

BIOOXIDATION BULK TEST SOLUTION SAMPLING

PAN LYSIMETER 3

Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO (ppm)
GRAB	08/03/94	1.93	488.4	1540	4640	1200	3440	20005	23896	-	
GRAB	08/11/94	1.52	496.1	3200	8700	2900	5800	-	-	Brown/Murky	
GRAB	08/12/94	1.89	450.4	2200	3900	2100	1800	-	27461	Lt Brown	1.5
GRAB	08/15/94	1.92	459.5	2170	3920	1270	2650	15417	27625	Med Brown	1.7
GRAB	08/17/94	1.97	462.7	1940	3220	560	2660	19502	25159	Med Brown	2.4
GRAB	08/19/94	2.00	458.4	1850	2300	1400	900	17828	23604	-	-
GRAB	08/22/94	1.90	464.0	1760	2300	360	1940	16677	23744	Grw/Br Ti	1.9
GRAB	08/24/94	2.04	468.5	1780	2680	770	1910	16795	23028	Green	.9
GRAB	08/26/94	2.05	479.6	1730	2700	690	2010	17030	24320	Br-Yel	4.5?
GRAB	08/29/94	2.08	472.8	1770	2760	360	2400	17936	25167	Yel-Br	OFL
GRAB	09/01/94	1.79	472.3	1870	2730	730	2000	19039	26822	Green	OFL
GRAB	09/06/94	1.83	492.1	1940	2620	210	2410	19748	30237	Lt Green	2.5
GRAB	09/08/94	1.80	488.8	1980	2870	300	2570	21454	30435	Dk Green	4.3
GRAB	09/13/94	1.68	499.7	2040	3310	510	2800	22662	32648	Gr;cldy	0.9
GRAB	09/20/94	1.66	494.8	2000	3930	300	3630	24512	33471	Lt Green	1.4
GRAB	09/22/94	1.56	481.2	1980	4250	770	3480	26724	34796	Gr-Br	1.6
GRAB	09/27/94	1.66	487.7	1920	3820	460	3360	24512	34253	Gr;cldy	1.8
GRAB	09/29/94	1.73	498.0	2070	3820	460	3360	25972	37735	Green	2.3
GRAB	10/04/94	1.63	504.6	2320	3710	330	3380	30067	42385	Gr;cldy	2.9
GRAB	10/06/94	1.66	496.1	2500	3880	440	3440	32530	46919	Gr;cldy	4.9
GRAB	10/11/94	1.63	508.9	2550	5630	430	5200	39606	54458	Br;cldy	3.9
GRAB	10/13/94	1.49	485.7	2400	6370	1020	5350	43658	57709	Gr-Brown	1.9
GRAB	10/18/94	1.52	469.2	2180	7050	1660	5390	43101	47232	Gr-Brown	2.8
GRAB	10/20/94	1.59	478.9	1940	7650	1230	6420	43738		Br;cldy	3.4

PAN LYSIMETER 4

Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO (ppm)
GRAB	08/11/94	2.62	526.3	55	87	-	-	-	-	Flush H2O	-
GRAB	08/12/94	2.06	560.0	567	1260	67	1193	5282	6801	Lt Brown	4.8
GRAB	08/15/94	1.87	671.9	1260	2920	105	2815	14311	17681	Lt Brown	2.9
GRAB	08/17/94	1.71	687.2	1610	3670	102	3568	19528	23875	Med Brown	2.9
GRAB	08/19/94	1.79	659.6	1790	2900	900	2000	19280	24583	-	-
GRAB	08/22/94	1.86	615.3	1720	2000	73	1927	16285	23809	Gr-Brown	3.2
GRAB	08/24/94	1.78	678.6	1770	2420	60	2360	16481	24196	Green	OFL
GRAB	08/26/94	1.80	601.2	1710	2450	75	2375	16742	25126	Lt Gr-Yel	OFL
GRAB	08/29/94	1.92	681.5	1710	2340	60	2280	17279	26073	Lt Green	OFL
GRAB	09/01/94	1.61	698.7	1700	2380	61	2319	17647	26443	Lt Green	OFL
GRAB	09/06/94	1.75	628.7	1700	2520	71	2449	18881	29768	Lt Green	3.5
GRAB	09/08/94	1.79	681.5	1710	2710	75	2635	20168	29817	Green	4.0
GRAB	09/13/94	1.68	570.2	1780	3540	114	3426	23765	34755	Green	3.5
GRAB	09/20/94	1.63	576.6	1880	4730	123	4607	28408	40117	Yellow	4.0
GRAB	09/22/94	1.52	595.7	1910	5620	146	5474	33612	44878	Lt Green	5.9
GRAB	09/27/94	1.60	612.7	1910	6060	142	5918	34291	48006	Yellow	5.0
GRAB	09/29/94	1.56	590.0	1930	6420	151	6269	37169	49783	Brown	4.1
GRAB	10/04/94	1.41	622.3	1820	6830	146	6684	38595	53001	Lt Brown	5.8
GRAB	10/06/94	1.48	658.9	1780	6930	142	6788	38595	53495	Yel-Lt Br	6.7
GRAB	10/11/94	1.51	655.9	1730	7300	166	7134	41083	56573	Brown	5.8
GRAB	10/13/94	1.43	575.8	1750	7650	200	7450	44242	58729	Yellow	4.3
GRAB	10/18/94	1.43	616.3	1700	7510	190	7320	43393	58417	Brown	5.7

BIOOXIDATION BULK TEST SOLUTION SAMPLING

PAN LYSIMETER 5

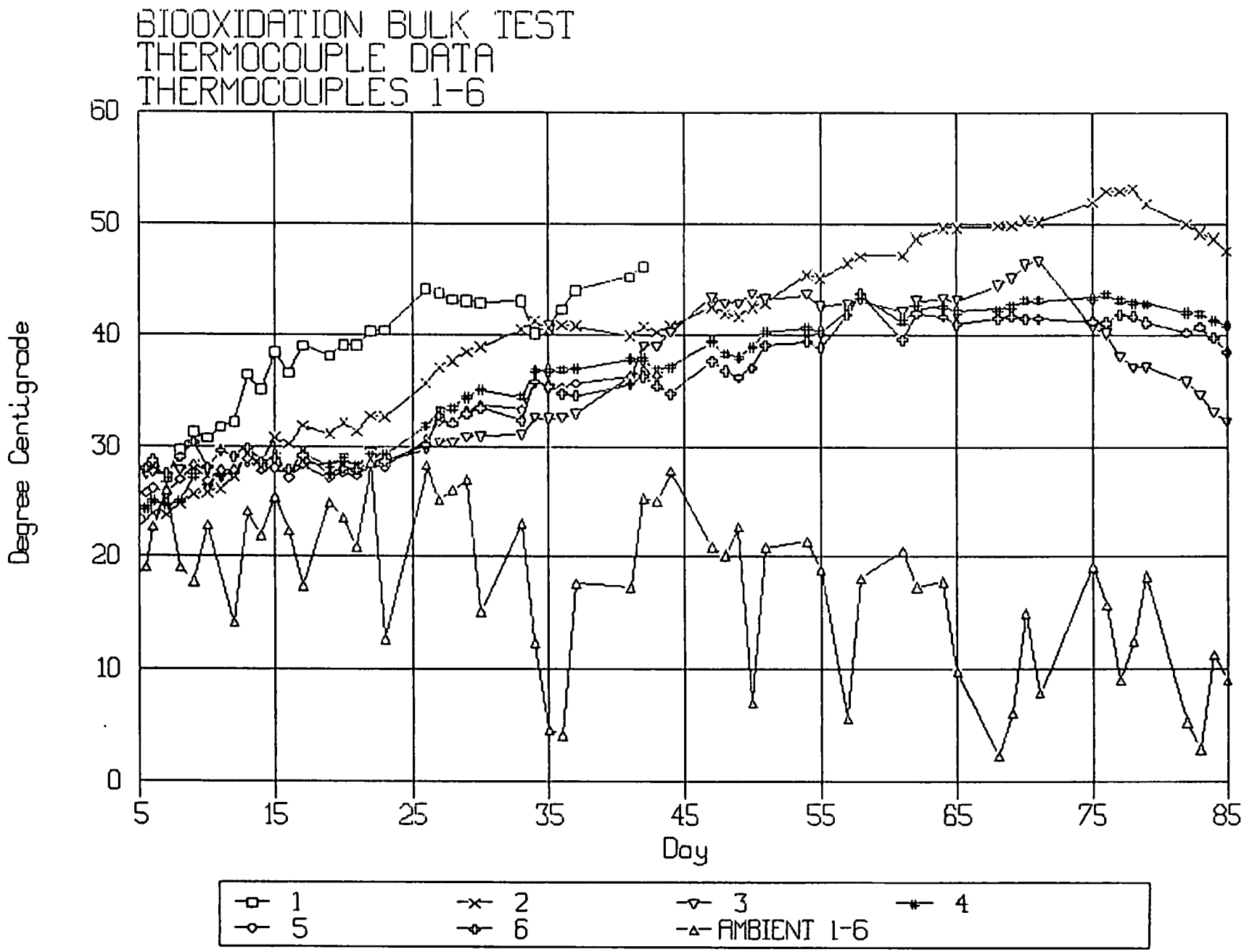
Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO (ppm)
GRAB	08/03/94	1.49	515.6	3690	17700	2100	15600	57687	66622	Dark Brown	-
GRAB	08/04/94	1.32	511.1	3930	14100	1600	12500	60119	67556	Dark Brown	-
GRAB	08/09/94	1.70	484.5	2600	4500	1400	3100	28440	38389	Dark Brown	-
GRAB	08/10/94	2.37	574.1	1740	990	36	954	11468	23641	Off Soln Flush	
GRAB	08/11/94	1.72	431.8	2000	3700	3400	300	-	-	Green Color	-
GRAB	08/12/94	1.80	439.7	2000	3900	2900	1000	20048	24627	Lt Green	3.7
GRAB	08/15/94	1.88	361.1	1940	3940	2200	1740	20543	24800	Green	2.6
GRAB	08/17/94	1.88	415.7	2030	4800	3700	1100	23073	27307	Green	2.7
GRAB	08/19/94	1.87	418.5	2170	4100	4000	100	21647	27324	-	-
GRAB	08/22/94	2.26	437.3	1920	2800	2300	500	18260	24542	Yel-Br	2.1
GRAB	08/24/94	2.12	385.4	1880	3250	2900	350	17056	25184	Lt Gr/Blue	OFL
GRAB	08/26/94	2.39	414.8	1780	3270	2290	980	16428	24641	Yel-Gr;odor	OFL
GRAB	08/29/94	2.47	402.7	1730	3260	2110	1150	16623	24698	Lt Green	OFL
GRAB	09/01/94	2.28	492.3	1700	2600	480	2120	16360	24254	Yel-Br;odor	OFL
GRAB	09/06/94	2.30	386.7	1520	3010	1830	1180	16097	25933	Bl-Gr;odor	2.5
GRAB	09/08/94	2.36	465.2	1480	2490	430	2060	16202	24534	Lt Br;ppt	4.3
GRAB	09/13/94	2.32	389.7	1170	3250	3700	-450	16019	25019	Lt Green	0.9
GRAB	09/20/94	2.30	386.7	1110	2470	2600	-130	15185	23797	Lt Green	1.8
GRAB	09/22/94	2.23	417.6	1110	2320	2000	320	15888	24163	Lt Green	2.8
GRAB	09/27/94	2.17	563.9	1110	1650	700	950	16416	24270	Lt Brown	2.8
GRAB	09/29/94	2.19	500.5	1280	1950	200	1750	13841	25834	Brown	2.8
GRAB	10/04/94	2.07	473.2	1240	1760	410	1350	16978	25776	Yel-Lt Br	3.0
GRAB	10/06/94	2.21	576.0	1290	1630	80	1550	16265	25390	Lt Brown	6.0
GRAB	10/11/94	2.17	637.1	1360	1740	690	1050	18274	29389	Gr-Yellow	5.0
GRAB	10/13/94	1.99	567.5	1500	1970	60	1910	21497	32739	Yel-Lt Br	4.0
GRAB	10/18/94	1.96	514.8	1760	2380	177	2203	24019	36517	Green	3.5
GRAB	10/20/94	1.85	514.6	2020	2600	171	2429	25983		Green	3.2

BIOOXIDATION BULK TEST THERMOCOUPLE DATA

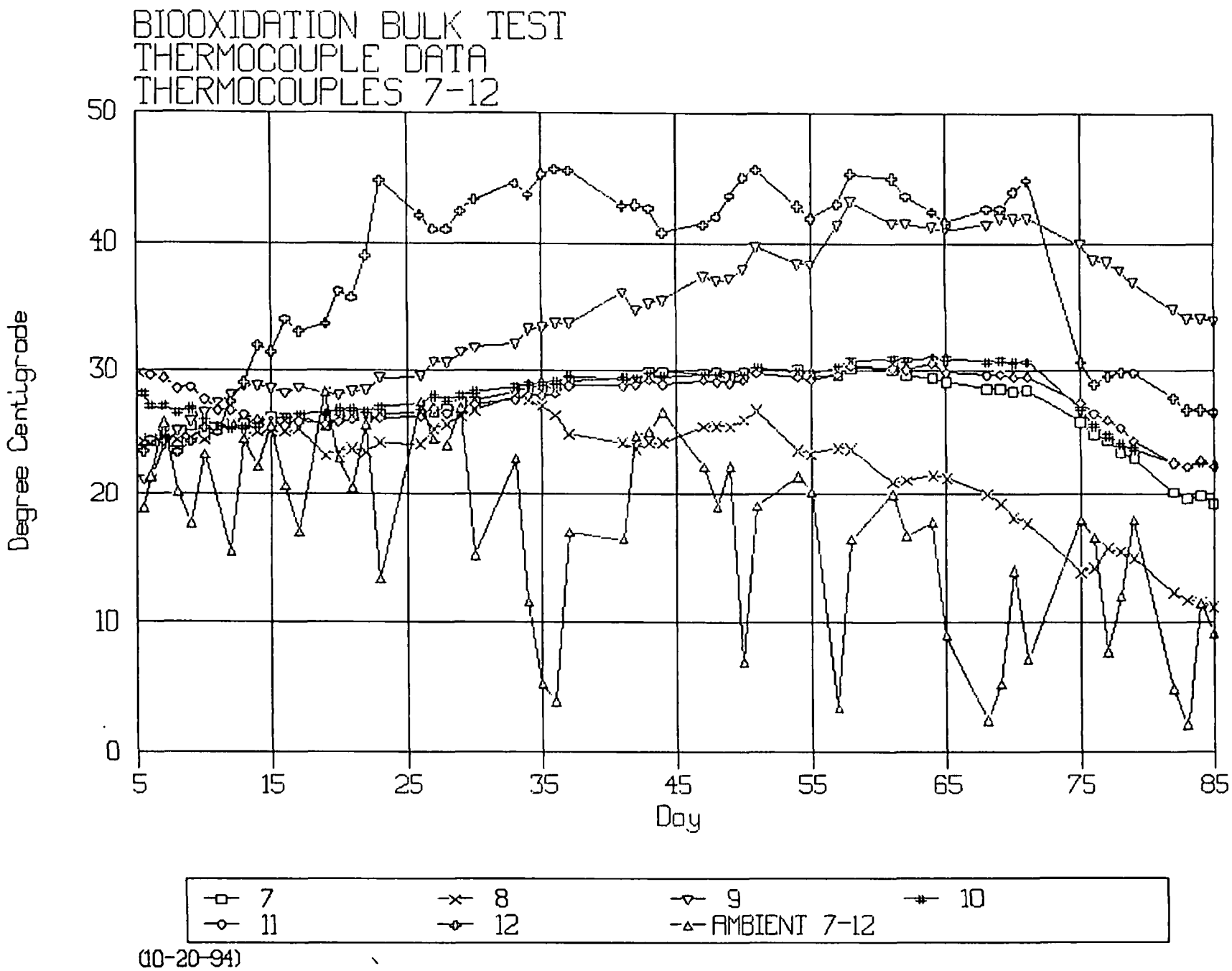
Date	West 1	West 2	West 3	West 4	West 5	Mid 6	Mid 7	Mid 8	East 9	East 10	East 11	East 12	AMBIENT 1-6	AMBIENT 7-12
08/02/94	27.8	23.2	27.4	24.3	25.7	28.0	24.3	24.3	21.2	28.1	29.8	23.5	19.0	18.9
08/02/94	28.2	23.8	27.6	25.0	26.2	28.7	24.3	24.5	21.3	27.1	29.6	24.4	22.6	21.5
08/03/94	27.2	23.7	27.2	24.6	25.6	27.5	24.5	24.8	24.0	27.1	29.4	24.3	26.0	25.8
08/04/94	29.7	24.7	27.8	25.0	27.0	29.0	24.2	24.4	25.1	26.6	28.5	23.4	19.0	20.3
08/05/94	31.3	25.6	28.2	27.3	28.3	30.4	25.5	24.6	25.9	26.9	28.6	24.3	17.7	17.7
08/06/94	30.7	25.8	27.7	26.6	26.9	28.1	24.8	24.4	26.6	25.9	27.7	25.4	22.8	23.3
08/07/94	31.8	26.2	27.1	27.4	27.9	29.6	25.4	25.5	27.3	25.5	26.8	25.0	-	-
08/08/94	32.2	27.3	27.9	27.6	27.9	29.1	25.5	25.7	27.9	25.3	26.8	27.5	14.0	15.5
08/09/94	36.4	28.9	28.6	29.3	28.9	29.9	25.7	24.9	28.7	25.4	26.4	29.0	24.0	24.5
08/10/94	35.1	28.8	28.0	28.3	27.8	28.6	25.8	25.0	28.8	25.5	26.0	32.0	21.9	22.3
08/11/94	38.4	30.8	28.5	29.2	28.1	28.9	26.2	25.1	28.5	25.6	25.8	31.5	25.4	25.6
08/12/94	36.6	30.2	27.7	27.8	27.2	27.9	26.1	25.0	28.1	26.0	25.6	34.0	22.3	20.7
08/13/94	39.0	31.9	28.6	29.4	28.3	29.2	26.3	25.3	28.6	26.4	25.9	33.1	17.3	17.0
08/14/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/15/94	38.1	31.2	28.2	28.3	27.1	27.5	25.6	23.2	28.2	26.5	25.7	33.7	24.9	28.3
08/16/94	39.1	32.2	29.0	28.8	27.6	28.0	26.2	23.5	28.0	26.8	25.9	36.2	23.5	22.9
08/17/94	39.1	31.4	28.3	28.3	27.4	27.9	26.3	23.7	28.3	26.8	26.0	35.7	20.8	20.6
08/18/94	40.3	32.8	29.4	29.2	28.3	28.6	26.1	23.5	28.4	26.7	25.9	39.0	28.6	25.7
08/19/94	40.4	32.7	28.8	29.3	28.2	28.7	26.4	24.2	29.4	27.0	26.2	44.8	12.6	13.3
08/20/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/21/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/22/94	44.1	35.7	29.8	31.9	30.7	30.2	26.5	24.1	29.5	27.4	26.3	42.1	28.3	27.5
08/23/94	43.7	37.1	30.4	33.3	32.3	32.8	26.7	25.3	30.7	27.9	26.9	41.0	25.1	24.5
08/24/94	43.1	37.7	30.4	33.5	32.2	32.1	26.8	25.7	30.6	27.6	26.5	41.0	26.0	24.0
08/25/94	43.0	38.5	30.9	34.4	33.2	33.0	27.3	26.3	31.4	28.0	27.0	42.4	27.0	27.0
08/26/94	42.9	38.9	31.0	35.1	33.8	33.5	27.5	26.8	31.8	28.3	27.3	43.3	15.0	15.2
08/27/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/28/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/29/94	43.0	40.5	31.1	34.5	33.4	32.4	28.3	27.9	32.1	28.7	27.7	44.6	23.0	22.9
08/30/94	40.1	41.2	32.6	36.8	35.7	35.8	28.6	27.7	33.2	28.9	28.0	43.7	12.4	11.6
08/31/94	40.8	40.6	32.5	36.8	35.7	35.4	28.6	27.1	33.3	28.9	28.0	45.3	4.6	5.3
09/01/94	42.3	40.9	32.6	36.9	35.3	34.8	28.7	26.4	33.7	29.0	28.1	45.7	4.1	3.9
09/02/94	44.0	40.8	33.0	37.0	35.7	34.6	29.1	24.9	33.7	29.5	28.8	45.6	17.6	17.0
09/03/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/04/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/05/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/06/94	45.2	39.9	36.4	37.9	36.3	35.6	29.4	24.2	36.1	29.4	28.8	42.8	17.2	16.4
09/07/94	46.1	40.7	39.0	37.9	36.8	36.3	29.2	23.7	34.7	29.3	28.9	42.9	25.3	24.8
09/08/94	-	40.2	39.0	36.9	36.4	35.5	29.9	24.2	35.3	29.7	29.2	42.6	25.0	25.1
09/09/94	-	40.8	40.2	37.2	-	34.8	29.9	24.2	35.5	29.5	28.9	40.8	27.8	26.7
09/10/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/11/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/12/94	-	42.5	43.4	39.4	-	37.7	29.8	25.5	37.4	29.6	29.2	41.4	20.8	22.3
09/13/94	-	41.9	42.8	38.3	-	36.8	29.9	25.6	37.0	29.6	29.1	42.0	20.1	19.0
09/14/94	-	41.7	42.8	38.0	-	36.2	29.6	25.5	37.2	29.4	29.0	43.6	22.6	22.4
09/15/94	-	42.5	43.6	38.9	-	37.1	29.9	26.0	37.9	29.6	29.2	45.1	7.0	7.0
09/16/94	-	42.9	43.2	40.3	-	39.1	30.2	26.8	39.7	30.1	29.8	45.7	20.8	19.1
09/17/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/18/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/19/94	-	45.4	43.6	40.6	-	39.4	30.0	23.6	38.4	29.9	29.5	42.8	21.3	21.5
09/20/94	-	45.1	42.5	40.3	-	38.9	29.5	23.3	38.3	29.8	29.3	41.9	18.8	20.3
09/21/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/22/94	-	46.5	42.8	42.1	-	41.8	29.6	23.8	41.3	30.2	29.7	43.0	5.6	3.5
09/23/94	-	47.1	43.1	43.5	-	43.7	30.2	23.7	43.2	30.8	30.4	45.4	18.0	16.4
09/24/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/25/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/26/94	-	47.2	42.1	41.2	-	39.6	30.1	21.0	41.5	30.9	30.2	45.0	20.5	20.0
09/27/94	-	48.7	43.1	42.4	-	41.9	29.6	21.2	41.5	30.8	30.1	43.6	17.2	16.7
09/28/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/29/94	-	49.7	43.2	42.5	-	41.7	29.4	21.6	41.2	31.0	30.6	42.4	17.7	17.8

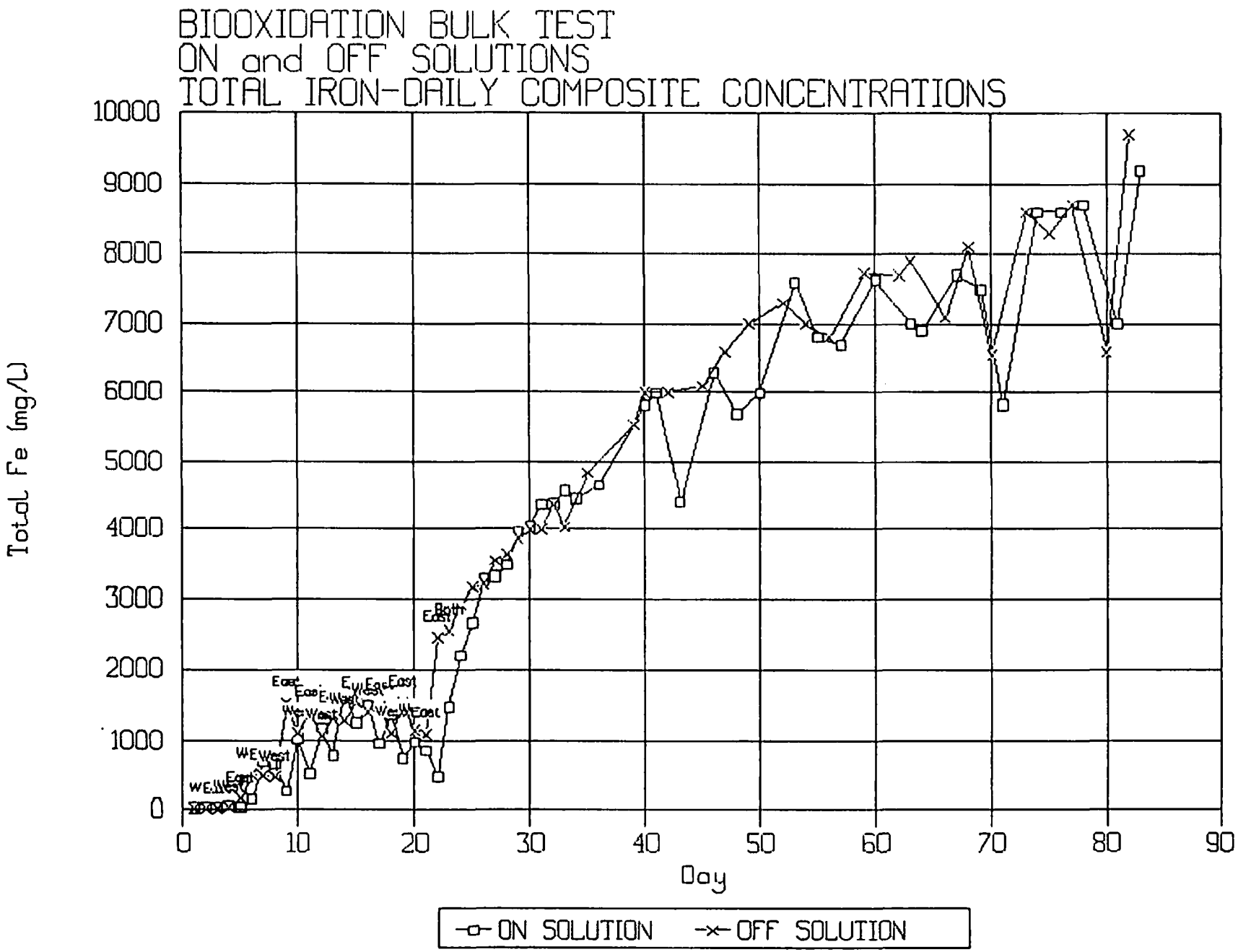
BIOOXIDATION BULK TEST THERMOCOUPLE DATA

Date	West 1	West 2	West 3	West 4	West 5	Mid 6	Mid 7	Mid 8	East 9	East 10	East 11	East 12	AMBIENT 1-6	AMBIENT 7-12
09/30/94	-	49.7	43.1	42.1	-	41.0	29.1	21.4	41.0	30.9	29.9	41.6	9.8	9.0
10/01/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/02/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/03/94	-	49.8	44.4	42.3	-	41.5	28.5	20.0	41.4	30.7	29.6	42.6	2.3	2.5
10/04/94	-	49.8	45.1	42.6	-	41.7	28.5	19.3	41.9	30.8	29.7	42.6	6.1	5.3
10/05/94	-	50.3	46.3	43.1	-	41.5	28.3	18.2	41.8	30.6	29.5	44.0	14.9	14.0
10/06/94	-	50.2	46.7	43.1	-	41.5	28.4	17.7	41.9	30.7	29.5	44.9	7.8	7.2
10/07/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/08/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/09/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/10/94	-	51.9	40.7	43.3	-	41.2	25.9	13.9	39.9	26.9	27.4	30.6	19.1	18.0
10/11/94	-	52.9	40.1	43.6	-	41.1	24.9	14.2	38.7	25.6	26.5	28.9	15.6	16.5
10/12/94	-	52.9	38.1	43.1	-	41.8	24.4	15.7	38.5	24.8	26.0	29.5	9.0	7.8
10/13/94	-	53.1	37.1	42.9	-	41.7	23.5	15.4	37.8	24.1	25.4	29.9	12.5	12.1
10/14/94	-	51.7	37.2	42.8	-	41.1	23.0	15.0	36.9	23.7	24.4	29.8	18.2	18.0
10/15/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/16/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/17/94	-	50.0	35.8	42.0	-	40.2	20.2	12.3	34.8	22.6	22.6	27.8	5.3	4.9
10/18/94	-	49.2	34.7	41.9	-	40.7	19.7	11.7	34.1	22.3	22.3	26.8	2.9	2.2
10/19/94	-	48.7	33.1	41.3	-	39.8	19.9	11.6	34.1	22.7	22.8	26.8	11.3	11.5
10/20/94	-	47.6	32.3	40.9	-	38.5	19.3	11.2	33.8	22.4	22.3	26.6	9.0	9.2

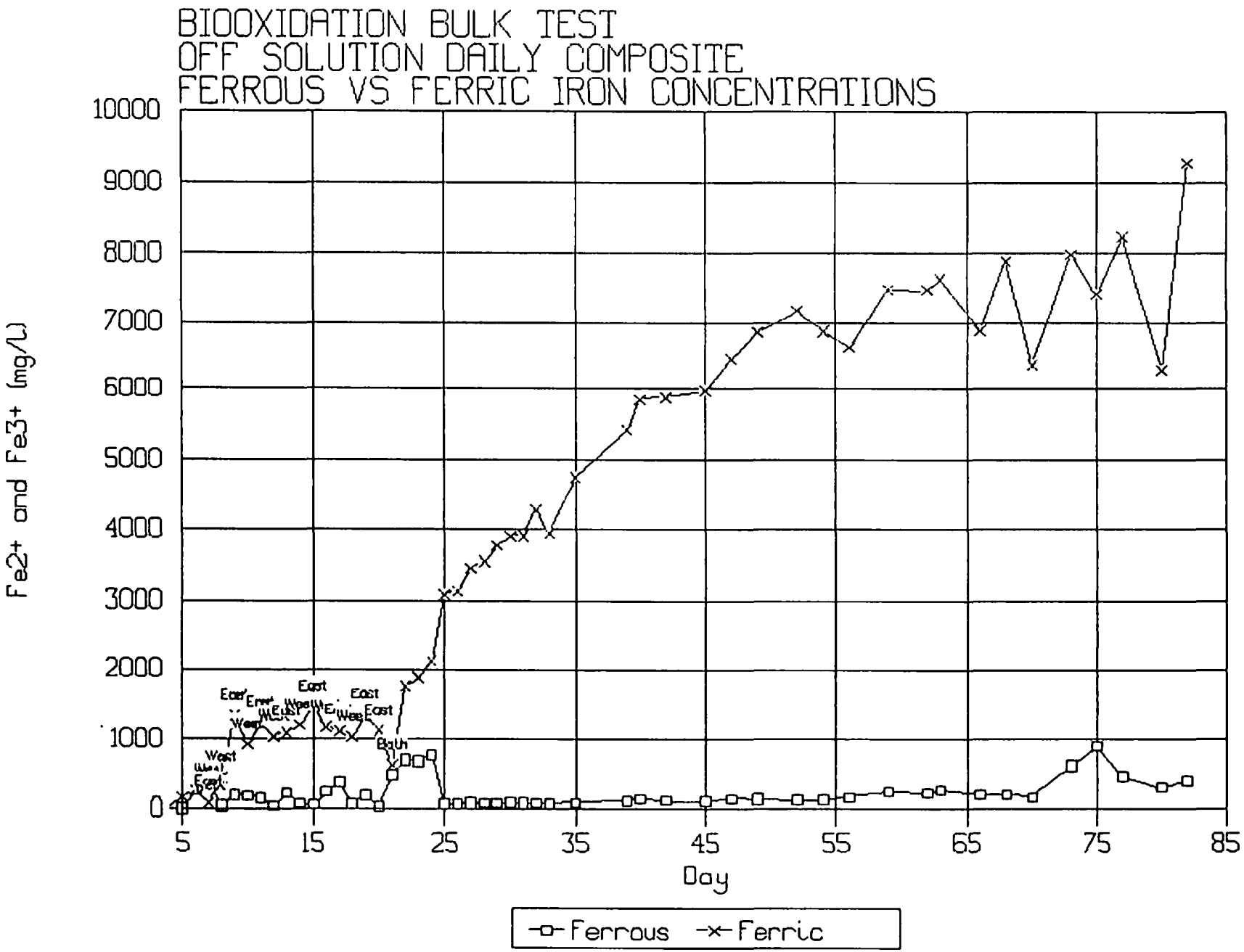

BIOOXIDATION BULK TEST
THERMOCOUPLE DATA
THERMOCOUPLES 1-6
Degree Centigrade
60
50
40
30
20
10
0
5
15
25
35
45
55
65
75
85
Day
1
2
3
4
5
6
AMBIENT 1-6

(10-20-94)

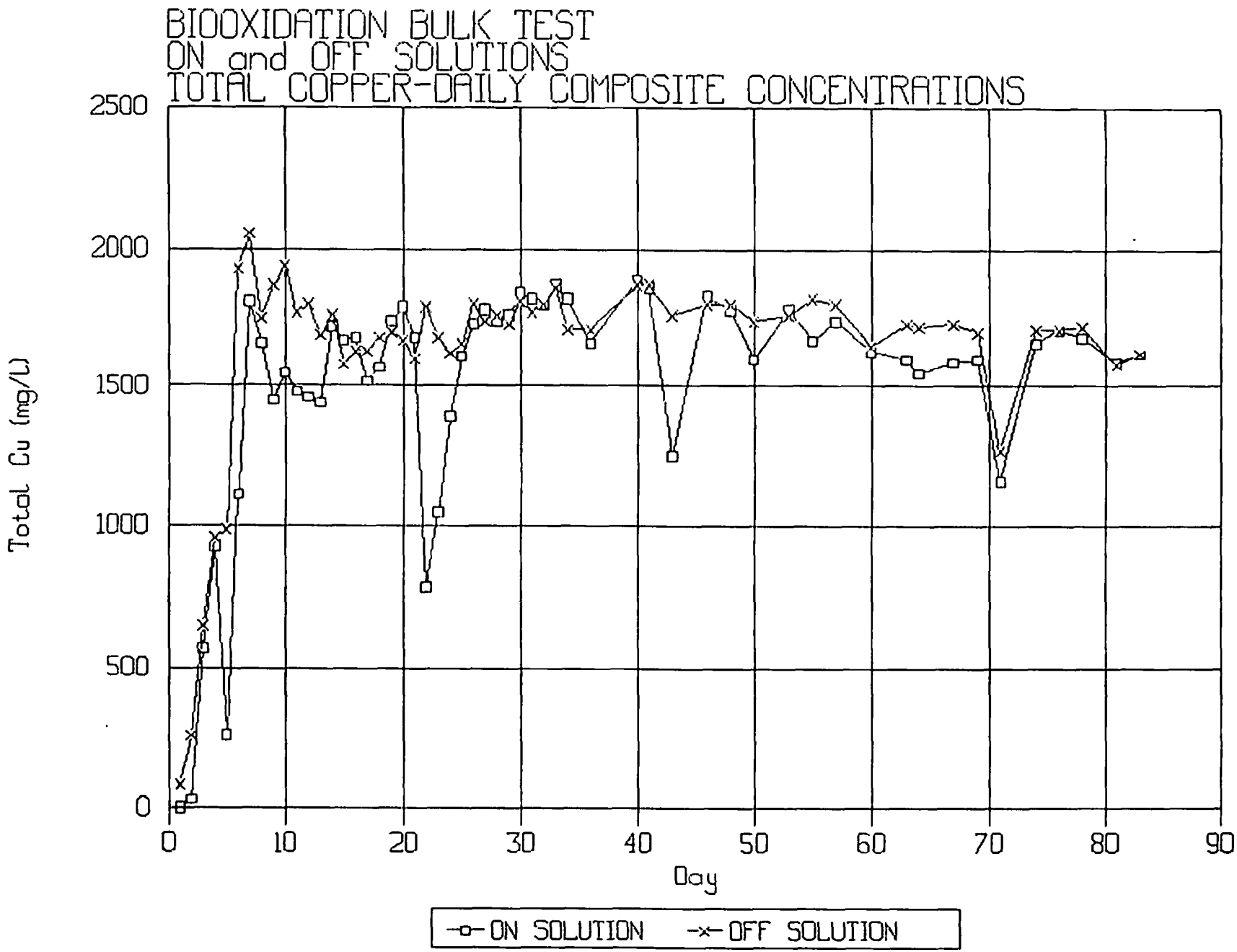

BIOOXIDATION BULK TEST
THERMOCOUPLE DATA
THERMOCOUPLES 7-12
Degree Centigrade
50
40
30
20
10
0
5
15
25
35
45
55
65
75
85
Day
7
8
9
10
11
12
AMBIENT 7-12
(10-20-94)


BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
TOTAL IRON-DAILY COMPOSITE CONCENTRATIONS
Total Fe (mg/L)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
0
10
20
30
40
50
60
70
80
90
Day
ON SOLUTION
OFF SOLUTION

(10-19-94)

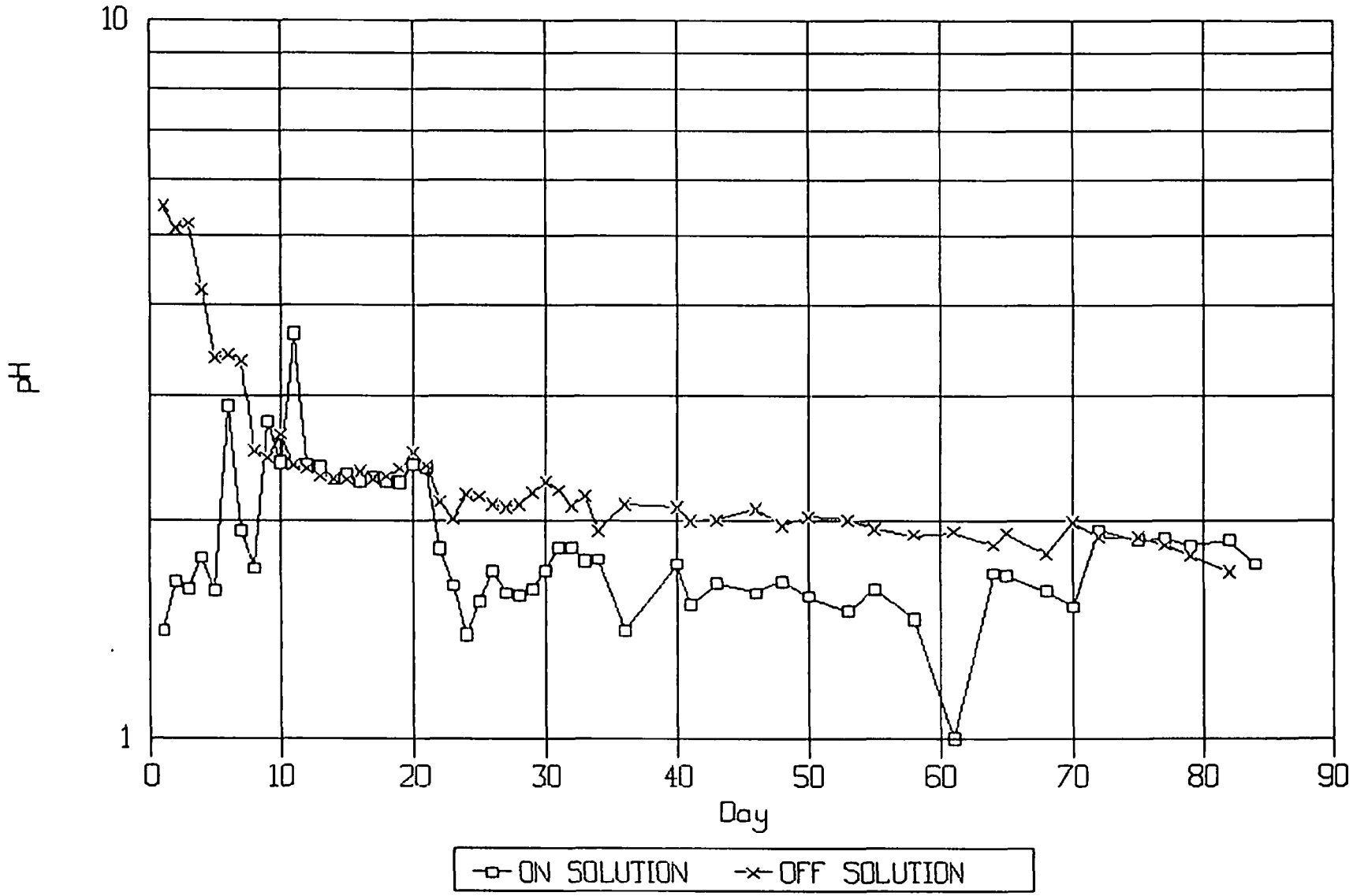

BIOOXIDATION BULK TEST
OFF SOLUTION DAILY COMPOSITE
FERROUS VS FERRIC IRON CONCENTRATIONS
Fe2+ and Fe3+ (mg/L)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
5
15
25
35
45
55
65
75
85
Day
Ferrous
Ferric

(10-19-94)

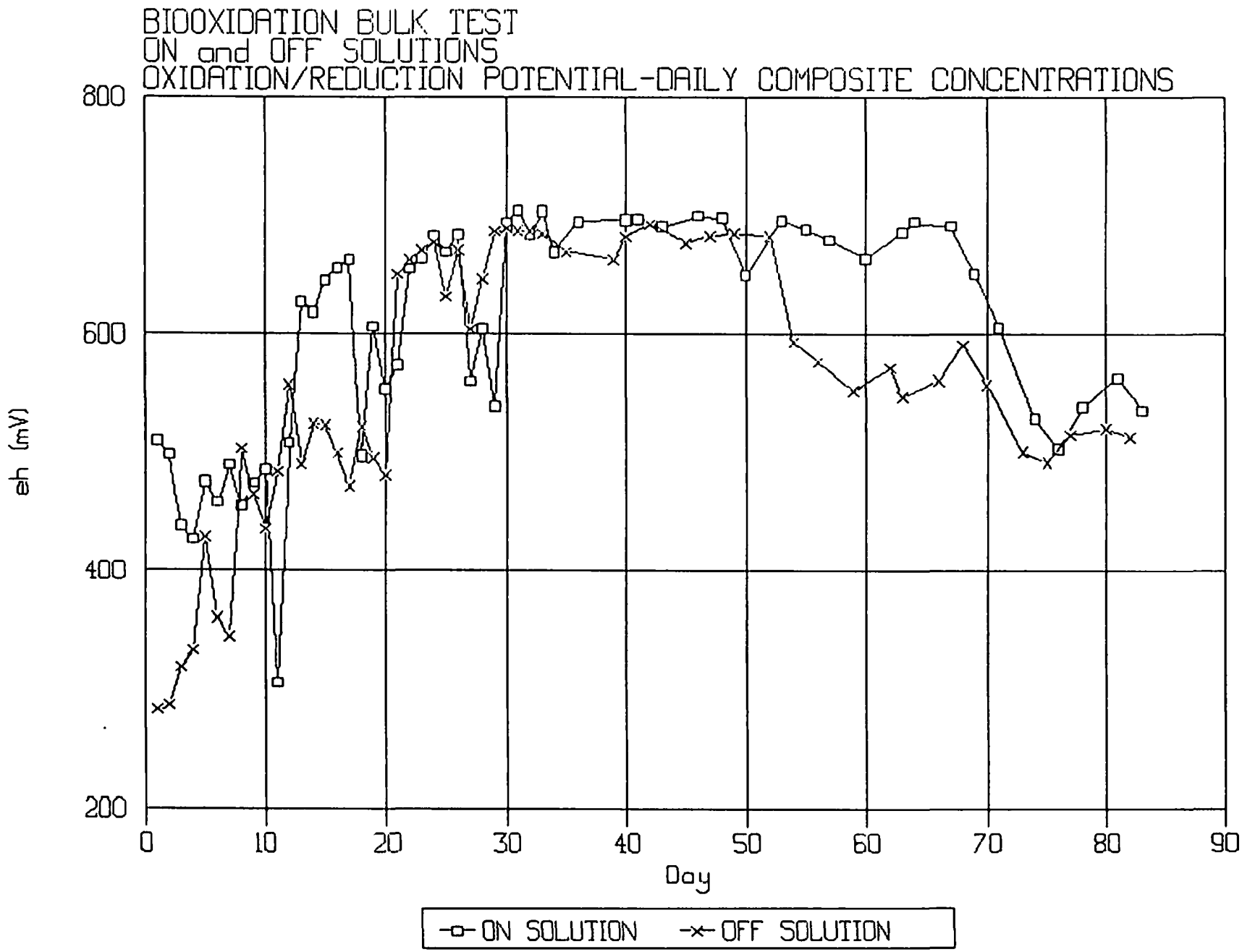

BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
TOTAL COPPER-DAILY COMPOSITE CONCENTRATIONS
Total Cu (mg/L)
2500
2000
1500
1000
500
0
0
10
20
30
40
50
60
70
80
90
Day
ON SOLUTION
OFF SOLUTION

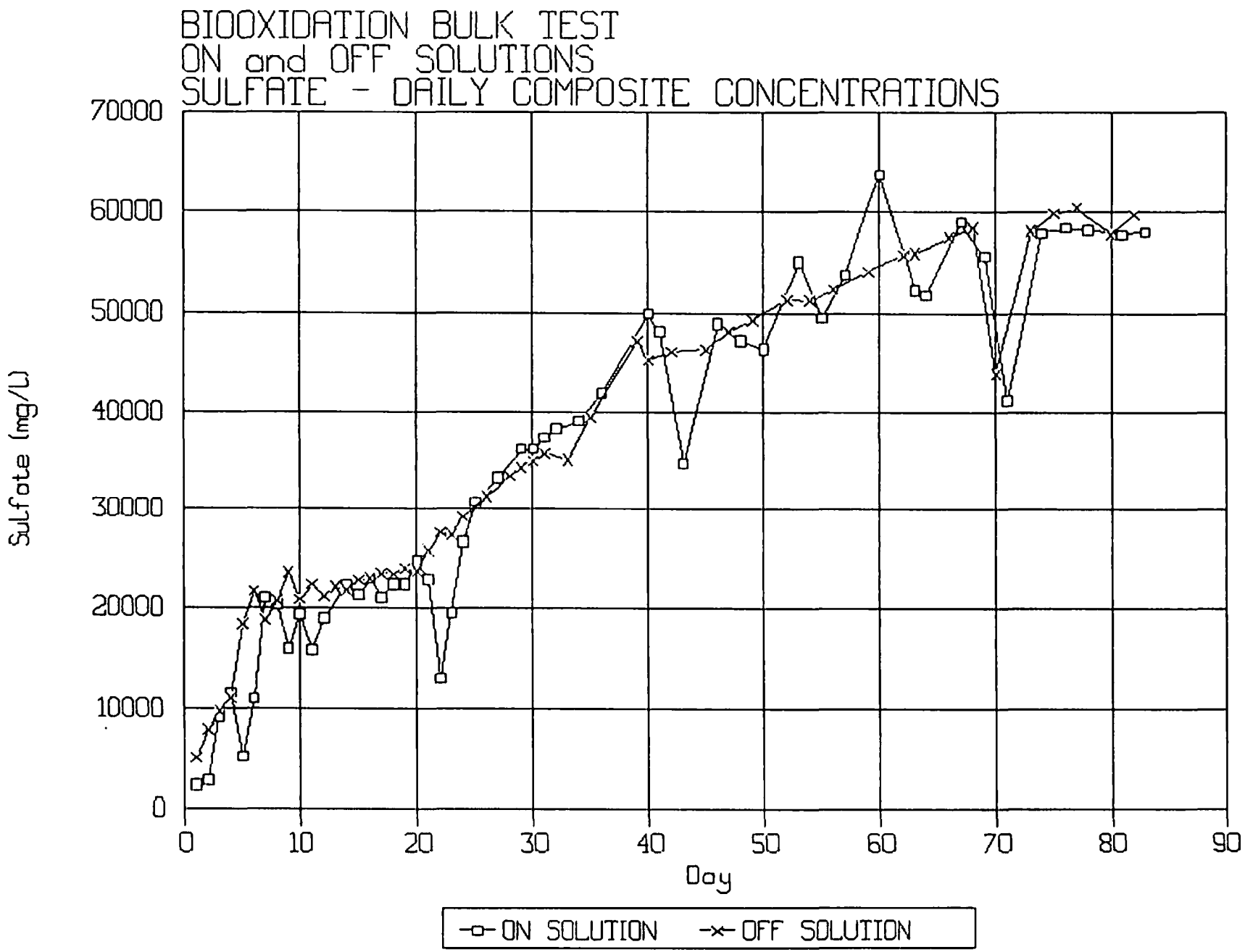
(10-19-94)

BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
pH - DAILY COMPOSITE



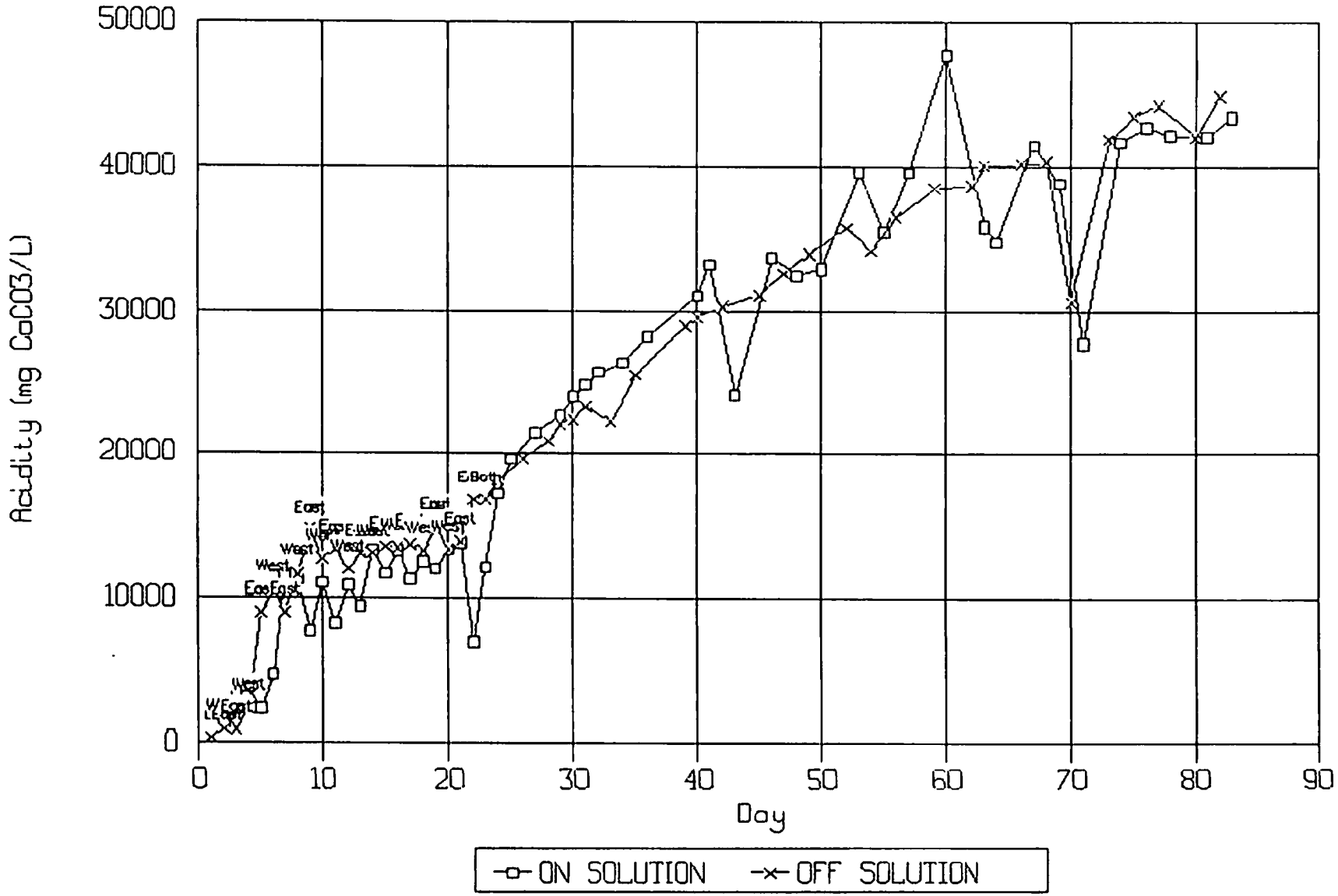
(10-19-94)


BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
OXIDATION/REDUCTION POTENTIAL-DAILY COMPOSITE CONCENTRATIONS
800
600
400
200
eh (mV)
0
10
20
30
40
50
60
70
80
90
Day
ON SOLUTION
OFF SOLUTION
(10-19-94)


BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
SULFATE - DAILY COMPOSITE CONCENTRATIONS
Sulfate (mg/L)
70000
60000
50000
40000
30000
20000
10000
0
0
10
20
30
40
50
60
70
80
90
Day
ON SOLUTION
OFF SOLUTION

(10-19-94)

BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
ACIDITY TO pH 7-DAILY COMPOSITE CONCENTRATIONS



(10-19-94)

BBT BOTTLE ROLL EXTRACTION

Sample I.D.		AUGER DRILL-2 WEST 26 lb/T CaO 5 lb/T NaCN 50% Solids	
Date		10/10/94	
FA Tail	Au (opt)	.0227	
AA Soln	Au (opt)	.0340	96 hr
Calc Head	Au (opt)	.0567	
NaCN (lb/ton) final		3.22	
NaCN Consumption (lb/ton)		1.8	
pH (initial)		11.82	
pH (final)		10.87	
% Extraction Au (AA Soln/Calc Head)		60.0	

BBT BOTTLE ROLL EXTRACTION

Sample I.D.		AUGER DRILL-2 MID 27 lb/T CaO 5 lb/T NaCN 50% Solids	
Date		10/10/94	
FA Tail	Au (opt)	.0226	
AA Soln	Au (opt)	.0276	96 hr
Calc Head	Au (opt)	.0502	
NaCN (lb/ton) final		2.68	
NaCN Consumption (lb/ton)		2.3	
pH (initial)		11.96	
pH (final)		10.91	
% Extraction Au (AA Soln/Calc Head)		55.0	

BBT BOTTLE ROLL EXTRACTION

Sample I.D.		AUGER DRILL-2 EAST 25 lb/T CaO 5 lb/T NaCN 50% Solids	
Date		10/10/94	
FA Tail	Au (opt)	.1196	Contamination?
AA Soln	Au (opt)	.0302	96 hr
Calc Head	Au (opt)	.1498	
NaCN (lb/ton) final		3.14	
NaCN Consumption (lb/ton)		1.9	
pH (initial)		11.76	
pH (final)		10.94	
% Extraction Au (AA Soln/Calc Head)		20.2	

AUGER DRILL 2 ~ 5% BIOOXIDIZED

AVERAGE WEST and MID
% Ext. Au = 57.5%

SP2 COMP (CONTROL)
% Ext. Au = 54.8%
Calc Head = 0.0518 opt
18 lb/ton CaO
2.1 lb/ton NaCN Consump.

MEMORANDUM

DATE: OCTOBER 13, 1994
TO: JIM THOMPSON
FROM: LAURA DAMON
SUBJECT: BIOOXIDATION BULK TEST (BBT) WEEKLY UPDATE (11)

The BBT has been on the biooxidation cycle for eleven weeks now. Both the west and east sides are on simultaneous solution application. The ON solution application rate has averaged 9.8 gpm this week while the OFF solution return rate has averaged 14.0 gpm. The large discrepancy in flows of the ON and OFF solutions this week is due to a 7 inch rainstorm on Thursday, October 6th. It is estimated that the biooxidation solution circuit gained approximately 30,000 gallons of rain water. 16,500 gallons, 11,000 gallons of neutralization solution and 5,500 gallons of OFF solution, were discharged on to Cell #7. The discharged gallons contained 757 lb of iron and 153 lb of copper. The other 13,500 gallons remain in the circuit. The heap remained intact and stable.

Although the neutralization flow meter indicates a total of 69,267 gallons of OFF solution has been neutralized, 11,000 gallons were discharged from the system. This leaves the total close to last week's reported value of 58,108 gallons. However, the estimated 30,000 gallons of rain water should have acted like a neutralization solution wash, therefore putting the total of neutralized solution at approximately 88,000 gallons. This figure is approaching the treatment goal of 100,000 total gallons.

If neutralization of the solution expidites the biooxidation rate as Geobiotics has indicated, then we should expect to see a sharp increase in iron, specifically ferric iron, and sulfate concentrations over the next week. Also thermocouple readings should increase indicating an overall increase in the biological activity.

Although the OFF solution total iron concentration seems to have stabilized around 8500 ppm this week, it must be compared with the increased solution amount. Last week the iron concentration was 8100 ppm with an average of 6900 gallons of return. This week the iron concentration is 8500 ppm but with an average return of 20,000 gallons. Therefore, the total iron concentration in the OFF solution has risen from 466 lb to 1417 lb over the last week. This is quite a substantial increase. The iron continues to be predominantly in the form of ferric iron although the ferrous concentration has increased with the rain water flush. The oxidation/reduction potential dropped to an eh range of 500 or less due to the increase in ferrous iron. The sulfate concentration has risen substantially this week as has the acidity. These analyses indicate that either the BBT is biooxidizing at an increased rate or the findings are merely the result of the rain water flush. Time will tell.

Gold extraction bottle rolls are being run on the auger drill-2 samples this week. The sulfide analyses indicated that these samples are about 5% biooxidized in comparison to the auger drill-1 samples. Gold extraction results should be available next week.

The BBT control columns are finished. A report is attached to this memo. These ore columns, with zero percent biooxidation, showed a total 56% gold extraction. This correlates with the 96 hour bottle roll data for the same ore. The average bottle roll results, based on the calculated head of the bottle rolls sampled only at 96 hours, were also 56% gold extraction. The ore column NaCN consumption was 2.2 lb/ton as compared to an average 2.5 lb/ton in the bottle rolls.

c: Rod MacLeod
Martin Quick
Herb Osborne

BBT CONTROL COLUMN GOLD EXTRACTION

Control columns of the BBT ore were cyanide leached to determine the percent gold extraction before the ore was biooxidized (i.e. zero percent biooxidation). Two test columns were set up, one with SP1 composite ore which was the -3/8" crushed ore with no agglomeration or bacterial treatment, and one with SP2 composite ore which was the ore that went to the heap and had been agglomerated and bacterial treated. The control column data will be compared to the gold extraction percentages of BBT ore columns leached at various biooxidation percentages.

Five foot PVC pipe columns with 10" diameters were loaded with ore and leached with 1 lb/ton NaCN, pH adjusted to 11 with caustic. The leach rate was 0.005 gpm/ft^2. The ore was on continual leach for 36 days and then leached for 6 days at 4 hours per day and allowed to drain for the remaining 20 hours. Daily composite solution samples were collected, weighed and assayed for Au, Ag, pH and NaCN concentration. After a total 42 day leach period, the columns were allowed to drain and then unloaded by dumping the ore in a pile and alternate shovelling to four piles. One pile was selected and prepped for assay. The tail sample was fire assayed ten times.

	SP1 (Nontreated Ore)	SP2 (Treated Ore)
Dry Ore Weight (lb)	185.8	206.5
Au Head Grade opt	.0492	.0457
Au Tail Grade opt	.0245	.0204
Au Calc Head opt	.0552	.0471
Cum Soln Ounces	2.852	2.758
% Au Ext (Head/Tail Basis)	50.2	55.4
% Au Ext (Soln/Head Basis)	62.4	58.4
% Au Ext (Calc Head Basis)	55.6	56.6
NaCN Consumption (lb/ton)	2.3	2.1
initial pH	11.5	11.8
final pH	11.0	10.8
CaO addition (lb/ton)	14	12
Bulk Density (lb/ft^3)	82.6	76.5

The percent gold extraction based on the calculated head is judged to be the most reliable since any discrepancy in the cum solution ounces would cancel in the equation: (cum soln oz/cum soln oz + tail oz) and the tail assays were fairly consistent. The SP1 and SP2 percent gold extraction results on this basis compare quite favorably at 55.6% and 56.6%. Furthermore the average of the percent gold extraction calculated on the other two basis, (Head/Tail and Soln/Head), collaborate a 56%-57% gold extraction value.

Therefore, it is reported that the percent gold extraction at zero percent biooxidation is 56%. The sodium cyanide consumption is 2.2 lb/ton with lime addition on the order of 12 lb/ton.

(October, 1994)

BIOOXIDATION BULK TEST SOLUTION SAMPLING

ON SOLUTION

Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)
Orofino	7/21-9/29		(91000)	7.91	337.4	.01	1.35	-	-	-	107
	7/21-7/28	19741	19741								
GRAB-1530	07/27/94	?	19741	1.94	516.2	1.26	3.0	-	-	-	-
GRAB	07/28/94	?	19741	1.20	555.3	.16	7.8	-	-	3042	3411
COMP	07/28/94	?	19741	1.41	510.8	.10	21.6	-	-	1924	2420
COMP	07/29/94	9542	29283	1.65	498.3	29	45.0	4.1	40.9	1416	3012
COMP	07/30/94	5504	34787	1.61	438.4	574	38.0	2.2	35.8	3442	9230
COMP	07/31/94	975	35762	1.78	426.7	930	51.0	2.3	48.7	3823	11575
COMP	08/01/94	21302	57063	1.60	475.9	260	33.0	1.3	31.7	2394	5238
COMP	08/02/94	18970	76034	2.89	458.4	1110	155	71	84	4705	10999
COMP	08/03/94	16238	92272	1.94	490.0	1810	710	130	580	11581	20982
COMP	08/04/94	12021	104293	1.72	455.8	1660	660	340	320	11167	20349
COMP	08/05/94	16734	121027	2.75	475.1	1450	260	40	220	7673	15888
COMP	08/06/94	16466	137492	2.41	486.8	1550	1030	60	970	11012	19332
COMP	08/07/94	16466	153958	3.66	304.8	1480	530	60	470	8191	15810
COMP	08/08/94	16502	170460	2.40	507.9	1460	1170	110	1060	10820	18867
COMP	08/09/94	16103	186563	2.38	627.5	1440	790	25	765	9380	-
COMP	08/10/94	15624	202187	2.28	618.1	1720	1680	63	1617	13218	22369
COMP	08/11/94	16113	218300	2.33	645.4	1670	1250	33	1217	11657	21262
COMP	08/12/94	14762	233062	2.27	656.2	1680	1510	146	1364	13205	22874
COMP	08/13/94	13785	246847	2.30	663.0	1520	950	41	909	11254	21036
COMP	08/14/94	10979	257826	2.27	497.5	1570	1380	229	1151	12451	22331
COMP	08/15/94	10129	267955	2.26	606.6	1740	750	53	697	11956	22333
COMP	08/16/94	6178	274133	2.40	553.1	1790	970	51	919	13257	24698
COMP	08/17/94	6444	280577	2.36	573.3	1680	860	171	689	13713	22929
COMP	08/18/94	7205	287782	1.83	655.6	790	490	170	320	6959	12987
COMP	08/19/94	12447	300229	1.63	664.1	1050	1480	440	1040	12007	19505
COMP	08/20/94	15338	315567	1.39	683.9	1390	2190	610	1580	17135	26608
COMP	08/21/94	12497	328064	1.55	669.8	1610	2660	710	1950	19555	30681
COMP	08/22/94	11793	339857	1.71	684.8	1730	3270	75	3195	-	-
COMP	08/23/94	12099	351956	1.59	560.0	1780	3310	123	3187	21399	33274
COMP	08/24/94	11183	363139	1.58	604.9	1740	3480	82	3398	-	-
COMP	08/25/94	11114	374253	1.61	538.6	1760	3960	230	3730	22733	36228
COMP	08/26/94	9502	383755	1.71	694.7	1840	4040	94	3946	24028	36237
COMP	08/27/94	9144	392899	1.84	705.2	1820	4370	99	4271	24868	37372
COMP	08/28/94	8493	401392	1.84	684.4	1800	4380	99	4281	25735	38352
COMP	08/29/94	8859	410251	1.76	704.1	1870	4570	86	4484	-	-
COMP	08/30/94	7349	417600	1.77	669.5	1820	4450	84	4366	26418	39084
COMP	08/31/94	8940	426540	-	-	-	-	-	0	-	-
COMP	09/01/94	8784	435324	1.41	695.6	1660	4660	94	4566	28282	41981
COMP	09/02/94	5757	441081	-	-	-	-	-	0	-	-
COMP	09/03/94	7779	448860	-	-	-	-	-	0	-	-
COMP	09/04/94	7563	456423	-	-	-	-	-	0	-	-
COMP	09/05/94	6512	462935	1.74	697.0	1890	5820	127	5693	31066	49890
COMP	09/06/94	5907	468842	1.53	698.3	1860	6000	138	5862	33298	48170
COMP	09/07/94	6074	474916	-	-	-	-	-	0	-	-
COMP	09/08/94	8632	483548	1.64	691.8	1250	4410	86	4324	24133	34862
COMP	09/09/94	9369	492917	-	-	-	-	-	0	-	-
COMP	09/10/94	6460	499377	-	-	-	-	-	0	-	-
COMP	09/11/94	6460	505837	1.59	700.2	1830	6300	114	6186	33773	48927
COMP	09/12/94	6004	511841	-	-	-	-	-	0	-	-
COMP	09/13/94	7143	518984	1.65	698.8	1780	5700	127	5573	32506	47216
COMP	09/14/94	8045	527029	-	-	-	-	-	0	-	-
COMP	09/15/94	10057	537086	1.57	649.7	1600	6000	117	5883	32933	46360
COMP	09/16/94	10719	547805	-	-	-	-	-	0	-	-
COMP	09/17/94	9886	557691	-	-	-	-	-	0	-	-
COMP	09/18/94	8902	566593	1.50	697.1	1780	7600	102	7498	39646	55042
COMP	09/19/94	5547	572140	-	-	-	-	-	0	-	-

BIOOXIDATION BULK TEST SOLUTION SAMPLING

ON SOLUTION

Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)
COMP	09/20/94	3226	575366	1.61	689.3	1670	6800	138	6662	35523	49528
COMP	09/21/94	4164	579530	-	-	-	-	-	0	-	-
COMP	09/22/94	3296	582826	1.46	680.5	1740	6700	151	6549	39570	53734
COMP	09/23/94	6300	589126	-	-	-	-	-	0	-	-
COMP	09/24/94	8519	597645	-	-	-	-	-	0	-	-
COMP	09/25/94	7928	605573	1.00	664.8	1630	7630	146	7484	47665	63889
COMP	09/26/94	6189	611762	-	-	-	-	-	0	-	-
COMP	09/27/94	6154	617916	-	-	-	-	-	0	-	-
COMP	09/28/94	5684	623600	1.69	686.9	1600	7000	138	6862	35900	52293
COMP	09/29/94	7387	630987	1.68	695.5	1550	6900	120	6780	34862	51808
COMP	09/30/94	5875	636862	-	-	-	-	-	0	-	-
COMP	10/01/94	4570	641431	-	-	-	-	-	0	-	-
COMP	10/02/94	4570	646001	1.60	691.9	1590	7700	171	7529	41524	58993
COMP	10/03/94	5786	651787	-	-	-	-	-	0	-	-
COMP	10/04/94	2417	654204	1.52	650.9	1600	7500	156	7344	38828	55577
COMP	10/05/94	5927	660131	-	-	-	-	-	0	-	-
COMP	10/06/94	9778	669909	1.94	605.5	1160	5830	123	5707	27760	41183
COMP	10/07/94	14172	684081	-	-	-	-	-	0	-	-
COMP	10/08/94	16206	700287	-	-	-	-	-	0	-	-
COMP	10/09/94	14417	714704	1.88	529.8	1660	8600	300	8300	41682	57947
COMP	10/10/94	14429	729133	-	-	-	-	-	0	-	-
COMP	10/11/94	15560	744693	1.89	504.1	1710	8600	610	7990	42768	58417
COMP	10/12/94		744693	-	-	-	-	-	0	-	-

BIOOXIDATION BULK TEST SOLUTION SAMPLING

OFF SOLUTION

Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	DO (ppm)
SUMP-GRAB	07/26/94	1200	1200	7.22	-	.84	.27	-	-	-	-	-
GRAB-1530	07/27/94	1750	2950	7.53	305.4	.89	.20	-	-	-	-	-
COMP	07/28/94	3000	5950	5.93	353.6	83	.55	-	-	83	4411	-
COMP	07/29/94	3293	9243	5.49	282.1	253	13	-	-	362	5094	-
COMP	07/30/94	4419	13662	5.11	285.7	654	14	-	-	994	7913	-
COMP	07/31/94	2688	16350	5.18	318.8	960	11	-	-	956	9835	-
COMP	08/01/94	7822	24172	4.20	332.3	990	39	1	38	2438	11106	-
COMP	08/02/94	21836	46008	3.39	429.6	1930	172	2	170	8960	18304	-
COMP	08/03/94	14710	60718	3.43	360.1	2050	520	260	260	10520	21678	-
COMP	08/04/94	7500	68218	3.36	344.2	1750	500	410	90	8967	18731	-
COMP	08/05/94	6821	75039	2.50	503.7	1870	480	40	440	11633	20711	-
COMP	08/06/94	21396	96436	2.45	463.2	1940	1530	200	1330	14570	23591	-
COMP	08/07/94	21396	117832	2.63	433.8	1770	1110	190	920	12617	20727	-
COMP	08/08/94	18698	136530	2.40	484.6	1800	1390	160	1230	13259	22299	-
COMP	08/09/94	21118	157648	2.36	557.4	1690	1070	36	1034	11904	21180	-
COMP	08/10/94	16419	174067	2.31	491.4	1760	1320	220	1100	12958	22052	-
COMP	08/11/94	16500	190567	2.29	524.4	1580	1290	86	1204	12958	21764	-
COMP	08/12/94	18213	208780	2.28	523.1	1630	1520	56	1464	13452	22729	1.3
COMP	08/13/94	18585	227365	2.34	500.2	1630	1420	240	1180	13361	22995	1.3
COMP	08/14/94	16646	244011	2.29	472.4	1680	1490	380	1110	13608	23458	-
COMP	08/15/94	13559	257570	2.31	522.4	1700	1110	84	1026	13179	23381	-
COMP	08/16/94	12267	269837	2.36	496.4	1670	1540	196	1344	14831	23933	1.4
COMP	08/17/94	7697	277534	2.49	481.4	1600	1160	43	1117	13309	23711	2.2
COMP	08/18/94	7136	284670	2.39	650.1	1790	1100	480	620	13839	25735	1.7
COMP	08/19/94	13078	297748	2.13	663.0	1680	2450	690	1760	16703	27554	-
COMP	08/20/94	14479	312227	2.02	672.0	1620	2550	670	1880	16716	27464	-
COMP	08/21/94	14213	326440	2.18	678.3	1660	2900	770	2130	18024	29200	-
COMP	08/22/94	14246	340686	2.16	631.0	1800	3160	75	3085	-	-	-
COMP	08/23/94	13868	354554	2.11	671.3	1740	3210	73	3137	19568	31299	-
COMP	08/24/94	12742	367296	2.09	604.1	1760	3540	82	3458	-	-	.7
COMP	08/25/94	11741	379037	2.11	646.9	1730	3640	86	3554	20823	33471	5.5?
COMP	08/26/94	12505	391542	2.19	687.1	1810	3860	86	3774	22006	34443	OFL
COMP	08/27/94	11272	402814	2.27	689.5	1770	4000	94	3906	22374	35035	-
COMP	08/28/94	9000	411814	2.21	688.0	1800	4000	82	3918	23319	35858	-
COMP	08/29/94	9000	420814	2.10	688.2	1860	4370	86	4284	-	-	OFL
COMP	08/30/94	11403	432217	2.17	685.5	1710	4030	84	3946	22242	35134	13.5?
COMP	08/31/94	10726	442943	-	-	-	-	-	-	-	-	OFL
COMP	09/01/94	10299	453242	1.94	669.9	1710	4840	89	4751	25577	39562	OFL
COMP	09/02/94	9075	462317	-	-	-	-	-	-	-	-	3.9
COMP	09/03/94	8149	470466	-	-	-	-	-	-	-	-	-
COMP	09/04/94	7612	478078	-	-	-	-	-	-	-	-	-
COMP	09/05/94	7357	485435	2.11	663.7	1870	5550	120	5430	29017	47141	-
COMP	09/06/94	6870	492305	2.09	682.9	1870	6010	151	5859	29543	45273	3.5
COMP	09/07/94	6503	498808	-	-	-	-	-	-	-	-	6.2
COMP	09/08/94	10447	509255	2.00	693.8	1760	6010	117	5893	30304	46121	5.5
COMP	09/09/94	8553	517808	-	-	-	-	-	-	-	-	5.5
COMP	09/10/94	8424	526232	-	-	-	-	-	-	-	-	-
COMP	09/11/94	8424	534656	2.01	677.7	1800	6100	114	5986	31157	46376	-
COMP	09/12/94	7258	541914	-	-	-	-	-	-	-	-	-
COMP	09/13/94	6630	548544	2.08	683.7	1800	6600	151	6449	32657	48154	2.8
COMP	09/14/94	7479	556023	-	-	-	-	-	-	-	-	2.6
COMP	09/15/94	11492	567515	1.97	685.6	1740	7000	142	6858	33989	49372	4.6
COMP	09/16/94	11244	578759	-	-	-	-	-	-	-	-	2.8
COMP	09/17/94	11287	590046	-	-	-	-	-	-	-	-	-
COMP	09/18/94	10435	600481	2.03	684.0	1760	7300	134	7166	35825	51363	-
COMP	09/19/94	9531	610012	-	-	-	-	-	-	-	-	2.5
COMP	09/20/94	6175	616187	2.01	593.5	1820	7000	134	6866	34241	51265	2.8
COMP	09/21/94	5061	621248	-	-	-	-	-	-	-	-	-

BIOOXIDATION BULK TEST SOLUTION SAMPLING

OFF SOLUTION

Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	DO (ppm)
COMP	09/22/94	5238	626486	1.95	576.7	1800	6800	171	6629	36579	52376	3.5
COMP	09/23/94	6073	632559	-	-	-	-	-	-	-	-	3.2
COMP	09/24/94	9286	641845	-	-	-	-	-	-	-	-	-
COMP	09/25/94	9592	651437	1.91	552.0	1650	7730	250	7480	38565	54096	-
COMP	09/26/94	7385	658822	-	-	-	-	-	-	-	-	2.8
COMP	09/27/94	9119	667941	-	-	-	-	-	-	-	-	3.5
COMP	09/28/94	7789	675730	1.93	571.8	1730	7700	230	7470	38690	55742	-
COMP	09/29/94	7387	683117	1.85	547.2	1720	7900	270	7630	40150	55898	-
COMP	09/30/94	7807	690924	-	-	-	-	-	-	-	-	3.2
COMP	10/01/94	6502	697426	-	-	-	-	-	-	-	-	-
COMP	10/02/94	6502	703928	1.92	560.7	1730	7100	210	6890	40202	57552	-
COMP	10/03/94	6231	710159	-	-	-	-	-	-	-	-	4.2
COMP	10/04/94	6834	716993	1.80	591.1	1700	8100	210	7890	40383	58458	4.5
COMP	10/05/94	6911	723904	-	-	-	-	-	-	-	-	4.5
COMP	10/06/94	28493	752396	1.99	557.3	1270	6550	170	6380	30663	43932	5.7
COMP	10/07/94	22817	775213	-	-	-	-	-	-	-	-	-
COMP	10/08/94	19403	794616	-	-	-	-	-	-	-	-	-
COMP	10/09/94	21196	815812	1.90	501.8	1710	8600	610	7990	41883	58178	-
COMP	10/10/94	17200	833012	-	-	-	-	-	-	-	-	2.8
COMP	10/11/94	11500	844512	1.90	492.7	1710	8300	890	7410	43442	59840	2.4
COMP	10/12/94		844512	-	-	-	-	-	-	-	-	-

BIOOXIDATION BULK TEST SOLUTION SAMPLING

PAN LYSIMETER 3

Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO (ppm)
GRAB	08/03/94	1.93	488.4	1540	4640	1200	3440	20005	23896	-	
GRAB	08/11/94	1.52	496.1	3200	8700	2900	5800	-	-	Brown/Murky	
GRAB	08/12/94	1.89	450.4	2200	3900	2100	1800	-	27461	Lt Brown	1.5
GRAB	08/15/94	1.92	459.5	2170	3920	1270	2650	15417	27625	Med Brown	1.7
GRAB	08/17/94	1.97	462.7	1940	3220	560	2660	19502	25159	Med Brown	2.4
GRAB	08/19/94	2.00	458.4	1850	2300	1400	900	17828	23604	-	-
GRAB	08/22/94	1.90	464.0	1760	2300	360	1940	16677	23744	Grw/Br Ti	1.9
GRAB	08/24/94	2.04	468.5	1780	2680	770	1910	16795	23028	Green	.9
GRAB	08/26/94	2.05	479.6	1730	2700	690	2010	17030	24320	Br-Yel	4.5?
GRAB	08/29/94	2.08	472.8	1770	2760	360	2400	17936	25167	Yel-Br	OFL
GRAB	09/01/94	1.79	472.3	1870	2730	730	2000	19039	26822	Green	OFL
GRAB	09/06/94	1.83	492.1	1940	2620	210	2410	19748	30237	Lt Green	2.5
GRAB	09/08/94	1.80	488.8	1980	2870	300	2570	21454	30435	Dk Green	4.3
GRAB	09/13/94	1.68	499.7	2040	3310	510	2800	22662	32648	Gr;cldy	0.9
GRAB	09/20/94	1.66	494.8	2000	3930	300	3630	24512	33471	Lt Green	1.4
GRAB	09/22/94	1.56	481.2	1980	4250	770	3480	26724	34796	Gr-Br	1.6
GRAB	09/27/94	1.66	487.7	1920	3820	460	3360	24512	34253	Gr;cldy	1.8
GRAB	09/29/94	1.73	498.0	2070	3820	460	3360	25972	37735	Green	2.3
GRAB	10/04/94	1.63	504.6	2320	3710	330	3380	30067	42385	Gr;cldy	2.9
GRAB	10/06/94	1.66	496.1	2500	3880	440	3440	32530	46919	Gr;cldy	4.9
GRAB	10/11/94	1.63	508.9	2550	5630	430	5200	39606	54458	Br;cldy	3.9

PAN LYSIMETER 4

Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO (ppm)
GRAB	08/11/94	2.62	526.3	55	87	-	-	-	-	Flush H2O	-
GRAB	08/12/94	2.06	560.0	567	1260	67	1193	5282	6801	Lt Brown	4.8
GRAB	08/15/94	1.87	671.9	1260	2920	105	2815	14311	17681	Lt Brown	2.9
GRAB	08/17/94	1.71	687.2	1610	3670	102	3568	19528	23875	Med Brown	2.9
GRAB	08/19/94	1.79	659.6	1790	2900	900	2000	19280	24583	-	-
GRAB	08/22/94	1.86	615.3	1720	2000	73	1927	16285	23809	Gr-Brown	3.2
GRAB	08/24/94	1.78	678.6	1770	2420	60	2360	16481	24196	Green	OFL
GRAB	08/26/94	1.80	601.2	1710	2450	75	2375	16742	25126	Lt Gr-Yel	OFL
GRAB	08/29/94	1.92	681.5	1710	2340	60	2280	17279	26073	Lt Green	OFL
GRAB	09/01/94	1.61	698.7	1700	2380	61	2319	17647	26443	Lt Green	OFL
GRAB	09/06/94	1.75	628.7	1700	2520	71	2449	18881	29768	Lt Green	3.5
GRAB	09/08/94	1.79	681.5	1710	2710	75	2635	20168	29817	Green	4.0
GRAB	09/13/94	1.68	570.2	1780	3540	114	3426	23765	34755	Green	3.5
GRAB	09/20/94	1.63	576.6	1880	4730	123	4607	28408	40117	Yellow	4.0
GRAB	09/22/94	1.52	595.7	1910	5620	146	5474	33612	44878	Lt Green	5.9
GRAB	09/27/94	1.60	612.7	1910	6060	142	5918	34291	48006	Yellow	5.0
GRAB	09/29/94	1.56	590.0	1930	6420	151	6269	37169	49783	Brown	4.1
GRAB	10/04/94	1.41	622.3	1820	6830	146	6684	38595	53001	Lt Brown	5.8
GRAB	10/06/94	1.48	658.9	1780	6930	142	6788	38595	53495	Yel-Lt Br	6.7
GRAB	10/11/94	1.51	655.9	1730	7300	166	7134	41083	56573	Brown	5.8

BIOOXIDATION BULK TEST SOLUTION SAMPLING

PAN LYSIMETER 5

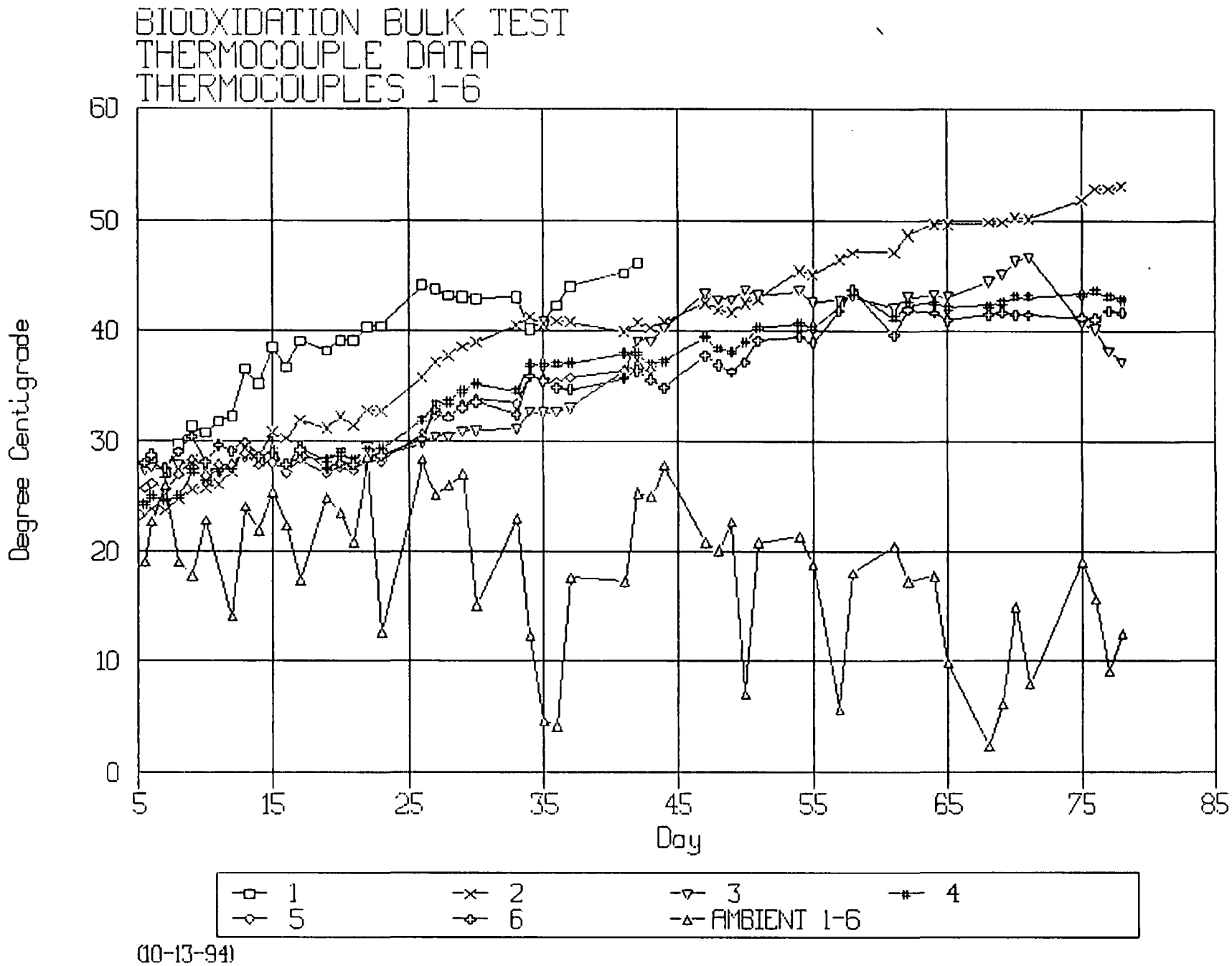
Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO (ppm)
GRAB	08/03/94	1.49	515.6	3690	17700	2100	15600	57687	66622	Dark Brown	-
GRAB	08/04/94	1.32	511.1	3930	14100	1600	12500	60119	67556	Dark Brown	-
GRAB	08/09/94	1.70	484.5	2600	4500	1400	3100	28440	38389	Dark Brown	-
GRAB	08/10/94	2.37	574.1	1740	990	36	954	11468	23641	Off Soln Flush	
GRAB	08/11/94	1.72	431.8	2000	3700	3400	300	-	-	Green Color	-
GRAB	08/12/94	1.80	439.7	2000	3900	2900	1000	20048	24627	Lt Green	3.7
GRAB	08/15/94	1.88	361.1	1940	3940	2200	1740	20543	24800	Green	2.6
GRAB	08/17/94	1.88	415.7	2030	4800	3700	1100	23073	27307	Green	2.7
GRAB	08/19/94	1.87	418.5	2170	4100	4000	100	21647	27324	-	-
GRAB	08/22/94	2.26	437.3	1920	2800	2300	500	18260	24542	Yel-Br	2.1
GRAB	08/24/94	2.12	385.4	1880	3250	2900	350	17056	25184	Lt Gr/Blue	OFL
GRAB	08/26/94	2.39	414.8	1780	3270	2290	980	16428	24641	Yel-Gr;odor	OFL
GRAB	08/29/94	2.47	402.7	1730	3260	2110	1150	16623	24698	Lt Green	OFL
GRAB	09/01/94	2.28	492.3	1700	2600	480	2120	16360	24254	Yel-Br;odor	OFL
GRAB	09/06/94	2.30	386.7	1520	3010	1830	1180	16097	25933	Bl-Gr;odor	2.5
GRAB	09/08/94	2.36	465.2	1480	2490	430	2060	16202	24534	Lt Br;ppt	4.3
GRAB	09/13/94	2.32	389.7	1170	3250	3700	-450	16019	25019	Lt Green	0.9
GRAB	09/20/94	2.30	386.7	1110	2470	2600	-130	15185	23797	Lt Green	1.8
GRAB	09/22/94	2.23	417.6	1110	2320	2000	320	15888	24163	Lt Green	2.8
GRAB	09/27/94	2.17	563.9	1110	1650	700	950	16416	24270	Lt Brown	2.8
GRAB	09/29/94	2.19	500.5	1280	1950	200	1750	13841	25834	Brown	2.8
GRAB	10/04/94	2.07	473.2	1240	1760	410	1350	16978	25776	Yel-Lt Br	3.0
GRAB	10/06/94	2.21	576.0	1290	1630	80	1550	16265	25390	Lt Brown	6.0
GRAB	10/11/94	2.17	637.1	1360	1740	690	1050	18274	29389	Gr-Yellow	5.0

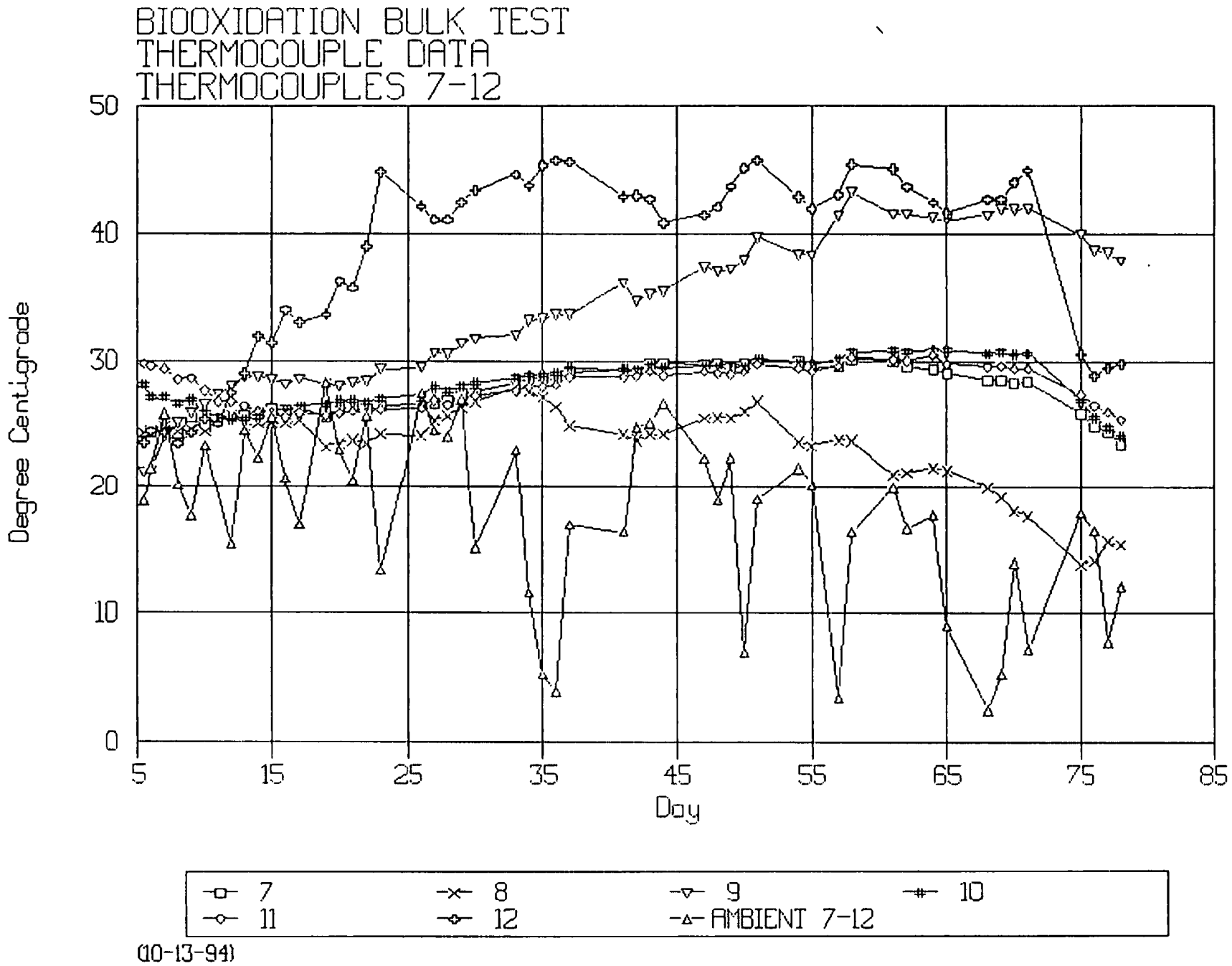
BIOOXIDATION BULK TEST THERMOCOUPLE DATA

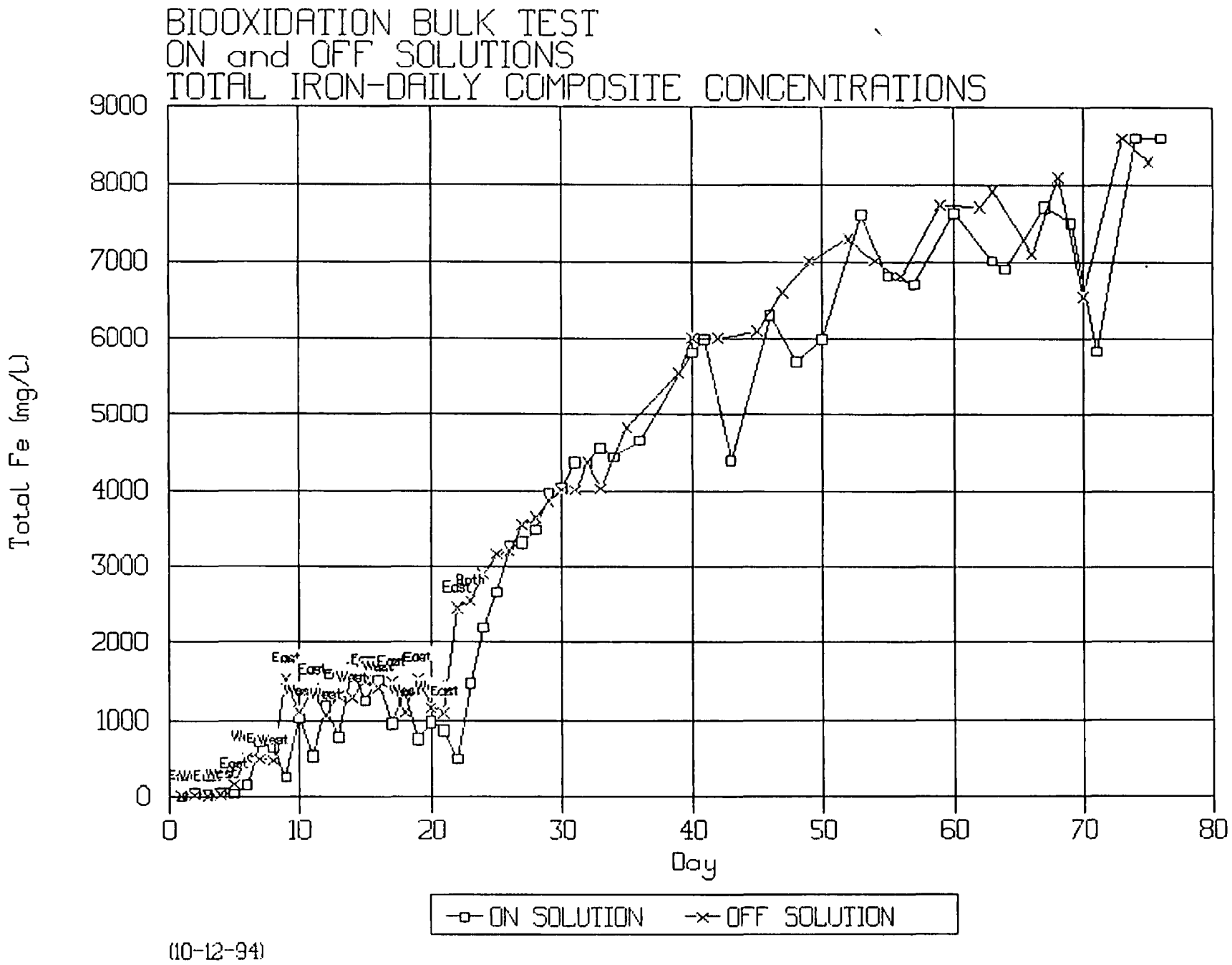
Date	West 1	West 2	West 3	West 4	West 5	Mid 6	Mid 7	Mid 8	East 9	East 10	East 11	East 12	AMBIENT 1-6	AMBIENT 7-12
08/02/94	27.8	23.2	27.4	24.3	25.7	28.0	24.3	24.3	21.2	28.1	29.8	23.5	19.0	18.9
08/02/94	28.2	23.8	27.6	25.0	26.2	28.7	24.3	24.5	21.3	27.1	29.6	24.4	22.6	21.5
08/03/94	27.2	23.7	27.2	24.6	25.6	27.5	24.5	24.8	24.0	27.1	29.4	24.3	26.0	25.8
08/04/94	29.7	24.7	27.8	25.0	27.0	29.0	24.2	24.4	25.1	26.6	28.5	23.4	19.0	20.3
08/05/94	31.3	25.6	28.2	27.3	28.3	30.4	25.5	24.6	25.9	26.9	28.6	24.3	17.7	17.7
08/06/94	30.7	25.8	27.7	26.6	26.9	28.1	24.8	24.4	26.6	25.9	27.7	25.4	22.8	23.3
08/07/94	31.8	26.2	27.1	27.4	27.9	29.6	25.4	25.5	27.3	25.5	26.8	25.0	-	-
08/08/94	32.2	27.3	27.9	27.6	27.9	29.1	25.5	25.7	27.9	25.3	26.8	27.5	14.0	15.5
08/09/94	36.4	28.9	28.6	29.3	28.9	29.9	25.7	24.9	28.7	25.4	26.4	29.0	24.0	24.5
08/10/94	35.1	28.8	28.0	28.3	27.8	28.6	25.8	25.0	28.8	25.5	26.0	32.0	21.9	22.3
08/11/94	38.4	30.8	28.5	29.2	28.1	28.9	26.2	25.1	28.5	25.6	25.8	31.5	25.4	25.6
08/12/94	36.6	30.2	27.7	27.8	27.2	27.9	26.1	25.0	28.1	26.0	25.6	34.0	22.3	20.7
08/13/94	39.0	31.9	28.6	29.4	28.3	29.2	26.3	25.3	28.6	26.4	25.9	33.1	17.3	17.0
08/14/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/15/94	38.1	31.2	28.2	28.3	27.1	27.5	25.6	23.2	28.2	26.5	25.7	33.7	24.9	28.3
08/16/94	39.1	32.2	29.0	28.8	27.6	28.0	26.2	23.5	28.0	26.8	25.9	36.2	23.5	22.9
08/17/94	39.1	31.4	28.3	28.3	27.4	27.9	26.3	23.7	28.3	26.8	26.0	35.7	20.8	20.6
08/18/94	40.3	32.8	29.4	29.2	28.3	28.6	26.1	23.5	28.4	26.7	25.9	39.0	28.6	25.7
08/19/94	40.4	32.7	28.8	29.3	28.2	28.7	26.4	24.2	29.4	27.0	26.2	44.8	12.6	13.3
08/20/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/21/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/22/94	44.1	35.7	29.8	31.9	30.7	30.2	26.5	24.1	29.5	27.4	26.3	42.1	28.3	27.5
08/23/94	43.7	37.1	30.4	33.3	32.3	32.8	26.7	25.3	30.7	27.9	26.9	41.0	25.1	24.5
08/24/94	43.1	37.7	30.4	33.5	32.2	32.1	26.8	25.7	30.6	27.6	26.5	41.0	26.0	24.0
08/25/94	43.0	38.5	30.9	34.4	33.2	33.0	27.3	26.3	31.4	28.0	27.0	42.4	27.0	27.0
08/26/94	42.9	38.9	31.0	35.1	33.8	33.5	27.5	26.8	31.8	28.3	27.3	43.3	15.0	15.2
08/27/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/28/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/29/94	43.0	40.5	31.1	34.5	33.4	32.4	28.3	27.9	32.1	28.7	27.7	44.6	23.0	22.9
08/30/94	40.1	41.2	32.6	36.8	35.7	35.8	28.6	27.7	33.2	28.9	28.0	43.7	12.4	11.6
08/31/94	40.8	40.6	32.5	36.8	35.7	35.4	28.6	27.1	33.3	28.9	28.0	45.3	4.6	5.3
09/01/94	42.3	40.9	32.6	36.9	35.3	34.8	28.7	26.4	33.7	29.0	28.1	45.7	4.1	3.9
09/02/94	44.0	40.8	33.0	37.0	35.7	34.6	29.1	24.9	33.7	29.5	28.8	45.6	17.6	17.0
09/03/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/04/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/05/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/06/94	45.2	39.9	36.4	37.9	36.3	35.6	29.4	24.2	36.1	29.4	28.8	42.8	17.2	16.4
09/07/94	46.1	40.7	39.0	37.9	36.8	36.3	29.2	23.7	34.7	29.3	28.9	42.9	25.3	24.8
09/08/94	-	40.2	39.0	36.9	36.4	35.5	29.9	24.2	35.3	29.7	29.2	42.6	25.0	25.1
09/09/94	-	40.8	40.2	37.2	-	34.8	29.9	24.2	35.5	29.5	28.9	40.8	27.8	26.7
09/10/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/11/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/12/94	-	42.5	43.4	39.4	-	37.7	29.8	25.5	37.4	29.6	29.2	41.4	20.8	22.3
09/13/94	-	41.9	42.8	38.3	-	36.8	29.9	25.6	37.0	29.6	29.1	42.0	20.1	19.0
09/14/94	-	41.7	42.8	38.0	-	36.2	29.6	25.5	37.2	29.4	29.0	43.6	22.6	22.4
09/15/94	-	42.5	43.6	38.9	-	37.1	29.9	26.0	37.9	29.6	29.2	45.1	7.0	7.0
09/16/94	-	42.9	43.2	40.3	-	39.1	30.2	26.8	39.7	30.1	29.8	45.7	20.8	19.1
09/17/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/18/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/19/94	-	45.4	43.6	40.6	-	39.4	30.0	23.6	38.4	29.9	29.5	42.8	21.3	21.5
09/20/94	-	45.1	42.5	40.3	-	38.9	29.5	23.3	38.3	29.8	29.3	41.9	18.8	20.3
09/21/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/22/94	-	46.5	42.8	42.1	-	41.8	29.6	23.8	41.3	30.2	29.7	43.0	5.6	3.5
09/23/94	-	47.1	43.1	43.5	-	43.7	30.2	23.7	43.2	30.8	30.4	45.4	18.0	16.4
09/24/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/25/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/26/94	-	47.2	42.1	41.2	-	39.6	30.1	21.0	41.5	30.9	30.2	45.0	20.5	20.0
09/27/94	-	48.7	43.1	42.4	-	41.9	29.6	21.2	41.5	30.8	30.1	43.6	17.2	16.7
09/28/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/29/94	-	49.7	43.2	42.5	-	41.7	29.4	21.6	41.2	31.0	30.6	42.4	17.7	17.8

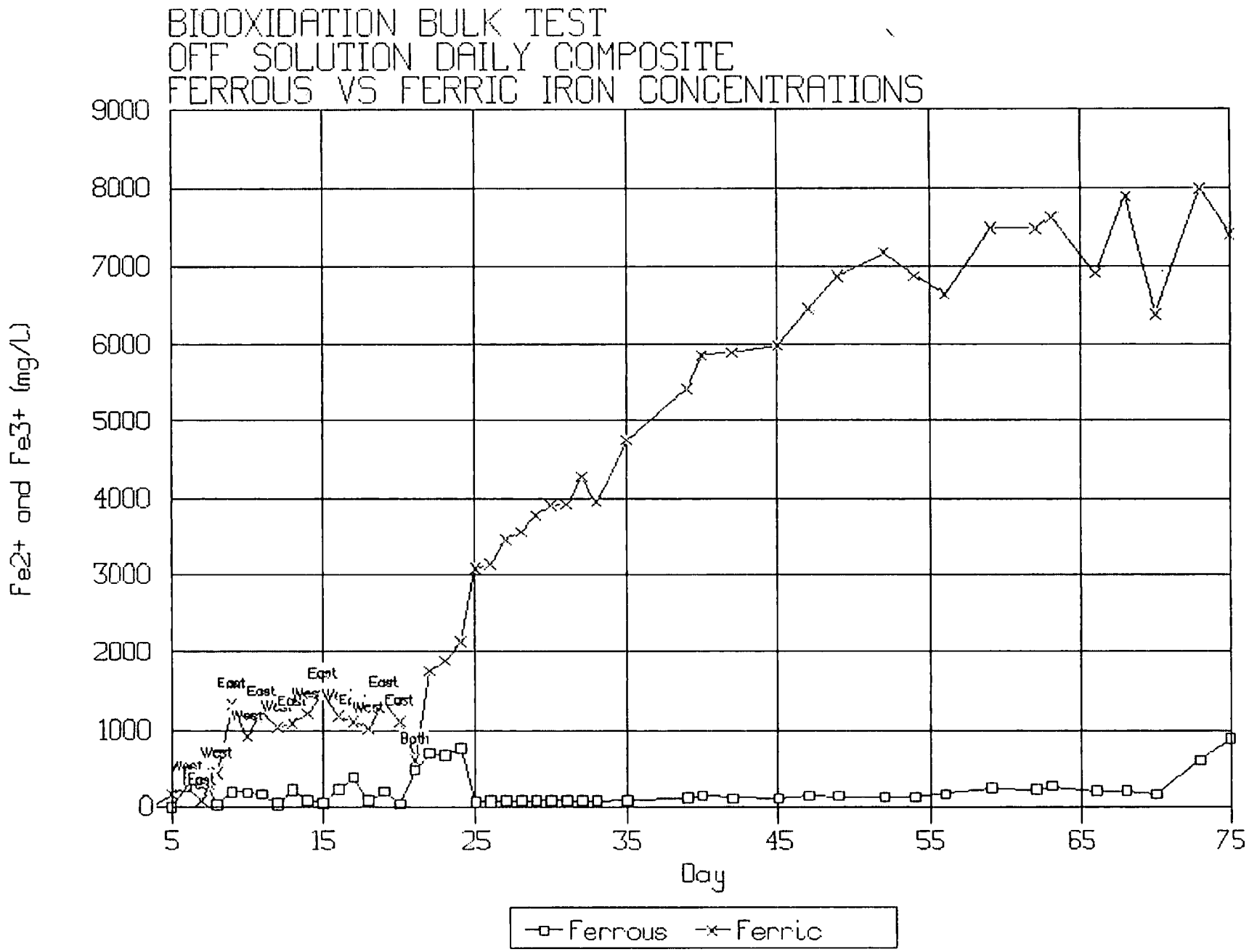
BIOOXIDATION BULK TEST THERMOCOUPLE DATA

Date	West 1	West 2	West 3	West 4	West 5	Mid 6	Mid 7	Mid 8	East 9	East 10	East 11	East 12	AMBIENT 1-6	AMBIENT 7-12
09/30/94	-	49.7	43.1	42.1	-	41.0	29.1	21.4	41.0	30.9	29.9	41.6	9.8	9.0
10/01/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/02/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/03/94	-	49.8	44.4	42.3	-	41.5	28.5	20.0	41.4	30.7	29.6	42.6	2.3	2.5
10/04/94	-	49.8	45.1	42.6	-	41.7	28.5	19.3	41.9	30.8	29.7	42.6	6.1	5.3
10/05/94	-	50.3	46.3	43.1	-	41.5	28.3	18.2	41.8	30.6	29.5	44.0	14.9	14.0
10/06/94	-	50.2	46.7	43.1	-	41.5	28.4	17.7	41.9	30.7	29.5	44.9	7.8	7.2
10/07/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/08/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/09/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/10/94	-	51.9	40.7	43.3	-	41.2	25.9	13.9	39.9	26.9	27.4	30.6	19.1	18.0
10/11/94	-	52.9	40.1	43.6	-	41.1	24.9	14.2	38.7	25.6	26.5	28.9	15.6	16.5
10/12/94	-	52.9	38.1	43.1	-	41.8	24.4	15.7	38.5	24.8	26.0	29.5	9.0	7.8
10/13/94	-	53.1	37.1	42.9	-	41.7	23.5	15.4	37.8	24.1	25.4	29.9	12.5	12.1

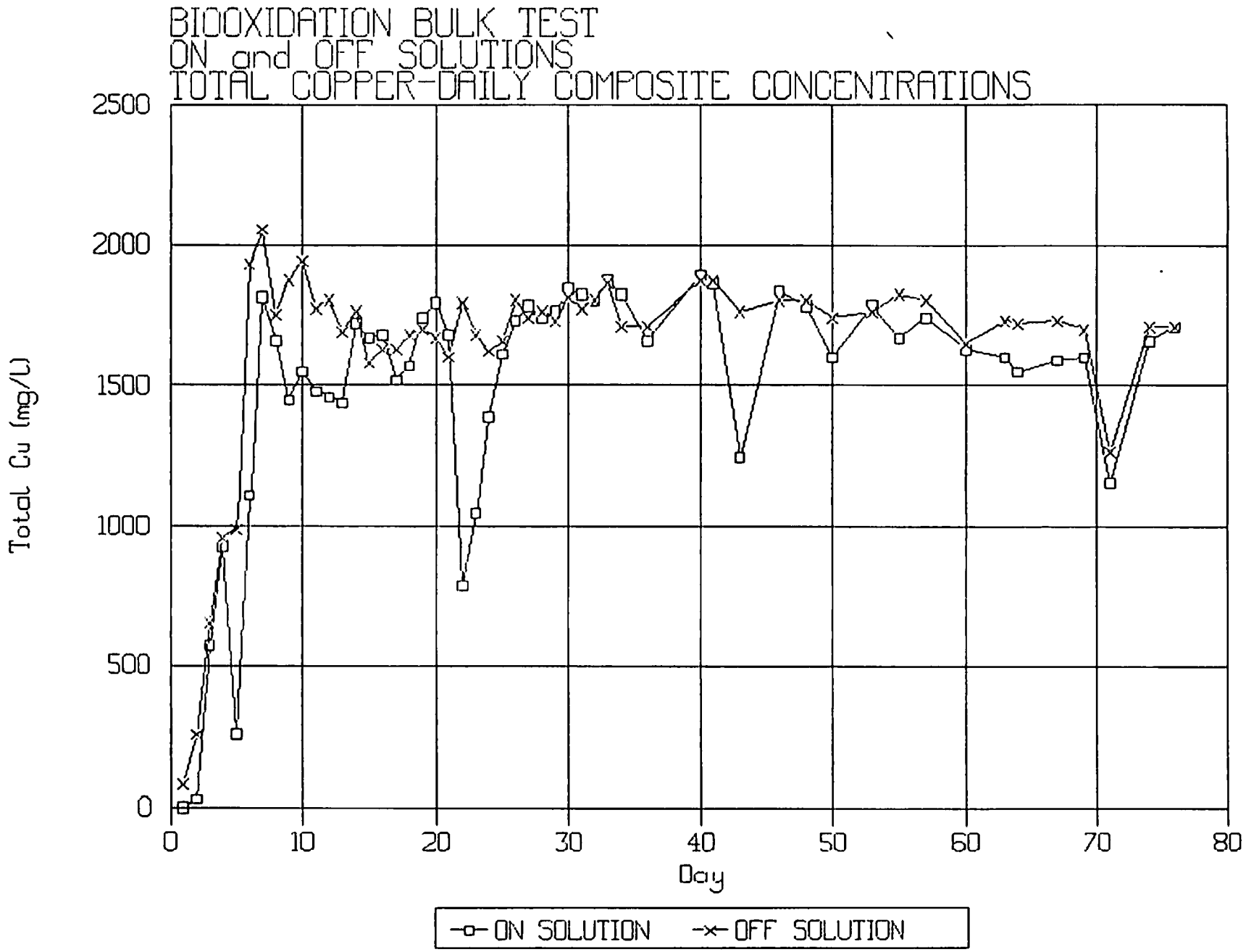

BIOOXIDATION BULK TEST
THERMOCOUPLE DATA
THERMOCOUPLES 1-6
Degree Centigrade
60
50
40
30
20
10
0
5
15
25
35
45
55
65
75
85
Day
1
2
3
4
5
6
AMBIENT 1-6
(10-13-94)


BIOOXIDATION BULK TEST
THERMOCOUPLE DATA
THERMOCOUPLES 7-12
Degree Centigrade
50
40
30
20
10
0
5
15
25
35
45
55
65
75
85
Day
7
8
9
10
11
12
AMBIENT 7-12
(10-13-94)


BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
TOTAL IRON-DAILY COMPOSITE CONCENTRATIONS
Total Fe (mg/L)
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
0
10
20
30
40
50
60
70
80
Day
ON SOLUTION
OFF SOLUTION
(10-12-94)

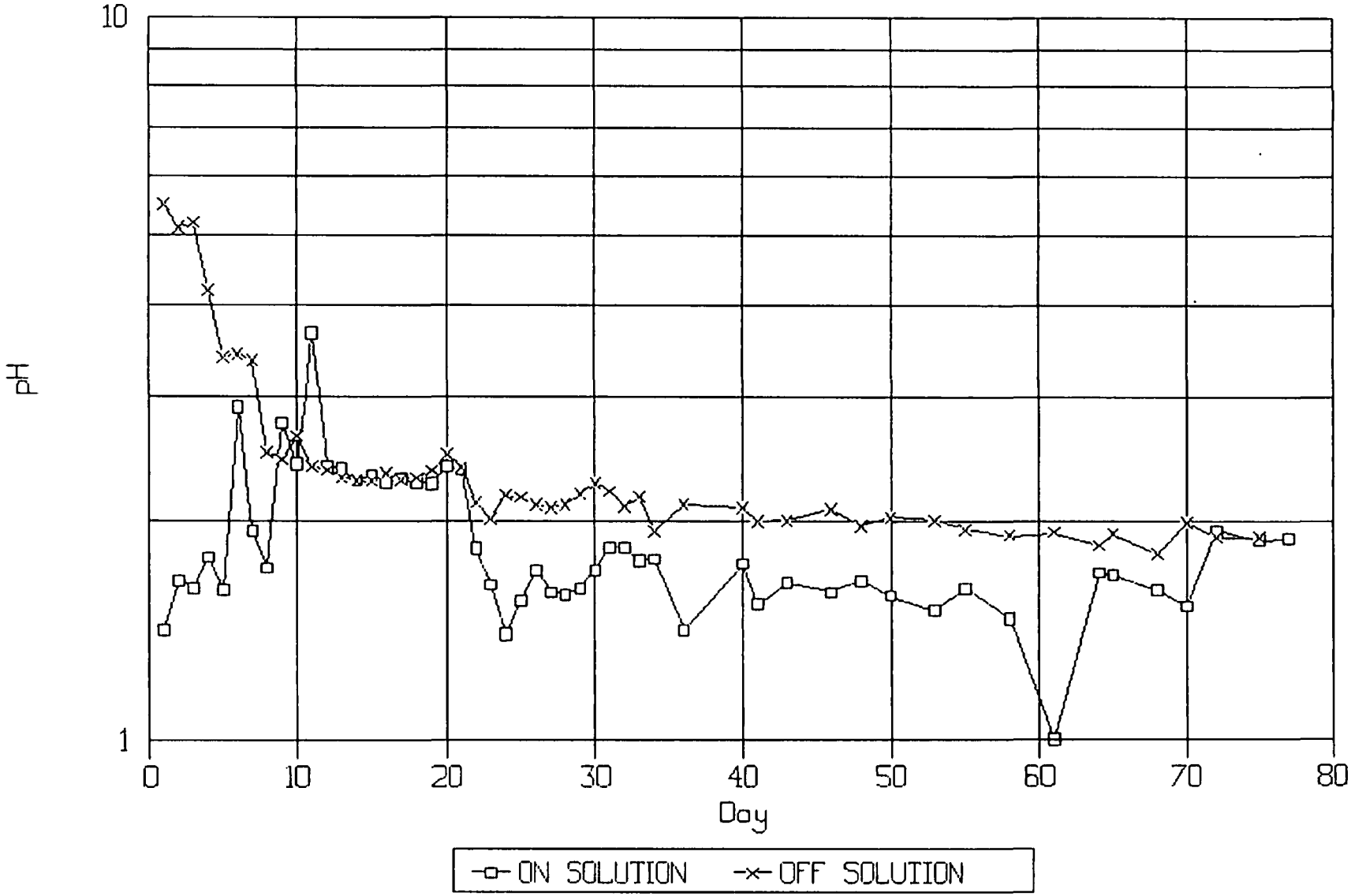

BIOOXIDATION BULK TEST
OFF SOLUTION DAILY COMPOSITE
FERROUS VS FERRIC IRON CONCENTRATIONS
Fe2+ and Fe3+ (mg/L)
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
5
15
25
35
45
55
65
75
Day
East
West
Both
Ferrous
Ferric

(10-12-94)


BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
TOTAL COPPER-DAILY COMPOSITE CONCENTRATIONS
Total Cu (mg/L)
2500
2000
1500
1000
500
0
0
10
20
30
40
50
60
70
80
Day
ON SOLUTION
OFF SOLUTION

(10-12-94)

BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
pH - DAILY COMPOSITE



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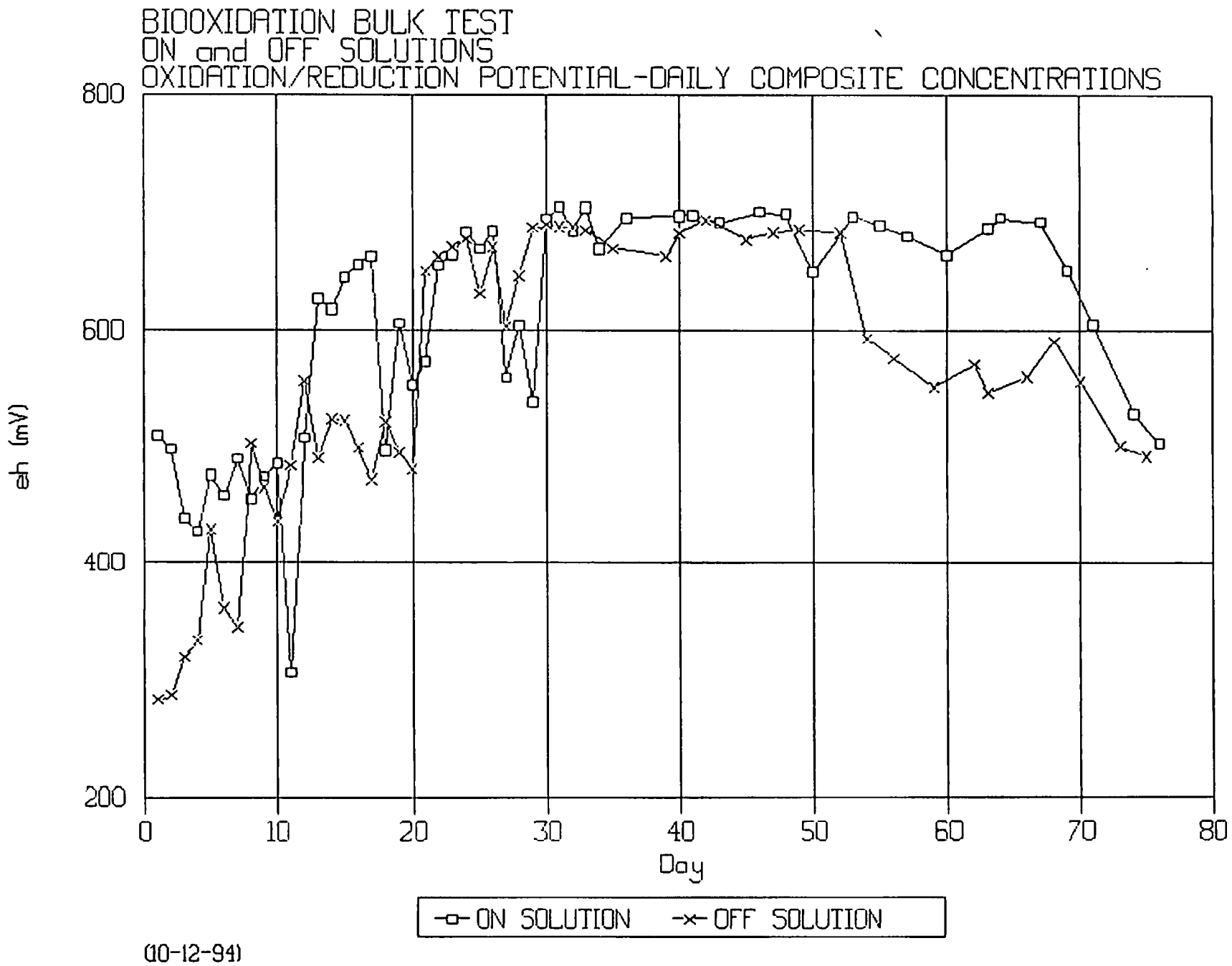
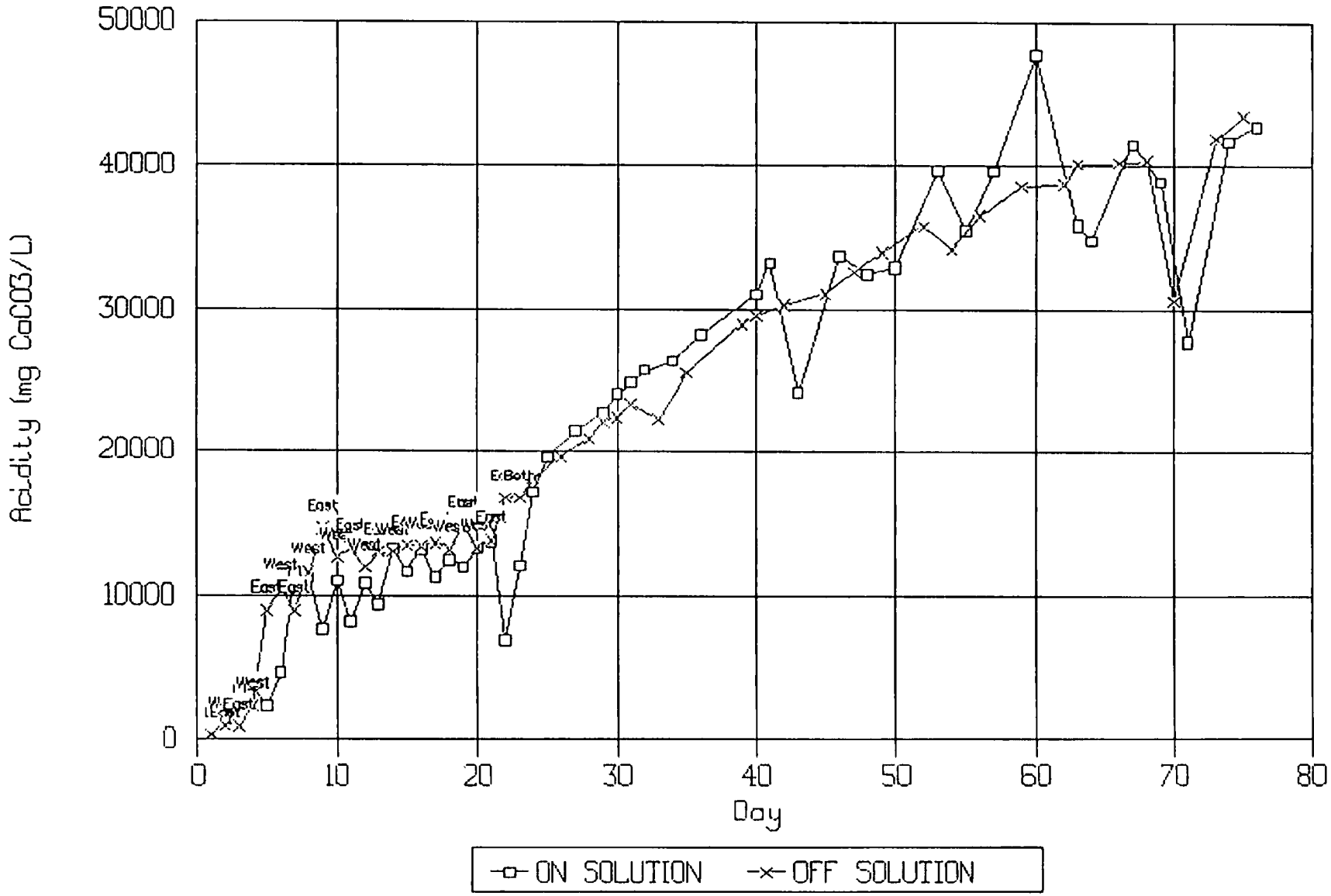

BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
OXIDATION/REDUCTION POTENTIAL-DAILY COMPOSITE CONCENTRATIONS
800
600
400
200
eh (mV)
0
10
20
30
40
50
60
70
80
Day
ON SOLUTION
OFF SOLUTION
(10-12-94)

BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
ACIDITY TO pH 7-DAILY COMPOSITE CONCENTRATIONS



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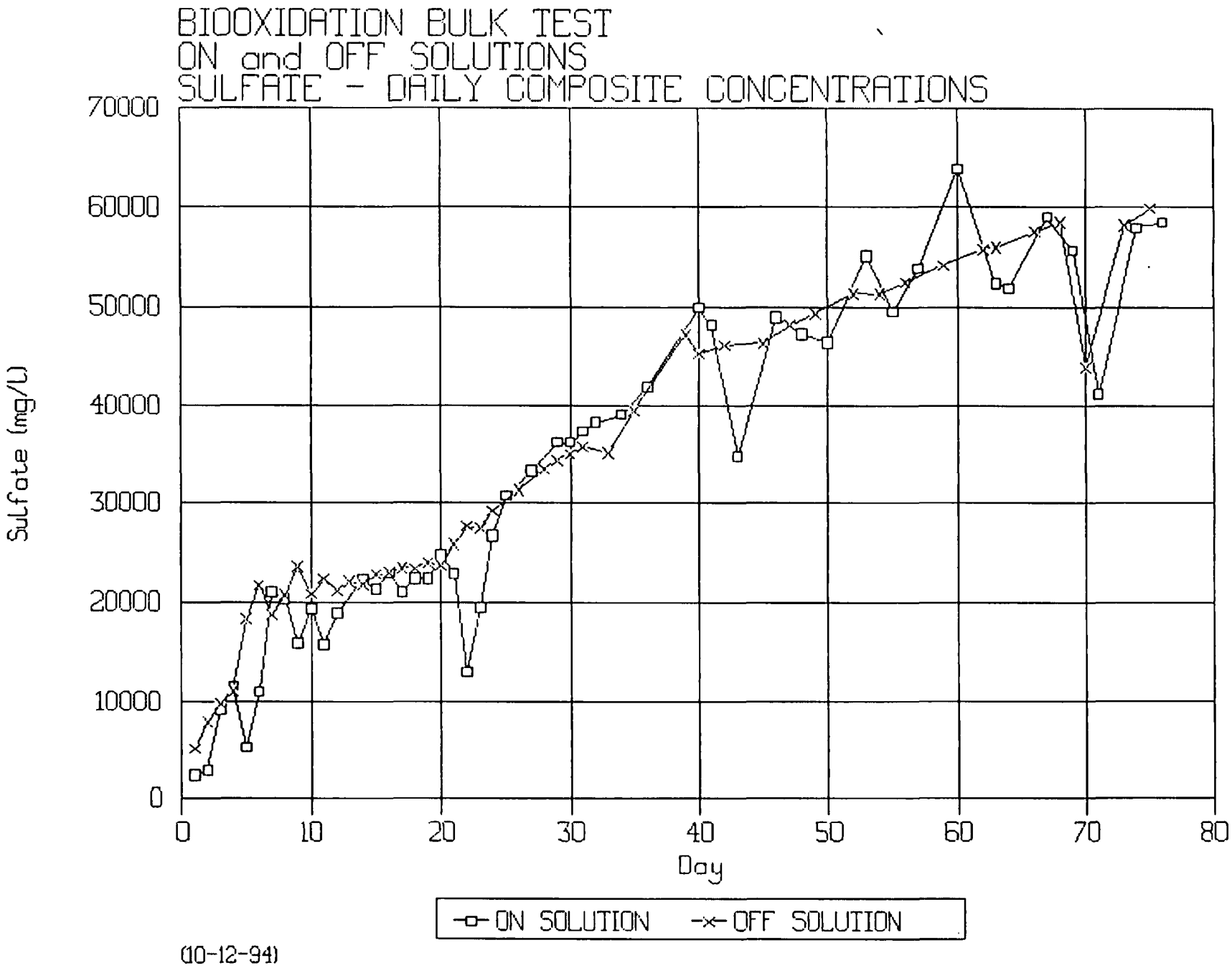

BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
SULFATE - DAILY COMPOSITE CONCENTRATIONS
Sulfate (mg/L)
70000
60000
50000
40000
30000
20000
10000
0
0
10
20
30
40
50
60
70
80
Day
ON SOLUTION
OFF SOLUTION
(10-12-94)

MEMORANDUM

DATE: OCTOBER 7, 1994
TO: JIM THOMPSON
FROM: LAURA DAMON
SUBJECT: BIOOXIDATION BULK TEST (BBT) WEEKLY UPDATE (10)

The BBT has been on the biooxidation cycle for ten weeks now. Both the west and east sides are on simultaneous solution application. The ON solution application rate has averaged 3.6 gpm this week while the OFF solution return rate has averaged 4.8 gpm.

There was a short conference call this week to discuss the need to release solution due to a 4+ inch rain which fell on Thursday October 6th. Solution was discharged from the neutralization tank onto Cell #7.

The limestone pool tank neutralization circuit is providing enough acidity control to use the screw feeder system as a polishing step. This system is proving adequate. 58,108 gallons have been neutralized to date with 100,000 total gallons being the treatment goal.

Sulfuric acid is no longer being added to the ON solution since the OFF solution pH has stayed consistently below 2.0 this week. Acid will only be added to the ON solution when neutralization solution is being transferred.

The OFF solution total iron concentration has risen to 8100 ppm this week. It continues to be predominantly in the form of ferric iron. The oxidation/reduction potential dropped to an eh range of 550-600 but the sulfate concentration continues to rise as does the acidity. These analyses indicate that the BBT continues to biooxidize.

The BBT was auger drilled for a second time on September 27th. Three holes were drilled, one each on the east and west sides and in the center of the heap, about one foot east of the auger samples drilled on August 23rd. Samples were collected from each hole in five foot composites. Analyses were run on each five foot composite sample to determine the total copper, iron and sulfur content. Sulfate analyses were also run with sulfide content calculated. The results are compared to the previous auger drill-1 samples and attached to this report. All of the iron and sulfide values are lower on the auger drill-2 samples as compared to the auger drill-1 samples although all of the auger drill sample values are higher than the control sample (10% HCl rinsed SP-2 Composite). Gold extraction bottle rolls will be run on the auger drill-2 samples next week.

c: Rod MacLeod
Martin Quick
Herb Osborne

BIOOXIDATION BULK TEST SOLUTION SAMPLING

ON SOLUTION

Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)
Orofino	7/21-9/29		(91000)	7.91	337.4	.01	1.35	-	-	-	107
	7/21-7/28	19741	19741								
GRAB-1530	07/27/94	?	19741	1.94	516.2	1.26	3.0	-	-	-	-
GRAB	07/28/94	?	19741	1.20	555.3	.16	7.8	-	-	3042	3411
COMP	07/28/94	?	19741	1.41	510.8	.10	21.6	-	-	1924	2420
COMP	07/29/94	9542	29283	1.65	498.3	29	45.0	4.1	40.9	1416	3012
COMP	07/30/94	5504	34787	1.61	438.4	574	38.0	2.2	35.8	3442	9230
COMP	07/31/94	975	35762	1.78	426.7	930	51.0	2.3	48.7	3823	11575
COMP	08/01/94	21302	57063	1.60	475.9	260	33.0	1.3	31.7	2394	5238
COMP	08/02/94	18970	76034	2.89	458.4	1110	155	71	84	4705	10999
COMP	08/03/94	16238	92272	1.94	490.0	1810	710	130	580	11581	20982
COMP	08/04/94	12021	104293	1.72	455.8	1660	660	340	320	11167	20349
COMP	08/05/94	16734	121027	2.75	475.1	1450	260	40	220	7673	15888
COMP	08/06/94	16466	137492	2.41	486.8	1550	1030	60	970	11012	19332
COMP	08/07/94	16466	153958	3.66	304.8	1480	530	60	470	8191	15810
COMP	08/08/94	16502	170460	2.40	507.9	1460	1170	110	1060	10820	18867
COMP	08/09/94	16103	186563	2.38	627.5	1440	790	25	765	9380	-
COMP	08/10/94	15624	202187	2.28	618.1	1720	1680	63	1617	13218	22369
COMP	08/11/94	16113	218300	2.33	645.4	1670	1250	33	1217	11657	21262
COMP	08/12/94	14762	233062	2.27	656.2	1680	1510	146	1364	13205	22874
COMP	08/13/94	13785	246847	2.30	663.0	1520	950	41	909	11254	21036
COMP	08/14/94	10979	257826	2.27	497.5	1570	1380	229	1151	12451	22331
COMP	08/15/94	10129	267955	2.26	606.6	1740	750	53	697	11956	22333
COMP	08/16/94	6178	274133	2.40	553.1	1790	970	51	919	13257	24698
COMP	08/17/94	6444	280577	2.36	573.3	1680	860	171	689	13713	22929
COMP	08/18/94	7205	287782	1.83	655.6	790	490	170	320	6959	12987
COMP	08/19/94	12447	300229	1.63	664.1	1050	1480	440	1040	12007	19505
COMP	08/20/94	15338	315567	1.39	683.9	1390	2190	610	1580	17135	26608
COMP	08/21/94	12497	328064	1.55	669.8	1610	2660	710	1950	19555	30681
COMP	08/22/94	11793	339857	1.71	684.8	1730	3270	75	3195	-	-
COMP	08/23/94	12099	351956	1.59	560.0	1780	3310	123	3187	21399	33274
COMP	08/24/94	11183	363139	1.58	604.9	1740	3480	82	3398	-	-
COMP	08/25/94	11114	374253	1.61	538.6	1760	3960	230	3730	22733	36228
COMP	08/26/94	9502	383755	1.71	694.7	1840	4040	94	3946	24028	36237
COMP	08/27/94	9144	392899	1.84	705.2	1820	4370	99	4271	24868	37372
COMP	08/28/94	8493	401392	1.84	684.4	1800	4380	99	4281	25735	38352
COMP	08/29/94	8859	410251	1.76	704.1	1870	4570	86	4484	-	-
COMP	08/30/94	7349	417600	1.77	669.5	1820	4450	84	4366	26418	39084
COMP	08/31/94	8940	426540	-	-	-	-	-	0	-	-
COMP	09/01/94	8784	435324	1.41	695.6	1660	4660	94	4566	28282	41981
COMP	09/02/94	5757	441081	-	-	-	-	-	0	-	-
COMP	09/03/94	7779	448860	-	-	-	-	-	0	-	-
COMP	09/04/94	7563	456423	-	-	-	-	-	0	-	-
COMP	09/05/94	6512	462935	1.74	697.0	1890	5820	127	5693	31066	49890
COMP	09/06/94	5907	468842	1.53	698.3	1860	6000	138	5862	33298	48170
COMP	09/07/94	6074	474916	-	-	-	-	-	0	-	-
COMP	09/08/94	8632	483548	1.64	691.8	1250	4410	86	4324	24133	34862
COMP	09/09/94	9369	492917	-	-	-	-	-	0	-	-
COMP	09/10/94	6460	499377	-	-	-	-	-	0	-	-
COMP	09/11/94	6460	505837	1.59	700.2	1830	6300	114	6186	33773	48927
COMP	09/12/94	6004	511841	-	-	-	-	-	0	-	-
COMP	09/13/94	7143	518984	1.65	698.8	1780	5700	127	5573	32506	47216
COMP	09/14/94	8045	527029	-	-	-	-	-	0	-	-
COMP	09/15/94	10057	537086	1.57	649.7	1600	6000	117	5883	32933	46360
COMP	09/16/94	10719	547805	-	-	-	-	-	0	-	-
COMP	09/17/94	9886	557691	-	-	-	-	-	0	-	-
COMP	09/18/94	8902	566593	1.50	697.1	1780	7600	102	7498	39646	55042
COMP	09/19/94	5547	572140	-	-	-	-	-	0	-	-

BIOOXIDATION BULK TEST SOLUTION SAMPLING

ON SOLUTION

Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)
COMP	09/20/94	3226	575366	1.61	689.3	1670	6800	138	6662	35523	49528
COMP	09/21/94	4164	579530	-	-	-	-	-	0	-	-
COMP	09/22/94	3296	582826	1.46	680.5	1740	6700	151	6549	39570	53734
COMP	09/23/94	6300	589126	-	-	-	-	-	0	-	-
COMP	09/24/94	8519	597645	-	-	-	-	-	0	-	-
COMP	09/25/94	7928	605573	1.00	664.8	1630	7630	146	7484	47665	63889
COMP	09/26/94	6189	611762	-	-	-	-	-	0	-	-
COMP	09/27/94	6154	617916	-	-	-	-	-	0	-	-
COMP	09/28/94	5684	623600	1.69	686.9	1600	7000	138	6862	35900	52293
COMP	09/29/94	7387	630987	1.68	695.5	1550	6900	120	6780	34862	51808
COMP	09/30/94	5875	636862	-	-	-	-	-	0	-	-
COMP	10/01/94	4570	641431	-	-	-	-	-	0	-	-
COMP	10/02/94	4570	646001	1.60	691.9	1590	7700	171	7529	41524	58993
COMP	10/03/94	5786	651787	-	-	-	-	-	0	-	-
COMP	10/04/94	2417	654204	1.52	650.9	1600	7500	156	7344	38828	55577
COMP	10/05/94	5927	660131	-	-	-	-	-	0	-	-

BIOOXIDATION BULK TEST SOLUTION SAMPLING

OFF SOLUTION

Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	DO (ppm)
SUMP-GRAB	07/26/94	1200	1200	7.22	-	.84	.27	-	-	-	-	-
GRAB-1530	07/27/94	1750	2950	7.53	305.4	.89	.20	-	-	-	-	-
COMP	07/28/94	3000	5950	5.93	353.6	83	.55	-	-	83	4411	-
COMP	07/29/94	3293	9243	5.49	282.1	255	13	-	-	362	5094	-
COMP	07/30/94	4419	13662	5.11	285.7	654	14	-	-	994	7913	-
COMP	07/31/94	2688	16350	5.18	318.8	960	11	-	-	956	9835	-
COMP	08/01/94	7822	24172	4.20	332.3	990	39	1	38	2438	11106	-
COMP	08/02/94	21836	46008	3.39	429.6	1930	172	2	170	8960	18304	-
COMP	08/03/94	14710	60718	3.43	360.1	2050	520	260	260	10520	21678	-
COMP	08/04/94	7500	68218	3.36	344.2	1750	500	410	90	8967	18731	-
COMP	08/05/94	6821	75039	2.50	503.7	1870	480	40	440	11633	20711	-
COMP	08/06/94	21396	96436	2.45	465.2	1940	1530	200	1330	14570	23591	-
COMP	08/07/94	21396	117832	2.63	435.8	1770	1110	190	920	12617	20727	-
COMP	08/08/94	18698	136530	2.40	484.6	1800	1390	160	1230	13259	22299	-
COMP	08/09/94	21118	157648	2.36	557.4	1690	1070	36	1034	11904	21180	-
COMP	08/10/94	16419	174067	2.31	491.4	1760	1320	220	1100	12958	22052	-
COMP	08/11/94	16500	190567	2.29	524.4	1580	1290	86	1204	12958	21764	-
COMP	08/12/94	18213	208780	2.28	523.1	1630	1520	56	1464	13452	22729	1.3
COMP	08/13/94	18585	227365	2.34	500.2	1630	1420	240	1180	13361	22995	1.3
COMP	08/14/94	16646	244011	2.29	472.4	1680	1490	380	1110	13608	23458	-
COMP	08/15/94	13559	257570	2.31	522.4	1700	1110	84	1026	13179	23381	-
COMP	08/16/94	12267	269837	2.36	496.4	1670	1540	196	1344	14831	23933	1.4
COMP	08/17/94	7697	277534	2.49	481.4	1600	1160	43	1117	13309	23711	2.2
COMP	08/18/94	7136	284670	2.39	650.1	1790	1100	480	620	13839	25735	1.7
COMP	08/19/94	13078	297748	2.13	663.0	1680	2450	690	1760	16703	27554	-
COMP	08/20/94	14479	312227	2.02	672.0	1620	2550	670	1880	16716	27464	-
COMP	08/21/94	14213	326440	2.18	678.3	1660	2900	770	2130	18024	29200	-
COMP	08/22/94	14246	340686	2.16	631.0	1800	3160	75	3085	-	-	-
COMP	08/23/94	13868	354554	2.11	671.3	1740	3210	73	3137	19568	31299	-
COMP	08/24/94	12742	367296	2.09	604.1	1760	3540	82	3458	-	-	.7
COMP	08/25/94	11741	379037	2.11	646.9	1730	3640	86	3554	20823	33471	5.5?
COMP	08/26/94	12505	391542	2.19	687.1	1810	3860	86	3774	22006	34443	OFL
COMP	08/27/94	11272	402814	2.27	689.5	1770	4000	94	3906	22374	35035	-
COMP	08/28/94	9000	411814	2.21	688.0	1800	4000	82	3918	23319	35858	-
COMP	08/29/94	9000	420814	2.10	688.2	1860	4370	86	4284	-	-	OFL
COMP	08/30/94	11403	432217	2.17	685.5	1710	4030	84	3946	22242	35134	13.5?
COMP	08/31/94	10726	442943	-	-	-	-	-	-	-	-	OFL
COMP	09/01/94	10299	453242	1.94	669.9	1710	4840	89	4751	25577	39562	OFL
COMP	09/02/94	9075	462317	-	-	-	-	-	-	-	-	3.9
COMP	09/03/94	8149	470466	-	-	-	-	-	-	-	-	-
COMP	09/04/94	7612	478078	-	-	-	-	-	-	-	-	-
COMP	09/05/94	7357	485435	2.11	663.7	1870	5550	120	5430	29017	47141	-
COMP	09/06/94	6870	492305	2.09	682.9	1870	6010	151	5859	29543	45273	3.5
COMP	09/07/94	6503	498808	-	-	-	-	-	-	-	-	6.2
COMP	09/08/94	10447	509255	2.00	693.8	1760	6010	117	5893	30304	46121	5.5
COMP	09/09/94	8553	517808	-	-	-	-	-	-	-	-	5.5
COMP	09/10/94	8424	526232	-	-	-	-	-	-	-	-	-
COMP	09/11/94	8424	534656	2.01	677.7	1800	6100	114	5986	31157	46376	-
COMP	09/12/94	7258	541914	-	-	-	-	-	-	-	-	-
COMP	09/13/94	6630	548544	2.08	683.7	1800	6600	151	6449	32657	48154	2.8
COMP	09/14/94	7479	556023	-	-	-	-	-	-	-	-	2.6
COMP	09/15/94	11492	567515	1.97	685.6	1740	7000	142	6858	33989	49372	4.6
COMP	09/16/94	11244	578759	-	-	-	-	-	-	-	-	2.8
COMP	09/17/94	11287	590046	-	-	-	-	-	-	-	-	-
COMP	09/18/94	10435	600481	2.03	684.0	1760	7300	134	7166	35825	51363	-
COMP	09/19/94	9531	610012	-	-	-	-	-	-	-	-	2.5
COMP	09/20/94	6175	616187	2.01	593.5	1820	7000	134	6866	34241	51265	2.8
COMP	09/21/94	5061	621248	-	-	-	-	-	-	-	-	-

BIOOXIDATION BULK TEST SOLUTION SAMPLING

OFF SOLUTION

Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	DO (ppm)
COMP	09/22/94	5238	626486	1.95	576.7	1800	6800	171	6629	36579	52376	3.5
COMP	09/23/94	6073	632559	-	-	-	-	-	-	-	-	3.2
COMP	09/24/94	9286	641845	-	-	-	-	-	-	-	-	-
COMP	09/25/94	9592	651437	1.91	552.0	1650	7730	250	7480	38565	54096	-
COMP	09/26/94	7385	658822	-	-	-	-	-	-	-	-	2.8
COMP	09/27/94	9119	667941	-	-	-	-	-	-	-	-	3.5
COMP	09/28/94	7789	675730	1.93	571.8	1730	7700	230	7470	38690	55742	-
COMP	09/29/94	7387	683117	1.85	547.2	1720	7900	270	7630	40150	55898	-
COMP	09/30/94	7807	690924	-	-	-	-	-	-	-	-	3.2
COMP	10/01/94	6502	697426	-	-	-	-	-	-	-	-	-
COMP	10/02/94	6502	703928	1.92	560.7	1730	7100	210	6890	40202	57552	-
COMP	10/03/94	6231	710159	-	-	-	-	-	-	-	-	4.2
COMP	10/04/94	6834	716993	1.80	591.1	1700	8100	210	7890	40383	58458	4.5
COMP	10/05/94	6911	723904	-	-	-	-	-	-	-	-	4.5

BIOOXIDATION BULK TEST SOLUTION SAMPLING

PAN LYSIMETER 3

Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO (ppm)
GRAB	08/03/94	1.93	488.4	1540	4640	1200	3440	20005	23896	-	
GRAB	08/11/94	1.52	496.1	3200	8700	2900	5800	-	-	Brown/Murky	
GRAB	08/12/94	1.89	450.4	2200	3900	2100	1800	-	27461	Lt Brown	1.5
GRAB	08/15/94	1.92	459.5	2170	3920	1270	2650	15417	27625	Med Brown	1.7
GRAB	08/17/94	1.97	462.7	1940	3220	560	2660	19502	25159	Med Brown	2.4
GRAB	08/19/94	2.00	458.4	1850	2300	1400	900	17828	23604	-	-
GRAB	08/22/94	1.90	464.0	1760	2300	360	1940	16677	23744	Grw/Br Ti	1.9
GRAB	08/24/94	2.04	468.5	1780	2680	770	1910	16795	23028	Green	.9
GRAB	08/26/94	2.05	479.6	1730	2700	690	2010	17030	24320	Br-Yel	4.5?
GRAB	08/29/94	2.08	472.8	1770	2760	360	2400	17936	25167	Yel-Br	OFL
GRAB	09/01/94	1.79	472.3	1870	2730	730	2000	19039	26822	Green	OFL
GRAB	09/06/94	1.83	492.1	1940	2620	210	2410	19748	30237	Lt Green	2.5
GRAB	09/08/94	1.80	488.8	1980	2870	300	2570	21454	30435	Dk Green	4.3
GRAB	09/13/94	1.68	499.7	2040	3310	510	2800	22662	32648	Gr;cldy	0.9
GRAB	09/20/94	1.66	494.8	2000	3930	300	3630	24512	33471	Lt Green	1.4
GRAB	09/22/94	1.56	481.2	1980	4250	770	3480	26724	34796	Gr-Br	1.6
GRAB	09/27/94	1.66	487.7	1920	3820	460	3360	24512	34253	Gr;cldy	1.8
GRAB	09/29/94	1.73	498.0	2070	3820	460	3360	25972	37735	Green	2.3
GRAB	10/04/94	1.63	504.6	2320	3710	330	3380	30067	42385	Gr;cldy	2.9
GRAB	10/06/94	1.66	496.1	2500	3880	440	3440	32530		Gr;cldy	4.9

PAN LYSIMETER 4

Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO (ppm)
GRAB	08/11/94	2.62	526.3	55	87	-	-	-	-	Flush H2O	-
GRAB	08/12/94	2.06	560.0	567	1260	67	1193	5282	6801	Lt Brown	4.8
GRAB	08/15/94	1.87	671.9	1260	2920	105	2815	14311	17681	Lt Brown	2.9
GRAB	08/17/94	1.71	687.2	1610	3670	102	3568	19528	23875	Med Brown	2.9
GRAB	08/19/94	1.79	659.6	1790	2900	900	2000	19280	24583	-	-
GRAB	08/22/94	1.86	615.3	1720	2000	73	1927	16285	23809	Gr-Brown	3.2
GRAB	08/24/94	1.78	678.6	1770	2420	60	2360	16481	24196	Green	OFL
GRAB	08/26/94	1.80	601.2	1710	2450	75	2375	16742	25126	Lt Gr-Yel	OFL
GRAB	08/29/94	1.92	681.5	1710	2340	60	2280	17279	26073	Lt Green	OFL
GRAB	09/01/94	1.61	698.7	1700	2380	61	2319	17647	26443	Lt Green	OFL
GRAB	09/06/94	1.75	628.7	1700	2520	71	2449	18881	29768	Lt Green	3.5
GRAB	09/08/94	1.79	681.5	1710	2710	75	2635	20168	29817	Green	4.0
GRAB	09/13/94	1.68	570.2	1780	3540	114	3426	23765	34755	Green	3.5
GRAB	09/20/94	1.63	576.6	1880	4730	123	4607	28408	40117	Yellow	4.0
GRAB	09/22/94	1.52	595.7	1910	5620	146	5474	33612	44878	Lt Green	5.9
GRAB	09/27/94	1.60	612.7	1910	6060	142	5918	34291	48006	Yellow	5.0
GRAB	09/29/94	1.56	590.0	1930	6420	151	6269	37169	49783	Brown	4.1
GRAB	10/04/94	1.41	622.3	1820	6830	146	6684	38595	53001	Lt Brown	5.8
GRAB	10/06/94	1.48	658.9	1780	6930	142	6788	38595		Yel-Lt Br	6.7

BIOOXIDATION BULK TEST SOLUTION SAMPLING

PAN LYSIMETER 5

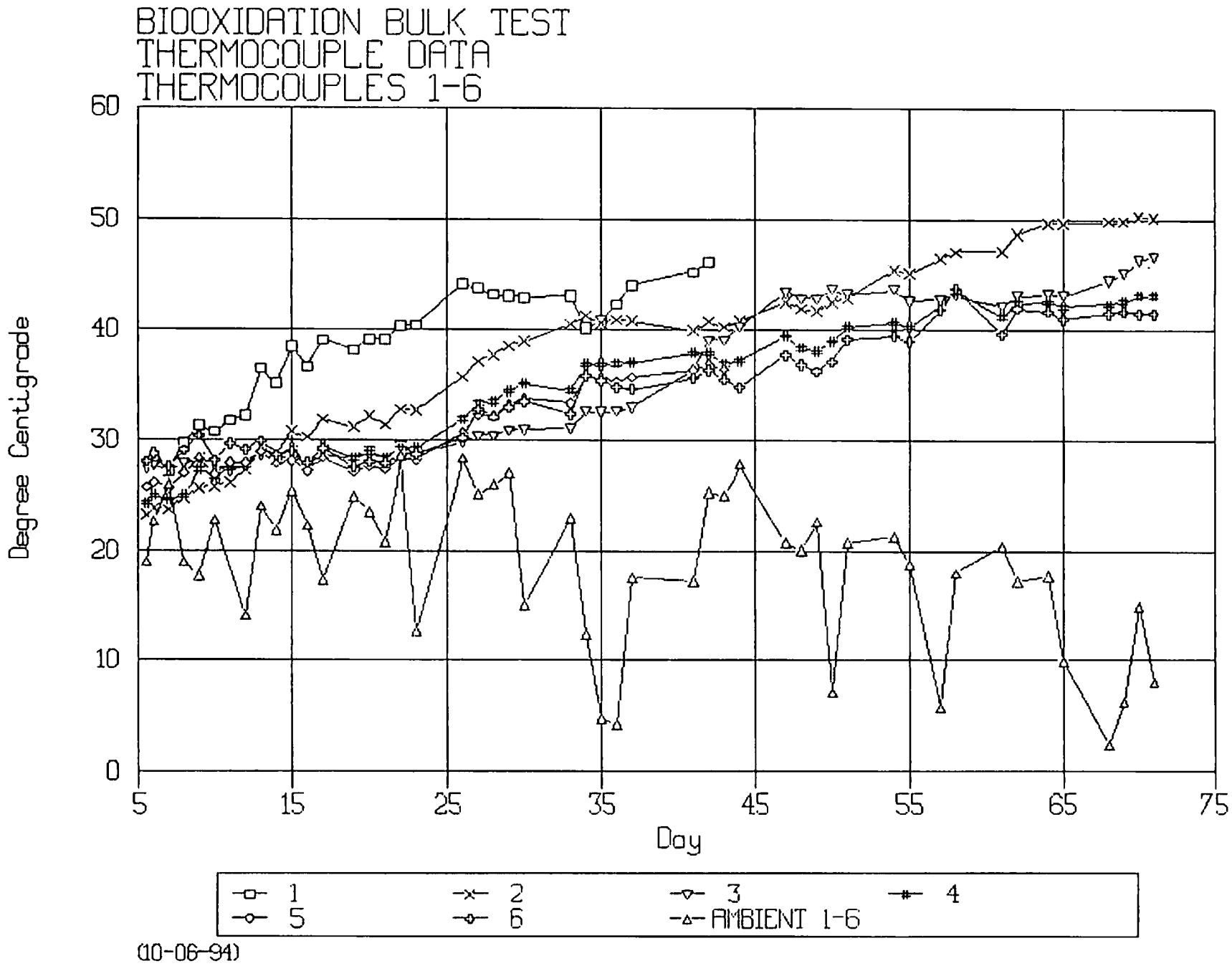
Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO (ppm)
GRAB	08/03/94	1.49	515.6	3690	17700	2100	15600	57687	66622	Dark Brown	-
GRAB	08/04/94	1.32	511.1	3930	14100	1600	12500	60119	67556	Dark Brown	-
GRAB	08/09/94	1.70	484.5	2600	4500	1400	3100	28440	38389	Dark Brown	-
GRAB	08/10/94	2.37	574.1	1740	990	36	954	11468	23641	Off Soln Flush	
GRAB	08/11/94	1.72	431.8	2000	3700	3400	300	-	-	Green Color	-
GRAB	08/12/94	1.80	439.7	2000	3900	2900	1000	20048	24627	Lt Green	3.7
GRAB	08/15/94	1.88	361.1	1940	3940	2200	1740	20543	24800	Green	2.6
GRAB	08/17/94	1.88	415.7	2030	4800	3700	1100	23073	27307	Green	2.7
GRAB	08/19/94	1.87	418.5	2170	4100	4000	100	21647	27324	-	-
GRAB	08/22/94	2.26	437.3	1920	2800	2300	500	18260	24542	Yel-Br	2.1
GRAB	08/24/94	2.12	385.4	1880	3250	2900	350	17056	25184	Lt Gr/Blue	OFL
GRAB	08/26/94	2.39	414.8	1780	3270	2290	980	16428	24641	Yel-Gr;odor	OFL
GRAB	08/29/94	2.47	402.7	1730	3260	2110	1150	16623	24698	Lt Green	OFL
GRAB	09/01/94	2.28	492.3	1700	2600	480	2120	16360	24254	Yel-Br;odor	OFL
GRAB	09/06/94	2.30	386.7	1520	3010	1830	1180	16097	25933	Bl-Gr;odor	2.5
GRAB	09/08/94	2.36	465.2	1480	2490	430	2060	16202	24534	Lt Br;ppt	4.3
GRAB	09/13/94	2.32	389.7	1170	3250	3700	-450	16019	25019	Lt Green	0.9
GRAB	09/20/94	2.30	386.7	1110	2470	2600	-130	15185	23797	Lt Green	1.8
GRAB	09/22/94	2.23	417.6	1110	2320	2000	320	15888	24163	Lt Green	2.8
GRAB	09/27/94	2.17	563.9	1110	1650	700	950	16416	24270	Lt Brown	2.8
GRAB	09/29/94	2.19	500.5	1280	1950	200	1750	13841	25834	Brown	2.8
GRAB	10/04/94	2.07	473.2	1240	1760	410	1350	16978	25776	Yel-Lt Br	3.0
GRAB	10/06/94	2.21	576.0	1290	1630	80	1550	16265		Lt Brown	6.0

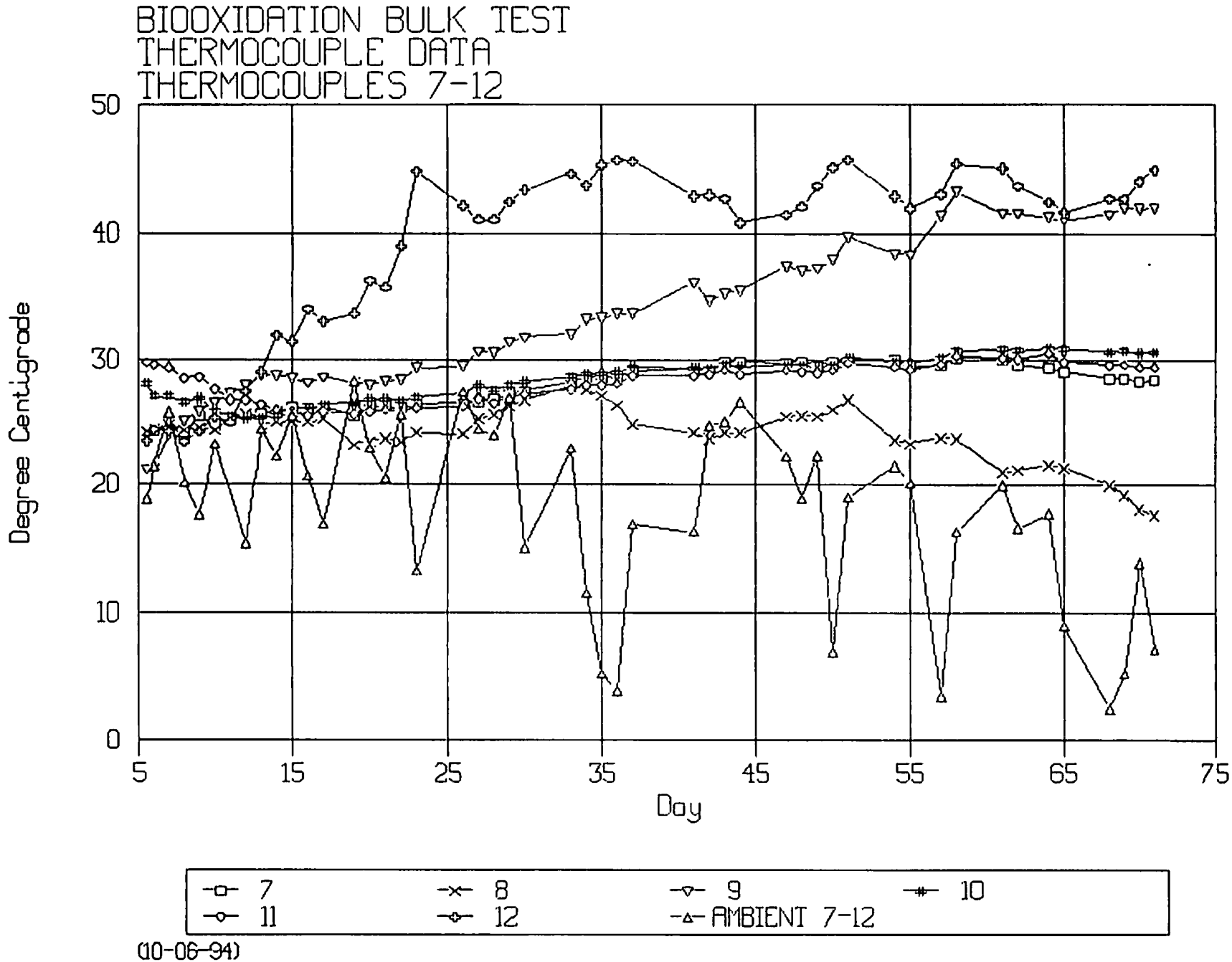
BIOOXIDATION BULK TEST THERMOCOUPLE DATA

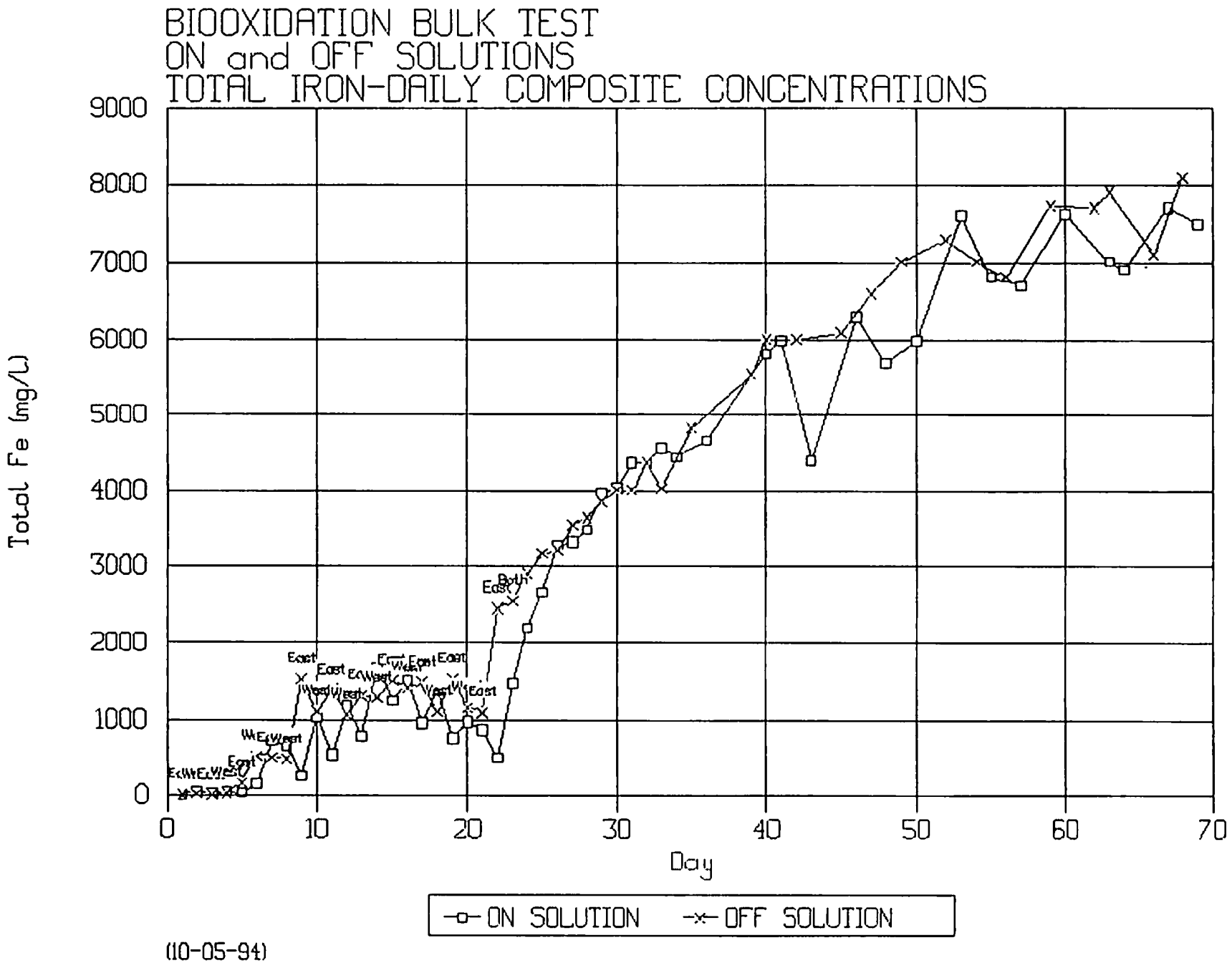
Date	West 1	West 2	West 3	West 4	West 5	Mid 6	Mid 7	Mid 8	East 9	East 10	East 11	East 12	AMBIENT 1-6	AMBIENT 7-12
08/02/94	27.8	23.2	27.4	24.3	25.7	28.0	24.3	24.3	21.2	28.1	29.8	23.5	19.0	18.9
08/02/94	28.2	23.8	27.6	25.0	26.2	28.7	24.3	24.5	21.3	27.1	29.6	24.4	22.6	21.5
08/03/94	27.2	23.7	27.2	24.6	25.6	27.5	24.5	24.8	24.0	27.1	29.4	24.3	26.0	25.8
08/04/94	29.7	24.7	27.8	25.0	27.0	29.0	24.2	24.4	25.1	26.6	28.5	23.4	19.0	20.3
08/05/94	31.3	25.6	28.2	27.3	28.3	30.4	25.5	24.6	25.9	26.9	28.6	24.3	17.7	17.7
08/06/94	30.7	25.8	27.7	26.6	26.9	28.1	24.8	24.4	26.6	25.9	27.7	25.4	22.8	23.3
08/07/94	31.8	26.2	27.1	27.4	27.9	29.6	25.4	25.5	27.3	25.5	26.8	25.0	-	-
08/08/94	32.2	27.3	27.9	27.6	27.9	29.1	25.5	25.7	27.9	25.3	26.8	27.5	14.0	15.5
08/09/94	36.4	28.9	28.6	29.3	28.9	29.9	25.7	24.9	28.7	25.4	26.4	29.0	24.0	24.5
08/10/94	35.1	28.8	28.0	28.3	27.8	28.6	25.8	25.0	28.8	25.5	26.0	32.0	21.9	22.3
08/11/94	38.4	30.8	28.5	29.2	28.1	28.9	26.2	25.1	28.5	25.6	25.8	31.5	25.4	25.6
08/12/94	36.6	30.2	27.7	27.8	27.2	27.9	26.1	25.0	28.1	26.0	25.6	34.0	22.3	20.7
08/13/94	39.0	31.9	28.6	29.4	28.3	29.2	26.3	25.3	28.6	26.4	25.9	33.1	17.3	17.0
08/14/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/15/94	38.1	31.2	28.2	28.3	27.1	27.5	25.6	23.2	28.2	26.5	25.7	33.7	24.9	28.3
08/16/94	39.1	32.2	29.0	28.8	27.6	28.0	26.2	23.5	28.0	26.8	25.9	36.2	23.5	22.9
08/17/94	39.1	31.4	28.3	28.3	27.4	27.9	26.3	23.7	28.3	26.8	26.0	35.7	20.8	20.6
08/18/94	40.3	32.8	29.4	29.2	28.3	28.6	26.1	23.5	28.4	26.7	25.9	39.0	28.6	25.7
08/19/94	40.4	32.7	28.8	29.3	28.2	28.7	26.4	24.2	29.4	27.0	26.2	44.8	12.6	13.3
08/20/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/21/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/22/94	44.1	35.7	29.8	31.9	30.7	30.2	26.5	24.1	29.5	27.4	26.3	42.1	28.3	27.5
08/23/94	43.7	37.1	30.4	33.3	32.3	32.8	26.7	25.3	30.7	27.9	26.9	41.0	25.1	24.5
08/24/94	43.1	37.7	30.4	33.5	32.2	32.1	26.8	25.7	30.6	27.6	26.5	41.0	26.0	24.0
08/25/94	43.0	38.5	30.9	34.4	33.2	33.0	27.3	26.3	31.4	28.0	27.0	42.4	27.0	27.0
08/26/94	42.9	38.9	31.0	35.1	33.8	33.5	27.5	26.8	31.8	28.3	27.3	43.3	15.0	15.2
08/27/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/28/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/29/94	43.0	40.5	31.1	34.5	33.4	32.4	28.3	27.9	32.1	28.7	27.7	44.6	23.0	22.9
08/30/94	40.1	41.2	32.6	36.8	35.7	35.8	28.6	27.7	33.2	28.9	28.0	43.7	12.4	11.6
08/31/94	40.8	40.6	32.5	36.8	35.7	35.4	28.6	27.1	33.3	28.9	28.0	45.3	4.6	5.3
09/01/94	42.3	40.9	32.6	36.9	35.3	34.8	28.7	26.4	33.7	29.0	28.1	45.7	4.1	3.9
09/02/94	44.0	40.8	33.0	37.0	35.7	34.6	29.1	24.9	33.7	29.5	28.8	45.6	17.6	17.0
09/03/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/04/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/05/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/06/94	45.2	39.9	36.4	37.9	36.3	35.6	29.4	24.2	36.1	29.4	28.8	42.8	17.2	16.4
09/07/94	46.1	40.7	39.0	37.9	36.8	36.3	29.2	23.7	34.7	29.3	28.9	42.9	25.3	24.8
09/08/94	-	40.2	39.0	36.9	36.4	35.5	29.9	24.2	35.3	29.7	29.2	42.6	25.0	25.1
09/09/94	-	40.8	40.2	37.2	-	34.8	29.9	24.2	35.5	29.5	28.9	40.8	27.8	26.7
09/10/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/11/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/12/94	-	42.5	43.4	39.4	-	37.7	29.8	25.5	37.4	29.6	29.2	41.4	20.8	22.3
09/13/94	-	41.9	42.8	38.3	-	36.8	29.9	25.6	37.0	29.6	29.1	42.0	20.1	19.0
09/14/94	-	41.7	42.8	38.0	-	36.2	29.6	25.5	37.2	29.4	29.0	43.6	22.6	22.4
09/15/94	-	42.5	43.6	38.9	-	37.1	29.9	26.0	37.9	29.6	29.2	45.1	7.0	7.0
09/16/94	-	42.9	43.2	40.3	-	39.1	30.2	26.8	39.7	30.1	29.8	45.7	20.8	19.1
09/17/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/18/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/19/94	-	45.4	43.6	40.6	-	39.4	30.0	23.6	38.4	29.9	29.5	42.8	21.3	21.5
09/20/94	-	45.1	42.5	40.3	-	38.9	29.5	23.3	38.3	29.8	29.3	41.9	18.8	20.3
09/21/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/22/94	-	46.5	42.8	42.1	-	41.8	29.6	23.8	41.3	30.2	29.7	43.0	5.6	3.5
09/23/94	-	47.1	43.1	43.5	-	43.7	30.2	23.7	43.2	30.8	30.4	45.4	18.0	16.4
09/24/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/25/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/26/94	-	47.2	42.1	41.2	-	39.6	30.1	21.0	41.5	30.9	30.2	45.0	20.5	20.0
09/27/94	-	48.7	43.1	42.4	-	41.9	29.6	21.2	41.5	30.8	30.1	43.6	17.2	16.7
09/28/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/29/94	-	49.7	43.2	42.5	-	41.7	29.4	21.6	41.2	31.0	30.6	42.4	17.7	17.8

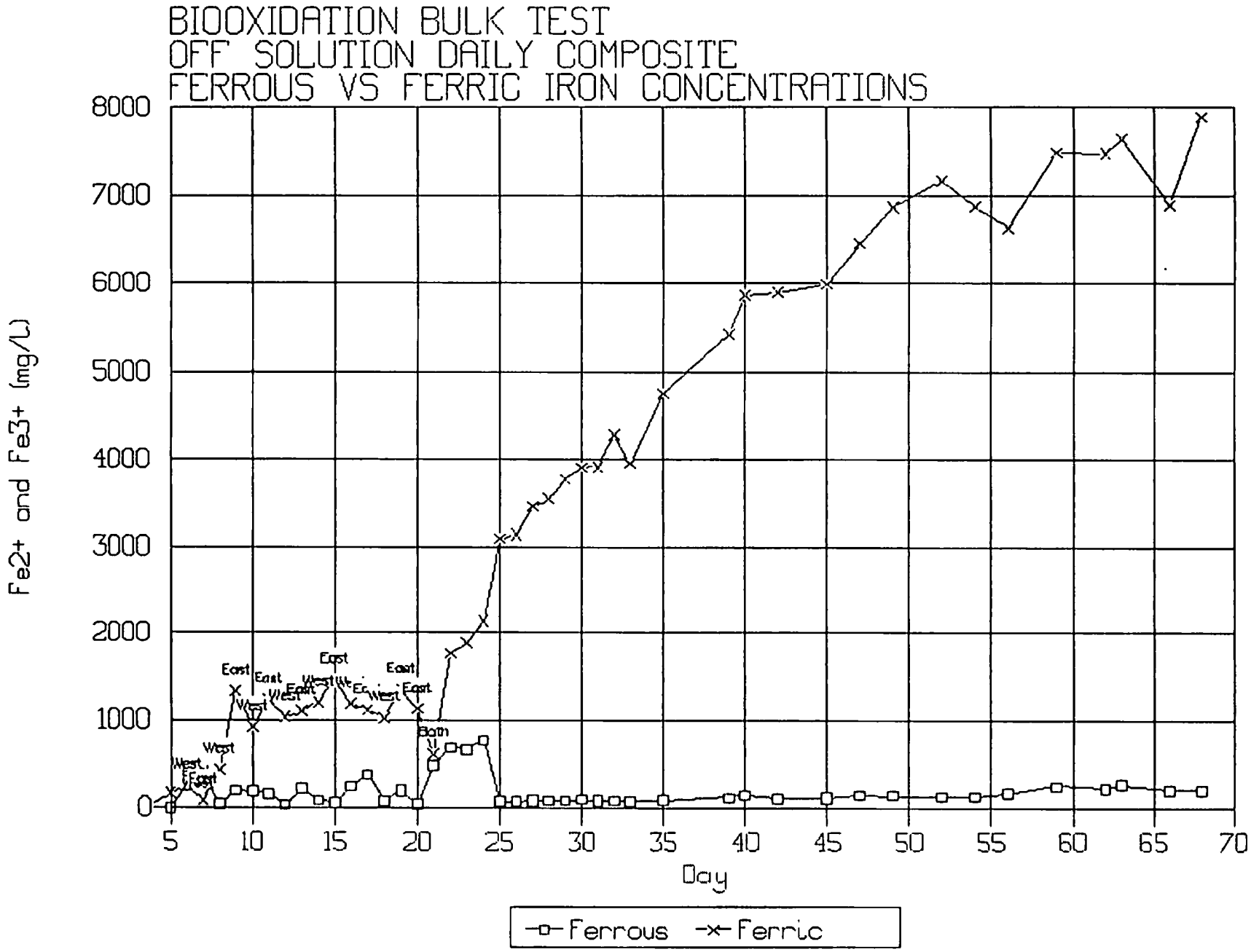
BIOOXIDATION BULK TEST THERMOCOUPLE DATA

Date	West 1	West 2	West 3	West 4	West 5	Mid 6	Mid 7	Mid 8	East 9	East 10	East 11	East 12	AMBIENT 1-6	AMBIENT 7-12
09/30/94	-	49.7	43.1	42.1	-	41.0	29.1	21.4	41.0	30.9	29.9	41.6	9.8	9.0
10/01/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/02/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/03/94	-	49.8	44.4	42.3	-	41.5	28.5	20.0	41.4	30.7	29.6	42.6	2.3	2.5
10/04/94	-	49.8	45.1	42.6	-	41.7	28.5	19.3	41.9	30.8	29.7	42.6	6.1	5.3
10/05/94	-	50.3	46.3	43.1	-	41.5	28.3	18.2	41.8	30.6	29.5	44.0	14.9	14.0
10/06/94	-	50.2	46.7	43.1	-	41.5	28.4	17.7	41.9	30.7	29.5	44.9	7.8	7.2

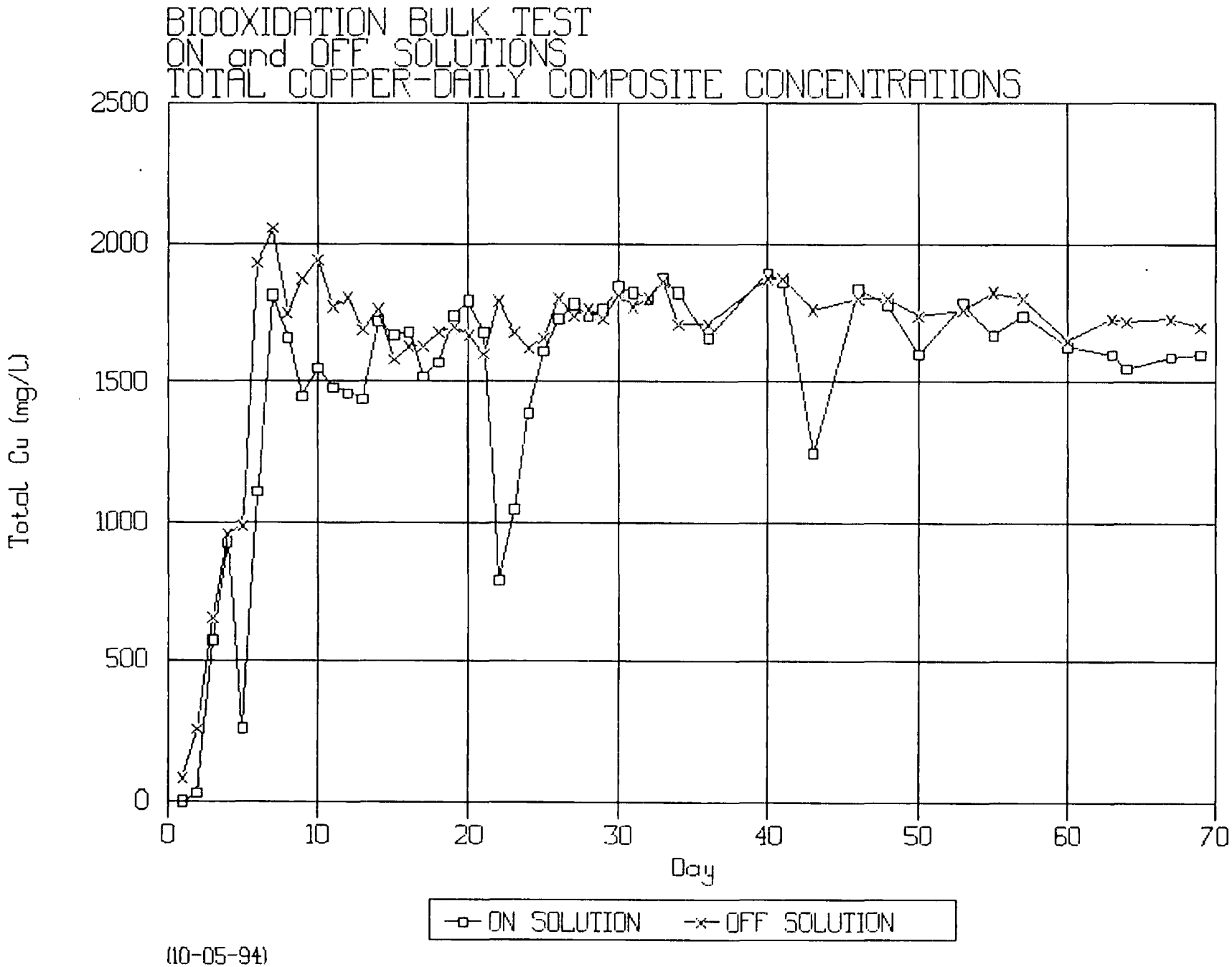

BIOOXIDATION BULK TEST
THERMOCOUPLE DATA
THERMOCOUPLES 1-6
Degree Centigrade
60
50
40
30
20
10
0
5
15
25
35
45
55
65
75
Day
1
2
3
4
5
6
AMBIENT 1-6
(10-06-94)

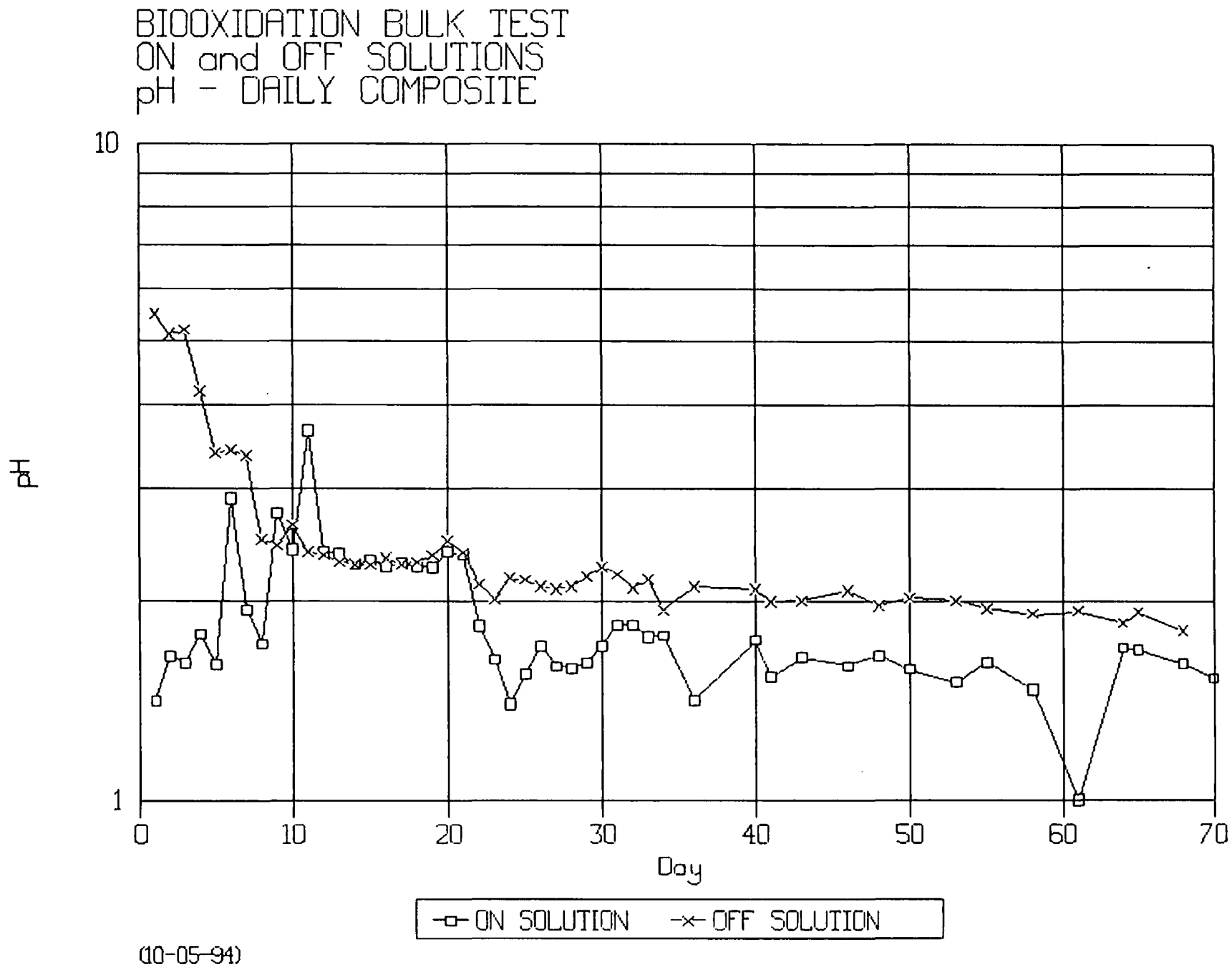

BIOOXIDATION BULK TEST
THERMOCOUPLE DATA
THERMOCOUPLES 7-12
Degree Centigrade
50
40
30
20
10
0
5
15
25
35
45
55
65
75
Day
7
8
9
10
11
12
AMBIENT 7-12
(10-06-94)

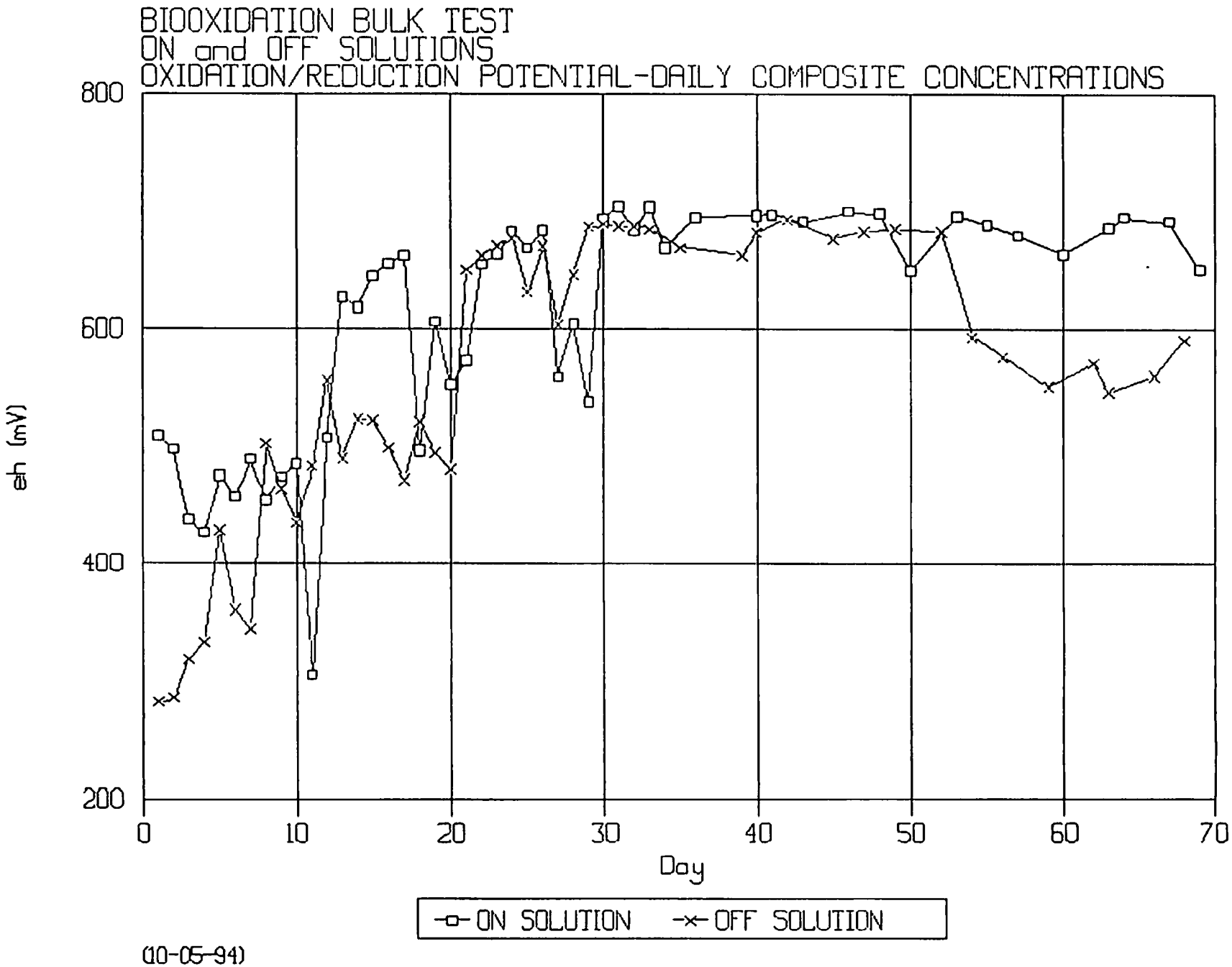

BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
TOTAL IRON-DAILY COMPOSITE CONCENTRATIONS
Total Fe (mg/L)
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
0
10
20
30
40
50
60
70
Day
ON SOLUTION
OFF SOLUTION
(10-05-94)


BIOOXIDATION BULK TEST
OFF SOLUTION DAILY COMPOSITE
FERROUS VS FERRIC IRON CONCENTRATIONS
Fe2+ and Fe3+ (mg/L)
8000
7000
6000
5000
4000
3000
2000
1000
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Day
West
East
Both
Ferrous
Ferric

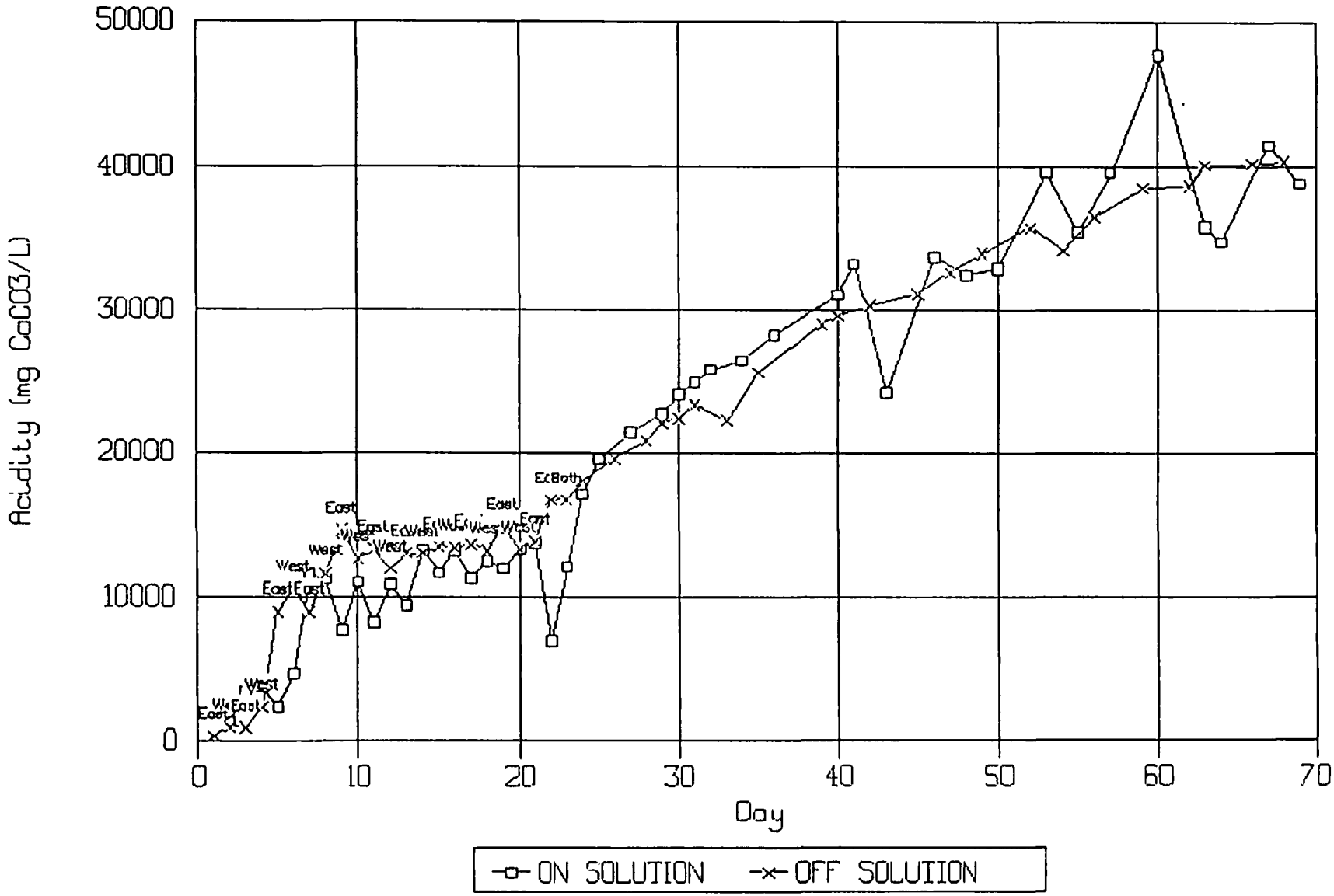
(10-05-94)


BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
TOTAL COPPER-DAILY COMPOSITE CONCENTRATIONS
Total Cu (mg/L)
2500
2000
1500
1000
500
0
0
10
20
30
40
50
60
70
Day
ON SOLUTION
OFF SOLUTION
(10-05-94)

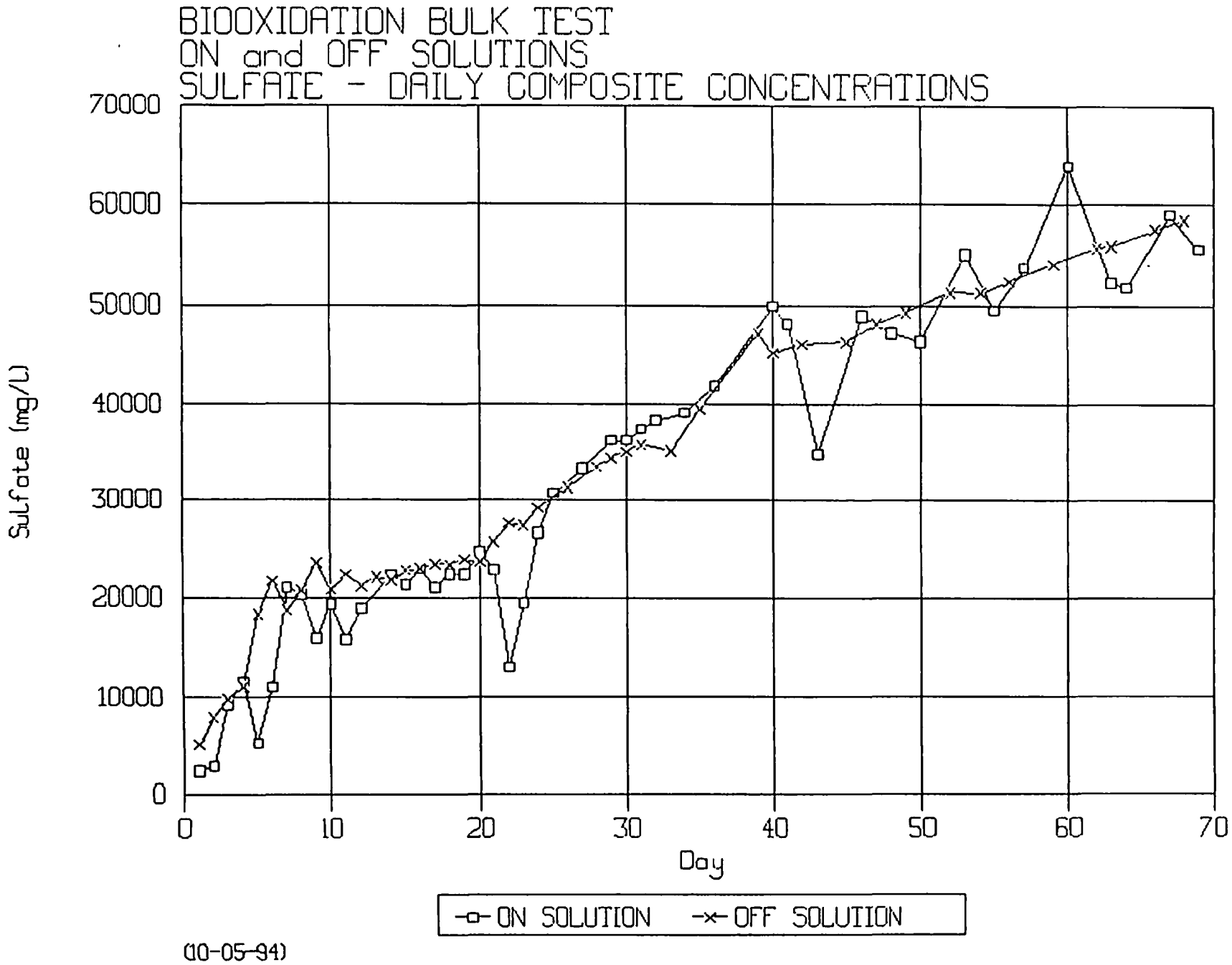

BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
pH - DAILY COMPOSITE
10
1
pH
0
10
20
30
40
50
60
70
Day
ON SOLUTION
OFF SOLUTION
(10-05-94)


BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
OXIDATION/REDUCTION POTENTIAL-DAILY COMPOSITE CONCENTRATIONS
800
600
400
200
eh (mV)
0
10
20
30
40
50
60
70
Day
ON SOLUTION
OFF SOLUTION
(10-05-94)

BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
ACIDITY TO pH 7-DAILY COMPOSITE CONCENTRATIONS



(10-05-94)


BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
SULFATE - DAILY COMPOSITE CONCENTRATIONS
Sulfate (mg/L)
70000
60000
50000
40000
30000
20000
10000
0
0
10
20
30
40
50
60
70
Day
ON SOLUTION
OFF SOLUTION
(10-05-94)

	SP-2 COMP 10% HCl Rinse	09/27/94 AUGER West 0'-5'	09/27/94 AUGER Mid 0'-5'	09/27/94 AUGER East 0'-5'	09/27/94 AUGER West 5'-10'	09/27/94 AUGER Mid 5'-10'	09/27/94 AUGER East 5'-10'	09/27/94 AUGER West 10'-15'	09/27/94 AUGER Mid 10'-15'	09/27/94 AUGER East 10'-15'
Fe	50792	60976	55678	57334	59173	62288	56608	58029	60927	58302
Cu	222	182	140	135	175	249	162	172	220	184
% Sulfur	4.65	5.47	5.40	5.10	5.77	5.72	5.11	5.26	5.71	5.34
% SO4	.65	1.01	.74	.74	.90	.79	.72	.73	.70	.80
% Sulfide	4.44	5.13	5.16	4.85	5.47	5.46	4.87	5.01	5.47	5.07

AUGER DRILL - 1

	08/23/94 Average 0'-5'	08/23/94 Average 5'-10'	08/23/94 Average 10'-15'	08/23/94 Average West	08/23/94 Average Mid	08/23/94 Average East
Fe	58525	63514	60682	62121	61695	58904
Cu	193	196	161	180	230	139
% Sulfur	5.51	5.81	5.52	5.71	5.73	5.39
% SO4	.66	.59	.56	.57	.69	.55
% Sulfide	5.29	5.61	5.33	5.52	5.50	5.21

AUGER DRILL - 2

	09/27/94 Average 1'-5'	09/27/94 Average 5'-10'	09/27/94 Average 10'-15'	09/27/94 Average West	09/27/94 Average Mid	09/27/94 Average East
Fe	57996	59356	59086	59393	59631	57415
Cu	152	195	192	176	203	160
% Sulfur	5.32	5.53	5.44	5.50	5.61	5.18
% SO4	.83	.80	.74	.88	.74	.75
% Sulfide	5.05	5.27	5.18	5.20	5.36	4.93

* All intervals are measured from the TOP of the heap

MEMORANDUM

DATE: SEPTEMBER 30, 1994
TO: JIM THOMPSON
FROM: LAURA DAMON
SUBJECT: BIOOXIDATION BULK TEST (BBT) WEEKLY UPDATE (9)

The BBT has been on the biooxidation cycle for nine weeks now. Both the west and east sides are on simultaneous solution application. The ON solution application rate has averaged 4.8 gpm this week while the OFF solution return rate has averaged 5.6 gpm.

There was no conference call this week due to safety training meetings.

The limestone pool tank neutralization circuit is providing enough acidity control to use the screw feeder system as a polishing step. This system is proving adequate. 53,638 gallons have been neutralized to date with 100,000 total gallons being the treatment goal.

Sulfuric acid is still being added to the ON solution to maintain an ON pH of 1.5 in order to reduce the internal pH of the heap and aid in the biooxidation process. The OFF solution's pH has dropped below the 2.0 range this week. Lysimeter data still suggest the internal pH is slightly lower.

The OFF solution total iron concentration has risen to 7900 ppm this week. It continues to be predominantly in the form of ferric iron. The oxidation/reduction potential dropped to an eh range of 550-600 but the sulfate concentration continues to rise as does the acidity. These analyses indicate that the BBT continues to biooxidize. The heap was drilled on September 27th and results should be available during the week of October 3rd.

To clarify GEM2 bottle roll results reported last week, the GEM2 sample was from Geobiotics laboratory column tests which was 60% biooxidized based on sulfur analysis. The ore is not from the ore placed in the BBT heap. The bottle rolls were done at Brohm to compare procedures and results with Geobiotics. Duplicate bottle rolls achieved 75.5% and 78.0% gold extraction in 96 hours. This compares with 82.0% and 85.3% gold extraction from Geobiotics bottle rolls run on the same ore.

c: Rod MacLeod
Martin Quick
Herb Osborne

BIOOXIDATION BULK TEST SOLUTION SAMPLING

ON SOLUTION

Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)
Orofino	7/21-9/29		(91000)	7.91	337.4	.01	1.35	-	-	-	107
	7/21-7/28	19741	19741								
GRAB-1530	07/27/94	?	19741	1.94	516.2	1.26	3.0	-	-	-	-
GRAB	07/28/94	?	19741	1.20	555.3	.16	7.8	-	-	3042	3411
COMP	07/28/94	?	19741	1.41	510.8	.10	21.6	-	-	1924	2420
COMP	07/29/94	9542	29283	1.65	498.3	29	45.0	4.1	40.9	1416	3012
COMP	07/30/94	5504	34787	1.61	438.4	574	38.0	2.2	35.8	3442	9230
COMP	07/31/94	975	35762	1.78	426.7	930	51.0	2.3	48.7	3823	11575
COMP	08/01/94	21302	57063	1.60	475.9	260	33.0	1.3	31.7	2394	5238
COMP	08/02/94	18970	76034	2.89	458.4	1110	155	71	84	4705	10999
COMP	08/03/94	16238	92272	1.94	490.0	1810	710	130	580	11581	20982
COMP	08/04/94	12021	104293	1.72	455.8	1660	660	340	320	11167	20349
COMP	08/05/94	16734	121027	2.75	475.1	1450	260	40	220	7673	15888
COMP	08/06/94	16466	137492	2.41	486.8	1550	1030	60	970	11012	19332
COMP	08/07/94	16466	153958	3.66	304.8	1480	530	60	470	8191	15810
COMP	08/08/94	16502	170460	2.40	507.9	1460	1170	110	1060	10820	18867
COMP	08/09/94	16103	186563	2.38	627.5	1440	790	25	765	9380	-
COMP	08/10/94	15624	202187	2.28	618.1	1720	1680	63	1617	13218	22369
COMP	08/11/94	16113	218300	2.33	645.4	1670	1250	33	1217	11657	21262
COMP	08/12/94	14762	233062	2.27	656.2	1680	1510	146	1364	13205	22874
COMP	08/13/94	13785	246847	2.30	663.0	1520	950	41	909	11254	21036
COMP	08/14/94	10979	257826	2.27	497.5	1570	1380	229	1151	12451	22331
COMP	08/15/94	10129	267955	2.26	606.6	1740	750	53	697	11956	22333
COMP	08/16/94	6178	274133	2.40	553.1	1790	970	51	919	13257	24698
COMP	08/17/94	6444	280577	2.36	573.3	1680	860	171	689	13713	22929
COMP	08/18/94	7205	287782	1.83	655.6	790	490	170	320	6959	12987
COMP	08/19/94	12447	300229	1.63	664.1	1050	1480	440	1040	12007	19505
COMP	08/20/94	15338	315567	1.39	683.9	1390	2190	610	1580	17135	26608
COMP	08/21/94	12497	328064	1.55	669.8	1610	2660	710	1950	19555	30681
COMP	08/22/94	11793	339857	1.71	684.8	1730	3270	75	3195	-	-
COMP	08/23/94	12099	351956	1.59	560.0	1780	3310	123	3187	21399	33274
COMP	08/24/94	11183	363139	1.58	604.9	1740	3480	82	3398	-	-
COMP	08/25/94	11114	374253	1.61	538.6	1760	3960	230	3730	22733	36228
COMP	08/26/94	9502	383755	1.71	694.7	1840	4040	94	3946	24028	36237
COMP	08/27/94	9144	392899	1.84	705.2	1820	4370	99	4271	24868	37372
COMP	08/28/94	8493	401392	1.84	684.4	1800	4380	99	4281	25735	38352
COMP	08/29/94	8859	410251	1.76	704.1	1870	4570	86	4484	-	-
COMP	08/30/94	7349	417600	1.77	669.5	1820	4450	84	4366	26418	39084
COMP	08/31/94	8940	426540	-	-	-	-	-	0	-	-
COMP	09/01/94	8784	435324	1.41	695.6	1660	4660	94	4566	28282	41981
COMP	09/02/94	5757	441081	-	-	-	-	-	0	-	-
COMP	09/03/94	7779	448860	-	-	-	-	-	0	-	-
COMP	09/04/94	7563	456423	-	-	-	-	-	0	-	-
COMP	09/05/94	6512	462935	1.74	697.0	1890	5820	127	5693	31066	49890
COMP	09/06/94	5907	468842	1.53	698.3	1860	6000	138	5862	33298	48170
COMP	09/07/94	6074	474916	-	-	-	-	-	0	-	-
COMP	09/08/94	8632	483548	1.64	691.8	1250	4410	86	4324	24133	34862
COMP	09/09/94	9369	492917	-	-	-	-	-	0	-	-
COMP	09/10/94	6460	499377	-	-	-	-	-	0	-	-
COMP	09/11/94	6460	505837	1.59	700.2	1830	6300	114	6186	33773	48927
COMP	09/12/94	6004	511841	-	-	-	-	-	0	-	-
COMP	09/13/94	7143	518984	1.65	698.8	1780	5700	127	5573	32506	47216
COMP	09/14/94	8045	527029	-	-	-	-	-	0	-	-
COMP	09/15/94	10057	537086	1.57	649.7	1600	6000	117	5883	32933	46360
COMP	09/16/94	10719	547805	-	-	-	-	-	0	-	-
COMP	09/17/94	9886	557691	-	-	-	-	-	0	-	-
COMP	09/18/94	8902	566593	1.50	697.1	1780	7600	102	7498	39646	55042

BIOOXIDATION BULK TEST SOLUTION SAMPLING

ON SOLUTION

Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)
COMP	09/20/94	3226	575366	1.61	689.3	1670	6800	138	6662	35523	49528
COMP	09/21/94	4164	579530	-	-	-	-	-	0	-	-
COMP	09/22/94	3296	582826	1.46	680.5	1740	6700	151	6549	39570	53734
COMP	09/23/94	6300	589126	-	-	-	-	-	0	-	-
COMP	09/24/94	8519	597645	-	-	-	-	-	0	-	-
COMP	09/25/94	7928	605573	1.00	664.8	1630	7630	146	7484	47665	63889
COMP	09/26/94	6189	611762	-	-	-	-	-	0	-	-
COMP	09/27/94	6154	617916	-	-	-	-	-	0	-	-
COMP	09/28/94	5684	623600	1.69	686.9	1600	7000	138	6862	35900	52293
COMP	09/29/94	7387	630987	1.68	695.5	1550	6900	120	6780	34862	

BIOOXIDATION BULK TEST SOLUTION SAMPLING

OFF SOLUTION

Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	DO (ppm)
SUMP-GRAB	07/26/94	1200	1200	7.22	-	.84	.27	-	-	-	-	-
GRAB-1530	07/27/94	1750	2950	7.53	305.4	.89	.20	-	-	-	-	-
COMP	07/28/94	3000	5950	5.93	353.6	83	.55	-	-	83	4411	-
COMP	07/29/94	3293	9243	5.49	282.1	255	13	-	-	362	5094	-
COMP	07/30/94	4419	13662	5.11	285.7	654	14	-	-	994	7913	-
COMP	07/31/94	2688	16350	5.18	318.8	960	11	-	-	956	9835	-
COMP	08/01/94	7822	24172	4.20	332.3	990	39	1	38	2438	11106	-
COMP	08/02/94	21836	46008	3.39	429.6	1930	172	2	170	8960	18304	-
COMP	08/03/94	14710	60718	3.43	360.1	2050	520	260	260	10520	21678	-
COMP	08/04/94	7500	68218	3.36	344.2	1750	500	410	90	8967	18731	-
COMP	08/05/94	6821	75039	2.50	503.7	1870	480	40	440	11633	20711	-
COMP	08/06/94	21396	96436	2.45	465.2	1940	1530	200	1330	14570	23591	-
COMP	08/07/94	21396	117832	2.63	435.8	1770	1110	190	920	12617	20727	-
COMP	08/08/94	18698	136530	2.40	484.6	1800	1390	160	1230	13259	22299	-
COMP	08/09/94	21118	157648	2.36	557.4	1690	1070	36	1034	11904	21180	-
COMP	08/10/94	16419	174067	2.31	491.4	1760	1320	220	1100	12958	22052	-
COMP	08/11/94	16500	190567	2.29	524.4	1580	1290	86	1204	12958	21764	-
COMP	08/12/94	18213	208780	2.28	523.1	1630	1520	56	1464	13452	22729	1.3
COMP	08/13/94	18585	227365	2.34	500.2	1630	1420	240	1180	13361	22995	1.3
COMP	08/14/94	16646	244011	2.29	472.4	1680	1490	380	1110	13608	23458	-
COMP	08/15/94	13559	257570	2.31	522.4	1700	1110	84	1026	13179	23381	-
COMP	08/16/94	12267	269837	2.36	496.4	1670	1540	196	1344	14831	23933	1.4
COMP	08/17/94	7697	277534	2.49	481.4	1600	1160	43	1117	13309	23711	2.2
COMP	08/18/94	7136	284670	2.39	650.1	1790	1100	480	620	13839	25735	1.7
COMP	08/19/94	13078	297748	2.13	663.0	1680	2450	690	1760	16703	27554	-
COMP	08/20/94	14479	312227	2.02	672.0	1620	2550	670	1880	16716	27464	-
COMP	08/21/94	14213	326440	2.18	678.3	1660	2900	770	2130	18024	29200	-
COMP	08/22/94	14246	340686	2.16	631.0	1800	3160	75	3085	-	-	-
COMP	08/23/94	13868	354554	2.11	671.3	1740	3210	73	3137	19568	31299	-
COMP	08/24/94	12742	367296	2.09	604.1	1760	3540	82	3458	-	-	.7
COMP	08/25/94	11741	379037	2.11	646.9	1730	3640	86	3554	20823	33471	5.5?
COMP	08/26/94	12505	391542	2.19	687.1	1810	3860	86	3774	22006	34443	OFL
COMP	08/27/94	11272	402814	2.27	689.5	1770	4000	94	3906	22374	35035	-
COMP	08/28/94	9000	411814	2.21	688.0	1800	4000	82	3918	23319	35858	-
COMP	08/29/94	9000	420814	2.10	688.2	1860	4370	86	4284	-	-	OFL
COMP	08/30/94	11403	432217	2.17	685.5	1710	4030	84	3946	22242	35134	13.5?
COMP	08/31/94	10726	442943	-	-	-	-	-	-	-	-	OFL
COMP	09/01/94	10299	453242	1.94	669.9	1710	4840	89	4751	25577	39562	OFL
COMP	09/02/94	9075	462317	-	-	-	-	-	-	-	-	3.9
COMP	09/03/94	8149	470466	-	-	-	-	-	-	-	-	-
COMP	09/04/94	7612	478078	-	-	-	-	-	-	-	-	-
COMP	09/05/94	7357	485435	2.11	663.7	1870	5550	120	5430	29017	47141	-
COMP	09/06/94	6870	492305	2.09	682.9	1870	6010	151	5859	29543	45273	3.5
COMP	09/07/94	6503	498808	-	-	-	-	-	-	-	-	6.2
COMP	09/08/94	10447	509255	2.00	693.8	1760	6010	117	5893	30304	46121	5.5
COMP	09/09/94	8553	517808	-	-	-	-	-	-	-	-	5.5
COMP	09/10/94	8424	526232	-	-	-	-	-	-	-	-	-
COMP	09/11/94	8424	534656	2.01	677.7	1800	6100	114	5986	31157	46376	-
COMP	09/12/94	7258	541914	-	-	-	-	-	-	-	-	-
COMP	09/13/94	6630	548544	2.08	683.7	1800	6600	151	6449	32657	48154	2.8
COMP	09/14/94	7479	556023	-	-	-	-	-	-	-	-	2.6
COMP	09/15/94	11492	567515	1.97	685.6	1740	7000	142	6858	33989	49372	4.6
COMP	09/16/94	11244	578759	-	-	-	-	-	-	-	-	2.8
COMP	09/17/94	11287	590046	-	-	-	-	-	-	-	-	-
COMP	09/18/94	10435	600481	2.03	684.0	1760	7300	134	7166	35825	51363	-
COMP	09/19/94	9531	610012	-	-	-	-	-	-	-	-	2.5
COMP	09/20/94	6175	616187	2.01	593.5	1820	7000	134	6866	34241	51265	2.8

BIOOXIDATION BULK TEST SOLUTION SAMPLING

OFF SOLUTION

Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	DO (ppm)
COMP	09/22/94	5238	626486	1.95	576.7	1800	6800	171	6629	36579	52376	3.5
COMP	09/23/94	6073	632559	-	-	-	-	-	-	-	-	3.2
COMP	09/24/94	9286	641845	-	-	-	-	-	-	-	-	-
COMP	09/25/94	9592	651437	1.91	552.0	1650	7730	250	7480	38565	54096	-
COMP	09/26/94	7385	658822	-	-	-	-	-	-	-	-	2.8
COMP	09/27/94	9119	667941	-	-	-	-	-	-	-	-	3.5
COMP	09/28/94	7789	675730	1.93	571.8	1730	7700	230	7470	38690	55742	-
COMP	09/29/94	7387	683117	1.85	547.2	1720	7900	270	7630	40150		-

BIOOXIDATION BULK TEST SOLUTION SAMPLING

PAN LYSIMETER 3

Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO (ppm)
GRAB	08/03/94	1.93	488.4	1540	4640	1200	3440	20005	23896	-	
GRAB	08/11/94	1.52	496.1	3200	8700	2900	5800	-	-	Brown/Murky	
GRAB	08/12/94	1.89	450.4	2200	3900	2100	1800	-	27461	Lt Brown	1.5
GRAB	08/15/94	1.92	459.5	2170	3920	1270	2650	15417	27625	Med Brown	1.7
GRAB	08/17/94	1.97	462.7	1940	3220	560	2660	19502	25159	Med Brown	2.4
GRAB	08/19/94	2.00	458.4	1850	2300	1400	900	17828	23604	-	-
GRAB	08/22/94	1.90	464.0	1760	2300	360	1940	16677	23744	Grw/Br Ti	1.9
GRAB	08/24/94	2.04	468.5	1780	2680	770	1910	16795	23028	Green	.9
GRAB	08/26/94	2.05	479.6	1730	2700	690	2010	17030	24320	Br-Yel	4.5?
GRAB	08/29/94	2.08	472.8	1770	2760	360	2400	17936	25167	Yel-Br	OFL
GRAB	09/01/94	1.79	472.3	1870	2730	730	2000	19039	26822	Green	OFL
GRAB	09/06/94	1.83	492.1	1940	2620	210	2410	19748	30237	Lt Green	2.5
GRAB	09/08/94	1.80	488.8	1980	2870	300	2570	21454	30435	Dk Green	4.3
GRAB	09/13/94	1.68	499.7	2040	3310	510	2800	22662	32648	Gr;cldy	0.9
GRAB	09/20/94	1.66	494.8	2000	3930	300	3630	24512	33471	Lt Green	1.4
GRAB	09/22/94	1.56	481.2	1980	4250	770	3480	26724	34796	Gr-Br	1.6
GRAB	09/27/94	1.66	487.7	1920	3820	460	3360	24512	34253	Gr;cldy	1.8
GRAB	09/29/94	1.73	498.0	2070	3820	460	3360	25972	37735	Green	2.3

PAN LYSIMETER 4

Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO (ppm)
GRAB	08/11/94	2.62	526.3	55	87	-	-	-	-	Flush H2O	-
GRAB	08/12/94	2.06	560.0	567	1260	67	1193	5282	6801	Lt Brown	4.8
GRAB	08/15/94	1.87	671.9	1260	2920	105	2815	14311	17681	Lt Brown	2.9
GRAB	08/17/94	1.71	687.2	1610	3670	102	3568	19528	23875	Med Brown	2.9
GRAB	08/19/94	1.79	659.6	1790	2900	900	2000	19280	24583	-	-
GRAB	08/22/94	1.86	615.3	1720	2000	73	1927	16285	23809	Gr-Brown	3.2
GRAB	08/24/94	1.78	678.6	1770	2420	60	2360	16481	24196	Green	OFL
GRAB	08/26/94	1.80	601.2	1710	2450	75	2375	16742	25126	Lt Gr-Yel	OFL
GRAB	08/29/94	1.92	681.5	1710	2340	60	2280	17279	26073	Lt Green	OFL
GRAB	09/01/94	1.61	698.7	1700	2380	61	2319	17647	26443	Lt Green	OFL
GRAB	09/06/94	1.75	628.7	1700	2520	71	2449	18881	29768	Lt Green	3.5
GRAB	09/08/94	1.79	681.5	1710	2710	75	2635	20168	29817	Green	4.0
GRAB	09/13/94	1.68	570.2	1780	3540	114	3426	23765	34755	Green	3.5
GRAB	09/20/94	1.63	576.6	1880	4730	123	4607	28408	40117	Yellow	4.0
GRAB	09/22/94	1.52	595.7	1910	5620	146	5474	33612	44878	Lt Green	5.9
GRAB	09/27/94	1.60	612.7	1910	6060	142	5918	34291	48006	Yellow	5.0
GRAB	09/29/94	1.56	590.0	1930	6420	151	6269	37169	49783	Brown	4.1

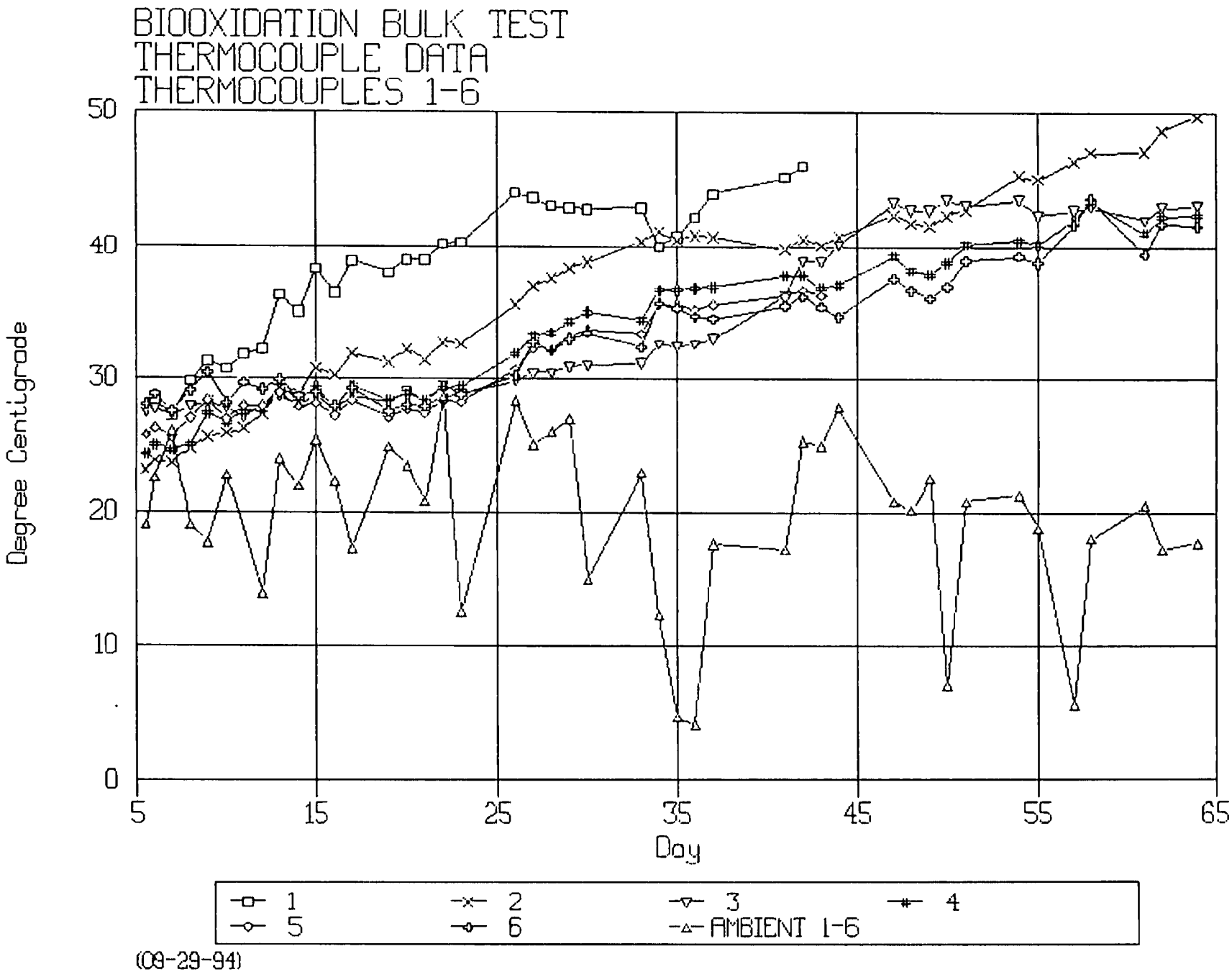
BIOOXIDATION BULK TEST SOLUTION SAMPLING

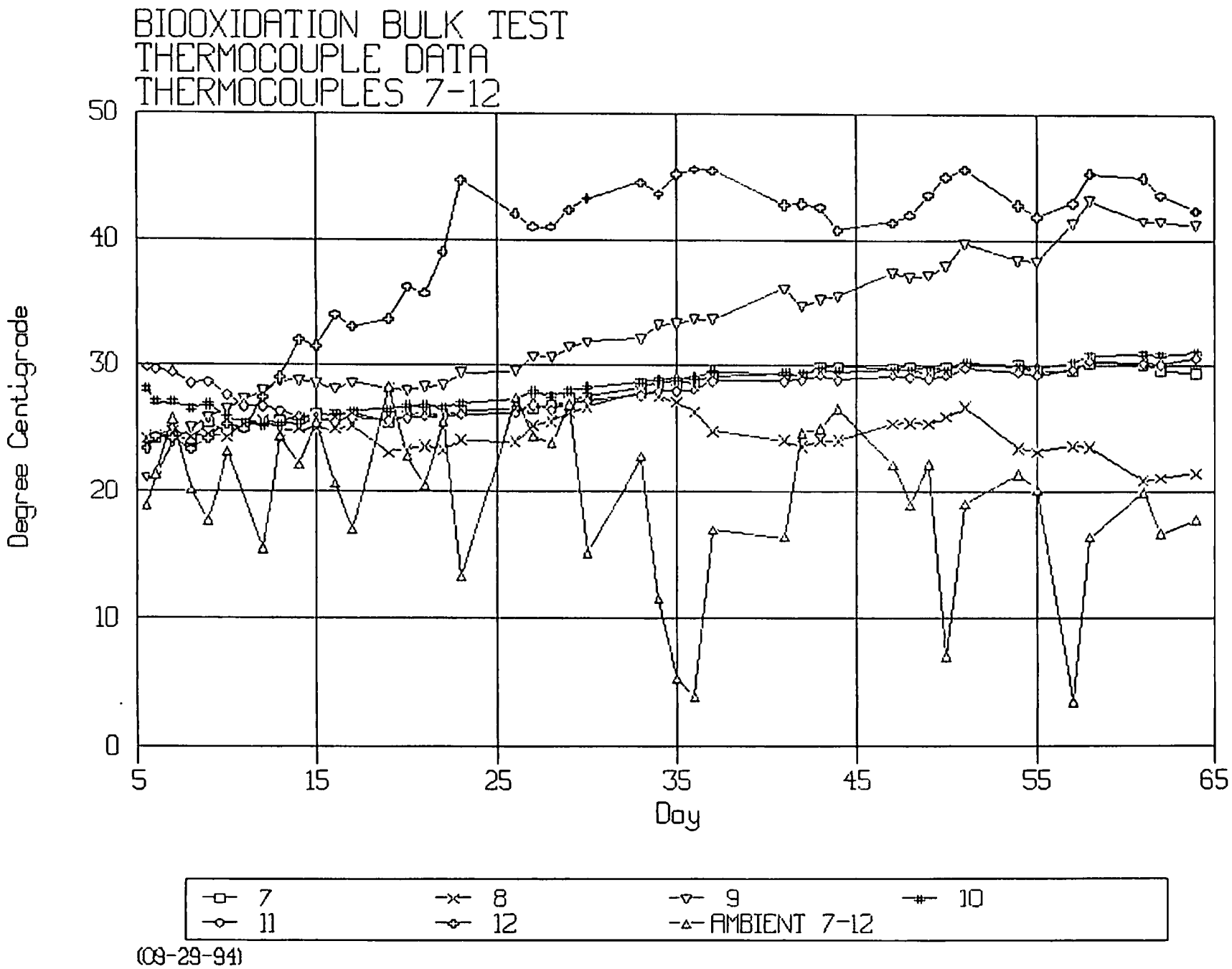
PAN LYSIMETER 5

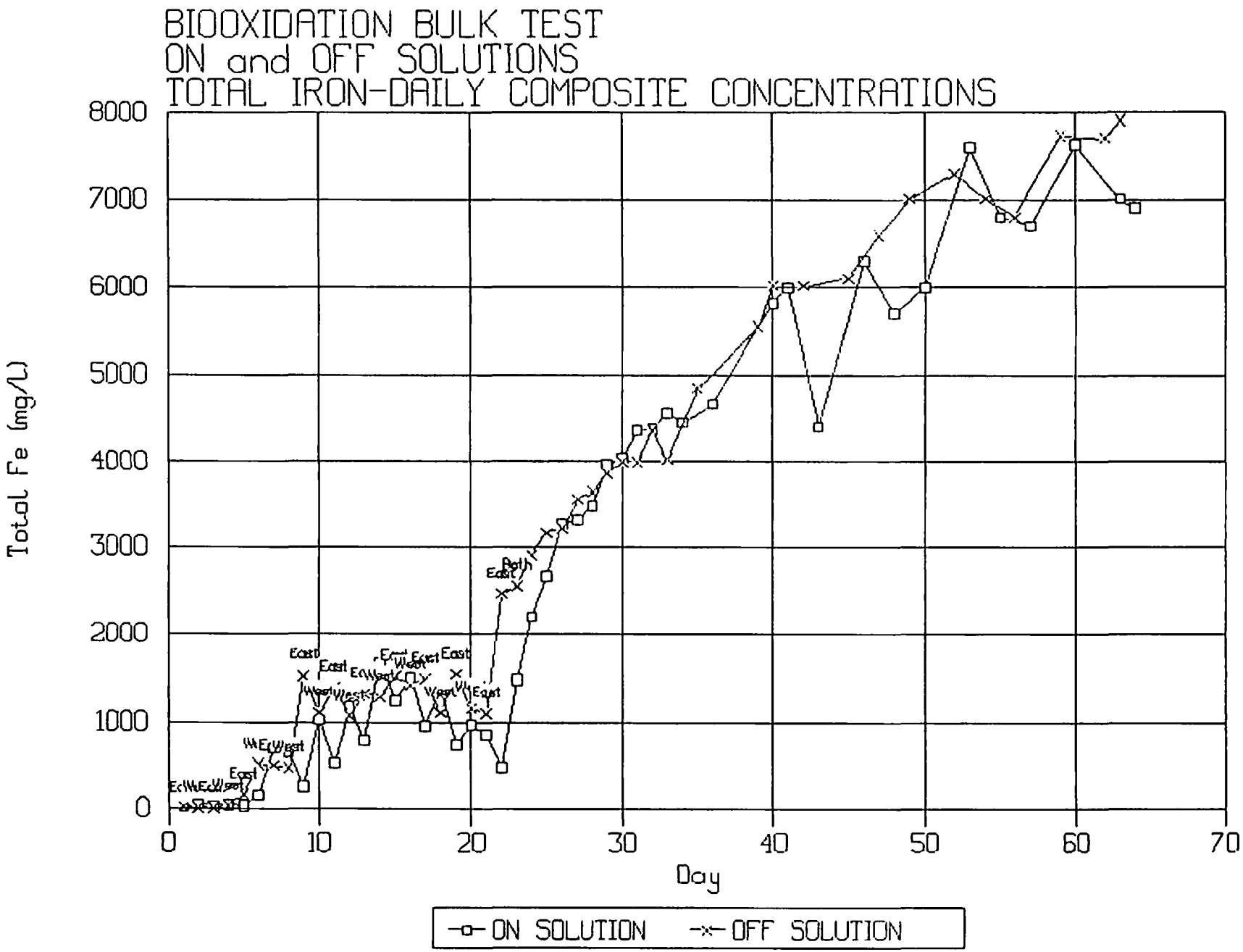
Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO (ppm)
GRAB	08/03/94	1.49	515.6	3690	17700	2100	15600	57687	66622	Dark Brown	-
GRAB	08/04/94	1.32	511.1	3930	14100	1600	12500	60119	67556	Dark Brown	-
GRAB	08/09/94	1.70	484.5	2600	4500	1400	3100	28440	38389	Dark Brown	-
GRAB	08/10/94	2.37	574.1	1740	990	36	954	11468	23641	Off Soln Flush	
GRAB	08/11/94	1.72	431.8	2000	3700	3400	300	-	-	Green Color	-
GRAB	08/12/94	1.80	439.7	2000	3900	2900	1000	20048	24627	Lt Green	3.7
GRAB	08/15/94	1.88	361.1	1940	3940	2200	1740	20543	24800	Green	2.6
GRAB	08/17/94	1.88	415.7	2030	4800	3700	1100	23073	27307	Green	2.7
GRAB	08/19/94	1.87	418.5	2170	4100	4000	100	21647	27324	-	-
GRAB	08/22/94	2.26	437.3	1920	2800	2300	500	18260	24542	Yel-Br	2.1
GRAB	08/24/94	2.12	385.4	1880	3250	2900	350	17056	25184	Lt Gr/Blue	OFL
GRAB	08/26/94	2.39	414.8	1780	3270	2290	980	16428	24641	Yel-Gr;odor	OFL
GRAB	08/29/94	2.47	402.7	1730	3260	2110	1150	16623	24698	Lt Green	OFL
GRAB	09/01/94	2.28	492.3	1700	2600	480	2120	16360	24254	Yel-Br;odor	OFL
GRAB	09/06/94	2.30	386.7	1520	3010	1830	1180	16097	25933	Bl-Gr;odor	2.5
GRAB	09/08/94	2.36	465.2	1480	2490	430	2060	16202	24534	Lt Br;ppt	4.3
GRAB	09/13/94	2.32	389.7	1170	3250	3700	-450	16019	25019	Lt Green	0.9
GRAB	09/20/94	2.30	386.7	1110	2470	2600	-130	15185	23797	Lt Green	1.8
GRAB	09/22/94	2.23	417.6	1110	2320	2000	320	15888	24163	Lt Green	2.8
GRAB	09/27/94	2.17	563.9	1110	1650	700	950	16416	24270	Lt Brown	2.8
GRAB	09/29/94	2.19	500.5	1280	1950	200	1750	13841	25834	Brown	2.8

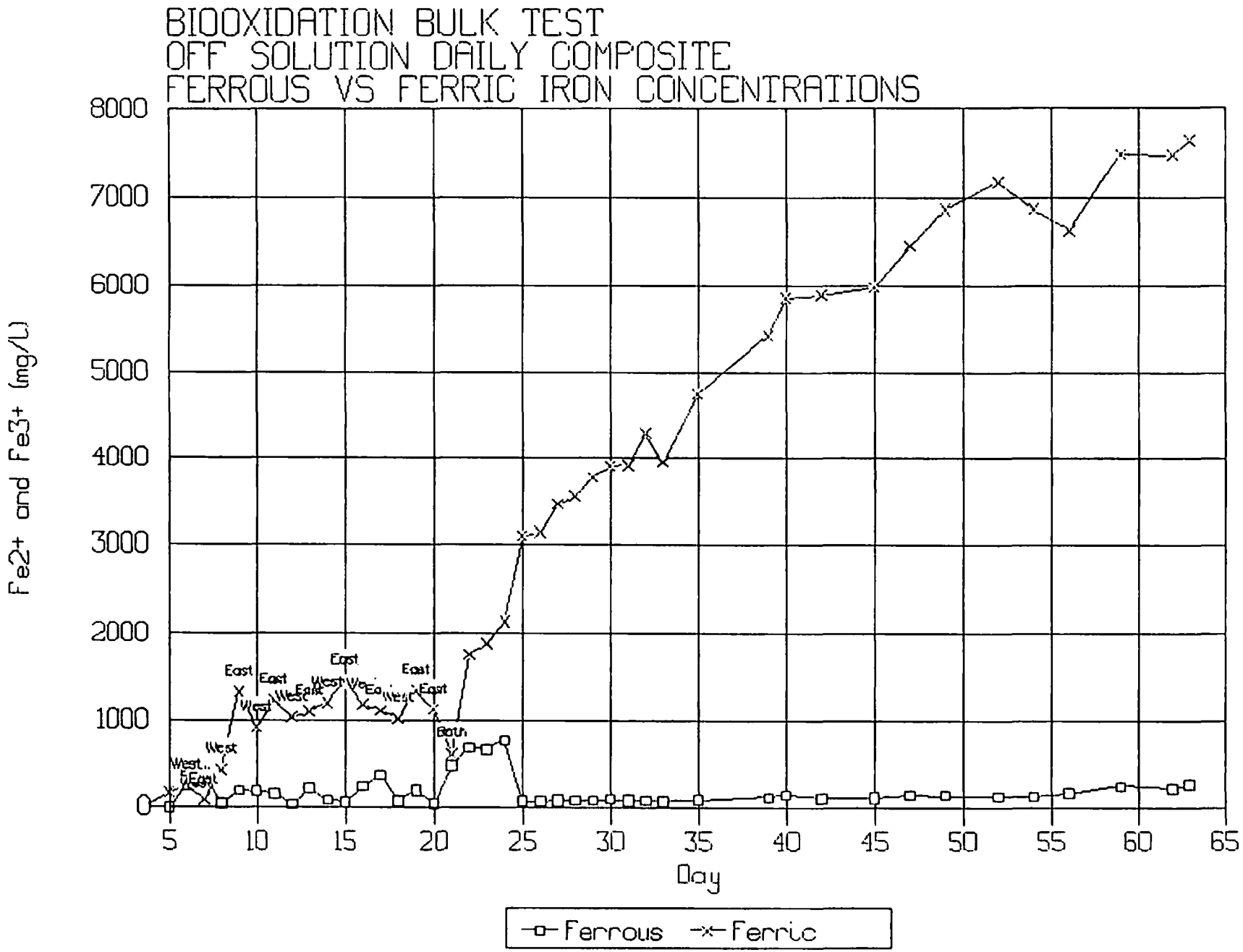
BIOOXIDATION BULK TEST THERMOCOUPLE DATA

Date	West 1	West 2	West 3	West 4	West 5	Mid 6	Mid 7	Mid 8	East 9	East 10	East 11	East 12	AMBIENT 1-6	AMBIENT 7-12
08/02/94	27.8	23.2	27.4	24.3	25.7	28.0	24.3	24.3	21.2	28.1	29.8	23.5	19.0	18.9
08/02/94	28.2	23.8	27.6	25.0	26.2	28.7	24.3	24.5	21.3	27.1	29.6	24.4	22.6	21.5
08/03/94	27.2	23.7	27.2	24.6	25.6	27.5	24.5	24.8	24.0	27.1	29.4	24.3	26.0	25.8
08/04/94	29.7	24.7	27.8	25.0	27.0	29.0	24.2	24.4	25.1	26.6	28.5	23.4	19.0	20.3
08/05/94	31.3	25.6	28.2	27.3	28.3	30.4	25.5	24.6	25.9	26.9	28.6	24.3	17.7	17.7
08/06/94	30.7	25.8	27.7	26.6	26.9	28.1	24.8	24.4	26.6	25.9	27.7	25.4	22.8	23.3
08/07/94	31.8	26.2	27.1	27.4	27.9	29.6	25.4	25.5	27.3	25.5	26.8	25.0	-	-
08/08/94	32.2	27.3	27.9	27.6	27.9	29.1	25.5	25.7	27.9	25.3	26.8	27.5	14.0	15.5
08/09/94	36.4	28.9	28.6	29.3	28.9	29.9	25.7	24.9	28.7	25.4	26.4	29.0	24.0	24.5
08/10/94	35.1	28.8	28.0	28.3	27.8	28.6	25.8	25.0	28.8	25.5	26.0	32.0	21.9	22.3
08/11/94	38.4	30.8	28.5	29.2	28.1	28.9	26.2	25.1	28.5	25.6	25.8	31.5	25.4	25.6
08/12/94	36.6	30.2	27.7	27.8	27.2	27.9	26.1	25.0	28.1	26.0	25.6	34.0	22.3	20.7
08/13/94	39.0	31.9	28.6	29.4	28.3	29.2	26.3	25.3	28.6	26.4	25.9	33.1	17.3	17.0
08/14/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/15/94	38.1	31.2	28.2	28.3	27.1	27.5	25.6	23.2	28.2	26.5	25.7	33.7	24.9	28.3
08/16/94	39.1	32.2	29.0	28.8	27.6	28.0	26.2	23.5	28.0	26.8	25.9	36.2	23.5	22.9
08/17/94	39.1	31.4	28.3	28.3	27.4	27.9	26.3	23.7	28.3	26.8	26.0	35.7	20.8	20.6
08/18/94	40.3	32.8	29.4	29.2	28.3	28.6	26.1	23.5	28.4	26.7	25.9	39.0	28.6	25.7
08/19/94	40.4	32.7	28.8	29.3	28.2	28.7	26.4	24.2	29.4	27.0	26.2	44.8	12.6	13.3
08/20/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/21/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/22/94	44.1	35.7	29.8	31.9	30.7	30.2	26.5	24.1	29.5	27.4	26.3	42.1	28.3	27.5
08/23/94	43.7	37.1	30.4	33.3	32.3	32.8	26.7	25.3	30.7	27.9	26.9	41.0	25.1	24.5
08/24/94	43.1	37.7	30.4	33.5	32.2	32.1	26.8	25.7	30.6	27.6	26.5	41.0	26.0	24.0
08/25/94	43.0	38.5	30.9	34.4	33.2	33.0	27.3	26.3	31.4	28.0	27.0	42.4	27.0	27.0
08/26/94	42.9	38.9	31.0	35.1	33.8	33.5	27.5	26.8	31.8	28.3	27.3	43.3	15.0	15.2
08/27/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/28/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/29/94	43.0	40.5	31.1	34.5	33.4	32.4	28.3	27.9	32.1	28.7	27.7	44.6	23.0	22.9
08/30/94	40.1	41.2	32.6	36.8	35.7	35.8	28.6	27.7	33.2	28.9	28.0	43.7	12.4	11.6
08/31/94	40.8	40.6	32.5	36.8	35.7	35.4	28.6	27.1	33.3	28.9	28.0	45.3	4.6	5.3
09/01/94	42.3	40.9	32.6	36.9	35.3	34.8	28.7	26.4	33.7	29.0	28.1	45.7	4.1	3.9
09/02/94	44.0	40.8	33.0	37.0	35.7	34.6	29.1	24.9	33.7	29.5	28.8	45.6	17.6	17.0
09/03/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/04/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/05/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/06/94	45.2	39.9	36.4	37.9	36.3	35.6	29.4	24.2	36.1	29.4	28.8	42.8	17.2	16.4
09/07/94	46.1	40.7	39.0	37.9	36.8	36.3	29.2	23.7	34.7	29.3	28.9	42.9	25.3	24.8
09/08/94	-	40.2	39.0	36.9	36.4	35.5	29.9	24.2	35.3	29.7	29.2	42.6	25.0	25.1
09/09/94	-	40.8	40.2	37.2	-	34.8	29.9	24.2	35.5	29.5	28.9	40.8	27.8	26.7
09/10/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/11/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/12/94	-	42.5	43.4	39.4	-	37.7	29.8	25.5	37.4	29.6	29.2	41.4	20.8	22.3
09/13/94	-	41.9	42.8	38.3	-	36.8	29.9	25.6	37.0	29.6	29.1	42.0	20.1	19.0
09/14/94	-	41.7	42.8	38.0	-	36.2	29.6	25.5	37.2	29.4	29.0	43.6	22.6	22.4
09/15/94	-	42.5	43.6	38.9	-	37.1	29.9	26.0	37.9	29.6	29.2	45.1	7.0	7.0
09/16/94	-	42.9	43.2	40.3	-	39.1	30.2	26.8	39.7	30.1	29.8	45.7	20.8	19.1
09/17/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/18/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/19/94	-	45.4	43.6	40.6	-	39.4	30.0	23.6	38.4	29.9	29.5	42.8	21.3	21.5
09/20/94	-	45.1	42.5	40.3	-	38.9	29.5	23.3	38.3	29.8	29.3	41.9	18.8	20.3
09/21/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/22/94	-	46.5	42.8	42.1	-	41.8	29.6	23.8	41.3	30.2	29.7	43.0	5.6	3.5
09/23/94	-	47.1	43.1	43.5	-	43.7	30.2	23.7	43.2	30.8	30.4	45.4	18.0	16.4
09/24/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/25/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/26/94	-	47.2	42.1	41.2	-	39.6	30.1	21.0	41.5	30.9	30.2	45.0	20.5	20.0
09/27/94	-	48.7	43.1	42.4	-	41.9	29.6	21.2	41.5	30.8	30.1	43.6	17.2	16.7
09/28/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/29/94	-	49.7	43.2	42.5	-	41.7	29.4	21.6	41.2	31.0	30.6	42.4	17.7	17.8

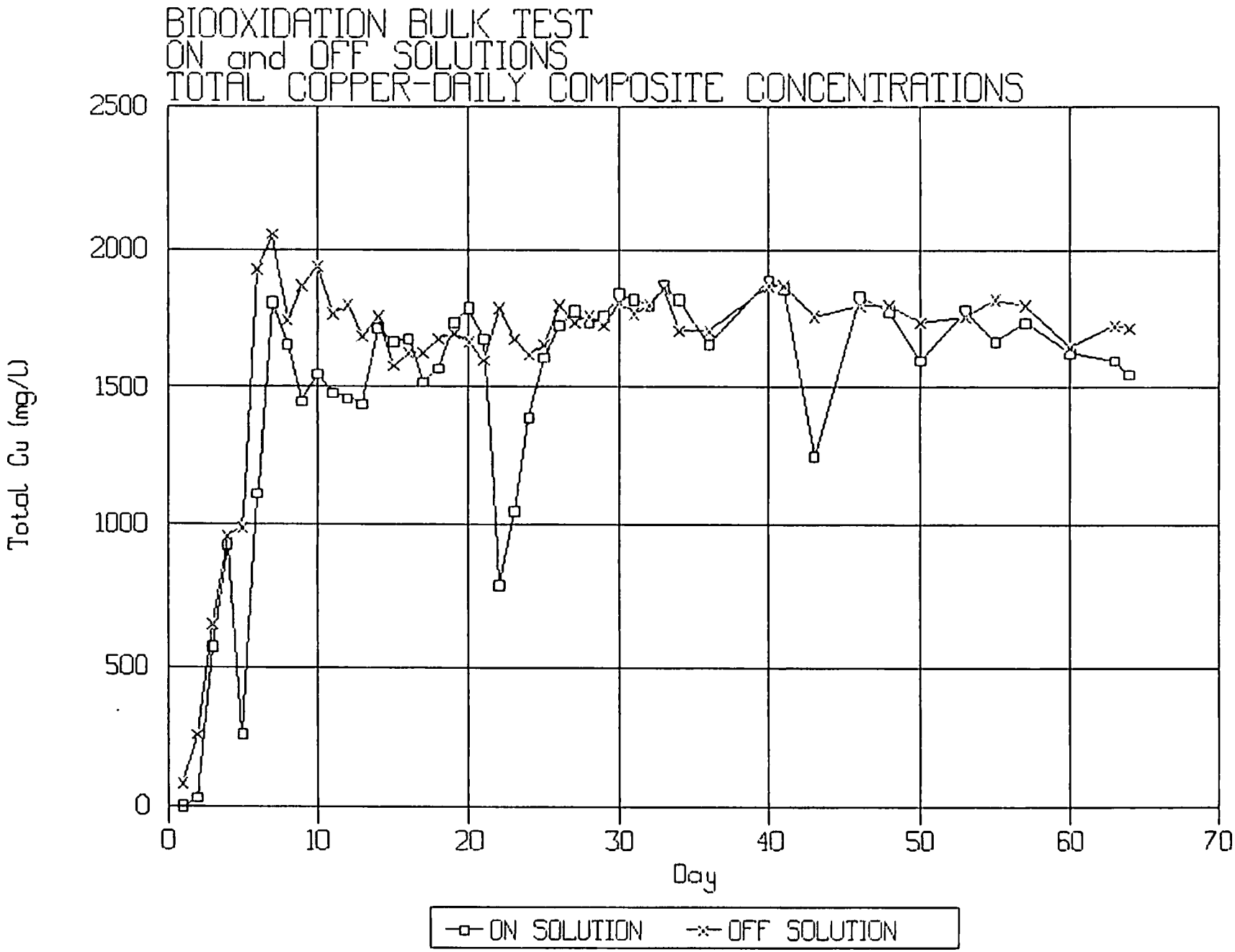

BIOOXIDATION BULK TEST
THERMOCOUPLE DATA
THERMOCOUPLES 1-6
Degree Centigrade
50
40
30
20
10
0
5
15
25
35
45
55
65
Day
1
2
3
4
5
6
AMBIENT 1-6
(09-29-94)


BIOOXIDATION BULK TEST
THERMOCOUPLE DATA
THERMOCOUPLES 7-12
Degree Centigrade
50
40
30
20
10
0
5
15
25
35
45
55
65
Day
7
8
9
10
11
12
AMBIENT 7-12
(09-29-94)

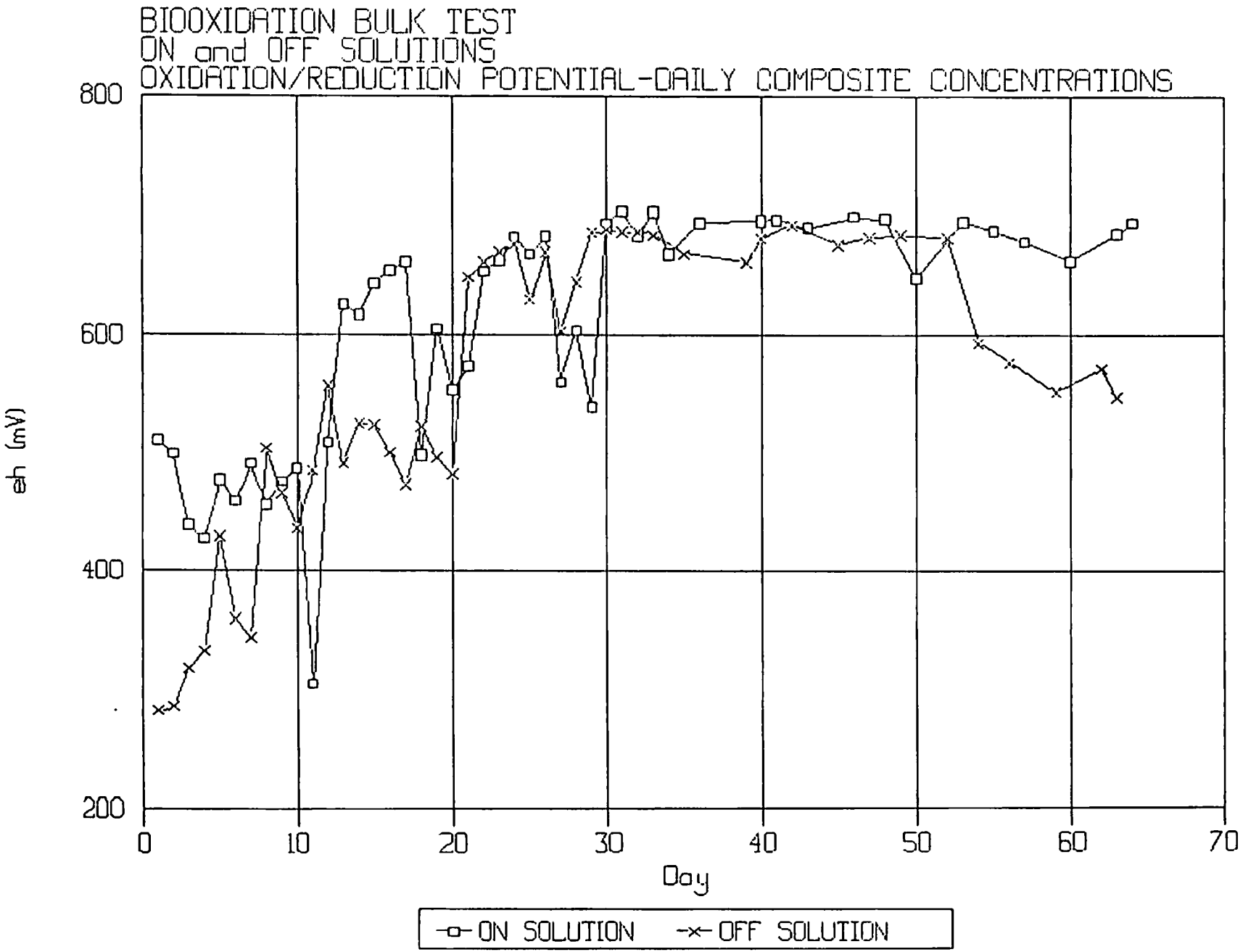

BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
TOTAL IRON-DAILY COMPOSITE CONCENTRATIONS
Total Fe (mg/L)
8000
7000
6000
5000
4000
3000
2000
1000
0
0
10
20
30
40
50
60
70
Day
ON SOLUTION
OFF SOLUTION
(09-29-94)


BIOOXIDATION BULK TEST
OFF SOLUTION DAILY COMPOSITE
FERROUS VS FERRIC IRON CONCENTRATIONS
Fe2+ and Fe3+ (mg/L)
8000
7000
6000
5000
4000
3000
2000
1000
0
5
10
15
20
25
30
35
40
45
50
55
60
65
Day
East
West
Both
Ferrous
Ferric

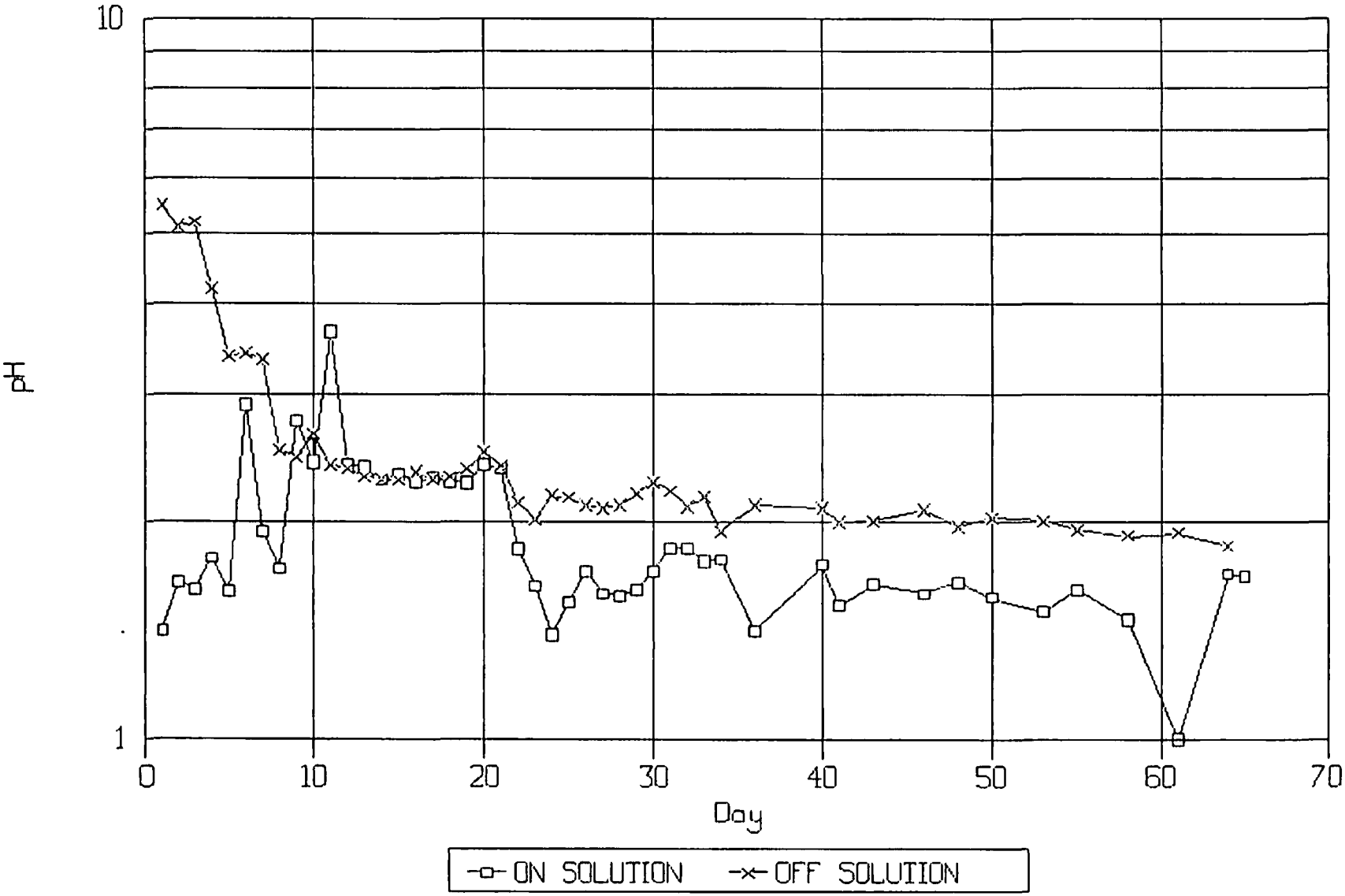
(09-29-94)


BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
TOTAL COPPER-DAILY COMPOSITE CONCENTRATIONS
Total Cu (mg/L)
2500
2000
1500
1000
500
0
0
10
20
30
40
50
60
70
Day
ON SOLUTION
OFF SOLUTION

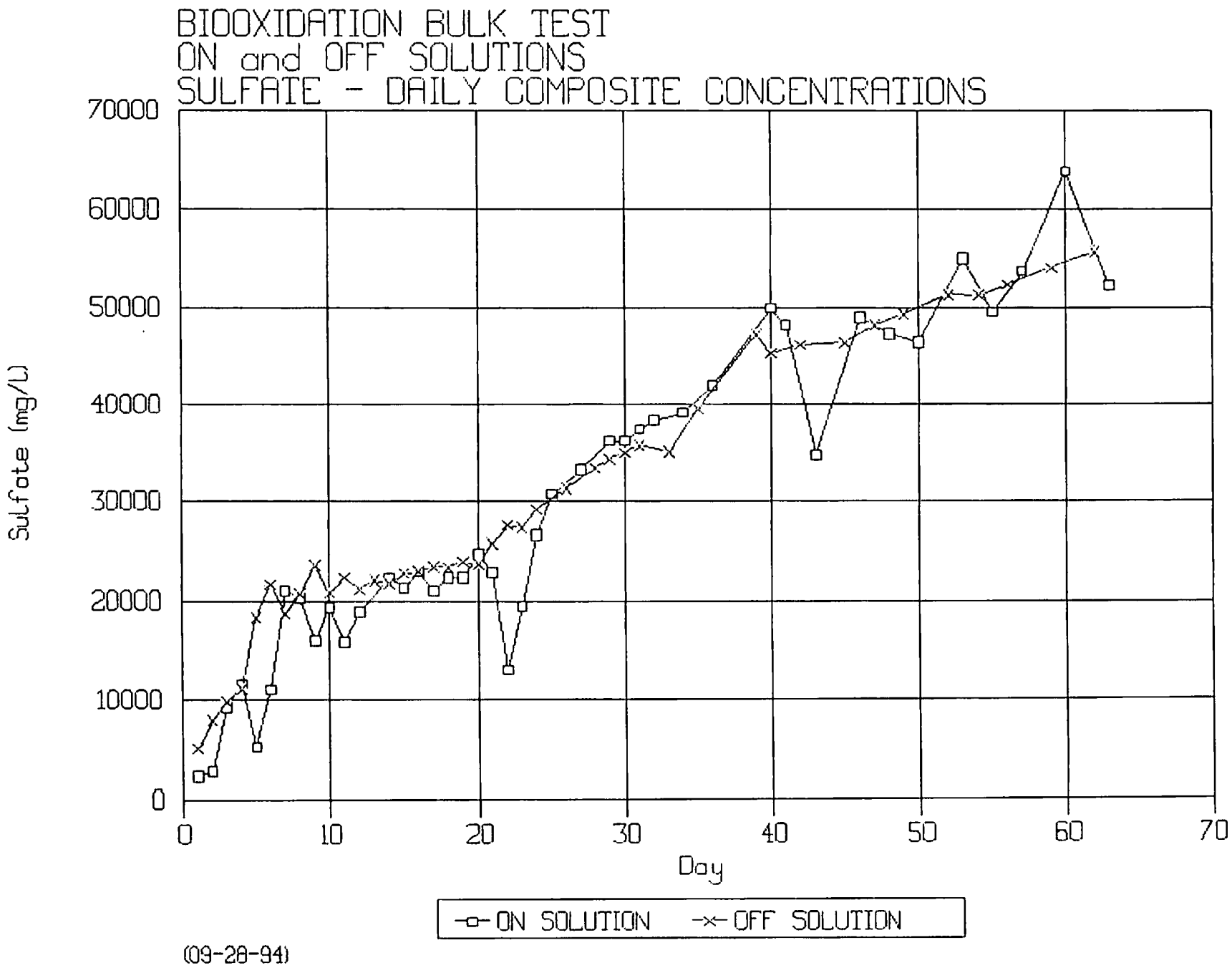
(09-23-94)

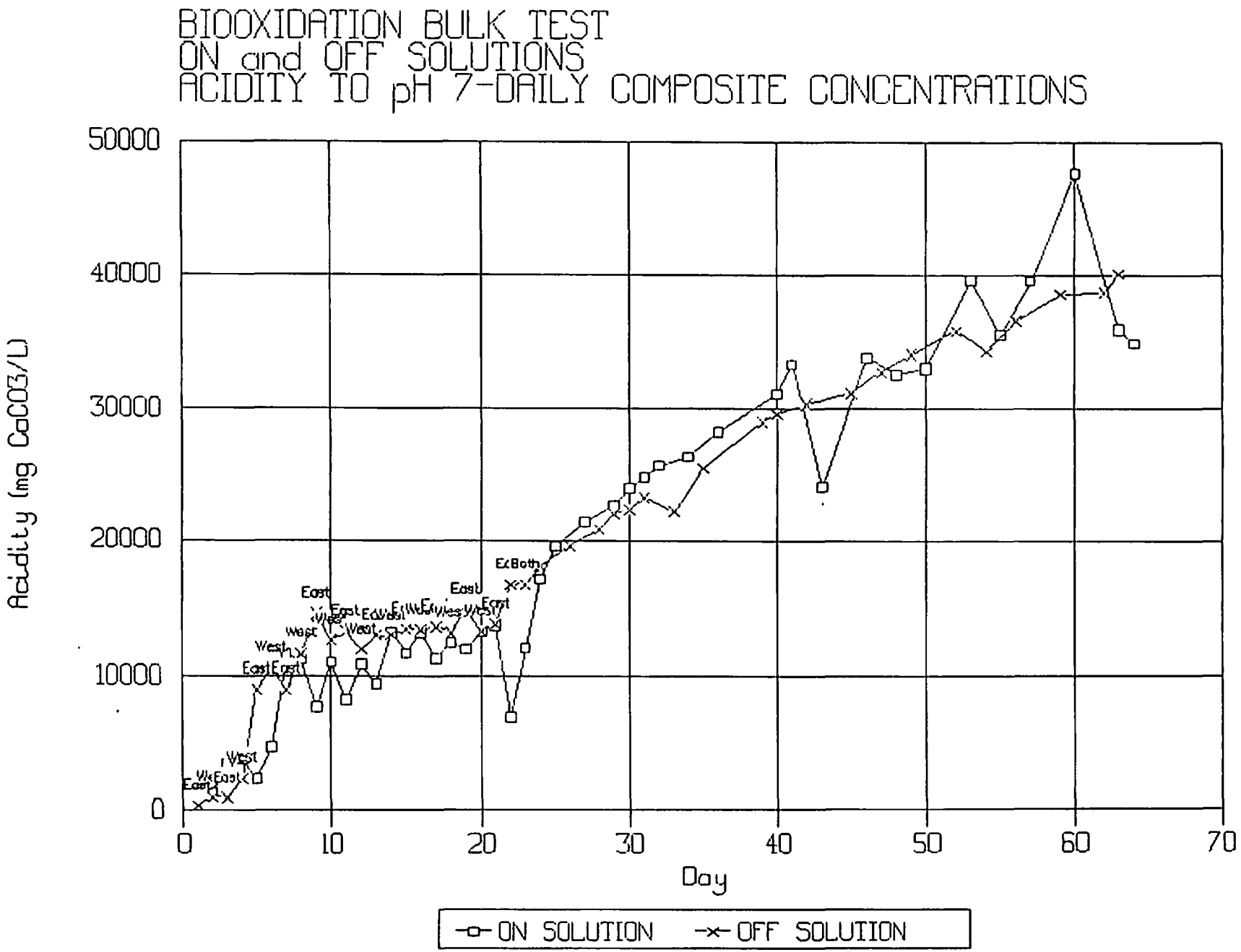

BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
OXIDATION/REDUCTION POTENTIAL-DAILY COMPOSITE CONCENTRATIONS
800
600
400
200
eh (mV)
0
10
20
30
40
50
60
70
Day
ON SOLUTION
OFF SOLUTION
(09-29-94)

BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
pH - DAILY COMPOSITE



(08-29-94)


BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
SULFATE - DAILY COMPOSITE CONCENTRATIONS
Sulfate (mg/L)
70000
60000
50000
40000
30000
20000
10000
0
0
10
20
30
40
50
60
70
Day
ON SOLUTION
OFF SOLUTION
(09-28-94)


BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
ACIDITY TO pH 7-DAILY COMPOSITE CONCENTRATIONS
Acidity (mg CaCO3/L)
50000
40000
30000
20000
10000
0
0
10
20
30
40
50
60
70
Day
East
West
Both
ON SOLUTION
OFF SOLUTION

(09-29-94)

MEMORANDUM

DATE: SEPTEMBER 23, 1994
TO: JIM THOMPSON
FROM: LAURA DAMON
SUBJECT: BIOOXIDATION BULK TEST (BBT) WEEKLY UPDATE (8)

The BBT has been on the biooxidation cycle for eight weeks now. Both the west and east sides are on simultaneous solution application. The ON solution application rate has averaged 5.6 gpm this week while the OFF solution return rate has averaged 6.7 gpm. The discrepancy in flow rates can be partially attributed to precipitation in the form of snow and rain on September 21st and to some solution draining from the neutralization sludge being placed in the SW corner of the pad.

A conference call was held Wednesday, September 21st between Brohm and Geobiotics personnel. The primary topics discussed were neutralization and the weather turning cold. It was decided to neutralize as much solution as possible before the tanks and lines must be pulled due to freezing temperatures. It will be JT's decision when to stop solution application. Although solution application will stop, the heap will continue to biooxidize.

The pool tank neutralization circuit was implemented this week. The limestone blinded off quickly rendering neut solution pH's of only about 2.8. The circuit was modified by putting a trash pump in the tank and feeding slaked lime directly to it. So far this system is proving adequate.

Sulfuric acid is still being added to the ON solution to maintain an ON pH of 1.5 in order to reduce the internal pH of the heap and aid in the biooxidation process. The OFF solution's pH has dropped to the 2.0 range. Lysimeter data still suggest the internal pH is slightly lower.

The OFF solution total iron concentration has stayed in the 7000 ppm range this week. It continues to be predominantly in the form of ferric iron. The oxidation/reduction potential is maintaining an eh of 650+. The sulfate concentration continues to rise as does the acidity. The heap will be drilled next week and the ore analyzed for percent biooxidation to date. 2 shipment to Geobiotics

Gold extraction bottle roll results from the GEM 2 ore were completed this week at Brohm. Duplicate bottle rolls achieved 75.5% and 78.0% gold extraction in 96 hours. This compares with 82.0% and 85.3% gold extraction from Geobiotics bottle rolls run on the same ore.

Biooxidized

c: Rod MacLeod
Martin Quick
Herb Osborne

Second drilling 9/28/94

BIOOXIDATION BULK TEST SOLUTION SAMPLING

ON SOLUTION

Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)
Orofino	7/21-9/14		(81100)	7.91	337.4	.01	1.35	-	-	-	107
	7/21-7/28	19741	19741								
GRAB-1530	07/27/94	?	19741	1.94	516.2	1.26	3.0	-	-	-	-
GRAB	07/28/94	?	19741	1.20	555.3	.16	7.8	-	-	3042	3411
COMP	07/28/94	?	19741	1.41	510.8	.10	21.6	-	-	1924	2420
COMP	07/29/94	9542	29283	1.65	498.3	29	45.0	4.1	40.9	1416	3012
COMP	07/30/94	5504	34787	1.61	438.4	574	38.0	2.2	35.8	3442	9230
COMP	07/31/94	975	35762	1.78	426.7	930	51.0	2.3	48.7	3823	11575
COMP	08/01/94	21302	57063	1.60	475.9	260	33.0	1.3	31.7	2394	5238
COMP	08/02/94	18970	76034	2.89	458.4	1110	155	71	84	4705	10999
COMP	08/03/94	16238	92272	1.94	490.0	1810	710	130	580	11581	20982
COMP	08/04/94	12021	104293	1.72	455.8	1660	660	340	320	11167	20349
COMP	08/05/94	16734	121027	2.75	475.1	1450	260	40	220	7673	15888
COMP	08/06/94	16466	137492	2.41	486.8	1550	1030	60	970	11012	19332
COMP	08/07/94	16466	153958	3.66	304.8	1480	530	60	470	8191	15810
COMP	08/08/94	16502	170460	2.40	507.9	1460	1170	110	1060	10820	18867
COMP	08/09/94	16103	186563	2.38	627.5	1440	790	25	765	9380	-
COMP	08/10/94	15624	202187	2.28	618.1	1720	1680	63	1617	13218	22369
COMP	08/11/94	16113	218300	2.33	645.4	1670	1250	33	1217	11657	21262
COMP	08/12/94	14762	233062	2.27	656.2	1680	1510	146	1364	13205	22874
COMP	08/13/94	13785	246847	2.30	663.0	1520	950	41	909	11254	21036
COMP	08/14/94	10979	257826	2.27	497.5	1570	1380	229	1151	12451	22331
COMP	08/15/94	10129	267955	2.26	606.6	1740	750	53	697	11956	22333
COMP	08/16/94	6178	274133	2.40	553.1	1790	970	51	919	13257	24698
COMP	08/17/94	6444	280577	2.36	573.3	1680	860	171	689	13713	22929
COMP	08/18/94	7205	287782	1.83	655.6	790	490	170	320	6959	12987
COMP	08/19/94	12447	300229	1.63	664.1	1050	1480	440	1040	12007	19505
COMP	08/20/94	15338	315567	1.39	683.9	1390	2190	610	1580	17135	26608
COMP	08/21/94	12497	328064	1.55	669.8	1610	2660	710	1950	19555	30681
COMP	08/22/94	11793	339857	1.71	684.8	1730	3270	75	3195	-	-
COMP	08/23/94	12099	351956	1.59	560.0	1780	3310	123	3187	21399	33274
COMP	08/24/94	11183	363139	1.58	604.9	1740	3480	82	3398	-	-
COMP	08/25/94	11114	374253	1.61	538.6	1760	3960	230	3730	22733	36228
COMP	08/26/94	9502	383755	1.71	694.7	1840	4040	94	3946	24028	36237
COMP	08/27/94	9144	392899	1.84	705.2	1820	4370	99	4271	24868	37372
COMP	08/28/94	8493	401392	1.84	684.4	1800	4380	99	4281	25735	38352
COMP	08/29/94	8859	410251	1.76	704.1	1870	4570	86	4484	-	-
COMP	08/30/94	7349	417600	1.77	669.5	1820	4450	84	4366	26418	39084
COMP	08/31/94	8940	426540	-	-	-	-	-	0	-	-
COMP	09/01/94	8784	435324	1.41	695.6	1660	4660	94	4566	28282	41981
COMP	09/02/94	5757	441081	-	-	-	-	-	0	-	-
COMP	09/03/94	7779	448860	-	-	-	-	-	0	-	-
COMP	09/04/94	7563	456423	-	-	-	-	-	0	-	-
COMP	09/05/94	6512	462935	1.74	697.0	1890	5820	127	5693	31066	49890
COMP	09/06/94	5907	468842	1.53	698.3	1860	6000	138	5862	33298	48170
COMP	09/07/94	6074	474916	-	-	-	-	-	0	-	-
COMP	09/08/94	8632	483548	1.64	691.8	1250	4410	86	4324	24133	34862
COMP	09/09/94	9369	492917	-	-	-	-	-	0	-	-
COMP	09/10/94	6460	499377	-	-	-	-	-	0	-	-
COMP	09/11/94	6460	505837	1.59	700.2	1830	6300	114	6186	33773	48927
COMP	09/12/94	6004	511841	-	-	-	-	-	0	-	-
COMP	09/13/94	7143	518984	1.65	698.8	1780	5700	127	5573	32506	47216
COMP	09/14/94	8045	527029	-	-	-	-	-	0	-	-
COMP	09/15/94	10057	537086	1.57	649.7	1600	6000	117	5883	32933	46360
COMP	09/16/94	10719	547805	-	-	-	-	-	0	-	-
COMP	09/17/94	9886	557691	-	-	-	-	-	0	-	-
COMP	09/18/94	8902	566593	1.50	697.1	1780	7600	102	7498	39646	55042
COMP	09/19/94	5547	572140	-	-	-	-	-	0	-	-
COMP	09/20/94	3226	575366	1.61	689.3	1670	6800	138	6662	35523	49528

BIOOXIDATION BULK TEST SOLUTION SAMPLING

OFF SOLUTION

Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	DO (ppm)
SUMP-GRAB	07/26/94	1200	1200	7.22	-	.84	.27	-	-	-	-	-
GRAB-1530	07/27/94	1750	2950	7.53	305.4	.89	.20	-	-	-	-	-
COMP	07/28/94	3000	5950	5.93	353.6	83	.55	-	-	83	4411	-
COMP	07/29/94	3293	9243	5.49	282.1	255	13	-	-	362	5094	-
COMP	07/30/94	4419	13662	5.11	285.7	654	14	-	-	994	7913	-
COMP	07/31/94	2688	16350	5.18	318.8	960	11	-	-	956	9835	-
COMP	08/01/94	7822	24172	4.20	332.3	990	39	1	38	2438	11106	-
COMP	08/02/94	21836	46008	3.39	429.6	1930	172	2	170	8960	18304	-
COMP	08/03/94	14710	60718	3.43	360.1	2050	520	260	260	10520	21678	-
COMP	08/04/94	7500	68218	3.36	344.2	1750	500	410	90	8967	18731	-
COMP	08/05/94	6821	75039	2.50	503.7	1870	480	40	440	11633	20711	-
COMP	08/06/94	21396	96436	2.45	465.2	1940	1530	200	1330	14570	23591	-
COMP	08/07/94	21396	117832	2.63	435.8	1770	1110	190	920	12617	20727	-
COMP	08/08/94	18698	136530	2.40	484.6	1800	1390	160	1230	13259	22299	-
COMP	08/09/94	21118	157648	2.36	557.4	1690	1070	36	1034	11904	21180	-
COMP	08/10/94	16419	174067	2.31	491.4	1760	1320	220	1100	12958	22052	-
COMP	08/11/94	16500	190567	2.29	524.4	1580	1290	86	1204	12958	21764	-
COMP	08/12/94	18213	208780	2.28	523.1	1630	1520	56	1464	13452	22729	1.3
COMP	08/13/94	18585	227365	2.34	500.2	1630	1420	240	1180	13361	22995	1.3
COMP	08/14/94	16646	244011	2.29	472.4	1680	1490	380	1110	13608	23458	-
COMP	08/15/94	13559	257570	2.31	522.4	1700	1110	84	1026	13179	23381	-
COMP	08/16/94	12267	269837	2.36	496.4	1670	1540	196	1344	14831	23933	1.4
COMP	08/17/94	7697	277534	2.49	481.4	1600	1160	43	1117	13309	23711	2.2
COMP	08/18/94	7136	284670	2.39	650.1	1790	1100	480	620	13839	25735	1.7
COMP	08/19/94	13078	297748	2.13	663.0	1680	2450	690	1760	16703	27554	-
COMP	08/20/94	14479	312227	2.02	672.0	1620	2550	670	1880	16716	27464	-
COMP	08/21/94	14213	326440	2.18	678.3	1660	2900	770	2130	18024	29200	-
COMP	08/22/94	14246	340686	2.16	631.0	1800	3160	75	3085	-	-	-
COMP	08/23/94	13868	354554	2.11	671.3	1740	3210	73	3137	19568	31299	-
COMP	08/24/94	12742	367296	2.09	604.1	1760	3540	82	3458	-	-	.7
COMP	08/25/94	11741	379037	2.11	646.9	1730	3640	86	3554	20823	33471	5.5?
COMP	08/26/94	12505	391542	2.19	687.1	1810	3860	86	3774	22006	34443	OFL
COMP	08/27/94	11272	402814	2.27	689.5	1770	4000	94	3906	22374	35035	-
COMP	08/28/94	9000	411814	2.21	688.0	1800	4000	82	3918	23319	35858	-
COMP	08/29/94	9000	420814	2.10	688.2	1860	4370	86	4284	-	-	OFL
COMP	08/30/94	11403	432217	2.17	685.5	1710	4030	84	3946	22242	35134	13.5?
COMP	08/31/94	10726	442943	-	-	-	-	-	-	-	-	OFL
COMP	09/01/94	10299	453242	1.94	669.9	1710	4840	89	4751	25577	39562	OFL
COMP	09/02/94	9075	462317	-	-	-	-	-	-	-	-	3.9
COMP	09/03/94	8149	470466	-	-	-	-	-	-	-	-	-
COMP	09/04/94	7612	478078	-	-	-	-	-	-	-	-	-
COMP	09/05/94	7357	485435	2.11	663.7	1870	5550	120	5430	29017	47141	-
COMP	09/06/94	6870	492305	2.09	682.9	1870	6010	151	5859	29543	45273	3.5
COMP	09/07/94	6503	498808	-	-	-	-	-	-	-	-	6.2
COMP	09/08/94	10447	509255	2.00	693.8	1760	6010	117	5893	30304	46121	5.5
COMP	09/09/94	8553	517808	-	-	-	-	-	-	-	-	5.5
COMP	09/10/94	8424	526232	-	-	-	-	-	-	-	-	-
COMP	09/11/94	8424	534656	2.01	677.7	1800	6100	114	5986	31157	46376	-
COMP	09/12/94	7258	541914	-	-	-	-	-	-	-	-	-
COMP	09/13/94	6630	548544	2.08	683.7	1800	6600	151	6449	32657	48154	2.8
COMP	09/14/94	7479	556023	-	-	-	-	-	-	-	-	2.6
COMP	09/15/94	11492	567515	1.97	685.6	1740	7000	142	6858	33989	49372	4.6
COMP	09/16/94	11244	578759	-	-	-	-	-	-	-	-	2.8
COMP	09/17/94	11287	590046	-	-	-	-	-	-	-	-	-
COMP	09/18/94	10435	600481	2.03	684.0	1760	7300	134	7166	35825	51363	-
COMP	09/19/94	9531	610012	-	-	-	-	-	-	-	-	2.5
COMP	09/20/94	6175	616187	2.01	593.5	1820	7000	134	6866	34241	51265	2.8

BIOOXIDATION BULK TEST SOLUTION SAMPLING

PAN LYSIMETER 1

Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS
GRAB	08/03/94	4.55	315.3	150	3.91	-	-	-	366	-

PAN LYSIMETER 2

Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO
GRAB	08/03/94	1.64	516	3100	14100	1900	12200	40761	46775	-	
GRAB	09/01/94	1.54	527.1	1820	3250	270	2980	20378	29184	Lt-Dk Green	OFL
GRAB	09/06/94	1.65	519.4	1850	3570	190	3380	22216	33677	Lt Greenw/sed	3.5
GRAB	09/08/94	1.60	527.9	1860	5240	490	4750	27415	37150	Gr-Br:Cldv	4.5
GRAB	09/13/94	1.46	528.4	1930	6860	490	6370	32746	42969	Br:Cldv	0.9
GRAB	09/20/94	1.58	503.6	1980	6110	490	5620	30445	40500	Br-Yel	1.8

PAN LYSIMETER 3

Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO (ppm)
GRAB	08/03/94	1.93	488.4	1540	4640	1200	3440	20005	23896	-	
GRAB	08/11/94	1.52	496.1	3200	8700	2900	5800	-	-	Brown/Murky	
GRAB	08/12/94	1.89	450.4	2200	3900	2100	1800	-	27461	Lt Brown	1.5
GRAB	08/15/94	1.92	459.5	2170	3920	1270	2650	15417	27625	Med Brown	1.7
GRAB	08/17/94	1.97	462.7	1940	3220	560	2660	19502	25159	Med Brown	2.4
GRAB	08/19/94	2.00	458.4	1850	2300	1400	900	17828	23604	-	-
GRAB	08/22/94	1.90	464.0	1760	2300	360	1940	16677	23744	Grw/Br Ti	1.9
GRAB	08/24/94	2.04	468.5	1780	2680	770	1910	16795	23028	Green	.9
GRAB	08/26/94	2.05	479.6	1730	2700	690	2010	17030	24320	Br-Yel	4.5?
GRAB	08/29/94	2.08	472.8	1770	2760	360	2400	17936	25167	Yel-Br	OFL
GRAB	09/01/94	1.79	472.3	1870	2730	730	2000	19039	26822	Green	OFL
GRAB	09/06/94	1.83	492.1	1940	2620	210	2410	19748	30237	Lt Green	2.5
GRAB	09/08/94	1.80	488.8	1980	2870	300	2570	21454	30435	Dk Green	4.3
GRAB	09/13/94	1.68	499.7	2040	3310	510	2800	22662	32648	Gr:cldv	0.9
GRAB	09/20/94	1.66	494.8	2000	3930	300	3630	24512	33471	Lt Green	1.4
GRAB	09/22/94	1.56	481.2	1980	4250	770	3480	26724		Gr-Br	1.6

PAN LYSIMETER 4

Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO (ppm)
GRAB	08/11/94	2.62	526.3	55	87	-	-	-	-	Flush H2O	-
GRAB	08/12/94	2.06	560.0	567	1260	67	1193	5282	6801	Lt Brown	4.8
GRAB	08/15/94	1.87	671.9	1260	2920	105	2815	14311	17681	Lt Brown	2.9
GRAB	08/17/94	1.71	687.2	1610	3670	102	3568	19528	23875	Med Brown	2.9
GRAB	08/19/94	1.79	659.6	1790	2900	900	2000	19280	24583	-	-
GRAB	08/22/94	1.86	615.3	1720	2000	73	1927	16285	23809	Gr-Brown	3.2
GRAB	08/24/94	1.78	678.6	1770	2420	60	2360	16481	24196	Green	OFL
GRAB	08/26/94	1.80	601.2	1710	2450	75	2375	16742	25126	Lt Gr-Yel	OFL
GRAB	08/29/94	1.92	681.5	1710	2340	60	2280	17279	26073	Lt Green	OFL
GRAB	09/01/94	1.61	698.7	1700	2380	61	2319	17647	26443	Lt Green	OFL
GRAB	09/06/94	1.75	628.7	1700	2520	71	2449	18881	29768	Lt Green	3.5
GRAB	09/08/94	1.79	681.5	1710	2710	75	2635	20168	29817	Green	4.0
GRAB	09/13/94	1.68	570.2	1780	3540	114	3426	23765	34755	Green	3.5
GRAB	09/20/94	1.63	576.6	1880	4730	123	4607	28408	40117	Yellow	4.0
GRAB	09/22/94	1.52	595.7	1910	5620	146	5474	33612		Lt Green	5.9

BIOOXIDATION BULK TEST SOLUTION SAMPLING

PAN LYSIMETER 5

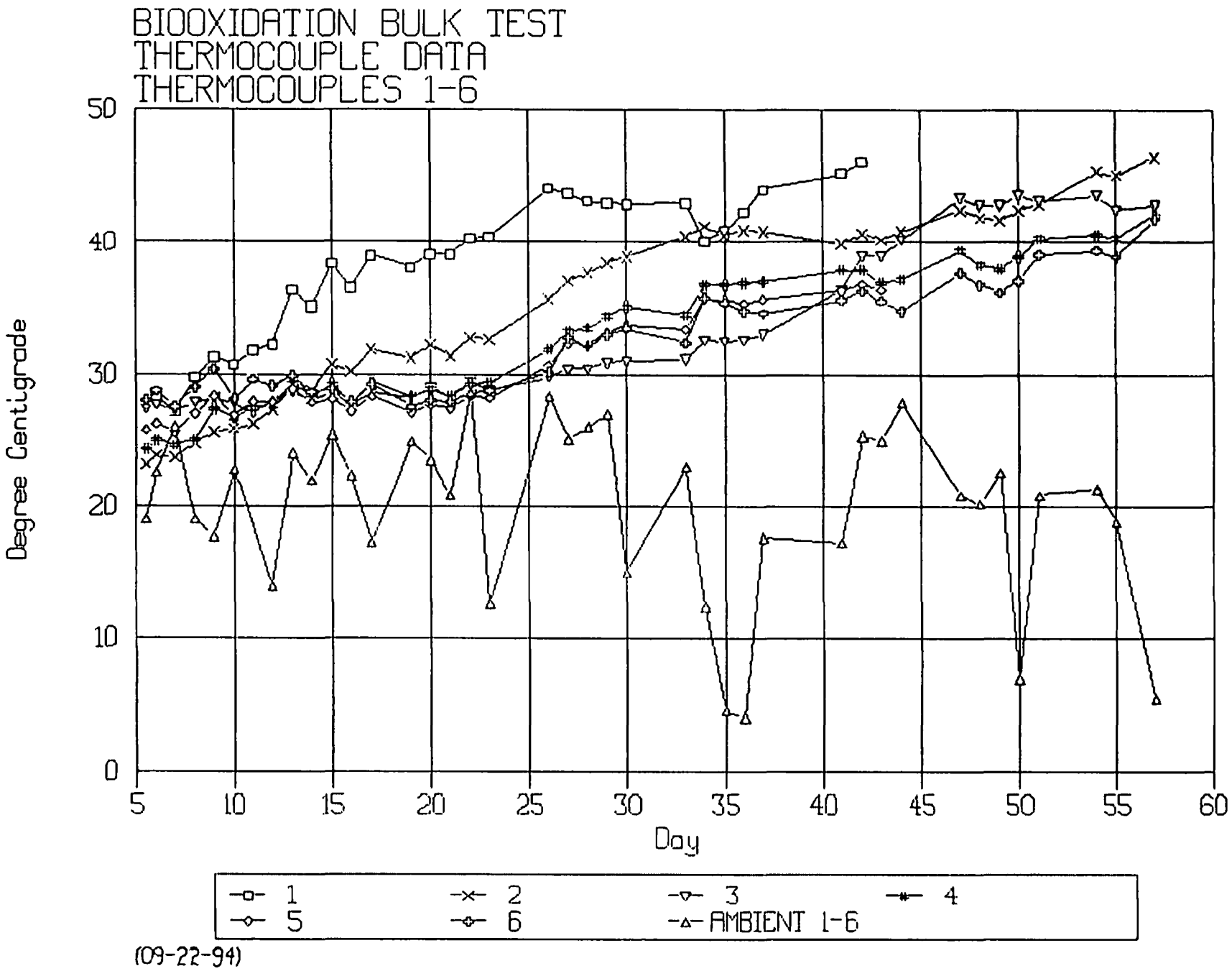
Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO (ppm)
GRAB	08/03/94	1.49	515.6	3690	17700	2100	15600	57687	66622	Dark Brown	-
GRAB	08/04/94	1.32	511.1	3930	14100	1600	12500	60119	67556	Dark Brown	-
GRAB	08/09/94	1.70	484.5	2600	4500	1400	3100	28440	38389	Dark Brown	-
GRAB	08/10/94	2.37	574.1	1740	990	36	954	11468	23641	Off Soln Flush	
GRAB	08/11/94	1.72	431.8	2000	3700	3400	300	-	-	Green Color	-
GRAB	08/12/94	1.80	439.7	2000	3900	2900	1000	20048	24627	Lt Green	3.7
GRAB	08/15/94	1.88	361.1	1940	3940	2200	1740	20543	24800	Green	2.6
GRAB	08/17/94	1.88	415.7	2030	4800	3700	1100	23073	27307	Green	2.7
GRAB	08/19/94	1.87	418.5	2170	4100	4000	100	21647	27324	-	-
GRAB	08/22/94	2.26	437.3	1920	2800	2300	500	18260	24542	Yel-Br	2.1
GRAB	08/24/94	2.12	385.4	1880	3250	2900	350	17056	25184	Lt Gr/Blue	OFL
GRAB	08/26/94	2.39	414.8	1780	3270	2290	980	16428	24641	Yel-Gr;odor	OFL
GRAB	08/29/94	2.47	402.7	1730	3260	2110	1150	16623	24698	Lt Green	OFL
GRAB	09/01/94	2.28	492.3	1700	2600	480	2120	16360	24254	Yel-Br;odor	OFL
GRAB	09/06/94	2.30	386.7	1520	3010	1830	1180	16097	25933	Bl-Gr;odor	2.5
GRAB	09/08/94	2.36	465.2	1480	2490	430	2060	16202	24534	Lt Br;ppt	4.3
GRAB	09/13/94	2.32	389.7	1170	3250	3700	-450	16019	25019	Lt Green	0.9
GRAB	09/20/94	2.30	386.7	1110	2470	2600	-130	15185	23797	Lt Green	1.8
GRAB	09/22/94	2.23	417.6	1110	2320	2000	320	15888		Lt Green	2.8

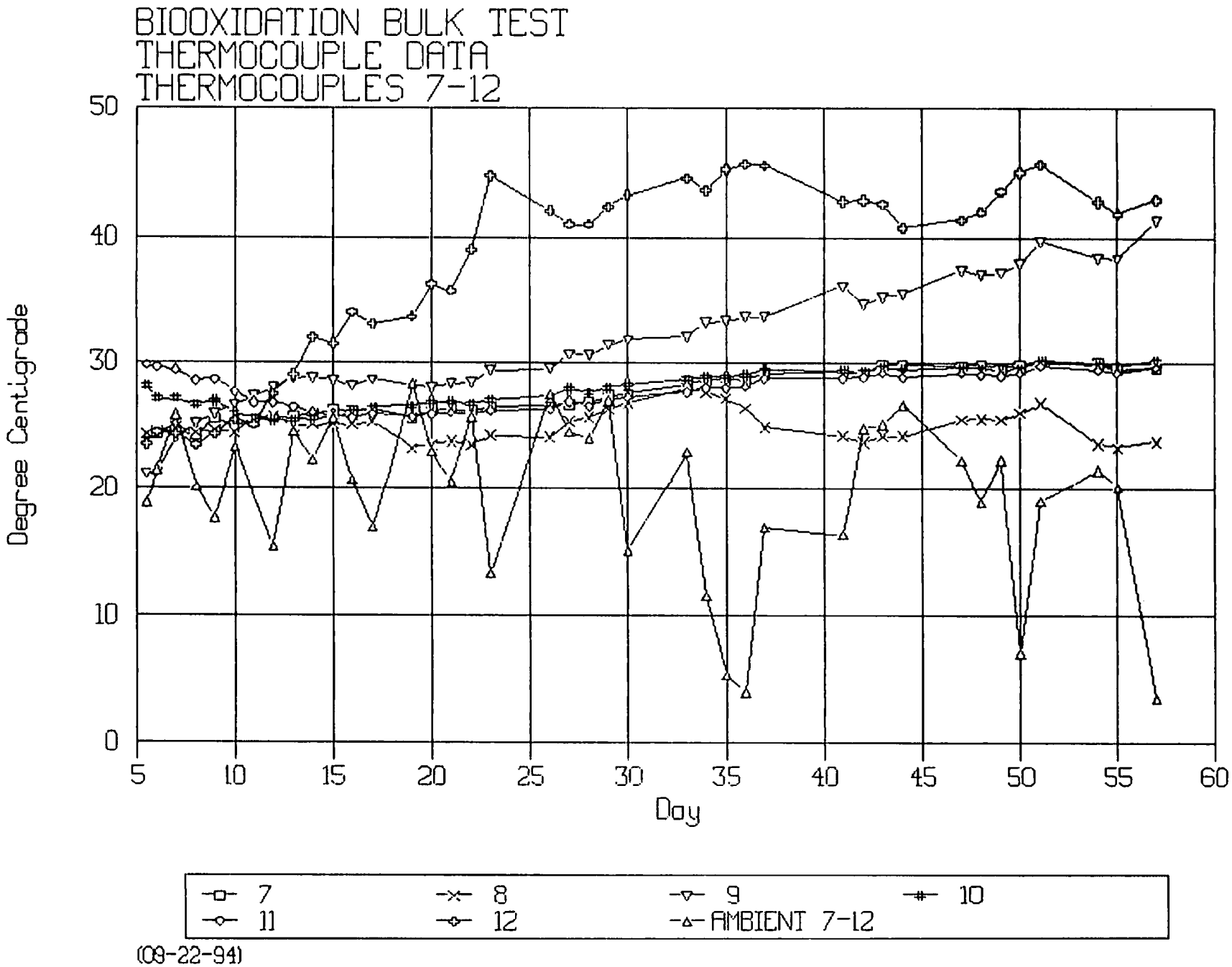
PAN LYSIMETER 6

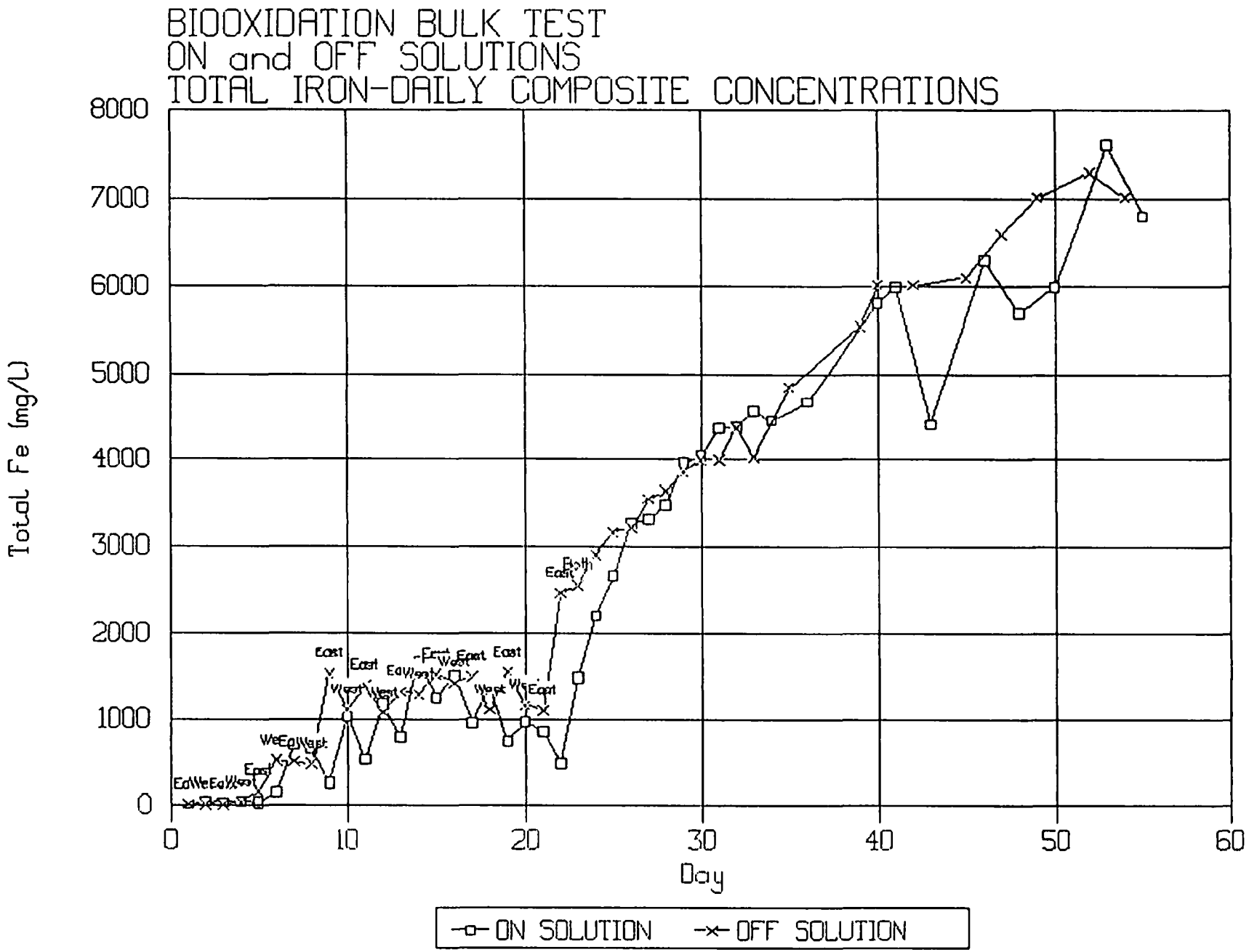
Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO (ppm)
GRAB	08/11/94	1.50	532.5	2000	4480	3300	1180	-	-	Dk Brown	-
GRAB	08/12/94	1.48	554.7	3770	8900	600	8300	31953	53838	Dk Brown	3.6
GRAB	08/15/94	1.72	361.1	2560	4300	700	3600	28024	33225	Med Brown	1.4
GRAB	08/17/94	1.73	662.4	2330	4000	1200	2800	25591	30262	Stringy Ppt	2.0
GRAB	08/19/94	1.61	586.7	2190	4500	160	4340	25781	31299	-	-
GRAB	08/22/94	1.65	580.4	1770	2600	130	2470	18168	23883	Gr-Br w/Chnks	0.8
GRAB	08/24/94	1.71	588.9	1770	3520	140	3380	19463	25011	Dk Gr/Br	OFL
GRAB	08/26/94	1.70	576.5	1680	3460	120	3340	19542	25850	Yel-Br;floats	OFL
GRAB	08/29/94	1.68	694.1	1600	4270	86	4184	21586	28509	Gr-Br;Floats	OFL
GRAB	09/01/94	1.43	716.7	1620	5100	150	4950	24501	31233	Lt Gr w/Flts	OFL
GRAB	09/06/94	1.57	579.8	1550	4600	210	4390	23398	31867	Lt Gr w/Flts	4.0
GRAB	09/08/94	1.60	622.3	1530	4440	130	4310	22715	29521	Green	4.0

BIOOXIDATION BULK TEST THERMOCOUPLE DATA

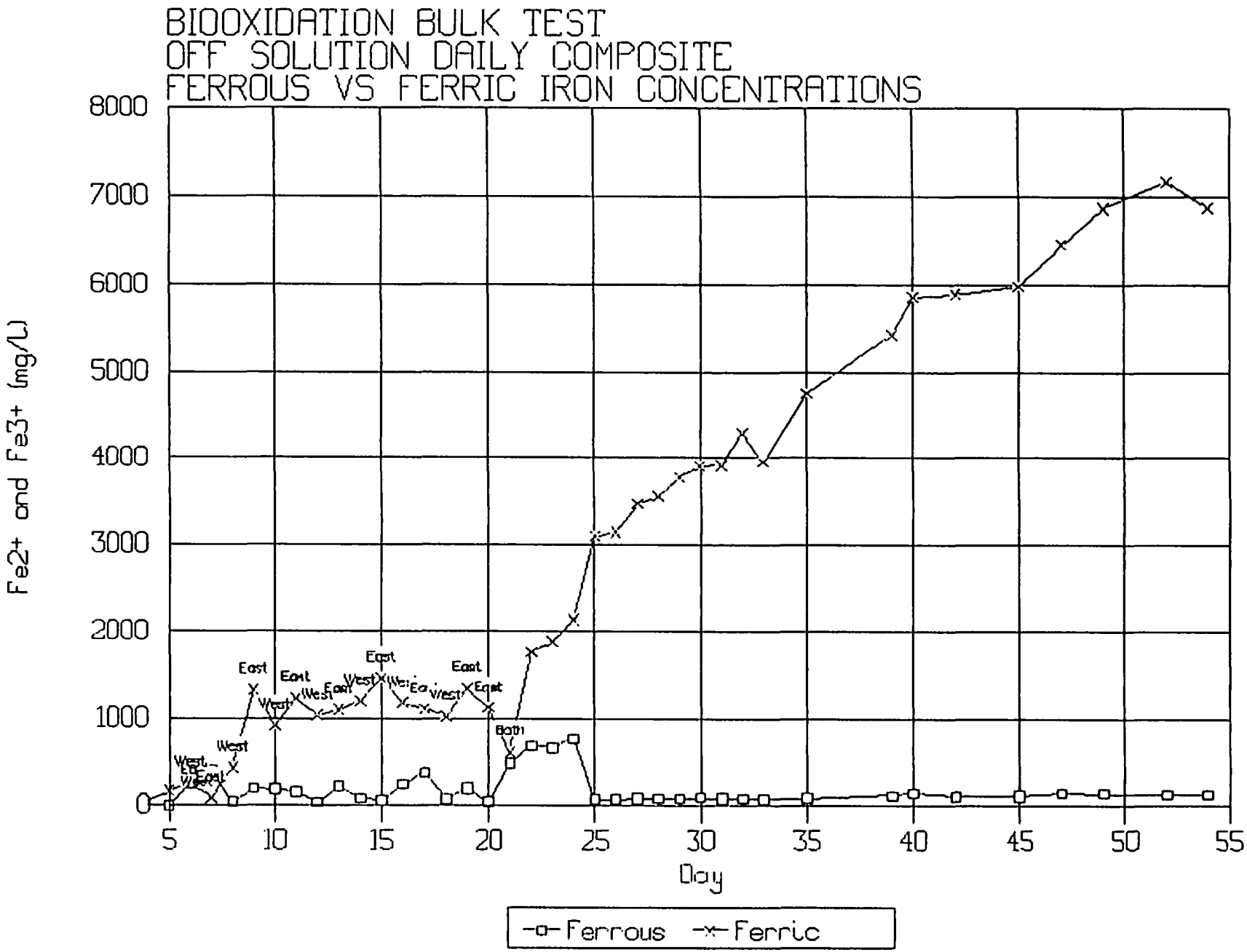
Date	West 1	West 2	West 3	West 4	West 5	Mid 6	Mid 7	Mid 8	East 9	East 10	East 11	East 12	AMBIENT 1-6	AMBIENT 7-12
08/02/94	27.8	23.2	27.4	24.3	25.7	28.0	24.3	24.3	21.2	28.1	29.8	23.5	19.0	18.9
08/02/94	28.2	23.8	27.6	25.0	26.2	28.7	24.3	24.5	21.3	27.1	29.6	24.4	22.6	21.5
08/03/94	27.2	23.7	27.2	24.6	25.6	27.5	24.5	24.8	24.0	27.1	29.4	24.3	26.0	25.8
08/04/94	29.7	24.7	27.8	25.0	27.0	29.0	24.2	24.4	25.1	26.6	28.5	23.4	19.0	20.3
08/05/94	31.3	25.6	28.2	27.3	28.3	30.4	25.5	24.6	25.9	26.9	28.6	24.3	17.7	17.7
08/06/94	30.7	25.8	27.7	26.6	26.9	28.1	24.8	24.4	26.6	25.9	27.7	25.4	22.8	23.3
08/07/94	31.8	26.2	27.1	27.4	27.9	29.6	25.4	25.5	27.3	25.5	26.8	25.0	-	-
08/08/94	32.2	27.3	27.9	27.6	27.9	29.1	25.5	25.7	27.9	25.3	26.8	27.5	14.0	15.5
08/09/94	36.4	28.9	28.6	29.3	28.9	29.9	25.7	24.9	28.7	25.4	26.4	29.0	24.0	24.5
08/10/94	35.1	28.8	28.0	28.3	27.8	28.6	25.8	25.0	28.8	25.5	26.0	32.0	21.9	22.3
08/11/94	38.4	30.8	28.5	29.2	28.1	28.9	26.2	25.1	28.5	25.6	25.8	31.5	25.4	25.6
08/12/94	36.6	30.2	27.7	27.8	27.2	27.9	26.1	25.0	28.1	26.0	25.6	34.0	22.3	20.7
08/13/94	39.0	31.9	28.6	29.4	28.3	29.2	26.3	25.3	28.6	26.4	25.9	33.1	17.3	17.0
08/14/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/15/94	38.1	31.2	28.2	28.3	27.1	27.5	25.6	23.2	28.2	26.5	25.7	33.7	24.9	28.3
08/16/94	39.1	32.2	29.0	28.8	27.6	28.0	26.2	23.5	28.0	26.8	25.9	36.2	23.5	22.9
08/17/94	39.1	31.4	28.3	28.3	27.4	27.9	26.3	23.7	28.3	26.8	26.0	35.7	20.8	20.6
08/18/94	40.3	32.8	29.4	29.2	28.3	28.6	26.1	23.5	28.4	26.7	25.9	39.0	28.6	25.7
08/19/94	40.4	32.7	28.8	29.3	28.2	28.7	26.4	24.2	29.4	27.0	26.2	44.8	12.6	13.3
08/20/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/21/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/22/94	44.1	35.7	29.8	31.9	30.7	30.2	26.5	24.1	29.5	27.4	26.3	42.1	28.3	27.5
08/23/94	43.7	37.1	30.4	33.3	32.3	32.8	26.7	25.3	30.7	27.9	26.9	41.0	25.1	24.5
08/24/94	43.1	37.7	30.4	33.5	32.2	32.1	26.8	25.7	30.6	27.6	26.5	41.0	26.0	24.0
08/25/94	43.0	38.5	30.9	34.4	33.2	33.0	27.3	26.3	31.4	28.0	27.0	42.4	27.0	27.0
08/26/94	42.9	38.9	31.0	35.1	33.8	33.5	27.5	26.8	31.8	28.3	27.3	43.3	15.0	15.2
08/27/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/28/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/29/94	43.0	40.5	31.1	34.5	33.4	32.4	28.3	27.9	32.1	28.7	27.7	44.6	23.0	22.9
08/30/94	40.1	41.2	32.6	36.8	35.7	35.8	28.6	27.7	33.2	28.9	28.0	43.7	12.4	11.6
08/31/94	40.8	40.6	32.5	36.8	35.7	35.4	28.6	27.1	33.3	28.9	28.0	45.3	4.6	5.3
09/01/94	42.3	40.9	32.6	36.9	35.3	34.8	28.7	26.4	33.7	29.0	28.1	45.7	4.1	3.9
09/02/94	44.0	40.8	33.0	37.0	35.7	34.6	29.1	24.9	33.7	29.5	28.8	45.6	17.6	17.0
09/03/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/04/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/05/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/06/94	45.2	39.9	36.4	37.9	36.3	35.6	29.4	24.2	36.1	29.4	28.8	42.8	17.2	16.4
09/07/94	46.1	40.7	39.0	37.9	36.8	36.3	29.2	23.7	34.7	29.3	28.9	42.9	25.3	24.8
09/08/94	-	40.2	39.0	36.9	36.4	35.5	29.9	24.2	35.3	29.7	29.2	42.6	25.0	25.1
09/09/94	-	40.8	40.2	37.2	-	34.8	29.9	24.2	35.5	29.5	28.9	40.8	27.8	26.7
09/10/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/11/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/12/94	-	42.5	43.4	39.4	-	37.7	29.8	25.5	37.4	29.6	29.2	41.4	20.8	22.3
09/13/94	-	41.9	42.8	38.3	-	36.8	29.9	25.6	37.0	29.6	29.1	42.0	20.1	19.0
09/14/94	-	41.7	42.8	38.0	-	36.2	29.6	25.5	37.2	29.4	29.0	43.6	22.6	22.4
09/15/94	-	42.5	43.6	38.9	-	37.1	29.9	26.0	37.9	29.6	29.2	45.1	7.0	7.0
09/16/94	-	42.9	43.2	40.3	-	39.1	30.2	26.8	39.7	30.1	29.8	45.7	20.8	19.1
09/17/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/18/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/19/94	-	45.4	43.6	40.6	-	39.4	30.0	23.6	38.4	29.9	29.5	42.8	21.3	21.5
09/20/94	-	45.1	42.5	40.3	-	38.9	29.5	23.3	38.3	29.8	29.3	41.9	18.8	20.3
09/21/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/22/94	-	46.5	42.8	42.1	-	41.8	29.6	23.8	41.3	30.2	29.7	43.0	5.6	3.5


BIOOXIDATION BULK TEST
THERMOCOUPLE DATA
THERMOCOUPLES 1-6
Degree Centigrade
0
10
20
30
40
50
5
10
15
20
25
30
35
40
45
50
55
60
Day
1
2
3
4
5
6
AMBIENT 1-6
(09-22-94)

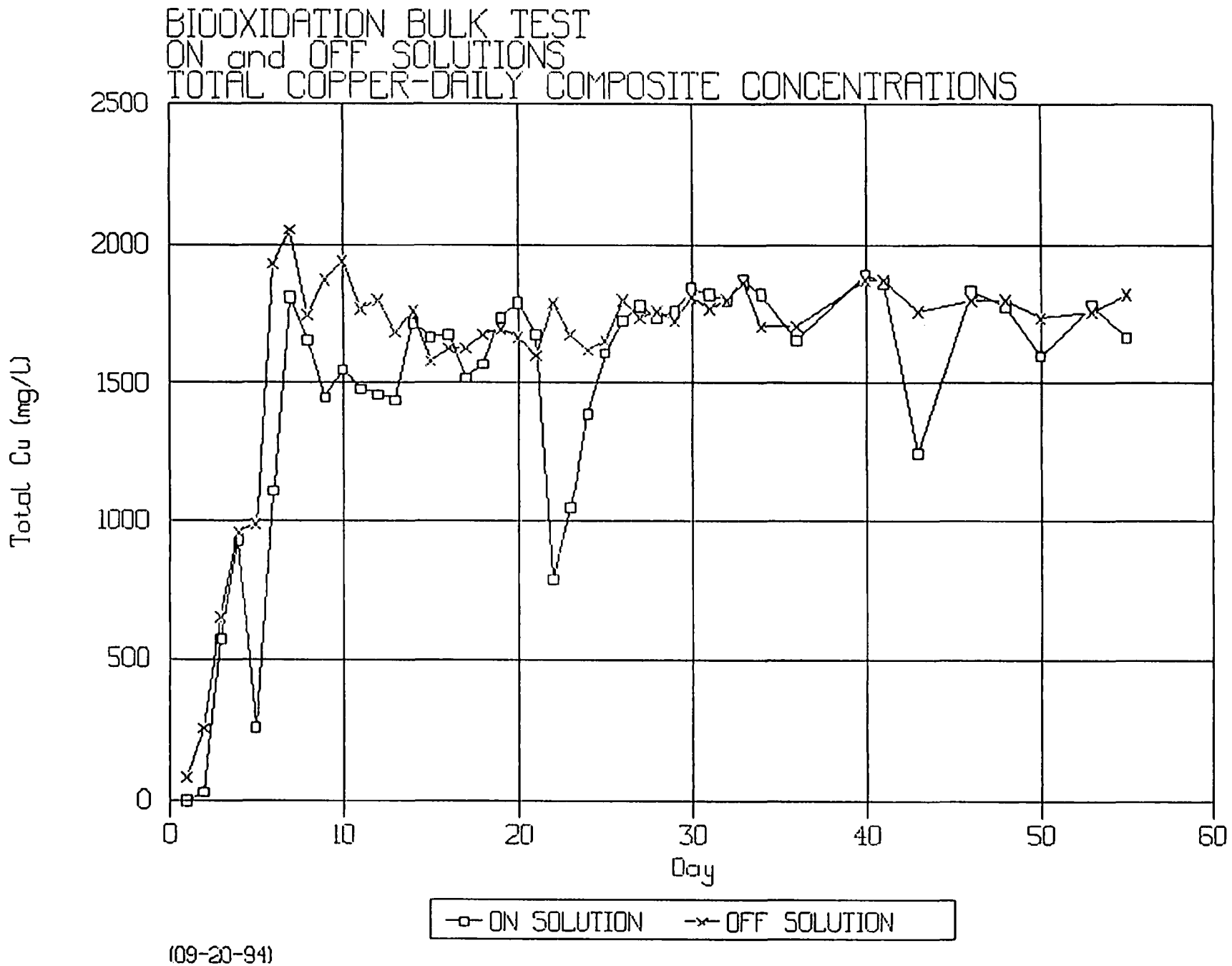

BIOOXIDATION BULK TEST
THERMOCOUPLE DATA
THERMOCOUPLES 7-12
Degree Centigrade
Day
0
10
20
30
40
50
5
10
15
20
25
30
35
40
45
50
55
60
7
8
9
10
11
12
AMBIENT 7-12
(09-22-94)


BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
TOTAL IRON-DAILY COMPOSITE CONCENTRATIONS
Total Fe (mg/L)
8000
7000
6000
5000
4000
3000
2000
1000
0
0
10
20
30
40
50
60
Day
ON SOLUTION
OFF SOLUTION

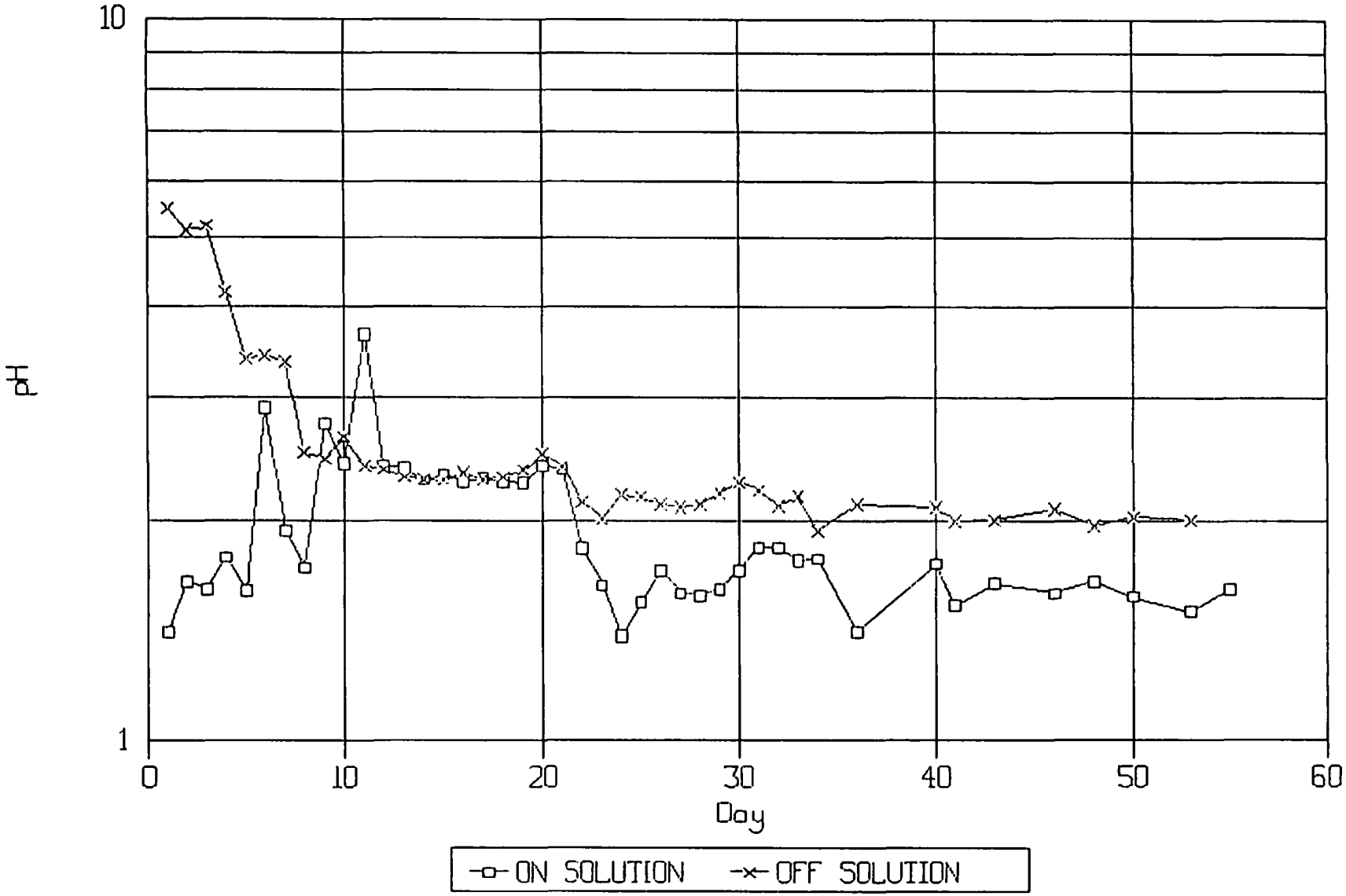
(09-20-94)


BIOOXIDATION BULK TEST
OFF SOLUTION DAILY COMPOSITE
FERROUS VS FERRIC IRON CONCENTRATIONS
Fe2+ and Fe3+ (mg/L)
8000
7000
6000
5000
4000
3000
2000
1000
0
5
10
15
20
25
30
35
40
45
50
55
Day
West
East
Both
Ferrous
Ferric

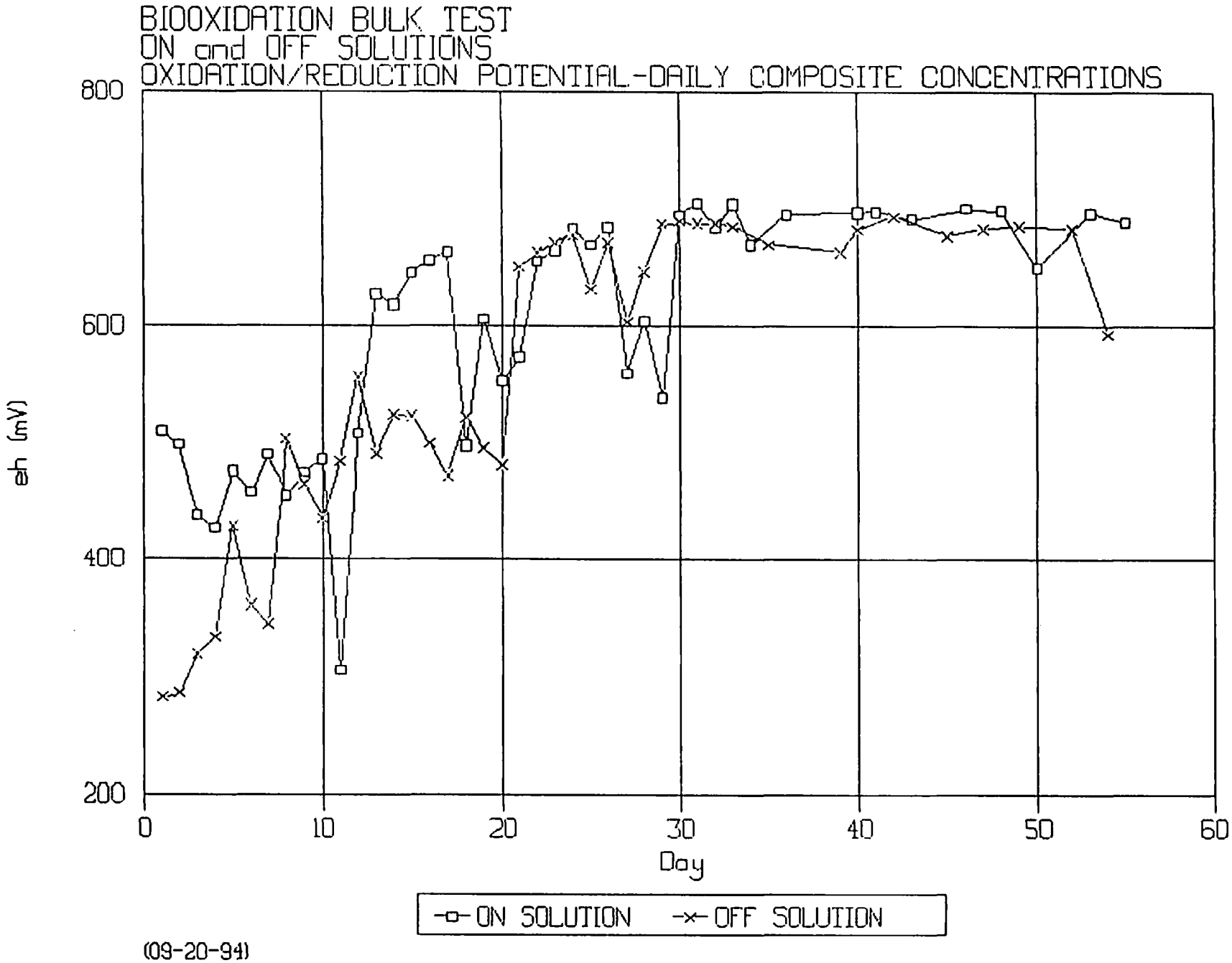
(09-20-94)

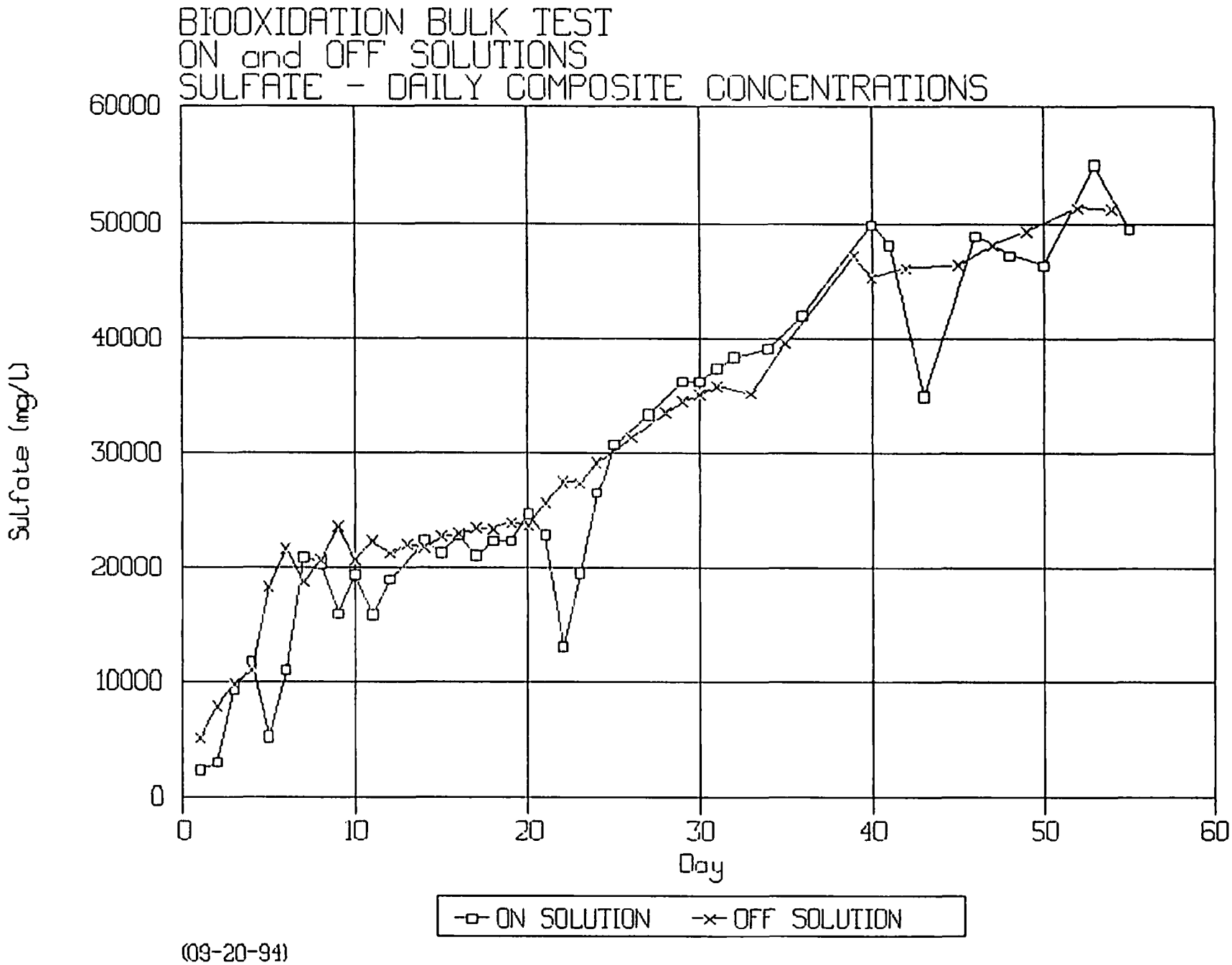

BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
TOTAL COPPER-DAILY COMPOSITE CONCENTRATIONS
Total Cu (mg/L)
2500
2000
1500
1000
500
0
0
10
20
30
40
50
60
Day
ON SOLUTION
OFF SOLUTION
(09-20-94)

BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
pH - DAILY COMPOSITE

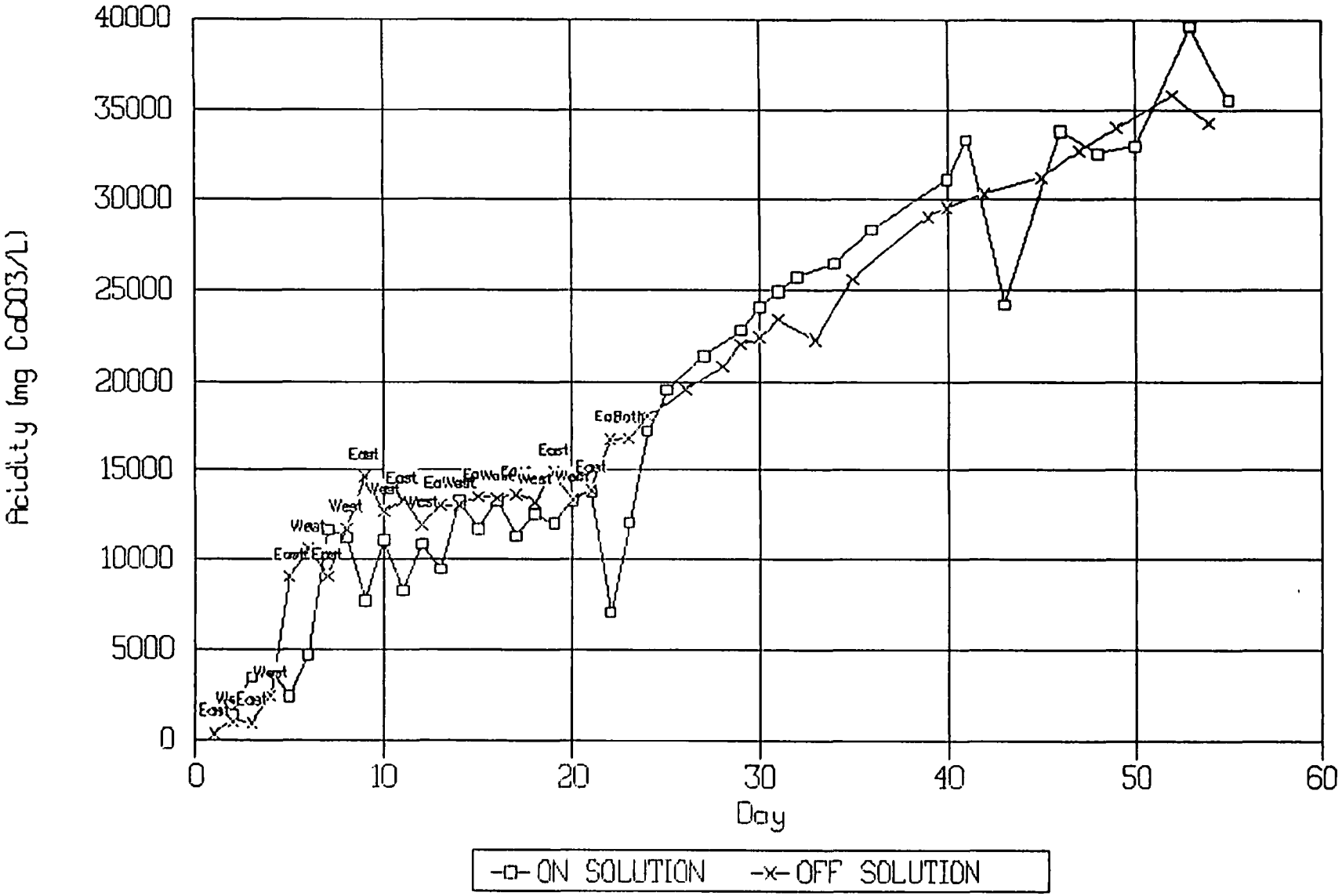


(09-20-94)


BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
OXIDATION/REDUCTION POTENTIAL-DAILY COMPOSITE CONCENTRATIONS
800
600
400
200
eh (mV)
0
10
20
30
40
50
60
Day
ON SOLUTION
OFF SOLUTION
(09-20-94)


BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
SULFATE - DAILY COMPOSITE CONCENTRATIONS
Sulfate (mg/L)
60000
50000
40000
30000
20000
10000
0
0
10
20
30
40
50
60
Day
ON SOLUTION
OFF SOLUTION
(03-20-94)

BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
ACIDITY TO pH 7-DAILY COMPOSITE CONCENTRATIONS



(09-20-94)

BIOOXIDATION BULK TEST

SP2 - Agglomerated Bacterial Inoculated Sample

Sample ID	BBT-SP2070594	BBT-SP2070694	BBT-SP2070794	BBT-SP2070894	BBT-SP2070994	BBT-SP2071094
Date	07/05/94	07/06/94	07/07/94	07/08/94	07/09/94	07/10/94
Tons Stacked (Weightometer)	107	367	579	409	372	564
% Moisture	7.9%	7.9%	7.9%	7.9%	7.9%	7.9%
Dry Tons	99	338	533	377	343	519
FA - Au (opt)	.050	.041	.058	.044	.042	.047
FA - Au (oz)	4.9	13.9	30.9	16.4	14.4	24.2
FA - Ag (opt)	.08	.21	.25	.20	.24	.22
FA - Ag (oz)	7.9	71.0	133.3	75.3	82.2	114.3
Total Fe (ppm)	55922	51672	53833	66026	56171	64211
Total Cu (ppm)	437	439	439	424	457	457
% Total Sulfur	4.64	4.72	5.09	4.97	5.34	5.22
% SO4	.69	.83	.81	.83	.89	.87
% Sulfide	4.41	4.45	4.82	4.69	5.04	4.93

BIOOXIDATION BULK TEST

SP2 - Agglomerated Bacterial Inoculated Sample

Sample ID	BBT-SP2071194	BBT-SP2071294	BBT-SP2071394	BBT-SP2071494	BBT-SP2071594	BBT-SP2071694
Date	07/11/94	07/12/94	07/13/94	07/14/94	07/15/94	07/18/94
Tons Stacked (Weightometer)	457	438	137	570	843	299
% Moisture	7.9%	5.8%	5.0%	7.9%	7.9%	7.9%
Dry Tons	421	413	130	525	776	275
FA - Au (opt)	.043	.043	.048	.043	.045	.053
FA - Au (oz)	18.1	17.5	6.2	22.3	34.9	14.5
FA - Ag (opt)	.22	.19	.26	.22	.14	.17
FA - Ag (oz)	92.6	78.4	33.8	115.5	108.7	46.8
Total Fe (ppm)	56071	56977	53871	55158	48216	57079
Total Cu (ppm)	493	463	449	475	420	451
% Total Sulfur	4.89	4.64	4.80	4.87	4.42	5.20
% SO4	.87	.88	1.02	.90	.89	.94
% Sulfide	4.60	4.35	4.46	4.57	4.12	4.88

BIOOXIDATION BULK TEST

SP2 - Agglomerated Bacterial Inoculated Sample

Sample ID Date	Total or Wt Avg to Date	BBT-SP2COLCOMP AB Split 7/5-7/18/94	BBT-SP2COLCOMP CD Split 7/5-7/18/94	BBT-SP2COLCOMP Average 7/5-7/18/94
Tons Stacked (Weightometer)	5142	5142	5142	5142
% Moisture	7.6%	7.6%	7.6%	7.6%
Dry Tons	4749	4749	4749	4749
FA - Au (opt)	.046	.044	.047	.046
FA - Au (oz)	218	209	223	216
FA - Ag (opt)	.20	.81	.82	.82
FA - Ag (oz)	960	3847	3894	3870
Total Fe (ppm)	55882	61608	56093	58851
Total Cu (ppm)	450	516	491	504
% Total Sulfur	4.88	5.33	5.12	5.23
% SO4	.87	.94	.96	.95
% Sulfide	4.59	5.02	4.80	4.91

BIOOXIDATION BULK TEST

SP1 - Non-treated Sample

Sample ID	BBT-SP1070594	BBT-SP1070694	BBT-SP1070794	BBT-SP1070894	BBT-SP1070994	BBT-SP1071094
Date	07/05/94	07/06/94	07/07/94	07/08/94	07/09/94	07/10/94
Tons Moved (Bucket Count)	141	458	598	493	352	493
% Moisture	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
Dry Tons	134	435	568	468	334	468
FA - Au (opt)	.053	.047	.047	.048	.055	.051
FA - Au (oz)	7.0	20.2	26.7	22.5	18.2	23.6
FA - Ag (opt)	.14	.16	.14	.15	.11	.23
FA - Ag (oz)	18.7	69.6	79.6	70.2	36.8	107.7
Total Fe (ppm)	57199	60708	76834	62506	70373	73133
Total Cu (ppm)	472	510	512	528	527	514
% Total Sulfur	4.08	5.32	6.38	5.81	6.43	6.48
% SO4	.73	.96	1.00	.96	.98	.97
% Sulfide	3.84	5.00	6.04	5.49	6.10	6.16

BIOOXIDATION BULK TEST

SP1 - Non-treated Sample

Sample ID	BBT-SP1071194	BBT-SP1071294	BBT-SP1071394	BBT-SP1071494	BBT-SP1071594	BBT-SP1071894
Date	07/11/94	07/12/94	07/13/94	07/14/94	07/15/94	07/18/94
Tons Moved (Bucket Count)	440	405	123	528	792	282
% Moisture	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
Dry Tons	418	385	117	502	752	268
FA - Au (opt)	.048	.052	.056	.059	.050	.044
FA - Au (oz)	19.9	20.0	6.5	29.3	37.2	11.8
FA - Ag (opt)	.27	.23	.23	.24	.18	.15
FA - Ag (oz)	112.9	88.4	26.9	120.4	135.4	40.1
Total Fe (ppm)	62637	57119	57658	54962	56886	62157
Total Cu (ppm)	492	471	482	507	474	517
% Total Sulfur	6.00	5.58	5.39	5.29	5.15	5.56
% SO4	.87	1.01	1.03	.92	1.03	.80
% Sulfide	5.71	5.24	5.04	4.99	4.80	5.30

BIOOXIDATION BULK TEST

SP1 - Non-treated Sample

Sample ID Date	Total or Wt Avg to Date	BBT-SP1COLCOMP AB Split 7/5-7/18/94	BBT-SP1COLCOMP CD Split 7/5-7/18/94	BBT-SP1COLCOMP Average 7/5-7/18/94
Tons Moved (Bucket Count)	5104	5104	5104	5104
% Moisture	5.0%	5.0%	5.0%	5.0%
Dry Tons	4849	4849	4849	4849
FA - Au (opt)	.050	.049	.049	.049
FA - Au (oz)	243	238	238	238
FA - Ag (opt)	.19	.66	.68	.67
FA - Ag (oz)	907	3200	3297	3249
Total Fe (ppm)	63244	62021	58539	60280
Total Cu (ppm)	502	486	483	484
% Total Sulfur	5.71	5.48	5.48	5.48
% SO4	.96	.91	.86	.89
% Sulfide	5.39	5.18	5.19	5.19

MEMORANDUM

DATE: SEPTEMBER 16, 1994
TO: JIM THOMPSON
FROM: LAURA DAMON
SUBJECT: BIOOXIDATION BULK TEST (BBT) WEEKLY UPDATE (7)

The BBT has been on the biooxidation cycle for seven weeks now. Both the west and east sides are on simultaneous solution application. The ON solution application rate has averaged 5.3 gpm this week while the OFF solution return rate has averaged 5.8 gpm. The heap seems to have stabilized even with heavy rains on September 15th.

A conference call was held Tuesday, September 13th between Brohm and Geobiotics personnel. The neutralization tank set up was discussed.

Jim Whitlock continued working with the existing neutralization circuit this week. The system was modified by attaching the lime feeder directly to the mixer, bypassing the feeder trough. Also the pool-type tank for the limestone bed neutralization was set up this week and should be in operation by next week. Geobiotics hired a neutralization helper who will start work on Monday, September 19th.

Sulfuric acid is still being added to the ON solution to maintain an ON pH of 1.5 in order to reduce the internal pH of the heap and aid in the biooxidation process. The OFF solution's pH has dropped to the 2.0 range. Lysimeter data still suggest the internal pH is slightly lower.

The BBT remains status quo. The data collected to date still indicate that the bacteria are biooxidizing the sulfide ore although possibly at a reduced rate. The total iron concentration has risen to 7000 ppm and continues to be predominantly in the form of ferric iron. The oxidation/reduction potential is maintaining an eh of 650+. The sulfate concentration continues to rise as does the acidity.

The gold extraction graph from the control columns is attached. The water rinse column is performing poorly having attained only about 25% gold extraction in 39 days on leach. The other two control columns, with lime addition, are duplicating well with gold extractions in the 61%-63% range after 39 days on cyanide leach. The non-water rinse control columns will be unloaded and their tails assayed next week. The water rinse column will continue on leach for another week.

c: Rod MacLeod
Martin Quick
Herb Osborne

BIOOXIDATION BULK TEST SOLUTION SAMPLING

ON SOLUTION

Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)
Orofino	7/21-9/14		(81100)	7.91	337.4	.01	1.35	-	-	-	107
	7/21-7/28	19741	19741								
GRAB-1530	07/27/94	?	19741	1.94	516.2	1.26	3.0	-	-	-	-
GRAB	07/28/94	?	19741	1.20	555.3	.16	7.8	-	-	3042	3411
COMP	07/28/94	?	19741	1.41	510.8	.10	21.6	-	-	1924	2420
COMP	07/29/94	9542	29283	1.65	498.3	29	45.0	4.1	40.9	1416	3012
COMP	07/30/94	5504	34787	1.61	438.4	574	38.0	2.2	35.8	3442	9230
COMP	07/31/94	975	35762	1.78	426.7	930	51.0	2.3	48.7	3823	11575
COMP	08/01/94	21302	57063	1.60	475.9	260	33.0	1.3	31.7	2394	5238
COMP	08/02/94	18970	76034	2.89	458.4	1110	155	71	84	4705	10999
COMP	08/03/94	16238	92272	1.94	490.0	1810	710	130	580	11581	20982
COMP	08/04/94	12021	104293	1.72	455.8	1660	660	340	320	11167	20349
COMP	08/05/94	16734	121027	2.75	475.1	1450	260	40	220	7673	15888
COMP	08/06/94	16466	137492	2.41	486.8	1550	1030	60	970	11012	19332
COMP	08/07/94	16466	153958	3.66	304.8	1480	530	60	470	8191	15810
COMP	08/08/94	16502	170460	2.40	507.9	1460	1170	110	1060	10820	18867
COMP	08/09/94	16103	186563	2.38	627.5	1440	790	25	765	9380	-
COMP	08/10/94	15624	202187	2.28	618.1	1720	1680	63	1617	13218	22369
COMP	08/11/94	16113	218300	2.33	645.4	1670	1250	33	1217	11657	21262
COMP	08/12/94	14762	233062	2.27	656.2	1680	1510	146	1364	13205	22874
COMP	08/13/94	13785	246847	2.30	663.0	1520	950	41	909	11254	21036
COMP	08/14/94	10979	257826	2.27	497.5	1570	1380	229	1151	12451	22331
COMP	08/15/94	10129	267955	2.26	606.6	1740	750	53	697	11956	22333
COMP	08/16/94	6178	274133	2.40	553.1	1790	970	51	919	13257	24698
COMP	08/17/94	6444	280577	2.36	573.3	1680	860	171	689	13713	22929
COMP	08/18/94	7205	287782	1.83	655.6	790	490	170	320	6959	12987
COMP	08/19/94	12447	300229	1.63	664.1	1050	1480	440	1040	12007	19505
COMP	08/20/94	15338	315567	1.39	683.9	1390	2190	610	1580	17135	26608
COMP	08/21/94	12497	328064	1.55	669.8	1610	2660	710	1950	19555	30681
COMP	08/22/94	11793	339857	1.71	684.8	1730	3270	75	3195	-	-
COMP	08/23/94	12099	351956	1.59	560.0	1780	3310	123	3187	21399	33274
COMP	08/24/94	11183	363139	1.58	604.9	1740	3480	82	3398	-	-
COMP	08/25/94	11114	374253	1.61	538.6	1760	3960	230	3730	22733	36228
COMP	08/26/94	9502	383755	1.71	694.7	1840	4040	94	3946	24028	36237
COMP	08/27/94	9144	392899	1.84	705.2	1820	4370	99	4271	24868	37372
COMP	08/28/94	8493	401392	1.84	684.4	1800	4380	99	4281	25735	38352
COMP	08/29/94	8859	410251	1.76	704.1	1870	4570	86	4484	-	-
COMP	08/30/94	7349	417600	1.77	669.5	1820	4450	84	4366	26418	39084
COMP	08/31/94	8940	426540	-	-	-	-	-	0	-	-
COMP	09/01/94	8784	435324	1.41	695.6	1660	4660	94	4566	28282	41981
COMP	09/02/94	5757	441081	-	-	-	-	-	0	-	-
COMP	09/03/94	7779	448860	-	-	-	-	-	0	-	-
COMP	09/04/94	7563	456423	-	-	-	-	-	0	-	-
COMP	09/05/94	6512	462935	1.74	697.0	1890	5820	127	5693	31066	49890
COMP	09/06/94	5907	468842	1.53	698.3	1860	6000	138	5862	33298	48170
COMP	09/07/94	6074	474916	-	-	-	-	-	0	-	-
COMP	09/08/94	8632	483548	1.64	691.8	1250	4410	86	4324	24133	34862
COMP	09/09/94	9369	492917	-	-	-	-	-	0	-	-
COMP	09/10/94	6460	499377	-	-	-	-	-	0	-	-
COMP	09/11/94	6460	505837	1.59	700.2	1830	6300	114	6186	33773	48927
COMP	09/12/94	6004	511841	-	-	-	-	-	0	-	-
COMP	09/13/94	7143	518984	1.65	698.8	1780	5700	127	5573	32506	47216
COMP	09/14/94	8045	527029	-	-	-	-	-	0	-	-
COMP	09/15/94	10057	537086	1.57	649.7	1600	6000	117	5883	32933	

BIOOXIDATION BULK TEST SOLUTION SAMPLING

OFF SOLUTION

Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	DO (ppm)
SUMP-GRAB	07/26/94	1200	1200	7.22	-	.84	.27	-	-	-	-	-
GRAB-1530	07/27/94	1750	2950	7.53	305.4	.89	.20	-	-	-	-	-
COMP	07/28/94	3000	5950	5.93	353.6	83	.55	-	-	83	4411	-
COMP	07/29/94	3293	9243	5.49	282.1	255	13	-	-	362	5094	-
COMP	07/30/94	4419	13662	5.11	285.7	654	14	-	-	994	7913	-
COMP	07/31/94	2688	16350	5.18	318.8	960	11	-	-	956	9835	-
COMP	08/01/94	7822	24172	4.20	332.3	990	39	1	38	2438	11106	-
COMP	08/02/94	21836	46008	3.39	429.6	1930	172	2	170	8960	18304	-
COMP	08/03/94	14710	60718	3.43	360.1	2050	520	260	260	10520	21678	-
COMP	08/04/94	7500	68218	3.36	344.2	1750	500	410	90	8967	18731	-
COMP	08/05/94	6821	75039	2.50	503.7	1870	480	40	440	11633	20711	-
COMP	08/06/94	21396	96436	2.45	465.2	1940	1530	200	1330	14570	23591	-
COMP	08/07/94	21396	117832	2.63	435.8	1770	1110	190	920	12617	20727	-
COMP	08/08/94	18698	136530	2.40	484.6	1800	1390	160	1230	13259	22299	-
COMP	08/09/94	21118	157648	2.36	557.4	1690	1070	36	1034	11904	21180	-
COMP	08/10/94	16419	174067	2.31	491.4	1760	1320	220	1100	12958	22052	-
COMP	08/11/94	16500	190567	2.29	524.4	1580	1290	86	1204	12958	21764	-
COMP	08/12/94	18213	208780	2.28	523.1	1630	1520	56	1464	13452	22729	1.3
COMP	08/13/94	18585	227365	2.34	500.2	1630	1420	240	1180	13361	22995	1.3
COMP	08/14/94	16646	244011	2.29	472.4	1680	1490	380	1110	13608	23458	-
COMP	08/15/94	13559	257570	2.31	522.4	1700	1110	84	1026	13179	23381	-
COMP	08/16/94	12267	269837	2.36	496.4	1670	1540	196	1344	14831	23933	1.4
COMP	08/17/94	7697	277534	2.49	481.4	1600	1160	43	1117	13309	23711	2.2
COMP	08/18/94	7136	284670	2.39	650.1	1790	1100	480	620	13839	25735	1.7
COMP	08/19/94	13078	297748	2.13	663.0	1680	2450	690	1760	16703	27554	-
COMP	08/20/94	14479	312227	2.02	672.0	1620	2550	670	1880	16716	27464	-
COMP	08/21/94	14213	326440	2.18	678.3	1660	2900	770	2130	18024	29200	-
COMP	08/22/94	14246	340686	2.16	631.0	1800	3160	75	3085	-	-	-
COMP	08/23/94	13868	354554	2.11	671.3	1740	3210	73	3137	19568	31299	-
COMP	08/24/94	12742	367296	2.09	604.1	1760	3540	82	3458	-	-	.7
COMP	08/25/94	11741	379037	2.11	646.9	1730	3640	86	3554	20823	33471	5.5?
COMP	08/26/94	12505	391542	2.19	687.1	1810	3860	86	3774	22006	34443	OFL
COMP	08/27/94	11272	402814	2.27	689.5	1770	4000	94	3906	22374	35035	-
COMP	08/28/94	9000	411814	2.21	688.0	1800	4000	82	3918	23319	35858	-
COMP	08/29/94	9000	420814	2.10	688.2	1860	4370	86	4284	-	-	OFL
COMP	08/30/94	11403	432217	2.17	685.5	1710	4030	84	3946	22242	35134	13.5?
COMP	08/31/94	10726	442943	-	-	-	-	-	-	-	-	OFL
COMP	09/01/94	10299	453242	1.94	669.9	1710	4840	89	4751	25577	39562	OFL
COMP	09/02/94	9075	462317	-	-	-	-	-	-	-	-	3.9
COMP	09/03/94	8149	470466	-	-	-	-	-	-	-	-	-
COMP	09/04/94	7612	478078	-	-	-	-	-	-	-	-	-
COMP	09/05/94	7357	485435	2.11	663.7	1870	5550	120	5430	29017	47141	-
COMP	09/06/94	6870	492305	2.09	682.9	1870	6010	151	5859	29543	45273	3.5
COMP	09/07/94	6503	498808	-	-	-	-	-	-	-	-	6.2
COMP	09/08/94	10447	509255	2.00	693.8	1760	6010	117	5893	30304	46121	5.5
COMP	09/09/94	8553	517808	-	-	-	-	-	0	-	-	5.5
COMP	09/10/94	8424	526232	-	-	-	-	-	0	-	-	-
COMP	09/11/94	8424	534656	2.01	677.7	1800	6100	114	5986	31157	46376	-
COMP	09/12/94	7258	541914	-	-	-	-	-	0	-	-	-
COMP	09/13/94	6630	548544	2.08	683.7	1800	6600	151	6449	32657	48154	2.8
COMP	09/14/94	7479	556023	-	-	-	-	-	0	-	-	2.6
COMP	09/15/94	11492	567515	1.97	685.6	1740	7000	142	6858	33989		4.6

PAN LYSIMETER 1

Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS
GRAB	08/03/94	4.55	315.3	150	3.91	-	-	-	366	-

PAN LYSIMETER 2

Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO
GRAB	08/03/94	1.64	516	3100	14100	1900	12200	40761	46775	-	
GRAB	09/01/94	1.54	527.1	1820	3250	270	2980	20378	29184	Lt-Dk Green	OFL
GRAB	09/06/94	1.65	519.4	1850	3570	190	3380	22216	33677	Lt Greenw/sed	3.5
GRAB	09/08/94	1.60	527.9	1860	5240	490	4750	27415	37150	Gr-Br;Cldy	4.5
GRAB	09/13/94	1.46	528.4	1930	6860	490	6370	32746	42969	Br;Cldy	0.9

PAN LYSIMETER 3

Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO (ppm)
GRAB	08/03/94	1.93	488.4	1540	4640	1200	3440	20005	23896	-	
GRAB	08/11/94	1.52	496.1	3200	8700	2900	5800	-	-	Brown/Murky	
GRAB	08/12/94	1.89	450.4	2200	3900	2100	1800	-	27461	Lt Brown	1.5
GRAB	08/15/94	1.92	459.5	2170	3920	1270	2650	15417	27625	Med Brown	1.7
GRAB	08/17/94	1.97	462.7	1940	3220	560	2660	19502	25159	Med Brown	2.4
GRAB	08/19/94	2.00	458.4	1850	2300	1400	900	17828	23604	-	-
GRAB	08/22/94	1.90	464.0	1760	2300	360	1940	16677	23744	Grw/Br Ti	1.9
GRAB	08/24/94	2.04	468.5	1780	2680	770	1910	16795	23028	Green	.9
GRAB	08/26/94	2.05	479.6	1730	2700	690	2010	17030	24320	Br-Yel	4.5?
GRAB	08/29/94	2.08	472.8	1770	2760	360	2400	17936	25167	Yel-Br	OFL
GRAB	09/01/94	1.79	472.3	1870	2730	730	2000	19039	26822	Green	OFL
GRAB	09/06/94	1.83	492.1	1940	2620	210	2410	19748	30237	Lt Green	2.5
GRAB	09/08/94	1.80	488.8	1980	2870	300	2570	21454	30435	Dk Green	4.3
GRAB	09/13/94	1.68	499.7	2040	3310	510	2800	22662	32648	Gr;cldy	0.9

PAN LYSIMETER 4

Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO (ppm)
GRAB	08/11/94	2.62	526.3	55	87	-	-	-	-	Flush H2O	-
GRAB	08/12/94	2.06	560.0	567	1260	67	1193	5282	6801	Lt Brown	4.8
GRAB	08/15/94	1.87	671.9	1260	2920	105	2815	14311	17681	Lt Brown	2.9
GRAB	08/17/94	1.71	687.2	1610	3670	102	3568	19528	23875	Med Brown	2.9
GRAB	08/19/94	1.79	659.6	1790	2900	900	2000	19280	24583	-	-
GRAB	08/22/94	1.86	615.3	1720	2000	73	1927	16285	23809	Gr-Brown	3.2
GRAB	08/24/94	1.78	678.6	1770	2420	60	2360	16481	24196	Green	OFL
GRAB	08/26/94	1.80	601.2	1710	2450	75	2375	16742	25126	Lt Gr-Yel	OFL
GRAB	08/29/94	1.92	681.5	1710	2340	60	2280	17279	26073	Lt Green	OFL
GRAB	09/01/94	1.61	698.7	1700	2380	61	2319	17647	26443	Lt Green	OFL
GRAB	09/06/94	1.75	628.7	1700	2520	71	2449	18881	29768	Lt Green	3.5
GRAB	09/08/94	1.79	681.5	1710	2710	75	2635	20168	29817	Green	4.0
GRAB	09/13/94	1.68	570.2	1780	3540	114	3426	23765	34755	Green	3.5

PAN LYSIMETER 5

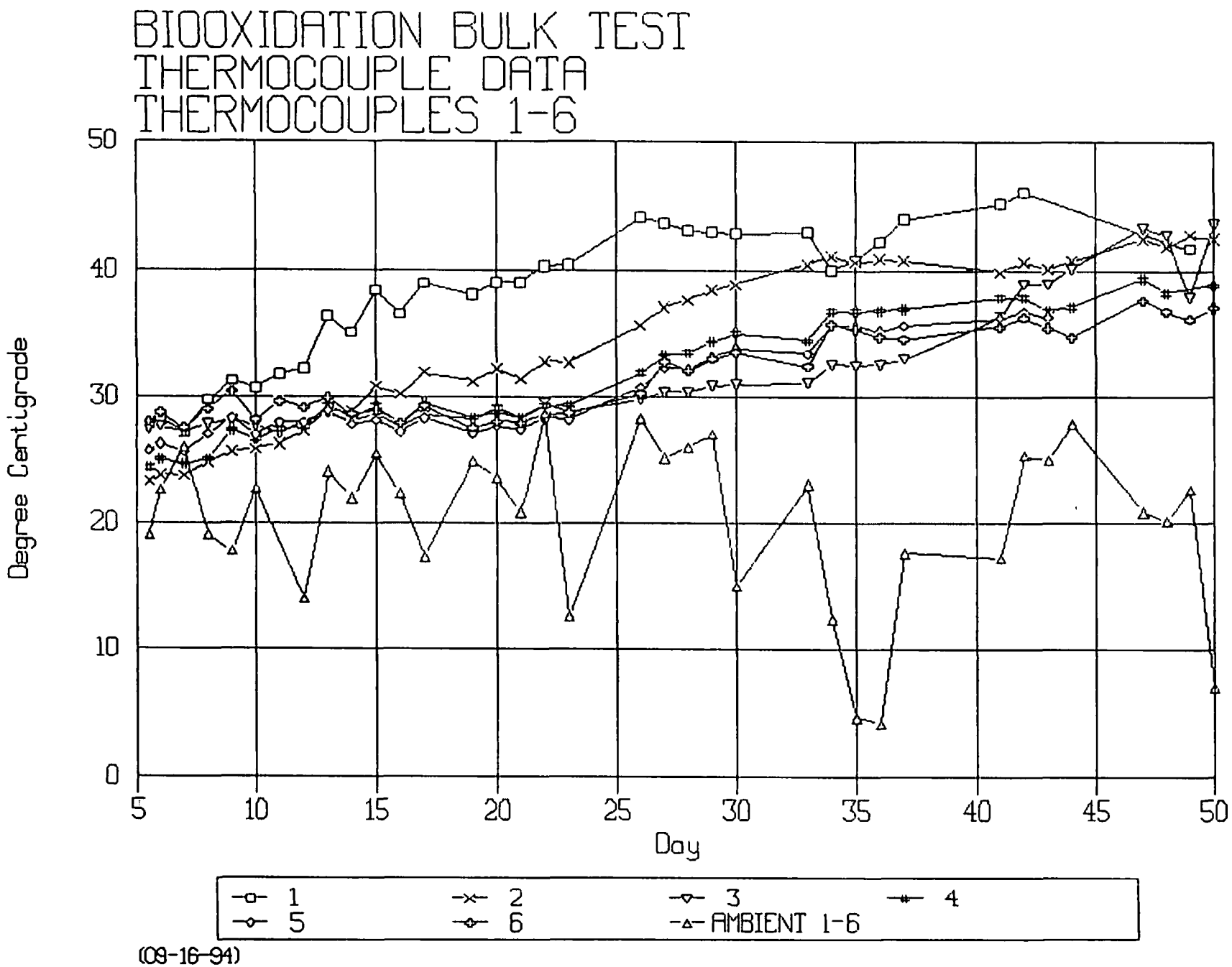
Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO (ppm)
GRAB	08/03/94	1.49	515.6	3690	17700	2100	15600	57687	66622	Dark Brown	-
GRAB	08/04/94	1.32	511.1	3930	14100	1600	12500	60119	67556	Dark Brown	-
GRAB	08/09/94	1.70	484.5	2600	4500	1400	3100	28440	38389	Dark Brown	-
GRAB	08/10/94	2.37	574.1	1740	990	36	954	11468	23641	Off Soln Flush	
GRAB	08/11/94	1.72	431.8	2000	3700	3400	300	-	-	Green Color	-
GRAB	08/12/94	1.80	439.7	2000	3900	2900	1000	20048	24627	Lt Green	3.7
GRAB	08/15/94	1.88	361.1	1940	3940	2200	1740	20543	24800	Green	2.6
GRAB	08/17/94	1.88	415.7	2030	4800	3700	1100	23073	27307	Green	2.7
GRAB	08/19/94	1.87	418.5	2170	4100	4000	100	21647	27324	-	-
GRAB	08/22/94	2.26	437.3	1920	2800	2300	500	18260	24542	Yel-Br	2.1
GRAB	08/24/94	2.12	385.4	1880	3250	2900	350	17056	25184	Lt Gr/Blue	OFL
GRAB	08/26/94	2.39	414.8	1780	3270	2290	980	16428	24641	Yel-Gr;odor	OFL
GRAB	08/29/94	2.47	402.7	1730	3260	2110	1150	16623	24698	Lt Green	OFL
GRAB	09/01/94	2.28	492.3	1700	2600	480	2120	16360	24254	Yel-Br;odor	OFL
GRAB	09/06/94	2.30	386.7	1520	3010	1830	1180	16097	25933	Bl-Gr;odor	2.5
GRAB	09/08/94	2.36	465.2	1480	2490	430	2060	16202	24534	Lt Br;ppt	4.3
GRAB	09/13/94	2.32	389.7	1170	3250	3700	-450	16019	25019	Lt Green	0.9

PAN LYSIMETER 6

Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO (ppm)
GRAB	08/11/94	1.50	532.5	2000	4480	3300	1180	-	-	Dk Brown	-
GRAB	08/12/94	1.48	554.7	3770	8900	600	8300	31953	53838	Dk Brown	3.6
GRAB	08/15/94	1.72	361.1	2560	4300	700	3600	28024	33225	Med Brown	1.4
GRAB	08/17/94	1.73	662.4	2330	4000	1200	2800	25591	30262	Stringy Ppt	2.0
GRAB	08/19/94	1.61	586.7	2190	4500	160	4340	25781	31299	-	-
GRAB	08/22/94	1.65	580.4	1770	2600	130	2470	18168	23883	Gr-Br w/Chnks	0.8
GRAB	08/24/94	1.71	588.9	1770	3520	140	3380	19463	25011	Dk Gr/Br	OFL
GRAB	08/26/94	1.70	576.5	1680	3460	120	3340	19542	25850	Yel-Br;floats	OFL
GRAB	08/29/94	1.68	694.1	1600	4270	86	4184	21586	28509	Gr-Br;Floats	OFL
GRAB	09/01/94	1.43	716.7	1620	5100	150	4950	24501	31233	Lt Gr w/Flts	OFL
GRAB	09/06/94	1.57	579.8	1550	4600	210	4390	23398	31867	Lt Gr w/Flts	4.0
GRAB	09/08/94	1.60	622.3	1530	4440	130	4310	22715	29521	Green	4.0

BIOOXIDATION BULK TEST THERMOCOUPLE DATA

Date	West 1	West 2	West 3	West 4	West 5	Mid 6	Mid 7	Mid 8	East 9	East 10	East 11	East 12	AMBIENT 1-6	AMBIENT 7-12
08/02/94	27.8	23.2	27.4	24.3	25.7	28.0	24.3	24.3	21.2	28.1	29.8	23.5	19.0	18.9
08/02/94	28.2	23.8	27.6	25.0	26.2	28.7	24.3	24.5	21.3	27.1	29.6	24.4	22.6	21.5
08/03/94	27.2	23.7	27.2	24.6	25.6	27.5	24.5	24.8	24.0	27.1	29.4	24.3	26.0	25.8
08/04/94	29.7	24.7	27.8	25.0	27.0	29.0	24.2	24.4	25.1	26.6	28.5	23.4	19.0	20.3
08/05/94	31.3	25.6	28.2	27.3	28.3	30.4	25.5	24.6	25.9	26.9	28.6	24.3	17.7	17.7
08/06/94	30.7	25.8	27.7	26.6	26.9	28.1	24.8	24.4	26.6	25.9	27.7	25.4	22.8	23.3
08/07/94	31.8	26.2	27.1	27.4	27.9	29.6	25.4	25.5	27.3	25.5	26.8	25.0	-	-
08/08/94	32.2	27.3	27.9	27.6	27.9	29.1	25.5	25.7	27.9	25.3	26.8	27.5	14.0	15.5
08/09/94	36.4	28.9	28.6	29.3	28.9	29.9	25.7	24.9	28.7	25.4	26.4	29.0	24.0	24.5
08/10/94	35.1	28.8	28.0	28.3	27.8	28.6	25.8	25.0	28.8	25.5	26.0	32.0	21.9	22.3
08/11/94	38.4	30.8	28.5	29.2	28.1	28.9	26.2	25.1	28.5	25.6	25.8	31.5	25.4	25.6
08/12/94	36.6	30.2	27.7	27.8	27.2	27.9	26.1	25.0	28.1	26.0	25.6	34.0	22.3	20.7
08/13/94	39.0	31.9	28.6	29.4	28.3	29.2	26.3	25.3	28.6	26.4	25.9	33.1	17.3	17.0
08/14/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/15/94	38.1	31.2	28.2	28.3	27.1	27.5	25.6	23.2	28.2	26.5	25.7	33.7	24.9	28.3
08/16/94	39.1	32.2	29.0	28.8	27.6	28.0	26.2	23.5	28.0	26.8	25.9	36.2	23.5	22.9
08/17/94	39.1	31.4	28.3	28.3	27.4	27.9	26.3	23.7	28.3	26.8	26.0	35.7	20.8	20.6
08/18/94	40.3	32.8	29.4	29.2	28.3	28.6	26.1	23.5	28.4	26.7	25.9	39.0	28.6	25.7
08/19/94	40.4	32.7	28.8	29.3	28.2	28.7	26.4	24.2	29.4	27.0	26.2	44.8	12.6	13.3
08/20/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/21/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/22/94	44.1	35.7	29.8	31.9	30.7	30.2	26.5	24.1	29.5	27.4	26.3	42.1	28.3	27.5
08/23/94	43.7	37.1	30.4	33.3	32.3	32.8	26.7	25.3	30.7	27.9	26.9	41.0	25.1	24.5
08/24/94	43.1	37.7	30.4	33.5	32.2	32.1	26.8	25.7	30.6	27.6	26.5	41.0	26.0	24.0
08/25/94	43.0	38.5	30.9	34.4	33.2	33.0	27.3	26.3	31.4	28.0	27.0	42.4	27.0	27.0
08/26/94	42.9	38.9	31.0	35.1	33.8	33.5	27.5	26.8	31.8	28.3	27.3	43.3	15.0	15.2
08/27/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/28/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/29/94	43.0	40.5	31.1	34.5	33.4	32.4	28.3	27.9	32.1	28.7	27.7	44.6	23.0	22.9
08/30/94	40.1	41.2	32.6	36.8	35.7	35.8	28.6	27.7	33.2	28.9	28.0	43.7	12.4	11.6
08/31/94	40.8	40.6	32.5	36.8	35.7	35.4	28.6	27.1	33.3	28.9	28.0	45.3	4.6	5.3
09/01/94	42.3	40.9	32.6	36.9	35.3	34.8	28.7	26.4	33.7	29.0	28.1	45.7	4.1	3.9
09/02/94	44.0	40.8	33.0	37.0	35.7	34.6	29.1	24.9	33.7	29.5	28.8	45.6	17.6	17.0
09/03/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/04/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/05/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/06/94	45.2	39.9	36.4	37.9	36.3	35.6	29.4	24.2	36.1	29.4	28.8	42.8	17.2	16.4
09/07/94	46.1	40.7	39.0	37.9	36.8	36.3	29.2	23.7	34.7	29.3	28.9	42.9	25.3	24.8
09/08/94	-	40.2	39.0	36.9	36.4	35.5	29.9	24.2	35.3	29.7	29.2	42.6	25.0	25.1
09/09/94	-	40.8	40.2	37.2	-	34.8	29.9	24.2	35.5	29.5	28.9	40.8	27.8	26.7
09/10/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/11/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/12/94	-	42.5	43.4	39.4	-	37.7	29.8	25.5	37.4	29.6	29.2	41.4	20.8	22.3
09/13/94	-	41.9	42.8	38.3	-	36.8	29.9	25.6	37.0	29.6	29.1	42.0	20.1	19.0
09/14/94	41.7	42.8	38.0	-	-	36.2	29.6	25.5	37.2	29.4	29.0	43.6	22.6	22.4
09/15/94	-	42.5	43.6	38.9	-	37.1	29.9	26.0	37.9	29.6	29.2	45.1	7.0	7.0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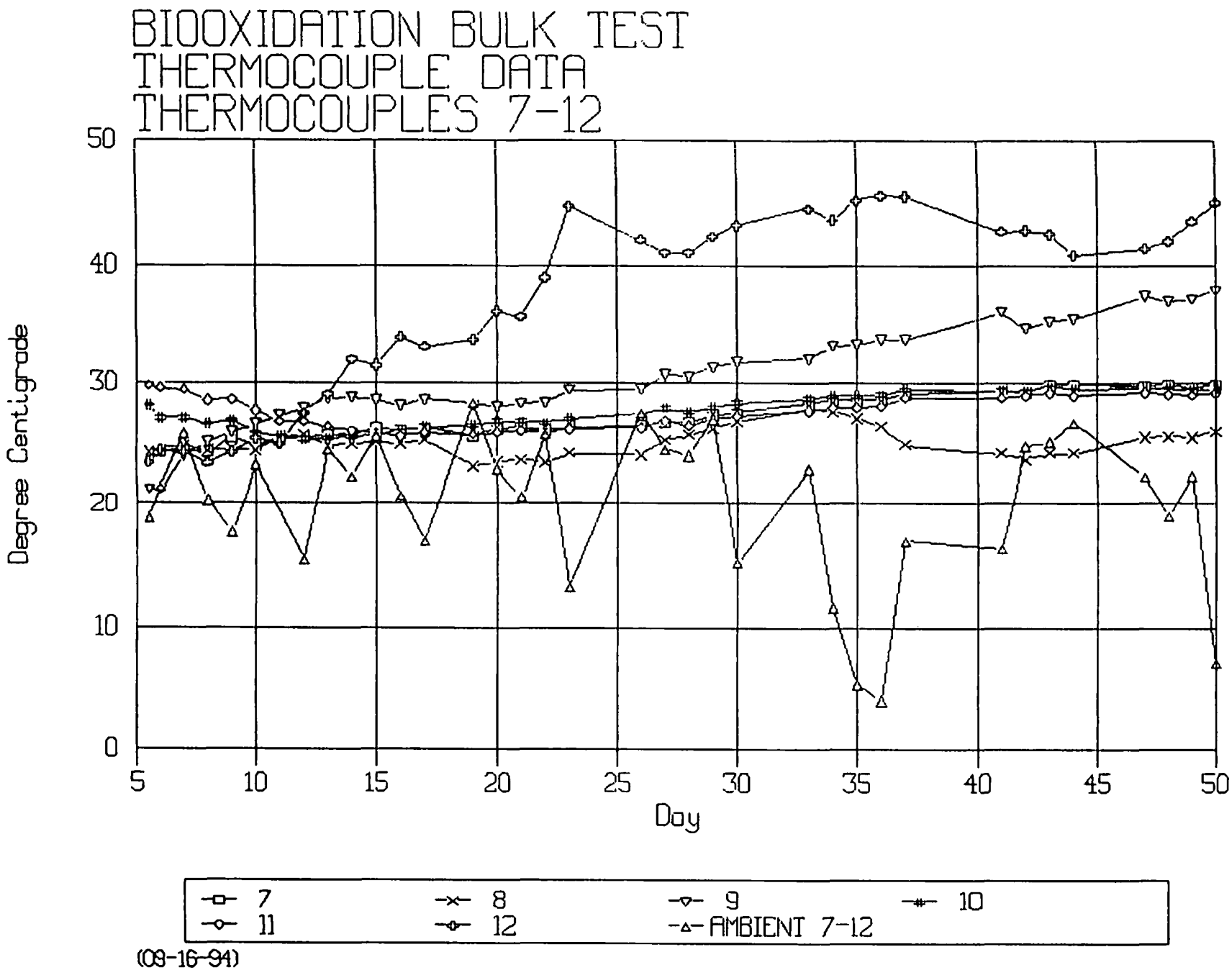
AMBIENT 1-6

(09-16-94)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THERMOCOUPLE DATA
THERMOCOUPLES 7-12
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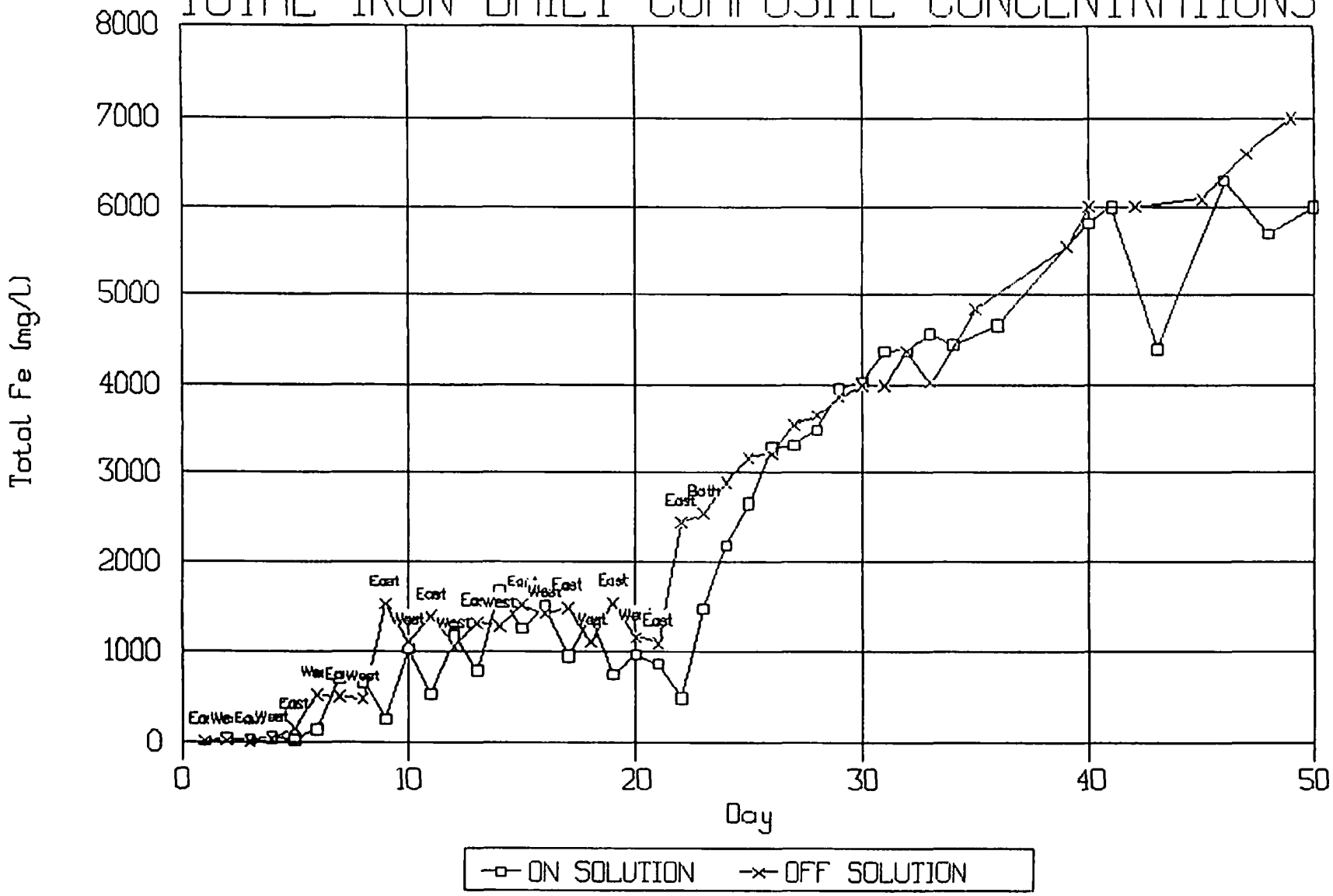
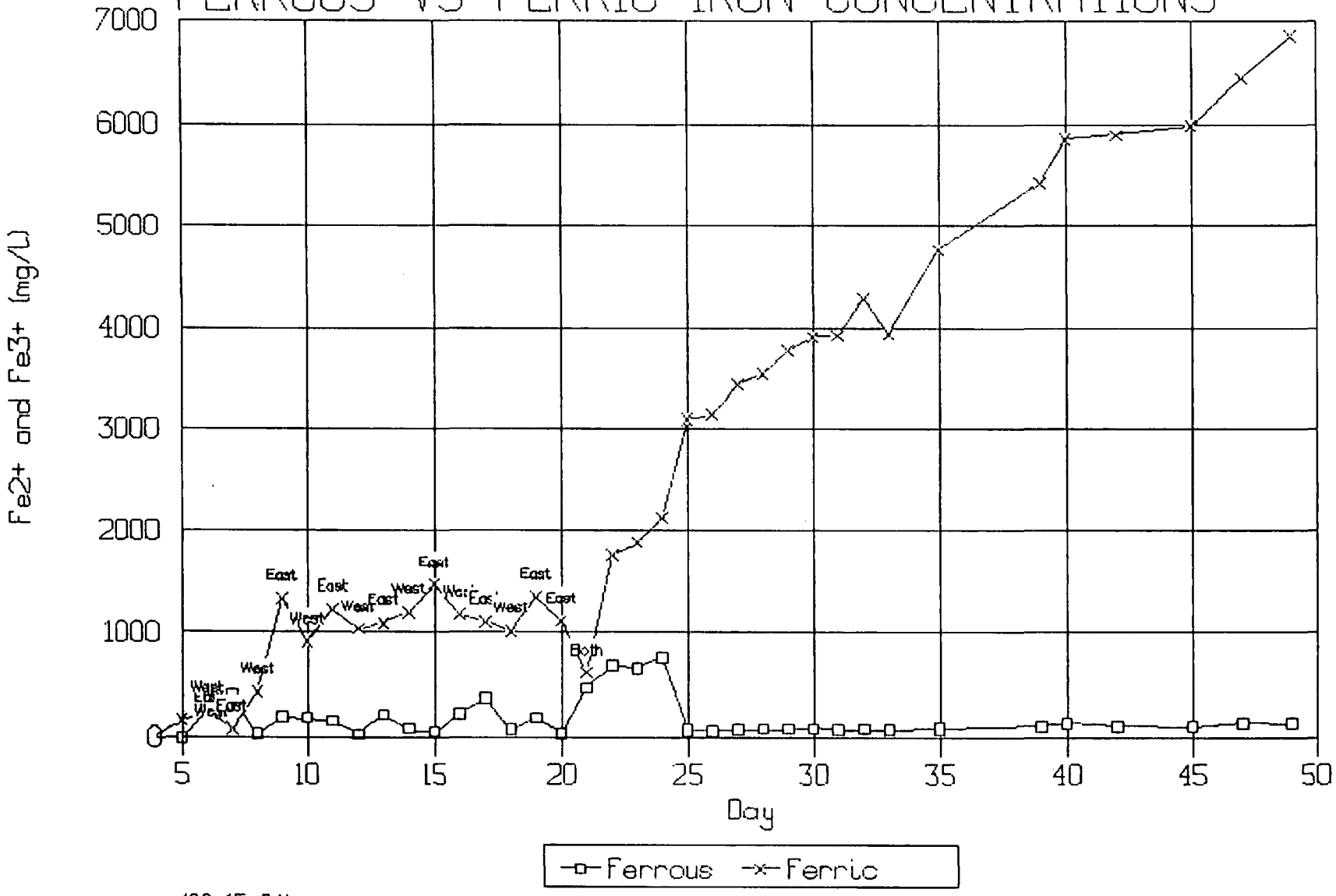
AMBIENT 7-12
(08-16-94)

BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
TOTAL IRON-DAILY COMPOSITE CONCENTRATIONS

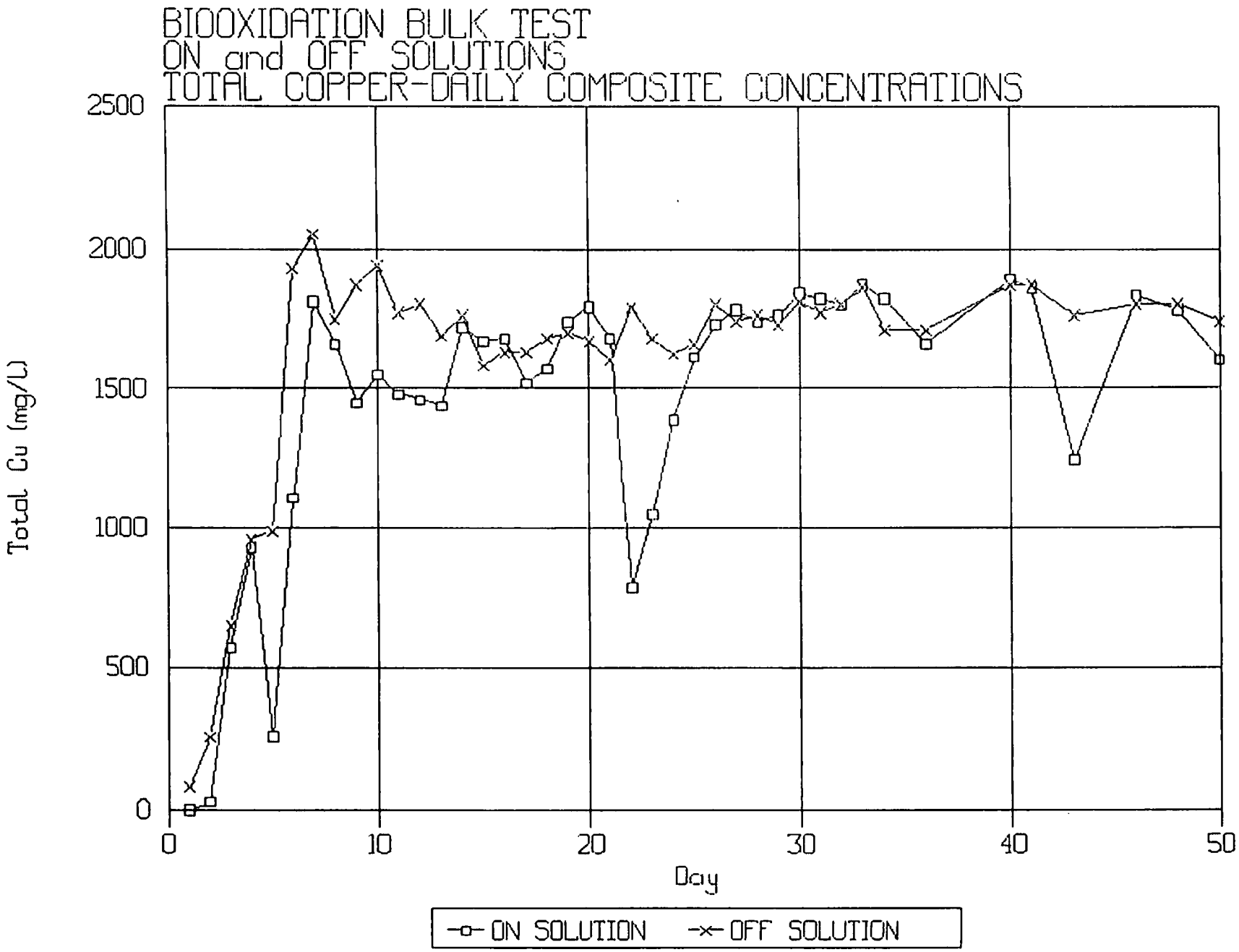


(09-15-94)

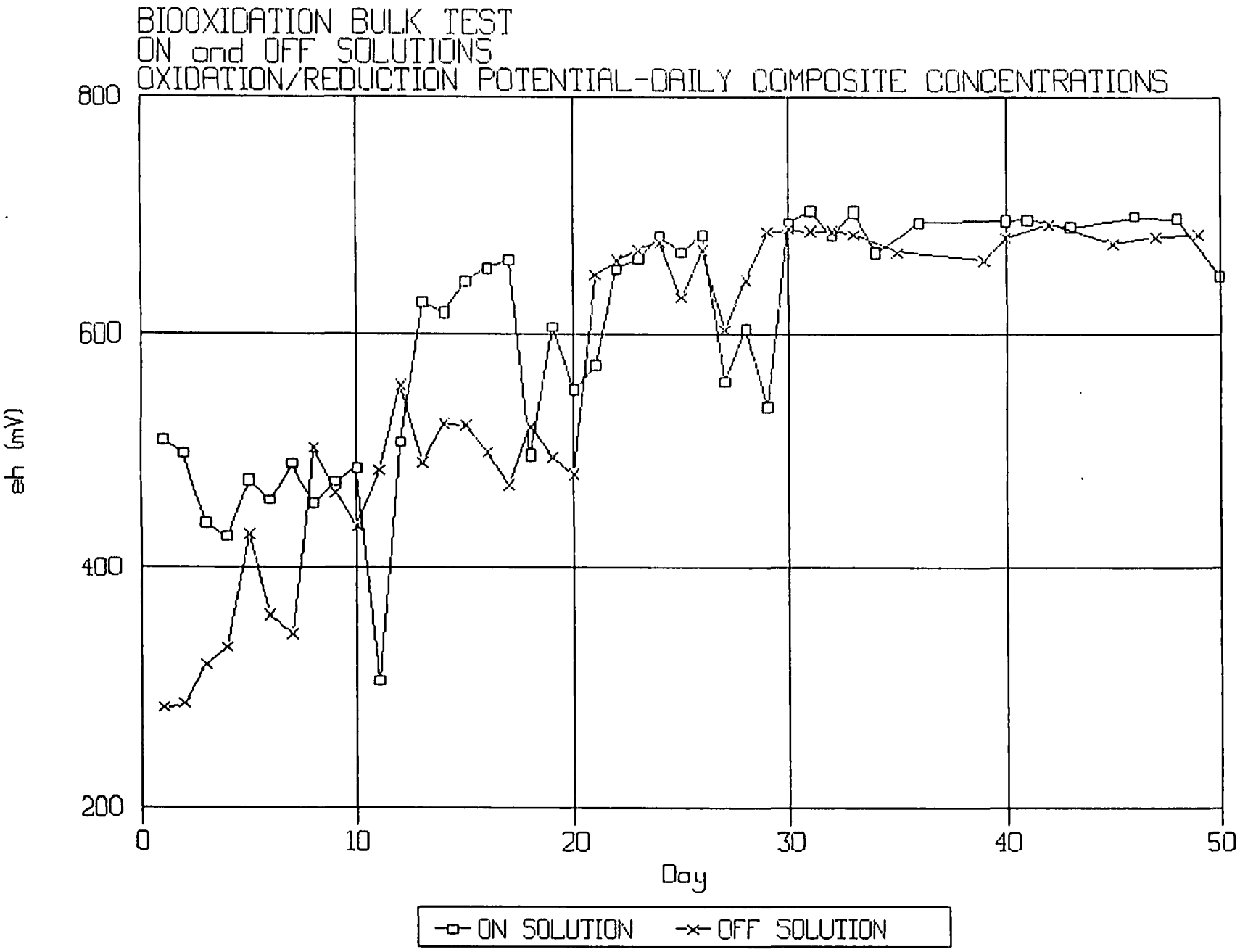
BIOOXIDATION BULK TEST
OFF SOLUTION DAILY COMPOSITE
FERROUS VS FERRIC IRON CONCENTRATIONS



(09-15-94)

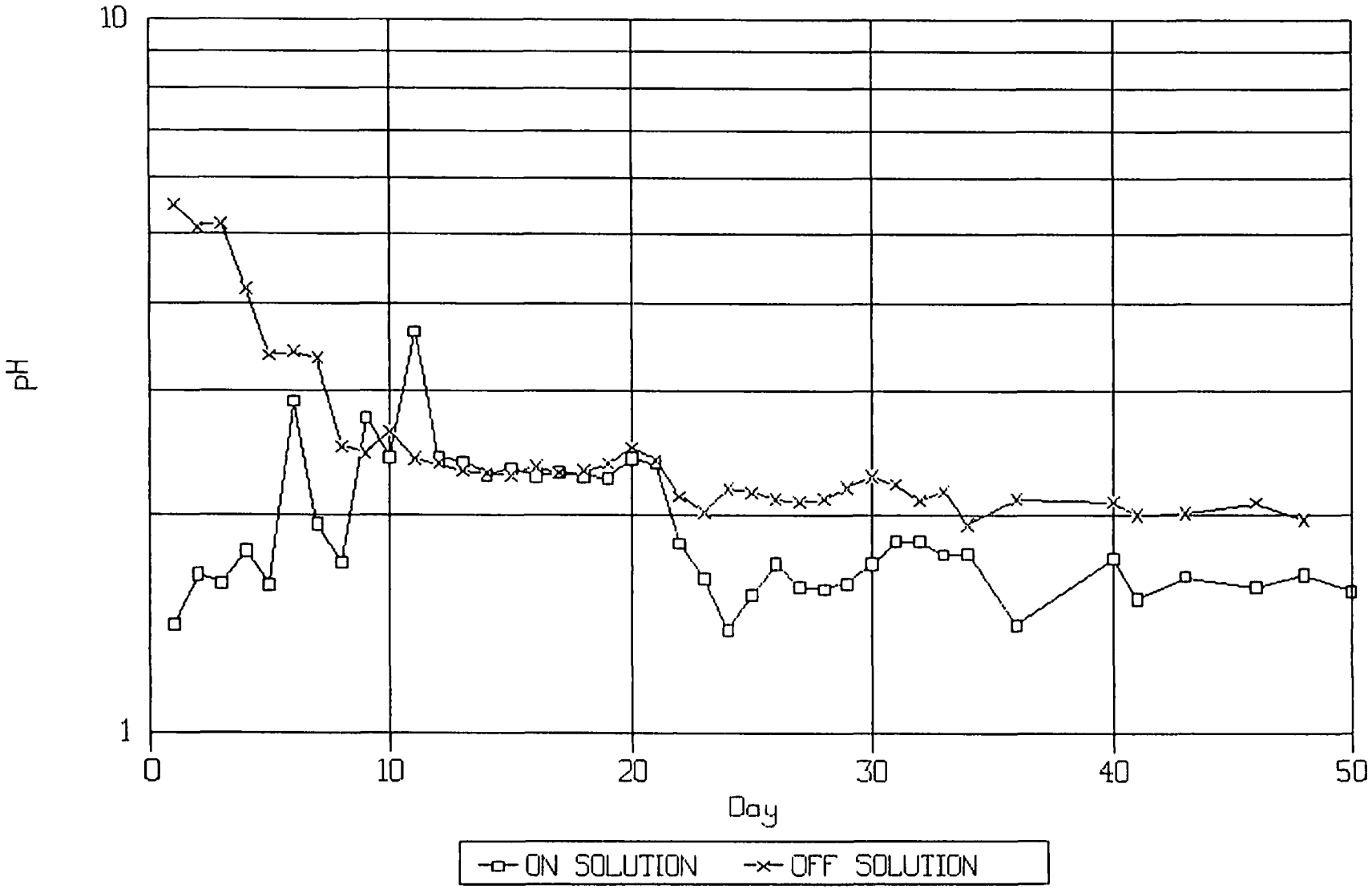

BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
TOTAL COPPER-DAILY COMPOSITE CONCENTRATIONS
Total Cu (mg/L)
2500
2000
1500
1000
500
0
0
10
20
30
40
50
Day
ON SOLUTION
OFF SOLUTION

(09-15-94)


BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
OXIDATION/REDUCTION POTENTIAL-DAILY COMPOSITE CONCENTRATIONS
800
600
400
200
eh (mV)
0
10
20
30
40
50
Day
ON SOLUTION
OFF SOLUTION

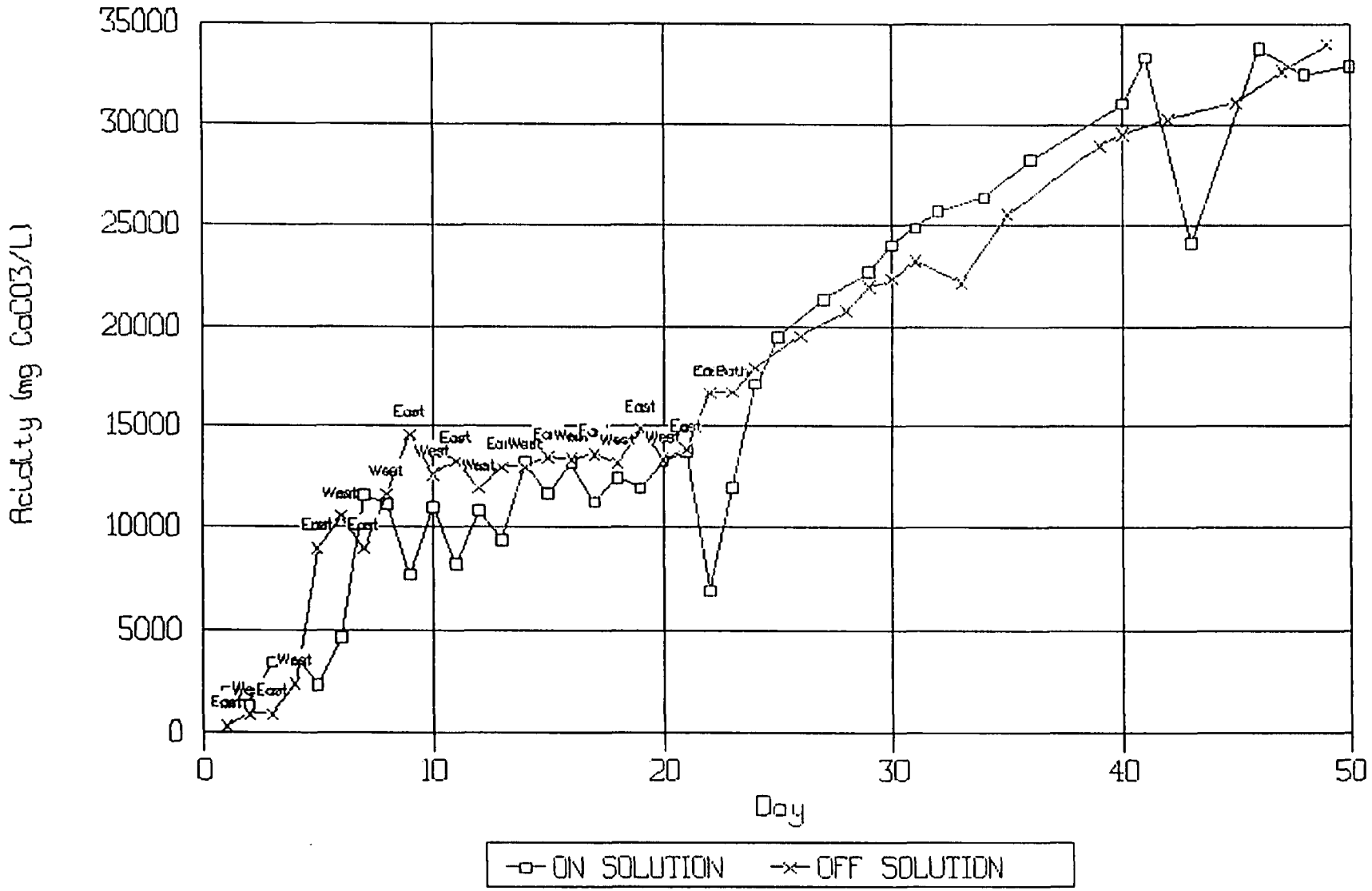
(09-15-94)

BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
pH - DAILY COMPOSITE

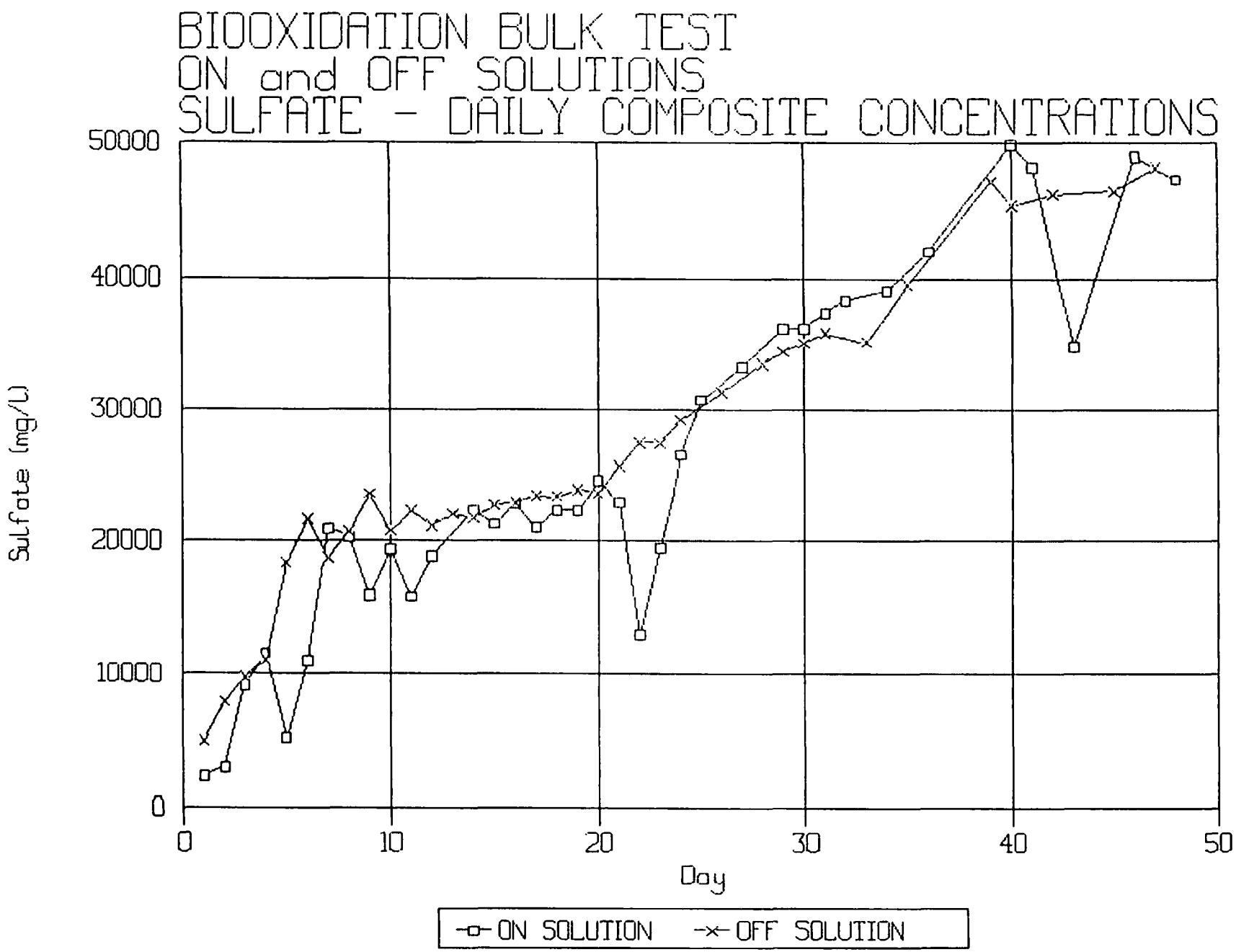


(09-15-94)

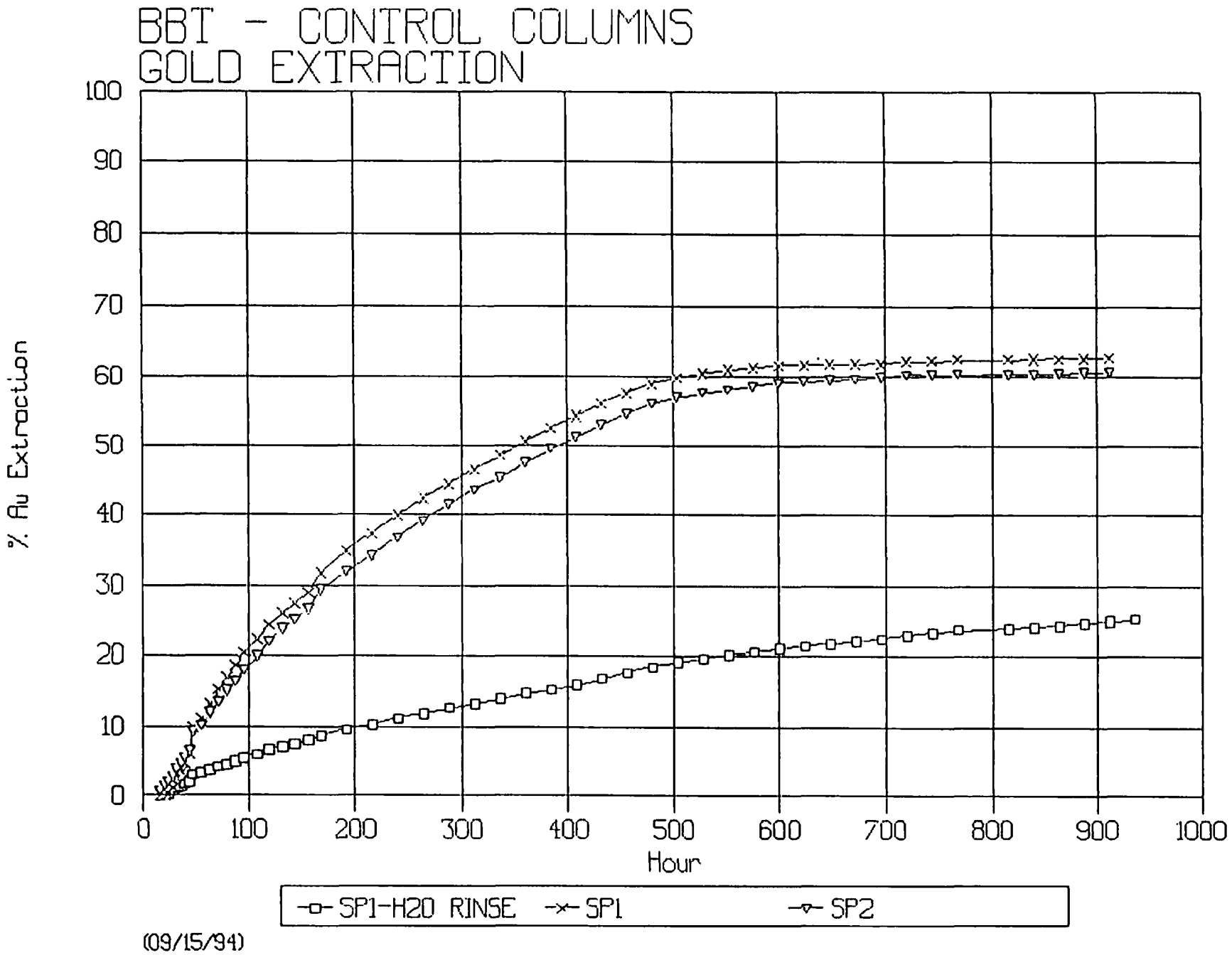
BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
ACIDITY TO pH 7-DAILY COMPOSITE CONCENTRATIONS



(09-15-94)


BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
SULFATE - DAILY COMPOSITE CONCENTRATIONS
Sulfate (mg/L)
50000
40000
30000
20000
10000
0
0
10
20
30
40
50
Day
ON SOLUTION
OFF SOLUTION

(09-13-94)


BBT - CONTROL COLUMNS
GOLD EXTRACTION
% Au Extraction
100
90
80
70
60
50
40
30
20
10
0
0
100
200
300
400
500
600
700
800
900
1000
Hour
SP1-H20 RINSE
SP1
SP2
(09/15/94)

MEMORANDUM

DATE: SEPTEMBER 9, 1994
TO: JIM THOMPSON
FROM: LAURA DAMON
SUBJECT: BIOOXIDATION BULK TEST (BBT) WEEKLY UPDATE (6)

The BBT has been on the biooxidation cycle for six weeks now. Both the west and east sides are on simultaneous solution application. The ON solution application rate has averaged 4.8 gpm this week while the OFF solution return rate has averaged 5.6 gpm. There still seems to be some discrepancy in the flow meter totalizations. There has been no line breakage or sloughing of the heap this week.

A conference call was held Tuesday, September 6th between Brohm and Geobiotics personnel. Geobiotics personnel continue to promote the use of a limestone bed neutralization system. Since previous experience with limestone neutralization at Brohm dictates that a limestone bed neutralization system is not effective, Geobiotics personnel agreed that if the system is not capable of neutralizing the 100,000+ gallons circulating in the BBT, they will pay for the pool-type tank and the limestone.

Jim Whitlock continued working with the existing neutralization circuit this week. A modification to the circuit is being implemented today. The modification consists of attaching the lime feeder directly to the mixer, bypassing the feeder trough. The lime should mix with the OFF solution more efficiently in the mixer and the precipitate will be settled in two 300 gallon tanks. The pool-type tank for the limestone bed neutralization circuit should be here next week.

Sulfuric acid is still being added to the ON solution to maintain an ON pH of 1.5 in order to reduce the internal pH of the heap and aid in the biooxidation process. The OFF solution's pH has been holding in the 2.1 range. Lysimeter data still suggest the internal pH is slightly lower at around 1.8.

The data collected to date still indicate that the bacteria are biooxidizing the sulfide ore although possibly at a much reduced rate. The total iron concentration has risen above 6000 ppm and continues to be predominantly in the form of ferric iron. The oxidation/reduction potential is maintaining an eh of 650+. The sulfate concentration continues to rise as does the acidity. The greatest thermocouple temperature increases are seen from the thermocouples placed furthest from the center of the heap (probably where aeration is the greatest). Also as depth into the pad increases, the temperature rise increases (may indicate a carbon source for the bacteria from the limestone in the drainrock).

The gold extraction graph from the control columns is attached. The water rinse column is performing poorly having attained only about 23% gold extraction in 31 days on leach. The other two control columns, with lime addition, are duplicating well with gold extractions in the 60%-62% range after 31 days on cyanide leach. The columns will be unloaded and their tails assayed in another week or two. All three columns are showing sodium cyanide consumption in the 2 lb/ton range.

c: Rod MacLeod
Martin Quick
Herb Osborne

BIOOXIDATION BULK TEST SOLUTION SAMPLING

ON SOLUTION

Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)
Orofino	7/21-8/18		(72100)	7.91	337.4	.01	1.35	-	-	-	107
	7/21-7/28	19741	19741								
GRAB-1530	07/27/94	?	19741	1.94	516.2	1.26	3.0	-	-	-	-
GRAB	07/28/94	?	19741	1.20	555.3	.16	7.8	-	-	3042	3411
COMP	07/28/94	?	19741	1.41	510.8	.10	21.6	-	-	1924	2420
COMP	07/29/94	9542	29283	1.65	498.3	29	45.0	4.1	40.9	1416	3012
COMP	07/30/94	5504	34787	1.61	438.4	574	38.0	2.2	35.8	3442	9230
COMP	07/31/94	975	35762	1.78	426.7	930	51.0	2.3	48.7	3823	11575
COMP	08/01/94	21302	57063	1.60	475.9	260	33.0	1.3	31.7	2394	5238
COMP	08/02/94	18970	76034	2.89	458.4	1110	155	71	84	4705	10999
COMP	08/03/94	16238	92272	1.94	490.0	1810	710	130	580	11581	20982
COMP	08/04/94	12021	104293	1.72	455.8	1660	660	340	320	11167	20349
COMP	08/05/94	16734	121027	2.75	475.1	1450	260	40	220	7673	15888
COMP	08/06/94	16466	137492	2.41	486.8	1550	1030	60	970	11012	19332
COMP	08/07/94	16466	153958	3.66	304.8	1480	530	60	470	8191	15810
COMP	08/08/94	16502	170460	2.40	507.9	1460	1170	110	1060	10820	18867
COMP	08/09/94	16103	186563	2.38	627.5	1440	790	25	765	9380	-
COMP	08/10/94	15624	202187	2.28	618.1	1720	1680	63	1617	13218	22369
COMP	08/11/94	16113	218300	2.33	645.4	1670	1250	33	1217	11657	21262
COMP	08/12/94	14762	233062	2.27	656.2	1680	1510	146	1364	13205	22874
COMP	08/13/94	13785	246847	2.30	663.0	1520	950	41	909	11254	21036
COMP	08/14/94	10979	257826	2.27	497.5	1570	1380	229	1151	12451	22331
COMP	08/15/94	10129	267955	2.26	606.6	1740	750	53	697	11956	22333
COMP	08/16/94	6178	274133	2.40	553.1	1790	970	51	919	13257	24698
COMP	08/17/94	6444	280577	2.36	573.3	1680	860	171	689	13713	22929
COMP	08/18/94	7205	287782	1.83	655.6	790	490	170	320	6959	12987
COMP	08/19/94	12447	300229	1.63	664.1	1050	1480	440	1040	12007	19505
COMP	08/20/94	15338	315567	1.39	683.9	1390	2190	610	1580	17135	26608
COMP	08/21/94	12497	328064	1.55	669.8	1610	2660	710	1950	19555	30681
COMP	08/22/94	11793	339857	1.71	684.8	1730	3270	75	3195	-	-
COMP	08/23/94	12099	351956	1.59	560.0	1780	3310	123	3187	21399	33274
COMP	08/24/94	11183	363139	1.58	604.9	1740	3480	82	3398	-	-
COMP	08/25/94	11114	374253	1.61	538.6	1760	3960	230	3730	22733	36228
COMP	08/26/94	9502	383755	1.71	694.7	1840	4040	94	3946	24028	36237
COMP	08/27/94	9144	392899	1.84	705.2	1820	4370	99	4271	24868	37372
COMP	08/28/94	8493	401392	1.84	684.4	1800	4380	99	4281	25735	38352
COMP	08/29/94	8859	410251	1.76	704.1	1870	4570	86	4484	-	-
COMP	08/30/94	7349	417600	1.77	669.5	1820	4450	84	4366	26418	39084
COMP	08/31/94	8940	426540	-	-	-	-	-	0	-	-
COMP	09/01/94	8784	435324	1.41	695.6	1660	4660	94	4566	28282	41981
COMP	09/02/94	5757	441081	-	-	-	-	-	0	-	-
COMP	09/03/94	7779	448860	-	-	-		-	0	-	-
COMP	09/04/94	7563	456423	-	-	-	-	-	0	-	-
COMP	09/05/94	6512	462935	1.74	697.0	1890	5820	127	5693	31066	49890
COMP	09/06/94	5907	468842	1.53	698.3	1860	6000	138	5862	33298	48170
COMP	09/07/94	6074	474916	-	-	-	-	-	0	-	-
COMP	09/08/94	8632	483548	1.64	691.8	1250	4410	86	4324	24133	

BIOOXIDATION BULK TEST SOLUTION SAMPLING

OFF SOLUTION

Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	DO (ppm)
SUMP-GRAB	07/26/94	1200	1200	7.22	-	.84	.27	-		-	-	-
GRAB-1530	07/27/94	1750	2950	7.53	305.4	.89	.20	-	-	-	-	-
COMP	07/28/94	3000	5950	5.93	353.6	83	.55	-	-	83	4411	-
COMP	07/29/94	3293	9243	5.49	282.1	255	13	-	-	362	5094	-
COMP	07/30/94	4419	13662	5.11	285.7	654	14	-	-	994	7913	-
COMP	07/31/94	2688	16350	5.18	318.8	960	11	-	-	956	9835	-
COMP	08/01/94	7822	24172	4.20	332.3	990	39	1	38	2438	11106	-
COMP	08/02/94	21836	46008	3.39	429.6	1930	172	2	170	8960	18304	-
COMP	08/03/94	14710	60718	3.43	360.1	2050	520	260	260	10520	21678	-
COMP	08/04/94	7500	68218	3.36	344.2	1750	500	410	90	8967	18731	-
COMP	08/05/94	6821	75039	2.50	503.7	1870	480	40	440	11633	20711	-
COMP	08/06/94	21396	96436	2.45	465.2	1940	1530	200	1330	14570	23591	-
COMP	08/07/94	21396	117832	2.63	435.8	1770	1110	190	920	12617	20727	-
COMP	08/08/94	18698	136530	2.40	484.6	1800	1390	160	1230	13259	22299	-
COMP	08/09/94	21118	157648	2.36	557.4	1690	1070	36	1034	11904	21180	-
COMP	08/10/94	16419	174067	2.31	491.4	1760	1320	220	1100	12958	22052	-
COMP	08/11/94	16500	190567	2.29	524.4	1580	1290	86	1204	12958	21764	-
COMP	08/12/94	18213	208780	2.28	523.1	1630	1520	56	1464	13452	22729	1.3
COMP	08/13/94	18585	227365	2.34	500.2	1630	1420	240	1180	13361	22995	1.3
COMP	08/14/94	16646	244011	2.29	472.4	1680	1490	380	1110	13608	23458	-
COMP	08/15/94	13559	257570	2.31	522.4	1700	1110	84	1026	13179	23381	-
COMP	08/16/94	12267	269837	2.36	496.4	1670	1540	196	1344	14831	23933	1.4
COMP	08/17/94	7697	277534	2.49	481.4	1600	1160	43	1117	13309	23711	2.2
COMP	08/18/94	7136	284670	2.39	650.1	1790	1100	480	620	13839	25735	1.7
COMP	08/19/94	13078	297748	2.13	663.0	1680	2450	690	1760	16703	27554	-
COMP	08/20/94	14479	312227	2.02	672.0	1620	2550	670	1880	16716	27464	-
COMP	08/21/94	14213	326440	2.18	678.3	1660	2900	770	2130	18024	29200	-
COMP	08/22/94	14246	340686	2.16	631.0	1800	3160	75	3085	-	-	-
COMP	08/23/94	13868	354554	2.11	671.3	1740	3210	73	3137	19568	31299	-
COMP	08/24/94	12742	367296	2.09	604.1	1760	3540	82	3458	-	-	.7
COMP	08/25/94	11741	379037	2.11	646.9	1730	3640	86	3554	20823	33471	5.5?
COMP	08/26/94	12505	391542	2.19	687.1	1810	3860	86	3774	22006	34443	OFL
COMP	08/27/94	11272	402814	2.27	689.5	1770	4000	94	3906	22374	35035	-
COMP	08/28/94	9000	411814	2.21	688.0	1800	4000	82	3918	23319	35858	-
COMP	08/29/94	9000	420814	2.10	688.2	1860	4370	86	4284	-	-	OFL
COMP	08/30/94	11403	432217	2.17	685.5	1710	4030	84	3946	22242	35134	13.5?
COMP	08/31/94	10726	442943	-	-	-	-	-	-	-	-	OFL
COMP	09/01/94	10299	453242	1.94	669.9	1710	4840	89	4751	25577	39562	OFL
COMP	09/02/94	9075	462317	-	-	-	-	-	-	-	-	3.9
COMP	09/03/94	8149	470466	-	-	-	-	-	-	-	-	-
COMP	09/04/94	7612	478078	-	-	-	-	-	-	-	-	-
COMP	09/05/94	7357	485435	2.11	663.7	1870	5550	120	5430	29017	47141	-
COMP	09/06/94	6870	492305	2.09	682.9	1870	6010	151	5859	29543	45273	3.5
COMP	09/07/94	6503	498808	-	-	-	-	-		-	-	6.2
COMP	09/08/94	10447	509255	2.00	693.8	1760	6010	117	5893	30304		5.5

BIOOXIDATION BULK TEST SOLUTION SAMPLING

PAN LYSIMETER 1

Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS
GRAB	08/03/94	4.55	315.3	150	3.91	-	-	-	366	-

PAN LYSIMETER 2

Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO
GRAB	08/03/94	1.64	516	3100	14100	1900	12200	40761	46775	-	
GRAB	09/01/94	1.54	527.1	1820	3250	270	2980	20378	29184	Lt-Dk Green	OFL
GRAB	09/06/94	1.65	519.4	1850	3570	190	3380	22216	33677	Lt Greenw/sed	3.5
GRAB	09/08/94	1.60	527.9	1860	5240	490	4750	27415	37150	Gr-Br;Cldy	4.5

PAN LYSIMETER 3

Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO (ppm)
GRAB	08/03/94	1.93	488.4	1540	4640	1200	3440	20005	23896	-	
GRAB	08/11/94	1.52	496.1	3200	8700	2900	5800	-	-	Brown/Murky	
GRAB	08/12/94	1.89	450.4	2200	3900	2100	1800	-	27461	Lt Brown	1.5
GRAB	08/15/94	1.92	459.5	2170	3920	1270	2650	15417	27625	Med Brown	1.7
GRAB	08/17/94	1.97	462.7	1940	3220	560	2660	19502	25159	Med Brown	2.4
GRAB	08/19/94	2.00	458.4	1850	2300	1400	900	17828	23604	-	-
GRAB	08/22/94	1.90	464.0	1760	2300	360	1940	16677	23744	Grw/Br Ti	1.9
GRAB	08/24/94	2.04	468.5	1780	2680	770	1910	16795	23028	Green	.9
GRAB	08/26/94	2.05	479.6	1730	2700	690	2010	17030	24320	Br-Yel	4.5?
GRAB	08/29/94	2.08	472.8	1770	2760	360	2400	17936	25167	Yel-Br	OFL
GRAB	09/01/94	1.79	472.3	1870	2730	730	2000	19039	26822	Green	OFL
GRAB	09/06/94	1.83	492.1	1940	2620	210	2410	19748	30237	Lt Green	2.5
GRAB	09/08/94	1.80	488.8	1980	2870	300	2570	21454	30435	Dk Green	4.3

PAN LYSIMETER 4

Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO (ppm)
GRAB	08/11/94	2.62	526.3	55	87	-	-	-		Flush H2O	-
GRAB	08/12/94	2.06	560.0	567	1260	67	1193	5282	6801	Lt Brown	4.8
GRAB	08/15/94	1.87	671.9	1260	2920	105	2815	14311	17681	Lt Brown	2.9
GRAB	08/17/94	1.71	687.2	1610	3670	102	3568	19528	23875	Med Brown	2.9
GRAB	08/19/94	1.79	659.6	1790	2900	900	2000	19280	24583	-	-
GRAB	08/22/94	1.86	615.3	1720	2000	73	1927	16285	23809	Gr-Brown	3.2
GRAB	08/24/94	1.78	678.6	1770	2420	60	2360	16481	24196	Green	OFL
GRAB	08/26/94	1.80	601.2	1710	2450	75	2375	16742	25126	Lt Gr-Yel	OFL
GRAB	08/29/94	1.92	681.5	1710	2340	60	2280	17279	26073	Lt Green	OFL
GRAB	09/01/94	1.61	698.7	1700	2380	61	2319	17647	26443	Lt Green	OFL
GRAB	09/06/94	1.75	628.7	1700	2520	71	2449	18881	29768	Lt Green	3.5
GRAB	09/08/94	1.79	681.5	1710	2710	75	2635	20168	29817	Green	4.0

PAN LYSIMETER 5

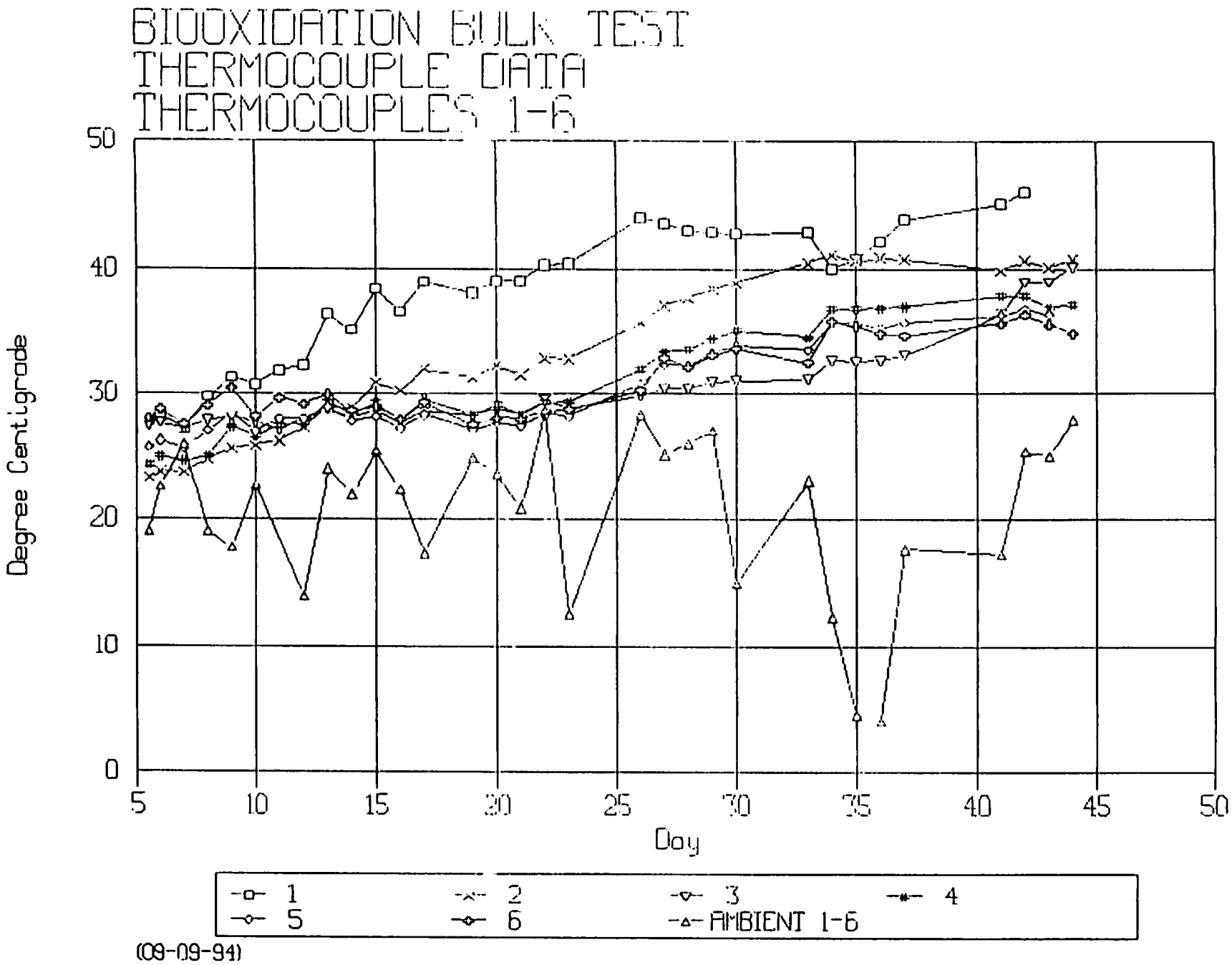
Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO (ppm)
GRAB	08/03/94	1.49	515.6	3690	17700	2100	15600	57687	66632	Dark Brown	-
GRAB	08/04/94	1.32	511.1	3930	14100	1600	12500	60119	67556	Dark Brown	-
GRAB	08/09/94	1.70	484.5	2600	4500	1400	3100	28440	38389	Dark Brown	-
GRAB	08/10/94	2.37	574.1	1740	990	36	954	11468	23641	Off Soln Flush	
GRAB	08/11/94	1.72	431.8	2000	3700	3400	300	-	-	Green Color	-
GRAB	08/12/94	1.80	439.7	2000	3900	2900	1000	20048	24627	Lt Green	3.7
GRAB	08/15/94	1.88	361.1	1940	3940	2200	1740	20543	24800	Green	2.6
GRAB	08/17/94	1.88	415.7	2030	4800	3700	1100	23073	27307	Green	2.7
GRAB	08/19/94	1.87	418.5	2170	4100	4000	100	21647	27324	-	-
GRAB	08/22/94	2.26	437.3	1920	2800	2300	500	18260	24542	Yel-Br	2.1
GRAB	08/24/94	2.12	385.4	1880	3250	2900	350	17056	25184	Lt Gr/Blue	OFL
GRAB	08/26/94	2.39	414.8	1780	3270	2290	980	16428	24641	Yel-Gr;odor	OFL
GRAB	08/29/94	2.47	402.7	1730	3260	2110	1150	16623	24698	Lt Green	OFL
GRAB	09/01/94	2.28	492.3	1700	2600	480	2120	16360	24254	Yel-Br;odor	OFL
GRAB	09/06/94	2.30	386.7	1520	3010	1830	1180	16097	25933	Bl-Gr;odor	2.5
GRAB	09/08/94	2.36	465.2	1480	2490	430	2060	16202	24534	Lt Br;ppt	4.3

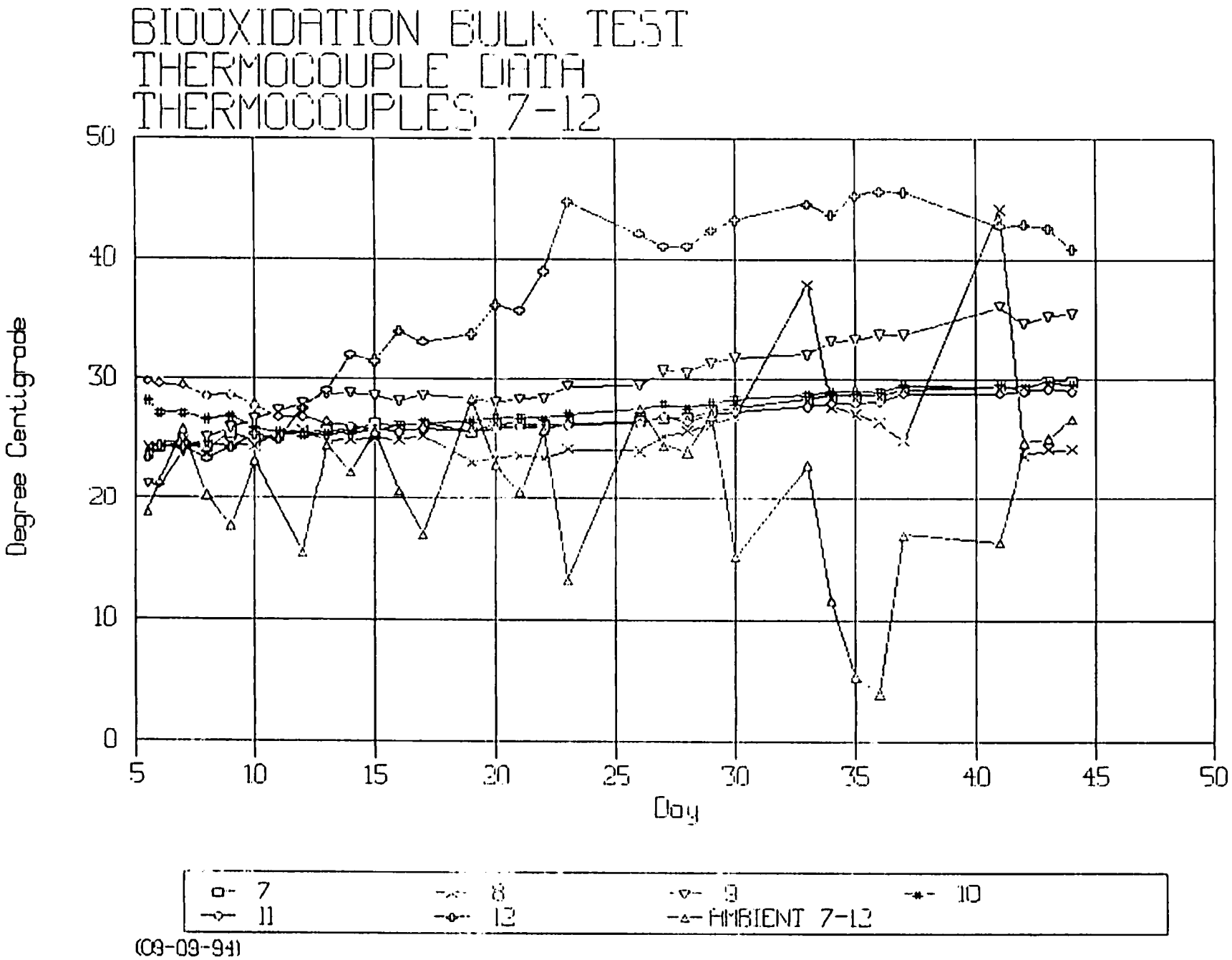
PAN LYSIMETER 6

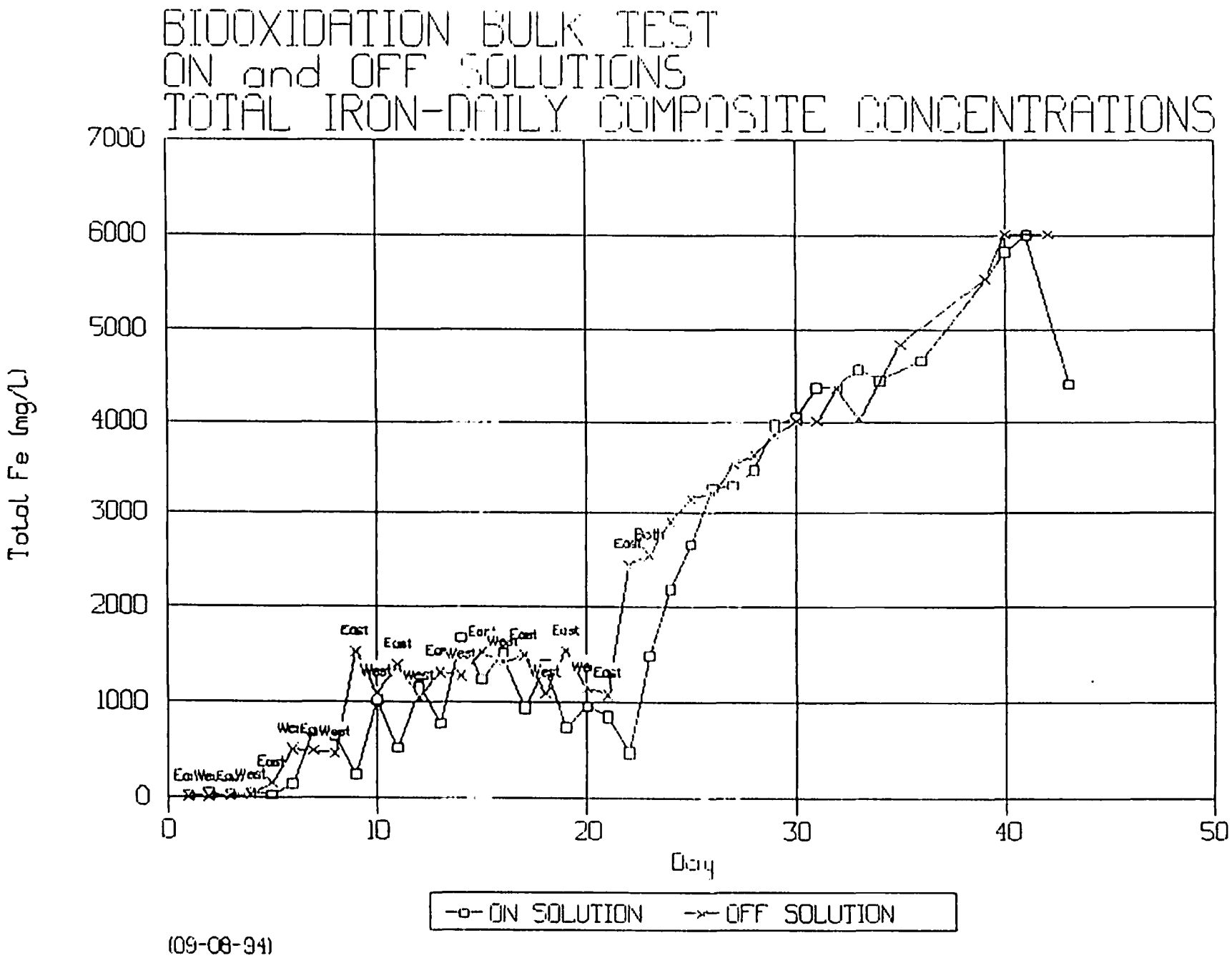
Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO (ppm)
GRAB	08/11/94	1.50	532.5	2000	4480	3300	1180	-	-	Dk Brown	-
GRAB	08/12/94	1.48	554.7	3770	8900	600	8300	31953	53838	Dk Brown	3.6
GRAB	08/15/94	1.72	361.1	2560	4300	700	3600	28024	33225	Med Brown	1.4
GRAB	08/17/94	1.73	662.4	2330	4000	1200	2800	25591	30262	Stringy Ppt	2.0
GRAB	08/19/94	1.61	586.7	2190	4500	160	4340	25781	31299	-	-
GRAB	08/22/94	1.65	580.4	1770	2600	130	2470	18168	23883	Gr-Br w/Chnks	0.8
GRAB	08/24/94	1.71	588.9	1770	3520	140	3380	19463	25011	Dk Gr/Br	OFL
GRAB	08/26/94	1.70	576.5	1680	3460	120	3340	19542	25850	Yel-Br;floats	OFL
GRAB	08/29/94	1.68	694.1	1600	4270	86	4184	21586	28509	Gr-Br;Floats	OFL
GRAB	09/01/94	1.43	716.7	1620	5100	150	4950	24501	31233	Lt Gr w/Flts	OFL
GRAB	09/06/94	1.57	579.8	1550	4600	210	4390	23398	31867	Lt Gr w/Flts	4.0
GRAB	09/08/94	1.60	622.3	1530	4440	130	4310	22715	29521	Green	4.0

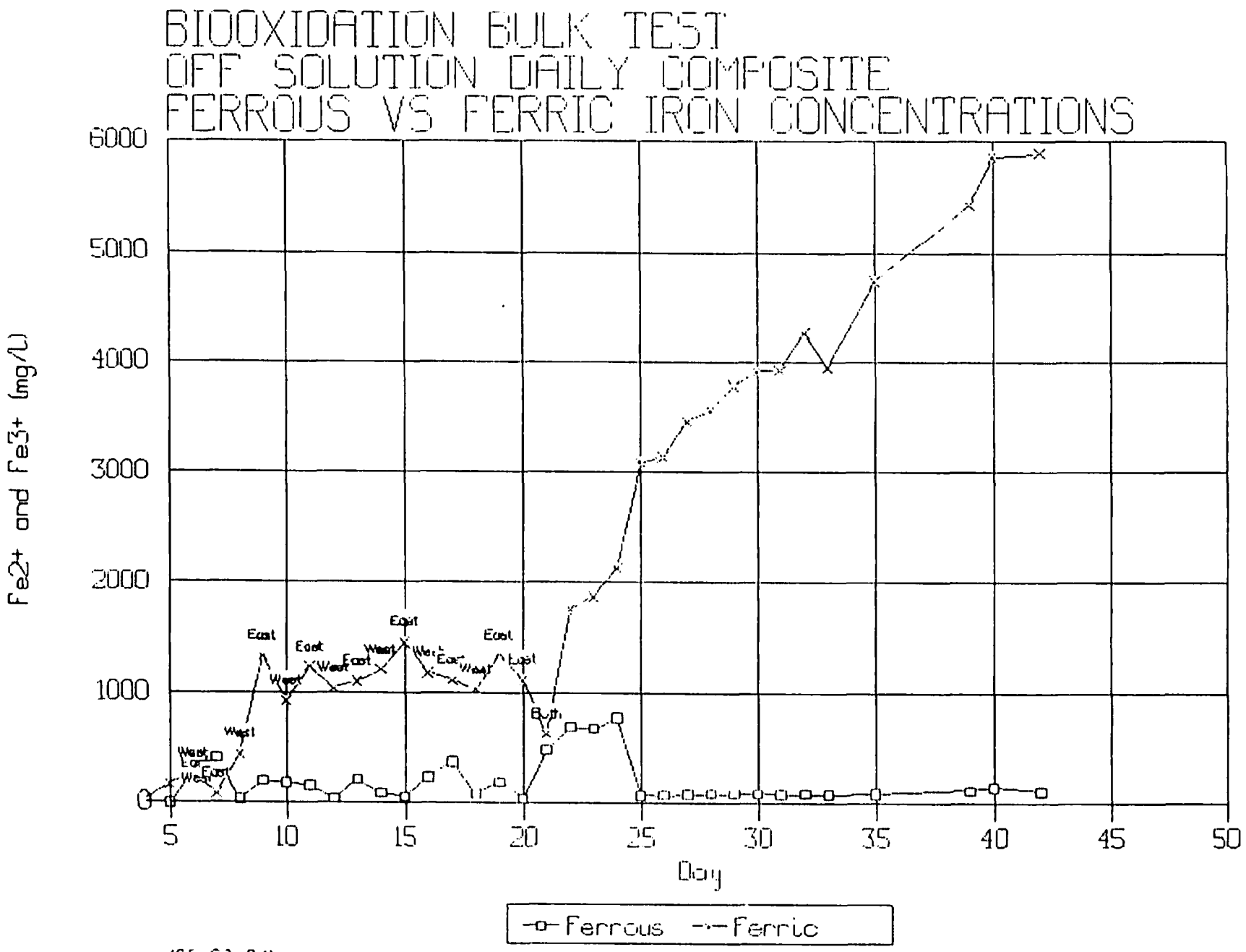
BIOOXIDATION BULK TEST THERMOCOUPLE DATA

Date	West 1	West 2	West 3	West 4	West 5	Mid 6	Mid 7	Mid 8	East 9	East 10	East 11	East 12	AMBIENT 1-6	AMBIENT 7-12
08/02/94	27.8	23.2	27.4	24.3	25.7	28.0	24.3	24.3	21.2	28.1	29.8	23.5	19.0	18.9
08/02/94	28.2	23.8	27.6	25.0	26.2	28.7	24.3	24.5	21.3	27.1	29.6	24.4	22.6	21.5
08/03/94	27.2	23.7	27.2	24.6	25.6	27.5	24.5	24.8	24.0	27.1	29.4	24.3	26.0	25.8
08/04/94	29.7	24.7	27.8	25.0	27.0	29.0	24.2	24.4	25.1	26.6	28.5	23.4	19.0	20.3
08/05/94	31.3	25.6	28.2	27.3	28.3	30.4	25.5	24.6	25.9	26.9	28.6	24.3	17.7	17.7
08/06/94	30.7	25.8	27.7	26.6	26.9	28.1	24.8	24.4	26.6	25.9	27.7	25.4	22.8	23.3
08/07/94	31.8	26.2	27.1	27.4	27.9	29.6	25.4	25.5	27.3	25.5	26.8	25.0	-	-
08/08/94	32.2	27.3	27.9	27.6	27.9	29.1	25.5	25.7	27.9	25.3	26.8	27.5	14.0	15.5
08/09/94	36.4	28.9	28.6	29.3	28.9	29.9	25.7	24.9	28.7	25.4	26.4	29.0	24.0	24.5
08/10/94	35.1	28.8	28.0	28.3	27.8	28.6	25.8	25.0	28.8	25.5	26.0	32.0	21.9	22.3
08/11/94	38.4	30.8	28.5	29.2	28.1	28.9	26.2	25.1	28.5	25.6	25.8	31.5	25.4	25.6
08/12/94	36.6	30.2	27.7	27.8	27.2	27.9	26.1	25.0	28.1	26.0	25.6	34.0	22.3	20.7
08/13/94	39.0	31.9	28.6	29.4	28.3	29.2	26.3	25.3	28.6	26.4	25.9	33.1	17.3	17.0
08/14/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/15/94	38.1	31.2	28.2	28.3	27.1	27.5	25.6	23.2	28.2	26.5	25.7	33.7	24.9	28.3
08/16/94	39.1	32.2	29.0	28.8	27.6	28.0	26.2	23.5	28.0	26.8	25.9	36.2	23.5	22.9
08/17/94	39.1	31.4	28.3	28.3	27.4	27.9	26.3	23.7	28.3	26.8	26.0	35.7	20.8	20.6
08/18/94	40.3	32.8	29.4	29.2	28.3	28.6	26.1	23.5	28.4	26.7	25.9	39.0	28.6	25.7
08/19/94	40.4	32.7	28.8	29.3	28.2	28.7	26.4	24.2	29.4	27.0	26.2	44.8	12.6	13.3
08/20/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/21/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/22/94	44.1	35.7	29.8	31.9	30.7	30.2	26.5	24.1	29.5	27.4	26.3	42.1	28.3	27.5
08/23/94	43.7	37.1	30.4	33.3	32.3	32.8	26.7	25.3	30.7	27.9	26.9	41.0	25.1	24.5
08/24/94	43.1	37.7	30.4	33.5	32.2	32.1	26.8	25.7	30.6	27.6	26.5	41.0	26.0	24.0
08/25/94	43.0	38.5	30.9	34.4	33.2	33.0	27.3	26.3	31.4	28.0	27.0	42.4	27.0	27.0
08/26/94	42.9	38.9	31.0	35.1	33.8	33.5	27.5	26.8	31.8	28.3	27.3	43.3	15.0	15.2
08/27/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/28/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/29/94	43.0	40.5	31.1	34.5	33.4	32.4	28.3	37.9	32.1	28.7	27.7	44.6	23.0	22.9
08/30/94	40.1	41.2	32.6	36.8	35.7	35.8	28.6	27.7	33.2	28.9	28.0	43.7	12.4	11.6
08/31/94	40.8	40.6	32.5	36.8	35.7	35.4	28.6	27.1	33.3	28.9	28.0	45.3	4.6	5.3
09/01/94	42.3	40.9	32.6	36.9	35.3	34.8	28.7	26.4	33.7	29.0	28.1	45.7	4.1	3.9
09/02/94	44.0	40.8	33.0	37.0	35.7	34.6	29.1	24.9	33.7	29.5	28.8	45.6	17.6	17.0
09/03/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/04/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/05/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09/06/94	45.2	39.9	36.4	37.9	36.3	35.6	29.4	44.2	36.1	29.4	28.8	42.8	17.2	16.4
09/07/94	46.1	40.7	39.0	37.9	36.8	36.3	29.2	23.7	34.7	29.3	28.9	42.9	25.3	24.8
09/08/94	-	40.2	39.0	36.9	36.4	35.5	29.9	24.2	35.3	29.7	29.2	42.6	25.0	25.1
09/09/94	-	40.8	40.2	37.2	-	34.8	29.9	24.2	35.5	29.5	28.9	40.8	27.8	26.7

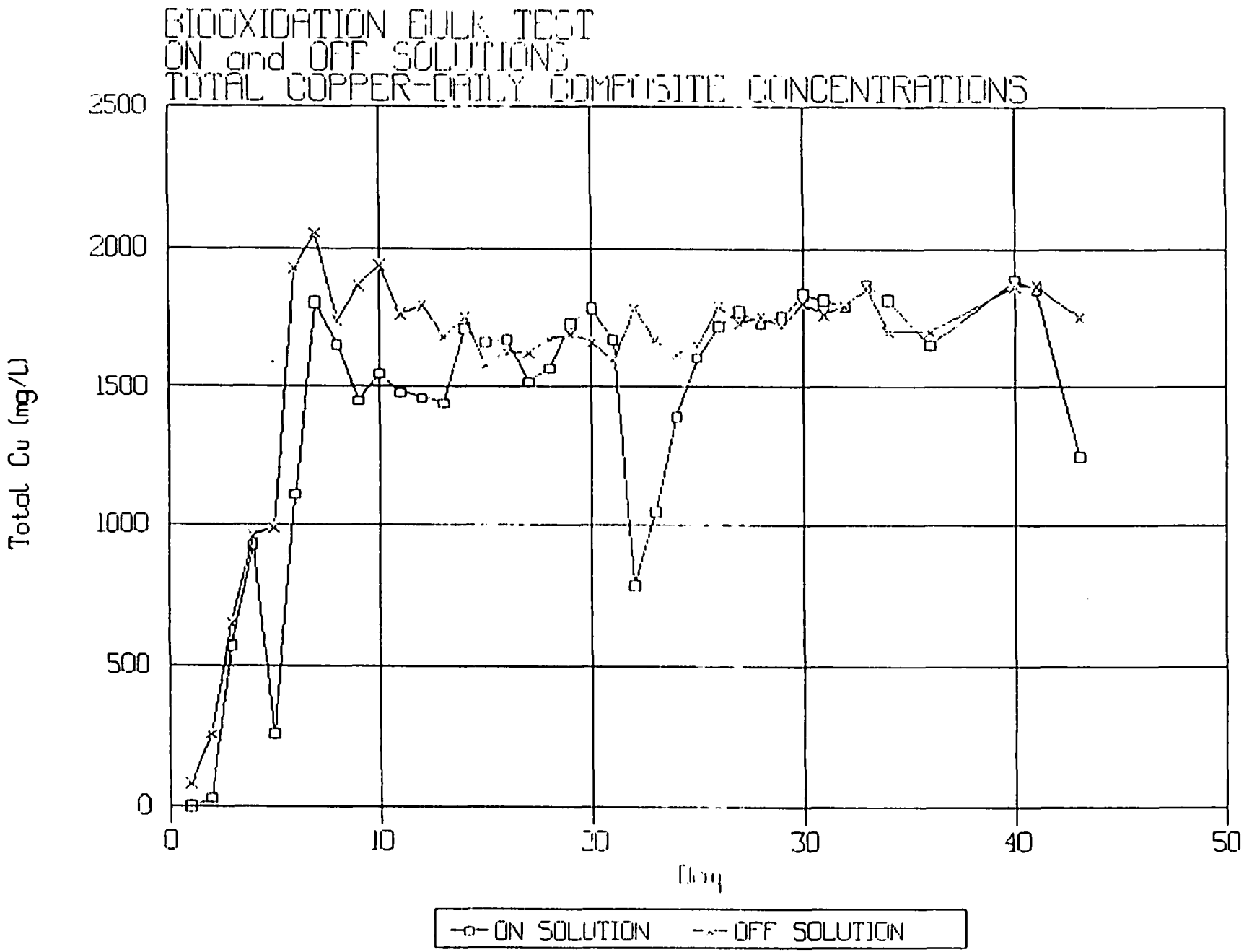

BIOOXIDATION BULK TEST
THERMOCOUPLE DATA
THERMOCOUPLES 1-6
Degree Centigrade
0
10
20
30
40
50
5
10
15
20
25
30
35
40
45
50
Day
1
2
3
4
5
6
AMBIENT 1-6
(09-09-94)


BIOOXIDATION BULK TEST
THERMOCOUPLE DATA
THERMOCOUPLES 7-12
Degree Centigrade
50
40
30
20
10
0
5
10
15
20
25
30
35
40
45
50
Day
7
8
9
10
11
12
AMBIENT 7-12
(09-09-94)

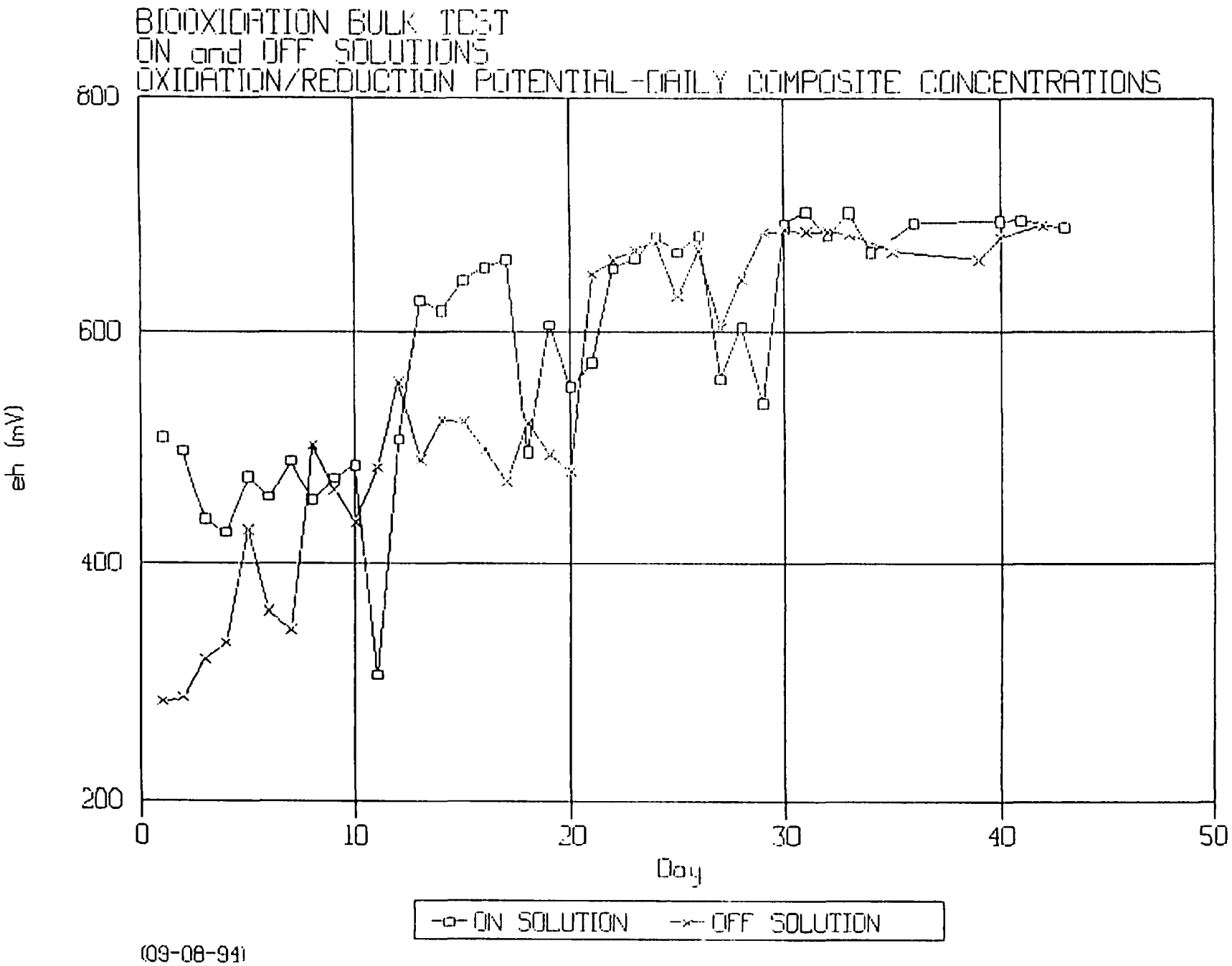

BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
TOTAL IRON-DAILY COMPOSITE CONCENTRATIONS
Total Fe (mg/L)
7000
6000
5000
4000
3000
2000
1000
0
0
10
20
30
40
50
Day
ON SOLUTION
OFF SOLUTION
(09-08-94)

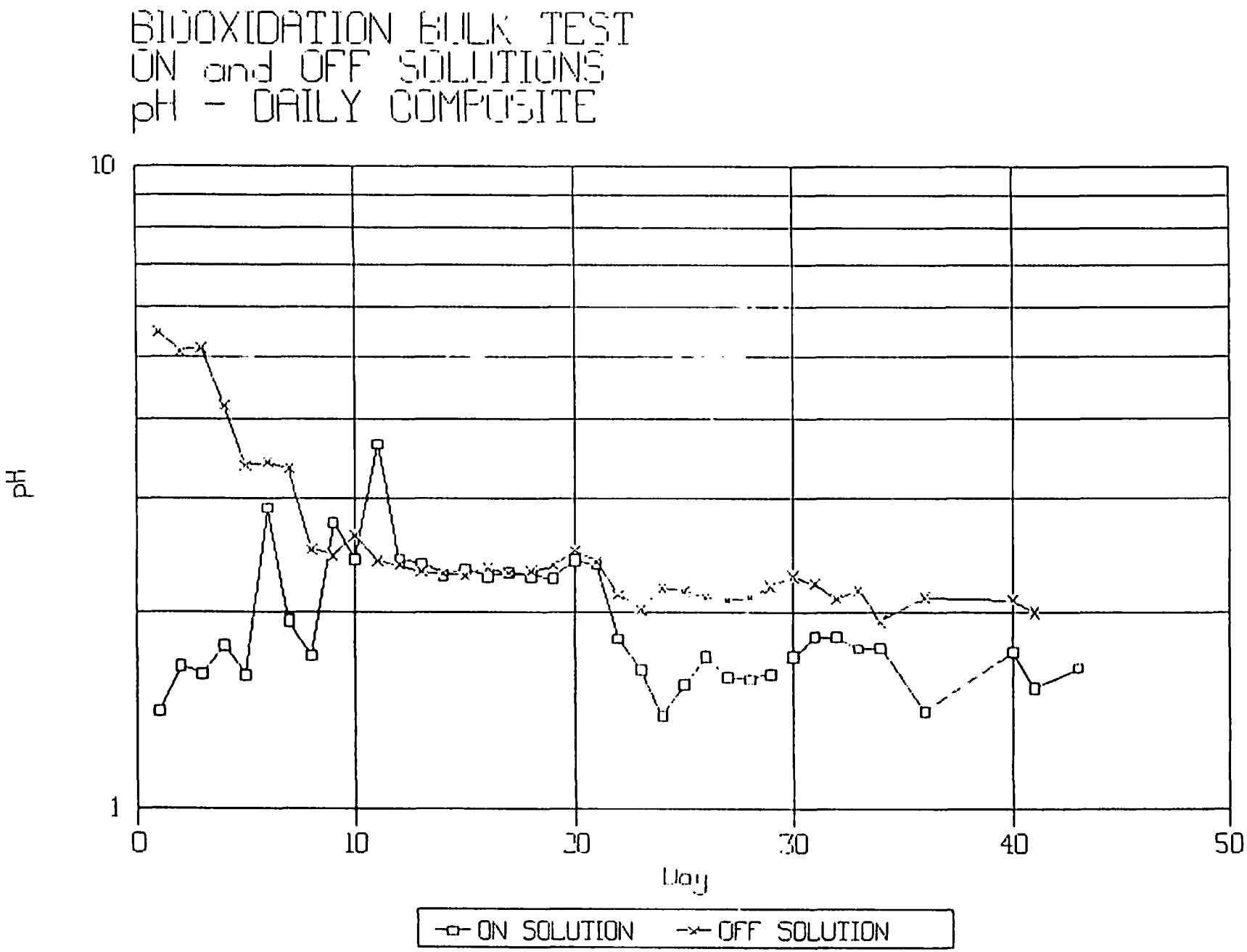

BIOOXIDATION BULK TEST
OFF SOLUTION DAILY COMPOSITE
FERROUS VS FERRIC IRON CONCENTRATIONS
Fe2+ and Fe3+ (mg/L)
6000
5000
4000
3000
2000
1000
0
5
10
15
20
25
30
35
40
45
50
Day
East
West
Both
Ferrous
Ferric

(09-08-94)


BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
TOTAL COPPER-DAILY COMPOSITE CONCENTRATIONS
Total Cu (mg/L)
2500
2000
1500
1000
500
0
0
10
20
30
40
50
Day
ON SOLUTION
OFF SOLUTION

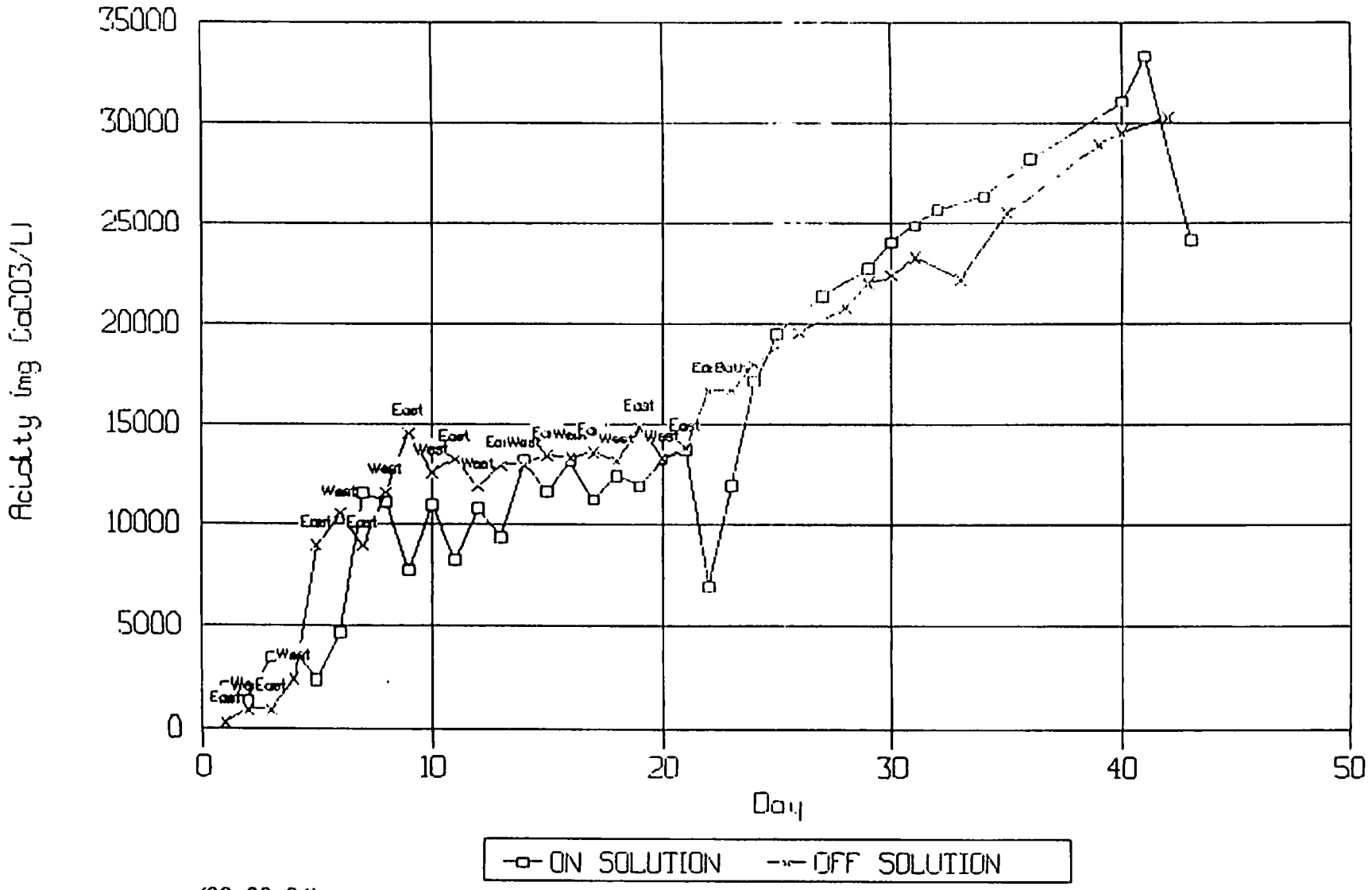
(09-08-94)


BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
OXIDATION/REDUCTION POTENTIAL-DAILY COMPOSITE CONCENTRATIONS
800
600
400
200
eh (mV)
0
10
20
30
40
50
Day
ON SOLUTION
OFF SOLUTION
(09-08-94)

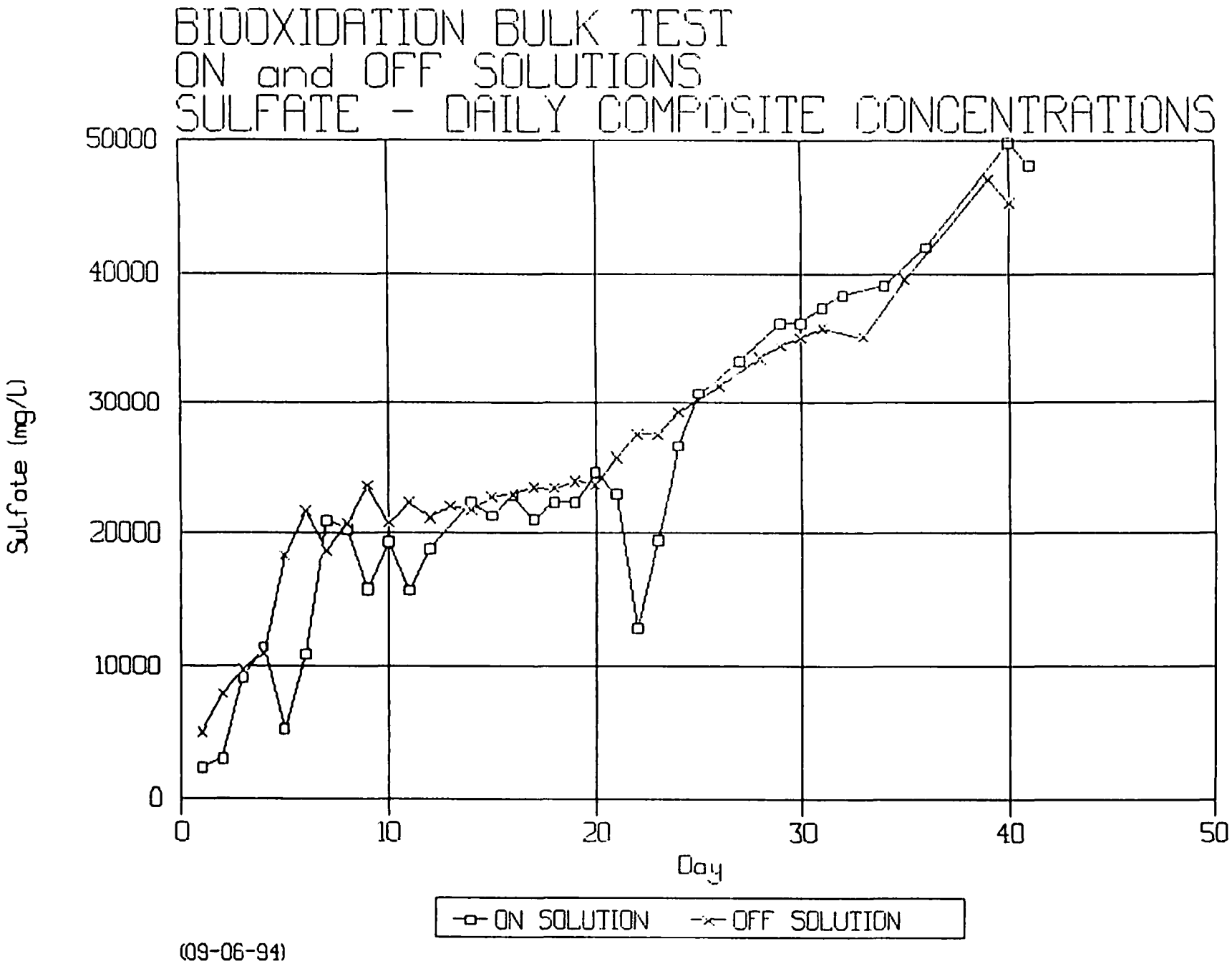

BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
pH - DAILY COMPOSITE
10
1
pH
0
10
20
30
40
50
Day
ON SOLUTION
OFF SOLUTION

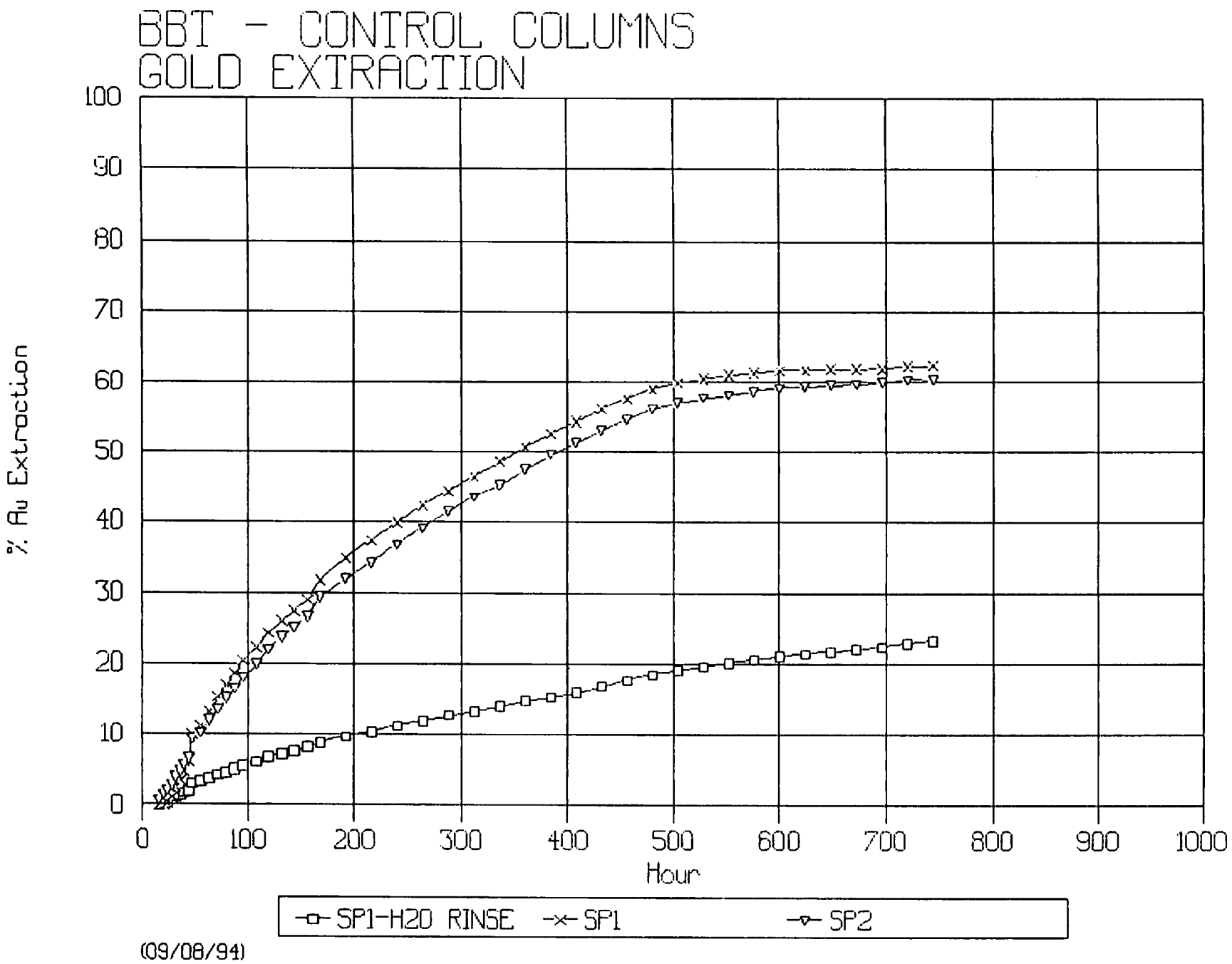
(09-08-94)

BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
ACIDITY TO pH 7-DAILY COMPOSITE CONCENTRATIONS



(09-08-94)


BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
SULFATE - DAILY COMPOSITE CONCENTRATIONS
Sulfate (mg/L)
50000
40000
30000
20000
10000
0
0
10
20
30
40
50
Day
ON SOLUTION
OFF SOLUTION
(09-06-94)


BBT - CONTROL COLUMNS
GOLD EXTRACTION
% Au Extraction
100
90
80
70
60
50
40
30
20
10
0
0
100
200
300
400
500
600
700
800
900
1000
Hour
SP1-H2O RINSE
SP1
SP2
(09/08/94)

MEMORANDUM

DATE: SEPTEMBER 2, 1994
TO: JIM THOMPSON
FROM: LAURA DAMON
SUBJECT: BIOOXIDATION BULK TEST (BBT) WEEKLY UPDATE (5)

The BBT has been on the biooxidation cycle for five weeks now. Both the west and east sides are on simultaneous solution application. The ON solution application rate has averaged 6.3 gpm this week while the OFF solution return rate has averaged 7.5 gpm. Although occasional rain showers Monday-Wednesday may account for some of the ON-OFF solution flow difference, there seems to be a discrepancy in the flow meter totalizations. There has been no line breakage or sloughing of the heap this week.

A conference call was held Monday, August 29th between Brohm and Geobiotics personnel. Discussed were the need for neutralization of the OFF solution metals and how the neutralization could be accomplished. Geobiotics lab data suggests that the BBT's OFF solution iron concentration should be on the order of 10,000 ppm after 30 days on the biooxidation cycle. Since the iron concentration is only about 4000 ppm, Bill Kohr feels, again from lab column data, that the metal concentration in the solution is inhibiting the growth of the bacteria and consequently the biooxidation reaction. With a neutralization circuit implemented on a short term basis (to neutralize the 100,000 gallons circulating in the system) Bill thinks that 10% oxidation can be achieved within the month of September and a total of 20% oxidation can be achieved by the end of October, weather permitting. Due to the limited time frame in which to obtain test results, it was decided that neutralization of the metals in solution should be implemented as soon as possible to determine if the metal concentration is the limiting factor for the bacteria growth and/or if there are other limiting factors such as air supply or temperature.

Rich Crowell, Geobiotics, spent this week at Brohm working with Jim Whitlock to try and get the existing neutralization circuit working with some modifications. Since only a pH of about 4 could be reached with lime addition alone, a follow-up conference call on Thursday, September 1st, including Herb Osborne, yielded a plan to use soda ash as a polishing step for the lime neutralization. Geobiotics personnel are developing a limestone neutralization circuit which they feel will work for acidity control. This will be discussed during the conference call next week.

Sulfuric acid is still being added to the ON solution to maintain an ON pH of 1.5 in order to reduce the internal pH of the heap and aid in the biooxidation process. The OFF solution's pH has been holding in the 2.1 range. Lysimeter data still suggest the internal pH is slightly lower at around 1.8.

The data collected to date still indicate that the bacteria are biooxidizing the sulfide ore although Bill Kohr thinks at a much reduced rate. The iron ions continue to be predominantly in the form of ferric iron. The oxidation/reduction potential is maintaining an eh of 650+ which indicates optimal conditions. The sulfate concentration continues to rise. Thermocouple temperatures for #1 and #12 (located near the lower corners of the heap where there may be more aeration) continue to stay over 40 degree centigrade. #2 has risen significantly this week and #3-#6 (located mainly on the west side of the heap) show an upward trend in temperature. #7-#11 (located mainly on the east side of the heap) have maintained fairly constant temperatures.

The first auger drill samples were collected from the heap on August 23rd. Three 15′ holes were drilled, one on the west side of the heap, one on the east side and one in the middle of the heap. The samples were composited from each hole in 5′ intervals. Each sample was assayed for total sulfur and sulfate content, iron and copper. The assay data is attached. The calculated sulfide percents are higher in the auger samples than in the control BBT SP2 composite sample indicating little if any oxidation. (It must be realized that these auger samples represent one isolated area in the heap so assays will differ from composite assays to some extent.) The 0′-5′ and 10′-15′ interval assay averages from the three holes are slightly lower in iron and sulfide content than the 5′-10′ interval average. It may be that the 0′-5′ and 10′-15′ intervals have more aeration causing a slightly faster rate of oxidation. Another interesting observation is that the east hole average is somewhat lower in iron, copper and sulfide content. This corresponds to the OFF solution iron concentration peaks seen when the ON solution was being applied to the east side of the heap.

The gold extraction graph from the control columns is attached. The water rinse column is performing poorly having attained only about 20% gold extraction in 24 days on leach. The other two control columns, with lime addition, are duplicating well with gold extractions in the 58%-61% range after 24 days on cyanide leach.

c: Rod MacLeod
Martin Quick
Herb Osborne

BIOOXIDATION BULK TEST SOLUTION SAMPLING

ON SOLUTION

Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Fe Kg/Day	Fe Cum Kg	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)
Orofino	7/21-8/18		(72100)	7.91	337.4	.01	1.35			-	-	-	107
	7/21-7/28	19741	19741										
GRAB-1530	07/27/94	?	19741	1.94	516.2	1.26	3.0			-	-	-	-
GRAB	07/28/94	?	19741	1.20	555.3	.16	7.8			-	-	3042	3411
COMP	07/28/94	?	19741	1.41	510.8	.10	21.6	.8	.8	-	-	1924	2420
COMP	07/29/94	9542	29283	1.65	498.3	29	45.0	1.6	2.4	4.1	40.9	1416	3012
COMP	07/30/94	5504	34787	1.61	438.4	574	38.0	.8	3.2	2.2	35.8	3442	9230
COMP	07/31/94	975	35762	1.78	426.7	930	51.0	.2	3.4	2.3	48.7	3823	11575
COMP	08/01/94	21302	57063	1.60	475.9	260	33.0	2.7	6.1	1.3	31.7	2394	5238
COMP	08/02/94	18970	76034	2.89	458.4	1110	155	11.1	17.2	71	84	4705	10999
COMP	08/03/94	16238	92272	1.94	490.0	1810	710	43.6	60.8	130	580	11581	20982
COMP	08/04/94	12021	104293	1.72	455.8	1660	660	30.0	90.9	340	320	11167	20349
COMP	08/05/94	16734	121027	2.75	475.1	1450	260	16.5	107.3	40	220	7673	15888
COMP	08/06/94	16466	137492	2.41	486.8	1550	1030	64.2	171.5	60	970	11012	19332
COMP	08/07/94	16466	153958	3.66	304.8	1480	530	33.0	204.6	60	470	8191	15810
COMP	08/08/94	16502	170460	2.40	507.9	1460	1170	73.1	277.6	110	1060	10820	18867
COMP	08/09/94	16103	186563	2.38	627.5	1440	790	48.2	325.8	25	765	9380	-
COMP	08/10/94	15624	202187	2.28	618.1	1720	1680	99.3	425.1	63	1617	13218	22369
COMP	08/11/94	16113	218300	2.33	645.4	1670	1250	76.2	501.4	33	1217	11657	21262
COMP	08/12/94	14762	233062	2.27	656.2	1680	1510	84.4	585.7	146	1364	13205	22874
COMP	08/13/94	13785	246847	2.30	663.0	1520	950	49.6	635.3	41	909	11254	21036
COMP	08/14/94	10979	257826	2.27	497.5	1570	1380	57.3	692.7	229	1151	12451	22331
COMP	08/15/94	10129	267955	2.26	606.6	1740	750	28.8	721.4	53	697	11956	22333
COMP	08/16/94	6178	274133	2.40	553.1	1790	970	22.7	744.1	51	919	13257	24698
COMP	08/17/94	6444	280577	2.36	573.3	1680	860	21.0	765.1	171	689	13713	22929
COMP	08/18/94	7205	287782	1.83	655.6	790	490	13.4	778.4	170	320	6959	12987
COMP	08/19/94	12447	300229	1.63	664.1	1050	1480	69.7	848.2	440	1040	12007	19505
COMP	08/20/94	15338	315567	1.39	683.9	1390	2190	127.1	975.3	610	1580	17135	26608
COMP	08/21/94	12497	328064	1.55	669.8	1610	2660	125.8	1,101.1	710	1950	19555	30681
COMP	08/22/94	11793	339857	1.71	684.8	1730	3270	146.0	1,247.1	75	3195	-	-
COMP	08/23/94	12099	351956	1.59	560.0	1780	3310	151.6	1,398.7	123	3187	21399	33274
COMP	08/24/94	11183	363139	1.58	604.9	1740	3480	147.3	1,546.0	82	3398	-	-
COMP	08/25/94	11114	374253	1.61	538.6	1760	3960	166.6	1,712.5	230	3730	22733	36228
COMP	08/26/94	9502	383755	1.71	694.7	1840	4040	145.3	1,857.8	94	3946	24028	36237
COMP	08/27/94	9144	392899	1.84	705.2	1820	4370	151.2	2,009.1	99	4271	24868	37372
COMP	08/28/94	8493	401392	1.84	684.4	1800	4380	140.8	2,149.9	99	4281	25735	38352
COMP	08/29/94	8859	410251	1.76	704.1	1870	4570	153.2	2,303.1	86	4484	-	-
COMP	08/30/94	7349	417600	1.77	669.5	1820	4450	123.8	2,426.9	84	4366	26418	39084
COMP	08/31/94	8940	426540	-	-	-	-	.0	2,426.9	-	0	-	-

BIOOXIDATION BULK TEST SOLUTION SAMPLING

OFF SOLUTION

Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Fe Kg/Day	Fe Cum Kg	% Fe Ext	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	DO (ppm)
SUMP-GRAB	07/26/94	1200	1200	7.22	-	.84	.27	.0	.0		-	-	-	-	-
GRAB-1530	07/27/94	1750	2950	7.53	305.4	.89	.20	.0	.0		-	-	-	-	-
COMP	07/28/94	3000	5950	5.93	353.6	83	.55	.0	.0		-	-	83	4411	-
COMP	07/29/94	3293	9243	5.49	282.1	255	13	.2	.2		-	-	362	5094	-
COMP	07/30/94	4419	13662	5.11	285.7	654	14	.2	.4	.00	-	-	994	7913	-
COMP	07/31/94	2688	16350	5.18	318.8	960	11	.1	.5	.00	-	-	956	9835	-
COMP	08/01/94	7822	24172	4.20	332.3	990	39	1.2	1.7	.00	1	38	2438	11106	-
COMP	08/02/94	21836	46008	3.39	429.6	1930	172	14.2	15.9	.00	2	170	8960	18304	-
COMP	08/03/94	14710	60718	3.43	360.1	2050	520	29.0	44.8	.00	260	260	10520	21678	-
COMP	08/04/94	7500	68218	3.36	344.2	1750	500	14.2	59.0	.01	410	90	8967	18731	-
COMP	08/05/94	6821	75039	2.50	503.7	1870	480	12.4	71.4	.00	40	440	11633	20711	-
COMP	08/06/94	21396	96436	2.45	465.2	1940	1530	123.9	195.3	-.01	200	1330	14570	23591	-
COMP	08/07/94	21396	117832	2.63	435.8	1770	1110	89.9	285.2	.03	190	920	12617	20727	-
COMP	08/08/94	18698	136530	2.40	484.6	1800	1390	98.4	383.6	.04	160	1230	13259	22299	-
COMP	08/09/94	21118	157648	2.36	557.4	1690	1070	85.5	469.1	.07	36	1034	11904	21180	-
COMP	08/10/94	16419	174067	2.31	491.4	1760	1320	82.0	551.2	.08	220	1100	12958	22052	-
COMP	08/11/94	16500	190567	2.29	524.4	1580	1290	80.6	631.7	.09	86	1204	12958	21764	-
COMP	08/12/94	18213	208780	2.28	523.1	1630	1520	104.8	736.5	.08	56	1464	13452	22729	1.3
COMP	08/13/94	18585	227365	2.34	500.2	1630	1420	99.9	836.4	.09	240	1180	13361	22995	1.3
COMP	08/14/94	16646	244011	2.29	472.4	1680	1490	93.9	930.3	.10	380	1110	13608	23458	-
COMP	08/15/94	13559	257570	2.31	522.4	1700	1110	57.0	987.2	.12	84	1026	13179	23381	-
COMP	08/16/94	12267	269837	2.36	496.4	1670	1540	71.5	1,058.7	.12	196	1344	14831	23933	1.4
COMP	08/17/94	7697	277534	2.49	481.4	1600	1160	33.8	1,092.5	.13	43	1117	13309	23711	2.2
COMP	08/18/94	7136	284670	2.39	650.1	1790	1100	29.7	1,122.2	.14	480	620	13839	25735	1.7
COMP	08/19/94	13078	297748	2.13	663.0	1680	2450	121.3	1,243.5	.14	690	1760	16703	27554	-
COMP	08/20/94	14479	312227	2.02	672.0	1620	2550	139.7	1,383.3	.18	670	1880	16716	27464	-
COMP	08/21/94	14213	326440	2.18	678.3	1660	2900	156.0	1,539.3	.21	770	2130	18024	29200	-
COMP	08/22/94	14246	340686	2.16	631.0	1800	3160	170.4	1,709.7	.22	75	3085	-	-	-
COMP	08/23/94	13868	354554	2.11	671.3	1740	3210	168.5	1,878.2	.24	73	3137	19568	31299	-
COMP	08/24/94	12742	367296	2.09	604.1	1760	3540	170.7	2,048.9	.25	82	3458	-	-	.7
COMP	08/25/94	11741	379037	2.11	646.9	1730	3640	161.8	2,210.7	.26	86	3554	20823	33471	5.5?
COMP	08/26/94	12505	391542	2.19	687.1	1810	3860	182.7	2,393.4	.26	86	3774	22006	34443	OFL
COMP	08/27/94	11272	402814	2.27	689.5	1770	4000	170.7	2,564.0	.27	94	3906	22374	35035	-
COMP	08/28/94	9000	411814	2.21	688.0	1800	4000	136.3	2,700.3	.28	82	3918	23319	35858	-
COMP	08/29/94	9000	420814	2.10	688.2	1860	4370	148.9	2,849.1	.27	86	4284	-	-	OFL
COMP	08/30/94	11403	432217	2.17	685.5	1710	4030	173.9	3,023.1	.28	84	3946	22242	35134	13.5?
COMP	08/31/94	10726	442943	-	-	-	-	.0	3,023.1	.28	-	0	-	-	OFL

BIOOXIDATION BULK TEST THERMOCOUPLE DATA

Date	West 1	West 2	West 3	West 4	West 5	Mid 6	Mid 7	Mid 8	East 9	East 10	East 11	East 12	AMBIENT 1-6	AMBIENT 7-12
08/02/94	27.8	23.2	27.4	24.3	25.7	28.0	24.3	24.3	21.2	28.1	29.8	23.5	19.0	18.9
08/02/94	28.2	23.8	27.6	25.0	26.2	28.7	24.3	24.5	21.3	27.1	29.6	24.4	22.6	21.5
08/03/94	27.2	23.7	27.2	24.6	25.6	27.5	24.5	24.8	24.0	27.1	29.4	24.3	26.0	25.8
08/04/94	29.7	24.7	27.8	25.0	27.0	29.0	24.2	24.4	25.1	26.6	28.5	23.4	19.0	20.3
08/05/94	31.3	25.6	28.2	27.3	28.3	30.4	25.5	24.6	25.9	26.9	28.6	24.3	17.7	17.7
08/06/94	30.7	25.8	27.7	26.6	26.9	28.1	24.8	24.4	26.6	25.9	27.7	25.4	22.8	23.3
08/07/94	31.8	26.2	27.1	27.4	27.9	29.6	25.4	25.5	27.3	25.5	26.8	25.0	-	-
08/08/94	32.2	27.3	27.9	27.6	27.9	29.1	25.5	25.7	27.9	25.3	26.8	27.5	14.0	15.5
08/09/94	36.4	28.9	28.6	29.3	28.9	29.9	25.7	24.9	28.7	25.4	26.4	29.0	24.0	24.5
08/10/94	35.1	28.8	28.0	28.3	27.8	28.6	25.8	25.0	28.8	25.5	26.0	32.0	21.9	22.3
08/11/94	38.4	30.8	28.5	29.2	28.1	28.9	26.2	25.1	28.5	25.6	25.8	31.5	25.4	25.6
08/12/94	36.6	30.2	27.7	27.8	27.2	27.9	26.1	25.0	28.1	26.0	25.6	34.0	22.3	20.7
08/13/94	39.0	31.9	28.6	29.4	28.3	29.2	26.3	25.3	28.6	26.4	25.9	33.1	17.3	17.0
08/14/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/15/94	38.1	31.2	28.2	28.3	27.1	27.5	25.6	23.2	28.2	26.5	25.7	33.7	24.9	28.3
08/16/94	39.1	32.2	29.0	28.8	27.6	28.0	26.2	23.5	28.0	26.8	25.9	36.2	23.5	22.9
08/17/94	39.1	31.4	28.3	28.3	27.4	27.9	26.3	23.7	28.3	26.8	26.0	35.7	20.8	20.6
08/18/94	40.3	32.8	29.4	29.2	28.3	28.6	26.1	23.5	28.4	26.7	25.9	39.0	28.6	25.7
08/19/94	40.4	32.7	28.8	29.3	28.2	28.7	26.4	24.2	29.4	27.0	26.2	44.8	12.6	13.3
08/20/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/21/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/22/94	44.1	35.7	29.8	31.9	30.7	30.2	26.5	24.1	29.5	27.4	26.3	42.1	28.3	27.5
08/23/94	43.7	37.1	30.4	33.3	32.3	32.8	26.7	25.3	30.7	27.9	26.9	41.0	25.1	24.5
08/24/94	43.1	37.7	30.4	33.5	32.2	32.1	26.8	25.7	30.6	27.6	26.5	41.0	26.0	24.0
08/25/94	43.0	38.5	30.9	34.4	33.2	33.0	27.3	26.3	31.4	28.0	27.0	42.4	27.0	27.0
08/26/94	42.9	38.9	31.0	35.1	33.8	33.5	27.5	26.8	31.8	28.3	27.3	43.3	15.0	15.2
08/27/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/28/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/29/94	43.0	40.5	31.1	34.5	33.4	32.4	28.3	37.9	32.1	28.7	27.7	44.6	23.0	22.9
08/30/94	40.1	41.2	32.6	36.8	35.7	35.8	28.6	27.7	33.2	28.9	28.0	43.7	12.4	11.6
08/31/94	40.8	40.6	32.5	36.8	35.7	35.4	28.6	27.1	33.3	28.9	28.0	45.3	4.6	5.3
09/01/94	42.3	40.9	32.6	36.9	35.3	34.8	28.7	26.4	33.7	29.0	28.1	45.7	4.1	3.9

BIOOXIDATION BULK TEST SOLUTION SAMPLING

PAN LYSIMETER 1

Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS
GRAB	08/03/94	4.55	315.3	150	3.91	-	-	-	366	-

PAN LYSIMETER 2

Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO
GRAB	08/03/94	1.64	516	3100	14100	1900	12200	40761	46775	-	
GRAB	09/01/94			1820	3250	270	2980			Lt-Dk Green	OFL

PAN LYSIMETER 3

Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO (ppm)
GRAB	08/03/94	1.93	488.4	1540	4640	1200	3440	20005	23896	-	
GRAB	08/11/94	1.52	496.1	3200	8700	2900	5800	-	-	Brown/Murky	
GRAB	08/12/94	1.89	450.4	2200	3900	2100	1800	-	27461	Lt Brown	1.5
GRAB	08/15/94	1.92	459.5	2170	3920	1270	2650	15417	27625	Med Brown	1.7
GRAB	08/17/94	1.97	462.7	1940	3220	560	2660	19502	25159	Med Brown	2.4
GRAB	08/19/94	2.00	458.4	1850	2300	1400	900	17828	23604	-	-
GRAB	08/22/94	1.90	464.0	1760	2300	360	1940	16677	23744	Grw/Br Ti	1.9
GRAB	08/24/94	2.04	468.5	1780	2680	770	1910	16795	23028	Green	.9
GRAB	08/26/94	2.05	479.6	1730	2700	690	2010	17030	24320	Br-Yel	4.5?
GRAB	08/29/94	2.08	472.8	1770	2760	360	2400	17936	25167	Yel-Br	OFL
GRAB	09/01/94			1870	2730	730	2000			Green	OFL

PAN LYSIMETER 4

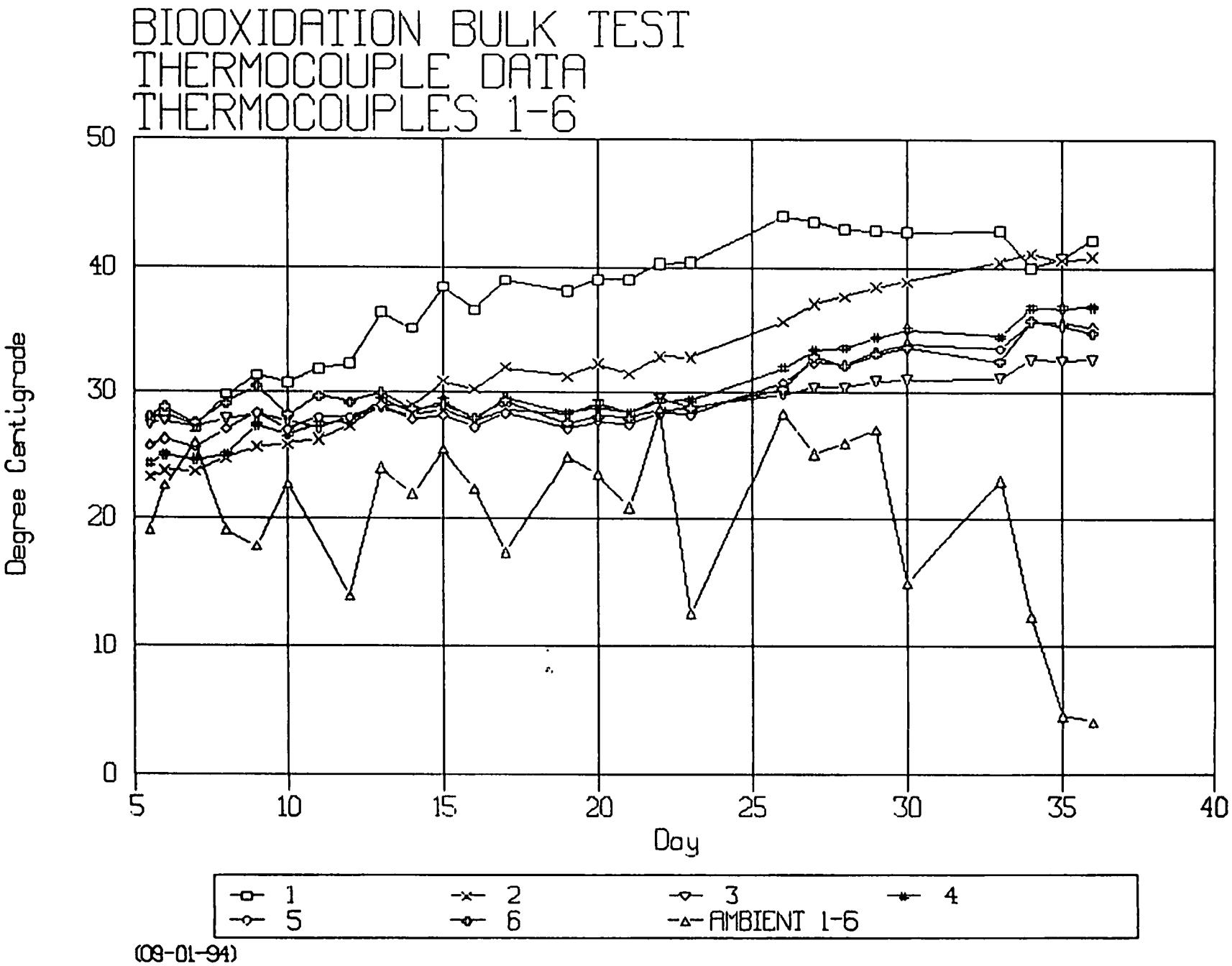
Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO (ppm)
GRAB	08/11/94	2.62	526.3	55	87	-	-	-	-	Flush H2O	-
GRAB	08/12/94	2.06	560.0	567	1260	67	1193	5282	6801	Lt Brown	4.8
GRAB	08/15/94	1.87	671.9	1260	2920	105	2815	14311	17681	Lt Brown	2.9
GRAB	08/17/94	1.71	687.2	1610	3670	102	3568	19528	23875	Med Brown	2.9
GRAB	08/19/94	1.79	659.6	1790	2900	900	2000	19280	24583	-	-
GRAB	08/22/94	1.86	615.3	1720	2000	73	1927	16285	23809	Gr-Brown	3.2
GRAB	08/24/94	1.78	678.6	1770	2420	60	2360	16481	24196	Green	OFL
GRAB	08/26/94	1.80	601.2	1710	2450	75	2375	16742	25126	Lt Gr-Yel	OFL
GRAB	08/29/94	1.92	681.5	1710	2340	60	2280	17279	26073	Lt Green	OFL
GRAB	09/01/94			1700	2380	61	2319			Lt Green	OFL

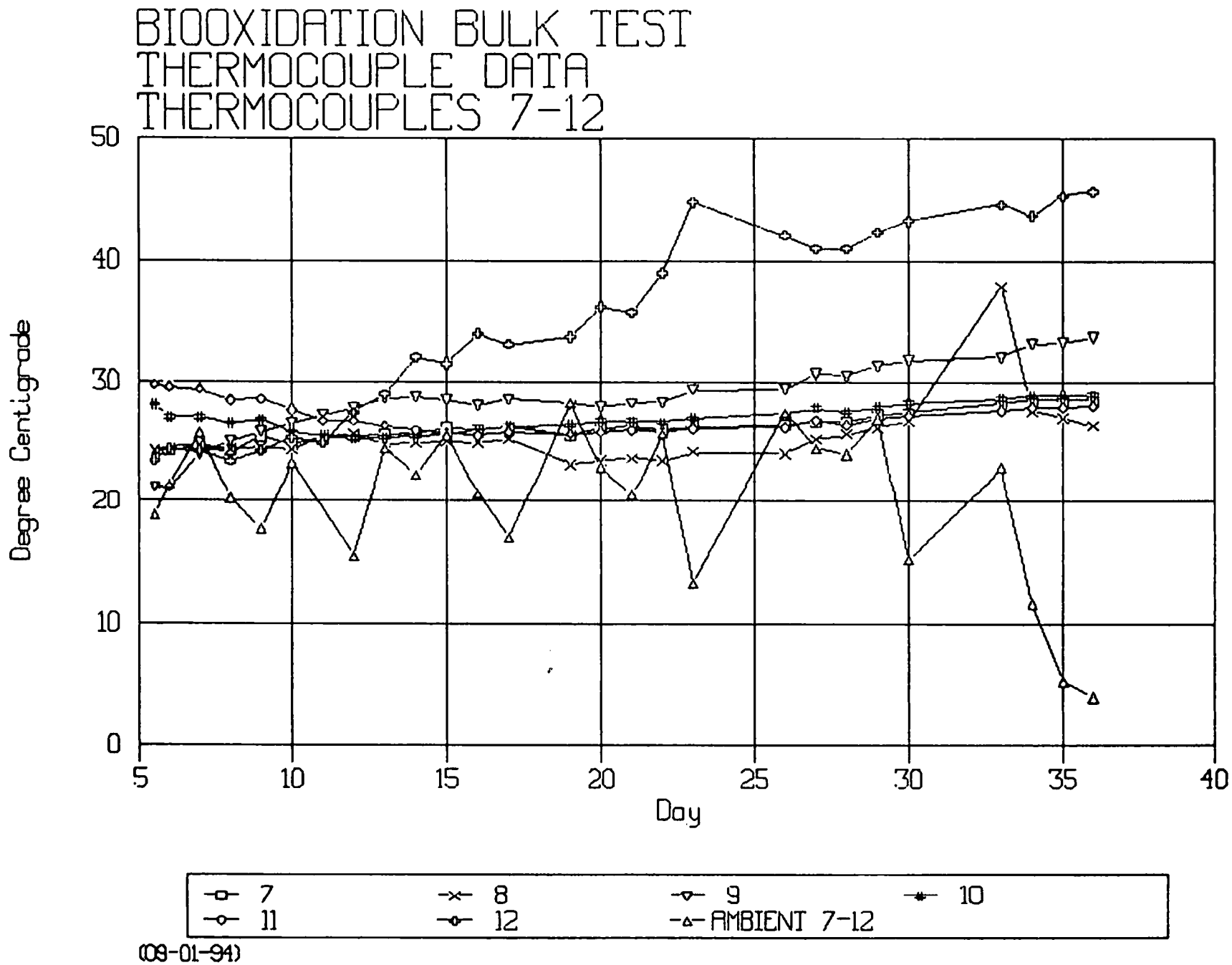
PAN LYSIMETER 5

Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO (ppm)
GRAB	08/03/94	1.49	515.6	3690	17700	2100	15600	57687	66622	Dark Brown	-
GRAB	08/04/94	1.32	511.1	3930	14100	1600	12500	60119	67556	Dark Brown	-
GRAB	08/09/94	1.70	484.5	2600	4500	1400	3100	28440	38389	Dark Brown	-
GRAB	08/10/94	2.37	574.1	1740	990	36	954	11468	23641	Off Soln Flush	
GRAB	08/11/94	1.72	431.8	2000	3700	3400	300	-	-	Green Color	-
GRAB	08/12/94	1.80	439.7	2000	3900	2900	1000	20048	24627	Lt Green	3.7
GRAB	08/15/94	1.88	361.1	1940	3940	2200	1740	20543	24800	Green	2.6
GRAB	08/17/94	1.88	415.7	2030	4800	3700	1100	23073	27307	Green	2.7
GRAB	08/19/94	1.87	418.5	2170	4100	4000	100	21647	27324	-	-
GRAB	08/22/94	2.26	437.3	1920	2800	2300	500	18260	24542	Yel-Br	2.1
GRAB	08/24/94	2.12	385.4	1880	3250	2900	350	17056	25184	Lt Gr/Blue	OFL
GRAB	08/26/94	2.39	414.8	1780	3270	2290	980	16428	24641	Yel-Gr;odor	OFL
GRAB	08/29/94	2.47	402.7	1730	3260	2110	1150	16623	24698	Lt Green	OFL
GRAB	09/01/94			1700	2600	480	2120			Yel-Br;odor	OFL

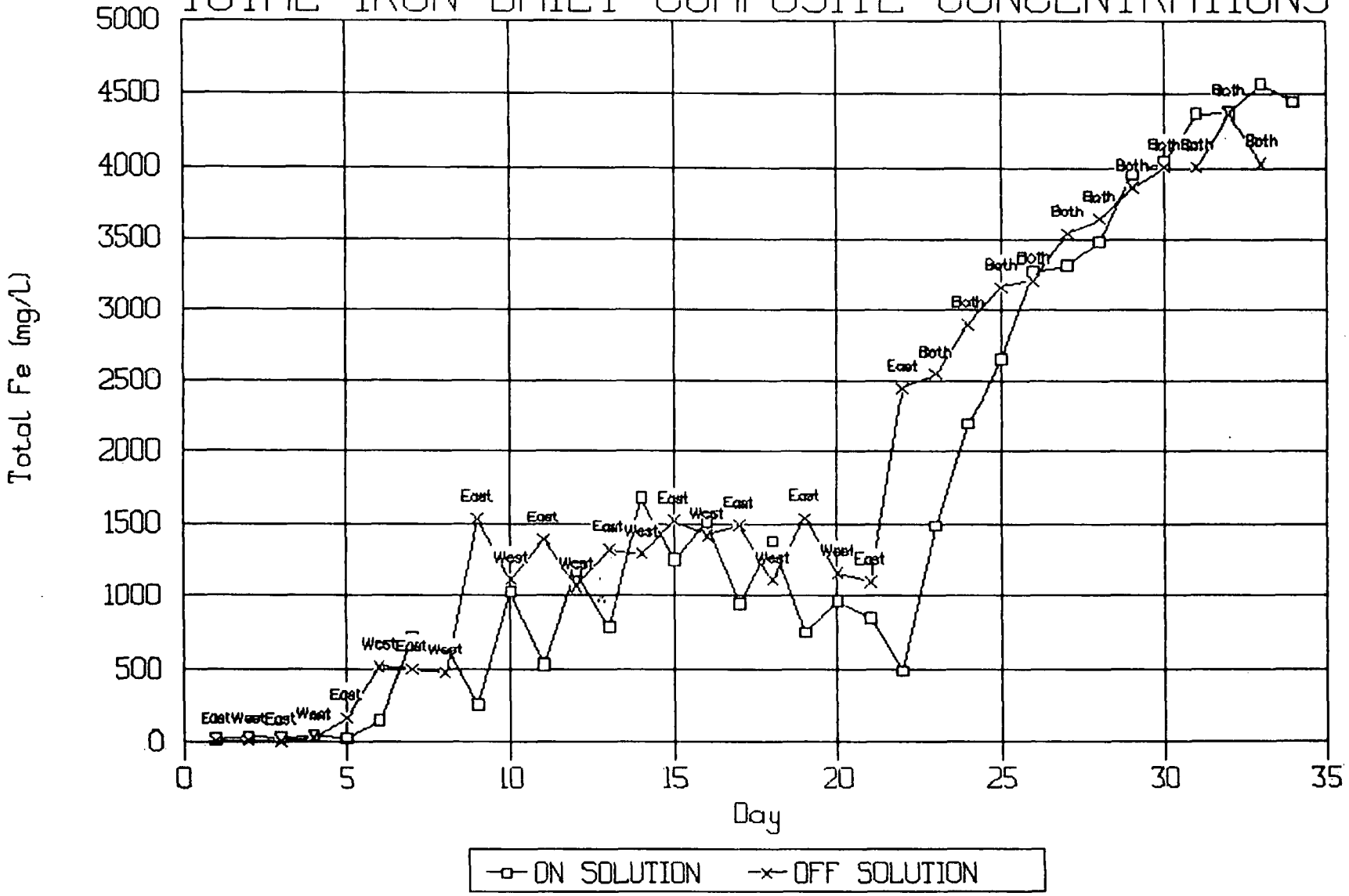
PAN LYSIMETER 6

Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO (ppm)
GRAB	08/11/94	1.50	532.5	2000	4480	3300	1180	-	-	Dk Brown	-
GRAB	08/12/94	1.48	554.7	3770	8900	600	8300	31953	53838	Dk Brown	3.6
GRAB	08/15/94	1.72	361.1	2560	4300	700	3600	28024	33225	Med Brown	1.4
GRAB	08/17/94	1.73	662.4	2330	4000	1200	2800	25591	30262	Stringy Ppt	2.0
GRAB	08/19/94	1.61	586.7	2190	4500	160	4340	25781	31299	-	-
GRAB	08/22/94	1.65	580.4	1770	2600	130	2470	18168	23883	Gr-Br w/Chnks	0.8
GRAB	08/24/94	1.71	588.9	1770	3520	140	3380	19463	25011	Dk Gr/Br	OFL
GRAB	08/26/94	1.70	576.5	1680	3460	120	3340	19542	25850	Yel-Br;floats	OFL
GRAB	08/29/94	1.68	694.1	1600	4270	86	4184	21586	28509	Gr-Br;Floats	OFL
GRAB	09/01/94			1620	5100	150	4950			Lt Gr w/Flts	OFL


BIOOXIDATION BULK TEST
THERMOCOUPLE DATA
THERMOCOUPLES 1-6
Degree Centigrade
0
10
20
30
40
50
5
10
15
20
25
30
35
40
Day
1
2
3
4
5
6
AMBIENT 1-6
(09-01-94)


BIOOXIDATION BULK TEST
THERMOCOUPLE DATA
THERMOCOUPLES 7-12
Degree Centigrade
50
40
30
20
10
0
5
10
15
20
25
30
35
40
Day
7
8
9
10
11
12
AMBIENT 7-12
(08-01-94)

BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
TOTAL IRON-DAILY COMPOSITE CONCENTRATIONS



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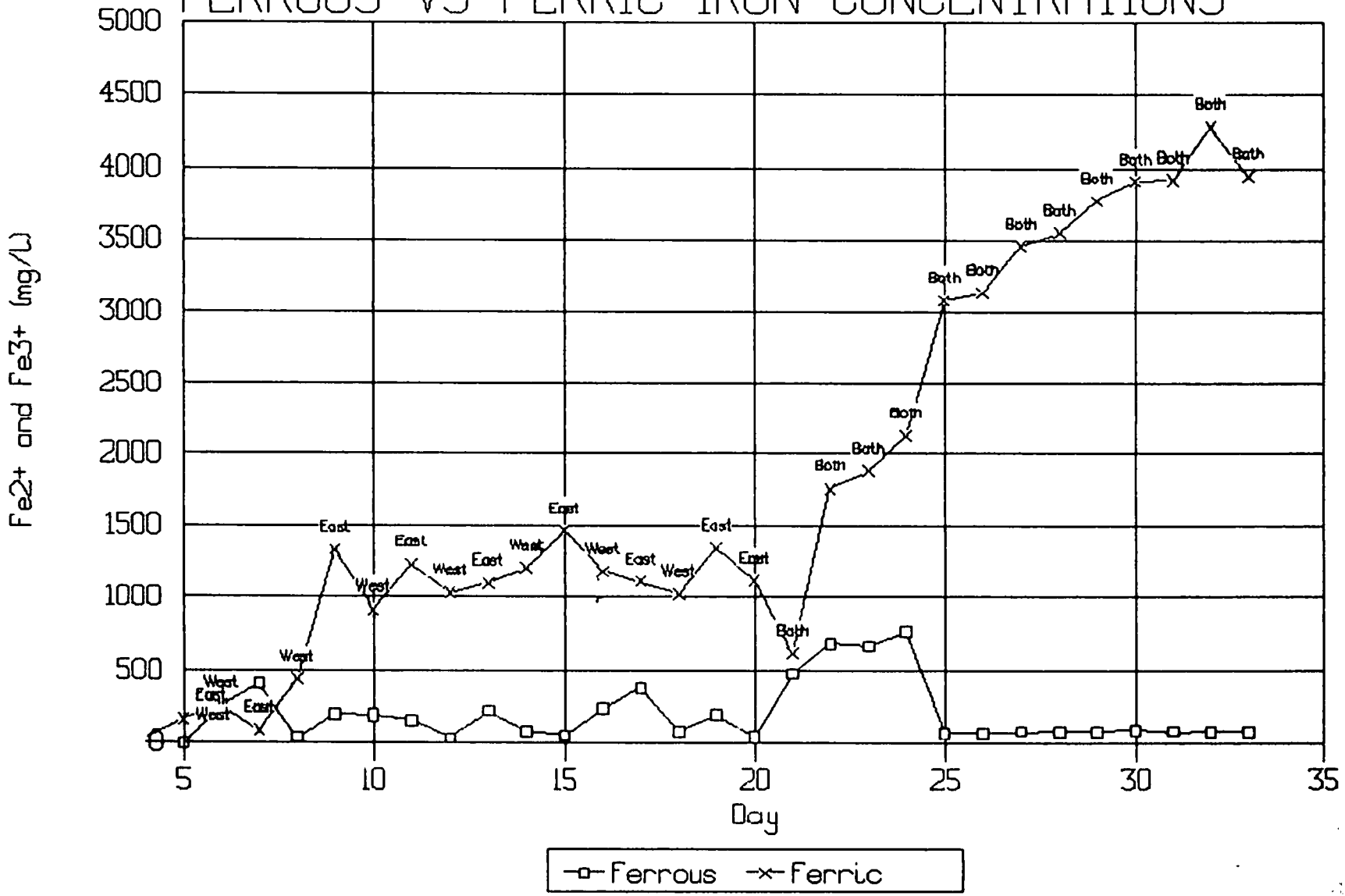
BIOOXIDATION BULK TEST
OFF SOLUTION DAILY COMPOSITE
FERROUS VS FERRIC IRON CONCENTRATIONS



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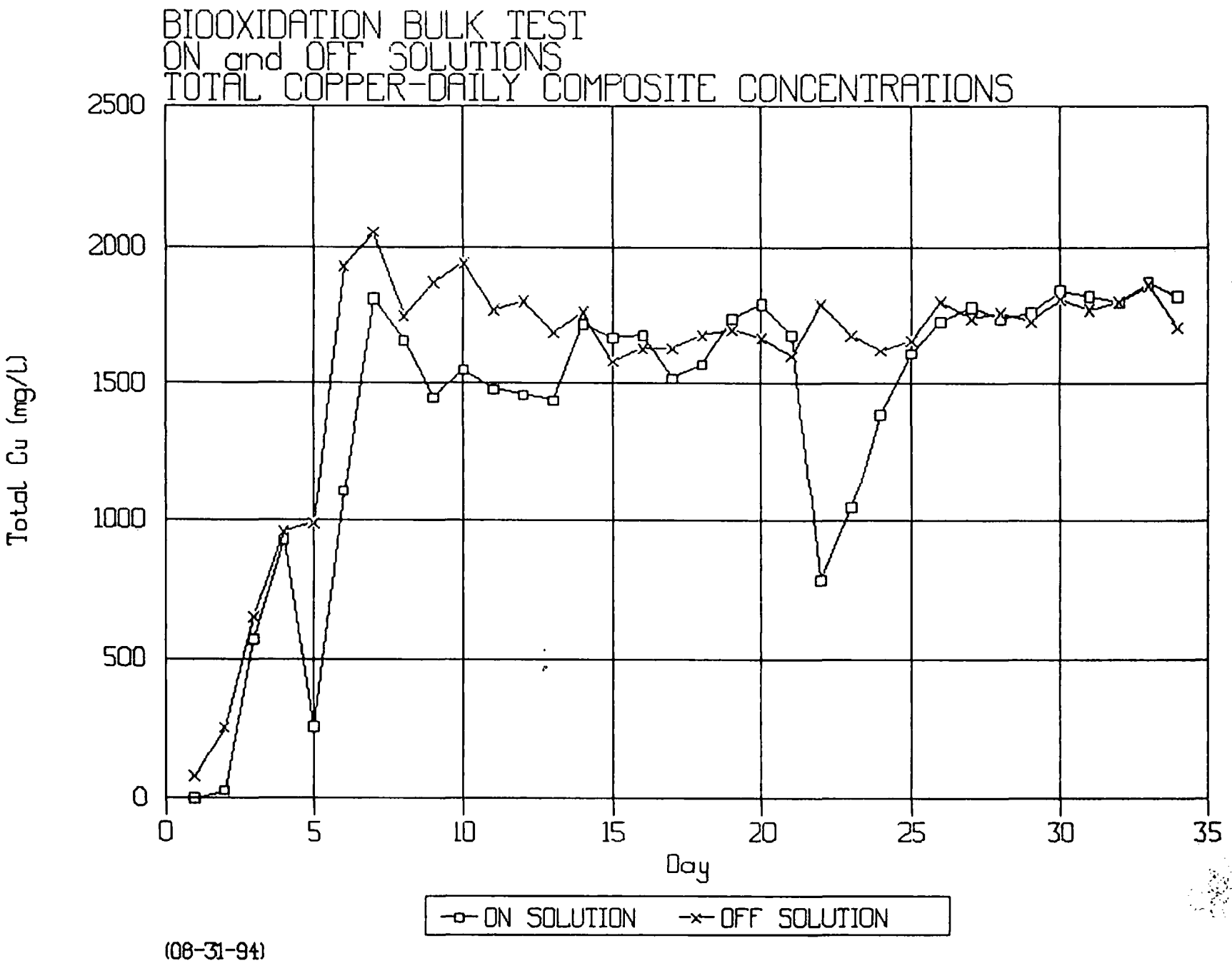
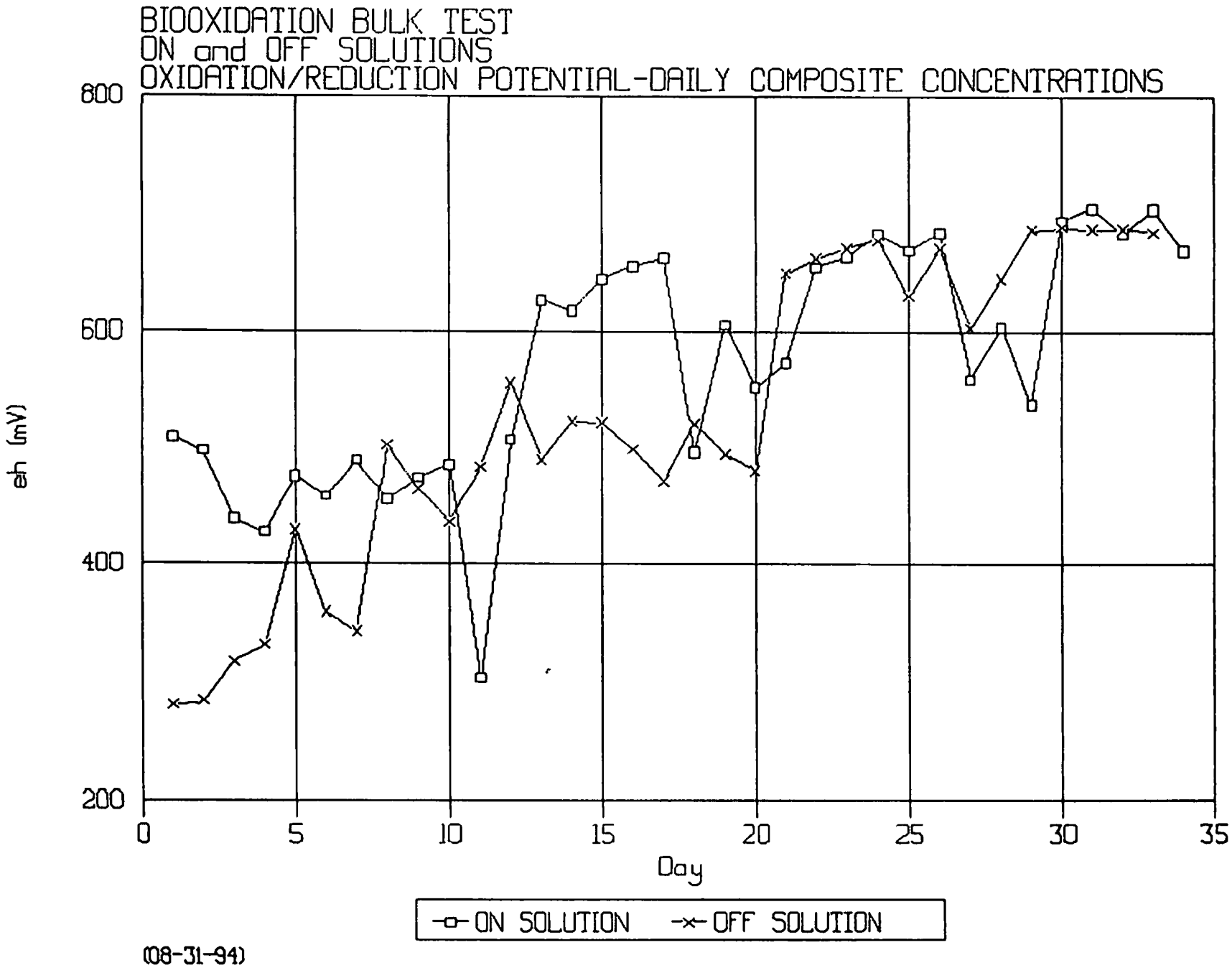
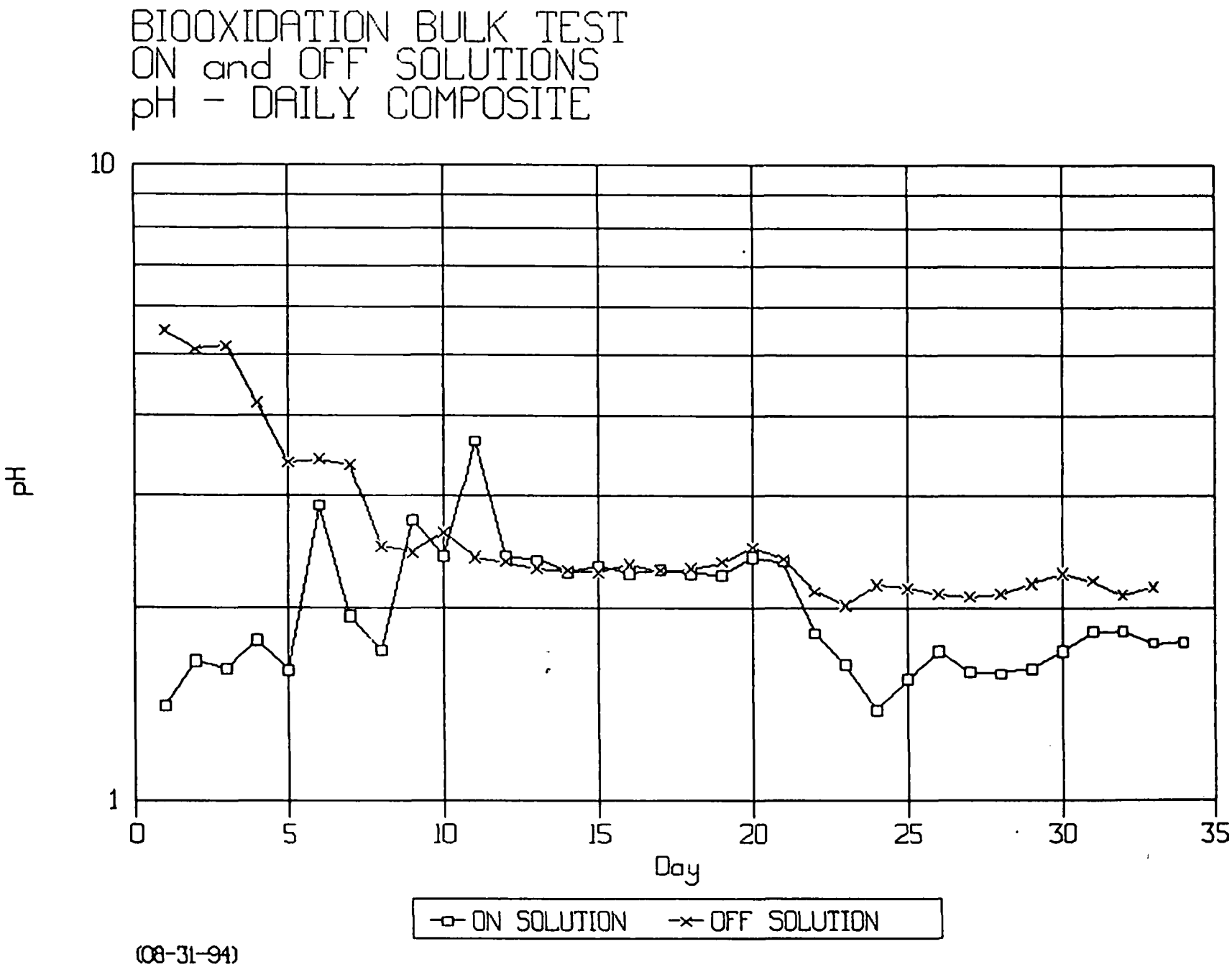
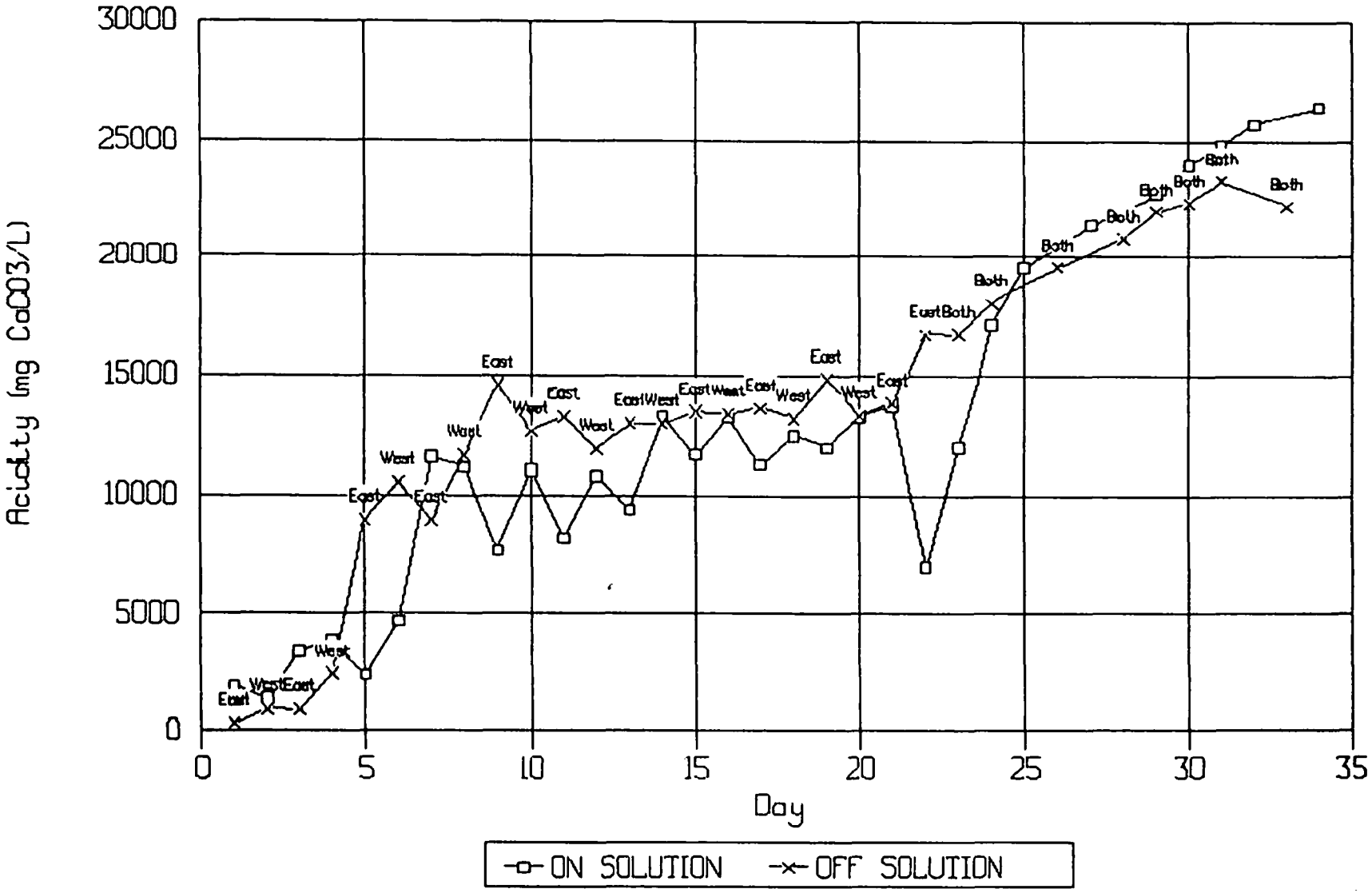

BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
TOTAL COPPER-DAILY COMPOSITE CONCENTRATIONS
Total Cu (mg/L)
2500
2000
1500
1000
500
0
0
5
10
15
20
25
30
35
Day
ON SOLUTION
OFF SOLUTION
(08-31-94)

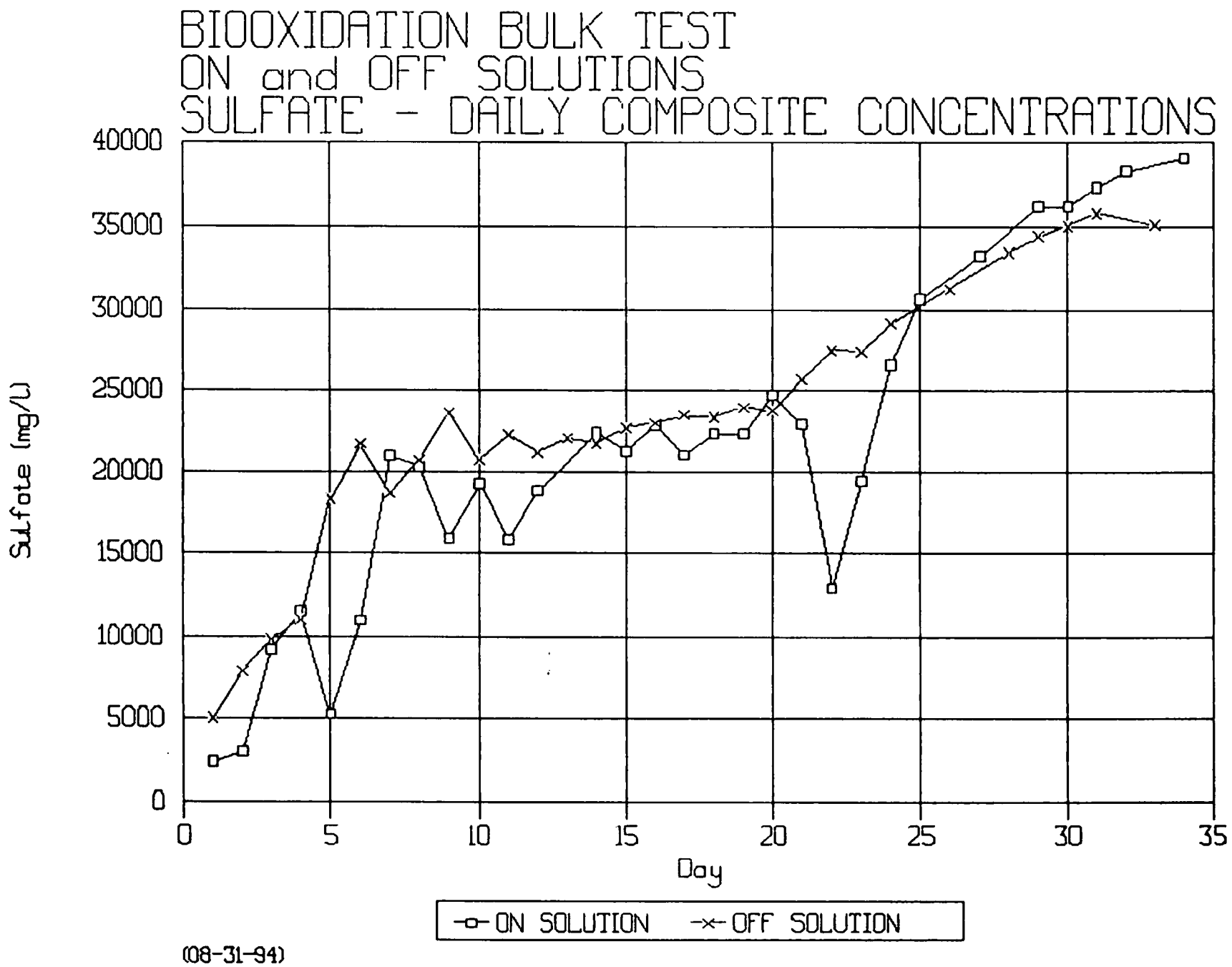

BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
OXIDATION/REDUCTION POTENTIAL-DAILY COMPOSITE CONCENTRATIONS
800
600
400
200
eh (mV)
0
5
10
15
20
25
30
35
Day
ON SOLUTION
OFF SOLUTION
(08-31-94)

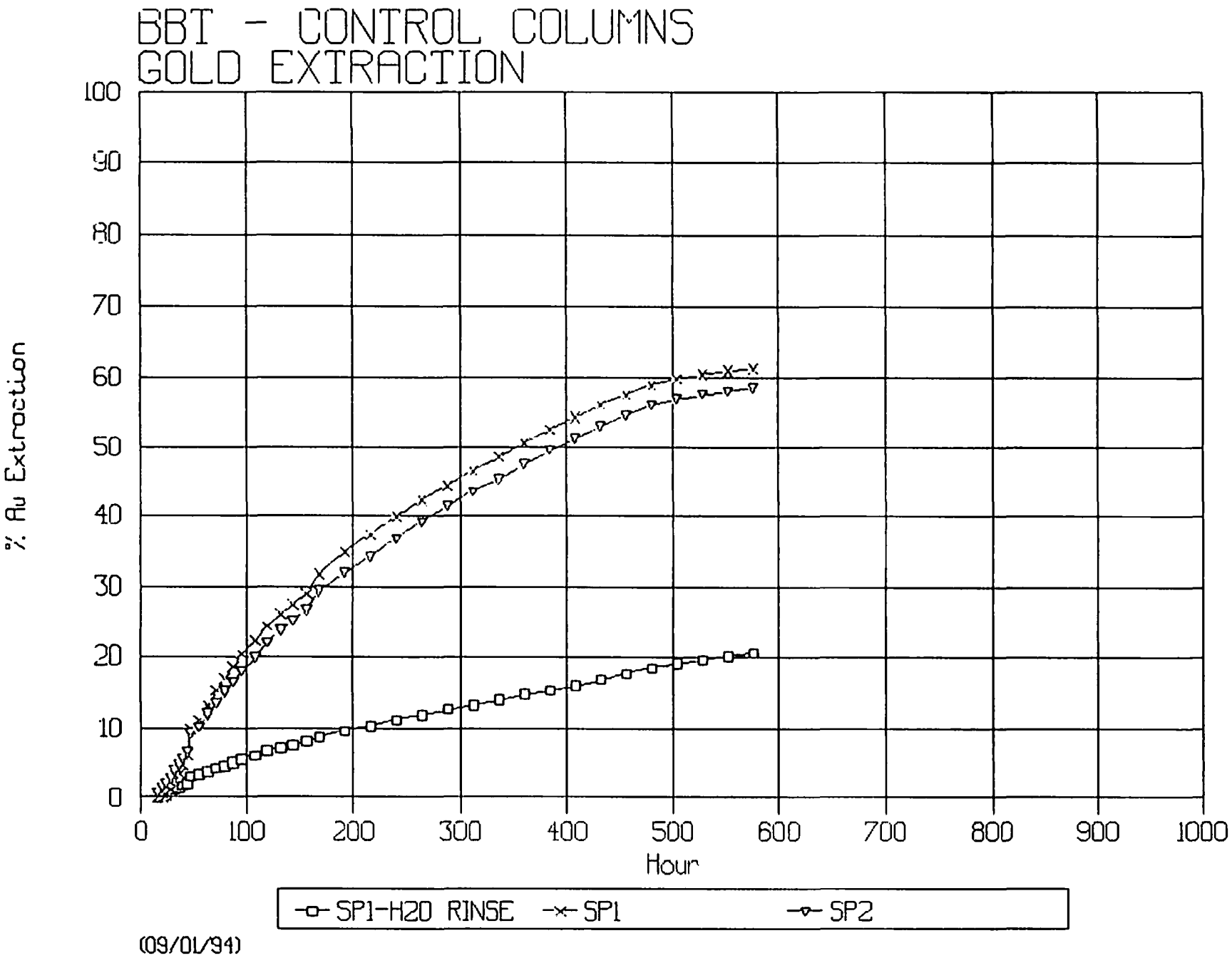

BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
pH - DAILY COMPOSITE
10
1
pH
0
5
10
15
20
25
30
35
Day
ON SOLUTION
OFF SOLUTION
(08-31-94)

BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
ACIDITY TO pH 7-DAILY COMPOSITE CONCENTRATIONS



(08-31-94)


BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
SULFATE - DAILY COMPOSITE CONCENTRATIONS
Sulfate (mg/L)
40000
35000
30000
25000
20000
15000
10000
5000
0
0
5
10
15
20
25
30
35
Day
ON SOLUTION
OFF SOLUTION
(08-31-94)


BBT - CONTROL COLUMNS
GOLD EXTRACTION
% Au Extraction
100
90
80
70
60
50
40
30
20
10
0
0
100
200
300
400
500
600
700
800
900
1000
Hour
SP1-H2O RINSE
SP1
SP2
(09/01/94)

	SP-2 COMP 10% HCl Rinse	08/23/94 AUGER West 0'-5'	08/23/94 AUGER Mid 0'-5'	08/23/94 AUGER East 0'-5'	08/23/94 AUGER West 5'-10'	08/23/94 AUGER Mid 5'-10'	08/23/94 AUGER East 5'-10'	08/23/94 AUGER West 10'-15'	08/23/94 AUGER Mid 10'-15'	08/23/94 AUGER East 10'-15'	BBT-SP2COLCOMP Average 7/5-7/18/94
Fe	50792	59346	60733	55495	66072	62912	61557	60945	61439	59661	58851
Cu	222	181	244	154	165	277	146	195	170	117	504
% Sulfur	4.65	5.40	5.74	5.40	6.03	5.83	5.56	5.71	5.63	5.22	5.23
% SO4	.65	.61	.76	.60	.54	.78	.46	.57	.53	.58	.95
% Sulfide	4.44	5.19	5.49	5.20	5.85	5.57	5.41	5.52	5.45	5.03	4.91

	Average 0'-5'	Average 5'-10'	Average 10'-15'	Average West	Average Mid	Average East
Fe	58525	63514	60682	62121	61695	58904
Cu	193	196	161	180	230	139
% Sulfur	5.51	5.81	5.52	5.71	5.73	5.39
% SO4	.66	.59	.56	.57	.69	.55
% Sulfide	5.29	5.61	5.33	5.52	5.50	5.21

* All intervals are measured from the TOP of the heap.

** SP2 Comp w/10% HCl rinse sat in a plastic bag with no lime addition, so therefore could have biooxidized somewhat.

MEMORANDUM

DATE: AUGUST 26, 1994
TO: JIM THOMPSON
FROM: LAURA DAMON
SUBJECT: BIOOXIDATION BULK TEST (BBT) WEEKLY UPDATE (4)

The BBT has been on the biooxidation cycle for four weeks now. Both the west and east sides were put on simultaneous solution application on August 19th. The ON solution application rate has averaged 8.2 gpm this week while the OFF solution return rate has averaged 8.4 gpm. There has been no line breakage or sloughing of the heap this week but there have been a few problems with pipe corrosion. The emitters were manually unplugged on August 19th. The last barrel of bacteria was added to the ON solution on August 25th. Geobiotics has finished bacterial fermentation on-site.

Due to the lack of information being circulated through all those involved in the project, it has been decided to have conference calls every Monday to discuss the previous week's data, operations and any other questions that may come up. This should aid in communications.

The neutralization circuit was shut down on August 19th due to its labor intensiveness, the operational problems with plugged emitters and the inefficiency of metals removal. Sulfuric acid has been added to the ON solution since August 19th to maintain an ON pH of 1.5 in order to reduce the internal pH of the heap and aid in the biooxidation process. The OFF solution's pH has been slowly dropping and is now in the 2.1 range. Lysimeter data suggest the internal pH is slightly lower at around 1.8. It has not been determined what effect the limestone in the drainrock has had on the OFF solution pH and metal concentrations.

Geobiotics personnel are still trying to identify the toxic source from the column testing (we haven't seen signs of it in the BBT yet) which would make metal precipitation neutralization necessary. The identification process can be very difficult since the toxic substance is probably not just one element but a combination of metals at relatively high concentrations. Toxicity is defined here as inhibiting the optimal rate of the biooxidation process. Solution samples will be sent out for a 32-element ICP scan next week to quantify dissolved metals.

29th

Rich Crowell will be here Monday, August 22nd to work with Jim Whitlock on a functional neutralization system design. There seems to be differing views on whether metals precipitation neutralization is actually needed for the BBT although a neutralization circuit for acidity control will most likely be needed down the road. These differing opinions on neutralization application will be discussed on Monday during the conference call.

The data collected to date still indicate that the bacteria are biooxidizing the sulfide ore. The iron ions continue to be predominantly in the form of ferric iron and in fact the total iron concentration more than doubled this week. The oxidation/reduction potential has accordingly risen this week maintaining an eh of 600+. An ideal eh, indicating optimal conditions, is 650-700 but may prove to be only 600+ in the field. Thermocouple temperatures for #1 and #12 (located near the lower corners of the heap where there may be more aeration) are over 40 degree centigrade. #2-#6 (located mainly on the west side of the heap) show an upward trend in temperature and #7-#11 (located mainly on the east side of the heap) have maintained fairly constant temperatures.

The BBT assay samples are starting to provide an adequate data base indicating trends from which to form hypotheses. It appears that during the first week of sample collection, the heap became saturated and started to flush soluble metals. The initial soluble metals flush continued into the second week and then the system seemed to come to an equilibrium state or plateau before the biooxidation process excelerated in the fourth week.

The first auger drill samples were collected from the heap on August 23rd. Three 15′ holes were drilled, one on the west side of the heap, one on the east side and one in the middle of the heap. The samples were composited from each hole in 5′ intervals. Each sample is being assayed for total sulfur and sulfate content, iron and copper. A decision will be made based on the assay data whether gold extraction bottle rolls are warranted.

The gold extraction graph from the control columns is attached. The water rinse column is performing poorly having attained only about 15% gold extraction in 16 days on leach. The pH has risen above 10. A blue precipitate was formed in solution when the pH was between 5-7. The gold may be tied up in this precipitate which will be assayed when time permits. The other two control columns, with lime addition, are duplicating well with gold extractions in the 50%-52% range after 16 days on cyanide leach.

c: Rod MacLeod
Martin Quick
Herb Osborne

BIOOXIDATION ROCK TEST SOLUTION SAMPLING

ON SOLUTION

Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Fe Kg/Day	Fe Cum Kg	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)
Orofino	7/21-8/18		(72100)	7.91	337.4	.01	1.35			-	-	-	107
	7/21-7/28	19741	19741										
GRAB-1530	07/27/94	?	19741	1.94	516.2	1.26	3.0			-	-	-	-
GRAB	07/28/94	?	19741	1.20	555.3	.16	7.8			-	-	3042	3411
COMP	07/28/94	?	19741	1.41	510.8	.10	21.6	.8	.8	-	-	1924	2420
COMP	07/29/94	9542	29283	1.65	498.3	29	45.0	1.6	2.4	4.1	40.9	1416	3012
COMP	07/30/94	5504	34787	1.61	438.4	574	38.0	.8	3.2	2.2	35.8	3442	9230
COMP	07/31/94	975	35762	1.78	426.7	930	51.0	.2	3.4	2.3	48.7	3823	11575
COMP	08/01/94	21302	57063	1.60	475.9	260	33.0	2.7	6.1	1.3	31.7	2394	5238
COMP	08/02/94	18970	76034	2.89	458.4	1110	155	11.1	17.2	71	84	4705	10999
COMP	08/03/94	16238	92272	1.94	490.0	1810	710	43.6	60.8	130	580	11581	20982
COMP	08/04/94	12021	104293	1.72	455.8	1660	660	30.0	90.9	340	320	11167	20349
COMP	08/05/94	16734	121027	2.75	475.1	1450	260	16.5	107.3	40	220	7673	15888
COMP	08/06/94	16466	137492	2.41	486.8	1550	1030	64.2	171.5	60	970	11012	19332
COMP	08/07/94	16466	153958	3.66	304.8	1480	530	33.0	204.6	60	470	8191	15810
COMP	08/08/94	16502	170460	2.40	507.9	1460	1170	73.1	277.6	110	1060	10820	18867
COMP	08/09/94	16103	186563	2.38	627.5	1440	790	48.2	325.8	25	765	9380	-
COMP	08/10/94	15624	202187	2.28	618.1	1720	1680	99.3	425.1	63	1617	13218	22369
COMP	08/11/94	16113	218300	2.33	645.4	1670	1250	76.2	501.4	33	1217	11657	21262
COMP	08/12/94	14762	233062	2.27	656.2	1680	1510	84.4	585.7	146	1364	13205	22874
COMP	08/13/94	13785	246847	2.30	663.0	1520	950	49.6	635.3	41	909	11254	21036
COMP	08/14/94	10979	257826	2.27	497.5	1570	1380	57.3	692.7	229	1151	12451	22331
COMP	08/15/94	10129	267955	2.26	606.6	1740	750	28.8	721.4	53	697	11956	22333
COMP	08/16/94	6178	274133	2.40	553.1	1790	970	22.7	744.1	51	919	13257	24698
COMP	08/17/94	6444	280577	2.36	573.3	1680	860	21.0	765.1	171	689	13713	22929
COMP	08/18/94	7205	287782	1.83	655.6	790	490	13.4	778.4	170	320	6959	12987
COMP	08/19/94	12447	300229	1.63	664.1	1050	1480	69.7	848.2	440	1040	12007	19505
COMP	08/20/94	15338	315567	1.39	683.9	1390	2190	127.1	975.3	610	1580	17135	26608
COMP	08/21/94	12497	328064	1.55	669.8	1610	2660	125.8	1,101.1	710	1950	19555	30681
COMP	08/22/94	11793	339857	1.71	684.8	1730	3270	146.0	1,247.1	75	3195	-	-
COMP	08/23/94	12099	351956	1.59	560.0	1780	3310	151.6	1,398.7	123	3187	21399	33274
COMP	08/24/94	11183	363139	1.58	604.9	1740	3480	147.3	1,546.0	82	3398	-	-

BIOOXIDATION BULK TEST SOLUTION SAMPLING

OFF SOLUTION

Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Fe Kg/Day	Fe Cum Kg	% Fe Ext	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	DO (ppm)
SUMP-GRAB	07/26/94	1200	1200	7.22	-	.84	.27	.0	.0		-	-	-	-	-
GRAB-1530	07/27/94	1750	2950	7.53	305.4	.89	.20	.0	.0		-	-	-	-	-
COMP	07/28/94	3000	5950	5.93	353.6	83	.55	.0	.0		-	-	83	4411	-
COMP	07/29/94	3293	9243	5.49	282.1	255	13	.2	.2		-	-	362	5094	-
COMP	07/30/94	4419	13662	5.11	285.7	654	14	.2	.4	.00	-	-	994	7913	-
COMP	07/31/94	2688	16350	5.18	318.8	960	11	.1	.5	.00	-	-	956	9835	-
COMP	08/01/94	7822	24172	4.20	332.3	990	39	1.2	1.7	.00	1	38	2438	11106	-
COMP	08/02/94	21836	46008	3.39	429.6	1930	172	14.2	15.9	.00	2	170	8960	18304	-
COMP	08/03/94	14710	60718	3.43	360.1	2050	520	29.0	44.8	.00	260	260	10520	21678	-
COMP	08/04/94	7500	68218	3.36	344.2	1750	500	14.2	59.0	.01	410	90	8967	18731	-
COMP	08/05/94	6821	75039	2.50	503.7	1870	480	12.4	71.4	.00	40	440	11633	20711	-
COMP	08/06/94	21396	96436	2.45	465.2	1940	1530	123.9	195.3	-.01	200	1330	14570	23591	-
COMP	08/07/94	21396	117832	2.63	435.8	1770	1110	89.9	285.2	.03	190	920	12617	20727	-
COMP	08/08/94	18698	136530	2.40	484.6	1800	1390	98.4	383.6	.04	160	1230	13259	22299	-
COMP	08/09/94	21118	157648	2.36	557.4	1690	1070	85.5	469.1	.07	36	1034	11904	21180	-
COMP	08/10/94	16419	174067	2.31	491.4	1760	1320	82.0	551.2	.08	220	1100	12958	22052	-
COMP	08/11/94	16500	190567	2.29	524.4	1580	1290	80.6	631.7	.09	86	1204	12958	21764	-
COMP	08/12/94	18213	208780	2.28	523.1	1630	1520	104.8	736.5	.08	56	1464	13452	22729	1.3
COMP	08/13/94	18585	227365	2.34	500.2	1630	1420	99.9	836.4	.09	240	1180	13361	22995	1.3
COMP	08/14/94	16646	244011	2.29	472.4	1680	1490	93.9	930.3	.10	380	1110	13608	23458	-
COMP	08/15/94	13559	257570	2.31	522.4	1700	1110	57.0	987.2	.12	84	1026	13179	23381	-
COMP	08/16/94	12267	269837	2.36	496.4	1670	1540	71.5	1,058.7	.12	196	1344	14831	23933	1.4
COMP	08/17/94	7697	277534	2.49	481.4	1600	1160	33.8	1,092.5	.13	43	1117	13309	23711	2.2
COMP	08/18/94	7136	284670	2.39	650.1	1790	1100	29.7	1,122.2	.14	480	620	13839	25735	1.7
COMP	08/19/94	13078	297748	2.13	663.0	1680	2450	121.3	1,243.5	.14	690	1760	16703	27554	-
COMP	08/20/94	14479	312227	2.02	672.0	1620	2550	139.7	1,383.3	.18	670	1880	16716	27464	-
COMP	08/21/94	14213	326440	2.18	678.3	1660	2900	156.0	1,539.3	.21	770	2130	18024	29200	-
COMP	08/22/94	14246	340686	2.16	631.0	1800	3160	170.4	1,709.7	.22	75	3085	-	-	-
COMP	08/23/94	13868	354554	2.11	671.3	1740	3210	168.5	1,878.2	.24	73	3137	19568	31299	-
COMP	08/24/94	12742	367296	2.09	604.1	1760	3540	170.7	2,048.9	.25	82	3458	-	-	.7

BIOOXIDATION BULK TEST SOLUTION SAMPLING

PAN LYSIMETER 3

Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO (ppm)
GRAB	08/03/94	1.93	488.4	1540	4640	1200	3440	20005	23896	-	
GRAB	08/11/94	1.52	496.1	3200	8700	2900	5800	-	-	Brown/Murky	
GRAB	08/12/94	1.89	450.4	2200	3900	2100	1800	-	27461	Lt Brown	1.5
GRAB	08/15/94	1.92	459.5	2170	3920	1270	2650	15417	27625	Med Brown	1.7
GRAB	08/17/94	1.97	462.7	1940	3220	560	2660	19502	25159	Med Brown	2.4
GRAB	08/19/94	2.00	458.4	1850	2300	1400	900	17828	23604	-	-
GRAB	08/22/94	1.90	464.0	1760	2300	360	1940	16677	23744	Grw/Br Ti	1.9
GRAB	08/24/94	2.04	468.5	1780	2680	770	1910	16795	23028	Green	.9

PAN LYSIMETER 4

Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO (ppm)
GRAB	08/11/94	2.62	526.3	55	87	-	-	-	-	Flush H2O	-
GRAB	08/12/94	2.06	560.0	567	1260	67	1193	5282	6801	Lt Brown	4.8
GRAB	08/15/94	1.87	671.9	1260	2920	105	2815	14311	17681	Lt Brown	2.9
GRAB	08/17/94	1.71	687.2	1610	3670	102	3568	19528	23875	Med Brown	2.9
GRAB	08/19/94	1.79	659.6	1790	2900	900	2000	19280	24583	-	-
GRAB	08/22/94	1.86	615.3	1720	2000	73	1927	16285	23809	Gr-Brown	3.2
GRAB	08/24/94	1.78	678.6	1770	2420	60	2360	16481	24196	Green	OFL

PAN LYSIMETER 5

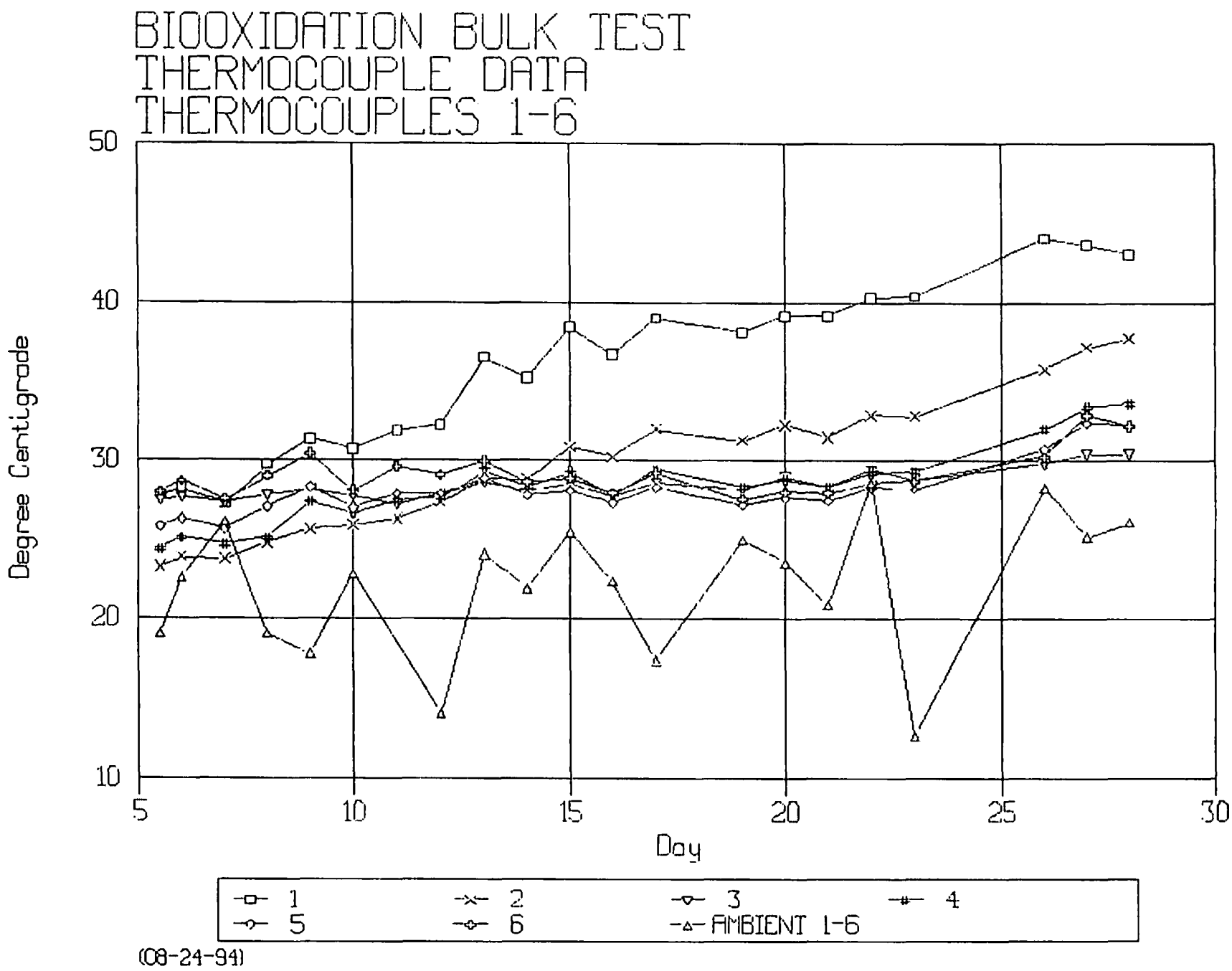
Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO (ppm)
GRAB	08/03/94	1.49	515.6	3690	17700	2100	15600	57687	66622	Dark Brown	-
GRAB	08/04/94	1.32	511.1	3930	14100	1600	12500	60119	67556	Dark Brown	-
GRAB	08/09/94	1.70	484.5	2600	4500	1400	3100	28440	38389	Dark Brown	-
GRAB	08/10/94	2.37	574.1	1740	990	36	954	11468	23641	Off Soln Flush	
GRAB	08/11/94	1.72	431.8	2000	3700	3400	300	-	-	Green Color	-
GRAB	08/12/94	1.80	439.7	2000	3900	2900	1000	20048	24627	Lt Green	3.7
GRAB	08/15/94	1.88	361.1	1940	3940	2200	1740	20543	24800	Green	2.6
GRAB	08/17/94	1.88	415.7	2030	4800	3700	1100	23073	27307	Green	2.7
GRAB	08/19/94	1.87	418.5	2170	4100	4000	100	21647	27324	-	-
GRAB	08/22/94	2.26	437.3	1920	2800	2300	500	18260	24542	Yel-Br	2.1
GRAB	08/24/94	2.12	385.4	1880	3250	2900	350	17056	25184	Lt Gr/Blue	OFL

PAN LYSIMETER 6

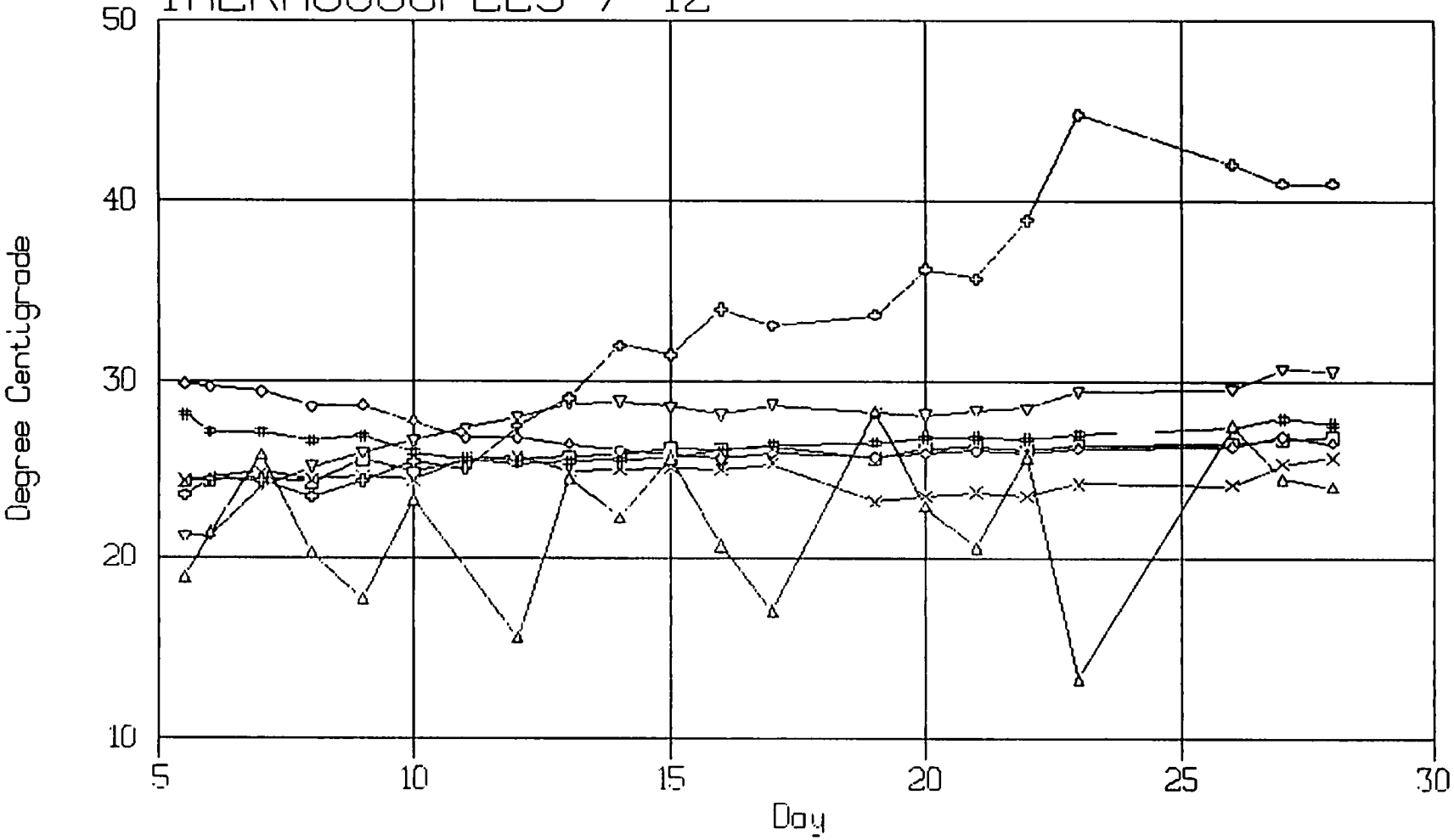
Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO (ppm)
GRAB	08/11/94	1.50	532.5	2000	4480	3300	1180	-	-	Dk Brown	-
GRAB	08/12/94	1.48	554.7	3770	8900	600	8300	31953	53838	Dk Brown	3.6
GRAB	08/15/94	1.72	361.1	2560	4300	700	3600	28024	33225	Med Brown	1.4
GRAB	08/17/94	1.73	662.4	2330	4000	1200	2800	25591	30262	Stringy Ppt	2.0
GRAB	08/19/94	1.61	586.7	2190	4500	160	4340	25781	31299	-	-
GRAB	08/22/94	1.65	580.4	1770	2600	130	2470	18168	23883	Gr-Br w/Chnks	0.8
GRAB	08/24/94	1.71	588.9	1770	3520	140	3380	19463	25011	Dk Gr/Br	OFL

BIOOXIDATION BULK TEST THERMOCOUPLE DATA

Date	West 1	West 2	West 3	West 4	West 5	Mid 6	Mid 7	Mid 8	East 9	East 10	East 11	East 12	AMBIENT 1-6	AMBIENT 7-12
08/02/94	27.8	23.2	27.4	24.3	25.7	28.0	24.3	24.3	21.2	28.1	29.8	23.5	19.0	18.9
08/02/94	28.2	23.8	27.6	25.0	26.2	28.7	24.3	24.5	21.3	27.1	29.6	24.4	22.6	21.5
08/03/94	27.2	23.7	27.2	24.6	25.6	27.5	24.5	24.8	24.0	27.1	29.4	24.3	26.0	25.8
08/04/94	29.7	24.7	27.8	25.0	27.0	29.0	24.2	24.4	25.1	26.6	28.5	23.4	19.0	20.3
08/05/94	31.3	25.6	28.2	27.3	28.3	30.4	25.5	24.6	25.9	26.9	28.6	24.3	17.7	17.7
08/06/94	30.7	25.8	27.7	26.6	26.9	28.1	24.8	24.4	26.6	25.9	27.7	25.4	22.8	23.3
08/07/94	31.8	26.2	27.1	27.4	27.9	29.6	25.4	25.5	27.3	25.5	26.8	25.0	-	-
08/08/94	32.2	27.3	27.9	27.6	27.9	29.1	25.5	25.7	27.9	25.3	26.8	27.5	14.0	15.5
08/09/94	36.4	28.9	28.6	29.3	28.9	29.9	25.7	24.9	28.7	25.4	26.4	29.0	24.0	24.5
08/10/94	35.1	28.8	28.0	28.3	27.8	28.6	25.8	25.0	28.8	25.5	26.0	32.0	21.9	22.3
08/11/94	38.4	30.8	28.5	29.2	28.1	28.9	26.2	25.1	28.5	25.6	25.8	31.5	25.4	25.6
08/12/94	36.6	30.2	27.7	27.8	27.2	27.9	26.1	25.0	28.1	26.0	25.6	34.0	22.3	20.7
08/13/94	39.0	31.9	28.6	29.4	28.3	29.2	26.3	25.3	28.6	26.4	25.9	33.1	17.3	17.0
08/14/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/15/94	38.1	31.2	28.2	28.3	27.1	27.5	25.6	23.2	28.2	26.5	25.7	33.7	24.9	28.3
08/16/94	39.1	32.2	29.0	28.8	27.6	28.0	26.2	23.5	28.0	26.8	25.9	36.2	23.5	22.9
08/17/94	39.1	31.4	28.3	28.3	27.4	27.9	26.3	23.7	28.3	26.8	26.0	35.7	20.8	20.6
08/18/94	40.3	32.8	29.4	29.2	28.3	28.6	26.1	23.5	28.4	26.7	25.9	39.0	28.6	25.7
08/19/94	40.4	32.7	28.8	29.3	28.2	28.7	26.4	24.2	29.4	27.0	26.2	44.8	12.6	13.3
08/20/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/21/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/22/94	44.1	35.7	29.8	31.9	30.7	30.2	26.5	24.1	29.5	27.4	26.3	42.1	28.3	27.5
08/23/94	43.7	37.1	30.4	33.3	32.3	32.8	26.7	25.3	30.7	27.9	26.9	41.0	25.1	24.5
08/24/94	43.1	37.7	30.4	33.5	32.2	32.1	26.8	25.7	30.6	27.6	26.5	41.0	26.0	24.0


BIOOXIDATION BULK TEST
THERMOCOUPLE DATA
THERMOCOUPLES 1-6
Degree Centigrade
50
40
30
20
10
5
10
15
20
25
30
Day
1
2
3
4
5
6
AMBIENT 1-6
(08-24-94)

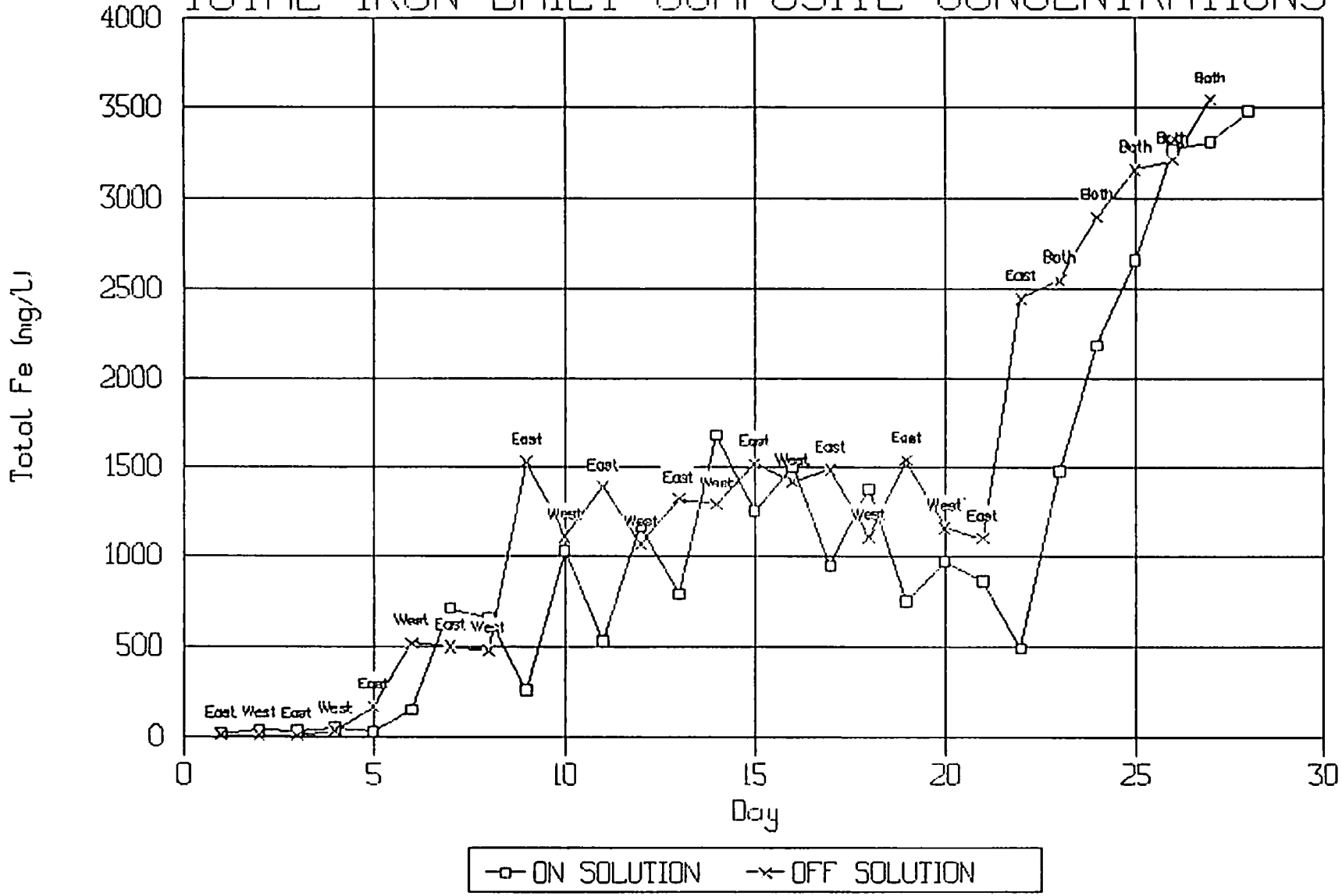
BIOOXIDATION BULK TEST
THERMOCOUPLE DATA
THERMOCOUPLES 7-12



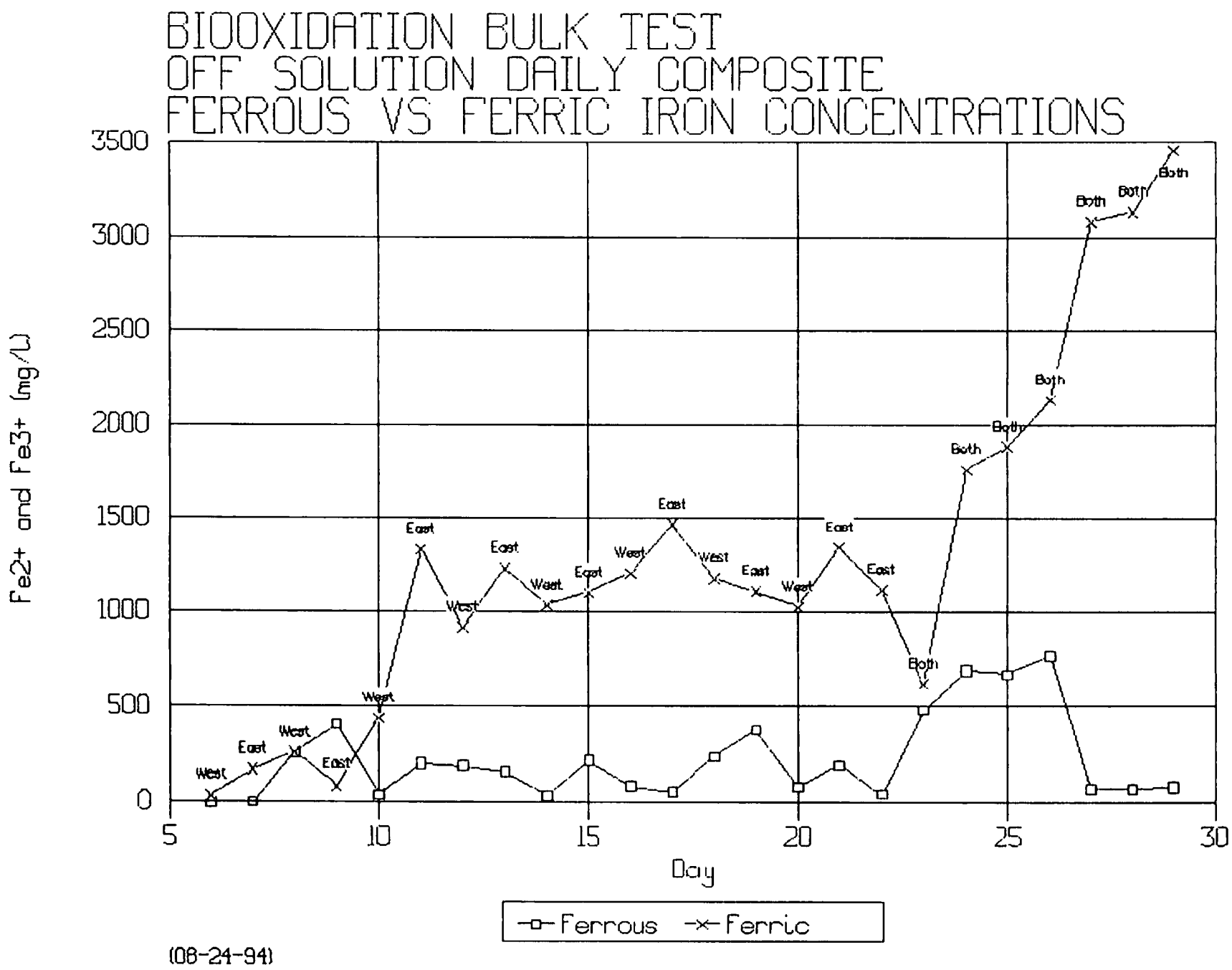
7	8	9	10
11	12	AMBIENT 7-12	

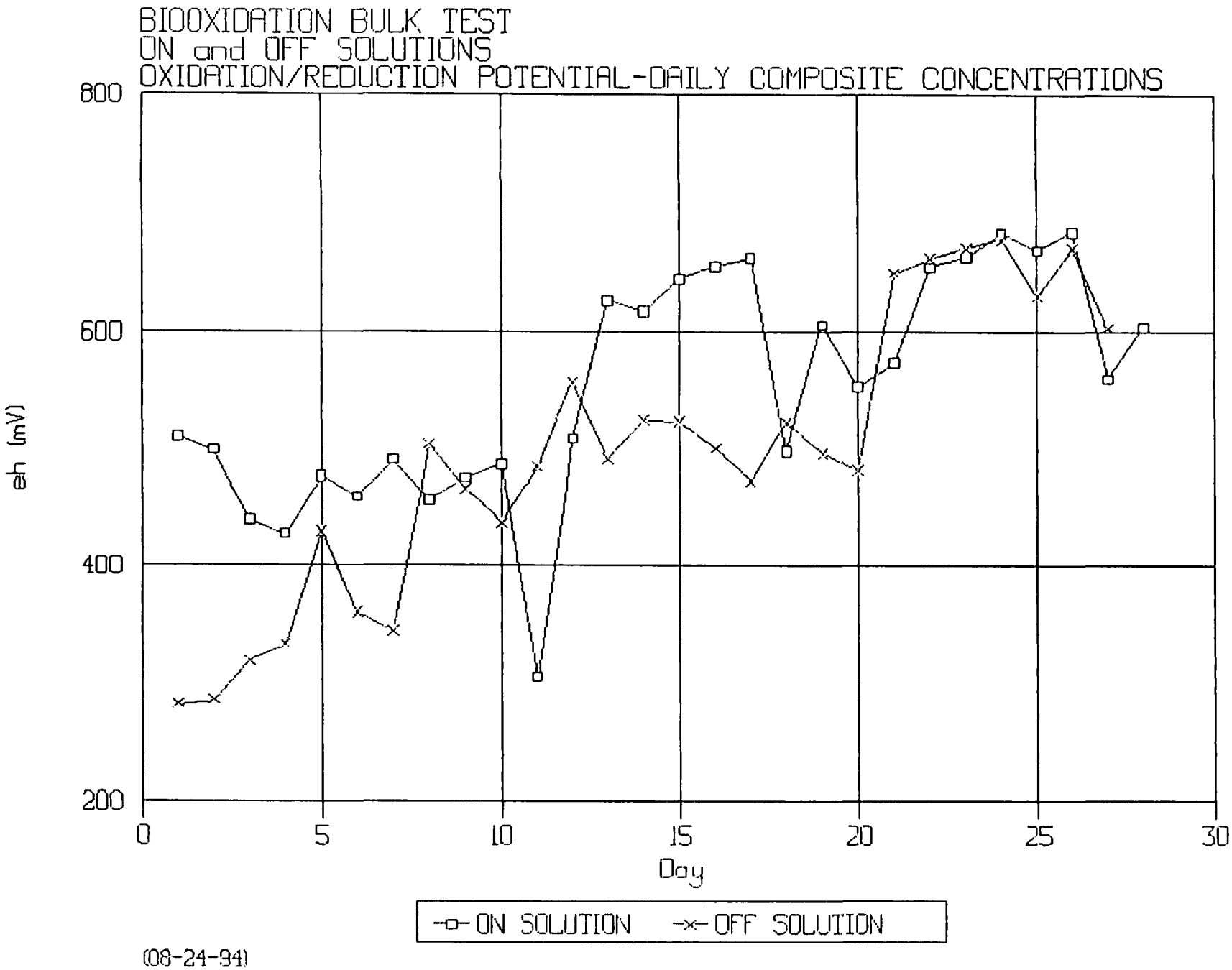
(08-24-94)

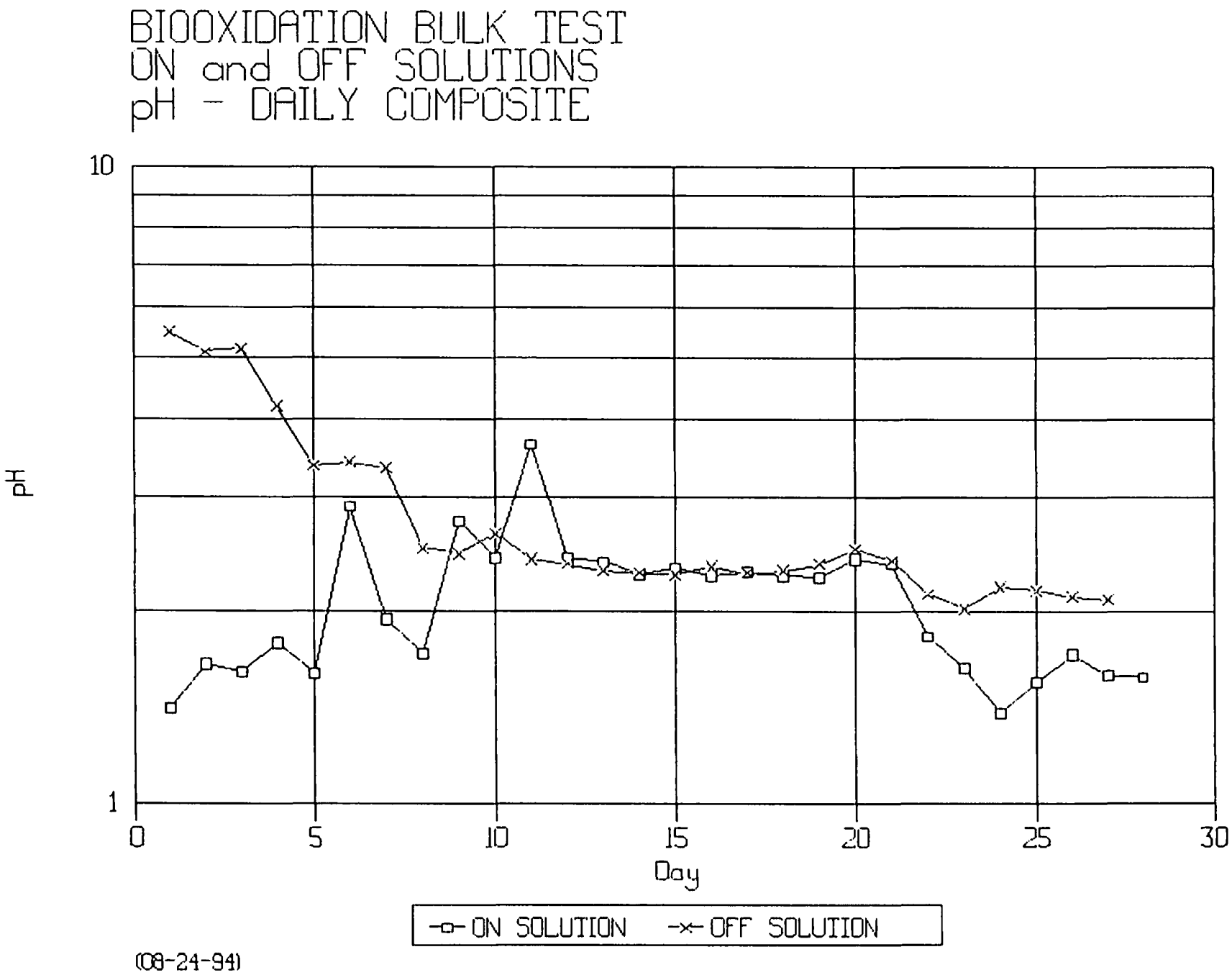
BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
TOTAL IRON-DAILY COMPOSITE CONCENTRATIONS

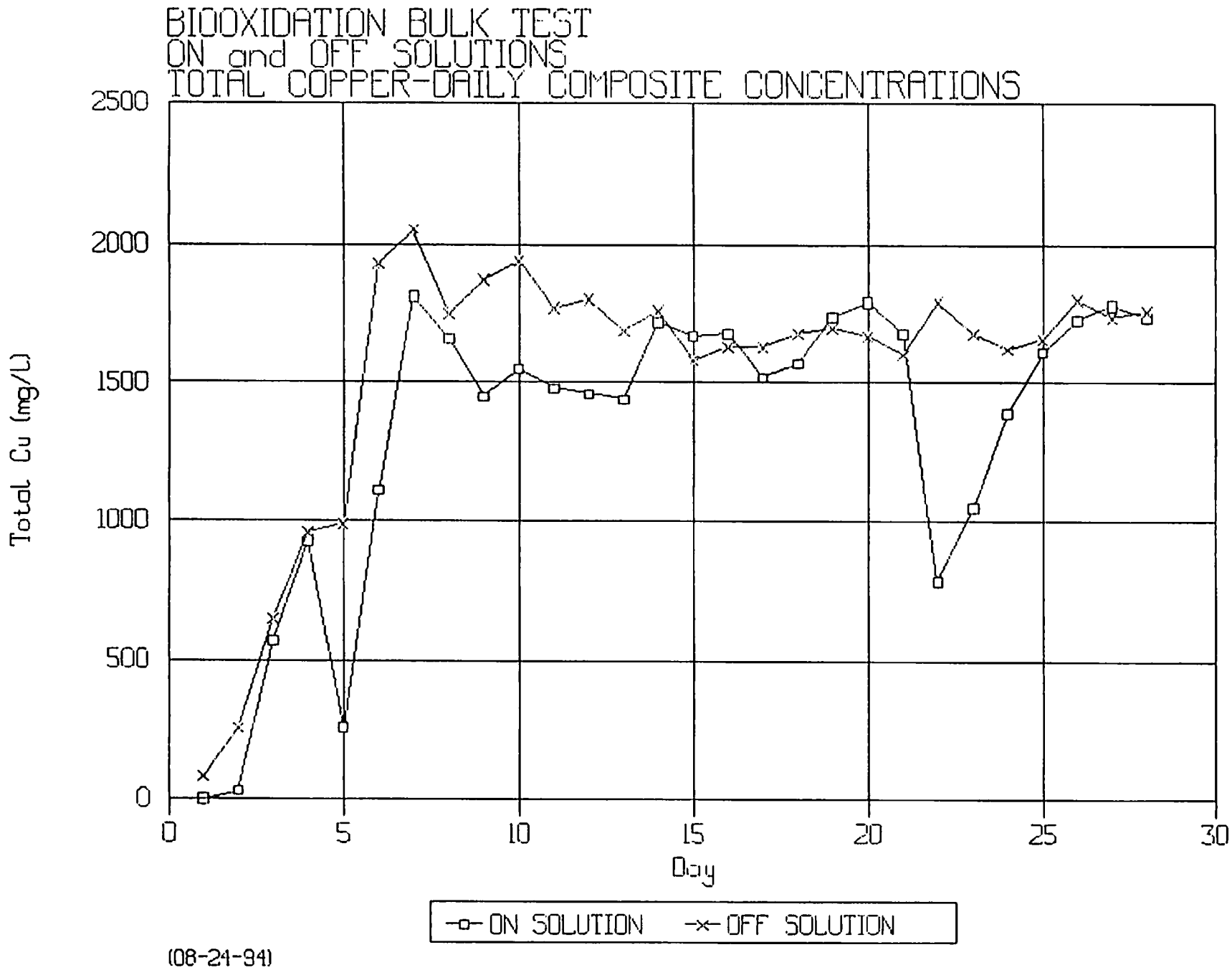


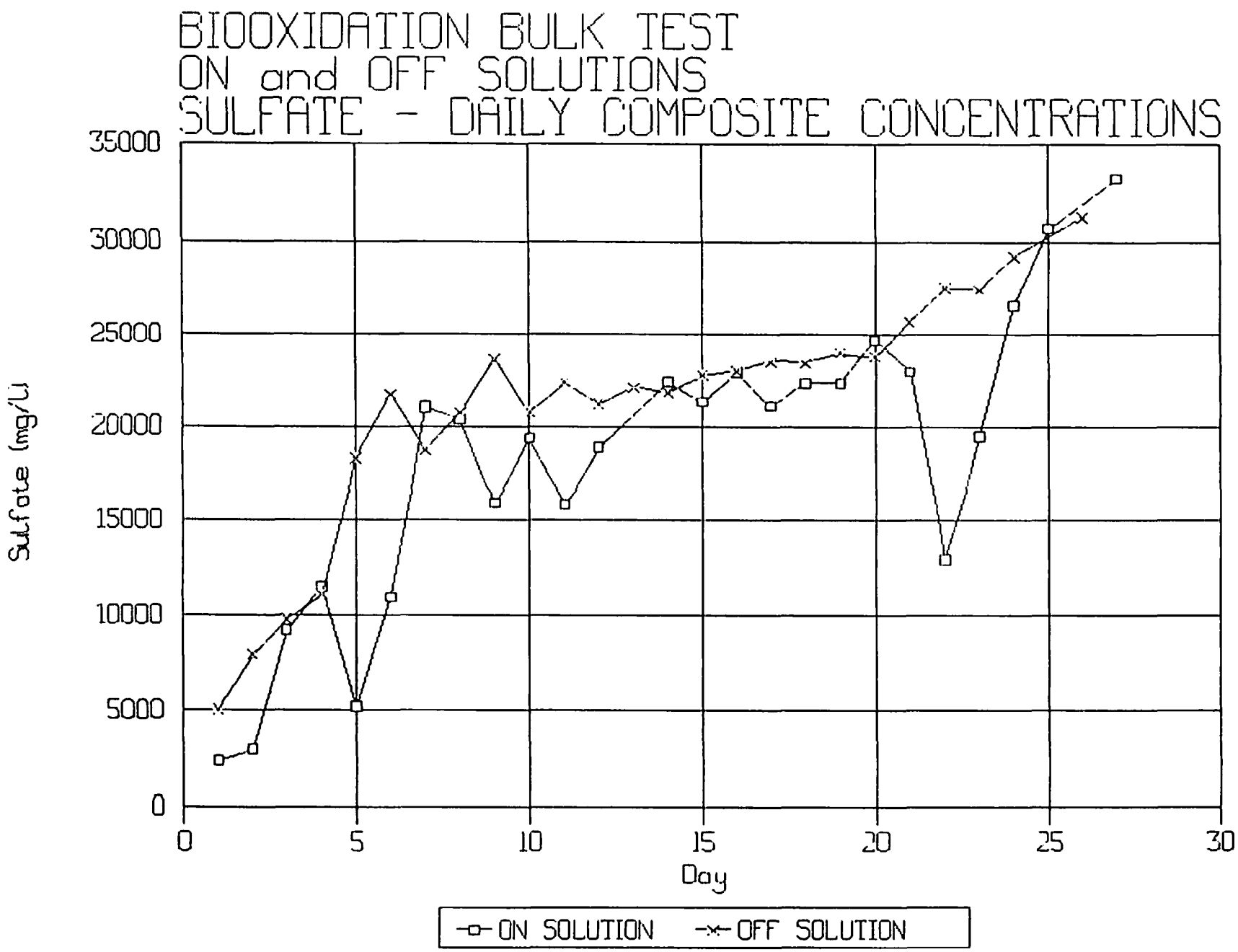
(08-24-94)


BIOOXIDATION BULK TEST
OFF SOLUTION DAILY COMPOSITE
FERROUS VS FERRIC IRON CONCENTRATIONS
Fe2+ and Fe3+ (mg/L)
3500
3000
2500
2000
1500
1000
500
0
5
10
15
20
25
30
Day
West
East
Both
Ferrous
Ferric
(08-24-94)


BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
OXIDATION/REDUCTION POTENTIAL-DAILY COMPOSITE CONCENTRATIONS
800
600
400
200
eh (mV)
0
5
10
15
20
25
30
Day
ON SOLUTION
OFF SOLUTION
(08-24-94)

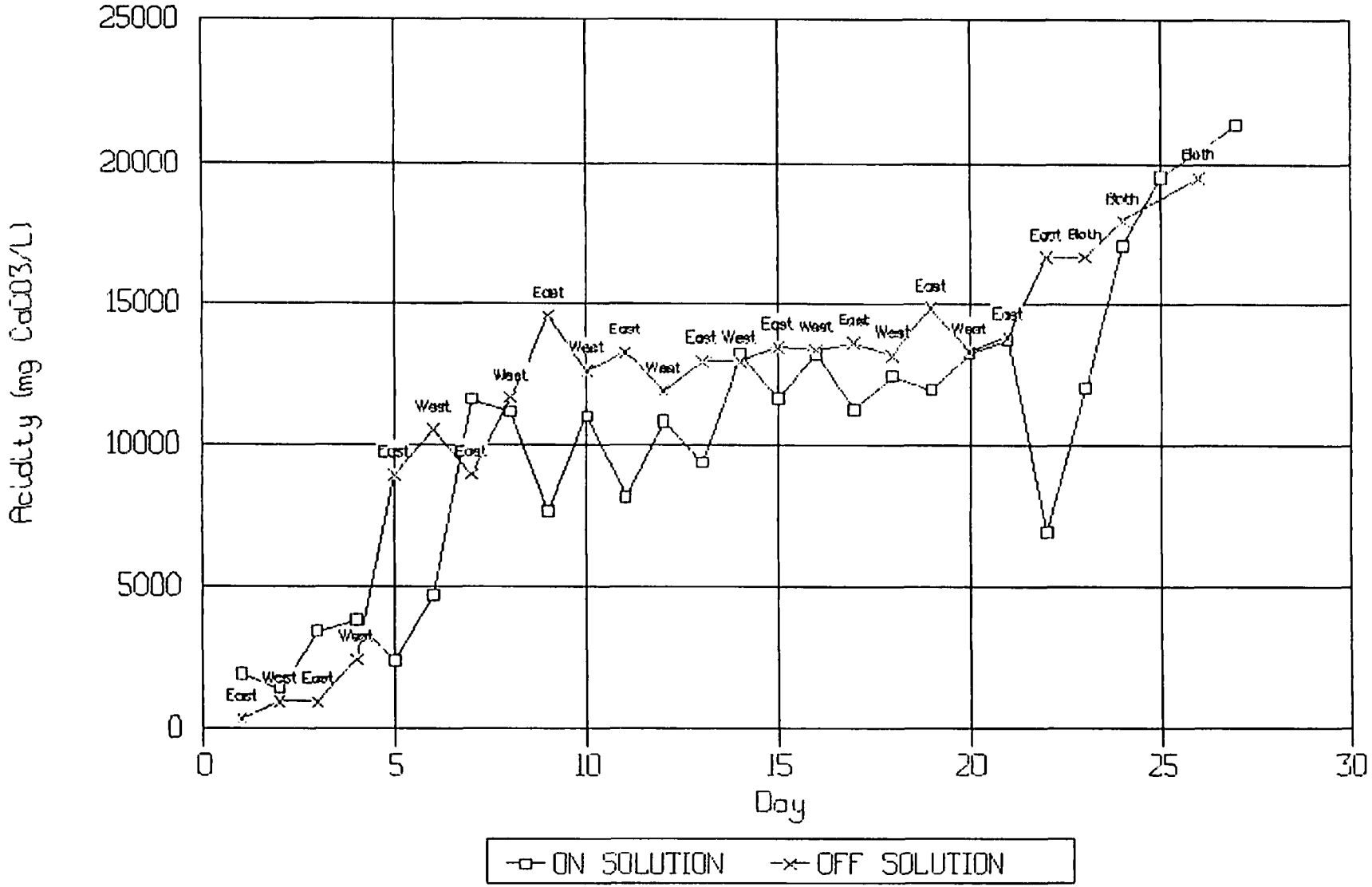

BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
pH - DAILY COMPOSITE
10
1
pH
0
5
10
15
20
25
30
Day
ON SOLUTION
OFF SOLUTION
(08-24-94)


BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
TOTAL COPPER-DAILY COMPOSITE CONCENTRATIONS
Total Cu (mg/L)
2500
2000
1500
1000
500
0
0
5
10
15
20
25
30
Day
ON SOLUTION
OFF SOLUTION
(08-24-94)

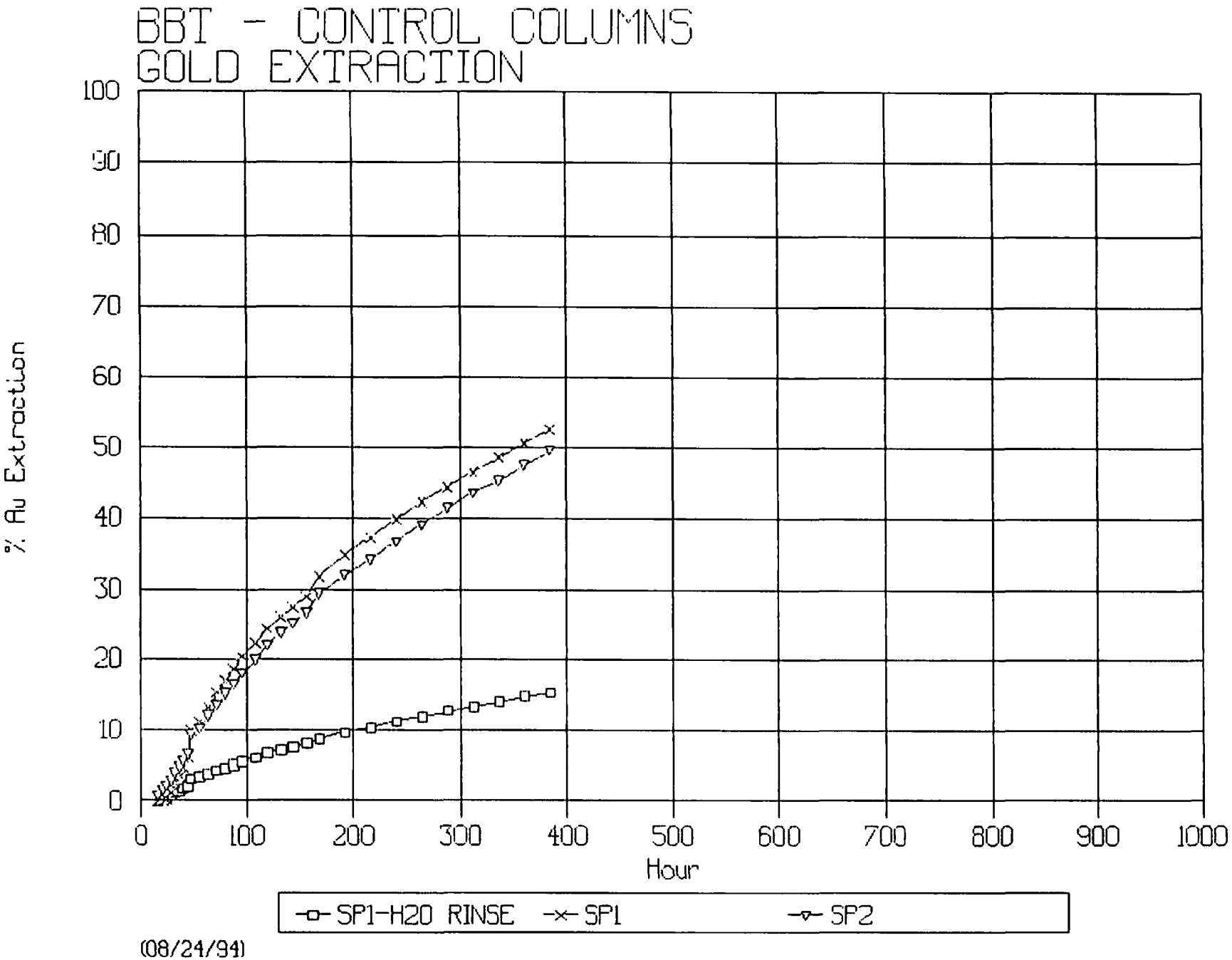

BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
SULFATE - DAILY COMPOSITE CONCENTRATIONS
Sulfate (mg/L)
35000
30000
25000
20000
15000
10000
5000
0
0
5
10
15
20
25
30
Day
ON SOLUTION
OFF SOLUTION

(08-24-94)

BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
ACIDITY TO pH 7-DAILY COMPOSITE CONCENTRATIONS



(08-24-94)


BBT - CONTROL COLUMNS
GOLD EXTRACTION
% Au Extraction
100
90
80
70
60
50
40
30
20
10
0
0
100
200
300
400
500
600
700
800
900
1000
Hour
SP1-H20 RINSE
SP1
SP2
(08/24/94)

daily composites from shovel samples as loaded heap
.040 - .049 2 splits each assayed in triplicate

MEMORANDUM

TREATED Heap

$\bar{x} \rightarrow 0.046$

DATE: AUGUST 19, 1994
TO: JIM THOMPSON
FROM: LAURA DAMON
SUBJECT: BIOOXIDATION BULK TEST (BBT) WEEKLY UPDATE

Loader bucket $\bar{x} = .049$

The BBT has been on the biooxidation cycle for three weeks now with the east and west sides having alternating solution application (i.e. each side - one day on/one day off). The ON solution application rate slowed down starting August 14 as the emitter lines were plugging from the neutralization sludge. There has been no line breakage or sloughing this week.

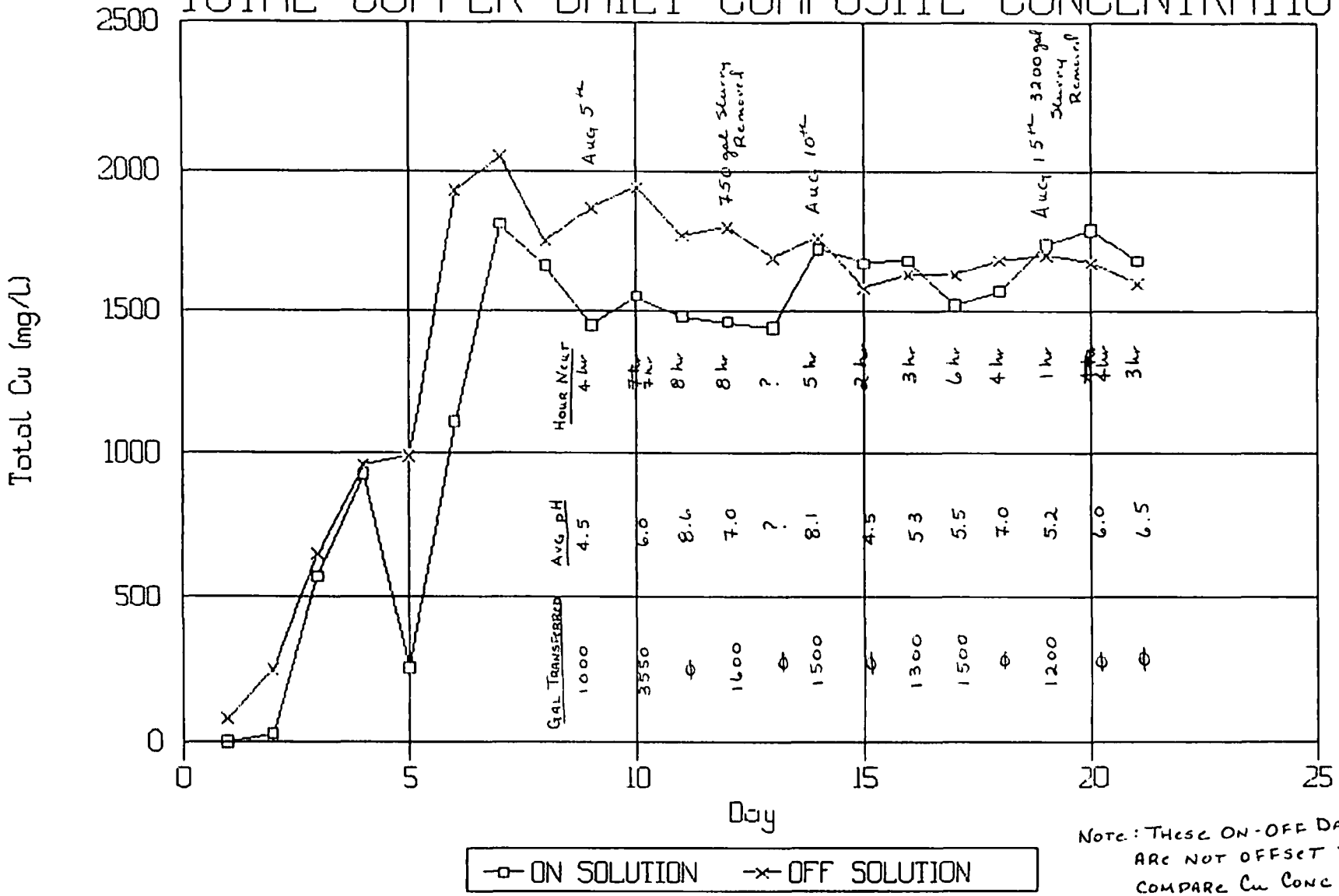
The neutralization circuit is still very labor intensive, the precipitate has been plugging the emitters and the metals removal is inefficient. The circuit will be temporarily shut down as of today and the ON solution pH dropped to 1.5 to try to clean out the emitters. A new neutralization design is being worked on by Geobiotics personnel. 3200 gallons from the neutralization slurry tank was drained on August 15. The slurry contained 16% solids which contained 3.1% iron and 4.4% copper. It is estimated that approximately 130 lb of iron and 190 lb of copper were dumped on the top of Cell #7.

The data collected to date still indicate that the bacteria are biooxidizing the sulfide ore although the rate of biooxidation has appeared to slow down after Day 10 as shown in the graphs. The iron ions are still predominantly in the form of ferric iron. An interesting observation is that the solution coming off the heap from the east side application has a consistently higher concentration of iron and acidity than the west side. The pan lysimeter data from the east side of the heap (4,5,6) indicate that the east side may be biooxidizing more rapidly, although this may be a premature assumption due to the limited lysimeter data.

A gold extraction graph of the control columns is attached. The water rinse column is performing poorly but the pH only rose above 8 for the last two samples taken. The other two control columns, with lime addition, are showing similar results with gold extractions in the 36%-40% range after 10 days on cyanide leach. All three columns of ore are showing sodium cyanide consumptions in the 1 lb NaCN/ton ore range although the water rinse column, with no lime addition, is slightly higher than the other two.

c: Rod MacLeod
Martin Quick
Herb Osborne

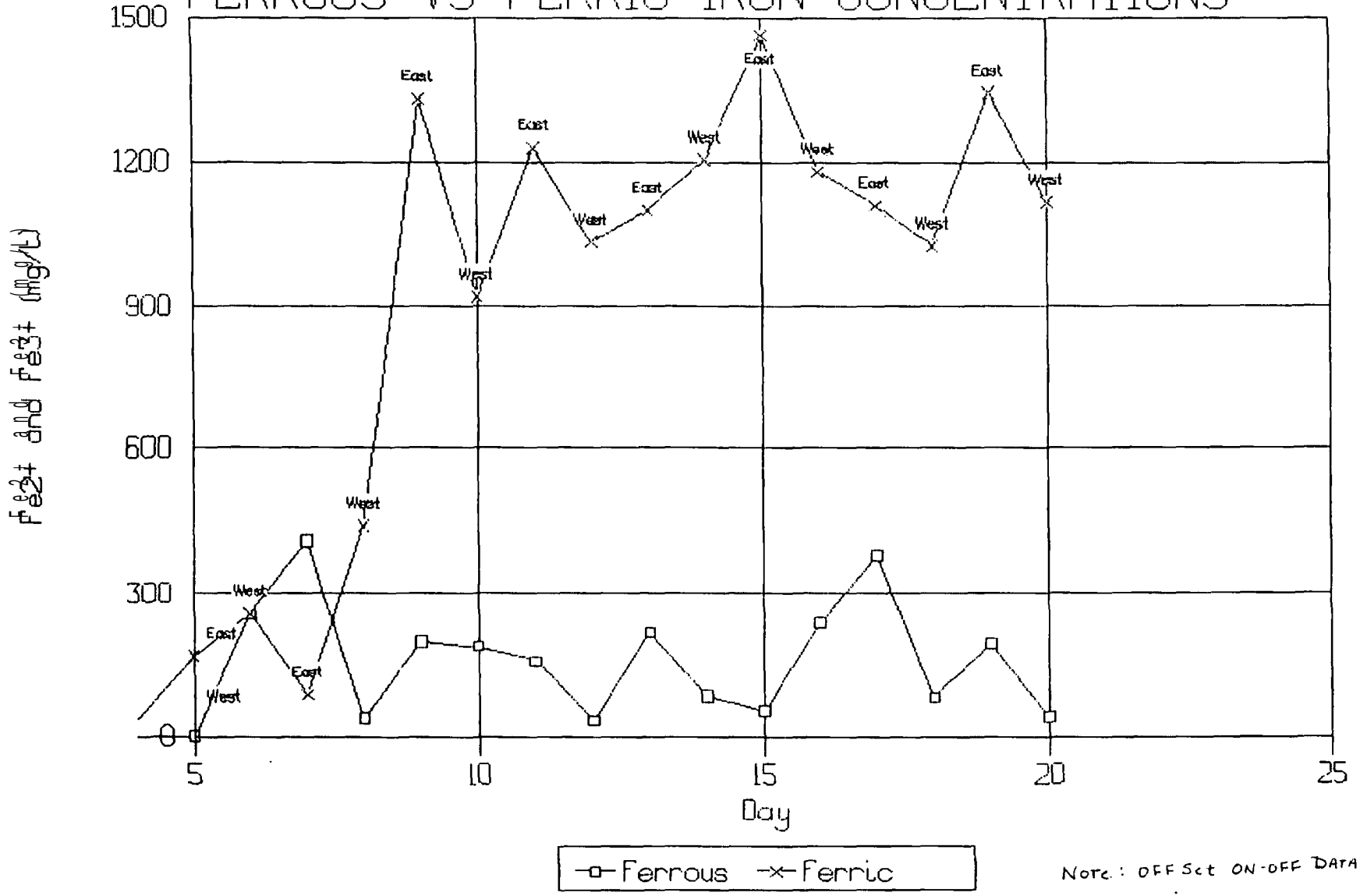
BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
TOTAL COPPER-DAILY COMPOSITE CONCENTRATION



(08-17-94)

Note: These ON-OFF Data are not offset to compare Cu Conc for Treatment Purposes.

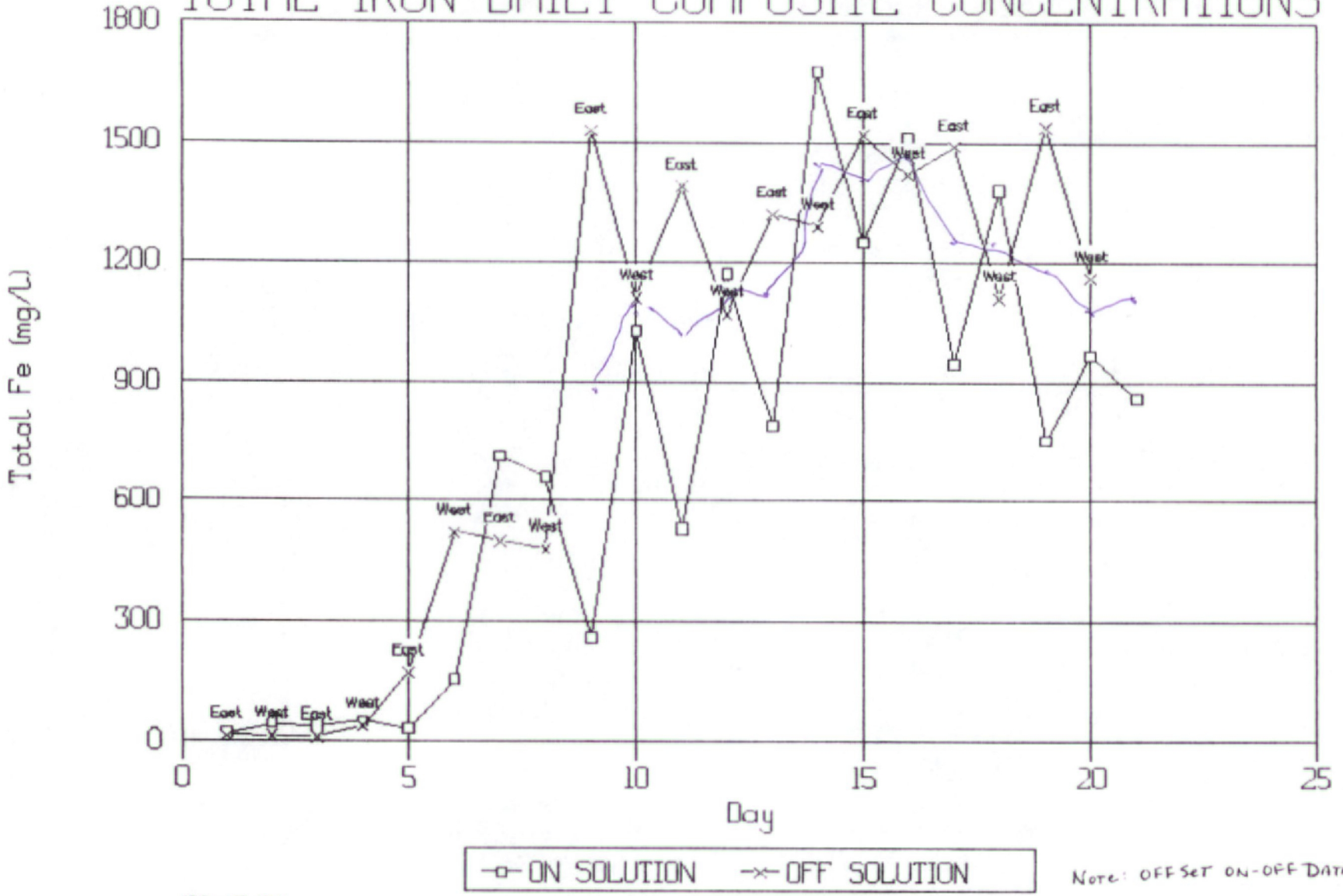
BIOOXIDATION BULK TEST
OFF SOLUTION DAILY COMPOSITE
FERROUS VS FERRIC IRON CONCENTRATIONS



Note: OFF Set ON-OFF DATA POINTS

(08-17-94)

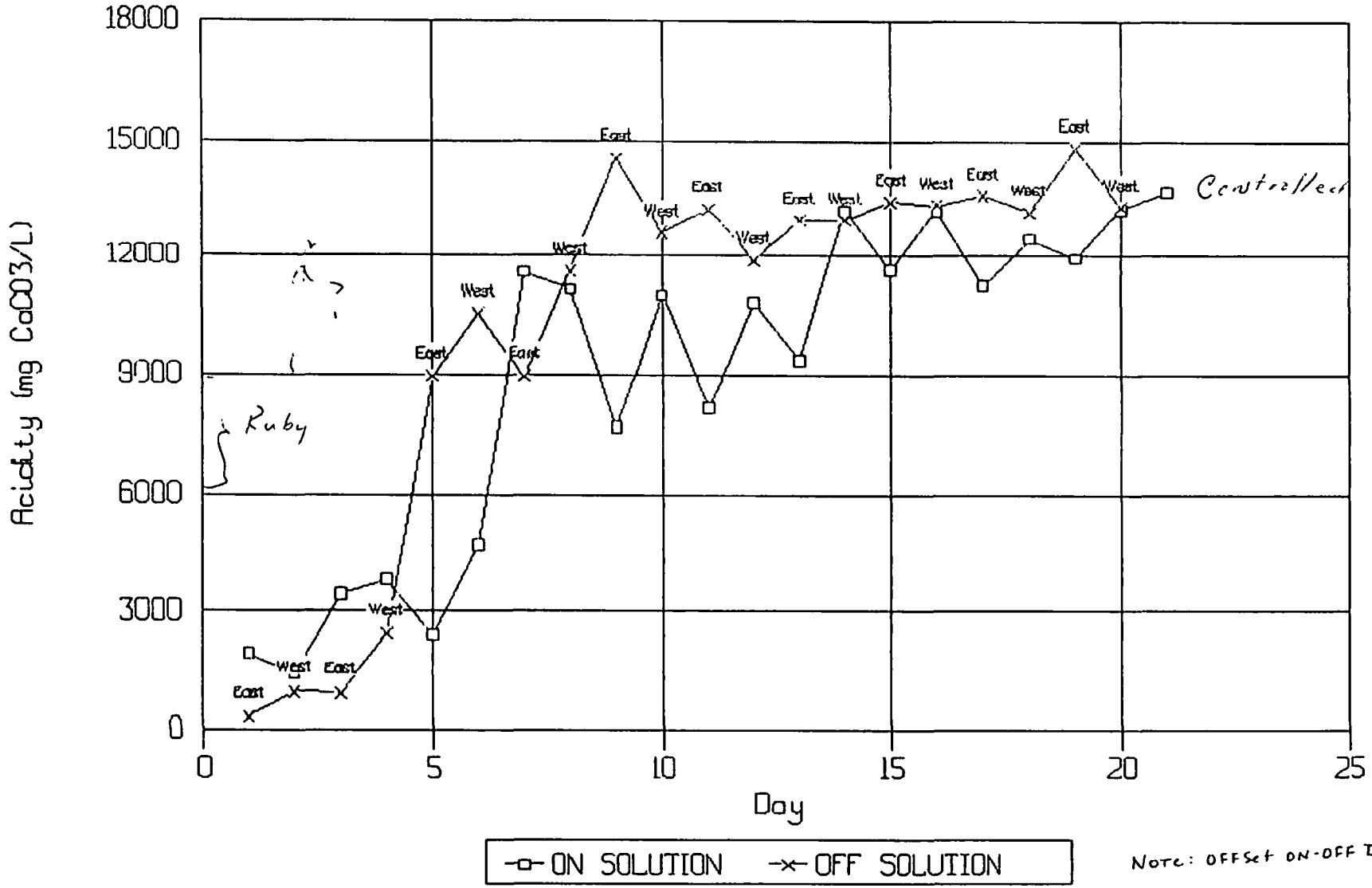
BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
TOTAL IRON-DAILY COMPOSITE CONCENTRATIONS



Note: OFF SET ON-OFF DATA PTS

(08-17-94)

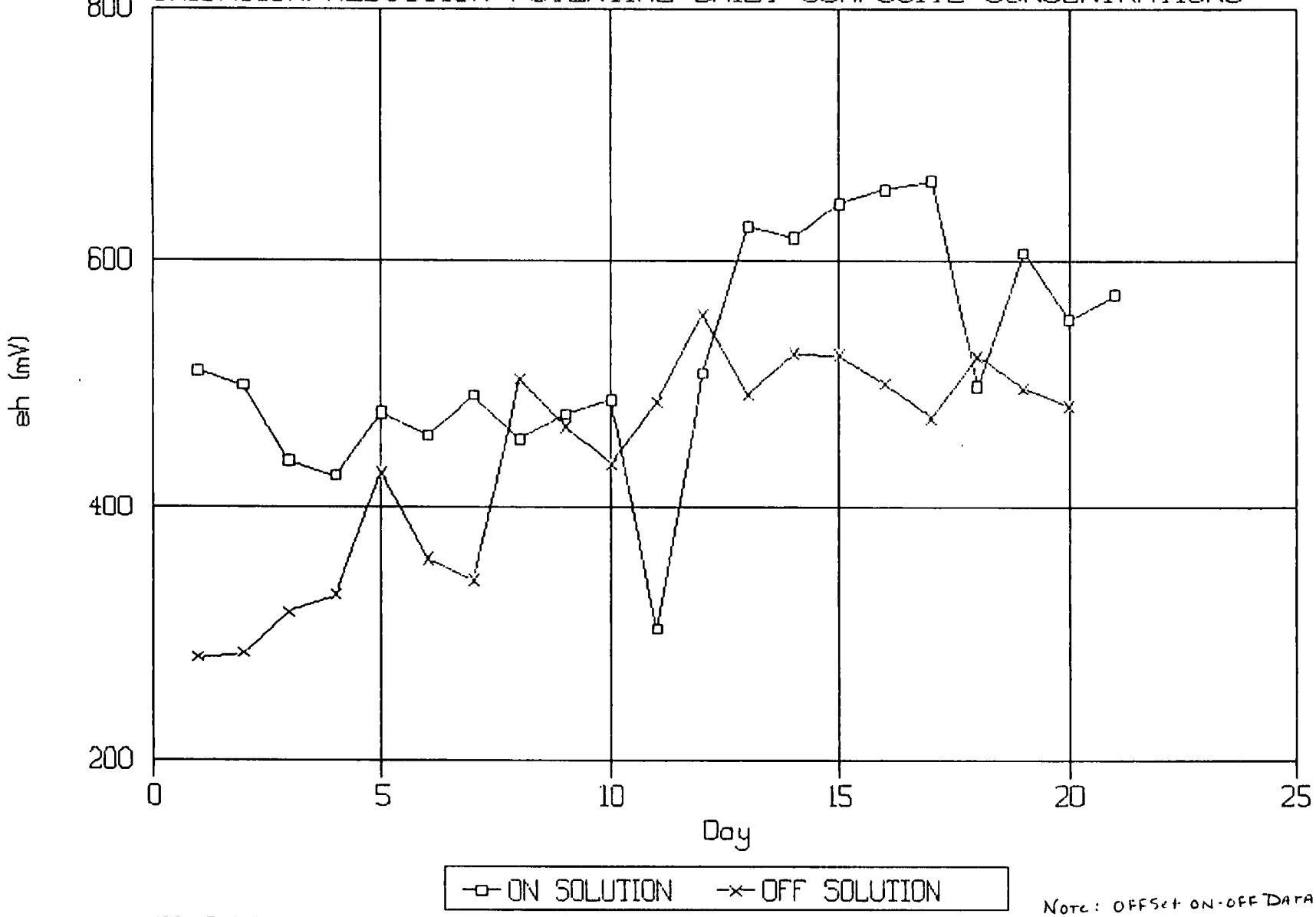
BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
ACIDITY TO pH 7-DAILY COMPOSITE CONCENTRATIONS



Note: OFFSet ON-OFF Data Prs

(08-17-94)

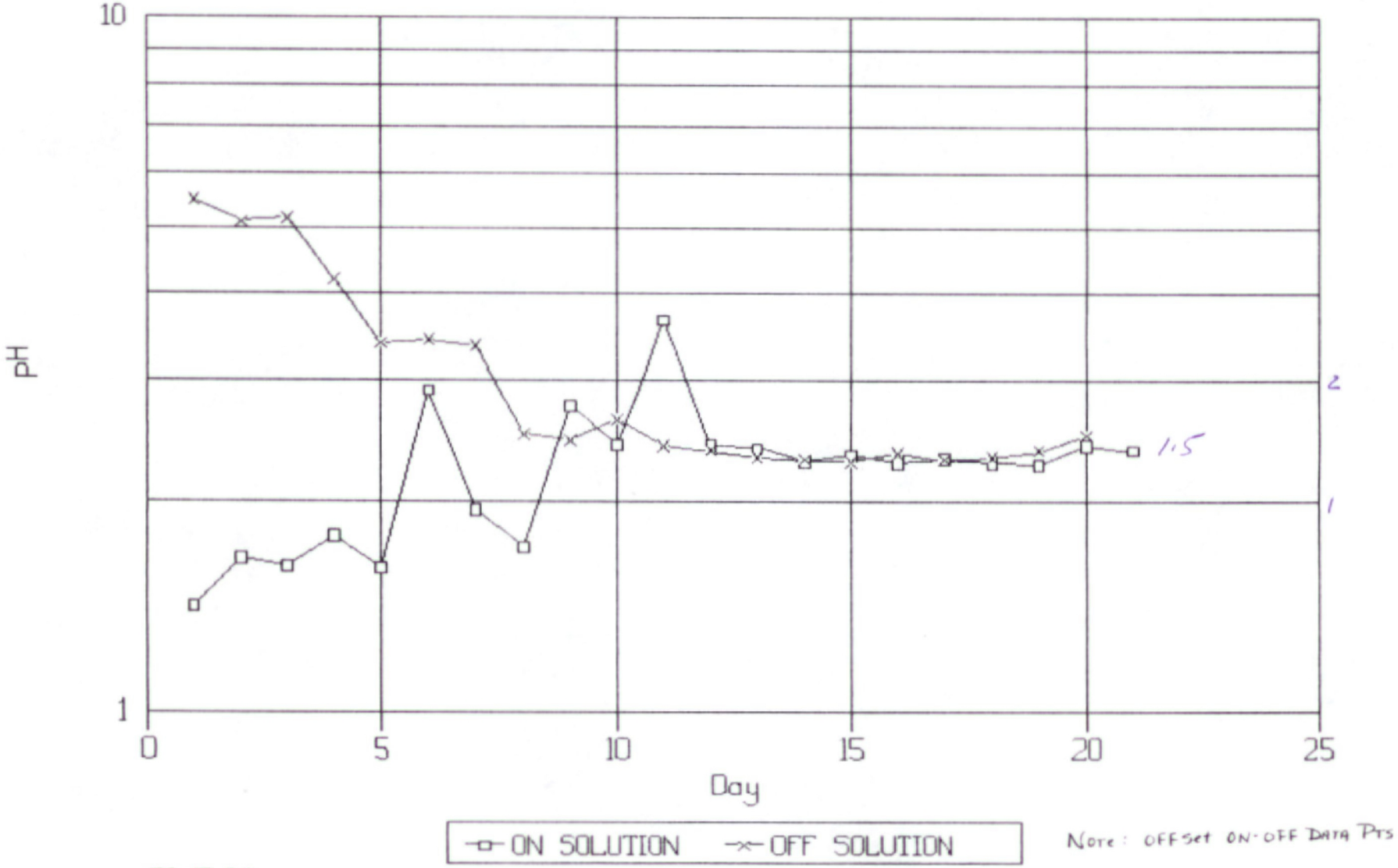
BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
OXIDATION/REDUCTION POTENTIAL-DAILY COMPOSITE CONCENTRATIONS



(08-17-94)

Note: OFFSet ON-OFF Data Pts

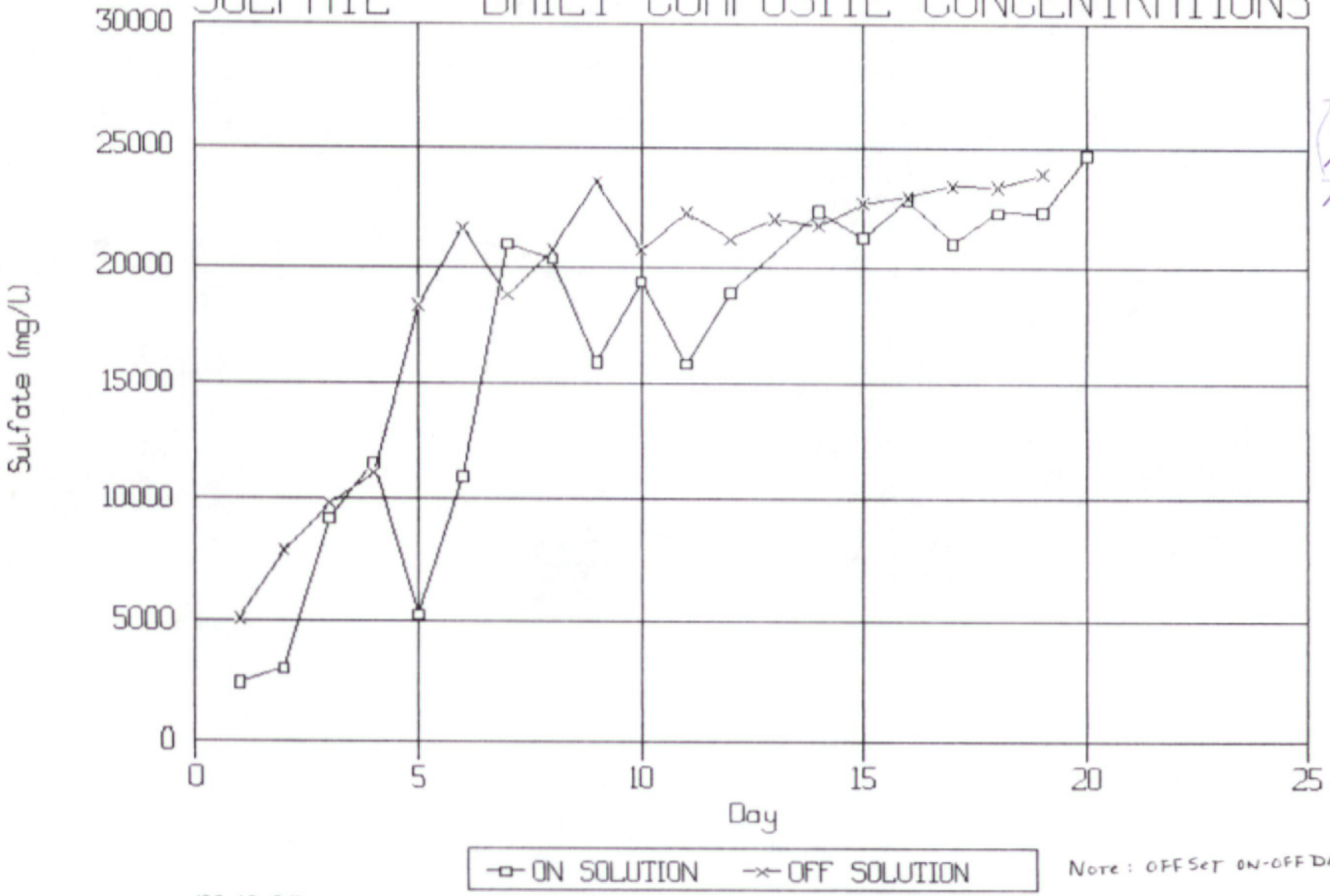
BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
pH - DAILY COMPOSITE



Note: OFF set ON-OFF Data Pts

(08-17-94)

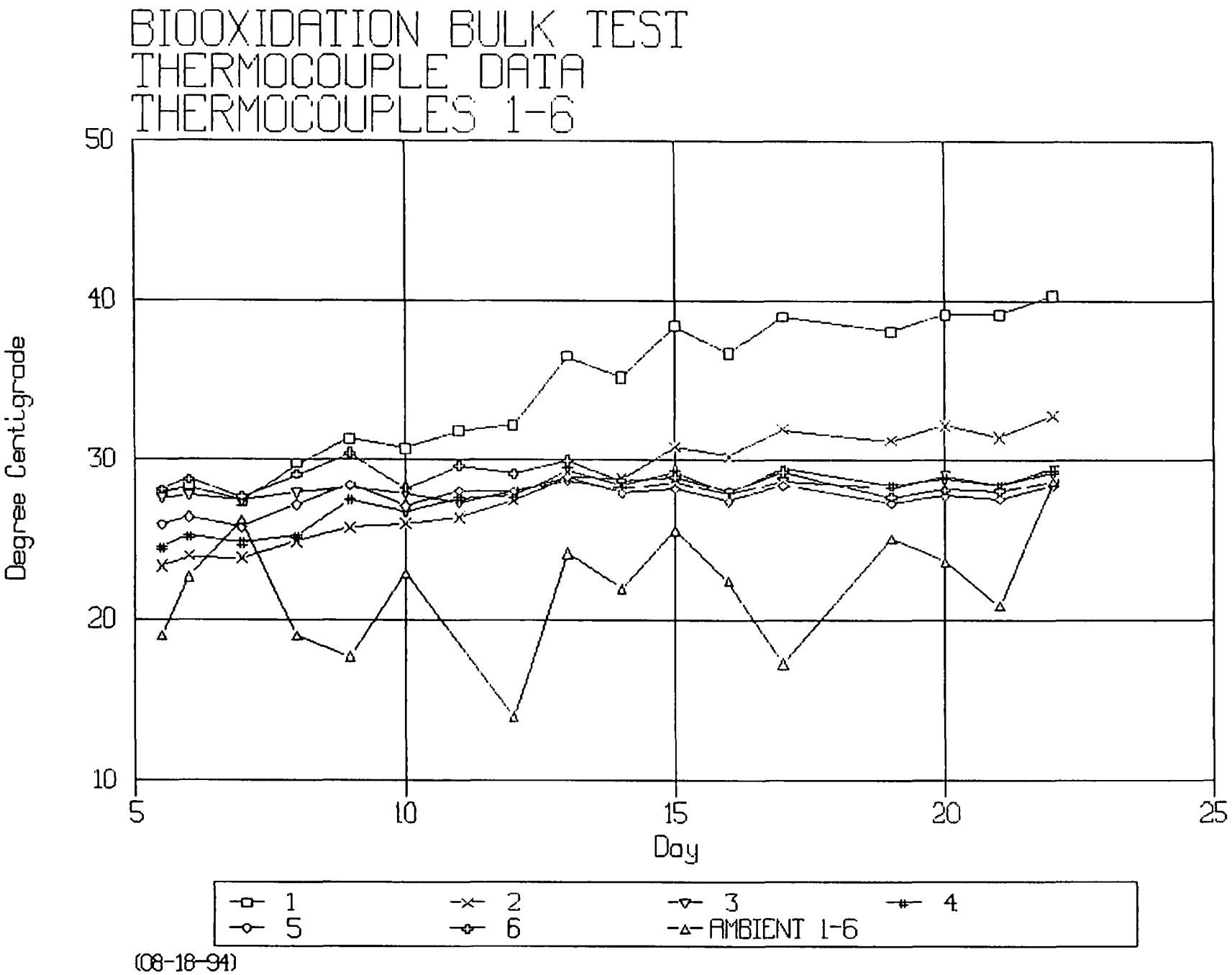
BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
SULFATE - DAILY COMPOSITE CONCENTRATIONS

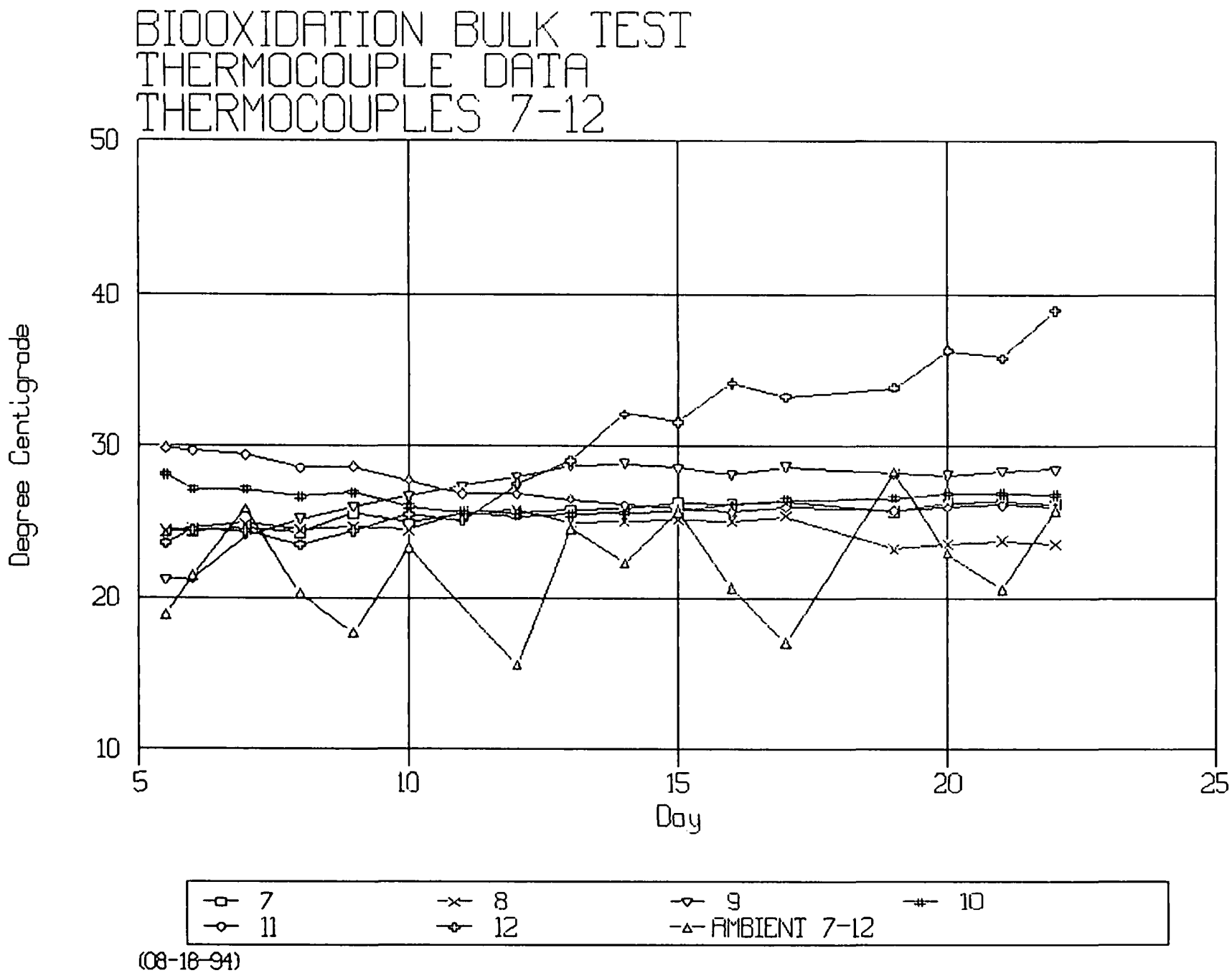


K_2O
Na_2O
Al

Note: OFF SET ON-OFF DATA PTS

(08-16-94)


BIOOXIDATION BULK TEST
THERMOCOUPLE DATA
THERMOCOUPLES 1-6
Degree Centigrade
50
40
30
20
10
5
10
15
20
25
Day
1
2
3
4
5
6
AMBIENT 1-6
(08-18-94)


BIOOXIDATION BULK TEST
THERMOCOUPLE DATA
THERMOCOUPLES 7-12
Degree Centigrade
50
40
30
20
10
5
10
15
20
25
Day
7
8
9
10
11
12
AMBIENT 7-12
(08-18-94)

BIOOXIDATION BULK TEST SOLUTION SAMPLING

ON SOLUTION

Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Fe Kg/Day	Fe Cum Kg	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)
Orofino	7/21-8/18		(72100)	7.91	337.4	.01	1.35			-	-	-	107
	7/21-7/28	19741	19741										
GRAB-1530	07/27/94	?	19741	1.94	516.2	1.26	3.0			-	-	-	-
GRAB	07/28/94	?	19741	1.20	555.3	.16	7.8			-	-	3042	3411
COMP	07/28/94	?	19741	1.41	510.8	.10	21.6	.8	.8	-	-	1924	2420
COMP	07/29/94	9542	29283	1.65	498.3	29	45.0	1.6	2.4	4.1	40.9	1416	3012
COMP	07/30/94	5504	34787	1.61	438.4	574	38.0	.8	3.2	2.2	35.8	3442	9230
COMP	07/31/94	975	35762	1.78	426.7	930	51.0	.2	3.4	2.3	48.7	3823	11575
COMP	08/01/94	21302	57063	1.60	475.9	260	33.0	2.7	6.1	1.3	31.7	2394	5238
COMP	08/02/94	18970	76034	2.89	458.4	1110	155	11.1	17.2	71	84	4705	10999
COMP	08/03/94	16238	92272	1.94	490.0	1810	710	43.6	60.8	130	580	11581	20982
COMP	08/04/94	12021	104293	1.72	455.8	1660	660	30.0	90.9	340	320	11167	20349
COMP	08/05/94	16734	121027	2.75	475.1	1450	260	16.5	107.3	40	220	7673	15888
COMP	08/06/94	16466	137492	2.41	486.8	1550	1030	64.2	171.5	60	970	11012	19332
COMP	08/07/94	16466	153958	3.66	304.8	1480	530	33.0	204.6	60	470	8191	15810
COMP	08/08/94	16502	170460	2.40	507.9	1460	1170	73.1	277.6	110	1060	10820	18867
COMP	08/09/94	16103	186563	2.38	627.5	1440	790	48.2	325.8	25	765	9380	-
COMP	08/10/94	15624	202187	2.28	618.1	1720	1680	99.3	425.1	63	1617	13218	22369
COMP	08/11/94	16113	218300	2.33	645.4	1670	1250	76.2	501.4	33	1217	11657	21262
COMP	08/12/94	14762	233062	2.27	656.2	1680	1510	84.4	585.7	146	1364	13205	22874
COMP	08/13/94	13785	246847	2.30	663.0	1520	950	49.6	635.3	41	909	11254	21036
COMP	08/14/94	10979	257826	2.27	497.5	1570	1380	57.3	692.7	229	1151	12451	22331
COMP	08/15/94	10129	267955	2.26	606.6	1740	750	28.8	721.4	53	697	11956	22333
COMP	08/16/94	6178	274133	2.40	553.1	1790	970	22.7	744.1	51	919	13257	24698
COMP	08/17/94	6444	280577	2.36	573.3	1680	860	21.0	765.1	171	689	13713	

BIOOXIDATION BULK TEST SOLUTION SAMPLING

OFF SOLUTION

Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Fe Kg/Day	Fe Cum Kg	% Fe Ext	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	DO (ppm)
SUMP-GRAB	07/26/94	1200	1200	7.22	-	.84	.27	.0	.0		-	-	-	-	-
GRAB-1530	07/27/94	1750	2950	7.53	305.4	.89	.20	.0	.0		-	-	-	-	-
COMP	07/28/94	3000	5950	5.93	353.6	83	.55	.0	.0		-	-	83	4411	-
COMP	07/29/94	3293	9243	5.49	282.1	255	13	.2	.2		-	-	362	5094	-
COMP	07/30/94	4419	13662	5.11	285.7	654	14	.2	.4	.00	-	-	994	7913	-
COMP	07/31/94	2688	16350	5.18	318.8	960	11	.1	.5	.00	-	-	956	9835	-
COMP	08/01/94	7822	24172	4.20	332.3	990	39	1.2	1.7	.00	1	38	2438	11106	-
COMP	08/02/94	21836	46008	3.39	429.6	1930	172	14.2	15.9	.00	2	170	8960	18304	-
COMP	08/03/94	14710	60718	3.43	360.1	2050	520	29.0	44.8	.00	260	260	10520	21678	-
COMP	08/04/94	7500	68218	3.36	344.2	1750	500	14.2	59.0	.01	410	90	8967	18731	-
COMP	08/05/94	6821	75039	2.50	503.7	1870	480	12.4	71.4	.00	40	440	11633	20711	-
COMP	08/06/94	21396	96436	2.45	465.2	1940	1530	123.9	195.3	-.01	200	1330	14570	23591	-
COMP	08/07/94	21396	117832	2.63	435.8	1770	1110	89.9	285.2	.03	190	920	12617	20727	-
COMP	08/08/94	18698	136530	2.40	484.6	1800	1390	98.4	383.6	.04	160	1230	13259	22299	-
COMP	08/09/94	21118	157648	2.36	557.4	1690	1070	85.5	469.1	.07	36	1034	11904	21180	-
COMP	08/10/94	16419	174067	2.31	491.4	1760	1320	82.0	551.2	.08	220	1100	12958	22052	-
COMP	08/11/94	16500	190567	2.29	524.4	1580	1290	80.6	631.7	.09	86	1204	12958	21764	-
COMP	08/12/94	18213	208780	2.28	523.1	1630	1520	104.8	736.5	.08	56	1464	13452	22729	1.3
COMP	08/13/94	18585	227365	2.34	500.2	1630	1420	99.9	836.4	.09	240	1180	13361	22995	1.3
COMP	08/14/94	16646	244011	2.29	472.4	1680	1490	93.9	930.3	.10	380	1110	13608	23458	-
COMP	08/15/94	13559	257570	2.31	522.4	1700	1110	57.0	987.2	.12	84	1026	13179	23381	-
COMP	08/16/94	12267	269837	2.36	496.4	1670	1540	71.5	1,058.7	.12	196	1344	14831	23933	1.4
COMP	08/17/94	7697	277534	2.49	481.4	1600	1160	33.8	1,092.5	.13	43	1117	13309		2.2

BIOOXIDATION BULK TEST SOLUTION SAMPLING

PAN LYSIMETER 1

Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS
GRAB	08/03/94	4.55	315.3	150	3.91	-	-	-	366	-

BIOOXIDATION BULK TEST SOLUTION SAMPLING

PAN LYSIMETER 2

Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS
GRAB	08/03/94	1.64	516	3100	14100	1900	12200	40761	46775	-

BIOOXIDATION BULK TEST SOLUTION SAMPLING

PAN LYSIMETER 3

Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO (ppm)
GRAB	08/03/94	1.93	488.4	1540	4640	1200	3440	20005	23896	-	
GRAB	08/11/94	1.52	496.1	3200	8700	2900	5800	-	-	Brown/Murky	
GRAB	08/12/94	1.89	450.4	2200	3900	2100	1800	-	27461	Lt Brown	1.5
GRAB	08/15/94	1.92	459.5	2170	3920	1270	2650	15417	27625	Med Brown	1.7
GRAB	08/17/94	1.97	462.7	1940	3220	560	2660	19302	25159	Med Brown	2.4

BIOOXIDATION BULK TEST SOLUTION SAMPLING

PAN LYSIMETER 4

Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO (ppm)
GRAB	08/11/94	2.62	526.3	55	87	-	-	-	-	Flush H2O	-
GRAB	08/12/94	2.06	560.0	567	1260	67	1193	5282	6801	Lt Brown	4.8
GRAB	08/15/94	1.87	671.9	1260	2920	105	2815	14311	17681	Lt Brown	2.9
GRAB	08/17/94	1.71	687.2	1610	3670	102	3568	19528	23875	Med Brown	2.9

BIOOXIDATION BULK TEST SOLUTION SAMPLING

PAN LYSIMETER 5

Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO (ppm)
GRAB	08/03/94	1.49	515.6	3690	17700	2100	15600	57687	66622	Dark Brown	-
GRAB	08/04/94	1.32	511.1	3930	14100	1600	12500	60119	67556	Dark Brown	-
GRAB	08/09/94	1.70	484.5	2600	4500	1400	3100	28440	38389	Dark Brown	-
GRAB	08/10/94	2.37	574.1	1740	990	36	954	11468	23641	Off Soln Flush	
GRAB	08/11/94	1.72	431.8	2000	3700	3400	300	-	-	Green Color	-
GRAB	08/12/94	1.80	439.7	2000	3900	2900	1000	20048	24627	Lt Green	3.7
GRAB	08/15/94	1.88	361.1	1940	3940	2200	1740	20543	24800	Green	2.6
GRAB	08/17/94	1.88	415.7	2030	4800	3700	1100	23073	27307	Green	2.7

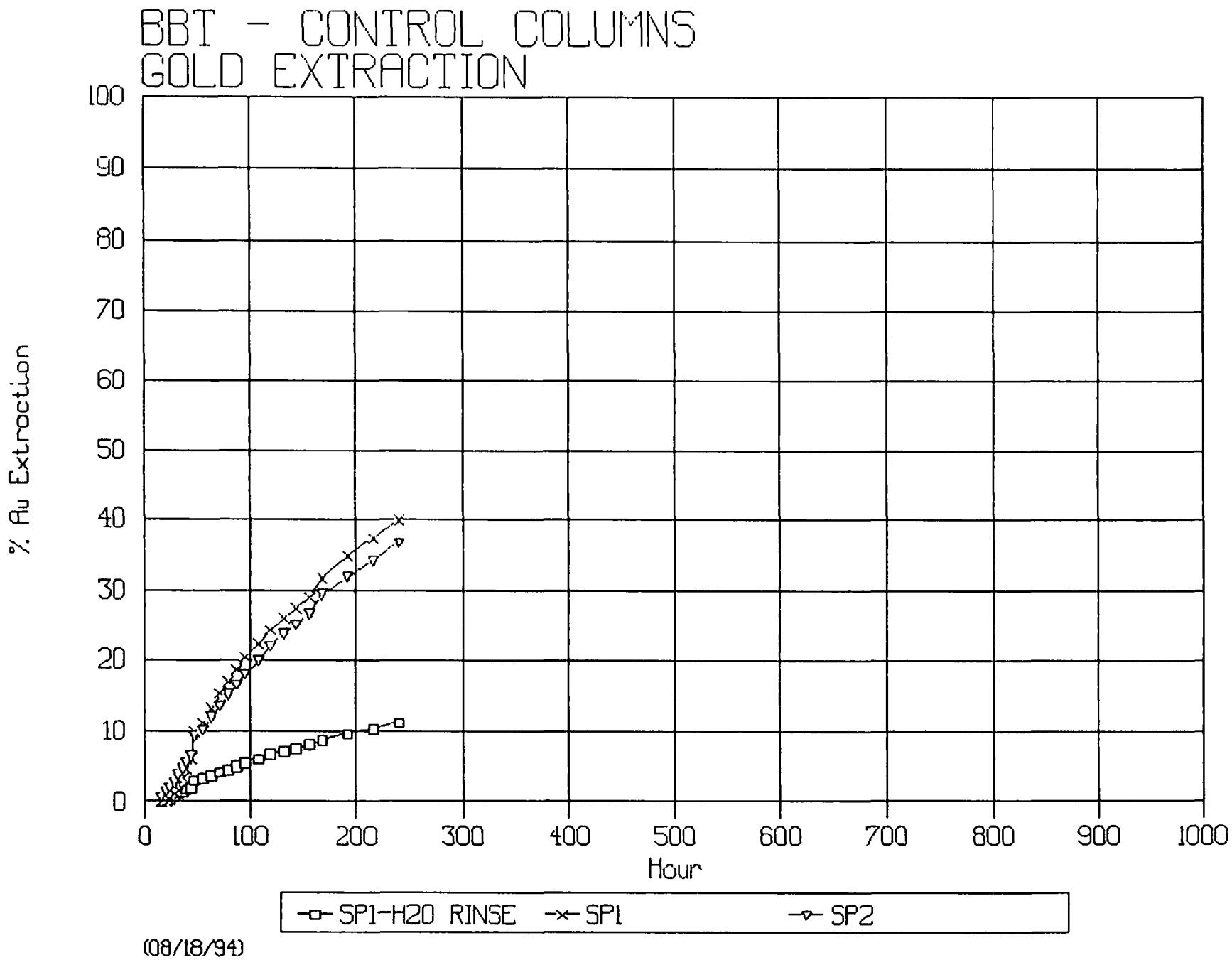
BIOOXIDATION BULK TEST SOLUTION SAMPLING

PAN LYSIMETER 6

Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity mg CaCO3/l	Sulfate (ppm)	REMARKS	DO (ppm)
GRAB	08/11/94	1.50	532.5	2000	4480	3300	1180	-	-	Dk Brown	-
GRAB	08/12/94	1.48	554.7	3770	8900	600	8300	31953	53838	Dk Brown	3.6
GRAB	08/15/94	1.72	361.1	2560	4300	700	3600	28024	33225	Med Brown	1.4
GRAB	08/17/94	1.73	662.4	2330	4000	1200	2800	25591	30262	Stringy Ppt	2.0

BIOOXIDATION BULK TEST THERMOCOUPLE DATA

Date	West 1	West 2	West 3	West 4	West 5	Mid 6	Mid 7	Mid 8	East 9	East 10	East 11	East 12	AMBIENT 1-6	AMBIENT 7-12
08/02/94	27.8	23.2	27.4	24.3	25.7	28.0	24.3	24.3	21.2	28.1	29.8	23.5	19.0	18.9
08/02/94	28.2	23.8	27.6	25.0	26.2	28.7	24.3	24.5	21.3	27.1	29.6	24.4	22.6	21.5
08/03/94	27.2	23.7	27.2	24.6	25.6	27.5	24.5	24.8	24.0	27.1	29.4	24.3	26.0	25.8
08/04/94	29.7	24.7	27.8	25.0	27.0	29.0	24.2	24.4	25.1	26.6	28.5	23.4	19.0	20.3
08/05/94	31.3	25.6	28.2	27.3	28.3	30.4	25.5	24.6	25.9	26.9	28.6	24.3	17.7	17.7
08/06/94	30.7	25.8	27.7	26.6	26.9	28.1	24.8	24.4	26.6	25.9	27.7	25.4	22.8	23.3
08/07/94	31.8	26.2	27.1	27.4	27.9	29.6	25.4	25.5	27.3	25.5	26.8	25.0	-	-
08/08/94	32.2	27.3	27.9	27.6	27.9	29.1	25.5	25.7	27.9	25.3	26.8	27.5	14.0	15.5
08/09/94	36.4	28.9	28.6	29.3	28.9	29.9	25.7	24.9	28.7	25.4	26.4	29.0	24.0	24.5
08/10/94	35.1	28.8	28.0	28.3	27.8	28.6	25.8	25.0	28.8	25.5	26.0	32.0	21.9	22.3
08/11/94	38.4	30.8	28.5	29.2	28.1	28.9	26.2	25.1	28.5	25.6	25.8	31.5	25.4	25.6
08/12/94	36.6	30.2	27.7	27.8	27.2	27.9	26.1	25.0	28.1	26.0	25.6	34.0	22.3	20.7
08/13/94	39.0	31.9	28.6	29.4	28.3	29.2	26.3	25.3	28.6	26.4	25.9	33.1	17.3	17.0
08/14/94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08/15/94	38.1	31.2	28.2	28.3	27.1	27.5	25.6	23.2	28.2	26.5	25.7	33.7	24.9	28.3
08/16/94	39.1	32.2	29.0	28.8	27.6	28.0	26.2	23.5	28.0	26.8	25.9	36.2	23.5	22.9
08/17/94	39.1	31.4	28.3	28.3	27.4	27.9	26.3	23.7	28.3	26.8	26.0	35.7	20.8	20.6
08/18/94	40.3	32.8	29.4	29.2	28.3	28.6	26.1	23.5	28.4	26.7	25.9	39.0	28.6	25.7
08/19/94	40.4	32.7	28.8	29.3	28.2	28.7	26.4	24.2	29.4	27.0	26.2	44.8	12.6	13.3


BBT - CONTROL COLUMNS
GOLD EXTRACTION
% Au Extraction
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90
80
70
60
50
40
30
20
10
0
0
100
200
300
400
500
600
700
800
900
1000
Hour
SP1-H20 RINSE
SP1
SP2
(08/18/94)

MEMORANDUM

DATE: AUGUST 11, 1994
TO: JIM THOMPSON
FROM: LAURA DAMON
SUBJECT: BIOOXIDATION BULK TEST (BBT) WEEKLY UPDATE

The BBT has been on the biooxidation cycle for two weeks now with the east and west sides having alternating solution application (i.e. each side - one day on/one day off). The ON solution application rate has averaged 10 gpm while the OFF solution has averaged 8 gpm. There has been no line breakage or sloughing of the heap this week although the material is still very loose as evidenced when walking up the side.

The neutralization circuit has proven to be very labor intensive thus far. We are trying to maintain a target pH of 5.5 to precipitate the majority of the copper. Although copper itself is not toxic to the Tf bacteria, it seems there may be a toxic substance which comes out at the same time as copper. Therefore the copper is being used as a marker for the initial neutralization process. The circuit has been partially re-designed using more lime than limestone as the limestone clogs the piping. Hoses have replaced steel pipe with the ninety degree elbows removed. A PVC pipe trough has replaced the steel one since the acidic solution corroded the steel quite badly. The neutralization slurry tank will need to be drained in the near future as the solids have about filled it. The slurry contains less than 10% precipitate which averages about 5% iron and 5% copper. The other 90% is presumed to be gypsum. The neutralization solids from the screw feeder are being placed on top of Cell #5. Hopefully the majority of the neutralization stage will be completed within the next month. Then it will be a matter of contolling the excess acidity.

The data collected to date suggest that the bacteria are biooxidizing the sulfide ore. While the pH of the OFF solution is dropping the oxidation/reduction potential is rising. The total iron concentrations are rising with the majority of the ions in the form of ferric iron. This is a good indication, along with the physical appearance of the heap (orange and green precipitate), that the biooxidation process is proceeding. Also indicating bacterial biooxidation, are some thermocouple data showing an internal temperature rise in the heap.

The water rinse ore column data showed that the majority of the copper, iron and sulfate were washed out within four days. The iron ions were mainly in the form of ferrous iron. The solution pH stayed in the 2-3 range while the oxidation/reduction potential was around 400 mV. Three columns were put on cyanide leach on August 8. Initial leach data should be available next week.

c: Rod MacLeod
Martin Quick
Herb Osborne

BIOOXIDATION BULK TEST SOLUTION SAMPLING

ON SOLUTION

Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity (ppm)	Sulfate (ppm)
Drofino	7/21-8/11		(67500)	7.91	337.4	.01	1.35	-	-	-	107
	7/21-7/28	19741	19741								
GRAB-1530	07/27/94	?	19741	1.94	516.2	1.26	3.0	-	-	-	-
GRAB	07/28/94	?	19741	1.20	555.3	.16	7.8	-	-	3042	3411
COMP	07/28/94	?	19741	1.41	510.8	.10	21.6	-	-	1924	2420
COMP	07/29/94	9542	29283	1.65	498.3	29	45.0	4.1	40.9	1416	3012
COMP	07/30/94	5504	34787	1.61	438.4	574	38.0	2.2	35.8	3442	9230
COMP	07/31/94	975	35762	1.78	426.7	930	51.0	2.3	48.7	3823	11575
COMP	08/01/94	21302	57063	1.60	475.9	260	33.0	1.3	31.7	2394	5238
COMP	08/02/94	18970	76034	2.89	458.4	1110	155	71	84	4705	10999
COMP	08/03/94	16238	92272	1.94	490.0	1810	710	130	580	11581	20982
COMP	08/04/94	12021	104293	1.72	455.8	1660	660	340	320	11167	20349
COMP	08/05/94	16734	121027	2.75	475.1	1450	260	40	220	7673	15888
COMP	08/06/94	16466	137492	2.41	486.8	1550	1030	60	970	11012	19332
COMP	08/07/94	16466	153958	3.66	304.8	1480	530	60	470	8191	15810
COMP	08/08/94	16502	170460	2.40	507.9	1460	1170	110	1060	10820	18867
COMP	08/09/94	16103	186563	2.38	627.5	1440	790	25	765	9380	
COMP	08/10/94	15624	202187	2.28	618.1	1720	1680	63	1617		

BIOOXIDATION BULK TEST SOLUTION SAMPLING

OFF SOLUTION

Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity (ppm)	Sulfate (ppm)
SUMP-GRAB	07/26/94	1200	1200	7.22	-	.84	.27	-	-	-	-
GRAB-1530	07/27/94	1750	2950	7.53	305.4	.89	.20	-	-	-	-
COMP	07/28/94	3000	5950	5.93	353.6	83	.55	-	-	83	4411
COMP	07/29/94	3293	9243	5.49	282.1	255	13	-	-	362	5094
COMP	07/30/94	4419	13662	5.11	285.7	654	14	-	-	994	7913
COMP	07/31/94	2688	16350	5.18	318.8	960	11	-	-	956	9835
COMP	08/01/94	7822	24172	4.20	332.3	990	39	1.0	38.0	2438	11106
COMP	08/02/94	21836	46008	3.39	429.6	1930	172	1.6	170.4	8960	18304
COMP	08/03/94	14710	60718	3.43	360.1	2050	520	260.0	260.0	10520	21678
COMP	08/04/94	7500	68218	3.36	344.2	1750	500	410.0	90.0	8967	18731
COMP	08/05/94	6821	75039	2.50	503.7	1870	480	40.0	440.0	11633	20711
COMP	08/06/94	21396	96436	2.45	465.2	1940	1530	200.0	1,330.0	14570	23591
COMP	08/07/94	21396	117832	2.63	435.8	1770	1110	190.0	920.0	12617	20727
COMP	08/08/94	18698	136530	2.40	484.6	1800	1390	160.0	1,230.0	13259	22299
COMP	08/09/94	21118	157648	2.36	557.4	1690	1070	36.0	1,034.0	11904	
COMP	08/10/94	16419	174067	2.31	491.4	1760	1320	220.0	1,100.0		

BIOOXIDATION BULK TEST THERMOCOUPLE DATA

Date	West 1	West 2	West 3	West 4	5	6	7	8	9	10	11	12	AMBIENT 1-6	AMBIENT 7-12
08/02/94	27.8	23.2	27.4	24.3	25.7	28.0	24.3	24.3	21.2	28.1	29.8	23.5	19.0	18.9
08/02/94	28.2	23.8	27.6	25.0	26.2	28.7	24.3	24.5	21.3	27.1	29.6	24.4	22.6	21.5
08/03/94	27.2	23.7	27.2	24.6	25.6	27.5	24.5	24.8	24.0	27.1	29.4	24.3	26.0	25.8
08/04/94	29.7	24.7	27.8	25.0	27.0	29.0	24.2	24.4	25.1	26.6	28.5	23.4	19.0	20.3
08/05/94	31.3	25.6	28.2	27.3	28.3	30.4	25.5	24.6	25.9	26.9	28.6	24.3	17.7	17.7
08/06/94	30.7	25.8	27.7	26.6	26.9	28.1	24.8	24.4	26.6	25.9	27.7	25.4	22.8	23.3
08/07/94	31.8	26.2	27.1	27.4	27.9	29.6	25.4	25.5	27.3	25.5	26.8	25.0	-	-
08/08/94	32.2	27.3	27.9	27.6	27.9	29.1	25.5	25.7	27.9	25.3	26.8	27.5	14.0	15.5
08/09/94	36.4	28.9	28.6	29.3	28.9	29.9	25.7	24.9	28.7	25.4	26.4	29.0	24.0	24.5
08/10/94	35.1	28.8	28.0	28.3	27.8	28.6	25.8	25.0	28.8	25.5	26.0	32.0	21.9	22.3
08/11/94	38.4	30.8	28.5	29.2	28.1	28.9	26.2	25.1	28.5	25.6	25.8	31.5	25.4	25.6

BIOOXIDATION BULK TEST SOLUTION SAMPLING

PAN LYSIMETER 1

Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity (ppm)	Sulfate (ppm)	REMARKS
GRAB	08/03/94	4.55	315.3	150	3.91	-	-	-	366	-

BIOOXIDATION BULK TEST SOLUTION SAMPLING

PAN LYSIMETER 2

Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity (ppm)	Sulfate (ppm)	REMARKS
GRAB	08/03/94	1.64	516	3100	14100	1900	12200	40761	46775	-

BIOOXIDATION BULK TEST SOLUTION SAMPLING

PAN LYSIMETER 3

Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity (ppm)	Sulfate (ppm)	REMARKS
GRAB	08/03/94	1.93	488.4	1540	4640	1200	3440	20005	23896	-
GRAB	08/11/94	1.52	496.1	3200	8700	2900	5800	-	-	Brown/Murky

BIOOXIDATION BULK TEST SOLUTION SAMPLING

PAN LYSIMETER 4

Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity (ppm)	Sulfate (ppm)	REMARKS
GRAB	08/11/94	2.62	526.3	55	87	-	-	-	-	Flush H2O

BIOOXIDATION BULK TEST SOLUTION SAMPLING

PAN LYSIMETER 5

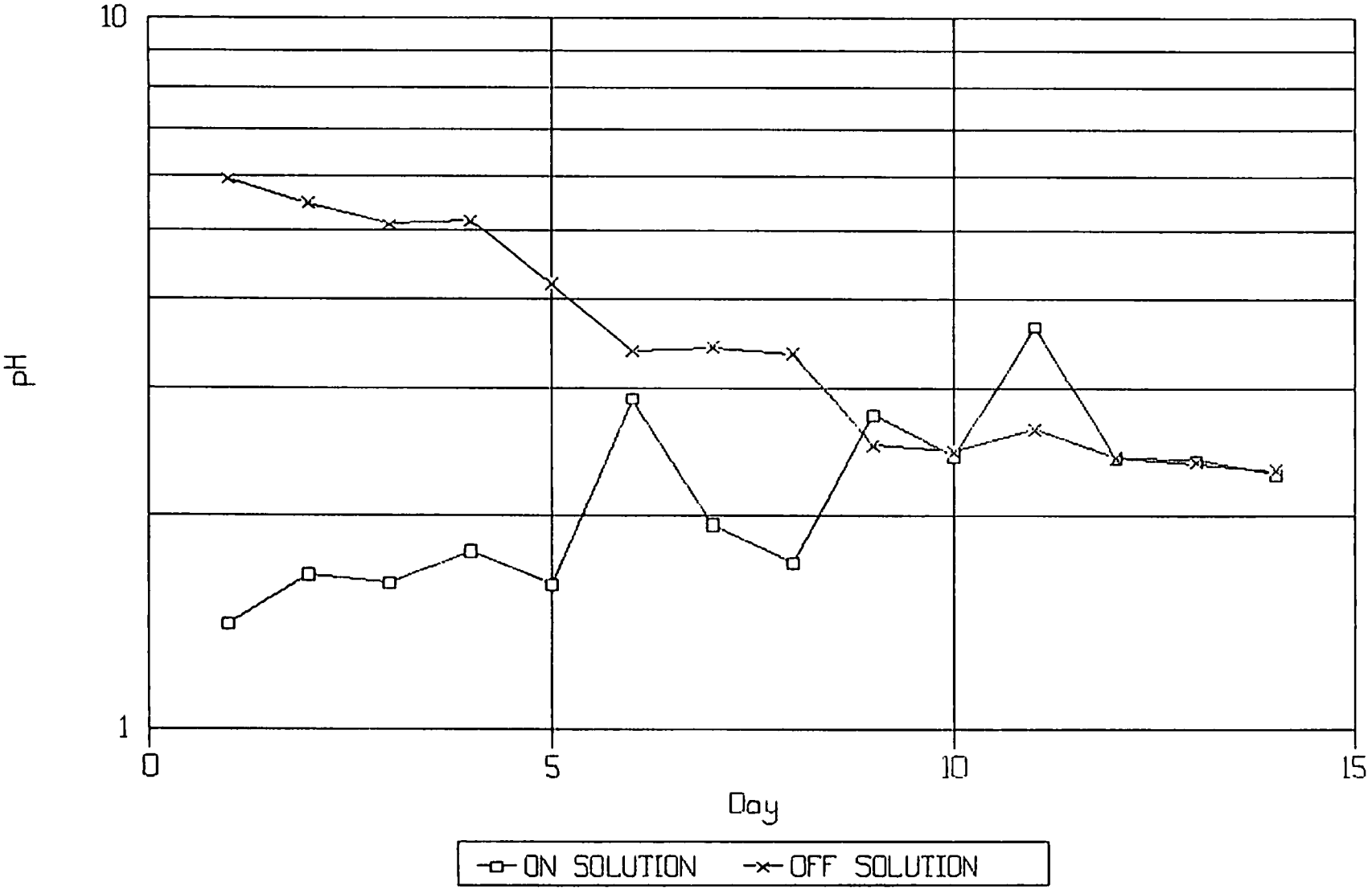
Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity (ppm)	Sulfate (ppm)	REMARKS
GRAB	08/03/94	1.49	515.6	3690	17700	2100	15600	57687	66622	Dark Brown
GRAB	08/04/94	1.32	511.1	3930	14100	1600	12500	60119	67556	Dark Brown
GRAB	08/09/94	1.70	484.5	2600	4500	1400	3100	28440	38389	Dark Brown
GRAB	08/10/94	2.37	574.1	1740	990	36	954	11468		Off Soln Flush
GRAB	08/11/94	1.72	431.8	2000	3700	3400	300	-	-	Green Color

BIOOXIDATION BULK TEST SOLUTION SAMPLING

PAN LYSIMETER 6

Sample ID	Date	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity (ppm)	Sulfate (ppm)	REMARKS
GRAB	08/11/94	1.50	532.5	2000	4480	3300	1180	-	-	Dk Brown

BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
pH - DAILY COMPOSITE



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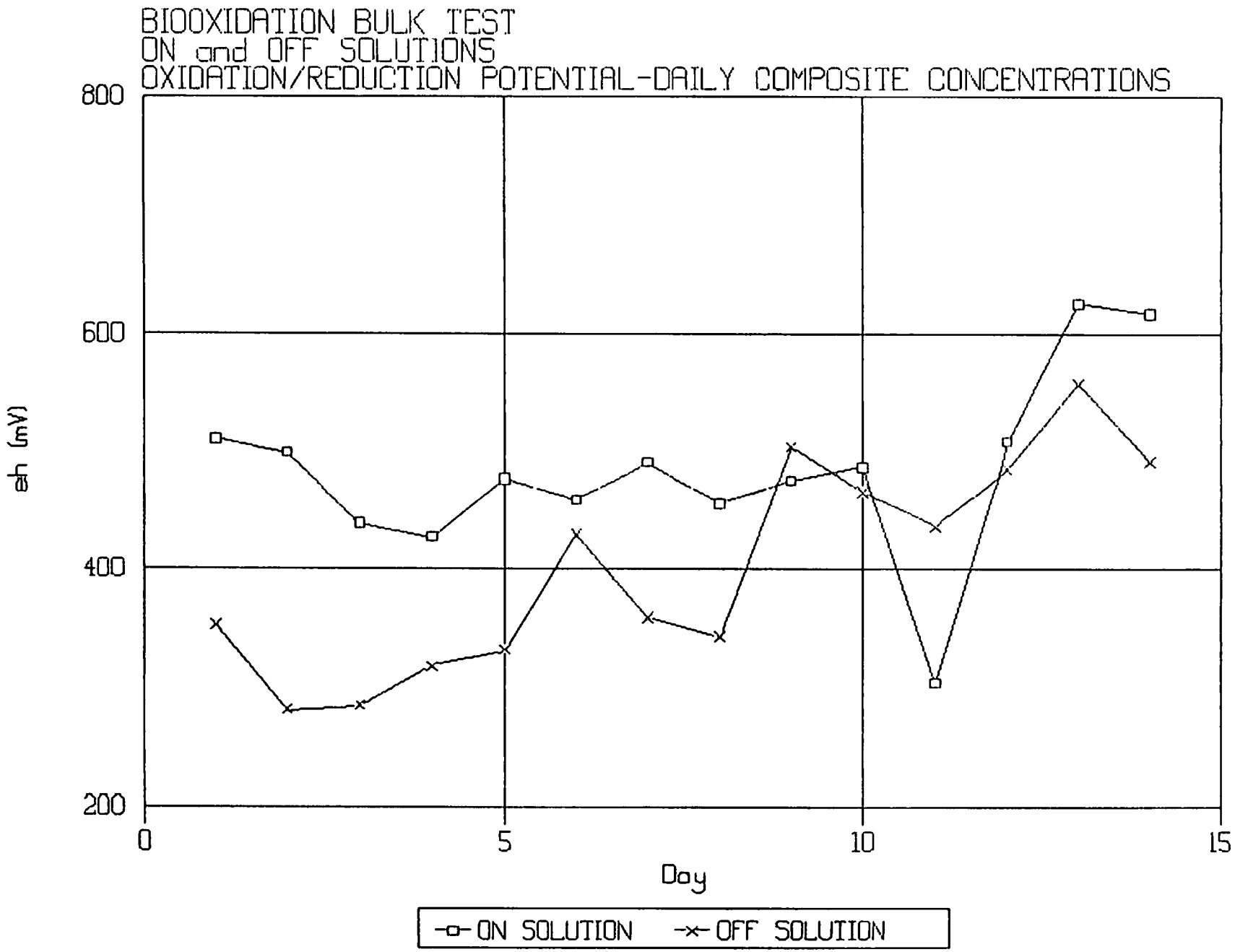
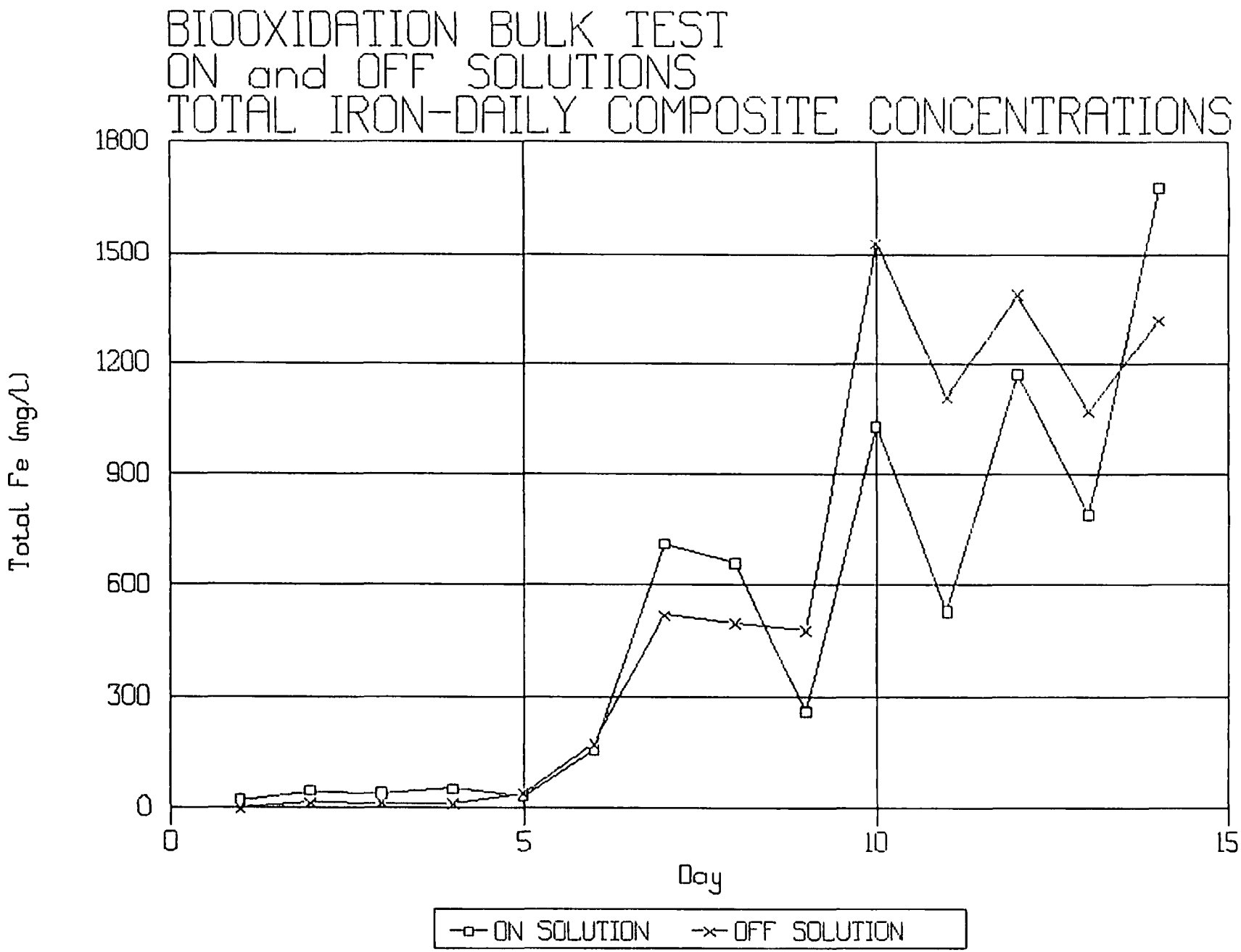
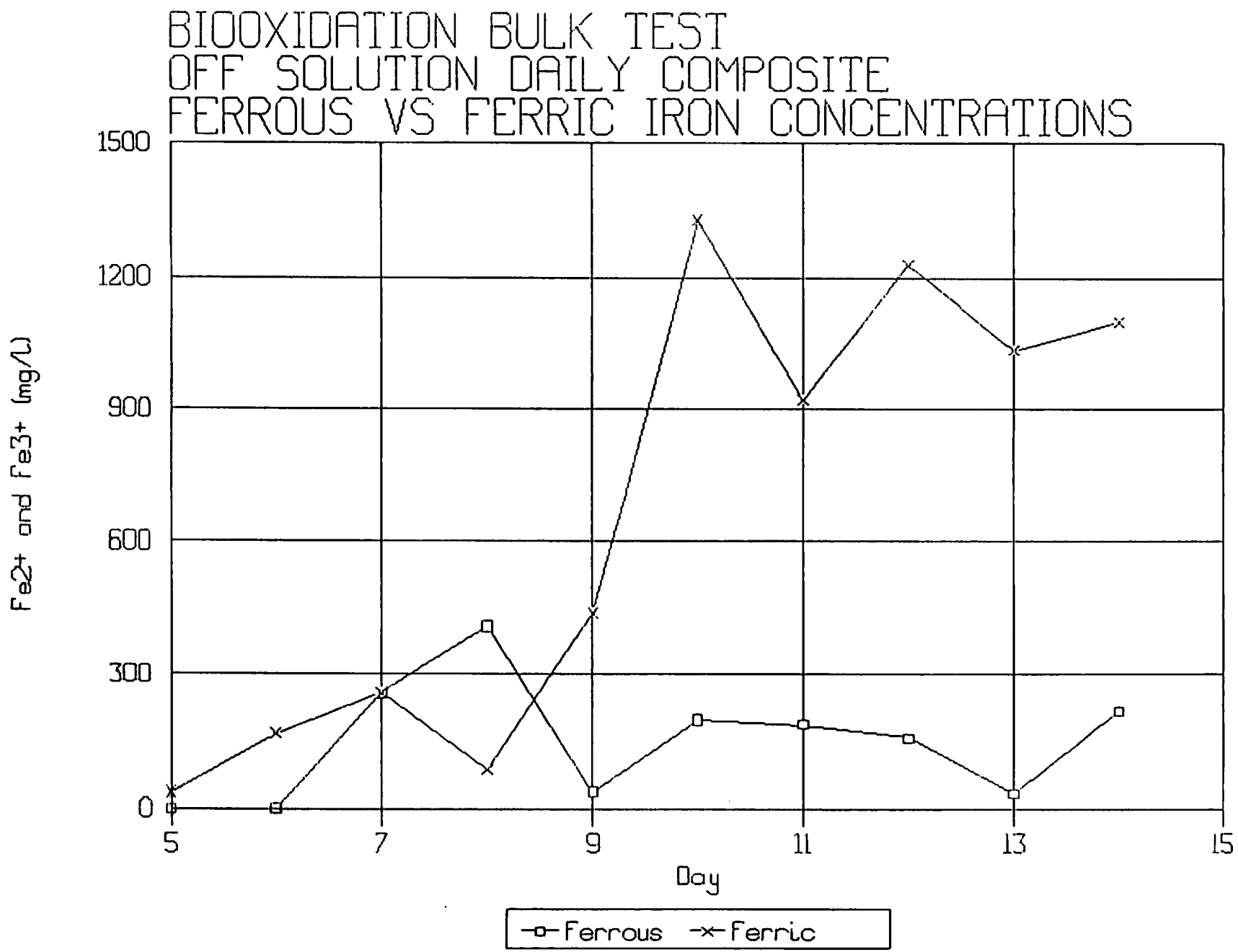

BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
OXIDATION/REDUCTION POTENTIAL-DAILY COMPOSITE CONCENTRATIONS
800
600
400
200
ah (mV)
0
5
10
15
Day
ON SOLUTION
OFF SOLUTION

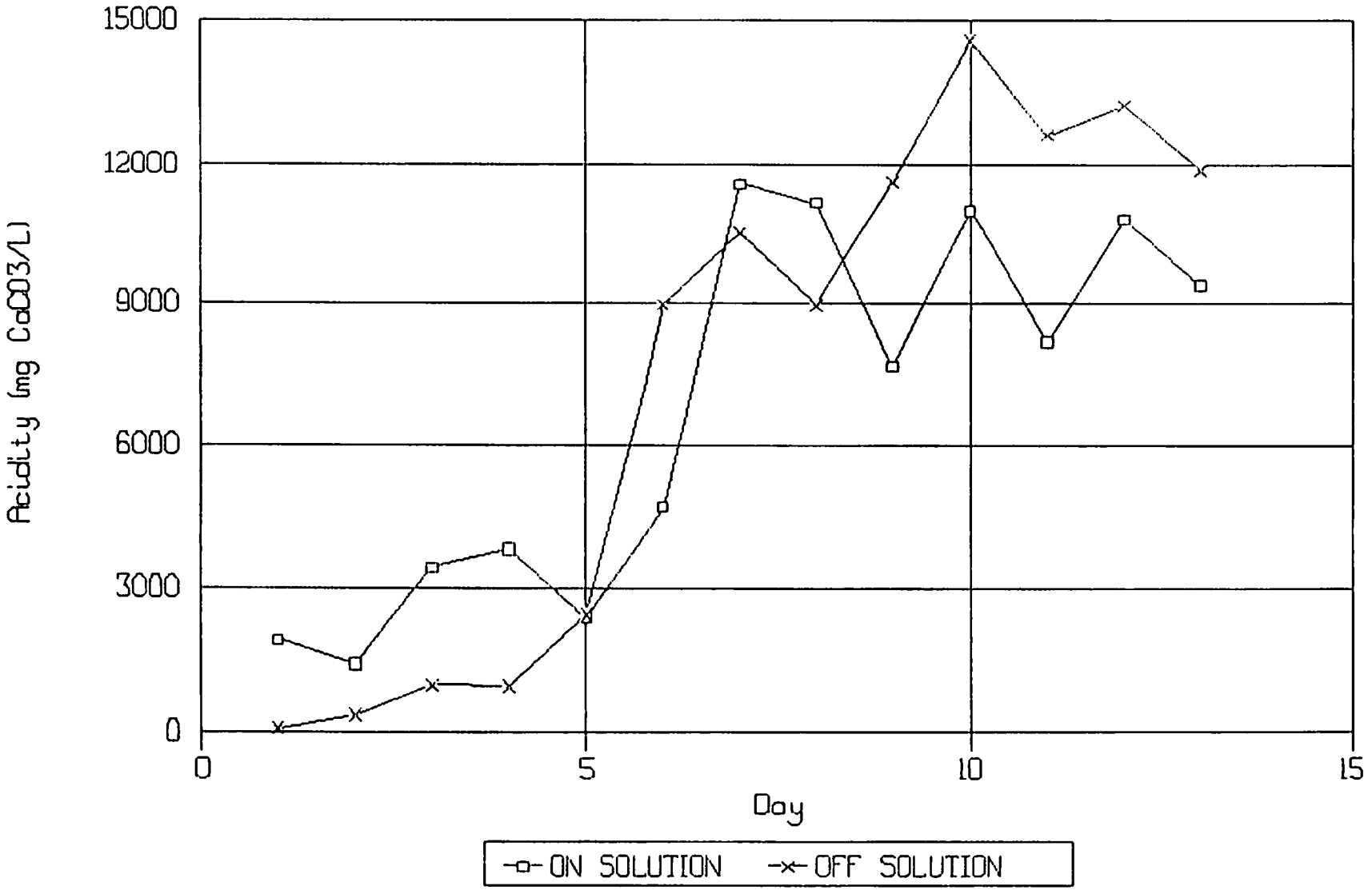
(08-11-94)


BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
TOTAL IRON-DAILY COMPOSITE CONCENTRATIONS
Total Fe (mg/L)
1800
1500
1200
900
600
300
0
0
5
10
15
Day
ON SOLUTION
OFF SOLUTION
(08-11-94)


BIOOXIDATION BULK TEST
OFF SOLUTION DAILY COMPOSITE
FERROUS VS FERRIC IRON CONCENTRATIONS
1500
1200
900
600
300
0
Fe2+ and Fe3+ (mg/L)
5
7
9
11
13
15
Day
Ferrous
Ferric

(08-11-94)

BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
ACIDITY TO pH 7-DAILY COMPOSITE CONCENTRATIONS



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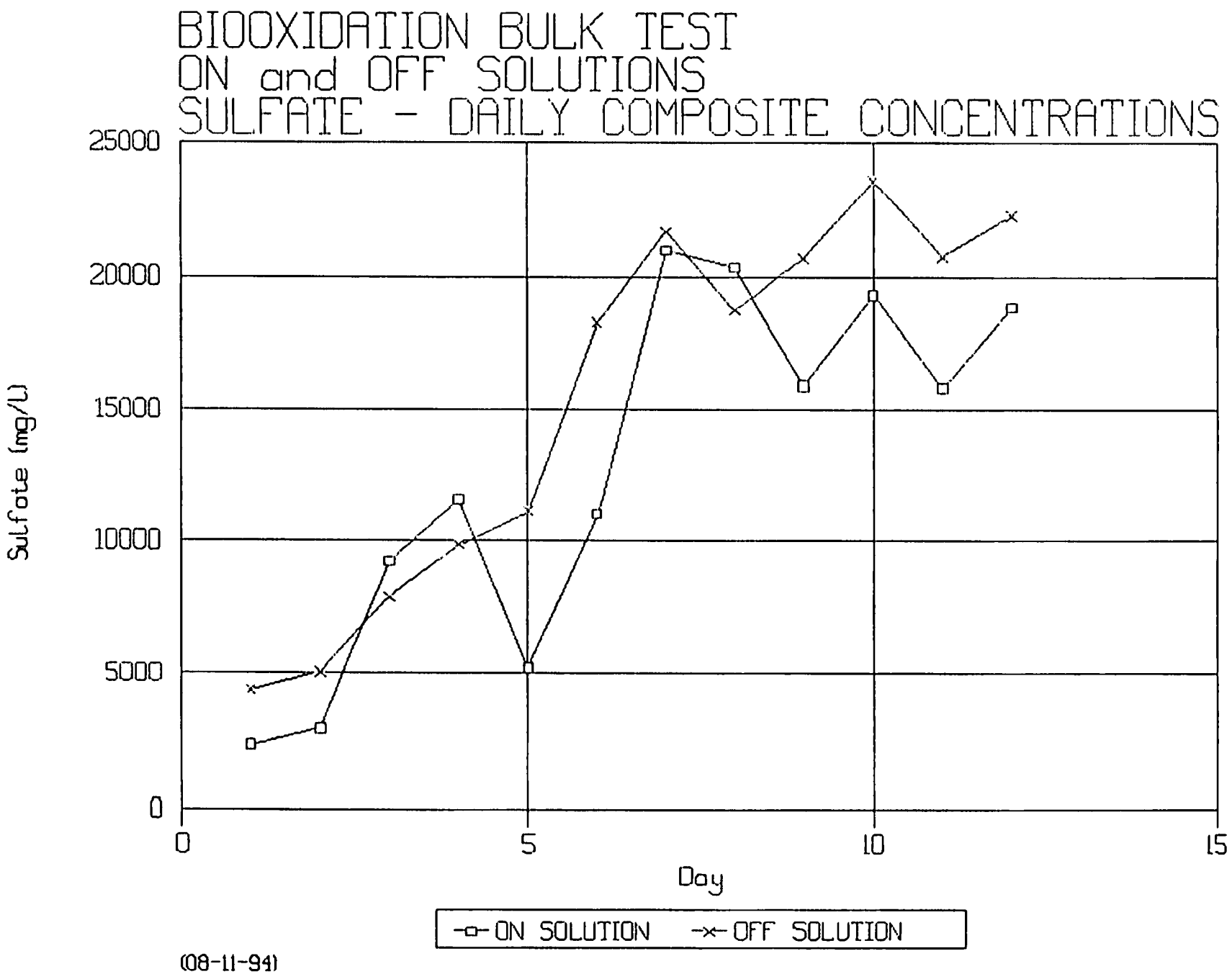
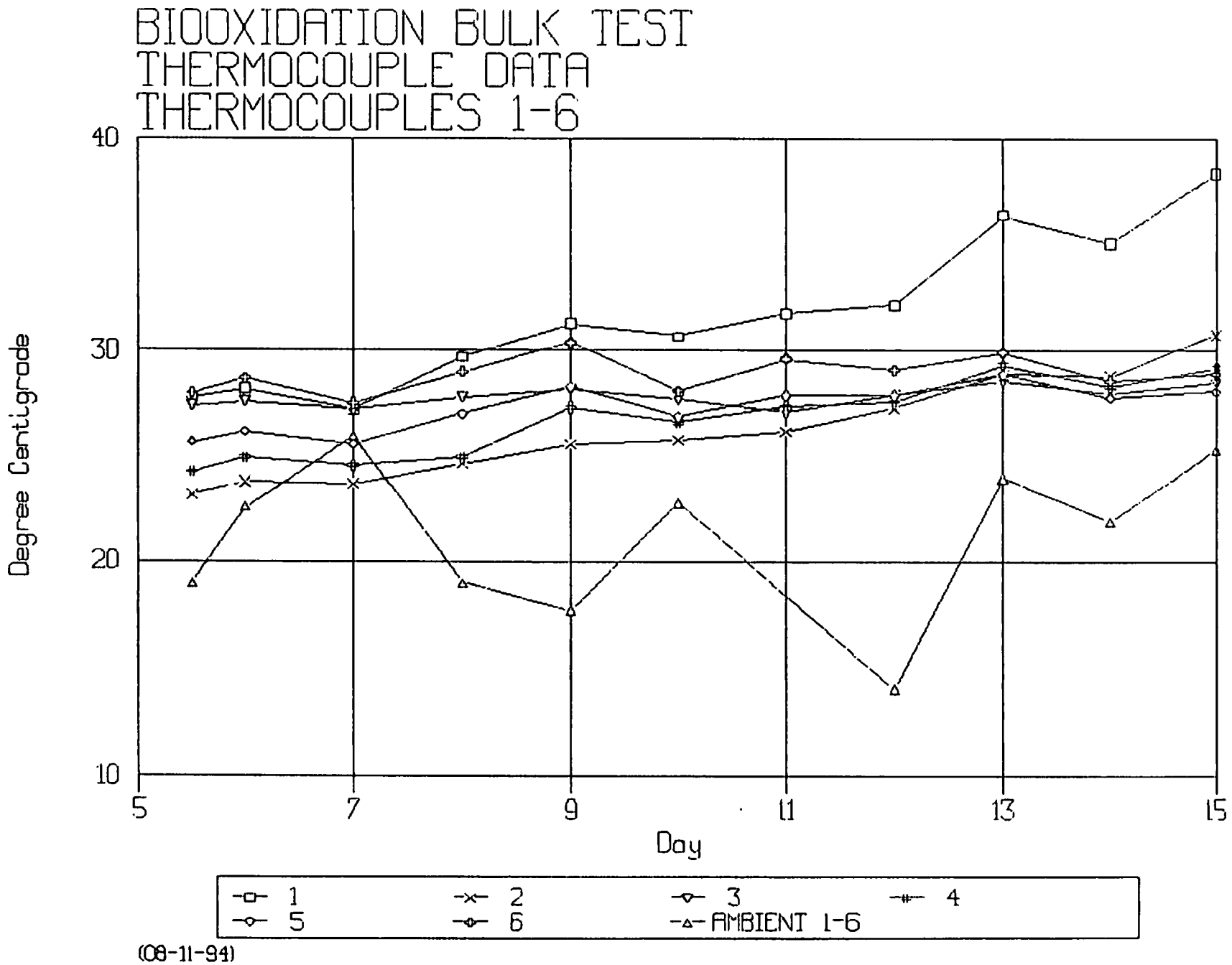
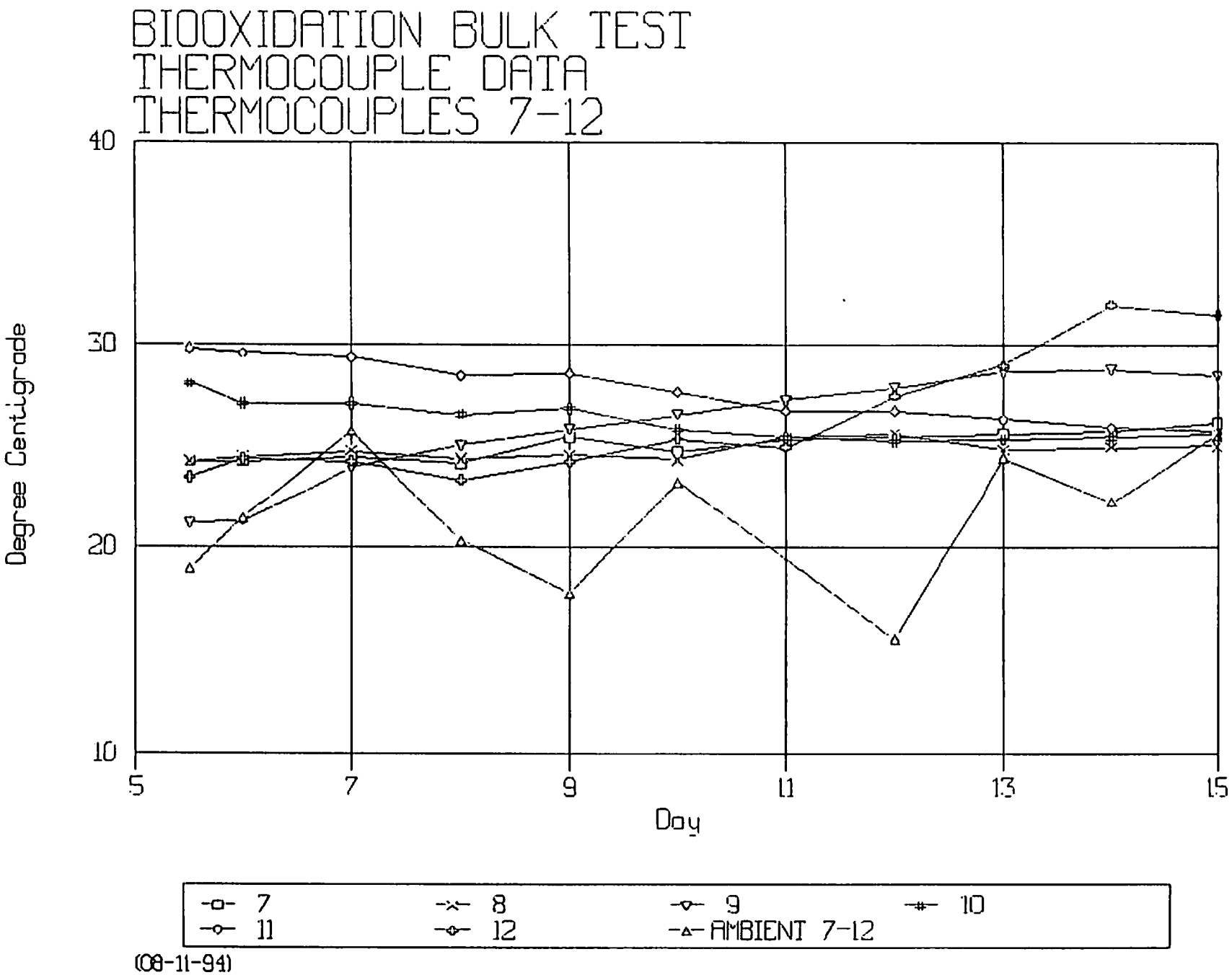

BIOOXIDATION BULK TEST
ON and OFF SOLUTIONS
SULFATE - DAILY COMPOSITE CONCENTRATIONS
Sulfate (mg/L)
25000
20000
15000
10000
5000
0
0
5
10
15
Day
ON SOLUTION
OFF SOLUTION
(08-11-94)


BIOOXIDATION BULK TEST
THERMOCOUPLE DATA
THERMOCOUPLES 1-6
Degree Centigrade
40
30
20
10
5
7
9
11
13
15
Day
1
2
3
4
5
6
AMBIENT 1-6

(08-11-94)


BIOOXIDATION BULK TEST
THERMOCOUPLE DATA
THERMOCOUPLES 7-12
Degree Centigrade
40
30
20
10
5
7
9
11
13
15
Day
7
8
9
10
11
12
AMBIENT 7-12
(08-11-94)

MEMORANDUM

DATE: AUGUST 4, 1994
TO: JIM THOMPSON
FROM: LAURA DAMON
SUBJECT: BIOOXIDATION BULK TEST (BBT) WEEKLY UPDATE

The biooxidation bulk test heap stacking was completed July 18. After final preparation of the heap and pad (i.e. tanks set, piping etc.), the heap was put on the biooxidation cycle July 21 about 4 PM. A line broke causing a wash-out of about 200 tons in the early morning hours of July 22. The lines were fixed and the heap was put back on biooxidation on July 28 and scheduled solution sampling commenced. The biooxidation ON solution was applied during daylight hours for 4 days. On August 1 both sides of the BBT heap were put on the biooxidation cycle and then on August 2 ON solution was started to be applied intermittently to each side (one side per day). In the early morning hours of August 4, another line broke causing a wash-out similar to the first one. The OFF solution sump was cleaned out and the heap was put back on the biooxidation cycle at 9 AM.

The stability of this heap is extremely questionable. So far it seems to be sloughing worse than the -1/4" sulfide test heap material. The plan to collect drill samples at various stages of biooxidation may have to be reconsidered since the wash-outs have lessened the heap's top area which will limit the number of drill holes.

The extent of biooxidation is being monitored with the solution samples. A copy of the solution data is attached. It shows that the metals concentration in the OFF solution started rising on August 3 along with a pH drop. This indicates that either the biooxidation process has started or the soluble metals are being washed out in the low pH application solution.

The head samples are in the process of being assayed. The composite head sample indicates the ore to have 5 percent sulfur as sulfide.

Gold extraction bottle rolls have been completed on the SP1 head composite (untreated crushed ore) and the SP2 head composite (bacteria applied agglomerated ore). The SP1 results show an average 49.6% gold extraction and the SP2 results show an average 48.4% gold extraction based on the fire assay heads and tails.

Starting next week, control columns with SP1 and SP2 material will be cyanide leached and compared with the bottle roll data. Also a SP1 ore column with a pre-water rinse is being run to compare with the non-rinsed SP1 control column.

c: Rod MacLeod

BIOOXIDATION BULK TEST SOLUTION SAMPLING

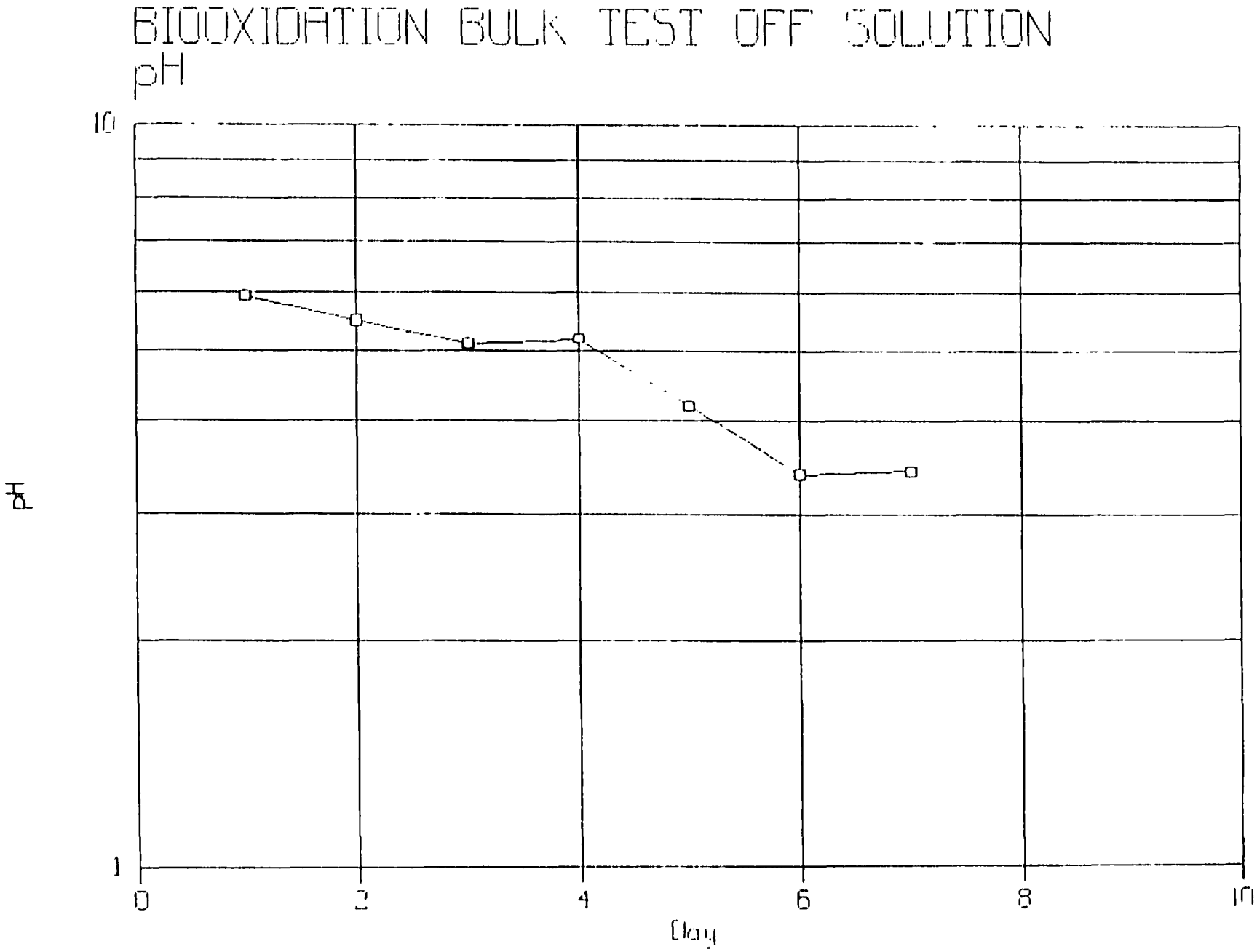
ON SOLUTION

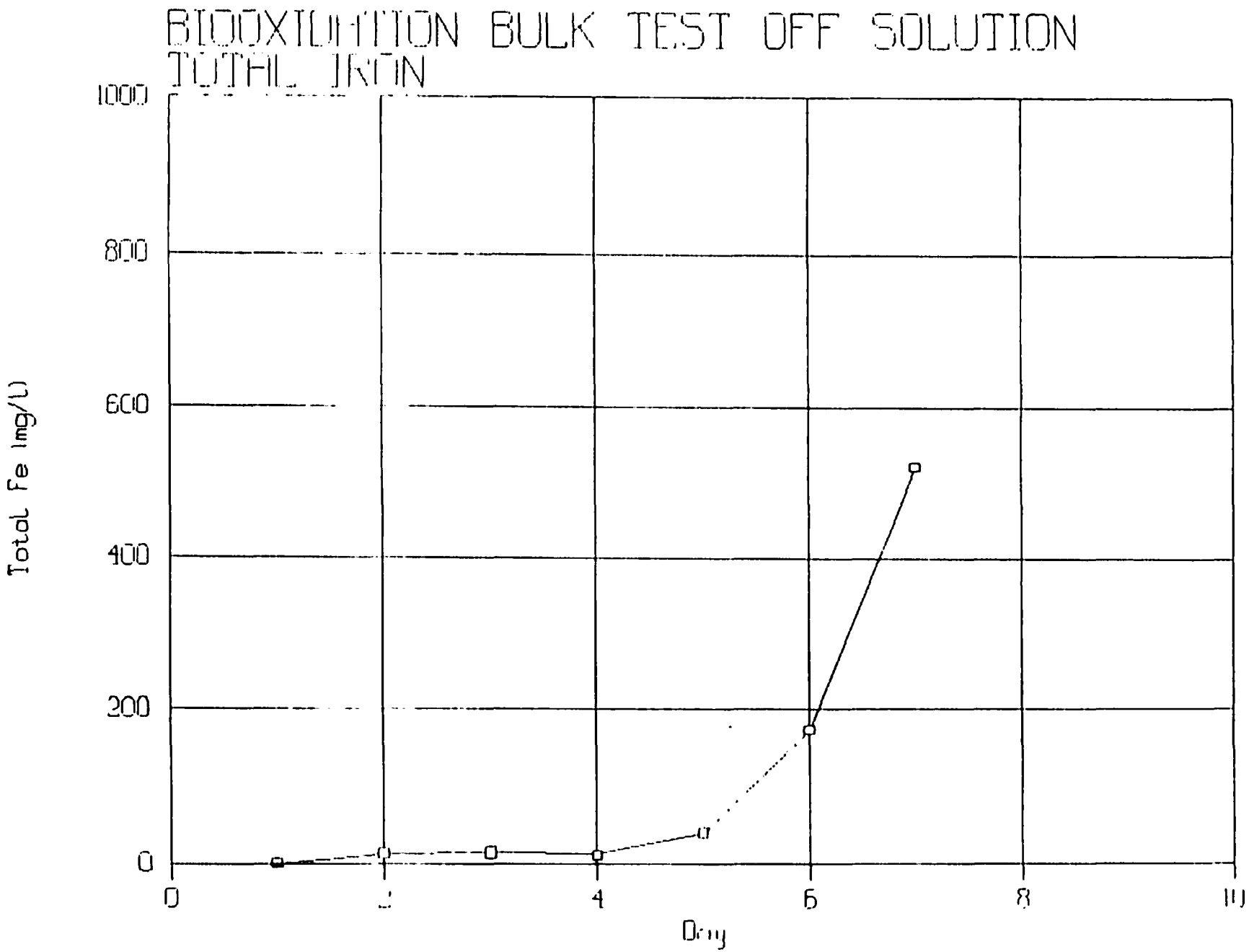
Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity (ppm)	Sulfate (ppm)
Drofino	7/21-8/3	55000									
	7/21-7/28	19741	19741								
GRAB-1530	07/27/94	?	19741	1.94	516.2	1.26	3.0	-	-	-	-
GRAB	07/28/94	?	19741	1.20	555.3	.16	7.8	-	-	3042	3411
COMP	07/28/94	?	19741	1.41	510.8	.10	21.6	-	-	1924	2420
COMP	07/29/94	9542	29283	1.65	498.3	29	45.0	4.1	40.9	1416	3012
COMP	07/30/94	5504	34787	1.61	438.4	574	38.0	2.2	35.8	3442	9230
COMP	07/31/94	975	35762	1.78	426.7	930	51.0	2.3	48.7	3823	11575
COMP	08/01/94	21302	57063	1.60	475.9	260	33.0	1.3	31.7	2394	5238
COMP	08/02/94	18970	76034	2.89	458.4	1110	155	71	84	4705	10999
COMP	08/03/94	16238	92272	1.94	490.0	1810	710.0	130	580	11581	

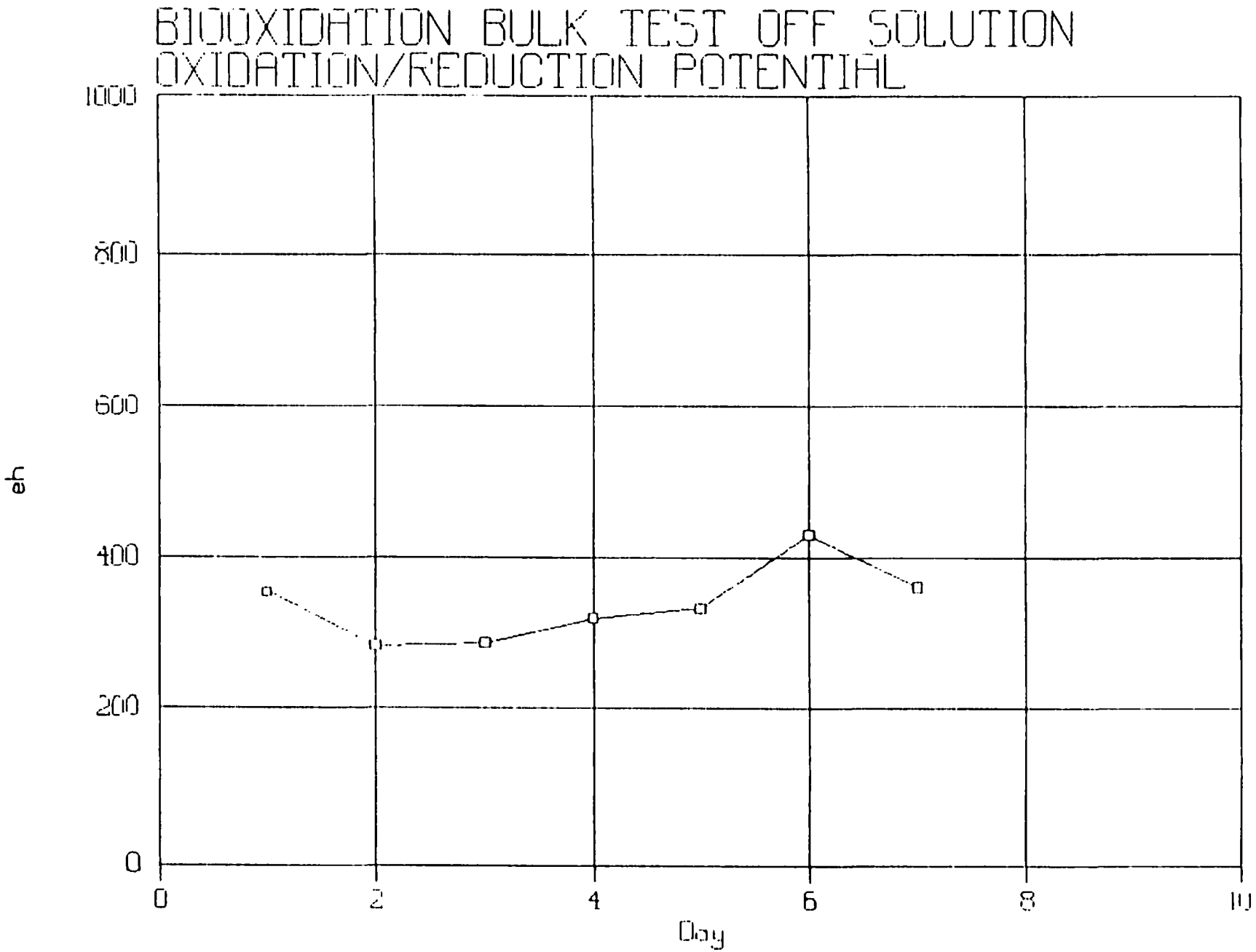
BIOOXIDATION BULK TEST SOLUTION SAMPLING

OFF SOLUTION

Sample ID	Date	Gal/ Day	Cum Gal	pH	eh (ORP)	Total Cu (ppm)	Total Fe (ppm)	Ferrous Fe (ppm)	Ferric Fe (ppm)	Acidity (ppm)	Sulfate (ppm)
SUMP-GRAB	07/26/94	1200	1200	7.22	-	.84	.27	-	-	-	-
GRAB-1530	07/27/94	1750	2950	7.53	305.4	.89	.20	-	-	-	-
COMP	07/28/94	3000	5950	5.93	353.6	83	.55	-	-	83	4411
COMP	07/29/94	3293	9243	5.49	282.1	255	13.0	-		362	5094
COMP	07/30/94	4419	13662	5.11	285.7	654	14.0	-	-	994	7913
COMP	07/31/94	2688	16350	5.18	318.8	960	11.0	-	-	956	9835
COMP	08/01/94	7822	24172	4.20	332.3	990	39.0	1.0	38.0	2438	11106
COMP	08/02/94	21836	46008	3.39	429.6	1930	172.0	1.6	170.4	8960	18304
COMP	08/03/94	14710	60718	3.43	360.1	2050	520.0	260.0	260.0	10520	


BIOOXIDATION BULK TEST OFF SOLUTION
pH
10
1
pH
0
2
4
6
8
10
Day


BIOOXIDATION BULK TEST OFF SOLUTION
TOTAL IRON
Total Fe (mg/L)
1000
800
600
400
200
0
0
2
4
6
8
10
Day


BIOOXIDATION BULK TEST OFF SOLUTION
OXIDATION/REDUCTION POTENTIAL
1000
800
600
400
200
0
eh
0
2
4
6
8
10
Day

BBT BOTTLE ROLL EXTRACTION

Sample I.D.		SP1-1 18 lb/T CaO 5 lb/T NaCN	
Date		08/02/94	
FA Head	Au (opt)	.0492	
FA Tail	Au (opt)	.0250	
AA Soln	Au (opt)	.025	17 hr
		.027	24 hr
		.027	48 hr
		.026	72 hr
		.026	96 hr
Calc Head	Au (opt)	.0509	
NaCN (lb/ton) final		1.9	
NaCN Consumption (lb/ton)		3.1	
pH (initial)		11.5	
pH (final)		10.5	
Lime Added (lb/ton)		18.0	
% Extraction Au (FA Head - FA Tail/FA		49.2	
% Extraction Au (AA Soln/Calc Head)		50.9	

BBT BOTTLE ROLL EXTRACTION

Sample I.D.		SP1-2 18 lb/T CaO 5 lb/T NaCN	
Date		08/02/94	
FA Head	Au (opt)	.0492	
FA Tail	Au (opt)	.0246	
AA Soln	Au (opt)	-	17 hr
		-	24 hr
		-	48 hr
		-	72 hr
		.032	96 hr
Calc Head	Au (opt)	.0562	
NaCN (lb/ton) final		2.1	
NaCN Consumption (lb/ton)		2.9	
pH (initial)		11.5	
pH (final)		10.4	
Lime Added (lb/ton)		18.0	
% Extraction Au (FA Head - FA Tail/FA		50.0	
% Extraction Au (AA Soln/Calc Head)		56.2	

BBT BOTTLE ROLL EXTRACTION

Sample I.D.		SP2-1 18 lb/T CaO 5 lb/T NaCN	
Date		08/02/94	
FA Head	Au (opt)	.0457	
FA Tail	Au (opt)	.0238	
AA Soln	Au (opt)	.019	17 hr
		.019	24 hr
		.019	48 hr
		.020	72 hr
		.019	96 hr
Calc Head	Au (opt)	.0432	
NaCN (lb/ton) final		2.8	
NaCN Consumption (lb/ton)		2.2	
pH (initial)		12.1	
pH (final)		11.1	
Lime Added (lb/ton)		18.0	
% Extraction Au (FA Head - FA Tail/FA		47.9	
% Extraction Au (AA Soln/Calc Head)		44.9	

BBT BOTTLE ROLL EXTRACTION

Sample I.D.		SP2-2 18 lb/T CaO 5 lb/T NaCN	
Date		08/02/94	
FA Head	Au (opt)	.0457	
FA Tail	Au (opt)	.0234	
AA Soln	Au (opt)	-	17 hr
		-	24 hr
		-	48 hr
		-	72 hr
		.028	96 hr
Calc Head	Au (opt)	.0518	
NaCN (lb/ton) final		3.0	
NaCN Consumption (lb/ton)		2.1	
pH (initial)		12.1	
pH (final)		11.2	
Lime Added (lb/ton)		18.0	
% Extraction Au (FA Head - FA Tail/FA		48.8	
% Extraction Au (AA Soln/Calc Head)		54.8	

Laura Damon

SULFIDE BIOOXIDATION – PILOT HEAP AT THE GILT EDGE MINE

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Brohm Mining Corp., Deadwood, SD 57732

November 8, 1995

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Abstract

Geobiotics, Inc. in conjunction with Brohm Mining Corporation has completed bench and pilot heap biooxidation tests on sulfidic ore from the Gilt Edge Mine located near Deadwood, South Dakota. Flask and column testing demonstrated that biooxidation can increase the gold recovery via direct cyanide extraction by more than 30 percentage points. After biooxidation in columns, subsequent gold recovery increased from 51% to over 82% after 37% of the sulfides had been oxidized, as measured by iron solubilization. Laboratory results indicate that improvement in gold recovery correlates with the extent of biooxidation. Experiments demonstrated that the rate of biooxidation of this ore could be accelerated by removing soluble components that became inhibitory when they concentrated in the leach liquor. A 4,317 t (4,749 st) pilot heap biooxidation test has confirmed these laboratory results. Bottle roll and column cyanide gold recovery of heap biooxidized ore increased over 16 percentage points when 21% of the sulfides had been biooxidized. Preliminary economic evaluation of heap biooxidation indicates that this process could be used for deposits that cannot justify more conventional processes for refractory ore oxidation.

Introduction

It is widely recognized that oxide gold reserves are being rapidly depleted, especially in regions with long histories of gold mining such as the Black Hills of South Dakota. However, these districts often have substantial additional deposits, where the gold is refractory to traditional cyanide extraction due to the presence of sulfide minerals that encapsulate or otherwise preclude the economic extraction of the gold. A number of different technologies have been developed to render refractory sulfide deposits amenable to traditional cyanide processing, including roasting and pressure autoclaving. Unfortunately, these oxidation processes require substantial capital investment and incur significant operating costs.

Microorganisms that obtain energy for their life processes via the oxidation of iron sulfides can be used to treat gold bearing refractory sulfide minerals. As the bacteria convert the sulfide to sulfate, they expose any gold associated with the sulfide matrix, making the gold amenable to cyanide extraction. Current commercial processes incorporating the biooxidation of sulfides involve the formation of a gold and sulfide rich flotation concentrate which is then treated biologically in a series of aerated and agitated bioreactors. This tank biooxidation process requires substantial capital investment and incurs significant operating costs. Tank biooxidation is best suited for mines where the gold is primarily associated with those sulfide minerals that biooxidize very rapidly (Odd *et al.*, 1993). Only mines with substantial refractory reserves can economically justify any of these process options, because of the substantial capital and operating costs involved (Nicholson and Oti-Atakorah, 1993, Simmons, 1993).

Brohm Mining Corporation operates the Gilt Edge Mine as an open-pit heap leach operation.

Previously permitted oxide reserves were exhausted in 1992, however an additional 7.8 Mt (8.58 million st) of proven and probable oxide ore at 0.89 g/t (0.026 oz/st) Au have been identified. Also an extensive sulfide resource containing 17.0 Mt (18.75 million st) of 1.20 g/t (0.035 oz/st) Au has been defined with an additional 24.0 Mt (26.4 million st) contiguous deposit grading 1.37 g/t (0.04 oz/st) Au indicated. The total sulfide resource is estimated to contain 61,700 kg (1.8 million ounces) of gold. Direct cyanide heap leaching of the sulfide ore gives a 50.5% recovery after 14 months (Damon, 1994). In this paper we outline the experimentation and field testing that have identified a heap biooxidation technology, suitable for this refractory sulfide ore, that leads to increased gold recoveries.

Mineralogy

Biooxidation kinetics is a function of the type and form of the sulfide minerals present in the ore. The recalcitrance to biooxidation of sulfide minerals is listed in Table I. (C. Brierley, 1995)

Table I - Relative Biooxidation Kinetics of Sulfide Minerals

Fastest	Pyrrhotite
	Chalcocite
	Covellite
	Arsenopyrite
	Sphalerite
	Pyrite
	Marcasite
Slowest	Chalcopyrite

Additionally, the crystal form of the mineral influences biooxidation kinetics. Anhedral pyrite biooxidizes more rapidly than subhedral pyrite which in turn biooxidizes more rapidly than euhedral pyrite. The difference in biooxidation rates has been exploited commercially by a number of mines worldwide; a good example is the Youanmi mine in Australia where gold mineralization is exclusively associated with arsenopyrite and the pyrite present is barren (Budden and Bunyard, 1994). A similar gold mineralization pattern occurs in the Carlin Trend refractory ore being used in the heap biooxidation tests being conducted by Newmont. Here the majority of the gold is associated with arsenopyrite. Additional gold is associated with anhedral pyrite which overlays barren euhedral pyrite (J. Brierley *et al.*, 1995). Consequently, excellent gold recoveries are achieved with only a partial biooxidation of the sulfides present by biooxidizing the sulfides associated with the gold.

At Gilt Edge, at least two distinct periods of hydrothermal mineralization are evident. The first period is characterized by disseminated subhedral to euhedral pyrite crystals and crystal aggregates. The second period is characterized by pyrite and marcasite which occur as disseminated crystals and crystal aggregates, vein and open space fillings, and as cement in breccia. Additionally there are trace amounts of chalcopyrite, covellite molybdenite, sphalerite, galena, and acanthite, as well as free gold and gold-silver tellurides. (MacLeod and Barron, 1990)

Gold mineralization is associated with sulfides and is found as distinct 10-150 micron particles along grain boundaries of sulfide crystals and as 5-10 micron particles encapsulated within the sulfides. The sulfides (euhedral pyrite and marcasite) found at the Gilt Edge Mine are among the slowest to biooxidize, increasing the challenge of implementing biooxidation technology at this site. However, as biooxidation preferentially occurs along mineralization and grain boundaries, complete sulfide oxidation is not required to give substantial increases in gold recovery.

Laboratory testing

Initial biooxidation testing was conducted using a sample obtained from a sulfide ore stockpile. Three tons of sulfide ore were removed from the interior of the stockpile and 360 kg (800 lbs) of this material were crushed to 98% passing 0.9 cm (3/8 in.). Splits of this material were further ground to 95% passing 180 micron for shake-flask biooxidation tests. Additional splits were used in column

biooxidation testing.

Biooxidation was measured by the fraction of iron solubilized, the reduction in sulfide sulfur, and the oxidation potential and pH of column effluent or of aliquots removed from the shake flasks. Soluble iron concentration was measured using a Perkin-Elmer Model 3100 atomic absorption spectrophotometer. Total iron and sulfide sulfur content were determined by an outside analytical laboratory. Extent of biooxidation as measured by reduction in sulfide sulfur was generally more difficult than iron measurements.

In shake-flask biooxidation tests, samples of ore were analyzed for gold recovery via cyanide extraction prior to biooxidation, at intermediate points and at the end of testing. Gold extraction was determined by slurrying small samples of the ground (100% passing 75 micron) and biooxidized ore with sodium cyanide at 1 kg/t (2 lb/st) and mixing in the presence of activated carbon. The samples were agitated for 96 hours after which carbon and tail samples were analyzed to obtain a calculated head and gold recovery.

Conventional bottle roll cyanide extraction was used to determine gold recovery for column biooxidized samples. Some column samples were split and confirmatory bottle roll testing was conducted by an outside metallurgical laboratory.

Improvements in gold recovery as a function of extent of biooxidation were determined in biological shake flask tests that used 30 grams of ground ore at a 20% pulp density in 250 ml Erlenmeyer flasks. A nutrient salt solution containing ammonium sulfate, potassium phosphate, potassium chloride and magnesium sulfate was used to make up the slurry. The pulp was adjusted to a pH of 1.8 to 2.0, inoculated with up to $2x10^{10}$ *Thiobacillus ferrooxidans* cells per gram of ore and shaken at 250 rpm at 25-30°C for up to 4 weeks. The microorganisms were obtained from a mixed and continuous culture of American Type Culture Collection strains 14119, 19859, 23270 and 33020 grown in a 14 L (3.8 gal) Bellco fermenter that maintains the microorganisms in an exponential growth phase. Control flasks containing an antimicrobial agent were used to provide non-biooxidized recovery results.

Shake flask experimentation to examine the inhibitory effect of accumulated soluble components was conducted using adapted microbes. An inoculum of $5x10^8$ *T. ferrooxidans* cells per milliliter in a nutrient salts solution at a pH of 2.2 was grown for 13 days on pyrite flotation concentrate at a 10% pulp density, and transferred to a 2,800 ml flask with 70 grams of sulfide flotation concentrate at a 10% pulp density and a pH of 1.9. Soluble inhibitory components were removed by decanting the leach liquor and replacing it with fresh nutrient solution.

Column biooxidation studies were conducted on 23 kg (50 lb) splits of ore that were agglomerated and then placed in 15 cm (6 in.) diameter, 1.8 m (6 ft) tall columns. Iron and gold content of the ore samples was analyzed to provide a baseline for extent of biooxidation and subsequent recovery improvement. Acute static and dynamic agglomerate stability dosage response tests were conducted with over 20 commercial and developmental polymeric agents. Agglomerate stability was further tested in columns. Column applied solutions were pH adjusted and contained nutrient salts similar to those in the flask studies. Column effluent was neutralized to remove inhibitory components prior to recycling.

Pilot heap construction

The biooxidation heap pilot test was sited atop an existing expended heap at the Gilt Edge Mine. The test site was leveled with a D-6 Caterpillar dozer and sloped to one corner for solution collection. Geotextile[1] (16 oz/ft^2) was laid on top of the prepared surface followed by 1 mm (0.04 in.) HDPE liner and a second layer of Geotextile. A one foot layer of crushed, washed, -2.5 cm + 1.3 cm (-1 in. +1/2 in.) river rock was used as a drain layer and spread with a Bobcat[2] loader. Lined

[1]Geotextile is a registered trademark of Synthetic Industries Corporation

[2]Bobcat is a trademark of Melrose Corporation

dimensions were 43 m by 34 m (140 ft by 110 ft) including 1 m (3 ft) berms on all sides to contain solution discharge.

Approximately 5,820 t (6,400 st) of sulfide ore grading 1.58 g/t (0.046 oz/st) Au and 4.91% sulfur as sulfide were loaded into 50-ton haul trucks with a Caterpillar 992C loader and dumped at the crusher site located on the leach pad haul road. The ore was originally mined from the Dakota Maid Pit and had been stockpiled on the Sunday Pit ramp. The ore is believed to be representative of 85-90% of the large sulfide ore resource.

A local contractor used a two stage crushing operation in a closed circuit to crush the ore to 95% passing 0.9 cm (3/8 in.) at 136 t/hr (150 stph). A jaw crusher fed a conveyor leading to a triple-deck screen which fed a cone crusher. The cone crusher discharged onto a conveyor leading to a second triple deck screen. The 0.9 cm (3/8 in.) material reported to a crushed ore stockpile, while the oversized ore was recirculated through the cone crusher.

Over a two week period, 4,317 dry tonnes (4,749 st) of ore were agglomerated and stacked at an average rate of 73 t/hr (80 stph). The material was trammed from the crushed ore stockpile to a hopper which fed a conveyor in turn feeding an agglomeration drum. The ore was agglomerated with site well-water adjusted to a pH of 1.7 and 50 to 100 g/t (0.1 to 0.2 lb/st) of Nalco 7534 polymeric agglomeration aid. (Gross and Gomer, 1993 discuss the use of polymeric agglomeration aids with biooxidation.) Final average moisture of agglomerated ore was 7.9%. The agglomerated product went to a scale conveyor feeding another conveyor where a highly concentrated bacterial inoculum was sprayed onto the ore. The surface inoculated ore was then stacked on the pad with a radial arm stacker to a heap height of 7.6 m (25 ft), which settled to a final height of 7 m (23 ft). Final heap base dimensions were 26 m by 36.6 m (85 ft by 120 ft), and the top of the heap measured 7.6 m by 18.3 m (25 ft by 60 ft).

Head samples were collected to make composites for analysis and control column cyanide extraction. The system feed was sampled approximately every 25 tons from the loader bucket supplying the agglomeration-stacker circuit. Thirty random scoop fulls were collected from every fourth loader bucket and split through a riffle splitter to obtain subsamples. Agglomerated, inoculated ore was also sampled approximately every 25 tons from the heap where the stacker was depositing the ore. Again, 30 random scoop fulls were collected and split into subsamples. Subsamples were combined to make composites for analysis and column testing.

Composite samples from the system feed and agglomerated ore were assayed for iron and copper by aqua regia acid digestion followed by atomic absorption spectroscopy, for sulfur and sulfate by barium precipitation and for gold by fire assay. Iron and copper concentrations were determined using a Perkin Elmer Model 2380 atomic absorption spectrophotometer.

Pan lysimeters were installed in the heap in order to collect solutions from specific locations within the heap. Four pan lysimeters were placed at ground level and two elevated about one and one half meters (five feet) above the base of the heap. The pan lysimeters consisted of plastic dish-shaped receptacles containing coarse +0.6 - 0.9 cm (+1/4 in. - 3/8 in.) washed sulfide ore, which were connected with tubing to 1.25 cm (0.5 in.) diameter PVC pipe that exited the heap.

Ten centimeter (4 in.) diameter perforated PVC pipe was laid under the base of the ore, on top of the drain rock, to facilitate air flow into the heap. The perforated pipes were spaced six meters (twenty feet) apart, with five pipes entering from each long side of the rectangular heap.

Drip emitters were buried 0.3 m (12 in.) below the heap surface on a 0.125 m (32 in.) grid. Four 19,000 L (5,000 gal) HDPE tanks were used for effluent (Off) solution, applied (On) solution, neutralized solution and as a spare. Piping and pumping arrangement permitted simple solution management between the heap, tanks and neutralization circuit. In-line, local output, flow meters were used to monitor solution flow rates and to maintain cumulative flow measurements.

Microbial inoculation

The bacterial solutions used to inoculate the ore were composed of a culture of *T. ferrooxidans* grown in a pilot scale fermentation facility assembled on site. This fermentation facility was inoculated with a culture derived from the earlier shake flask studies conducted at Geobiotics' Hayward, California

laboratories.

Fermentation was initiated two weeks prior to commencement of heap construction. The fermenter size incorporated a microbial growth rate that permitted daily withdrawal of inoculum for application to the ore being stacked on the test heap. After the test heap was constructed, additional inoculum was added to the applied circulating solution for the first month into the test. The fermentation facility included provisions to control nutrient concentration, dissolved oxygen content, pH and oxidation potential in the fermentation broth.

Heap biooxidation circuit operation

The biooxidation heap circuit operated for 11 months starting in July, 1994 and is depicted in Figure 1. Initially, the On-solution was applied at a rate of 0.04 to 0.16 L/min/m^2 (0.001 to 0.004 gpm/ft^2) and the pH was adjusted to 1.5 - 2.0 by the addition of concentrated sulfuric acid via a small peristaltic pump. Microbial nutrients were applied with the On-solution during the first month of operation. The Off-solution exited the heap at approximately 80 L/min (20 gpm). A portion of the Off-solution was diverted to an acid neutralization circuit where the pH was adjusted to 5.5 to 6.0. The neutralized solution was then mixed with the remaining Off-solution prior to reapplication to the heap.

Neutralization of the excess acidity was performed by contacting a portion of the Off-solution with minus 0.6 cm (0.25 in.) limestone and hydrated lime in a small mix tank followed by a screw classifier that removed unreacted limestone gravel. Neutralization sludge was allowed to precipitate and settle after which neutralized solution was decanted and recycled.

To monitor the biooxidation process, daily liquid samples of the On-, Off- and neutralized solutions were analyzed for: pH, oxidation potential (Eh), dissolved copper, total dissolved iron, dissolved ferrous iron, acidity and dissolved sulfate. Samples from the pan lysimeters, and any water added to or discharged from the test heap were collected and analyzed.

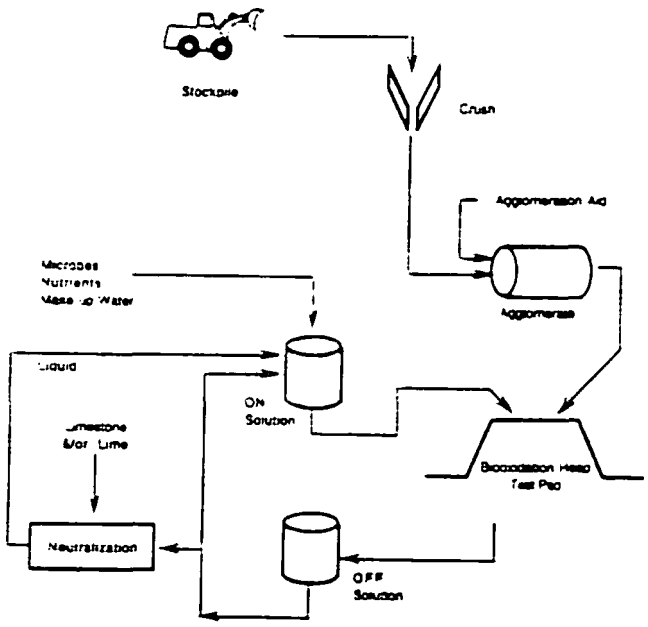

Figure 1. Schematic diagram of pilot test heap at the Gilt Edge Mine.

After 3 months of operation, solution recirculation through tanks and neutralization circuit was halted due to cold weather. Direct recirculation was maintained for another 4 weeks, because the Off-solution was sufficiently warm to prevent freezing during reapplication. Later, the recirculation system, tanks and neutralization circuit were removed due to anticipated operational difficulties associated with severe weather.

Operational difficulties with the neutralization circuit precluded complete removal of the inhibitory components in the test heap prior to the dismantling of the equipment. As conditions permitted, fresh water was applied to the heap to further remove or dilute remaining inhibitory components.

Off-solution samples continued to be collected as the test heap drained. As the heap test progressed, samples were no longer obtainable from the pan lysimeters. When the test heap was dismantled it was ascertained that the tubing portion of the pan lysimeters crimped and a more robust design is needed for future biooxidation heap test work.

Four inch diameter auger drilled samples were taken approximately every 30 days from three locations within the heap. Each drill hole was composited into 1.5 m (5 ft) intervals with the top 0.3 m (1 ft) discarded because it was above the emitter percolation horizon. The twelve samples were then composited into a single sample and subjected to bottle roll cyanide extraction or column cyanide leaching tests.

At the conclusion of the test, samples representing a composite of the entire heap, as well as auger samples from every region of the heap, were collected. The rate and extent of biooxidation were monitored by calculating sulfur balances on discharged and solubilized sulfate, and on the sulfide content of auger samples.

Column cyanide extraction of head samples and augered samples were conducted in 0.25 m (10 in.) diameter, 1.5 m (5 ft) tall columns that were leached with 0.5 kg/t (1 lb/st) cyanide solution for 30 - 40 days. Solution assays were determined via atomic absorption spectrometry and column tail assays by fire assay. Gold recovery was determined using a calculated head. Column cyanide extraction of the final tail composite was conducted by an independent metallurgical laboratory.

Laboratory results and discussion

Figure 2 depicts the improvement in gold recovery in shake flask experiments as a function of the extent of biooxidation. After 35% of the sulfides have been biooxidized, gold recovery upon subsequent cyanide extraction improved to 90%. Gold extraction from ore that had been oxidized via roasting at 475°C was 92%, representing a gold recovery upper limit for this ore. Partial biooxidation was nearly as effective as high temperature roasting in liberating gold in these shake flask experiments.

A similar plot for the agglomerated ore biooxidation column experiments is also shown, again depicting an increase in gold recovery with an increase in biooxidation. In the column experiments, the non-biooxidized control recovery was 51%, similar to the extraction seen for Gilt Edge sulfide ore in other column and heap cyanide extraction tests. The control shake flask experiment containing an antimicrobial agent and no biooxidation demonstrated a recovery of 66%, indicating that the fine grinding associated with preparing ore for shake flask studies contributed about 14 percentage points to the improvement in recovery.

After an initial recovery boost seen with the first few percentage points of sulfide biooxidation, both the column and shake flask data indicate that improvements in gold recovery are proportional to the extent of biooxidation up to 40% biooxidation. The incremental improvement due to the grinding seen in the shake flasks over column experiments remained constant as biooxidation progressed.

Figure 3 depicts the gold recovery and extent of biooxidation as a function of time in the agglomerated ore column biooxidation tests. Over the course of the experiment, the gold extraction increase was comparable to the increase in extent of biooxidation.

Shake flask studies are inherently batch in nature, where any inhibitory components that leach from the ore are retained in solution. Figure 4 shows the importance of removing these components in

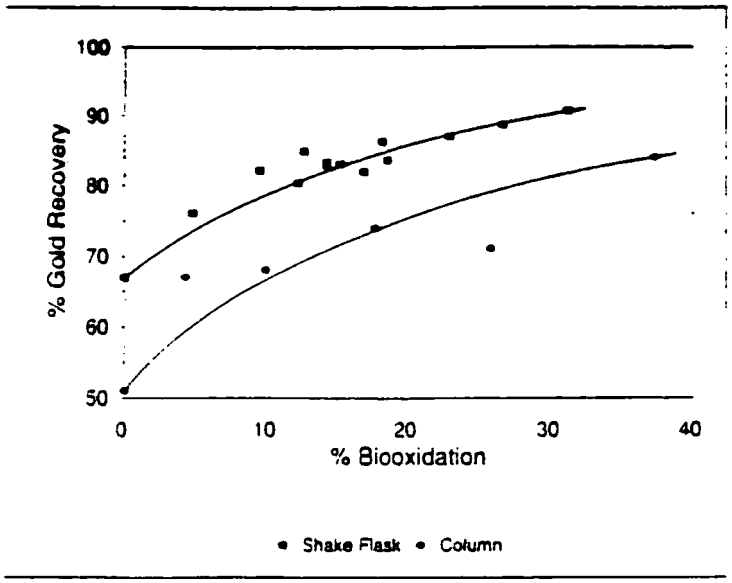

Figure 2. Increase in gold recovery with extent of biooxidation in shake flask (■), and column (●) laboratory experiments.

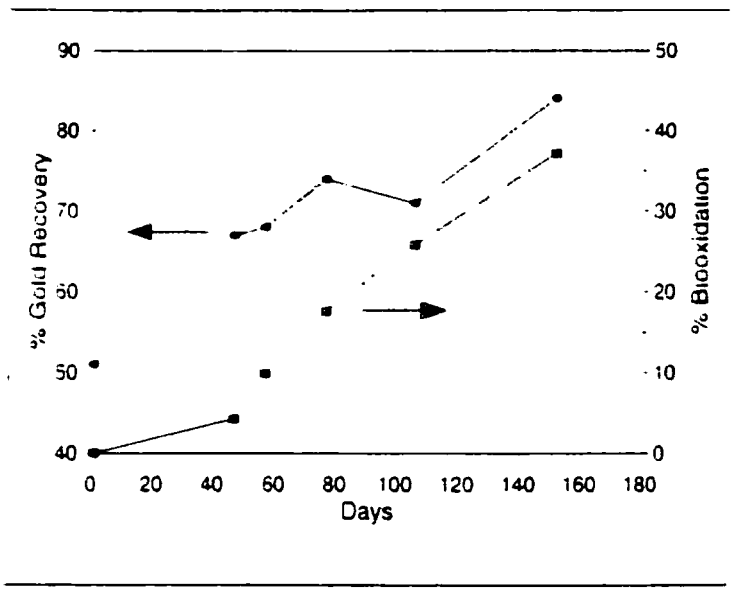

Figure 3. Gold extraction (●) and extent of biooxidation (■) during laboratory column biooxidation tests.

enhancing the rate of biooxidation. A sulfide flotation concentrate slurry containing excess nutrients and inoculated with *T. ferrooxidans* biooxidized slowly at less than 0.05 %/day until day 28. At this time the leach liquor was replaced with fresh nutrient solution, effectively removing the inhibitory components. Biooxidation rate then increased to 0.8 %/day. Similar results were obtained from whole ore shake flask and column biooxidation testing. Additional tests identified that a combination of soluble components at individually noninhibitory levels caused the inhibitory effect and that the effect can be removed from the leach liquor by neutralization (data not shown).

These laboratory studies indicated that heap biooxidation is technically feasible for the Gilt Edge sulfide ore and warranted a field test.

Heap results and discussion

The major objectives of the heap pilot test were to confirm laboratory column testing, identify important field operating parameters, demonstrate the technology at scale, and quantify field operating costs. The pilot heap was operated as a field experiment to determine the optimal conditions for commercial scale production. As the optimal conditions were determined after the experimentation, no regions of the heap were maintained at those conditions throughout the demonstration. The goals for the heap test included improving gold recovery by 20 percentage points to 75% and identifying the conditions necessary to achieve an average sulfide biooxidation rate of 0.1%/day.

Measurement of extent of biooxidation using iron and sulfur mass balance calculations proved to be difficult due to assay variability introduced by ore heterogeneity. Bottle roll gold extraction results from bored samples from within the heap also varied significantly, again attributed to ore heterogeneity. More consistent results were obtained from cyanide extraction columns that utilized 90

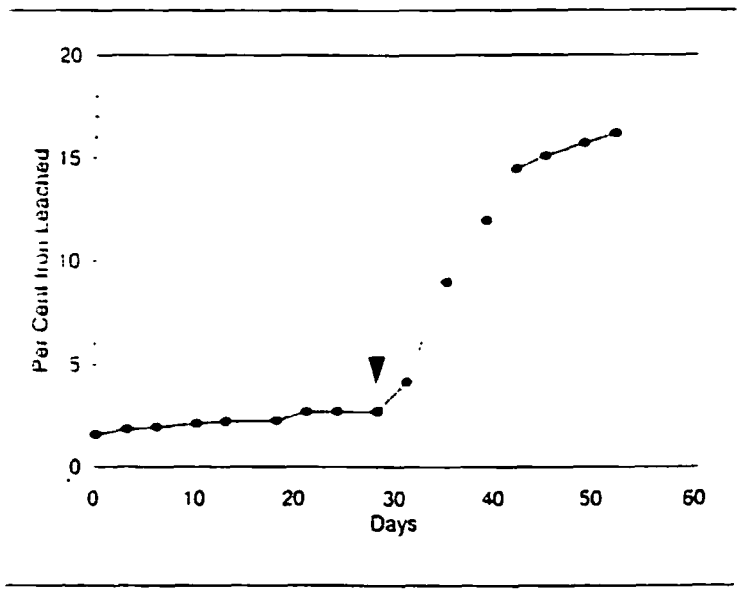

Figure 4. Extent of biooxidation as measured by percent iron leached in shake flasks with time. Leach liquor replaced at ↓, removing inhibitory component buildup.

kg (200 lbs) of auger sampled ore. Figure 5 depicts the fraction of gold recovered versus cyanide leach time in the cyanide extraction columns. As the biooxidation test heap progressed both the ultimate recovery and the rate of gold recovery improved.

The rate improvement can be clearly seen by examining the fraction of the extractable gold recovered early in the cyanide column leach as a function of biooxidation. In Figure 6, this fraction obtained after 9 days of leaching is plotted against heap biooxidation time. There was a more rapid dissolution of gold as biooxidation progressed. This may be a result of biooxidation improving gold exposure to the subsequent cyanide leaching solution. The rate improvement was most pronounced during the first 260 days of biooxidation.

Bottle roll gold extractions from different regions of the heap demonstrated that differences in operating conditions influence biooxidation and subsequent gold recovery. Moisture content, inhibitory component removal, pH, oxidation potential, soluble iron concentration, aeration, nutrients, and temperature all influence biooxidation and were not uniform within the heap during the field test. Differences in gold recovery from regions within the heap have been used to identify the relative importance of these factors and to determine the optimal heap operating conditions.

Bottle roll gold extractions of samples from different regions within the heap showed gold recoveries up to 73.9%. Bottle roll gold extraction from the final heap composite was 68.9%, confirming that different regions of the heap biooxidized at different rates due to the variability in operating conditions within the heap. Column extraction from a composite of the biooxidized ore showed 71.6% gold recovery after 73 days. Commercial biooxidation heaps would utilize optimal conditions and more rapid biooxidation with higher gold recoveries are anticipated.

Gold and iron assays, extent of biooxidation and gold recovery from column cyanide leach tests of the initial and final composite samples are shown in Table II. The increase in gold recovery

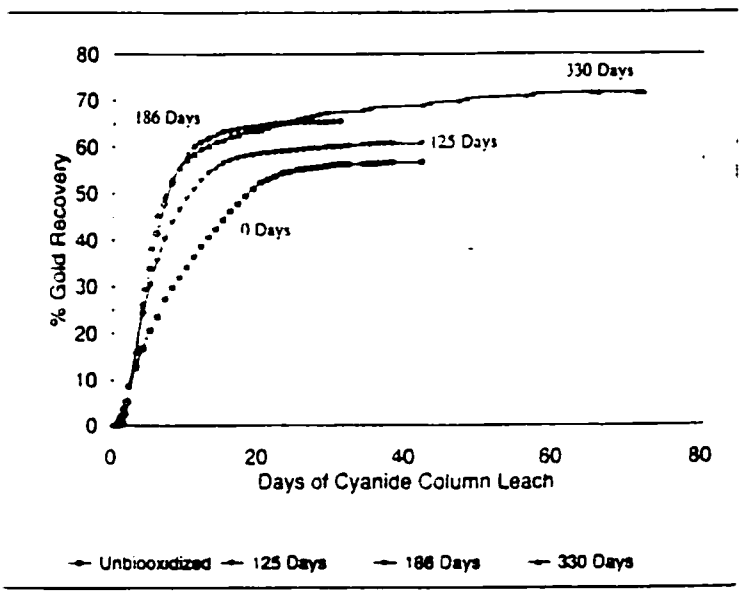

Figure 5. Gold extraction column cyanide leach curves using biooxidized ore removed from pilot test heap. The curves represent ore that had been biooxidized for different lengths of time.

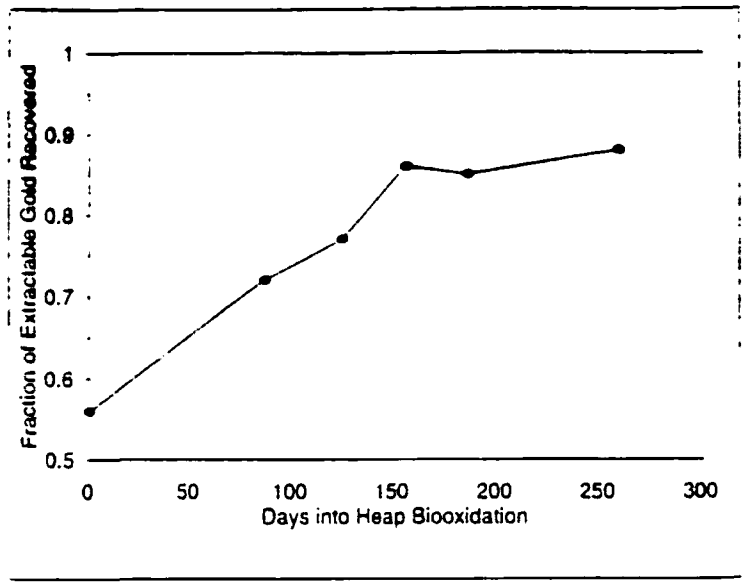

Figure 6. Fraction of extractable gold recovered after 9 days of cyanide column leaching using biooxidized ore removed from pilot test heap.

observed in the field test was accurately projected by laboratory studies. The bulk extent of biooxidation as measured by the reduction in ore sulfide content over the course of the test was 21%, equivalent to 0.06%/day. This rate is less than the 0.1% daily biooxidation rate predicted by column testing and is attributed to the operational difficulties encountered in removing the inhibitory components of the ore. A similar detrimental effect of the inhibitory component concentration was observed in laboratory column testing. Additional testing demonstrated that adequate neutralization was absolutely necessary to achieve the higher biooxidation rates. (Data not shown.)

In retrospect, the neutralization circuit as designed was unable to adequately neutralize Off-solution from the entire test heap and remove the inhibitory components from the circulating solution, contributing to the lower than expected bulk rate of biooxidation. Significant rainfalls during the test tend to confirm the influence of inhibitory components on biooxidation. Two months after initiation of the test, rainfall occurred which diluted the recirculating solution in the test heap. In the days following, the rate of biooxidation (as measured by the increase in sulfate concentration in effluent solution) increased by 30% and remained at an elevated rate for two weeks. Then the rate of biooxidation returned to the previous level as the concentration of soluble components again increased in the recirculating solution. As solution was being continuously applied to the heap, the boost in biooxidation rate cannot be attributed to a change in the moisture content.

Seven months later, another significant rainfall occurred and flushed additional inhibitory components from the test heap. The biooxidation rate increased several fold, and remained at an elevated level through the remainder of the test.

During the later portion of the test when the level of solubilized inhibitory components had been reduced, biooxidation rates (as measured by a decrease in auger sample sulfide contents) of 0.14 %/day were observed, slightly exceeding the rate determined in laboratory testing.

Table II - Summary Heap Test Results

Parameter	Initial Composite	Final Composite	Delta
Sulfide Sulfur	4.91 %	3.88 %	21.0 %
Total Iron	54,822 ppm	44,323 ppm	19.2 %
Au Recovery - Bottle Roll	52.6 %	68.9 %	16.3 %
Au Recovery - Column	56.2 %	71.6 %	15.4 %
Average Biooxidation Rate	-	0.063 %/day	

Estimated commercial costs

The pilot heap experience has been used to estimate the capital and operating costs for a commercial operation. The conceptual design incorporates processing by heap biooxidation 2.3 Mt/yr or 6,220 t/d (2.5 million st/yr or 6,840 stpd) of ore crushed to 0.9 cm (3/8 in.) nominal feed followed by cyanide heap leaching. Biooxidation occurs on a reusable asphaltic lined heap, followed by agglomeration with limestone and heap leach cyanidation on a permanent HDPE pad. Figure 7 outlines this flow sheet, and Table III and IV outline the estimated capital and operating costs.

Neutralization of acid generated during biooxidation represents a significant component of the capital and operating costs. This estimate assumes a worst case scenario involving ore with no inherent neutralization capability, relying exclusively on an active neutralization process to consume all the generated acid.

Pregnant solution processing consists of a carbon-in-column circuit, followed by an atmospheric strip circuit; eluant reports to electrowinning cells.

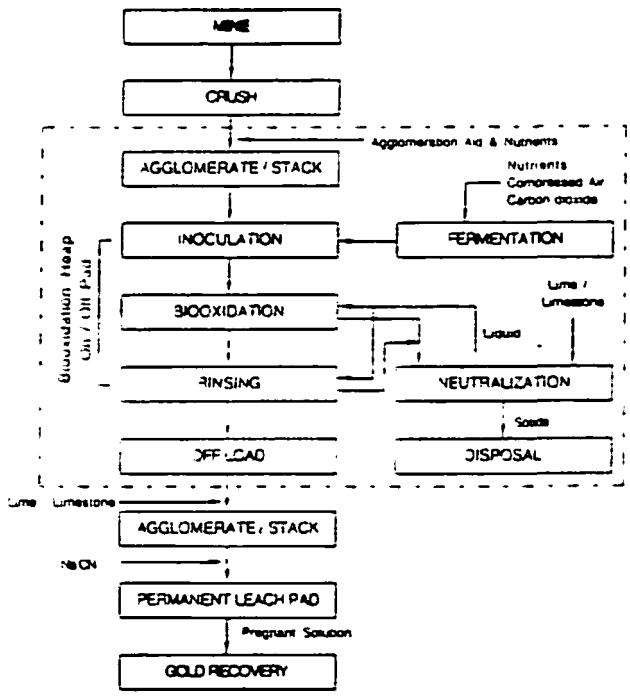

Figure 7. Conceptual flow sheet for heap biooxidation process. Operations inside dashed line are incremental to traditional heap leaching.

Capital costs for a heap biooxidation process include those costs associated with a conventional cyanide heap leach operation and those costs specific to biooxidation. Biooxidation associated capital includes a reusable pad, ore handling equipment and a biooxidation process plant. The biooxidation plant capital includes bacterial fermentation facilities to provide a continuous inoculum stream and a solution neutralization plant required to remove generated acid and precipitate inhibitory components from the biooxidation heap effluent.

The operating cost is the sum of costs associated with conventional cyanide heap leaching and the costs specific to biooxidation. The biooxidation operating cost includes the agglomeration, stacking, microbe fermentation, nutrients, supplies, consumables and maintenance associated with the biooxidation heap operation and neutralization of generated acid. Cyanide heap leach operating cost includes the reagglomeration with lime and limestone, stacking, cyanide consumption, and pregnant solution processing through doré production, as well as support services .

Reclamation costs associated with heap leaching oxide gold ores can be substantial, and increase when processing sulfidic ores due to the necessity to counteract the acid generating capability of the material. As biooxidation oxidizes the most reactive sulfide components of an ore, the rate of acid generation in spent ore will be substantially decreased over that for unbiooxidized sulfidic ore. Consequently, reclamation costs for biooxidized ore can be anticipated to be significantly reduced over unoxidized sulfide ore, and perhaps comparable to reclamation costs for oxide ores. The operating cost estimate includes a provision for reclamation based on estimated reclamation costs for oxide gold ores.

Preliminary analysis indicates that biooxidation reduces cyanide consumption by the ore, due in part to the oxidation of reactive sulfides and the leaching of iron and base metals. The reduction in base metals further improves activated carbon gold loading, carbon stripping efficiency and doré refining. Consequently, a biooxidized ore may incur some lower operating costs than a comparable, unbiooxidized ore. This estimate does not include <u>any</u> of these potential operating benefits.

Table III - 2.3 Mt/yr Heap Biooxidation Capital Cost Estimate ($1,000)

Crushers (primary jaw, secondary cone and tertiary impact crushers)	3,300	
Cyanide Leach Agglomeration & Stacking	1,000	
Cyanide Leach Pad (1st 2 years, 20 m lift, $21/m^2)	3,300	
Processing Plant (Carbon-in-Column)	600	
Ponds	200	
Subtotal - Cyanide Extraction Process		$ 8,400
Biooxidation Asphalt Pad (130,000 m^2 @ $37/m^2)	$ 4,800	
Biooxidation Agglomeration, Stacking & Reclaim	2,300	
Biooxidation Plant (Neutralization & Fermentation)	4,300	
Ponds	200	
Subtotal - Biooxidation Process		$ 11,600
Contingency		3,500
Total		$ 23,500

Table IV - Heap Biooxidation Operating Cost Estimate ($/t)

Mining (1.1:1 strip ratio)	$ 2.20	
Crushing (90% passing 0.9 cm)	0.83	
Cyanide Heap Leach (0.5 kg/t NaCN, 1 kg/t CaO, 40 kg/t $CaCO_3$)	2.18	
General & Administrative	1.34	
Reclamation	0.28	
Subtotal - Heap Leach Operation		$ 6.83
Biooxidation (Heap, fermentation and neutralization)		1.12
Total		$ 7.95

The operating and capital costs for the heap biooxidation process outlined here are substantially lower than the costs required for competing technologies. A biooxidation operating cost of $1.12/t ($1.02/st) indicates that this technology could be utilized in processing lower grade sulfide ores. As the capital required for heap biooxidation is significantly less than required for alternative technologies, this process can be used on smaller deposits. The $11.6 million capital cost estimate for the biooxidation portion of a this extraction process compares favorably with the capital required for autoclaves, roasters or concentrate stirred tank processes. Much of the capital associated with the biooxidation portion of a heap process is invested in pads and a facility to neutralize acidic waste waters. Because heap biooxidation involves these simple unit operations, the demands for a skilled operating and maintenance force will be less stringent than for alternative oxidation technologies. Though the preparation of microbial inoculum is specialized, operating experience from other industries utilizing fermentation is available.

Conclusions

Capital and operating costs for any sulfide ore oxidation process include those costs associated with conventional cyanide leach operations and those costs specific to oxidation. Heap biooxidation is a substantially less expensive alternative to autoclaving, roasting or tank biooxidation as a means of oxidizing sulfidic refractory gold ores. In a manner similar to the way cyanide heap leaching reduced costs and expanded reserves for oxide deposits, heap biooxidation will have a similar impact on refractory sulfidic deposits. The reduction in operating and capital costs for processing sulfidic ores will allow previously non-economic deposits to be brought into production.

The Gilt Edge field test demonstrated that laboratory biooxidation results correlate well with larger scale pilot results. The field test also demonstrated that heap biooxidation continues through severe winter weather. The major factors associated with heap biooxidation that influence production costs were identified, and involve fermentation of microbial inoculum, treatment of generated acid, removal of soluble inhibitory components, and rate of biooxidation. Further laboratory experimentation conducted in conjunction with the pilot test has successfully reduced the costs associated with these factors.

The pilot test identified the operating conditions required to successfully conduct whole ore heap biooxidation. A number of rate limiting factors were examined, and it is anticipated that with the improvements in heap operation identified during this test, that subsequent heap biooxidations could be conducted in substantially less time.

Geobiotics has conducted additional laboratory column testing and has developed technologies whereby gold bearing sulfide ores can be rapidly and inexpensively biooxidized. These innovations include improving the air and liquid flow within whole ore heaps and biooxidizing a sulfide concentrate in a heap configuration (Kohr, 1995).

Today there is a torrid pace of developments in the pharmaceutical, agricultural, and biochemical industries due to biotechnology advances in the understanding of microbial processes. An

opportunity exists to apply these advances to other industries that are not typically associated with biotechnology. The use of microbes for precious metal processing is one such opportunity currently being pursued in our laboratories and field tests.

Acknowledgements

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