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DIRT FEEDLOT RESIDUE EXPERIMENTS

QUARTERLY PROGRESS REPORT

FOR THE PERIOD JULY 1, 1977 - SEPTEMBER 30, 1977

HAMILTON STANDARD DIVISION
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WINDSOR LOCKS, CONNECTICUT 06096

OCTOBER, 1977

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THE U.S. DEPARTMENT OF ENERGY
WASHINGTON, D. C. 20545

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1.0 INTRODUCTION

This progress report describes the program activities for the Hamilton Standard mobile fermentation system at the Monfort feedlots during the July - September, 1977 period.

2.0 ACTIVITIES DURING THE LAST QUARTER

2.1 OBJECTIVES

During the third quarter of 1977, the objectives established for the field experimental program were:

- Continue evaluation of baseline performance utilizing fresh beef steer residue at 0.25# volatile solids/ft^3/day with a ten day residence time and an operating temperature of 57°C.
- Begin evaluation of the comparative yield from typical aged feedlot pen residue at the same parametric conditions previously used for the baseline study.

2.2 TEST RESULTS

Use of fresh residue from beef cattle continued during the early stages of the reporting period. Cessation of the daily additions of iron chloride on June 10, 1977 were associated with a slow increase in total volatile acid concentration from 1000 mg/l to 2000 mg/l by June 17, 1977. Operation of the system at 57°C, 10 day residence time and 0.25# volatile solids/ft^3/day ultimately resulted in a baseline specific gas yield at 7 ft^3/# volatile solids loaded. Coupled with an average methane percentage of 55%, this resulted in a specific methane yield of approximately 4 ft^3/# volatile solids loaded.

During the month of July occasional dosages of either iron chloride or aluminum chloride were made in an attempt to reduce TVA concentration within the fermentor without much success. During this time soluble concentrations of phosphorous and sulfur remained essentially constant at 80 and 100 ppm respectively.

Because of the relatively high sulfate levels (800 ppm) previously found in the well water used for processing, a new water line was installed. The source of this new supply was the Greeley Water Company. The basic water line was already in place at the Kuner facility for the purpose of providing water for the feed mill boilers. This water is derived from Rocky Mountain runoff and is essentially free of all impurities (e.g., sulfate concentration equal to 3 ppm). While this change reduced the levels of sulfate introduced with the process water used for mixing the slurry, it did not affect the drinking water utilized by the cattle which still contained high levels of sulfate. Thus, sulfate is still introduced via the residue into the system.

During this stabilization period a review of the Monfort pens to locate a "typical" dirt lot pen had been performed. Several pens whose waste characteristics (dry matter and volatility) appeared typical were chosen. It was then determined which of the pens was due for cleaning. Pen 307, located in the approximate center of the feedlot, met the above criteria. The pen was scraped utilizing a front end loader and brought to the mobile processing facility.

The collected residue was then ground through a "Muscle Buster" (hay grinder) to provide a large stockpile of homogeneous material. A comparison of the pen 307 material which had lain in the feedlot for approximately six months prior to collection and the fresh residue collected from the steers set aside for us is indicated in Table 1.

TABLE 1

COMPARISON OF RESIDUES

	Fresh, Drug-Free Feed	Aged Drug-Supplement Feed	Fresh, Drug-Supplemented Feed
Dry Matter (%)	20-30	75-80	25-40
Volatility (% of D.M.)	75-85	65-70	75-80
Chlortetracycline (ppm v.s. basis)	2	2	4-8
Monensin (ppm v.s. basis)	None	None	2-12

It may be seen that, as expected, the analysis of the aged residue indicates that dry matter is considerable higher while the volatility of these solids is less than the fresh residue. The residue from pen 307 was collected from the front section of the pen with the majority being scraped from the concrete apron extending back from the feeding bunk. This eleminated a large amount of extraneous sand and grit from the collected residue, thereby avoiding potential mechanical and operational difficulties, while retaining the basic objective of evaluating aged residue. Methodology for the removal of sand and grit from highly contaminated residue will be investigated as a future task of this program.

The levels of pharmaceuticals indicated as present in the aged residue probably are the result of degradation from the levels found in fresh residue from pharmaceutical-fed cattle. The existence of chlortetracycline in the fresh residue from the cattle fed drug-free feed is probably due to the inability to completely clear the production feed trucks of all prior materials. The trucks which carry the premix containing the monensin were not allowed to carry the feed for our cattle. Unfortunately, the possibility existed for the chlortetracycline-bearing premix trucks to occasionally mix our feed. The level of chlortetracycline shown in the fresh residue is, therefore, probably a carryover.

First loading of the pen 307 residue was initiated on August 11, 1977 by the inclusion of small amounts along with the normal daily loading. Complete switchover to the aged residue was accomplished on August 15, 1977. The effects of this transition may be seen in figures 1, 2 & 3. Total daily gas production, as well as specific methane yield, indicated a sudden decrease. This decrease, however, stabilized relatively quickly indicating that the material, while having a lower gaseous yield, was not grossly toxic.

After stabilization at a 10 day residence time, 57°C operating temperature and nominal 0.25 pound volatile solids/ft^3/day (the same conditions as those in operation during baseline fresh residue parametric testing), the daily specific methane yield was approximately 2-3 ft^3 methane/pound volatile solids. The 10 day running average of specific methane yield, which acts as a smoothing function for the somewhat more erratic daily yields, indicates a yield of 2.5 ft^3 CH_4/pound volatile solids. This represents 60% of that obtained from the fresh residue and is most encouraging.

During this period of time the concentration of Total Volatile Acid was allowed to rise. That is, no attempts at control (e.g. iron chloride) were made in order to learn what equilibrium value would result. By the end of the reporting period, the TVA concentration was approximately 4000-5000 mg/l. While reasonable gas production was obtained, the likelihood exists that the elevated TVA concentration was causing additional stress upon the fermentation system. As a minimum, it probably leaves the fermentor more vulnerable to upset.

At the end of the reporting period the system is still in a stabilization period.

2.3 PEN WASTE CHARACTERIZATION STUDY

The effort associated with "mapping" the Kuner feedlot, which was reported last quarter, was continued. This sampling will provide a more complete profile of the facility. In addition, the effects of seasonal variations may become evident.

2.4 REFEEDING

During the reporting period preliminary attempts at refeeding the fermentor contents were performed. The objective of the test was to determine acceptability rather than any nutritional benefits. Several bucketsfull of fermentor contents were poured over one section of the feed for the cattle set aside for our use. On a free choice basis the cattle chose to ignore the treated feed. Only after the entire feed bunk was treated and after much hesitation did the cattle consume the treated feed.

3.0 PROBLEMS

None

4.0 PLANNED EFFORT

During the next quarterly period it is planned to complete the following activities:

- Use of the aged pen 307 residue will continue at a nominal loading rate of 0.25 pound volatile solids/ ft^3/day along with a ten day residence time and an operating temperature of 57°C for the purpose of establishing comparative yields.

- Evaluate the nutritional benefits obtained by refeeding the fermentor contents prior to application of centrifugal separation technology.

- Continue evaluation of the variability of feedlot residue.

- Establish separation operational parameters and refeed product analyses.

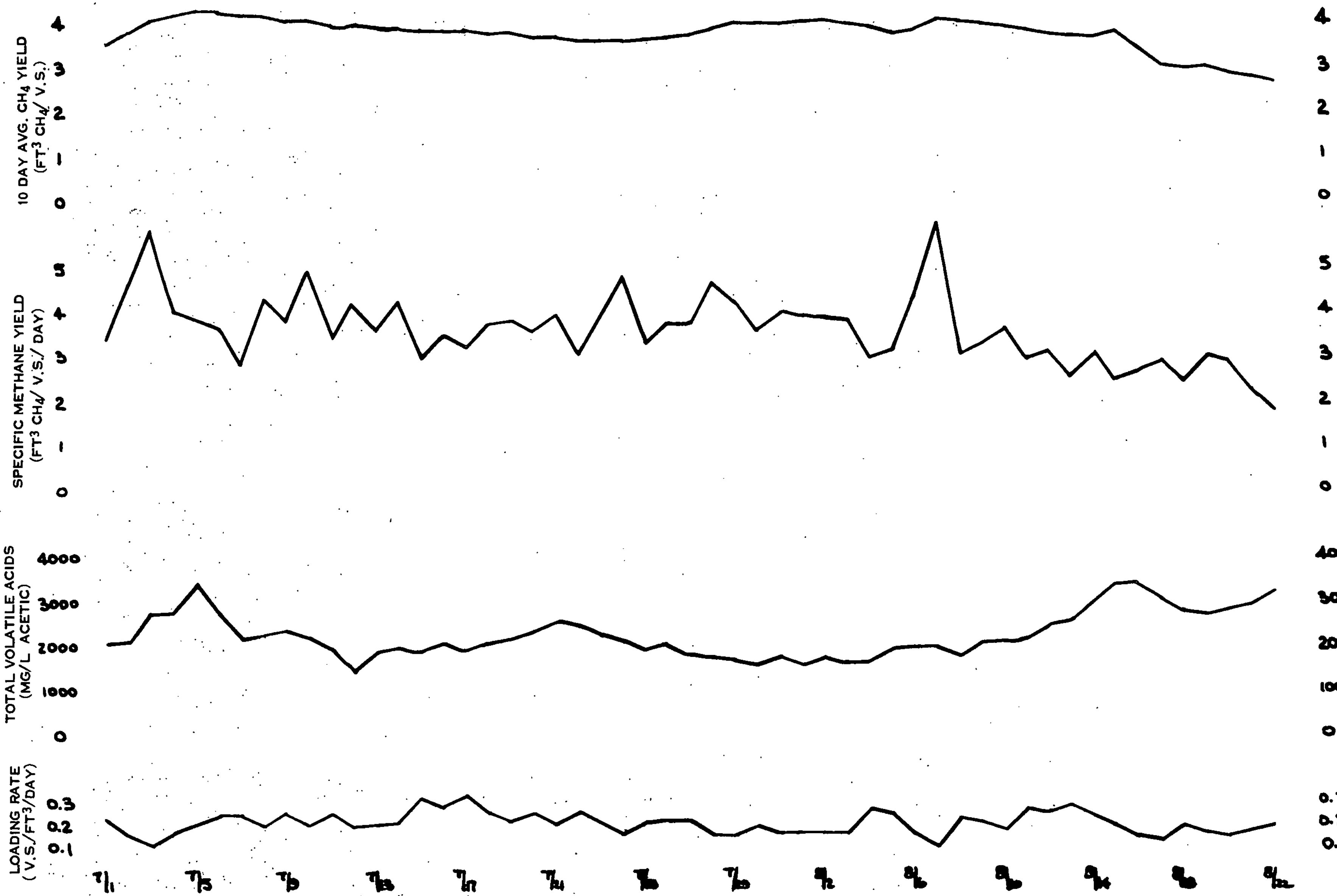

10 DAY AVG. CH4 YIELD
(FT3 CH4/ V.S.)
SPECIFIC METHANE YIELD
(FT3 CH4/ V.S./ DAY)
TOTAL VOLATILE ACIDS
(MG/L ACETIC)
LOADING RATE
(V.S./FT3/DAY)

Figure 1

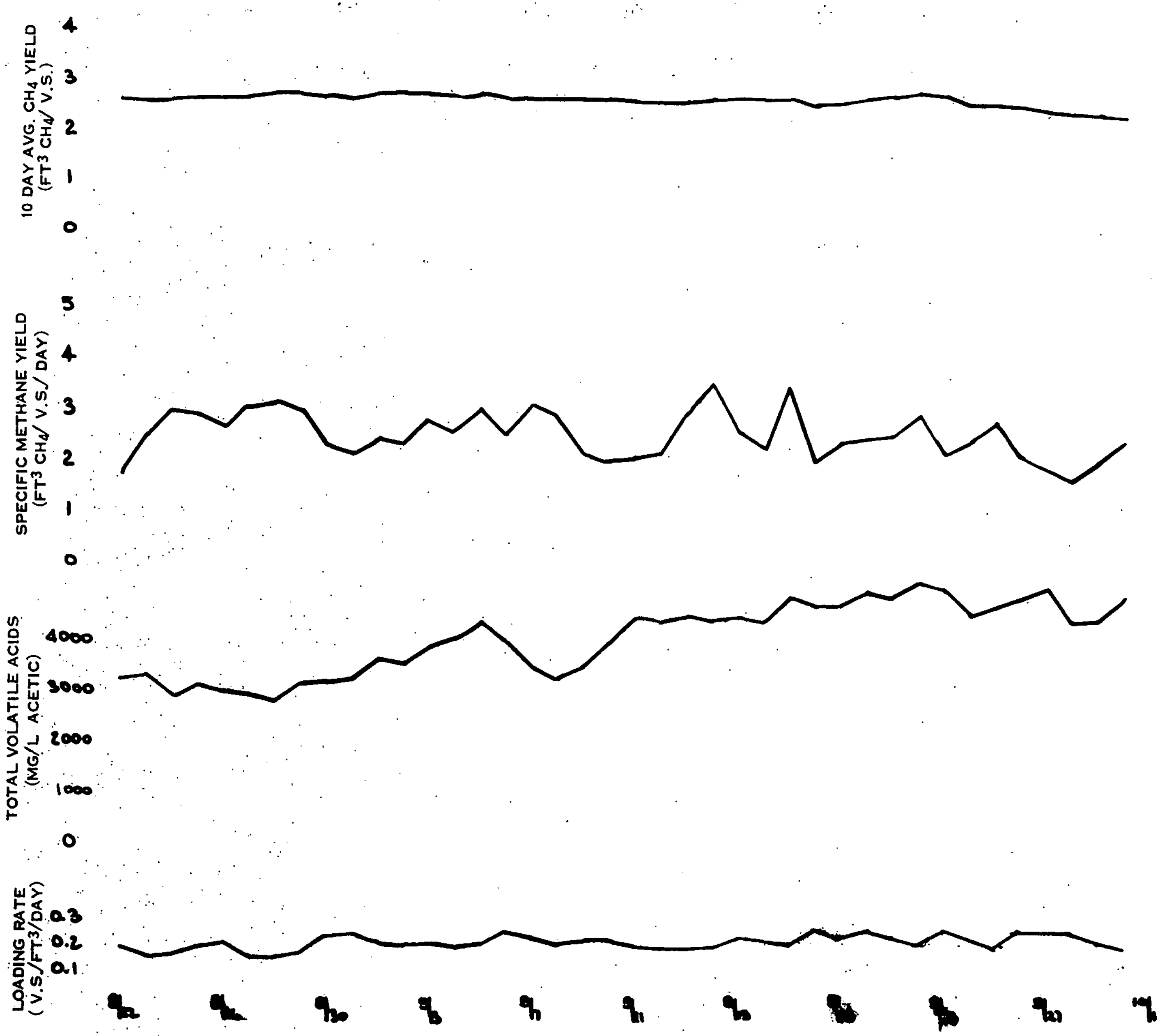


Figure 1 (Continued)

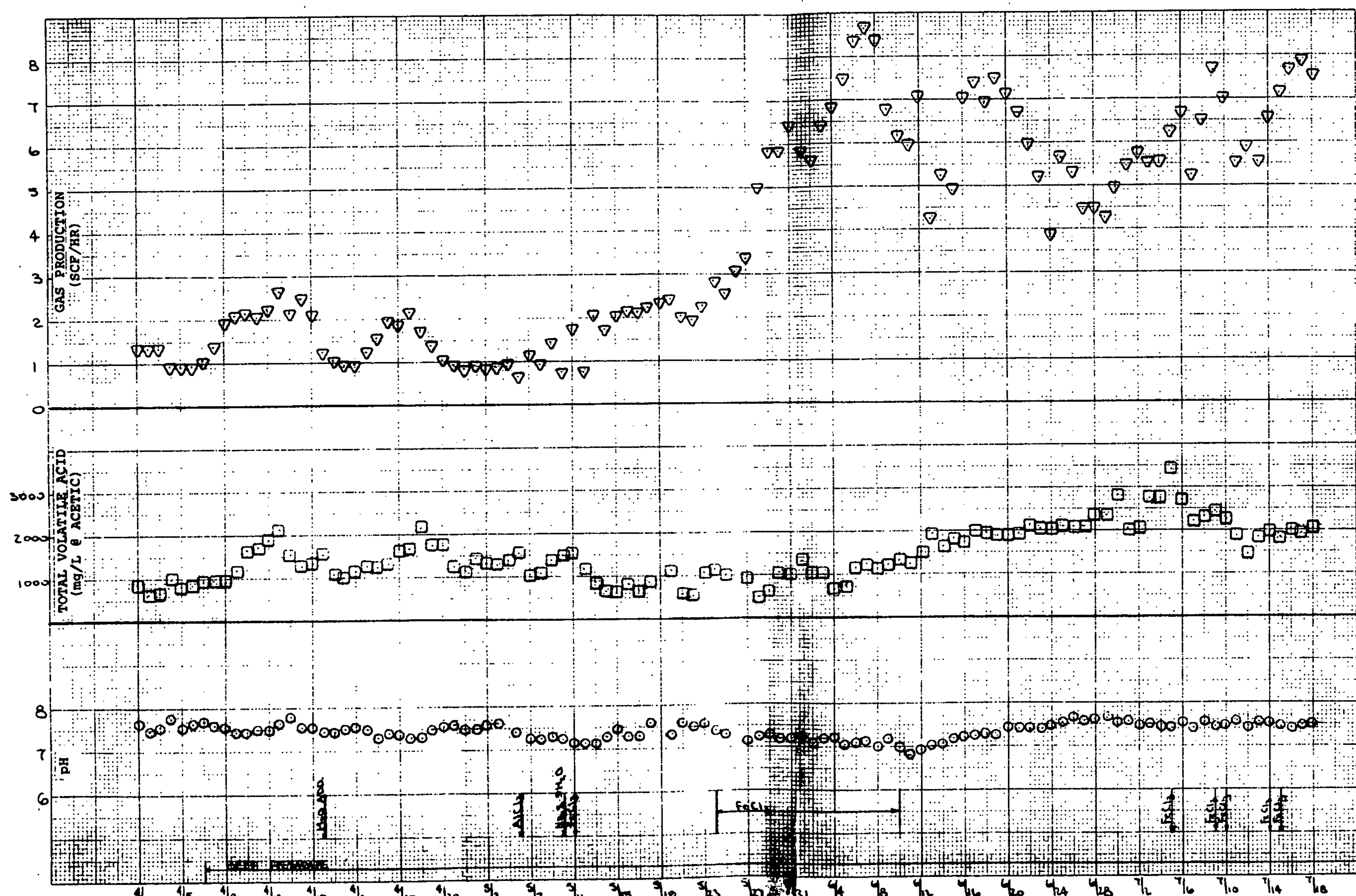

GAS PRODUCTION (SCF/HR)
TOTAL VOLATILE ACID (mg/L @ ACETIC)
pH
0
1
2
3
4
5
6
7
8
1000
2000
3000
4/1
4/5
4/9
4/13
4/17
4/21
4/25
4/29
5/3
5/7
5/11
5/15
5/19
5/23
5/27
5/31
6/4
6/8
6/12
6/16
6/20
6/24
6/28
7/2
7/6
7/10
7/14
7/18

FIGURE 2

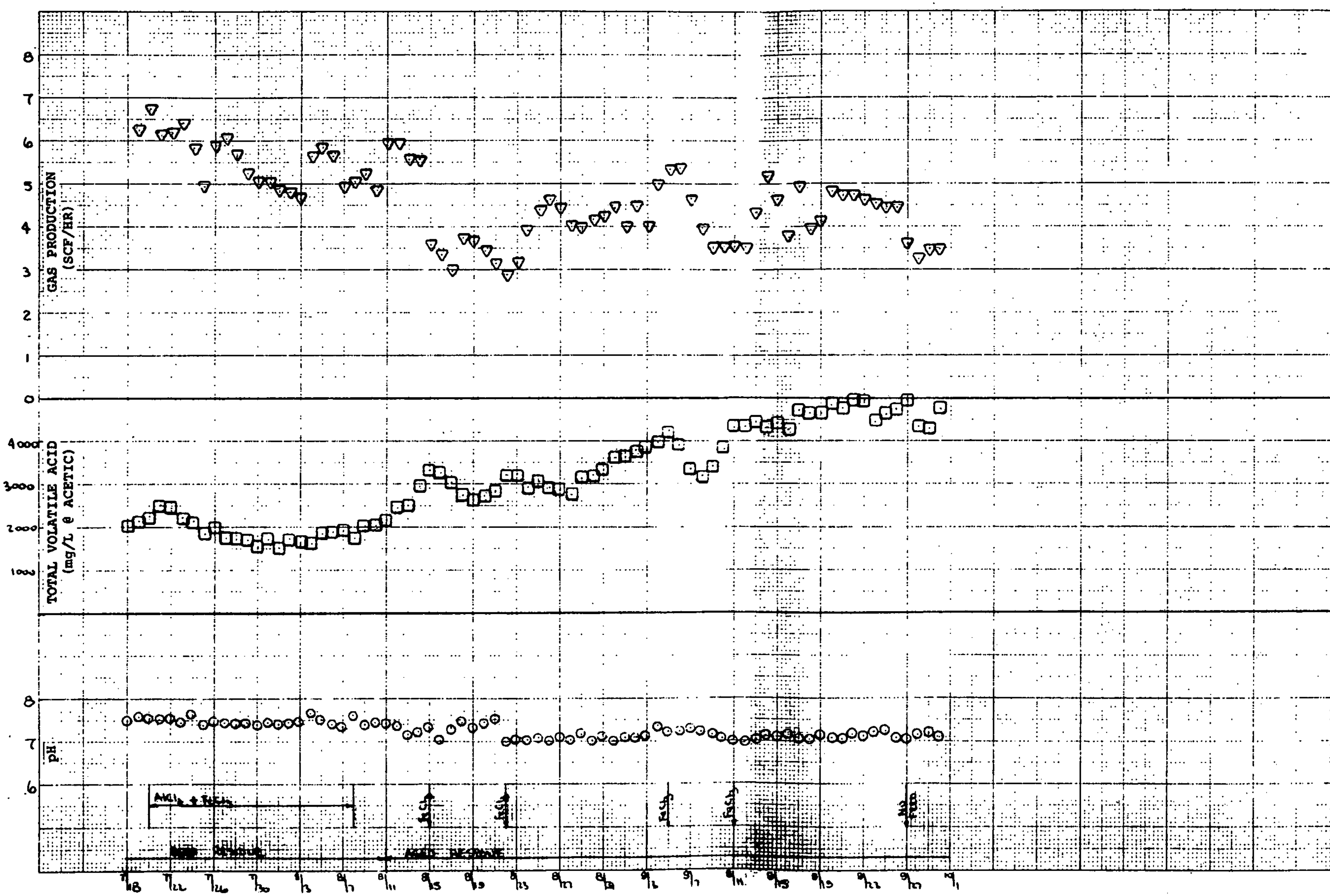


FIGURE 2 (Continued)

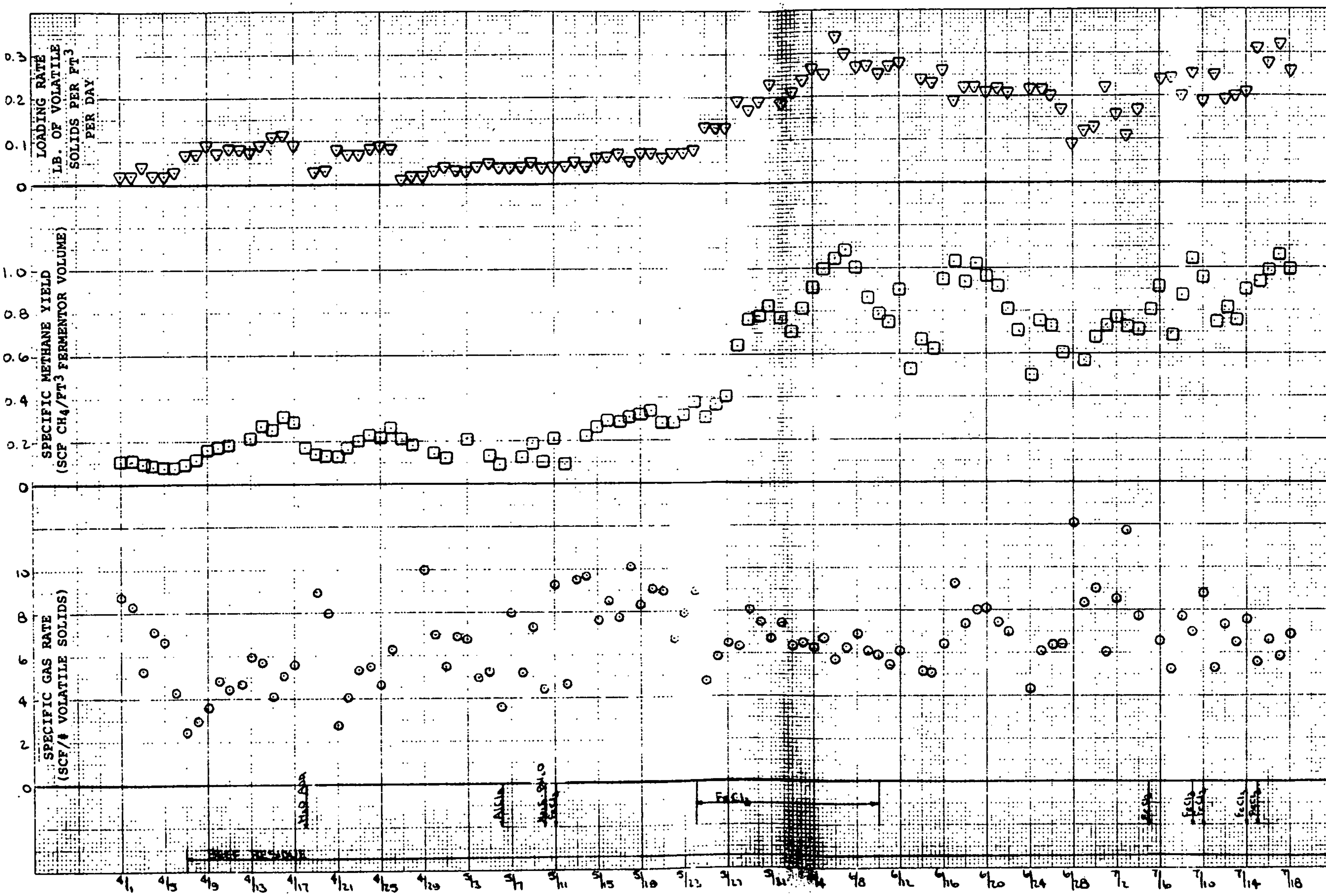

LOADING RATE
LB. OF VOLATILE SOLIDS PER FT^3 PER DAY
SPECIFIC METHANE YIELD
(SCF CH_4/FT^3 FERMENTOR VOLUME)
SPECIFIC GAS RATE
(SCF/# VOLATILE SOLIDS)
0.3
0.2
0.1
0
1.0
0.8
0.6
0.4
0.2
10
8
6
4
2
$FeCl_3$
4/1
4/5
4/9
4/13
4/17
4/21
4/25
4/29
5/3
5/7
5/11
5/15
5/19
5/23
5/27
5/31
6/4
6/8
6/12
6/16
6/20
6/24
6/28
7/2
7/6
7/10
7/14
7/18

FIGURE 3

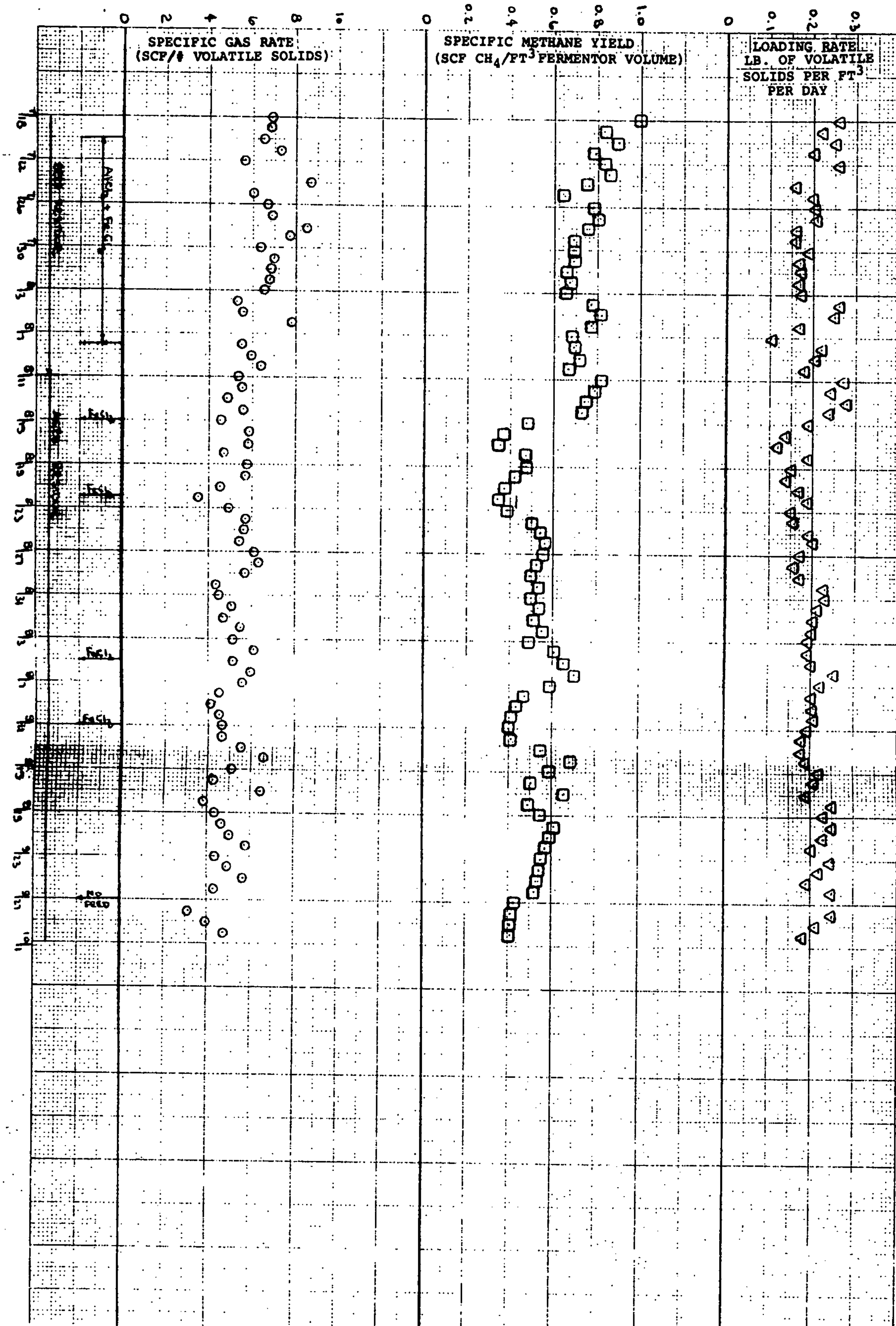


FIGURE 3 (Continued)

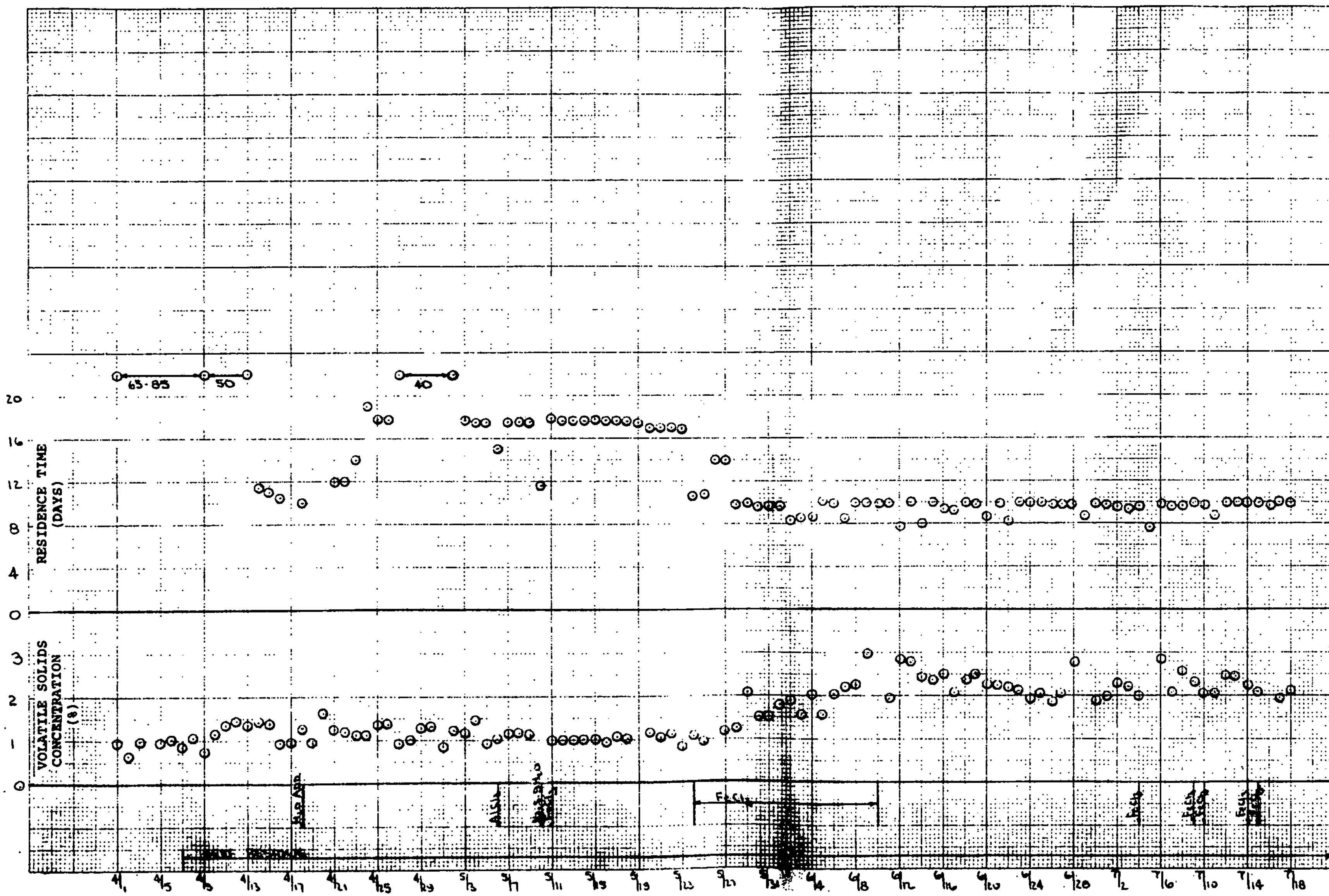

RESIDENCE TIME (DAYS)
VOLATILE SOLIDS CONCENTRATION (%)
65-85
50
40
$FeCl_3$
$AlCl_3$
20
16
12
8
4
0
3
2
1
0
4/1
4/5
4/9
4/13
4/17
4/21
4/25
4/29
5/3
5/7
5/11
5/15
5/19
5/23
5/27
5/31
6/4
6/8
6/12
6/16
6/20
6/24
6/28
7/2
7/6
7/10
7/14
7/18

FIGURE 4

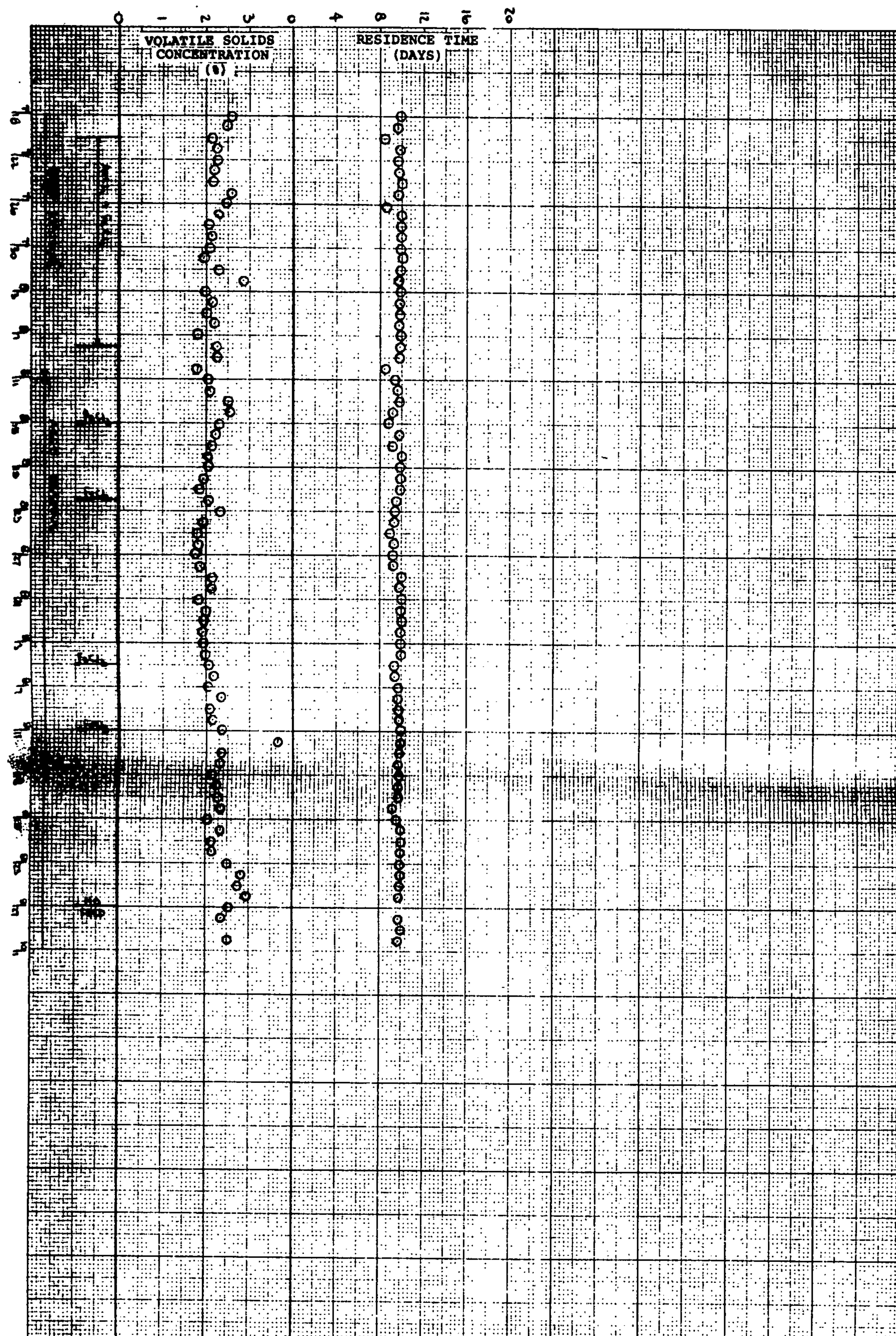


FIGURE 4 (Continued)

APPENDIX A

GRAPHICAL DATA

PROCESS GAS YIELD TOTAL GAS

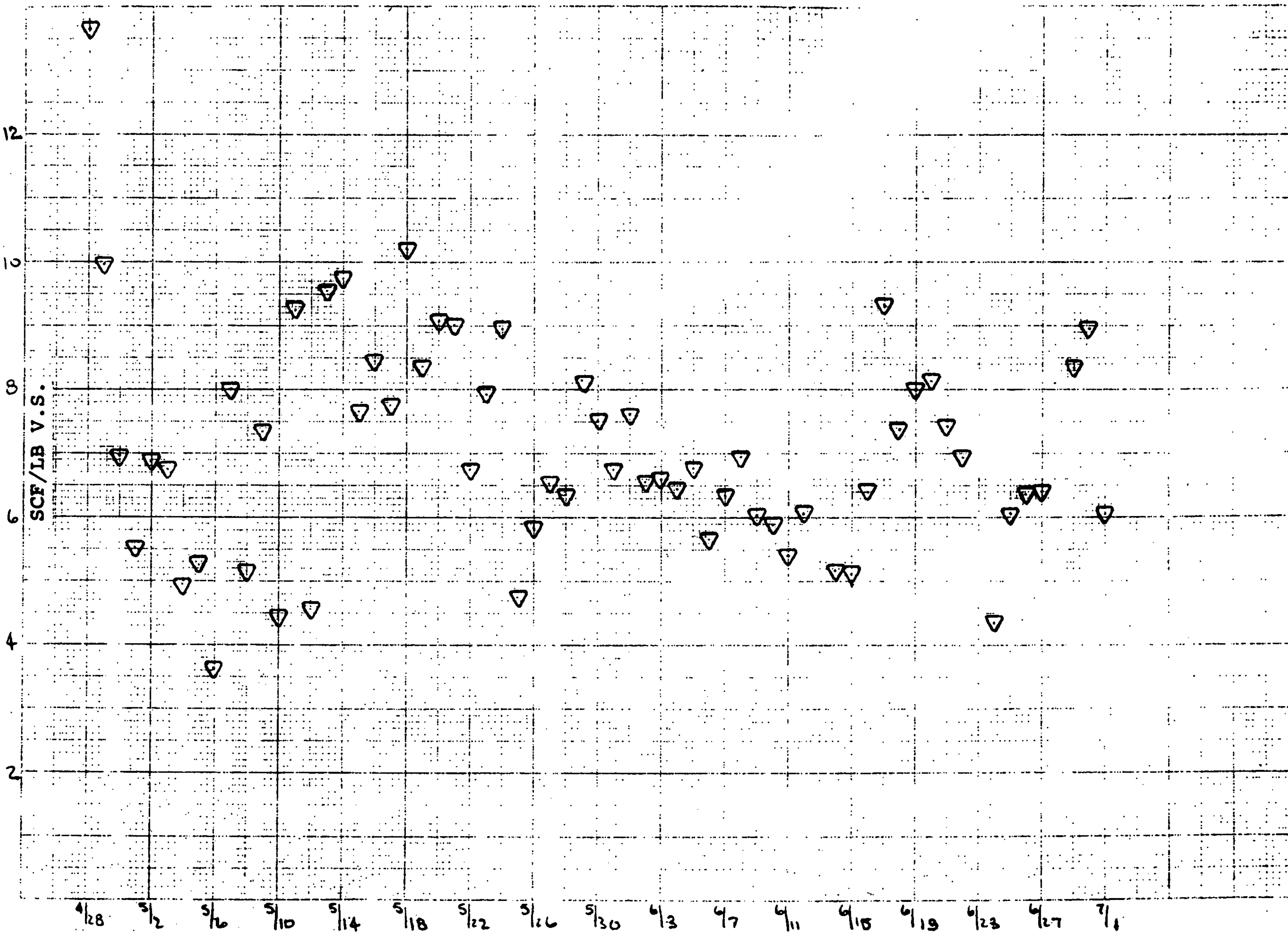


FIGURE 1

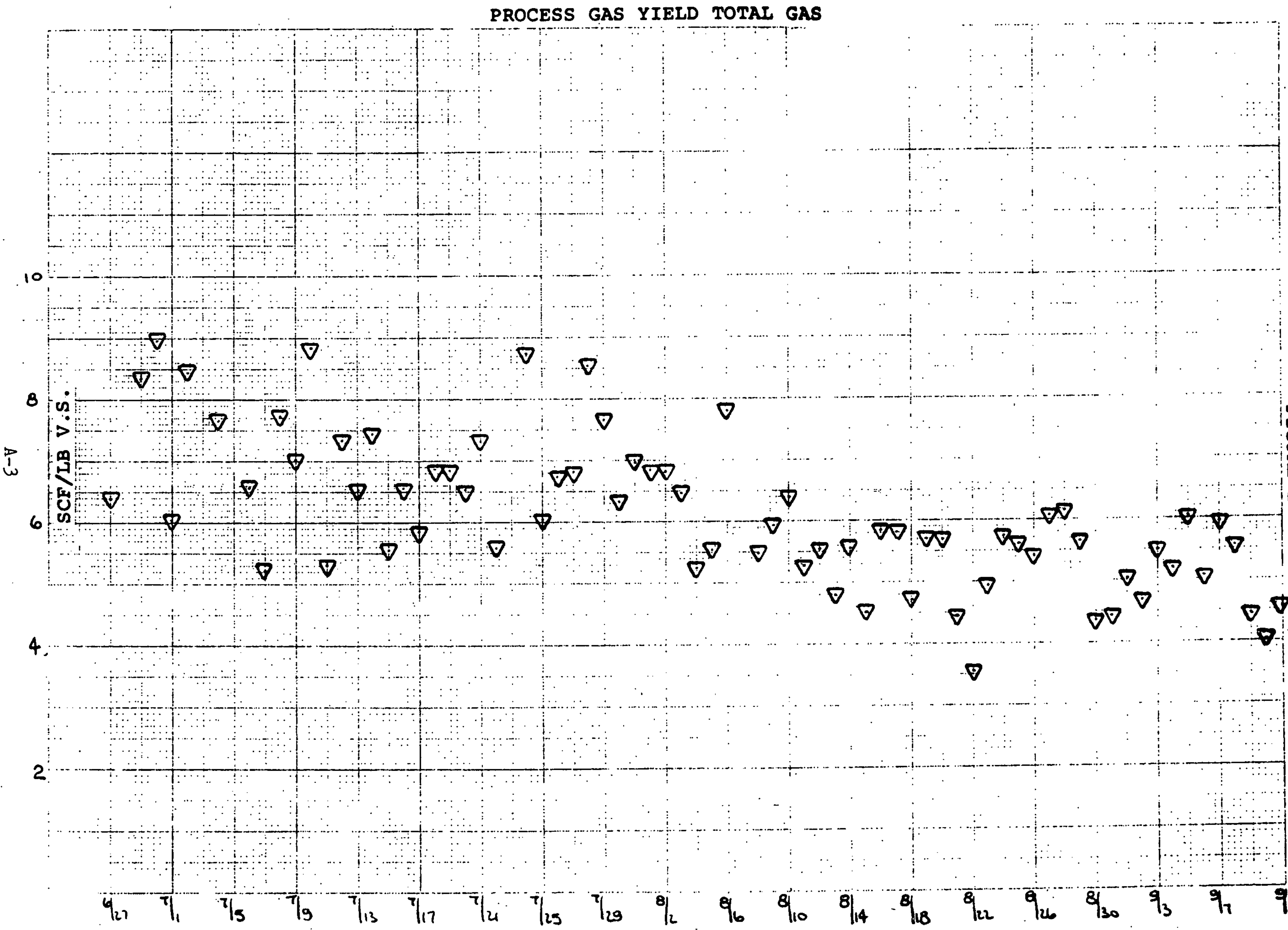


FIGURE 1 (Continued)

GAS PRODUCTION RATE

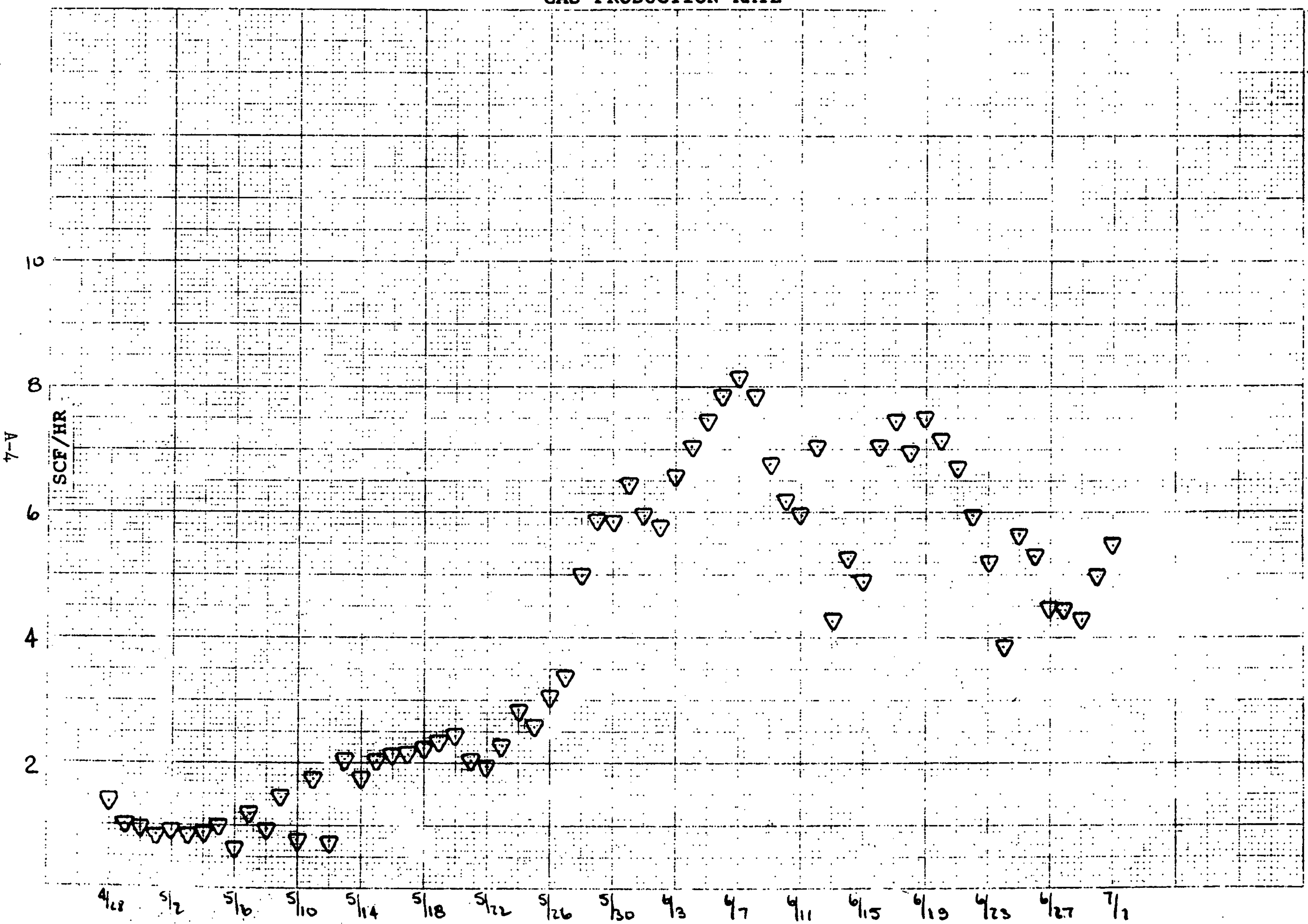


FIGURE 2

GAS PRODUCTION RATE

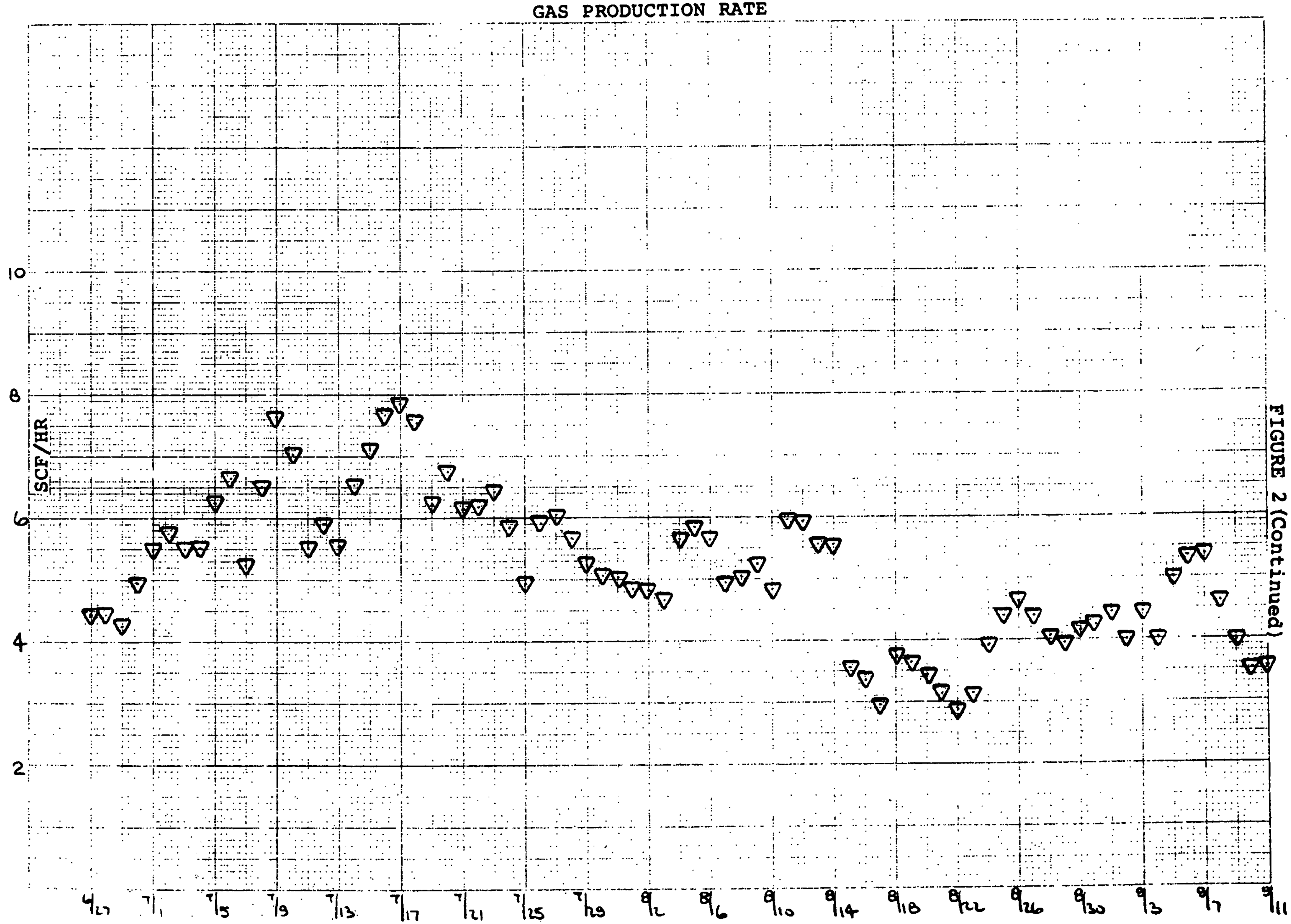


FIGURE 2 (Continued)

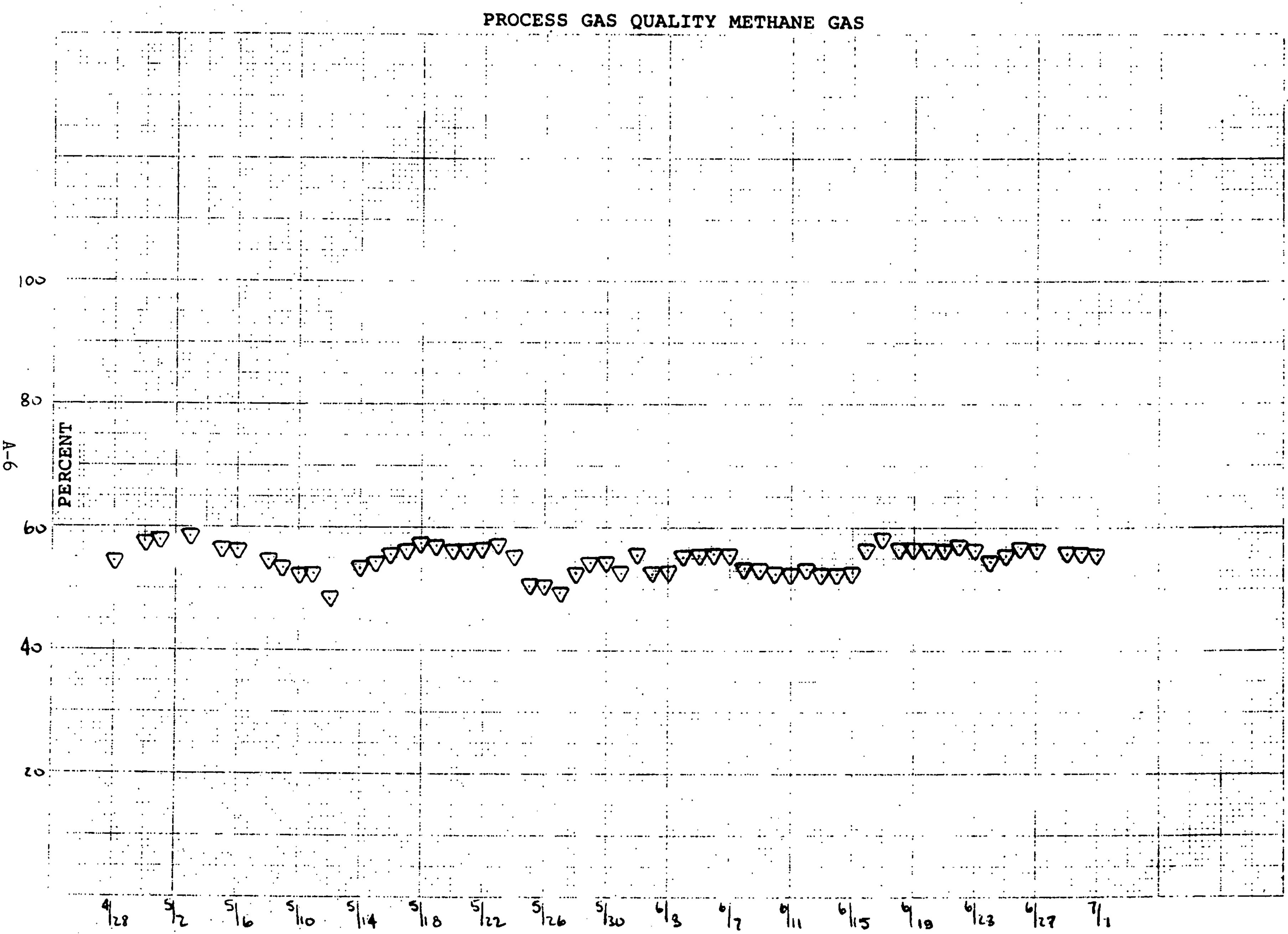

PROCESS GAS QUALITY METHANE GAS
PERCENT
100
80
60
40
20
4/28
5/2
5/6
5/10
5/14
5/18
5/22
5/26
5/30
6/3
6/7
6/11
6/15
6/19
6/23
6/27
7/1

FIGURE 3

PROCESS GAS QUALITY METHANE GAS

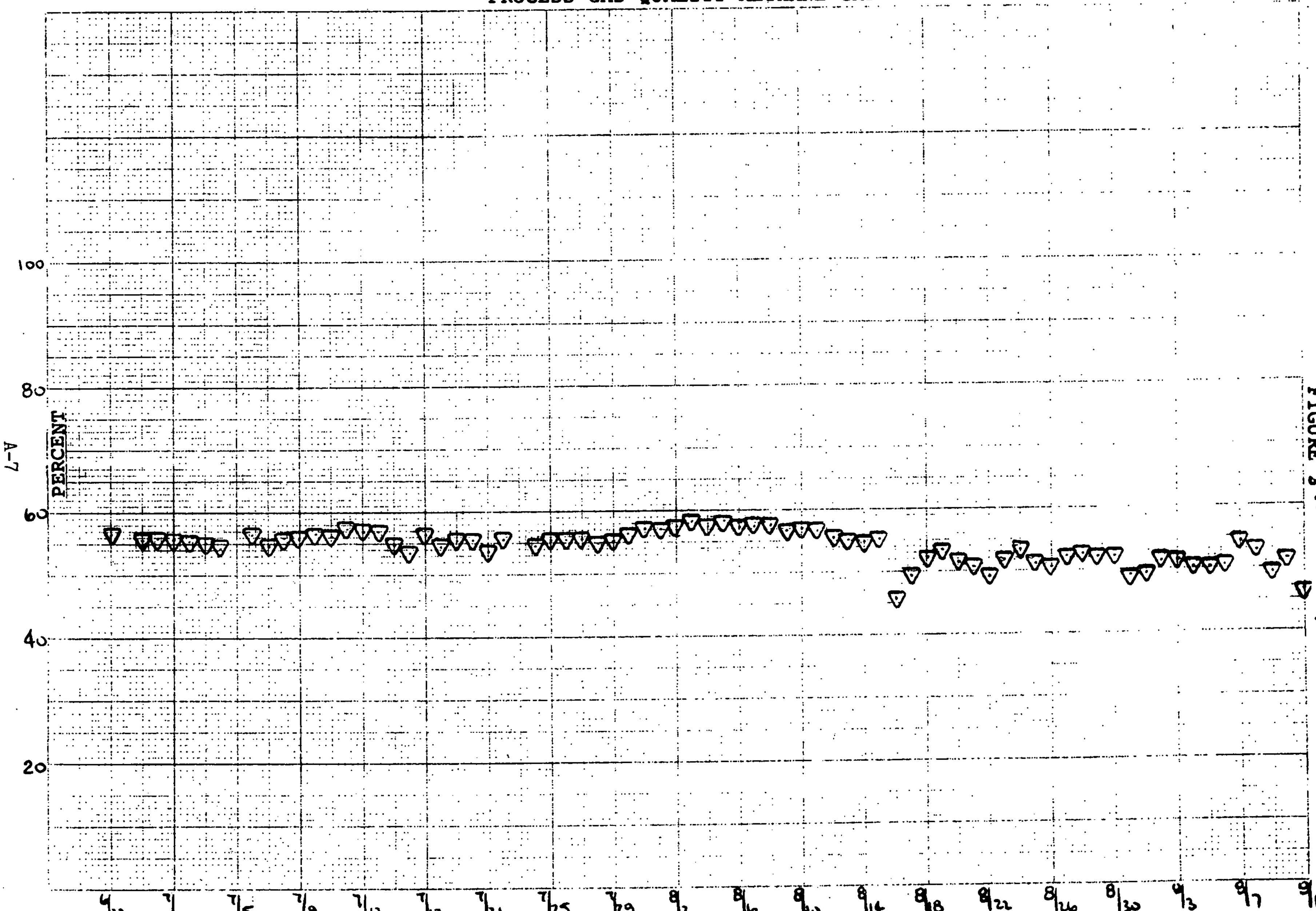
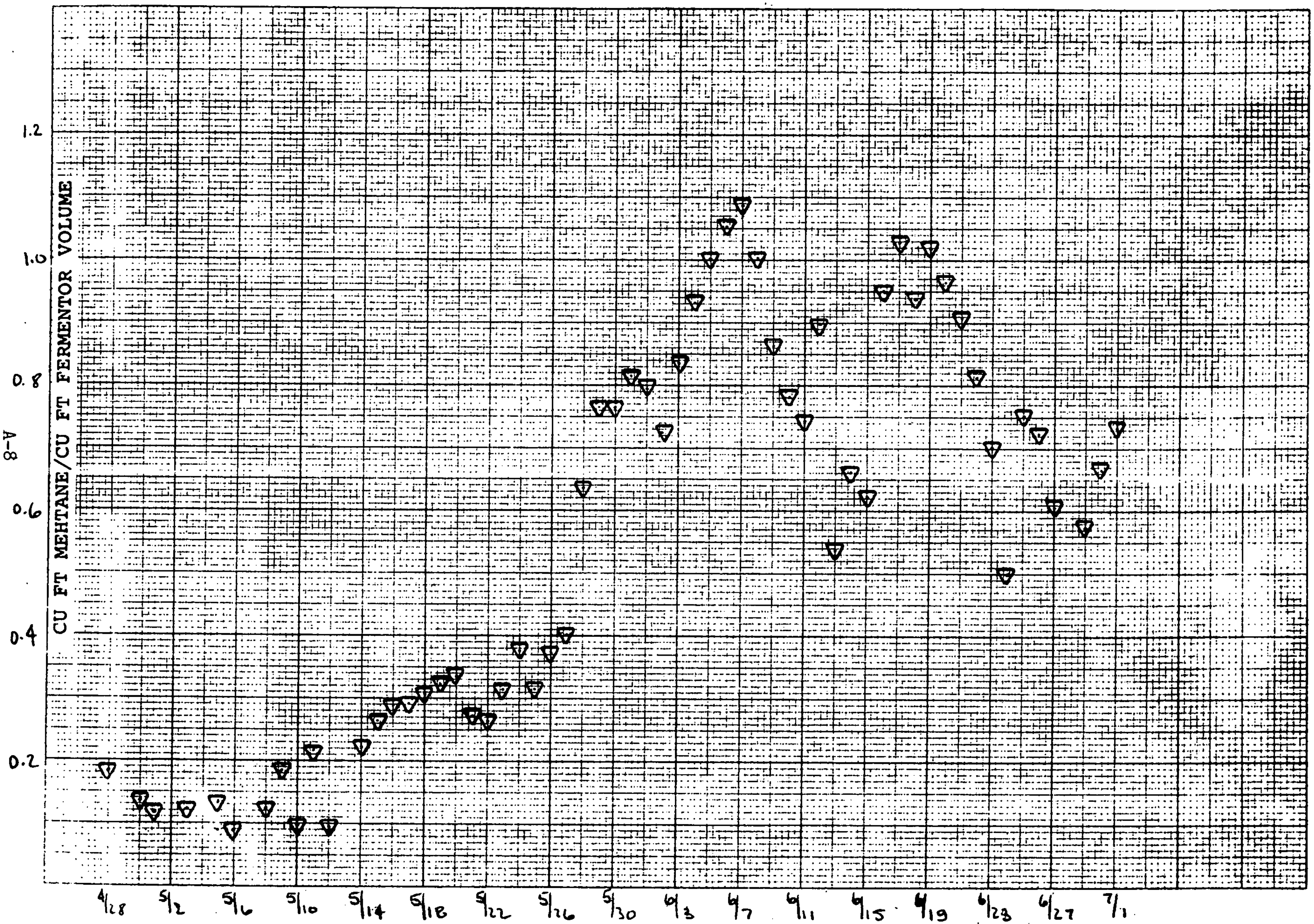


FIGURE 3 (Continued)

FERMENTOR GAS YIELD METHANE GAS



A-8

FIGURE 4

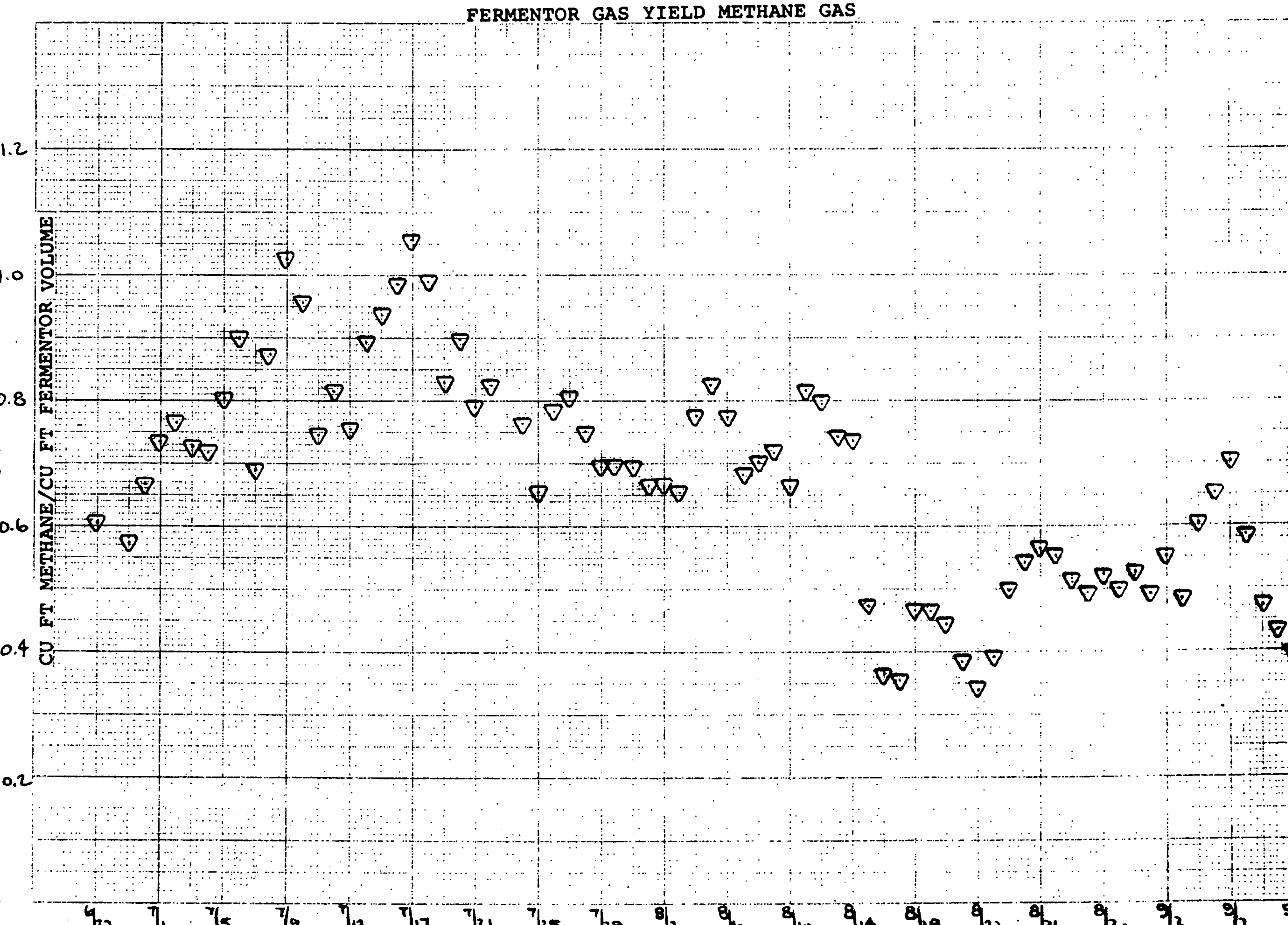


FIGURE 4 (Continued)

PROTEIN FERMENTATION PRODUCTS TOTAL WEIGHT

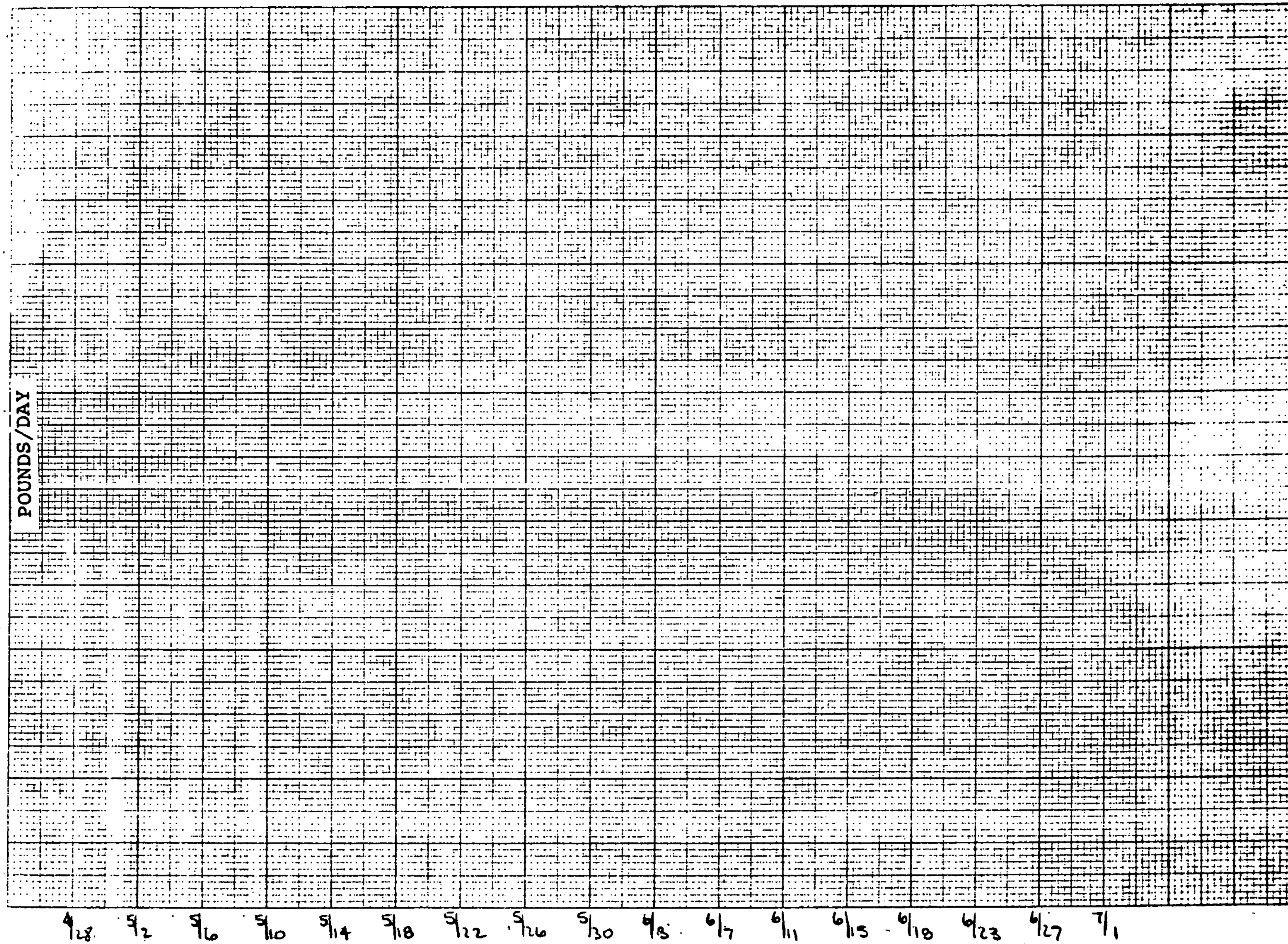


FIGURE 5

PROTEIN FERMENTATION PRODUCTS TOTAL WEIGHT

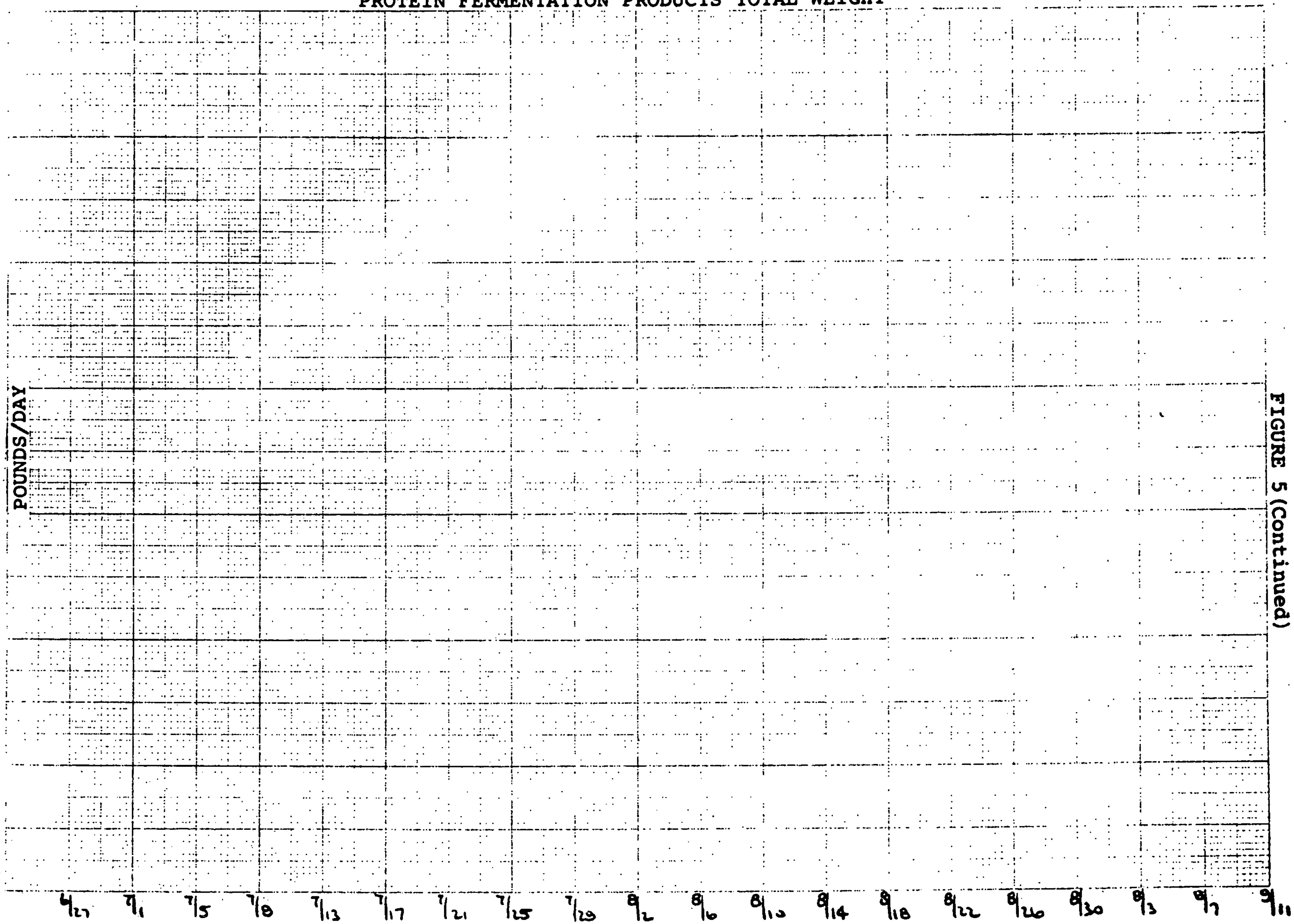


FIGURE 5 (Continued)

PROTEIN FERMENTATION PRODUCT DRY MATTER

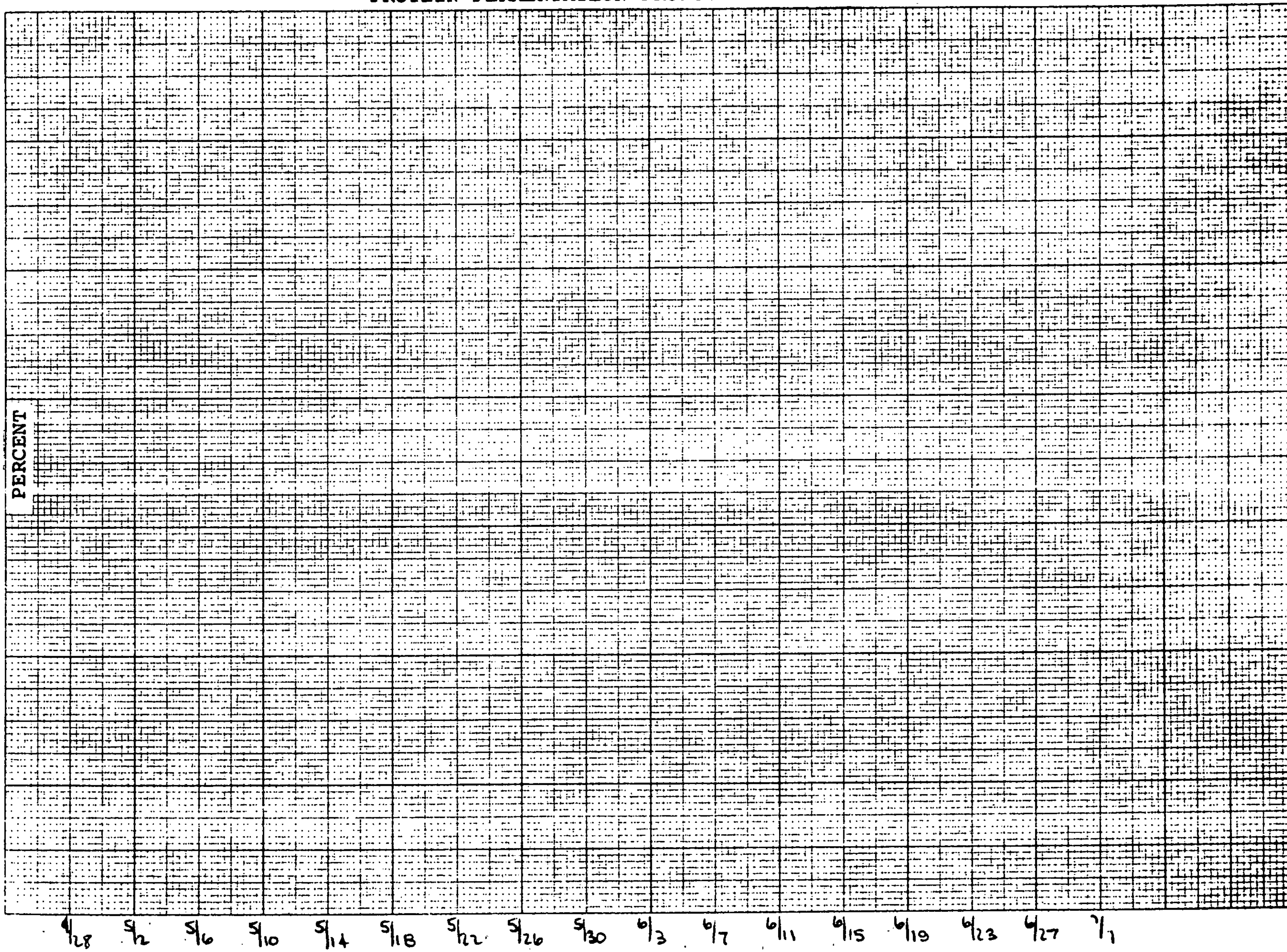


FIGURE 6

PROTEIN FERMENTATION PRODUCT DRY MATTER

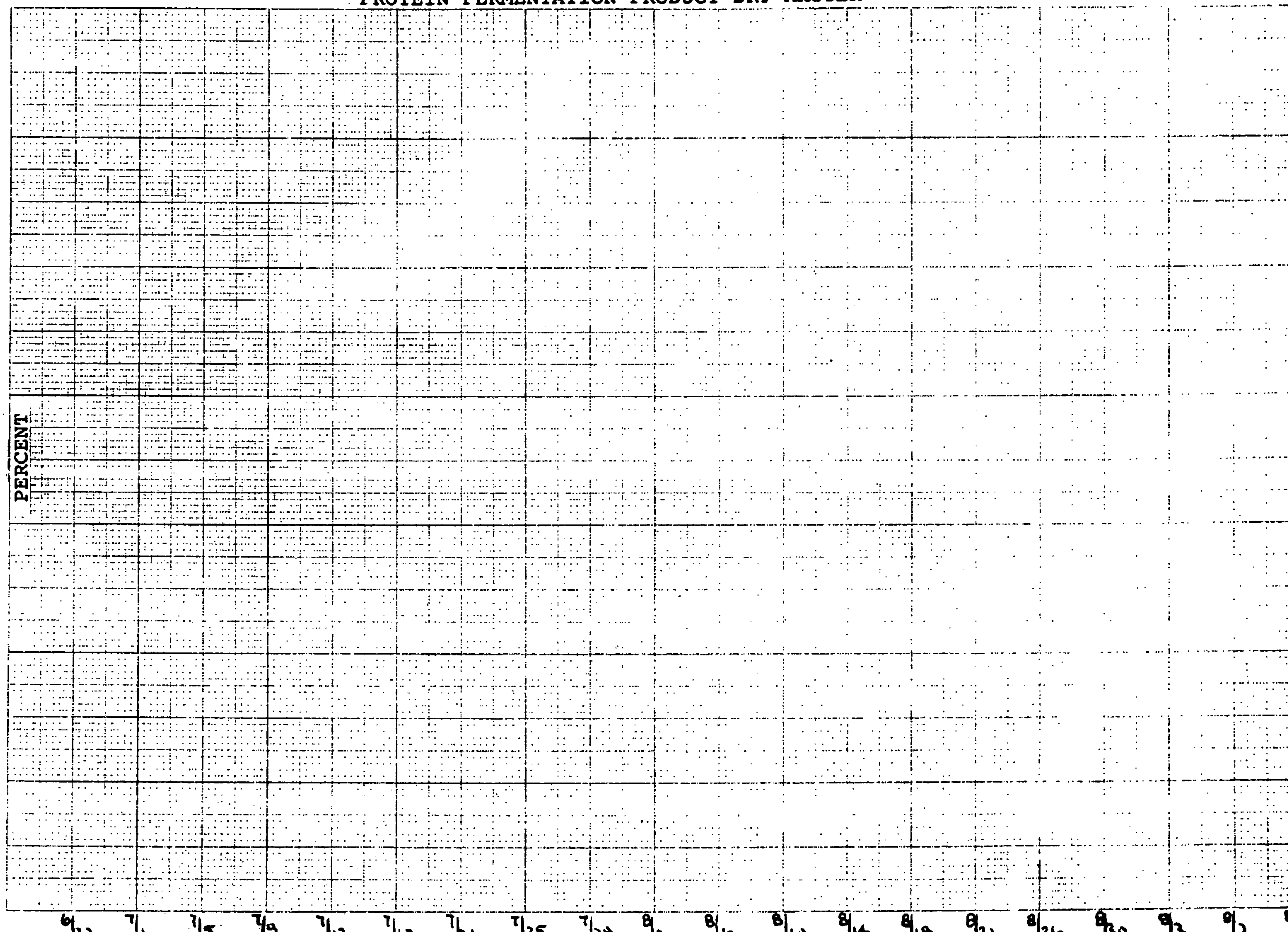


FIGURE 6 (Continued)

PROTEIN FERMENTATION PRODUCT CRUDE PROTEIN

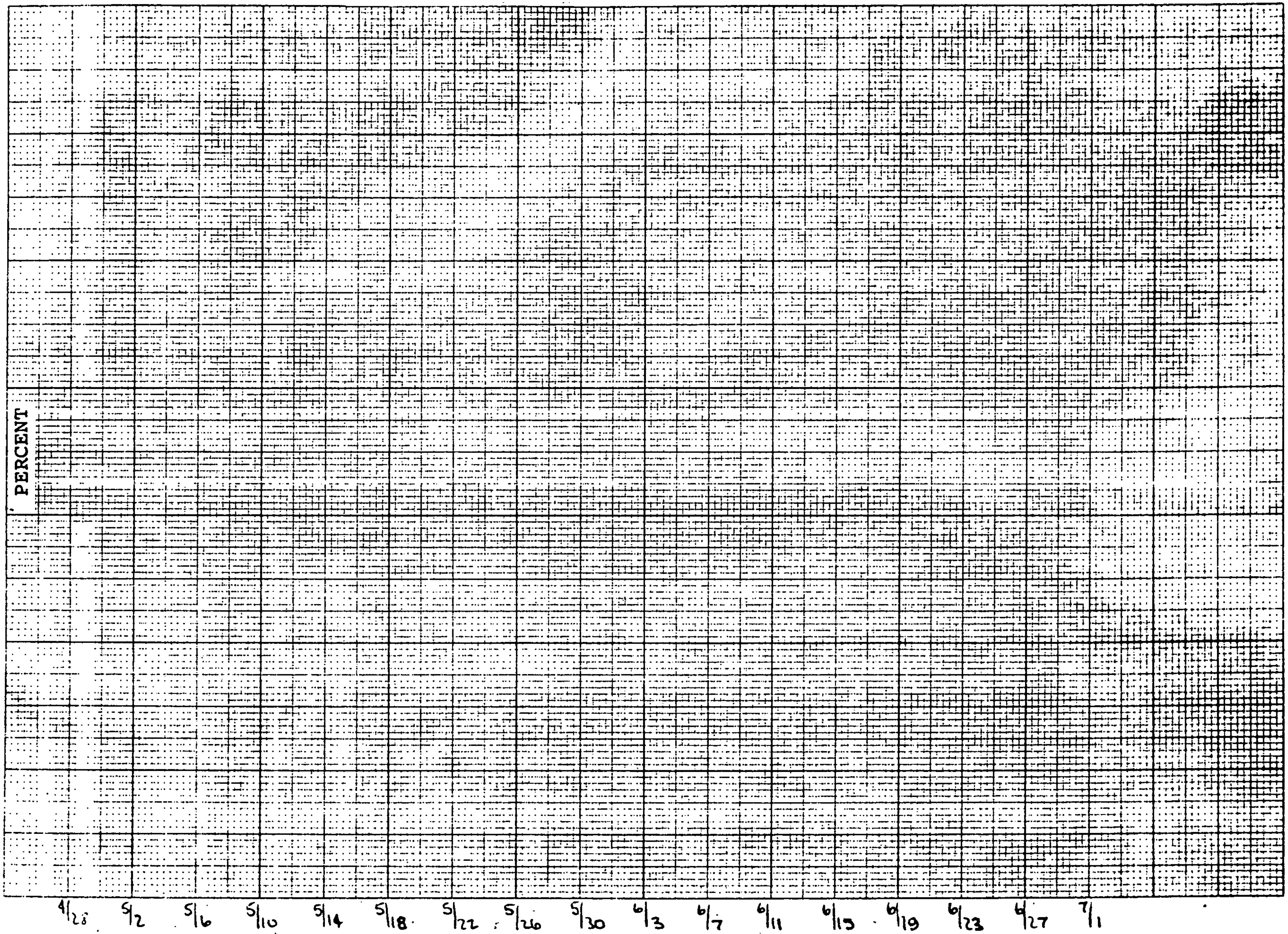


FIGURE 7

PROTEIN FERMENTATION PRODUCT CRUBE PROTEIN

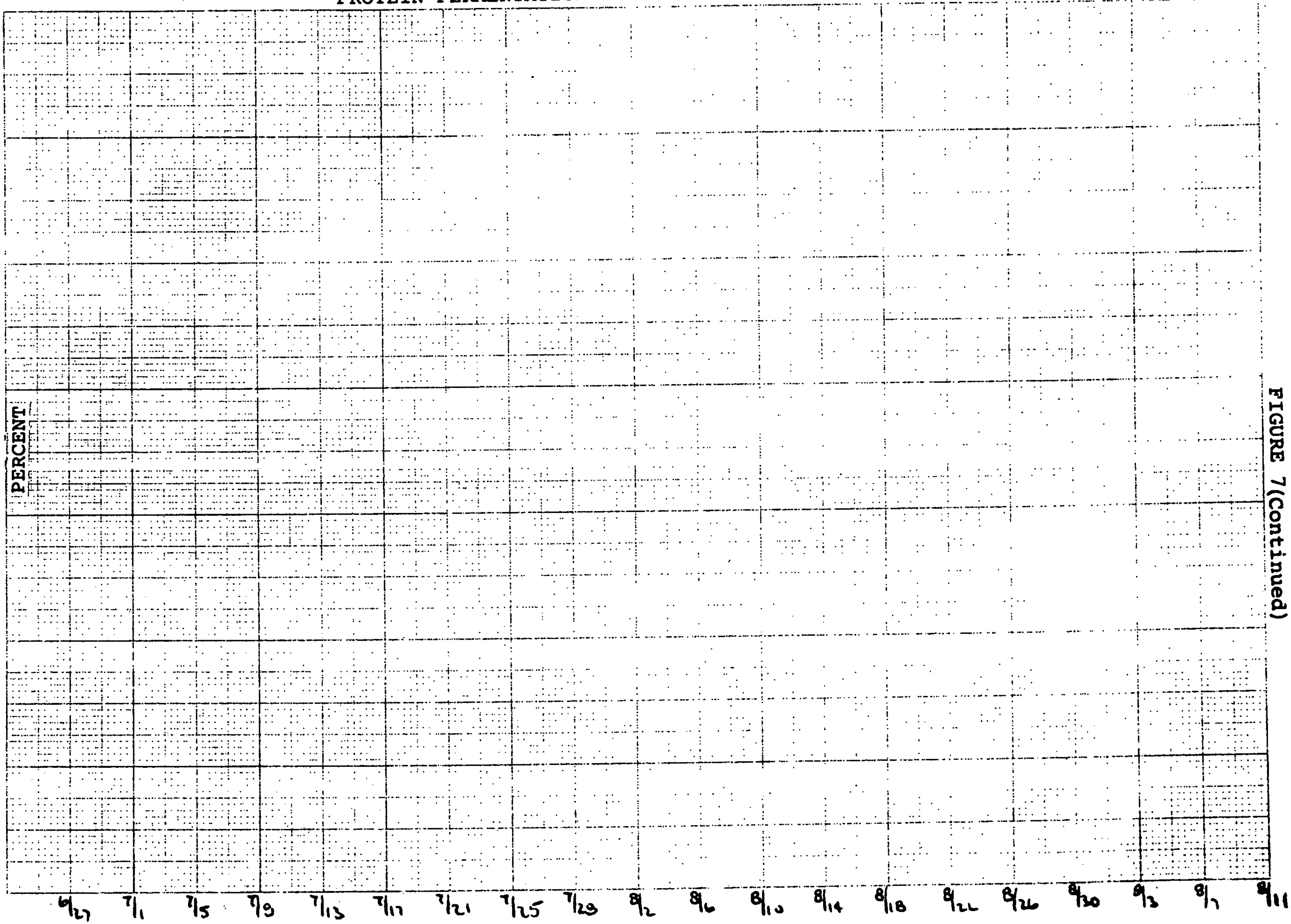


FIGURE 7(Continued)

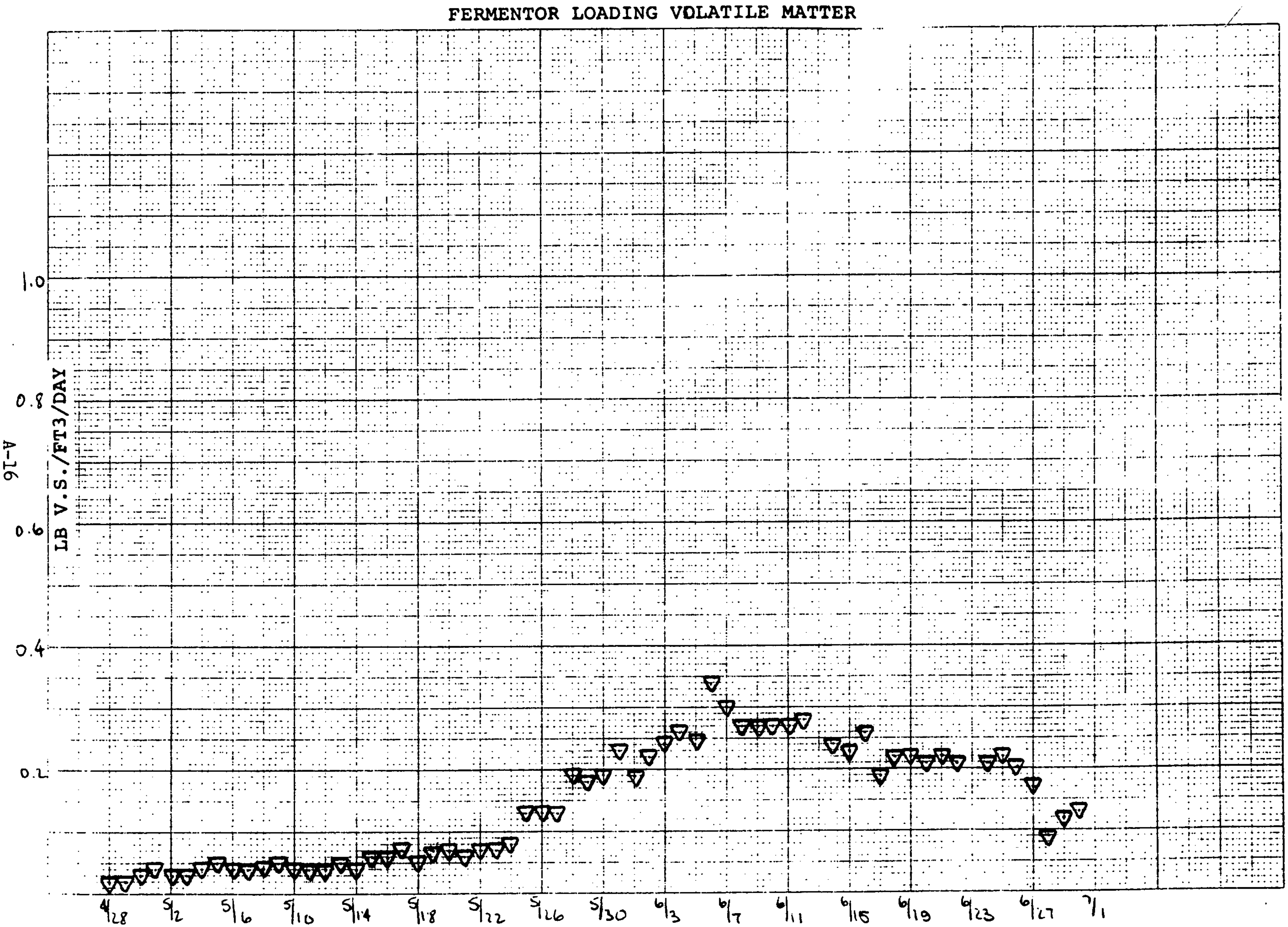

FERMENTOR LOADING VOLATILE MATTER
LB V.S./FT3/DAY
1.0
0.8
0.6
0.4
0.2
4/28
5/2
5/6
5/10
5/14
5/18
5/22
5/26
5/30
6/3
6/7
6/11
6/15
6/19
6/23
6/27
7/1

FIGURE 8

FERMENTOR LOADING VOLATILE MATTER

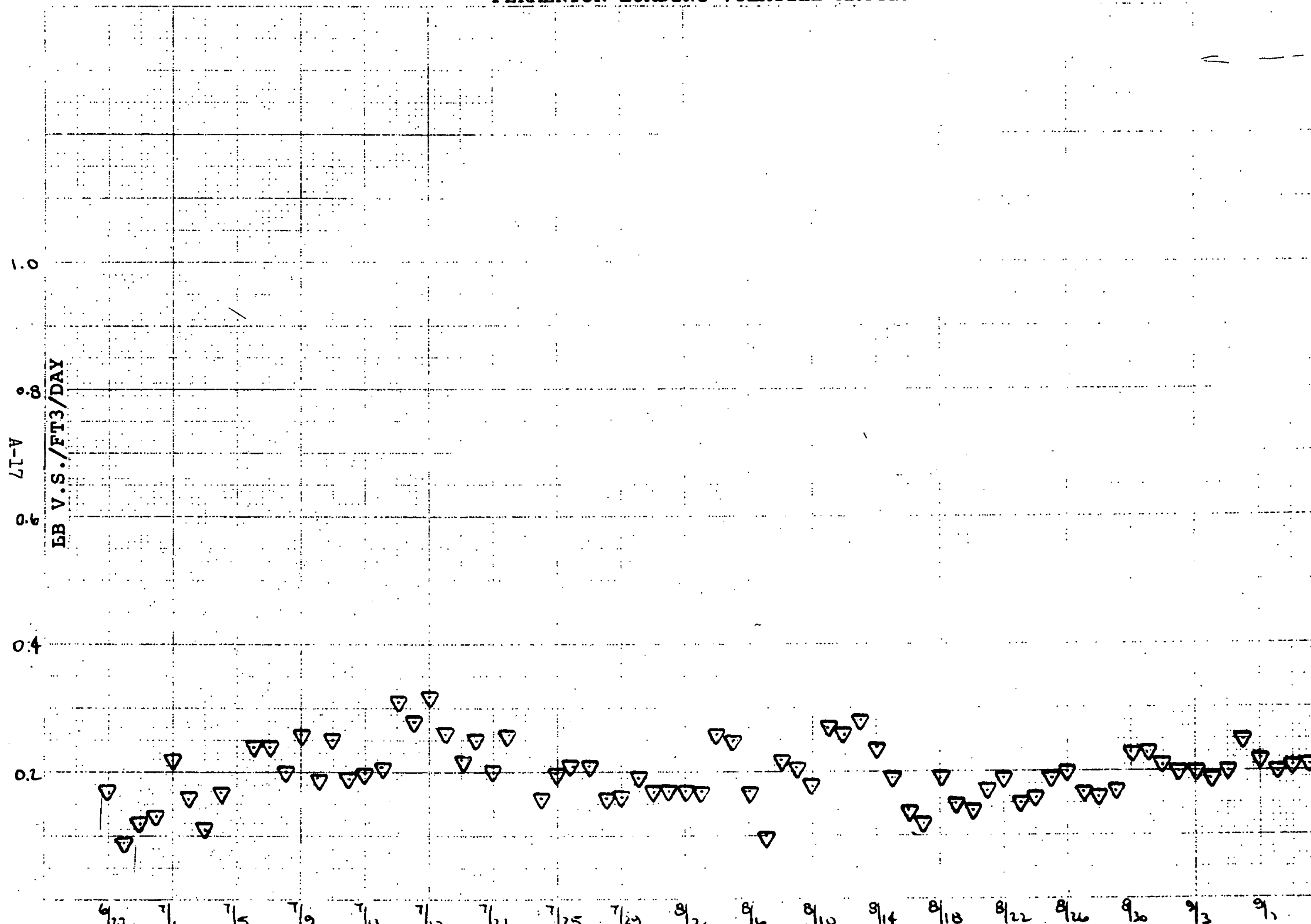


FIGURE 8 (Continued)

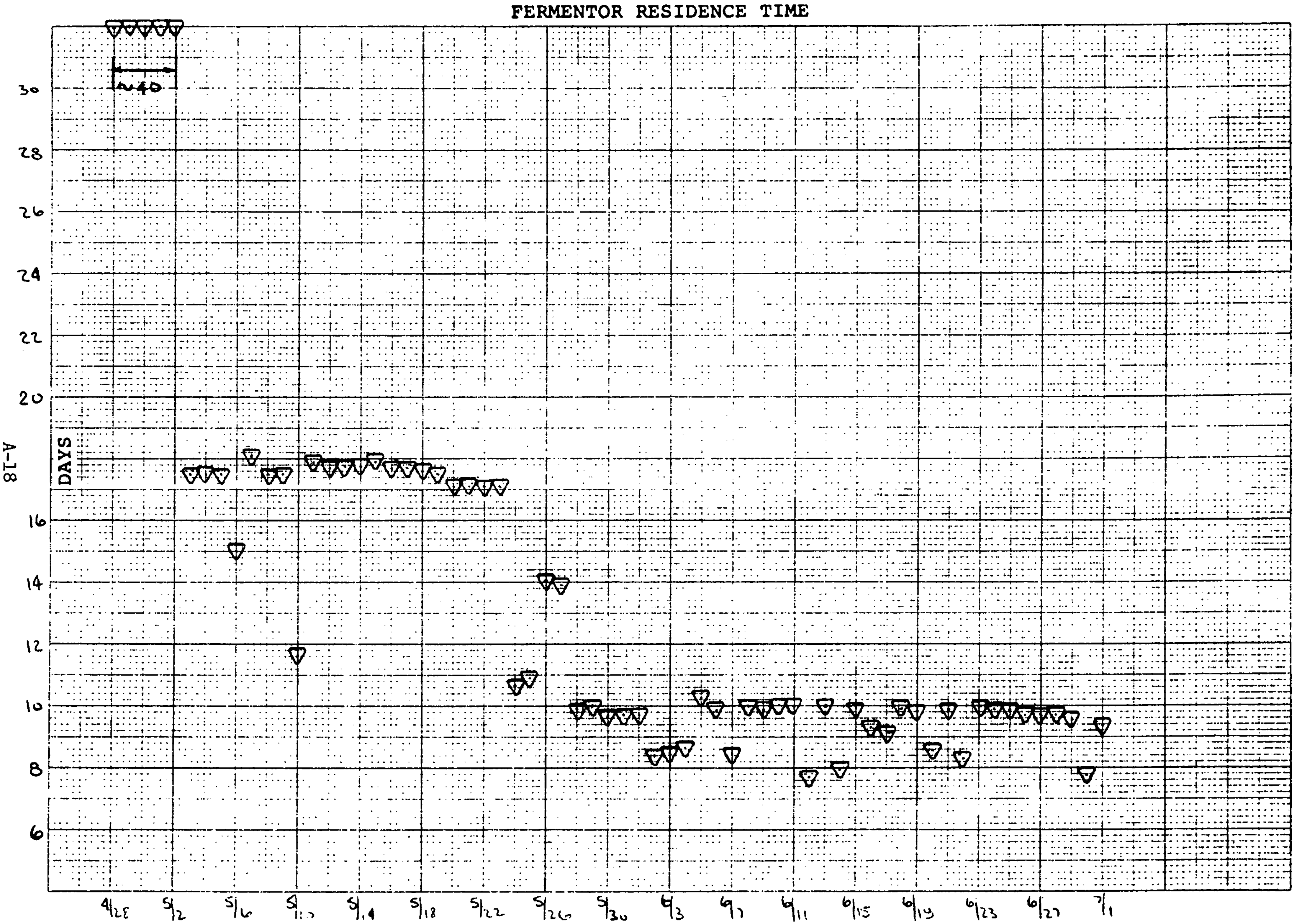

FERMENTOR RESIDENCE TIME
DAYS
30
28
26
24
22
20
16
14
12
10
8
6
4/28
5/2
5/6
5/10
5/14
5/18
5/22
5/26
5/30
6/3
6/7
6/11
6/15
6/19
6/23
6/27
7/1

FIGURE 9

FERMENTOR RESIDENCE TIME

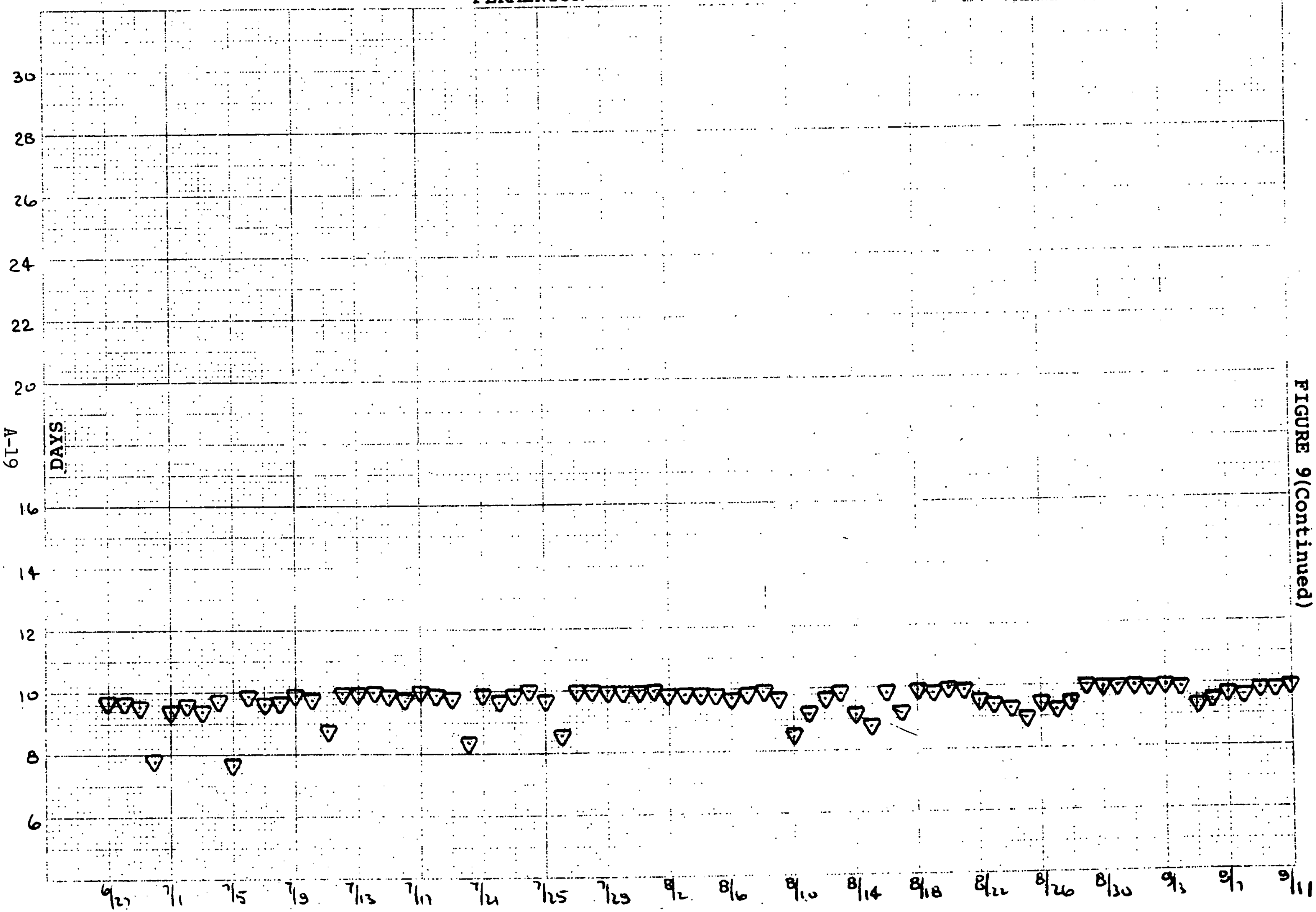


FIGURE 9(Continued)

RAW WASTE TOTAL WEIGHT

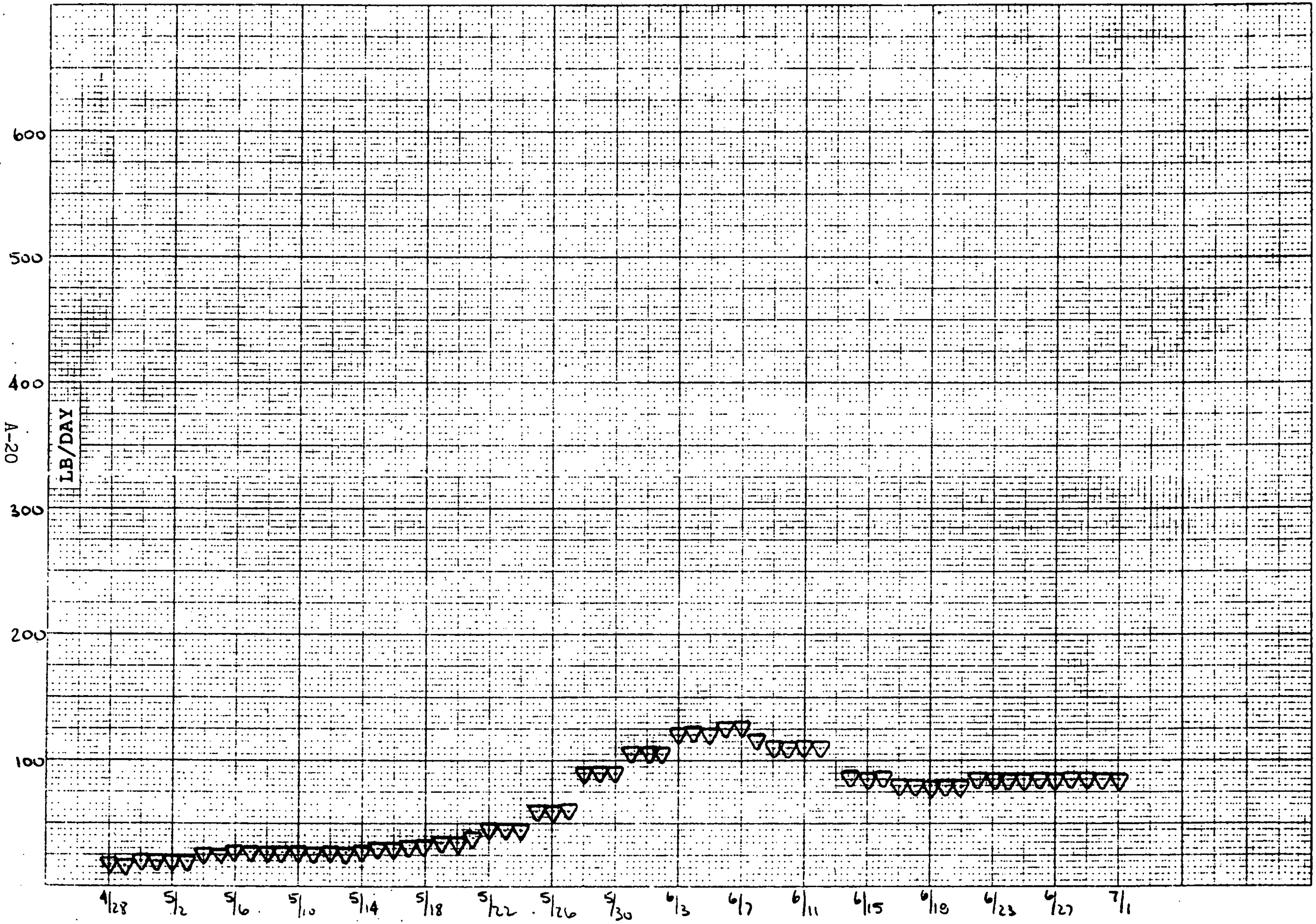


FIGURE 10

RAW WASTE TOTAL WEIGHT

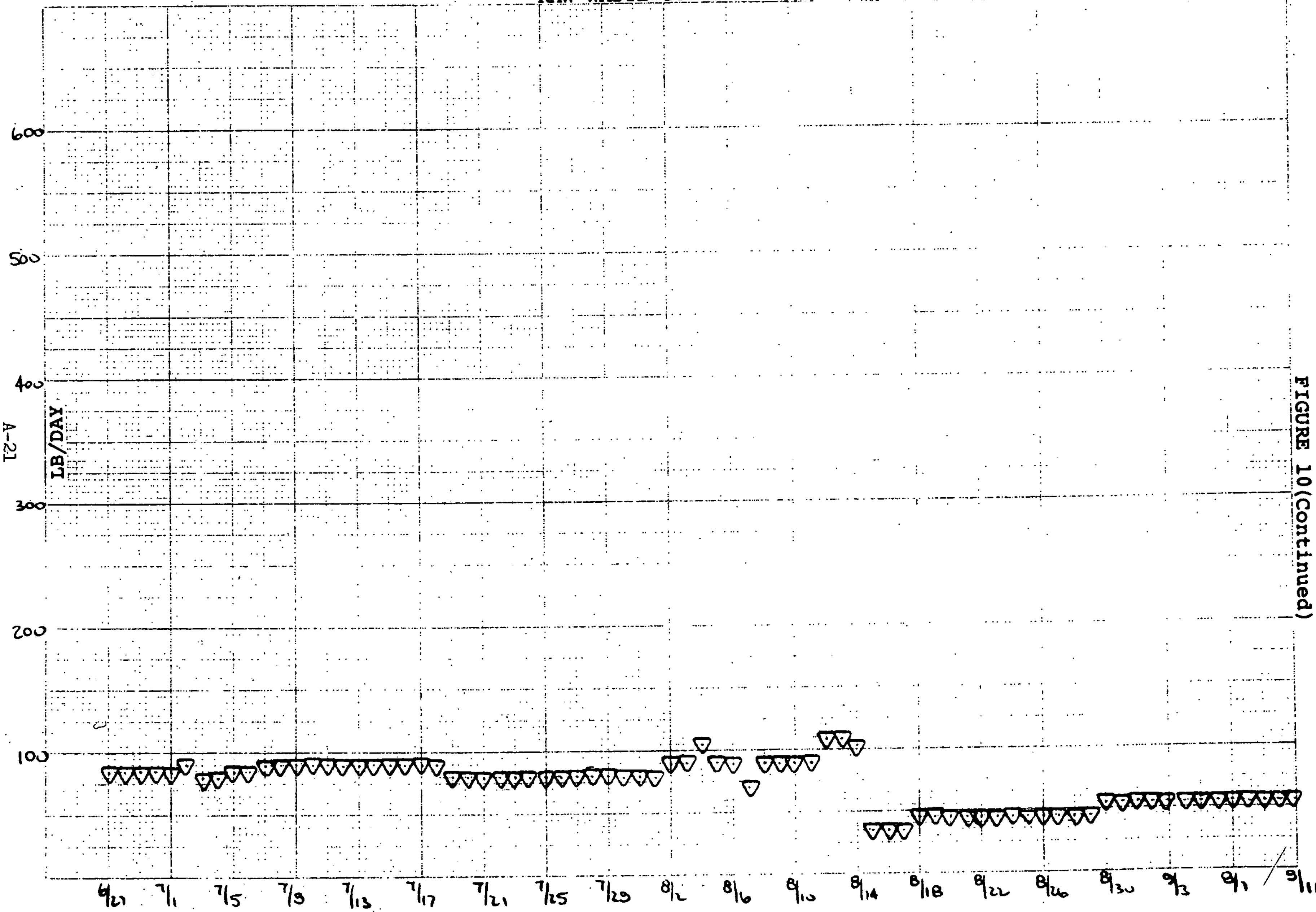


FIGURE 10 (Continued)

RAW WASTE DRY MATTER

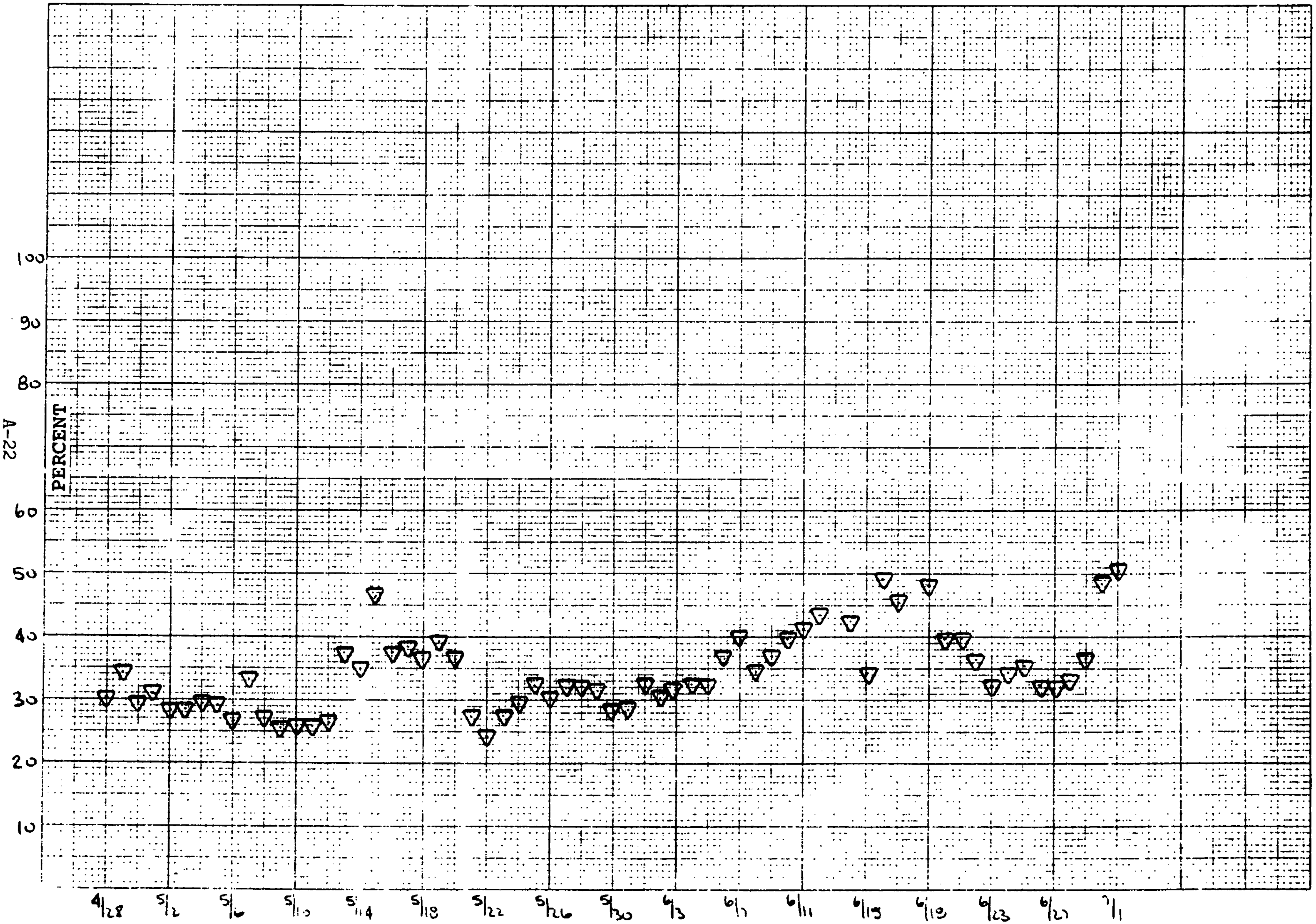


FIGURE 11

RAW WASTE DRY MATTER

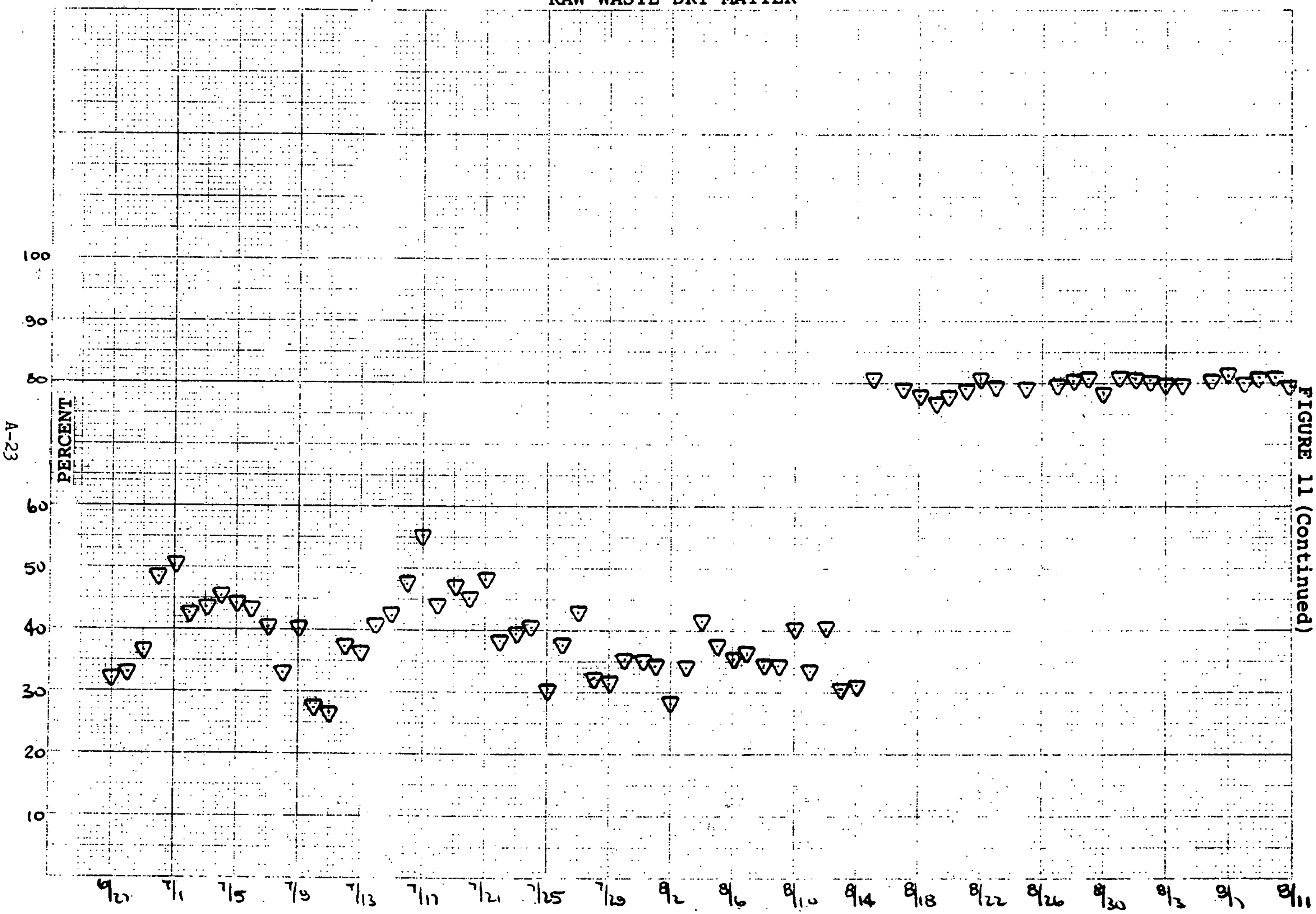


FIGURE 11 (Continued)

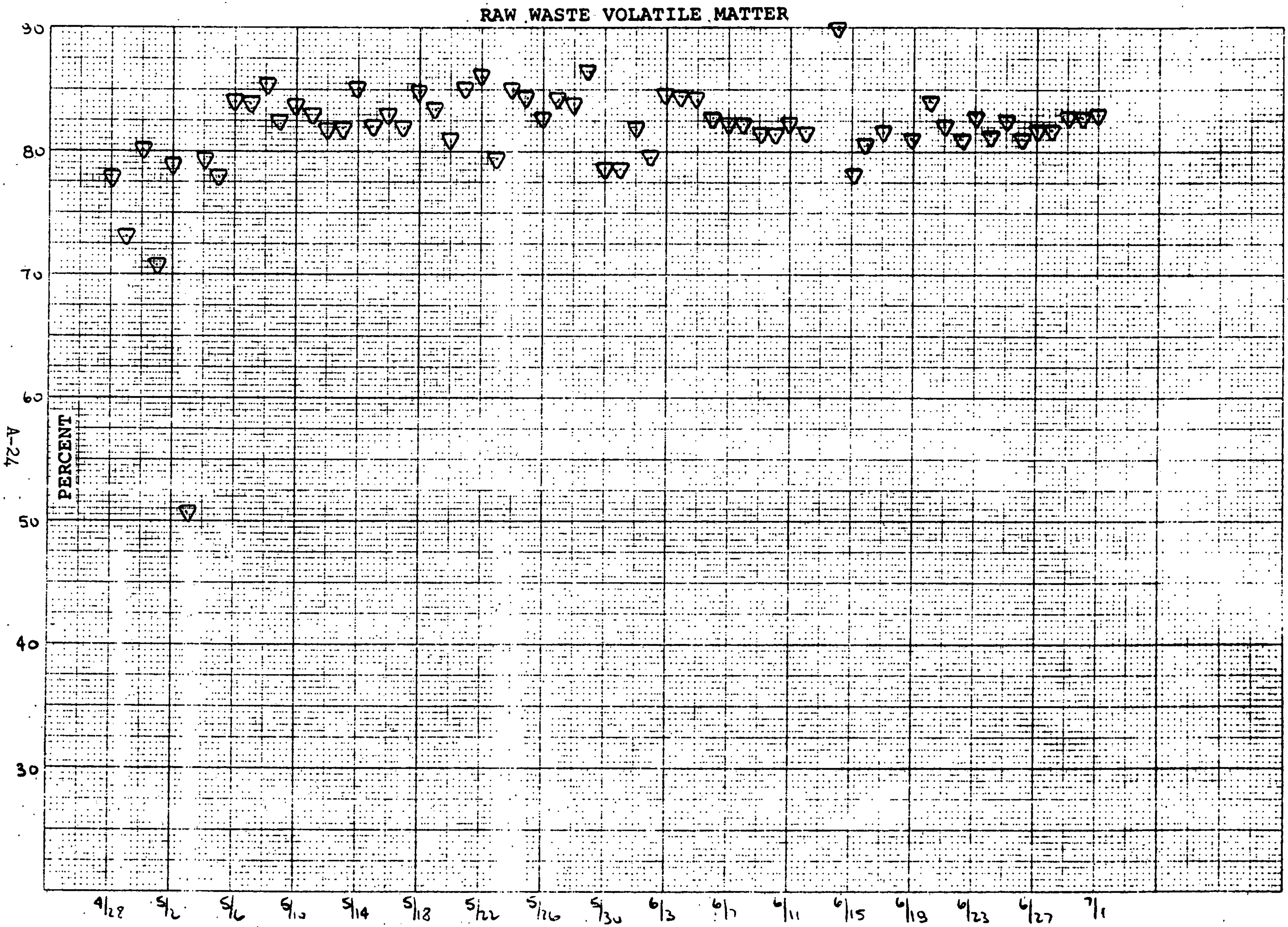
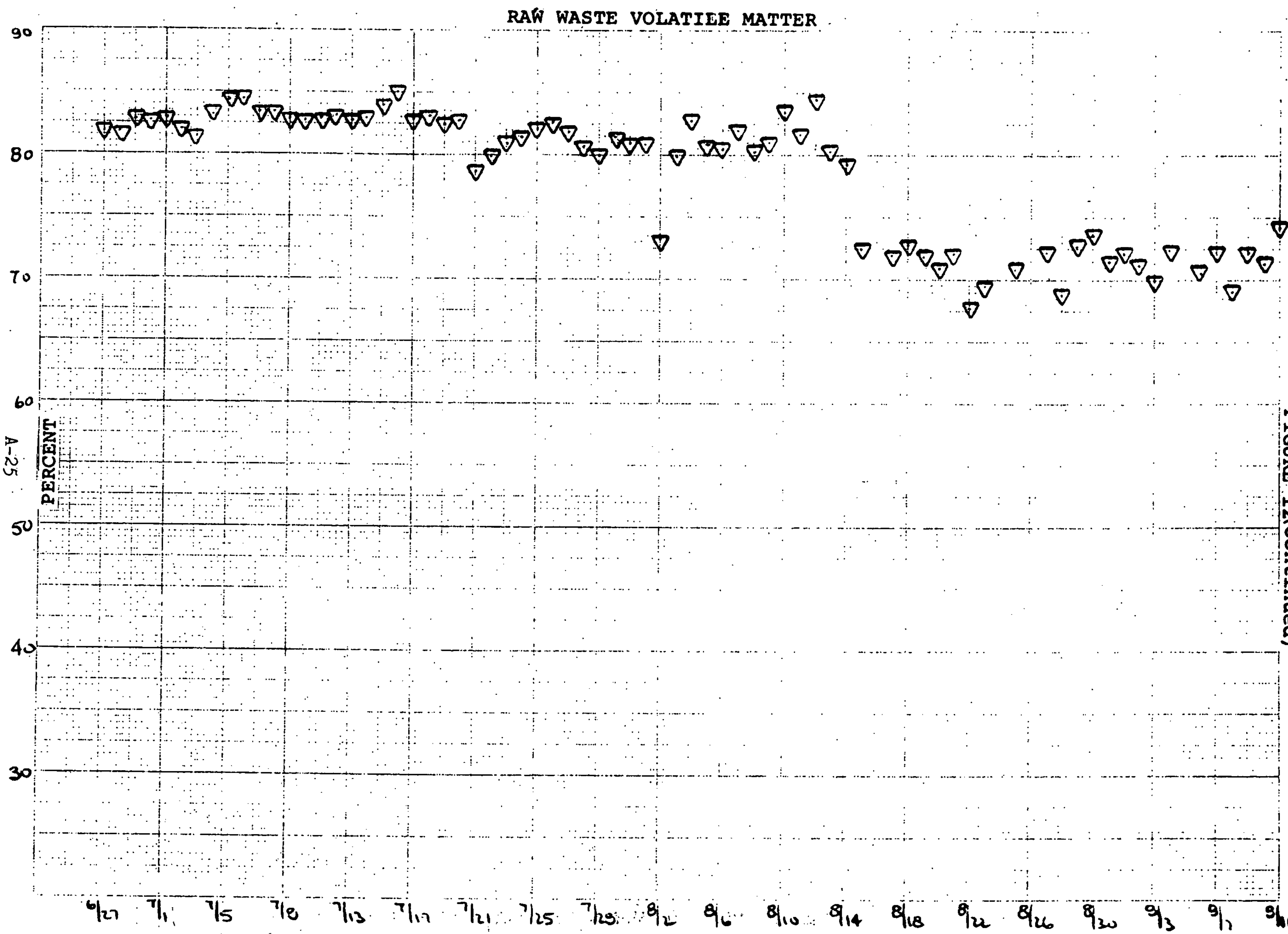

RAW WASTE VOLATILE MATTER
PERCENT
90
80
70
60
50
40
30
4/28
5/2
5/6
5/10
5/14
5/18
5/22
5/26
5/30
6/3
6/7
6/11
6/15
6/19
6/23
6/27
7/1

FIGURE 12



A-25

FIGURE 12(Continued)

RECYCLE WASTE (CENTRATE) TOTAL WEIGHT

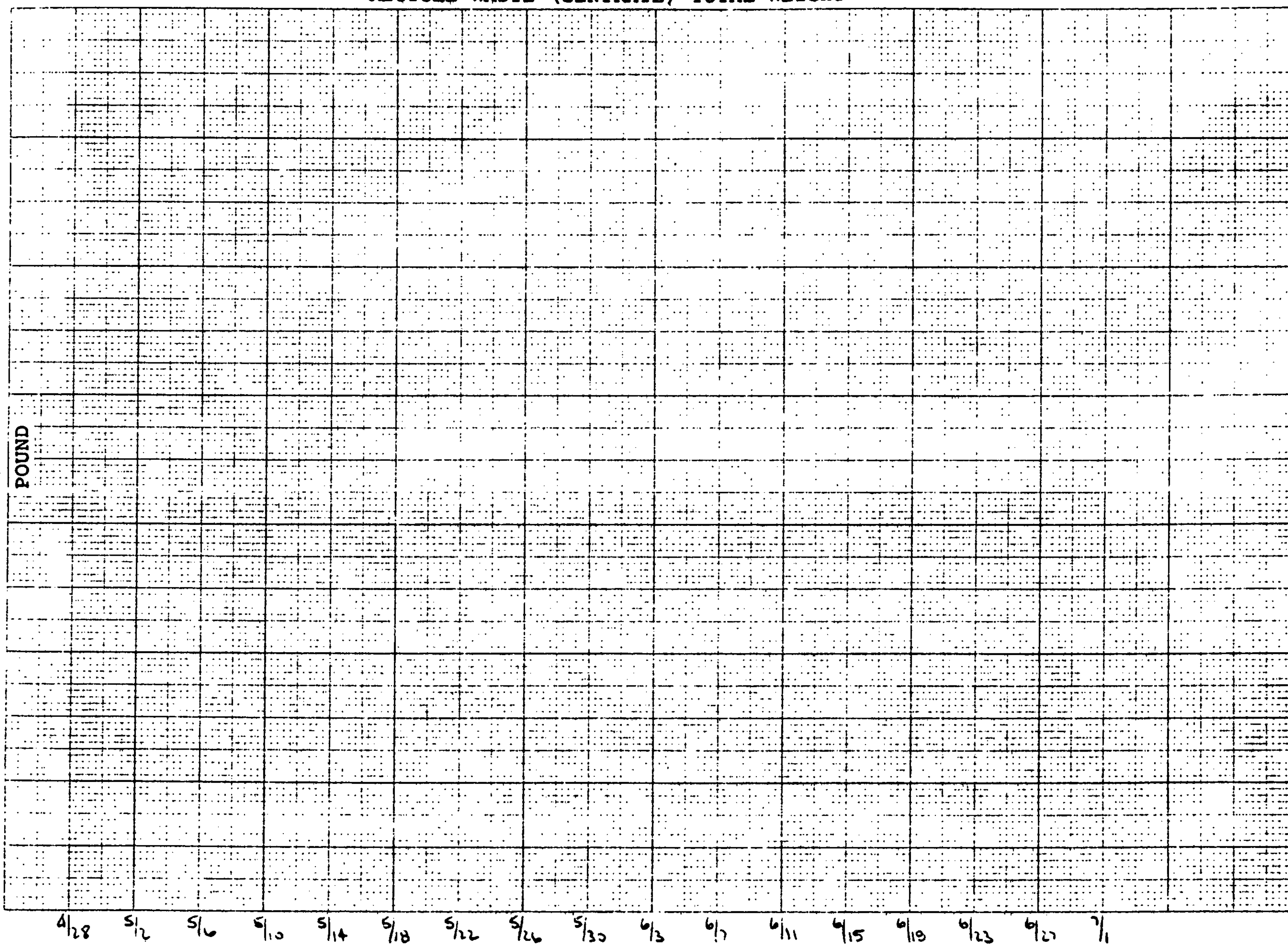


FIGURE 13

RECYCLE WASTE (CENTRATE) TOTAL WEIGHT

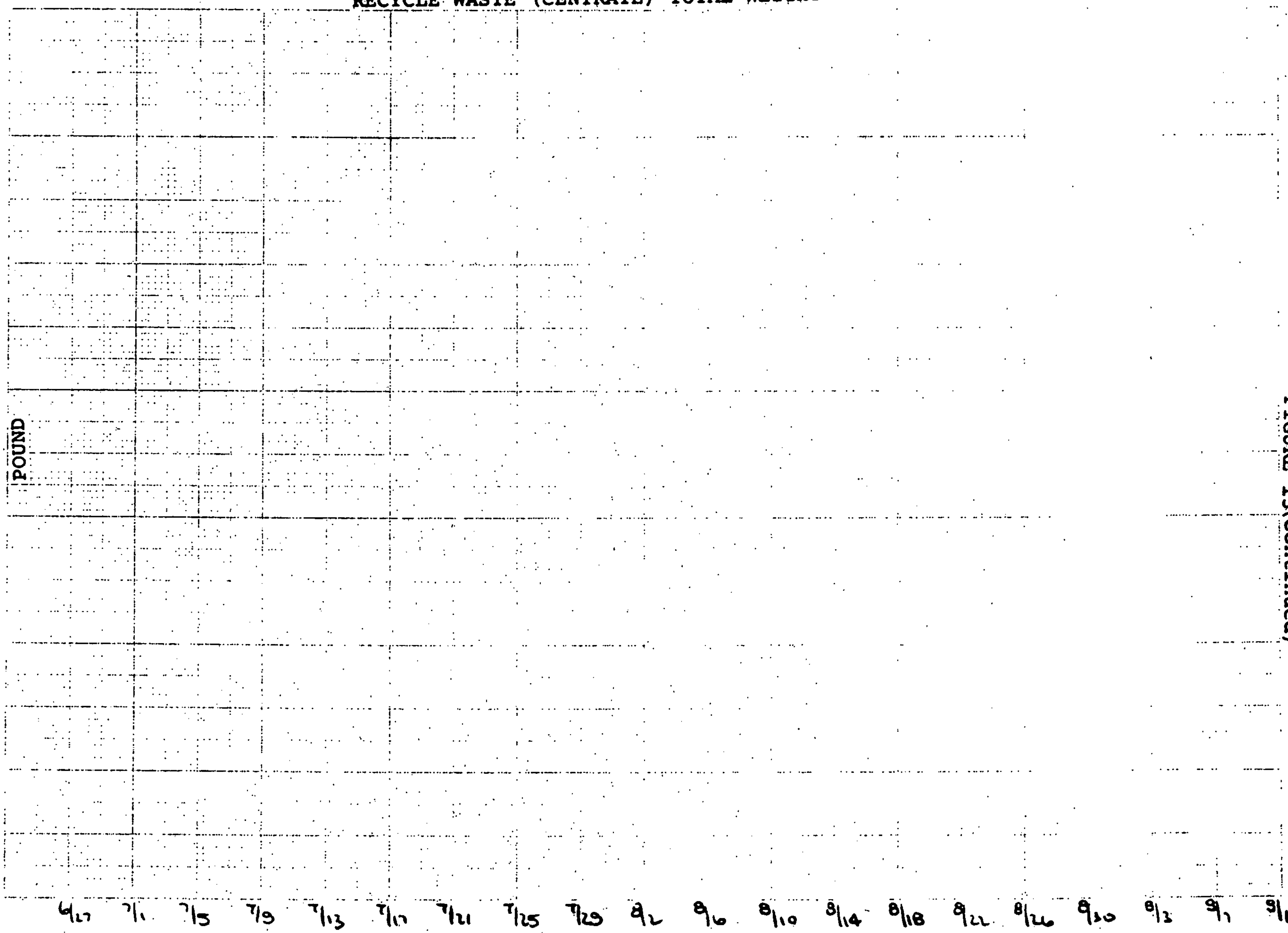


FIGURE 13(Continued)

RECYCLE WASTE (CENTRATE) DRY MATTER

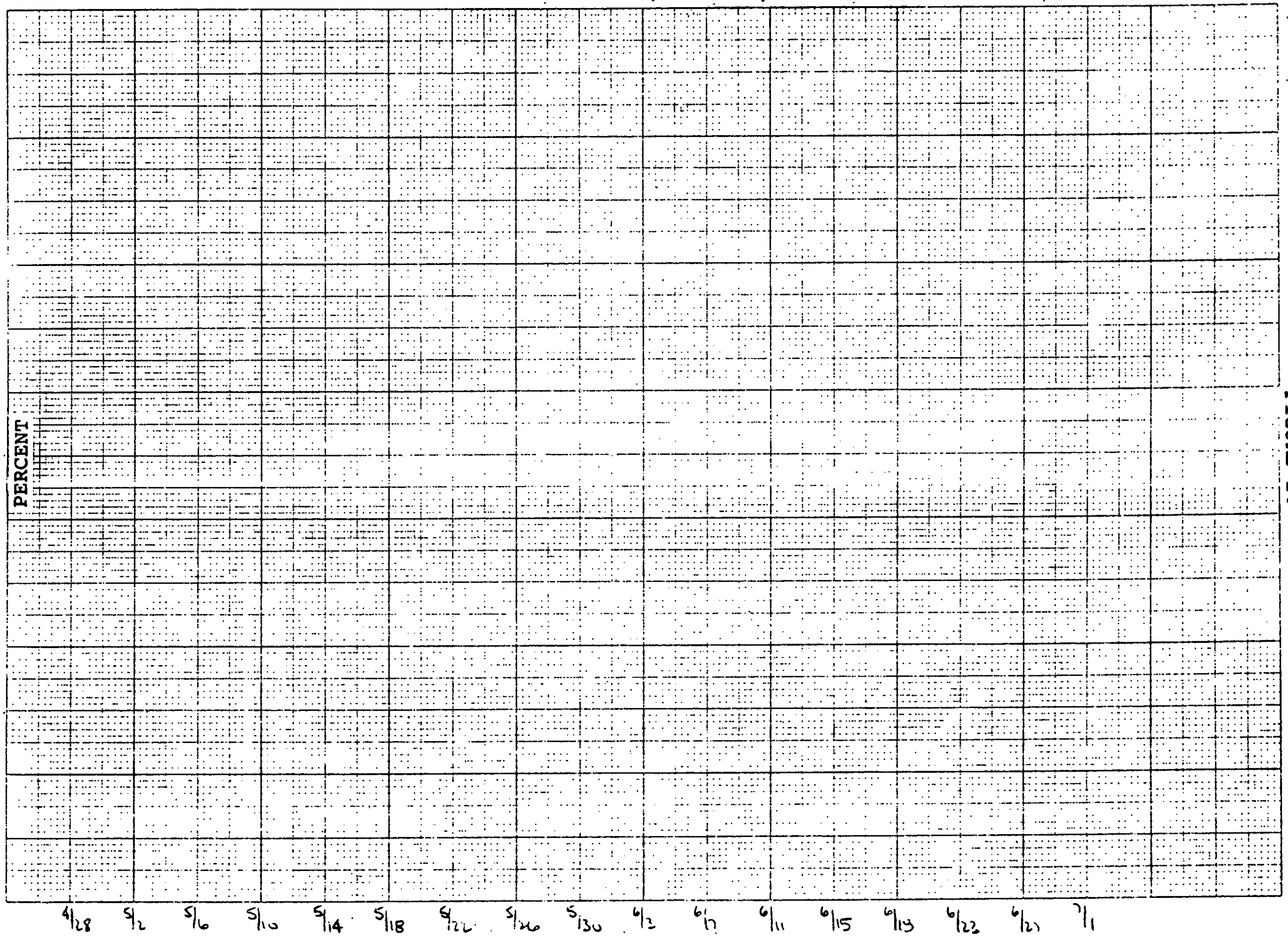


FIGURE 14

RECYCLE WASTE (CENTRATE) DRY MATTER

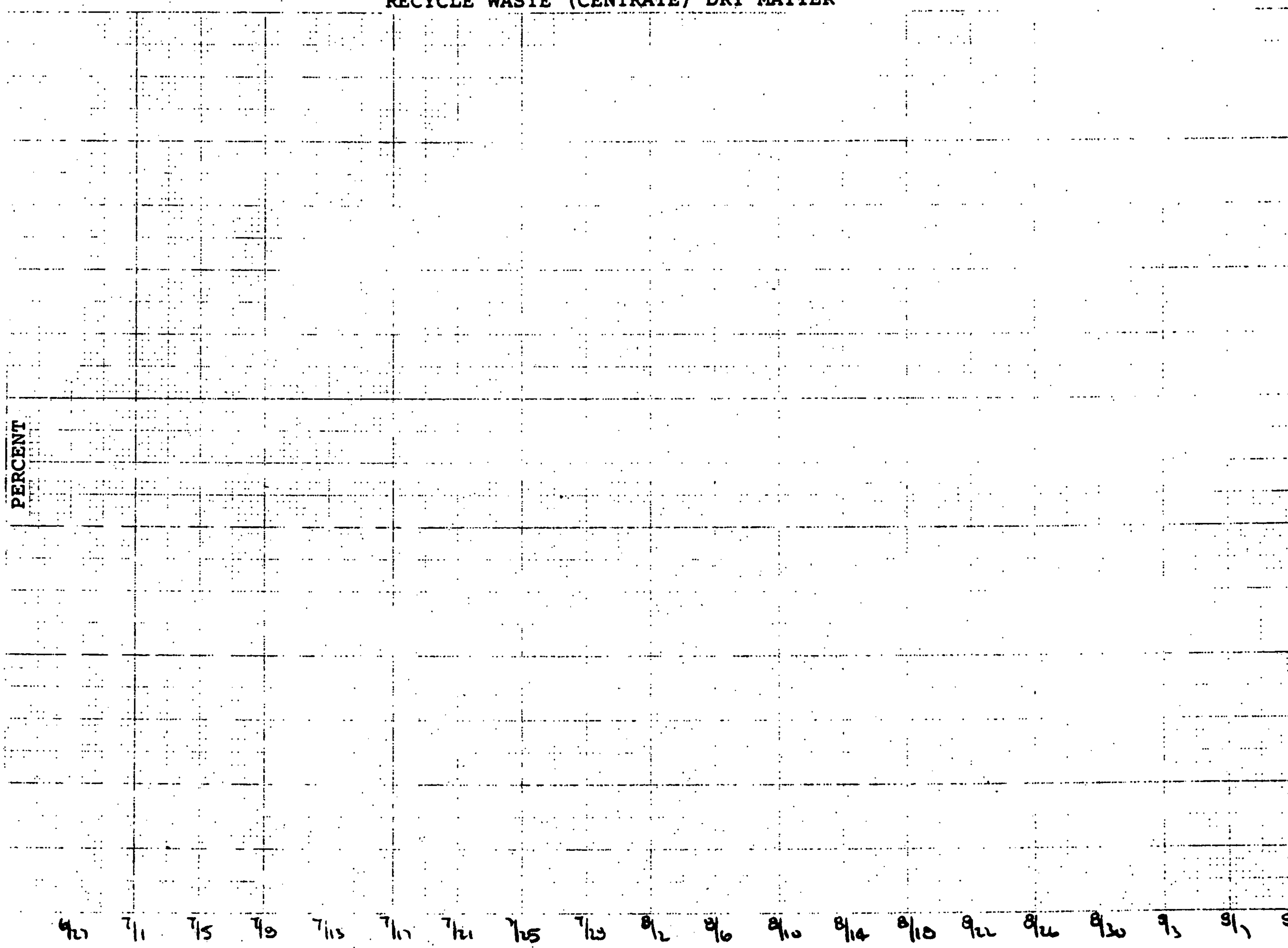


FIGURE 14(Continued)

RECYCLE WASTE (CENTRATE) VOLATILE MATTER

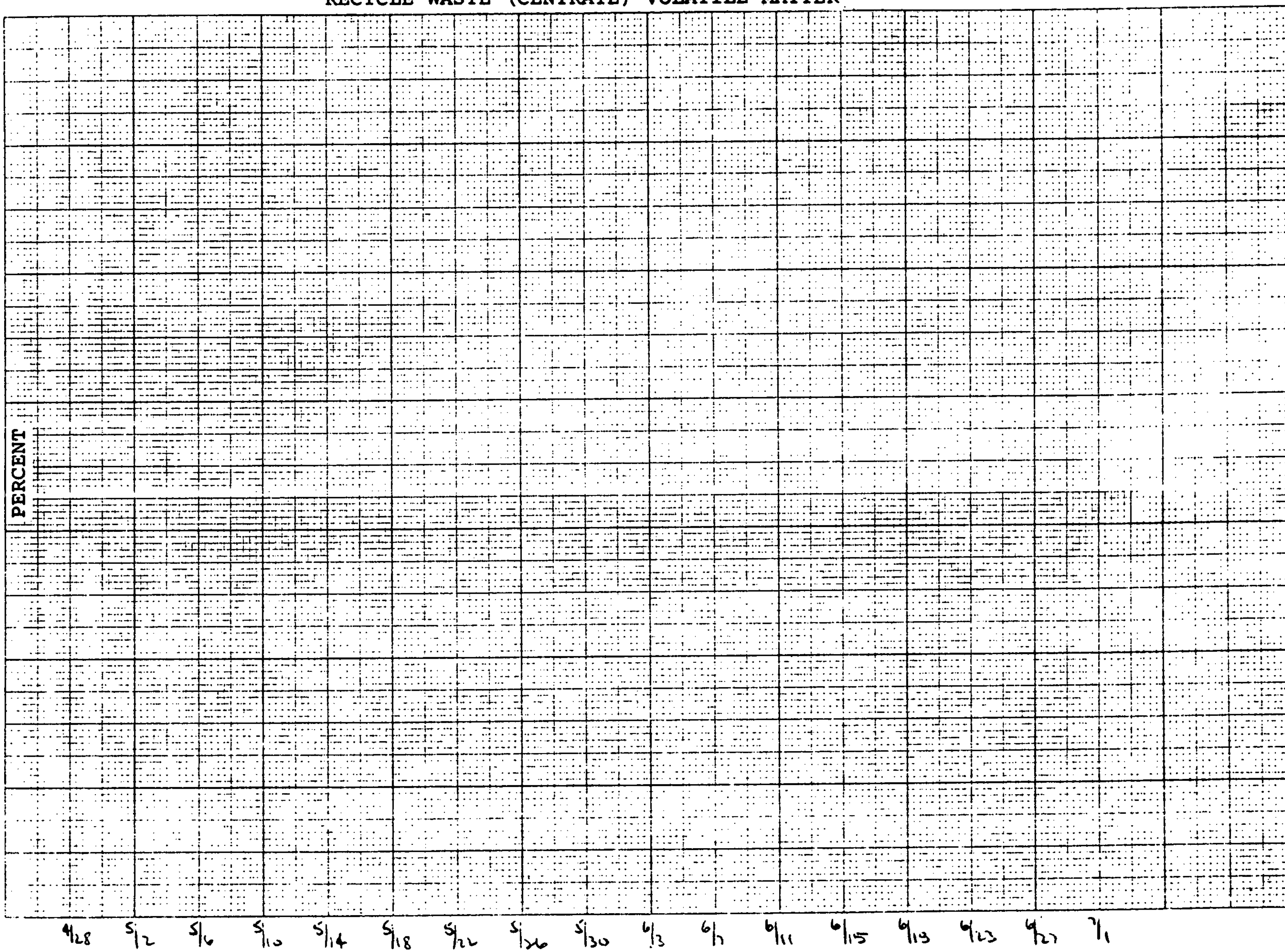


FIGURE 15

RECYCLE WASTE (CENTRATE) VOLATILE MATTER

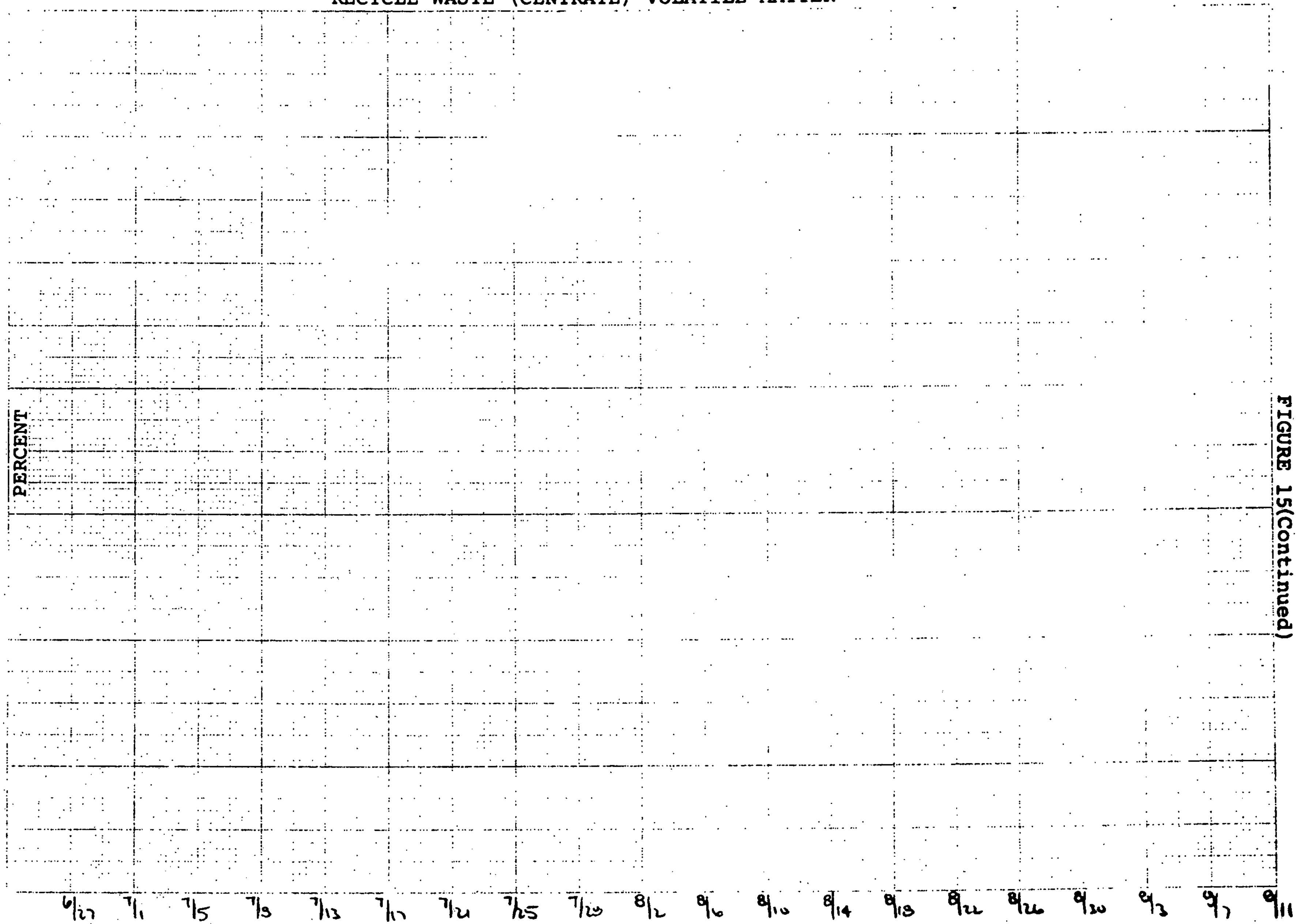


FIGURE 15(Continued)

MAKE-UP WATER TOTAL WEIGHT

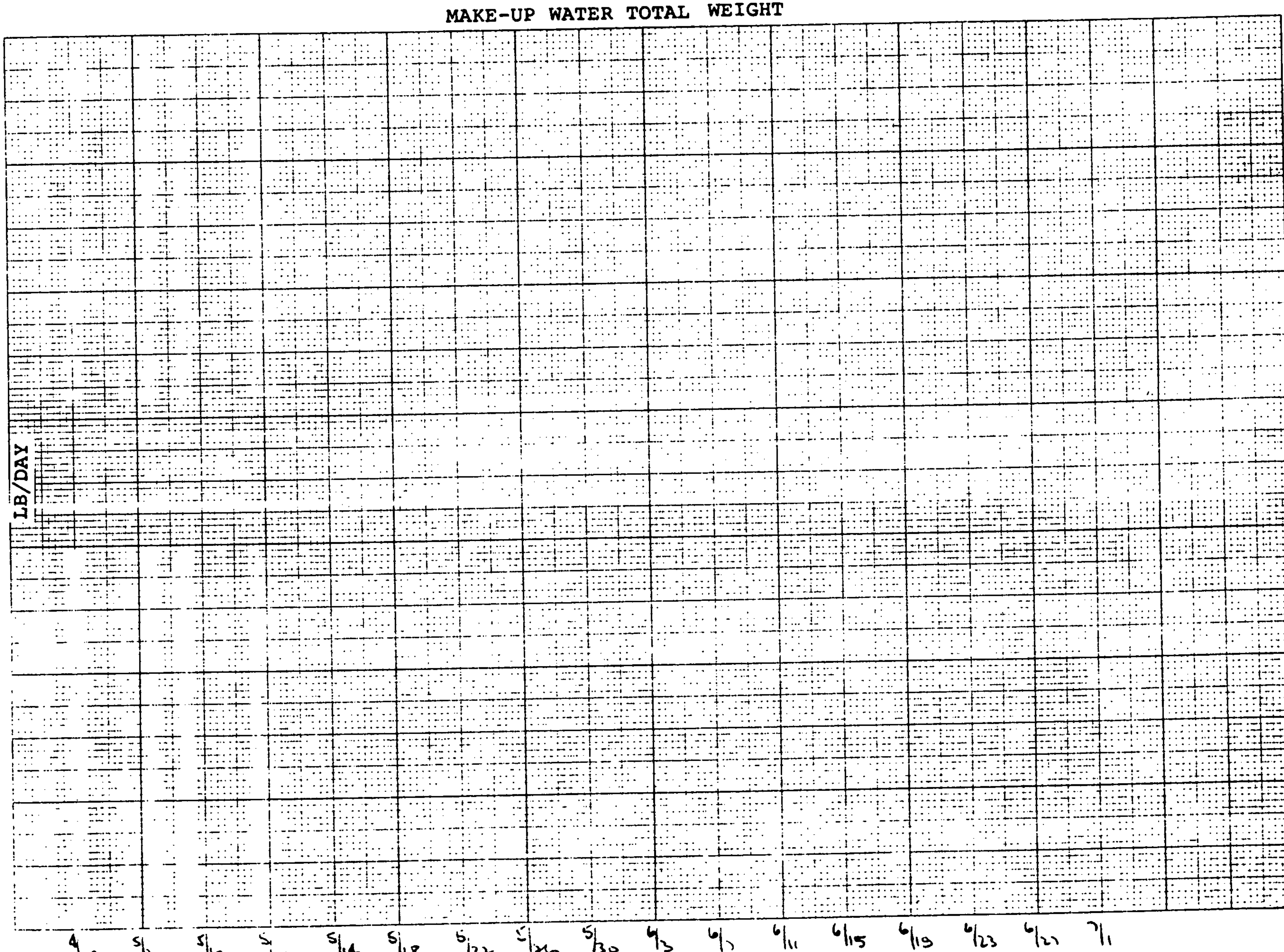


FIGURE 16

MAKE-UP WATER TOTAL WEIGHT

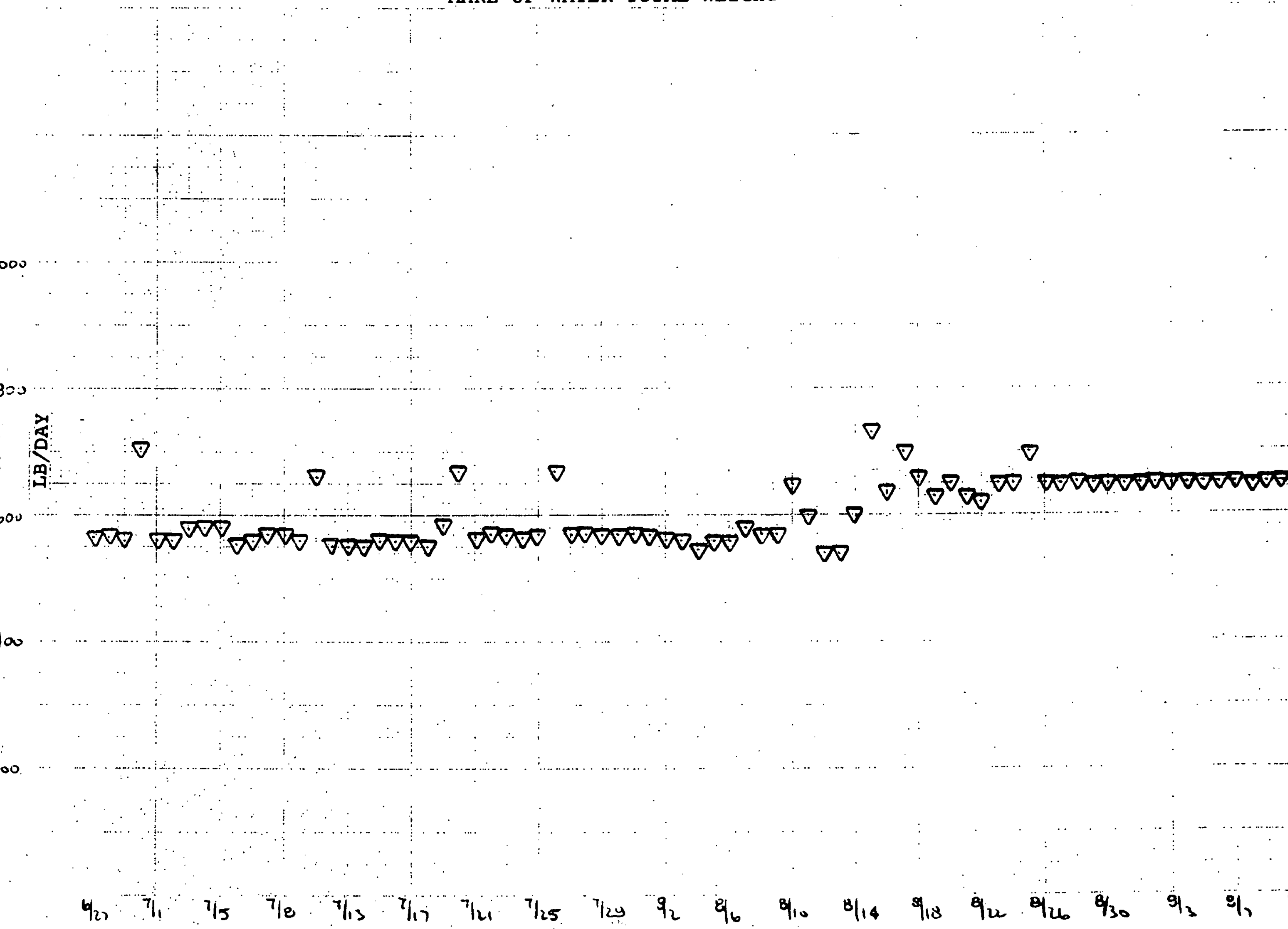


FIGURE 16(Continued)

RESIDUAL GRIT VOLATILE MATTER

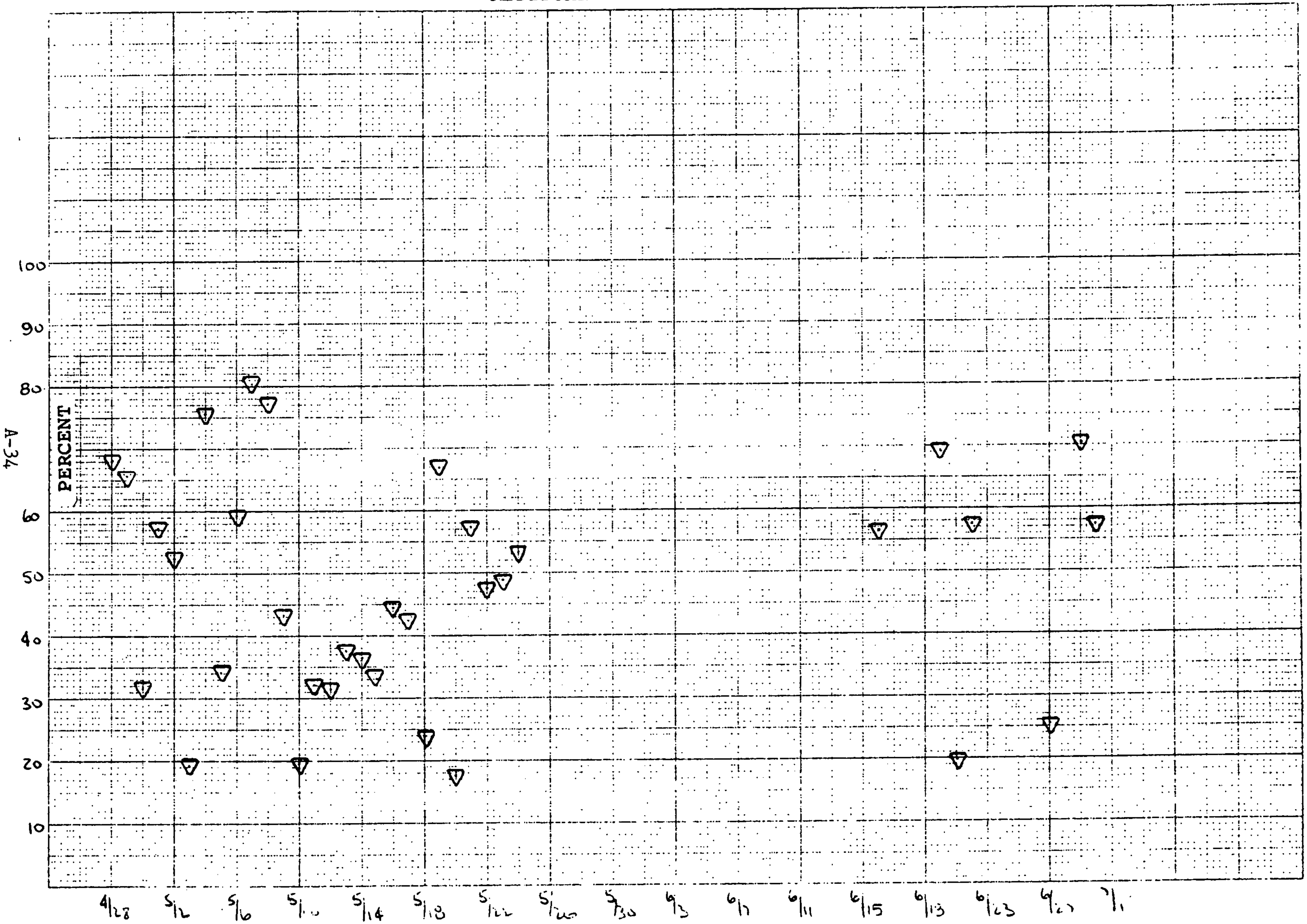


FIGURE 17

A-34

RESIDUAL GRIT VOLATILE MATTER

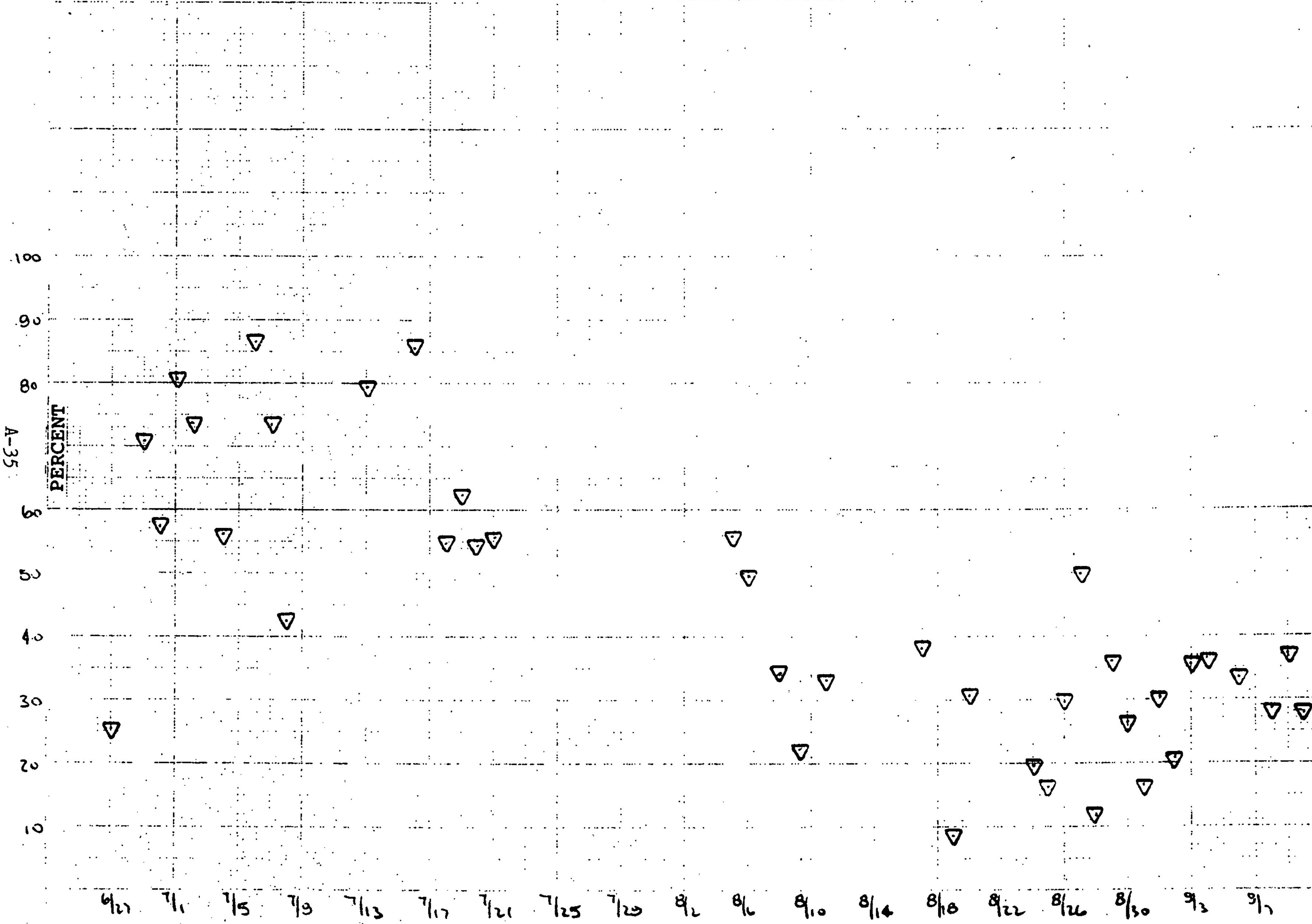


FIGURE 17(Continued)

PROCESSED WASTE LOAD TOTAL WEIGHT

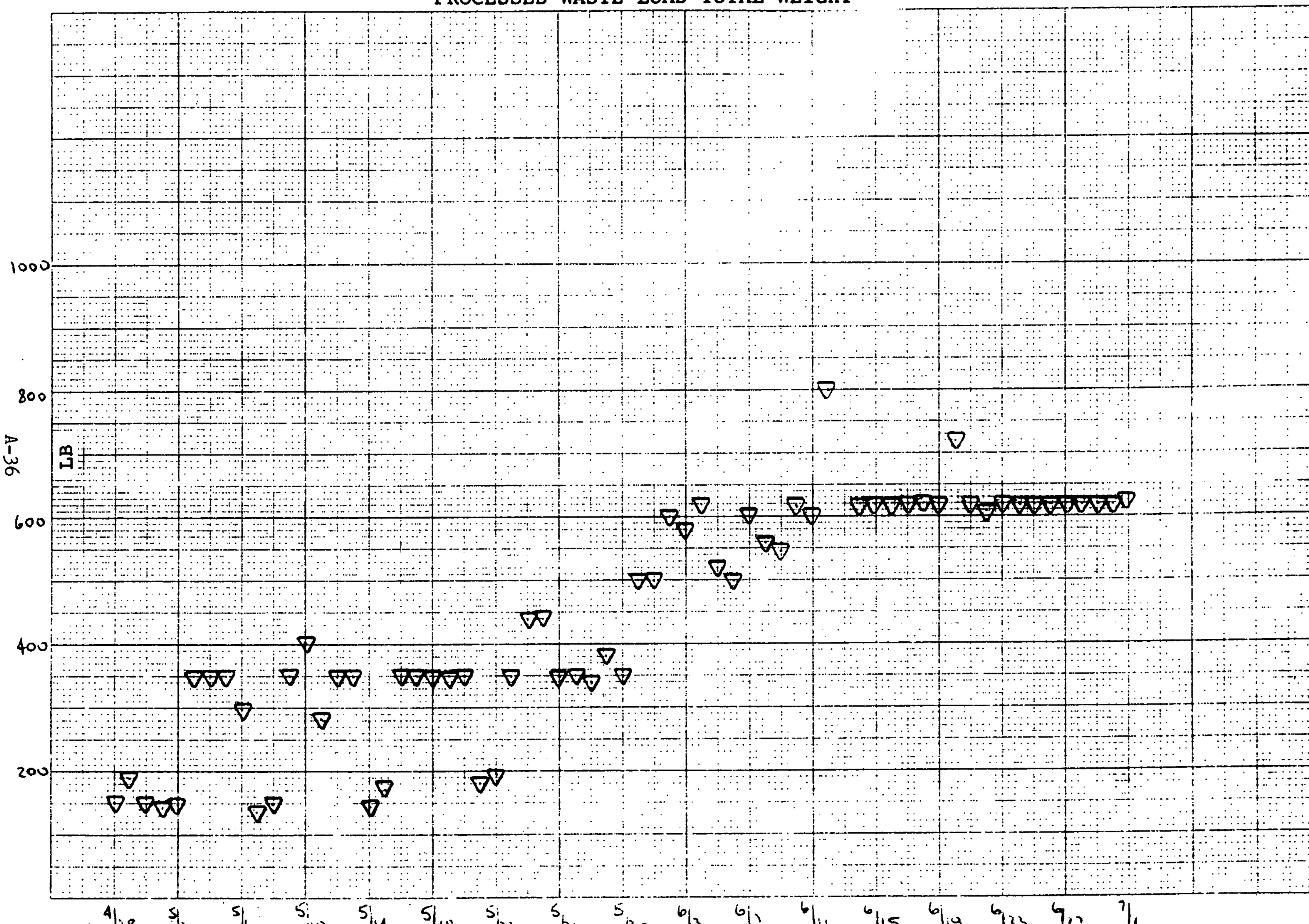


FIGURE 18

PROCESSED WASTE LOAD TOTAL WEIGHT

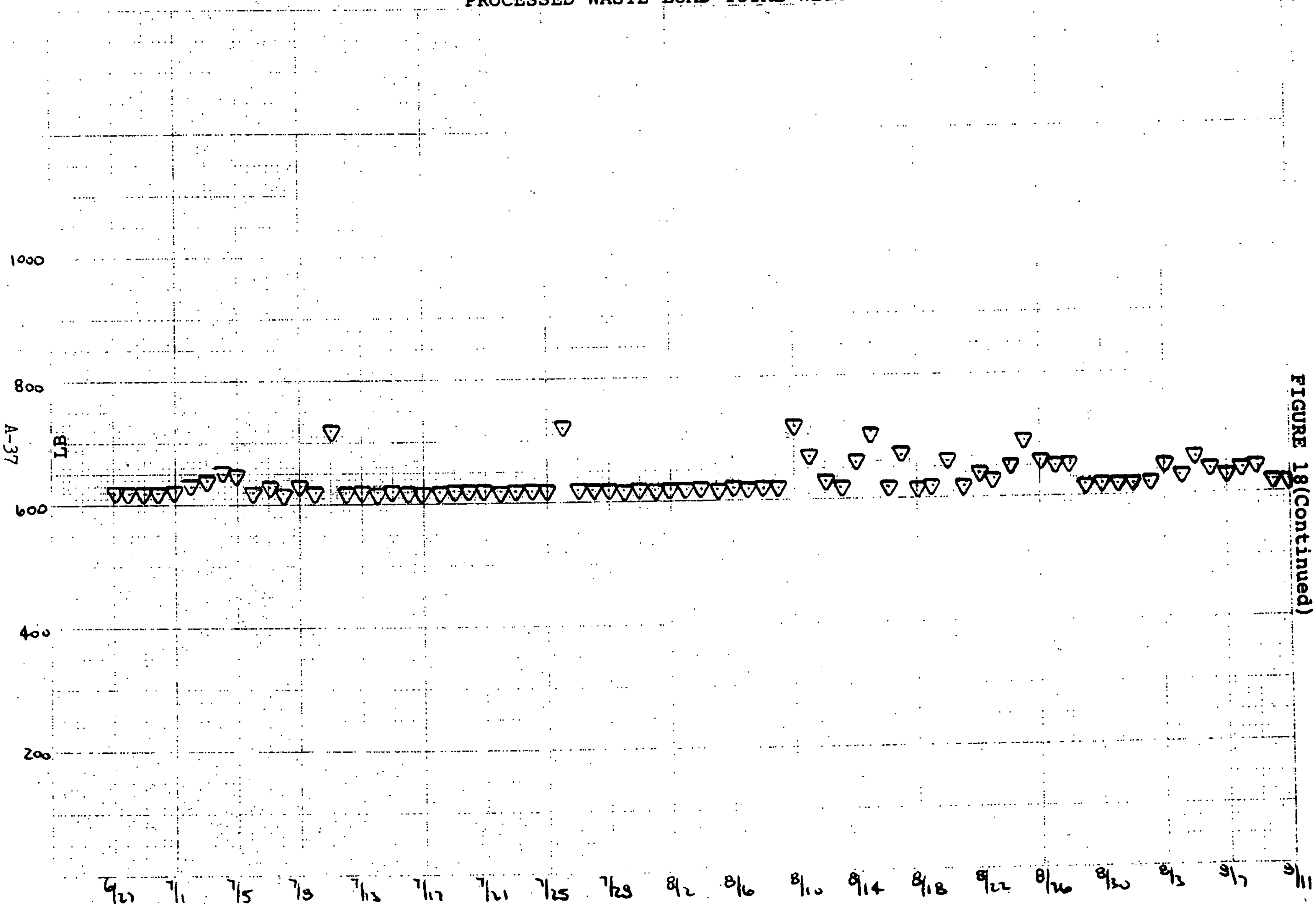


FIGURE 18(Continued)

PROCESSED WASTE LOAD DRY MATTER

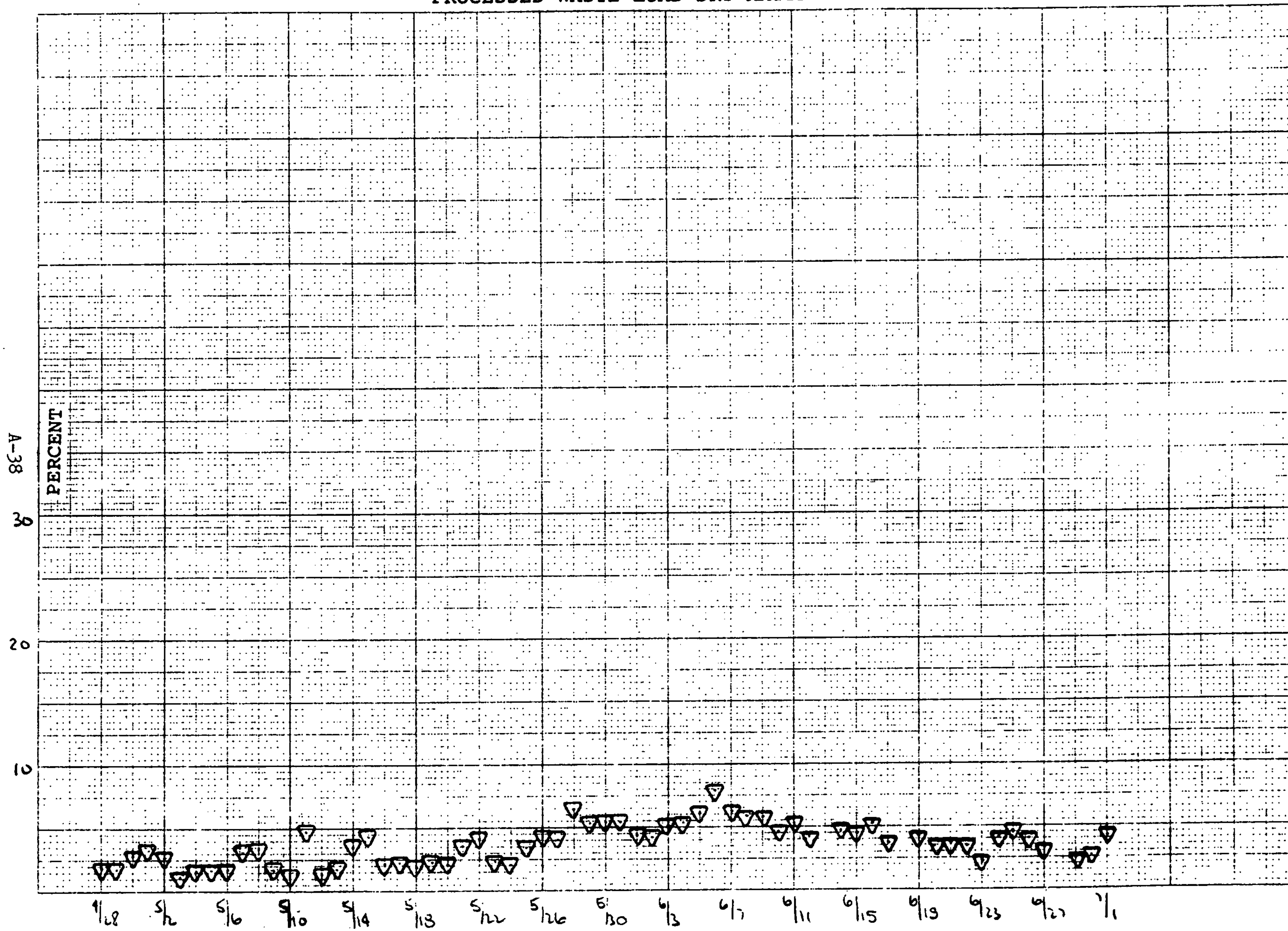


FIGURE 19

PROCESSED WASTE LOAD DRY MATTER

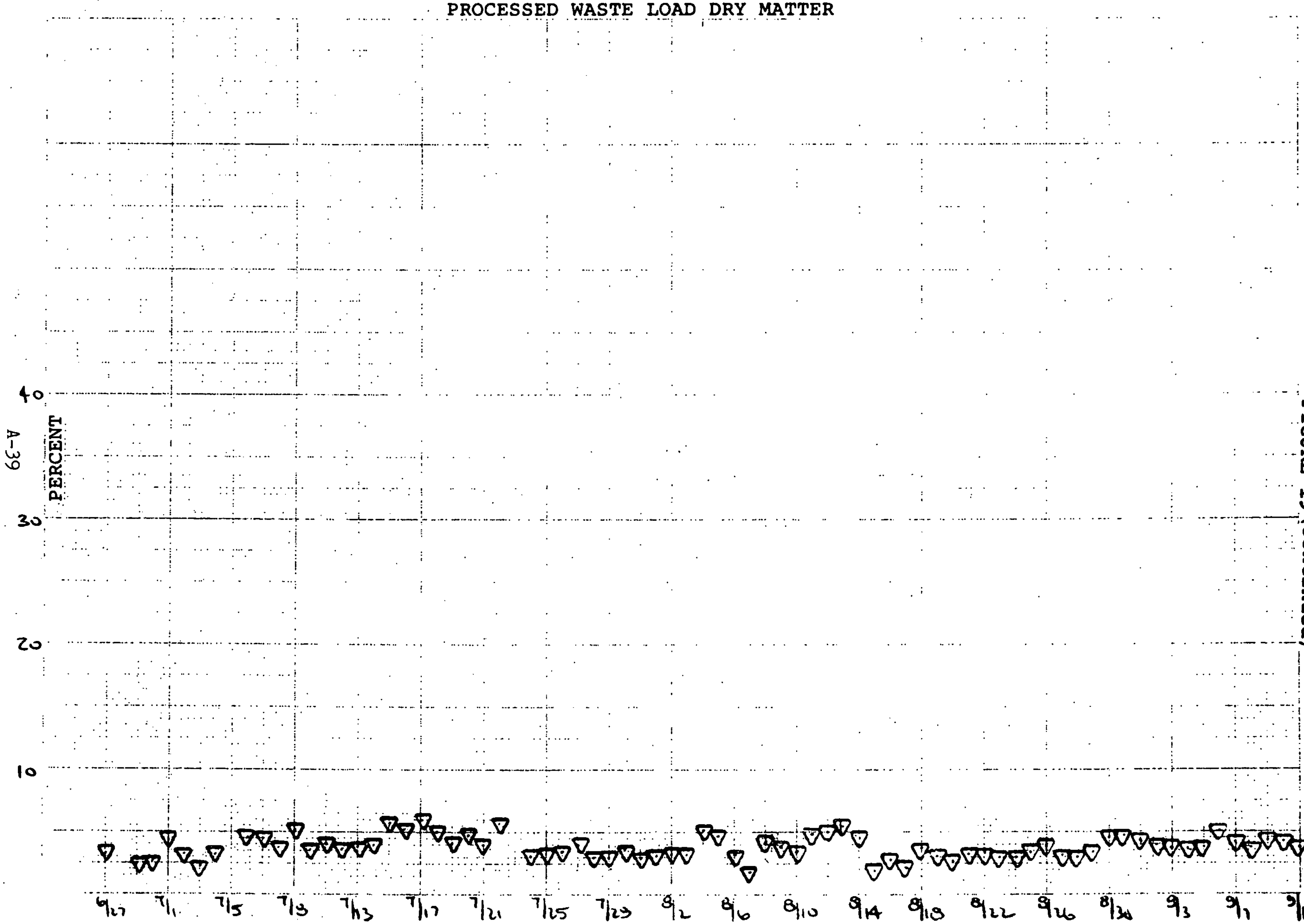


FIGURE 19 (Continued)

PROCESSED WASTE LOAD VOLATILE MATTER

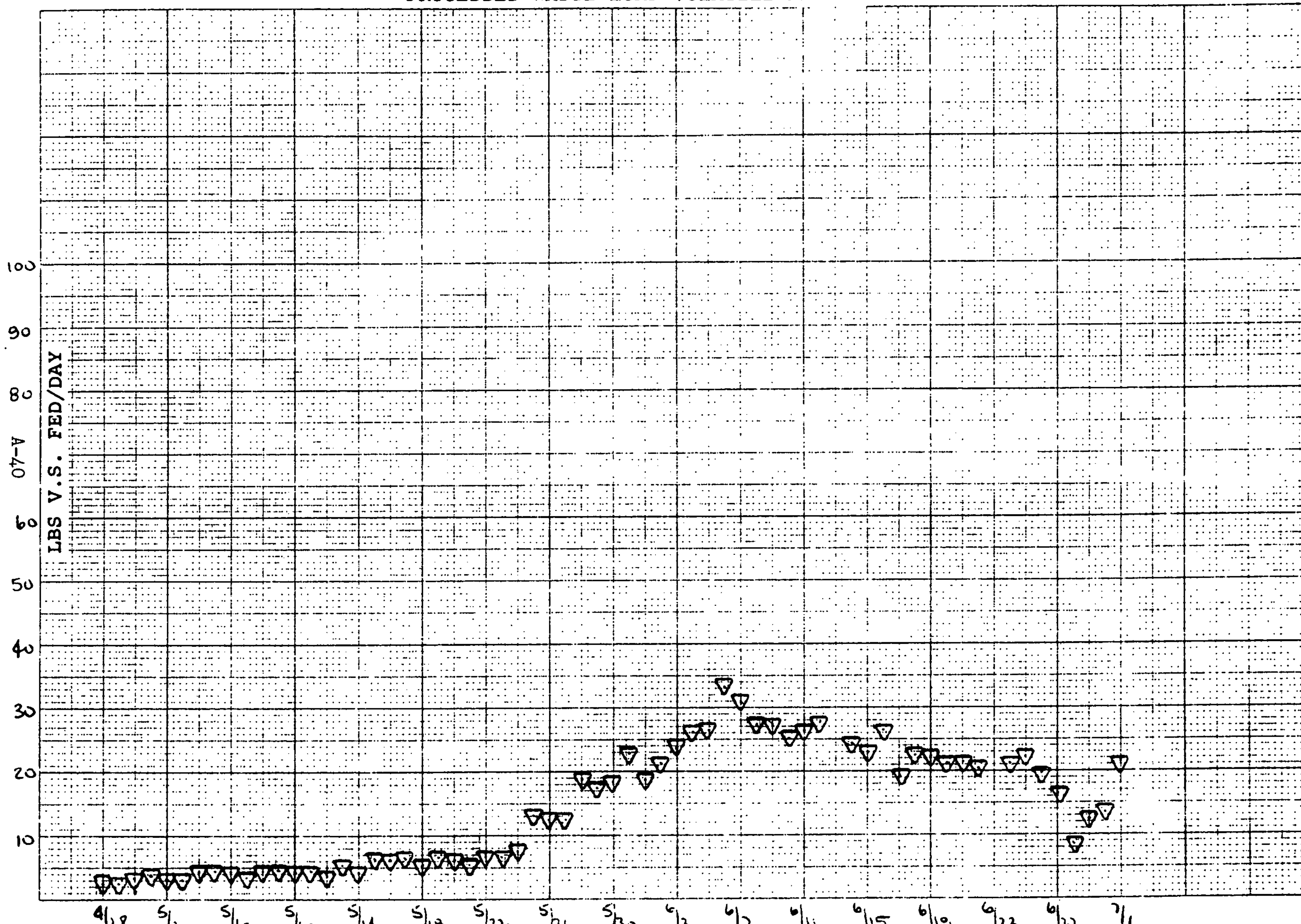


FIGURE 20

PROCESSED WASTE LOAD VOLATILE MATTER

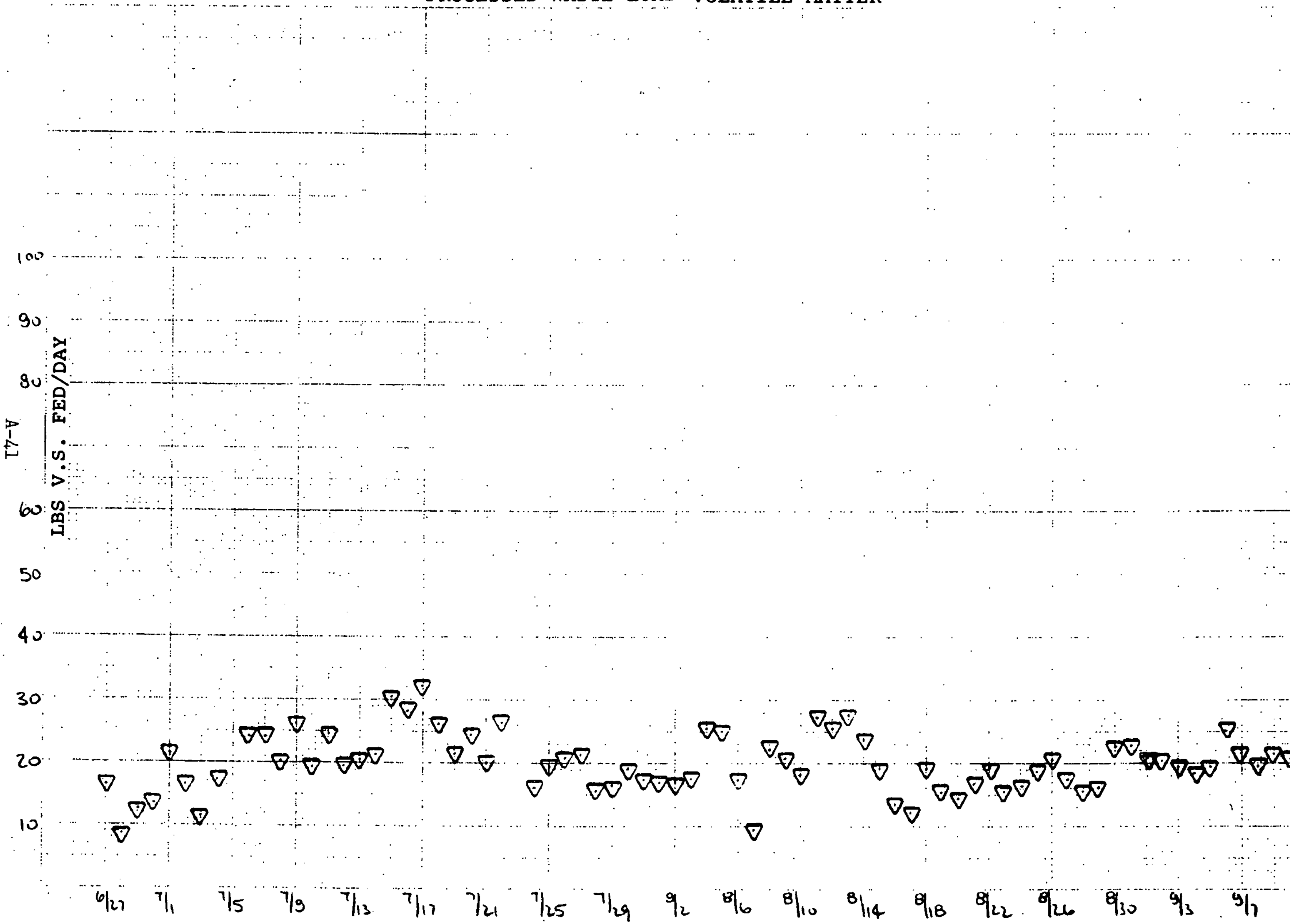


FIGURE 20 (Continued)

PROCESSED WASTE LOAD pH

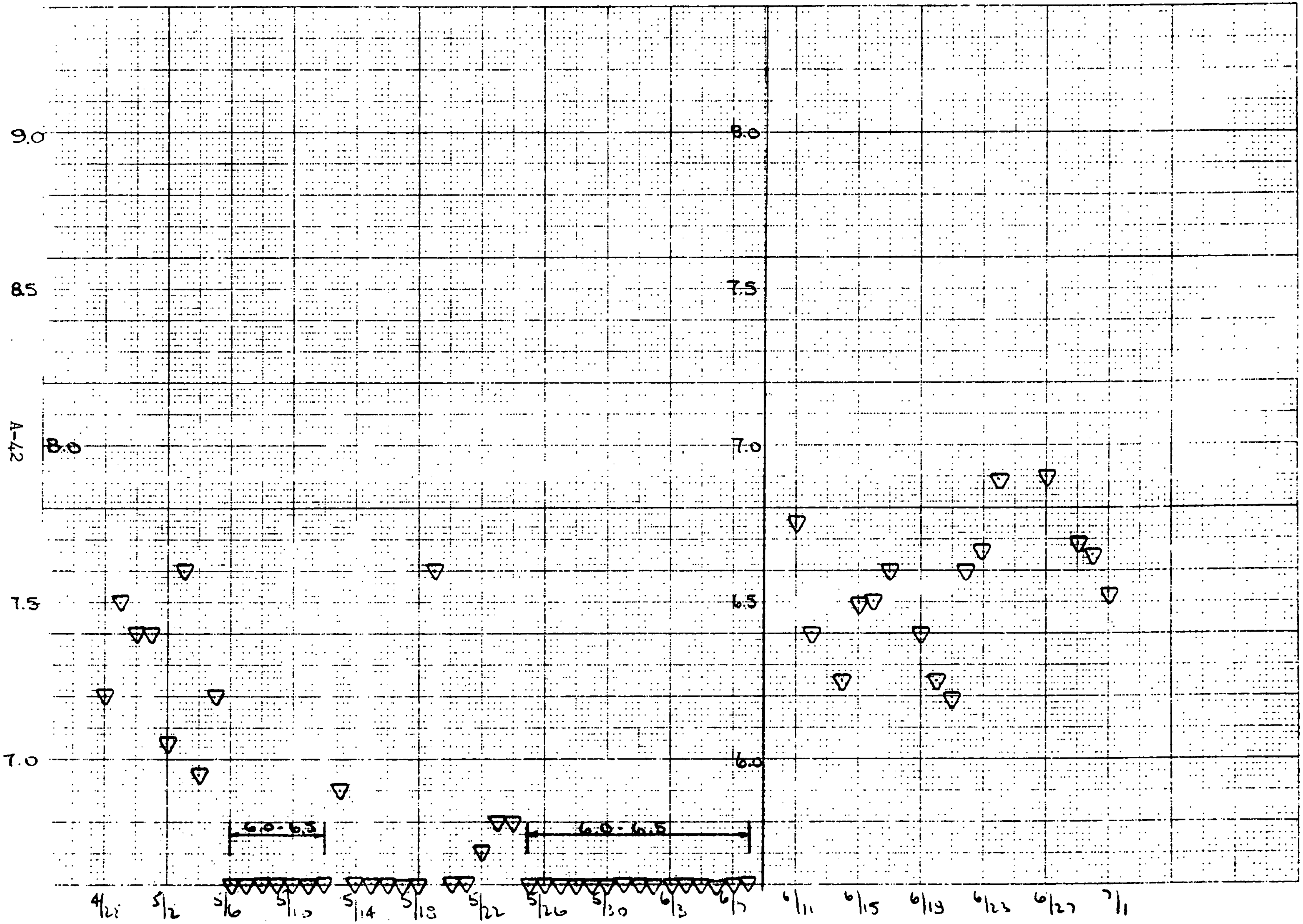


FIGURE 21

PROCESSED WASTE LOAD pH

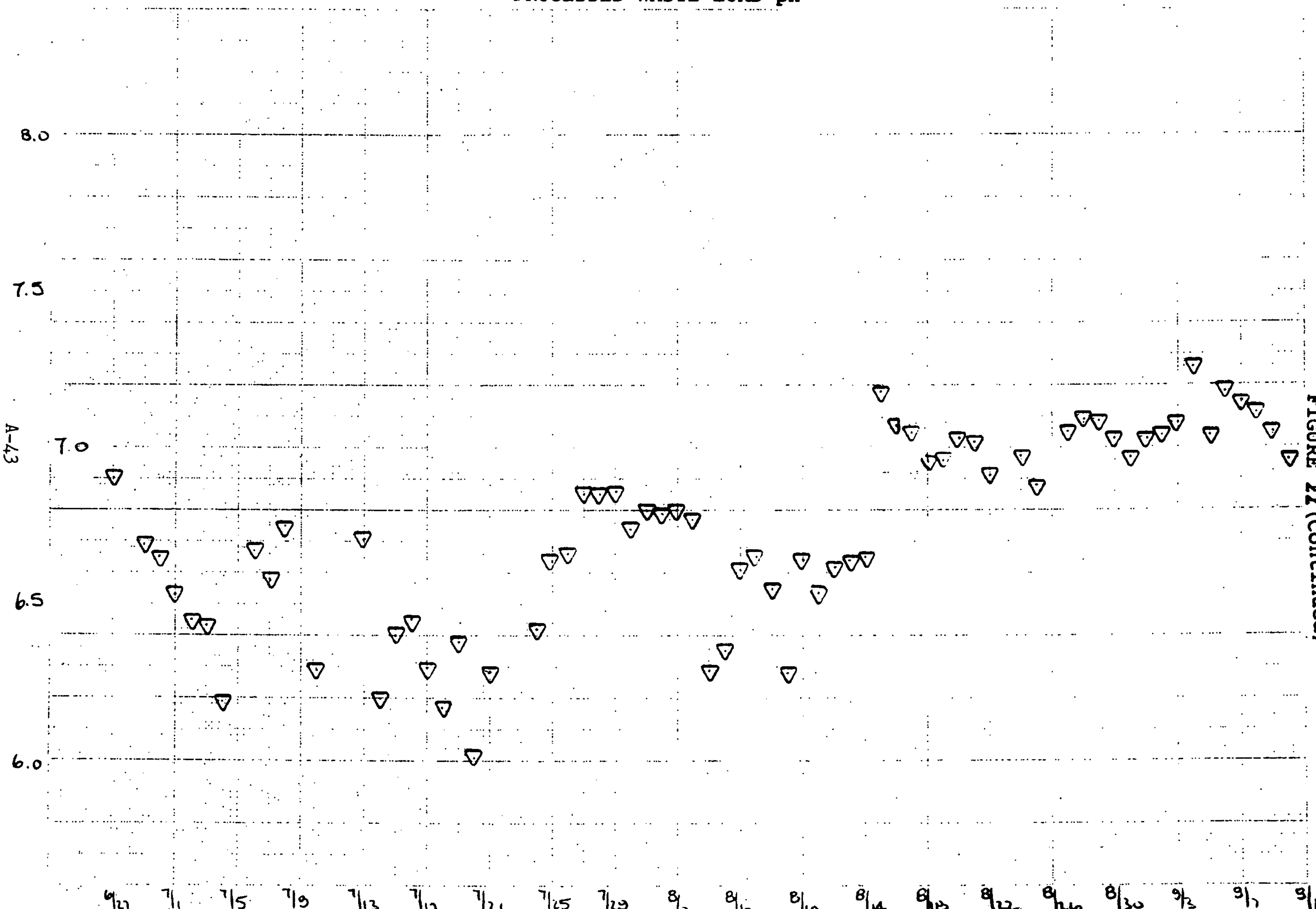


FIGURE 22 (Continued)

PROCESSED WASTE LOAD ALKALINITY

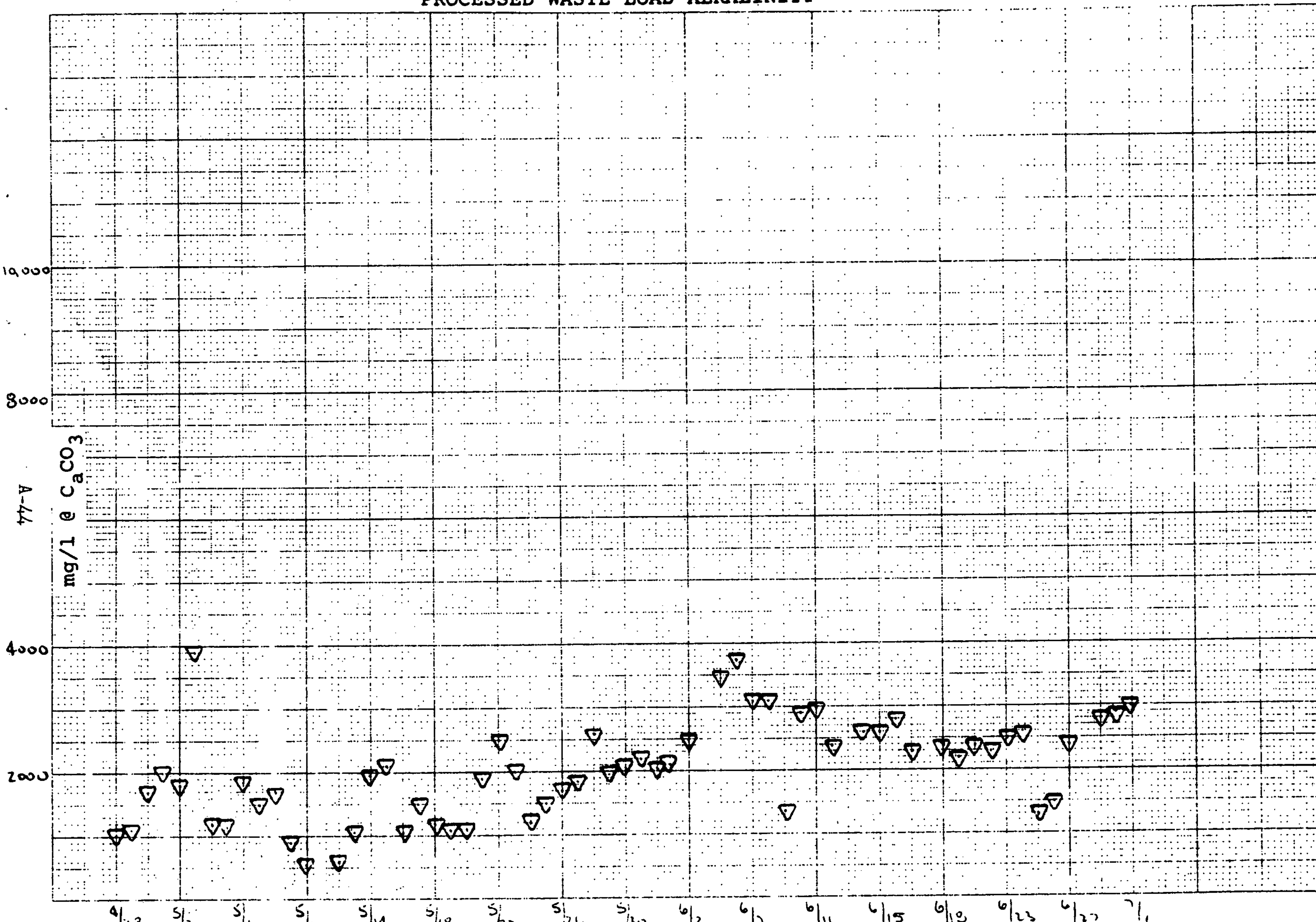


FIGURE 22

PROCESSED WASTE LOAD ALKALINITY

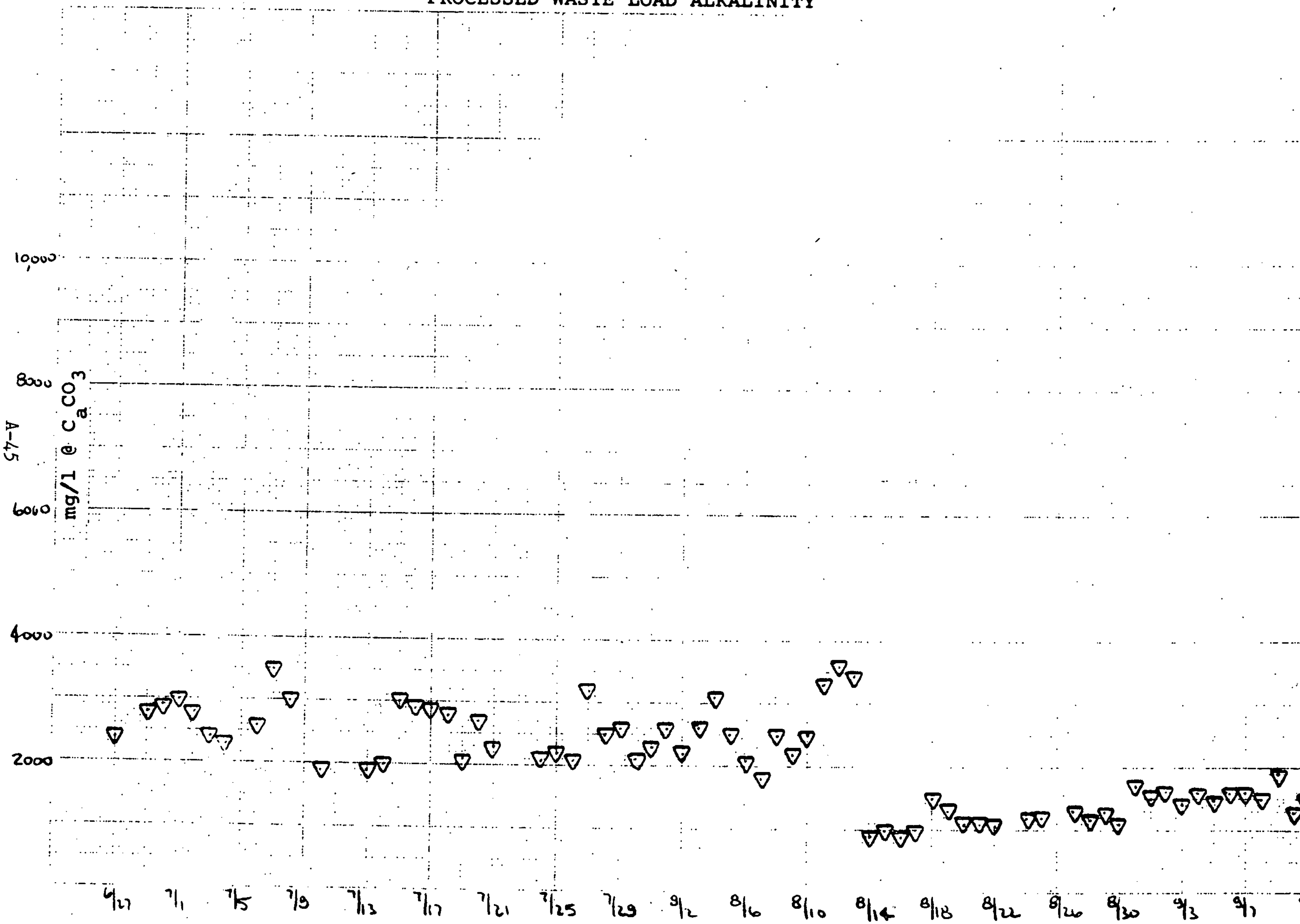
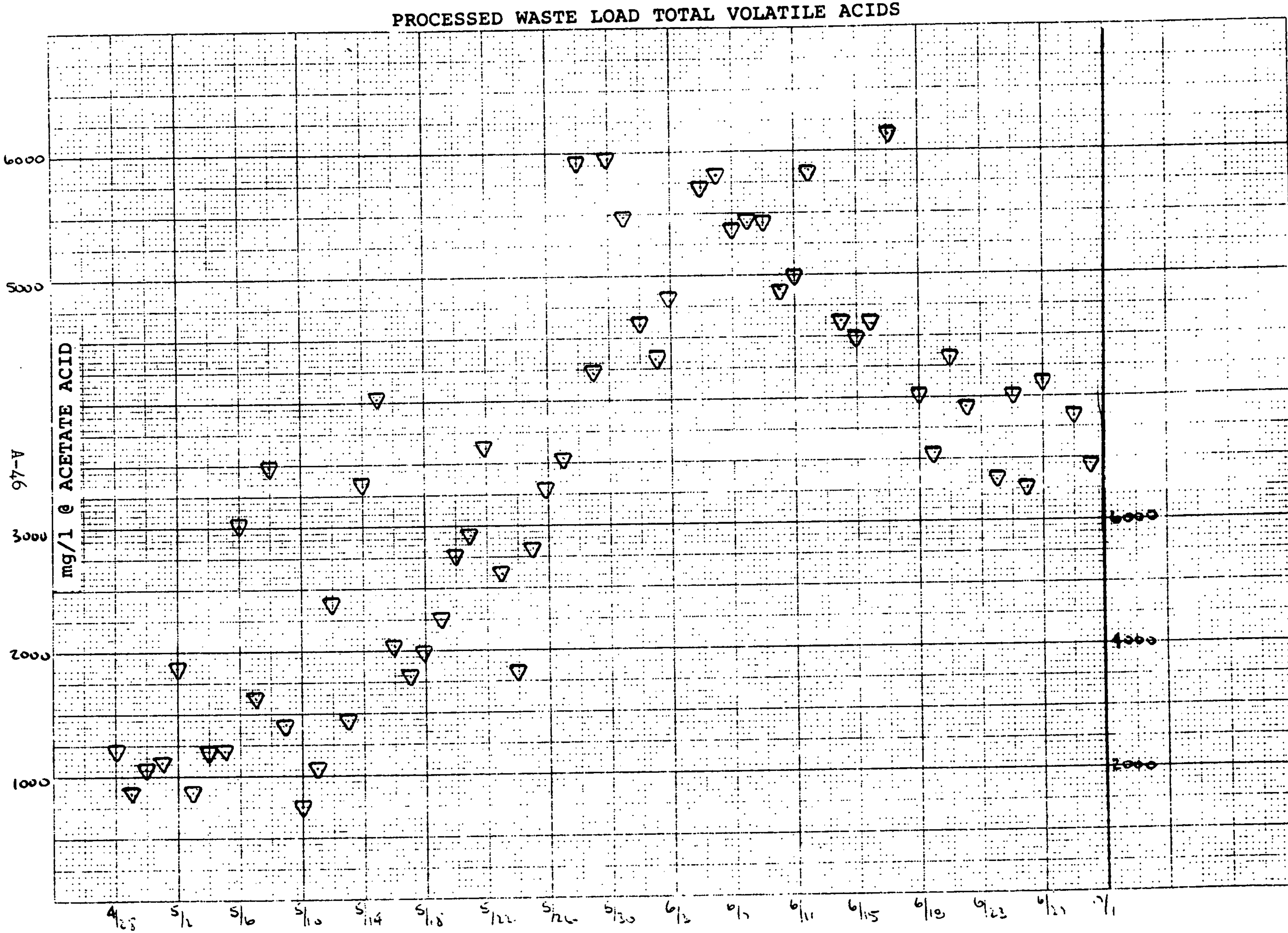


FIGURE 22 (Continued)

PROCESSED WASTE LOAD TOTAL VOLATILE ACIDS



A-46

FIGURE 23

PROCESSED WASTE LOAD TOTAL VOLATILE ACIDS

FIGURE 23(Continued)

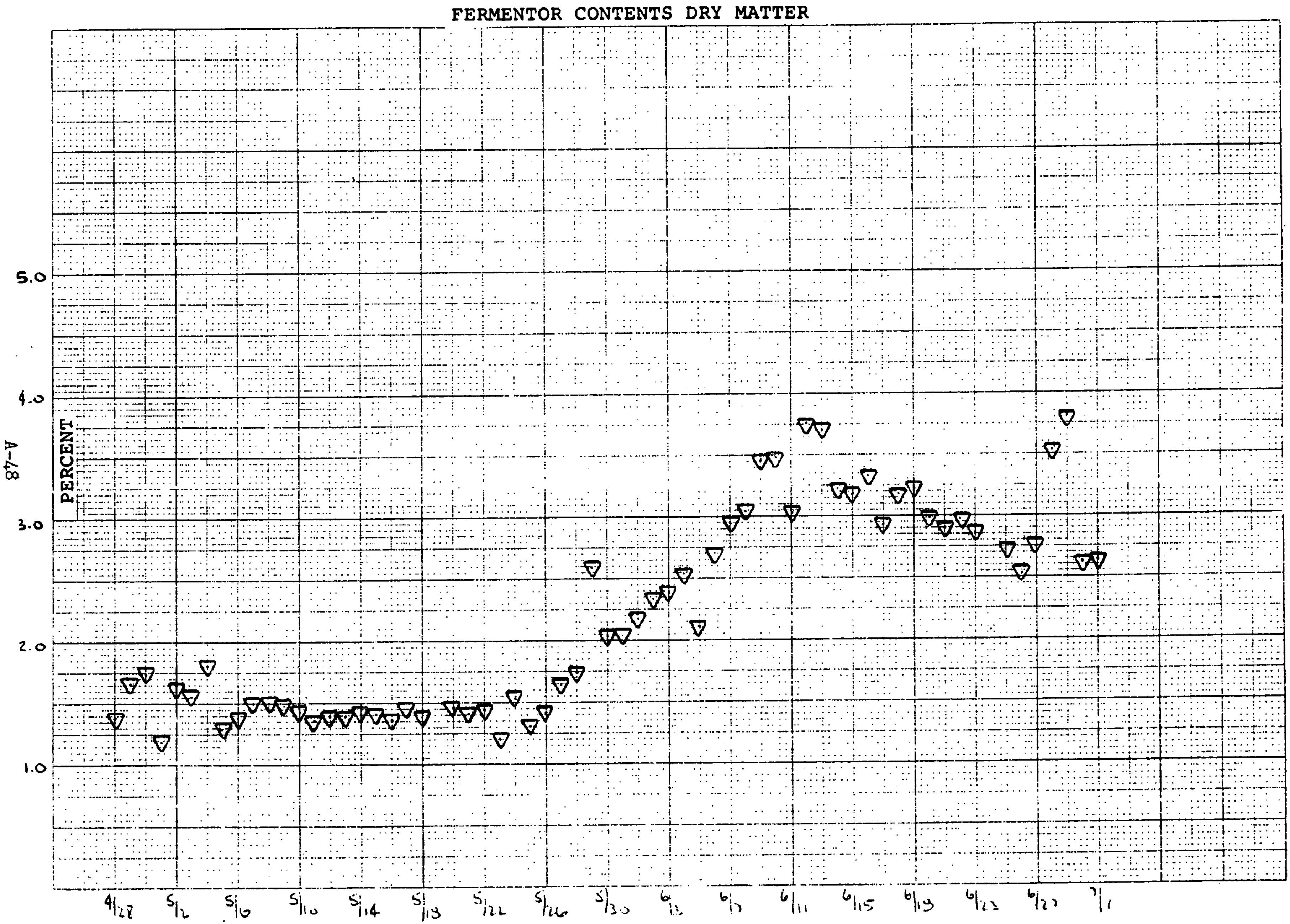

FERMENTOR CONTENTS DRY MATTER
PERCENT
5.0
4.0
3.0
2.0
1.0
4/28
5/2
5/6
5/10
5/14
5/18
5/22
5/26
5/30
6/3
6/7
6/11
6/15
6/19
6/23
6/27
7/1

FIGURE 24

FERMENTOR CONTENTS DRY MATTER

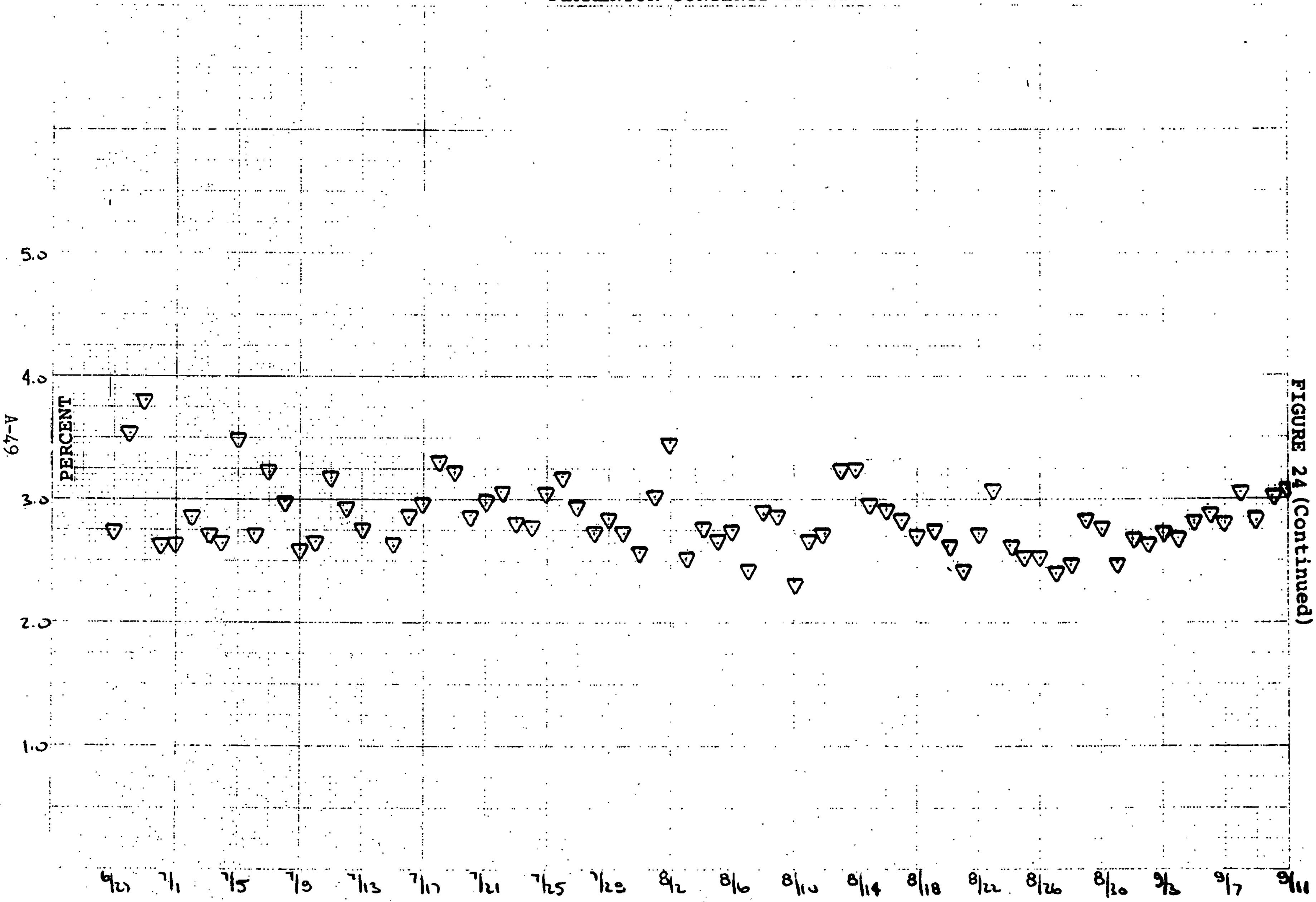


FIGURE 24 (Continued)

FERMENTOR CONTENTS VOLATILE MATTER

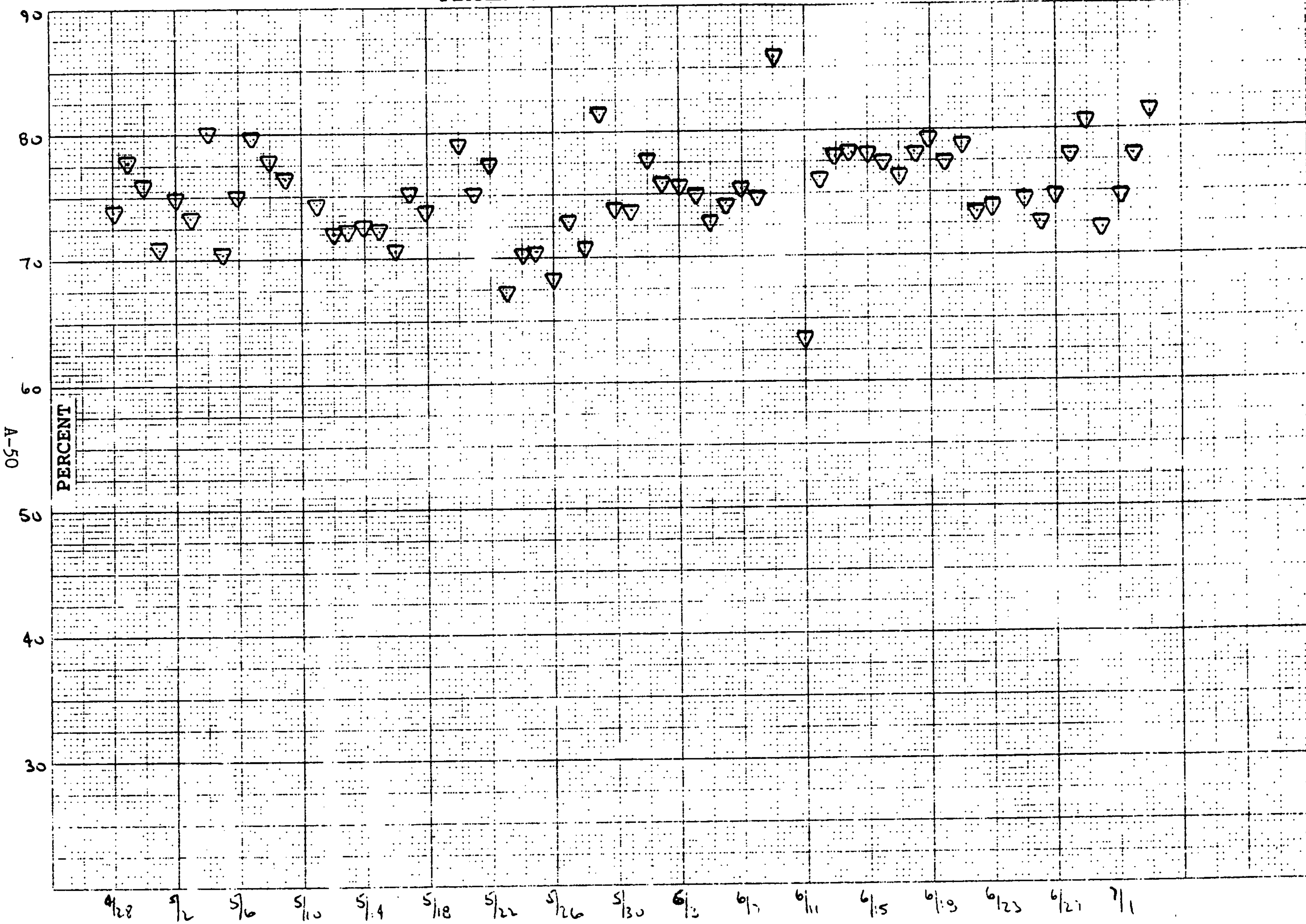


FIGURE 25

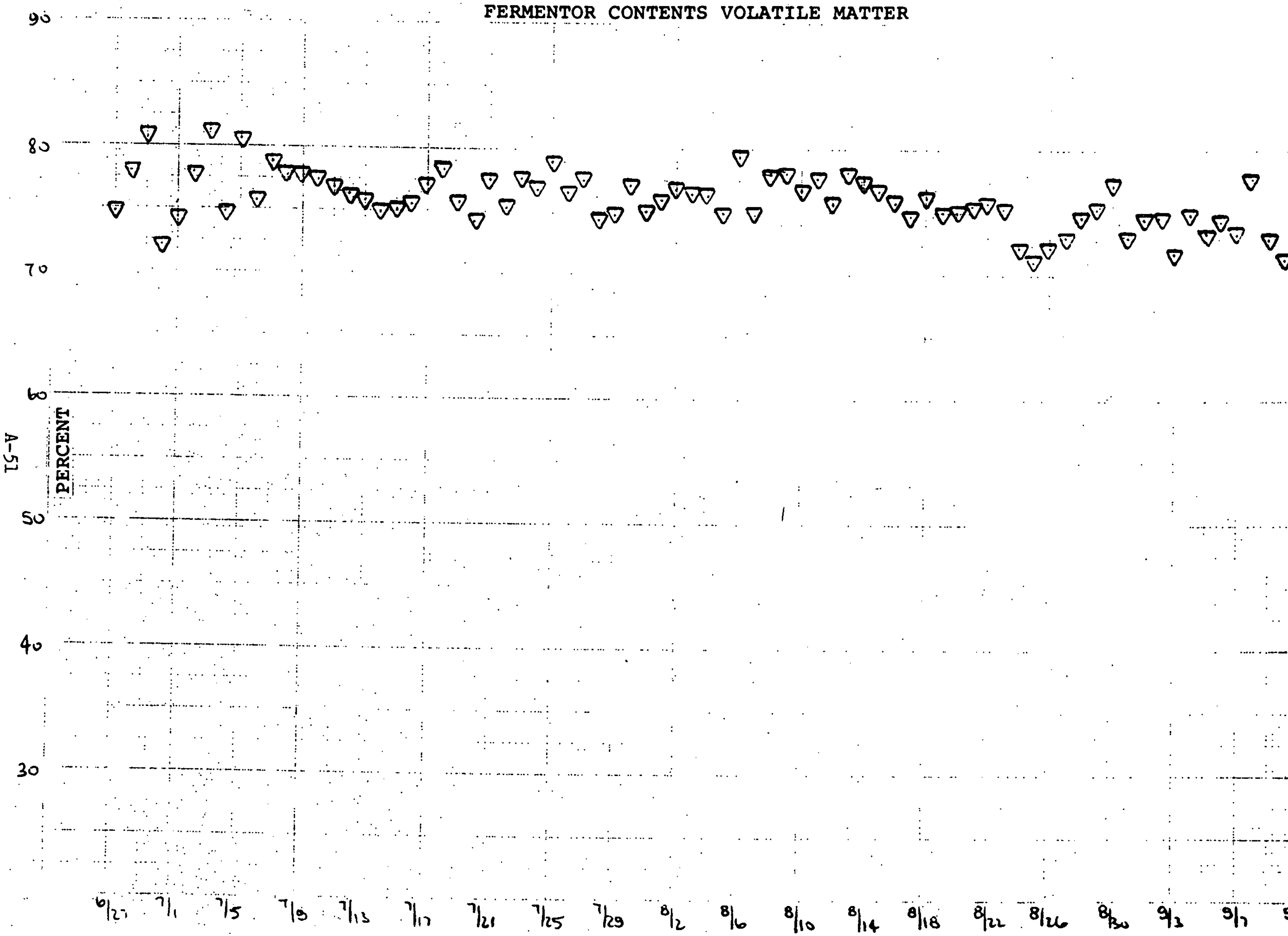


FIGURE 25 (Continued)

FERMENTOR CONTENTS pH

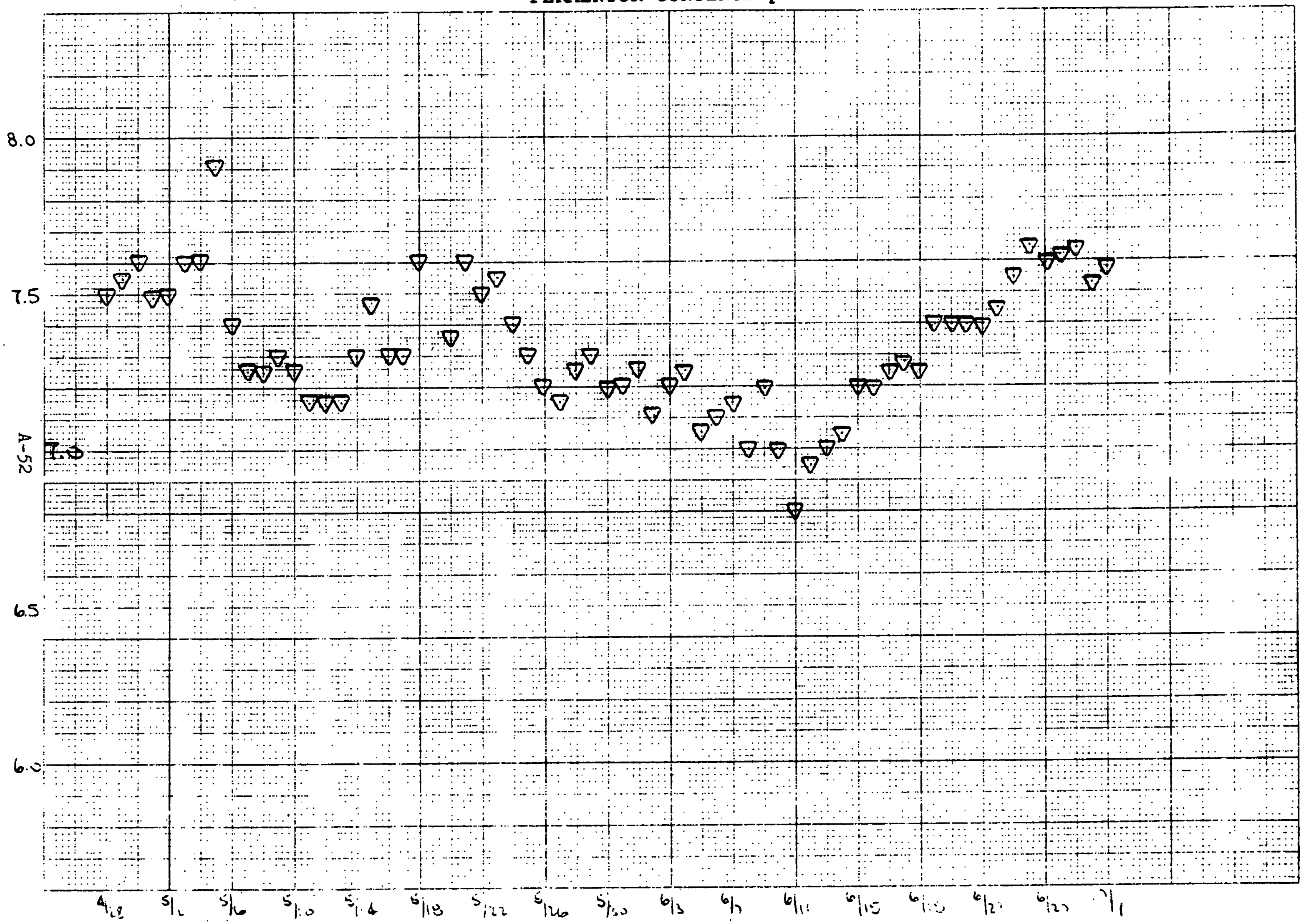


FIGURE 26

FERMENTOR CONTENTS pH

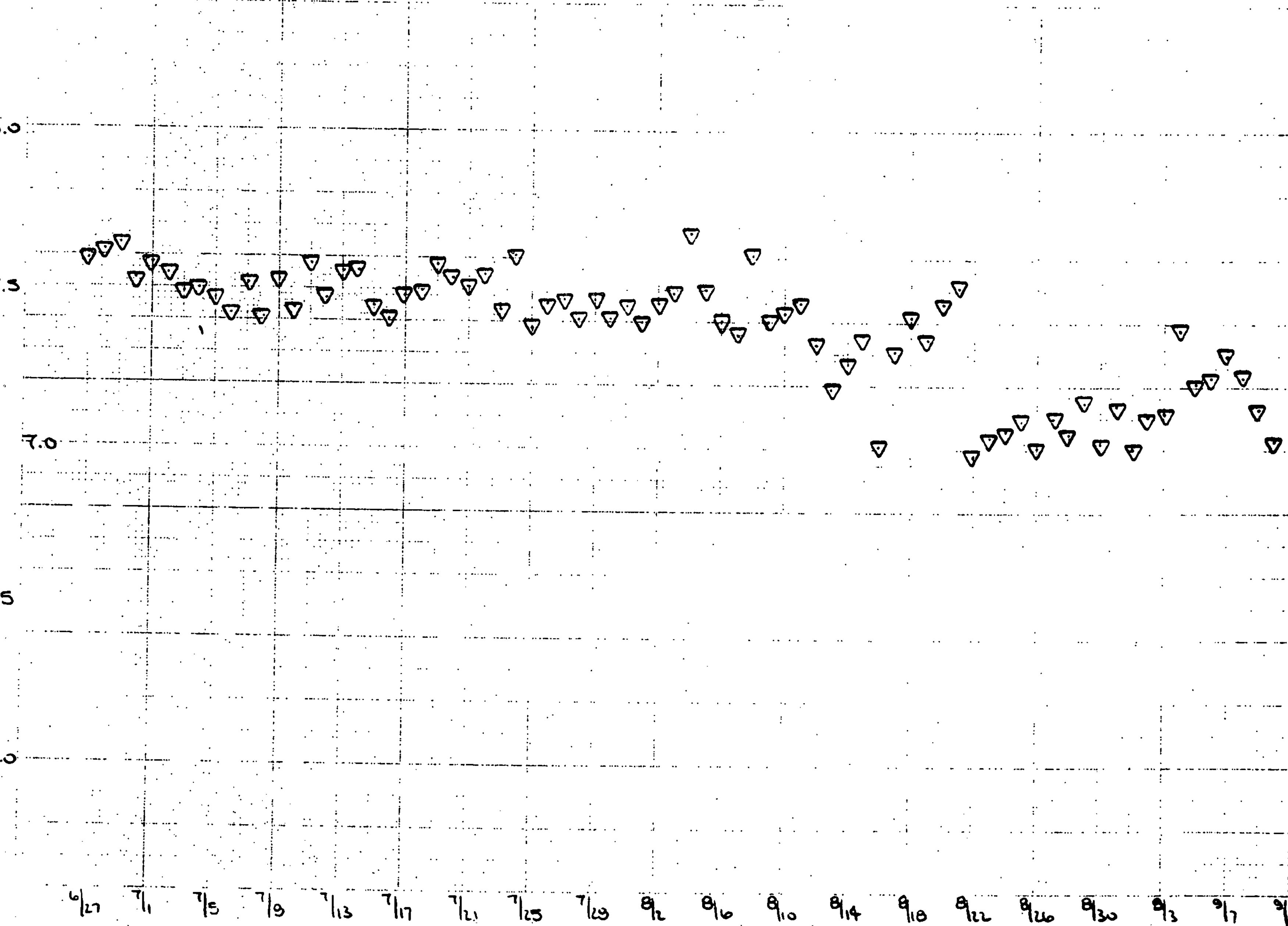


FIGURE 26 (Continued)

FERMENTOR CONTENTS ALKALINITY

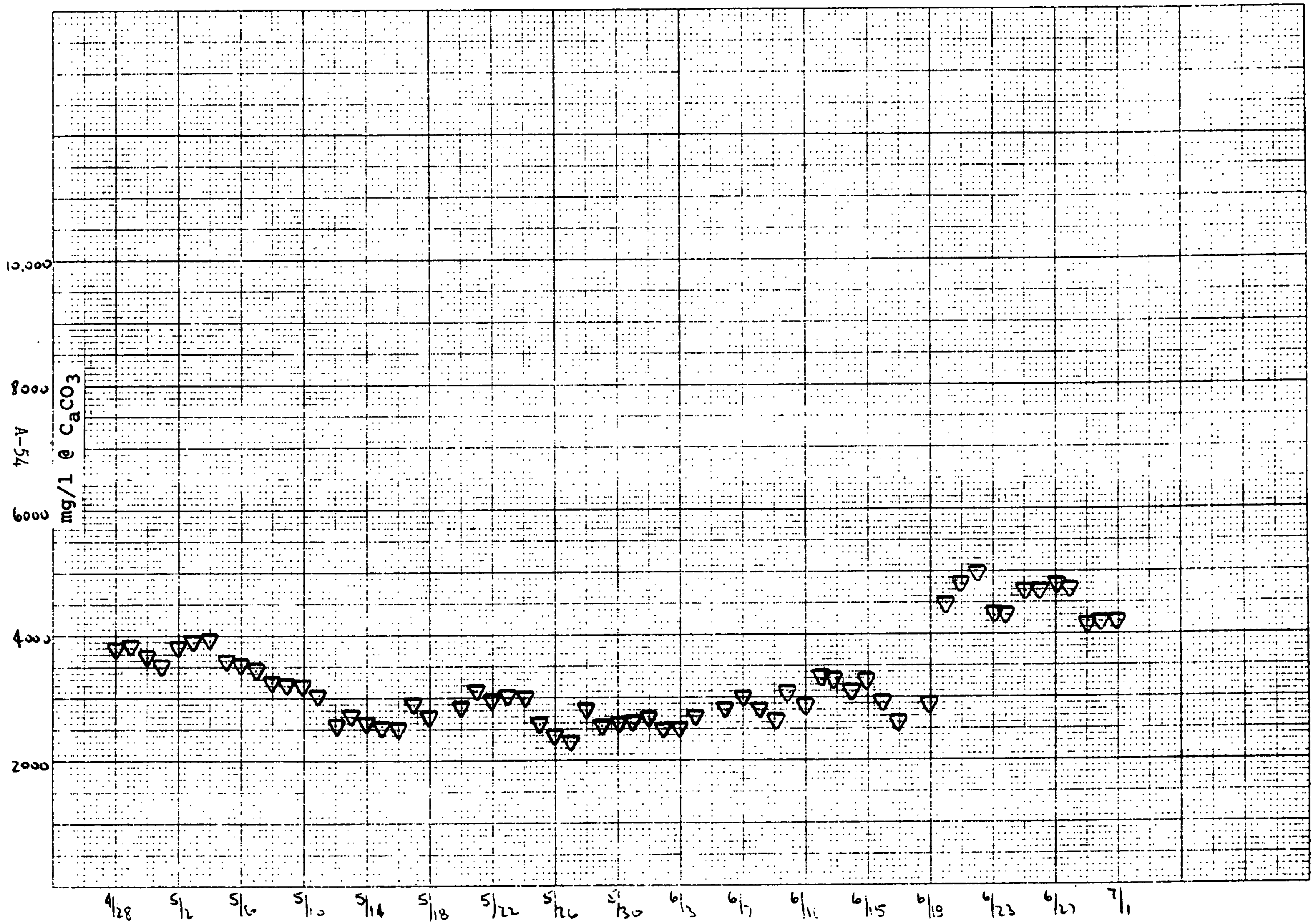


FIGURE 27

FERMENTOR CONTENTS ALKALINITY

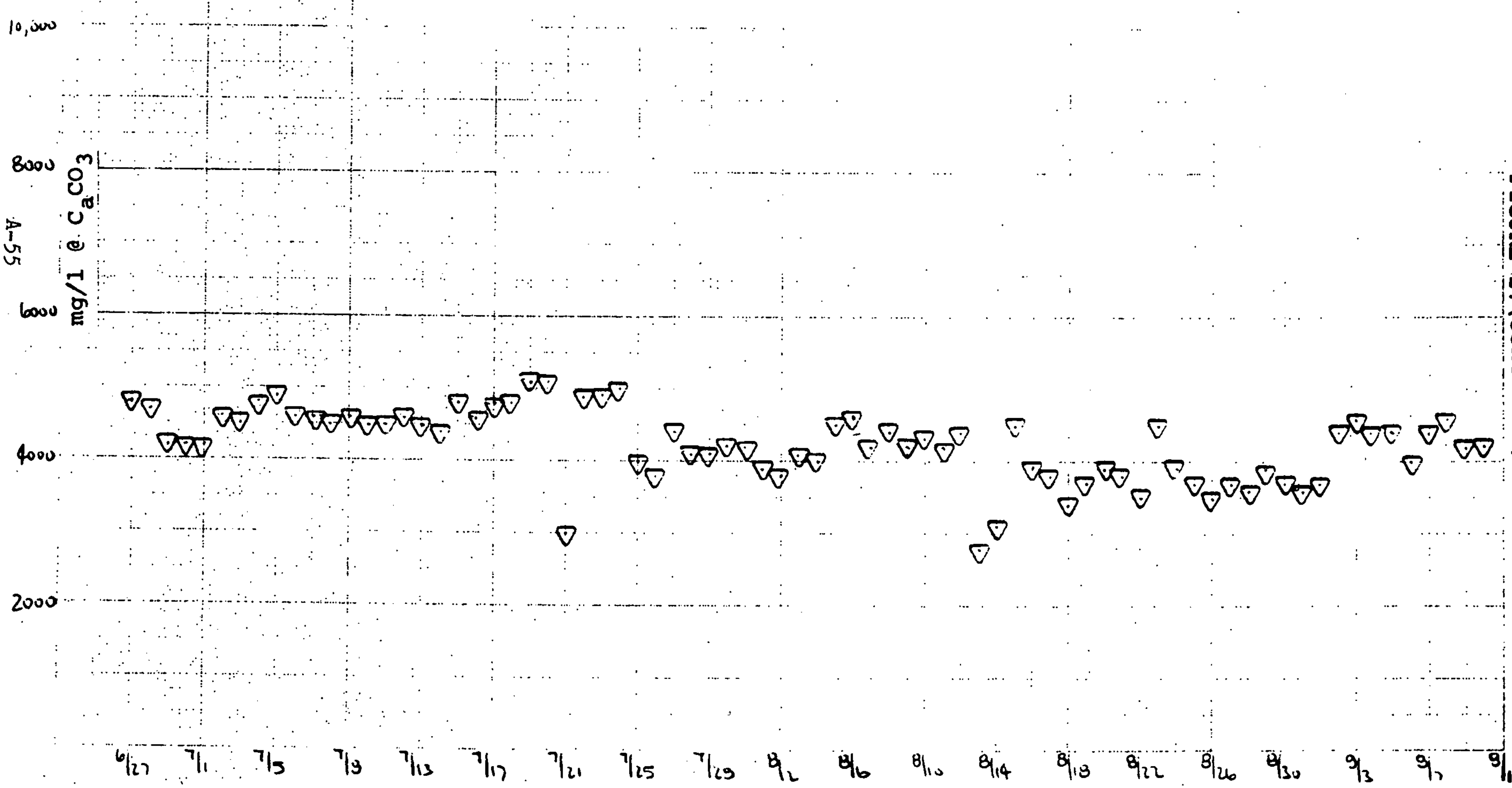
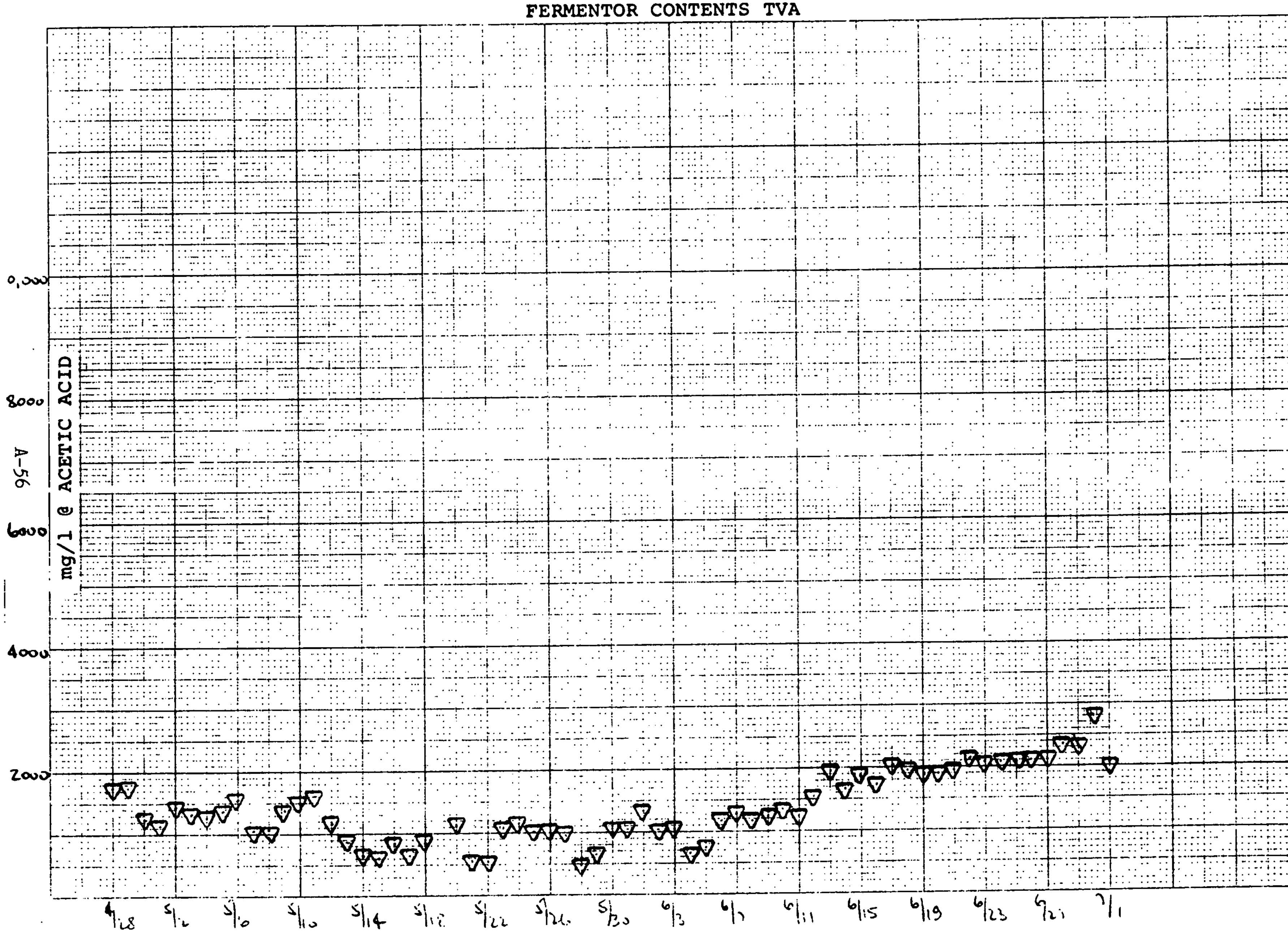


FIGURE 27 (Continued)

FERMENTOR CONTENTS TVA



A-56

FIGURE 28

FERMENTOR CONTENTS TVA

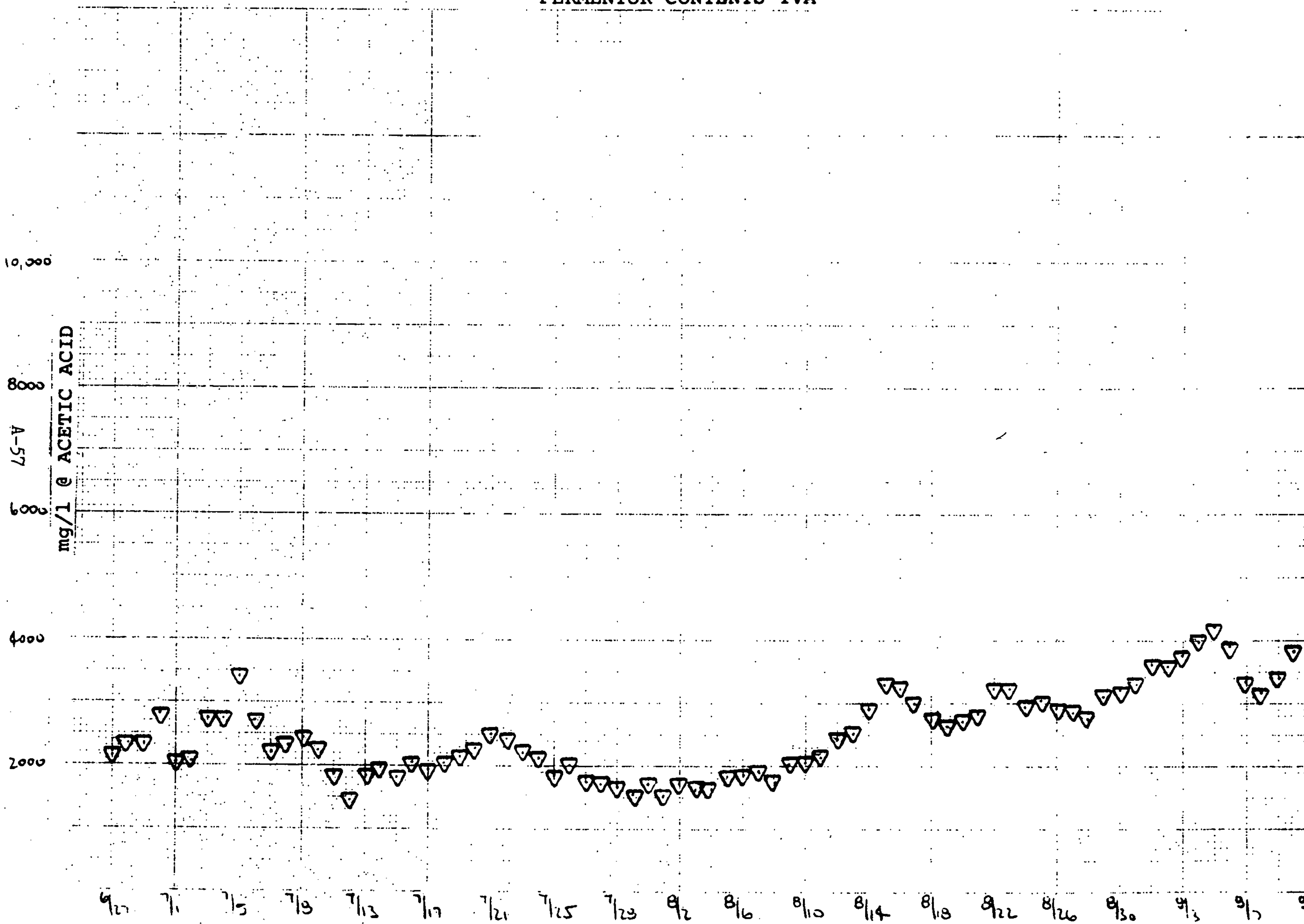


FIGURE 28 (Continued)

FERMENTOR TEMP

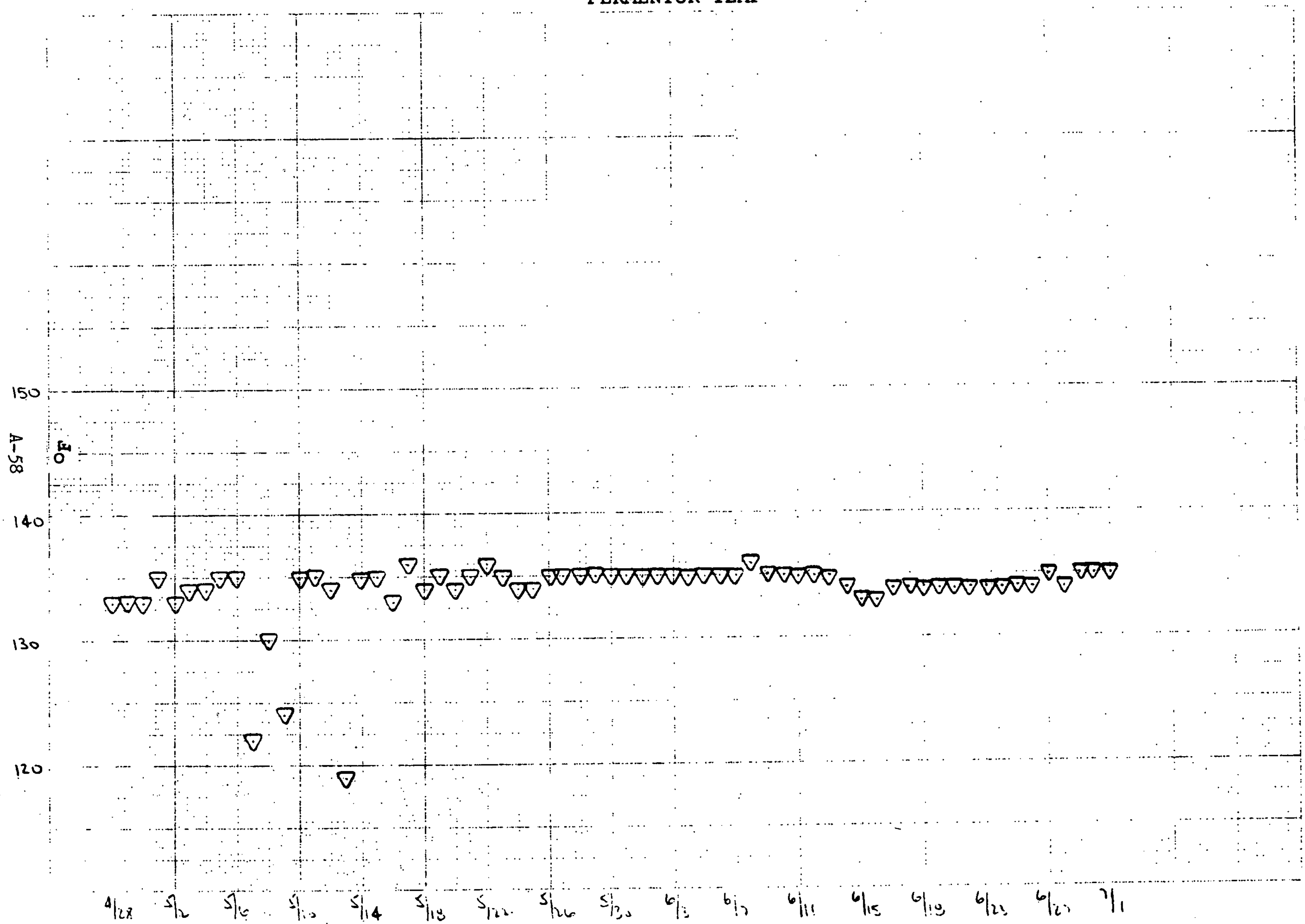


FIGURE 29

FERMENTOR TEMP

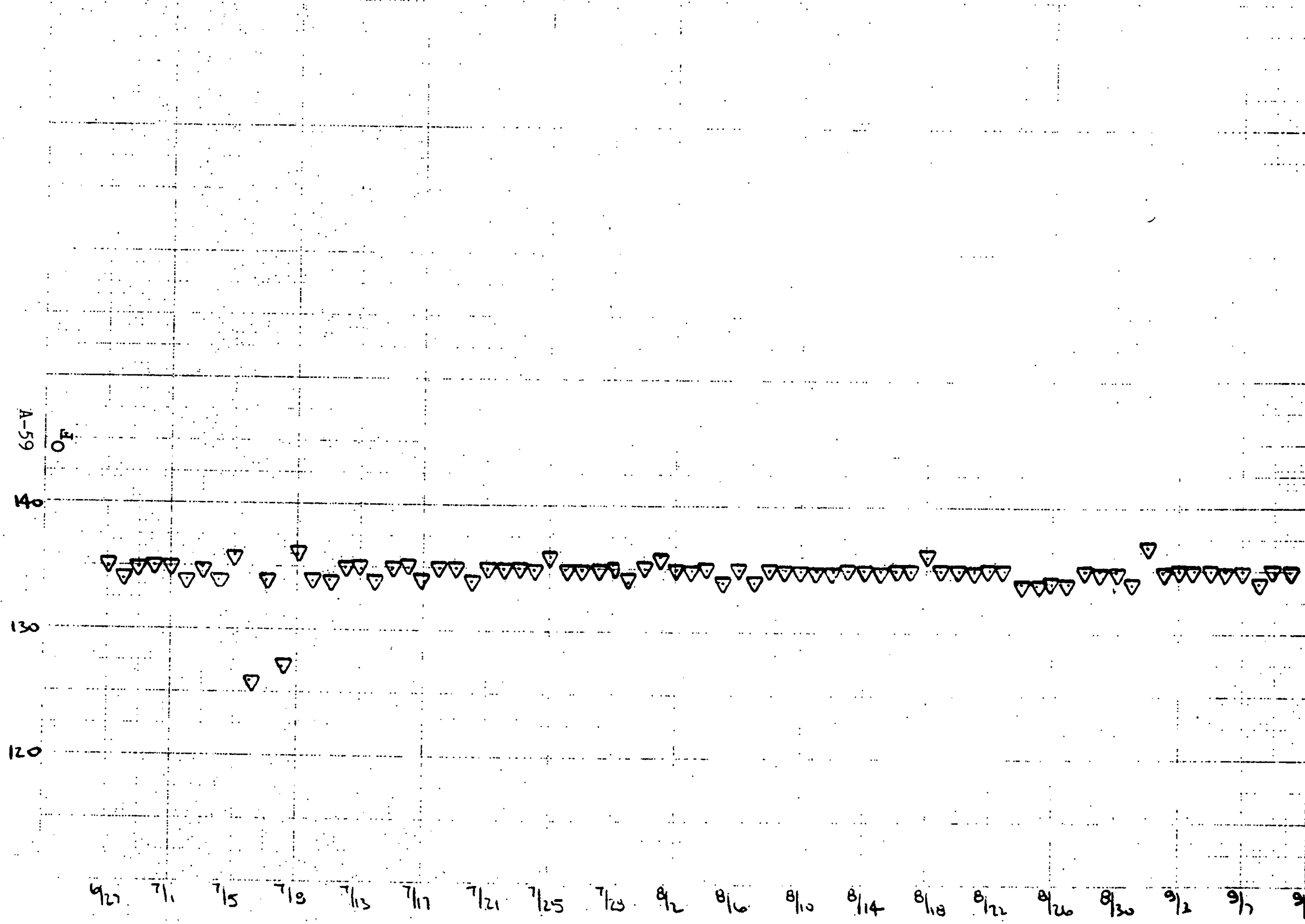
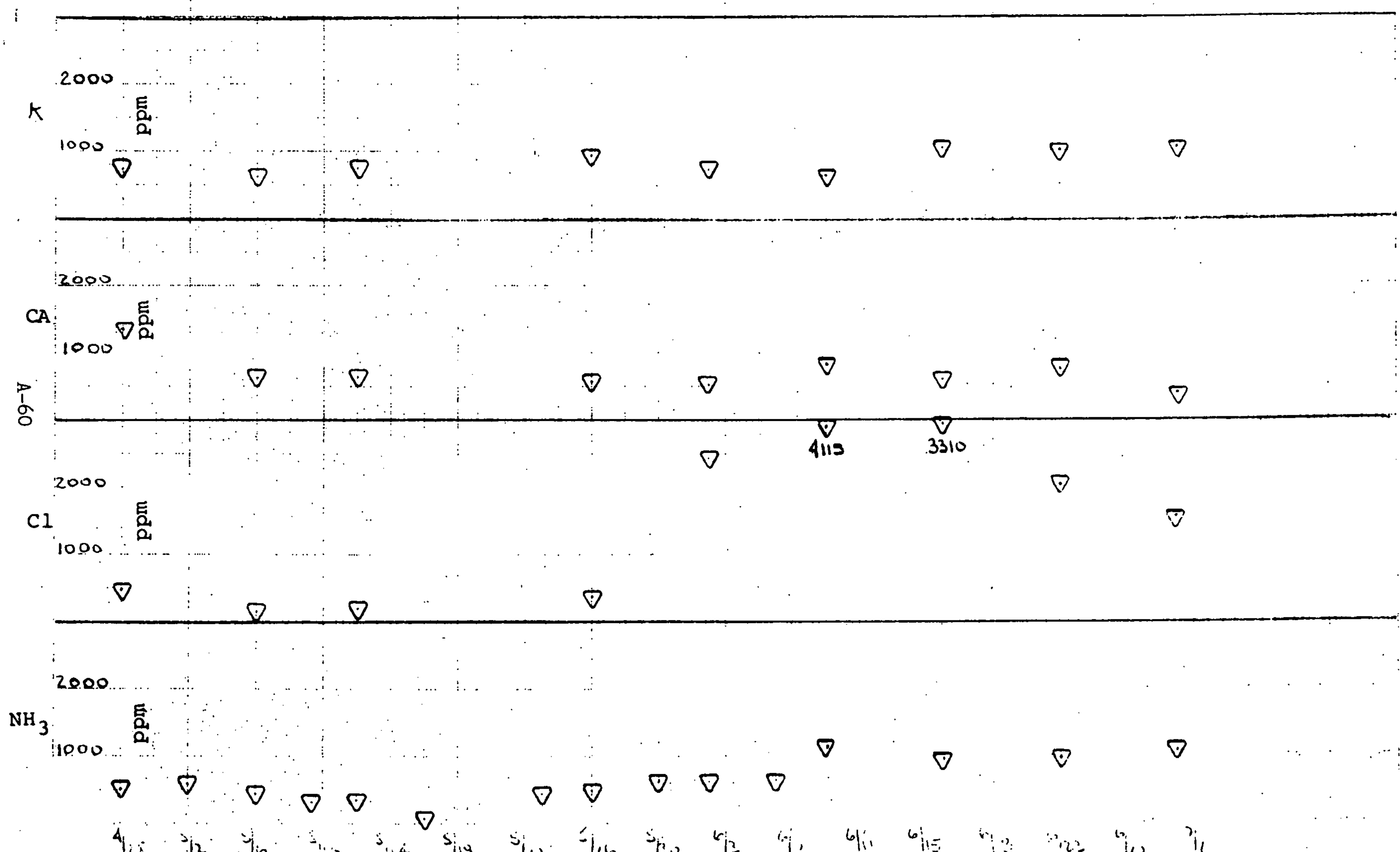


FIGURE 29 (Continued)

FERMENTOR CONTENTS-MISCELLANEOUS ANALYSES



A-60

FIGURE 30

FERMENTOR CONTENTS-MISCELLANEOUS ANALYSES

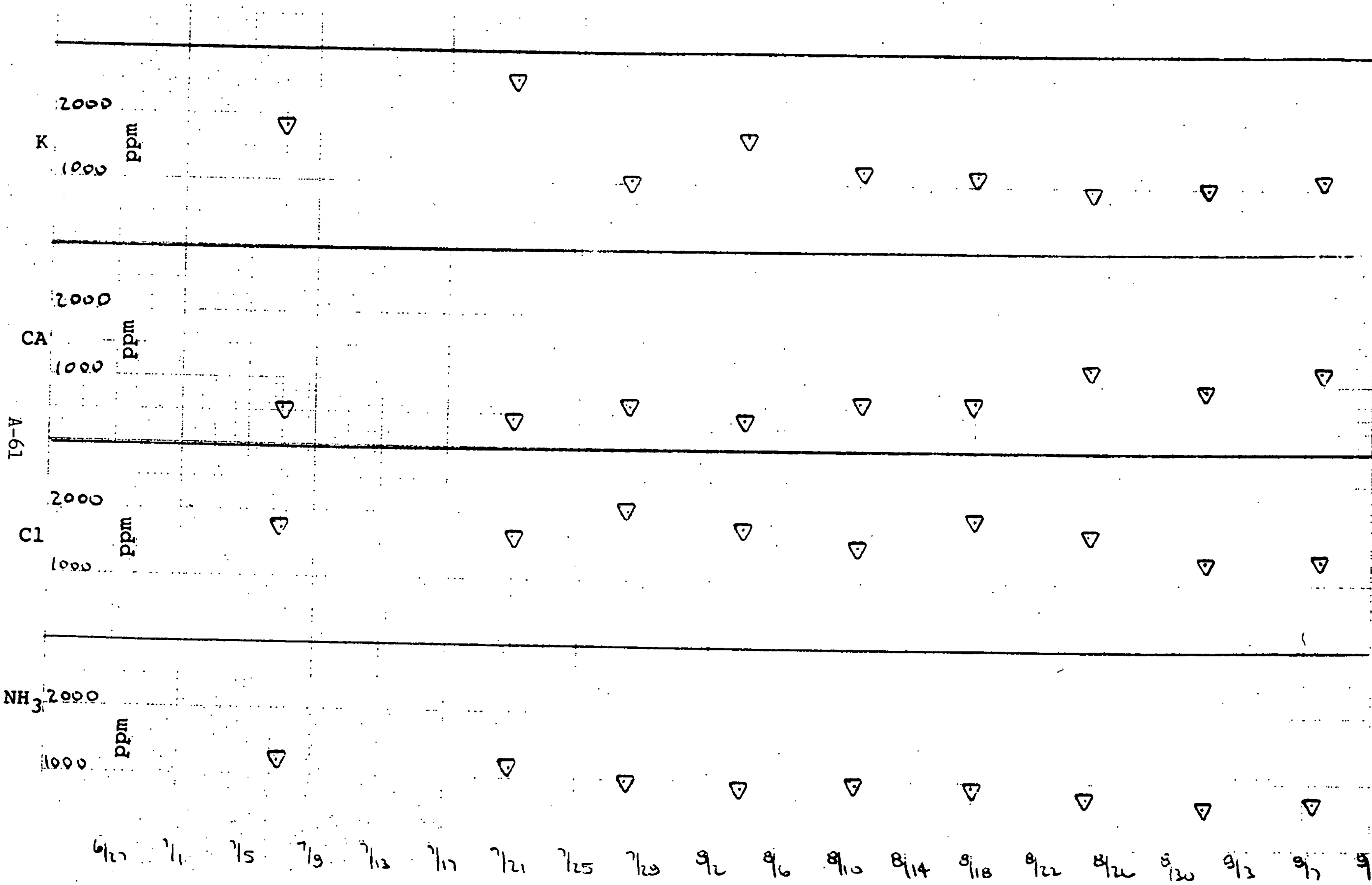


FIGURE 30(Continued)

FERMENTOR CONTENTS-MISCELLANEOUS ANALYSES

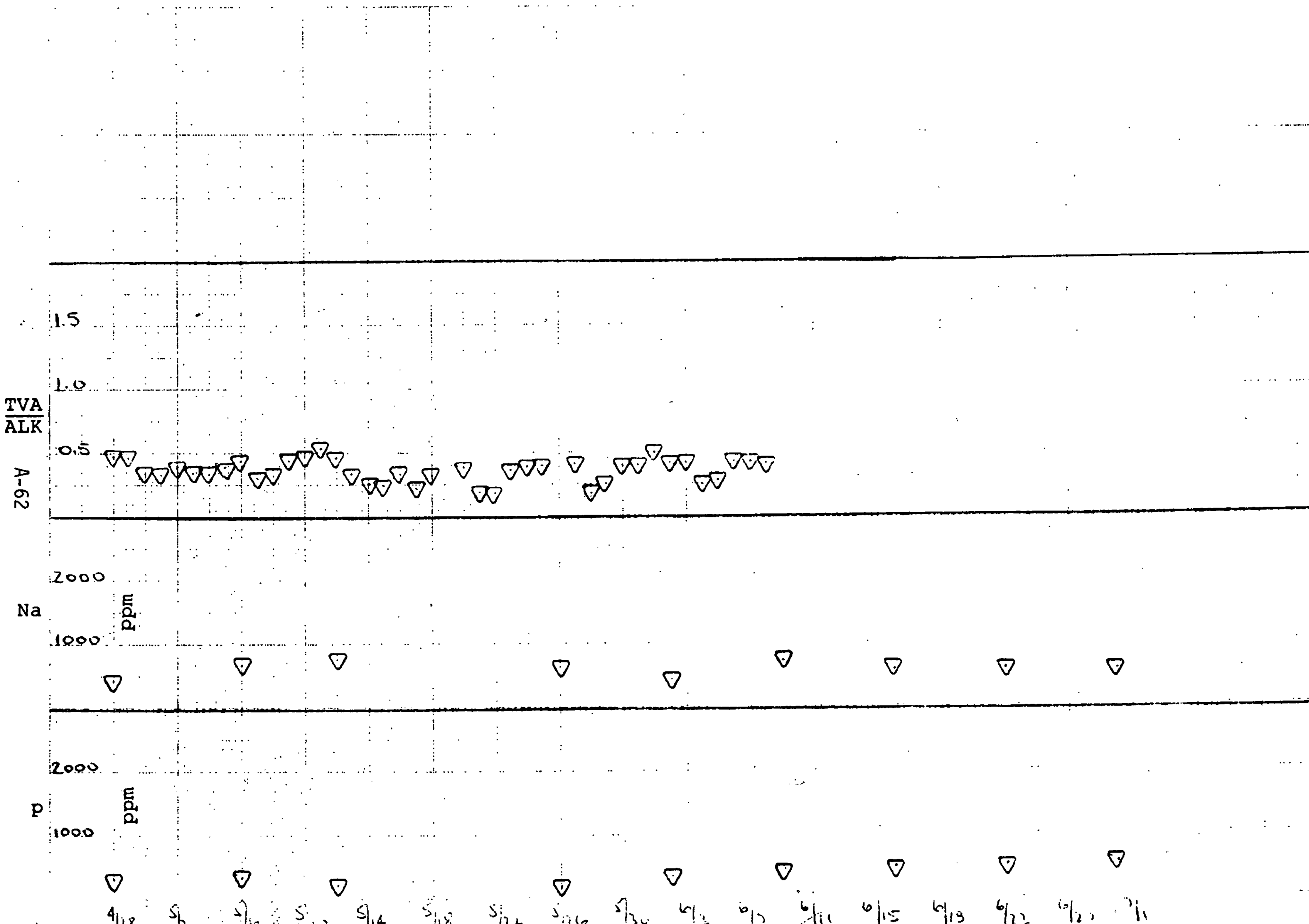


FIGURE 31

FERMENTOR CONTENTS-MISCELLANEOUS ANALYSES

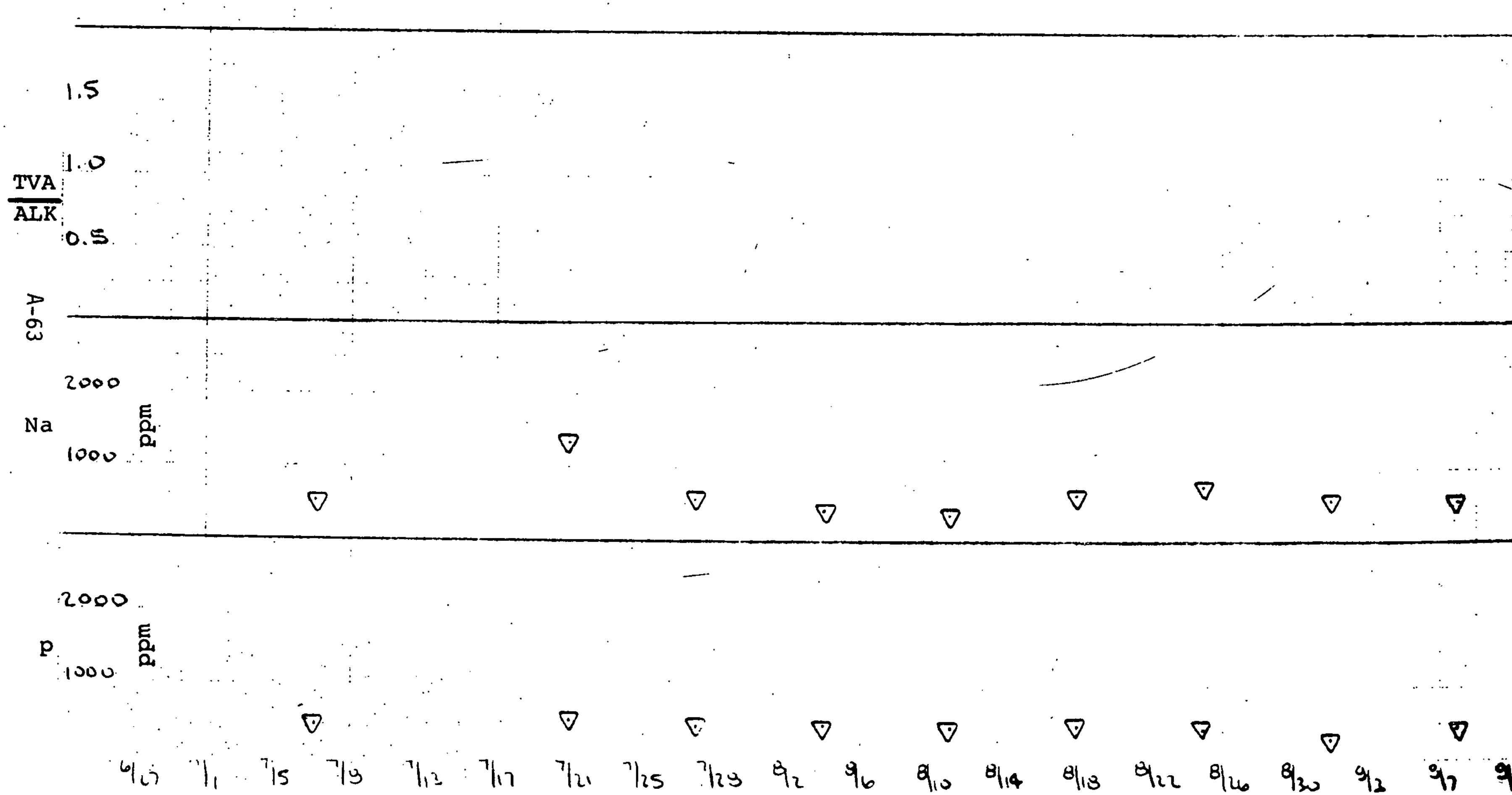


FIGURE 31(Continued)