San Antonio

Evapo-Transpiration

Pilot Study Report

1998

Conducted by:

Texas Agricultural Extension Service - Bexar County
Bexar County Master Gardeners
Texas A&M University

For:

San Antonio Water System

SAN ANTONIO EVAPOTRANSPIRATION ET PROJECT

MANAGEMENT, TRAINING AND ANALYSIS TEAM

Karen Guz
Joe Taylor
Calvin Finch, Ph.D.
Dee Emory
David Smith

WEATHER STATION

Guy Phipps, Ph.D.

VOLUNTEER MONITORS

Wilbur Watje
Russell Deniston
Cleon Warren
Carrie Hammer
Al Mote
Loris Perkins
Kim Kissinger-Ayala
Dennis Fortissain
Joe Taylor
Dee Emory

SAWS LIAISON

Conservation Director - Chris Brown

SAN ANTONIO EVAPO-TRANSPIRATION (ET) STUDY

In the summer of 1997 and '98 a partnership between the Texas Agriculture Extension Service and Bexar County Master Gardeners with funding from the San Antonio Water System conducted the San Antonio Evapo-Transpiration (**ET**) study. The first year of the project determined that an ET program for home lawns was feasible. A single weather station was appropriate for the whole area and common watering instructions could be utilized by area residents to maintain lawn performance and save water.

The objective in 1998 was to fine tune the instructions and determine how much irrigation was needed for the various turf types.

Table of Contents:

Executive Summary

For a number of years the Extension Service has been recommending one inch of irrigation per week applied to St. Augustine grass in the summer. The results of the San Antonio ET project indicate that the 1 inch per week recommendation is unnecessarily high. In 1998 at 100% of evapo-transpiration (E.T.) St. Augustine grass only required 16.5 inches of irrigation during a period where the 1 inch rule would have prescribed 24" of irrigation, a reduction of approximately one-third.

The savings were even greater for experimenters irrigating at the .70 of ET and .50 of ET. In all cases the appearance of St. Augustine grass declined in mid-summer but rebounded to its original spring rating in the fall.

Evapo-transpiration is the amount of water that is lost to a plant through evaporation from the soil and transpiration from the leaf surface. Potential evapo-transpiration (PET) is an approximation of that water loss by applying a species specific factor to a formula that utilizes daily temperatures, humidity, wind and rain. In San Antonio the weather data is collected by a weather station operating at the SAWS Jones Maltsberger Turfgrass/Xeriscape Management site. The site is managed by the Texas Agricultural Extension Service/Bexar County Master Gardeners. Evapo-Transpiration is calculated by multiplying PET values by an empirically derived co-efficient.

In addition to the determination that less water was needed to maintain St. Augustine grass, the experiment revealed that Bermuda grass performed as well at 70% of ET as it did at 100% and that buffalo grass performed best at 50% of ET. The experiment only included a few zoysia lawns. With limited evidence it appears that zoysia does best at 100% of ET.

Soil depth and bulk density measured as dry weight per unit volume were also factored in the experiment. The results were varied across different grasses and watering levels but it appears soil depth accounts for slightly more than 10% of lawn performance across all samples. In the case of Bermuda grass and to a lesser extent buffalo grass soil depth was more important than for St. Augustine grass. Soil weight/unit volume was not a major factor over all samples but buffalo grass at 50% of ET performed better in lighter soils. Soil weight accounted for 36% of lawn appearance rating for these buffalo lawns, reinforcing the belief that organic material in soils is a positive factor.

After studying the 1997 and 1998 results the staff and ET Advisory Committee recommended that a major ET initiative be launched in 1999 and 2000.

It would be useful to have more data on how lawns perform in the shade; the water requirements of the available selections of turf species; and the effect on lawns of dividing the irrigation into two applications per week. Until that data is available the committee believes significant water can be saved through the following recommendation: (1)The program would encourage homeowners with St. Augustine grass and zoysia grass in the sun to irrigate at the 100% of ET rate and homeowners with those turf varieties in the shade to water at the .70 rate. (2) homeowners with Bermuda grass would be encouraged to water at .70 of ET; (3) and those with buffalo grass at .50 of ET. The program would give homeowners who choose to participate the option to divide their water applications into two parts over the week.

It is recommended that the program provide an ET lawn watering kit to participants and launch an ambitious educational program through the media and community outreach. The media weather persons would be an important part of the area wide program. The estimated cost of the program would be $236,100 in 1999 and $136,100 in 2000. It is believed that 25,000 homes would potentially participate in an ET program and that they would save approximately 630 million gallons water per year.

Recommendation for 1999

Introduction

It is believed that based on the conclusions in this experiment that implementation of an area wide ET program will save considerable water in landscape watering.

The TV, radio and newspaper weather persons could provide ET data every day (the data would be offered everyday for the last 7 day period). Homeowners would apply the data to personal worksheets or if the program was simple enough, the reports would tell them what to water.

Watering would occur 1 day/week unless homeowners wanted to divide it into 2 applications. The Worksheet will provide guidance on watering once or twice/week

Homeowners would be enlisted at all SAWS and Master Gardener Events. Instructors would hold special ET days all around the city to enlist participants, and volunteer ET instructor for every neighborhood could be trained.

The program would begin in 1999 as soon as it could be authorized and funded with full implementation in 2000.

The city could be divided in four quadrants sliced from north to south (E of 35, between 35 and 281, between 10 and 281 and west of 10). Primary watering days would be designated for each quadrant with a second day designated for split irrigation application if that was a desirable option for some homeowners. To further reduce peak demand pressures we could divide quadrant watering by odd and even address. Other options would be designate watering days consistent with what they would be under drought restrictions or to let the homeowners decide themselves.

Interactive websites for youth and adults would be created and maintained by program staff.

A curriculum enrichment program for middle school and high school science teachers would be established. The goal would be to involve 20 teachers and 2,000 youth the first year and 40 teachers and 4,000 youth the second year. Youth would have incentives for collecting data at home and school sites.

The program could be operated by SAWS or subcontracted. The Extension Service and Bexar County Master Gardeners would be very interested in operating the program or a contractor could be selected by RFP.

ET Lawn Kit

Plastic Rain Gauge
ET "How it Works"
Sprinkler Rate Pans (with measuring scale inside)
Sprinkler Rate Testing Instructions
Personal Lawn Worksheets
ET Lawn Sign
Chart of Expected Water Savings

Media Orientations

Offer a breakfast and/or lunch hosted by the Mayor and County Judge to describe the program and how we would like it to work.

Estimated Water Savings

If this program was implemented the estimated water savings would be 630 million gallons per year. The estimate was made based on 25,000 homes with 1/8 acre of turf using 24" of irrigation now reducing to 16" with ET. Eight inches of water over 3125 acres equals 2093 acre feet of water per year. Two thousand ninety three acre feet equals approximately 630 million gallons/year.

Campaign Activities

Information at Public Events
- Earth Day
- Employee Fairs
- ET Booth at Rodeo
- Jazz Festival
- Special Neighborhood Events
- Spring Bloom Giveaway
- USAA Environmental Fair
- Viva Botanica

Video for Cable Station

Media Campaign
- Morning Shows
- Newspaper Columns
  - ...... SAG
  - ...... Scion
  - ...... Hortibull
  - ...... Express News
  - ...... Recorder Times
  - ...... Southside Reporter
  - ...... NSA times
  - ...... Senior Sentinal
  - ...... TAN
  - ...... TALC
- Radio Garden Shows
- SAWS Monthly Statements
- Talk Shows
- Weather Shows

Youth Activities
- ...... Compile Curriculum for Secondary Science Students
- ...... Interactive Website for teachers/students
- ...... Youth water Conference/Poster Contest for ET Science Projects

ET Information Website
- ...... Question & Answer Service via e-mail

Budget

ET Coordinator	$30,000
Fringe	4,500
Travel	2,400
Homeowner Kits (50,000 @ $2.00 each)	100,000
Clerical Support	20,000
Fringe	3,000
Media Luncheons	5,000
Display for Events	5,000
Office, Phones, Utilities	24,000
Volunteer Coordinator ½ time	12,000
Fringe	1,800
Travel	1,200
Youth Curriculum Coordinator 1/2 time	12,000
Fringe	1,800
Travel	2,400
Postage	1,200
Equipment Repair	5,000
Equipment	5,000
(Year 1)	$236,200
(Year 2)	$136,200

Recommended Timeline for 1999

2000 Recruitment	Jan-Jun. 2000
ET Team and Advisory (Committee discuss and revise)	Jan. 1999
Complete Final Report	Jan. 1999
Present Report and Recommendation to SAWS Board	Feb 1999
Complete Homeowner Package	Feb. 1999
Begin Implementation of Area wide ET Program	Mar. 1999
Hire staff and find office space	Mar. 1999
Manufacture Homeowner Package	Mar. 1999
Youth Curriculum Search & Compilation	Mar. 1999
Organize Speakers Bureau	Apr. 1999
Media Luncheon	Apr. 1999
Begin Recruiting Homeowners	Apr. 1999
Begin Media Efforts	Apr. 1999
Manufacture Display	Apr. 1999
ET Interactive Website	Jun. 1999
Implement Youth Curriculum	Sep. 1999
Implement Youth ET Website	Sep. 1999
Evaluate 1999 program	Dec. 1999
Evaluate 2000 Program	Dec. 2000

Definitions

Potential evapotranspiration (PET) is defined as the potential water use from a hypothetical cool season grass growing four inches tall under well-watered conditions. PET is used as a "reference" to which a particular turfgrass species is compared mathematically.

PET values can be calculated using several empirical methods developed through research. For The ET Study, the "Penman-Monteith" method is used. Several organizations such as the International Committee of Irrigation and Drainage and the Water Requirements Committee of the American Society of Civil Engineers have proposed establishing the Penman-Monteith method as a world-wide standard. In this method, PET is calculated on a daily basis according to weather input parameters, which are collected with automatic weather stations. Input data includes wind speed, relative humidity, temperature and solar radiation. Thus, PET rates will differ from location to location according to climate.

Texas ET Network and Web Site

Daily weather information is collected from an automated weather station located at the Jones-Maltsberger demonstration site in San Antonio. Data is downloaded via telephone/modem connection to the Texas ET Network center at the Agricultural Engineering Department at Texas A & M University in College Station. Data is then fed into a program to calculate PET. PET values are immediately reported on the Texas ET Network web site,http://texaset.tamu.edu and becomes accessible for use in irrigation scheduling.

Application

PET is an important tool for predicting water lost to specific plants through *evaporation* of water from the plant surface and the water lost to *transpiration* through the plant, or **evapotranspiration (ET)**. To obtain the ET for specific plants, the PET value is multiplied by a turf (or crop) coefficient (Tc), which represents the percentage of PET that a specific turfgrass will use. For example, a turf coefficient of 0.6 represents warm season grasses, such as St. Augustine, Bermuda, buffalo and zoysia. A turf coefficient of 0.8 is used for cool season grasses such as tall fescue.

Example: PET = 0.25 inches of water per day
Tc = 0.6
Water Use, or ET = 0.25 x 0.6, or **0.15 inches of water**

Differences in growth characteristics and drought response among warm season grasses are visible. Buffalo, for example, exhibits a higher drought tolerance that St. Augustine. For this reason, an allowable stress factor must be included as part of the equation to determine the amount of water required for each type of grass for acceptable quality and appearance. This project studies allowable stress values of 100%, 70%, and 50% for each of the four warm season grasses above while at the same time measuring the quality and appearance of the turf using a rating scale.

Bulk Density - soil bulk density is the ratio of the mass of the soil to the total or bulk volume of the soil (gms/cm3).

E.T. monitors removed soil samples in three sites of each lawn, the top two inches of each sample was removed, then the next 3 inches of each sample were placed in a paper bag which was then air-dried at Texas A&M and the samples were then weighed and weight information was returned to the Bexar County office for dry soil bulk density calculation.

Soil Depth - soil depth is the average soil depth in lawn turfgrass sites. E.T. monitors measured soil depth in 3 areas of each turfgrass site. The soil depth was then averaged to come up with the means soil depth of each participating lawn site.

Methods and Materials

The Evapo-Transpiration (ET) pilot study began in 1997 and a follow-up study continued in 1998. Volunteers from the Bexar County area monitored turfgrass quality and followed a weekly watering schedule determined by Evapo-Transpiration or "E.T." Homeowners watered on Monday evening or Tuesday morning.

Potential Evapo-Transpiration and weather summary data is collected by an automated weather station located at the corner of Jones-Maltsberger and Loop 410 North. The weather station data collection includes the date, the maximum temperature, minimum temperature, relative humidity, solar radiation, average wind speed and rainfall. This information is transmitted to Texas A&M University where the information is analyzed. The PET (Potential ET) is calculated and the crop coefficient applied to produce the Evapo-Transpiration (E.T.) in inches per day. This information is recorded and updated on a daily basis and available on the web at **http://texaset.tamu.edu**.

In 1998 homeowners for the Bexar County ET Project were recruited in several ways. Those experimenters who were punctual and accurate in providing data in 1997 were invited to participate again in 1998. Additional individuals were recruited by soliciting volunteers through messages in CEA Finch's Express-News, Southside Reporter, Northside Recorder, North SA Times, SA Gardener and Scion articles. He also announced the need for experimenters on his KLUP radio program. Other experimenters were recruited through solicitations at Master Gardener training classes.

The goal was to have a volunteer monitor for every 5 experimenters. The monitors for 1998 were Master Gardeners and lawn experimenters from 1997. Potential monitors were recruited in the Scion Newsletter (Bexar County Master Gardeners). Other candidates were directly recruited by ET staff members.

A team of ET staff members and a monitor in the prospective candidate's neighborhood visited the lawn to determine its suitability. Lawns in full sun with at least 4 inches of soil and rated at least a 2 were sought. The choice was further defined by trying to select 9 St. Augustine lawns, 3 Bermudas, 3 buffalos and 3 zoysias in each of the four quadrants.

Homeowners selected had to sign an agreement (copy in appendix) that outlined their responsibilities. They also had to agree to attend one of 2 training sessions scheduled for their benefit. The training session covered how to measure irrigation output, the goals of the experiment, introduction to their monitor, how to complete required paperwork, how to obtain the weekly ET information over the phone, and the required lawn cultural practices. Each participant received an instruction manual (appendix).

The team determined soil depth by applying a soil probe in three locations and then using a plastic ruler to measure soil depth. The locations to probe were selected in the center and to the east and west portion of the test area.

Experimenters rated their lawns every week and submitted the information to the monitor every month. Ratings were conducted from 05/14/98 through 11/16/98. If the data appeared inaccurate (wildly fluctuating, etc) or was late it was the volunteer monitors job to confer with the homeowner.

The monitors were also responsible for collecting the data from moisture meters placed in their lawns (5 total meters).

The environmental coordinator collected the data from the monitors. It was her job to again examine the data provided and send the monitor back to the experimenter if there were questions.

Late in the experiment (November) members of the staff team and monitors collected soil samples to determine bulk density. A 91.44 cm soil probe was used to collect a cu. cm sample from the center of the turf area. The sample was sent to Texas A&M where it was dried at 120°C and weighed. The weight was then divided by volume (5.98 cu.cm) to determine bulk density.

Lawn rating means were calculated and graphed. Ratings by quadrant, turf variety, and watering regime, moisture meter readings, and ET values were graphed. Correlations and multiple regressions analysis were run on soil depth, bulk density and water use.

On July 6 Stage 3 drought restrictions were implemented forcing experimenters to water according to guidelines under the restriction. The restrictions took away the flexibility for experimenters to water on Monday or Tuesday and required watering on Tuesday or Thursday depending on whether experimenters had an odd or even address. ET data was offered on Monday and Wednesday after restrictions were imposed.

The ET Advisory Committee consisted of volunteers from the Bexar County Horticultural Advisory Committee supplemented by monitors from the ET program. Staff completed preliminary reports for meetings on August 31, November 2 and January 12. The data and tentative conclusions were discussed and revised through the discussions.

ET PROJECT ADVISORY COMMITTEE

Abernathy, Scott	Extension Assistant - Urban Water Management
Chris Brown	San Antonio Water Systems
Dennison, Russell	ET Monitor
Emory, Dee	Bexar County Master Gardeners
Finch, Calvin Dr.	ET Project Team
Fipps, Guy	Associate Professor and Extension Agricultural Engineer
Fortassain, Dennis	ET Monitor
Guz, Karen	ET Project Team
Hammer, Carrie	ET Monitor
Kissinger-Ayala, Kim	ET Monitor
Mote, Al	ET Monitor
Mullens, Vernon	Bexar County Master Gardener
Perkins, Loris	ET Project Monitor
Smith, David	Extension Associate Landscape Irrigation
Suarez, Frank	Landscaper Contractor
Taylor, Joe	ET Project Team
Taylor, Gene Dr.	Assistant Professor and Extension Turfgrass Specialist
Troy, John	Landscape Architect
Wahnke, Mary	Irrigator
Warren, Cleon	ET Monitor
Watjie, Wilbur	ET Project Team
Zavala, Leticia	Landscape Contractor

Discussion and Results

1. Water use at 100% of **ET** used in this experiment was about 2/3 of the water used at the recommended 1" per week rate. The 70% and 50% of the water respectively were compared to the 1" per week rate **(Table 1).**

2. The extreme weather in 1998 (record heat and drought plus record rainfall and cool) was generally stressful for turf. There were relatively large variations in ratings through the year. St. Augustine, Bermuda and Zoysia (small sample) showed the least variation at 100% of **ET**; Buffalo at 50% of ET **(Table 2).**

3. Effort was made to select lawns for the experiment that had at least 4 inches of soil. Three samples were taken from each lawn with a soil probe and the samples was averaged. Mean soil depth ranged between 4.5 and 10" **(Table 3)**. The average was used for the analysis in Table 4.

   As in 1997, the results in this experiment indicate that soil depth accounts for about 13% of the lawn rating and standard error (variation) **(Table 4).** The importance of soil depth is very important to Bermuda grass, the deeper it is, apparently, the better the lawn is rated especially at low irrigation levels. Buffalo shows the same relationship but to a lesser degree.

4. Bulk density is a measure of weight for unit volume. It is a measure that reflects the amount of soil and air spaces. A heavy bulk density is a dense soil.

   The results indicate that bulk density is not a good predictor of mean lawn rating or variation for lawns overall. The r^2 values are nearly 0 for all samples **(Table 5).** At low irrigation levels, however, bulk density has a high correlation with lawn rating. The higher the bulk density, the lower the mean lawn rating for Buffalo and St. Augustine **(Table 5).** The opposite relationship existed for Bermuda grass. It seemed to perform better in dense soils. There also seemed to be a less clear but a general correlation that there was less variation in lawn ratings for grasses on dense soils.

5. At 100% of **ET** St. Augustine showed a slower summer decline, quicker recovery when the rains returned and a higher final rating. At 50% of **ET** St. Augustine showed the quickest and deepest decline. At all levels of irrigation St. Augustine eventually returned to the original rating **(Figure 3) (Table 6).**

6. At 50% of **ET** Buffalo grass showed a summer dip but ended the year with an improved rating. Buffalo lawns with no irrigation showed a similar pattern but were slower to recover. Buffalo lawns watered at 70% of ET were slower to begin their decline but fell just as deeply. Seventy percent Buffalo lawns were erratic in their ratings and the heavy rains in the fall seemed to affect them more negatively than the 50% and no irrigation lawns **(Figure 4, Table 7)**.

7. Bermuda lawns watered at 100% of **ET** improved by the end of the year. Lawn ratings dipped later and more shallowly in the summer, and their was a quicker recovery in the fall than the other watering patterns. However even the 50% of **ET** Bermuda lawns recovered quickly in the fall **(Figure 7) (Table 8)**.

8. There were very few Zoysia lawns in the experiment. Like, 1997, the ratings were rather erratic. It is suspected that some Zoysia selections are very drought tolerant and others are not. More variety tests must be conducted to identify which selections are drought tolerant **(Figure 8) (Table 9)**.

9. As in 1997, it did not seem to matter which quadrant of the city in which you lived **(Figures 1-13)**.

10. The weather was less severe in 1997 and less irrigation was required but the results overall showed consistent patterns **(Table 10) (Tables 11a and 11b)**. Watering by **ET** saves water over the 1" recommendation and lawns recover after a summer decline **(Table 10)**.

11. Volunteers were an important part of the '97 and '98 experiments. They would probably contribute to the '99 implementation as neighborhood mentors, speaker bureau instructors and as resources at events.

12. The use of monitors and volunteer lawn experimenters was more effective in 1998 than in 1997. There was still some late data and strange data did manage to pass undetected through to the analysis.

13. The ET Advisory Committee was very effective in reviewing and discussing the experiment results and conclusions. It included irrigators, monitors, horticulturists and water conservation expert that were informed and interested in the results.

14. Table 4 would indicate that soil depth accounts for about 13% of the lawn rating. Deeper soil would mean a better mean lawn rating. In the case of St. Augustine, the results of the table indicate that overall, deeper soil has a negative impact on lawn appearance especially in the case of high irrigation rates. (Figure 14) reflects the relationship. It would appear that St. Augustine grass appearance at low water availability (50% ET) does benefit by more soil depth.

15. Buffalo grass and Bermuda grass results reinforce the idea that soil depth is more important to lawn appearance at low rates of irrigation. In the case of buffalo grass the same relationship exists as in the St. Augustine lawns. Deep soil contributes to poorer lawn ratings at high levels of irrigation.

    In the case of Bermuda, however, soil depth is a positive factor in mean lawn rating no matter how much water is applied.

16. Standard Error is a measure of variability. The higher the positive correlation the more that soil depth contributes to variation in the lawn rating. Overall soil depth contributes slightly to variation. The most striking relationship evident in Table 4 is that soil depth reduces variation in every lawn type as less irrigation water is available compared to higher levels of irrigation.

17. Bulk density is a measure of the density or compactness of the soil. Table 5 indicates for all samples there is little impact (.0135) on lawn rating. There is much variation, however, in this relationship.

    St. Augustine ratings benefit by high density soil at high irrigation, lower bulk density predicts poorer rating (Table 5). The relationship for Bermuda grass is just the opposite of St. Augustine grass for bulk density - heavy soils relate to higher ratings at high irrigation levels and to lower ratings at low irrigation levels. Buffalo responds negatively to more dense soils at high or low irrigation levels.

18. It is easy to grasp the idea that deeper soil provides a larger reservoir for rustling water and nutrients and thus it was a major factor in lawn appearance and variation at low water availability. It is also easy to see why soil depth becomes less a factor as more water is available but an explanation for why deep soil may negatively affect soil appearance at 100% of ET is less apparent.

Potential explanations may include more plants in deeper soils such as trees that compete more successfully with turf. Turf in deeper soils may have a wider distribution of roots. With summer drought roots in the deeper part of the soil become non-functional due to lack of O_2 or anaerobic activity.

19. Further exploring the relationship of the turf grasses with multiple regression analysis reveals that water is the only variable measured in this experiment that is significant (p=.10) for mean rating when all samples are included (Table 12). Water is also the only significant variable affecting variation measured standard error (Table 13). The mean lawn rating increases (lower score) as more water was applied (Figure 15).

20. In examining St. Augustine grass a similar relationship is evident. Water applied has the most influence over lawn rating (Table 14, 15 and Figure 16 and Figure 17).

21. For Bermuda grass none of the p values is less than .10 indicating that none of the variables has a significant effect on lawn rating for Bermuda at the p=.10 level (Table 16). For mean lawn rating depth is the most influential variable at p=.24. For standard error water is the most influential variable at p=.38. (Table 7).

22. Mean lawn rating for Buffalo grass is significantly affected by both depth and bulk density (weight) at the p=.10 level (Table 18). None of the variables have as great an influence on standard error (Table 19). Buffalo grass appearance improves to the depth of ≈ 8 inches and then decreases (Figure 18).

23. Only 4 zoysia grass samples were available, not enough data for a multiple regression analysis (Table 20 and Table 21).

24. On Table 4 50% Buffalo grass is a treatment with a relatively large number of samples and soil depth seem to have a positive effect on lawn rating.

25. Table 22 verifies that both depth and bulk density affect mean lawn rating. Up to about 8 inches in depth, depth improves lawn appearance (Figure 20). The lighter the soil the lower the appearance score (Figure 21). A low score translates to high appearance rating.

Table 1: Water Use for 1998 ET Participants					
Week	**Date**	**Rain**	**100%**	**70%**	**50%**
1	5/4	None	.75"	.5"	Wait
2	5/11	None	.75"	.5"	.5"
3	5/18	None	.5"	.25"	Wait
4	5/28	None	.75"	.5"	.5"
5	6/1	None	1"	.75"	.5"
6	6/8	None	1"	.75"	.5"
7	6/15	.5"	.5"	Wait	Wait
8	6/22	None	1"	.75"	.5"
9	6/29	.5"	.75"	.5"	Wait
10	7/6	.2"	.5"	Wait	Wait
11	7/13	None	1"	.75"	.5"
12	7/20	None	1"	.75"	.5"
13	7/27	None	1"	.75"	.5"
14	8/3	None	1"	.75"	.5"
15	8/10	.5"	.5"	Wait	Wait
16	8/17	None	1"	.75"	.5"
17	8/24	3.1"	Wait	Wait	Wait
18	8/31	None	Wait	Wait	Wait
19	9/7	None	1"	.5"	.5"
20	9/14	1"	Wait	Wait	Wait
21	9/21	.3"	.5"	Wait	Wait
22	9/28	None	.75"	.75"	.5"
23	10/5	.3"	.75"	.5"	Wait
24	10/12	1.6"	.5"	Wait	Wait
25	10/19	14.1"	Wait	Wait	Wait
26	10/26	.1"	Wait	Wait	Wait
27	11/2	.9"	Wait	Wait	Wait
28	11/9	None	Wait	Wait	Wait
29	11/16	None	Wait	Wait	Wait
TOTAL			16.50	10.00	6.00

Table 2: Summaries 1998			
	100%	**70%**	**50%**
Total Irrigation	21	16	12
Total Water Applied	16.5"	10.0"	6.0"
Initial Rating			
St. Augustine	1.33	1.45	2.17
Buffalo	2.06	1.33	2.00
Bermuda	2.33	1.50	1.25
Zoysia	1.00	1.00	--
Final Rating			
St. Augustine	1.22	1.55	1.89
Buffalo	2.25	2.00	1.92
Bermuda	1.33	1.63	1.63
Zoysia	2.00	2.33	--
Difference Between Initial and Final Rating			
St. Augustine	↓0.11	↓0.11	↓0.28
Buffalo	↓0.25	↓0.67	↑0.28
Bermuda	↑1.00	↓0.13	↓0.38
Zoysia	--	↓1.33	--
Variation *			
St. Augustine	4.22	6.16	5.5
Buffalo	6.00	5.67	3.71
Bermuda	3.33	6.00	6.38
Zoysia	5.00	5.00	--

* Variation any change in rating week to week in all lawns in the sample divided by total lawns in the sample.

(Figure 1)

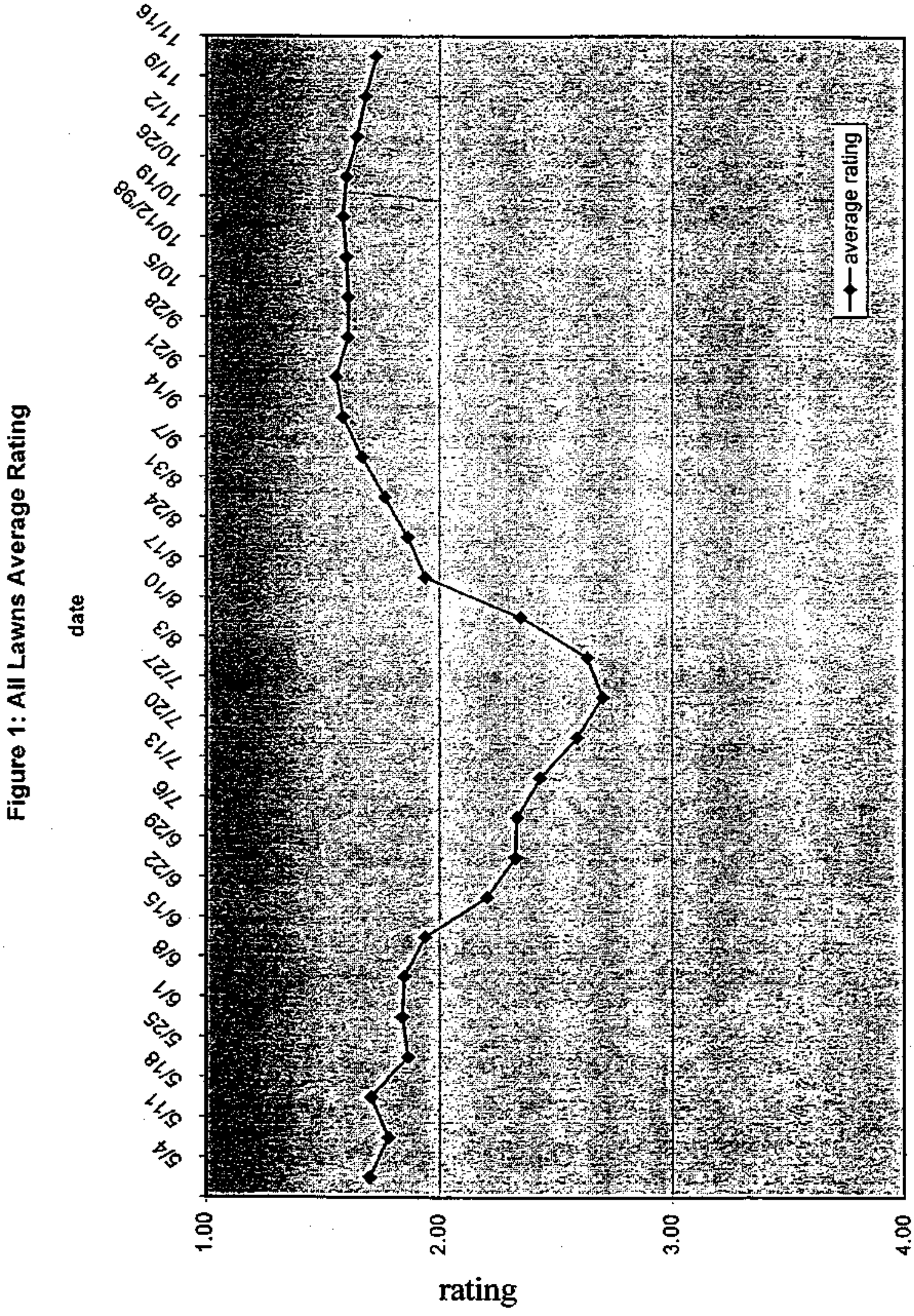
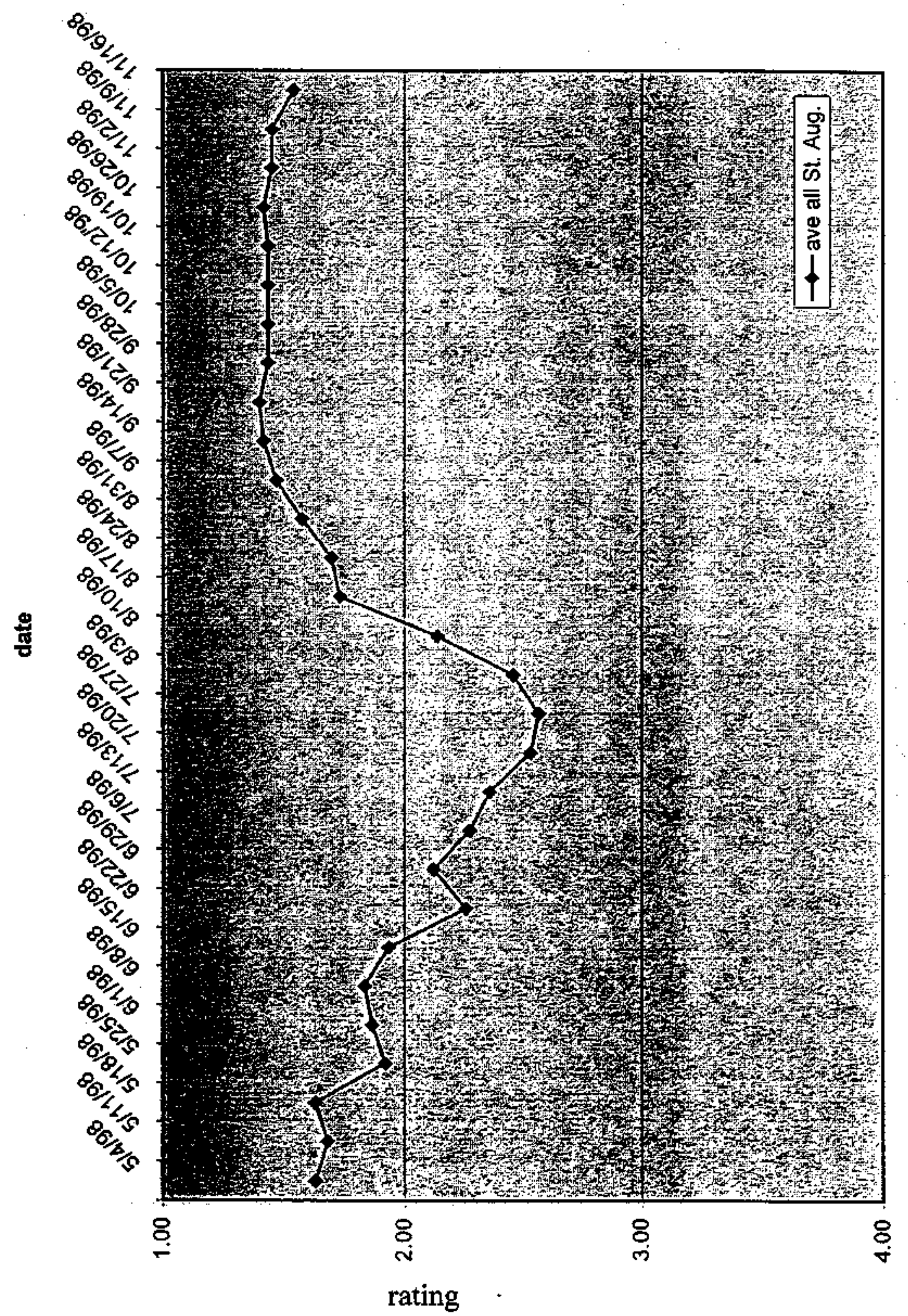


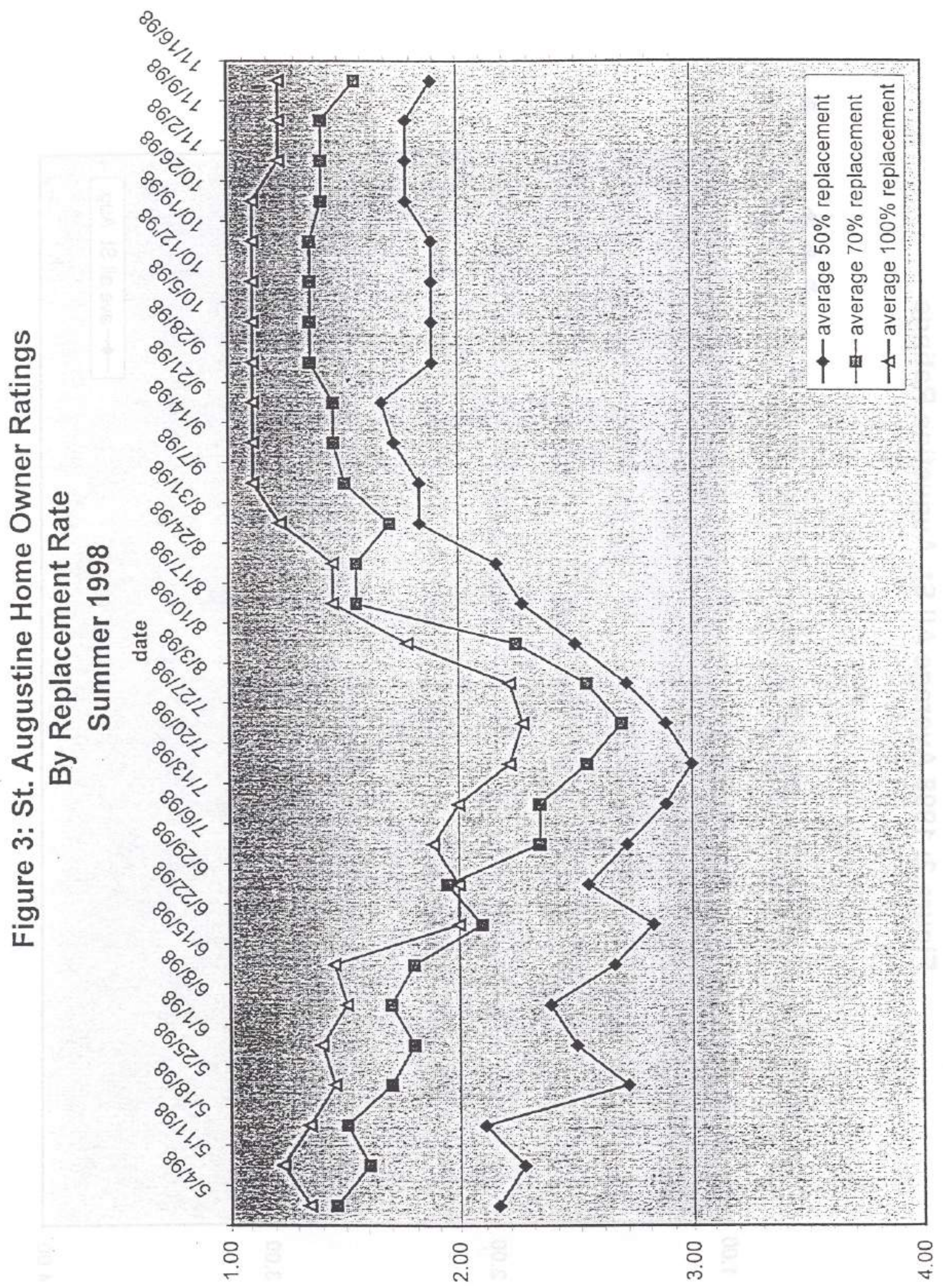
Figure 1: All Lawns Average Rating
date
5/4
5/11
5/18
5/25
6/1
6/8
6/15
6/22
6/29
7/6
7/13
7/20
7/27
8/3
8/10
8/17
8/24
8/31
9/7
9/14
9/21
9/28
10/5
10/12/98
10/19
10/26
11/2
11/9
11/16
1.00
2.00
3.00
4.00
rating
average rating

(Figure 2)

Figure 2: 1998 Average All St. Augustine Ratings



(Figure 3)



rating

(Figure 4)

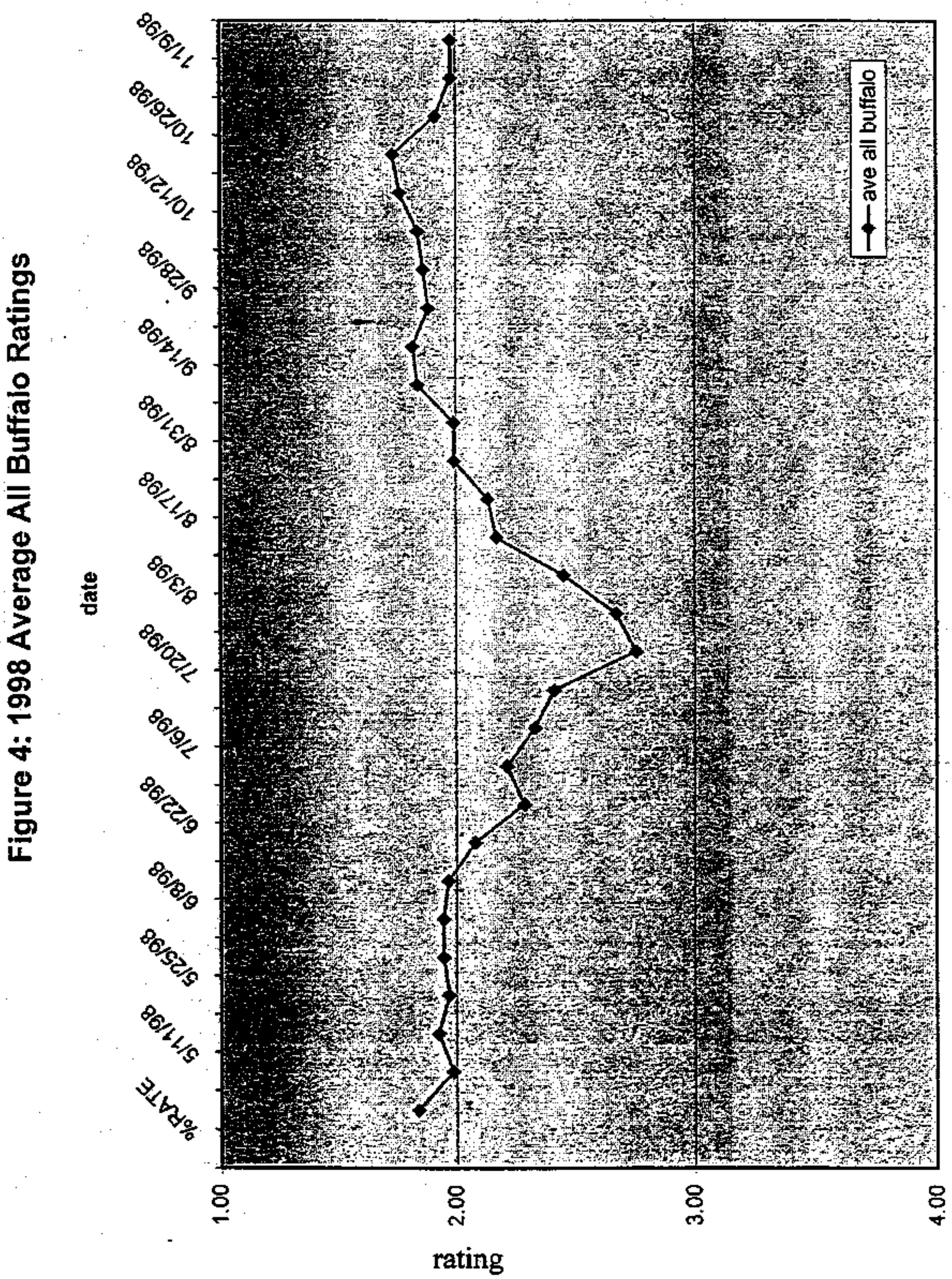


Figure 4: 1998 Average All Buffalo Ratings
date
%RATE
5/11/98
5/25/98
6/8/98
6/22/98
7/6/98
7/20/98
8/3/98
8/17/98
8/31/98
9/14/98
9/28/98
10/12/98
10/26/98
11/9/98
ave all buffalo
1.00
2.00
3.00
4.00
rating

(Figure 5)

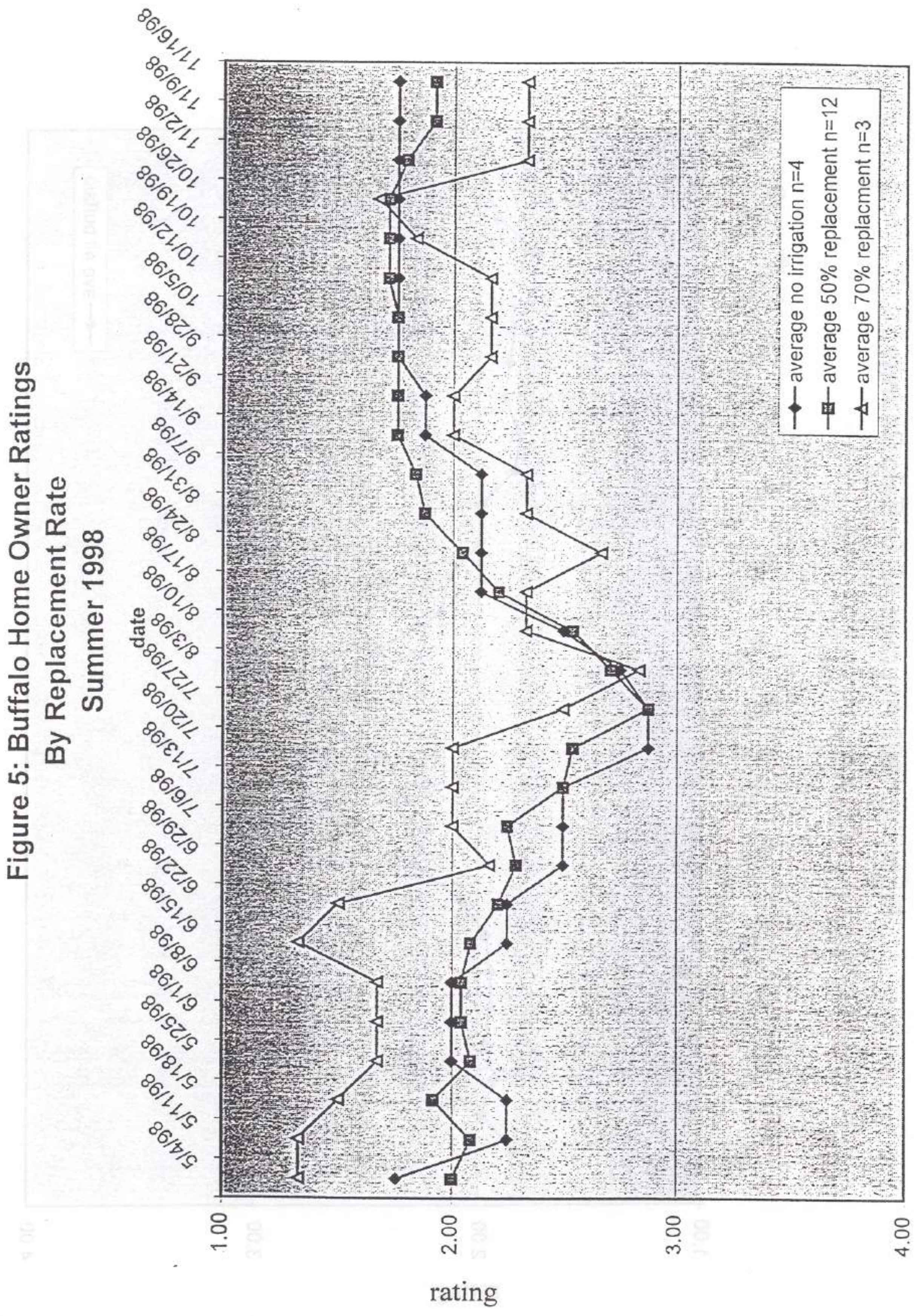


Figure 5: Buffalo Home Owner Ratings
By Replacement Rate
Summer 1998
date
5/4/98
5/11/98
5/18/98
5/25/98
6/1/98
6/8/98
6/15/98
6/22/98
6/29/98
7/6/98
7/13/98
7/20/98
7/27/98
8/3/98
8/10/98
8/17/98
8/24/98
8/31/98
9/7/98
9/14/98
9/21/98
9/28/98
10/5/98
10/12/98
10/19/98
10/26/98
11/2/98
11/9/98
11/16/98
1.00
2.00
3.00
4.00
average no irrigation n=4
average 50% replacement n=12
average 70% replacment n=3
rating

(Figure 6)

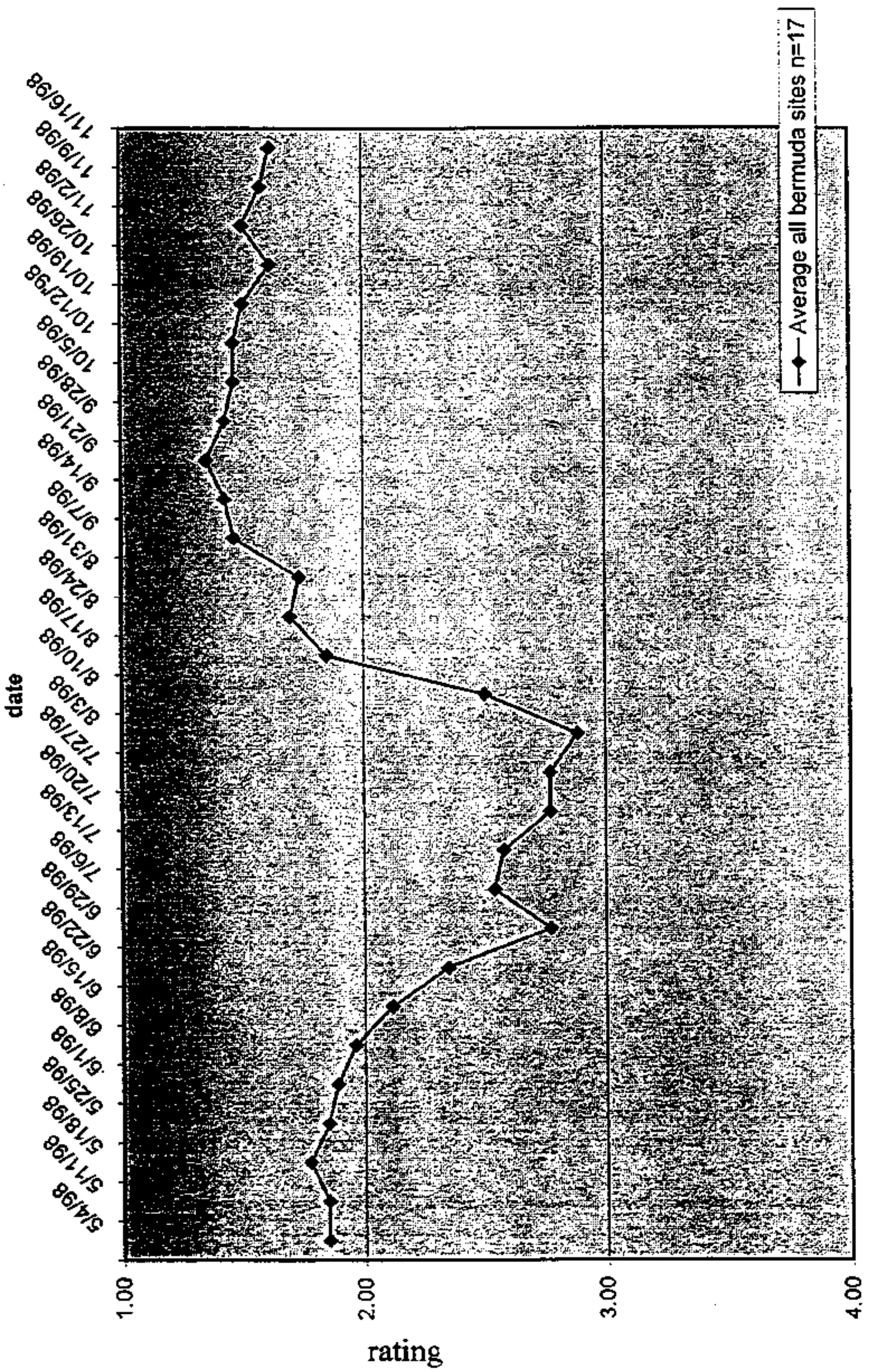


Figure 6: 1998 Average All Bermuda Ratings

(Figure 7)

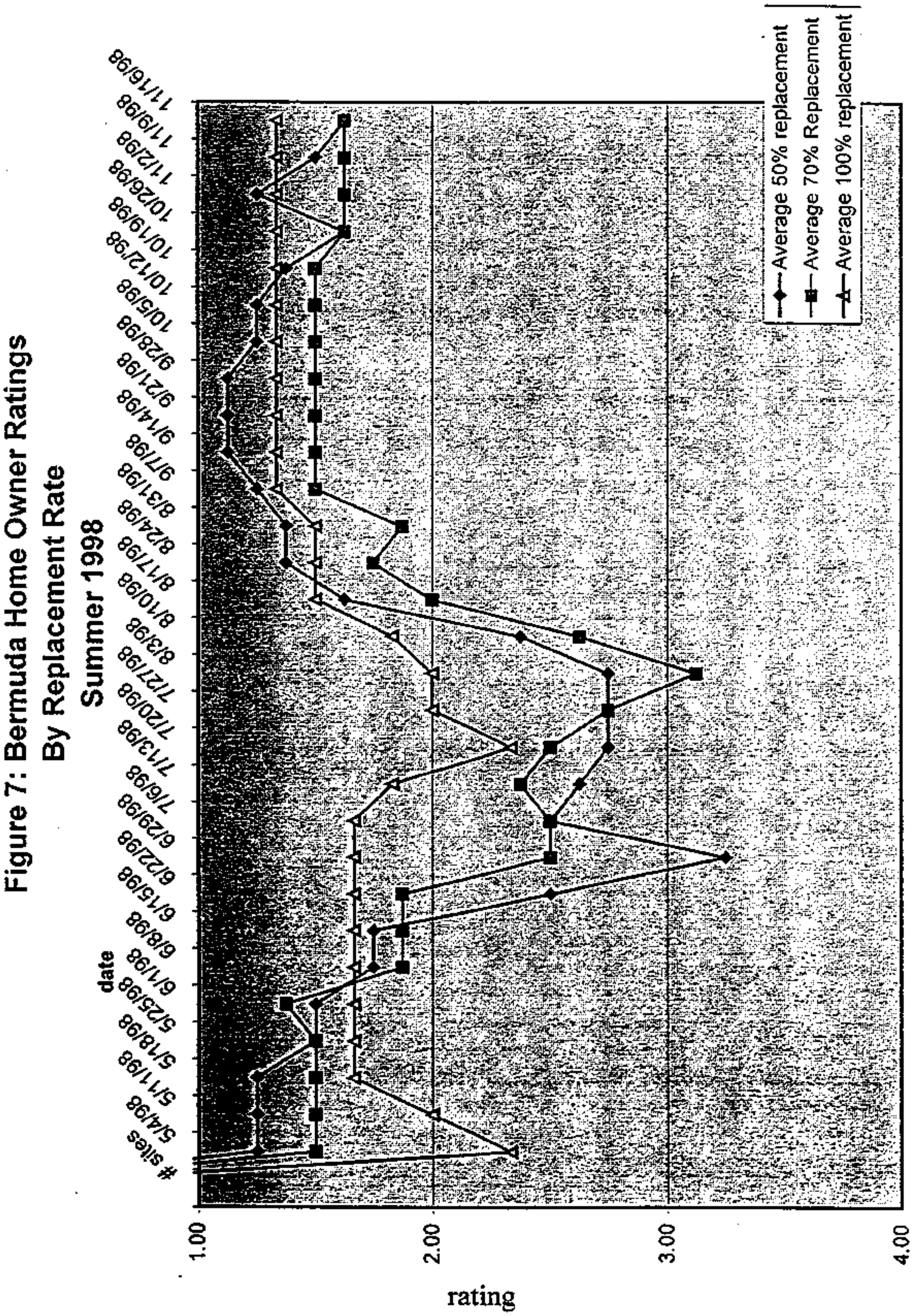


Figure 7: Bermuda Home Owner Ratings
By Replacement Rate
Summer 1998
date
sites
5/4/98
5/11/98
5/18/98
5/25/98
6/1/98
6/8/98
6/15/98
6/22/98
6/29/98
7/6/98
7/13/98
7/20/98
7/27/98
8/3/98
8/10/98
8/17/98
8/24/98
8/31/98
9/7/98
9/14/98
9/21/98
9/28/98
10/5/98
10/12/98
10/19/98
10/26/98
11/2/98
11/9/98
11/16/98
Average 50% replacement
Average 70% Replacement
Average 100% replacement
1.00
2.00
3.00
4.00
rating

(Figure 8)

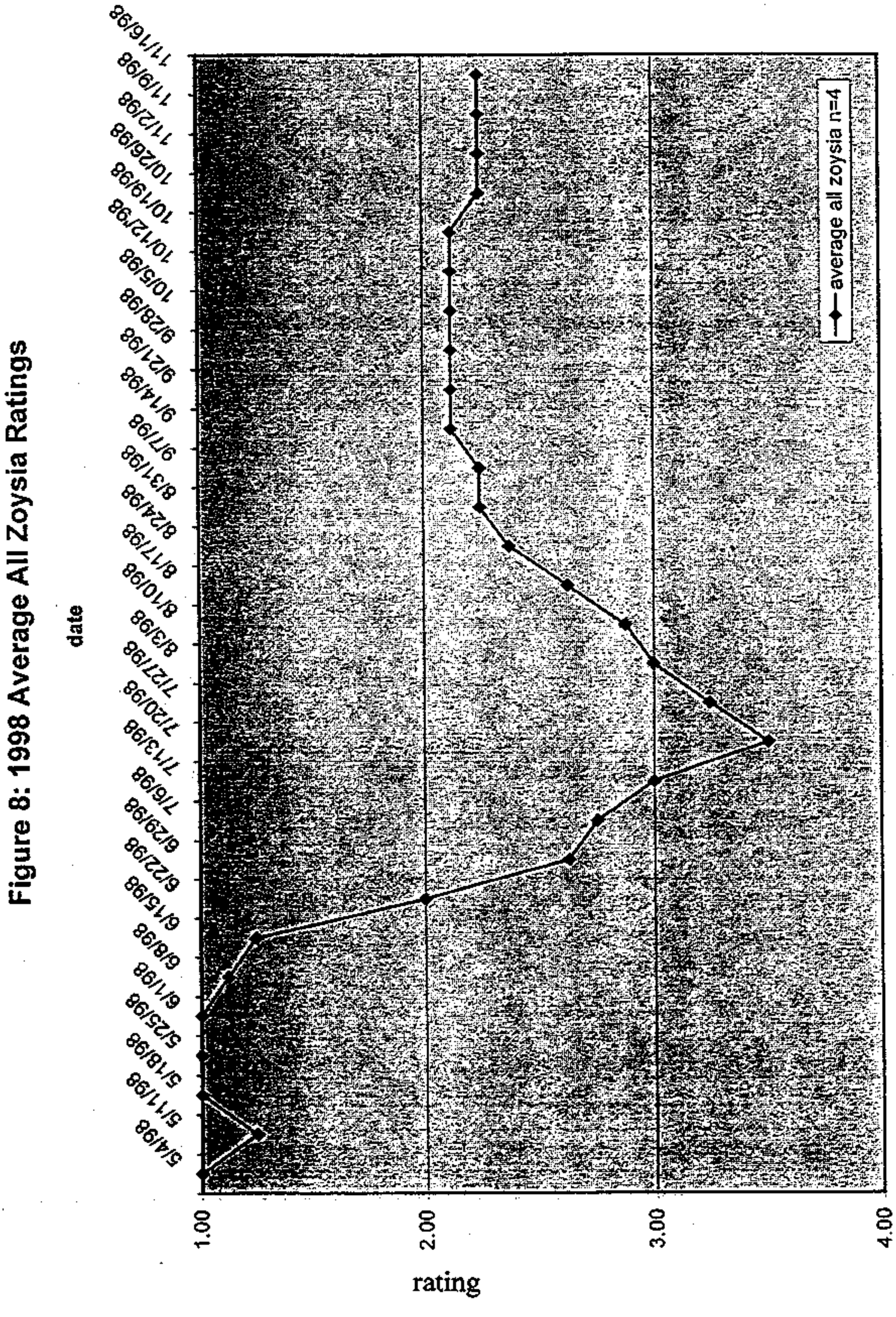
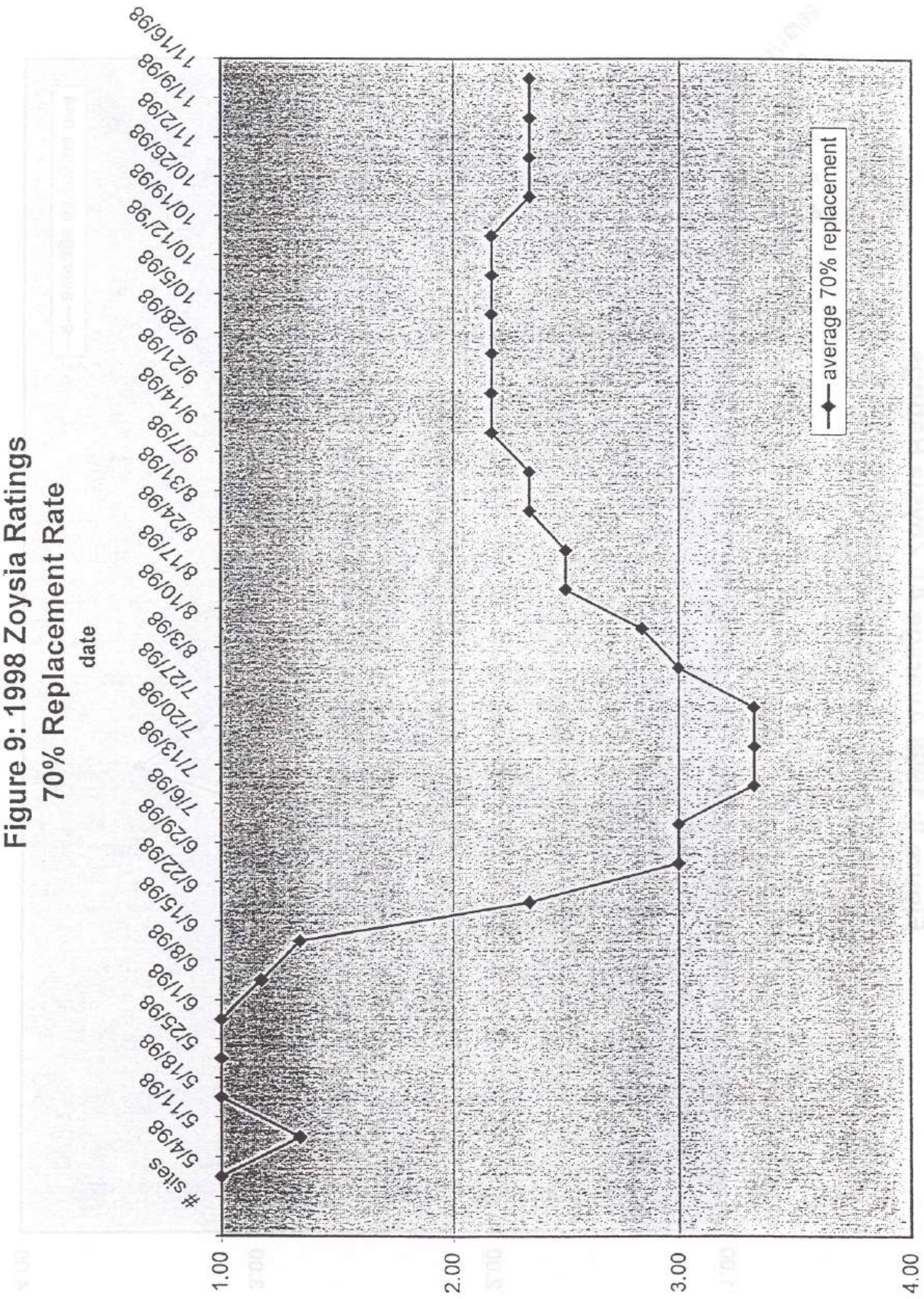


Figure 8: 1998 Average All Zoysia Ratings
date
rating
average all zoysia n=4
1.00
2.00
3.00
4.00
5/4/98
5/11/98
5/18/98
5/25/98
6/1/98
6/8/98
6/15/98
6/22/98
6/29/98
7/6/98
7/13/98
7/20/98
7/27/98
8/3/98
8/10/98
8/17/98
8/24/98
8/31/98
9/7/98
9/14/98
9/21/98
9/28/98
10/5/98
10/12/98
10/19/98
10/26/98
11/2/98
11/9/98
11/16/98

(Figure 9)



rating

(Figure 10)

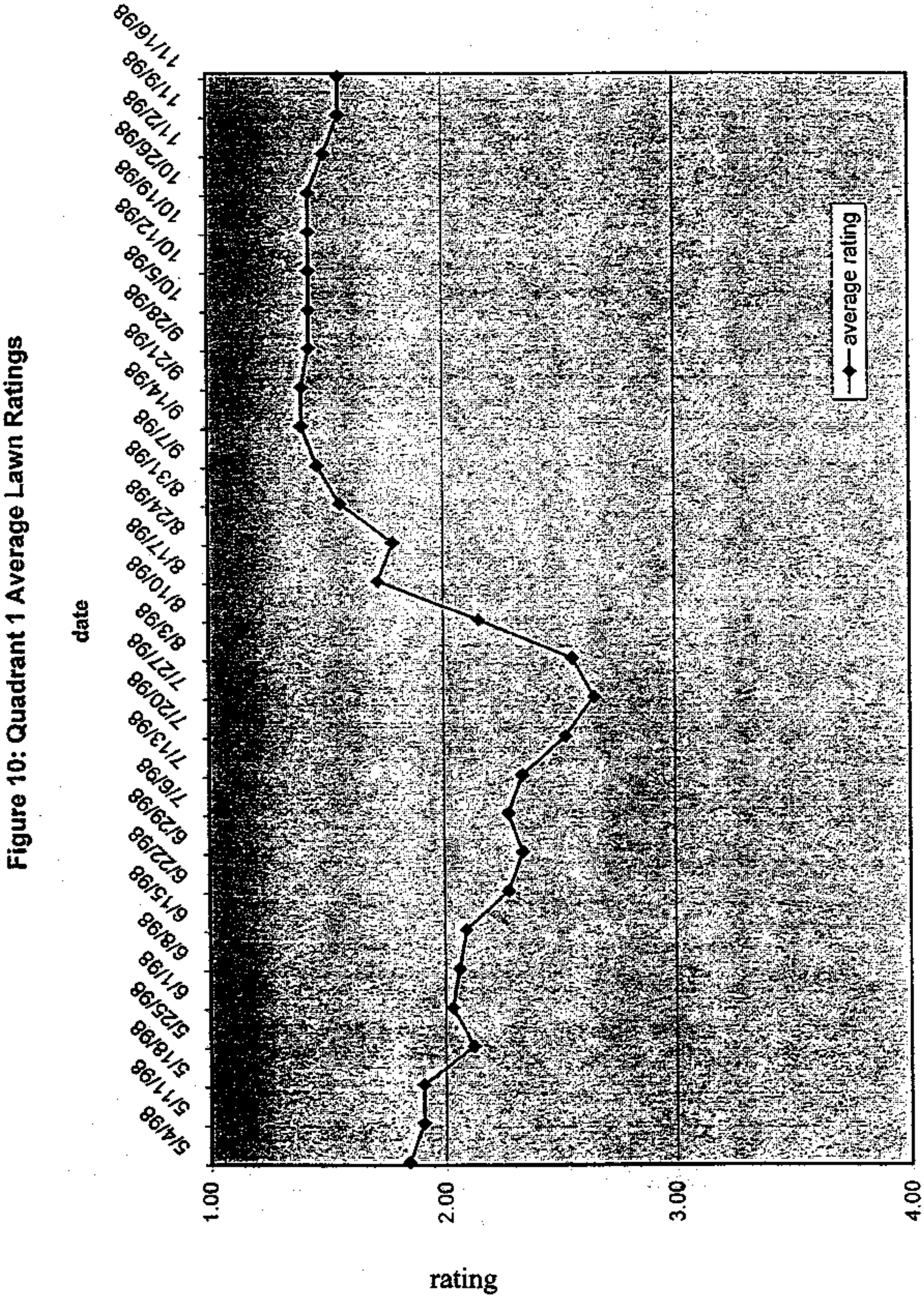


Figure 10: Quadrant 1 Average Lawn Ratings
date
rating
average rating
1.00
2.00
3.00
4.00
5/4/98
5/11/98
5/18/98
5/25/98
6/1/98
6/8/98
6/15/98
6/22/98
6/29/98
7/6/98
7/13/98
7/20/98
7/27/98
8/3/98
8/10/98
8/17/98
8/24/98
8/31/98
9/7/98
9/14/98
9/21/98
9/28/98
10/5/98
10/12/98
10/19/98
10/26/98
11/2/98
11/9/98
11/16/98

(Figure 11)

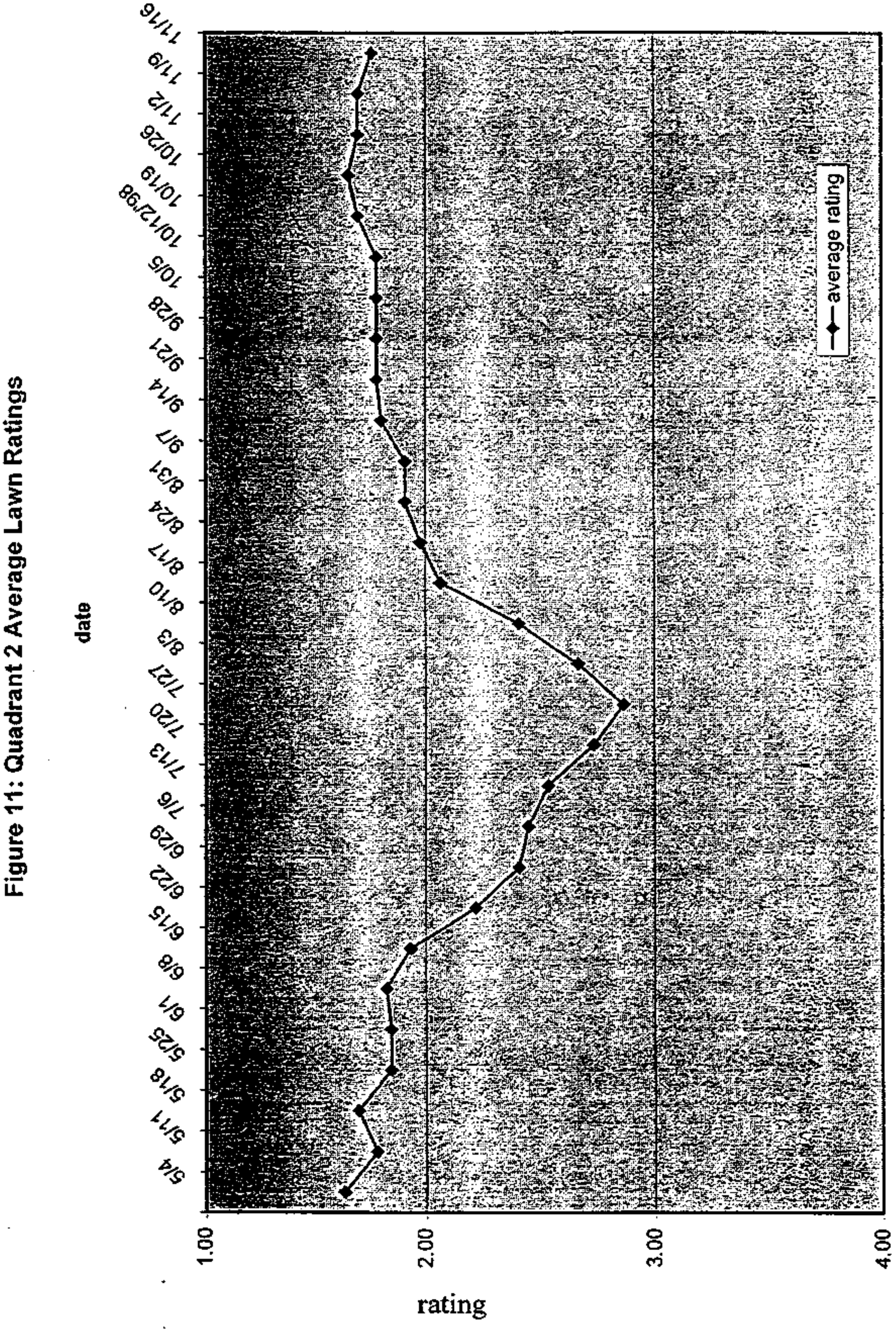


Figure 11: Quadrant 2 Average Lawn Ratings
date
5/4
5/11
5/18
5/25
6/1
6/8
6/15
6/22
6/29
7/6
7/13
7/20
7/27
8/3
8/10
8/17
8/24
8/31
9/7
9/14
9/21
9/28
10/5
10/12/98
10/19
10/26
11/2
11/9
11/16
average rating
1.00
2.00
3.00
4.00
rating

(Figure 12)

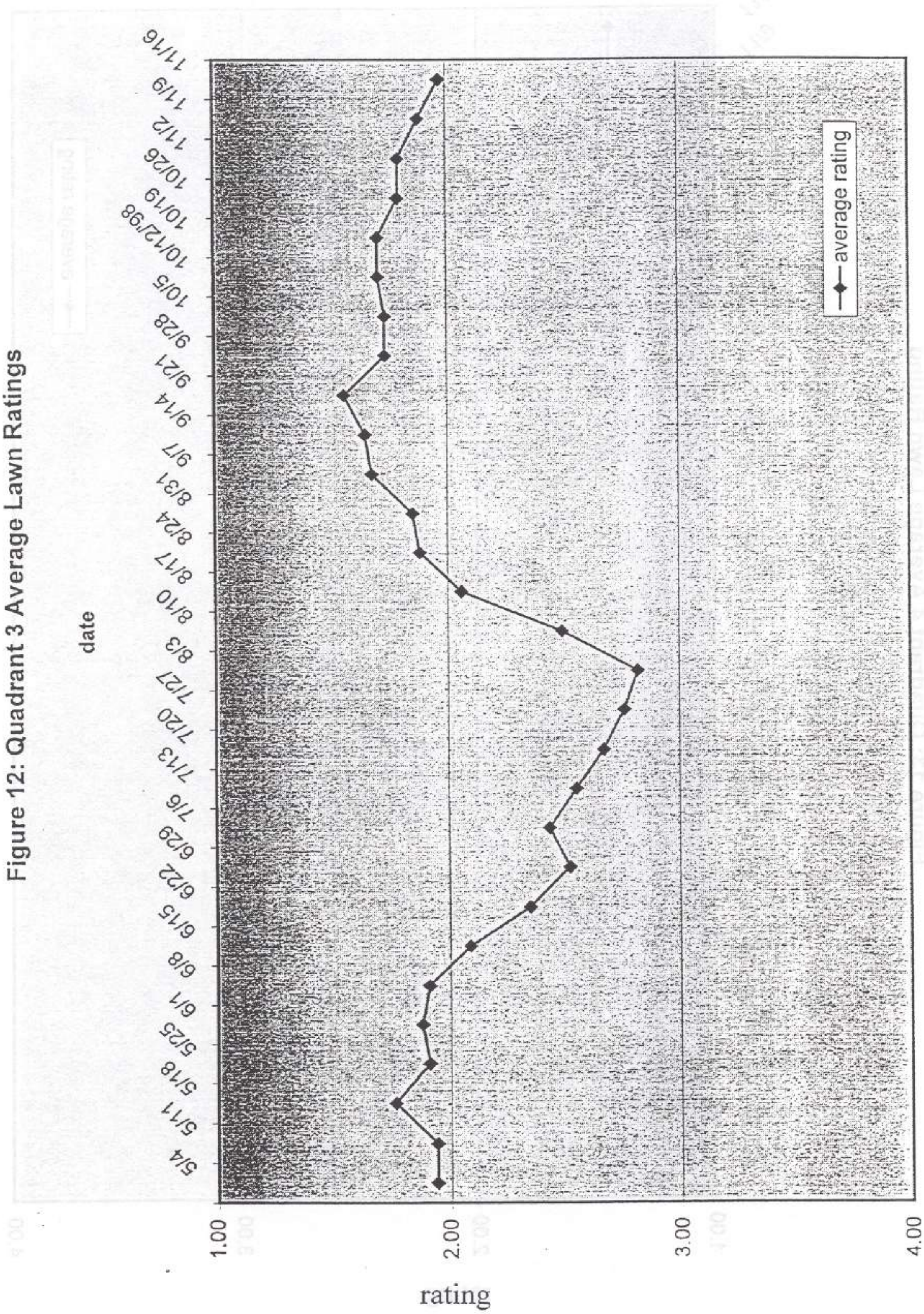


Figure 12: Quadrant 3 Average Lawn Ratings
date
5/4
5/11
5/18
5/25
6/1
6/8
6/15
6/22
6/29
7/6
7/13
7/20
7/27
8/3
8/10
8/17
8/24
8/31
9/7
9/14
9/21
9/28
10/5
10/12/'98
10/19
10/26
11/2
11/9
11/16
average rating
1.00
2.00
3.00
4.00
rating

(Figure 13)

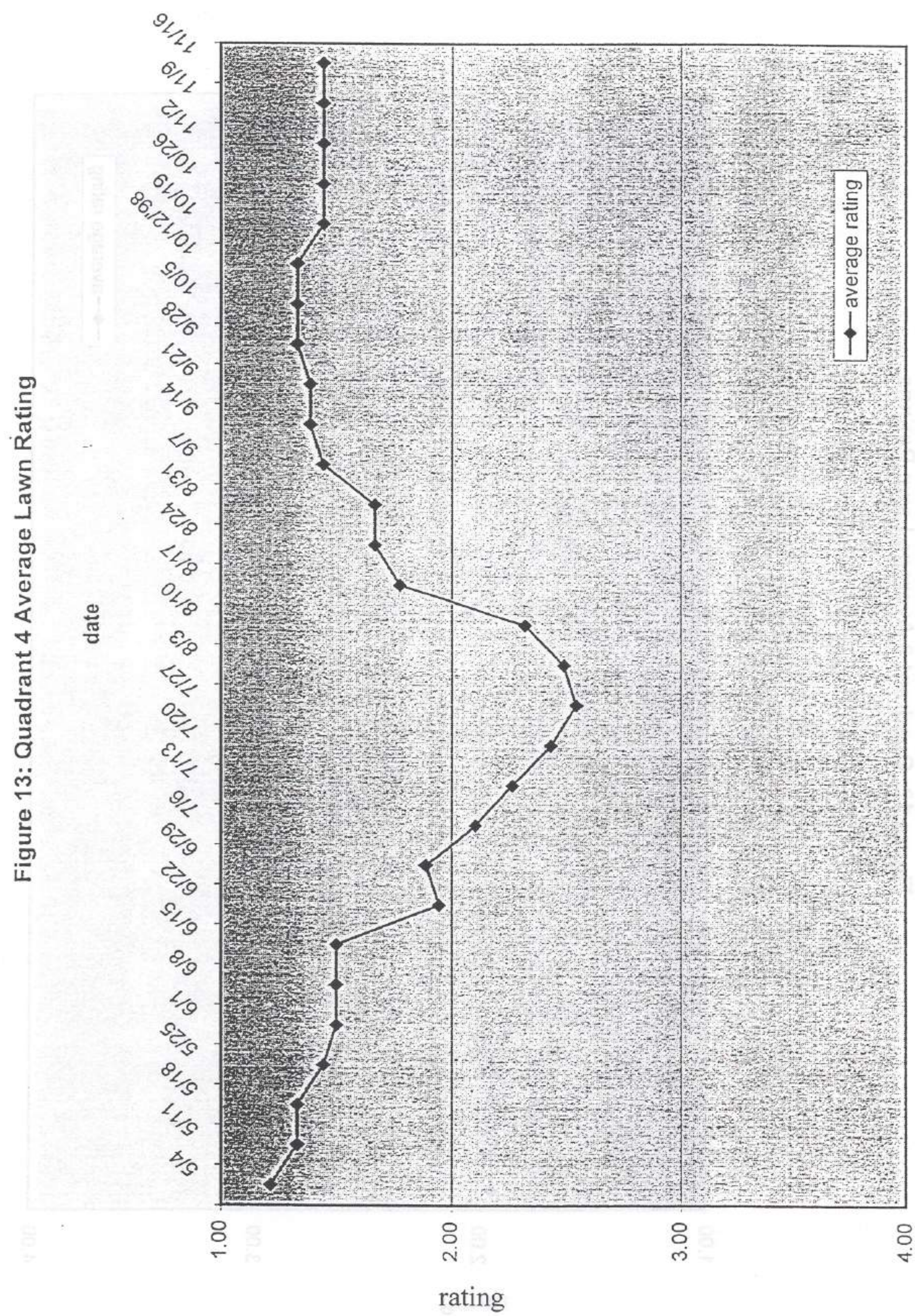
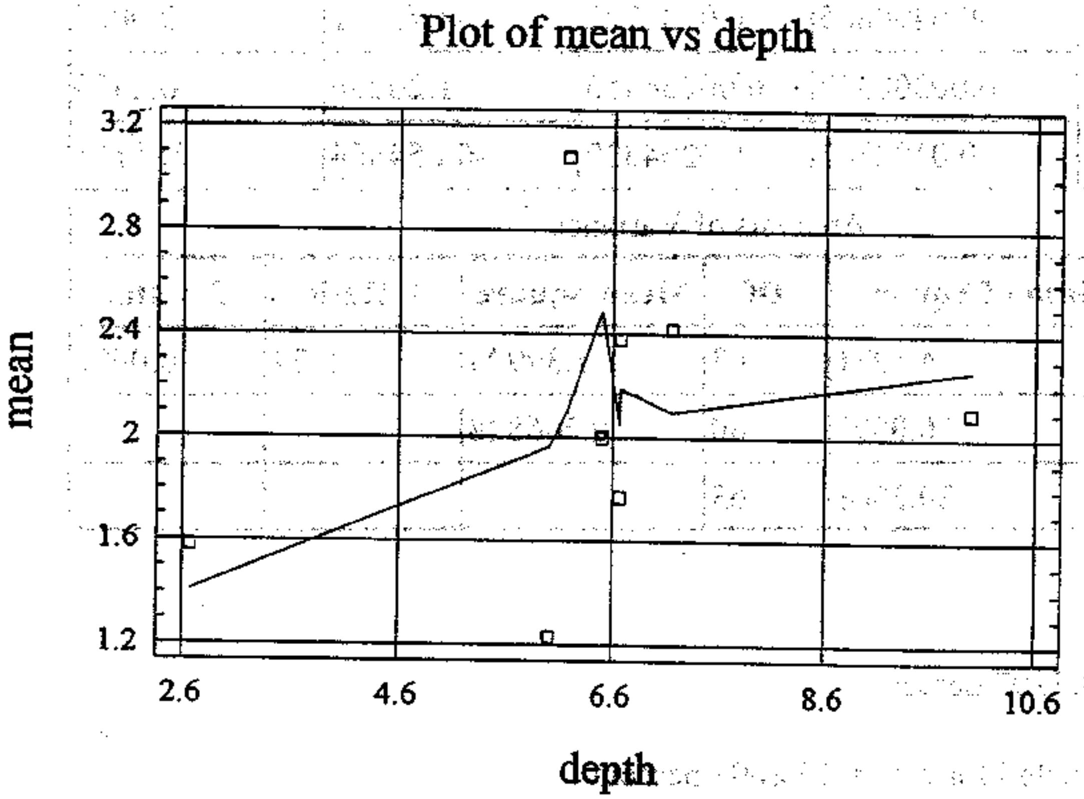


Figure 13: Quadrant 4 Average Lawn Rating
date
5/4
5/11
5/18
5/25
6/1
6/8
6/15
6/22
6/29
7/6
7/13
7/20
7/27
8/3
8/10
8/17
8/24
8/31
9/7
9/14
9/21
9/28
10/5
10/12/98
10/19
10/26
11/2
11/9
11/16
1.00
2.00
3.00
4.00
rating
average rating

FIGURE 14 - 100% ST. AUGUSTINE



$r^2 = 8.38$

TABLE 12 - ALL LAWNS - MEAN

Multiple Regression Analysis				
Dependent variable: mean				
Parameter	**Estimate**	**Standard Error**	**T Statistic**	**P-Value**
Constant	3.6247	0.497739	7.28233	0.0000
Water in inches	-0.0490665	0.0130722	-3.75351	0.0004
Weight	0.00308352	0.00256455	1.20236	0.2339
Depth	-0.0192741	0.0294322	-0.654864	0.5151

Analysis of Variance					
Source	**Sum of Squares**	**Df**	**Mean Square**	**F-Ratio**	**P-Value**
Model	4.1971	03	1.39903	5.24	0.0028
Residual	16.0097	60	0.266828		
Total (Corr)	20.2068	63			

R - squared = 20.7707 percent

R - squared (adjusted for d.f.) = 16.8093 percent

Standard Error of Est. = 0.516554

Mean Absolute Error = 0.405133

Durbin - Watson Statistic = 1.92185

The StatAdvisor (Table 12)

The output shows the results of fitting a multiple linear regression model to describe the relationship between mean and 3 independent variables. The equation of the fitted model is:

*"mean = 3.6247 - 0.0490665*Water in Inches + 0.00308352*Weight - 0.0192741*Depth"*

Since the P-value in the ANOVA table is less than 0.01, there is statistically significant relationship between the variables at the 99% confidence level.

The R-Squared statistic indicates that the model as fitted explains 20.7707% of the variability in mean. The adjusted R-Squared statistic, which is more suitable for comparing models with different numbers of independent variables, is 16/8093%. The standard error of the estimate shows the standard deviation of the residuals to be 0.516554. This value can be used to construct prediction limits for new observations by selecting the Reports option from the text menu. The mean absolute error (MAE) of 0.405133 is the average value of the residuals. The Durbin-Watson (DW) statistic tests the residuals to determine if there is any significant correlation based on the order in which they occur in your data file. Since the DW value is greater than 1.4, there is probably not any serious auto-correlation in the residuals.

In determining whether the model can be simplified, notice that the highest P-value on the independent variables is 0.5151, belonging to depth. Since the P-value is greater or equal to 0.10, that term is not statistically significant at the 90% or higher confidence level. Consequently, you should consider removing depth from the model.

TABLE 13 - ALL LAWNS STANDARD ERROR

Multiple Regression Analysis					
Dependent variable: S Error					
Parameter		**Estimate**	**Standard Error**	**T Statistic**	**P-Value**
CONSTANT		0.215533	0.0475715	4.53072	0.0000
Water in Inches		-0.00269414	0.00124937	-2.15639	0.0351
Weight		0.0000705156	0.000245107	0.287693	0.7746
Depth		-0.000944394	0.00281299	-0.335726	0.7382
Analysis of Variance					
Source	**Sum of Square**	**DF**	**Mean Square**	**F-Ratio**	**P-Value**
Model	0.0125611	03	0.00418702	1.72	0.1729
Residual	0.146242	60	0.00243737		
Total (Corr.)	0.158803	63			

R - squared = 7.90983 percent

R - squared (adjusted for d.f.) = 3.30532 percent

Standard Error of Est. = 0.0493697

Mean Absolute Error =0.0365263

Durbin - Watson Statistic = 1.65265

<u>The StatAdvisor</u> (Table 13)

The output shows the results of fitting a multiple linear regression model to describe the relationship between S Error and 3 independent variables. The equation of the fitted model is:

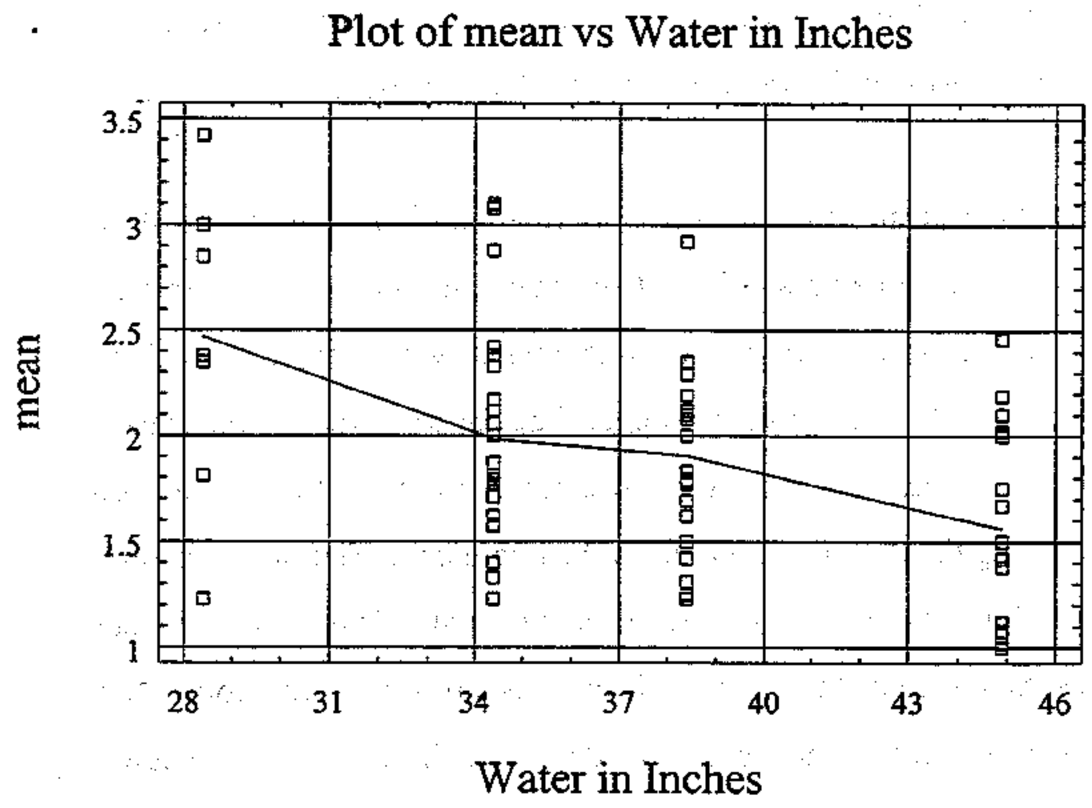
*"S Error = 0.215533 - 0.00269414*Water in Inches + 0.0000705156*Weight - 0.000944394*Depth"*

Since the P-value in the ANOVA table is less than 0.10, there is statistically significant relationship between the variables at the 90% confidence level.

The R-Squared statistic indicates that the model as fitted explains 7.90983% of the variability in S Error. The adjusted R-Squared statistic, which is more suitable for comparing models with different numbers of independent variables, is 3.30532%. The standard error of the estimate shows the standard deviation of the residuals to be 0.0493697. This value can be used to construct prediction limits for new observations by selecting the Reports option from the text menu. The mean absolute error (MAE) of 0.0365263 is the average value of the residuals. The Durbin-Watson (DW) statistic tests the residuals to determine if there is any significant correlation based on the order in which they occur in your data file. Since the DW value is greater than 1.4, there is probably not any serious auto-correlation in the residuals.

In determining whether the model can be simplified, notice that the highest P-value on the independent variables is 0.7746, belonging to weight. Since the P-value is greater or equal to 0.10, that term is not statistically significant at the 90% or higher confidence level. Consequently, you should consider removing weight from the model.

FIGURE 15 - ALL LAWNS



r^2 - 18.77

TABLE 14 - ST. AUGUSTINE - MEAN

Multiple Regression Analysis					
Dependent variable: Mean					
Parameter		**Estimate**	**Standard Error**	**T Statistic**	**P-Value**
CONSTANT		4.49907	0.693404	6.48838	0.0000
Water in Inches		-0.0800679	0.0191998	-4.17024	0.0003
Weight		0.0067133	0.00428296	0.156745	0.8768
Depth		0.0603793	0.0486276	1.24167	0.2264
Analysis of Variance					
Source	**Sum of Square**	**DF**	**Mean Square**	**F-Ratio**	**P-Value**
Model	4.25909	03	1.4197	6.57	0.0021
Residual	5.18971	24	0.216238		
Total (Corr.)	9.4488	27			

R - squared = 45.0754 percent

R - squared (adjusted for d.f.) = 38.2098 percent

Standard Error of Est. = 0.465014

Mean Absolute Error =0.355792

Durbin - Watson Statistic = 1.96713

The StatAdvisor (Table 14)

The output shows the results of fitting a multiple linear regression model to describe the relationship between S Error and 3 independent variables. The equation of the fitted model is:

*"mean = 4.49907 - 00800679*Water in Inches + 0.000067133*Weight + 0.0603793*Depth"*

Since the P-value in the ANOVA table is less than 0.01, there is statistically significant relationship between the variables at the 99% confidence level.

The R-Squared statistic indicates that the model as fitted explains 45.0754% of the variability in Mean. The adjusted R-Squared statistic, which is more suitable for comparing models with different numbers of independent variables, is 38.2098%. The standard error of the estimate shows the standard deviation of the residuals to be 0.465014. This value can be used to construct prediction limits for new observations by selecting the Reports option from the text menu. The mean absolute error (MAE) of 0.355792 is the average value of the residuals. The Durbin-Watson (DW) statistic tests the residuals to determine if there is any significant correlation based on the order in which they occur in your data file. Since the DW value is greater than 1.4, there is probably not any serious auto-correlation in the residuals.

In determining whether the model can be simplified, notice that the highest P-value on the independent variables is 0.8768, belonging to weight. Since the P-value is greater or equal to 0.10, that term is not statistically significant at the 90% or higher confidence level. Consequently, you should consider removing weight from the model.

TABLE 15 - ST. AUGUSTINE- STANDARD ERROR

Multiple Regression Analysis					
Dependent variable: S Error					
Parameter		**Estimate**	**Standard Error**	**T Statistic**	**P-Value**
CONSTANT		0.162153	0.0770797	2.10371	0.0461
Depth		0.0087184	0.00540551	1.61287	0.1198
Water in Inches		-0.00256735	0.00213428	-1.20291	0.2407
Weight		-0.000170778	0.000476099	-0.358702	0.7230
Analysis of Variance					
Source	**Sum of Square**	**DF**	**Mean Square**	**F-Ratio**	**P-Value**
Model	0.0101062	03	0.00336872	1.26	0.3101
Residual	0.0641285	24	0.00267202		
Total (Corr.)	0.0742347	27			

R - squared = 13.6138 percent

R - squared (adjusted for d.f.) = 2.81554 percent

Standard Error of Est. = 0.05169167

Mean Absolute Error =0.0384458

Durbin - Watson Statistic = 1.58916

The StatAdvisor (Table 15)

The output shows the results of fitting a multiple linear regression model to describe the relationship between S Error and 3 independent variables. The equation of the fitted model is:

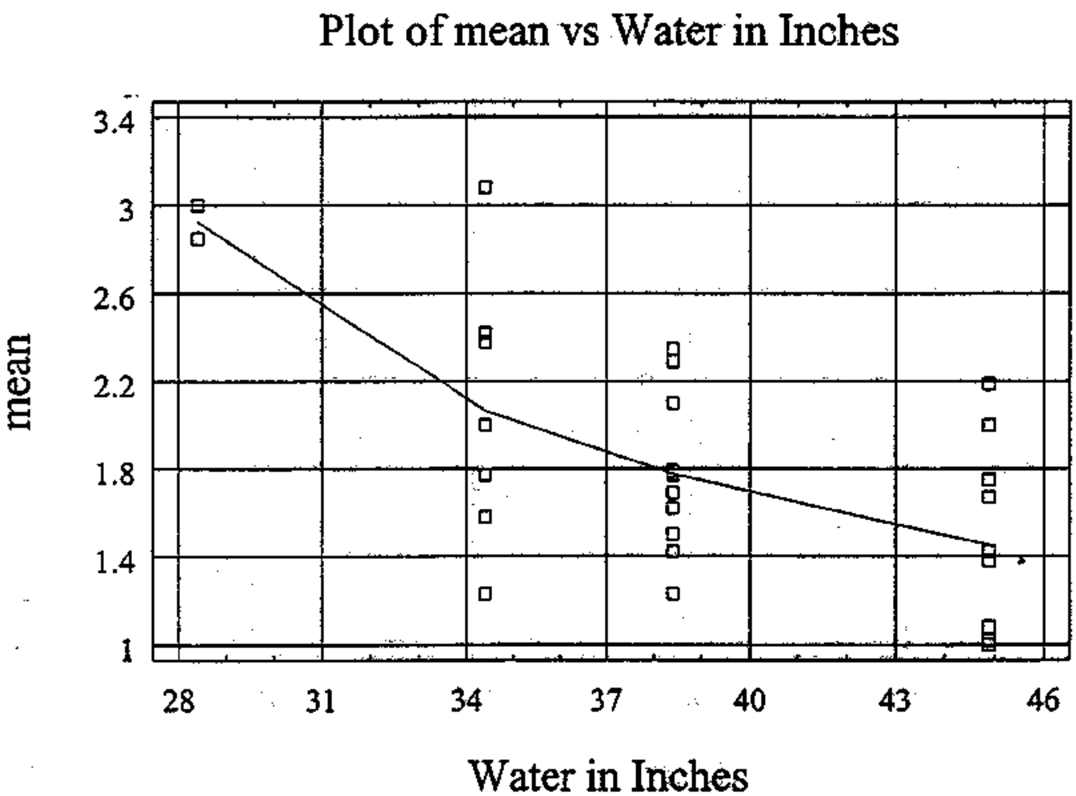
*"S Error = 0.162153 + 0.0087184*Depth - 0.00256735*Water in Inches - 0.000170778* Weight"*

Since the P-value in the ANOVA table is less than 0.10, there is statistically significant relationship between the variables at the 90% confidence level.

The R-Squared statistic indicates that the model as fitted explains 13.6138% of the variability in S Error. The adjusted R-Squared statistic, which is more suitable for comparing models with different numbers of independent variables, is 2.81554%. The standard error of the estimate shows the standard deviation of the residuals to be 0.0516916. This value can be used to construct prediction limits for new observations by selecting the Reports option from the text menu. The mean absolute error (MAE) of 0.0384458 is the average value of the residuals. The Durbin-Watson (DW) statistic tests the residuals to determine if there is any significant correlation based on the order in which they occur in your data file. Since the DW value is greater than 1.4, there is probably not any serious auto-correlation in the residuals.

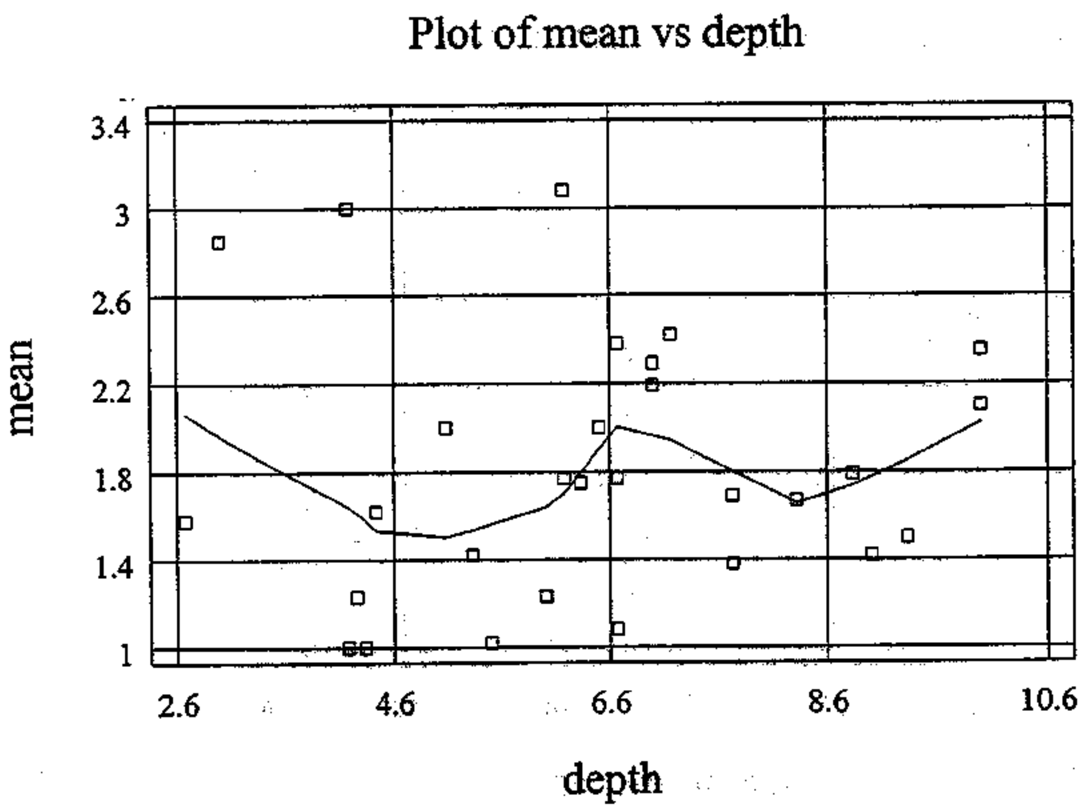
In determining whether the model can be simplified, notice that the highest P-value on the independent variables is 0.7230, belonging to weight. Since the P-value is greater or equal to 0.10, that term is not statistically significant at the 90% or higher confidence level. Consequently, you should consider removing weight from the model.

FIGURE 16 - ST. AUGUSTINE



$r^2 = 40.63$

FIGURE 17 - ST. AUGUSTINE



$r^2 = 0.24$

TABLE 16 - BERMUDA - MEAN

Multiple Regression Analysis					
Dependent variable: Mean					
Parameter		**Estimate**	**Standard Error**	**T Statistic**	**P-Value**
CONSTANT		2.75679	1.13594	2.42687	0.0382
Weight		-0.000932394	0.00537633	-0.173426	0.8662
Water in Inches		-0.00403383	0.0388628	-0.103797	0.9196
Depth		-0.116592	0.0928026	-1.25634	0.2406
Analysis of Variance					
Source	**Sum of Square**	**DF**	**Mean Square**	**F-Ratio**	**P-Value**
Model	1.09757	03	0.365856	0.98	0.4451
Residual	3.36651	09	0.374057		
Total (Corr.)	4.46408	12			

R - squared = 24.5867 percent

R - squared (adjusted for d.f.) = 0.0 percent

Standard Error of Est. = 0.611602

Mean Absolute Error =0.357546

Durbin - Watson Statistic = 2.01639

The StatAdvisor (Table 16)

The output shows the results of fitting a multiple linear regression model to describe the relationship between Mean and 3 independent variables. The equation of the fitted model is:

*"mean = 2.75679 - 0.000932394*Weight - 0.00403383*Water - 0.116592*Depth"*

Since the P-value in the ANOVA table is less than 0.10, there is statistically significant relationship between the variables at the 90% confidence level.

The R-Squared statistic indicates that the model as fitted explains 24.5867% of the variability in Mean. The adjusted R-Squared statistic, which is more suitable for comparing models with different numbers of independent variables, is 0.0%. The standard error of the estimate shows the standard deviation of the residuals to be 0.611602. This value can be used to construct prediction limits for new observations by selecting the Reports option from the text menu. The mean absolute error (MAE) of 0.357546 is the average value of the residuals. The Durbin-Watson (DW) statistic tests the residuals to determine if there is any significant correlation based on the order in which they occur in your data file. Since the DW value is greater than 1.4, there is probably not any serious auto-correlation in the residuals.

In determining whether the model can be simplified, notice that the highest P-value on the independent variables is 0.9196, belonging to water. Since the P-value is greater or equal to 0.10, that term is not statistically significant at the 90% or higher confidence level. Consequently, you should consider removing weight from the model.

TABLE 17 - BERMUDA - STANDARD ERROR

Multiple Regression Analysis					
Dependent variable: S Error					
Parameter		**Estimate**	**Standard Error**	**T Statistic**	**P-Value**
CONSTANT		0.277802	0.123417	2.25092	0.0509
Depth		-0.00066582	0.0100827	-0660357	0.9488
Water in Inches		-0.00385009	0.00422232	-0.911841	0.3856
Weight		-0.0000485539	0.00584123	-0.0831228	0.9356
Analysis of Variance					
Source	**Sum of Square**	**DF**	**Mean Square**	**F-Ratio**	**P-Value**
Model	0.00729313	03	0.00243104	0.55	0.6603
Residual	0.0397389	09	0.00441543		
Total (Corr.)	0.047032	12			

R - squared = 15.5067 percent

R - squared (adjusted for d.f.) = 0.0 percent

Standard Error of Est. = 0.0664487

Mean Absolute Error = 0.0413748

Durbin - Watson Statistic = 1.53155

The StatAdvisor (Table 17)

The output shows the results of fitting a multiple linear regression model to describe the relationship between S Error and 3 independent variables. The equation of the fitted model is:

*"S Error = 0.277802 - 0.00066582*Depth - 0.00385009*Water in Inches - 0.0004855398* Weight"*

Since the P-value in the ANOVA table is less than 0.10, there is statistically significant relationship between the variables at the 90% confidence level.

The R-Squared statistic indicates that the model as fitted explains 15.5067% of the variability in S Error. The adjusted R-Squared statistic, which is more suitable for comparing models with different numbers of independent variables, is 0.0%. The standard error of the estimate shows the standard deviation of the residuals to be 0.0664487. This value can be used to construct prediction limits for new observations by selecting the Reports option from the text menu. The mean absolute error (MAE) of 0.0413748 is the average value of the residuals. The Durbin-Watson (DW) statistic tests the residuals to determine if there is any significant correlation based on the order in which they occur in your data file. Since the DW value is greater than 1.4, there is probably not any serious auto-correlation in the residuals.

In determining whether the model can be simplified, notice that the highest P-value on the independent variables is 0.9488, belonging to depth. Since the P-value is greater or equal to 0.10, that term is not statistically significant at the 90% or higher confidence level. Consequently, you should consider removing weight from the model.

TABLE 18 - BUFFALO - MEAN

Multiple Regression Analysis					
Dependent variable: Mean					
Parameter		**Estimate**	**Standard Error**	**T Statistic**	**P-Value**
CONSTANT		1.6977	0.920571	1.84418	0.0838
Depth		-0.135913	0.0530233	-2.56328	0.0208
Water in Inches		-0.00909962	0.0233716	-0.389344	0.7022
Weight		0.0200537	0.00729279	2.7498	0.0142
Analysis of Variance					
Source	**Sum of Square**	**DF**	**Mean Square**	**F-Ratio**	**P-Value**
Model	2.13273	03	0.710909	3.20	0.0515
Residual	3.55017	16	0.221886		
Total (Corr.)	5.68289	19			

R - squared = 37.5289 percent

R - squared (adjusted for d.f.) = 25.8155 percent

Standard Error of Est. = 0.471047

Mean Absolute Error = 0.355188

Durbin - Watson Statistic = 1.6069

The StatAdvisor (Table 18)

The output shows the results of fitting a multiple linear regression model to describe the relationship between Mean and 3 independent variables. The equation of the fitted model is:

*"Mean = 1.6977 - 0.135913*Depth - 0.00909962*Water + 0.0200537*Weight"*

Since the P-value in the ANOVA table is less than 0.10, there is statistically significant relationship between the variables at the 90% confidence level.

The R-Squared statistic indicates that the model as fitted explains 37.5289% of the variability in Mean. The adjusted R-Squared statistic, which is more suitable for comparing models with different numbers of independent variables, is 25.8155%. The standard error of the estimate shows the standard deviation of the residuals to be 0.471047. This value can be used to construct prediction limits for new observations by selecting the Reports option from the text menu. The mean absolute error (MAE) of 0.355188 is the average value of the residuals. The Durbin-Watson (DW) statistic tests the residuals to determine if there is any significant correlation based on the order in which they occur in your data file. Since the DW value is greater than 1.4, there is probably not any serious auto-correlation in the residuals.

In determining whether the model can be simplified, notice that the highest P-value on the independent variables is 0.7022, belonging to water in inches. Since the P-value is greater or equal to 0.10, that term is not statistically significant at the 90% or higher confidence level. Consequently, you should consider removing weight from the model.

TABLE 19 - BUFFALO - STANDARD ERROR

Multiple Regression Analysis					
Dependent variable: S Error					
Parameter		**Estimate**	**Standard Error**	**T Statistic**	**P-Value**
CONSTANT		0.131553	0.0757341	1.73704	0.1016
Depth		-0.00241587	0.00436215	-0.553825	0.5874
Water in Inches		0.000605138	0.00192275	0.314725	0.7570
Weight		-0.000387163	0.000599967	-0.645307	0.5279
Analysis of Variance					
Source	**Sum of Square**	**DF**	**Mean Square**	**F-Ratio**	**P-Value**
Model	0.00223625	03	0.000745417	0.50	0.6899
Residual	0.024028	16	0.00150175		
Total (Corr.)	0.0262642	19			

R - squared = 8.51444 percent

R - squared (adjusted for d.f.) = 0.0 percent

Standard Error of Est. = 0.0387524

Mean Absolute Error = 0.0284181

Durbin - Watson Statistic = 1.8354

<u>The StatAdvisor</u> (Table 19)

The output shows the results of fitting a multiple linear regression model to describe the relationship between S Error and 3 independent variables. The equation of the fitted model is:

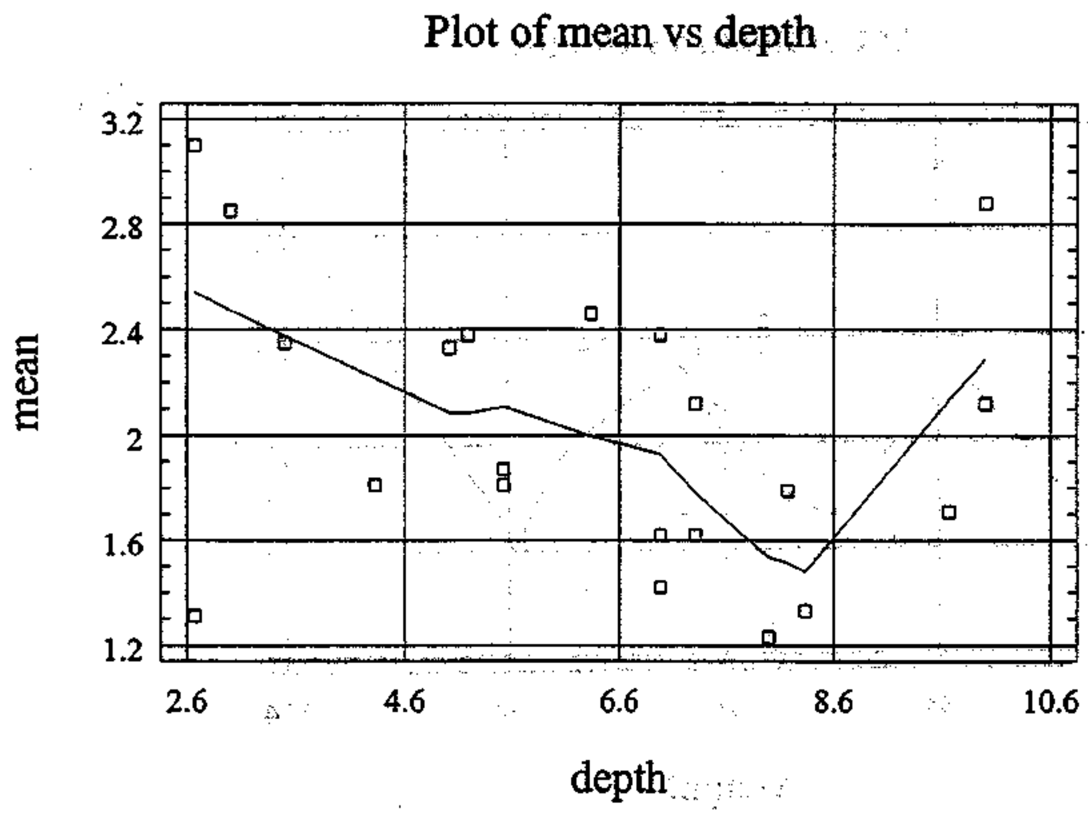
*"S Error = 0.131553 - 0.00241587*Depth + 0.000605138*Water in Inches - 0.000387163* Weight"*

Since the P-value in the ANOVA table is less than 0.10, there is statistically significant relationship between the variables at the 90% confidence level.

The R-Squared statistic indicates that the model as fitted explains 8.51444% of the variability in S Error. The adjusted R-Squared statistic, which is more suitable for comparing models with different numbers of independent variables, is 0.0%. The standard error of the estimate shows the standard deviation of the residuals to be 0.0387524. This value can be used to construct prediction limits for new observations by selecting the Reports option from the text menu. The mean absolute error (MAE) of 0.0284181 is the average value of the residuals. The Durbin-Watson (DW) statistic tests the residuals to determine if there is any significant correlation based on the order in which they occur in your data file. Since the DW value is greater than 1.4, there is probably not any serious auto-correlation in the residuals.

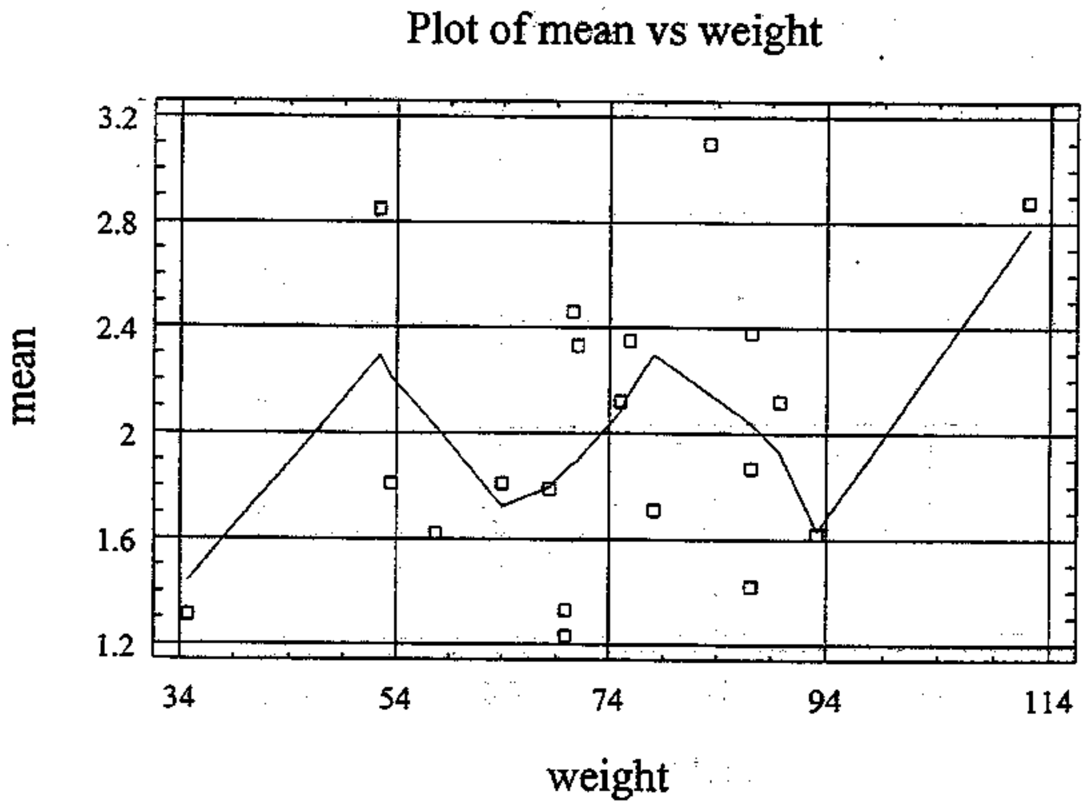
In determining whether the model can be simplified, notice that the highest P-value on the independent variables is 0.7570, belonging to water in inches. Since the P-value is greater or equal to 0.10, that term is not statistically significant at the 90% or higher confidence level. Consequently, you should consider removing Water in Inches from the model.

FIGURE 18 - BUFFALO



$r^2 = 6.91\%$

FIGURE 19 - BUFFALO



$r^2 = 6.91\%$

TABLE 20 - ZOYSIA - MEAN

Multiple Regression Analysis					
Dependent variable: Mean					
Parameter		**Estimate**	**Standard Error**	**T Statistic**	**P-Value**
CONSTANT		15.2926			
Weight		0.047032			
Water in Inches		-0.448282			
Depth		0.0169224			
Analysis of Variance					
Source	**Sum of Square**	**DF**	**Mean Square**	**F-Ratio**	**P-Value**
Model	0.5931	03	0.1977		
Residual	0.0	00	0.0		
Total (Corr.)	0.5931	03	0.1977		

R - squared = 100.0 percent

R - squared (adjusted for d.f.) = 0.0 percent

Standard Error of Est. = 0.0

Mean Absolute Error = 0.0

Durbin - Watson Statistic =

<u>The StatAdvisor</u> (Table 20)

The output shows the results of fitting a multiple linear regression model to describe the relationship between Mean and 3 independent variables. The equation of the fitted model is:

*"Mean = 15.2926 + 0.047032*Weight - 0.448282*Water In Inches + 0.0169224*Depth"*

The R-Squared statistic indicates that the model as fitted explains 100.0% of the variability in Mean. The adjusted R-Squared statistic, which is more suitable for comparing models with different numbers of independent variables, is 0.0%. The standard error of the estimate shows the standard deviation of the residuals to be 0.0. This value can be used to construct prediction limits for new observations by selecting the Reports option from the text menu. The mean absolute error (MAE) of 0.0 is the average value of the residuals. The Durbin-Watson (DW) statistic tests the residuals to determine if there is any significant correlation based on the order in which they occur in your data file. Since the DW value is less than 1.4, there may be some indication of serial correlation. Plot both residuals versus row order to see if there is any pattern which can be seen.

TABLE 22 - 50 % BUFFALO - MEAN

Multiple Regression Analysis					
Dependent variable: Mean					
Parameter		**Estimate**	**Standard Error**	**T Statistic**	**P-Value**
CONSTANT		0.853837	0.430758	1.98218	0.0708
Weight		0.0249465	0.00621913	4.01125	0.0017
Depth		-0.119087	0.0476417	-2.49964	0.0279
Analysis of Variance					
Source	**Sum of Square**	**DF**	**Mean Square**	**F-Ratio**	**P-Value**
Model	2.43244	02	1.21622	8.27	0.0055
Residual	1.76445	12	0.147037		
Total (Corr.)	4.19689	14			

R - squared = 57.9582 percent

R - squared (adjusted for d.f.) = 50.9512 percent

Standard Error of Est. = 0.383455

Mean Absolute Error = 0.288627

Durbin - Watson Statistic = 1.44017

The StatAdvisor (Table 22)

The output shows the results of fitting a multiple linear regression model to describe the relationship between Mean and 2 independent variables. The equation of the fitted model is:

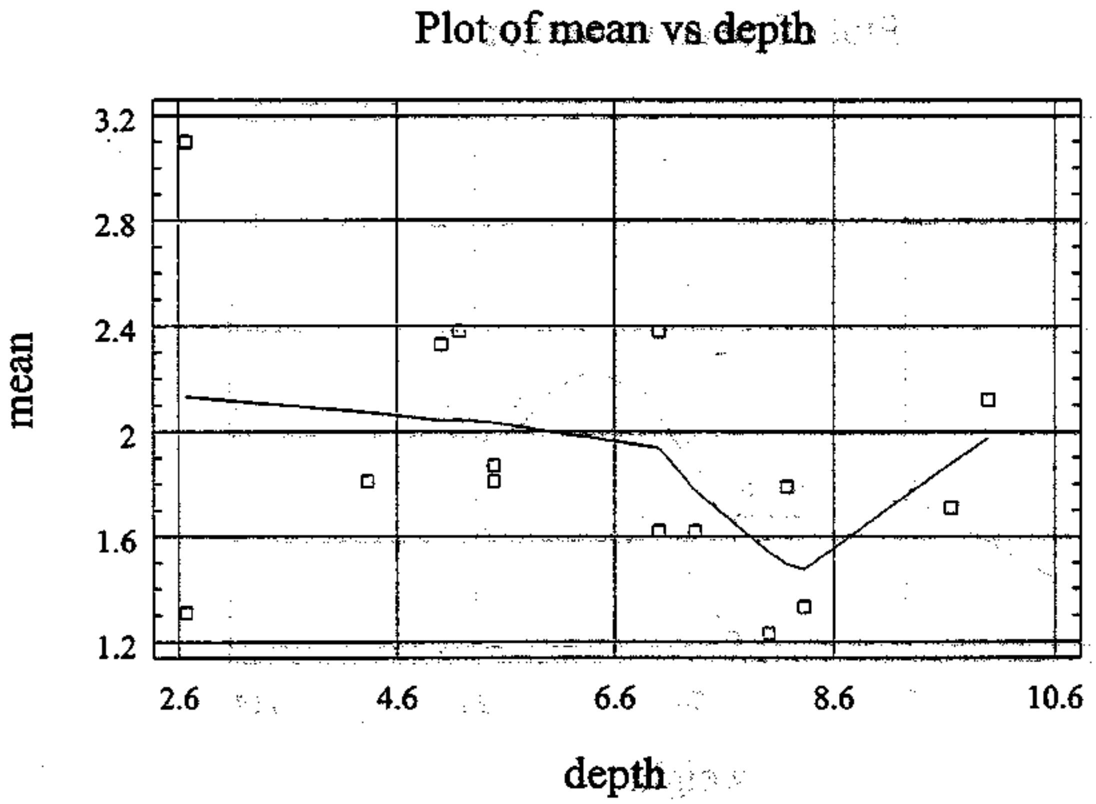
*"Mean = 0.853837 + 0.0249465*Weight- 0.119087*Depth"*

Since the P-value in the ANOVA table is less than 0.01, there is statistically significant relationship between the variables at the 99% confidence level.

The R-Squared statistic indicates that the model as fitted explains 57.9582% of the variability in Mean. The adjusted R-Squared statistic, which is more suitable for comparing models with different numbers of independent variables, is 50.9512%. The standard error of the estimate shows the standard deviation of the residuals to be 0.383455. This value can be used to construct prediction limits for new observations by selecting the Reports option from the text menu. The mean absolute error (MAE) of 0.288627 is the average value of the residuals. The Durbin-Watson (DW) statistic tests the residuals to determine if there is any significant correlation based on the order in which they occur in your data file. Since the DW value is greater than 1.4, there is probably not any serious auto-correlation in the residuals.

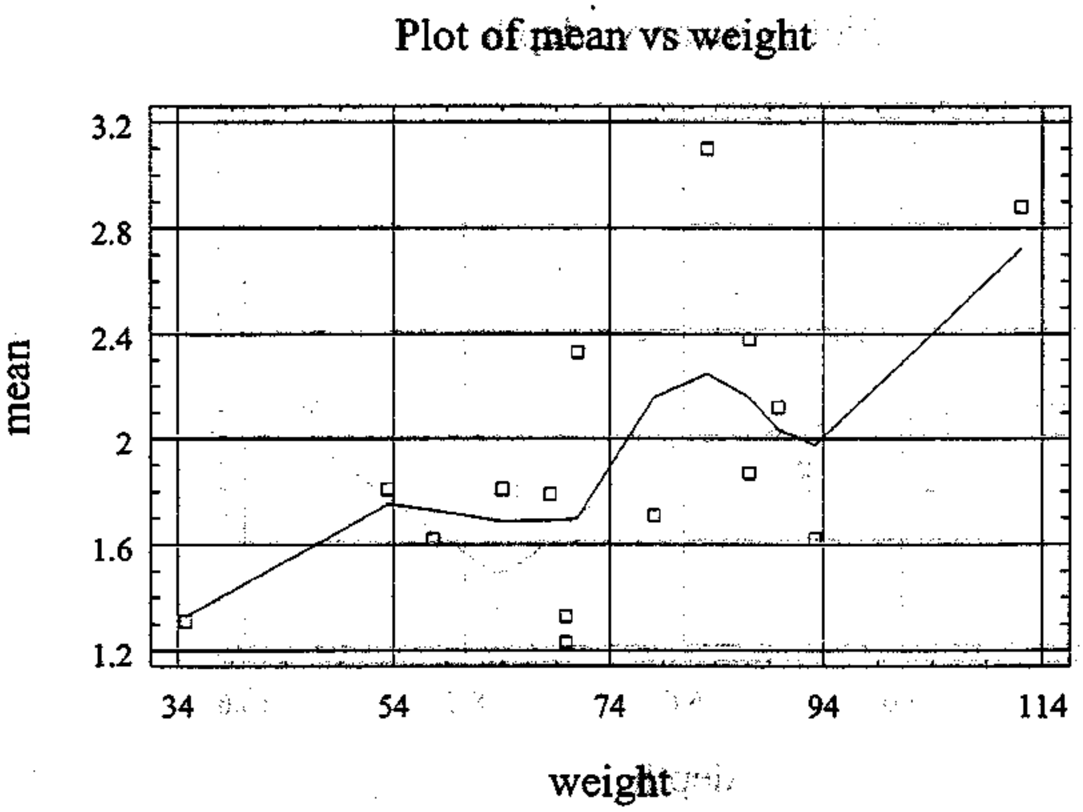
In determining whether the model can be simplified, notice that the highest P-value on the independent variables is 0.7022, belonging to water in inches. Since the P-value is greater or equal to 0.10, that term is not statistically significant at the 90% or higher confidence level. Consequently, you should consider removing weight from the model.

FIGURE 20 - 50% BUFFALO



$r^2 = 1.32\%$

FIGURE 21 - 50% BUFFALO



$r^2 = 36.07\%$

ET

PROCEDURE HANDBOOK

1998

Evapotranspiration Project
Summer 1998

Project Goals:

3. To conserve water by irrigating on the basis of evapotranspiration data.

4. To determine the best ET based watering practices for San Antonio.

5. To utilize the results of the second years project to develop a broad ET Based Lawn Watering Program.

Project Partners: Texas Agricultural Extension Service
Bexar County Master Gardeners
Texas A&M University
San Antonio Water System

How the Project Will Work:

Our weather station located at the Jones-Maltsberger demonstration site collects data necessary to calculate evapotranspiration rates. We will determine ET rates for each day and communicate them to you using our ET Phone Line. you will use the information on the ET Phone Line to follow the ET Study Protocol. The feedback you give us through your data sheets and comments will help us make any necessary adjustments in how we use the ET data.

Terms We Will Be Using:

Evapotranspiration (ET) is water lost due to evaporation and transpiration.

Evaporation: This is the process which causes water out in the sun to disappear as water molecules change state from liquid to gas.

Transpiration: During transpiration water is taken up by plant roots, used in photosynthesis and released into the atmosphere.

Soil Water Reservoir: This refers to water stored in the soil under plants. The amount of water which can be held depends on the type of soil and the depth of soil. The amount that soil can hold is expressed in inches.

Water Application Rate: This refers to the amount of water that is applied to grass by a sprinkler system over a period of time. It is expressed in inches/hour. Your measure this by conducting a "catch-can" test while your sprinkler system is running.

Questions You May Have On The ET Program

Why a Watering Program is Needed:

25% of our potable water is used for landscape irrigation. During hot summer months, landscape irrigation may account for up to 60% of total water use. Because most people unknowingly over-water, this can be reduced through appropriate irrigation methods. Reducing our high water use will save money, assist in efforts to keep aquifer levels above drought levels and help assure that San Antonio will not be limited in growth capacity by water shortage.

Appropriate Watering Produces Healthy Grass:

Appropriate water application is perhaps the most important factor contributing to turf quality. Watering too much and too often encourages shallow rooted grass which will not withstand the extreme heat of our summers. However, no irrigation results in brown and dormant grass that does not meet the quality preferences of most home owners.

Appropriate irrigation is thought to "drought train" grass by encouraging deep routs and lower water usage. Grass that is drought trained is thought to use less water, be more resistant to disease and to stay greener during the hottest parts of the summer.

How Do We Know How To Appropriately Water?

Grass should be watered when the soil reservoir under grass is nearly depleted. When very little water is left in the soil, the grass will show signs of water stress. At this time, the reservoir shall be refilled. Waiting until the reservoir is nearly empty encourages grass roots to go deeper into the soil so that more of the soil reservoir is used.

What Are Signs of Water Stress?

When grass is deprived of water in the soil, it becomes less firm and elastic. Grass that has enough water available will spring back after being stepped on. When a footprint is left in the grass, there is water stress. Other signs of stress include leaf blade curling, wilting and discolorations.

How Does ET Data Fit Into All of This?

Evapotranspiration data will give us an estimate of when the soil water reservoir is nearly depleted. We will refill the soil reservoir with only the needed amount of water. This should be healthy for the grass and should also conserve water.

Why is Your Participation In This Pilot Study Important?

If our pilot program is successful, we will use information you provide to develop a city-wide ET based water conservation program. Your reactions to the pilot study will be critical in the design of any future program. No lawn care program works unless home owners find it simple to follow. The program must also result in grass the meets the aesthetic needs of home owners. Your attention to these issues will give us feedback we need to create a successful program for our city.

Please help us by staying in touch during the entire study period. We especially need your attention for the following areas:

- Fill in the data forms as completely as possible. <u>We need to know about each of the topics listed on the bottom of the Calendar Data Sheet</u>.

- Write extra information you think might be of interest.

- Call us with any questions. If something isn't clear, WE NEED TO KNOW!

- Tell us if your grass seems to be getting more water than it needs OR if you think it is looking too stressed to meet your aesthetic needs.

Why Isn't Everyone In the Pilot Study Doing the Same Thing?

We will follow several different methods of applying ET data to a home lawn watering program.

The ET Project Team

The Evapotranspiration Pilot Study is a joint project being conducted by the Texas Agricultural Extension Service, the Bexar County Master Gardeners and A&M University. Funding to complete the pilot study was provided by San Antonio Water System.

Texas Agricultural Extension Service:

The ET Pilot Study is being directed by three Bexar County Extension Service Staff including Dr. Calvin Finch-County Extension Agent-Horticulture; Joe Taylor-County Extension Agent-Agriculture; and Karen Guz-County Extension Associate-Horticulture. Each of us will be actively involved in the ET Pilot Study and will be pleased to address questions or concerns you may have.

Bexar County Master Gardeners:

The Bexar County Master Gardeners have adopted the ET Pilot as one of their community service projects. Master Gardener staff person Dee Emory is coordinating the study and the efforts of Master Gardener volunteers working on the project. Dee will be keeping all records for the study and tracking the results as it continues. Master Gardener volunteers who are Team Leaders will make regular site visits to home test sites to check soil moisture levels and to determine how well the grass at each site is responding to the study. Master Gardener Team Leaders will also be available to address the concerns of the home-owners assigned to them.

Texas A&M University:

Experts in turfgrass and irrigation are being consulted on a regular basis for the design and implementation of the ET Pilot Study. The ET Home Page on the World Wide Web which is maintained by Dr. Guy Fipps is our primary source of ET data. You may wish to visit this site to learn more about how ET data is used in other parts of Texas. The site address is: http://texaset.tamu.edu

San Antonio Water System(SAWS):

SAWS has provided materials and funding necessary to conduct the pilot study. In addition, the weather station used for San Antonio ET calculations is located at the Jones-Maltsberger SAWS Pumping Station.

ET Protocol: Refill Once a Week

We are studying three different water replacement rates in order to discover which one works best for homeowners. We hope to match replacement rates to homeowner acceptance levels for lawn appearance during summer months.

Summary:

Homeowners will water their lawns on the same day each week. Each day we will add up how much water is removed from the soil. At the end of the week, we will have a total amount in inches that they will need to add to their soil in order to refill the soil reservoir. This method should result in water saving because participants will apply no more than is necessary to refill. We will track rainfall during the week and subtract any rainfall from the refill amount. During an extremely hot and dry week, the refill amount may be up to one inch. However, during a cloudy or rainy week, the refill amount may be only ¼".

Important Tasks For Participants:

1. Participants will have to be very familiar with their sprinkler application rate and know how long it will take to apply water in ¼" increments. Those with automatic systems will have to adjust their timer to make the system only run for as long as it is necessary to apply the refill amount.

2. Rating of lawns must be done on Sunday morning. This will give us feedback on whether your lawn is responding well to this schedule.

Why This Method?

We believe this method of using ET data will be easy for homeowners. It only requires attention to ET rates on one weekday and there is only one watering day. However, it will be important that we obtain feedback on the quality of lawns on this protocol.

100% During the 1997 ET Pilot Study we found that lawns where homeowners replacing 100% of ET maintained a good appearance. They had only a slight decline in quality during July and early August.

70% Homeowners replacing 70% of total ET during the 1997 ET Pilot Study had their lawn ratings drop by 1 to 2 levels during July and early August. However, the lawns quickly recovered their quality appearance in the fall when weather conditions improved.

50% We did not test a 50% replacement rate last summer. This will be a new level to test. We expect lawns to drop in ratings and perhaps go dormant. However, we also expect all lawns to recover and become green again in the fall.

Directions for Participants In the Bexar County ET Study

We are hoping to discover the best way to utilize ET data for home lawn care. Because this technology has been applied to turfgrass in this area, we are pioneers and will need to learn as the study progresses. This protocol is our starting point. The directions we ask you to follow may change as you provide us with feedback.

Daily Tasks:

1. Note any measurable rainfall on your data sheet.

2. Note any lawn efforts you make such as mowing or fertilization.

Every Sunday:

1. Call the ET Phone Line to get the total ET for the past week. The recording will tell you how many inches to apply if you are on a 100% replacement rate, on a 70% replacement rate or on a 50% replacement rate.

2. Rate your lawn before 10:00 am.

3. Record your ratings and observations on your data sheet.

Watering:

1. Water your lawn with amount instructed on the ET Phone Line either on Sunday evening (after 8:00 pm) or on Tuesday morning (before 10:00 am).

2. Carefully time your watering so that you can apply only the amount instructed on the ET Phone Line.

3. Note any deviation from watering instructions on your data sheet.

4. If the total water you would apply at your replacement rate adds up to less than ½", the instructions will be to wait one week before watering. If rainfall has refilled the soil reservoirs, the recording will instruct you to delay watering.

Communicating Your Data:

We will need to see your data sheets every two weeks. Your monitor will pick up your data every two weeks.

Communicating Problems:

PLEASE CALL YOUR MONITOR IF THERE IS A PROBLEM WITH YOUR LAWN OR IF YOU NEED CLARIFICATION ON INSTRUCTIONS. If for some reason you find you are unable to follow the instructions or your lawn is responding very poorly, we need to know immediately. Call Dee Emory at 225-5848. she will be checking her messages daily.

Bexar County Master Gardener
ET-Program - Data Form

IMPORTANT NOTICE - ET PARTICIPANTS WILL ONLY WATER ON TUESDAYS (AM OR PM).

Wilbur Watje
8718 London Heights
San Antonio, TX 78250
Rate: 100%
Turf type: St. Augusting - front
Quadrant: 1

E-mail address: KLGuz @ aol.com

Rating sheet for all participants.

DATE	OCT 26	NOV 03	NOV 10	NOV 17	NOV 20, 1998
LAWN RATING					Mail In Data Sheet

System for rating lawn: • 1- Excellent: •2 - Good; •3 - Fair; •4 - Poor

Other Information: (Include any evidence of disease, herbicide use or accidental deviation from watering instructions:

Purposes and Responsibilities of the ET Study Monitor

The monitors are some of the most important people in the pilot study. Each monitor will also serve as the initial contact person for the homeowner. If there are any problems or questions, the homeowner will attempt to contact their monitor first. Then the monitor and other members of the ET project team will work to find a solution to the problem.

The responsibilities of the monitor are as follows:

1. The monitor will act as the key contact person for everyone assigned to him/her. As part of keeping up communications, the monitor will be asked to:

   a. Call participants on their assignment list with information on protocol changes.

   b. Receive feedback from participants which will be passed on to the ET Coordinator.

   c. Pay close attention to the quality of each assigned lawn and how each homeowner feels about his/her lawn quality. If the satisfaction level of a participant is low, we will need to hear about it from the monitor in order to make adjustments.

2. Make regular site visits to assigned lawns.

   a. Visit twice per month to check quality.

   b. Visit in response to homeowner questions.

   c. Pick up data sheets from participants.

3. Evaluate data records being maintained by homeowner.

4. Spot check accuracy following protocol.

Start Dates

*Inform homeowners to saturate lawns on Sunday, April 26th (at least 1 inch of water).

*Begin monitoring on Monday, April 27th.

HOW TO OBTAIN ET DATA

We have set up an "ET Phone Line" for your convenience. Each day the message on the phone line will be updated for you.

The ET Phone Line Number is:

(210) 281-1478

Call the ET Phone Line every Sunday. A pre-recorded message will have the information that you need.

If you are unable to access the Bexar County Master Gardener ET hotline, call the Springview Master Gardener office at (210) 225-5848 or the Extension Office at (210) 467-6575 and ask to speak with a member of the ET Project Team.

Questions on the ET Study and Who to Call

1. **Try to reach your monitor.** You have been assigned a monitor in your area. This monitor will be familiar with your lawn because he/she will be making site visits regularly to see how your grass is responding to the protocol. Please try to reach this person first with any questions. You can find his/her phone number on our participants list.

2. **Call ET Coordinator Dee Emory at 225-5848.** Dee is responsible for coordinating the ET Pilot Study under the direction of the Texas Agricultural extension Service. she can be reached during the week.

3. **Call the Texas Agricultural Extension Service at 467-6575.** Three staff members at the Texas Agricultural Extension Service are collaborating on the ET Project.

How to Determine Your Sprinkler Application Rate

We cannot tell you any average numbers for the output of sprinkler systems, because there are none. Each station of an individual sprinkler system varies tremendously in output. And, different locations and sprinkler equipment cause vastly different amounts of water to be applied in the same time period. For this reason, it is imperative that you conduct your own test to determine your sprinkler application rate.

Equipment Needed:

Three straight sided containers such as cake pants or tuna cans
A ruler
A watch or timer

Steps to Follow:

1. Place out your pans in the area where you will evaluating your grass. Space the pans apart several feet from each other in a triangular pattern.

2. Turn on your sprinkler system for 15 minutes.

3. Measure the depth of the water in each pan.

4. Add the water you measured in each pan and divide by three to obtain the average depth.

5. You now know for that area of your lawn, the application rate for a fifteen minute period.

6. To determine the sprinkler application rate for one hour, multiply by four.

**We will only ask you to apply water in increments of ¼" of water. If you find out how long it takes to apply ¼" of water, it will be easy for you to follow the instructions.

"DON'T BAG IT" LAWN CARE PROGRAM

Calvin R. Finch, Ph.D. . . . . . .
County Extension Agent-Horticulture
Texas Agricultural Extension Service

Joe G. Taylor
County Extension Agent - Agriculture
Texas Agricultural Extension Service

Fertilizing Plan

The rate of fertilizer application, the frequency of application, the ratio of nutrients in the fertilizer, and the source of the nitrogen all have a great deal to do with how fast the lawn grows.

The following fertilizing plan is designed to allow the lawn to grow at a reasonable rate and still have a good color.

Fertilizer Ratio (NPK)	Fertilizer Analysis	Application rate - Pounds per 1000 sq. ft.
3-1-2*	12-4-8	8
	15-5-10	7
	21-7-14	5
4-1-2	16-4-8	6
	20-5-10	5
	19-5-9	5
Other	27-3-3	4

For slow, even growth, use a fertilizer containing either sulfur-coated urea or ureaformaldehyde as a nitrogen source, rather than soluble forms, for the spring. The soluble forms, such as urea or ammonium sulfate, tend to produce very fast growth for short periods of time. Organize fertilizers are also good sources of slow release fertilizer.

Organic	9-1-1	11
	7-2-2	14

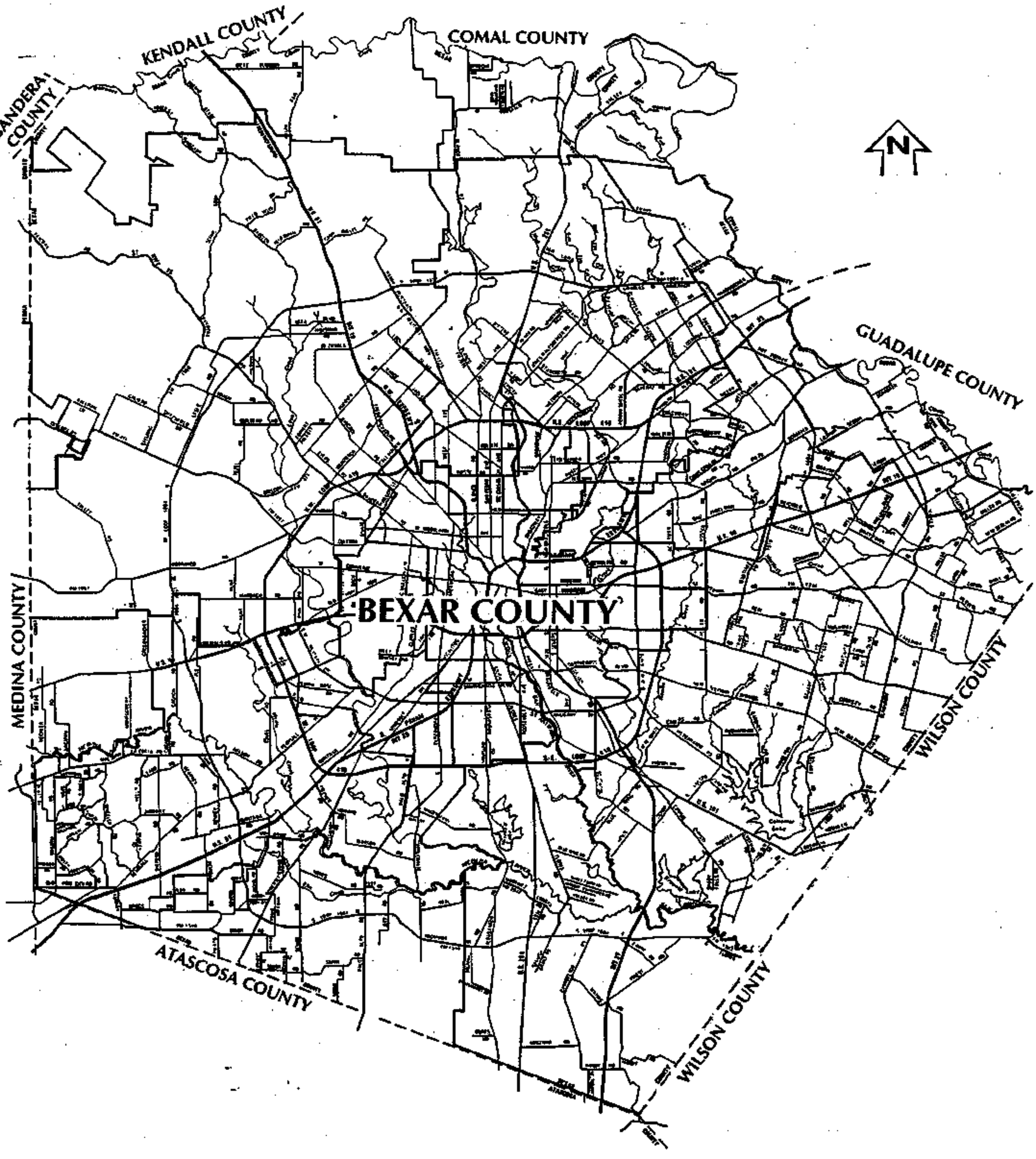
Yellowing is often caused by iron deficiency in our alkaline soil. A Fe-Iron Treatment may be necessary to improve green color of grass.

Watering Plan

Grass varieties and their need for water:

1. St. Augustine (needs the most water)
2. "Tif" Bermuda
3. Zoysia
4. Common Bermuda
5. Buffalo (needs the least water)

Bexar County Map



EVAPO-TRANSPIRATION TESTING AGREEMENT

In order for the lawn demonstrator to be an eligible participant of the Evapo-Transpiration Project testing, he/she must agree to the following:

1. Test sites must have a well-established turf grass

2. Allow Master Gardener, Extension Service and other ET officials to have access to the part of your property involved in the experiment for the purposes of the experiment.

3. Attend a training session where the following will be reviewed:

   a. Watering program procedures
   b. Determine the sprinkler application rate
   c. Measure PET (Potential Evapo-Transpiration)
   d. Rate turf quality
   e. Look for signs of disease and stress on lawn.

4. Record all data on date table and monitor will pick up data every two weeks

5. Follow Texas Agricultural Extension Service recommendations for lawn care

   a. Mow at height and frequency recommended for your grass variety.
   b. Apply recommended amounts of fertilizer
   c. Lawn clippings cannot be bagged

6. Post a sign in a visible spot identifying the lawn as part of the experiment. The sign will help educate area residents to the potential of ET

7. Allow the San Antonio Water System to release to ET staff information on your water usage for two years past and during the experiment for analysis of changes in water use. No names will be published and your data will be used only as part of the statistics of the project.

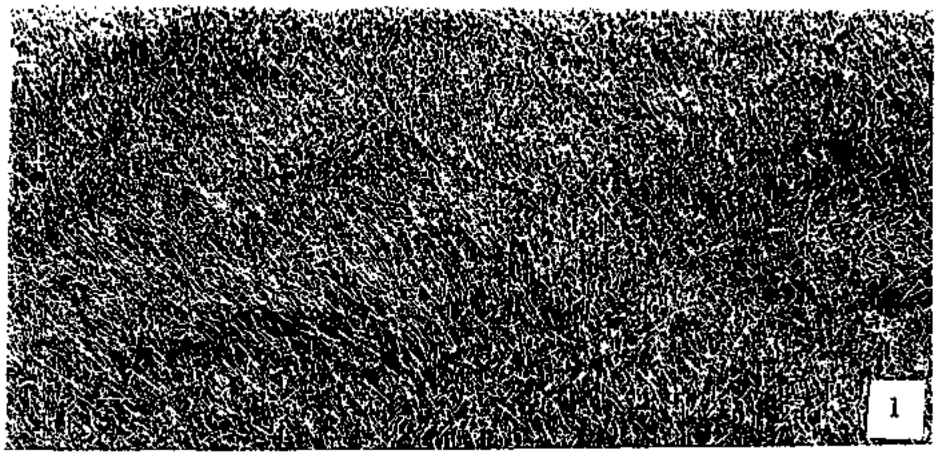
8. Attend a follow-up session in the fall to offer feedback on the study.

I agree to follow the Evapo-Transpiration study guidelines as described above. As part of my participation, I will receive free lawn fertilizer, a Lawn Care/Evapo-Transpiration notebook, and will have available master Gardener and Extension Agent resources for consultation on my lawn as needed.

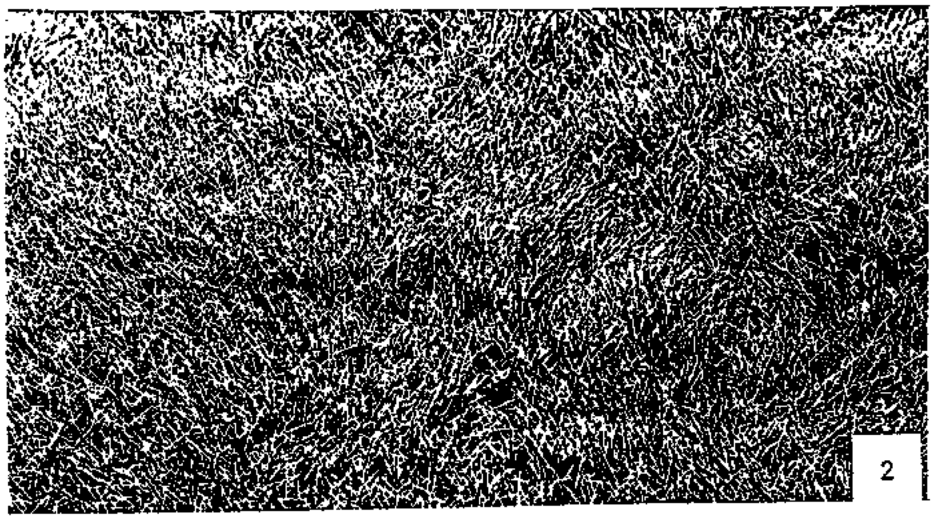
______________________________ ______________________________

Lawn Demonstrator Signature Date

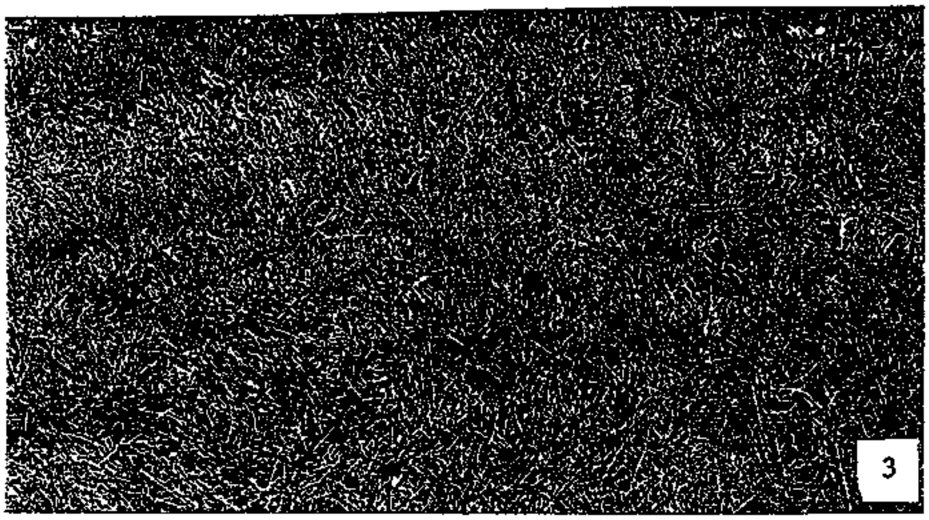
ZOYSIA



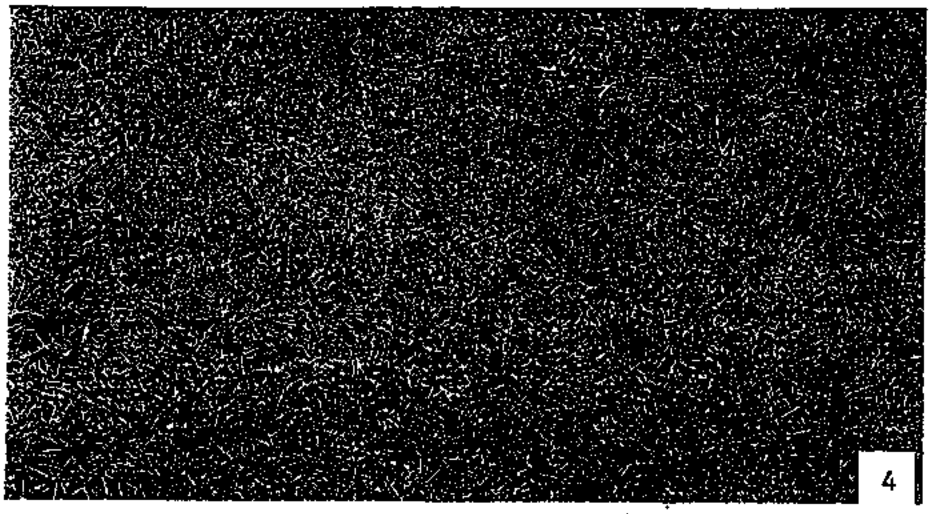
1. EXCELLENT: The turf is very dense with no ground visible when looking from above. The color is a uniform green with no yellowing. No weeds or bare spots are evident.



2. GOOD: No ground is visible when looking from above. The color is uniform green nearly throughout. There may be a few areas with color variation. Very few weeds are evident and there are no completely bare spots.

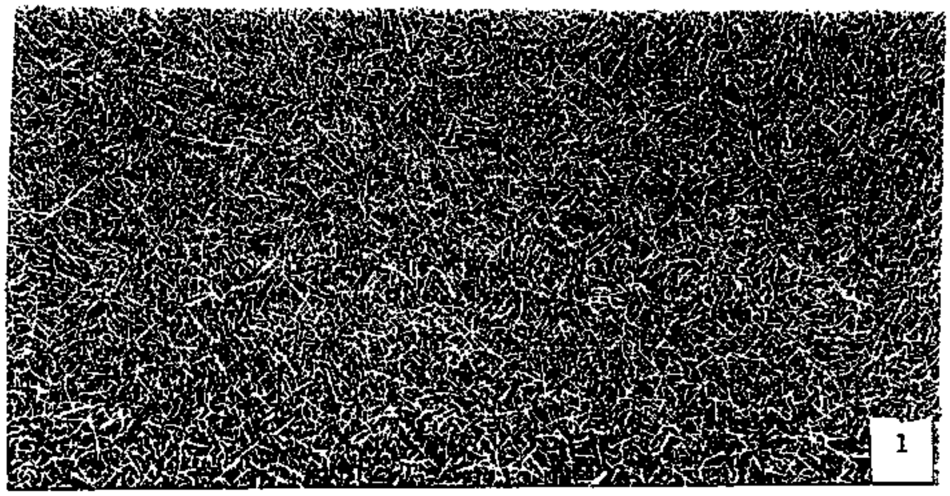


3. FAIR: There are areas in the lawn where the grass is thin enough to see soil through the stems, but most is dense enough to cover the lawn. Variations of green color and some browning are evident. Some weeds may be evident in the thin areas.

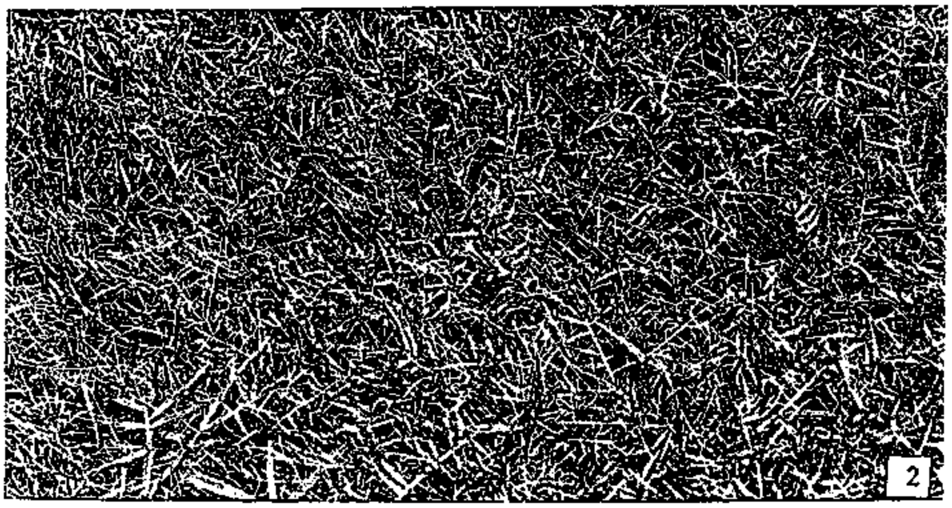


4. POOR: The lawn is not dense enough to cover the soil. There are brown patches and bare spots. Weeds have invaded the lawn and are obvious.

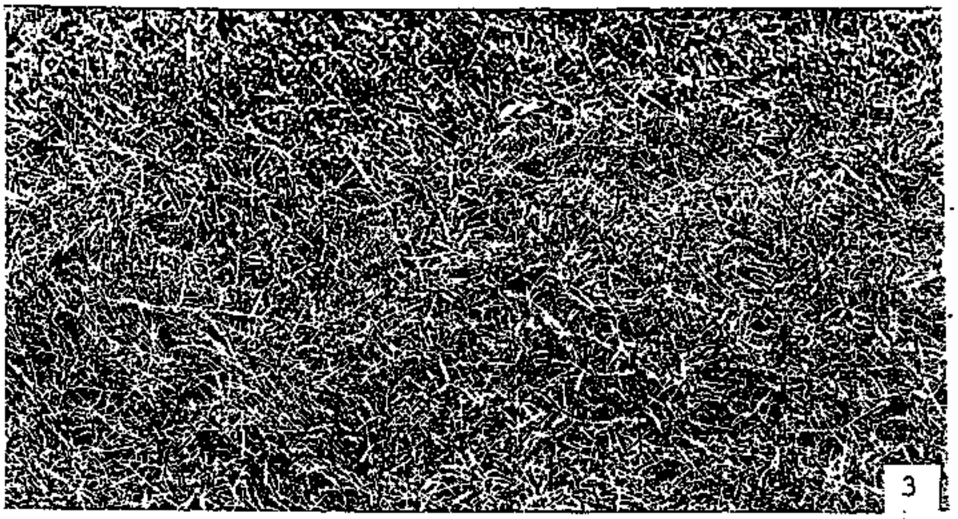
BERMUDA



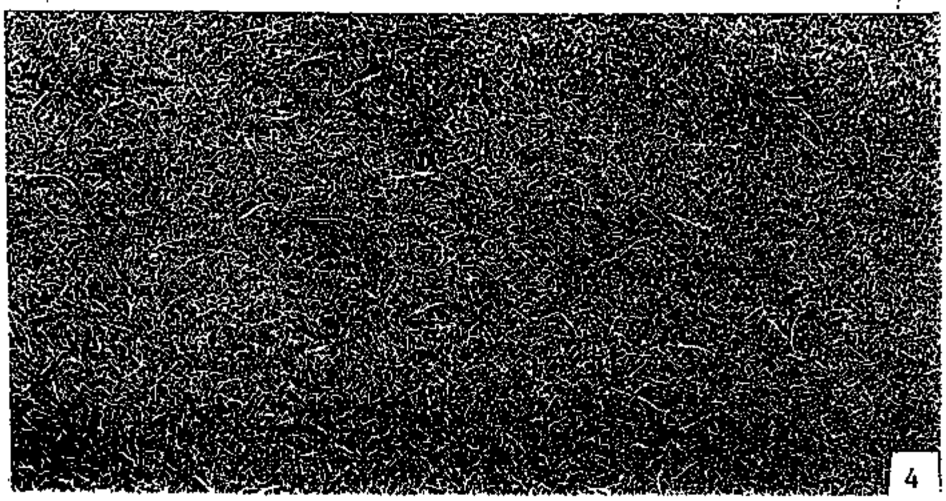
1. EXCELLENT: Density — very close spacing of leaves and stolens; lush green in color; no brown on leaf margins, no evidence of weeds; appearance is similar to that of a well kept golf green.



2. GOOD: Density — no evidence of bare ground, may see runners moving to thin areas; green in color; grass springs back well to walking pressure; no evidence of weed encroachment.

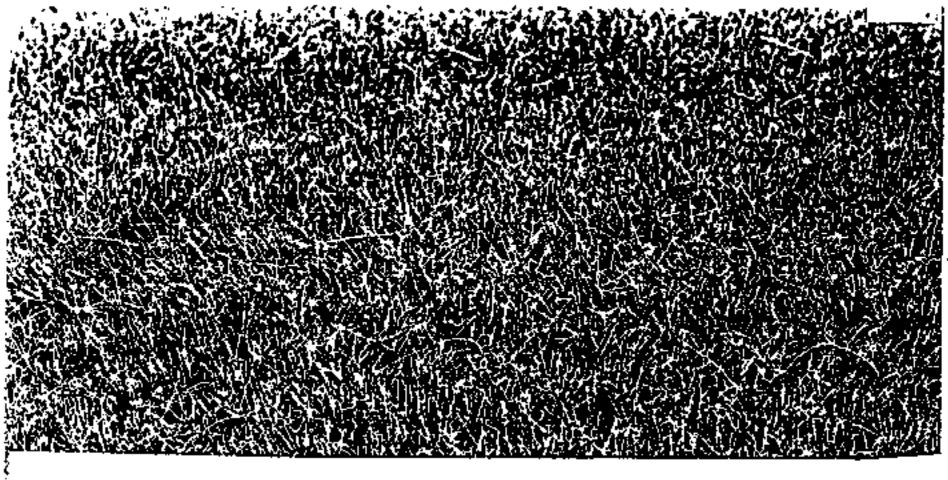


3. FAIR: Density — Plant stolens are thin, evidence of bare spots sparsely scattered, lots of runners may be present; evidence of weeds is noticed; brown and yellowing or light green plants are seen.

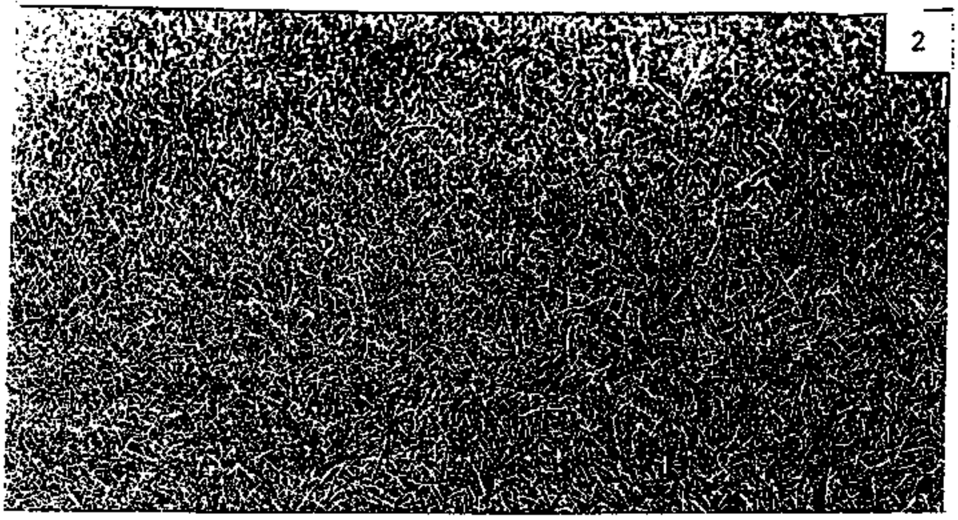


4. POOR: Density — thin with lots of bare ground; grass is brown under heat and water stress; grass may be dormant in excessively dry areas; evidence of weeds such as crouton, pig weed, purslane, and dollar weed are present.

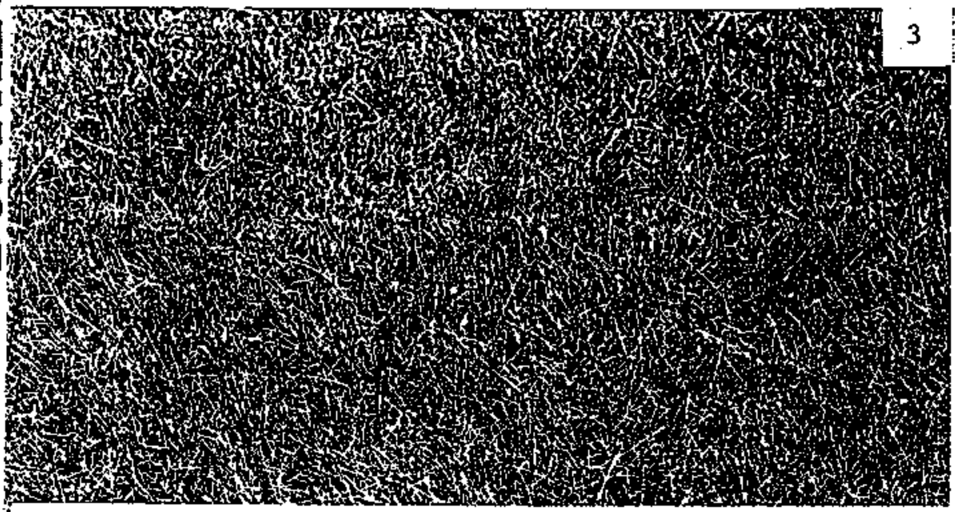
BUFFALOGRASS



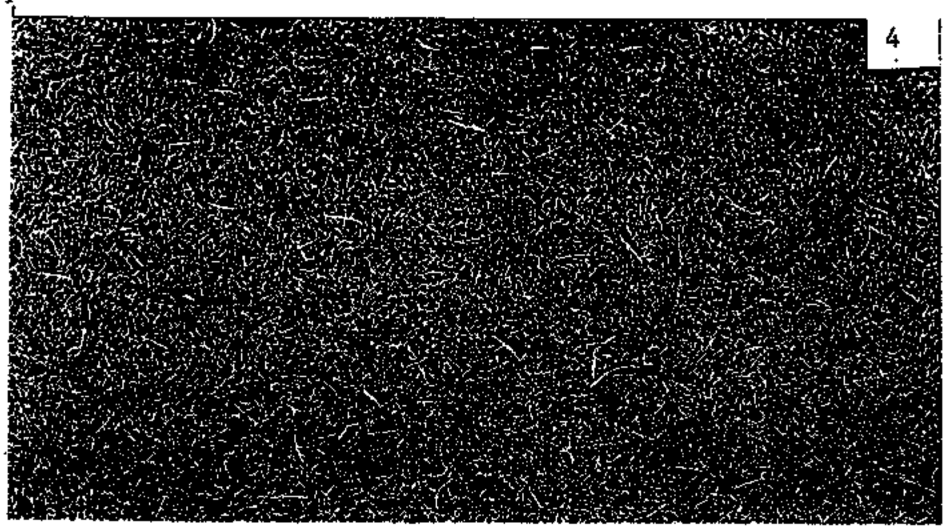
1. EXCELLENT: The turf is a pure stand of buffalograss with no Bermuda grass or other weeds evident. The entire lawn is growing at the same rate and the color is uniform.



2. GOOD: The turf appears to be a pure stand of buffalograss with no weeds evident. The lawn may have some areas of shallow surface browning, but is generally a uniform green throughout. Growth is generally even throughout the lawn.

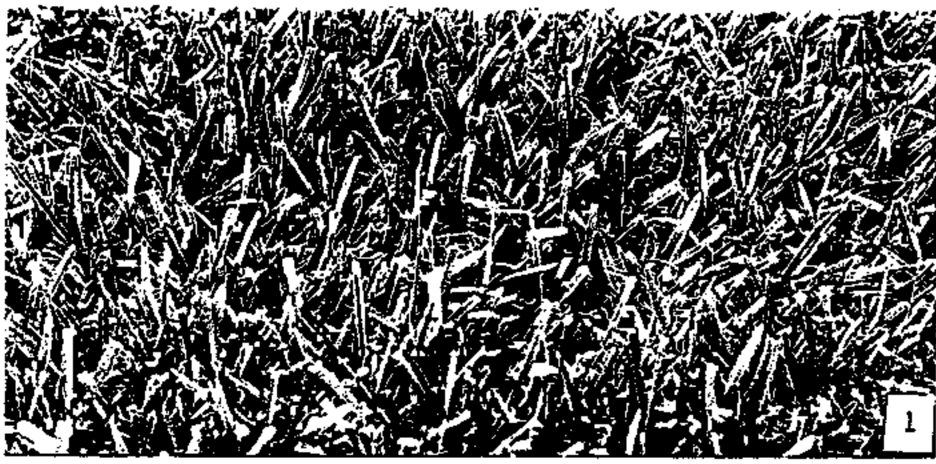


3. FAIR: There is Bermuda grass or other weeds in the lawn but the lawn still is dominated by buffalograss. Some off-color areas and variations in density are evident.

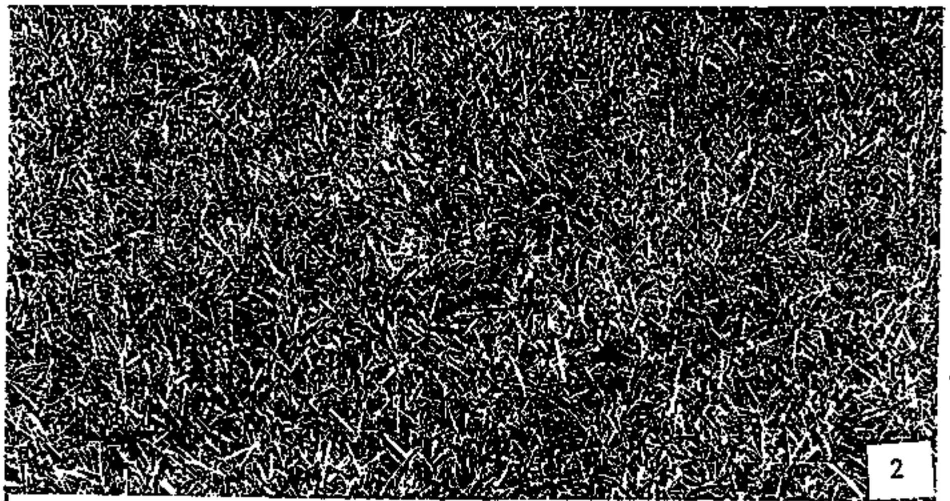


4. POOR: The density of the grass is uneven through the lawn. Weeds are very evident. Bare spots and areas of uneven growth exist and off-color areas are obvious.

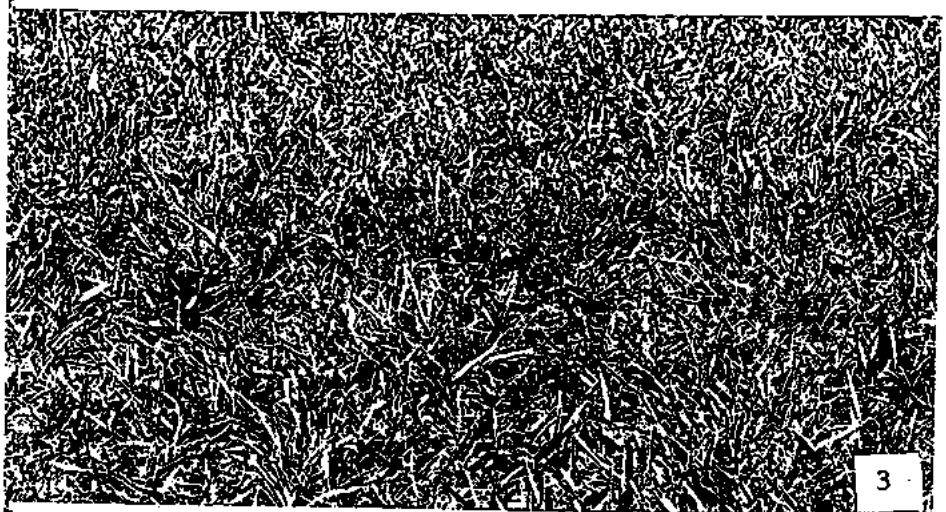
ST. AUGUSTINE



1. EXCELLENT: Density — very thick; lush green color; no yellowing; Blades flat and wide; sod springs back after walking over in the morning; no evidence of weeds.



2. GOOD: Density — No evidence of bare ground, however grass blades are not thick and close; green in color, may be mottled dark and light green areas; blades are flat but may curl in the heat of the afternoon on hot days; no evidence of weeds.



3. FAIR: Density — finding sparse, scattered bare spots; yellowing may be present; leaf blades may be curled and show browning of leaf margins; weed encroachment is evident. Grass doesn't spring back after walking over.

4. POOR: Density — finding several scattered bare spots; yellowing and off-green color is present; leaf margins are brown; disease symptoms may be present; weeds are present and represent more than 25% of turf area. Grass is stressed and does not respond or spring back after walking over.

APPENDIX

1998 Participant Data Tables

Soil Moisture Meter Data Graphs

PET Graphs

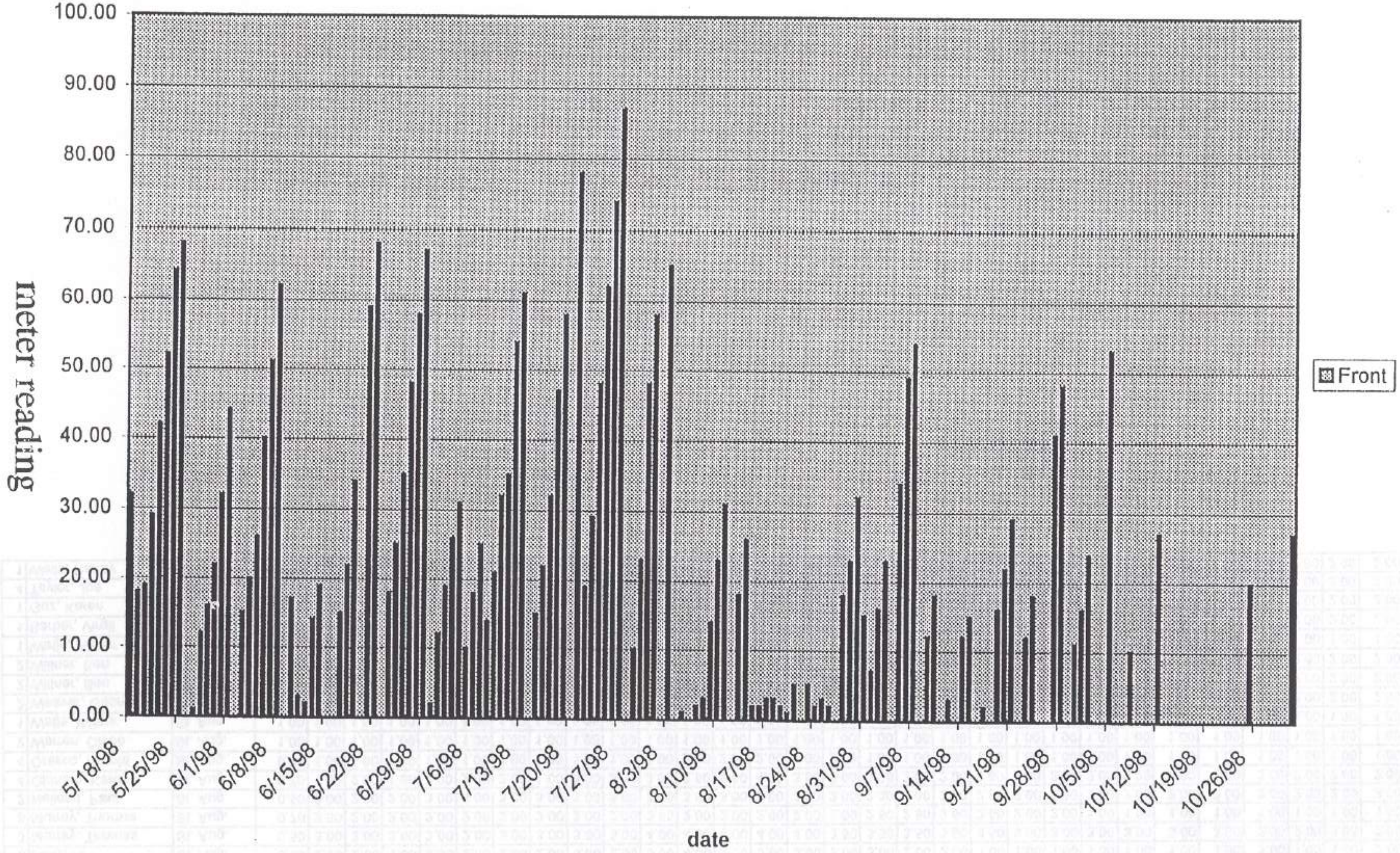
Quadrant Data

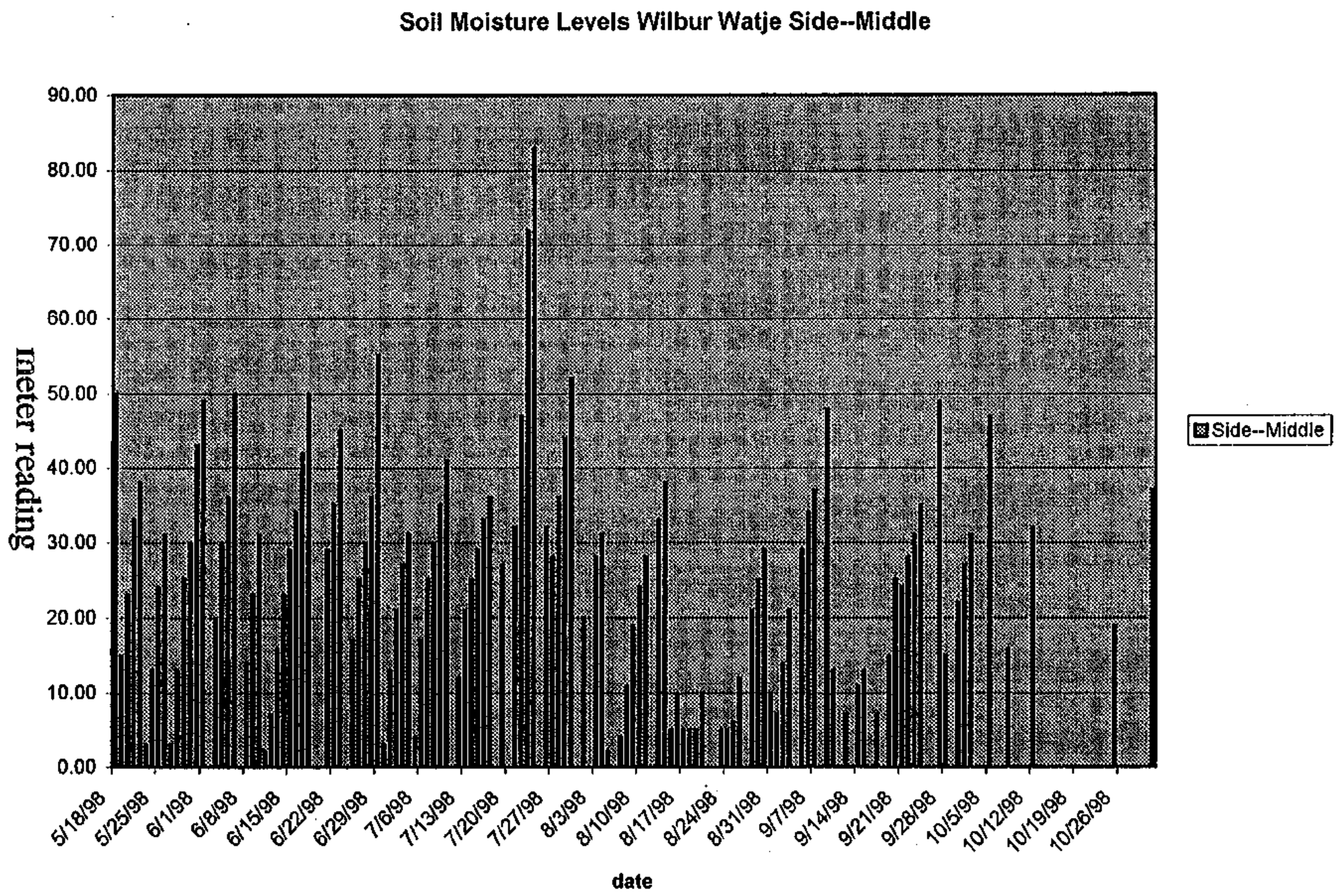
Appendix Table 1: 1998 Participant Data

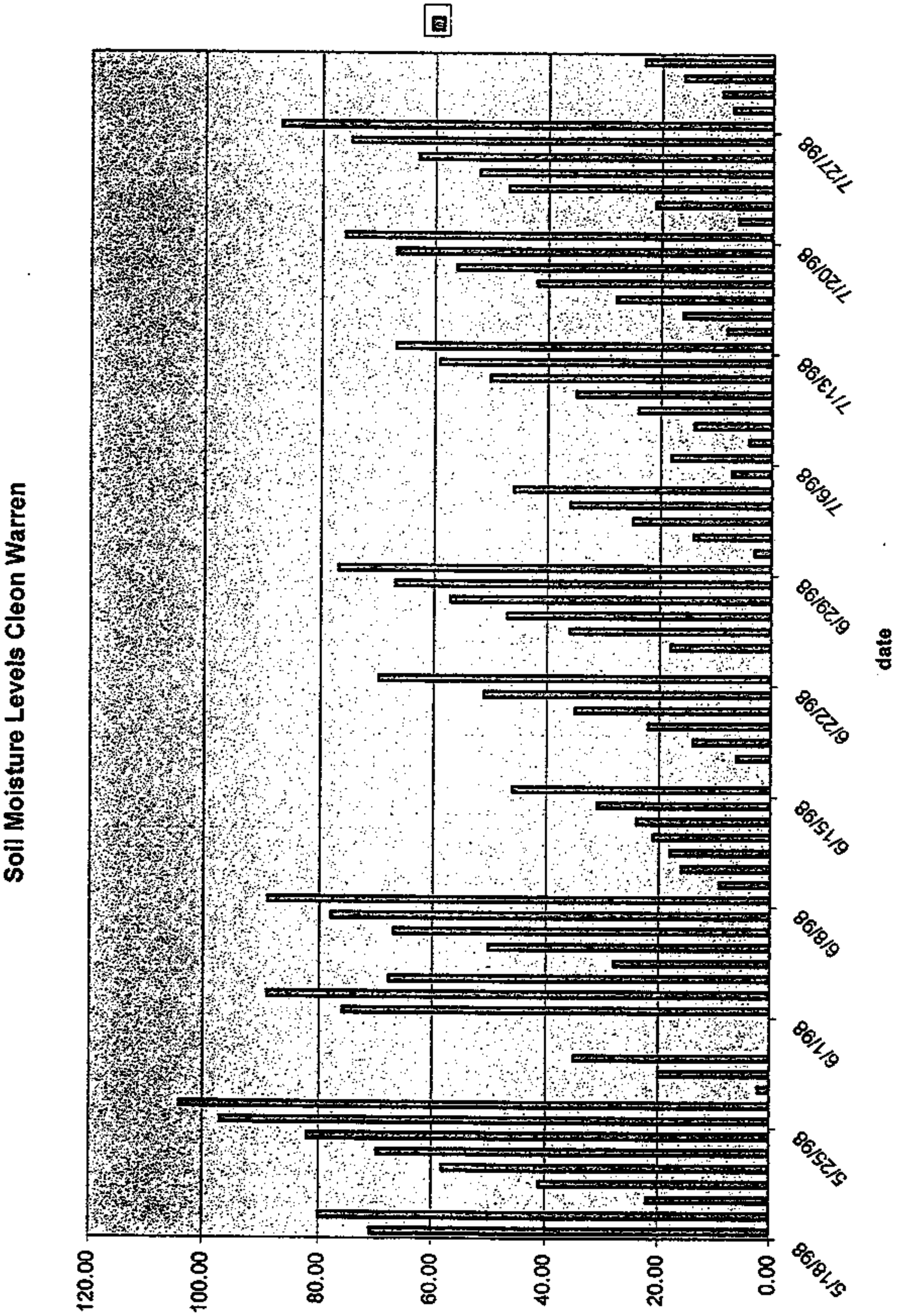
Q.	NAME	TURF		5/4	5/11	5/18	5/25	6/1	6/8	6/15	6/22	6/29	7/6	7/13	7/20	7/27	8/3	8/10	8/17	8/24	8/31	9/7	9/14	9/21	9/28	10/5	10/12	10/19	10/26	11/2	11/9	11/16
3	Barenblat, Elise	Bermuda	1.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	3.00	2.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3	Brown, Jarvis	Bermuda	0.70	2.00	2.00	2.00	2.00	1.00	2.00	2.00	2.00	2.00	3.00	3.00	3.00	3.00	3.00	3.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
1	Guz, Karen	Bermuda	0.50	1.00	1.00	1.00	2.00	2.00	2.50	3.00	3.50	3.50	3.00	3.00	3.00	3.00	3.00	3.00	2.50	2.00	1.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.50	1.50	1.50	1.50
1	Guz, Karen	Bermuda	0.70	1.00	1.00	1.00	1.00	1.50	2.50	2.50	2.00	2.00	3.00	3.00	3.00	3.00	3.00	2.50	2.00	2.00	1.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.50	1.50	1.50	1.50
4	Justice Center	Bermuda	1.00	3.00	3.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.50	3.00	3.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
3	MacCauley, Donald	Bermuda	0.50	1.00	1.00	1.00	1.00	1.00	1.50	1.50	2.50	3.00	2.00	2.00	2.00	2.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3	Melcher, Irene	Bermuda	0.50	2.00	2.00	2.00	2.00	2.00	2.00	1.50	2.00	2.50	2.00	2.50	3.00	3.00	3.00	2.50	2.00	1.50	2.00	2.00	1.50	1.50	1.50	2.00	2.00	2.50	3.00	1.50	2.50	3.00
1	Mezzetti, James	Bermuda	0.70	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	3.00	3.00	2.00	2.00	3.00	4.00	4.00	3.00	2.00	3.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
1	Mooney, Daniel	Bermuda	0.70	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.50	3.00	1.00	1.50	2.00	2.00	2.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4	Taylor, Joe	Bermuda	0.00	3.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	3.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4	Taylor, Joe	Bermuda	0.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	4.00	3.00	3.00	3.00	3.00	3.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2	Warren, Cleon	Bermuda	0.00	3.00	3.00	3.00	3.00	4.00	2.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	3.00	3.00	2.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
1	Watje, Wilbur	Bermuda	1.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	1.50	1.50	1.50	1.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4	Bartlett, Charles	Buffalo	0.50	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	3.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	3.00	3.00
1	Callins, Olga	Buffalo	0.50	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.50	3.50	4.00	4.00	3.50	4.00	4.00	4.00	3.50	3.50	3.00	3.00	3.00	3.00	3.00	3.00	3.00	2.00	2.00	2.00	2.00	2.00
1	Castillo, Roberta	Buffalo	0.50	2.00	2.00	2.00	2.00	2.50	2.00	3.00	3.00	3.00	2.00	3.00	3.00	3.00	3.00	3.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
2	Fagan, C.A.	Buffalo	0.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2:00	3.00	3.00	3.00	3.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00	2.00	2.00
1	Fischer, Alton	Buffalo	0.70	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	3.00	3.00	3.00	2.00	3.00	3.00	3.00	3.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	3.00	2.00	3.00	3.00	3.00
4	Fortassain, Dennis	Buffalo	0.00	2.00	2.00	3.00	3.00	3.00	3.00	4.00	4.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
4	Fortassain, Dennis	Buffalo	0.50	2.00	2.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	2.00	2.00	2.00	3.00	3.00	3.00
2	McAnnely, Suzanne	Buffalo	0.00	1.00	2.00	1.00	2.00	2.00	2.00	2.00	2.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	2.50	2.50	2.50	2.50	2.50	2.50	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
2	McAnnely, Suzanne	Buffalo	0.50	1.00	2.00	1.00	2.00	2.00	1.50	1.00	1.00	1.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
2	McAnnely, Suzanne	Buffalo	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.50	1.50	1.50	1.50	1.50	1.50	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
2	Nicholson, Paul	Buffalo	0.50	2.00	2.00	2.00	3.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2	Nicholson, Paul	Buffalo	0.00	1.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	3.00	2.00	2.00	3.00	3.00	3.00	3.00	2.00	2.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2	Schutlz, Rissa	Buffalo	1.00	3.00	3.00	3.00	2.50	2.50	2.50	2.50	3.00	3.00	2.50	2.00	1.50	3.50	3.00	3.00	2.00	2.00	2.00	2.50	2.50	2.00	3.00	2.50	2.50	2.00	2.00	2.50	2.50	2.50
3	Turner, Ian	Buffalo	0.50	2.00	2.00	2.00	2.00	2.00	2.00	2.00	3.00	3.00	2.00	2.00	2.00	3.00	2.50	2.50	2.00	2.00	1.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1	Vertees, Julia	Buffalo	0.50	2.00	2.00	2.00	2.00	2.00	2.50	2.00	2.00	3.00	2.00	2.00	3.00	3.00	3.00	2.00	2.00	2.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1	Vertees, Julia	Buffalo	0.70	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	3.00	3.00	3.00	3.00	2.00	2.00	1.00	1.00	1.50	1.50	1.50	1.50	2.00	3.00	3.00	3.00
2	Vestal, Norman	Buffalo	0.50	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	3.00	3.00	3.00	3.00	3.00	3.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
3	Watts, K.	Buffalo	0.50	2.00	2.00	2.00	2.00	2.00	2.50	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	2.00	1.00	1.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
2	Wilhelm, Steven	Buffalo	0.50	3.00	3.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.50	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.50	1.50	1.50	1.50	2.00	2.00
2	Schwesinger, K.	Buffalo 609	0.70	1.00	1.00	1.50	2.00	2.00	2.00	1.00	1.50	1.50	1.00	1.00	2.00	2.50	2.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2	Wilhelm, Steven	Buff. back	0.00	3.00	3.00	3.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.50	2.50	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3	Baribeau, Robert	St. Aug.	0.70	1.50	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.50	2.50	3.00	2.50	3.00	2.50	3.00	2.00	2.00	2.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	2.00	2.00	2.00	2.50
3	Brag, Roger	St. Aug.	1.00	1.00	1.00	2.00	2.00	2.00	2.50	2.00	2.00	2.00	2.00	2.00	3.00	3.00	3.00	2.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3	Bragg, Roger	St. Aug.	1.00	1.00	1.00	1.00	2.00	2.50	2.50	2.00	3.00	3.00	2.00	3.00	4.00	4.00	4.00	3.00	2.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3	Brennand, Shannon	St. Aug.	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	3.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3	Brennand, Shannon	St. Aug.	0.70	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00	3.00	3.00	3.00	3.00	3.00	3.00	2.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3	Brewer, Millie	St. Aug.	0.70	1.00	1.00	2.00	2.00	2.00	2.00	1.00	2.00	1.00	3.00	3.00	3.00	3.00	3.00	2.00	1.00	1.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3	Cane, J.C.	St. Aug.	0.50	1.50	1.50	1.50	2.00	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3	Capers, Linda	St. Aug.	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2	Dennison, Russell	St. Aug.	0.50	2.00	2.00	2.00	3.00	2.50	2.50	3.00	2.50	3.00	2.50	2.00	2.00	3.00	2.00	2.00	1.00	2.00	1.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2	Fohn, Joe	St. Aug.	0.50	2.00	2.00	2.50	2.50	2.50	2.50	3.50	3.50	2.50	2.50	2.50	2.50	2.50	3.00	3.00	3.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
3	Greene, Leroy	St. Aug.	1.00	3.00	2.00	2.00	2.00	1.00	1.50	2.00	3.00	3.00	2.00	3.00	3.00	3.00	3.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00
2	Guerra, Olivia	St. Aug.	0.70	2.00	2.00	2.00	2.00	3.00	2.00	3.00	2.00	2.00	1.00	1.00	2.00	2.00	1.50	1.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2	Hammer, Carrie	St. Aug.	0.00	3.00	3.00	2.00	3.00	4.00	3.00	3.00	3.00	3.00	3.00	4.00	4.00	4.00	3.00	3.00	3.00	3.00	2.00	2.00	2.00	2.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
2	Hammer, Carrie	St. Aug.	0.00	2.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	2.00	2.00	2.00	2.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00

3	Hayes, Allen	St. Aug.	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	3.00	2.00	2.00	2.00	3.00	2.00	1.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1	Hudson, Stephen	St. Aug.	0.50	2.00	2.00	2.00	3.00	2.00	2.00	2.00	3.00	2.00	2.00	2.00	3.00	2.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2	Mote, Al	St. Aug.	0.70	2.00	2.00	1.00	2.00	2.00	2.00	2.00	3.00	2.00	2.00	2.00	2.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00
2	Mote, Al	St. Aug.	0.60	2.00	2.00	1.00	2.00	2.00	2.00	2.00	3.00	2.00	3.00	4.00	4.00	3.00	3.00	3.00	3.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00
3	Murray, Thomas	St. Aug.	0.60	3.00	3.00	3.00	3.00	2.00	2.00	3.00	3.00	3.00	4.00	4.00	4.00	4.00	4.00	3.50	3.50	3.50	3.50	3.50	3.50	3.00	3.00	3.00	3.00	3.00	2.00	2.00	2.00	2.00
3	Murray, Thomas	St. Aug.	0.70	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.50	2.50	2.50	2.50	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2	Nellond, Paul	St. Aug.	0.50	2.00	2.00	2.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
4	Oldham, Karen	St. Aug.	0.70	1.00	2.00	1.00	2.00	2.00	2.00	1.00	3.00	3.00	3.00	2.50	4.00	4.00	3.50	3.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
4	Orasco, Harold	St. Aug.	0.70	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00	2.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2	Warren, Cleon	St. Aug.	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1	Watje, Wilbur	St. Aug.	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2	Weaver, George	St. Aug.	0.70	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.50	2.00	1.00	1.00	1.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
2	Willner, Ben	St. Aug.	0.70	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	3.00	3.00	3.00	4.00	3.50	3.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
2	Willner, Ben	St. Aug.	1.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	3.00	2.00	3.00	3.00	3.00	3.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
1	Watje, Wilbur	St. Aug.	control	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1	Barber, Virgil	Zoysia	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.50	2.00	2.00	4.00	3.00	3.00	3.00	3.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
1	Guz, Karen	Zoysia	0.70	1.00	2.00	1.00	1.00	1.00	1.50	2.00	2.00	3.00	3.00	3.00	3.00	3.00	3.00	2.50	2.50	2.50	2.00	2.00	1.50	1.50	1.50	1.50	1.50	1.50	2.00	2.00	2.00	2.00
4	Taylor, Joe	Zoysia	0.70	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
1	Wells, Randy	Zoysia	0.70	1.00	1.00	1.00	1.00	1.00	1.00	1.00	3.00	2.00	2.00	3.00	3.00	3.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00

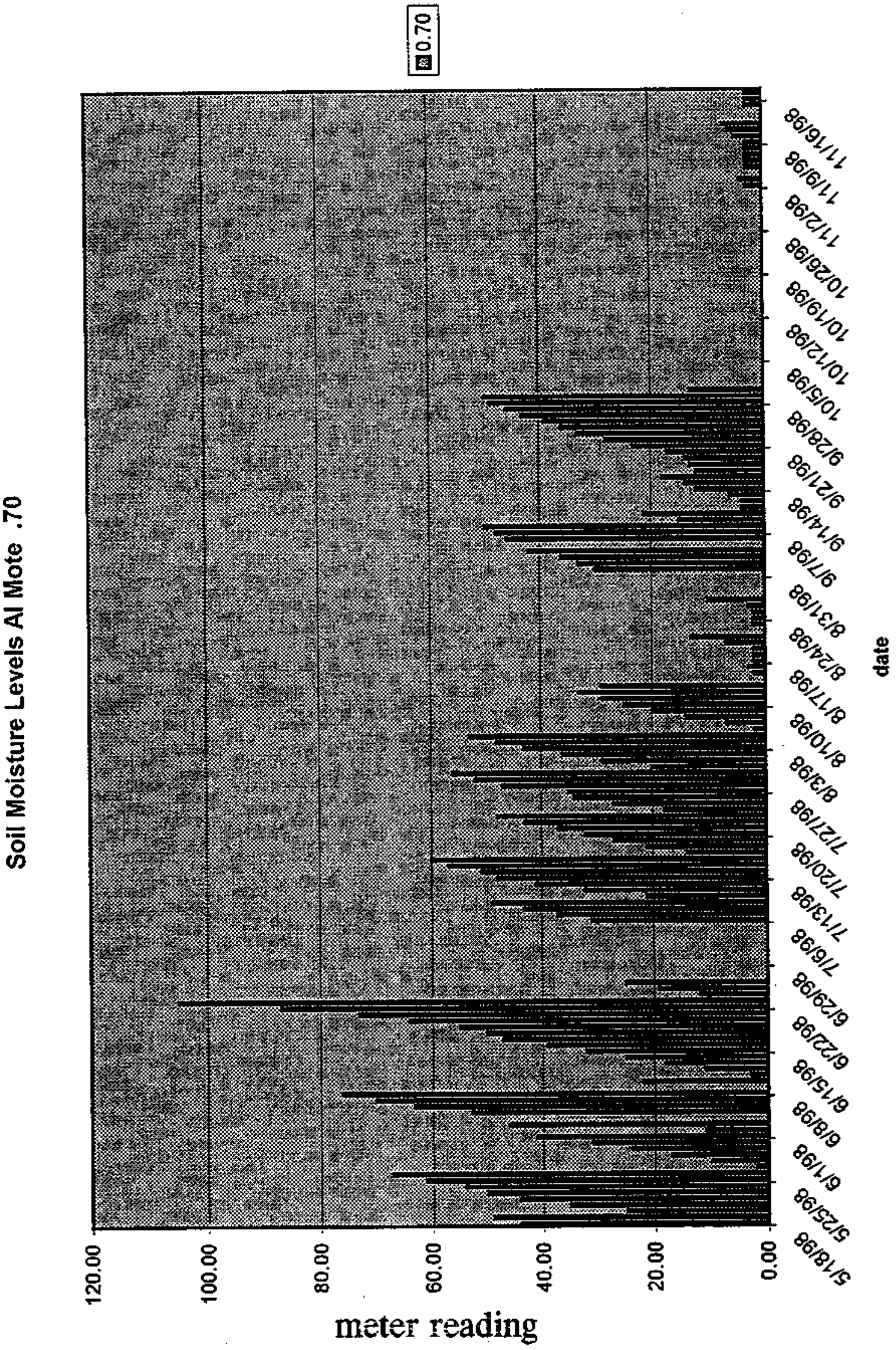
Soil Moisture Levels Wilbur Watje Front



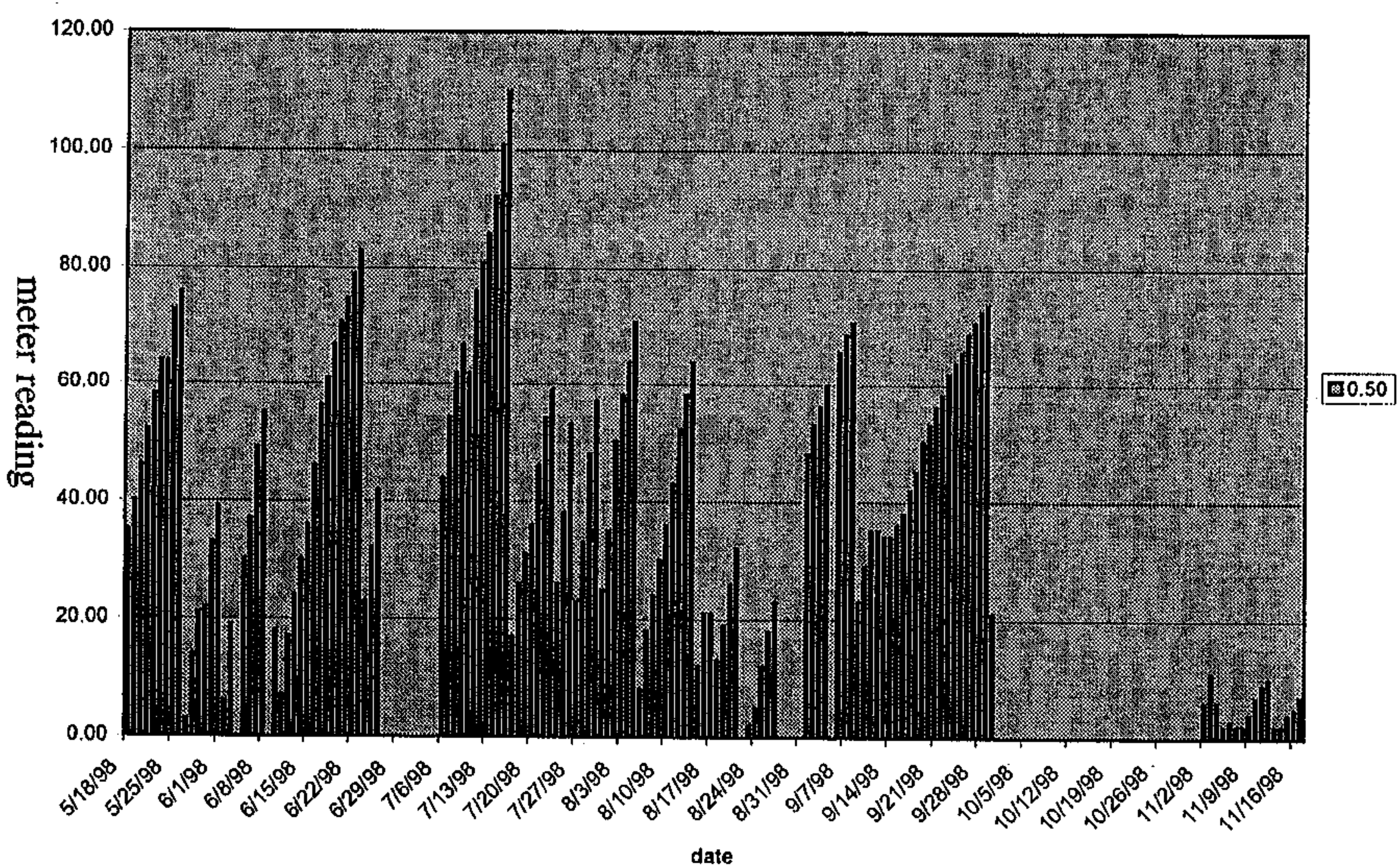

Soil Moisture Levels Wilbur Watje Side--Middle
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
meter reading
5/18/98
5/25/98
6/1/98
6/8/98
6/15/98
6/22/98
6/29/98
7/6/98
7/13/98
7/20/98
7/27/98
8/3/98
8/10/98
8/17/98
8/24/98
8/31/98
9/7/98
9/14/98
9/21/98
9/28/98
10/5/98
10/12/98
10/19/98
10/26/98
date
Side--Middle

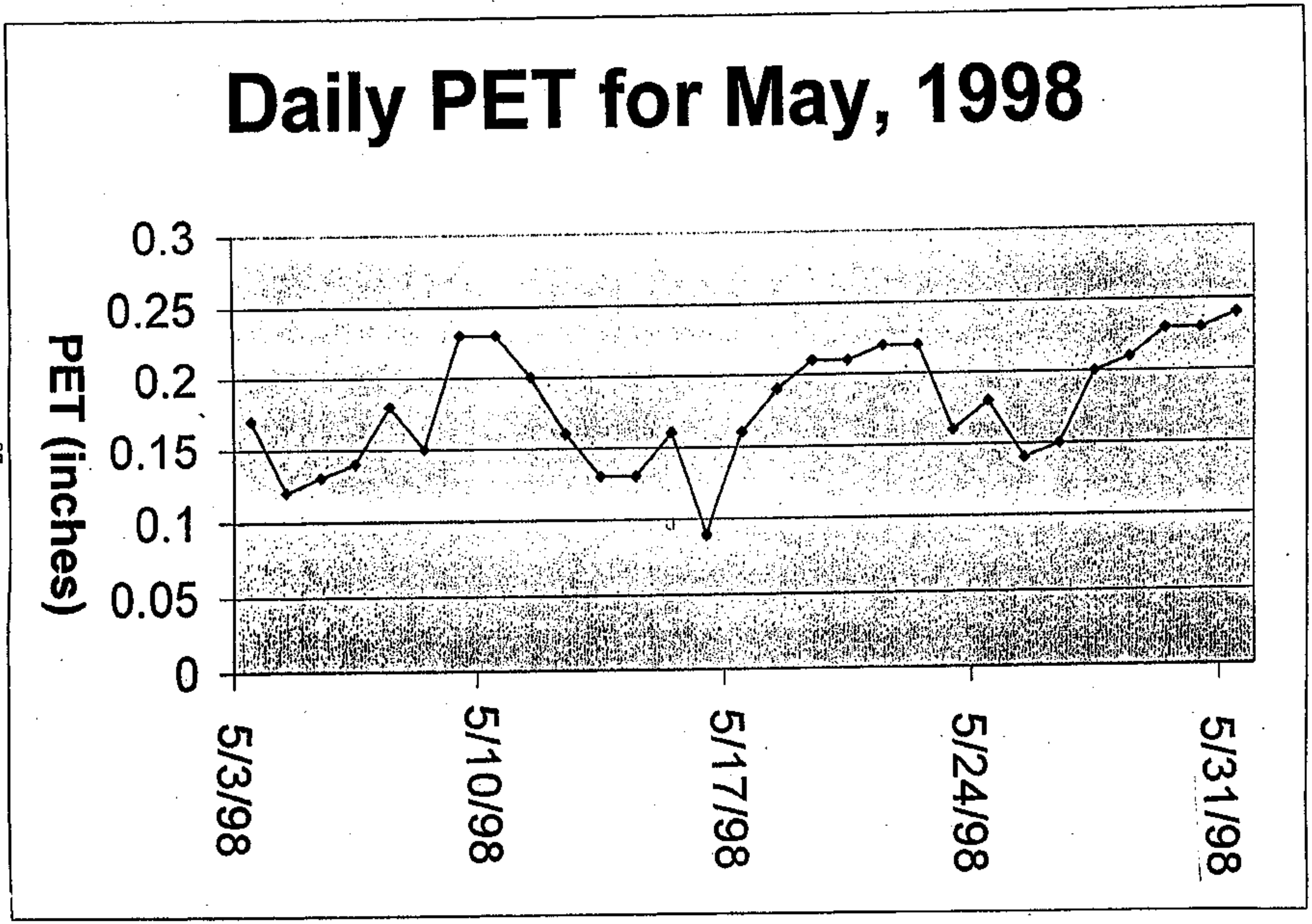


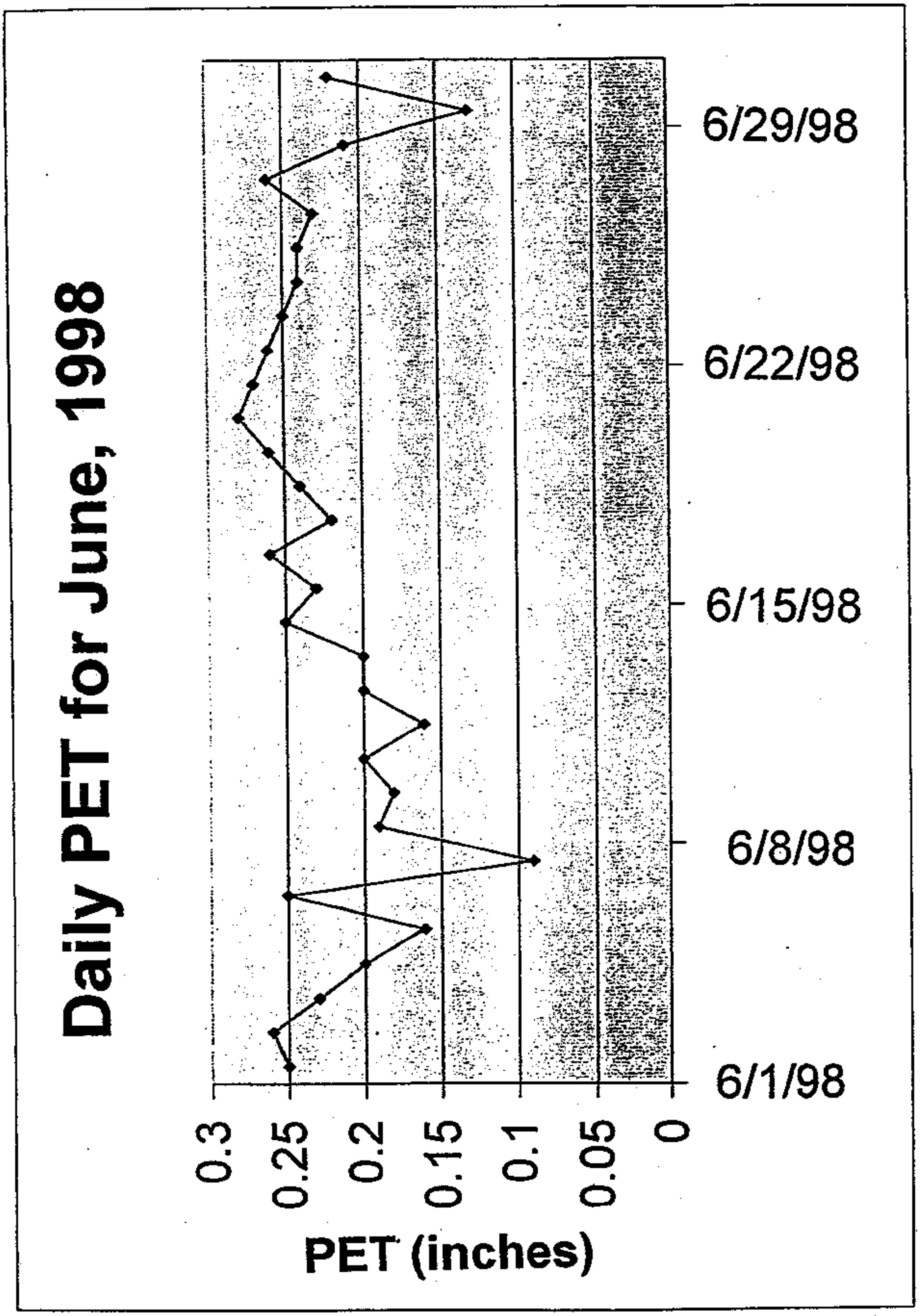
meter reading

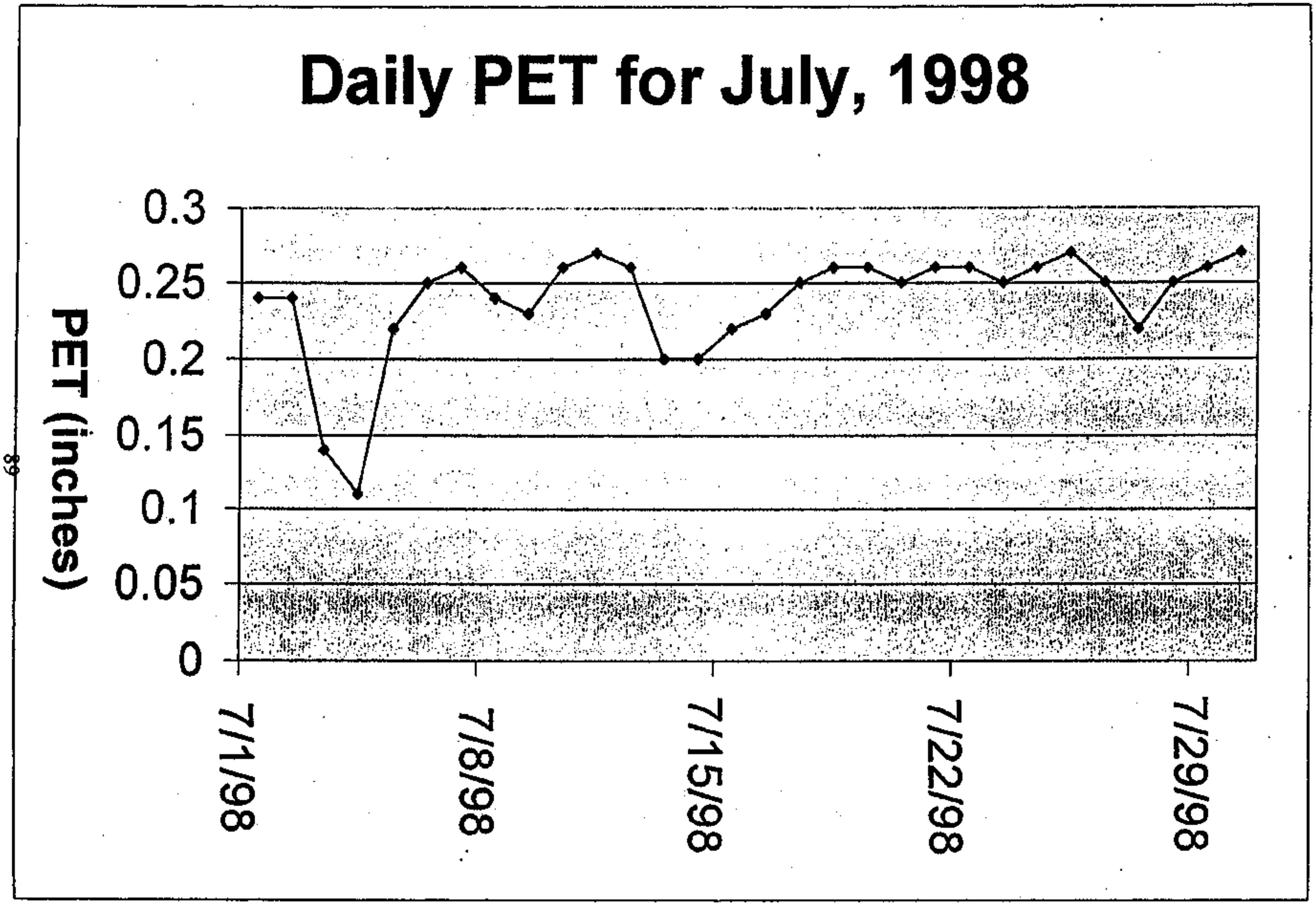

Soil Moisture Levels Al Mote .70
0.70
120.00
100.00
80.00
60.00
40.00
20.00
0.00
meter reading
5/18/98
5/25/98
6/1/98
6/8/98
6/15/98
6/22/98
6/29/98
7/6/98
7/13/98
7/20/98
7/27/98
8/3/98
8/10/98
8/17/98
8/24/98
8/31/98
9/7/98
9/14/98
9/21/98
9/28/98
10/5/98
10/12/98
10/19/98
10/26/98
11/2/98
11/9/98
11/16/98
date

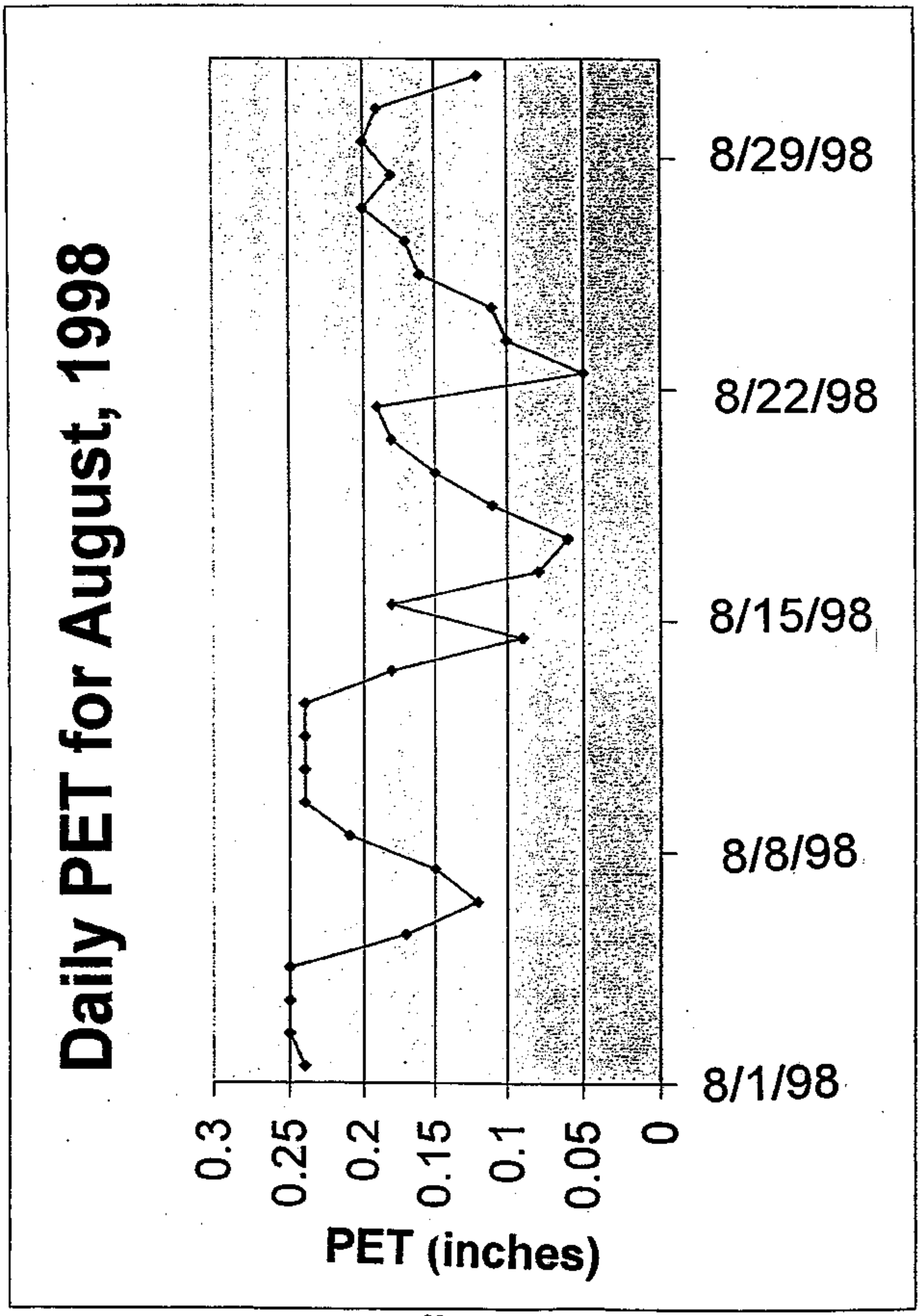
Soil Moisture Levels Russel Denison 0.50



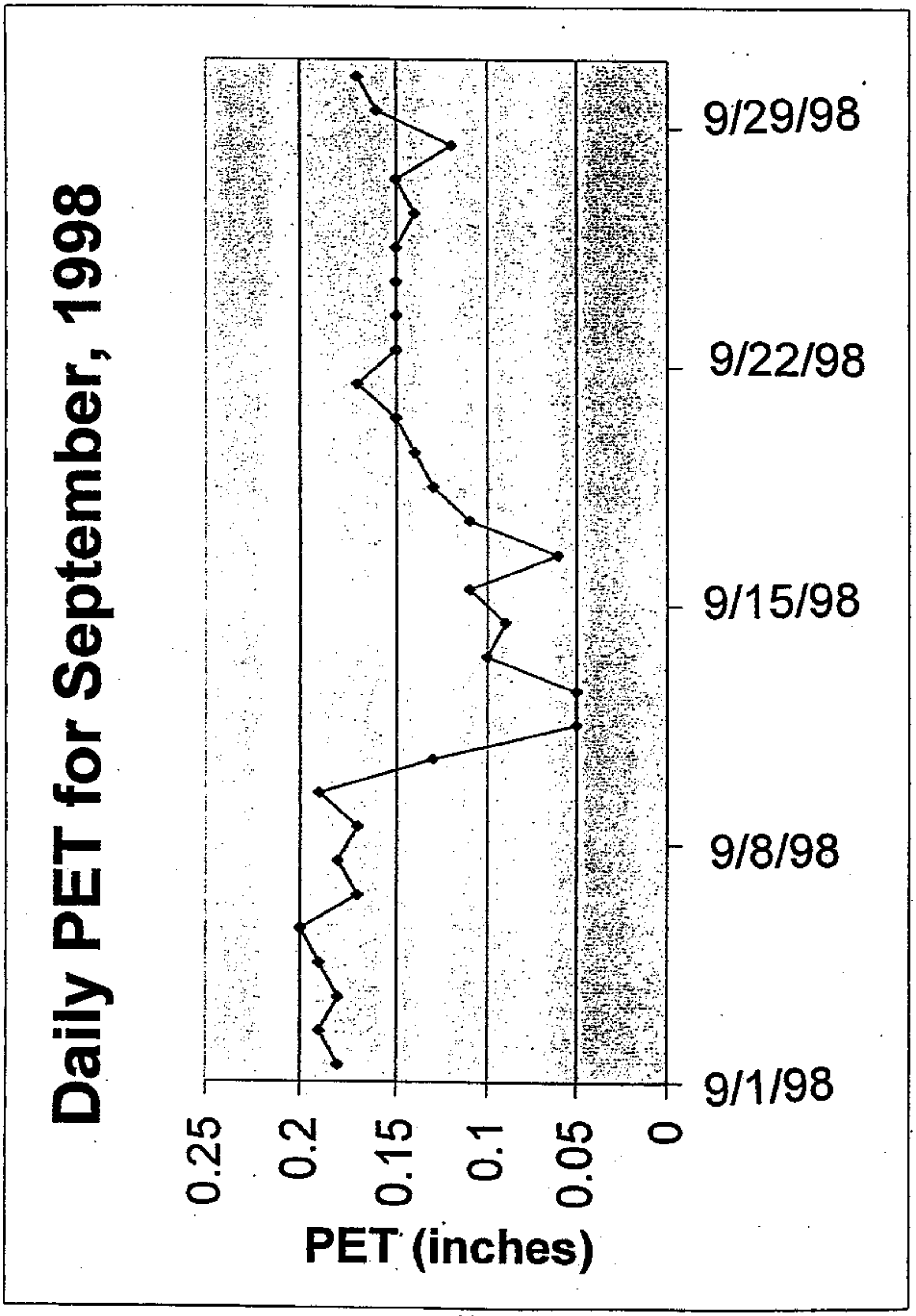

Daily PET for May, 1998
PET (inches)
0.3
0.25
0.2
0.15
0.1
0.05
0
5/3/98
5/10/98
5/17/98
5/24/98
5/31/98

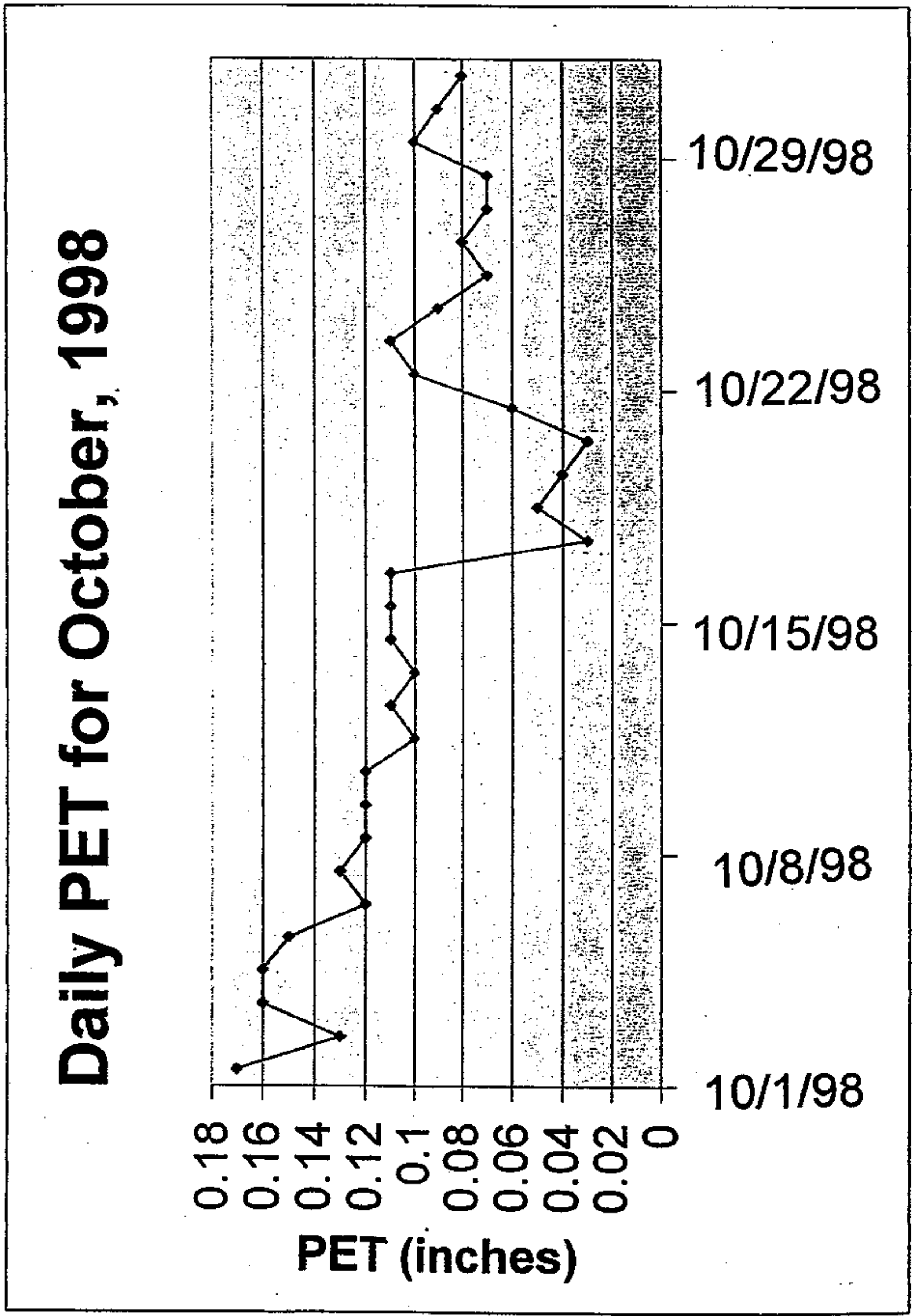

Daily PET for June, 1998
6/1/98
6/8/98
6/15/98
6/22/98
6/29/98
0.3
0.25
0.2
0.15
0.1
0.05
0
PET (inches)

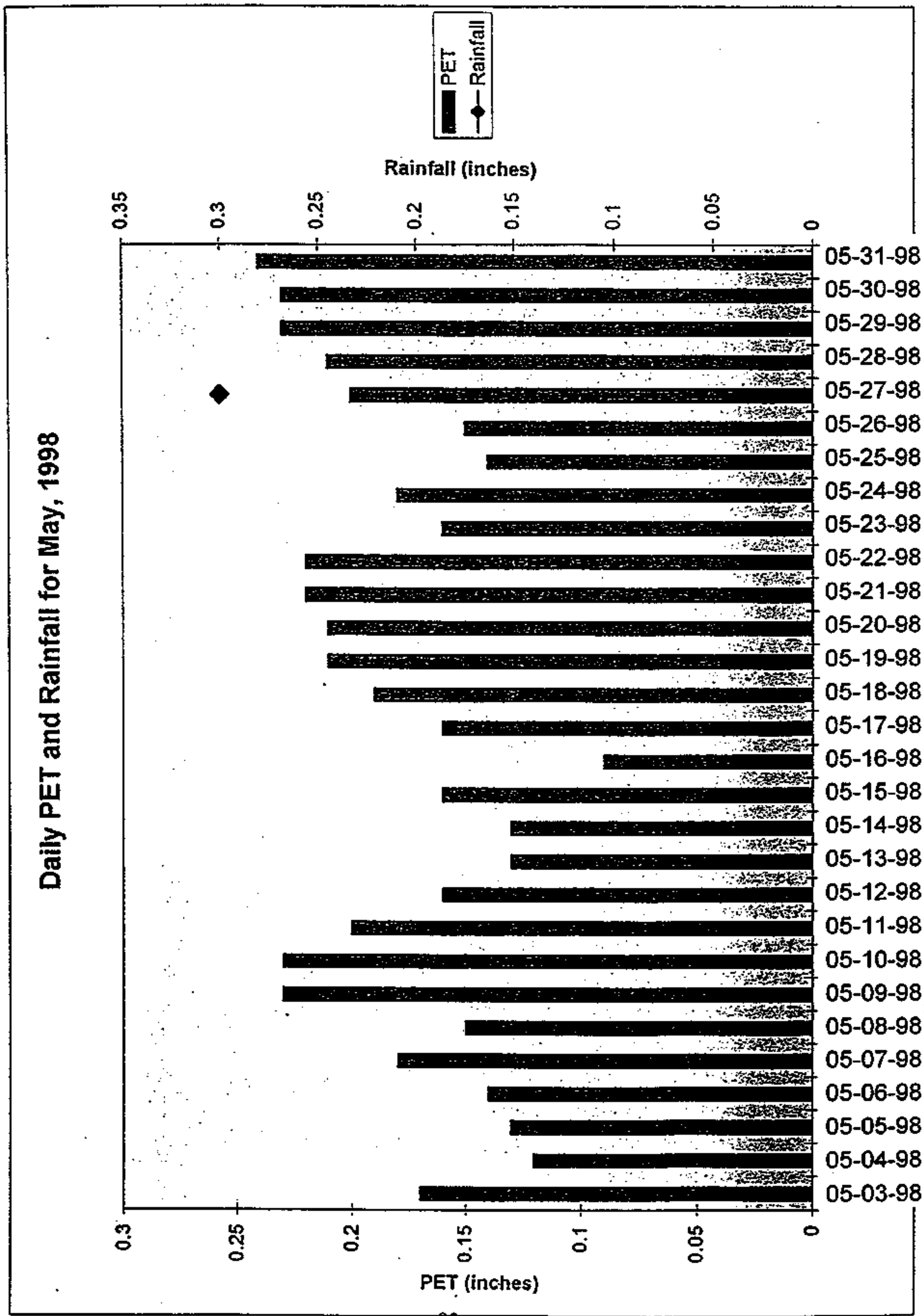

Daily PET for July, 1998
PET (inches)
0.3
0.25
0.2
0.15
0.1
0.05
0
7/1/98
7/8/98
7/15/98
7/22/98
7/29/98

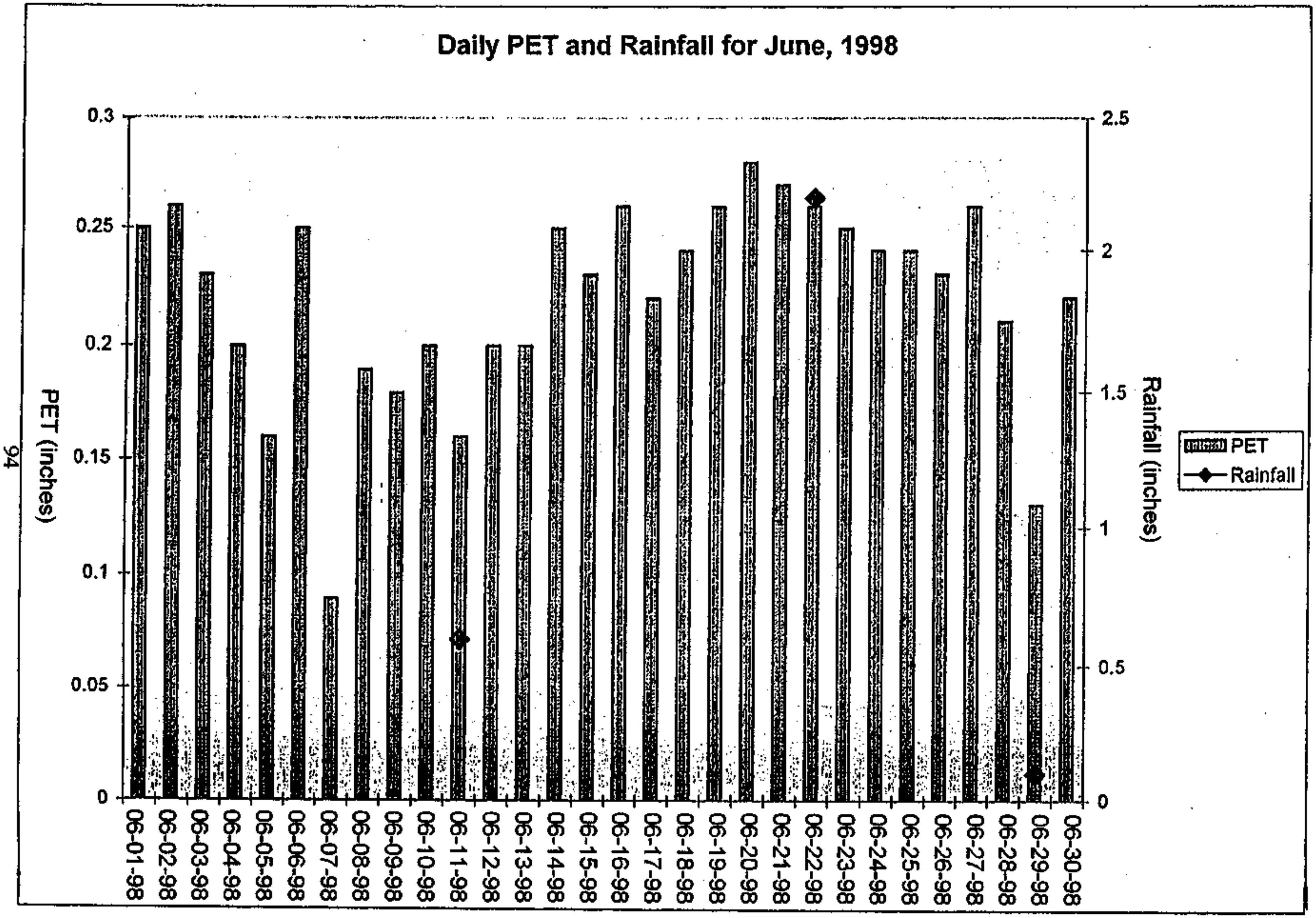


Daily PET for August, 1998
8/29/98
8/22/98
8/15/98
8/8/98
8/1/98
0.3
0.25
0.2
0.15
0.1
0.05
0
PET (inches)


Daily PET for September, 1998
PET (inches)
0.25
0.2
0.15
0.1
0.05
0
9/1/98
9/8/98
9/15/98
9/22/98
9/29/98

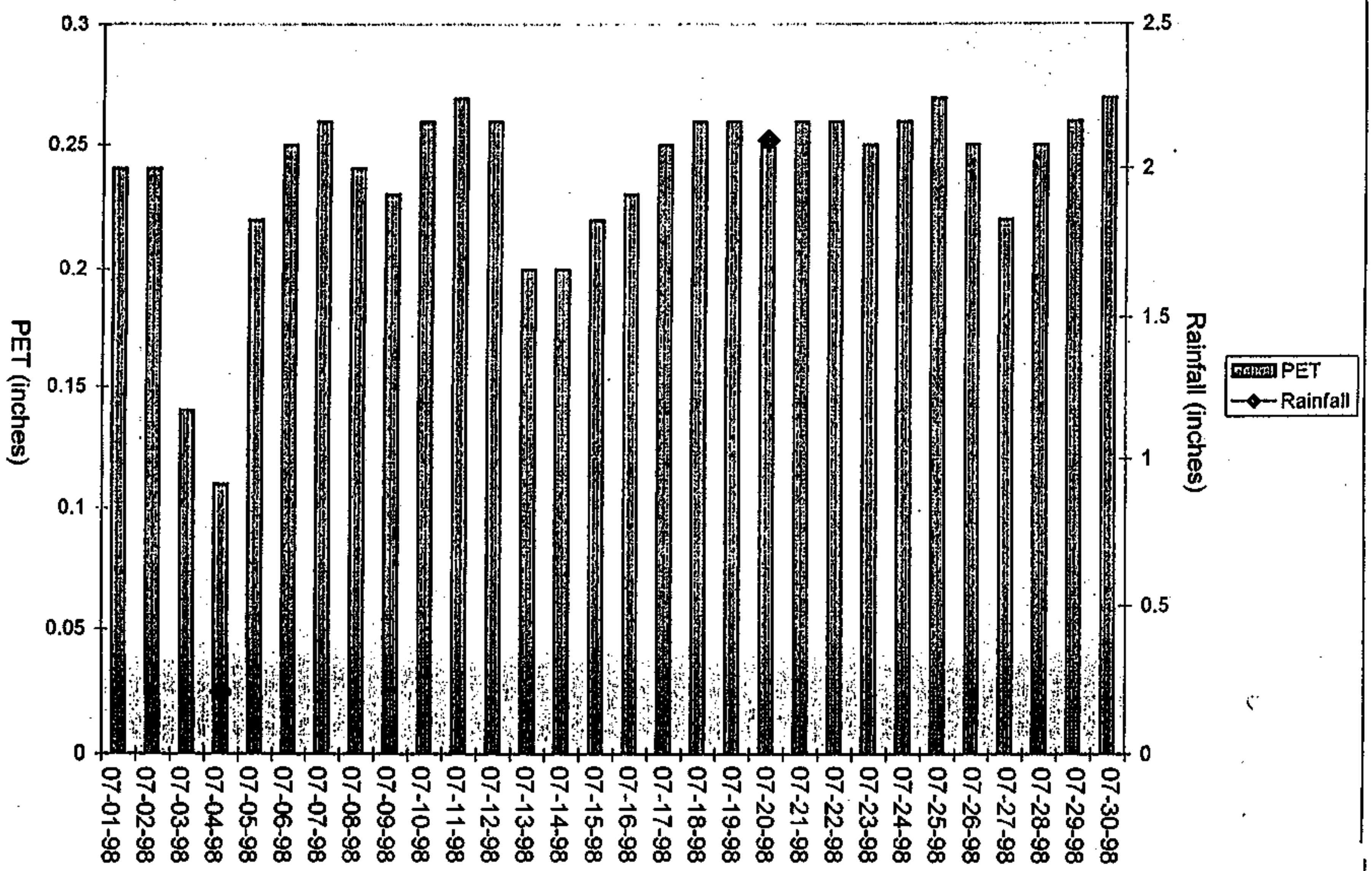

Daily PET for October, 1998
10/29/98
10/22/98
10/15/98
10/8/98
10/1/98
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
PET (inches)

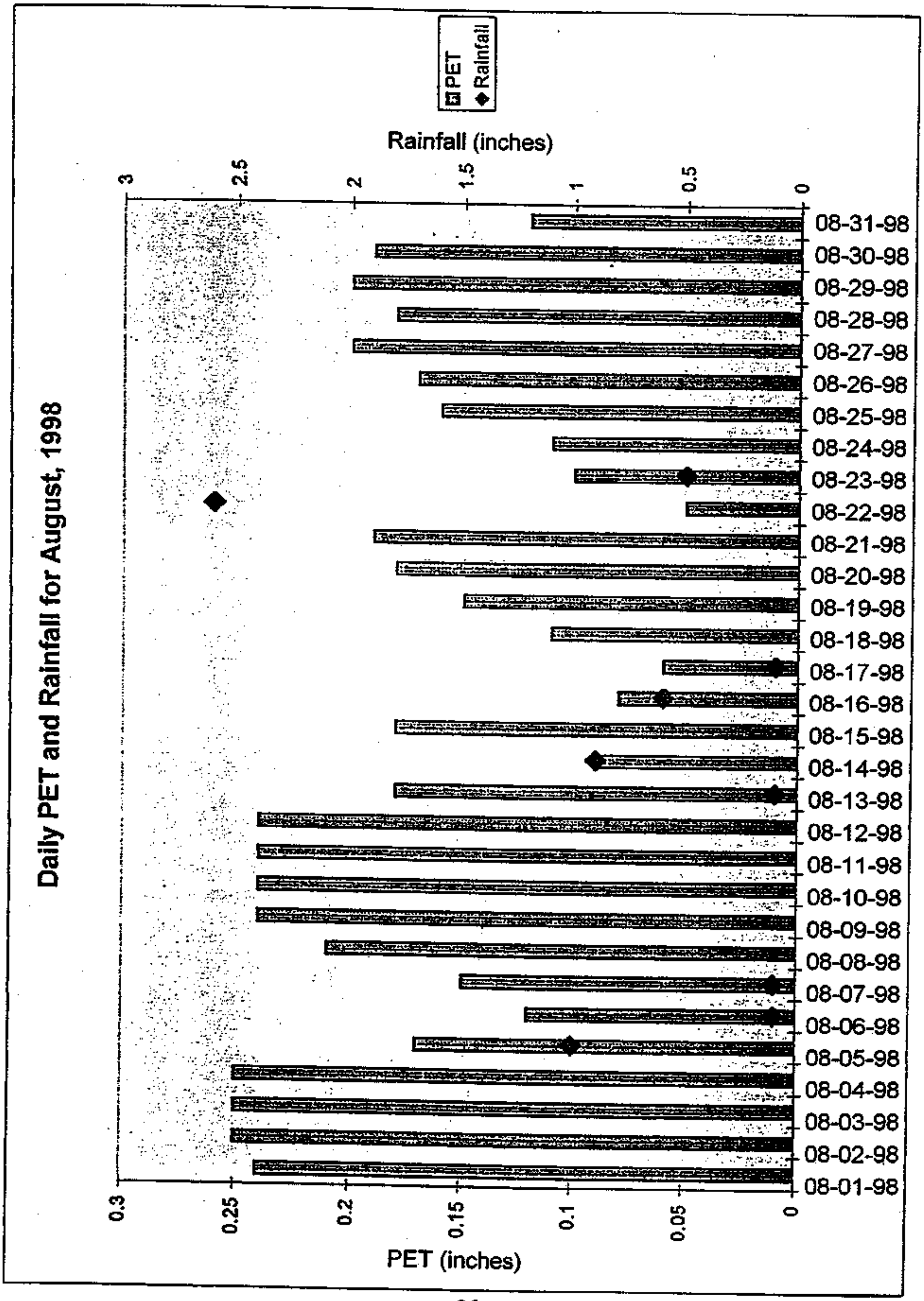

Daily PET and Rainfall for May, 1998
PET
Rainfall
Rainfall (inches)
PET (inches)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
05-31-98
05-30-98
05-29-98
05-28-98
05-27-98
05-26-98
05-25-98
05-24-98
05-23-98
05-22-98
05-21-98
05-20-98
05-19-98
05-18-98
05-17-98
05-16-98
05-15-98
05-14-98
05-13-98
05-12-98
05-11-98
05-10-98
05-09-98
05-08-98
05-07-98
05-06-98
05-05-98
05-04-98
05-03-98



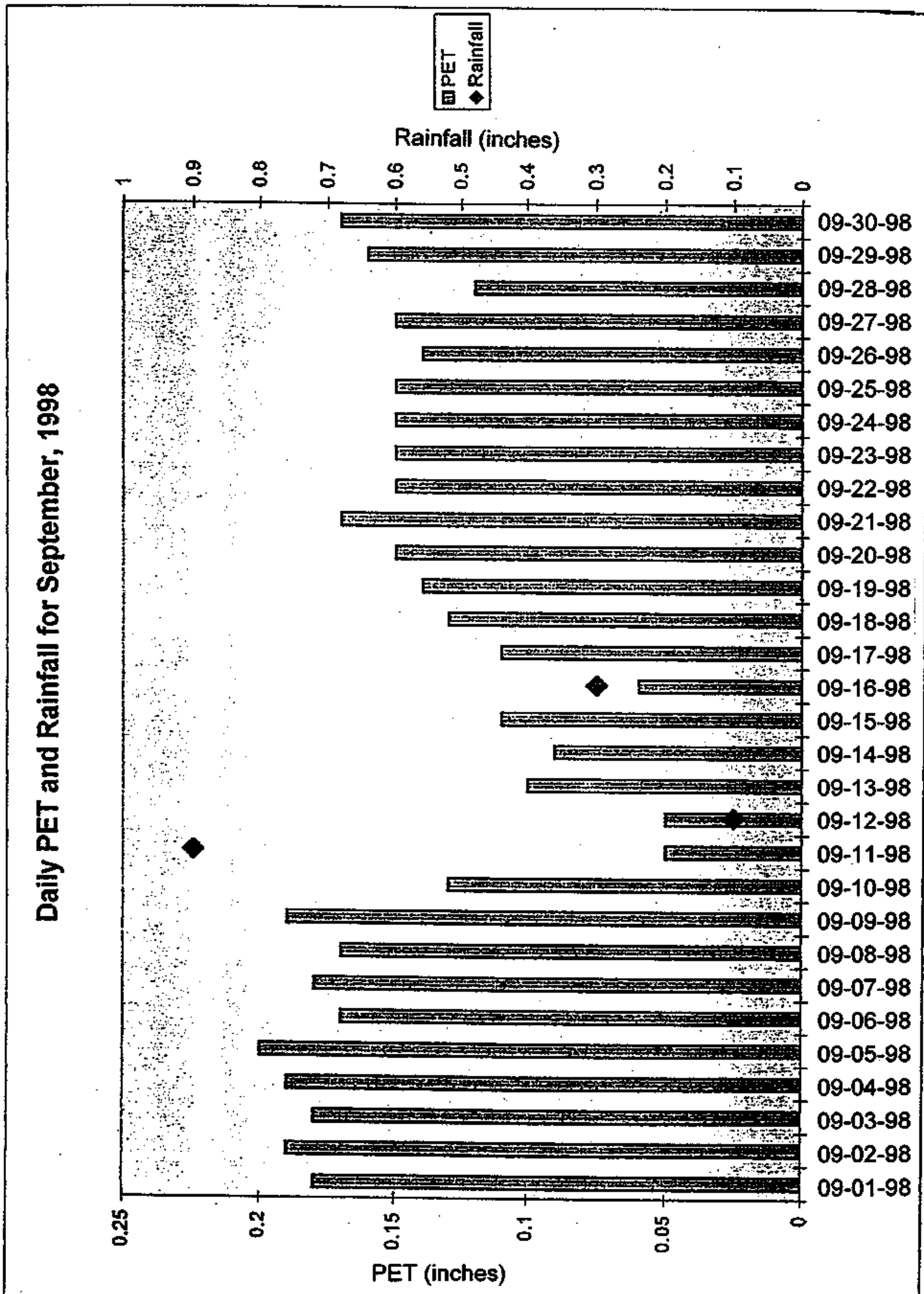
Daily PET and Rainfall for June, 1998
PET (inches)
0.3
0.25
0.2
0.15
0.1
0.05
0
Rainfall (inches)
2.5
2
1.5
1
0.5
0
PET
Rainfall
06-01-98
06-02-98
06-03-98
06-04-98
06-05-98
06-06-98
06-07-98
06-08-98
06-09-98
06-10-98
06-11-98
06-12-98
06-13-98
06-14-98
06-15-98
06-16-98
06-17-98
06-18-98
06-19-98
06-20-98
06-21-98
06-22-98
06-23-98
06-24-98
06-25-98
06-26-98
06-27-98
06-28-98
06-29-98
06-30-98

Daily PET and Rainfall for July, 1998

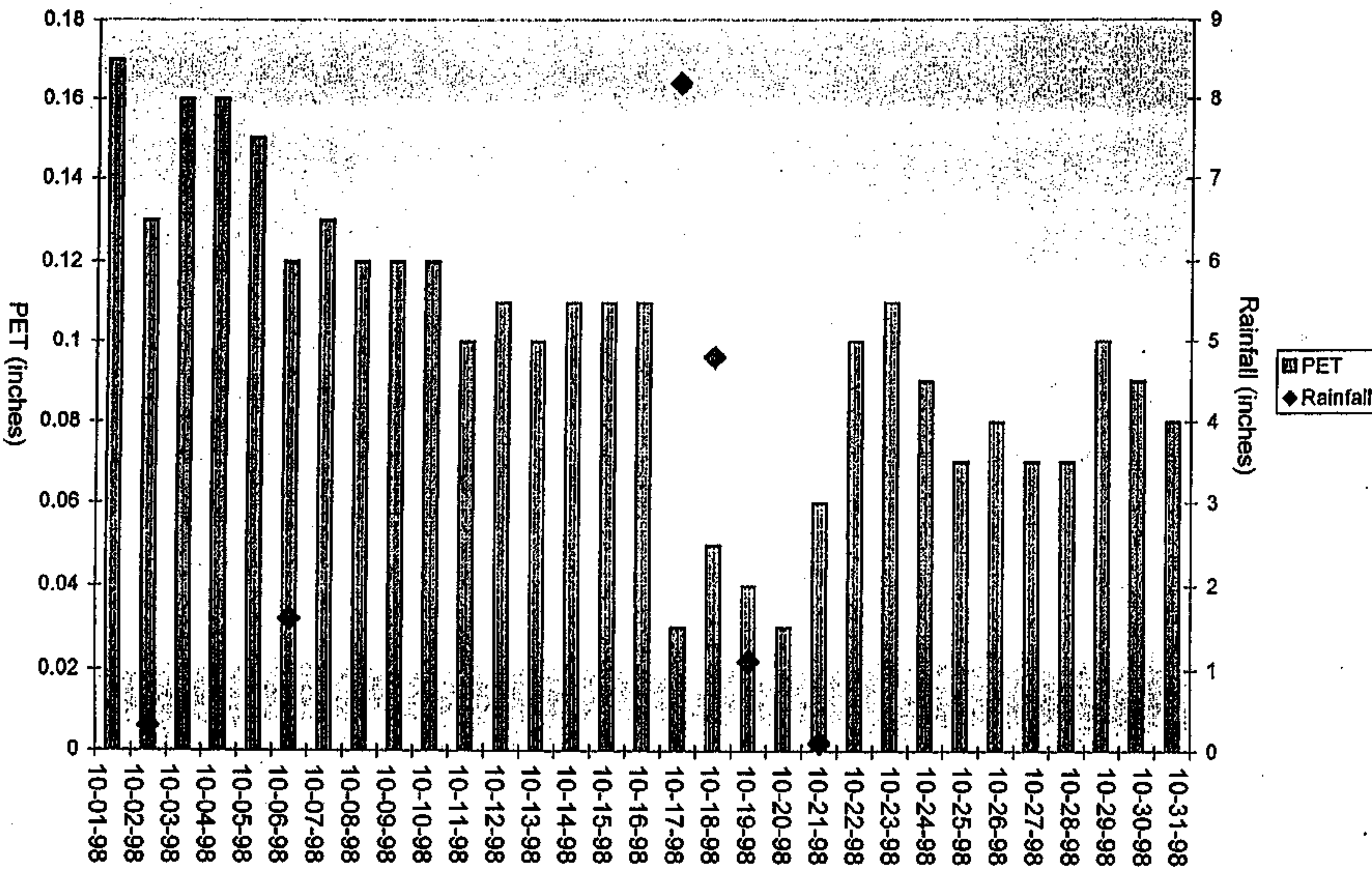


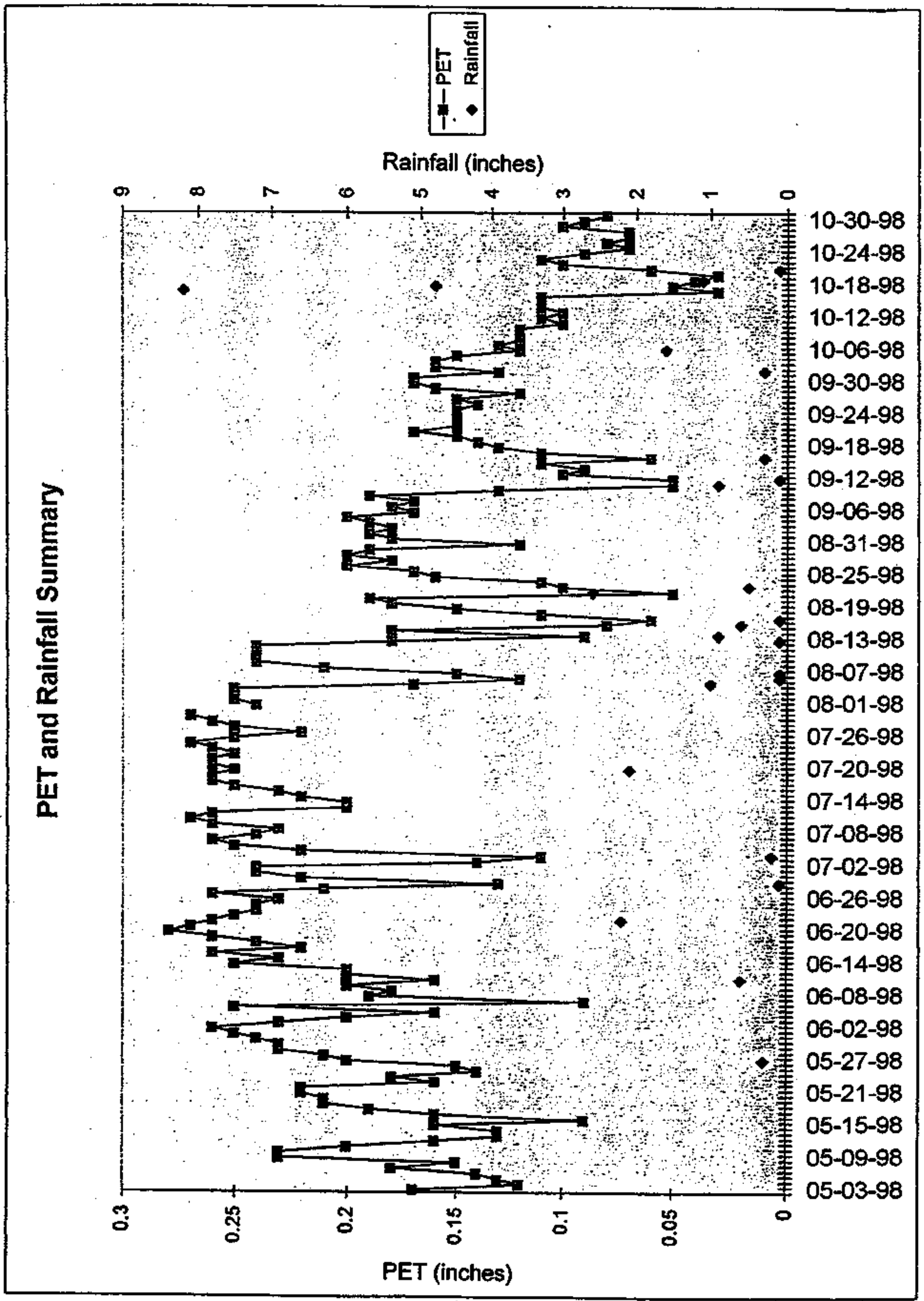


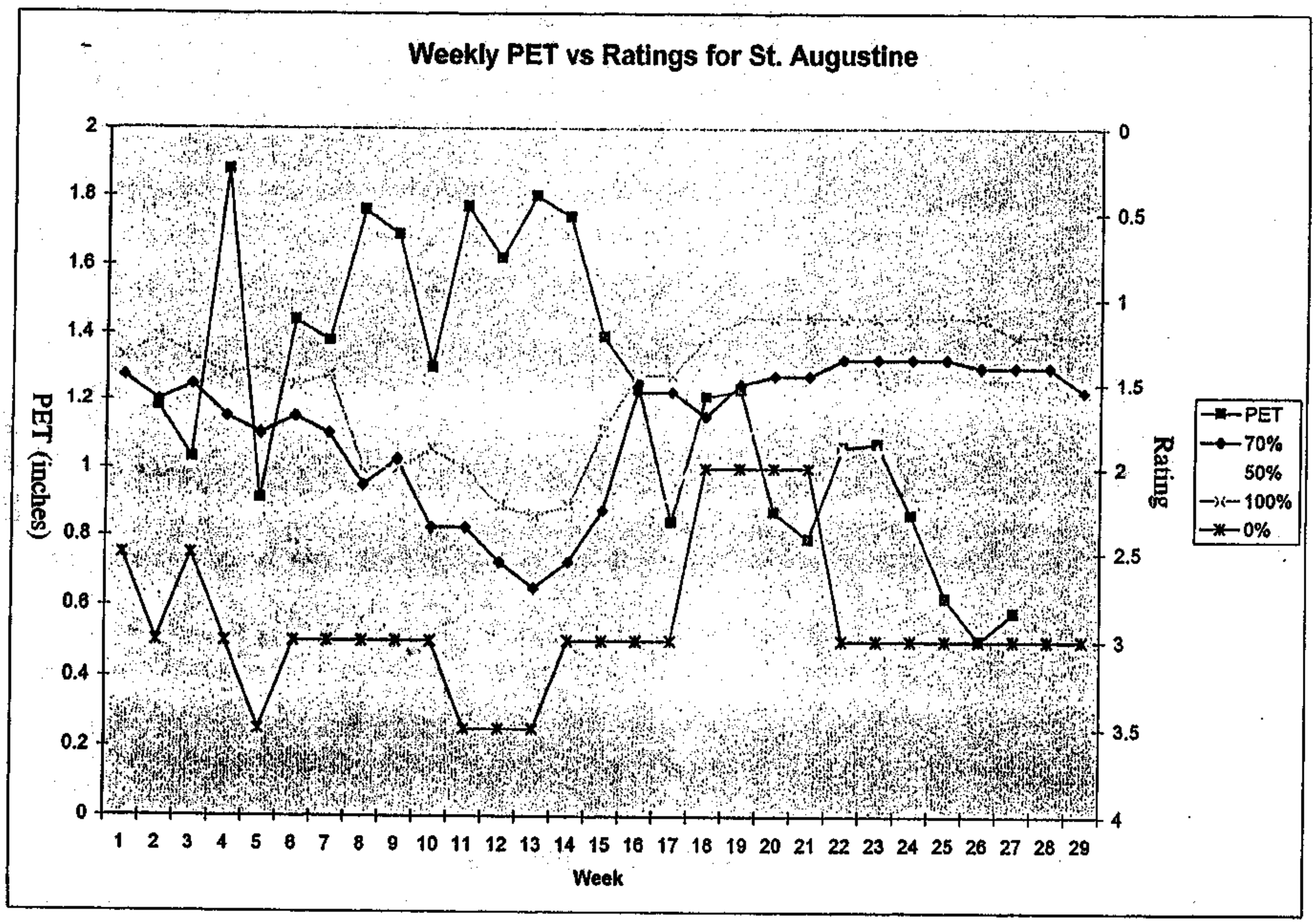
Daily PET and Rainfall for August, 1998
Rainfall (inches)
PET
Rainfall
PET (inches)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.5
1
1.5
2
2.5
3
08-01-98
08-02-98
08-03-98
08-04-98
08-05-98
08-06-98
08-07-98
08-08-98
08-09-98
08-10-98
08-11-98
08-12-98
08-13-98
08-14-98
08-15-98
08-16-98
08-17-98
08-18-98
08-19-98
08-20-98
08-21-98
08-22-98
08-23-98
08-24-98
08-25-98
08-26-98
08-27-98
08-28-98
08-29-98
08-30-98
08-31-98

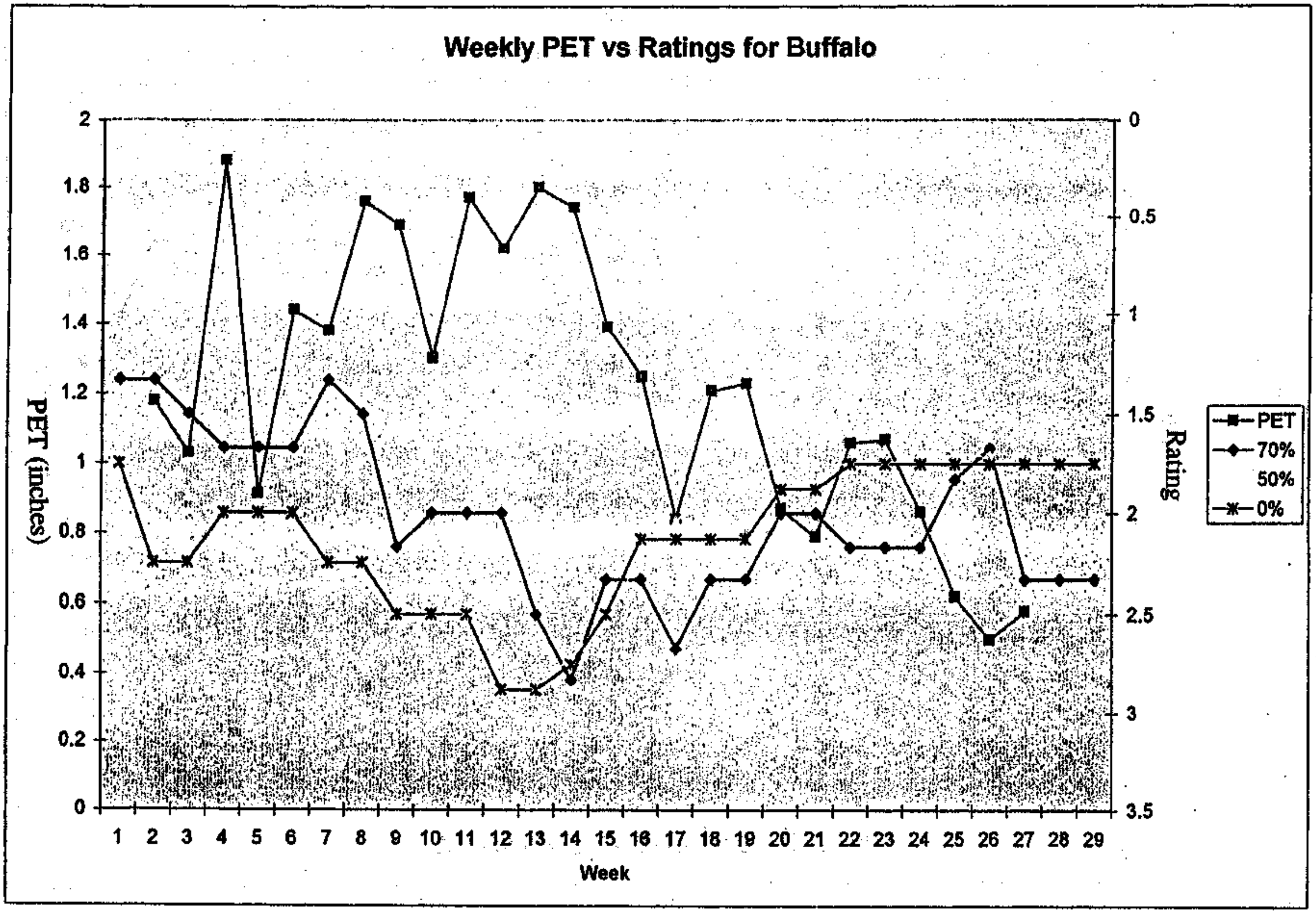

Daily PET and Rainfall for September, 1998
Rainfall (inches)
PET (inches)
PET
Rainfall
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.05
0.15
0.25
09-01-98
09-02-98
09-03-98
09-04-98
09-05-98
09-06-98
09-07-98
09-08-98
09-09-98
09-10-98
09-11-98
09-12-98
09-13-98
09-14-98
09-15-98
09-16-98
09-17-98
09-18-98
09-19-98
09-20-98
09-21-98
09-22-98
09-23-98
09-24-98
09-25-98
09-26-98
09-27-98
09-28-98
09-29-98
09-30-98

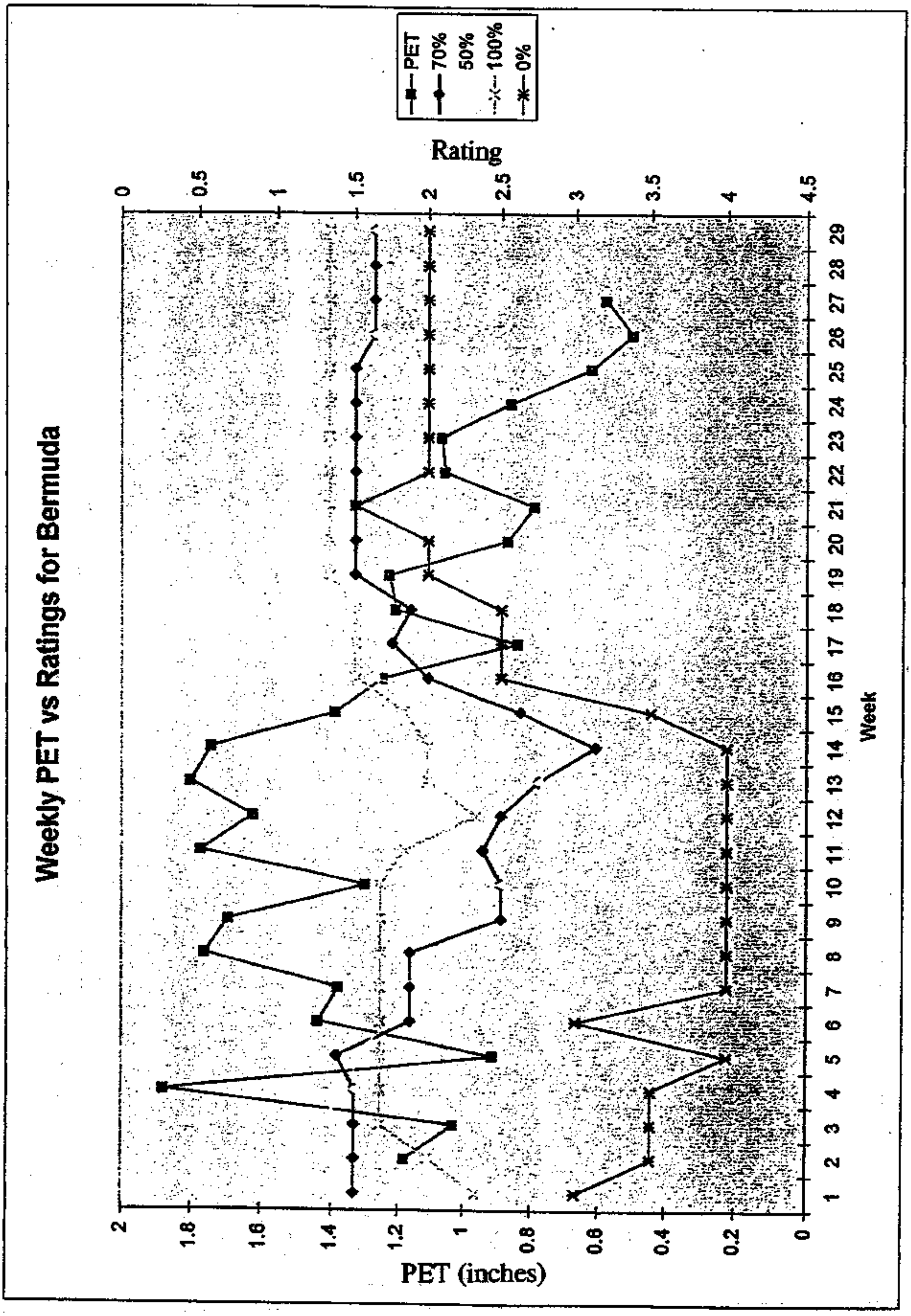
Daily PET and Rainfall for October, 1998



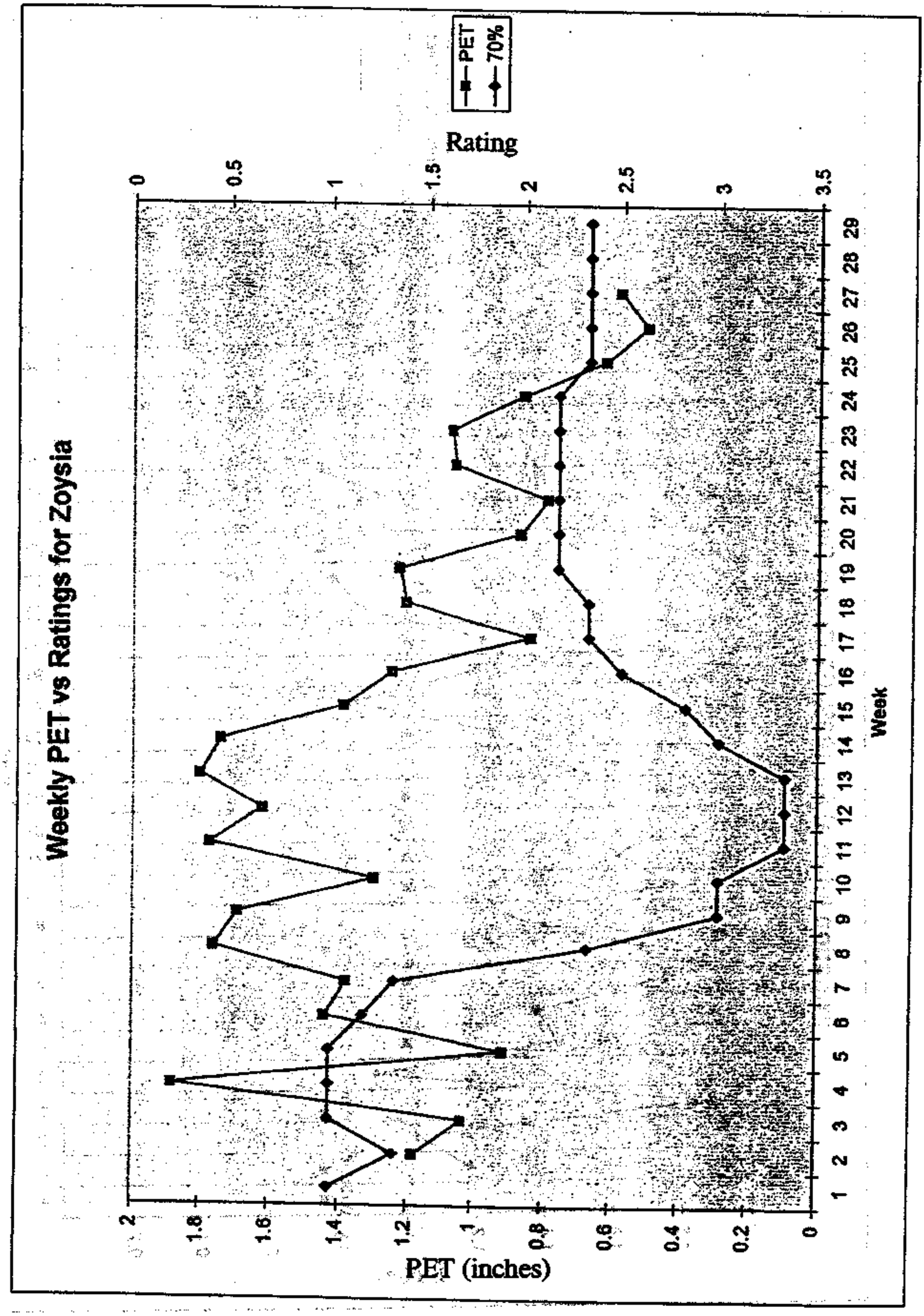

PET and Rainfall Summary
PET
Rainfall
Rainfall (inches)
PET (inches)
10-30-98
10-24-98
10-18-98
10-12-98
10-06-98
09-30-98
09-24-98
09-18-98
09-12-98
09-06-98
08-31-98
08-25-98
08-19-98
08-13-98
08-07-98
08-01-98
07-26-98
07-20-98
07-14-98
07-08-98
07-02-98
06-26-98
06-20-98
06-14-98
06-08-98
06-02-98
05-27-98
05-21-98
05-15-98
05-09-98
05-03-98

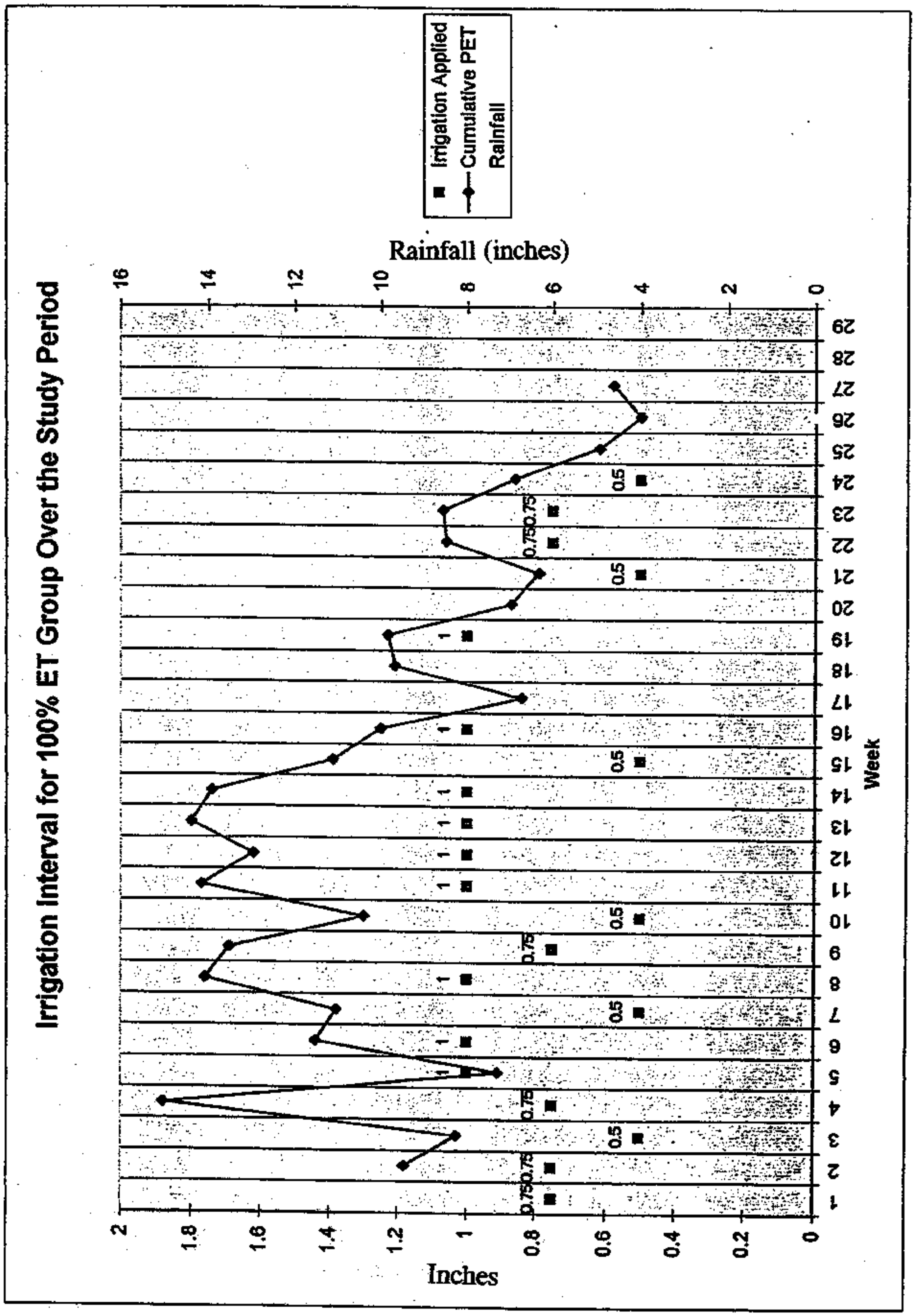

Weekly PET vs Ratings for St. Augustine
PET (inches)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Rating
0
0.5
1
1.5
2
2.5
3
3.5
4
Week
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29
PET
70%
50%
100%
0%


Weekly PET vs Ratings for Buffalo
PET (inches)
Rating
Week
PET
70%
50%
0%
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0.5
1.5
2.5
3
3.5
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 26 27 28 29



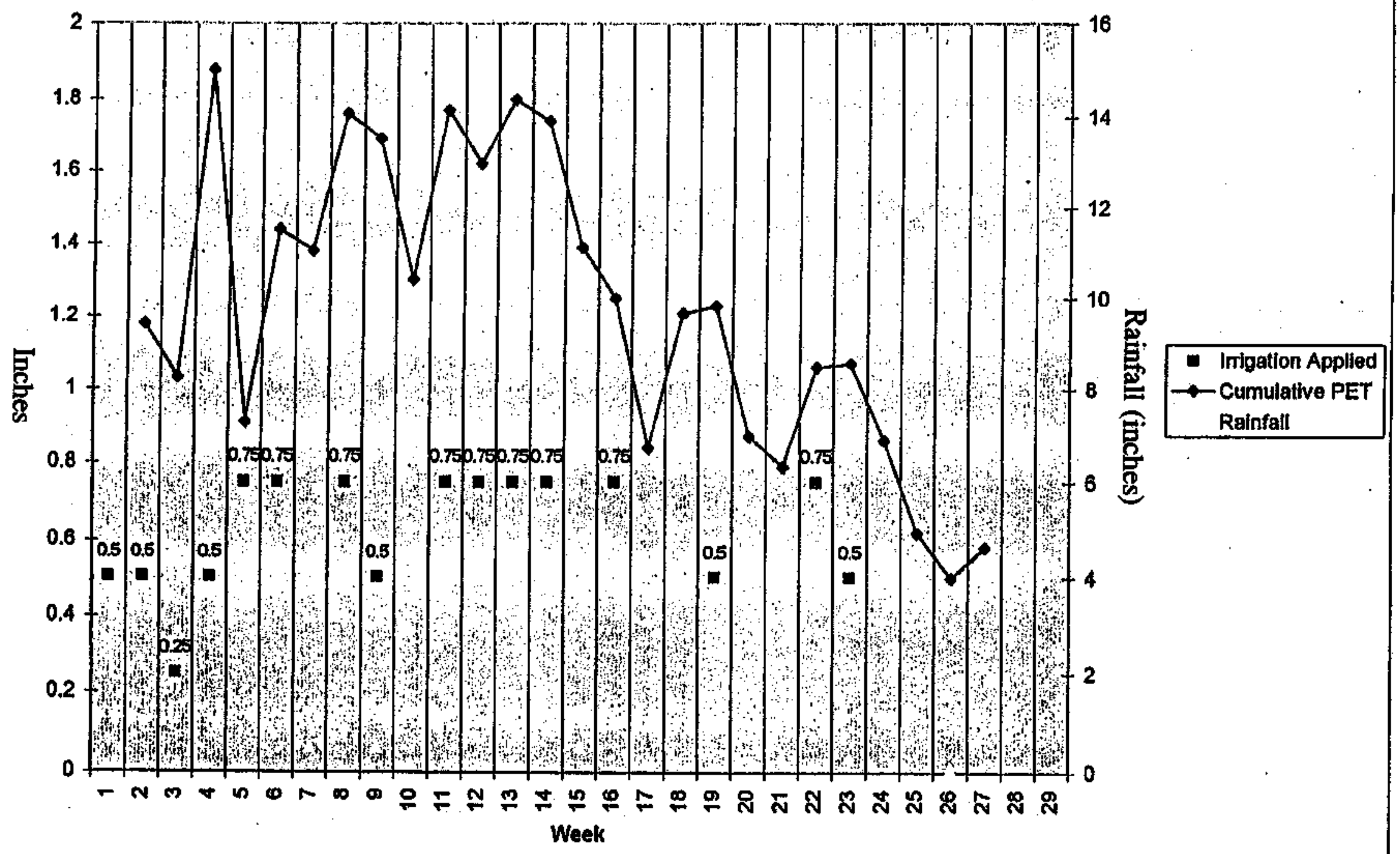
Weekly PET vs Ratings for Bermuda
PET
70%
50%
100%
0%
Rating
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
PET (inches)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Week
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29

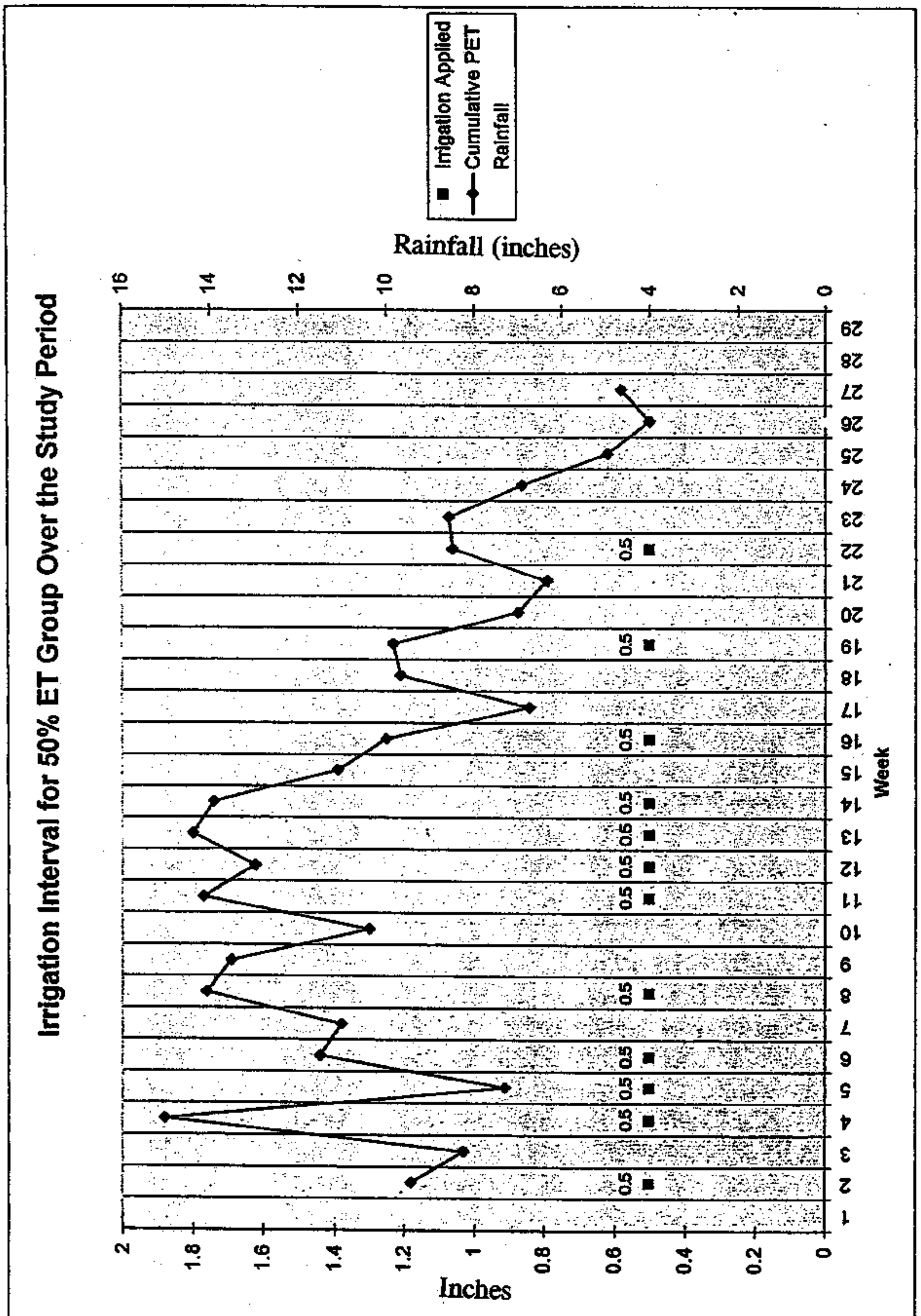

Weekly PET vs Ratings for Zoysia
Rating
0 0.5 1 1.5 2 2.5 3 3.5
PET
70%
PET (inches)
2 1.8 1.6 1.4 1.2 1 0.8 0.6 0.4 0.2 0
Week
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29



Irrigation Interval for 100% ET Group Over the Study Period
Irrigation Applied
Cumulative PET
Rainfall
Rainfall (inches)
Inches
Week

Irrigation Interval for 70% ET Group Over the Study Period



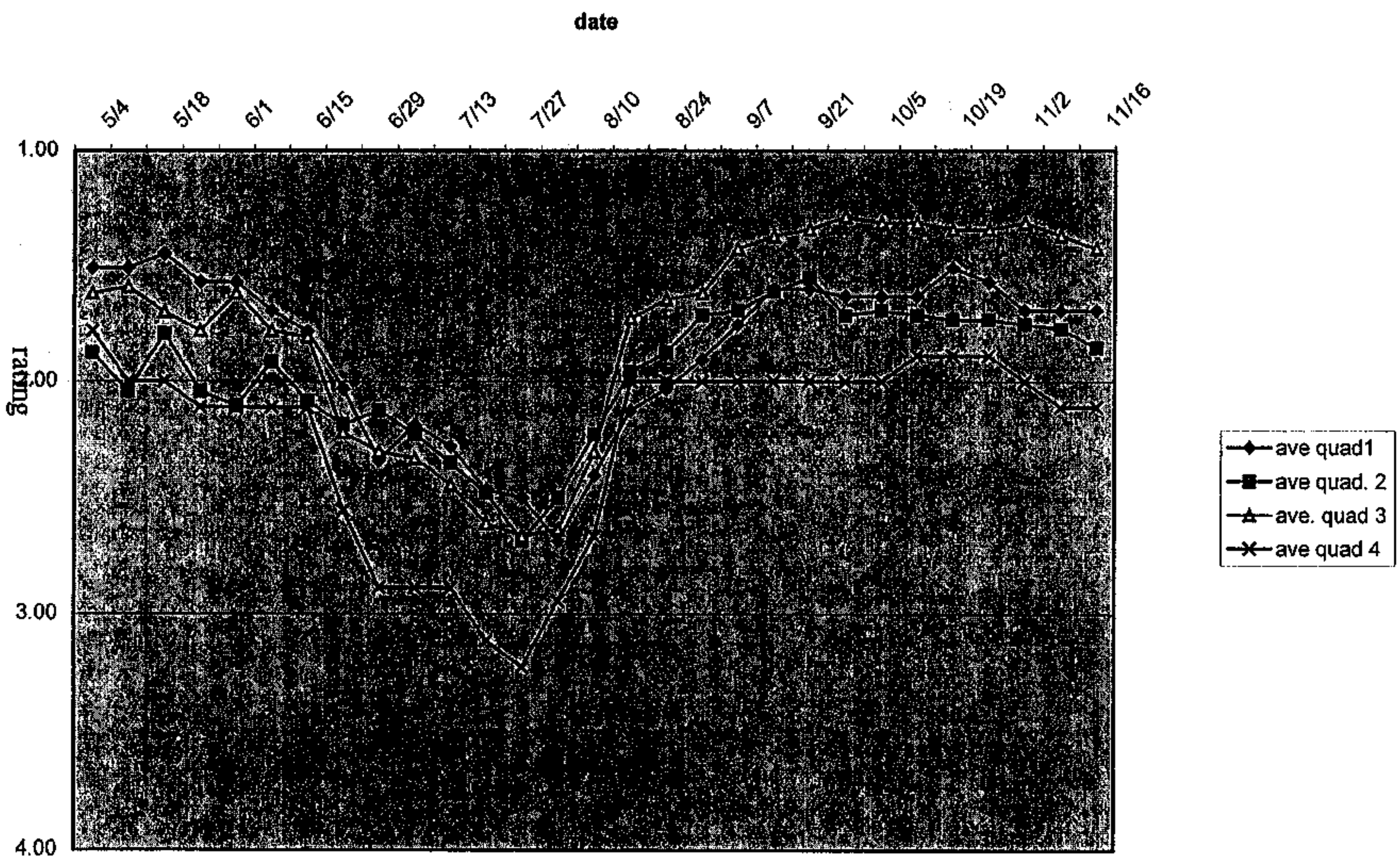

Irrigation Interval for 50% ET Group Over the Study Period
Irrigation Applied
Cumulative PET
Rainfall
Rainfall (inches)
Inches
Week
0.5

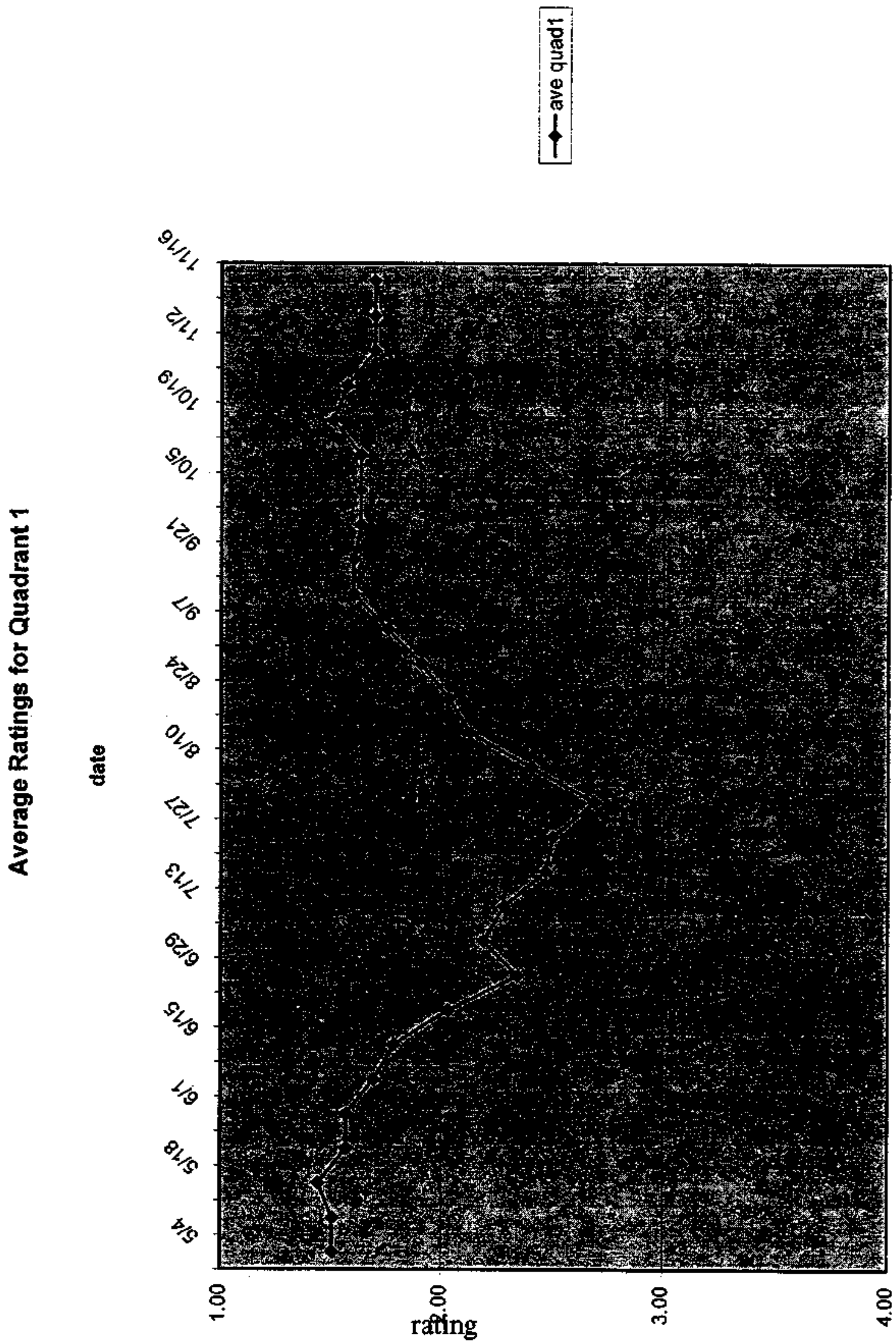
DATE	PET RAINFALL	DATE	PET RAINFALL
05-03-98	0.17	06-01-98	0.25
05-04-98	0.12	06-02-98	0.26
05-05-98	0.13	06-03-98	0.23
05-06-98	0.14	06-04-98	0.2
05-07-98	0.18	06-05-98	0.16
05-08-98	00.15	06-06-98	0.25
05-09-98	0.23	06-07-98	0.09
05-10-98	0.23	06-08-98	0.19
05-11-98	0.2	06-09-98	0.18
05-12-98	0.16	06-10-98	0.2
05-13-98	0.13	06-11-98	0.16 0.6
05-14-98	0.13	06-12-98	0.2
05-15-98	0.16	06-13-98	0.2
05-16-98	0.09	06-14-98	0.25
05-17-98	0.16	06-15-98	0.23
05-18-98	0.19	06-16-98	0.26
05-19-98	0.21	06-17-98	0.22
05-20-98	0.21	06-18-98	0.24
05-21-98	0.22	06-19-98	0.26
05-22-98	0.22	06-20-98	0.28
05-23-98	0.16	06-21-98	0.27
05-24-98	0.18	06-22-98	0.26 2.2
05-25-98	0.14	06-23-98	0.25
05-26-98	0.15	06-24-98	0.24
05-27-98	0.2 0.3	06-25-98	0.24
05-28-98	0.21	06-28-98	0.21
05-29-98	0.23	06-26-98	0.23
05-30-98	0.23	06-27-98	0.26
05-31-98	0.24	06-29-98	0.21
		06-30-98	0.13 0.1
		06-31-98	0.22

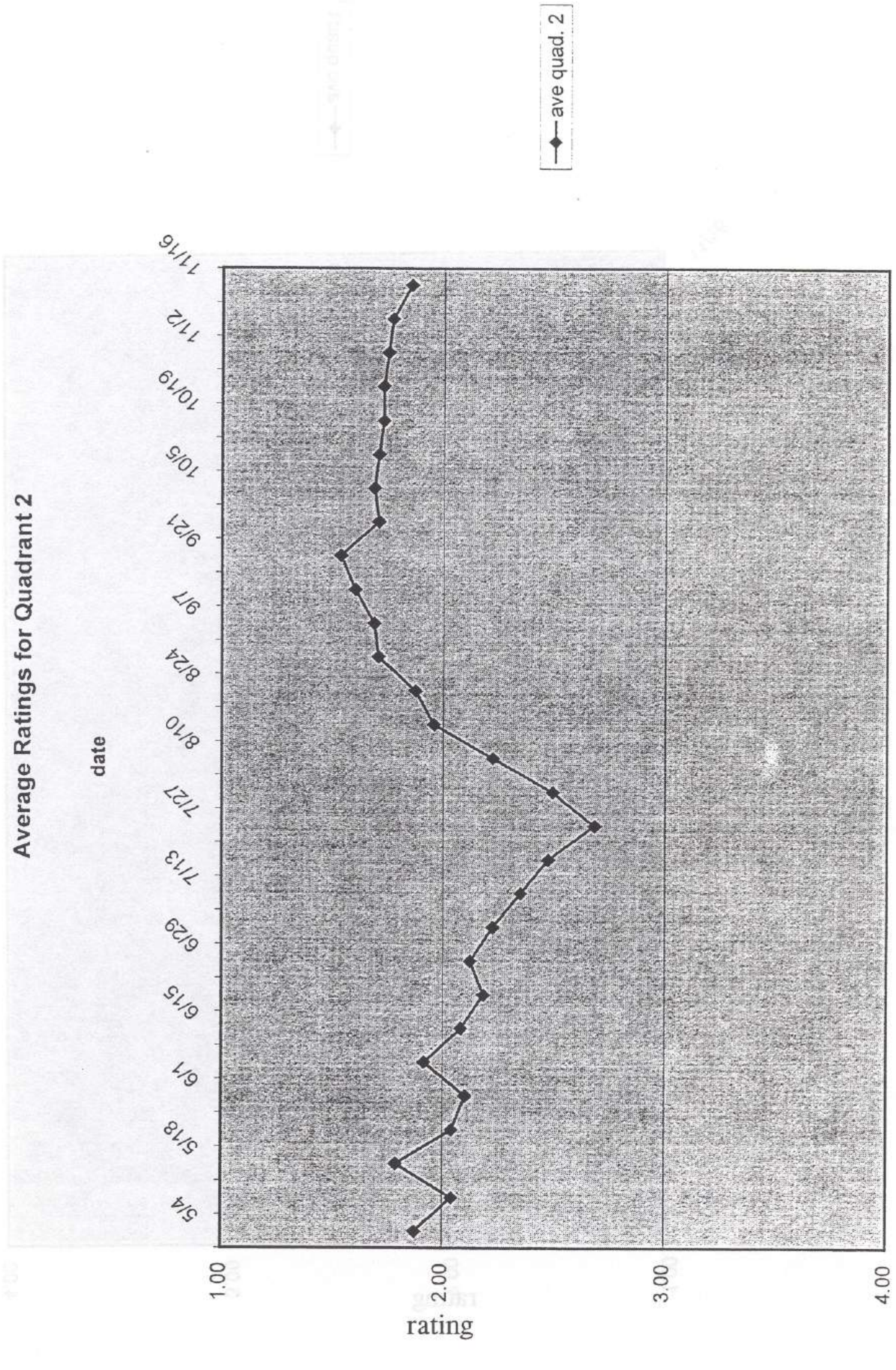
DATE	PET RAINFALL	DATE	PET RAINFALL
07-01-98	0.24	08-01-98	0.24
07-02-98	0.24	08-02-98	0.25
07-03-98	0.14	08-03-98	0.25
07-04-98	0.11 0.2	08-04-98	0.25
07-05-98	0.22	08-05-98	0.17 1
07-06-98	0.25	08-06-98	0.12 0.1
07-07-98	0.26	08-07-98	0.15 0.1
07-08-98	0.24	08-08-98	0.21
07-09-98	023	08-09-98	0.24
07-10-98	0.26	08-10-98	0.24
07-11-98	0.27	08-11-98	0.24
07-12-98	0.26	08-12-98	0.24
07-13-98	0.2	08-13-98	0.18 0.1
07-14-98	0.2	08-14-98	0.09 0.09
07-15-98	0.22	08-15-98	0.18
07-16-98	0.23	08-16-98	0.08 0.6
07-17-98	0.25	08-17-98	0.06 0.1
07-18-98	0.26	08-18-98	0.11
07-19-98	026	08-19-98	0.15
07-20-98	0.25 2.1	08-20-98	0.18
07-21-98	0.26	08-21-98	0.19
07-22-98	0.26	08-22-98	0.05 206
07-23-98	0.25	08-23-98	0.1 0.5
07-24-98	0.26	08-24-98	0.11
07-25-98	0.27	08-25-98	0.16
07-26-98	0.25	08-26-98	0.17
07-27-98	0.22	08-27-98	0.2
07-28-98	0.25	08-28-98	0.18
07-29-98	0.26	08-29-98	0.2
07-30-98	0.27	08-30-98	0.19
07-31-98		08-31-98	0.12

DATE	PET RAINFALL	DATE	PET RAINFALL
09-01-98	0.18	10-01-98	0.17
09-02-98	0.19	10-02-98	0.13 0.3
09-03-98	0.18	10-03-98	0.16
09-04-98	0.19	10-04-98	0.16
09-05-98	0.2	10-05-98	0.15
09-06-98	0.17	10-06-98	0.12 1.6
09-07-98	0.18	10-07-98	0.13
09-08-98	0.17	10-08-98	0.12
09-09-98	0.19	10-09-98	0.12
09-10-98	0.13	10-10-98	0.12
09-11-98	0.05 0.9	10-11-98	0.1
09-12-98	0.05 0.1	10-12-98	0.11
09-13-98	0.1	10-13-98	0.1
09-14-98	0.09	10-14-98	0.11
09-15-98	0.11	10-15-98	0.11
09-16-98	006 0.3	10-16-98	0.11
09-17-98	0.11	10-17-98	0.03 8.2
09-18-98	0.13	10-18-98	0.05 4.8
09-19-98	0.14	10-19-98	0.04 1.1
09-20-98	0.15	10-20-98	0.03
09-21-98	0.17	10-21-98	0.06 0.1
09-22-98	0.15	10-22-98	0.1
09-23-98	0.15	10-23-98	0.11
09-24-98	0.15	10-24-98	0.09
09-25-98	0.15	10-25-98	0.07
09-26-98	0.14	10-26-98	0.08
09-27-98	0.15	10-27-98	0.07
09-28-98	0.12	10-28-98	0.07
09-29-98	0.16	10-29-98	0.1
09-30-98	0.17	10-30-98	0.09
		10-31-98	008

Average Ratings By Quadrant

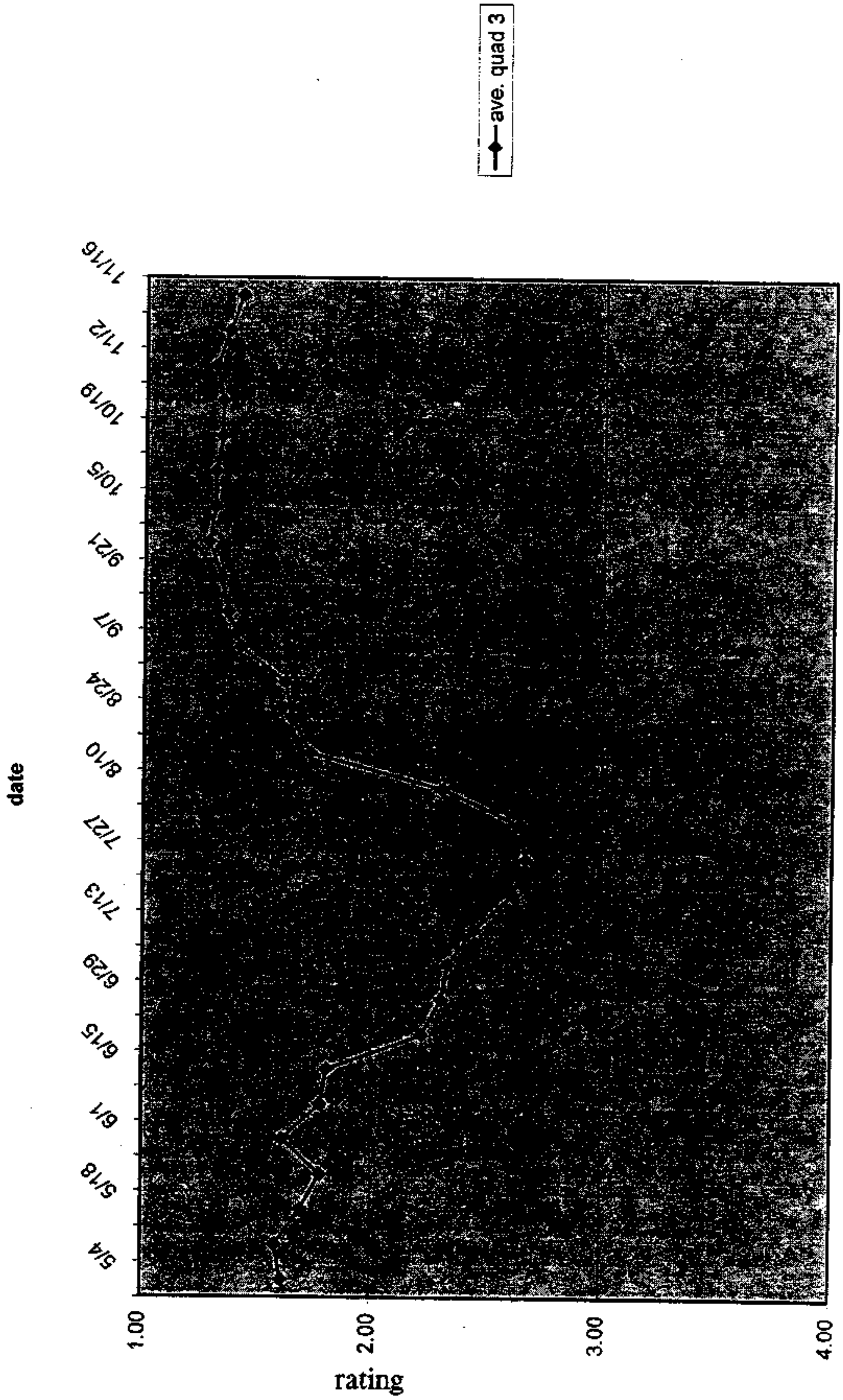


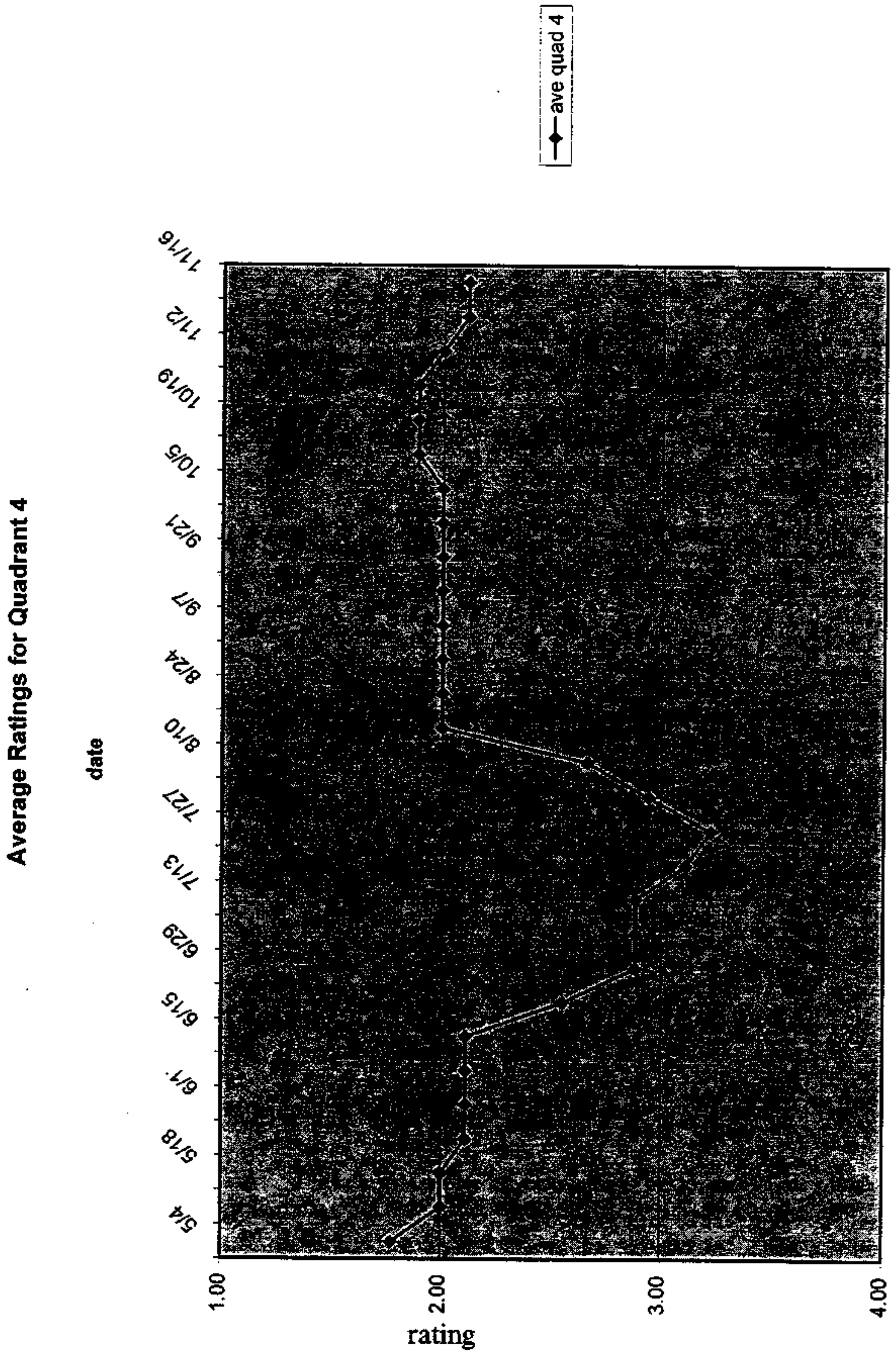

Average Ratings for Quadrant 1
date
rating
ave quad1
1.00
2.00
3.00
4.00
5/4
5/18
6/1
6/15
6/29
7/13
7/27
8/10
8/24
9/7
9/21
10/5
10/19
11/2
11/16



Average Ratings for Quadrant 2
date
rating
1.00
2.00
3.00
4.00
5/4
5/18
6/1
6/15
6/29
7/13
7/27
8/10
8/24
9/7
9/21
10/5
10/19
11/2
11/16
ave quad. 2

Average Ratings for Quadrant 3




Average Ratings for Quadrant 4
date
ave quad 4
5/4
5/18
6/1
6/15
6/29
7/13
7/27
8/10
8/24
9/7
9/21
10/5
10/19
11/2
11/16
1.00
2.00
3.00
4.00
rating