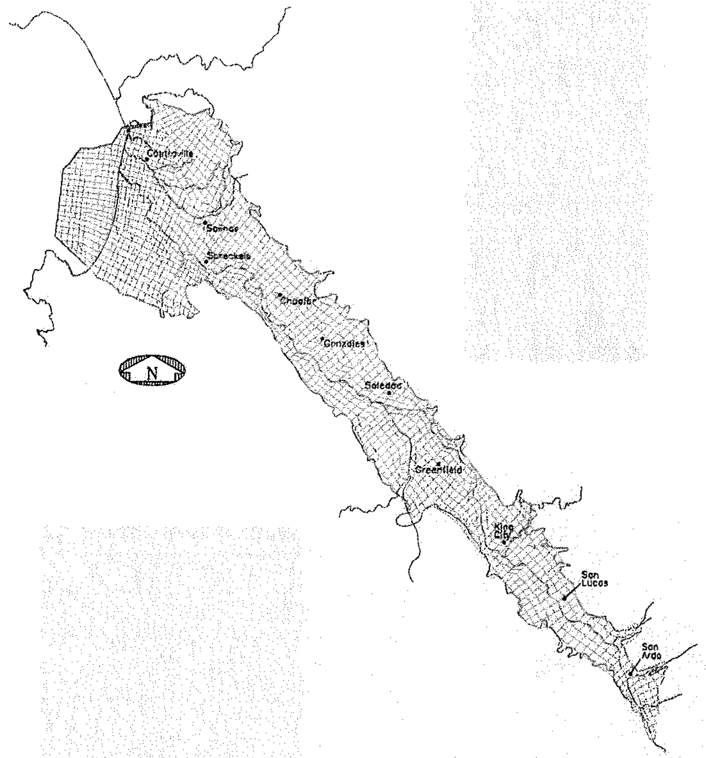


Monterey County Water Resources Agency

Final Report

Salinas Valley Integrated Ground Water and Surface Model Update

May 1997

MONTGOMERY WATSON

MONTGOMERY WATSON

June 2, 1997

Mr. Gene Taylor
Monterey County Water Resources Agency
893 Blanco Circle
Salinas, CA 93901

Dear Gene;

I am pleased to send you a copy of the final report documenting the data updates, refinements, and recalibration of the Salinas Valley Integrated Ground and Surface Water Model (SVIGSM).

The report contains the description of data used for the update, and any analysis and assumption made to prepare the data for model input. In addition, the report provides explanation of model calibration procedure, and results of model recalibration based on the updated data.

The report addresses the concerns and comments received after IGSM Workshop Number 5. Enclosed, is a list of the comments by category and a reference of how they are addressed.

The model updated data sets and executable will be prepared and mailed to you by Friday June 6, 1997.

If you have any questions and/or concerns, please do not hesitate to call me.

Sincerely Yours,

S. Ali Taghavi, Ph.D., P.E.
Supervising Engineer

cc: Dr. U. Win
Tim Durbin
Dave Foote
Lyndel Melton
Ted Mills
Peter Pyle
Joe Scalmanini
Dennis Williams

777 Campus Commons
Suite 250
Sacramento, California
95825-8308

Tel: 916 924 8844
Fax: 916 924 9102

Serving the World's Environmental Needs

SALINAS VALLEY BMP
SUMMARY OF COMMENTS ON SVIGSM MODEL UPDATE DRAFT TECHNICAL MEMORANDUM

Comment	Action
Water Use	
1. Gross irrigated acreage in Upper Valley requires adjustment	No additional data provided. Comment noted.
2. Cropping intensity for truck crops needs to be accounted for.	Cropping "in-between rotation" percentages modified based on cropping intensity data, as discussed on page 2-16
3. Irrigation efficiency and vineyard water use need to be adjusted based on ground water pumping data.	Vineyard water use parameters adjusted based on GEMS pumping data, as discussed in on page 2-23
4. Graphically show riparian water use.	Annual riparian water use shown in Figure 2-9
Ground Water Levels and Ground Water Budget	
5. Show ground water level residuals by layer.	Shown in Figures 3-5a,b,c,d
6. Provide ground water balances by layer.	A full ground water balance by layer is not feasible without extensive pre- and post-processing of the data. specific water balance items of interest will be processed and provided at the next SVIGSM workshop.
7. Improvements needed in ground water simulations in the Upper Valley.	Improvements made, as discussed in Section 3.3 and shown in accompanying figures
8. Use correct naming convention when referencing aquifer layers in the East Side Subarea.	Naming conventions verified with MCWRA
9. Provide boundary flows along each boundary for each subarea.	Boundary flows provided in Figures C-4 a,b
10. Provide plots of ground water level contours.	Ground water level contours shown in Figures 3-6,7,8
11. Provide ground water calibration well hydrographs for areas farther from the Salinas River.	Comment noted. Sufficient calibration well data for areas farther from the Salinas River are not available.
12. Expand scale on ground water calibration well hydrographs.	Scales expanded to the extent possible, as can be seen in ground water calibration well hydrographs in Appendix D
Stream Flow & Reservoir Operation	

SALINAS VALLEY BMP
SUMMARY OF COMMENTS ON SVIGSM MODEL UPDATE DRAFT TECHNICAL MEMORANDUM

Comment	Action
13. Provide trend analysis on scatterplots of Salinas River gains.	R^2 provided for scatterplots, as shown in Figures 3-9,10
14. Provide simulated and recorded reservoir storage levels.	To be refined in the HBA process.
15. Provide simulated flows at Bradley, Soledad, and Spreckels under reservoir operations.	To be refined in the HBA process.
Aquifer Parameters	
16. Refine aquifer parameters in the East Side Subarea	Aquifer parameters refined, as shown in Figures 3-1 a,b
17. Refine aquifer parameters in the Forebay/Upper Valley Subarea boundary	Aquifer parameters refined, as shown in Figures 3-1 a,b
Calibration Statistics & Sensitivity Analysis	
18. Provide statistical criteria for calibration evaluation.	Comment noted
19. Provide additional sensitivity analysis model runs for aquifer storitivity and deep percolation parameters.	Additional sensitivity analysis performed, results discussed on page 3-32
20. Provide discussion of anomalies in sensitvity analysis.	Discussion of sensitivity analysis provided on page 3-32
Seawater Intrusion	
21. Show extent of seawater intrusion.	Contour lines of 500 ppm chloride concentration provided in Figures 3-16,17
22. Discuss simulation of fresh water - salt water interface.	Discussion provide on page 3-25

Table of Contents

SECTION 1 - INTRODUCTION

SECTION 2 - MODEL DATA ANALYSIS

SECTION 3 - MODEL CALIBRATION

SECTION 4 - SUMMARY AND CONCLUSIONS

SECTION 5 - REFERENCES

APPENDIX A - AUGUST 1996 MEMORANDUM ON CROP POTENTIAL ET

APPENDIX B - SVIGSM WATER BUDGET TABLES

APPENDIX C - AVERAGE ANNUAL AND ANNUAL CHANGES IN GROUND WATER BALANCE

APPENDIX D - MODEL GROUND WATER HYDROGRAPHS FOR EACH CALIBRATION WELL

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES

Section 1
Introduction

The primary goal of developing the Salinas River Basin Management Plan (BMP) is to fulfill Monterey County's need for a long-term water resources management plan to ensure good quality water, improve existing water quality, and to provide adequate water supplies. As the Salinas Valley is predominantly dependent on ground water supplies to meet municipal, agricultural, and industrial needs, protecting the ground water resources in the face of worsening overdraft and seawater intrusion problems is critical. Generally, ground water and surface water are integral parts of the hydrologic cycle therefore, the interaction of these components should be accounted for properly. Due to the complexities of the hydrologic processes and their interaction on a basin-wide scale, sophisticated analytical methods and tools are used for better understanding the nature and behavior of the hydrologic system, quantify the impacts of various developmental and operational schemes undertaken by society, and evaluate the various alternatives for a water resource management plan.

The specific goals of the Salinas River Basin Management Plan (BMP) as described in the BMP Scoping Report (MCWRA, 1996) are to:

- stop seawater intrusion,
- create a long-term balance between recharge and withdrawal, and to
- provide a sufficient water supply for Salinas Valley up to the year 2030.

1.1 SVIGSM Development

The Salinas Valley Integrated Ground and Surface Water Model (SVIGSM) is developed to be the primary analytical tool to analyze the hydrologic and operational impacts of the various BMP alternatives. The goals of the model development has been to provide a reliable and comprehensive analytical tool to address a number of basin-wide hydrological and water supply operational issues. As such, the model can be used to:

- Provide a better understanding of the nature of the physical and hydrological processes that govern the ground water flow system in the Salinas River Basin. This includes natural and operational factors that influence the rate and areal extent of intrusion of seawater at the Monterey Bay.

- Analyze the hydrologic impacts of the Salinas River Basin Management Plan (BMP), and provide sufficient information to the decision makers and stakeholders for screening of alternatives, and selection of the preferred alternative.

- Assist in the allocation of the amount and area of BMP water delivery, in order to meet the goals of the BMP.

The SVIGSM was calibrated accordingly to serve the BMP goals as a planning level analytical tool. To-date the SVIGSM has been applied to a number of projects, including the Castroville Seawater Intrusion Project, hydrologic impacts of preliminary BMP components, reservoir operations analysis, and hydrologic analysis for the White Paper process. The SVIGSM is a hydrologic/operational model which simulates the surface water and ground water flows and their interaction in the Salinas Valley. In specific, the model has the following features:

- Simulation of the ground water flow in the Salinas Valley through the various water bearing material underlying the valley and their vertical interactions, including:
    - the 180 foot, 400 foot, and the Deep Aquifer in the Pressure subarea;
    - the East Side Shallow, East Side Deep, and the Deep Aquifer in the East Side subarea;
    - the Shallow and Deep Aquifers in the Forebay subarea; and
    - the unconfined aquifer in the Upper Valley subarea.
- Simulation of the in the Salinas River and its major tributaries from Nacimiento and San Antonio Reservoirs to the Monterey Bay. The interaction between the Salinas River and its tributaries with the ground water system is an integral part of the model.
- Simulation of the streamflow operation of Nacimiento and San Antonio Reservoirs based on the specific operational rules for water supply and flood control.
- The model does not simulate surface and/or ground water rights in the legal sense. However, in terms of any surface water diversions, it can honor priorities for operation of the upstream reservoirs, such as, releasing water for maintaining certain flow in the river channel.
- Simulation of the rate and extent of seawater intrusion.
- Simulation of the agricultural water use requirements based on crop irrigated acreage, crop potential evapotranspiration, minimum soil moisture requirements, and crop irrigation efficiency.
- Simulation of direct runoff and deep percolation from rainfall and irrigation applied water.

In order to simulate such conditions, the SVIGSM requires massive amounts of data, many of which are in monthly and/or daily time series format. This data has been collected, evaluated and analyzed as part of the different tasks in the BMP project. The technical memoranda for tasks 1.01 through task 1.09 of the BMP provide documentation for the data collection and model assumptions.

1.2 Past Modeling Studies

The SVIGSM is the most recent analytical tool developed for analysis of hydrologic conditions in the Salinas Valley. Prior to this model there were two other modeling efforts at a basin-wide level. In 1978, the US Geological Survey (USGS) in cooperation with the US Army Corps of Engineers, developed a group of interacting models including a small-stream model, a Salinas River model, and a two-dimensional and three-dimensional ground water model (Durbin et al., 1978). In 1986, Boyle Engineering Corporation developed the Salinas Valley Ground Water Model under contract with the Monterey County Flood Control and Water Conservation District to compliment the previous USGS modeling efforts and simulate the ground water and surface water conditions in an interactive model. In 1988, the USGS updated the two-dimensional model previously developed in 1978 (Yates, 1988).

The SVIGSM has used the database and results from all the previous work, as well as the additional data and analyses as reported in Task Memoranda 1.01 to 1.09 to provide a comprehensive and hydrologic model for analysis of BMP alternatives. The model includes a complete hydrologic database from 1949 to 1994 and a land and water use database from 1970 to 1994.

1.3 SVIGSM Update

As the BMP alternatives have evolved into more comprehensive components that involve programs such as the re-operation of the upstream reservoirs, diversion and storage facilities, and ground water recharge and withdrawal systems, the need to analyze these issues in more detail and site-specific scale has grown.

In order to evaluate the performance of the SVIGSM for these more detailed hydrological and operational analyses, and to gain consensus among the technical and scientific community on the assumptions, approaches and tools used in the BMP process and the subsequent analyses, the Monterey County Water Resource Agency (MCWRA) held four technical workshops during September and December 1996. The technical workshops identified a set of refinements to be made to the SVIGSM data sets, as follows:

- revision of the 1989/91 land use and irrigated crop acreages;
- revision of assumptions on areas "in-between crop" for the Truck crop acreages;
- treatment of the vegetation corridor along the Salinas River as riparian type; and
- revision of the distribution of hydraulic conductivity.

Since the type of data revisions and updates impact the estimates of ground water pumping, ground water recharge, and the aquifer parameters, the model needed to be recalibrated to the observed ground water levels and streamflow measurements. This recalibration effort would ensure the integrity of model simulations for future model applications and analysis of alternatives.

The results of the model data update and the preliminary recalibration was documented in draft form in a technical memorandum (March 1997), and presented at IGSM Workshop number 5 in March 1997.

This report provides documentation for the refinements made to the model data sets, as well as a discussion on the required recalibration procedure and results. Comments received on the preliminary recalibration are also incorporated in this document.

Section 2
Model Data Analysis

As part of this study, much of the data for input into the SVIGSM have been updated and analyzed. This section discusses the updates to each type of data, and the analysis used to prepare the data for model input. The following data categories have been updated and/or revised:

- Crop potential evapotranspiration;
- Irrigated crop acreage by subarea;
- Distribution of land use categories;
- Irrigation efficiency;
- Urban water use;
- Ground water pumping;
- Aquifer parameters.

Following is the description of the updates and assumptions in development of each data type.

2.1 Crop Potential Evapotranspiration

In order to determine the consumptive use of water by crops, SVIGSM uses the crop potential evapotranspiration (PET_c). The PET_c is computed based on reference crop potential ET (PET^o) and crop factors. The 1994 version of the SVIGSM included potential crop ET values based on DWR Bulletin 113-3. This Bulletin estimates the ET for the Central Coast area based on historical field measurements in San Joaquin Valley. Since the California Irrigation Management Information System (CIMIS) stations have been operational in the Salinas Valley from the early 1990s, CIMIS records are available for climatological data through DWR and MCWRA. The reference crop PET_o is measured at the six CIMIS stations in the Salinas Valley and are correlated to the four hydrologic subareas in the model. The details of the procedure and assumptions are documented in the August 1996 memorandum by Montgomery Watson to MCWRA (Appendix A).

Table 2-1 presents the annual potential ET rates for each crop. Figures 2-1(a-d) show the monthly distribution of the crop potential ET for the four primary subareas in the Salinas Valley.

Table 2-1
Summary of Annual Crop Evapotranspiration by Subarea
(Inches/Year)

Irrigated Crop	Pressure	East Side	Forebay	Upper Valley	Average
Pasture	35.10	35.70	46.24	47.46	41.12
Sugar Beets	27.37	27.85	36.07	37.02	32.08
Field Crops	28.08	28.56	36.99	37.97	32.90
Truck Crops	23.48	23.86	30.78	31.53	27.41
Orchard	27.37	27.85	36.07	37.02	32.08
Vineyard	16.60	16.91	22.11	22.77	19.60

2.2 Land Use and Crop Irrigated Acreage

As land use and crop irrigated acreage are critical items in the estimates of agricultural water use requirements, these data have been the subject of significant reviews for the Salinas Valley. An item of particular concern has been the multiple cropping practices common in the truck (vegetable) crop areas, and the procedures and assumptions used to model these practices.

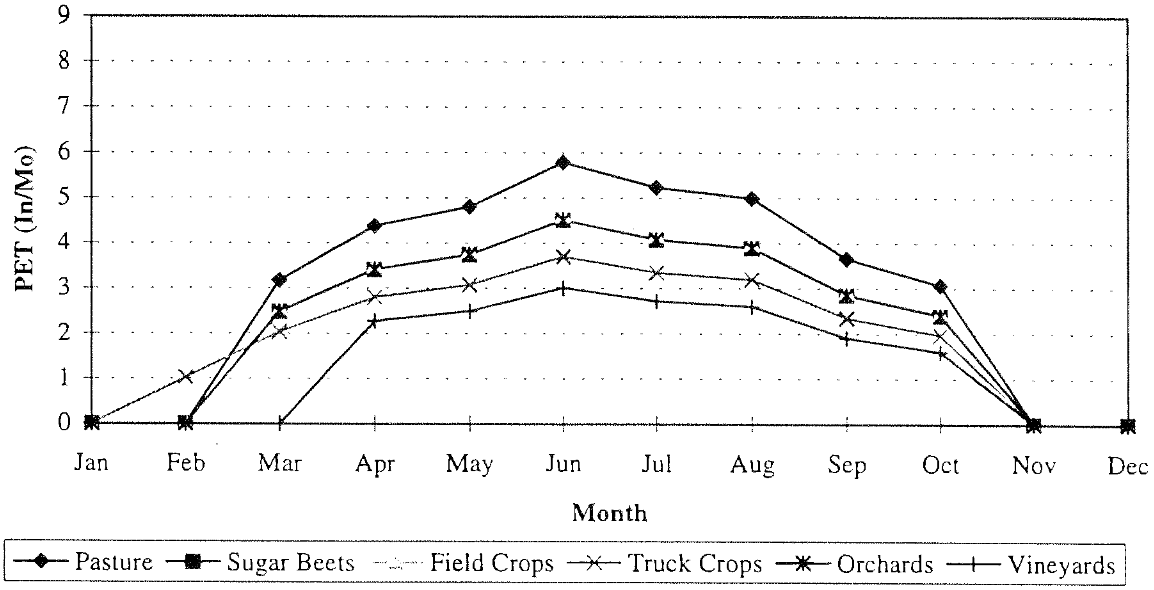
The SVIGSM requires two sets of land use-based data: (1) the annual acreage of each irrigated crop category by subarea; and (2) the land use data by finite elements, which defines the distribution of the four major land use types (agricultural, urban, native vegetation, and riparian vegetation) within each subarea.

The land use data used in the SVIGSM are primarily based on the regular land use surveys made by the California Department of Water Resources (DWR) on an approximately seven year cycle. The DWR reports the land use acreages by the four major Detailed Analysis Units (DAU) covering the Salinas Valley floor. These are DAU 48, 49, 50, and 51. Although the boundaries of these DAUs correspond closely to the boundaries of the four primary hydrologic subareas in the valley (respectively, Pressure, East Side, Forebay, and Upper Valley), they do not completely correspond to the boundaries of the same subareas in the SVIGSM. The boundaries of SVIGSM follow the geologic boundaries of the water bearing material as delineated by the California Division of Mines and Geology (1959, and 1966). This is especially significant in the Pressure and East Side areas. In the Pressure area, DAU 48 does not cover the area to the northwest part of the Salinas river, which mostly consists of the areas between the Salinas river and the coast line, including the City of Marina. In the East Side area, the DAU 49 does not cover the areas to the northeast of the Monterey County, generally known as the north county area. This area is covered by the model to the Elkhorn Slough and boundaries of the

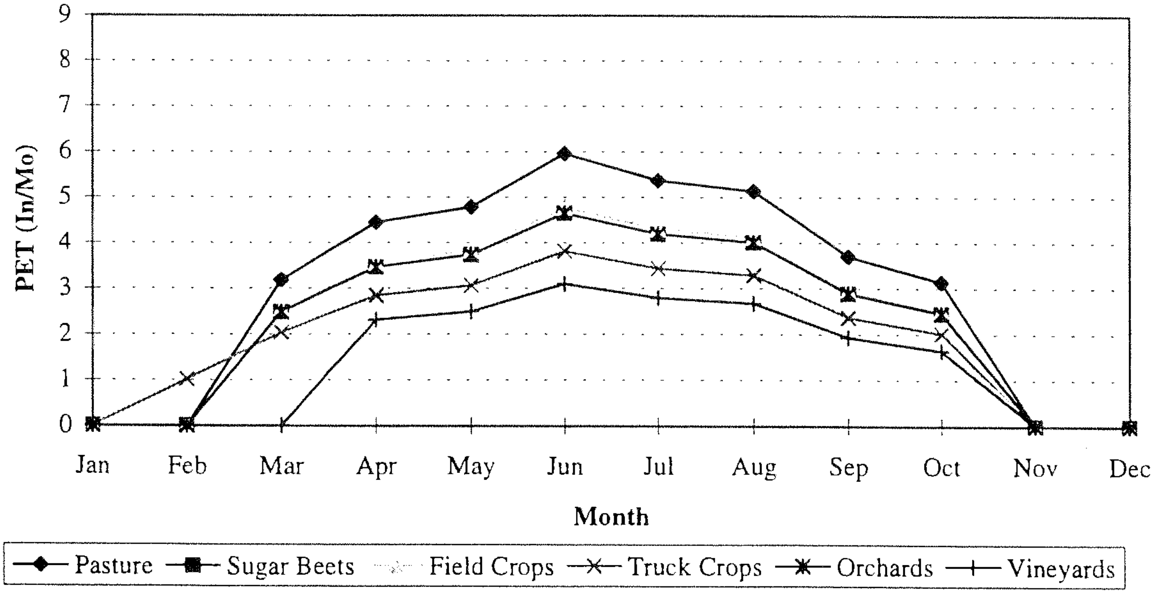
FIGURE 2-1

MONTHLY DISTRIBUTION OF CROP POTENTIAL ET

(a) PRESSURE SUBAREA



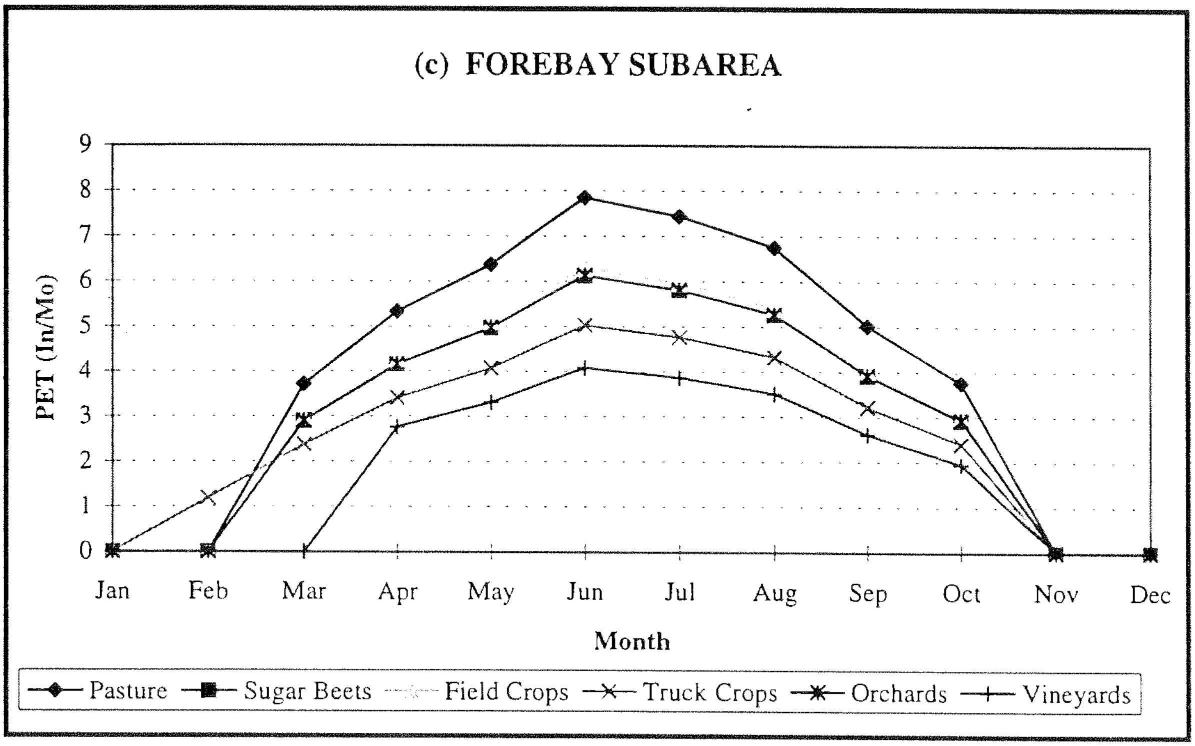
(b) EAST SIDE SUBAREA

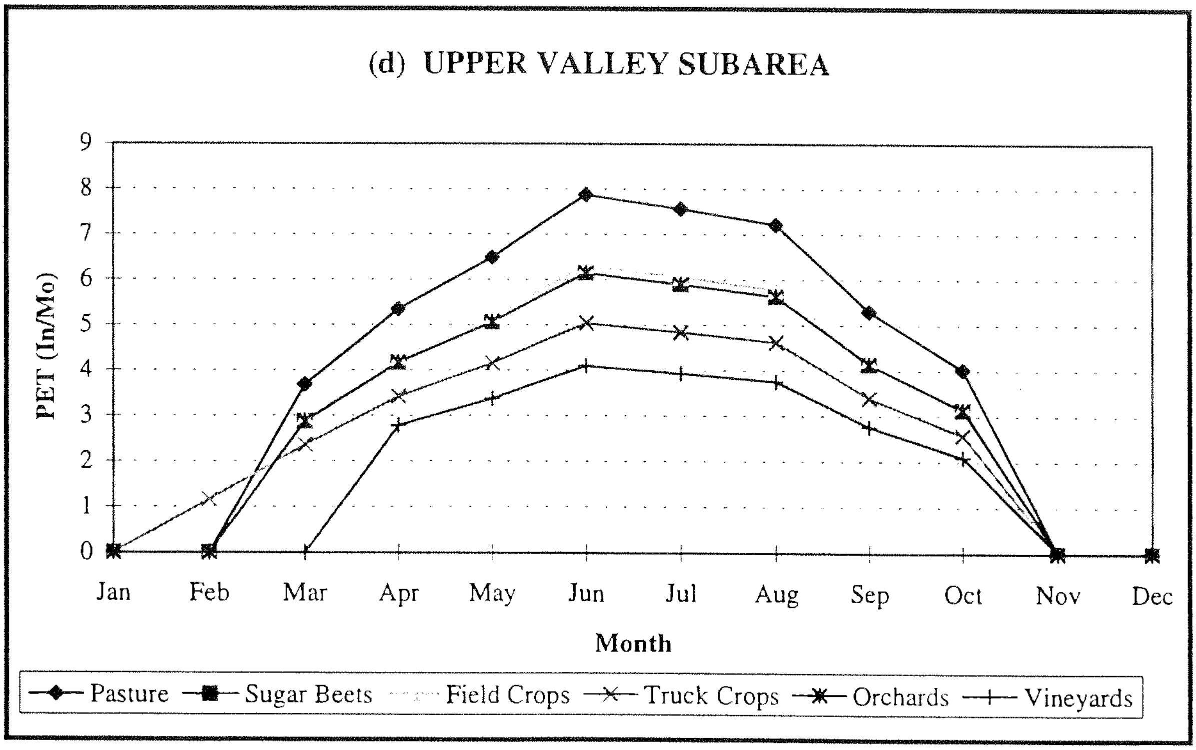


FIGS.XLS

FIGURE 2-1 (continued)

MONTHLY DISTRIBUTION OF CROP POTENTIAL ET





FIGS.XLS

Pajaro Valley Water Management Agency (Figure 2-2). This area is generally covered by DAU 58. Thus the land use data from the DWR surveys used in the SVIGSM have been adjusted for these differences in coverage area, based on the limited information available from the local agencies.

The DWR surveys used in the development of land use data for SVIGSM are: the 1968, 1976, and 1982. In addition, DWR also surveyed the Salinas Valley in 1989. This survey was made in Fall of 1989, and did not reflect the actual acreage of land under production for the survey year. Subsequently, the Bureau of Reclamation (Reclamation) made a partial survey of the Valley in 1991 to correct deficiencies in the DWR 1989 survey, as well as collect information for development of a crop calendar for the Salinas Valley. The result of this effort is a composite 1989/91 land use coverage published by Reclamation in December 1996. As part of the efforts in updating the SVIGSM database, the MCWRA reviewed this coverage in cooperation with various interest groups and stakeholders in the valley, and subsequently developed a "verified 1989/91" land use coverage. Through the same effort, the MCWRA also modified this coverage to reflect the 1995 land use and crop mix and developed a "MCWRA 1995" land use coverage, which reflects the existing conditions. Both these coverages are also used in development of the land use database for the model. Thus the specific annual crop acreage data currently used in the SVIGSM are based on the following:

- DWR 1968, 1976, and 1982 surveys;
- MCWRA 1989/91 "verified land use" coverage;
- MCWRA 1995 land use coverage.

The annual irrigated crop acreages for other years are interpolated based on the above survey years.

Although, both the DWR and USBR/MCWRA crop acreage data are published in detail by each crop type, for modeling purposes, the SVIGSM crop acreages are categorized into seven crop categories based on the DWR Standard Land Use Legend (DWR, 1981, updated in 1993). These crop categories are: pasture, sugar beets, field crops, truck crops, orchards, grain, and vineyards. A complete list of the crops included in each agricultural class is available in the DWR Standard Land Use Legend (July 1993).

Table 2-2 shows the acreage for each crop category used in the SVIGSM for each survey year. As the model requires crop acreage for each simulation year, crop acreages for other years are linearly interpolated between the survey years. Note that although DWR land use surveys show the grain acreages as partly irrigated and partly non-irrigated, based on conversations with local growers and the Monterey County Agricultural Commissioner's office (Gerry Wiley), a substantial area under

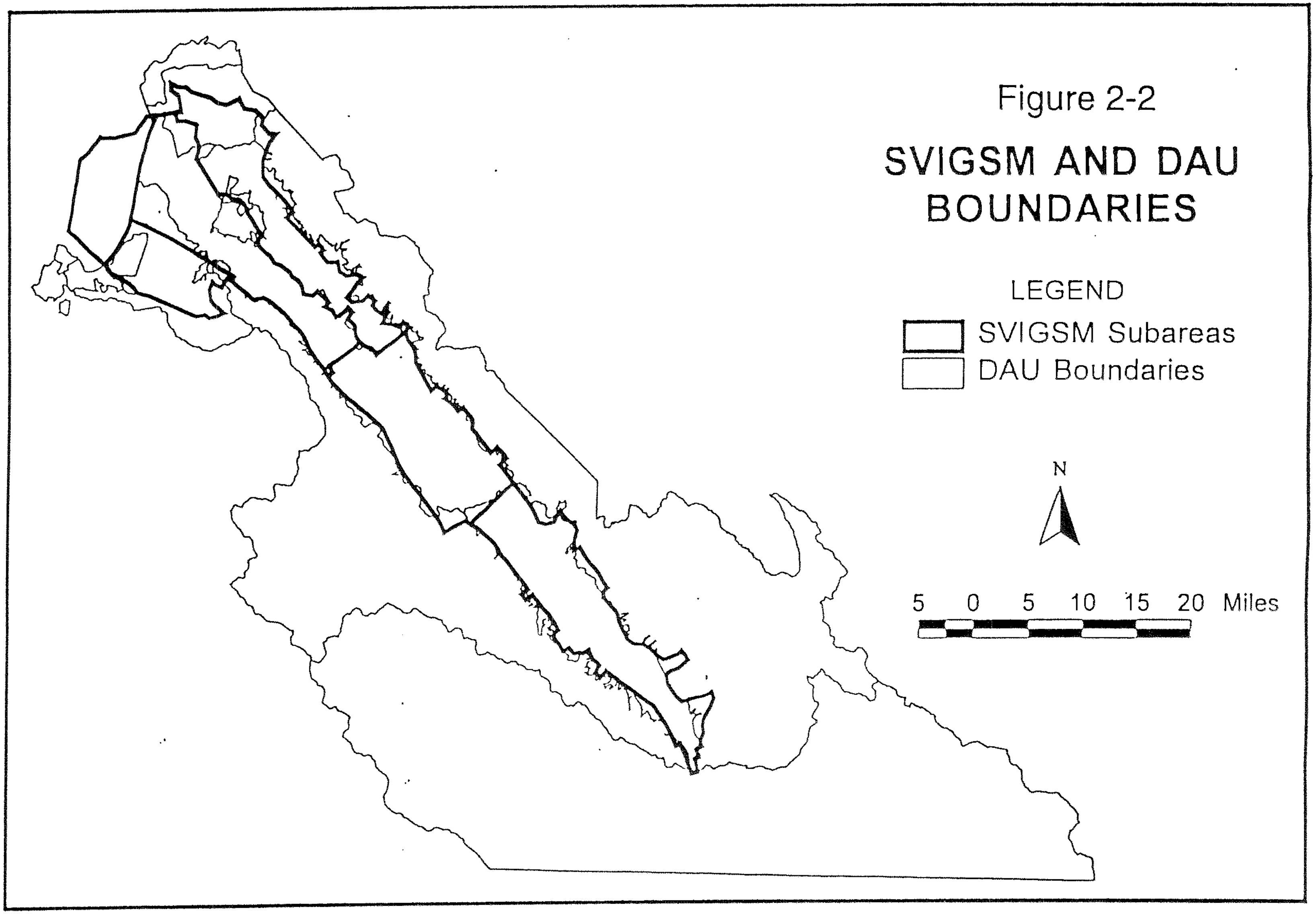


Figure 2-2

SVIGSM AND DAU BOUNDARIES

TABLE 2-2
SUMMARY OF IGSM LAND USE DATA
(All Units in Acres)

	PRESSURE AREA					EAST SIDE AREA				
CROP TYPE	1968(1)	1976(1)	1982(1)	1989/91 (2)	1995 (3)	1968(1)	1976(1)	1982(1)	1989/91 (2)	1995 (3)
Pasture	1,566	375	381	352	352	2,798	1,575	772	535	440
Sugar Beets	1,753	3,439	19	0	0	3,409	4,991	0	0	0
Field Crops	2,980	2,552	435	876	876	5,505	3,623	525	2,733	2,733
Truck Crops	43,160	44,819	50,306	50,696	51,103	21,492	21,503	30,474	30,197	30,501
Orchard	0	0	0	29	29	274	113	42	26	26
Grain	0	0	0	0	0	0	0	0	0	0
Vineyard	0	741	732	740	740	0	4,962	3,760	3,117	3,117
Total Irrigated Acreage	**49,459**	**51,926**	**51,873**	**52,694**	**53,101**	**33,478**	**36,767**	**35,573**	**36,609**	**36,817**
Urban Area	7,577	8,693	9,086	12,650	12,650	3,476	5,826	6,810	10,978	10,978
Native Vegetation	29,845	26,262	25,923	21,538	21,130	37,547	31,908	32,118	26,914	26,706
Riparian Vegetation	3,936	3,936	3,936	3,936	3,936	0	0	0	0	0
Total Land Area	**90,817**	**90,817**	**90,817**	**90,817**	**90,817**	**74,501**	**74,501**	**74,501**	**74,501**	**74,501**

Sources:
1) DWR Land Use Surveys
2) MCWRA 1989/91 "Verified Land Use" (3/97)
3) MCWRA (3/97)

Notes:
1) All grain acreage assumed to be non-irrigated.
2) Acreage values include irrigated fallow and/or idle crop acreages.
3) Riparian veg acreages are assumed to be the same as the MCWRA 1989/91 (3/97).
4) Total land area is based on the total land area estimated in the MCWRA 1989/91 data set.
5) For all surveys: Urban acreage includes Urban, Suburban Residential & Freeway areas.
6) For the Pressure Subarea, DWR urban acreages were increased proportionally to account for Marina.
7) For the East Side Subarea, DWR urban acreages were increased proportionally to account for the portions of urban area in DAU 58 that are included in the SVIGSM East Side Subarea.
8) The native veg acreages include non-irrigated acreages (including grain), farmsteads, feedlots, and dairies.

TABLES.XLS

TABLE 2-2 (continued)
SUMMARY OF IGSM LAND USE DATA
(All Units in Acres)

	FOREBAY AREA					UPPER VALLEY AREA				
CROP TYPE	1968(1)	1976(1)	1982(1)	1989/91 (2)	1995 (3)	1968(1)	1976(1)	1982(1)	1989/91 (2)	1995 (3)
Pasture	3,238	2,515	2,032	1,959	1,545	4,370	3,827	3,147	1,898	2,040
Sugar Beets	5,188	5,973	1,755	0	0	5,010	5,897	701	0	0
Field Crops	14,633	10,101	4,493	3,152	3,095	9,587	6,114	4,800	728	458
Truck Crops	24,727	21,704	31,362	36,673	36,387	14,305	13,018	22,821	26,508	25,832
Orchard	724	398	389	521	637	1,383	160	160	258	454
Grain	0	0	0	0	0	0	0	0	0	0
Vineyard	1,584	15,830	15,831	13,678	15,171	0	14,427	17,422	15,128	16,366
Total Irrigated Acreage	**50,094**	**56,521**	**55,862**	**55,984**	**56,834**	**34,655**	**43,443**	**49,051**	**44,520**	**45,151**
Urban Area	1,840	1,962	2,175	2,885	2,885	1,998	3,322	3,356	3,385	3,385
Native Vegetation	29,511	22,962	23,408	22,576	21,725	48,413	38,301	32,659	37,160	36,530
Riparian Vegetation	5,267	5,267	5,267	5,267	5,267	7,242	7,242	7,242	7,242	7,242
Total Land Area	**86,712**	**86,712**	**86,712**	**86,712**	**86,712**	**92,308**	**92,308**	**92,308**	**92,308**	**92,308**

Sources:
1) DWR Land Use Surveys
2) MCWRA 1989/91 "Verified Land Use" (3/97)
3) MCWRA (3/97)

Notes:
1) All grain acreage assumed to be non-irrigated.
2) Acreage values include irrigated fallow and/or idle crop acreages.
3) Riparian veg acreages are assumed to be the same as the MCWRA 1989/91 (3/97).
4) Total land area is based on the total land area estimated in the MCWRA 1989/91 data set.
5) For all surveys: Urban acreage includes Urban, Suburban Residential & Freeway areas.
6) For the Pressure Subarea, DWR urban acreages were increased proportionally to account for Marina.
7) For the East Side Subarea, DWR urban acreages were increased proportionally to account for the portions of urban area in DAU 58 that are included in the SVIGSM East Side Subarea.
8) The native veg acreages include non-irrigated acreages (including grain), farmsteads, feedlots, and dairies.

TABLE 2-2 (continued)
SUMMARY OF IGSM LAND USE DATA
(All Units in Acres)

	TOTAL AREA				
CROP TYPE	1968(1)	1976(1)	1982(1)	1989/91 (2)	1995 (3)
Pasture	11,972	8,292	6,332	4,745	4,376
Sugar Beets	15,360	20,300	2,475	0	0
Field Crops	32,705	22,390	10,253	7,489	7,163
Truck Crops	103,684	101,044	134,963	144,074	143,824
Orchard	2,381	671	591	834	1,146
→Grain	0	0	0	0	0
Vineyard	1,584	35,960	37,745	32,664	35,394
Total Irrigated Acreage	**167,686**	**188,657**	**192,359**	**189,807**	**191,903**
Urban Area	14,892	19,804	21,426	29,898	29,892
Native Vegetation	145,315	119,432	114,108	108,188	106,098
Riparian Vegetation	16,445	16,445	16,445	16,445	16,445
Total Land Area	**344,338**	**344,338**	**344,338**	**344,338**	**344,338**

Sources:
1) DWR Land Use Surveys
2) MCWRA 1989/91 "Verified Land Use" (3/97)
3) MCWRA (3/97)

Notes:
1) All grain acreage assumed to be non-irrigated.
2) Acreage values include irrigated fallow and/or idle crop acreages.
3) Riparian veg acreages are assumed to be the same as the MCWRA 1989/91 (3/97).
4) Total land area is based on the total land area estimated in the MCWRA 1989/91 data set.
5) For all surveys: Urban acreage includes Urban, Suburban Residential & Freeway areas.
6) For the Pressure Subarea, DWR urban acreages were increased proportionally to account for Marina.
7) For the East Side Subarea, DWR urban acreages were increased proportionally to account for the portions of urban area in DAU 58 that are included in the SVIGSM East Side Subarea.
8) The native veg acreages include non-irrigated acreages (including grain), farmsteads, feedlots, and dairies.

it is assumed that irrigated grain acreages are zero. Figures 2-3(a-e) show the irrigated crop acreage for each subarea and the entire Salinas Valley.

In analysis of the crop acreages, the following definitions are important to consider:

Gross Land Acreage: This includes total land area within each parcel, DAU, or subarea, including irrigated and non-irrigated farm areas, as well as, farmstead, rural roads, and ponds.

Gross Irrigated Acreage: This includes the irrigated crop acreage, as well as the irrigated fallow or idle land at the time of survey. The roads, ponds, farmstead, dairies, and other acreages are not included in this definition.

Net Irrigated Acreage: This includes only the irrigated acreage at the time of survey. It does include irrigated acreages that were left fallow/idle for tilling or in between crop rotation at the time of survey.

Since SVIGSM uses the irrigated acreage data to calculate irrigation water requirements, the input data should reflect net irrigated acreage. The acreages reported by DWR reflect net irrigated acreage for most crops except for field and truck crops; the latter constitutes a large portion of irrigated acreage in the valley. For truck and field crops, DWR reports the fallow/idle acreages. These reported fallow/idle acreages represent the temporary conditions of the land at the time of survey. In reality, these lands are not left as fallow for long periods of time. Due to large agro-economic returns, the cropping intensity on lands cultivated for truck crops have increased significantly. Multiple cropping is practiced to a large extent on most truck crop lands, and fallow/idle period is generally minimized to the extent possible, and is limited to the period which is "in-between cropping". This period is to allow time for crop rotation and land preparation. In many areas, this period is a little as two weeks.

In order for the SVIGSM to best represent the irrigation water requirements for truck crops, the gross irrigated truck crop acreage (which include the fallow/idle acreage) is used in the model. However, the resulting irrigation water requirement is adjusted for the periods in-between rotation, which does not necessarily require irrigation water. In this regards, the MCWRA estimated the monthly percentages of gross irrigated acreage that are "in-between rotation". These estimates are shown in the first column of Table 2-3. They are applicable to the truck crops only and are assumed to be reflective of the valley-wide vegetable cropping practices. These percentages are estimated based on interviews with key growers in the Salinas Valley representing the northern, as well as southern parts of the Valley. According to these interviews, column one of Table 2-3 reasonably represents the prevailing

FIGS.XLS

FIGURE 2-3a
ANNUAL IRRIGATED ACREAGE IN THE PRESSURE SUBAREA

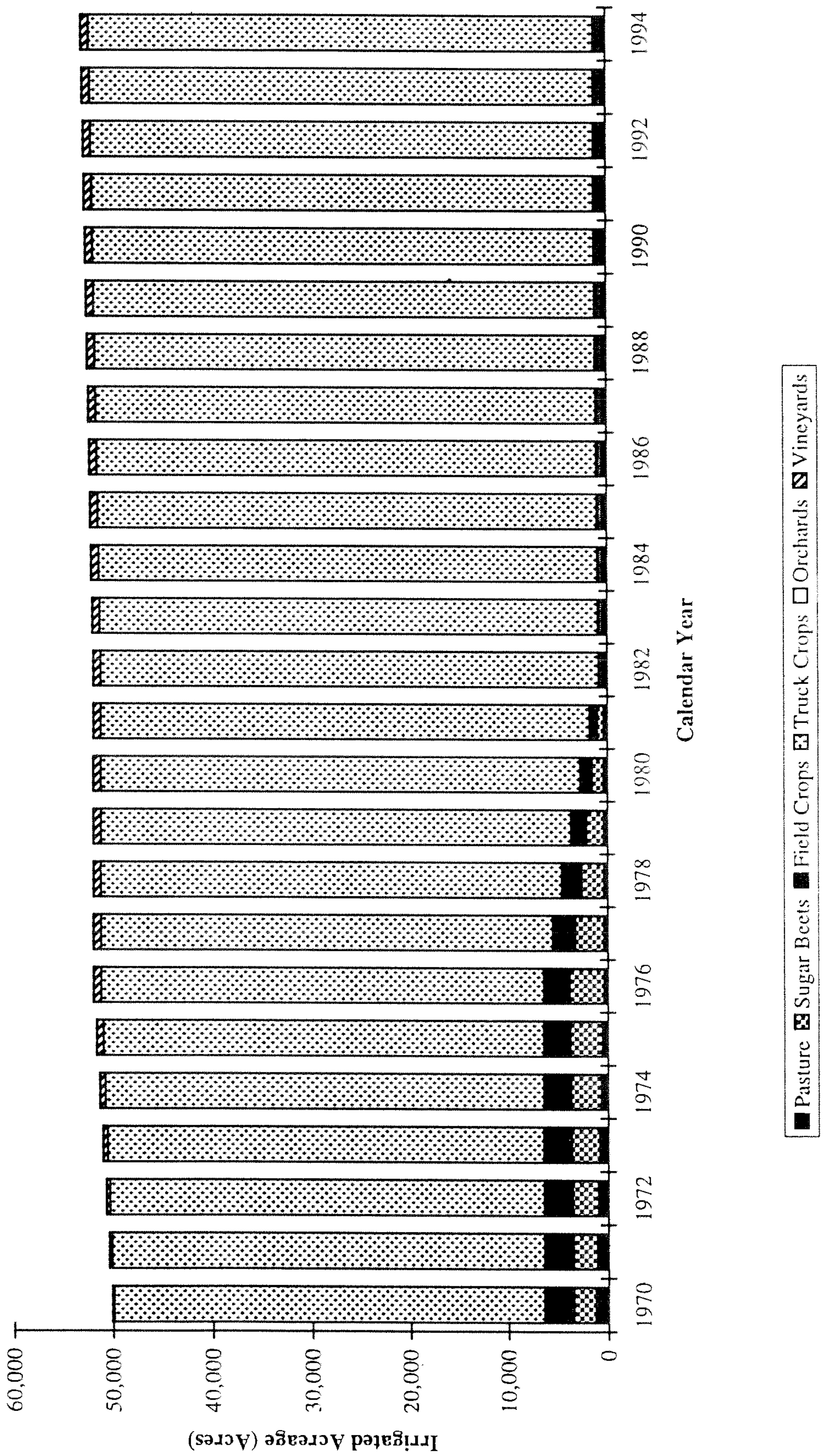
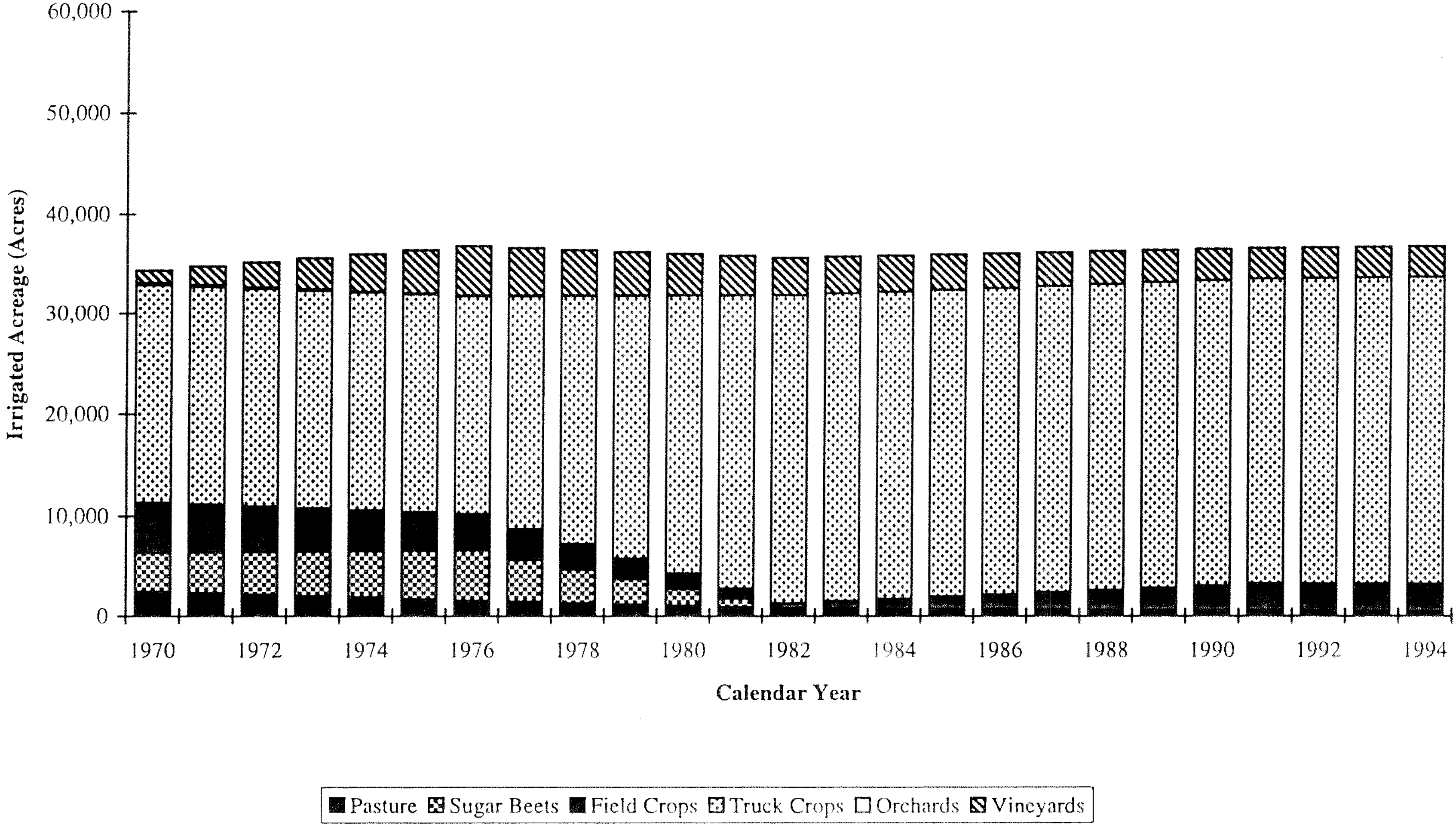


FIGURE 2-3b
ANNUAL IRRIGATED ACREAGE IN THE EAST SIDE SUBAREA



FIGS.XLS

FIGS.XLS

FIGURE 2-3c
ANNUAL IRRIGATED ACREAGE IN THE FOREBAY SUBAREA

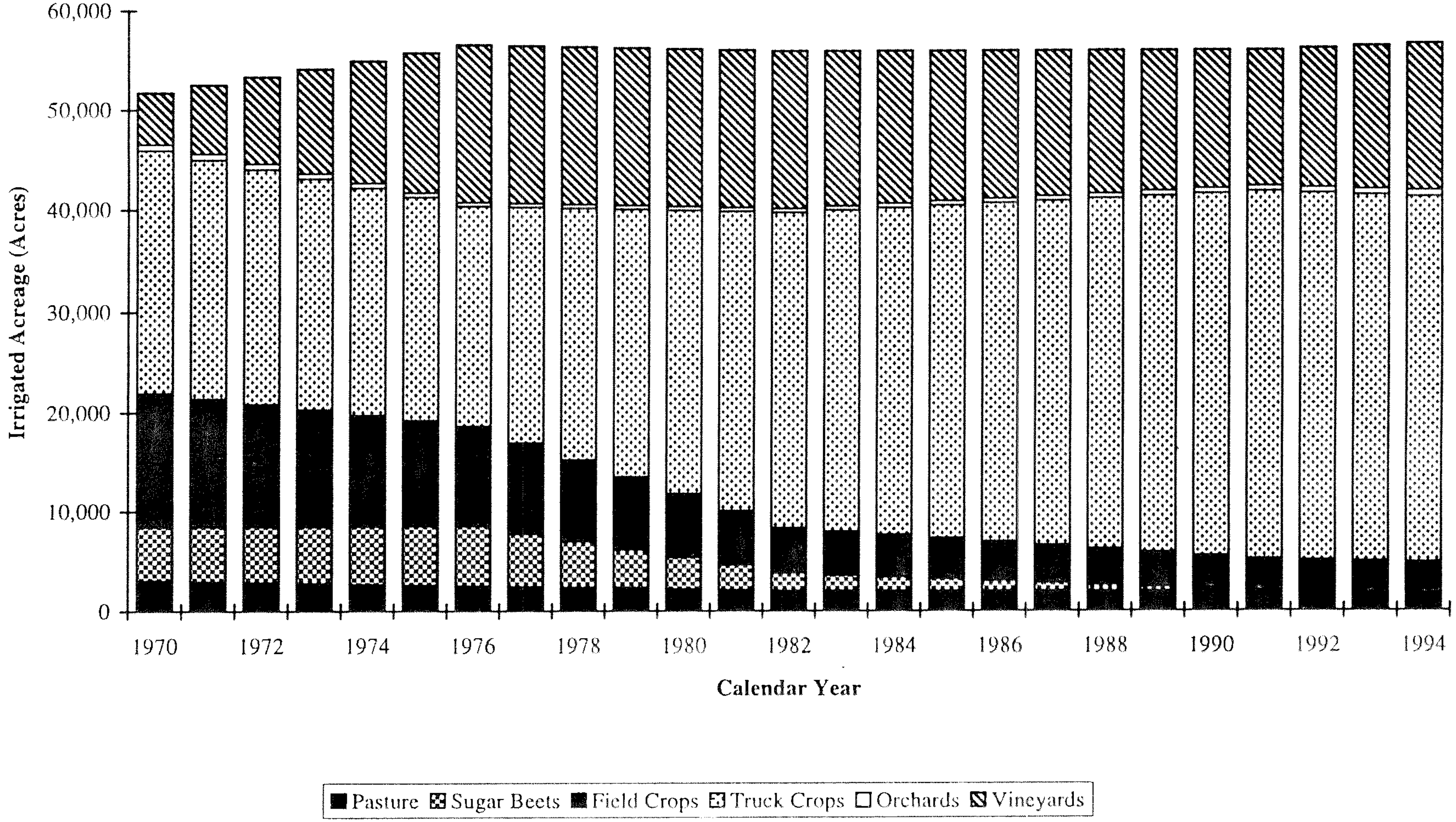


FIGURE 2-3d
ANNUAL IRRIGATED ACREAGE IN THE UPPER VALLEY SUBAREA

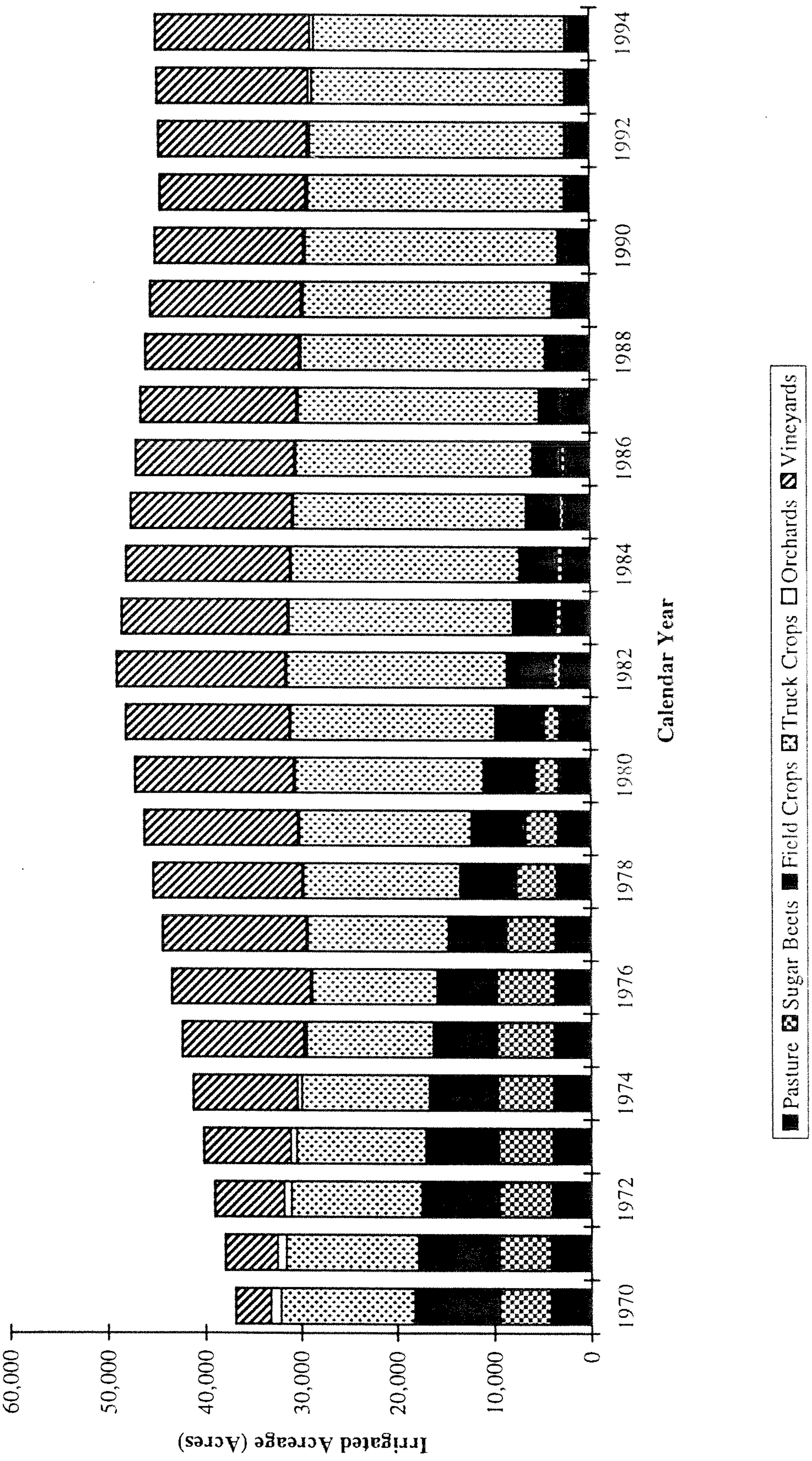
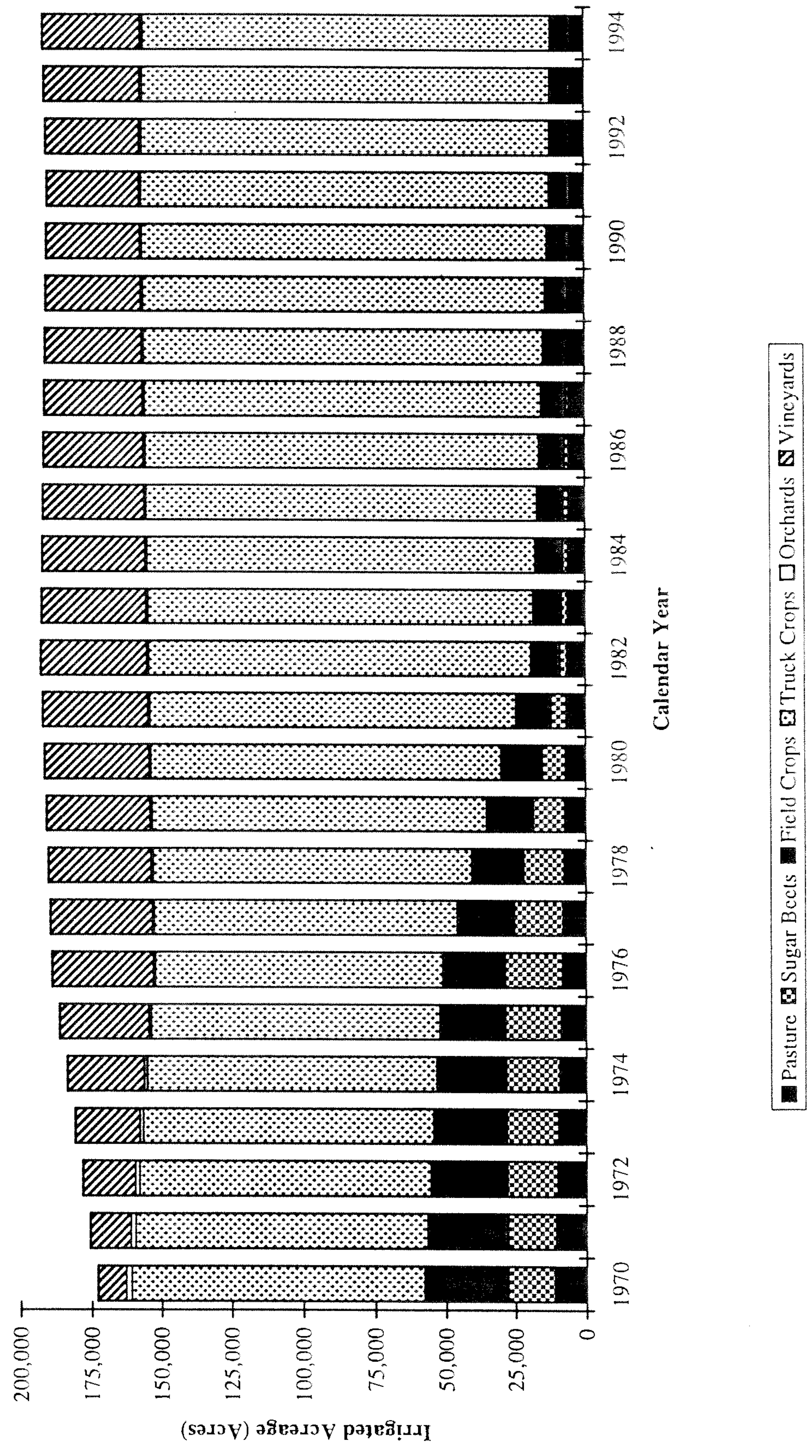


FIGURE 2-3e
ANNUAL IRRIGATED ACREAGE IN THE SALINAS VALLEY



concept of "fallow" or "in-between rotation" acreages in the truck crop areas of Salinas Valley.

Although the cropping patterns are generally similar in the northern and southern parts of the valley, recently obtained data (Charles V. Moore, 1997) show slight differences in the cropping intensities in each of the subarea. Therefore, the "in-between" rotation estimates have been varied accordingly. The cropping intensity data from 40 acre parcels in each subarea were developed for 1995 irrigation practices. The cropping intensity, defined as the ratio of harvested acreage to land acreage, for the Pressure, East Side, Forebay, and Upper Valley areas are reported as 1.97, 1.85, 1.65, and 1.71, respectively. The valley-wide average in-between rotation estimates were adjusted according to the relative differences in cropping intensities between each subarea, as shown in Table 2-3.

As discussed earlier, the SVIGSM crop acreage input data represents gross irrigated acreages. As such, appropriate reductions are made to the calculated truck crop irrigation water requirements to account for the multiple cropping practices in the different parts of the valley.

The SVIGSM land use distribution data is divided into four categories:

- agricultural land, which includes the gross irrigated acreage;
- urban land, which includes all the urban, suburban, and freeway areas;
- native vegetation, which includes all the other land categories, including barns, farmstead, dairies, rural roads, ponds, and water bodies; and
- riparian vegetation, which includes the phreatophitic vegetation along the Salinas River.

The area for riparian vegetation has not been published in any of the past land use surveys, and thus very little information existed in this regards. As part of the land use verification efforts for the SVIGSM database update, the MCWRA in cooperation with local interest groups and stakeholders developed a GIS coverage of the riparian vegetation corridor along the Salinas River, based on the 1994 orthophotographic maps. The composite MCWRA "verified 1989/91" and 1995 land use coverages include the riparian vegetation coverage.

The distribution of land use in the model area is based on the DWR 1976 land use maps, MCWRA "verified 1989/91" and MCWRA 1995 coverages. This set of data provides a comprehensive spatial and temporal distribution of land use cover in the model area during the calibration period of 1970-94.

Table 2-3

Monthly Estimates of Truck Crop Acreage that are "In-Between Rotation"

Month	Valley-Wide Average (%)	Pressure (%)	East Side (%)	Forebay (%)	Upper Valley (%)
January	90	89	90	91	90
February	70	67	69	72	71
March	30	24	28	36	33
April	20	13	18	26	24
May	10	2	7	17	14
June	10	2	7	17	14
July	10	2	7	17	14
August	10	2	7	17	14
September	20	13	18	17	24
October	70	67	69	72	71
November	80	78	79	82	81
December	90	89	90	91	90

Notes:
1. Applied to truck crops only.
2. Valley-wide average based on interviews with major growers in the Salinas Valley.
3. Adjustments to valley-wide average for each subarea based on cropping intensity data obtained for each subarea.

2.3 Agricultural Water Use

The agricultural water use is computed in the SVIGSM based on the consumptive use methodology and is explained in detail in the model documentation (Montgomery Watson, 1995).

The major factors influencing the agricultural water use requirement are:

- Crop irrigated acreage, as explained in Section 2.2.
- Crop potential ET, as described in Section 2.1.
- Effective precipitation, calculated daily, based on the SCS methodology, and is explained in detail in the model documentation.

- Irrigation efficiency, defined on two scales: on a field scale, it is called the crop irrigation efficiency; and on a basin-wide scale it is called the basin irrigation efficiency.

Crop irrigation efficiency is defined as:

$$Crop\ I.E. = \frac{CUAW + Leaching\ Requirement}{Applied\ Water}$$

Where:
CUAW = Consumptive Use of Applied Water
Leaching Requirement = Water applied for Salinity Management
Applied Water = Water applied to the field

Crop I.E. generally includes distribution losses within the irrigation system at the field.

Basin irrigation efficiency is defined by the following equation:

$$Basin\ I.E. = \frac{CUAW + Leaching\ Requirement + Frost\ Protection + Post\ Harvest\ Irrigation}{Total\ Quantity\ of\ Water\ Pumped}$$

Where:
CUAW = Consumptive Use of Applied Water
Leaching Requirement = Water applied for Salinity Management
Frost Protection = Water used to meet frost protection requirements
Post Harvest Irrigation = Any Irrigation water applied after harvest is complete (does not include Frost Protection)
Pumped Water = Total water pumped for irrigation purposes

Basin I.E. generally includes all the transmission, conveyance and distribution losses between pumping location and point of application.

Because water used for salinity management, frost protection, and post harvest irrigation purposes is often infrequent and not well documented, these components are considered to be negligible in the SVIGSM simulation.

- Since SVIGSM uses the consumptive use methodology to estimate irrigation water use requirements, and ultimately the total water pumped in each subarea for agricultural water use, the Basin I.E. is used as input in the model.

- Due to the changes in agricultural practices in the Salinas Valley over the past few decades, the crop irrigation efficiency is assumed to vary over time as shown in Table 2-4.

- It is noteworthy that the crop irrigation efficiencies for a particular crop may be similar in all subareas, due to similar irrigation practices. However, the basin efficiencies may vary between subareas due to variations in conveyance losses between the production well and the crop field. A study of the location map of production wells produced as part of the 1995 Ground Water Extraction Monitoring System (GEMS) (MCWRA, Nov. 1996) reveals that most of the production wells used for irrigation in the valley are close to the crop field and conveyance losses are minimal. In these cases, the Basin I.E. is similar to the crop I.E. However, some of the farms in the Upper Valley currently growing vineyards, pump water in the close vicinity of the Salinas River and transmit the pumped water to the fields away from river. These practices are generally subject to large conveyance losses and thus the Basin I.E. is much lower than crop I.E. The average basin I.E. used for the vineyards in the Upper Valley are 52%, 57% and 62%, respectively, for the 1970's, 1980's and 1990's.

Of the seven crop categories used in the Salinas Valley, the irrigation and cultural practices of two major ones (truck crops and vineyards) require special discussion, in relation to modeling their water use.

Table 2-4

Basin Irrigation Efficiencies

Subarea	Pasture			Sugar Beets			Field Crops		
	1970s	1980s	1990s	1970s	1980s	1990s	1970s	1980s	1990s
Pressure	0.55	0.60	0.64	0.55	0.60	0.64	0.63	0.68	0.72
East Side	0.55	0.60	0.64	0.55	0.60	0.64	0.63	0.68	0.72
Forebay	0.55	0.60	0.64	0.55	0.60	0.64	0.63	0.68	0.72
Upper Valley	0.55	0.60	0.64	0.55	0.60	0.64	0.63	0.68	0.72

Subarea	Truck Crops			Orchards			Vineyards		
	1970s	1980s	1990s	1970s	1980s	1990s	1970s	1980s	1990s
Pressure	0.55	0.60	0.64	0.55	0.60	0.64	0.70	0.75	0.80
East Side	0.55	0.60	0.64	0.55	0.60	0.64	0.70	0.75	0.80
Forebay	0.55	0.60	0.64	0.55	0.60	0.64	0.70	0.75	0.80
Upper Valley	0.50	0.50	0.50	0.55	0.60	0.64	0.70	0.75	0.80

Truck Crop Water Use

Truck crops constitute a large portion of irrigated agriculture in the Salinas Valley, with over 140,000 acres. The irrigation systems used by truck crop growers range from highly sophisticated drip lines to the traditional furrow systems. As discussed in section 2.2, multiple cropping is practiced widely to maximize per acre production rate. The SVIGSM was used to estimate the irrigation water pumped for truck crops; accounting for the range of crop potential ET requirements, and the range of irrigation practices, in the valley.

To ensure that the truck crop average unit pumped water, estimated by the model for the period 1990-94 is reasonable, output from the model was compared to annual pumping records from GEMS reports for truck crops from 1994-1996. The consumptive component of water use is assumed to be estimated reasonably well, since it is based on crop potential ET. However, the irrigation efficiencies used in the model were adjusted slightly to bring the simulated results in agreement with the pumping records. A comparison of simulated and observed unit pumped water is presented in Table 2-5. Since the simulated truck crop unit pumped water is similar to the reported values, the model estimates are assumed reasonable. The model is then used to estimate ground water pumping for the entire calibration period. Figures 2-4(a-d) show the simulated unit pumped water use by subarea for the simulation period.

Table 2-5

Comparison of Simulated and Observed Unit Pumped Water For Truck Crops for the 1990s Period

Subarea	Simulated Unit Pumped Water (ft/yr)	Observed Unit Pumped Water (ft/yr)
Pressure	2.28	2.42
East Side	2.32	2.33
Forebay	3.17	3.23
Upper Valley	3.98	4.04

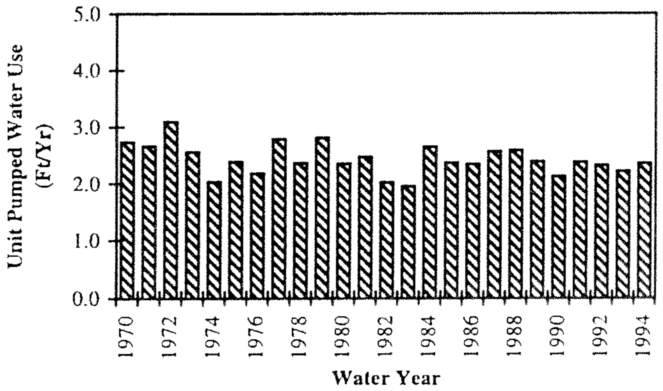
* Source: Unit pumped water is from GEMS pumping records for 1994-1996, MCWRA (1997).

UNIT_WU.XLS

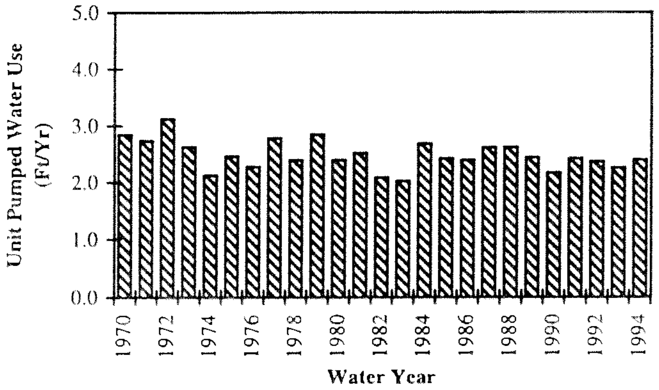
FIGURE 2-4

SIMULATED UNIT PUMPED WATER FOR TRUCK CROPS

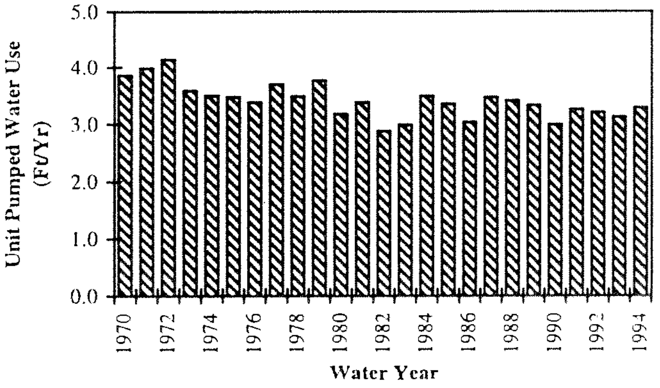
(a) PRESSURE SUBAREA



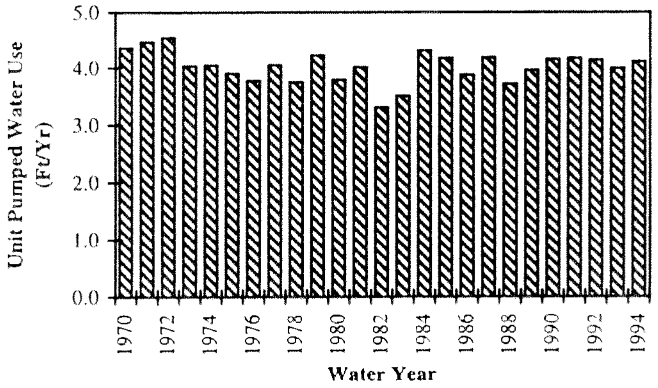
(b) EAST SIDE SUBAREA



(c) FOREBAY SUBAREA



(d) UPPER VALLEY SUBAREA



Vineyard Water Use

Vineyards have been introduced in the Salinas Valley since the late 1960's and early 1970's. Although the fluctuations in the vineyard acreage have been driven by market forces, the trend has generally been upward from about 1,600 acres in 1968 to more than 35,000 acres in 1995. This increase in vineyard acreage, however, has been accompanied by a reduced unit water use in the grapevine industry.

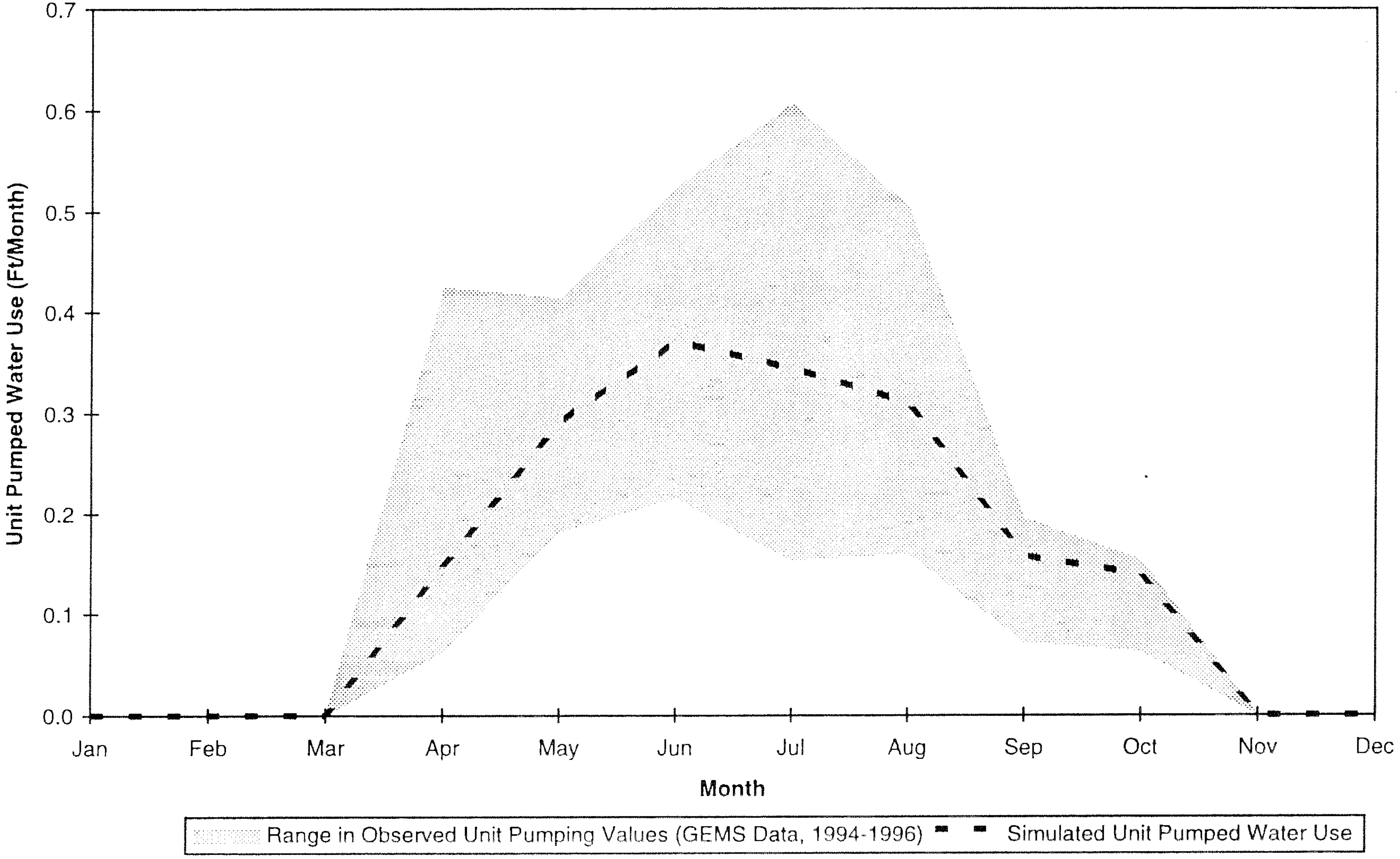
Water use by grapevines is dependent upon the age of the vine, the vine's seasonal development and evaporative demand. The water use by grapevines has been studied extensively in areas which have very high evaporative demands. However, quantifying water used by grapevines in cool climates has received less attention. While in high temperature areas, vineyard water use may be as high as 30 to 36 inches per year, in more moderate areas the vine water use ranges from 16 to 23 inches per year. There have been reports of even lower water use by some vineyard growers. In the wine industry, the quality of wine is a function of the sugar content in the grape. In order to increase sugar content of the grape to the desired level, the vineyards are irrigated under stress during the growing season. This practice, generally referred to as "deficit irrigation", reduces the crop water use for the vineyards to a reported value of 10 to 13 inches per year.

In order to properly simulate the unit water pumped by the vineyard growers in the Salinas Valley, the reported unit pumped water for two of the major vineyards in the Upper Valley and other vineyard growers in the Forebay were extracted from the GEMS database. Values reported by these growers represent different ranges of unit pumped water depending on their irrigation conveyance, distribution systems, and irrigation practices.

Based on an assumed crop irrigation efficiency of 80%, which reflects low loss drip irrigation systems, a unit Consumptive Use of Applied Water (CUAW) for each grower was calculated as the product of crop irrigation efficiency and reported unit pumped water. This unit CUAW represents the conditions in the 1990's. The SVIGSM uses crop potential ET as a basis for calculating evaporative water requirement. However, under deficit irrigation, crop actual ET may be much less than crop potential ET. In this case, the calculated CUAW is used to estimate the vineyard ET under deficit irrigation. The unit CUAW along with the basin irrigation efficiency was used in the model to calculate unit pumped water through several iterative SVIGSM runs. The average basin I.E. was developed based on basin I.E. for each vineyard grower in the subarea, weighted by corresponding reported vineyard acreage. Figure 2-5 shows the relative agreement between the simulated unit pumped water and the range of observed unit pumped for vineyards in the Upper Valley for the 1990's period.

FIGURE 2-5

AVERAGE SIMULATED UNIT PUMPED WATER FOR UPPER VALLEY VINEYARDS FOR THE
1990'S PERIOD AND RANGE IN OBSERVED UNIT PUMPING VALUES



UNIT_WU.XLS

Unit water use was increased for the 1980s and 1970s period, to reflect varying degrees of deficit irrigation, and varying irrigation practices over time. Figure 2-6(a-d) shows the monthly pattern of simulated pumped water for vineyards by subarea for the 1970s, 1980s, and 1990s. Table 2-6 summarizes the average simulated annual vineyard unit pumped water for each subarea by decade. Figure 2-7(a-d) shows the simulated total annual unit pumped water for vineyards by subarea over the calibration period.

Table 2-6
Summary of Average Simulated Annual Unit Pumped Water for Vineyards

Subarea	1970s SVIGSM (ft/Yr)	1980s SVIGSM (ft/Yr)	1990s SVIGSM (ft/Yr)
Pressure	1.55	1.33	1.16
East Side	1.59	1.36	1.18
Forebay	2.22	1.82	1.62
Upper Valley	2.71	2.02	1.70

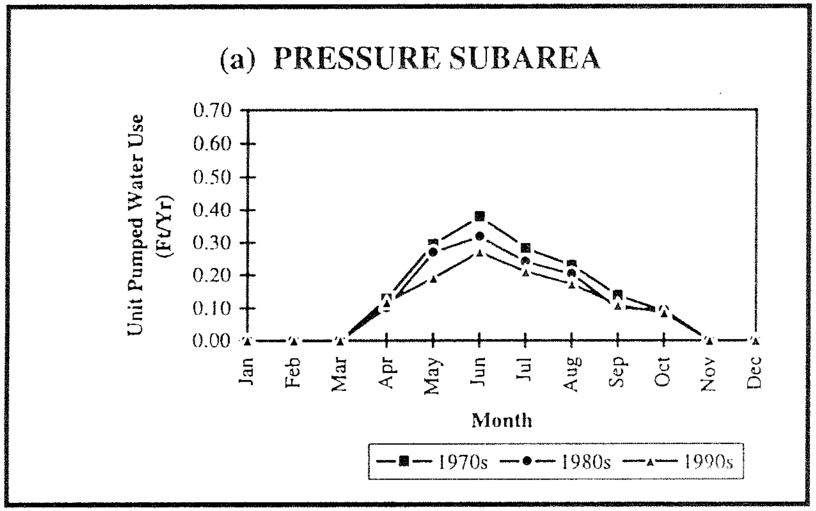
Based on the foregoing discussion, the average annual agricultural pumped water requirement for the water years 1970 to 1994 is then estimated to be 494,700 acre-feet. Annual variations in the agricultural pumped water requirement are due to annual hydrological fluctuations, as well as changes in the irrigated acreage (Figure 2-8).

2.4 Riparian Vegetation Water Use

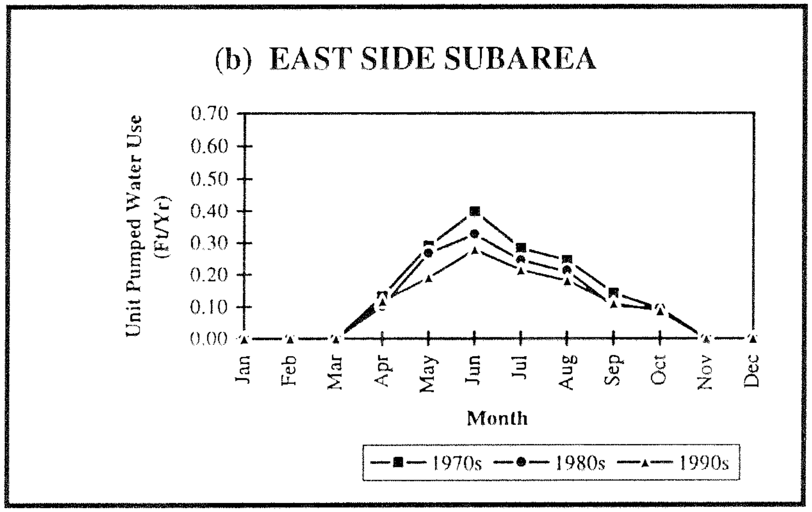
This section of the report discusses the methodology used to estimate water use by riparian vegetation along the Salinas River. The SVIGSM in its original calibration (1994) did simulate the consumptive use of the vegetation along the Salinas River in an indirect method. Due to the lack of land use coverage, the riparian vegetation were approximated as native vegetation. The water consumption was then calculated as part of the overall water balance in the model. This update includes an explicit specification of riparian land and water use along the Salinas River.

FIGURE 2-6

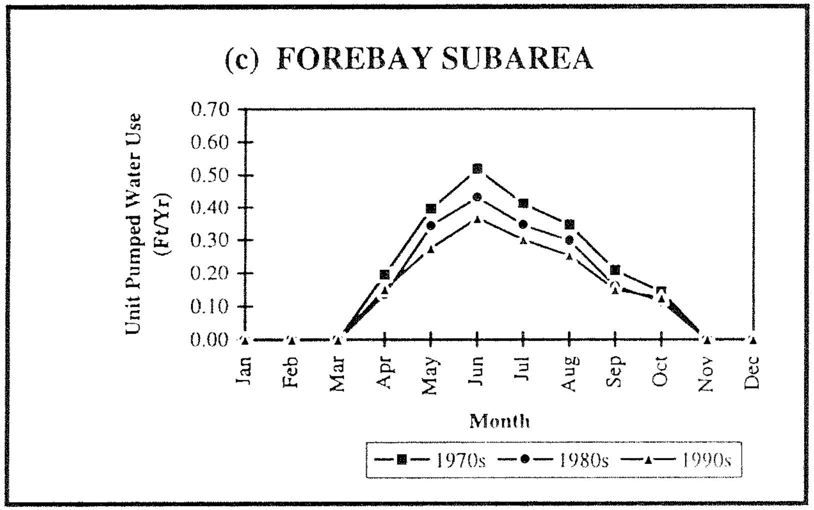
SIMULATED AVERAGE MONTHLY PUMPED WATER USE FOR VINEYARDS



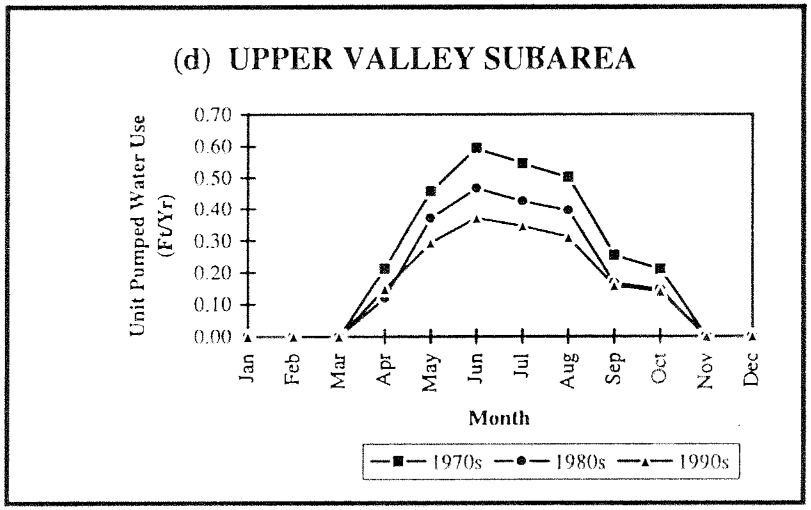
(a) PRESSURE SUBAREA



(b) EAST SIDE SUBAREA



(c) FOREBAY SUBAREA

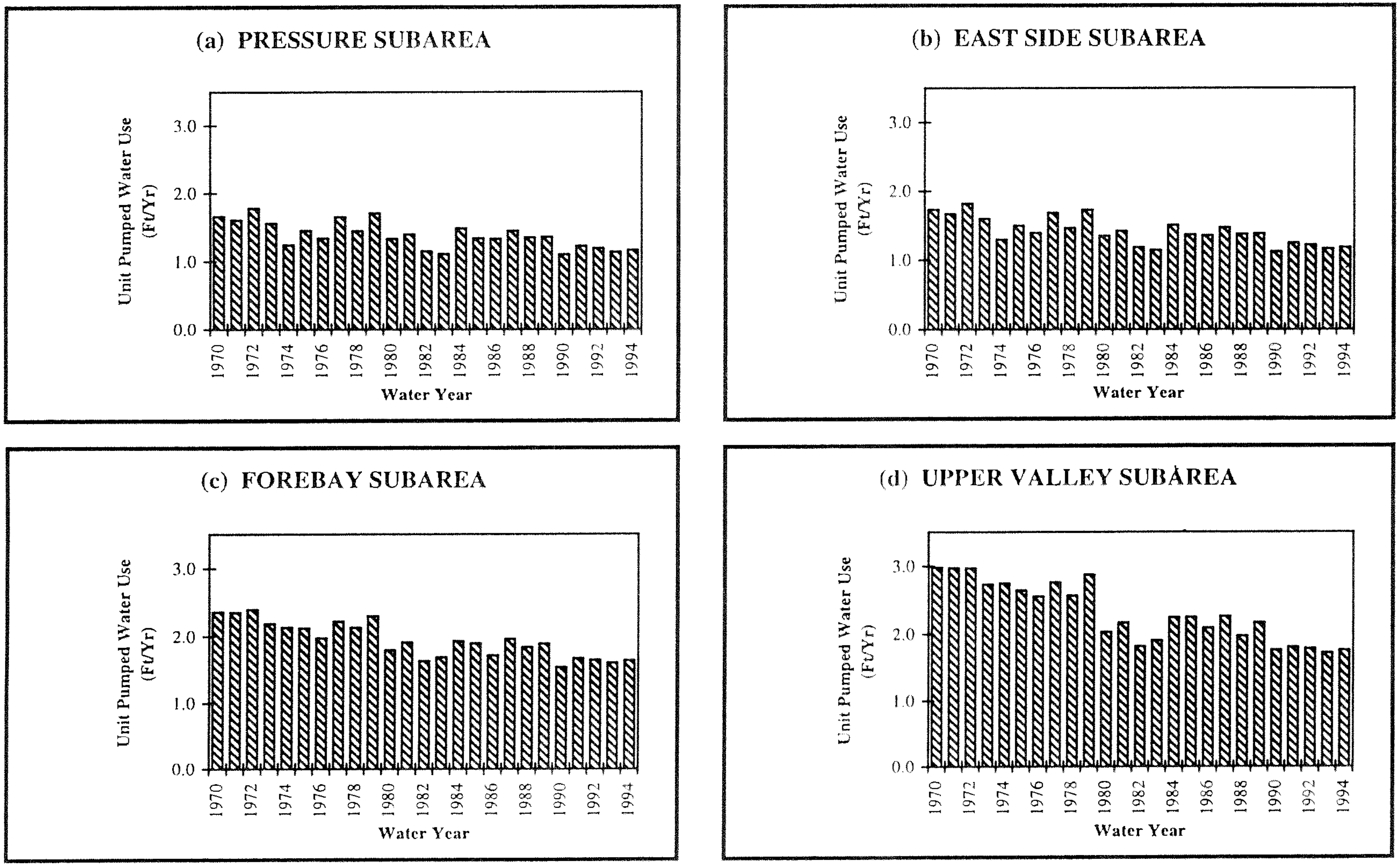


(d) UPPER VALLEY SUBAREA

UNIT_WU.XLS

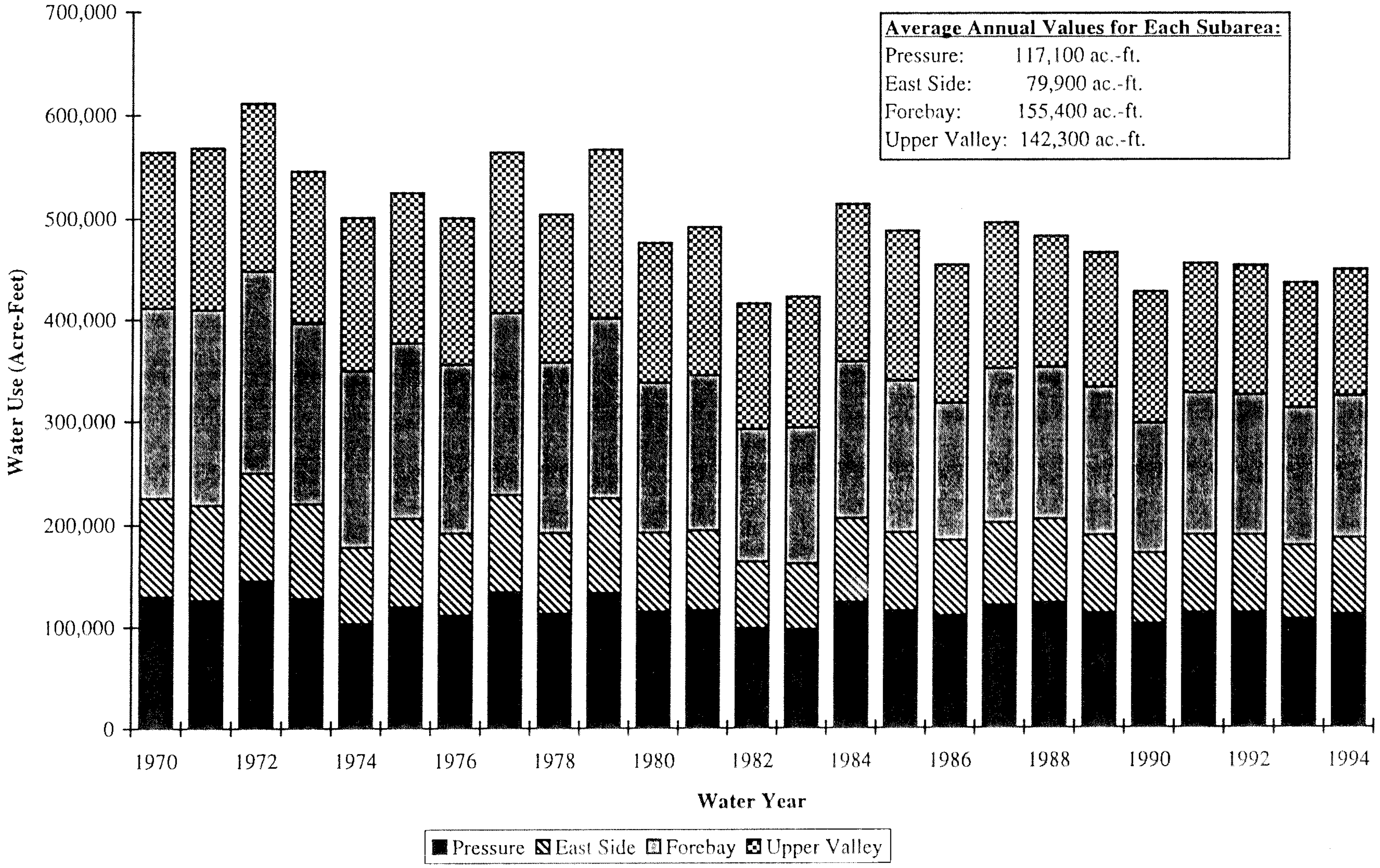
FIGURE 2-7

SIMULATED UNIT PUMPED WATER FOR VINEYARDS



UNIT_WU.XLS

FIGURE 2-8
ANNUAL AGRICULTURAL PUMPED WATER REQUIREMENT



FIGS.XLS

The riparian vegetation along the Salinas River are generally of phreatophytic nature. These vegetations are deeply rooted and use the shallow ground water as their source of water supply. The amount of ground water consumed by phreatophytes depends on climate; depth and salinity of ground water, rooting depth of species, vegetation density, and stage of growth of the plants.

Research efforts on water use and evapotranspiration rates of the different types of phreatophytic plants has been minimal. Rantz (1968) suggested a method for estimating the ET by riparian vegetation based on the Blaney-Criddle Method. (Bower, 1978, also presented a variation of this method).

There are number of different types of phreatophytes. In the Salinas Valley, the predominant type of phreatophytes are shrub and woody species. Durbin (1978) used the method suggested by Rantz and estimated the annual phreatophytic water used along the Salinas River to be approximately 25,000 af/yr.

Anderson-Nichols & co. (1985) used a variation of the method suggested by Rantz, and estimated a 300 foot corridor of riparian vegetation along the Salinas River with various densities. The estimated annual water use of phreatophytes using this method is 15,000 - 23,000 af/yr, within the 300-foot channel corridor.

In this study, to estimate the annual water use by the phreatophytes along Salinas River, the MCWRA developed a coverage of the riparian corridor along the river by merging a GIS coverage developed at the MCWRA with a similar GIS coverage of the riparian corridor developed by Stetson Engineers (January 1997). The riparian corridor for the Salinas River was defined by the MCWRA using digital orthophotos and a GIS coverage of land surface elevation contours. Subsequently, MCWRA developed a composite coverage to utilize the land use and vegetation densities within the riparian corridor and the river channel. Based on this composite coverage a total of about 14,000 acres of phreatophytic plants with various cover densities were identified along the Salinas River. This includes the riparian vegetation along the river channel as well as those within the river channel. The cover densities are based on the 1994 orthophotos and are estimated based on the shades of gray of the photos.

The water used by phreatophytes is estimated based on the following equation:

$$\text{Consumptive Water Use} = ET^a * A_e \, ,$$

in which, ET^a = Actual ET of the plant species, calculated simply as potential ET less effective precipitation [Ft], and

A_e = Effective area of the plant species, calculated as physical area, A, times density of cover [acres].

The potential ET for the species is estimated as:

$$ET^p = ET^o * K,$$

In which, K is the plant coefficient, assumed to be 1.1 for shrub and 0.6 for woody species, and ET^o is the reference crop ET based on CIMIS station data.

Appropriate input data sets for IGSM based on the above information is prepared. The data sets include effective area of riparian vegetation, potential ET, and rooting depth for the species. SVIGSM is used to dynamically calculate the riparian water use over the calibration period. The model uses effective precipitation, soil moisture, and shallow ground water as direct sources of water supply to the riparian vegetation. The species also have access to the streamflow through recharge to shallow ground water. Since the model dynamically simulates the water use by the phreatophytes, there are times that the water supply is not fully available to the plants, and they may be shorted. The SVIGSM thus simulates the average annual water use by the riparian vegetation to be 16,700 AF/yr (4,200 AF/yr in Pressure Area, 4,900 AF/yr in Forebay Area, and 7,600 AF/yr in Upper Valley Area). The annual fluctuations are shown in Figure 2-9.

2.5 Urban Water Use

The urban water use data has been updated from the original model data to account for additional details on the unit water use estimates obtained from the agency. This information reflects the reduction in per capita water use in the urban areas as a result of the conservation measures taken during the last decade. To develop the M&I water use input data, population and urban unit water use data are used. Tables 2-7 and 2-8 show the population and per capita water use data respectively, for each urban area in the Salinas Valley.

The urban water use for each municipality was developed based on Tables 2-7 and 2-8. The following specific assumptions were made in the data development:

1. For all cities except Spreckels and the unincorporated areas, the 1970 to 1982 values were based on per capita water use data reported in the Salinas Valley Urban Water Use (1984) report. To interpolate the water use for the 1983 to 1994, the 1995 values were used from the MCWRA ground water extraction data.

Table 2-7
Estimated Population for Major Cities in the Salinas Valley

City	Population		
	1970	1980	1990
Salinas	58,896	80,479	108,777
Castroville	3,235	4,396	5,272
Greenfield	2,608	4,181	7,464
Gonzales	2,575	2,891	4,660
King City	3,717	5,495	7,634
Marina	8,343	13,887	16,984
Soledad	7,154	8,860	13,369
Fort Ord	25,000	22,420	9,452
San Ardo	460	460	533
Sprecklеs	670	670	1,110
Chualar	580	580	700
San Lucas	202	202	439

Source: U.S. Census Bureau, 1970, 1980, and 1990.

Table 2-8
Estimated Per Capita Water Use by City (gallons per capita daily, gpcd)

City	Per Capita Water Use		
	1970	1980	1990
Salinas	140	140	120
Castroville	175	175	110
Greenfield	133	133	132
Gonzales	154	154	134
King City	165	165	134
Marina	120	120	111
Soledad	99	99	134
Fort Ord	155	155	134
San Ardo	215	215	134
Spreckles	201	201	134
Chualar	150	150	134
San Lucas	148	148	134

Sources:
1970 and 1980 values based on Salinas Valley Urban Water Use (MCWRA, 1984)
1990 values based on urban water use data provided by MCWRA.

2. For Spreckles, the 1990 to 1994 values were assumed to be the reported per capita water use in 1995 of 134 gallons per day. The 1980 to 1989 values were estimated be 5% greater than the 1995 value and 1970 to 1979 values were estimated to be 10% greater than the 1995 value.

The urban water use by each city were grouped together to develop urban water use by each model subarea. In developing the urban water use by subarea, the following assumptions were made.

1. **Pressure Area:** Urban water use is equal to water use from the following cities: all of Castroville, Marina, Chualar, Spreckels, 70% of the unincorporated area, and 14% of Gonzales. Water use for Salinas was estimated as the following: 90% from 1970 through 1979, 74% from 1980 through 1989, and 58% from 1991 through 1994.

2. **East Side Area:** Urban water use is equal to water use from the following cities: 86% of Gonzales, and 25% of the unincorporated area. Water use in Salinas was

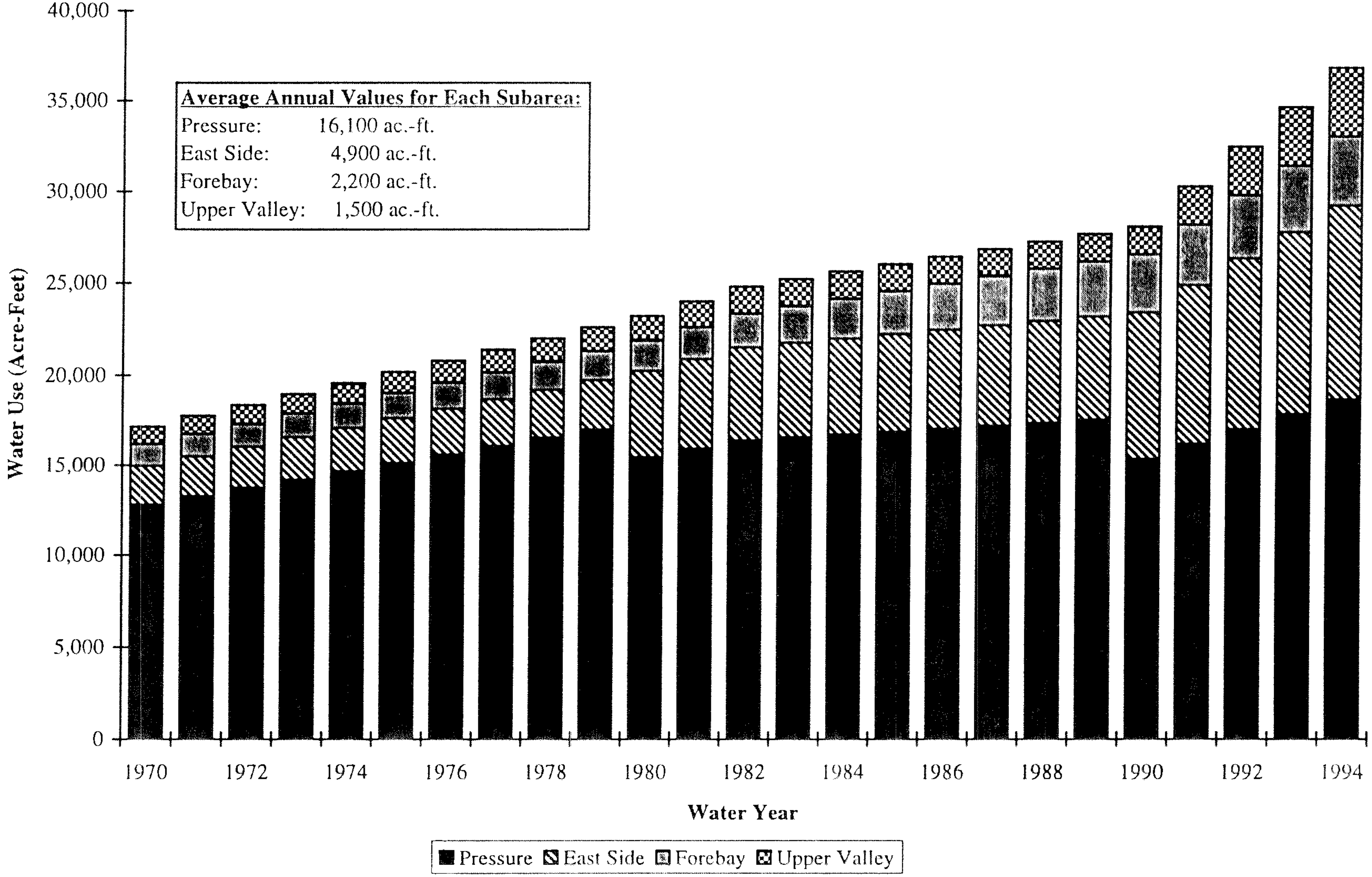
estimated as the following: 10% from 1970 though 1979, 26% from 1980 through 1989, and 42% from 1991 through 1994.

3. **Forebay Area:** Urban water use is equal to water use from the following cities: all of Soledad, Greenfield, and 1% of the Unincorporated area.
4. **Upper Valley:** Urban water use is equal to water use from the following cities: all of King City, San Lucas, San Ardo, and 4% of the unincorporated area.

The average annual urban water use for the water years 1970 to 1994 is estimated to be 24,700 AF/yr for the four primary subareas, and 3,200 AF/yr in the Fort Ord subarea. The annual variation of the urban water use in each subarea is shown in Figure 2-10.

FIGURE 2-10

ANNUAL URBAN WATER USE



2.6 Ground Water Pumping

Ground water pumping in the model area is computed as the sum of agricultural and urban water use. The average annual ground water pumping in the four primary subareas for the calibration period (Oct. 1969 to Sept. 1994) is 519,400 AF/yr. Figure 2-12 shows the annual ground water extraction estimated by the model for each subarea.

The pumping input data is divided by subarea, and is distributed geographically to each model element based on the percentage of developed area (agricultural and urban acreage as a percentage of total element area). This distribution was combined with the latest information obtained from the MCWRA on the approximate location of the production wells in Zone 2/2A (MCWRA Nov. 1996), to develop the distribution of pumping within each model subarea.

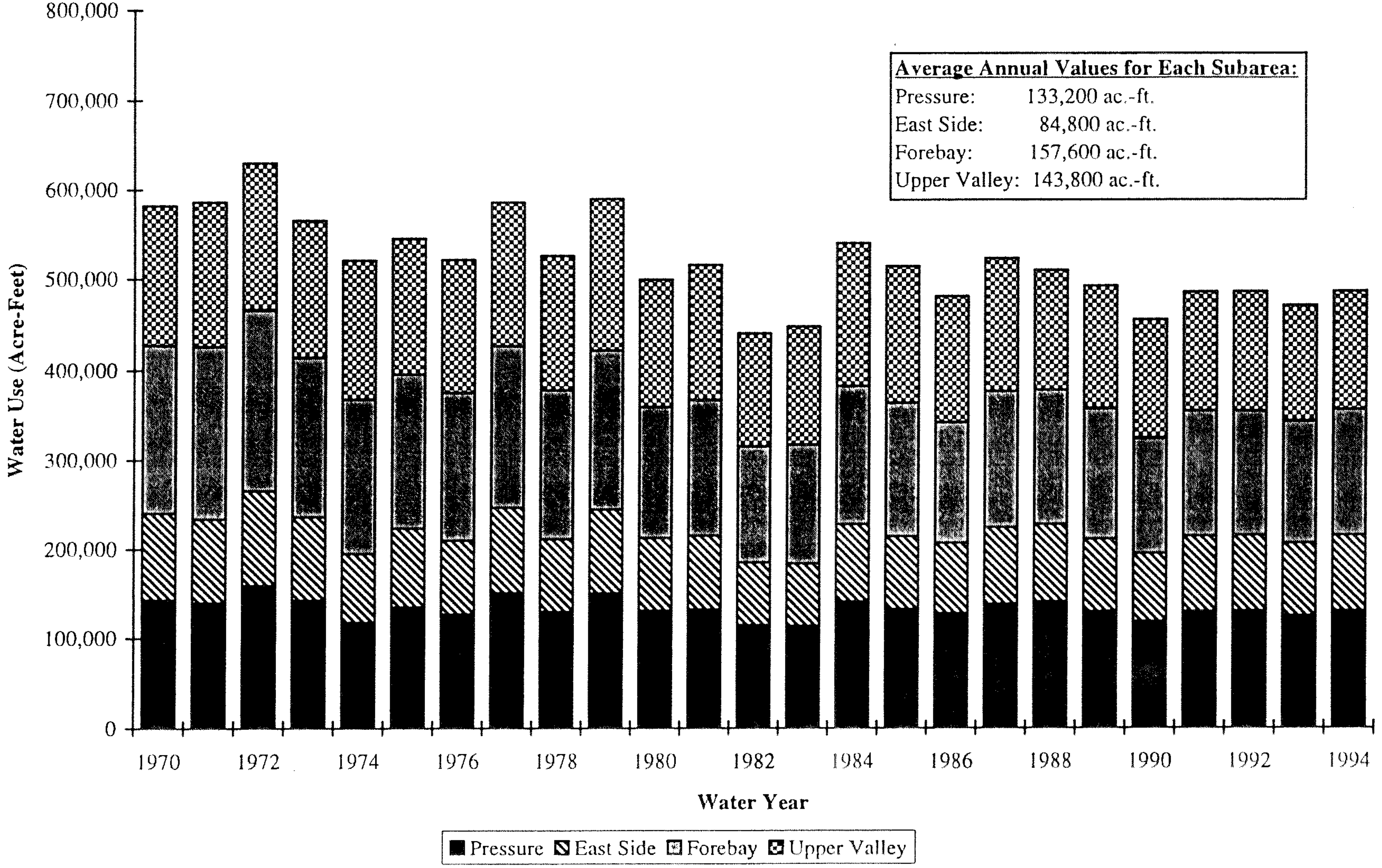
In order to determine the pumping distribution between the aquifer layers within the Pressure and East Side areas, a field study was conducted by the MCWRA in 1986. The study estimated the vertical distribution of pumping between the aquifer layers based on a representative number of wells in six agricultural zones and one municipal zone. Boyle (1986) reports the results of this study. The vertical distribution of pumping in the SVIGSM is primarily based on this field survey. In addition, it appears that due to the intrusion of seawater in the coastal areas, the pumping from the 180-foot aquifer was shifted to the 400-foot aquifer between 1980-85. Later on, after 1985, some limited pumping in the coastal areas shifted from the 400-foot to the deep aquifer. This shift in pumping over time has been incorporated in the SVIGSM to properly calibrate pumping from the appropriate aquifers. Table 2-9 shows the range of distribution of pumping within different aquifer layers.

Table 2-9
Range of Vertical Distribution of Pumping

Aquifer	180 Aquifer	400 Aquifer	Deep Aquifer
Pressure Area			
1970-80	15% - 35%	60% - 80%	5%
1980 to 1985	0 - 35%	60% - 94%	5% - 6%
1985 to 1994	0 - 35%	0 - 60%	5% - 100%
East Side Area	10% - 60%	35% - 85%	5%

FIGURE 2-11

ANNUAL GROUNDWATER PUMPING



Average Annual Values for Each Subarea:

Pressure:	133,200 ac.-ft.
East Side:	84,800 ac.-ft.
Forebay:	157,600 ac.-ft.
Upper Valley:	143,800 ac.-ft.

2.7 Aquifer Parameters

The hydraulic conductivity values used in calibration of the SVIGSM in 1994 were based on previous reported values, as well as few aquifer tests performed by MCWRA in the late 1980s. As part of the Ground Water Extraction Management System (GEMS) database maintained by the MCWRA, a series of pump efficiency test results were collected on a number of wells. Generally in a pump efficiency test, the specific capacity information is also provided. Specific capacity of a well is defined as the yield of the well per unit of drawdown, generally expressed as gallons of water per minute per foot of drawdown (gpm/ft), after a period of time (generally 24 hours) has elapsed. In the absence of reliable aquifer test information, specific capacity can be used to develop a reasonable order of magnitude estimate for the aquifer transmissivities. Driscoll (1986) presents the following relationship between specific capacity and aquifer transmissivity:

$$T = 2000\ Q/s, \text{ for a confined aquifer [gpd/ft]}$$

$$T = 1500\ Q/s, \text{ for a unconfined aquifer [gpd/ft]}$$

These relationships are developed based on the modified non-equilibrium (Jacob) equation. The equation assumes an average well diameter, average duration of pumping, and typical values for the applicable storage coefficient. In addition Hurr (1966) presents a correlation graph relating transmissivity to specific capacity, time since pumping started, and apparent specific yield. Both Driscoll (1986) and Hurr (1966) note that the specific capacity to transmissivity relationships are to be used with the understanding that they give the most conservative values with respect to detailed aquifer tests. However, they are useful tools to obtain quick estimates of the transmissivity.

Specific capacity and perforation data from 102 wells were available from the MCWRA. The wells are scattered in the Pressure, East Side, Forebay, and Upper Valley Areas. The majority of the wells in the Pressure area were perforated in the 180 or 400 foot aquifers. The wells in the East Side area were generally perforated in the East Side Deep aquifer.

For each well, the aquifer thickness and depth for the nearest model grid node was taken from the stratigraphic database in the SVIGSM. Since most of the wells partially penetrate the aquifers, correction was made to the specific capacity data for partial penetration (Driscoll, 1986). Simulated ground water levels for March 1994 were used to estimate the saturated thickness for unconfined aquifers. Since the degree of penetration of a well is based on the regional stratigraphic data from the model and not local scale data, a potentially wide range of estimates for the transmissivity exists. Similarly, the saturated thickness of the unconfined aquifers are based on preliminary model simulations, thus a wide range of hydraulic conductivity values also exist.

Table 2-10 presents the range of hydraulic conductivities for each aquifer layer in each primary subarea. This data is primarily developed based on the well specific capacity information, supplemented by prior studies. These values are used in the model calibration as the starting point. Appropriate adjustments are made to these values during the calibration process to fine tune the model calibration.

Table 2-10

Initial Hydraulic Conductivity Estimates from Pumping Efficiency Data

	Range of Hydraulic Conductivities (ft/day)	
Subarea	Layer 1	Layer 2
Pressure	150 - 250	20 - 100
East Side	50 - 250	10 - 100
Forebay	50 - 250	10 - 190
Upper Valley	120 - 230	N/A

Section 3
Model Calibration

The update and revisions made to the SVIGSM input data during this study has changed the land and water use conditions in the model. In addition, the recent information obtained and developed for the aquifer parameters, especially in the East Side, warrant a recalibration of the model. This section describes the model calibration procedure and results.

3.1 Calibration Procedure

The primary step in the calibration of SVIGSM is to attain reasonable water balance in the hydrologic system. This involves the analysis of water budget tables generated by the model for land and water use, soil system, ground water system, and stream system. Subsequently, the model calibration involves a systematic refinement and adjustment to a number of model parameters to achieve reasonable agreement between the results of model simulation and observed records for specific model features.

The simulation output that are compared against recorded values are:

- Water levels at specific wells, and
- Salinas River streamflow at specific gaging stations.
- Regional seawater intrusion contours, as well as chloride trends over time.

The model components that cannot be verified directly with observed records, such as runoff and deep percolation, are checked for reasonableness with respect to other components, the overall water balance, and previous modeling results.

The hydrologic time period selected for calibration of the model is water years 1970-1994 (October 1969 - September 1994). This period was selected because:

1. This period includes various hydrologic conditions such as wet and dry cycles.

2. Complete ground water level measurement records exist for most of the wells used in model calibration.

3. Nacimiento and San Antonio reservoirs are on-line and operational during this period, resulting in a more robust calibration from an operational standpoint. (Although model reservoir operations are not calibrated simultaneously with surface and ground water flow.)

Several points can be made regarding calibration of SVIGSM:

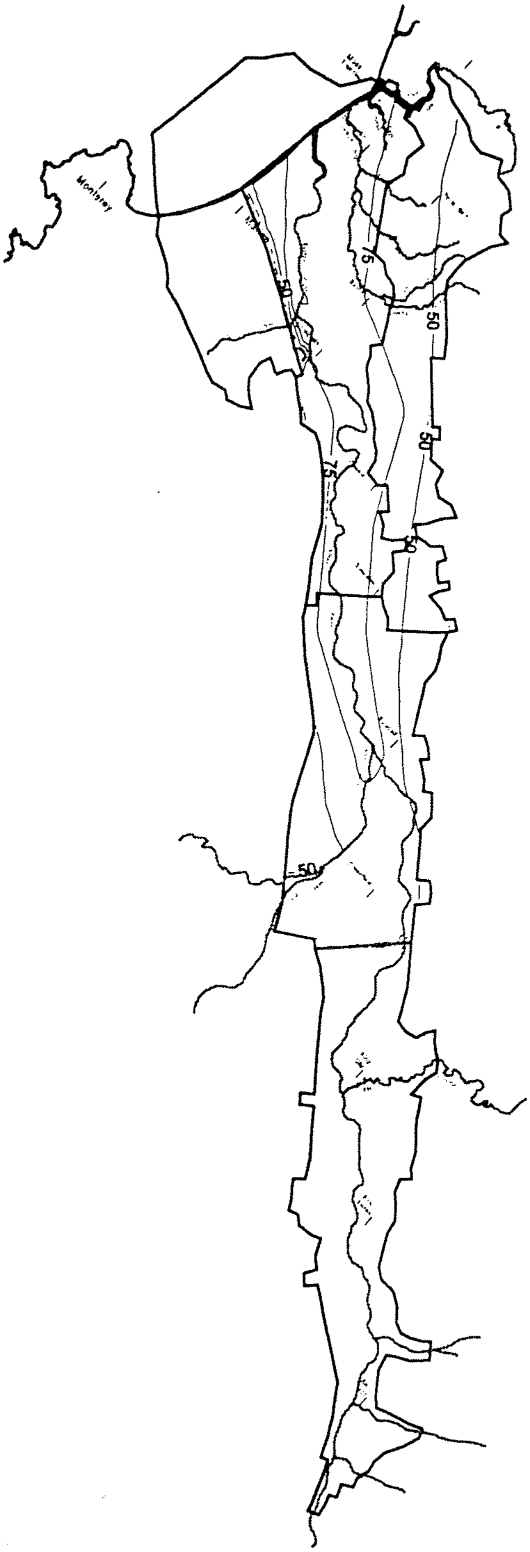
1. The subsurface and aquifer hydrogeologic parameters are adjusted based on a regional variation of the properties of porous material. To do this, a regional "parametric grid" is numerically overlayed on the model grid. The aquifer parameter values are specified by the nodes of the parametric grid. These values are then interpolated to the finite element grid nodes.

2. As explained in Section 2.7 of this report, a range of hydraulic conductivity values were derived based on the information collected from pump efficiency tests. During the calibration process, it was determined that initial hydraulic conductivity values in the East Side are too low, causing highly unreasonable fluctuations in the simulated ground water levels. Based on a series of calibration runs, the range of hydraulic conductivities for the East Side Shallow and Deep aquifers were adjusted to obtain reasonable simulated ground water levels in all the subareas. In addition, the initial estimates of the hydraulic conductivity in the Upper Valley were found to be unrealistically too high. The calibrated parameters turned out to be somewhat lower than the initial estimates. The initial hydraulic conductivities in other areas seemed to be reasonable, and no adjustments were required. Table 3-1 shows the range of final aquifer parameters used in the calibrated model. Figures 3-1(a-b) show the contour of hydraulic conductivity for model layers 1 and 2.

3. The range of streambed parameters are presented by reach in Table 3-2. The combination of the two streambed parameters, as described in the model documentation, governs the rate of seepage through the bed material. In areas with a high degree of stream-aquifer interaction, the streambed thickness tends to impact the rate of ground water fluctuations in the nearby wells. In this case a higher streambed thickness value is assigned.

FIGURE 3-1b

SALINAS VALLEY IGSM AQUIFER PARAMETERS HYDRAULIC CONDUCTIVITY, LAYER 2 (FT/DAY)



3.2 Water Balance

The primary criteria for calibration of the model is reasonableness of the water balance computed by the model. The SVIGSM provides detailed information for each component of the water balance by model subarea on a monthly and/or annual basis. As mentioned earlier, the main components of the water balance include the land and water use, ground water, stream, and soil systems. The major water budget tables for these four systems are provided in Appendix B.

In order to evaluate the model calibration results, as well as better understand the inter-relationship between the ground water system in each subarea in the Salinas Valley, the model simulated water balance results are presented in schematic form in Figures 3-2 and 3-3. These figures show the average annual water balance in the ground water system for each subarea and valley wide, for the water years 1970 to 1994. The components shown in the ground water balance include the boundary flows, deep percolation, stream recharge, ground water pumping, subsurface flows, and seawater intrusion. Note that the change in storage shown in these figures corresponds to the fresh ground water storage. Although average annual values are easily understood for most cases, the annual fluctuations of each water balance component reveal information on the water balance conditions during different hydrologic conditions. Appendix C provides figures showing the annual values of each water balance component.

Table 3-1

Salinas Valley IGSM Parameter Ranges

Parameter	Range	Units
Soil Parameters		
Infiltration Capacity	0.005 - 0.10	feet/day
Total Porosity Minus Wilting Point	0.17 - 0.24	
Field Capacity Minus Wilting Point	0.06 - 0.16	
Curve Number	60 - 85	
Unsaturated Zone Parameters		
Hydraulic Conductivity	0.2 - 1.0	feet/day
Effective Porosity	0.04 - 0.08	
Streambed Parameters		
Hydraulic Conductivity	0.1 - 7.5	feet/day
Streambed Material Thickness	3-5	feet
Aquifer Parameters *		
Hydraulic Conductivity		
Layer 1	25 - 250	feet/day

Layer 2	5 - 100	feet/day
Layer 3	20 - 25	feet/day
Specific Yield		
Layer 1	0.08 - 0.16	
Layer 2	0.06	
Layer 3	0.06	
Storage Coefficient		
Layer 1	0.004	
Layer 2	0.00001 - 0.0003	
Layer 3	0.00001 - 0.0003	
Vertical Hydraulic Conductivity		
Layer 1	n/a	feet/day
Layer 2	0.001 - 0.025	feet/day
Layer 3	0.0036	feet/day

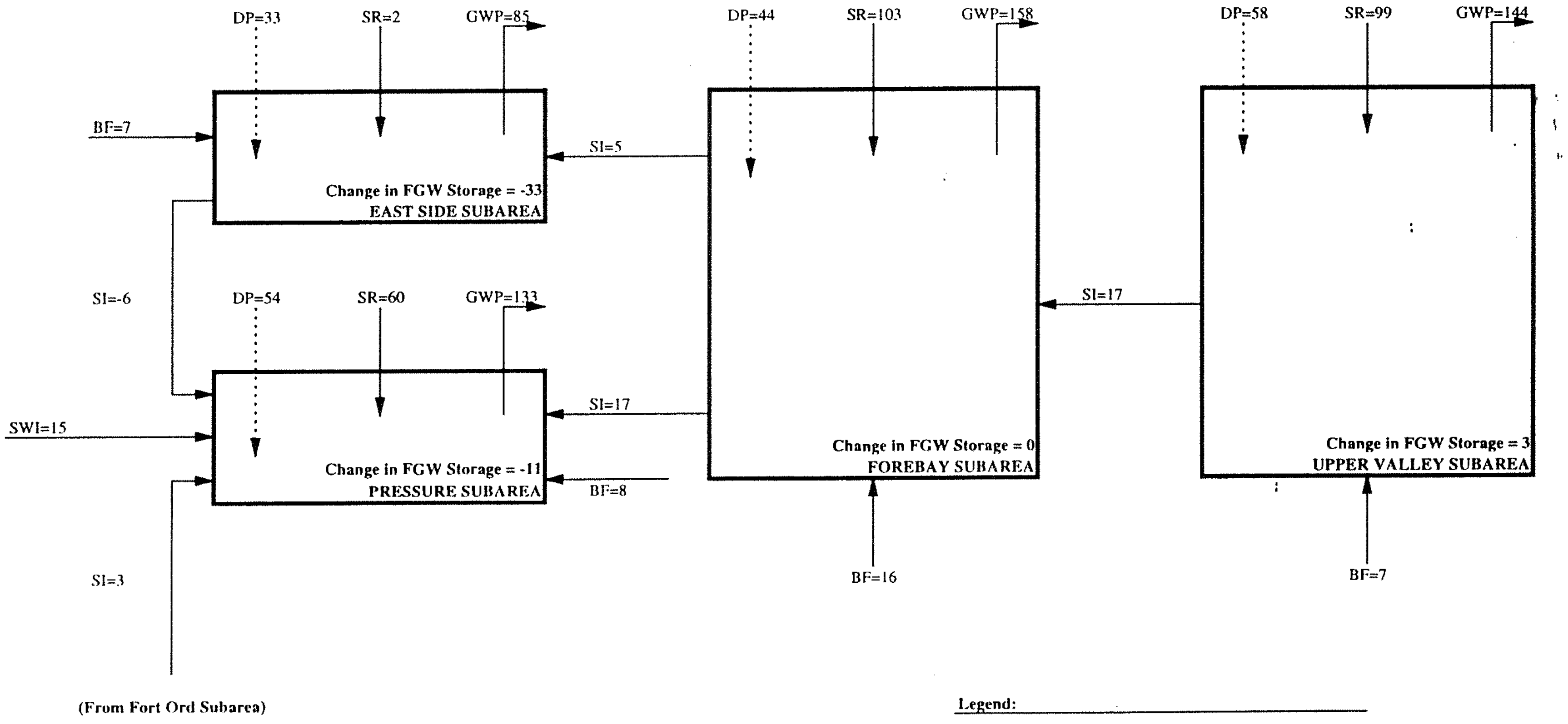
* These ranges are for the values used in the parametric grid used to determine parameter distribution over the entire model area.

Table 3-2
SVIGSM Range of Streambed Parameters

River Reach	Streambed Hydraulic Conductivity (ft/day)	Streambed Thickness (ft)
Salinas River between Bradley and Soledad	0.4-7.5	3.0
Rancho Rico Creek	3.0	3.0
Pine Valley Creek	3.0	3.0
San Lorenzo Creek	3.0	3.0
Arroyo Seco River	3.0-4.0	3.0-5.0
Salinas River between Soledad and Gonzales	2.0	3.0
Salinas River between Gonzales and Spreckels	0.2-1.5	5.0
El Toro Creek	3.0	3.0
Gabilan Creek	0.2-3.0	3.0

FIGURE 3-2

AVERAGE ANNUAL GROUNDWATER BALANCE BY SUBAREA
WATER YEARS 1970-1994
(VALUES IN 1000 ACRE-FEET)



Legend:

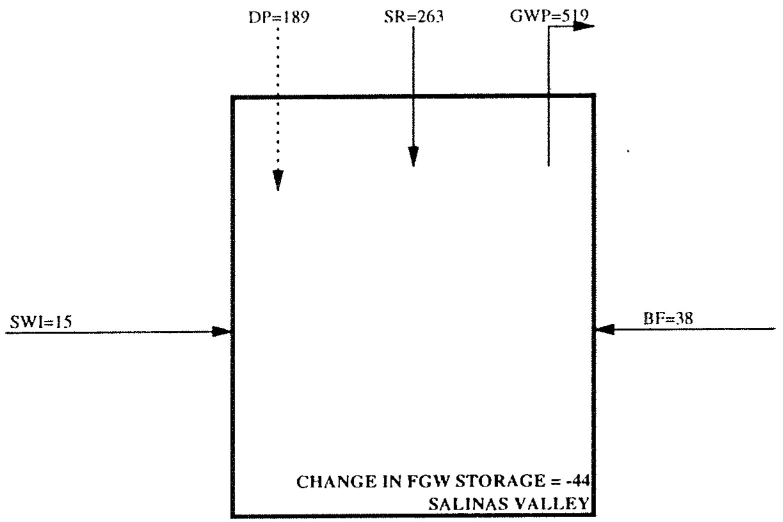
FGW	Fresh Ground Water Storage
BF	Boundary Flow
DP	Deep Percolation from Rain and Aplied Water
SR	Stream Recharge
GWP	Ground Water Pumping
SI	Subsurface Flow
SWI	Seawater Intrusion

RUN_STAT.XLS

FIGURE 3-3

AVERAGE ANNUAL GROUND WATER BALANCE FOR THE SALINAS VALLEY GROUND WATER BASIN
WATER YEARS 1970-1994

(VALUES IN 1000 ACRE-FEET)



Legend:

FGW	Fresh Ground Water Storage
BF	Boundary Flow
DP	Deep Percolation from Rain and Aplied Water
SR	Stream Recharge
GWP	Ground Water Pumping
SI	Subsurface Flow
SWI	Seawater Intrusion

RUN_STAT.XLS

3.3 Ground Water Levels

In order to calibrate the model simulations to observed ground water levels, 64 calibration wells which were selected for the original model calibration are used. These wells are selected because they represent good spatial coverage in the model area and the length of records and quality of measurements are also good. The model parameters are adjusted appropriately to obtain reasonable agreement between the recorded water levels and simulated ones. The goal is to achieve simulation results that follow the long-term trends of the water levels, as well as seasonal water level fluctuations observed at the well.

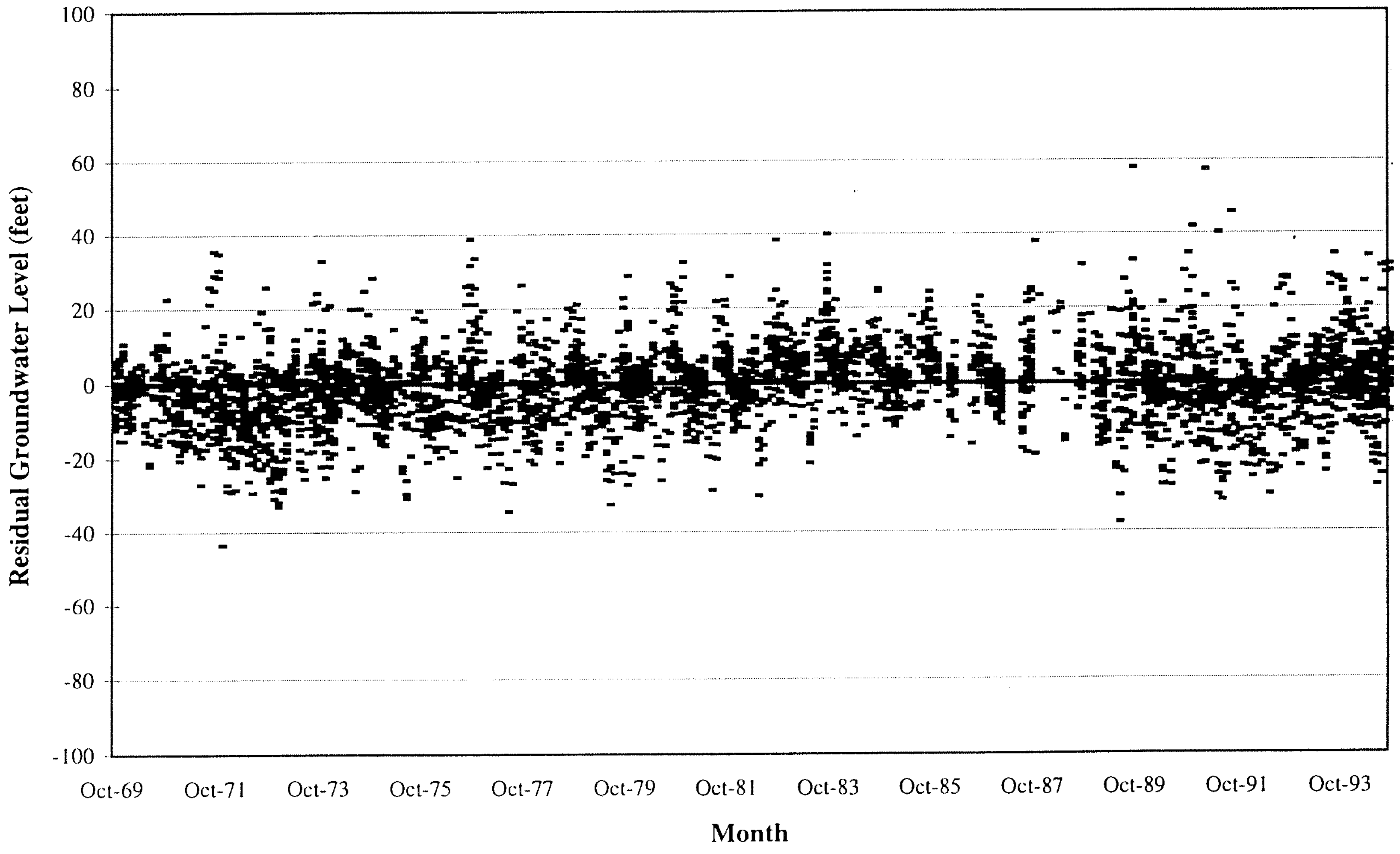
The monthly observed records were obtained from the MCWRA. The comparison of individual hydrographs for each well are shown in Appendix D. To evaluate the goodness of fit of the model simulations to the observed records, time series error plots (deviations of model simulations from the observed records) are shown in Figures 3-4(a-d) for each subarea. In addition, to gain additional statistics on the model simulation results, Figures 3-5(a-d) show the distribution of the model simulation deviations from observed values for each layer for every subarea.

Based on these figures, the model performance in each subarea is summarized as follows:

Pressure Area: The model simulates the ground water levels with 5-10 feet of the observed values most of the time. About 38% of model simulations lie within ± 5 feet of the observed, and 70% lie within ± 10. The model tends to distribute the errors in a approximately normal around the observed values. This trend is consistent in the 180-Ft and the 400-Ft aquifers. In the Deep aquifer, the model tends to have a more uniform distribution of the errors, which indicates that simulated water levels are somewhat higher than the observed values. Since the Deep aquifer has been used only from about 1986 with limited number of wells in this aquifer, the number of measurements are small, and do not provide sufficient regional distribution for proper calibration of the model in this layer.

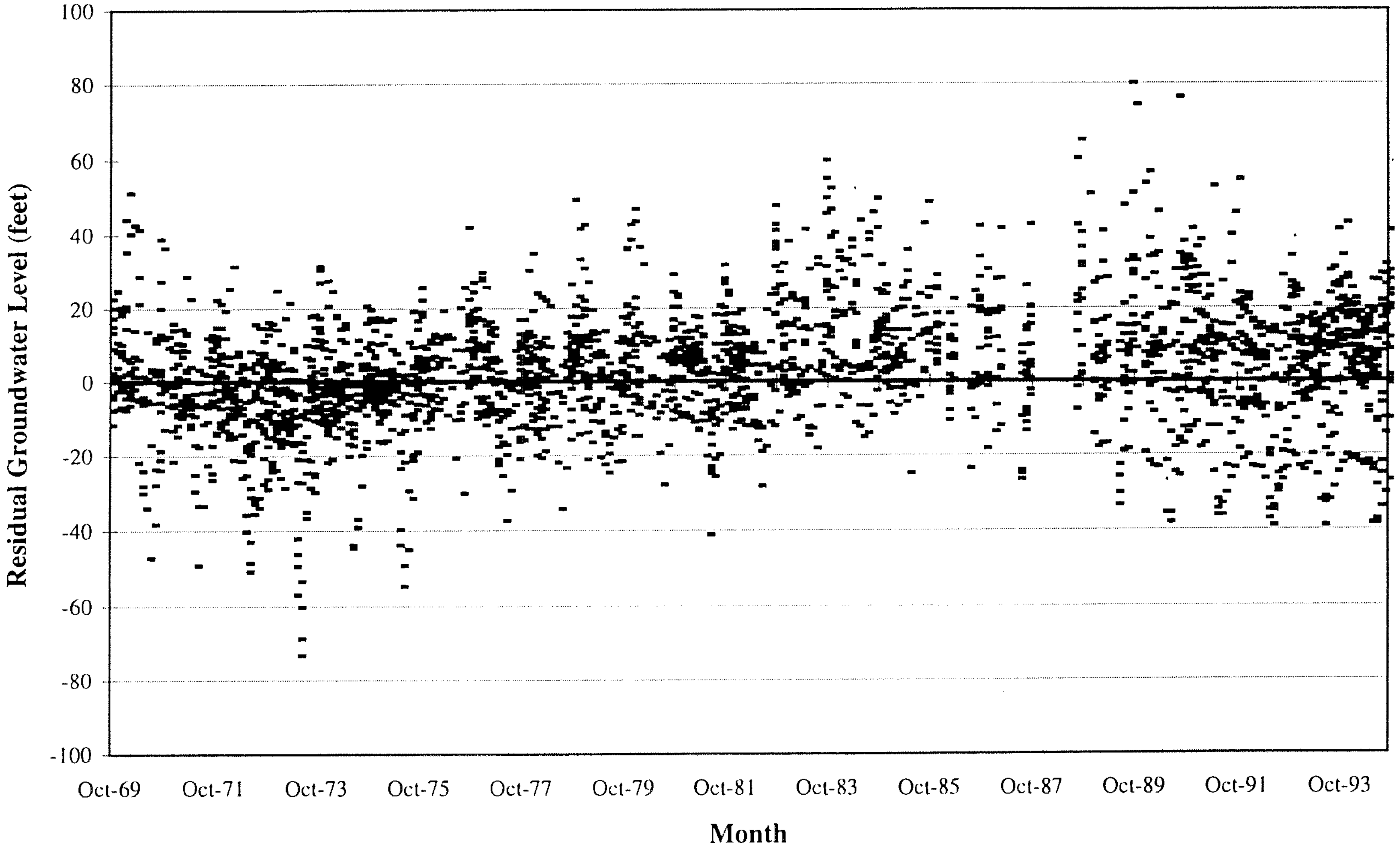
East Side: Most of the calibration wells in the East Side area are in the East Side Deep aquifer. The East Side area water levels generally demonstrate high degrees of fluctuation. The amplitude of these fluctuations often times are not consistent with each other, even for wells which are in the same vicinity (e.g. well 29 shows a 50-60 ft seasonal fluctuation, and well 30, in the same vicinity, shows a 30-40 ft seasonal fluctuation). Without detail data on well construction, and conditions of water level measurement, the model can not simulate the individual behaviors of each well. In addition, some other wells have apparent anomalies in the observed records, which are not quite obvious for modeling purposes (e.g., wells 15 and 16 have very low and sparse in time measurements after 1980s).

FIGURE 3-4a
RESIDUAL GROUNDWATER LEVELS (SIMULATED - HISTORICAL)
Pressure Subarea



CALPLOT.XLS

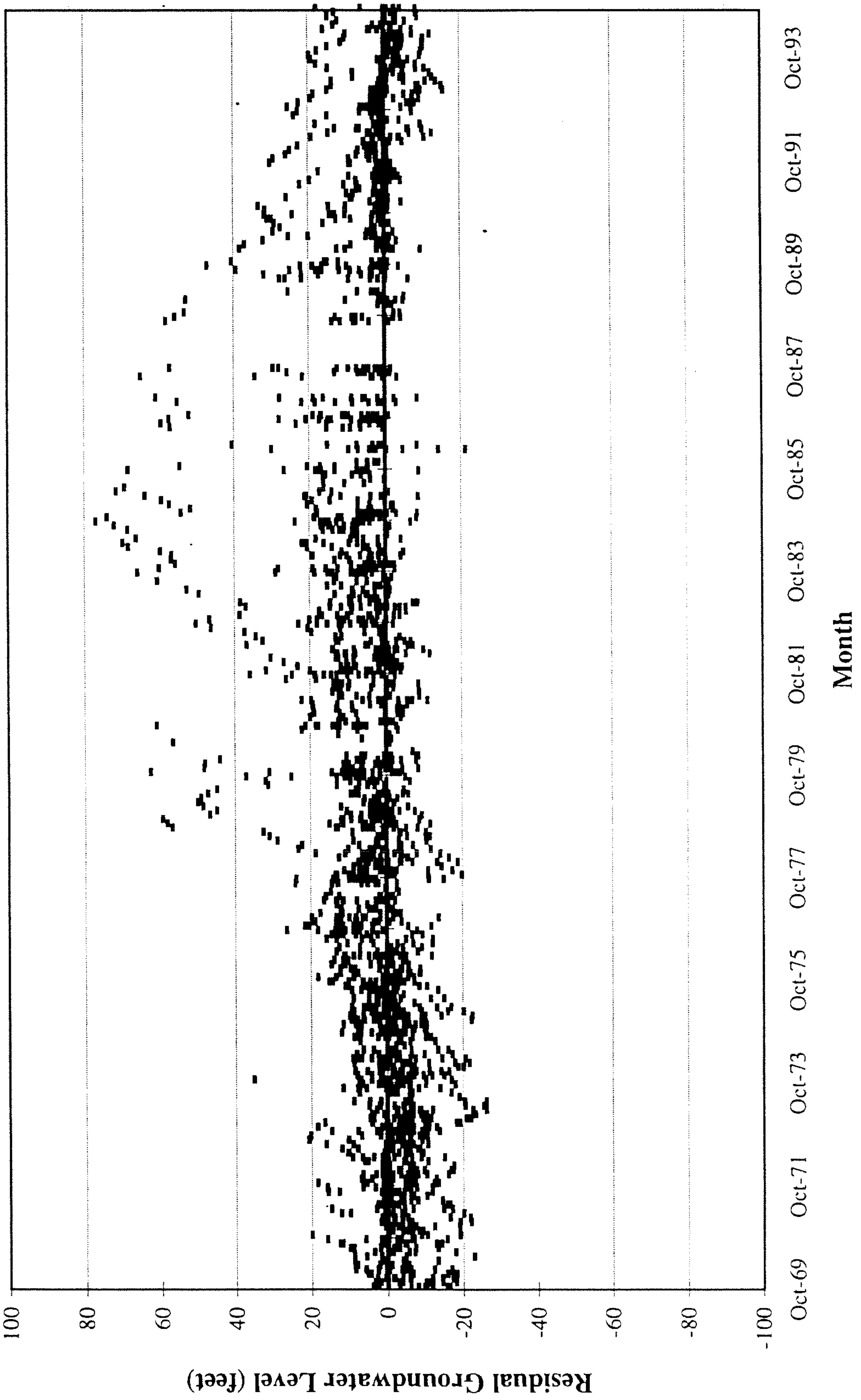
FIGURE 3-4b
RESIDUAL GROUNDWATER LEVELS (SIMULATED - HISTORICAL)
East Side Subarea



CALPLOT.XLS

CALPLOT.XLS

FIGURE 3-4c
RESIDUAL GROUNDWATER LEVELS (SIMULATED - HISTORICAL)
Forebay Subarea



CALPLOT.XLS

FIGURE 3-4d
RESIDUAL GROUNDWATER LEVELS (SIMULATED - HISTORICAL)
Upper Valley Subarea

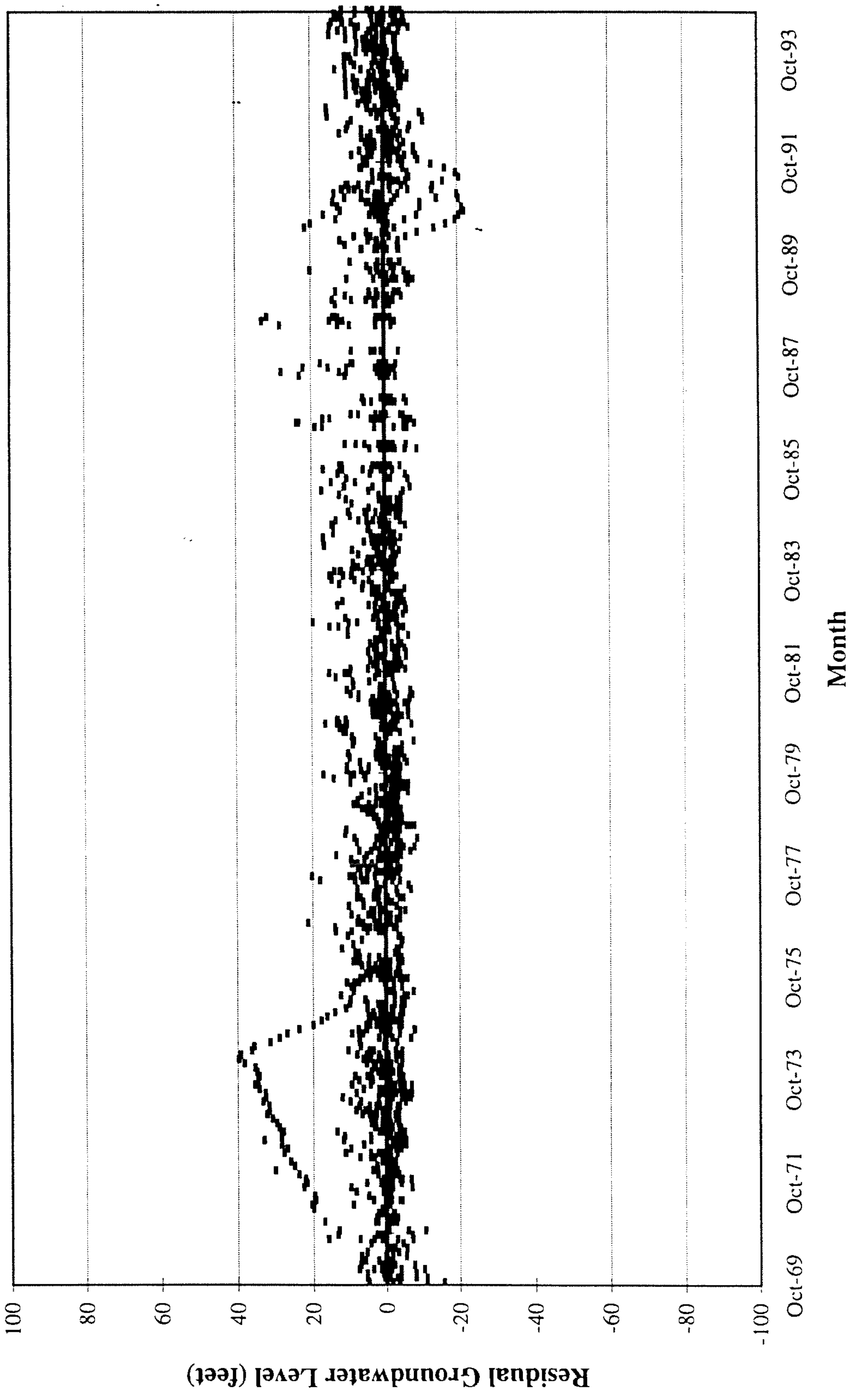
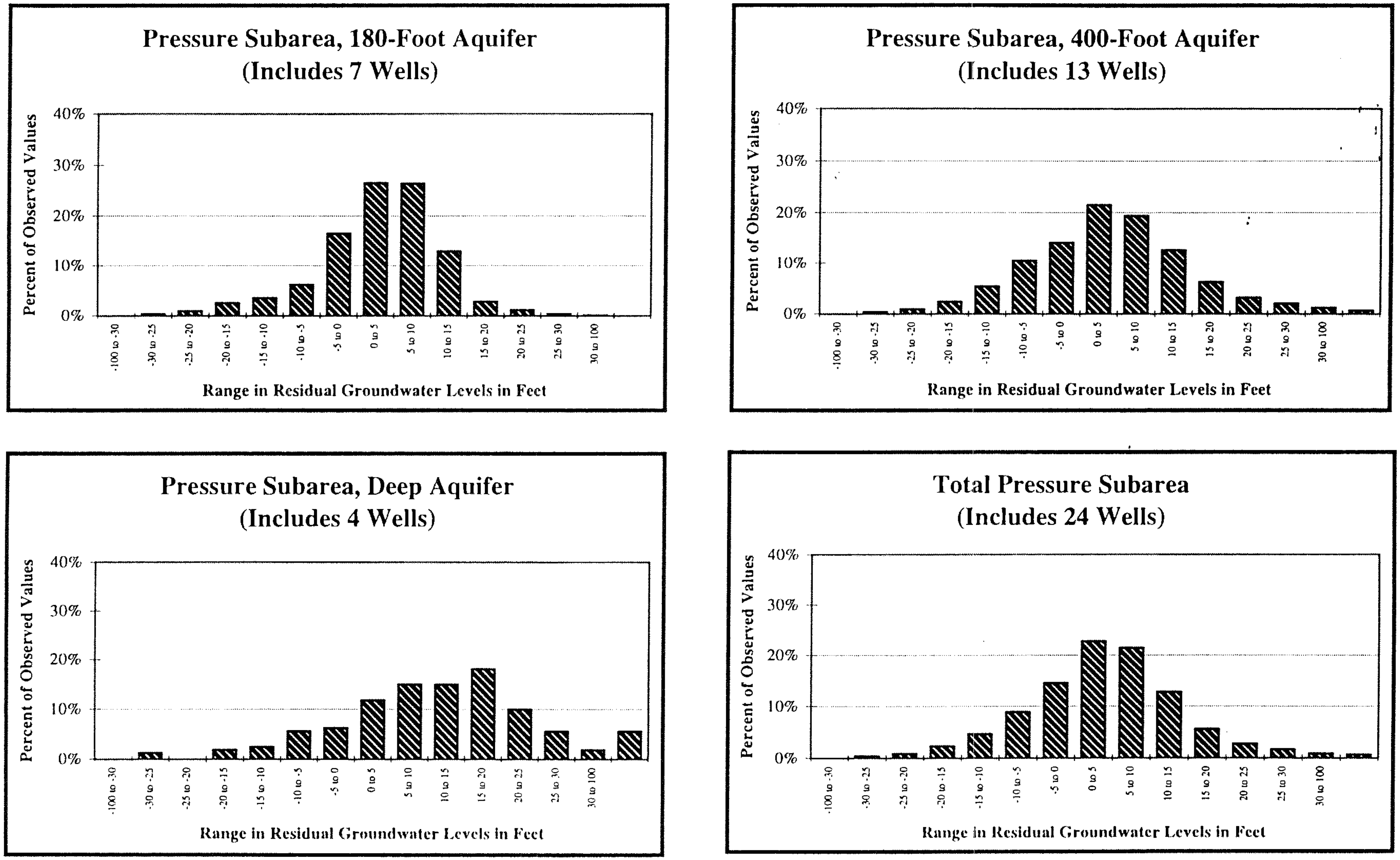


FIGURE 3-5a

DISTRIBUTION OF RESIDUAL GROUNDWATER LEVELS



Pressure Subarea, 180-Foot Aquifer (Includes 7 Wells)

Pressure Subarea, 400-Foot Aquifer (Includes 13 Wells)

Pressure Subarea, Deep Aquifer (Includes 4 Wells)

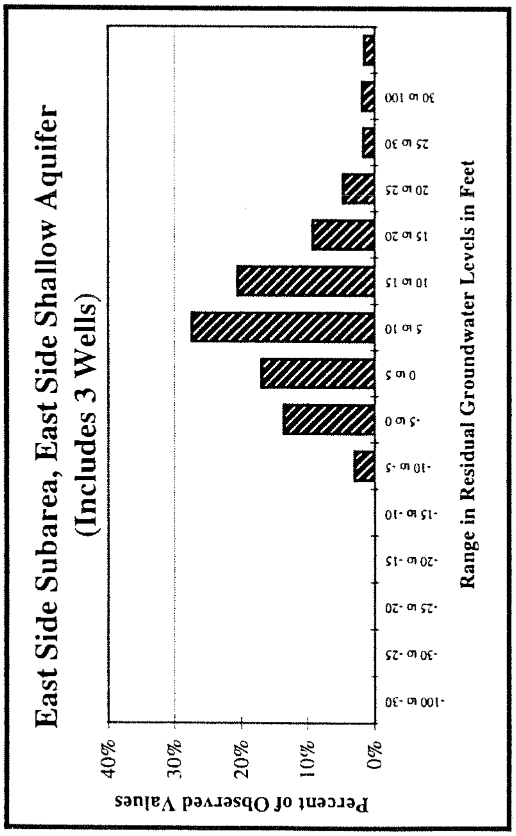
Total Pressure Subarea (Includes 24 Wells)

CALPLOT.XLS

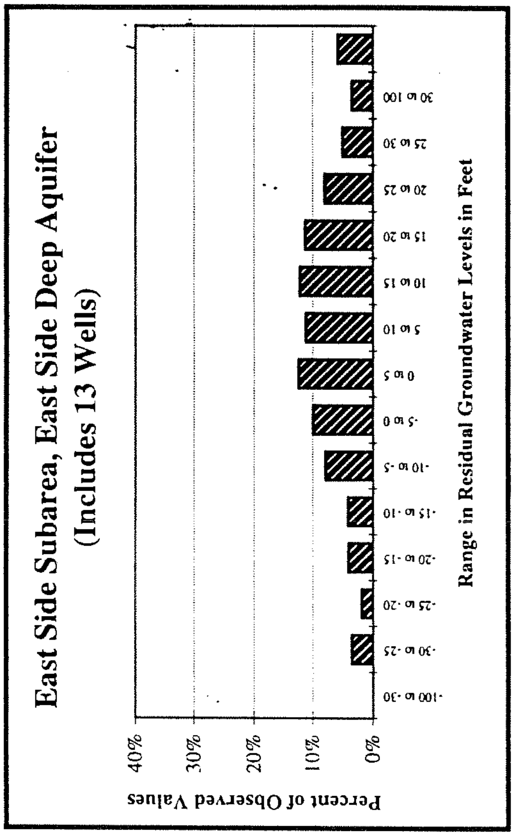
CALPLOT.XLS

FIGURE 3-5b

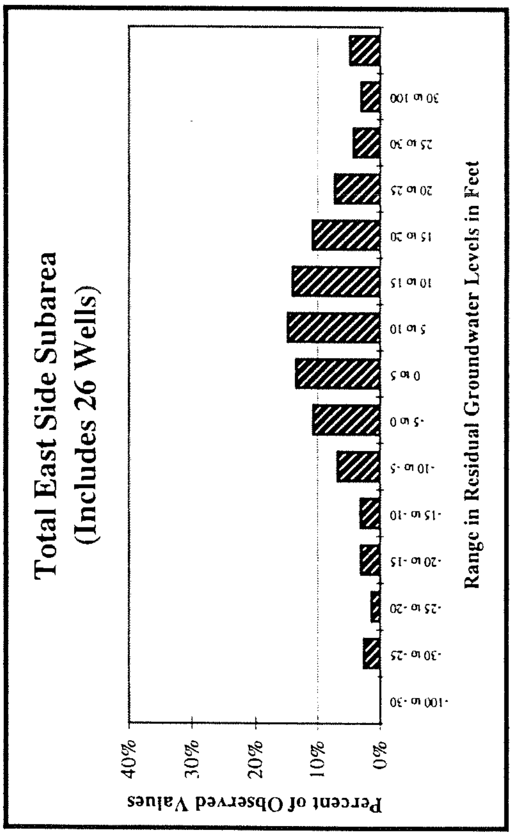
DISTRIBUTION OF RESIDUAL GROUNDWATER LEVELS



East Side Subarea, East Side Shallow Aquifer
(Includes 3 Wells)



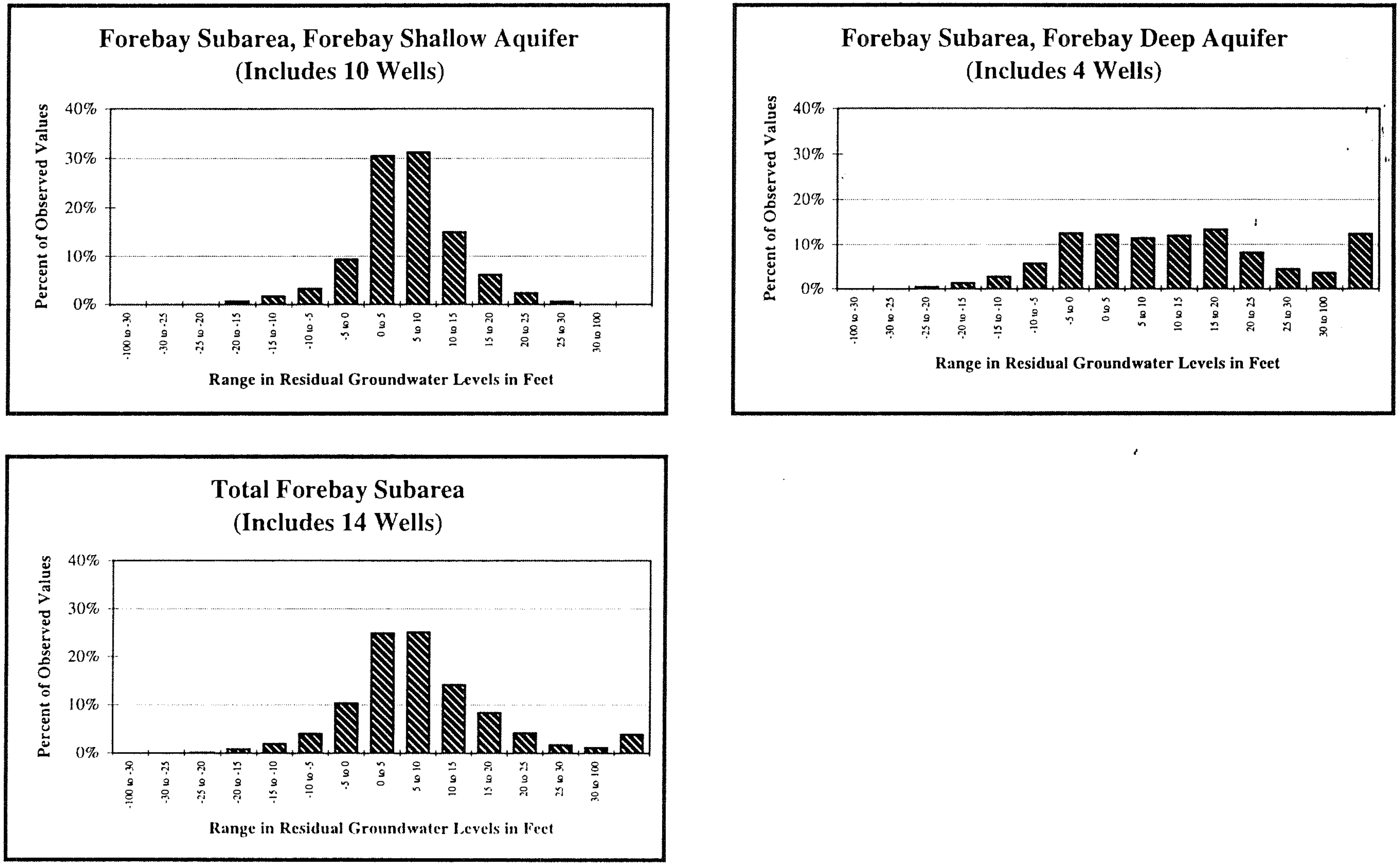
East Side Subarea, East Side Deep Aquifer
(Includes 13 Wells)



Total East Side Subarea
(Includes 26 Wells)

FIGURE 3-5c

DISTRIBUTION OF RESIDUAL GROUNDWATER LEVELS



Forebay Subarea, Forebay Shallow Aquifer (Includes 10 Wells)

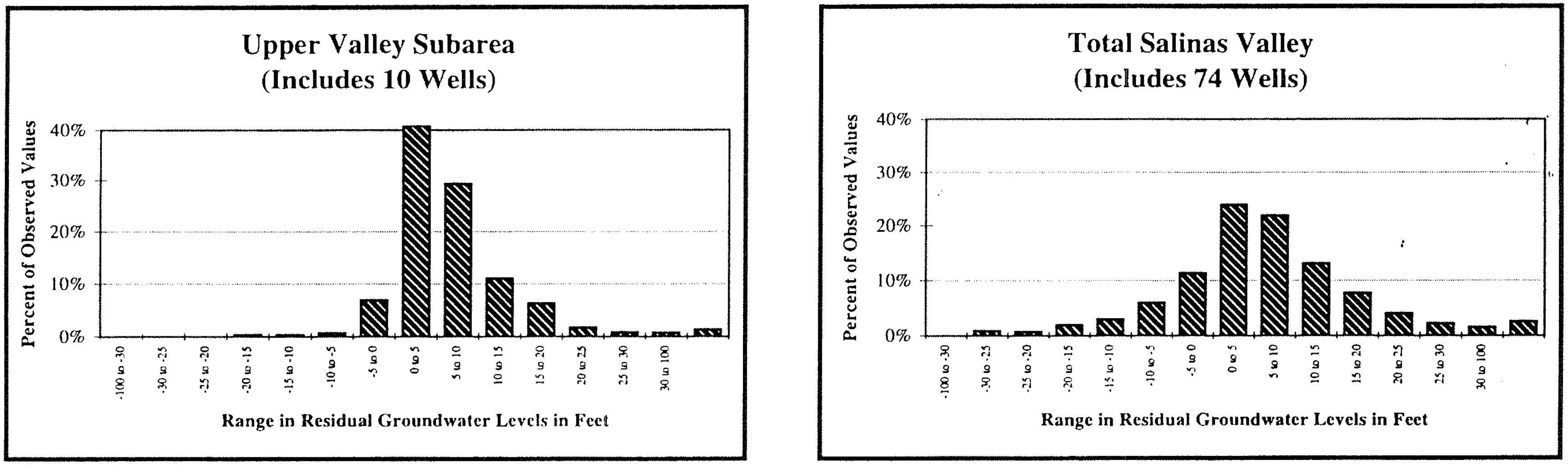
Forebay Subarea, Forebay Deep Aquifer (Includes 4 Wells)

Total Forebay Subarea (Includes 14 Wells)

CALPLOT.XLS

FIGURE 3-5d

DISTRIBUTION OF RESIDUAL GROUNDWATER LEVELS



CALPLOT.XLS

The model simulations present is then calibrated to achieve the most reasonable regional agreements in water level, as well as agreements on many of the calibration wells. The model simulated water levels are within ± 5 feet approximately 30% of the time, and 57% of the time within ± 10 feet of the observed values. The errors tend to be evenly distributed around the observed values.

Forebay: In the Forebay area, the model generally has good calibration in model layer one (Shallow Forebay aquifer), except in the areas of wells 51 and 52. The model simulations for this area tend to be higher than the observed records. In layer two, the model simulations have relatively good agreements with the observed records, except for the area near well 53. In this area, the water level fluctuations tend to have long-term cyclical trend, which is apparently an effect of the flows in the Arroyo Seco River. However, the model simulations further downstream in the vicinity of well number 49 appear to be in much better agreement with the observed records, even though, well 49 shows the same long-term cyclical behavior. It is of interest that there seems to be a lag time of about 9 months to a year between the cycles in well 53 and well 49.

In general, and from regional stand point, the model tends to normally distribute the errors between simulated and observed values. 55% of the time the simulated values lie within ± 5 feet and 80% of the time, they lie within ± 10 feet of observed values.

Upper Valley: The model simulations closely follow the observed values with a normally distributed error, a sign of healthy simulation. Two points in particular can be made regarding the model simulations in Upper Valley. First, the simulated water levels in well number 64 shows an apparent pulse during the early simulation periods. This well is situated in a narrow trough near the river. The cause of this is not quite known. Second, the model simulates the drop in ground water levels during the drought conditions of 1990 relatively closely. However, the observed records in well number 60, in particular, do not show any drop in the water levels during the 1990 drought. This may be because the well water level is under the influence of river flows. However, the well further upstream (well number 62) shows a drop in water level during the same period, which suggests that the river flows were very small during that period. The reason for this contradiction in the observed records is unclear. In general, the simulated water levels are within ± 5 feet of observed values 50% of the time, and within ± 10 feet 80% of the time.

In order to provide a spatial perspective of the simulated groundwater levels, Figures 3-6 through 3-8 show groundwater level contours for layers 1 and 2 for every subarea during Fall of 1970, and Fall and Spring of 1994.

FIGURE 3-6a

SALINAS VALLEY IGSM GROUNDWATER LEVELS FALL 1970, LAYER 1 (ft, msl)

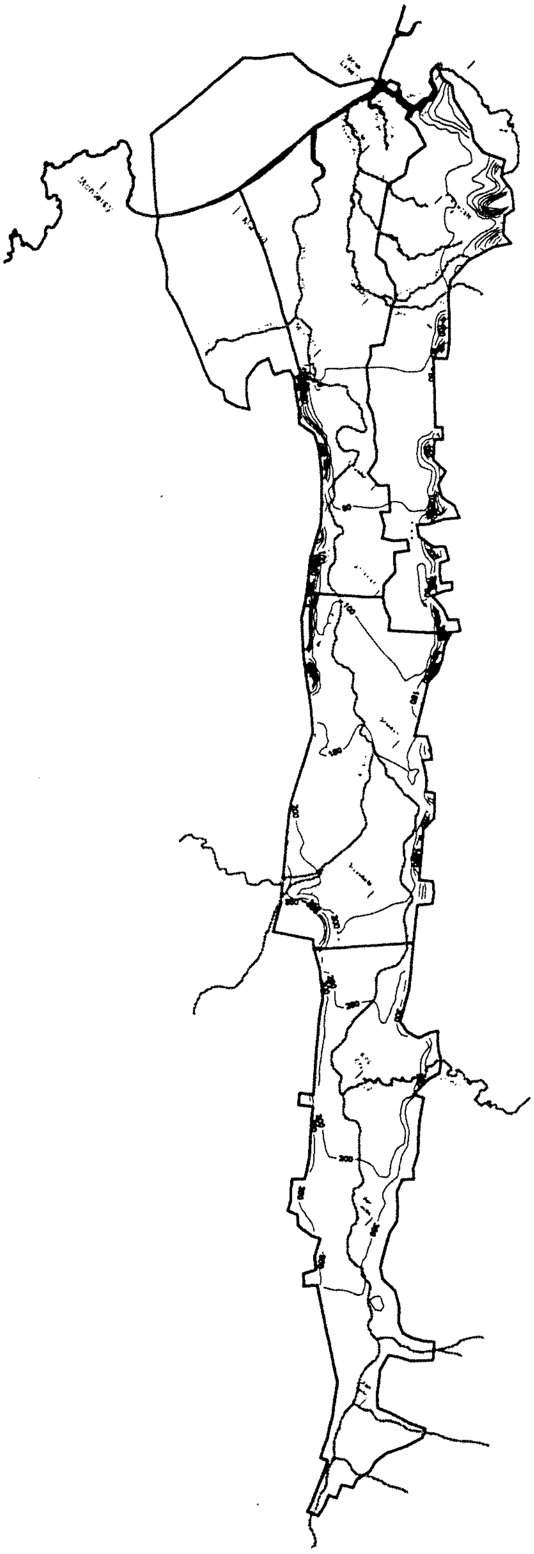


FIGURE 3-6b

SALINAS VALLEY IGSM GROUNDWATER LEVELS
FALL 1970, LAYER 2 (ft, msl)

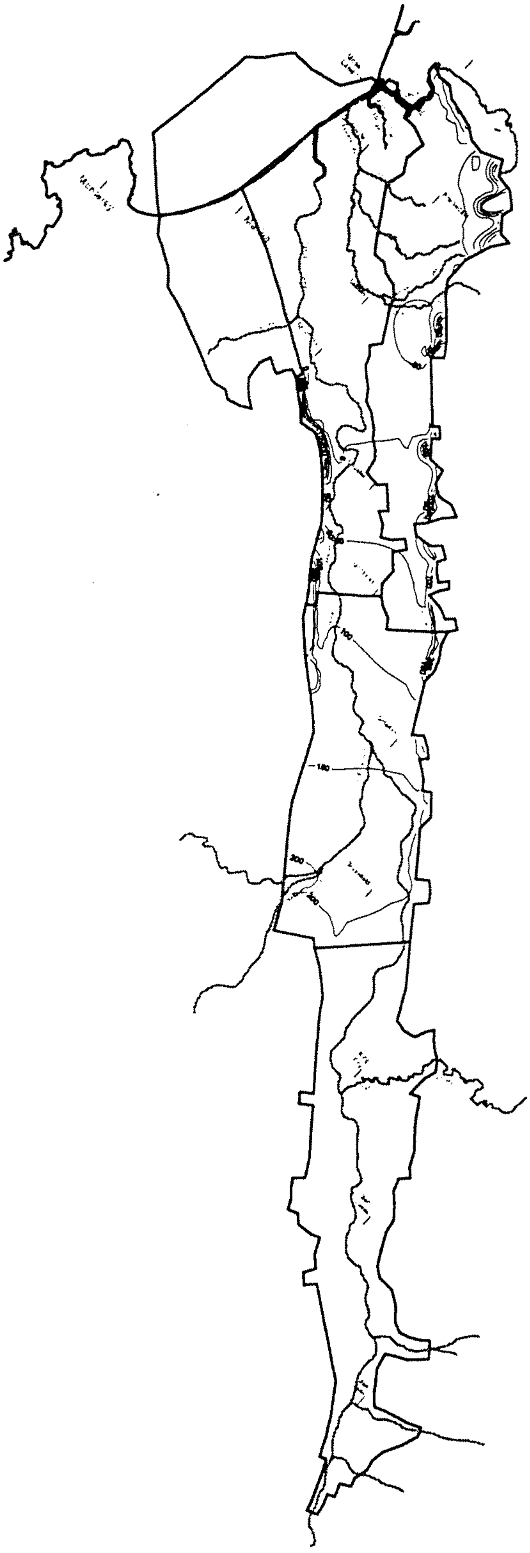


FIGURE 3-7a

SALINAS VALLEY IGSM GROUNDWATER LEVELS SPRING 1994, LAYER 1 (ft, msl)

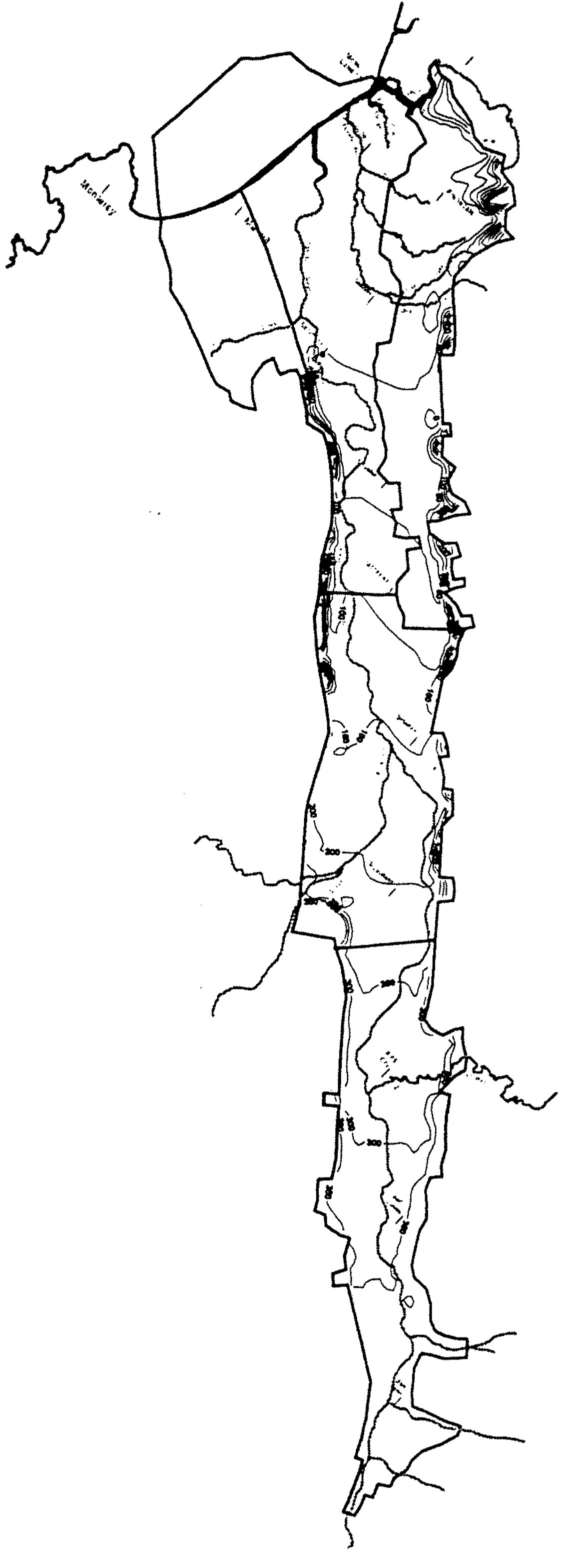
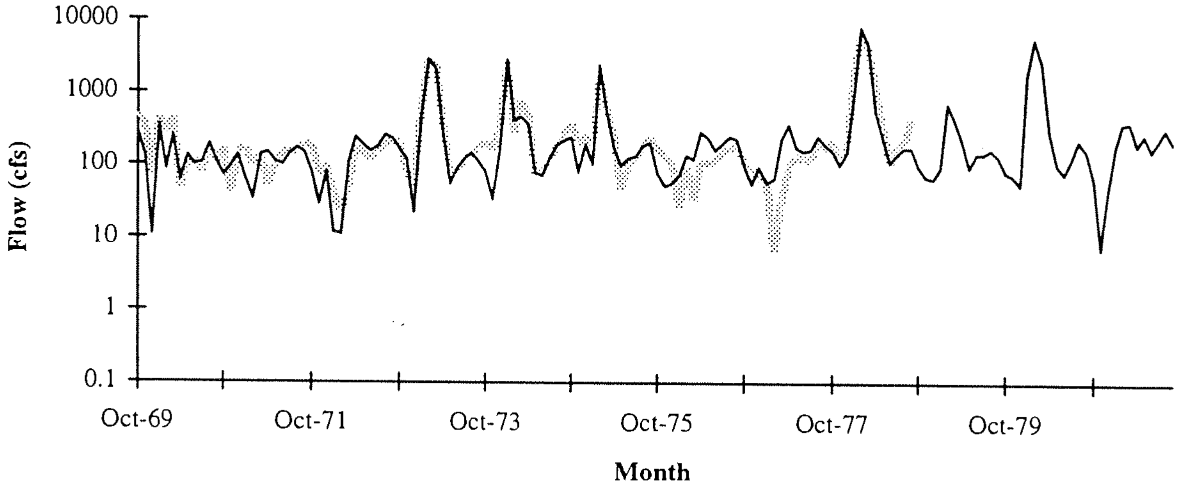


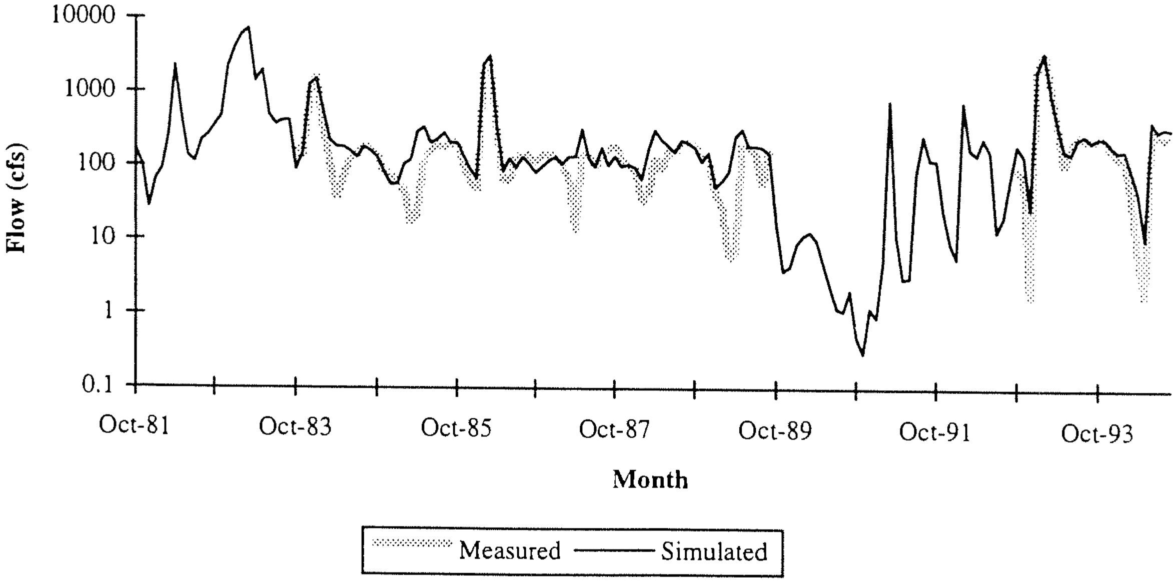
FIGURE 3-11

MEASURED AND SIMULATED SALINAS RIVER FLOW NEAR SOLEDAD

Water Years 1970 - 1981



Water Years 1982 - 1994

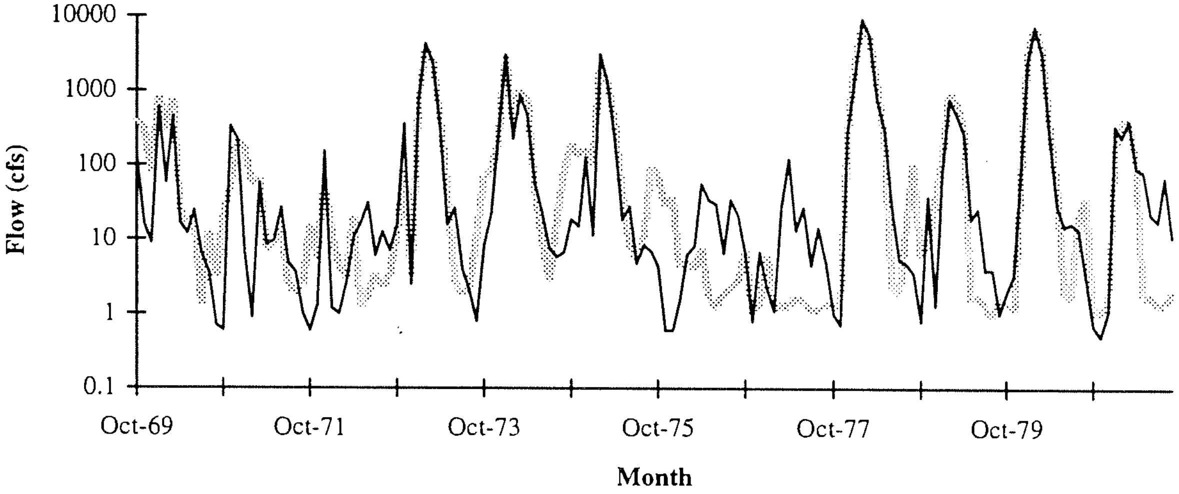


STRMHYD.XLS

FIGURE 3-12

MEASURED AND SIMULATED SALINAS RIVER FLOW NEAR SPRECKELS

Water Years 1970 - 1981



Water Years 1981 - 1994

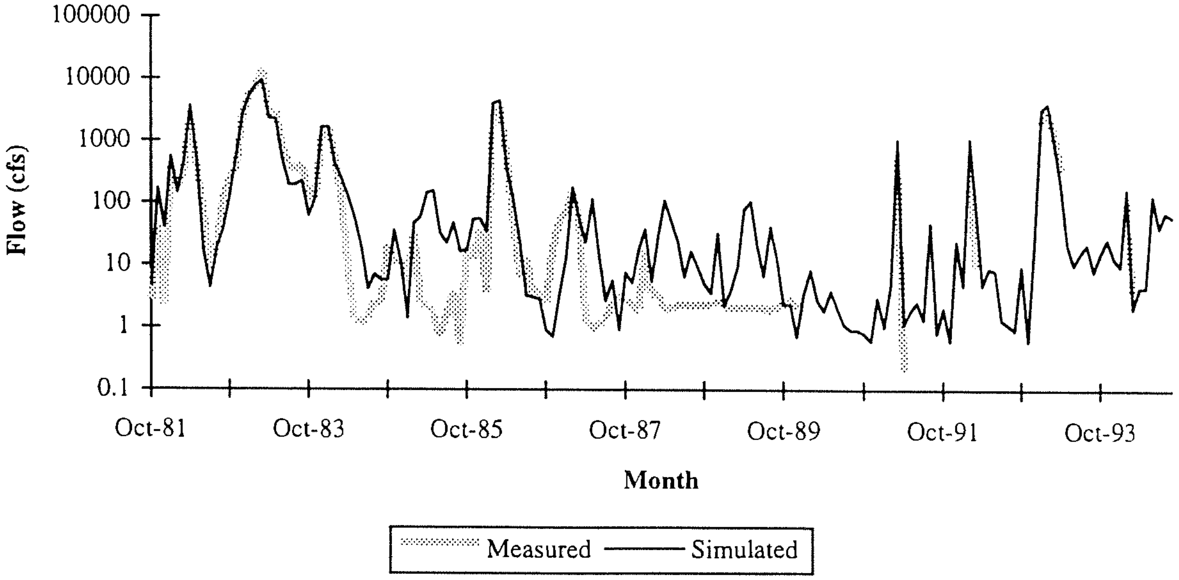


FIGURE 3-7a

SALINAS VALLEY IGSM GROUNDWATER LEVELS
SPRING 1994, LAYER 1 (ft, msl)

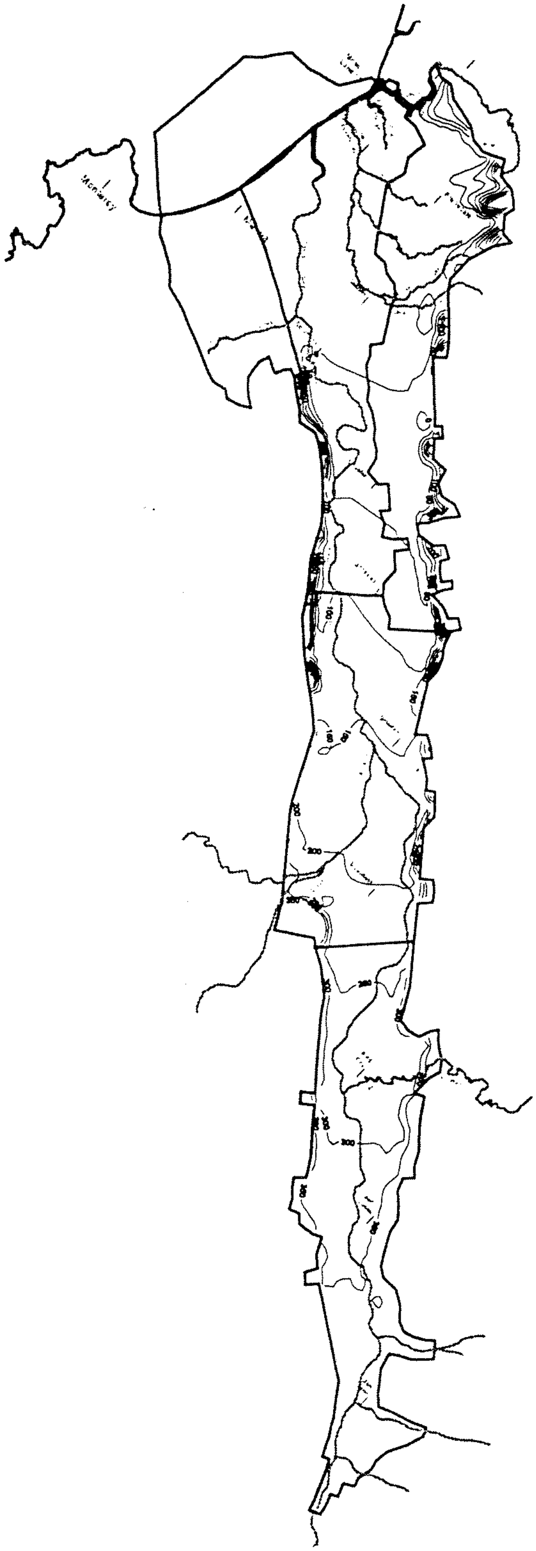


FIGURE 3-7b

SALINAS VALLEY IGSM GROUNDWATER LEVELS SPRING 1994, LAYER 2 (ft, msl)

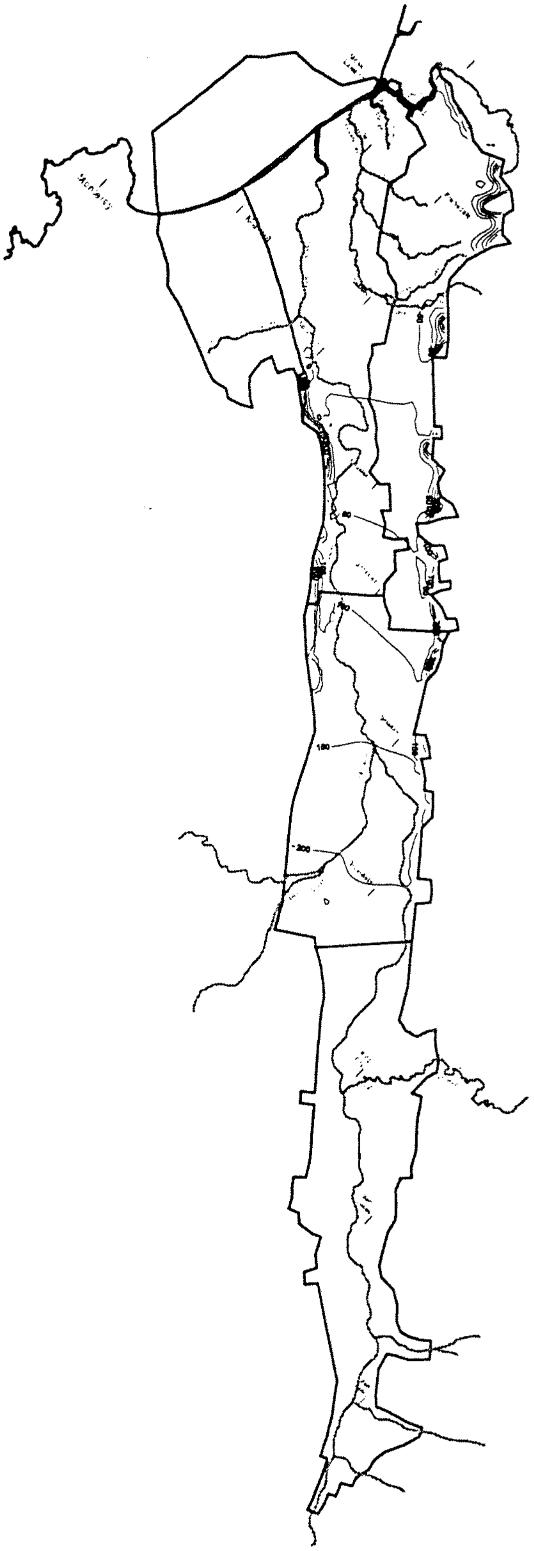


FIGURE 3-8a

SALINAS VALLEY IGSM GROUNDWATER LEVELS
FALL 1994, LAYER 1 (ft, msl)

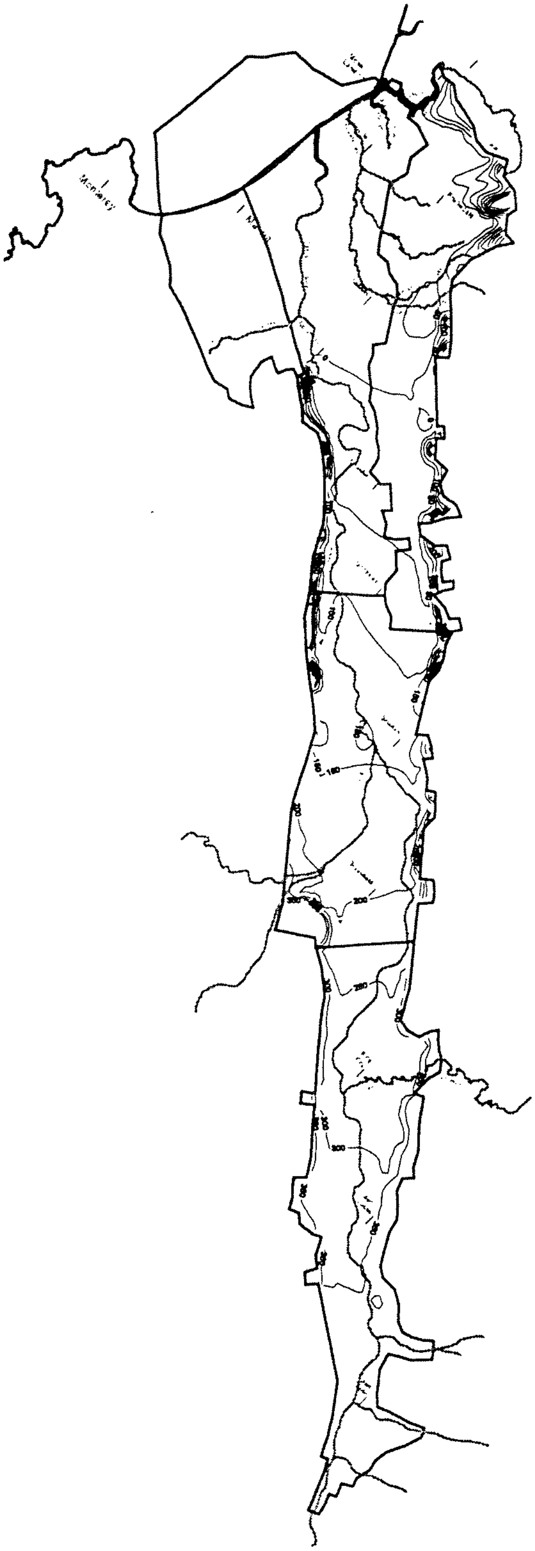


FIGURE 3-8b

SALINAS VALLEY IGSM GROUNDWATER LEVELS FALL 1994, LAYER 2 (ft, msl)

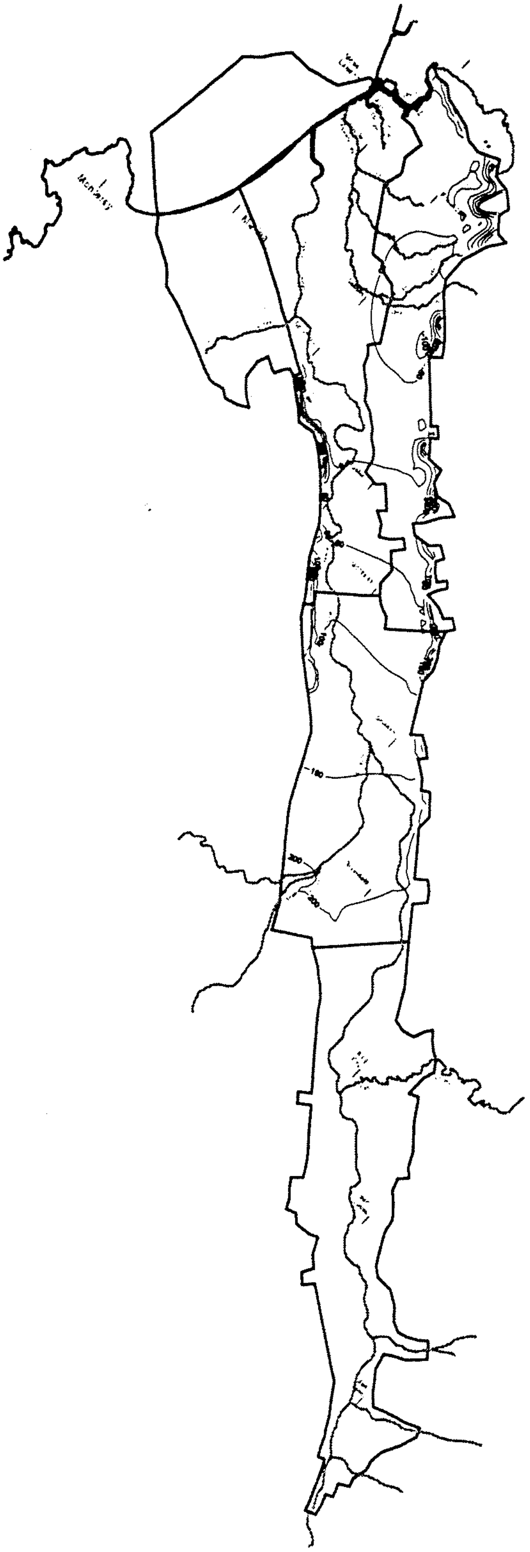
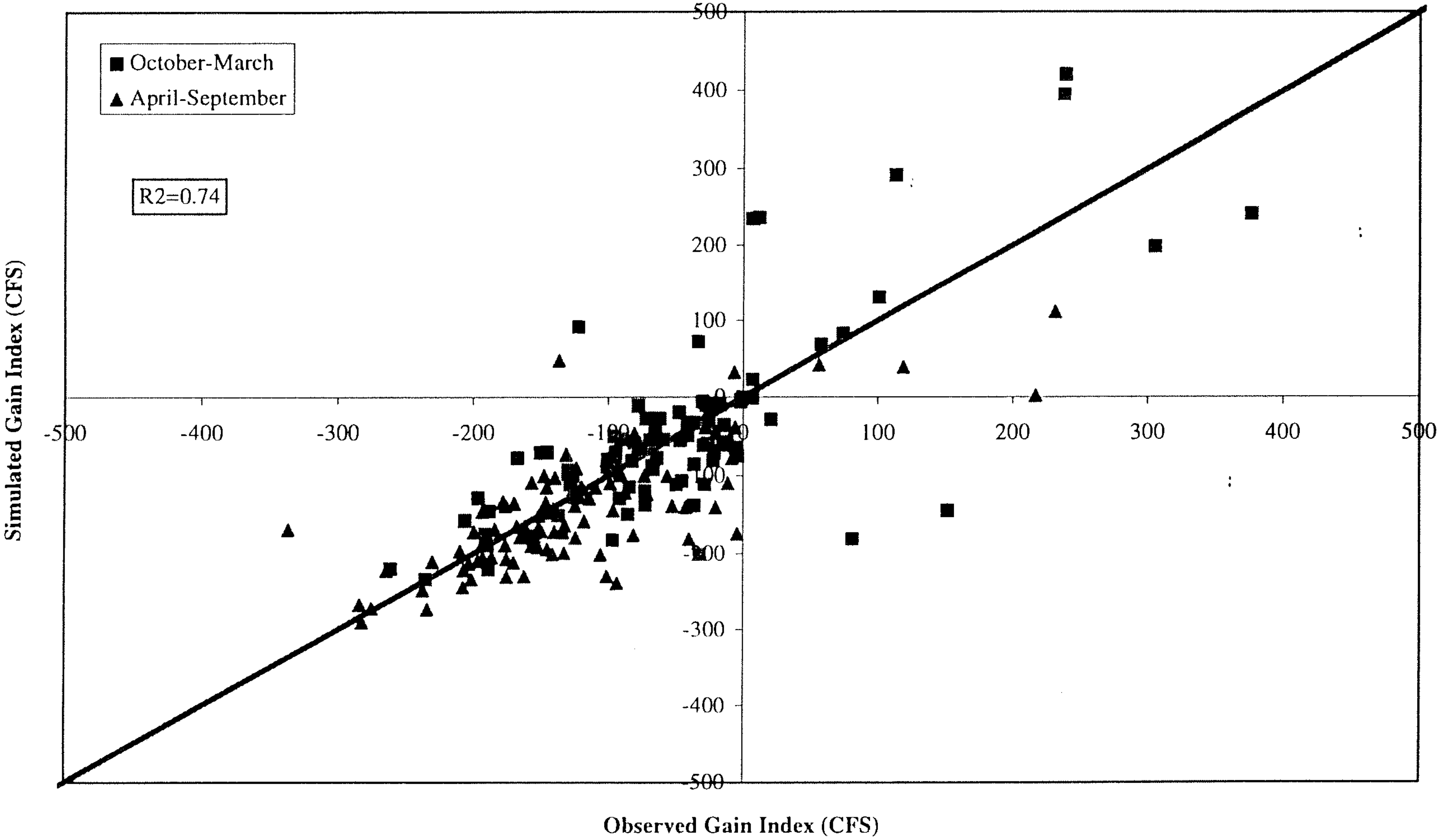


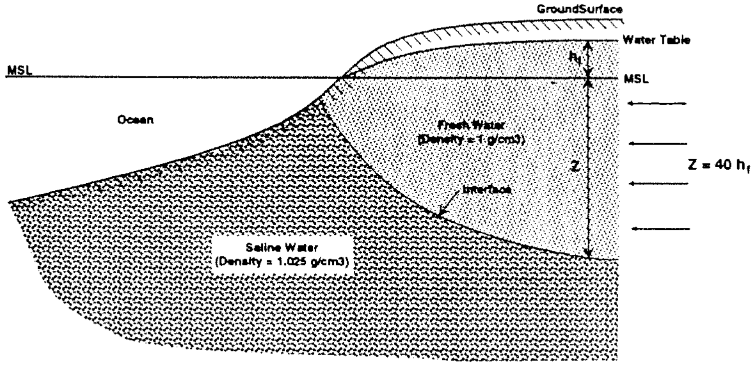
FIGURE 3-10

SCATTERGRAM OF SIMULATED AND OBSERVED STREAM RECHARGE FROM SOLEDAD TO SPRECKELS (Based on Flows at Soledad<1000 cfs)



STRMHYD2.XLS

and salt water (density = 1.025 g/cm^3). A major assumption in this theory is that the two fluids are immiscible, i.e., do not mix (Figure 3-13).



MONTGOMERY WATSON

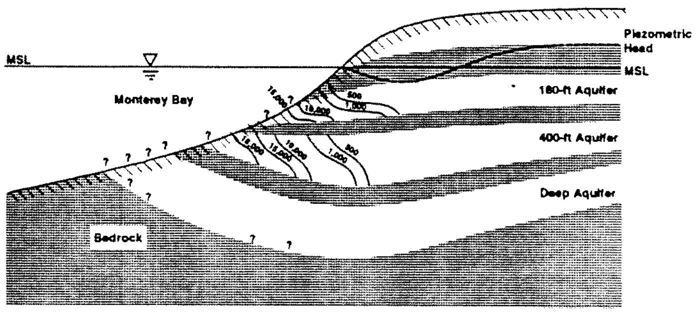
Figure 3-13
Occurance of Fresh Water - Salt Water Interface Under Idealized Conditions In An Unconfined Aquifer

In reality, though, the two assumptions of immiscibility (not mixing) and hydrostatic conditions generally do not hold. In most coastal aquifers, the natural movement of fresh ground water due to the varying hydrologic conditions (precipitation and streamflow), as well as, ground water extractions for water supply, cause a dynamic circulation of salt water back and forth between the sea floor. This dynamic circulation forms a zone of mixed salt water and fresh water. The rate of movement of this zone is a function of the head difference (gradient) on both sides of the zone. Within this zone, where seawater is generally dispersed, the concentration of salt water reduces land ward from about 18,000 PPM chloride to concentrations of chloride in native fresh ground water (Figure 3-14). Cooper (1959) studied this phenomenon in more detail.

According to EPA, a chloride concentration of 250 PPM can be used as the secondary water quality standard, for domestic water supply wells. In California, a range of 250 to 600 PPM is an acceptable range, by EPA secondary standards. A secondary standard is generally non-enforceable and is used for taste and odor control, only. Some communities in California have been reported to have domestic water supply of up to 1,000 PPM chloride. In Salinas Valley, a limit of 500 PPM is used to monitor the seawater intrusion front.

In coastal areas of Salinas Valley, where salt water has been detected in the fresh ground water of the 180-ft and 400-ft aquifers, the aquifer outcrops are off the coasts of Monterey Bay. The zone of dispersion, thus, originates in the aquifer under the

Monterey Bay and the 500 PPM chloride concentration line has advanced land ward in the form of a mixed zone, rather than a sharp interface.



Note:
The figure is intended to show the conceptual intrusion of salt water into the aquifer. The contour lines and aquifer thicknesses are not to scale. The aquifer outcrops are inferred and denoted by ? marks.

MONTGOMERY WATSON

Figure 3-14
Conceptual Dispersion of Salt Water in the Coastal Aquifers of the Salinas Valley

To simulate the rate and extent of salt water intrusion in the Salinas Valley, the following points are considered:

1. This study considers the regional movement of the salt water as discussed earlier, assuming a zone of dispersion. Based on the chloride levels detected in the coastal wells, it is inferred that the origin of the salt water front in the 180-ft and 400-ft aquifers is under the Monterey Bay. It is the 500 PPM chloride concentration line which is being monitored by the MCWRA.

2. The regional rate of movement of salt water zone is a function of the head difference, density difference, and the hydraulic properties of the porous media in the vicinity of the zone of dispersion. The rate of ground water flow across the coastline, then, is considered a good indication for the rate of movement of the 500 PPM chloride line. The SVIGSM is used to simulate the rate of ground water flow as primary indication for seawater intrusion.

3. The extent of the salt water zone can be simulated using equations governing the advective-dispersive transport of conservative substances in the ground water aquifer. These equations and their solution techniques are well documented by Bear (1979) and others. The SVIGSM water quality model uses these equations to simulate the movement of chloride in the coastal aquifers. The details of the model is provided in the IGSM documentation (1995).

Based on model simulations, the average annual rate of seawater intrusion at the coast line is approximately 15,000 AF/yr. This value is calculated in the model as net flux of water from Monterey Bay into the Pressure Subarea. Figure 3-15 shows the annual rate of seawater intrusion at the coast line.

The SVIGSM water quality model simulates the extent of the seawater intrusion. The details of the assumptions and methodology used in this model is explained in Task 1.09 report (Montgomery Watson, 1994.) To show the geographical extent of the seawater intrusion over time, Figures 3-16(a-b) and 3-17(a-b) present the observed and simulated 500 PPM chloride contour lines in the 180-ft and 400-foot aquifers. These figures show that the model closely simulates the observed front of seawater intrusion.

3.6 Sensitivity Analysis

To understand the effects of changing various model parameters on the model simulation, a sensitivity analysis was performed. The analysis consisted of four uniform incremental changes to six model parameters, for a total of 24 scenarios.

The first set of parameters selected are those which impact the hydrologic and hydrogeologic characteristics of the water balance in the basin. These are:

- Aquifer hydraulic conductivity
- Aquifer specific storage/specific yield
- Soil infiltration parameter
- River bed hydraulic conductivity
- Vertical aquifer conductivity

In addition, two other parameters which directly impact the model water budget are selected. These are:

- Ground water pumping
- Boundary condition parameter

Water use parameters, such as irrigated acreage, crop potential ET, and basin irrigation efficiency directly impact the estimation of ground water pumping. This relationship is almost one to one, and thus not included in the sensitivity analysis.

The following general points are made in this regard:

1. The sensitivity analysis scenarios consist of changing a parameter by ± 25% and ± 50% from the calibrated model scenario.

FIGURE 3-16b

SALINAS VALLEY OBSERVED 500 PPM CHLORIDE CONCENTRATION LAYER 2

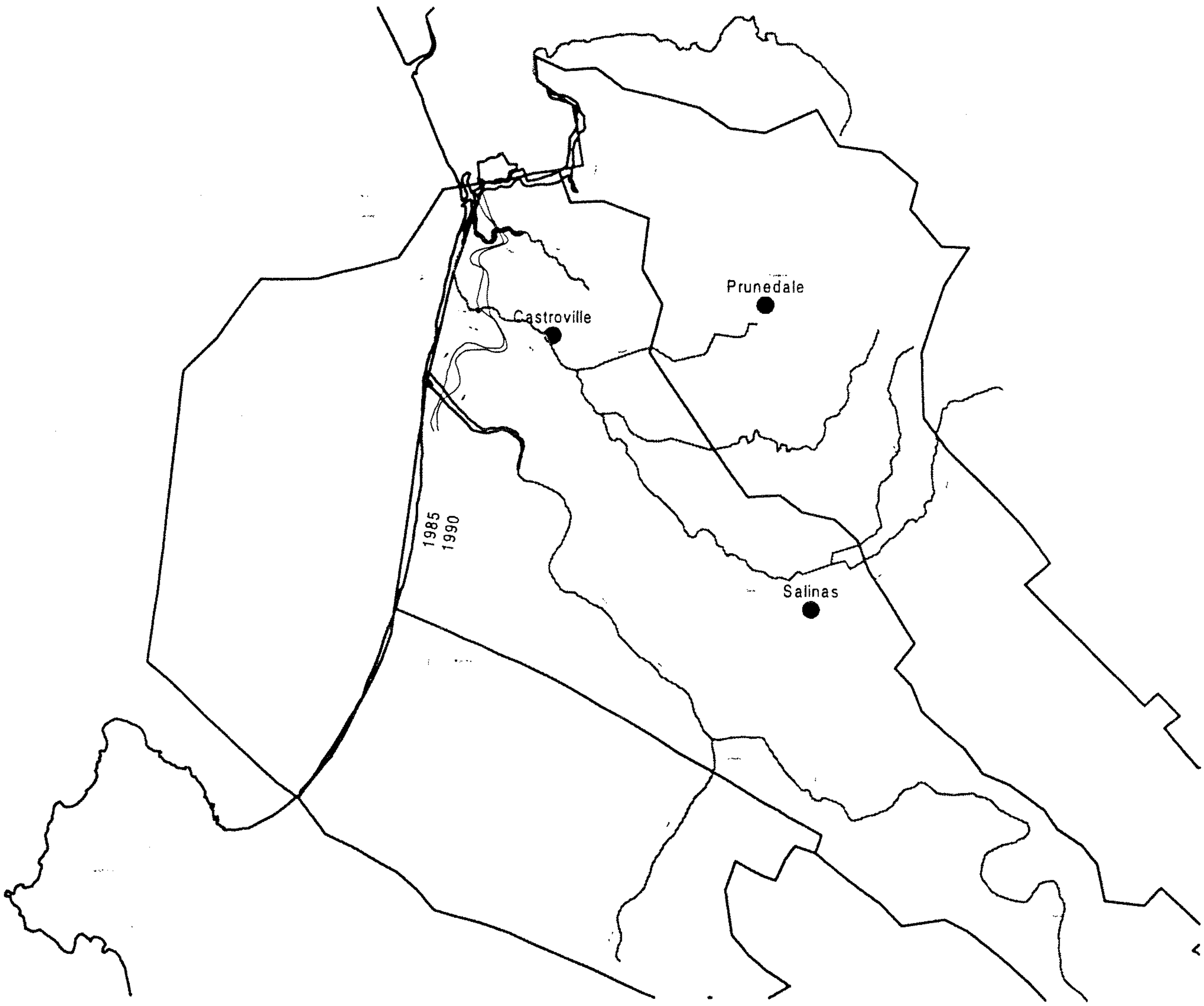


FIGURE 3-17a

SALINAS VALLEY SIMULATED 500 PPM CHLORIDE CONCENTRATION LAYER 1

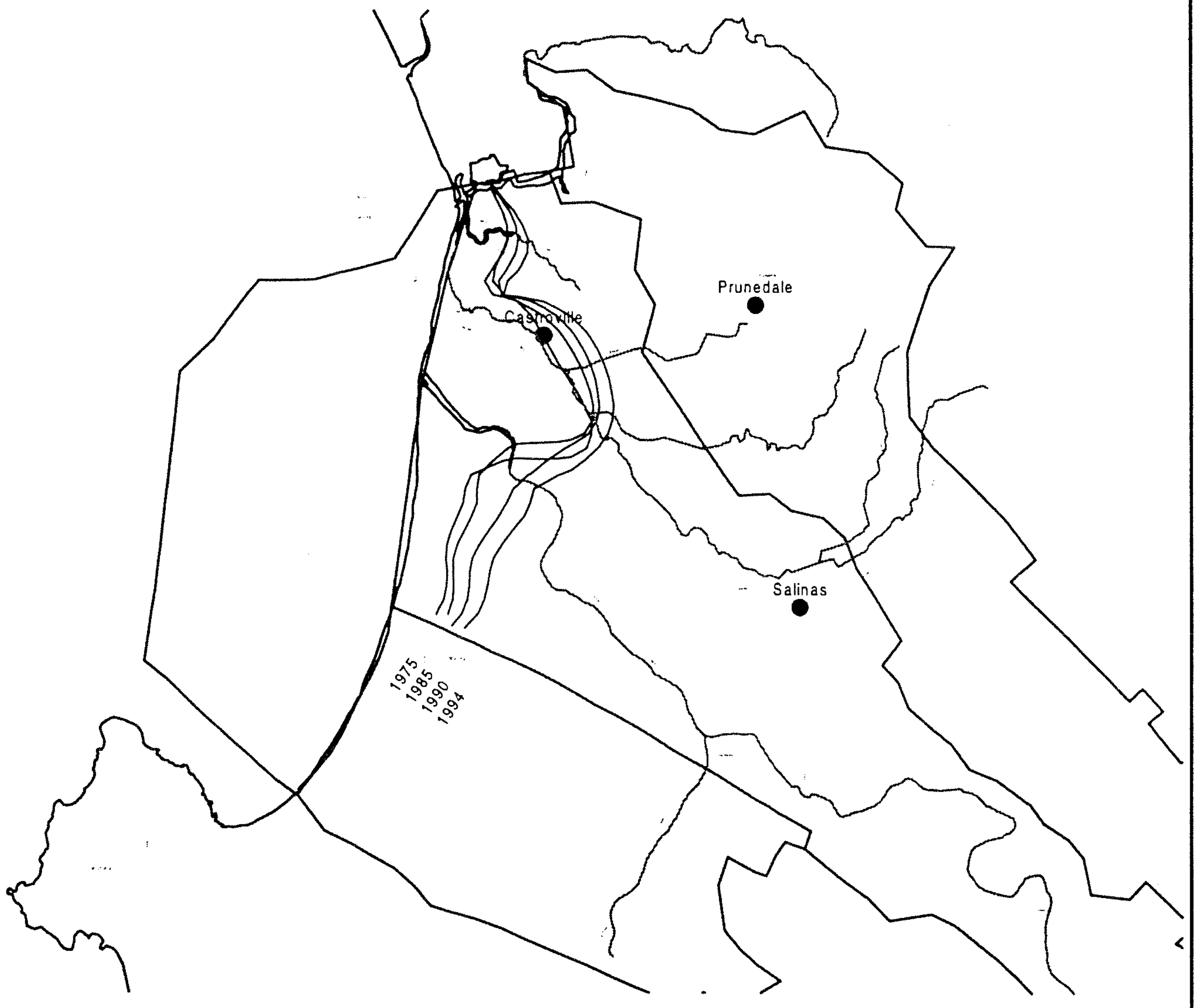


FIGURE 3-17b

SALINAS VALLEY SIMULATED
500 PPM CHLORIDE CONCENTRATION
LAYER 2

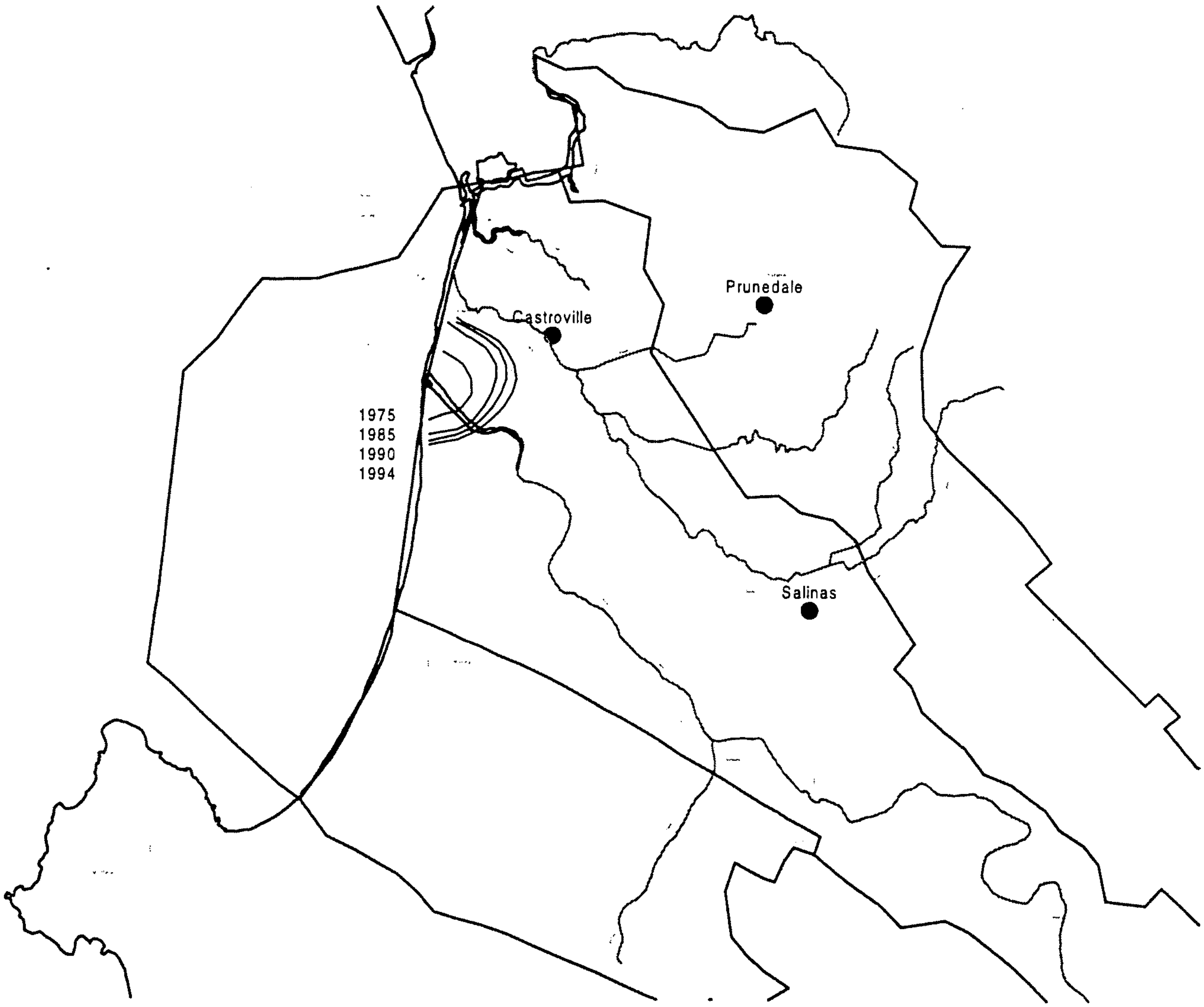
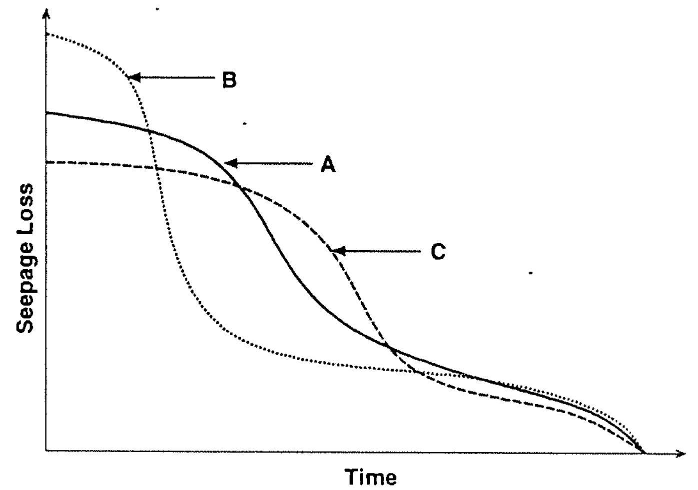


TABLE 3-3

RESULTS OF SENSITIVITY ANALYSIS

Scenario #	Parameter	Relative Change (%)	Relative Change in Stream Recharge (%)					Relative Change in Deep Percolation (%)					Relative Change in Seawater Intrusion Into the Pressure Subarea (%)	Relative Change in Salinas River Flow At Spreckles (%)	Relative Change in Ground Water Levels (ft)			
			Pressure	East Side	Forebay	Upper Valley	Total	Pressure	East Side	Forebay	Upper Valley	Total			Pressure	East Side	Forebay	Upper Valley
1	Aquifer Hydraulic Conductivity	+50%	-13.0%	+0.0%	+3.4%	+8.1%	+1.4%	+0.1%	+0.2%	+0.0%	-0.0%	+0.0%	-6.5%	-2.0%	3	7	1	0
2		+25%	-6.7%	+0.0%	+1.9%	+4.0%	+0.7%	+0.0%	+0.1%	+0.0%	-0.0%	+0.0%	-2.3%	-1.0%	2	4	1	0
3		-25%	+6.9%	+0.0%	-2.3%	-4.0%	-0.8%	-0.1%	-0.1%	-0.0%	+0.0%	-0.0%	+0.3%	+1.2%	-3	-6	-1	-1
4		-50%	+12.4%	+0.0%	-5.5%	-7.9%	-2.3%	-0.2%	-0.4%	-0.1%	+0.0%	-0.1%	-4.1%	+3.0%	-7	-14	-4	-2
5	River Hydraulic Conductivity	+50%	-13.8%	+28.7%	+7.4%	-1.3%	-0.5%	-0.0%	-0.1%	+0.1%	+0.0%	+0.0%	+12.6%	+0.1%	-4	-3	3	2
6		+25%	-17.0%	+15.9%	+6.4%	-0.7%	-1.5%	-0.1%	-0.1%	+0.0%	+0.0%	-0.0%	+17.1%	+0.8%	-5	-4	1	1
7		-25%	-24.0%	-19.1%	+1.6%	+0.9%	-4.7%	-0.2%	-0.2%	-0.1%	-0.0%	-0.1%	+24.5%	+3.4%	-7	-7	-4	-3
8		-50%	-27.6%	-39.5%	-8.2%	+1.0%	-9.5%	-0.3%	-0.3%	-0.4%	-0.1%	-0.3%	+29.2%	+7.7%	-10	-10	-12	-9
9	Soil Infiltration Parameter	+50%	-0.1%	-1.3%	-3.0%	-3.5%	-2.5%	+6.0%	+8.7%	+6.5%	+5.9%	+6.6%	-12.6%	+0.9%	2	3	1	0
10		+25%	-0.0%	-0.7%	-1.5%	-2.1%	-1.4%	+3.3%	+4.6%	+3.3%	+3.6%	+3.7%	-6.9%	+0.5%	1	1	0	0
11		-25%	+1.0%	+0.9%	+1.8%	+1.7%	+1.5%	-4.5%	-6.3%	-3.8%	-2.6%	-4.4%	+9.5%	-0.1%	-2	-2	0	0
12		-50%	+1.1%	+2.3%	+4.6%	+4.9%	+3.9%	-11.5%	-15.9%	-9.5%	-8.0%	-11.3%	+24.5%	+0.1%	-4	-5	-1	0
13	Ground Water Pumping	+20%	-3.0%	+1.5%	+4.2%	+2.5%	+1.9%	+44.5%	+40.9%	+61.6%	+46.2%	+46.9%	+15.3%	-0.4%	-3	-4	-1	-1
14		+10%	-1.7%	+0.7%	+2.2%	+1.3%	+1.0%	+22.1%	+20.6%	+30.5%	+23.0%	+23.3%	+8.1%	-0.3%	-2	-2	-1	-1
15		-10%	+1.9%	-0.6%	-2.7%	-1.6%	-1.2%	-20.1%	-19.9%	-28.4%	-22.4%	-22.0%	-9.0%	+0.7%	2	2	1	1
16		-20%	+5.1%	-1.1%	-8.1%	-4.4%	-3.7%	-37.5%	-37.2%	-49.0%	-43.3%	-40.5%	-23.4%	+2.6%	5	6	2	1
17	Specific Storage/ Yield	+50%	+7.8%	+0.0%	+0.8%	+1.4%	+2.6%	+0.1%	+0.2%	+0.1%	+0.0%	+0.1%	-11.3%	-2.1%	4	4	1	0
18		+25%	+4.5%	+0.0%	+0.2%	+0.7%	+1.4%	+0.1%	+0.1%	+0.0%	+0.0%	+0.1%	-6.8%	-1.1%	2	2	1	0
19		-25%	-6.5%	+0.0%	+0.4%	-0.5%	-1.5%	-0.1%	-0.2%	-0.0%	-0.0%	-0.1%	+11.9%	+1.1%	-4	-4	-2	0
20		-50%	-19.3%	+0.0%	+2.3%	-1.2%	-3.9%	-0.4%	-0.4%	-0.1%	-0.0%	-0.2%	+37.0%	+2.8%	-13	-12	-5	-2
21	Vertical Aquifer Conductivity	+50%	+0.5%	+0.0%	+0.0%	+0.2%	+0.2%	-0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+2.1%	-0.2%	0	0	0	0
22		+25%	+0.2%	+0.0%	+0.1%	+0.1%	+0.1%	-0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+1.5%	-0.1%	0	0	0	0
23		-25%	-0.4%	+0.0%	+0.1%	-0.1%	-0.1%	+0.0%	+0.0%	-0.0%	+0.0%	+0.0%	-1.5%	+0.1%	0	0	0	0
24		-50%	-0.9%	+0.0%	+0.2%	-0.3%	-0.3%	+0.0%	+0.0%	-0.0%	+0.0%	+0.0%	-4.2%	+0.3%	0	1	0	0
25	Boundary Flow Parameter	+50%	+3.7%	+0.0%	-6.1%	-3.8%	-3.0%	+0.1%	+0.1%	+0.1%	+0.0%	+0.1%	-6.7%	+3.0%	2	2	2	0
26		+25%	+1.9%	+0.0%	-3.1%	-1.9%	-1.5%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	-3.5%	+1.5%	1	1	1	0
27		-25%	-2.2%	+0.0%	+3.2%	+2.0%	+1.5%	-0.1%	-0.0%	-0.0%	-0.0%	-0.0%	+4.3%	-1.5%	-1	-1	-1	0
28		-50%	-6.5%	+0.0%	+6.9%	+4.3%	+2.8%	-0.1%	-0.1%	-0.1%	-0.0%	-0.1%	+10.2%	-2.9%	-3	-3	-2	0

SENSITIV.XLS



MONTGOMERY WATSON

Figure 3-18
Schematic of Time-Dependent
Seepage Loss

Area under each curve show the total recharge during time interval of one year. in most of above normal and wet years, a change in k_b would result in conditions B or C, depending on the direction of change in k_b. This would result in a respective change in total volume of recharge.

This phenomena does not necessarily apply to other areas, due to the differences in the basin hydrogeology. The seepage losses, in general, are propagated and dissipated relatively slower in the Forebay and Pressure Areas.

3. Soil infiltration parameter impacts the deep percolation rates in all areas. This impact propagates to changes in ground water levels and stream seepage losses. The impact is also propagated from upstream to downstream direction.

4. Ground water pumping, as discussed earlier, is directly and almost linearly a function of crop potential ET, irrigated acreage, and irrigation efficiency. Any change in ground water pumping has high impacts on the deep percolation, because, deep percolation is a function of amount of applied water. This impact is then propagated to changes in ground water levels and stream seepage losses from upstream to downstream direction. Seawater intrusion is almost linearly a function of changes in valley-wide ground water pumping.

5. Specific yield and/or storage coefficient also impacts the changes in the seasonal ground water level. This impact propagates to changes in stream seepage losses which is carried through the valley in the downstream direction.

6. Vertical Hydraulic Conductivity has some impact on the relative changes in the ground water levels in each aquifer. However, the layer average ground water level does not present these changes. The impact on stream recharge is relatively small.

7. Boundary flows from small watersheds impact the water balance of the basin. This would in turn change the ground water levels and seepage loss rates from the river. The pressure area seepage loss changes show a reverse direction, because of the propagation of upstream effects to downstream. Due to lack of data on the flows from the basin boundaries, this component is estimated, using the model, in order to achieve reasonable water balance in each subarea.

The sensitivity analysis performed here are changes in the selected parameters valley-wide The high degree of surface water and ground water interaction in the valley causes a feed back loop between the impact areas and a propagation of effects in a domino fashion from upstream to downstream. In order to contain the effects of changes to parameters within each subarea, many more model runs are required. In this case, changes to selected parameter should be considered only on the impact areas within that subarea, without regards to that impact in other subareas. This would still not guarantee the isolation of the effect of the inter-related hydrogeologic parameters within the subarea. Although it may be tempting from a non-technical point of view, any attempt to contain the effects of parameter changes to each subarea and/or isolate the individual effects of each parameter (over-looking the inter-relationship between the hydrogeologic parameter) results in undermining the nature of the hydrogeologic conditions in the valley and is not a technically valid exercise.

3.7 Reservoir Operations

The reservoir operation routine in the Salinas Valley IGSM has the ability to simulate the operations of Nacimiento and San Antonio Reservoirs for water supply and flood control. For the purposes of calibrating the streamflow and ground water flow simulations in the model, however, the reservoir operations simulation is not in effect, and the historical gaged flows at Bradley are used for the Salinas River inflow. Gaged flows more accurately reflect actual historical reservoir operations, as opposed to operations simulated based on generalized operating rules. This allows for a more accurate calibration of the surface water and ground water simulation components. The remainder of this section describes the reservoir operations simulation in the model and presents results of a supplemental calibration run performed with reservoir operations simulation in effect.

The reservoirs are operated using a mass balance approach. Coordinated releases from the reservoirs are simulated based on release requirements and target storage levels set by the user. In this case, the target storages are set such that the end-of-day storage levels in San Antonio and Nacimiento reservoirs follow the target storage levels as shown in Figure 3-19. Although the rule for flood control space requirements have changed a few times during the operations of Nacimiento and San Antonio reservoirs, the flood control rule curve currently used by the MCWRA is used in the model for the entire calibration period. Figure 3-20(a-b) show the flood control rule curves for Nacimiento and San Antonio reservoirs, respectively.

Releases from the reservoirs have historically been made to maximize the recharge through the Salinas River bed and minimize the Salinas River outflow to the ocean. Based on reviews of the historical hydrographs of the Salinas River at Chualar and Spreckels and on discussions with reservoir operators, historical operational criteria can best be honored when approximately 40 cfs flow is maintained at Chualar Bridge. This flow target is currently used to determine releases from Nacimiento and San Antonio Reservoirs. Figure 3-21 shows the scatterplot of observed and simulated Salinas River flows at Bradley. A R^2 of 0.86 signifies a good agreement for the combined reservoir releases.

In order to accurately calibrate the ground water portion of the model, the most reliable daily streamflow records for Salinas River at Bradley are the observed records. Use of this record eliminate the impact of the simulations of reservoir operations on the calibration of the ground water model.

3.8 Model Accuracy

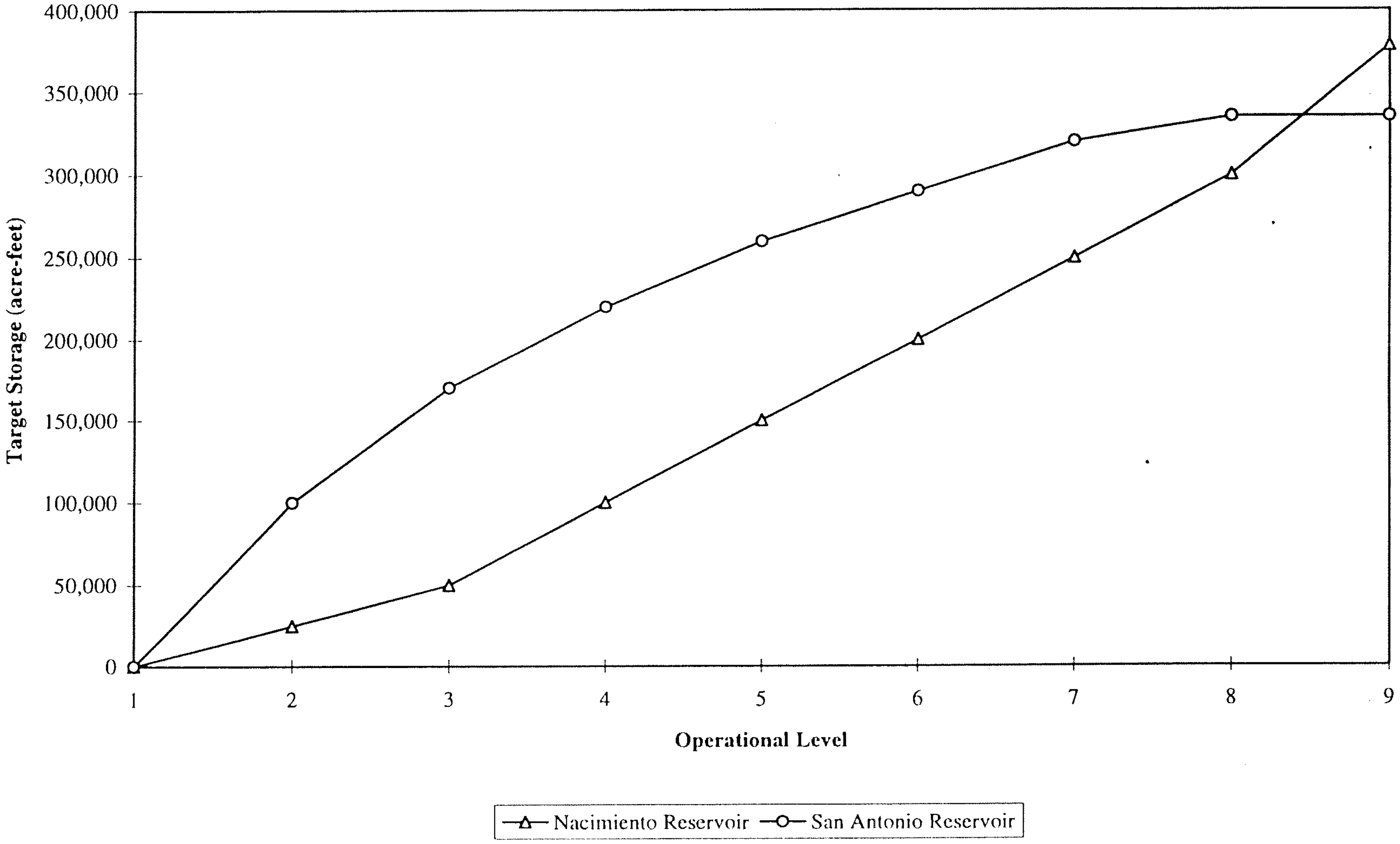
The SVIGSM uses the latest numerical techniques in computer modeling to represent the following major processes:

- land and water use computations, rainfall and runoff, and agricultural applied water, and urban water use;
- infiltration of water through soil zone, and evapotranspiration by native vegetation, and agricultural crops;
- vertical movement of water through the unsaturated zone;
- two-dimensional water flow in the saturated confined and/or unconfined layered aquifer system;
- operation of reservoir systems for water supply and flood control;
- flow of water through the stream system, and its interaction with ground water aquifer; and
- transport of conservative substances, such as chloride, in the ground water system.

These processes are simulated based on reliable mathematical formulae, which are developed based on certain assumptions, to simulate the real-world operations of

FIGURE 3-19

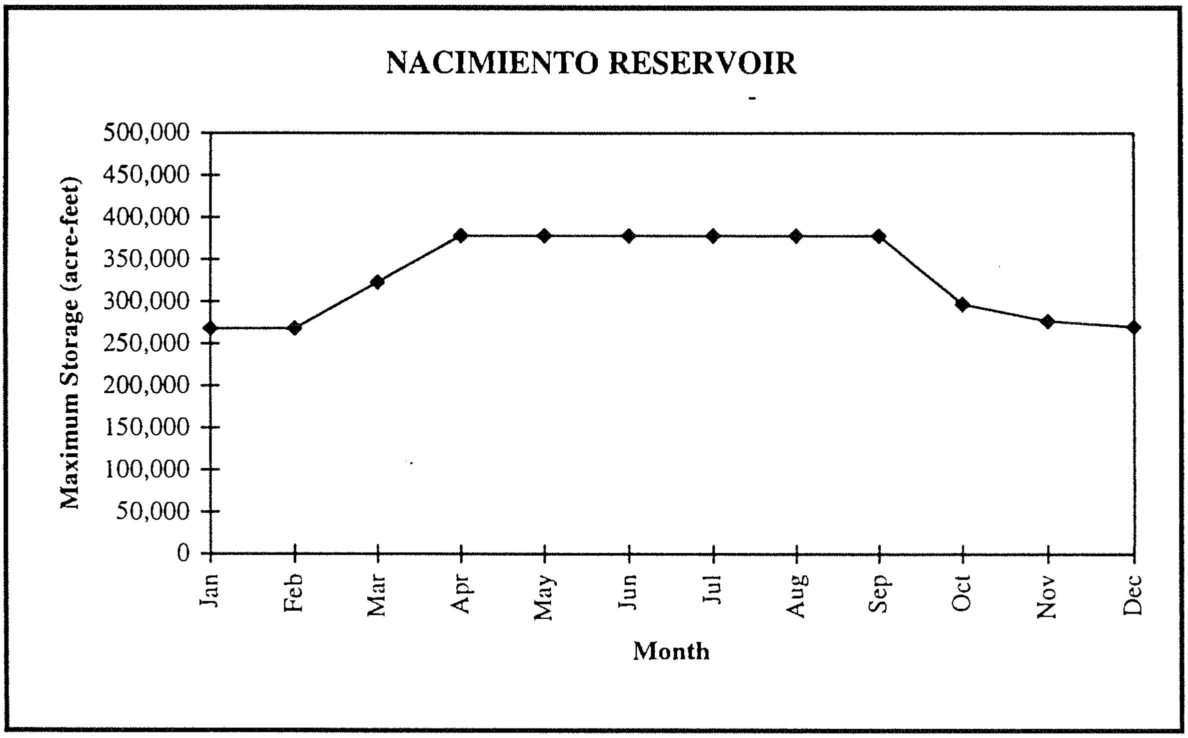
TARGET RESERVOIR STORAGES
FOR NACIMIENTO AND SAN ANTONIO RESERVOIRS

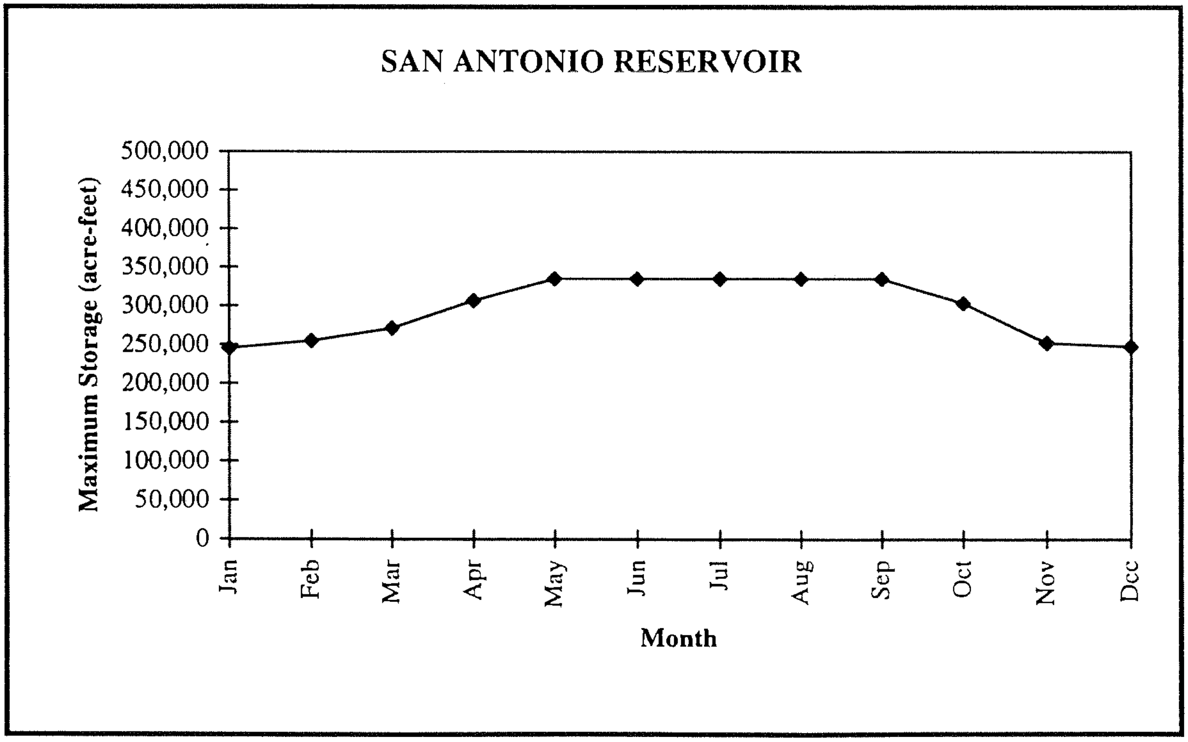


FIGS.XLS

FIGURE 3-20

FLOOD CONTROL STORAGES FOR NACIMIENTO AND SAN ANTONIO RESERVOIRS



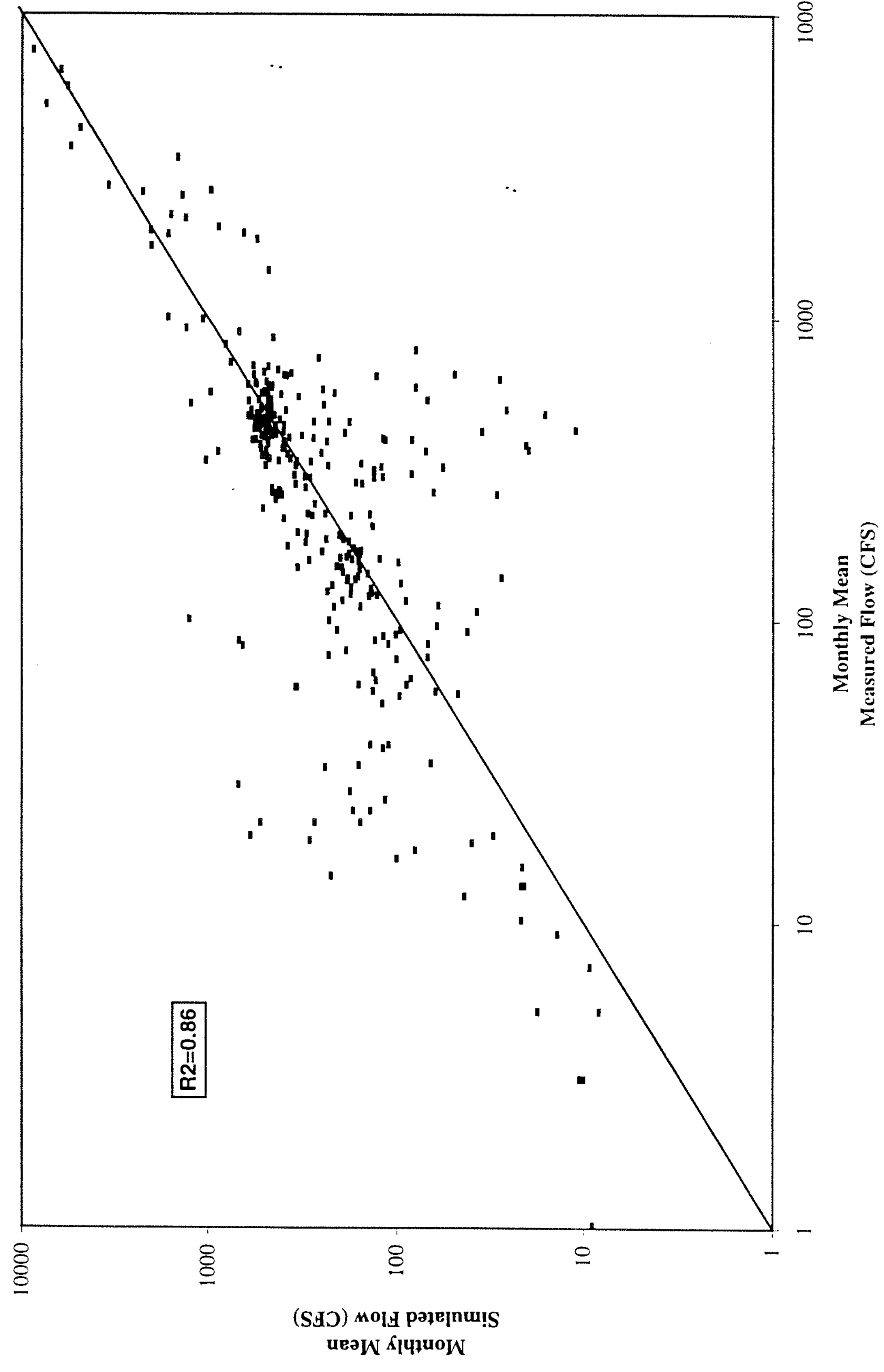


FIGS.XLS

STRMHYD.XLS

FIGURE 3-21

SCATTERGRAM OF MONTHLY MEAN STREAM FLOWS AT BRADLEY



man on land. These mathematical formulae, although generally tested for accuracy, can never replicate the human and natural activities perfectly.

In addition, a vast amount of data are used in the SVIGSM to represent the agricultural, urban, and natural water use, ground water geology and hydrogeology, and surface water conditions in the Salinas Valley. It is inevitable that there would be inaccuracies in the recorded and measured data, as well as, many unknowns regarding the natural state of the systems. A prime example would be the geologic conditions in the Valley. In these cases, scientific inferences are made to best represent the state of the system, based on available information and data. However, the definition of the state of the system is as good as the data available, and the analysis performed on the data.

The SVIGSM, in its current version, has used the latest data available to represent the land and water use, ground water conditions, and surface water system to the best condition possible. However, the following points can be made regarding the model simulations:

1. The agricultural and urban water use estimates which are the basis for estimation of ground water pumping are based on the latest and most reliable information available. The information has been reviewed by most of the stakeholders in the valley, and does not require additional refinements. The unit pumped water values simulated and used by the model closely represent the actual practices in the different parts of the valley at a regional scale.

2. The model simulations of ground water levels are reasonably close to the observed records. Additional work may be required to obtain better simulations in the East Side and in the Arroyo Seco areas. In these areas, the following points may be considered:
   - The recorded water levels need to be reviewed to rule out the possibility of pumping water level measurement, as opposed to static water level measurements;
   - Additional work may be required to further define the vertical distribution of pumping between the two aquifer layers. This is specially the case in the Arroyo Seco area.
   - For more reliable site specific studies, a better definition of stream geometry, and stream bed parameters are needed in the Arroyo Seco area.

3. The regional contours of water levels represent the regional water levels reasonably.

4. The model simulates the streamflow at different locations along the Salinas River at reasonably accurate level. The streamflow at Soledad and Spreckel gage and the scatterplot of seasonal stream seepage loss indices verify that the model has

reasonably good simulation capability of streamflow and stream-aquifer interaction. For more site specific studies in the future, refinements of stream geometry and stage-discharge relationships, along with a study of stream bed conditions are recommended.

5. The reservoir operation module simulates the Salinas River flows at Bradley reasonably good, with 0.86 coefficient of determination. However, the spread of low flows is somewhat higher than expected. This may be improved by refining some of the reservoir operation parameters. Since the simulated Bradley flows are not used in the ground water model simulations, the refinement to this module may be made at later time, with longer periods of record for reservoir operation.

6. The water quality model simulates the extent of the seawater intrusion in the 180-Ft aquifer very close to the contours of observed 500 PPM chloride concentration. The simulation of the seawater intrusion in the 400-Ft aquifer is somewhat more southwesterly than the observed contours. This may be because the

Section 4
Summary and Conclusions

The Salinas Valley Integrated Ground and Surface Water Model (SVIGSM) is updated to incorporate the recent data available as follows:

- The potential crop ET data has been updated to include the latest records available from CIMIS stations.
- The land use data is updated for the MCWRA "verified 1989/91" and MCWRA 1995 land use coverages.
- The urban water use estimates are updated for the recent urban conservation measures implemented in the Valley.
- The agricultural practices (unit water pumped) for Vineyard and Truck crops have been updated to include latest data available from the Ground Water Extraction Monitoring System (GEMS).
- Distribution of ground water pumping in the model area has been refined to incorporate the latest well location maps available from GEMS.
- The aquifer parameters have been updated to include the latest data available from the GEMS database.

The model data analysis and input data preparation are discussed in Section 2 of this report.

The calibration procedures, and results are discussed in Section 3. The model results presented in Section 3, show that the model simulations are in close agreement with the observed values. In addition, the accuracy of the model is discussed in Section 3, and recommendations are made for additional improvements in the model simulation capabilities.

Based on discussions of Section 3 and the model results presented, it is concluded that:

1. The SVIGSM simulates the hydrologic and hydrogeologic conditions of the Salinas Valley seasonally. The model water balance for each subarea and the inter-relationship of the different subareas are simulated properly.
2. The model seasonally simulates the regional ground water flow in the Salinas Valley. The site-specific simulations are also good, although improvements can be made to the East Side and Arroyo Seco Areas.

3. The SVIGSM simulates interaction between Salinas River and the aquifer properly.

4. The model simulates the rate and extent of seawater intrusion in a proper manner.

5. The updates and refinements made to the model data set and the present model calibration has improved the simulation capabilities of the model significantly. The model is at a point to be used for the simulation of impacts of the Basin Management Plan alternatives.

Section 5
References

Anderson, James, R., Ernest E. Hardy, John T. Roach, and Richard E. Witmer, 1976. A land use and Land Cover Classification System for Use with Remote Sensor Data. U.S. Geological Survey Professional Paper 964.

Anderson-Nichols & Co., Inc., January 1985. Salinas River Study Phase III Report, Phreatophyte Water Use.

Bear, J., 1979, Hydraulics of Groundwater. McGraw Hill, NY.

Boyle Engineering Corporation, 1986. Salinas Valley Ground water Model.

California Division of Mines and Geology. Geologic Map of California. San Luis Obispo Sheet (1959), San Jose Sheet (1966), and Santa Cruz Sheet (1959).

California Department of Water Resources, 1995. "Land Use Legend".

California Department of Water Resources, 1946. Salinas River Basin Investigation. Bulletin 52.

California Department of Water Resources, 1993. Standard Land Use Legend.

California Department of Water Resources - San Joaquin District, 1996. Personal communication.

Cooper, H.H., 1959. A Hypothesis Concerning the Dynamic Balance of Fresh Water and Salt Water in a Coastal Aquifer. Journal of Geophysical Research, Vol. 64, No. 4 pages 461-467.

Driscoll (1986), Groundwater and Wells, Johnson Filtration Systems, Inc.

Durbin, T.J., G.W. Kapple, and J.R. Freckleton, 1978. Two-Dimensional and Three-Dimensional Digital Flow Models for the Salinas Valley Ground-Water Basin, California. United States Geological Survey Water Resources Investigation Report 78-113.

Earthware of California, 1992. Selected Geological Cross Sections in the Salinas Valley Using Geobase.

Greene, H.G., 1970. Geology of Southern Monterey Bay and its Relation to the Ground Water Basin and Salt Water Intrusion. United States Geological Survey Open File Report.

Section 5
References

Hurr (1966). "A New Approach for Estimating Transmissivity from Specific Capacity." Water Resources Research, Vol. 2, No. 4 pages 657-664.

James M. Montgomery Consulting Engineers Inc., 1994. Salinas River Basin Water Resources Management Plan. Task 1.09 Technical Memorandum - Salinas Valley Ground water Flow and Quality Model Report.

MCWRA (1984) Salinas Valley Urban Water Use.

Montgomery Watson, August 1996. ET Memorandum to Matthew Zidar at MCWRA, by S. Ali Taghavi.

Montgomery Watson, October 1996. SVIGSM Review Memorandum to Matthew Zidar at MCWRA by S. Ali Taghavi.

Moore, Charles, V., 1997. University of California Davis, Personal communication.

Muir, K.S., 1982, Ground Water in Seaside Area, Monterey County, California. United States Geological Survey Water Resources Investigation 82-10.

United States Bureau of Reclamation, December 1996. "Salinas River Basin Land Use and Land Cover Study, Monterey County Area, California".

Wiley, Gerry, 1997. Monterey County Agricultural Commissioner Office. Personal communication.

APPENDIX A

Memorandum on Crop Potential ET

MEMORANDUM

MONTGOMERY WATSON

To:	Matt Zidar	**Date:**	August 15, 1996
From:	S. Ali Taghavi	**File No.:**	2631.0420
Subject:	Revised Crop Potential ET	**Client:**	MCWRA
cc:	Lauran Howard, MCWRA U. Win, MCWRA Danyal Kasapligil, MCWRA Eric Zigas, EDAW Lyndel Melton		

Background

The purpose of this memorandum is to describe the methodology used in updating the reference crop evapotranspiration (ET_o) and crop potential evapotranspiration (PET_c) in the Salinas Valley Integrated Ground and Surface water Model (SVIGSM). In this memorandum, we refer to the calibration of SVIGSM made in 1993 as the *original* model calibration, and any additional efforts on the calibration as the *revised* calibration.

The SVIGSM calculates the monthly crop irrigation water requirements based on the consumptive use methodology which takes into account the actual crop ET_c, minimum soil moisture content, effective rainfall, hydrologic soil type, and monthly irrigation efficiency. Actual crop ET_c is computed as a function of potential crop ET_c, and soil moisture. Detailed information regarding this process is provided in the model documentation (January 1995).

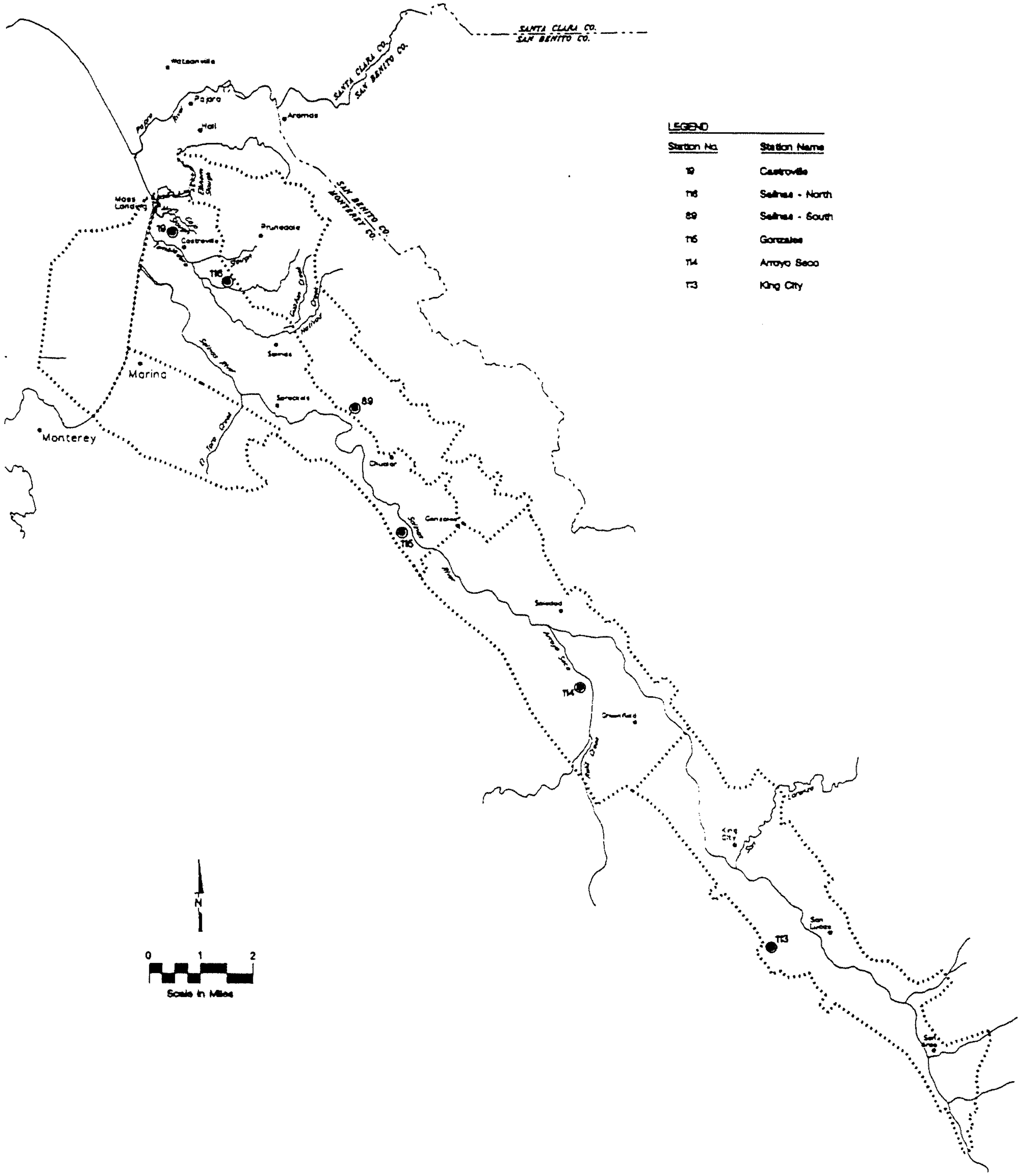
Crop PET_c used in the SVIGSM original calibration is based on information contained in DWR Bulletin 113-3, which report PET_c values based on data collected and analyzed for the period 1957-72. This information has been checked for consistency with PET_c information compiled by Mr. Peter Canessa (1992), for the MCWRA. As reported in numerous literature and supporting data, multiple cropping practice is common in various parts of Salinas Valley. The monthly crop PET_c values were subsequently modified to reflect these practices. The crop PET_c values used in the model original calibration are average monthly rates, and represent average hydrological conditions for every year. For more detail information, please refer to the Task 1.09 report (February 1994).

Updating ET_0 Estimates

The agricultural water use information in the SVIGSM is one of the important data items in the hydrologic analysis of the Salinas River Basin Management Plan. As this information is highly sensitive to the crop PET_c, it is important to use the most representative ET values. Since 1993 the California Irrigation Management Information System (CIMIS) stations have been operated and maintained by the DWR in Salinas Valley. In this respect, the CIMIS station information collected by the DWR for 1993-96 is used to update the monthly ET_0 values. There are six CIMIS stations in the Salinas Valley, approximately representing different climatic conditions in the valley. Table 1 shows the average monthly ET_0 data for each station. Because the ET_0 data used in the SVIGSM is represented by each subregion, it is necessary to correlate the CIMIS station data to the four hydrologic subregions. Figure 1 shows the location of the CIMIS stations in relation to the four hydrologic subregions. The ET_0 values for each subregion, then are the average of those for the corresponding stations (Table 2). These ET_0 values are used to update the estimates of the crop monthly potential ET_c for each crop in each subregion.

Table 1
1993-1996 ET_0 Data Summary from Salinas Valley CIMIS Stations (In/Month)
Source: DWR, CIMIS Stations

	Castroville	Salinas - N	Salinas - S	Gonzalez	Arroyo Seco	King City
January	1.33	1.22	1.49	1.40	1.53	1.56
February	1.58	1.49	1.68	1.60	1.86	1.81
March	2.99	3.06	3.30	3.36	3.72	3.68
April	4.02	4.05	4.83	4.73	5.33	5.34
May	4.23	4.19	5.37	5.37	6.37	6.48
June	4.97	5.28	6.63	6.60	7.85	7.87
July	4.06	4.43	6.31	6.40	7.44	7.56
August	3.91	4.38	5.89	6.08	6.75	7.21
September	2.90	3.07	4.33	4.42	5.02	5.3
October	2.74	2.81	3.47	3.41	3.76	4.02
November	1.75	1.82	2.06	2.06	2.19	2.21
December	1.18	1.17	1.31	1.35	1.44	1.44
Total (In/Yr)	35.66	36.97	46.67	46.78	53.26	54.48
Apr - Sep	24.09	25.40	33.36	33.60	38.76	39.76



LOCATION OF CIMIS STATIONS
IN SALINAS VALLEY

Figure 1

MONTGOMERY WATSON

Table 2
CIMIS Stations used in each Hydrologic Subregion

Hydrologic Subregions	CIMIS Stations	Average Annual ET_o (In/Yr)
Pressure Area	Castroville and Gonzalez	41.22
East Side Area	Salinas - N and Salinas - S	41.82
Forebay Area	Arroyo Seco	53.26
Upper Valley Area	King City	54.48

Crop Potential ET (PET_c)

Potential evapotranspiration of crops can be determined by direct measurement or estimated by empirical methods. The direct measurements generally produce accurate results, but the level of effort required to site the measurements and setup equipment as well as the cost of the program at a regional level may not justify the accuracy obtained by the method. Direct measurement is made using lysimeters, neutron probes, and other equipment.

The empirical methods generally use equations such as Kohler, Blaney-Cridle or Penman equation to estimate the crop PET_c. In these cases, additional data such as air temperature, humidity, wind, and solar radiation is required.

A modified version of Penman equation is now used in the CIMIS program. The program determines daily turf grass reference crop ET (ET_o) from hourly computed values. Then crop coefficients are used to convert the ET_o values to crop PET_c values as follows:

$$ET_c = K_c * ET_o$$

in which K_c is the crop coefficient, estimated from ratio ET in the crop field to ET in turf grass, using various techniques, such as, Bowen Ratio energy method, and lysimeters.

DWR Bulletin 113-4 (1986) presents representative values of crop coefficients for some of the Central Valley crops. In general, however, crop coefficients vary by month during the crop growing season, and by climatic region. Since limited data is available on temporal and spatial variability of crop coefficients in the Central Coast areas, an average representative seasonal value for each crop, representing the Central Coast areas, is used in this study. These values are developed based on the information available from DWR Bulletin 113-3 and 113-4, data collected by Mr. Peter Canessa for MCWRA, and the knowledge of the hydrology and crop types in the valley. In addition, recent limited information collected by U.C. cooperative Extension and referred to in "Developing Crop Coefficient for Vegetable Crops in Central Coasts Using the Bowen Ratio Energy Balance Method" by Kurt Schulbach and Richard Snyder (1994-95) is used to develop representative regional estimates of crop coefficient. In order to prevent misinterpretation of this factor with actual crop coefficients, as measured in the field during growing season of crop, these values as presented in Table 3, are called "crop factors".

Table 3
Representative Crop Factors

Crop	**Crop Factor, C**
Pasture	1.00
Sugar Beets	0.78
Field Crops	0.80
Truck Crops	0.64
Orchard	0.78
Grains	0.70
Vineyard	0.52

Using the ET_0 for each subregion and the crop factors, the monthly crop PET_c for each subregion is calculated as:

$$PET_c = C * ET_0$$

In order to incorporate the effects of growing season PET_c , the annual crop PET_c is then redistributed on a monthly pattern over the growing season for each crop. Tables 4 through 7 present these values for each subregion. Table 8 presents a seasonal of the crop PET_c for each subregion.

Table 4
Estimated Crop PET$_c$ in the *Pressure Area*

Note: ET$_o$ is represented by average of Castroville and Gonzalez Stations

	Pasture	Sugar Beets	Field Crops	Truck Crops	Orchard	Grains	Vineyard	Average
January	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.14
February	0.00	0.00	0.00	1.02	0.00	1.11	0.00	0.30
March	3.18	2.48	2.54	2.03	2.48	2.22	0.00	2.13
April	4.41	3.44	3.53	2.82	3.44	3.09	2.29	3.29
May	4.79	3.74	3.83	3.07	3.74	3.35	2.49	3.57
June	5.87	4.58	4.70	3.76	4.58	0.00	3.05	3.79
July	5.30	4.13	4.24	3.39	4.13	0.00	2.76	3.42
August	5.07	3.95	4.05	3.24	3.95	0.00	2.63	3.27
September	3.68	2.87	2.94	2.36	2.87	0.00	1.91	2.38
October	3.11	2.42	2.49	1.99	2.42	0.00	1.62	2.01
November	0.00	0.00	0.00	0.00	0.00	1.35	0.00	0.19
December	0.00	0.00	0.00	0.00	0.00	0.88	0.00	0.13
Total (In/Yr)	35.40	27.61	28.32	23.67	27.61	12.95	16.75	24.62
Apr - Sep	29.11	22.71	23.29	18.63	22.71	6.44	15.14	19.72

Table 5
Estimated Crop PET$_c$ in the *East Side Area*

Note: ETo is represented by average of Salinas-N and Salinas-S Stations

	Pasture	Sugar Beets	Field Crops	Truck Crops	Orchard	Grains	Vineyard	Average
January	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.14
February	0.00	0.00	0.00	1.01	0.00	1.11	0.00	0.30
March	3.18	2.48	2.54	2.04	2.48	2.23	0.00	2.14
April	4.44	3.46	3.55	2.84	3.46	3.11	2.31	3.31
May	4.78	3.73	3.82	3.06	3.73	3.35	2.49	3.56
June	5.96	4.64	4.76	3.81	4.64	0.00	3.10	3.85
July	5.37	4.19	4.30	3.44	4.19	0.00	2.79	3.47
August	5.14	4.01	4.11	3.29	4.01	0.00	2.67	3.32
September	3.70	2.89	2.96	2.37	2.89	0.00	1.92	2.39
October	3.14	2.45	2.51	2.01	2.45	0.00	1.63	2.03
November	0.00	0.00	0.00	0.00	0.00	1.36	0.00	0.19
December	0.00	0.00	0.00	0.00	0.00	0.87	0.00	0.12
Total (In/Yr)	35.70	27.85	28.56	23.86	27.85	12.96	16.91	24.81
Apr - Sep	29.38	22.92	23.50	18.80	22.92	6.45	15.28	19.89

APPENDIX B

SVIGSM Water Budget Tables

LAND AND WATER USE IN AC.-FT. FOR PRESSURE AREA
AREA: 90781. ACRES

TIME	AG ACRES	URBAN ACRES	CUAW DEMAND	AG SUP. REQ. (+)	URBAN SUP. REQ. (+)	GW PUMPING (-)	SW DIVERSION (-)	RECOV. LOSS (+)	NON-REC. LOSS (+)	IMPORT (-)	EXPORT (+)	SHORTAGE (=)
1970	50076.	7855.	0.	130004.	12780.	142784.	0.	0.	0.	0.	0.	0.
1971	50384.	7995.	0.	126423.	13158.	139581.	0.	0.	0.	0.	0.	0.
1972	50694.	8134.	0.	145440.	13629.	159069.	0.	0.	0.	0.	0.	0.
1973	51002.	8274.	0.	128242.	14099.	142341.	0.	0.	0.	0.	0.	0.
1974	51310.	8412.	0.	103293.	14567.	117860.	0.	0.	0.	0.	0.	0.
1975	51618.	8552.	0.	119949.	15037.	134986.	0.	0.	0.	0.	0.	0.
1976	51926.	8690.	0.	111405.	15506.	126911.	0.	0.	0.	0.	0.	0.
1977	51918.	8757.	0.	134363.	16104.	150467.	0.	0.	0.	0.	0.	0.
1978	51908.	8823.	0.	112983.	16470.	129453.	0.	0.	0.	0.	0.	0.
1979	51901.	8890.	0.	133375.	16911.	150286.	0.	0.	0.	0.	0.	0.
1980	51891.	8955.	0.	115117.	15734.	130851.	0.	0.	0.	0.	0.	0.
1981	51883.	9021.	0.	116449.	15829.	132282.	0.	0.	0.	0.	0.	-4.
1982	51873.	9086.	0.	98602.	16299.	114904.	0.	0.	0.	0.	0.	-2.
1983	51964.	9482.	0.	97509.	16520.	114033.	0.	0.	0.	0.	0.	-4.
1984	52056.	9878.	0.	124243.	16687.	140933.	0.	0.	0.	0.	0.	-3.
1985	52147.	10274.	0.	115600.	16850.	132454.	0.	0.	0.	0.	0.	-4.
1986	52238.	10670.	0.	110783.	17014.	127881.	0.	0.	0.	0.	0.	-84.
1987	52328.	11066.	0.	120897.	17176.	138284.	0.	0.	0.	0.	0.	-211.
1988	52419.	11462.	0.	123245.	17340.	140798.	0.	0.	0.	0.	0.	-213.
1989	52510.	11858.	0.	113052.	16637.	129815.	0.	0.	0.	0.	0.	-126.
1990	52602.	12254.	0.	102629.	15765.	118546.	0.	0.	0.	0.	0.	-152.
1991	52693.	12650.	0.	113332.	16037.	129590.	0.	0.	0.	0.	0.	-221.
1992	52795.	12649.	0.	113269.	16868.	130257.	0.	0.	0.	0.	0.	-120.
1993	52897.	12647.	0.	106874.	17702.	124779.	0.	0.	0.	0.	0.	-203.
1994	52998.	12396.	0.	111518.	18533.	130249.	0.	0.	0.	0.	0.	-198.
AVERAGE	51921.	9949.	0.	117144.	15970.	133176.	0.	0.	0.	0.	0.	-62.

LAND AND WATER USE IN AC.-FT. FOR EAST SIDE AREA
AREA: 74476. ACRES

TIME	AG ACRES	URBAN ACRES	CUAW DEMAND	AG SUP. REQ. (+)	URBAN SUP. REQ. (+)	GW PUMPING (-)	SW DIVERSION (-)	RECOV. LOSS (+)	NON-REC. LOSS (+)	IMPORT (-)	EXPORT (+)	SHORTAGE (=)
1970	34302.	4064.	0.	95101.	2162.	97263.	0.	0.	0.	0.	0.	0.
1971	34711.	4356.	0.	91704.	2213.	93917.	0.	0.	0.	0.	0.	0.
1972	35124.	4649.	0.	103910.	2274.	106104.	0.	0.	0.	0.	0.	80.
1973	35534.	4941.	0.	91086.	2336.	93420.	0.	0.	0.	0.	0.	2.
1974	35946.	5232.	0.	74303.	2400.	76703.	0.	0.	0.	0.	0.	0.
1975	36356.	5522.	0.	85511.	2463.	87974.	0.	0.	0.	0.	0.	0.
1976	36767.	5811.	0.	79813.	2526.	82339.	0.	0.	0.	0.	0.	0.
1977	36568.	5984.	0.	93342.	2601.	95830.	0.	0.	0.	0.	0.	113.
1978	36367.	6152.	0.	78568.	2653.	81209.	0.	0.	0.	0.	0.	12.
1979	36172.	6317.	0.	91183.	2709.	93892.	0.	0.	0.	0.	0.	0.
1980	35973.	6482.	0.	76699.	4415.	81114.	0.	0.	0.	0.	0.	0.
1981	35772.	6646.	0.	77278.	4937.	82178.	0.	0.	0.	0.	0.	37.
1982	35573.	6810.	0.	64629.	5103.	69731.	0.	0.	0.	0.	0.	1.
1983	35688.	7273.	0.	63994.	5198.	69192.	0.	0.	0.	0.	0.	0.
1984	35802.	7736.	0.	81003.	5272.	86275.	0.	0.	0.	0.	0.	0.
1985	35919.	8199.	0.	75878.	5346.	81224.	0.	0.	0.	0.	0.	0.
1986	36033.	8662.	0.	73190.	5422.	78608.	0.	0.	0.	0.	0.	4.
1987	36148.	9126.	0.	80035.	5497.	85526.	0.	0.	0.	0.	0.	6.
1988	36262.	9589.	0.	81047.	5572.	86612.	0.	0.	0.	0.	0.	7.
1989	36379.	10052.	0.	75592.	5367.	80948.	0.	0.	0.	0.	0.	11.
1990	36493.	10515.	0.	68271.	7627.	75891.	0.	0.	0.	0.	0.	7.
1991	36608.	10978.	0.	75722.	8585.	84303.	0.	0.	0.	0.	0.	4.
1992	36660.	10978.	0.	75410.	9207.	84617.	0.	0.	0.	0.	0.	0.
1993	36713.	10978.	0.	71407.	9829.	81236.	0.	0.	0.	0.	0.	0.
1994	36765.	10968.	0.	74276.	10454.	84730.	0.	0.	0.	0.	0.	0.
AVERAGE	36025.	7521.	0.	79958.	4887.	84833.	0.	0.	0.	0.	0.	11.

LAND AND WATER USE IN AC.-FT. FOR FOREBAY AREA
AREA: 86692. ACRES

TIME	AG ACRES	URBAN ACRES	CUAW DEMAND	AG SUP. REQ. (+)	URBAN SUP. REQ. (+)	GW PUMPING (-)	SW DIVERSION (-)	RECOV. LOSS (+)	NON-REC. LOSS (+)	IMPORT (-)	EXPORT (+)	SHORTAGE (=)
1970	51701.	1871.	0.	186303.	1218.	187521.	0.	0.	0.	0.	0.	0.
1971	52504.	1886.	0.	191635.	1251.	192886.	0.	0.	0.	0.	0.	0.
1972	53309.	1901.	0.	199157.	1294.	200451.	0.	0.	0.	0.	0.	0.
1973	54112.	1916.	0.	177029.	1338.	178367.	0.	0.	0.	0.	0.	0.
1974	54916.	1932.	0.	171884.	1381.	173265.	0.	0.	0.	0.	0.	0.
1975	55718.	1947.	0.	171396.	1426.	172822.	0.	0.	0.	0.	0.	0.
1976	56521.	1962.	0.	164455.	1468.	165923.	0.	0.	0.	0.	0.	0.
1977	56412.	1998.	0.	178721.	1542.	180263.	0.	0.	0.	0.	0.	0.
1978	56301.	2033.	0.	166016.	1562.	167578.	0.	0.	0.	0.	0.	0.
1979	56193.	2069.	0.	176090.	1596.	177686.	0.	0.	0.	0.	0.	0.
1980	56082.	2104.	0.	145516.	1640.	147156.	0.	0.	0.	0.	0.	0.
1981	55973.	2140.	0.	150861.	1726.	152587.	0.	0.	0.	0.	0.	0.
1982	55862.	2175.	0.	128623.	1828.	130451.	0.	0.	0.	0.	0.	0.
1983	55876.	2254.	0.	131730.	1980.	133710.	0.	0.	0.	0.	0.	0.
1984	55889.	2333.	0.	153250.	2148.	155398.	0.	0.	0.	0.	0.	0.
1985	55902.	2412.	0.	147643.	2310.	149953.	0.	0.	0.	0.	0.	0.
1986	55916.	2491.	0.	132927.	2477.	135404.	0.	0.	0.	0.	0.	0.
1987	55929.	2569.	0.	150095.	2640.	152735.	0.	0.	0.	0.	0.	0.
1988	55943.	2648.	0.	147819.	2803.	150622.	0.	0.	0.	0.	0.	0.
1989	55956.	2727.	0.	143657.	2828.	146485.	0.	0.	0.	0.	0.	0.
1990	55969.	2806.	0.	126296.	3132.	129428.	0.	0.	0.	0.	0.	0.
1991	55983.	2885.	0.	137562.	3293.	140863.	0.	0.	0.	0.	0.	-8.
1992	56197.	2885.	0.	136254.	3457.	139713.	0.	0.	0.	0.	0.	-2.
1993	56410.	2885.	0.	133260.	3617.	136883.	0.	0.	0.	0.	0.	-6.
1994	56623.	2876.	0.	137694.	3780.	141474.	0.	0.	0.	0.	0.	0.
AVERAGE	55528.	2308.	0.	155435.	2149.	157585.	0.	0.	0.	0.	0.	-1.

LAND AND WATER USE IN AC.-FT. FOR UPPER VALLEY AREA
AREA: 92300. ACRES

TIME	AG ACRES	URBAN ACRES	CUAW DEMAND	AG SUP. REQ. (+)	URBAN SUP. REQ. (+)	GW PUMPING (-)	SW DIVERSION (-)	RECOV. LOSS (+)	NON-REC. LOSS (+)	IMPORT (-)	EXPORT (+)	SHORTAGE (=)
1970	36852.	2329.	0.	152890.	967.	153857.	0.	0.	0.	0.	0.	0.
1971	37950.	2495.	0.	158302.	997.	159299.	0.	0.	0.	0.	0.	0.
1972	39052.	2659.	0.	162877.	1034.	163911.	0.	0.	0.	0.	0.	0.
1973	40148.	2825.	0.	149525.	1072.	150597.	0.	0.	0.	0.	0.	0.
1974	41246.	2989.	0.	151395.	1109.	152504.	0.	0.	0.	0.	0.	0.
1975	42345.	3155.	0.	148092.	1146.	149238.	0.	0.	0.	0.	0.	0.
1976	43443.	3318.	0.	144588.	1181.	145769.	0.	0.	0.	0.	0.	0.
1977	44378.	3326.	0.	157372.	1218.	158590.	0.	0.	0.	0.	0.	0.
1978	45312.	3331.	0.	146063.	1256.	147319.	0.	0.	0.	0.	0.	0.
1979	46248.	3338.	0.	165689.	1292.	166981.	0.	0.	0.	0.	0.	0.
1980	47182.	3344.	0.	138303.	1329.	139632.	0.	0.	0.	0.	0.	0.
1981	48116.	3349.	0.	146669.	1376.	148045.	0.	0.	0.	0.	0.	0.
1982	49051.	3356.	0.	123316.	1424.	124740.	0.	0.	0.	0.	0.	0.
1983	48548.	3359.	0.	128838.	1441.	130279.	0.	0.	0.	0.	0.	0.
1984	48043.	3362.	0.	155263.	1450.	156713.	0.	0.	0.	0.	0.	0.
1985	47541.	3366.	0.	148365.	1460.	149825.	0.	0.	0.	0.	0.	0.
1986	47037.	3369.	0.	136967.	1468.	138435.	0.	0.	0.	0.	0.	0.
1987	46534.	3372.	0.	144327.	1477.	145804.	0.	0.	0.	0.	0.	0.
1988	46030.	3375.	0.	129647.	1487.	131134.	0.	0.	0.	0.	0.	0.
1989	45528.	3379.	0.	133236.	1423.	134659.	0.	0.	0.	0.	0.	0.
1990	45023.	3382.	0.	129419.	1505.	130924.	0.	0.	0.	0.	0.	0.
1991	44520.	3385.	0.	128246.	1975.	130221.	0.	0.	0.	0.	0.	0.
1992	44679.	3385.	0.	128094.	2554.	130648.	0.	0.	0.	0.	0.	0.
1993	44835.	3385.	0.	124157.	3135.	127292.	0.	0.	0.	0.	0.	0.
1994	44994.	3383.	0.	125527.	3711.	129238.	0.	0.	0.	0.	0.	0.
AVERAGE	44585.	3213.	0.	142287.	1539.	143826.	0.	0.	0.	0.	0.	0.

GROUND WATER BUDGET IN AC.-FT. FOR FOREBAY AREA
AREA: 86692. ACRES

TIME	DEEP PERC.	NET DEEP PERC. (+)	GAIN FROM STREAM (+)	RECHARGE (+)	OTHER INFLOW (+)	BOUNDARY INFLOW (+)	SUBSURF. INFLOW (+)	PUMPING (-)	CHANGE IN STORAGE (=)	END STORAGE 1000 AF	LAND SUBSIDENCE 1000 AF
1970	53293.	48469.	105089.	0.	0.	15401.	-7448.	187521.	-26009.	4503.8	0.0
1971	66603.	65891.	109741.	0.	0.	15482.	-4287.	192886.	-6059.	4498.0	0.0
1972	58453.	57823.	98123.	0.	0.	15403.	-4362.	200451.	-33464.	4463.5	0.0
1973	74216.	74835.	137754.	0.	0.	15803.	-5303.	178367.	44721.	4507.3	0.0
1974	61997.	63729.	133979.	0.	0.	15660.	-5711.	173265.	34392.	4542.3	0.0
1975	53945.	54752.	120849.	0.	0.	15839.	-7116.	172822.	11501.	4554.4	0.0
1976	43586.	45378.	84513.	0.	0.	15565.	-6099.	165923.	-26567.	4527.2	0.0
1977	47311.	44453.	81284.	0.	0.	15488.	-6304.	180263.	-45341.	4480.8	0.0
1978	66661.	67370.	154985.	0.	0.	16452.	-5263.	167578.	65967.	4546.4	0.0
1979	51572.	52909.	129778.	0.	0.	15914.	-6869.	177686.	14047.	4559.6	0.0
1980	43006.	47097.	132551.	0.	0.	16620.	-7372.	147156.	41740.	4599.7	0.0
1981	30089.	30356.	98846.	0.	0.	16132.	-7206.	152587.	-14460.	4583.1	0.0
1982	32159.	33486.	126743.	0.	0.	16332.	-6716.	130451.	39394.	4621.5	0.0
1983	62074.	61469.	114913.	0.	0.	17366.	-6923.	133710.	53115.	4674.1	0.0
1984	36533.	37231.	70446.	0.	0.	16876.	-7669.	155398.	-38514.	4632.9	0.0
1985	36870.	36520.	76192.	0.	0.	16556.	-5675.	149953.	-26360.	4603.8	0.0
1986	42347.	42338.	97435.	0.	0.	17427.	-6219.	135404.	15577.	4616.4	0.0
1987	29454.	28880.	71383.	0.	0.	16855.	-5852.	152735.	-41469.	4572.0	0.0
1988	31965.	31296.	81720.	0.	0.	16960.	-4767.	150622.	-25413.	4543.8	0.0
1989	29002.	28822.	82876.	0.	0.	16755.	-3852.	146485.	-21884.	4520.0	0.0
1990	20586.	21547.	20330.	0.	0.	16703.	-796.	129428.	-71644.	4442.6	0.0
1991	35945.	32949.	63031.	0.	0.	16845.	1685.	140863.	-26354.	4409.6	0.0
1992	30709.	31910.	105188.	0.	0.	16772.	1856.	139713.	16013.	4419.3	0.0
1993	37718.	38431.	165100.	0.	0.	17127.	-1612.	136883.	82163.	4496.7	0.0
1994	22912.	23553.	102997.	0.	0.	16799.	-8256.	141474.	-6381.	4489.1	0.0
AVERAGE	43960.	44060.	102634.	0.	0.	16365.	-5125.	157585.	348.	4489.1	0.0

GROUND WATER BUDGET IN AC.-FT. FOR UPPER VALLEY AREA
AREA: 92300. ACRES

TIME	DEEP PERC.	NET DEEP PERC. (+)	GAIN FROM STREAM (+)	RECHARGE (+)	OTHER INFLOW (+)	BOUNDARY INFLOW (+)	SUBSURF. INFLOW (+)	PUMPING (-)	CHANGE IN STORAGE (=)	END STORAGE 1000 AF	LAND SUBSIDENCE 1000 AF
1970	53833.	47941.	144819.	0.	0.	6104.	-15786.	153857.	29221.	2430.3	0.0
1971	69407.	69439.	115156.	0.	0.	6197.	-18694.	159299.	12798.	2441.4	0.0
1972	56145.	56938.	126845.	0.	0.	6154.	-18556.	163911.	7470.	2446.8	0.0
1973	85393.	83739.	81984.	0.	0.	6622.	-19011.	150597.	2737.	2448.6	0.0
1974	64269.	64884.	98892.	0.	0.	6549.	-17137.	152504.	683.	2447.9	0.0
1975	60985.	61286.	98832.	0.	0.	6653.	-16370.	149238.	1163.	2447.5	0.0
1976	45869.	49686.	112501.	0.	0.	6313.	-16776.	145769.	5955.	2452.2	0.0
1977	54599.	51576.	111125.	0.	0.	6282.	-17820.	158590.	-7427.	2443.4	0.0
1978	78217.	76485.	92363.	0.	0.	7405.	-18917.	147319.	10017.	2452.6	0.0
1979	67179.	67297.	104163.	0.	0.	6557.	-16784.	166981.	-5748.	2445.3	0.0
1980	64816.	66923.	90587.	0.	0.	7296.	-16146.	139632.	9030.	2453.2	0.0
1981	44727.	45589.	110045.	0.	0.	6588.	-15172.	148045.	-995.	2451.0	0.0
1982	46612.	47748.	94724.	0.	0.	6889.	-15657.	124740.	8964.	2459.2	0.0
1983	89291.	87257.	66859.	0.	0.	8164.	-14908.	130279.	17095.	2476.1	0.0
1984	57987.	58383.	76439.	0.	0.	6963.	-13250.	156713.	-28179.	2448.1	0.0
1985	57039.	57640.	102044.	0.	0.	6673.	-14077.	149825.	2454.	2450.4	0.0
1986	66681.	66201.	77801.	0.	0.	7660.	-14947.	138435.	-1721.	2448.7	0.0
1987	44187.	44765.	101908.	0.	0.	6840.	-15019.	145804.	-7310.	2441.0	0.0
1988	46900.	47204.	101322.	0.	0.	6935.	-16565.	131134.	7763.	2448.1	0.0
1989	44441.	45407.	106679.	0.	0.	6794.	-17694.	134659.	6527.	2453.7	0.0
1990	35336.	34689.	11438.	0.	0.	6818.	-18121.	130924.	-96100.	2358.5	0.0
1991	61177.	58107.	117992.	0.	0.	7026.	-16512.	130221.	36392.	2394.7	0.0
1992	44726.	47431.	114404.	0.	0.	6967.	-19310.	130648.	18844.	2412.1	0.0
1993	65977.	66258.	115565.	0.	0.	7527.	-20322.	127292.	41736.	2452.6	0.0
1994	39832.	40948.	99416.	0.	0.	6940.	-18535.	129238.	-470.	2450.8	0.0
AVERAGE	57825.	57753.	98956.	0.	0.	6837.	-16884.	143826.	2836.	2450.8	0.0

GROUND WATER BUDGET IN AC.-FT. FOR ENTIRE MODEL AREA
AREA: 416580. ACRES

TIME	DEEP PERC.	NET DEEP PERC. (+)	GAIN FROM STREAM (+)	RECHARGE (+)	OTHER INFLOW (+)	BOUNDARY INFLOW (+)	SUBSURF. INFLOW (+)	PUMPING (-)	CHANGE IN STORAGE (=)	END STORAGE 1000 AF	LAND SUBSIDENCE 1000 AF
1970	227425.	208274.	309355.	0.	1847.	46348.	0.	586473.	-20650.	18620.7	0.0
1971	259727.	257288.	252281.	0.	1409.	44533.	0.	590673.	-35161.	18586.2	0.0
1972	207094.	209369.	258189.	0.	1802.	55005.	0.	634562.	-110197.	18476.7	0.0
1973	343127.	330724.	290342.	0.	1452.	44783.	0.	569601.	97699.	18575.0	0.0
1974	272815.	278859.	311235.	0.	1097.	37217.	0.	525065.	103342.	18678.9	0.0
1975	211438.	219657.	290977.	0.	1410.	43994.	0.	549774.	6265.	18685.9	0.0
1976	158694.	172028.	245435.	0.	1610.	50004.	0.	525643.	-56565.	18630.0	0.0
1977	179821.	172611.	239979.	0.	1733.	56476.	0.	589880.	-119080.	18511.6	0.0
1978	301063.	287779.	339309.	0.	1437.	47405.	0.	530130.	145800.	18658.0	0.0
1979	217593.	224768.	295964.	0.	1653.	51512.	0.	593478.	-19580.	18639.1	0.0
1980	195144.	209022.	308362.	0.	1533.	51015.	0.	503248.	66684.	18706.5	0.0
1981	132000.	138559.	288609.	0.	1639.	54969.	0.	519383.	-35607.	18671.5	0.0
1982	193274.	188260.	313465.	0.	1375.	46670.	0.	443814.	105956.	18778.1	0.0
1983	310575.	303277.	294180.	0.	910.	35293.	0.	450885.	182775.	18961.5	0.0
1984	163650.	175255.	201394.	0.	1200.	43699.	0.	542799.	-121250.	18841.1	0.0
1985	158659.	163581.	252039.	0.	1412.	49294.	0.	516604.	-50279.	18791.5	0.0
1986	191208.	186154.	237679.	0.	1546.	49616.	0.	483110.	-8115.	18784.1	0.0
1987	141691.	142717.	222862.	0.	1719.	53837.	0.	524838.	-103702.	18681.0	0.0
1988	139881.	141587.	246009.	0.	1961.	60032.	0.	511335.	-61746.	18619.9	0.0
1989	134554.	135835.	246743.	0.	2075.	62387.	0.	493658.	-46617.	18573.8	0.0
1990	101378.	104553.	35432.	0.	2034.	64459.	0.	456314.	-249837.	18324.6	0.0
1991	180897.	162680.	199392.	0.	2254.	67423.	0.	486614.	-54865.	18270.3	0.0
1992	156077.	157695.	247883.	0.	2269.	68736.	0.	487138.	-10556.	18260.2	0.0
1993	215548.	212744.	392712.	0.	2049.	63233.	0.	472361.	198376.	18459.1	0.0
1994	116699.	126921.	285337.	0.	2177.	66190.	0.	488107.	-7482.	18452.2	0.0
AVERAGE	196401.	196408.	264207.	0.	1664.	52565.	0.	523019.	-8176.	18452.2	0.0

AVERAGE GROUNDWATER BUDGET IN AC.-FT. FROM 1970 THRU 1994

REGION	DEEP PERC.	NET DEEP PERC. (+)	GAIN FROM STREAM (+)	RECHARGE (+)	OTHER INFLOW (+)	BOUNDARY INFLOW (+)	SUBSURF. INFLOW (+)	PUMPING (-)	CHANGE IN STORAGE (=)	END STORAGE 1000 AF	LAND SUBSIDENCE 1000 AF
1	0.	0.	0.	0.	1664.	13999.	-15403.	0.	260.	1630.5	0.0
2	6985.	7069.	829.	0.	0.	378.	-2999.	3599.	1678.	488.4	0.0
3	54566.	54337.	59958.	0.	0.	8484.	29614.	133176.	19217.	6853.2	0.0
4	33065.	33189.	1830.	0.	0.	6502.	10798.	84833.	-32515.	2540.2	0.0
5	43960.	44060.	102634.	0.	0.	16365.	-5125.	157585.	348.	4489.1	0.0
6	57825.	57753.	98956.	0.	0.	6837.	-16884.	143826.	2836.	2450.8	0.0
TOTAL	196401.	196408.	264207.	0.	1664.	52565.	0.	523019.	-8176.	18452.2	0.0

STREAMFLOW BUDGET IN AC.-FT. FOR MONTEREY BAY
AREA: 37143. ACRES

TIME	UPSTREAM FLOW (+)	TRIB. FLOW (+)	D.R. FROM RAIN (+)	AG/URBAN SW RETURN (+)	GAIN FROM GW (+)	SW DIVERSION (-)	BY-PASS FLOW (-)	ERROR ADJUST. (+)	DOWNSTRM FLOW (=)	DIVERSION SHORT
1970	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1971	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1972	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1973	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1974	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1975	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1976	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1977	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1978	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1979	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1980	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1981	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1982	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1983	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1984	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1985	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1986	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1987	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1988	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1989	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1990	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1991	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1992	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1993	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1994	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
AVERAGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

STREAMFLOW BUDGET IN AC.-FT. FOR FORT ORD/TORO
AREA: 35187. ACRES

TIME	UPSTREAM FLOW (+)	TRIB. FLOW (+)	D.R. FROM RAIN (+)	AG/URBAN SW RETURN (+)	GAIN FROM GW (+)	SW DIVERSION (-)	BY-PASS FLOW (-)	ERROR ADJUST. (+)	DOWNSTRM FLOW (=)	DIVERSION SHORT
1970	636.	0.	909.	0.	-559.	0.	0.	0.	986.	0.
1971	335.	0.	409.	0.	-370.	0.	0.	0.	375.	0.
1972	72.	0.	22.	0.	-81.	0.	0.	0.	13.	0.
1973	3858.	491.	2215.	0.	-2131.	0.	0.	0.	4432.	0.
1974	1937.	0.	3491.	0.	-1280.	0.	0.	0.	4148.	0.
1975	665.	32.	181.	0.	-634.	0.	0.	0.	243.	0.
1976	86.	0.	28.	0.	-98.	0.	0.	0.	16.	0.
1977	73.	0.	39.	0.	-94.	0.	0.	0.	17.	0.
1978	2211.	581.	2178.	0.	-1614.	0.	0.	0.	3357.	0.
1979	803.	0.	201.	0.	-801.	0.	0.	0.	204.	0.
1980	1532.	376.	504.	0.	-1183.	0.	0.	0.	1230.	0.
1981	298.	0.	163.	0.	-346.	0.	0.	0.	114.	0.
1982	2029.	336.	1412.	0.	-1535.	0.	0.	0.	2242.	0.
1983	8188.	1398.	3059.	0.	-3760.	0.	0.	0.	8885.	0.
1984	887.	268.	308.	0.	-959.	0.	0.	0.	504.	0.
1985	133.	0.	392.	0.	-272.	0.	0.	0.	254.	0.
1986	996.	1571.	1015.	0.	-805.	0.	0.	0.	2778.	0.
1987	87.	0.	1174.	0.	-204.	0.	0.	0.	1057.	0.
1988	44.	0.	400.	0.	-193.	0.	0.	0.	251.	0.
1989	32.	0.	618.	0.	-207.	0.	0.	0.	443.	0.
1990	30.	0.	612.	0.	-214.	0.	0.	0.	428.	0.
1991	273.	21.	1028.	0.	-332.	0.	0.	0.	990.	0.
1992	1120.	13.	1525.	0.	-690.	0.	0.	0.	1967.	0.
1993	5044.	978.	2690.	0.	-2006.	0.	0.	0.	6707.	0.
1994	198.	0.	782.	0.	-357.	0.	0.	0.	623.	0.
AVERAGE	1263.	243.	1014.	0.	-829.	0.	0.	0.	1691.	0.

```
                          STREAMFLOW BUDGET  IN AC.-FT. FOR  PRESSURE AREA
                                  AREA:     90781. ACRES
----------------------------------------------------------------------------------------------------------------
          UPSTREAM    TRIB.     D.R.     AG/URBAN   GAIN        SW     BY-PASS      ERROR    DOWNSTRM  DIVERSION
   TIME     FLOW      FLOW   FROM RAIN  SW RETURN  FROM GW  DIVERSION   FLOW      ADJUST.     FLOW      SHORT
             (+)       (+)       (+)        (+)       (+)       (-)       (-)        (+)        (=)
----------------------------------------------------------------------------------------------------------------
   1970    118719.       0.    17522.     7595.   -56622.         0.        0.         0.     87214.         0.
   1971     56079.       0.    18334.     7621.   -26455.         0.        0.         0.     55580.         0.
   1972     41298.       0.     5279.     8271.   -33045.         0.        0.         0.     21803.         0.
   1973    513282.     732.    37879.     8404.   -63971.         0.        0.         0.    496325.         0.
   1974    347402.     297.    51205.     7537.   -71210.         0.        0.         0.    335232.         0.
   1975    328455.     201.     9902.     8554.   -69339.         0.        0.         0.    277773.         0.
   1976     52018.       0.     5410.     8498.   -48209.         0.        0.         0.     17716.         0.
   1977     51896.       0.     3968.     8624.   -47394.         0.        0.         0.     17095.         0.
   1978   1097545.     917.    37054.     8638.   -88516.         0.        0.         0.   1055638.         0.
   1979    143345.       0.     9227.     9326.   -60677.         0.        0.         0.    101219.         0.
   1980    846498.       0.    14922.     8074.   -81650.         0.        0.         0.    787844.         0.
   1981    136556.       0.     3858.     7983.   -79001.         0.        0.         0.     69397.         0.
   1982    394909.       0.    25950.     7756.   -84905.         0.        0.         0.    343711.         0.
   1983   1950695.      99.    42858.     8070.   -97190.         0.        0.         0.   1904532.         0.
   1984    306259.       0.     6113.     8286.   -50959.         0.        0.         0.    269699.         0.
   1985     91349.       0.     6921.     8184.   -73121.         0.        0.         0.     33333.         0.
   1986    573522.       0.    17049.     8285.   -59516.         0.        0.         0.    539340.         0.
   1987     60511.       0.    16300.     8456.   -49123.         0.        0.         0.     36144.         0.
   1988     70028.       0.     5703.     8321.   -62688.         0.        0.         0.     21364.         0.
   1989     64775.       0.     8110.     7876.   -56867.         0.        0.         0.     23894.         0.
   1990      1615.       0.     7413.     7399.    -3334.         0.        0.         0.     13093.         0.
   1991     76813.       0.    13339.     7637.   -17822.         0.        0.         0.     79967.         0.
   1992     87399.       0.    19089.     7935.   -27213.         0.        0.         0.     87210.         0.
   1993    571516.       0.    30613.     8061.  -107729.         0.        0.         0.    502461.         0.
   1994     96245.       0.     8464.     8697.   -82393.         0.        0.         0.     31013.         0.
----------------------------------------------------------------------------------------------------------------
AVERAGE    323149.      90.    16899.     8164.   -59958.         0.        0.         0.    288344.         0.
----------------------------------------------------------------------------------------------------------------
```

```
                          STREAMFLOW BUDGET  IN AC.-FT. FOR  EAST SIDE AREA
                                  AREA:     74476. ACRES
----------------------------------------------------------------------------------------------------------------
          UPSTREAM    TRIB.     D.R.     AG/URBAN   GAIN        SW     BY-PASS      ERROR    DOWNSTRM  DIVERSION
   TIME     FLOW      FLOW   FROM RAIN  SW RETURN  FROM GW  DIVERSION   FLOW      ADJUST.     FLOW      SHORT
             (+)       (+)       (+)        (+)       (+)       (-)       (-)        (+)        (=)
----------------------------------------------------------------------------------------------------------------
   1970      2625.       0.     1270.      165.    -2266.         0.        0.         0.      1794.         0.
   1971       436.       0.     1317.      153.     -560.         0.        0.         0.      1345.         0.
   1972         0.       0.      435.      194.      -94.         0.        0.         0.       534.         0.
   1973      7301.       0.     2646.      196.    -4501.         0.        0.         0.      5641.         0.
   1974      9151.       0.     3410.       91.    -5875.         0.        0.         0.      6777.         0.
   1975      1342.       0.      815.      175.    -1323.         0.        0.         0.      1008.         0.
   1976         0.       0.      467.      151.     -115.         0.        0.         0.       503.         0.
   1977         0.       0.      331.      127.      -83.         0.        0.         0.       375.         0.
   1978      2440.       0.     2490.      122.    -1831.         0.        0.         0.      3221.         0.
   1979       550.       0.      669.      166.     -545.         0.        0.         0.       839.         0.
   1980      3669.       0.     1048.       93.    -2391.         0.        0.         0.      2419.         0.
   1981       611.       0.      289.       81.     -371.         0.        0.         0.       609.         0.
   1982      8375.       0.     1753.       48.    -5558.         0.        0.         0.      4618.         0.
   1983     21510.       0.     2771.       71.   -11458.         0.        0.         0.     12893.         0.
   1984      3013.       0.      439.       74.    -2592.         0.        0.         0.       934.         0.
   1985       380.       0.      466.       63.     -411.         0.        0.         0.       498.         0.
   1986      3551.       0.     1093.       69.    -2124.         0.        0.         0.      2589.         0.
   1987       133.       0.      987.       74.     -245.         0.        0.         0.       950.         0.
   1988         0.       0.      342.       56.      -86.         0.        0.         0.       313.         0.
   1989         5.       0.      475.       62.     -114.         0.        0.         0.       428.         0.
   1990        13.       0.      424.       39.     -116.         0.        0.         0.       360.         0.
   1991       100.       0.      815.       50.     -215.         0.        0.         0.       750.         0.
   1992       237.       0.     1097.       46.     -388.         0.        0.         0.       992.         0.
   1993      3083.       0.     1884.       32.    -2312.         0.        0.         0.      2687.         0.
   1994        51.       0.      533.       46.     -174.         0.        0.         0.       455.         0.
----------------------------------------------------------------------------------------------------------------
AVERAGE      2743.       0.     1131.       98.    -1830.         0.        0.         0.      2141.         0.
----------------------------------------------------------------------------------------------------------------
```

STREAMFLOW BUDGET IN AC.-FT. FOR FOREBAY AREA
AREA: 86692. ACRES

TIME	UPSTREAM FLOW (+)	TRIB. FLOW (+)	D.R. FROM RAIN (+)	AG/URBAN SW RETURN (+)	GAIN FROM GW (+)	SW DIVERSION (-)	BY-PASS FLOW (-)	ERROR ADJUST. (+)	DOWNSTRM FLOW (=)	DIVERSION SHORT
1970	217219.	0.	1414.	2396.	-105089.	0.	0.	0.	115939.	0.
1971	151445.	701.	9581.	2375.	-109741.	0.	0.	0.	54360.	0.
1972	131524.	0.	4851.	2498.	-98123.	0.	0.	0.	40750.	0.
1973	614537.	6338.	17661.	2426.	-137754.	0.	0.	0.	503208.	0.
1974	452383.	5108.	11125.	1839.	-133979.	0.	0.	0.	336477.	0.
1975	427911.	12685.	5369.	2087.	-120849.	0.	0.	0.	327203.	0.
1976	132307.	6.	1695.	2003.	-84513.	0.	0.	0.	51498.	0.
1977	130224.	0.	782.	1782.	-81284.	0.	0.	0.	51504.	0.
1978	1210052.	16106.	17896.	1899.	-154985.	0.	0.	0.	1090968.	0.
1979	265546.	1176.	3384.	1973.	-129778.	0.	0.	0.	142301.	0.
1980	954817.	13524.	5860.	1198.	-132551.	0.	0.	0.	842848.	0.
1981	232123.	699.	692.	1165.	-98846.	0.	0.	0.	135833.	0.
1982	502602.	7914.	3494.	782.	-126743.	0.	0.	0.	388049.	0.
1983	2003813.	19928.	18991.	1097.	-114913.	0.	0.	0.	1928917.	0.
1984	363637.	7541.	2937.	1152.	-70446.	0.	0.	0.	304821.	0.
1985	163849.	0.	1877.	1063.	-76192.	0.	0.	0.	90598.	0.
1986	635229.	19652.	9706.	1004.	-97435.	0.	0.	0.	568155.	0.
1987	127654.	182.	944.	1107.	-71383.	0.	0.	0.	58505.	0.
1988	147072.	1228.	1983.	901.	-81720.	0.	0.	0.	69464.	0.
1989	144662.	0.	1064.	1054.	-82876.	0.	0.	0.	63904.	0.
1990	19445.	0.	1002.	711.	-20330.	0.	0.	0.	827.	0.
1991	129466.	2906.	4932.	800.	-63031.	0.	0.	0.	75074.	0.
1992	183298.	498.	5048.	783.	-105188.	0.	0.	0.	84439.	0.
1993	716008.	3365.	7154.	695.	-165100.	0.	0.	0.	562122.	0.
1994	196448.	17.	916.	784.	-102997.	0.	0.	0.	95167.	0.
AVERAGE	410131.	4783.	5614.	1423.	-102634.	0.	0.	0.	319317.	0.

STREAMFLOW BUDGET IN AC.-FT. FOR UPPER VALLEY AREA
AREA: 92300. ACRES

TIME	UPSTREAM FLOW (+)	TRIB. FLOW (+)	D.R. FROM RAIN (+)	AG/URBAN SW RETURN (+)	GAIN FROM GW (+)	SW DIVERSION (-)	BY-PASS FLOW (-)	ERROR ADJUST. (+)	DOWNSTRM FLOW (=)	DIVERSION SHORT
1970	260902.	0.	1208.	5664.	-144819.	0.	0.	0.	122955.	0.
1971	189042.	1207.	8632.	5749.	-115156.	0.	0.	0.	89475.	0.
1972	223197.	0.	3097.	5792.	-126845.	0.	0.	0.	105241.	0.
1973	438759.	4874.	16793.	5838.	-81984.	0.	0.	0.	384280.	0.
1974	380188.	8938.	14641.	5842.	-98892.	0.	0.	0.	310717.	0.
1975	321337.	17985.	15121.	5876.	-98832.	0.	0.	0.	261488.	0.
1976	225345.	15.	2476.	5880.	-112501.	0.	0.	0.	121215.	0.
1977	229209.	0.	1065.	6031.	-111125.	0.	0.	0.	125180.	0.
1978	948606.	16362.	17992.	6017.	-92363.	0.	0.	0.	896612.	0.
1979	238265.	1648.	4163.	6219.	-104163.	0.	0.	0.	146131.	0.
1980	711880.	20459.	11517.	6812.	-90587.	0.	0.	0.	660081.	0.
1981	249789.	1156.	1578.	7139.	-110045.	0.	0.	0.	149617.	0.
1982	318889.	10983.	6350.	7018.	-94724.	0.	0.	0.	248515.	0.
1983	1492018.	33140.	24953.	7120.	-66859.	0.	0.	0.	1490372.	0.
1984	326409.	11608.	4656.	7266.	-76439.	0.	0.	0.	273500.	0.
1985	211083.	0.	2766.	7202.	-102044.	0.	0.	0.	119007.	0.
1986	411307.	34624.	25183.	7185.	-77801.	0.	0.	0.	400500.	0.
1987	189391.	248.	1317.	7191.	-101908.	0.	0.	0.	96240.	0.
1988	212963.	1443.	3761.	7091.	-101322.	0.	0.	0.	123935.	0.
1989	220433.	0.	3203.	6678.	-106679.	0.	0.	0.	123636.	0.
1990	7474.	1.	935.	8036.	-11438.	0.	0.	0.	5009.	0.
1991	175867.	4264.	10433.	9053.	-117992.	0.	0.	0.	81625.	0.
1992	210069.	255.	3747.	9913.	-114404.	0.	0.	0.	109581.	0.
1993	585068.	7424.	13857.	10738.	-115565.	0.	0.	0.	501521.	0.
1994	251095.	0.	2180.	11628.	-99416.	0.	0.	0.	165487.	0.
AVERAGE	361143.	7065.	8065.	7159.	-98956.	0.	0.	0.	284477.	0.

```
                         STREAMFLOW BUDGET  IN AC.-FT. FOR ENTIRE MODEL AREA
                              AREA:   416580. ACRES
 -----------------------------------------------------------------------------------------------------------
          UPSTREAM    TRIB.     D.R.      AG/URBAN    GAIN       SW       BY-PASS    ERROR    DOWNSTRM DIVERSION
  TIME      FLOW      FLOW    FROM RAIN  SW RETURN  FROM GW  DIVERSION  FLOW      ADJUST.    FLOW     SHORT
            (+)       (+)       (+)        (+)        (+)       (-)       (-)        (+)       (=)
 -----------------------------------------------------------------------------------------------------------
  1970   358427.        0.    22322.    15820.  -309355.        0.        0.        0.    87214.        0.
  1971   251783.     1907.    38273.    15898.  -252281.        0.        0.        0.    55580.        0.
  1972   249553.        0.    13683.    16755.  -258189.        0.        0.        0.    21803.        0.
  1973   680174.    12436.    77193.    16864.  -290342.        0.        0.        0.   496325.        0.
  1974   532940.    14344.    83872.    15310.  -311235.        0.        0.        0.   335232.        0.
  1975   489767.    30903.    31388.    16692.  -290977.        0.        0.        0.   277773.        0.
  1976   236522.       21.    10075.    16532.  -245435.        0.        0.        0.    17716.        0.
  1977   234325.        0.     6185.    16563.  -239979.        0.        0.        0.    17095.        0.
  1978  1266696.    33966.    77610.    16676.  -339309.        0.        0.        0.  1055638.        0.
  1979   359034.     2823.    17643.    17683.  -295964.        0.        0.        0.   101219.        0.
  1980  1011818.    34360.    33852.    16178.  -308362.        0.        0.        0.   787844.        0.
  1981   333203.     1855.     6579.    16369.  -288609.        0.        0.        0.    69397.        0.
  1982   583379.    19234.    38959.    15604.  -313465.        0.        0.        0.   343711.        0.
  1983  2035157.    54564.    92632.    16359.  -294180.        0.        0.        0.  1904532.        0.
  1984   420446.    19417.    14452.    16778.  -201394.        0.        0.        0.   269699.        0.
  1985   256438.        0.    12422.    16512.  -252039.        0.        0.        0.    33333.        0.
  1986   650584.    55847.    54047.    16543.  -237679.        0.        0.        0.   539340.        0.
  1987   221024.      431.    20723.    16828.  -222862.        0.        0.        0.    36144.        0.
  1988   236144.     2671.    12189.    16370.  -246009.        0.        0.        0.    21364.        0.
  1989   241496.        0.    13471.    15670.  -246743.        0.        0.        0.    23894.        0.
  1990    21953.        1.    10387.    16184.   -35432.        0.        0.        0.    13093.        0.
  1991   224081.     7191.    30547.    17540.  -199392.        0.        0.        0.    79967.        0.
  1992   285143.      767.    30506.    18677.  -247883.        0.        0.        0.    87210.        0.
  1993   807682.    11766.    56199.    19526.  -392712.        0.        0.        0.   502461.        0.
  1994   282304.       17.    12875.    21155.  -285337.        0.        0.        0.    31013.        0.
 -----------------------------------------------------------------------------------------------------------
AVERAGE  490803.    12181.    32723.    16843.  -264207.        0.        0.        0.   288344.        0.
 -----------------------------------------------------------------------------------------------------------

                         AVERAGE STREAMFLOW BUDGET IN AC.-FT. FROM   1970 THRU   1994
 -----------------------------------------------------------------------------------------------------------
          UPSTREAM    TRIB.     D.R.      AG/URBAN    GAIN       SW       BY-PASS    ERROR    DOWNSTRM DIVERSION
 REGION     FLOW      FLOW    FROM RAIN  SW RETURN  FROM GW  DIVERSION  FLOW      ADJUST.    FLOW     SHORT
            (+)       (+)       (+)        (+)        (+)       (-)       (-)        (+)       (=)
 -----------------------------------------------------------------------------------------------------------
    1          0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
    2       1263.      243.     1014.        0.     -829.        0.        0.        0.     1691.        0.
    3     323149.       90.    16899.     8164.   -59958.        0.        0.        0.   288344.        0.
    4       2743.        0.     1131.       98.    -1830.        0.        0.        0.     2141.        0.
    5     410131.     4783.     5614.     1423.  -102634.        0.        0.        0.   319317.        0.
    6     361143.     7065.     8065.     7159.   -98956.        0.        0.        0.   284477.        0.
 -----------------------------------------------------------------------------------------------------------
TOTAL    490803.    12181.    32723.    16843.  -264207.        0.        0.        0.   288344.        0.
 -----------------------------------------------------------------------------------------------------------
```

SOIL MOISTURE BUDGET IN INCHES FOR MONTEREY BAY
AREA: 37143. ACRES

	AGRICULTURAL AREA							MUNICIPAL AREA						UNDEVELOPED AREA			
TIME	RAIN	IRIG.	C.U.	ET	D.R.	RETURN	PERC.	RAIN	W.U.	ET	D.R.	RETURN	PERC.	RAIN	ET	D.R.	PERC.
1970	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1971	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1972	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1973	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1974	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1975	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1976	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1977	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1978	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1979	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1980	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1981	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1982	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1983	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1984	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1985	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1986	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1987	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1988	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1989	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1990	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1991	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1992	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1993	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1994	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

SOIL MOISTURE BUDGET IN INCHES FOR FORT ORD/TORO
AREA: 35187. ACRES

	AGRICULTURAL AREA							MUNICIPAL AREA						UNDEVELOPED AREA			
TIME	RAIN	IRIG.	C.U.	ET	D.R.	RETURN	PERC.	RAIN	W.U.	ET	D.R.	RETURN	PERC.	RAIN	ET	D.R.	PERC.
1970	14.4	56.7	34.2	41.1	1.1	0.3	28.0	14.9	12.3	8.6	8.6	6.6	2.8	15.1	10.7	0.7	3.6
1971	14.2	55.0	33.8	40.5	1.0	0.3	27.4	14.7	12.2	8.2	8.5	6.6	3.7	14.8	11.3	0.2	3.2
1972	7.1	61.1	36.2	41.0	0.1	0.3	26.8	7.4	12.1	6.9	4.1	6.5	2.0	7.4	6.8	0.0	0.6
1973	22.6	52.8	31.6	43.0	1.7	0.3	30.4	23.5	12.0	10.4	13.8	6.4	4.8	23.6	15.4	1.7	6.5
1974	24.5	45.1	28.0	39.4	3.3	0.2	26.6	25.4	11.9	9.3	15.7	6.4	5.9	25.6	16.5	3.4	5.8
1975	14.0	50.6	31.0	41.6	0.1	0.3	22.7	14.6	11.7	9.6	8.2	6.3	2.2	14.7	12.9	0.1	1.6
1976	9.2	49.8	32.0	38.2	0.0	0.2	20.6	9.6	11.6	7.3	5.2	6.2	2.4	9.7	8.0	0.0	0.5
1977	6.9	56.7	34.8	38.8	0.0	0.3	24.5	7.2	11.5	7.1	3.7	6.2	1.7	7.2	7.9	0.0	0.5
1978	22.2	48.7	28.9	42.0	2.1	0.2	26.5	23.1	11.3	10.9	14.0	6.1	3.5	23.2	15.7	1.4	6.1
1979	11.8	58.0	33.8	41.9	0.2	0.3	27.4	12.3	11.2	8.7	7.0	6.0	1.8	12.3	11.0	0.0	1.4
1980	13.7	50.6	33.6	41.8	0.4	0.3	21.7	14.3	11.1	8.9	8.1	6.0	2.5	14.3	12.0	0.3	2.0
1981	7.1	50.3	32.2	38.7	0.0	0.3	18.5	7.4	10.5	7.1	4.1	5.7	1.1	7.4	7.0	0.0	0.4
1982	21.0	44.6	30.6	42.3	1.0	0.2	22.0	21.9	9.9	9.9	12.8	5.3	3.6	21.9	16.5	0.7	3.9
1983	26.5	43.5	29.1	43.4	2.7	0.2	23.7	26.1	8.7	10.3	15.5	4.7	4.2	26.5	17.5	1.9	6.7
1984	9.6	54.3	35.0	41.5	0.1	0.3	22.2	9.0	7.6	6.2	5.0	4.1	1.6	9.3	9.9	0.0	0.5
1985	10.8	49.2	32.4	40.5	0.0	0.2	19.5	10.2	6.6	6.3	5.6	3.6	1.4	10.4	9.9	0.0	0.6
1986	13.0	49.0	32.9	41.9	0.5	0.2	19.7	13.0	5.8	6.6	7.4	3.1	1.3	13.0	9.9	0.4	2.0
1987	10.0	52.7	33.7	41.2	1.2	0.3	20.3	10.2	4.9	6.0	5.9	2.7	1.0	10.2	8.9	0.8	1.1
1988	8.8	52.5	35.6	41.6	0.0	0.3	19.6	7.7	4.2	4.8	4.1	2.3	0.7	7.8	7.4	0.0	0.4
1989	11.8	50.4	33.4	42.2	0.1	0.3	19.6	10.3	3.3	5.1	5.7	1.7	0.8	10.4	9.3	0.0	0.6
1990	10.6	45.6	32.9	41.9	0.1	0.2	15.1	9.4	2.9	5.3	5.2	1.6	0.6	9.5	9.4	0.0	0.5
1991	15.2	45.3	33.1	46.3	0.6	0.2	15.4	11.4	3.1	5.4	6.4	1.7	1.0	11.4	8.9	0.2	2.4
1992	13.6	38.7	27.7	37.4	1.0	0.2	13.6	13.5	3.6	6.1	7.8	1.9	1.3	13.4	10.6	0.5	2.3
1993	18.9	40.0	28.3	38.7	2.0	0.2	17.9	18.8	4.2	7.2	11.1	2.2	2.4	18.6	12.8	1.1	4.7
1994	10.6	41.3	29.2	37.2	0.3	0.2	13.8	10.4	4.7	6.1	5.7	2.5	0.7	10.3	9.6	0.0	0.7
AVERAGE	13.9	49.7	32.2	41.0	0.8	0.2	21.7	13.9	8.4	7.5	8.0	4.5	2.2	13.9	11.0	0.5	2.3

SOIL MOISTURE BUDGET IN INCHES FOR PRESSURE AREA

AREA: 90781. ACRES

	AGRICULTURAL AREA							MUNICIPAL AREA						UNDEVELOPED AREA			
TIME	RAIN	IRIG.	C.U.	ET	D.R.	RETURN	PERC.	RAIN	W.U.	ET	D.R.	RETURN	PERC.	RAIN	ET	D.R.	PERC.
1970	13.9	31.2	21.4	28.9	1.1	0.2	13.1	13.9	19.5	12.0	7.2	10.5	2.5	14.2	10.5	0.5	3.3
1971	13.8	30.1	20.5	28.6	1.4	0.2	13.6	13.6	19.7	11.4	7.1	10.6	4.1	14.2	10.9	0.1	3.1
1972	7.0	34.4	23.3	28.6	0.3	0.2	12.4	6.8	20.1	10.1	3.4	10.8	2.7	7.2	6.6	0.0	0.7
1973	22.5	30.2	19.7	31.2	2.7	0.2	18.4	21.9	20.4	14.6	11.8	10.9	4.9	22.8	15.5	1.1	6.2
1974	23.3	24.2	18.0	29.6	3.6	0.1	14.1	23.5	20.8	13.5	13.5	11.1	6.0	24.2	16.5	2.4	5.3
1975	14.1	27.9	18.8	29.8	0.4	0.1	11.6	13.7	21.1	13.6	6.5	11.3	3.3	14.2	12.6	0.1	1.5
1976	9.2	25.7	17.5	26.2	0.1	0.1	9.1	9.0	21.4	11.0	4.4	11.5	3.4	9.3	7.6	0.0	0.5
1977	7.0	31.1	21.6	26.7	0.1	0.2	10.5	6.8	22.1	11.1	3.1	11.8	2.8	7.0	7.6	0.0	0.5
1978	22.1	26.1	17.7	30.4	2.6	0.1	15.1	21.7	22.4	16.0	11.8	12.0	4.3	22.3	15.6	0.9	5.9
1979	11.9	30.8	20.4	29.7	0.4	0.2	12.4	11.6	22.8	13.4	5.8	12.2	3.0	12.0	10.6	0.0	1.4
1980	13.9	26.6	19.5	29.6	0.8	0.1	10.1	13.5	21.1	13.0	6.7	11.3	3.5	13.9	11.8	0.2	2.0
1981	7.2	26.9	19.4	26.2	0.0	0.1	7.8	7.0	21.1	11.5	3.3	11.3	2.0	7.3	6.8	0.0	0.4
1982	20.2	22.8	16.4	30.0	1.4	0.1	11.8	20.5	21.5	14.8	10.8	11.5	4.9	20.9	16.1	0.5	3.6
1983	25.1	22.5	15.4	30.1	2.5	0.1	14.8	24.7	20.9	15.7	13.4	11.2	5.3	25.8	17.8	1.2	6.6
1984	8.9	28.6	20.6	27.7	0.0	0.1	9.3	8.6	20.3	10.8	4.1	10.9	3.0	9.1	9.6	0.0	0.6
1985	10.0	26.6	19.5	27.9	0.0	0.1	8.5	9.7	19.7	11.1	4.6	10.5	3.0	10.3	9.7	0.0	0.6
1986	13.0	25.4	18.3	28.2	0.8	0.1	9.5	12.5	19.1	12.3	6.1	10.3	2.9	13.0	10.1	0.4	2.0
1987	9.4	27.7	20.0	27.2	0.9	0.1	8.7	9.7	18.6	11.7	4.8	10.0	1.8	9.9	8.8	0.6	1.1
1988	7.7	28.2	20.6	27.5	0.0	0.1	8.3	7.4	18.2	10.1	3.5	9.7	2.2	7.9	7.4	0.0	0.4
1989	9.6	25.8	18.7	27.6	0.1	0.1	8.0	9.7	16.8	10.7	4.6	8.8	2.3	10.2	9.0	0.0	0.7
1990	8.8	23.4	18.1	26.0	0.0	0.1	5.9	8.9	15.4	10.2	4.3	8.3	1.6	9.3	9.2	0.0	0.6
1991	10.8	25.8	19.1	26.6	0.4	0.1	9.5	10.9	15.2	11.1	5.2	8.1	1.7	11.3	9.0	0.2	2.3
1992	12.6	25.7	19.4	28.5	0.8	0.1	9.0	12.8	16.0	11.8	6.5	8.6	2.0	13.3	10.4	0.5	2.4
1993	17.4	24.2	18.7	29.4	1.2	0.1	10.8	17.8	16.8	12.9	9.2	9.0	3.4	18.4	12.9	0.8	4.7
1994	9.3	25.3	19.3	27.5	0.1	0.1	6.9	9.8	17.9	11.8	4.6	9.6	1.7	10.1	9.3	0.0	0.8
AVERAGE	13.1	27.1	19.3	28.4	0.9	0.1	10.8	13.0	19.6	12.3	6.6	10.5	3.1	13.5	10.9	0.4	2.3

SOIL MOISTURE BUDGET IN INCHES FOR EAST SIDE AREA

AREA: 74476. ACRES

	AGRICULTURAL AREA							MUNICIPAL AREA						UNDEVELOPED AREA			
TIME	RAIN	IRIG.	C.U.	ET	D.R.	RETURN	PERC.	RAIN	W.U.	ET	D.R.	RETURN	PERC.	RAIN	ET	D.R.	PERC.
1970	13.0	33.3	23.6	30.9	1.2	0.6	11.7	14.4	6.4	7.3	8.7	3.4	0.9	15.4	10.6	1.3	3.5
1971	12.9	31.7	22.4	30.0	1.9	0.6	11.9	13.6	6.1	6.5	8.6	3.3	1.2	15.5	11.2	0.7	3.6
1972	6.6	35.5	25.1	30.0	0.5	0.7	10.8	6.9	5.9	5.0	4.0	3.1	0.5	7.9	7.2	0.0	0.8
1973	21.2	30.8	21.0	32.5	3.1	0.7	15.4	22.4	5.7	9.3	14.0	3.0	1.7	25.2	15.2	2.7	7.3
1974	21.6	24.8	19.0	30.6	3.8	0.3	11.5	24.0	5.5	8.3	15.8	2.9	2.4	26.5	16.6	4.2	5.7
1975	13.4	28.2	20.0	30.9	0.4	0.7	9.6	14.2	5.4	8.0	8.0	2.9	0.6	15.8	13.5	0.3	2.1
1976	8.6	26.0	19.0	27.1	0.2	0.6	7.3	9.3	5.2	5.6	5.1	2.8	0.5	10.3	8.5	0.0	0.5
1977	6.6	30.6	22.4	27.6	0.1	0.5	8.6	7.1	5.2	5.7	3.8	2.8	0.5	7.8	8.6	0.0	0.4
1978	20.9	25.9	18.7	31.4	2.8	0.5	12.2	23.2	5.2	9.5	14.5	2.8	1.6	24.6	15.7	2.2	6.7
1979	11.3	30.2	21.3	30.4	0.4	0.6	10.1	12.4	5.1	7.2	7.1	2.8	0.6	13.2	11.4	0.1	1.7
1980	13.3	25.6	20.0	30.0	1.0	0.4	7.6	14.5	8.2	8.6	8.5	4.3	1.0	15.4	12.3	0.6	2.4
1981	6.9	25.9	19.9	26.6	0.0	0.3	6.0	7.6	8.9	7.0	4.3	4.8	0.5	8.0	7.6	0.0	0.3
1982	19.1	21.8	16.7	30.2	1.7	0.2	9.3	22.4	9.0	10.3	13.8	4.8	2.1	22.4	16.3	1.3	4.0
1983	24.0	21.5	15.7	30.3	3.1	0.3	11.7	26.9	8.6	11.1	17.0	4.6	2.6	28.0	17.6	2.8	7.3
1984	8.5	27.2	20.8	27.8	0.2	0.3	7.1	9.3	8.2	6.8	5.4	4.4	1.3	9.9	10.6	0.0	0.4
1985	9.6	25.3	19.7	27.9	0.2	0.3	6.6	10.6	7.8	7.1	5.9	4.2	1.2	11.1	10.7	0.0	0.5
1986	12.6	24.4	18.6	28.5	0.9	0.3	7.4	13.7	7.5	7.9	7.9	4.0	1.0	14.4	10.7	1.0	2.0
1987	9.1	26.6	20.3	27.5	0.8	0.3	6.7	10.7	7.2	7.5	6.3	3.9	0.6	10.5	9.3	1.0	0.8
1988	7.5	26.8	20.7	27.7	0.1	0.2	6.3	8.0	7.0	6.1	4.4	3.7	0.8	8.6	8.3	0.0	0.3
1989	9.3	24.9	19.2	27.9	0.1	0.3	6.2	10.8	6.4	6.6	6.1	3.3	0.7	10.8	9.7	0.0	0.5
1990	8.5	22.4	18.3	26.3	0.0	0.2	4.4	9.9	8.7	7.8	5.6	4.6	0.8	9.8	9.8	0.0	0.4
1991	10.5	24.8	19.6	27.0	0.6	0.2	7.4	12.1	9.4	8.3	6.9	5.0	1.1	12.0	9.1	0.5	2.5
1992	12.3	24.7	19.8	28.9	0.8	0.2	6.9	14.3	10.1	9.1	8.5	5.4	1.4	14.0	10.6	0.9	2.4
1993	16.8	23.3	19.0	29.7	1.7	0.1	8.5	19.8	10.7	10.1	12.1	5.7	2.5	19.2	12.8	1.9	4.5
1994	9.1	24.2	19.5	27.9	0.0	0.2	5.1	10.8	11.4	9.1	6.1	6.1	0.9	10.4	9.8	0.0	0.6
AVERAGE	12.5	26.7	20.0	29.0	1.0	0.4	8.6	14.0	7.4	7.8	8.3	3.9	1.2	14.7	11.3	0.9	2.4

SOIL MOISTURE BUDGET IN INCHES FOR FOREBAY AREA
AREA: 86692. ACRES

	AGRICULTURAL AREA							MUNICIPAL AREA						UNDEVELOPED AREA			
TIME	RAIN	IRIG.	C.U.	ET	D.R.	RETURN	PERC.	RAIN	W.U.	ET	D.R.	RETURN	PERC.	RAIN	ET	D.R.	PERC.
1970	8.7	43.2	31.3	37.7	0.0	0.5	12.0	8.0	7.8	6.2	4.4	4.2	0.5	9.1	8.6	0.0	0.5
1971	9.9	43.8	31.6	37.3	1.5	0.5	14.3	9.1	8.0	6.2	5.6	4.3	1.0	10.8	8.8	0.5	1.4
1972	6.0	44.8	32.7	36.5	0.8	0.5	12.8	5.5	8.2	5.5	3.2	4.4	0.6	6.5	5.8	0.2	0.5
1973	19.8	39.3	27.9	41.2	2.3	0.5	14.9	18.1	8.4	9.3	11.1	4.5	1.7	21.2	17.1	1.5	2.7
1974	13.1	37.6	27.8	36.3	1.3	0.4	12.6	12.0	8.6	7.5	7.2	4.6	1.3	14.0	11.3	1.0	1.7
1975	13.9	36.9	27.2	38.6	0.6	0.4	11.0	12.7	8.8	8.6	7.3	4.7	0.8	15.0	13.6	0.4	1.1
1976	7.7	34.9	26.4	33.6	0.2	0.4	9.1	7.1	9.0	6.1	4.1	4.8	0.8	8.2	6.3	0.0	0.3
1977	6.5	38.0	28.6	33.6	0.1	0.4	9.8	5.9	9.3	6.6	3.1	5.0	0.8	6.8	7.9	0.0	0.4
1978	19.2	35.4	25.9	39.4	2.0	0.4	12.8	17.4	9.2	10.5	10.3	4.9	1.0	20.5	15.9	2.2	2.6
1979	11.7	37.6	28.1	37.9	0.4	0.4	10.6	10.6	9.3	8.2	6.0	5.0	0.7	12.5	11.7	0.1	0.7
1980	14.6	31.1	25.7	36.9	0.6	0.2	8.2	13.1	9.4	9.1	7.4	5.0	0.9	15.7	13.3	0.5	1.9
1981	7.7	32.3	26.2	33.6	0.0	0.2	6.3	7.0	9.7	7.2	3.8	5.2	0.5	8.2	7.9	0.0	0.3
1982	14.3	27.6	22.7	35.3	0.3	0.2	6.5	12.8	10.1	8.6	7.2	5.4	1.3	15.3	13.8	0.0	0.7
1983	23.1	28.3	22.3	37.9	2.0	0.2	11.4	20.7	10.5	11.3	12.3	5.6	2.0	24.9	18.9	2.4	3.6
1984	8.5	32.9	26.6	33.1	0.4	0.2	7.5	7.6	11.0	7.0	4.3	5.9	1.4	9.1	9.1	0.1	0.5
1985	9.8	31.7	25.9	33.5	0.2	0.2	7.6	8.7	11.5	7.6	4.9	6.1	1.5	10.4	10.0	0.0	0.5
1986	16.5	28.5	23.3	35.9	0.9	0.2	8.1	14.7	11.9	10.1	8.5	6.4	1.5	17.8	14.5	1.1	1.8
1987	7.2	32.2	26.2	32.9	0.0	0.2	6.2	6.5	12.3	8.1	3.5	6.6	0.6	7.7	7.8	0.0	0.3
1988	9.7	31.7	26.0	34.5	0.2	0.2	6.6	8.5	12.7	8.6	4.7	6.8	1.0	10.6	10.1	0.0	0.5
1989	7.9	30.8	24.9	32.8	0.0	0.2	6.0	7.1	12.4	8.0	3.9	6.5	1.1	8.5	7.3	0.0	0.3
1990	6.9	27.1	23.1	29.7	0.0	0.1	4.2	6.4	13.4	8.1	3.5	7.2	0.9	7.2	7.5	0.0	0.3
1991	10.4	29.5	24.7	32.5	0.4	0.2	6.8	9.3	13.7	9.5	5.2	7.3	0.9	11.3	9.2	0.6	1.8
1992	11.7	29.1	24.9	34.3	0.5	0.2	5.8	10.7	14.4	9.8	6.2	7.7	1.4	12.5	10.5	0.5	1.3
1993	15.2	28.3	24.3	36.0	0.5	0.1	6.8	13.7	15.0	11.2	7.8	8.0	1.7	16.6	13.8	0.7	2.4
1994	7.0	29.2	24.7	31.3	0.0	0.2	4.7	6.3	15.8	9.1	3.3	8.4	1.2	7.6	7.3	0.0	0.3
AVERAGE	11.5	33.7	26.4	35.3	0.6	0.3	8.9	10.4	10.8	8.3	5.9	5.8	1.1	12.3	10.7	0.5	1.1

SOIL MOISTURE BUDGET IN INCHES FOR UPPER VALLEY AREA
AREA: 92300. ACRES

	AGRICULTURAL AREA							MUNICIPAL AREA						UNDEVELOPED AREA			
TIME	RAIN	IRIG.	C.U.	ET	D.R.	RETURN	PERC.	RAIN	W.U.	ET	D.R.	RETURN	PERC.	RAIN	ET	D.R.	PERC.
1970	8.5	49.8	34.3	39.7	0.1	0.3	16.2	8.5	5.0	5.2	4.7	2.7	0.6	8.6	7.7	0.0	0.9
1971	10.4	50.1	33.8	38.7	1.7	0.3	19.5	10.0	4.8	4.9	6.1	2.6	1.2	10.9	8.6	0.5	1.8
1972	6.0	50.0	34.5	38.2	0.7	0.3	16.6	5.8	4.7	4.2	3.3	2.5	0.5	6.2	5.7	0.0	0.5
1973	21.4	44.7	29.5	42.2	2.8	0.3	20.6	21.1	4.6	8.6	13.0	2.4	1.7	22.0	16.8	1.3	3.9
1974	13.6	44.0	29.9	38.2	2.3	0.3	16.7	13.4	4.5	6.0	8.5	2.4	1.0	13.9	10.9	1.3	1.7
1975	16.1	42.0	28.3	39.6	2.4	0.3	15.6	15.9	4.4	7.4	9.7	2.3	0.9	16.5	13.8	1.2	1.5
1976	7.8	39.9	28.6	34.8	0.4	0.3	12.2	7.8	4.3	4.6	4.2	2.3	0.4	7.9	6.7	0.0	0.4
1977	6.1	42.6	29.2	33.8	0.0	0.3	14.3	6.1	4.4	5.0	3.2	2.4	0.5	6.2	6.6	0.0	0.4
1978	21.6	38.7	26.0	40.3	2.5	0.3	17.1	21.6	4.5	9.4	13.1	2.4	1.3	21.9	16.8	1.5	3.6
1979	13.0	43.0	28.6	38.8	0.5	0.3	16.3	13.0	4.6	7.1	7.4	2.5	0.6	13.1	11.9	0.0	1.2
1980	17.5	35.2	25.3	37.0	1.5	0.2	13.9	17.6	4.8	8.1	10.3	2.6	1.3	17.8	14.0	0.9	2.9
1981	8.5	36.6	26.2	34.0	0.1	0.2	10.7	8.5	4.9	5.6	4.8	2.6	0.4	8.6	8.1	0.0	0.5
1982	17.3	30.2	22.7	36.5	0.8	0.2	10.2	17.3	5.1	8.4	10.0	2.7	0.9	17.5	15.3	0.1	1.4
1983	27.6	31.8	22.5	38.6	3.3	0.2	17.1	27.5	5.1	10.8	16.8	2.8	2.5	27.6	19.8	2.4	5.8
1984	9.1	38.8	27.6	33.3	0.7	0.2	13.7	9.0	5.2	5.0	5.3	2.8	1.2	9.0	8.4	0.1	0.8
1985	10.3	37.4	26.9	33.6	0.3	0.2	13.6	10.2	5.2	5.5	5.8	2.8	1.3	10.2	9.3	0.0	0.8
1986	20.0	34.9	24.7	36.6	3.7	0.2	14.5	19.9	5.2	8.4	12.2	2.8	1.5	20.0	14.6	2.4	2.6
1987	7.9	37.2	26.5	33.9	0.0	0.2	11.0	7.9	5.3	5.7	4.3	2.8	0.4	7.9	7.8	0.0	0.4
1988	13.2	33.8	23.9	35.0	0.4	0.2	11.4	13.1	5.3	7.1	7.4	2.8	1.0	13.1	12.2	0.1	0.8
1989	9.2	35.1	24.5	33.2	0.5	0.2	11.2	9.2	5.1	5.0	5.3	2.6	0.6	9.2	7.2	0.0	0.5
1990	5.3	34.5	25.8	29.7	0.0	0.2	9.2	5.3	5.3	5.3	2.7	2.9	0.4	5.3	6.4	0.0	0.2
1991	13.1	34.6	24.4	32.7	1.3	0.2	13.5	13.1	7.0	7.2	7.9	3.7	1.2	13.2	9.4	1.0	2.9
1992	11.7	34.4	24.5	34.5	0.4	0.2	10.9	11.7	9.1	8.3	6.7	4.8	0.8	11.8	10.7	0.1	1.0
1993	19.3	33.2	24.0	36.3	1.9	0.2	14.2	19.3	11.1	10.6	11.7	5.9	2.0	19.4	14.9	1.1	3.4
1994	9.8	33.5	24.4	33.1	0.2	0.2	9.8	9.8	13.2	9.4	5.5	7.0	0.9	9.9	9.1	0.0	0.8
AVERAGE	13.0	38.6	27.1	36.1	1.1	0.2	14.0	12.9	5.7	6.9	7.6	3.0	1.0	13.1	10.9	0.6	1.6

SOIL MOISTURE BUDGET IN INCHES FOR ENTIRE MODEL AREA
AREA: 416580. ACRES

	AGRICULTURAL AREA							MUNICIPAL AREA						UNDEVELOPED AREA			
TIME	RAIN	IRIG.	C.U.	ET	D.R.	RETURN	PERC.	RAIN	W.U.	ET	D.R.	RETURN	PERC.	RAIN	ET	D.R.	PERC.
1970	11.0	39.2	27.6	34.2	0.6	0.4	13.2	13.1	12.7	9.1	7.3	6.8	1.8	12.1	9.4	0.5	2.2
1971	11.7	38.8	27.1	33.6	1.6	0.4	14.8	13.0	12.6	8.5	7.5	6.7	2.8	13.0	10.0	0.4	2.5
1972	6.4	41.2	28.9	33.4	0.6	0.4	13.1	6.7	12.5	7.3	3.6	6.7	1.6	7.0	6.4	0.1	0.6
1973	21.2	36.2	24.6	36.9	2.7	0.4	17.3	21.9	12.5	11.4	12.8	6.7	3.5	22.9	16.0	1.6	5.2
1974	17.7	32.8	23.8	33.7	2.6	0.3	13.7	21.7	12.4	10.1	13.2	6.7	4.1	20.3	14.1	2.4	3.8
1975	14.4	33.9	23.7	34.9	0.9	0.4	12.0	14.2	12.4	10.3	7.7	6.6	1.9	15.4	13.3	0.5	1.6
1976	8.3	31.8	23.0	30.6	0.2	0.3	9.5	8.9	12.4	7.8	4.7	6.6	1.9	9.0	7.4	0.0	0.4
1977	6.5	35.8	25.6	30.6	0.1	0.3	10.8	6.8	12.6	7.9	3.4	6.7	1.6	6.9	7.6	0.0	0.4
1978	20.9	31.8	22.3	35.6	2.5	0.3	14.4	22.0	12.7	12.1	12.9	6.8	2.8	22.5	16.0	1.6	4.9
1979	12.0	35.7	24.8	34.5	0.4	0.3	12.4	12.0	12.8	9.7	6.6	6.8	1.7	12.7	11.4	0.1	1.3
1980	14.9	29.9	22.9	33.7	0.9	0.2	10.0	14.4	12.9	10.2	7.9	6.9	2.1	15.6	12.8	0.5	2.3
1981	7.6	30.8	23.2	30.4	0.0	0.2	7.8	7.4	13.0	8.5	3.9	7.0	1.1	7.9	7.5	0.0	0.4
1982	17.5	25.9	19.9	33.2	1.0	0.2	9.4	20.1	13.2	11.4	11.5	7.0	3.1	19.6	15.6	0.5	2.7
1983	25.0	26.4	19.3	34.6	2.7	0.2	13.8	25.6	12.7	12.6	15.1	6.8	3.8	26.7	18.4	2.2	6.0
1984	8.8	32.2	24.2	30.7	0.3	0.2	9.5	8.8	12.2	7.9	4.8	6.6	1.9	9.3	9.4	0.0	0.6
1985	9.9	30.6	23.3	31.0	0.2	0.2	9.1	10.0	11.8	8.2	5.3	6.3	1.9	10.5	9.9	0.0	0.6
1986	15.7	28.5	21.4	32.6	1.6	0.2	9.9	13.9	11.4	9.5	7.7	6.1	1.8	16.0	12.2	1.2	2.1
1987	8.3	31.1	23.5	30.6	0.4	0.2	8.1	9.6	11.0	8.6	5.2	5.9	1.1	9.1	8.5	0.5	0.7
1988	9.6	30.3	23.0	31.4	0.2	0.2	8.2	8.3	10.7	7.6	4.4	5.7	1.3	9.9	9.4	0.0	0.5
1989	9.0	29.3	22.0	30.5	0.2	0.2	7.8	9.9	9.9	7.8	5.2	5.2	1.3	9.8	8.4	0.0	0.5
1990	7.3	26.9	21.5	28.0	0.0	0.2	5.9	8.8	10.1	8.0	4.6	5.4	1.0	7.9	8.2	0.0	0.4
1991	11.2	28.8	22.1	29.9	0.6	0.2	9.2	11.4	10.4	8.8	6.2	5.6	1.3	12.0	9.1	0.6	2.4
1992	12.1	28.6	22.3	31.7	0.6	0.2	8.1	13.1	11.3	9.5	7.3	6.0	1.5	12.8	10.6	0.5	1.8
1993	17.1	27.4	21.6	33.0	1.3	0.1	10.0	18.4	12.1	10.7	10.5	6.5	2.7	18.5	13.6	1.1	3.9
1994	8.7	28.2	22.2	30.1	0.1	0.2	6.6	9.9	13.0	9.5	5.2	6.9	1.2	9.7	9.0	0.0	0.6
AVERAGE	12.5	31.7	23.3	32.4	0.9	0.3	10.6	13.2	12.1	9.3	7.4	6.4	2.0	13.5	11.0	0.6	1.9

AVERAGE SOIL MOISTURE BUDGET IN INCHES FROM 1970 THRU 1994

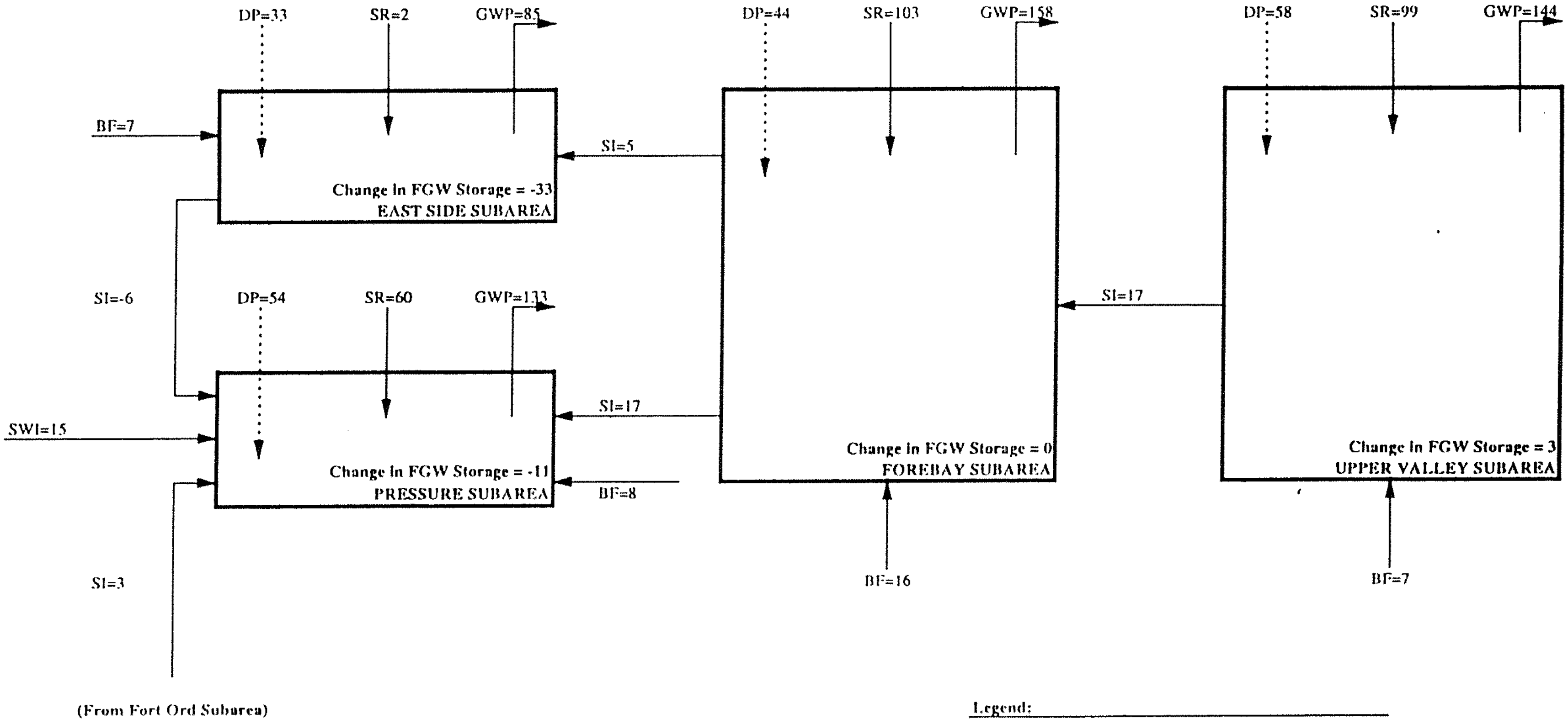
	AGRICULTURAL AREA							MUNICIPAL AREA						UNDEVELOPED AREA			
REGION	RAIN	IRIG.	C.U.	ET	D.R.	RETURN	PERC.	RAIN	W.U.	ET	D.R.	RETURN	PERC.	RAIN	ET	D.R.	PERC.
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	13.9	49.7	32.2	41.0	0.8	0.2	21.7	13.9	8.4	7.5	8.0	4.5	2.2	13.9	11.0	0.5	2.3
3	13.1	27.1	19.3	28.4	0.9	0.1	10.8	13.0	19.6	12.3	6.6	10.5	3.1	13.5	10.9	0.4	2.3
4	12.5	26.7	20.0	29.0	1.0	0.4	8.6	14.0	7.4	7.8	8.3	3.9	1.2	14.7	11.3	0.9	2.4
5	11.5	33.7	26.4	35.3	0.6	0.3	8.9	10.4	10.8	8.3	5.9	5.8	1.1	12.3	10.7	0.5	1.1
6	13.0	38.6	27.1	36.1	1.1	0.2	14.0	12.9	5.7	6.9	7.6	3.0	1.0	13.1	10.9	0.6	1.6
TOTAL	12.5	31.7	23.3	32.4	0.9	0.3	10.6	13.2	12.1	9.3	7.4	6.4	2.0	13.5	11.0	0.6	1.9

APPENDIX C

Average Annual and Annual Changes in Ground Water Balance

AVERAGE ANNUAL GROUNDWATER BALANCE BY SUBAREA
WATER YEARS 1970-1994

(VALUES IN 1000 ACRE-FEET)

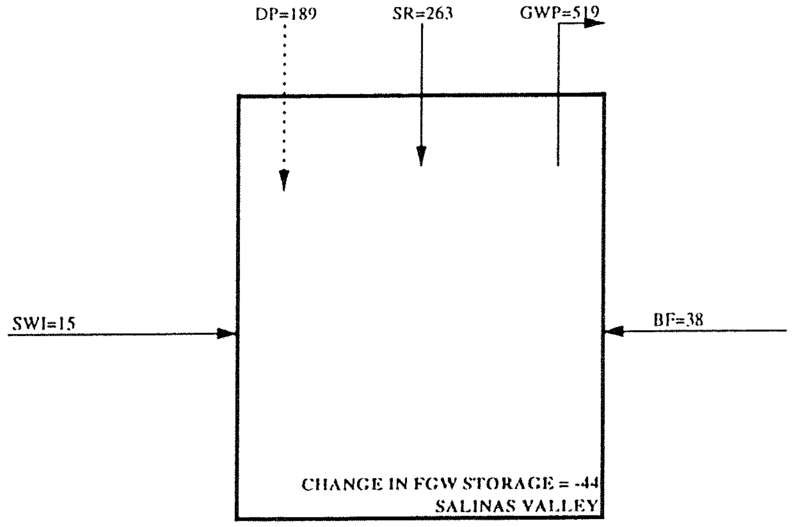


Legend:

FGW	Fresh Ground Water Storage
BF	Boundary Flow
DP	Deep Percolation from Rain and Aplied Water
SR	Stream Recharge
GWP	Ground Water Pumping
SI	Subsurface Flow
SWI	Seawater Intrusion

RUN_STAT.XLS

AVERAGE ANNUAL GROUND WATER BALANCE FOR THE SALINAS VALLEY GROUND WATER BASIN
WATER YEARS 1970-1994
(VALUES IN 1000 ACRE-FEET)



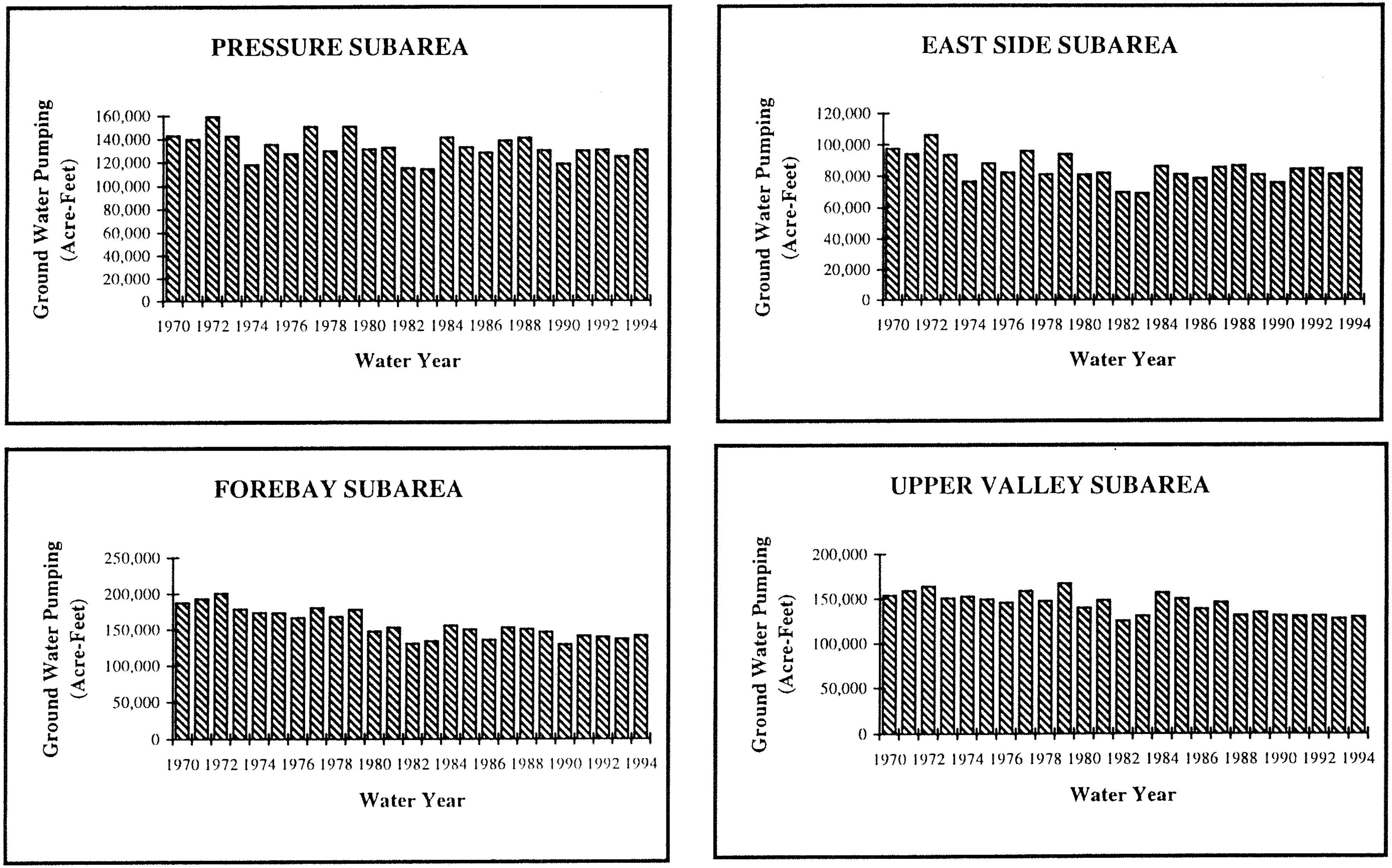
Legend:

FGW	Fresh Ground Water Storage
BF	Boundary Flow
DP	Deep Percolation from Rain and Aplied Water
SR	Stream Recharge
GWP	Ground Water Pumping
SI	Subsurface Flow
SWI	Seawater Intrusion

RUN_STAT.XLS

FIGURE C-1

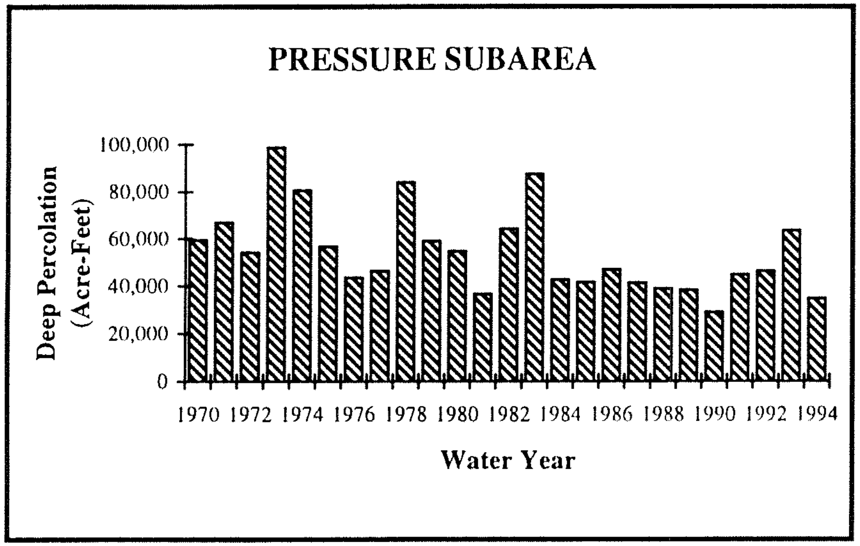
ANNUAL GROUND WATER PUMPING

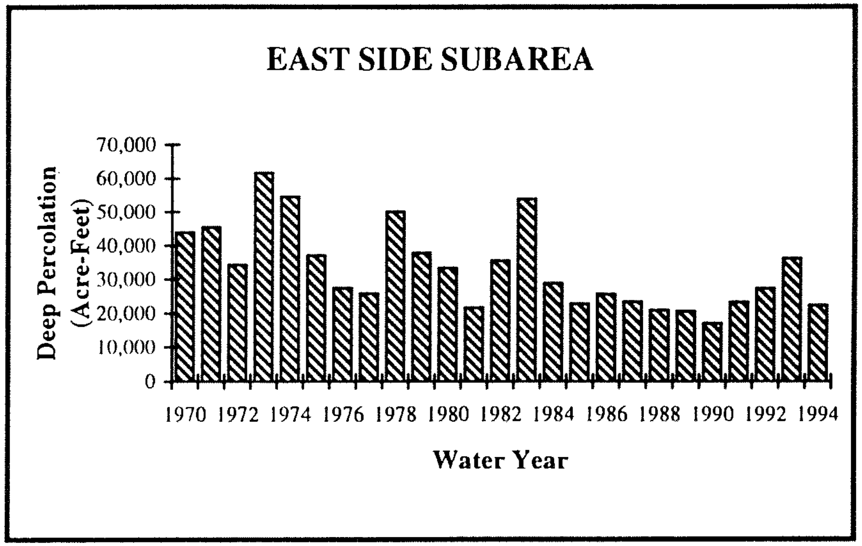


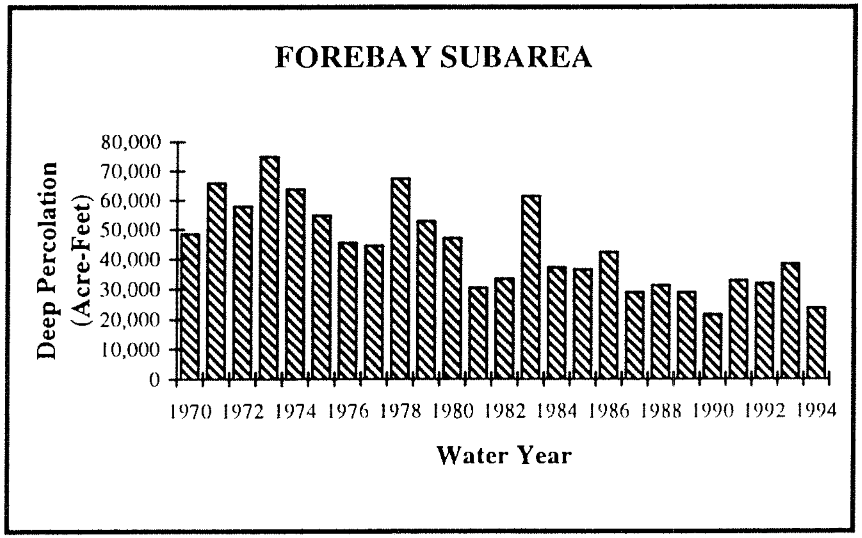
SW_BUD.XLS

FIGURE C-2

ANNUAL DEEP PERCOLATION FROM RAIN AND APPLIED WATER


PRESSURE SUBAREA


EAST SIDE SUBAREA


FOREBAY SUBAREA

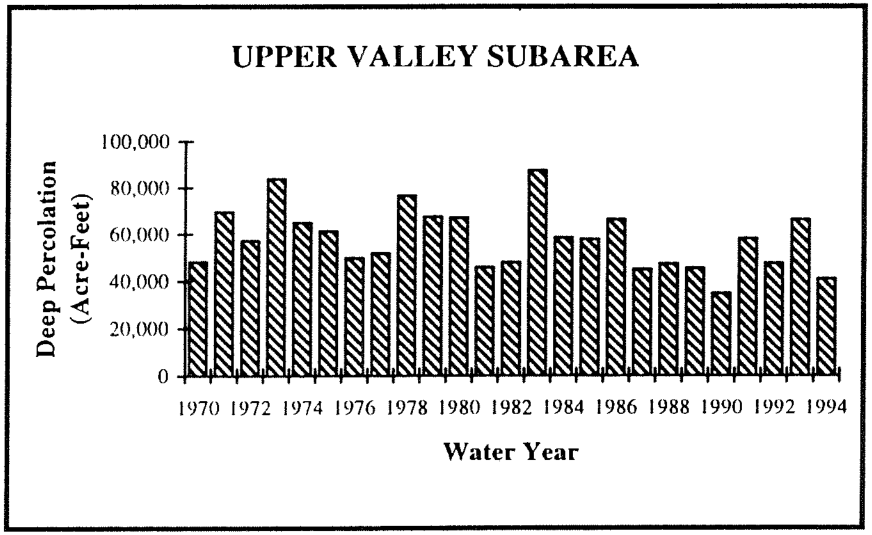
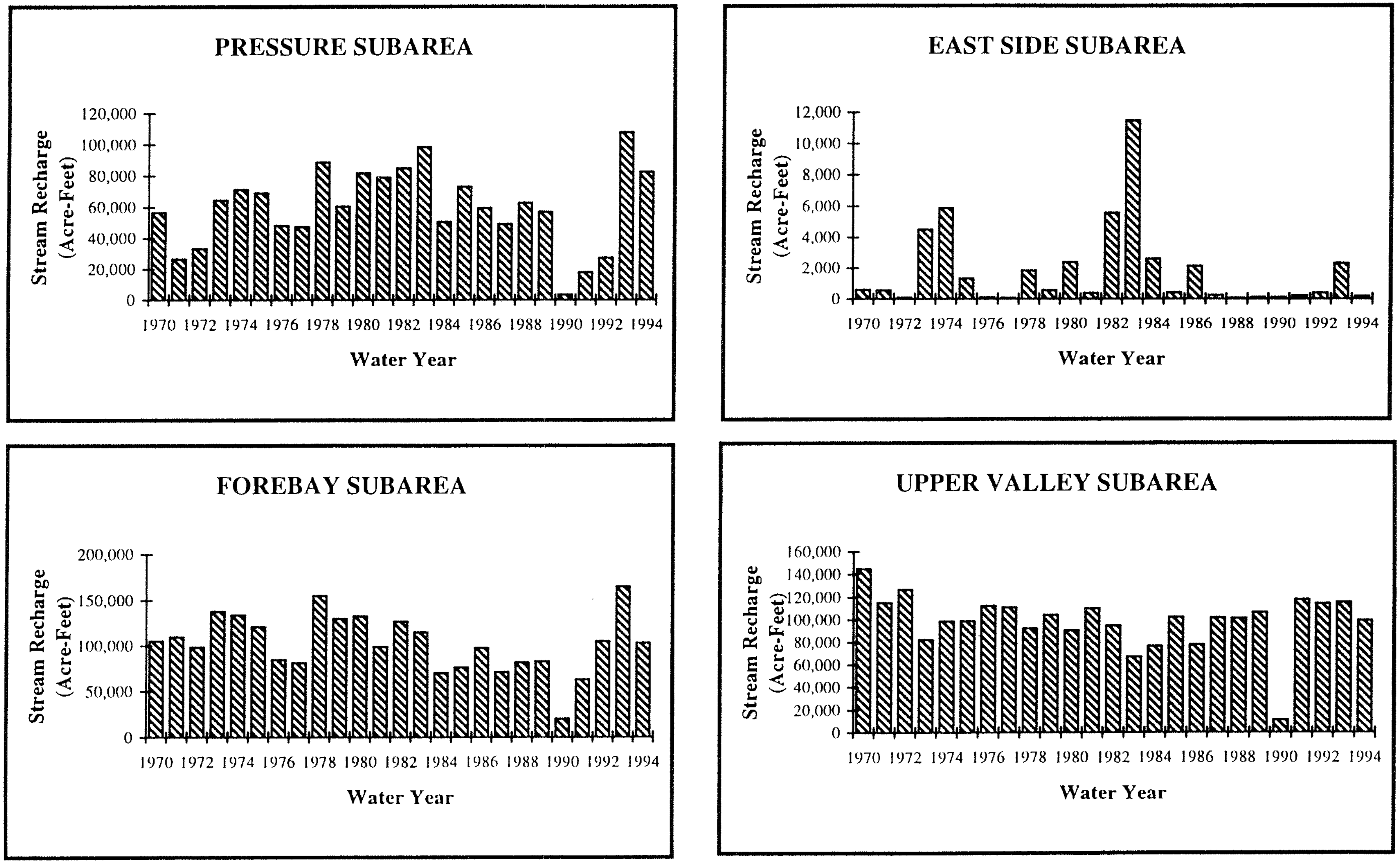

UPPER VALLEY SUBAREA

FIGURE C-3

ANNUAL STREAM RECHARGE



PRESSURE SUBAREA

EAST SIDE SUBAREA

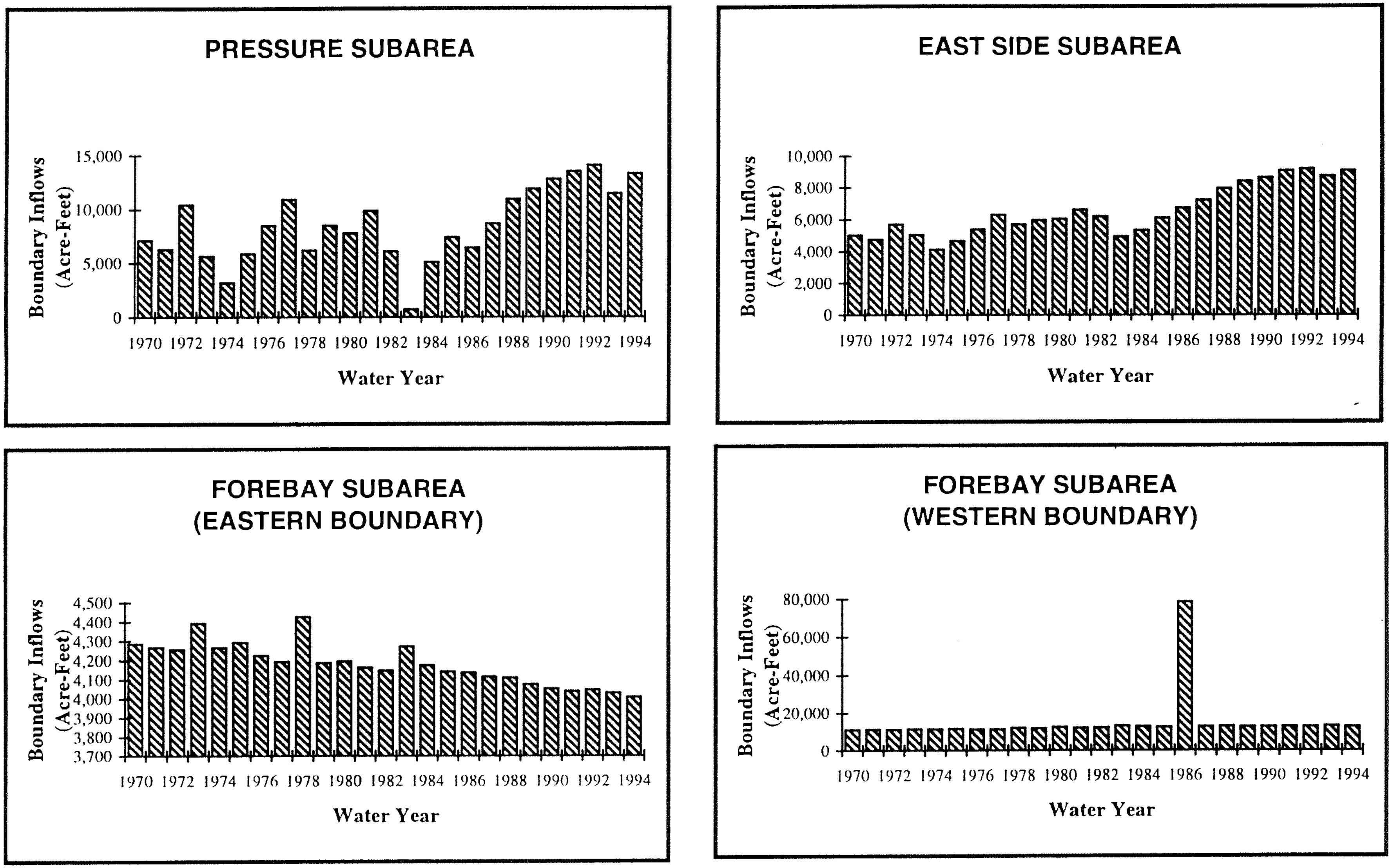
FOREBAY SUBAREA

UPPER VALLEY SUBAREA

SW_BUD.XLS

FIGURE C-4a

ANNUAL SUBSURFACE BOUNDARY FLOWS



PRESSURE SUBAREA

EAST SIDE SUBAREA

FOREBAY SUBAREA (EASTERN BOUNDARY)

FOREBAY SUBAREA (WESTERN BOUNDARY)

FIGURE C-4b

ANNUAL SUBSURFACE BOUNDARY FLOWS

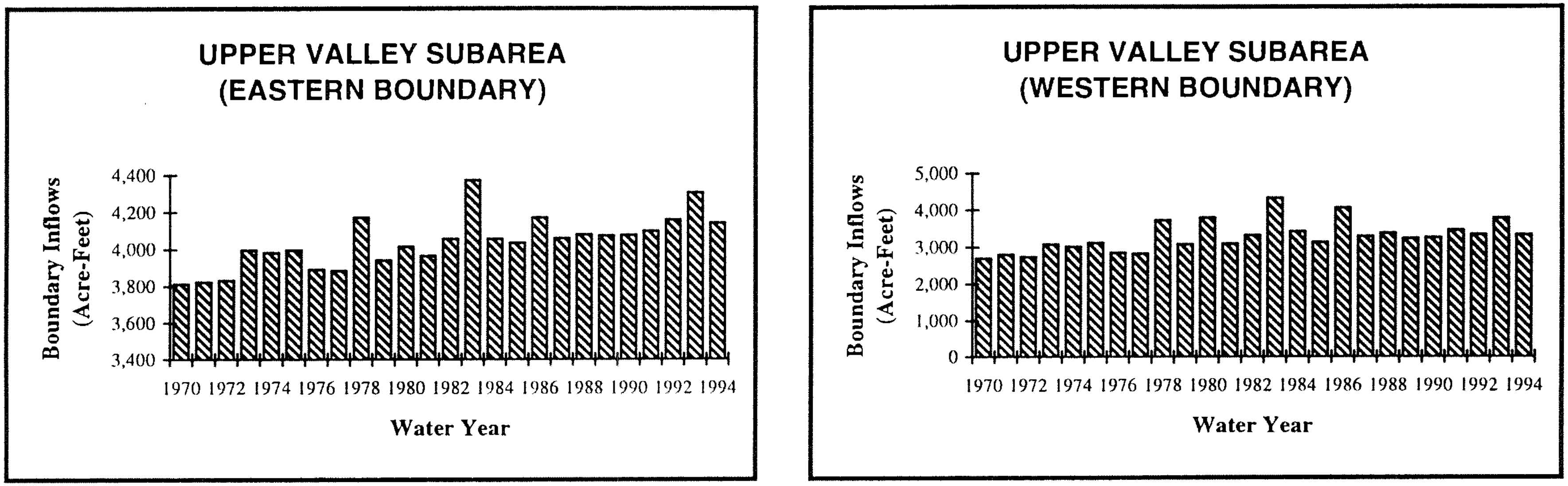
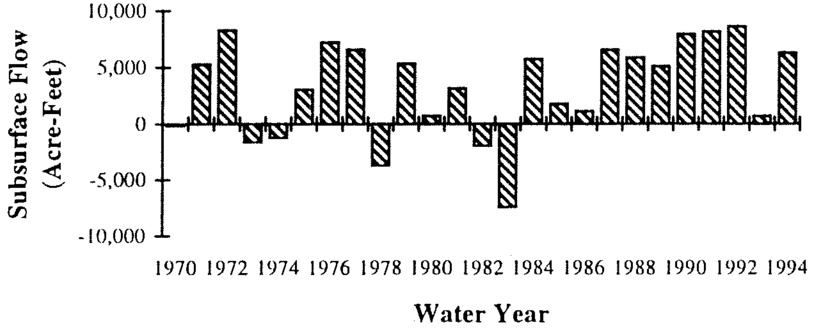


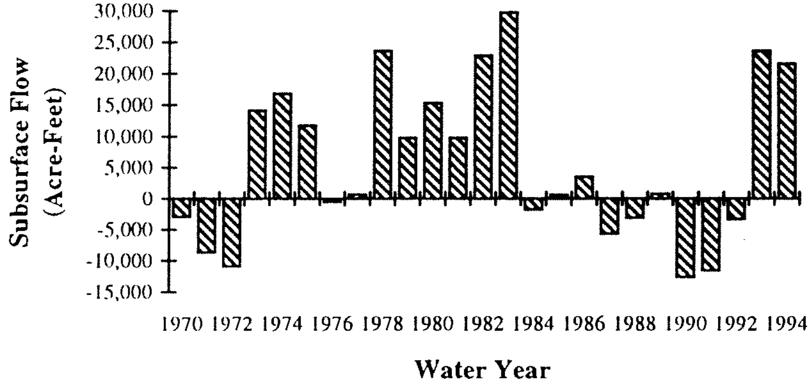
FIGURE C-5a

ANNUAL SUBSURFACE FLOW BETWEEN SUBAREAS
(Total of All Three Model Layers)

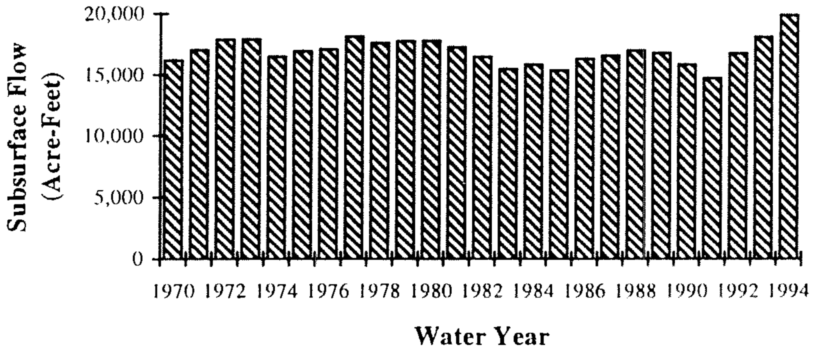


SUBSURFACE FLOW FROM THE FORT ORD TO THE PRESSURE SUBAREA

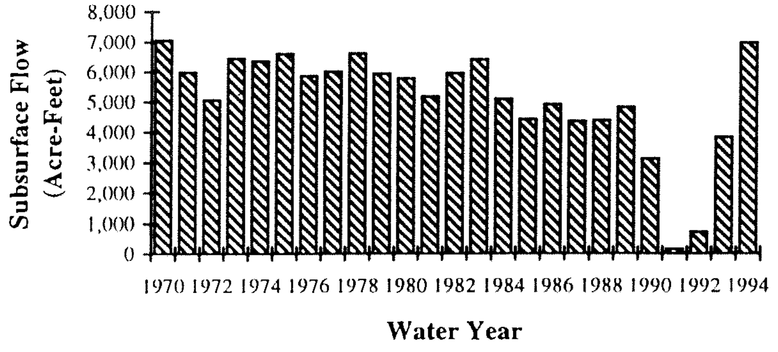
Note: Calibration in the Fort Ord Subarea has not been refined to the same extent as the other subareas.



SUBSURFACE FLOW FROM THE PRESSURE TO THE EAST SIDE SUBAREA



SUBSURFACE FLOW FROM THE FOREBAY TO THE PRESSURE SUBAREA

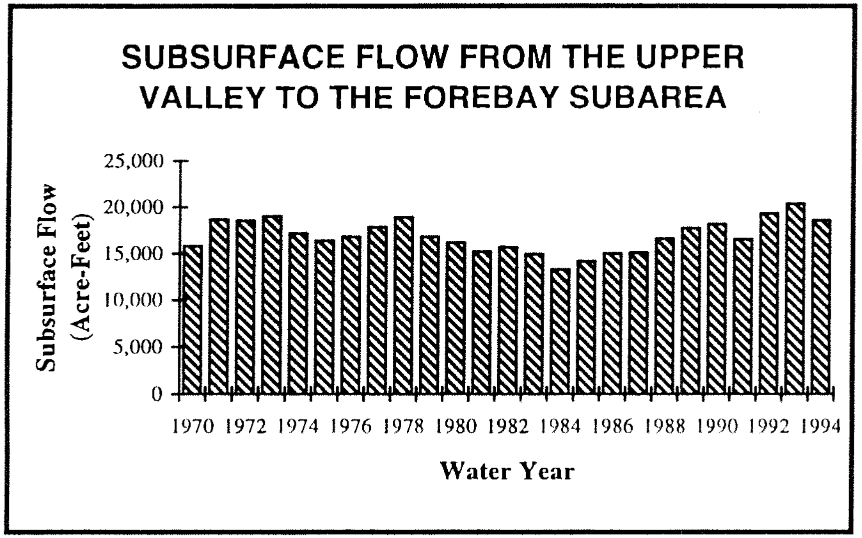


SUBSURFACE FLOW FROM THE FOREBAY TO THE EAST SIDE SUBAREA

SW_BUD.XLS

FIGURE C-5b

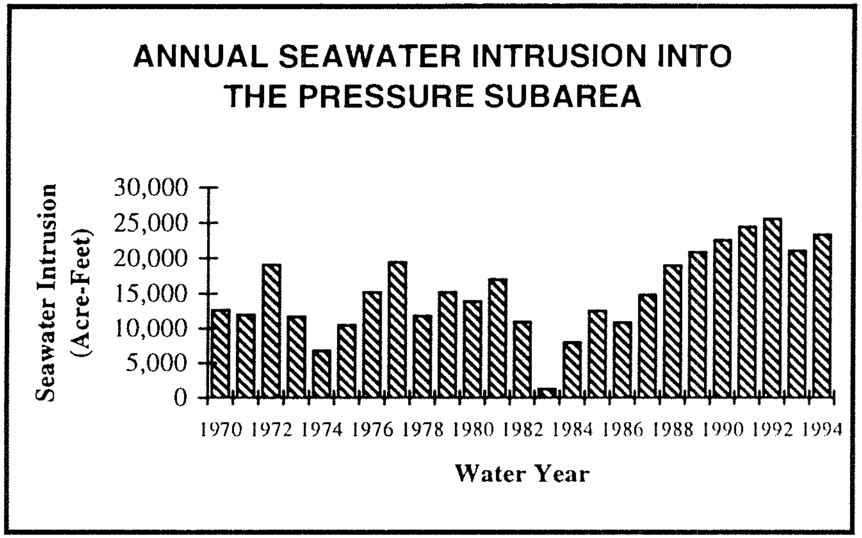
ANNUAL SUBSURFACE FLOW BETWEEN SUBAREAS



SUBSURFACE FLOW FROM THE UPPER VALLEY TO THE FOREBAY SUBAREA

FIGURE 3-6

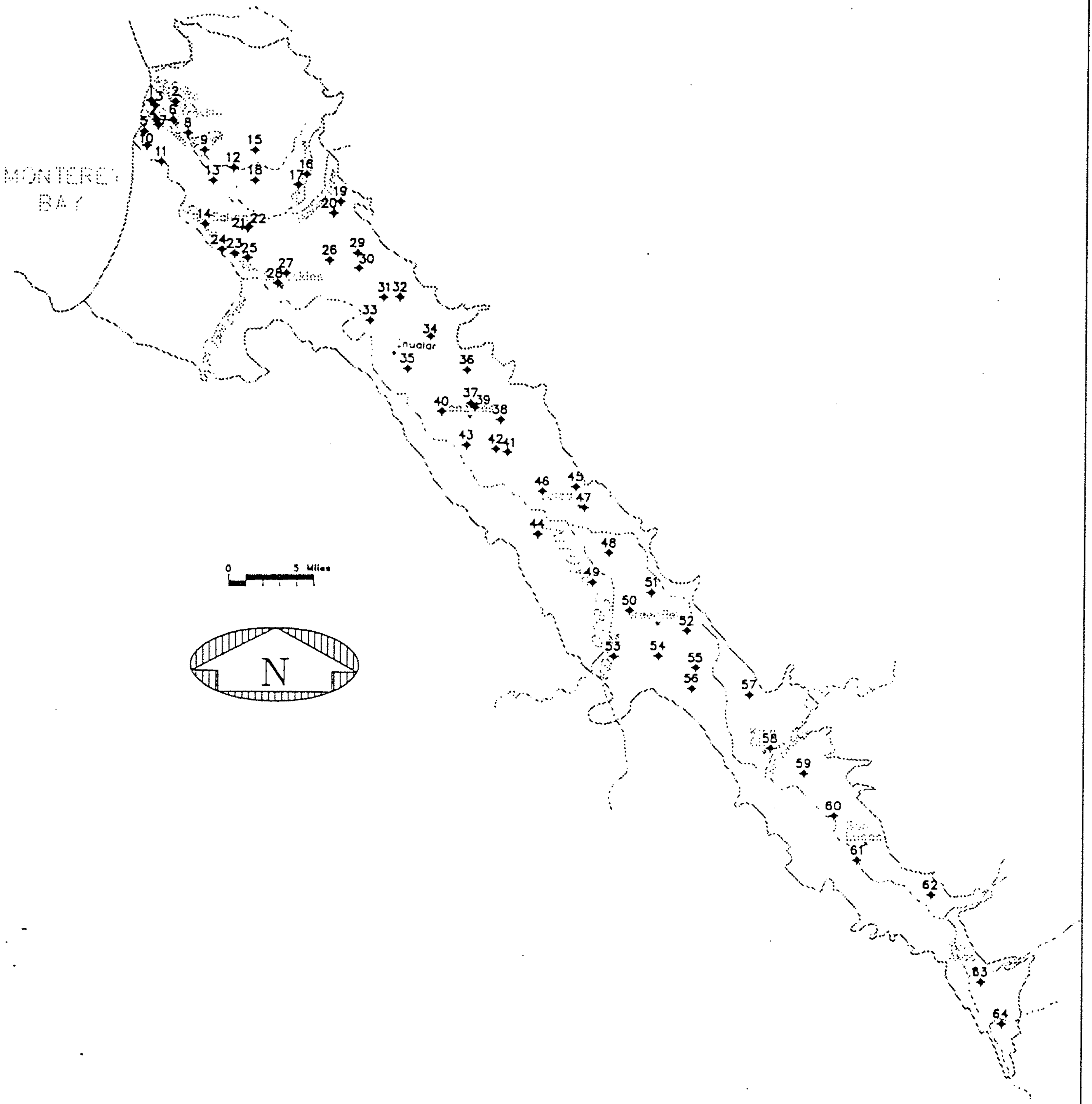
ANNUAL SEAWATER INTRUSION INTO THE PRESSURE SUBAREA



SW_BUD.XLS

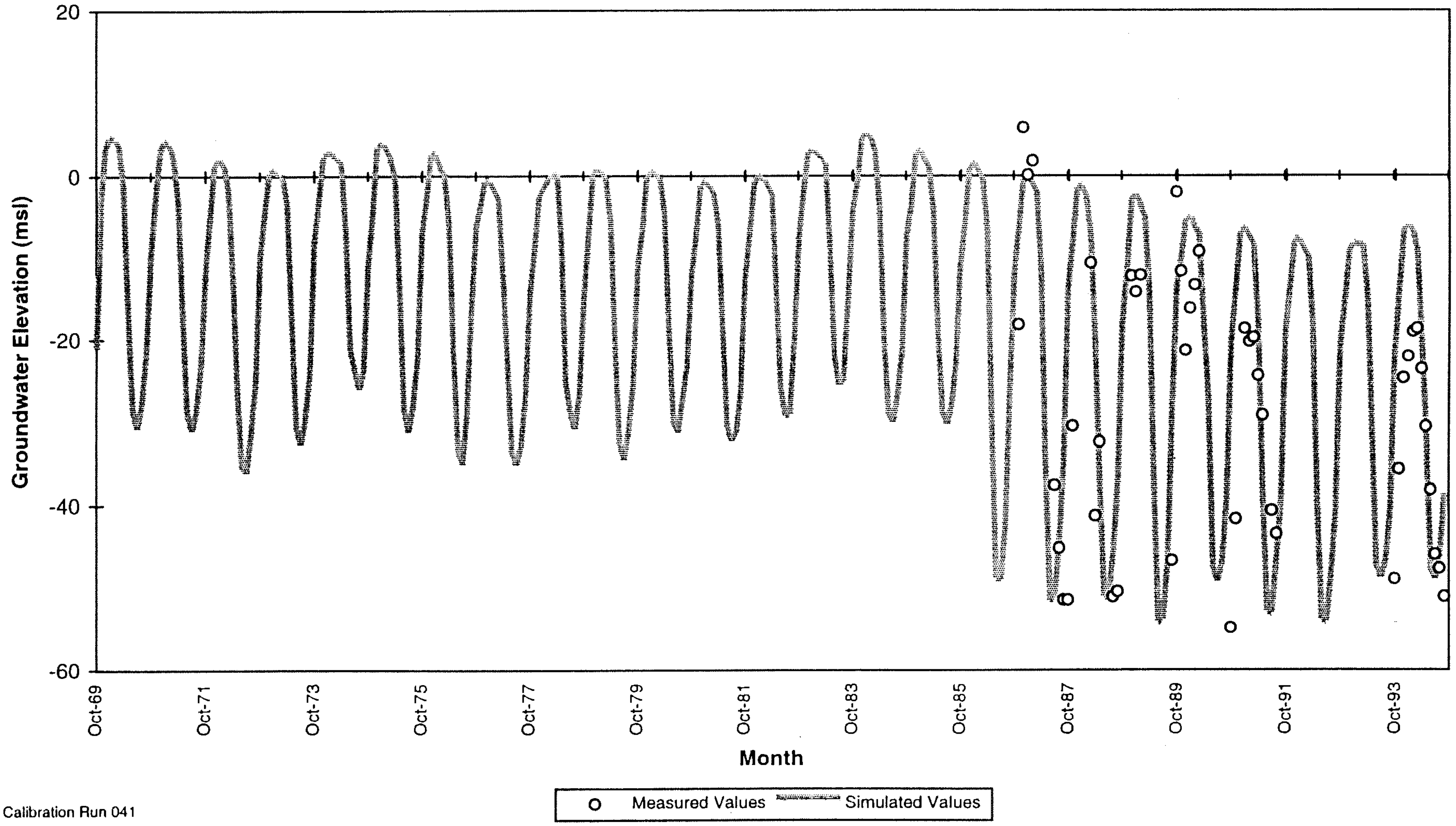
APPENDIX D

Model Ground Water Hydrographs For Each Calibration Well



LOCATION OF FLOW MODEL CALIBRATION WELLS

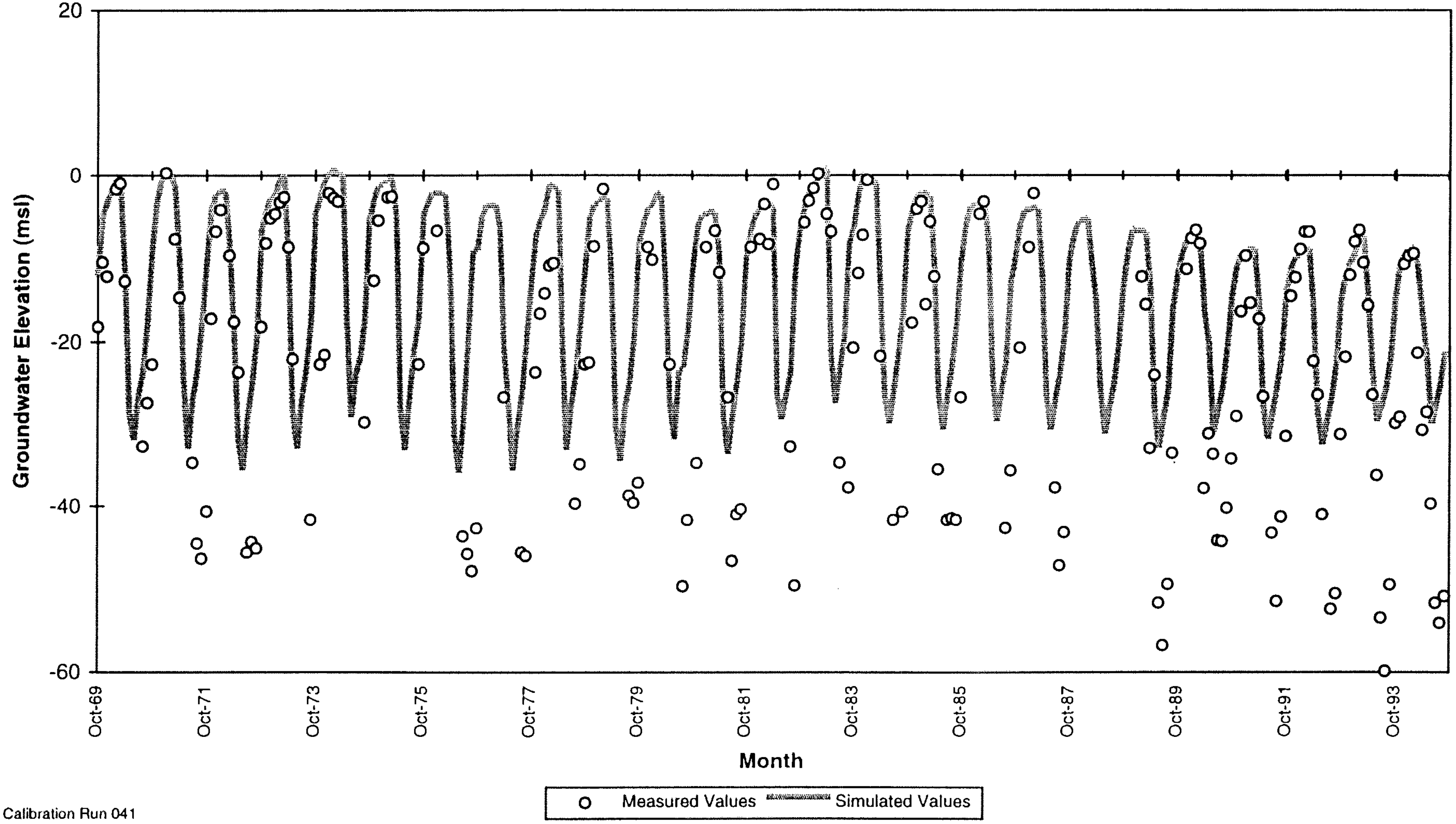
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 1: Pressure Subarea, Deep Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

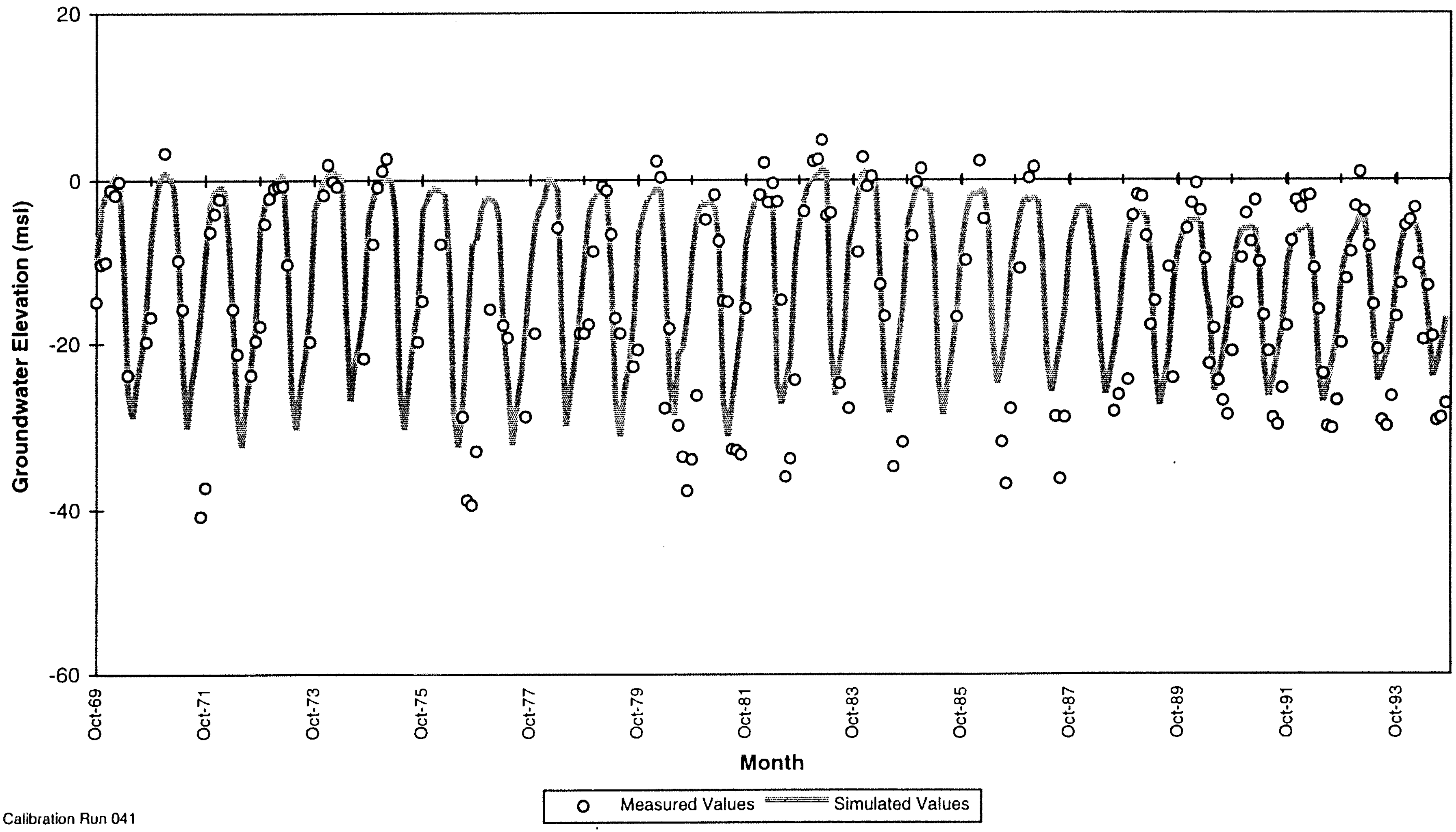
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 2: Pressure Subarea, 400 Foot Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

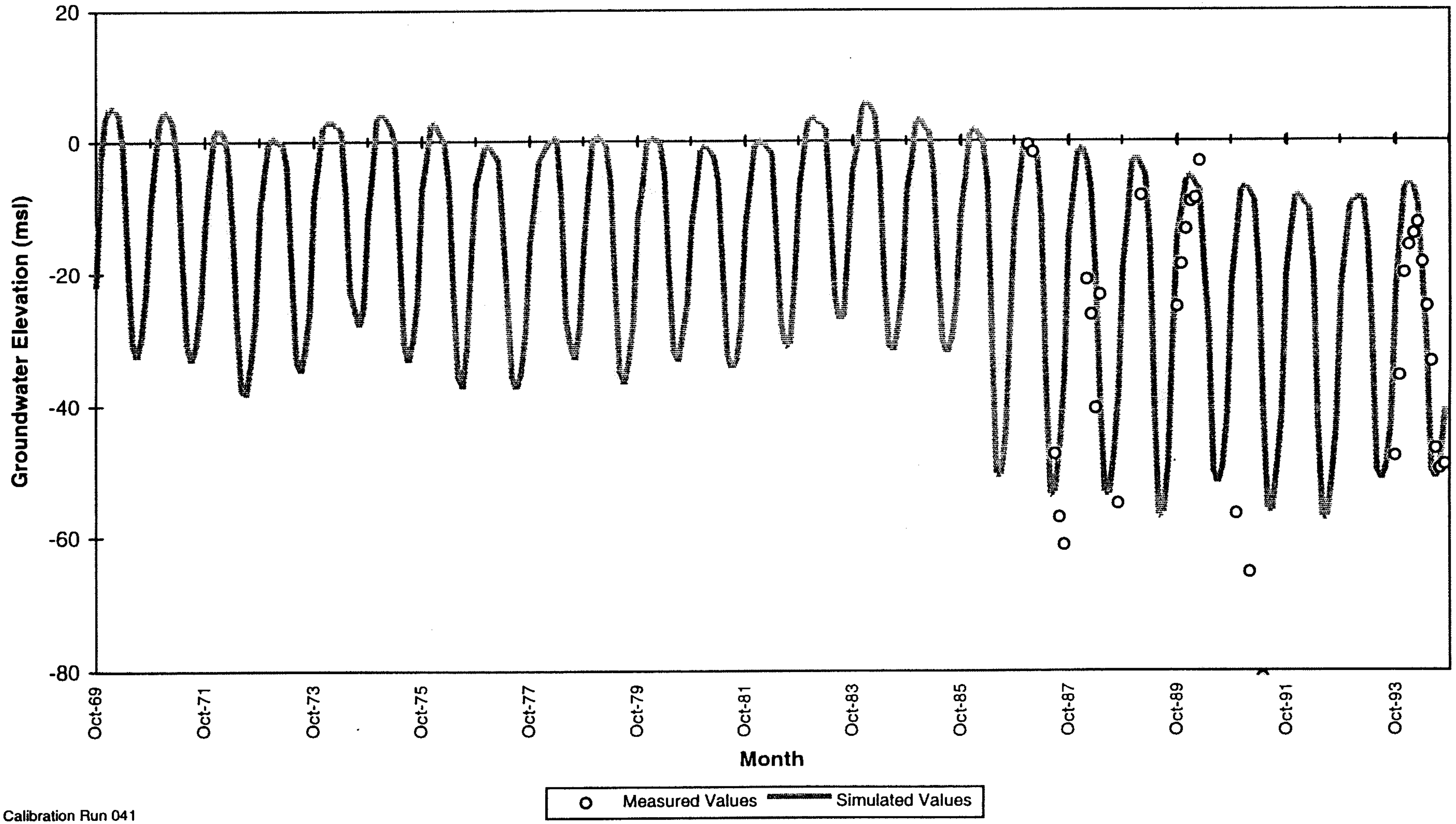
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 3: Pressure Subarea, 400 Foot Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

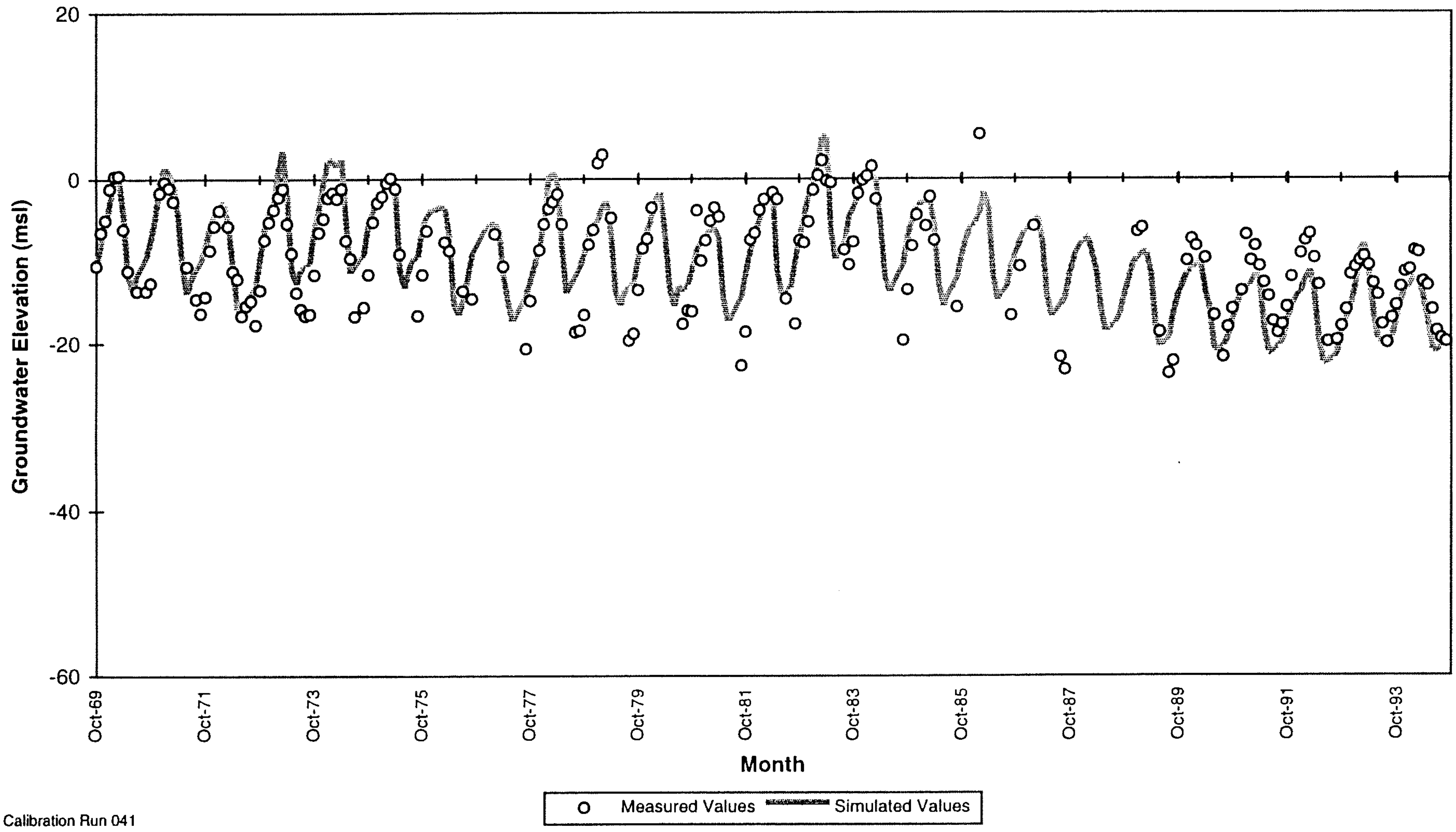
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 4: Pressure Subarea, Deep Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

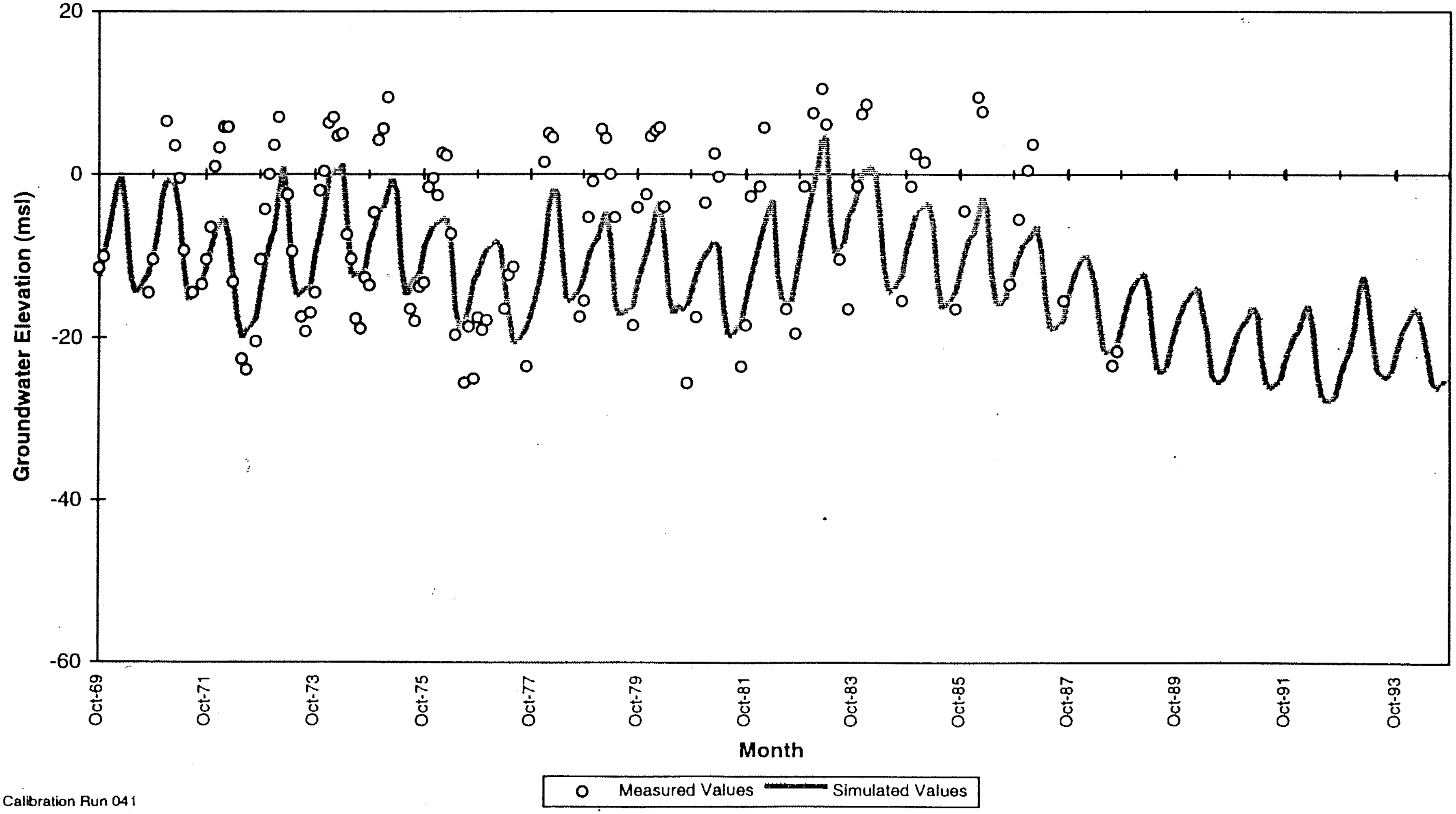
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 8: Pressure Subarea, 180 Foot Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

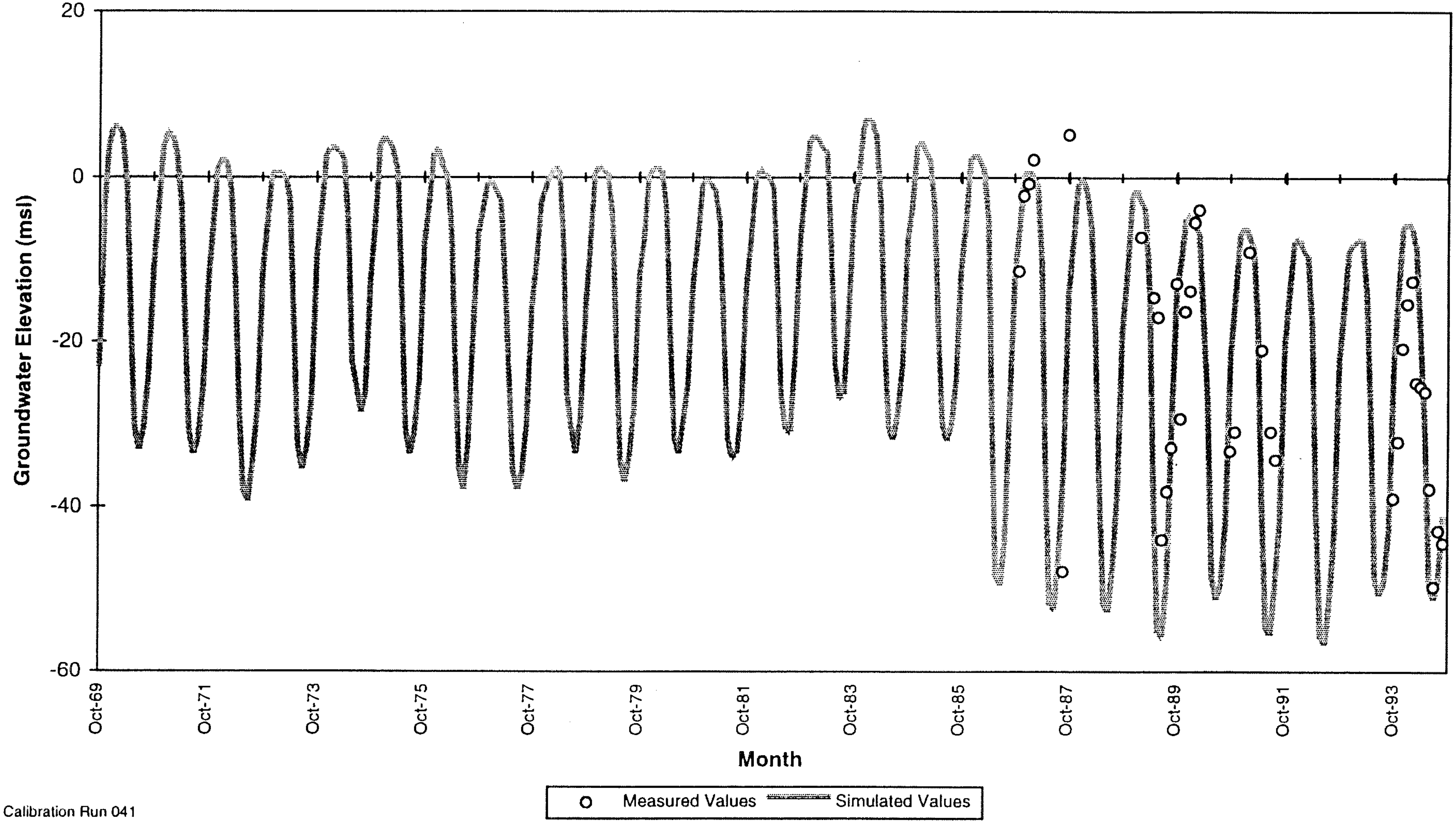
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 9: Pressure Subarea, 180 Foot Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

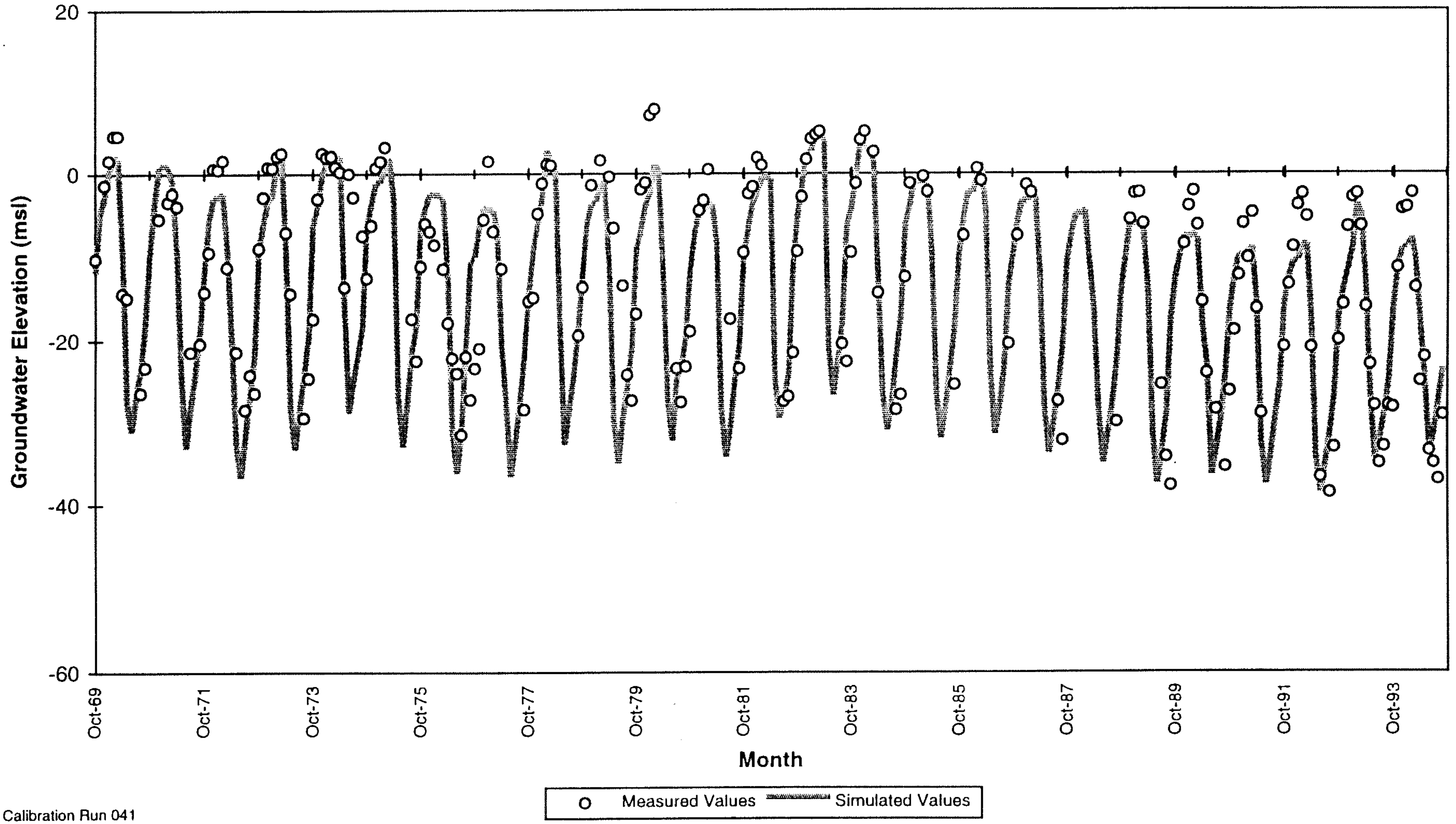
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 10: Pressure Subarea, Deep Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

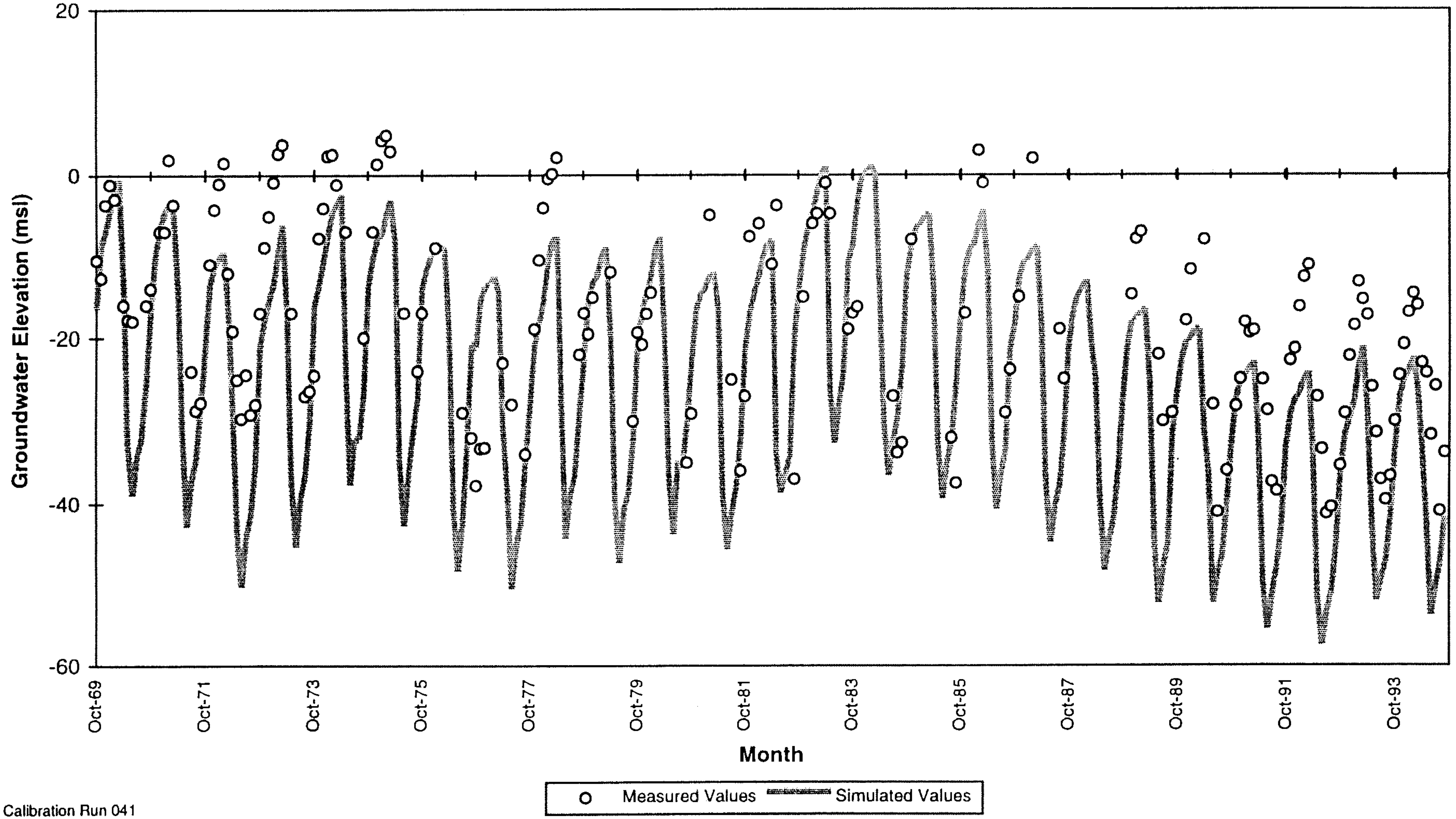
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 11: Pressure Subarea, 180 Foot Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

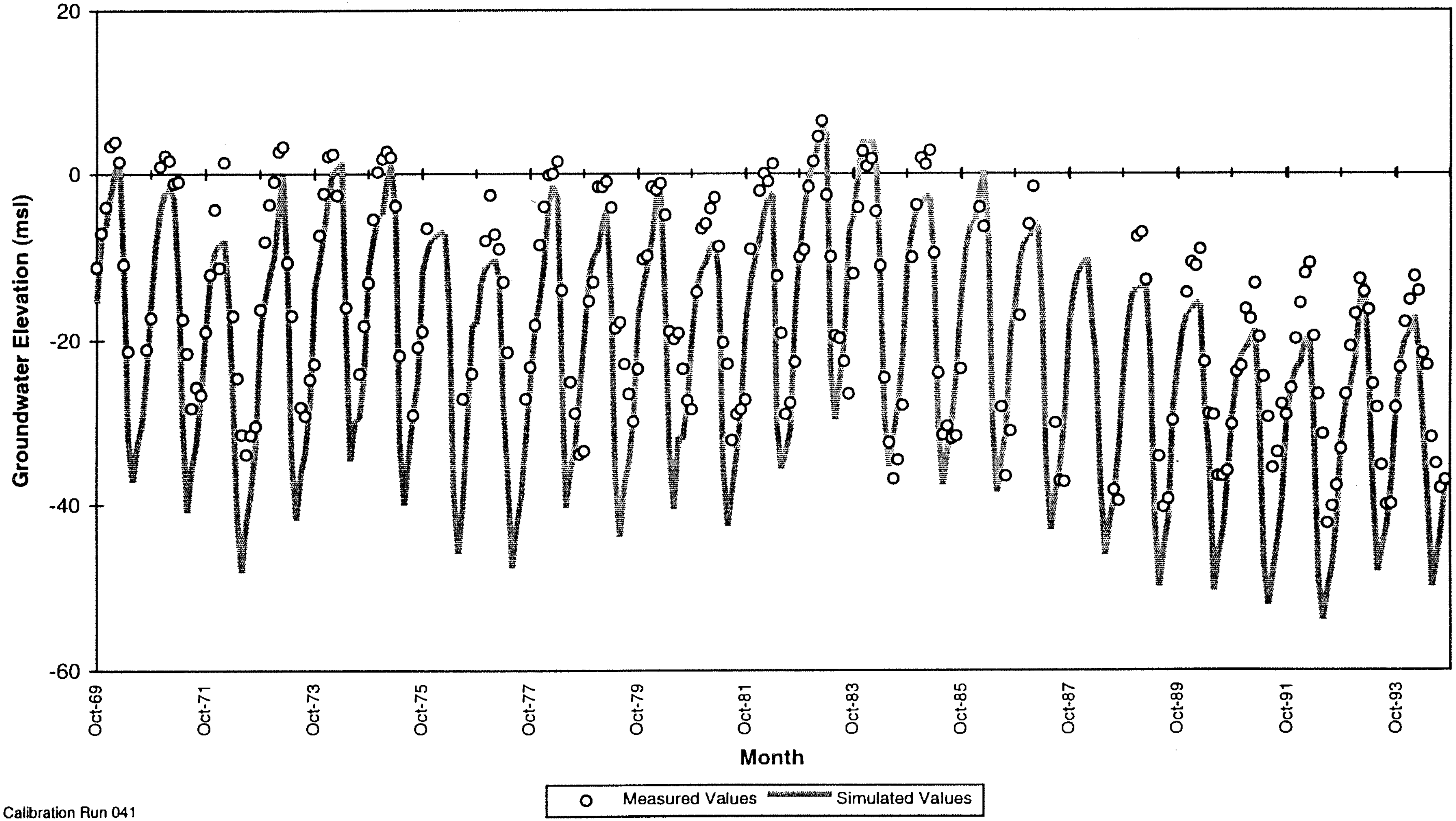
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 12: Pressure Subarea, 180 Foot Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

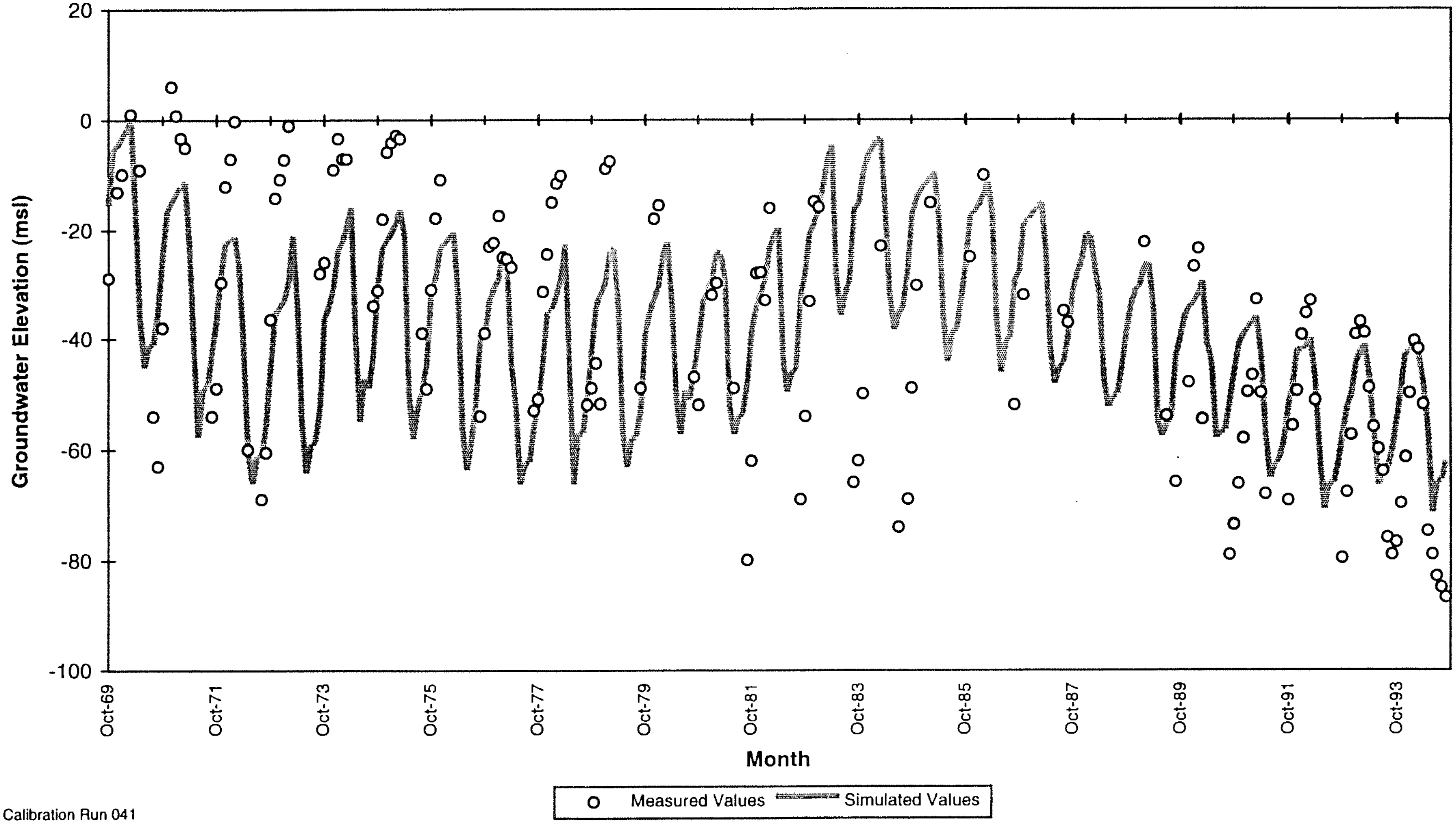
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 13: Pressure Subarea, 400 Foot Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

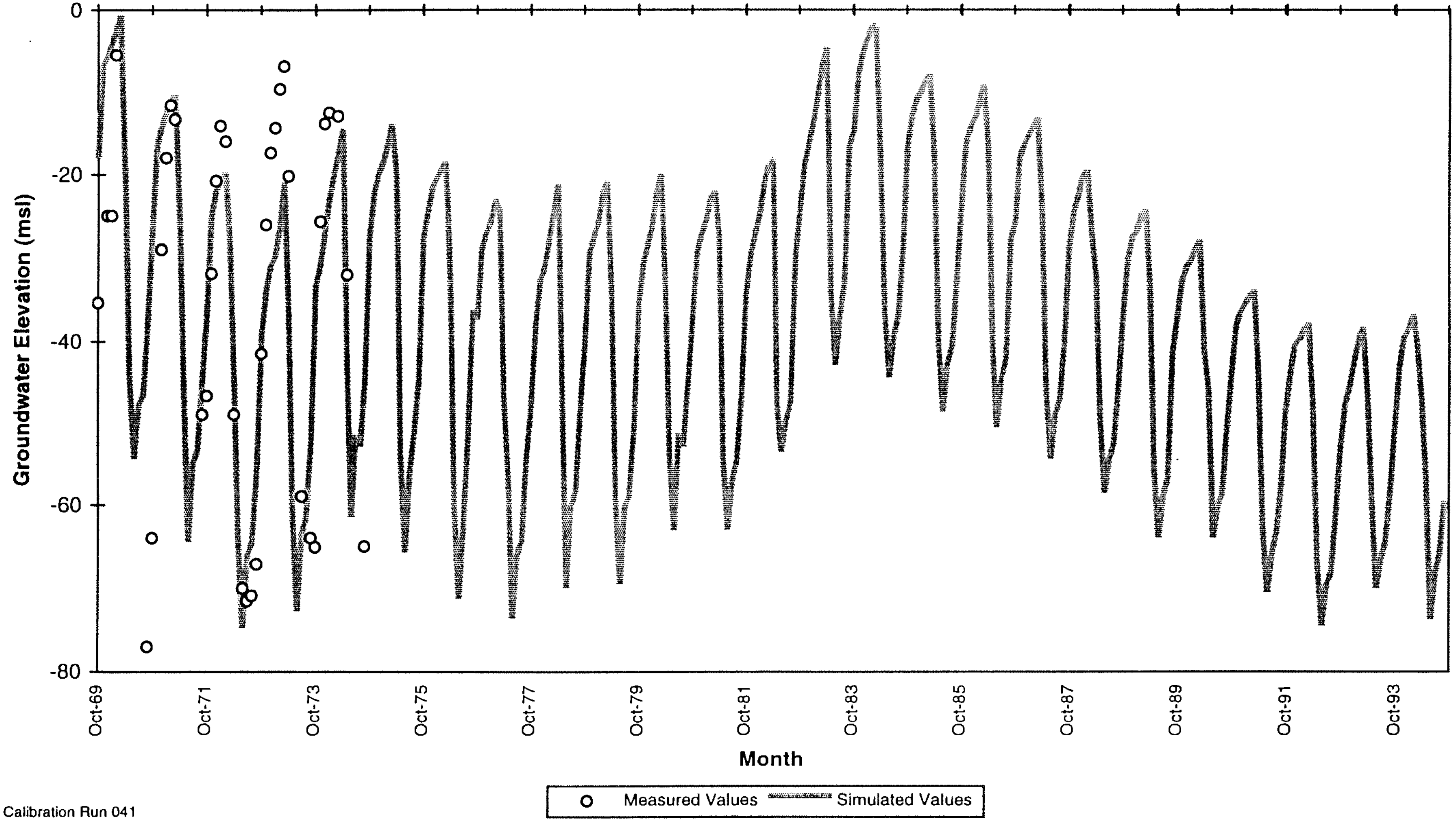
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 16: East Side Subarea, East Side Deep Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

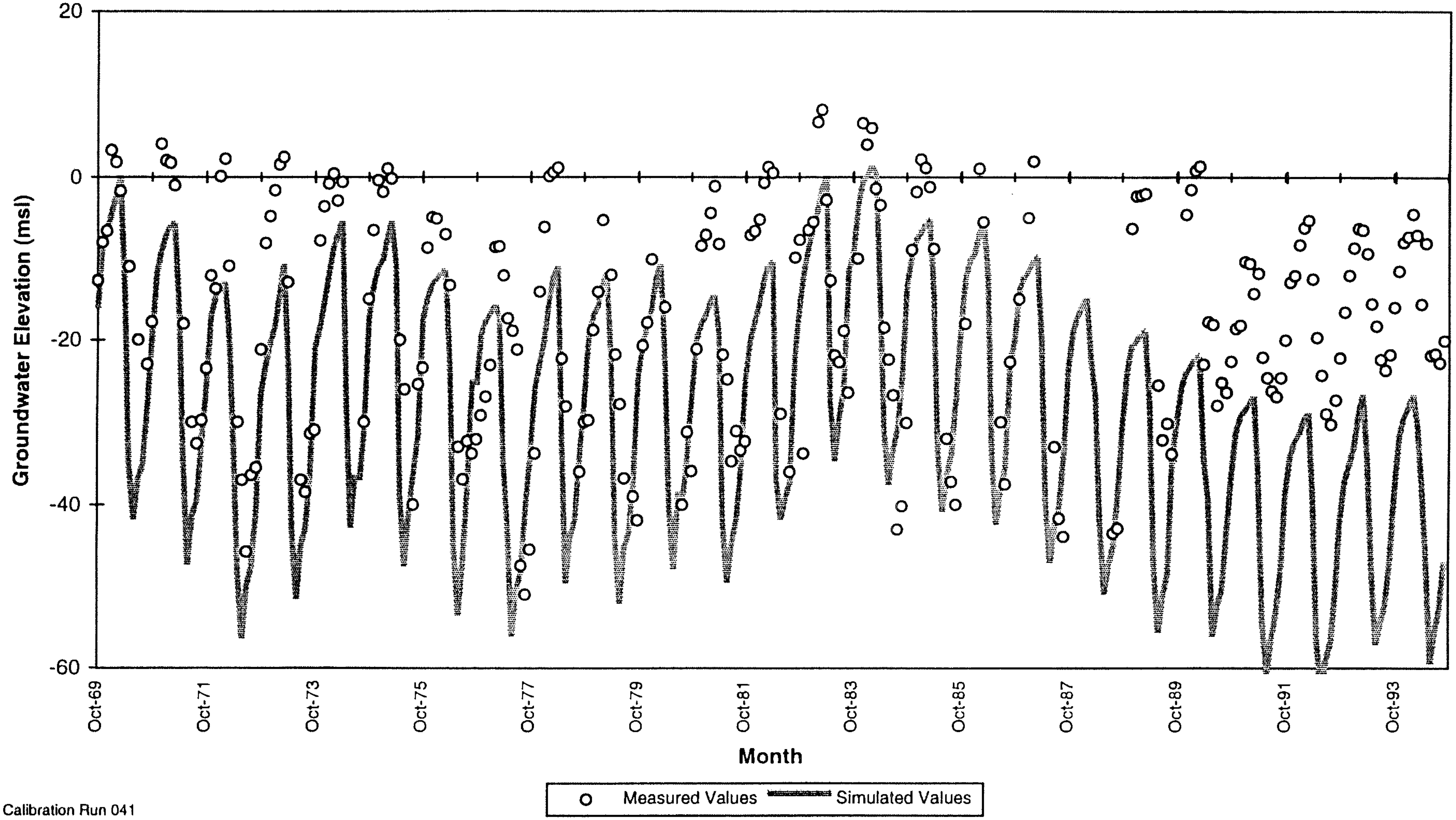
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 17: East Side Subarea, East Side Deep Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

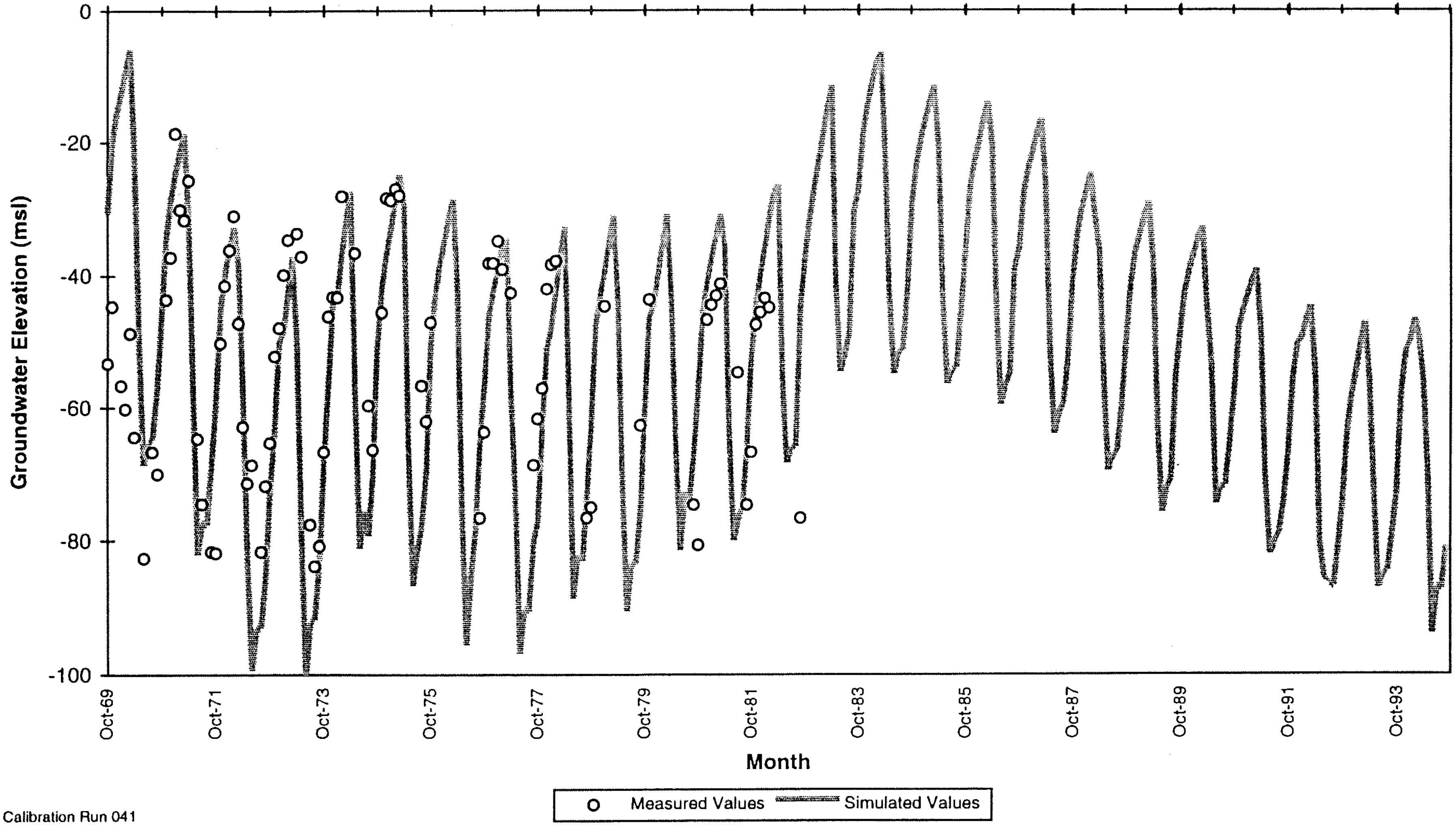
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 18: East Side Subarea, East Side Deep Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

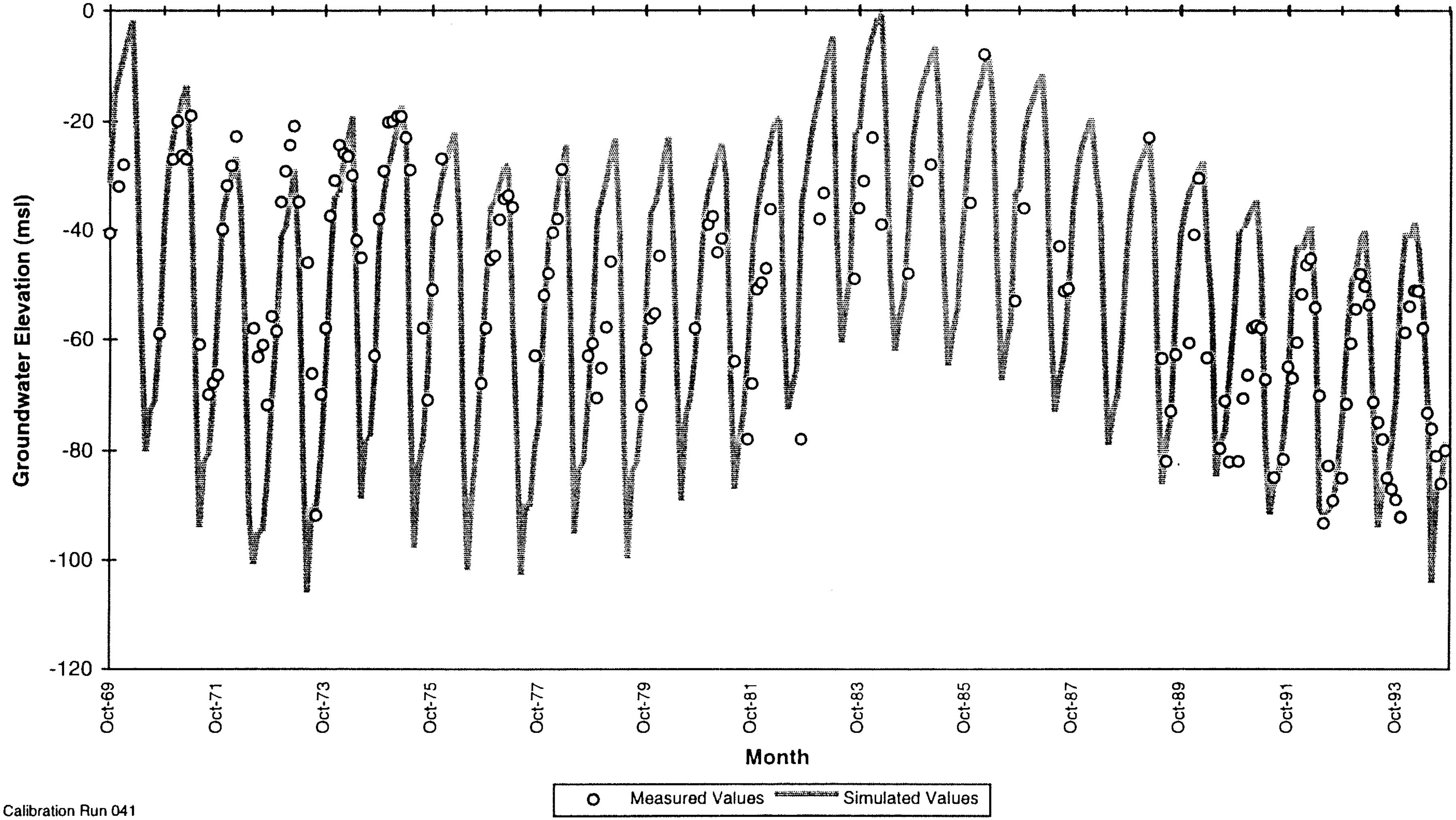
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 19: East Side Subarea, East Side Deep Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

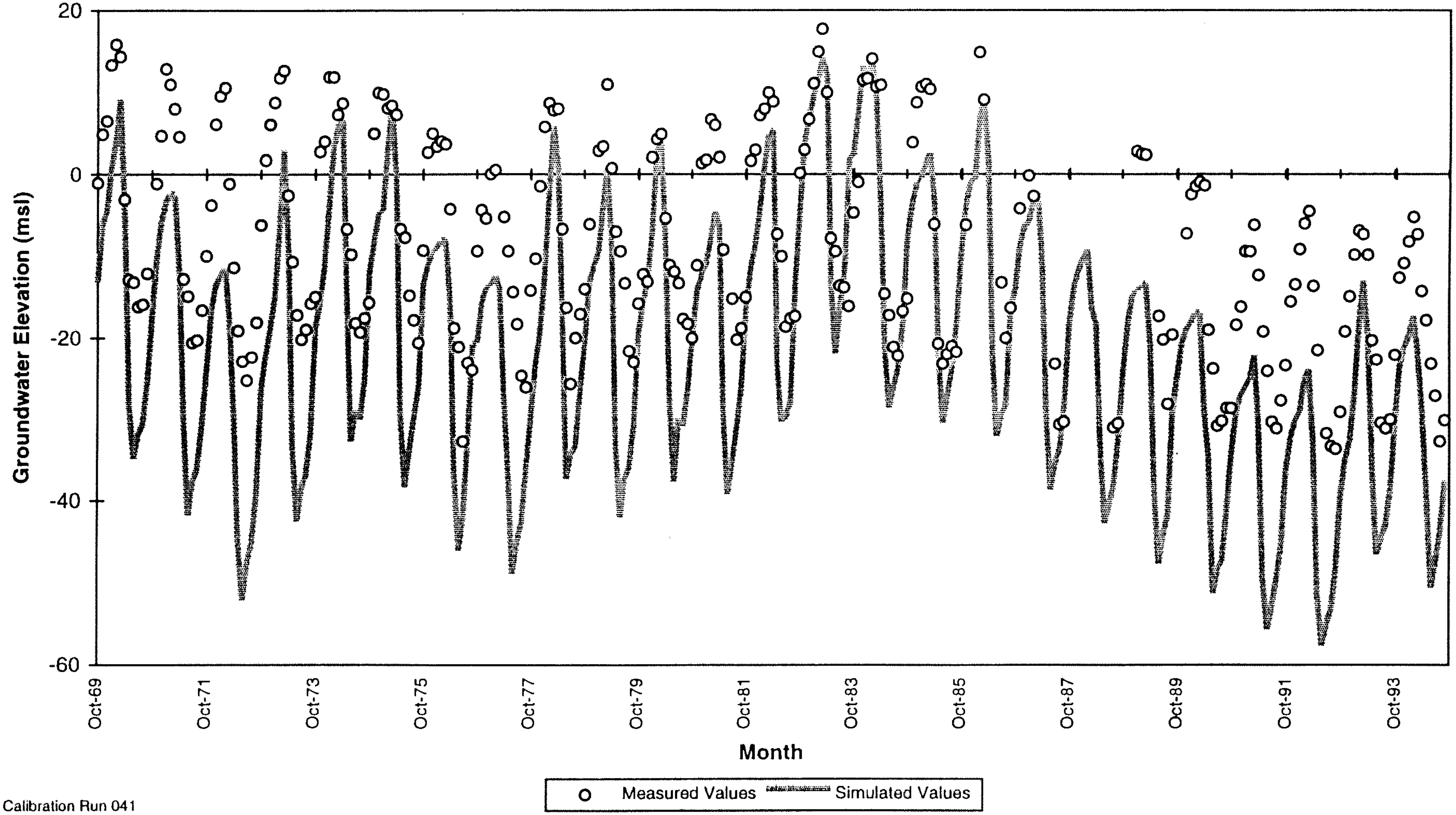
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 20: East Side Subarea, East Side Deep Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

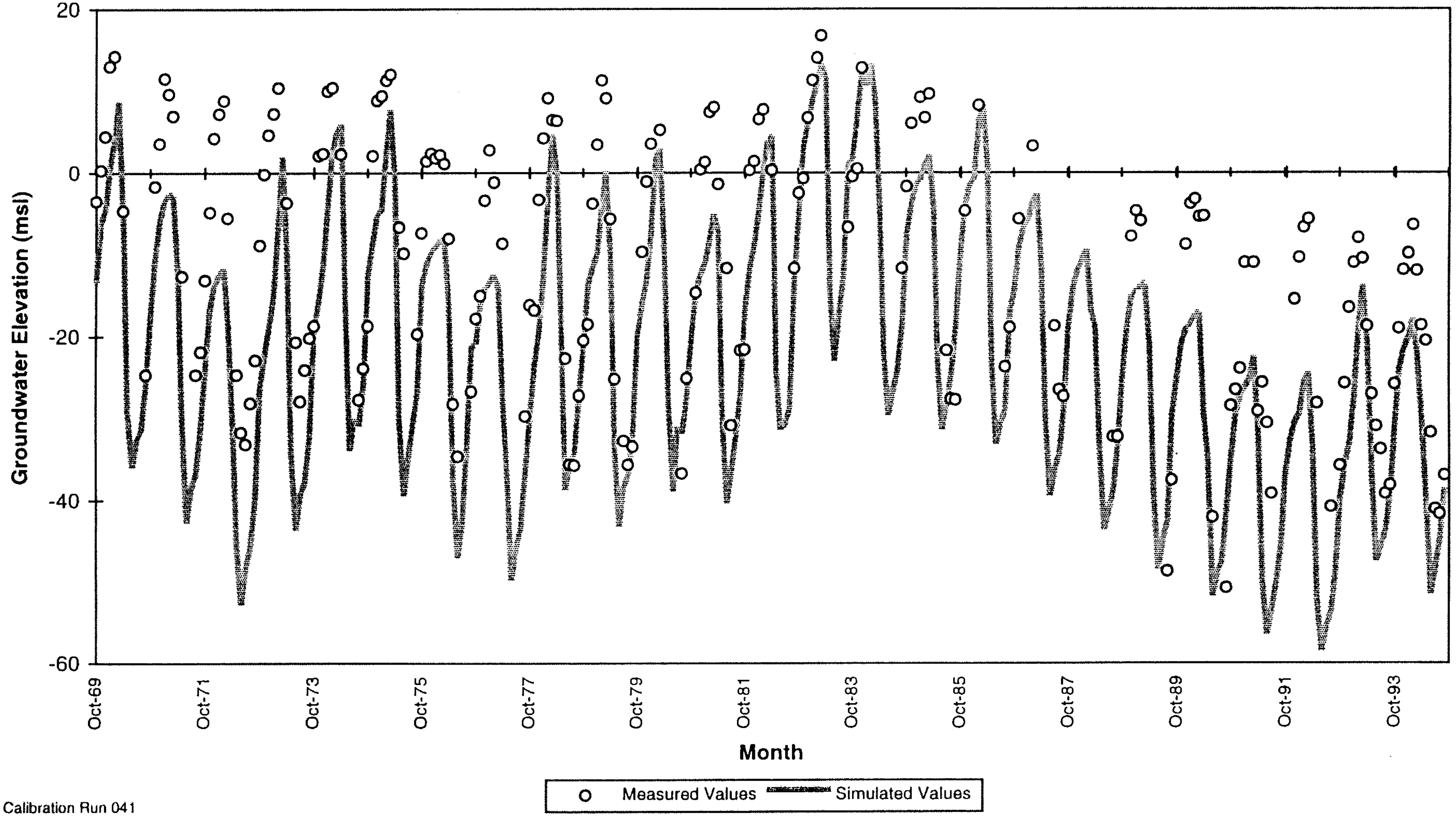
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 21: Pressure Subarea, 400 Foot Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

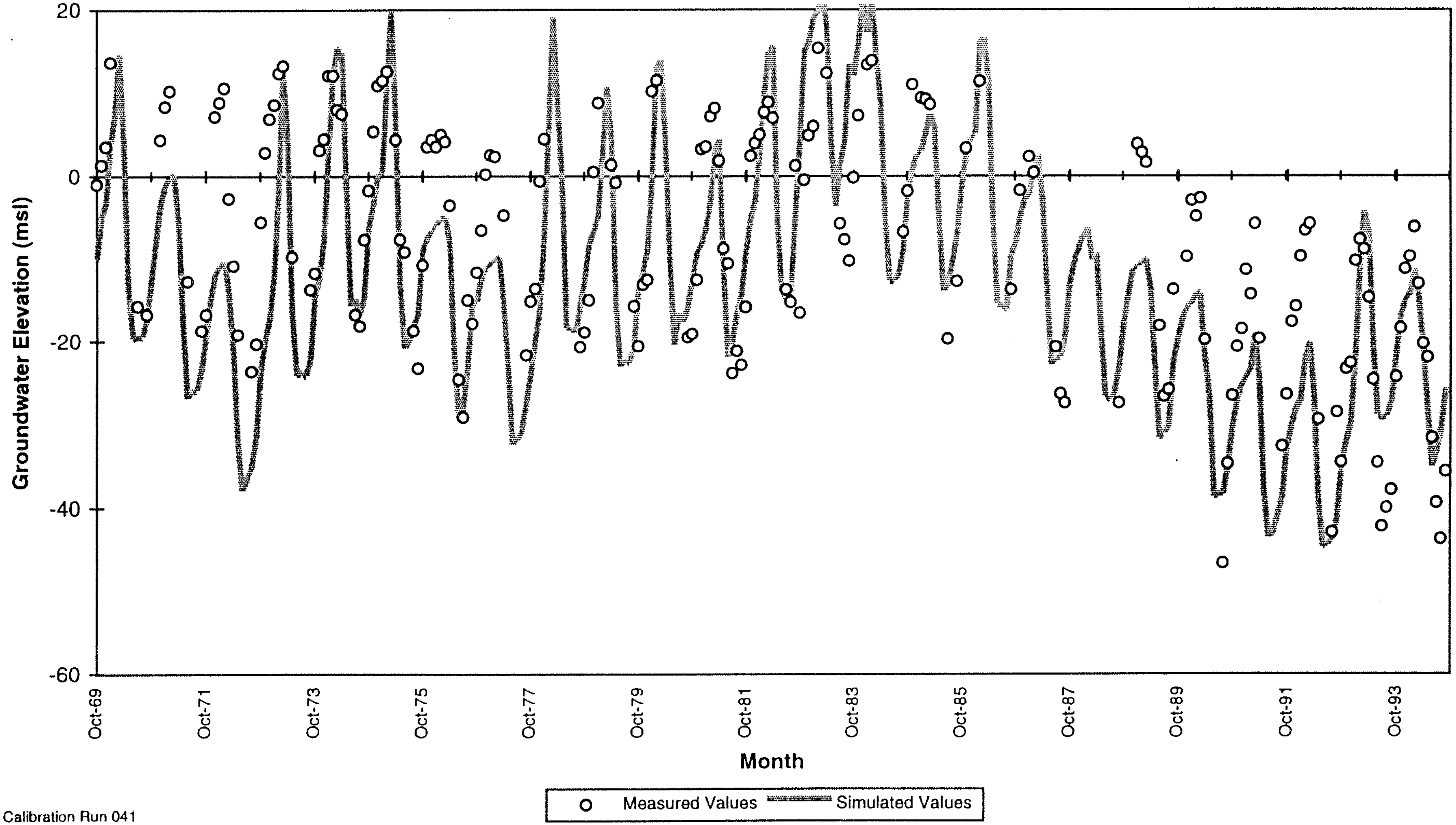
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 22: Pressure Subarea, 400 Foot Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

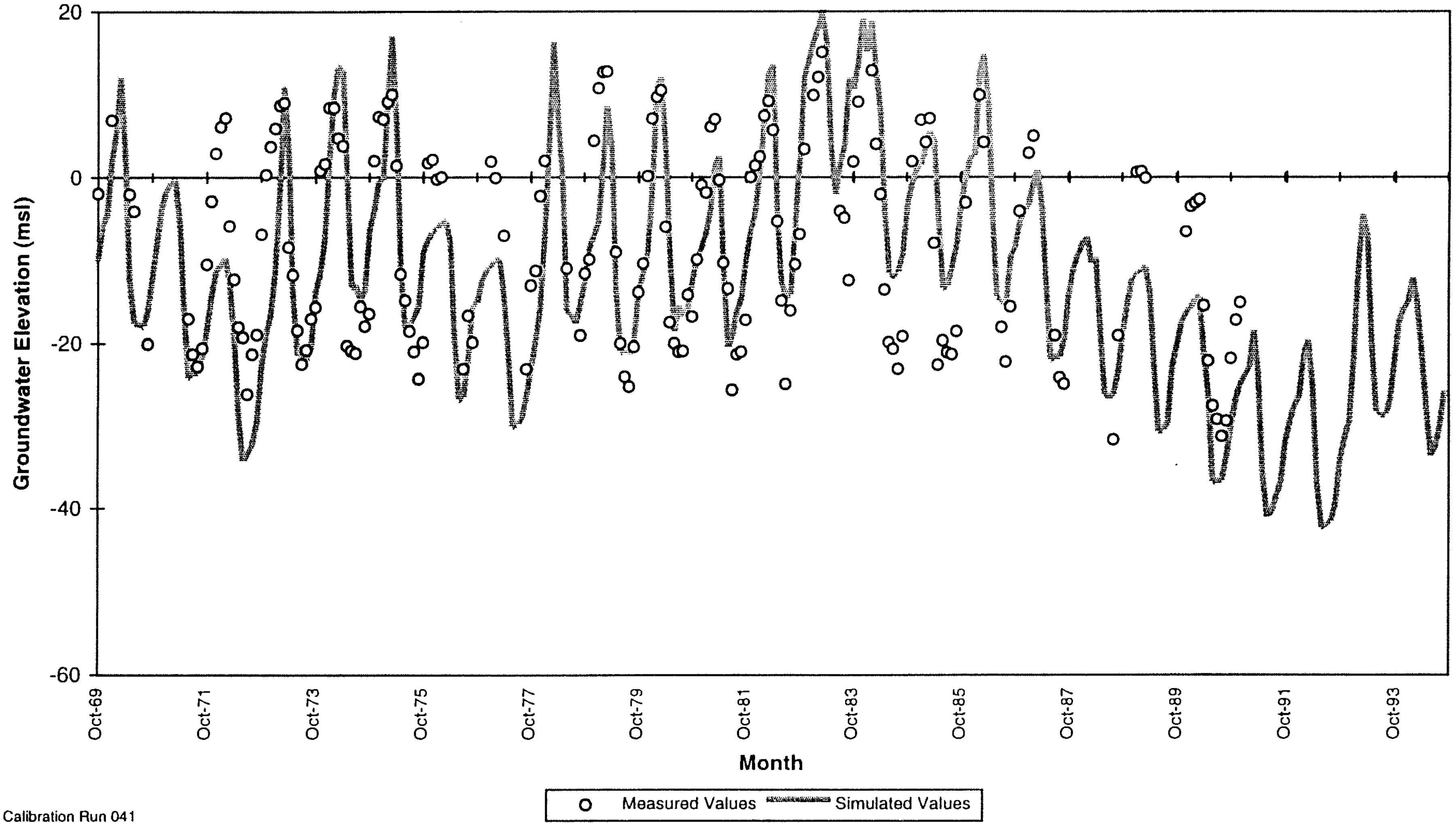
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 23: Pressure Subarea, 400 Foot Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

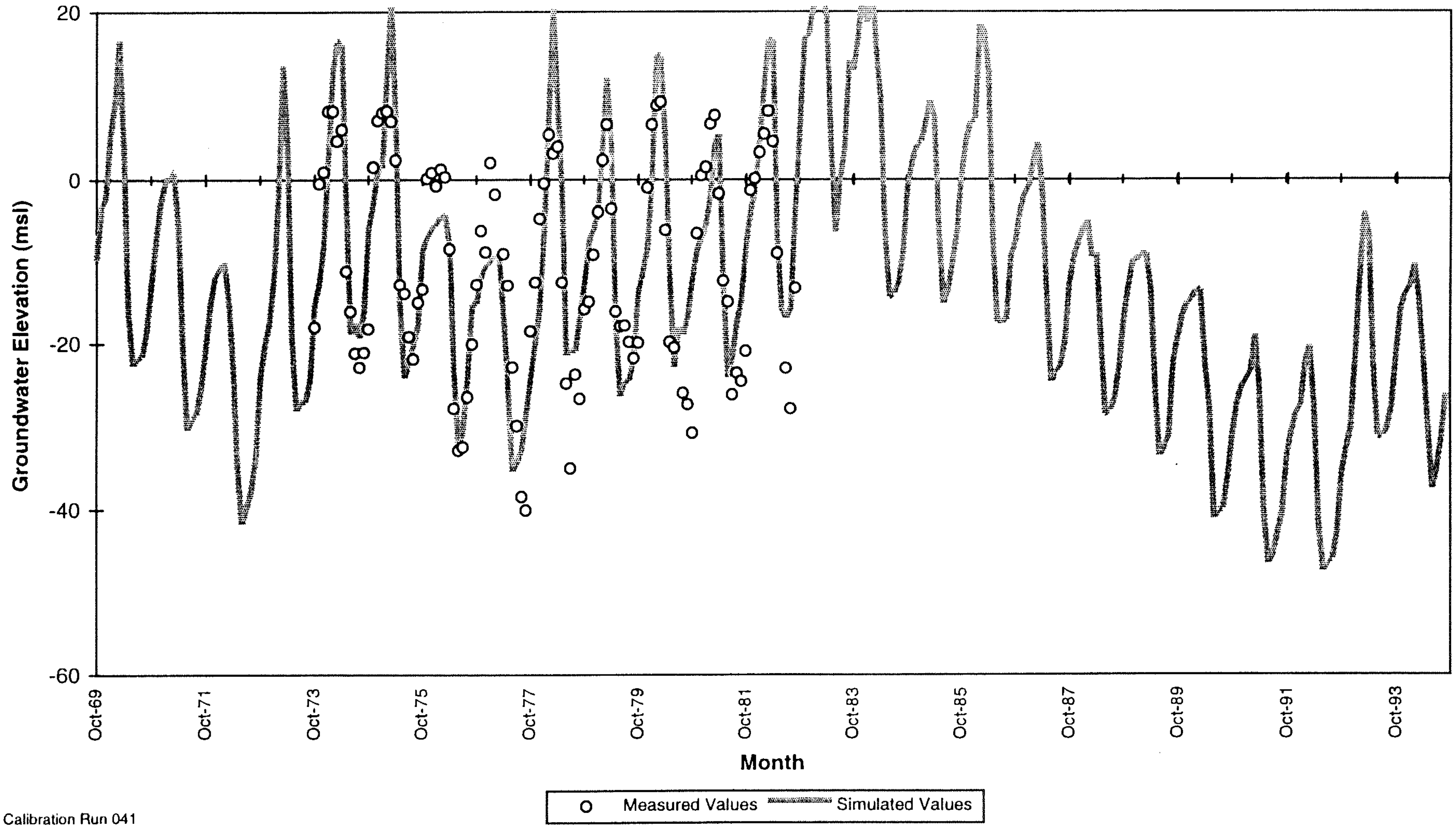
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 24: Pressure Subarea, 400 Foot Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

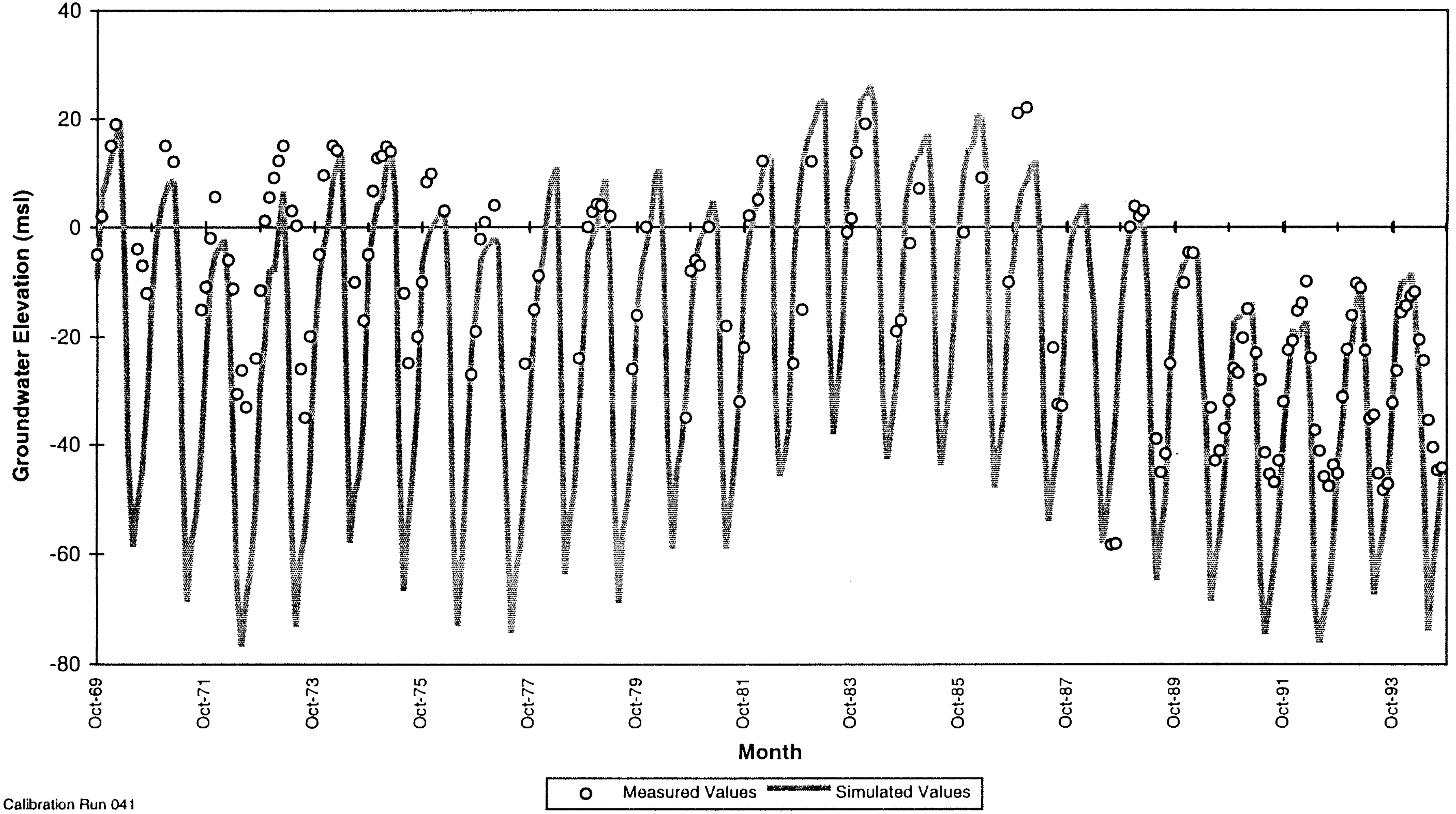
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 25: Pressure Subarea, 400 Foot Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

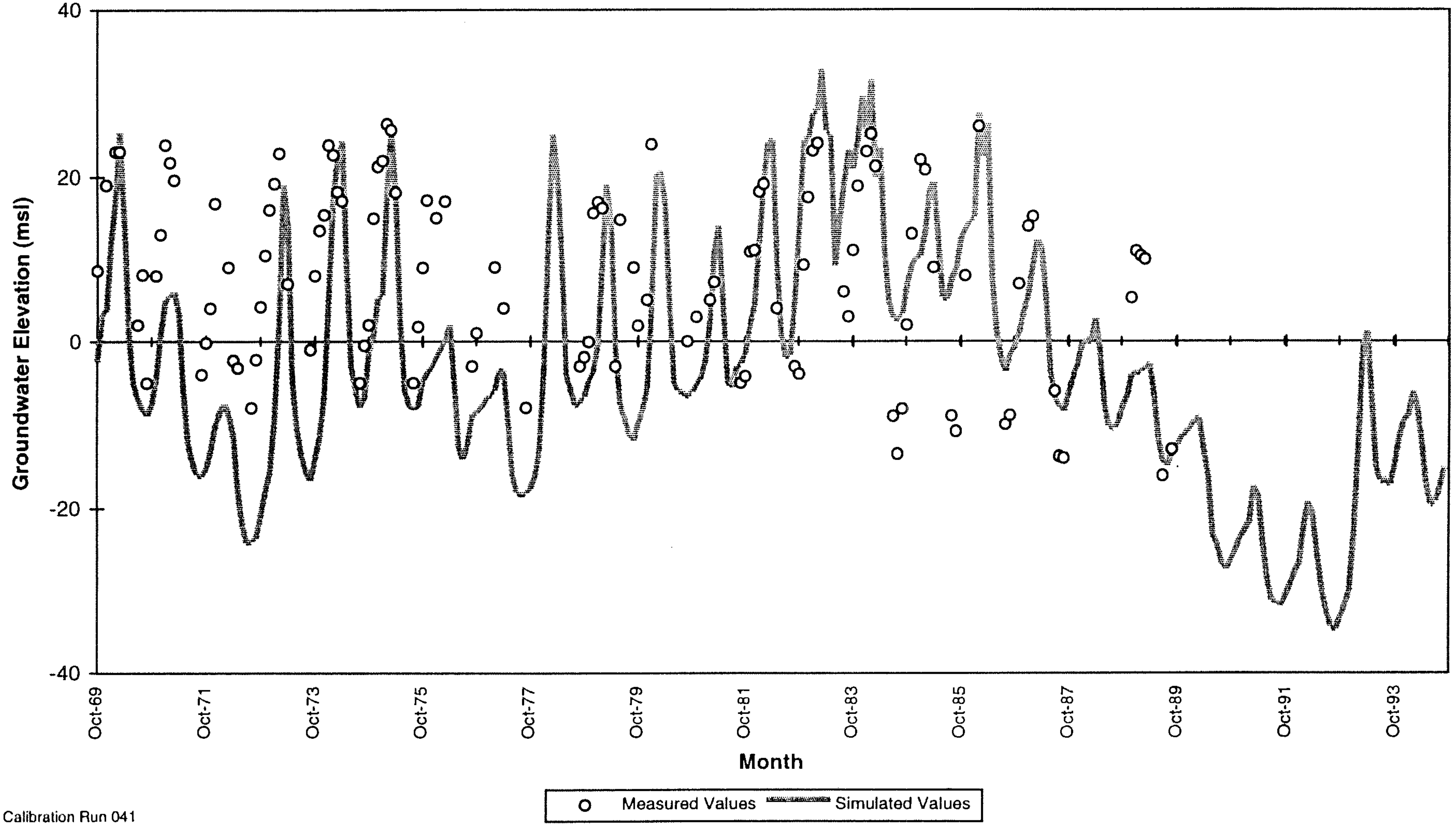
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 26: East Side Subarea, East Side Deep Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

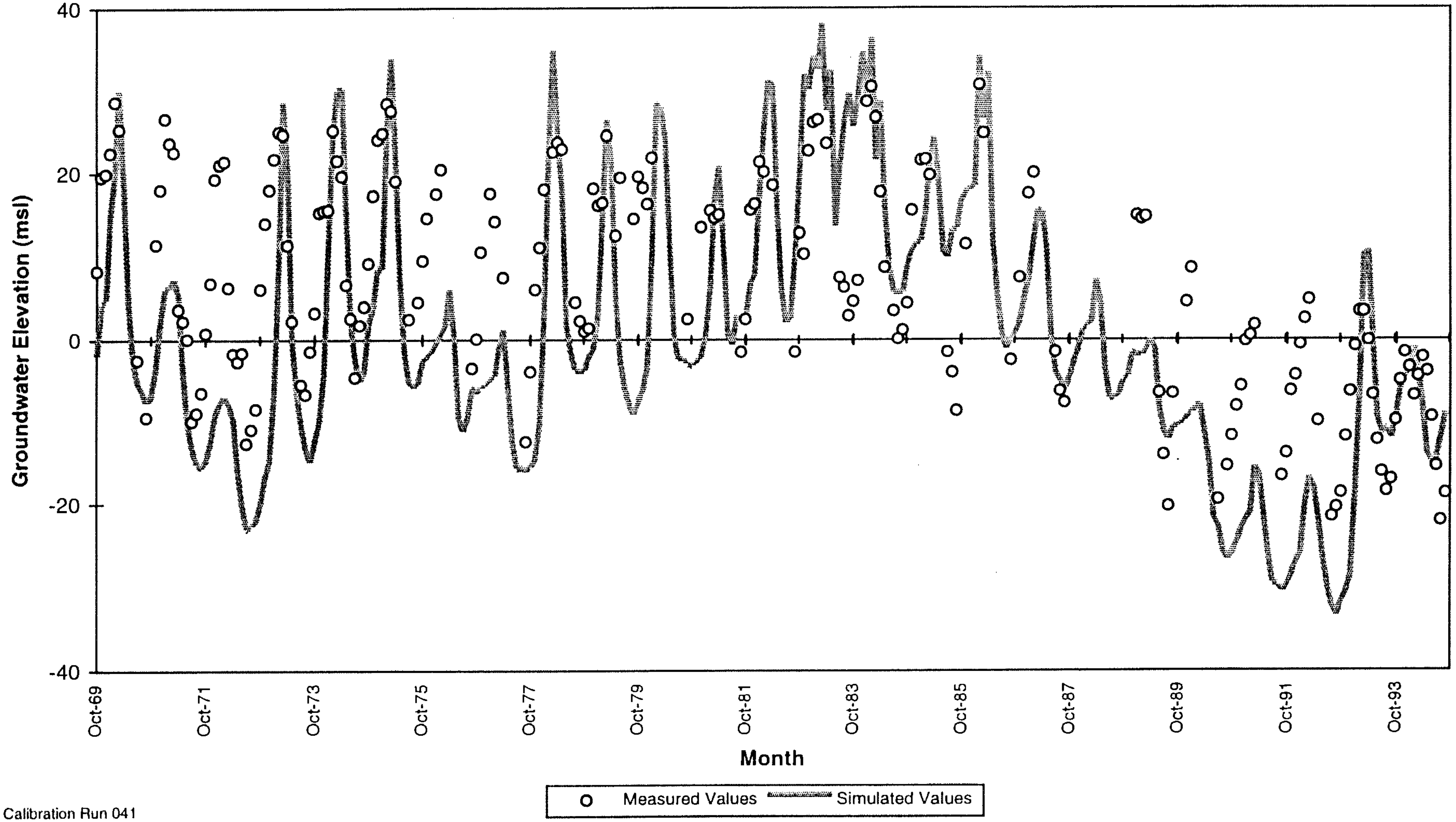
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 27: Pressure Subarea, 400 Foot Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

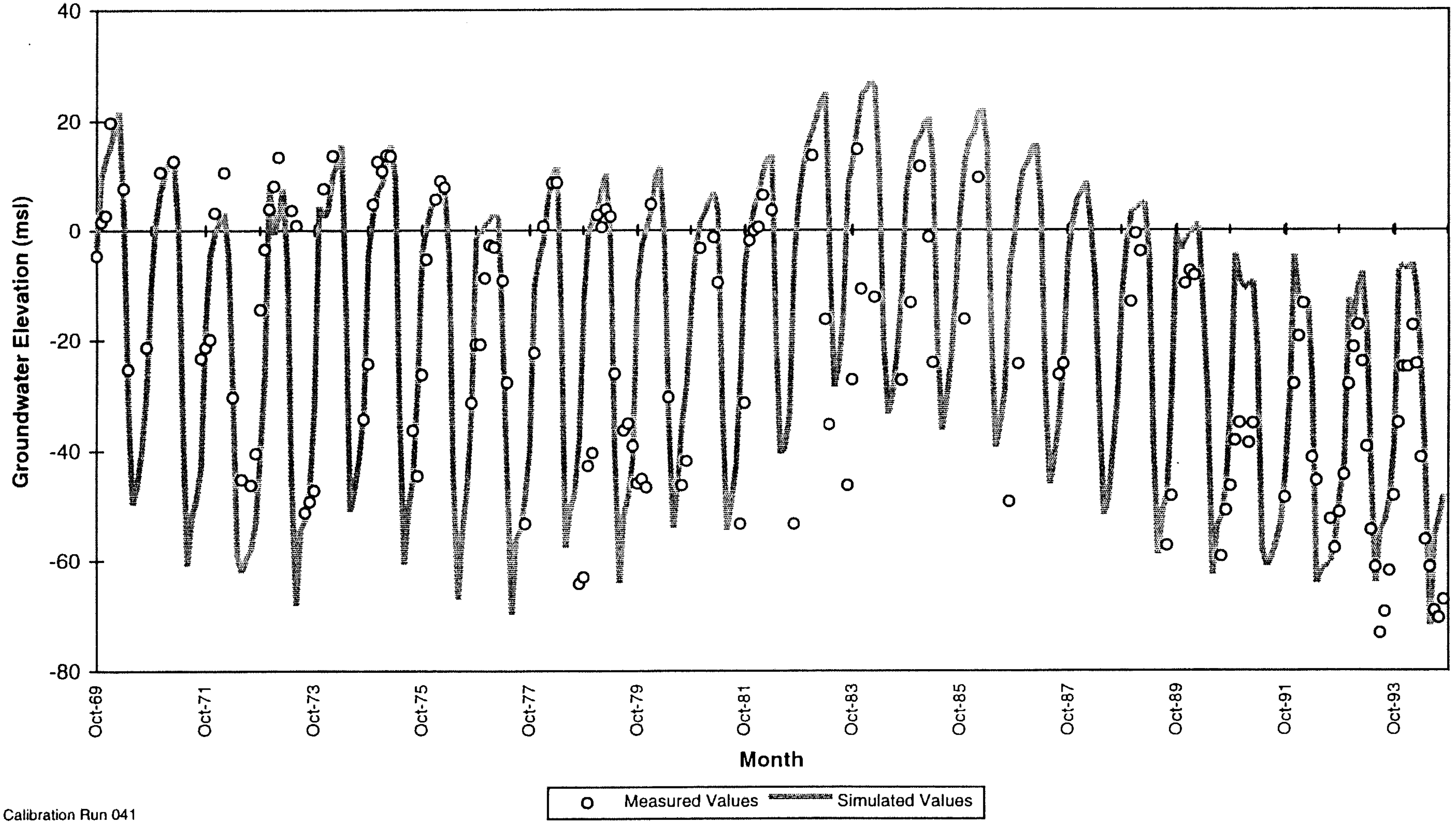
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 28: Pressure Subarea, 180 Foot Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

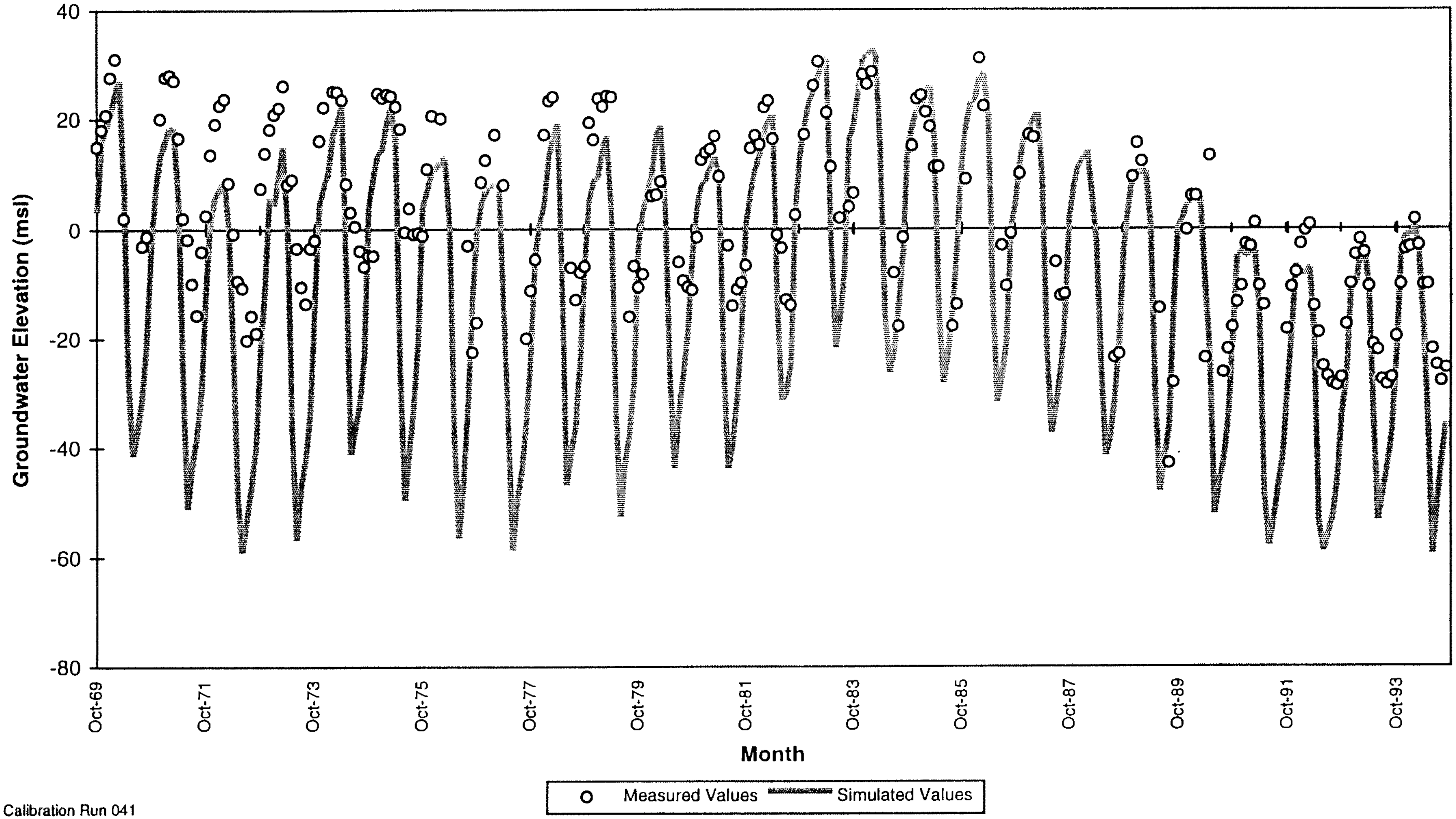
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 29: East Side Subarea, East Side Deep Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

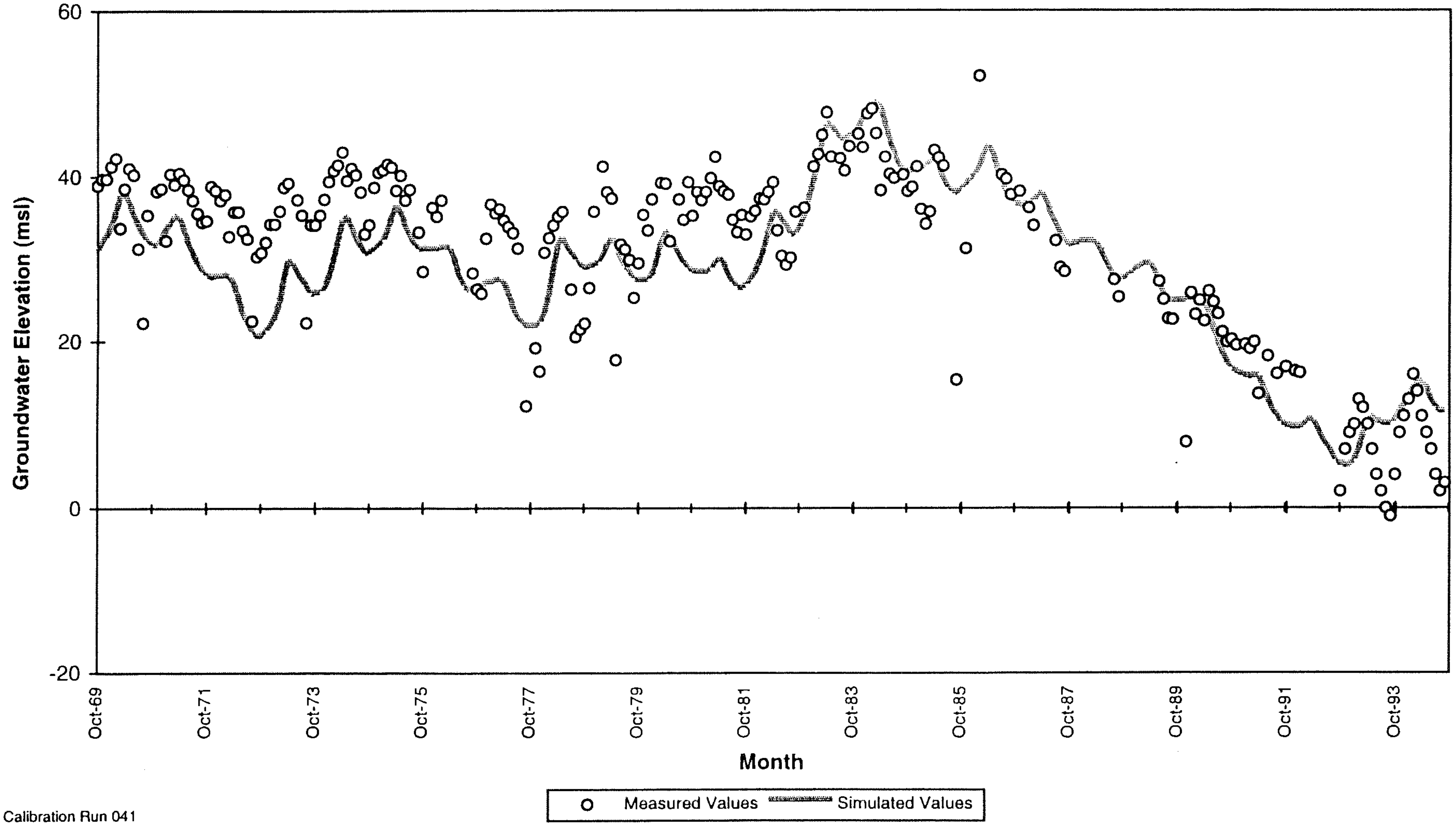
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 30: East Side Subarea, East Side Deep Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

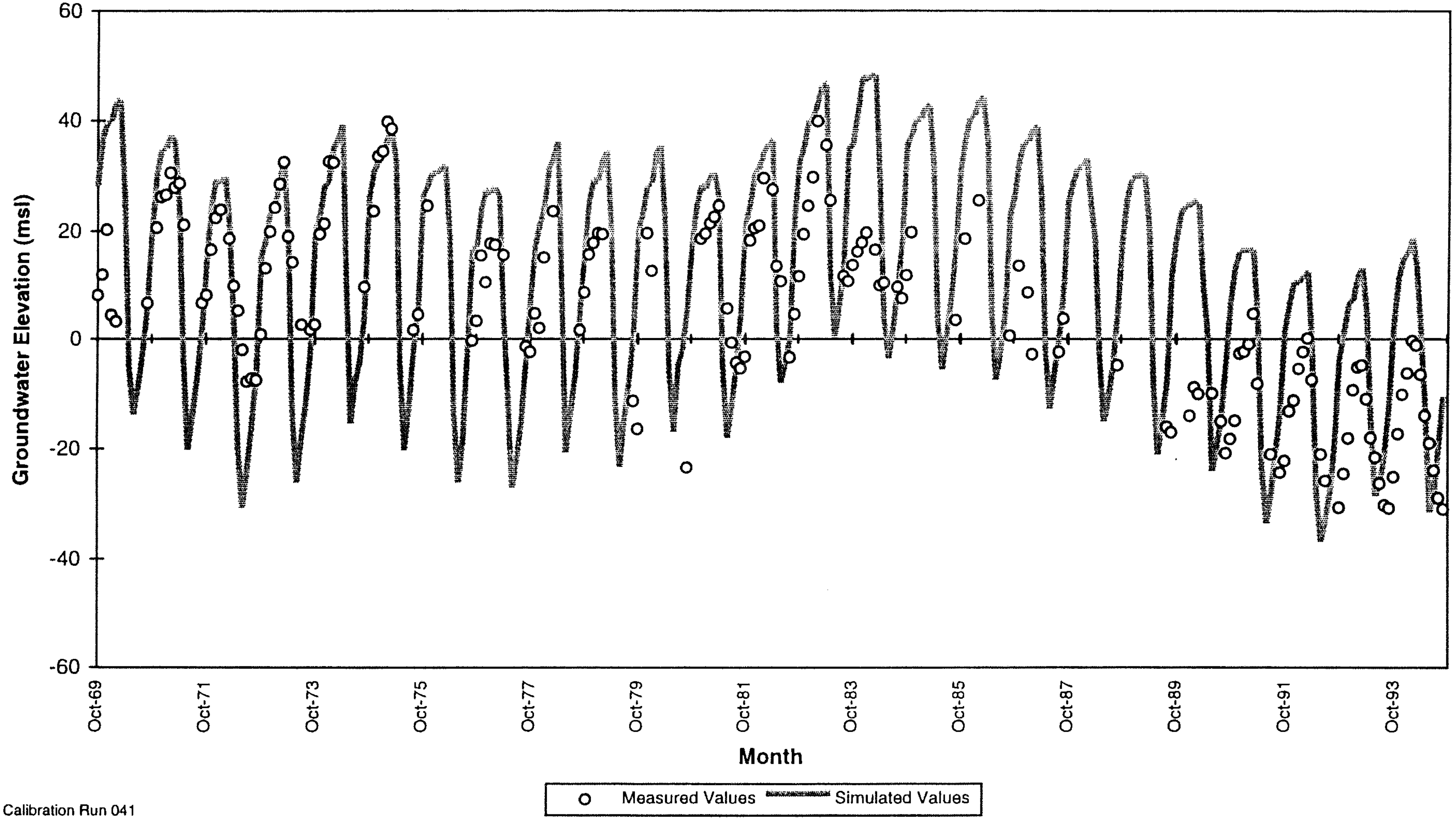
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 31: East Side Subarea, East Side Shallow Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

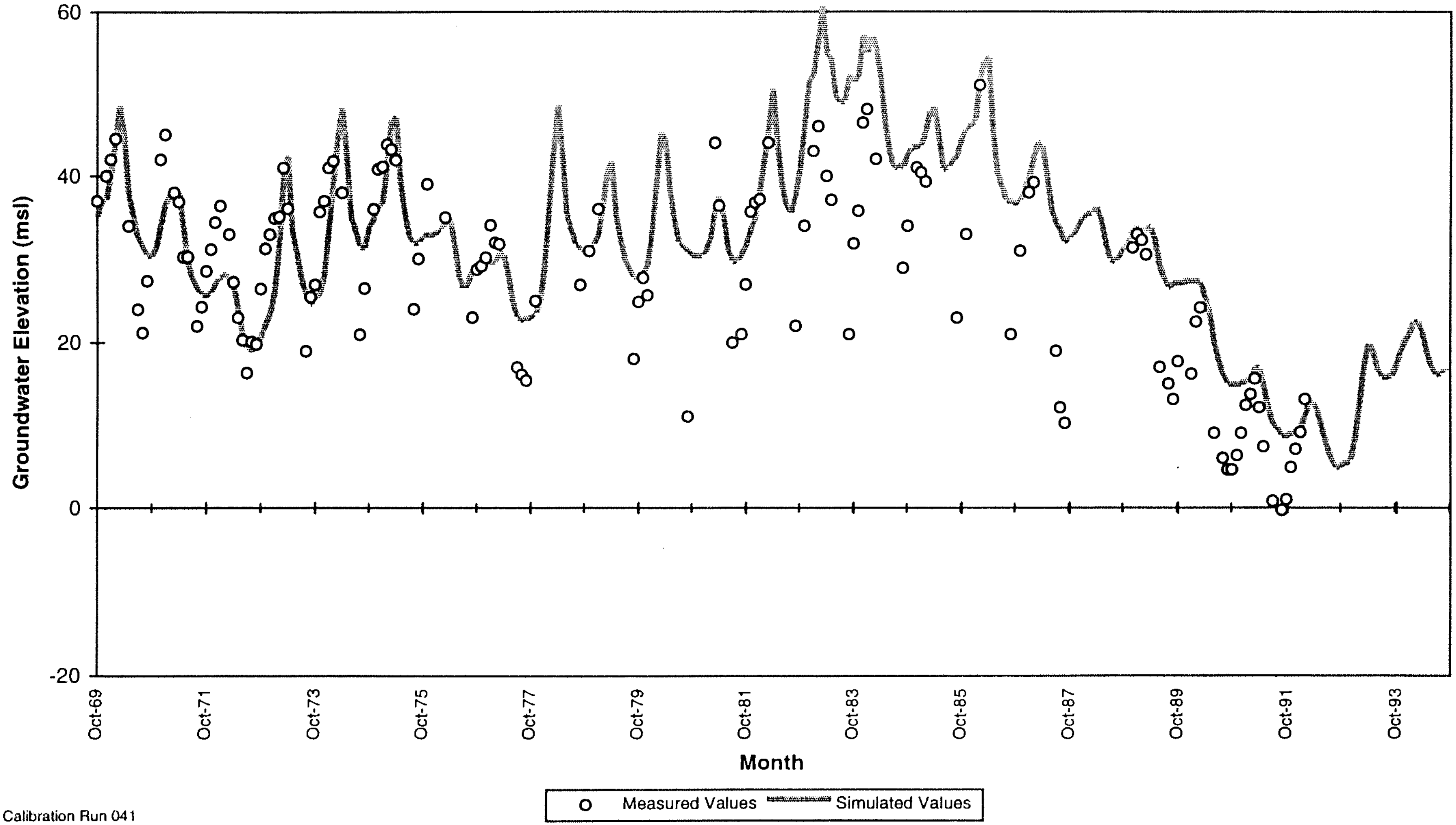
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 32: East Side Subarea, East Side Deep Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

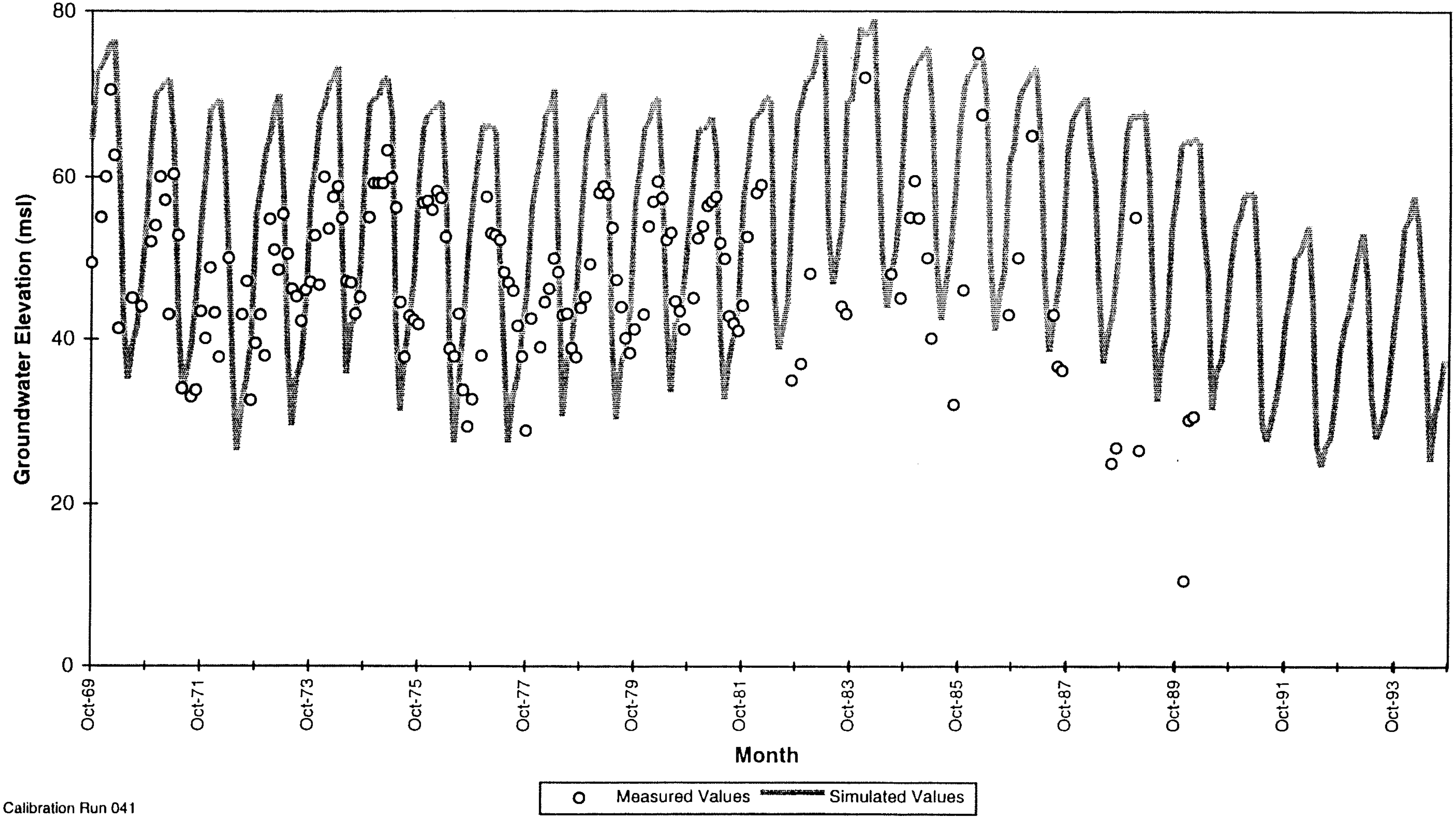
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 33: Pressure Subarea, 400 Foot Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

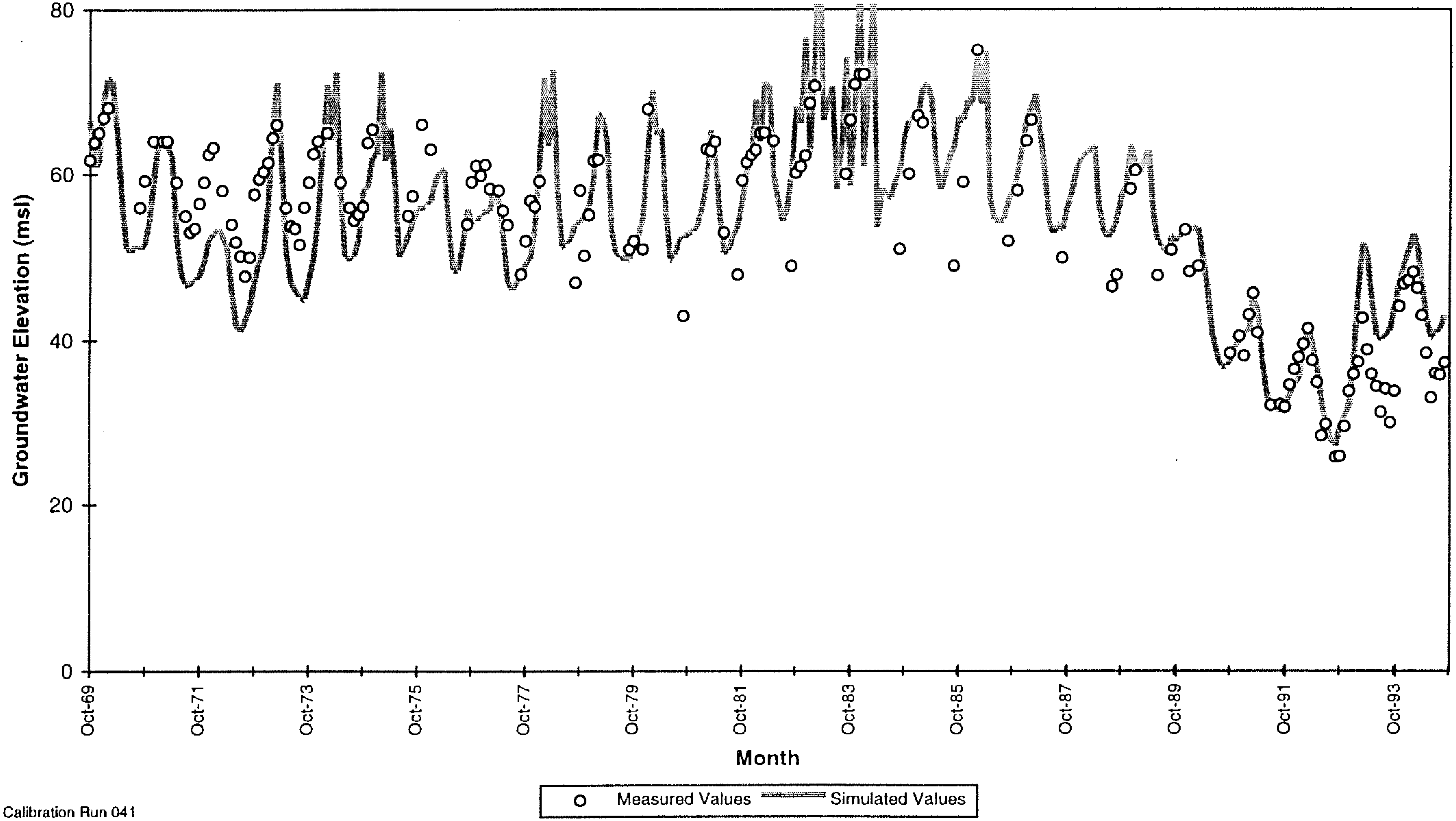
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 34: East Side Subarea, East Side Deep Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

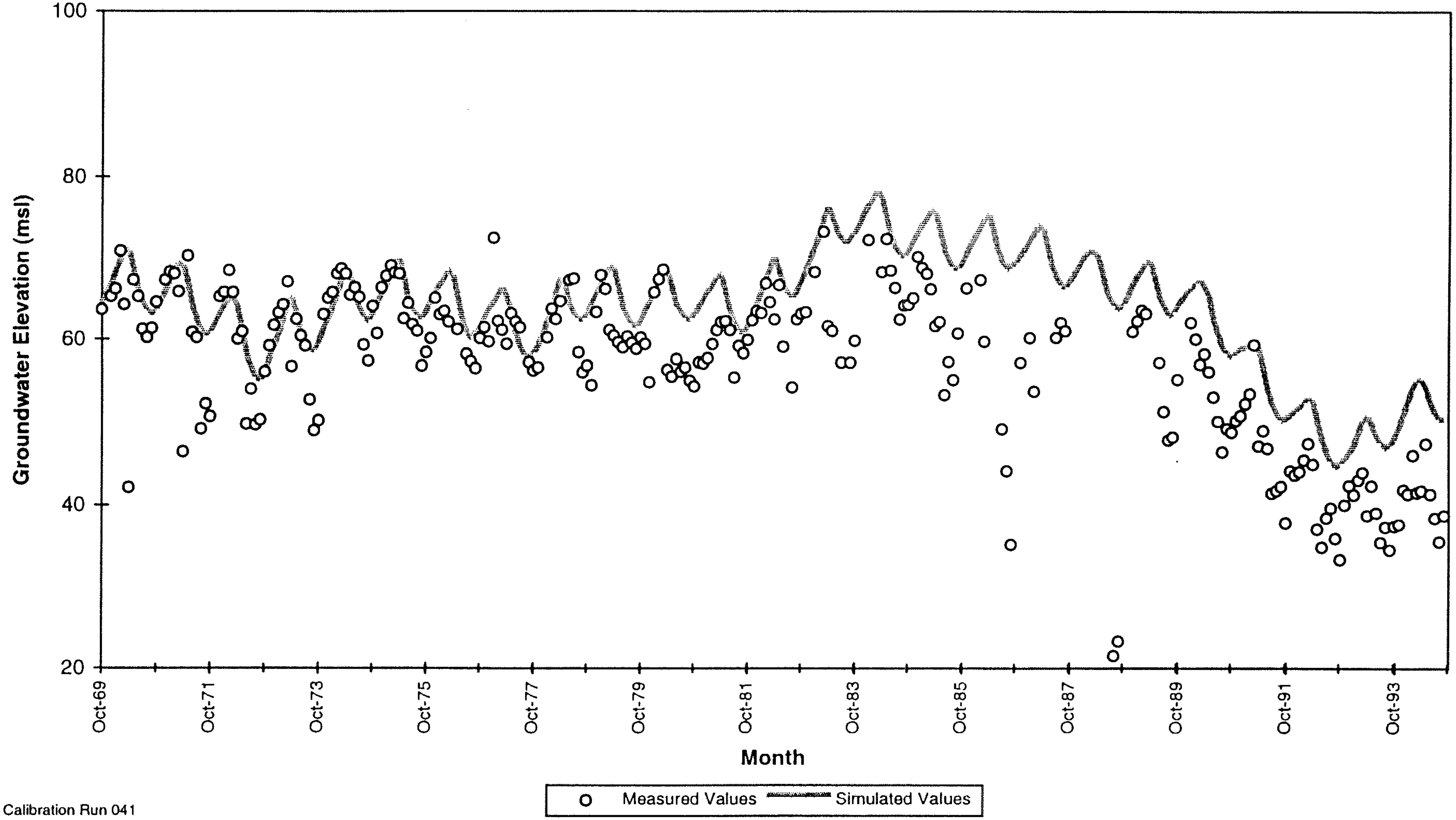
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 35: Pressure Subarea, 180 Foot Aquifer



Calibration Run 041

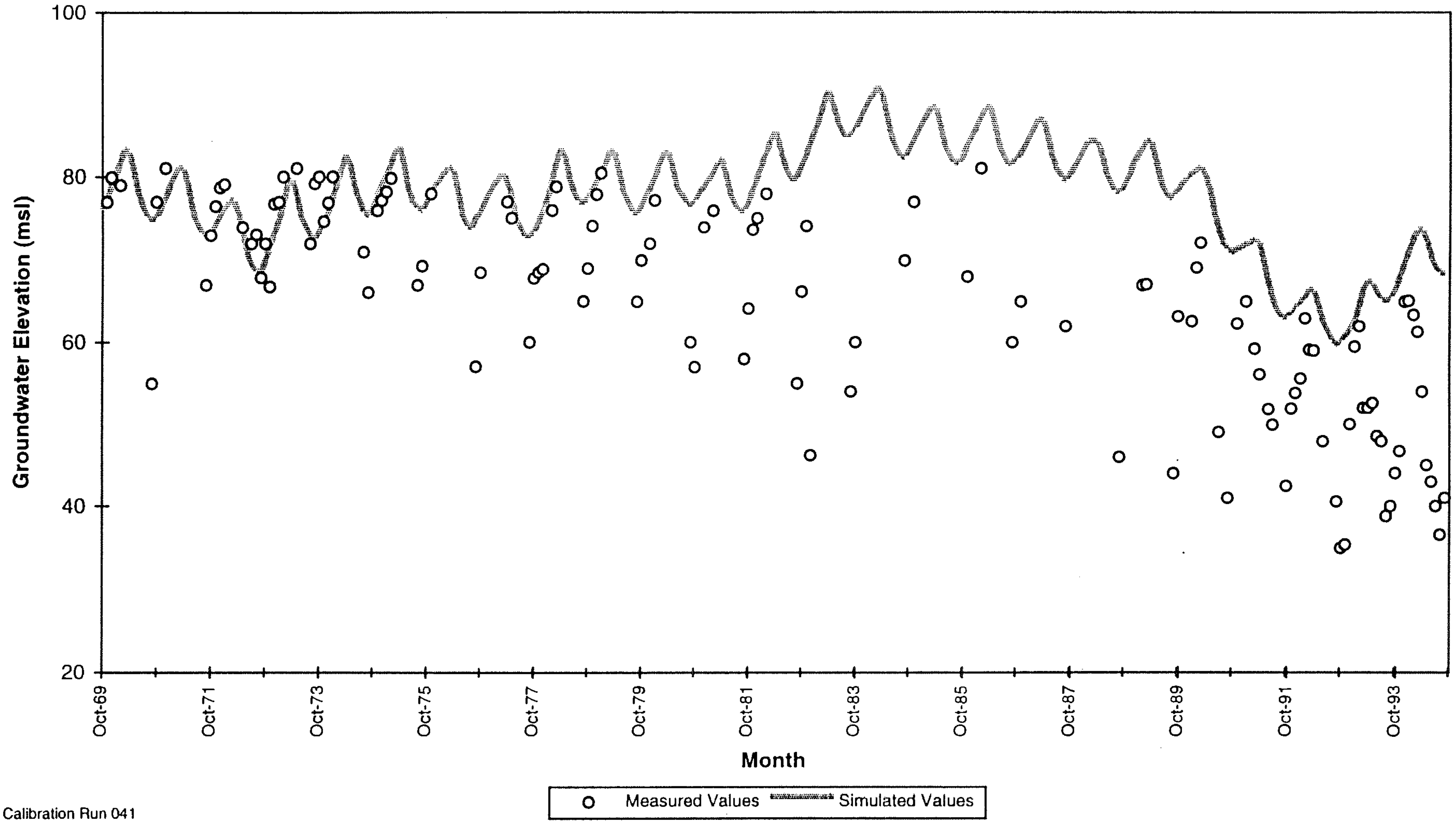
CALHYDRO.XLS
5/29/97

HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 36: East Side Subarea, East Side Shallow Aquifer



Calibration Run 041

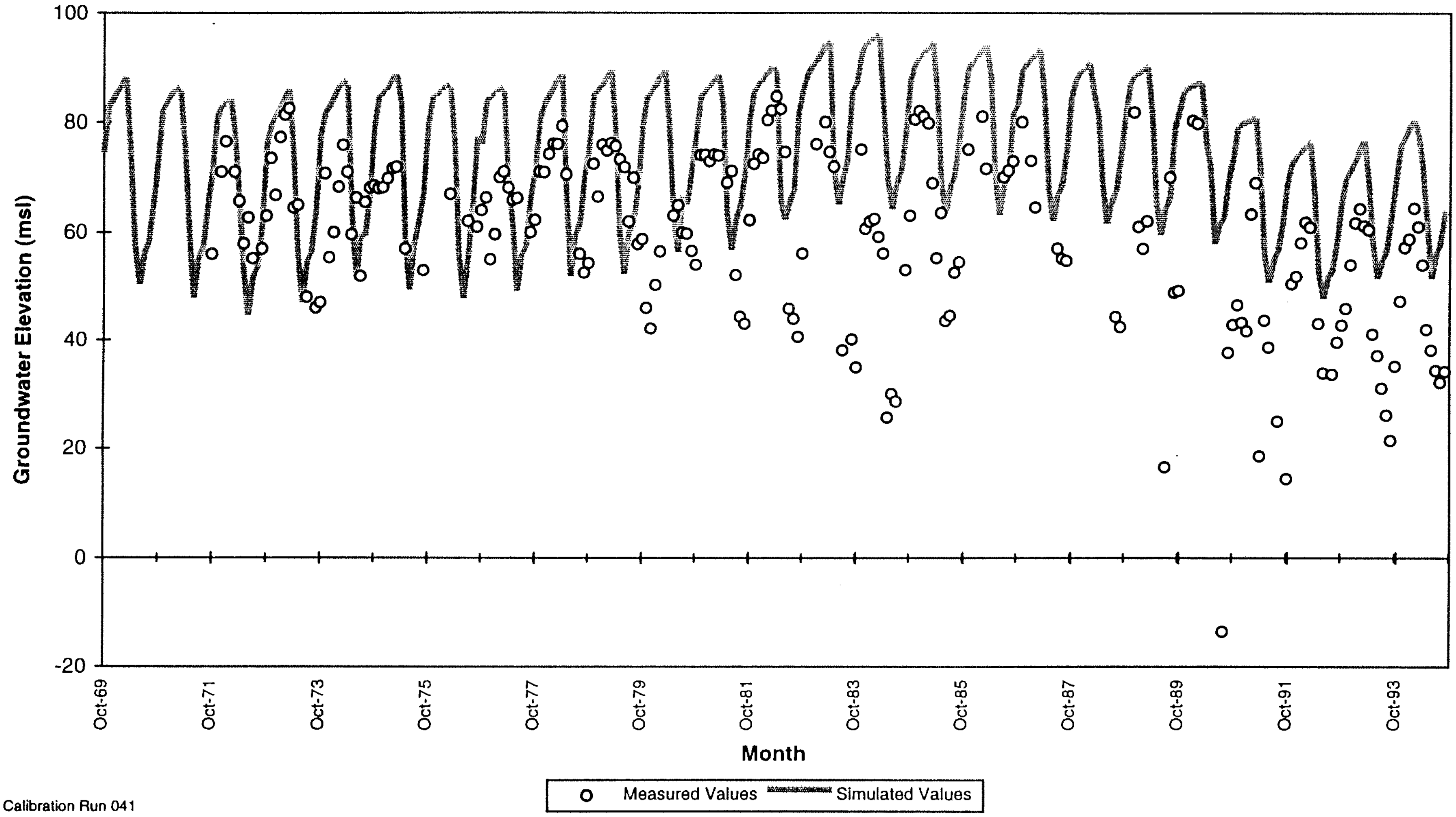
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 37: East Side Subarea, East Side Shallow Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

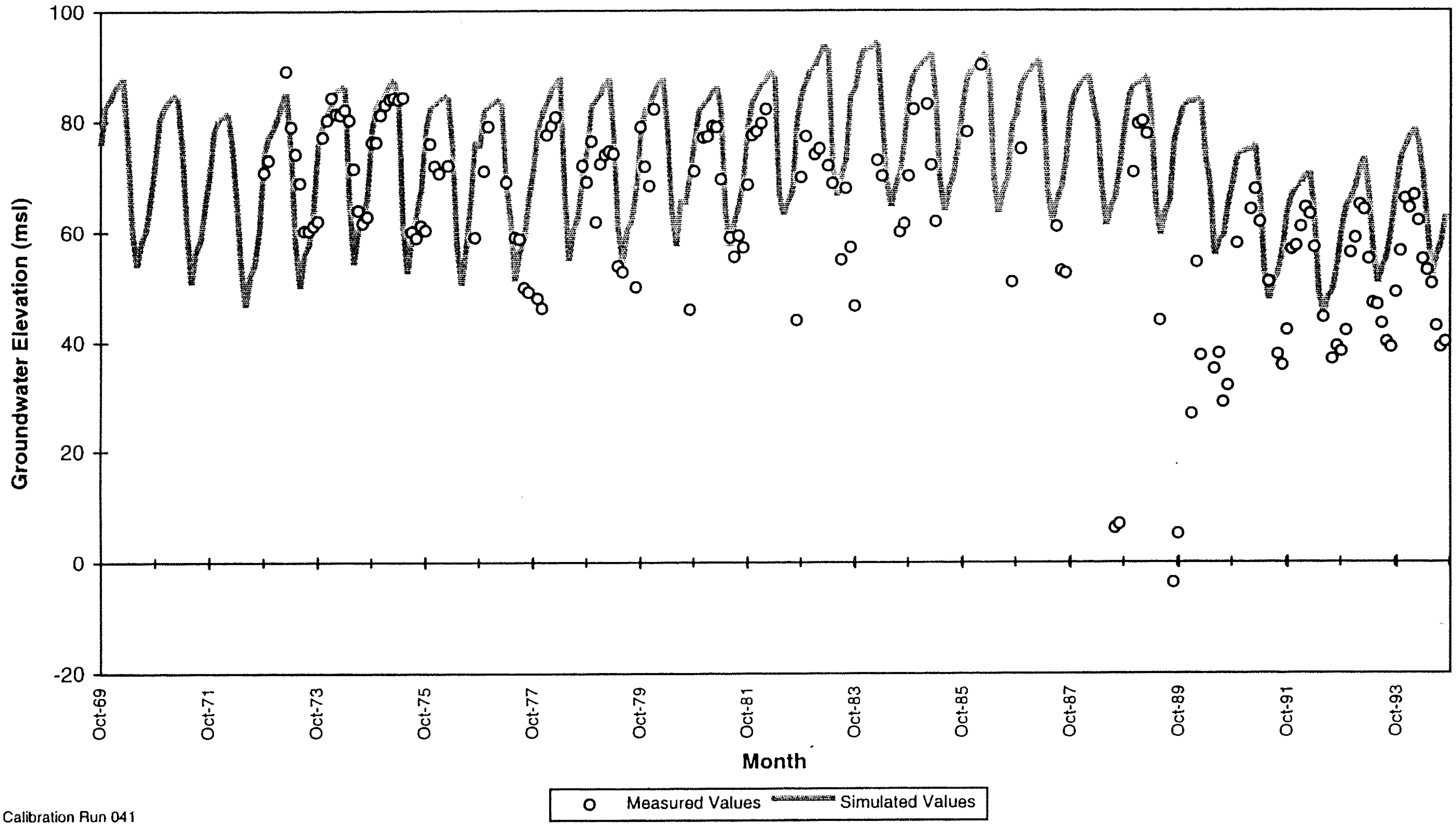
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 38: East Side Subarea, East Side Deep Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

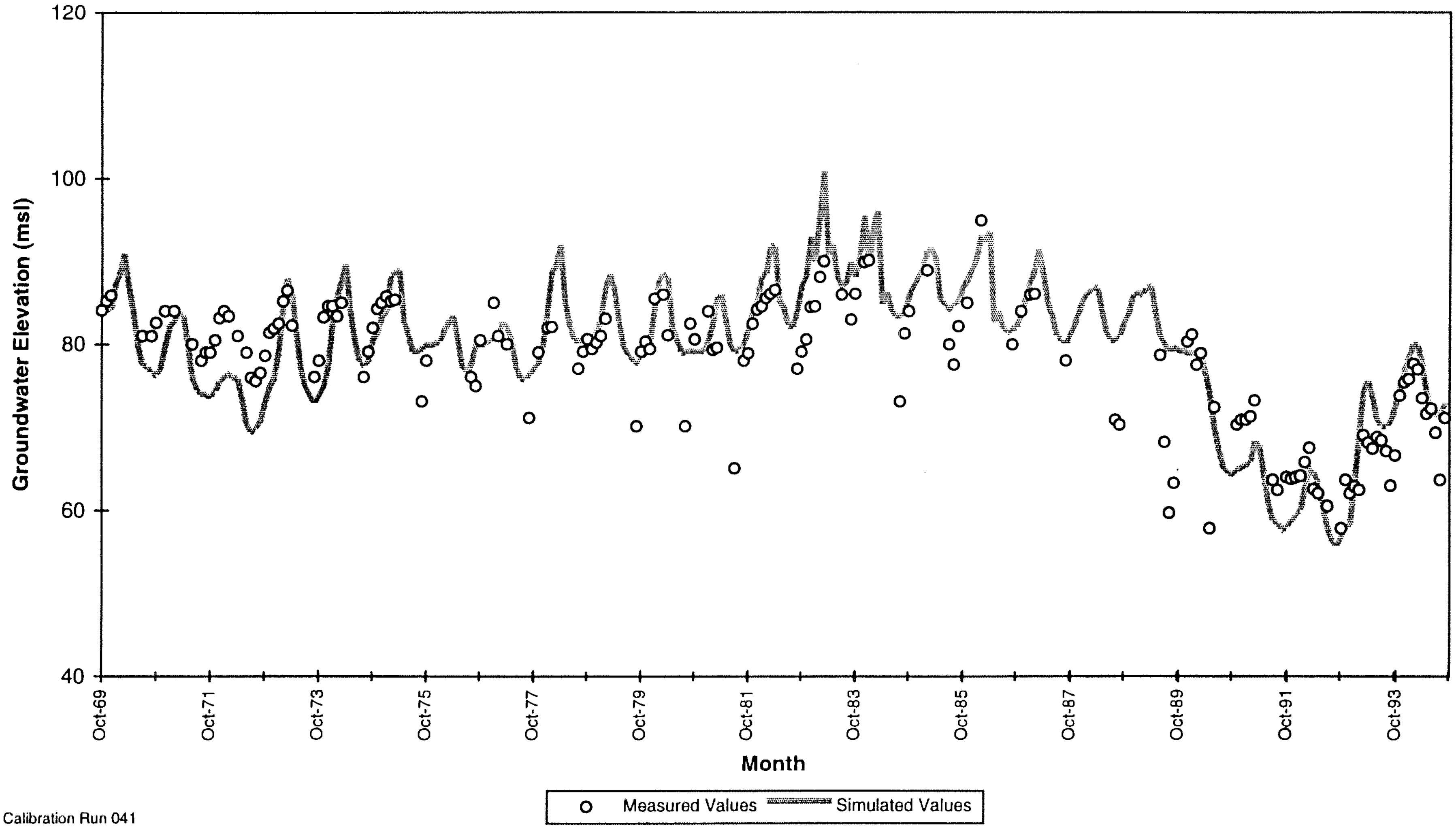
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 39: East Side Subarea, East Side Deep Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

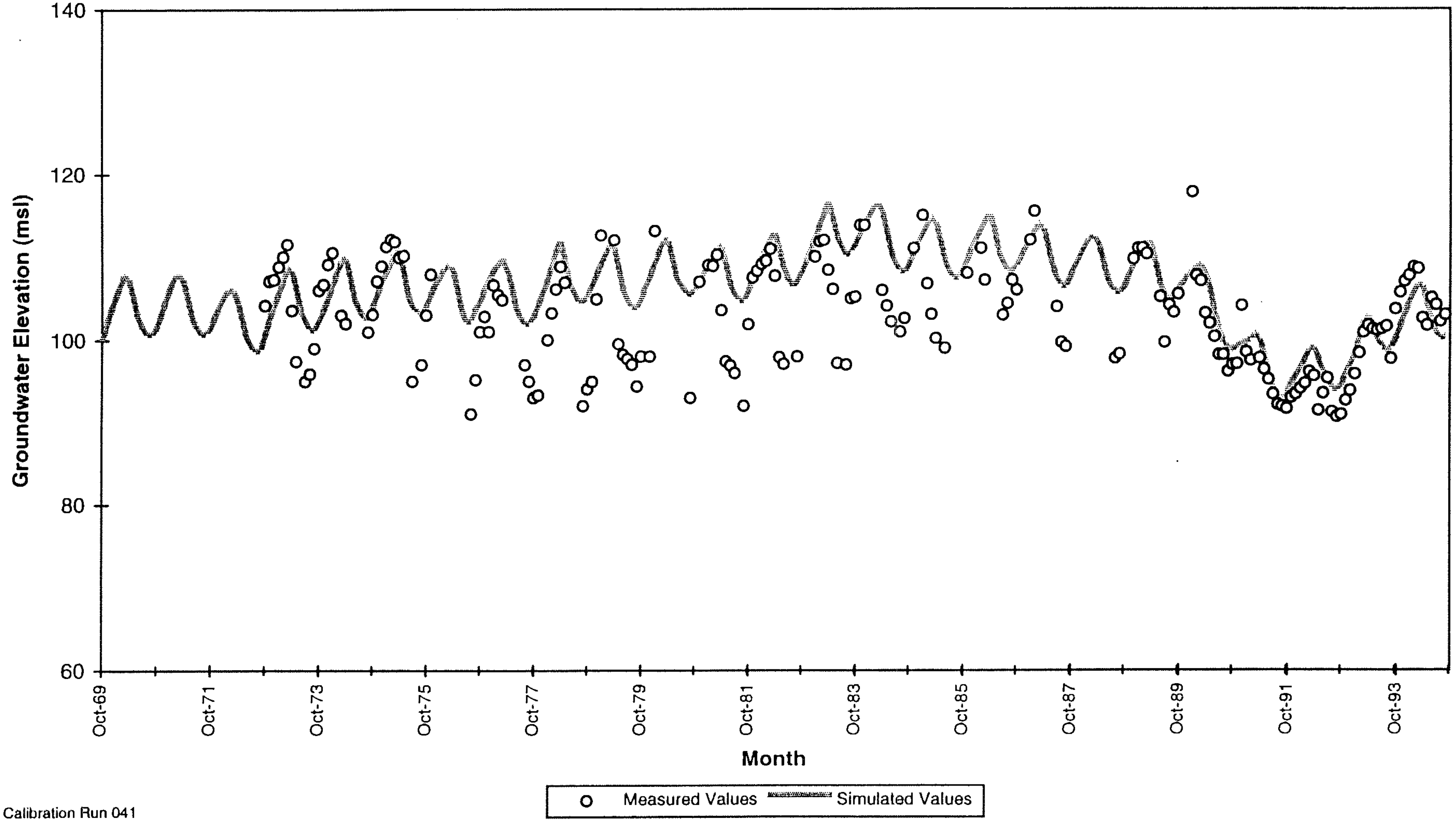
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 40: Pressure Subarea, 180 Foot Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

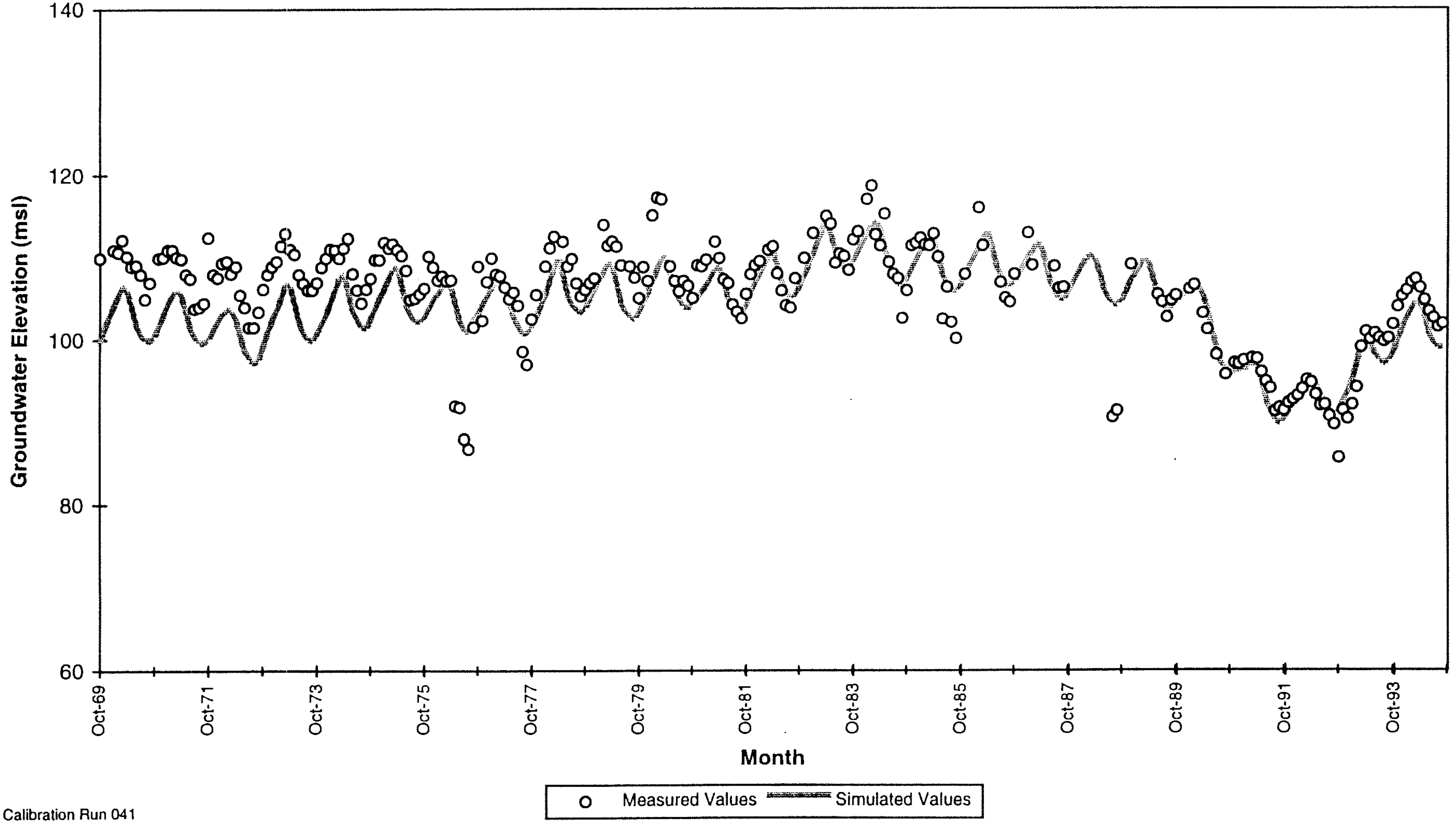
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 41: Forebay Subarea, Forebay Shallow Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

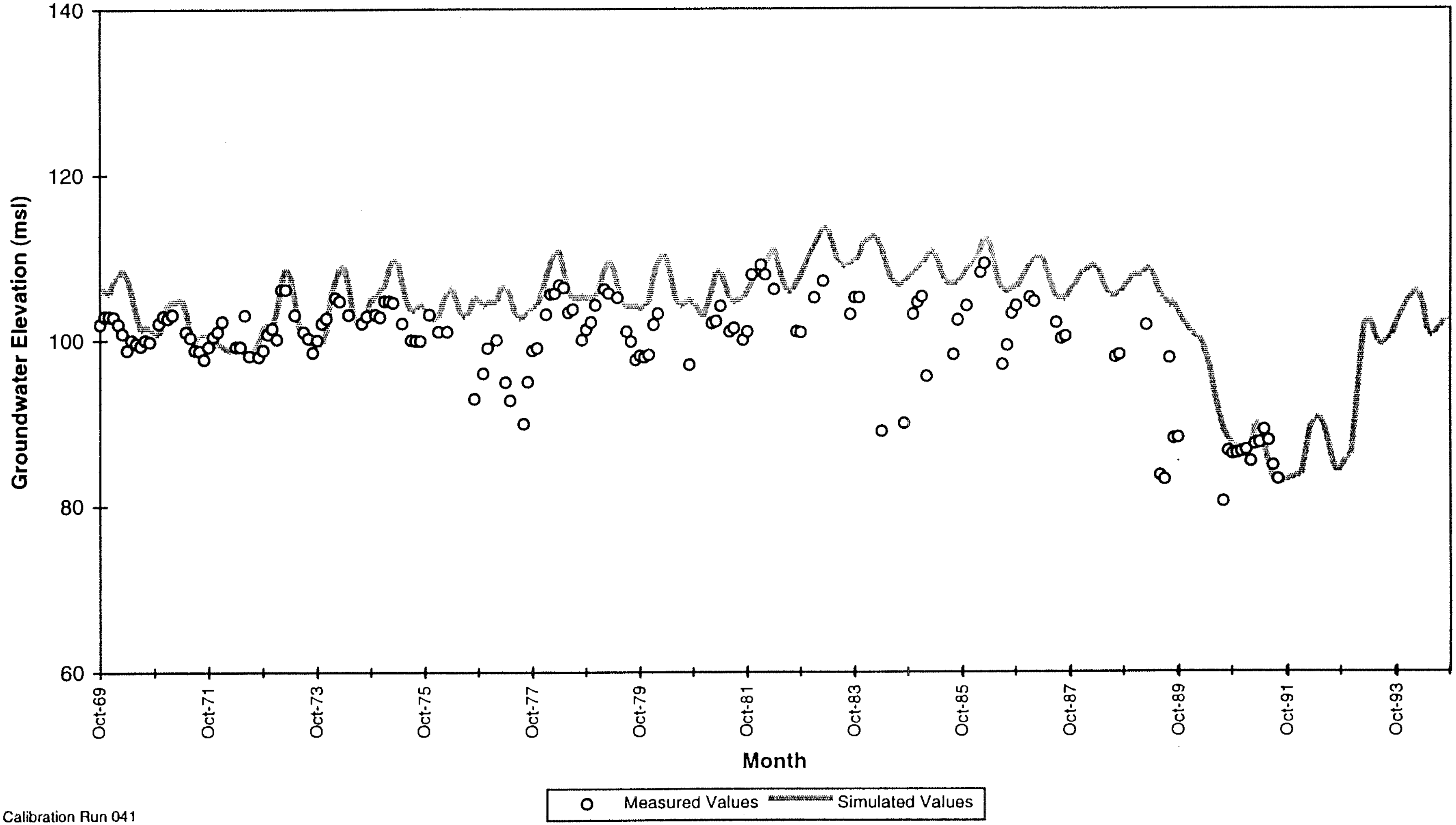
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 42: Forebay Subarea, Forebay Shallow Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

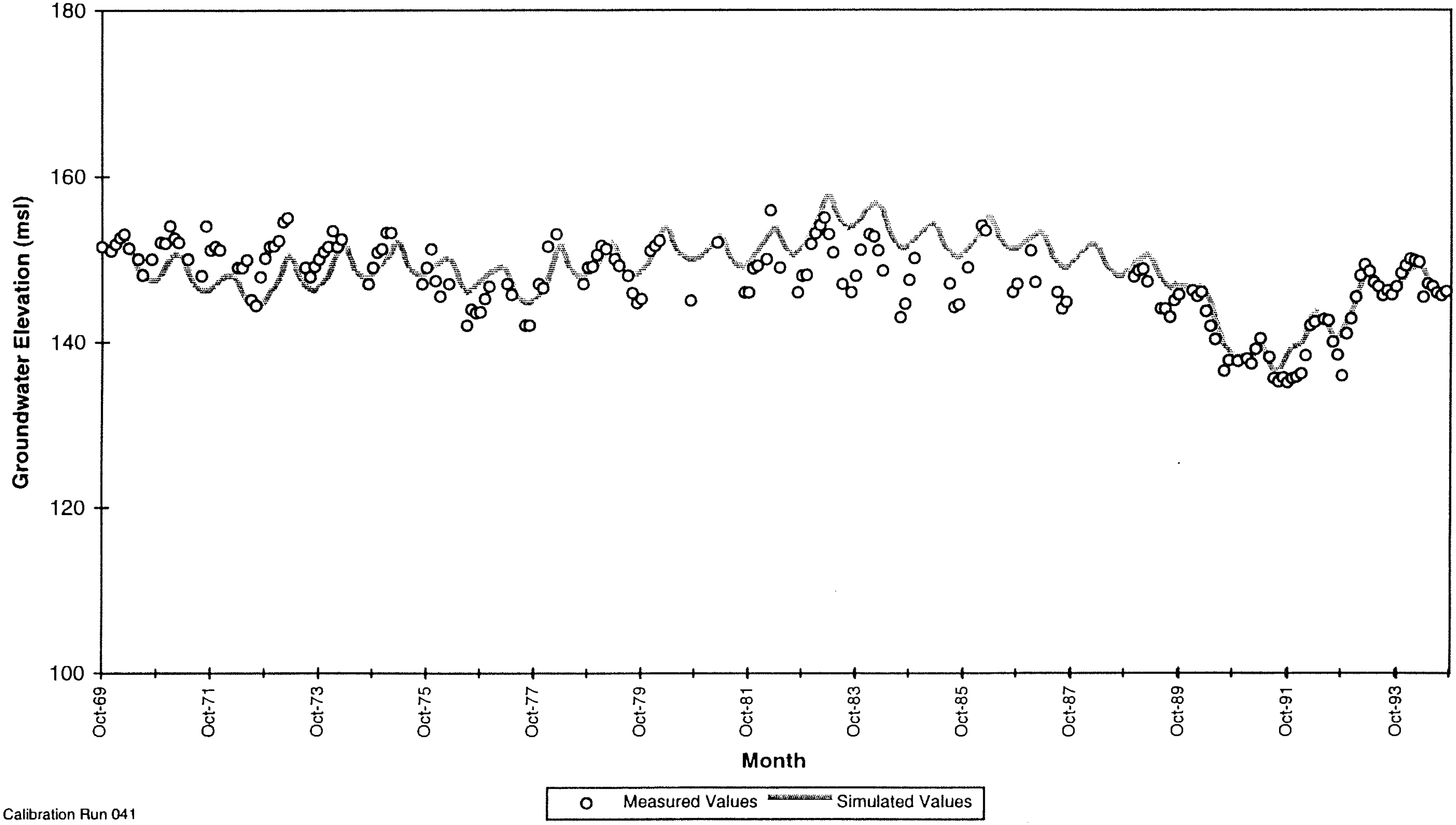
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 43: Forebay Subarea, Forebay Shallow Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

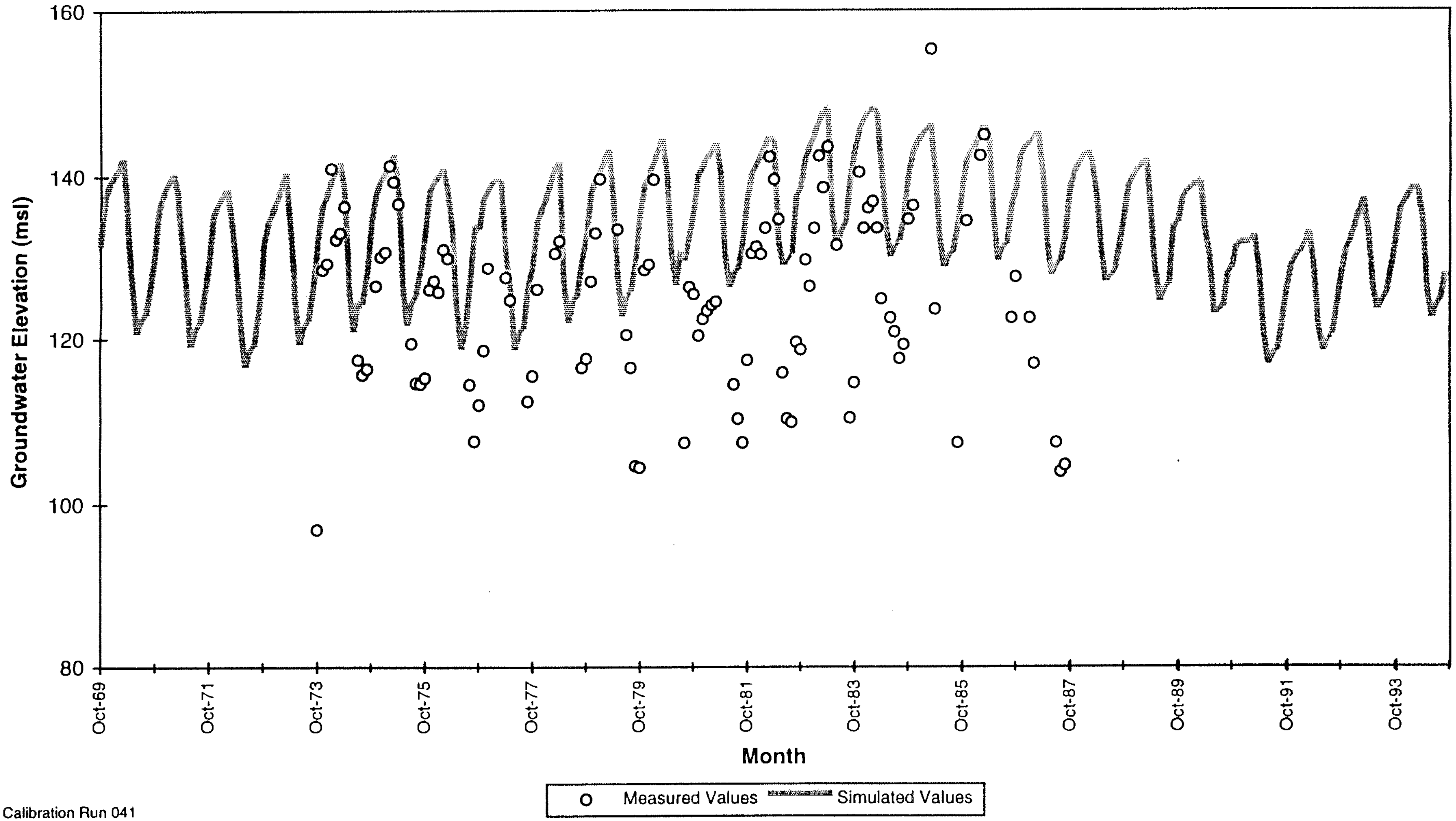
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 44: Forebay Subarea, Forebay Shallow Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

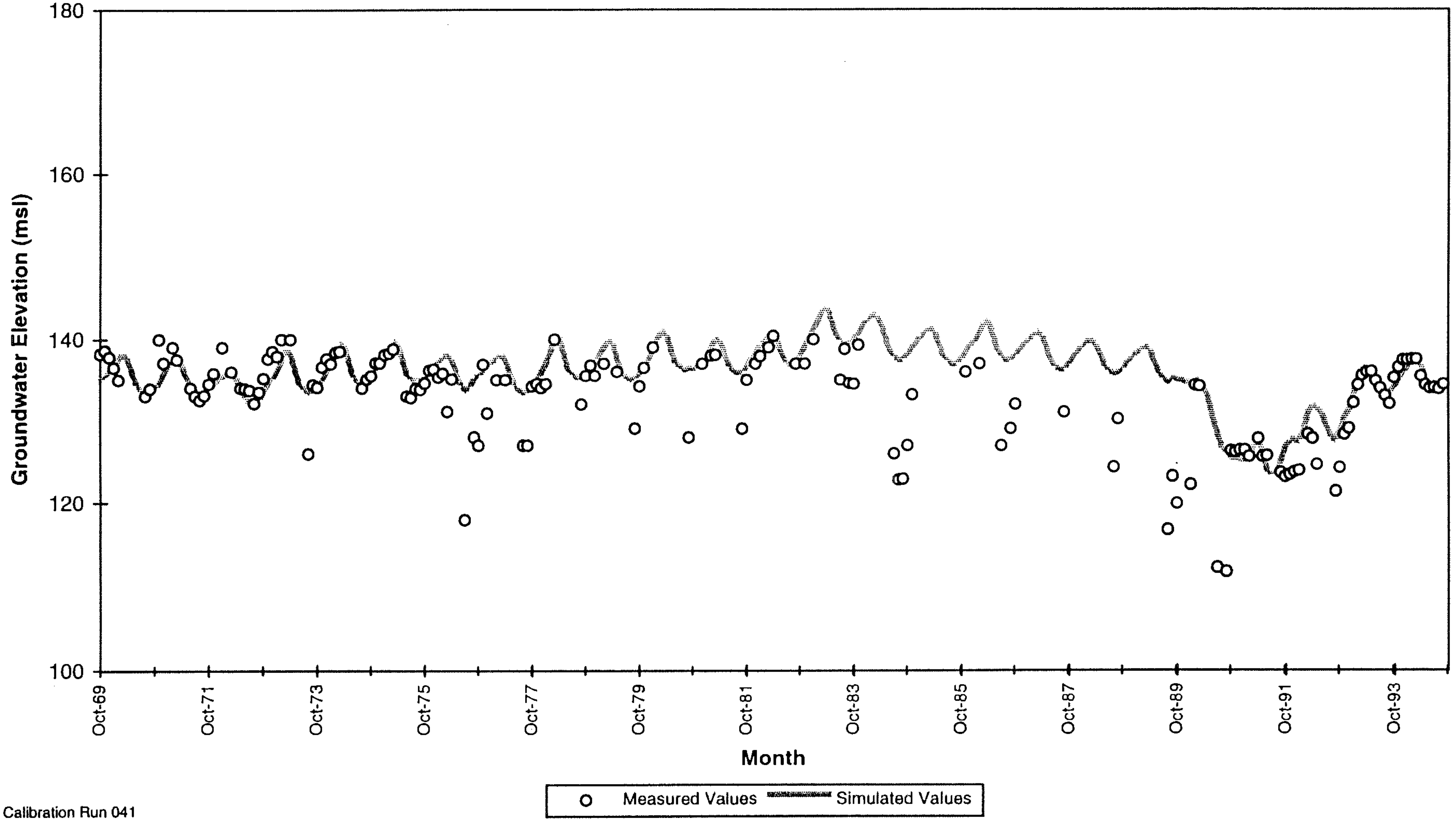
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 45: Forebay Subarea, Forebay Deep Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

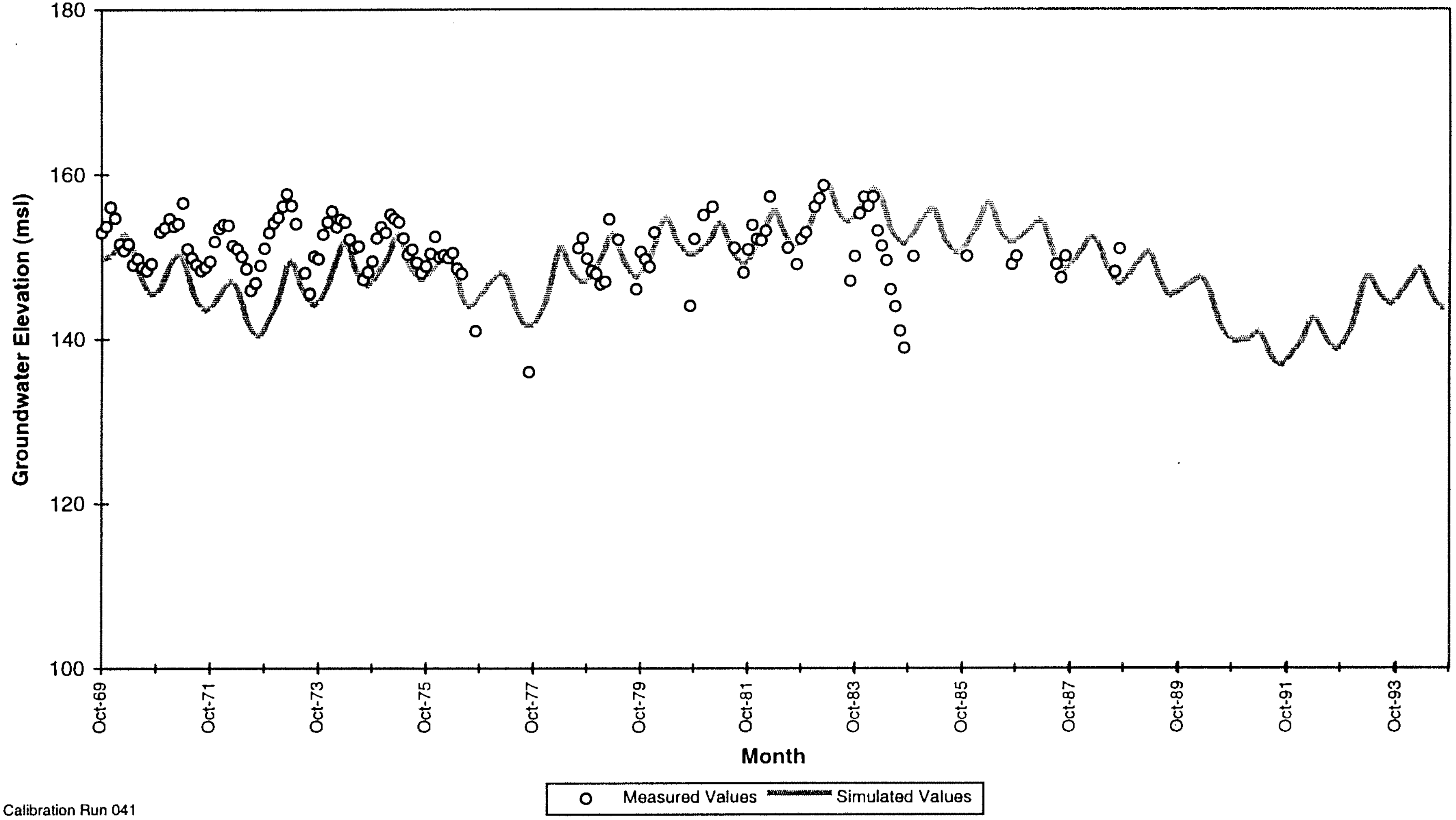
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 46: Forebay Subarea, Forebay Shallow Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

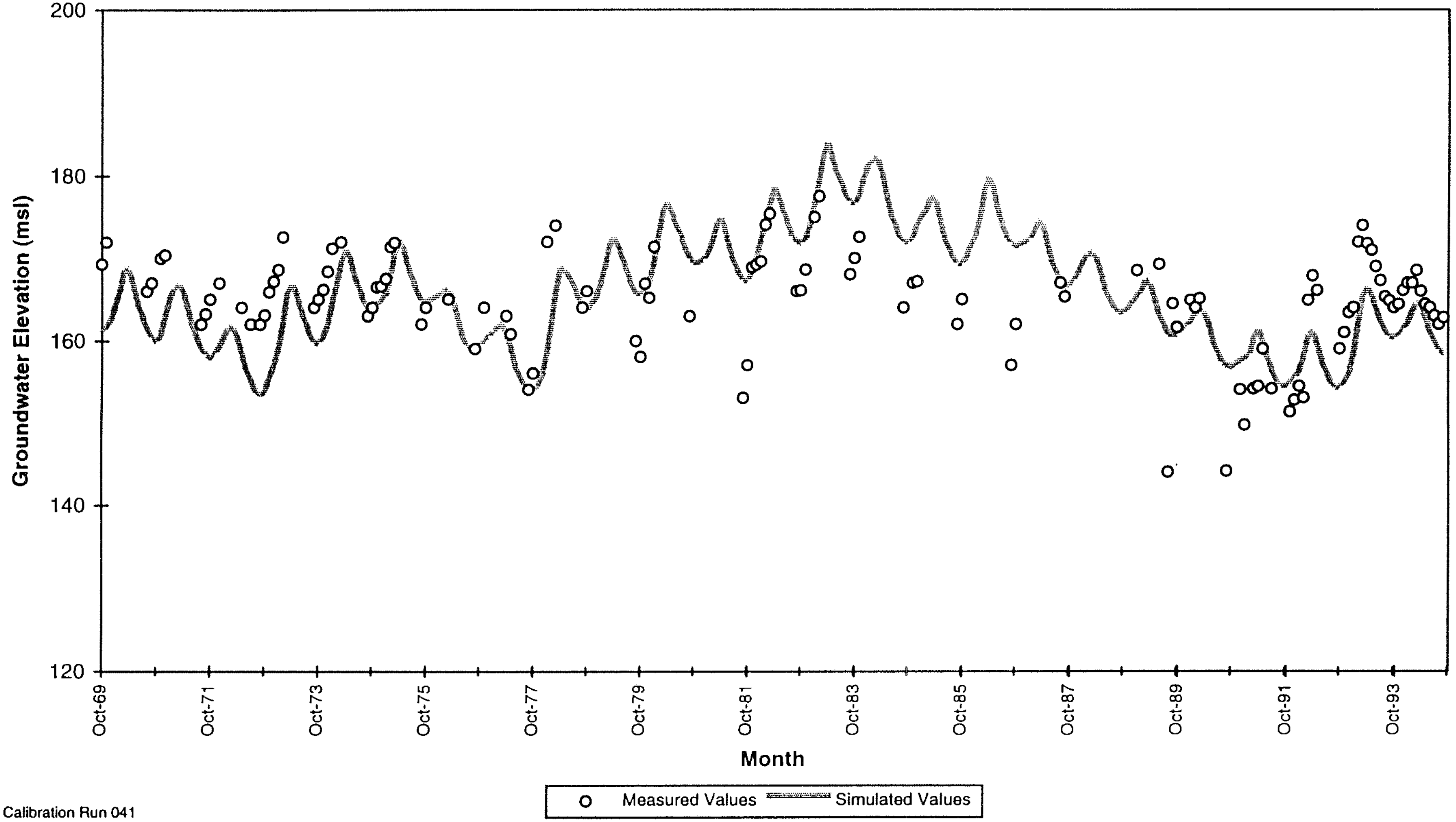
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 47: Forebay Subarea, Forebay Shallow Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

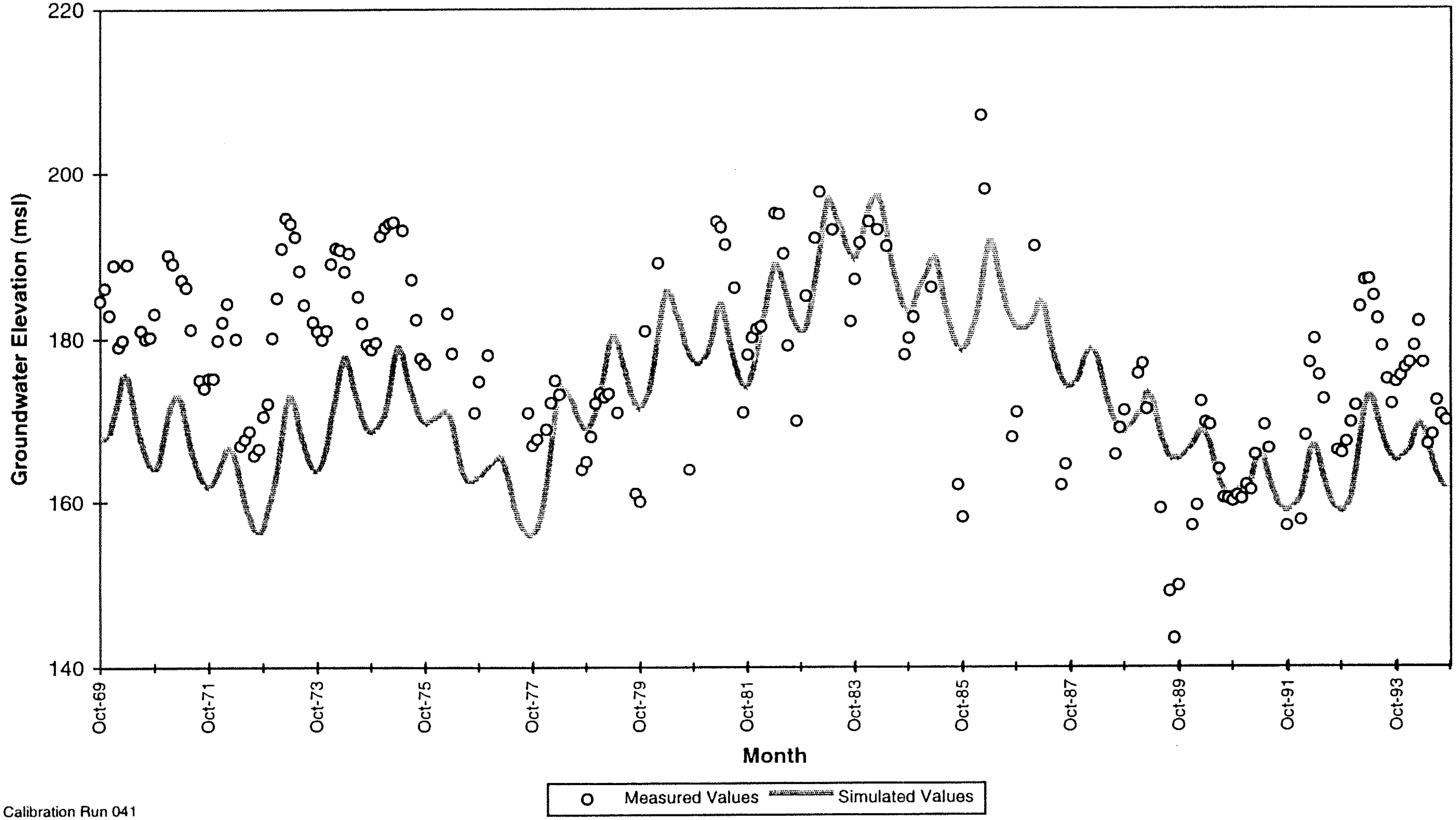
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 48: Forebay Subarea, Forebay Shallow Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

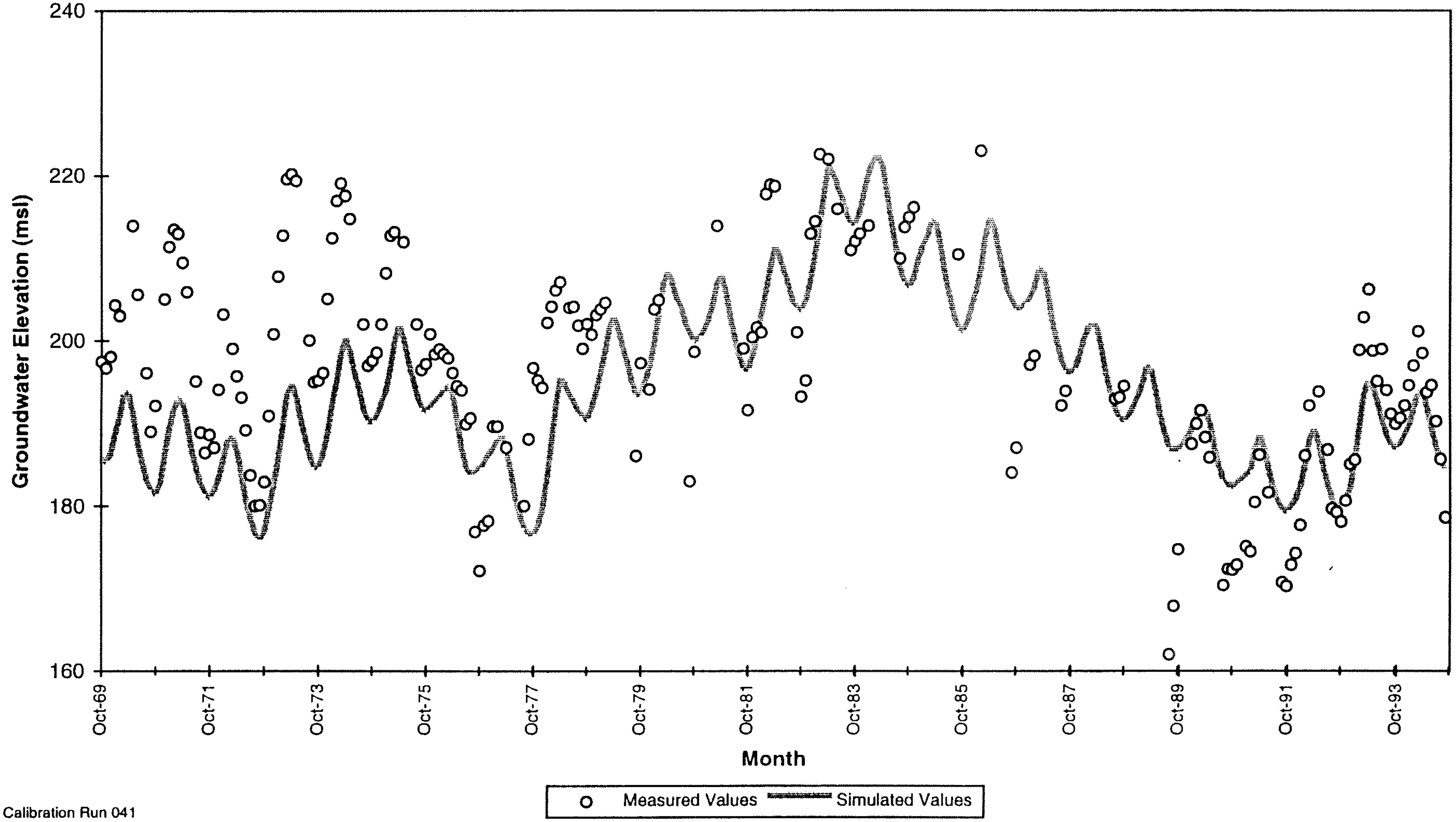
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 49: Forebay Subarea, Forebay Shallow Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

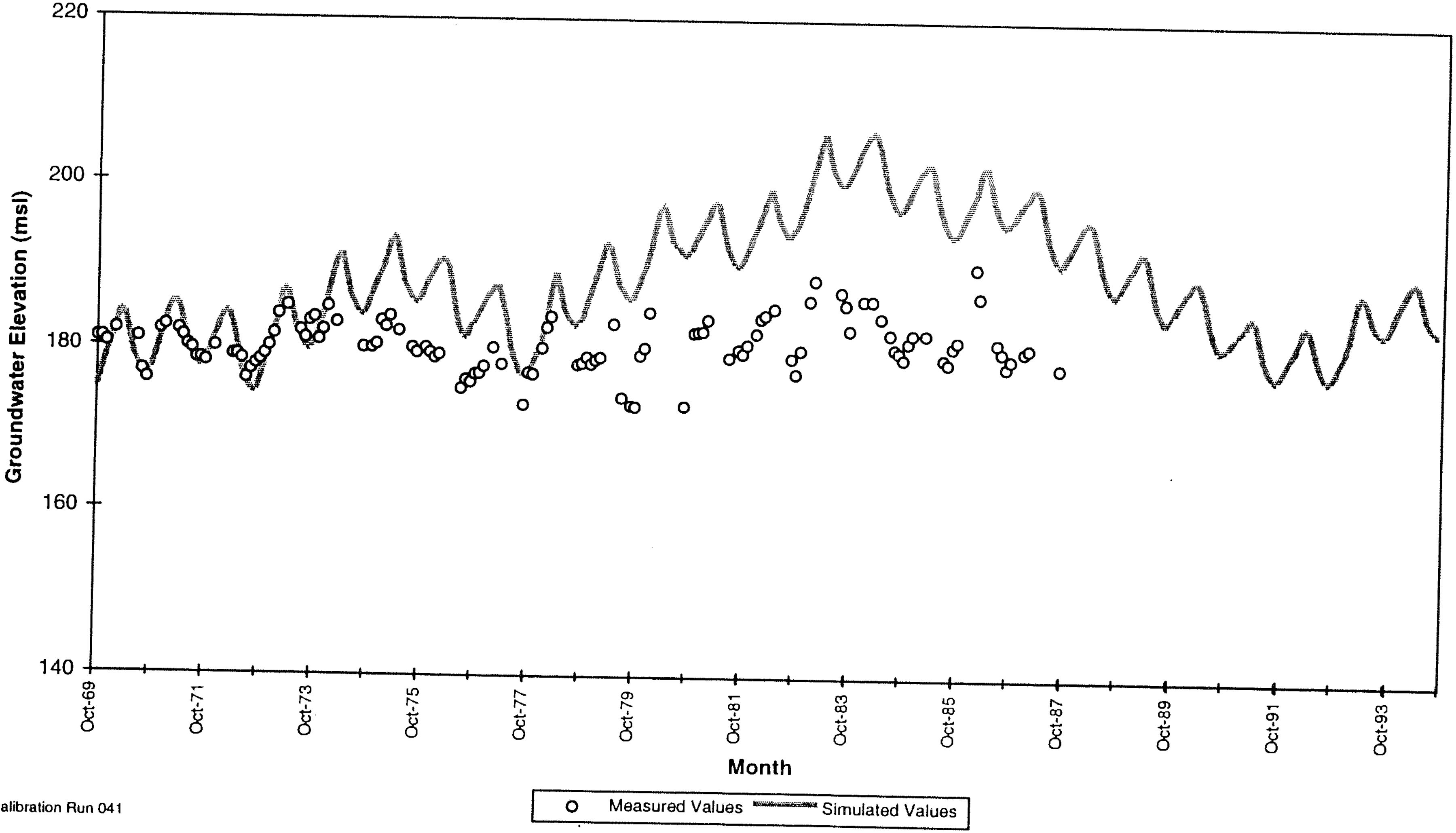
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 50: Forebay Subarea, Forebay Deep Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

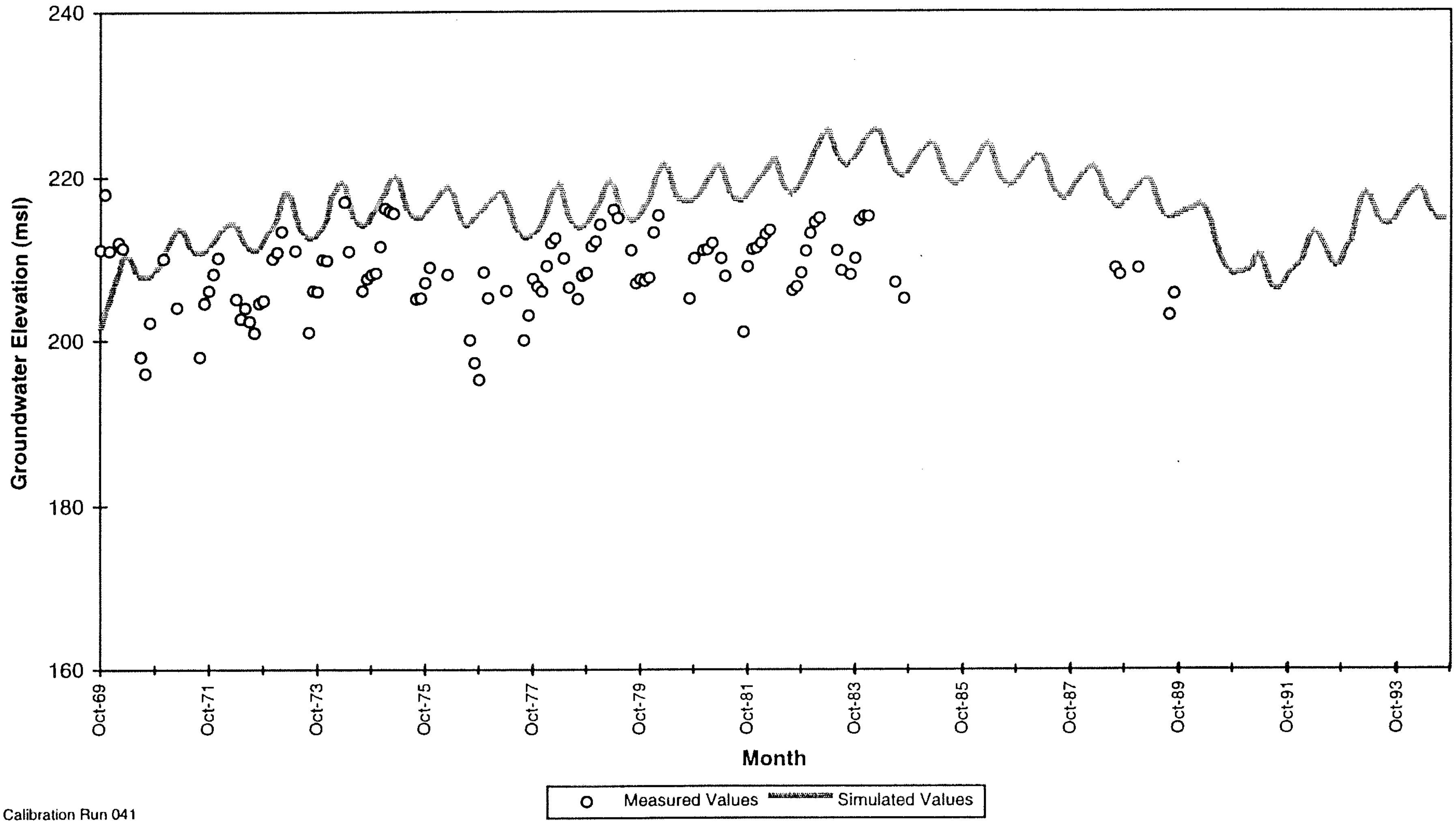
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 51: Forebay Subarea, Forebay Shallow Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

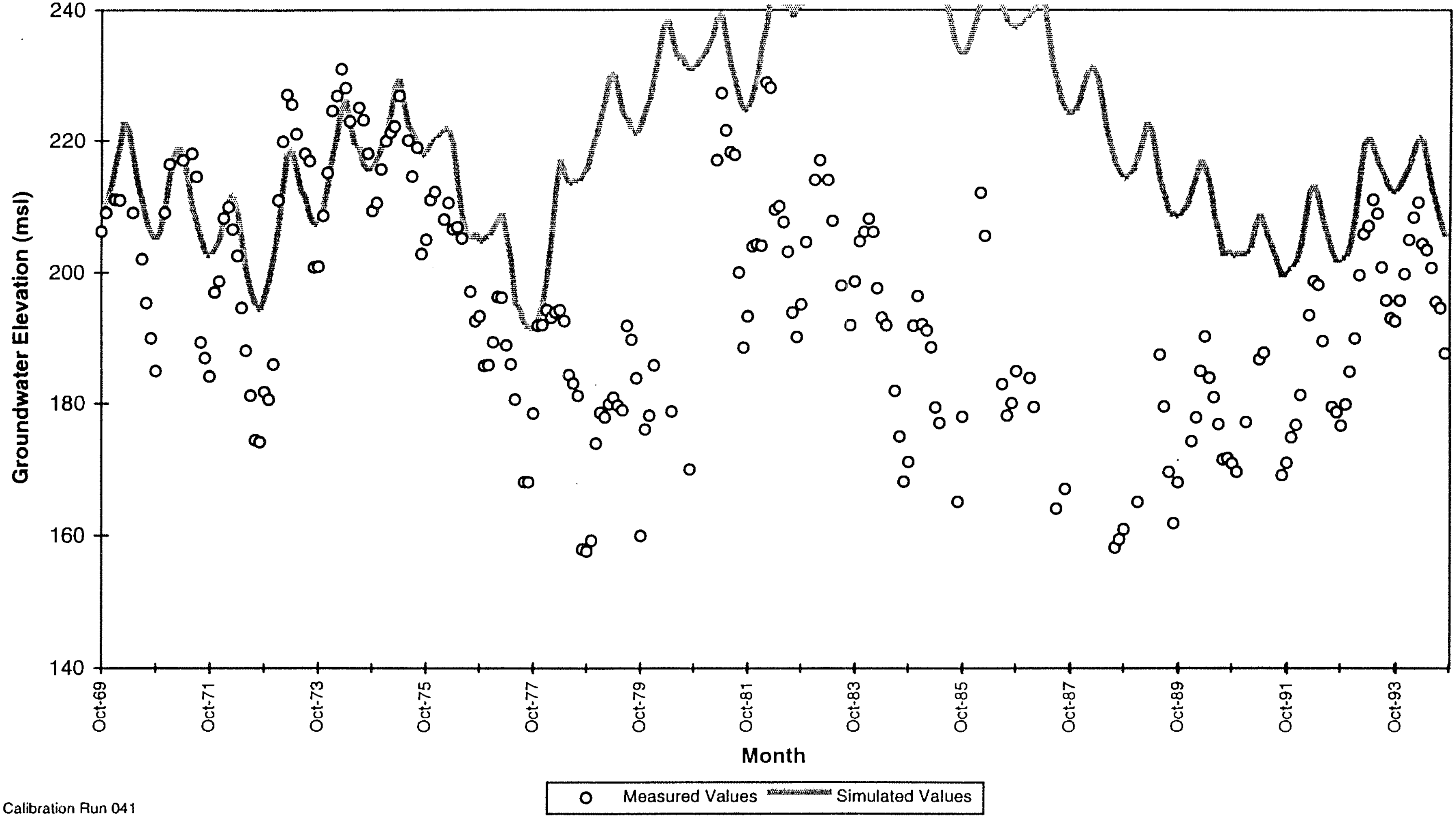
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 52: Forebay Subarea, Forebay Shallow Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

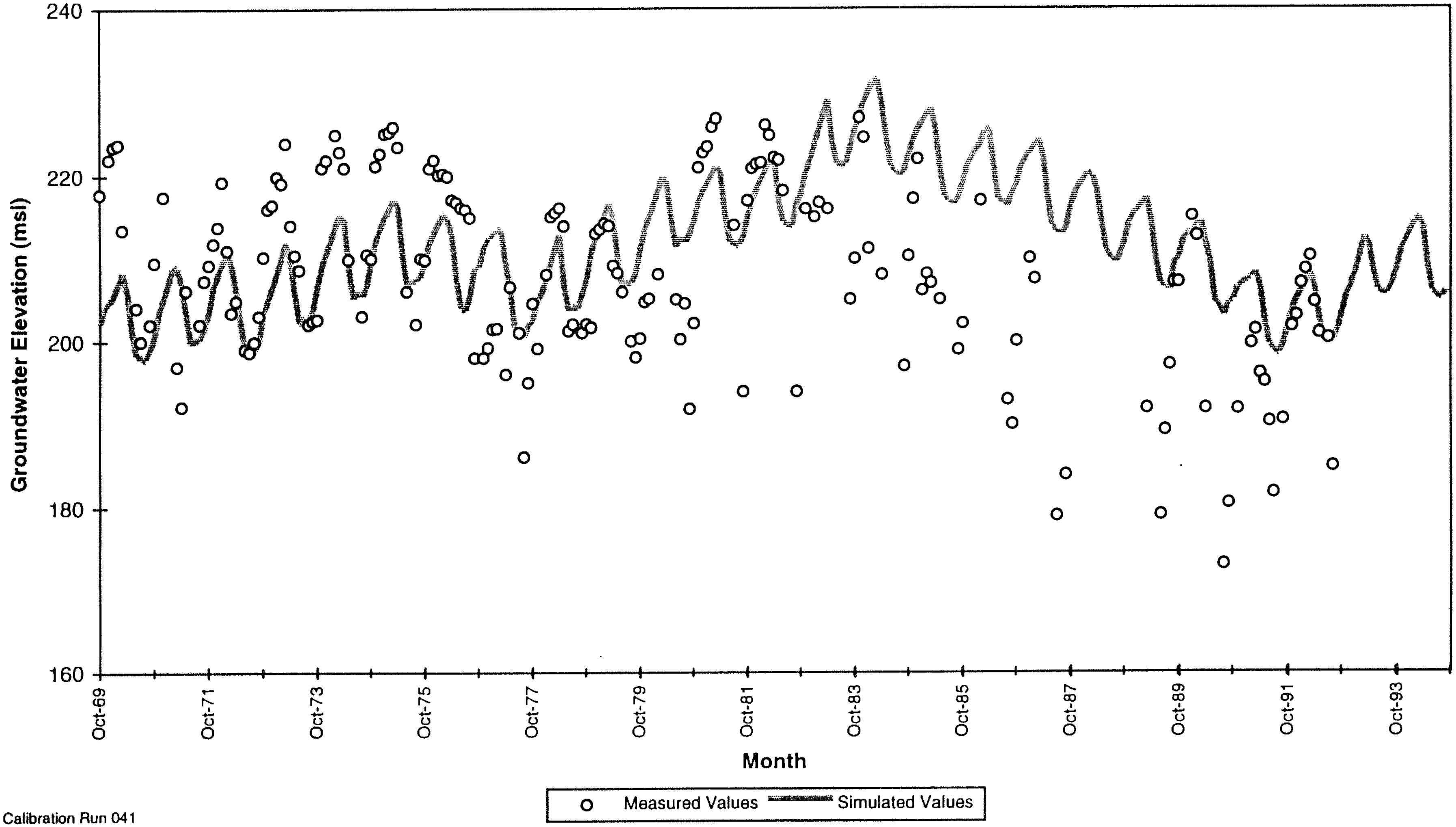
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 53: Forebay Subarea, Forebay Deep Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

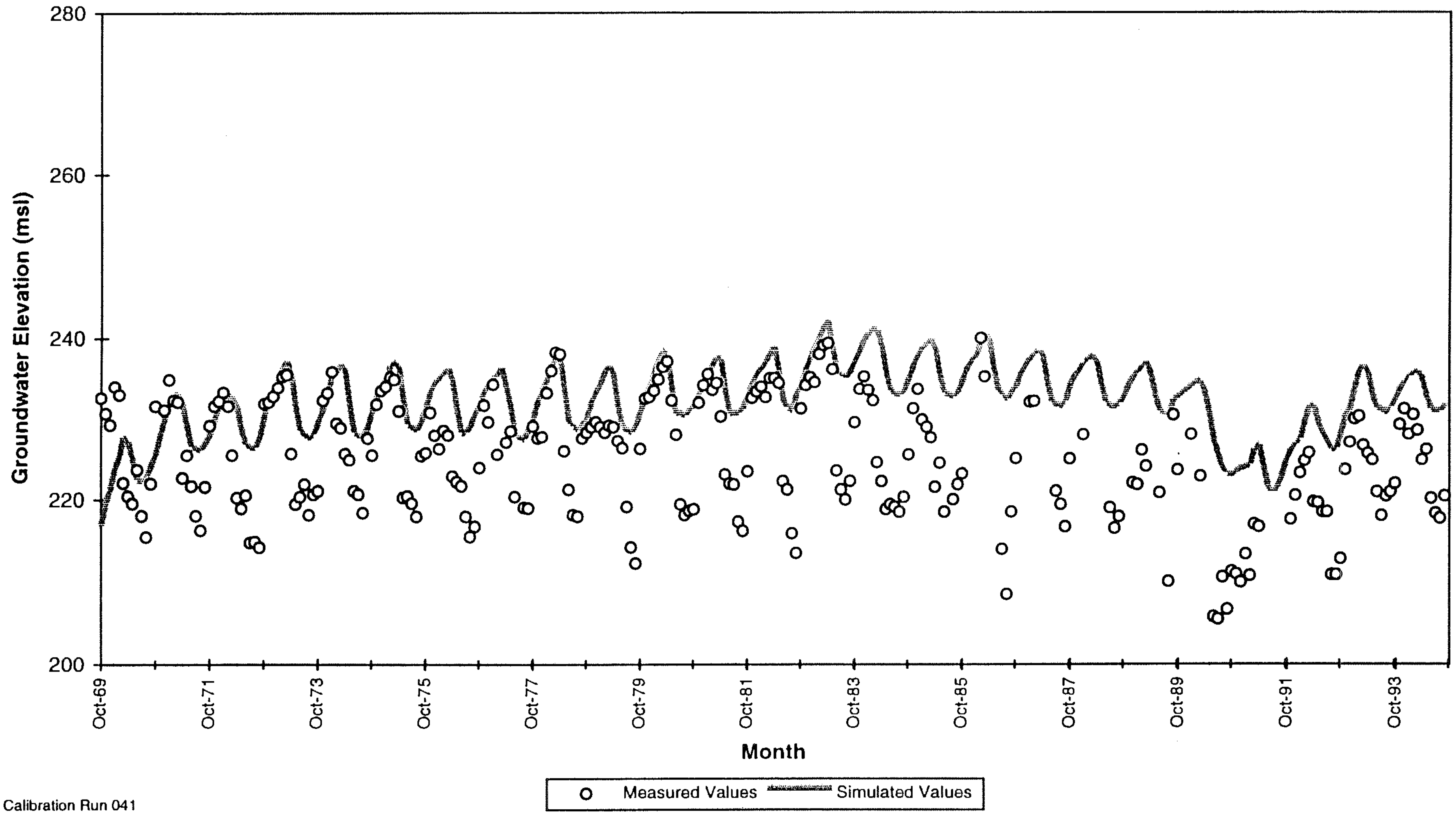
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 54: Forebay Subarea, Forebay Deep Aquifer



Calibration Run 041

CALHYDRO.XLS
5/29/97

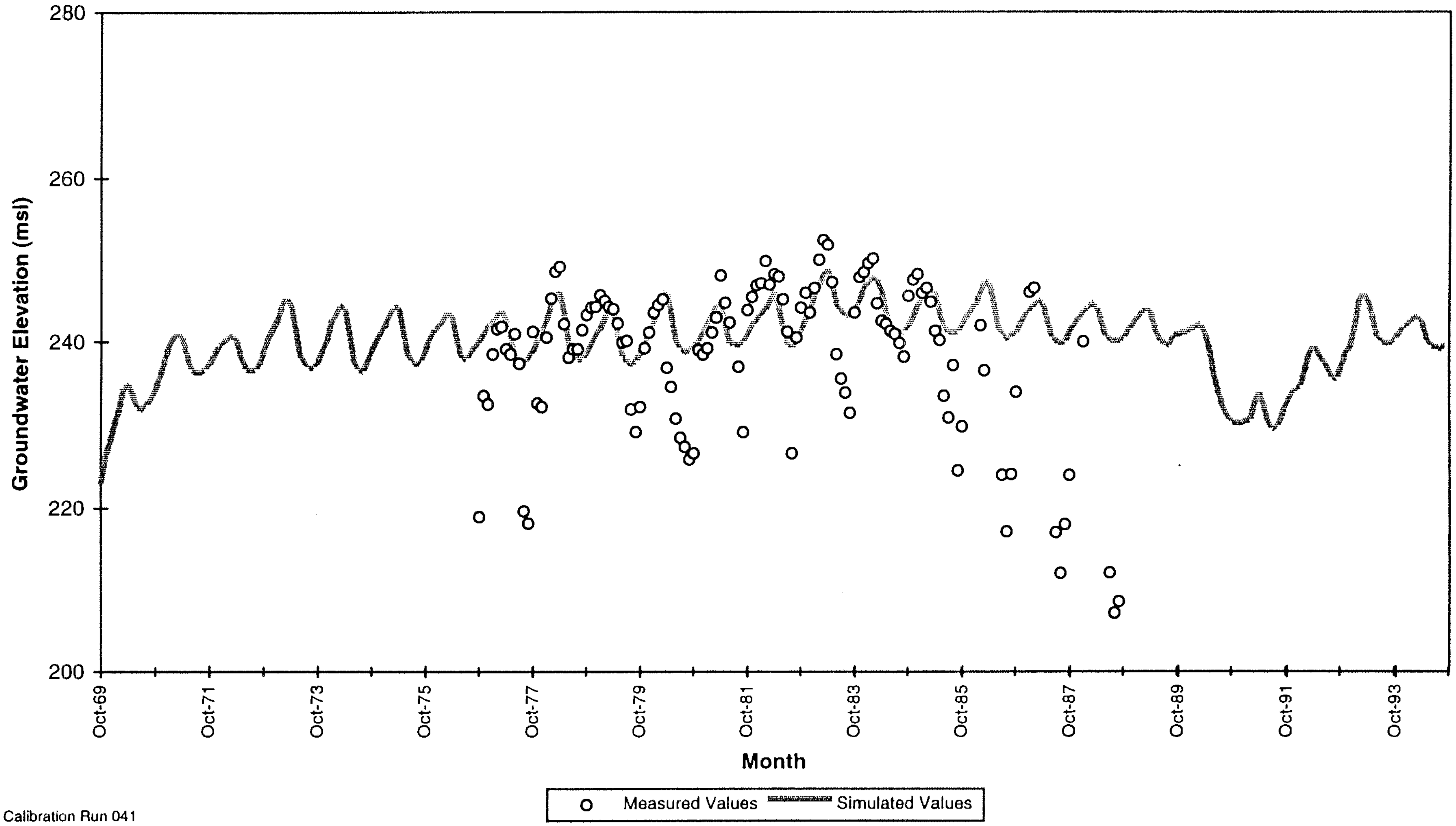
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 55: Upper Valley Subarea



Calibration Run 041

CALHYDRO.XLS
5/29/97

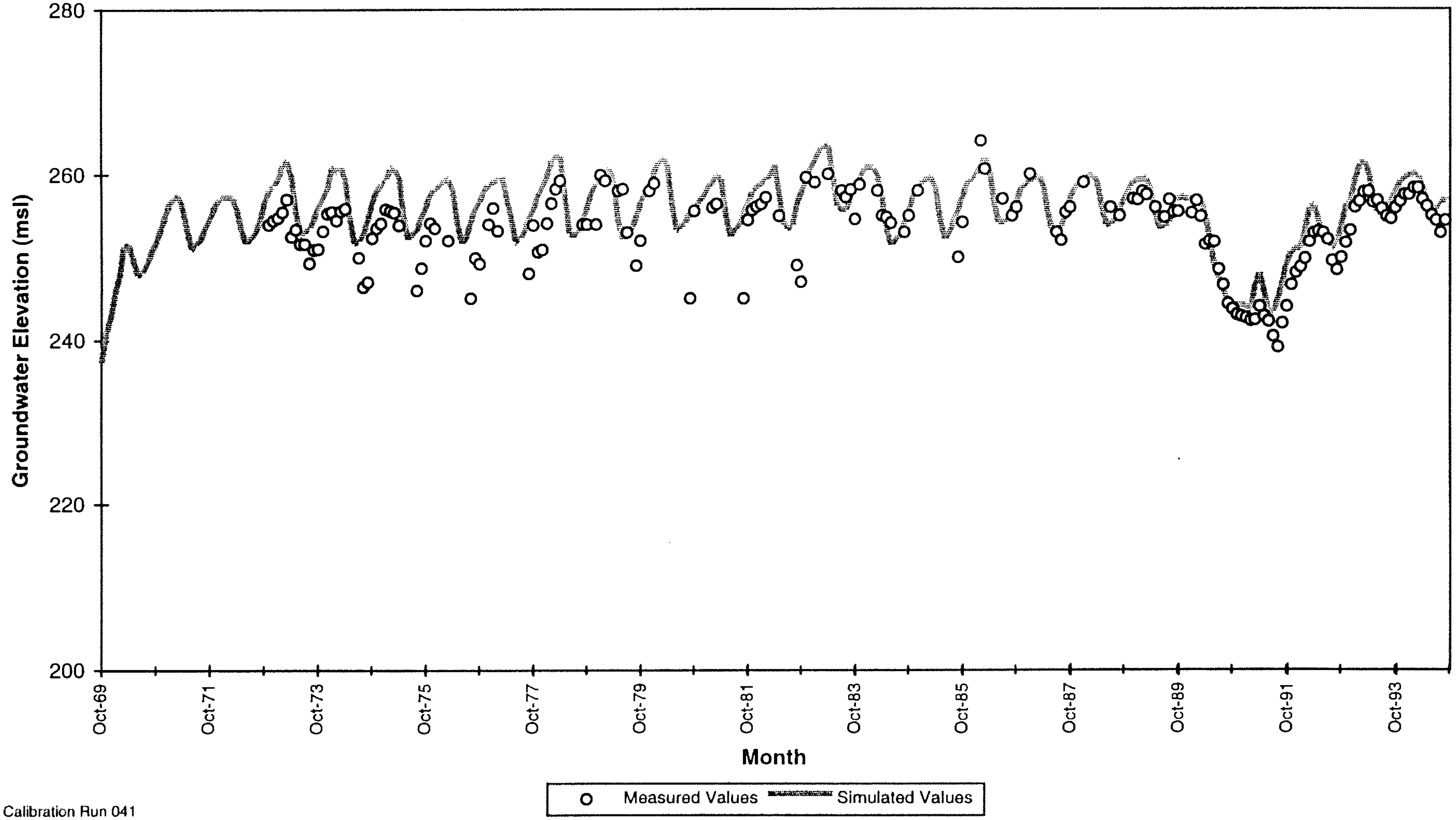
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 56: Upper Valley Subarea



Calibration Run 041

CALHYDRO.XLS
5/29/97

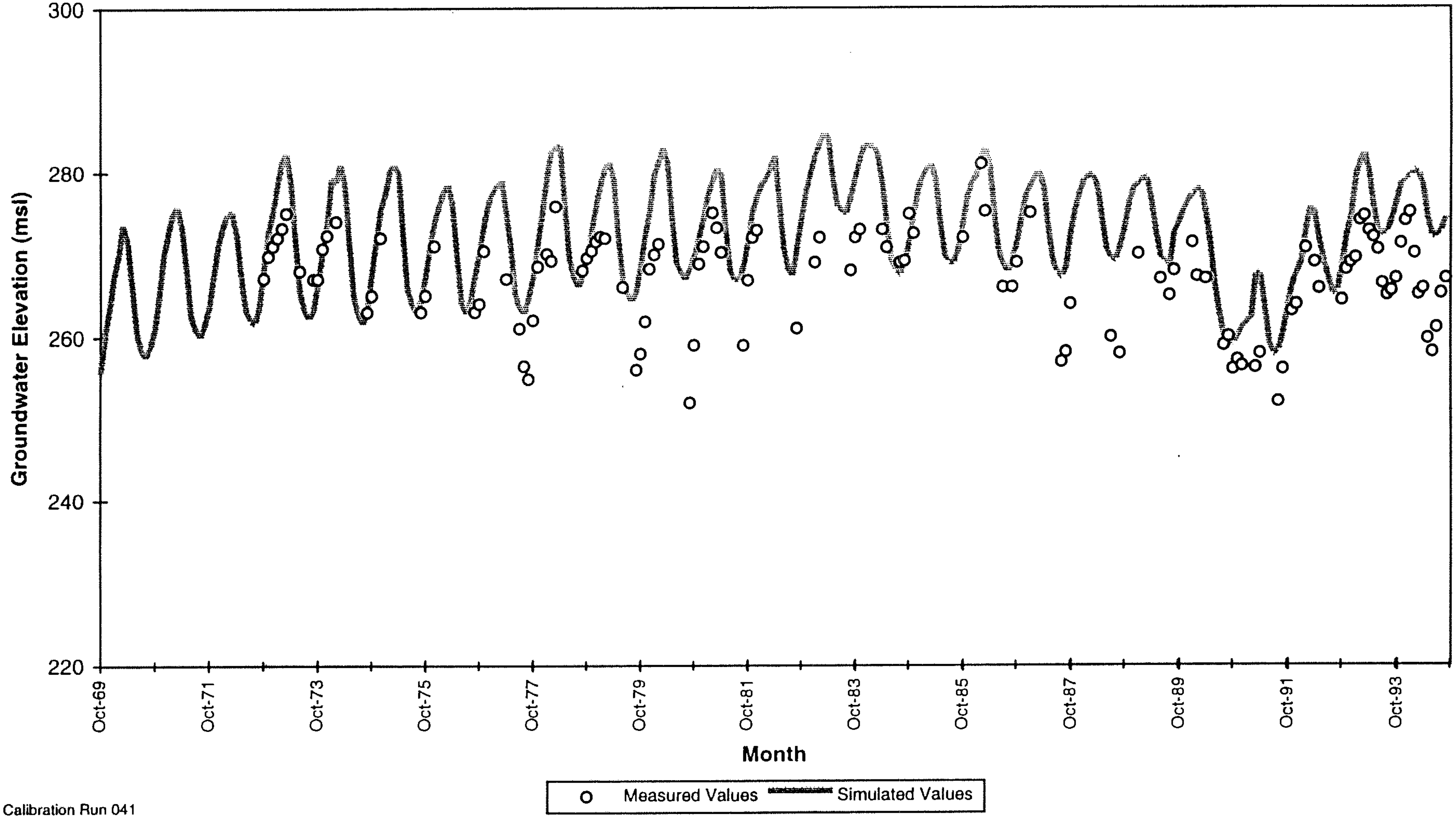
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 57: Upper Valley Subarea



Calibration Run 041

CALHYDRO.XLS
5/29/97

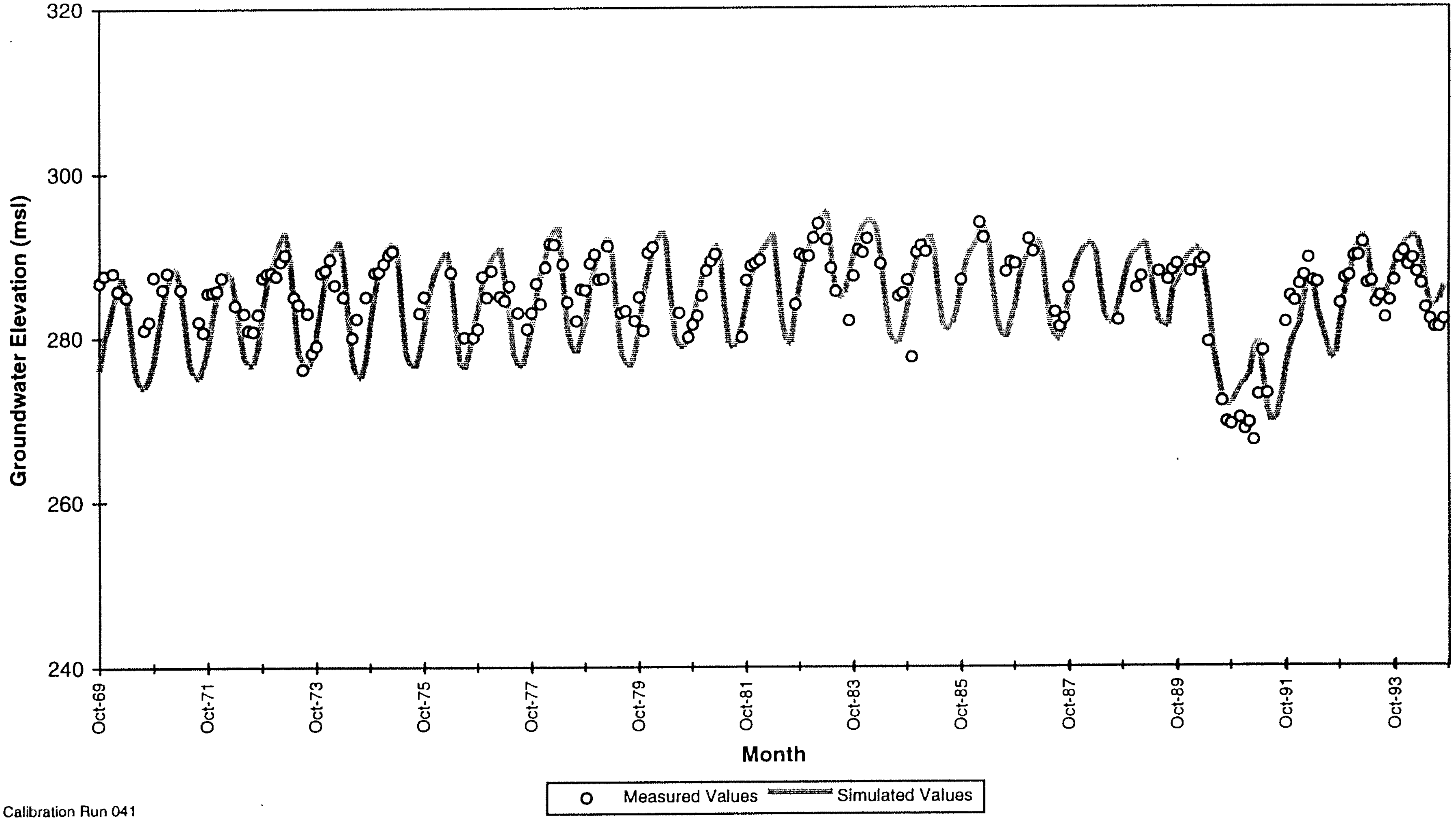
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 58: Upper Valley Subarea



Calibration Run 041

CALHYDRO.XLS
5/29/97

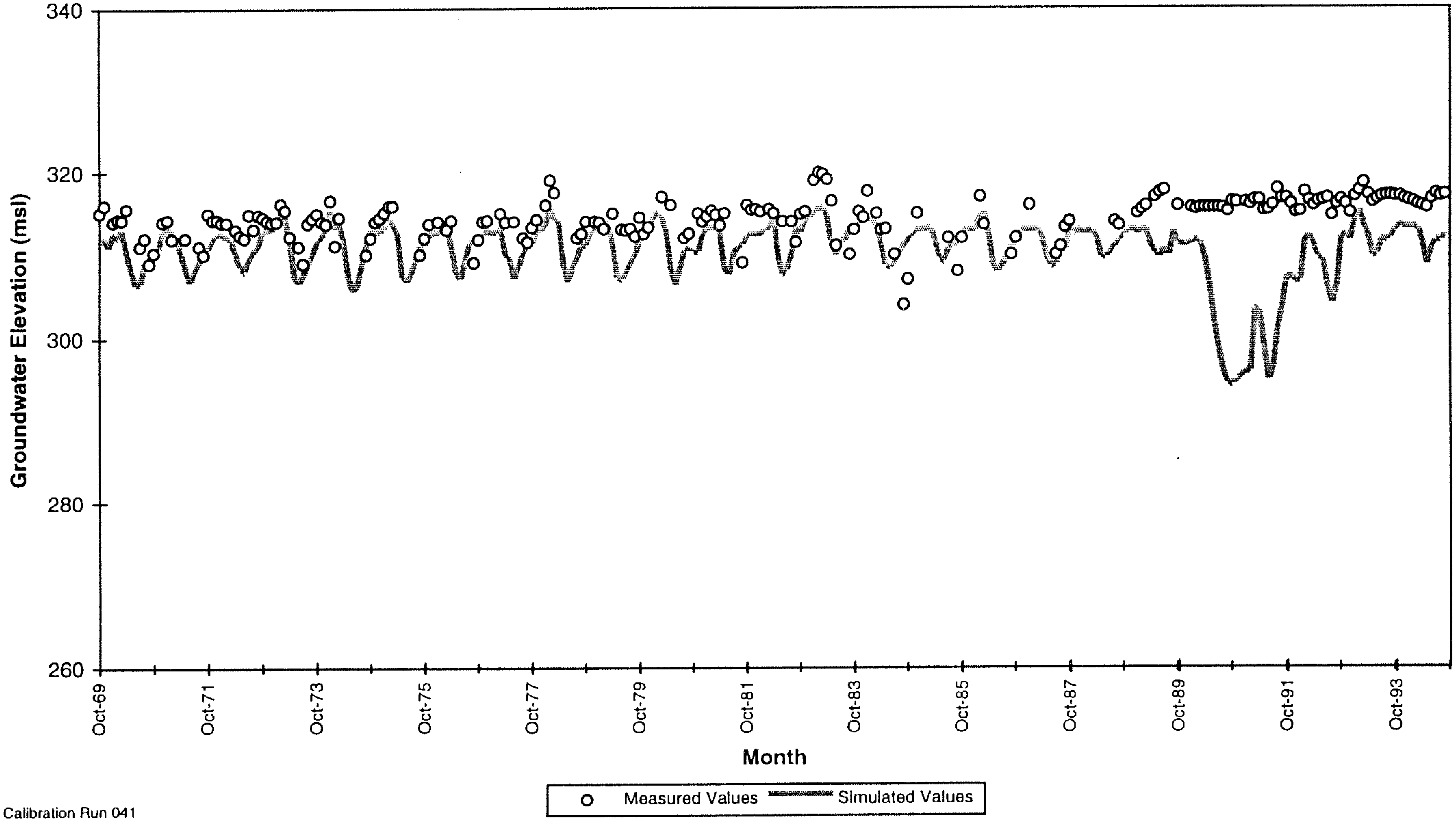
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 59: Upper Valley Subarea



Calibration Run 041

CALHYDRO.XLS
5/29/97

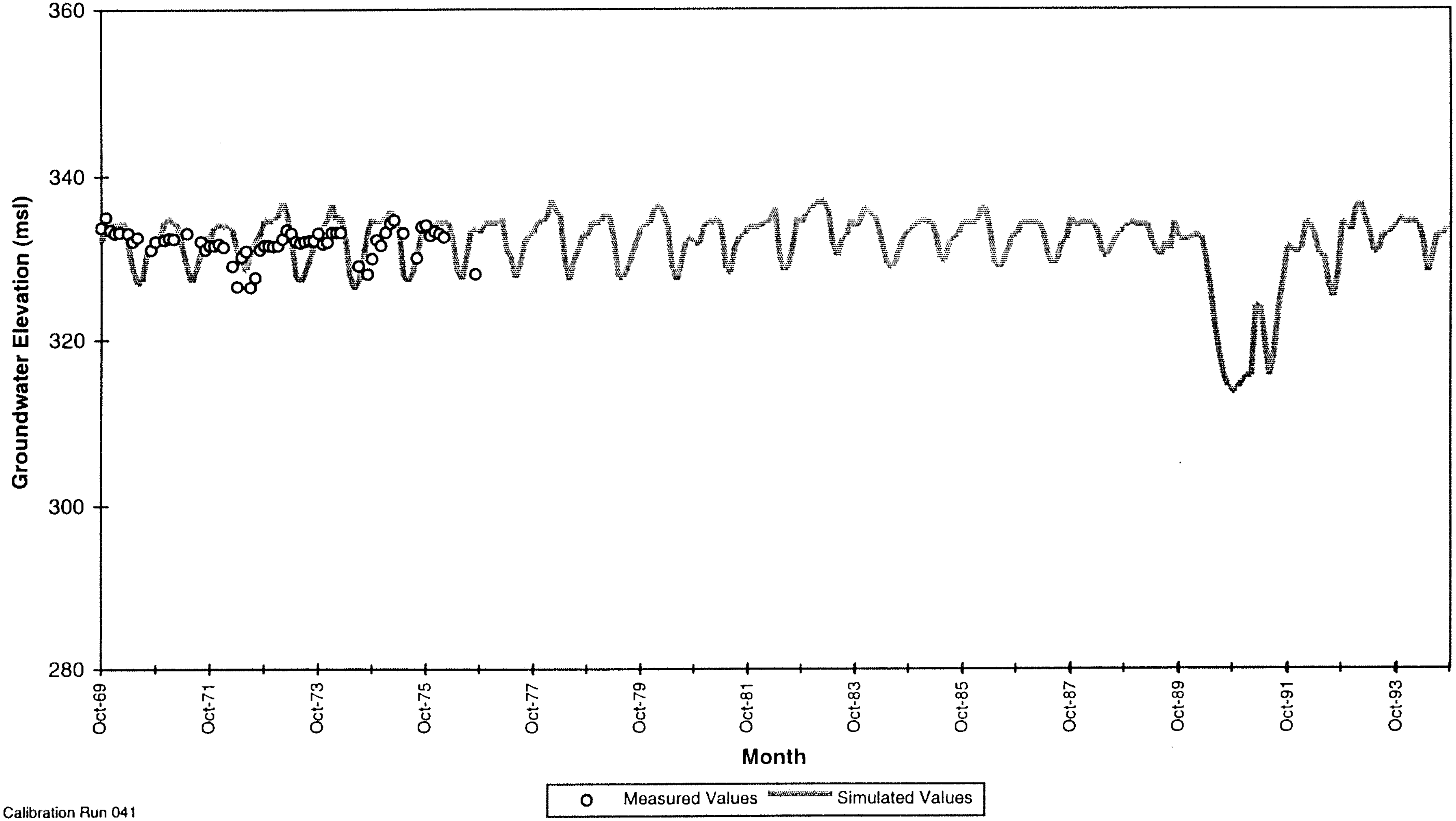
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 60: Upper Valley Subarea



Calibration Run 041

CALHYDRO.XLS
5/29/97

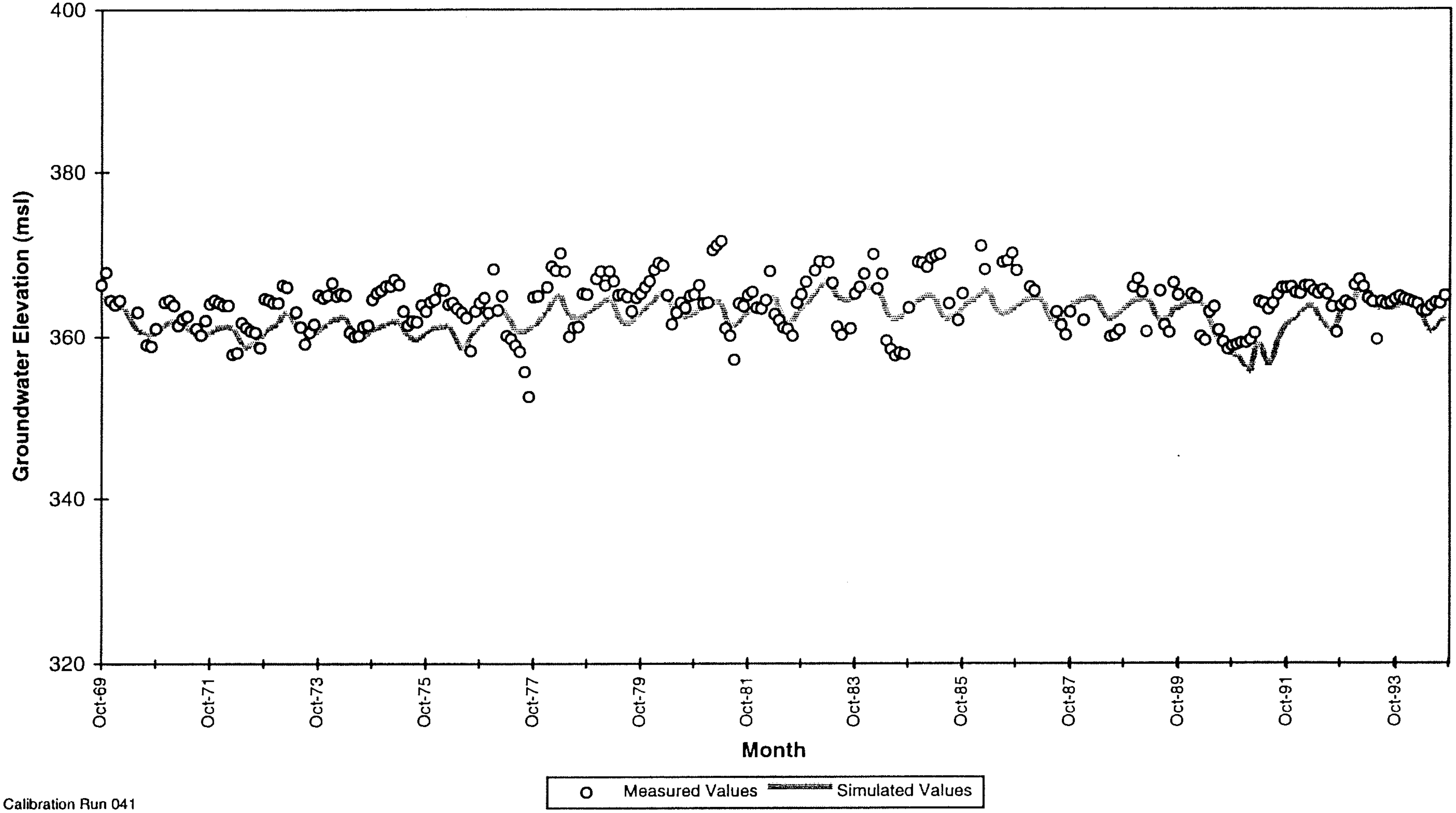
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 61: Upper Valley Subarea



Calibration Run 041

CALHYDRO.XLS
5/29/97

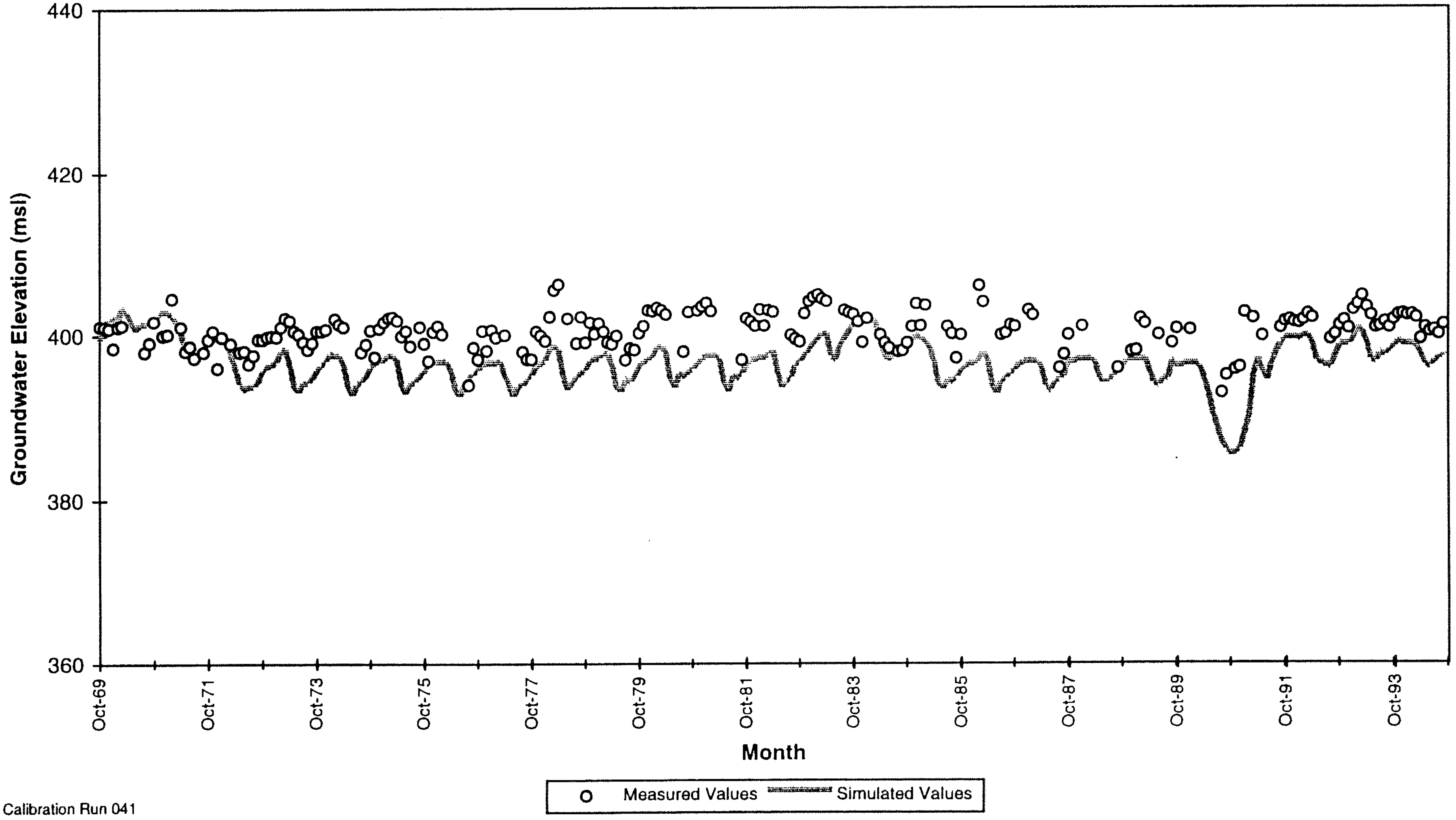
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 62: Upper Valley Subarea



Calibration Run 041

CALHYDRO.XLS
5/29/97

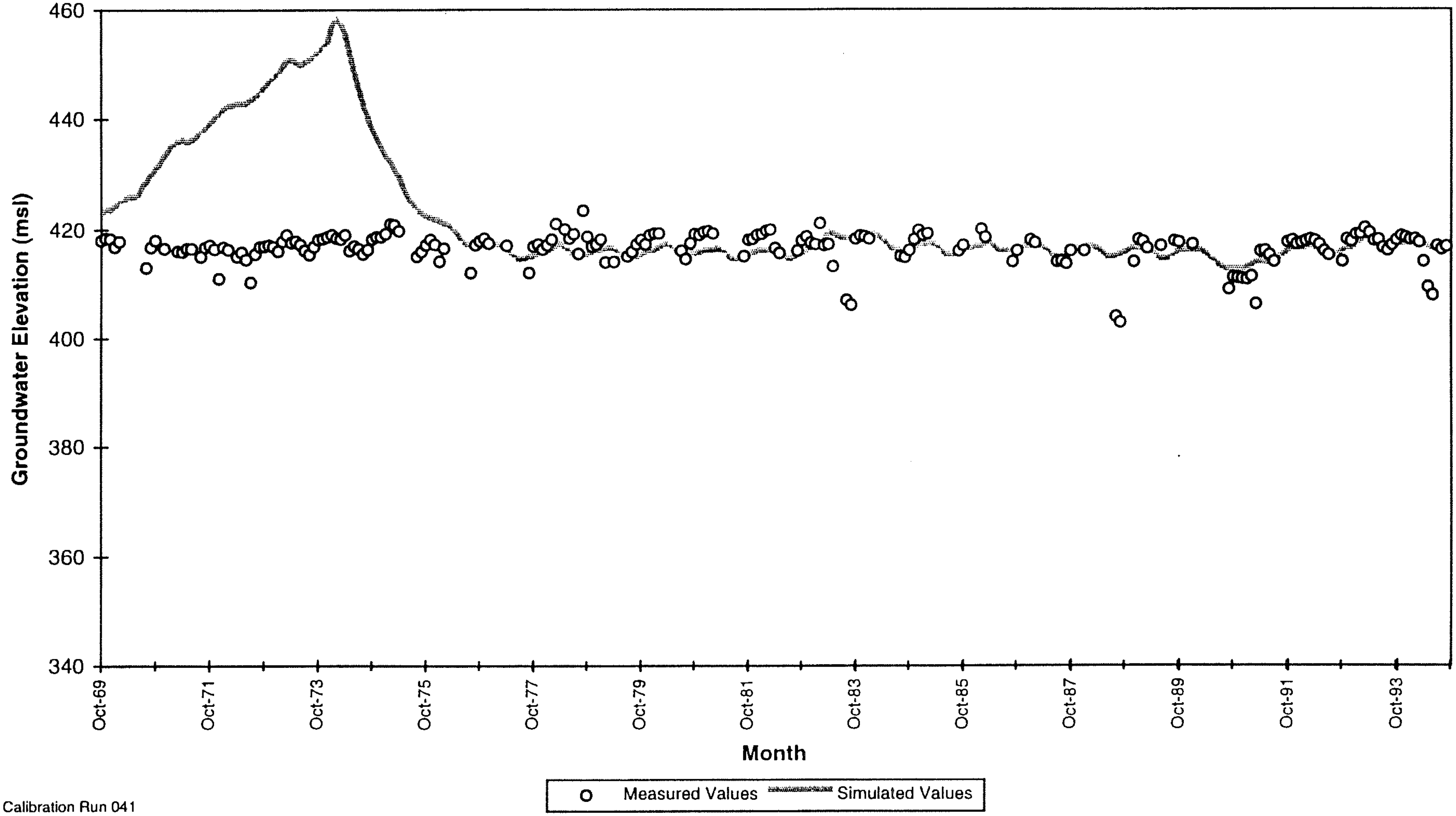
HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 63: Upper Valley Subarea



Calibration Run 041

CALHYDRO.XLS
5/29/97

HYDROGRAPH OF MEASURED AND SIMULATED GW LEVELS
Calibration Well No. 64: Upper Valley Subarea



Calibration Run 041

CALHYDRO.XLS
5/29/97