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Operation of Rain Gauge and Groundwater Monitoring Networks for the Imperial Valley Water Authority

Year Fifteen: September 2006-August 2007

by
Nancy E. Westcott, Kevin L. Rennels, and Steven D. Wilson

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Illinois State Water Survey
Institute of Natural Resource Sustainability
University of Illinois at Urbana-Champaign

Champaign, Illinois

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Abstract

The Illinois State Water Survey (ISWS), under contract to the Imperial Valley Water Authority (IVWA), has operated a network of rain gauges in Mason and Tazewell Counties since August 1992. The ISWS also established a network of groundwater observation wells in the Mason-Tazewell area in 1994, which is monitored by the IVWA. The purpose of the rain gauge network and the groundwater observation well network is to collect long-term data to determine the impact of groundwater withdrawals in dry periods and during the growing season, and the rate at which the aquifer recharges. This report presents data accumulated from both networks since their inception through August 2007. Precipitation is recorded continuously at 20 rain gauges. Groundwater levels are measured at 13 observation wells. Ten of the observation wells are now outfitted with continuous digital recorders and three are hand measured periodically. The database from these networks consists of 15 years of precipitation data and 13 years of groundwater observations.

The Year Fifteen network precipitation of 31.94 inches was below average, 1.77 inches lower than the network 15-year average of 33.71, and 1.90 inches below the previous 14-year average of 33.84 inches. Overall, precipitation was near average, although the spring and summer seasons in Year Fifteen were below average in seasonal total precipitation.

In 2006-2007, groundwater levels continued to decline in some of the study area because of below average precipitation and increased irrigation demand. However, in much of the study area, water levels rebounded somewhat after the end of the 2006 irrigation season. The dry growing season of 2007 had an effect on irrigation water demands, with the amount of irrigation pumpage being the second highest total, second only to the 72 billion gallons pumped in 2005. Total irrigation for the June-September 2007 period was estimated to be 57 billion gallons.

To improve our understanding of the relationship among groundwater, stream discharge, and irrigation pumpage, an irrigation test site was established in April 2003 (Year Eleven) near Easton, IL. Nine observation wells were installed in close proximity to an irrigated field that abuts Crane Creek. Transducers with data loggers have been installed in various wells since 2003 to monitor groundwater levels, and an additional logger was installed in Crane Creek to monitor stream stage. Data collection at the test site ended after the 2006 growing season. These data will be included in a groundwater flow model, currently in development. Data indicate there is groundwater discharge into Crane Creek at the test site even during irrigation withdrawals. The groundwater data indicate a rapid (within 24 hours) response of groundwater levels to precipitation, probably due to the increase in stage in Crane Creek in this area of prevalent sandy soils, though shallow water levels also are a contributing factor.

Introduction

The Imperial Valley area, a portion of which also is called the Havana Lowlands, is located principally in Mason and southern Tazewell Counties in west-central Illinois, just east of the Illinois River (Figure 1). The area overlies the confluence of the ancient Mississippi and the Mahomet-Teays bedrock valleys. The sandy soils and rolling dunes of the confluence area in the western portion of the Imperial Valley stand in stark contrast to the typically flat silt loam soils throughout much of the rest of central Illinois. The sand-and-gravel deposits associated with these two valleys contain an abundant groundwater resource. The area is used primarily for row and specialty crops, and it is extensively irrigated from the easily developed groundwater resource that underlies the Imperial Valley.

Regional precipitation variability affects irrigation water demand on the aquifer, recharge to the aquifer, and the extent to which the aquifer can be used for agricultural irrigation and municipal, industrial, and domestic water supplies. All these factors affect any required water withdrawals from an aquifer. Therefore, knowledge of precipitation variability and its relationship to groundwater recharge over an extensively irrigated region, such as the area within the Imperial Valley Water Authority (IVWA), should provide useful information for the management of groundwater resources in that region.

The Illinois State Water Survey (ISWS) has a long-term interest in precipitation measurement and related research, and has performed precipitation research in areas such as hydrology, weather modification, climate change, and urban influences on precipitation climate. Scientists and engineers from the ISWS have conducted extensive research on Illinois groundwater resources and have a continued interest in the hydrodynamics and recharge of aquifers in the state.

The objective of this project is to conduct long-term monitoring of precipitation and groundwater levels in the Imperial Valley region to learn how groundwater resources respond to drought and seasonal irrigation, and to assess groundwater recharge.

Rain Gauge and Observation Well Networks

A number of studies (Walker et al., 1965; Panno et al., 1994; Clark, 1994) have shown that precipitation is the primary source of water for groundwater recharge in the Imperial Valley. Therefore, detailed precipitation measurements are important for understanding its contribution to groundwater levels in the Imperial Valley area.

During the past 50 years, the ISWS has operated rain gauge networks of varying areal gauge densities over various time periods in both rural and urban areas. Sampling requirements, as determined from these past studies (e.g., Huff, 1970), indicate that a 2- to 3-mile gridded rain gauge spacing should be adequate for properly capturing convective precipitation systems (spring and summer), while a 6-mile spacing is adequate for more widespread precipitation-producing systems (fall and winter). The Belfort weighing bucket rain gauge provides precise and reliable precipitation measurements. Given the size of the IVWA area and the above spacing guidelines, a gridded, 25-site rain gauge network (Figure 1) with approximately 5 miles between gauges was established in late August 1992. The network was reduced to 20 sites in September 1996. Results of the previous years of the network operation are reported in Peppler and Hollinger (1994,

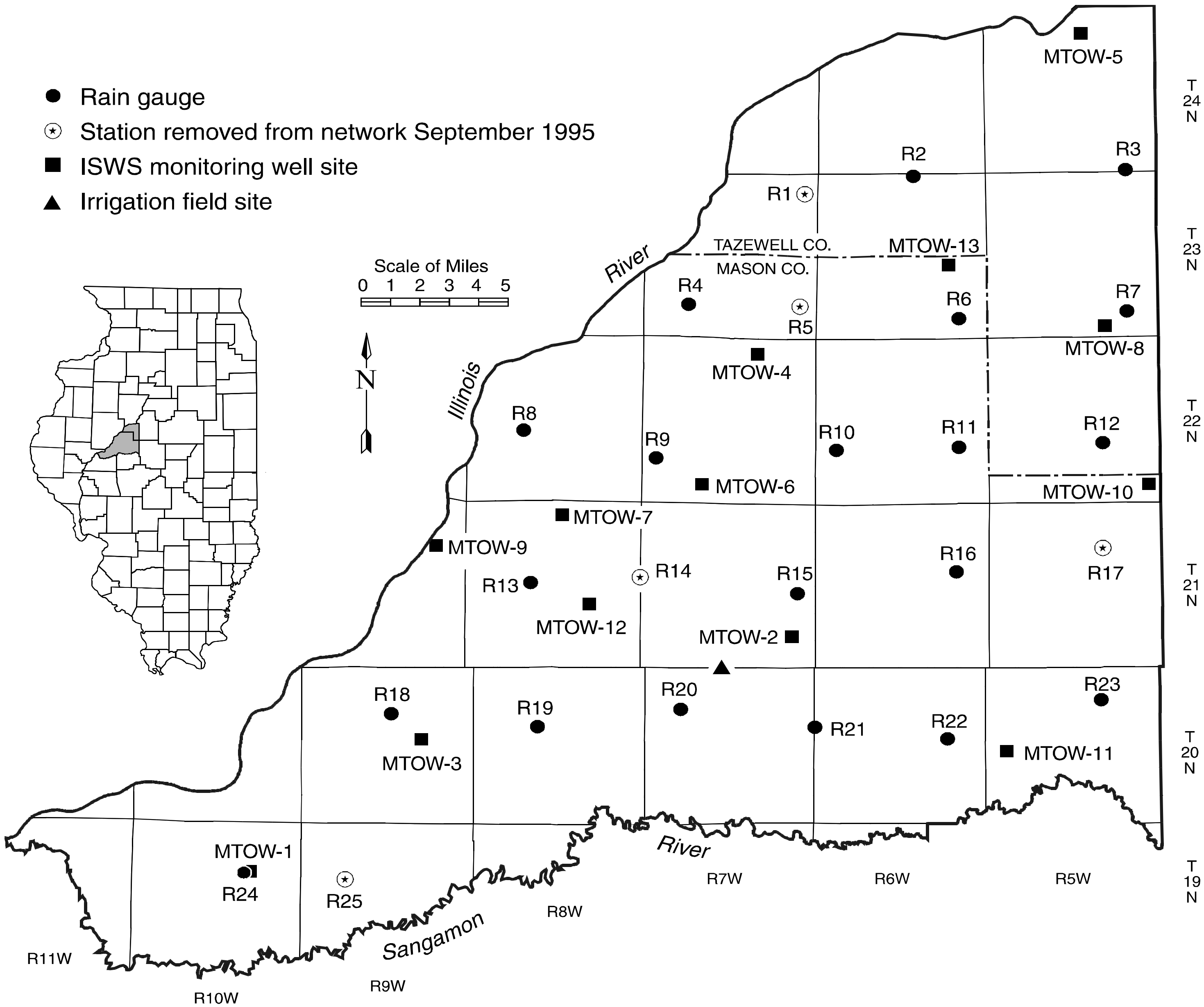


Figure 1. Configuration of the 13-site observation well and 25-site rain gauge networks, and location of the irrigation field site, Imperial Valley, 2006-2007

1995), Hollinger and Peppler (1996), Hollinger (1997), Hollinger and Scott (1998), Hollinger et al. (1999, 2000), Scott et al. (2001, 2002), Wehrmann et al. (2004, 2005), and Wilson et al. (2008a, b, c).

The observation well network originally consisted of 11 wells, Mason-Tazewell Observation Wells (MTOW) 1 through 11. The network was established for the IVWA in 1994 by Sanderson and Buck (1995). The IVWA added two wells (MTOW-12 and MTOW-13) in 1995 and 1996, respectively, to improve spatial coverage of the network. The 13 observation wells are located fairly uniformly across the Imperial Valley study area (Figure 1). Hollinger et al. (1999) includes the first summary of the groundwater-level data and statistical analyses of the correlation between precipitation, Illinois River stage, and groundwater levels for the four years that the observation well network had been in operation. Hollinger et al. (2000), Scott et al. (2001, 2002), Wehrmann et al. (2004, 2005), and Wilson et al. (2008a, b, c) include groundwater-level data and reanalysis of the correlation among precipitation, Illinois River stage, and groundwater levels for the observation well network prior to Year Fifteen.

Irrigation Test Site

Understanding the relationship between the regional groundwater discharge to streams and the effects of irrigation on water levels near these streams is a key component in developing a transient model of the Imperial Valley area. In order to model the conditions as they change during the summer, additional input data will be required on the effects of irrigation on groundwater levels and groundwater discharge to streams. Necessary data inputs for an ideal site include continuous water-level data, pumping rates and times for irrigation systems, and discharge/stage readings at a nearby stream, all at a location where groundwater is influenced by a stream and where the groundwater system is under the influence of irrigation pumpage. A test site meeting these criteria was located along Crane Creek, near Easton, IL, in Mason County. The site has only one center-pivot irrigation system within a half mile of the creek, which provides some control over irrigation effects in the immediate vicinity. The site, owned by Jeff Smith, has been studied to gather some of the necessary data for input into a regional flow model and eventually a nested model of the site within the regional model.

Report Objective

This report documents the operation, maintenance, data reduction and analysis, and management of the networks during the fifteenth year of the rain gauge network operation and the thirteenth year of the observation well network operation. A discussion of observed relationships among precipitation, Illinois River stage, irrigation, and groundwater levels is included.

Several appendices document groundwater hydrographs (Appendix A), observed groundwater-level data (Appendix B), rain gauge network site descriptions (Appendix C), instructions for rain gauge technicians (Appendix D), and rain gauge maintenance for the 2006-2007 period (Appendix E). The transducer data for the irrigation test site are included (Appendix F). Contour maps of annual precipitation across the Imperial Valley are presented for Years One-Fourteen (Appendix G). Documentation also is presented for the monthly and seasonal 1992-2006 precipitation events (Appendix H) and for all 2006-2007 precipitation events (Appendix I).

Acknowledgments

This work was conducted for the Imperial Valley Water Authority (IVWA) with partial support from the Illinois State Water Survey (ISWS) General Revenue Fund. The IVWA Board under the direction of Mr. Morris Bell, chairman, administers the project. The views expressed in this report are those of the authors and do not necessarily reflect the views of the sponsor or the ISWS. Paul Nelson and Robert Ranson run the rain gauge network, and Morris Bell collected the monthly groundwater-level data. Sara Olson drafted the precipitation maps for this report, Patti Hill assembled the report, and Lisa Sheppard edited the report. Their efforts are greatly appreciated. The ISWS and IVWA also take this opportunity to thank all of the local Mason/Tazewell County observers for their diligence in making this analysis possible. Special thanks are extended to Jeff Smith of Easton, Illinois, for allowing the installation of nine observation wells at his farm and permitting our continual presence there to gather data.

Rain Gauge Network: Description, Operation, and Maintenance

Peppler and Hollinger (1994) described construction of the IVWA rain gauge network and the type and setup of the weighing-bucket rain gauges used. Figure 1 shows locations for gauges R1-R25. Appendix C gives complete site descriptions for the 20 operational rain gauges as of August 31, 2007. Also included are the locations of five rain gauges removed from the network in 1996. In December 1997, the rain gauges were upgraded to include a data logger and linear potentiometer to automatically record the amount of water in the rain gauges every 10 minutes. This eliminates the necessity to digitize weekly or monthly paper charts, saves two to three days of analysis time each month, and provides more accurate time frames for events. Precipitation also is recorded each month on eight-day paper charts for backup if data loggers fail.

The 20 active sites are maintained by a local Mason County resident hired to change the charts once a month, download data from the data loggers, and perform other routine servicing. Rain gauge servicing includes checking the felt-tipped pen to make sure it is inking properly, emptying the bucket contents from approximately April-October, and noting any unusual problems, including chart-drive malfunction, gauge imbalance or instability, vandalism, unauthorized movement of the gauge, etc. During the warm season, evaporation shields are fitted into the collection orifice above the bucket to minimize evaporation. During the cold season, one quart of antifreeze is added to each rain gauge bucket so that any frozen precipitation collected will melt to allow a proper weight reading, and to prevent freeze damage to the collection bucket. Rain gauges are serviced during the first few days of the month. The memory card with the digital data and the 20 rain gauge charts are sent monthly to the ISWS. Appendix D presents instructions for the rain gauge technician.

Champaign-based personnel visit the network to perform major maintenance and repairs as needed. This usually consists of a site assessment of an observer-noted problem and determination of a solution. Sometimes problems pertain to the chart drives, and the usual solution is to adjust or replace the chart drive. If replaced, the defective chart drive is cleaned and readied for reuse at the ISWS. Other typical repairs performed on these trips include resoldering wires and battery replacement. The 20 gauges are calibrated every two years. If a gauge appears to record consistently high or low precipitation amounts compared with its neighbors, the gauge is first cleaned and calibrated. If the problem persists, the gauge is replaced. Appendix E documents non-routine maintenance or repairs, including any site relocations, for the 20 rain gauges during Year Fifteen.

Groundwater-Level Observation Well Network: Description, Operation, and Maintenance

Table 1 provides a general description of each network well, including well location, depth, and the predominant soil associations in proximity to each well. This provides some determination of relative soil permeability around the wells. Generally, the greater permeabilities associated with the Plainfield-Bloomfield, Sparta-Plainfield-Ade, and Onarga-Dakota-Sparta soil associations (Calsyn, 1995) are found at MTOW-1, -3, -4, -6, -7, -9, and -12, which are all located in the western portion of the study area (Figure 1). Fine-grained materials found in the upper portion of the geologic profiles at MTOW-10 and MTOW-11 (southeastern portion of the study area) indicate that the water levels in these two wells are under artesian conditions. Because water in these wells is under pressure, water-level responses may be different from those of other wells.

The observation wells range in depth from 24 to 100 feet. Most network wells were constructed after 1985 as part of special studies within the Imperial Valley or for use in the observation well network. A few wells that existed prior to the development of the network were used for water supply. All of the network wells have been surveyed for well head elevation above mean sea level.

Well MTOW-1, located at Snicarte, is an inactive, large-diameter, hand-dug domestic well that has been monitored by the ISWS since 1958. MTOW-1 has been incorporated into the Shallow Groundwater Well Network of the ISWS Water and Atmospheric Resources Monitoring (WARM) Program. This well is equipped with a Stevens Type F water-level recorder that produces a continuous record of the groundwater level on a 32-day paper chart. ISWS staff visit the well monthly to measure the groundwater level, change the recorder chart, and perform recorder maintenance. Therefore, a longer and more complete groundwater level record is available for this well than for any other well in the IVWA network.

Because the Snicarte well has been dry several times in recent years, a new well was drilled to replace it. The new well is located just south of the existing well, at the road intersection. This new well is currently named Snicarte #2 to avoid any confusion with the original Snicarte well (MTOW-01), and will eventually take the place of the original well (MTOW-01 or Snicarte #1) within the monitoring well network. The two wells must be observed for a period of time so that water-level data from Snicarte #1 can be correlated to Snicarte #2. The new well is equipped with the same type of Stevens recorder as the original well. It is unknown at this time how long this procedure will take as Snicarte #1 has been intermittently dry.

From 1995 through 2001, groundwater levels in the IVWA observation wells were measured at the beginning of each month from March through November (December, January, and February readings typically were not collected). Beginning in 2002, monthly measurements were collected throughout the entire year. A mid-month measurement was collected during the 1995-1997 irrigation seasons (May-October 1995, May-September 1996, and May-August 1997). Groundwater levels measured manually with a steel tape or electric probe are entered into a database as depth below land surface. The IVWA collected these measurements, maintained the database, and forwarded the resulting data annually to the ISWS.

In January 2005, Year Thirteen, four of the wells (MTOW-2, -3, -7, -13) were outfitted with digital data loggers for collecting water level measurements. In Year Fourteen, six additional wells were outfitted with digital data loggers. Currently, the 10 observation wells with digital records collect near-continuous measurements (every 6 or 12 hours). These data are downloaded six times a year, and water levels are sent to the IVWA for their use.

MTOW-5 and -9 are very near the Illinois River and previous measurements indicate their readings are a reflection of river stage, much more so than groundwater conditions. Because continuous river stage data are available, these three wells are no longer regularly measured.

Table 1. Imperial Valley Network Observation Wells

Name	*I.D.*	*Location*	*Depth (feet)*	*Generalized Soil Association*	*Remarks*
Snicarte	MTOW-1	Section 11.8b, T.19N., R.10W., Mason County	40.5	Sparta-Plainfield-Ade	Inactive well, continuous record since 1958
Easton	MTOW-2	Section 25.8a, T.21N., R.7W., Mason County	82	Elburn-Plano-Thorp	Abandoned city fire well
Mason County Wildlife Refuge & Recreation Area	MTOW-3	Section 14.8c, T.20N., R.9W., Mason County	24	Plainfield-Bloomfield	Installed in 1985 for ISGS study
Sand Ridge SR-11	MTOW-4	Section 2.8d, T.22N., R.7W., Mason County	27	Plainfield-Bloomfield	Installed in 1989 for ISWS study
Pekin - OW8	MTOW-5	Section 3.6a, T.24N., R.5W., Tazewell County	49	Selma-Harpster	Installed in 1991 for ISWS study
Mason State Tree Nursery	MTOW-6	Section 33.8f, T.22N., R.7W., Mason County	45.5	Onarga-Dakota-Sparta	Installed in 1993
IL Route 136 Rest Area	MTOW-7	Section 3.7e, T.21N., R.8W., Mason County	44	Onarga-Dakota-Sparta	Installed in 1993
Green Valley	MTOW-8	Section 34.1c, T.23N., R.5W., Mason County	53.5	Elburn-Plano-Thorp	Installed in 1993
IDOT - DWR	MTOW-9	Section 12.8e, T.21N., R.9W., Mason County	48	Sparta-Plainfield-Ade	Installed in 1994 for flood study
San Jose	MTOW-10	Section 36.2d, T.22N., R.5W., Mason County	56	Elburn-Plano-Thorp	Old municipal well
Mason City	MTOW-11	Section 18.2a, T.20N., R.5W., Mason County	63	Tama-Ipava	Old municipal well
Hahn Farm	MTOW-12	Section 23.8c, T.21N., R.8W., Mason County	100	Plainfield-Bloomfield	Old turkey farm well
Talbott Tree Farm	MTOW-13	Section 9.4a, T.23N, R.6W., Tazewell County	82	Selma-Harpster	Installed in 1996

Notes: General Soil Map Units are from Calsyn (1995).
MTOW = Mason-Tazewell Observation Well.

Irrigation Test Site: Description, Operation, and Maintenance (Year Five)

The irrigation test site along Crane Creek, southwest of Easton, IL, is located in Section 4 of Township 20 North, Range 7 West (Crane Creek Township) on property owned by Mr. Jeff Smith. Nine observation wells were installed in April 2003. Three are on the north side of Crane Creek and six are on the south side of Crane Creek. The irrigation well is on the south side of Crane Creek; its irrigation pattern, along with the observation well locations, are shown in Figure 2. The observation wells range from 31 to 37 feet deep, and the non-pumping water levels are less than 10 feet below land surface during the off-irrigation season. The depth and date of construction for each well are listed in Table 2. Data collection was completed during Year Fifteen at the site. Monitoring included groundwater level observations (manual and digital), surface water stage (manual and digital), discharge measurements, and measurement of well elevations.

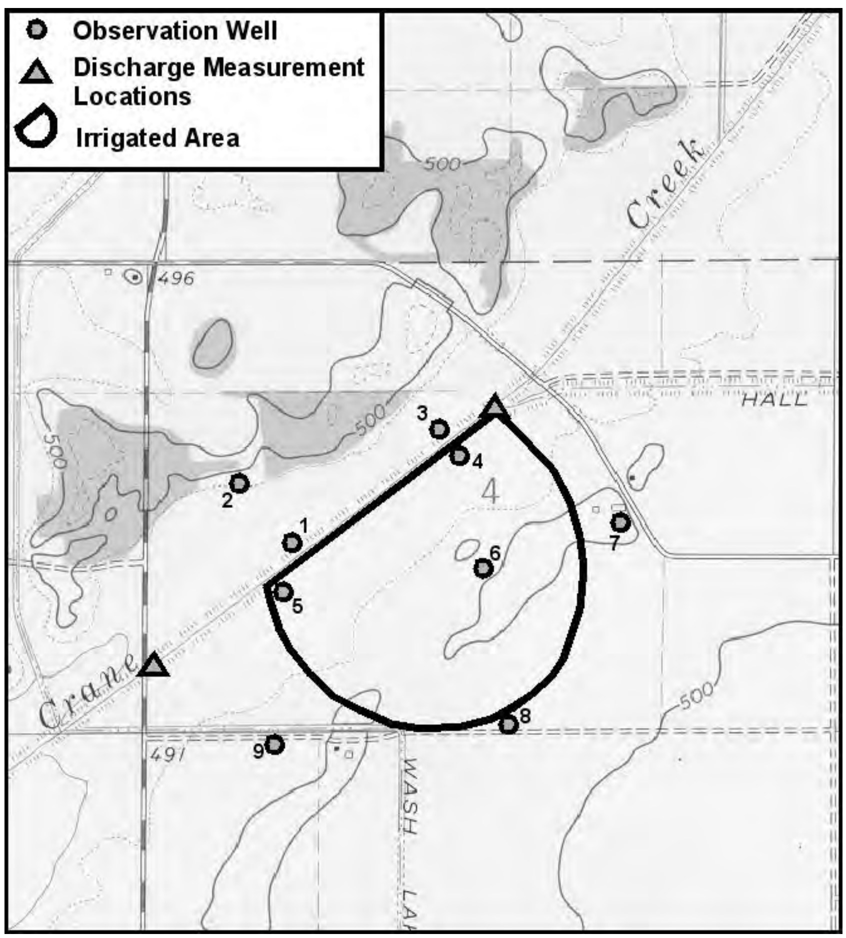


Figure 2. Locations of observation wells and streamflow discharge measurement points in relation to the irrigation test site

As of September 1, 2005, data loggers were installed in all wells at the site, and in Crane Creek near the downstream bridge. The data logger in well 1 was removed on August 3, 2006, and the data logger in well 9 was removed on July 14, 2006. The remaining seven data loggers were removed on September 26, 2006. The data logger located within Crane Creek near the downstream bridge remains. The logger is serviced and a field check is done to verify accuracy a few times throughout the year.

Data loggers placed at the site were set up to collect data at varying intervals. Well 6 and the data logger in Crane Creek collected data at 15-minute intervals. Those in wells 4, 5, 8, and 9 were set to collect data every 30 minutes. In wells 1, 2, 3, and 7, the data loggers collected data every hour. Hydrographs of the transducer data for the site wells are provided in Appendix F.

The measuring point elevations of the wells and stage readings were determined previously based on the downstream bridge elevation of 494.00 feet mean sea level (MSL) (taken from the U.S. Geological Survey topographic map). Elevations were surveyed from the downstream bridge so that relative water levels could be determined. The elevations are listed in Table 2.

Table 2. Depths, Installation Dates, and Measuring Point Elevations, Imperial Valley Irrigation Site Observation Wells

Well number	*Depth (feet)*	*Date installed*	*MP Elevation (MSL)*
1	33.10	4/23/03	492.45
2	32.75	4/22/03	495.07
3	31.10	4/23/03	493.26
4	34.30	4/22/03	495.03
5	34.75	4/22/03	491.86
6	37.00	4/22/03	495.81
7	32.85	4/23/03	496.27
8	34.00	4/23/03	494.24
9	33.50	4/23/03	492.28
Upstream bridge	----	----	496.61
Downstream bridge	----	----	494.00

Precipitation, Groundwater-Level, and Irrigation Data Analysis

This report presents rainfall and groundwater-level data for the period September 2006-August 2007, called Year Fifteen in this report. Data collected from the rain gauge and observation well networks were maintained in separate databases, but the resulting data were evaluated together to examine the response of groundwater levels to local precipitation. Observed network groundwater levels may be influenced by irrigation pumpage, so an estimate of monthly pumpage also is presented.

Precipitation Analysis

Data reduction activities during Year Fifteen of network operation are similar to those performed during the previous 14 years (Peppler and Hollinger, 1994, 1995; Hollinger and Peppler, 1996; Hollinger, 1997; Hollinger and Scott, 1998; Hollinger et al., 1999, 2000; Scott et al., 2001, 2002; Wehrmann et al., 2004, 2005; and Wilson et al., 2008a, b, c). Hourly rainfall amounts are totaled from 10-minute digital data and are placed in an array of monthly values for the 20 gauges. This data array is used to check for spatial and temporal consistency among gauges, and to divide the data into storm periods. If the digital data are missing, hourly rainfall amounts from the analog (paper) charts are used. In the rare event that data from both a data logger and the corresponding chart are missing, the hourly amounts are estimated based on an interpolation of values from the nearest surrounding gauges.

Groundwater-Level Analysis

Monthly Measurements

Groundwater levels for each well for the period of record (1995-2007) are presented graphically (Appendix A) and in tabular form (Appendix B). Graphs of groundwater levels are commonly called hydrographs. Each hydrograph also contains the total monthly precipitation for the nearest rain gauge. For observation wells located between several rain gauges, an average of the surrounding rain gauge data is presented. Groundwater level data are presented as depth-to-water from land surface. For observation wells located relatively near the Illinois River (MTOW-1, -5, and -9), the stage of the river at the nearest U.S. Army Corps of Engineers (USACE) gauging station also is shown. Mean monthly stage data were downloaded for the Beardstown, Havana, and Kingston Mines stations from the USACE Internet site (http://water.mvr.usace.army.mil).

Continuous Measurements

Selected historical daily groundwater-level data from recorder chart records for the Snicarte observation well (MTOW-1) were transferred to digital format and graphed with daily rainfall data from gauge 24. The results, shown in the Year Eleven report, indicate that there is indeed a quick response to rainfall at MTOW-1. In response to those findings, transducers were temporarily installed in the Green Valley (MTOW-8) and Rest Area (MTOW-7) wells during Year Twelve, which showed marginal success at correlating rainfall to groundwater-level changes. In Year Thirteen, four digital water level recorders were purchased and installed in wells MTOW-2, -3, -7, and -13. In Year Fourteen, six more transducers were purchased and installed in wells MTOW-4, -6, -8, -10, -11, and -12. MTOW-1 is the Snicarte observation well that has a continuous paper recorder. MTOW-5 and -9 are very near the Illinois River and historical data indicate that they are heavily influenced by the stage of the river. For this reason, transducers at these three locations would provide limited benefit.

Irrigation Water-Use Analysis

Since 1995, the IVWA has estimated irrigation pumpage from wells in the Imperial Valley based on electric power consumption, using the equation below:

$$Q = 1505 \times KWH \times IRR/MEC$$

where Q is the total estimated monthly irrigation pumpage (in gallons), KWH is the monthly electrical power consumption (in kilowatt hours) used by the irrigation accounts served by Menard Electric Cooperative, IRR is the total number of irrigation systems in the IVWA region, MEC is the number of Menard Electric Cooperative irrigation accounts, and 1505 is a power consumption conversion factor (in gallons/KWH). Irrigation systems in the region receive electric power from the Menard Electric Cooperative and two investor-owned utilities (AmerenCIPS and AmerenCILCO). Menard Electric Cooperative provides the IVWA with electric power consumption data for the irrigation services they serve during the growing season (June-September). Not all the irrigation systems use electric power to pump water, and Menard serves only some of these systems. The pumpage estimate assumed that application rates for the irrigation wells with electric pumps in Menard Electric Cooperative also are representative of other utilities and other energy sources. Past estimates were based on the assumption that 33 percent of the irrigation wells were in Menard Electric Cooperative in 1995-1997, and 40 percent in 1998-2001.

In summer 2002, a U.S. Geological Survey (USGS) study indicated the need for a new power consumption conversion factor. An updated conversion factor was determined by recording electrical consumption while closely measuring the pumping rate at 77 irrigation systems. The updated value, 1259 gallons/KWH, is appreciably lower than the previously used factor of 1505 gallons/KWH, suggesting that previous estimates of water withdrawals may have overestimated pumpage by approximately 20 percent (i.e., pumping system efficiency is estimated to be 20 percent less than previously thought). Therefore, irrigation withdrawals for the years 1997 to the present were recalculated using the new formula, replacing earlier published estimates. Collection of additional data related to the irrigation systems (such as system age and size) and the conversion factors associated with those systems may further enhance withdrawal estimates.

Results

Precipitation

Annual and Monthly Precipitation

The Year Fifteen dataset was used to produce the following analyses: 1) monthly and annual (September 2006-August 2007) precipitation amounts for each site in the IVWA network (Table 3); 2) the average precipitation pattern for the 15-year network operation (Figure 3); 3) the total precipitation pattern for Year Fifteen (Figure 4); 4) a comparison of total precipitation, precipitation events, and precipitation per event (Table 4); and 5) the average precipitation for each month in Year Fifteen (Figures 5-10). The annual precipitation patterns for Years One-Fourteen also are presented (Appendix G).

The Year Fifteen network precipitation of 31.94 inches was below average, 1.77 inches lower than the network 15-year average of 33.71, and 1.90 inches below the previous 14-year average of 33.84 inches. It was the ninth driest year in the 15 years of network operation. The spring and summer seasons in Year Fifteen were below average in seasonal total precipitation.

Table 3. Monthly Precipitation Amounts (inches), September 2006-August 2007

	Month												
Station	*Sep*	*Oct*	*Nov*	*Dec*	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Total*
2	1.57	3.00	5.40	3.08	2.88	1.46	5.14	4.92	2.17	4.37	2.99	1.18	38.16
3	1.89	1.98	3.65	2.02	2.27	1.81	4.30	3.21	1.71	3.35	2.62	1.02	29.83
4	1.50	1.91	3.75	2.39	2.21	1.71	4.37	3.51	1.99	4.36	3.40	0.99	32.09
6	2.32	2.14	3.11	1.94	2.35	1.47	5.71	2.27	1.20	4.14	2.81	0.68	30.14
7	1.59	2.16	3.51	1.68	2.38	2.00	4.98	2.65	1.56	4.03	2.22	2.45	31.21
8	2.71	1.83	3.29	2.04	2.08	1.89	4.45	2.21	1.96	3.45	2.54	1.05	29.50
9	3.19	2.03	4.35	2.91	2.27	1.44	5.75	2.48	1.61	5.40	3.07	0.80	35.30
10	3.10	2.01	4.02	1.91	2.46	1.49	5.81	2.70	1.67	4.78	2.58	1.14	33.67
11	1.93	1.80	3.35	2.19	2.58	1.97	7.02	2.46	1.60	4.15	3.40	0.94	33.39
12	1.47	2.41	4.11	1.86	3.05	2.78	6.20	2.92	1.83	3.93	2.99	1.18	34.73
13	2.41	1.95	3.83	1.94	2.39	1.76	3.91	1.84	2.31	4.56	2.68	0.81	30.39
15	2.69	2.02	3.78	1.90	2.58	1.49	4.23	2.55	1.87	4.50	2.11	0.76	30.48
16	1.55	2.04	2.43	2.05	2.27	1.43	4.54	2.16	1.34	4.20	2.43	1.31	27.75
18	3.55	2.58	3.66	2.26	2.81	2.09	3.48	2.13	2.30	5.49	1.50	2.84	34.69
19	3.78	2.50	4.05	2.65	2.81	2.02	4.05	1.91	2.28	5.47	1.93	1.76	35.21
20	2.69	2.27	3.98	1.85	2.65	1.50	4.34	1.99	1.25	4.42	2.35	1.42	30.71
21	2.02	1.91	3.84	2.11	2.50	1.51	3.25	1.42	1.17	4.62	2.05	1.46	27.86
22	2.58	2.21	4.76	1.98	2.63	1.51	4.45	1.69	1.36	4.36	1.90	0.91	30.34
23	1.77	2.47	4.45	2.25	2.76	1.69	4.35	1.91	1.68	4.68	2.17	1.03	31.21
24	2.58	2.53	3.85	2.25	2.58	1.69	2.92	2.27	2.07	5.66	1.46	2.81	32.04
Avg	2.34	2.19	3.86	2.16	2.53	1.74	4.66	2.46	1.75	4.50	2.46	1.30	31.94

Note:
Stations 1, 5, 14, 17, and 25 were removed from the network in September 1995.

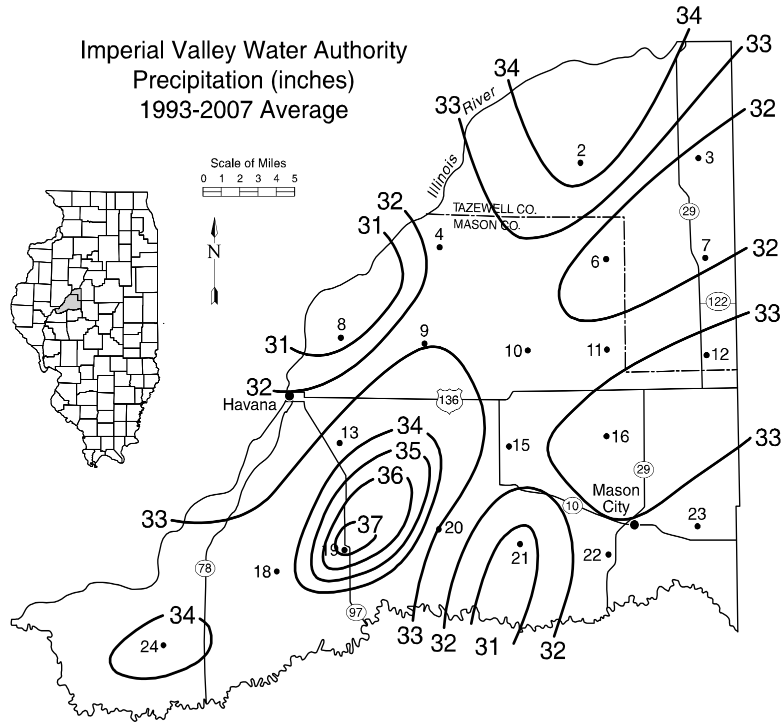


Figure 3. Network average annual precipitation (inches) for September 1992-August 2007

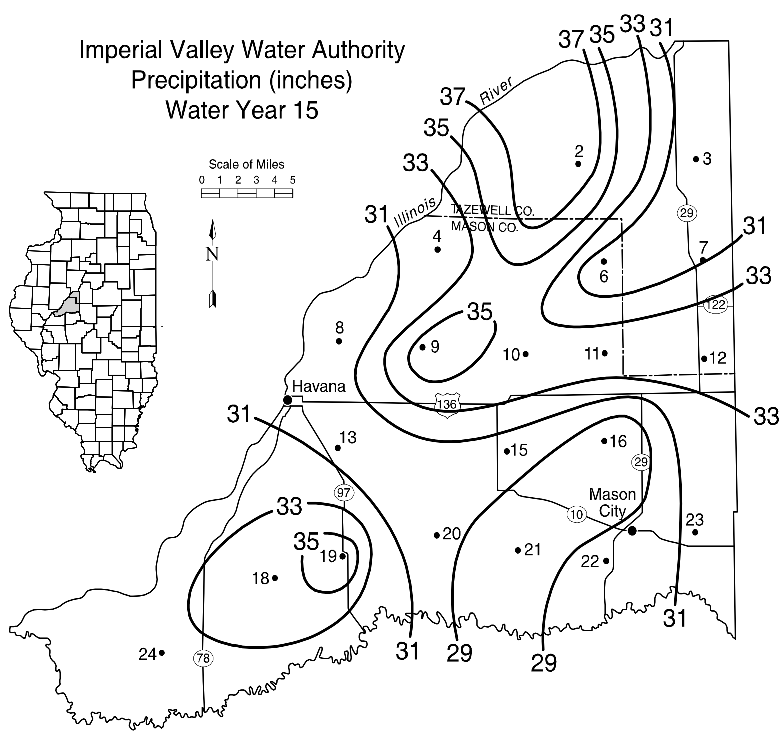


Figure 4. Total precipitation (inches) for September 2006-August 2007

Table 4. Comparison of Total Precipitation (inches), Number of Precipitation Events, and Average Precipitation per Event for Each Month and Season, 1992-2006 and 2006-2007

	1992-2006 14-yr average			*2006-2007 average*		
Period	*Precipitation*	*Events*	*Inches/event*	*Precipitation*	*Events*	*Inches/event*
Sep	2.62	7.1	0.37	2.34	7	0.33
Oct	2.43	9.2	0.26	2.19	6	0.36
Nov	2.75	9.9	0.28	3.86	6	0.64
Dec	1.41	8.6	0.16	2.16	5	0.43
Jan	2.19	9.9	0.22	2.53	7	0.36
Feb	1.55	7.7	0.20	1.74	7	0.25
Mar	2.05	8.2	0.25	4.66	16	0.29
Apr	3.46	11.1	0.31	2.46	6	0.41
May	4.34	14.4	0.30	1.75	10	0.17
Jun	3.70	11.8	0.31	4.50	10	0.45
Jul	3.80	10.9	0.35	2.46	8	0.31
Aug	3.55	12.9	0.27	1.30	12	0.11
Fall	7.80	26.1	0.30	8.39	19	0.44
Winter	5.15	26.1	0.20	6.42	19	0.34
Spring	9.85	33.7	0.29	8.87	32	0.28
Summer	11.04	35.6	0.31	8.25	30	0.28
Annual	33.84	121.6	0.28	31.94	100	0.32

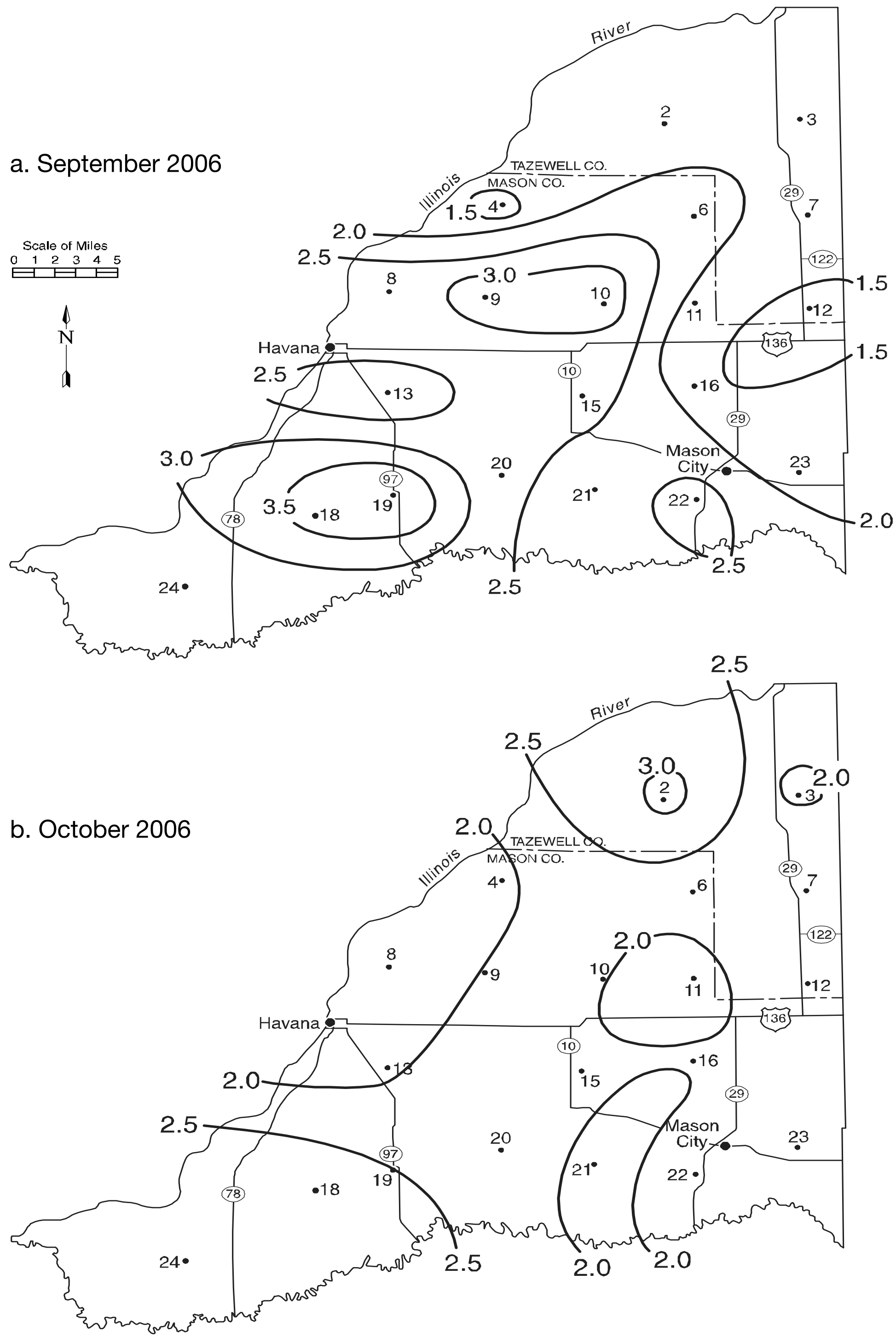


Figure 5. Precipitation (inches) for September 2006 and October 2006

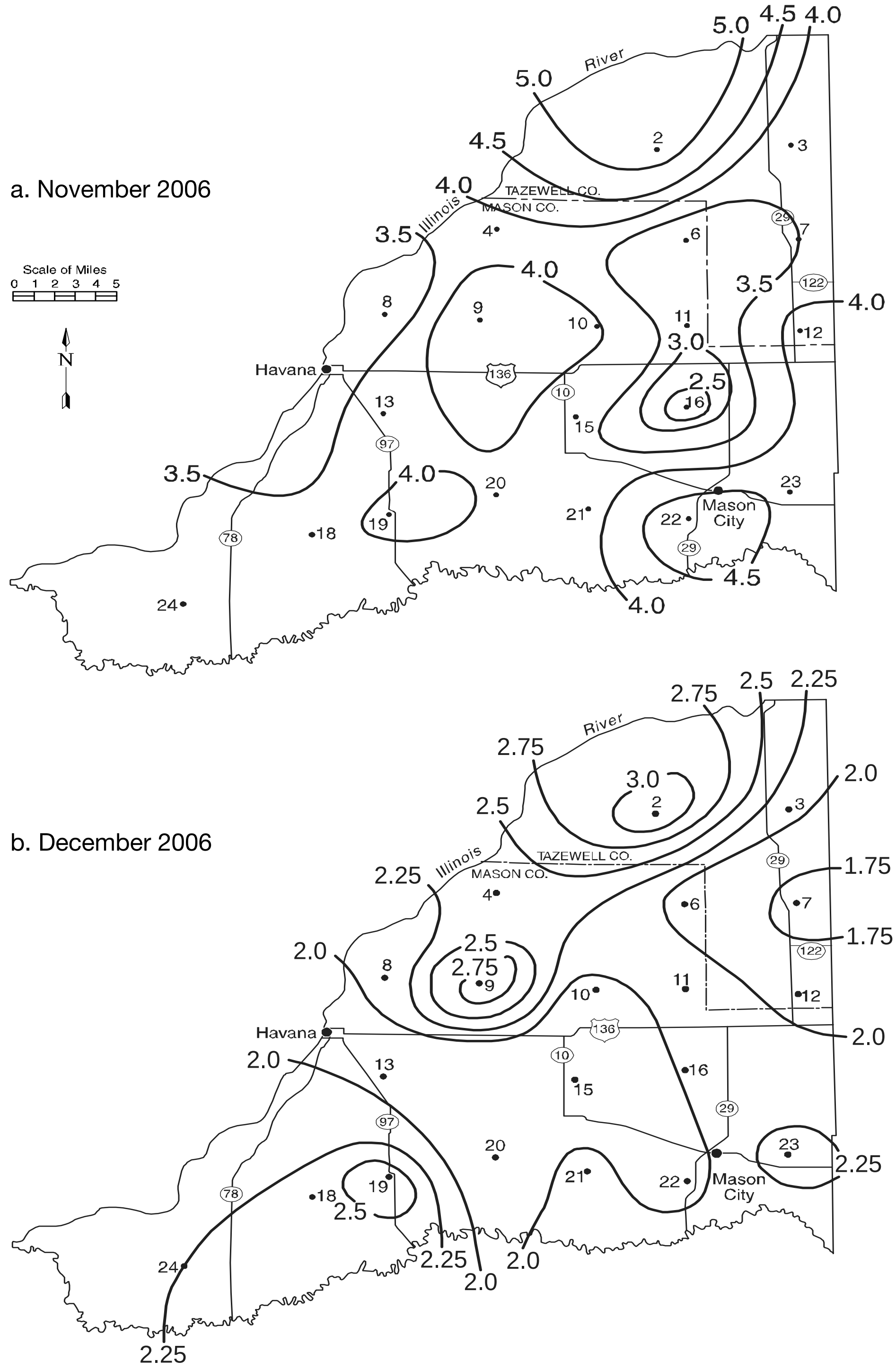


Figure 6. Precipitation (inches) for November 2006 and December 2006

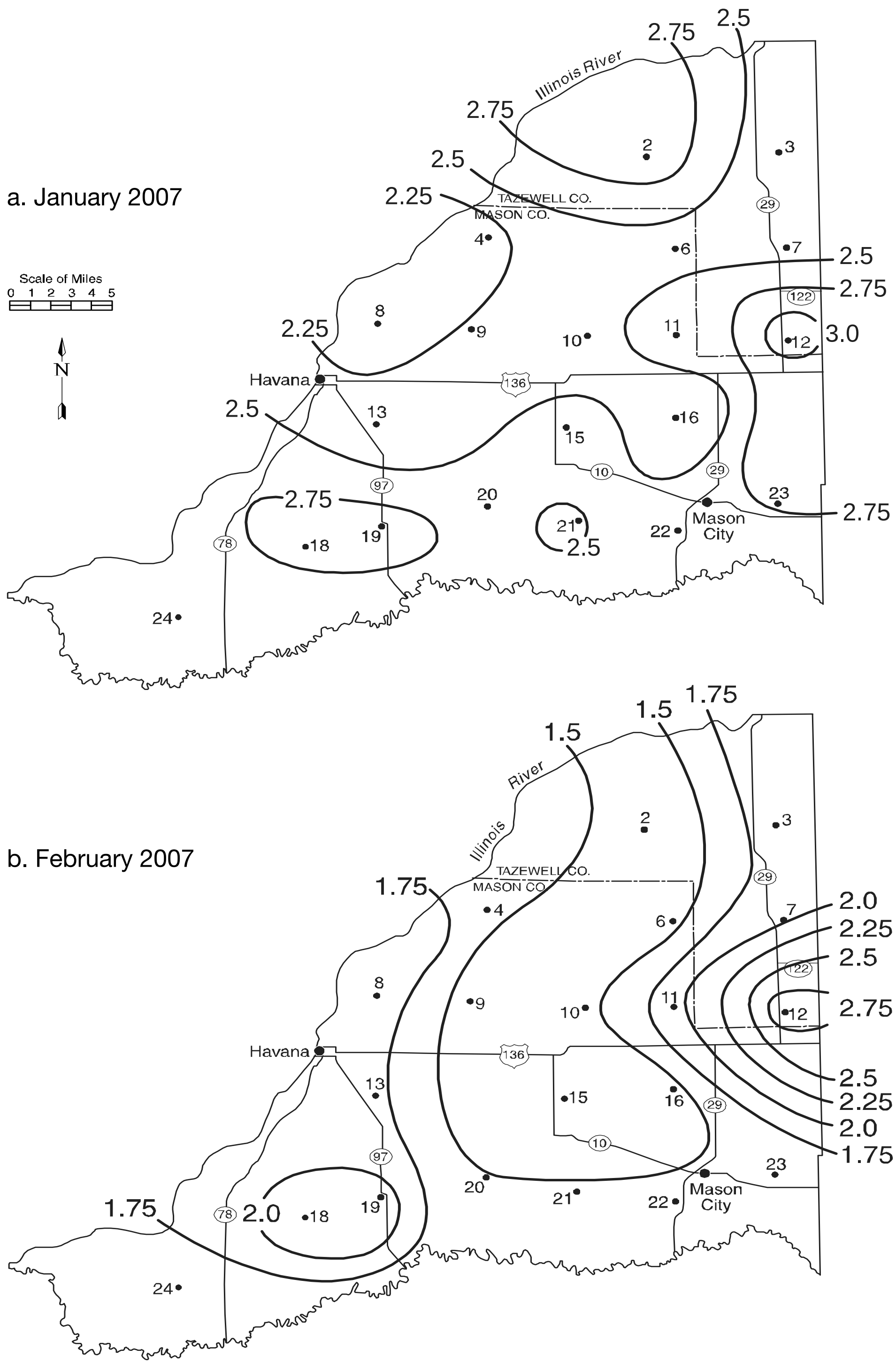


Figure 7. Precipitation (inches) for January 2007 and February 2007

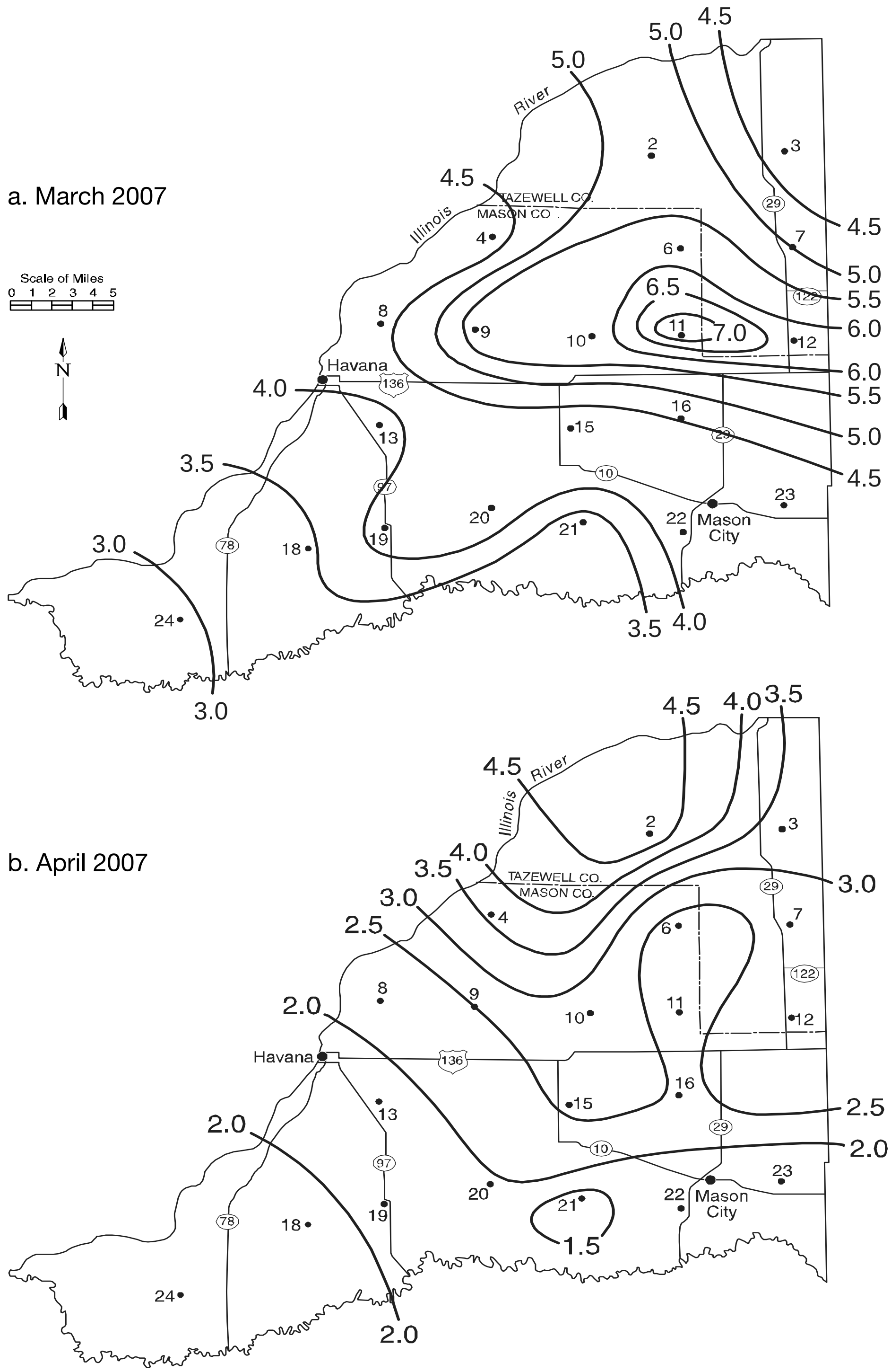


Figure 8. Precipitation (inches) for March 2007 and April 2007

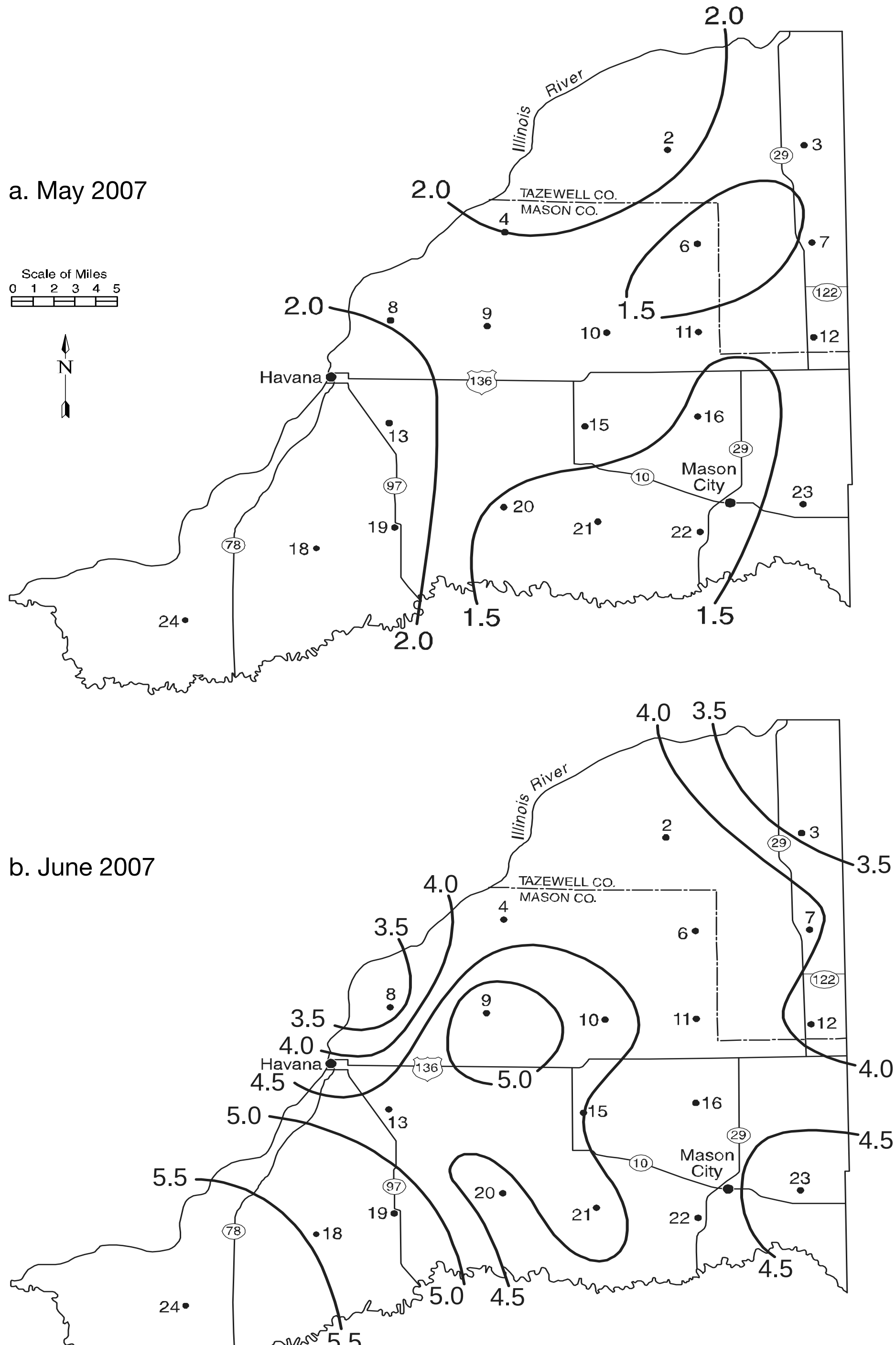
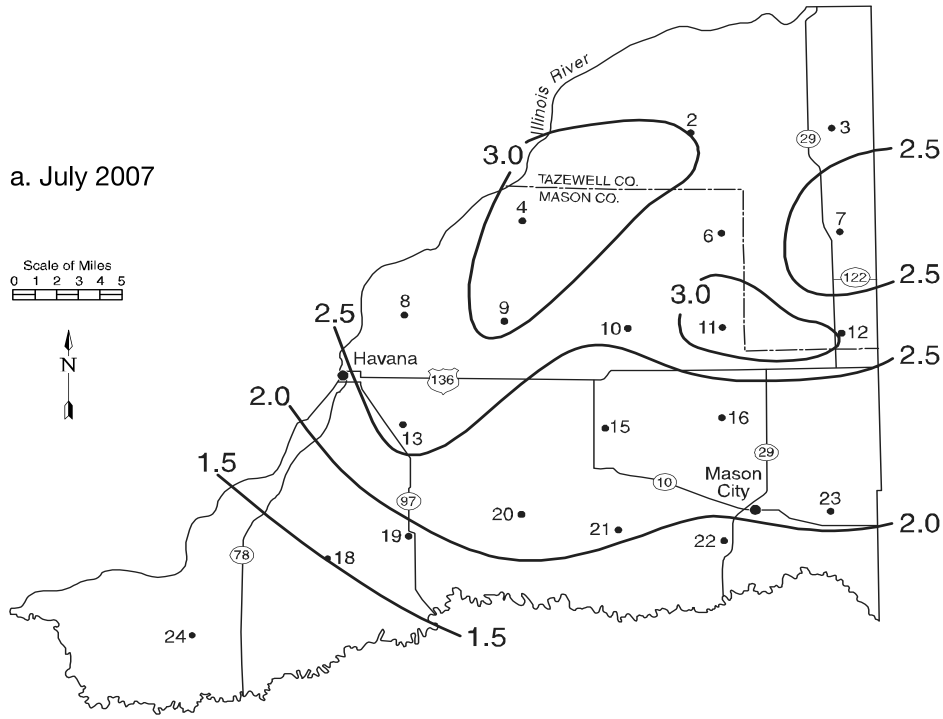


Figure 9. Precipitation (inches) for May 2007 and June 2007



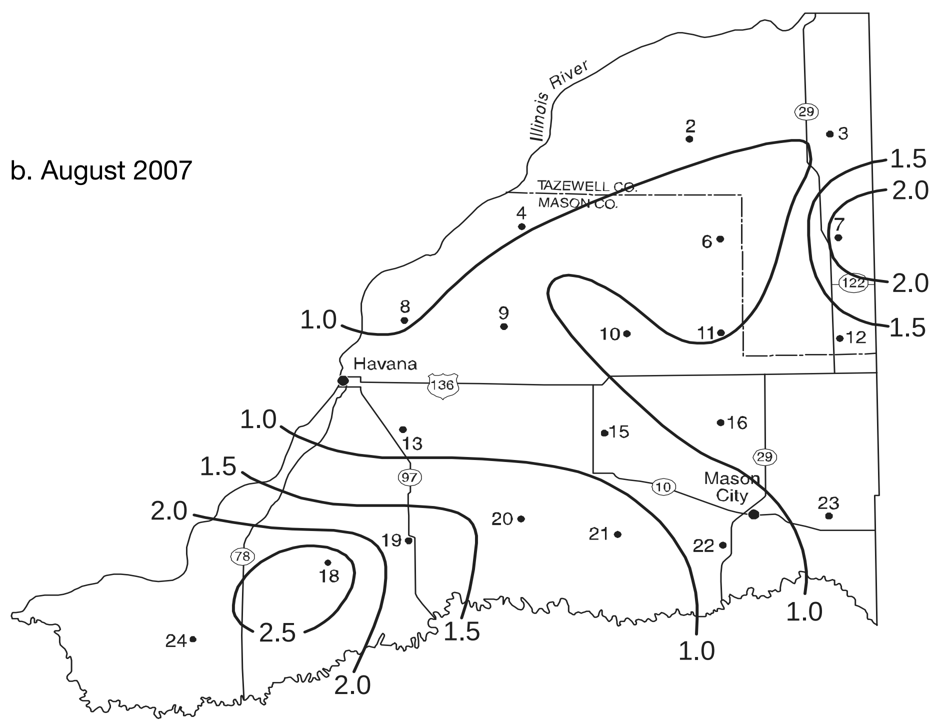


Figure 10. Precipitation (inches) for July 2007 and August 2007

Figure 3 presents the 15-year network average, excluding sites 16, 19, and 21 during the period 1997-2002, and Figure 4 presents the annual precipitation pattern for Year Fifteen. During Year Fifteen, annual gauge totals varied from 27.75 inches at site 16 to 38.16 inches at site number 2 (Figure 4). Eight-inch gradients in annual precipitation are not unusual during any given year, as long as they are not replicated at the same gauges year after year, and are somewhat supported by surrounding gauges.

March and June 2007 (Figure 8a and 9b) were the wettest months of Year Fifteen, reporting network averages of 4.66 inches and 4.50 inches, respectively, followed by November 2006 (Figure 6a) with 3.86 inches of precipitation. August 2007 was the driest month of the year (Figure 10b, 1.30 inches) followed by February and May 2007 (Figure 7b, 1.74 inches; Figure 9a, 1.75 inches).

Individually, November 2006, December 2006, and March 2007 were more than 33 percent above average (see Table 4). May 2007, July 2007, and August 2007 received less than 67 percent of their respective average monthly precipitation. The remaining six months, September and October 2006, and January, February, April, and June 2007 were within ± 0.33 percent of the 14-year average precipitation.

The spring and summer seasons of 2007 were the wettest seasons of the year, and the winter 2006-2007 was the driest season. The spring and summer seasons, however, received below average seasonal precipitation. The summer of 2007 was 75% of the 14-year average summer precipitation. The annual precipitation total for 2006-2007 was the ninth driest of the 15 years of network operation. The network received 23.61 inches less precipitation than in the wettest year (1992-1993) and 6.24 inches more than in the driest year (1995-1996).

Storm Events

The number of network precipitation periods were determined for the 15-year period. Mean monthly, seasonal, and annual numbers of these precipitation events are presented for each year (Appendix H), and for 2006-2007 (Table 4). The monthly, seasonal, and annual numbers of precipitation events averaged over the 1992-2006 period also are presented (Table 4). A network storm period was defined as a precipitation event separated from preceding and succeeding events at all network stations by at least three hours. Data for the individual network storm periods also are presented (Appendix I, Tables I-2 and I-3).

During Year Fifteen, there were 100 precipitation events, fewer than the 14-year average number of events. Fewer events than average occurred in all seasons of the year. Most events occurred in the spring and summer, as is typical. The amount of precipitation per event was above average in the fall of 2006 and winter of 2006-2007, but near average in the spring and summer of 2007.

The plot of the network average monthly precipitation time series (Figure 11) shows the monthly variation of precipitation. It is not uncommon for precipitation in five to six months of the fall-winter seasons to fall below 2.75 inches. This occurred in the five years from 1995-1996 to 1999-2000 and in the three years from 2001-2002 to 2003-2004. It is not unusual for precipitation in one or two spring and summer months to fall below 2.75 inches in any given year. In the four summers of 1995, 1996, 1997, and 2000, precipitation in three or four months during the spring-summer seasons fell below 2.75 inches. From February 2005 through February 2007, only one month had precipitation greater than 4.0 inches. From February 2005 through August 2007, there were only three months with precipitation over 4.0 inches.

A total of 1803 network storm periods occurred during the 15-year observation period: 148 in 1992-1993, 102 in 1993-1994, 129 in 1994-1995, 98 in 1995-1996, 121 in 1996-1997, 134 in 1997-1998, 144 in 1998-1999, 156 in 1999-2000, 148 in 2000-2001, 122 in 2001-2002, 80 in 2002-2003, 110 in 2003-2004, 98 in 2004-2005, 113 in 2005-2006, and 100 in 2006-2007, resulting in a 15-year average of 120 storms per year.

Appendix I documents each network storm period for Year Fifteen with the date and hour of the start time, duration, number of sites receiving precipitation, network average precipitation, storm average precipitation, maximum precipitation received, station (gauge) where the maximum occurred, and storm recurrence frequency of the maximum observed precipitation. The network average precipitation is the arithmetic mean of the precipitation received at all network stations, and the storm average is the arithmetic mean of the precipitation received at stations reporting precipitation during the storm period.

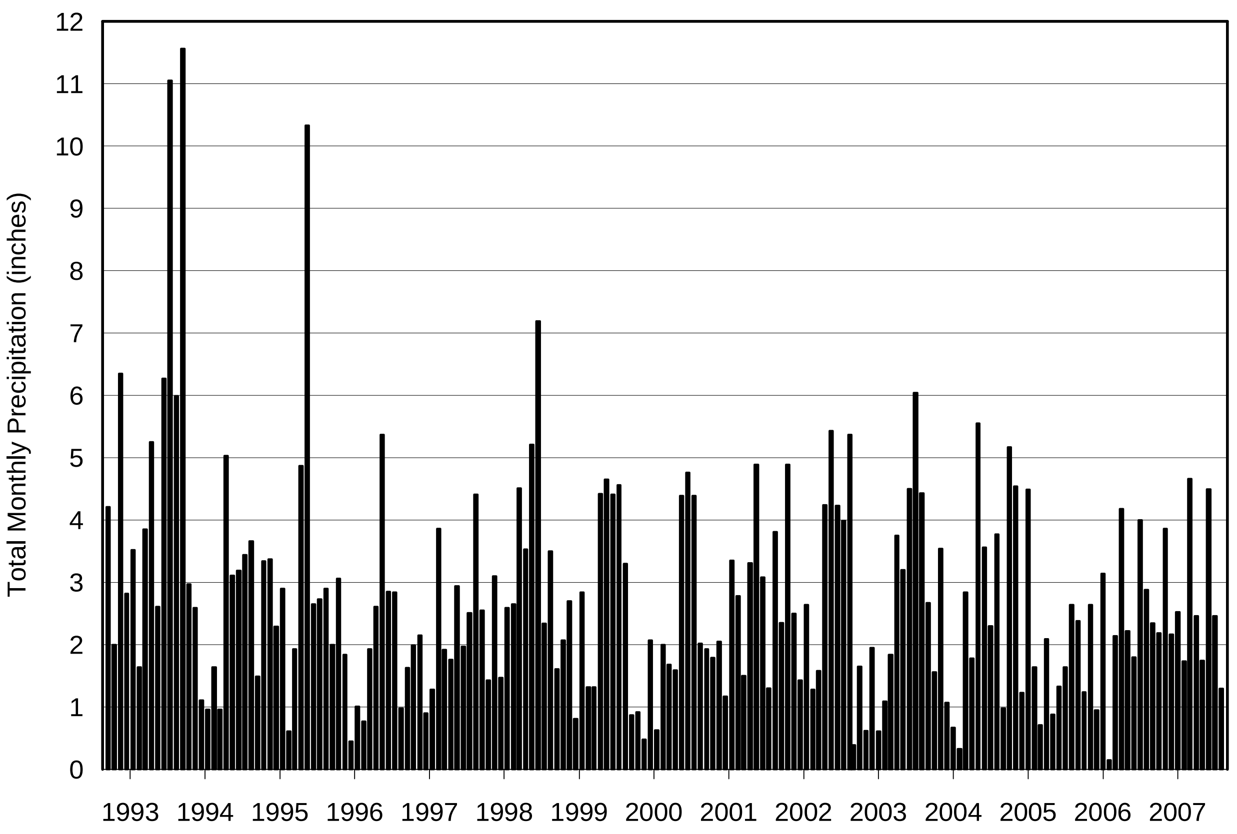


Figure 11. Network average monthly precipitation (inches), September 1992-August 2007

The storm recurrence frequency is the statistical probability of the recurrence of a storm with the reported precipitation (e.g., a 10-year storm would be expected to occur on average only once every 10 years at a given station, or have a 10 percent chance of occurring in any given year). The recurrence frequencies computed here are based on the total storm duration for the area. See Appendix I for further explanation. Also included in Appendix I is a table indicating the precipitation received at each of the 20 stations for each network storm period (Table I-3) for Year Fifteen. Sites that exceed the one-year or more recurrence frequency are indicated in bold type (Table I-3). Previous years of network storm periods can be found in Scott et al. (2002) and in Wehrmann et al. (2004, 2005).

In the first 14 years of network operation, 64 of the 1703 storm periods produced maximum precipitation at one or more stations with a recurrence frequency greater than one year: 50-year (1 storm), 10-year (3 storms), 5-year (8 storms), 2-year (34 storms), and greater than 1-year but less than 2-year (18 storms). The 50-year storm (storm 153) occurred on September 13, 1993 and the 10-year storms on May 16, 1995 (storm 323), May 8, 1996 (storm 432), and July 19, 1997 (storm 580). These four heaviest storms occurred during the warm season months (May-September).

Ten storms had a recurrence interval exceeding the one-year or greater recurrence frequency in 1992-1993, five in 1993-1994, six in 1994-1995, one in 1995-1996, three in 1996-1997, four in 1997-1998, four in 1998-1999, five in 1999-2000, and four in 2000-2001, eight in 2001-2002, seven in 2002-2003, five in 2003-2004, one in 2004-2005, and two in 2005-2006.

In Year Fifteen, four of the 100 network storm periods exceeded the one-year or greater recurrence frequency. Year Fifteen had a below average number of network storm periods and a near average number of heavy rainfall periods. One event exceeded the 5-year or more recurrence frequency. Three of the four Year Fifteen storm events were 1-year events with one occurring in June, one in July, and one in August. The 10-year event occurred on March 30, 2007 (storm 1754).

Groundwater Levels

Monthly Measurements

The long-term hydrograph at MTOW-1 (Snicarte) in Figure 12 provides a reference for comparison with the shorter records of the other network wells. The ISWS has recorded water levels in this well since 1958. Annual fluctuations from less than 1 foot to more than 6 feet have been observed. Based on the data we have available, these annual fluctuations often appear to be superimposed on longer term trends, perhaps 10 years or more. For the 49-year record, both the record low and high have been observed within the past 15 years. A detailed look at water levels since 1990 is shown in Figure 13. During and shortly after the drought years of 1988 and 1989, the water level fell to 40.5 feet below land surface from September 1989 until April 1990, the only time in its 45-year history that the well went dry, until it did so again in 2006. During the 1993 flood, groundwater levels rose almost 10 feet and peaked at approximately 30 feet in September 1993. In the years since then, groundwater levels in MTOW-1 show an almost linear decline until 1998, when water levels rose dramatically, recovering to peak levels similar to those observed in 1994 and 1995.

Groundwater levels in observation wells MTOW-5 and MTOW-9, because of their proximity to the Illinois River, have been found to fluctuate largely in response to river stage. Since these two monitoring wells are so strongly influenced by the Illinois River, the wells are not outfitted with data loggers and in the future will be measured infrequently. The rest of the monitoring well sites do not have monthly measurements taken because the data loggers have eliminated this need. The sites are visited as data loggers need servicing or as a need for data grows due to irrigation pumpage.

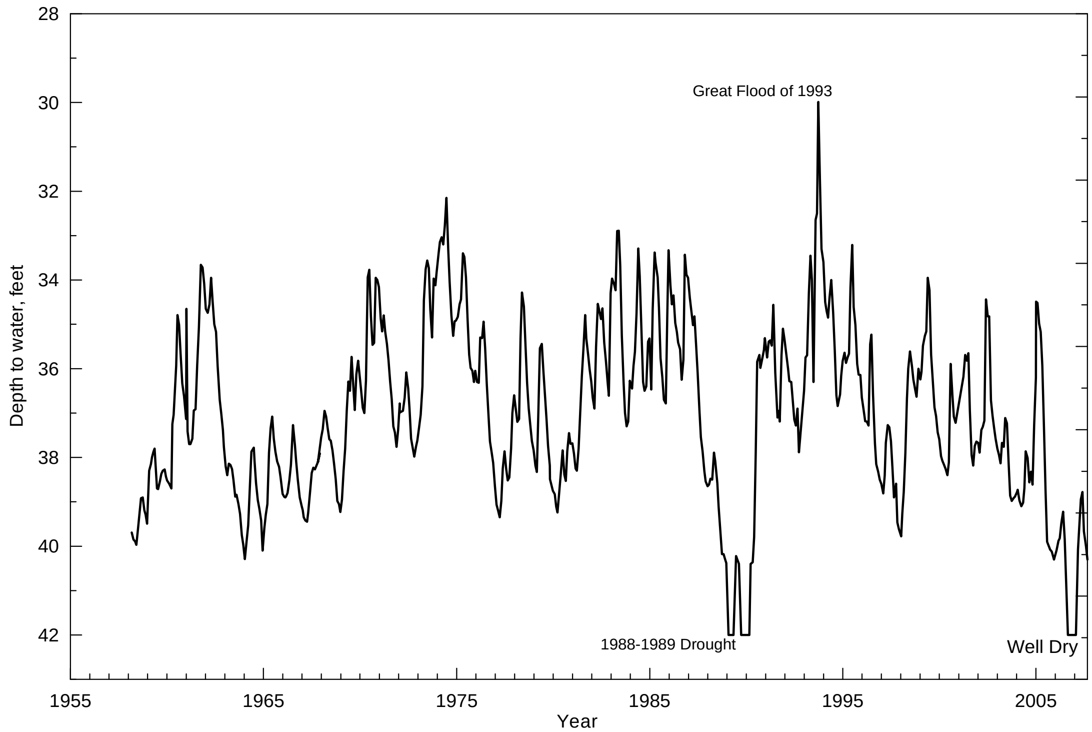


Figure 12. Groundwater levels at the Snicarte well, MTOW-1, 1958-2007

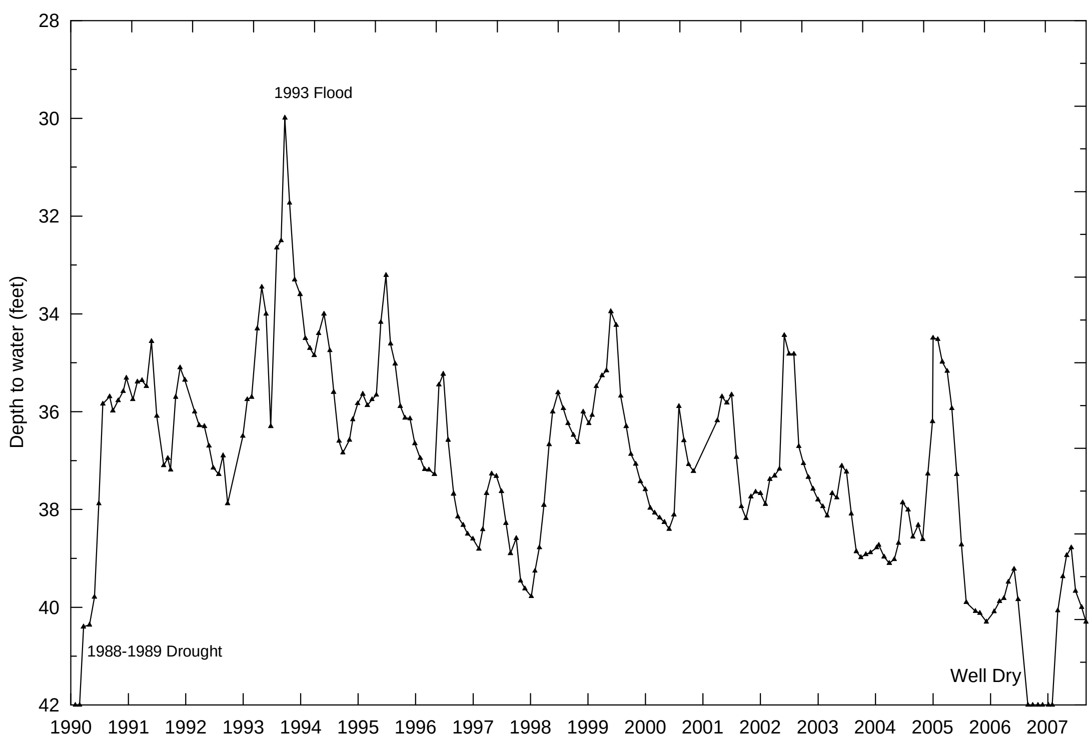


Figure 13. Groundwater levels at the Snicarte well, MTOW-1, 1990-2007

Over the course of the past few years, the study area has received below average rainfall. These below average precipitation totals coupled with irrigation withdrawals have affected groundwater elevations in the study area. This trend began in March 2005 when rainfall amounts fell below average and has continued overall since that time. During Year Thirteen, it was reported that groundwater levels were at or near the lowest levels since the study began, and for Year Fourteen, they had dropped below those levels. Year Fifteen does not seem to have offered any relief as groundwater elevations were still below normal (see the graphs in Appendix A).

Continuous Measurements

An analysis of the continuous record from the Snicarte well (MTOW-1) in the Year Eleven Report (Wehrmann et al., 2005) indicated that recharge often occurs within one to three days of the rainfall event and typically lasts three to five days after the rainfall event has ended. In other words, recharge occurs on a scale of days, not months after a precipitation event; thus using monthly water-level data to develop correlations with rainfall may not be meaningful. In response to this finding, during Year Twelve of the study, transducers were placed in the Green Valley (MTOW-8) and Route 136 Rest Area (MTOW-7) observation wells to begin collecting continuous water-level data. The data indicated that indeed recharge was evident two to three days after significant rainfall events at these wells.

Based on these results, the IVWA purchased 10 data loggers that were installed in wells between December 30, 2004 and August 2005. The hydrographs for these 10 loggers can be seen in Figures 14-23. Reviewing the groundwater-level data confirms that monthly hand measurements are not adequate for determining recharge events.

For Year Fifteen, the rainfall events were very evident as recharge at the Easton well (Figure 24). The rainfall event during late February/early March produced nearly 2 feet of recharge within approximately 14 days. Other recharge events were evident throughout this project year that produced similar results. However, recharge was not as pronounced during irrigation seasons that were drier and when water use was high. The May to August rainfall events showed this trend. On Figure 24 the nearly 2-inch rainfall event on July 17, 2007, caused less than 0.5 feet of recharge, while a similar rainfall event at the end of March produced nearly 1.5 feet of water level change. However, the rainfall events of May through August show that recharge was not as pronounced during the irrigation season when conditions were drier and water use was high.

Along with Easton, the hydrographs showing continuous water levels and daily rain gauge data for MTOW-12 and MTOW-07 are provided in Figures 25 and 26. Although the hydrographs showing the recharge following precipitation for the Hahn Farm and Rest Area are not as dramatic as at Easton, the information they provide is just as vital.

We anticipate that as more data are collected, recharge events will be evident on the water level hydrographs. The relationship of depth to water and distance from a stream, and their effect on the amount of recharge, will be more identifiable and quantifiable.

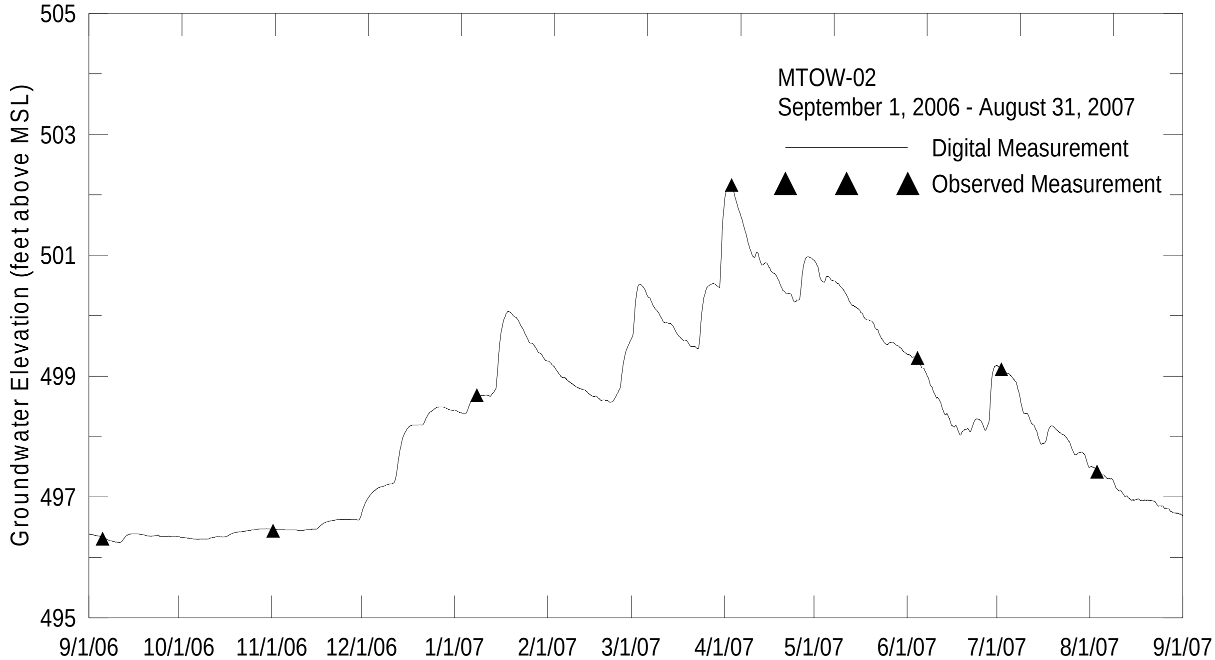


Figure 14. Groundwater levels for the Easton well (MTOW-2)

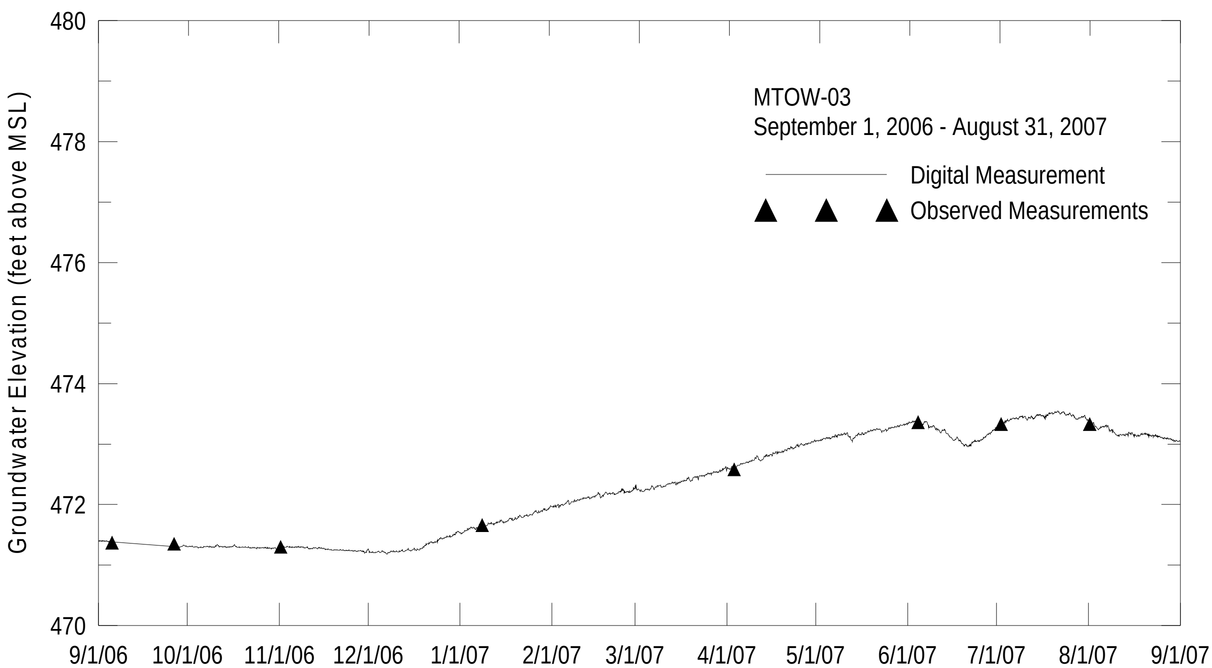


Figure 15. Groundwater levels for the Wildlife Refuge (MTOW-3)

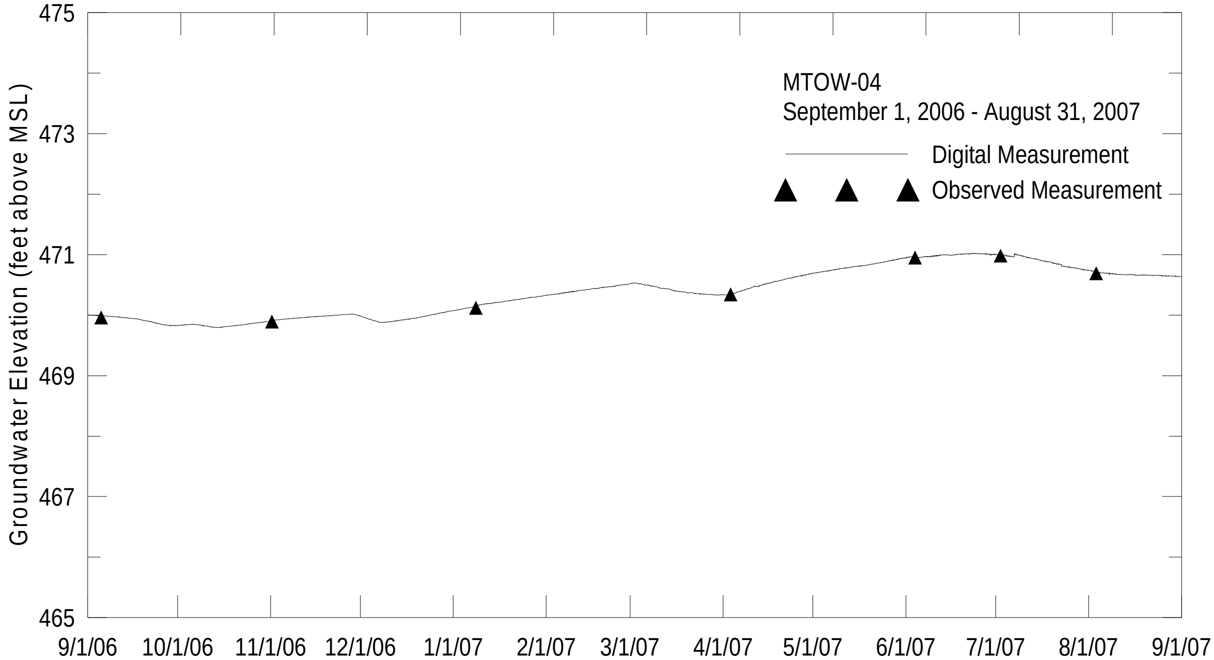


Figure 16. Groundwater levels for the Sand Ridge well (MTOW-4)

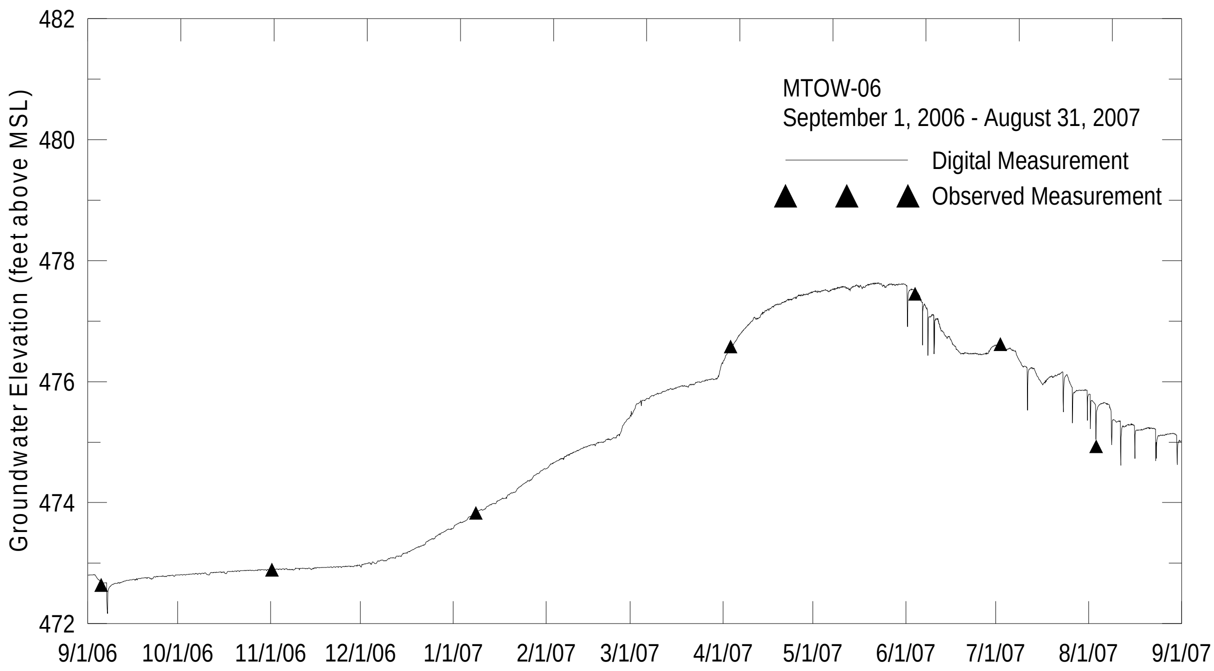


Figure 17. Groundwater levels for the Mason State Tree Nursery well (MTOW-6)

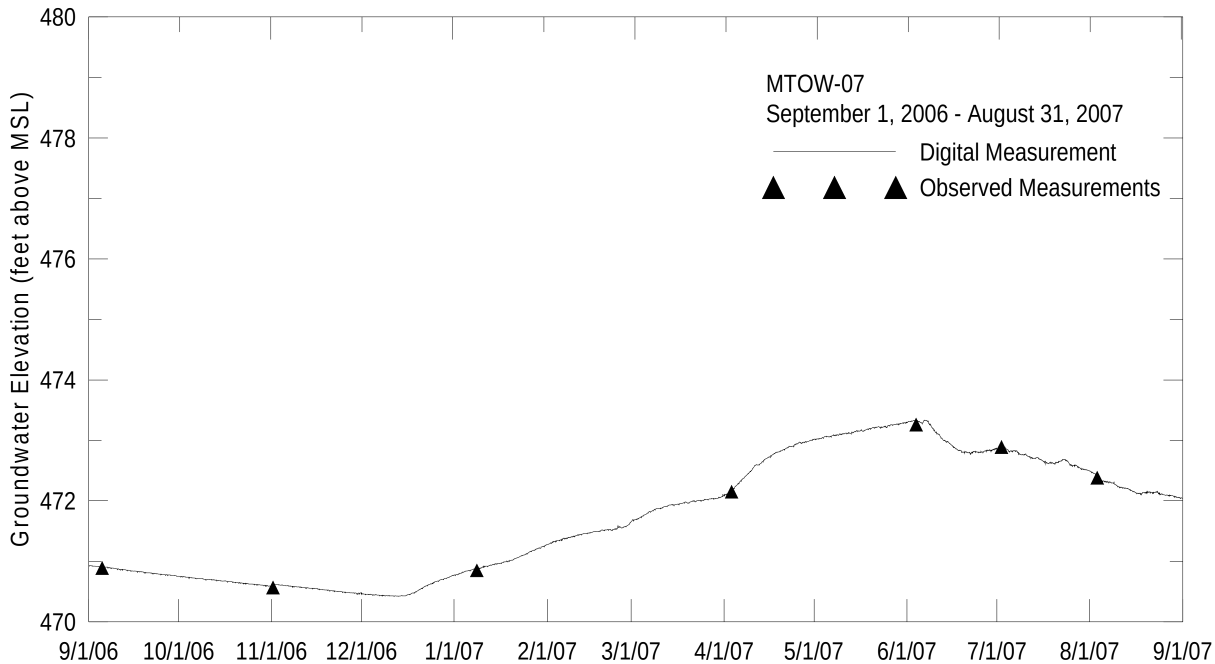


Figure 18. Groundwater levels for the Rest Area well (MTOW-7)

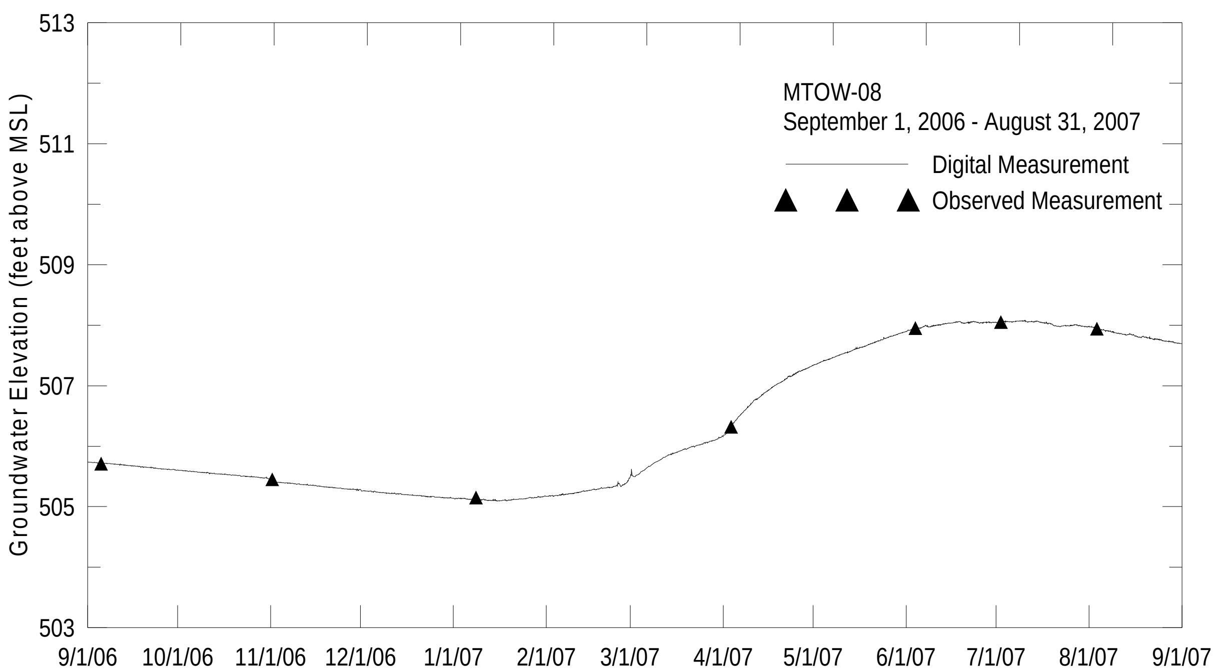


Figure 19. Groundwater levels for the Green Valley well (MTOW-8)

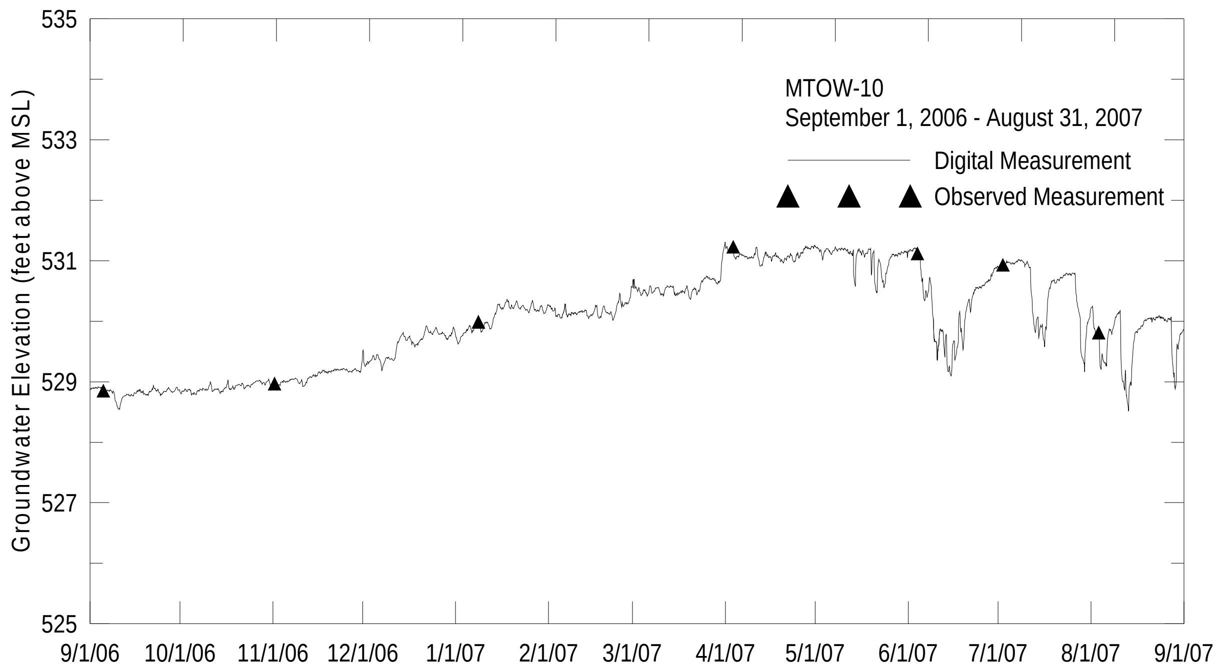


Figure 20. Groundwater levels for the San Jose well (MTOW-10)

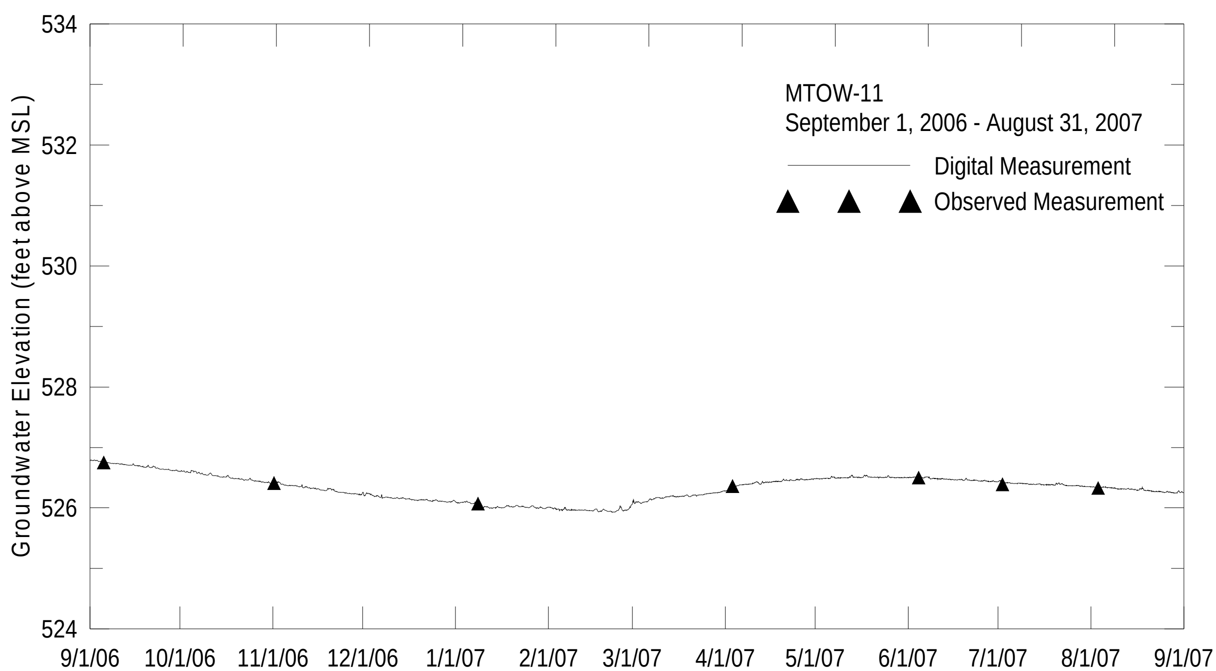


Figure 21. Groundwater levels for the Mason City well (MTOW-11)

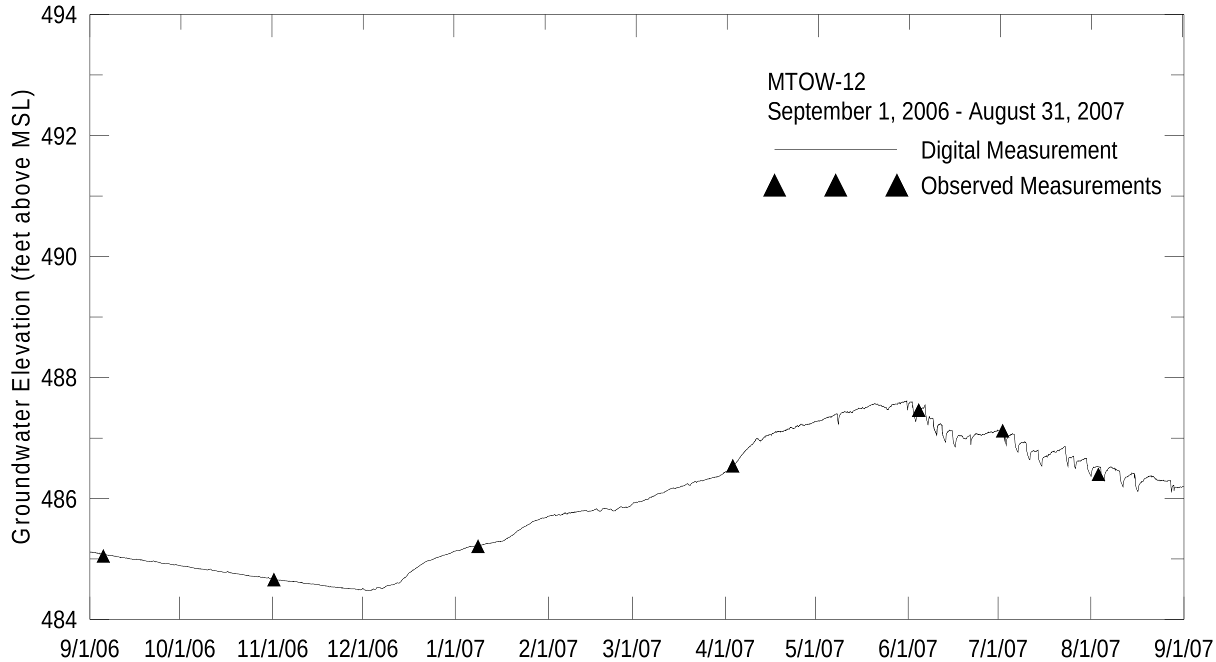


Figure 22. Groundwater levels for the Hahn Farm well (MTOW-12)

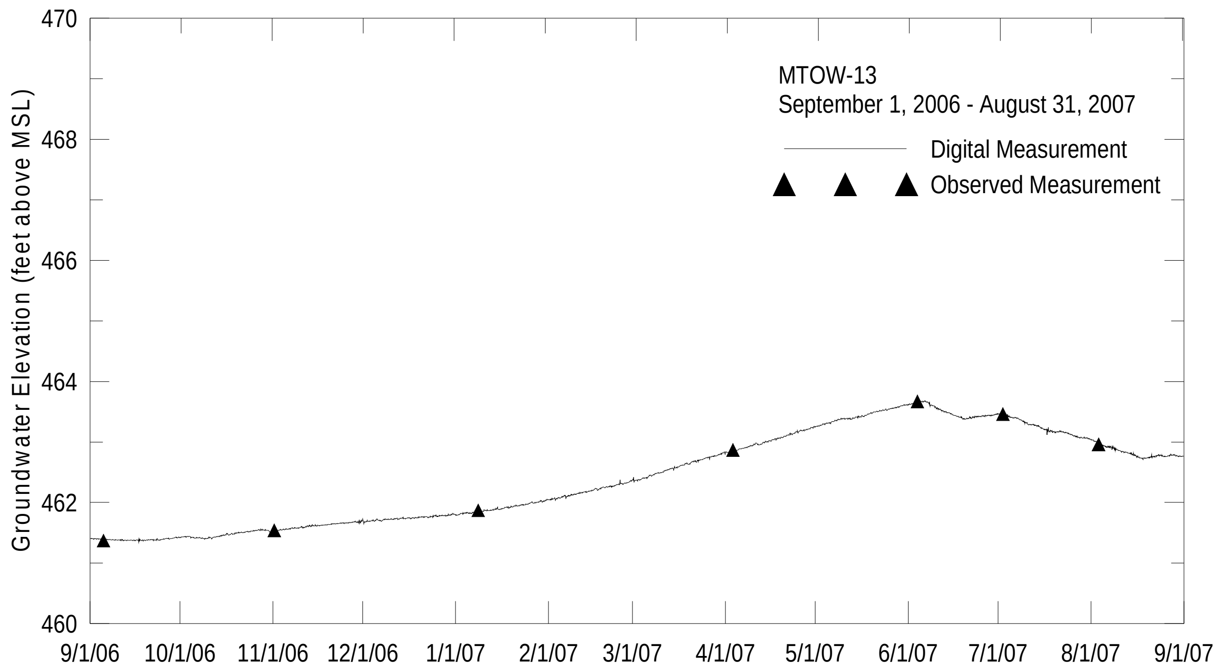


Figure 23. Groundwater levels for the Talbott Tree Farm well (MTOW-13)

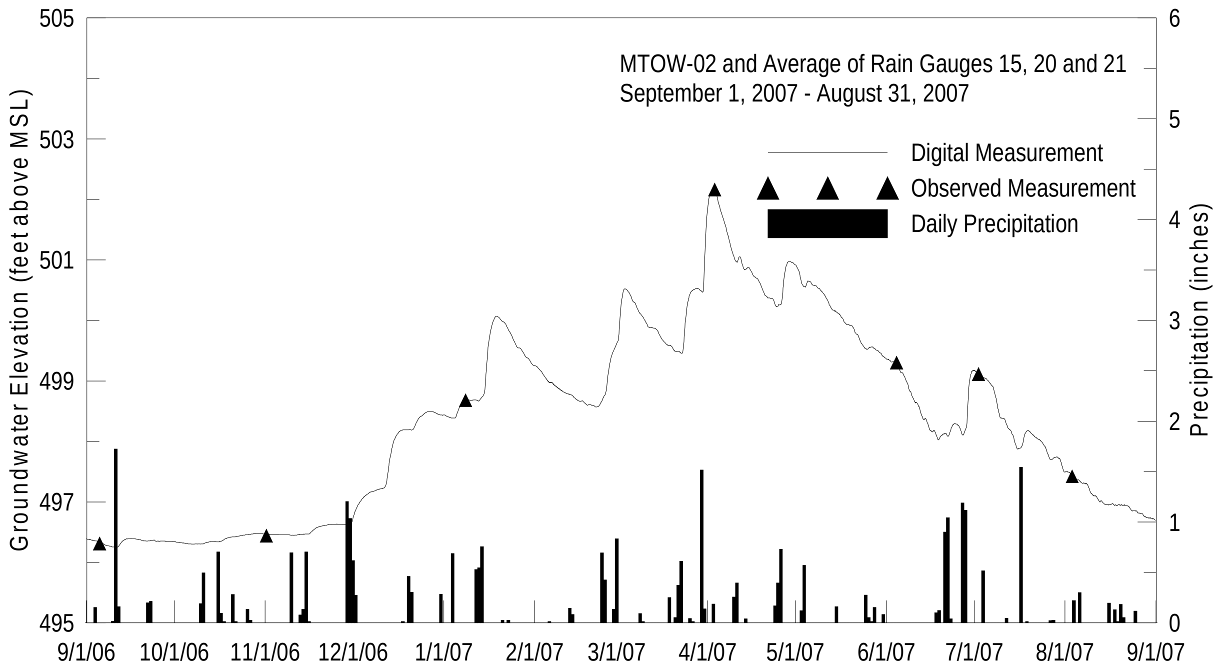


Figure 24. Groundwater elevations and precipitation at the Easton well (MTOW-2)

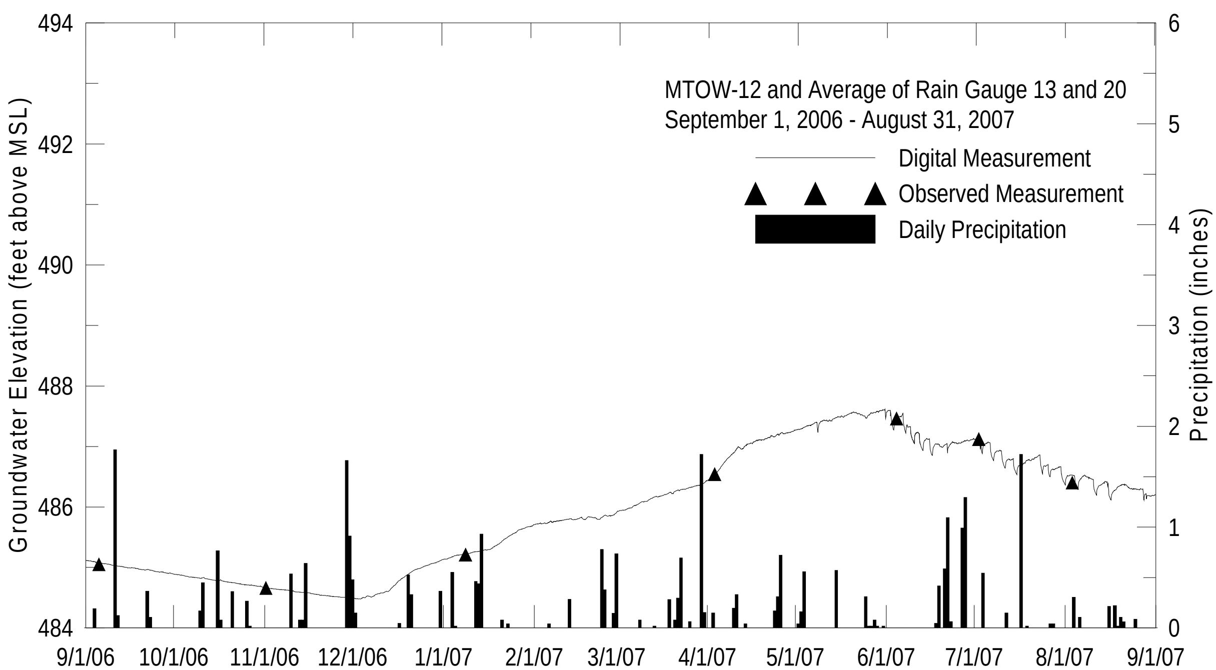


Figure 25. Groundwater elevations and precipitation at the Hahn Farm well (MTOW-12)

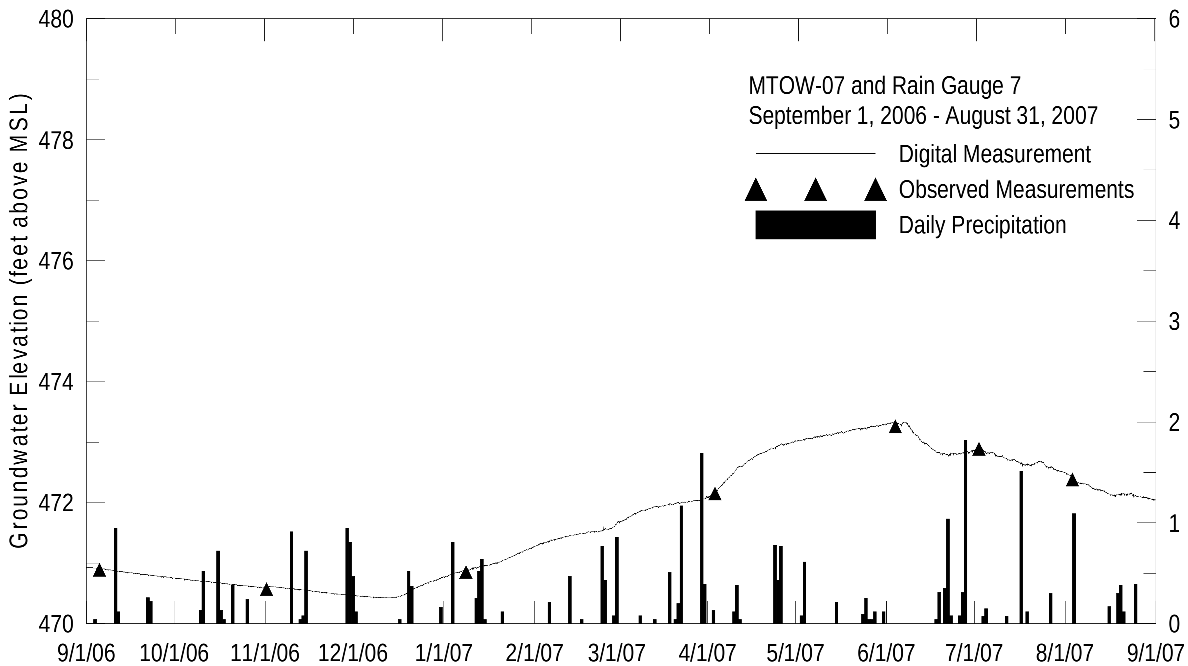


Figure 26. Groundwater elevations and precipitation at the Rest Area well (MTOW-7)

Irrigation Water Use

For Year Fifteen, the low precipitation early in the summer of 2007 affected irrigation, but not as dramatically as in 2005. Irrigation in June was the highest June pumpage for the length of the study. Total irrigation pumpage in 2007 was approximately 57 billion gallons (bg), which is the second highest irrigation amount, second only to the 72 bg pumped in 2005.

Monthly and seasonal estimates of irrigation withdrawals are shown in Table 5. These data were calculated for the Imperial Valley by previously described methods. Total annual irrigation withdrawals, from highest to lowest, are as follows: 2005, 2007, 1996, 2006; 2001 and 2002 (equal); 2003; 2004; 1999; 1997 and 1995 (equal); and 1998 and 2000 (equal). Typically, irrigation withdrawals are greatest in July and August; September and June withdrawals are much less. Though more irrigation systems are added each year, the influence of rainfall during the irrigation season is the primary factor in determining the amount of irrigation that takes place.

The estimated monthly irrigation pumpage is displayed graphically in Figure 27 along with average monthly network precipitation. These pumpage values show a tendency for lower irrigation amounts during times of greater precipitation and vice versa, but also show that irrigation is dependent on the timing of precipitation. For example, only 30 bg were pumped in 2000 (Year Eight), even though Year Eight showed a deficit of 9.5 inches (Table 6). This was because significant precipitation fell during the summer of 2000, reducing the need for irrigation. Year 15 was only the ninth driest year of network operation, but rnaked second highest for irrigation pumpage because the summer months were so dry (i.e., May, July and August received less than 67 percent of their respective average monthly precipitation). The influence of the reduced rainfall is evident in both the increased amount of water withdrawn for irrigation and in lower groundwater levels throughout the study area. Table 6 also shows that for 10 of the past 12 years, rainfall has been below the 30-year (1971-2000), historical average of 36.76 inches (average of Havana and Mason City), although the timing of rainfall during the growing season has the most impact on the amount of irrigation withdrawals.

Table 5. Estimated Monthly Irrigation Withdrawals (billion gallons), Number of Irrigation Systems, Withdrawal per System, and Withdrawal Rank

Year	*June*	*July*	*August*	*September*	*Total*	*# Systems*	*BG/system*	*Rank*
1995	2.6	14	10	11	38			10
1996	2.0	20	18	12	52			3
1997	2.6	19	14	2.0	38			10
1998	2.1	7.8	13	6.9	30	1622	.018	12
1999	2.8	18	12	6.0	39	1771	.022	9
2000	6.4	6.0	12	5.6	30	1799	.017	12
2001	4.4	21	17	5.0	47	1818	.026	5
2002	3.4	24	16	3.7	47	1839	.026	5
2003	4.1	16	15	10	46	1867	.025	7
2004	5.3	12	19	5.7	42	1889	.022	8
2005	15	29	23	4.8	72	1909	.038	1
2006	7.2	22	16	5.2	50	1940	.026	4
2007	16	17	19	4.9	57	1971	.029	2
Average	5.7	17	15	6.4	45			

Note:
Total annual withdrawal may differ from sum of monthly withdrawals due to rounding error. Also, data regarding the number of systems in 1995-1997 are unavailable.

Table 6. Average Annual Precipitation, Annual Precipitation Surplus, Running Surplus, and Ranked Annual Precipitation and Irrigation, Imperial Valley Network

September-August period	*Network average precipitation (in.)*	*Annual surplus (in.)*	*Running surplus (in.)*	*Rank*	
				Precip.	*Irrigation*
1992 - 1993	55.55	+18.79	+18.79	1	-
1993 - 1994	40.21	+3.45	+22.24	2	-
1994 - 1995	39.42	+2.66	+24.90	5	10
1995 - 1996	25.70	-11.06	+13.84	15	3
1996 - 1997	27.31	-9.45	+4.39	13	10
1997 - 1998	40.06	+3.30	+7.69	3	12
1998 - 1999	34.02	-2.74	+4.95	6	9
1999 - 2000	25.81	-10.95	-6.00	14	12
2000 - 2001	30.97	-5.79	-11.79	8	5
2001 - 2002	39.91	+3.15	-8.64	4	5
2002 - 2003	30.06	-6.70	-15.34	9	7
2003 - 2004	29.64	-7.12	-22.46	10	8
2004 - 2005	27.34	-9.42	-31.88	12	1
2005 - 2006	27.74	-9.02	-40.90	11	4
2006 - 2007	31.94	-4.82	-45.72	7	2

1971-2000 30-yr average 37.82 (Havana)
1971-2000 30-yr average 35.70 (Mason City)
1971-2000 30-yr average 36.76 (average of Mason City and Havana used to determine surplus)

Note: Site 16 was excluded from network average computations from 1996-1997 through 2001-2002.

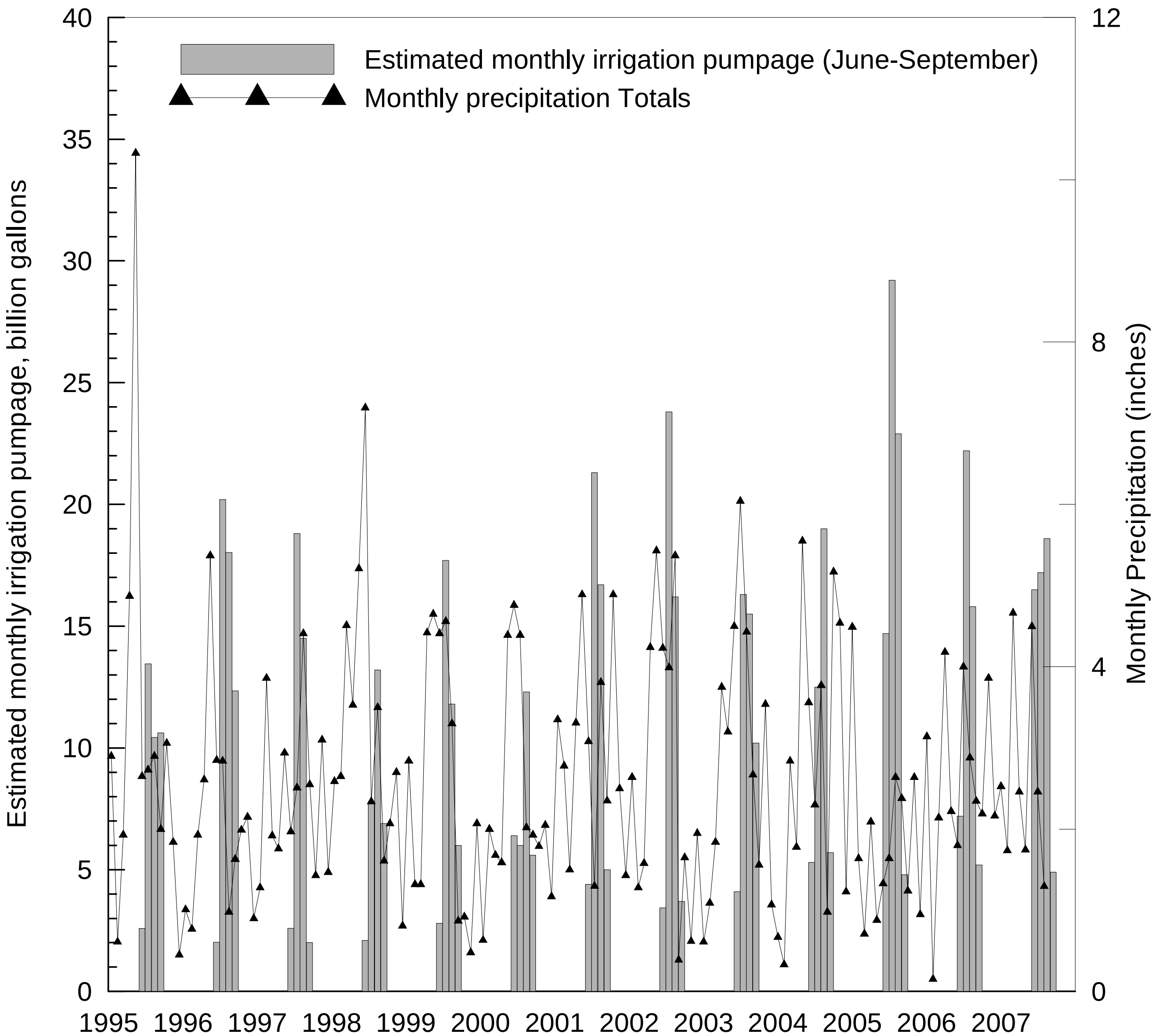


Figure 27. Estimated irrigation pumpage and average monthly precipitation, Imperial Valley

Summary

For Year Fifteen of the rain gauge network operation (September 2006-August 2007), the network received an average of 31.94 inches of precipitation, 1.90 inches less than the network 14-year average precipitation of 33.84 inches. For the year as a whole, precipitation was near average, although below average precipitation fell during the spring and summer seasons. Traditionally, groundwater levels tend to peak in most wells in the Imperial Valley during the spring and early summer, then decline in late summer and autumn when groundwater is evaporated and transpired back into the atmosphere by growing crops, and as a result of seasonal irrigation withdrawals. In Year Twelve, 2003-2004, some wells declined throughout the entire year, until showing a slight recovery in May 2004. For those wells, the highest water levels for the year were in September 2003. Therefore, the wetter-than-average autumn of 2004 brought about a marked increase in groundwater levels as the aquifer recovered from the previous dry weather. As a result of four relatively dry years, Year Eleven-Year Fourteen, groundwater levels have been decreasing since Year Twelve. Since February 2005, as rainfall again fell significantly below average, groundwater levels declined in most wells to the lowest levels recorded during the study. The Snicarte well, for example, went dry and prompted the decision to replace it with a deeper well nearby. Observations in 2007 have indicated limited recovery of water levels; but at their highest, these are still well below pre-2004 levels over most of the study area.

With the data gathered at the irrigation test site, a better understanding of the relationship among precipitation, pumpage, stream flow in Crane Creek, and groundwater levels has been developed. For the five years of observations at this site, we found that groundwater levels remained above the level of Crane Creek, even during periods of irrigation, which indicates that the system was discharging to the stream even during the summer under irrigation conditions. Water levels on both sides of Crane Creek was lower when the irrigation system is operating, which reduces groundwater discharge to the stream. However, water levels are not lower than the stream, so there was no reversal of flow from the stream. This data is being used as input to a computer flow model.

Ten pressure transducers installed at study wells have shown mixed results but indicate that the amount of rainfall, depth to water, and distance to a nearby stream all influence how quickly and to what extent groundwater levels rise in the aquifer after a precipitation event. The Easton well provides evidence that recharge is occurring over a fairly short time period (several days or less after a significant precipitation event). We expect to have more supporting data to analyze as more storm events of greater magnitude occur in the future.

Year Fifteen included the second highest irrigation withdrawal, even though it was only the ninth driest year of the study. This highlights the importance of rainfall timing on irrigation use.

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Appendix A. Hydrographs, Imperial Valley Observation Well Network

Appendix A. Hydrographs, Imperial Valley Observation Well Network

This appendix shows hydrographs of groundwater levels in each of the Imperial Valley observation wells. The hydrographs also include monthly precipitation totals from the nearest rain gauge or average of nearby gauges from the Imperial Valley rain gauge network, and Illinois River stage for wells near the river. The hydrographs maintain a common y-axis range (25 feet).

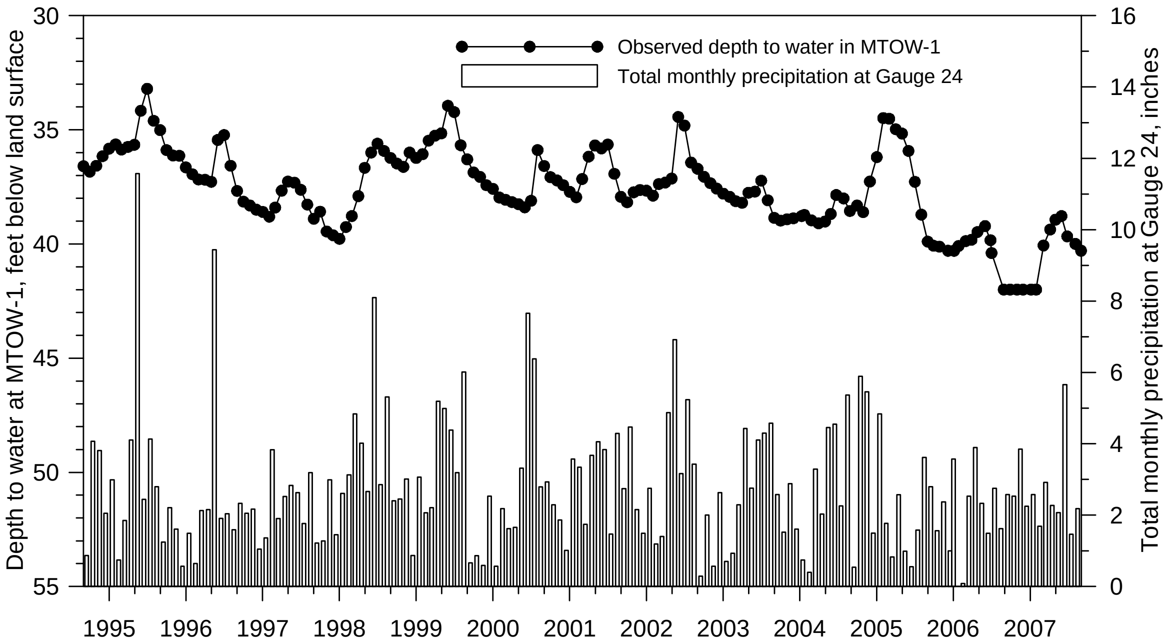


Figure A-1. Groundwater depth and precipitation for MTOW-1

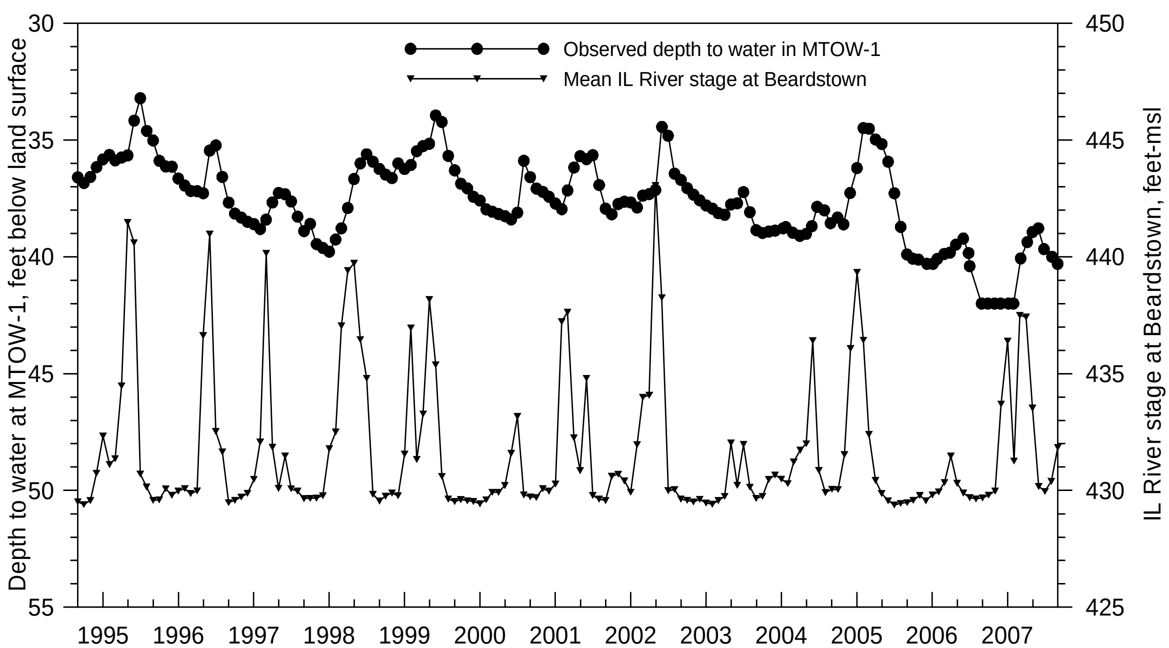


Figure A-2. Groundwater depth and Illinois River Stage for MTOW-1

Appendix A. (continued)

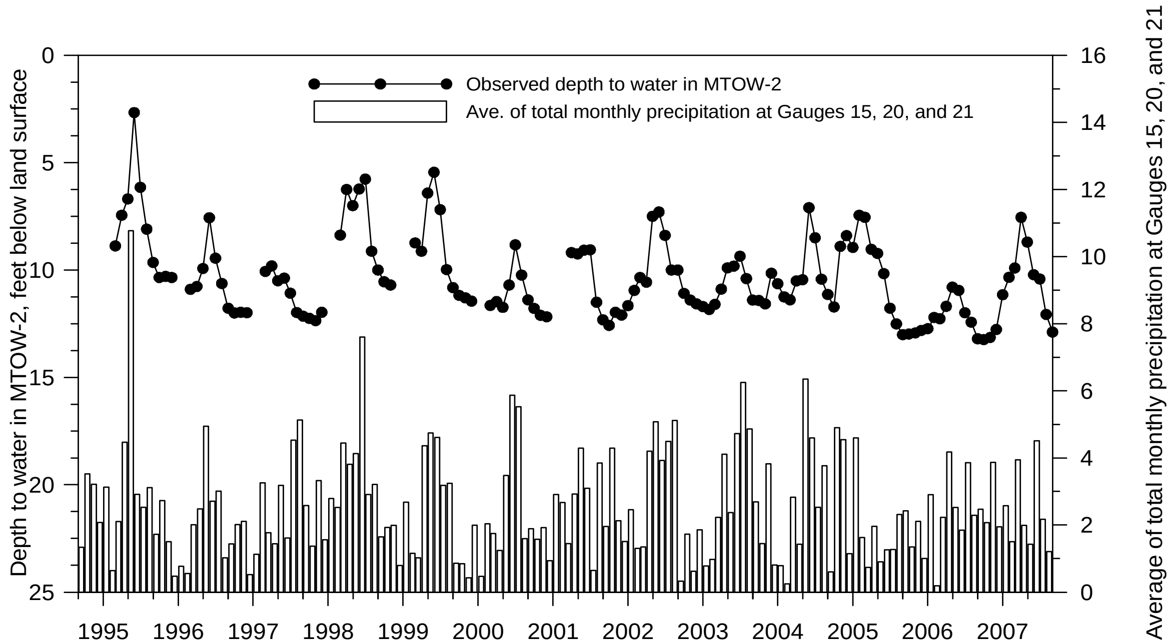


Figure A-3. Groundwater depth and precipitation for MTOW-2

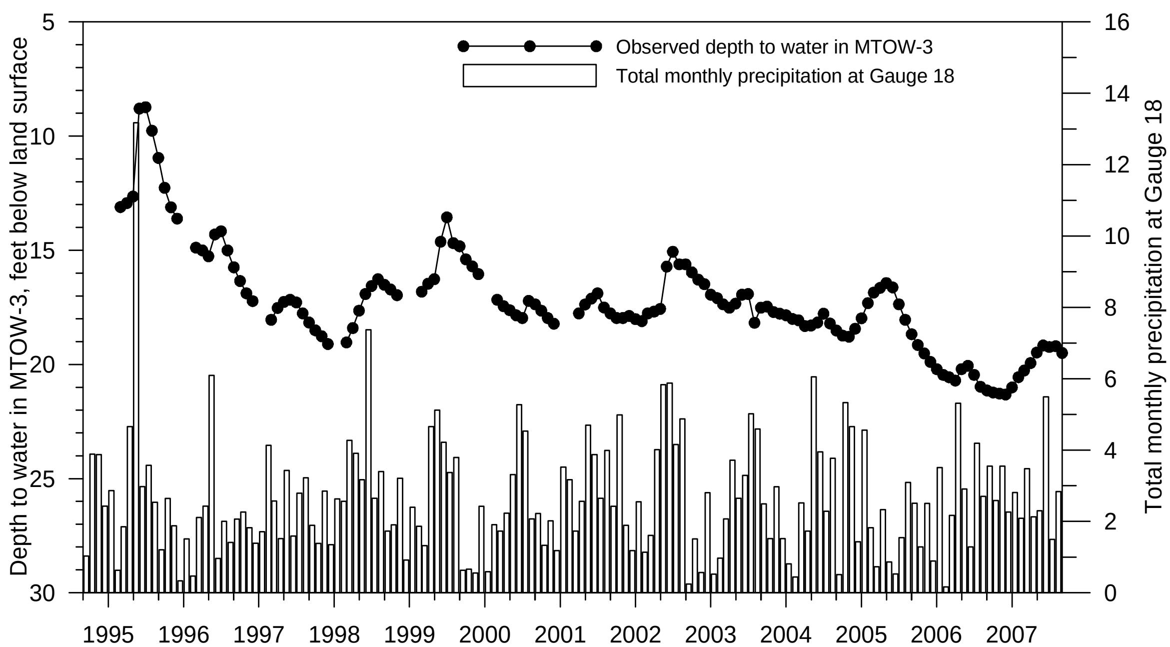


Figure A-4. Groundwater depth and precipitation for MTOW-3

Appendix A. (continued)

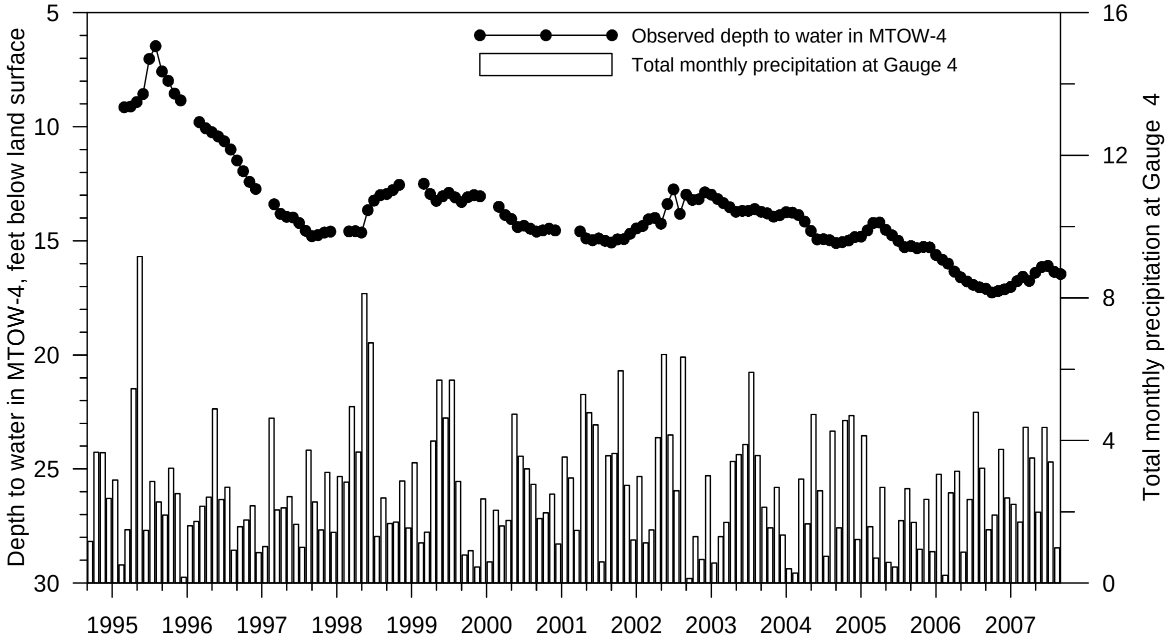


Figure A-5. Groundwater depth and precipitation for MTOW-4

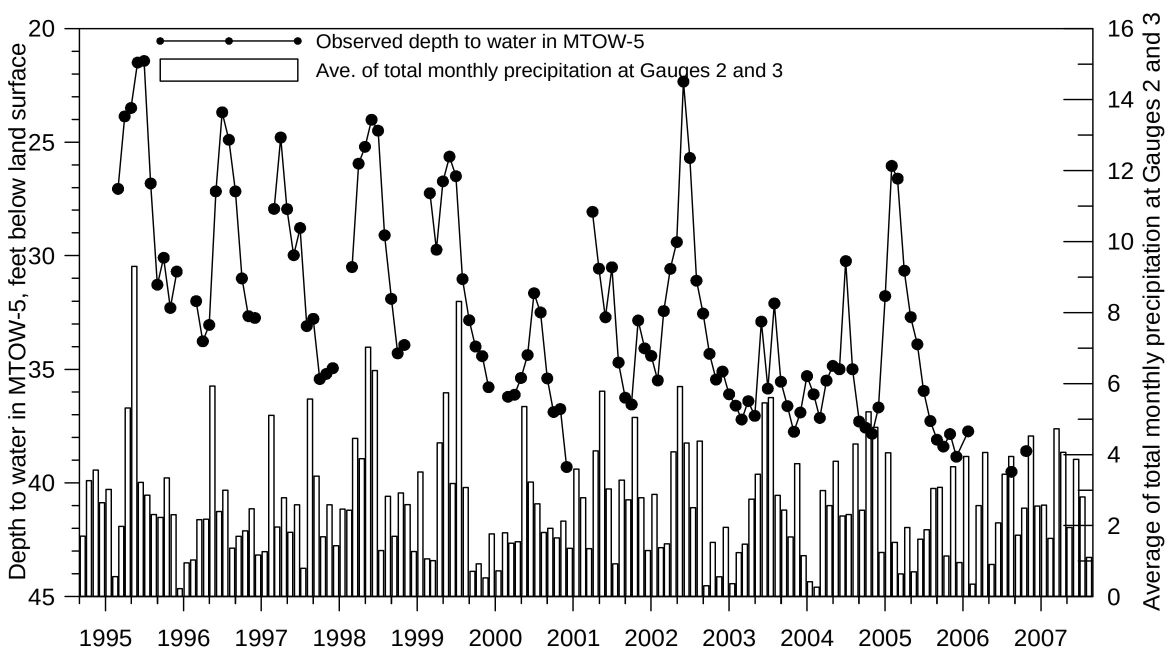


Figure A-6. Groundwater depth and precipitation for MTOW-5

Appendix A. (continued)

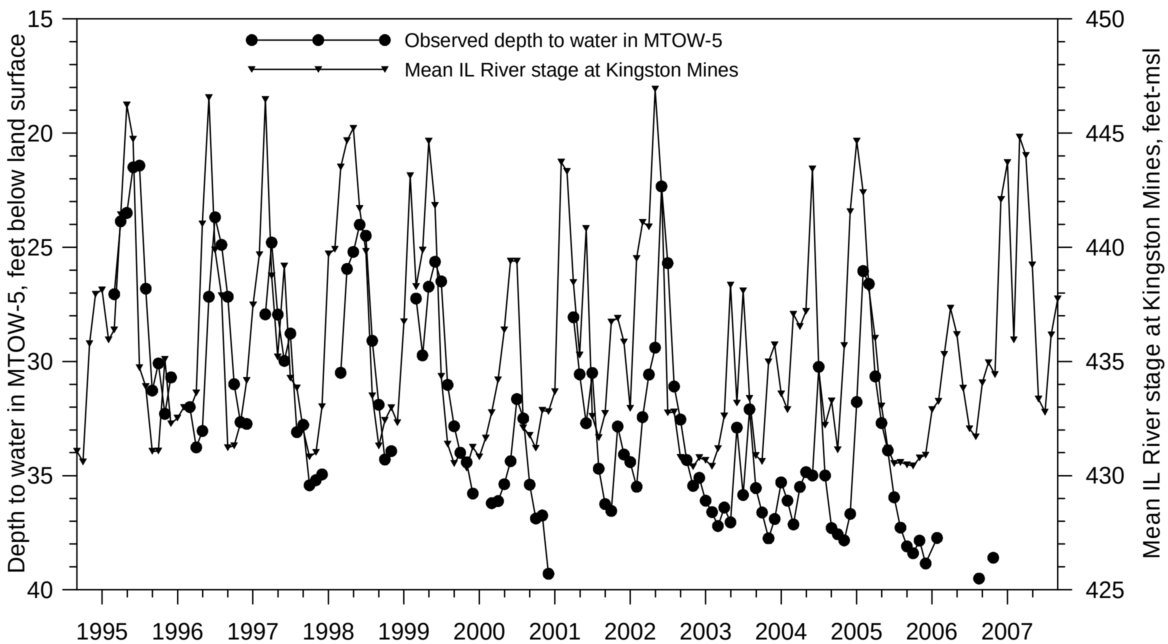


Figure A-7. Groundwater depth and Illinois River stage for MTOW-5

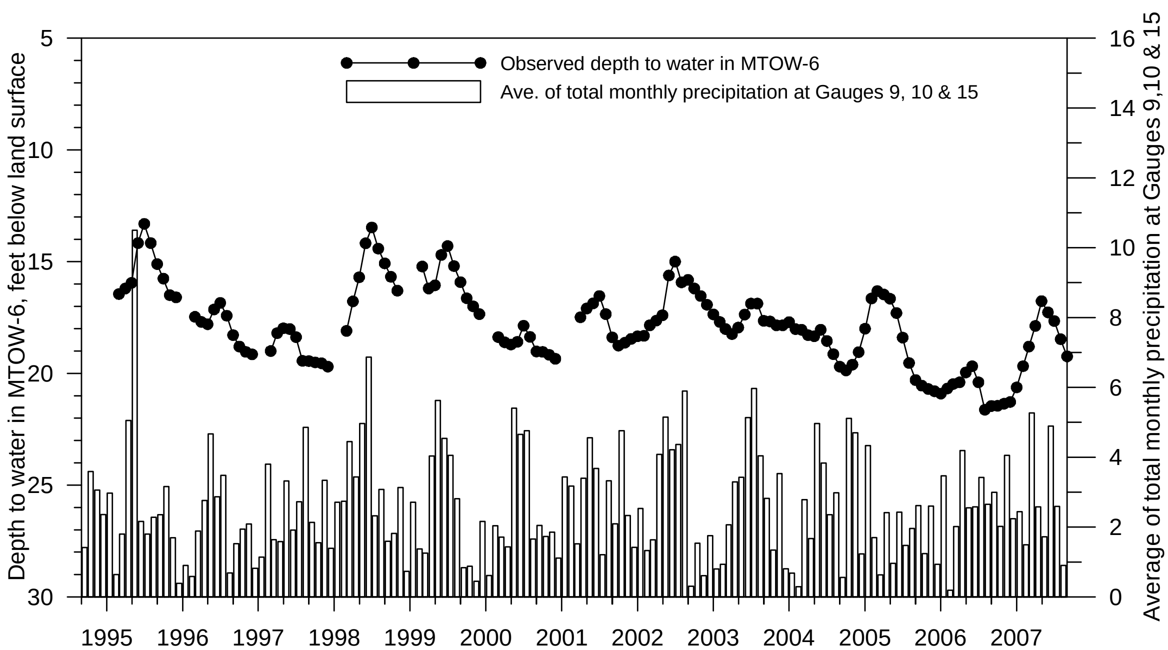


Figure A-8. Groundwater depth and precipitation for MTOW-6

Appendix A. (continued)

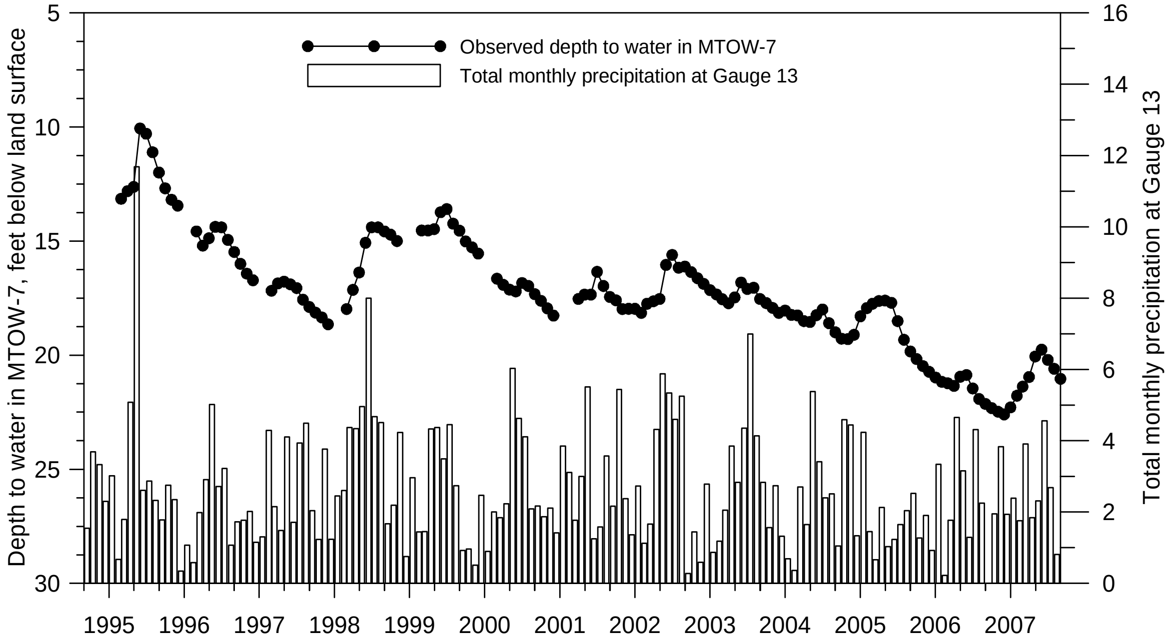


Figure A-9. Groundwater depth and precipitation for MTOW-7

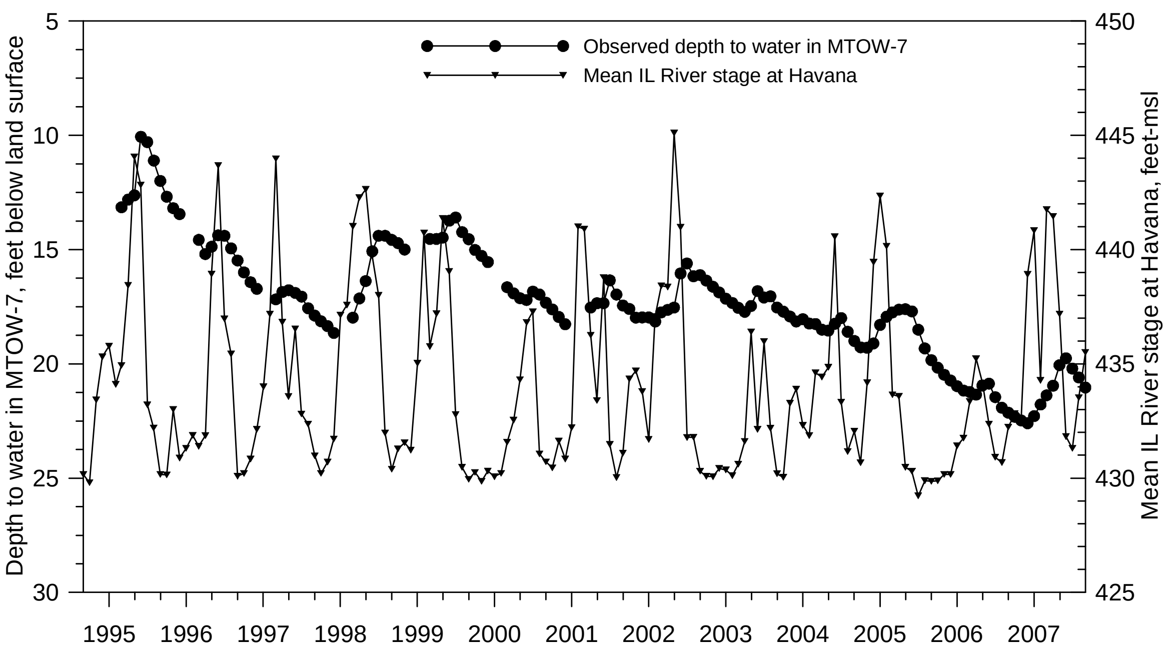


Figure A-10. Groundwater depth and Illinois River stage for MTOW-7

Appendix A. (continued)

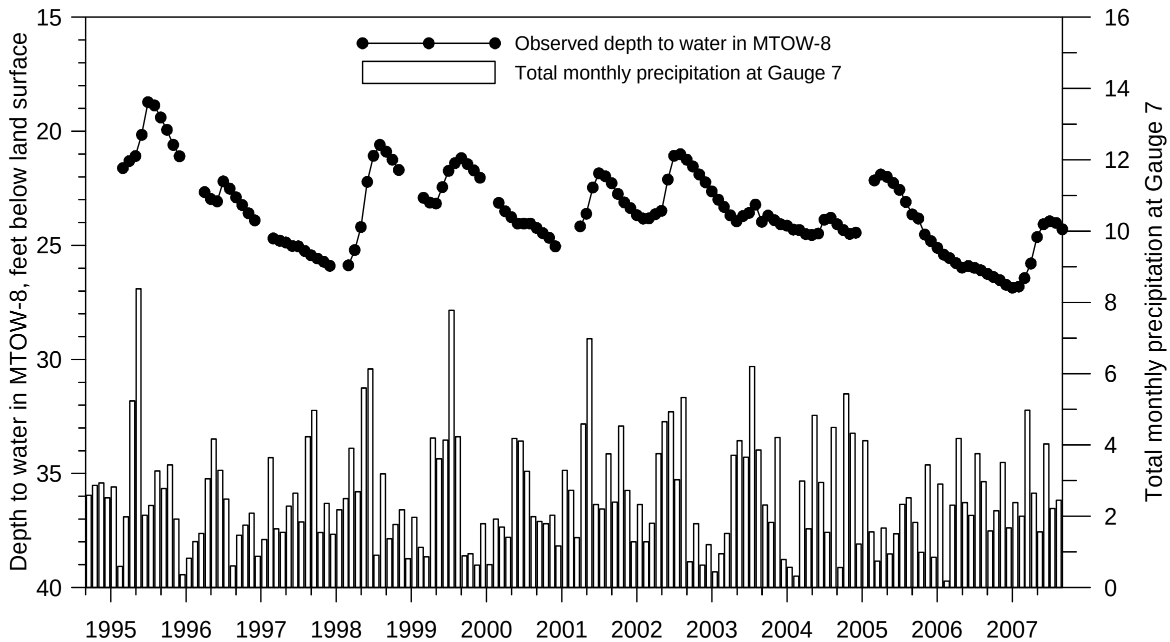


Figure A-11. Groundwater depth and precipitation for MTOW-8

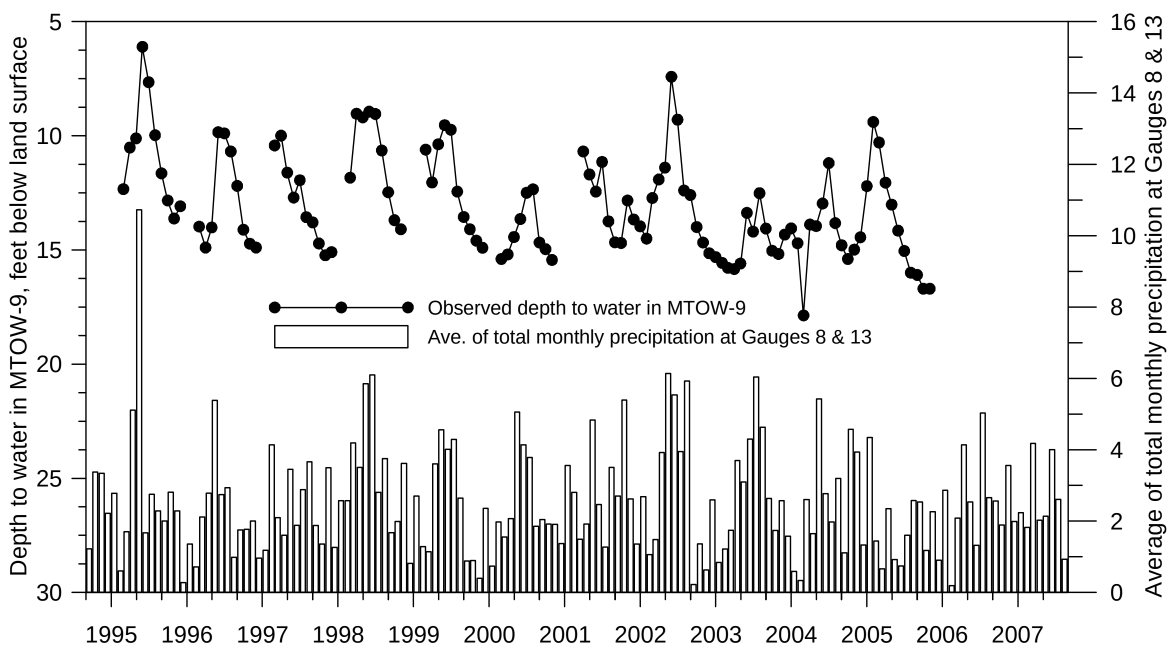


Figure A-12. Groundwater depth and precipitation for MTOW-9

Appendix A. (continued)

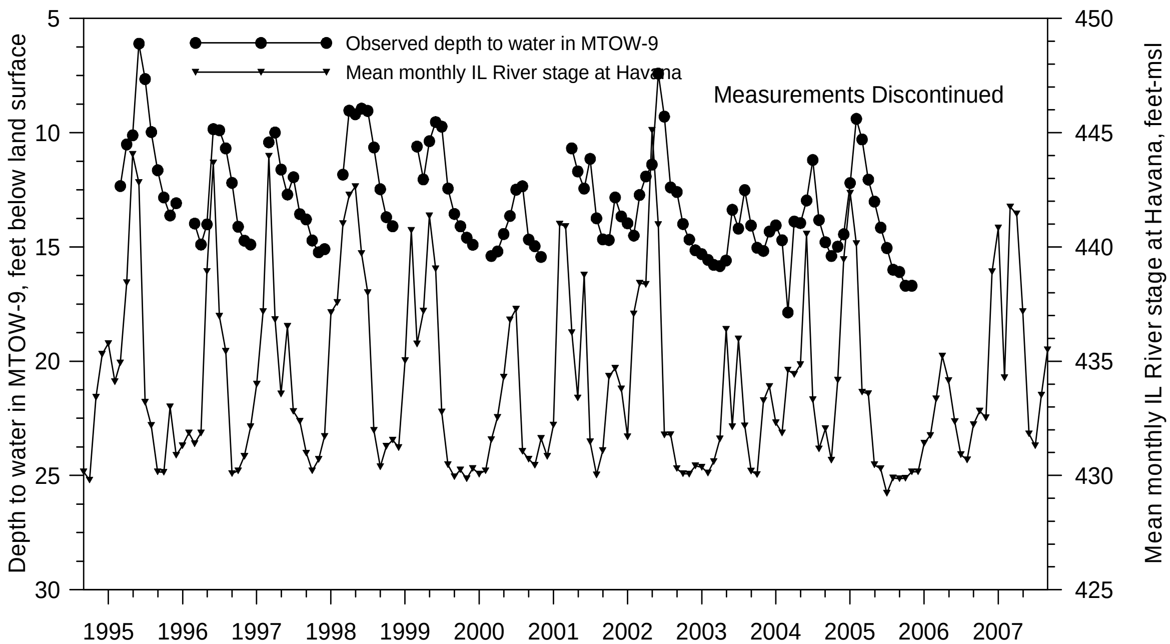


Figure A-13. Groundwater depth and Illinois River stage for MTOW-9

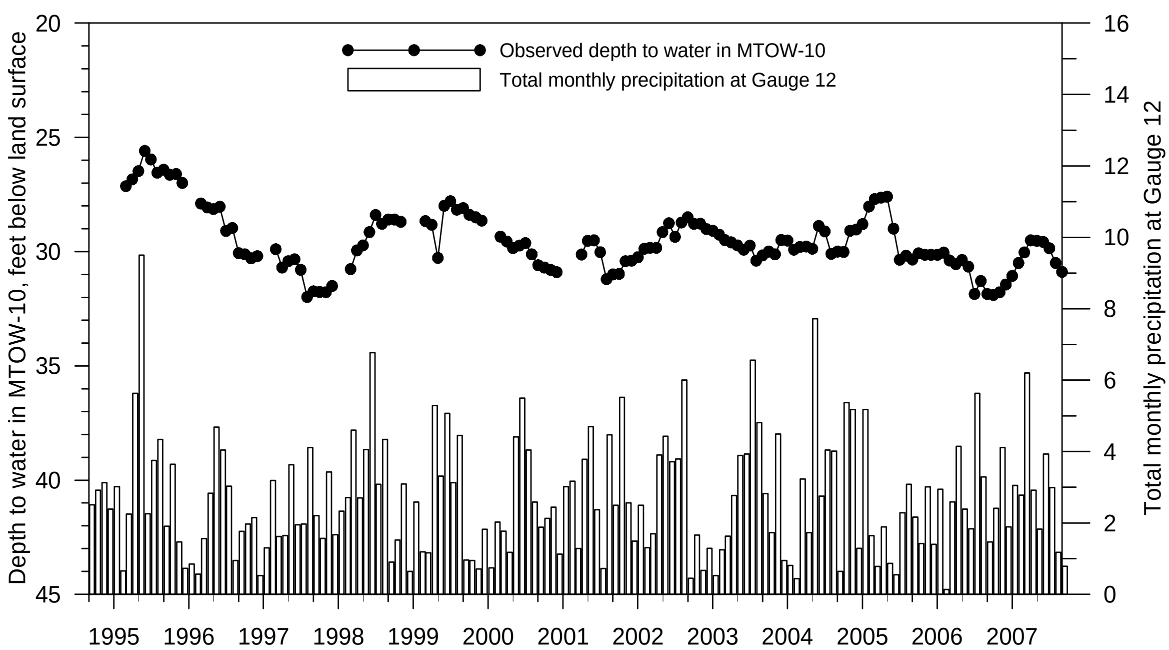


Figure A-14. Groundwater depth and precipitation for MTOW-10

Appendix A. (continued)

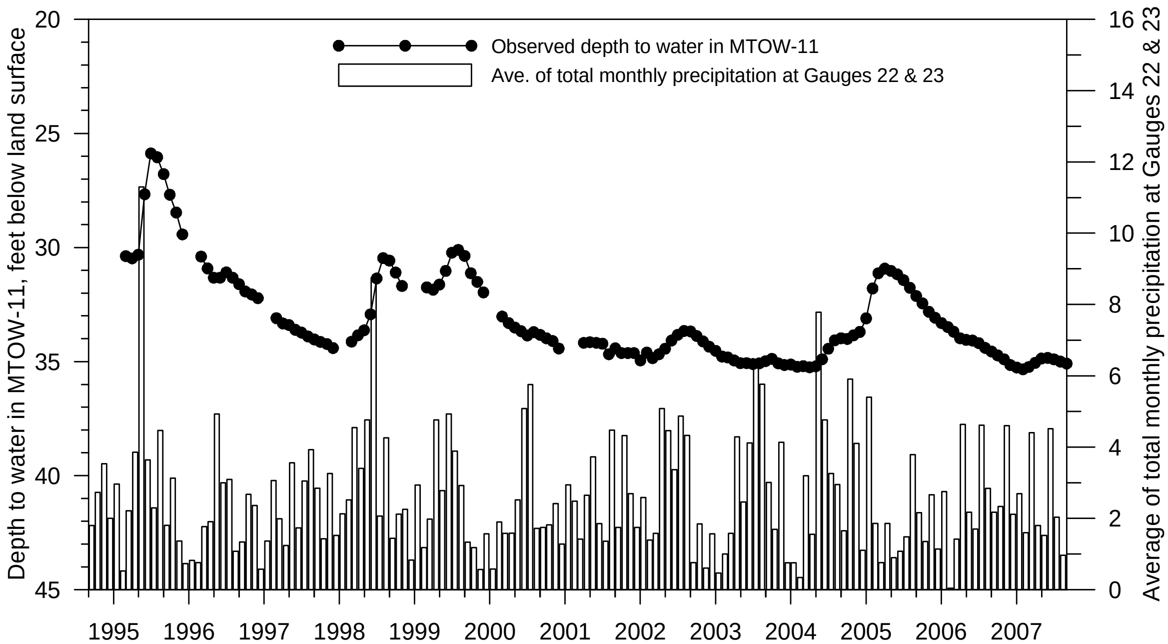


Figure A-15. Groundwater depth and precipitation for MTOW-11

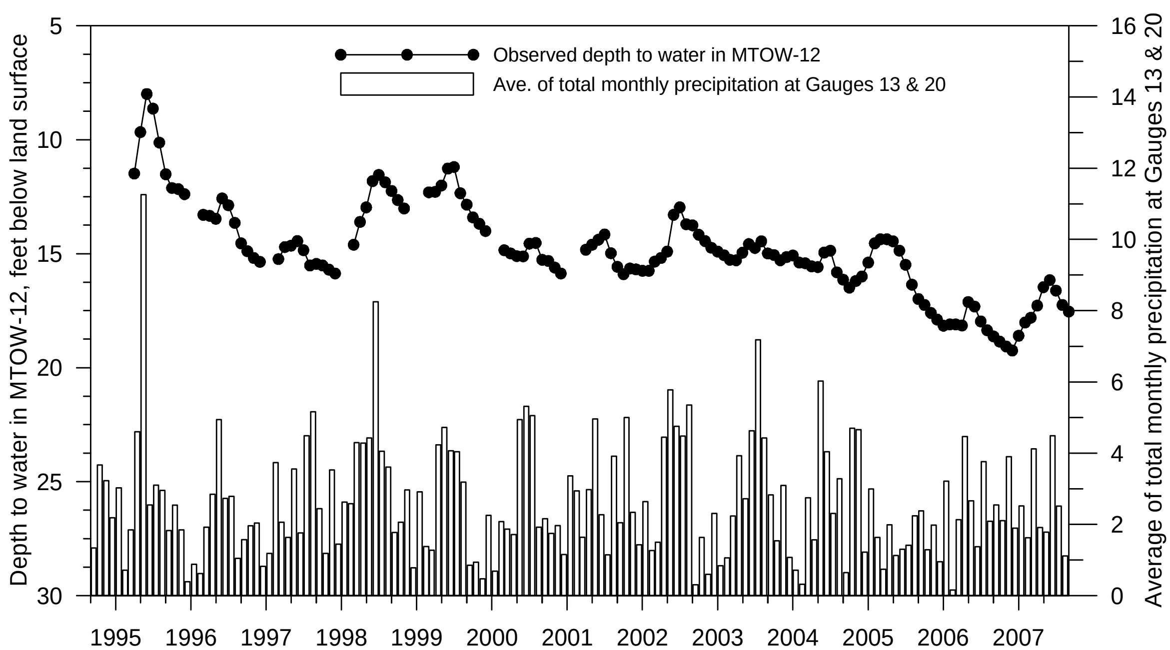


Figure A-16. Groundwater depth and precipitation for MTOW-12

Appendix A. (concluded)

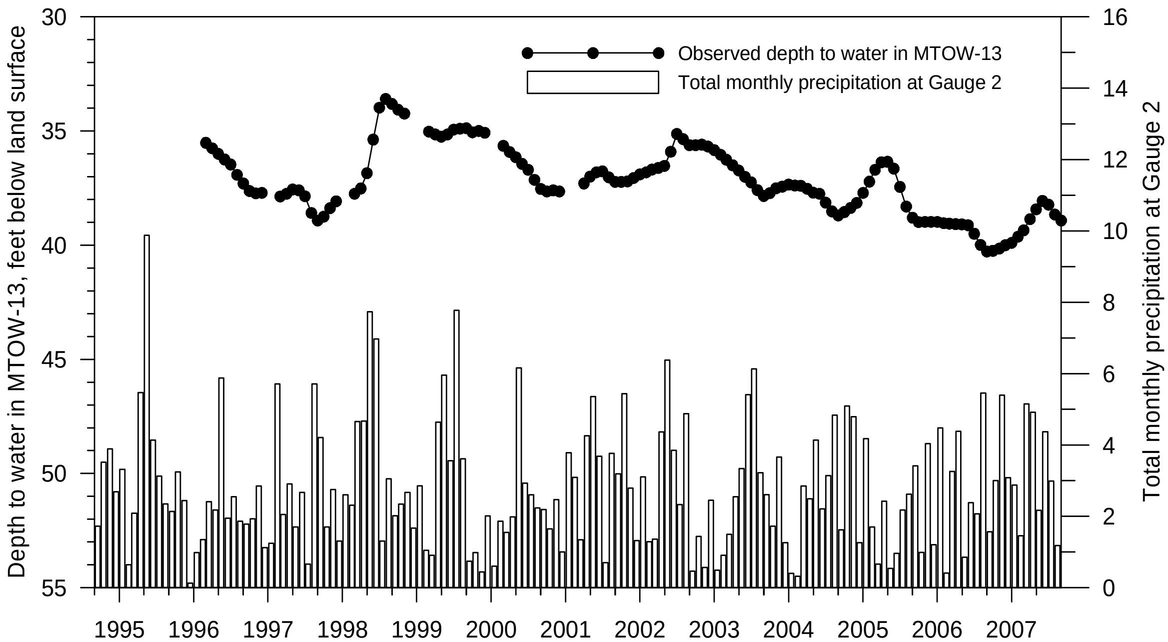


Figure A-17. Groundwater depth and precipitation for MTOW-13

Appendix B. Observed Groundwater Levels, Imperial Valley Observation Well Network, 2003-2007

Appendix B.

Depth to Water (feet below land surface) at Imperial Valley Network Observation Wells

Date	*MTOW-1*	*MTOW-2*	*MTOW-3*	*MTOW-4*	*MTOW-5*	*MTOW-6*	*MTOW-7*	*MTOW-8*	*MTOW-9*	*MTOW-10*	*MTOW-11*	*MTOW-12*	*MTOW-13*
9-01-2003	38.86	11.40	17.52	13.73	35.55	17.65	17.54	22.97	14.07	30.17	34.98	14.99	*37.85*
10-01-2003	*38.98*	11.42	17.47	13.80	36.62	17.68	17.72	23.70	15.04	30.00	34.88	15.06	37.72
11-01-2003	38.92	11.58	17.71	*13.94*	*37.75*	17.85	17.93	23.90	15.18	30.12	35.08	*15.29*	37.51
12-01-2003	38.88	10.15	17.78	13.88	36.90	17.85	*18.15*	*24.08*	14.33	29.50	*35.15*	15.15	37.44
1-01-2004	38.78	10.64	17.85	**13.75**	35.30	**17.71**	18.05	24.14	14.06	29.52	35.13	15.08	**37.35**
2-10-2004	38.73	11.25	18.01	13.77	36.10	18.02	18.24	24.31	14.71	29.92	35.23	15.39	37.39
3-01-2004	38.97	*11.39*	18.07	13.87	37.14	18.05	18.26	24.33	*17.87*	29.80	35.20	15.42	37.40
4-01-2004	*39.10*	10.51	*18.32*	14.16	35.50	18.29	18.51	24.51	13.89	29.78	*35.25*	15.56	37.53
5-01-2004	39.02	10.45	18.30	14.57	34.85	18.34	18.55	*24.55*	13.96	29.88	35.21	15.59	37.70
6-01-2004	38.69	**7.10**	18.17	14.94	35.00	18.05	18.25	24.49	12.97	**28.88**	34.90	14.95	37.75
7-01-2004	**37.86**	8.50	**17.78**	14.93	**30.24**	18.55	**18.00**	23.88	**11.20**	29.12	34.44	**14.87**	38.14
8-01-2004	38.01	10.43	18.21	14.98	35.00	19.14	18.60	**23.80**	13.83	*30.10*	34.07	15.82	38.52
9-01-2004	38.58	11.14	18.52	*15.10*	37.30	19.70	19.00	24.08	14.80	30.00	33.98	16.14	*38.70*
10-01-2004	38.98	11.72	18.74	15.06	37.57	*19.87*	19.28	24.33	15.40	30.02	34.01	*16.49*	38.55
11-01-2004	38.61	8.90	18.79	14.99	*37.84*	19.61	*19.30*	24.50	14.99	29.09	33.85	16.20	38.37
12-01-2004	n/a	8.40	18.44	14.84	36.68	19.05	19.11	24.45	14.45	29.04	**33.70**	16.00	38.15
1-01-2005	36.20	8.95	17.98	14.82	31.78	18.00	18.30	n/a	12.21	28.80	*33.11*	15.39	37.71
2-01-2005	**34.49**	**7.45**	17.32	14.55	**26.05**	16.65	17.94	n/a	**9.40**	28.03	31.80	14.55	37.22
3-01-2005	34.52	7.55	16.86	14.22	26.61	**16.32**	17.75	22.16	10.30	27.70	31.13	**14.37**	36.70
4-01-2005	34.98	9.04	16.65	**14.20**	30.66	16.47	17.63	**21.90**	12.06	27.64	**30.93**	**14.37**	36.37
5-01-2005	35.17	9.23	**16.44**	14.52	32.70	16.66	**17.61**	22.00	13.02	**27.60**	31.03	14.46	**36.35**
6-01-2005	35.93	10.17	16.63	14.76	33.90	17.30	17.71	22.27	14.16	29.00	31.18	14.87	36.65
7-01-2005	37.28	11.78	17.37	15.00	35.95	18.40	18.51	22.57	15.05	*30.36*	31.43	15.49	37.45
8-01-2005	*38.72*	*12.51*	*18.05*	*15.28*	*37.28*	*19.54*	*19.33*	*23.10*	*16.00*	30.18	31.77	*16.36*	*38.31*
9-01- 2005	39.90	*13.01*	18.68	15.23	38.10	20.30	19.84	23.65	16.10	30.35	32.13	16.99	38.80
10-01-2005	39.90	12.98	19.15	*15.33*	38.40	20.55	20.17	23.83	16.38	30.08	32.45	17.25	*38.99*
11-01-2005	40.08	12.93	19.52	15.27	37.85	20.70	20.48	24.53	*16.70*	30.14	32.82	17.60	38.98
12-01-2005	*40.12*	12.81	*19.89*	15.29	*38.85*	*20.80*	*20.73*	*24.82*	*16.70*	30.14	33.08	*17.89*	38.98
1-01-2006	40.30	*12.73*	**20.21**	15.62	n/a	n/a	20.98	n/a	n/a	30.14	**33.31**	18.16	**38.98**
2-01-2006	40.09	12.21	20.46	**14.83**	n/a	20.68	21.17	**25.41**	n/a	**30.05**	33.49	18.10	39.04
3-01-2006	39.88	12.27	20.56	16.00	n/a	20.48	21.23	25.56	n/a	30.39	33.69	18.10	39.06
4-01-2006	39.82	11.69	20.71	16.35	n/a	20.40	21.35	25.78	n/a	30.55	33.98	18.15	39.08
5-01-2006	39.48	**10.80**	**20.21**	16.60	n/a	19.96	20.95	25.98	n/a	30.37	34.05	**17.12**	39.09
6-01-2006	**39.22**	10.95	20.06	16.78	n/a	**19.68**	**20.87**	25.91	n/a	30.66	34.08	17.32	39.13
7-01-2006	39.84	11.99	20.46	16.93	n/a	20.40	21.46	25.99	n/a	*31.86*	34.19	17.97	39.50
8-01-2006	well dry	12.43	*20.98*	*17.04*	n/a	*21.63*	*21.92*	*26.10*	n/a	31.29	*34.40*	*18.36*	*39.99*
9-01-2006	well dry	13.20	21.14	17.10	n/a	21.46	22.14	26.25	n/a	31.86	34.56	18.63	*40.28*
10-01-2006	well dry	*13.24*	21.23	*17.27*	n/a	21.45	22.32	26.39	n/a	*31.90*	34.73	18.86	40.25
11-01-2006	well dry	13.14	21.28	17.20	38.60	21.36	22.48	26.53	n/a	31.78	34.90	19.07	40.15
12-01-2006	well dry	12.77	*21.32*	17.13	n/a	21.28	*22.60*	26.73	n/a	31.44	35.15	*19.25*	40.00

Appendix B. (concluded)

1-01-2007	well dry	11.15	21.01	17.02	n/a	20.63	22.29	*26.86*	n/a	31.07	35.26	18.60	39.90
2-01-2007	well dry	10.34	20.56	16.77	n/a	*21.68*	21.78	26.81	n/a	30.50	*35.34*	18.02	39.63
3-01-2007	40.07	9.91	20.27	16.58	n/a	18.80	21.38	26.44	n/a	30.04	35.24	17.81	39.35
4-01-2007	39.37	**7.55**	19.94	16.76	n/a	17.88	20.96	25.80	n/a	**29.51**	35.06	17.28	38.86
5-01-2007	38.94	8.70	19.48	16.40	n/a	**16.77**	20.06	24.64	n/a	29.53	34.87	16.47	38.43
6-01-2007	**38.78**	10.22	**19.17**	16.15	n/a	17.27	**19.76**	24.08	n/a	29.58	**34.84**	**16.16**	**38.06**
7-01-2007	39.84	10.42	19.24	**16.10**	n/a	17.66	20.21	**23.95**	n/a	29.86	34.90	16.62	38.23
8-01-2007	40.00	12.07	20.94	16.36	n/a	18.47	20.60	24.02	n/a	30.50	35.00	17.25	38.66

Note: **Bold** numbers are the shallowest groundwater levels for the calendar year; *italic* numbers are the deepest groundwater levels. Shaded areas distinguish between years.

Appendix C. Site Descriptions, Imperial Valley Rain Gauge Network

Appendix C. Site Descriptions, Imperial Valley Rain Gauge Network

This appendix contains site descriptions of each rain gauge site in the IVWA network as of August 31, 2007. Sites that have been relocated since the network was established in August 1992 are so noted in the "Placement" portion of their site description. Sites with shaded descriptions have been removed from the network.

SITE DESCRIPTION		
Site Number: 1		
County: Tazewell	Latitude: 40° 28' 3"	Longitude: 89° 50' 9"
Property Owner: Melvin Fornoff		
Address: 10200 Fornoff Road, Manito, IL 61546		
Telephone: 309-968-6653		
Permission Date: 8-10-92		
Installation Date: 8-25-92		
Gauge Mfrs. No.: 4695	Gauge ID No.: SWS 5068	
Placement: Near apple/pear trees, northeast of a garage. Property on east side of 450 E. in Tazewell County, north of 1000 N. Large dog. Gauge 15 meters northwest of lat/long reading. Station removed from the network in September 1995.		

SITE DESCRIPTION		
Site Number: 2		
County: Tazewell	Latitude: 40° 28' 42"	Longitude: 89° 45' 54"
Property Owner: Ken Becker		
Address: 8479 Townline Road, Manito, IL 61546		
Telephone: 309-545-2207		
Permission Date: 8-15-92		
Installation Date: 8-25-92		
Gauge Mfrs. No.: 4723	Gauge ID No.: SWS 5030	
Placement: Moved 30 ft to northeast in same yard on 8-13-07, about 15 ft east of a yard shed. In back yard (grass) near garbage burner. Property on south side of 1100 N. in Tazewell County, west of 900 E. Gauge 2 meters west of lat/long reading.		

Appendix C. (continued)

SITE DESCRIPTION		
Site Number: 3		
County: Tazewell	Latitude: 40° 28' 56"	Longitude: 89° 37' 33"
Property Owner: Lonn Schleder		
Address: 11177 S. 14th Street, Pekin, IL 61554		
Telephone: 309-348-2447		
Permission Date: 8-10-92		
Installation Date: 8-25-92		
Gauge Mfrs. No.: 1463	Gauge ID No.: SWS 3693	
Placement: Moved 5-13-94 to a position about 60 meters north-northeast of original position, which was in a back pasture along a wire fence between a white aluminum shed and a large tree. Present position is between a garage and another shed near a well. Property on northwest corner of the intersection of 1600 E. and 1100 N. Gauge 50 meters north-northwest of lat/long reading.		

SITE DESCRIPTION		
Site Number: 4		
County: Mason	Latitude: 40° 24' 29"	Longitude: 89° 54' 41"
Property Owner: Ellis Popcorn (Maureen Hanks)		
Address: 24095 County Road 2330 E., Topeka, IL 61567		
Telephone: 309-535-3840		
Permission Date: 8-10-92		
Installation Date: 8-25-92		
Gauge Mfrs. No.: 7382	Gauge ID No.: SWS 6573	
Placement: South of large white office building, between two trees in a grassy area. Property on east side of 2340 E. in Mason County, northeast of Goofy Ridge. Gauge 10 meters south-southwest of lat/long reading.		

Appendix C. (continued)

SITE DESCRIPTION		
Site Number: 5		
County: Mason	Latitude: 40° 24' 29"	Longitude: 89° 50' 19"
Property Owner: Joseph Meyer		
Address: 24234 County Road 2750 E., Topeka, IL 61567		
Telephone: 309-968-6378		
Permission Date: 8-10-92		
Installation Date: 8-25-92		
Gauge Mfrs. No.: 5985	Gauge ID No.: CDA 000130	
Placement: Next to stone drive in a pasture in front of house. Property on west side of 2750 E. in Mason County, south of 2500 N. Gauge 3 meters east of lat/long reading. Station removed from network in September 1995.		

SITE DESCRIPTION		
Site Number: 6		
County: Mason	Latitude: 40° 22' 42"	Longitude: 89° 43' 16"
Property Owner: Lawrence Whiteford		
Address: 22172 N. County Road 3400 E., Manito, IL 61546-7988		
Telephone: 309-968-6234		
Permission Date: 3-22-01		
Installation Date: 3-22-01		
Gauge Mfrs. No.: 5295	Gauge ID No.: SWS 5309	
Placement: Gauge was moved on 3-22-01 approximately 1.9 miles south-southeast of old location, or about 0.4 miles north of 2180 N. on 3400 E., Mason County. New location is in an open area west of machine shed. Old location was on west side of 3300 E. in Mason County, just south of 2400 N., 18 meters south of lat/long reading.		

Appendix C. (continued)

SITE DESCRIPTION		
Site Number: 7		
County: Tazewell	Latitude: 40° 24' 24"	Longitude: 89° 37' 29"
Property Owner: David Van Orman		
Address: 5801 Warner Road, Green Valley, IL 61534		
Telephone: 309-352-5673		
Permission Date: 8-10-92		
Installation Date: 8-25-92		
Gauge Mfrs. No.: 5935	Gauge ID No.: --	
Placement: Moved in May 1993 to a position south of a barn with a green roof, near edge of field. Original position was 30 meters to the northeast, north of the same barn. Both positions are northwest of the house. Property located just east of Green Valley on south side of 600 N. in Tazewell County, just west of 1600 E. Gauge 17 meters west-northwest of lat/long reading.		

SITE DESCRIPTION		
Site Number: 8		
County: Mason	Latitude: 40° 20' 56"	Longitude: 90° 1' 18"
Property Owner: c/o Steve Havera, Forbes Biological Station		
Address: P.O. Box 49, Havana, IL 62644		
Telephone: 309-543-3950		
Permission Date: 6-3-02		
Installation Date: 6-3-02		
Gauge Mfrs. No.: 2000	Gauge ID No.: US148085	
Placement: New location as of 6-3-02, Illinois Natural History Survey station on Quiver Creek, 0.2 mile northeast of old location. From 4-20-00 to 6-3-02, was on Blakely property located on north side of 1950 N. in Mason County west of 1900 E., 0.5 mile northwest of old site east-southeast of house near a small tree.		

Appendix C. (continued)

SITE DESCRIPTION		
Site Number: 9		
County: Mason	Latitude: 40° 19' 41"	Longitude: 89° 55' 55
Property Owner: Mason State Tree Nursery		
Address: 17855 County Road 2400 E., Topeka, IL 61567		
Telephone: 309-535-2185		
Permission Date: 8-9-00		
Installation Date: 8-9-00		
Gauge Mfrs. No.: 5986	Gauge ID No.: CDA 000132	
Placement: Located about 400 yards south of office among several weather stations. Prior location from 5-14-93 to 8-9-00 at R.R. #1, Box 19, Topeka. Original position from 8-24-92 to 5-14-93 was at R.R. #1, Box 6, Topeka.		

SITE DESCRIPTION		
Site Number: 10		
County: Mason	Latitude: 40° 19' 58"	Longitude: 89° 48' 53"
Property Owner: Paul Meeker		
Address: RR # 1, Box 31, Forest City, IL 61532		
Telephone: 309-597-2163		
Permission Date: 8-10-92		
Installation Date: 8-24-92		
Gauge Mfrs. No.: 4679	Gauge ID No.: SWS 5100	
Placement: West of hedgerow on southwest edge of home property. Property is on north side of 1900 N. in Mason County, east of 2800 E., and the gauge is about 3 meters north of 1900 E. Gauge 5 meters northeast of lat/long reading.		

Appendix C. (continued)

SITE DESCRIPTION		
Site Number: 11		
County: Mason	Latitude: 40° 20' 2"	Longitude: 89° 44' 4"
Property Owner: Louis Moehring		
Address: 32972 E. County Road 1900 N., Manito, IL 61546		
Telephone: 217-482-3320		
Permission Date: 8-10-92		
Installation Date: 8-24-92		
Gauge Mfrs. No.: 3362	Gauge ID No.: SWS 4450	
Placement: North side (back) of house along a walk. Property is on northwest corner of intersection of 1900 N. and 3300 E. in Mason County. Gauge 12 meters southwest of lat/long reading.		

SITE DESCRIPTION		
Site Number: 12		
County: Tazewell	Latitude: 40° 20' 16"	Longitude: 89° 38' 26"
Property Owner: Harold Deiss		
Address: 1327 Route 29, San Jose, IL 62682		
Telephone: 309-247-3535		
Permission Date: 8-10-92		
Installation Date: 8-24-92		
Gauge Mfrs. No.: 3346	Gauge ID No.: SWS 4439	
Placement: East side of Route 29 (1500 E.) in Tazewell County in a grassy area southwest of a red shed. Deiss house is 1/4 mile north. Just north of Day Ditch. Gauge 2 meters south of lat/long reading.		

Appendix C. (continued)

SITE DESCRIPTION		
Site Number: 13		
County: Mason	Latitude: 40° 15' 43"	Longitude: 90° 0' 48"
Property Owner: Don Hahn		
Address: 18307 E. Hahn/Stelter Rd., Havana, IL 62644		
Telephone: 309-543-4660		
Permission Date: 8-11-92		
Installation Date: 8-25-92		
Gauge Mfrs. No.: 5939	Gauge ID No.: --	
Placement: Left side of front entrance drive near a short fence. Property on south side of the diagonal 1450 N., east of Route 92. Gauge 3 meters north-northeast of lat/long reading.		

SITE DESCRIPTION		
Site Number: 14		
County: Mason	Latitude: 40° 15' 52"	Longitude: 89° 56' 33"
Property Owner: Wayne Patterson (650 E. Taintor Rd., Springfield, IL 62702-1755)		
Address: R.R. #1, Box 220, Easton, IL 62633		
Telephone: 309-543-4664		
Permission Date: 8-11-92		
Installation Date: 8-24-92		
Gauge Mfrs. No.: 4678	Gauge ID No.: SWS 5098	
Placement: In a small clearing north of house. Property located on east side of 2200 E. in Mason County south of 1500 N. Correspondence address changed to that of Wayne Patterson on 3-26-94. Gauge 17 meters northwest of lat/long reading. Station removed from network in September 1995.		

Appendix C. (continued)

SITE DESCRIPTION		
Site Number: 15		
County: Mason	Latitude: 40° 15' 27"	Longitude: 89° 50' 22"
Property Owner: c/o Joe Umbach		
Address: 25989 E. County Road 1300 N., Easton, IL 62633		
Telephone: 309-562-7611		
Permission Date: 8-12-92		
Installation Date: 8-24-92		
Gauge Mfrs. No.: 6462	Gauge ID No.: CDA 000136	
Placement: Along right side of the house lane which extends north from 1410 N. in Mason County between Route 10 and 2800 E. 1410 N. runs from southwest to northeast along Central Ditch. Gauge 2 meters north-northeast of lat/long reading.		

SITE DESCRIPTION		
Site Number: 16		
County: Mason	Latitude: 40° 16' 5"	Longitude: 89° 44' 9"
Property Owner: Donald Osborn, Sr.		
Address: 32866 E. County Road 1450 N., Mason City, IL 62664		
Telephone: 217-482-5816		
Permission Date: 8-11-92		
Installation Date: 8-24-92		
Gauge Mfrs. No.: 4666	Gauge ID No.: SWS 5059	
Placement: Along right side of drive near pigpen and road (1450 N.). Property located on north side of 1450 N. just west of 3300 E. Gauge 2 meters east of lat/long reading.		

Appendix C. (continued)

SITE DESCRIPTION		
Site Number: 17		
County: Mason	Latitude: 40° 16' 51"	Longitude: 89° 38' 25"
Property Owner: Larry Jennings		
Address: 15316 County Road 3800 E., San Jose, IL 62682		
Telephone: 309-274-3781		
Permission Date: 8-11-92		
Installation Date: 8-24-92		
Gauge Mfrs. No.: 5280	Gauge ID No.: SWS 5317	
Placement: West of garage near back fence and animal petting area. Property located on 3800 E. in Mason County just north of 1500 N. Gauge 34 meters west of lat/long reading. Station removed from network in September 1995.		

SITE DESCRIPTION		
Site Number: 18		
County: Mason	Latitude: 40° 11' 32"	Longitude: 90° 6' 15"
Property Owner: Vernon Heye		
Address: R.R. #1, Bath, IL 62617		
Telephone: 309-546-2266		
Permission Date: 8-11-92		
Installation Date: 8-26-92		
Gauge Mfrs. No.: 5278	Gauge ID No.: SWS 5308	
Placement: Co-located with groundwater well MTOW-3. Was located from Oct. 19, 2005-March 27, 2006 on property of Alan Toncray about 1 mile SW of previous location. Prior to Oct. 19, 2005, was east of white shed near field on east edge of home property. Property located on north side of 900 N. in Mason County about 2 miles east of Bath. Gauge about 37 meters east-northeast of lat/long reading.		

Appendix C. (continued)

SITE DESCRIPTION		
Site Number: 19		
County: Mason	Latitude: 40° 11' 1"	Longitude: 90° 0' 19"
Property Owner: Charles W. Lane		
Address: R.R. #1, Box 51, Kilbourne, IL 62655		
Telephone: 309-538-4397		
Permission Date: 8-11-92		
Installation Date: 8-26-92		
Gauge Mfrs. No.: 4718	Gauge ID No.: SWS 5081	
Placement: Along a wire fence separating home property from pigpen, northwest of house. Property located on west side of Route 97 on southern end of a large curve between 900 N. and 800 N. Gauge 14 meters northwest of lat/long reading.		

SITE DESCRIPTION		
Site Number: 20		
County: Mason	Latitude: 40° 11' 46"	Longitude: 89° 54' 56"
Property Owner: Wanda Krause		
Address: R.R. #1, Box 109, Easton, IL 62633		
Telephone: 309-562-7528		
Permission Date: 8-11-92		
Installation Date: 8-26-92		
Gauge Mfrs. No.: 3371	Gauge ID No.: US 148830	
Placement: In yard of Jon Krause just north of east-west lane and west of lane to the Krause home. The gauge was moved to this position in early 1995. The previous location on the east side of 2400 E. in Mason County near Jon Krause mailbox was in a strawberry patch along the same lane about 250 meters to the west on the Wanda Krause property. Gauge 150 meters east of lat/long reading.		

Appendix C. (continued)

SITE DESCRIPTION		
Site Number: 21		
County: Mason	Latitude: 40° 11' 10"	Longitude: 89° 49' 39"
Property Owner: John Walters		
Address: 28030 E. County Road 850 N., Mason City, IL 62664		
Telephone: 309-562-7527		
Permission Date: 8-11-92		
Installation Date: 8-26-92		
Gauge Mfrs. No.: 6294	Gauge ID No.: CDA 00013A	
Placement: East of the house and driveway and southeast of a shed. Property located on a hill on the northeast corner of the intersection of 2800 E. and 850 N. in Mason County. Position previous to May 20, 1994 was between a windmill and a bush about 25 meters west of present position. Gauge 25 meters east of lat/long reading.		

SITE DESCRIPTION		
Site Number: 22		
County: Mason	Latitude: 40° 10' 46"	Longitude: 89° 44' 28"
Property Owner: Kirk Martin		
Address: 33534 E. County Road 930 N., Mason City, IL 62664		
Telephone: 217-482-3509		
Permission Date: 3-23-04		
Installation Date: 3-26-04		
Gauge Mfrs. No.: 4708	Gauge ID No.: SWS 5021	
Placement: Gauge moved 1.25 miles north-northeast of previous location, 15-20 feet off local road, with field about 70 feet away. Was on a concrete slab with two two-by-fours attached to the base of the gauge, west of the house and lane on a ridge, and located on north side of 800 N. in Mason County west of Route 29 and southwest of Mason City. Gauge 25 meters west of lat/long reading.		

Appendix C. (continued)

SITE DESCRIPTION		
Site Number: 23		
County: Mason	Latitude: 40° 12' 0"	Longitude: 89° 38' 28"
Property Owner: Dale C. Fancher		
Address: 9482 N. County Road 3800 E., Mason City, IL 62664-7209		
Telephone: 217-482-3506		
Permission Date: 8-11-92		
Installation Date: 8-26-92		
Gauge Mfrs. No.: 3773	Gauge ID No.: US 148832	
Placement: On the west edge of a garden located north of a wood shop and the house. Property located on the west side of 3800 E. in Mason County about a half mile north of Route 10, east of Mason City. Gauge 30 meters north-northwest of lat/long reading.		

SITE DESCRIPTION		
Site Number: 24		
County: Mason	Latitude: 40° 6' 26"	Longitude: 90° 11' 58"
Property Owner: Norman L. Fletcher		
Address: 3286 N. County Road 800 E., Bath, IL 62617		
Telephone: 309-546-2677		
Permission Date: 8-11-92		
Installation Date: 8-26-92		
Gauge Mfrs. No.: --	Gauge ID No.: --	
Placement: North of a garage near a grapevine, northeast of the house. Property located on the east side of 800 E. in Mason County west of Route 78, just north of 300 N. Gauge 32 meters northeast of lat/long reading.		

Appendix C. (concluded)

SITE DESCRIPTION		
Site Number: 25		
County: Mason	Latitude: 40° 6' 14"	Longitude: 90° 8' 0"
Property Owner: Rocky Adkins		
Address: 11669 E. County Road 300 N., Chandlerville, IL 62627		
Telephone: 217-458-2587		
Permission Date: 8-11-92		
Installation Date: 8-26-92		
Gauge Mfrs. No.: 5947	Gauge ID No.: --	
Placement: Next to two tanks and a sign in a small grassy area surrounded by truck access. Property located at Adkins Farms on south side of 300 N. (east of Route 78) in Mason County. Gauge 2 meters south of lat/long reading. Station removed from network in September 1995.		

Appendix D. Instructions for Rain Gauge Technicians

Appendix D. Instructions for Rain Gauge Technicians

A. Use Central Standard Time Year-Around

From November through March, Illinois is in the Central Standard Time zone, so your watch will indicate the correct time and date to be noted on the chart. From April through October when Illinois is in the Central Daylight Time zone, subtract one hour from your watch reading.

B. Order of Servicing

1) Old Chart

a) Unlock and open (slide up) door on the side of the instrument case and then lock door in place to prevent it from falling.

b) Depress the bucket platform casting to mark the OFF time position on the chart (a vertical trace will be written by the pen).

c) Note the time on your watch, and move the pen point and arm away from the chart by pushing out on the pen shifter.

d) Lift up on the chart cylinder that contains the chart to disengage it from the chart drive, and remove it.

e) Remove the chart from the cylinder and write the OFF date and time on the chart on the red line at the right end of the chart.

2) Bucket

a) Remove the collector from the top of the gauge by rotating it clockwise to disengage the tongue-and-groove assembly.

b) Carefully lift the bucket off the weighing platform. If there is water in it and no antifreeze, dump the water on the ground.

c) Reposition the empty bucket on the platform.

d) Reinstall the collector by setting it on top of the rain gauge case and turning it counterclockwise until the tongue-and-groove assembly meshes.

e) During wintertime operation, when 2 inches (about one quart) of antifreeze is in the bucket to prevent freezing, leave the liquid in the bucket until the chart reading passes the 6-inch mark. At that point, pour the bucket contents into a sealed container and dispose of properly. DO NOT POUR SOLUTION ONTO THE GROUND! If wintertime conditions prevail, recharge the empty bucket with 2 inches of antifreeze. Reposition the dry bucket on the platform and reinstall the collector assembly.

f) In the winter, stir the contents of the bucket to keep the antifreeze mixed with the water.

g) At any time of the year, once the collector is repositioned, check the gauge to make sure the collector orifice top edge is level.

3) New Chart

a) Copy the OFF time from the old chart to the ON time on the new chart (another red line on the end of the chart), and write your site number on the chart.
b) Clip the new chart to the cylinder, making sure the crease at the right end of the chart is sharp and the chart is tight on the cylinder.
c) Reinstall the chart cylinder onto the chart drive, making sure the chart cylinder and drive gears mesh. Simply push down on the cylinder and wiggle it a little. You should feel some resistance if done correctly.
d) Move the pen arm and point over to the chart cylinder with the pen bracket and rotate the cylinder counterclockwise until the pen point coincides with the correct ON time position.
e) Let the pen point rest right on the chart and depress the platform casting again to make a small, vertical line denoting the ON time position. This also ensures that the pen point is writing correctly. If it is not, check the tip of the pen point to see why it is not drawing. Replace if necessary. It helps if the word "ON" is written on the chart near the ON line for later chart editing. Rezero the pen point if necessary by turning the fine adjustment screw. It is a good idea to "zero" the pen near the 0.25-inch mark to prevent evaporation from taking the pen point below the zero line.
f) When you are sure that everything is in order, carefully unlock the door, push the door down, and lock it in place for another month.

4) Data Logger

a) Plug HP200X Palmtop PC into the data logger and download data.
b) Transfer data to flash card.
c) Mail flash card and charts to ISWS.

5) Problems

a) If you notice anything unusual about the gauge or the chart drive, write a note on the upper right corner of the old chart.
b) If you think the problem requires immediate attention, call Nancy Westcott collect at 866-292-7305 or e-mail her at nan@illinois.edu to relay the information. Situations worthy of immediate attention include questions concerning the operation described above, premature chart-drive stoppage, data logger problems, or unauthorized tampering with the gauge. Immediate repairs will be scheduled if necessary.
c) Write a note describing problems and send with the charts when mailing charts to the ISWS.
d) Also, write a note or call when new supplies are needed: antifreeze, pen tips, batteries, charts, spare clock drive, envelopes, and stamps.

6) Annual Tasks

a) In the fall, usually November, the gauges are winterized. The evaporation shield is removed. Antifreeze is added to the bucket. The clock batteries are changed.

b) Usually in December, the batteries in the data loggers are changed by the ISWS field technician.

c) Usually in March or April, the antifreeze is removed as per 2e, and the evaporation shield is reinstalled.

d) Over the span of two years, all gauges should be recalibrated and cleaned in the field by the ISWS field technician.

e) Any gauge thought to be problematic (too high or too low) will be tested against the official ISWS 8-inch non-recording gauge at the ISWS.

C. Change in Site Status

If the gauge is no longer wanted on the property, please contact Nancy Westcott. Either call her toll-free at 866-292-7305 or e-mail her at nan@illinois.edu immediately so that new arrangements can be made. It is important to try to keep the sites near the same locations during the course of this project because precipitation generally can vary greatly over short distances.

Appendix E. Documentation, Imperial Valley Rain Gauge Network Maintenance, 2006-2007

Appendix E. Documentation, Imperial Valley Rain Gauge Network Maintenance, 2006-2007

This appendix documents major maintenance work carried out at sites in the Imperial Valley rain gauge network from September 1, 2006 through August 31, 2007.

1. Winterized, including changing clock batteries, removing evaporation shield, and adding anti-freeze to all gauges on November 3-4, 2006.

2. Replaced gauge at site 2 on February 22, 2007.

3. Replaced cylindrical shelter for the gauge at site 10 on May 15, 2007.

4. Moved gauge at site 2 on August 13, 2007. The gauge was moved about 30 feet to the northeast to a point close to an unpaved drive on the east and a small yard shed ~15 feet to the west, out of the way of the sprinkler system.

Appendix F. Hydrographs, Transducer Data at the Test Site

Appendix F. Hydrographs, Transducer Data at the Test Site

This appendix shows hydrographs of groundwater levels in each of the wells in place at the test site. The data are not continuous on each hydrograph due to removal of the transducers at various wells at various intervals.

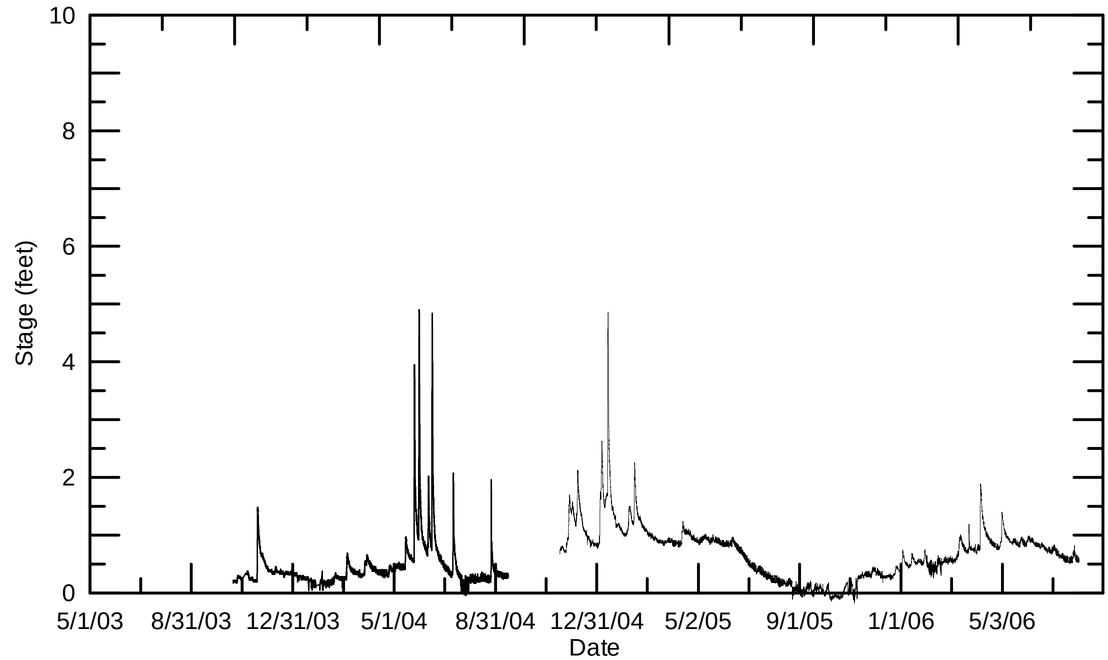


Figure F-1. Stage in Crane Creek at the downstream bridge

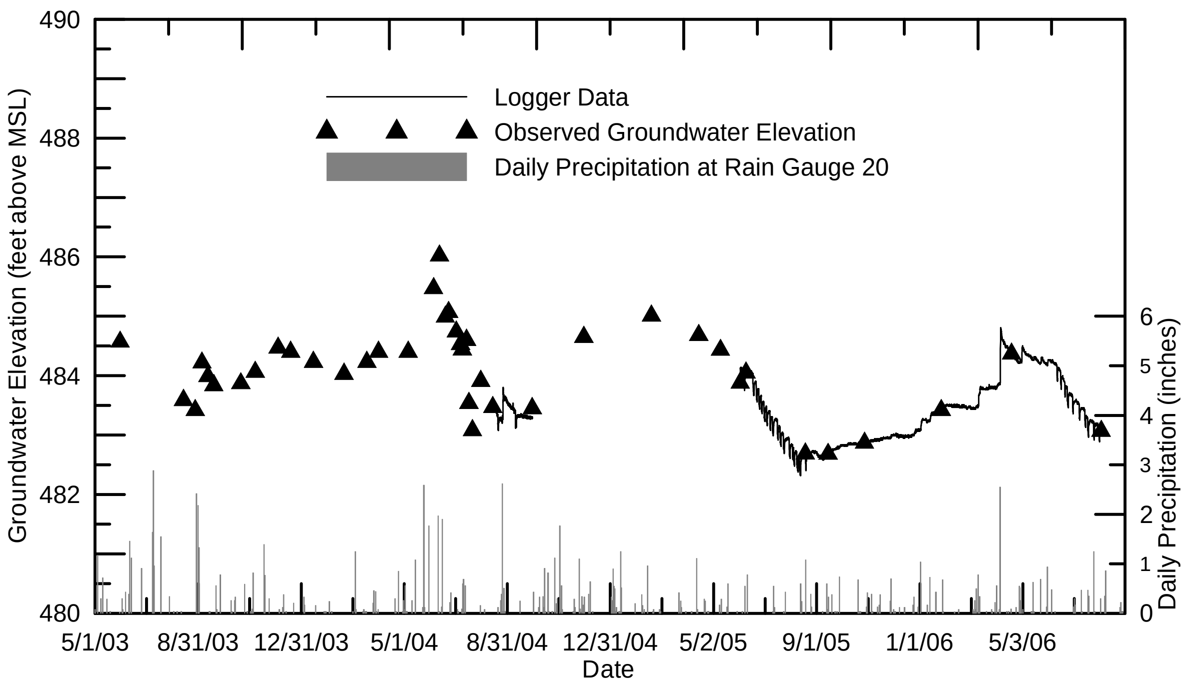


Figure F-2. Water level elevation in Well 1 at the test site

Appendix F. (Continued)

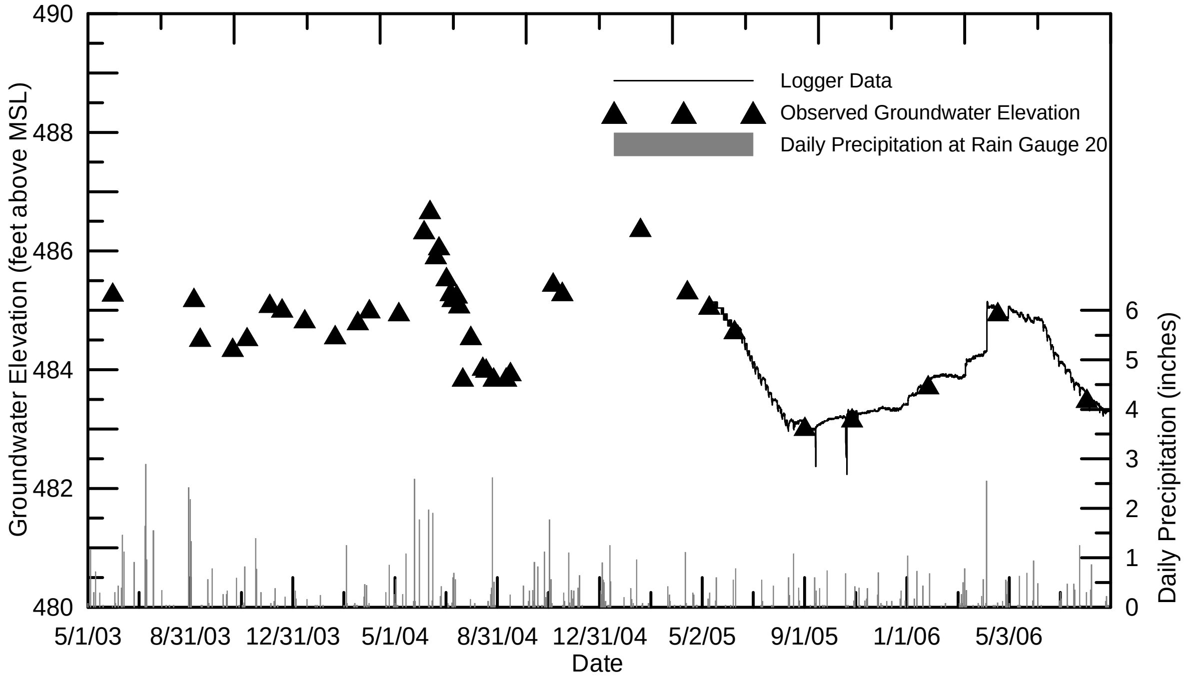


Figure F-3. Water level elevation in Well 2 at the test site

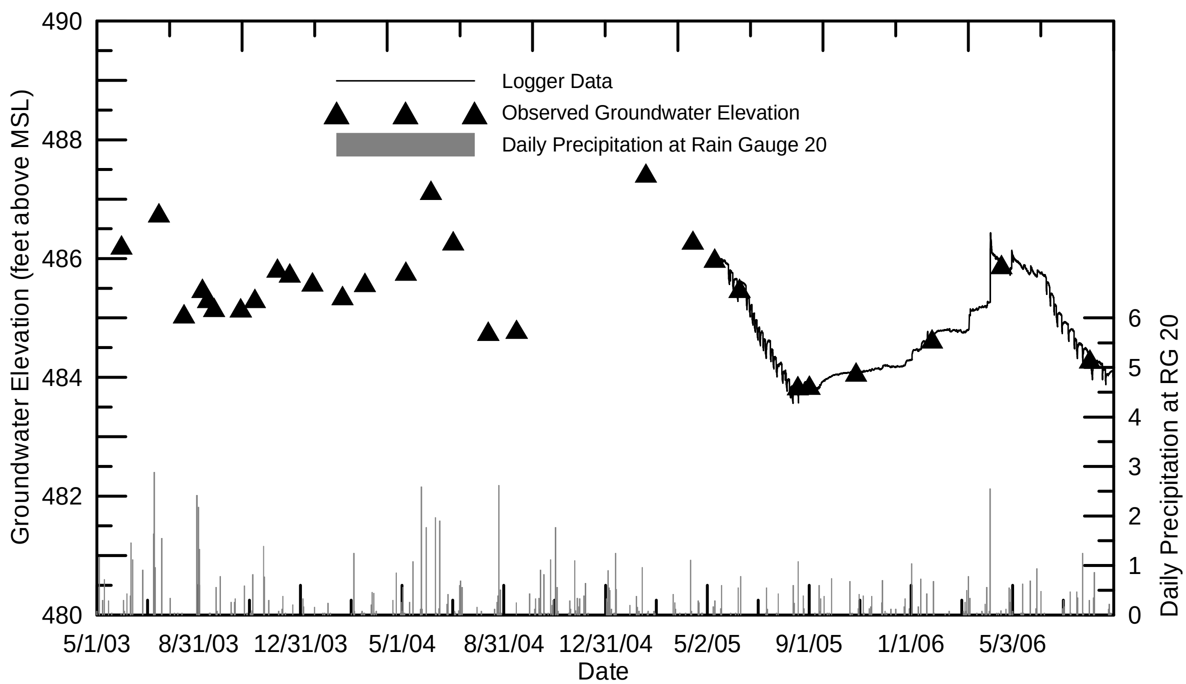


Figure F-4. Water level elevation in Well 3 at the test site

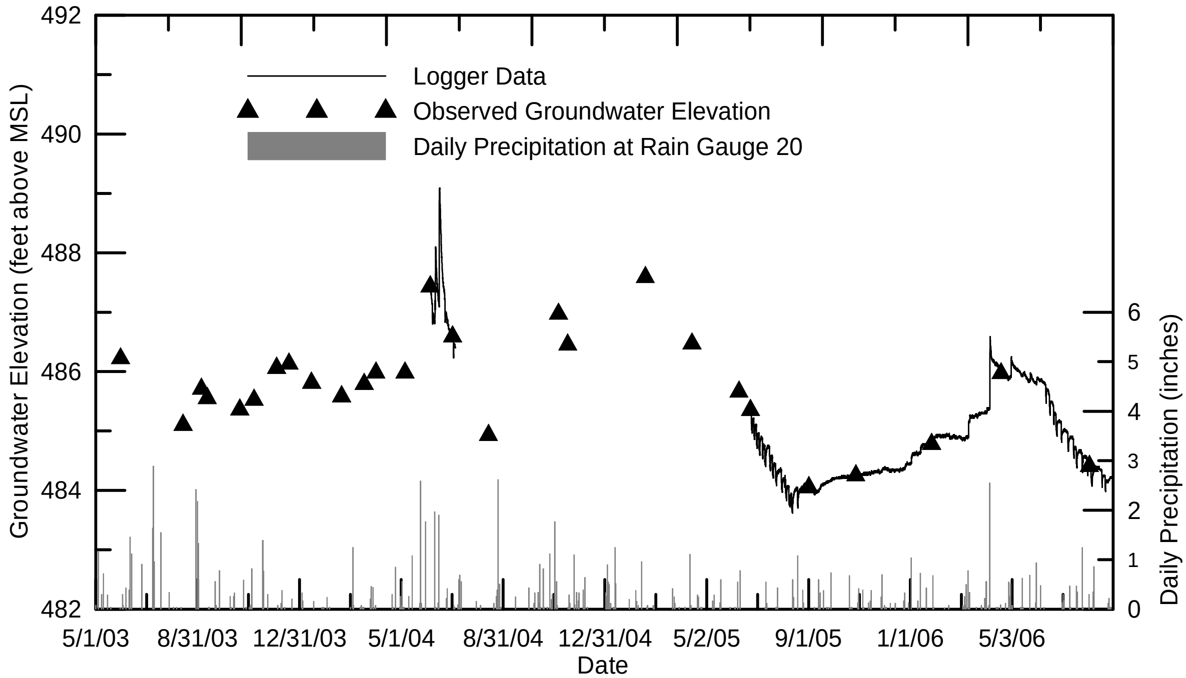


Figure F-5. Water level elevation in Well 4 at the test site

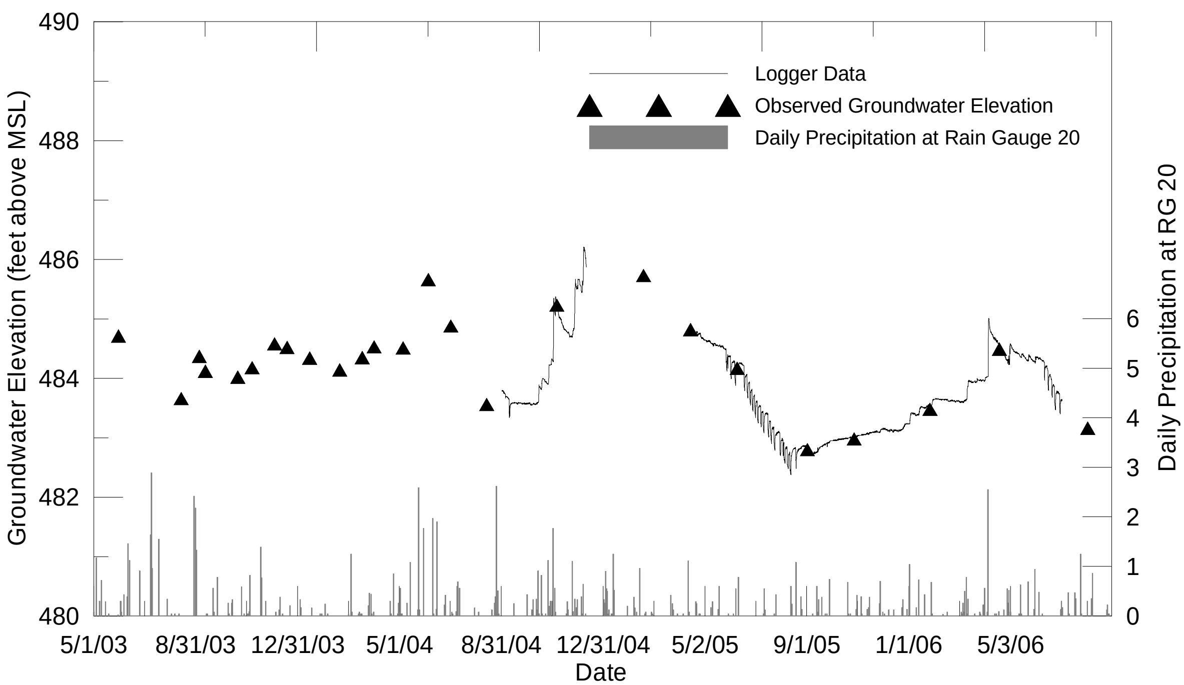


Figure F-6. Water level elevation in Well 5 at the test site

Appendix F. (Continued)

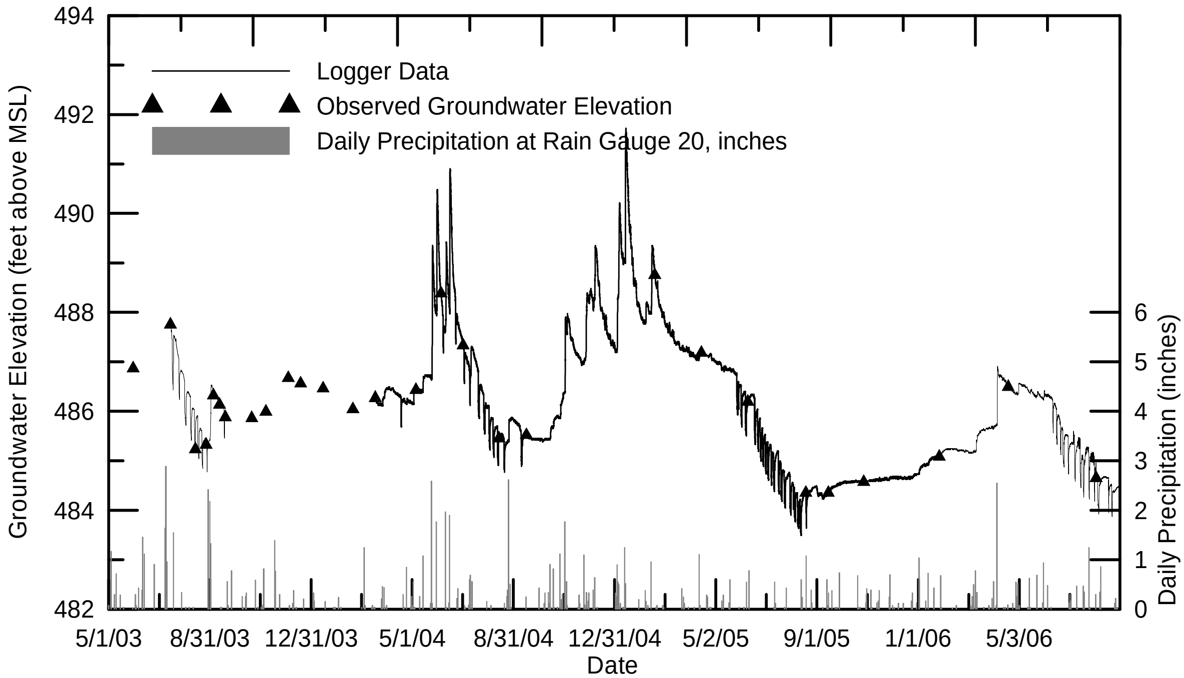


Figure F-7. Water level elevation in Well 6 at the test site

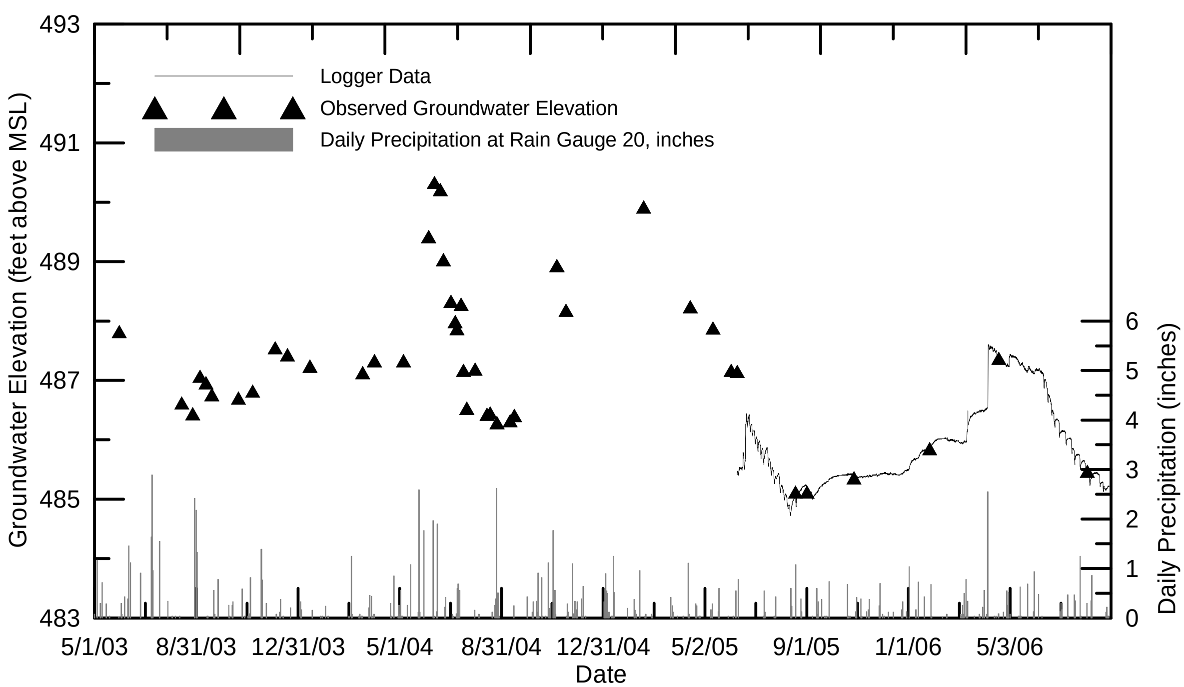


Figure F-8. Water level elevation in Well 7 at the test site

Appendix F. (Concluded)

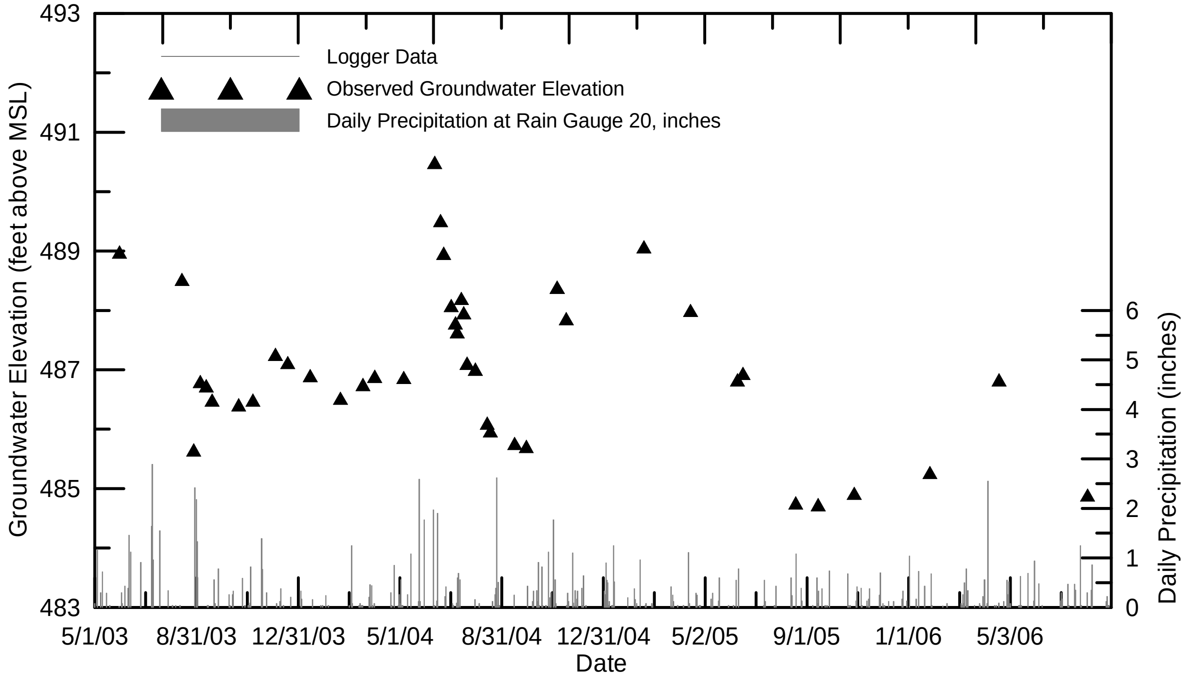


Figure F-9. Water level elevation in Well 8 at the test site

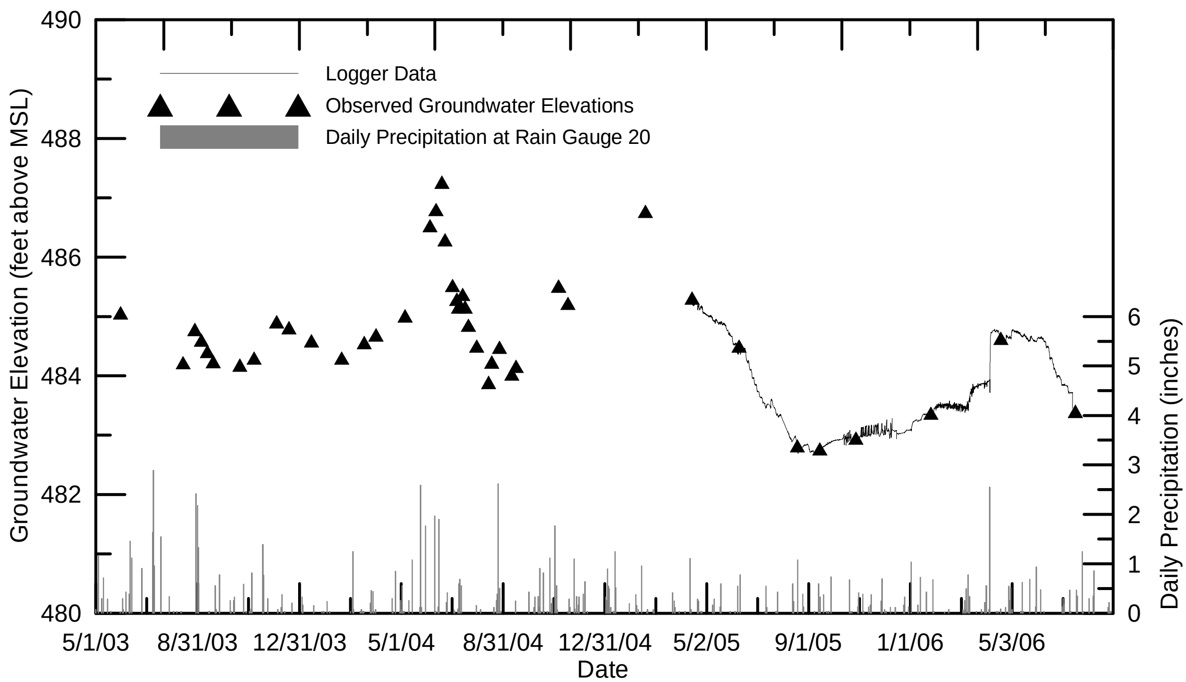
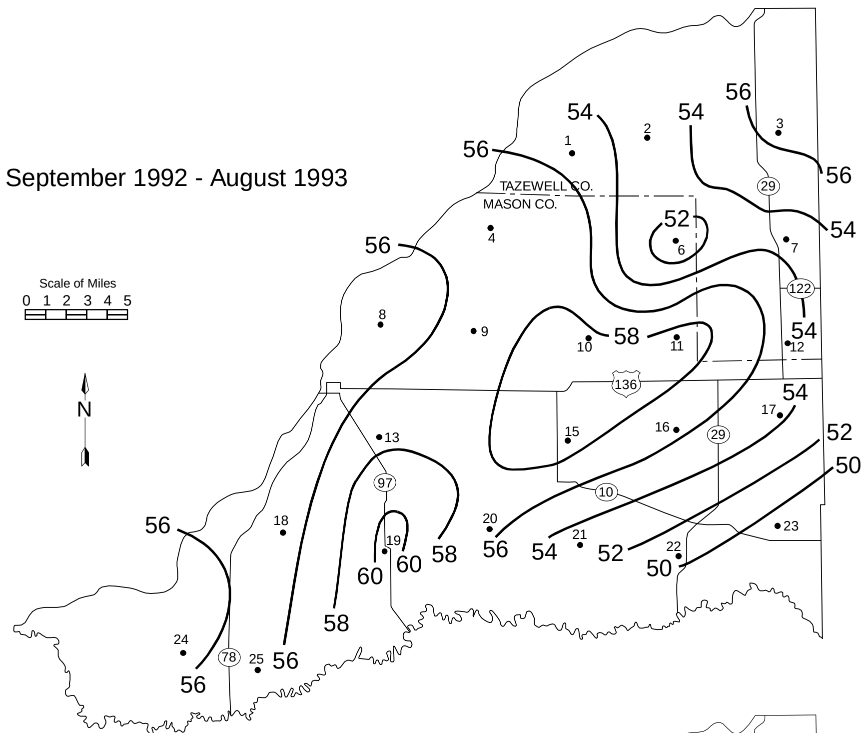


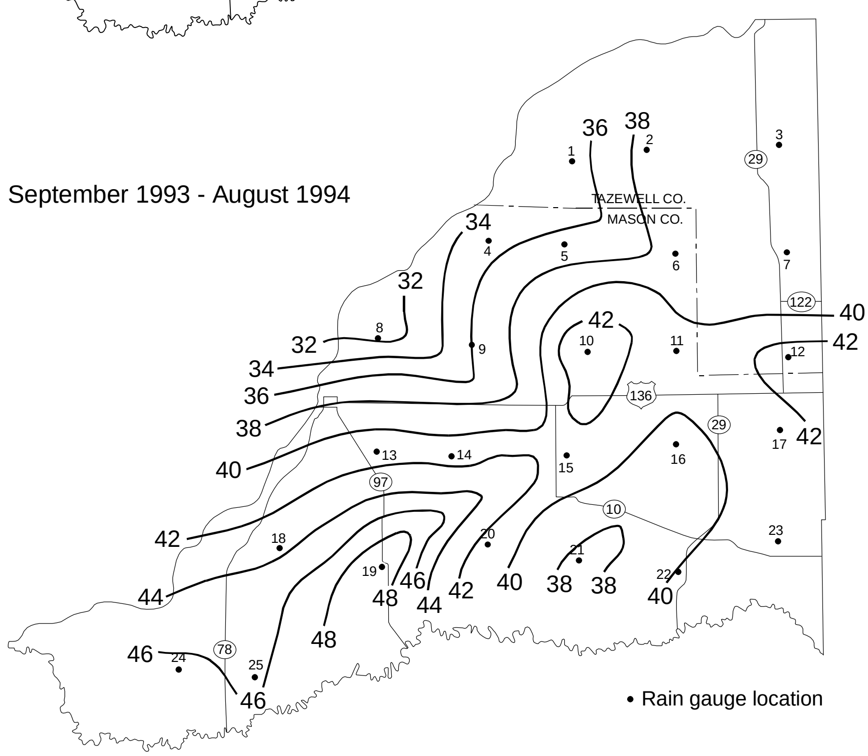
Figure F-10. Water level elevation in Well 9 at the test site

Appendix G. Annual Precipitation, Years One-Fourteen

(Rain gauge #16 omitted from Years 5-10)

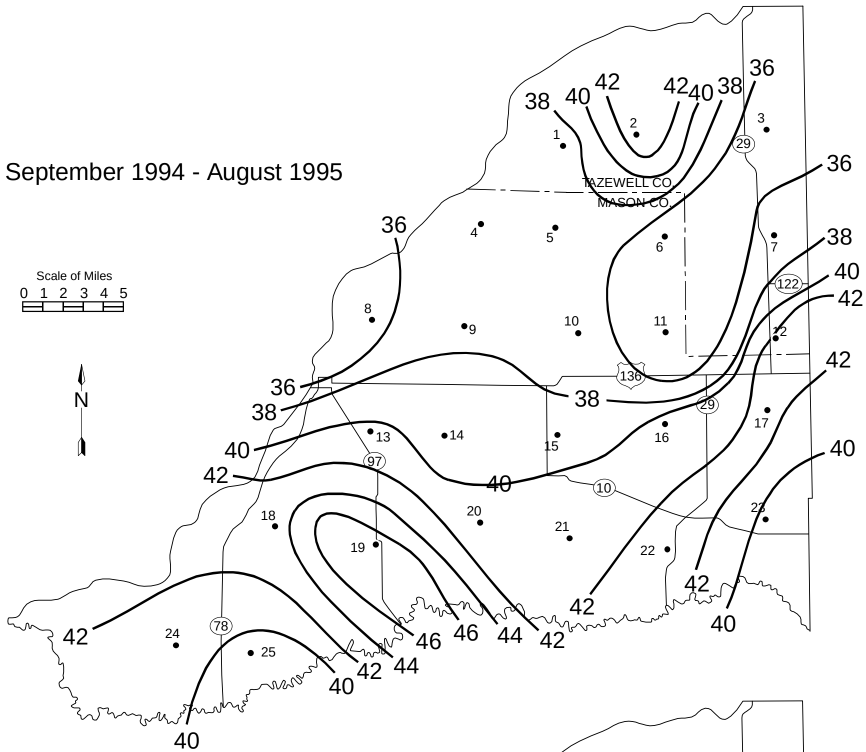
Appendix G. (Continued)



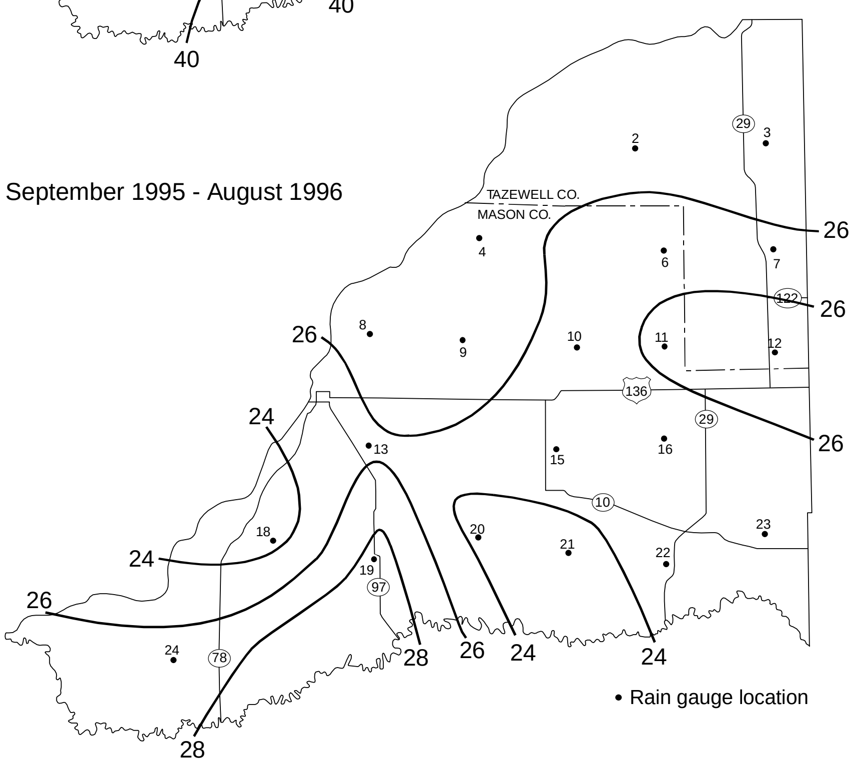


Appendix G. (continued)

September 1994 - August 1995

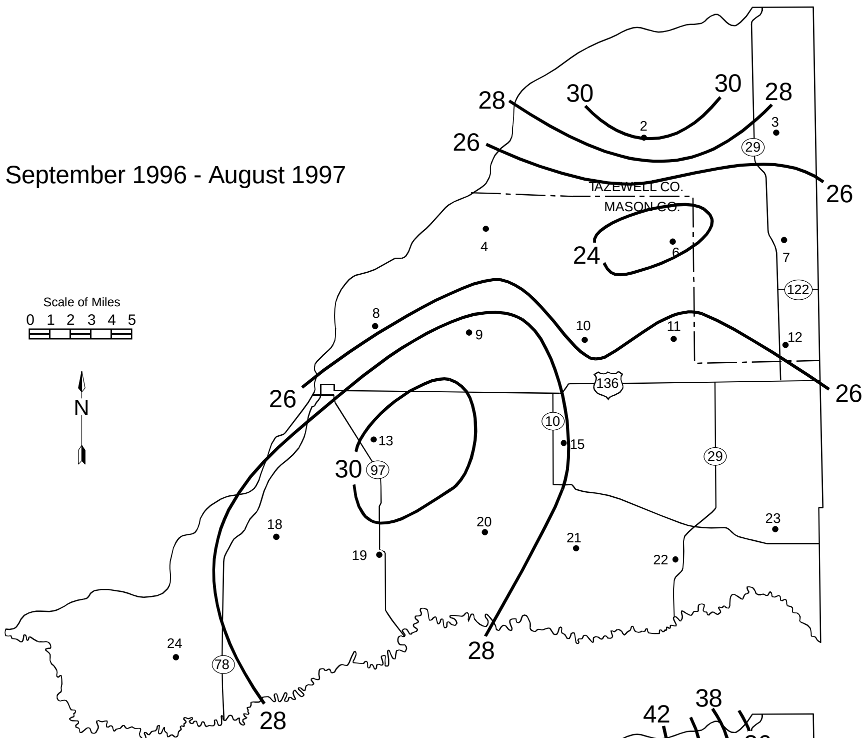


September 1995 - August 1996

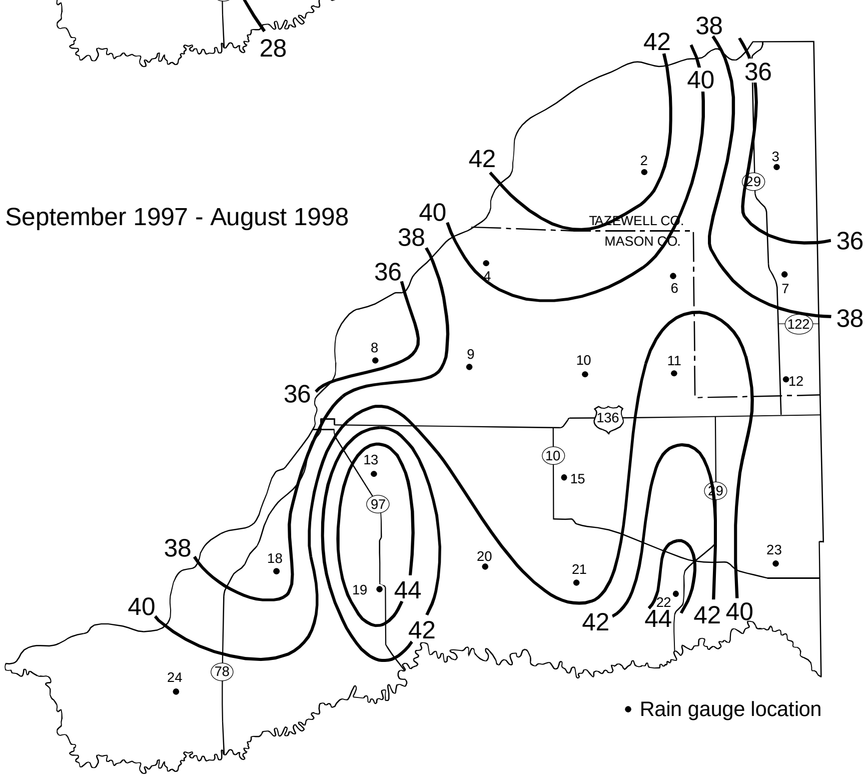


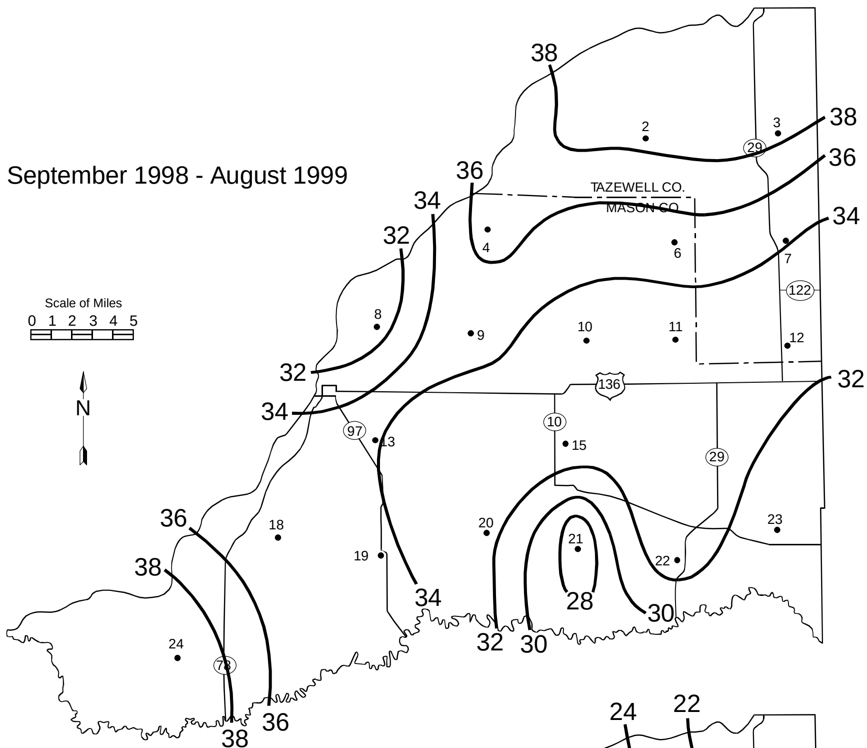
Appendix G. (continued)

September 1996 - August 1997

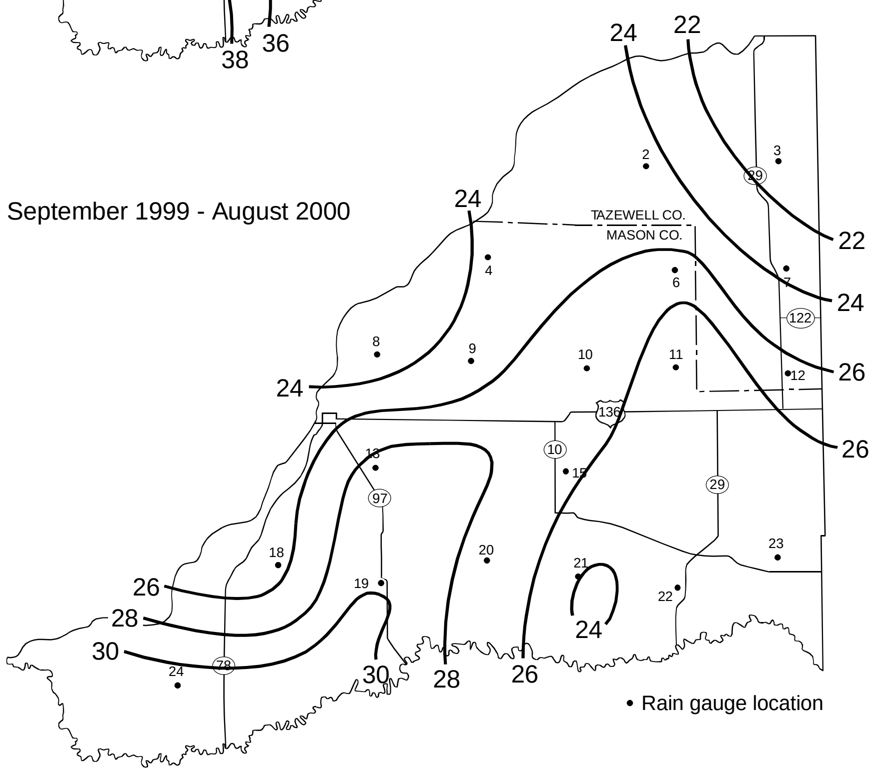


September 1997 - August 1998



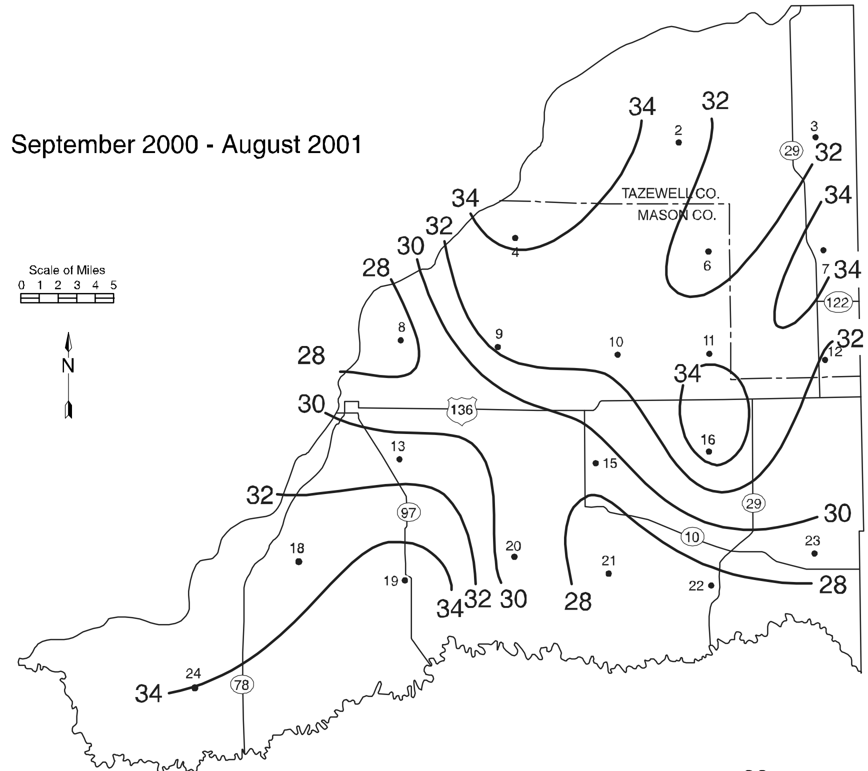


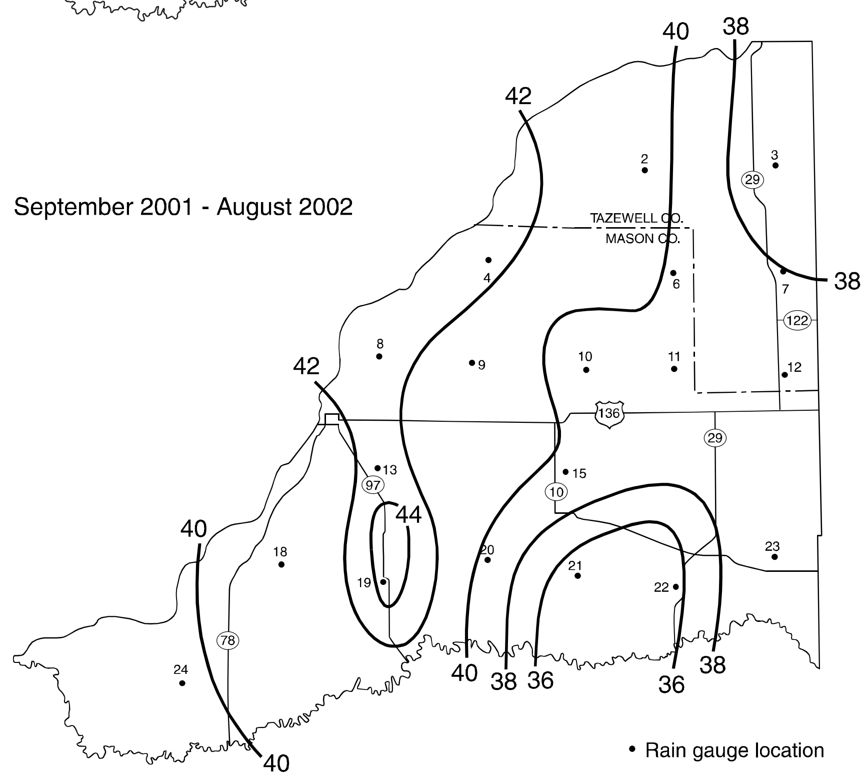
September 1998 - August 1999



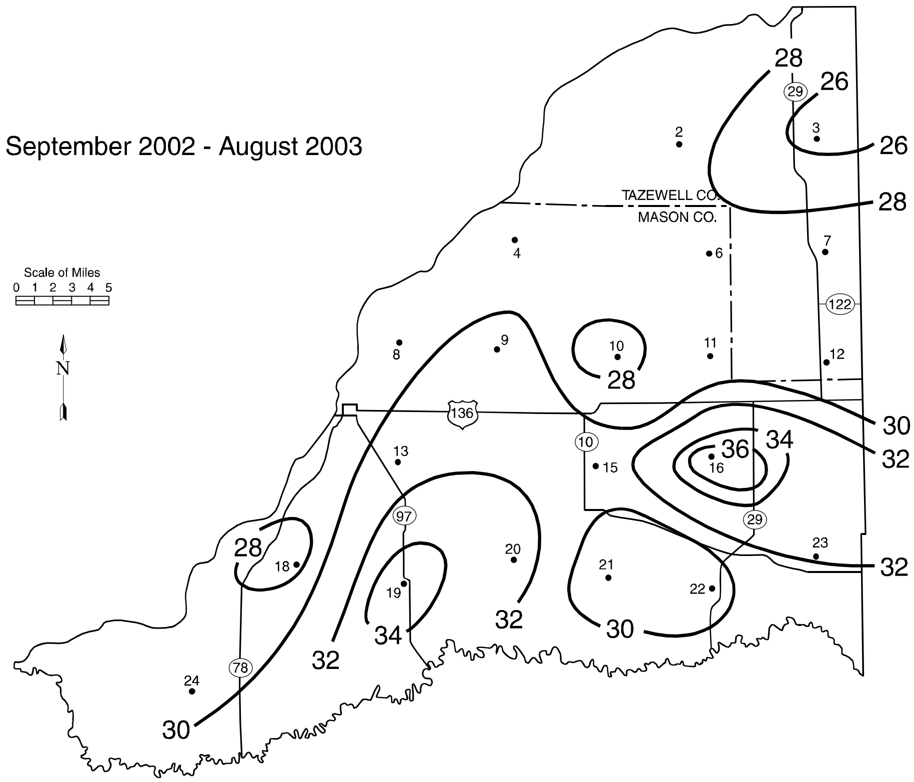
September 1999 - August 2000

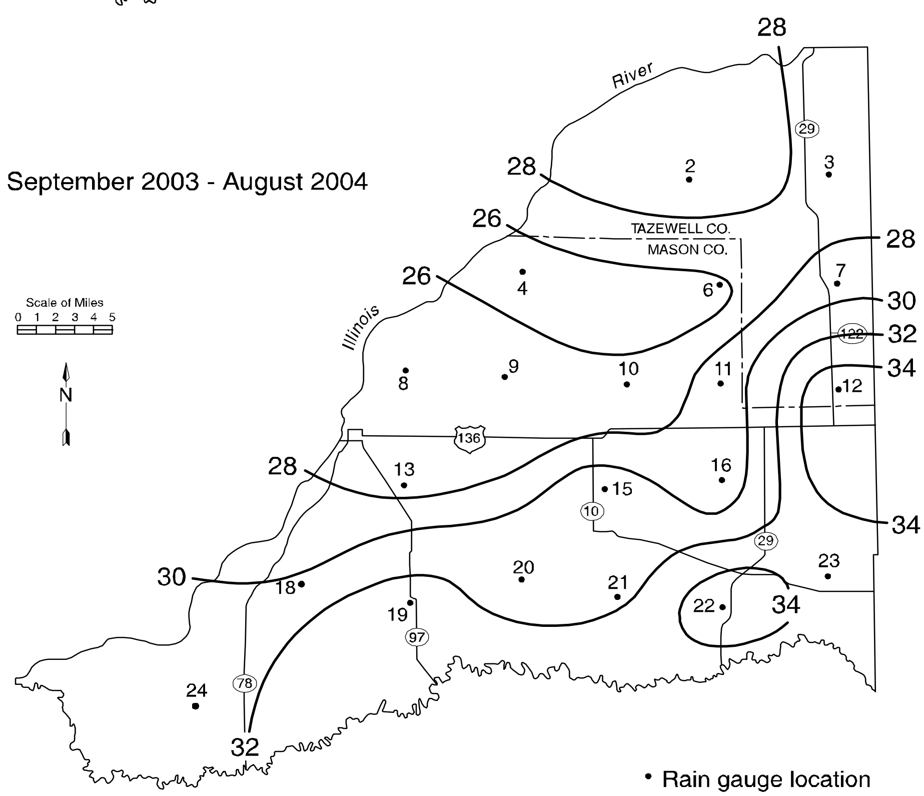
Appendix G. (continued)



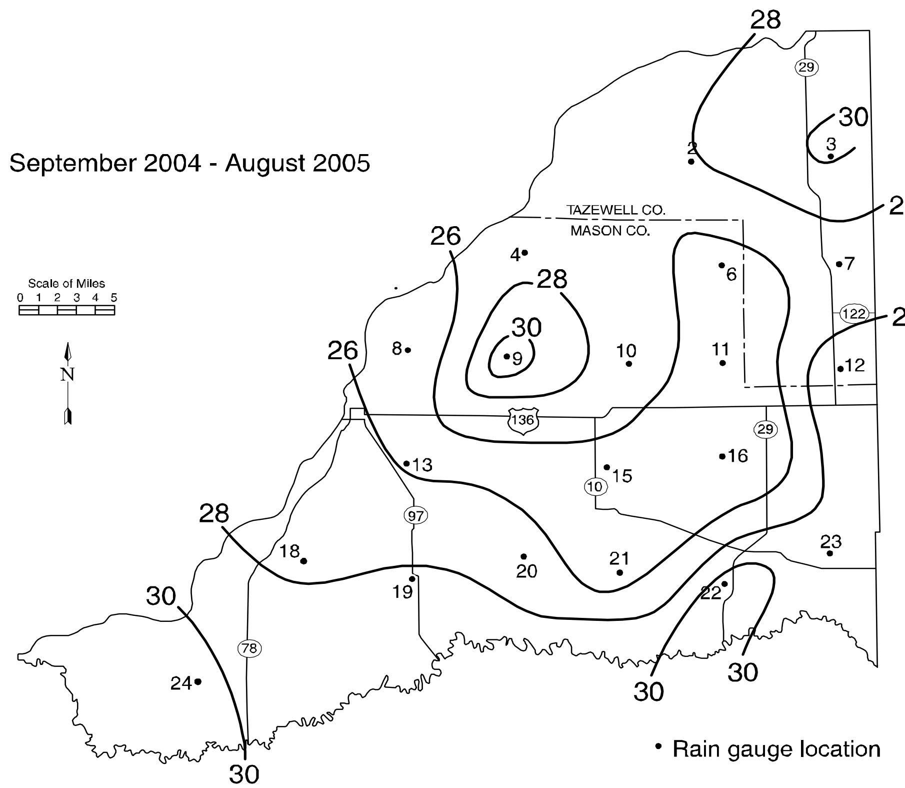


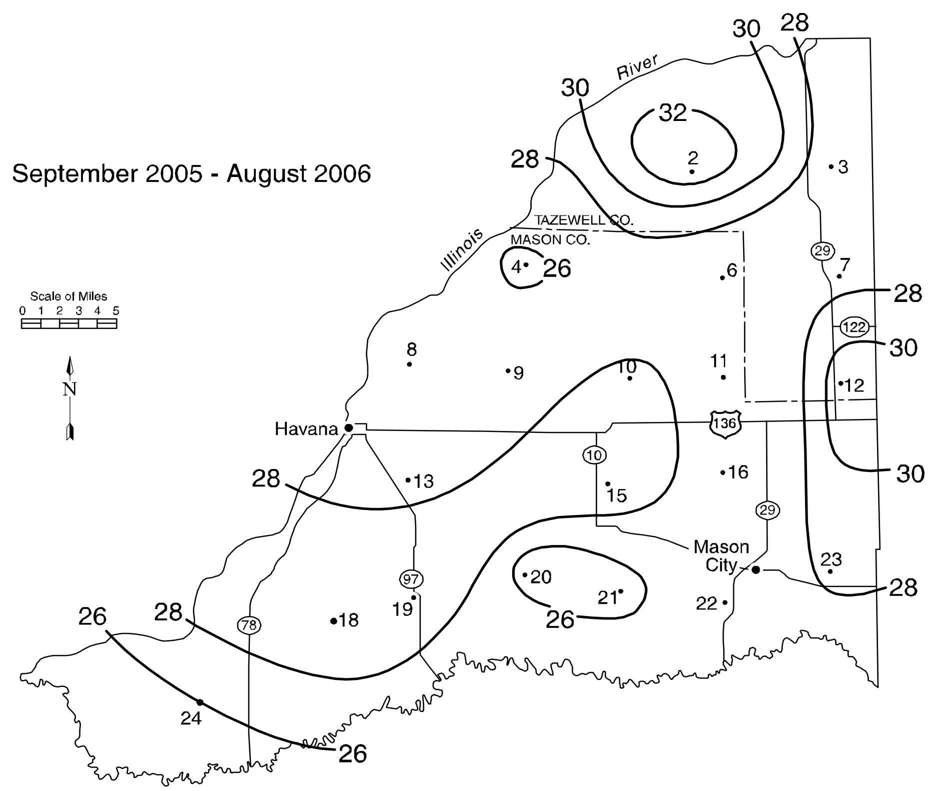
Appendix G. (continued)





Appendix G. (concluded)





Appendix H. Precipitation Events, Total Precipitation, and Precipitation per Precipitation Event by Month and Season, 1992-2006

Appendix H. Precipitation Events, Total Precipitation, and Precipitation per Precipitation Event by Month and Season, 1992-2006

Number of precipitation events

Month	*1992-93*	*1993-94*	*1994-95*	*1995-96*	*1996-97*	*1997-98*	*1998-99*	*1999-00*	*2000-01*	*2001-02*	*2002-03*	*2003-04*	*2004-05*	*2005-06*
September	10	8	6	6	6	6	8	8	10	7	3	7	4	10
October	10	5	7	9	11	7	11	6	10	17	8	7	16	5
November	13	7	10	3	9	8	14	17	11	12	7	9	9	9
December	9	9	8	5	5	10	6	14	21	9	2	8	5	9
January	9	8	5	8	13	12	19	11	18	4	6	8	12	5
February	5	6	3	4	8	7	17	21	8	9	5	6	7	2
March	10	6	6	7	8	8	6	9	7	12	6	12	4	14
April	11	12	19	6	11	12	18	14	14	9	6	5	8	11
May	16	7	16	25	15	16	15	16	14	13	10	16	9	13
June	13	13	15	11	14	17	12	12	11	10	11	7	8	11
July	21	9	16	10	6	15	9	11	10	10	5	14	5	12
August	21	12	18	4	15	16	9	17	14	10	11	11	11	12
Fall	33	20	23	18	26	21	33	31	31	36	18	23	29	24
Winter	23	23	16	17	26	29	42	46	47	22	13	22	24	16
Spring	37	25	41	38	34	36	39	39	35	34	22	33	21	38
Summer	55	34	49	25	35	48	30	40	35	30	27	32	24	35
Annual	148	102	129	98	121	134	144	156	148	122	80	110	98	113

Total precipitation, inches

Month	*1992-93*	*1993-94*	*1994-95*	*1995-96*	*1996-97*	*1997-98*	*1998-99*	*1999-00*	*2000-01*	*2001-02*	*2002-03*	*2003-04*	*2004-05*	*2005-06*
September	4.21	11.56	1.49	2.00	1.63	2.55	1.61	0.87	1.93	2.35	0.39	2.67	0.98	2.38
October	2.00	2.97	3.34	3.06	1.99	1.43	2.07	0.92	1.79	4.89	1.65	1.56	5.17	1.24
November	6.35	2.59	3.37	1.84	2.15	3.10	2.70	0.48	2.05	2.50	0.62	3.54	4.54	2.64
December	2.82	1.11	2.29	0.45	0.90	1.47	0.81	2.07	1.17	1.43	1.95	1.07	1.23	0.95
January	3.52	0.96	2.90	1.01	1.28	2.59	2.84	0.63	3.35	2.64	0.61	0.67	4.49	3.14
February	1.64	1.64	0.61	0.77	3.86	2.65	1.32	2.00	2.78	1.28	1.09	0.33	1.64	0.15
March	3.85	0.96	1.93	1.93	1.92	4.51	1.32	1.68	1.50	1.58	1.84	2.84	0.71	2.14
April	5.25	5.03	4.87	2.61	1.76	3.53	4.42	1.59	3.31	4.24	3.75	1.78	2.09	4.18
May	2.61	3.11	10.33	5.37	2.94	5.21	4.65	4.39	4.89	5.43	3.20	5.55	0.88	2.22
June	6.27	3.19	2.65	2.85	1.97	7.19	4.41	4.76	3.08	4.23	4.50	3.56	1.33	1.80
July	11.05	3.44	2.73	2.84	2.51	2.34	4.56	4.39	1.30	3.99	6.04	2.30	1.64	4.00
August	5.99	3.66	2.90	0.98	4.41	3.50	3.30	2.02	3.81	5.37	4.43	3.77	2.64	2.88
Fall	12.56	17.12	8.20	6.89	5.77	7.08	6.38	2.27	5.77	9.74	2.66	7.77	10.69	6.26
Winter	7.97	3.70	5.80	2.23	6.04	6.71	4.97	4.70	7.30	5.35	3.65	2.07	7.36	4.24
Spring	11.71	9.10	17.14	9.91	6.62	13.25	10.39	7.66	9.70	11.25	8.79	10.17	3.68	8.54
Summer	23.31	10.29	8.28	6.68	8.89	13.03	12.27	11.17	8.19	13.59	14.97	9.63	5.61	8.68
Annual	55.55	40.21	39.42	25.70	27.31	40.06	34.02	25.81	30.97	39.91	30.06	29.64	27.34	27.72

Appendix H. (concluded)

Month	*Inches of precipitation per precipitation event*													
	1992-93	*1993-94*	*1994-95*	*1995-96*	*1996-97*	*1997-98*	*1998-99*	*1999-00*	*2000-01*	*2001-02*	*2002-03*	*2003-04*	*2004-05*	*2005-06*
September	0.42	1.45	0.25	0.33	0.27	0.43	0.20	0.11	0.19	0.34	0.13	0.38	0.25	0.24
October	0.20	0.59	0.48	0.34	0.18	0.2	0.19	0.15	0.18	0.29	0.27	0.22	0.32	0.25
November	0.49	0.37	0.34	0.61	0.24	0.39	0.19	0.03	0.19	0.21	0.10	0.39	0.50	0.29
December	0.31	0.12	0.29	0.09	0.18	0.15	0.14	0.15	0.06	0.16	0.65	0.13	0.25	0.11
January	0.39	0.12	0.58	0.13	0.10	0.22	0.15	0.06	0.19	0.66	0.10	0.08	0.37	0.63
February	0.33	0.27	0.20	0.19	0.48	0.38	0.08	0.10	0.35	0.14	0.14	0.06	0.23	0.08
March	0.38	0.16	0.32	0.28	0.24	0.56	0.22	0.19	0.21	0.13	0.23	0.24	0.18	0.15
April	0.48	0.42	0.26	0.43	0.16	0.29	0.25	0.11	0.24	0.47	0.42	0.36	0.26	0.38
May	0.16	0.44	0.65	0.21	0.20	0.33	0.31	0.27	0.35	0.42	0.32	0.35	0.10	0.17
June	0.48	0.25	0.18	0.26	0.14	0.42	0.37	0.40	0.28	0.42	0.45	0.51	0.17	0.16
July	0.53	0.38	0.17	0.28	0.42	0.16	0.51	0.40	0.13	0.40	1.01	0.16	0.33	0.33
August	0.29	0.31	0.16	0.25	0.29	0.22	0.37	0.12	0.27	0.54	0.74	0.34	0.24	0.24
Fall	0.38	0.86	0.36	0.38	0.22	0.34	0.19	0.07	0.19	0.27	0.15	0.34	0.37	0.26
Winter	0.35	0.16	0.36	0.13	0.23	0.23	0.12	0.10	0.16	0.24	0.28	0.09	0.31	0.27
Spring	0.32	0.36	0.42	0.26	0.19	0.37	0.27	0.20	0.28	0.33	0.40	0.31	0.18	0.22
Summer	0.42	0.30	0.17	0.27	0.25	0.27	0.41	0.28	0.23	0.45	0.55	0.30	0.23	0.25
Annual	0.38	0.39	0.31	0.26	0.23	0.30	0.24	0.17	0.21	0.33	0.38	0.27	0.28	0.25

Note:
The tables are based on the total number of precipitation events in a given month, season, or year.

Appendix I. Documentation of Precipitation Events in the Imperial Valley, 2006-2007

Appendix I. Documentation of Precipitation Events in the Imperial Valley, 2006-2007

This appendix documents all storm event amounts, start times, and durations, and notes those that exceed an expected event amount (for 1-year to 100-year recurrence intervals, Table I-1) during the period September 1, 2005-August 31, 2006 (Table I-2). Table I-3 documents the storm event amounts for each gauge. The maximum storm amount in a given network storm period is used to compute the recurrence interval for a given precipitation event. The same information for previous years is found in Scott et al. (2002), Wehrmann et al. (2004, 2005), and Wilson et al. (2008 a, b). Individual network storm durations of one hour to ten days were considered. The precipitation amounts and storm durations for 1- to 100-year recurrence intervals for west-central Illinois are given in Table I-1 (Huff and Angel, 1989).

To determine the return frequency of any storm in Table I-2 or I-3, obtain the storm duration from the tables, then look in the left-hand column of Table I-1 to locate the storm duration that equals or just exceeds the storm duration in Table I-2 or I-3. If the precipitation for the event at any gauge in Table I-2 or I-3 exceeds the amount in Table I-1, obtain the return frequency by looking at the heading of the right-hand column that the precipitation amount exceeds. For example, Table I-3 indicates storm number 1754 has a duration of 14 hours. This storm duration falls between the 12- and 18-hour storm duration in Table I-1. Assume an 18-hour storm duration. Table I-3 indicates the gauge at site 11 recorded precipitation equal to 4.21 inches. Therefore, site 11 exceeded the 10-year return frequency amount (4.09 inches) for an 18-hour storm.

Table I-3 indicates whether the maximum precipitation for the storm exceeds the expected amount for the observed storm duration (1-year to 100-year recurrence intervals) considered. A storm recurrence frequency of 50 years means that a storm of this intensity and duration would be expected once every 50 years.

Table I-1. Precipitation Amounts in Central Illinois for Different Storm Durations and Recurrence Intervals (Huff and Angel, 1989)

Storm duration	*Precipitation (inches) for given recurrence interval*						
	1-Yr	*2-Yr*	*5-Yr*	*10-Yr*	*25-Yr*	*50-Yr*	*100-Yr*
1 hour	1.18	1.42	1.77	2.09	2.50	2.86	3.25
2 hours	1.48	1.78	2.22	2.62	3.14	3.59	4.08
3 hours	1.61	1.93	2.41	2.85	3.41	3.89	4.43
6 hours	1.89	2.26	2.82	3.33	3.99	4.56	5.19
12 hours	2.17	2.62	3.27	3.87	4.63	5.29	6.02
18 hours	2.28	2.75	3.46	4.09	4.90	5.59	6.37
24 hours	2.52	3.02	3.76	4.45	5.32	6.08	6.92
48 hours	2.81	3.38	4.19	4.86	5.78	6.62	7.51
72 hours	3.05	3.70	4.55	5.26	6.15	7.25	8.16
5 days	3.48	4.17	5.11	5.84	6.96	7.98	9.21
10 days	4.29	5.12	6.27	7.10	8.19	9.10	10.18

Table I-2. Documentation of Maximum Storm Amounts in the Imperial Valley, 2006-2007

Storm Number	*Storm Start Day*	*Start Time (CST)*	*Storm Duration (Hours)*	*Number Gauges with Precipitation*	*Network Average Precipitation (inches)*	*Storm Average Precipitation (inches)*	*Network Maximum Precipitation (inches)*	*Gauge No. with Maximum*	*Storm Recurrence Frequency*
					September-06				
1705	5	1300	2	2	0.01	0.06	0.09	10	
1706	10	2400	14	20	0.87	0.87	1.25	18	
1707	11	1800	23	20	0.86	0.86	1.85	8	
1708	14	1000	1	2	0	0.05	0.05	3	
1709	17	1400	3	1	0.01	0.12	0.12	10	
1710	22	1600	25	20	0.46	0.46	0.99	6	
					October-06				
1711	10	2200	14	20	0.62	0.62	0.78	16	
1712	11	1500	2	5	0.01	0.04	0.05	3	
1713	16	1200	24	20	0.92	0.92	1.3	23	
1714	18	1700	4	9	0.02	0.04	0.05	3	
1715	21	1700	8	20	0.37	0.37	0.5	2	
1716	26	100	35	20	0.25	0.25	0.49	24	
					November-06				
1717	10	1300	10	20	0.85	0.85	1.98	22	
1718	13	600	11	20	0.07	0.07	0.12	2	
1719	14	1100	12	20	0.13	0.13	0.36	22	
1720	15	900	19	20	0.63	0.63	0.91	12	
1721	29	500	29	20	1.59	1.59	2.27	2	
1722	30	1700	23	20	1.23	1.23	1.79	9	
					December-06				
1723	2	900	6	18	0.18	0.2	0.43	11	
1724	17	2200	4	9	0.02	0.05	0.09	13	
1725	20	1000	32	20	0.97	0.97	1.6	2	
1726	30	2400	14	20	0.29	0.29	0.5	24	
1727	6	31	1700	6	11	0.04	0.08	0.13	
					January-07				
1728	4	1200	14	20	0.7	0.7	1.1	2	
1729	5	1200	4	4	0.01	0.04	0.05	12	
1730	12	1300	17	20	0.44	0.44	0.75	21	
1731	13	900	12	20	0.4	0.4	0.68	15	
1732	13	2400	37	20	0.85	0.85	1.3	18	
1733	21	300	24	18	0.1	0.11	0.23	12	
1734	23	2200	3	8	0.02	0.04	0.04	4	
					February-07				
1735	6	1000	8	17	0.09	0.1	0.28	3	
1736	13	100	20	20	0.27	0.27	0.83	12	
1737	14	800	7	4	0.02	0.12	0.25	21	
1738	17	100	14	14	0.05	0.07	0.16	11	
1739	24	1200	12	20	0.78	0.78	1.1	18	
1740	25	300	11	20	0.39	0.39	0.51	12	
1741	28	1100	5	20	0.12	0.12	0.23	12	

Table I-2. Documentation of Maximum Storm Amounts in the Imperial Valley, 2006-2007

					March-07				
1742	1	100	14	20	0.81	0.81	0.92	12	
1743	9	1700	9	20	0.09	0.09	0.18	3	
1744	10	900	2	10	0.02	0.04	0.05	3	
1745	14	2000	8	8	0.05	0.11	0.27	2	
1746	19	200	10	20	0.36	0.36	0.52	22	
1747	20	2300	15	20	0.1	0.1	0.25	8	
1748	22	400	5	11	0.05	0.09	0.22	2	
1749	22	1800	23	20	1.15	1.15	1.71	2	
1750	24	900	6	4	0.03	0.15	0.31	3	
1751	26	1800	6	13	0.07	0.11	0.29	18	
1752	27	300	2	2	0	0.04	0.04	18	
1753	27	800	3	5	0.01	0.04	0.04	4	
1754	30	500	14	20	1.67	1.67	4.21	11	10-yr, 18-hr
1755	31	300	2	4	0.01	0.07	0.13	2	
1756	31	800	3	8	0.02	0.04	0.05	3	
1757	31	1600	7	18	0.21	0.24	0.58	23	
					April-07				
1758	3	1000	4	20	0.17	0.17	0.26	19	
1759	10	2100	19	20	0.61	0.61	1.25	2	
1760	12	100	1	2	0	0.05	0.05	2	
1761	14	800	4	9	0.03	0.06	0.12	18	
1762	24	1900	16	20	0.68	0.68	1.74	3	
1763	25	1600	24	20	0.97	0.97	1.99	2	
					May-07				
1764	2	1300	4	6	0.02	0.07	0.09	10	
1765	3	300	11	20	0.13	0.13	0.3	19	
1766	4	300	15	20	0.55	0.55	0.91	18	
1767	15	1100	9	17	0.42	0.49	1.05	13	
1768	24	2400	15	20	0.31	0.31	0.55	11	
1769	26	600	7	9	0.04	0.08	0.14	3	
1770	26	1600	5	8	0.03	0.07	0.17	2	
1771	27	100	10	9	0.02	0.04	0.04	2	
1772	28	700	6	16	0.13	0.16	0.3	15	
1773	31	1000	10	15	0.1	0.14	0.67	23	
					June-07				
1774	2	300	1	1	0	0.09	0.09	18	
1775	7	2400	2	2	0.01	0.12	0.13	24	
1776	18	1200	9	12	0.08	0.13	0.29	22	
1777	18	2400	8	19	0.29	0.31	0.62	13	
1778	21	2100	19	20	1.27	1.27	2.56	24	1-yr, 24-hr
1779	22	2000	27	20	0.74	0.74	2.42	23	
1780	26	1300	4	3	0.06	0.39	0.62	3	
1781	27	200	7	16	0.41	0.51	1.51	9	
1782	27	1400	10	8	0.11	0.27	0.68	4	
1783	28	300	15	20	1.53	1.53	2.24	6	
					July-07				
1784	4	500	5	20	0.34	0.34	0.56	20	
1785	5	1200	2	7	0.1	0.29	0.63	12	
1786	10	1600	5	9	0.1	0.22	0.71	3	

Table I-2. Documentation of Maximum Storm Amounts in the Imperial Valley, 2006-2007

1787	12	1700	12	14	0.07	0.1	0.27	12	
1788	17	100	20	20	1.68	1.68	2.63	11	1-yr, 24-hr
1789	19	400	13	9	0.03	0.07	0.12	2	
1790	27	600	8	17	0.13	0.15	0.3	6	
1791	27	1800	1	1	0.01	0.12	0.12	4	
					August-07				
1792	4	1500	4	15	0.34	0.45	2.14	18	1-yr, 6-hr
1793	6	400	11	9	0.09	0.21	0.65	21	
1794	7	2400	1	1	0.01	0.12	0.12	4	
1795	9	200	2	3	0.03	0.19	0.3	8	
1796	16	900	9	20	0.19	0.19	0.26	12	
1797	18	1000	5	15	0.13	0.17	0.29	18	
1798	19	600	5	14	0.06	0.08	0.3	7	
1799	19	1900	3	1	0.01	0.13	0.13	2	
1800	20	500	11	18	0.15	0.17	0.38	7	
1801	21	300	13	17	0.08	0.09	0.29	10	
1802	22	2200	1	2	0.01	0.06	0.08	4	
1803	25	100	13	20	0.22	0.22	0.42	10	

Table I-3. Precipitation (inches) Received at Each Station from Each Storm Period during the 2006-2007 Observation Period

Storm	*Date*	*Hour*	*Duration*	*Rain gauge site number*																			
				2	*3*	*4*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*15*	*16*	*18*	*19*	*20*	*21*	*22*	*23*	*24*
1704	9032006	2300	13	0.08	0.00	0.25	0.00	0.04	0.09	0.17	0.08	0.17	0.14	0.13	0.21	0.00	0.50	0.57	0.25	0.00	0.00	0.00	0.04
1705	9052006	1300	2	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1706	9102006	2400	14	0.92	0.85	0.58	0.99	0.87	0.65	0.97	0.97	0.95	0.77	0.65	0.77	0.78	1.25	1.07	0.65	0.95	0.90	0.80	1.05
1707	9112006	1800	23	0.29	0.27	0.54	0.30	0.20	1.85	1.38	0.88	0.39	0.14	1.24	1.28	0.47	1.38	1.76	1.24	0.81	1.38	0.59	0.83
1708	9142006	1000	1	0.00	0.05	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1709	9172006	1400	3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1710	9222006	1600	25	0.28	0.72	0.13	0.99	0.48	0.08	0.67	0.96	0.42	0.42	0.39	0.43	0.30	0.42	0.38	0.55	0.26	0.30	0.38	0.66
1711	10102006	2200	14	0.70	0.54	0.50	0.60	0.61	0.51	0.50	0.55	0.64	0.77	0.47	0.65	0.78	0.59	0.69	0.77	0.60	0.65	0.68	0.54
1712	10112006	1500	2	0.04	0.05	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00
1713	10162006	1200	24	1.26	0.74	0.74	0.88	0.85	0.74	0.91	0.88	0.70	1.08	0.85	0.75	0.77	1.13	1.02	0.84	0.81	0.97	1.30	1.17
1714	10182006	1700	4	0.04	0.05	0.04	0.04	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.04	0.04	0.00	0.04
1715	10212006	1700	8	0.50	0.41	0.42	0.42	0.38	0.34	0.38	0.38	0.34	0.32	0.34	0.38	0.33	0.42	0.43	0.38	0.34	0.35	0.25	0.29
1716	10262006	100	35	0.46	0.19	0.21	0.20	0.24	0.24	0.24	0.20	0.12	0.24	0.29	0.20	0.16	0.44	0.32	0.28	0.12	0.20	0.20	0.49
1717	11102006	1300	10	1.59	0.59	0.71	0.52	0.91	0.43	1.10	0.59	0.77	0.86	0.56	0.64	0.60	0.75	0.77	0.51	0.94	1.98	1.55	0.54
1718	11132006	600	11	0.12	0.05	0.04	0.08	0.04	0.08	0.04	0.12	0.04	0.10	0.08	0.08	0.08	0.08	0.12	0.08	0.08	0.04	0.04	0.10
1719	11142006	1100	12	0.16	0.15	0.04	0.08	0.08	0.04	0.04	0.08	0.12	0.19	0.04	0.12	0.16	0.08	0.12	0.12	0.16	0.36	0.29	0.15
1720	11152006	900	19	0.85	0.49	0.46	0.54	0.72	0.33	0.80	0.62	0.63	0.91	0.52	0.64	0.32	0.67	0.85	0.76	0.75	0.67	0.56	0.57
1721	11292006	500	29	2.27	1.82	1.91	1.37	1.24	1.86	1.87	2.07	1.24	1.37	2.01	1.57	0.80	1.41	1.59	1.85	1.23	1.20	1.47	1.74
1722	11302006	1700	23	1.26	1.16	1.39	1.05	0.99	1.19	1.79	0.92	1.14	1.14	1.08	1.24	1.22	1.52	1.36	1.16	1.53	0.84	1.10	1.45
1723	12022006	900	6	0.04	0.27	0.04	0.26	0.12	0.00	0.00	0.17	0.43	0.23	0.13	0.26	0.21	0.08	0.34	0.17	0.39	0.30	0.21	0.04
1724	12172006	2200	4	0.04	0.00	0.00	0.08	0.04	0.00	0.00	0.08	0.04	0.00	0.09	0.04	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.00
1725	12202006	1000	32	1.60	0.90	1.04	0.87	0.89	1.03	1.11	0.99	0.87	0.98	0.87	0.79	0.84	0.95	1.13	0.84	0.66	1.01	1.11	1.01
1726	12302006	2400	14	0.42	0.15	0.38	0.16	0.12	0.29	0.38	0.25	0.26	0.19	0.30	0.30	0.25	0.34	0.38	0.34	0.21	0.30	0.33	0.50
1727	12312006	1700	1700	0.13	0.09	0.13	0.04	0.04	0.08	0.13	0.04	0.00	0.00	0.09	0.00	0.00	0.04	0.04	0.00	0.00	0.00	0.00	0.00
1728	1042007	1200	14	1.10	0.80	0.67	0.67	0.81	0.50	0.59	0.67	0.72	0.85	0.38	0.72	0.63	0.63	0.67	0.72	0.63	0.81	0.73	0.66
1729	1052007	1200	4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.04	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.04	0.00
1730	1122007	1300	17	0.46	0.19	0.24	0.34	0.25	0.47	0.45	0.42	0.38	0.55	0.38	0.42	0.37	0.42	0.72	0.58	0.75	0.41	0.46	0.61
1731	1132007	900	12	0.17	0.41	0.42	0.51	0.52	0.12	0.24	0.58	0.65	0.50	0.20	0.68	0.55	0.25	0.16	0.64	0.16	0.64	0.50	0.20

Note: *Duration specified in hours. Values in boldface type exceed one-year storm recurrence frequency.

Table I-3. (continued)

1732	1132007	2400	37	1.11	0.68	0.76	0.67	0.68	0.83	0.95	0.75	0.71	0.87	1.23	0.72	0.64	1.30	1.10	0.63	0.92	0.77	0.83	0.91
1733	1212007	300	24	0.04	0.19	0.08	0.12	0.12	0.12	0.04	0.04	0.12	0.23	0.12	0.04	0.08	0.13	0.12	0.04	0.00	0.00	0.20	0.20
1734	1232007	2200	3	0.00	0.00	0.04	0.04	0.00	0.04	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.04	0.04	0.04	0.04	0.00	0.00	0.00
1735	2062007	1000	8	0.08	0.28	0.04	0.12	0.21	0.12	0.08	0.04	0.17	0.27	0.08	0.04	0.04	0.04	0.04	0.00	0.00	0.00	0.08	0.04
1736	2132007	100	20	0.05	0.24	0.33	0.08	0.47	0.45	0.12	0.08	0.24	0.83	0.41	0.12	0.12	0.41	0.53	0.16	0.16	0.20	0.24	0.16
1737	2142007	800	7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.25	0.08	0.00	0.04
1738	2172007	100	14	0.09	0.10	0.00	0.08	0.04	0.04	0.04	0.08	0.16	0.04	0.00	0.00	0.00	0.04	0.08	0.00	0.00	0.08	0.08	0.04
1739	2242007	1200	12	0.73	0.63	0.85	0.68	0.77	0.82	0.63	0.71	0.98	0.90	0.80	0.72	0.77	1.10	0.78	0.76	0.60	0.60	0.87	1.00
1740	2252007	300	11	0.40	0.46	0.37	0.34	0.43	0.34	0.45	0.42	0.34	0.51	0.34	0.44	0.42	0.34	0.38	0.42	0.42	0.47	0.29	0.29
1741	2282007	1100	5	0.11	0.10	0.12	0.17	0.08	0.12	0.12	0.16	0.08	0.23	0.13	0.17	0.08	0.16	0.08	0.16	0.08	0.08	0.13	0.12
1742	3012007	100	14	0.80	0.81	0.80	0.77	0.86	0.72	0.88	0.80	0.82	0.92	0.61	0.87	0.90	0.70	0.86	0.86	0.77	0.85	0.79	0.74
1743	3092007	1700	9	0.13	0.18	0.12	0.13	0.08	0.08	0.08	0.13	0.08	0.10	0.08	0.12	0.08	0.09	0.08	0.08	0.08	0.04	0.09	0.04
1744	3102007	900	2	0.01	0.05	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.04	0.00	0.04	0.04	0.04	0.04
1745	3142007	2000	8	0.27	0.18	0.21	0.04	0.04	0.09	0.04	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1746	3192007	200	10	0.39	0.36	0.34	0.42	0.51	0.39	0.28	0.43	0.42	0.37	0.35	0.29	0.26	0.33	0.30	0.21	0.25	0.52	0.51	0.26
1747	3202007	2300	15	0.22	0.09	0.24	0.04	0.04	0.25	0.12	0.08	0.04	0.05	0.12	0.08	0.04	0.16	0.12	0.04	0.04	0.04	0.08	0.20
1748	3222007	400	5	0.22	0.14	0.04	0.00	0.08	0.00	0.08	0.13	0.04	0.00	0.04	0.00	0.08	0.00	0.00	0.09	0.00	0.00	0.00	0.09
1749	3222007	1800	23	1.71	1.17	1.04	1.38	1.29	1.46	1.00	1.17	1.03	1.14	0.87	0.81	0.99	0.96	1.12	0.98	1.07	1.33	1.34	1.10
1750	3242007	900	6	0.22	0.31	0.00	0.00	0.00	0.00	0.04	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1751	3262007	1800	6	0.09	0.00	0.12	0.09	0.00	0.00	0.20	0.04	0.00	0.00	0.04	0.04	0.04	0.29	0.00	0.09	0.00	0.13	0.08	0.16
1752	3272007	300	2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.04	0.00	0.00
1753	3272007	800	3	0.00	0.00	0.04	0.04	0.00	0.00	0.04	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00
1754	3302007	500	14	0.69	0.55	1.26	**2.54**	1.69	1.38	**2.95**	**2.90**	**4.21**	**3.21**	1.58	1.89	1.86	0.45	1.49	1.86	0.80	1.12	0.80	0.25
1755	3312007	300	2	0.13	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00
1756	3312007	800	3	0.00	0.05	0.00	0.00	0.04	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.04	0.04	0.04	0.04
1757	3312007	1600	7	0.26	0.41	0.12	0.26	0.35	0.04	0.00	0.13	0.30	0.41	0.09	0.13	0.21	0.38	0.04	0.13	0.12	0.30	0.58	0.00
1758	4032007	1000	4	0.08	0.18	0.17	0.13	0.13	0.18	0.17	0.12	0.13	0.13	0.13	0.22	0.09	0.21	0.26	0.17	0.17	0.21	0.21	0.25
1759	4102007	2100	19	1.25	0.47	0.73	0.45	0.50	0.59	0.46	0.60	0.63	0.75	0.42	0.70	0.58	0.83	0.59	0.63	0.41	0.51	0.52	0.66
1760	4122007	100	1	0.05	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1761	4142007	800	4	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.04	0.04	0.00	0.12	0.04	0.04	0.04	0.00	0.09	0.08
1762	4242007	1900	16	1.55	1.74	0.92	0.67	1.17	0.68	0.80	0.96	0.57	0.77	0.42	0.73	0.42	0.22	0.34	0.38	0.29	0.20	0.42	0.37
1763	4252007	1600	24	1.99	0.82	1.69	1.02	0.81	0.76	1.01	1.02	1.13	1.27	0.83	0.86	1.07	0.75	0.68	0.77	0.51	0.77	0.67	0.91

Note: *Duration specified in hours. Values in boldface type exceed one-year storm recurrence frequency.

Table I-3. (continued)

1764	5022007	1300	4	0.00	0.00	0.04	0.00	0.00	0.04	0.00	0.09	0.00	0.00	0.08	0.00	0.00	0.09	0.09	0.00	0.00	0.00	0.00	0.00
1765	5032007	300	11	0.22	0.09	0.12	0.13	0.08	0.21	0.16	0.08	0.04	0.09	0.16	0.16	0.08	0.16	0.30	0.16	0.04	0.16	0.12	0.13
1766	5042007	300	15	0.48	0.58	0.42	0.57	0.61	0.42	0.58	0.59	0.33	0.59	0.52	0.56	0.38	0.91	0.77	0.60	0.55	0.43	0.34	0.78
1767	5152007	1100	9	0.79	0.36	0.84	0.21	0.21	0.69	0.59	0.63	0.43	0.45	1.05	0.39	0.26	0.49	0.39	0.09	0.00	0.00	0.00	0.54
1768	5242007	2400	15	0.13	0.27	0.33	0.21	0.34	0.34	0.28	0.20	0.55	0.23	0.38	0.34	0.29	0.49	0.39	0.24	0.25	0.26	0.17	0.50
1769	5262007	600	7	0.09	0.14	0.00	0.00	0.04	0.04	0.00	0.00	0.00	0.10	0.00	0.00	0.08	0.00	0.00	0.00	0.08	0.08	0.08	0.00
1770	5262007	1600	5	0.17	0.00	0.04	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.04	0.08	0.00	0.00	0.00	0.00	0.00	0.04	0.09	0.04
1771	5272007	100	10	0.04	0.00	0.04	0.04	0.04	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.04	0.00	0.00	0.00	0.04	0.00	0.04	0.04
1772	5282007	700	6	0.25	0.23	0.16	0.00	0.12	0.22	0.00	0.00	0.17	0.14	0.04	0.30	0.04	0.08	0.30	0.12	0.04	0.13	0.17	0.00
1773	5312007	1000	10	0.00	0.04	0.00	0.04	0.12	0.00	0.00	0.04	0.08	0.23	0.00	0.04	0.17	0.08	0.04	0.04	0.17	0.26	0.67	0.04
1774	6022007	300	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00
1775	6072007	2400	2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.13
1776	6182007	1200	9	0.09	0.24	0.00	0.22	0.04	0.00	0.00	0.09	0.09	0.10	0.00	0.04	0.04	0.00	0.00	0.09	0.17	0.29	0.00	0.00
1777	6182007	2400	8	0.37	0.40	0.59	0.39	0.31	0.34	0.42	0.33	0.21	0.14	0.62	0.08	0.17	0.50	0.47	0.21	0.08	0.04	0.00	0.13
1778	6212007	2100	19	0.92	0.91	0.92	0.86	1.21	0.65	1.09	1.25	0.94	0.96	0.80	1.23	0.94	1.90	1.63	1.68	1.80	1.77	1.30	**2.56**
1779	6222007	2000	27	0.30	0.28	0.21	0.34	0.26	0.24	0.46	0.50	0.61	0.96	0.67	0.47	1.07	1.56	1.36	0.34	0.43	0.64	2.42	1.71
1780	6262007	1300	4	0.46	0.62	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1781	6272007	200	7	0.00	0.00	0.00	0.09	0.31	0.04	1.51	0.54	0.13	0.05	0.74	1.17	0.04	0.13	0.48	0.99	1.20	0.51	0.21	0.00
1782	6272007	1400	10	0.33	0.19	0.68	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.04	0.00	0.00	0.00	0.38	0.21	0.00	0.00	0.00	0.29
1783	6282007	300	15	1.90	0.71	1.96	2.24	1.82	2.18	1.92	2.07	2.13	1.72	1.69	1.51	1.94	1.21	1.15	0.90	0.94	1.11	0.75	0.84
1784	7042007	500	5	0.13	0.18	0.33	0.13	0.07	0.26	0.51	0.17	0.17	0.27	0.53	0.43	0.21	0.55	0.47	0.56	0.56	0.52	0.46	0.25
1785	7052007	1200	2	0.58	0.00	0.00	0.38	0.15	0.00	0.00	0.00	0.13	0.63	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.13	0.00
1786	7102007	1600	5	0.57	0.71	0.21	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.16	0.00	0.00	0.00	0.03	0.16	0.04
1787	7122007	1700	12	0.00	0.02	0.21	0.08	0.07	0.04	0.05	0.07	0.21	0.27	0.22	0.00	0.00	0.00	0.06	0.08	0.06	0.03	0.00	0.00
1788	7172007	100	20	1.59	1.38	2.36	1.88	1.51	2.03	2.43	2.18	**2.63**	1.54	1.85	1.64	1.84	0.79	1.32	1.59	1.40	1.28	1.22	1.13
1789	7192007	400	13	0.12	0.10	0.04	0.04	0.12	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.00	0.00	0.00	0.04
1790	7272007	600	8	0.00	0.23	0.13	0.30	0.30	0.08	0.08	0.16	0.26	0.28	0.08	0.04	0.30	0.00	0.04	0.08	0.03	0.04	0.20	0.00
1791	7272007	1800	1	0.00	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1792	8042007	1500	4	0.05	0.00	0.04	0.04	1.09	0.03	0.03	0.02	0.02	0.00	0.13	0.00	0.00	**2.14**	1.04	0.48	0.18	0.04	0.00	1.42
1793	8062007	400	11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.04	0.08	0.38	0.00	0.13	0.17	0.65	0.09	0.10	0.00
1794	8072007	2400	1	0.00	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1795	8092007	200	2	0.02	0.00	0.25	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1796	8162007	900	9	0.08	0.04	0.08	0.17	0.17	0.16	0.20	0.25	0.25	0.26	0.22	0.21	0.21	0.21	0.17	0.21	0.17	0.22	0.21	0.26
1797	8182007	1000	5	0.18	0.15	0.13	0.00	0.00	0.12	0.12	0.00	0.00	0.10	0.22	0.17	0.04	0.29	0.12	0.22	0.00	0.26	0.21	0.21

Note: *Duration specified in hours. Values in boldface type exceed one-year storm recurrence frequency.

Table I-3. (concluded)

1798	8192007	600	5	0.04	0.14	0.04	0.00	0.30	0.06	0.04	0.08	0.08	0.09	0.04	0.00	0.13	0.00	0.00	0.00	0.04	0.04	0.04	0.00
1799	8192007	1900	3	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1800	8202007	500	11	0.29	0.24	0.08	0.21	0.38	0.04	0.08	0.08	0.08	0.18	0.04	0.17	0.26	0.00	0.13	0.17	0.21	0.12	0.30	0.00
1801	8212007	300	13	0.00	0.10	0.00	0.04	0.12	0.04	0.04	0.29	0.17	0.05	0.04	0.00	0.08	0.12	0.09	0.08	0.08	0.02	0.04	0.12
1802	8222007	2200	1	0.04	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1803	8252007	100	13	0.35	0.35	0.17	0.22	0.39	0.30	0.29	0.42	0.34	0.27	0.08	0.13	0.21	0.08	0.08	0.09	0.13	0.12	0.13	0.17

Note: *Duration specified in hours. Values in boldface type exceed one-year storm recurrence frequency.