Technical Memorandum
EMA # 401

Hydrologic Report for St. Lucie County and Preferred Database Development

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by

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EXECUTIVE SUMMARY

This report presents a summary of the hydrometeorologic data (rainfall, evaporation, stage and flow) for St. Lucie County available from the South Florida Water Management District Corporate Database DBHYDRO. A good set of continuous data existing for each site, or preferred data set, is also developed. Preferred dbkeys (database identification key) are assigned to store these preferred data sets in DBHYDRO.

Procedures are presented for selecting and developing each preferred data set. Selection of climatic data sites is based on spatial and temporal distribution. Four rainfall stations out of 27 and two pan evaporation stations out of five have been selected to better describe the rainfall and evaporation distribution in the area. Monthly and yearly statistics (mean, median, standard deviation, maximum and minimum values) for the selected stations, as well as monthly and yearly areal rainfall for the county (tabular and graphical formats), are reported.

Wet season, as depicted from the areal rainfall, goes from June to October and accounts for 61 percent (32.38 inches) of the total annual mean rainfall (52.74 inches). September is the wettest month with a mean monthly rainfall of 7.68 inches. Drought periods have been observed in the county during the 86-year period of record (1914-1999). The wettest and driest years were 1947 (77.76 inches) and 1917 (32.05 inches), respectively.

More than 70 percent of the evaporation occurs during the period March to September. Mean monthly pan evaporation values vary from 5.10 to 5.32 inches in the two selected pan evaporation sites, while mean annual values vary from 61.20 to 63.89 inches.

Flow data are presented for three major structures, namely S-49, S-50 and S-99, while stage data are presented for most of the major canals and structures located in the county (C-23, C-25, G-78, G-79, G-81, S-49, S-50 and S-99). Historical daily data and corresponding monthly and annual statistics are also presented.

Rainfall plays a major role in the St. Lucie hydrologic system. The C-23, C-24 and C-25 drainage basins (53 percent being in St. Lucie County) drain an average of 1.4 million acre-feet annually, with 70 percent going into groundwater storage and consumptive use (irrigation, water supply), and the remaining 30 percent leaving the system through structures S-49, S-97 and S-99. A rainfall-runoff model presented for the three drainage basins depicts a poor relationship ($r^2 = 0.56$). However a strong relationship ($r^2 = 0.99$) is found in plotting a double mass curve for cumulative runoff and rainfall, which shows that the rainfall-runoff relationship is relatively constant through the years.

ACKNOWLEDGEMENTS

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1. INTRODUCTION

St. Lucie County is in the upper east coast planning region of the South Florida Water Management District, at the northeastern corner of the District boundary with the St. Johns River Water Management District (Figure 1). The county lies between the Atlantic Ocean to the east, Okeechobee County to the west, and Martin County to the south.

Five major drainage basins are in the county, namely C-23, C-24, C-25, C-59 and the North Fork of the St. Lucie River Basin, covering a total of 453.6 square miles (Table 1). The North Fork of the St. Lucie River Basin (180.7 square miles) covers about 40 percent of the total drainage-basin area. Fifty-three percent (263.5 square miles) of the C-23, C-24 and C-25 drainage basins lie in St. Lucie County.

Six major water control structures are in the county, namely S-50 (fixed crest weir), S-99 (gated spillway), S-49 (gated spillway), G-78 (gated culvert), G-79 (culvert) and G-81 (steel sheet pile dam with gated weir). Structures S-48 (fixed crest weir) and S-97 (gated spillway) although located on the C-23 canal, which lies in the boundary with Martin County, belong to Martin County. Hydrologic data for these two structures have been summarized in the Hydrologic Report for Martin County (Raymond, 1999) and, therefore, are not presented in this report. However, results from the analysis of the data are used in this report.

The coastal structures S-49, S-50 and S-48 (for Martin County) are the most important and are designed to prevent saltwater intrusion to local groundwater by maintaining upstream water surface elevations to specified design levels. Also S-49, a gated spillway, controls discharge from C-24 to tidewater. The other structures work as dividers between basins and control flood waters from one basin to another. A summary of the structures' information is given in Table 2.

This report will present a summary of the hydrometeorologic information (rainfall, evaporation, flow and stage) available in the District corporate database DBHYDRO for the St. Lucie County, and a methodology to develop a best set of hydrometeorologic information. A good set of information developed and known as the preferred data set will be incorporated into DBHYDRO database. A set of preferred dbkeys has been assigned and are reported.

The hydrometeorologic information is presented in tabular and graphical formats to give better understanding to the reader. Daily, monthly and yearly statistics (mean, median, standard deviation, maximum and minimum values) are presented for rainfall, pan evaporation, flow and stage data.

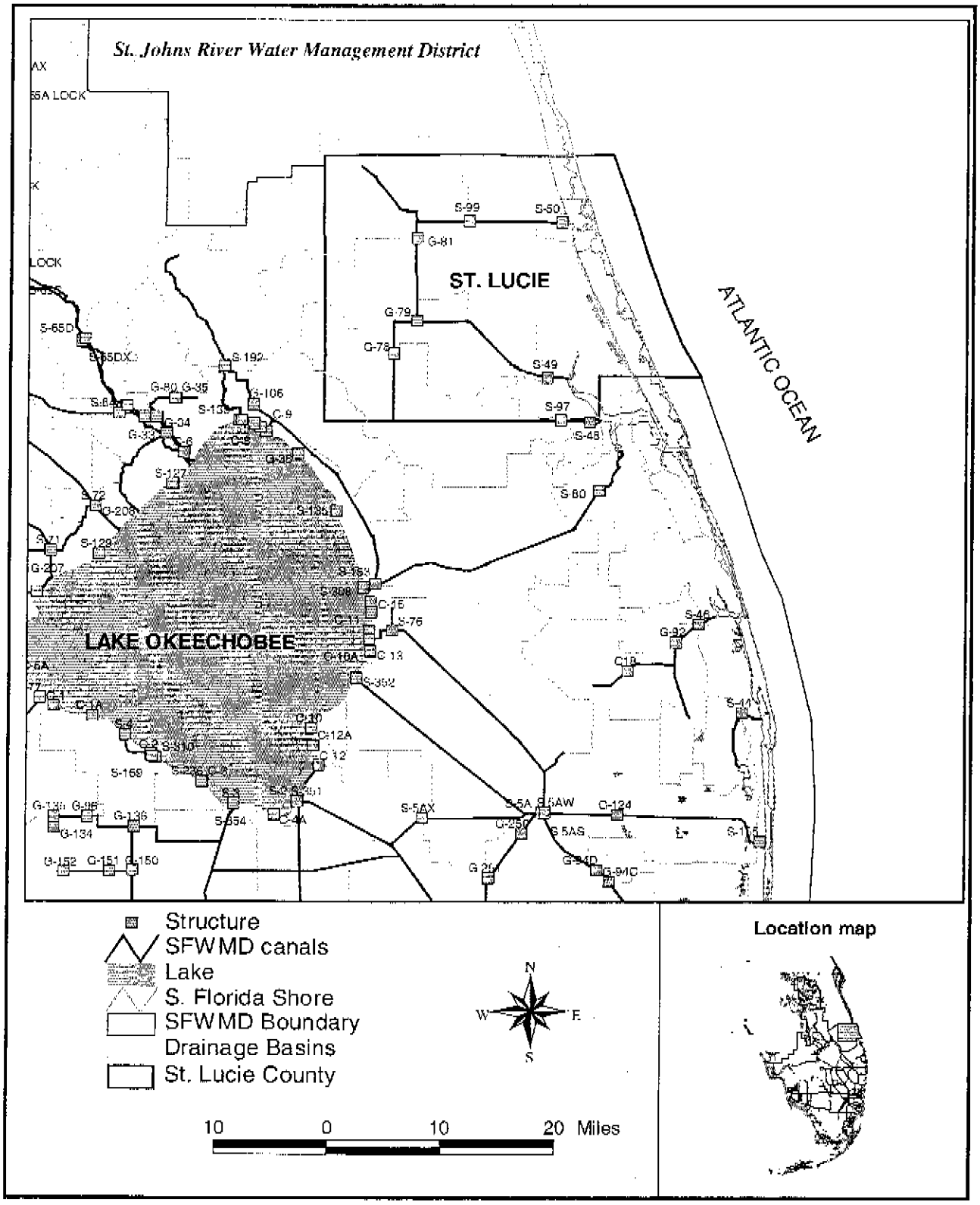


Figure 1. St. Lucie County location map

Table 1. Major drainage basins in St. Lucie County

Basin	St. Lucie County (mi^2)	Martin County (mi^2)	Okeechobee County (mi^2)	Indian River County (mi^2)	Total (mi^2)
C-23	82.7	71.0	14.0	0	167.7
C-25	41.8	0	117	6	164.8
C-24	139.0	0	27.6	0	166.6
C-59	9.4	18.7	159.8	0	187.9
North Fork of the St. Lucie River	180.7	10.9	0	0	191.6
Total (mi^2)	**453.6**	100.6	318.4	6	878.6

Table 2. Description of major structures in St. Lucie County

Control structures	Type	Location (basin)	Specifications
S50	Fixed crest weir	C-25	Maintains stage greater than 12 ft. in lower reach of C-25 if flow in the canal is adequate, to prevent saltwater intrusion to local groundwater
S99	Gated spillway	C-25	Controls water surface elevations in upper reach of C-25 (19.2 ft. $\leq$ HW $\leq$ 20.2 ft. during wet season and 21.5 ft. $\leq$ HW $\leq$ 22.5 ft. during dry season) and discharge to lower reach of C-25.
G81	Steel sheet-pile dam with gated weir	C-25	Normally closed and functions as a divide between C-24 and C-25 basins. Can be opened to supply water from C-25 to C-24 basin during dry season, or to pass flood discharges from one basin to the other.
S49	Gated spillway	C-24	Controls water surface elevations in C-24 and discharge from C-24 to tide water. Prevents saltwater intrusion to local groundwater when flow in the canal is adequate. When flow is adequate, 18.5 ft. $\leq$ HW $\leq$ 20.2 ft. during wet season and 19.5 ft. $\leq$ HW $\leq$ 21.2 ft. during dry season.
G78	Gated culvert	C-24	Functions as a divide between C-23 and C-24 basins. Normally closed, can be opened to discharge excess water from C-23 to C-24 during a storm event, or to supply water during periods of low flow from C-23 to C-24 basin.
G79	Culvert	C-24	Operated as a weir to maintain max. HW stage of 23 ft. in C-23 South to G78. Flashboards are set at 21 ft. during wet season and at 22 ft. during dry season.

2. CLIMATIC DATA

In the following section, the existing climatic data (rainfall, pan evaporation) are presented, as well as a methodology for selecting stations and sites, and for developing the preferred data set.

2.1 EXISTING DATA

2.1.1 Rainfall

Twenty-seven rainfall stations (13 active and 14 non-active) are in St. Lucie County. Figure 2 shows the locations of all the rainfall stations in the county, and Table 3 gives the description of the stations. As it can be noted in Figures 3 and 4, data availability ranges from two to 98 years, and only five stations have 30 or more years of data. The oldest station (98 years) is FORT PIERCE, a National Oceanic and Atmospheric Administration (NOAA) site, with data starting as early as 1901 and a large gap of missing data between 1909 and 1914.

2.1.2 Evaporation

Five pan evaporation stations (two active and three non-active) are in St. Lucie County (Figure 5). Table 4 gives a description of the stations with associated dbkeys in DBHYDRO database. Only the two active sites have data for more than 15 years. As it can be seen in Figure 6, although daily information is available for the two active pan evaporation sites, a large amount of missing daily data are observed. The only period where data were available for all the five sites was during the one-year period 1982-1983.

2.1.3 Other Climatic Data

An active weather station (SVWX, Savannas Preserve weather station) is in St. Lucie County. Starting in 1997, it provides net and total solar radiation, air temperature, relative humidity and wind speed data. However, these climatic data are not part of this report.

2.2 METHODOLOGY

The methodology that will be followed below has been discussed in the hydrologic report for Martin County (Raymond, 1999). It includes station and site selection, and the different methods used for climatic data quality assurance (QA/QC).

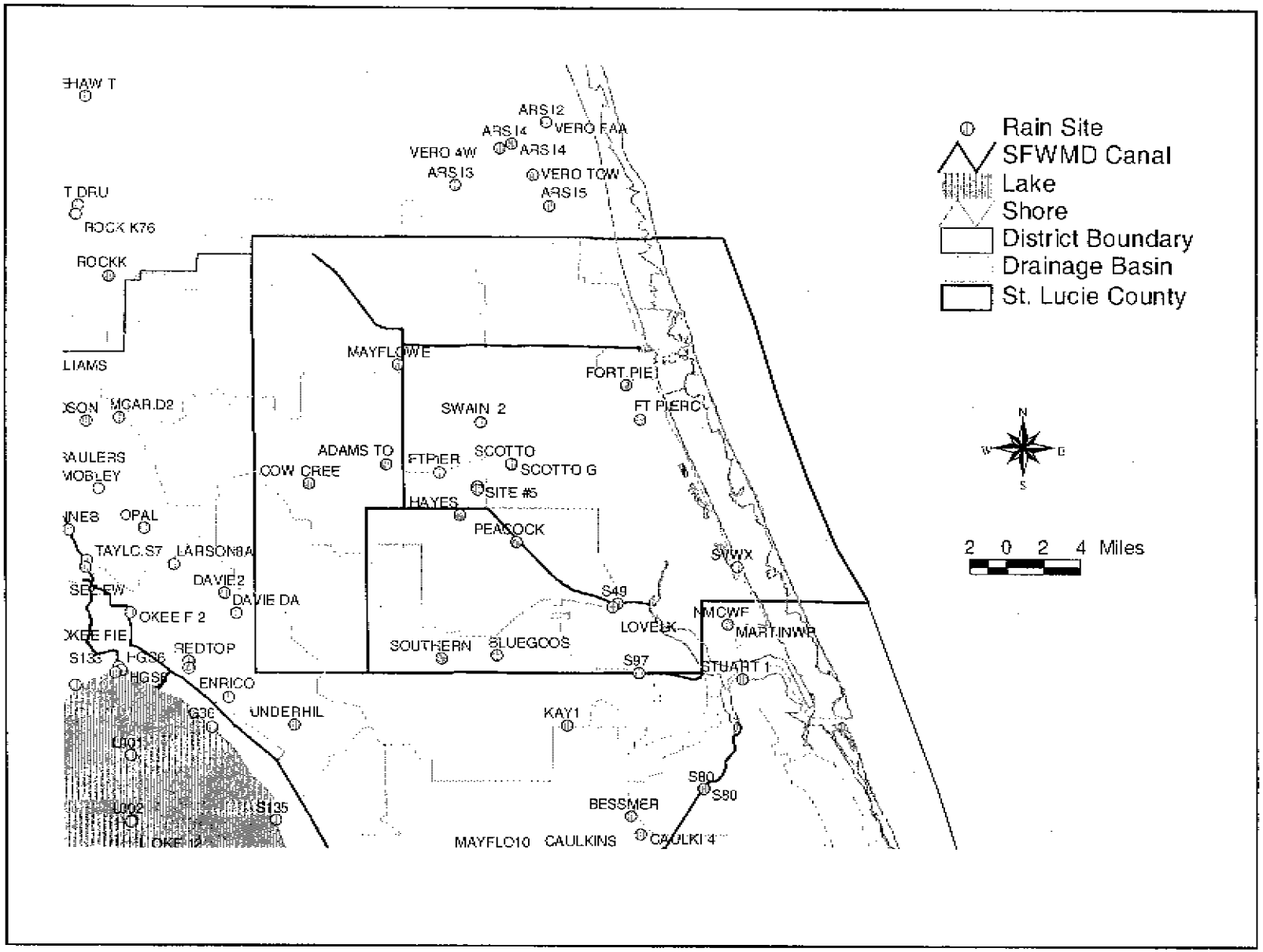


Figure 2. Location of rainfall stations in St. Lucie County

Table 3. Rainfall stations in St. Lucie County

STATION	ALTERNATE ID	AGCY	RCDR	STRT	END	STATION DESCRIPTION	DBKEY	LAT	LONG	yrs*
ADAMS TO_R	MRF5052	FS	????	1969	1988	ADAMS TOWER	06115	272226	803342	20
BLUEGOOS_R	MRF241	WMD	BELF	1979	1998	BLUEGOOSE GROVES	05914	271311	802754	20
BLUEGOOS_R	BLUEG+R	WMD	CR10	1998	2000	BLUEGOOSE GROVES	HD301	271311	802754	3
C24SE	C24SE+R	WMD	CR10	1998	2000	C24SE	JI170	271950	802747	3
COW CREE_R	MRF148	WMD	BELF	1970	1999	COW CREEK RANCH (BELFORT)	05848	272128	803747	30
COW CREE_R	COWCRK+R	WMD	CR10	1998	2000	COW CREEK RANCH (BELFORT)	JG320	272128	803747	3
FORT PIE_R	MRF6032	NOAA	CAN	1901	1998	FORT PIERCE	06151	272516	802059	98
FT PIERC_R	MRF5053	FS	????	1969	2000	FT PIERCE TOWER	06116	272437	802013	32
FT. PIER_R	MRF37	WMD	CAN	1965	2000	FT. PIERCE FIELD STATION	06015	272201	803051	36
FTP FS_R	MRF407	WMD	BELF	1984	1998	FT. PIERCE FIELD STATION	06594	272201	803051	15
FTP FS_R		WMD	OMD	1991	2000	FT. PIERCE FIELD STATION	16591	272201	803051	10
FTP FS_R	FTPIER+R	WMD	CR10	1998	2000	FT. PIERCE FIELD STATION	HD299	272201	803051	3
HAYES_R	MRF40	WMD	BELF	1971	1998	HAYES PROPERTY (BELFORT)	06043	271957	802948	28
MAYFLOWE_R	MRF306	WMD	????	1981	1985	MAYFLOWER CORP. (FT. PIERCE GRO	05968	272717	803303	5
PEACOCK_R	MRF147	WMD	BELF	1970	1979	PEACOCK RANCH (BELFORT)	05847	271840	802648	10
S49_R	S49+R	WMD	SP01	1988	1993	S-49 SPILLWAY ON CANAL C-24 NEA	04004	271542	802132	6
S49_R		WMD	OMD	1991	2000	S-49 SPILLWAY ON CANAL C-24 NEA	16589	271542	802132	10
S49_R	S49-R	WMD	TELE	1997	2000	S-49 SPILLWAY ON CANAL C-24 NEA	K8681	271542	802132	4
S99_R		WMD	OMD	1991	2000	S-99 SPILLWAY ON CANAL C-25 NEA	16672	272814	802818	10
S99_R	S99-R	WMD	TELE	1997	2000	S-99 SPILLWAY ON CANAL C-25 NEA	K8699	272814	802818	4
SCOTTO	SCOTTO+R	WMD	CR10	1998	2000	SCOTTO GROVES @ ST. LUCIE DRAIN	HD784	272227	802703	3
SCOTTO G_R	MRF39	WMD	CAN	1960	1998	SCOTTO GROVES	06031	272224	802702	39
SITE #5_R	MRF346	WMD	BELF	1982	1985	SITE #5 B-1 GROVE (BELFORT)	05995	272118	802853	4
SOUTHERN_R	MRF314	WMD	????	1981	1984	SOUTHERN FRUIT DIST	05975	271300	803052	4
SVWX	SVWX+R	WMD	CR10	1997	2000	SAVANNAS PRESERVE, WEATHER STAT	FI273	271725	801513	4
SWAIN 2_R	MRF390	WMD	BELF	1984	1985	SWAIN GROVE (BELFORT)	06032	272428	802842	2
SWAIN GR_R	MRF347	WMD	????	1982	1983	SWAIN GROVE	05996	272110	802852	2

*: years (rounded) of data available

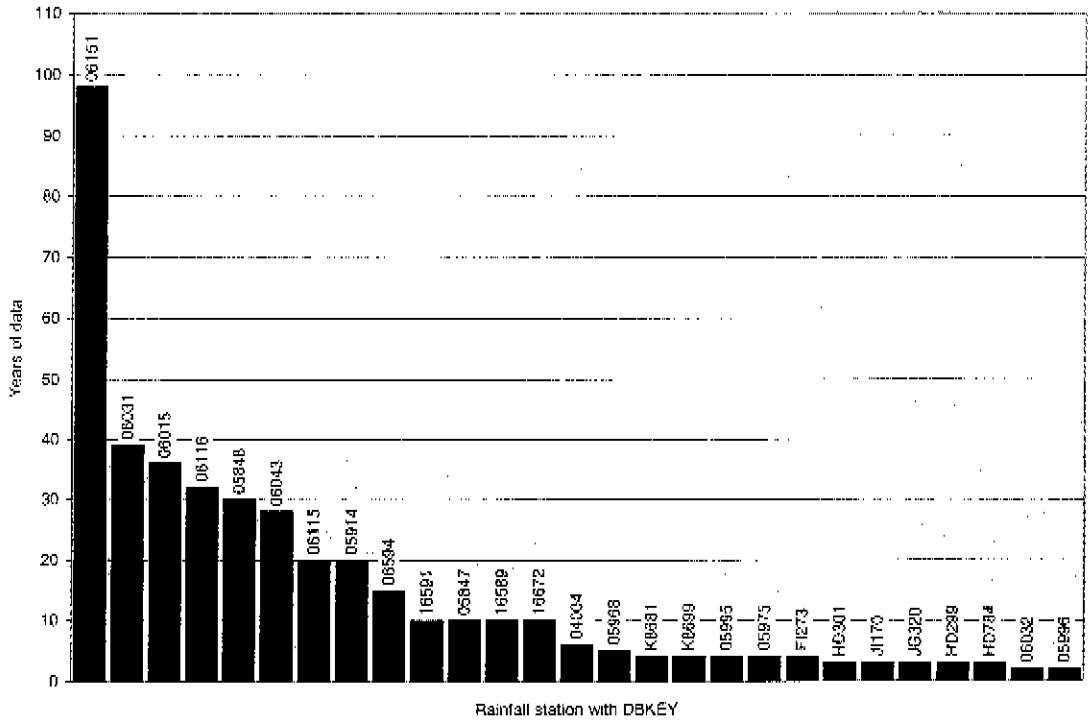


Figure 3. Rainfall data available for St. Lucie County

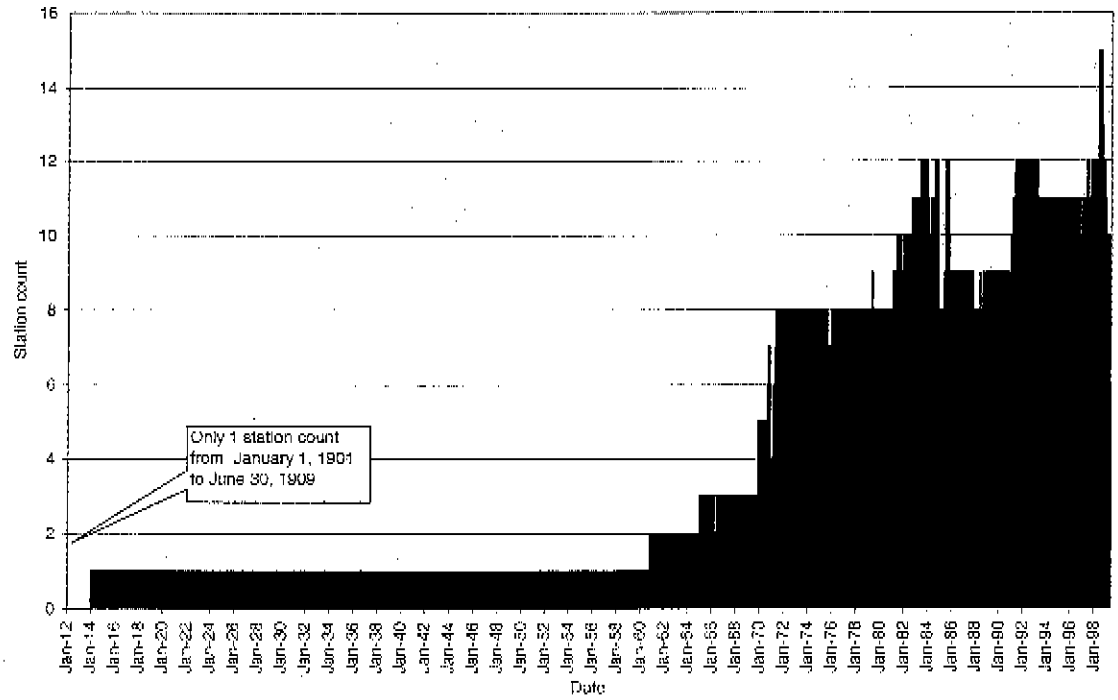


Figure 4. Daily historical rainfall data available for St. Lucie County

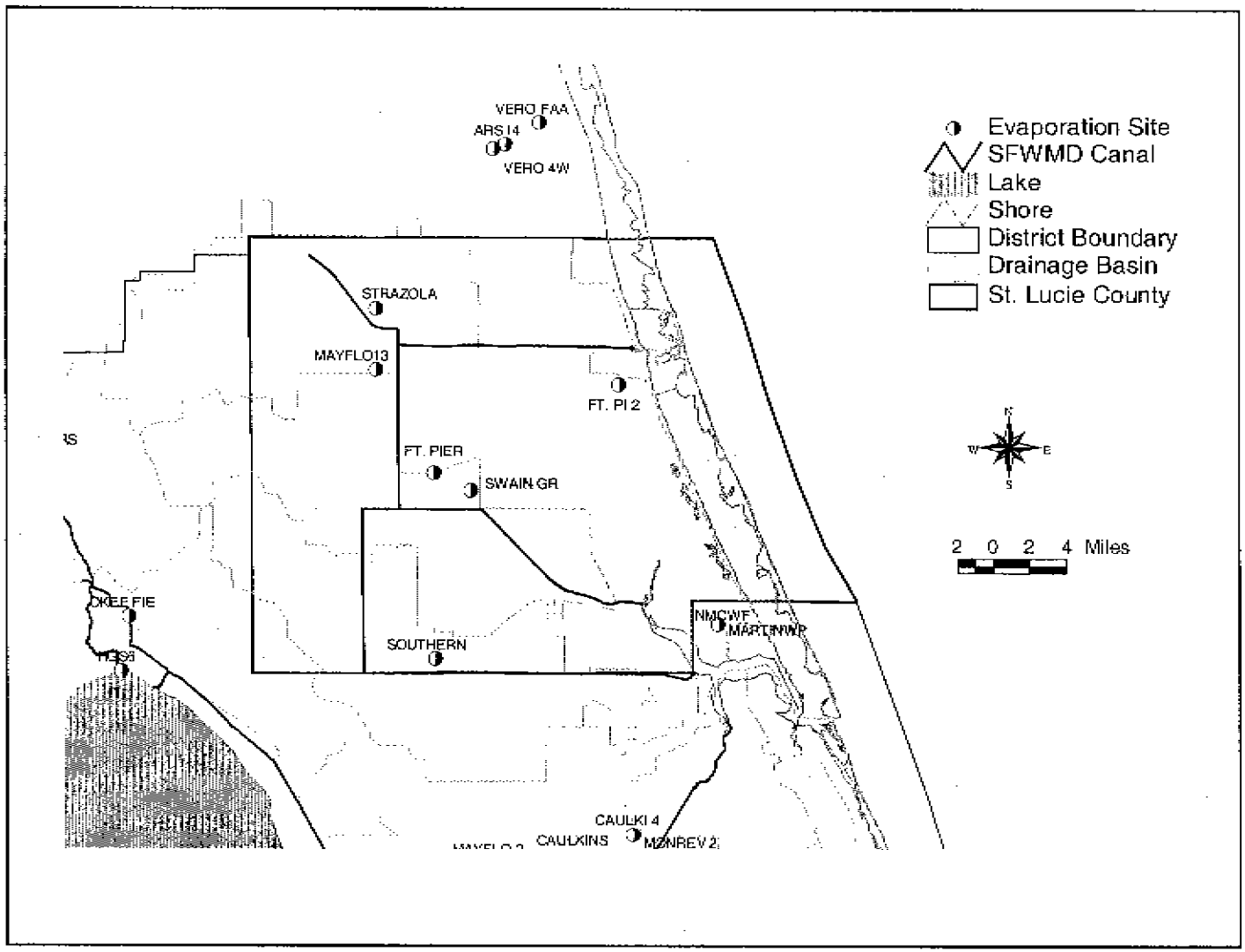


Figure 5. Location of pan evaporation stations in St. Lucie County

Table 4. Evaporation stations in St. Lucie County

STATION	ALTERNATE ID	AGCY	RCDR	STRT	END	STATION DESCRIPTION	DBKEY	LAT	LONG	yrs*
SOUTHERN_E	EVP314	WMD	APAN	1981	1984	SOUTHERN FRUIT DIST	06339	271300	803052	4
SWAIN GR_E	EVP347	WMD	APAN	1982	1983	SWAIN GROVE	06342	272110	802852	2
FT. PIER_E	EVP37	WMD	APAN	1982	2000	FT. PIERCE FIELD STATION	06347	272202	803052	18
FT. PI 2_E	EVP615	WMD	APAN	1969	2000	FT. PIERCE	06356	272616	802059	31
MAYFLO13_E	EVP306	WMD	APAN	1981	1985	MAYFLOWER CORP.	06388	272701	803359	5

*: years (rounded) of data available

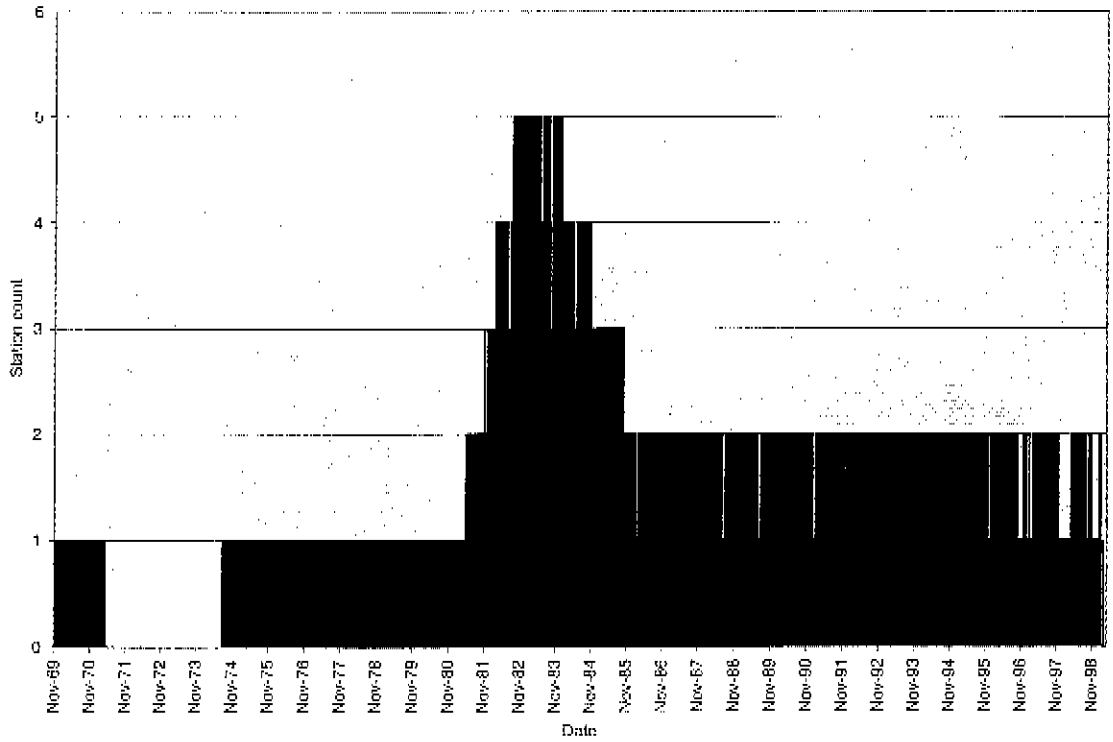


Figure 6. Daily historical pan evaporation data available for St. Lucie County

2.2.1 Station and Site Selection

The selection was based on the following procedure:

a. Stations were grouped based on their proximity to each other.

b. Stations with long periods of record were considered within each group.

c. All stations with less than 10 years of data or with more than 10 percent of missing data were disregarded inside the groups, but were used for filling gaps in selected stations.

Sixteen rainfall groups (Table 5) were determined using this procedure, and four rainfall sites were selected to better represent the rainfall distribution in the county: BLUE GOOSE, COW CREEK, FT PIERCE TOWER and SCOTTO GROVES. For pan evaporation data, only two sites, namely FT PIERCE and FT PIERCE FIELD STATION, were selected based on the same procedure.

2.2.2 QA/QC

Cumulative daily rainfall values

The cumulative daily rainfall values (tagged as A, for cumulated, preceded by X, for unknown value, in DBHYDRO) are common cases in the database for manual recorders. It happens when daily values are cumulated during weekend or holidays, and then recorded on Monday or the next business day.

The procedure is the following:

a. Horizontal distances between rainfall stations were used (under the assumption that there is not much concern about the station elevation; which is indeed the case in the south Florida area where the topography is flat).

b. Cumulative daily rainfall values were distributed in proportion to that of the nearest station, which involves an iterative process whenever the nearest station also has a cumulative value.

Whenever the cumulative daily rainfall values could not be distributed over the period (no data available for nearby stations), and the gap fell between two consecutive months, the specific months were not included in statistical analyses for both monthly and yearly estimates.

Missing daily rainfall values

Daily rainfall estimation also involves a two-step procedure where horizontal distances are used to assign the rainfall value from the nearest station with a value (zero or non-zero) to the missing daily-value station. If the nearest station has a missing value, one proceeds with the value for the next nearest station. An M tag was reassigned to the missing daily rainfall value if there was no close station with data for the day.

Monthly rainfall values

The procedure involved is the following:

a. Regression relationships for monthly total rainfall values between pairs of stations were established.

Table 5. Selected rainfall sites for St. Lucie County

Group	STATION	AGCY	RCDR	STRT	END	STATION DESCRIPTION	DBKEY	LAT	LONG	years	Observations
1	SOUTHERN_R	WMD	????	1981	1984	SOUTHERN FRUIT DIST	05975	271300	803052	4	Too short
2	BLUEGOOS_R	WMD	BELF	1979	1998	BLUEGOOSE GROVES	05914	271311	802754	20	Selected (combined)
	BLUEGOOS_R	WMD	CR10	1998	2000	BLUEGOOSE GROVES	HD301	271311	802754	3	
3	S49_R	WMD	OMD	1991	2000	S-49 SPILLWAY ON CANAL C-24 NEA	16589	271542	802132	10	
	S49_R	WMD	SP01	1988	1993	S-49 SPILLWAY ON CANAL C-24 NEA	04004	271542	802132	6	Too short
	S49_R	WMD	TELE	1997	2000	S-49 SPILLWAY ON CANAL C-24 NEA	K8681	271542	802132	4	
4	SVWX	WMD	CR10	1997	2000	SAVANNAS PRESERVE, WEATHER STAT	FI273	271725	801513	4	Too short
5	PEACOCK_R	WMD	BELF	1970	1979	PEACOCK RANCH (BELFORT)	05847	271840	802648	10	Too short
6	HAYES_R	WMD	BELF	1971	1998	HAYES PROPERTY (BELFORT)	06043	271957	802948	28	
	SWAIN GR_R	WMD	????	1982	1983	SWAIN GROVE	05996	272110	802852	2	Too short
	SITE #5_R	WMD	BELF	1982	1985	SITE #5 B-1 GROVE (BELFORT)	05995	272118	802853	4	Too short
7	COW CREE_R	WMD	BELF	1970	1999	COW CREEK RANCH (BELFORT)	05848	272128	803747	30	Selected (combined)
	COW CREE_R	WMD	CR10	1998	2000	COW CREEK RANCH (BELFORT)	JG320	272128	803747	3	
8	FT. PIER_R	WMD	CAN	1965	2000	FT. PIERCE FIELD STATION	06015	272201	803051	36	
	FTP FS_R	WMD	BELF	1984	1998	FT. PIERCE FIELD STATION	06594	272201	803051	15	
	FTP FS_R	WMD	OMD	1991	2000	FT. PIERCE FIELD STATION	16591	272201	803051	10	
	FTP FS_R	WMD	CR10	1998	2000	FT. PIERCE FIELD STATION	HD299	272201	803051	3	
9	SCOTTO G_R	WMD	CAN	1960	1998	SCOTTO GROVES	06031	272224	802702	39	Selected
	SCOTTO	WMD	CR10	1998	2000	SCOTTO GROVES @ ST. LUCIE DRAIN	HD784	272227	802703	3	Too short
10	ADAMS TO_R	FS	????	1969	1988	ADAMS TOWER	06115	272226	803342	20	
11	SWAIN 2_R	WMD	BELF	1984	1985	SWAIN GROVE (BELFORT)	06032	272428	802842	2	Too short
12	FT PIERC_R	FS	????	1969	2000	FT PIERCE TOWER	06116	272437	802013	32	
13	FORT PIE_R	NOAA	CAN	1901	1998	FORT PIERCE	06151	272616	802059	98	Selected
14	MAYFLOWE_R	WMD	????	1981	1985	MAYFLOWER CORP. (FT. PIERCE GRO	05968	272717	803303	5	Too short
15	S99_R	WMD	OMD	1991	2000	S-99 SPILLWAY ON CANAL C-25 NEA	16672	272814	802818	10	Too short
	S99_R	WMD	TELE	1997	2000	S-99 SPILLWAY ON CANAL C-25 NEA	K8699	272814	802818	4	Too short
16	C24SE	WMD	CR10	1998	2000	C24SE	JI170	271950	802747	3	Too short

b. Monthly rainfall totals (derived from the sum of daily rainfall totals) were checked against the estimated total monthly rainfall derived from regression equations. If they differ significantly, then an adjustment to the estimated daily values is necessary.

The three procedures described above for cumulative daily rainfall values, daily rainfall values and monthly rainfall values, will be used jointly and iteratively when doing QA/QC. Regression relationships for pairs of stations located nearby (group of stations) were completed. Pairs of monthly data points with missing values were disregarded. The estimated monthly values from the regression relationship were used jointly with the procedures discussed above for estimating missing daily values. The full procedure discussed above is shown in the flow chart on Figure 7.

Pan evaporation data

The procedure involved is to:

a. Limit maximum daily pan evaporation values, based on location, month, maximum extra-terrestrial radiation (water equivalent values are 0.36, 0.43, 0.52, 0.59, 0.62, 0.64, 0.63, 0.60, 0.54, 0.46, 0.38, 0.34 inches/day for January to December), and on the fact that approximately 58 percent of the solar radiation is not reflected into universal space (Gray, D., 1970). Therefore, an estimated daily maximum pan evaporation was 0.37 inches.

b. Estimate daily missing records using linear interpolation.

2.2.3 Estimating Areal Rainfall

The objective for estimating areal rainfall is to provide a data summary for the historical rainfall average over the study area. This average can be computed in two ways: (i) from a weighted average using the Thiessen polygon method, whenever the digital boundary for the area is available, or (ii) simply from an arithmetic average of the data.

Since there are years for given stations without data, the Thiessen polygon method requires a different weight for each subsequent layout of the rainfall stations, and, therefore, was not used, being cumbersome. The arithmetic average was used in this report.

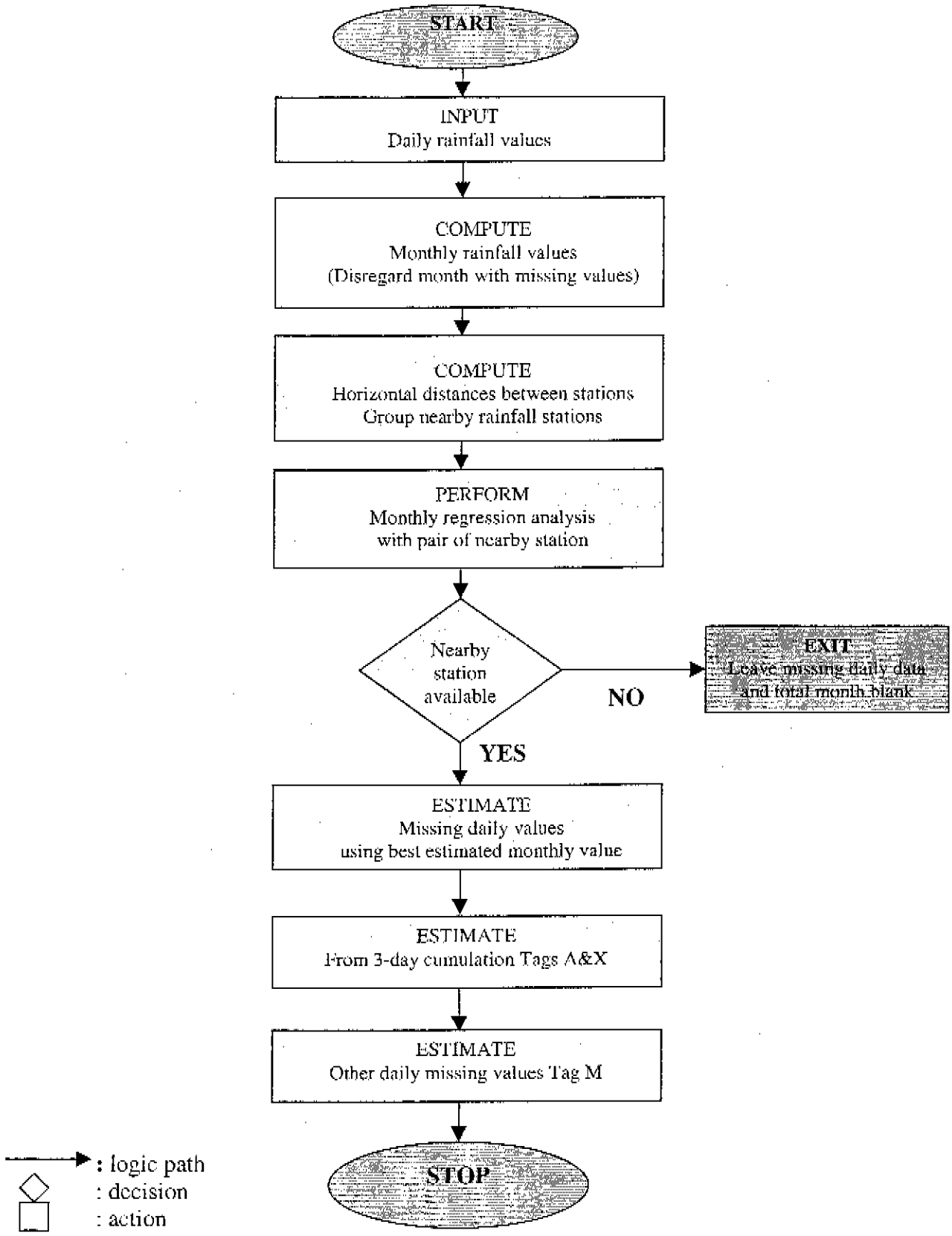


Figure 7. Flow chart for estimating missing daily rainfall values

2.3 SUMMARY OF CLIMATIC DATA

2.3.1 Rainfall

For the selected monitoring sites in Figure 8, horizontal distances are given in Table 6. Regression relationships between pairs of rainfall stations are given in Table 7. Appendix A gives a summary of the daily and annual historical rainfall data for the four selected stations BLUEGOOS_R, COW CREE_R, FORT PIE_R and SCOTTOG_R. Annual mean rainfall varies from 46.26 inches in COW CREE_R to 58.67 inches in SCOTTOG_R. Monthly and annual rainfall statistics (mean, maximum, minimum, median and standard deviation) are presented on tabular format in Appendix B and graphically in Figures 9, 10, 11 and 12. The monthly means at the selected rainfall sites are 4.26 inches (BLUEGOOS_R), 3.86 inches (COW CREE_R), 4.43 inches (FORT PIE_R) and 4.89 inches (SCOTTOG_R).

Computed daily distribution of areal rainfall is given in Figure 13. The maximum of 7.37 inches was reached during Hurricane Cleo (08/27/64), which was among the worst hurricanes in the southeast coastal area of Florida. Cleo (Figure 14) moved up the east coast of peninsular Florida, about 20 miles inland, paralleling the east coast, and damaging citrus groves in the Indian River area and vegetable fields in the Pompano Beach and Ft. Pierce areas (Attaway, 1999). Hurricane Cleo caused heavy damage to vegetable crops along the lower east coast, particularly vine-ripe tomatoes in the Pompano Beach area, mature green tomatoes in the Ft. Pierce area and early pepper plantings in the Pompano Beach-Martin County area.

Monthly and annual distribution of areal rainfall is given in Appendix B and Figure 15, while the monthly statistics are presented in Figure 16. For the 86-year period, the mean annual areal rainfall for St. Lucie County is 52.74 inches, and the monthly mean is 4.39 inches. The wet season, as depicted in Figure 16, goes from June to October, accounting for 61 percent (32.38 inches) of the total rainfall (52.74 inches). September is the wettest month with a mean monthly of 7.68 inches. The driest year was 1917 with 32.05 inches, while the wettest year was 1947 with 77.76 inches.

2.3.2 Evaporation

Historical daily and monthly evaporation data are summarized in Appendix C for the two sites FT. PI2_E and FT. PIER_E. The monthly and annual statistics are presented in tabular form in Appendix D and in graphical format in Figures 17 and 18.

Mean annual pan evaporation varies from 61.2 to 63.89 inches, while mean monthly evaporation is 5.1 and 5.32 inches for the two sites FT. PI2_E and FT. PIER_E respectively. For both sites, more than 70 percent of the evaporation occurs during March to September.

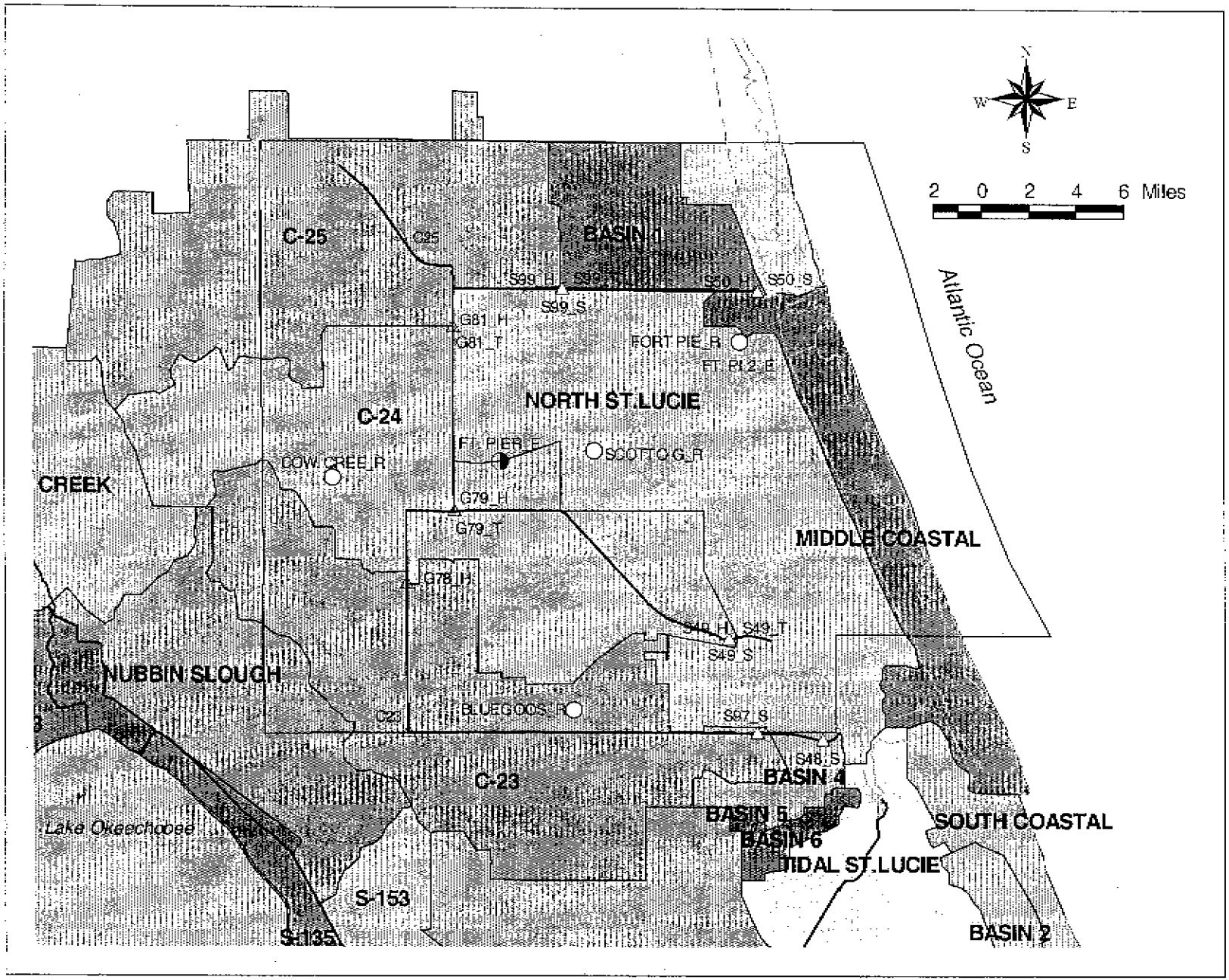


Figure 8. Selected monitoring sites in St. Lucie County

Table 6. Distances between selected rainfall stations (miles) in St. Lucie County

Site	FORT PIE	COW CREE	BLUE GOOSE	SCOTTO
FORT PIE		18	17	8
COW CREE			14	11
BLUE GOOSE				11
SCOTTO				

Table 7. Regression relationships between selected rainfall stations (monthly values) within St. Lucie County

Site X	Site Y	Equation	r^2
FT. PIER	BLUE GOOSE	Y = 0.82 X + 0.54	0.68
FT. PIER	COW CREE	Y = 0.77 X + 0.53	0.72
STUART	FORT PIE	Y = 0.85 X + 0.18	0.87
FORT PIE	SCOTTO	Y = 0.91 X + 0.87	0.52

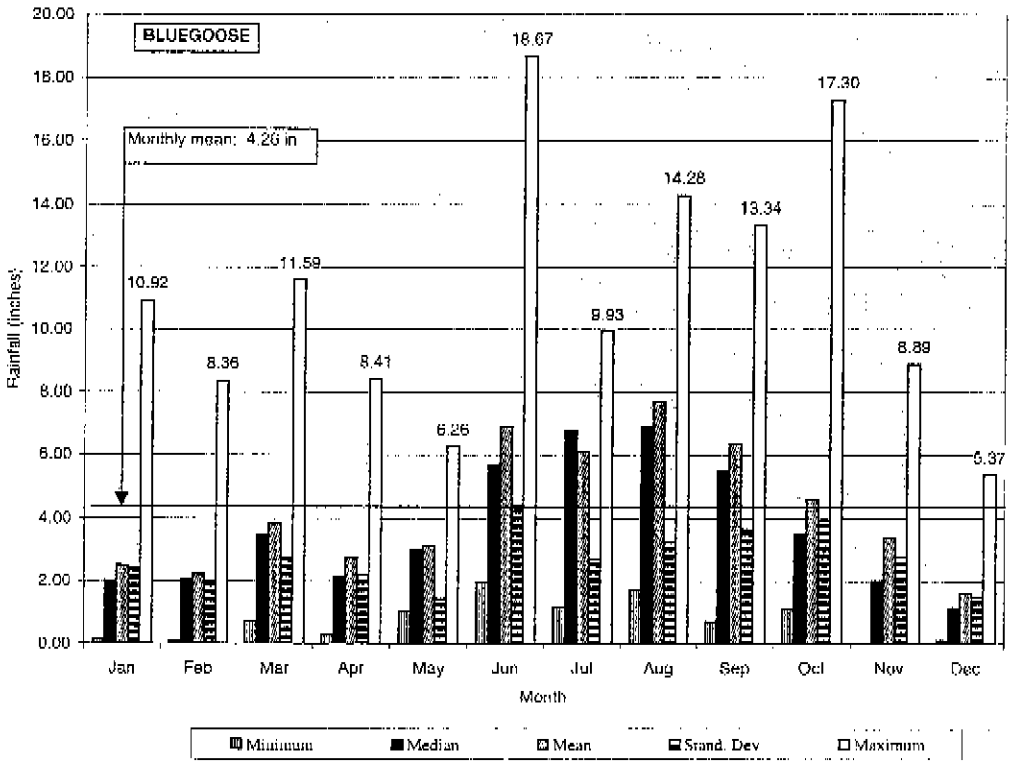


Figure 9. Statistics for monthly rainfall at station BLUEGOOS_R (Period: 01/01/79-12/31/99)

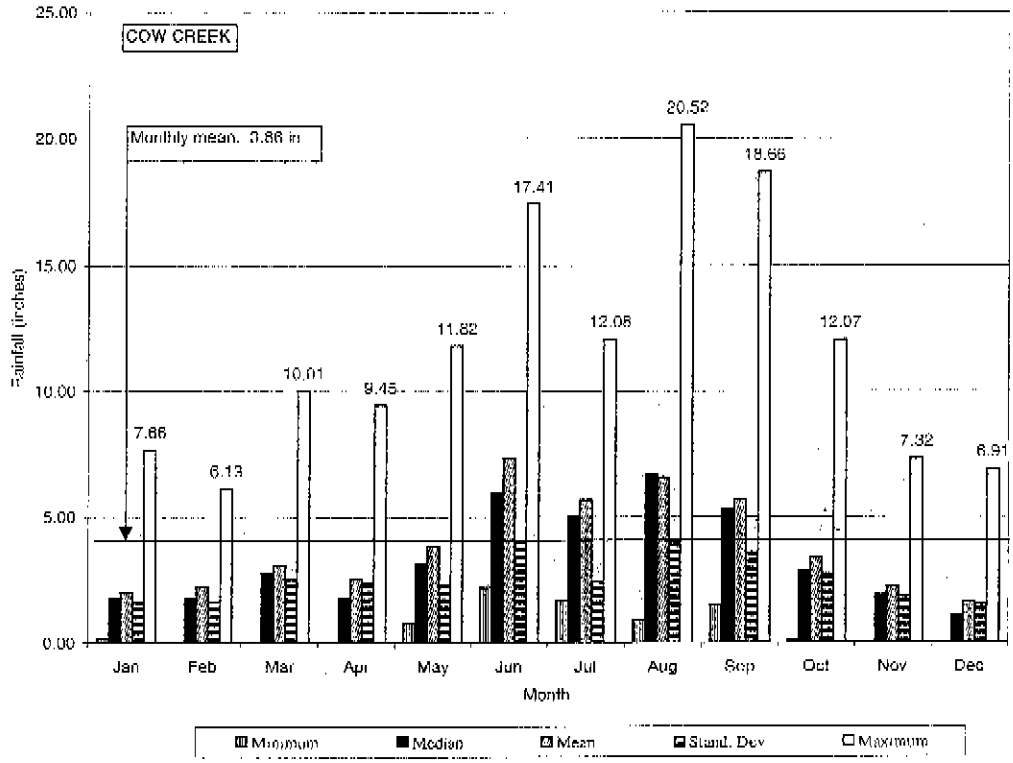


Figure 10. Statistics for monthly rainfall at station COW CREE_R (Period: 01/01/70-12/31/99)

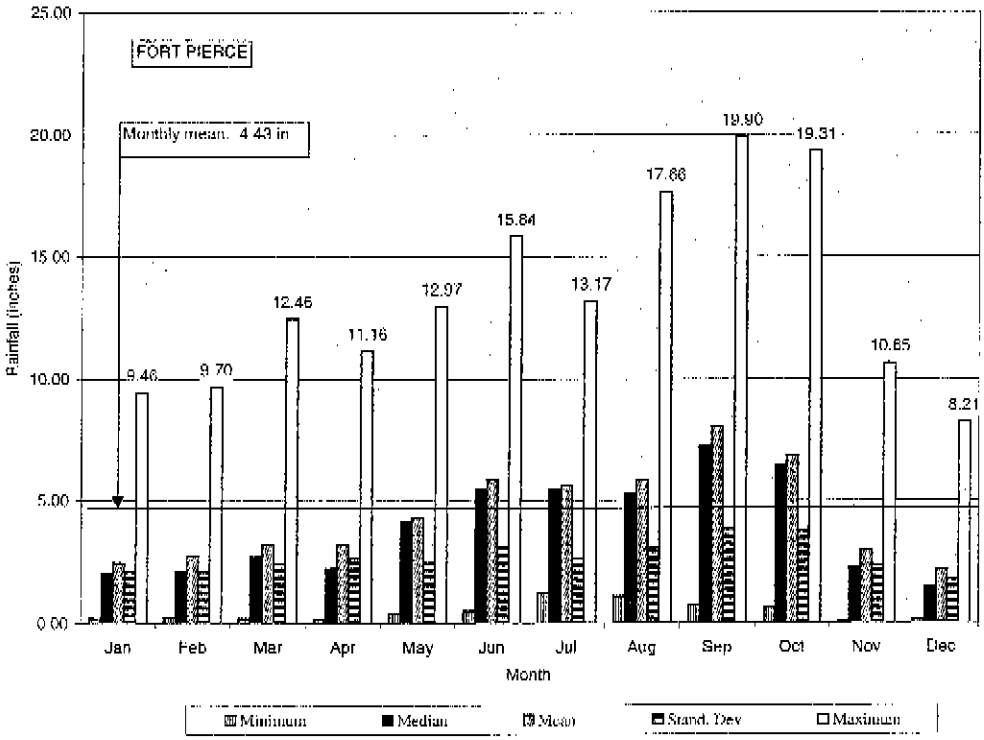


Figure 11. Statistics for monthly rainfall at station FORT PIE_R (Period: 01/01/14-12/31/98)

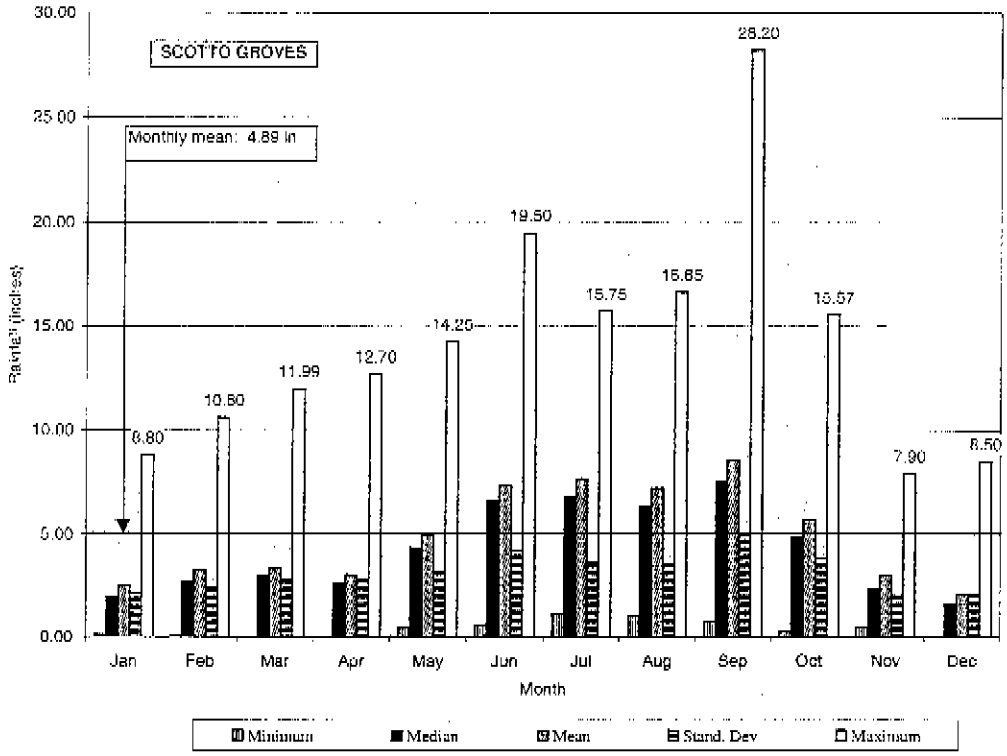


Figure 12. Statistics for monthly rainfall at station SCOTTO G_R (Period: 01/01/60-12/31/99)

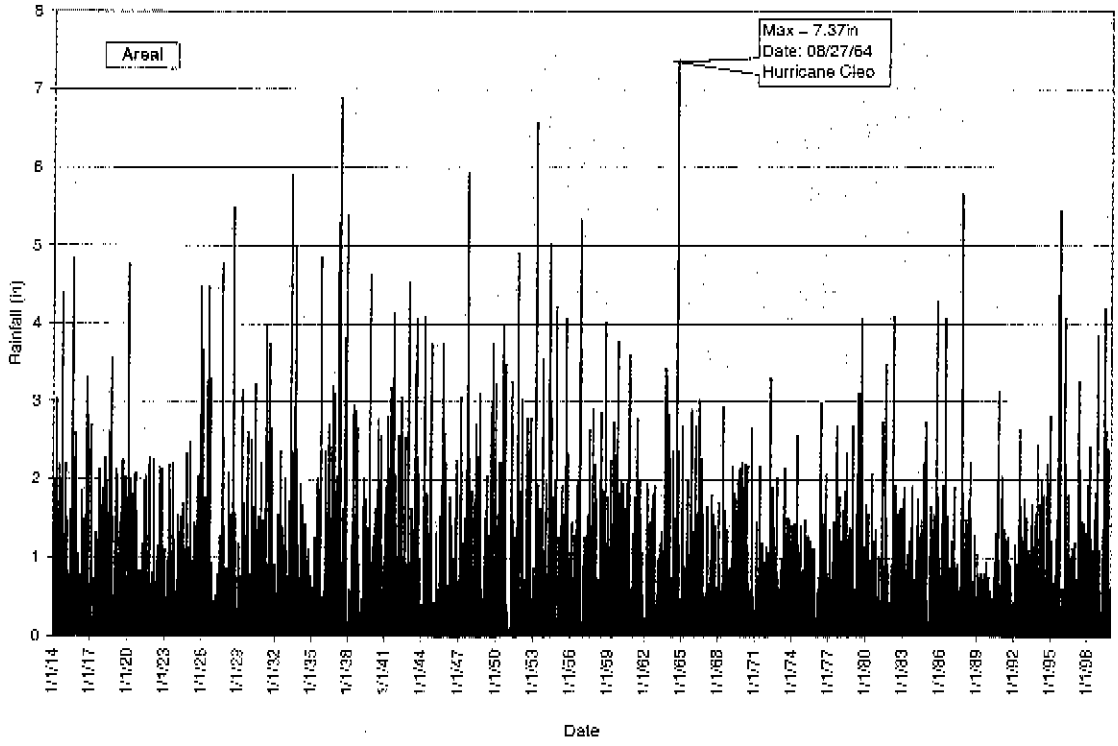


Figure 13. Daily distribution of areal rainfall in St. Lucie County

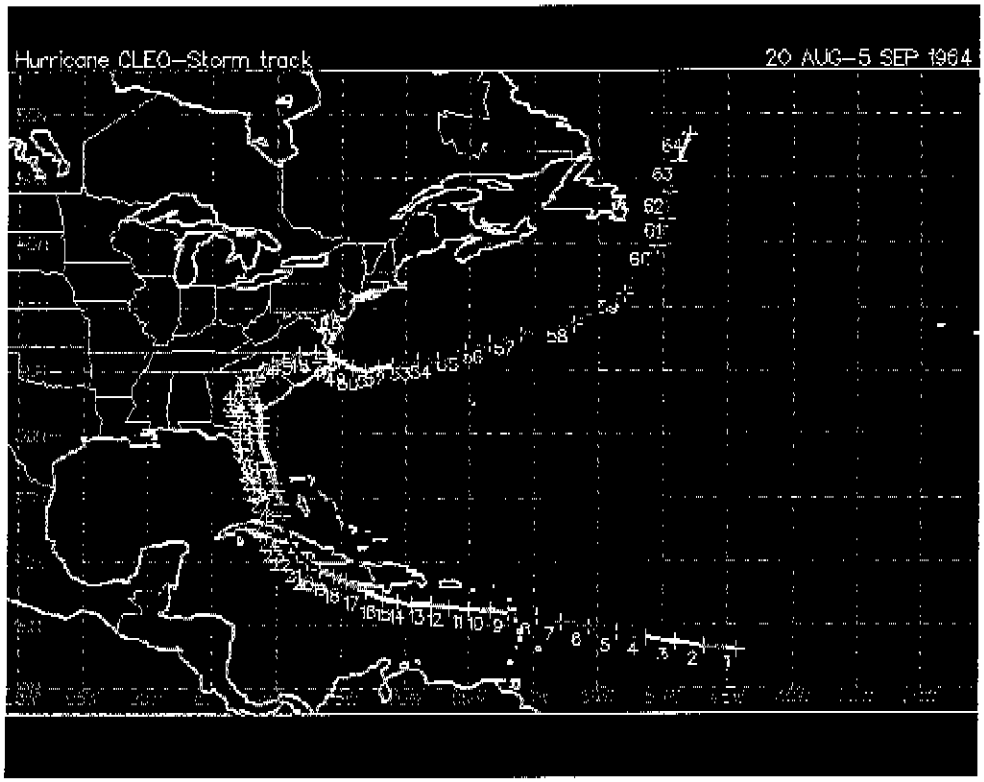


Figure 14. Hurricane Cleo track (08/20-09/05/64)

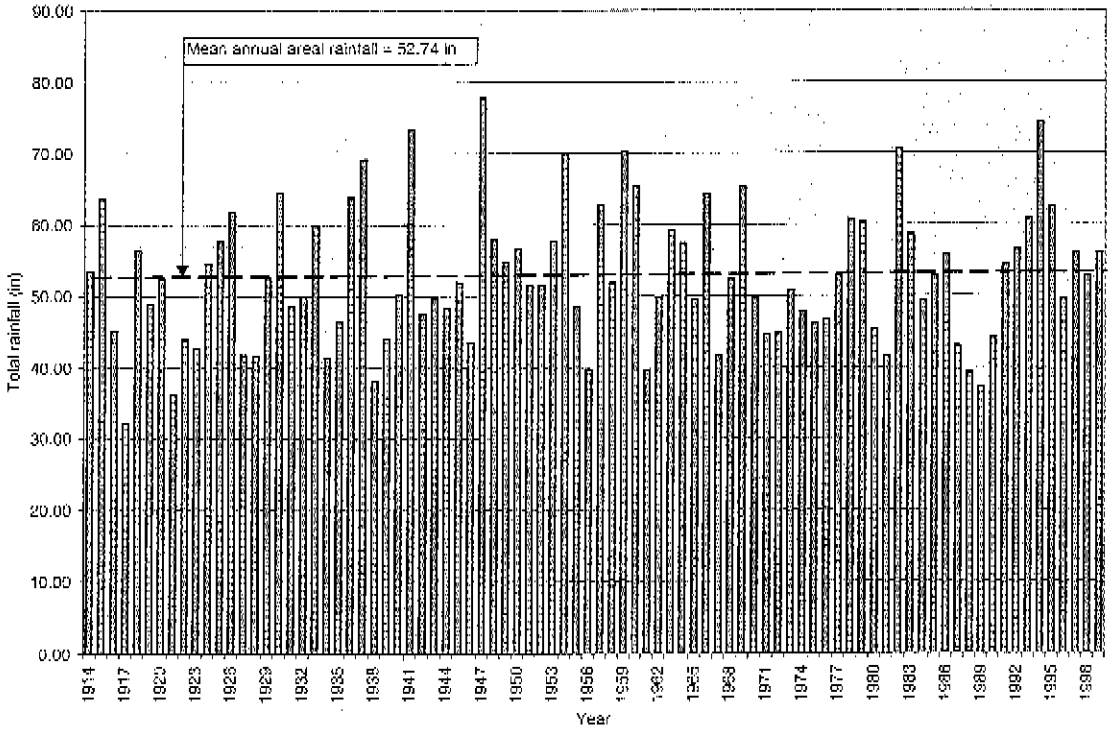


Figure 15. Yearly distribution of areal rainfall in St. Lucie County

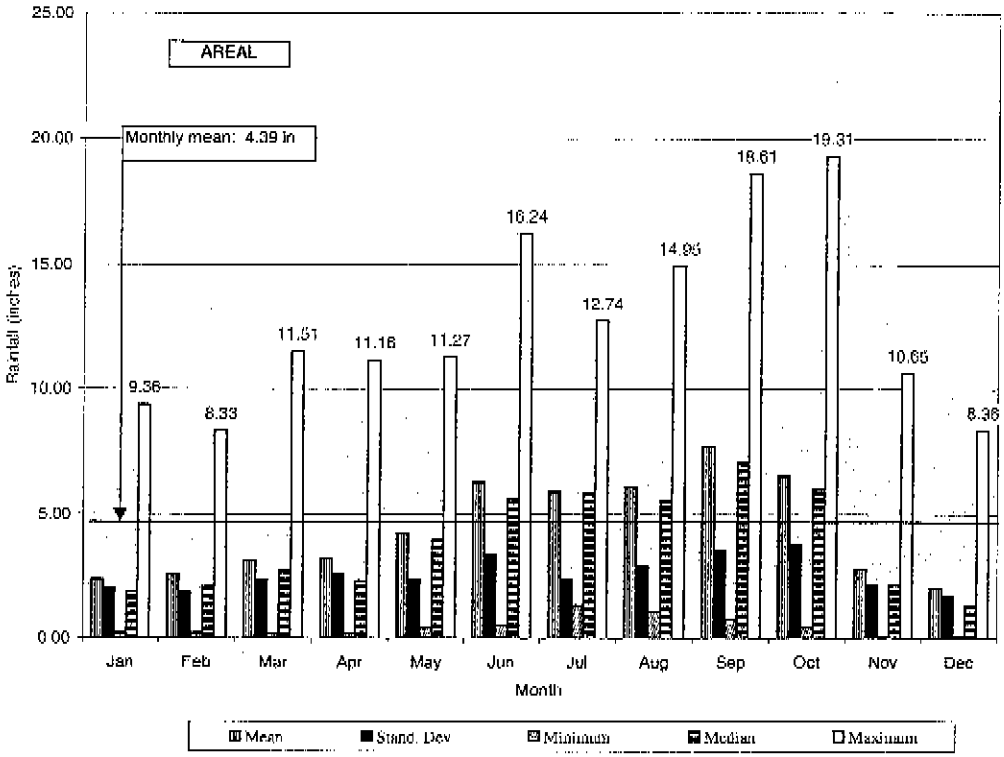


Figure 16. Statistics for monthly areal rainfall in St. Lucie County (Period: 01/01/14 12/31/99)

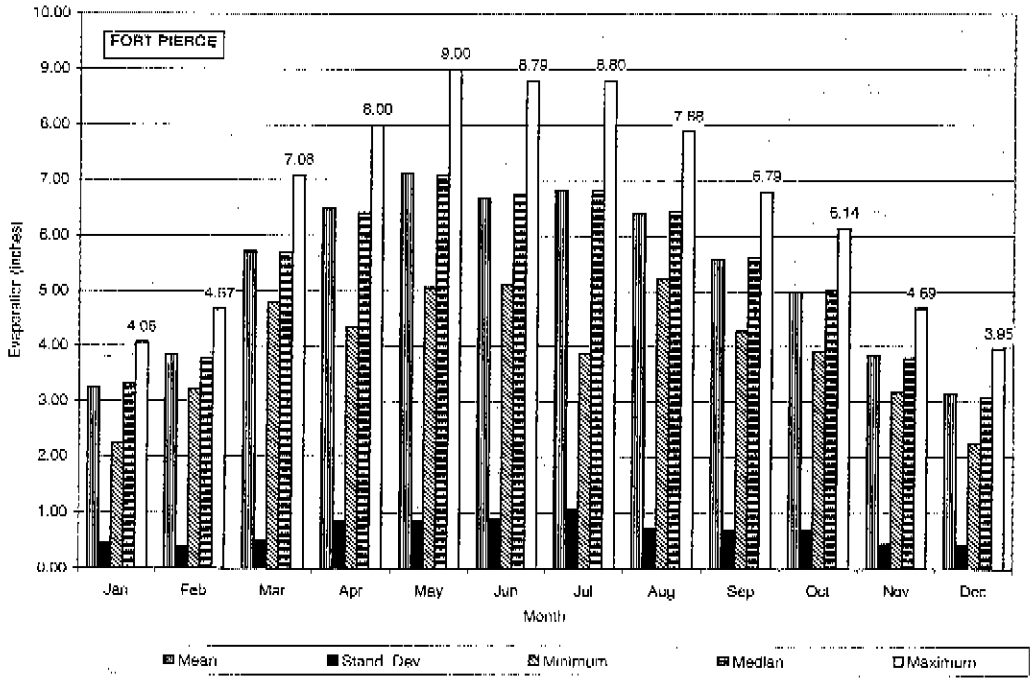


Figure 17. Statistics for monthly pan evaporation at station FT. PI2_E (Period: 01/01/75-12/31/99)

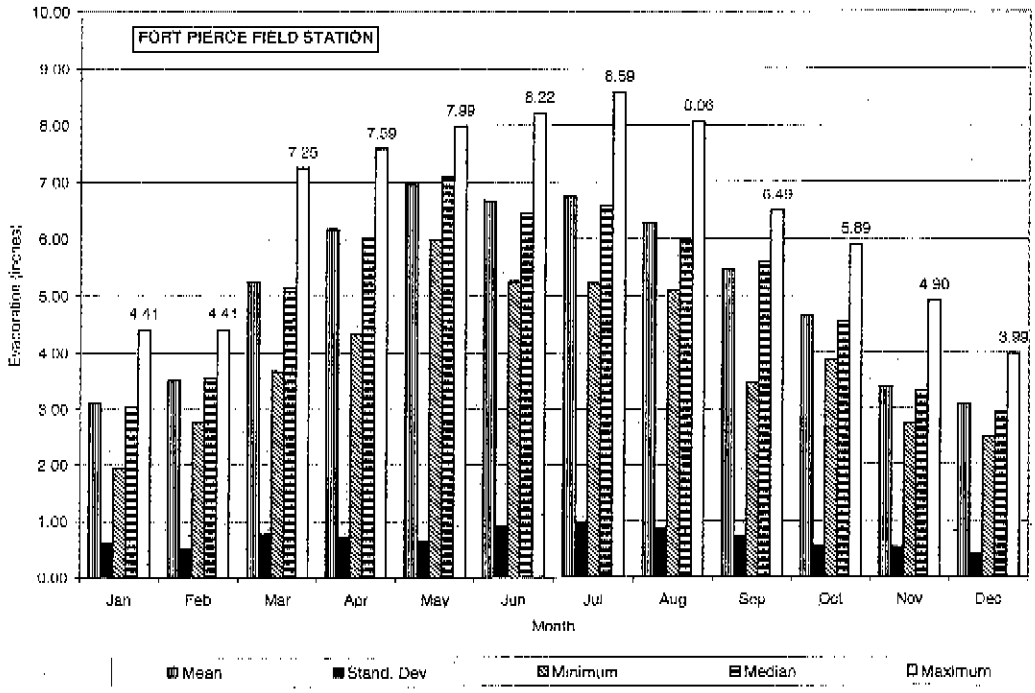


Figure 18. Statistics for monthly pan evaporation at station FT. PIER_E (Period: 01/01/82-12/31/98)

3. SURFACE WATER DATA

In the following section, the existing flow and stage data are presented as well as a summary of structure operation and specification. A methodology for site selection is also discussed and a summary of information is presented.

3.1 EXISTING DATA

3.1.1 Flow

Fifteen flow stations (five active and 10 non-active) are located in eight flow monitoring sites in St. Lucie County (Figure 19). Data availability varies from two to 32 years and is summarized in Table 8.

Each structure's operation is based on stage elevation data. Therefore, the QA/QC process involves some basic knowledge of structure operation and specification, as discussed below.

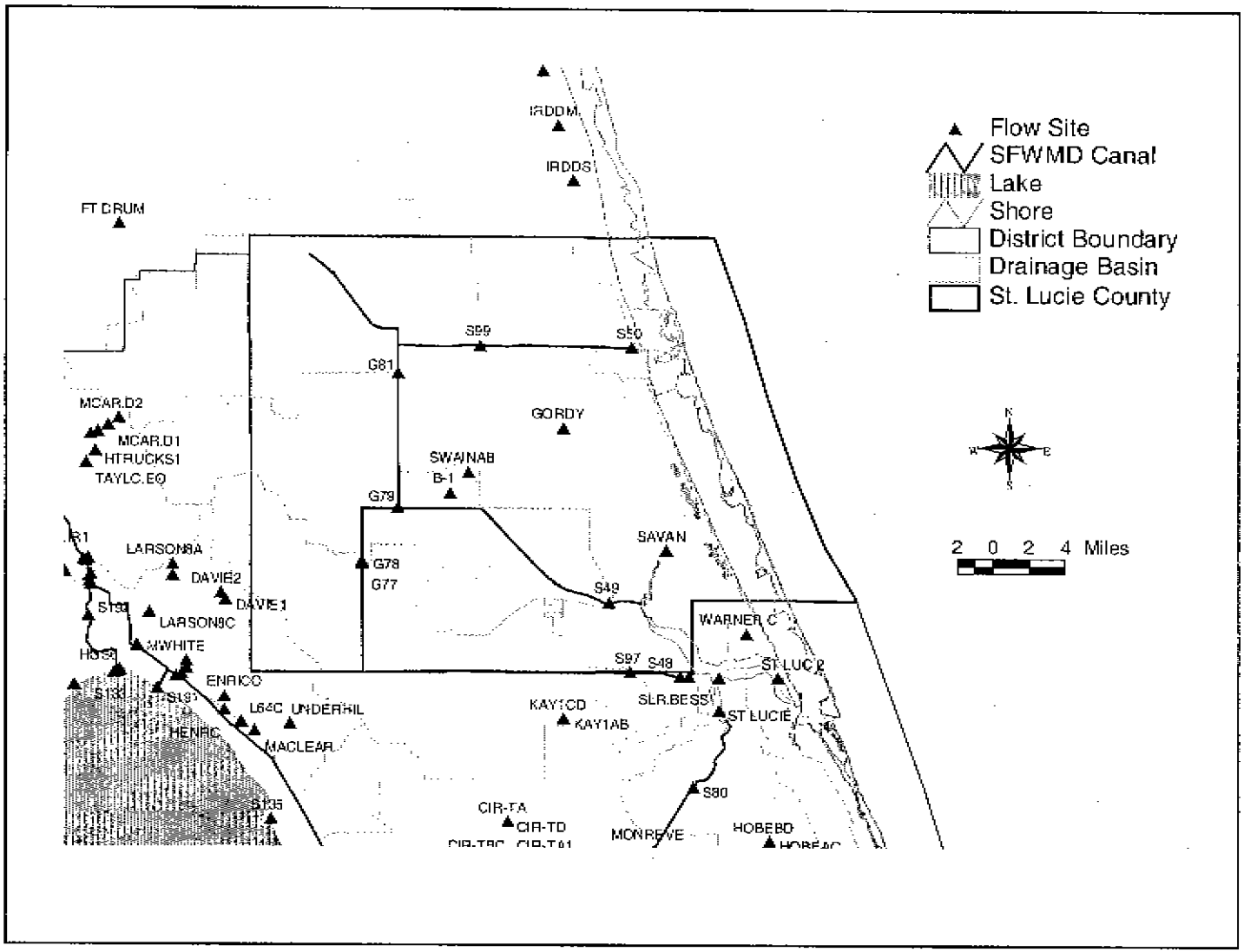


Figure 19. Location of flow stations in St. Lucie County

Table 8. Flow stations in St. Lucie County

STATION	ALTERNATE ID	AGCY	RCDR	STRT	END	STATION DESCRIPTION	DBKEY	LAT	LONG	years*
G79_C	71736381	WMD	NA	1986	1999	G79 DIVIDING STRUCTURE BETWEEN	16559	272019	803247	14
G81_C	20835381	WMD	TELE	1997	2000	C24 AT S.R. 68	FB763	272652	803246	4
G81_C	60835381	WMD	NA	1995	1998	C24 AT S.R. 68	16564	272652	803246	4
G81_C	50835381	WMD	STAF	1987	1996	C24 AT S.R. 68	06887	272652	803246	10
S49_S	21737401	WMD	TELE	1994	2000	S-49 SPILLWAY ON CANAL C-24 NEA	15777	271542	802132	7
S49_S	61737401	WMD	NA	1987	1994	S-49 SPILLWAY ON CANAL C-24 NEA	12741	271542	802132	8
S49_S	51737401	WMD	NA	1961	1992	S-49 SPILLWAY ON CANAL C-24 NEA	04790	271542	802132	32
S50_S	63334401	WMD	NA	1995	2000	S-50 SPILLWAY ON CANAL C-25 AT	16535	272807	802017	6
S50_S	53334401	WMD	NA	1964	1995	S-50 SPILLWAY ON CANAL C-25 AT	04388	272807	802017	32
S99_S	20635391	WMD	TELE	1994	2000	S-99 SPILLWAY ON CANAL C-25 NEA	15783	272814	802818	7
S99_S	60635391	WMD	SP01	1987	1994	S-99 SPILLWAY ON CANAL C-25 NEA	07744	272814	802818	8
S99_S	50635391	WMD	NA	1964	1993	S-99 SPILLWAY ON CANAL C-25 NEA	04856	272814	802818	30
SAVAN	2276568	USGS	NA	1976	1977	SAVANNAHS DRAINAGE CANAL AT POR	00274	271813	801826	2
VAIN	VAIN+Q	WMD	CR10	1993	1996	VIRGINIA AVENUE RETENTION POND/INFLOW	DU529	272521	801910	4
VAOU	VAOU+Q	WMD	CR10	1993	1996	VIRGINIA AVENUE RETENTION POND/OUTFLOW	DU527	272529	801904	4

*: years (rounded) of data available

Structure S-50:

- Operation of this coastal structure is uncontrolled.
- Since weir crest elevation is 12 feet, discharge begins only when the upstream water surface elevation exceeds 12 feet.
- Control of the drainage basin is affected by S-99 located about 8 miles upstream.

Structure S-99:

- During low range conditions, when the headwater falls to 19.2 feet, the gates begin to close. The gates remain closed when the headwater elevation rises or falls to elevation 19.7 feet. The gates begin to open when the headwater elevation rises to 20.2 feet.
- During high range conditions, the gates begin to close when the headwater elevation falls to 21.5 feet. The gates remain closed when headwater elevation rises or falls to 22.0 feet. The gates begin to open when the headwater elevation rises to 22.5 feet.

Structure S-49:

- During the flood season and under normal conditions, the gates begin to open when the headwater rises to 20.2 feet, remain closed when the headwater rises or falls to elevation 19.0 feet, and begin to close when the headwater elevation falls to 18.5 feet.
- During the dry season and under normal conditions, the gates begin to open when the headwater rises to 21.2 feet, remain open when the headwater rises or falls to elevation 20.0 feet, and begin to close when the headwater elevation falls to 19.5 feet.

Structure G-81 (Orange Avenue Control Structure):

- Allows uncontrolled flow from C-24 to C-25 basin (and vice versa) when stage on either side of the structure exceeds the crest elevation of 23.0 feet.
- During the dry season the structure is opened when the stage at S-49 (C-24 basin) is below optimum and when it is considerably lower than the stage measured at S-99 (C-25 basin).
- During the flood season the structure is opened when flood conditions exist in one basin and additional flows will not create a flood condition in the other basin.

Structure G-79 (Carlton Road Control Structure):

- The structure acts as a drainage structure for C-23 between G-78 and G-79, and it permits flow to be transferred from C-23 to C-24 as required.
- Control is effected by flashboards mounted on a riser pipe on the west end of the culverts.

G-78 (C-23 Plug Structure):

- The structure acts as a drainage divide structure of C-23 between the north and south sides of the structure.
- Control is effected by flashboards mounted on a riser pipe at the south end of the culvert (top elevation is 23.2 feet).
- The structure is normally closed but it allows transfer of water from C-23 to C-24 when the western portion of the C-23 basin is well in excess of optimum and the C-24 basin has capacity to spare.

3.1.2 Stage

There are 56 stage monitoring stations in St. Lucie County at 20 sites. Only nine sites are active and located at the major structures and in C-23 and C-25 canals. Figure 20 gives a layout of stage location in St. Lucie County. Table 9 gives a summary of all the stage monitoring stations with descriptions and years of data available.

3.2 METHODOLOGY

The methodology includes the selection of station and sites, a QA/QC process involving graphical examination, establishing relationships between flow sites, and filling gaps of missing data.

3.2.1 Station and Site Selection

Only three flow sites were selected, namely S-50, S-99 and S-49. The selection was based on the importance of the structure and the availability of information on the station. For stage data, more information was available; therefore more sites were selected. The stage sites include C-23, C-25, G-78, G-79, G-81, S-49, S50 and S-99.

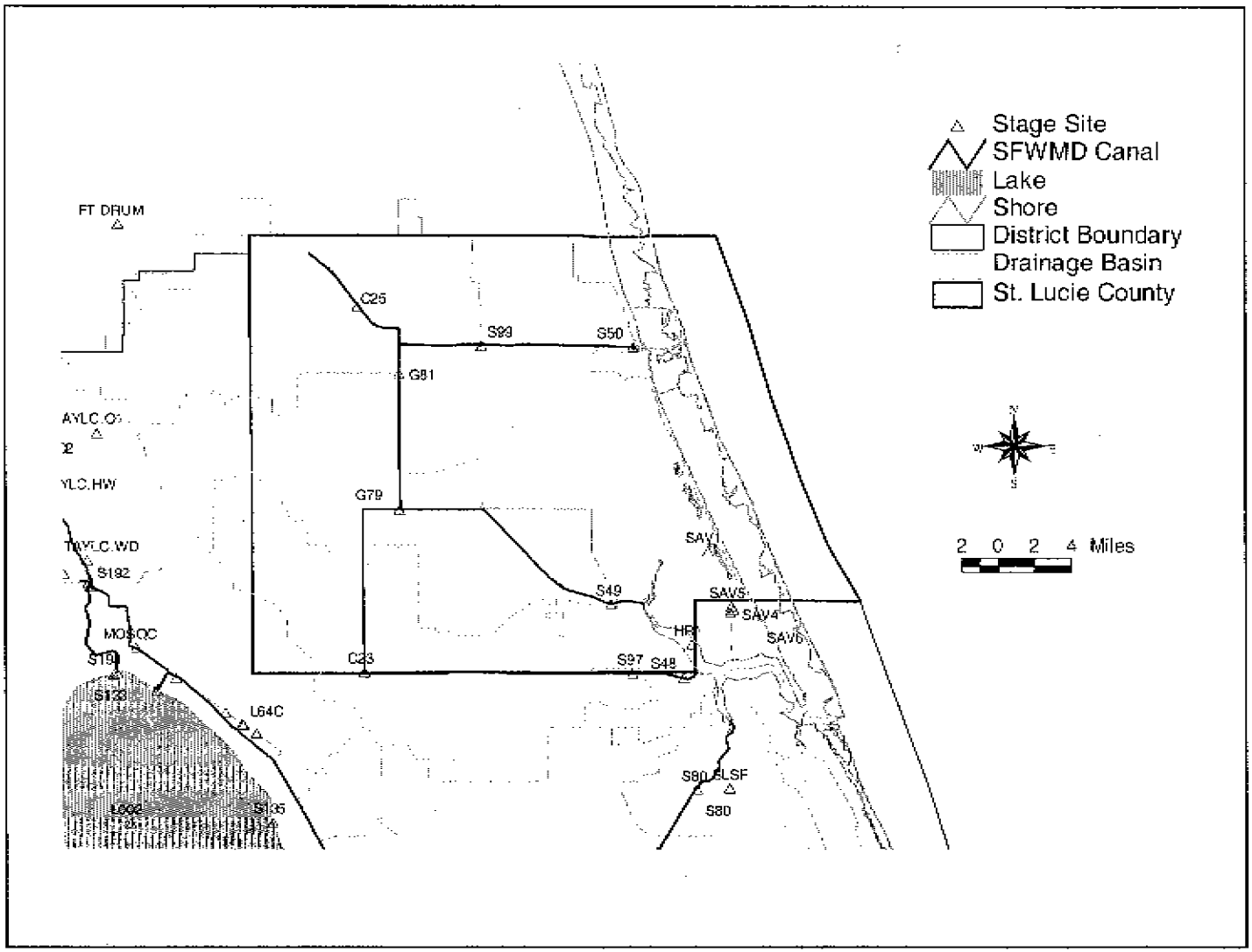


Figure 20. Location of stage monitoring stations in St. Lucie County

Table 9. Stage monitoring stations in St. Lucie County

STATION	ALTERNATE	AGCY	RCDR	STRT	END	STATION DESCRIPTION	DBKEY	LAT	LONG	years*
C23	C23*FEC	WMD	????	1983	1999	CANAL C-23 AT F.E.C. RAILROAD	04575	271225	803445	17
C23	C23FEC+	WMD	CR10	1999	2000	CANAL C-23 AT F.E.C. RAILROAD	JG322	271225	803445	2
C25	C25*RADE	WMD	????	1984	1997	CANAL C-25 EXTENSION BELOW RADE	04586	273008	803457	14
C25	C25RAD+	WMD	CR10	1997	1999	CANAL C-25 EXTENSION BELOW RADE	G6807	273008	803457	3
C25	C25RAD-	WMD	TELE	1998	2000	CANAL C-25 EXTENSION BELOW RADE	HJ724	273008	803457	3
G78_H	G78@H	WMD	STAF	1986	1989		13048	271744	803445	4
G79_H	G79+H	WMD	CR10	1995	1999	STATION IN C-23W AT G-79	16560	272019	803247	5
G79_H	G79-H	WMD	TELE	1997	2000	STATION IN C-23W AT G-79	FB748	272019	803247	4
G79_H	G79@H	WMD	STAF	1986	1996	STATION IN C-23W AT G-79	13047	272019	803247	11
G79_T	G79+T	WMD	CR10	1995	1999	STATION IN C-24E AT G-79	16561	272019	803247	5
G79_T	G79-T	WMD	TELE	1997	2000	STATION IN C-24L AT G-79	FB749	272019	803247	4
G81_H	G81+H	WMD	CR10	1995	1998	STATION ON C-24 AT G-81	16565	272652	803246	4
G81_H	G81-H	WMD	TELE	1997	2000	STATION ON C-24 AT G-81	FB750	272652	803246	4
G81_T	G81+T	WMD	CR10	1995	1998	STATION ON C-25 AT G-81	16566	272652	803246	4
G81_T	G81-T	WMD	TELE	1997	2000	STATION ON C-25 AT G-81	FB751	272652	803246	4
GORDY_H	GORDY+H	WMD	CR10	1999	2000	GORDY RD. BRIDGE N ST. LUCIE WA	JW237	272410	802355	2
GORDY_T	GORDY+T	WMD	CR10	1999	2000	GORDY RD. BRIDGE N ST. LUCIE WA	JW238	272410	802355	2
IR.BOATL	BOATLAND	WMD	SDIG	1985	1991	ST. LUCIE RIVER AT BOATLAND	07057	272729	801925	7
IR.BOATL	BOATLAND	WMD	SDIG	1985	1991	ST. LUCIE RIVER AT BOATLAND	07058	272729	801925	7
IR.BOATL	BOATLAND	WMD	SDIG	1985	1991	ST. LUCIE RIVER AT BOATLAND	07059	272729	801925	7
IR.MCCAR	MCCARTNE	WMD	SDIG	1985	1986	ST. LUCIE RIVER AT MCCARTNEY'S	07063	272413	801820	2
IR.MCCAR	MCCARTNE	WMD	SDIG	1985	1986	ST. LUCIE RIVER AT MCCARTNEY'S	07064	272413	801820	2
IR.MCCAR	MCCARTNE	WMD	SDIG	1985	1986	ST. LUCIE RIVER AT MCCARTNEY'S	07065	272413	801820	2
IR.OSTEE	OSTEENS	WMD	SDIG	1985	1986	ST. LUCIE RIVER AT OSTEEN'S DOC	07060	272558	801902	2
IR.OSTEE	OSTEENS	WMD	SDIG	1985	1986	ST. LUCIE RIVER AT OSTEEN'S DOC	07061	272558	801902	2
IR.OSTEE	OSTEENS	WMD	SDIG	1985	1986	ST. LUCIE RIVER AT OSTEEN'S DOC	07062	272558	801902	2
S49_H	S49*H	WMD	????	1961	1997	S-49 SPILLWAY ON CANAL C-24 NEA	04786	271542	802132	37
S49_H	S49+H	WMD	SP01	1987	1994	S-49 SPILLWAY ON CANAL C-24 NEA	07953	271542	802132	8
S49_H	S49-H	WMD	TELE	1994	2000	S-49 SPILLWAY ON CANAL C-24 NEA	15775	271542	802132	7
S49_T	S49+T	WMD	SP01	1993	1993	S-49 SPILLWAY ON CANAL C-24 NEA	12740	271542	802132	1
S49_T	S49-T	WMD	TELE	1994	2000	S-49 SPILLWAY ON CANAL C-24 NEA	15776	271542	802132	7
S50_H	S50*H	WMD	A35	1964	1995	S 50 SPILLWAY ON CANAL C-25 AT	04384	272807	802017	32
S50_H	S50+H	WMD	CR10	1995	2000	S-50 SPILLWAY ON CANAL C-25 AT	16534	272807	802017	6
S99_H	S99*H	WMD	????	1964	1994	S-99 SPILLWAY ON CANAL C-25 NEA	04852	272814	802818	31
S99_H	S99+H	WMD	SP01	1987	1994	S-99 SPILLWAY ON CANAL C-25 NEA	07703	272814	802818	8
S99_H	S99-H	WMD	TELE	1994	2000	S-99 SPILLWAY ON CANAL C-25 NEA	15781	272814	802818	7
S99_T	S99*T	WMD	????	1964	1995	S 99 SPILLWAY ON CANAL C-25 NEA	04854	272814	802818	32
S99_T	S99+T	WMD	SP01	1987	1994	S-99 SPILLWAY ON CANAL C-25 NEA	07745	272814	802818	8
S99_T	S99-T	WMD	TELE	1994	2000	S-99 SPILLWAY ON CANAL C-25 NEA	15782	272814	802818	7
SAV1	SAV1+	WMD	CR10	1997	2000	SAVANNAS PRESERVE, SITE 1	FI262	271610	801625	4
SAVAN_H	2276568	USGS	????	1976	1977	SAVANNAHS DRAINAGE CANAL AT POR	00273	271613	801926	2
SLR.BRIT	BRITT	WMD	SDIG	1981	1982	BRITT CREEK NEAR N. FORK ST. LU	07012	271355	801711	2
SLR.BRIT	BRITT	WMD	SDIG	1981	1982	BRITT CREEK NEAR N. FORK ST. LU	07013	271355	801711	2
SLR.BRIT	BRITT	WMD	SDIG	1981	1982	BRITT CREEK NEAR N. FORK ST. LU	07014	271355	801711	2
SLR.KELL	KELLST	WMD	SDIG	1982	1982	N. FORK ST. LUCIE RIVER AT KELL	07007	271618	801918	1
SLR.KELL	KELLST	WMD	SDIG	1982	1982	N. FORK ST. LUCIE RIVER AT KELL	07008	271618	801918	1
SLR.KELL	KELLST	WMD	SDIG	1982	1982	N. FORK ST. LUCIE RIVER AT KELL	07009	271618	801918	1
SLR.SAND	SANDPIPE	WMD	SDIG	1981	1982	N. FORK ST. LUCIE RIVER AT SAND	07010	271438	801848	2
SLR.SAND	SANDPIPE	WMD	SDIG	1981	1982	N. FORK ST. LUCIE RIVER AT SAND	07011	271438	801848	2
SLR.SAND	SANDPIPE	WMD	SDIG	1981	1982	N. FORK ST. LUCIE RIVER AT SAND	07086	271438	801848	2
SWAINAB	SWAIN*A	WMD	????	1982	1985	OUTFLOW CULVERT ON SWAIN GROVES	05332	272201	802859	4
SWAINAB	SWAIN*B	WMD	????	1982	1985	OUTFLOW CULVERT ON SWAIN GROVES	05334	272201	802859	4
VAIN_H	VAIN+H	WMD	CR10	1993	1996	VIRGINIA AVENUE RETENTION POND	DU530	272521	801910	4
VAIN_T	VAIN+T	WMD	CR10	1993	1996	VIRGINIA AVENUE RETENTION POND	DU531	272521	801910	4
VAOU_H	VAOU+H	WMD	CR10	1993	1996	VIRGINIA AVENUE RETENTION POND	DU528	272529	801904	4
VAOU_T	VAOU+T	WMD	CR10	1993	1996	VIRGINIA AVENUE RETENTION POND	DU532	272529	801904	4

* years (rounded) of data available

3.2.2 QA/QC

A preliminary examination of the time series was completed through graphical plots. Gaps, overlaps and relationships were depicted. The missing daily data from the selected long time series were filled using the following procedures, as presented in the flow chart in Figure 21:

a. Missing daily data in the selected long time series data were filled with daily data from other dbkeys at the site. Most of the time, the difference was in the type of recorders.

b. Estimates of daily data were also made from linear regression relationships after downstream and upstream flow-site relationships have been established. Summaries of regression relationships for flow sites and stages are given in Tables 10 and 11. Two sets of relationships (linear and nonlinear) have been developed between S-50 and S-99 (flow and stage data). As depicted in Figure 22, the nonlinear stage relationship between the tailwater at S-99 and the headwater at S-50 better fits the data with a coefficient of determination of 0.99. Major differences between the two models are observed for stage elevation higher than 13 feet. For the flow relationship in Figure 23, although the coefficient of determination did not change very much from the linear to the nonlinear relationship, for flow greater than 2,000 cubic feet per second (cfs) the nonlinear relationship fits better.

c. When the missing gap is short (less than three days), linear interpolation was used.

d. For all other missing daily data not within these three cases, an M tag was reassigned to the data.

3.3 SUMMARY OF SURFACE WATER DATA

3.3.1 Flow

Historical daily flows are presented in Appendix E for S-49, S-50 and S-99, while monthly and annual flow statistics are in Appendix F. Table 12 gives a summary of the computed mean, maximum and minimum mean daily flows. Monthly statistics for the mean daily flow values are also presented in Figures 24-26.

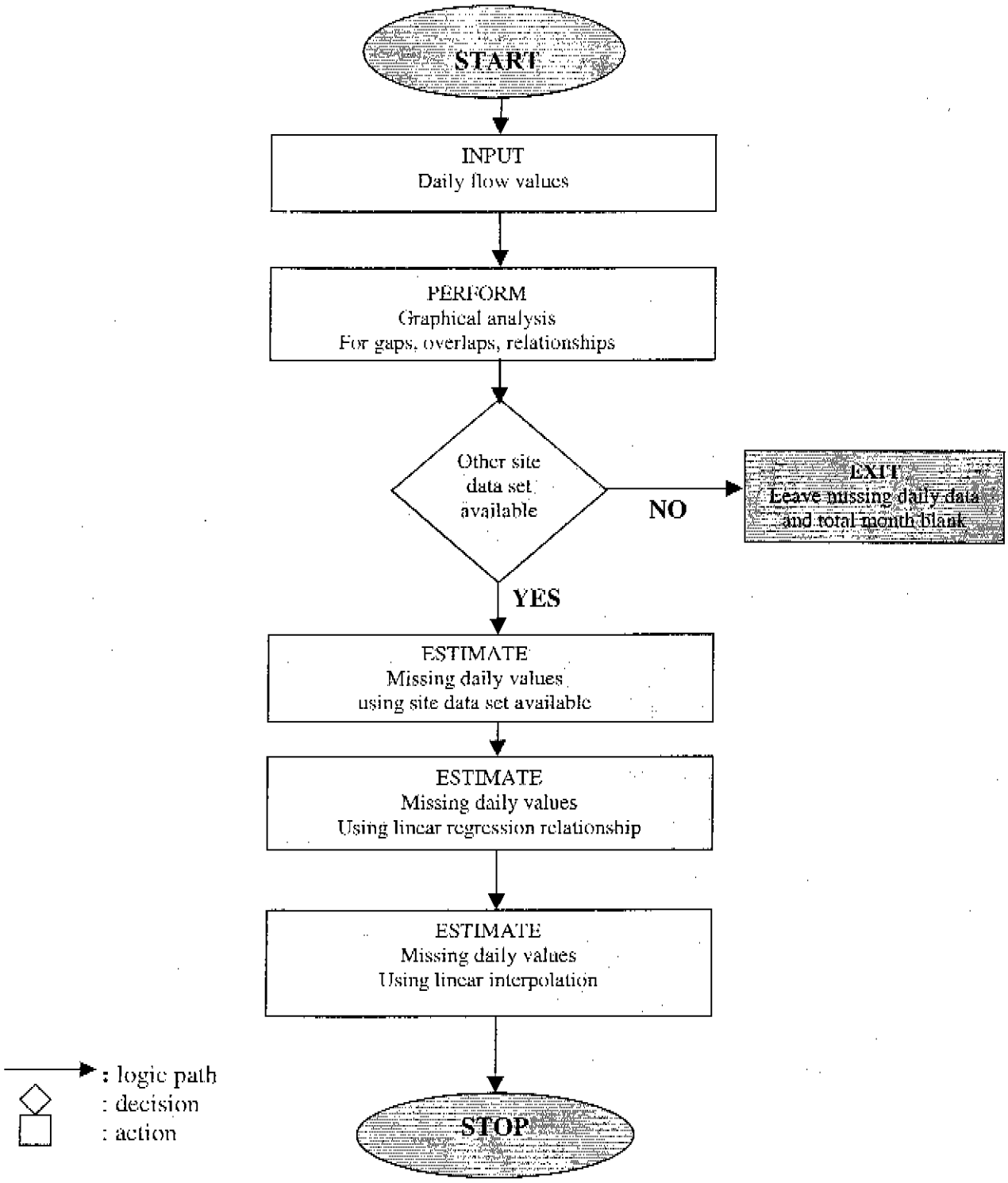


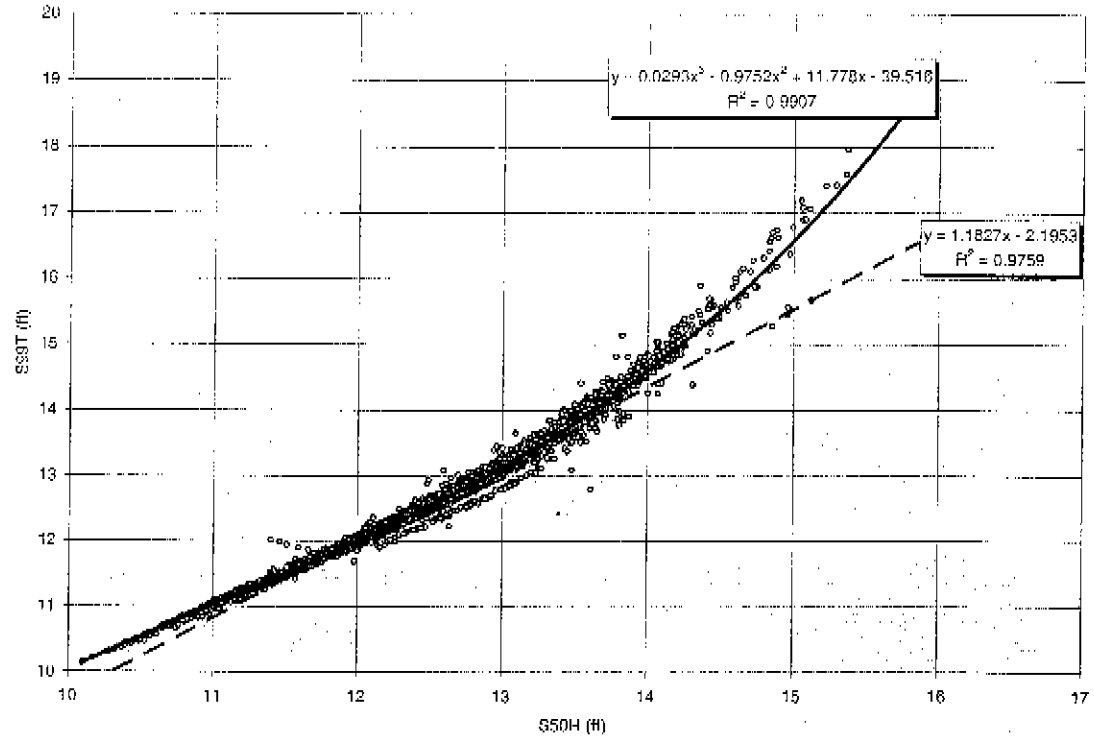
Figure 21. Flow chart for estimating missing daily flow values

Table 10. Regression relationships between flow stations (daily values)

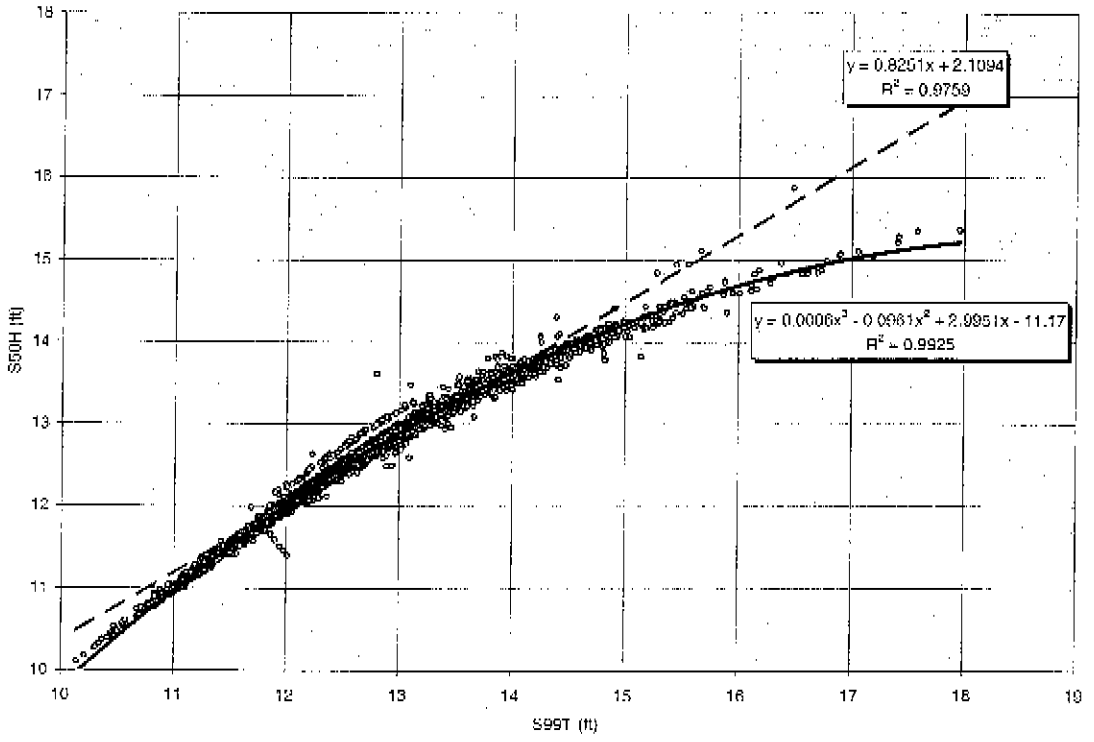
Site (X)	Site (Y)	Relationship	r^2
S-50	S-99	$Y = 0.9824X + 10.048$	0.88
S-50	S-99	$Y = aX^4 + bX^3 + cX^2 + dX + e$ $a = 5E\text{-}11 (\cong 0)$ $b = -4E\text{-}07 (\cong 0)$ $c = 0.0007 (\cong 0)$ $d = 0.6205$ $e = 26.888$	0.89

Table 11. Regression relationships between stages (daily values)

Site (X)	Site (Y)	Relationship	r^2
G-79T	G-81T	$Y = 0.9854X + 0.0057$	0.99
G-79T	S-49H	$Y = 1.0163X - 0.4807$	0.97
S-99H	G-81H	$Y = 0.9322X + 1.0683$	0.97
S-99H	C-25	$Y = 0.9842X + 0.2235$	0.94
S-50H	S-99T	$Y = 1.1827X - 2.1953$	0.98
S-50H	S-99T	$Y = aX^3 + bX^2 + cX + d$ $a = 0.0293$ $b = -0.9752$ $c = 11.778$ $d = -39.516$	0.99
S-99T	S-50H	$Y = 0.8251X + 2.1094$	0.98
S-99T	S-50H	$Y = aX^3 + bX^2 + cX + d$ $a = 0.0006 (\cong 0)$ $b = -0.0961$ $c = 2.9951$ $d = -11.17$	0.99
C-25	G-81H	$Y = 0.9888X - 0.0271$	0.99
S-97H	C-23	$Y = 0.9889X + 0.5852$	0.98
G-79H	G-78H	$Y = 1.0767X - 1.3405$	0.71

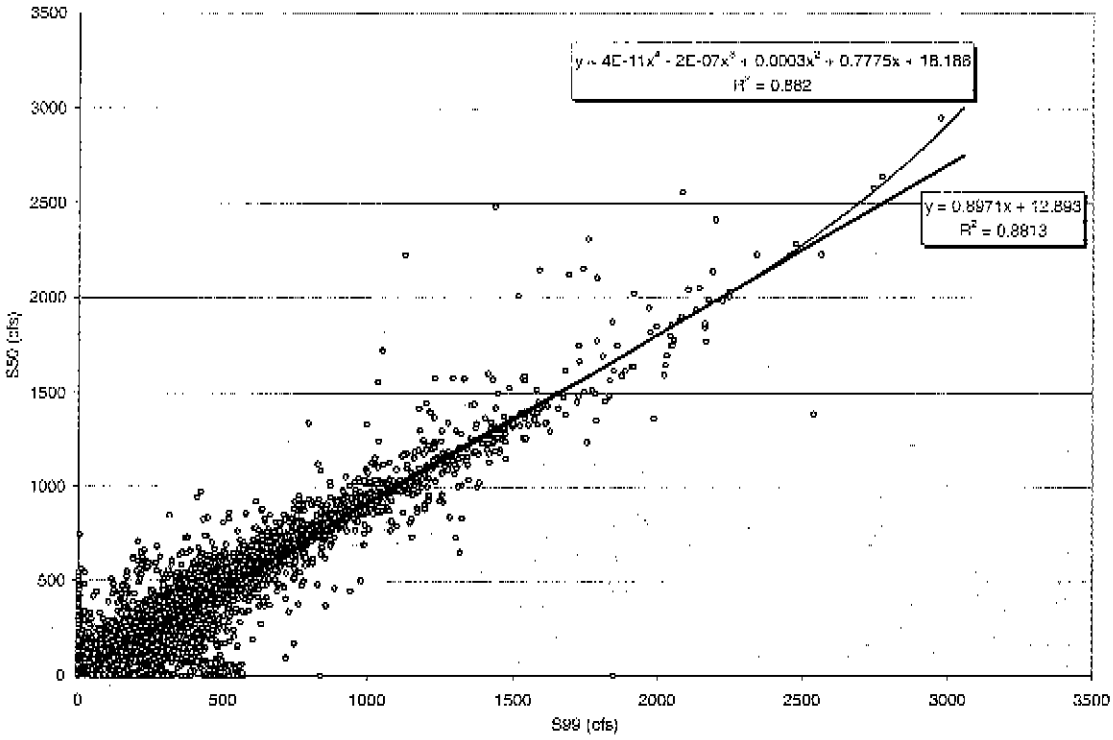


(a)

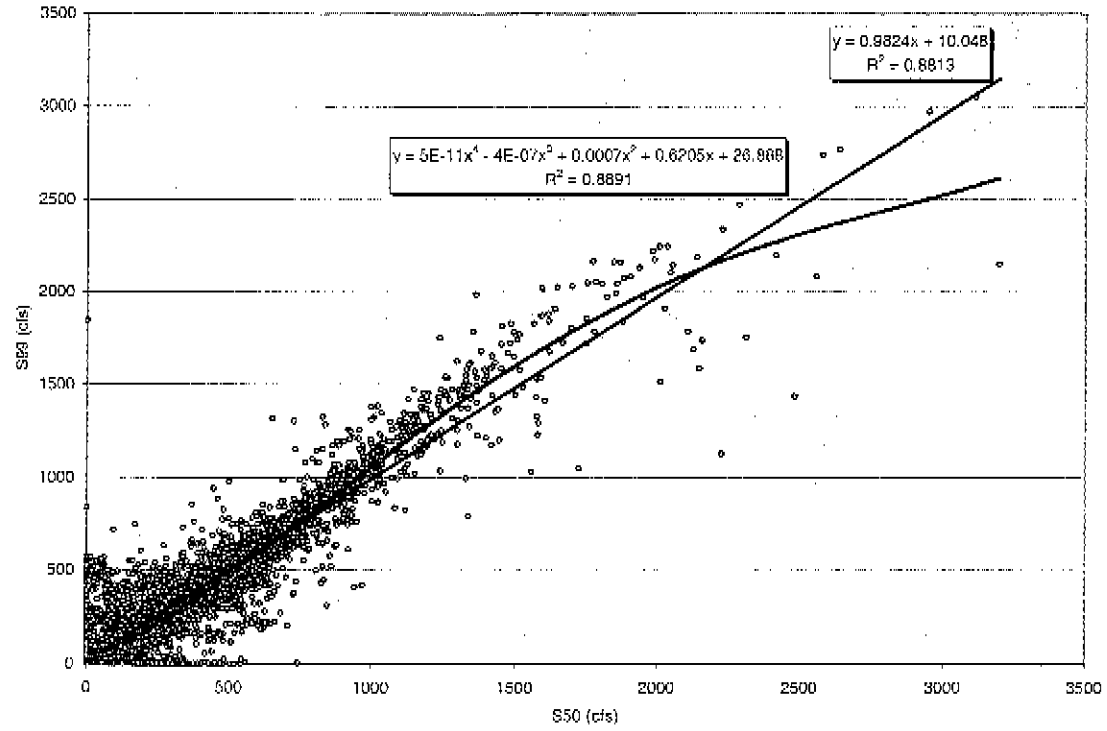


(b)

Figure 22. Linear and nonlinear stage relationships between S-99T and S-50H



(a)



(b)

Figure 23. Linear and nonlinear flow relationships between S-99 and S-50

Table 12. Flow data summary

Site	Mean daily (cfs)	Maximum mean daily (cfs)	Minimum mean daily (cfs)
S-49	171	1512	0
S-50	180	1145	0
S-99	190	1204	0

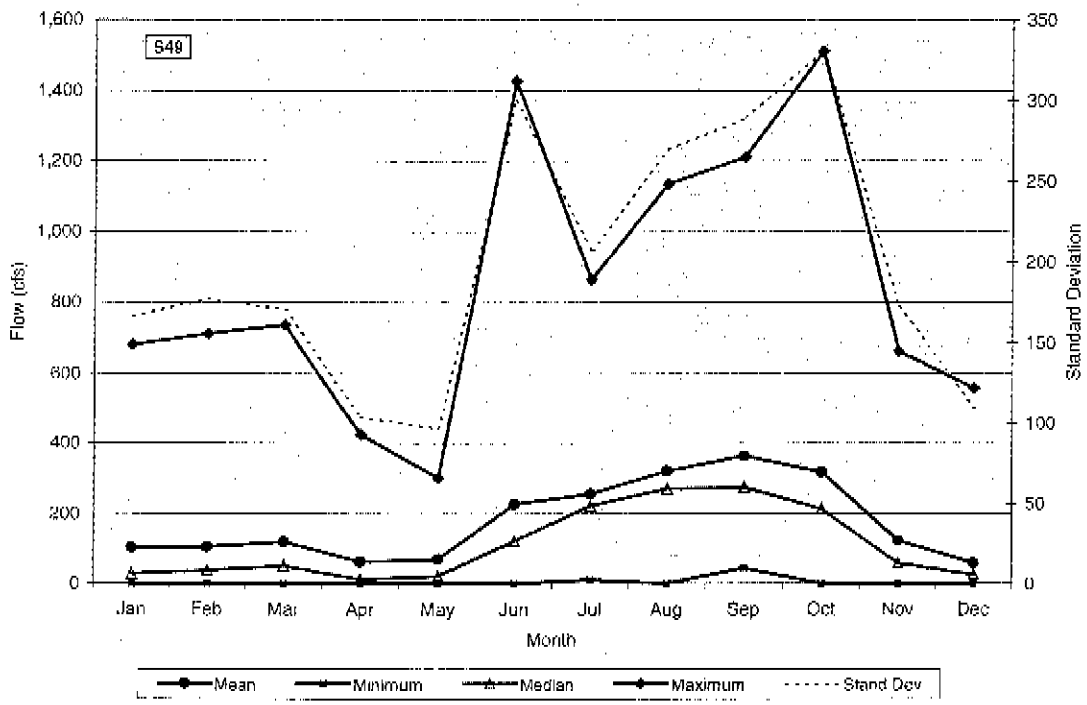


Figure 24. Monthly statistics for mean daily flow at S-49 (Period: 01/01/62-12/31/99)

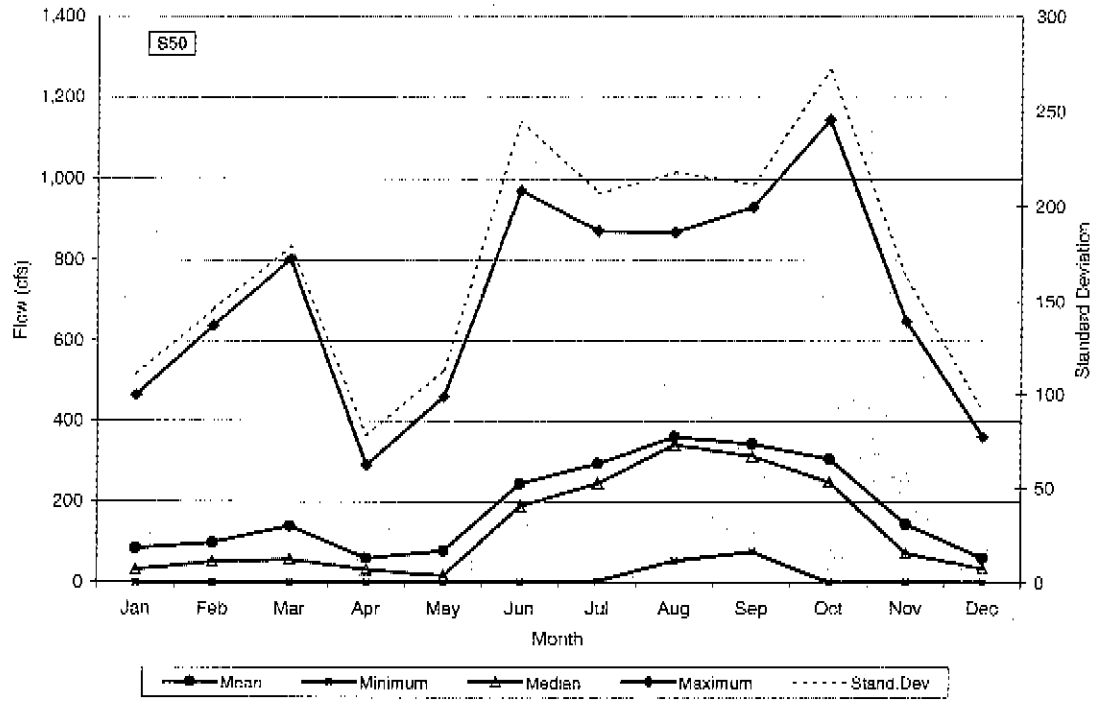


Figure 25. Monthly statistics for mean daily flow at S-50 (Period: 01/01/65-12/31/99)

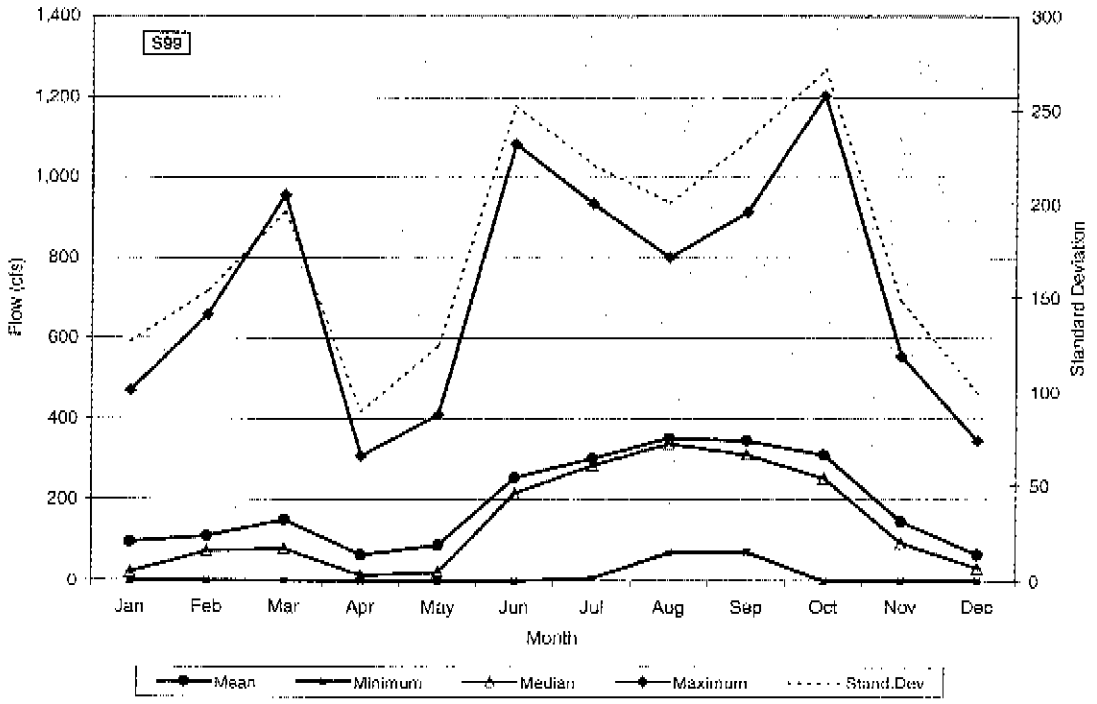


Figure 26. Monthly statistics for mean daily flow at S-99 (Period: 03/01/64-12/31/99)

3.3.2 Stage

Historical daily stage data are summarized in Appendix G for C-23, C-25, G-78, G-79, G-81, S-49, S-50 and S-99, while monthly and annual statistics are summarized in Appendix H. Table 13 gives a summary of the mean, maximum and minimum monthly stage elevation as tabulated in Appendix H. Figures 27-38 give graphical presentation of the mean stage data statistics. The following are a few comments related to the stage data and structures operation:

- The headwater at S-50, with a mean elevation of 12.36 feet, has been kept above the weir crest elevation of 12 feet to avoid saltwater intrusion to local groundwater wells. However, during the end of the dry season (April and May) saltwater intrusion may be an issue with lower water levels.

- S-99, with a mean headwater of 19.98 feet, has been operated in the low range condition.

- S-49, with a mean headwater elevation of 19.32 feet, has been operated during flood season and normal condition.

Table 13. Stage data summary

Site	Mean monthly (ft)	Maximum monthly mean (ft)	Minimum monthly mean (ft)
C-23	21.38	23.02	15.04
C-25	19.83	22.10	14.35
G-78H	21.58	23.09	18.83
G-79H	20.91	22.57	17.30
G-79T	19.58	20.57	16.69
G-81H	19.38	21.54	15.97
G-81T	19.26	20.20	17.46
S-49T	0.77	1.98	0.06
S-49H	19.32	21.19	14.20
S-50H	12.36	13.85	11.26
S-99H	19.98	22.26	14.35
S-99T	12.43	14.58	10.81

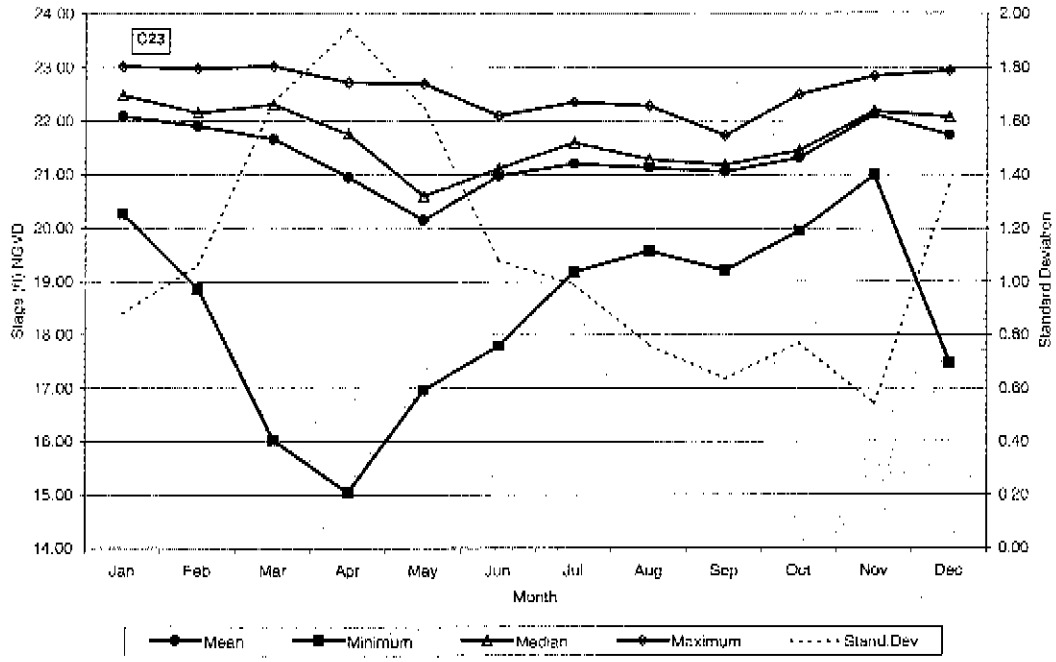


Figure 27. Monthly statistics for mean daily stage at C-23 (Period: 02/01/83 - 12/31/99)

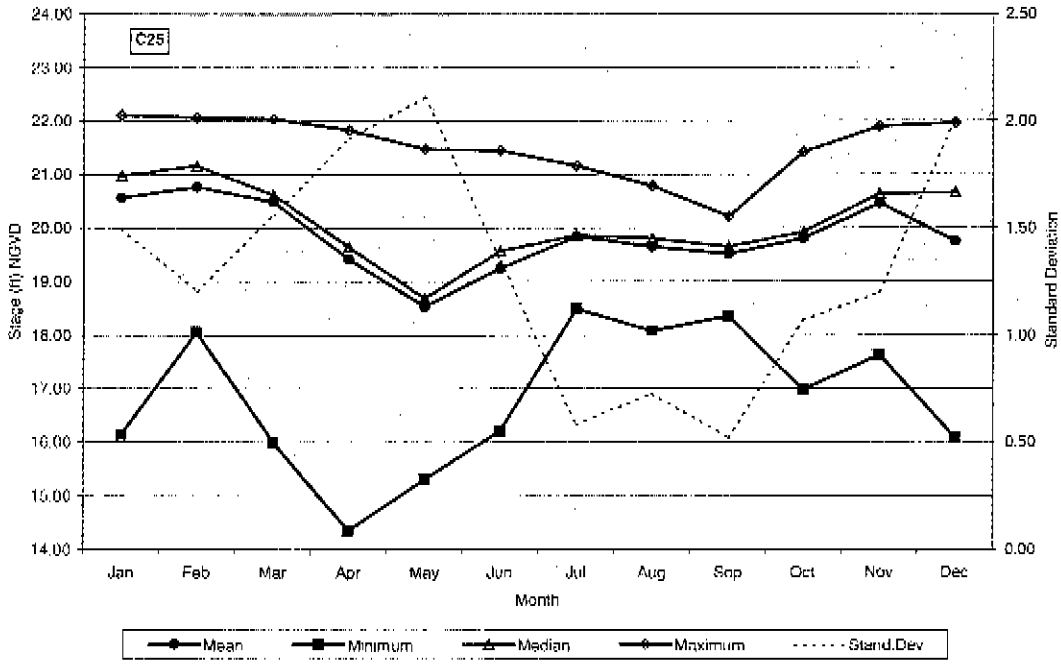


Figure 28. Monthly statistics for mean daily stage at C-25 (Period: 01/01/84 - 12/31/99)

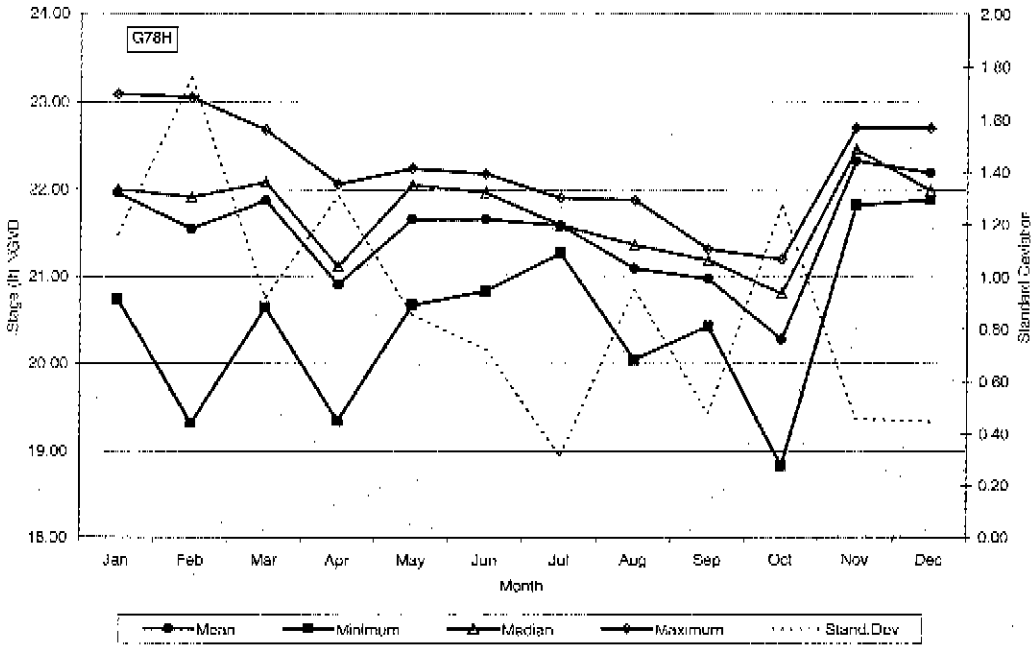


Figure 29. Monthly statistics for mean daily headwater stage at G-78 (Period: 01/01/86 - 04/30/89)

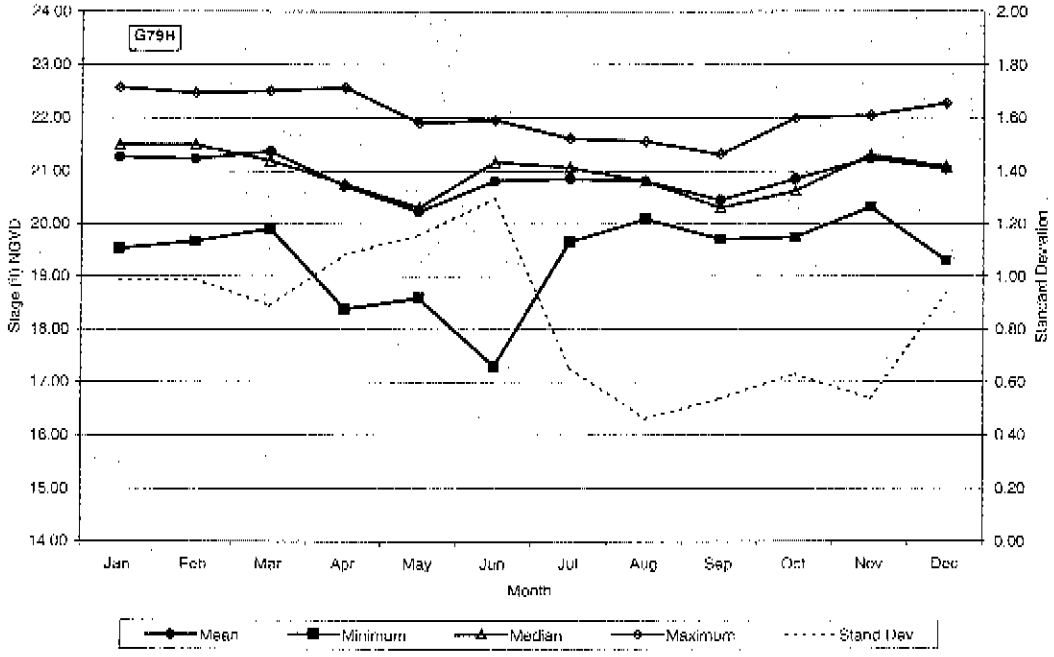


Figure 30. Monthly statistics for mean daily headwater stage at G-79 (Period: 01/01/87 - 12/31/98)

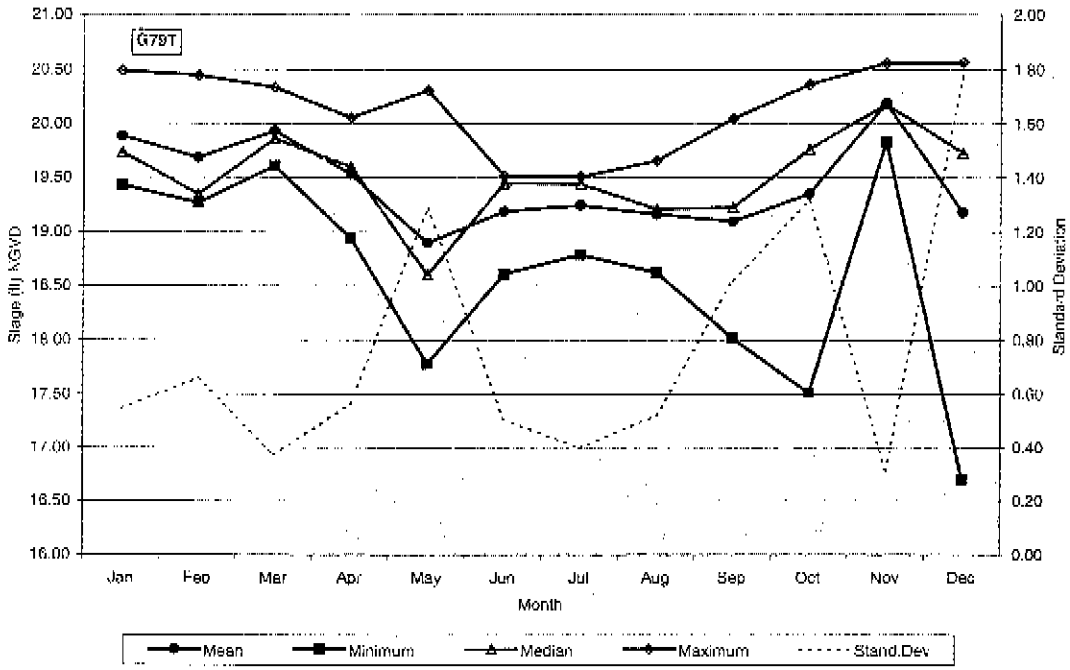


Figure 31. Monthly statistics for mean daily tailwater stage at G-79 (Period: 10/01/95-12/31/98)

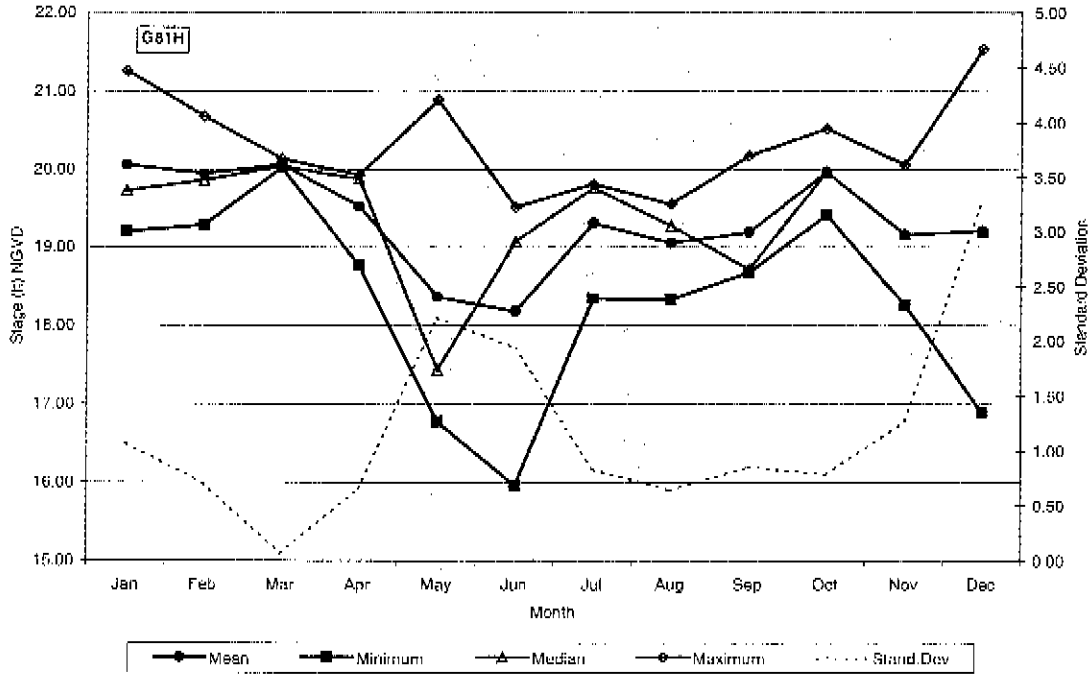


Figure 32. Monthly statistics for mean daily headwater stage at G-81 (Period: 01/01/96-09/30/98)

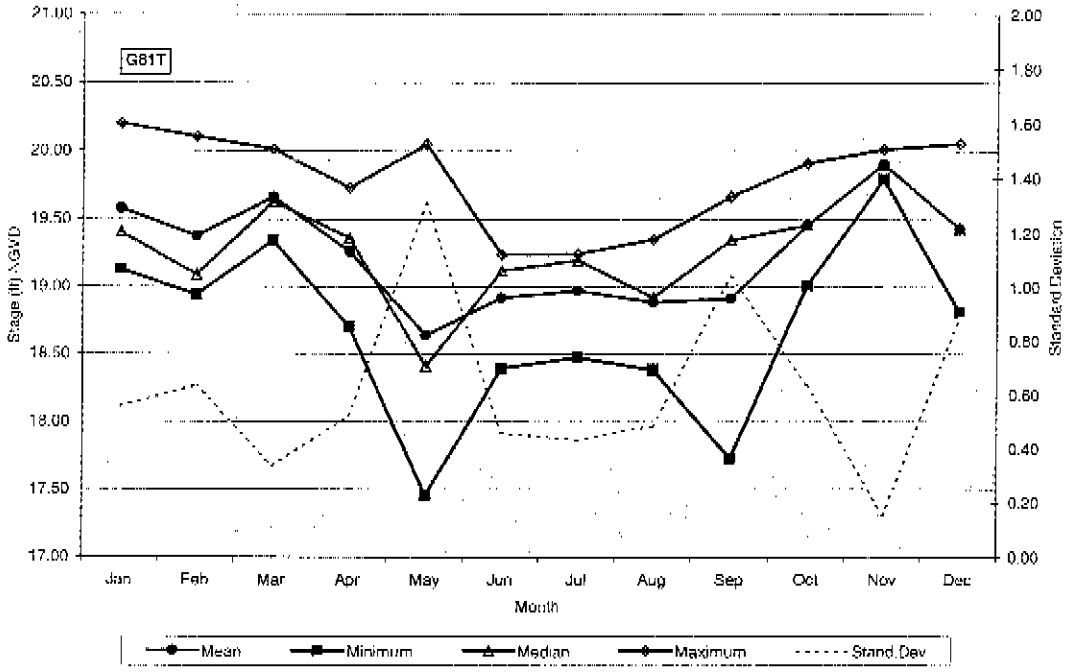


Figure 33. Monthly statistics for mean daily tailwater stage at G-81 (Period: 01/01/96-09/30/98)

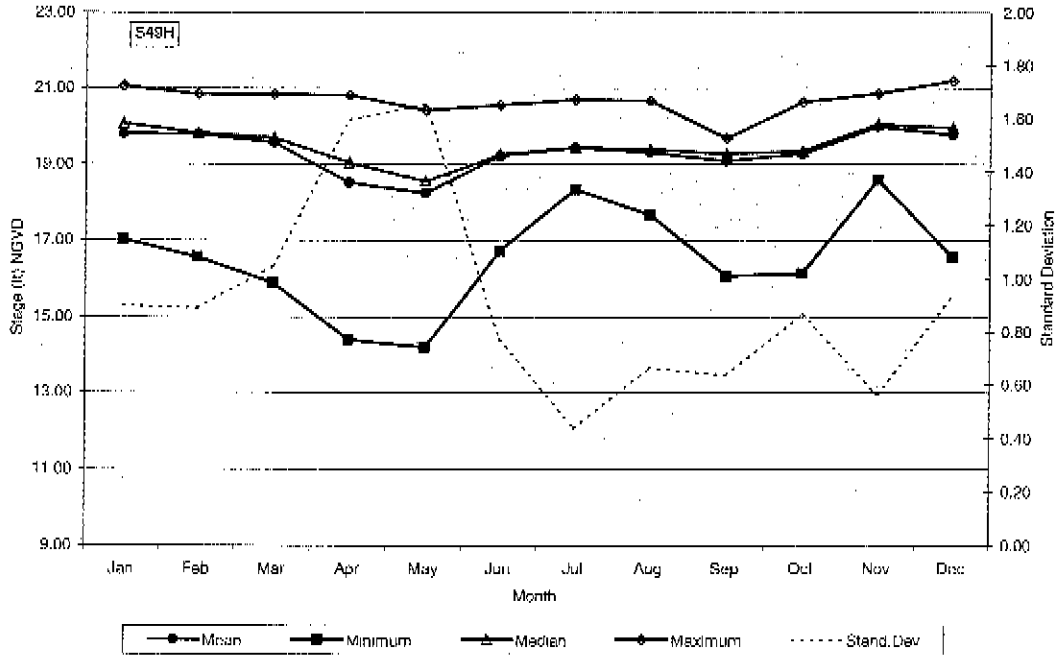


Figure 34. Monthly statistics for mean daily headwater stage at S-49 (Period: 01/01/62-12/31/99)

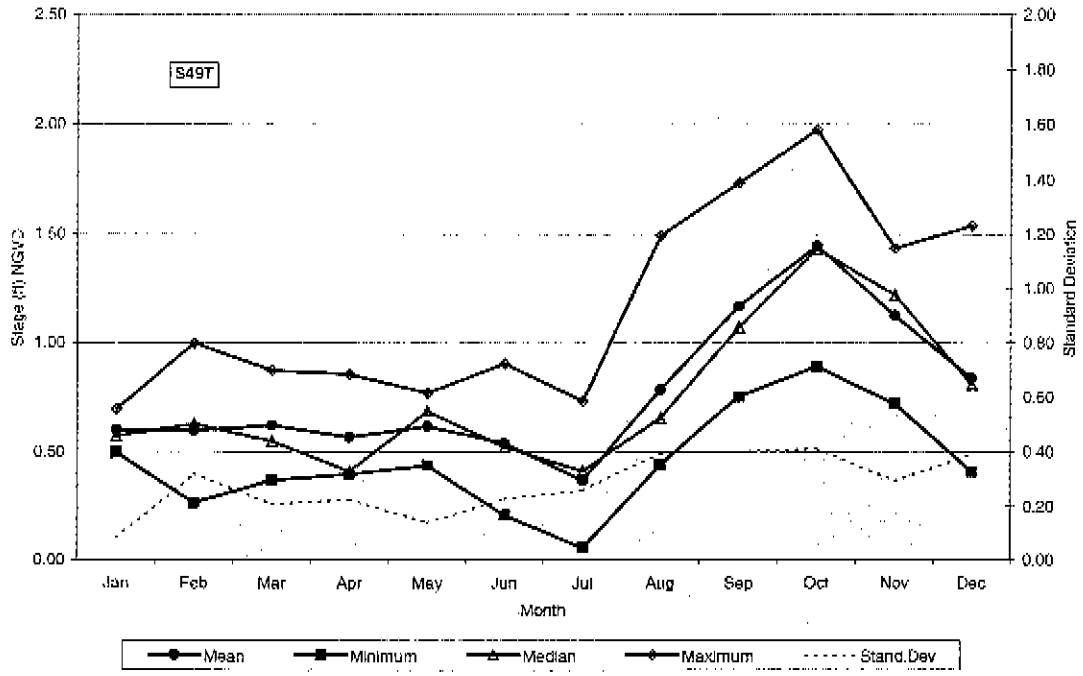


Figure 35. Monthly statistics for mean daily tailwater stage at S-49 (Period: 06/01/94-12/31/99)

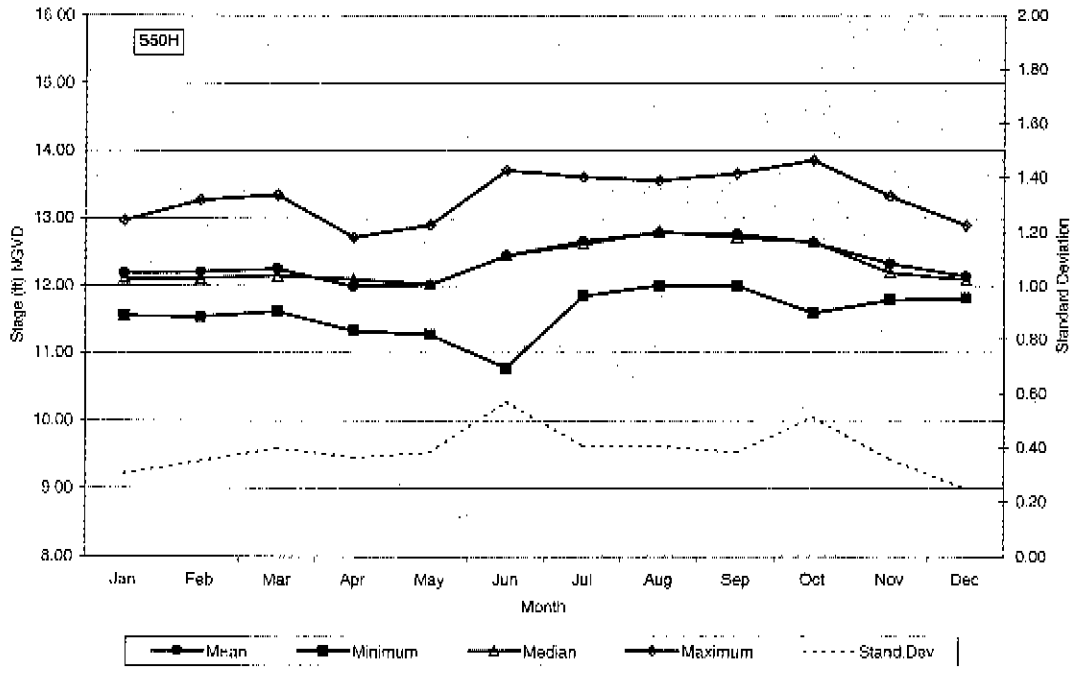


Figure 36. Monthly statistics for mean daily headwater stage at S-50 (Period: 01/01/65-12/31/99)

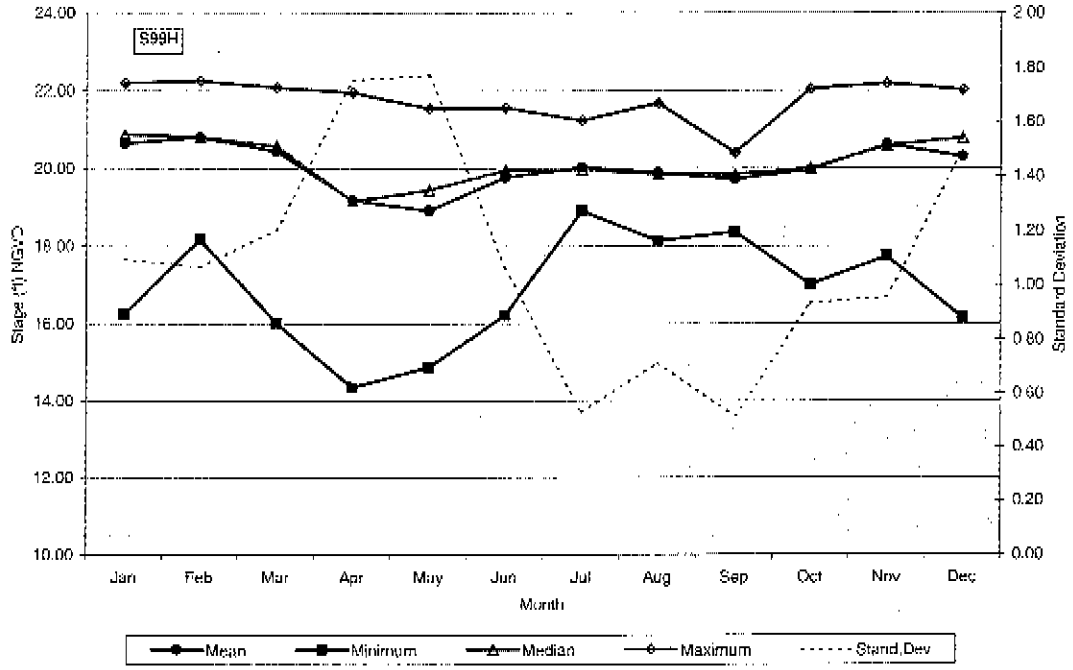


Figure 37. Monthly statistics for mean daily headwater stage at S-99 (Period: 03/01/64-12/31/99)

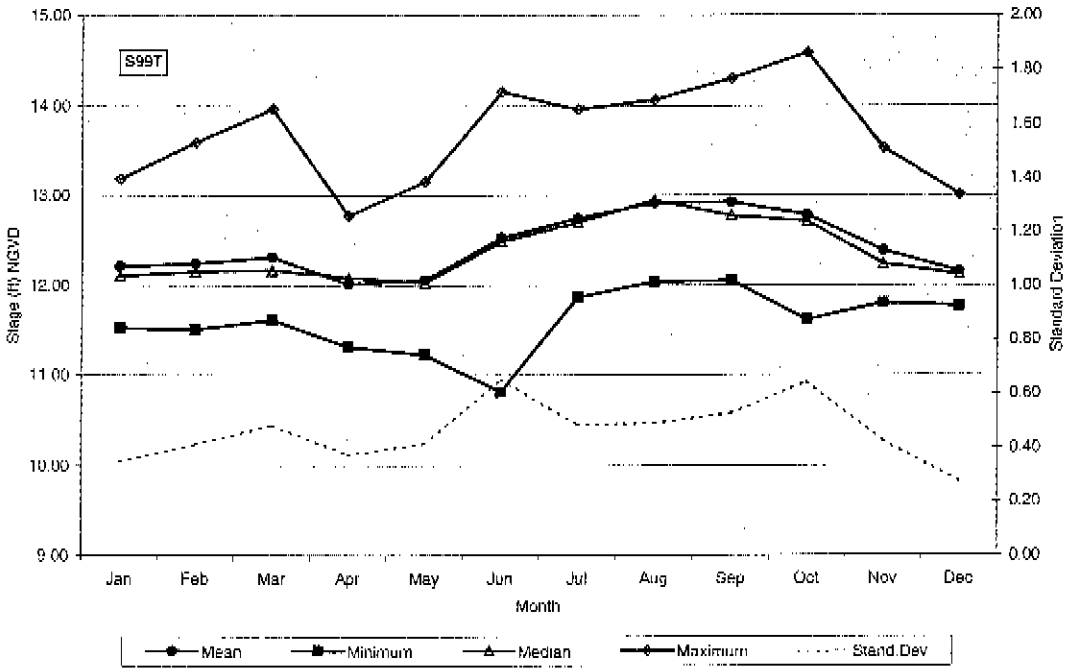


Figure 38. Monthly statistics for mean daily tailwater stage at S-99 (Period: 03/01/64-12/31/99)

- No flow has been allowed at G-81 since stages on either side never exceeded the weir crest elevation of 23 feet. This might explain the reason why this station has been retired in the database after almost three years of monitoring.

- Although the maximum elevation of 23.2 feet (top elevation) has been exceeded at G-78 (maximum observed of 23.81 feet), no flow has been recorded at the site during the three years of monitoring (with probably the assumption that the structure is normally closed).

3.4 HYDROLOGIC SYSTEM AND WATER BUDGET

The C-23, C-24 and C-25 basins are the three major drainage basins in St. Lucie County. The total drainage area is 499.1 square miles, with 53 percent located in the county. The major hydrologic components for the county, as presented in Figure 39, include contribution from rainfall from the three drainage basins, and the outflow components located at structures S-49, S-97 and S-99. Inter-drainage basin transfers through G-81 and G-78 are not monitored and could be reasonably neglected in any individual water budget analysis. Rainfall contribution to the system accounts for 1.4 million acre-feet (AF). About 30 percent of the rainfall is leaving the system as runoff through S-49, S-97 and S-99, while 70 percent is going into groundwater storage and consumptive use (CU).

Flow hydrographs at the outflow structures are about the same and reflect the seasonal rainfall pattern in the area. Total outflow from the three structures S-49, S-97 and S-99 are plotted against areal rainfall in Figure 40. Rainfall-runoff relationships are described in Figure 41 for period 1965-1999 (35 years). The linear and the nonlinear relationships give about the same results for monthly rainfall less than 10 inches. The double mass curve plotted for cumulative outflow and rainfall (Figure 42) shows that the outflow-rainfall relationship is relatively constant through the years with a coefficient of determination of 0.99.

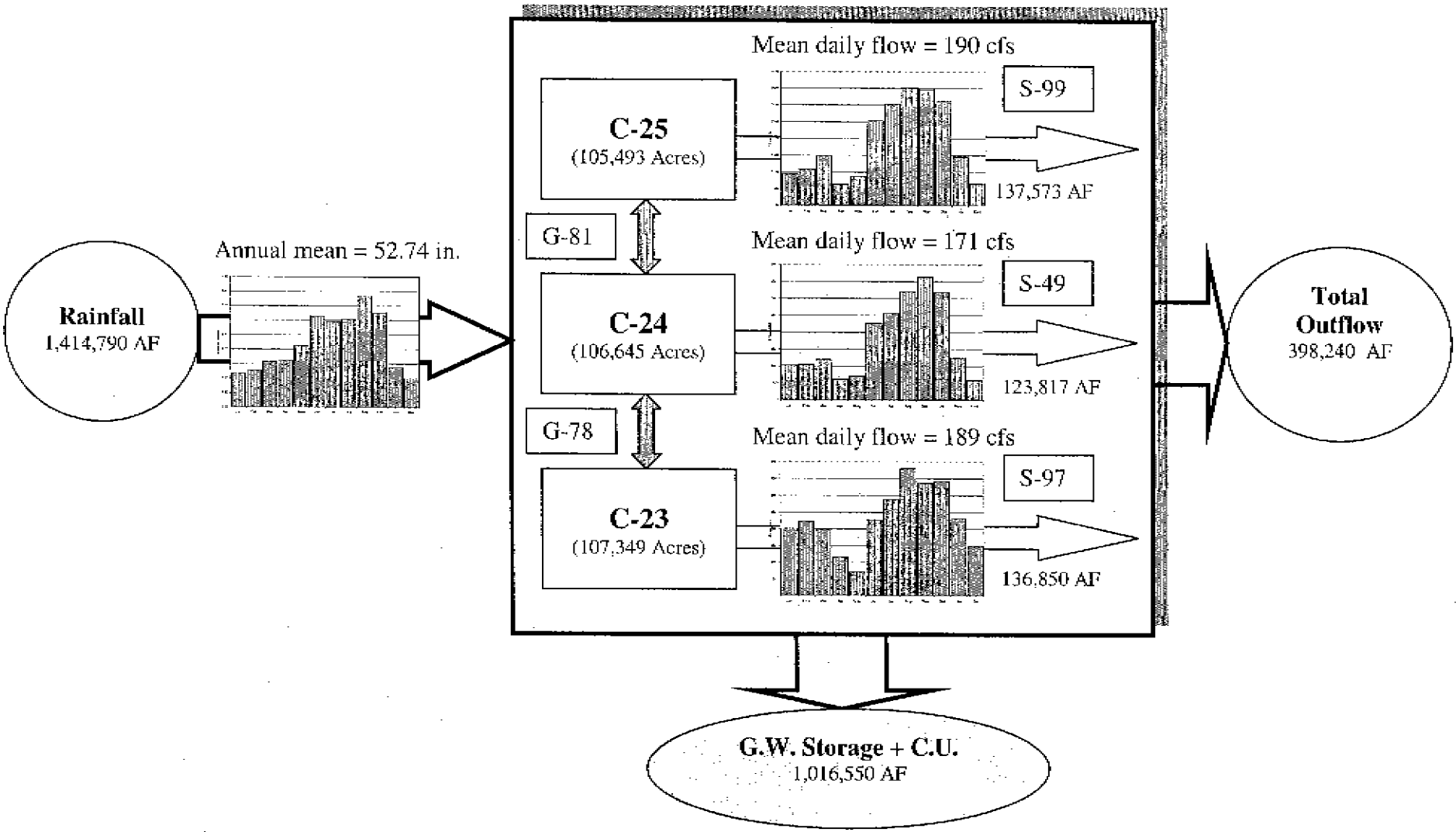


Figure 39. Schematic view of C-23, C-24 and C-25 basins hydrologic system and annual water budget

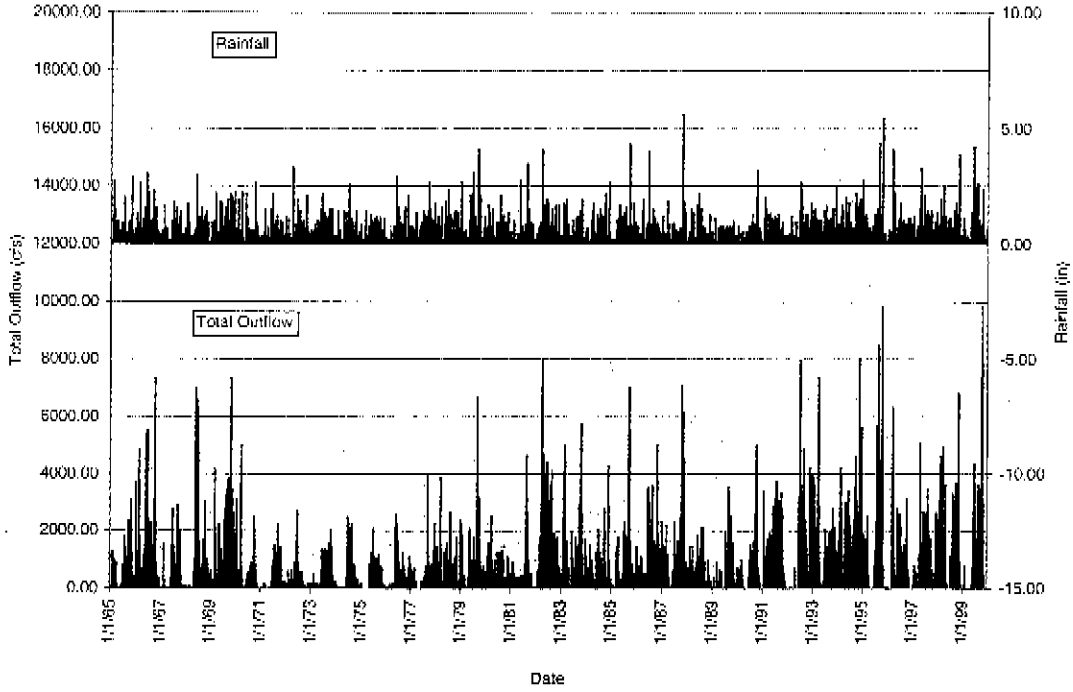


Figure 40. Daily rainfall and total outflow from the C-23, C-24 and C-25 basins (Period: 1965-1999)

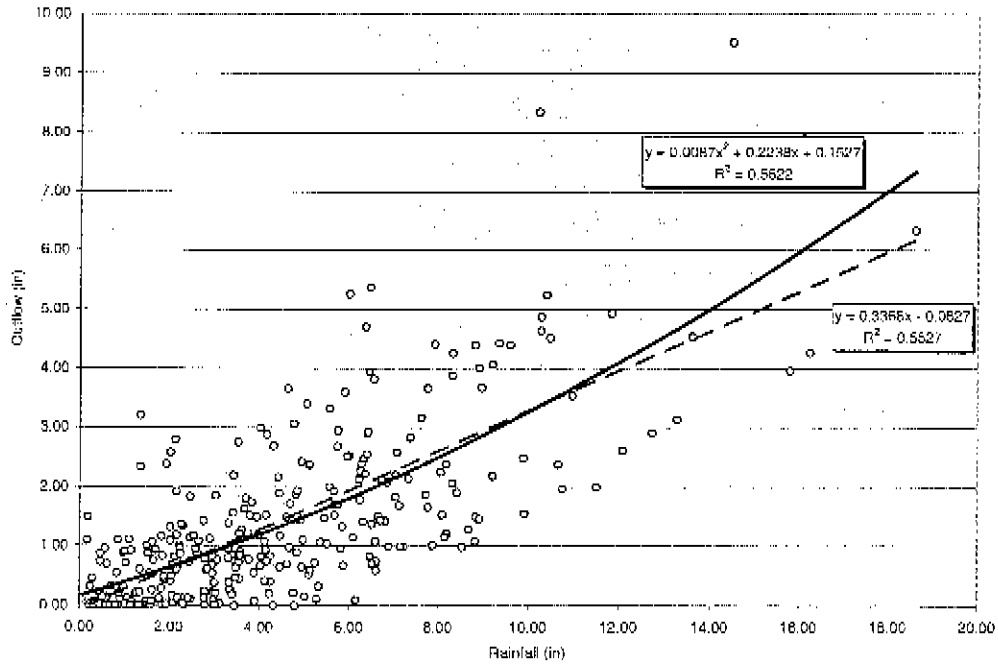


Figure 41. Relationship between monthly rainfall and total monthly outflow from C-23, C-24 and C-25 basins (Period: 1965-1999)

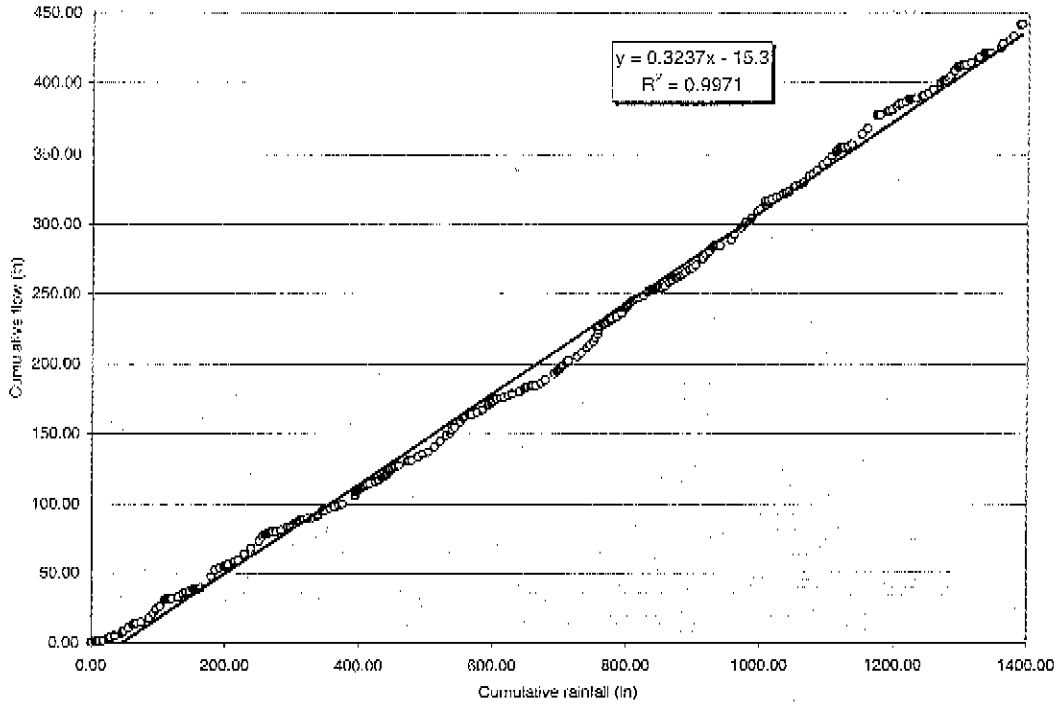


Figure 42. Double mass curve for cumulative annual rainfall and cumulative total annual outflow in C-23, C-24 and C-25 basins (Period: 1965-1999)

4. SUMMARY

This report has presented a summary of the hydrometeorologic data for St. Lucie County (rainfall, evaporation, stage and flow), as available in the District corporate database DBHYDRO. A methodology to fill missing data has been presented. The resulting data have been presented in tabular and graphical formats for the convenience of the reader.

Four rainfall sites have been selected out of 16 sites to better describe the rainfall distribution in the area: BLUEGOOS_R, COW CREE_R, FORT PIE_R and SCOTTOG_R. Wet and dry seasons have been depicted from the computed areal rainfall. The wet season goes from June to October and accounts for 61 percent (32.38 inches) of the mean total annual rainfall (52.74 inches). September is the wettest month with a mean monthly rainfall of 7.68 inches. Within the 86-year period of record (1914-1999) the wettest and driest years were 1917 (32.05 inches) and 1947 (77.76 inches), respectively.

Two pan evaporation sites have been selected out of five for the area: FT. PI2_E and FT. PIER_E. More than 70 percent of the evaporation occurs during the period March to September. Mean monthly values vary from 5.10 to 5.32 inches in the two sites, while mean annual values vary from 61.20 to 63.89 inches.

Flow data have been presented for the major structures where flow is available (e.g., S49, S-50 and S-99), while stage data covers most of the major canals and structures located in the county (C-23, C-25, G-78, G-79, G-81, S-49, S-50 and S-99). Mean daily flow varies from 171 cfs to 190 cfs in the three flow structures, while mean maximum daily varies from 1,204 cfs to 1,512 cfs.

In terms of operations of the system, based on the stage elevation data, it can be stated that: (i) although headwater elevation has been kept above the weir elevation at S-50, some saltwater intrusion issues may arise during the end of the dry season; (ii) operation of S-99 falls mainly in the low range condition; (iii) S-49 has been operated during flood season and normal conditions, (iv) no flow has been allowed through G-81 since stages on either sides of the structure never exceeded the weir crest elevation, and (v) although G-78 was kept closed and flow was not monitored, the gate have been overtopped several times.

Rainfall plays a major role in the hydrologic system in St. Lucie County. The C-23, C-24 and C-25 basins (53 percent being in St. Lucie County) received an average of 1.4 million of acre-feet of rainfall per year, with 70 percent going into groundwater storage and consumptive use, and the remaining 30 percent leaving the system through the structures S-49, S97 and S-99. Rainfall-outflow models have been presented for the three drainage basins with a poor relationship ($r^2 = 0.56$). However a strong relationship ($r^2 = 0.99$) has been found in plotting a double mass curve for cumulative outflow and rainfall, which showed that the rainfall-outflow relationship is relatively constant through the years.

The preferred data sets, as developed in this report, are stored in the following preferred dbkeys: N2471 (S-99), N2470 (S-50), and JW223 (S-49).

REFERENCES

1. Attaway, J. 1999. Hurricanes and Florida Agriculture. Published by Florida Science Source, Inc., Lake Alfred, Florida.

2. Cooper, R. and T. Ortel. 1988. An Atlas of St. Lucie County Surface Water Management Basins. Technical Memorandum DRE 265. South Florida Water Management District, West Palm Beach, Florida.

3. Gray, D. 1970. Handbook on the Principles of Hydrology. Water Information Center, Huntington, New York.

4. Raymond, J. 1999. Hydrologic Report for Martin County. Technical Memorandum WRE 381. South Florida Water Management District, West Palm Beach, Florida.

5. Van Horn, S. 1996. Hydrometeorologic Monitoring Network Metadata Report. Water Resource Evaluation Department, WRE 344. South Florida Water Management District, West Palm Beach, Florida.

6. Water Resources Evaluation Department. 1994. Standard Operating Procedures for Hydrometeorologic Data Collection and Validation in Support of the Everglades Water Conditions Report. Hydrologic Data Management Division, South Florida Water Management District, West Palm Beach, Florida.

APPENDICES

APPENDIX A

Historical Rainfall Data

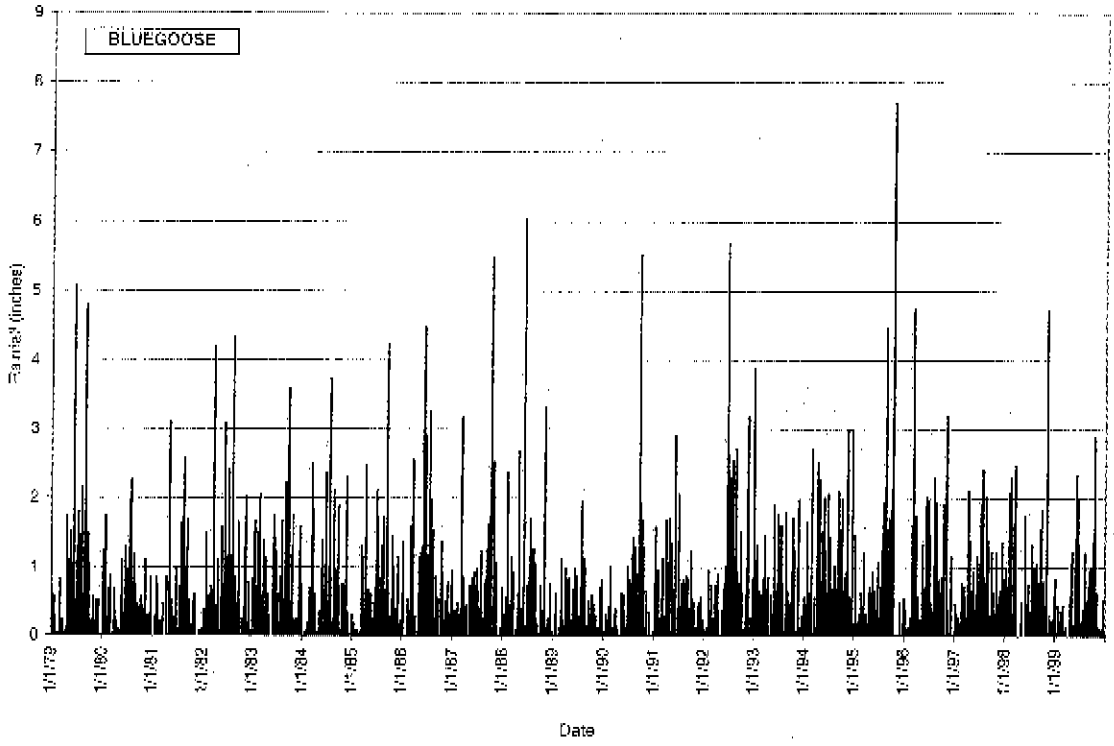


Figure A1. Daily rainfall at station BLUEGOOS_R

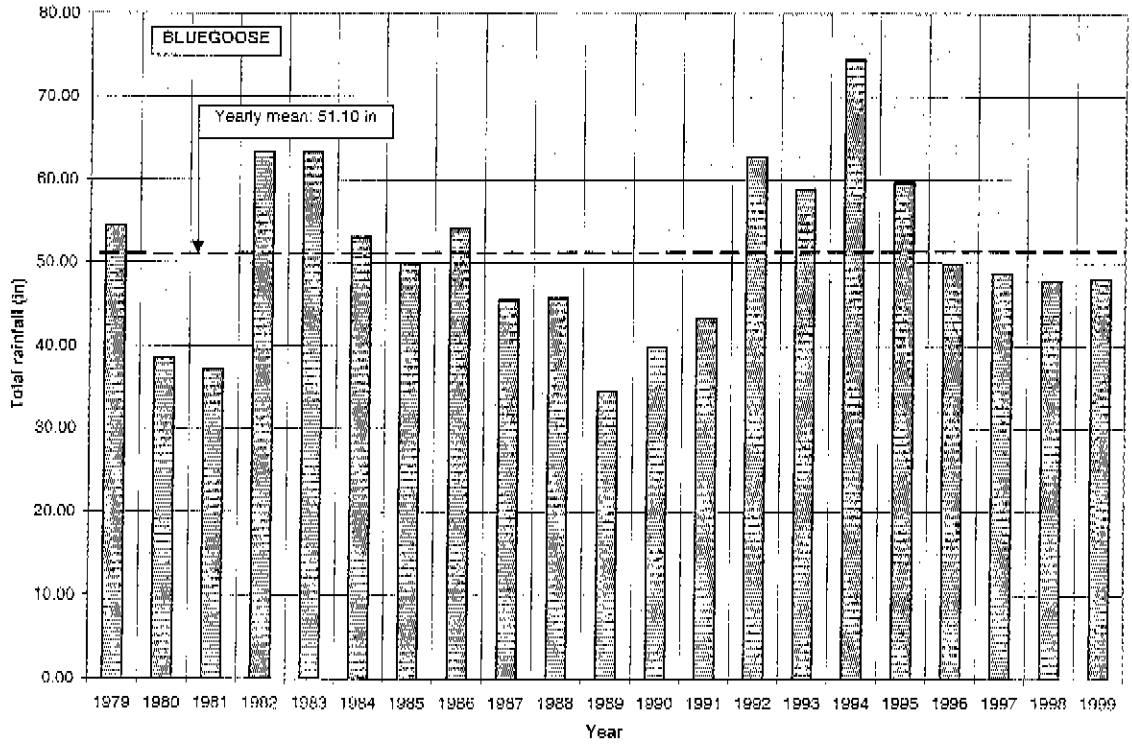


Figure A2. Annual rainfall at station BLUEGOOS_R

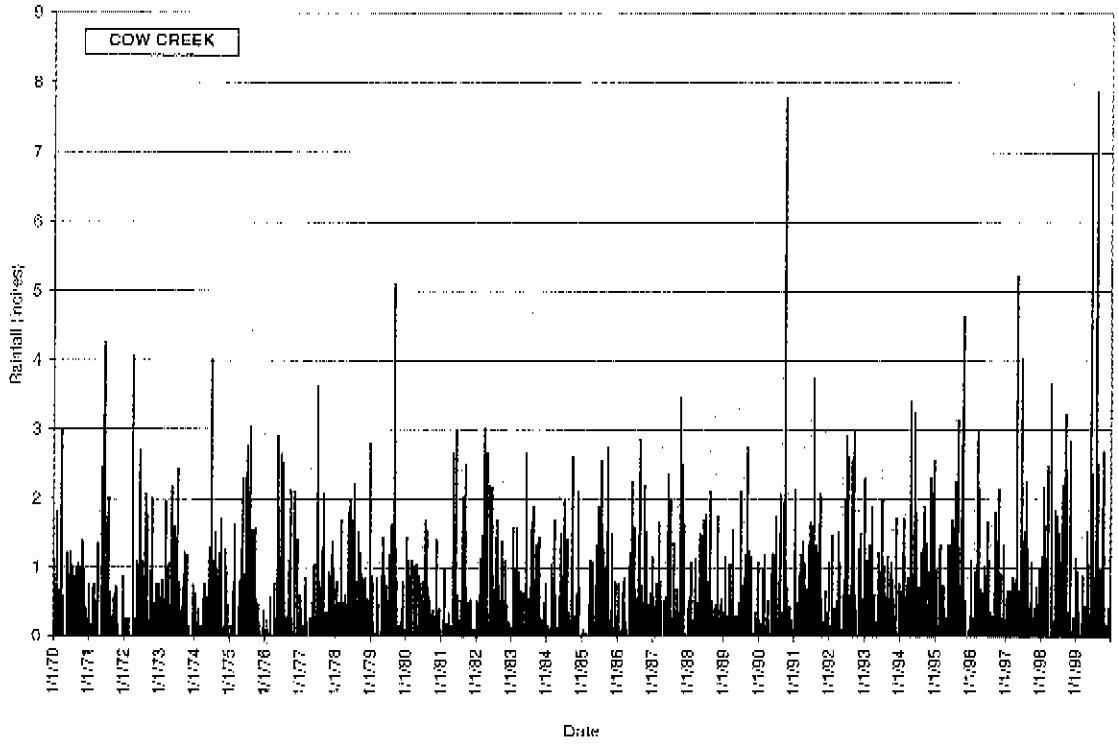


Figure A3. Daily rainfall at station COWCREE_R

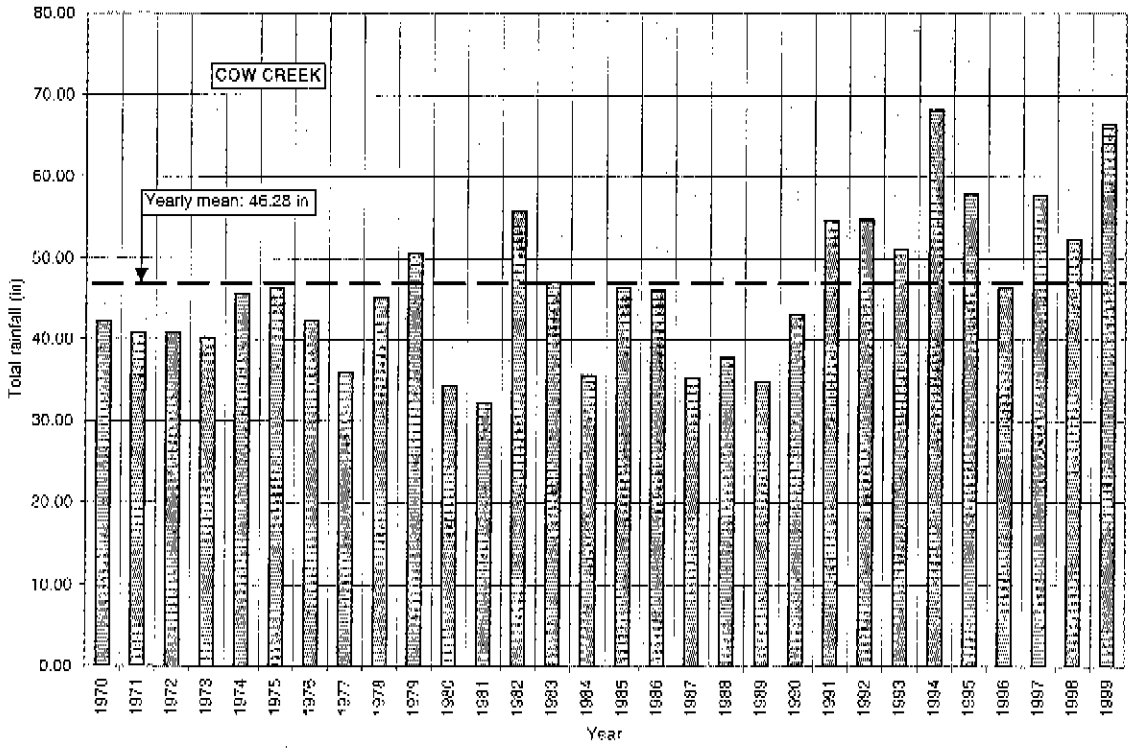


Figure A4. Annual rainfall at station COWCREE_R

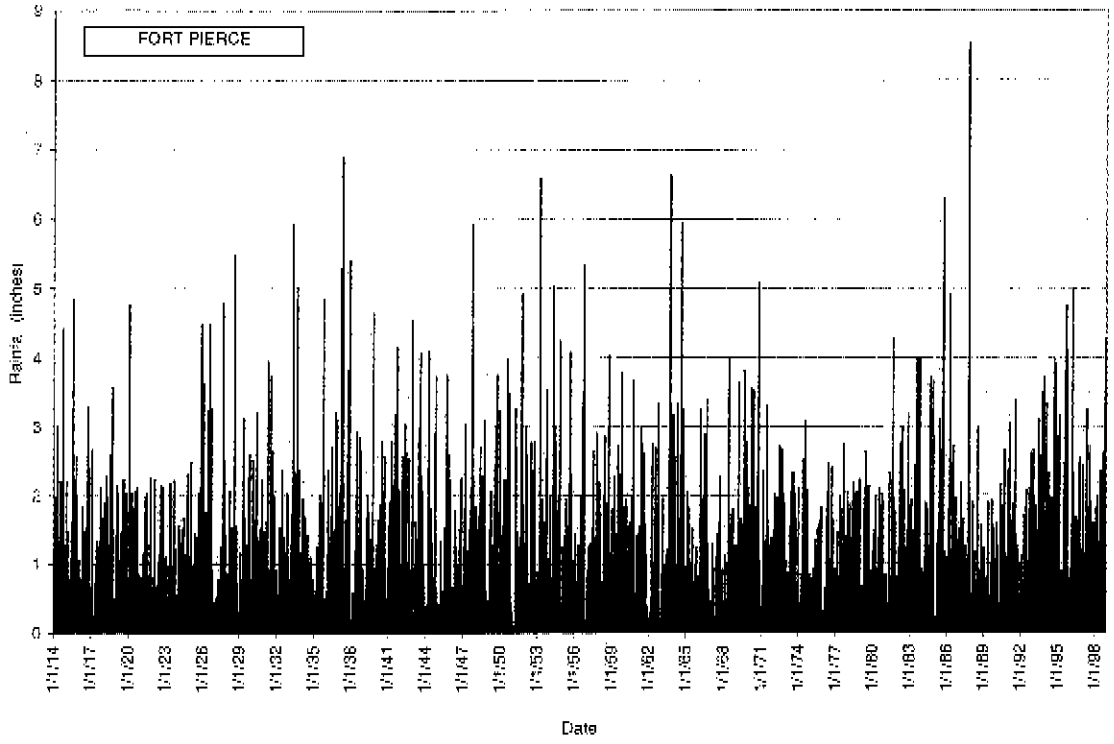


Figure A5. Daily rainfall at station FORT PIE_R

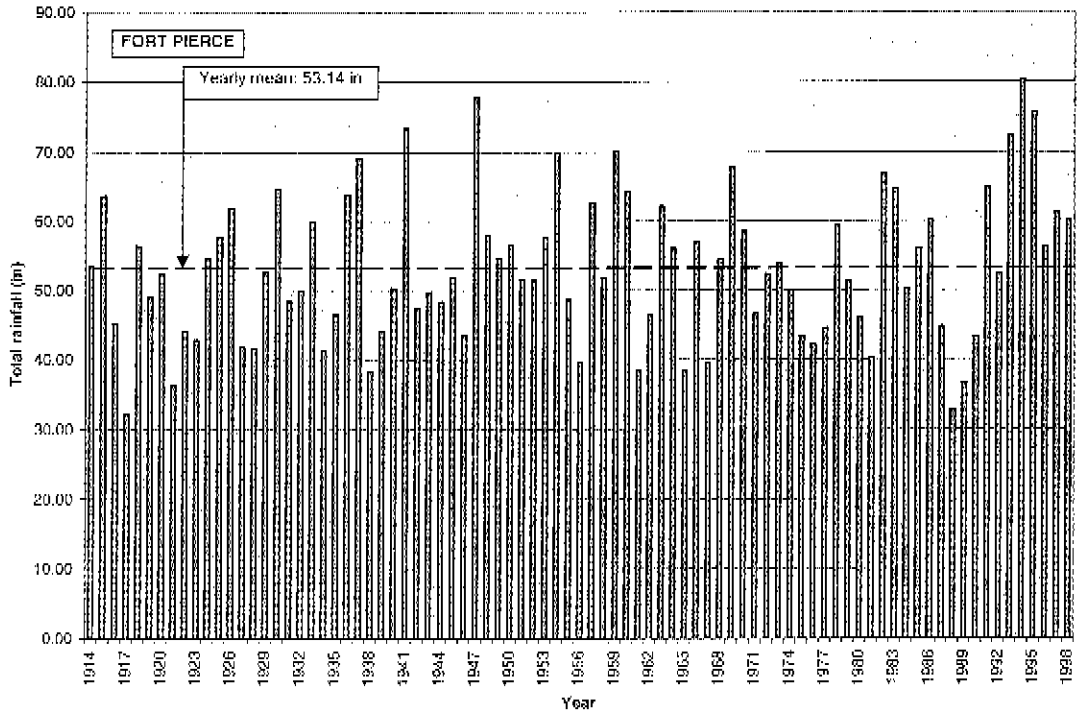


Figure A6. Annual rainfall at station FORT PIE_R

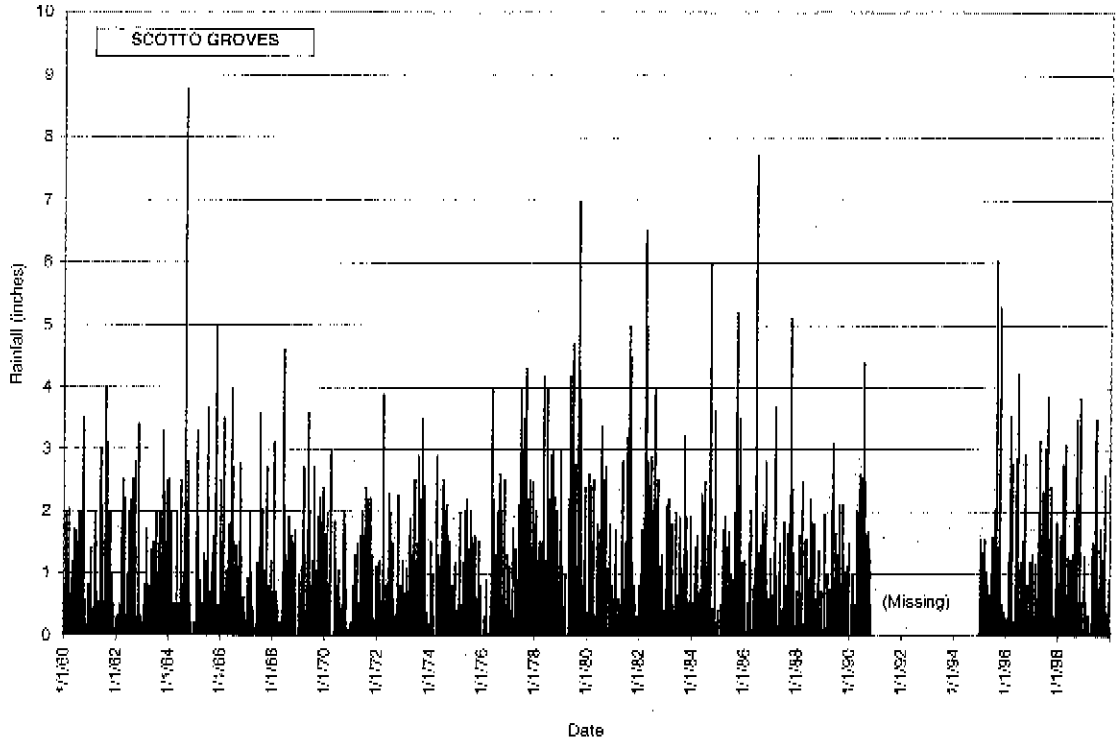


Figure A7. Daily rainfall at station SCOTTOG_R

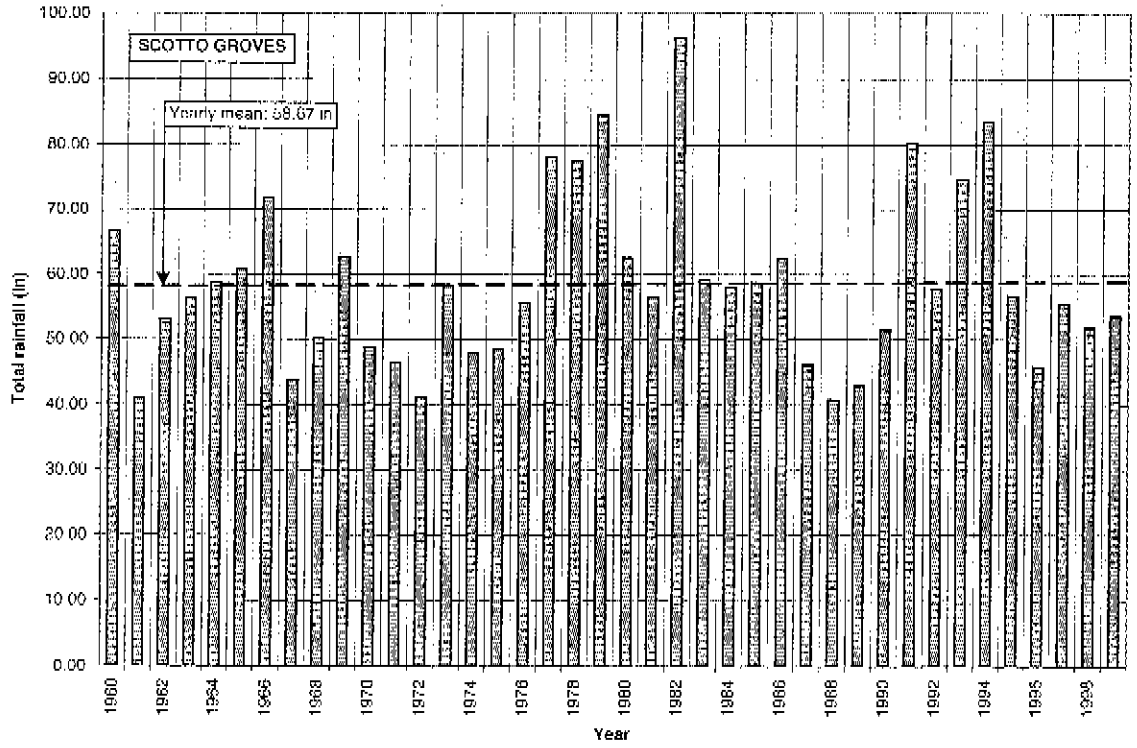


Figure A8. Annual rainfall at station SCOTTOG_R

APPENDIX B

Monthly and Annual Rainfall Statistics

Table B1. Monthly and annual rainfall (inches) at station BLUEGOOS_R

Year	Month												Year
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1979	**3.62**	**0.08**	**1.25**	**2.12**	6.26	9.15	7.32	6.13	13.34	1.99	2.01	1.14	54.41
1980	4.08	1.57	1.58	1.98	2.98	3.59	6.76	7.78	2.50	2.07	1.93	1.62	38.44
1981	0.60	2.06	0.84	0.85	4.10	3.26	1.62	14.28	6.43	1.59	1.41	0.18	37.22
1982	0.48	3.75	8.39	3.76	4.40	9.27	9.84	11.41	4.73	1.18	4.56	1.62	63.39
1983	4.21	8.36	4.01	2.15	1.06	8.39	2.45	8.45	11.02	7.14	0.68	5.37	63.29
1984	0.15	2.32	5.70	1.23	4.40	7.23	9.16	5.71	8.26	**1.43**	**7.04**	**0.45**	53.08
1985	**1.02**	**0.18**	**4.01**	**5.21**	1.39	2.91	9.21	5.88	12.10	4.55	1.73	1.73	49.92
1986	2.88	0.92	5.09	0.29	3.47	14.31	9.93	6.61	2.48	3.36	1.84	2.90	54.08
1987	1.15	1.11	6.55	0.48	2.47	3.45	4.69	1.72	8.54	8.62	6.44	0.31	45.53
1988	2.76	2.99	4.15	3.49	2.72	7.16	8.03	6.91	0.71	1.83	4.07	0.94	45.76
1989	1.40	0.16	3.16	3.67	1.20	4.56	4.30	7.61	1.93	3.51	0.41	2.57	34.48
1990	0.78	2.22	0.96	0.29	2.07	2.27	6.90	8.88	10.23	4.06	1.05	0.11	39.82
1991	3.68	2.47	2.97	6.32	3.02	4.56	5.59	4.48	2.82	5.34	1.19	0.87	43.31
1992	0.27	2.45	1.29	2.47	1.53	18.67	6.86	14.01	4.00	1.11	8.45	1.70	62.81
1993	10.92	2.49	6.15	1.86	4.51	5.68	6.32	5.99	3.90	6.19	4.08	0.85	58.94
1994	4.94	3.61	3.49	8.41	5.33	7.35	7.88	5.77	8.64	5.23	8.89	4.94	74.48
1995	2.01	1.32	2.01	2.90	1.57	4.63	5.12	13.93	8.18	17.30	0.00	0.70	59.67
1996	1.10	0.38	11.59	1.09	4.34	7.49	2.45	7.30	4.08	5.14	3.66	1.25	49.87
1997	1.36	1.66	1.99	6.10	3.29	4.06	8.47	**8.01**	4.36	2.06	3.71	3.67	48.74
1998	2.97	5.99	4.53	0.66	3.30	1.97	3.67	5.24	9.90	1.88	7.29	0.46	47.86
1999	2.21	0.70	0.74	2.46	2.13	14.75	1.17	5.36	5.50	11.07	1.04	0.92	48.05

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	P.O.R.*
Mean	2.50	2.23	3.83	2.75	3.12	6.89	6.08	7.69	6.36	4.60	3.40	1.63	51.10
Stand. Dev	2.40	2.00	2.76	2.20	1.43	4.43	2.71	3.27	3.65	3.94	2.76	1.48	10.12
Minimum	0.15	0.08	0.74	0.29	1.06	1.97	1.17	1.72	0.71	1.11	0.00	0.11	34.48
Median	2.01	2.06	3.49	2.15	3.02	5.68	6.76	6.91	5.50	3.51	2.01	1.14	49.87
Maximum	10.92	8.36	11.59	8.41	6.26	18.67	9.93	14.28	13.34	17.30	8.89	5.37	74.48

* : indicates period of records for station and excludes partial year results

** : indicates partial year

-- : indicates no data available or large gaps of missing data

Bold number: indicates estimate from monthly correlation with Fort Pierce Field Station

BLUEGOOS_R = (FT.PIER_R x 0.82) + 0.54; $R^2 = 0.68$

Table B2. Monthly and annual rainfall (inches) at station COW CREE_R

Year	Month												Year
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1970	**2.63**	**2.52**	**6.38**	**0.72**	**3.23**	**3.72**	**4.90**	**4.63**	3.40	**6.71**	**2.48**	**0.89**	42.21
1971	**1.06**	**1.95**	1.25	1.35	5.05	12.97	9.12	1.52	2.39	3.15	0.06	0.92	40.79
1972	0.28	0.83	4.07	0.82	5.55	9.19	3.60	9.49	1.87	2.20	2.20	0.75	40.85
1973	2.72	1.70	3.65	1.59	5.05	5.19	7.90	2.34	5.53	3.24	0.15	1.15	40.21
1974	1.51	0.67	0.17	1.87	1.92	14.69	7.09	7.34	3.80	2.83	2.50	1.20	45.59
1975	0.15	3.83	0.00	1.25	7.03	9.25	8.01	8.55	4.55	2.39	0.40	0.97	46.38
1976	0.37	1.50	0.62	1.81	11.82	8.10	5.70	0.90	6.64	0.10	2.20	2.51	42.27
1977	1.60	0.97	0.30	0.26	2.95	5.83	4.13	5.82	4.95	1.93	4.09	3.02	35.85
1978	2.05	1.55	3.50	1.72	3.12	10.53	5.13	2.55	6.34	3.34	1.00	4.45	45.28
1979	3.73	0.04	1.46	1.81	9.03	2.20	3.11	6.65	18.66	0.90	1.77	1.28	50.64
1980	3.08	2.16	2.50	4.48	2.90	3.42	4.21	4.90	1.92	1.16	2.87	0.66	34.26
1981	0.35	2.10	0.64	0.15	3.67	5.25	1.71	9.95	6.01	1.27	0.85	0.23	32.18
1982	1.02	2.79	9.95	6.34	4.47	8.28	6.90	7.17	4.28	2.18	1.85	0.50	55.73
1983	2.66	6.13	2.82	0.65	2.12	4.96	4.24	8.45	5.84	5.53	0.77	3.05	47.22
1984	0.18	3.49	2.68	0.92	2.76	2.35	6.73	3.20	7.79	0.44	4.34	0.73	35.61
1985	0.24	0.10	2.09	4.05	2.92	6.25	10.08	6.77	9.35	1.44	2.10	1.05	46.44
1986	1.67	1.83	2.95	0.14	3.26	9.66	3.89	9.32	2.70	5.94	1.09	3.63	46.08
1987	1.21	1.72	4.10	0.00	2.17	5.80	4.09	1.67	2.88	4.31	7.32	0.00	35.27
1988	2.26	1.66	3.09	2.06	4.72	3.71	6.55	6.91	1.52	1.32	2.53	1.42	37.75
1989	2.11	0.32	2.78	3.77	0.78	5.54	3.06	4.37	5.20	3.73	0.40	2.83	34.89
1990	1.11	2.70	0.53	0.77	3.24	6.11	3.72	6.59	13.88	2.86	1.22	0.39	43.12
1991	5.37	1.74	3.63	5.65	2.98	5.66	12.08	4.62	6.48	4.38	1.67	0.42	54.68
1992	1.38	2.59	1.47	3.43	0.91	15.92	5.72	9.69	5.72	0.85	5.82	1.26	54.76
1993	7.66	4.09	6.80	1.58	3.08	3.34	6.80	4.43	3.33	6.46	2.75	0.83	51.15
1994	3.46	5.91	3.07	7.65	5.22	11.08	3.42	6.71	6.19	3.87	4.68	6.91	68.17
1995	1.46	3.33	2.71	2.51	2.19	5.87	8.02	12.68	5.78	12.07	0.54	0.70	57.86
1996	1.83	1.36	10.01	1.20	5.37	6.08	4.31	1.85	5.45	**5.98**	**1.55**	**1.57**	46.56
1997	2.26	1.12	2.82	9.45	3.71	8.72	8.62	10.17	4.18	1.03	1.95	3.68	57.71
1998	2.52	5.95	4.60	5.23	2.32	2.77	**4.54**	7.60	10.22	0.58	5.64	0.41	52.38
1999	2.40	0.41	1.17	3.52	2.00	17.41	2.98	20.52	**4.76**	**9.13**	**0.52**	**1.74**	66.57

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	P.O.R.*
Mean	2.01	2.24	3.06	2.56	3.85	7.33	5.68	6.58	5.72	3.38	2.24	1.64	46.28
Stand. Dev	1.60	1.65	2.51	2.37	2.31	3.99	2.42	3.99	3.58	2.75	1.82	1.52	9.28
Minimum	0.15	0.04	0.00	0.00	0.78	2.20	1.71	0.90	1.52	0.10	0.06	0.00	32.18
Median	1.75	1.79	2.80	1.77	3.17	5.98	5.02	6.68	5.33	2.85	1.90	1.10	45.84
Maximum	7.66	6.13	10.01	9.45	11.82	17.41	12.08	20.52	18.66	12.07	7.32	6.91	68.17

* : indicates period of records for station and excludes partial year results

** : indicates partial year

-- : indicates no data available or large gaps of missing data

Bold number: indicates estimate from monthly correlation with Fort Pierce Field Station

COW CREE_R = (FT.PIER R x 0.77) + 0.53; $R^2 = 0.72$

Table B3. Monthly and annual rainfall (inches) at station FORT PIE_R

Year	Month												Year
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1914	2.86	2.95	0.62	4.53	3.29	3.05	7.17	4.28	11.13	5.93	4.18	3.44	53.43
1915	9.36	2.24	2.74	1.36	2.25	5.41	8.81	7.91	7.44	10.88	3.35	1.89	63.64
1916	1.83	2.05	0.60	1.84	4.04	5.75	3.53	2.98	8.06	10.34	2.94	1.19	45.15
1917	0.90	3.23	0.19	0.44	1.18	4.66	5.09	3.18	6.67	3.37	0.49	2.65	32.05
1918	3.51	0.69	4.38	6.74	1.35	6.30	8.21	2.74	14.22	6.02	0.89	1.31	56.36
1919	2.16	4.30	5.64	2.15	2.94	4.13	9.43	5.33	2.82	0.60	7.32	2.14	48.96
1920	7.38	1.97	2.13	4.22	4.50	2.83	5.91	5.32	9.67	4.14	3.50	0.78	52.35
1921	0.43	1.99	1.56	1.36	6.26	1.96	6.90	1.63	0.75	11.31	0.98	1.02	36.15
1922	2.18	3.19	0.60	0.65	2.54	2.94	4.34	5.88	8.44	10.46	2.10	0.67	43.99
1923	1.28	0.30	0.79	4.84	7.72	8.40	5.39	1.09	8.50	2.93	0.46	1.12	42.82
1924	5.16	1.47	3.63	2.22	4.42	0.69	7.38	1.41	7.19	19.31	0.38	1.28	54.54
1925	4.99	2.15	3.31	1.75	7.16	5.21	6.44	5.49	1.91	1.79	10.65	6.77	57.62
1926	7.48	1.84	2.40	4.75	0.72	9.52	12.74	7.74	11.07	1.88	0.71	1.03	61.88
1927	0.65	0.78	1.56	1.21	0.92	2.00	4.93	5.13	11.81	10.27	1.95	0.56	41.77
1928	1.04	1.27	3.56	0.25	3.88	3.98	2.84	14.57	4.72	3.50	1.70	0.35	41.66
1929	1.89	0.59	2.32	1.46	11.09	6.85	5.45	3.04	6.97	8.76	1.60	2.51	52.53
1930	1.78	5.28	5.43	7.72	7.41	11.88	2.78	3.84	7.34	4.78	2.90	3.49	64.63
1931	3.27	0.79	3.76	11.16	1.80	1.17	6.39	4.12	6.89	6.37	1.48	1.37	48.57
1932	1.45	1.44	3.04	1.74	4.16	12.90	1.48	6.41	5.44	4.05	6.86	0.94	49.91
1933	1.98	1.18	4.23	9.86	1.65	5.45	2.98	8.87	6.36	12.97	3.62	0.75	59.90
1934	1.49	5.54	2.12	5.44	5.72	4.97	2.89	4.00	3.68	3.09	1.06	1.32	41.32
1935	0.22	1.61	0.27	5.31	3.44	9.15	4.00	3.57	6.53	10.63	0.77	0.99	46.49
1936	1.83	5.86	3.44	2.74	5.87	12.00	3.81	2.60	10.33	6.41	4.54	4.42	63.85
1937	1.60	4.55	9.08	5.09	9.90	2.80	3.32	4.75	7.75	12.46	6.94	0.93	69.17
1938	0.46	1.11	0.49	0.39	3.25	5.72	3.95	2.65	8.42	6.46	4.07	1.25	38.22
1939	0.48	0.46	1.11	5.16	4.61	4.59	6.21	3.30	5.12	10.42	1.55	1.12	44.13
1940	2.98	2.53	4.92	0.96	3.76	6.34	5.16	5.55	12.40	1.95	0.23	3.51	50.29
1941	5.92	5.64	3.03	7.51	3.02	5.73	8.23	3.74	14.19	5.80	6.30	4.32	73.43
1942	2.16	4.24	6.17	1.17	7.94	7.65	1.94	2.43	5.95	1.84	0.87	5.10	47.46
1943	0.29	1.28	5.57	1.11	4.96	5.10	6.65	9.29	6.30	5.84	2.65	0.59	49.63
1944	1.10	0.27	1.73	6.74	2.15	7.46	5.82	4.49	4.90	11.56	1.55	0.57	48.34
1945	1.16	0.37	1.51	1.69	0.98	4.23	4.32	5.38	17.05	6.74	4.28	4.17	51.88
1946	1.20	0.77	2.32	0.42	6.75	3.71	5.23	5.53	6.23	4.75	3.13	3.55	43.59
1947	1.42	3.48	6.75	4.62	5.23	5.58	8.79	6.97	15.22	12.35	6.03	1.32	77.76
1948	5.11	0.58	2.27	5.10	4.27	3.74	5.56	9.70	14.31	4.78	1.43	1.11	57.96
1949	1.01	1.88	0.81	2.97	3.53	6.90	4.67	12.16	8.97	5.80	0.37	5.57	54.64
1950	0.68	1.88	4.04	3.28	3.83	3.68	4.21	12.12	8.59	11.01	2.48	0.72	56.52
1951	0.31	2.11	0.76	10.25	3.84	4.02	3.11	5.21	7.03	10.73	3.28	0.84	51.49
1952	2.45	7.08	2.31	2.11	1.57	0.50	6.96	7.58	5.48	13.50	0.55	1.32	51.41
1953	1.98	1.40	9.83	3.36	1.41	5.81	4.27	6.58	7.16	10.14	4.40	1.32	57.66
1954	2.32	1.92	2.13	10.82	4.91	12.48	5.92	5.81	9.50	7.46	6.08	0.60	69.95
1955	1.64	1.32	2.41	3.26	4.24	7.43	3.35	7.35	4.83	7.67	0.09	4.98	48.57
1956	0.41	2.76	0.53	2.76	2.03	1.58	5.73	4.03	7.82	10.51	0.55	0.90	39.61
1957	0.99	3.87	5.03	5.31	5.22	5.72	10.67	6.77	6.93	7.69	1.96	2.56	62.72
1958	8.39	0.88	3.49	2.00	6.88	5.70	1.79	5.70	3.15	8.94	0.81	4.07	51.80
1959	2.52	0.96	7.76	1.41	4.54	13.51	4.97	5.86	10.55	11.41	3.78	2.92	70.19
1960	0.19	6.14	3.93	5.85	4.30	6.52	6.05	7.78	16.73	4.85	0.84	1.10	64.28
1961	3.24	1.39	3.40	1.14	7.18	5.47	1.25	5.19	3.24	5.09	1.22	0.49	38.30

Table B3. Continued

Year	Month												Year
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1962	0.64	0.71	2.82	3.19	2.20	5.11	12.65	8.46	5.19	3.63	1.68	0.28	46.56
1963	0.80	4.82	1.67	0.35	2.71	5.43	5.10	2.66	19.90	7.49	3.05	8.21	62.19
1964	2.16	6.13	1.36	5.44	3.24	2.44	7.16	9.80	6.19	9.96	0.47	1.64	55.99
1965	0.45	5.61	3.40	2.07	0.66	5.52	5.90	1.37	3.28	7.10	1.42	1.52	38.30
1966	3.73	7.60	2.29	3.01	6.57	11.26	4.96	2.72	6.76	4.52	2.28	1.31	57.01
1967	1.29	2.69	1.66	0.34	0.37	8.57	5.20	5.03	5.32	6.92	0.27	1.81	39.47
1968	0.48	2.08	0.87	0.87	3.80	15.84	6.61	6.91	7.87	7.06	1.97	0.13	54.49
1969	2.29	1.05	7.78	1.18	8.27	3.45	4.99	8.94	9.81	11.41	5.67	3.10	67.94
1970	3.92	2.60	7.26	0.45	7.81	3.20	3.81	4.92	12.32	9.67	1.41	1.13	58.50
1971	0.46	3.57	1.55	1.67	2.18	6.82	9.43	3.78	4.87	6.19	1.78	4.29	46.59
1972	2.37	4.55	2.69	4.31	5.21	10.11	5.33	4.60	2.04	5.37	4.03	1.77	52.38
1973	3.37	2.61	2.18	2.06	5.49	7.95	5.16	6.55	9.11	6.47	1.49	1.38	53.82
1974	2.66	0.86	0.48	2.07	4.93	8.08	12.62	4.48	6.21	3.62	2.10	1.82	49.93
1975	0.19	2.21	1.91	1.44	7.82	5.16	5.70	3.19	8.43	2.62	3.38	1.35	43.40
1976	0.40	1.52	0.72	4.51	7.74	7.70	2.68	4.44	5.45	0.66	2.87	3.47	42.16
1977	2.03	1.76	0.70	1.03	5.54	3.63	2.69	4.89	10.22	4.47	2.48	5.12	44.56
1978	3.21	2.93	2.95	1.96	5.48	5.67	9.37	5.33	4.94	8.00	2.28	7.25	59.37
1979	5.39	0.93	1.13	1.90	5.56	5.22	7.92	3.97	14.22	1.44	2.10	1.66	51.44
1980	3.12	2.79	2.15	2.90	2.54	4.65	6.59	1.31	6.30	6.94	4.78	1.97	46.04
1981	0.57	2.16	1.04	0.35	4.84	0.78	5.72	12.25	5.84	4.05	2.21	0.38	40.19
1982	1.39	3.63	7.48	4.10	12.97	8.31	5.64	5.24	4.86	2.76	8.70	1.79	66.87
1983	4.35	8.21	5.51	2.89	1.15	6.35	1.53	10.74	8.18	10.82	0.91	3.94	64.58
1984	0.94	2.77	4.05	0.76	7.85	4.15	3.80	7.41	6.93	1.34	9.33	0.86	50.19
1985	0.68	0.24	3.31	3.68	4.30	5.05	6.45	6.21	17.50	4.29	2.77	1.50	55.98
1986	3.40	1.80	8.94	0.17	2.43	7.45	6.06	9.21	7.29	6.11	3.21	4.05	60.12
1987	1.57	1.51	4.93	0.32	3.45	2.87	3.49	3.89	4.98	11.36	6.16	0.27	44.80
1988	2.85	2.91	3.43	1.49	2.73	1.54	5.90	4.35	1.34	2.45	2.19	1.48	32.66
1989	3.34	0.22	3.08	2.56	2.88	3.00	1.21	5.83	3.58	6.52	0.93	3.36	36.51
1990	1.65	2.33	0.72	0.65	4.33	3.14	8.13	4.54	11.27	3.71	2.40	0.44	43.31
1991	4.36	6.46	4.42	6.70	6.46	6.49	13.17	3.41	6.05	4.58	1.20	1.72	65.02
1992	0.94	3.33	1.12	4.34	1.00	14.13	1.33	7.48	7.50	1.38	7.74	2.00	52.29
1993	9.46	4.95	6.44	2.07	4.12	5.81	6.98	5.31	7.31	12.83	5.93	0.99	72.20
1994	3.97	9.70	2.34	5.39	4.21	5.33	5.96	6.35	13.97	9.98	5.77	7.42	80.39
1995	2.73	6.50	2.13	3.39	1.13	5.16	8.43	17.66	14.01	13.04	0.80	0.69	75.67
1996	2.83	1.15	12.46	0.83	4.95	5.19	4.28	3.40	9.75	7.49	2.40	1.50	56.23
1997	5.31	1.70	3.35	10.37	2.26	5.68	6.04	12.16	5.01	2.21	3.46	3.68	61.23
1998	2.40	5.23	3.98	3.15	2.75	6.00	3.31	9.17	11.61	2.93	8.05	1.51	60.09

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	P.O.R.*
Mean	2.43	2.75	3.22	3.20	4.31	5.83	5.63	5.82	8.01	6.83	2.94	2.16	53.14
Stand. Dev	2.06	2.07	2.44	2.64	2.46	3.11	2.61	3.05	3.88	3.75	2.35	1.78	10.66
Minimum	0.19	0.22	0.19	0.17	0.37	0.50	1.21	1.09	0.75	0.60	0.09	0.13	32.05
Median	1.98	2.11	2.69	2.22	4.16	5.45	5.45	5.31	7.19	6.41	2.28	1.48	52.29
Maximum	9.46	9.70	12.46	11.16	12.97	15.84	13.17	17.66	19.90	19.31	10.65	8.21	80.39

* : indicates period of records for station and excludes partial year results

** : indicates partial year

-- : indicates no data available or large gaps of missing data

Bold number: indicates estimate from monthly correlation with Stuart

FORT PIE_R = (STUART_R * 0.85) + 0.18 R^2 = 0.87

Table B4. Monthly and annual rainfall (inches) at station SCOTTO G_R

Year	Month												Year
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1960	**0.95**	**6.27**	**4.38**	**6.10**	**4.69**	**6.80**	**6.35**	**7.89**	**15.93**	4.86	1.01	1.35	66.58
1961	3.10	0.55	4.15	1.00	7.05	5.50	1.42	8.50	3.60	3.80	2.20	0.20	41.07
1962	1.15	0.80	3.10	5.10	0.60	4.70	8.40	11.60	11.40	0.30	5.40	0.50	53.05
1963	0.50	4.60	2.00	0.40	6.50	5.90	6.70	2.50	6.60	7.40	4.80	8.50	56.40
1964	3.60	5.80	1.10	5.40	1.70	2.80	8.70	13.20	9.10	6.50	0.70	0.20	58.80
1965	0.20	7.60	1.00	1.50	1.60	6.80	10.50	3.10	9.90	14.40	3.20	1.00	60.80
1966	8.80	6.10	2.20	3.71	6.65	12.91	6.84	5.32	7.32	8.21	2.06	1.66	71.78
1967	1.63	2.87	2.96	0.12	0.44	9.08	11.15	4.66	3.17	4.78	0.97	1.90	43.73
1968	3.70	1.81	0.95	0.21	1.79	16.35	5.40	5.28	5.90	6.50	2.30	0.01	50.20
1969	1.50	1.10	5.10	1.10	9.40	0.60	3.94	8.70	10.73	12.27	4.44	3.75	62.63
1970	4.01	3.35	7.17	0.02	6.76	6.06	4.13	1.01	6.48	8.40	0.95	0.50	48.84
1971	0.10	2.50	1.00	1.50	3.10	7.20	7.50	7.50	3.90	8.00	2.15	2.02	46.47
1972	1.91	3.69	4.82	1.00	4.82	8.05	5.70	3.50	0.72	3.20	2.15	1.60	41.16
1973	2.95	2.05	2.30	2.55	6.35	6.70	12.15	7.85	6.90	7.40	0.76	0.30	58.26
1974	1.50	1.30	0.01	5.90	2.30	7.40	12.30	4.90	6.10	1.70	1.45	3.00	47.86
1975	0.80	4.30	0.50	1.70	9.65	4.45	8.90	6.05	7.45	0.95	2.00	1.80	48.55
1976	0.30	2.40	0.93	0.05	14.25	9.80	4.30	6.60	10.00	0.61	3.30	3.15	55.69
1977	2.50	2.15	0.50	2.20	5.90	6.10	15.75	12.95	14.50	6.30	4.20	5.20	78.25
1978	5.60	2.90	4.40	3.80	7.25	9.40	13.20	6.60	6.65	8.05	2.30	7.50	77.65
1979	7.00	0.10	1.25	3.90	10.05	9.50	10.55	4.70	28.20	3.45	3.15	2.75	84.60
1980	3.45	4.15	5.60	3.95	3.75	4.45	15.05	5.90	8.65	2.10	3.70	1.80	62.55
1981	0.75	3.60	1.40	0.50	3.55	4.35	9.65	16.65	11.30	3.40	0.90	0.50	56.55
1982	1.20	5.40	11.05	12.70	12.90	10.00	13.25	13.00	8.90	2.55	4.15	1.10	96.20
1983	4.70	10.60	1.80	2.60	4.00	3.56	6.04	4.72	8.65	7.00	1.70	3.77	59.14
1984	0.59	3.26	3.52	1.01	6.32	6.71	6.35	5.71	16.67	0.95	6.54	0.41	58.04
1985	0.42	0.58	4.51	5.54	3.38	4.86	7.53	6.17	15.49	4.55	3.90	1.84	58.77
1986	3.13	1.97	4.83	0.10	2.13	19.50	5.39	5.91	5.23	8.64	2.43	3.18	62.44
1987	1.51	1.12	7.13	0.16	3.89	2.20	4.36	1.41	9.90	7.94	6.30	0.15	46.07
1988	2.52	2.65	4.36	1.65	4.10	2.72	10.61	5.65	1.08	1.97	2.63	0.85	40.79
1989	2.05	0.15	3.02	3.36	3.36	4.17	4.70	7.78	5.09	5.00	1.10	3.10	42.88
1990	0.50	2.10	1.11	2.65	6.60	6.88	9.20	8.84	5.71	4.90	**2.72**	**0.20**	51.41
1991	**4.43**	**2.48**	**5.72**	**7.04**	**7.08**	**15.62**	**12.41**	**9.32**	**8.82**	**4.89**	**1.95**	**0.56**	80.32
1992	**0.48**	**4.80**	**0.25**	**2.95**	**1.75**	**13.71**	**5.75**	**7.65**	**7.70**	**2.12**	**7.90**	**2.70**	57.76
1993	**8.10**	**5.35**	**6.72**	**2.75**	**4.61**	**6.15**	**7.22**	**5.70**	**7.52**	**12.54**	**6.25**	**1.75**	74.66
1994	**4.48**	**9.70**	**3.01**	**5.76**	**4.70**	**5.72**	**6.28**	**6.65**	**13.55**	**9.95**	**6.12**	**7.60**	83.52
1995	1.91	2.81	2.25	3.14	0.98	4.41	3.67	15.51	5.30	15.57	0.49	0.67	56.71
1996	0.58	1.66	11.99	0.34	5.86	9.43	1.11	4.15	4.23	4.07	1.17	1.18	45.77
1997	2.19	1.96	1.02	9.74	2.62	6.53	6.36	11.56	4.91	2.04	**2.37**	4.17	55.47
1998	2.00	5.10	4.17	3.49	3.27	1.37	5.08	6.49	12.17	0.89	7.28	0.45	51.76
1999	2.43	0.44	0.49	4.40	2.84	15.21	1.95	6.09	7.01	10.45	0.94	1.36	53.61

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	P.O.R.*
Mean	2.48	3.30	3.34	3.03	4.96	7.34	7.65	7.18	8.56	5.72	3.00	2.11	58.67
Stand. Dev	2.13	2.44	2.76	2.77	3.16	4.23	3.64	3.55	4.95	3.86	2.01	2.09	13.31
Minimum	0.10	0.10	0.01	0.02	0.44	0.60	1.11	1.01	0.72	0.30	0.49	0.01	40.79
Median	1.96	2.73	2.99	2.63	4.36	6.62	6.77	6.33	7.49	4.90	2.34	1.63	56.63
Maximum	8.80	10.60	11.99	12.70	14.25	19.50	15.75	16.65	28.20	15.57	7.90	8.50	96.20

* : indicates period of records for station and excludes partial year results

** : indicates partial year

-- : indicates no data available or large gaps of missing data

Bold number: indicates estimate from monthly correlation with Fort Pierce

SCOTTO G_R = (FORT PIE_R x 0.91) + 0.87; $R^2 = 0.52$

Table B5. Monthly and annual areal rainfall (inches) in St. Lucie County

Year	Month												Year
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1914	2.86	2.95	0.62	4.53	3.29	3.05	7.17	4.28	11.13	5.93	4.18	3.44	53.43
1915	9.36	2.24	2.74	1.36	2.25	5.41	8.81	7.91	7.44	10.88	3.35	1.89	63.64
1916	1.83	2.05	0.60	1.84	4.04	5.75	3.53	2.98	8.06	10.34	2.94	1.19	45.15
1917	0.90	3.23	0.19	0.44	1.18	4.66	5.09	3.18	6.67	3.37	0.49	2.65	32.05
1918	3.51	0.69	4.38	6.74	1.35	6.30	8.21	2.74	14.22	6.02	0.89	1.31	56.36
1919	2.16	4.30	5.64	2.15	2.94	4.13	9.43	5.33	2.82	0.60	7.32	2.14	48.96
1920	7.38	1.97	2.13	4.22	4.50	2.83	5.91	5.32	9.67	4.14	3.50	0.78	52.35
1921	0.43	1.99	1.56	1.36	6.26	1.96	6.90	1.63	0.75	11.31	0.98	1.02	36.15
1922	2.18	3.19	0.60	0.65	2.54	2.94	4.34	5.88	8.44	10.46	2.10	0.67	43.99
1923	1.28	0.30	0.79	4.84	7.72	8.40	5.39	1.09	8.50	2.93	0.46	1.12	42.82
1924	5.16	1.47	3.63	2.22	4.42	0.69	7.38	1.41	7.19	19.31	0.38	1.28	54.54
1925	4.99	2.15	3.31	1.75	7.16	5.21	6.44	5.49	1.91	1.79	10.65	6.77	57.62
1926	7.48	1.84	2.40	4.75	0.72	9.52	12.74	7.74	11.07	1.88	0.71	1.03	61.88
1927	0.65	0.78	1.56	1.21	0.92	2.00	4.93	5.13	11.81	10.27	1.95	0.56	41.77
1928	1.04	1.27	3.56	0.25	3.88	3.98	2.84	14.57	4.72	3.50	1.70	0.35	41.66
1929	1.89	0.59	2.32	1.46	11.09	6.85	5.45	3.04	6.97	8.76	1.60	2.51	52.53
1930	1.78	5.28	5.43	7.72	7.41	11.88	2.78	3.84	7.34	4.78	2.90	3.49	64.63
1931	3.27	0.79	3.76	11.16	1.80	1.17	6.39	4.12	6.89	6.37	1.48	1.37	48.57
1932	1.45	1.44	3.04	1.74	4.16	12.90	1.48	6.41	5.44	4.05	6.86	0.94	49.91
1933	1.98	1.18	4.23	9.86	1.65	5.45	2.98	8.87	6.36	12.97	3.62	0.75	59.90
1934	1.49	5.54	2.12	5.44	5.72	4.97	2.89	4.00	3.68	3.09	1.06	1.32	41.32
1935	0.22	1.61	0.27	5.31	3.44	9.15	4.00	3.57	6.53	10.63	0.77	0.99	46.49
1936	1.83	5.86	3.44	2.74	5.87	12.00	3.81	2.60	10.33	6.41	4.54	4.42	63.85
1937	1.60	4.55	9.08	5.09	9.90	2.80	3.32	4.75	7.75	12.46	6.94	0.93	69.17
1938	0.46	1.11	0.49	0.39	3.25	5.72	3.95	2.65	8.42	6.46	4.07	1.25	38.22
1939	0.48	0.46	1.11	5.16	4.61	4.59	6.21	3.30	5.12	10.42	1.55	1.12	44.13
1940	2.98	2.53	4.92	0.96	3.76	6.34	5.16	5.55	12.40	1.95	0.23	3.51	50.29
1941	5.92	5.64	3.03	7.51	3.02	5.73	8.23	3.74	14.19	5.60	6.30	4.32	73.43
1942	2.16	4.24	6.17	1.17	7.94	7.65	1.94	2.43	5.95	1.84	0.87	5.10	47.46
1943	0.29	1.28	5.57	1.11	4.96	5.10	6.65	9.29	6.30	5.84	2.65	0.59	49.63
1944	1.10	0.27	1.73	6.74	2.15	7.46	5.82	4.49	4.90	11.56	1.55	0.57	48.34
1945	1.16	0.37	1.51	1.69	0.98	4.23	4.32	5.38	17.05	6.74	4.28	4.17	51.88
1946	1.20	0.77	2.32	0.42	6.75	3.71	5.23	5.53	6.23	4.75	3.13	3.55	43.59
1947	1.42	3.48	6.75	4.62	5.23	5.58	8.79	6.97	15.22	12.35	6.03	1.32	77.76
1948	5.11	0.58	2.27	5.10	4.27	3.74	5.56	9.70	14.31	4.78	1.43	1.11	57.96
1949	1.01	1.88	0.81	2.97	3.53	6.90	4.67	12.16	8.97	5.80	0.37	5.57	54.64
1950	0.68	1.88	4.04	3.28	3.83	3.68	4.21	12.12	8.59	11.01	2.48	0.72	56.52
1951	0.31	2.11	0.76	10.25	3.84	4.02	3.11	5.21	7.03	10.73	3.28	0.84	51.49
1952	2.45	7.08	2.31	2.11	1.57	0.50	6.96	7.58	5.48	13.50	0.55	1.32	51.41
1953	1.98	1.40	9.83	3.36	1.41	5.81	4.27	6.58	7.16	10.14	4.40	1.32	57.66
1954	2.32	1.92	2.13	10.82	4.91	12.48	5.92	5.81	9.50	7.46	6.08	0.60	69.95
1955	1.64	1.32	2.41	3.26	4.24	7.43	3.35	7.35	4.83	7.67	0.09	4.98	48.57
1956	0.41	2.76	0.53	2.76	2.03	1.58	5.73	4.03	7.82	10.51	0.55	0.90	39.61
1957	0.99	3.87	5.03	5.31	5.22	5.72	10.67	6.77	6.93	7.69	1.96	2.56	62.72
1958	8.39	0.88	3.49	2.00	6.88	5.70	1.79	5.70	3.15	8.94	0.81	4.07	51.80
1959	2.52	0.96	7.76	1.41	4.54	13.51	4.97	5.86	10.55	11.41	3.78	2.92	70.19
1960	0.57	6.19	4.15	5.98	4.49	6.60	6.21	7.86	16.38	4.86	0.93	1.23	65.44
1961	3.17	0.97	3.78	1.07	7.12	5.49	1.34	6.85	3.42	4.45	1.71	0.35	39.69

Table B5. Continued

Year	Month												Year
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1962	0.90	0.76	2.96	4.15	1.40	4.91	10.53	10.03	8.30	1.97	3.54	0.39	49.81
1963	0.65	4.71	1.84	0.38	4.61	5.67	5.90	2.58	13.25	7.45	3.93	8.36	59.30
1964	2.88	5.97	1.23	5.42	2.47	2.62	7.93	11.50	7.65	8.23	0.59	0.92	57.40
1965	0.33	6.61	2.20	1.79	1.13	6.16	8.20	2.24	6.59	10.75	2.31	1.26	49.55
1966	6.27	6.85	2.25	3.36	6.61	12.09	5.90	4.02	7.04	6.37	2.17	1.49	64.40
1967	1.46	2.78	2.31	0.23	0.41	8.83	8.18	4.85	4.25	5.85	0.62	1.86	41.60
1968	2.09	1.95	0.91	0.54	2.80	16.10	6.01	6.10	6.89	6.78	2.14	0.07	52.35
1969	1.90	1.08	6.44	1.14	8.84	2.03	4.47	8.82	10.27	11.84	5.06	3.43	65.29
1970	3.52	2.82	6.94	0.40	5.93	4.33	4.28	3.52	7.40	8.26	1.61	0.84	49.85
1971	0.54	2.67	1.27	1.51	3.44	9.00	8.68	4.27	3.72	5.78	1.33	2.41	44.62
1972	1.52	3.02	3.86	2.04	5.19	9.12	4.88	5.86	1.54	3.59	2.79	1.37	44.80
1973	3.01	2.12	2.71	2.07	5.63	6.61	8.40	5.58	7.18	5.70	0.80	0.94	50.76
1974	1.89	0.94	0.22	3.28	3.05	10.06	10.67	5.57	5.37	2.72	2.02	2.01	47.79
1975	0.38	3.45	0.80	1.46	8.17	6.29	7.54	5.93	6.81	1.99	1.93	1.37	46.11
1976	0.36	1.81	0.76	2.12	11.27	8.53	4.23	3.98	7.36	0.46	2.79	3.04	46.71
1977	2.04	1.63	0.50	1.16	4.80	5.19	7.52	7.89	9.89	4.23	3.59	4.45	52.89
1978	3.62	2.46	3.62	2.49	5.28	8.53	9.23	4.83	5.98	6.46	1.86	6.40	60.77
1979	4.93	0.29	1.27	2.43	7.73	6.52	7.23	5.36	18.61	1.95	2.26	1.71	60.27
1980	3.43	2.67	2.96	3.33	3.04	4.03	8.15	4.97	4.84	3.07	3.32	1.51	45.32
1981	0.57	2.48	0.98	0.46	4.04	3.41	4.68	13.28	7.40	2.58	1.34	0.32	41.54
1982	1.02	3.89	9.22	6.73	8.69	8.97	8.91	9.21	5.69	2.17	4.82	1.25	70.55
1983	3.98	8.33	3.54	2.07	2.08	5.82	3.57	8.09	8.42	7.62	1.02	4.03	58.56
1984	0.47	2.96	3.99	0.98	5.33	5.11	6.51	5.51	9.91	1.04	6.81	0.61	49.23
1985	0.59	0.28	3.48	4.62	3.00	4.77	8.32	6.26	13.61	3.71	2.63	1.53	52.78
1986	2.77	1.63	5.45	0.18	2.82	12.73	6.32	7.76	4.43	6.01	2.14	3.44	55.68
1987	1.36	1.37	5.68	0.24	3.00	3.58	4.16	2.17	6.65	8.06	6.56	0.18	42.99
1988	2.60	2.55	3.76	2.17	3.57	3.78	7.77	5.96	1.16	1.89	2.86	1.17	39.24
1989	2.23	0.21	3.01	3.34	2.06	4.32	3.32	6.40	3.95	4.69	0.71	2.97	37.19
1990	1.01	2.34	0.83	1.09	4.06	4.60	6.99	7.21	10.27	3.88	1.56	0.31	44.15
1991	4.47	3.56	3.67	6.22	4.15	5.57	10.28	4.17	5.12	4.77	1.35	1.00	54.34
1992	0.86	2.79	1.29	3.41	1.15	16.24	4.64	10.39	5.74	1.11	7.34	1.65	56.62
1993	9.35	3.84	6.46	1.84	3.90	4.94	6.70	5.24	4.85	8.49	4.25	0.89	60.76
1994	4.12	6.41	2.97	7.15	4.92	7.92	5.75	6.28	9.60	6.36	6.45	6.42	74.35
1995	2.03	3.49	2.28	2.99	1.47	5.02	6.31	14.95	8.32	14.50	0.46	0.69	62.48
1996	1.59	1.14	11.51	0.87	5.13	7.05	3.04	4.18	5.88	5.67	2.19	1.37	49.60
1997	2.78	1.61	2.30	8.92	2.97	6.25	7.37	10.48	4.62	1.84	3.04	3.80	55.96
1998	2.47	5.57	4.32	3.13	2.91	3.03	4.13	7.13	10.98	1.57	7.07	0.44	52.74
1999	2.35	0.52	0.80	3.46	2.32	15.79	2.03	10.66	5.76	10.22	0.83	1.34	56.08

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	P.O.R.*
Mean	2.37	2.57	3.15	3.23	4.23	6.26	5.88	6.07	7.68	6.49	2.77	2.03	52.74
Stand. Dev	2.05	1.88	2.34	2.62	2.36	3.40	2.36	2.91	3.55	3.80	2.15	1.72	9.51
Minimum	0.22	0.21	0.19	0.18	0.41	0.50	1.34	1.09	0.75	0.46	0.09	0.07	32.05
Median	1.89	2.08	2.73	2.33	3.97	5.62	5.86	5.56	7.10	5.97	2.16	1.32	51.84
Maximum	9.36	8.33	11.51	11.16	11.27	16.24	12.74	14.95	18.61	19.31	10.65	8.36	77.76

* : indicates period of records for station and excludes partial year results

** : indicates partial year

-- : indicates no data available or large gaps of missing data

APPENDIX C

Historical Evaporation Data

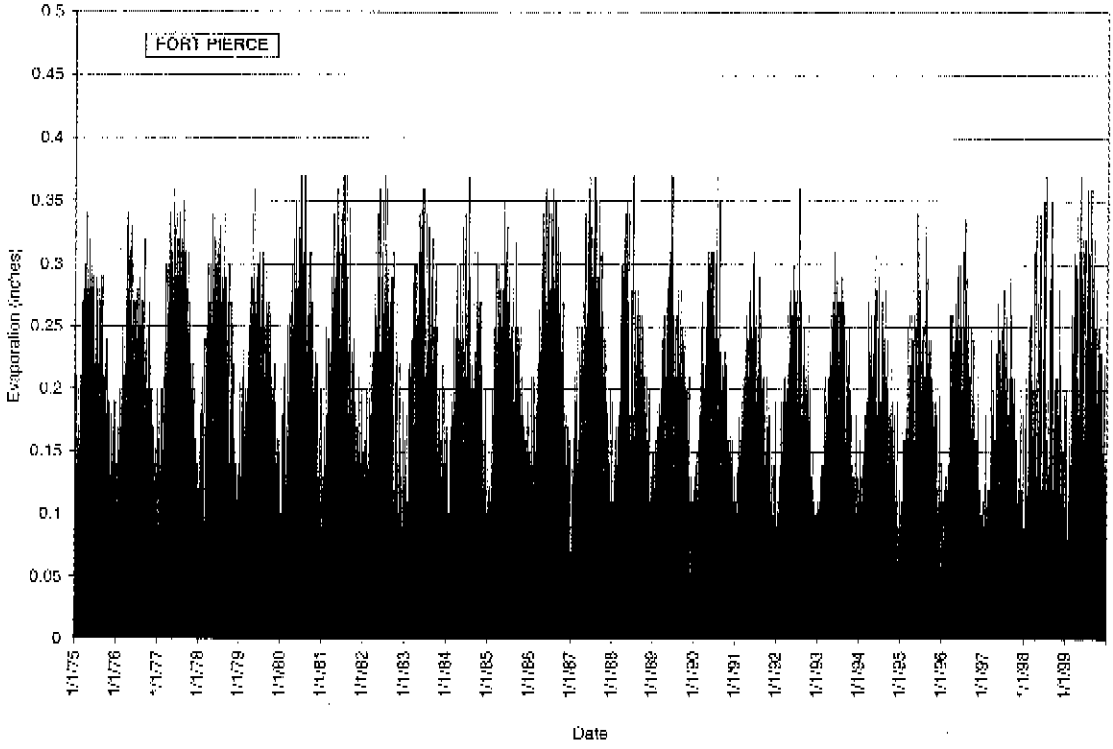


Figure C1. Daily pan evaporation at station FT. PI2_E

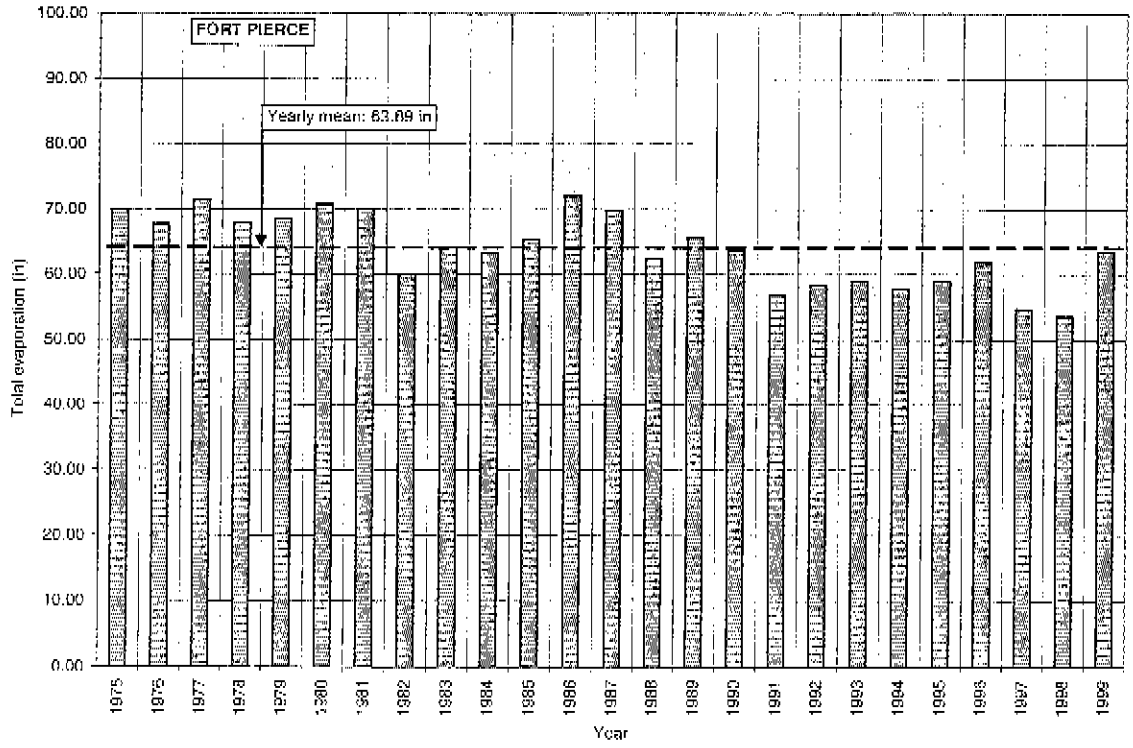


Figure C2. Annual pan evaporation at station FT. PI2_E

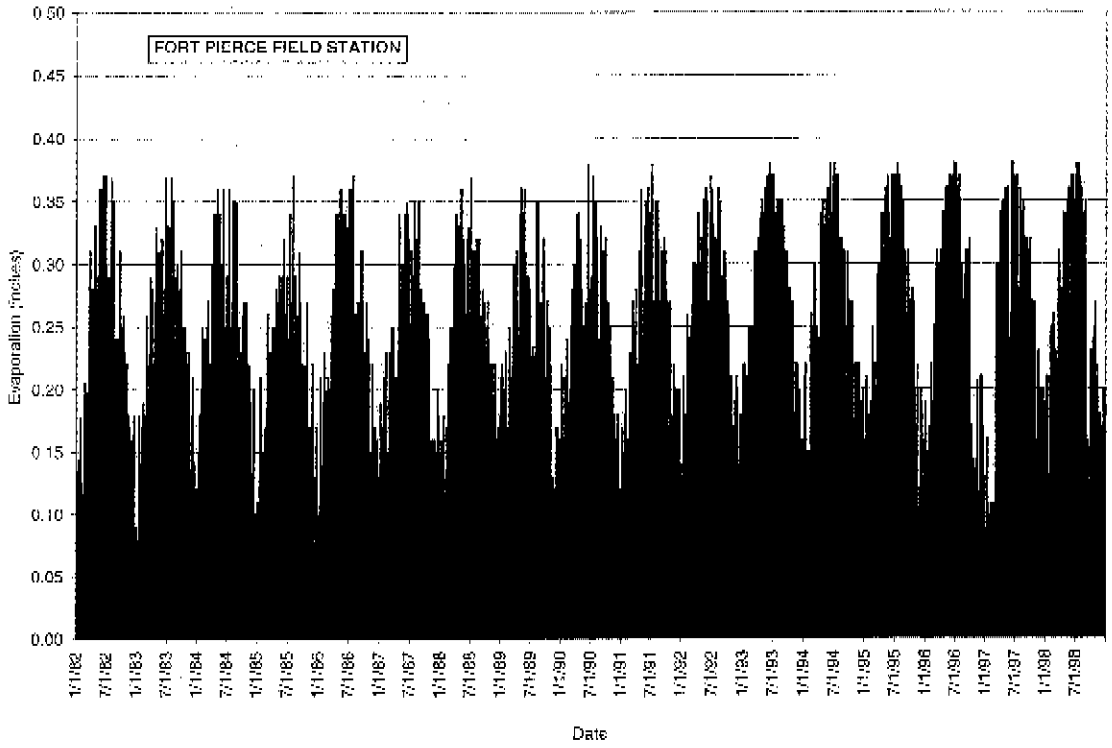


Figure C3. Daily pan evaporation at station FT. PIER_E

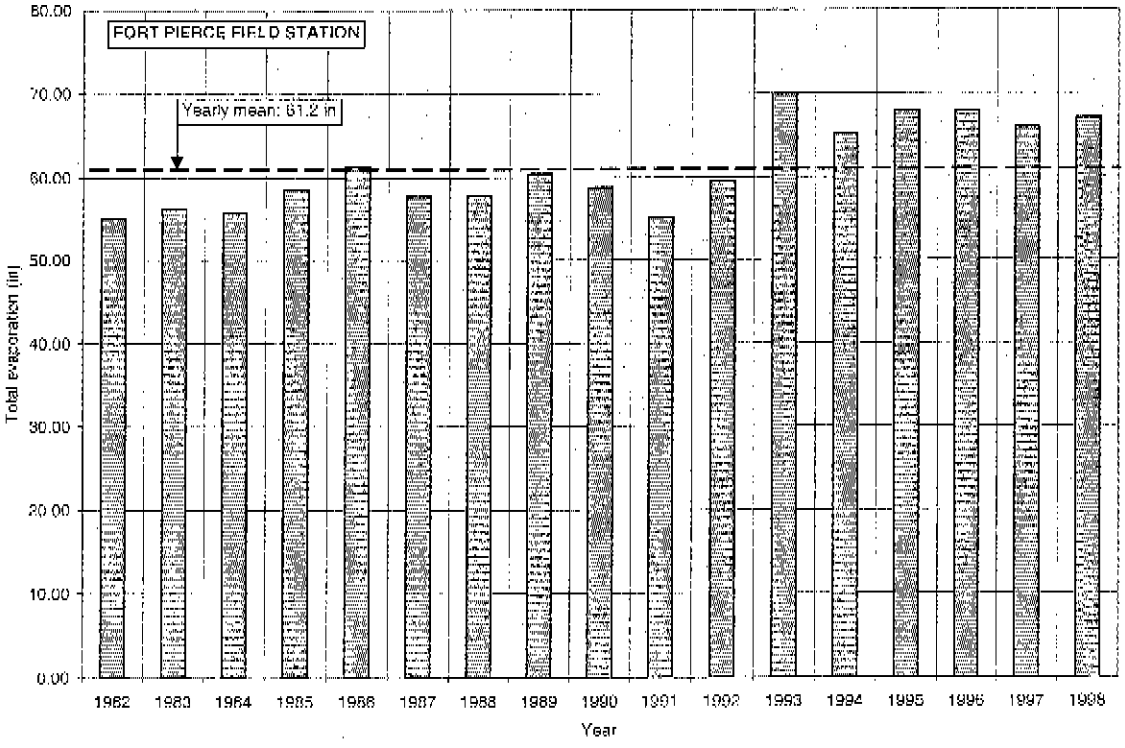


Figure C4. Annual pan evaporation at station FT. PIER_E

APPENDIX D

Monthly and Annual Evaporation Statistics

Table D1. Monthly and annual evaporation (inches) at station FT. PI2_E

Year	Month												Year
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1975	4.06	4.59	7.08	7.54	8.05	6.69	6.54	6.50	5.30	5.54	3.97	3.95	69.81
1976	3.90	4.67	6.26	7.14	6.86	7.20	6.81	7.01	4.99	5.73	3.59	3.55	67.71
1977	3.53	4.24	6.40	8.00	7.88	7.48	6.98	7.27	6.67	5.41	4.55	3.07	71.48
1978	3.59	3.45	6.00	6.81	7.09	7.16	7.63	7.07	5.97	5.39	4.36	3.50	68.02
1979	3.91	3.94	5.93	7.14	6.93	7.85	7.93	6.52	5.62	5.41	4.22	3.16	68.56
1980	3.57	3.96	6.15	6.71	6.89	8.79	8.30	6.87	5.94	5.60	4.54	3.46	70.78
1981	3.48	4.34	6.14	7.73	9.00	6.81	7.83	6.65	5.54	5.08	3.78	3.67	70.05
1982	3.55	3.53	5.39	6.05	7.31	5.94	6.58	6.00	4.64	4.53	3.57	2.96	60.05
1983	2.93	3.63	5.70	6.52	7.77	7.25	7.21	6.53	5.80	4.34	3.45	3.07	64.20
1984	2.99	3.78	5.88	6.11	5.89	6.64	6.42	5.69	6.39	6.14	4.09	3.37	63.39
1985	3.20	4.25	5.83	6.41	8.27	6.97	6.07	5.76	5.48	5.02	4.23	3.91	65.40
1986	3.56	3.29	5.83	7.65	8.24	7.32	8.23	7.25	6.79	6.07	4.19	3.62	72.04
1987	3.55	4.01	5.44	6.63	6.74	7.75	8.80	7.88	6.68	4.69	4.13	3.46	69.76
1988	3.31	3.76	5.70	7.40	7.35	5.65	5.12	5.75	5.82	5.44	4.00	3.06	62.36
1989	3.48	3.85	5.22	6.26	7.87	7.44	6.17	6.91	6.31	6.10	3.39	2.61	65.61
1990	3.37	4.32	5.71	6.61	7.14	7.13	6.96	5.68	5.24	4.64	3.78	3.05	63.63
1991	2.24	3.53	4.99	6.03	6.90	5.79	6.27	6.08	4.72	4.16	3.16	2.92	56.79
1992	2.75	3.56	5.16	6.01	7.45	5.83	7.09	5.24	4.88	4.41	3.33	2.58	58.29
1993	2.76	3.33	4.79	5.77	6.41	6.75	7.03	5.94	5.70	4.21	3.37	2.84	58.90
1994	3.21	3.74	5.53	6.15	7.05	5.52	6.30	5.48	4.27	4.49	3.49	2.60	57.83
1995	2.74	3.67	5.59	5.79	7.38	5.97	6.05	6.07	5.30	4.46	3.42	2.46	58.90
1996	2.82	3.41	5.69	6.18	6.56	6.40	7.70	6.45	5.62	4.30	3.75	3.09	61.97
1997	3.02	3.20	5.13	5.15	6.07	5.85	5.95	5.24	4.70	4.10	3.18	3.14	54.73
1998	2.67	4.35	5.20	4.35	5.06	5.45	3.86	7.75	4.99	3.90	3.83	2.23	53.64
1999	2.94	3.84	6.19	5.94	5.92	5.11	6.79	6.37	6.30	5.77	4.69	3.60	63.46

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	P.O.R.*
Mean	3.25	3.85	5.72	6.48	7.12	6.67	6.82	6.40	5.59	5.00	3.84	3.16	63.89
Stand. Dev	0.45	0.41	0.51	0.84	0.87	0.90	1.06	0.73	0.69	0.70	0.45	0.45	5.46
Minimum	2.24	3.20	4.79	4.35	5.06	5.11	3.86	5.24	4.27	3.90	3.16	2.23	53.64
Median	3.31	3.78	5.70	6.41	7.09	6.75	6.81	6.45	5.62	5.02	3.78	3.09	63.63
Maximum	4.06	4.67	7.08	8.00	9.00	8.79	8.80	7.88	6.79	6.14	4.69	3.95	72.04

* : indicates period of records for station and excludes partial year results

** : indicates partial year

-- : indicates no data available or large gaps of missing data

Table D2. Monthly and annual evaporation (inches) at station FT. PIER_E

Year	Month												Year
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1982	**3.17**	**3.16**	**5.35**	5.55	6.27	5.25	6.25	5.54	4.69	4.04	2.93	2.81	55.01
1983	1.94	3.04	4.78	5.88	6.99	5.87	6.77	5.34	5.13	4.36	3.22	2.95	56.27
1984	2.80	3.54	5.15	6.02	6.05	6.02	5.21	5.75	5.24	4.13	3.09	2.70	55.70
1985	3.02	3.37	5.78	5.73	7.09	6.58	5.92	5.08	5.01	4.63	3.65	2.73	58.59
1986	2.86	3.68	4.96	6.79	7.08	6.24	6.49	5.93	5.56	5.08	3.11	3.57	61.35
1987	3.00	2.95	4.23	5.87	6.33	6.74	6.59	6.04	5.92	4.34	2.95	2.82	57.78
1988	2.14	2.77	4.92	6.16	7.31	6.24	5.73	5.93	5.66	4.37	3.39	3.29	57.91
1989	4.41	3.74	5.25	5.87	6.90	6.45	**5.56**	5.64	6.39	4.33	3.07	2.85	60.46
1990	3.66	3.88	5.11	5.83	6.38	5.85	6.04	5.96	5.58	4.55	2.72	3.23	58.79
1991	2.59	2.96	3.67	4.33	6.09	6.07	6.23	6.33	5.72	4.73	3.17	3.33	55.22
1992	3.29	3.47	4.74	6.19	7.44	5.54	6.71	6.06	5.30	4.17	3.39	3.24	59.54
1993	4.11	4.01	5.77	6.88	7.99	8.22	7.45	7.25	5.92	5.89	3.94	2.50	69.93
1994	3.42	4.05	5.41	7.08	7.57	7.93	7.88	5.96	4.85	4.64	3.34	3.12	65.25
1995	3.30	3.62	5.86	5.97	7.70	7.46	8.26	8.03	5.83	5.67	3.31	2.80	67.81
1996	3.03	4.12	7.25	6.45	7.69	7.23	8.59	6.51	5.82	**3.86**	**3.37**	3.99	67.90
1997	**2.70**	**2.86**	5.08	7.59	5.97	7.57	6.98	7.20	6.49	4.83	4.90	3.73	65.90
1998	3.35	4.41	5.76	6.69	7.24	8.09	7.96	8.06	**3.48**	5.14	4.13	2.71	67.02

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	P.O.R.*
Mean	3.11	3.51	5.24	6.17	6.95	6.67	6.74	6.27	5.45	4.63	3.39	3.08	61.20
Stand. Dev	0.62	0.49	0.77	0.73	0.65	0.92	0.99	0.87	0.71	0.55	0.52	0.41	5.03
Minimum	1.94	2.77	3.67	4.33	5.97	5.25	5.21	5.08	3.48	3.86	2.72	2.50	55.01
Median	3.03	3.54	5.15	6.02	7.08	6.45	6.59	5.96	5.58	4.55	3.31	2.95	59.54
Maximum	4.41	4.41	7.25	7.59	7.99	8.22	8.59	8.06	6.49	5.89	4.90	3.99	69.93

* : indicates period of records for station and excludes partial year results

** : indicates partial year

-- : indicates no data available or large gaps of missing data

Bold number: indicates estimate from monthly correlation with Fort Pierce

FT.PIER_E = (FT.PI2_E x 0.91) - 0.063 $R^2 = 0.99$

APPENDIX E

Historical Daily Flow Data

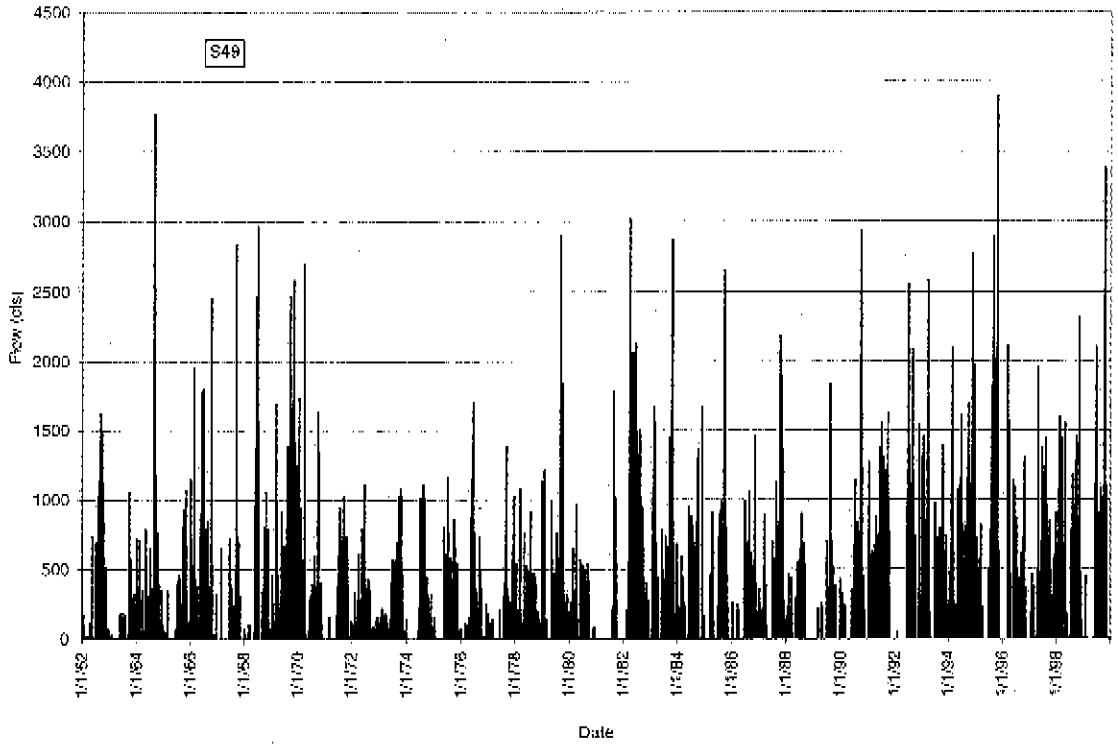


Figure E1. Mean daily flow at S-49

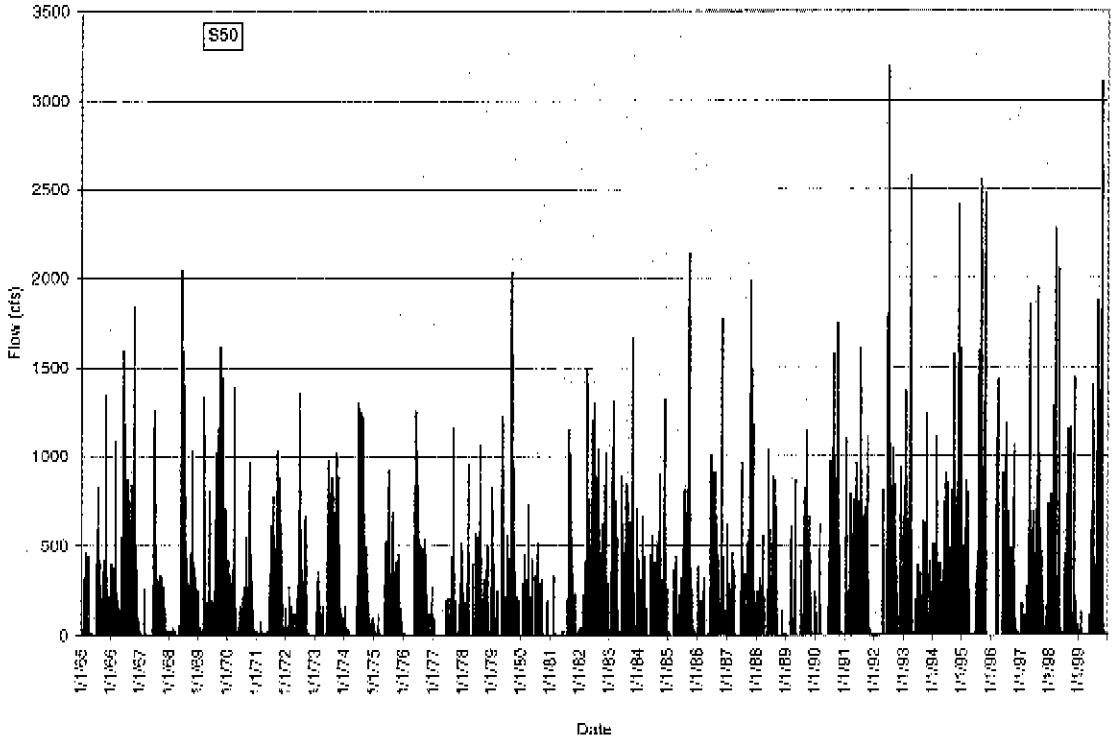


Figure E2. Mean daily flow at S-50

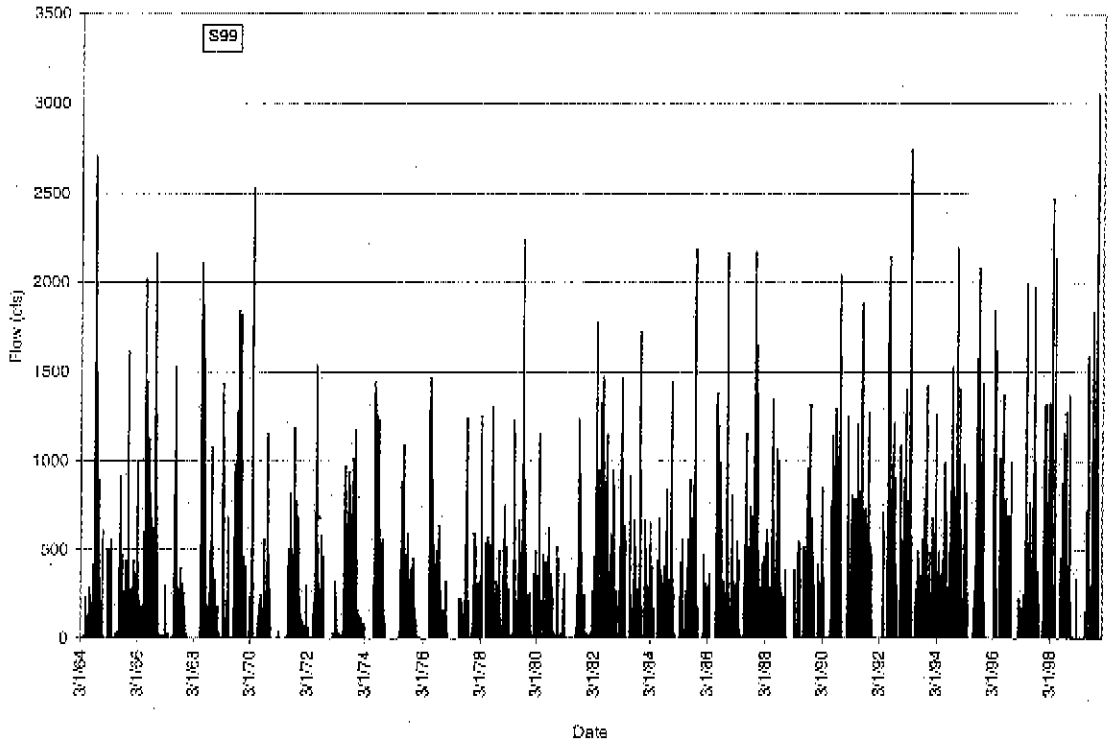


Figure E3. Mean daily flow at S-99

APPENDIX F

Monthly and Annual Flow Data Statistics

Table F1. Mean daily flow at S-49 (cfs)

Year	Month												Year
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1962	15	0	1	5	26	32	143	554	1093	397	41	6	193
1963	1	3	0	0	12	1	16	0	110	79	27	41	24
1964	72	111	12	33	51	11	139	452	472	76	49	52	127
1965	26	41	11	0	0	17	108	16	140	228	100	34	60
1966	222	280	101	16	132	252	336	300	102	470	3	12	186
1967	0	28	0	0	0	138	134	8	221	177	10	2	60
1968	21	6	46	0	166	1428	447	27	205	230	115	26	226
1969	175	45	358	86	275	156	86	812	978	677	663	347	388
1970	675	372	434	159	0	45	140	185	167	492	75	0	229
1971	0	9	70	0	1	84	299	225	291	297	148	25	121
1972	18	70	51	124	192	413	57	94	45	24	29	61	98
1973	84	94	57	46	39	229	260	215	430	377	57	14	158
1974	0	0	0	0	0	198	696	727	140	88	27	34	159
1975	34	0	0	0	125	186	326	282	239	139	52	30	118
1976	11	6	51	49	295	584	207	96	253	32	7	73	139
1977	42	21	23	0	0	8	11	122	329	38	94	206	74
1978	106	64	134	9	25	115	157	170	92	122	54	91	95
1979	306	81	5	0	301	129	129	119	1210	467	124	66	245
1980	29	85	18	88	19	23	45	27	132	0	2	3	39
1981	0	0	0	0	0	0	17	307	400	27	0	0	63
1982	0	19	322	425	276	764	783	729	335	197	126	--	**
1983	--	712	492	97	0	130	26	241	393	623	182	84	**
1984	96	87	146	16	44	76	291	176	345	156	221	51	142
1985	7	0	52	111	0	8	361	439	815	283	31	0	176
1986	35	0	33	0	0	330	297	532	159	111	134	8	137
1987	103	15	118	28	0	0	181	63	111	299	527	14	122
1988	15	89	75	0	62	55	236	283	72	0	0	0	74
1989	0	0	21	8	7	0	116	458	168	196	18	45	86
1990	76	52	22	0	0	55	249	259	553	944	50	0	188
1991	190	133	253	358	56	357	865	411	259	485	0	0	281
1992	0	2	0	0	0	483	571	766	408	121	254	41	221
1993	681	268	736	132	0	31	288	111	301	593	67	30	270
1994	135	640	94	66	196	760	236	411	658	334	662	558	396
1995	321	69	147	24	0	17	216	1134	622	1512	70	0	344
1996	0	0	281	209	92	372	227	63	119	360	16	0	145
1997	29	25	1	304	104	388	483	722	191	60	61	215	215
1998	292	531	396	5	190	6	98	287	689	148	466	8	260
1999	2	34	0	0	0	701	424	352	553	1208	136	1	284

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	P.O.R*
Mean	103	105	120	63	71	226	255	320	363	318	124	59	171
Stand.Dev	167	177	171	104	97	300	207	269	289	332	172	110	95
Minimum	0	0	0	0	0	0	11	0	45	0	0	0	24
Median	29	38	51	12	22	122	222	270	275	213	59	26	152
Maximum	681	712	736	425	301	1,428	865	1,134	1,210	1,512	663	558	396

*: indicates period of records for station and excludes partial year results

**: indicates partial year

--: indicates no data available or large gaps of missing data

Table F2. Mean daily flow at S-50 (cfs)

Year	Month												Year
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1965	10	74	183	39	2	0	235	199	109	248	304	43	121
1966	228	311	185	62	131	436	390	497	465	715	338	54	318
1967	4	11	8	0	0	202	540	203	113	193	51	5	111
1968	7	9	8	0	56	971	791	229	211	350	229	71	244
1969	45	7	445	53	324	170	108	557	631	664	649	361	334
1970	230	142	370	153	9	64	105	179	146	469	100	17	165
1971	5	12	3	5	8	150	370	375	494	481	235	30	181
1972	36	95	55	32	99	514	306	153	313	5	1	1	134
1973	61	176	35	36	16	406	476	599	635	529	189	40	266
1974	36	4	3	1	0	297	872	621	362	209	36	47	224
1975	17	10	7	0	86	304	279	341	252	270	153	17	145
1976	5	0	0	0	324	507	288	240	254	55	20	55	146
1977	45	0	0	0	0	33	13	111	342	10	24	251	69
1978	69	47	147	0	18	188	227	384	75	85	124	68	119
1979	275	42	14	0	460	53	82	85	930	308	7	13	189
1980	16	60	34	152	14	11	101	58	94	0	12	6	46
1981	0	57	0	0	0	6	4	296	412	38	36	8	71
1982	26	64	182	267	175	498	552	476	160	203	300	--	**
1983	--	638	349	91	4	237	180	490	336	458	108	67	**
1984	114	98	191	6	24	50	202	270	256	117	230	86	137
1985	8	0	40	85	16	78	356	382	765	239	27	6	167
1986	61	14	56	1	1	244	283	492	206	167	224	33	149
1987	194	51	98	26	0	8	201	53	130	230	467	34	124
1988	19	65	102	11	114	132	245	352	99	0	8	3	96
1989	0	0	99	56	64	0	43	238	288	257	34	16	91
1990	21	57	32	0	0	98	225	645	345	591	18	4	170
1991	164	79	278	290	135	271	686	415	295	382	20	4	252
1992	0	2	3	85	0	902	368	533	323	86	126	41	206
1993	464	250	803	176	4	57	102	82	330	465	57	53	237
1994	151	331	109	57	127	505	222	325	675	318	520	350	307
1995	162	185	317	59	0	13	216	869	516	977	10	0	277
1996	0	0	186	100	75	354	407	132	80	303	19	6	139
1997	21	12	24	204	115	293	359	803	265	61	19	190	197
1998	308	483	483	28	286	13	97	250	572	74	239	43	240
1999	12	18	3	1	12	484	370	484	527	1145	71	5	261

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	P.O.R*
Mean	83	97	139	59	77	244	294	361	343	306	143	60	180
Stand.Dev	111	145	179	78	113	245	207	218	212	272	162	91	76
Minimum	0	0	0	0	0	0	4	53	75	0	1	0	46
Median	31	51	56	32	16	188	245	341	313	248	71	34	167
Maximum	464	638	803	290	460	971	872	869	930	1,145	649	361	334

*: indicates period of records for station and excludes partial year results

**: indicates partial year

--: indicates no data available or large gaps of missing data

Table F3. Mean daily flow at S-99 (cfs)

Year	Month												Year
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1964	--	--	0	4	24	44	32	415	911	305	31	32	**
1965	0	84	190	23	3	24	266	200	80	198	319	37	119
1966	255	316	189	67	141	501	430	539	414	850	268	9	332
1967	2	13	15	5	0	236	585	165	72	165	24	1	107
1968	0	0	0	0	57	1083	865	121	144	320	170	26	232
1969	9	0	380	13	231	0	13	522	734	712	376	45	253
1970	56	21	322	31	1	34	116	160	118	487	62	0	117
1971	0	3	0	0	0	42	389	375	506	400	322	93	178
1972	30	30	17	0	75	521	261	112	167	0	0	0	101
1973	7	92	11	2	3	305	422	567	512	494	224	39	223
1974	34	9	0	0	0	314	935	774	337	235	7	0	220
1975	0	0	0	0	94	382	339	300	222	254	128	16	145
1976	3	0	0	0	374	521	295	227	264	62	21	61	152
1977	0	0	0	0	0	40	23	156	345	3	31	297	75
1978	93	82	180	0	23	194	218	392	89	82	136	68	130
1979	304	74	27	9	411	43	99	104	914	274	26	41	194
1980	28	86	46	200	21	22	115	69	110	14	46	21	65
1981	7	74	2	0	0	0	7	332	390	43	46	8	76
1982	9	81	221	259	176	500	482	416	109	176	280	--	**
1983	--	658	271	53	0	188	85	232	117	385	78	77	**
1984	122	87	181	14	25	56	190	179	183	74	253	129	124
1985	6	0	57	106	16	86	347	312	780	192	0	1	159
1986	101	21	74	0	0	315	274	494	150	196	247	41	159
1987	280	90	122	41	0	358	418	432	456	363	556	283	283
1988	277	256	323	270	397	289	357	389	240	208	190	0	266
1989	0	0	85	133	202	0	155	347	343	335	108	35	145
1990	261	297	141	0	0	149	351	638	365	640	6	0	237
1991	180	134	349	307	279	304	701	344	264	500	269	0	303
1992	0	0	0	81	0	891	382	557	312	98	167	177	222
1993	471	274	956	170	0	161	131	82	309	471	35	49	259
1994	200	341	113	68	123	439	161	295	682	282	509	345	297
1995	169	192	329	71	0	11	204	768	438	823	19	0	252
1996	0	0	273	153	79	333	414	177	128	250	0	0	151
1997	15	6	18	210	98	275	358	801	195	31	8	336	196
1998	303	471	503	10	293	0	81	233	550	34	229	0	226
1999	0	21	0	0	12	474	366	463	497	1204	59	0	258

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	P.O.R*
Mean	95	109	150	64	88	254	302	352	346	310	146	65	190
Stand.Dev	127	154	196	89	125	253	221	201	234	272	148	100	73
Minimum	0	0	0	0	0	0	7	69	72	0	0	0	65
Median	21	74	80	14	22	215	284	338	310	252	93	32	194
Maximum	471	658	956	307	411	1,083	935	801	914	1,204	556	345	332

*: indicates period of records for station and excludes partial year results

**: indicates partial year

- ': indicates no data available or large gaps of missing data

APPENDIX G

Historical Daily Stage Data

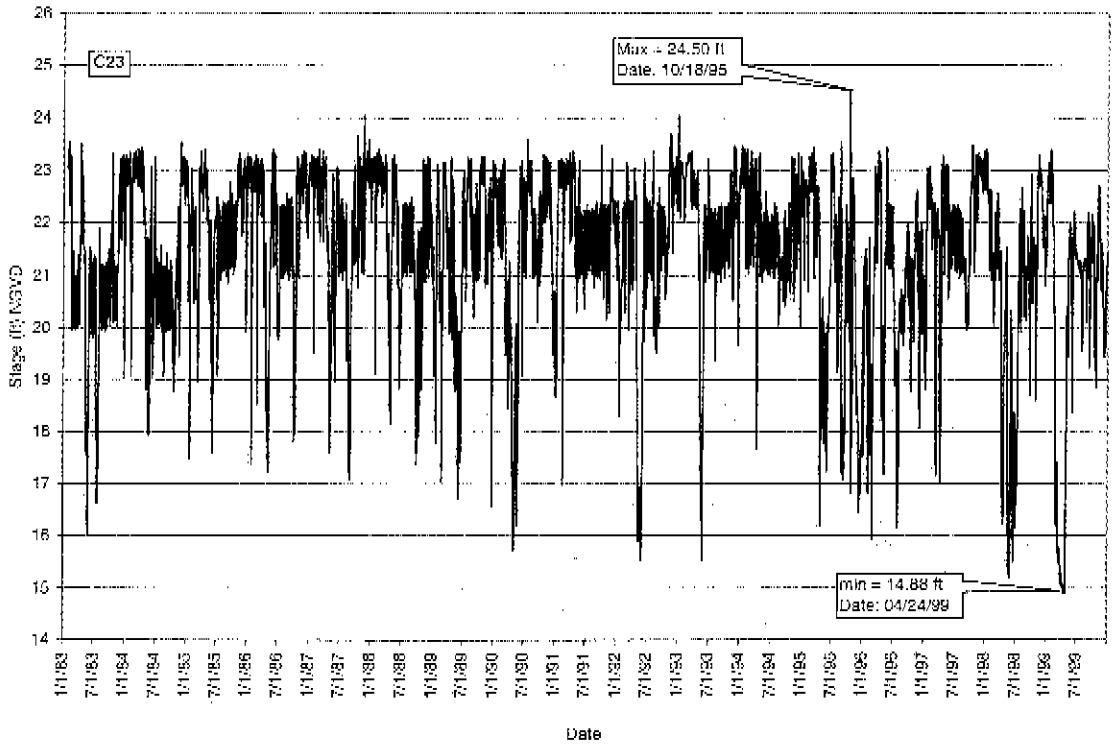


Figure G1. Mean daily stage at C-23

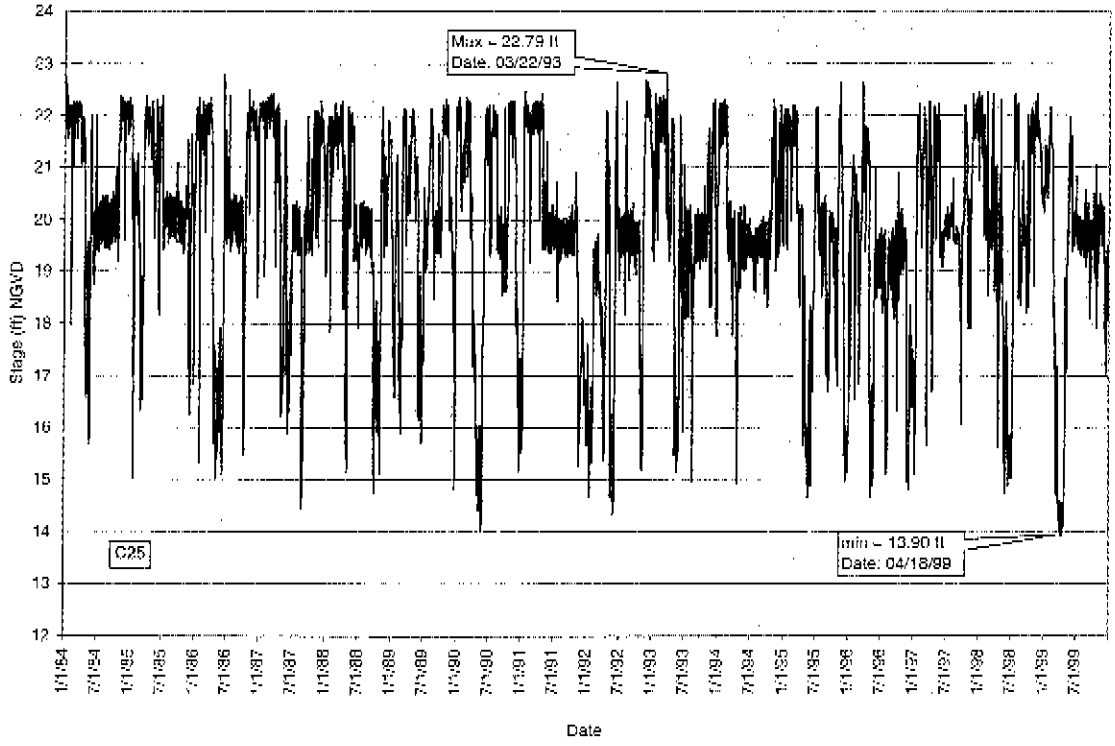


Figure G2. Mean daily stage at C-25

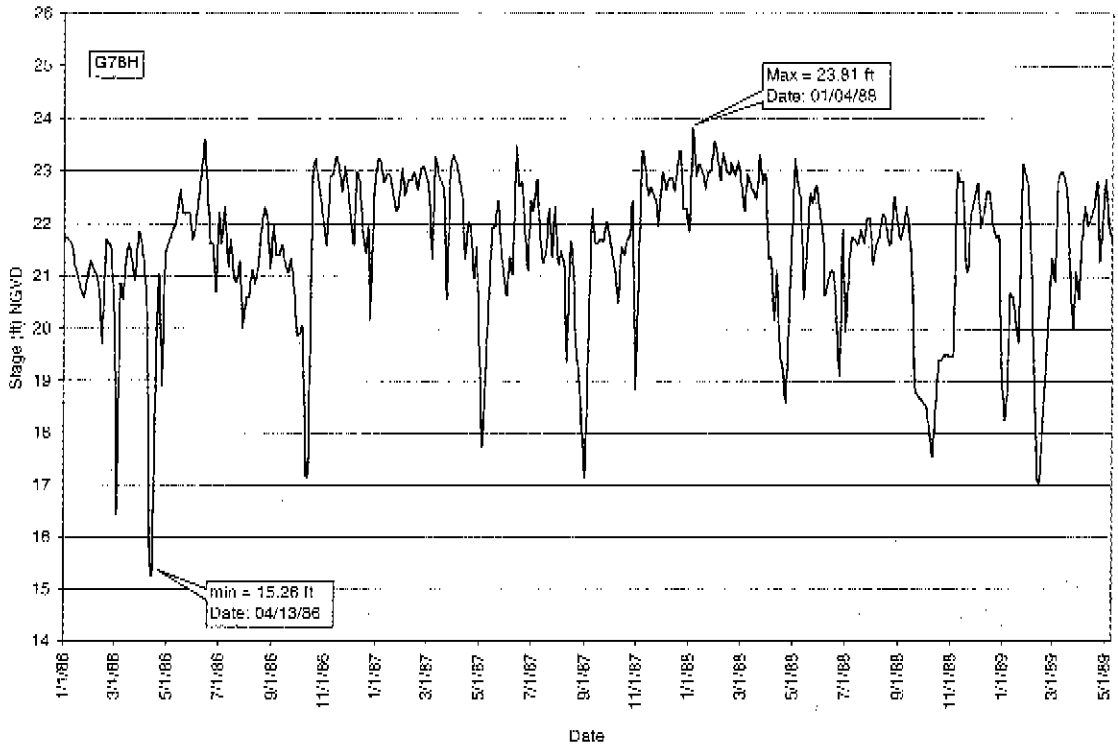


Figure G3. Mean daily headwater stage at G-78

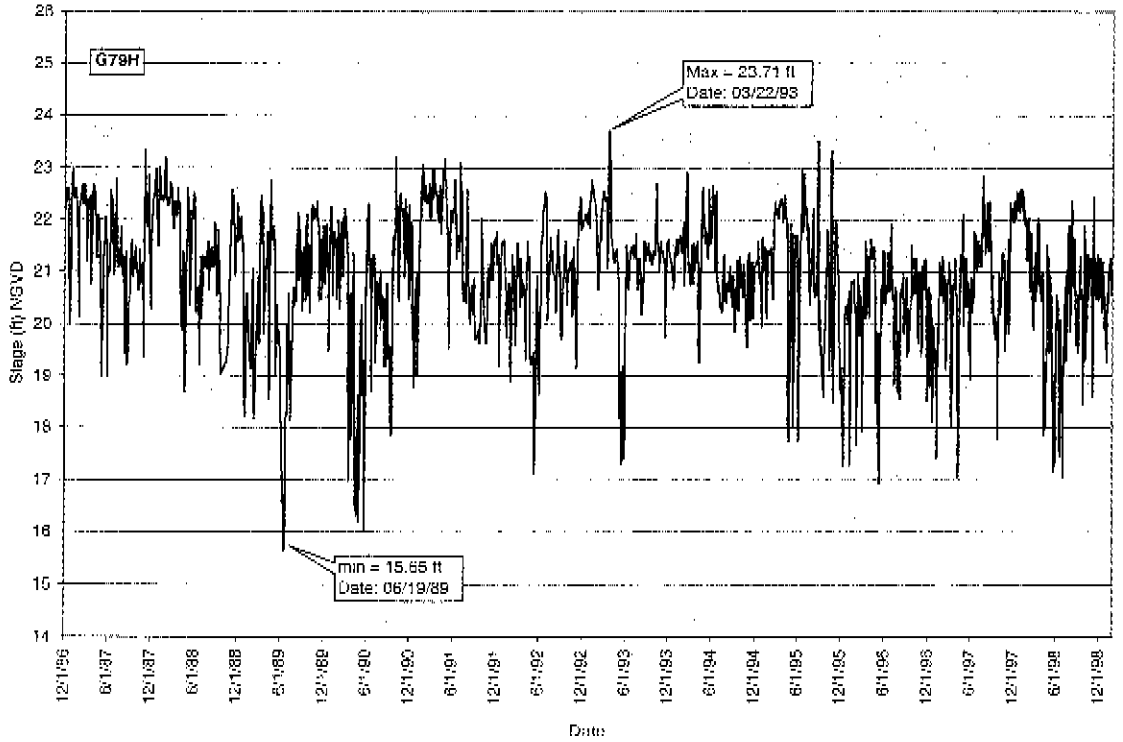


Figure G4. Mean daily headwater stage at G-79

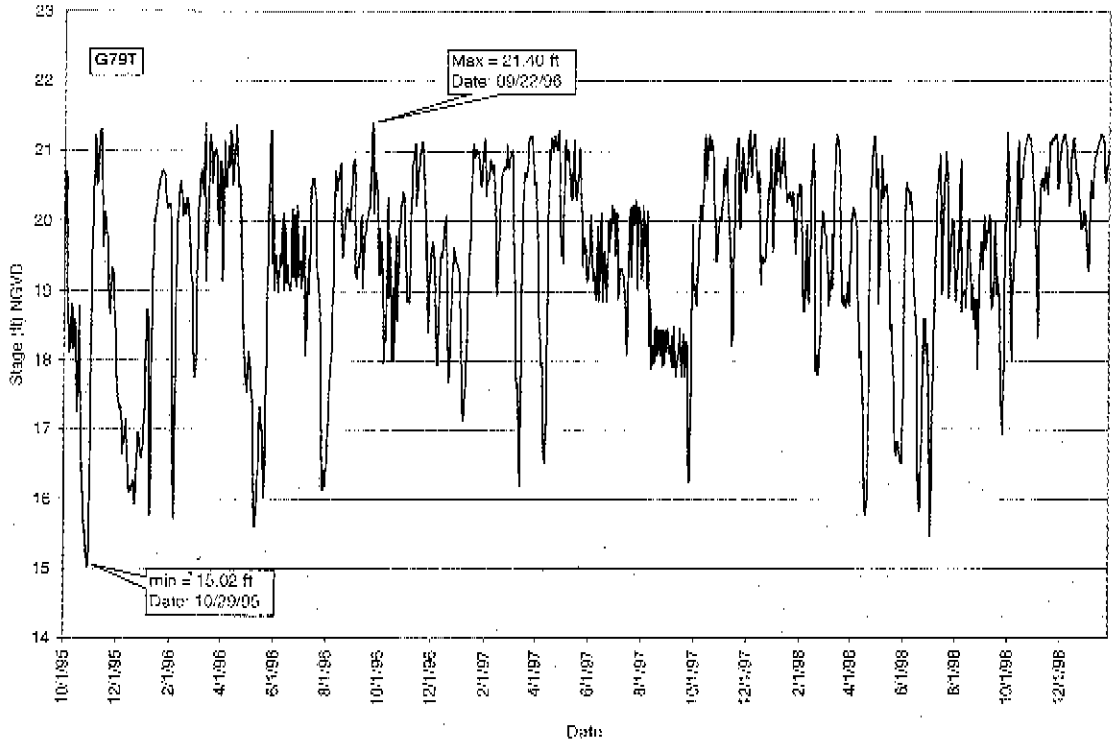


Figure G5. Mean daily tailwater stage at G-79

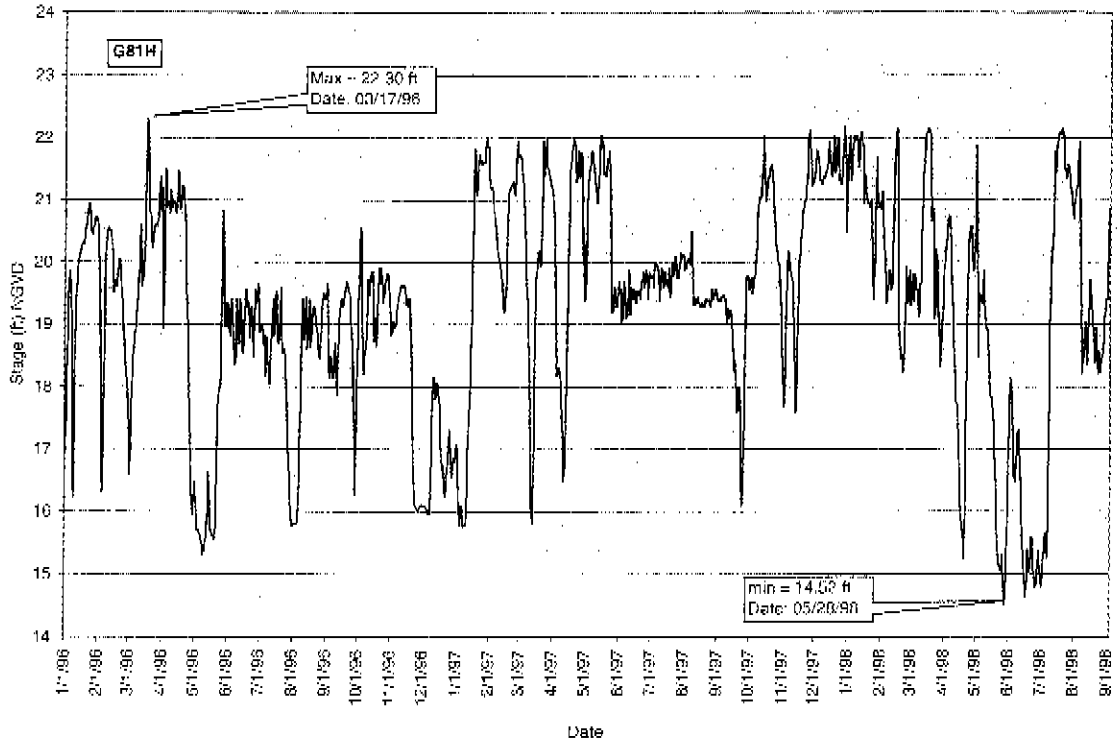


Figure G6. Mean daily headwater stage at G-81

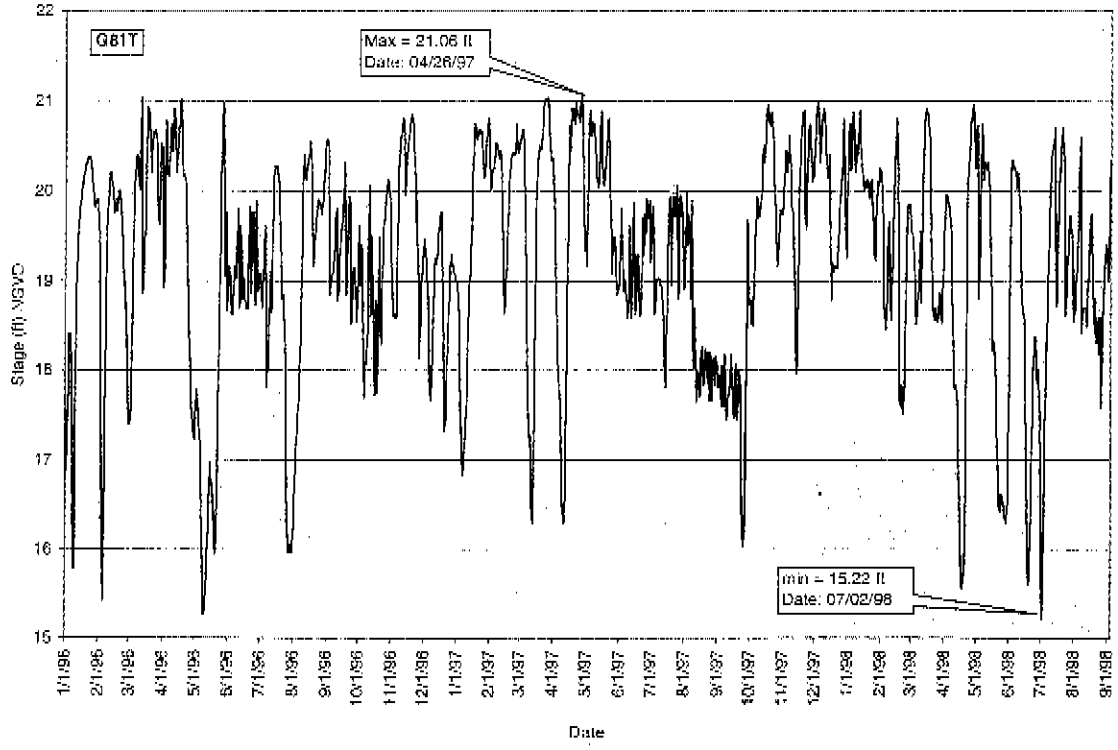


Figure G7. Mean daily tailwater stage at G-81

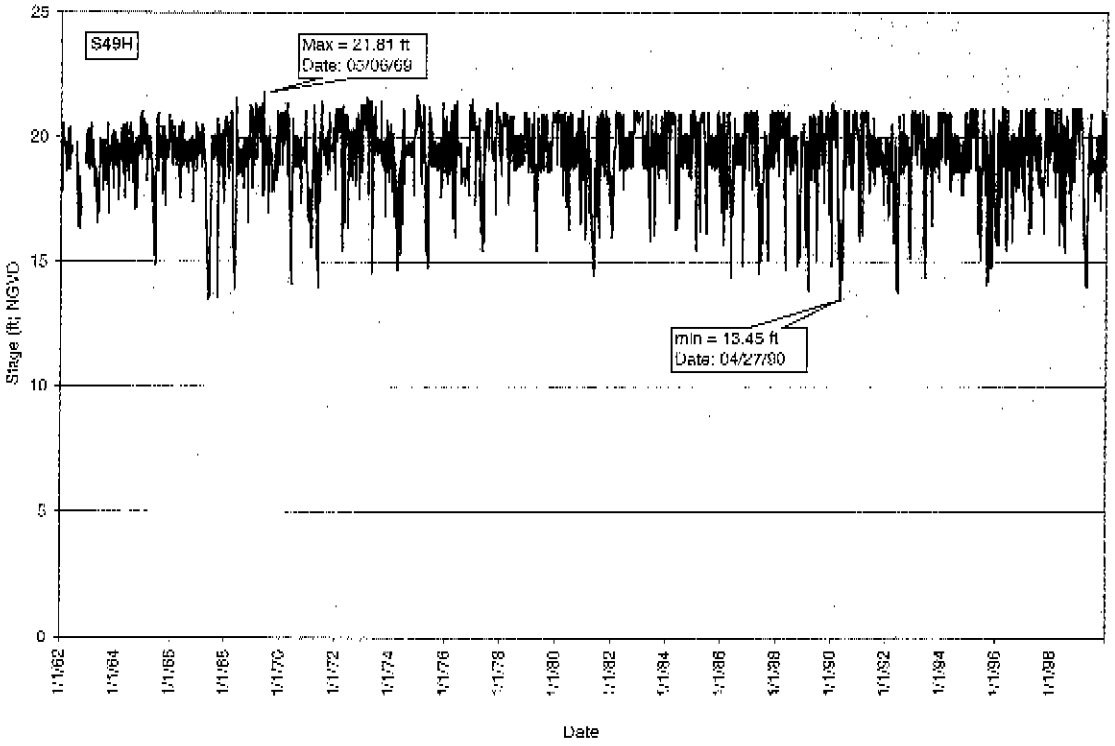


Figure G8. Mean daily headwater stage at S-49

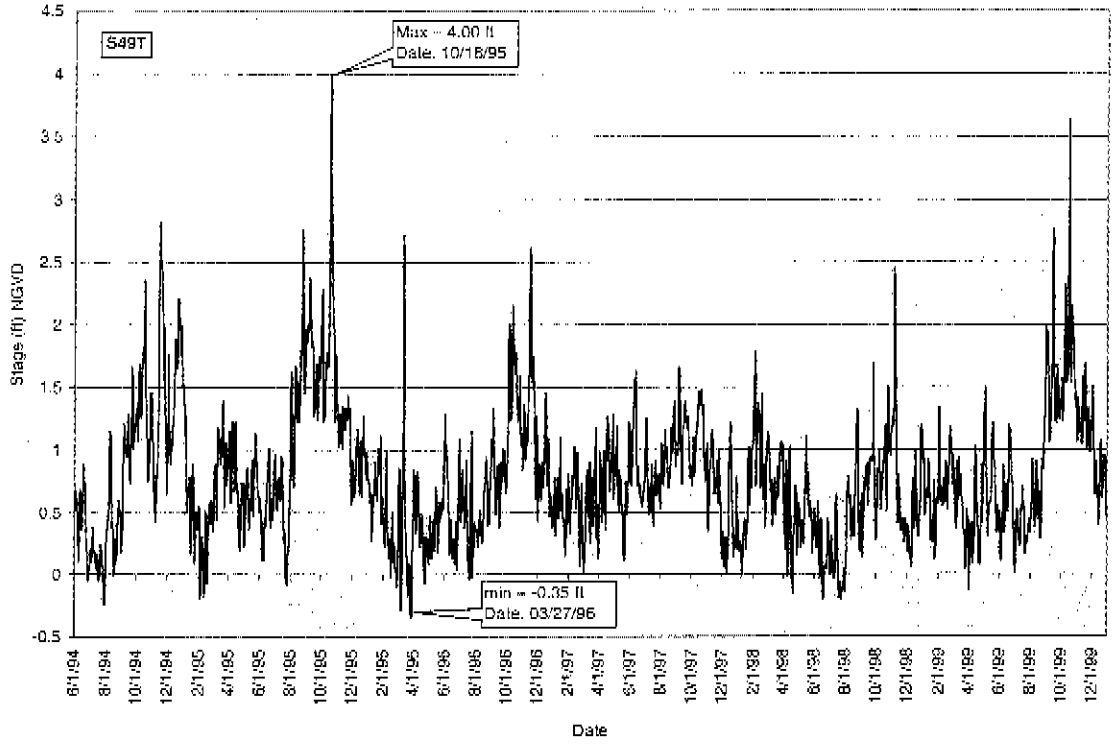


Figure G9. Mean daily tailwater stage at S-49

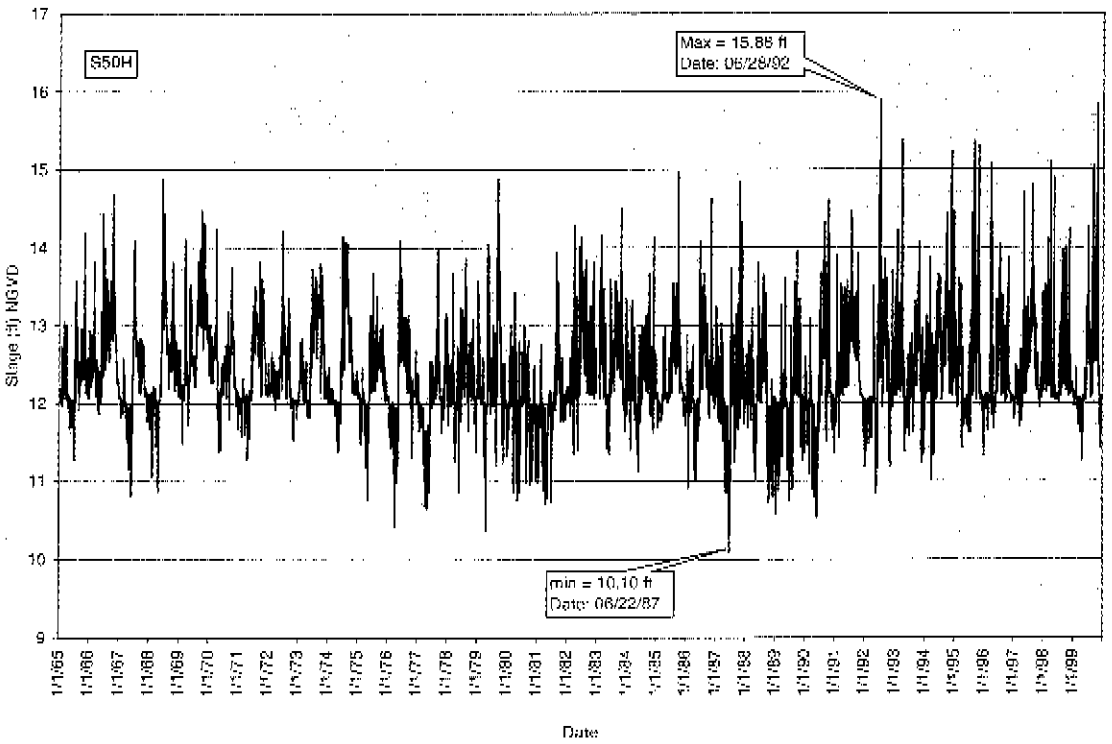


Figure G10. Mean daily headwater stage at S-50

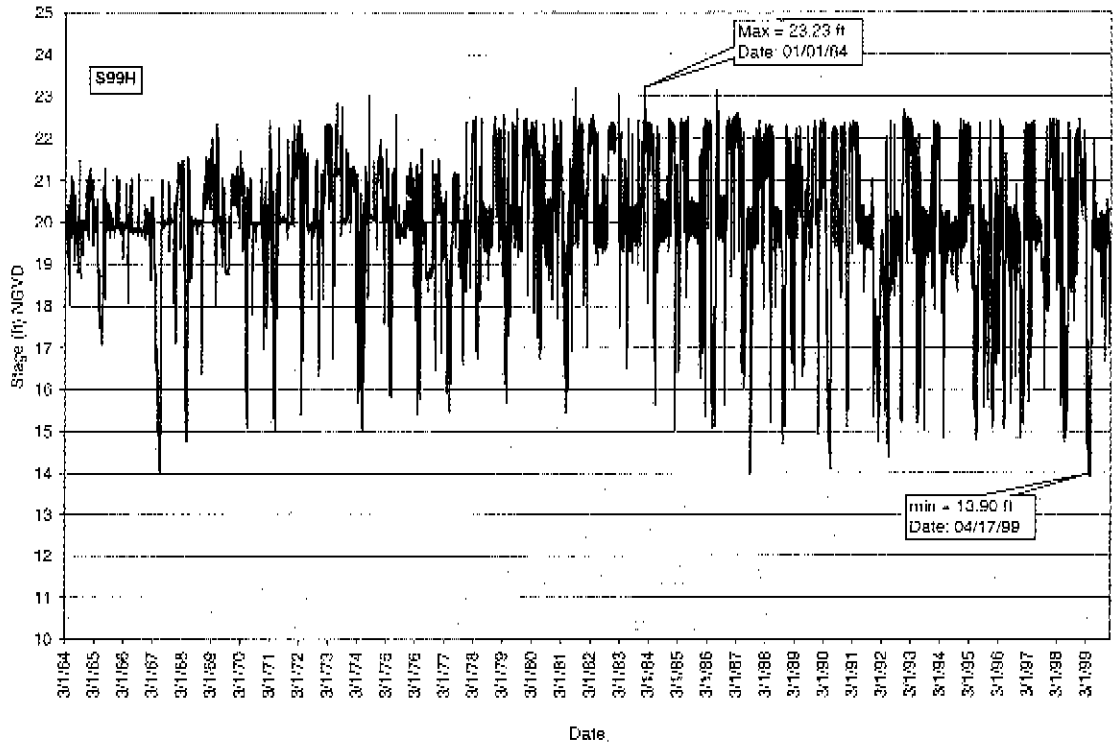


Figure G11. Mean daily headwater stage at S-99

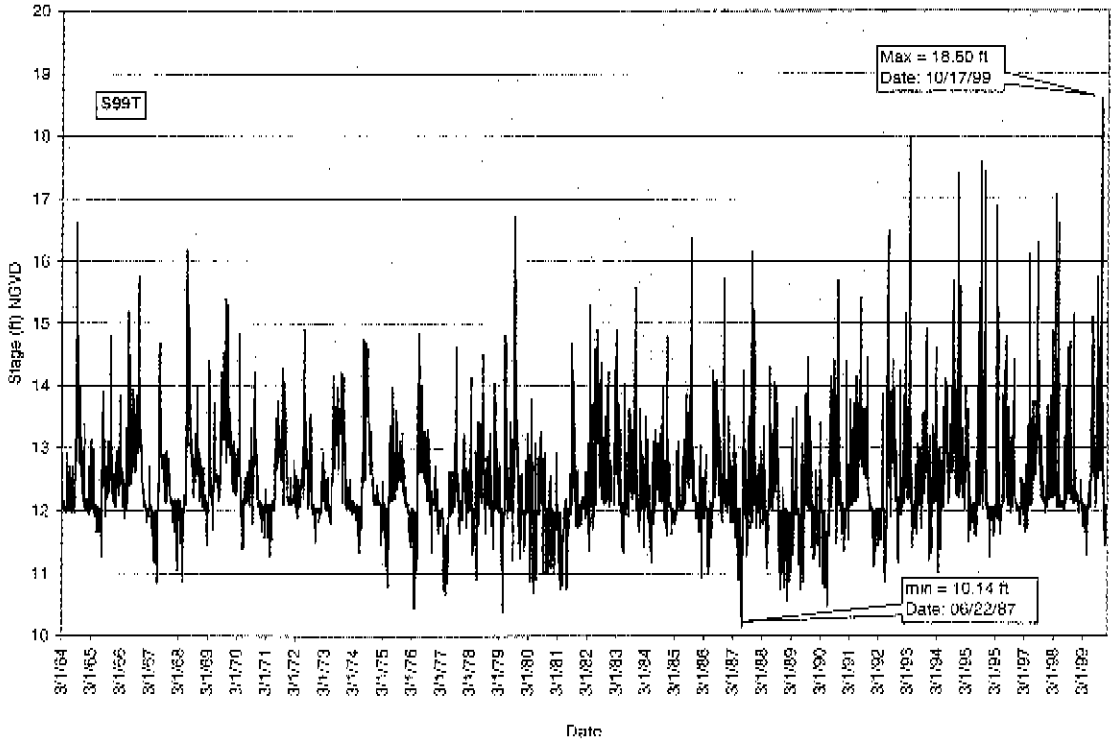


Figure G12. Mean daily tailwater stage at S-99

APPENDIX II

Monthly and Annual Stage Data Statistics

Table H1. Monthly and annual average stage at C-23 (ft, NGVD)

Year	Month												Year
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1983	--	21.80	20.48	22.01	18.96	20.60	19.18	20.72	20.59	21.12	21.41	22.21	**
1984	22.85	22.54	23.02	22.49	20.11	21.12	20.72	20.42	20.65	20.06	21.64	22.93	21.55
1985	21.77	21.86	21.52	22.73	21.76	20.75	21.35	21.74	21.58	21.72	22.72	22.48	21.83
1986	22.46	22.89	22.43	20.67	20.62	21.93	20.95	21.68	21.62	20.83	22.68	22.56	21.78
1987	22.68	22.98	22.61	21.75	20.60	21.60	21.67	19.72	21.09	22.08	22.36	22.94	21.84
1988	22.67	22.98	22.88	20.25	22.70	20.63	21.84	21.79	20.39	19.95	22.30	21.99	21.70
1989	20.78	20.49	22.31	21.52	20.49	19.40	22.11	22.28	21.53	22.49	21.98	21.37	21.40
1990	22.51	22.39	20.83	19.05	18.03	22.10	22.35	22.06	21.43	22.15	22.80	20.79	21.37
1991	21.54	22.36	22.92	22.68	21.78	21.43	21.58	21.61	21.73	21.64	21.76	22.08	21.92
1992	20.73	21.80	21.81	22.09	16.96	20.59	21.59	20.57	21.35	21.51	22.63	22.80	21.20
1993	22.99	22.76	22.88	22.57	18.23	21.91	21.67	21.28	21.66	21.74	22.11	22.15	21.83
1994	23.02	22.07	22.48	21.78	21.38	21.57	21.59	21.41	21.18	21.44	22.26	21.99	21.85
1995	22.40	22.45	22.53	20.23	19.21	20.49	22.12	20.81	19.21	20.47	20.99	17.48	20.70
1996	20.28	18.87	21.07	21.85	20.63	21.81	19.29	19.58	20.93	20.80	21.51	20.59	20.60
1997	21.50	22.15	20.87	20.82	22.27	21.83	21.80	21.44	20.66	22.40	22.83	22.93	21.79
1998	22.62	21.02	21.59	18.77	18.17	17.79	19.48	21.18	20.84	21.13	22.18	21.87	20.55
1999	22.69	21.02	16.03	15.04	20.84	20.97	21.15	20.87	21.44	20.67	21.78	20.37	20.24

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	P.O.R*
Mean	22.09	21.91	21.66	20.96	20.16	20.97	21.20	21.13	21.05	21.31	22.11	21.74	21.38
Stand.Dev	0.88	1.06	1.67	1.94	1.65	1.08	0.99	0.76	0.64	0.77	0.54	1.36	0.56
Minimum	20.28	18.87	16.03	15.04	16.96	17.79	19.18	19.58	19.21	19.95	20.99	17.48	20.24
Median	22.49	22.15	22.31	21.75	20.60	21.12	21.59	21.28	21.18	21.44	22.18	22.08	21.62
Maximum	23.02	22.98	23.02	22.73	22.70	22.10	22.35	22.28	21.73	22.49	22.83	22.94	21.92

*: indicates period of records for station and excludes partial year results

**: indicates partial year

--: indicates no data available or large gaps of missing data

Table H2. Monthly and annual average stage at C-25 (ft, NGVD)

Year	Month												Year
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1984	22.10	21.51	22.04	20.66	18.50	20.05	19.98	20.03	20.05	20.25	21.89	21.96	20.75
1985	20.57	20.06	19.88	21.83	21.37	21.06	20.21	20.11	20.21	19.88	19.78	19.63	20.38
1986	21.16	21.71	21.83	18.45	16.33	18.68	20.13	20.06	19.90	19.84	21.77	21.04	20.08
1987	21.82	22.06	21.65	20.63	18.87	17.67	19.86	18.08	19.73	20.39	21.04	21.45	20.27
1988	20.95	21.66	21.76	19.19	21.48	19.62	19.85	19.82	18.36	16.98	20.46	20.98	20.09
1989	18.83	18.06	20.97	21.32	20.93	17.29	19.82	20.79	19.94	21.42	20.94	19.17	19.96
1990	21.42	21.54	20.62	16.75	15.31	21.45	21.16	20.67	19.75	20.49	21.50	17.16	19.82
1991	20.10	21.66	21.98	21.45	20.05	19.71	19.58	19.62	19.67	19.96	17.63	17.11	19.88
1992	16.14	18.51	18.40	19.04	16.17	19.83	19.55	19.98	19.60	18.62	19.93	21.85	18.97
1993	20.72	21.92	21.43	20.64	16.65	19.27	19.27	18.76	19.62	19.65	20.38	20.42	19.89
1994	21.84	21.02	19.55	18.16	19.46	19.51	19.28	19.53	19.44	20.07	20.81	20.91	19.96
1995	21.44	21.31	20.61	18.76	16.30	18.46	20.46	19.36	18.64	18.47	21.21	16.07	19.26
1996	20.00	19.55	20.34	20.20	16.67	19.23	18.50	18.42	18.94	19.68	18.16	16.83	18.88
1997	19.32	20.90	20.27	20.09	21.04	19.66	19.99	19.82	18.97	20.83	20.35	21.84	20.26
1998	21.55	20.17	20.46	19.07	17.71	16.20	20.02	19.53	19.69	20.84	21.51	20.98	19.81
1999	21.00	20.69	16.00	14.35	19.71	20.22	19.71	19.79	19.62	19.46	19.96	18.56	19.09

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	P.O.R*
Mean	20.56	20.77	20.49	19.41	18.53	19.24	19.84	19.65	19.51	19.80	20.46	19.75	19.83
Stand.Dev	1.49	1.20	1.56	1.92	2.11	1.35	0.58	0.73	0.52	1.07	1.20	2.01	0.53
Minimum	16.14	18.06	16.00	14.35	15.31	16.20	18.50	18.08	18.36	16.98	17.63	16.07	18.88
Median	20.97	21.16	20.62	19.64	18.68	19.56	19.86	19.80	19.65	19.92	20.64	20.66	19.93
Maximum	22.10	22.06	22.04	21.83	21.48	21.45	21.16	20.79	20.21	21.42	21.89	21.96	20.75

*: indicates period of records for station and excludes partial year results

**: indicates partial year

--': indicates no data available or large gaps of missing data

Table H3. Monthly and annual average headwater stage at G-78 (ft, NGVD)

Year	Month												Year
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1986	21.20	20.96	20.65	19.35	22.06	22.18	21.27	21.37	21.19	20.81	22.70	21.99	21.31
1987	22.80	22.85	22.47	21.92	20.67	21.97	21.91	20.04	21.32	21.20	22.46	22.71	21.86
1988	23.09	23.05	22.68	20.32	22.25	20.84	21.59	21.88	20.43	18.83	21.82	21.88	21.56
1989	20.74	19.32	21.69	22.06	--	--	--	--	--	--	--	--	**

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	P.O.R*
Mean	21.96	21.55	21.87	20.91	21.66	21.66	21.59	21.10	20.98	20.28	22.33	22.19	21.58
Stand.Dev	1.16	1.76	0.92	1.31	0.86	0.72	0.32	0.95	0.48	1.27	0.46	0.45	0.27
Minimum	20.74	19.32	20.65	19.35	20.67	20.84	21.27	20.04	20.43	18.83	21.82	21.88	21.31
Median	22.00	21.91	22.08	21.12	22.06	21.97	21.59	21.37	21.19	20.81	22.46	21.99	21.56
Maximum	23.09	23.05	22.68	22.06	22.25	22.18	21.91	21.88	21.32	21.20	22.70	22.71	21.86

*: indicates period of records for station and excludes partial year results
**: indicates partial year
--: indicates no data available or large gaps of missing data

Table H4. Monthly and annual average headwater stage at G-79 (ft, NGVD)

Year	Month												Year
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1987	22.19	22.47	22.01	21.87	20.67	21.69	21.55	20.35	21.17	20.82	22.04	22.23	21.59
1988	22.57	22.44	22.17	20.31	21.91	20.56	21.06	21.23	20.21	19.74	21.91	21.45	21.30
1989	19.52	19.74	21.23	21.38	20.20	17.30	19.65	21.22	21.07	21.75	21.40	21.29	20.48
1990	21.50	21.49	19.91	18.38	18.84	21.11	20.41	20.09	19.99	22.00	21.74	20.65	20.51
1991	21.61	22.37	22.49	22.57	21.63	21.96	21.40	20.50	20.00	20.45	21.24	20.97	21.43
1992	20.54	20.52	20.82	20.40	19.10	21.60	21.07	20.89	20.79	20.97	21.38	22.02	20.84
1993	22.28	21.72	22.51	21.32	18.58	21.24	21.26	20.97	21.32	21.56	21.16	21.15	21.26
1994	21.49	21.63	21.16	21.18	21.67	21.75	20.59	20.70	20.62	20.56	20.81	21.02	21.10
1995	21.17	21.51	22.18	20.76	20.87	21.29	21.36	21.22	19.70	20.57	20.55	19.29	20.87
1996	20.21	19.67	20.72	20.75	19.77	20.88	19.91	20.21	20.29	20.66	20.32	19.63	20.25
1997	20.04	20.50	20.17	20.00	20.42	20.98	21.62	21.56	19.92	20.58	21.55	22.27	20.80
1998	22.09	20.79	21.12	19.78	19.16	19.41	20.35	20.71	20.33	20.60	20.80	20.56	20.48

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	P.O.R*
Mean	21.27	21.24	21.37	20.73	20.24	20.81	20.85	20.81	20.45	20.85	21.24	21.04	20.91
Stand.Dev	0.98	0.99	0.89	1.08	1.16	1.30	0.65	0.46	0.54	0.63	0.54	0.93	0.43
Minimum	19.52	19.67	19.91	18.38	18.58	17.30	19.65	20.09	19.70	19.74	20.32	19.29	20.25
Median	21.50	21.50	21.20	20.75	20.31	21.17	21.07	20.80	20.31	20.63	21.31	21.08	20.86
Maximum	22.57	22.47	22.51	22.57	21.91	21.96	21.62	21.56	21.32	22.00	22.04	22.27	21.59

*: indicates period of records for station and excludes partial year results
**: indicates partial year
--: indicates no data available or large gaps of missing data

Table H5. Monthly and annual average tailwater stage at G-79 (ft, NGVD)

Year	Month												Year
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1995	--	--	--	--	--	--	--	--	--	17.51	19.83	16.69	**
1996	19.43	19.27	20.34	20.06	17.78	19.45	18.79	19.66	20.05	19.29	20.06	19.12	19.44
1997	19.73	20.45	19.86	19.60	20.31	19.51	19.51	18.62	18.02	20.24	20.30	20.34	19.71
1998	20.49	19.34	19.60	18.94	18.60	18.61	19.44	19.21	19.22	20.36	20.56	20.57	19.58

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	P.O.R*
Mean	19.88	19.69	19.93	19.53	18.90	19.19	19.25	19.16	19.10	19.35	20.19	19.18	19.58
Stand.Dev	0.55	0.66	0.37	0.56	1.29	0.51	0.40	0.52	1.02	1.32	0.31	1.78	0.13
Minimum	19.43	19.27	19.60	18.94	17.78	18.61	18.79	18.62	18.02	17.51	19.83	16.69	19.44
Median	19.73	19.34	19.86	19.60	18.60	19.45	19.44	19.21	19.22	19.77	20.18	19.73	19.58
Maximum	20.49	20.45	20.34	20.06	20.31	19.51	19.51	19.66	20.05	20.36	20.56	20.57	19.71

*: indicates period of records for station and excludes partial year results
**: indicates partial year
--': indicates no data available or large gaps of missing data

Table H6. Monthly and annual average headwater stage at G-81 (ft, NGVD)

Year	Month												Year
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1996	19.73	19.28	20.02	19.93	16.78	19.07	18.35	18.33	18.72	19.41	18.26	16.88	18.73
1997	19.20	20.69	20.04	19.88	20.90	19.52	19.81	19.56	18.68	20.53	20.06	21.54	20.03
1998	21.26	19.86	20.14	18.77	17.43	15.97	19.77	19.27	20.18	--	--	--	**

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	P.O.R*
Mean	20.06	19.94	20.07	19.53	18.37	18.19	19.31	19.05	19.19	19.97	19.16	19.21	19.38
Stand.Dev	1.07	0.70	0.06	0.66	2.21	1.94	0.83	0.64	0.85	0.79	1.27	3.29	0.92
Minimum	19.20	19.28	20.02	18.77	16.78	15.97	18.35	18.33	18.68	19.41	18.26	16.88	18.73
Median	19.73	19.86	20.04	19.88	17.43	19.07	19.77	19.27	18.72	19.97	19.16	19.21	19.38
Maximum	21.26	20.69	20.14	19.93	20.90	19.52	19.81	19.56	20.18	20.53	20.06	21.54	20.03

*: indicates period of records for station and excludes partial year results
**: indicates partial year
--': indicates no data available or large gaps of missing data

Table H7. Monthly and annual average tailwater stage at G-81 (ft, NGVD)

Year	Month												Year
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1996	19.13	18.94	20.01	19.73	17.46	19.12	18.47	19.35	19.35	19.01	19.79	18.81	19.10
1997	19.41	20.10	19.63	19.36	20.05	19.24	19.25	18.38	17.73	19.91	20.01	20.05	19.43
1998	20.20	19.09	19.34	18.70	18.41	18.39	19.20	18.92	19.67	--	--	--	**

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	P.O.R*
Mean	19.58	19.38	19.66	19.26	18.64	18.92	18.97	18.89	18.91	19.46	19.90	19.43	19.26
Stand.Dev	0.56	0.63	0.33	0.52	1.31	0.46	0.43	0.49	1.04	0.63	0.15	0.88	0.23
Minimum	19.13	18.94	19.34	18.70	17.46	18.39	18.47	18.38	17.73	19.01	19.79	18.81	19.10
Median	19.41	19.09	19.63	19.36	18.41	19.12	19.20	18.92	19.35	19.46	19.90	19.43	19.26
Maximum	20.20	20.10	20.01	19.73	20.05	19.24	19.25	19.35	19.67	19.91	20.01	20.05	19.43

*: indicates period of records for station and excludes partial year results
**: indicates partial year
--: indicates no data available or large gaps of missing data

Table H8. Monthly and annual average tailwater stage at S-49 (ft, NGVD)

Year	Month												Year
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1994	--	--	--	--	--	0.45	0.09	0.44	1.02	1.41	1.43	1.54	**
1995	0.69	0.27	0.87	0.76	0.69	0.54	0.51	1.49	1.74	1.98	1.19	0.90	0.97
1996	0.67	0.29	0.37	0.40	0.44	0.50	0.46	0.50	0.82	1.45	1.35	0.77	0.67
1997	0.56	0.63	0.51	0.85	0.68	0.90	0.73	0.97	1.12	1.11	0.72	0.41	0.77
1998	0.50	1.00	0.79	0.41	0.50	0.21	0.06	0.59	0.75	0.89	0.81	0.56	0.59
1999	0.57	0.80	0.55	0.40	0.77	0.63	0.37	0.72	1.56	1.83	1.25	0.84	0.86

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	P.O.R*
Mean	0.60	0.59	0.62	0.56	0.62	0.54	0.37	0.79	1.17	1.44	1.12	0.84	0.77
Stand.Dev	0.08	0.32	0.21	0.23	0.14	0.23	0.26	0.40	0.40	0.41	0.29	0.39	0.15
Minimum	0.50	0.27	0.37	0.40	0.44	0.21	0.06	0.44	0.75	0.89	0.72	0.41	0.59
Median	0.57	0.63	0.55	0.41	0.68	0.52	0.41	0.65	1.07	1.43	1.22	0.81	0.77
Maximum	0.69	1.00	0.87	0.85	0.77	0.90	0.73	1.49	1.74	1.98	1.43	1.54	0.97

*: indicates period of records for station and excludes partial year results
**: indicates partial year
--: indicates no data available or large gaps of missing data

Table H9. Monthly and annual average headwater stage at S-49 (ft, NGVD)

Year	Month												Year
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1962	19.48	19.78	19.14	19.47	--	--	--	17.85	--	--	--	19.68	**
1963	19.45	19.51	18.82	17.90	18.11	19.35	19.09	19.07	19.16	19.42	19.57	19.62	19.09
1964	19.30	19.13	19.67	19.11	19.73	19.25	19.43	19.26	19.14	19.49	20.22	20.28	19.50
1965	20.33	19.68	19.72	18.59	16.76	18.44	19.84	19.70	19.69	19.35	19.70	20.39	19.35
1966	19.66	19.65	19.47	19.29	19.52	19.69	19.48	19.40	19.49	19.25	19.73	19.69	19.53
1967	19.73	19.85	19.48	16.57	14.20	18.12	19.60	19.64	18.98	19.50	19.25	19.38	18.69
1968	20.13	19.41	20.07	15.41	18.68	19.13	19.00	19.13	19.49	19.21	20.39	19.80	19.15
1969	20.56	20.41	20.59	20.26	19.70	19.74	19.31	19.03	18.37	19.05	20.08	20.43	19.79
1970	20.28	20.50	20.43	18.60	15.86	19.70	19.46	19.38	19.14	19.39	20.09	17.89	19.23
1971	17.02	17.86	19.93	17.03	17.28	20.00	19.63	19.48	19.51	19.60	19.84	19.49	18.89
1972	20.54	20.68	18.65	19.49	20.36	19.73	19.66	19.54	19.31	20.31	19.45	20.32	19.84
1973	21.05	20.85	20.24	19.63	19.43	20.20	19.70	19.84	19.38	19.20	19.81	19.63	19.91
1974	19.72	18.00	16.42	17.93	17.11	19.79	19.50	19.54	19.54	19.08	20.42	21.19	19.02
1975	20.37	19.66	20.02	16.89	19.15	19.53	19.34	19.23	19.28	19.12	20.07	20.19	19.40
1976	19.41	19.46	19.63	19.15	19.57	19.47	18.77	18.59	18.65	18.96	20.83	20.73	19.44
1977	20.19	20.04	19.42	17.16	18.16	20.56	20.70	20.67	19.45	19.12	20.77	19.99	19.68
1978	20.07	20.73	20.32	19.27	20.11	19.90	19.45	19.37	19.48	19.59	20.72	19.66	19.89
1979	19.60	19.59	19.42	16.87	19.62	19.73	19.96	20.48	19.07	19.15	20.56	20.80	19.57
1980	20.24	20.32	19.73	20.13	18.55	18.66	19.87	19.30	19.64	19.58	19.07	19.91	19.58
1981	18.31	20.17	18.04	15.87	16.88	19.13	19.14	20.45	19.25	20.20	19.51	17.49	18.70
1982	18.64	20.56	20.53	20.22	19.70	19.18	19.37	19.34	19.34	20.15	20.86	--	**
1983	--	19.73	19.43	20.03	17.37	19.75	18.63	19.71	19.24	19.78	20.03	19.95	**
1984	20.85	20.12	20.79	19.73	17.95	19.21	19.46	19.57	19.40	19.30	20.29	20.71	19.78
1985	19.56	19.41	18.99	20.82	19.23	19.25	19.58	19.44	19.32	19.47	20.43	19.51	19.58
1986	20.10	19.68	20.25	18.18	17.29	19.07	19.57	19.47	19.52	18.40	20.57	20.20	19.36
1987	20.60	20.78	19.70	18.99	16.25	16.72	19.49	18.14	18.92	20.10	20.05	20.37	19.18
1988	20.33	20.81	20.71	17.31	20.42	19.23	19.44	19.48	18.23	16.14	18.97	19.83	19.24
1989	17.56	16.56	19.66	19.83	20.04	17.01	19.98	20.26	19.24	20.63	19.22	20.01	19.17
1990	20.54	20.70	18.50	15.07	15.39	19.98	20.32	20.04	19.31	19.66	20.61	18.22	19.03
1991	19.12	20.35	20.85	20.14	19.07	19.42	19.16	19.46	19.30	19.27	18.58	19.57	19.52
1992	18.43	19.04	18.97	17.96	14.92	18.52	19.40	19.74	19.29	18.13	19.21	20.69	18.69
1993	20.05	20.57	20.05	19.73	15.87	19.70	19.36	18.37	19.32	19.36	20.02	20.22	19.39
1994	20.82	19.88	20.41	19.66	19.15	19.16	19.29	19.14	18.84	19.14	19.85	19.67	19.58
1995	20.47	20.55	20.43	18.88	17.45	18.65	19.70	17.67	16.08	16.77	19.68	16.56	18.57
1996	19.34	19.18	20.20	19.87	17.59	19.13	18.34	18.94	18.83	19.34	20.02	19.06	19.15
1997	19.67	20.37	19.78	19.50	20.22	19.39	19.38	18.45	17.91	20.15	20.21	20.26	19.61
1998	20.40	19.22	19.49	18.88	18.53	18.53	19.34	19.12	19.06	20.26	20.42	20.48	19.48
1999	20.74	19.40	15.89	14.40	19.56	19.14	18.76	18.60	19.15	18.45	20.38	20.03	18.71

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	P.O.R*
Mean	19.80	19.80	19.57	18.52	18.24	19.22	19.45	19.31	19.09	19.27	19.99	19.78	19.32
Stand.Dev	0.90	0.89	1.05	1.60	1.65	0.77	0.44	0.66	0.64	0.87	0.56	0.93	0.37
Minimum	17.02	16.56	15.89	14.40	14.20	16.72	18.34	17.67	16.08	16.14	18.58	16.56	18.57
Median	20.07	19.82	19.71	19.05	18.55	19.25	19.45	19.39	19.28	19.35	20.05	19.95	19.39
Maximum	21.05	20.85	20.85	20.82	20.42	20.56	20.70	20.67	19.69	20.63	20.86	21.19	19.91

*: indicates period of records for station and excludes partial year results

**: indicates partial year

'-': indicates no data available or large gaps of missing data

Table H10. Monthly and annual average headwater stage at S-50 (ft, NGVD)

Year	Month												Year
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1965	12.08	12.24	12.51	12.13	11.91	11.93	12.38	12.54	12.37	12.65	12.70	12.18	12.30
1966	12.60	12.72	12.51	12.18	12.35	12.93	12.89	13.09	13.02	13.37	12.83	12.25	12.73
1967	12.02	12.01	11.99	11.62	11.61	12.16	13.15	12.59	12.37	12.57	12.22	12.03	12.20
1968	12.01	11.91	11.98	11.74	12.18	13.70	13.50	12.64	12.60	12.83	12.62	12.28	12.50
1969	12.21	12.00	12.92	12.22	12.74	12.55	12.39	13.18	13.28	13.31	13.32	12.90	12.75
1970	12.65	12.46	12.85	12.40	11.94	12.27	12.38	12.51	12.44	13.05	12.35	12.08	12.45
1971	12.04	12.03	11.98	11.95	12.02	12.43	12.90	12.92	13.09	13.03	12.63	12.17	12.43
1972	12.18	12.34	12.20	12.16	12.34	13.08	12.78	12.43	12.72	12.04	11.94	11.99	12.35
1973	12.22	12.54	12.15	12.13	12.03	12.94	13.07	13.25	13.31	13.13	12.51	12.18	12.62
1974	12.16	12.03	12.03	11.91	11.76	12.59	13.60	13.55	12.88	12.58	12.19	12.22	12.46
1975	12.10	11.92	12.00	11.60	11.93	12.74	12.68	12.80	12.66	12.69	12.47	12.10	12.31
1976	11.96	11.86	11.66	11.35	12.41	13.08	12.73	12.63	12.64	12.12	12.06	12.21	12.23
1977	12.13	11.95	11.79	11.33	11.30	12.07	12.05	12.32	12.77	12.01	12.07	12.63	12.03
1978	12.19	12.11	12.27	11.85	11.86	12.45	12.62	12.90	12.24	12.27	12.35	12.07	12.26
1979	12.66	12.13	11.94	11.36	12.91	12.19	12.21	12.13	13.66	12.73	11.85	11.97	12.31
1980	11.86	12.14	11.85	12.22	11.69	11.80	12.24	12.06	12.26	11.75	11.78	11.82	11.96
1981	11.73	12.14	11.62	11.34	11.71	11.67	11.85	12.58	12.93	12.12	12.09	12.02	11.98
1982	12.15	12.16	12.23	12.63	12.27	13.05	13.18	13.03	12.46	12.51	12.69	--	**
1983	--	13.27	12.84	12.25	11.84	12.59	12.52	13.09	12.84	12.97	12.33	12.10	**
1984	12.32	12.11	12.49	11.93	11.69	12.08	12.57	12.72	12.65	12.33	12.43	12.27	12.30
1985	12.03	11.96	12.08	12.27	12.08	12.23	12.83	12.91	13.42	12.64	12.15	12.03	12.39
1986	12.08	12.05	12.16	11.68	11.70	12.48	12.70	13.08	12.58	12.28	12.50	12.13	12.29
1987	12.47	12.14	12.20	11.95	11.46	10.77	12.52	12.01	12.26	12.42	12.97	12.06	12.10
1988	12.04	12.21	12.28	11.68	12.12	12.37	12.60	12.85	12.00	11.59	11.81	11.81	12.11
1989	11.55	11.53	12.13	12.10	12.05	11.60	11.90	12.43	12.72	12.66	12.04	11.84	12.05
1990	12.01	12.01	11.99	11.62	11.26	12.06	12.59	13.29	12.68	13.16	12.07	11.93	12.22
1991	12.37	12.23	12.70	12.72	12.41	12.71	13.35	12.98	12.77	12.87	12.13	11.94	12.60
1992	11.74	11.95	11.96	12.20	11.42	13.32	12.82	13.13	12.80	12.12	12.18	12.18	12.32
1993	12.97	12.67	13.34	12.40	11.94	12.14	12.34	12.22	12.81	13.02	12.09	12.06	12.50
1994	12.44	12.78	12.14	12.08	12.38	13.11	12.56	12.79	13.30	12.76	12.99	12.78	12.68
1995	12.50	12.49	12.74	12.12	11.97	11.98	12.47	13.51	13.08	13.69	12.17	11.92	12.55
1996	12.07	11.97	12.47	12.33	12.17	12.76	12.88	12.40	12.24	12.73	12.12	12.03	12.35
1997	12.08	12.08	12.02	12.37	12.35	12.79	12.91	13.52	12.68	12.26	12.11	12.49	12.47
1998	12.76	13.03	12.95	12.15	12.57	12.10	12.30	12.62	13.16	12.28	12.57	12.22	12.56
1999	12.09	12.10	11.99	11.73	12.08	12.99	12.86	12.87	13.13	13.85	12.19	11.98	12.49

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	P.O.R*
Mean	12.19	12.21	12.26	11.99	12.01	12.45	12.67	12.79	12.77	12.64	12.33	12.14	12.36
Stand.Dev	0.30	0.35	0.40	0.36	0.38	0.57	0.41	0.41	0.38	0.51	0.36	0.25	0.21
Minimum	11.55	11.53	11.62	11.33	11.26	10.77	11.85	12.01	12.00	11.59	11.78	11.81	11.96
Median	12.11	12.11	12.15	12.10	12.02	12.45	12.62	12.80	12.72	12.65	12.19	12.09	12.35
Maximum	12.97	13.27	13.34	12.72	12.91	13.70	13.60	13.55	13.66	13.85	13.32	12.90	12.75

*: indicates period of records for station and excludes partial year results

**: indicates partial year

--: indicates no data available or large gaps of missing data

Table H11. Monthly and annual average headwater stage at S-99 (ft, NGVD)

Year	Month												Year
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1964	--	--	19.84	19.22	20.25	20.04	19.90	19.84	19.78	19.87	20.32	20.46	**
1965	20.87	20.11	19.97	18.82	17.61	19.25	20.06	19.98	19.93	19.91	20.13	20.57	19.77
1966	19.95	19.81	20.02	19.37	20.03	19.99	19.81	19.80	19.87	19.79	19.89	20.12	19.87
1967	19.69	20.00	19.39	16.89	14.88	18.47	19.97	19.98	20.17	20.01	19.87	19.85	19.10
1968	21.29	20.79	20.61	16.14	19.56	19.62	19.84	20.00	19.98	20.00	19.81	20.84	19.87
1969	20.98	21.00	21.00	20.05	20.99	19.96	20.14	19.77	18.81	19.78	20.79	20.78	20.34
1970	20.89	20.79	21.00	20.37	17.97	20.20	20.08	19.78	19.92	19.97	20.54	19.67	20.10
1971	19.75	20.14	20.51	18.04	18.02	20.61	20.07	20.06	20.04	20.14	20.20	21.46	19.92
1972	21.36	21.84	20.01	20.31	20.92	20.19	19.88	19.62	20.25	20.20	19.52	20.29	20.37
1973	21.63	21.75	21.32	20.31	19.92	21.56	21.22	20.37	20.03	20.27	21.05	20.97	20.87
1974	21.16	19.90	18.71	18.13	17.88	20.49	19.90	20.12	20.39	20.17	21.24	21.47	19.96
1975	20.20	20.11	20.74	18.28	19.46	20.47	19.80	19.80	19.75	19.74	20.90	20.89	20.01
1976	20.46	19.31	19.15	18.83	19.80	19.76	18.91	18.73	19.08	19.19	20.43	20.91	19.55
1977	19.95	19.98	19.25	17.25	18.05	20.66	20.68	20.86	19.70	18.90	20.21	19.81	19.61
1978	20.19	22.15	21.55	17.69	20.14	20.78	19.96	19.72	19.61	20.11	22.19	20.73	20.40
1979	21.14	20.14	20.78	17.54	20.37	20.37	21.13	21.59	19.88	19.83	21.52	22.02	20.53
1980	20.53	22.06	20.96	21.96	19.44	18.95	20.97	19.76	19.91	19.93	20.50	21.41	20.53
1981	20.58	22.00	20.01	17.27	17.97	20.54	19.87	21.68	20.38	21.73	21.58	19.57	20.27
1982	20.87	22.09	21.95	21.27	20.52	19.94	19.96	19.99	20.24	22.05	22.06	--	**
1983	--	20.34	20.07	20.50	18.81	20.21	20.03	20.10	19.99	20.55	20.62	21.43	**
1984	22.21	21.59	22.09	20.76	18.61	20.12	20.04	20.11	20.12	20.32	21.94	22.02	20.83
1985	20.66	20.16	19.96	21.90	21.47	21.18	20.28	20.17	20.11	19.97	19.86	19.71	20.45
1986	21.28	21.82	21.92	18.50	16.38	18.74	20.28	20.18	20.06	19.98	21.93	21.25	20.19
1987	22.01	22.26	21.83	20.83	19.07	17.72	19.85	18.13	19.82	20.42	21.03	21.54	20.37
1988	21.04	21.73	21.81	19.27	21.55	19.66	19.88	19.85	18.37	17.00	20.72	21.14	20.17
1989	18.92	18.17	21.08	21.40	21.06	17.90	19.96	20.89	20.03	21.50	21.04	19.26	20.10
1990	21.49	21.61	20.70	16.85	15.40	21.53	21.24	20.70	19.80	20.42	21.58	17.18	19.87
1991	20.11	21.76	22.07	21.48	20.13	19.80	19.54	19.69	19.76	20.01	17.73	17.21	19.94
1992	16.24	18.60	18.50	19.09	16.26	19.64	19.58	19.98	19.67	18.73	19.97	21.91	19.01
1993	20.71	22.01	21.17	20.69	16.73	19.36	19.37	18.83	19.68	19.66	20.48	20.54	19.93
1994	21.91	21.03	19.59	18.14	19.45	19.57	19.44	19.61	19.50	20.17	20.78	21.02	20.02
1995	21.62	21.47	20.73	18.89	16.44	18.62	20.51	18.84	18.38	17.89	21.03	16.15	19.21
1996	19.90	19.46	20.38	20.71	17.22	19.82	19.00	18.96	19.13	19.65	18.25	16.92	19.12
1997	19.45	21.05	20.37	20.19	21.24	19.74	19.87	19.20	18.63	20.84	20.34	21.82	20.23
1998	21.55	20.09	20.31	19.08	17.63	16.21	20.02	19.49	19.56	20.86	21.50	21.02	19.78
1999	21.03	20.72	16.02	14.35	19.73	20.11	19.66	19.68	19.55	18.92	19.99	18.59	19.03

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	P.O.R*
Mean	20.64	20.79	20.43	19.18	18.91	19.77	20.02	19.89	19.72	19.96	20.60	20.30	19.98
Stand.Dev	1.09	1.07	1.20	1.75	1.77	1.06	0.53	0.71	0.51	0.93	0.95	1.49	0.49
Minimum	16.24	18.17	16.02	14.35	14.88	16.21	18.91	18.13	18.37	17.00	17.73	16.15	19.01
Median	20.87	20.79	20.56	19.15	19.45	19.95	19.96	19.84	19.84	19.99	20.58	20.78	20.01
Maximum	22.21	22.26	22.09	21.96	21.55	21.56	21.24	21.68	20.39	22.05	22.19	22.02	20.87

*: indicates period of records for station and excludes partial year results

**: indicates partial year

--': indicates no data available or large gaps of missing data

Table H12. Monthly and annual average tailwater stage at S-99 (ft, NGVD)

Year	Month												Year
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1964	--	--	12.11	12.03	12.13	12.08	12.27	12.97	13.96	12.99	12.40	12.17	**
1965	12.06	12.22	12.52	12.10	11.90	11.93	12.48	12.61	12.41	12.71	12.83	12.18	12.33
1966	12.63	12.77	12.52	12.19	12.38	13.09	13.00	13.23	13.17	13.66	12.92	12.25	12.82
1967	12.03	12.04	12.03	11.66	11.63	12.26	13.35	12.66	12.41	12.64	12.25	12.05	12.25
1968	12.03	11.91	11.99	11.75	12.19	14.15	13.79	12.69	12.68	12.98	12.63	12.27	12.59
1969	12.18	11.96	12.99	12.22	12.79	12.52	12.35	13.33	13.54	13.60	13.53	12.94	12.83
1970	12.67	12.49	12.98	12.41	11.95	12.28	12.39	12.55	12.47	13.21	12.38	12.07	12.49
1971	12.03	12.03	11.98	11.93	12.02	12.45	12.98	12.99	13.26	13.21	12.68	12.17	12.48
1972	12.18	12.34	12.20	12.17	12.37	13.28	12.86	12.45	12.80	12.04	11.93	12.00	12.38
1973	12.23	12.55	12.18	12.16	12.04	13.06	13.20	13.47	13.50	13.34	12.66	12.17	12.71
1974	12.17	12.03	12.02	11.94	11.79	12.72	13.96	13.91	13.02	12.66	12.19	12.20	12.55
1975	12.10	11.93	12.02	11.60	11.99	12.86	12.78	12.93	12.76	12.81	12.59	12.14	12.38
1976	11.96	11.86	11.67	11.37	12.59	13.31	12.81	12.70	12.72	12.15	12.07	12.22	12.29
1977	12.10	11.95	11.82	11.31	11.32	12.06	12.06	12.37	12.92	12.00	12.07	12.68	12.06
1978	12.24	12.15	12.37	11.88	11.89	12.52	12.71	13.06	12.26	12.29	12.37	12.12	12.32
1979	12.79	12.17	11.98	11.36	13.15	12.23	12.28	12.17	14.30	12.88	11.87	12.00	12.43
1980	11.90	12.19	11.90	12.30	11.67	11.82	12.28	12.09	12.32	11.78	11.80	11.84	11.99
1981	11.73	12.17	11.61	11.36	11.73	11.68	11.87	12.76	13.10	12.12	12.07	12.02	12.02
1982	12.16	12.19	12.33	12.72	12.41	13.25	13.38	13.22	12.52	12.60	12.81	--	**
1983	--	13.60	12.93	12.27	11.85	12.59	12.32	12.93	12.63	13.13	12.32	12.12	**
1984	12.38	12.15	12.55	11.94	11.72	12.14	12.68	12.76	12.71	12.35	12.51	12.29	12.35
1985	12.01	11.96	12.09	12.27	12.10	12.25	12.91	12.97	13.77	12.70	12.15	12.01	12.43
1986	12.10	12.06	12.17	11.66	11.78	12.56	12.80	13.26	12.65	12.38	12.61	12.17	12.35
1987	12.56	12.18	12.27	11.99	11.51	10.81	12.59	12.04	12.31	12.55	13.18	12.10	12.18
1988	12.09	12.26	12.33	11.69	12.18	12.42	12.69	12.95	12.05	11.61	11.80	11.77	12.15
1989	11.52	11.51	12.14	12.07	12.06	11.60	11.90	12.49	12.76	12.68	12.03	11.82	12.05
1990	12.00	12.03	11.98	11.59	11.22	12.06	12.61	13.39	12.74	13.36	12.05	11.91	12.24
1991	12.39	12.21	12.72	12.77	12.42	12.73	13.58	13.02	12.78	12.95	12.08	11.90	12.63
1992	11.68	11.91	11.93	12.22	11.41	13.68	12.87	13.31	12.87	12.12	12.22	12.17	12.37
1993	13.19	12.77	13.97	12.49	11.97	12.21	12.40	12.26	12.94	13.23	12.06	12.05	12.63
1994	12.48	12.92	12.16	12.11	12.41	13.29	12.68	13.00	13.79	12.97	13.40	13.01	12.85
1995	12.63	12.62	12.84	12.15	11.98	11.97	12.51	14.07	13.27	14.25	12.14	11.89	12.69
1996	12.02	11.93	12.64	12.39	12.21	12.86	13.05	12.41	12.20	12.84	12.11	12.00	12.39
1997	12.05	12.06	12.00	12.45	12.36	12.88	13.02	13.91	12.75	12.28	12.13	12.54	12.54
1998	12.87	13.24	13.25	12.16	12.76	12.10	12.32	12.72	13.42	12.29	12.67	12.22	12.67
1999	12.10	12.11	12.01	11.74	12.09	13.21	13.00	13.07	13.31	14.58	12.22	11.98	12.62

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	P.O.R*
Mean	12.21	12.24	12.31	12.01	12.05	12.53	12.74	12.91	12.92	12.78	12.38	12.16	12.43
Stand.Dev	0.35	0.41	0.48	0.37	0.42	0.65	0.48	0.49	0.53	0.64	0.42	0.27	0.24
Minimum	11.52	11.51	11.61	11.31	11.22	10.81	11.87	12.04	12.05	11.61	11.80	11.77	11.99
Median	12.10	12.15	12.17	12.08	12.03	12.48	12.70	12.94	12.77	12.71	12.24	12.12	12.39
Maximum	13.19	13.60	13.97	12.77	13.15	14.15	13.96	14.07	14.30	14.58	13.53	13.01	12.85

*: indicates period of records for station and excludes partial year results

**: indicates partial year

--: indicates no data available or large gaps of missing data