GATOR SLOUGH XP SWMM MODEL
CALIBRATION REPORT
June 18, 2001

To: Mike HANSON, Doug ECKMANN

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Subject: GATOR SLOUGH/CAPE CORAL STORM WATER MODELING – Calibration and XP SWMM model requirements

Topics:

- Data set summary: hydraulic parameters
- Calibration criteria and Gumbel analysis
- Mass balance and Conclusions
- Input data:
  - Cumulative rainfall
  - Daily rainfall
  - Hwy 41 inflow
- Results graphs:
  - Hydrograph comparison for weir 11 (daily average). Model versus USGS
  - Water surface profile comparison (1 year event). Model versus Johnson report
  - Continuous and daily average hydrograph for weir 11

Data set summary; hydraulic parameters

Manning's factors

Based on the review of the information and photo documentation received from Bradley Vance (Lee County Environmental Services), the canal Manning factors has been double checked and possibly improved.

The n factors used for the channels in tidal reaches of the conveyances have been set as 0.03. Generally these conveyances are wide with minimal plant growth in the channel.

The n factors in the freshwater channel portion of the conveyances located east of Nelson Road has been set as 0.07. Fresh water areas tend to be narrower and have more plant growth in the channel than the tidal portions of channels.

From Nelson Road due west until Weir # 11, 13, 14, and 15 the factors have been set as 0.06 or 0.05. Specifications were taken from Johnson Engineering report (1991).

New Manning "n" factors have been selected for the overland flow within each subcatchment: 0.02 for the impervious portion and 0.5 for the pervious portion.

Infiltration

The Horton equation parameters has been modified along with the calibration process to match the mass balance goals, thus forcing their values to make up for the lack of groundwater simulation options.

The final values chosen are:

Max infiltration rate	1 inch/hour
Min (asymptotic) infiltration rate	0.01 inch/hour
Decay rate of infiltration	0.00115 sec^{-1}

Tidal boundary conditions

Data received from the FDEP (Doug Thompson) are limited and not linked to the calibration event. The following best available value will be consequently adopted as Mean High Water (MHW):

Calibration	1.4 feet NGVD
Design events	2.5 or 2.7 feet NGVD

Imperviousness percentages

The project area has been subdivided and assigned six different imperviousness percentages based on the projected 1993 functional population (specifications were taken from WICC Master plan – City of Cape Coral, by Boyle Engineering, 1988), computed using the *New Jersey* equation:

$$I = 9.6\ PD\ (0.53 - 0.0391 \log 10\ PD)$$

Where:
I = imperviousness [%]
PD = population density in developed portion of the urbanized area [persons/acre]

The imperviousness range is between 1% and 8% with a limited (751 acres) high populated area to which has bees assigned a imperviousness percentage of 34%

Initial depth

For purposes of initializing the simulation, the water surface profile of the system was assumed to be four feet below local land surface (channel bank) elevation. This assumption generated initial depths in the canal system, ranging from 4 to 8 feet

Bottom slope

The channel side slope varies depending on location. For the ground slope adjacent to the channels, we assumed a mean value of 1 ft/1 mi = 0.0002 based on previous studies . Based on the channels elevation found in the City of Cape Coral Maps (Field Information/Road Design Maps) we assumed channel bottom slopes of:

Gator Slough Canal (Weir # 9 to Weir # 4) slope = 0.001
(Weir # 19 to # 11) slope = 0.0003
Horseshoe Canal (Bridge # 20 to Weir # 13) slope = 0.00025
(tributary canals bottom slope) slope = 0.001
Hermosa Canal (Bridge # 16 to Weir # 14) slope = 0.00015
(tributary canals bottom slope) slope = 0.00016
Shadroe Canal (Weir # 18 to Weir # 15) slope = 0.0002
(tributary canals bottom slope) slope = 0.00016

Main canals cross sections

Gator Slough Canal: Bottom width from 30 to 200 feet
Depth 12 feet
Slope 2:1

Horseshoe Canal: : Bottom width from 90 to 170 feet
Depth 12 feet
Slope 2:1

Hermosa Canal: : : Bottom width from 80 to 200 feet
Depth from 10 to 13.5 feet
Slope 2:1

Shadroe Canal: : : : Bottom width from 40 to 220 feet
Depth from 11 to 27.5 feet
Slope 2:1

Data source: A Water Management Study of the Cape Coral Networks, Lee County. Prepared by Connell, Metcalf, and Eddy, (1979).

Calibration criteria and Gumbel analysis

The only data available for calibration and verification was for the Gator Slough Canal.

Two set of data have been taken in account:

1) 1-year event water surface profile along the Gator Slough

Data source: Lee County Surface Water Management Plan. LCSWMP, 1991, prepared by Johnson Engineering, Inc.

2) historical series of monthly discharge (daily mean value) measured at the USGS station "Gator Slough at SR 765 near Ft. Myers, Fl". The period of record covered from July 84 to Sep 87

Data source: U.S. Geological Survey

Other data used to run the model for the same period of time were:

1) Inflow monthly discharge coming from the portion of the watershed located north and east at Hwy US41 (33 square miles undeveloped watershed of wildlife management area). Data from gaging station located 0.5 miles west of US 41, named "Gator Slough at US 41 near Ft. Myers, Fl" were used to represent runoff water entering into Lee County

Data source: U.S. Geological Survey

2) Rainfall data from the gauging station of Lake Fairaway (0.5 miles west of the bridge of Hwy 41 on the Gator Slough. See Fig 1

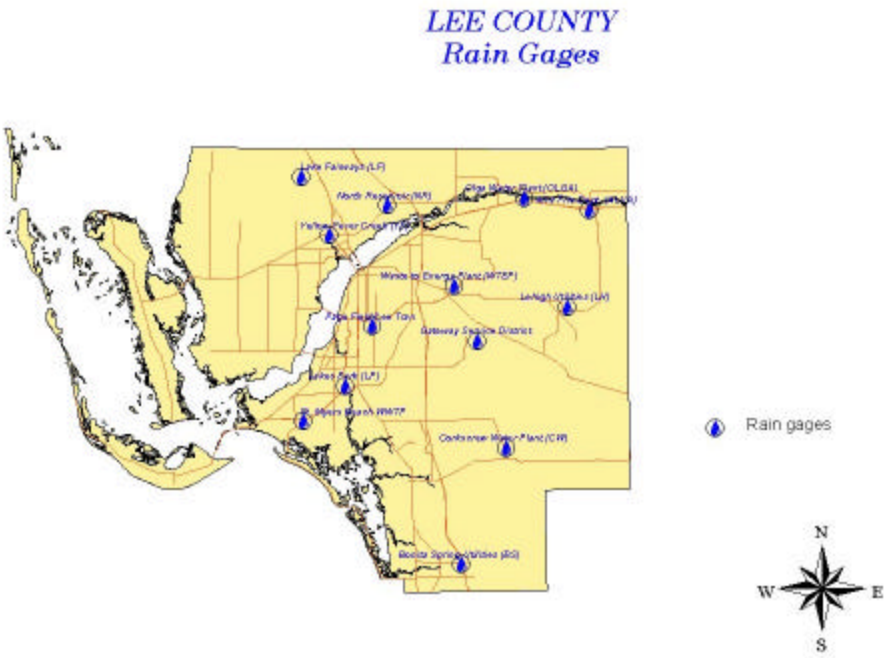


Fig. 1 Rain gauge location
Data source: Lee County

The main criteria used in selecting the calibration period of record purpose was the Gumbel statistical analysis applied to the outflow data for the station located near SR 765, corresponding to weir #11.

The results are given in the following table:

Return Time	Peak Q expected (cfs)	Return Time	Peak Q expected (cfs))
1	332	50	1469
1.5	400	55	1495
2	523	60	1518
5	826	65	1540
10	1027	70	1560
15	1140	75	1578
20	1220	80	1596
25	1281	85	1612
30	1330	90	1627
35	1372	95	1642
40	1409	100	1656
45	1440		

Table 1

The period of record that possessed all the required data sets was from September 1991 to September 1997. Within this range, the month with the peak value closest to the 1-year Gumbel analysis result was **September 1996** (peak value 346 cfs).

Mass balance and Conclusions

September 1996 was selected as the period of record for calibration of the Cape Coral canals model. This was the only period for which all basic data sets for a one-year recurrence interval storm event were available: (1) inflow data for the Gator Slough at Hwy 41 USGS station, (2) outflow data for the Gator Slough at Hwy 765 USGS station, and (3) rainfall data at the Lee County Lake Fairaways station.

The one-year recurrence interval event was selected based on statistical analysis of discharge data at Hwy 765. Thus, the period of record used for the calibration run represents a documented flow event with a peak near to the statistical one-year recurrence interval flow magnitude. The calibration event was not selected on the basis of the one-year rainfall magnitude.

Attached are graphics describing the current model calibration results and input data sets. The model appears to be performing reasonably well but improvements are possible and within our immediate grasp.

Flow Peak:	USGS = 346 cfs	Model = 277 cfs	Deviation = 69 cfs (20%)
Flow Volume:	USGS = 9.3 inches	Model = 5.6 inches	Deviation = 3.7 inches (40%)
Base Flow:	USGS = 50 cfs	Model = 0 cfs	Deviation = 3.9 inches

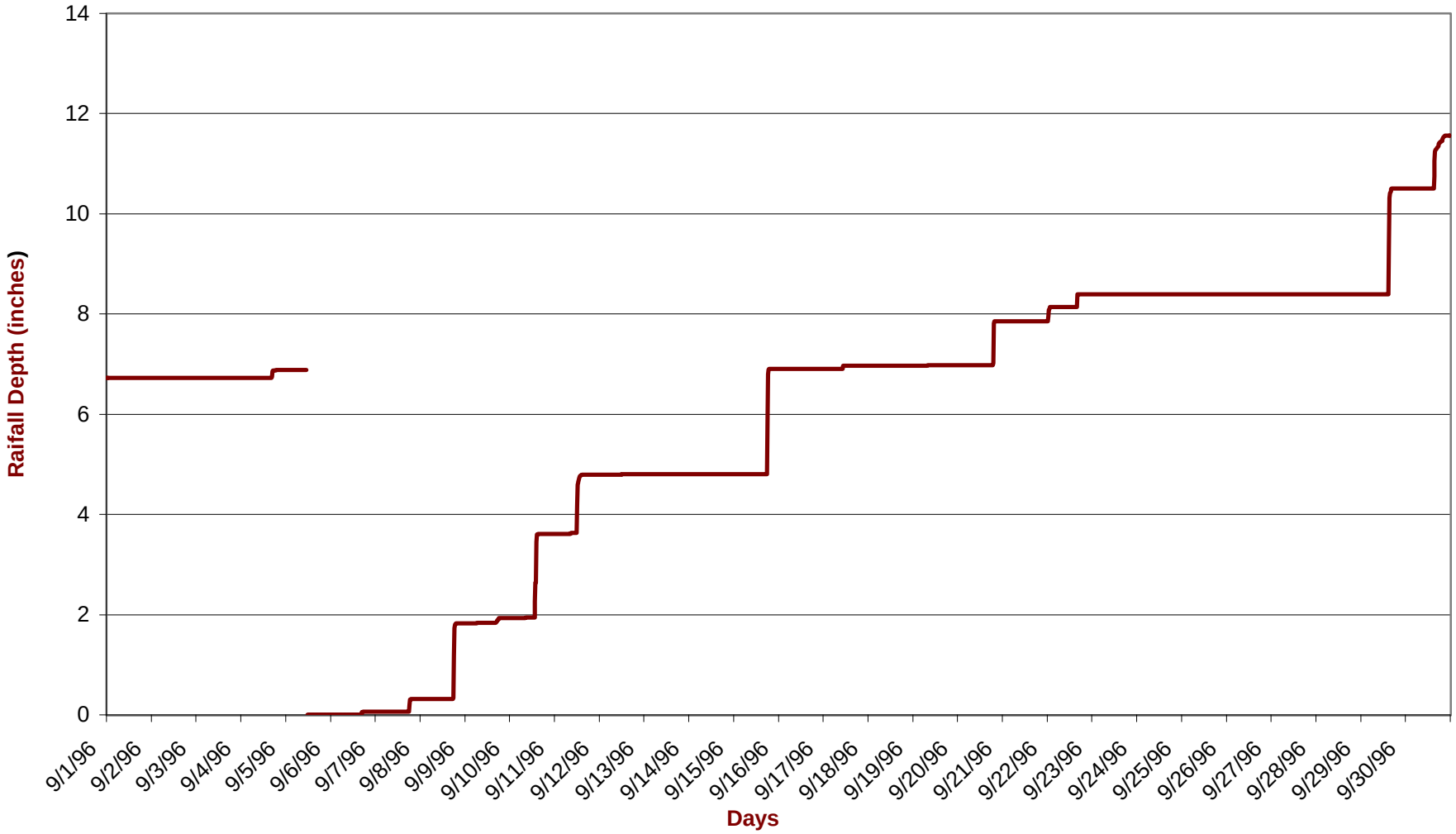
As these distilled results show, the base flow volume effectively accounts for both the runoff volume and the runoff peak deviations between the USGS runoff record and

the model results. The XP-SWMM model delivered no base flow since we have not implemented the ground water component (as per discussions with Boyle Engineering on May 15). If, on the other hand, the XP-SWMM model were now revised to activate the ground water module and we calibrated this component to deliver 50 cfs then the model performance would be greatly improved.

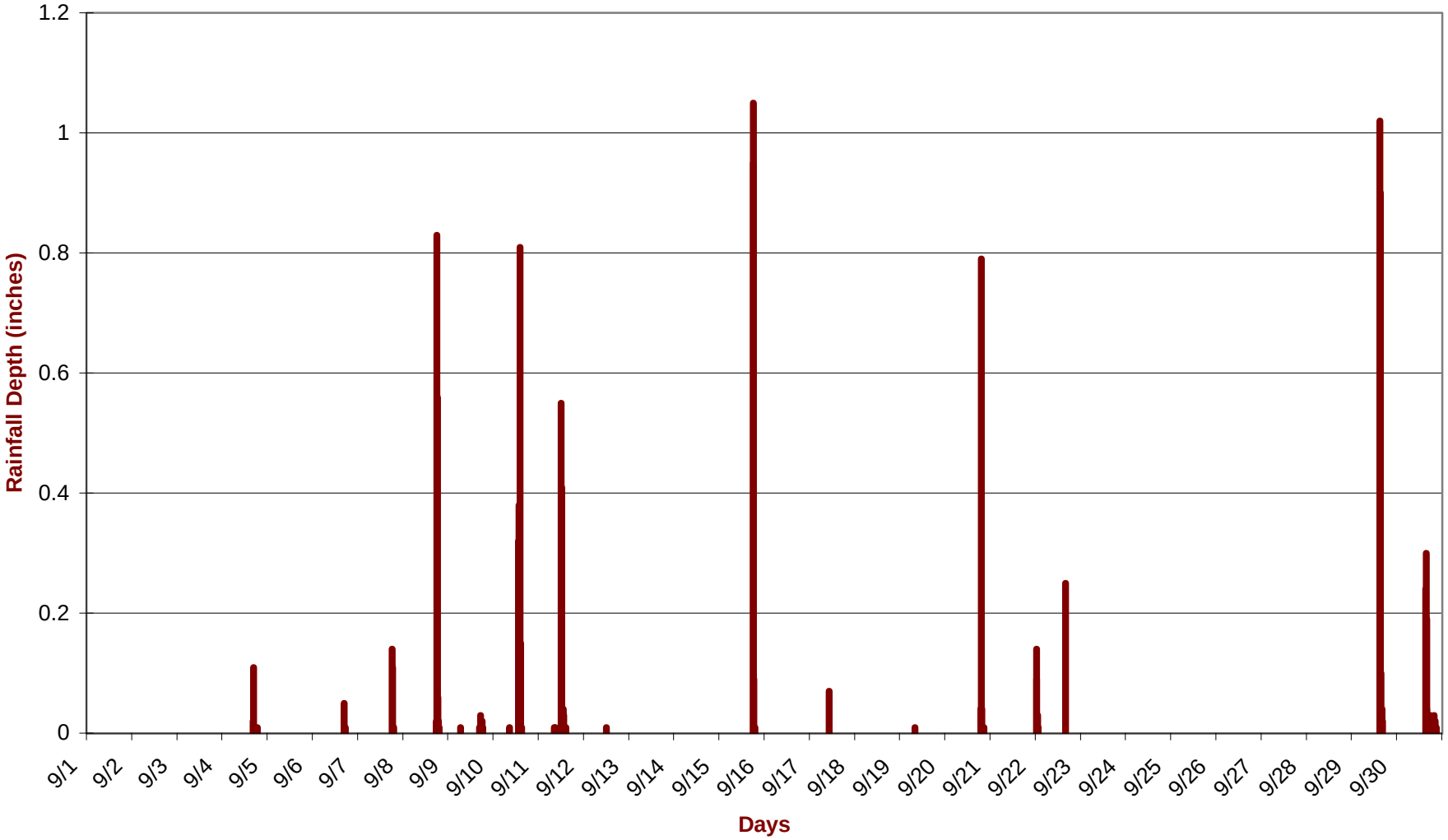
Based on these model calibration results and comparisons with USGS records, we recommend that the ground water option of XP-SWMM be utilized in the Cape Coral model and that our calibration report incorporate this enhanced model capability. If you agree with this conclusion then we would like to review with you via conference call the ground water module parameters to be used as a starting point in this effort at improving the model calibration. We think this model enhancement can be accomplished this week. If you think this addition to the model in not necessary then we will simply generate a more complete model calibration report and submit it to your as the calibration deliverable.

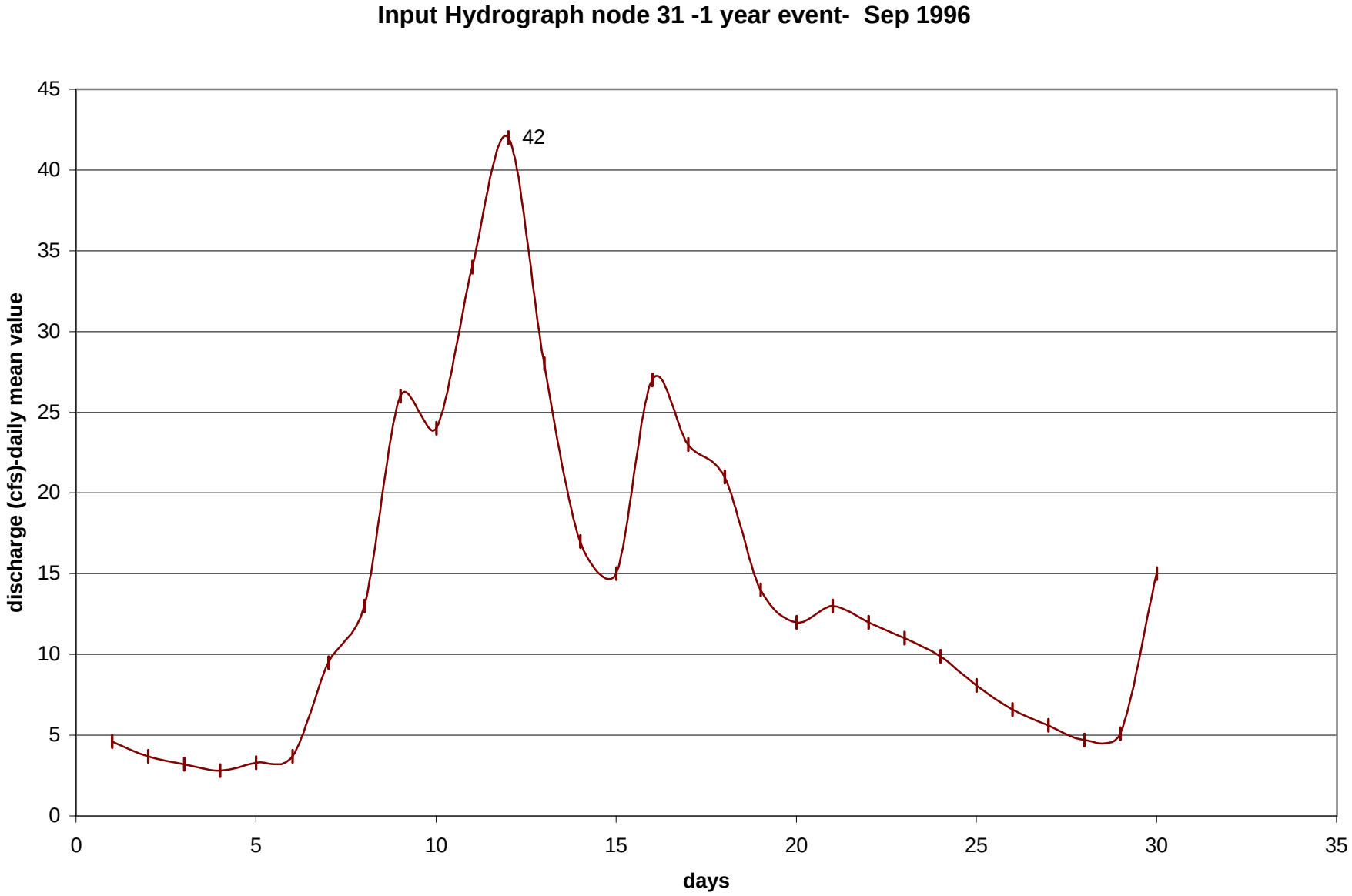
Gator Slough Canal Watwershed - 1 year event Sep 1996		
Total Area	396,657,360	ft^2
South of Hwy 41	9,106	acres
	14.23	sq. miles
	volume (cubic feet)	depth over total area (inches)
Tot. Inflow from North of Hwy 41	36,097,920	1.1
Tot. Rain Lake FairAway station	387,071,474	11.7
Tot. Infiltration	216,077,808	6.5
Tot. ET considering a Sep monthly value of 4 inches (0.13 inches/day)	132,219,120	4
Tot. outflow link weir # 11	186,445,658	5.6
Tot. outflow of USGS data	307,238,400.00	9.3
Missing Runoff		3.7
Percent error	39	
50 cfs Base Flow	129,600,000	3.9
MODEL MASS BALANCE		
Inflow + Rain - Inflitration	207,091,586	6.3
Outflow	186,445,658	5.6
missing water in model	20,645,928	
Percent error	11.07	

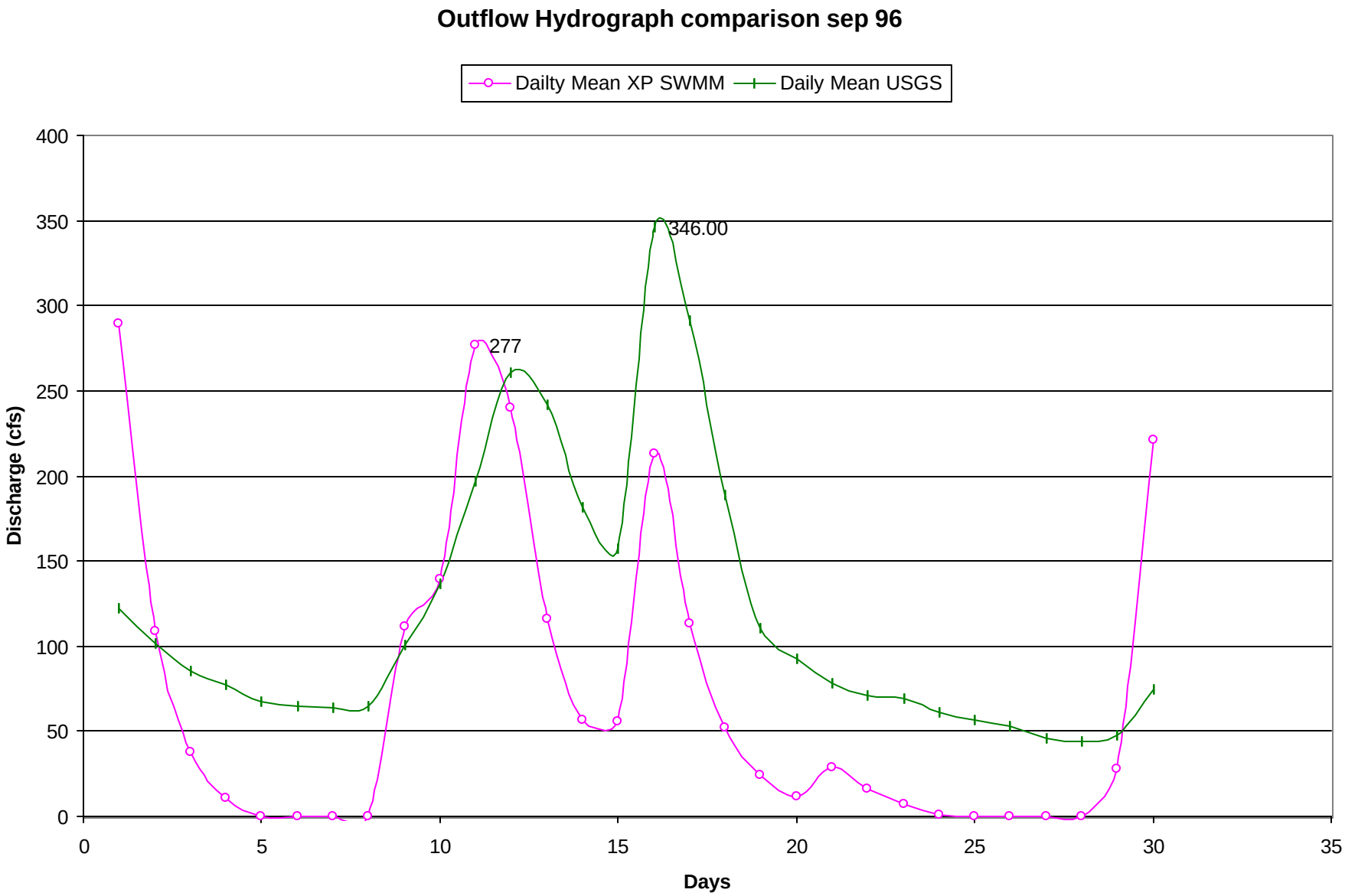
Cumulative Rainfall September 1996
Gauge Station: Lake Fairaway (0.5 miles west of Hwy 41)



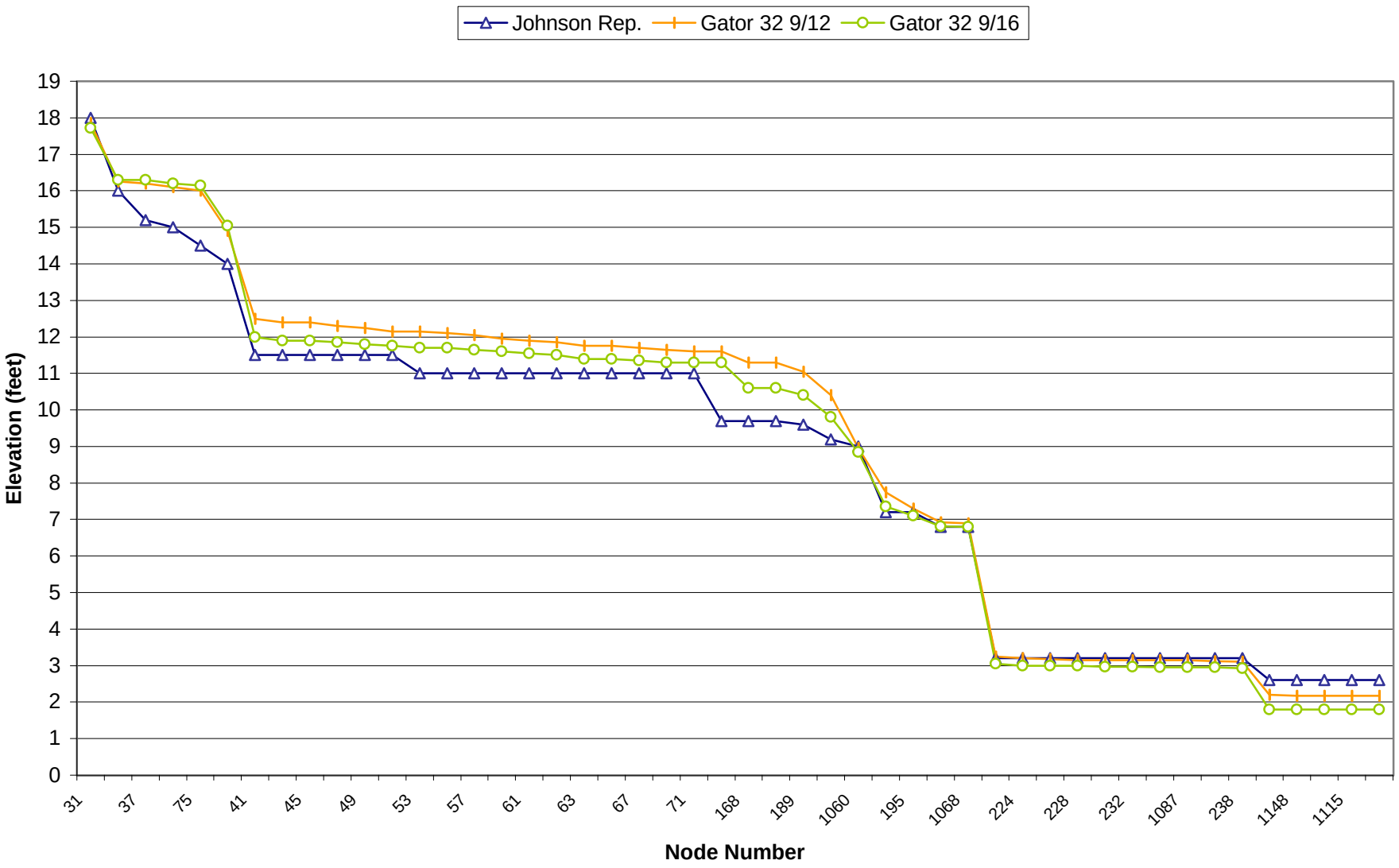
Absolute Rain Depth September 96
Gauge Station: Lake Fairaway (0.5 miles west of Hwy 41)

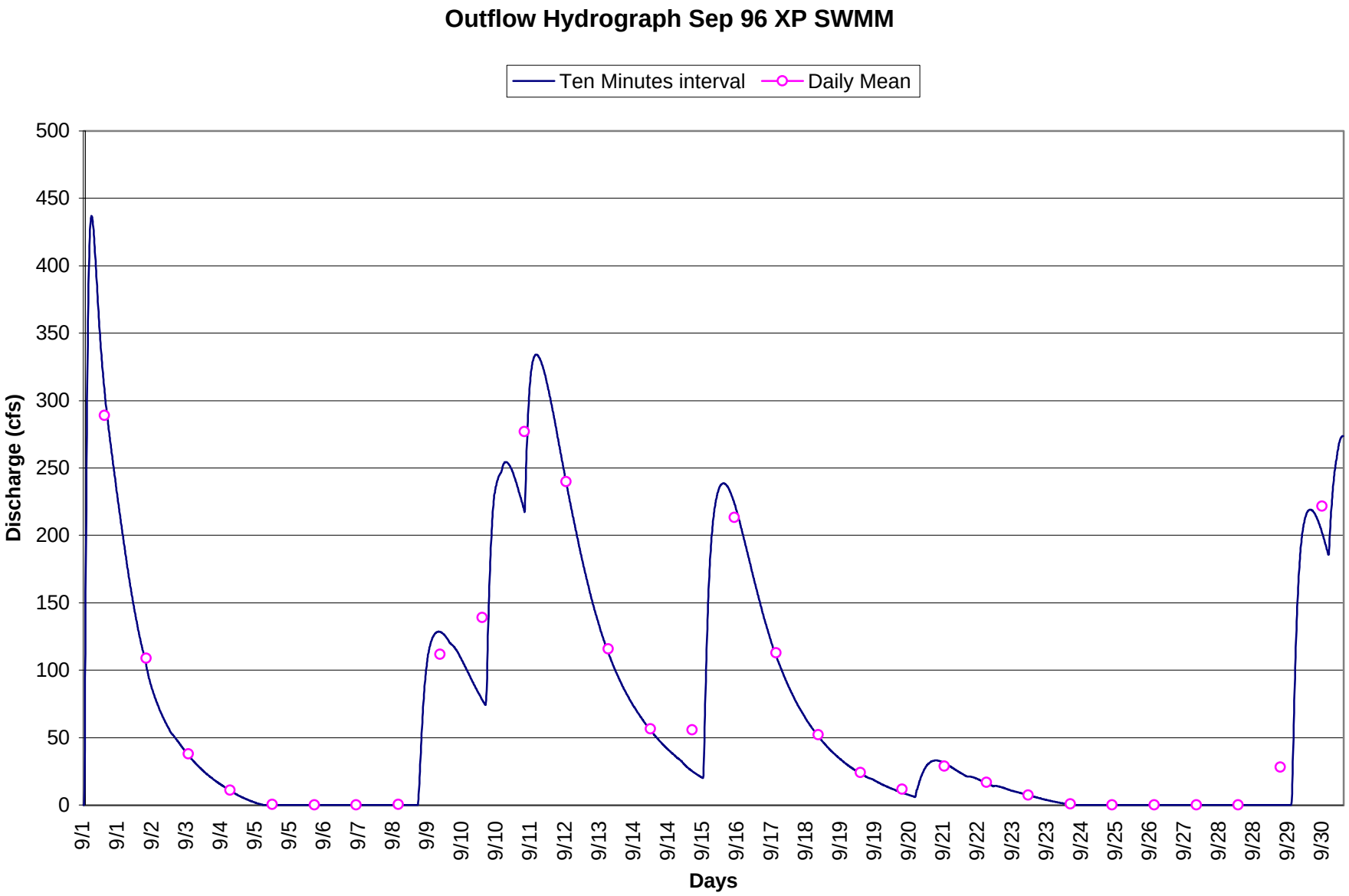



Input Hydrograph node 31 -1 year event- Sep 1996
discharge (cfs)-daily mean value
days
42
0
5
10
15
20
25
30
35
40
45


Outflow Hydrograph comparison sep 96
Dailty Mean XP SWMM
Daily Mean USGS
346.00
277
Discharge (cfs)
Days
0
50
100
150
200
250
300
350
400
0
5
10
15
20
25
30
35

1 Year Event Water Elevation comparison- Gator Slough




Outflow Hydrograph Sep 96 XP SWMM
Ten Minutes interval
Daily Mean
Discharge (cfs)
500
450
400
350
300
250
200
150
100
50
0
9/1
9/1
9/2
9/3
9/4
9/5
9/5
9/6
9/7
9/8
9/9
9/10
9/10
9/11
9/12
9/13
9/14
9/14
9/15
9/16
9/17
9/18
9/19
9/19
9/20
9/21
9/22
9/23
9/23
9/24
9/25
9/26
9/27
9/28
9/28
9/29
9/30
Days