

**PRELIMINARY REPORT ON
RAINSTORM OF
MARCH 28-29, 1982**

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RAINSTORM OF MARCH 28-29, 1982

BY

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I. Description of the Torrential Rainstorm

Floods and droughts are inescapable elements of subtropical south Florida living. In the evening of March 28, 1982 through the morning of March 29, 1982, intense rains and high winds lashed the coastal areas of Palm Beach, Martin, and St. Lucie Counties, flooding houses and mobile homes, closing streets, stalling cars, and contributing to several deaths.

The intense rains with high winds are commonly referred to as torrential rainstorm. There was a stationary front down through the Florida Straits. Meanwhile, a very large and strong high pressure system was located with its center off the Carolinas on March 28, 1982. At the same time, a weak low pressure system formed in the Gulf of Mexico and was moving slowly across the state in the late afternoon of March 28, 1982. The high pressure system off the coast of the Carolinas produced easterly winds (that gusted up to 41 miles per hour) in south Florida. This warm and moist air mass, meeting the slow moving low pressure system crossing the state, triggered the cloudburst in the area. The precipitation which began about 8 PM March 28, 1982 fell in spasmodic surges of rain and finally subsided about 11 AM March 29, 1982. The occurrence of this type of rainstorm, associated with frontal activity, is not unusual. The large rainfall amounts recorded locally in Palm Beach County were notable, however.

II. Rainfall Distribution

As mentioned above, the intense rains occurred primarily between 8 PM March 28, 1982 through 11 AM March 29, 1982. However, the rainfall readings for this storm event were spread out over two to three days as a result of the different reading time for many of the raingauges. For example, rainfall data at Jim Lane's house is observed at 7 AM daily; therefore, the value of 5.25 inches of rain on March 29, 1982

actually occurred between the hours of 7:01 AM March 28, 1982 through 7 AM March 29, 1982. The remaining rainfall which fell after 7 AM March 29, 1982 was read on the following morning at 7 AM (i.e. March 30, 1982). Some observers read their gauges at random morning hours. The recording gauges record rainfall values from 0 to 24 hours at midnight.

Table 1 shows the daily rainfall values at those locations available as of April 6, 1982. Eastern Palm Beach County received the highest intensity rainfall during this event. The coastal area of Martin and St. Lucie Counties received from about 5 to 8.7 inches, and was next in intensity. Lake Okeechobee received 2 to 4.3 inches, while the Everglades Agricultural Area received 0.2 to 2.8 inches. Figure 1 shows the general rainfall distribution of this rainstorm over Central and Southern Florida. As one can observe, the majority of the area received between 0.5 to 2.5 inches.

The areas of highest rainfall intensity during this rainstorm occurred along the coastal area of Palm Beach County. Lantana Airport reported 16 inches of rainfall, Manalapan Water Plant reported 14.40 inches, and Dick Rodgers (Resource Control Department Director) reported 15.01 inches of rainfall at his home in Palm Beach Gardens. Figure 2 shows the isohyetal map of rainfall resulting from this rainstorm. The return-frequency analysis is presented in District Technical Publication 81-3 entitled "Frequency Analysis of Rainfall Maximum for Central and South Florida". The highest located intense rainfall amounts, such as at the Lantana Airport and Palm Beach Gardens, may be on the order of a one in 100 years event. Due to the fact that the area covered by this amount of rainfall is so limited, it may be misleading to say this is a one in 100 years event. The area of North Palm Beach, Palm Beach Gardens,

TABLE 1 DAILY RAINFALL VALUES AT VARIOUS LOCATIONS DURING RAINSTORM OF MARCH 28-29, 1982

Lower East Coast

<u>Station Name</u>	<u>3-28</u>	<u>3-29</u>	<u>3-30</u>	<u>Total</u>	<u>Reading Time</u>
4434 Fuscia Cir.So.(PBGdns)	0	14.59	0.42	15.01	6 pm
419 Sequoia Dr.(WPB)(Jim Lane)	0	5.25	1.15	6.40	7 am
Lake Worth D.D. Office	0	8.55	0.92	9.47	am**
Pratt Whitney	1.45	3.30		4.75	12 pm
WPB Field Station	0	10.30	0.80	11.10	8 am
Jupiter Fire Station		11.55		11.55	8 am
Greenacres City		10.27	0.28	10.55	am
S-5A	0.61	1.83	0.25	2.69	8 am
Lake Worth Rd & E1		3.77	0.22	3.99	am
Boynton Rd & Mil. Trl	0	8.50	0.21	8.71	am
Range Line & L39		2.75	0.12	2.87	am
Boca Rd & Range		2.72	0.12	2.84	am
Boca Rd & Powerline		3.16	0.06	3.22	am
Mil. & L38	0	5.10	0.24	5.34	am
Lantana Airport		16.00		16.00	8-8:30 am
Manalapan Water Plant		14.40		14.40	midnight
Loxahatchee	0.16	3.00		3.16	5 pm
Margate		0.82	0.07	0.89	9 am
Miami Field Station		1.20*	0.03	1.23	8 am
Homestead Field Station		1.38*	0.03	1.41	8 am
Miami Airport	0.04	1.33	0.04	1.40	midnight
Flamingo Ranger Station	0.01	2.11	0	2.12	8 am
WPB Airport	3.65	5.15	0.44	9.24	***
Royal Palm Ranger Station	0.26	0.61	0.03	0.90	2 pm
Pompano State Farmers Market	1.15	0.17	0.10	1.42	4 pm
Tamiami 40 Mile Bend	1.75	0.34	0	2.09	2 pm
S-9		0.32*	0.13	0.45	8 am
S-13		1.12*	0.05	1.17	8 am

Lower West Coast

<u>Station Name</u>	<u>3-28</u>	<u>3-29</u>	<u>3-30</u>	<u>Total</u>	<u>Reading Time</u>
S-79	0	0.84	0	0.84	8 am
S-78	0	1.42	0	1.42	8 am
Fort Myers	0.51	0.05	0.01	0.57	
Everglades City	0	0.65	0	0.65	8 am

TABLE 1 Continued

DAILY RAINFALL VALUES AT VARIOUS LOCATIONS DURING
RAINSTORM OF MARCH 28-29, 1982Everglades Agricultural Area

<u>Station Name</u>	<u>3-28</u>	<u>3-29</u>	<u>3-30</u>	<u>Total</u>	<u>Reading Time</u>
S-4		2.18*	0.15	2.33	8 am
HGS-4		2.20*	0	2.20	8 am
HGS-3		1.50*	0	1.50	8 am
S-5A	0.61	1.83	0.25	2.69	8 am
South Bay	1.70	0.73		2.43	Recording
Miami Lock	0.95	0.49		1.44	Recording
Pelican Lake	1.20	1.24		2.44	Recording
Belle Glade Exper. Station		2.80		2.80	8 am
S-78		1.42*	0	1.42	8 am
S-77		1.81*	0	1.81	8 am
S-6		0.80*	0	0.80	8 am
S-7		0.20*	0	0.20	8 am
S-8		0.36*	0	0.36	8 am
Devils Garden	0	1.36	0	1.36	7-8 am

Upper & Lower Kissimmee Basins

<u>Station Name</u>	<u>3-28</u>	<u>3-29</u>	<u>3-30</u>	<u>Total</u>	<u>Reading Time</u>
Kissimmee Field Station		1.69*	0.04	1.73	8 am
S-61		2.11*	0.30	2.43	8 am
Clermont (6SSW)	0.94	0.59	0	1.53	6 pm
S-65		3.32*	0.07	2.39	8 am
S-65A		2.44*	0	2.44	8 am
S-65B		2.95*	0	2.95	8 am
S-65C		4.00*	0.05	4.05	8 am
S-65D		4.35*	0.02	4.37	8 am
S-65E		5.00*	0.05	5.05	8 am
S-68		3.55*	0	3.55	8 am

*Accumulated

**Between 8-12 am

***Midnight to Midnight for 3-28-82, Midnight to 11 am for 3-29-82

TABLE 1 Continued

DAILY RAINFALL VALUES AT VARIOUS LOCATIONS DURING
RAINSTORM OF MARCH 28-29, 1982Upper East Coast

<u>Station Name</u>	<u>3-28</u>	<u>3-29</u>	<u>3-30</u>	<u>Total</u>	<u>Reading Time</u>
Fort Pierce		5.22*	0.07	5.29	8 am
Stuart 1N (MRF6082)	2.51	6.20		8.71	4-4:30 pm
S-80	0	5.25	0.45	5.70	8 am
S-308	0	2.10	0.10	2.20	8 am
Fort Drum 5NW	1.00	2.29	0.02	3.31	5 pm
Fort Pierce Water Plant	2.75	2.65	0.08	5.48	12 midnight
S-135		3.14*	0.05	3.19	8 am
Melbourne	1.34	1.04	0.03	2.41	12 midnight

Lake Okeechobee

<u>Station Name</u>	<u>3-28</u>	<u>3-29</u>	<u>3-30</u>	<u>Total</u>	<u>Reading Time</u>
S-135		3.14*	0.05	3.19	8 am
S-308	0	2.10	0.10	2.20	8 am
S-133		4.28*	0.07	4.30	8 am
Okeechobee Field Station		4.53*	0.02	4.55	8 am
S-127		4.35*	0	4.35	8 am
S-129		2.10*	0	2.10	8 am
S-131		2.80*	0.05	2.85	8 am
S-77	0	1.81	T	1.81	8 am
S-4		2.18*	0.15	2.33	8 am
HGS-4		2.20*	0	2.20	8 am
HGS-3		1.50*	0	1.50	8 am

and Lake Park received about 12 to 15 inches of rain, and may be considered as an event of a frequency greater than one in 50 years. The area

of Lake Worth, Lantana, Manalapan, and Atlantis received about 12 to 16 inches of rain, this also can be considered on the order of a one in 50 years event. Rainfall for the area of central Palm Beach County east of the Florida Turnpike approximated a one in 5 to 10 years event.

III. Antecedent Condition

A. Rainfall

Rainfall deficiency existed in most parts of the District except the coastal area of Palm Beach and Martin Counties. Table 2 shows the antecedent rainfall condition in Palm Beach County prior to this rainstorm. There were 3 to 6 inches reported by many Lake Worth Drainage District gauges during March 24-26, 1982 as compared to less than 2 inches or none for the rest of the District area. This amount of rainfall provided a very wet soil moisture condition within south central Palm Beach County which contributed to the severe flooding in the area during the rainstorm of March 28-29, 1982.

B. Water Level Conditions

The greatest amount of rainfall occurred mostly in eastern Palm Beach County. Therefore, the water level conditions in this area were examined. Due to District-wide year long drought situations and the dry season of the year, the water levels in the coastal structures are maintained slightly above their normal optimum stages. Table 3 shows the water levels on March 26, 1982 (just two days prior to the rainstorm) at selected coastal structures as compared to their optimum stages.

TABLE 2 ANTECEDENT RAINFALL CONDITIONS PRIOR TO MARCH 28-29, 1982 RAINSTORM

<u>Station Name</u>	<u>3-24</u>	<u>3-25</u>	<u>3-26</u>
Lake Worth D.D. Office	1.43	3.98	0.12
WPB Field Station	0.26	0.05	0.73
Greenacres City	1.15	0.78	0.06
S-5A	1.10	0.22	0.12
Lake Worth Rd & E1	2.00	0.73	0.20
Boynton Rd & Mil. Trl	2.20	3.22	0.16
Rangeline & L39	0.25	2.96	0.06
Boca Rd & Range	0.11	4.55	0.06
Boca Rd & Powerline	0.61	5.02	0.07
Miami Field Station	0.73	0	1.10
Miami Airport	0	1.01	0.05
Flamingo Ranger Station	0	0.10	0.86
Royal Palm Ranger Station	0	0.27	0.28
S-9	0	0	0.06
S-13	0	0	0

TABLE 3. The Water Levels on March 26, 1982 as Compared to Their Optimum Stages

<u>Structure</u>	<u>Headwater Stage ft msl</u>	<u>Current Optimum Stage ft msl</u>	<u>Normal Optimum Stage ft msl</u>
S-40	8.77	9.00	8.50
S-41	8.86	9.00	8.50
S-44	7.61	7.70	7.10
S-46	14.76	15.00	14.0-15.0
Palm Beach Lock	8.71	8.60	8.50

Due to rainfall on March 24-26, 1982, some gates were operated to relieve local runoff and then one gate on most of the structures was left open a small amount to maintain optimum stages prior to this rainstorm.

VI. Discussions of Projects Performance

A. Flooded Areas

More than 6000 people in Palm Beach County were without electricity during this rainstorm and schools were closed as flooding caved in portions of some major roads in the county and temporarily closed sections of others.

In the north end of Palm Beach County, flooding occurred on U.S. 1 and Indiantown road in Jupiter; Burns Road near Palm Beach Gardens Community Hospital was flooded forcing the hospital to relocate 20 patients to the second and third floors until the water was pumped out by early afternoon March 29, 1982; the Beeline Highway leading to Pratt-Whitney Aircraft; all side streets off Indiantown Road west of Jupiter and stretches of PGA Boulevard and Northlake Boulevard.

In the central and southern parts of Palm Beach County, there was severe flooding on Okeechobee Boulevard east of Congress Avenue, at 45th Street and Haverhill, on Hypoluxo Road east of Lawrence Road, Prince Drive west of Congress Avenue near John Prince Park, SRA1A from Lantana south,

at 10th Avenue South and Military Trail, Congress Avenue in the Boynton Beach area, and segments of Belvedere Road and Australian Avenue. The area north of Lake Clarke Shores and the eastern portion of Glenn Ridge were flooded, with water in some homes.

Stretches of three roads in the central-south county area were closed through midnight March 29, 1982. They were Congress Avenue from Lantana Road to Boynton Road, Hypoluxo Road from High Ridge Road to Military Trail, and Lake Worth Road from Military Trail to Jog Road.

Electricity was intentionally turned off by FPL in two mobile home parks - Waterview Mobile Park of West Palm Beach had water entering trailers and submerging cars, and Sunshine Mobile Village, west of Lake Worth, where severe flooding caused the evacuation of more than 120 people. Over 220 campers were evacuated from John Prince Park campsite due to severe flooding. Jupiter Island and the Lake Park - Singer Island areas were without electricity.

The flood waters receded from most parts of the above-mentioned areas during the night of March 29, 1982 except for a few places where flood water did not recede until the night of March 30, 1982.

The following high water marks were surveyed on April 5, 1982:

1. Waterview Mobile Home Park, 1522 and 1532 Monor Street: 13.50 ft msl
2. Bridge at Australian Avenue crossing stub canal: 12.71 ft msl
3. Bridge at Belvedere Road crossing stub canal: 12.13 ft msl
4. Bridge at South Congress Avenue crossing Lake Worth
Drainage District Lateral Canal 14: 12.35 ft msl
5. WPB stub canal east of Palm Beach Airport 11.8 ft msl
6. WPB canal at Summit Boulevard 11.3 ft msl
7. WPB canal at Forest Hill Boulevard ±11.1 ft msl
8. WPB canal at Field Station 11.66 ft msl
±11:30 AM, 3-29-82

B. Project Performance

During this rainstorm, most of the flooded areas mentioned previously were not directly caused by the deficiencies of the project design, operation, or function of the District facilities. However, there are some steps that can be taken to improve the operations of the District facilities as will be discussed in this section.

1. Palm Beach Lock - Figure 3 shows the stage hydrograph during this rainstorm. The gate on the lock which was closed until 6 PM March 28, 1982 opened on automatic at 6 PM and was opened full on manual at ±10 PM. The crew started pulling boards at ±11 PM and finished at ±4 AM. Therefore, at ±4 AM the structure was full open, all boards out, and the lock gate full open. The discharge at 1 AM March 29, 1982 was over 5000 cfs and reached its peak of 5800 cfs at noon. The average flow during March 29, 1982 was at 5360 cfs which is a record high as compared to the last maximum daily discharge of 5320 cfs on April 18, 1942. The maximum peak stage during this rainstorm was 10.68 ft msl which is also pretty close to the record high of 10.89 ft msl on October 13, 1947. The peak stage in the West Palm Beach Canal at the District's West Palm Beach Field Station was 11.66 ft msl at 11:30 AM March 29, 1982. In other words, this structure was able to maintain canal stage fairly below its banks during and after this rainstorm.
2. S-41 - This structure is a reinforced concrete gated spillway with two automatically controlled gates. This structure maintains and drains the C-16 basin which covers the area of Boynton Beach, Lake Worth, Lantana, Hyopluxo, Atlantis, etc., as mentioned in the flooded area and rainfall distribution map. This basin was severely hit by the rainstorm.

Figure 4 shows the stage hydrograph at the headwater of S-41 during this rainstorm. The gates were first opened at 10 PM March 28, 1982. The discharge rose to 2600 cfs during the first two hours of gate operation, and peaked at 5600 cfs during the morning of March 29, 1982. It stayed at above 5400 cfs throughout the rest of that day. The stage dropped to 6.3 ft msl at 10:30 AM March 30, 1982. The stage again rose to 8.80 ft msl at noon March 30, 1982, because of the closing of one gate. This gate was opened again at 1 PM and the canal stage dropped to 7.35 ft msl at 4 PM March 30, 1982. This operation probably can be improved because the canal stage rose at such a rapid rate after the one gate was closed. Gate closure should be more gradual, and closer attention given to the response of the canal stage. Only one gate at S-40 was operational during this rainstorm. Under most conditions, the month of March is a good period in which to schedule essential maintenance, since full structure capacity is rarely needed. However, this did not contribute to the flooding in the area. The estimated discharge rate of 5600 cfs in the morning of March 29, 1982 was a record high since the completion of this structure in 1965. Table 4 presents the hydraulic design of water control structures for both the design and Standard Project Flood conditions. This peak discharge of 5600 cfs exceeded that of SPF.

3. S-40 - This structure is similar to S-41 and its drainage basin covers the City of Delray Beach. Figure 5 shows the stage hydrograph at S-40 headwater during the rainstorm. Even though only one gate was available, the other gate was down for maintenance during this rainstorm, the stage in the canal was maintained below 9.0 ft msl. However, if there had been more rainfall in this basin it would have been severely flooded (see rainfall distribution map, Figure 2).

TABLE 4 Project Design of Water Control Structures for Design and Standard Project Flood Conditions

Structure	Stage, ft msl				Discharge cfs	
	Headwater Design	SPF	Tailwater Design	SPF	Design	SPF
S-40	8.2	9.0	2.7	2.7	4800	5500
S-41	8.1	8.8	1.8	1.9	4600	5300
S-44	9.0	10.2	3.9	3.9	2070	2750
S-46	12.8	16.4	2.2	2.2	3420	3420

NOTE: Design was 60% of SPF, except S-46 which was 50% of SPF.

4. S-44 - This structure is a two-gated reinforced concrete spillway structure with automatic control. Its drainage basin (C-17) covers Riviera Beach, Lake Mangonia, the eastern portion of Palm Beach Gardens, Palm Beach Mall area, Westward Expansion area, and several square miles west of I-95 and south of 45th Street. This basin was also hardest hit by the rainstorm. Figure 6 shows the stage hydrograph at S-44 headwater during this rainstorm. Gate opening began at 9 PM March 28, 1982 and the discharge reached its peak at 8 AM March 29, 1982. A discharge of 2480 cfs was measured at 1 PM March 29, 1982 by District crews. The peak discharge of 2680 cfs was very close to the SPF rate of 2750 cfs. The stage reached ± 9.8 ft msl during the rainstorm. There was no problem with the design or operation of this structure.
5. S-46 - This structure is a gated reinforced concrete spillway structure with three automatic control gates. It drains the C-18 basin, which covers a portion of the Corbett Wildlife area, Pratt-Whitney, and the Loxahatchee Slough. The flooded area during this rainstorm was located mostly in its eastern portion of the basin near S-46. Figure 7 shows the stage hydrograph at S-46 headwater during this rainstorm; again there was no problem with this structure. The stage was able to be maintained between 14 to 15 ft msl of its normal operating range. Peak discharge was ± 1900 cfs and mean daily discharge was ± 1530 cfs, well below the design level. The analysis presented here clearly indicates that most of the flooding was caused by inadequate secondary or tertiary drainage system capacities, maintenance, and operation, plus excessive rainfall with a wet antecedent condition.

Lantana, Manalapan, and Atlantis which received about 12 to 16 inches of rain. The rainfall in these two areas can be considered to approximate a one in 50 years event. The rainfall in the area of central Palm Beach County east of the Florida Turnpike approximated a one in 5 to a one in 10 years event. The rainfall in the rest of the District area was less than a one in 5 years occurrence.

The flood waters receded from most of the flooded areas during the night of March 29, 1982 except for a few places where the flood water did not recede until the night of March 30, 1982.

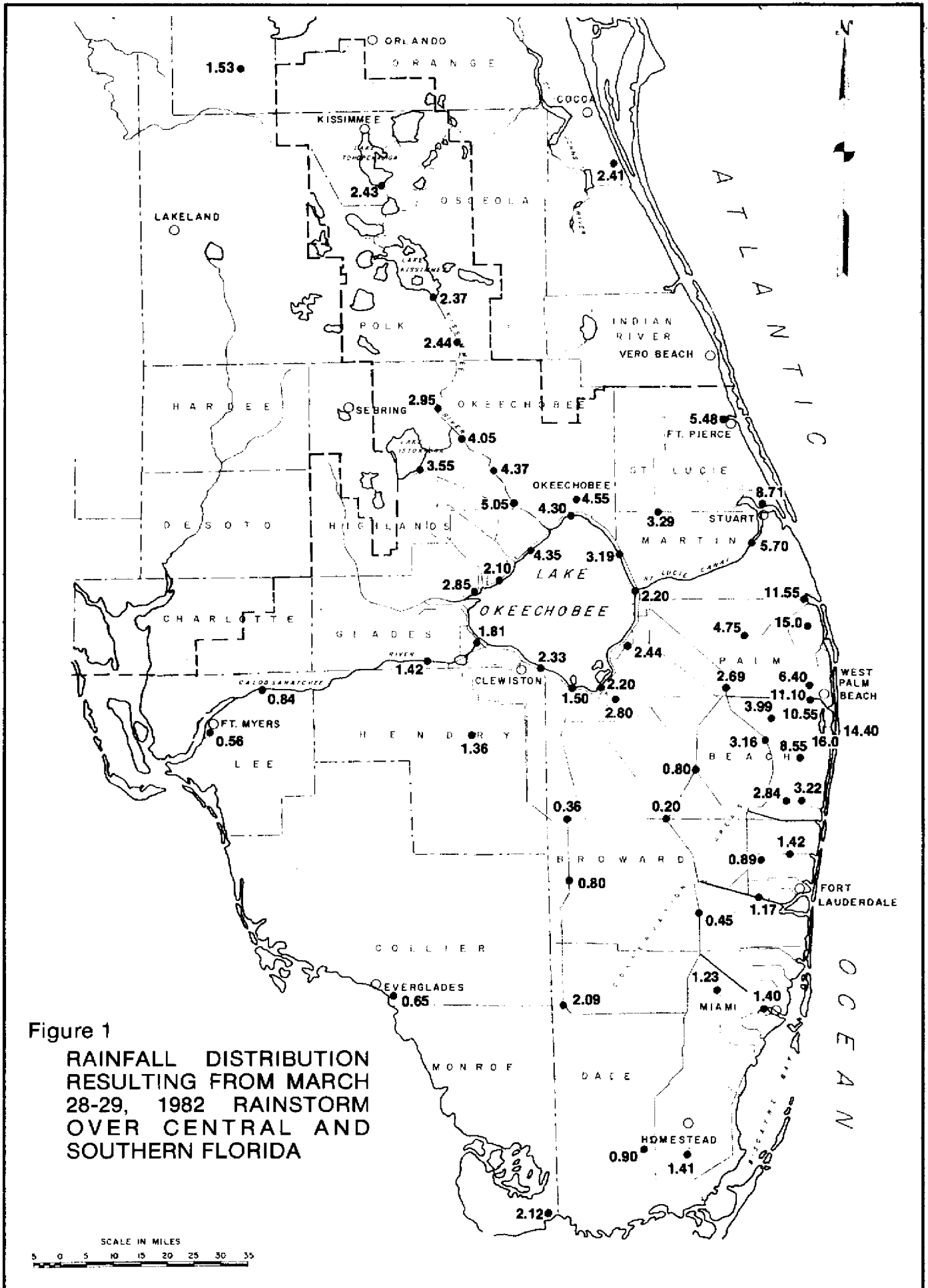
Waterview Mobile Home Park of West Palm Beach, and an area of Congress Avenue from Lantana Road to Boynton Road, Hypoluxo Road from High Ridge Road to Military Trail, and Lake Worth Road from Military Trail to Jog Road were flooded. The stage in Lake Osborne reached its record high of 12.35 ft msl.

An analysis of the project system performance during this rainstorm indicates that there were no serious problems encountered except one gate at S-40 which was under maintenance repair and was out of service during this rainstorm. Design stages and flow at S-40, S-41, and S-44 were surpassed. Headwater stage at S-40 reached ± 9.0 ft msl, the design stage is 8.2 ft msl and the SPF stage is 9.00 ft msl. Discharge through the one operable gate approximated 2800 to 3000 cfs.

Peak stage upstream of S-41 reached ± 9.5 ft msl. Design stage is 8.1 ft msl, SPF design stage is 8.80 ft msl. The design discharge is 4600 cfs, the peak discharge was something greater than 5300 cfs which is the SPF discharge for S-41 and S-40. A stream gauge measurement of 2480 cfs was made at S-44 with a stage of 9.8 ft msl. The design stage is 9.0 ft msl and the design discharge is 2070 cfs. The SPF stage is 10.2 ft msl and SPF discharge is 2750 cfs (see Table 4). Stages upstream of S-44 were not excessive due to the fact that C-17 was over-dug by $\pm 200\%$ for fill

material. Without this excavation undoubtedly there would have been flooding in the upper reaches of the basin. As noted earlier in the report, stages and discharges at the Palm Beach Lock were basically at an all-time high for an event that was probably less than a one in 10 years occurrence. If the ± 10 inches of rainfall would have extended out to the Turnpike, we would have had serious flooding in Lake Clarke Shores. The peak stage under this storm must have approximated 11.5 ft msl in Lake Clarke Shores. The peak discharge at S-46 approximates 1900 cfs; this is well below the design discharge of 3400 cfs.

The comparison of this event with historical values recorded at Hypoluxo, West Palm Beach Airport, and Greenacres City indicated that there were periods such as June 11-12, 1901, April 16-17, 1942, and Oct. 14-15, 1965 that were greater than this event.



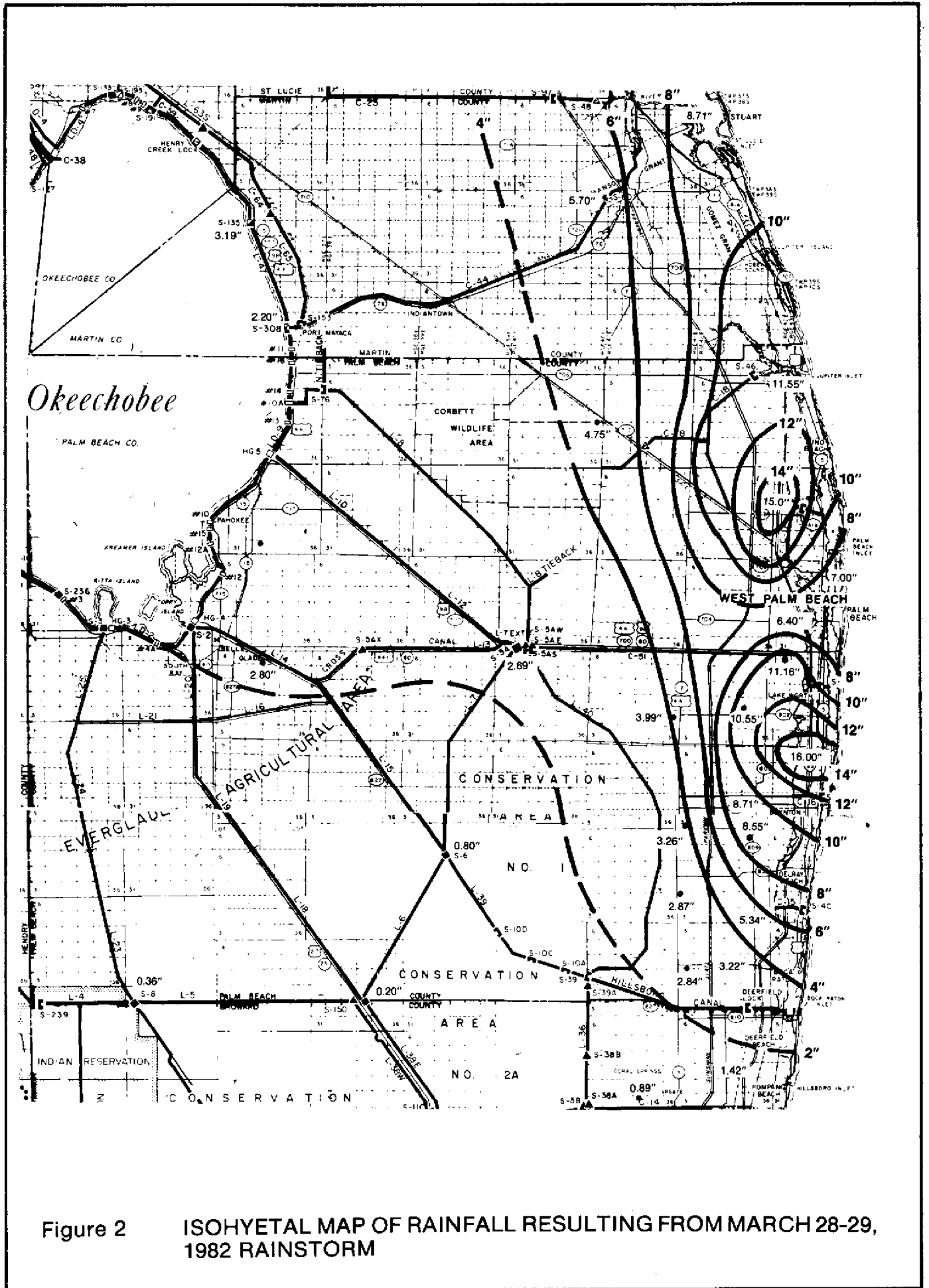


Figure 2 ISOHYETAL MAP OF RAINFALL RESULTING FROM MARCH 28-29, 1982 RAINSTORM

STRUCTURE PALM BEACH LOCK

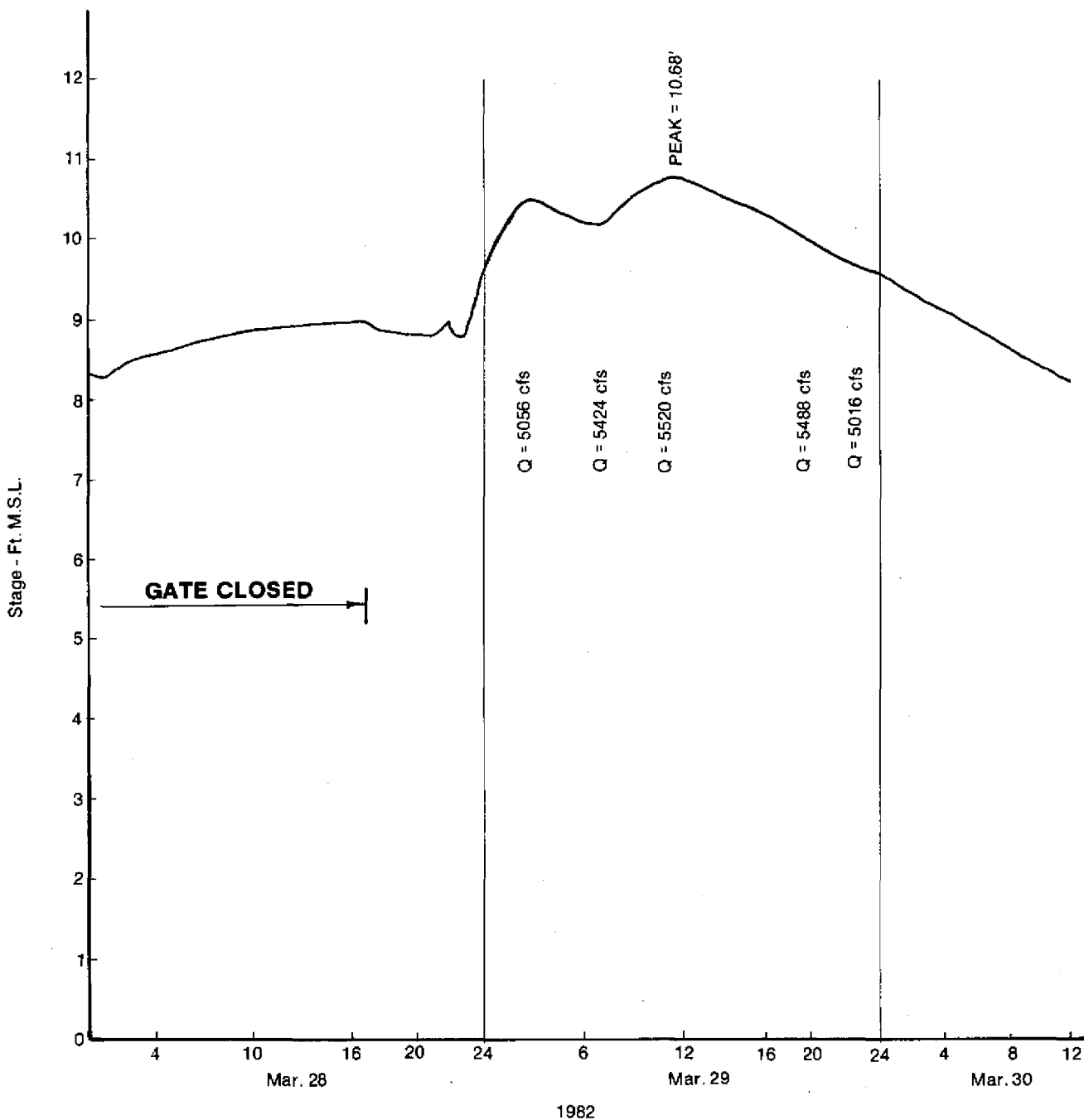


Figure 3

STAGE HYDROGRAPH AT PALM BEACH LOCK HEADWATER DURING RAINSTORM OF MARCH 28-29, 1982

STRUCTURE S-41 HEADWATER

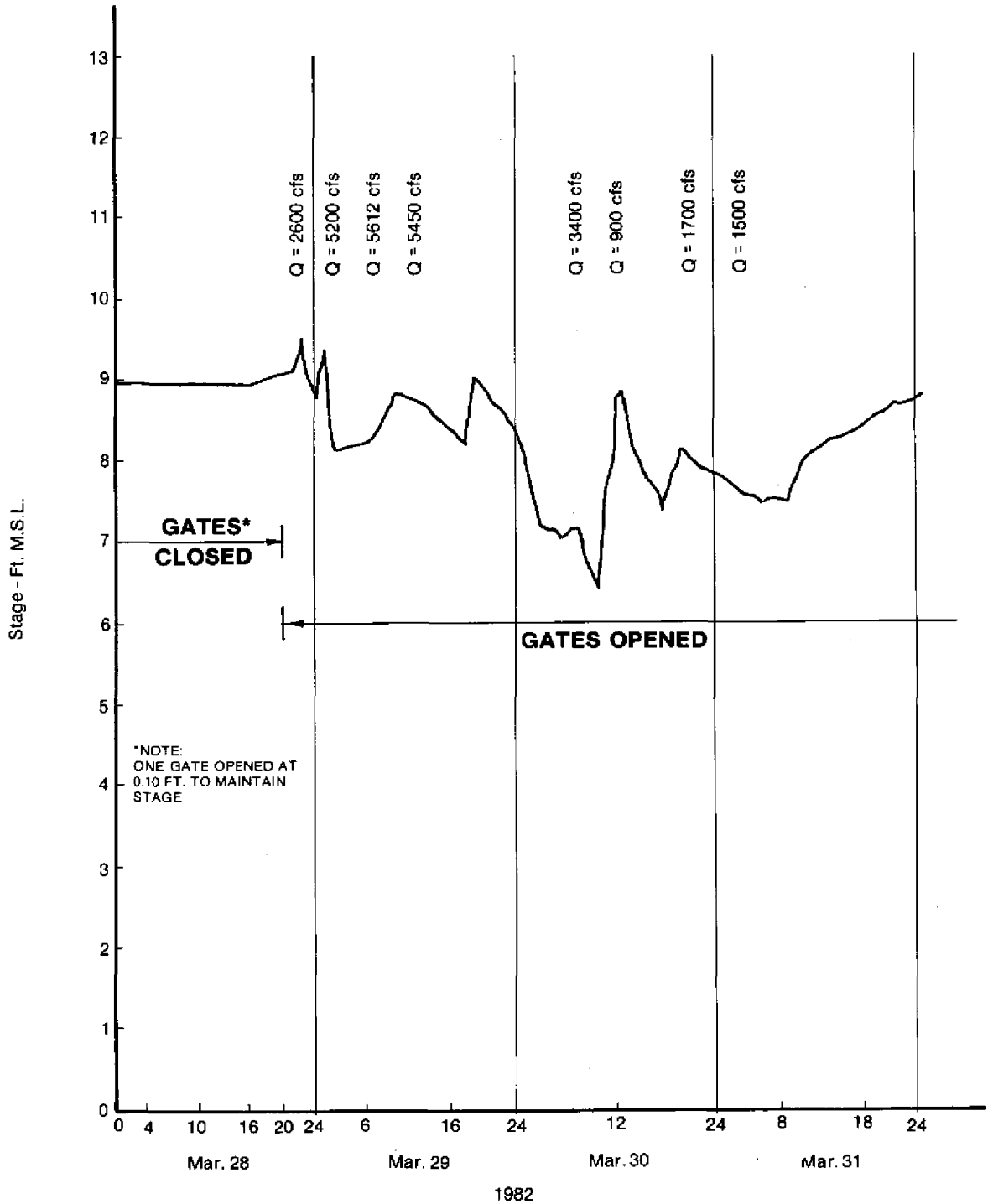


Figure 4 STAGE HYDROGRAPH AT S-41 HEADWATER DURING RAINSTORM OF MARCH 28-29, 1982

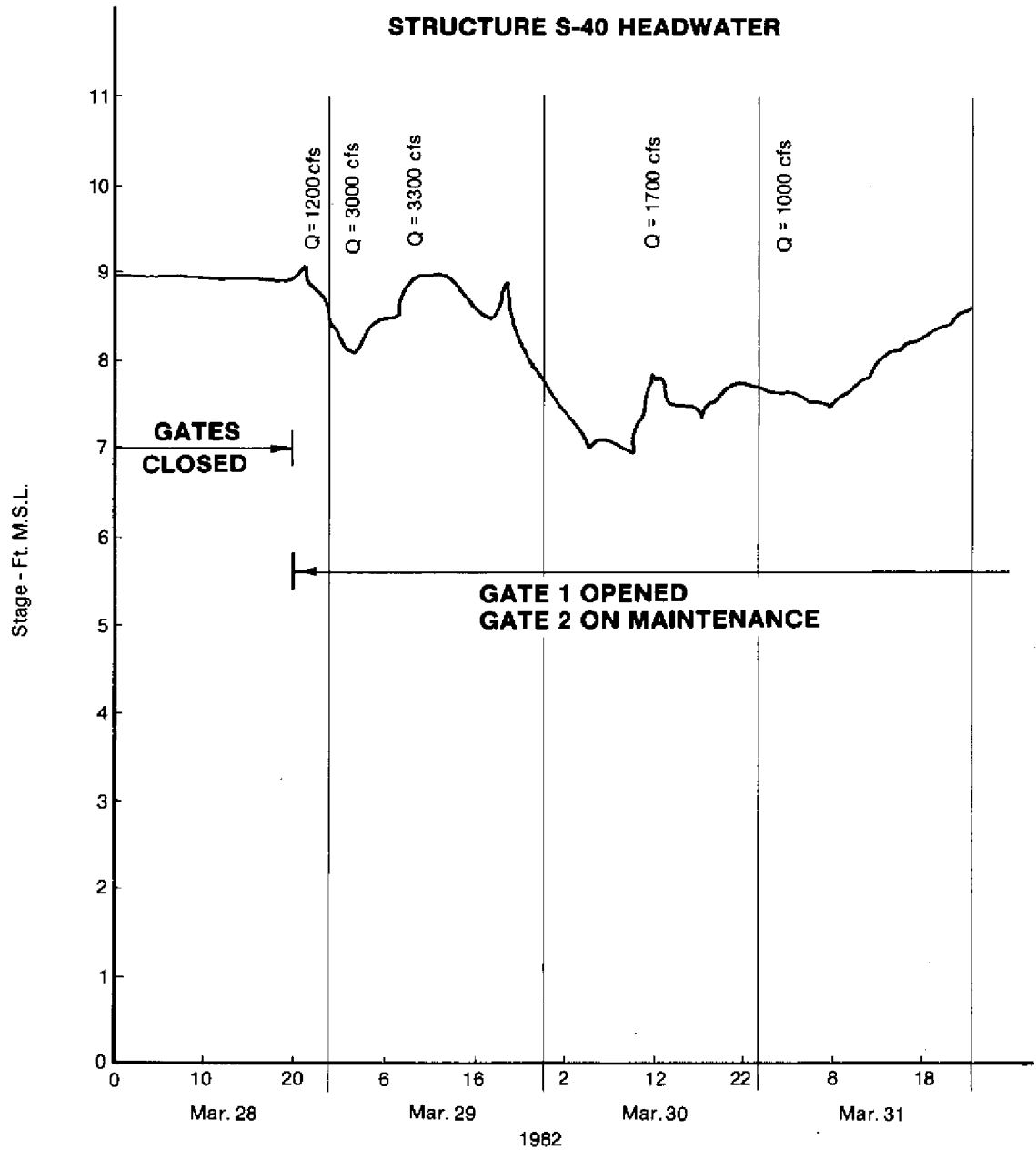


Figure 5

STAGE HYDROGRAPH AT S-40 HEADWATER DURING RAINSTORM OF MARCH 28-29, 1982

STRUCTURE S-44 HEADWATER

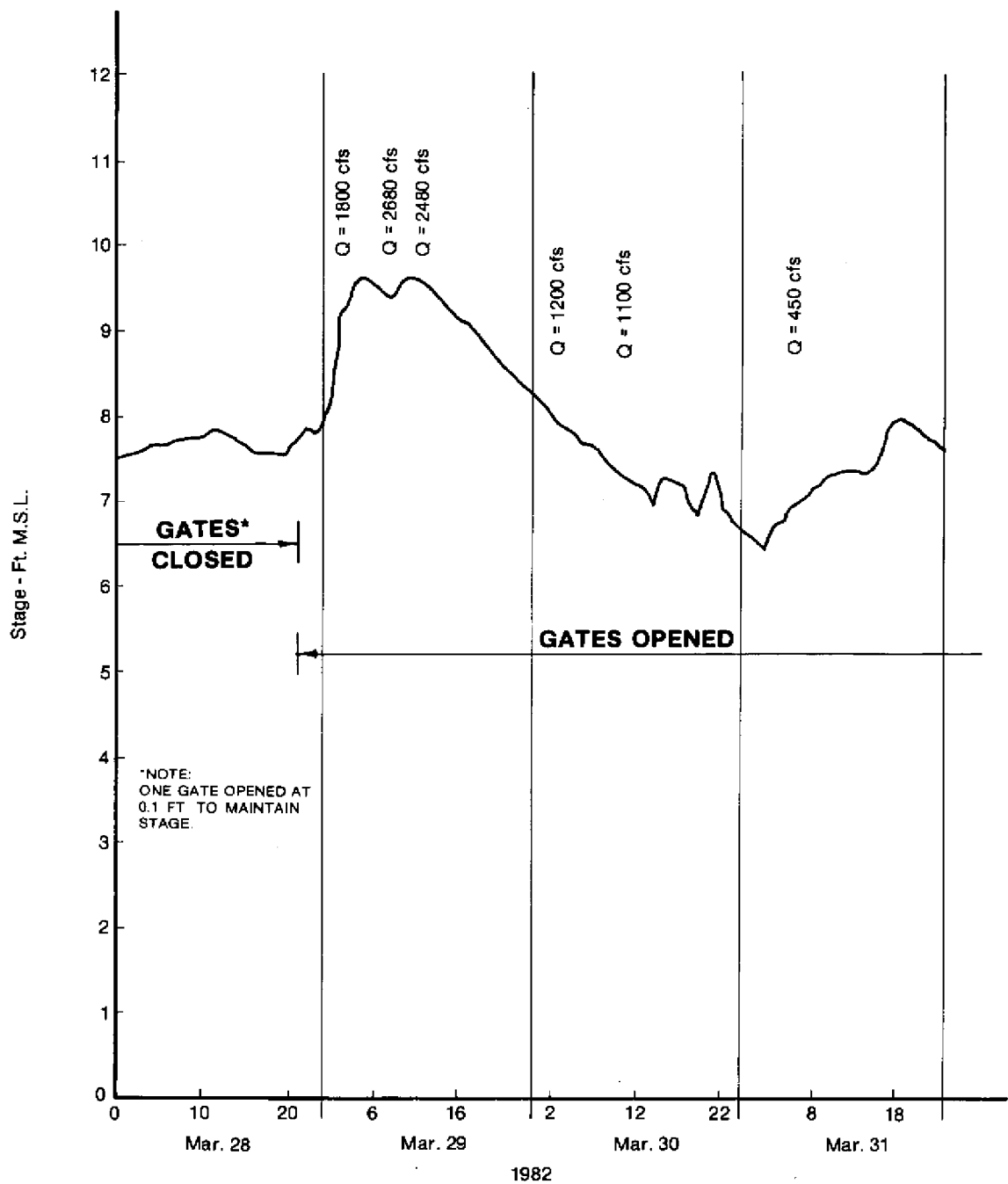


Figure 6

STAGE HYDROGRAPH AT S-44 HEADWATER DURING RAINSTORM OF MARCH 28-29, 1982

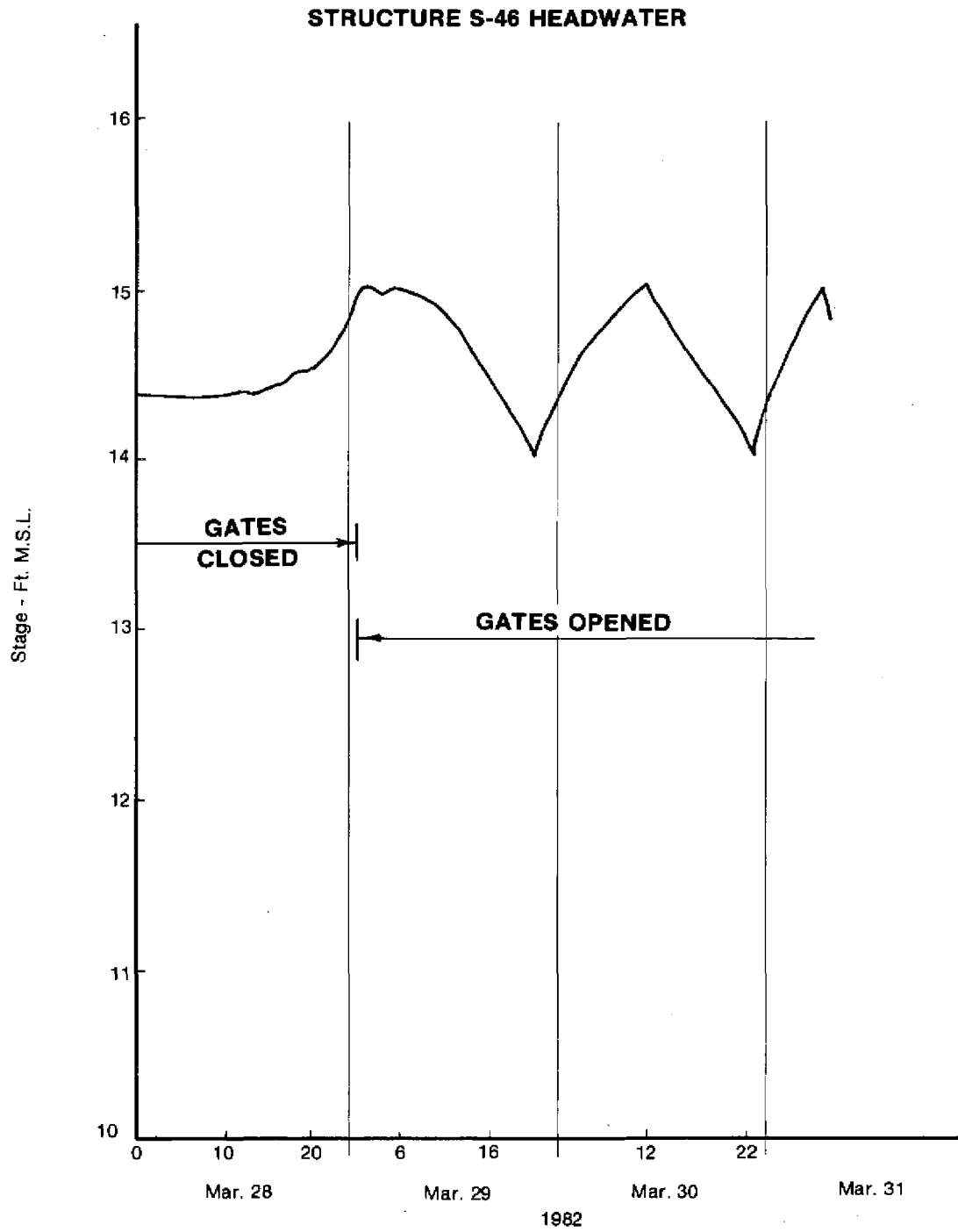


Figure 7

STAGE HYDROGRAPH AT S-46 HEADWATER DURING RAINSTORM OF MARCH 28-29, 1982