In the calibration of the model, the precipitation data from the Redickville station was used for the Mad River. Similarly the Shelburne precipitation station was used for the Boyne River and the Shanty Bay precipitation station for Willow Creek.

As indicated previously, the NWS snowmelt routine requires several input parameters. The most important and most sensitive parameters are:

MFMAX - Maximum non-rain melt factor
MFMIN - Minimum non-rain melt factor
UADJ - Mean wind function value during rain on snow periods
SI - Areal water equivalent above which there is always complete areal snow cover (mm)

In the calibration of the model various ranges of parameter were used. (Ref. 19).

These are:

MFMAX	0.004 - 0.009
MFMIN	0.0018 - 0.0035
UADJ	0.017 - 0.057
SI	64 mm - 128 mm

The best overall results were obtained as indicated below:

MFMAX	0.005
MFMIN	0.0018
UADJ	0.057
SI	127 mm

For the Boyne River catchment it was found that the recession constant (K) computed by the Williams equations had to be reduced by 30% to 0.7 time

the equation values. The presence of the reservoir within Earl Rowe Park upstream of the hydrometric station complicated the calibration procedure.

Plots of the observed and simulated hydrographs for each of the spring calibration events are presented in the Figures 3.6(a) to 3.6(f).

3.2.5 Model Validation

3.2.5.1 General

Events used over the summer and the spring period for the validation of the QUALHYMO model were selected from the computer plots of daily flows that were recorded over the 1975 to 1979 period. Hourly recorded discharges for the selected events thereafter formed a basis of comparison with simulated flows.

3.2.5.2 Lumped Models

Suitable validation events over the summer period were very sparse between 1975 and 1979. Only one event was found for the Mad River on September 26, 1977 (Table 3.7). Validation for the lumped catchment model for this event proved to be successful (Figure 3.7). A high flow event was also measured on the Boyne River at the Earl Rowe Park gauge; however, hourly streamflow records are not available and validation could not be carried out.

Validation events (Table 3.9) for the spring period were more numerous since annual peak flows usually occur during the freshet as a result of snowmelt, rainfall on saturated ground, or a combination of both. Plots (Figures 3.8 (a) to 3.8(f)) of the observed and simulated hydrographs for each of the spring validation events indicate a close agreement with the exception of the March 25, 1976 event. The observed flow peaks on Willow Creek were checked against those measured at adjoining watersheds and were found not to reflect the general pattern of higher runoff during the initial event.

TABLE 3.9
SPRING VALIDATION EVENTS

WATERCOURSE	PEAK FLOW (m^3/s)				OBSERVED RAINFALL (mm)						OBSERVED SNOW WATER EQUIVALENT (mm)						SIMULATED
	Date	Observed	Simulated	Type of Event	Date	Barrie	Shanty Bay	Allis-ton	Shel-burne	Redick-ville	Date	Eden-vale	Colwell	Totten-ham	Hono Centre	Maple Valley	Snow Water Equivalent (mm)
Mad River at Glencairn	21 Mar. 1976	102	88.5	Snowmelt	23 Mar. 24 Mar. 25 Mar.	0 2.4 0	0 0 0	0 2.4 0	0 0 0	0 0 0	15 Feb. 15 Mar. 01 Apr.	71 135 <-----ASSUME 0----->	76 112	0 0	71 112	91 132	133 114 3.4
	13 Mar. 1977	57.9	81.5	Rainfall on Snowmelt	12 Mar. 13 Mar.	18.1 -	18.5 -	20.1 -	16.3 -	19.1 -	14 Feb. 28 Feb. 15 Mar.	122 99 <-----NO DATA----->	94 84	No Data Trace	83.8 76.0	132 122	134 132 25
Willow Creek above Little Lake	25 Mar. 1976	31.1	9.3[1]	Snowmelt	23 Mar. 24 Mar. 25 Mar.	0 2.4 0	0 0 0	0 2.4 0	0 0 0	0 0 0	15 Feb. 15 Mar.	71 135	76 112	0 0	71 112	91 132	150 142
	24 Mar. 1979	26.5	41.5	Rainfall on Snowmelt	23 Mar. 24 Mar.	4.0 14.0	4.2 13.8	4.4 14.8	- -	0 16.2	15 Mar. 01 Apr.	130 0	89 0	0 0	31 0	91 0	185 14.8
Boyne River at Earl Rowe Park	13 Mar. 1977	46.4	42.0	Rainfall on Snowmelt	12 Mar. 13 Mar.	18.1 -	18.5 -	20.1 -	16.1 -	19.1 -	14 Feb. 28 Feb. 15 Mar.	122 99 <-----NO DATA----->	94 84	No Data Trace	83.8 76.0	132 122	87.2 90.7 10
	12 Apr. 1978	25.1	33.6	Rainfall on Snowmelt	10 Mar. 11 Mar.	6.7 10.0	7.8 9.6	7.4 4.2	10.8 6.5	0 22	15 Mar. 01 Apr. 15 Apr.	191 183 0	155 178 0	91 5 0	130 175 0	150 183 0	156.8 132.4 52.6

[1] Anomaly in Historical Streamflow Data

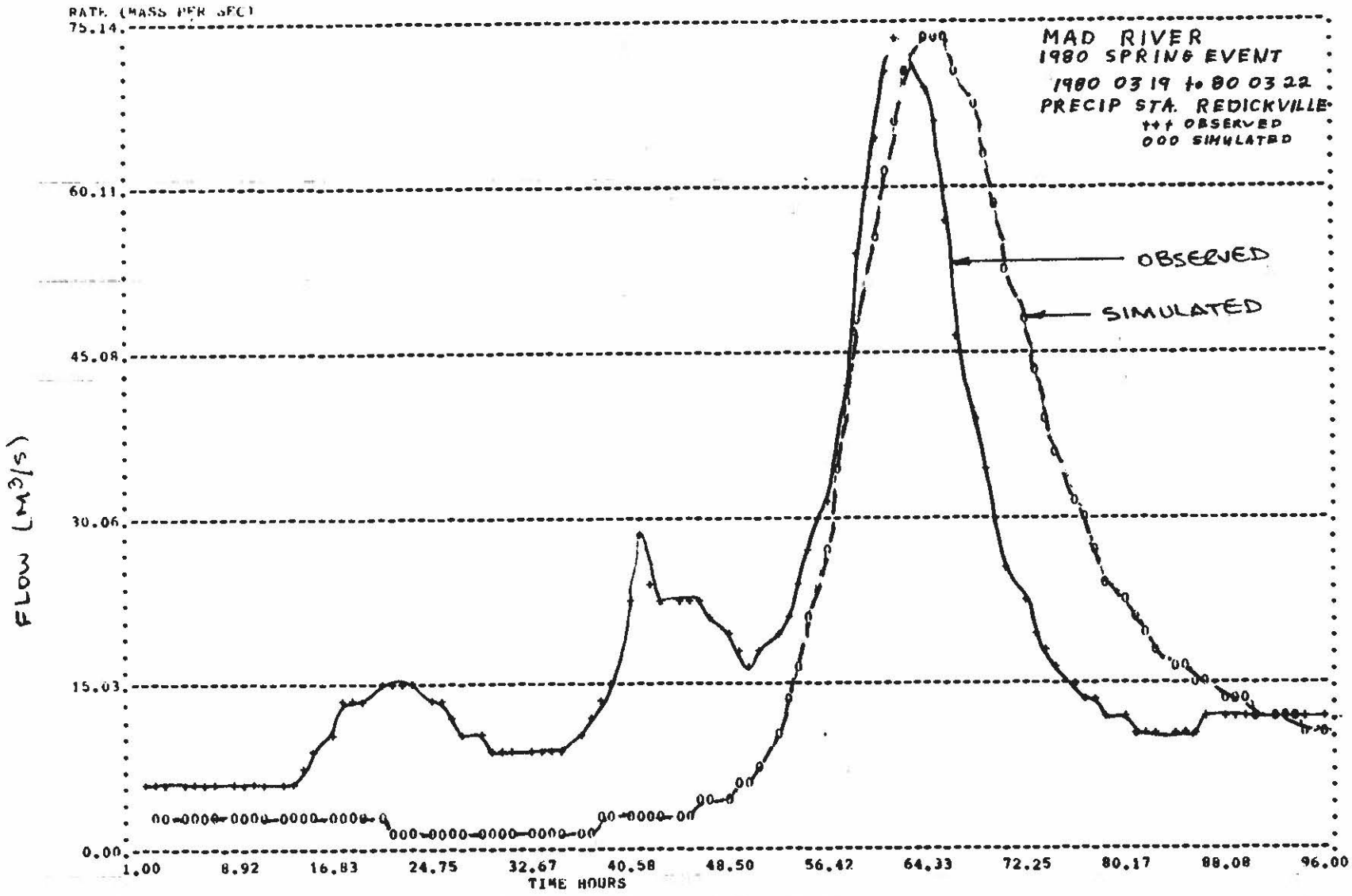
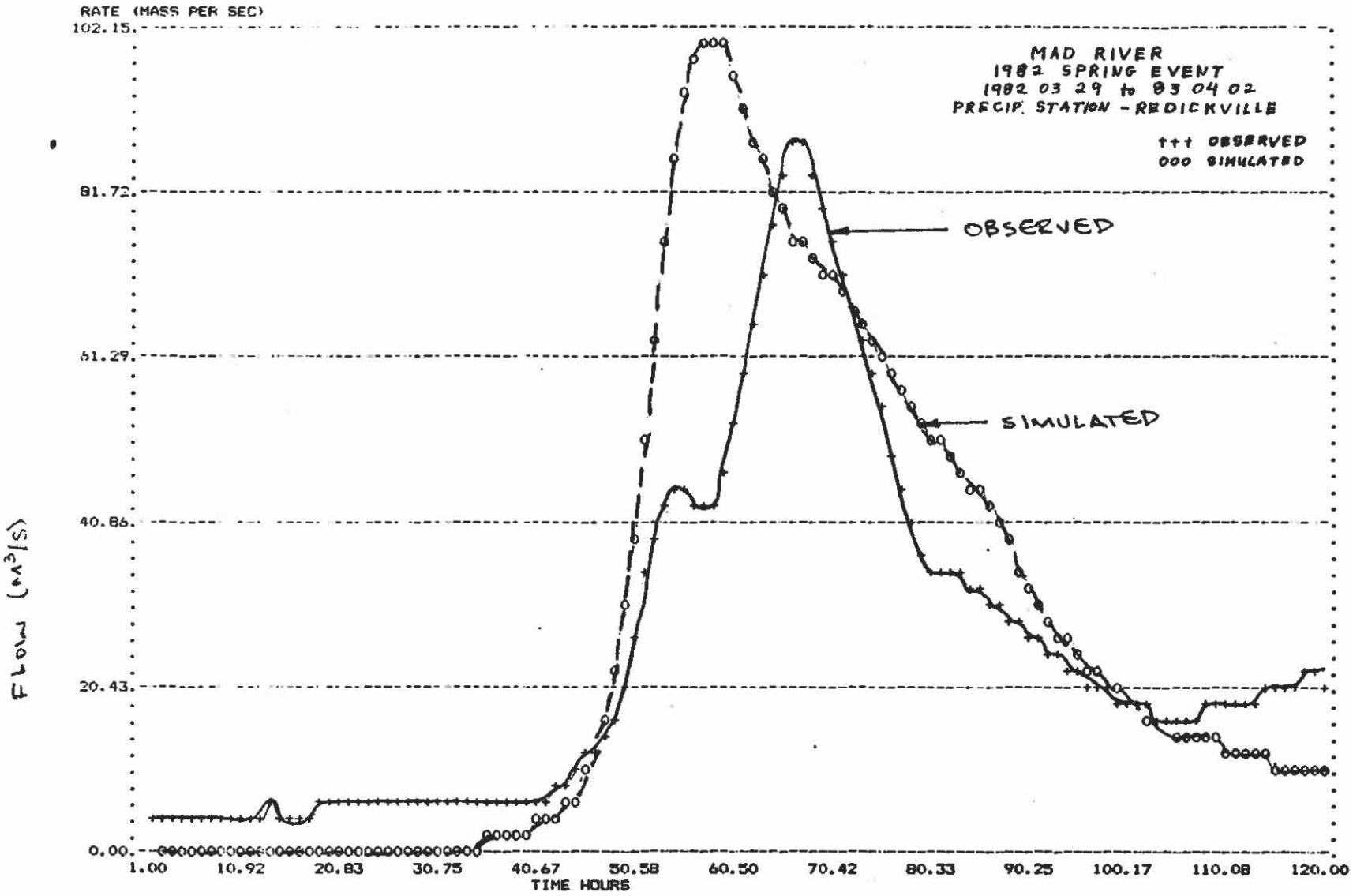

RATE (MASS PER SEC)
75.14
60.11
45.08
30.06
15.03
0.00
FLOW (M3/S)
MAD RIVER
1980 SPRING EVENT
1980 03 19 to 80 03 22
PRECIP STA. REDICKVILLE
+++ OBSERVED
000 SIMULATED
OBSERVED
SIMULATED
1.00
8.92
16.83
24.75
32.67
40.58
48.50
56.42
64.33
72.25
80.17
88.08
96.00
TIME HOURS
PLOT SERIES FOR
ID I= 2
NAME 1= 701
ID II= 3
NAME 2= 700

Fig. 3.6 (a)



PLOT SERIES FOR ID I= 2 ID II= 3
NAME 1= 701 NAME 2= 700

Fig 3.6 (b)

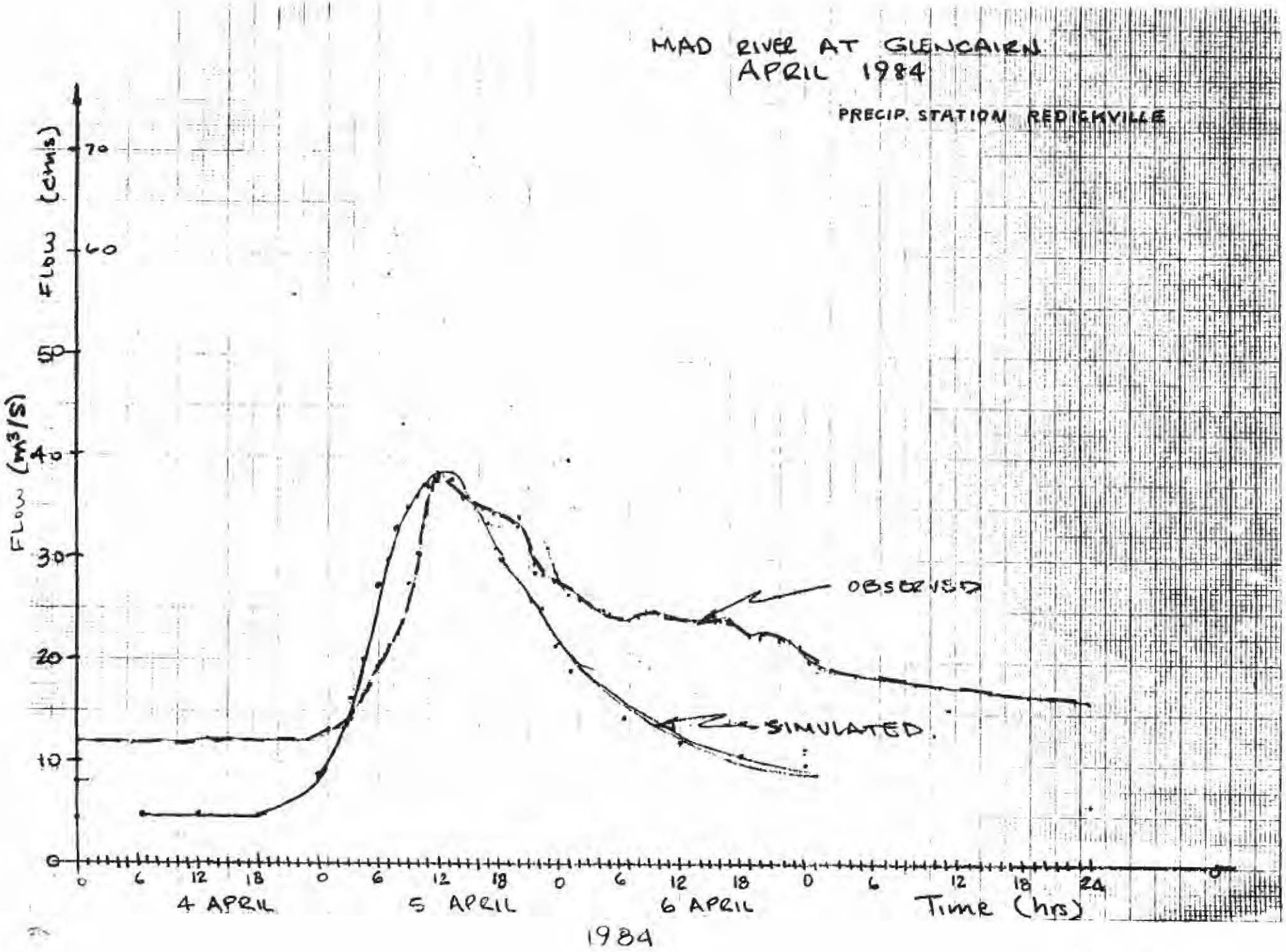

MAD RIVER AT GLENCAIRN
APRIL 1984
PRECIP. STATION REDICKVILLE
FLOW (cms)
FLOW (m³/s)
70
60
50
40
30
20
10
0
OBSERVED
SIMULATED
0 6 12 18 0 6 12 18 0 6 12 18 0 6 12 18 24
4 APRIL
5 APRIL
6 APRIL
Time (hrs)
1984

Fig 3.6 (c)

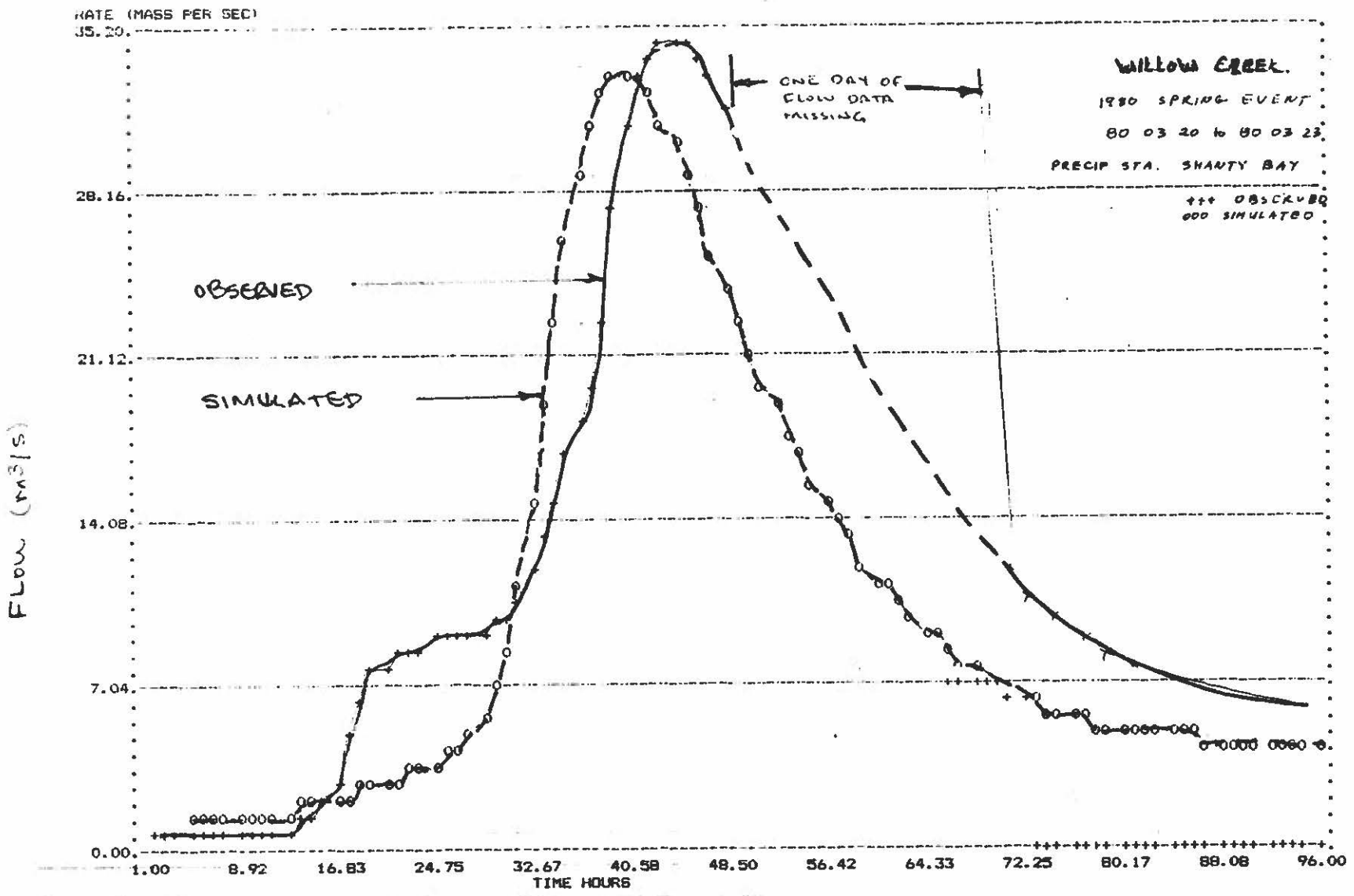

RATE (MASS PER SEC)
35.20.
28.16.
21.12.
14.08.
7.04.
0.00.
FLOW (m3/s)
ONE DAY OF FLOW DATA MISSING
WILLOW CREEK.
1980 SPRING EVENT
80 03 20 to 80 03 23
PRECIP STA. SHANTY BAY
+++ OBSERVED
000 SIMULATED
OBSERVED
SIMULATED
1.00
8.92
16.83
24.75
32.67
40.58
48.50
56.42
64.33
72.25
80.17
88.08
96.00
TIME HOURS
PLOT SERIES FOR
ID I= 2
NAME 1= 701
ID II= 3
NAME 2= 700

Fig 3.6 (d)

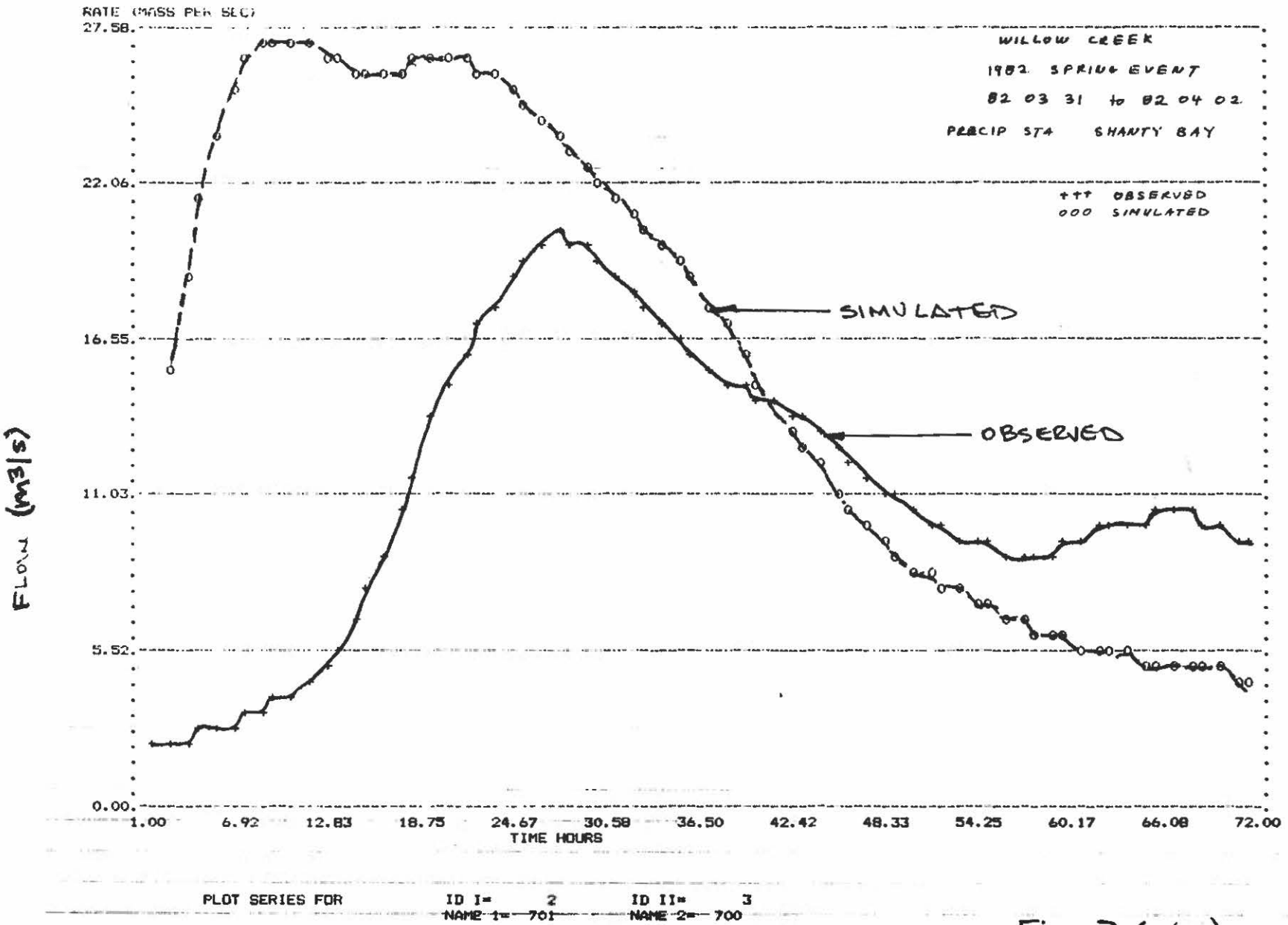

RATE (MASS PER SEC)
27.58
22.06
16.55
11.03
5.52
0.00
FLOW (m3/s)
WILLOW CREEK
1982 SPRING EVENT
82 03 31 to 82 04 02
PRECIP STA SHANTY BAY
+++ OBSERVED
000 SIMULATED
SIMULATED
OBSERVED
1.00
6.92
12.83
18.75
24.67
30.58
36.50
42.42
48.33
54.25
60.17
66.08
72.00
TIME HOURS
PLOT SERIES FOR
ID I= 2
NAME 1= 701
ID II= 3
NAME 2= 700

Fig 3.6 (a)

BOYNE RIVER AT EARL ROWE PARK

APRIL 1984 EVENT

PRECIP STA SHELBURNE

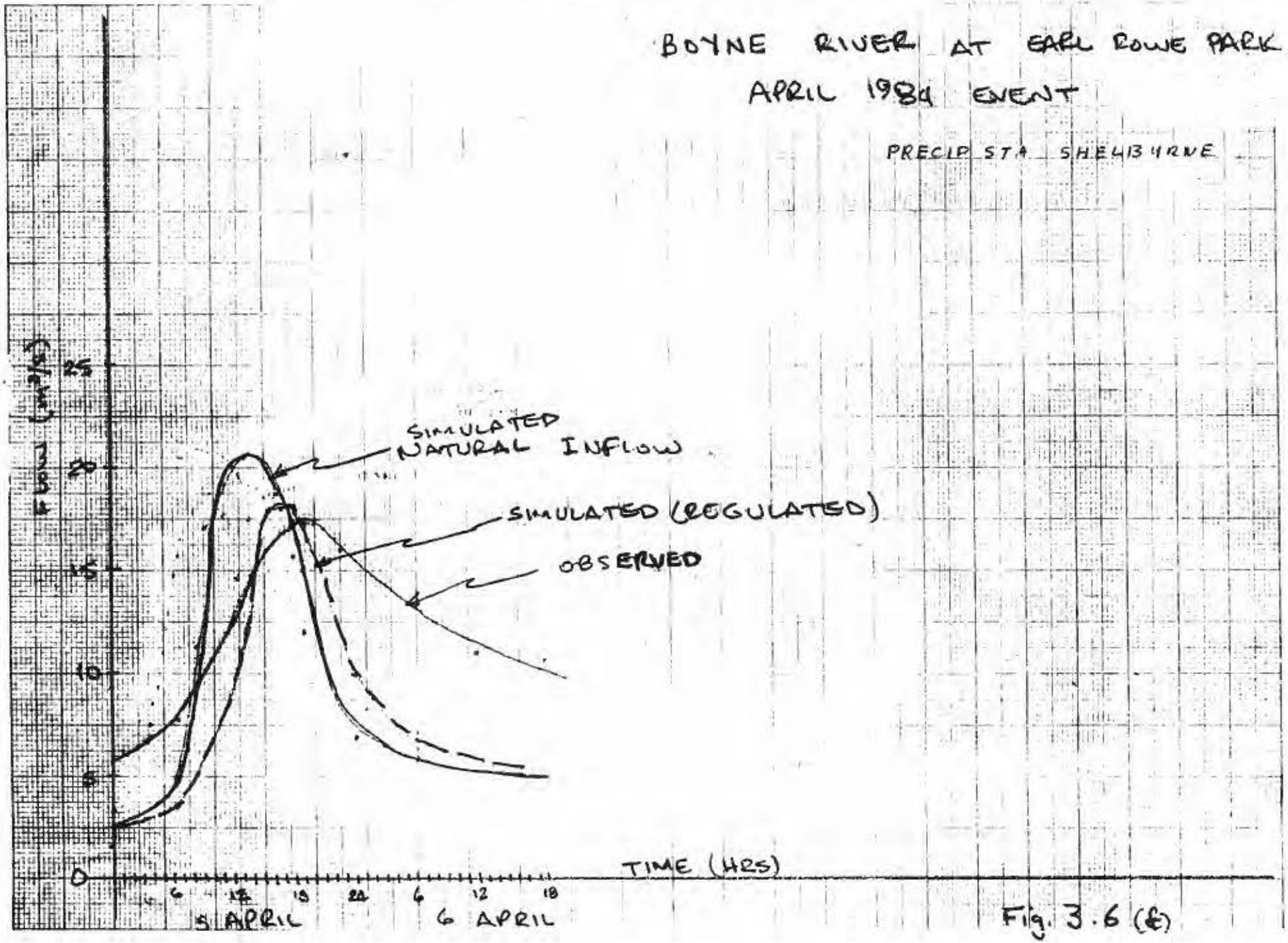


Fig. 3.6 (e)

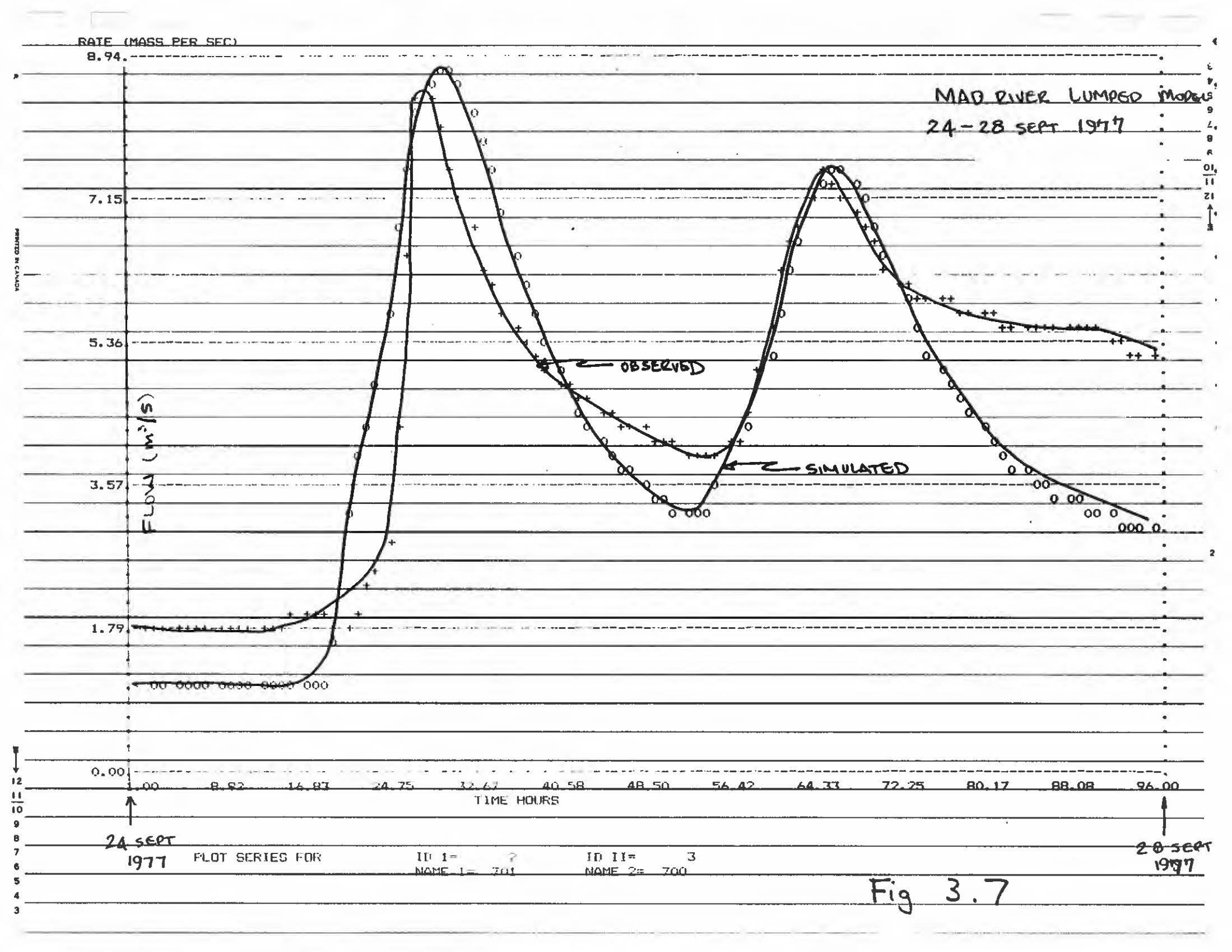

RATE (MASS PER SEC)
8.94
7.15
5.36
3.57
1.79
0.00
FLOW (m³/s)
MAD RIVER LUMPED MODEL
24 - 28 SEPT 1977
OBSERVED
SIMULATED
1.00
8.83
16.67
24.75
32.67
40.58
48.50
56.42
64.33
72.25
80.17
88.08
96.00
TIME HOURS
24 SEPT 1977
28 SEPT 1977
PLOT SERIES FOR
ID I= 2
NAME 1= 701
ID II= 3
NAME 2= 700

Fig 3.7

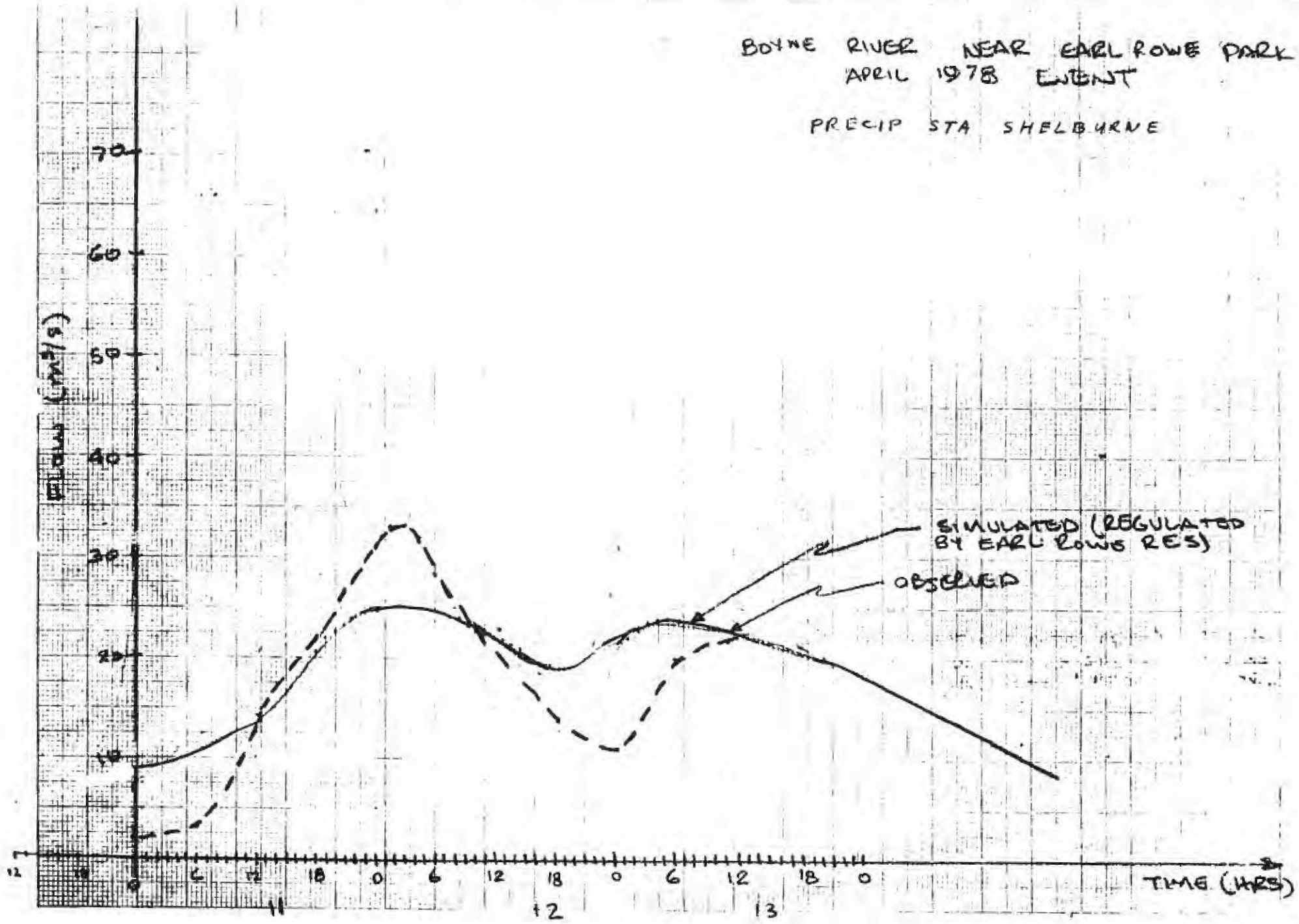

BOYNE RIVER NEAR EARL ROWE PARK
APRIL 1978 EVENT
PRECIP STA SHELBURNE
FLOW (m³/s)
70
60
50
40
30
20
10
SIMULATED (REGULATED BY EARL ROWE RES)
OBSERVED
TIME (HRS)
11
12
13

Fig 3.8 (a)

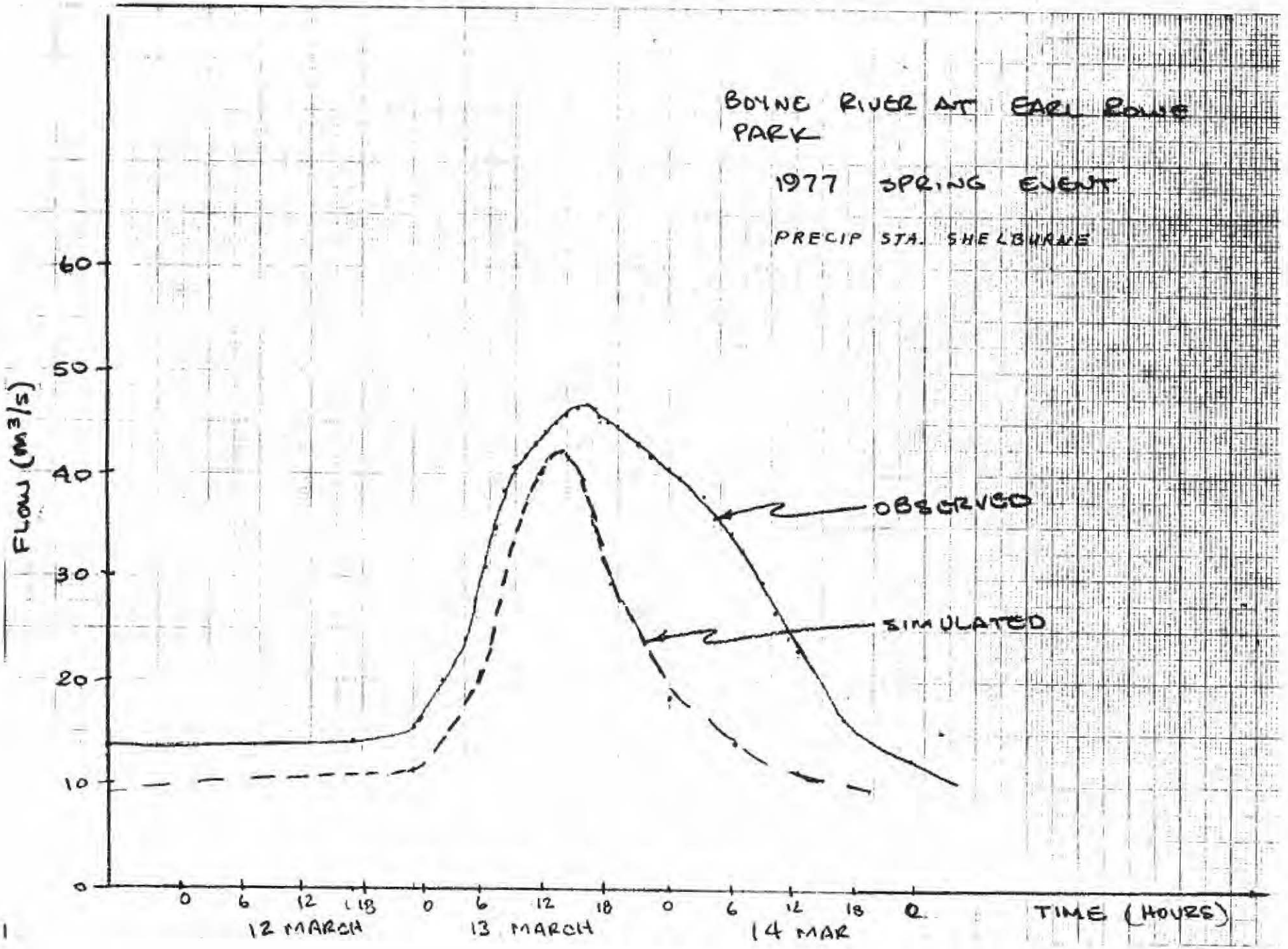

BOYNE RIVER AT EARL ROWE PARK
1977 SPRING EVENT
PRECIP STA. SHELBURNE
FLOW (m³/s)
0
10
20
30
40
50
60
OBSERVED
SIMULATED
0 6 12 18 0 6 12 18 0 6 12 18 0
12 MARCH
13 MARCH
14 MAR
TIME (HOURS)

Fig 3.8 (b)

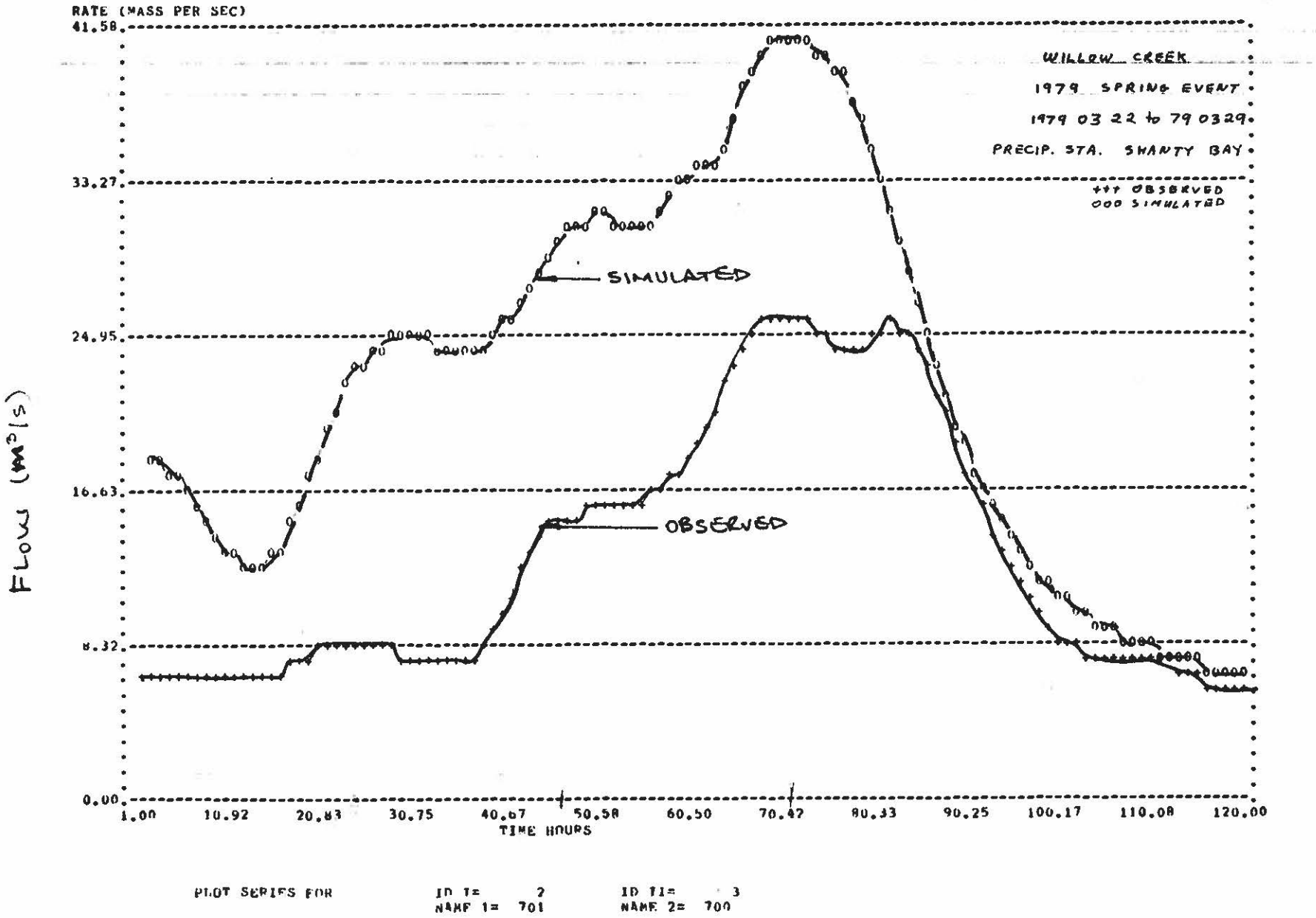

RATE (MASS PER SEC)
41.58
33.27
24.95
16.63
8.32
0.00
FLOW (M³/S)
WILLOW CREEK
1979 SPRING EVENT
1979 03 22 to 79 0329
PRECIP. STA. SHANTY BAY
+++ OBSERVED
000 SIMULATED
SIMULATED
OBSERVED
1.00
10.92
20.83
30.75
40.67
50.58
60.50
70.42
80.33
90.25
100.17
110.08
120.00
TIME HOURS
PLOT SERIES FOR
ID I= 2
NAME 1= 701
ID I1= 3
NAME 2= 700

Fig. 3.8 (c)

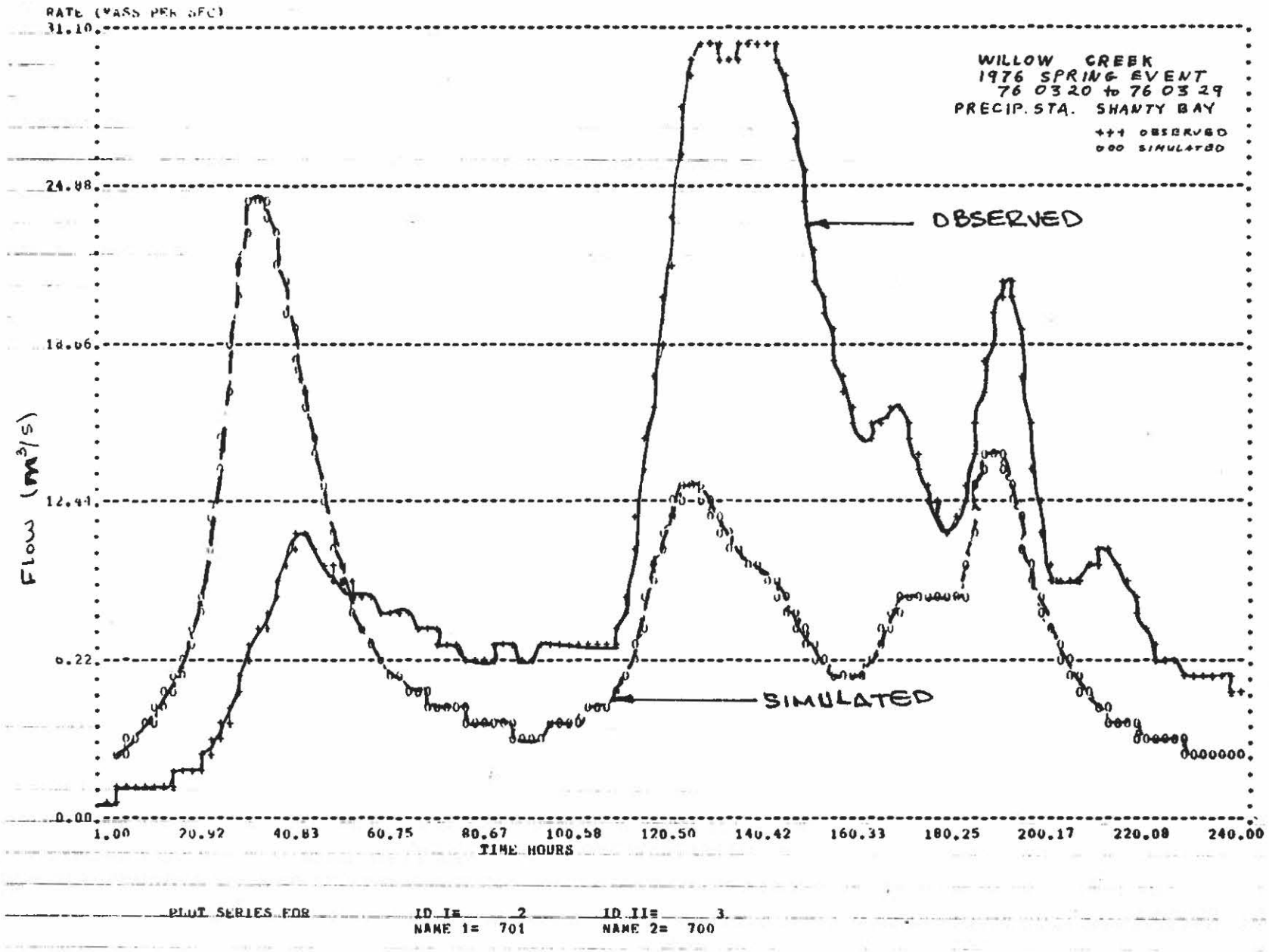

RATE (MASS PER SEC)
31.10
24.88
18.66
12.44
6.22
0.00
Flow (m^3/s)
WILLOW CREEK
1976 SPRING EVENT
76 0320 to 76 0329
PRECIP. STA. SHANTY BAY
+++ OBSERVED
ooo SIMULATED
OBSERVED
SIMULATED
1.00
20.92
40.83
60.75
80.67
100.58
120.50
140.42
160.33
180.25
200.17
220.08
240.00
TIME HOURS
PLOT SERIES FOR
ID I= 2
NAME 1= 701
ID II= 3
NAME 2= 700

Fig. 3.8(d)

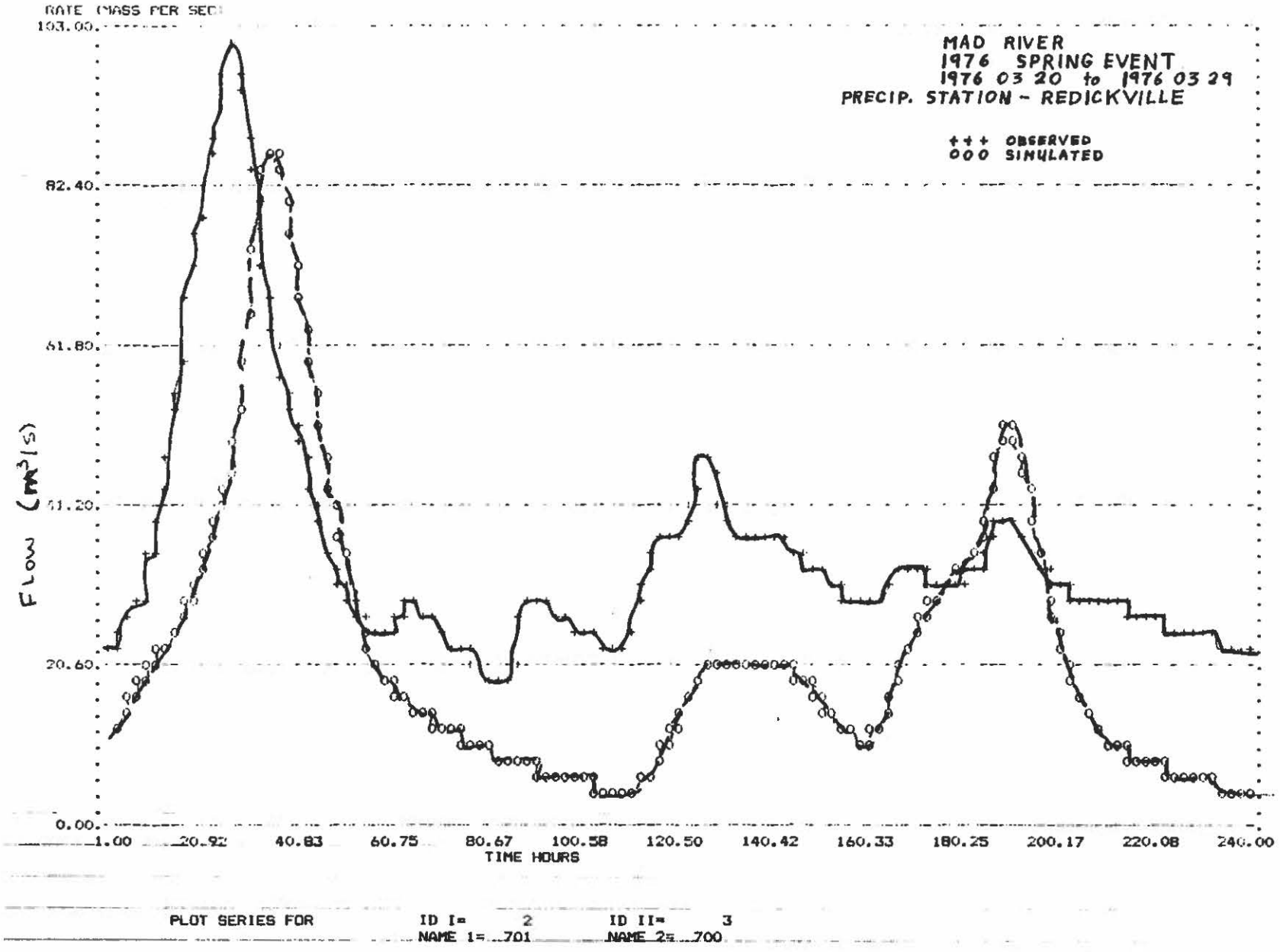

RATE (MASS PER SEC
103.00
82.40
61.80
41.20
20.60
0.00
Flow (m³/s)
MAD RIVER
1976 SPRING EVENT
1976 03 20 to 1976 03 29
PRECIP. STATION - REDICKVILLE
+++ OBSERVED
000 SIMULATED
1.00
20.92
40.83
60.75
80.67
100.58
120.50
140.42
160.33
180.25
200.17
220.08
240.00
TIME HOURS
PLOT SERIES FOR
ID I= 2
NAME 1= 701
ID II= 3
NAME 2= 700

Fig. 3.8(e)

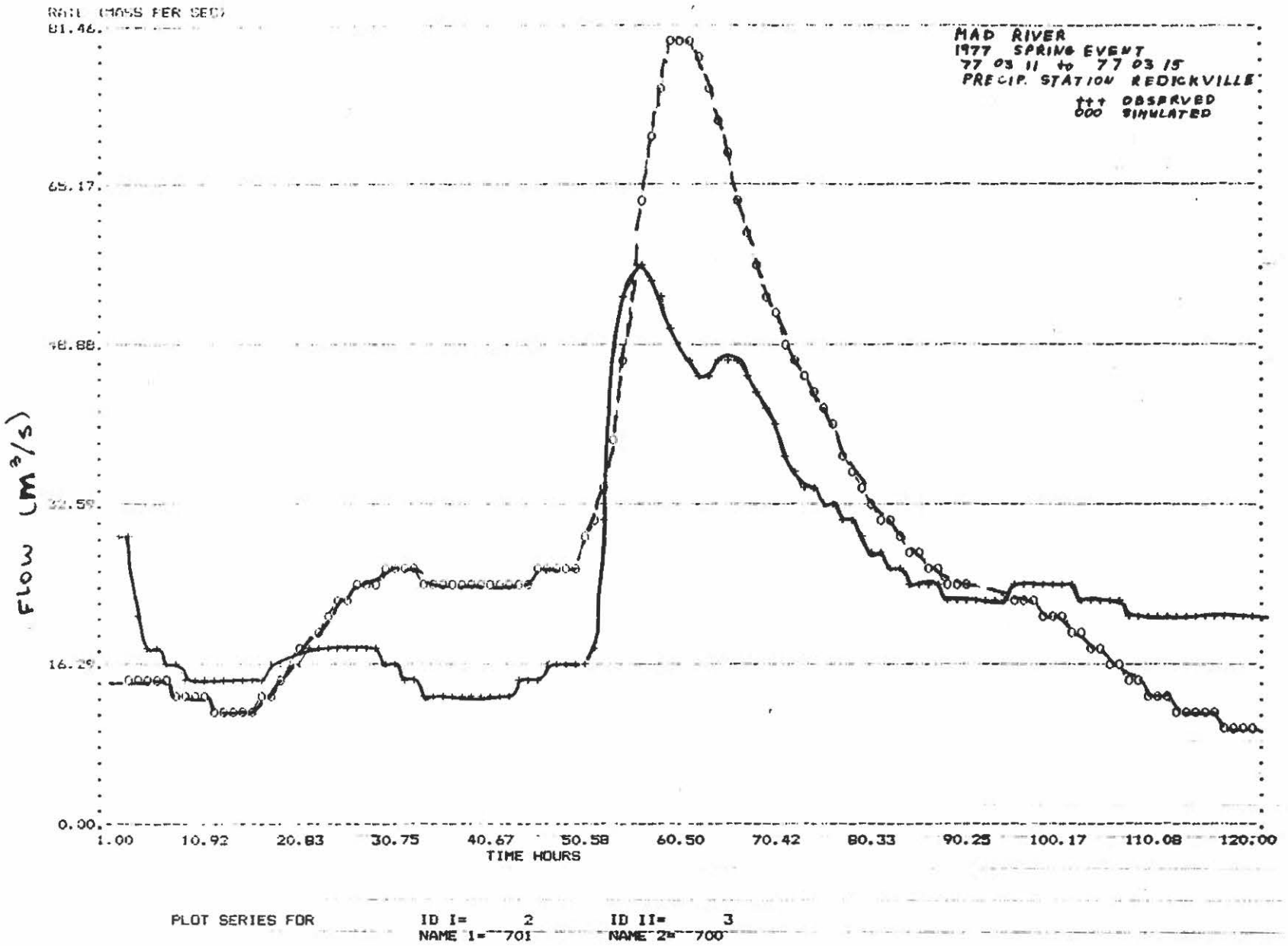

RATE (MASS PER SEC)
81.46.
65.17.
48.88.
32.59.
16.29.
0.00.
FLOW (M³/S)
MAD RIVER
1977 SPRING EVENT
77 03 11 to 77 03 15
PRECIP. STATION REDICKVILLE
+++ OBSERVED
000 SIMULATED
1.00
10.92
20.83
30.75
40.67
50.58
60.50
70.42
80.33
90.25
100.17
110.08
120.00
TIME HOURS
PLOT SERIES FOR
ID I= 2
ID II= 3
NAME 1= 701
NAME 2= 700

Fig. 3.8(f)

Since discussions with Water Survey of Canada indicated that the Willow Creek gauge above Little Lake is subject to backwater affects from the lake, this event was dismissed as an anomaly.

3.2.5.3 Discretized Model

The calibration/validation for the summer and spring events discussed in the previous sections was undertaken using lumped models. In order to confirm the above results, the discretized models for the Mad River, Boyne River, Pine River, Willow Creek and Nottawasaga River catchments were run for specific events.

Hydrologic model schematic for the Nottawasaga River and its tributaries and the Nottawasaga Bay watercourses are presented in Appendix K.

The results using the discretized models for some of the summer events are shown in Figure 3.9(a) to 3.9(c). For the spring and summer events, the comparison in peak flows is summarized in Table 3.10.

Since the lumped and discretized model produce similar results, this comparison provided a firm basis during the subsequent evaluation of frequency based design flows to use the lumped models for the simulation of the 22 years of historical flows and the discretized model to distribute the flow to tributary sub-catchments.

A further analysis of the sensitivity of flows with the time step used in the Variable Storage Coefficient routing was carried out (Table 3.10a) for the discretized model. Little variation in peak flow was noted for a shorter routing interval (15 minutes) than used in the model calibration and validation (one hour); therefore, the one hour time step was considered acceptable for application of the discretized model.

3.2.5.4 Historical Flood Peaks

As further validation of the QUALHYMO models, the annual peak flows were simulated for the 1963 to 1984 period and compared with observed discharges in a scatter diagram indicating individual events and by frequency analyses.

TABLE 3.10

Comparison of Results Using Lumped and Discretized QUALHYMO Models

Catchment	Date	Observed Peak Flow (m^3/s)	Simulated Peak Flow: Lumped Model (m^3/s)	Simulated Peak Flow: Discretized Model (m^3/s)
Mad River near Glencairn	21 March 1980	74.4	75.0	78.2
Boyne River at Earl Rowe Park	13 March 1977	46.4	42.0	51.0
Willow Creek above Little Lake	21 March 1980	35.3	33.5	38.6
Beeton Creek near Tottenham	29 July 1980	3.9	4.4	5.0
Pine River near Everett	29 July 1980	21.7	15.7	19.2 (1)
Nottawasaga River near Baxter	29 July 1980	66.7	66.3	96.6

(1) Observed baseflow of 5.0 m^3/s was added to simulated peak flow of 14.2 m^3/s

TABLE 3.10a

SENSITIVITY TESTING OF ROUTING EFFECT USING 0.25 HOURS AND 1.0 HOUR TIME STEP FOR TIMMINS STORM

(All flows in m^3/s)

		0.25 HOUR TIME STEP		1.0 HOUR TIME STEP	
REACH NO.	FLOW POINT	PEAK FLOW	ROUTED PEAK FLOW	PEAK FLOW	ROUTED PEAK FLOW
	1070	1657.5	-	1648.0	-
44	1072	1682.8	1646.2	1674.3	1639.9
45	1074	1743.8	1682.5	1733.2	1672.7
46	1078	1844.6	1741.4	1827.2	1727.6
48	480	1867.9	1832.1	1851.5	1819.1
49			1844.9		1833.2

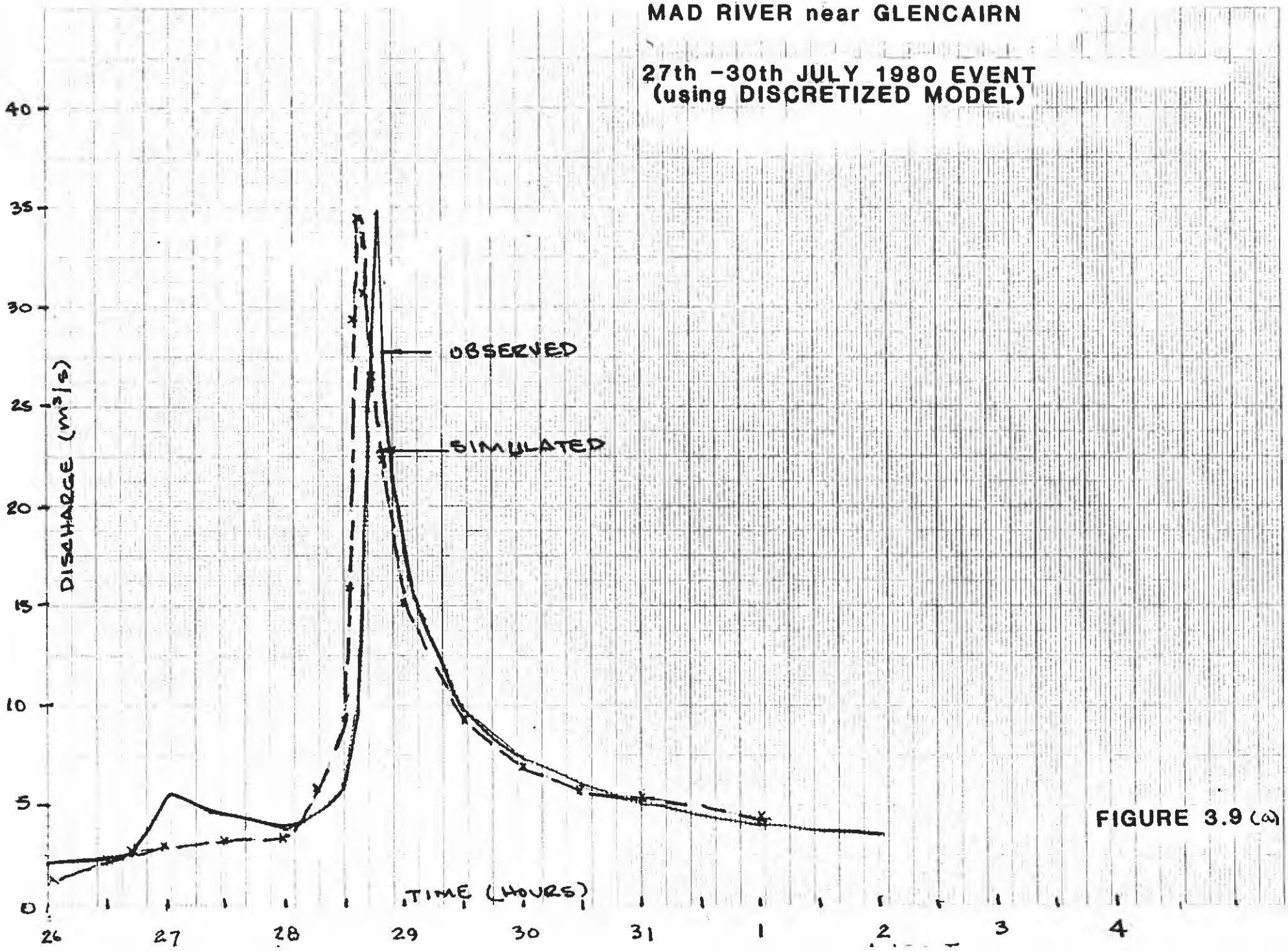

MAD RIVER near GLENCAIRN
27th -30th JULY 1980 EVENT
(using DISCRETIZED MODEL)
OBSERVED
SIMULATED
DISCHARGE (m³/s)
TIME (HOURS)
0
5
10
15
20
25
30
35
40
26
27
28
29
30
31
1
2
3
4

FIGURE 3.9 (a)