DEVON AREA INTERNAL REPORT

INVESTIGATION INTO THE STORM OVERFLOW DISCHARGE REGIME OF HILL BARTON S.T.W. - OKEHAMPTON.

MARCH 1996

DEV/E/10/96

Author: T CRONIN
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Area Manager (Devon)

NRA

National Rivers Authority
South Western Region

KGO

INVESTIGATION INTO THE STORM OVERFLOW DISCHARGE REGIME OF HILL BARTON S.T.W. - OKEHAMPTON.

1. INTRODUCTION.

Hill Barton S.T.W. services Okehampton and the surrounding environs, it discharges treated final effluent into the River Okement at N.G.R. SX 6005 9824 (Figure 1).

In September 1993 the National Rivers Authority imposed an embargo on the works, due to the environmental effect on the river Okement, caused by the final effluent.
The introduction of the embargo attempts to ensure that the problems are not exacerbated, by any increase in the flow of final effluent, or the discharging of crude sewage via the storm overflow.

2. TERMS OF REFERENCE.

2.1. OBJECTIVES.

A major problem arises when planning applications are rejected because of embargoed sewage works. If the applicant were to appeal against such a rejection, the N.R.A. would need to provide demonstrable evidence that the water environment would be under threat by any such action.

An original request was made by the Water Quality section for an investigation into the storm overflow discharge regime in an attempt to add weight to the argument that the works is overloaded.
During the course of the survey, an additional request was made to assess any environmental impact of the storm overflow on the water quality of the river Okement.

2.2. PROJECT TEAM.

T.Cronin (Project Leader)
M.Humphreys. (Project Technician)

3. METHODS.

3.1. STORM DISCHARGE FLOW MEASUREMENT.

A Prolec 'Water Rat' flow monitor was initially installed in the outlet pipe of the storm tanks (Figure 2) in an attempt to measure all storm discharges made during three times dry weather flow conditions.

After collecting data for a short period of time it was discovered that due to an underground bend in the pipe, the discharging effluent was swirling around the walls of the pipe, making it impossible to make any measurement of flow.

The water rat was then re positioned at the entrance to the storm discharge pipe, so that all subsequent flow data would relate to both the three times, and the six times dry weather flow.

Unfortunately this means that it is impossible to differentiate between the discharges.

3.2. RAINFALL MEASUREMENT.

A Didcot portable meteorological station was erected on site (Figure 3) to collect rainfall data. It was assumed that there would be a correlation between rainfall and flow through the storm overflow.

Data from two local rainfall stations were also requested from the Devon Area Hydrological section (Appendix 1). The results from these and a graph showing the comparison with the portable station are shown in Appendix 2.

3.3. WATER QUALITY MEASUREMENT.

A DMP mk IV water logger measuring dissolved oxygen, pH, turbidity, ammonia, temperature, and conductivity was installed approximately 10 metres downstream of the final effluent discharge (Appendix 3). This was then connected to a meteorburst telemetry system (Appendix 3), to allow real time results to be displayed on a computer terminal, situated in the communications room at Manley House.

4. DISCUSSION.

In 1990, both upstream (Knowle bridge) and downstream (South Dornaford) sampling sites were of RE class 1 (Appendix 4). By 1992 the downstream sampling site had fallen to a class 2, it was in 1993 that the embargo was placed upon the works.

In September 1995 Lee Knight (Devon Area Biologist) was requested to undertake a biological impact assessment of Hill Barton. This report is shown in Appendix 5.

The flow from the storm discharge pipe for the period of the investigation is shown graphed against the total daily rainfall (Appendix 6), with a month by month break down (Appendix 6a-6g).

Trends between flow and rain can be seen in certain instances i.e. March 1st - March 7th (Appendix 6c).
However, as is typical with this type of works it is extremely difficult to find accurate correlations between flows and rainfall due to the unknown factors, such as retention in the storm tanks, and quantities and timings of any recharge back into the treatment process.

Cause and effect are highlighted in the monthly graphs, such as February 1995 (Appendix 6b) where it is apparent that any consistent rainfall will cause the storm to discharge.

During the survey an additional request was made by the Water Quality section to assess the impact on the water quality from the storm discharge. It has been assumed that localised rainfall will cause the flow in the River Okement to increase, however, by the time the storm water is discharged, having reached the works and been retained within the tanks, the river levels have dropped back to its normal level, and so the impact on water quality is increased due to the storm water being discharged into normal or low flow conditions.

Due to proximity of the storm discharge and the final effluent it was impossible to monitor each effect separately. Also the topography of the area (steep sided gorge, and solid bed rock) makes it very difficult to place a monitor in an acceptable location. The DMP mk IV water quality monitor was installed on a suspended rope structure, so that the probe was in the centre of the river approximately 10 meters downstream of the final effluent discharge. A meteor burst telemetry system was installed to display and collect data at the communications room at Manley House (Appendix 3).
This allowed for data collection within the mixing zone, but all measurements would be of the combined effect of both storm and final discharges.

It was quickly found that due to the harsh environment of the sampling position, the probe was being coated and fouled with leaves and a mixture of sewage fungus and silt within about two days of deployment (Appendix 7). This caused the readings to go off scale and subsequently invalidated the data (Appendix 8).

During the period of the investigation general observations were made of sewage fungus and some sewage litter on the rocks just downstream of the final effluent (Appendix 9).

5. CONCLUSIONS.

Due to very dynamic regime of the works, it is extremely difficult to produce conclusive proof that the works is either overloaded (or under designed).

It is difficult to measure the retention and recharge from the storm tanks, and due to topography, difficult to gather meaningful water quality data.

The storm tanks appear to discharge for a large percentage of the time when there are periods of rainfall.

The problems experienced with the water quality probe becoming fouled would indicate poor quality in itself.

FIGURE 1

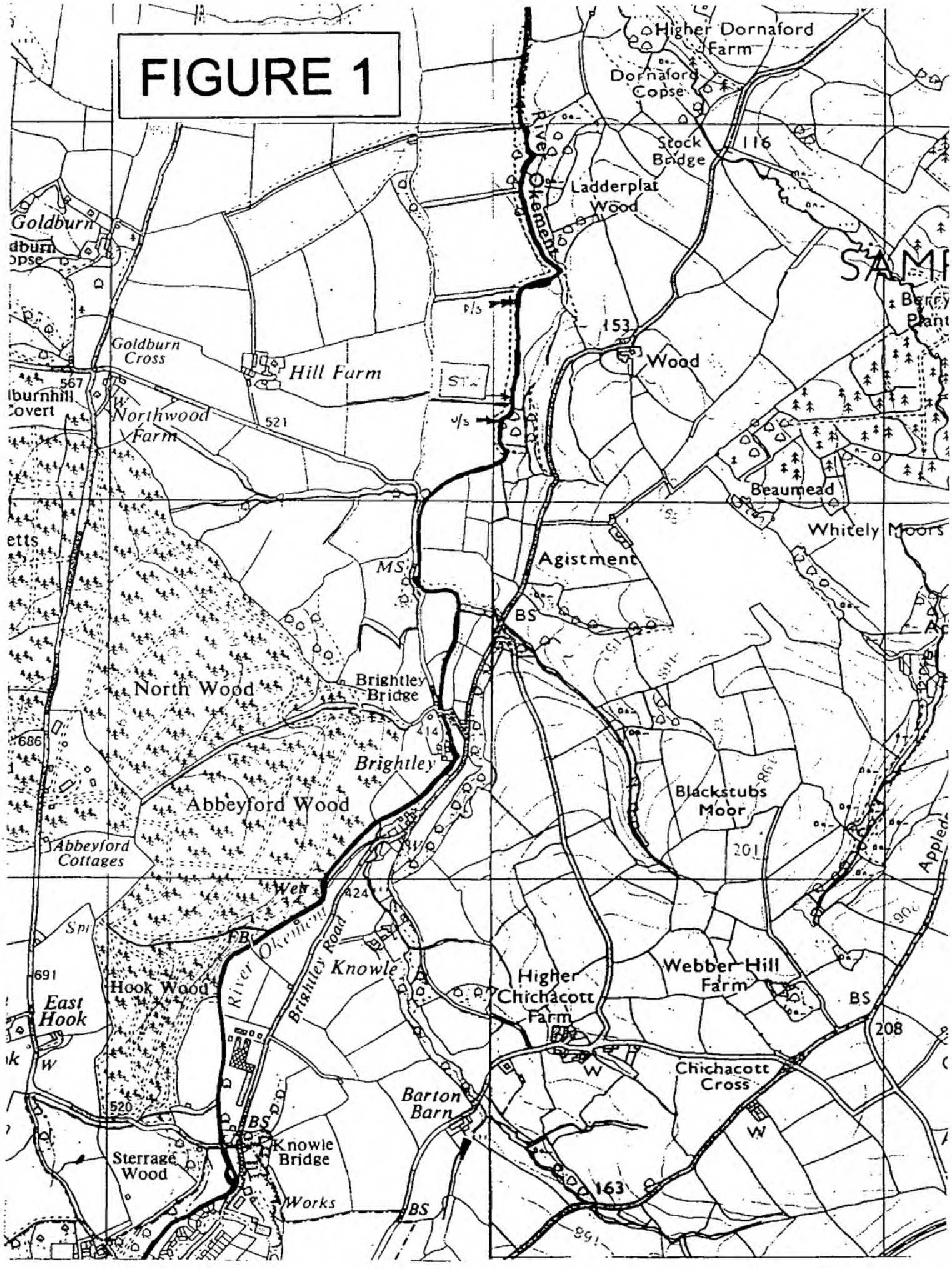


FIGURE 2

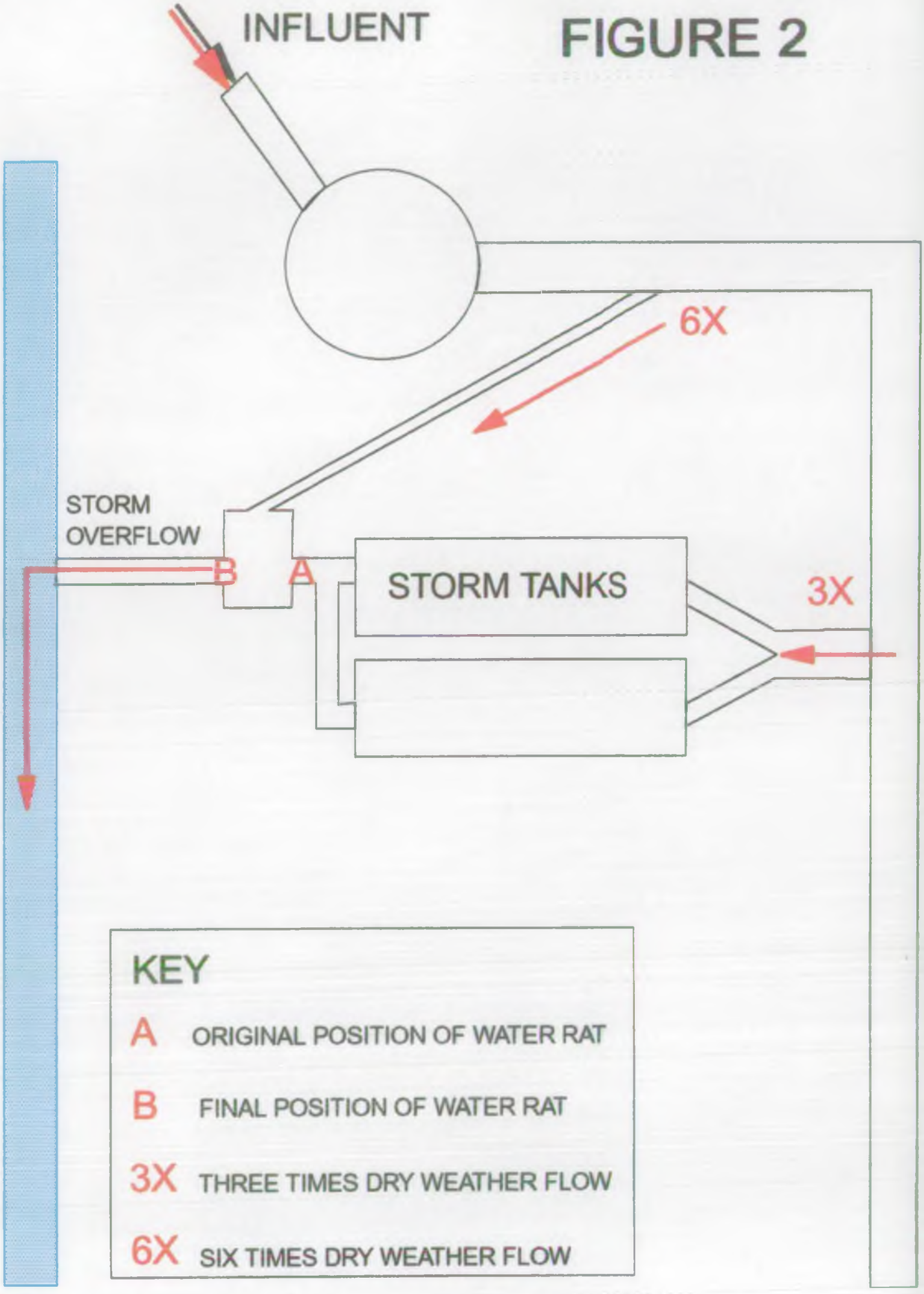
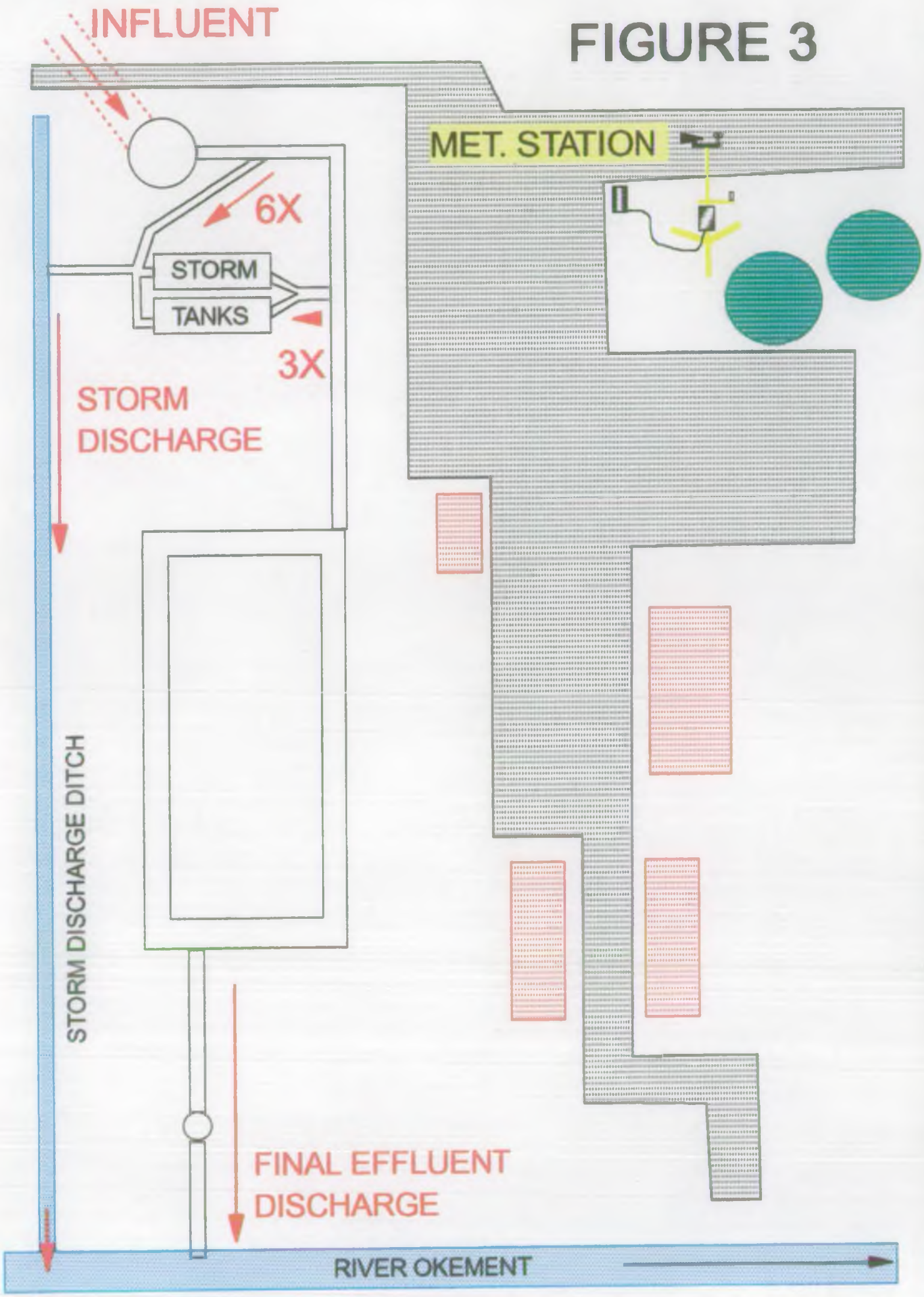

INFLUENT
6X
STORM
OVERFLOW
B
A
STORM TANKS
3X
KEY
A ORIGINAL POSITION OF WATER RAT
B FINAL POSITION OF WATER RAT
3X THREE TIMES DRY WEATHER FLOW
6X SIX TIMES DRY WEATHER FLOW

FIGURE 3


INFLUENT
MET. STATION
6X
STORM
TANKS
3X
STORM
DISCHARGE
STORM DISCHARGE DITCH
FINAL EFFLUENT
DISCHARGE
RIVER OKEMENT

Output from RAINARK data logging
STATION RAINFALL REPORT

APPENDIX 1

·96 Hydro-Logic Lt
'1996 at 12:52 hrs

National Rivers Authority - South West Region

GAUGE REFERENCE : **388957**
M.O. REFERENCE : **388957**
GAUGE TYPE : **Storage**
RAIN DAY START : **09:00 GMT**

Annual Summary : **1995**

STATION NAME : **OKEHAMPTON,E.OKEMEI**
LOCATION : **EAST OKEMENT FARM**
GRID REF : **SX 6050 9130**
ALTITUDE : **400.0 m**

Record Type : **Archive file**
Quality Level: **Mixed Quality**

Daily Rainfall totals recorded in mm

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1	1.9	2.5	6.5	-	-	T	-	T	1.1	1.3 Q	-	0.2 Q	1
2	-	4.3	10.6	T	-	11.7	-	-	T	1.4 Q	-	1.3 Q	2
3	16.1	1.4	5.4	T	-	7.6	T	-	2.5	11.5 Q	-	1.4 Q	3
4	4.8	T	4.5	-	-	-	-	T	2.1	1.8 Q	-	-	4
5	8.1	0.7	7.4	3.4	-	-	-	0.8	1.0	13.6 Q	-	T Q	5
6	0.1	T	10.5	T	-	0.9	0.1	-	25.3	26.9 Q	-	T Q	6
7	2.0	13.5	7.8	T	-	1.2	-	-	10.5	7.8 Q	0.6 Q	6.0 Q	7
8	4.5	3.2	2.7	T	-	0.8	-	-	0.7	-	0.4 Q	0.2 Q	8
9	0.1	17.4	0.8	T	-	0.6	7.3	-	7.1	-	7.1 Q	T Q	9
10	8.5	5.5	3.1	-	2.5	0.4	0.2	-	11.3	-	18.5 Q	T Q	10
11	-	16.2	0.9	-	11.4	0.1	0.4	T	7.4	-	17.3 Q	T Q	11
12	-	8.4	-	-	4.2	-	T	-	10.3	-	-	0.4 Q	12
13	T	7.4	-	-	0.3	-	10.8	-	2.6	-	0.2 Q	0.2 Q	13
14	3.2	13.6	5.6	T	-	-	10.0	-	6.8	-	9.3 Q	T Q	14
15	0.1	9.3	3.6	-	2.2	-	1.2	-	3.9	0.1 Q	5.0 Q	0.4 Q	15
16	11.8	10.6	15.5	0.5	10.1	2.8	1.3	-	T	1.4 Q	2.0 Q	3.1 Q	16
17	23.2	8.0	4.7	30.1	0.1	5.2	T	-	2.2	1.9 Q	-	0.4 Q	17
18	6.9	17.5	4.8	0.9	T	1.5	T	-	0.6	-	-	8.7 Q	18
19	28.2	1.3	2.0	T	-	0.2	-	-	-	0.5 Q	-	16.2 Q	19
20	8.0	9.4	-	-	-	0.4	0.4	-	-	-	14.9 Q	17.8 Q	20
21	21.4 e	0.9	-	1.2	-	T	T	-	-	-	3.0 Q	29.0 Q	21
22	22.6 e	19.6	-	19.4	-	-	-	7.0 e	0.9	0.3 Q	0.4 Q	14.6 Q	22
23	4.5	12.1	-	0.3	-	-	-	2.3 e	12.6	-	6.9 Q	8.6 Q	23
24	29.5	12.6	0.3	17.6	2.9	-	-	3.4 e	0.5	37.9 Q	6.5 Q	-	24
25	15.8	4.1	-	T	1.7	-	24.3	1.3 e	3.7	0.1 Q	0.6 Q	-	25
26	3.6	7.7	5.0 e	-	13.0	-	0.5	1.0 e	28.1	18.3 Q	20.4 Q	-	26
27	26.1	2.1	8.1	-	13.2	-	0.2	-	1.4	0.1 Q	8.8 Q	-	27
28	24.0	12.4	10.1	3.2	1.8	-	-	-	0.7	0.6 Q	16.3 Q	-	28
29	14.0		-	0.9	4.5	-	32.7	-	0.1	-	0.7 Q	6.1 Q	29
30	2.9		0.8	-	0.9	-	3.2 e	-	3.6	-	9.0 Q	7.2 Q	30
31	17.4		T		T		T	-		-		3.8 Q	31
Totals:	309.3 e	221.7	120.7 e	77.5	68.8	33.4	92.6 e	15.8 e	147.0	125.5 Q	147.9 Q	125.6 Q	
Mx.Day:	29.5	19.6	15.5	30.1	13.2	11.7	32.7	7.0 e	28.1	37.9 Q	20.4 Q	29.0 Q	

Annual Total : 1485.8 mm e

Quality Observer Data : E=Edited S=Snow ?=Suspect M=Incomplete T=Trace
Quality MO Quality Contro : e=Edited s=Snow ?=Suspect m=Incomplete t=Trace
Quality Code : Q = Original Record

Output from RAINARK data logging & processing system, (c)1989-96 Hydro-Logic Lt
STATION RAINFALL REPORT Printed on 29/02/1996 at 12:52 hrs

National Rivers Authority - South West Region

GAUGE REFERENCE : **389018**
M.O. REFERENCE : **389018**
GAUGE TYPE : **Storage**
RAIN DAY START : **09:00 GMT**

STATION NAME : **OKEHAMPTON P G**
LOCATION : **PLEASURE GARDENS**
GRID REF : **SX 591 946**
ALTITUDE : **162.0 m**

Annual Summary : **1995**

Record Type : **Archive file**
Quality Level: **Mixed Quality**

Daily Rainfall totals recorded in mm

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1	1.0 e	2.1	7.1	0.1 e	-	-	-	-	-	0.4 Q	-	0.9 Q	1
2	-	2.4	13.6	0.1 e	-	6.0	-	-	0.3	0.1 Q	-	0.6 Q	2
3	9.3	1.3 e	8.1 e	0.1	-	7.5	-	-	2.5	6.0 Q	-	0.8 Q	3
4	2.7	0.1 e	8.5 e	-	-	-	T	-	0.5	0.5 Q	-	0.1 Q	4
5	7.1	0.2 e	9.4 e	2.6	-	-	-	0.3	1.7	5.2 Q	-	T Q	5
6	-	T	5.3	0.2	-	-	-	-	13.2	22.6 Q	-	T Q	6
7	1.5 e	10.6	9.4	-	-	1.2	-	-	10.1	10.7 Q	0.4 Q	2.5 Q	7
8	2.2 e	1.7	1.1	-	-	-	-	-	0.6	-	0.5 Q	-	8
9	-	13.9	0.4	-	-	-	9.1	-	10.0	-	5.2 Q	T Q	9
10	4.3	5.9 e	2.0	-	0.6	-	0.2	-	11.8	-	15.1 Q	-	10
11	-	10.9 e	0.7 e	-	7.3	-	-	-	3.7	-	11.2 Q	-	11
12	-	5.7 e	-	-	1.0	-	-	0.1	2.1	-	0.1 Q	-	12
13	-	7.1	0.4 e	-	-	-	7.9	-	1.2	-	-	-	13
14	1.0 e	14.8	2.6	-	-	-	8.0	-	5.8	0.2 Q	6.5 Q	-	14
15	-	8.0	3.6	-	1.5	-	2.2	-	2.2	0.1 Q	3.6 Q	0.1 Q	15
16	12.5	10.0	12.2	-	10.3 e	2.3	8.7	-	T	0.9 Q	0.9 Q	2.4 Q	16
17	29.3	4.2 e	3.7 e	20.1	-	4.1	-	-	0.1	0.8 Q	-	0.3 Q	17
18	1.7	14.3 e	4.5 e	2.4	T	-	-	-	2.2	-	-	6.9 Q	18
19	31.5	0.5 e	1.4 e	T	-	-	-	-	-	0.4 Q	-	13.8 Q	19
20	6.7 e	8.0	0.1	T	-	T	0.2	-	-	0.1 Q	10.9 Q	12.3 Q	20
21	15.4 e	1.6	-	-	-	-	-	-	-	-	1.4 Q	22.1 Q	21
22	19.1 e	13.7	-	20.6	-	-	-	7.9	0.4	-	0.5 Q	A Q	22
23	4.5	7.6	-	T	-	-	-	4.4	11.1	0.3 Q	3.5 Q	A Q	23
24	26.0	12.8 e	-	14.0 e	2.8	-	-	1.0	0.3	43.8 Q	6.8 Q	A Q	24
25	14.4	1.4 e	-	-	0.6	-	17.4 e	0.2	2.1	0.1 Q	0.3 Q	A Q	25
26	2.0	5.6 e	3.2 e	-	7.2	-	0.7 e	0.3	23.8	11.4 Q	23.4 Q	A Q	26
27	28.1 e	0.8	2.1	-	10.0	-	0.1	-	1.2	0.3 Q	6.7 Q	A Q	27
28	22.4 e	9.4	10.7	2.4 e	0.3	-	-	-	0.1	-	10.0 Q	A Q	28
29	7.7 e		-	0.9 e	3.1	-	25.0	-	-	-	0.2 Q	A Q	29
30	1.6		T	-	0.2	-	1.9	-	2.2	-	5.6 Q	A Q	30
31	16.3		T		-		-	-		-		33.5 Q	31
Totals:	268.3 e	174.6 e	110.1 e	63.5 e	44.9 e	21.1	81.4 e	14.2	109.2	103.9 Q	112.8 Q	96.3 Q	
Mx.Day:	31.5 e	14.8	13.6	20.6 e	10.3 e	7.5	25.0 e	7.9	23.8	43.8 Q	23.4 Q	33.5 Q	

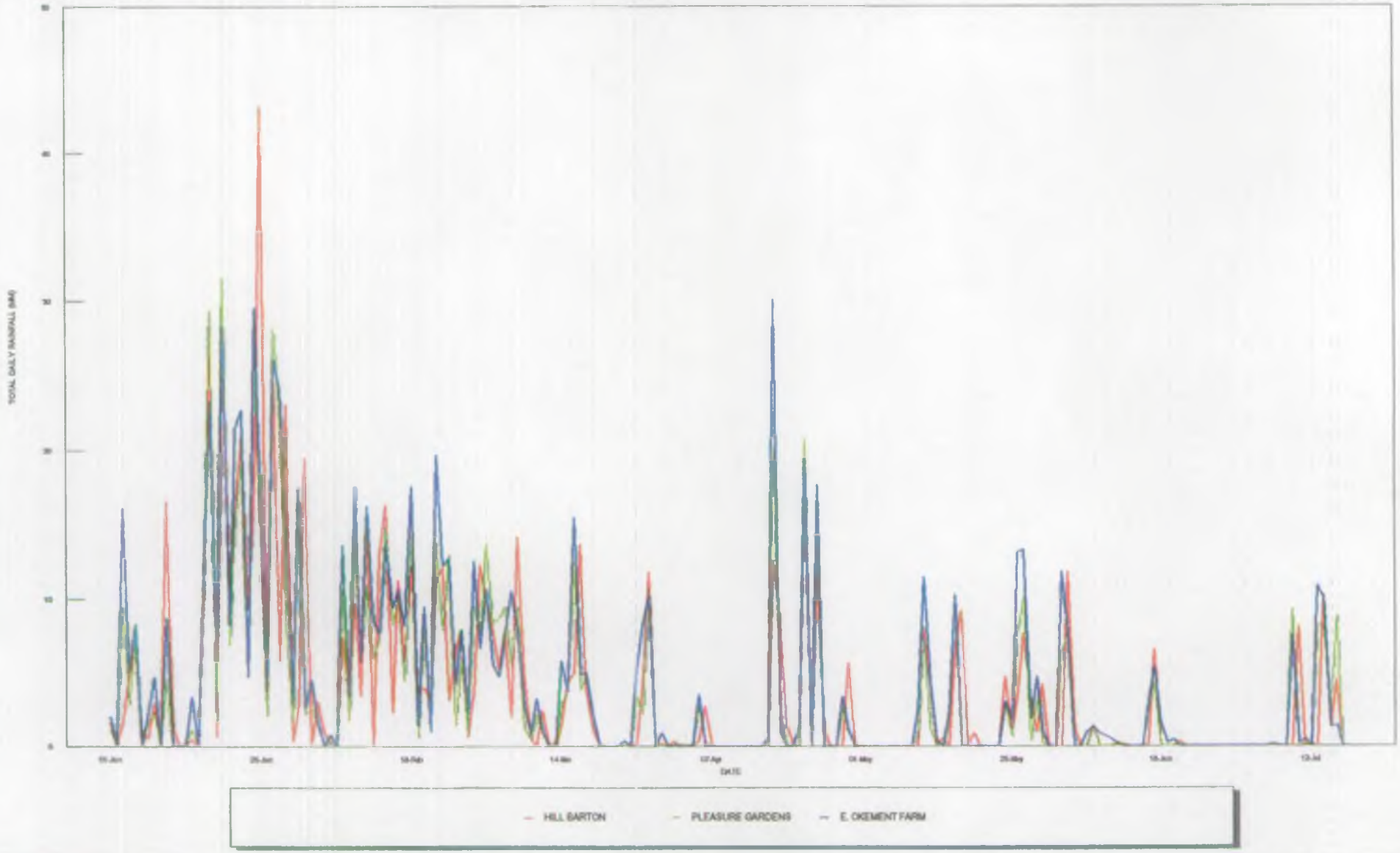
Annual Total : 1200.3 mm e

Quality Observer Data : E=Edited S=Snow ?=Suspect M=Incomplete T=Trace
Quality MO Quality Contro : e=Edited s=Snow ?=Suspect m=Incomplete t=Trace
Quality Code : Q = Original Record

APPENDIX 2

TOTAL DAILY RAINFALL

SITE COMPARISON



APPENDIX 3

Photogragh showing DMP Mk IV
deployed approx. 10 metres d/s of final effluent.

Photograph of Meteorburst telemetry unit.

RIVER OKEMENT - TORRIDGE CATCHMENT

HISTORICAL RE CLASSIFICATION

APPENDIX 4

River	Stretch Name	1995 URN	NGR	RQO (NWC)	RE Classification							
					1990		1992		1993		1994	
					OPT	FV	OPT	FV	OPT	FV	OPT	FV
Okement	Okehampton Hospital-Knowle Bridge	R29D026	SX 5930 9630	1A	1	1	1	1	1	1	1	1
	Knowle Bridge-Brightley Bridge	R29D003	SX 5987 9745	1A	1	1	1	1	1	1	1	1
	Brightley Bridge-South Dornaford	R29D004	SS 5999 0005	1A	1	1	2	2	1	2	1	2
	South Dornaford-Below Jacobstowe Stw			1A	1	1	1	1	0	0	1	1
	Below Jacobstowe Stw-Jacobstowe			1A	1	1	1	1	1	2	1	1
	Jacobstowe-Woodhall Bridge	R29D005	SS 5847 0340	1A	1	2	1	2	1	2	1	1
	Woodhall Bridge-Iddesleigh Bridge			1A	2	2	1	2	1	2	1	1
	Iddesleigh Bridge-Torridge Confluence	R29D006	SS 5679 0585	1B	2	2	1	2	1	2	1	1

APPENDIX 5

MEMORANDUM

TO: John Hancock, Senior Water Quality Officer

CC: Pete Rose.

From: Lee Knight (Biologist)

Report Number: DBT / 95 / 14

Date: 22nd September 1995.

A BIOLOGICAL ASSESSMENT OF THE IMPACT FROM OKEHAMPTON (HILL BARTON) STW ON THE RIVER OKEMENT (18th ~~JULY~~ SEPT 1995).

Following your request for a biological assessment of the impact from Okehampton STW, a survey was carried out on 18th September.

At the time of the survey the discharge from the works was observed to be flowing fast and clear. Extensive sewage fungus growth and algal growth were observed on rocks immediately below the outfall and in the river below, where a grey plume was evident up to five feet downstream of the discharge. There was a distinct "organic" smell emitting from the river, even at 162m below the main outfall.

Approximately 40m downstream of the main outfall a land drain was observed with a fast, clear flow. No sewage fungus nor smell were noted in the pipe, but thick ochre deposits were observed both in the pipe and on the rocks below.

Three sites were selected for biological sampling, one upstream of the outfall and two downstream, above and below the land drain. The locations are listed on the accompanying sheet. Examination of the benthic macro-invertebrate fauna collected at each site showed no marked impact from the STW discharge, although a 30% coverage of sewage fungus was recorded on the substrate at site 1, 162m downstream of the outfall. Numbers of Chironomidae (a taxon tolerant of organic input) increased significantly downstream of the outfall, as did the numbers of Hydropsychidae and Simuliidae at site 2, 22m downstream of the discharge. These two taxa are filter-feeders and would benefit from increased organic loading upstream.

LEE KNIGHT
BIOLOGIST

NATIONAL RIVERS AUTHORITY
DISCHARGE SURVEY
BIOLOGY

SOUTH WESTERN REGION

SITE DETAILS

Discharge: OKEHAMPTON (HILL BARTON) STW D
Grid Reference: SX 5992 9832 Catchment No: 29.0
Watercourse: OKEMENT
Sampling Method: 03 Samplers Initials: LK Sorters Initials: LK

SAMPLE	U/S DISCHARGE 3	D/S DISCHARGE 1	ADDITIONAL D/S 2
Sample Date	18/09/1995	18/09/1995	18/09/1995
Sample Time	11:15	10:15	10:45
Location	15m U/S STORM OUTFALL	125m D/S LAND DRAIN D/S MAIN OUTFALL	22m D/S MAIN OUTFALL
Grid Reference	SX 6005 9825	SX 6006 9848	SX 6005 9834
Width	4.2 m	4.55 m	7.55 m
Average Depth	25 cm	39 cm	22 cm
Boulders/Cobbles	55 %	55 %	75 %
Pebbles/Gravel	41 %	44 %	21 %
Sand	3 %	1 %	3 %
Silt/Clay	1 %	0 %	1 %
Conductivity	115 us/cm	150 us/cm	145 us/cm
Sewage Fungus	0 % above stones	30 % above stones	10 % above stones
	0 % below stones	5 % below stones	5 % below stones
Ochre	0 %	0 %	0 %
Cladophora	0 %	0 %	4 %

SCORE RESULTS

Scoring families	23	24	21
BMWP Score	138	149	126
BMWP ASPT	6.00	6.21	6.00
Predicted BMWP			
Predicted ASPT			
No Predicted Taxa			
EQI Class			

COMMENTS Sheet ___ of ___

Discharge: SEE ACCOMPANYING SHEET.

Stream: SMELT STRONGLY D/S OF OUTFALLS

Signed ..... Date .....

TAXA LIST

Discharge Site Reference __ : ____

	U/S (3)	D/S (1)	(2)
GROUP 1 TAXA (10)			
Siphlonuridae			
Heptageniidae	C	A	B
Leptophlebiidae	A		
Ephemerellidae			
Potamanthidae			
Ephemeridae			
Taeniopterygidae			
Leuctridae	B	B	B
Capniidae			
Perlodidae	A	A	A
Perlidae			
Chloroperlidae			
Aphelocheiridae			
Phryganeidae			
Molannidae			
Beraeidae			
Odontoceridae			
Leptoceridae	A	A	A
Goeridae			
Lepidostomatidae			
Brachycentridae		A	
Sericostomatidae	B	B	B
SUB–TOTAL TAXA	06	06	05
GROUP 2 TAXA (8)			
Astacidae			
Lestidae			
Calopterygidae		A	
Gomphidae			
Cordulegasteridae			
Aeshnidae			
Corduliidae			
Libellulidae			
Psychomyiidae (Ecnomidae)			
Philopotamidae			
SUB–TOTAL TAXA	00	01	00
GROUP 3 TAXA (7)			
Caenidae			
Nemouridae		B	A
Rhyacophilidae (Glossosomatidae)	B	B	C
Polycentropodidae	A	A	A
Limnephilidae			
SUB–TOTAL TAXA	02	03	03

	U/S (1)	D/S (2)
GROUP 4 TAXA (6)		
Neritidae		
Viviparidae		
Ancylidae (Acroloxidae)	B	B
Hydroptilidae		
Unionidae		
Corophiidae		
Gammaridae (Crangonyctidae)	B	A
Platycnemidae		
Coenagriidae		
SUB–TOTAL TAXA	02	02
GROUP 5 TAXA (5)		
Mesoveliidae		
Hydrometridae		
Gerridae		
Nepidae		
Naucoridae		
Notonectidae		
Pleidae		
Corixidae		
Haliplidae		
Hygrobiidae		
Dytiscidae (Noteridae)		A
Gyrinidae	A	A
Hydrophilidae (Hydraenidae)	A	
Clambidae		
Scirtidae		
Dryopidae		
Elmidae	B	B
(Chrysomelidae) *		
(Curculionidae) *		
Hydropsychidae	B	C
Tipulidae	B	A
Simuliidae	B	A
Planariidae (Dugesiidae)		A
Dendrocoelidae	A	
SUB–TOTAL TAXA	06	07

	U/S (3)	D/S (1)	(2)
GROUP 6 TAXA (4)			
Baetidae	B	A	C
Sialidae			
Piscicolidae	A		
SUB–TOTAL TAXA	02	01	01
GROUP 7 TAXA (3)			
Valvatidae			
Hydrobiidae (Bithyniidae)	A	A	A
Lymnaeidae		A	A
Physidae			
Planorbidae			
Sphaeriidae	A		
Glossiphoniidae			
Hirudinidae			
Erpobdellidae			
Asellidae			
SUB–TOTAL TAXA	02	02	02
GROUP 8 TAXA (2)			
Chironomidae	A		C
SUB–TOTAL TAXA	01	01	01
GROUP 9 TAXA (1)			
Oligochaeta	C	B	B
SUB–TOTAL TAXA	01	01	01
TOTAL TAXA	23	24	21
BMWP SCORE	138	144	126

Abundance — No of Individuals
A – 1–9
B – 10–99
C – 100–999
D – 1000–9999
E – 10000+

Other Taxa

SITE1
CERATOPOGONIDAE – A
HYDRACARINA – A
ATHERICIDAE – A
EMPIDIDAE – A

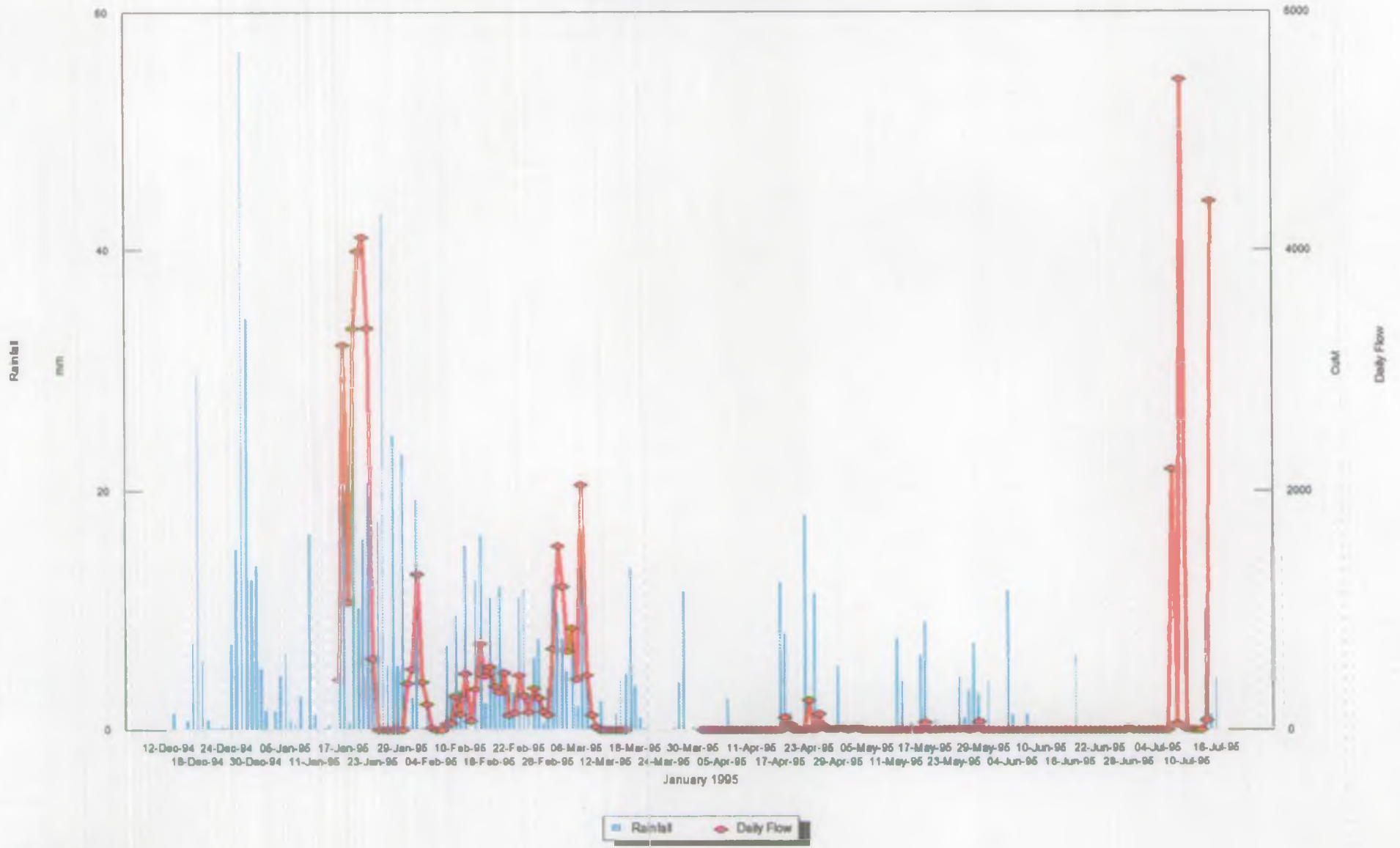
SITE 2
PSYCHODIDAE – A

SITE 3
ATHERICIDAE – B
EMPIDIDAE – A
HYDRACARINA – A

* Non-scoring

HILL BARTON S.T.W.

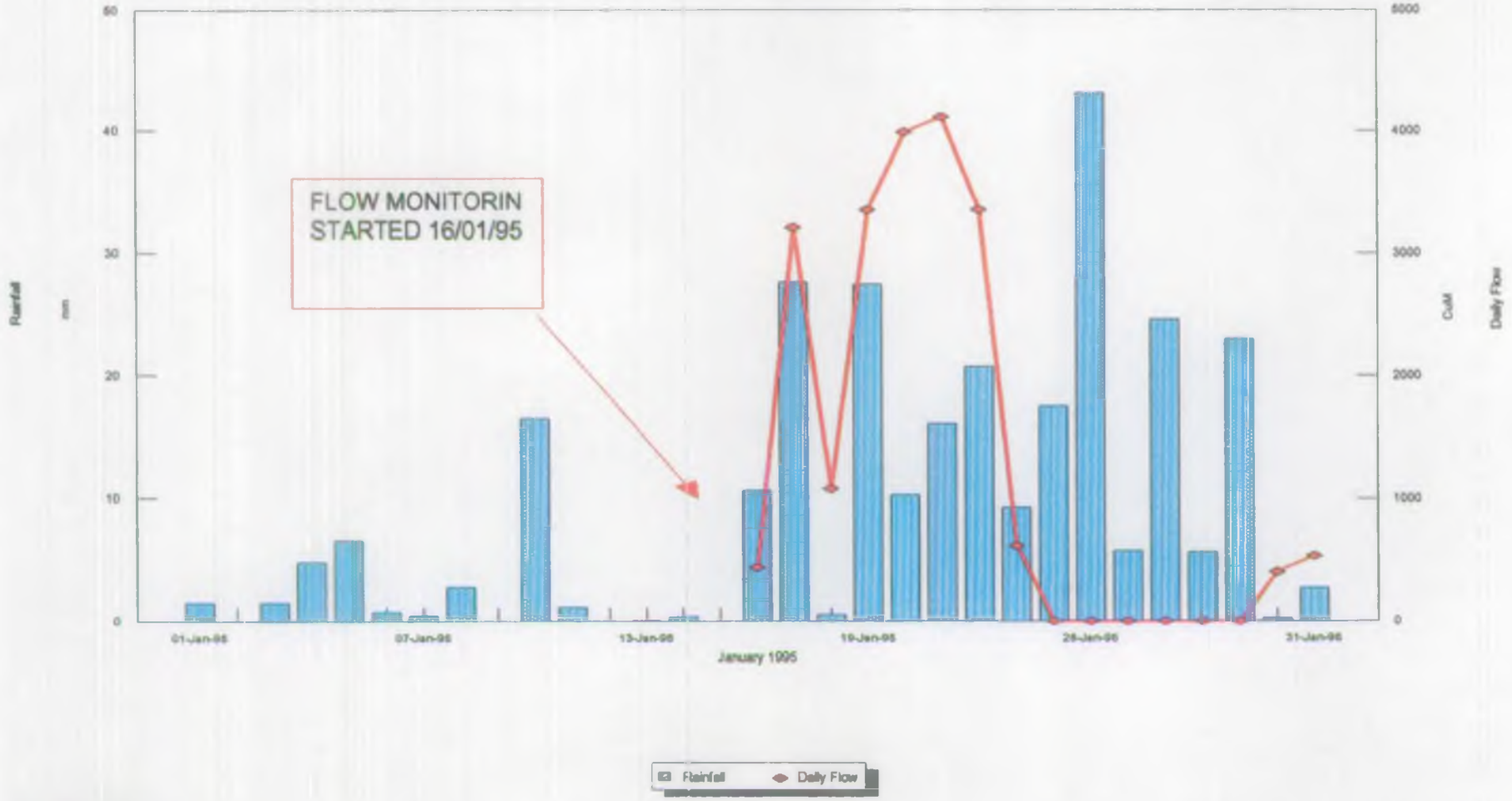
TOTAL DAILY RAINFALL vs TOTAL DAILY FLOW



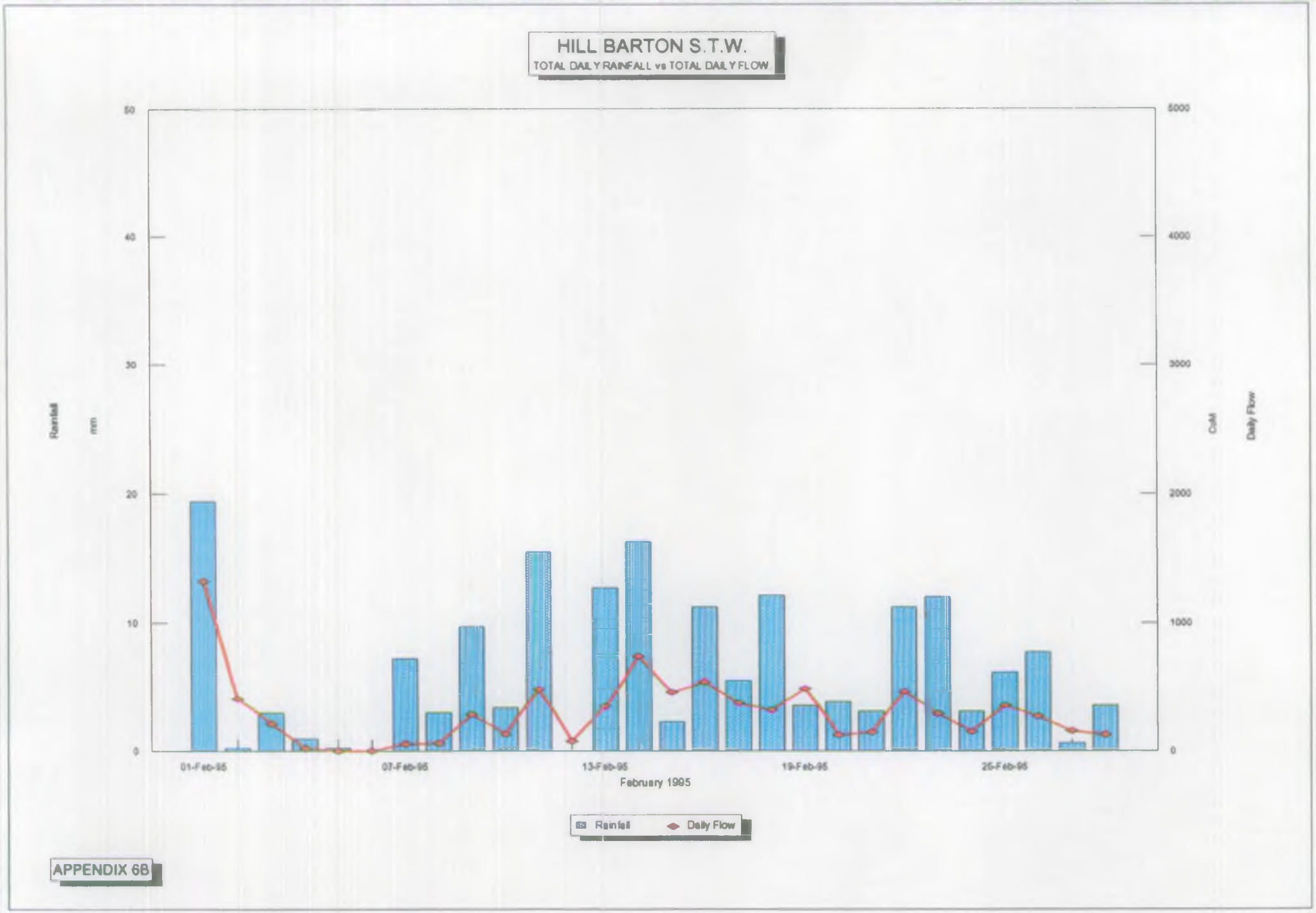
APPENDIX 6

HILL BARTON S.T.W.

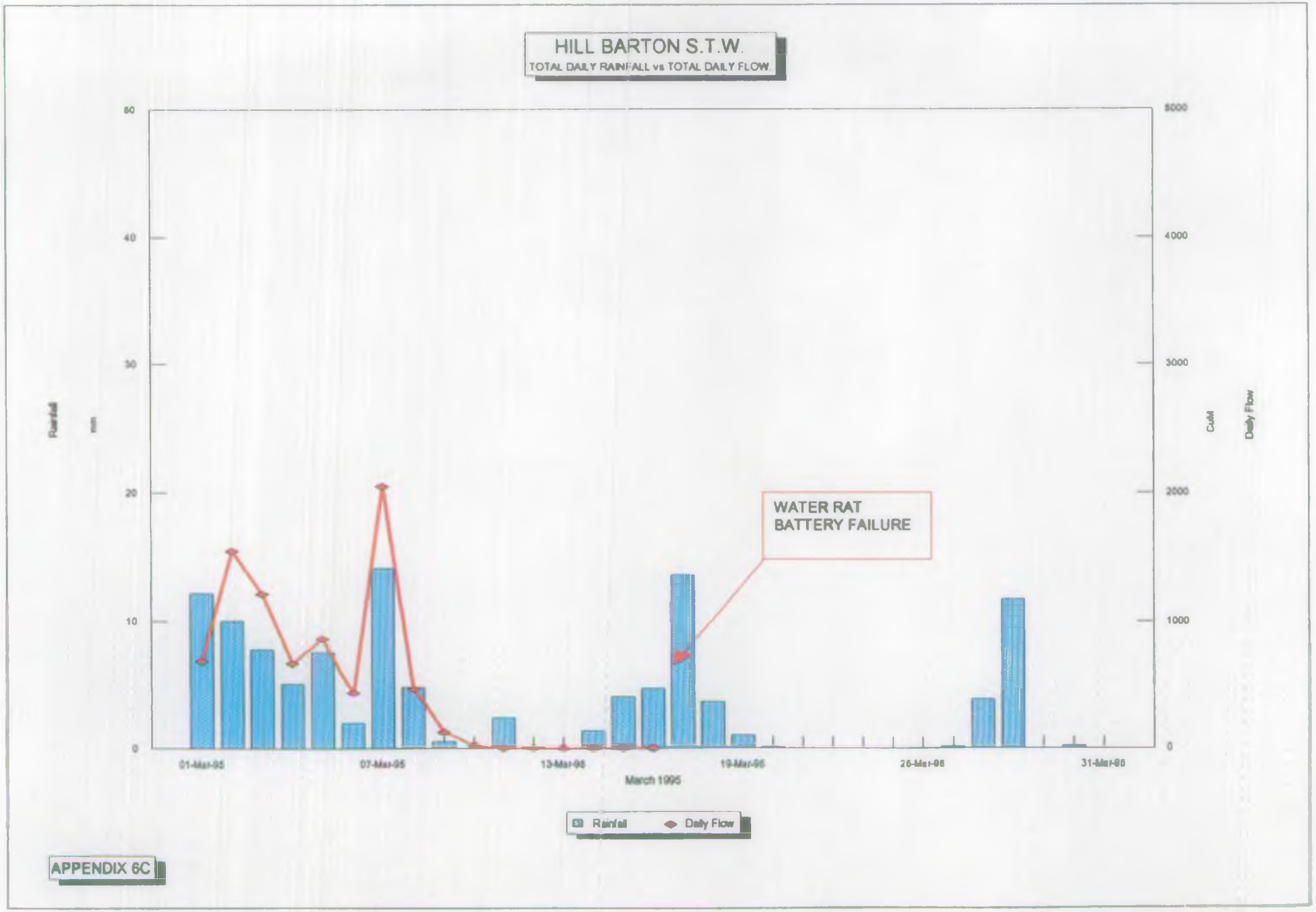
TOTAL DAILY RAINFALL vs TOTAL DAILY FLOW



APPENDIX 6A


HILL BARTON S.T.W.
TOTAL DAILY RAINFALL vs TOTAL DAILY FLOW
Rainfall
mm
Daily Flow
CuM
50
40
30
20
10
0
5000
4000
3000
2000
1000
0
01-Feb-95
07-Feb-95
13-Feb-95
19-Feb-95
25-Feb-95
February 1995
Rainfall
Daily Flow

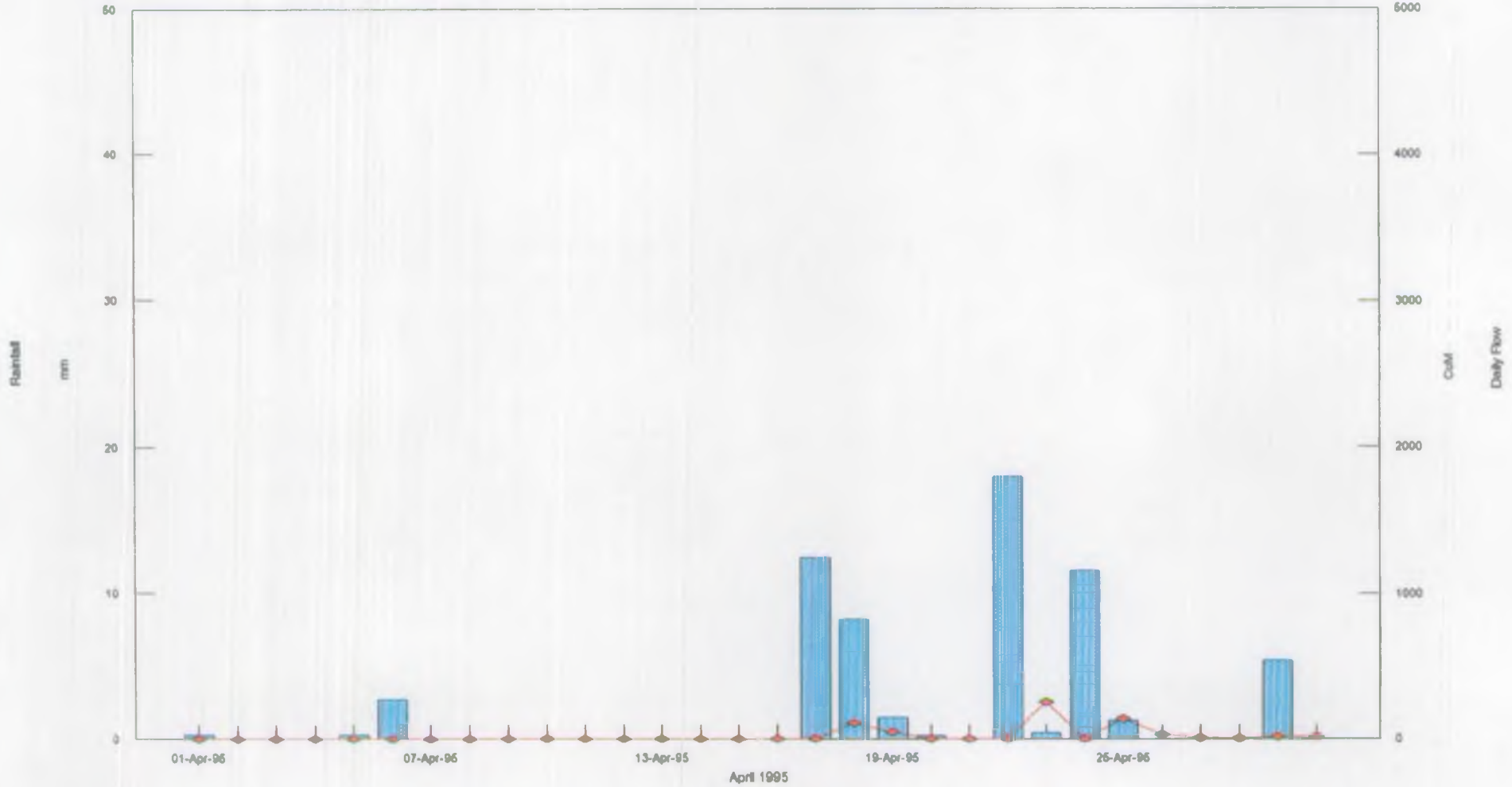
APPENDIX 6B


HILL BARTON S.T.W.
TOTAL DAILY RAINFALL vs TOTAL DAILY FLOW
Rainfall
mm
Daily Flow
Cubic
0
10
20
30
40
50
0
1000
2000
3000
4000
5000
01-Mar-95
07-Mar-95
13-Mar-95
19-Mar-95
25-Mar-95
31-Mar-95
March 1995
WATER RAT
BATTERY FAILURE
Rainfall
Daily Flow

APPENDIX 6C

HILL BARTON S.T.W.

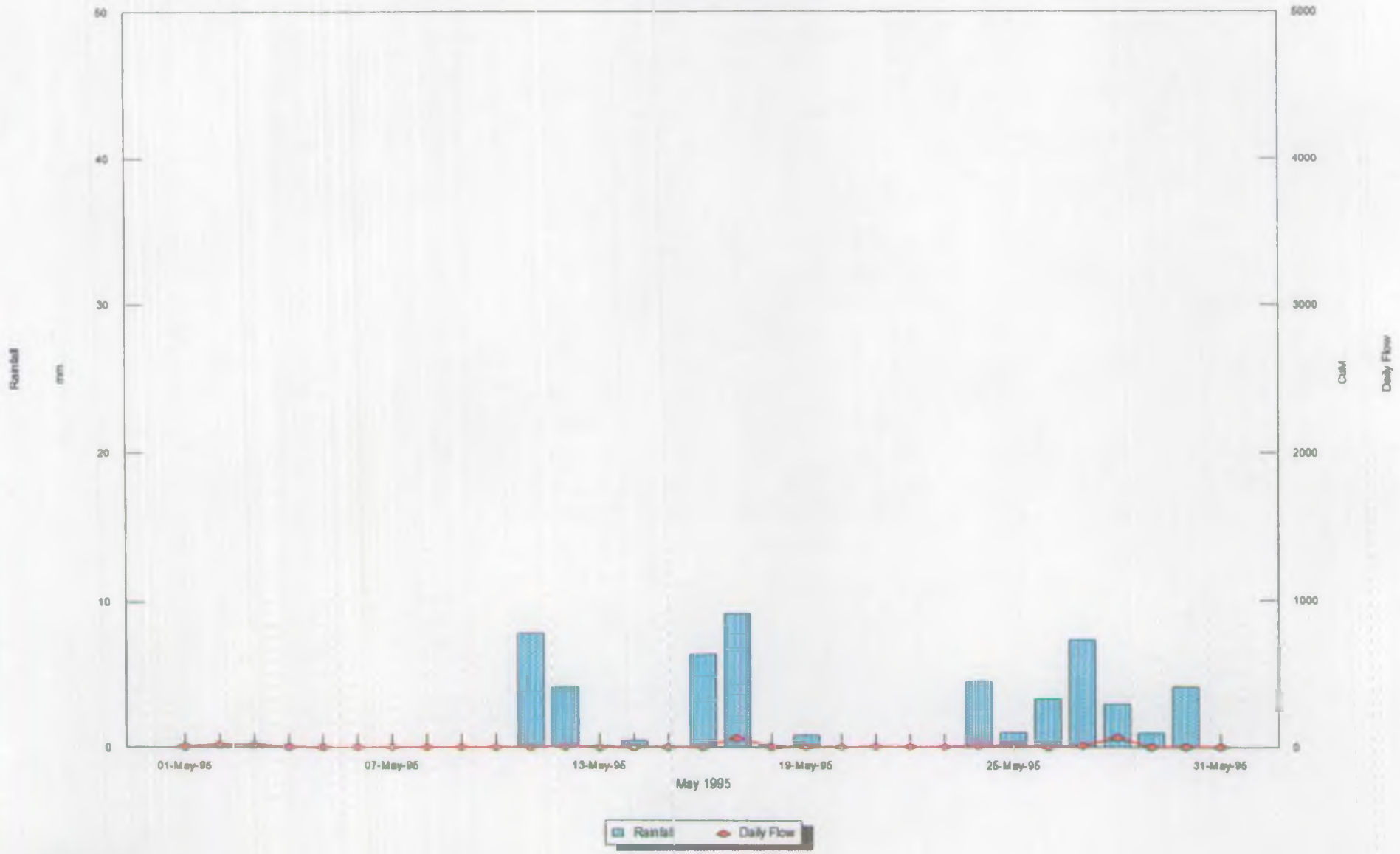
TOTAL DAILY RAINFALL vs TOTAL DAILY FLOW



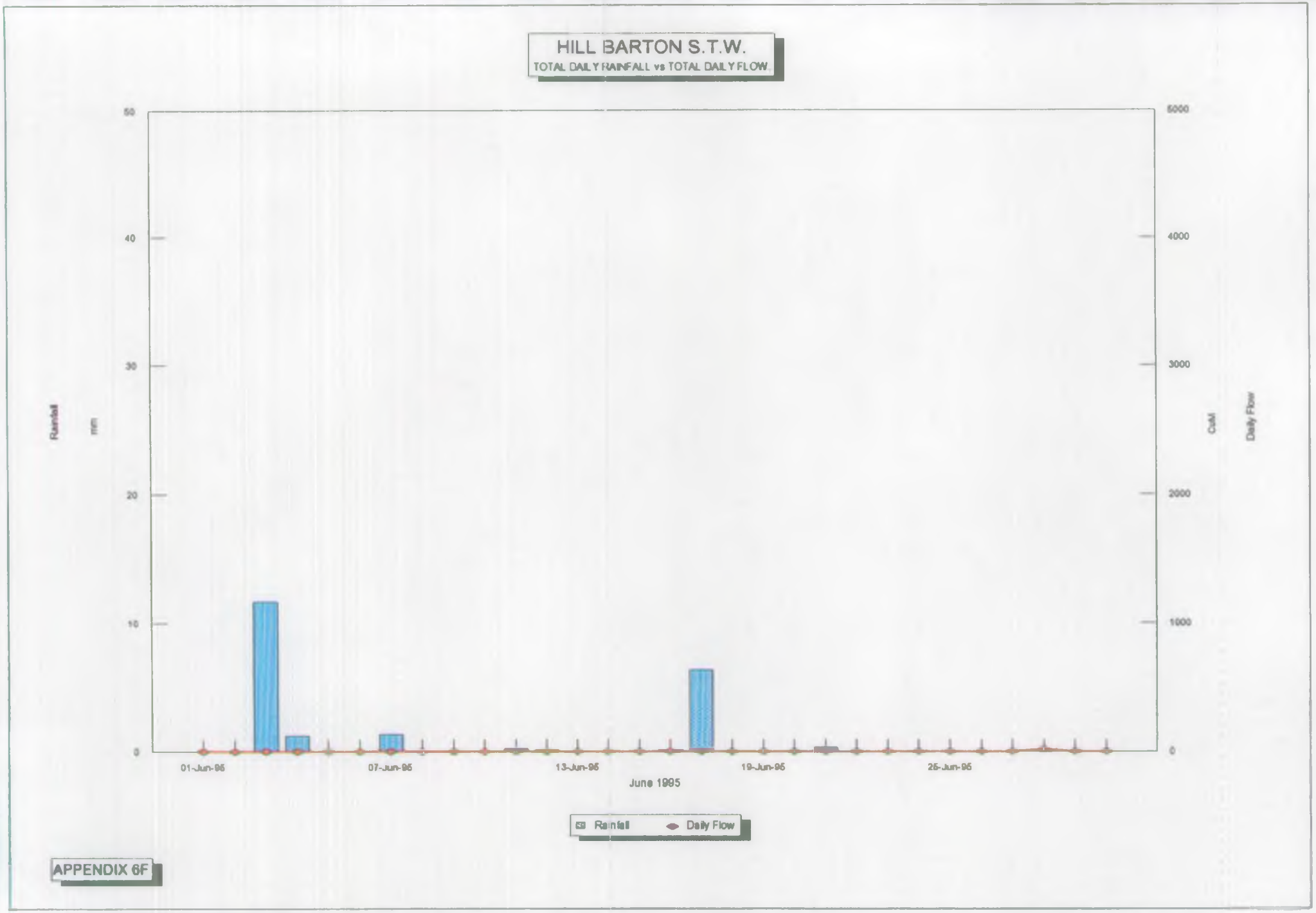
APPENDIX 6D

HILL BARTON S.T.W.

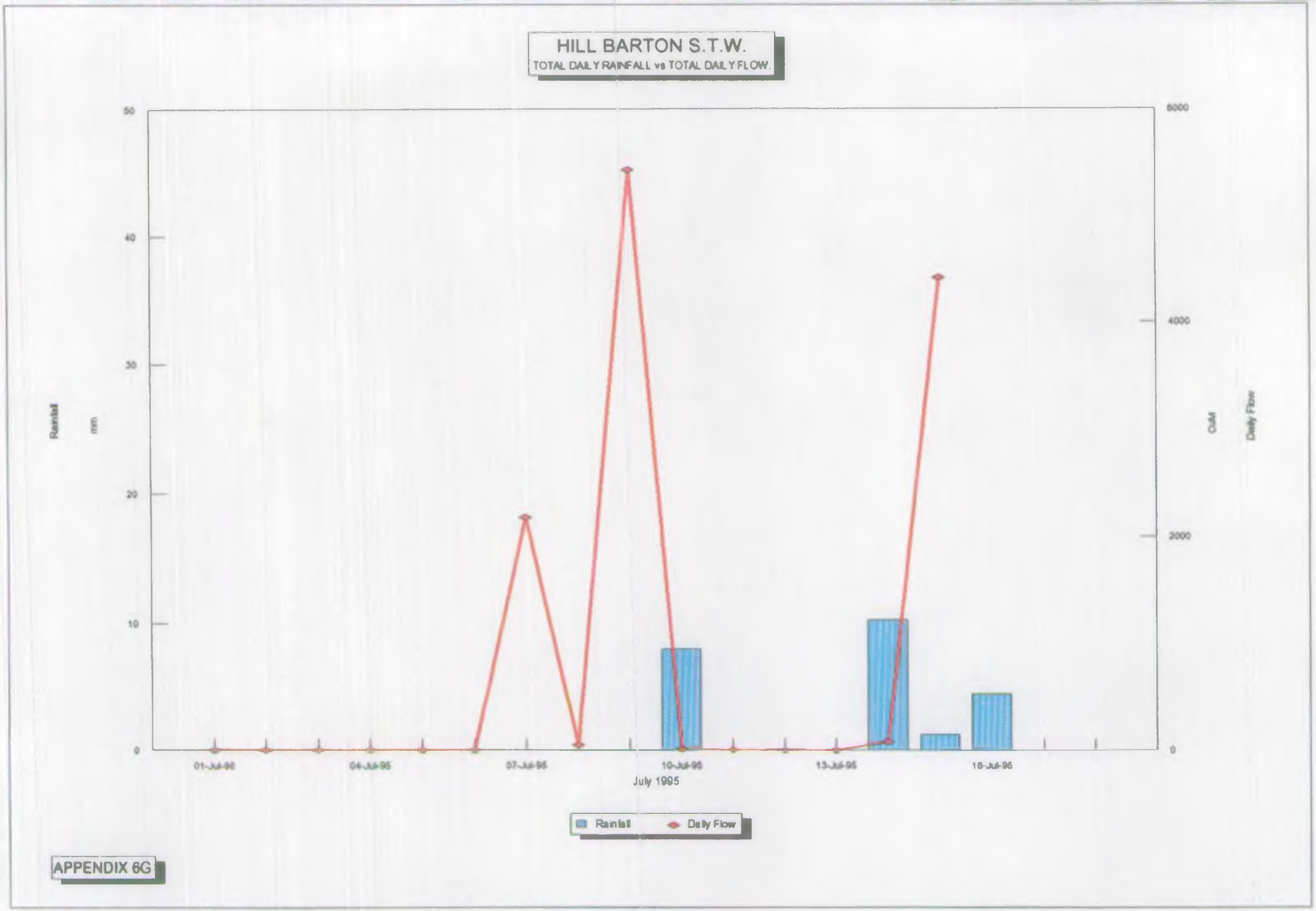
TOTAL DAILY RAINFALL vs TOTAL DAILY FLOW



APPENDIX 6E


HILL BARTON S.T.W.
TOTAL DAILY RAINFALL vs TOTAL DAILY FLOW
Rainfall
mm
Daily Flow
Cu/M
50
40
30
20
10
0
5000
4000
3000
2000
1000
0
01-Jun-95
07-Jun-95
13-Jun-95
19-Jun-95
25-Jun-95
June 1995
Rainfall
Daily Flow

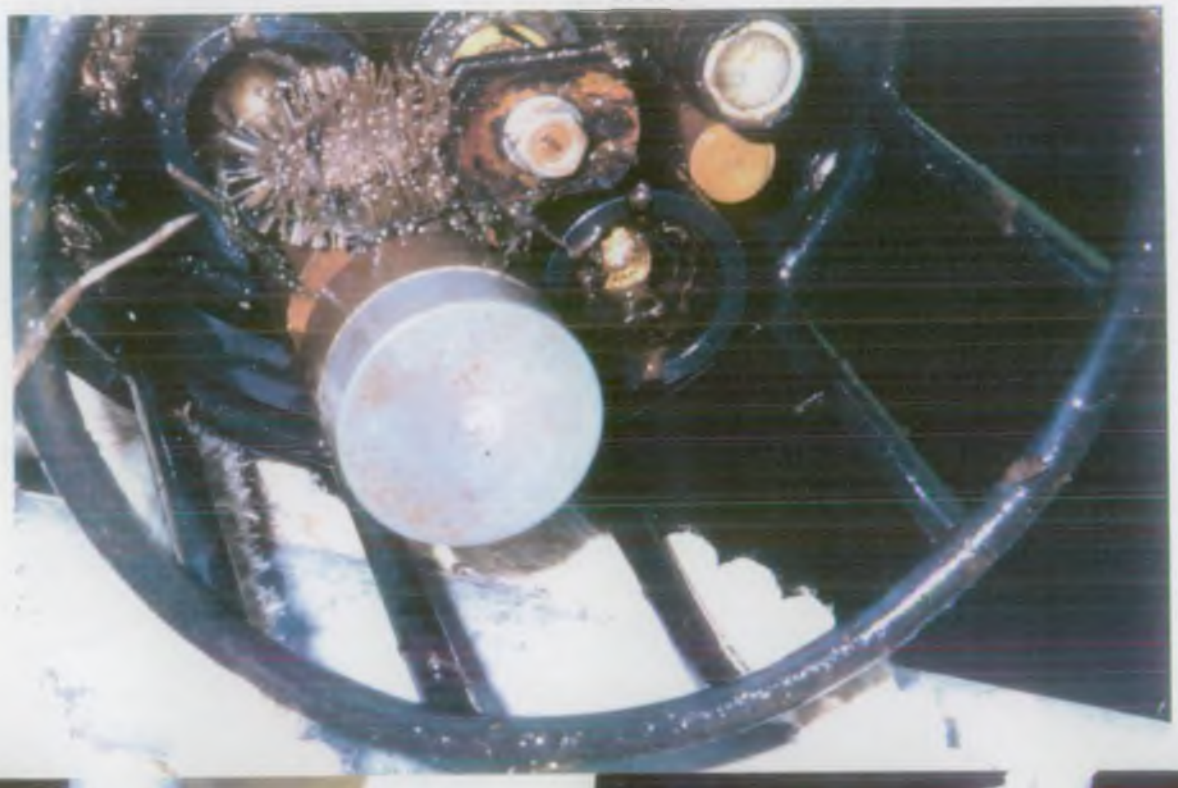
APPENDIX 6F

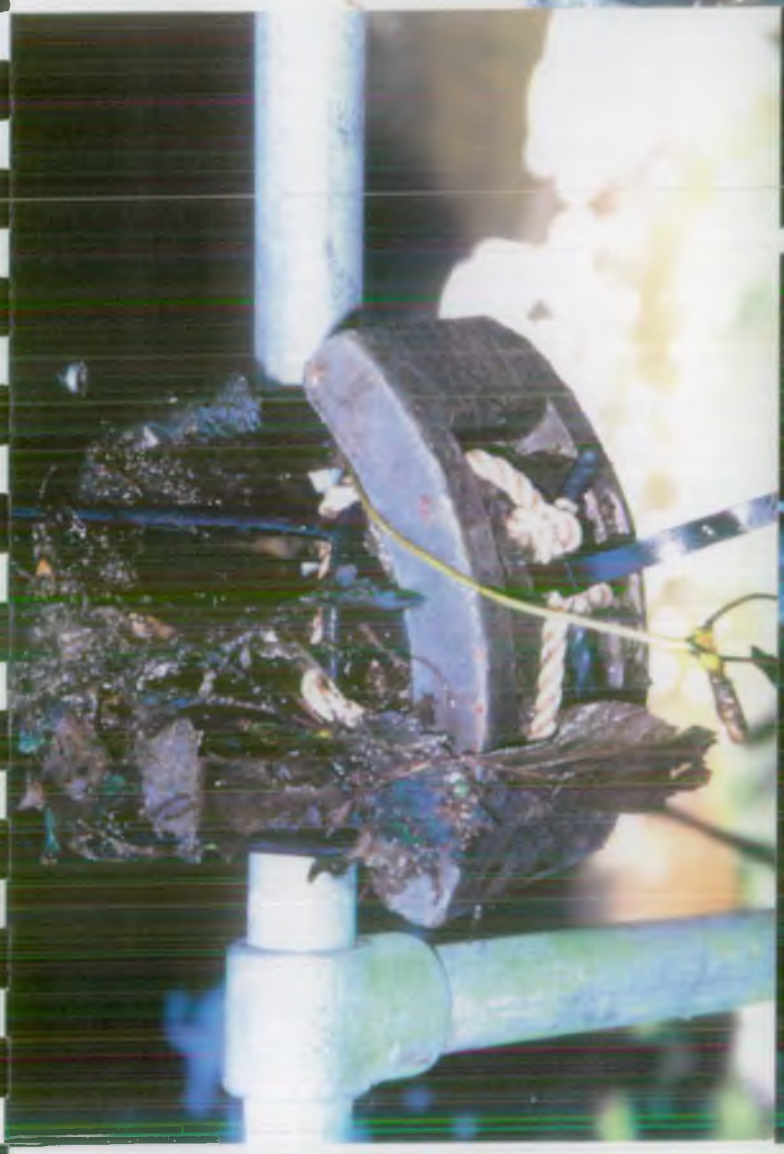

HILL BARTON S.T.W.
TOTAL DAILY RAINFALL vs TOTAL DAILY FLOW.
Rainfall
mm
Cum
Daily Flow
50
40
30
20
10
0
6000
4000
2000
0
01-Jul-95
04-Jul-95
07-Jul-95
10-Jul-95
13-Jul-95
16-Jul-95
July 1995
Rainfall
Daily Flow

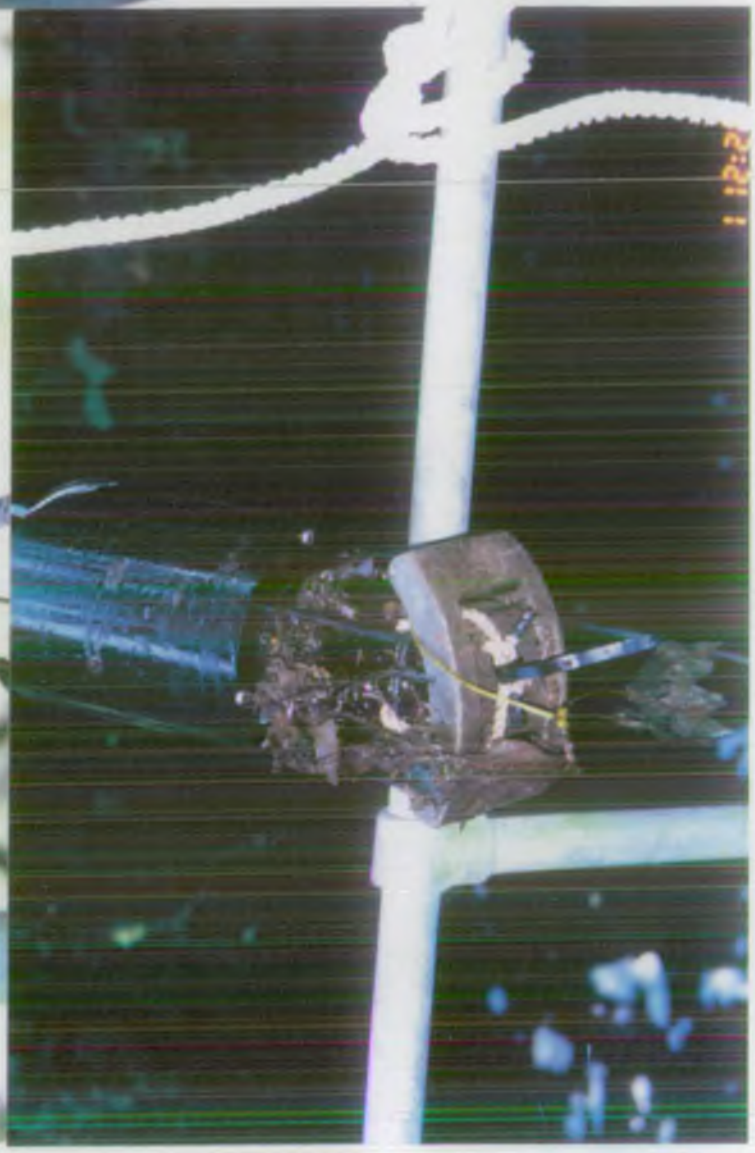
APPENDIX 6G

APPENDIX 7

Photographs of probe deterioration after 2 days

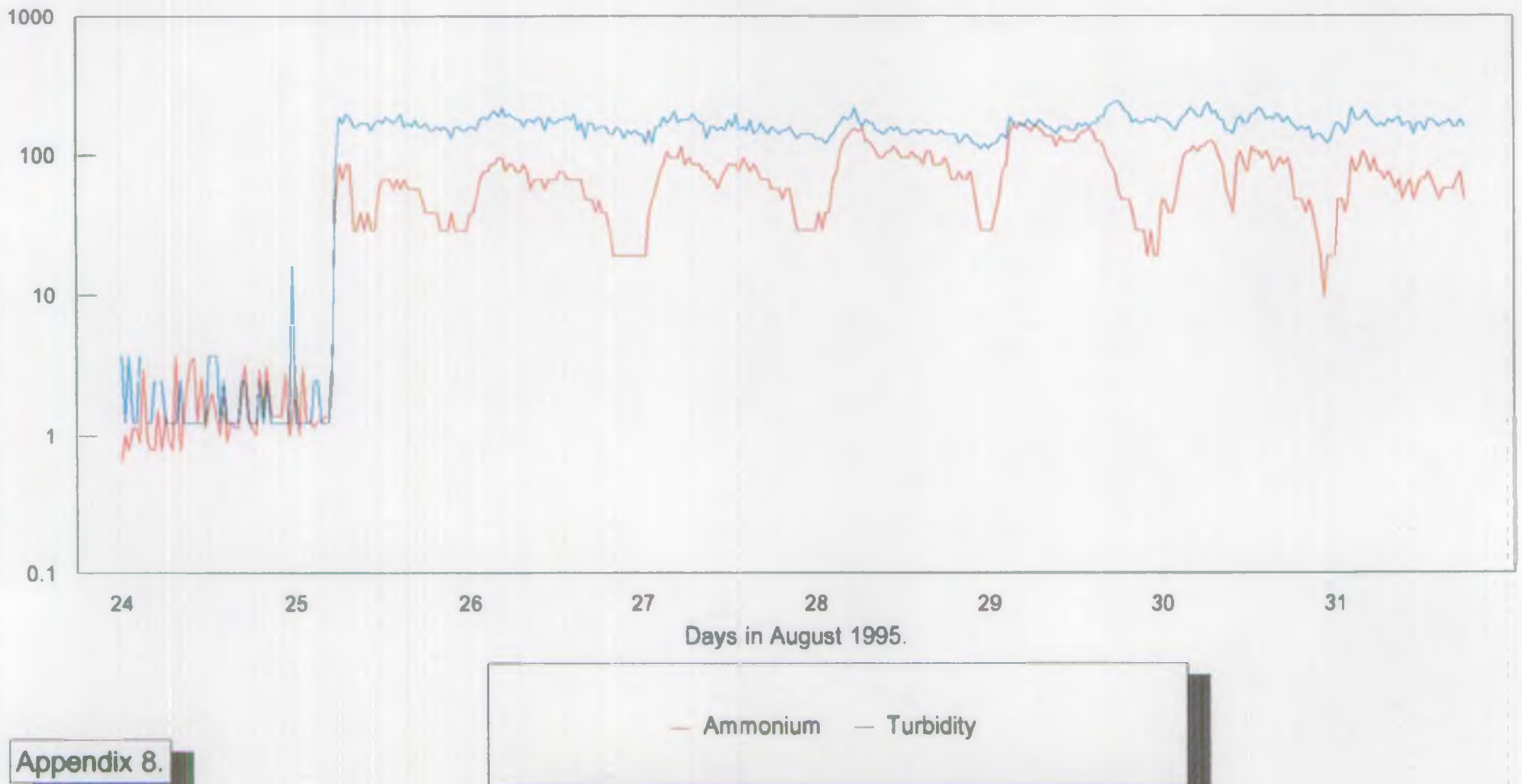






Hill Barton S.T.W.

Water Quality Monitor Results.



Appendix 8.

APPENDIX 9

Photograph of sewage fungus on rock d/s of FE.

Photograph of paper litter on rock d/s of FE..