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D'ANGERS

STUDY OF THE BEHAVIOUR AND THE IMPACT OF TWO SEWAGE TREATMENT WORKS OF THE THAMES CATCHMENT

STAGE FODA

CONTENTS

RIVER RAY

I INTRODUCTION

1) DESCRIPTION OF THE WATERCOURSE

The Ray river rises from a series of springs to the south west of Wroughton (SU 136 796) and flows in a northerly direction to join the River Thames near Cricklade (SU 123 939). The total distance is 21 km. The river has a mean gradient of 1 in 370 and the catchment area is approximately 85 km2.

The river has no large tributaries but those which are significant include the Wroughton Ditch, Swinbourne, Whitehill stream, Lydiard brook, Hroad Burna and the Maydon Wick brook. The catchment area is dominated by the large conurbation of Swindon which is currently one of the fastest growing towns in Europe. Local authority structure plans predict a continued rapid rise of the population in the future years. The increased urbanisation within the catchment has caused large changes to the river, particularly with regard to the increase in the disposal of sewage effluent and drainage problems.

2) GEOLOGY AND HYDROLOGY

The river rises from a series of springs at the edge of the Marlborough Downs which corresponds to the boundary of the Lower Chalk and Upper Greensand with the underlying gualt clays.

The catchment is clay dominated (77%) with the river running over the following strata from source downstream. As the River Ray meets the Thames confluence, there are signs of Terrace gravels obscuring the Oxford clay.

From the source to STW, river flow comprises a low base flow from groundwater sources together with seasonal surface run-off. Consequently this section possesses very low dry weather flows. The river flow downstream of the STW is affected greatly by the discharge from the works. The average daily discharge from the works is 0.42cumecs which represents approximately 40% of the mean daily flow at the water gauge station located at the bottom of the river. Under dry conditions, the maximum consented discharge of 0.37 cumecs constitutes 80% of river flow at the point of discharge.

3) RIVER CLASSIFICATION

River Quality is classified according to the National Water Council river quality objectives. The River Ray is classified as follows:

Section	Distance	ROO
Source -> Swindon STW	.9	2B
Swindon STW -> Haydon Wick Brook	4.1	3/2B*
HWB -> Thames	7.8	2A

* the second element indicates the long term objective.

Tributary	Section	Distance	ROO
Wroughton Ditch	Wroughton STW R.R.	0.8	2B
Lydiard Brook	Source - Radbourne tip	3.7	1A
	Radbourne Tip R.R.	0.7	3
Haydon Wick Brook	2.8 km upstream R.RAY	2.8	1B

4) CONSENTED DISCHARGE

The existing consent conditions for Swindon STW were altered on 31st October 1989 under the provisions set out in the new Water Act 1989. This new consent sets out further alterations which come into force on 1st October 1991.

II AIMS AND OBJECTIVES

The aim of this study, due to the short timescale, is not a detailed approach of the real impact of two sewage treatment works on rivers but rather a syntheses using available data concerning biochemical and biological aspects of the downstream water.

This should enable both a mid-term vision of the consequence of discharges on the river and of the behaviour of the works as their are being reconstructed.

III RESULTS

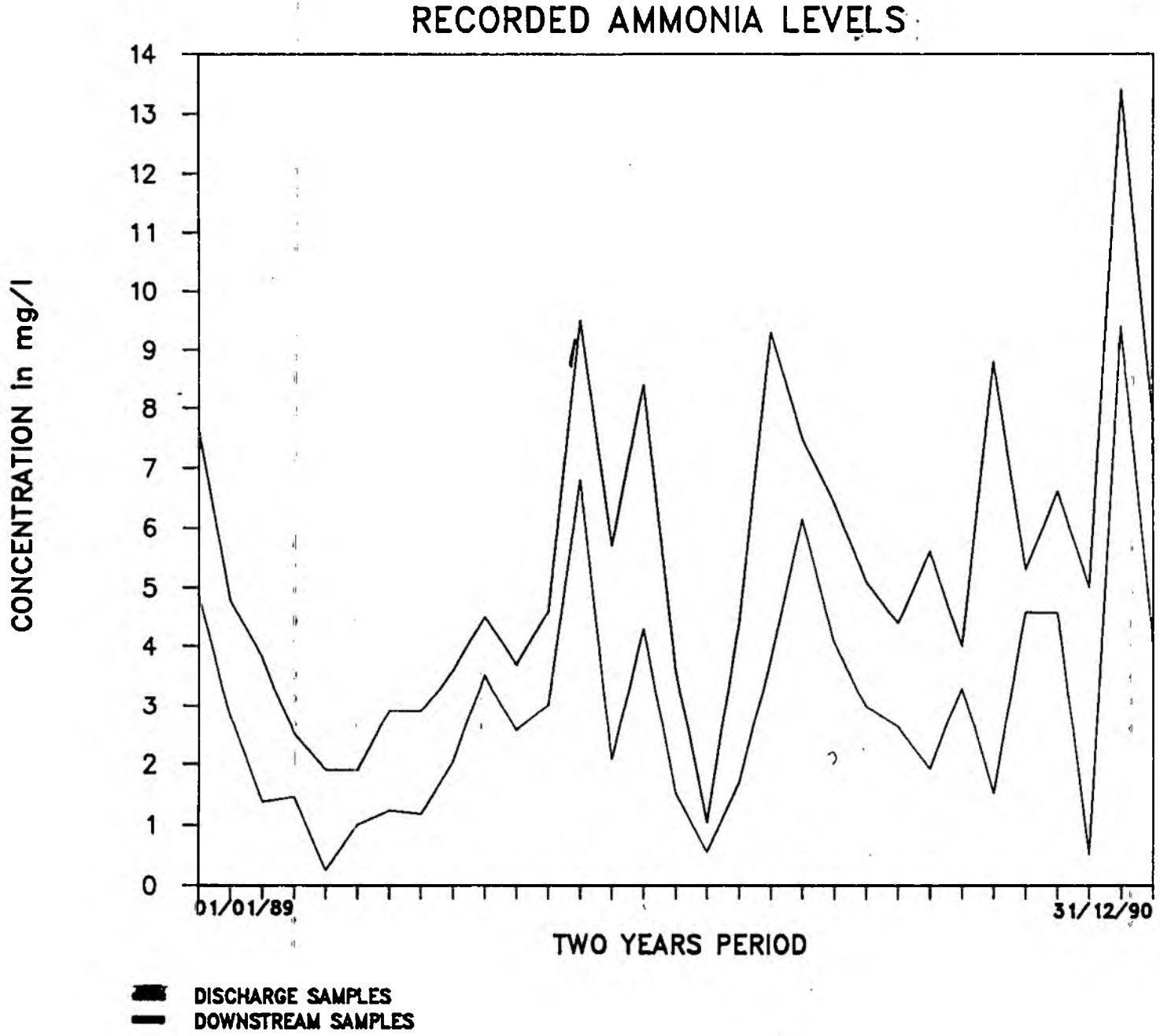
1) COMPARISON OF THE UPSTREAM AND DOWNSTREAM SAMPLES

I have chosen two sites to assess the evolution of the suspended solids, ammonia as N and BOD. Morris Street is upstream and Moredon Bridge the downstream one. The problem is that two of the Ray tributaries (LYDIARD BROOK and HREAD BURNA) flow into the river just between the discharge and Moredon Bridge, which might influence the observed data. Hence a short assessment of their impact is necessary.

From the manual samples taken over the last two years, which represent 8 samples for the Hreod Burna and 13 for the Lydiard, it seems that the biochemical impact is very small, especially as far as Ammonia and BOD are concerned. In actual fact the maximum ammonia concentration observed is 1.3 units with only two values above 1. The BOD is below 4.6 mg/l as far as Hreod Burna is concerned but reaches 12 mg/l in the Lydiard Brook. However the other values remain below. If you bear in mind that these two rivers are really small compared to the Ray in terms of flow, we can conclude, according to the previous quoted data, that the influence can be regarded as negligeable.

SWRELATI DRW

RELATIONSHIP BETWEEN DISCHARGE AND DOWNSTREAM SAMPLES



However, the Hreod Burna suffers from of chronic oil pollution, which is probably responsible for the low BMWP scores observed in 1986 (15 and 29). It is in fact common to see a characteristic oil film on the river but apart from big pollution incidents, it seems that there is no really significant impact on the Ray.

The graph 16, comparing discharge samples and downstream samples taken in the same day, shows the big impact of the discharge on the river but it does not reveal any difference which might stem from the two tributary's influence. The correlation between these data is 0.5693, which may confirm the previous hypothesis, although the fact that there is only 33 sets data be taken into account when assessing this result.

The Whitehill stream is also likely to interfere into the accurateness of the data but it is also so small that it can be overlooked.

a) <u>Analysis of the Ammonia as N Levels (1 & 2)</u>

The evolution of the recorded ammonia levels from Mordon Bridge in 1989 shows great irregularity in terms of concentration. In actual fact, apart from May and June, which are rather close, all the recorded samples have different levels which go from less than 0.5 mg/l up to 8 mg/l.

On the other hand, the graph shows a steady increase of the concentration for the second part of the year, which might stress a problem as far as the sewage works is concerned. But the most obvious finding is the impact of the discharge on the river, which is revealed by the difference between upstream and downstream data.

The year 1990 is characterised by a higher quality of upstream water but chiefly by an increase of downstream ammonia concentrations. Acturally all the tower are above 2 mg/l and the maximum almost reaches 10 mg/l. Hence, we can claim that there is a degradation in the STW effectiveness which might be due to the reconstruction works.

b) <u>Analysis of the BOD (3 & 4)</u>

The difference between the extreme values is less important as far as the BOD is concerned. The two graphs illustrate the same kind of general conclusion as the onces for ammonia.

The contribution of the Ray above the STW is rather important and it sometimes explains most of the downstream results observed. 1990 also has worse results than 1989 and if the pollution of the upstream water is less important, the downstream BOD concentration has increased, which shows the impact of the STW. If we analyse the two year period graph, the difference is quite obvious.

Sol-susp : Evolution of susp. solids 1989-1990

Sol 90 : evolution susp.sol in 1990

Sol 89 : " " 1989

~~AMM089~~ : evolution Ammonia 1990

~~BOD90~~ : evolution DBO in 1990

~~AMM089~~ : " Ammonia in 1989

~~BOD 89~~ : " DBO in 1989

~~DBOCOMP2 : comparison of up-downstream BOD in 1990~~

~~UPDOWN2~~ : comparison of the ~~BOD~~ BOD 1989-1990.

~~AM UPDOWN~~ : " " AMMONIA " "

~~BOD EANS~~ : evolution of BOD over 1989 a 1990

~~AMMONEAN~~ : Evolution " AMMONIA " "

~~DBOCOMP~~ : ~~COMPARISON OF THE UPSTREAM DOWN~~

~~AMCOMP~~ : " " " " " " AMMONIA 1989 BOD 1989

SWREATI : relationship between discharge a Downstream 1989.1990.

DRW FILES

CHART FILES

DBOCOMP2 : comparison of the upx DOWN BOD 1990.

DBOCOMP1 : " 1989.

AMMCOMP1 : comparison of the upx downstra [illegible] of ammonia levels 1985

AMMCOMP2 : " 1990.

BIOMORIS : BIOLOGICAL DATAS. UPSTREAM

BIOMORDOS " " DOWNSTREAM

[illegible].

LUTON

TLBIOUP1 : UPSTREAM BIO DATA

LBIODOWN DOWNSTREAM "

LCOMPDMM : comparison of upstream BOD 1989-1990

LAMCOMP : " " " AMMONIA 1990

LDISDOWN : ~~comparison~~ relationship between discharge and downstream samples 1989-1990

LBODCANS : ~~evolution of the BOD level~~ over 1989-1990, DISCHARGE

LAMMAD : ~~,~~ evolution of the Ammonia [illegible] in 1990. Discharge samples

DRW FILES

LAMCO89 : comparison of the upst
DOWN BOD in 1989

LBODCOM9 : COMP " " in 1990

LSUSP89 : Evolution of susp. solids in 1989
LSUSP90 : " " " 1990
LSUSPTAN : " " 1989 1990
LAMMCOMP : comparison of upstream
DOWNSTREAM AMMONIA
1989. 1990
LAMM89 : discharge samples of AMMONIA
in 1989
LBOD90 : BOD discharge samples 1990
LBOD89 : " 1989

LAMM2ONS : evolution of discharged
AMMO 1989 1990

LDISDOWN : relationship DISCH. FREE
AMMONIA

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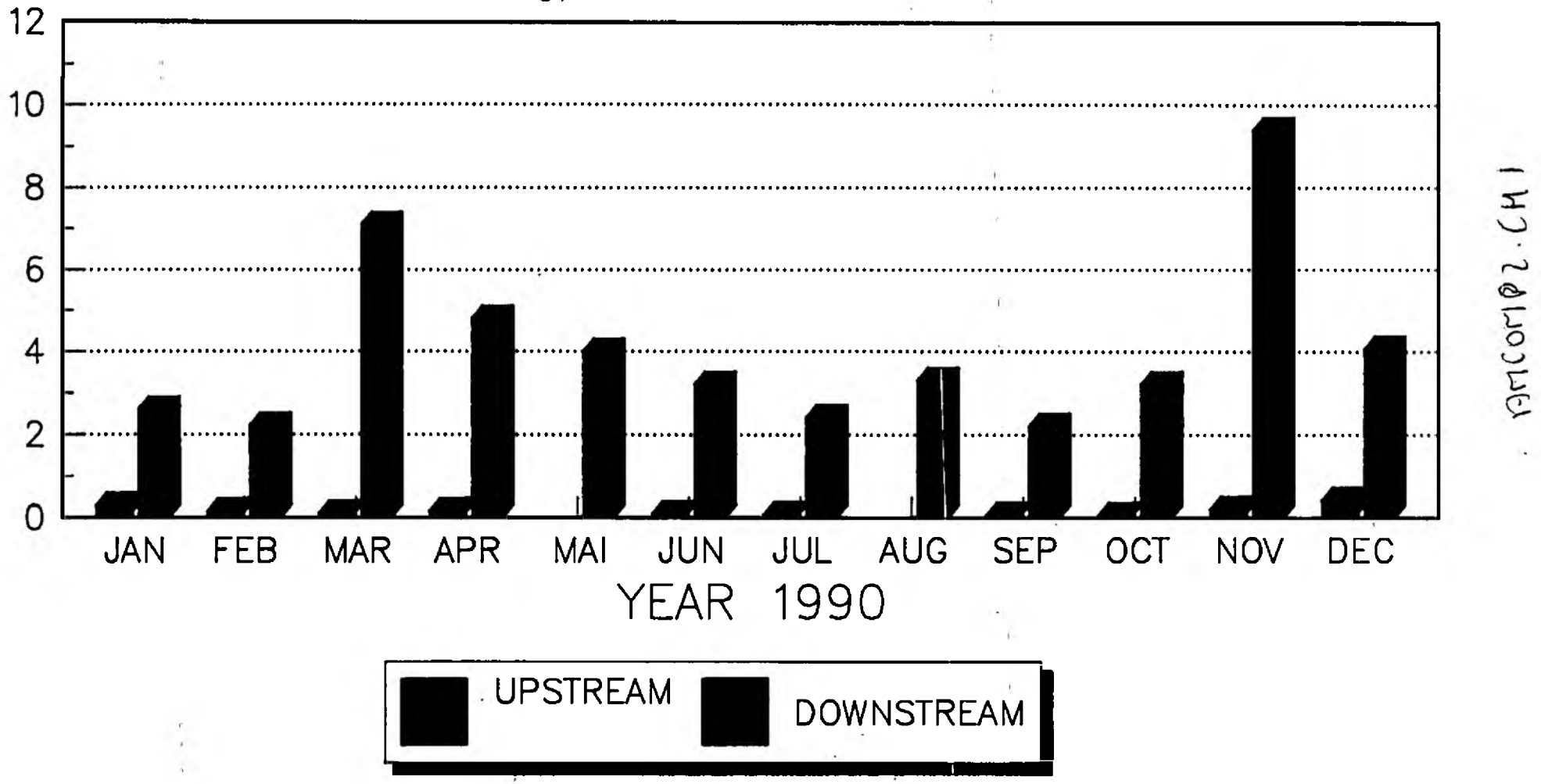

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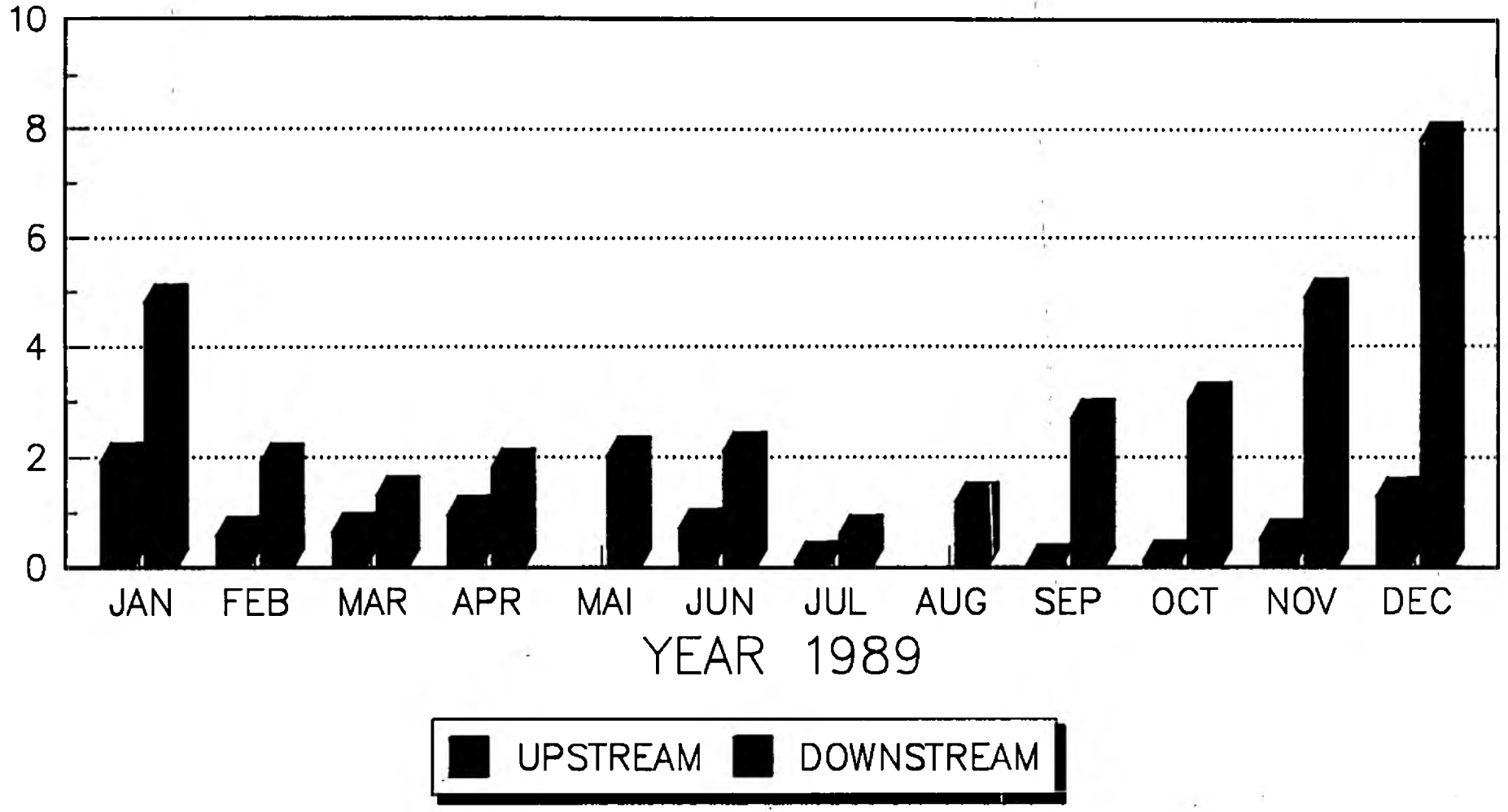
CONCENTRATIION in mg/l
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4
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0
JAN
FEB
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APR
MAI
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SEP
OCT
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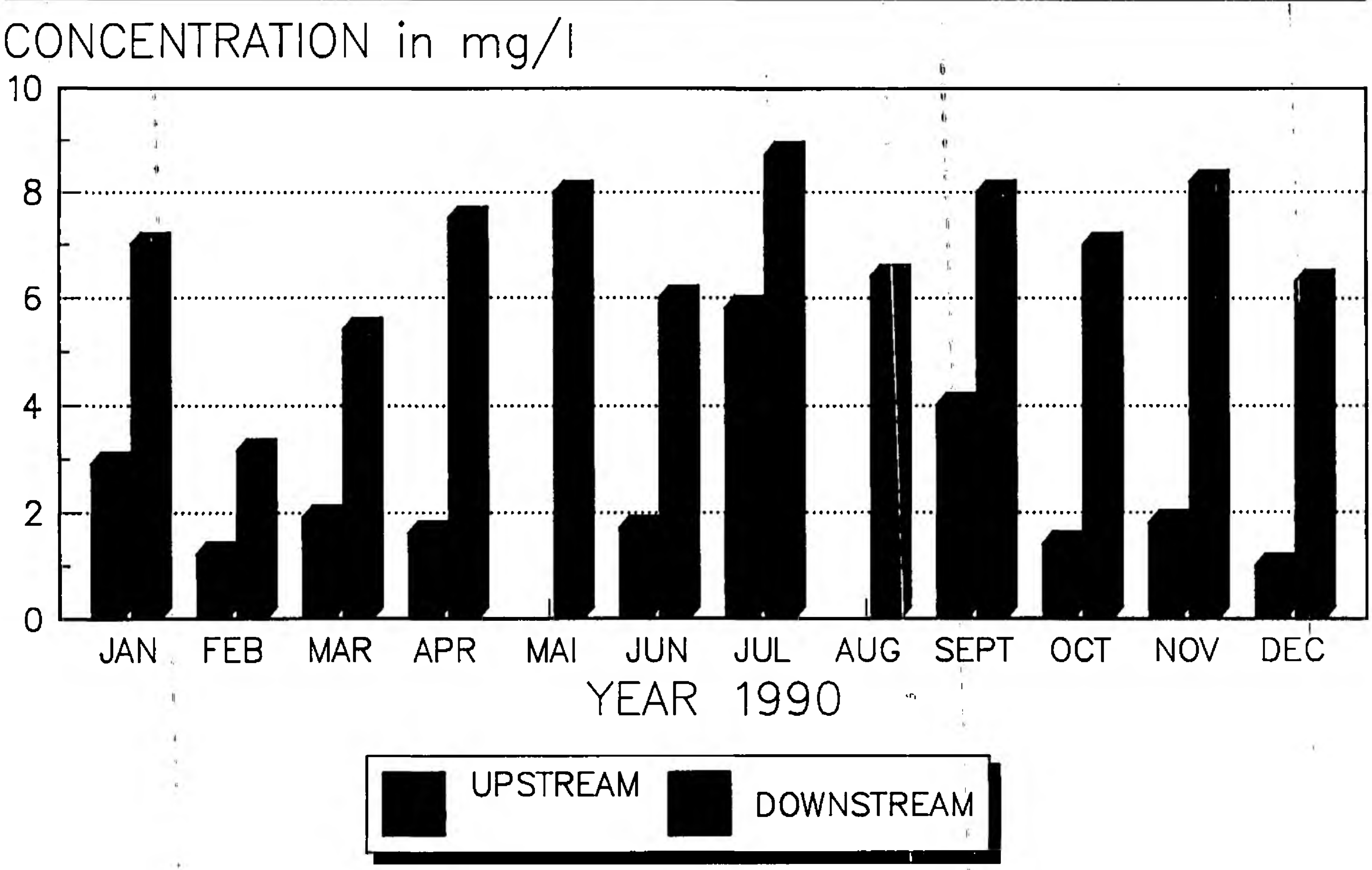
DEC
YEAR 1989
UPSTREAM
DOWNSTREAM

[redacted]


CONCENTRATION in mg/l
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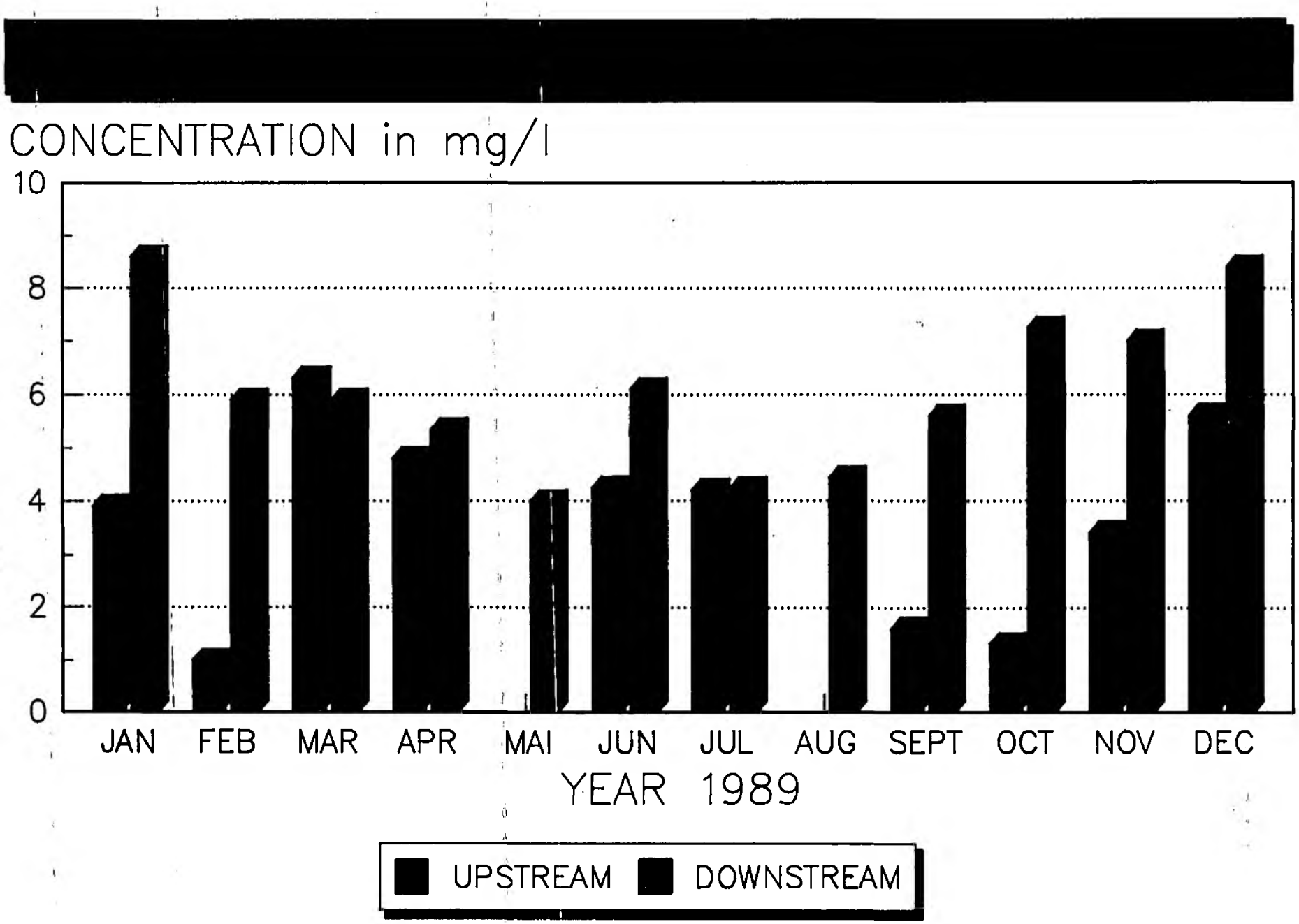
YEAR 1990
UPSTREAM
DOWNSTREAM


CONCENTRATION in mg/l
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JAN
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YEAR 1989
UPSTREAM
DOWNSTREAM

The conclusion is obviously that the discharge influences the quality of the river, but we have to put this into context. In actual fact, the upstream available data is only monthly data and it has been necessary to do the mean of the downstream sampling to be able to compare. Consequently these results should not be taken as strictly accurate.

c) Analysis of the Biological Results (5 & 6)

The biological results are also revealing. In actual fact, if you compare the observed and predicted score for the up and downstream sites, you can easily see that the difference is wider downstream which means that the invertebrates population suffers from a higher pollution than upstream.

d) Analysis of the Fisheries Results

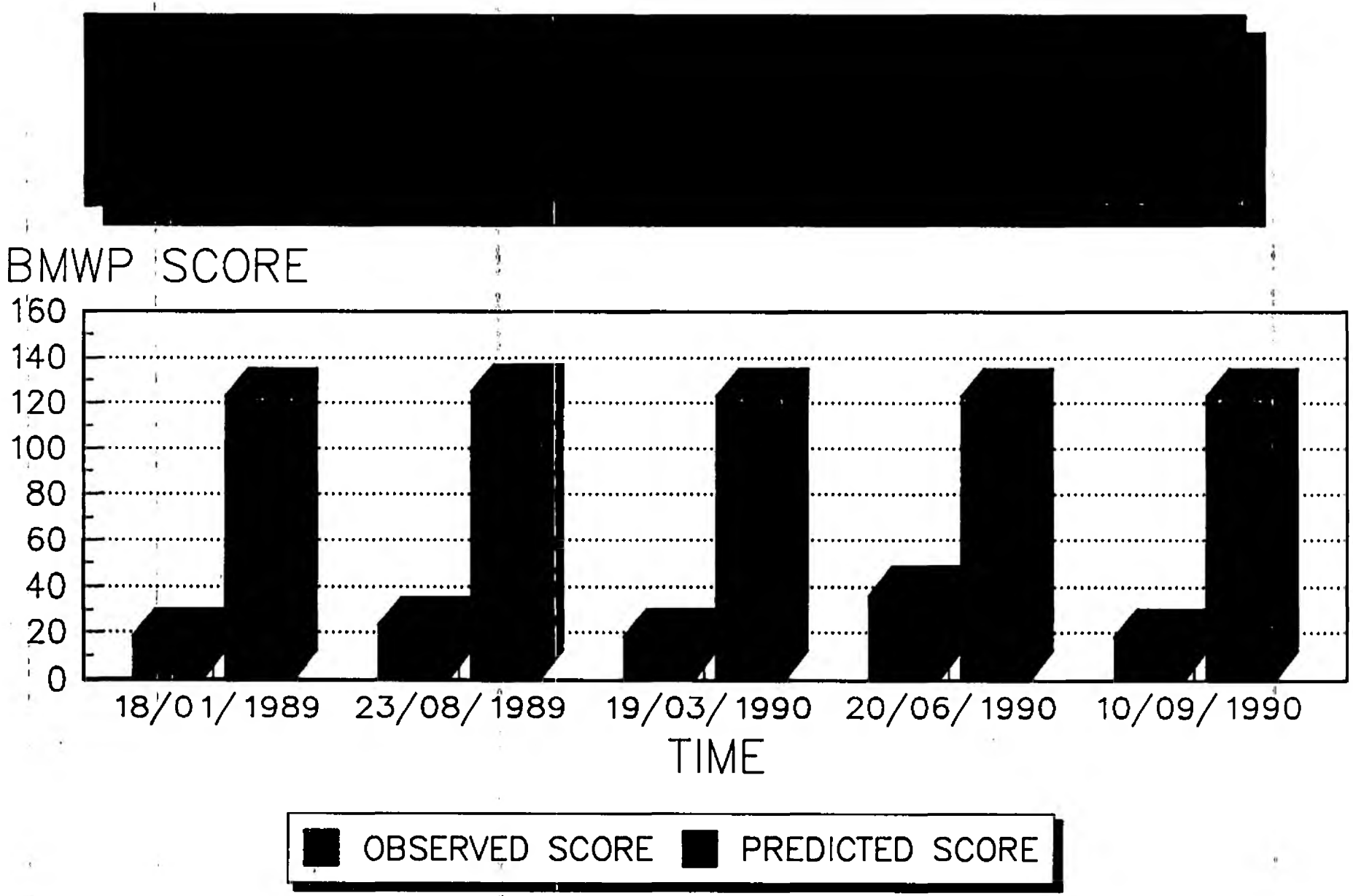
The survey results show the site immediately below the Swindon STW supports a healthy biomass (23.2 g/m^2) and density (0.370 $fish/m^2$). This is an increase in biomass in comparison to the last survey in 1988 (17.5 g/m^2). The population structure has also changed, with dace becoming dominant and roach declining. These results are not unexpected and have been found during other surveys. Though the organic load discharged from a treatment works consumes oxygen as it is broken down, oxygen levels remain at acceptable levels for a distance which varies depending on size of load, dilution factors, temperature etc.. The aggregation of fish at organic discharges can also be explained by the rich food supply in the form of increased biomass of invertebrates, algae and sewage fungus.

However, the results of the survey at Mordon Bridge show a marked contrast to those of the above sites located only 2 km upstream. The biomass and density are very poor (5.9 g/m^2) (0.002 $fish/m^2$) and only a few dace can be found. The river also reaches very low levels of dissolved oxygen. The mean at Tadpole Bridge is only 52% and 36% of the values are below 40 % (it even reaches 10 and 16%) whereas it was about 80% upstream of the STW.

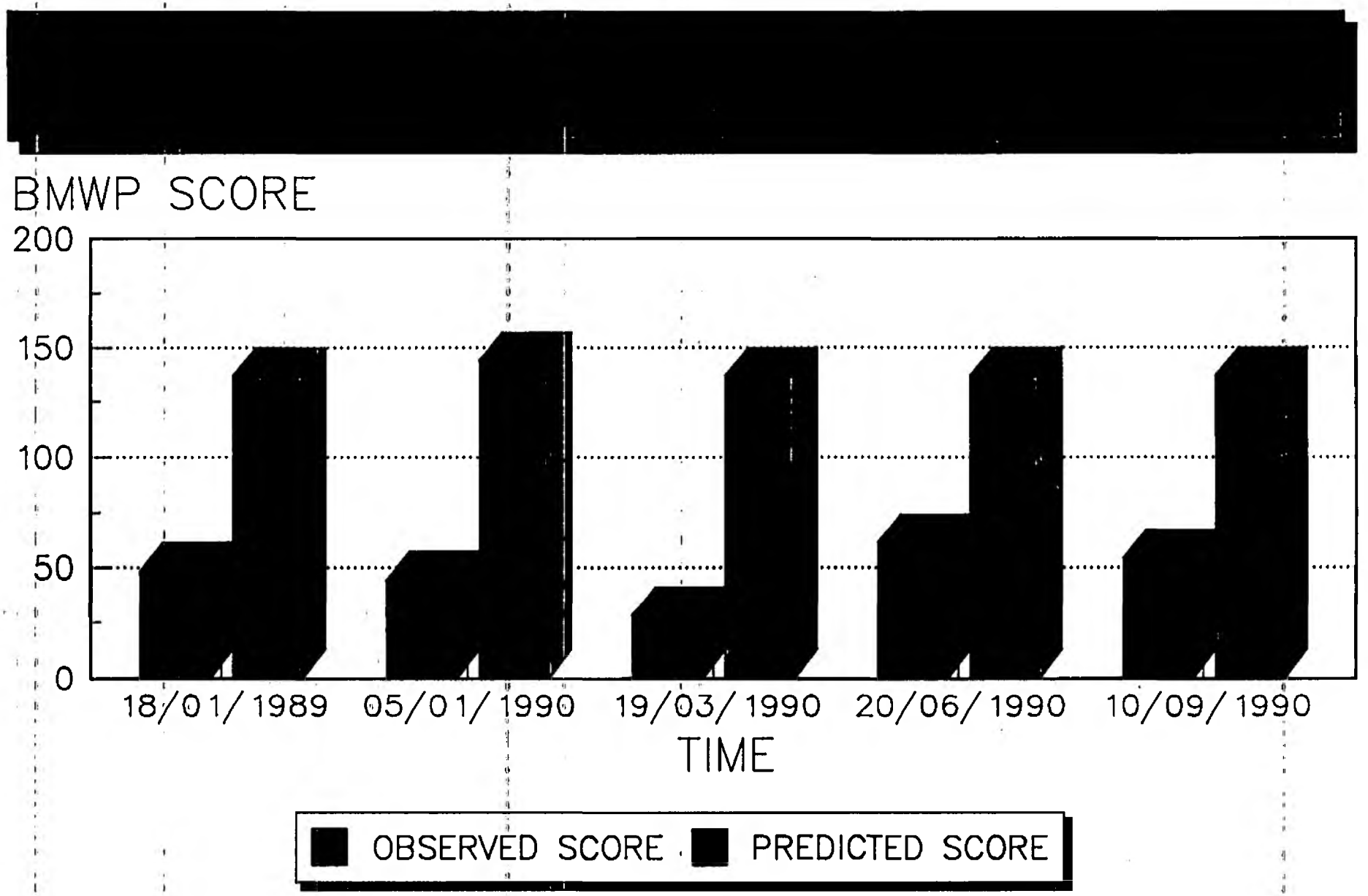
2) ANALYSIS OF THE DISCHARGE SAMPLES GRAPHS

a) Ammonia (7,8,9)

The great irregularity of the samples is shown once again and all the graphs illustrate this aspect of the discharge. The seasonal effect of this is also shown. In actual fact we can see trends from January to April and from September to December, which indicates the way the STW works. May and June 1989 reveal problems in the functioning of the station. 7 sample results exceed the consent limits.

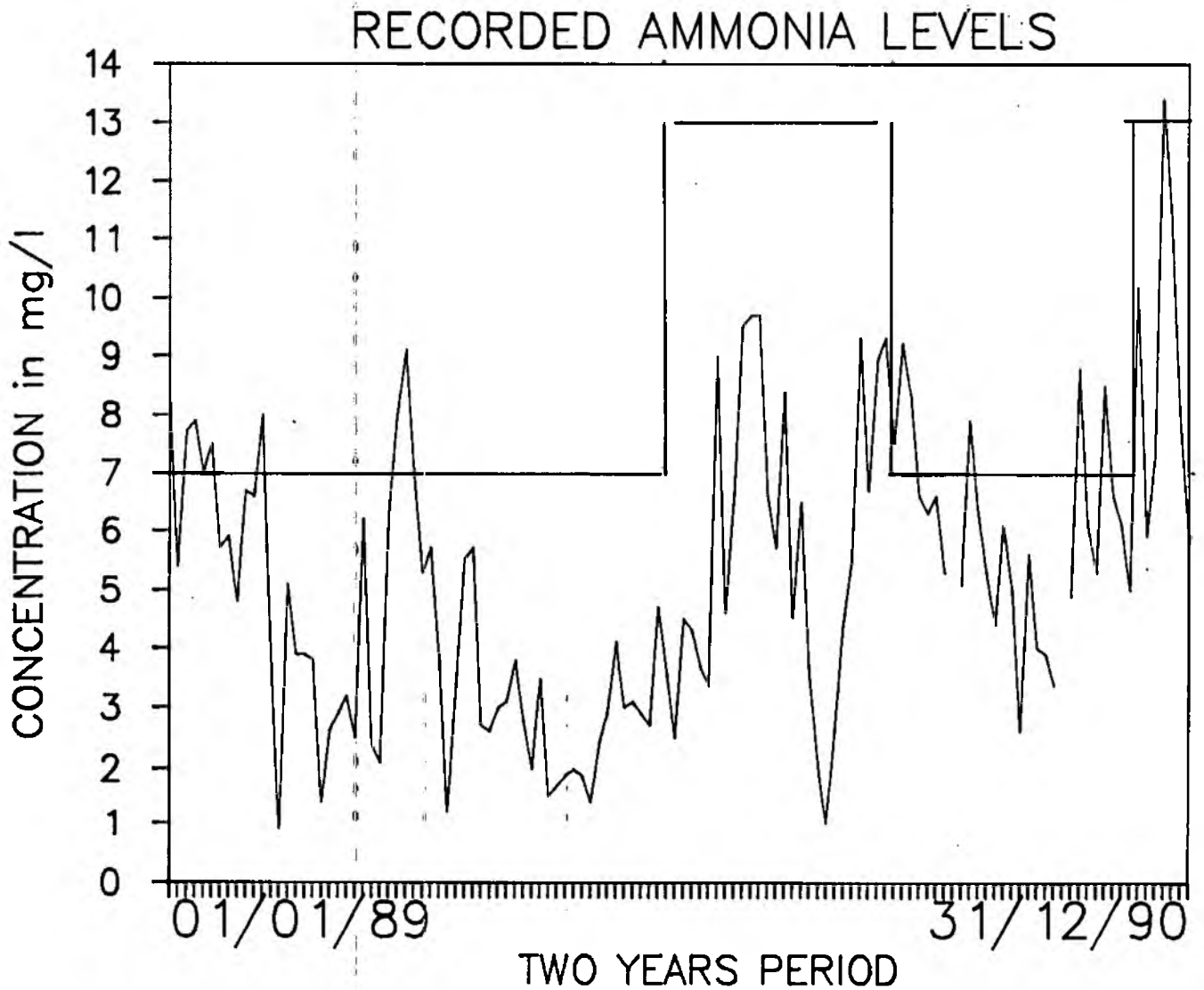


DOWNSTREAM DATAS
MOREDON BRIDGE

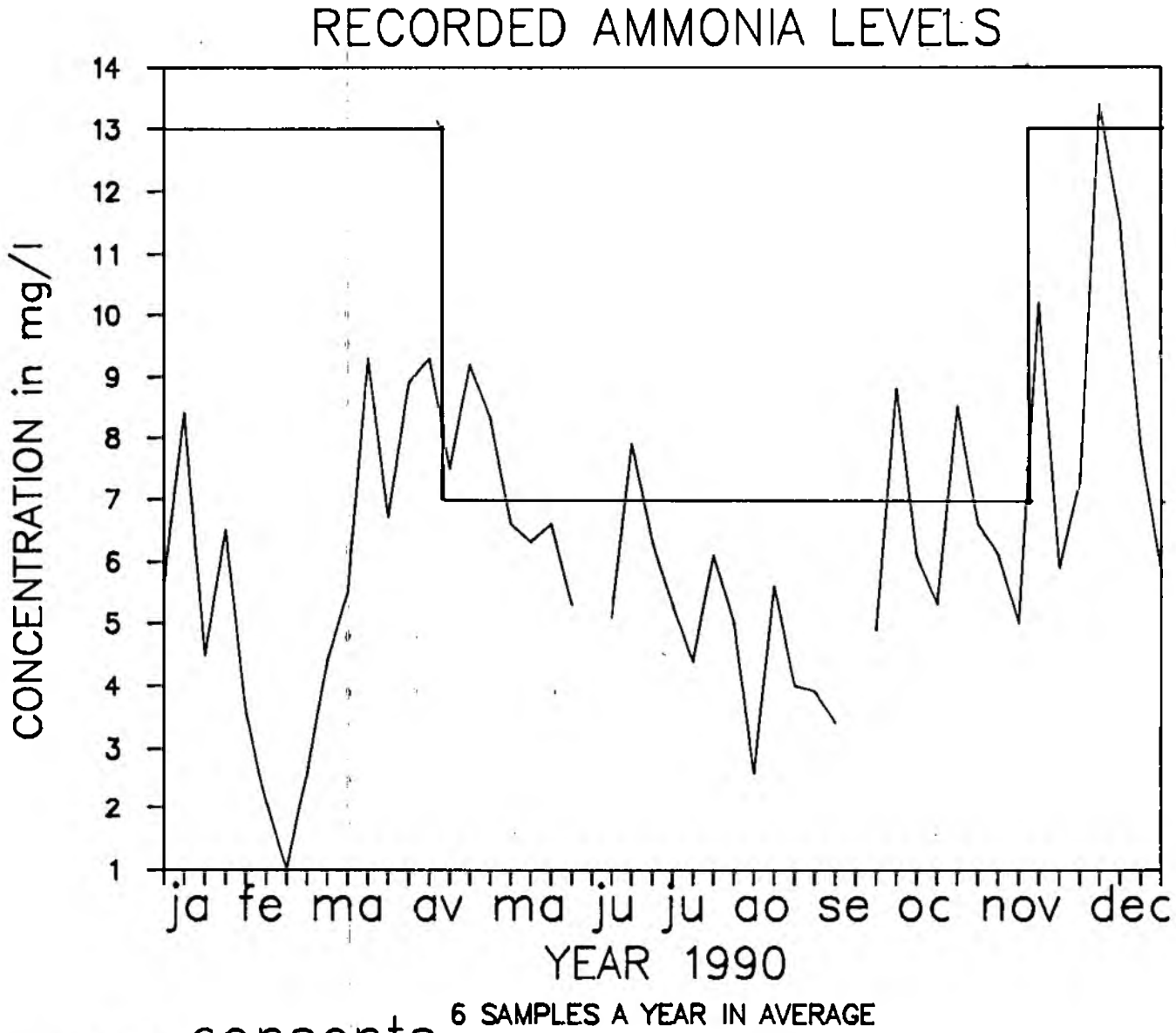


UPSTREAM DATAS
MORRIS STREET

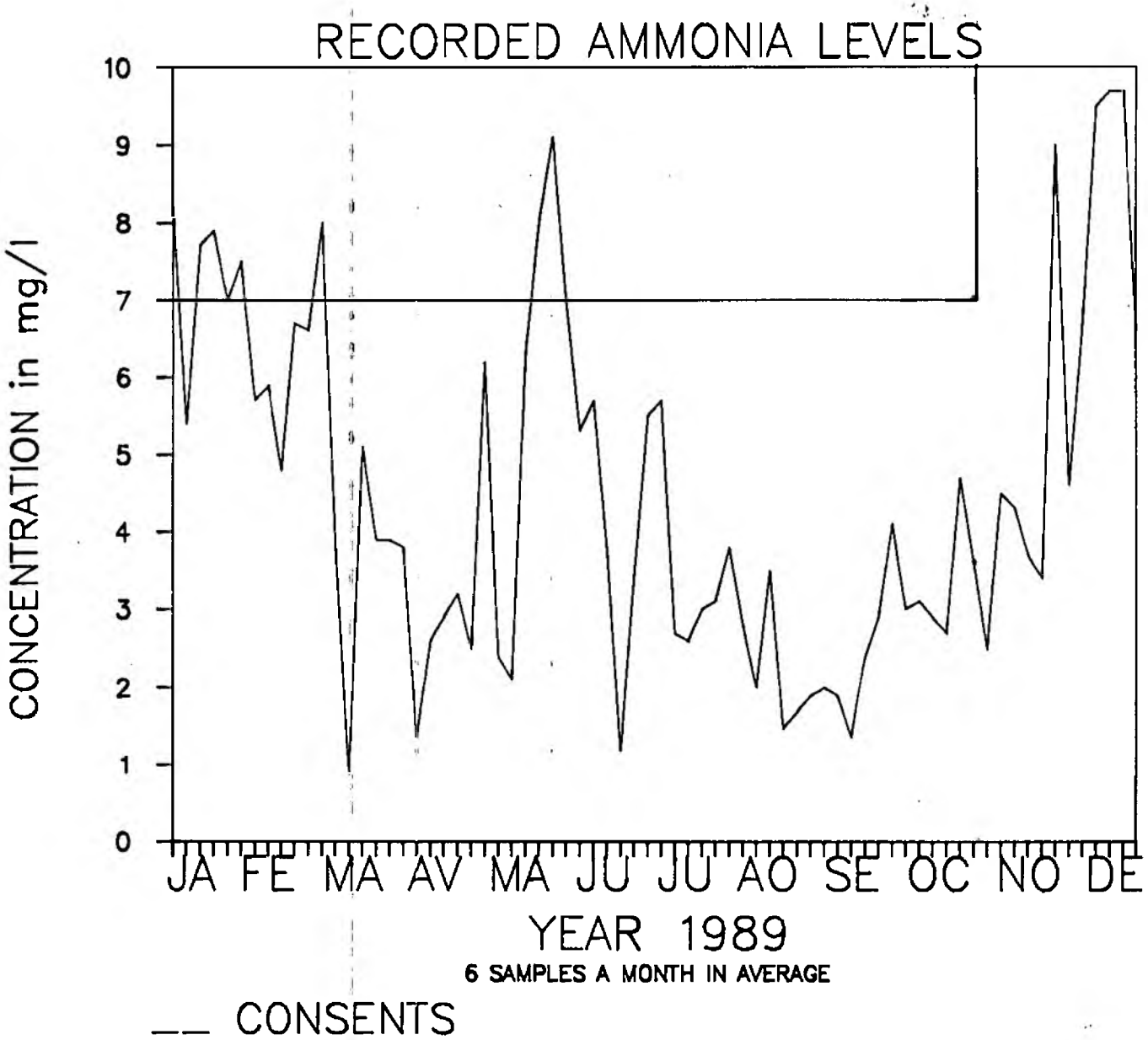
DISCHARGE CONSENTS



DISCHARGE SAMPLES



DISCHARGE SAMPLES



The discharge in 1990 contains higher ammonia levels and the general aspect of the graph shows a different distribution. The growing increase of the last term still exists but this time it reaches very high levels. March, April and May also reveal problems and July, which should have low levels of ammonia, failed as far as the consent was concerned. 7 other samples exceeded the limits.

If we have a look at the statistical look-up table which gives the maximum number of samples permitted to exceed limits for given determinands, we see that in 1990 the STW failed.In 1989, however the STW had 7 failures which was the exact number permitted by the look-up table . 50 samples have been registered in 1990, which allow only 4 samples to exceed the limits. The problem is 7 samples have failed, which should enable the NRA to prosecute the STW. Nevertheless, none of these samples are tripartite samples and the prosecution is, hence, impossible.

We might show a relationship between discharge sampling and downstream biological results if we try to link the data. Actually the surveys of 18/01/89, 19/03/90 and 10/09/90 which point out bad observed scores, take place in a period where discharge samples exceed the consents (7.6 and 7.9 mg/l in January, 9.2 mg/l in March and 8.8 mg/l in September).

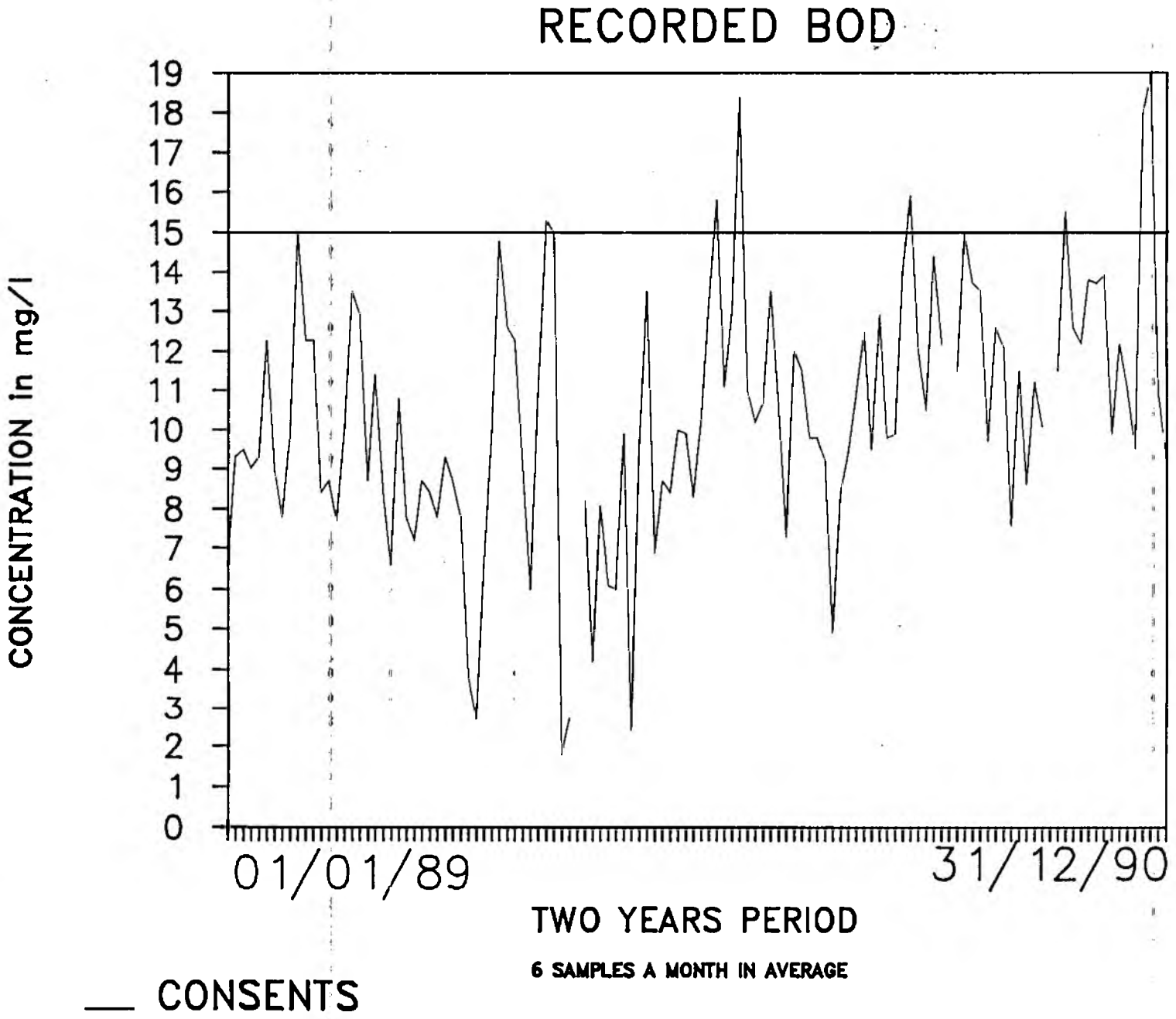
However it might not be enough to establish correlations between these factors, in so far as the two other observed scores are also rather bad but are registered in a period during which the discharge samples are about 3 mg/l, which is far below the consents.

Now, if we take these two other observed scores for granted, due to the constant discharge impact, the difference may be significant and this second approach more relevant.

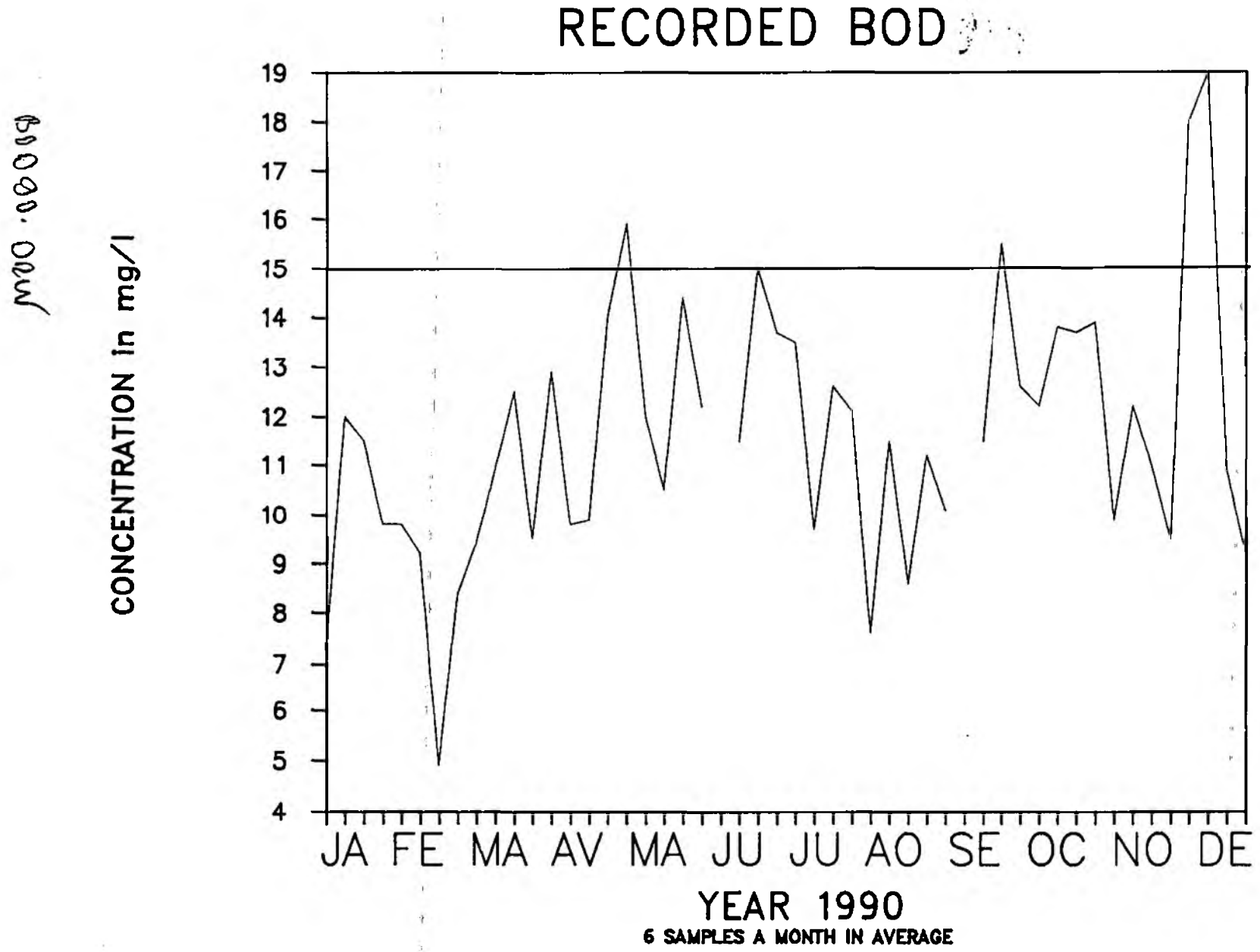
b) <u>BOD (10.11.12)</u>

The BOD has exactly the same kind of evolution as ammonia as far as 1989 and 1990 are concerned and we can also observe high BOD levels during 1989's summer and 1990's spring. As a result of this we can have the same kind of conclusion as before. The two year period graph shows an increase of BOD values beginning at the end of 1989. This must stress a problem as far as the STW is concerned. It failed this 4 times in 1989 and 3 times in 1990 which complies with the theoretical limits.

DISCHARGE SAMPLES

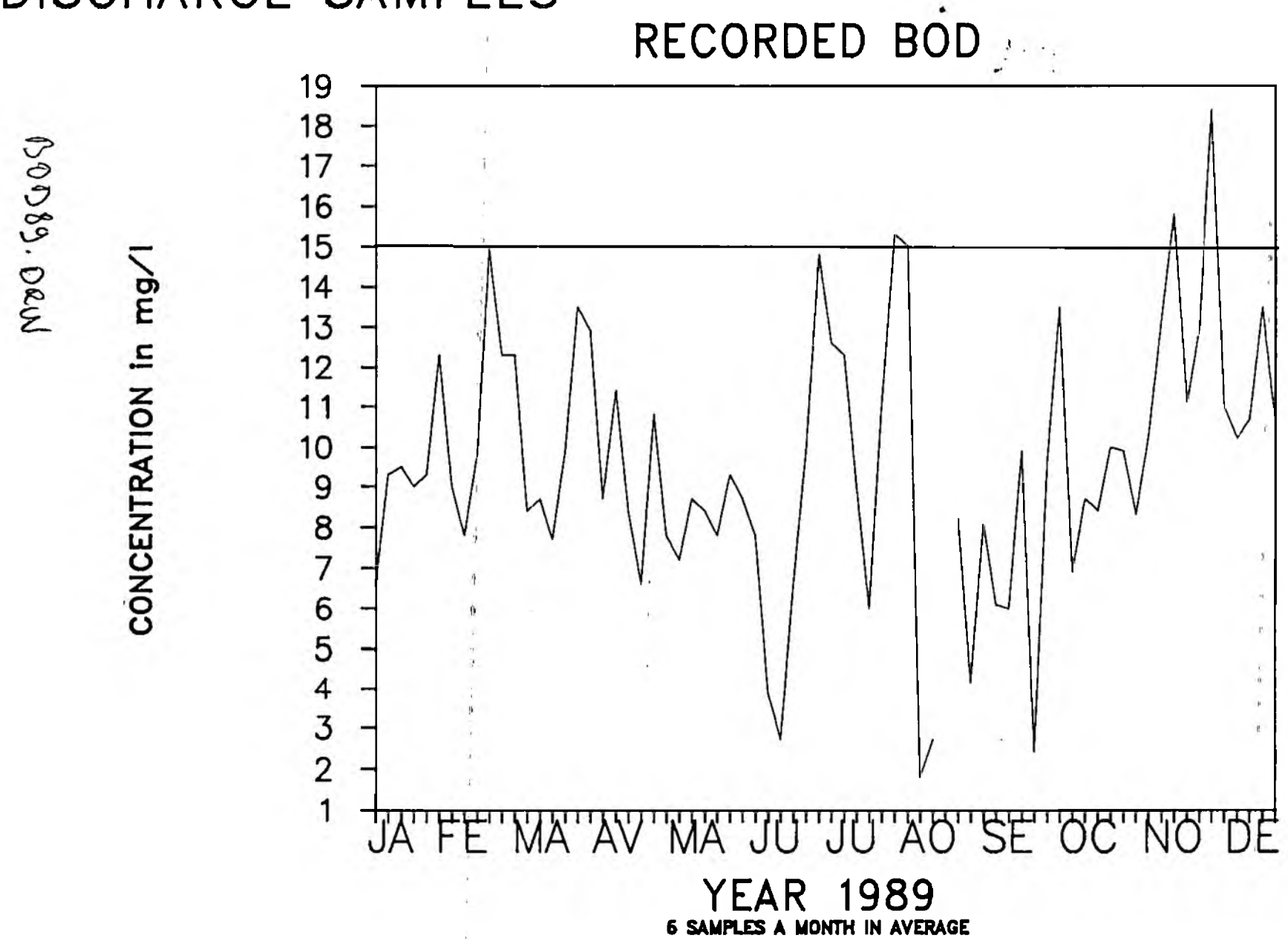


DISCHARGE SAMPLES



CONSENTS

DISCHARGE SAMPLES



c) Suspended Solids (13,14,15)

The suspended solids levels are also very irregular but do not really vary according to the season. The two year period graph enables us to see that a mean value (10-15 mg/l) could be noticed for this component. Moreover, it seems that the suspended solids level has increased in 1990 and reaches higher levels than during the previous year, which might confirm the fact that the STWs find it hard to keep up with the required levels.

3) CONCLUSIONS

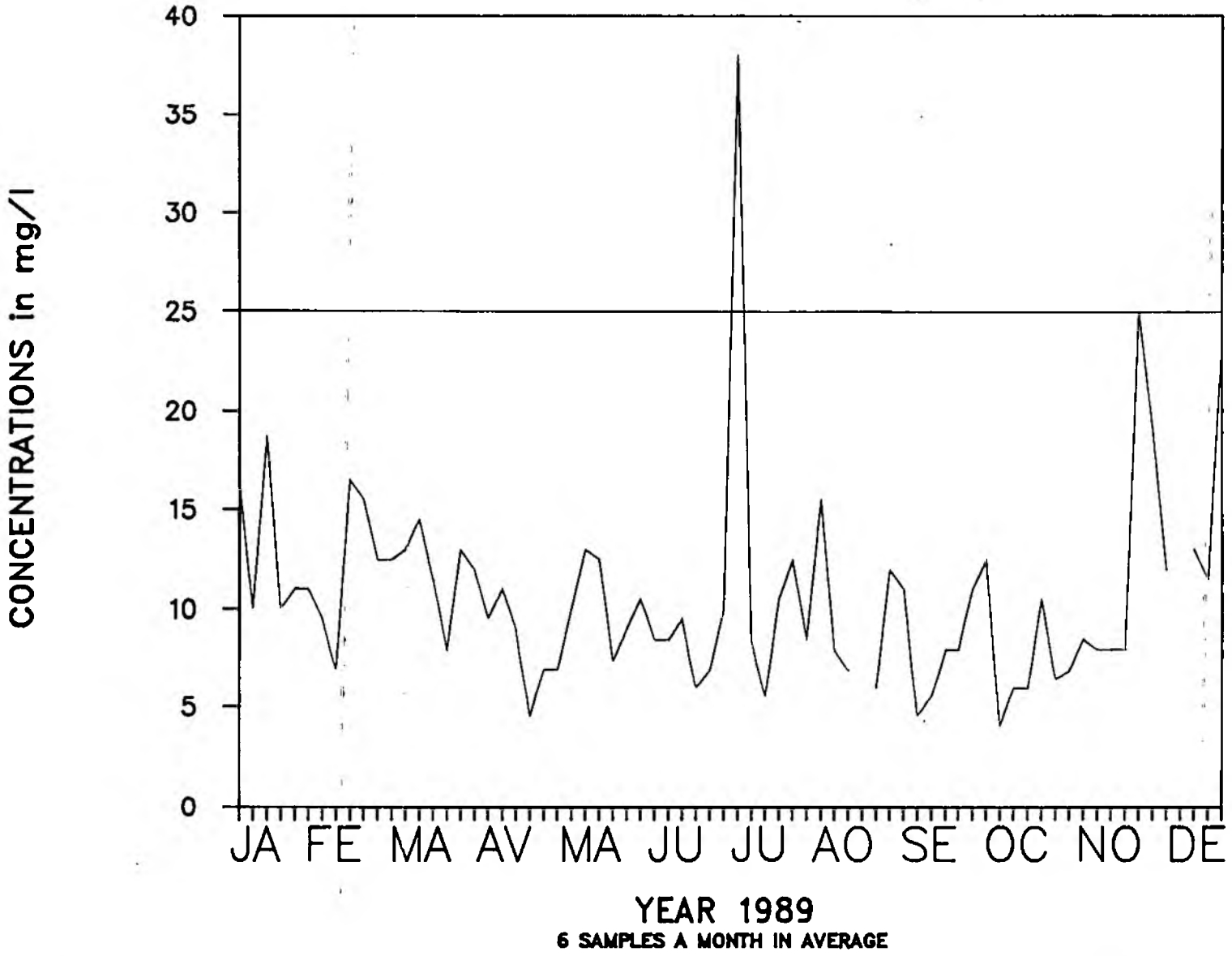
The comparison between upstream and downstream data stresses indisputably the impact of the Swindon STW on the river. In actual fact, data concerning biochemical and biologicals criterions reveal a very negative influence. But these results have to be criticised in so far as they stem only from a few data.

The discharge data sort of reveal the health of the works and if 1989 was rather good as far as ammonium, bod and suspended solids are concerned, it is not really the case in 1990.
The observed ammonia levels go beyong the authorised levels and the station failed. However Swindon STW can not be prosecuted in so far as most of the sample are routine samples (not tripartite) . The other biochemical components comply with the consent, but all of them show a degradation in the quality of water, which illustrate the problems the station is faced with.

DISCHARGE SAMPLES

SOL 89.DRW

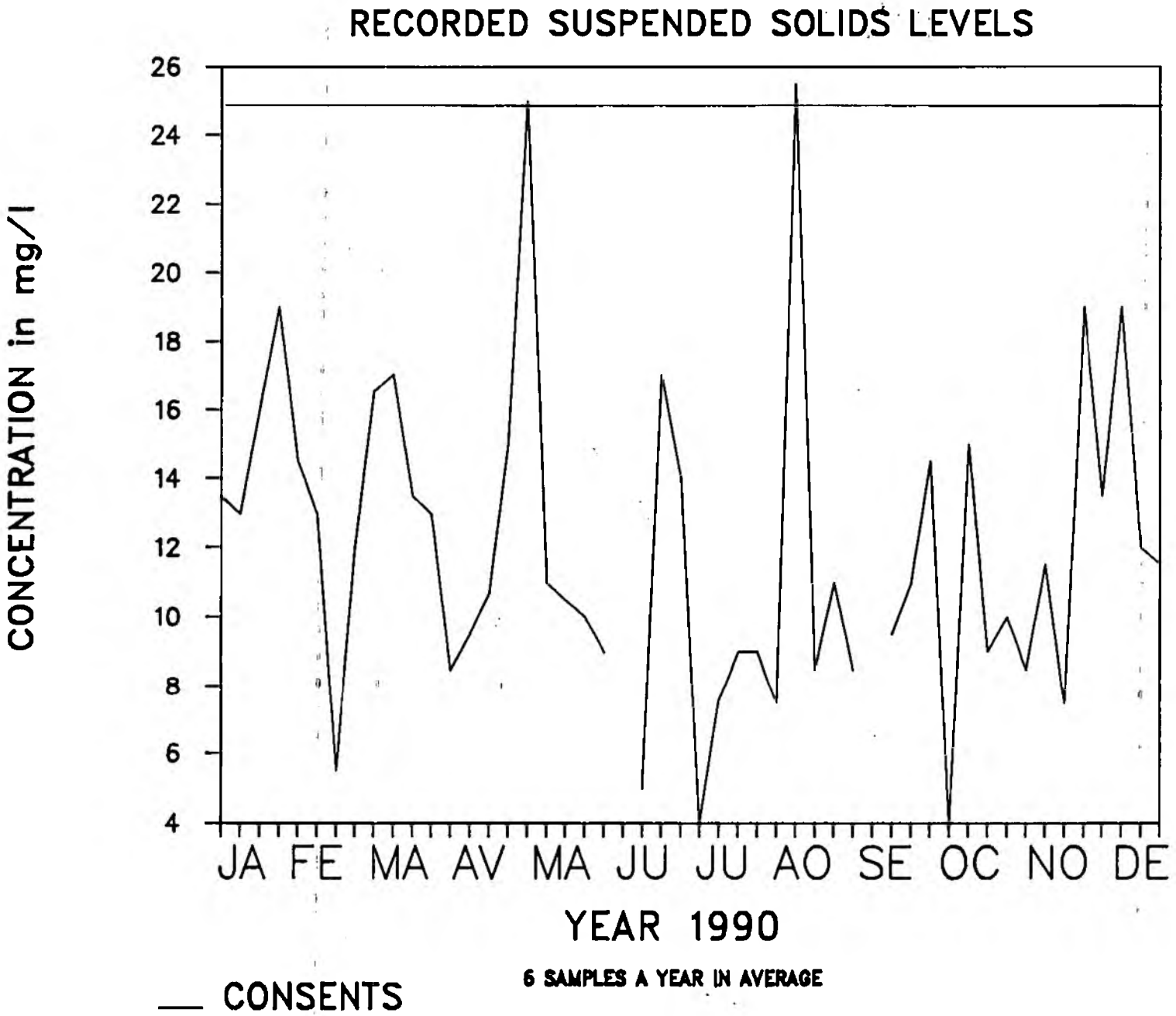
RECORDED SUSPENDED SOLIDS LEVELS



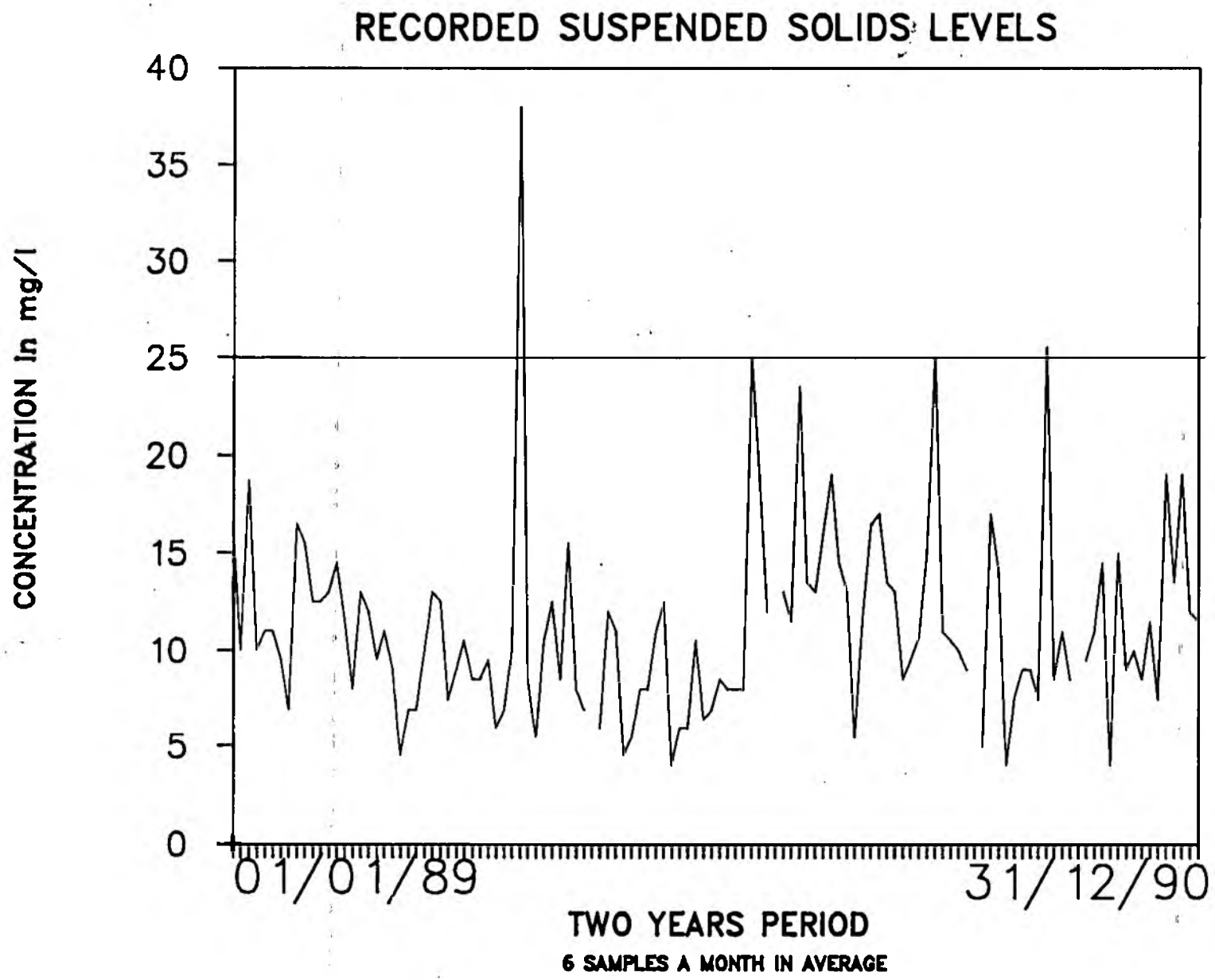
— CONSENTS

DISCHARGE SAMPLES

Mod. 06705 Dew



DISCHARGE SAMPLES



RIVER LEE

I INTRODUCTION

1. THE RIVER QUALITY OBJECTIVES

The manual samples taken in Morris Street tend to confirm that the standards are respected. In actual fact all the BOD data is below the 9 mg/l value and the DO data above 40% of its samples (Moredon Bridge) fitting with required concentrations. The last section seems, however, to be less successful in so far as both the samples taken in Tadpole and Seven Bridges don't fit in with the 95% required.

II RESULTS

1. COMPARISON OF THE UPSTREAM AND DOWNSTREAM SAMPLES

a) Analysis of the Ammonia as N Level (17)

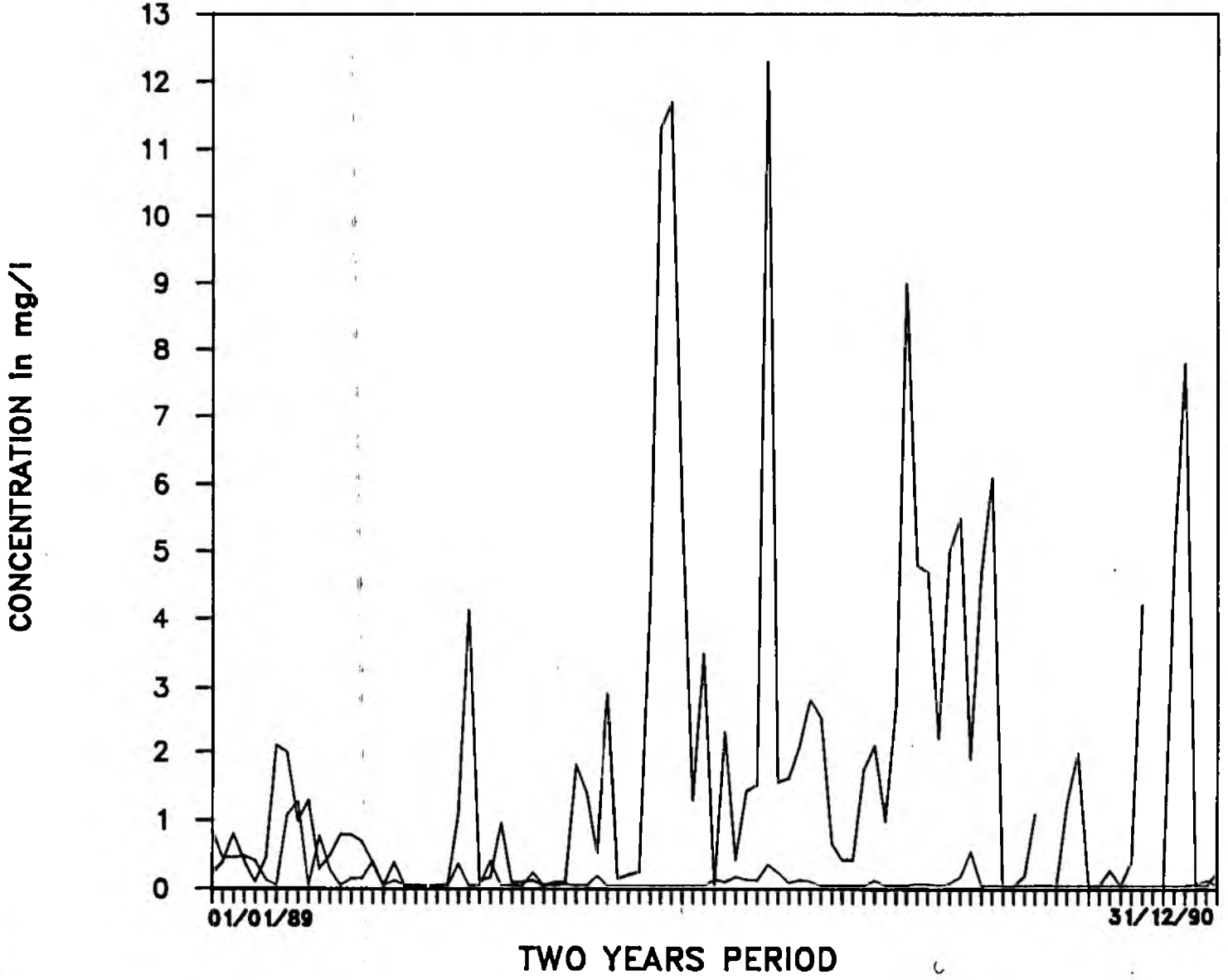
All of the samples have been taken together and regularly which enables a very good vision of the reality. The first thing to notice is the striking difference between upstream and downstream ammonia levels. The upstream curve shows a very low level, whith small peaks, whereas the downstream one shows difficulties. The period from the end of 1989 to the end of 1990 stresses a degradation of the quality of water. The missing values observed are from pollution incidents, which reach high levels and do not really reflect the general behaviour of the works.

b) Analysis of the BOD (18,19,20)

The curves are more difficult to analyse but we can see in 1989 that the concentrations are on the whole rather low. The downstream concentrations have a decreasing tendency, with only two high values likely to come from the works. Most of the peak probably stem from the LEE as a result of heavy rain or something else.

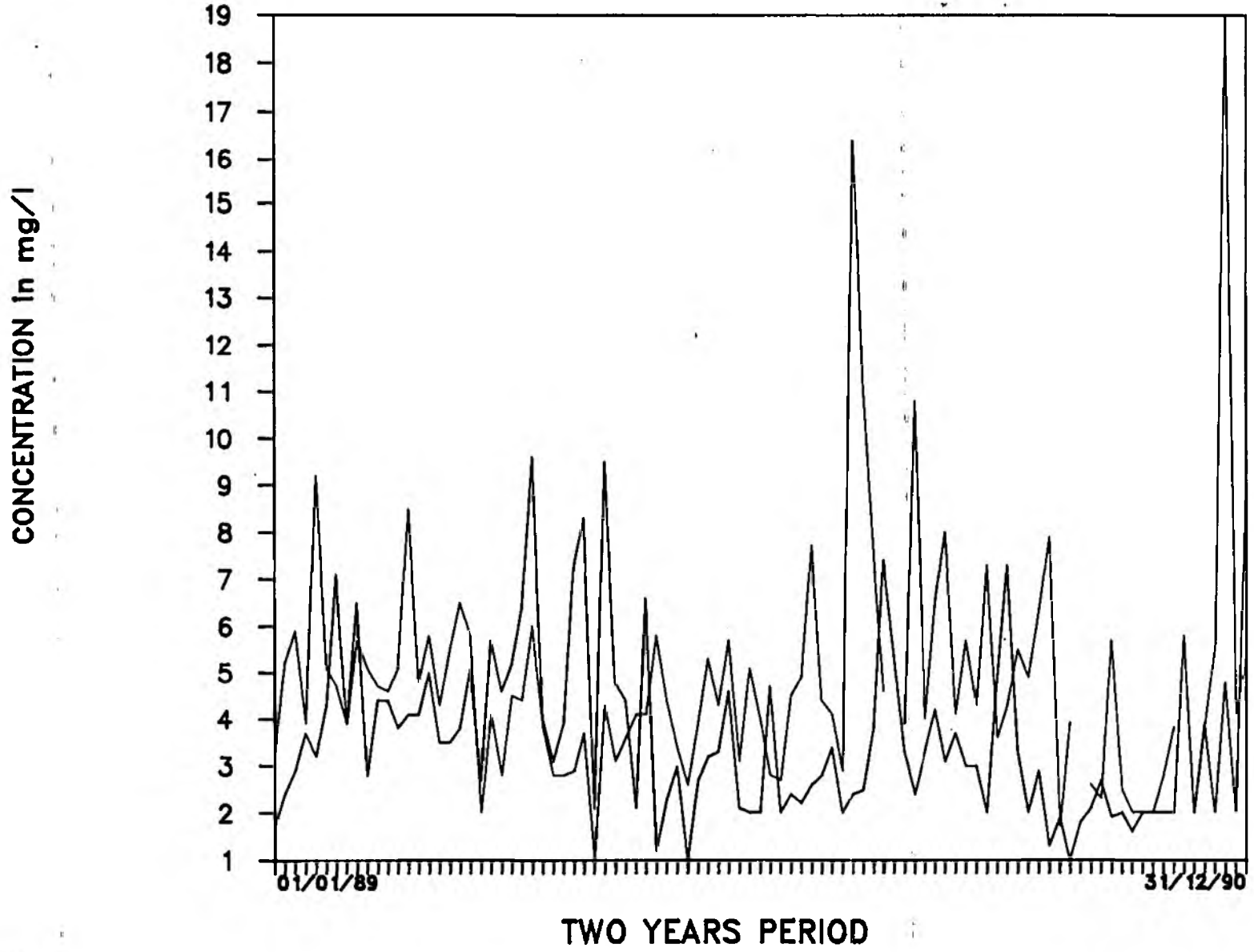
The year 1990 shows a few excesses and an increase of the levels all through the year.

COMPARISON OF THE UPSREAM AND DOWNSTREAM CONCENTRATION OF AMMONIA AS NH4



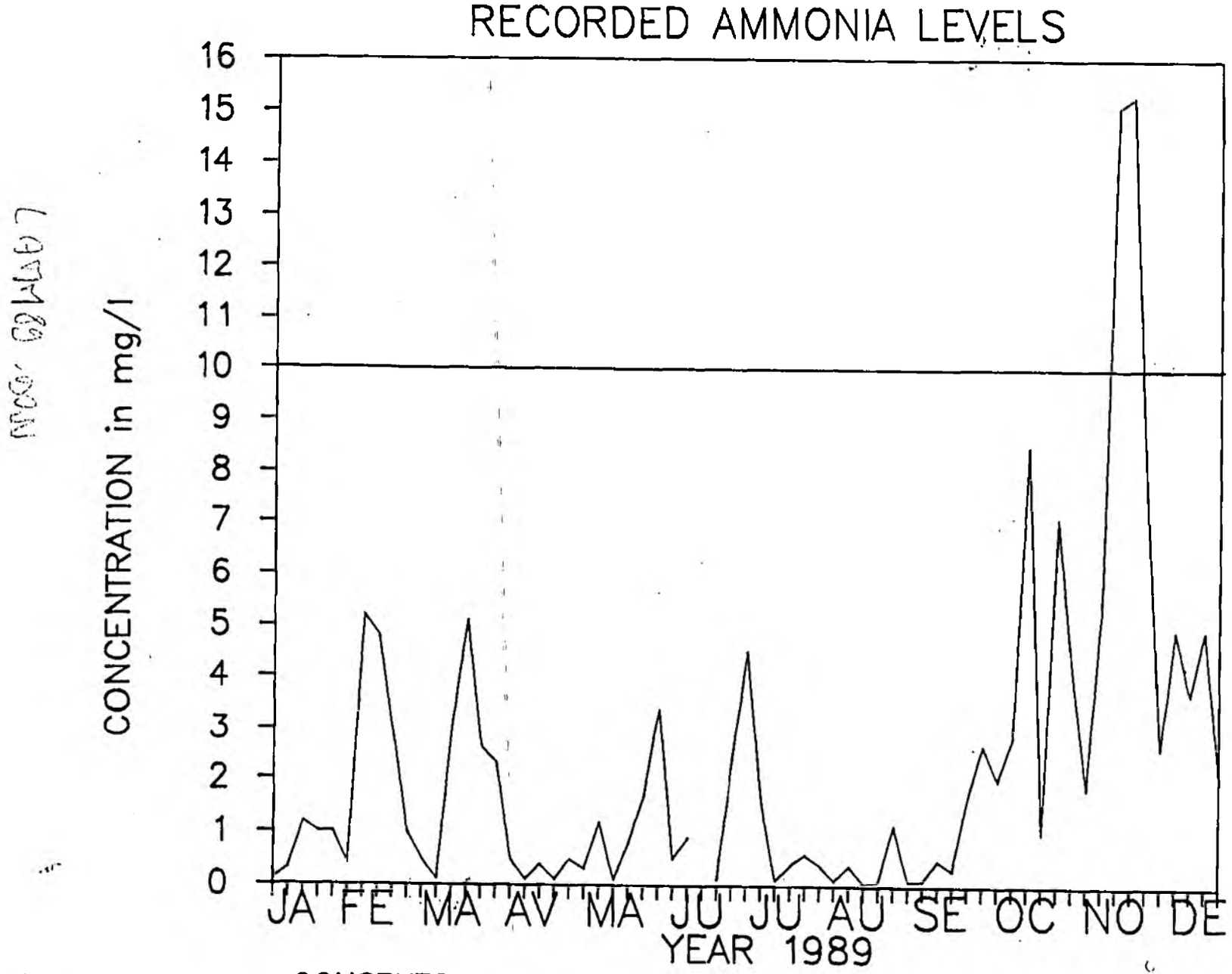
LUTON

COMPARISON OF THE UPSTREAM AND DOWNSTREAM BOD



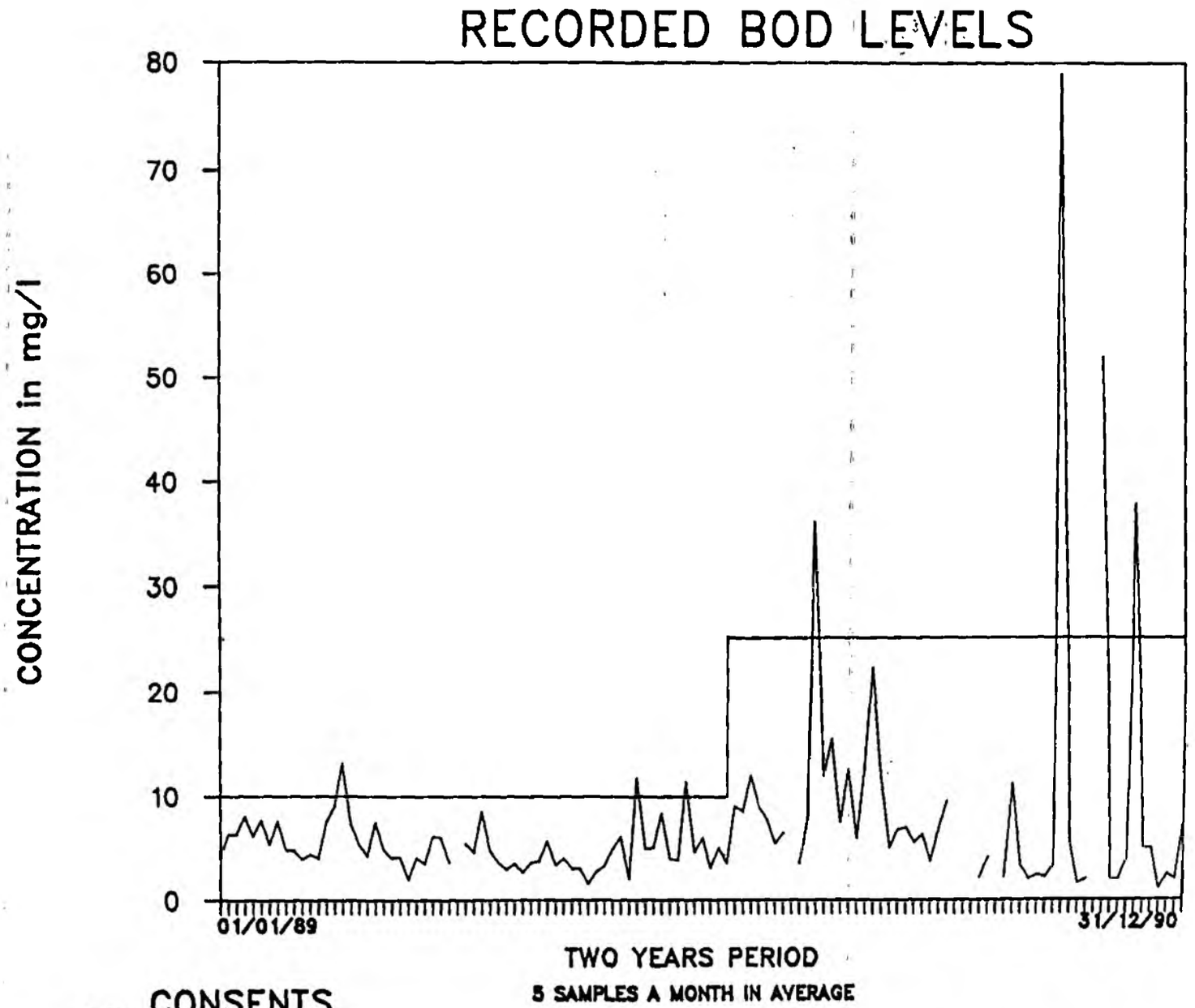
LAMCOD.DAT
LCOMPARM.DAT

DISCHARGE SAMPLES



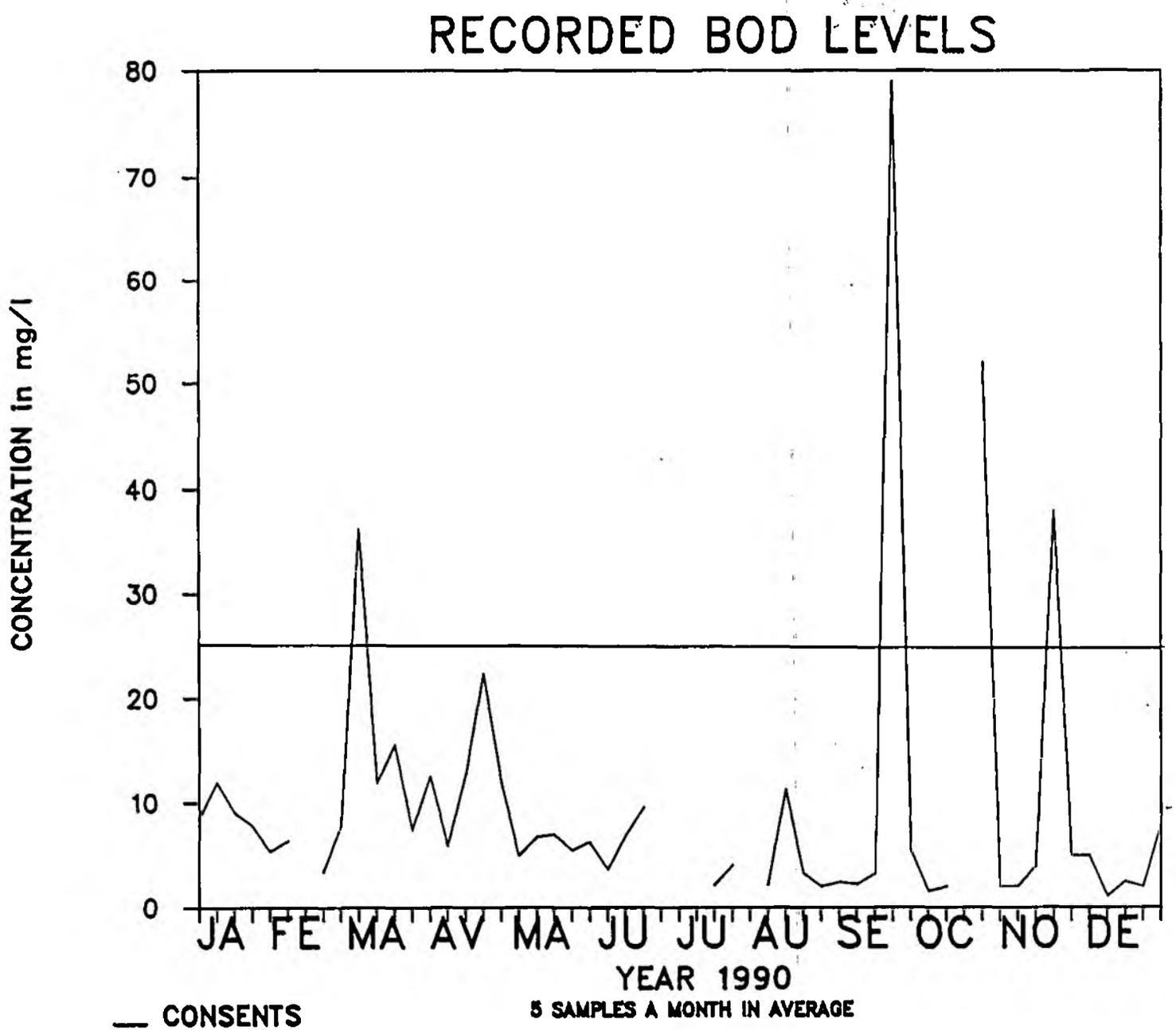
LUTON STW ___CONSENTS 5 SAMPLES A MONTH IN AVERAGE

DISCHARGE SAMPLES

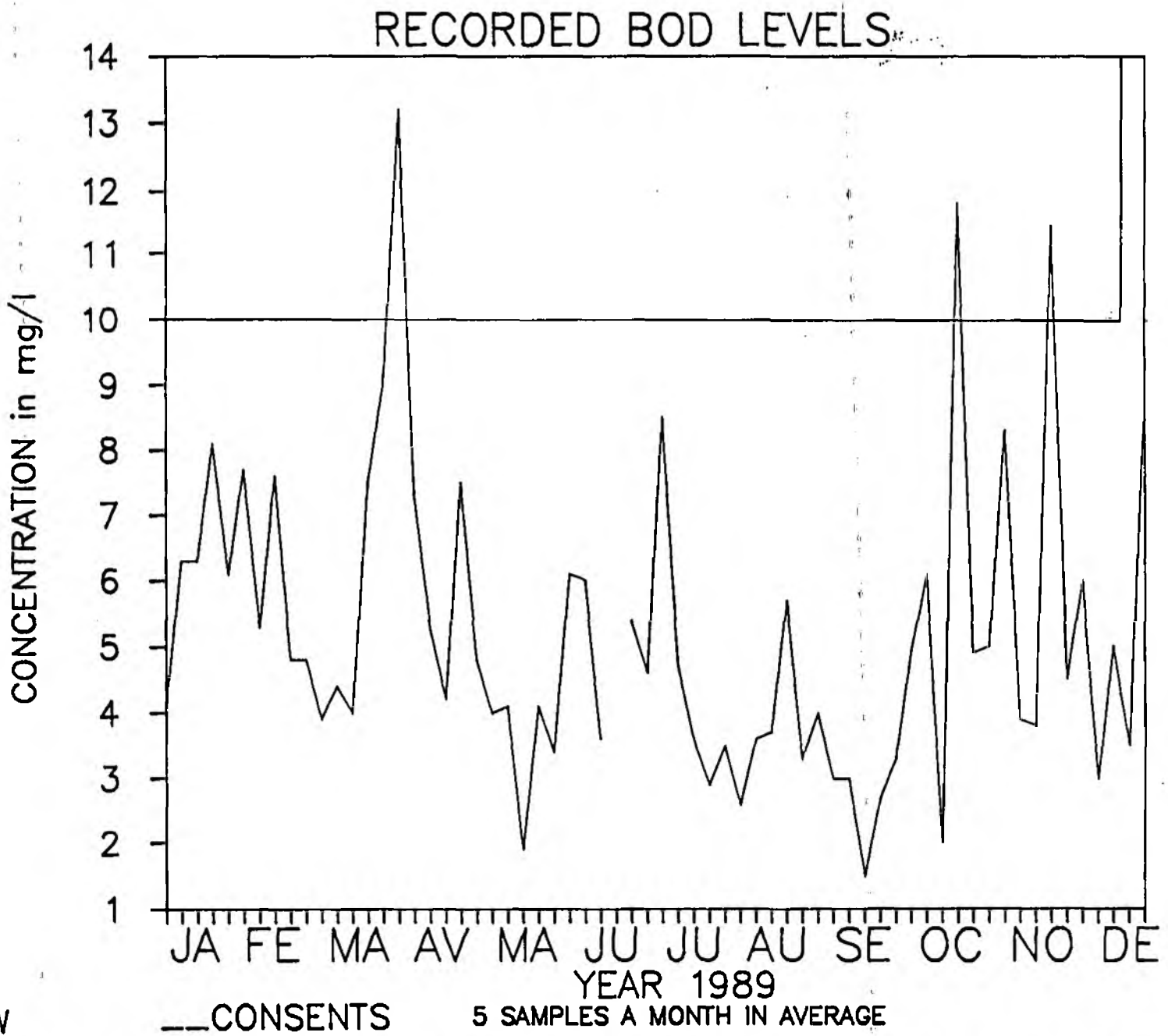


LOADINGS DRY

DISCHARGE SAMPLES



DISCHARGE SAMPLES



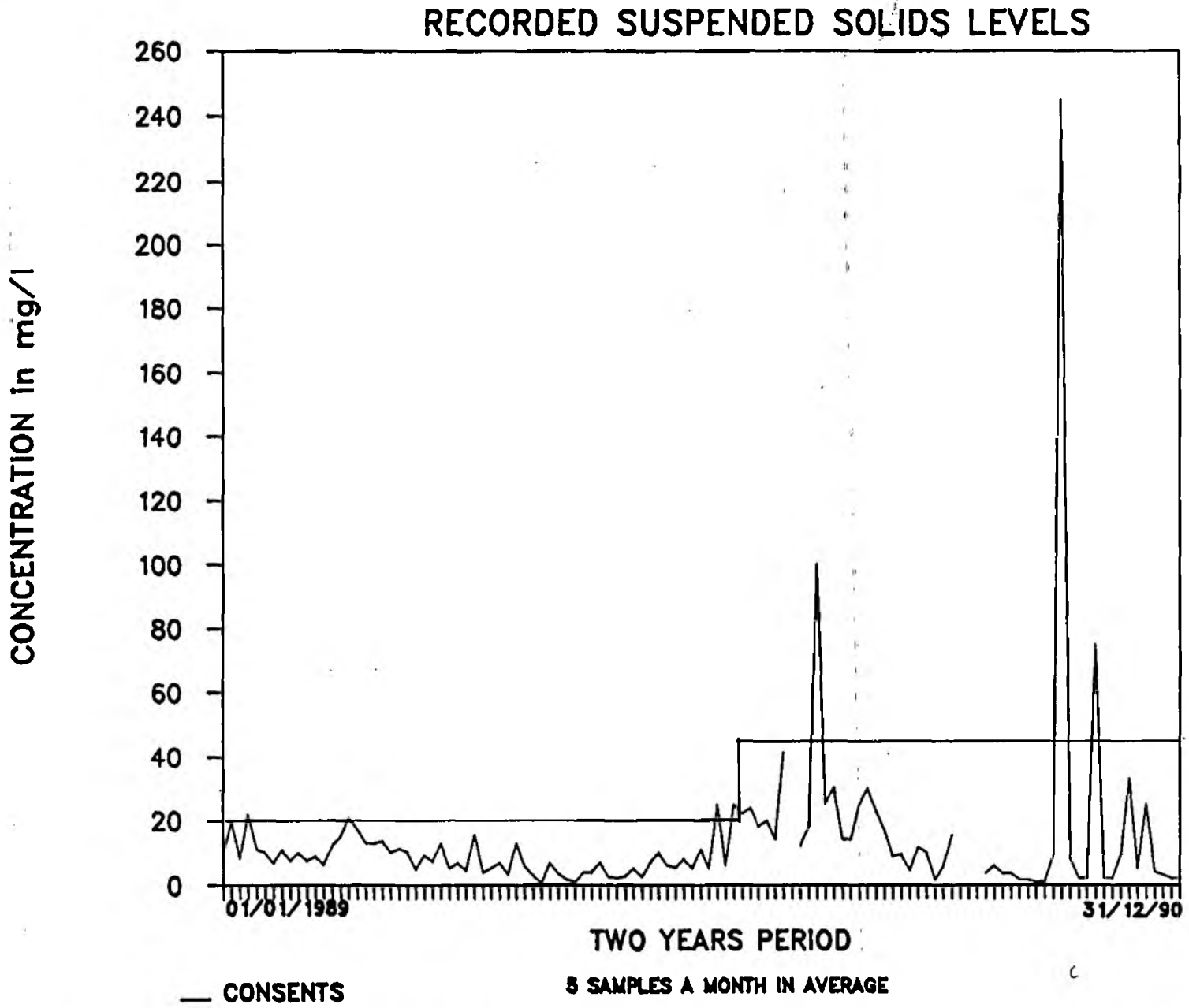
LUTON STW

__CONSENTS

5 SAMPLES A MONTH IN AVERAGE

LBOD 80 Obs

DISCHARGE SAMPLES



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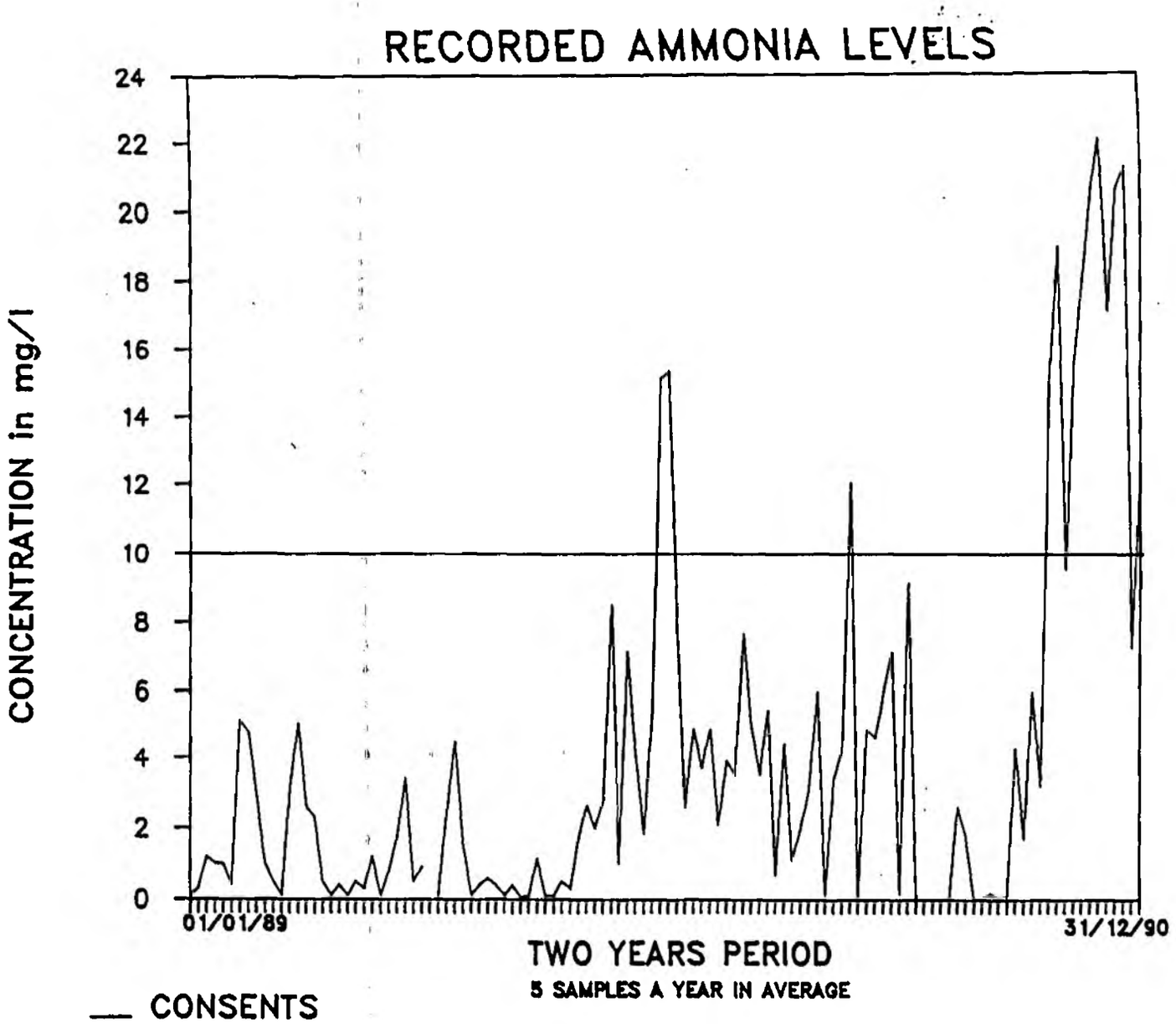
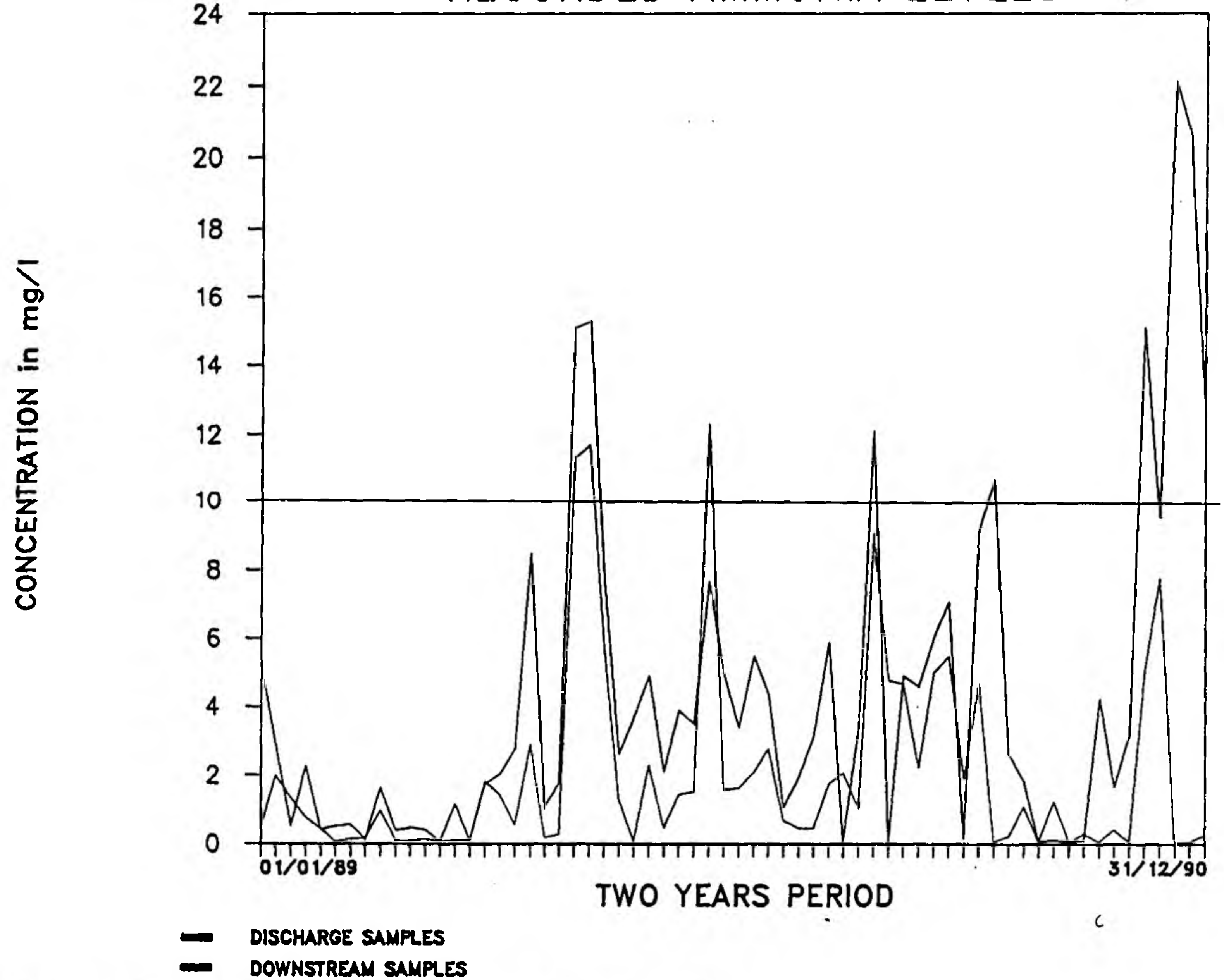
DISCHARGE SAMPLES



LOANLOANS.DOW

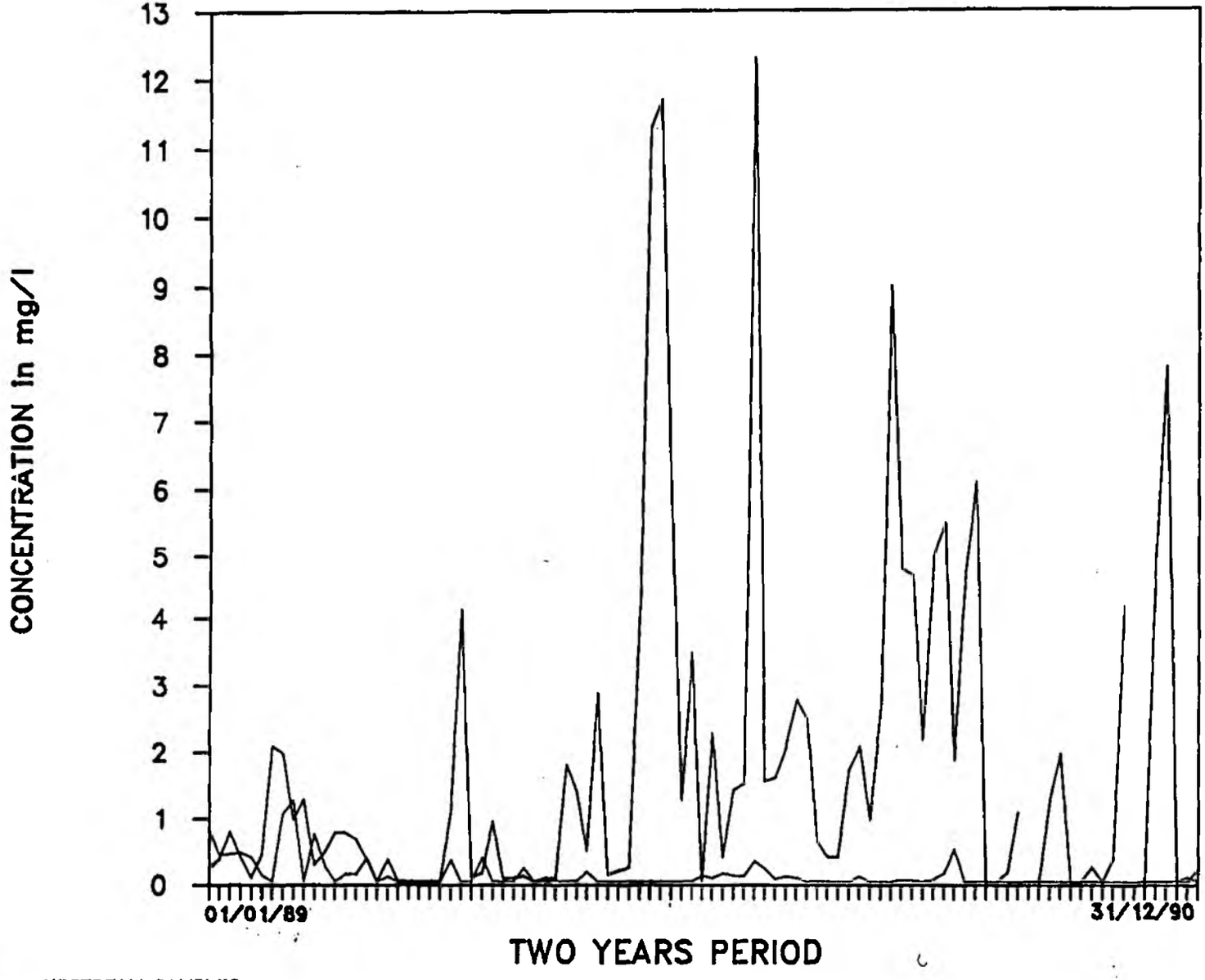
RELATIONSHIP BETWEEN DISCHARGE AND DOWNSTREAM SAMPLES

RECORDED AMMONIA LEVELS



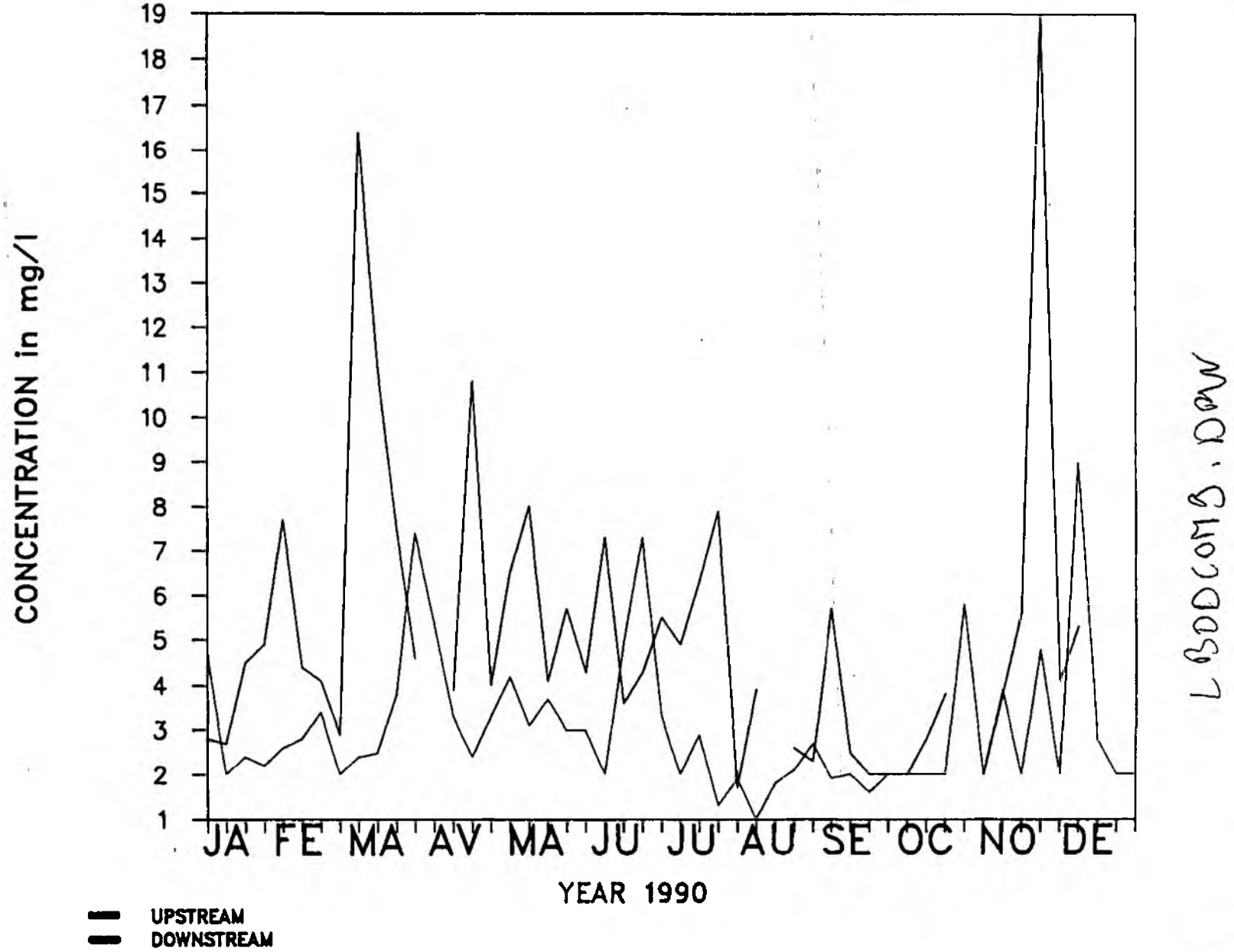
LDISDWN.DRW

COMPARISON OF THE UPSREAM AND DOWNSTREAM CONCENTRATION OF AMMONIA AS NH4

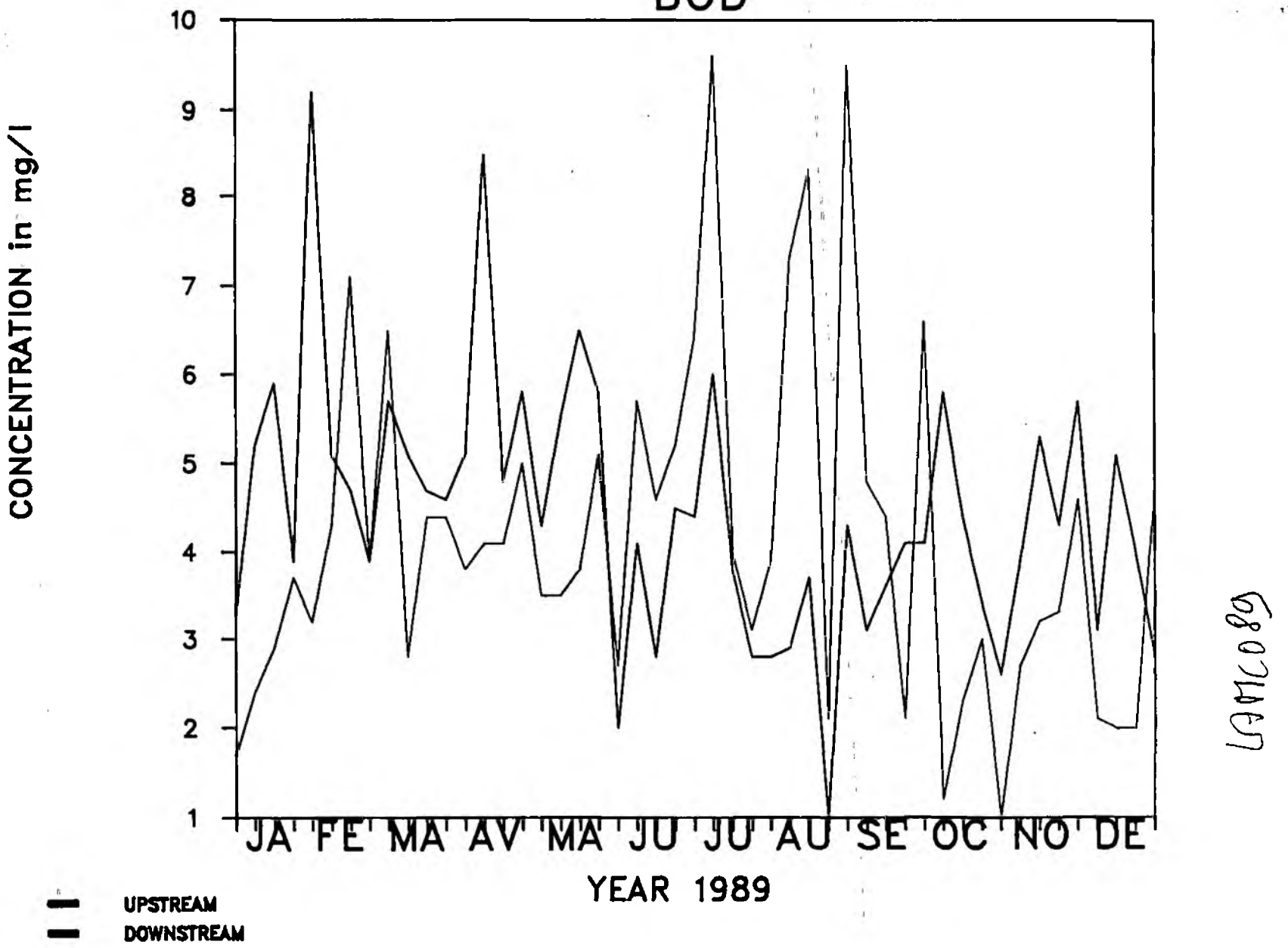


LUTON

COMPARISON OF THE UPSTREAM AND DOWNSTREAM BOD



COMPARISON OF THE UPSTREAM AND DOWNSTREAM



LA01089

c) Analysis of the Biological Data (21,22)

The score predicated at East Hyde road Bridge is higher than those from the upstream sample site. Now the observed scores are always lower downstream than upstream, which urges us to think that the river is more polluted after the work than before.

2) ANALYSIS OF THE DISCHARGE SAMPLES

a) Ammonia (23,24,25)

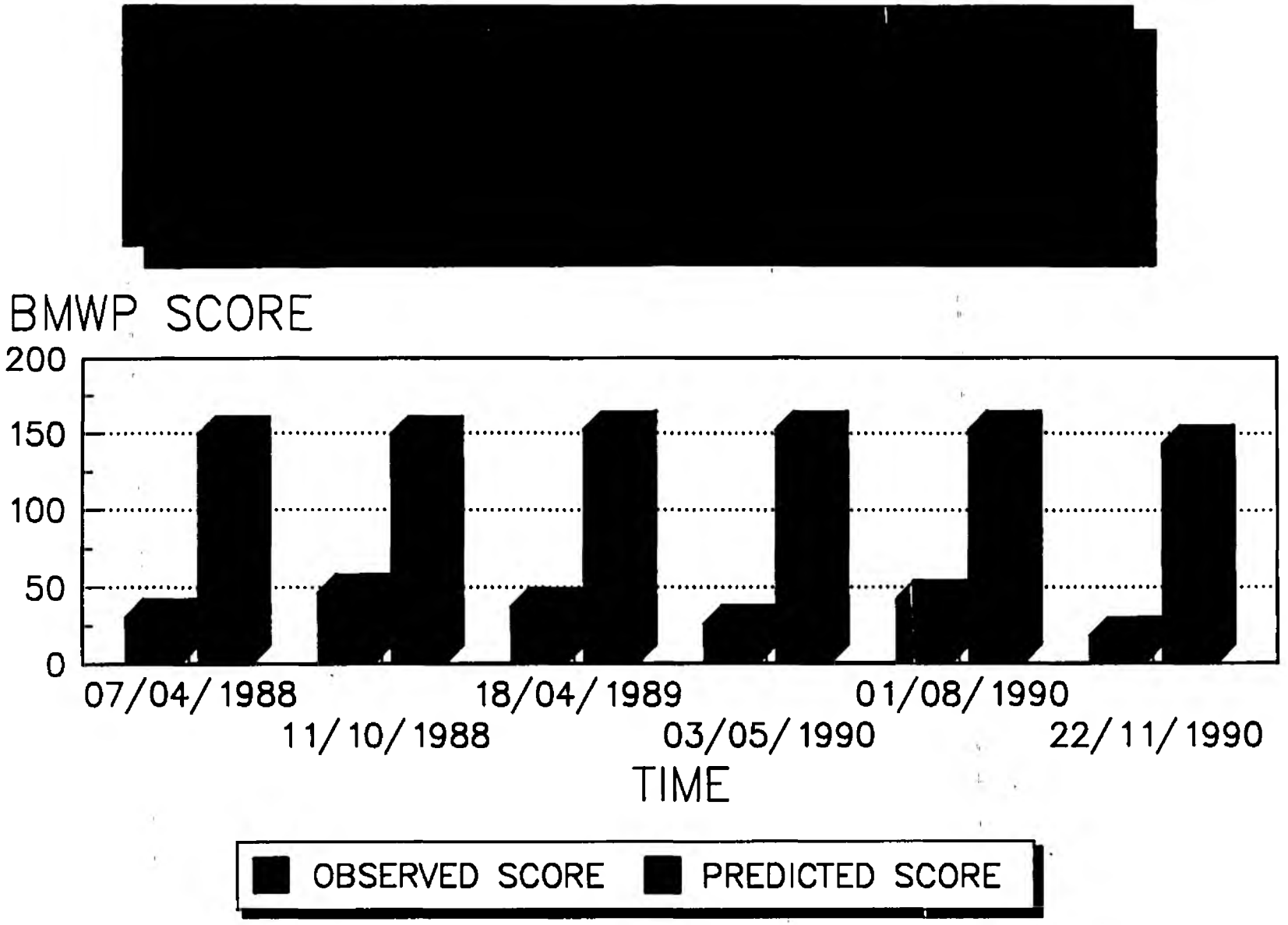
The first eight months of the year in 1990 enhance quite a good behaviour of the works but the situations starts to change from September to December. In actual fact, samples reach high levels which are above consent levels. 1990 is far more negative and if the general behaviour of the discharged level is the same as in 1989, the concentrations are much higher. We can notice the same drop in July and August and the same excess from September to December. A few incidents characterised by high levels are also to be noticed, although they are not on this graph.

The two year period illustrates a steady degradation of the effectiveness of the STW.

The works complies with its consent in 1989 and 4 failures are below the maximum number of 6 (69 samples). 1989 is, nevertheless, unsuccessful in so far as 10 samples go beyond the 5 allowed (51 samples). Because these samples are tripartite samples it is likely that the works will be prosecuted. 3 samples even go beyond the upper tier, which could also be used in favour of the prosecution.

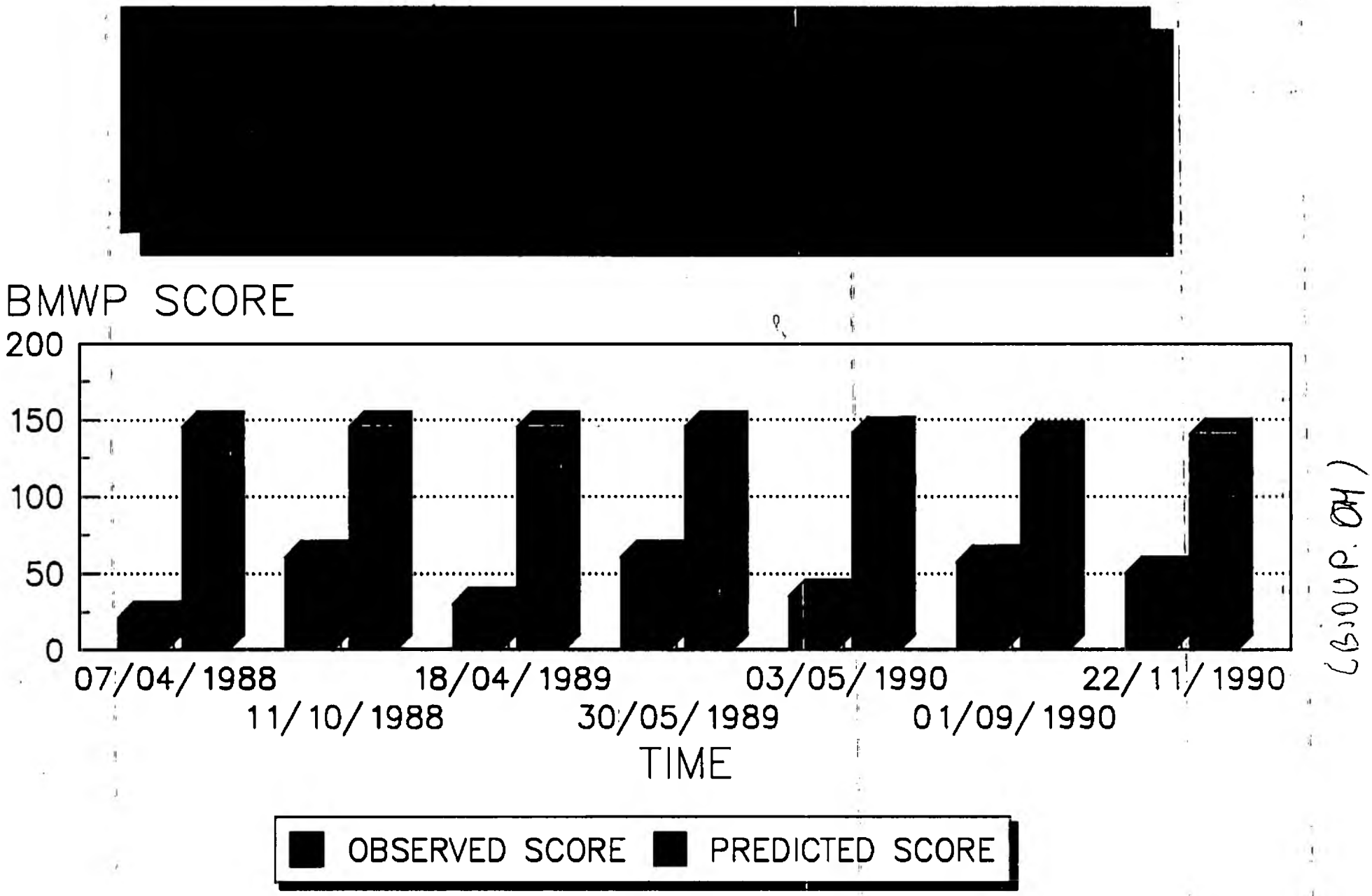
If we now try to assess the impact of the discharge on biological data and if we suppose that the two surveys of April 1989 and August 1990 reveal the real capacity of the river, we can show an impact of the discharge on invertebrate life. These two surveys take place in periods where the discharge is quite normal, with ammonia levels below 3 mg/l, which is close to the mean, and they are likely to represent the common capacity of the river. The two others take place when the discharge is particularly bad (12 mg/l and 10 mg/l) and we can see that the BMWP scores are worse. This might confirm the findings we had in the case of Swindon STW.

Last but not least the graph 30 stresses the impact of the discharge on samples taken 1 km downstream.



LEE AT EAST HYDE ROAD BRIDGE
DOWNSTREAM LUTON STW

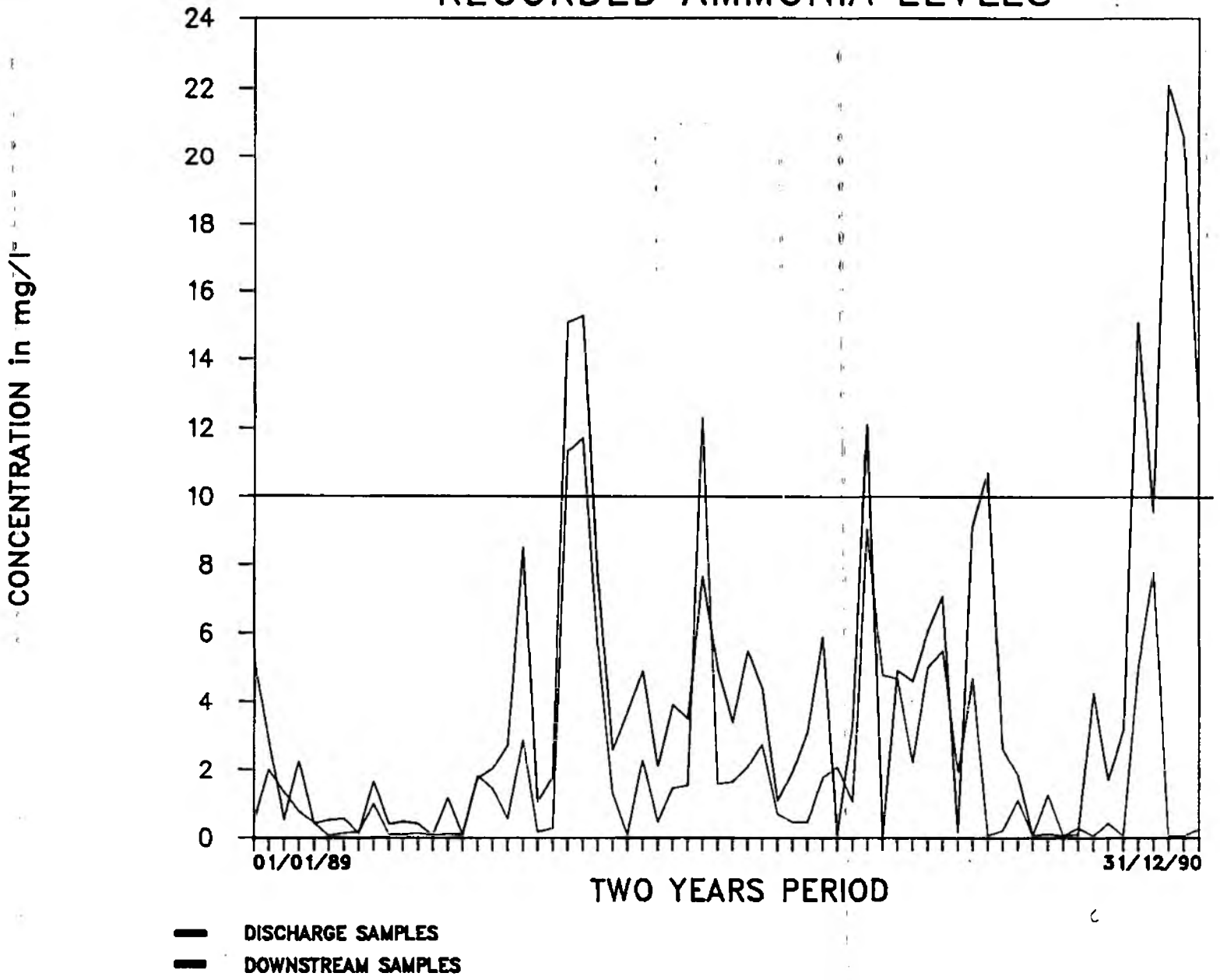
LBIODOWN.CH1


BMWP SCORE
200
150
100
50
0
07/04/1988
11/10/1988
18/04/1989
30/05/1989
03/05/1990
01/09/1990
22/11/1990
TIME
OBSERVED SCORE
PREDICTED SCORE
LEE ABOVE LUTON STW

(GROUP OH)

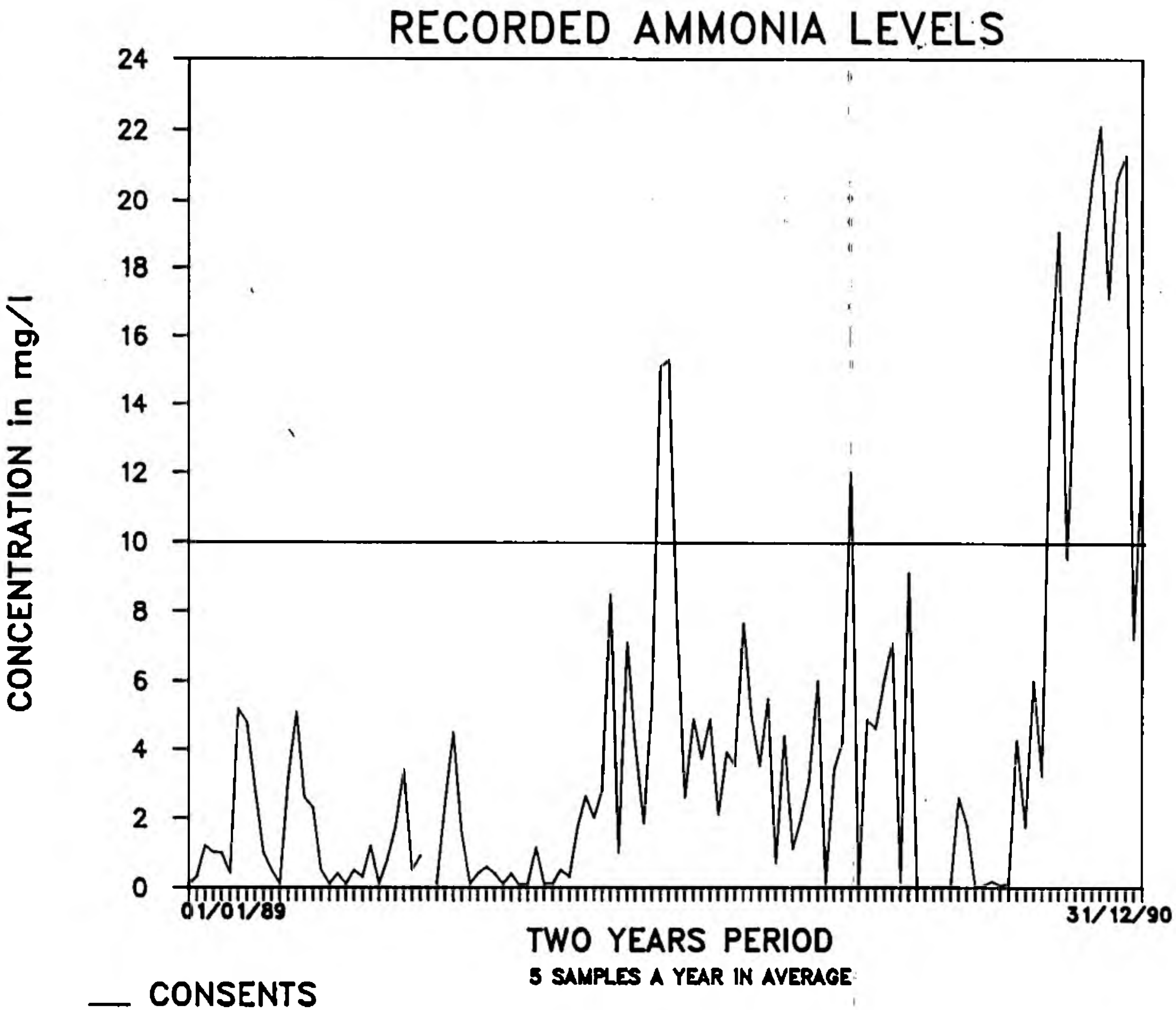
RELATIONSHIP BETWEEN DISCHARGE AND DOWNSTREAM SAMPLES

RECORDED AMMONIA LEVELS

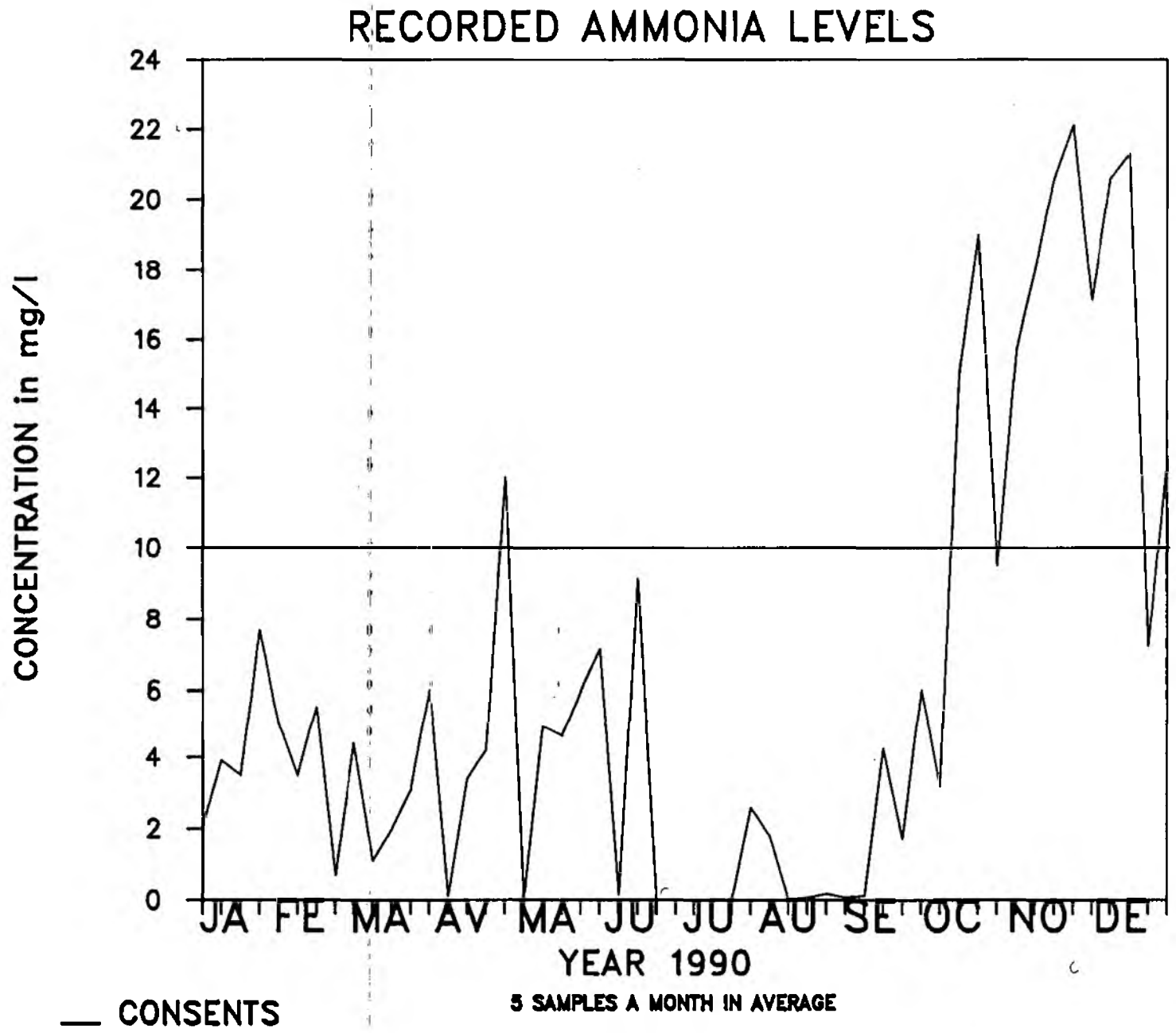


LDISDWN.DNW

DISCHARGE SAMPLES

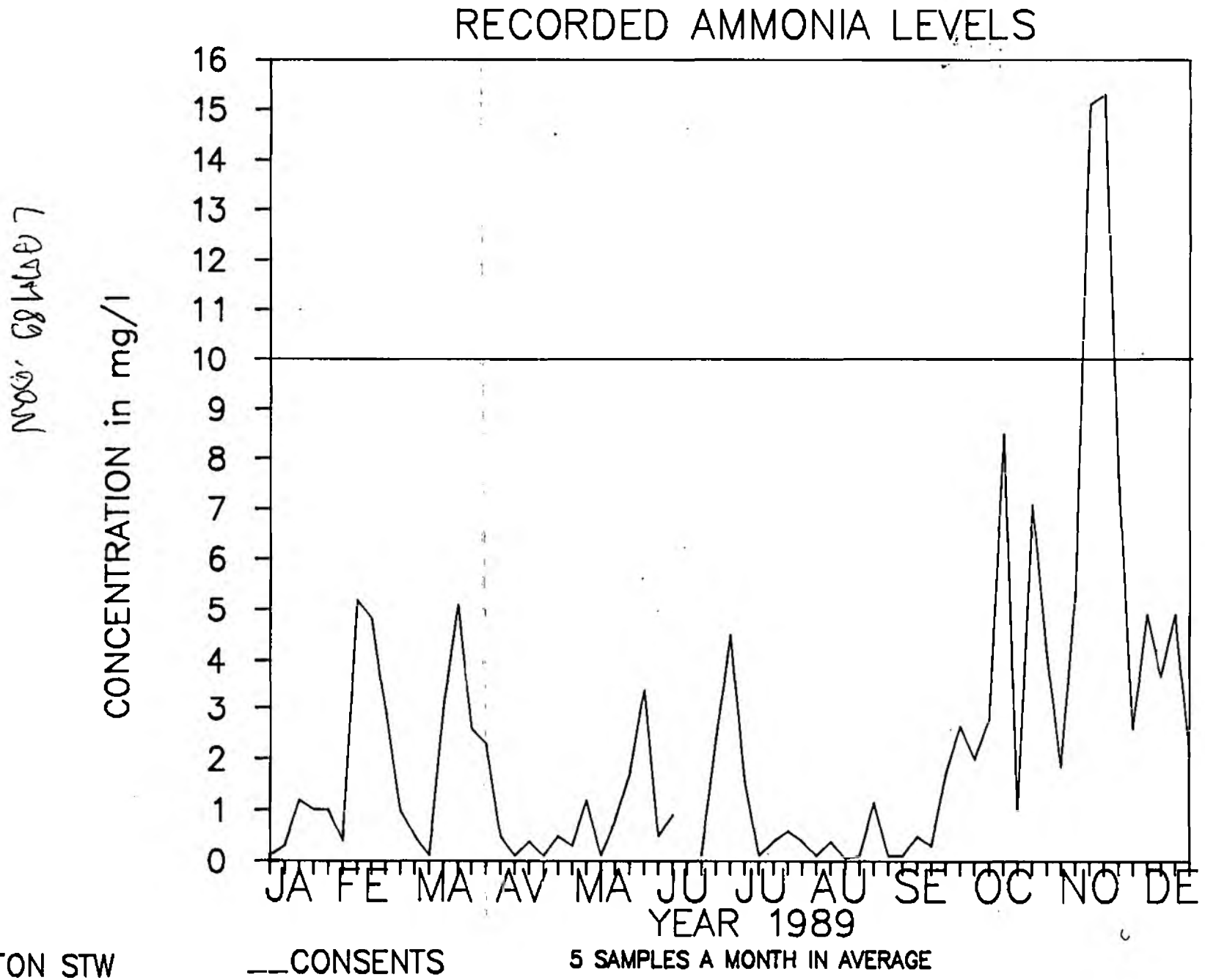


DISCHARGE SAMPLES



LUTON STW

DISCHARGE SAMPLES



LUTON STW

__CONSENTS

5 SAMPLES A MONTH IN AVERAGE

b) BOD (26.27.28)

The two year period graph shows the same kind of degradation as for ammonia, which confirms the fact that the works is in trouble. If the 1989 results are correct, the year 1990 is once again really bad and presents catastrophic results. 4 samples (3 tripartites) are higher than the relaxed consent, which is not enough to prosecute , but two tripartite samples go above the upper tier limit which could be used to prosecute Luton STW.

c) Suspended Solids (29)

This third component also reveals 1990's problems and the 295 mg/l recorded value could also be used in case of prosecution.

d) Fisheries results

No recent fisheries survey was available and I did only manage to have a few rough assessment of the fish population. It seems that the population is very poor in terms of quantity and diversity which is very likely to illustrate an important pollution.

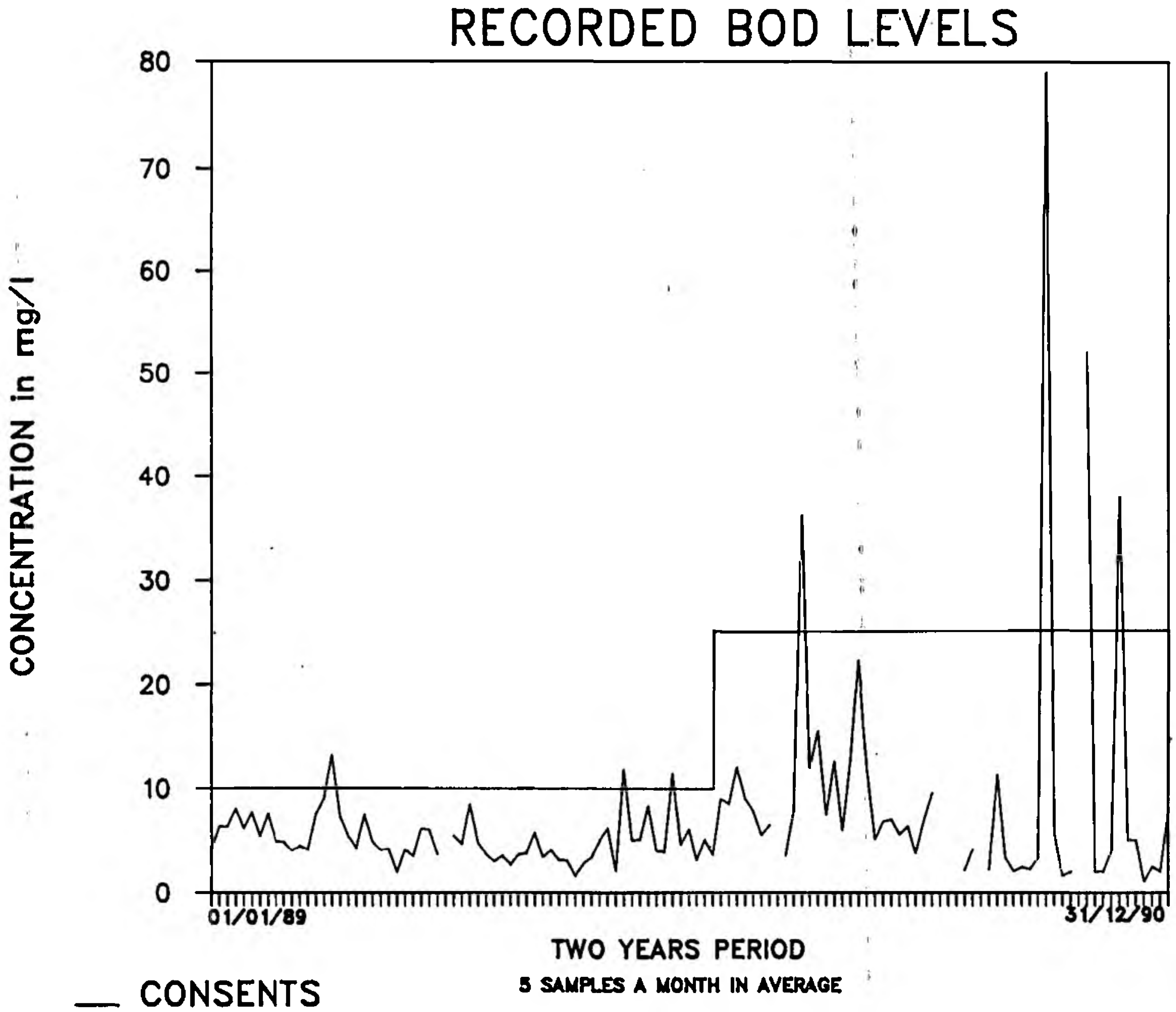
3) CONCLUSION

The upstream and downstream comparison shows the hazards of the discharge and there are more data available which makes the results more reliable. From the long term study, it seems that the evolution of the different components shows an important degradation of the works effectiveness.
As far as the consent is concerned, it is obvious that the STW has failed and has to be prosecuted.

CONCLUSION

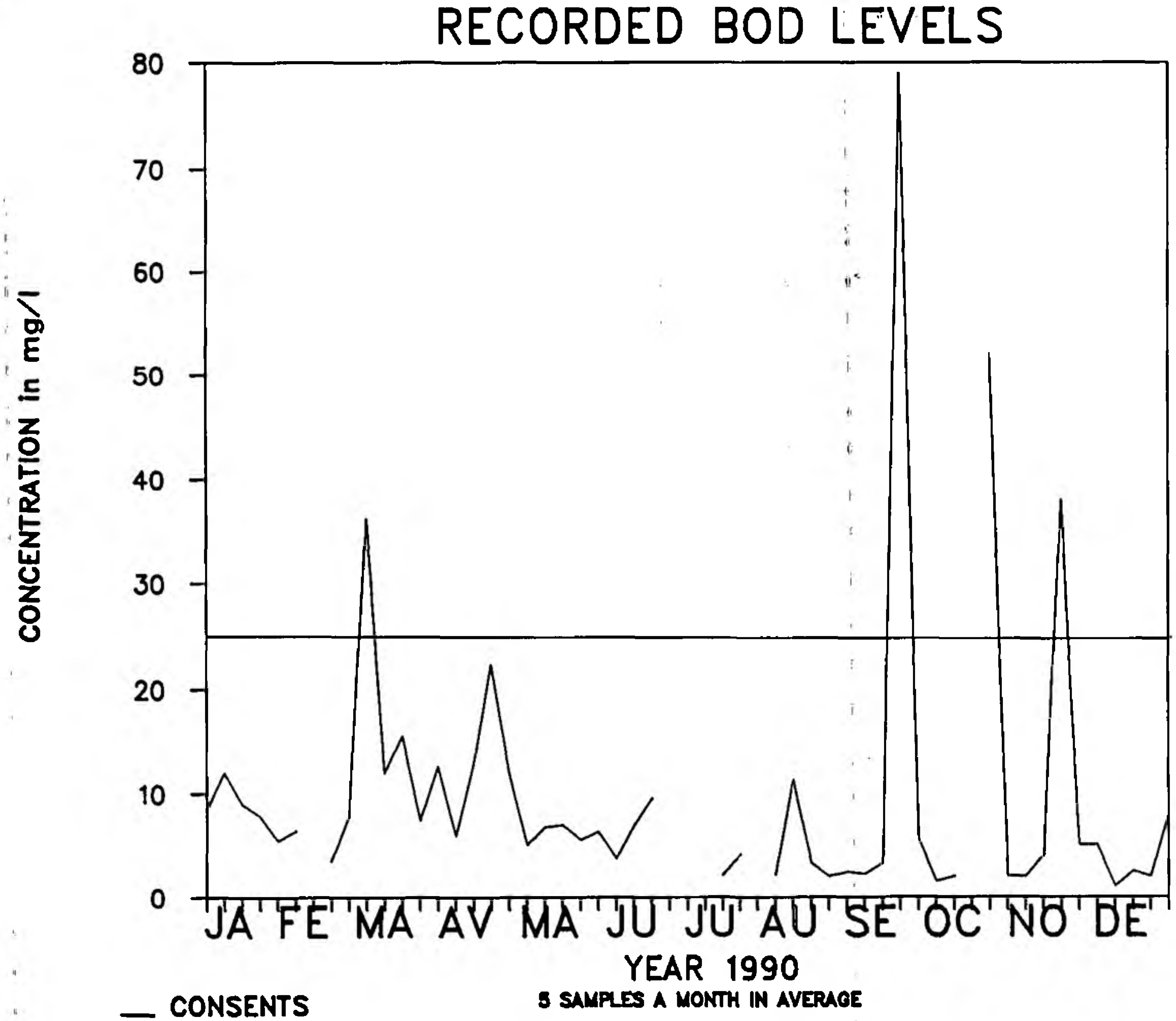
This short study should give us quite a good idea of what happened over the last two years in the two STW. It also reveals an important impact of the discharges on the downstream quality of water. But we have to bear in mind that this project can not be as accurate and complete as if it was based on more adapted data. This kind of study deserve a longer time of work and require more specific results. As a student, however, I must admit it is very interesting in so far as it enabled me to deal with many aspects of the NRA's job, which was one of the aim of this placement. It also enabled me to discover the Thames and its catchment and the problems the British environment is faced with. Last but not least It enabled me to discover a vanguard way of puting the growing awareness of environments problems in concrete form.

DISCHARGE SAMPLES



LUTON STW

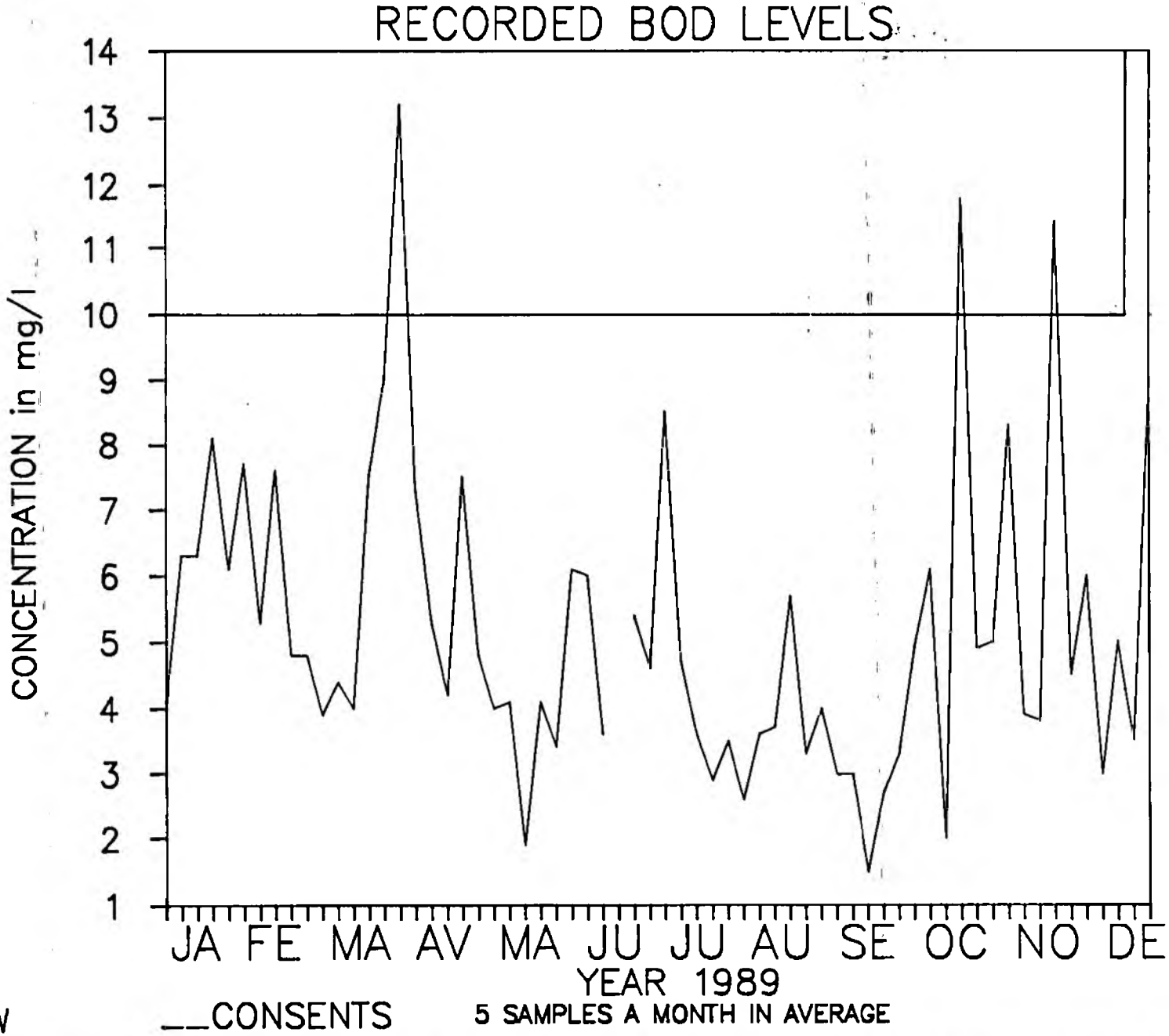
DISCHARGE SAMPLES



LUTON STW

LBODOO.DAV

DISCHARGE SAMPLES



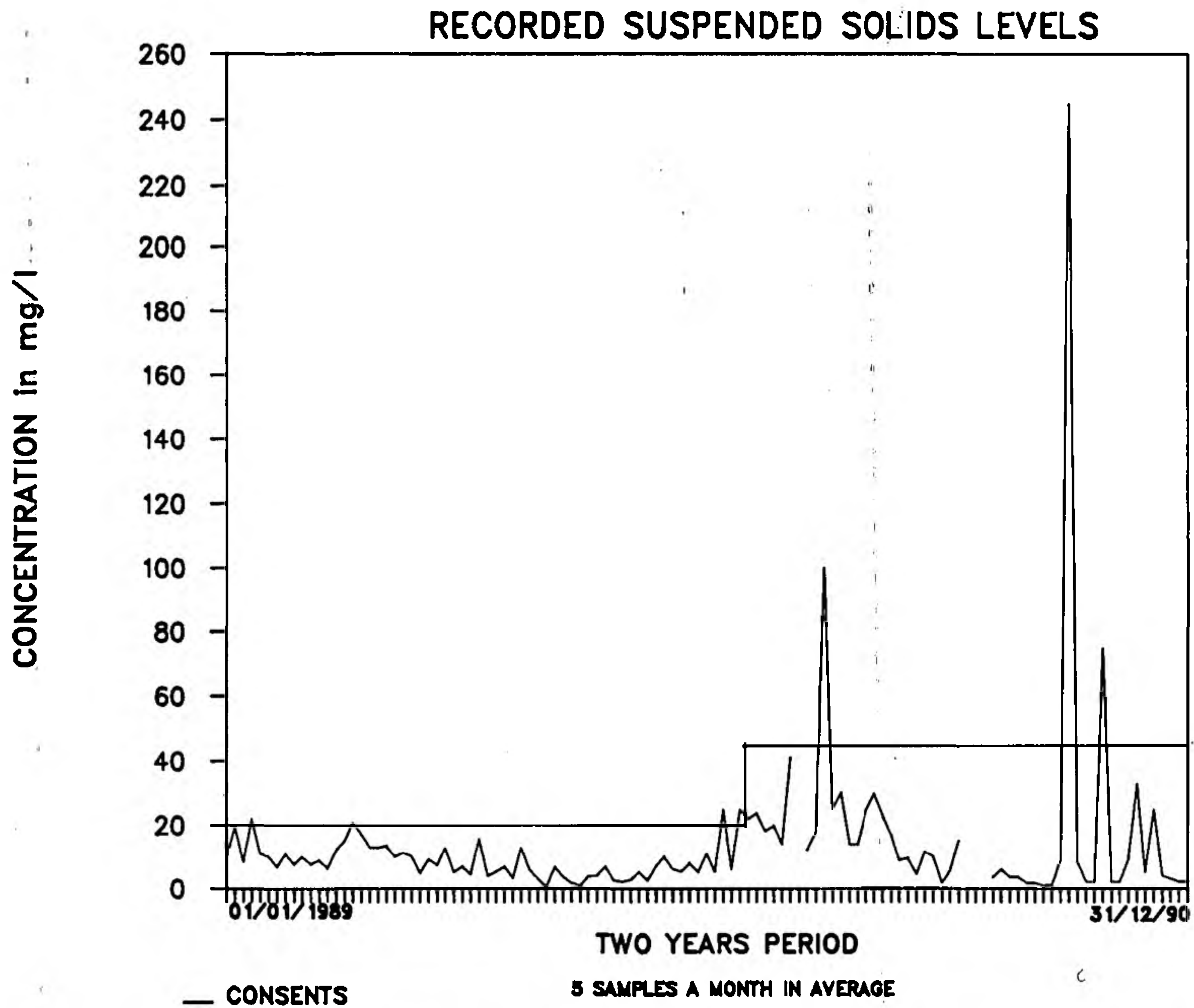
LUTON STW

__CONSENTS

5 SAMPLES A MONTH IN AVERAGE

LBOD 80 : 00W

DISCHARGE SAMPLES



PS : if the X-axis scale is not accurate, due to the quantity of data, the consent limits drawn are on the other hand strictly precise.

Figure 3 : R.Ray study - Biological Results (TWABI Scores)