NRA Southern 152

The River Ouse, Barcombe Mills

Guardians of the Water Environment

NRA

National Rivers Authority
Southern Region

NATIONAL RIVERS AUTHORITY

SOUTHERN REGION

ENVIRONMENTAL PROTECTION

SCIENCE GROUP

A REPORT ON THE USE

OF PESTICIDES AT TWO

HAMPSHIRE WATERCRESS FARMS

SCIENCE GROUP
JANUARY 1991

CONTENTS

1 *INTRODUCTION*

The watercress industry uses a variety of crop protection products to control pest and fungal problems. Malathion, a broad-spectrum, contact organophosphorus insecticide is sprayed for general insect control. Dimethoate, a contact and systemic organophosphorus insecticide, controls aphids, flea beetles and midges, again by spraying. In addition, the fungicides benomyl, and mancozeb with metalaxyl, are incorporated into compost used for seedling cultivation in order to control damping-off and rhizoctonia respectively.

Use of pesticides is carefully regulated by the Food and Environment Protection Act (1985). Only approved compounds may be used, and then only under the conditions and for the purposes specified on the approved product label. Allowance is made, however, for use on other crops by means of an "Off Label Approval" (OLA) which is usually granted for a specified time period.

The pesticides malathion and dimethoate, together with the three fungicides, were granted off-label approval by MAFF until September 1990 subject to various restrictions. After the expiry of this approval, crops sprayed in the course of this investigation were subsequently destroyed.

The watercress industry feels that continued use of these products is essential to their operation. It was agreed that a study would be carried out by the National Rivers Authority, in conjunction with Hampshire Watercress Ltd.. The objective was to determine whether significant levels of malathion and dimethoate are detectable in the receiving water downstream of the cress beds after spraying, and whether the macroinvertebrate populations of the river are affected. This report details the results of the investigation.

2 METHODS

2.1 *SAMPLING SITES*

Two farms, which are currently the subject of a routine monitoring programme to assess the impact of their discharges on the receiving waters, were chosen for the study. These were St. Mary Bourne on the Bourne Rivulet and Fobdown on the Candover Brook, both operated by Hampshire Watercress Ltd.. Their locations are shown in figures 1 and 2.

Sampling points were selected at both sites for water sampling for chemical analysis, and drift net and kick-sweep sampling for macroinvertebrates. The locations of these points are shown in Figures 3 and 4 and listed in Table 1.

2.2 *APPLICATION OF PESTICIDES*

2.2.1 *Fungicides*

The systemic and protectant fungicides benomyl (as Benlate), and metalaxyl with mancozeb (as Fubol 58), are used on watercress seedlings during propagation under glass. They are applied as a drench to the compost at the start of cultivation when there is no outlet to the river. A small amount of this compost may be transferred to the beds at planting, two to three weeks later, by which time the fungicides should be present only at very low levels. Benomyl was used from January to June 1990 and metalaxyl with mancozeb throughout the year.

2.2.2 *Insecticides*

Details of the application of malathion and dimethoate at the two farms are given in Table 2. The application methods, rates, coverage, and dilutions were according to routine farm procedure which follows the Conditions of Approval relating to use. Malathion (as Malathion 60) was applied to beds using a "Micron Herbi" spinning disc applicator (Fig. 5), and dimethoate (as Turbair Systemic) with a "Turbair Sprite". On both occasions the wind was not ideal for use of the Turbair sprayer which is most effective under calm conditions.

During the first monitored spray application in July at St. Mary Bourne, dimethoate was applied to a bed feeding the right branch (i.e. the Bourne Rivulet) only, while malathion was applied to beds feeding both branches. At both farms flow to the beds was stopped shortly before the application of spray to enable partial draining of the beds. A longer draining period was deemed unnecessary and would have meant a longer time delay before flow could have been restored to the receiving stream and sampling commenced. The residual flow to the stream was blocked off during application of the spray, and restored immediately afterwards.

On the second spraying occasion, in October, malathion and dimethoate were both applied to the same beds, feeding to both branches of the receiving water. A minimal flow to and from the beds was maintained throughout spraying. It was thought unlikely that employing this different method would hinder the detection of any peak concentrations or impacts downstream.

The timing of spraying in relation to sampling is tabulated as follows:

Table 3	Timetable of events: Monitoring of pesticide application at St. Mary Bourne, July 1990.
Table 4	Timetable of events: Monitoring of pesticide application at St. Mary Bourne, October 1990.
Table 5	Timetable of events: Monitoring of pesticide application at Fobdown, July 1990.
Table 6	Timetable of events: Monitoring of pesticide application at Fobdown, October 1990.

2.3 *WATER AND SEDIMENT SAMPLING FOR CHEMICAL ANALYSIS*

2.3.1 *Routine sampling*

2.3.1.1 *Water*

Water samples were taken at the routine monitoring sites downstream of St. Mary Bourne and upstream and downstream of Fobdown in April, July and October (see Figs.3 and 4, and Table 1).

In April and July a single one litre water sample was collected in a clean glass bottle from each site, whilst two litre samples were taken in October to permit analysis to a lower detection limit.

2.3.1.2 *Sediments*

Sediment samples for pesticide residue analysis were taken from the stream bed at the same sites and at the same time as the water samples (see above). At each site duplicate samples of accumulated fine sediment, which was present at all sites, were taken in 0.5 litre clean glass bottles. The samples were allowed to stand briefly, supernatant water was poured off and more sediment added to give a concentrated sample.

2.3.2 *Non-routine water sampling*

Sampling sites are shown in Figures 3 and 4 and listed in Table 1. Upstream chemical sampling sites were selected for ease of access and to avoid any possibility of aerial pesticide drift during spraying. Downstream points were chosen for proximity to the drift net sites and to minimise the distance between the effluent point and the sample point.

Water samples were taken in clean 1 litre glass bottles as for the routine samples. On both occasions at each farm (with the exceptions given below) one sample was taken upstream and downstream prior to application of the sprays. After spraying, a single sample was taken upstream, whilst downstream samples were taken at half hourly intervals for three hours (7 samples).

On the second sampling occasion in October at St. Mary Bourne, the Bourne Rivulet was dry upstream of the farm. This meant that no upstream samples could be taken and that all the water downstream originated from the farm. No post-spray upstream sample was taken at Fobdown in October due to sampler error.

2.3.3 *Analysis of water and sediment samples*

Water and sediment samples were sent to Reading Scientific Services at the Lord Zuckerman Research Centre, University of Reading for analysis by standard methods, of which details are given in Appendix 1.

For routine samples the detection limits were as follows:

Analyte	Water $\mu g.l^{-1}$	Sediment $\mu g.kg^{-1}$
Dimethoate	1	10
Malathion	1	10

The detection limits for non-routine water samples were 1.0 $\mu g.l^{-1}$ for the July samples and 0.01 $\mu g.l^{-1}$ for October.

2.4 *MACROINVERTEBRATE SAMPLING*

2.4.1 ***Kick-sweep Sampling***

Kick-sweep sampling sites, shown in Figures 3 and 4 and listed in Table 1, were identical with those of the routine sampling programme to permit comparison of the data sets if necessary.

Standard 3 minute kick-sweep pond net samples were taken at each of the sites at least one day before spraying took place for pre-spray data, and 1-3 weeks after spraying for comparative post-spray data and to detect any longer term effects on the invertebrate fauna. Samples were preserved with 4% formaldehyde solution prior to processing in the laboratory where organisms were identified to mixed taxonomic level.

Enumeration used the standard logarithmic abundance scale given below.

Number of organisms	Log. Abundance
1	1
2-10	2
11-100	3
101-1000	4
1001-10000	5

The data was assessed using the following techniques.

Biological Scores

The *BMWP Score* was devised by the Biological Monitoring Working Party for the 1980 Water Quality Survey of England and Wales. It has since become nationally accepted as a reliable means of assessing the water quality information which can be derived from populations of macroinvertebrates inhabiting the bottom sediments of rivers.

A score between one and ten is allocated to each family of invertebrates found in the sample based on their sensitivity to pollution. For example, most mayfly nymphs and caddis larvae score ten, water beetles five, molluscs three, and worms one. The final score is calculated by summing the individual scores for each family.

The *number of taxa* indicates the diversity of the population (a list of *taxa* may include organisms identified to species, genus, family or other required level). In addition, the *average score per taxon* (ASPT) is given. This is simply the BMWP score divided by the number of taxa, and represents the "sensitivity" of the families found, in terms of their average score.

RIVPACS

This is a computer programme (River Invertebrate Prediction and Classification System) developed over the last ten years by the Institute of Freshwater Ecology. It utilises a nationally derived set of information on invertebrate populations and the characteristics of the rivers in which they are found, based on samples taken at 268 sites selected as having high water quality.

Sophisticated mathematical analysis has classified a range of river types and their associated fauna such that the model can predict, from the physical and chemical characteristics of a site, the likely BMWP scores which would be found assuming the water quality to be satisfactory. Comparison of the observed and predicted scores can then highlight any deficiencies which may be attributable to pollution.

This is most easily achieved by calculating the ratio of the observed to predicted scores, known as the Environmental Quality Index (EQI). If this is equal to or greater than one, water quality is satisfactory. As the value drops below this level progressively poorer water quality is indicated. Statistical confidence limits attached to RIVPACS predicted scores show that differences of less than 16% (EQIs between 0.84 and 1) are unlikely to be significant.

2.4.2 *Drift Net Sampling*

In order to demonstrate any changes in the invertebrate drift in the streams following pesticide spraying, drift net samples were taken downstream of the farms (Fig. 6). A standard drift net was used with a rectangular opening 40cm wide and 25 cm high, giving an area of $0.1m^2$. The bag length was 60 cm, with a mesh pore size of 0.5 mm.

Prior to and following application of the sprays on each of the two spraying occasions a single drift net was placed mid channel at each of the sites shown in figures 3 and 4. Drift nets were sited downstream of the farms and at least 50 metres from the effluent point. At St. Mary Bourne, on the right branch, the first net was placed 150m downstream of the effluent point to compensate for a concreted stretch of river bed approximately 80m long.

Selected sites had a relatively smooth gravel bed on which the nets could be securely anchored, and were free of obstructions immediately upstream thus ensuring a clear flow of water.

Two nets were placed in the right channel at St. Mary Bourne, one upstream of the silt pond and one downstream, in order to establish the possible effect of the silt pond on the invertebrate drift.

On the first sampling occasion at Fobdown, an additional net was placed across the effluent of the sprayed bed (designated "outfall" in Table 10 and Appendix 3) for 3.5 hours to determine whether significant numbers of invertebrates were leaving the bed as opposed to the downstream watercourse.

A trial sampling run showed that 2.5 hours was a suitable time period over which to sample the drift before spraying and enable a comparison with post-spray drift. Pre-spray drift net sampling was undertaken at approximately the same time of day as the post-spray sampling, and as close to the day of spraying as was practicable. On the first sampling occasion the nets were replaced in the stream for a further hour following the initial period so that any delayed drift could be detected.

At the end of each 2.5 hour sampling period the contents of the drift nets were emptied into white trays containing stream water and the invertebrates were observed over a period of one hour. Any behavioural reactions or mortalities were noted.
During drift net sampling no beds were cleared, nor did any activities take place in the channels between the beds and the nets, to prevent silt or organisms being dislodged and washed downstream into the nets.

At the end of the sampling and observation periods the samples were preserved with 4% formaldehyde solution and returned to the laboratory where they were sorted and identified to family (BMWP) level. Enumeration used the same logarithmic abundance scale as for the kick samples.

3 *RESULTS*

3.1 *CHEMICAL ANALYSIS OF WATER AND SEDIMENT SAMPLES*

3.1.1 *Routine Water and Sediment Samples*

Pesticide data from the routine sampling in April, July and October are given in Tables 7, 8 and 9.

3.1.2 *Non-routine Water Samples*

Pesticide data from the non-routine pre-spray and post-spray water sampling in July and October are given in Table 8.

3.2 *MACROINVERTEBRATE SAMPLES*

3.2.1 *Kick Sweep Samples*

Full taxa lists are given in Appendix 2 and the data is summarised in Table 9 in terms of the BMWP scores, number of scoring taxa, and ASPT. A set of data from routine samples taken upstream of the Fobdown farm is included in the summary.

The observed and predicted scores, together with EQIs, are presented in Table 11. As RIVPACS makes allowance for the naturally occurring seasonal variations in the fauna, the samples have been grouped into July and October sets.

3.2.2 *Drift Net Samples*

Full taxa lists are given in Appendix 3 and the data is summarised in Table 10.

The duration of sampling is expressed as follows:

2.5 hours: invertebrates collected over an initial 2.5 hour period.

+ 1 hour: invertebrates collected in the hour following the initial period.

3.5 hours: invertebrates collected in a net left in place without emptying for 3.5 hours.

On each occasion, observations of the contents of the drift nets in the trays revealed no behavioural abnormalities in the invertebrates. Mortalities were restricted to one individual chironomid larva in a pre-spray sample at Fobdown in July, and to one *Gammarus* and 2 caseless caddis larvae at Fobdown in the July post-spray sample.

FOBDOWN

The number of taxa found in the 2.5 hour pre- and post-spray samples increased from 13 to 20 in July but fell from 15 to 12 in October. No taxa were found above abundance level 3 (10-100 individuals) and many were represented only by single specimens.

Patterns of change were different on the two sampling occasions. For example, Glossiphoniid leeches, mayflies, and the freshwater shrimp *Gammarus*, were more numerous after spraying in July but less numerous or absent in October. The only consistent increase after spraying was Elminthid beetles (abundance 2 on both occasions).

The net placed at the outlet of the sprayed bed in July captured moderate numbers of individuals from 9 taxa, including mayflies and beetles. This shows that invertebrate populations develop within the beds and enter the drift during spraying. It is likely, therefore, that a component of the samples collected at the normal sites had originated from within the sprayed beds and not from the river.

ST. MARY BOURNE

Left branch, d/s silt lagoon

The number of taxa found in the 2.5 hour pre- and post-spray samples increased from 14 to 15 in July but fell from 8 to 7 in October. Only Chironomidae in the July pre-spray sample were found above abundance level 3 (10-100 individuals) and many taxa were represented only by single specimens.

The only notable increase after spraying was again amongst the beetles though very few individuals were involved and some were probably marginal/terrestrial species. *Gammarus* were absent from all samples and mayflies showed slight decreases after spraying.

Right branch, u/s silt pond

The number of taxa found in the 2.5 hour pre- and post-spray samples increased from 14 to 20 in July, and from 15 to 18 in October. In July, a further 5 taxa appeared in the additional hour (the only site at which this happened). No taxa were found above abundance level 3 (10-100 individuals) and many were represented only by single specimens.

Although several taxa were more abundant after spraying at this site in both months, there was again a lack of consistency between the two occasions or compared with other sites, and only small numbers were involved.

Single specimens of two beetle families appeared after spraying in July but the number of Hydrophilid beetles fell. Elminthidae occurred as singles before and after spraying in October with another single in the final hour in July. The crustacea *Asellus* and *Gammarus* increased on both occasions, though only in the final hour in July.

Right branch, d/s silt pond

The number of taxa found in the 2.5 hour pre- and post-spray samples increased from 11 to 17 in July but fell from 12 to 10 in October. No taxa were found above abundance level 3 (10-100 individuals) and many were represented only by single specimens, including 10 of the 12 new taxa found after spraying in July.

As at the other sites, no clear pattern emerged. There was a small increase in numbers of crustacea after spraying in July, and of *Gammarus* only in October. Baetid and Ephemerellid mayflies occurred at abundance 3 in both pre- and post-spray July samples whereas Baetidae were found only before, and Ephemerellidae only after spraying in October. Only small numbers of beetles were found, showing no clear pattern.

It appeared that a proportion of the drift animals were being retained by the silt pond as numbers of both taxa and individuals were lower at the downstream site.

4 *DISCUSSION*

4.1 *ASSESSING SAFE LEVELS FOR PESTICIDES IN ENVIRONMENTAL WATERS*

At present, the only legislation against which to assess safe levels of pesticides in environmental waters is the EC Directive on Quality Requirements for Surface Water Intended for the Abstraction of Drinking Water (1975). This classifies waters as A1, A2 or A3 depending on the level of treatment required for potable supply. The Bourne Rivulet and Candover would fall in class A2 for which the permitted maximum concentration (95-percentile) of total pesticides is 2.5 $ug.l^{-1}$. Although neither of these waters are used for potable extraction, this value would seem to offer a useful guide to safe levels. If future legislation and the introduction of Environmental Quality Standards should impose new limits, a review of pesticide usage may be necessary.

It is clear that, although technically included in the description "total pesticides", the three fungicides are not considered to pose any serious environmental hazard. Data from the 1990 routine sampling programme was inconclusive and the NRA hopes to carry out further analysis in 1991 to satisfy itself that this is indeed the case.

The insecticides, and in particular malathion which is a "Red List" substance, are of more concern, and it was for this reason that the detailed analysis was directed at them.

4.2 *ANALYSIS OF WATER SAMPLES FOR PESTICIDES*

4.2.1 *Routine Water Samples*

Malathion and dimethoate

Detection limit: 1 µg.l-1

Only two positive results were obtained, both for the April sample downstream of St. Mary Bourne, when malathion and dimethoate were present at 1$\mu g.l^{-1}$. As this was the detection limit for the routine samples and all other routine results were below that limit, these values must be viewed with some suspicion particularly in the light of the October non-routine surveys when, immediately after spraying, the maximum concentration found was only 0.83 $\mu g.l^{-1}$.

4.2.2 *Non Routine Water Samples*

In July the detection limit for malathion and dimethoate was 1 $\mu g.l^{-1}$ but this was lowered to 0.01 $\mu g.l^{-1}$ for October.

In October, all dimethoate results were below 0.01 $\mu g.l^{-1}$ at Fobdown whilst four values of 0.01-0.02 $\mu g.l^{-1}$ occurred downstream of St. Mary Bourne on the right branch.

All malathion levels were at or above the limit of detection in the post-spray downstream samples, ranging from 0.82 $\mu g.l^{-1}$ in the right branch at St. Mary Bourne immediately after spraying, to 0.1 $\mu g.l^{-1}$ or less after 2.5 - 3 hours. In no sample at either farm did the *total* concentration of malathion and dimethoate reach 1 $\mu g.l^{-1}$.

4.3 *PESTICIDE ANALYSIS OF SEDIMENTS*

Analysis of sediments was undertaken as part of the routine sampling programme. On no occasion were malathion or dimethoate found above the limit of detection (10 $ug.kg^{-1}$).

4.4 *BENTHIC MACROINVERTEBRATES AND DRIFT*

4.4.1 *Kick Samples*

Although the kick samples are described as pre- or post-spray, the intermittent use of pesticides both before and during the sampling programme means that these designations have little relevance. No distinction has therefore been made in analysis of the data.

Examination of routine biological monitoring data for comparable tributaries of the Test and Itchen during 1990 shows that the invertebrate populations downstream of the farms are typical of the area. There are no significant absences from or additions to the fauna as would be expected if it was disturbed by pollution.

Sites less than 10km from the source of other rivers may be compared with St. Mary Bourne, where the flow is often minimal above the farm and had ceased when the October spraying was carried out. The mean BMWP, number of taxa and ASPTs for these sites were 109, 22, and 4.79 (15 samples, 6 sites). For sites more than 10km from the source the corresponding values were 165, 30, and 5.46 (12 samples, 4 sites).

St. Mary Bourne

Right branch:

The mean values as given above for the four samples were 111, 23, and 4.88. It can be seen that these are very close to the mean for similar sites in the area, showing that there has been no deterioration of the invertebrate populations downstream of the farm.

Left branch:

The mean values of 94, 21, 4.46 suggest a slight impoverishment of the fauna at this site, probably due to the lower discharge and the higher proportion of silt in the substratum. Sensitive species were still present as indicated by the mean ASPT of 4.46.

Fobdown

For a site on a relatively small stream only 6km from the source, the mean values of 151, 29, 5.15 represent a very healthy macroinvertebrate population indicative of high water quality. It is, in fact, comparable with nearby sites on longer tributaries where a wider diversity of habitats is available.

RIVPACS Predictions

It can be seen that at St. Mary Bourne all EQIs were between 0.90 and 1.15 indicating excellent water quality. At Fobdown, the EQIs for score and number of taxa ranged from 1.33 to 1.57 due to underprediction by RIVPACS. This may occur when the full diversity of ecological niches available to invertebrates cannot be adequately described by the site data accepted by the programme. That underprediction has occurred is borne out by the comparisons with other tributaries described above.

The EQIs for ASPT were, however, 1.08 and 1.09 showing that the sensitivity of the fauna, which is often the most satisfactory measure of water quality, was accurately predicted. Again, this analysis indicates that the fauna downstream of the farm is not being adversely affected by the discharge.

4.4.2 *Drift Net Samples*

The data from the drift net sampling is extremely variable and it is difficult to detect any clear pattern of change in the drift population after the application of pesticides. Many of the taxa found were represented only by single individuals and only once (Chironomidae, in a pre-spray sample) were more than 100 specimens from a single taxon found. It seems probable that a proportion of the animals collected originated from within the sprayed bed rather than from the river.

Overall, despite an apparent tendency for animals to move downstream, the numbers involved were small, and there is no consistent pattern of change between sites or seasons. In October fewer taxa were involved and only one site showed an increase in the number of taxa after spraying. In numerous cases, taxa were represented by fewer specimens after spraying than before.

5 *CONCLUSIONS*

In none of the water samples did the total concentration of malathion and dimethoate exceed 2.5 $ug.l^{-1}$. In the non-routine samples with a detection limits of 0.01 $ug.l^{-1}$, the maximum concentration of dimethoate encountered was 0.02 $ug.l^{-1}$ and of malathion, 0.82 $ug.l^{-1}$. Their total concentration never exceeded 0.83 $ug.l^{-1}$.

Pesticide release from the watercress farms is, therefore, well within the limits laid down by the EC Directive on Surface Waters for Abstraction.

Kick sampling downstream of the farms revealed numerous and diverse populations of benthic macroinvertebrates, which were closely comparable with those of similar tributaries in the area. Numerous sensitive families were present as shown by the ASPT values.

BMWP scores, number of taxa and ASPT values in most cases equalled or exceeded those predicted by the Institute of Freshwater Ecology's RIVPACS computer package.

Although the results of the drift net sampling suggest that there is some downstream movement of invertebrates after spraying, the numbers involved were small. There was no indication that particular taxa consistently reacted to the spray.

It is concluded that the limited and carefully controlled use of pesticides at these watercress farms produces pesticide concentrations in the receiving waters which are well within acceptable limits, and which have no significant adverse effect on their macroinvertebrate fauna.

Future work will be aimed at improving the data for malathion and dimethoate and at clarifying the position regarding the three fungicides.

FIGURES

Figure 1 LOCATION OF ST MARY BOURNE 'CRESS FARM

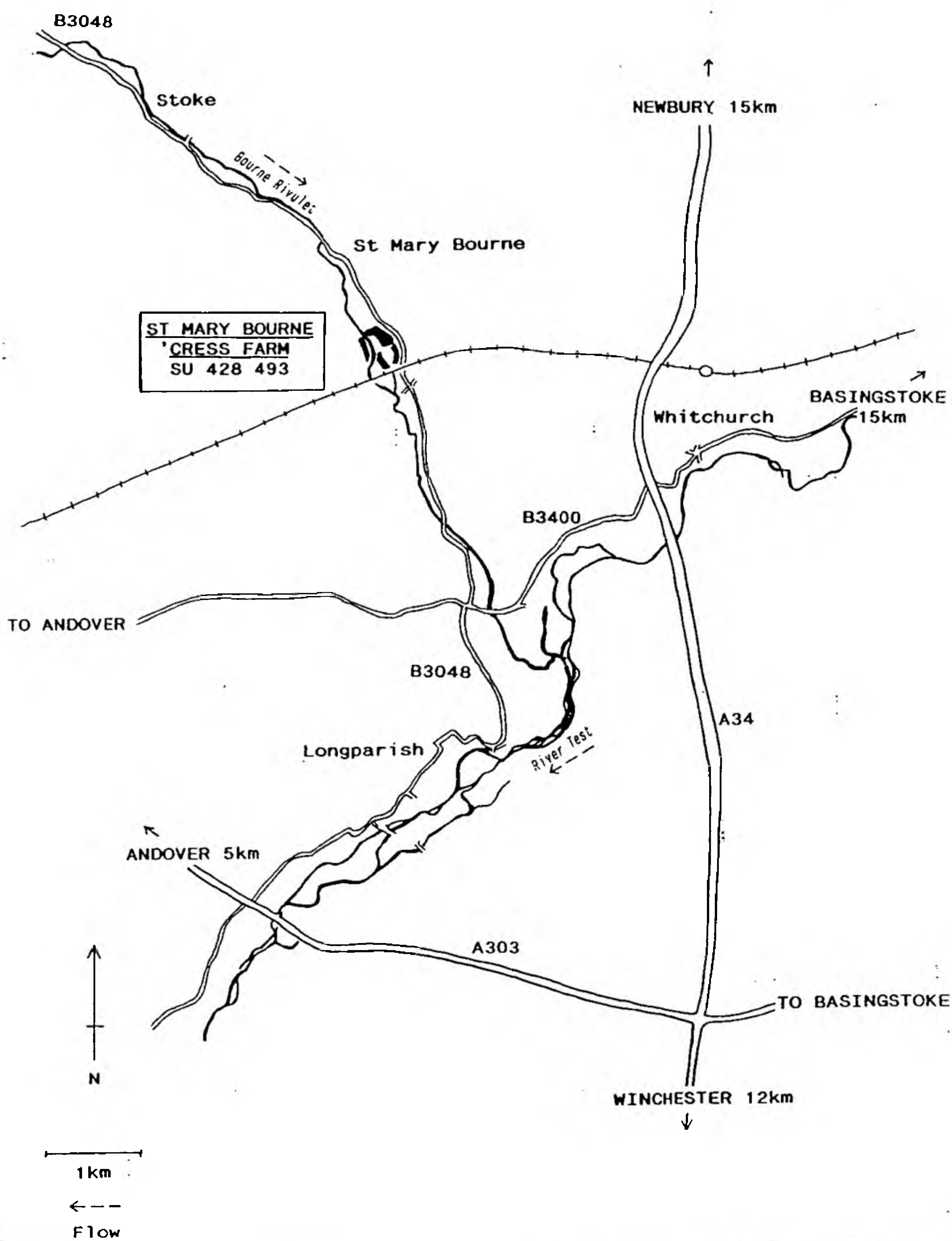


Figure 2 LOCATION OF FOBDOWN 'CRESS FARM

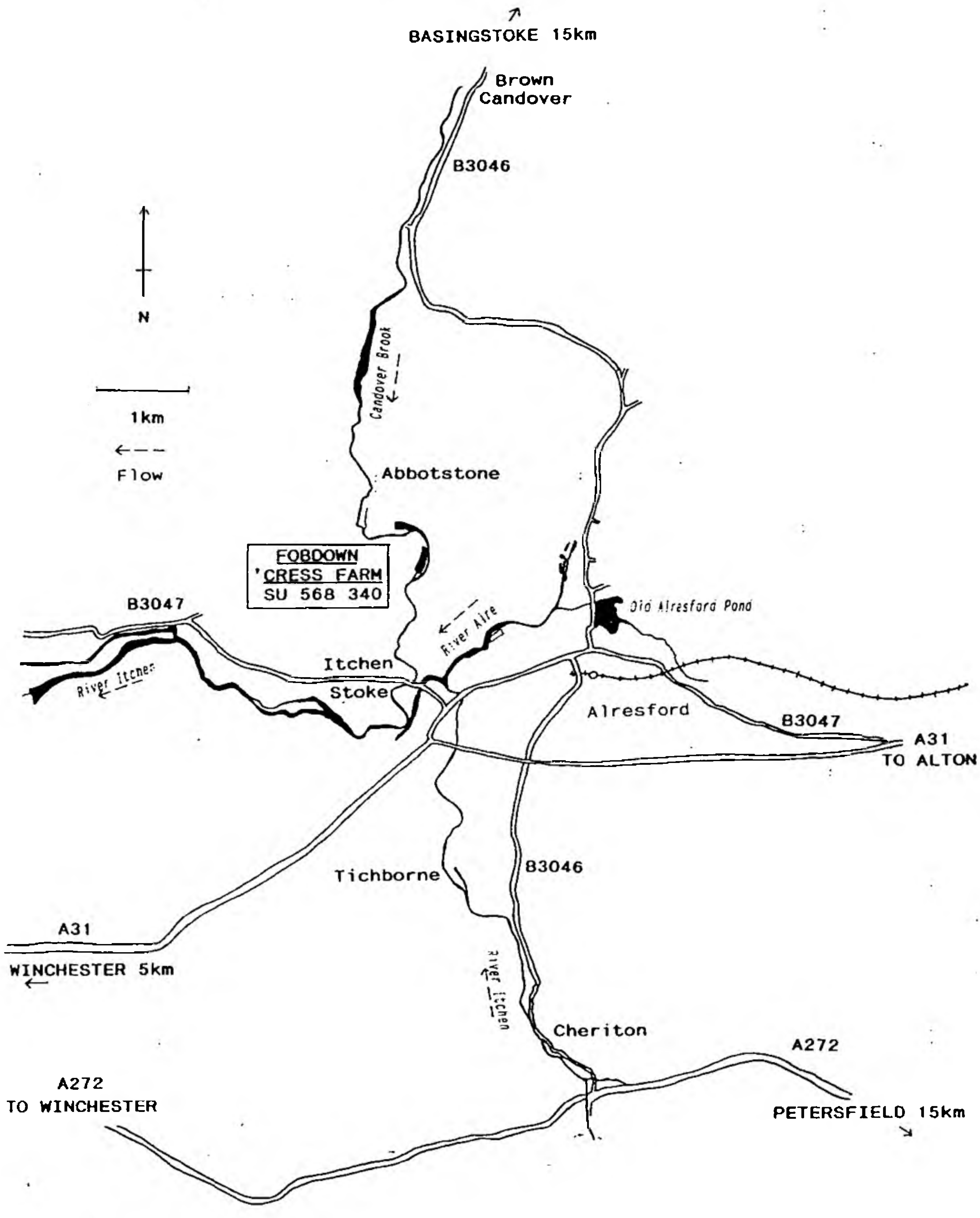
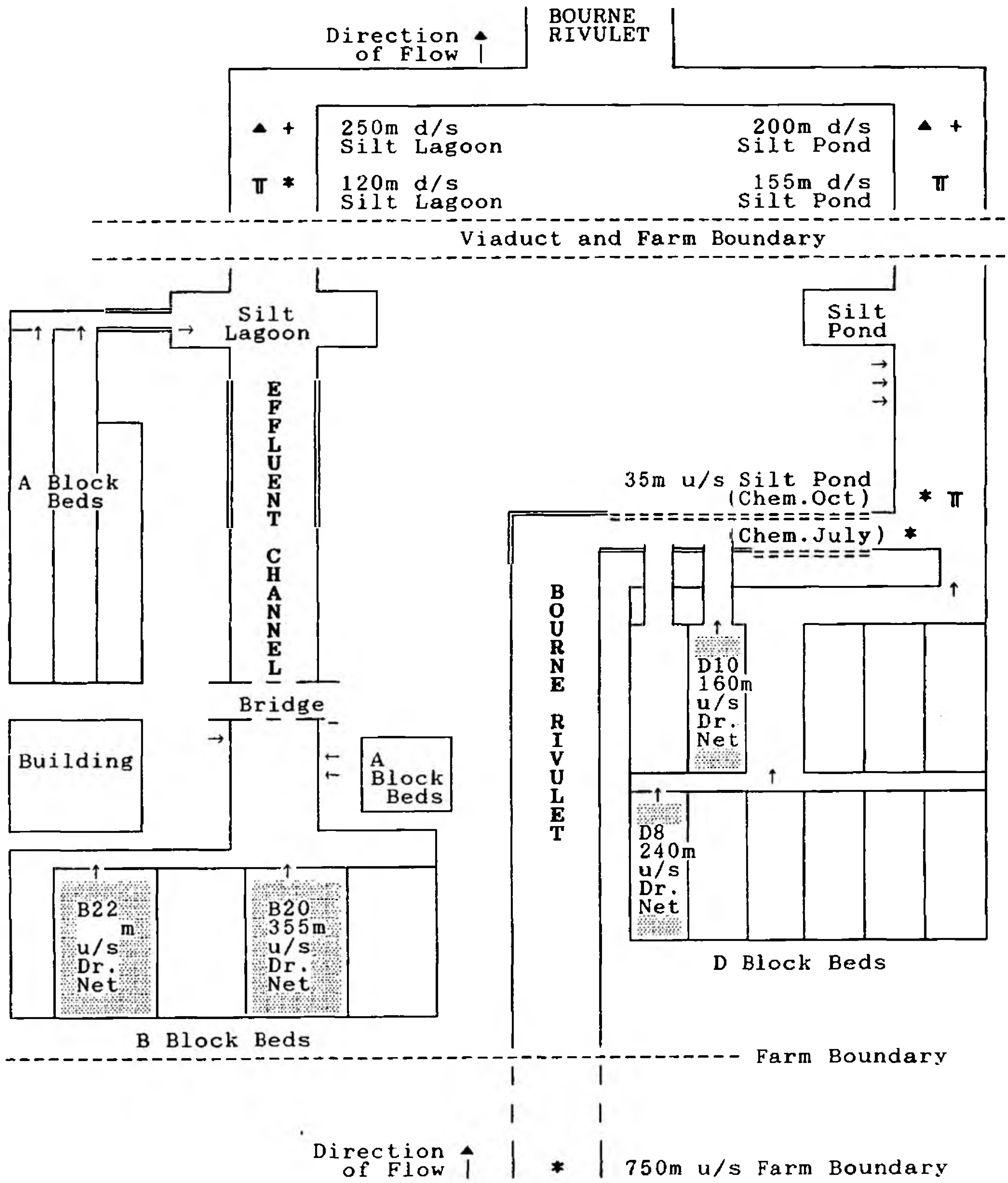


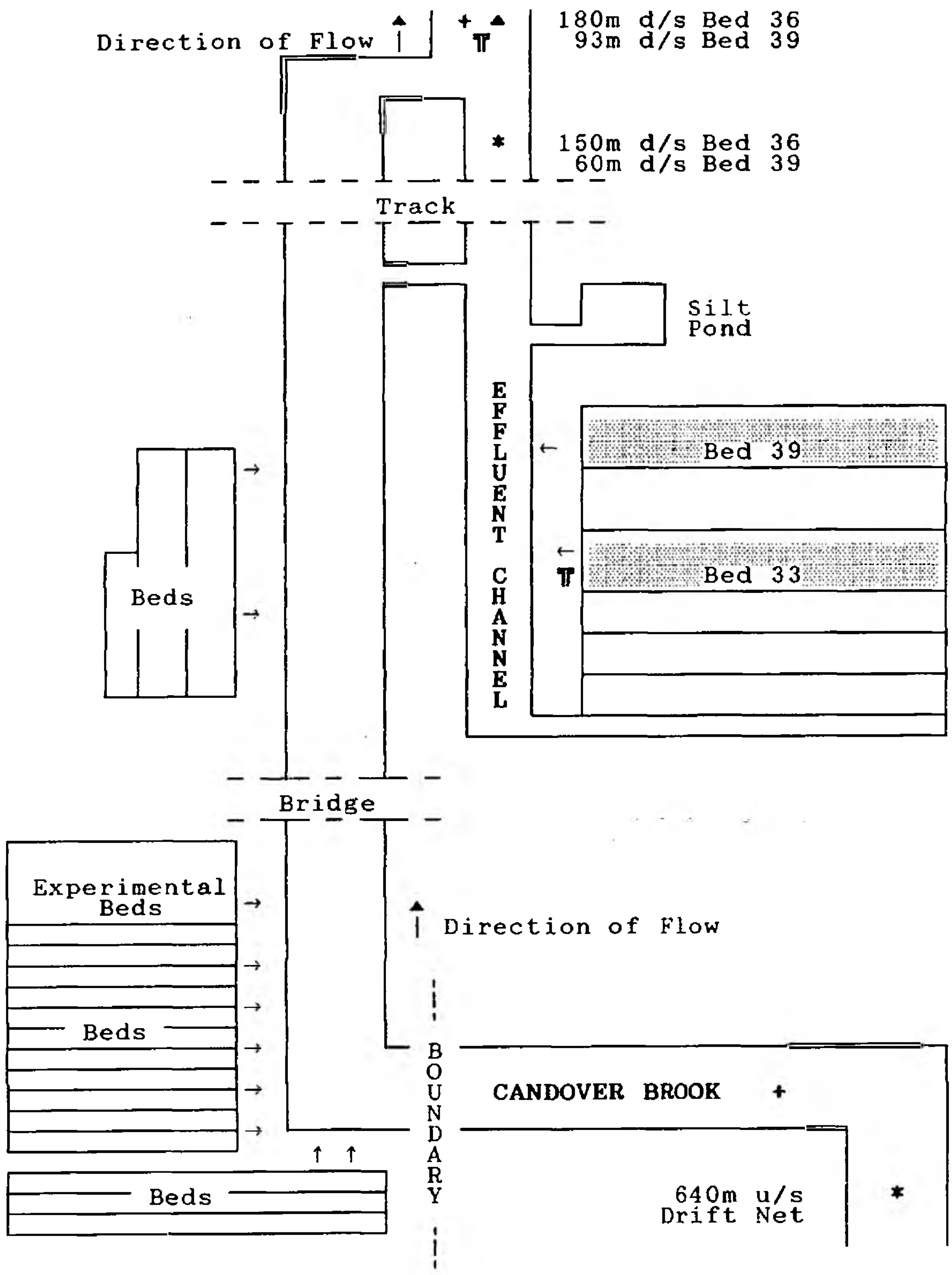
FIGURE 3 <u>**SCHEMATIC SITE MAP OF ST MARY BOURNE FARM**</u>



KEY:

▬	Culverted Section	*	Survey Chemical Sampling Point
==	Concreted Section	+	Routine Chemical Sampling Point
→	Selected Outfalls	▲	Routine Kick/Sweep Sampling Point
░	Sprayed Beds	π	Drift Net Site

FIGURE 4 SCHEMATIC SITE MAP OF FOBDOWN FARM



KEY:

═	Culverted Section	✱	Survey Chemical Sampling Point
→	Selected Outfalls	+	Routine Chemical Sampling Point
▒	Sprayed Beds	▲	Routine Kick/Sweep Sampling Point
		╥	Drift Net Site

FIGURE 5 Malathion application at St Mary Bourne, July 1990

FIGURE 6 Drift net in place at St Mary Bourne, July 1990

TABLES

Table 1 SAMPLING POINTS FOR WATER CHEMISTRY AND BIOLOGY

Routine Chemical and Biological Sites.

ST.MARY BOURNE

Bourne Rivulet. 450m d/s bed effluent, 200m d/s silt pond, right branch	SU 4295 4880
Effluent Channel. 250m d/s silt lagoon, left branch	SU 4305 4880

FOBDOWN

Candover Brook. 50m u/s farm boundary, (chemical samples only).	SU 5685 3400
Candover Brook. 35m d/s farm boundary, d/s effluent	SU 5690 3345

Non-routine Chemical Sampling Sites.

ST. MARY BOURNE

Bourne Rivulet. 750m upstream farm boundary	SU 4230 5001
Bourne Rivulet. 35m u/s silt pond, right branch	SU 4273 4895
Effluent Channel.120m d/s silt lagoon, left branch	SU 4302 4888

FOBDOWN

Candover Brook. 120m upstream farm boundary	SU 5681 3395
Candover Brook. 5m d/s farm boundary, d/s effluent	SU 5690 3345

Drift Net Sites.

ST. MARY BOURNE

Bourne Rivulet. 35m u/s silt pond, 150m d/s bed effluent, right branch	SU 4273 4895
Bourne Rivulet. 155m d/s silt pond, 350m d/s bed effluent, right branch	SU 4287 4882
Effluent channel. 120m d/s silt lagoon, left branch	SU 4302 4888

FOBDOWN

Candover Brook. 35m d/s farm boundary, d/s effluent point	SU 5690 3345
Effluent channel. Bed outlet (1 sample only)	SU 5704 3359

TABLE 2 APPLICATION OF PESTICIDES AT ST.MARY BOURNE AND FOBDOWN, JULY & OCTOBER 1990.						
FARM	DATE OF MONITORED SPRAY	*	DATE OF PREVIOUS SPRAY APPLICATION	AREA COVERED BY MONITORED SPRAY	RATE OF APPLICATION OF MONITORED SPRAY	CONDITIONS OF BEDS & CROPS AT TIME OF SPRAYING
FOBDOWN	11.7.90	M:	29.6.90	1500 m^2	60ml/1000m^2	Well established with complete cover No water discharge.
		D:	12.3.90	1600 m^2	285ml/1000m^2	Well established, 95% cover. No water discharge.
	4.10.90	M:	3.9.90	1000 m^2	60ml/1000m^2	Established stubble No water discharge
		D:	14.9.90	1000 m^2	285ml/1000m^2	
ST.MARY BOURNE	6.7.90	M:	15.6.90	2000 m^2	60ml/1000m^2	Well established seedlings, minimal water discharge
		D:	30.4.90	1000 m^2	285ml/1000m^2	Well established, complete bed cover, no water discharge
	3.10.90	M:	8.7.90	2000 m^2	60ml/1000m^2	Established stubble complete bed cover, minimal discharge
		D:	14.9.90	2000 m^2	285ml/1000m^2	

* M: Malathion, D: Dimethoate.

TABLE 3 TIMETABLE OF EVENTS: MONITORING OF PESTICIDE APPLICATION AT ST.MARY BOURNE, JULY 1990

(D/s: downstream, u/s: upstream; RB: Right Branch, LB: Left Branch looking d/s)

DATE	TIME	ACTION AT FARM	CHEMICAL SAMPLE	BIOLOGICAL SAMPLE
27.6.90	-			Pre-spray drift LB 2.5hrs
4.7.90	-			Pre-spray drift RB 2.5hrs Pre-spray k/s RB Pre-spray k/s LB
6.7.90	9.00		Pre-spray u/s	
	9.38		Pre-spray d/s LB	
	9.58		Pre-spray d/s RB RIGHT BRANCH:	
	11.00	Start of spray application to RB beds		
	11.20	Finish spray application		
	11.35		1st post spray d/s	
	11.45			RB drift nets in place (u/s & d/s silt pond)
	12.05		2nd post spray d/s	
	12.35		3rd " " "	
	13.05		4th	
	13.35		5th	
	14.15			RB drift samples emptied into trays & nets replaced
	14.05		6th	Observation of samples
	14.35		7th	in trays (1 hour)
	15.20			Drift nets removed & sample retained
	12.50		Post spray u/s LEFT BRANCH	
	11.45	Start of spray application to LB beds		
	12.20	Finish spray application		
	12.30		1st post spray d/s	LB drift net in place
	13.00		2nd " " "	
	13.30		3rd	
	14.00		4th	
	14.30		5th	
	15.00		6th	LB drift samples emptied
	15.30		7th	into trays & nets replaced Observation of samples in trays (1 hour)
	16.30			Drift nets removed & sample retained
17.7.90				Post spray k/s, L & R branches d/s.

TABLE 4 TIMETABLE OF EVENTS: MONITORING OF PESTICIDE APPLICATION AT ST. MARY BOURNE, OCTOBER 1990

(D/s: downstream, u/s: upstream; RB: Right Branch, LB: Left Branch looking d/s)

DATE	TIME	ACTION AT FARM	CHEMICAL SAMPLE	BIOLOGICAL SAMPLE
2.10.90	10.15		Pre-spray d/s RB	Pre-spray drift RB 2.5hrs
	10.30		Pre-spray d/s LB	" " LB 2.5hrs
			No u/s sample due to absence of flow	Pre-spray k/s RB
				" " LB
	14.30			Observation of samples in tray for 1 hour
3.10.90	11.00		Pre-spray d/s RB	
	11.15		Pre-spray d/s LB	
			RIGHT BRANCH:	
	12.55	Start of spray application to RB beds		
	13.05	Finish spray application	1st post spray d/s	RB drift nets in place (u/s & d/s silt pond)
	13.35		2nd " " "	
	14.05		3rd	
	14.35		4th	End of drift net sampling
	15.05		5th	Observation of sample
	15.35		6th	in trays for 1 hour
	16.05		7th	
			LEFT BRANCH:	
	13.05	Start of spray application to LB beds		
	13.15	Finish spray application	1st post spray d/s	LB drift net in place
	13.45		2nd " " "	
	14.15		3rd	
	14.45		4th	
	15.15		5th	
	15.45		6th	End of drift net sampling
	16.15		7th	Observation of sample in
	16.45			trays for 1 hour
24.10.90				Post spray k/s LB & RB

TABLE 5 TIMETABLE OF EVENTS: MONITORING OF PESTICIDE APPLICATION AT FOBDOWN. JULY 1990.

(D/s: downstream, u/s: upstream)

DATE	TIME	ACTION AT FARM	CHEMICAL SAMPLE	BIOLOGICAL SAMPLE
9.7.90	-			Pre-spray k/s
10.7.90				Pre-spray drift 2.5hrs + 1hr
11.7.90	09.00		Pre-spray d/s	
	09.20		Pre-spray u/s	
	09.45	Start of spray application		
	10.00	Finish spray application		
	11.10	Flow from beds to channel returned	Post spray u/s. 1st post spray d/s	Drift nets in place (d/s bed effluent & d/s road bridge)
	11.40		2nd post spray d/s	
	12.10		3rd	
	12.40		4th	
	13.10		5th	
	13.40		6th	D/s road bridge drift emptied into tray & net replaced Observation of tray for 1 hour
	14.10		7th	
	14.40			Both drift nets removed and samples retained
17.7.90				Post spray k/s

TABLE 6 TIMETABLE OF EVENTS: MONITORING OF PESTICIDE APPLICATION AT FOBDOWN , OCTOBER 1990.

(D/s: downstream, u/s: upstream)

DATE	TIME	ACTION AT FARM	CHEMICAL SAMPLE	BIOLOGICAL SAMPLE
2.10.90	15.15		Pre-spray d/s	Pre-spray drift 2.5hrs Observation of sample in tray 1hr
3.10.90				Pre-spray k/s
4.10.90	09.30		Pre-spray d/s	
	09.45		Pre-spray u/s	
	10.15	Start of spray application		
	10.25	Finish spray application	1st post-spray d/s	Drift net in place
	10.55		2nd post-spray d/s	
	11.25		3rd " " "	
	11.55		4th " " "	End of drift net sampling
	12.25		5th " " "	Observation of sample
	12.55		6th " " "	in trays for 1 hour
	13.25		7th " " "	
24.10.90				Post spray k/s

TABLE 7 RESULTS OF ROUTINE PESTICIDE ANALYSIS: ST.MARY BOURNE & FOBDOWN (Results in $ug.l^{-1}$ & $ug.kg^{-1}$)

DATE			APRIL 1990		JULY 1990		OCTOBER 1990	
FARM/SITE		*	DIMETHOATE	MALATHION	DIMETHOATE	MALATHION	DIMETHOATE	MALATHION
FOBDOWN 1. 50m u/s cress farm upper boundary	Water		<1	<1	-	-	<1	<1
	Sediment	A	<10	<10	<10	<10	<10	<10
		B	<10	<10	-	-	<10	<10
2. 50m d/s cress farm lower boundary	Water		<1	<1	<1	<1	<1	<1
	Sediment	A	<10	<10	<10	<10	<10	<10
		B	<10	<10	-	-	<10	<10
ST. MARY BOURNE 1. 200m d/s cress farm boundary, right branch	Water		<1	<1	<1	<1	<1	<1
	Sediment	A	<10	<10	<10	<10	<10	<10
		B	<10	<10	<10	<10	<10	<10
2. 200m d/s cress farm boundary, left branch	Water		1.0	1.0	<1	<1	<1	<1
	Sediment	A	<10	<10	<10	<10	<10	<10
		B	<10	<10	-	-	<10	<10

Detection Limits:	Analyte	Sediment (ug/kg)	Water (ug/l)
	Dimethoate	10	1
	Malathion	10	1

*: A & B are duplicates

TABLE 8 RESULTS OF NON-ROUTINE PESTICIDE ANALYSIS: JULY AND OCTOBER 1990 — ALL VALUES IN $ug.l^{-1}$

JULY 1990: DETECTION LIMIT 1.0 $ug.l^{-1}$		PRE-SPRAY	POST-SPRAY (time in hours after spraying)						
SITE AND SAMPLING POINT	ANALYTE		0	0.5	1	1.5	2	2.5	3
FOBDOWN UPSTREAM	DIMETHOATE	<1.0	<1.0	-	-	-	-	-	-
	MALATHION	<1.0	<1.0	-	-	-	-	-	-
FOBDOWN DOWNSTREAM	DIMETHOATE	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	MALATHION	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
ST MARY BOURNE UPSTREAM	DIMETHOATE	<1.0	<1.0	-	-	-	-	-	-
	MALATHION	<1.0	<1.0	-	-	-	-	-	-
ST MARY BOURNE DOWNSTREAM RIGHT BRANCH	DIMETHOATE	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	MALATHION	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
ST MARY BOURNE DOWNSTREAM LEFT BRANCH	DIMETHOATE	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	MALATHION	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

OCT 1990: DETECTION LIMIT 0.01 $ug.l^{-1}$		PRE-SPRAY	POST-SPRAY (time in hours after spraying)						
SITE AND SAMPLING POINT	ANALYTE		0	0.5	1	1.5	2	2.5	3
FOBDOWN UPSTREAM	DIMETHOATE	<0.01	-	-	-	-	-	-	-
	MALATHION	<0.01	-	-	-	-	-	-	-
FOBDOWN DOWNSTREAM	DIMETHOATE	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	MALATHION	<0.01	0.14	0.21	0.30	0.34	0.36	0.07	0.08
ST MARY BOURNE UPSTREAM	DIMETHOATE	<0.01	-	-	-	-	-	-	-
	MALATHION	<0.01	-	-	-	-	-	-	-
ST MARY BOURNE DOWNSTREAM RIGHT BRANCH	DIMETHOATE	<0.01	<0.01	0.01	0.01	<0.01	0.01	0.02	<0.01
	MALATHION	<0.01	0.82	0.50	0.72	0.14	0.28	0.10	0.02
ST MARY BOURNE DOWNSTREAM LEFT BRANCH	DIMETHOATE	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-
	MALATHION	<0.01	0.01	0.46	0.55	0.34	0.22	-	-

TABLE 9 SUMMARY OF KICK SAMPLING DATA

CANDOVER BROOK - 50M U/S FOBDOWN

DATE	07.11.89	16.01.90	25.04.90	09.07.90
No of SCORING TAXA	26	24	22	26
BMWP SCORE	136	126	125	149
ASPT SCORE	5.23	5.25	5.69	5.73

CANDOVER BROOK - 25M D/S FOBDOWN

DATE	PRE-SPRAY 09.07.90	POST-SPRAY 17.07.90	PRE-SPRAY 03.10.90	POST-SPRAY 24.10.90
No of SCORING TAXA	28	27	33	29
BMWP SCORE	149	137	172	145
ASPT SCORE	5.32	5.07	5.21	5.00

BOURNE RIVULET, ST MARY BOURNE, LEFT BRANCH

DATE	Pre-spray 04.07.90	Post-spray 17.07.90	Pre-spray 02.10.90	Post-spray 24.10.90
No of SCORING TAXA	19	21	21	23
BMWP SCORE	79	98	94	104
ASPT SCORE	4.16	4.67	4.48	4.52

BOURNE RIVULET, ST MARY BOURNE, RIGHT BRANCH

DATE	Pre-spray 04.07.90	Post-spray 17.07.90	Pre-spray 02.10.90	Post-spray 24.10.90
No of SCORING TAXA	18	27	21	25
BMWP SCORE	85	130	104	126
ASPT SCORE	4.72	4.81	4.95	5.04

TABLE 10 SUMMARY OF DRIFT NET SAMPLING DATA

CANDOVER BROOK 25m DOWNSTREAM FOBDOWN

DATE	PRE-SPRAY 100790	PRE-SPRAY 100790	POST-SPRAY 110790	POST-SPRAY 110790	PRE-SPRAY 021090	POST-SPRAY 041090	OUTFALL 110790
DURATION (HOURS)	2.5	+1	2.5	+1	2.5	2.5	3.5
TOTAL NUMBER OF TAXA	13	7	20	15	15	12	9

ST MARY BOURNE EFFLUENT CHANNEL (LEFT BRANCH)
150M DOWNSTREAM OF SILT POND

DATE	PRE-SPRAY 270690	POST SPRAY 060790	POST SPRAY 060790	PRE-SPRAY 021090	POST-SPRAY 031090
DURATION (HOURS)	2.5	2.5	+1	2.5	2.5
TOTAL NUMBER OF TAXA	14	15	10	8	7

BOURNE RIVULET RIGHT BRANCH, ST MARY BOURNE CRESS FARM
UPSTREAM OF SILT POND, 150m DOWNSTREAM OF BED EFFLUENT

DATE	PRE-SPRAY 040790	POST SPRAY 060790	POST SPRAY 060790	PRE-SPRAY 021090	POST-SPRAY 031090
DURATION (HOURS)	2.5	2.5	+1	2.5	2.5
TOTAL NUMBER OF TAXA	14	20	25	15	18

BOURNE RIVULET RIGHT BRANCH, ST MARY BOURNE CRESS FARM
DOWNSTREAM OF SILT POND, 350m DOWNSTREAM OF BED EFFLUENT

DATE	PRE-SPRAY 040790	POST-SPRAY 060790	POST-SPRAY 060790	PRE-SPRAY 021090	POST-SPRAY 031090
DURATION (HOURS)	2.5	2.5	+1	2.5	2.5
TOTAL NUMBER OF TAXA	11	17	10	12	10

TABLE 11 OBSERVED AND PREDICTED SCORES FOR KICK SWEEP SAMPLES

St Mary Bourne, Right Branch

July

	0407	1707	Mean	Pred.	EQI
BMWP	85	130	108	119	0.91
No Taxa	18	27	23	22	1.05
ASPT	4.72	4.81	4.77	5.2	0.92

October

	0210	2410	Mean	Pred.	EQI
BMWP	104	126	115	100	1.15
No Taxa	21	25	23	20	1.15
ASPT	4.95	5.04	5.00	4.8	1.04

SMB Left Branch

July

	0407	1707	Mean	Pred.	EQI
BMWP	79	98	89	92	0.97
No Taxa	19	21	20	19	1.05
ASPT	4.16	4.67	4.42	4.6	0.96

October

	0210	2410	Mean	Pred.	EQI
BMWP	94	104	99	107	0.93
No Taxa	21	23	22	21	1.05
ASPT	4.48	4.52	4.50	5.0	0.90

Fobdown

July

	0907	1707	Mean	Pred.	EQI
BMWP	149	137	143	105	1.36
No Taxa	28	27	28	21	1.33
ASPT	5.32	5.07	5.20	4.8	1.08

October

	0310	2410	Mean	Pred.	EQI
BMWP	172	145	159	101	1.57
No Taxa	33	29	31	21	1.48
ASPT	5.21	5.00	5.11	4.7	1.09

APPENDICES

Appendix 1		Pesticide analytical methodology.
Appendix 2		Full Taxa Lists for Kick Samples
	1	St.Mary Bourne, Right Branch
	2	St.Mary Bourne, Left Branch
	3	Fobdown
Appendix 3		Full Taxa Lists for Drift Net Samples
	1	St.Mary Bourne, Right Branch, Upstream of Silt Pond
	2	St Mary Bourne, Right Branch, Downstream of Silt Pond
	3	St.Mary Bourne, Left Branch
	4	Fobdown

APPENDIX 1 PESTICIDE ANALYTICAL METHODOLOGY

1 Dimethoate and malathion - routine detection limits

Water samples were extracted with dichloromethane, the extracts evaporated to dryness and redissolved in methanol prior to analysis by dual column capillary gas chromatography using nitrogen phosphorus detection.

Sediment samples were blended with acetone and filtered, the filtrates being extracted into dichloromethane which was then treated as above.

2 Dimethoate and malathion - detection limit of 0.01 $\mu g.l^{-1}$

The sample was filtered through a 1 µm prefilter in front of a 0.2 µm PTFE disc filter, One litre of the filtrate was added to 50 ml MeOH and the solution passed through an Empore C_{18} extraction disc under vacuum. Before use, the disc was activated by washing with 10 ml ethylacetate, 20 ml methanol and 20 ml HPLC grade water. After the water sample had passed through the disc, the disc was dried by maintaining vacuum for a further ten minutes. Retained solutes were recovered from the disc by elution with 5 ml ethyl acetate. The solvent was evaporated under a stream of nitrogen at 30°C and the residue dissolved in 1 ml methanol containing 1 $mg.l^{-1}$ ditalimfos as an internal standard. Analyses were performed using a dual column gas chromatograph with NPD detectors.

APPENDIX 2 FULL TAXA LISTS FOR KICK SAMPLES

1 Bourne Rivulet, St Mary Bourne, Right Branch

DATE	Pre-spray 04.07.90	Post-spray 17.07.90	Pre-spray 02.10.90	Post-spray 24.10.90
TRICLADIDA				
Planariidae				
Polycelis spp.		3	2	3
GASTROPODA				
Valvatidae				
Valvata cristata		2		
Valvata piscinalis				2
Hydrobiidae				
Potamopyrgus jenkinsi	2	3		
Physidae				
Physa fontinalis			1	2
Lymnaeidae				
Lymnaea palustris		2		
Lymnaea peregra	4	3		
Planorbidae				
Planorbis planorbis				2
Anisus vortex		3	2	
Bathyomphalus contortus		2		
Ancylidae				
Ancylus fluviatilis		3		
BIVALVIA				
Sphaeriidae				
Sphaerium spp.	3			
Pisidium spp.		2	3	3
OLIGOCHAETA	3	4	4	4
HIRUDINEA				
Piscicolidae				
Piscicola geometra		1		2
Glossiphoniidae				
Theromyzon tessulatum			1	
Glossiphonia complanata	2	3	2	3
Helobdella stagnalis	2	4	3	3
Erpobdellidae				
Erpobdella octoculata	2	2	2	2
HYDRACARINA	2	3		2
ISOPODA				
Asellidae				
Asellus aquaticus	2	3	2	3
AMPHIPODA				
Gammaridae				
Gammarus pulex	2	4	4	4
Niphargidae				
Niphargus aquilex		1		
EPHEMEROPTERA				
Baetidae				
Baetis rhodani	2	3	3	3
Baetis scambus		3	2	
Baetis vernus	2	2	2	3
Centroptilum luteolum				1

DATE	Pre-spray 04.07.90	Post-spray 17.07.90	Pre-spray 02.10.90	Post-spray 24.10.90
Centroptilum pennulatum	1			
Ephemeridae				
Ephemera danica			2	1
Ephemerellidae				
Ephemerella ignita	4	4	2	2
PLECOPTERA				
Leuctridae				
Leuctra sp.		2		
ODONATA				
Platycnemididae				
HEMIPTERA				
Corixidae				
Sigara dorsalis/striata		1	2	2
COLEOPTERA				
Haliplidae				2
Dytiscidae	1	1	3	
Oreodytes sanmarkii		2	2	3
Hydrophilidae		2		
Helophorus brevipalpis		1		
Elmidae				
Elmis aenea		2	2	2
Limnius volkmari		1		
TRICHOPTERA				
Rhyacophilidae				
Rhyacophila dorsalis		2		2
Agapetus fuscipes		2	2	1
Hydroptilidae	2			
Agraylea spp.				1
Hydroptila spp.		3		
Oxyethira spp.		1	1	2
Psychomyiidae				
Tinodes waeneri		1		
Limnephilidae	2			
Drusus annulatus		3		
Goeridae				
Silo nigricornis			2	2
Sericostomatidae	1			
Sericostoma personatum				2
DIPTERA				
Tipulidae	2	3	2	1
Psychodidae		3		
Dixidae				1
Ceratopogonidae		3	2	2
Simuliidae	5	4	1	3
Chironomidae	3	4	4	4
Empididae		3		
No of SCORING TAXA	18	27	21	25
BMWP SCORE	85	130	104	126
ASPT SCORE	4.72	4.81	4.95	5.04

2 Bourne Rivulet, St Mary Bourne, Left Branch

DATE	Pre-spray 04.07.90	Post-spray 17.07.90	Pre-spray 02.10.90	Post-spray 24.10.90
TRICLADIDA				
Planariidae				
Polycelis spp.	2	2	2	
GASTROPODA				
Valvatidae				
Valvata cristata	2			
Valvata macrostoma				2
Valvata piscinalis	2		3	
Hydrobiidae				
Potamopyrgus jenkinsi	1			
Physidae				
Physa fontinalis		2	3	2
Lymnaeidae				
Lymnaea peregra	3	3	3	2
Lymnaea truncatula	2			
Planorbidae				
Planorbis planorbis			2	
Anisus vortex	3	3		3
Bathyomphalus contortus	2	3	3	3
Gyraulus albus			3	2
Armiger crista				2
Ancylidae				
Ancylus fluviatilis	3	3		
BIVALVIA				
Sphaeriidae				
Sphaerium spp.	2	2		
Pisidium spp.	2		3	2
OLIGOCHAETA	4	3	4	4
HIRUDINEA				
Piscicolidae				
Piscicola geometra		1	2	1
Glossiphoniidae				
Glossiphonia complanata	3	3	2	3
Helobdella stagnalis	3	3	3	3
Erpobdellidae	2			
Erpobdella octoculata	1	2	2	3
HYDRACARINA	2		2	3
ISOPODA				
Asellidae				
Asellus aquaticus	3	3	3	3
AMPHIPODA				
Gammaridae				
Gammarus pulex			3	3
EPHEMEROPTERA				
Baetidae				
Baetis rhodani	4	2	3	3
Baetis scambus	3			
Baetis vernus		2	2	1
Ephemeridae				
Ephemera danica			1	1
Ephemerellidae				
Ephemerella ignita	3	3	1	3
Caenidae				

DATE	Pre-spray 04.07.90	Post-spray 17.07.90	Pre-spray 02.10.90	Post-spray 24.10.90
Caenis rivulorum				2
HEMIPTERA				
Corixidae				
Sigara dorsalis/striata				1
COLEOPTERA				
Haliplidae				
Brychius elevatus			1	
Dytiscidae	2	2		2
Oreodytes sanmarkii	3	3	3	3
Hydrophilidae	1	2		
Helophorus brevipalpis		2		
Elmidae				
Elmis aenea				1
Riolus subviolaceus	1			
MEGALOPTERA				
Sialidae				
Sialis lutaria				1
TRICHOPTERA				
Rhyacophilidae				
Rhyacophila dorsalis				2
Psychomyiidae				
Tinodes waeneri		2	1	
Hydropsychidae				
Hydropsyche siltalai				2
Limnephilidae		1		
Drusus annulatus		2		
Limnephilus lunatus	1			
Sericostomatidae				
Sericostoma personatum		1		
DIPTERA				
Tipulidae		2	2	
Psychodidae				2
Dixidae			1	
Chaoboridae			1	
Ceratopogonidae	4	2	2	
Simuliidae	3	3	3	3
Chironomidae	5	3	4	3
Stratiomyidae				1
Empididae	2			
No of SCORING TAXA	19	21	21	23
BMWP SCORE	79	98	94	104
ASPT SCORE	4.16	4.67	4.48	4.52

3 Candover Brook - 25m Downstream of Fobdown

DATE	PRE-SPRAY 09.07.90	POST-SPRAY 17.07.90	PRE-SPRAY 03.10.90	POST-SPRAY 24.10.90
TRICLADIDA				
Planariidae				
Polycelis spp.	2	3	3	3
GASTROPODA				
Valvatidae				
Valvata cristata				2
Valvata piscinalis	2	2	3	3
Hydrobiidae				
Potamopyrgus jenkinsi	4	4	4	4
Physidae				
Physa fontinalis			2	2
Lymnaeidae				
Lymnaea palustris			2	
Lymnaea peregra	3	3	3	3
Planorbidae				
Planorbis planorbis				1
Anisus vortex	2	3		3
Bathyomphalus contortus	2		3	2
Gyraulus albus		1		2
Ancylidae				
Ancylus fluviatilis	2	3	3	3
BIVALVIA				
Sphaeriidae				
Sphaerium spp.	2	2	4	3
Pisidium spp.		3		2
OLIGOCHAETA	3	4	4	3
HIRUDINEA				
Piscicolidae				
Piscicola geometra			2	1
Glossiphoniidae				
Theromyzon tessulatum			1	
Glossiphonia complanata	3	3	2	3
Helobdella stagnalis	2	3		3
Erpobdellidae				
Erpobdella octoculata	3	2	2	3
HYDRACARINA	3	3	2	3
ISOPODA				
Asellidae				
Asellus aquaticus	3	3	3	3
AMPHIPODA				
Gammaridae				
Gammarus pulex	3	4	3	3
EPHEMEROPTERA				
Baetidae				
Baetis muticus				1
Baetis rhodani	2	3	3	3
Baetis scambus	2	3		2
Baetis vernus	3		2	2
Centroptilum luteolum			1	
Centroptilum pennulatum	1			
Heptageniidae			1	
Heptagenia sulphurea	1			
Leptophlebiidae				
Paraleptophlebia submarginata			2	

DATE	PRE-SPRAY 09.07.90	POST-SPRAY 17.07.90	PRE-SPRAY 03.10.90	POST-SPRAY 24.10.90
Ephemerellidae				
Ephemerella ignita	3	3	3	2
Caenidae				
Caenis luctuosa	2	1		1
Caenis rivulorum				2
PLECOPTERA				
Leuctridae				
Leuctra geniculata		2		
Leuctra hippopus	2	3		
HEMIPTERA				
Corixidae		1		
Sigara dorsalis/striata			3	1
Sigara limitata				1
Sigara venusta			2	
COLEOPTERA				
Haliplidae	2		2	2
Dytiscidae	2			2
Coelambus confluens			2	
Potamonectes depressus elegans			2	1
Oreodytes sanmarkii	2	3		2
Hydrophilidae	1			
Hydrobius fuscipes			1	
Elmidae				
Elmis aenea	2	3	2	3
Limnius volkmari		1		
Oulimnius sp.				1
Riolus subviolaceus		1	1	
TRICHOPTERA				
Rhyacophilidae				3
Rhyacophila dorsalis		2	2	2
Agapetus fuscipes	3	4	1	
Hydroptilidae				
Hydroptila spp.	2	4	2	2
Oxyethira spp.		1	2	3
Psychomyiidae				
Metalype fragilis				1
Polycentropodidae				
Polycentropus flavomaculatus	1	1	2	
Hydropsychidae				
Hydropsyche siltalai			2	3
Limnephilidae			1	2
Drusus annulatus		1		
Halesus sp.	1			
Goeridae				
Silo nigricornis				1
Sericostomatidae				
Sericostoma personatum			3	3
Odontoceridae				
Odontocerum albicorne			3	
Leptoceridae				
Athripsodes albifrons	2			
Athripsodes cinereus		2		
Ylodes conspersus		1		

DATE	PRE-SPRAY 09.07.90	POST-SPRAY 17.07.90	PRE-SPRAY 03.10.90	POST-SPRAY 24.10.90
DIPTERA				
Tipulidae	2	3		2
Psychodidae			2	
Dixidae			3	
Ceratopogonidae	2	2	2	
Simuliidae	2	3	3	
Chironomidae	3	3	3	3
Empididae		3		
Muscidae				2
No of SCORING TAXA	28	27	33	29
BMWP SCORE	149	137	172	145
ASPT SCORE	5.32	5.07	5.21	5.00

APPENDIX 3 FULL TAXA LISTS FOR DRIFT NET SAMPLES

1 Bourne Rivulet, St Mary Bourne, Right Branch Upstream of Silt Pond, 150m Downstream of Bed Effluent

	PRE-SPRAY	POST-SPRAY		PRE-SPRAY	POST-SPRAY
DATE	040790	060790	060790	021090	031090
DURATION (HOURS)	2.5	2.5	+1	2.5	2.5
Hydrobiidae*					2
Lymnaeidae*	3	3	2	1	2
Planorbidae*	1	2	2	1	2
Ancylidae*			1		1
Zonitidae	1				
Sphaeriidae*			1		
OLIGOCHAETA*	2	2	2	2	3
Glossiphoniidae*			1		
HYDRACARINA			2	1	
OSTRACODA	2	2	2	2	2
Asellidae*			2		
Gammaridae*			2		2
COLLEMBOLA	2	2	1		2
Baetidae*	3	3	2	2	2
Ephemerellidae*	3	3	2		
Corixidae*		1			
Haliplidae*		1			
Dytiscidae*		1			
Hydrophilidae*	3	2	2		
Elimidae*			1	1	1
Chrysomelidae*	2	3	3		
Curculionidae*		1	2		
Rhyacophilidae*		1	2		
Psychomyiidae*		1		1	
Hydroptilidae*			2	1	1
Tipulidae*		1	1	1	1
Psychodidae			2	1	
Dixidae				2	3
Culicidae		1	2		2
Ceratopogonidae					1
Chironomidae*	2	3	2	3	3
Simuliidae*	2	2	2	3	2
Stratiomyidae					1
Dolichopodidae	1	1	1		
Syrphidae				1	
Ephyridae	1				
TOTAL NUMBER OF TAXA	14	20	25	15	18

(* BMWP Scoring Taxa)

2 Bourne Rivulet, St Mary Bourne, Right Branch
Downstream of Silt Pond, 350m Downstream of Bed Effluent

	PRE-SPRAY	POST-SPRAY		PRE-SPRAY	POST-SPRAY
DATE	040790	060790	060790	021090	031090
DURATION (HOURS)	2.5	2.5	+1	2.5	2.5
Hydrobiidae*		2			
Lymnaeidae*		1		1	
Planorbidae*					1
Ancylidae*				1	
Zonitidae	2	1			
OLIGOCHAETA*				2	
Glossiphoniidae*		1			
HYDRACARINA	1	2		1	
OSTRACODA	1	2			
Asellidae*			1		
Gammaridae*		1	2		2
COLLEMBOLA				3	2
Baetidae*	3	3	3	2	
Ephemerellidae*	3	3	3		2
Leuctridae*		1			
Veliidae		1			
Dytiscidae*		1	1	1	1
Hydrophilidae*		2	1	1	
Elimidae*	1		1		
Chrysomelidae*					2
Curculionidae*		1			1
Psychomyiidae*		1			
Tipulidae*	1				
Psychodidae			1		1
Dixidae				1	3
Culicidae				1	
Ceratopogonidae	1				
Chironomidae*	3	2	2	2	1
Simuliidae*	2	2	2	3	
Empididae	1				
TOTAL NUMBER OF TAXA	11	17	10	12	10

(* BMWP Scoring Taxa)

3 <u>Effluent Channel, St Mary Bourne, Left Branch 150m Downstream of Silt Pond</u>

DATE	PRE-SPRAY 270690	POST 060790	SPRAY 060790	PRE-SPRAY 021090	POST-SPRAY 031090
DURATION (HOURS)	2.5	2.5	+1	2.5	2.5
Lymnaeidae*	2	2	1		
Planorbidae*	2	2	2	1	
Ancylidae*	2	1		1	
OLIGOCHAETA*	3		2	2	3
Glossiphoniidae*			1		
HYDRACARINA	2	2	2	1	
OSTRACODA	2				
Asellidae*	2	1	1		
Baetidae*	2	2	2	3	2
Ephemerellidae*	2	1			
Dytiscidae*	2				1
Hydrophilidae*		2			
Elimidae*		1			1
Chrysomelidae*		1			
Hydropsychidae*					1
Psychodidae	1	2			
Dixidae				2	
Chironomidae*	4	3	3	2	2
Simuliidae*	2	2	2	3	3
Empididae	2				
Ephyridae		1			
Muscidae		1			
TOTAL NUMBER OF TAXA	14	15	10	8	7

(* BMWP Scoring Taxa)

4 CANDOVER BROOK. FOBDOWN. 25m DOWNSTREAM

	PRE-SPRAY		POST-SPRAY		PRE-SPRAY	POST-SPRAY	OUTFALL
DATE	100790	100790	110790	110790	021090	041090	110790
DURATION (HOURS)	2.5	+1	2.5	+1	2.5	2.5	3.5
Planariidae*			1				
Hydrobiidae*			3	2		2	
Lymnaeidae*			1	1	2	1	1
Planorbidae*			1				
Ancylidae*		1				2	
Zonitidae				1			
Sphaeriidae*			1				
OLIGOCHAETA*	3		2		3	3	
Glossiphoniidae*			2	2			
HYDRACARINA	2			2			
OSTRACODA	2		2	2			
Gammaridae*			2	2	1		
COLLEMBOLA					1		2
Baetidae*		1	2	2	2	2	2
Ephemerellidae*	1		2	2			1
Hydrometridae*			1				
Veliidae							1
Corixidae*		2	1				
Haliplidae*					1		
Hygrobiidae*					3		
Dytiscidae*	1					1	2
Hydrophilidae*	1				1		
Elimidae*			2	2		2	
Rhyacophilidae*	1	1	3	3		2	
Psychomyiidae*	1						
Hydropsychidae*					1	2	
Hydroptilidae*	1			2	2		
Leptoceridae*				1			
Tipulidae*					1		
Psychodidae					1		1
Dixidae					2	2	
Chironomidae*	3	3	3	3	3	3	3
Simuliidae*	2	2	2	3	2	2	
Empididae			1				
Tabanidae	1		1				
Ephyridae	1	1					1
Muscidae			1				
TOTAL NUMBER OF TAXA	13	7	20	15	15	12	9

(* BMWP Scoring Taxa)