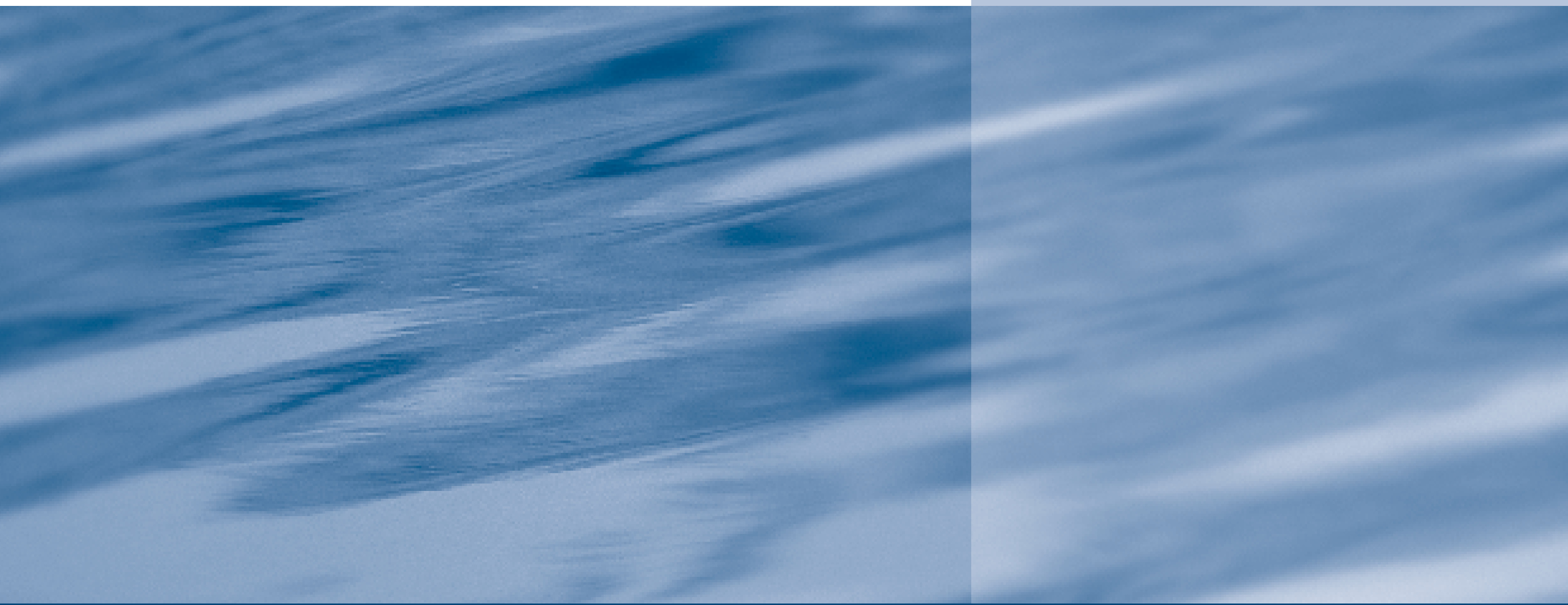

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# The effect of the Voluntary Initiative on water quality

Science Report SC030191/SR

Environment Agency

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**Author(s):**
Lascelles, B., Turley, E., Davies, J., Knight, L., Kelly, M., Pemberton, E., Wells, C.

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**Research Contractor:**
Cresswell Associates (Environmental Consultants) Ltd
The Mill, Brimscombe Port, Brimscombe, Stroud, Gloucestershire, GL5 2QG
Tel: 01453 731231

**Environment Agency's Project Manager:**
Claire Wells
Environment Agency Science Group, Howbery Park, Wallingford, OXON, OX10 8BD

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# Science at the Environment Agency

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- **Providing advice**: To ensure that the knowledge, tools and techniques generated by the science programme are taken up by relevant decision-makers, policy makers and operational staff.

Professor Mike Depledge Head of Science

# Executive Summary

The Voluntary Initiative (VI) is the industry-led alternative approach to a pesticide tax, and provides an important opportunity for the farming industry to demonstrate that it can reduce the environmental impacts of using pesticides. The Environment Agency plays an active role in the VI as a member of the independent steering group that oversees progress, assisting with individual projects and developing indicators for success.

The VI is dependent on a commitment by farmers and growers to formally consider the environmental impacts of their own activities and take steps to reduce them. For example, Crop Protection Management Plans are drawn up to address the farm's crop protection policy, water protection measures taken, commitment to improved operator competency and mitigation of direct and indirect impacts.

To demonstrate the environmental benefits of the core measures of the VI, the VI Indicator Farms project was set up. The overall objective of this project was to determine the effectiveness of the VI measures at reducing pesticide impacts and enhancing biodiversity. Initially, 11 farms were selected to cover a range of cropping systems and geographical areas across the UK. The Environment Agency focused its study on three of these farms, which were considered to have the greatest potential for impacts on the local aquatic ecosystem. The results of this work are reported here. In addition to the work carried out by the Environment Agency, any changes in the terrestrial biodiversity on the farms will be assessed using techniques provided by the Farm Wildlife Advisory Group (FWAG). This part of the VI Indicator Farms project will be reported separately.

The original intention of the project had been to monitor prior to the implementation of any VI measures, to establish a baseline from which to observe any environmental improvements. However, significant delays in the selection of the farms meant that they had already implemented measures designed to minimise the environmental impacts of pesticide use, such as conservation headlands and improved control over pesticide handling procedures. It was therefore not possible to determine a baseline, and the original study plan was revised.

Detailed chemical and biological water-quality monitoring was undertaken on the three farms to provide an indication of the water quality at each farm. The results of this 'scoping study' indicate that there is no obvious impact on the aquatic environment as a consequence of pesticide use, with the invertebrate faunas of all the watercourses considered to be typical. However, the results do show that both pesticide handling areas and pesticides applied on fields can be a source of pesticides to the aquatic environment.

This project provides an indication of the current state of the local aquatic environment of the three farms. It shows that the protocol for monitoring the effectiveness of the VI would be, with some amendments, appropriate for use on other farms, although particular emphasis should be placed on careful farm selection. The farms monitored for this project had good to very good biological water quality and a low frequency of pesticide detection. This suggests that there is little value in continuing to monitor water quality at these locations with respect to the aims of the original project.

# Contents

# 1 Introduction

The Voluntary Initiative (VI) is the industry-led alternative approach to a pesticide tax. It provides an important opportunity for the farming industry to demonstrate that it can reduce the environmental impacts of using pesticides. Its success is reliant on the uptake of improvement measures by farmers. The Environment Agency plays an active role in the VI as a member of the independent steering group, which oversees progress, assists with a number of the individual projects and develops indicators for success.

One of the key elements in the VI is a commitment from farmers and growers to formally consider the environmental impacts of their own activities and to take steps to reduce them, by drawing up a 'Crop Protection Management Plan' (CPMP). CPMPs address the farm's crop protection policy, detail water protection measures taken, indicate a commitment to improved operator competency and consider how the direct and indirect impacts of pesticides on non-target species can be mitigated.

To demonstrate the environmental benefits of the core measures of the VI, such as CPMPs, the VI Indicator Farms project was set up by the Crop Protection Association (CPA). The overall objective of this project was to determine the effectiveness of the VI measures at reducing pesticide impacts on the environment and at enhancing biodiversity. Initially, 11 farms were selected by the CPA as 'indicator' farms to cover a range of cropping systems and geographical areas across the UK.

The Environment Agency focused its study on the aquatic environment at three of these farms. The results of this work are reported here. In addition, any changes in the terrestrial biodiversity on the farms will be assessed using techniques provided by the Farm Wildlife Advisory Group (FWAG). This part of the VI Indicator Farms project will be reported separately.

Significant delays in the selection of farms to participate in the study, and also limitations in terms of the farms selected for study, meant that it was not possible to establish the baseline water-quality status for each farm prior to implementation of the VI measures. Without baseline data it was not possible to (a) determine whether there was a significant improvement in water quality over the monitoring period or (b) determine if any improvement observed could be attributed to implementation of the VI measures. This preliminary survey was therefore undertaken to establish the viability of undertaking the proposed longer-term study at these sites.

This report presents the results of the preliminary monitoring survey, undertaken between October and December 2004, on the three selected farms to assess the biological and chemical status of the on-farm and receiving watercourses.

The conditions at each farm were examined to select a number of monitoring points from which an assessment could be made of the impacts of pesticide usage on the aquatic environment. This took into account pesticides applied during the sampling period and also historical applications, where information was available.

Monitoring was undertaken with the full cooperation of the farmers involved, who provided detailed information on the pesticides used, handling and storage procedures and locations, weather conditions preceding and following application, and potential hydrological drainage links to receiving water bodies.

# 2 Methods

## 2.1 Introduction

The objective of this study was to provide a snapshot of the chemical and biological water quality at each of the three indicator farms selected. The results from this study will be used to inform the viability of a longer term monitoring study at these sites.

A total of four sampling events, approximately 3 weeks apart, took place at each farm between October and December 2004. *Table 2.1* shows the samples taken at each of the sampling events. High rainfall in late October resulted in a delay in the first sampling event at Farm C (the River Stour was in spate). Sampling was subsequently carried out a week later. No other sampling events were postponed.

**Table 2.1 Sampling event timetable**

| | *Dates* | *Sampling and/or surveys undertaken* |
|---|---|---|
| **Sampling event 1** | Farm A: 21 October 2004<br>Farm B: 26 October 2004<br>Farm C: 4 November 2004 | • Aquatic macro-invertebrate sampling<br>• Chemical sampling<br>• Installing benthic diatom artificial substrates |
| **Sampling event 2** | Farm A: 23 November 2004<br>Farm B: 19 November 2004<br>Farm C: 18 November 2004 | • Chemical sampling<br>• River Corridor Surveys |
| **Sampling event 3** | Farm A: 7 December 2004<br>Farm B: 3 December 2004<br>Farm C: 2 December 2004 | • Chemical sampling<br>• Collecting benthic diatom samples from the artificial substrates |
| **Sampling event 4** | Farm A: 21 December 2004<br>Farm B: 17 December 2004<br>Farm C: 16 December 2004 | • Chemical sampling |

## 2.2 Farm selection and characterisation

In 2002, the VI Steering Group considered establishing a network of 'indicator' farms across the UK that could be used to support technology transfer and promote the work of the VI. These farms would also be used to provide indicative evidence of whether the core measures of the VI, when implemented on an indicator farm, resulted in a reduction of the environmental impact of crop protection products.

A total of 11 farms were selected, from which three were chosen for detailed biological and chemical water-quality monitoring. The Environment Agency selected the three farms considered to have the greatest potential for impacted watercourses, on the basis of location of watercourses on the farm and from information given in the CPMP.

The three farms selected were:

- Farm A, Anglian Region;
- Farm B, South West Region;
- Farm C, Midlands Region.

The original intention of the project had been to monitor prior to implementation of any VI measures, to establish a baseline from which to observe any environmental improvements. However, significant delays in the selection of farms meant that the indicator farms had already implemented measures designed to minimise the environmental impacts of pesticide use, such as conservation headlands and improved control over pesticide handling procedures.

It was therefore not possible to determine a baseline. The survey described herein was undertaken to provide a snapshot of water quality at a selection of the indicator farms. If no adverse impacts were observed during this preliminary survey it was agreed that these farms would be unsuitable for further study.

A scoping visit was made to all three farms over the course of three days, between 21 and 23 September 2004. This allowed identification of the most suitable sampling locations and the most appropriate methods for biological and chemical sampling. Over this same period, the farmers were interviewed to collate information regarding the nature of the farm enterprise, their implementation of VI measures and to gain access to pesticide application records.

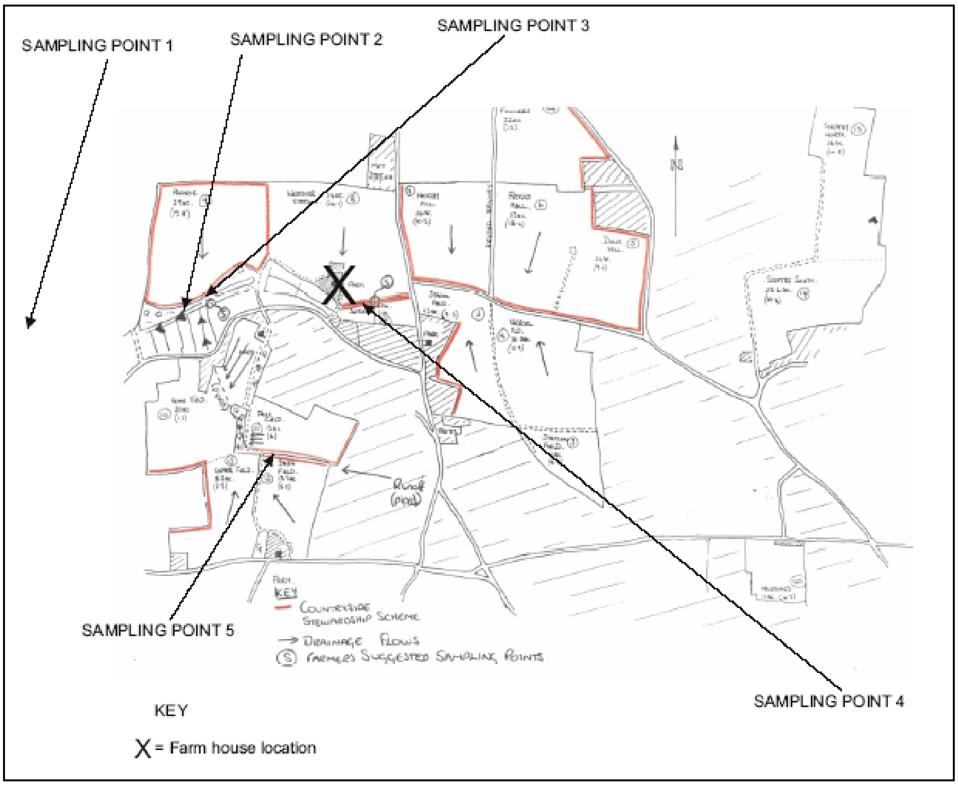
## 2.3 Selection of sampling locations

Up to five sampling points were selected at each farm. For the biological sampling, the aim was to select a minimum of three sites. One upstream site would act as a control, with two downstream sites to show immediate and continuing effects of any pesticides that entered the water. While this was possible on the River Stour at Farm C, the more complex hydrology at Farms A and B meant that only two biological sampling locations could be selected at these farms.

Water samples for chemical analysis were taken at all biological sampling locations, plus a number of additional sites. These additional sampling sites were deemed unsuitable for biological sampling because of their characteristics, but were chosen to highlight pesticide inputs via run-off from isolated fields or areas of the farms.

At the time of sampling-point selection, a number contained no flowing or standing water. These were sampling points 3, 4 and 5 at Farm A and sampling point 5 at Farm B. It was anticipated that these might hold water after heavy rainfall events, carrying run-off from fields which were likely to receive pesticide applications. These sites are described here, but would only be sampled should flow occur, or should additional visits be made in response to heavy or prolonged rainfall events.

## Figure 1a  Farm A



## Figure 1b  Farm B

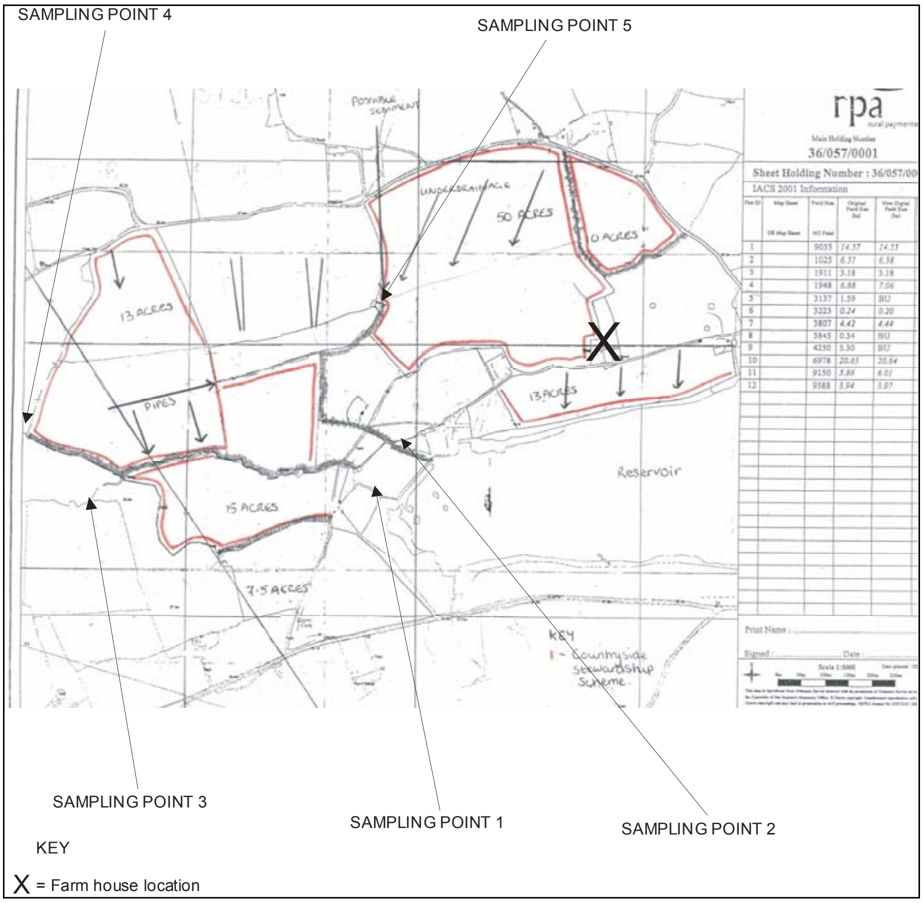
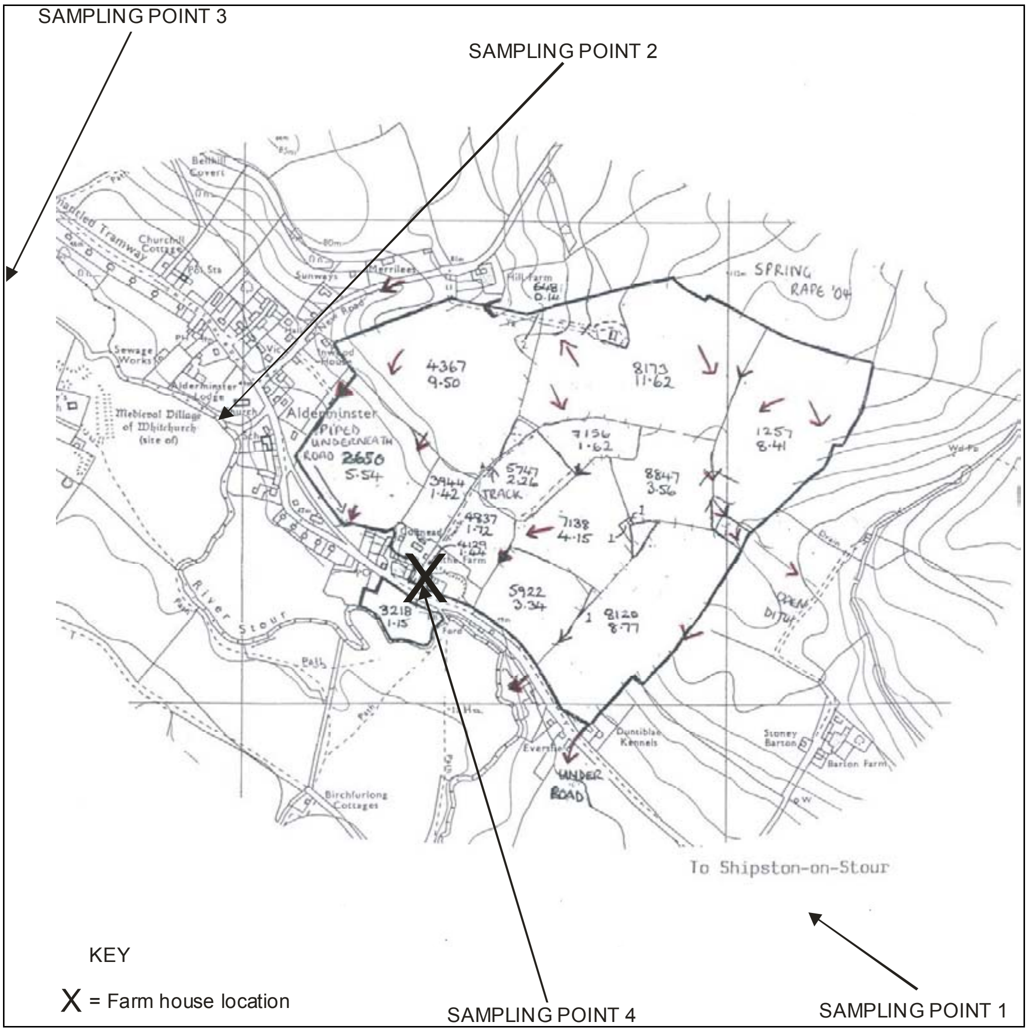


**Figure 1c Farm C**




# 2.4 Sampling point descriptions and environmental data

Outlined below are descriptions of the sampling points. Detailed information collected during the River Corridor Survey (RCS) is presented in Appendix II. Appendix III presents tabulated environmental data for each sampling point. *Figures 1a–c* show sampling point locations and field numbers.

## 2.4.1 Farm A

Five sampling points were selected at Farm A. Sampling points 1 and 2 were suitable for both biological and chemical sampling; sampling points 3, 4 and 5 were chemical sampling sites only as they contained no water at the time of site selection. There was no available upstream sampling location because the main carrier ditch on the farm rose within Farm A itself.

Sampling Point 1 was located on the main carrier ditch, downstream from the farm. It appeared to be well managed with a typical trapezoidal cross-section. The substrate was largely silt, with a small amount of underlying gravel and few or no cobbles. Fool's watercress (*Apium nodiflorum*) and water mint (*Mentha aquatica*) were present in the open water at this sampling point.

Sampling Point 2 was an upstream sampling location on the main carrier ditch, although it is unlikely that these ditches experience significant levels of flow. It had very similar characteristics to those of sampling point 1. Sampling point 3 was a small ditch that joined the main carrier ditch above sampling points 1 and 2. It was anticipated that this might carry run-off from Field 9.

Sampling point 4 was a ditch that carried run-off from Field 8, to the east of Farm A, and was chosen because it occasionally received overflow drainage from the adjacent sewage treatment works. There was concern that this would have a significant impact on water quality if such a situation arose during the investigation. Sampling point 5 was accessed through an adjacent farm, and received drainage water from Fields 11 and 12. Sampling points 3, 4 and 5 appeared to be unmanaged, and had not received significant flow for some time.

As detailed above, sampling points 3, 4 and 5 were dry at the time of initial site selection and would probably only provide the potential to be sampled after significant heavy or prolonged rainfall. No other watercourses occurred within or immediately adjacent to this farm.

### 2.4.2 Farm B

Five sampling points were selected at Farm B. Sampling points 1 and 3 were suitable for both biological and chemical sampling; sampling points 2, 4 and 5 were chemical sampling sites only. It appeared from the initial site visit that the majority of the run-off from the farm drained into the Durleigh Brook, a small watercourse with a mostly coarse substrate of cobbles and pebbles. The majority of drainage ditches on this farm held water at the time of the initial visit.

Sampling point 1 was a downstream site located on the Durleigh Brook. This site could not be used to assess all of the potential impacts related to this farm holding because a ditch carrying some run-off entered the brook almost immediately prior to the reservoir. Two fields also bordered the shores of the reservoir. Below the confluence of the ditch, the brook was very sluggish, with a predominately silty substrate. This was atypical of the rest of the reach and was likely to be affected by reservoir drawdown. Hence it was not practical to sample here. It is estimated that the sampling point used could potentially be impacted by run-off from approximately 60-80 percent of the farm.

Sampling point 1 had a substrate primarily of gravel and sand, with some overlying silt and few or no cobbles. The channel was characterised by bare silt deposits with debris accumulations. There was very little marginal vegetation in the channel itself, and the stream banks were steep (near vertical).

Sampling point 2 was another downstream site, a drainage ditch that received run-off from the majority of the eastern and central parts of the farm, and discharged eventually into the Durleigh Reservoir. At the initial site visit it appeared that the majority of the run-off at low-flow conditions would soak away as the ditch ran through the wet woodland adjacent to the brook and reservoir. This ditch was not suitable for macro-invertebrate sampling, being a small, silty watercourse with very little flow and no comparable upstream site above the farm. Therefore, only chemical monitoring was undertaken at this location.

Sampling point 3 was at an upstream location on the Durleigh Brook. Just above the boundary of Farm B is a ruined weir, which has collapsed to form a cobble riffle in the brook. The upstream site was located on the first riffle above this, which consisted of two sections, a cobble–pebble lower part and a sand–gravel stretch above this. Sampling was restricted to the upper section, to be more comparable with the physical characteristics of the downstream site. The banks were steep in places at this location.

Sampling point 4 was on a very narrow drainage ditch that held very little water, other than at the sump where the sample point was located. The ditch was uniformly trapezoidal in cross-section, with a hedge bank at the top of the right bank. The substrate was composed mostly of sand and silt. Sampling points 3 and 4 were within an adjacent farm, but the owners were willing for samples to be taken.

Sampling point 5 was the outflow pipe of the under-drainage from the large 50-acre field in the eastern part of the farm. This would be sampled for chemical water quality only, and it was likely that, at times, no discharge would flow from this pipe.

### 2.4.3 Farm C

Four sampling points were selected at Farm C. Sampling points 1, 2 and 3 were suitable for both biological and chemical sampling; sampling point 4 was a chemical sampling site only. In general, the watercourses within the farm boundary were dry at the time of the initial site visit, and thus, as above, no sampling was proposed from within these unless they contained flow and were sampled reactively.

Sampling points 1, 2 and 3 were on the River Stour. The River Stour is a fairly deep, typical low-lying river. Flow was quite fast and the channel was deep in places, which created under-currents. The substrate was mainly clay and silt, with little or no material of larger size.

Sampling point 1 was upstream from all known discharge points from the farm into the river. Sampling point 2 was immediately downstream from all the known outfalls of drainage water from the farm. Sampling point 3 was further downstream from sampling point 2, and was chosen to assess any continuing downstream impact.

Water clarity was generally poor at both sampling points 1 and 2. Sampling point 3 was on a wider and clearer section of the river, where the substrate was composed predominantly of silt and clay, with some gravel and pebbles.

Sampling point 4 was a sub-surface pipe that drains the farmyard and upslope fields. This includes run-off from the pesticide storage and handling area. This pipe ran under the road and discharged onto a field on the opposite side. Most of the discharge infiltrated back to ground, but there was evidence that, during wet periods, surface flow from this pipe discharged into the River Stour.

## 2.5 Environmental parameters

A variety of environmental data were collected at each sampling point. These included:

- Depth and width readings (taken at one sampling event only);
- A Global Positioning System (GPS) reading;
- Dissolved oxygen (DO) readings (taken at each of the four sampling events);
- Hardness, conductivity and biochemical oxygen demand (BOD) readings (measured in the laboratory from water samples collected at each of the four sampling events);
- Site registration data were obtained from 1:25000 Ordnance Survey maps and included: altitude, distance from source, discharge category and slope.

### 2.5.1 River corridor survey

River Corridor Surveys (RCSs) were undertaken during sampling event 2, in November 2004. The RCS methodology devised by the then National Rivers Authority (NRA, now Environment Agency; NRA, 1992) was used to survey 100 m upstream and 200 m downstream from each sampling point. This involved mapping the dominant habitat features of the river corridor (the river itself and an area at least 50 m either side of it).

Each RCS account included the following information (where relevant):

- Conditions on the day of survey (e.g., weather, water level);
- Special and typical features of the river channel;
- Marginal vegetation, on both banks where possible;
- Bank zone habitats;
- Adjacent land use;
- Notes of insects, birds and mammals of special interest;
- Recreational features;
- Existing management, such as bank mowing or tree pollarding;
- Observed or potential threats that may affect conservation value, such as crop spraying, invasion, hedge removal, refuse dumping, etc.;
- Habitats to be retained intact and the proposed means of achieving this;
- Suggestions for habitat improvement.

## 2.6 Aquatic macro-invertebrate sampling

### 2.6.1 Sampling

Benthic aquatic macro-invertebrate sampling took place during sampling event 1, in late October and early November.

### 2.6.2 Sampling techniques

Samples of the benthic macro-invertebrate fauna were collected through 3 minutes of active (kicks and sweeps) sampling with an FBA-pattern pond net, fitted with a 1 mm mesh collecting bag. The 3 minutes were allocated proportionately to the meso-habitats present at each site. This active sampling was accompanied by a 1 minute search of the water surface, submerged stones and coarse woody debris, etc., for attached organisms and fauna (such as whirligig beetles and freshwater limpets) that might be missed during the sweeps and kicking. This method is the standard sampling method used by the Environment Agency on shallow watercourses, and is compatible with the River Invertebrate Prediction and Classification System (RIVPACS; Murray-Bligh, 1999).

The 3-minute active sampling varied somewhat at each of the three farms because of differences in the nature of the watercourses. At Farm B, the Durleigh Brook is predominately a shallow brook with a pebble–gravel substrate, changing to gravel and sand and then silt as it flows into the reservoir. The two sampling sites were located on sand–gravel riffles, and kick sampling was used to sample the benthic fauna.

The main carrier ditch at Farm A is fairly deep, with a clay base overlain with a thick layer of silt. Sweeping of the marginal and submerged vegetation was the main method employed here, with occasional ‘puddling’ of the silt substrate.

The River Stour at Farm C is a rich, fairly deep, lowland river with occasional patches of dense marginal vegetation. Although there are shallower stretches present, these are not typical of the reach as a whole. Thus, for comparability between all three sampling locations, the sites were located on fairly deep sections of the river and some kick sampling was employed, along with sweeping of stands of marginal vegetation.

The use of surber sampling, in conjunction with the method described above, had initially been proposed. Surber sampling is a fully quantitative method that would have provided information on the abundances of the various taxa and would have enabled statistical analysis of the results, as well as the calculation of diversity indices.

However, the depths of the watercourses at Farms A and C made surber sampling impractical, and therefore it was not employed at any farm. While not being fully quantitative in comparison, the 3 minutes sampling method described above is semi-quantitative, and gives an estimate of invertebrate numbers and the numerical proportions of various taxa within the invertebrate communities.

After collection, the samples were preserved in industrial methylated spirits (IMS) for transportation to the laboratory. There they were sorted and the taxa identified, where possible to the species taxonomic level. The taxonomically difficult groups (Hydracarina, Oligochaeta and Ostracoda) were identified to Order level. Diptera larvae were identified to whatever level the available keys and larval maturity permitted.

The environmental and site registration data were entered into the computer package RIVPACS III. This predicts the taxa and biotic indices of the Biological Monitoring Working Party (BMWP) scoring system at a theoretical unpolluted site, based on the data entered. These predicted indices were then compared with the observed data after the identification of the samples.

The BMWP scoring system assigns a value of one to ten to invertebrate families, according to their degree of sensitivity to the effects of organic pollution, with the more sensitive families scoring the higher values. The BMWP scores for all the taxa in a sample are then totalled to provide an overall BMWP score for the sample; the higher the score, the better the water quality. The average score per taxon (ASPT) is calculated by dividing the BMWP score by the number of families present, which provides a score less biased by sampling effort.

The BMWP–ASPT scoring system is designed for flowing water sites and is only applicable to samples of invertebrates collected according to the Environment Agency's standard methods (as employed here). It was designed primarily to detect the effects of organic pollution.

An environmental quality index (EQI) is a biotic index observed at a site, divided by the value expected if the environmental quality was good (i.e., the value predicted by the Environment Agency's RIVPACS system). EQIs remove the effects of natural differences between the invertebrate communities at different sites, and so place the biotic indices from all sites on a common scale. The closer to unity the observed and predicted indices are (i.e., the nearer to one the EQI value), the better the water quality of the site. Scores over one denote water quality higher than expected.
Invertebrate faunas can be allocated a 'community score', based on their BMWP, which ranges from one (samples with a BMWP of 1-50) to 15 (BMWP of greater than 301; see *Table IV.1* in Appendix IV). In addition, individual taxa can be allocated a conservation score ranging from one to ten, according to their rarity. A score of one means that the species is very common and occurs in 50–100 percent of all samples collected from similar habitats, while a score of ten means that the species is endangered. Most of the individual species in a sample are allocated a score. These scores are totalled and averaged to provide an average conservation score.

These two numbers (the community score and the average conservation score) can be multiplied together to provide a 'community conservation index'. The higher the index, the greater the conservation importance of the site.

Appendix IV provides a more detailed explanation of these indices, and shows how they are calculated.

## 2.7 Benthic diatom sampling

Benthic diatom samples were collected from all of the biological sampling points. These were taken in addition to the aquatic macro-invertebrate samples to show levels of eutrophication in the watercourses, which would not be picked up by aquatic macro-invertebrate sampling alone. Usually, to sample for benthic diatoms five cobbles or small boulders (free from filamentous algae) are selected from the main flow of the watercourse and all attached diatoms removed. However, the initial site visit identified only two sampling points that exhibited these conditions (sampling point 2 on the River Stour at Farm C and sampling point 3 on the Durleigh Brook at Farm B). Therefore, to maintain consistency between sites and to allow benthic diatom samples to be collected at all biological sampling points, artificial substrates were used.

### 2.7.1 Sampling

To sample for benthic diatoms artificial substrates were introduced in the form of five household bricks secured to the bank using thick rope. Where possible, the bricks were laid out across the bed of the watercourse, resting on the substrate. The bricks were left in the water for approximately 1 month.

### 2.7.2 Diatom extraction

Diatom samples were collected by washing each brick in water to remove any excess sediment and attached vegetation (bryophytes and filamentous algae). The bricks were then placed in a white tray with a small amount of water and scrubbed using a stiff toothbrush to remove all attached diatoms. The suspension collected from the five scrubbed bricks from each sampling point was placed in a 1 litre sterile plastic bottle. The suspensions were left to settle for 1 day and the supernatant decanted into a vial. The samples were preserved using Lugol's Iodine solution, ready to be transported to the laboratory. The diatom samples were prepared and identified after Kelly *et al*. (2001), which is compatible with EN 13946 – the European Guidance Standard on sampling diatoms from flowing waters.

## 2.8 Chemical sampling

The suite of pesticides analysed at each sampling location was determined after the initial interviews with the farmers and subsequent discussions with the Environment Agency's National Laboratory Service to identify which chemicals had available analytical methods.

Sampling took into account the pesticides that had been, or were likely to be, applied during the current cropping season. In addition, information about the pesticides that had been applied during the 2003/2004 season was collated, so that the design of the first sampling event could take into account the possibility that these, or their residues, may still be detectable within the aquatic environment. *Tables 2.2-2.4* list the pesticides that were applied either immediately prior to, or during, this sampling programme.

A total of four sampling events took place between October and December 2004 (see *Table 2.1*).

**Table 2.2 Pesticides used at Farm A**

| *Pesticide trade name* | *Pesticide type* | *Active ingredient* | *Analysed* |
|---|---|---|---|
| Round-up | Herbicide | Glyphosate | ✓ |
| Plinth | Herbicide | Pendimethalin | ✓ |
| Picona | Herbicide | Pendimethalin/Picolinafen | ✓ |
| Ice/Crystol | Herbicide | Pendimethalin/Flufanacet | ✓ |
| Toppel/Perma sect | Insecticide | Cypermethrin | ✓ |
| Arelon IPU | Herbicide | Isoproturon | ✓ |
| Panther | Herbicide | Isoproturon/Diflufenican | ✓ |
| Trump | Herbicide | Isoproturon/Pendimethalin | ✓ |
| Encore | Herbicide | Isoproturon/Pendimethalin | ✓ |
| Trifluralin | Herbicide | Trifluralin | ✓ |
| HallMark | Herbicide | Lambda cyhalothrin | ✓ |
| Lexus Millenium | Herbicide | Flupyrsulfuron-methyl/Thifensulfuron-methyl | No available analytical method |
| Maverick | Herbicide | Sulfosulfuron | No available analytical method |

**Table 2.3 Pesticides used at Farm B**

| *Pesticide trade name* | *Pesticide type* | *Active ingredient* | *Analysed* |
|---|---|---|---|
| Round-up | Herbicide | Glyphosate | ✓ |
| Picona | Herbicide | Pendimethalin/Picolinafen | ✓ |
| Crystol | Herbicide | Pendimethalin/Flufanacet | ✓ |
| Toppel/Permasect | Insecticide | Cypermethrin | ✓ |
| Arelon IPU | Herbicide | Isoproturon | ✓ |
| Panther | Herbicide | Isoproturon/Diflufenican | ✓ |
| Trump | Herbicide | Isoproturon/Pendimethalin | ✓ |
| Trifluralin | Herbicide | Trifluralin | ✓ |
| Encore | Herbicide | Isoproturon/Pendimethalin | ✓ |
| Sumi-alpha | Insecticide | Esfenvalerate | ✓ |
| Lexus Millenuim | Herbicide | Flupyrsulfuron-methyl/Thifensulfuron-methyl | No available analytical method |
| Maverick | Herbicide | Sulfosulfuron | No available analytical method |

**Table 2.4 Pesticides used at Farm C**

| *Pesticide trade name* | *Pesticide type* | *Active ingredient* | *Analysed* |
|---|---|---|---|
| Round-up | Glyphosate | Glyphosate | ✓ |
| Plinth | Herbicide | Pendimethalin | ✓ |
| Picona | Herbicide | Pendimethalin/Picolin afen | ✓ |
| Ice/Crystol | Herbicide | Pendimethalin/Flufan acet | ✓ |
| Toppel/Perma sect | Insecticide | Cypermethrin | ✓ |
| Arelon IPU | Herbicide | Isoproturon | ✓ |
| Panther | Herbicide | Isoproturon/Diflufenic an | ✓ |
| Trump | Herbicide | Isoproturon/Pendimet halin | ✓ |
| Trifluralin | Herbicide | Trifluralin | ✓ |
| Encore | Herbicide | Isoproturon/Pendimet halin | ✓ |
| Lexus Millenium | Herbicide | Flupyrsulfuron-methyl/Thifensulfuron -methyl | No available analytical method |
| Atlantis | Herbicide | Iodosulfuron methyl sodium/Mesosulfuron methyl | No available analytical method |
| Triclopyr | Herbicide | Triclopyr | ✓ |

### 2.8.1 Sampling technique

A 1 litre water sample was collected (in sterilised, standard glass bottles) for each of the pesticides and/or pesticide groups identified as potentially being present. The samples were collected from the main flow, away from areas of slack, marginal water.

For those pesticides that could potentially be detected in sediment, sediment samples were also collected in sterilised glass jars. It was not possible to collect sediment samples at sampling points that were not watercourses (i.e., the pipe outlet at sampling point 5 at Farm B and the drain at sampling point 4 at Farm C).

At each sampling point, a further 1 litre water sample was collected for the measurement of BOD, ammonia, conductivity and hardness. This was transferred to a sterilised, plastic 1 litre bottle.

During the first sampling event an additional 1 litre water sample was collected for a general pesticide scan analysis – full scan gas chromatography–mass spectrometry (GC-MS). This was to detect any other substances that might be present and that might not have been accounted for in the suite of pesticides identified for each farm.

The samples were taken to the appropriate Environment Agency laboratory for analysis. Samples were refrigerated during transport and storage.

Results were assessed against a variety of standards. Levels of BOD and ammonia were assessed against the General Quality Assessment (GQA) Chemical Grading for Rivers and Canals (NRA, 1994).

Levels of pesticides recorded were assessed against two standards:

- EC Drinking Water Directive standard of <0.1 μg/l. This standard is valid at the consumer's tap, and water companies regularly utilise activated carbon and ozone processes to remove pesticides prior to delivery to the consumer. However, comparison of measured environmental concentrations against this is a useful indicator of pesticide contamination and the need to treat water.
- Environmental Quality Standards (EQS), where available. These are available from lists produced by the Environment Agency under the Dangerous Substances Directive (76/464/EEC). The EQS is set for the receiving watercourse, and not for the discharge itself.

# 3 Results and observations

## 3.1 Introduction

The following sections describe the survey results and analyses undertaken.

## 3.2 Farm and sampling point descriptions

Descriptions of each farm are provided in Appendix I using information collated during interviews with each farmer. This includes:

- The 2003/4 cropping and stocking regimes;
- Expected cropping for 2004/5;
- Chemical applications for the 2003/4 season;
- Likely chemical applications for autumn 2004;
- Field under-drainage and ditch drainage flows;
- Any pesticide ‘problems’ or ‘accidents’ in the previous year that should be accounted for in this assessment.

Environmental parameters measured at each site are reported in Appendix III and the results of the RCSs are given in Appendix II.

## 3.3 Aquatic macro-invertebrate sampling

A number of biotic indices were calculated from the invertebrate data obtained, and these are presented in *Tables 3.1-3.3*. The raw data from which these indices are calculated (i.e., the species present in each sample and their abundances) are presented in Appendix V.

**Table 3.1 BMWP and EQI results from Farm A**

| | *Sampling point 1 (D/S 2)* | *Sampling point 2 (D/S 1)* |
|---|---|---|
| Observed BMWP | 84 | 85 |
| Observed numbers of families | 20 | 20 |
| Observed ASPT | 4.2 | 4.25 |
| Predicted BMWP | 105.5 | 99.4 |
| Predicted numbers of families | 22.9 | 21.5 |
| Predicted ASPT | 4.59 | 4.61 |
| EQI BMWP | 0.8 | 0.86 |
| EQI numbers of families | 0.87 | 0.93 |
| EQI ASPT | 0.91 | 0.92 |
| GQA biological grade | b, Good | b, Good |
| Community conservation index | 7.6 | 3.54 |
| Community score | 5 | 3 |
| Average conservation score | 1.52 | 1.18 |

The results of the invertebrate data analysis for Farm A are presented in *Table 3.1*. The BMWP score and community conservation index are relatively low, with the EQI less than 1.00. Although the indices calculated are relatively low, lowland drains such as these rarely support particularly diverse faunas, and it is not considered that the BMWP is significantly lower than would be expected. Indeed, water quality in the drain would be classified as ‘good’. The implications of these results are analysed in more detail in Section 4.3.

### Table 3.2 BMWP and EQI results from Farm B

| | *Sampling point 1 (D/S)* | *Sampling point 3 (U/S)* |
|---|---|---|
| Observed BMWP | 154 | 146 |
| Observed numbers of families | 28 | 25 |
| Observed ASPT | 5.5 | 5.84 |
| Predicted BMWP | 136.8 | 132.9 |
| Predicted numbers of families | 24.4 | 22.8 |
| Predicted ASPT | 5.6 | 5.83 |
| EQI BMWP | 1.13 | 1.1 |
| EQI numbers of families | 1.15 | 1.1 |
| EQI ASPT | 0.98 | 1.002 |
| GQA biological grade | a/b, Very Good/Good | a, Very Good |
| Community conservation index | 14.49 | 10.6 |
| Community score | 7 | 5 |
| Average conservation score | 2.07 | 2.12 |

The results of the invertebrate data analysis for Farm B are presented in *Table 3.2*, and indicate very good water quality. In contrast to Farm A, the biotic indices calculated here are generally higher than expected for this type of watercourse in this part of the country, though again the difference is not considered to be significant. The implications of these results are analysed in more detail in Section 4.3.

**Table 3.3 BMWP and EQI results from Farm C**

| | *Sampling point 1 (U/S)* | *Sampling point 2 (D/S 1)* | *Sampling point 3 (D/S 2)* |
|---|---|---|---|
| Observed BMWP | 206 | 238 | 197 |
| Observed numbers of families | 38 | 41 | 36 |
| Observed ASPT | 5.42 | 5.8 | 5.47 |
| Predicted BMWP | 120.5 | 140.6 | 141 |
| Predicted numbers of families | 24.4 | 26.8 | 26.8 |
| Predicted ASPT | 4.92 | 5.23 | 5.25 |
| EQI BMWP | 1.71 | 1.69 | 1.4 |
| EQI numbers of families | 1.56 | 1.53 | 1.34 |
| EQI ASPT | 1.1 | 1.11 | 1.04 |
| GQA biological grade | a, Very Good | a, Very Good | a, Very Good |
| Community conservation index | 21.5 | 20.6 | 14.77 |
| Community score | 10 | 10 | 7 |
| Average conservation score | 2.15 | 2.06 | 5.47 |

The results of the invertebrate data analysis for Farm C are presented in *Table 3.3*. These indicate that water quality in the River Stour is particularly good, with very high biotic indices recorded – indeed, they are considerably higher than expected. The implications of these results are analysed in more detail in Section 4.3.

## 3.4 Benthic diatoms

The results of the diatom sampling are summarised in *Tables 3.4-3.6*. The raw data, including species lists, are presented in Appendix VI.

Although every effort was made to conceal the artificial substrate during the time they were in the water, in three cases the bricks were removed for an unknown period of time (sampling point 2 at Farm A, sampling point 3 at Farm B and sampling point 2 at Farm C). Although it is not known how long these may have been out of the water, samples were still taken to provide some data for analysis.

Benthic diatom analysis was based on the trophic diatom index (TDI; Kelly *et al*., 2001). This index was initially developed to assess the nutrient status of rivers (see Appendix VI for details), and thus provides an indication of water quality with respect to eutrophication. The higher the TDI score the more nutrient-rich the water. To interpret the extent to which variation in the TDI score may be attributable to non-nutrient factors (such as habitat features), and thus make the analysis less nutrient-biased, another score, 'percent motile valves', is also calculated from the same data. Hard substrata in moderate or fast currents are dominated by attached (non-motile) diatoms, while softer substrates and slower currents favour more motile taxa. A high percentage of motile diatoms therefore indicates silty and slow-moving watercourses.

*Tables 3.4-3.6* identify the dominant benthic diatom species present, and presents both the TDI values and percentage of motile species recorded. A detailed analysis of the implications of these results is presented in Section 4.4.

**Table 3.4 Dominant benthic diatom species from Farm A**

| | *Dominant* species present* | *TDI* | *Motile (percent)* |
|---|---|---|---|
| Sampling point 1 | *Achnanthidium minutissimum* | 44 | 24.4 |
| Sampling point 2 | *Achnanthidium minutissimum* | 62 | 23.9 |

*Dominant species = >10 percent.

**Table 3.5 Dominant* benthic diatom species from Farm B**

| | *Species present* | *TDI* | *Motile (percent)* |
|---|---|---|---|
| Sampling point 1 | *Achnanthidium minutissimum, Amphora pediculus, Cocconeis placentula, Navicula gregaria* | 68 | 31.4 |
| Sampling point 2 | *Amphora pediculus, Navicula gregaria* | 81 | 59.3 |

*Dominant species = >10 percent.

**Table 3.6 Dominant* benthic diatom species from Farm C**

| | *Species present* | *TDI* | *Motile (percent)* |
|---|---|---|---|
| Sampling point 1 | *Cocconeis placentula, Navicula lanceolata, Amphora pediculus* | 85 | 60.2 |
| Sampling point 2 | *Cocconeis placentula, Navicula lanceolata* | 84 | 61.9 |
| Sampling point 3 | *Navicula lanceolata* (>50 percent) | 92 | 78.4 |

*Dominant species = >10 percent.

Preparation and analysis of the benthic diatom samples followed the TDI system (Kelly *et al*., 2001), with species-level identification where possible. The poor condition of the samples, with high levels of suspended material and fairly sparse diatom numbers, meant only 200 valves were counted per sample. This most likely reflects the time of year, the type of stream or a combination of these, rather than the impact from a pollution event.

Although some of the substrata had been removed from the water, the numbers of taxa tolerant to desiccation (e.g., *Hantzschia amphioxys, Luticola* spp., *Diadesmis* spp.) were low at all sites, which suggests that the period of removal was limited. A few acid-tolerant taxa were found in each sample, but not enough to suggest that the water was significantly lower than pH7 for extended periods.

## 3.5 Chemical sampling

The full results from each sampling event are presented in Appendices III and VII. *Tables 3.7-3.9* summarise the average BOD, ammonia, conductivity and hardness values, and *Table 3.11-3.13* the pesticides detected at each sampling point, for each farm. No pesticides were detected in sediment samples, and thus all the results refer to water samples. *Table 3.10* lists EQS values for pesticides recorded here, where these have been derived.

**Table 3.7 Conductivity, DO, BOD, hardness and ammonia readings from Farm A**

| *Sampling point* | *Parameter* | *Average** |
|---|---|---|
| 1 | Conductivity (µS/cm) | 903 |
| | DO (ppm) | 1.9 |
| | BOD (mg/l) | <1.71 |
| | Hardness (mg/l) | 435 |
| | Ammonia (mg/l) | 0.092 |
| 2 | Conductivity (µS/cm) | 882 |
| | DO (ppm) | 1.7 |
| | BOD (mg/l) | <1.48 |
| | Hardness (mg/l) | 419 |
| | Ammonia (mg/l) | 0.165 |
| 3 | Not sampled | |
| 4 | Not sampled | |
| 5 | Not sampled | |

*Average over the four sampling events.

**Table 3.8 Conductivity, DO, BOD, hardness and ammonia readings from Farm B**

| *Sampling point* | *Parameter* | *Average** |
|---|---|---|
| 1 | Conductivity (μS/cm) | 469 |
| | DO (ppm) | 10.2 |
| | BOD (mg/l) | <3.22 |
| | Hardness (mg/l) | 341 |
| | Ammonia (mg/l) | 0.315 |
| 2 | Conductivity (μS/cm) | 559 |
| | DO (ppm) | 8.1 |
| | BOD (mg/l) | <2.52 |
| | Hardness (mg/l) | 285 |
| | Ammonia (mg/l) | 0.059 |
| 3 | Conductivity (μS/cm) | 469 |
| | DO (ppm) | 10.4 |
| | BOD (mg/l) | 3.03 |
| | Hardness (mg/l) | 275 |
| | Ammonia (mg/l) | 0.134 |
| 4 | Conductivity (μS/cm) | 526 |
| | DO (ppm) | 9.2 |
| | BOD (mg/l) | 1.78 |
| | Hardness (mg/l) | 266 |
| | Ammonia (mg/l) | 0.222 |

*Average over the four sampling events.

**Table 3.9 Conductivity, DO, BOD, hardness and ammonia readings from Farm C**

| *Sampling point* | *Parameter* | *Average** |
|---|---|---|
| 1 | Conductivity (μS/cm) | 469 |
| | DO (ppm) | 10.2 |
| | BOD (mg/l) | <1.505 |
| | Hardness (mg/l) | 341 |
| | Ammonia (mg/l) | 0.038 |
| 2 | Conductivity (μS/cm) | 648 |
| | DO (ppm) | 10.3 |
| | BOD (mg/l) | <1.505 |
| | Hardness (mg/l) | 340 |
| | Ammonia (mg/l) | 0.037 |
| 3 | Conductivity (μS/cm) | 469 |
| | DO (ppm) | 10.1 |
| | BOD (mg/l) | <1.505 |
| | Hardness (mg/l) | 341 |
| | Ammonia (mg/l) | 0.37 |
| 4 | Conductivity (μS/cm) | 526 |
| | DO (ppm) | N/A |
| | BOD (mg/l) | <5.57 |
| | Hardness (mg/l) | 514 |
| | Ammonia (mg/l) | 0.167 |
| 5 | Not sampled | |

*Average over the four sampling events.

**Table 3.10 EQS levels**

| *Pesticide name* | *EQS (μg/l)* |
|---|---|
| Isoproturon | 2 |
| Pendimethalin | 1.5 |
| Simazine | 2 |
| Propyzamide | 100 |
| Trifluralin | 0.1 |
| Bentazone | 500 |
| Atrazine | 2 |
| Chloropropham | 10 |

**Table 3.11 Summary of chemical sampling results from Farm A**

| *Sampling point* | *Pesticides monitored for* | *Concentration (μg/l)** | *Number of occasions detected* |
|---|---|---|---|
| 1 | No synthetic pyrethroids, isoproturon, glyphosate or pendimethalin detected | – | – |
| | General scan detected: | | |
| | Chloropropham | 0.02 | 1 |
| | Atrazine | 0.06 | 1 |
| | Bromacil | 0.11 | 1 |
| 2 | No synthetic pyrethroids, isoproturon, glyphosate or pendimethalin detected | – | – |
| | General scan detected: | | |
| | Atrazine | 0.04 | 1 |
| | Bromacil | 0.03 | 1 |
| 3 | Dry ditch, not sampled | | |
| 4 | Dry ditch, not sampled | | |
| 5 | Dry ditch, not sampled | | |

*At levels above detection limits.

**Table 3.12 Summary of chemical sampling results from Farm B**

| *Sampling point* | *Pesticides monitored for* | *Concentration ($\mu g/l$)** | *Number of occasions detected* |
|---|---|---|---|
| 1 | No synthetic pyrethroids or glyphosate detected | – | – |
| | Isoproturon | 0.02-0.85 | 3 |
| | Pendimethalin | 0.05 | 1 |
| | General scan detected no pesticides | | |
| 2 | No synthetic pyrethroids or glyphosate detected | – | – |
| | Pendimethalin | 0.03->0.1 | 2 |
| | Isoproturon | 4.73† | 1 |
| | General scan detected no pesticides | | |
| 3 | No synthetic pyrethroids or glyphosate detected | – | – |
| | Pendimethalin | 0.02 | 1 |
| | Isoproturon | 0.40 | 1 |
| | General scan detected no pesticides | | |
| 4 | No synthetic pyrethroids or glyphosate detected | – | – |
| | Isoproturon | 0.04-2.77† | 3 |
| | Pendimethalin | 0.02 | 1 |
| | General scan detected: Metazachlor | 0.06 | 1 |
| 5 | Dry ditch, not sampled | | |

*At levels above detection limits. Range presented where pesticides were recorded on more than one event at different levels.
†Exceeds EQS value.

**Table 3.13 Summary of chemical sampling results from Farm C**

| *Sampling point* | *Pesticides monitored for* | *Concentration ($\mu g/l$)** | *Number of occasions detected* |
|---|---|---|---|
| 1 | No synthetic pyrethroids detected | – | – |
| | Isoproturon | 0.148-3.14 | 4 |
| | Glyphosate | 3.34 | 1 |
| | Pendimethalin | 0.03-0.38 | 3 |
| | Trifluralin | 0.017 | 1 |
| | General scan detected: | | |
| | Simazine | 0.02 | 1 |
| | Isoproturon | 0.21 | 1 |
| | Metazachlor | 0.03 | 1 |
| 2 | No phenoxyacids, synthetic pyrethroids or glyphosate detected | – | – |
| | Isoproturon | 0.125-0.866 | 4 |
| | Pendimethalin | 0.02-0.03 | 3 |
| | Trifluralin | 0.021 | 1 |
| | General scan detected: | | |
| | Simazine | 0.05 | 1 |
| | Isoproturon | 0.18 | 1 |
| | Metazachlor | 0.03 | 1 |
| | Propyzamide | 0.07 | 1 |
| 3 | No phenoxyacids, synthetic pyrethroids or glyphosate detected | – | – |
| | Isoproturon | 0.129-0.859 | 3 |
| | Pendimethalin | 0.02-0.03 | 3 |
| | Trifluralin | 0.022 | 1 |
| | General scan detected: | | |
| | Simazine | 0.06 | 1 |
| | Isoproturon | 0.23 | 1 |
| | Metazachlor | 0.02 | 1 |
| | Propyzamide | 0.08 | 1 |

| *Sampling point* | *Pesticides monitored for* | *Concentration ($\mu g/l$)** | *Number of occasions detected* |
|---|---|---|---|
| 4 | No synthetic pyrethroids detected | – | – |
| | | | |
| | Isoproturon | 0.12-2.09† | 4 |
| | Glyphosate | 0.24-0.46 | 2 |
| | Trifluralin | 0.012-0.111† | 3 |
| | Pendimethalin | 0.02-0.10 | 3 |
| | | | |
| | General scan detected: | | |
| | Simazine | 0.13 | 1 |
| | Isoproturon | 1.54 | 1 |
| | Trifluralin | 0.09 | 1 |
| | Propyzamide | 13 | 1 |
| | Terbutryn | 0.35 | 1 |
| | Ethofumesate | 0.52 | 1 |
| | Bentazone | 0.06 | 1 |
| | Pendimethalin | 0.76 | 1 |
| | Flutriafol | 0.04 | 1 |
| | Flusilazole | 0.07 | 1 |
| | Tebuconazole | 0.07 | 1 |
| | Epoxiconazole | 0.34 | 1 |

*At levels above detection limits. Range presented where pesticides were recorded on more than one event at different levels.
†Exceeds EQS value.

# 4 Analysis and discussion

## 4.1 Introduction

Monitoring of water quality was undertaken via a series of spot samples over a 3 month period at the end of 2004. It should therefore be considered to provide only a snapshot of conditions at that time. Information provided by individual farms shows that a much wider range of pesticides are likely to be applied later in the cropping season (particularly between March and June). Monitoring over that period may, therefore, give different results.

However, the assessment presented here does indicate conditions at the time of sampling, and monitoring of the aquatic invertebrate fauna indicates whether there are any longer-term water-quality issues at each of the sites. What this assessment is not able to do is assess the success of the VI. As discussed previously, the selected farms had already implemented measures to reduce the impacts of pesticides on the aquatic environment prior to the commencement of this study. Therefore, we were not able to determine a baseline and cannot make a judgement about the effectiveness of the VI at these sites.

In the following sections we discuss the results, and highlight any indications that activities on the farms are, or could be, having an impact on the aquatic environment.

## 4.2 Biological sampling

There was no indication from the aquatic invertebrate data that any type of pollution was adversely affecting the watercourses monitored. At all three farms water quality was either ‘good’ or ‘very good’, and the invertebrate communities present were at least as diverse (if not more diverse) than expected for the type of watercourses surveyed. However, this assessment is based on the use of the BMWP score system, which is based on sensitivity to organic, rather than pesticide, contamination.

All of the pesticides recorded during the study were herbicides, and little is known about the toxicity of particular herbicides to particular species of invertebrates. Herbicides may have a direct adverse effect on invertebrates. However, the invertebrate faunas of all the watercourses were considered typical, and no species that would be expected to be present were missing.

In addition to direct toxic affects, herbicides may also exert an indirect effect on the fauna by having an adverse impact on aquatic vegetation, on which the majority of aquatic macro-invertebrates depend. However, this was again not apparent from the surveys (in particular the RCSs), with no obvious lack of aquatic macrophytic vegetation reported. Indeed, emergent and submerged vegetation was considered to be typical of the type of watercourses surveyed.

### 4.2.1 Farm A

At Farm A, the aquatic macro-invertebrate fauna recorded at both sites was not particularly diverse, but was nevertheless typical of lowland drains. There were slightly more taxa at the further downstream site, and subtle differences in the taxa were recorded between the two sites. However, these taxa were present in such small numbers that this observation is more likely to have been to the result of sampling variation than of any other influences. Certainly, no firm conclusions can be drawn with regard to any potential effects of pesticides, not least because both sample sites were downstream of potential pesticide inputs from the farm.

The only significant difference was that there were greater numbers of the naturalised shrimp species *Crangonyx pseudogracilis* at sampling point 1 (the furthest downstream of the sites), compared to those at sampling point 2. However, rather than reflecting possible differences in pesticide loads at the two locations, it is more likely that this is because of increased vegetation cover at sampling point 1, since *C. pseudogracilis* is herbivorous, grazing on algae as well as living and dead plant materials.

Although RIVPACS analysis classified both sites as good quality, RIVPACS was not designed to assess pesticide impacts, and was also not designed for use with predicting the fauna of lowland drains and ditches. Nevertheless, the presence of a moderately diverse aquatic invertebrate community, typical of such habitats, indicates no significant water-quality issues on this ditch system.

As shown by the low community conservation indices, no species of particular conservation importance were recorded. This is unsurprising given that these represent average field ditches, and the lack of rarities is certainly not an indication of pesticide pollution. Hawker dragonfly nymphs (*Aeshna* spp.) were observed, but were too immature for further identification.

### 4.2.2 Farm B

The results of the biological sampling at Farm B again suggest that pesticides are not having an adverse effect on invertebrate communities in the receiving watercourses. The EQI and BMWP scores (see *Table 3.2*) generally indicate that water quality here is at least as high as would be expected without pollution, if not higher. The EQI ASPT for the downstream site was 0.98, just below the 1.0 limit for Grade A (very good). As this is isolated data from one season and the other EQI were above 1, a Grade A classification is more likely to be an accurate indication of the water quality at this site.

The Environment Agency has a GQA monitoring site in the vicinity of Farm B. However, this is too far upstream to be used to monitor the impact from the majority of land at Farm B. Data from the 1995 and 2000 national surveys did indicate that the ecological quality of this site was Grade A, which was supported by the current study.

Although diversity was slightly higher at the downstream site, overall differences in the macro-invertebrate communities of the two sites were very small, and the faunas recorded at both sampling stations are representative of such stream habitats.

With regard to species of conservation importance, the cased caddis fly larvae of *Lasiocephala basalis* were recorded at both sites. These prefer stony rivers and large streams, often with a reasonable calcium content. The species' current status is under review, although it is thought to be Notable[1] in some regions. It has been recorded from

[1]Notable species are those estimated to occur within 16 to 100 ten-kilometre squares of the British national grid system since 1970.

several locations in the South West, generally from stony, medium-sized streams. It occurs in the Halse water, a tributary of the River Tone, which flows off the Brendon Hills, the next range to the west of the southern Quantocks. It probably deserves the designation 'Local'[2] within this region, and provides further evidence of the relatively high water quality at this location.

### 4.2.3 Farm C

The River Stour, in the vicinity of Farm C, forms a stretch of rich, lowland, meandering river habitat. The substrate is mostly compacted clay, with occasional patches of gravel and sand. Frequent sections of dense emergent vegetation particularly form on marginal silt banks. Along the majority of the reach the river is quite deep, and the three sites were located on deep glides with marginal emergents.

Exceptional invertebrate diversity was recorded at all three sites on the River Stour, with ecological quality being indicated as Very Good. There was no evidence of any impact from the farm on the river. Indeed, BMWP and EQI scores were significantly higher than those predicted by RIVPACS, because of the extremely high diversity of the species present.

While RIVPACS assesses the river's characteristics against reference sites, it is unlikely that the reference site's characteristics will all be the same as the river's, and thus a number of sites are averaged to give the score. This can result in an underestimate of the predicted ecological quality of the reach when using RIVPACS, especially if the sections selected for sampling comprise particularly good habitats for invertebrates, as was the case here.

Several nationally uncommon species were recorded, but the main conservation importance of the aquatic invertebrate communities, especially at the upstream sampling site and the first downstream sampling site, was their high diversity.

With regard to species of conservation importance, case-building larvae of the caddis fly *Phryganea grandis* were recorded in the river margins at all three sites. This species is found throughout Britain in weedy ponds, lakes, canals and slow-flowing rivers, but usually not as a large group of records. It is allocated the conservation status 'Local'.

In addition, the Nationally Notable B (recorded from 31 to 100 ten-kilometre squares of the OS grid) whirligig beetle *Gyrinus urinator* was found at the upstream site, and nymphs of the nationally uncommon white-legged damselfly (*Platycnemis pennipes*) were recorded at the upstream site and at sampling point 3 (the furthest downstream sampling location). This latter species breeds along unshaded sections of larger streams and rivers, with a moderately slow-to-sluggish flow, and along canals. It is vulnerable to pollution, the canalisation of streams and rivers, the drainage of associated water meadows and the removal of waterside vegetation. There is evidence that the species has declined in the eastern part of its range, possibly through pollution and the intensive management of riverside vegetation. Its presence in the samples taken at Farm C therefore further indicates good water quality.

[2] Local species are those that, while fairly common, are evidently less widespread than truly common species, but do not qualify as nationally Notable having been recorded from over 100, but less than 300, ten-kilometre squares.

Indeed, this reach of the River Stour appears to represent particularly good habitat for Odonata. Nymphs of the beautiful demoiselle (*Calopteryx splendens*, recorded at all three sites), the large red damselfly (*Pyrrhosoma nymphula*, recorded at sampling location 2) and the southern hawker (*Aeshna cyanea*, recorded at the upstream site) confirm the presence of breeding populations. The *A. cyanea* nymphs were slightly immature, and thus their identification is not 100 percent reliable. Adult common darter (*Sympetrum striolatum*) and a hawker species were observed on the wing at the upstream site. The latter did not settle long enough to be properly observed, but was likely to have been the southern hawker.

Minnows (*Phoxinus phoxinus*), stone loach (*Barbatula barbatulus*), bullheads (*Cottus gobio*), three-spined sticklebacks (*Gasterosteus aculeatus*) and kingfisher (*Alcedo atthis*) were observed during invertebrate sampling along the River Stour.

All of this suggests that the pesticide load in the River Stour is not having an adverse effect on the aquatic ecosystem. However, dilution will be having a significant effect. Given that this is a relatively large river, only very large inputs might be expected to have an obvious detrimental impact on the aquatic macro-invertebrate fauna present. To detect the ecological effects of relatively small amounts of pesticide, the receiving watercourse would need to be considerably smaller.

## 4.3 Benthic diatoms

It is extremely difficult to disentangle the likely effects on diatom communities of high nutrient status and pesticide pollution. Those ‘weedy’ species that tend to become dominant in eutrophic conditions (such as *Navicula lanceolata*) also tend to be relatively tolerant of pollution. Therefore, a high TDI score could indicate either high pesticides or nutrient concentration.

Furthermore, it is also more difficult to detect subtle changes in diatom populations during the winter when diversity and abundance are relatively low. Indeed, given that diatom populations are likely to exhibit relatively short-lived fluctuations relative to particular pollution events, not only would it be better to sample during the spring and/or summer, but also it would be best to sample reactively after periods of heavy rain. In this way any changes as a result of pesticides are more likely to be observed.

Also, given that diatoms can become distorted under the effects of pesticides, it may be more appropriate to look for such abnormalities with a threshold (e.g., >1 percent distorted valves) to indicate pesticide pollution. Clearly, specific tests need to be carried out to establish a set of thresholds. Furthermore, relatively large samples of diatoms are required for firm conclusions to be drawn.

It is clear, therefore, that results from this single winter sampling event *cannot* be considered sufficient to draw detailed conclusions regarding the water-quality parameters – a longer monitoring period is required. However, some qualitative analysis of the results is possible.

The relatively low proportion of motile diatoms at Farm A suggests that this is a quick-flowing stream. However, this is not the case, as it is an almost stagnant ditch, so there must be other influences. A perennial problem with artificial substrata is that samples often contain high numbers of early colonisers. This can be particularly acute for samples collected in the winter when growth rates are slower and, consequently, colonisation and successional processes are slower. Some of the species that were common (especially *N. lanceolata* and *N. gregaria*) are particularly common in the winter, and it is possible that the 'seasonal' signal is as strong as the 'environment' signal in some samples. The relatively low TDIs for Farm A suggest that this ditch is relatively nutrient-poor, which may partly explain the lower than expected BMWP scores recorded here (see Section 4.3.1).

At Farm B, there appeared to be a significant difference between the two sites, with the downstream site (sampling point 1) having a much lower TDI value. This suggests a lower nutrient status and an environment that favours attached over motile diatoms. This is, however, difficult to confirm with only a single sampling event, although the predominance of attached diatoms may suggest that the riffles sampled on this part of the stream were more rapid than those at the other sampling location.

At Farm C, there were no obvious spatial trends between the sampling locations despite the species differences (see Appendix VI for a full species list). The species recorded suggest the three sites were enriched (TDI > 80) with high levels of suspended solids, which would settle onto stones and favour motile over attached diatoms (hence the high motile values of >60). Sampling point 3, the furthest downstream site, showed the highest level of eutrophication.

Finally, both Farm A and B had higher species diversity than Farm C, and a greater proportion of attached diatoms. The presence of *Achnanthidium minutissimum,* and sub-dominants such as *Fragilaria capucina,* suggests relatively low nutrient levels in the River Stour at Farm C. However, all three sampling points at Farm C had a higher TDI value than at the other farms, probably because of a greater proportion of *Planothidium*. This emphasises the difficulty in interpreting the data.

Given that the invertebrate faunas at the three farms are relatively diverse, and that high nutrient status can be beneficial for invertebrates (as long as it is not too high), it is perhaps most likely that the diatom results indicate a relatively high nutrient status in the watercourses and low levels of pesticides. However, this cannot be inferred directly from the data for the reasons given above, and a more comprehensive and targeted sampling programme is required to better understand the relationships between nutrient status, pesticides and diatom populations.

## 4.4 Chemical sampling

The results of the chemical water-quality analyses are discussed below. Sampling locations at each farm were chosen in an attempt to represent drainage sources from either the whole farm or from individual fields, to isolate the potential impacts of activities on the farm. No pesticides were recorded in any sediment samples collected. All the following discussion therefore relates to pesticides detected in water samples.

As discussed in Section 4.3, the pesticides detected were herbicides, and little is known about the toxicity of particular herbicides on the particular species of invertebrates found at these sites. However, the species recorded and aquatic vegetation present were as expected and thus no evidence of pesticide impacts was observed.

Where possible, links between pesticides applied on each farm and pesticides detected in subsequent sampling events have been highlighted. However, none of the farms occupied the whole of a drainage basin, which makes the detection of downstream trends caused by these specific farms difficult to isolate. The results do not, generally, show any significant trends in pesticide concentrations in the main receiving watercourses.

### 4.4.1 Farm A

Over the four sampling events at Farm A, no flow or standing water was observed within the drainage ditches for sampling points 3, 4 and 5, and thus there are no results from these locations. The ditches were generally overgrown with significant quantities of leaf litter and debris within the channel, which indicates that these locations do not experience flow on a regular basis. However, they will have been created to act as land drainage channels, and thus would be expected to carry flow intermittently.

The characteristics of the ditch network here do not lend themselves easily to the comparison of an upstream and downstream location. However, the overall orientation of the network indicates that there may be a general movement of water from east to west. Therefore, sampling point 1 can be described as being downstream from the farm unit, and downstream of sampling point 2. No sampling location was available upstream from the farm (as the drainage network has its source within the farm), but sampling point 1 could receive drainage from a large proportion of the fields associated with this farm.

Information on those pesticides used on this farm over the 2003/2004 cropping season was gathered. However, a more restricted range of chemicals were used during the period of monitoring for this study. It is anticipated that a wider range will be used throughout the remainder of 2005, with many being applied in the period March to June.

Samples were analysed by full scan GC-MS to look for evidence of any additional pesticides present. A number of compounds were detected and, while EQS are not available for all, none of those for which an EQS is available exceeded this standard. Of the remaining compounds, the majority were detected at very low levels of below 0.1 μg/l, although the maximum level recorded was 0.11 μg/l of Bromacil.

As a result of the restricted choice of potential sampling points it has not been possible to confirm that any of these chemicals originated on Farm A as a result of previous pesticide applications, or if they originated from adjacent land holdings. Drainage channels from land to the south of Farm A were also noted to discharge into the main carrier ditch, and thus may also be a source of pollutants entering the aquatic environment. There was no evidence of significant sediment mobilisation from the fields, and thus there is likely to be a low risk of pesticides reaching the ditch network via surface run-off.

Of the pesticides used in the autumn of 2004 (glyphosate, pendimethalin, isoproturon and cypermethrin), none were detected in either water or sediment samples within the ditch network. The lack of positive results from sediment samples indicates that, at least for compounds such as cypermethrin and pendimethalin that partition to sediment, pesticides applied to these fields are not reaching the aquatic environment in detectable quantities. Nor does there appear to be significant input of sediment-laden run-off carrying contaminated material into the ditches.

However, the presence of ditches that carry very intermittent flow may be of concern. As these lie closer to the locations where pesticides are being and have been applied than the ditches sampled, they may contain greater quantities of sediments and organic materials with associated higher concentrations of hydrophobic pesticides. Should these ditches subsequently experience a high rate of flow, there is a risk that this material could be flushed into the ditch network. The lack of flow in the ditch network would, however, be likely to result in very localised impacts.

Other chemical parameters measured, in particular BOD and ammonia, provide an indication of general water quality. Both BOD and ammonia measurements throughout the monitoring period were within the limits, as set under the Water Quality Association (WQA), of Grade A (Good) water quality.

### 4.4.2 Farm B

At Farm B, all the watercourses contained flow and were therefore sampled on each occasion. The discharge point from the sub-surface drainage of the 50-acre field (sampling point 5) carried flow on only one occasion. However, it was not possible to collect a sample as the drainage ditch that this pipe discharges into was flooded, and as such it would not have been possible to isolate a sample from the flow entering the ditch from upslope (and a different farm unit).

The two upstream sampling points (3 and 4) were assumed not to receive any run-off from Farm B. At these locations, the only pesticide detected by the general scan was metazachlor at sampling point 4.

Pendimethalin was recorded at both locations, although at very low concentrations (0.02 μg/l). Isoproturon was also recorded, and at sampling point 4 this was detected at a maximum concentration of 2.77 μg/l, marginally exceeding the EQS standard. Ammonia concentrations at both locations were low, and would result in a Grade A water-quality classification. BOD levels at sampling point 4 were also low, although at sampling point 3 the levels were slightly elevated, and would give a Grade B water-quality classification.

The general scan at the two downstream sampling points did not detect any pesticides.

Isoproturon and pendimethalin were recorded at both downstream sampling locations, although not on sampling event 1, which was prior to any known applications of these chemicals on this farm. At sampling point 1, on the Durleigh Brook, concentrations were relatively low (up to 0.85 μg/l). However, at sampling point 2, a small drainage ditch likely to only receive run-off from Farm B fields and not from any upstream location, concentrations were higher, with isoproturon being recorded at a level of 4.73 μg/l. This value is more than twice the EQS. This concentration was detected on the fourth sampling event, prior to which it is known that pesticides were applied across this farm. This suggests that conditions during or immediately after the applications were such that pesticides were transported to the watercourse.

BOD and ammonia levels at these locations would result in a Grade A or B water-quality classification (Good to Very Good).

These results show that some pesticides enter the Durleigh Brook from farm units upstream from Farm B. However, the results from sampling location 2 show that pesticides applied on Farm B also enter the aquatic environment, and at levels that exceed the relevant EQS. Two factors are likely to minimise the potential impacts on the aquatic environment. Firstly, there will be dilution within Durleigh Brook, which reduces the concentrations of pesticides that enter from point or diffuse sources. In addition, the ditch in which the highest levels of pesticides were recorded does not have a direct link to the Durleigh Brook. Throughout the monitoring period, the outfall from this ditch was into an area of wet woodland, into which run-off appeared to be infiltrating, with no overland flow reaching the brook or the adjacent reservoir. While there is still a groundwater link, this serves to reduce the quantities of pesticides that reach the neighbouring surface water bodies.

### 4.4.3 Farm C

At Farm C, over the course of the monitoring period the majority of the drainage ditches within the farm did not experience flow, and so could not be monitored. However, piped outfalls to the River Stour, assumed to be carrying at least a proportion of land drainage from the farm, were noted to be discharging into the river.

Sampling point 1 was believed to be upstream from all surface and land drainage outfalls from the farm unit. The general scan detected a small number of pesticides. Isoproturon was present at a concentration greater than 0.1 μg/l. The detection of isoproturon at this site indicates that at least a proportion of any isoproturon detected at downstream locations originates from other land holdings. The concentration of isoproturon detected is below the EQS value for this pesticide, although it would exceed the drinking water standard. Isoproturon is one of the most commonly occurring pesticides in surface waters (Environment Agency, 2004).

Towards the end of 2004, Thames Water Utilities called on the Pesticides Safety Directorate to ban the use of isoproturon (Farmers Weekly Interactive 2004) because of the high costs associated with removing it from water supplies. However, it is reported that Bayer CropScience’s product stewardship manager said that any ban would be ‘premature and risk undermining the VI’.

While it is the view of the VI that 40 percent of isoproturon recorded in water samples originates from the farmyard, Thames Water utilities claim that, in wet years, 90 percent comes from fields on which it has been applied.

In addition to isoproturon, triclopyr, glyphosate, pendimethalin and trifluralin were also detected at this sampling location, all of which are assumed to originate from other land areas, upstream from Farm C. While none of these exceeded their EQS levels (where these are available), isoproturon, glyphosate and pendimethalin levels did exceed 0.1 μg/l.

At sampling point 2, immediately downstream from the final known outfall, a similar range of compounds as found at site 1 was detected by the general scan. These were again at generally low levels.

Isoproturon, pendimethalin and trifluralin were also recorded at this location. On two sampling occasions the levels of isoproturon detected were marginally higher than those at the upstream location. On the third sampling event, pendimethalin was recorded at a marginally higher level at this location, although on the second sampling event, the level was significantly lower at the downstream location (19 ng/l compared to 384 ng/l upstream), which again indicates sources from elsewhere and not just from Farm C.

Trifluralin was recorded on the fourth sampling event, at a concentration comparable to that recorded at the upstream sampling point (21 ng/l compared with 17 ng/l upstream). Trifluralin was applied across the farm immediately prior to this sampling event.

A similar range of compounds was detected at the final downstream sampling location (site 3), and again all were detected at levels below EQS standards, with little variation between this location and those upstream.

The most significant results obtained for this site were from sampling point 4, the drain that carries run-off from the farmyard and a number of upslope fields. This location is assumed to carry run-off from Farm C only, and not receive inputs from any other land holdings. At this location, the general scan picked up a much wider range of compounds, although again none exceeded their EQS.

Isoproturon, glyphosate, trifluralin and pendimethalin were detected at sampling point 4 as part of the targeted analysis. Isoproturon concentrations exceeded EQS values (on the first sampling event this was recorded at 2.1 $\mu$g/l, compared to an EQS of 2 $\mu$g/l). Trifluralin also exceeded its EQS (on the first sampling event 0.11 $\mu$g/l compared to an EQS of 0.1 $\mu$g/l). Glyphosate, recorded on sampling events 1 and 4, was known to have been used on the farm prior to event 1. Pendimethalin was recorded on events 2, 3 and 4, and is known to have been used on the farm prior to sampling events 2 and 4.

The general water-quality parameter of BOD was consistently below detection limits at all sampling locations on the River Stour (sites 1-3). Ammonia levels recorded at these three locations were slightly above the threshold for classification as Grade A under the GQA grading system, and would classify water quality in the river as Grade B (although still described as Good). However, at sampling point 4, the discharge from the farmyard, water quality would only be described as Fair (Grade D) on account of very high BOD readings (14 mg/l on the second sampling event). Ammonia levels at this location were also higher than those recorded in the River Stour (an average of 0.167 mg/l), which again would result in a Fair water-quality classification.

These results indicate that there is a potential direct link between pesticide use on the farm and levels recorded in the River Stour, as well as general water-quality parameters such as BOD and nutrients. This is likely to relate particularly to pesticide handling and/or storage activities within the farmyard itself.

Pesticides were occasionally detected at levels in excess of EQS standards at sampling point 4 on Farm C. However, concentrations of pesticides in the River Stour were below those expected to cause a biological impact. At present two processes minimise the impacts of this discharge on the river environment. Firstly, there is likely to be significant dilution within the River Stour. Secondly, the discharge from the farmyard is not linked directly to the river. The drainage pipe ends, and run-off flows out over a field within the floodplain. During the sampling period, the majority of this run-off was recorded as infiltrating back to ground. This serves to minimise the quantity of polluted run-off that reaches the river channel at this location. However, during periods of heavy or prolonged rainfall, when infiltration rates are reduced, it is possible that polluted run-off will reach the river channel, although dilution is also likely to increase in these conditions.

There is a risk that pesticides will enter the aquatic environment at concentrations that may cause biological effects from activities within the farmyard, most probably through the handling of these materials. It is understood that this has already been recognised as a risk area on Farm C, and it is planned to relocate the pesticide handling area.

# 5 Conclusions

This monitoring programme has shown that pesticides used on the three selected farms have the potential to reach nearby watercourses. In addition, pesticides are also entering the aquatic environment from upstream and adjacent land holdings. While levels have been recorded in excess of relevant EQS values, aquatic invertebrate monitoring has shown that there do not appear to be detectable impacts on the aquatic environment.

At Farm A, the monitoring regime failed to detect any of the pesticides applied during the monitoring programme in any of the samples. There was evidence from the general scan that additional pesticides were present in the watercourses. However, the aquatic invertebrate fauna in the ditch at Farm A was typical of the habitat and there was no evidence of any impact from the farm on the watercourse.

At Farm B the results show that pesticides reach the aquatic environment from the farm and from neighbouring and upstream land holdings. The field margin ditch in which the highest concentrations of pesticide were recorded did not have a direct link to the receiving water bodies. This is likely to limit potential downstream impacts. The analysis of the invertebrate communities in the Durleigh Brook showed no evidence of being impacted by pollution. Ecological quality was Very Good (Grade A).

A similar situation occurred at Farm C, with the main identified risk to the aquatic environment not having a direct link with the river. Exceptionally diverse communities of aquatic invertebrates were recorded from the River Stour in the vicinity of Farm C, including the Nationally Notable B *G. urinator* and the Local *P. grandis*. The rich diversity of the invertebrate fauna indicates that this reach of the River Stour should be considered as being of high conservation value. Once again, there was no evidence of any adverse impact on the aquatic fauna downstream of the farm.

These results indicate that any further monitoring to assess the effectiveness of the VI, particularly in terms of chemical water quality, should concentrate on the on-farm drainage ditches, rather than the receiving water bodies, in which dilution can mean that only the most serious impacts are detectable. From the results it has not been possible to show obvious trends between upstream and downstream monitoring locations in relation to the known pesticide regimes.

Where ditches are predominantly dry, any future monitoring should include an assessment of pesticide levels in the sediment and organic material that accumulates between flow events in these. During wetter periods, when these channels convey run-off, there may be a greater risk that pesticides will reach, and thus impact on, the aquatic environment. However, for the three farms assessed, the results from the aquatic invertebrate sampling indicate no long-term impacts on water quality and suggest that this is not a significant issue at these farms.

Continued monitoring of biological water quality within the receiving water bodies would provide an indication of long-term trends in terms of water quality. However, where the receiving water body already has good to very good water quality, it will be difficult to show long-term improvements in the aquatic environment as a result of the successful implementation of VI measures, and thus further monitoring is unlikely to be of value.

The potential risk to the aquatic environment from handling and storage operations within a farmyard are highlighted by the results from Farm C. However, many of the potential surface water links between the fields on which pesticides were being applied and the receiving water bodies were dry throughout this project, and thus it has not been possible to determine if pesticides are at risk of being washed off fields.

This project provides an indication of the current state of the local aquatic environment of the three farms studied, and examines the potential and actual pathways by which pesticides used on the farm could enter local watercourses.

The results provide a snapshot of the current health of the aquatic ecosystem. However, given the low frequency of detection of pesticides and the general good to very good biological water quality at these farms, there is little value in continuing water-quality monitoring at these locations. Future monitoring should focus on farms on which pesticide use is recognised to result in impacts to the aquatic environment, and where VI measures have not yet been implemented.

# 6 Recommendations

Listed here are the main recommendations from this project:

- The main purpose of the study was to determine a monitoring protocol to measure the effectiveness of the VI, and to provide an indication of water quality associated with three farms. The study has shown that the protocol used in this study would achieve the aim of monitoring effectiveness, with some amendments as detailed below. However, given the current quality of the aquatic environment at these locations, there is little value in continuing water-quality monitoring at these specific farms.
- Farm selection is critical to further surveys undertaken. Particular emphasis should be placed on those that have not already begun to implement VI measures, on farms that fill all or the majority of a definable catchment (such that impacts of the farm can be more readily isolated from impacts associated with neighbouring land holdings) and on farms on which pesticide usage is recognised to have an impact on the aquatic environment.
- Sampling at future farms should concentrate on field margin drainage ditches, and should also include an assessment of the sediment within ditches that are predominantly dry throughout the year.
- Sampling should be extended through the full cropping cycle at these farms to assess any seasonal changes as a result of the use of a wider range of pesticide products. This should also place more emphasis on reactive sampling so that samples can be collected immediately after significant rainfall events.
- Receiving water bodies, such as streams and rivers, should continue to be sampled to assess long-term trends in biological water quality. This would also be able to pick up the effects of isolated pollution events missed by the chemical monitoring programme, as there will be a lag before the aquatic invertebrate fauna recovers after such incidents.
- To reduce pesticide inputs to the environment particular emphasis should be placed on good pesticide handling procedures, particularly where there is an identifiable pathway to a water body.

# References

Environment Agency (2004). *Pesticides Report 2003*. http://www.environment-agency.gov.uk/yourenv/eff/business_industry/agri/pests/ [Accessed March 2005].

*Farmers Weekly Interactive* (2004, 5 November). http://www.fwi.co.uk/article [Accessed November 2004].

Kelly *et al.* (2001). *The Trophic Diatom Index: A User's Manual.* Revised edition. R&D Technical Report E2/TR2. Environment Agency, Bristol.

Murray-Bligh (1999). *Procedures for Collecting and Analysing Macroinvertebrate Samples*. Environment Agency, Bristol.

NRA (1992). *River Corridor Surveys: Methods and Procedures*. Conservation Technical Handbook No. 1. Environment Agency, Bristol.

NRA (1994). *The Quality of Rivers and Canals in England and Wales (1990 to 1992). Report of the National Rivers Authority*. NRA Water Quality Series No. 19. Environment Agency, Bristol.

# Glossary of terms

| | |
|---|---|
| **Acid-tolerant species** | Species that can survive in acidic conditions |
| **Baseline** | Normal conditions used as a reference point from which to judge any impacts |
| **Benthic invertebrate or diatom** | Invertebrates or diatoms that live on the bed of a watercourse |
| **Biodiversity** | The existence of a wide range of different types of organisms in a given place at a given time |
| **Bryophytes** | Plant division that comprises mosses and liverworts |
| **Community** | An assemblage of interacting populations that occupy a given area |
| **Conductivity** | The degree to which a substance transmits heat or electricity |
| **Confluence** | Joining of two or more streams |
| **Conservation headland** | A field margin that has been managed to benefit wildlife |
| **Crop protection products** | Artificial chemicals, such as pesticides, used to control pest species |
| **Diatom** | A microscopic one-celled algae with the cell wall composed of two overlapping valves |
| **Dissolved oxygen** | The concentration of oxygen dissolved in water as a percentage saturation |
| **Discharge** | Flow from an outlet or watercourse |
| **Early colonisers** | A species that establishes itself at an early stage in successional processes |
| **Enriched** | A medium that contains extra unusual nutrients or contains higher concentrations of regular nutrients than in baseline conditions |
| **Environmental Quality Standards** | A regulatory devised and approved set of water-quality standards (recognised as the general standard for which surface water quality should comply) |
| **Eutrophication** | The gradual increase in nutrient levels in a water body |
| **Farm unit** | Within the boundary of the farm |
| **Filamentous algae** | Algae that forms filaments or mats attached to sediment and vegetation |
| **Habitat** | The locality, site and particular type of environment occupied by an organism |
| **Hardness** | The concentration of calcium and magnesium ions in water |
| **Hydrology** | The scientific study of the properties, distribution and effects of water on the earth's surface, in the soil and underlying rocks, and in the atmosphere |

| | |
|---|---|
| **Infiltrate** | To permeate a porous substance with a liquid or gas |
| **Macro-invertebrate** | An invertebrate animal large enough to be visible without magnification |
| **Mitigation** | Measures taken to avoid, reduce or remove environmental impacts – mitigation can moderate adverse effects and enhance the beneficial ones that arise from the whole or specific elements of the scheme |
| **Notable B status** | Known from fewer than 100 ten-kilometre squares in the British Isles |
| **Outfall** | The mouth of a watercourse |
| **Pesticide** | Chemical compounds, including herbicides, insecticides and fungicides, that are used to kill pest species |
| **Pollarding** | Cutting back the branches of a tree to the crown to produce a crown of shoots at the top of the trunk |
| **Red Data Book species** | Species listed in an official publication that describes species of high conservation concern at a given geographical level; the term is usually used to refer to the national Red Data Books, though such books exist at international levels (e.g., global/European) and sub-national levels (e.g., county) |
| **Run-off** | Rainwater flowing over the surface and running into streams and rivers, especially during heavy rainfall |
| **Source** | Where a watercourse begins |
| **Substrate** | The material (e.g., gravel or sand, etc.) that a living organism grows on or is attached to |
| **Tributary** | A branch that flows into the main stream |
| **Valve** | A structural component of the diatom frustule – two valves make-up a frustule. |

# List of abbreviations

| | |
|---|---|
| ASPT | Average score per taxa |
| BMWP | Biological Monitoring Working Party |
| BOD | Biological oxygen demand |
| CPMP | Crop Protection Management Plans |
| CPA | Crop Protection Association |
| DO | Dissolved oxygen |
| EQI | Environmental quality indices |
| EQS | Environmental Quality Standards |
| FWAG | Farming and Wildlife Advisory Group |
| GC-MS | Gas chromatography–mass spectrometry |
| GPS | Global Positioning System |
| GQA | General Quality Assessment |
| IMS | Industrial methylated spirits |
| NRA | National Rivers Authority, now the Environment Agency |
| RCS | River Corridor Survey |
| RIVPACS | River Invertebrate Prediction and Classification System |
| TDI | Trophic Diatom Index |
| VI | Voluntary Initiative |
| WQA | Water Quality Association |

## Appendix I: Information from the farms

# 1. FACTUAL INFORMATION COLLECTED

1.1 At the outset of the study, the three volunteer farmers were interviewed in order to record factual information and initial opinions on the VI

| Farm A | |
|---|---|
| Size | 250ha (620 acres) |
| Cropping | A rotation of winter wheats, winter barley, sugar beet, vining peas, maincrop potatoes and field vegetables is grown. |
| Environment | There are small areas of ESA grass and there are Countryside Stewardship Scheme grass headlands. |

| Farm B | |
|---|---|
| Size | 75ha (170 acres) |
| Cropping | Farm B is run in conjunction with other farmland. The overall rotation involves first and second wheats with oilseed rape and set aside in rotation. |
| Environment | Countryside Stewardship Scheme headlands. |

| Farm C | |
|---|---|
| Size | 65ha (160 acres) |
| Cropping | Farm C is run with another unit. Over the whole farm an arable rotation of winter wheats (first and second) with a break of oilseed rape or field beans, is grown. For the 2005 cropping year, Farm C is planned for a total wheat sowing. |
| Environment | Countryside Stewardship Scheme headlands and field corners. |

1.2 The following information was collected during an interview held on each farm, and is summarised in sections 2-4:

i) last year's cropping and stocking on a field by field basis;

ii) the expected cropping for 2004/5 and the cultivations already carried out or to be carried out;

iii) the chemical applications for the 2003/4 cropping year by crop or field (or both);

iv) the likely chemical applications for autumn 2004;

v) field underdrainage and ditch drainage flows;

vi) any pesticide “problems” or “accidents” in the last year which might affect the survey.

1.3 As part of the interview the farmers were asked what changes the VI is bringing about on the farm, and their perceptions and opinions of these. These general comments are in Section 5.

1.4 The questions asked are in Section 6.

# 2. FARM A, ANGLIAN

About The Farm

2.1 The farming information was provided by the farmer and his agronomist.

2.2 The farm extends to 250 hectares. There are six crops grown. The cereals are in effect the break crop between higher value crops:

- maincrop potatoes, grown by Harrison and Co;
- field vegetables, last year all lettuce grown by Shropshire's;
- sugar beet;
- vining peas;
- winter wheat;
- winter barley.

2.3 There is a relatively small area of ESA grassland.

2.4 The farm has the benefit of a reservoir, fed by seepage, so that some crops can be irrigated.

Cropping 2003/4 and 2004/5

2.5 The cropping plans for 2004 and 2005 harvests were obtained from the farm. The exact acreages were included on the cropping printout.

Pesticide Applications

2.6 **2003/2004**. Detailed records of the product, date of application, area covered and rates were obtained on a field by field basis.

2.7 **2004/2005**. Autumn applications for 2004/5 will follow a similar pattern. The cereal seed was dressed with Berrygold. The completed or expected cultivations and applications between September and January are:

- cereals. The cereals mainly follow roots or vegetables although fields 1 and 5 will be second year cereals. In all areas the previous crop residue or chopped straw is ploughed in and the field is then drilled using a cultivator drill. A post-emergence application is likely in about mid-November;

- roots and vegetables. The previous crop residues will be ploughed in during late autumn or over winter, following an application of Roundup.

Drainage

2.8 The main drainage flows were identified by the farmers, who also identified two potential sampling points.

Spraying Practice

2.9 Spray applications and rates are advised by an agronomist. He advises the farmer who instructs the spraying contractor to make the necessary applications. The contractor is a relative as well as an experienced contractor and best practice is followed.

2.10 Mixing is carried out at the farmyard at another farm. The sprayer has its own clean water tank and most tank residues are sprayed out on the crops. Any surplus is collected for specialist disposal in a tank at the other farm.

2.11 Headlands are usually sprayed first. Most fields have 6 metre margins and spraying is carried out up to the edge of the margin. The sprayer and tractor are washed off before leaving each field.

Drift and Sediment Transfer

2.12 The farm is very flat and windy. Hence care has been taken to avoid aerial drift. However, as most fields have good hedges drift off the crop is not a problem issue.

2.13 The fields are generally flat and, as a consequence, sediment transfer is not a problem in this farm.

Factors Affecting Sampling

2.14 There are no known incidences in 2003/2004 of spray drift, rainfall immediately after spraying, or spillages which would affect the sampling results.

## 3. FARM B, SOUTH WEST

About The Farm

3.1 Farm B extends to 75ha. It is farmed in conjunction with a similar sized farm unit. The information was provided by the farmer and his agronomist.

3.2 First and second wheats are grown with breakcrops of oilseed rape and set aside.

3.3 The farm is entered into the CSS, and 6 metre margins are widely in place.

Cropping 2003/4 and 2004/5

3.4 Last year most of the farm was under winter wheat, with only two areas of spring-sown oilseed rape. The 2004/5 cropping is all winter wheat with three areas of rotational set aside.

Pesticide Applications

3.5 **2003/2004**. The 2003/4 applications were obtained on a field by field basis.

3.6 **2004/2005**. The first wheats will have been seed dressed with Cibutol Latitude. The fields are minimum tilled. Previous cereal crop straw was baled, oilseed rape straw was chopped and ploughed in with FYM. Most of the grounds is sprayed with Roundup prior to being ploughed and then power- harrowed, then drilled on the same day wherever possible. Spraying will then be similar to last year's applications.

Drainage

3.7 The general drainage flows were identified by the farmer.

Spraying Practice

3.8 An agronomist advises on application dates and dosages. The farmer does the actual spraying.

3.9 A Crop Protection Management Plan is in place. The sprayer is taken from the other farm unit to Farm B empty and is mixed and filled at

Farm B. All tanks are switched to clear and run clean prior to leaving the field. Headlands are generally sprayed last. Tyres are not washed off but a long farm track is used prior to the public road. Spraying is right to the crop/6m margin edge.

Drift and Sediment Transfer

3.10 Care is taken to avoid drift. The field adjacent to the reservoir is only sprayed early morning or late evening, and never on a windy day.

Factors Affecting Sampling

3.11 There were no accidents during 2003/4 and direct spray into watercourses or ditches is not thought to have occurred. Some risks of run-off transferring sediment do exist, but there were no incidences during 2003/4.

# 4. FARM C, MIDLANDS

About The Farm

4.1 Farm C is farmed in conjunction with another farm, but the details below relate only to Farm C. The farming information was provided by the owner of Farm C.

4.2 Farm C extends to about 65 hectares. The combined farm unit is usually grown on a two-wheat rotation followed by a break crop of oilseed rape or beans.

4.3 There are numerous CSS headlands and corners of fields under various CSS tiers.

Cropping 2003/4 and 2004/5

4.4 In 2003/4 the cropping included winter wheat, oilseed rape, winter and spring beans. In 2004/5 the whole farm is scheduled to be sown with winter wheat.

Pesticide Applications

4.5 **2003/2004**. The 2003/4 records were obtained on a field by field basis.

4.6 **2004/2005**. Some of the 2004 harvest winter wheat was baled, but most was chopped and spread. OSR and bean residues were chopped and spread. The fields will (or have been) treated with Roundup 2-3 days prior to being disced, and in some cases, subjected to a shallow press and tilling prior to drilling. The wheat seed will have been dressed with Cibutol.

Drainage

4.7 Most of the drainage flows down moderate slopes. Some flow off a field immediately north may run off into those fields. That northern field was cropped to winter barley in 2003/04.

4.8 There are numerous, generally old, under-field drainage systems. These were identified by the farmer.

Spraying

4.9 The predominant wind is south-westerly or westerly. The lower half of the farm is quite sheltered but wind affects the higher ground. The farm has a newly acquired 24m boom sprayer. In 2003/4 spray was applied right to the crop edges but in 2004/5 a 2 metre margin will be lelt. The boom is kept low to minimise drift.

4.10 The application times and dosages are agreed between the two farm owners, with the owner of Farm C doing most of the applications. Spraying tends to be reactive.

4.11 Tanks are filled in the farmyard, on an outside concrete yard. This is to be moved shortly. Full tank washings in the fields are rarely carried out, and the tractor is not washed off prior to leaving the field.

Drift and Sediment Transfer

4.12 It is possible that with wind drift some spray settled into watercourses or dry ditches, in 2003/2004. For that reason 2 metre margins will be left in future.

4.13 There may be some sediment transfer along drainage routes, but it is not recognised as a problem issue at present.

Factors Affecting Sampling

4.14 There may have been some drift over water courses in 2003/4. However, there were no washoff or other incidences last year.

# 5. FEEDBACK ON THE VOLUNTARY INITIATIVE

5.1 On the whole all three farmers found the VI easy to work with. In most cases it was a continuation of existing practice.

5.2 Specific changes as a result of the VI were:

- the moving of the sprayer washing point on Farm A and Farm C;
- no longer transporting a mixed and filled sprayer from the accompanying farm to Farm B by road;
- CPMP production on Farm B;
- greater awareness of pollution risks, especially from point sources such as caps.

5.3 There was no negative feedback about the VI, and nobody had experienced problems with implementation.

5.4 In respect of the sampling, it was considered that the three farms are already practicing according to the VI. Therefore, any recorded change may be less than from a farm not currently part of the VI but changing over to it.

# 6. QUESTIONS FOR THE FARMERS

FARM NAME:
FARMER'S NAME:
INTERVIEW TIME AND DATE:

About the project. Aims are to establish baseline, so we need to know what you have been doing until recently and any recent changes as a result of the VI.

We need details of the chemical use to inform the monitoring.

1 About the farm

2 About the VI

3 What changes the VI has brought to farm management

4 Are these good or bad? Time, cost, timing, crop performance etc...

5 Implementation problems?

6 Deciding on what and when to spray and doses. Who makes the decisions and how?

7 What has been applied in the last few months (and get copy of records if possible)?

8 What are the likely pathways across the farm:
   - Spray drift?
   - Sediment transfer?

9 Which watercourses are most likely to be affected and why?

10 What is anticipated to be applied in the next few months (the monitoring period)?

11 Wash off and other issues.

12 Overall comments.

## Appendix II: River Corridor Survey results

**Farm A**

**Sampling point 1**

Conditions on the day of survey were cold and overcast following heavy rain.

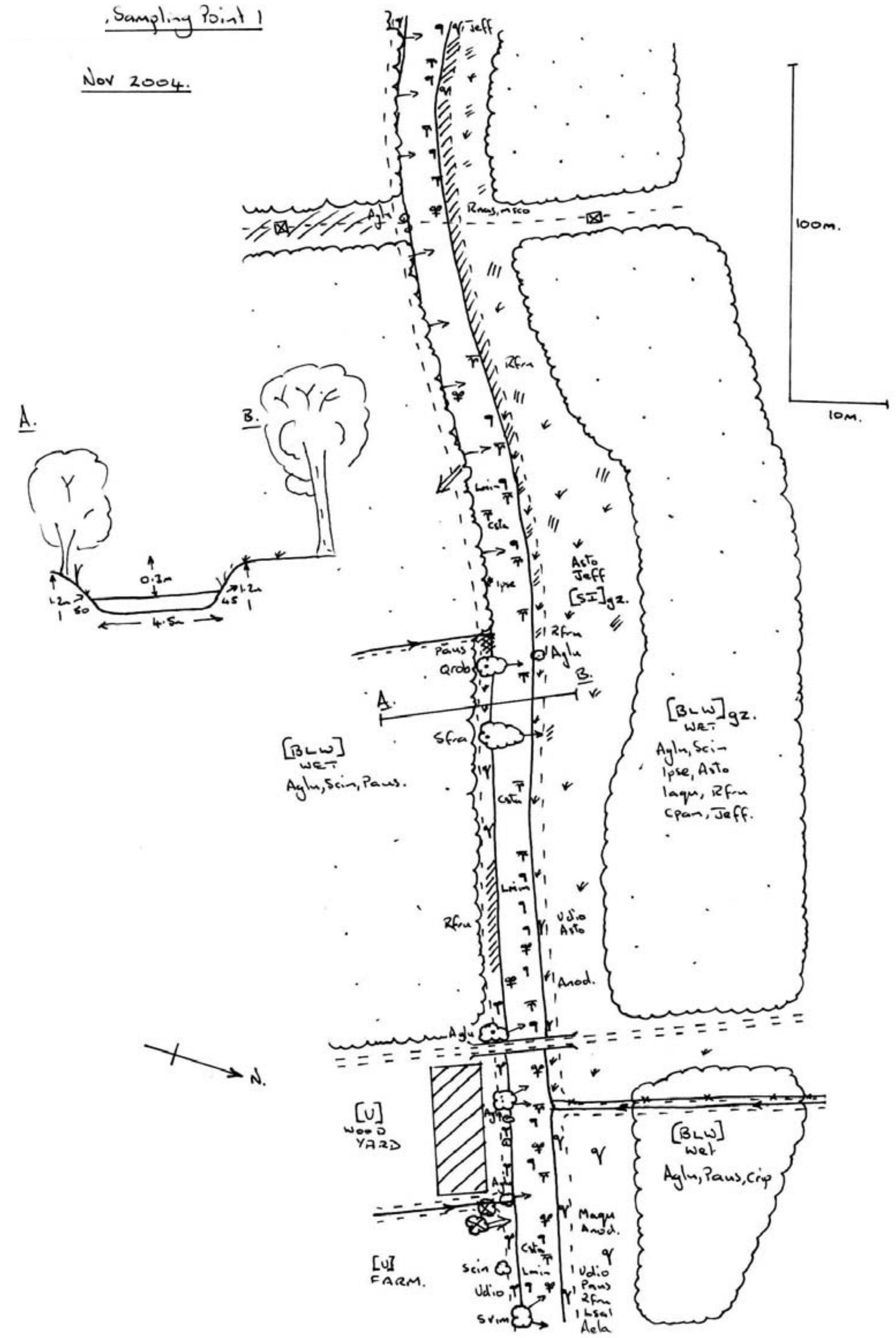
This wide, very slow flowing, drain appeared to be well managed with a typical trapezoidal cross-section throughout. The substrate appeared to be entirely comprised of silt, and water levels may be artificially maintained.

The left bank supported an almost continuous line of trees and scrub, much of which was continuous with the adjacent woodland. Species recorded included Grey Willow (*Salix cinerea*), Crack Willow (*Salix fragilis*), Alder (*Alnus glutinosa*) and Bramble (*Rubus fruticosus* agg.). To the east, the right bank was open and supported tall herb and grass vegetation, which comprised False Oat-grass (*Arrhenatherum elatius*), Cock's-foot (*Dactylis glomerata*), Creeping Bent (*Agrostis stolonifera*), Common Nettle (*Urtica dioica*), and Common Reed (*Phragmites australis*). To the west, low growing grazed bramble scrub dominated the bank.

Emergent, submerged and floating vegetation was recorded along the entire length of the watercourse, with small patches of marginal vegetation. Common Water-starwort (*Calitriche stagnalis* agg.), Lesser Duckweed (*Lemna minor*), Fool's Water-cress (*Apium nodiflorum*) and Water Mint (*Mentha aquatica*) were recorded in the open water throughout.

To the left-hand side the adjacent land-use comprised wet woodland to the west (Alder, Grey Willow and Common Reed) and a farmyard to the east. The right-hand side supported marshy grassland and small blocks of wet woodland.

Intensive management may be reducing the nature conservation value of the watercourse. However, its proximity to valuable, habitats such as the wet woodland and less intensively managed grasslands, mean that the channel is likely to be of some local nature conservation value or higher. A less intensive management regime and fencing of the banks to restrict livestock access may help to maintain and enhance this watercourse. A kingfisher (*Alcedo atthis*) was observed during the survey.


Sampling Point 1
Nov 2004.
100m.
10m.
A.
B.
0.2m
1.2m
4.5m
[BLW] WET Aglu, Scin, Paus.
[BLW] gz. WET Aglu, Scin Ipse, Asto laqu, Rfru Cpan, Jeff.
[SI] gz.
[U] WOOD YARD
[U] FARM.
[BLW] Wet Aglu, Paus, Crip
N.

**Sampling point 2**

Conditions on the day of survey were cold and overcast following heavy rain.

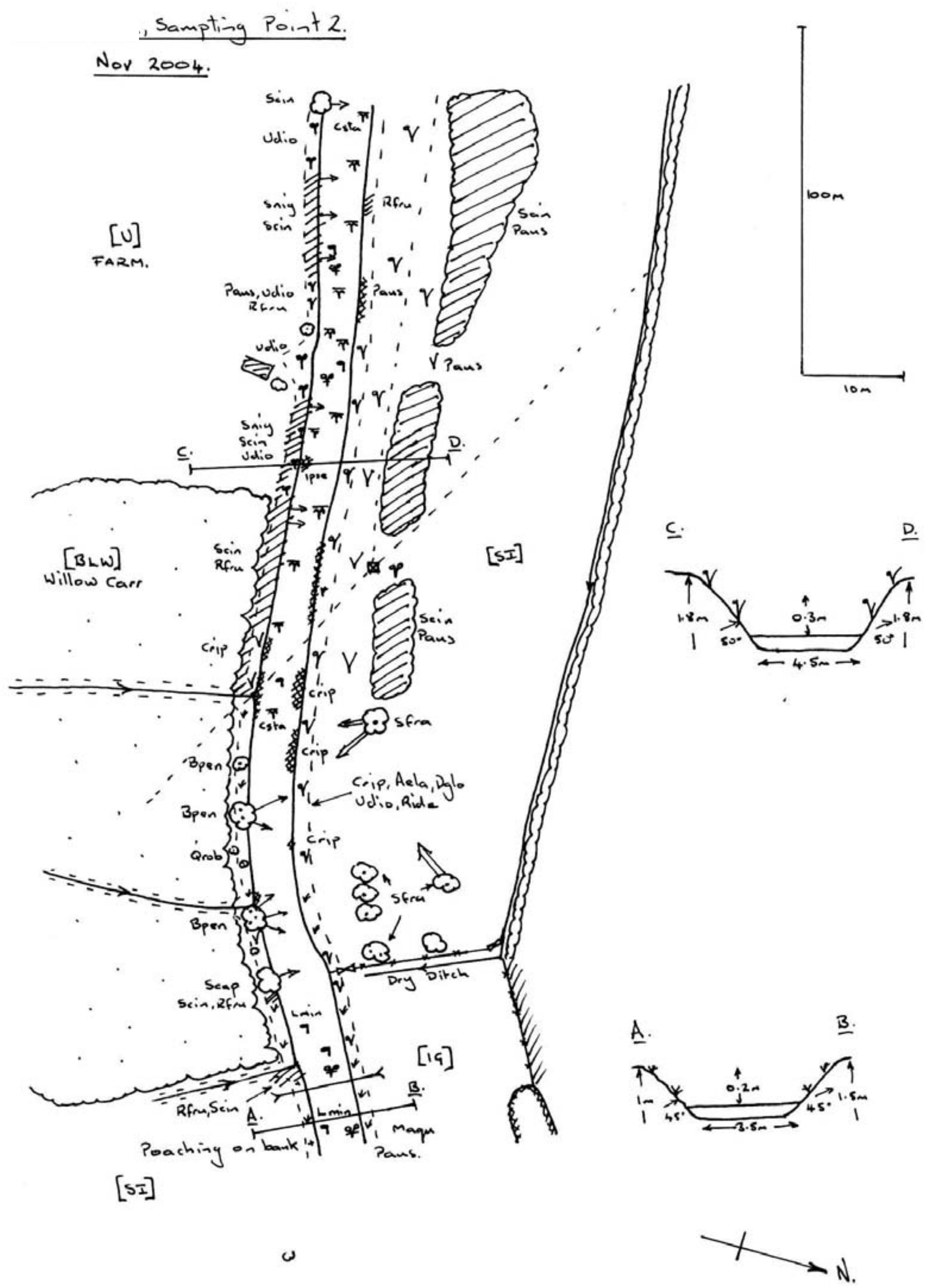
This wide, very slow flowing, drain appeared to be well managed with a typical trapezoidal cross-section throughout. The substrate appeared to be entirely comprised of silt, and water levels may be artificially maintained.

The left bank supported an almost continuous line of trees and scrub much of which was continuous with the adjacent woodland. Species recorded included Grey Willow, Silver Birch (*Betula pendula*), Elder (*Sambucus nigra*) and Bramble. The right bank was open and supported tall herb and grass vegetation, which comprised False Oat-grass, Cock's-foot, Common Nettle, Common Reed, Raspberry (*Rubus ideaus*) and Greater Pond-sedge (*Carex riparia*).

Marginal, emergent, submerged and floating vegetation was recorded along the entire length of the watercourse. Small marginal fringes of Greater Pond-sedge, Common Reed and Flag Iris (*Iris pseudacorus*) were recorded along the banksides, with Common Water-starwort, Lesser Duckweed (*Lemna minor*) and Water Mint (*Mentha aquatica*) recorded in the open channel.

To the left-hand side, the adjacent land-use comprised wet woodland/willow carr to the east and a farmyard to the west, whilst the right-hand side supported improved grassland to the east and a mosaic of damp semi-improved grassland, marshy grassland and wet woodland/willow carr to the west.

Intensive management may be reducing the nature conservation value of the watercourse. However, its proximity to valuable habitats, such as the wet woodland and less intensively managed grasslands, mean that the channel is likely to be of some local nature conservation value or higher. A less intensive management regime and fencing of the banks to restrict livestock access may help to maintain and enhance this watercourse.


Sampling Point 2.
Nov 2004.
[U]
FARM.
[BLW]
Willow Carr
[SI]
[IG]
Dry Ditch
Poaching on bank
Sfra
Bpen
Qrob
Crip
Crip, Aela, Dglo
Udio, Ride
Scin
Udio
Snig
Rfru
Paus
Csta
Lmin
Magu
Rfru, Scin
Scap
Scin, Rfru
100m
10m
C.
D.
A.
B.
1.8m
0.3m
50°
4.5m
1m
0.2m
1.5m
45°
3.5m
N.

**Sampling point 3**

Conditions on the day of survey were cold and overcast following heavy rain.

This short section of farmland drain contained no water and did not appear to have undergone any management for several years. The channel was linked to a large main drain (Sites 1 & 2).

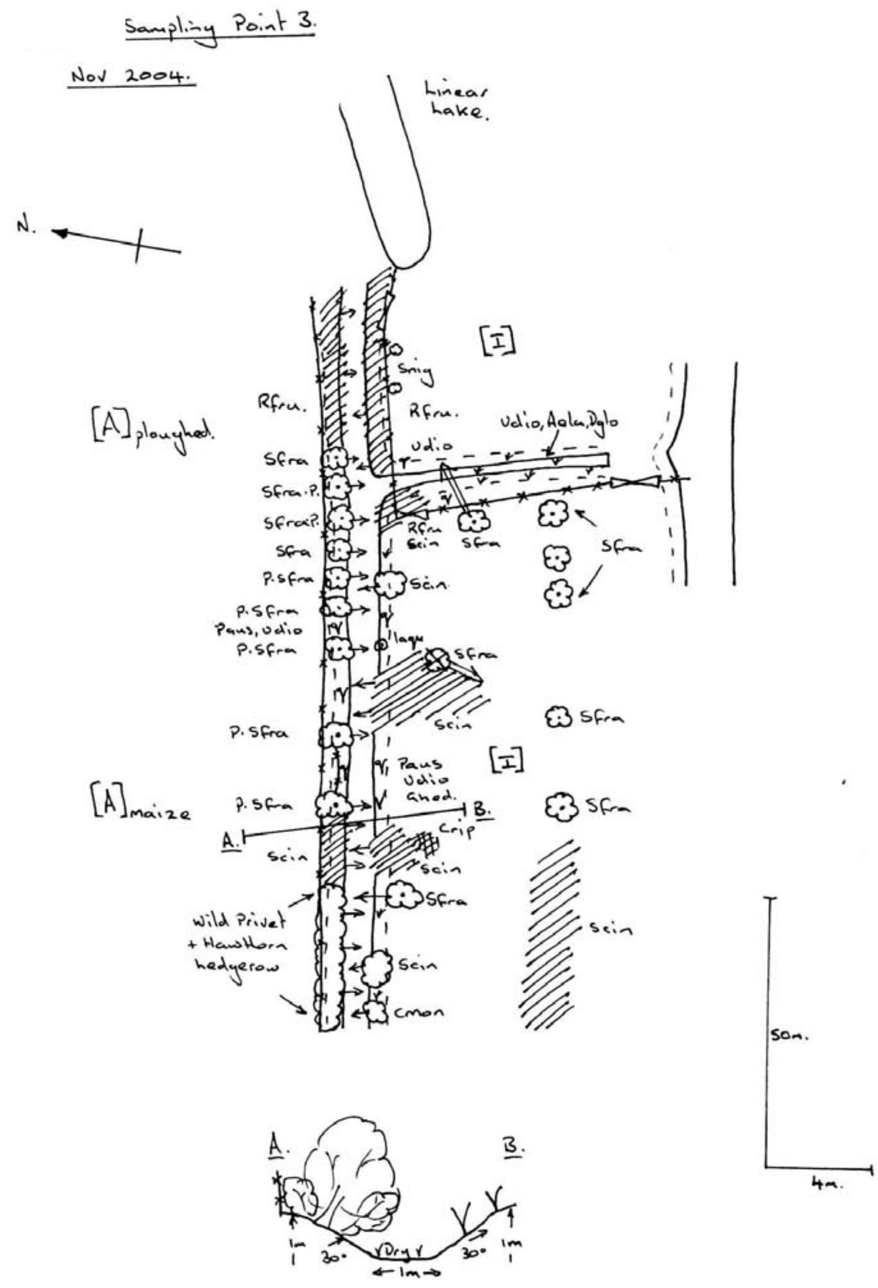
The left bank supported trees and scrub along its entire length. To the west a short section of Hawthorn (*Crataegus monogyna*) and Wild Privet (*Ligustrum vulgare*) hedgerow was recorded, whilst to the east the bank was lined with Crack Willow pollards, Grey Willow and Bramble, creating heavy shade to much of the channel. The right bank supported small areas of short grassy vegetation between areas of willow and bramble scrub.

The channel contained no water and, due to the high level of shading, supported no vegetation.

The adjacent land-use on the survey section was arable (maize) on the left, and improved grassland, scattered scrub and trees, and a drain on the right.

The habitats recorded are of low nature conservation value, although the mature trees and scrub are likely to provide suitable bird breeding habitat.

Management to decrease the amount of shading to the channel, resectioning and a maintained water level are likely to increase the conservation value of this site.


Sampling Point 3.
Nov 2004.
Linear Lake.
N.
[I]
Snig
Rfru.
Rfru.
[A] ploughed.
Udio, Aela, Dglo
Udio
Sfra
Sfra. P.
Sfra P.
Sfra
P. Sfra
Rfru
Scin
Sfra
Scin
Sfra
P. Sfra
Paus, Udio
P. Sfra
Iagu
Sfra
Scin
P. Sfra
Sfra
[I]
Paus
Udio
Ghed.
[A] maize
P. Sfra
A.
B.
Sfra
Crip
Scin
Scin
Sfra
Wild Privet
+ Hawthorn
hedgerow
Scin
Scin
Cmon
50m.
4m.
A.
B.
1m
30°
Dry
30°
1m
1m

**Sampling point 4**

Conditions on the day of survey were cold and overcast following heavy rain.

This intensively managed farmland drain contained no water for much of its length, although flattened vegetation suggested that it does carry water during periods of heavy rainfall. Stagnant pools of water were recorded to the west of the channel and it appears to disappear to the east. The channel cross-section was of a typical trapezoidal form throughout

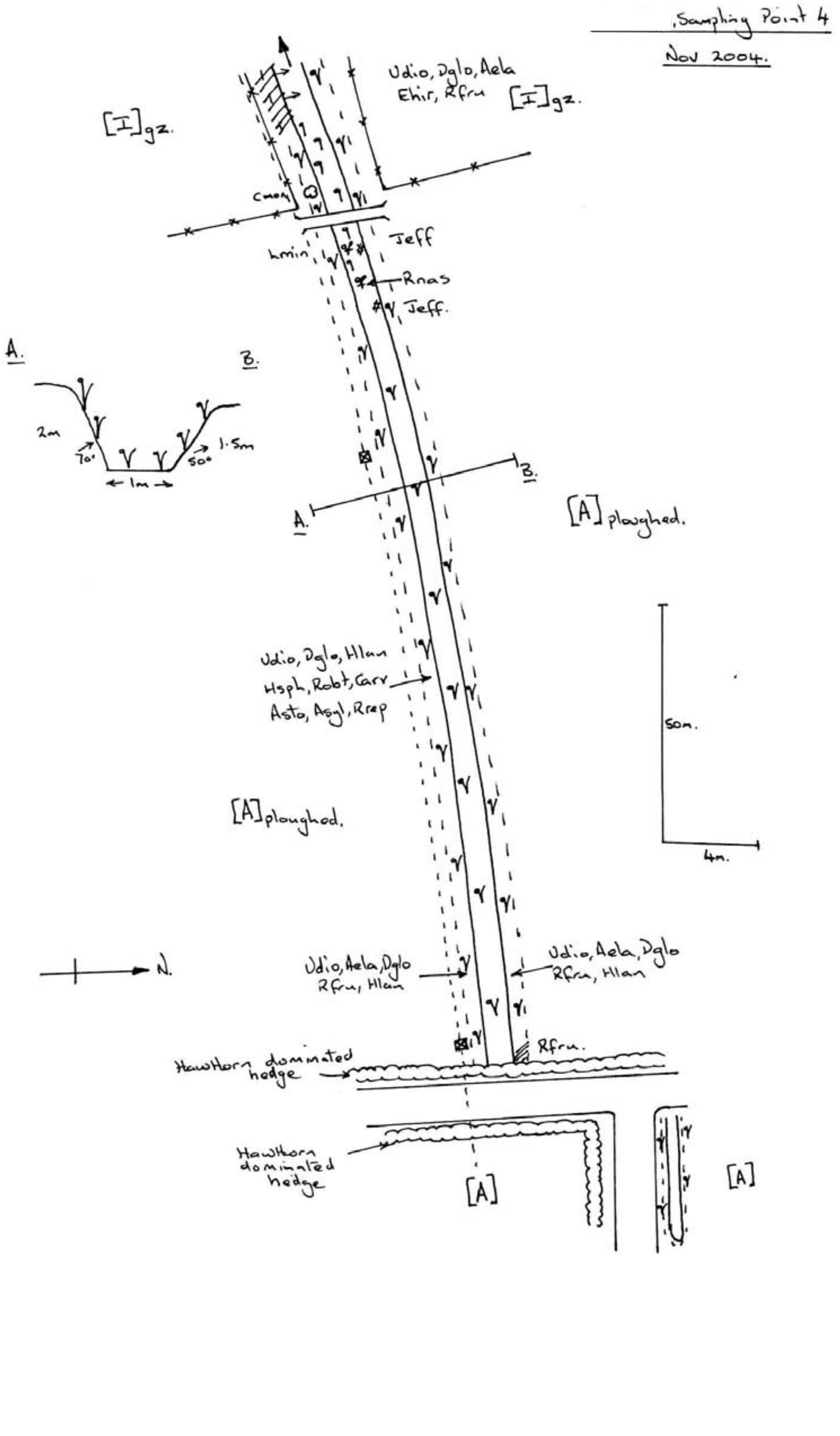
The left bank supported tall grass and ruderal vegetation, typical of high nutrient levels, along much of its length, characterised by Yorkshire-fog (*Holcus lanatus*), Creeping Bent, False Oat-grass, Cock's-foot, Common Nettle and Hogweed (*Heraclium sphondylium*). To the west small areas of Bramble and Hawthorn were recorded on the bank. The right bank supported a similar species composition of tall grass and ruderal vegetation, to that of the left bank along its entire length.

For much of its length the channel was dry and supported a grass-dominated vegetation similar to that on the adjacent banks, with a high proportion of Creeping Buttercup (*Ranunculus repens*) and Yorkshire-fog recorded. To the west a small amount of Water-cress (*Rorripa nasturtium-aquaticum*), Soft-rush (*Juncus effusus*) and Lesser Duckweed was recorded in the standing water.

The adjacent land-use on the survey section was, in the main, arable land, which had been ploughed at the time of survey. To the west two horse grazed pastures were fenced allowing no access of animals to the watercourse or banks.

The habitats recorded are typical of an intensively managed lowland farm drain. The lack of water and associated wetland vegetation would give this watercourse negligible nature conservation value.

A decrease in management, a maintained water level and re-engineering the channel to create a sinuous planform are likely to increase the conservation value of this site.



Sampling Point 4
Nov 2004.
Udio, Dglo, Aela
Ehir, Rfru
[I]gz.
[I]gz.
Cmon
Jeff
Lmin
Rnas
Jeff.
A.
B.
2m
70°
1m
50°
1.5m
B.
A.
[A] ploughed.
Udio, Dglo, Hlan
Hsph, Robt, Carv
Asto, Agyl, Rrep
50m.
[A] ploughed.
4m.
N.
Udio, Aela, Dglo
Rfru, Hlan
Udio, Aela, Dglo
Rfru, Hlan
Rfru.
Hawthorn dominated hedge
Hawthorn dominated hedge
[A]
[A]

**Sampling point 5**

Conditions on the day of survey were cold and overcast following heavy rain.

This short section of farmland drain contained no water and did not appear to have undergone any management for several years. The drain appeared to disappear to the north.

The left bank supported tall grass and ruderal vegetation, typical of high nutrient levels, along its entire length, characterised by Creeping Bent, False Oat-grass, Cock's-foot and Common Nettle. The right bank supported trees and scrub along its entire length which comprised Crack Willow, Grey Willow, Osier (*Salix viminalis*) and Hawthorn, creating heavy shade to much of the channel.

The channel contained no water and, due to the high level of shading, supported no vegetation.

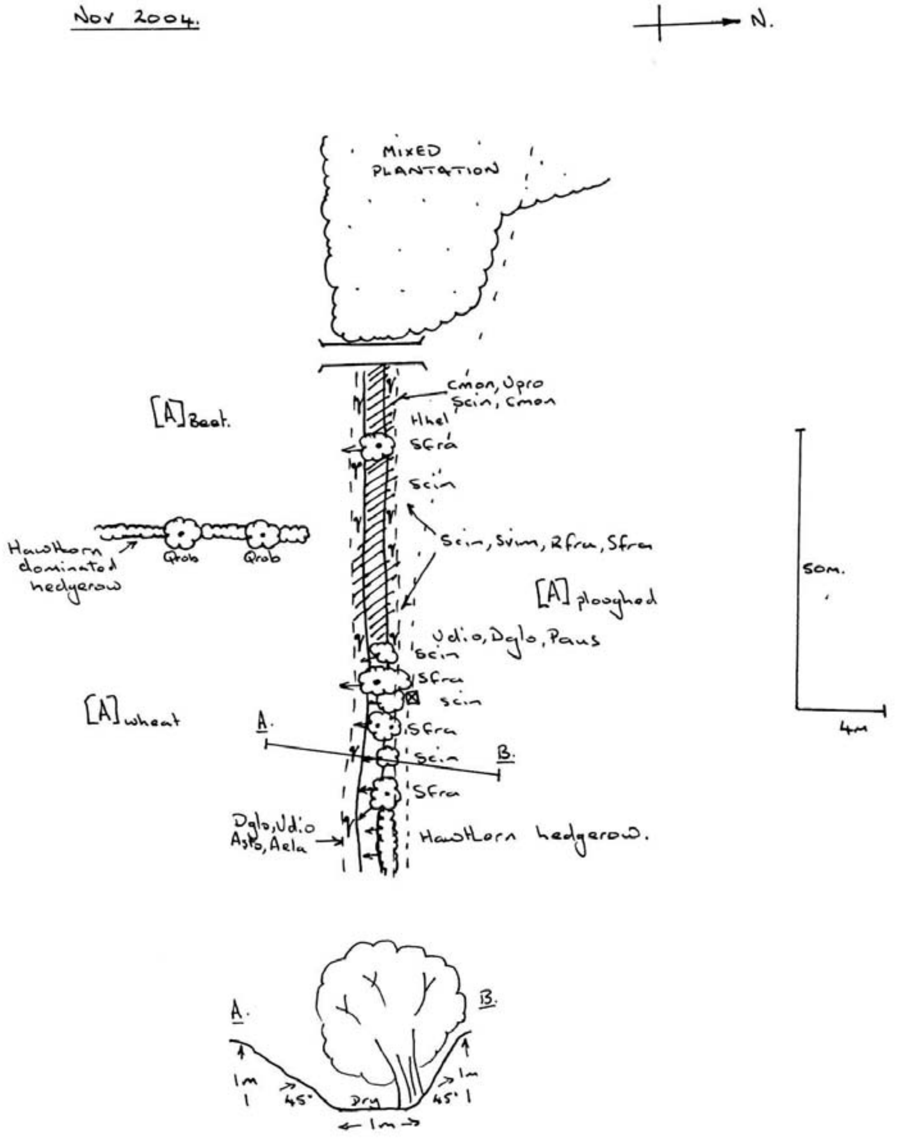
The adjacent land-use on the survey section was, in the main, arable land, which had either been ploughed or contained crops of wheat and beet. To the west, where the channel appeared to disappear, a small block of mixed plantation was recorded.

The habitats recorded are of low nature conservation value, although the mature trees and scrub are likely to provide suitable bird breeding habitat.

Management to decrease the amount of shading to the channel, resectioning and a maintained water level are likely to increase the conservation value of this site.

Sampling Point 5

Nov 2004.



## Farm B

### Sampling point 1

Conditions on the day of survey were sunny and cold. This followed heavy rain the day before.

The channel was characterised by bare silt deposits on the upstream two thirds, with debris accumulations at two locations creating low natural weirs. The downstream third was cleared of silt and had a gravel substrate.There was very little marginal vegetation in the channel itself (see comments on existing management), with a single specimen of Water forget-me-not (*Myosotis scorpioide*s) found. The stream ran through a poorly drained area with stands of emergent plants on adjacent land. The immediate banksides of the stream were steep and trapezoidal at the downstream third of the survey section and steep to vertical on the upstream two thirds. Here, the bank zone habitat was composed of wet woodland plants such as Pendulous sedge (*Carex pendula*) and species characteristic of drier conditions such as bramble.

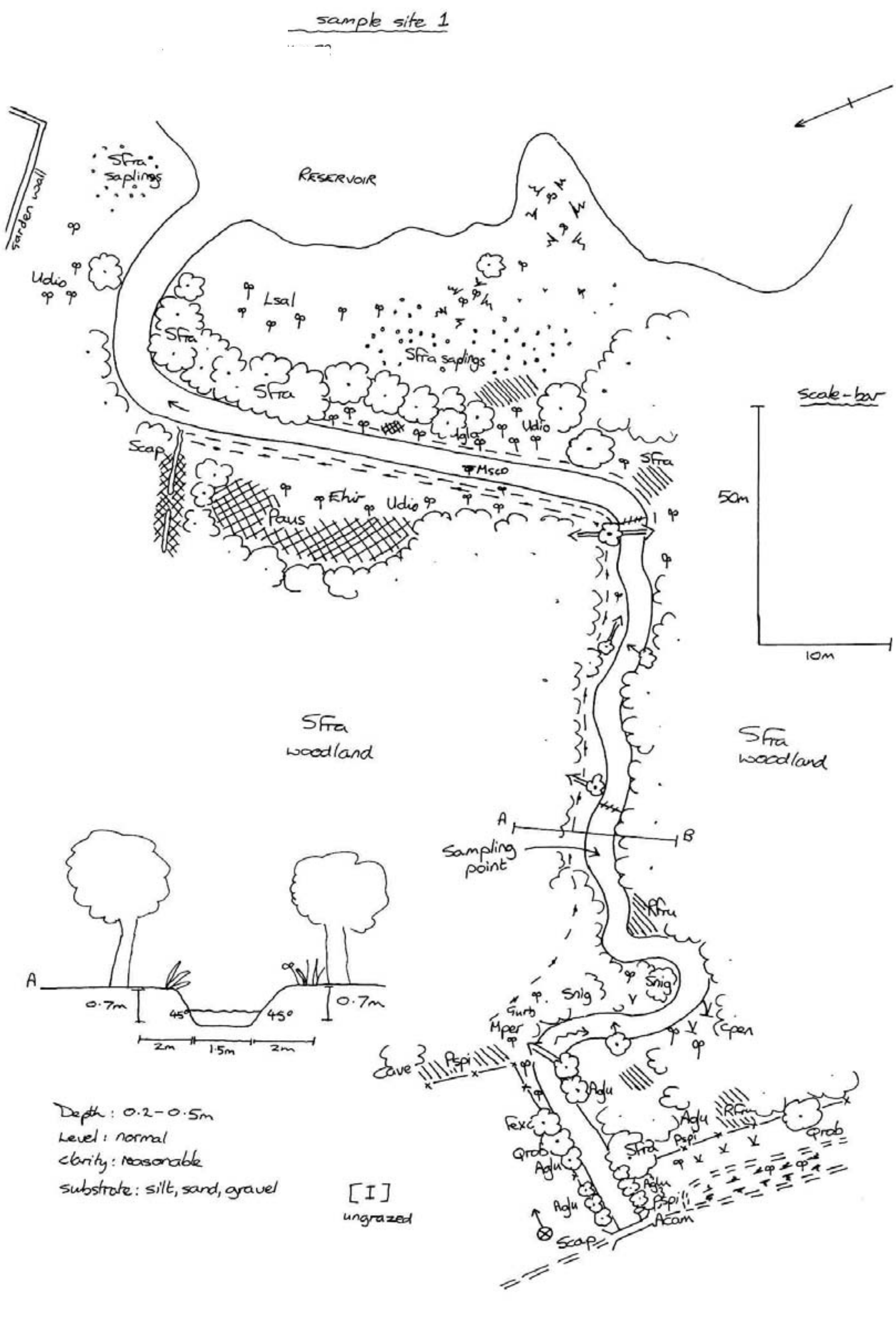
The adjacent land use on both sides of the stream comprised a wet woodland habitat dominated by tall crack willows. The understorey included shrub willows and Elder, and the ground layer was dominated by Common Reed, Common Nettle and Himalayan Balsam (*Impatiens glandulifera*). Drier areas had patches of bramble growing on them and a small patch of Dog's Mercury (*Mercurialis perennis*) and Wood Avens (*Geum urbanum*) was found towards the upstream end of the survey. A short section of the upstream end of the stream flowed adjacent to ungrazed improved grassland.

The stream flowed into Durleigh Reservoir. The banks of this waterbody were very shallowly sloping and were dominated by growth of Crack-willow and Purple-loosestrife (*Lythrum salicaria*) on what appeared to be a recently exposed substrate.

A kingfisher was seen and bullfinches (*Pyrrhula pyrrhula*) and a great spotted woodpecker (*Dendrocopos major*) were heard within the woodland. A number of wildfowl species were also noted on the reservoir. It is likely that the wet woodland provides nesting opportunities for a wide variety of bird species, possibly including birds of conservation concern such as lesser spotted woodpecker (*Dendrocopos minor*) and willow tit (*Parus montanus*). Many of the trees had features which could be suitable as roosting sites for bats.

A path running along the watercourse was noted. This is likely to be used by the residents of West Bower Manor; it is not a public right of way. The upstream two thirds of the survey section appeared to be unmanaged. The downstream third had been cleared of vegetation and silt in the relatively recent past and overhanging willow branches cut back.

Wet woodland is a UK Biodiversity Action Plan Priority Habitat. It is therefore of conservation significance and should be retained.



sample site 1
RESERVOIR
garden wall
Sfra saplings
Udio
Lsal
Sfra
Sfra saplings
scale-bar
50m
10m
Scap
Msco
Ehir
Udio
Paus
Sfra woodland
Sfra woodland
A
B
Sampling point
Rfru
Snig
Snig
Gurb
Mper
Cpen
Cave
Pspi
Aglu
Fexc
Qrob
Aglu
Aglu
Rfru
Sfra
Pspi
Qrob
Aglu
Pspi
Acam
Scap
A
0.7m
45°
45°
0.7m
2m
1.5m
2m
Depth: 0.2–0.5m
Level: normal
clarity: reasonable
substrate: silt, sand, gravel
[I]
ungrazed

**Sampling point 2**

Conditions on the day of survey were sunny and cold. This followed heavy rain the day before.

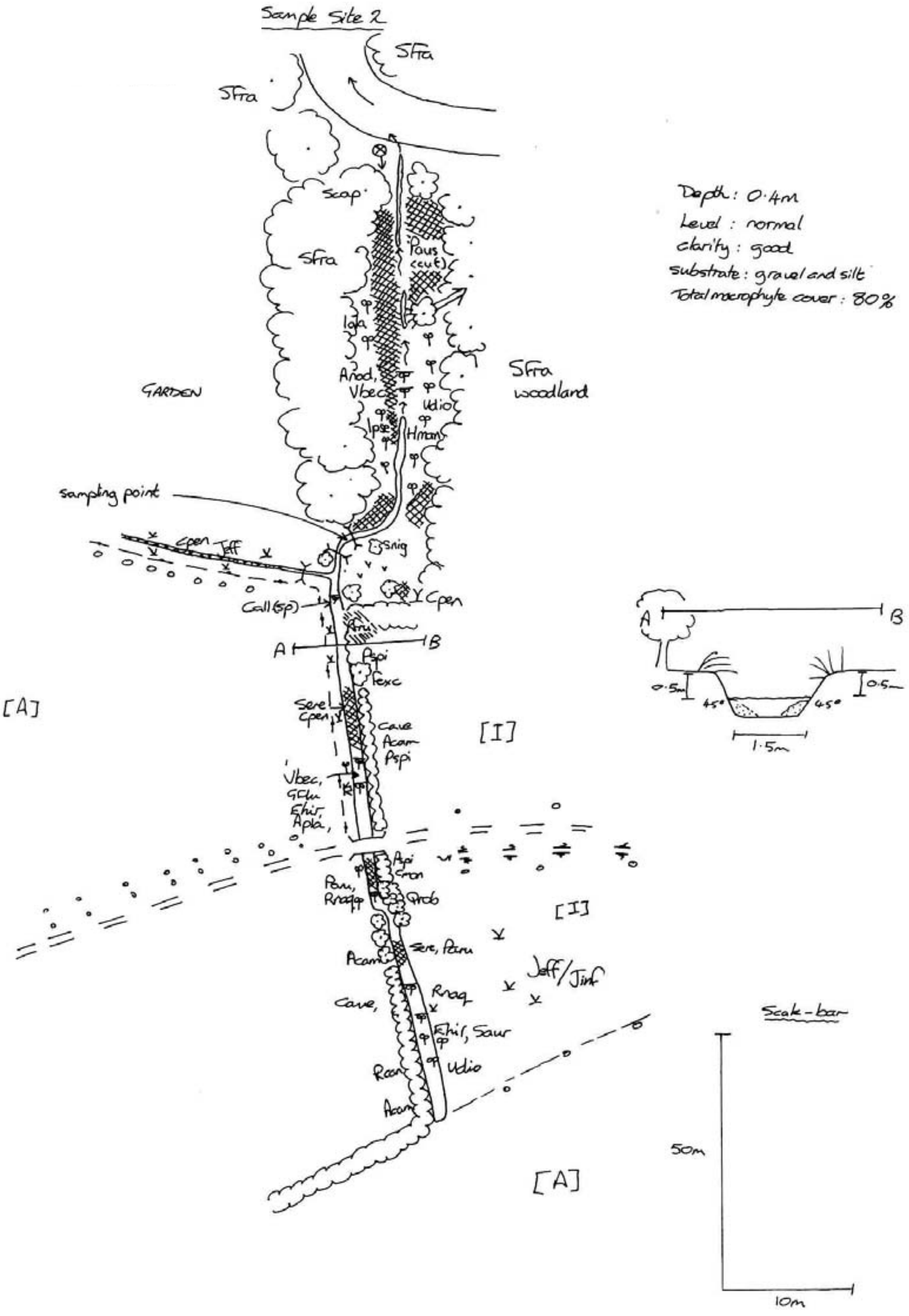
The watercourse surveyed was an agricultural drainage ditch with a slow flow of water to the stream surveyed for Sample Point 1. The upstream two thirds were deep and silty whilst the downstream third was a diffuse trickle of water through a bed of Common Reed on the edge of the wet woodland identified in the survey for Sample Point 1.

For a ditch of such short length, the diversity and abundance of marginal vegetation was notable. The dominant species at the downstream end was Common Reed, whilst stands of Floating Sweet-grass (*Glyceria fluitans*), Pendulous Sedge, Reed Sweet-grass and Branched Bur-reed (*Sparganium erectum*) were found upstream of the wet woodland. Submerged and floating macrophytes included Water-plantain (*Alisma plantago-aquatica*) Water Starwort (*Callitriche* sp.), Water-cress, Water figwort (*Scrophularia auriculata*) and Brooklime (*Veronica beccabunga*).

Bank zones on the upstream sections were dominated by hedgerows, long grass and tall herbaceous vegetation associated with field edges. The downstream section was dominated by Common Reed.

The upstream sections flowed through farmland (arable and improved grassland) and the downstream section through a wet woodland.

It is likely that the ditch is maintained for drainage, although there was no evidence of recent management. There appeared to be an abstraction point half way along the ditch on the right bank (a sunken plastic barrel and a plastic pipe placed in the water).


Sample Site 2
Depth: 0·4m
Level: normal
clarity: good
substrate: gravel and silt
Total macrophyte cover: 80%
GARDEN
SFra woodland
sampling point
[A]
[I]
Scale-bar
50m
10m
1·5m

**Sample point 3**

Conditions on the day of survey were sunny and cold. This followed heavy rain the day before.

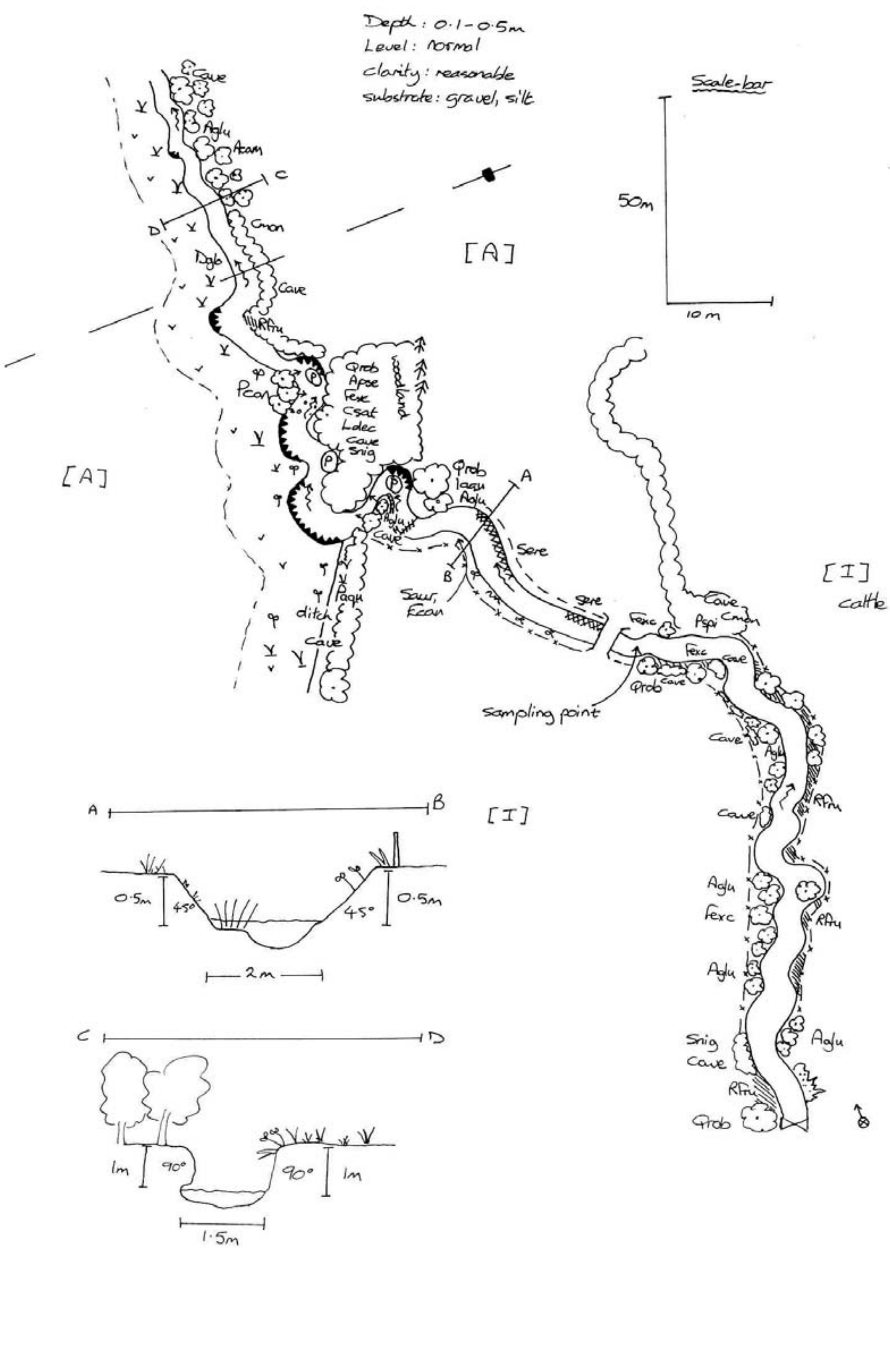
This was a narrow stream with frequent runs and some riffles but also with slower flowing sections. The entire length of the survey section was characterised by tight and small meanders. Marginal vegetation was limited by the shading effect of bankside trees but two stands of Branched Bur-reed were present in the middle of the section. The banks were largely vertical and undercut. Bank zone habitats were overhanging terrestrial vegetation such as Bramble and tall herbaceous plants with tall trees (Hazel, Alder, Oak and Ash predominant).

Adjacent land-use was arable with strips of grass ley alongside the stream, as well as cattle-grazed improved pasture and a copse.

A kingfisher was seen during the survey.

There was no evidence of existing management of the stream. The Hazel appeared to have been coppiced in the past, but not for some time.

sample site 3



**Sample point 4**

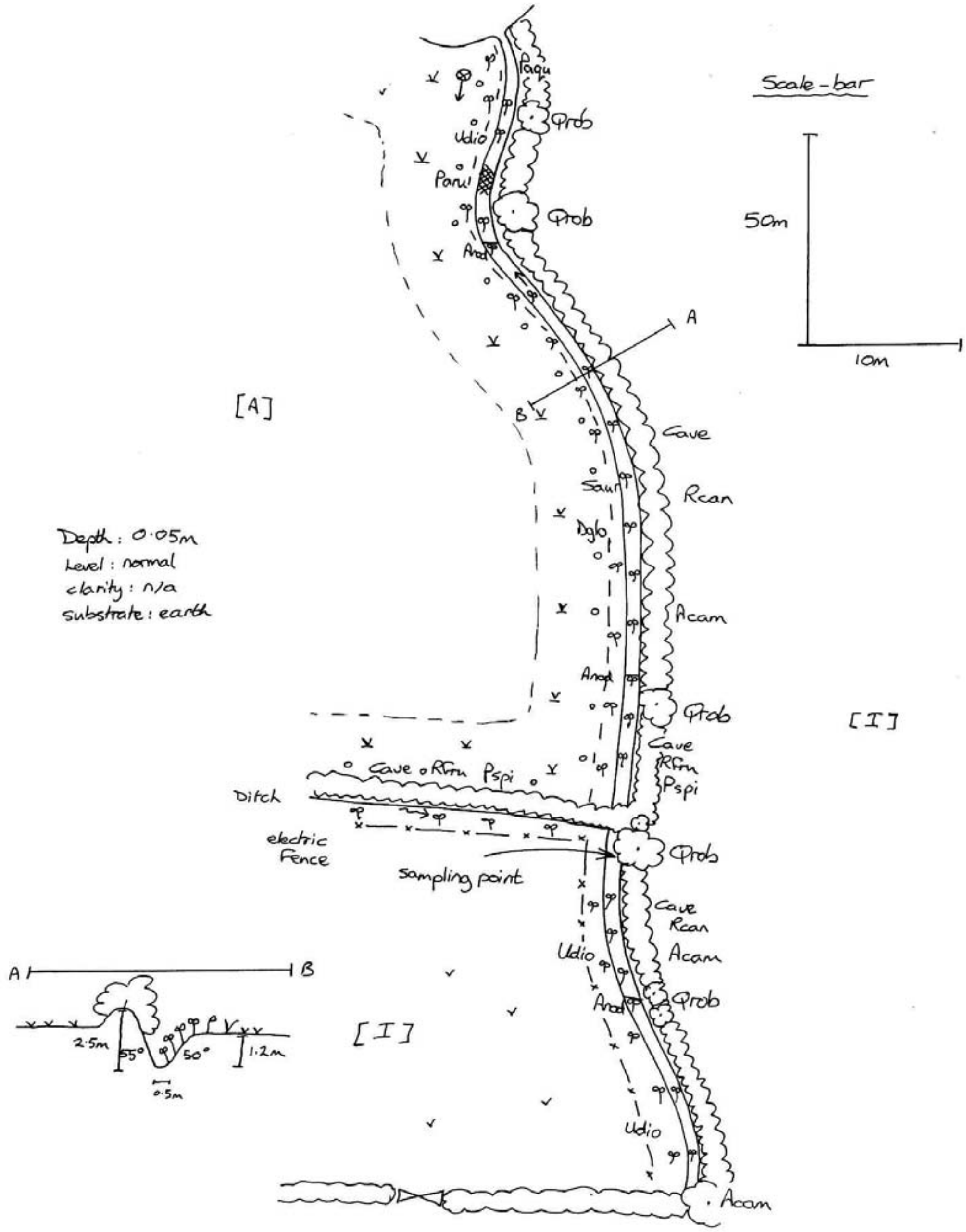
Conditions on the day of survey were sunny and cold. This followed heavy rain the day before.

This was a very narrow drainage ditch with very little water other than at the sump where the water samples were taken. The ditch was uniformly trapezoidal in cross-section, with a hedge bank on the right bank. The plants in the channel were dominated by Common Nettle, with a few individuals of Water Figwort. Fool's Water-cress was present in the damper sections.

Adjacent land-use was arable with strips of grass ley alongside the stream, as well as cattle-grazed improved pasture.

Existing management of the ditch appeared to be regular mowing of the left bank.

Sample site 4



## Farm C

### Sampling point 1

Conditions on the day of survey were cold with persistent rain. The water level in the river appeared to be only slightly affected by this, although suspended sediment in the water column was present and made water clarity poor.

Typical features of the river channel included a slow-flowing river with few features of note other than an island on the inside bend of a meander. The flow form of the water suggested that a pool had developed at the downstream end, but this was not visible at the time of the survey. Silt deposition on meander bends on both banks has led to the establishment of stands of marginal vegetation, including Reed Sweet-grass (*Glyceria maxima*), Reed Canary-grass (*Phalaris arundinacea*) and Common club-rush (*Schoenoplectus lacustris*).

The left bank zone was characterised by close-cropped grass on a relatively uniform bank slope, with some slumping of the bank. There were a number of isolated broadleaf trees with one row of Alders on the eroding bank top at the downstream end. The right bank zone was more heavily vegetated, with extensive growth of tall herbaceous vegetation dominated by Common Nettle and with several individuals of Giant Hogweed. Tree cover was also more extensive, along at least two thirds of the survey section. A pond was noted just beyond the downstream end of the section.

The adjacent land-use on the survey section comprised entirely of improved pasture with sheep grazing on the left bank. Although it is likely that animals graze the right bank, none were present at the time of the survey.

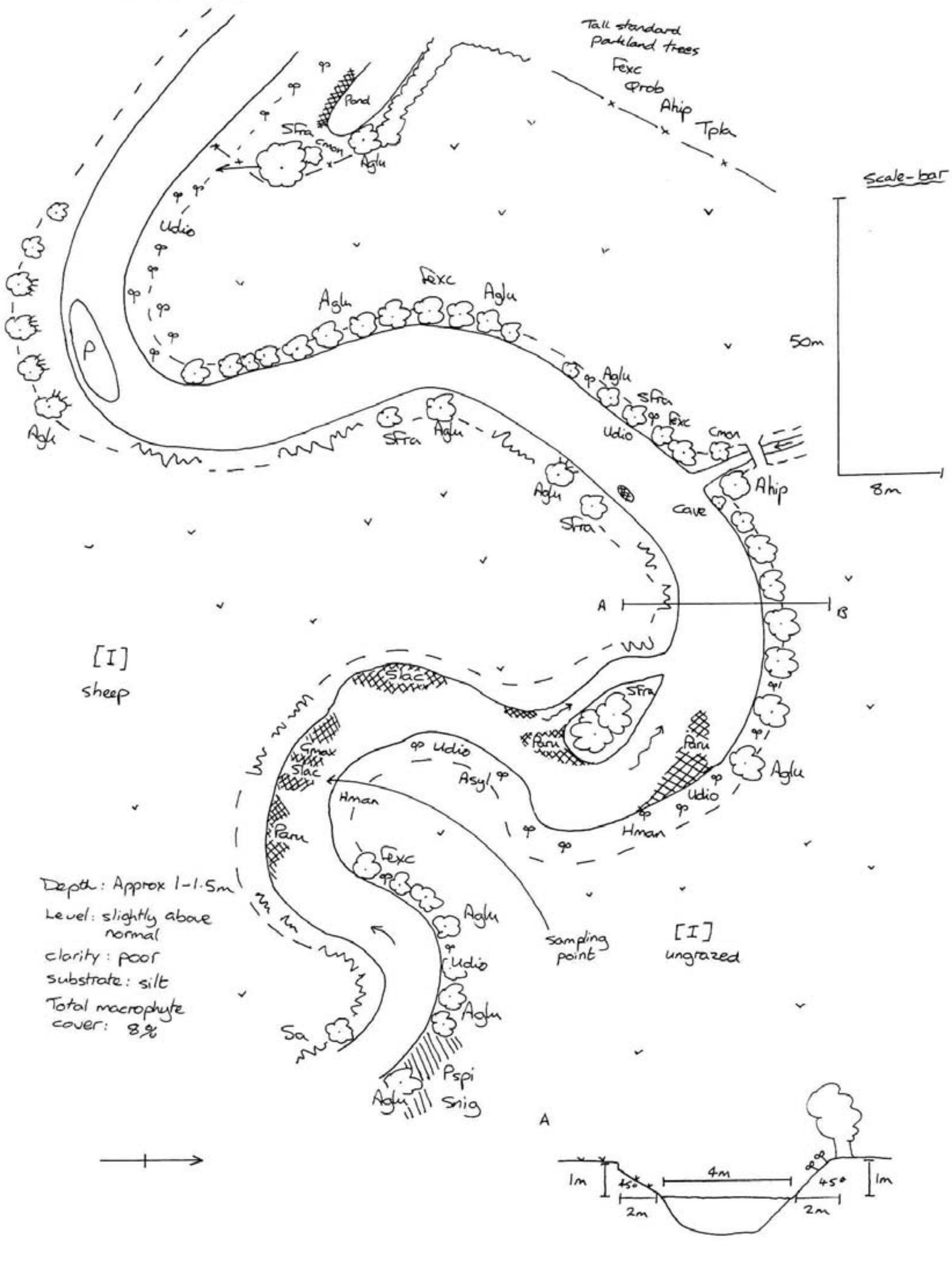
The survey section was adjacent to a wide avenue of large broadleaf trees leading to a hotel.

The habitats recorded are typical of a lowland river not subject to intense management, and so are intrinsically valuable both as a landscape feature and for their habitat value to native species.

The presence of Giant Hogweed is a concern since this species can be invasive and is toxic to humans and animals. Eradication of this species should be carried out along the river in the near future in order to protect human health and biodiversity.

It may be appropriate to fence off certain meander bends to allow the growth of taller herbaceous vegetation and/or trees. This would provide cover and nesting sites for riparian birds and otters.

Sampling point 1



**Sampling point 2**

Conditions on the day of survey were cold with persistent rain. The water level in the river appeared to be only slightly affected by this, although suspended sediment in the water column was present and made water clarity very poor.

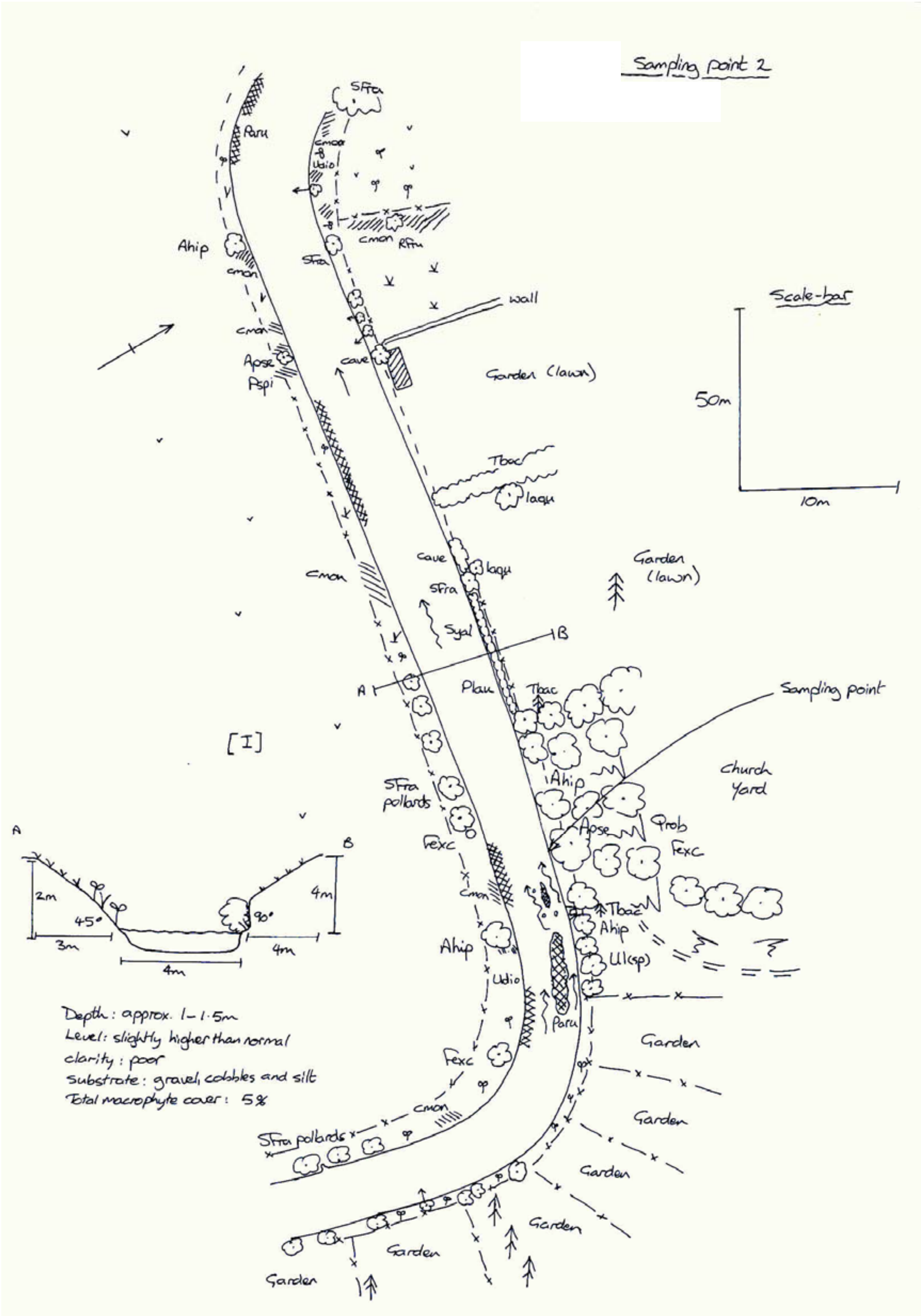
Typical features of the river channel included a run and a small vegetated island at the upstream end of the survey section. Most of the section consisted, however, of slow-flowing and deep water. Marginal vegetation consisted of narrow stands of Reed Canary-grass.

The left bank zone habitat comprised tall herbaceous plants and grasses on a steep bank with some Crack Willow pollards, intermittent Hawthorn bushes and single specimens of Horse Chestnut (*Aesculus hippocastanum*), Sycamore (*Acer psuedoplatanus*) and Ash (*Fraxinus excelsior*). The right bank zone habitat was also steep-sided with a narrow band of tall herbaceous plants at the up and downstream sections. The central reach of the survey section had no effective bank zone habitat, being dominated by Snowberry (*Symphoricarpos alba*) and Cherry Laurel (*Prunus laurocerasus*) on a vertical bank. A short section behind a churchyard was dominated by tall, mature, broadleaf trees.

The adjacent land-use on the survey section comprised improved grassland on the left bank and a series of gardens, tall trees associated with the rear of the churchyard, a field dominated by tall grasses and herbs and a sheep-grazed field.

The habitats noted on the survey section were unremarkable and the profile and channel alignment of the river suggested that it has been dredged in the past. No evidence of existing management was noted on the left bank. Any management of the right bank is likely to be restricted to the management of the gardens.

It is possible that the run at the upstream end has some local value for oxygenation of the water and should be retained. Shading from the trees at the rear of the churchyard may be of importance as shelter for fish along a reach with low tree cover.


Sampling point 2
Scale-bar
50m
10m
wall
Garden (lawn)
Garden (lawn)
Sampling point
Church Yard
Garden
Garden
Garden
Garden
Garden
Garden
[I]
Depth: approx. 1–1.5m
Level: slightly higher than normal
clarity: poor
substrate: gravel, cobbles and silt
Total macrophyte cover: 5%
2m
45°
3m
4m
4m
90°
4m

**Sampling point 3**

Conditions on the day of survey were cold with persistent rain. The water level in the river appeared to be only slightly affected by this, although suspended sediment in the water column was present and made water clarity very poor.

Typical features of the river channel included a riffle at the upstream end of the survey section, with a pool developing below a slump and an eroding earth bank. Most of the section consisted, however, of slow-flowing and deep water. Silt deposition on meander bends on both banks has led to the establishment of stands of marginal vegetation, including Reed Canary-grass and Common club-rush, as well as some growth of Fool's water-cress (*Apium nodiflorum*) and Great willowherb (*Epilobium hirsutum*).

The river banks included long reaches of slumping on the left bank, with wide areas of exposed earth and small patches of remaining grass turf at the water's edge. The right bank was also suffering from slumping but to a much lesser extent. This bank was characterised by a number of pollarded Crack Willows interspersed with low Hawthorn, Elder and Blackthorn (*Prunus spinosa*) bushes as well as stands of Common Nettle.

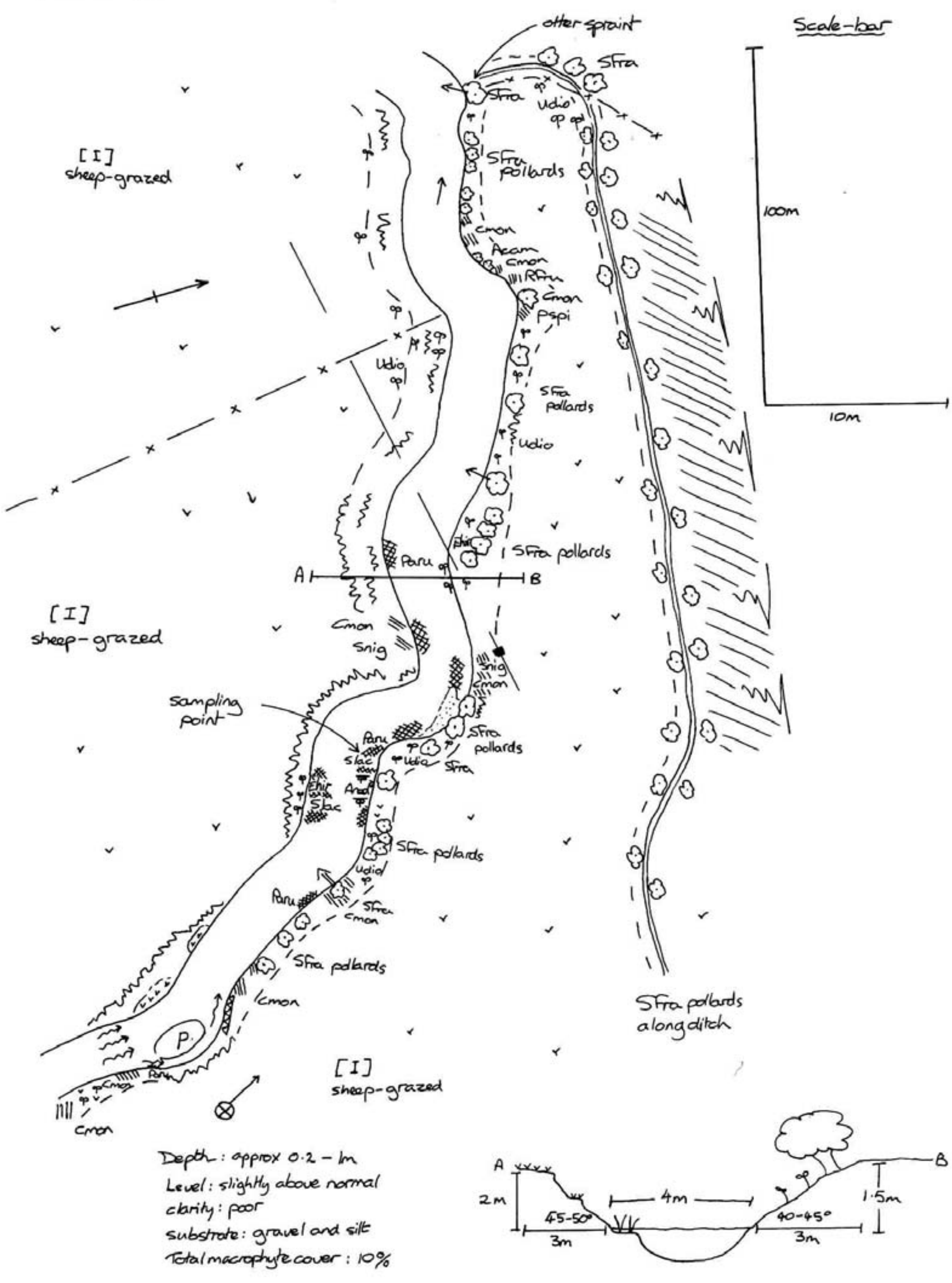
The adjacent land-use on the survey section comprised entirely of improved pasture with sheep grazing. An intermittently wet and dry ditch on the right bank had pollarded crack willow and scrub occurring along its banks. An embankment up to the adjacent road was vegetated by scrub.

Skylarks (*Alauda arvensis*) and fieldfares (*Turdus iliacus*) were noted in the course of the survey, and an otter (*Lutra lutra*) spraint (dropping) was found on an exposed root of a crack willow at the downstream end. The pollarded trees were noted as having the potential to support roosting bats.

The river banks were not managed actively, although allowing stock access to all banksides was probably the cause of the extensive slumping observed. It is possible that the silt loading in the river could be increased as further bank erosion occurs. This could block gaps between gravel and affect fish spawning areas. Fencing of stock away from the river banks in at least some of this section would reduce their erosive effect and encourage the growth of a taller herb and scrub community. This would be beneficial in stabilising the banks, providing shade for fish in the summer and cover for otters throughout the year.

The pollards appeared to have been cut within the last ten years but were in a poor state, having large rotten splits in the main boles and other tree species growing in, or on them. They are clearly of some antiquity as a mature feature of the landscape and as potential roosting sites for bats and nesting sites for a variety of birds.

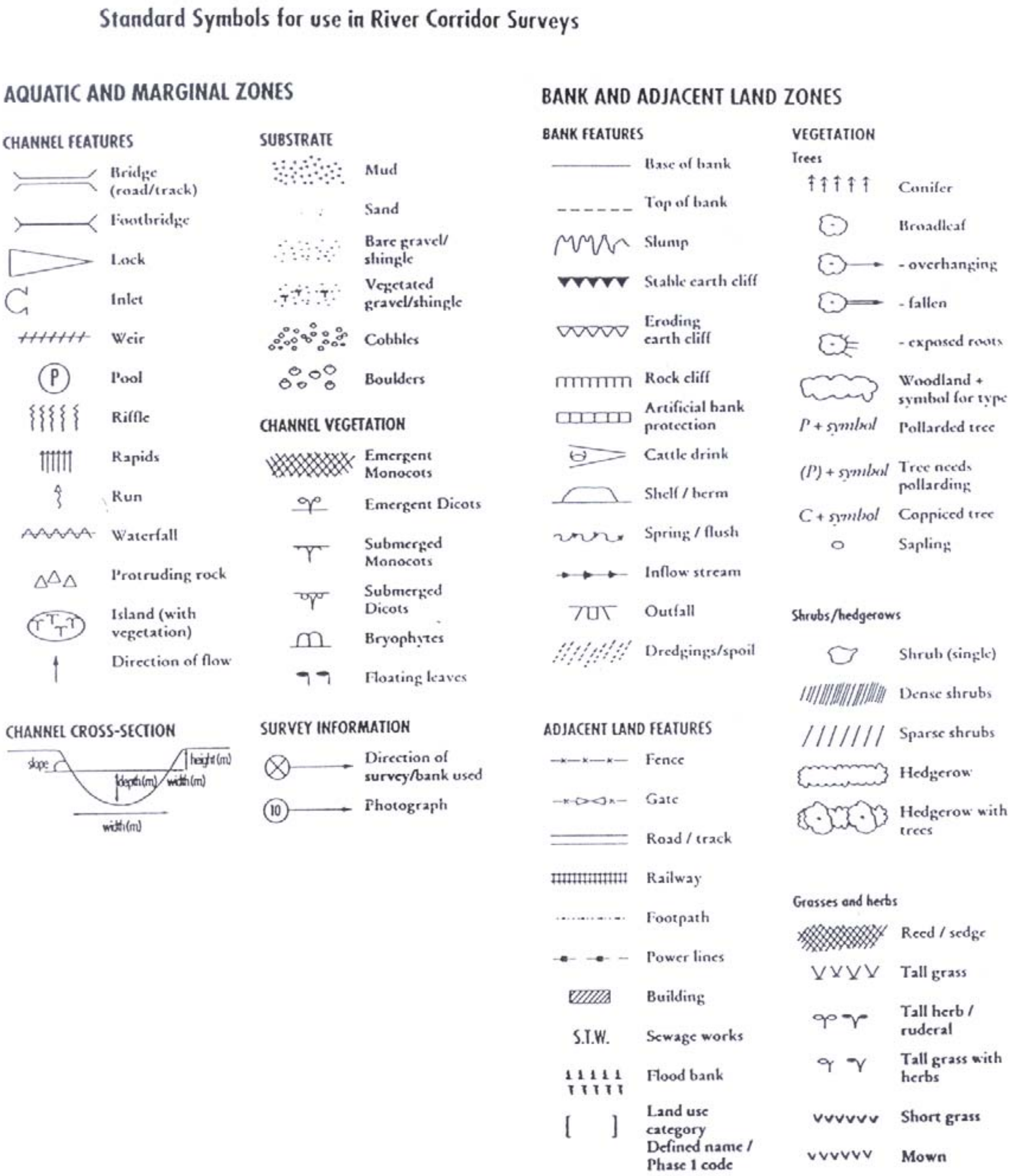
, sampling point 3



## References


National Rivers Authority. 1992. *River Corridor Surveys: Methods and Procedures. Conservation Technical Handbook No.1*


## Key



## Plant species abbreviations

**Dicotyledons**
**Herbs**

| | | |
|---|---|---|
| Anod | *Apium nodiflorum* | Fool's Water-cress |
| Asyl | *Anthriscus sylvestris* | Cow Parsley |
| Call.(Sp) | *Callitriche sp.* | Water starwort sp. |
| Ecan | *Eupatorium cannabinum* | Hemp-agrimony |
| Ehir | *Epilobium hirsutum* | Great willow-herb |
| Fulm | *Filipendula ulmaria* | Meadowsweet |
| Gurb | *Geum urbanum* | Wood avens |
| Hman | *Heracleum mantegazzianum* | Giant Hogweed |
| Lsal | *Lythrum salicaria* | Purple-loosestrife |
| Mper | *Mercurialis perennis* | Dog's Mercury |
| Msco | *Myosotis scorpioides* | Water forget-me-not |
| Ocro | *Oenanthe crocata* | Hemlock Water-dropwort |
| Olac | *O. lachenalii* | Parsley Water-dropwort |
| Rnaq | *Rorippa nasturtium-aquaticum* | Water-cress |
| Saur | *Scrophularia auriculata* | Water Figwort |
| Udio | *Urtica dioica* | Common nettle |
| Vbec | *Veronica beccabunga* | Brooklime |
| Apla | *Alisma plantago-aquatica* | Water-plantain |

**Monocotyledons**
**Grasses**

| | | |
|---|---|---|
| Cpen | *Carex pendula* | Pendulous sedge |
| Dces | *Deschampsia caespitosa* | Tufted hair-grass |
| Dglo | *Dactylis glomerata* | Cock's-foot |
| Frub | *Festuca rubra* | Red Fescue |
| Gflu | *Glyceria fluitans* | Floating sweet-grass |
| Gmax | *Glyceria maxima* | Reed Sweet-grass |
| Hlan | *Holcus lanatus* | Yorkshire-fog |
| Paru | *Phalaris arundinacea* | Reed canary-grass |
| Paus | *Phragmites australis* | Common Reed |

**Sedges and rushes**

| | | |
|---|---|---|
| Jeff | *Juncus effusus* | Soft Rush |
| Jinf | *Juncus inflexus* | Hard Rush |

**Other monocotyledons**

| | | |
|---|---|---|
| Ipse | *Iris psuedacorus* | Yellow Flag |
| Sere | *Sparganium erectum* | Branched Bur-reed |

**Trees and shrubs**

| | | |
|---|---|---|
| Ahip | *Aesculus hippocastanum* | Horse chestnut |
| Apse | *Acer psuedoplatanus* | Sycamore |
| Aglu | *Alnus glutinosa* | Alder |
| Csat | *Castanea sativa* | Sweet Chestnut |
| Cave | *Corylus avellana* | Hazel |
| Cmon | *Crataegus monogyna* | Hawthorn |
| Fexc | *Fraxinus excelsior* | Ash |

| | | |
|---|---|---|
| Fsyl | *Fagus sylvatica* | Beech |
| Iaqu | *Ilex aquifolium* | Holly |
| Ldec | *Larix decidua* | European Larch |
| Msyl | *Malus sylvestris* | Crab apple |
| Pcan | *Populus canescens* | Grey poplar |
| Plau | *Prunus laurocerasus* | Cherry Laurel |
| Pspi | *Prunus spinosa* | Blackthorn |
| Qrob | *Quercus robur* | Pedunculate oak |
| Rfru | *Rubus fruticosus* | Bramble |
| Sa (sp) | *Salix sp.* | Willow sp. |
| Syal | *Symphoricarpos alba* | Snowberry |
| Scap | *Salix caprea* | Goat willow |
| Scin | *S. cinerea* | Grey willow |
| Sfra | *S. fragilis* | Crack willow |
| Tbac | *Taxus baccata* | Yew |
| Tpla | *Tilia platyphyllos* | Large-leaved lime |
| Ul(sp) | *Ulmus sp.* | Elm |

**Ferns**

| | | |
|---|---|---|
| Ddil | *Dryopteris dilatata* | Broad Buckler |
| Dfil | *D. filix-mas* | Male Fern |
| Paqu | *Pteridium aquilinum* | Bracken |

**Alien Plants**

| | | |
|---|---|---|
| Fjap | *Fallopia japonica* | Japanese knotweed |
| Igla | *Impatiens glandulifera* | Himalayan balsam |

## Appendix III: Physical and chemical data for each farm

**Table III.1: Farm A**

| | Sampling point 1 | Sampling point 2 | Sampling point 3* | Sampling point 4* | Sampling point 5* |
|---|---|---|---|---|---|
| **Samples taken** | Biological/ Chemical | Biological/ Chemical | Chemical | Chemical | Chemical |
| **Location** | 20m d/s bridge | 20m d/s ditch confluence | 20m u/s sampling point 2 | 10m west from road | 5m west of track |
| **Width (m)** | 4 | 4 | 1 | 1 | 1 |
| **Depth (cm)** | 74.33 | 56.67 | Dry | Dry | Dry |
| **Substrate (percent cover)** | 100 | 100 | N/A | N/A | N/A |
| **Silt** | 90 | 100 | N/A | N/A | N/A |
| **Gravel** | 10 | 0 | N/A | N/A | N/A |
| **Distance from source (km)** | 0.75 | 0.5 | 0.1 | 0.1 | Unknown |
| **Altitude (m)** | 5 | 5 | 5 | 5 | 5 |
| **Slope (m/km)** | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 |
| **Discharge category** | 1 | 1 | N/A | N/A | N/A |
| **Flow** | Negligible | Negligible | None | None | None |
| **Shading** | Light | Light | Moderate | Light | Light |
| **Macrophyte cover (percent)** | 95 | 67 | None | 5 | None |
| **Macropyhte species** | *Apium nodiflorum, Lemna minor, Mentha aquatica, Rorippa nasturtium-aquaticum, Elodea canadensis* | *Carex riparia, Callitriche obtusangula, Lemna minor, Veronica beccabunga, Elodea canadensis* | N/A | *Rorripa nasturtium-aquaticum, Juncus effusus* | N/A |
| **Algal cover (percent)** | 1 | 1 | None | None | None |
| **Algal species** | Benthic Diatoms | Benthic Diatoms | N/A | N/A | N/A |

*No samples or data were collected from these sites, the ditches remained dry throughout the duration of the sampling.

**Table III.2: Conductivity, DO, BOD and Hardness readings from Farm A**

| | Sampling event 1 | Sampling event 2 | Sampling event 3 | Sampling event 4 | Average |
|---|---|---|---|---|---|
| **Sampling point 1** | | | | | |
| Conductivity (µS/cm) | 859 | 915 | 919 | 918 | 903 |
| DO (ppm) | 1.3 | 1.7 | 2.0 | 2.5 | 1.9 |
| BOD (mg/l) | 1.1 | 1.8 | <1.0 | <2.92 | 1.71 |
| Hardness (mg/l) | 409 | 453 | 438 | 440 | 435 |
| **Sampling point 2** | | | | | |
| Conductivity (µS/cm) | 846 | 882 | 897 | 902 | 882 |
| DO (ppm) | 1.1 | 1.6 | 2.0 | 2.0 | 1.7 |
| BOD (mg/l) | <1.0 | <1.0 | <1.0 | <2.92 | 1.48 |
| Hardness (mg/l) | 403 | 420 | 427 | 426 | 419 |
| **Sampling point 3** | Not sampled | Not sampled | Not sampled | Not sampled | N/A |
| **Sampling point 4** | Not sampled | Not sampled | Not sampled | Not sampled | N/A |
| **Sampling point 5** | Not sampled | Not sampled | Not sampled | Not sampled | N/A |

**Table III.3: Farm B**

| | Sampling point 1 | Sampling point 2 | Sampling point 3 | Sampling point 4 | Sampling point 5* |
|---|---|---|---|---|---|
| **Samples taken** | Biological/ Chemical | Chemical | Biological/ Chemical | Chemical | Chemical |
| **Location** | 20m d/s sharp bend, u/s reservoir | At footbridge | 15m u/s track bridge | 5m from hedge | Pipe outlet |
| **Width (m)** | 2.7 | 1.5 | 2.7 | 0.5 | N/A |
| **Average depth (cm)** | 15 | 20 | 17.33 | 10 | N/A |
| **Substrate (percent cover)** | 100 | 100 | 100 | 100 | N/A |
| **Clay** | 1 | 4 | 0 | 2 | N/A |
| **Silt** | 3 (more overlying) | 50 | 10 (more overlying) | 35 | N/A |
| **Sand** | 54 | 30 | 30 | 35 | N/A |
| **Gravel** | 40 | 15 | 40 | 27 | N/A |
| **Pebbles** | 2 | 1 | 15 | 1 | N/A |
| **Cobbles** | 0 | 0 | 5 | 0 | N/A |
| **Distance from source (km)** | 5.6 | 0.5 | 5 | 0.4 | N/A |
| **Altitude (m)** | 25 | 25 | 30 | 30 | 30 |
| **Slope (m/km)** | 7.0 | 10 | 10 | 10 | 10 |
| **Discharge category** | 1 | 1 | 1 | 1 | N/A |
| **Flow** | Moderate | Slow | Moderate | Slow | None |
| **Shading** | Light | Light | Moderate | Moderate | N/A |
| **Macrophyte cover (percent)** | 0 | 0 | 0 | 0 | N/A |
| **Algal cover (percent)** | 2 | N/A | 8 | N/A | N/A |
| **Algal species** | Benthic Diatoms | N/A | Benthic Diatoms, *Hildenbrandia, Cladophora* | N/A | N/A |

*No samples were collected from this site, no flow was recorded from the pipe throughout the duration of the sampling.

**Table III.4: Conductivity, DO, BOD and Hardness readings from Farm B**

| | Sampling event 1 | Sampling event 2 | Sampling event 3 | Sampling event 4 | Average |
|---|---|---|---|---|---|
| **Sampling point 1** | | | | | |
| Conductivity (µS/cm) | 478 | 478 | 485 | 436 | 469 |
| DO (ppm) | 9.5 | 10.7 | 10.4 | 9.8 | 10.1 |
| BOD (mg/l) | 1.1 | 1.2 | <1.0 | 9.58 | 3.22 |
| Hardness (mg/l) | 251 | 257 | 269 | 226 | 251 |
| **Sampling point 2** | | | | | |
| Conductivity (µS/cm) | 548 | 583 | 622 | 482 | 559 |
| DO (ppm) | 5.7 | 7.4 | 10.4 | 9.0 | 8.1 |
| BOD (mg/l) | <3.0 | 1.9 | 1.6 | 3.57 | 2.52 |
| Hardness (mg/l) | 276 | 298 | 332 | 235 | 285 |
| **Sampling point 3** | | | | | |
| Conductivity (µS/cm) | 470 | 481 | 484 | 441 | 469 |
| DO (ppm) | 9.2 | 10.9 | 11.4 | 10.1 | 10.4 |
| BOD (mg/l) | 1.2 | 1.5 | 1.10 | 8.33 | 3.03 |
| Hardness (mg/l) | 250 | 263 | 265 | 321 | 275 |
| **Sampling point 4** | | | | | |
| Conductivity (µS/cm) | 558 | 520 | 541 | 484 | 526 |
| DO (ppm) | 7.5 | 10.7 | 10.5 | 8.1 | 9.2 |
| BOD (mg/l) | 1.5 | 1.6 | 1.0 | 3.01 | 1.78 |
| Hardness (mg/l) | 280 | 267 | 286 | 229 | 266 |
| **Sampling point 5** | Not sampled | Not sampled | Not sampled | Not sampled | N/A |

**Table III.5: Farm C**

| | Sampling point 1 (U/S) | Sampling point 2 (D/S 1) | Sampling point 3 (D/S 2) | Sampling point 4 |
|---|---|---|---|---|
| **Samples taken** | Biological/ Chemical | Biological/ Chemical | Biological/ Chemical | Chemical |
| **Location** | Approx.50m u/s stream confluence | 35m d/s land drain | 100m d/s footpath ford | Drain at entrance to farm |
| **Width (m)** | 6.5 | 7.7 | 5.9 | N/A |
| **Average depth (cm)** | 110 | 76.67 | 82 | 5 |
| **Substrate (percent cover)** | 100 | 100 | 100 | N/A |
| **Clay** | 50 | 50 | 30 | N/A |
| **Silt** | 40 | 3 | 20 | N/A |
| **Sand** | 5 | 20 | 5 | N/A |
| **Gravel** | 5 | 20 | 43 | N/A |
| **Pebbles** | 0 | 2 | 2 | N/A |
| **Cobbles** | 0 | 5 | 0 | N/A |
| **Distance from source (km)** | 29.25 | 32.25 | 32.75 | N/A |
| **Altitude (m)** | 50 | 45 | 45 | 50 |
| **Slope (m/km)** | 1.43 | 1.11 | 1.11 | N/A |
| **Discharge category** | 4 | 4 | 4 | 1 |
| **Flow** | Fast | Fast | Fast | Moderate |
| **Shading** | Nil | Light | Nil | N/A |
| **Macrophyte cover (percent)** | 45 | 15 | 20 | N/A |
| **Macrophyte species** | *Phalaris arundinacea, Glyceria maxima, Sparganium erectum Schoenoplectus lacustris* | *Phalaris arundinacea, Schoenoplectus lacustris* | *Phalaris arundinacea, Myosotis scorpioides, Agrostis stolonifera, Sparganium erectum, Schoenoplectus lacustris, Apium* | N/A |

| | | | | |
|---|---|---|---|---|
| | | | *nodiflorum* | |
| **Bryophtye cover (percent)** | 0 | 2 | 0 | N/A |
| **Bryophyte species** | | Amblystegium riparium, Fontinalis antipyretica, Rhyncostegium riparoides | | N/A |
| **Algal cover (percent)** | 2 | 2 | 2 | N/A |
| **Algal species** | Benthic Diatoms | Benthic Diatoms | Benthic diatoms | N/A |

*No samples or data were collected from these sites, the ditches remained dry throughout the duration of the sampling.

**Table III.6: Conductivity, DO, BOD and Hardness readings from Farm C**

| | Sampling event 1 | Sampling event 2 | Sampling event 3 | Sampling event 4 | Average |
|---|---|---|---|---|---|
| **Sampling point 1** | | | | | |
| Conductivity (µS/cm) | 637 | 644 | 649 | 654 | 469 |
| DO (ppm) | 9.6 | 10.1 | 10.4 | 10.6 | 10.2 |
| BOD (mg/l) | <1.85 | <1.39 | <1.39 | <1.39 | 1.505 |
| Hardness (mg/l) | 336 | 331 | 341 | 354 | 341 |
| **Sampling point 2** | | | | | |
| Conductivity (µS/cm) | 638 | 649 | 650 | 655 | 648 |
| DO (ppm) | 9.6 | 10.1 | 11.0 | 10.5 | 10.3 |
| BOD (mg/l) | <1.85 | <1.39 | <1.39 | <1.39 | 1.505 |
| Hardness (mg/l) | 339 | 337 | 339 | 346 | 340 |
| **Sampling point 3** | | | | | |
| Conductivity (µS/cm) | 637 | 647 | 650 | 657 | 469 |
| DO (ppm) | 9.6 | 9.6 | 10.9 | 10.4 | 10.1 |
| BOD (mg/l) | <1.85 | <1.39 | <1.39 | <1.39 | 1.505 |
| Hardness (mg/l) | 339 | 337 | 342 | 345 | 341 |
| **Sampling point 4** | | | | | |
| Conductivity (µS/cm) | 701 | 306 | 880 | 764 | 526 |
| DO (ppm) | N/A | N/A | N/A | N/A | N/A |
| BOD (mg/l) | <2.77 | 14.0 | 4.11 | <1.39 | 5.57 |
| Hardness (mg/l) | 408 | 364 | 519 | 764 | 514 |
| **Sampling point 5** | Not sampled | Not sampled | Not sampled | Not sampled | N/A |

## Appendix IV: Biotic indices used to analyse aquatic macro-invertebrate data

**Community Conservation Index**

The invertebrate data were analysed using a community based classification scheme, developed by biologists in the NRA Anglian region. Within this system species are allocated a conservation score ranging from 1 to 10, according to their rarity. A score of 1 means that the species is very common and occurs in 50 to 100% of all samples collected from similar habitats. A score of 10 means that the species is endangered (i.e. Red Data Book category 1). Most of the individual species in a sample are allocated a score. These scores are then totalled and averaged, to provide a mean conservation score. This mean score is then multiplied by a community score, which is computed according to Table IV.1.

Table IV.1: BMWP ranges and corresponding community score

| BMWP | Community scores |
|---|---|
| 301 + | 15 |
| 251 - 300 | 12 |
| 201 - 250 | 10 |
| 151 - 200 | 7 |
| 101 - 150 | 5 |
| 51 - 100 | 3 |
| 1 - 50 | 1 |
| 0 | 0 |

The overall result is a community conservation index for the sample.

The higher the index, the greater the conservation interest. Generally sites scoring less than 10 have little or no current invertebrate conservation interest; sites scoring between 10 and 20 have features worth conserving but they are generally not high priority; sites scoring in excess of 20 have high conservation interest, either due to the presence of rare species, the occurrence of exceptionally rich communities, or both.

**BMWP and ASPT**

In addition to the classification scheme above, the BMWP and ASPT scores were calculated from the data. The BMWP scoring system assigns a value of one to ten to invertebrate families, according to their degree of sensitivity to the effects of organic pollution, with the more sensitive families scoring higher values. The BMWP scores for all the taxa in a sample are totalled to provide an overall BMWP score for the sample. The ASPT is calculated by dividing the BMWP score by the number of families used to calculate it.

This scoring system is designed for use with flowing water sites and is only applicable to samples of invertebrates collected by means of the Environment Agency’s standard methods. Biotic indices, such as the BMWP system, have been designed to detect the effects of organic pollution. The BMWP system may respond to the effects of toxic pollution and when used in conjunction with RIVPACS analysis (see below) will provide an indication of potential impacts from the farms. However, it was not designed for this purpose and the response of BMWP scores to toxic stresses has not been studied.

**EQI**
Reference sites with identical physical characteristics are often hard to locate along a watercourse and direct comparison cannot always be made. RIVPACS was used to express the BMWP indices as Environmental Quality Indices (EQIs). An EQI is a biotic index observed at a site, divided by the value expected if the environmental quality was good (i.e. the value predicted by RIVPACS). EQIs remove the effects of natural differences between the invertebrate communities at different sites and so place the biotic indices from all sites on a common scale. The closer to unity the observed and predicted indices are (i.e. the nearer to 1 the EQI value), the better the water quality of the site. Scores above 1 indicate that the biological quality of the site is higher than expected.

Since 1995 the Environment Agency has been using a biological classification scheme based on EQIs generated by RIVPACS III. A copy of this scheme is illustrated in Table IV.2 (Murray-Bligh, 1999).

Table IV.2: The Environment Agency biological classification scheme

| | | Lower Class Limits | |
|---|---|---|---|
| **Class** | **Description** | **EQI ASPT** | **EQI Number of BMWP families** |
| a | Very Good | 1.00 | 0.85 |
| b | Good | 0.90 | 0.70 |
| c | Fairly Good | 0.77 | 0.55 |
| d | Fair | 0.65 | 0.45 |
| e | Poor | 0.50 | 0.30 |
| f | Bad | 0.00 | 0.00 |

## Appendix V: Aquatic macro-invertebrate sampling data

**Table V.1: Farm A sampling point 1 and 2**

| | Sampling point 1 | | Sampling point 2 | |
|---|---|---|---|---|
| **TAXA** | **Nos.** | **RELATIVE ABUNDANCE** | **Nos.** | **RELATIVE ABUNDANCE** |
| **TRICLADIDA** | | | | |
| PLANARIIDAE | | | | |
| *Polycelis tenuis gp.* | 2 | 0.13 | | |
| DENDROCOELIDAE | | | | |
| *Dendrocoelium lacteum* | 1 | 0.06 | 1 | 0.11 |
| **OLIGOCHAETA** | 14 | 0.88 | 30 | 3.22 |
| **HIRUDINEA** | | | | |
| GLOSSIPHONIIDAE | | | | |
| *Glossiphonia complanata* | | | 1 | 0.11 |
| *Helobdella stagnalis* | | | 2 | 0.21 |
| **GASTROPODA** | | | | |
| BITHYNIIDAE | | | | |
| *Bithynia tentaculata* | | | 1 | 0.11 |
| HYDROBIIDAE | | | | |
| *Potamopyrgus antipodarum* | 1 | 0.06 | | |
| VALVATIDAE | | | | |
| *Valvata cristata* | 2 | 0.13 | 6 | 0.64 |
| LYMNAEIDAE | | | | |
| *Lymnaea peregra* | 510 | 31.91 | 301 | 32.30 |
| *Lymnaea palustris* | 1 | 0.06 | | |
| PHYSIDAE | | | | |
| *Physa fontinalis* | 17 | 1.06 | 5 | 0.54 |
| PLANORBIDAE | | | | |
| *Planorbis carinatus* | 29 | 1.81 | 14 | 1.50 |
| *Planorbis carinatus gp.* | | | 4 | 0.43 |
| *Gyraulus albus* | 13 | 0.81 | | |
| ZONITIDAE | | | | |
| *Zonitoides nitidus* | 2 | 0.13 | | |
| SUCCINEIDAE | | | | |
| *Succinea / Oxyloma sp.* | 3 | 0.19 | 2 | 0.21 |
| **CRUSTACEA** | | | | |
| CRANGONYCTIDAE | | | | |
| *Crangonyx pseudogracilis* | 517 | 32.35 | 94 | 10.09 |
| ASELLIDAE | | | | |
| *Asellus aquaticus* | 249 | 15.58 | 250 | 26.82 |
| OSTRACODA | | | | |
| Ostracoda sp. | 1 | 0.06 | | |
| **ANISOPTERA** | | | | |
| AESHNIDAE | | | | |
| *Aeshna sp.* | 2 | 0.13 | 1 | 0.11 |
| **ZYGOPTERA** | | | | |
| COENAGRIONIDAE | | | | |
| Coenagrionidae sp. | | | 1 | 0.11 |
| **EPHEMEROPTERA** | | | | |
| BAETIDAE | | | | |
| *Cloeon dipterum* | 5 | 0.31 | | |
| **TRICHOPTERA** | | | | |

| | | | | |
|---|---|---|---|---|
| LIMNEPHILIDAE | | | | |
| Limnephilidae sp. | | | 2 | 0.21 |
| **MEGALOPTERA** | | | | |
| SIALIDAE | | | | |
| *Sialis lutaria* | | | 1 | 0.11 |
| **HEMIPTERA** | | | | |
| HYDROMETRIDAE | | | | |
| *Hydrometra stagnorum* | 2 | 0.13 | | |
| VELIIDAE | | | | |
| *Velia caprai* | 4 | 0.25 | | |
| CORIXIDAE | | | | |
| *Sigara dorsalis* | 4 | 0.25 | | |
| *Hesperocorixa sahlbergi* | 2 | 0.13 | | |
| NOTONECTIDAE | | | | |
| *Notonecta maculata* | 1 | 0.06 | | |
| *Notonecta glauca* | 1 | 0.06 | 3 | 0.32 |
| **DIPTERA** | | | | |
| CHIRONOMIDAE | | | | |
| Chironomidae sp. | 133 | 8.32 | 190 | 20.39 |
| STRATIOMYIDAE | | | | |
| *Beris sp.* | | | 2 | 0.21 |
| SCIOMYZIDAE | | | | |
| *Tetanocera sp.* | | | | |
| TIPULIDAE | | | 4 | 0.43 |
| *Tipula sp.* | 1 | 0.06 | | |
| EMPIDIDAE | | | | |
| *Chelifera* type | 1 | 0.06 | | |
| DIXIDAE | | | | |
| *Dixella amphibia* | 1 | 0.06 | | |
| **COLEOPTERA** | | | | |
| DYTISCIDAE | | | | |
| *Agabus sturmii* | 3 | 0.19 | 1 | 0.11 |
| *Agabus sp.* (larvae) | 44 | 2.75 | 3 | 0.32 |
| *Ilybius fuliginosus* | 2 | 0.13 | 1 | 0.11 |
| *Agabus / Ilybius* larvae (immature) | 11 | 0.69 | | |
| *Hydroporus palustris* | 2 | 0.13 | | |
| *Stictotarsus duodecimpustulatus* | 3 | 0.19 | 2 | 0.21 |
| HYDROPHILIDAE | | | | |
| *Anacaena globulus* | 2 | 0.13 | 2 | 0.21 |
| *Laccobius sp.* (larva) | 1 | 0.06 | | |
| HYDRAENIDAE | | | | |
| *Hydraena rufipes gp.* (female) | | | 1 | 0.11 |
| HALIPLIDAE | | | | |
| *Haliplus lineatocollis* | 10 | 0.63 | 3 | 0.32 |
| *Halilpus sp.* (larva) | 1 | 0.06 | 4 | 0.43 |
| **Nos. Identified Taxa** | **34** | | **27** | |
| **Total Nos. of Invertebrates** | **1598** | | **932** | |

## Table V.2: Farm B sampling point 1 and sampling point 3

| | Sampling point 1 | | Sampling point 3 | |
|---|---|---|---|---|
| **TAXA** | **Nos.** | **RELATIVE ABUNDANCE** | **Nos.** | **RELATIVE ABUNDANCE** |
| **TRICLADIDA** | | | | |
| PLANARIIDAE | | | | |
| *Polycelis felina* | | | 2 | 0.07 |
| Planariidae sp. (indet.) | | | 2 | 0.07 |
| **OLIGOCHAETA** | 145 | 5.31 | 289 | 10.75 |
| **HIRUDINEA** | | | | |
| PISCICOLIDAE | | | | |
| *Piscicola geometra* | 1 | 0.04 | | |
| ERPOBDELLIDAE | | | | |
| *Trocheta sp.* | 3 | 0.11 | | |
| GLOSSIPHONIIDAE | | | | |
| *Glossiphonia complanata* | 1 | 0.04 | 6 | 0.22 |
| *Helobdella stagnalis* | 1 | 0.04 | 3 | 0.11 |
| **GASTROPODA** | | | | |
| HYDROBIIDAE | | | | |
| *Potamopyrgus antipodarum* | 3 | 0.11 | 14 | 0.52 |
| ANCYLIDAE | | | | |
| *Ancylus fluviatilis* | | | 22 | 0.82 |
| PHYSIDAE | | | | |
| *Physa fontinalis* | | | 11 | 0.41 |
| LYMNAEIDAE | | | | |
| *Lymnaea peregra* | 1 | 0.04 | | |
| ZONITIDAE | | | | |
| *Zonitoides nitidus* | 1 | 0.04 | | |
| **BIVALVIA** | | | | |
| SPHAERIIDAE | | | | |
| *Pisidium subtruncatum* | 80 | 2.93 | 66 | 2.45 |
| *Pisidium nitidum* | 13 | 0.48 | 27 | 1.00 |
| *Pisidium milium* | 3 | 0.11 | 12 | 0.45 |
| *Pisidium personatum* | 3 | 0.11 | | |
| *Pisidium sp.* | 9 | 0.33 | 30 | 1.12 |
| **CRUSTACEA** | | | | |
| GAMMARIDAE | | | | |
| *Gammarus pulex* | 1799 | 65.83 | 660 | 24.54 |
| ASELLIDAE | | | | |
| *Asellus aquaticus* | 22 | 0.80 | 1 | 0.04 |
| OSTRACODA | | | | |
| Ostracoda sp. | | | 4 | 0.15 |
| **HYDRACARINA** | | | | |
| Hydracarina sp. | | | 4 | 0.15 |
| **EPHEMEROPTERA** | | | | |
| EPHEMERIDAE | | | | |
| *Ephemera danica* | 34 | 1.24 | 41 | 1.52 |
| HEPTAGENIIDAE | | | | |
| *Ecdyonurus sp.* | 79 | 2.89 | 8 | 0.30 |
| LEPTOPHLEBIIDAE | | | | |
| *Paraleptophlebia sp.* | 3 | 0.11 | | |

| | | | | |
|---|---|---|---|---|
| Leptophlebiidae sp. (indet.) | 9 | 0.33 | | |
| BAETIDAE | | | | |
| *Baetis rhodani* | 292 | 10.68 | 114 | 4.24 |
| *Baetis sp.* | 18 | 0.66 | | |
| **TRICHOPTERA** | | | | |
| RHYACOPHILIDAE | | | | |
| *Rhyacophila dorsalis* | 1 | 0.04 | | |
| HYDROPSYCHIDAE | | | | |
| *Hydropsyche siltalai* | 1 | 0.04 | 1 | 0.04 |
| *Hydropsyche pellucidula* | 15 | 0.55 | 1 | 0.04 |
| *Hydropsyche sp.* | 2 | 0.07 | 1 | 0.04 |
| POLYCENTROPODIDAE | | | | |
| *Polycentropus flavomaculatus* | | | 3 | 0.11 |
| *Cyrnus trimaculatus* | | | 1 | 0.04 |
| Polycentropodidae sp. (indet.) | | | 1 | 0.04 |
| PSYCHOMYIIDAE | | | | |
| *Lype phaeopa* | | | 1 | 0.04 |
| SERICOSTOMATIDAE | | | | |
| *Sericostoma personatum* | 6 | 0.22 | 9 | 0.33 |
| GOERIDAE | | | | |
| *Silo pallipes* | 1 | 0.04 | 2 | 0.07 |
| *Goera pilosa* | 1 | 0.04 | | |
| Goeridae sp. (pupa) | | | 1 | 0.04 |
| LEPIDOSTOMATIDAE | | | | |
| *Lasiocephala basalis* | 1 | 0.04 | 8 | 0.30 |
| LEPTOCERIDAE | | | | |
| *Mystacides sp.* | | | 3 | 0.11 |
| LIMNEPHILIDAE | | | | |
| *Potamophylax sp.* | 2 | 0.07 | | |
| *Potamophylax cingulatus gp.* | | | 2 | 0.07 |
| Limnephilidae sp. (indet.) | 2 | 0.07 | 4 | 0.15 |
| **HEMIPTERA** | | | | |
| NEPIDAE | | | | |
| *Nepa cinerea* | 1 | 0.04 | | |
| **DIPTERA** | | | | |
| CHIRONOMIDAE | | | | |
| Chironomidae sp. | 31 | 1.13 | 777 | 28.90 |
| TIPULIDAE | | | | |
| *Elaeophila sp.* | 12 | 0.44 | 6 | 0.22 |
| *Dicranota sp.* | 32 | 1.17 | 24 | 0.89 |
| EMPIDIDAE | | | | |
| *Chelifera* type | | | 1 | 0.04 |
| *Hemerodromia* type | | | 1 | 0.04 |
| PSYCHODIDAE | | | | |
| *Pericoma sp.* | 2 | 0.07 | | |
| CERATOPOGONIDAE | | | | |
| *Palpomyia / Bezzia* type | 1 | 0.04 | | |
| SIMULIIDAE | | | | |
| *Simulium ornatum gp.* | 3 | 0.11 | | |
| *Simulium sp.* | 5 | 0.18 | | |
| **COLEOPTERA** | | | | |

| | | | | |
|---|---|---|---|---|
| DYTISCIDAE | | | | |
| *Platambus maculatus* | 1 | 0.04 | 17 | 0.63 |
| Dytiscidae sp. (indet. imm. larvae) | | | 4 | 0.15 |
| ELMIDAE | | | | |
| *Elmis aenea* | 31 | 1.13 | 96 | 3.57 |
| *Limnius volckmari* | 8 | 0.29 | 377 | 14.02 |
| *Oulimnius tuberculatus* | 2 | 0.07 | | |
| *Oulimnius sp.* (larvae) | 28 | 1.02 | 20 | 0.74 |
| GYRINIDAE | | | | |
| *Orectochilus villosus* | 3 | 0.11 | 8 | 0.30 |
| HYDRAENIDAE | | | | |
| *Hydraena riparia* | 1 | 0.04 | | |
| *Hydraena rufipes gp.* (females) | 2 | 0.07 | | |
| SCIRTIDAE | | | | |
| *Helodes sp.* (larvae) | 18 | 0.66 | 3 | 0.11 |
| STAPHYLINIDAE | | | | |
| *Stenus sp.* | | | 1 | 0.04 |
| **Nos. Identified Taxa** | **40** | | **39** | |
| **Total Nos. of Invertebrates** | **2733** | | **2689** | |

Table V.3: Farm C sampling point 1, 2 and 3

| | Sampling point 1 | | Sampling point 2 | | Sampling point 3 | |
|---|---|---|---|---|---|---|
| **TAXA** | **Nos.** | **RELATIVE ABUNDANCE** | **Nos.** | **RELATIVE ABUNDANCE** | **Nos.** | **RELATIVE ABUNDANCE** |
| **TRICLADIDA** | | | | | | |
| DUGESIIDAE | | | | | | |
| *Dugesia polychroa gp.* | 1 | 0.07 | | | | |
| DENDROCOELIDAE | | | | | | |
| *Dendrocoeleum lacteum* | 1 | 0.07 | | | | |
| **OLIGOCHAETA** | 27 | 1.82 | 68 | 4.28 | 342 | 16.12 |
| **HIRUDINEA** | | | | | | |
| PISCICOLIDAE | | | | | | |
| *Piscicola geometra* | 2 | 0.13 | | | | |
| ERPOBDELLIDAE | | | | | | |
| *Erpobdella octoculata* | 9 | 0.61 | 3 | 0.19 | 23 | 1.08 |
| *Erpobdella sp.* (indet.) | | | | | 3 | 0.14 |
| PISCICOLIDAE | | | | | | |
| *Piscicola geometra* | | | | | 1 | 0.05 |
| GLOSSIPHONIIDAE | | | | | | |
| *Glossiphonia complanata* | 1 | 0.07 | 10 | 0.63 | 24 | 1.13 |
| *Theromyzon tessulatum* | | | | | 3 | 0.14 |
| *Hemiclepsis marginata* | | | | | 1 | 0.05 |
| *Glossiphonia heteroclita* | | | 1 | 0.06 | | |
| *Helobdella stagnalis* | 2 | 0.13 | 1 | 0.06 | 7 | 0.33 |
| **GASTROPODA** | | | | | | |
| HYDROBIIDAE | | | | | | |
| *Potamopyrgus antipodarum* | 1 | 0.07 | 356 | 22.40 | 268 | 12.64 |
| BITHYNIIDAE | | | | | | |
| *Bithynia tentaculata* | 12 | 0.81 | 15 | 0.94 | 10 | 0.47 |
| ACROLOXIDAE | | | | | | |
| *Acroloxus lacustris* | 3 | 0.20 | 17 | 1.07 | 3 | 0.14 |
| ANCYLIDAE | | | | | | |
| *Ancylus fluviatilis* | 1 | 0.07 | 3 | 0.19 | 1 | 0.05 |
| VALVATIDAE | | | | | | |
| *Valvata piscinalis* | 17 | 1.14 | | | 11 | 0.52 |
| *Valvata cristata* | 12 | 0.81 | 26 | 1.64 | 10 | 0.47 |
| NERITIDAE | | | | | | |
| *Theodoxus fluviatilis* | 1 | 0.07 | 24 | 1.51 | 28 | 1.32 |
| PHYSIDAE | | | | | | |
| *Physa fontinalis* | 3 | 0.20 | 2 | 0.13 | 7 | 0.33 |
| LYMNAEIDAE | | | | | | |
| *Lymnaea peregra* | | | 2 | 0.13 | 2 | 0.09 |
| *Lymnaea auricularia* | | | | | 1 | 0.05 |
| *Lymnaea stagnalis* | | | | | 2 | 0.09 |
| *Lymnaea sp.* (indet.) | | | 1 | 0.06 | | |
| PLANORBIDAE | | | | | | |
| *Planorbis planorbis* | | | 2 | 0.13 | | |
| *Bathyomphalus contortus* | 23 | 1.55 | 60 | 3.78 | 12 | 0.57 |
| *Anisus vortex* | 18 | 1.21 | 15 | 0.94 | 11 | 0.52 |
| *Gyraulus albus* | 2 | 0.13 | 7 | 0.44 | 6 | 0.28 |
| SUCCINEIDAE | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| *Succinea / Oxyloma sp.* | | | | | 2 | 0.09 |
| **BIVALVIA** | | | | | | |
| UNIONIDAE | | | | | | |
| *Anodonta anatina* | | | | | 1 | 0.05 |
| SPHAERIIDAE | | | | | | |
| *Sphaerium corneum* | 26 | 1.75 | 63 | 3.96 | 110 | 5.19 |
| *Pisidium subtruncatum* | 61 | 4.10 | 124 | 7.80 | 146 | 6.88 |
| *Pisidium nitidum* | 7 | 0.47 | 41 | 2.58 | 61 | 2.88 |
| *Pisidium amnicum* | 22 | 1.48 | 59 | 3.71 | 19 | 0.90 |
| *Pisidium milium* | | | 6 | 0.38 | | |
| *Pisidium henslowanum* | 10 | 0.67 | 171 | 10.76 | 94 | 4.43 |
| *Pisidium sp.* | 39 | 2.62 | 24 | 1.51 | 47 | 2.22 |
| **CRUSTACEA** | | | | | | |
| GAMMARIDAE | | | | | | |
| *Gammarus pulex* | 634 | 42.66 | 131 | 8.24 | 303 | 14.29 |
| CRANGONYCTIDAE | | | | | | |
| *Crangonyx pseudogracilis* | 104 | 7.00 | 15 | 0.94 | 18 | 0.85 |
| ASELLIDAE | | | | | | |
| *Asellus aquaticus* | 207 | 13.93 | 53 | 3.34 | 88 | 4.15 |
| OSTRACODA | | | | | | |
| Ostracoda sp. | 2 | 0.13 | 2 | 0.13 | 1 | 0.05 |
| **ANISOPTERA** | | | | | | |
| AESHNIDAE | | | | | | |
| *Aeshna cyanea?* (immature) | 3 | 0.20 | | | | |
| *Aeshna sp.* | 1 | 0.07 | 1 | 0.06 | | |
| **ZYGOPTERA** | | | | | | |
| CALOPTERYGIDAE | | | | | | |
| *Calopteryx splendens* | 17 | 1.14 | 5 | 0.31 | 6 | 0.28 |
| *Calopteryx sp.* | 11 | 0.74 | 4 | 0.25 | 2 | 0.09 |
| COENAGRIONIDAE | | | | | | |
| *Pyrrhosoma nymphula* | | | 3 | 0.19 | | |
| Coenagrionidae sp. (indet.) | | | 3 | 0.19 | | |
| PLATYCNEMIDAE | | | | | | |
| *Platycnemis pennipes* | 3 | 0.20 | 9 | 0.57 | 1 | 0.05 |
| **PLECOPTERA** | | | | | | |
| TAENIOPTERYGIDAE | | | | | | |
| *Taeniopteryx nebulosa* | 1 | 0.07 | 5 | 0.31 | 4 | 0.19 |
| NEMOURIDAE | | | | | | |
| *Nemoura sp.* | 2 | 0.13 | | | | |
| *Nemoura cambrica* | | | 1 | 0.06 | | |
| **EPHEMEROPTERA** | | | | | | |
| EPHEMERIDAE | | | | | | |
| *Ephemera vulgata* | 26 | 1.75 | 35 | 2.20 | 11 | 0.52 |
| *Ephemera danica* | 4 | 0.27 | | | | |
| *Ephemera sp.* | 12 | 0.81 | 20 | 1.26 | 2 | 0.09 |
| CAENIDAE | | | | | | |
| *Caenis luctuosa gp.* | 4 | 0.27 | 6 | 0.38 | 14 | 0.66 |
| BAETIDAE | | | | | | |
| *Baetis rhodani* | 1 | 0.07 | | | | |
| *Baetis sp.* | 1 | 0.07 | 1 | 0.06 | 1 | 0.05 |
| **TRICHOPTERA** | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| POLYCENTROPODIDAE | | | | | | |
| *Polycentropus flavomaculatus* | 11 | 0.74 | 11 | 0.69 | 6 | 0.28 |
| *Polycentropus sp.* | 2 | 0.13 | | | 1 | 0.05 |
| Polycentropodidae sp. | 5 | 0.34 | 11 | 0.69 | 2 | 0.09 |
| HYDROPSYCHIDAE | | | | | | |
| *Hydropsyche pellucidula* | | | 21 | 1.32 | 50 | 2.36 |
| *Hydropsyche sp.* | | | | | 7 | 0.33 |
| PSYCHOMYIIDAE | | | | | | |
| *Lype phaeopa* | 1 | 0.07 | | | | |
| MOLANNIDAE | | | | | | |
| *Molanna angustata* | 2 | 0.13 | 5 | 0.31 | 5 | 0.24 |
| PHRYGANEIDAE | | | | | | |
| *Phryganea grandis* | 1 | 0.07 | 6 | 0.38 | 4 | 0.19 |
| BRACHYCENTRIDAE | | | | | | |
| *Brachycentrus subnubilus* | | | 16 | 1.01 | 128 | 6.03 |
| GOERIDAE | | | | | | |
| *Goera pilosa* | | | 1 | 0.06 | | |
| LEPTOCERIDAE | | | | | | |
| *Athripsodes cinereus* | | | 5 | 0.31 | 31 | 1.46 |
| *Athripsodes aterrimus* | | | 5 | 0.31 | | |
| *Athripsodes sp.* | | | | | 10 | 0.47 |
| *Mystacides sp.* | | | 2 | 0.13 | 3 | 0.14 |
| LEPIDOSTOMATIDAE | | | | | | |
| *Lepidostoma hirtum* | | | 2 | 0.13 | | |
| HYDROPTILIDAE | | | | | | |
| *Hydroptila sp.* | 1 | 0.07 | 1 | 0.06 | 1 | 0.05 |
| LIMNEPHILIDAE | | | | | | |
| *Limnephilus rhombicus* | 19 | 1.28 | 7 | 0.44 | 3 | 0.14 |
| *Limnephilus lunatus* | | | | | 1 | 0.05 |
| *Limnephilus affini/incisus ?* | | | | | 1 | 0.05 |
| *Limnephilidae sp.* | 19 | 1.28 | 1 | 0.06 | 3 | 0.14 |
| **MEGALOPTERA** | | | | | | |
| SIALIDAE | | | | | | |
| *Sialis lutaria* | 22 | 1.48 | 17 | 1.07 | 30 | 1.41 |
| **HEMIPTERA** | | | | | | |
| CORIXIDAE | | | | | | |
| *Sigara dorsalis* | 12 | 0.81 | 1 | 0.06 | | |
| *Sigara falleni* | 5 | 0.34 | | | | |
| NOTONECTIDAE | | | | | | |
| *Notonecta glauca* | 6 | 0.40 | 1 | 0.06 | | |
| *Notonecta maculata* | 1 | 0.07 | | | | |
| **DIPTERA** | | | | | | |
| CHIRONOMIDAE | | | | | | |
| Chironomidae sp. | 13 | 0.87 | 30 | 1.89 | 83 | 3.91 |
| PSYCHODIDAE | | | | | | |
| *Pericoma sp.* | | | 4 | 0.25 | 1 | 0.05 |
| SIMULIIDAE | | | | | | |
| *Simulium sp.* | | | 4 | 0.25 | 14 | 0.66 |
| CERATOPOGONIDAE | | | | | | |
| *Palpomyia / Bezzia* type | | | | | 1 | 0.05 |
| TIPULIDAE | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| *Tipula couckei* | 4 | 0.27 | | | | |
| *Tipula montium* | | | | | 3 | 0.14 |
| *Tipula montium gp.* | 4 | 0.27 | | | 1 | 0.05 |
| *Antocha vitripennis* | | | | | 1 | 0.05 |
| *Pilaria discicollis gp.* | 2 | 0.13 | 1 | 0.06 | 2 | 0.09 |
| **COLEOPTERA** | | | | | | |
| DYTISCIDAE | | | | | | |
| *Nebrioporus elegans* | 6 | 0.40 | 12 | 0.76 | 4 | 0.19 |
| *Hydroporus memnonius* | 1 | 0.07 | | | | |
| ELMIDAE | | | | | | |
| *Elmis aenea* | | | 15 | 0.94 | 2 | 0.09 |
| *Limnius volckmari* | 1 | 0.07 | 1 | 0.06 | 1 | 0.05 |
| *Oulimnius sp.* | 4 | 0.27 | | | | |
| *Oulimnius sp.* (larvae) | | | 11 | 0.69 | 5 | 0.24 |
| GYRINIDAE | | | | | | |
| *Gyrinus urinator* | 1 | 0.07 | | | | |
| *Orectochilus villosus* | | | | | 8 | 0.38 |
| HALIPLIDAE | | | | | | |
| *Haliplus fluviatilis* | 8 | 0.54 | 1 | 0.06 | | |
| *Haliplus sp.* (larva) | 1 | 0.07 | 2 | 0.13 | | |
| **Nos. Identified Taxa** | **56** | | **60** | | **60** | |
| **Total Nos. of Invertebrates** | **1486** | | **1589** | | **2121** | |

## Appendix VI:  Benthic diatom sampling data and explanation of the TDI

## The TDI Index taken from Kelly *et al.* (2001)

Diatoms ("Bacillariophyta") are a group of microscopic algae that are extremely widespread in freshwater, brackish and marine habitats world-wide. A characteristic of diatoms is their silica cell wall, or "frustule". Ornamentation on this frustule is the key feature for separating one species from another, whilst the nature of the frustule itself makes it robust and resistant to decay. These characteristics, along with knowledge of each species' unique environmental preferences, has led to diatoms being widely used for both contemporary environmental monitoring and the reconstruction of past environments. Many indices for using diatoms to assess water quality have been developed in Europe: in the UK practical interest in diatoms started with their use to monitor nutrients in order to enforce the European Union's Urban Wastewater Treatment Directive on water quality (Harding & Kelly, 1998). Their use is, however, not confined to this role and several Agency laboratories have used diatoms to provide an alternative perspective on particular water quality issues. A new project, funded by the Environment Agency and SNIFFER, is developing the method to make it applicable to the Water Framework Directive (see: http://craticula.ncl.ac.uk/dares/).

The main index used to indicate longitudinal changes is the revised version of the Trophic Diatom Index (TDI: Kelly, 1998; Kelly *et al*., 2001), based on the weighted average equation of Zelinka and Marvan (1961):

$$index = \frac{\sum_{j=1}^{n} a_j s_j v_j}{\sum_{j=1}^{n} a_j v_j}$$

where $a_j$ = abundance or proportion of valves of species j in sample, $s_j$ = pollution sensitivity (1 - 5) of species j and $v_j$ = indicator value (1-3). Values of sensitivity (s) are as follows:

- 1 = favoured by very low nutrient concentrations
- 2 = favoured by low nutrient concentrations
- 3 = favoured by intermediate concentrations of nutrients
- 4 = favoured by high concentrations of nutrients
- 5 = favoured by very high concentrations of nutrients

In addition, a few taxa have TDI sensitivity values of zero. These include a few taxa that are relatively rare in freshwaters and whose ecological preferences are not well defined, along with planktonic taxa, which are routinely excluded from calculations.

Values of the TDI range from 0, in very nutrient-poor environments, to 100 in very nutrient-rich environments. In addition, a second value, percent motile valves, is calculated from the same data and is used to aid data interpretation. This provides an indication of the extent to which changes in the TDI can be attributed to non-nutrient factors, such as a significant change in micro-habitat. Hard substrata in moderate or fast currents will be dominated by attached taxa whilst softer substrata and slower currents will favour more motile taxa.

Harding, J.P.C. & Kelly, M.G. (1999). Recent developments in the use of algae to monitor rivers in the U.K. pp. 26-34. In: Use of Algae for Monitoring Rivers III (edited by J. Prygiel, B.A. Whitton & J. Bukowska). Agence de l'Eau Artois-Picardie, Douai.

Kelly, M.G. (1998). Use of the trophic diatom index to monitor eutrophication in rivers. *Water Research* 32: 236-242.

Kelly, M.G., Adams, C., Graves, A.C., Jamieson, J., Krokowski, J., Lycett, E.B., Murray-Bligh, J., Pritchard, S. & Wilkins, C. (2001). *The Trophic Diatom Index: A User's Manual. Revised Edition*. R&D Technical Report E2/TR2, Bristol: Environment Agency.

Zelinka, M. & Marvan, P., 1961 *Zur Prazisierung der biologischen Klassifikation des Reinheit fliessender Gewasser.* Archiv für Hydrobiologie **57**, 389-407.

## Table VI.1: Summary table

| Site Code | Farm | TDI | motile | TDI-D-av | TI-av |
|---|---|---|---|---|---|
| 104484 | Farm C: sampling point 1 | 85 | 60.2 | 3.059785 | 3.097951 |
| 104485 | Farm C: sampling point 2 | 84 | 61.9 | 3.2257 | 3.169627 |
| 104486 | Farm C: sampling point 3 | 92 | 78.4 | 3.104464 | 3.333529 |
| 104487 | Farm B: sampling point 1 | 68 | 31.4 | 2.828438 | 2.834211 |
| 104488 | Farm B: sampling point 3 | 81 | 59.3 | 3.145345 | 3.0824 |
| 104489 | Farm A: sampling point 1 | 44 | 24.4 | 1.789029 | 2.344444 |
| 104490 | Farm A: sampling point 2 | 62 | 23.9 | 2.269512 | 2.774388 |

## Table VI.2: Sampling data

| Site code | Genus | Species | | Infraspecific taxon | TDI-s | TDI-v | motile | TDI-D (s) | TDI-D (v) | TI (s) | TI (v) | TDI-asv | TDI-av | motile | TDI-D-asv | TDI-D-av | TI-asv | TI-av |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 104484 | Achnanthidium | minutissimum | 4 | | 2 | 2 | 0 | 1.6 | 1 | 1.2 | 1 | 16 | 8 | 0 | 6.4 | 4 | 4.8 | 4 |
| 104484 | Amphora | inariensis | 2 | | 5 | 1 | 0 | 2.8 | 0.5 | 2.1 | 1 | 10 | 2 | 0 | 2.8 | 1 | 4.2 | 2 |
| 104484 | Amphora | ovalis | 1 | | 5 | 1 | 0 | 3.2 | 3 | 3.3 | 2 | 5 | 1 | 0 | 9.6 | 3 | 6.6 | 2 |
| 104484 | Amphora | pediculus | 20 | | 5 | 2 | 0 | 2.8 | 0.5 | 2.8 | 2 | 200 | 40 | 0 | 28 | 10 | 112 | 40 |
| 104484 | Cocconeis | pediculus | 1 | | 4 | 2 | 0 | 2.5 | 0.5 | 2.6 | 2 | 8 | 2 | 0 | 1.25 | 0.5 | 5.2 | 2 |
| 104484 | Cocconeis | placentula | 31 | var. euglypta | 3 | 2 | 0 | 2 | 0.5 | 2.3 | 2 | 186 | 62 | 0 | 31 | 15.5 | 142.6 | 62 |
| 104484 | Cocconeis | placentula | 1 | var. placentula | 3 | 2 | 0 | 2 | 0.5 | 2.6 | 2 | 6 | 2 | 0 | 1 | 0.5 | 5.2 | 2 |
| 104484 | Diadesmis | contenta | 2 | fo. biceps | 5 | 1 | 0 | 1.3 | 1 | 1.4 | 0 | 10 | 2 | 0 | 2.6 | 2 | 0 | 0 |
| 104484 | Diatoma | tenue | 1 | | 2 | 2 | 0 | 2.9 | 1 | 1.4 | 0 | 4 | 2 | 0 | 2.9 | 1 | 0 | 0 |
| 104484 | Gomphonema | gracile | 1 | | 3 | 1 | 0 | 1.5 | 1 | 0 | 0 | 3 | 1 | 0 | 1.5 | 1 | 0 | 0 |
| 104484 | Gomphonema | sp. | 1 | | 3 | 1 | 0 | 2 | 1 | 0 | 0 | 3 | 1 | 0 | 2 | 1 | 0 | 0 |
| 104484 | Gyrosigma | acuminatum | 5 | | 5 | 2 | 1 | 2.8 | 5 | 3.7 | 3 | 50 | 10 | 5 | 70 | 25 | 55.5 | 15 |
| 104484 | Hantzschia | amphioxys | 1 | | 5 | 1 | 1 | 4 | 1 | 3.6 | 3 | 5 | 1 | 1 | 4 | 1 | 10.8 | 3 |
| 104484 | Melosira | varians | 1 | | 4 | 2 | 0 | 3.2 | 1 | 2.9 | 4 | 8 | 2 | 0 | 3.2 | 1 | 11.6 | 4 |

| Site code | Genus | Species | | Infraspecific taxon | TDI-s | TDI-v | motile | TDI-D (s) | TDI-D (v) | TI (s) | TI (v) | TDI-asv | TDI-av | motile | TDI-D-asv | TDI-D-av | TI-asv | TI-av |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 104484 | Melosira | varians | 2 | | 4 | 2 | 0 | 3.2 | 1 | 2.9 | 4 | 16 | 4 | 0 | 6.4 | 2 | 23.2 | 8 |
| 104484 | Navicula | cryptocephala | 1 | | 4 | 1 | 1 | 3 | 1 | 3.5 | 4 | 4 | 1 | 1 | 3 | 1 | 14 | 4 |
| 104484 | Navicula | cryptotenella | 10 | | 5 | 2 | 1 | 2.8 | 1 | 2.3 | 1 | 100 | 20 | 10 | 28 | 10 | 23 | 10 |
| 104484 | Navicula | gregaria | 8 | | 5 | 1 | 1 | 3.3 | 1 | 3.5 | 4 | 40 | 8 | 8 | 26.4 | 8 | 112 | 32 |
| 104484 | Navicula | lanceolata | 40 | | 5 | 2 | 1 | 2.8 | 0.5 | 3.5 | 4 | 400 | 80 | 40 | 56 | 20 | 560 | 160 |
| 104484 | Navicula | menisculus | 9 | | 5 | 2 | 1 | 3.1 | 5 | 2.7 | 2 | 90 | 18 | 9 | 139.5 | 45 | 48.6 | 18 |
| 104484 | Navicula | minima | 1 | | 5 | 1 | 1 | 3.6 | 1 | 2.9 | 2 | 5 | 1 | 1 | 3.6 | 1 | 5.8 | 2 |
| 104484 | Navicula | reichardtiana | 4 | | 5 | 2 | 1 | 2.8 | 1 | 2.3 | 1 | 40 | 8 | 4 | 11.2 | 4 | 9.2 | 4 |
| 104484 | Navicula | small species | 1 | | 5 | 1 | 1 | 3.6 | 1 | 0 | 0 | 5 | 1 | 1 | 3.6 | 1 | 0 | 0 |
| 104484 | Navicula | tenelloides | 2 | | 5 | 1 | 1 | 2.6 | 1 | 2.9 | 2 | 10 | 2 | 2 | 5.2 | 2 | 11.6 | 4 |
| 104484 | Navicula | tripunctata | 6 | | 4 | 2 | 1 | 3 | 2 | 3.1 | 3 | 48 | 12 | 6 | 36 | 12 | 55.8 | 18 |
| 104484 | Nitzschia | dissipata | 5 | | 5 | 2 | 1 | 2.8 | 1 | 2.4 | 2 | 50 | 10 | 5 | 14 | 5 | 24 | 10 |
| 104484 | Nitzschia | fonticola | 1 | | 3 | 2 | 1 | 3 | 3 | 1.9 | 0 | 6 | 2 | 1 | 9 | 3 | 0 | 0 |
| 104484 | Nitzschia | frustulum | 1 | | 4 | 1 | 1 | 4 | 10 | 3.3 | 4 | 4 | 1 | 1 | 40 | 10 | 13.2 | 4 |
| 104484 | Nitzschia | inconspicua | 1 | | 5 | 1 | 1 | 2.8 | 1 | 3.1 | 1 | 5 | 1 | 1 | 2.8 | 1 | 3.1 | 1 |
| 104484 | Nitzschia | palea | 5 | | 5 | 1 | 1 | 4 | 1 | 3.3 | 3 | 25 | 5 | 5 | 20 | 5 | 49.5 | 15 |
| 104484 | Nitzschia | sociabilis | 5 | | 4 | 1 | 1 | 3 | 3 | 2.8 | 1 | 20 | 5 | 5 | 45 | 15 | 14 | 5 |
| 104484 | Nitzschia | sp. | 6 | | 4 | 1 | 1 | 3.2 | 1 | 0 | 0 | 24 | 6 | 6 | 19.2 | 6 | 0 | 0 |
| 104484 | Planothidium | lanceolatum | 5 | | 5 | 2 | 0 | 3.4 | 1 | 3.3 | 3 | 50 | 10 | 0 | 17 | 5 | 49.5 | 15 |
| 104484 | Psammothidium | lauenburgianum | 1 | | 4 | 2 | 0 | 3 | 3 | 1.8 | 3 | 8 | 2 | 0 | 9 | 3 | 5.4 | 3 |
| 104484 | Rhoicosphenia | abbreviata | 4 | | 5 | 1 | 0 | 3.5 | 5 | 2.9 | 2 | 20 | 4 | 0 | 70 | 20 | 23.2 | 8 |
| 104484 | Sellaphora | pupula | 1 | | 4 | 1 | 1 | 2.6 | 1 | 3.7 | 5 | 4 | 1 | 1 | 2.6 | 1 | 18.5 | 5 |
| 104484 | Stauroneis | anceps | 1 | | 5 | 2 | 1 | 1.6 | 1 | 1.8 | 0 | 10 | 2 | 1 | 1.6 | 1 | 0 | 0 |
| 104484 | Surirella | angusta | 1 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 104484 | Surirella | brebissoni | 3 | | 3 | 1 | 1 | 2.8 | 1 | 3.6 | 5 | 9 | 3 | 3 | 8.4 | 3 | 54 | 15 |
| 104484 | Surirella | terricola | 1 | | 3 | 1 | 1 | 2.8 | 1 | 0 | 0 | 3 | 1 | 1 | 2.8 | 1 | 0 | 0 |
| 104484 | Synedra | parasitica | 1 | | 4 | 1 | 0 | 3.2 | 3 | 2.3 | 2 | 4 | 1 | 0 | 9.6 | 3 | 4.6 | 2 |
| 104484 | Tryblionella | apiculata | 1 | | 4 | 1 | 1 | 4 | 8 | 3.9 | 5 | 4 | 1 | 1 | 32 | 8 | 19.5 | 5 |
| 104484 | Tryblionella | debilis | 2 | | 4 | 1 | 1 | 4 | 8 | 2.9 | 2 | 8 | 2 | 2 | 64 | 16 | 11.6 | 4 |
| | | | 201 | 0 | 177 | 61 | 25 | 122.1 | 85 | 102.5 | 87 | 1526 | 348 | 121 | 852.15 | 278.5 | 1511.8 | 488 |
| 104484 | | | | | | | | | | | | | 84.626 | 60.2 | | 3.05978 | | 3.098 |
| 104485 | Achnanthes | conspicua | 1 | | 5 | 2 | 0 | 2.7 | 3 | 1.7 | 0 | 10 | 2 | 0 | 8.1 | 3 | 0 | 0 |

| Site code | Genus | Species | | Infraspecific taxon | TDI-s | TDI-v | motile | TDI-D (s) | TDI-D (v) | TI (s) | TI (v) | TDI-asv | TDI-av | motile | TDI-D-asv | TDI-D-av | TI-asv | TI-av |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 104485 | Achnanthidium | minutissimum | 4 | | 2 | 2 | 0 | 1.6 | 1 | 1.2 | 1 | 16 | 8 | 0 | 6.4 | 4 | 4.8 | 4 |
| 104485 | Amphora | inariensis | 1 | | 5 | 1 | 0 | 2.8 | 0.5 | 2.1 | 1 | 5 | 1 | 0 | 1.4 | 0.5 | 2.1 | 1 |
| 104485 | Amphora | pediculus | 16 | | 5 | 2 | 0 | 2.8 | 0.5 | 2.8 | 2 | 160 | 32 | 0 | 22.4 | 8 | 89.6 | 32 |
| 104485 | Caloneis | sp. | 1 | | 3 | 1 | 1 | 2 | 1 | 0 | 0 | 3 | 1 | 1 | 2 | 1 | 0 | 0 |
| 104485 | Cocconeis | placentula | 31 | var. euglypta | 3 | 2 | 0 | 2 | 0.5 | 2.3 | 2 | 186 | 62 | 0 | 31 | 15.5 | 142.6 | 62 |
| 104485 | Cocconeis | placentula | 3 | var. lineata | 3 | 2 | 0 | 2 | 0.5 | 0 | 0 | 18 | 6 | 0 | 3 | 1.5 | 0 | 0 |
| 104485 | Diadesmis | contenta | 1 | fo. biceps | 5 | 1 | 0 | 1.3 | 1 | 1.4 | 0 | 5 | 1 | 0 | 1.3 | 1 | 0 | 0 |
| 104485 | Encyonema | silesiacum | 3 | | 3 | 2 | 0 | 1.8 | 2 | 2 | 0 | 18 | 6 | 0 | 10.8 | 6 | 0 | 0 |
| 104485 | Fragilaria | vaucheriae | 1 | | 3 | 2 | 0 | 3.2 | 1 | 1.8 | 1 | 6 | 2 | 0 | 3.2 | 1 | 1.8 | 1 |
| 104485 | Frustulia | vulgaris | 1 | | 1 | 2 | 1 | 1.8 | 1 | 2 | 2 | 2 | 2 | 1 | 1.8 | 1 | 4 | 2 |
| 104485 | Gomphonema | parvulum | 2 | | 5 | 3 | 0 | 4 | 1 | 3.6 | 2 | 30 | 6 | 0 | 8 | 2 | 14.4 | 4 |
| 104485 | Gomphonema | pumilum | 1 | | 3 | 1 | 0 | 1.8 | 1 | 1.1 | 1 | 3 | 1 | 0 | 1.8 | 1 | 1.1 | 1 |
| 104485 | Gyrosigma | acuminatum | 1 | | 5 | 2 | 1 | 2.8 | 5 | 3.7 | 3 | 10 | 2 | 1 | 14 | 5 | 11.1 | 3 |
| 104485 | Hantzschia | amphioxys | 3 | | 5 | 1 | 1 | 4 | 1 | 3.6 | 3 | 15 | 3 | 3 | 12 | 3 | 32.4 | 9 |
| 104485 | Luticola | goeppertiana | 1 | | 5 | 2 | 1 | 3.2 | 3 | 3.6 | 5 | 10 | 2 | 1 | 9.6 | 3 | 18 | 5 |
| 104485 | Luticola | mutica | 1 | | 5 | 2 | 1 | 2.6 | 1 | 2.9 | 1 | 10 | 2 | 1 | 2.6 | 1 | 2.9 | 1 |
| 104485 | Melosira | varians | 2 | | 4 | 2 | 0 | 3.2 | 1 | 2.9 | 4 | 16 | 4 | 0 | 6.4 | 2 | 23.2 | 8 |
| 104485 | Navicula | capitata | 1 | var. capitata | 4 | 1 | 1 | 3.2 | 5 | 3.4 | 3 | 4 | 1 | 1 | 16 | 5 | 10.2 | 3 |
| 104485 | Navicula | capitatoradiata | 2 | | 3 | 2 | 1 | 2.6 | 1 | 3.3 | 4 | 12 | 4 | 2 | 5.2 | 2 | 26.4 | 8 |
| 104485 | Navicula | cari | 5 | | 4 | 1 | 1 | 3.2 | 1 | 2.6 | 1 | 20 | 5 | 5 | 16 | 5 | 13 | 5 |
| 104485 | Navicula | cryptocephala | 1 | | 4 | 1 | 1 | 3 | 1 | 3.5 | 4 | 4 | 1 | 1 | 3 | 1 | 14 | 4 |
| 104485 | Navicula | cryptotenella | 10 | | 5 | 2 | 1 | 2.8 | 1 | 2.3 | 1 | 100 | 20 | 10 | 28 | 10 | 23 | 10 |
| 104485 | Navicula | gregaria | 11 | | 5 | 1 | 1 | 3.3 | 1 | 3.5 | 4 | 55 | 11 | 11 | 36.3 | 11 | 154 | 44 |
| 104485 | Navicula | lanceolata | 52 | | 5 | 2 | 1 | 2.8 | 0.5 | 3.5 | 4 | 520 | 104 | 52 | 72.8 | 26 | 728 | 208 |
| 104485 | Navicula | menisculus | 3 | | 5 | 2 | 1 | 3.1 | 5 | 2.7 | 2 | 30 | 6 | 3 | 46.5 | 15 | 16.2 | 6 |
| 104485 | Navicula | reichardtiana | 2 | | 5 | 2 | 1 | 2.8 | 1 | 2.3 | 1 | 20 | 4 | 2 | 5.6 | 2 | 4.6 | 2 |
| 104485 | Navicula | tripunctata | 9 | | 4 | 2 | 1 | 3 | 2 | 3.1 | 3 | 72 | 18 | 9 | 54 | 18 | 83.7 | 27 |
| 104485 | Nitzschia | amphibia | 5 | | 5 | 3 | 1 | 4 | 10 | 3.8 | 5 | 75 | 15 | 5 | 200 | 50 | 95 | 25 |
| 104485 | Nitzschia | dissipata | 6 | | 5 | 2 | 1 | 2.8 | 1 | 2.4 | 2 | 60 | 12 | 6 | 16.8 | 6 | 28.8 | 12 |
| 104485 | Nitzschia | palea | 2 | | 5 | 1 | 1 | 4 | 1 | 3.3 | 3 | 10 | 2 | 2 | 8 | 2 | 19.8 | 6 |

| Site code | Genus | Species | | Infraspecific taxon | TDI-s | TDI-v | motile | TDI-D (s) | TDI-D (v) | TI (s) | TI (v) | TDI-asv | TDI-av | motile | TDI-D-asv | TDI-D-av | TI-asv | TI-av |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 104485 | Nitzschia | recta | 1 | | 4 | 1 | 1 | 2.8 | 1 | 3 | 3 | 4 | 1 | 1 | 2.8 | 1 | 9 | 3 |
| 104485 | Nitzschia | sociabilis | 2 | | 4 | 1 | 1 | 3 | 3 | 2.8 | 1 | 8 | 2 | 2 | 18 | 6 | 5.6 | 2 |
| 104485 | Nitzschia | sp. | 1 | | 4 | 1 | 1 | 3.2 | 1 | 0 | 0 | 4 | 1 | 1 | 3.2 | 1 | 0 | 0 |
| 104485 | Planothidium | frequentissimum | 4 | | 5 | 2 | 0 | 3.4 | 1 | 2.8 | 3 | 40 | 8 | 0 | 13.6 | 4 | 33.6 | 12 |
| 104485 | Planothidium | lanceolatum | 1 | | 5 | 2 | 0 | 3.4 | 1 | 3.3 | 3 | 10 | 2 | 0 | 3.4 | 1 | 9.9 | 3 |
| 104485 | Reimeria | sinuata | 1 | | 4 | 3 | 0 | 2 | 1 | 2.1 | 1 | 12 | 3 | 0 | 2 | 1 | 2.1 | 1 |
| 104485 | Rhoicosphenia | abbreviata | 8 | | 5 | 1 | 0 | 3.5 | 5 | 2.9 | 2 | 40 | 8 | 0 | 140 | 40 | 46.4 | 16 |
| 104485 | Surirella | brebissoni | 5 | | 3 | 1 | 1 | 2.8 | 1 | 3.6 | 5 | 15 | 5 | 5 | 14 | 5 | 90 | 25 |
| 104485 | Tryblionella | debilis | 4 | | 4 | 1 | 1 | 4 | 8 | 2.9 | 2 | 16 | 4 | 4 | 128 | 32 | 23.2 | 8 |
| | | | 210 | 0 | 167 | 67 | 24 | 114.3 | 77.5 | 101.8 | 85 | 1654 | 380 | 130 | 979 | 303.5 | 1784.5 | 563 |
| 104485 | | | | | | | | | | | | | 83.816 | 61.9 | | 3.2257 | | 3.17 |
| 104486 | Achnanthidium | minutissimum | 3 | | 2 | 2 | 0 | 1.6 | 1 | 1.2 | 1 | 12 | 6 | 0 | 4.8 | 3 | 3.6 | 3 |
| 104486 | Amphora | pediculus | 6 | | 5 | 2 | 0 | 2.8 | 0.5 | 2.8 | 2 | 60 | 12 | 0 | 8.4 | 3 | 33.6 | 12 |
| 104486 | Cocconeis | placentula | 15 | var. euglypta | 3 | 2 | 0 | 2 | 0.5 | 2.3 | 2 | 90 | 30 | 0 | 15 | 7.5 | 69 | 30 |
| 104486 | Diatoma | vulgare | 1 | | 5 | 3 | 0 | 2.6 | 5 | 2 | 0 | 15 | 3 | 0 | 13 | 5 | 0 | 0 |
| 104486 | Encyonema | silesiacum | 1 | | 3 | 2 | 0 | 1.8 | 2 | 2 | 0 | 6 | 2 | 0 | 3.6 | 2 | 0 | 0 |
| 104486 | Gomphonema | minutum | 1 | | 4 | 2 | 0 | 2.8 | 1 | 2.2 | 1 | 8 | 2 | 0 | 2.8 | 1 | 2.2 | 1 |
| 104486 | Gomphonema | parvulum | 1 | | 5 | 3 | 0 | 4 | 1 | 3.6 | 2 | 15 | 3 | 0 | 4 | 1 | 7.2 | 2 |
| 104486 | Gomphonema | pumilum | 1 | | 3 | 1 | 0 | 1.8 | 1 | 1.1 | 1 | 3 | 1 | 0 | 1.8 | 1 | 1.1 | 1 |
| 104486 | Melosira | varians | 6 | | 4 | 2 | 0 | 3.2 | 1 | 2.9 | 4 | 48 | 12 | 0 | 19.2 | 6 | 69.6 | 24 |
| 104486 | Navicula | cryptotenella | 6 | | 5 | 2 | 1 | 2.8 | 1 | 2.3 | 1 | 60 | 12 | 6 | 16.8 | 6 | 13.8 | 6 |
| 104486 | Navicula | gregaria | 17 | | 5 | 1 | 1 | 3.3 | 1 | 3.5 | 4 | 85 | 17 | 17 | 56.1 | 17 | 238 | 68 |
| 104486 | Navicula | lanceolata | 111 | | 5 | 2 | 1 | 2.8 | 0.5 | 3.5 | 4 | 1110 | 222 | 111 | 155.4 | 55.5 | 1554 | 444 |
| 104486 | Navicula | menisculus | 2 | | 5 | 2 | 1 | 3.1 | 5 | 2.7 | 2 | 20 | 4 | 2 | 31 | 10 | 10.8 | 4 |
| 104486 | Navicula | minima | 1 | | 5 | 1 | 1 | 3.6 | 1 | 2.9 | 2 | 5 | 1 | 1 | 3.6 | 1 | 5.8 | 2 |
| 104486 | Navicula | reichardtiana | 1 | | 5 | 2 | 1 | 2.8 | 1 | 2.3 | 1 | 10 | 2 | 1 | 2.8 | 1 | 2.3 | 1 |
| 104486 | Navicula | reichardtiana | 1 | | 5 | 2 | 1 | 2.8 | 1 | 2.3 | 1 | 10 | 2 | 1 | 2.8 | 1 | 2.3 | 1 |
| 104486 | Navicula | small species | 2 | | 5 | 1 | 1 | 3.6 | 1 | 0 | 0 | 10 | 2 | 2 | 7.2 | 2 | 0 | 0 |
| 104486 | Navicula | tripunctata | 5 | | 4 | 2 | 1 | 3 | 2 | 3.1 | 3 | 40 | 10 | 5 | 30 | 10 | 46.5 | 15 |
| 104486 | Nitzschia | amphibia | 1 | | 5 | 3 | 1 | 4 | 10 | 3.8 | 5 | 15 | 3 | 1 | 40 | 10 | 19 | 5 |
| 104486 | Nitzschia | capitellata | 1 | | 4 | 1 | 1 | 3.8 | 5 | 3.8 | 5 | 4 | 1 | 1 | 19 | 5 | 19 | 5 |

| Site code | Genus | Species | | Infraspecific taxon | TDI-s | TDI-v | motile | TDI-D (s) | TDI-D (v) | TI (s) | TI (v) | TDI-asv | TDI-av | motile | TDI-D-asv | TDI-D-av | TI-asv | TI-av |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 104486 | Nitzschia | dissipata | 6 | | 5 | 2 | 1 | 2.8 | 1 | 2.4 | 2 | 60 | 12 | 6 | 16.8 | 6 | 28.8 | 12 |
| 104486 | Nitzschia | fonticola | 1 | | 3 | 2 | 1 | 3 | 3 | 1.9 | 0 | 6 | 2 | 1 | 9 | 3 | 0 | 0 |
| 104486 | Nitzschia | palea | 1 | | 5 | 1 | 1 | 4 | 1 | 3.3 | 3 | 5 | 1 | 1 | 4 | 1 | 9.9 | 3 |
| 104486 | Nitzschia | sociabilis | 3 | | 4 | 1 | 1 | 3 | 3 | 2.8 | 1 | 12 | 3 | 3 | 27 | 9 | 8.4 | 3 |
| 104486 | Planothidium | lanceolatum | 1 | | 5 | 2 | 0 | 3.4 | 1 | 3.3 | 3 | 10 | 2 | 0 | 3.4 | 1 | 9.9 | 3 |
| 104486 | Rhoicosphenia | abbreviata | 9 | | 5 | 1 | 0 | 3.5 | 5 | 2.9 | 2 | 45 | 9 | 0 | 157.5 | 45 | 52.2 | 18 |
| 104486 | Surirella | brebissoni | 3 | | 3 | 1 | 1 | 2.8 | 1 | 3.6 | 5 | 9 | 3 | 3 | 8.4 | 3 | 54 | 15 |
| 104486 | Tryblionella | debilis | 1 | | 4 | 1 | 1 | 4 | 8 | 2.9 | 2 | 4 | 1 | 1 | 32 | 8 | 5.8 | 2 |
| | | | 208 | 0 | 121 | 49 | 17 | 84.7 | 64.5 | 73.4 | 59 | 1777 | 380 | 163 | 695.4 | 224 | 2266.8 | 680 |
| 104486 | | | | | | | | | | | | | 91.908 | 78.37 | | 3.10446 | | 3.334 |
| 104487 | Achnanthidium | minutissimum | 30 | | 2 | 2 | 0 | 1.6 | 1 | 1.2 | 1 | 120 | 60 | 0 | 48 | 30 | 36 | 30 |
| 104487 | Amphora | montana | 1 | | 5 | 1 | 0 | 3.2 | 3 | 0 | 0 | 5 | 1 | 0 | 9.6 | 3 | 0 | 0 |
| 104487 | Amphora | pediculus | 38 | | 5 | 2 | 0 | 2.8 | 0.5 | 2.8 | 2 | 380 | 76 | 0 | 53.2 | 19 | 212.8 | 76 |
| 104487 | Cocconeis | placentula | 49 | var. euglypta | 3 | 2 | 0 | 2 | 0.5 | 2.3 | 2 | 294 | 98 | 0 | 49 | 24.5 | 225.4 | 98 |
| 104487 | Cocconeis | placentula | 2 | var. pseudolineata | | 2 | 0 | 2 | 0.5 | 0 | 0 | 0 | 4 | 0 | 2 | 1 | 0 | 0 |
| 104487 | Craticula | accomoda | 1 | | 5 | 1 | 1 | 4 | 10 | 3.9 | 5 | 5 | 1 | 1 | 40 | 10 | 19.5 | 5 |
| 104487 | Frustulia | vulgaris | 1 | | 1 | 2 | 1 | 1.8 | 1 | 2 | 2 | 2 | 2 | 1 | 1.8 | 1 | 4 | 2 |
| 104487 | Gomphonema | angustatum | 3 | | 1 | 2 | 0 | 2 | 1 | 0 | 0 | 6 | 6 | 0 | 6 | 3 | 0 | 0 |
| 104487 | Gomphonema | parvulum | 1 | | 5 | 3 | 0 | 4 | 1 | 3.6 | 2 | 15 | 3 | 0 | 4 | 1 | 7.2 | 2 |
| 104487 | Gomphonema | pumilum | 3 | | 3 | 1 | 0 | 1.8 | 1 | 1.1 | 1 | 9 | 3 | 0 | 5.4 | 3 | 3.3 | 3 |
| 104487 | Gyrosigma | acuminatum | 1 | | 5 | 2 | 1 | 2.8 | 5 | 3.7 | 3 | 10 | 2 | 1 | 14 | 5 | 11.1 | 3 |
| 104487 | Melosira | varians | 1 | | 4 | 2 | 0 | 3.2 | 1 | 2.9 | 4 | 8 | 2 | 0 | 3.2 | 1 | 11.6 | 4 |
| 104487 | Navicula | capitata | 1 | var. capitata | 4 | 1 | 1 | 3.2 | 5 | 3.4 | 3 | 4 | 1 | 1 | 16 | 5 | 10.2 | 3 |
| 104487 | Navicula | cari | 1 | | 4 | 1 | 1 | 3.2 | 1 | 2.6 | 1 | 4 | 1 | 1 | 3.2 | 1 | 2.6 | 1 |
| 104487 | Navicula | cryptocephala | 1 | | 4 | 1 | 1 | 3 | 1 | 3.5 | 4 | 4 | 1 | 1 | 3 | 1 | 14 | 4 |
| 104487 | Navicula | cryptotenella | 1 | | 5 | 2 | 1 | 2.8 | 1 | 2.3 | 1 | 10 | 2 | 1 | 2.8 | 1 | 2.3 | 1 |
| 104487 | Navicula | gregaria | 28 | | 5 | 1 | 1 | 3.3 | 1 | 3.5 | 4 | 140 | 28 | 28 | 92.4 | 28 | 392 | 112 |
| 104487 | Navicula | lanceolata | 2 | | 5 | 2 | 1 | 2.8 | 0.5 | 3.5 | 4 | 20 | 4 | 2 | 2.8 | 1 | 28 | 8 |

| Site code | Genus | Species | | Infraspecific taxon | TDI-s | TDI-v | motile | TDI-D (s) | TDI-D (v) | TI (s) | TI (v) | TDI-asv | TDI-av | motile | TDI-D-asv | TDI-D-av | TI-asv | TI-av |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 104487 | Navicula | menisculus | 1 | | 5 | 2 | 1 | 3.1 | 5 | 2.7 | 2 | 10 | 2 | 1 | 15.5 | 5 | 5.4 | 2 |
| 104487 | Navicula | minima | 1 | | 5 | 1 | 1 | 3.6 | 1 | 2.9 | 2 | 5 | 1 | 1 | 3.6 | 1 | 5.8 | 2 |
| 104487 | Navicula | reichardtiana | 7 | | 5 | 2 | 1 | 2.8 | 1 | 2.3 | 1 | 70 | 14 | 7 | 19.6 | 7 | 16.1 | 7 |
| 104487 | Navicula | small species | 1 | | 5 | 1 | 1 | 3.6 | 1 | 0 | 0 | 5 | 1 | 1 | 3.6 | 1 | 0 | 0 |
| 104487 | Navicula | subminuscula | 2 | | 5 | 1 | 1 | 3.6 | 1 | 3.5 | 4 | 10 | 2 | 2 | 7.2 | 2 | 28 | 8 |
| 104487 | Navicula | tenelloides | 1 | | 5 | 1 | 1 | 2.6 | 1 | 2.9 | 2 | 5 | 1 | 1 | 2.6 | 1 | 5.8 | 2 |
| 104487 | Navicula | tripunctata | 5 | | 4 | 2 | 1 | 3 | 2 | 3.1 | 3 | 40 | 10 | 5 | 30 | 10 | 46.5 | 15 |
| 104487 | Navicula | veneta | 1 | | 4 | 1 | 1 | 3.8 | 5 | 3.5 | 5 | 4 | 1 | 1 | 19 | 5 | 17.5 | 5 |
| 104487 | Nitzschia | dissipata | 1 | | 5 | 2 | 1 | 2.8 | 1 | 2.4 | 2 | 10 | 2 | 1 | 2.8 | 1 | 4.8 | 2 |
| 104487 | Nitzschia | frustulum | 1 | | 4 | 1 | 1 | 4 | 10 | 3.3 | 4 | 4 | 1 | 1 | 40 | 10 | 13.2 | 4 |
| 104487 | Nitzschia | palea | 2 | | 5 | 1 | 1 | 4 | 1 | 3.3 | 3 | 10 | 2 | 2 | 8 | 2 | 19.8 | 6 |
| 104487 | Nitzschia | sp. | 2 | | 4 | 1 | 1 | 3.2 | 1 | 0 | 0 | 8 | 2 | 2 | 6.4 | 2 | 0 | 0 |
| 104487 | Planothidium | frequentissimum | 7 | | 5 | 2 | 0 | 3.4 | 1 | 2.8 | 3 | 70 | 14 | 0 | 23.8 | 7 | 58.8 | 21 |
| 104487 | Planothidium | lanceolatum | 2 | | 5 | 2 | 0 | 3.4 | 1 | 3.3 | 3 | 20 | 4 | 0 | 6.8 | 2 | 19.8 | 6 |
| 104487 | Psammothidium | lauenburgianum | 1 | | 4 | 2 | 0 | 3 | 3 | 1.8 | 3 | 8 | 2 | 0 | 9 | 3 | 5.4 | 3 |
| 104487 | Reimeria | sinuata | 6 | | 4 | 3 | 0 | 2 | 1 | 2.1 | 1 | 72 | 18 | 0 | 12 | 6 | 12.6 | 6 |
| 104487 | Surirella | angusta | 1 | | 3 | 1 | 1 | 2.8 | 1 | 3.7 | 3 | 3 | 1 | 1 | 2.8 | 1 | 11.1 | 3 |
| 104487 | Surirella | brebissoni | 2 | | 3 | 1 | 1 | 2.8 | 1 | 3.6 | 5 | 6 | 2 | 2 | 5.6 | 2 | 36 | 10 |
| 104487 | Tryblionella | debilis | 1 | | 4 | 1 | 1 | 4 | 8 | 2.9 | 2 | 4 | 1 | 1 | 32 | 8 | 5.8 | 2 |
| | | | 210 | 0 | 150 | 58 | 24 | 111 | 81 | 92.4 | 87 | 1400 | 376 | 66 | 606.7 | 214.5 | 1292.4 | 456 |
| 104487 | | | | | | | | | | | | | 68.085 | 31.43 | | 2.82844 | | 2.834 |
| 104488 | Achnanthidium | minutissimum | 12 | | 2 | 2 | 0 | 1.6 | 1 | 1.2 | 1 | 48 | 24 | 0 | 19.2 | 12 | 14.4 | 12 |
| 104488 | Amphora | pediculus | 21 | | 5 | 2 | 0 | 2.8 | 0.5 | 2.8 | 2 | 210 | 42 | 0 | 29.4 | 10.5 | 117.6 | 42 |
| 104488 | Cocconeis | pediculus | 1 | | 4 | 2 | 0 | 2.5 | 0.5 | 2.6 | 2 | 8 | 2 | 0 | 1.25 | 0.5 | 5.2 | 2 |
| 104488 | Cocconeis | placentula | 14 | var. euglypta | 3 | 2 | 0 | 2 | 0.5 | 2.3 | 2 | 84 | 28 | 0 | 14 | 7 | 64.4 | 28 |
| 104488 | Cyclotella | meneghiniana | 2 | | 0 | 0 | 0 | 2.2 | 1 | 2.8 | 5 | 0 | 0 | 0 | 4.4 | 2 | 28 | 10 |
| 104488 | Denticula | tenuis | 2 | | 2 | 2 | 0 | 2 | 1 | 1.4 | 3 | 8 | 4 | 0 | 4 | 2 | 8.4 | 6 |
| 104488 | Diploneis | oblongella | 1 | | 1 | 1 | 1 | 2.2 | 1 | 1 | 2 | 1 | 1 | 1 | 2.2 | 1 | 2 | 2 |
| 104488 | Gomphonema | clavatum | 1 | | 3 | 1 | 0 | 2 | 1 | 0 | 0 | 3 | 1 | 0 | 2 | 1 | 0 | 0 |
| 104488 | Gomphonema | minutum | 1 | | 4 | 2 | 0 | 2.8 | 1 | 2.2 | 1 | 8 | 2 | 0 | 2.8 | 1 | 2.2 | 1 |
| 104488 | Gomphonema | olivaceum | 2 | | 5 | 2 | 0 | 3.1 | 0.5 | 2.9 | 1 | 20 | 4 | 0 | 3.1 | 1 | 5.8 | 2 |

| Site code | Genus | Species | | Infraspecific taxon | TDI-s | TDI-v | motile | TDI-D (s) | TDI-D (v) | TI (s) | TI (v) | TDI-asv | TDI-av | motile | TDI-D-asv | TDI-D-av | TI-asv | TI-av |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 104488 | Gomphonema | parvulum | 5 | | 5 | 3 | 0 | 4 | 1 | 3.6 | 2 | 75 | 15 | 0 | 20 | 5 | 36 | 10 |
| 104488 | Gomphonema | sp. | 4 | | 3 | 1 | 0 | 2 | 1 | 0 | 0 | 12 | 4 | 0 | 8 | 4 | 0 | 0 |
| 104488 | Navicula | atomus | 1 | | 5 | 1 | 1 | 3.6 | 1 | 2.8 | 3 | 5 | 1 | 1 | 3.6 | 1 | 8.4 | 3 |
| 104488 | Navicula | capitata | 1 | var. capitata | 4 | 1 | 1 | 3.2 | 5 | 3.4 | 3 | 4 | 1 | 1 | 16 | 5 | 10.2 | 3 |
| 104488 | Navicula | capitatoradiata | 4 | | 3 | 2 | 1 | 2.6 | 1 | 3.3 | 4 | 24 | 8 | 4 | 10.4 | 4 | 52.8 | 16 |
| 104488 | Navicula | cryptotenella | 6 | | 5 | 2 | 1 | 2.8 | 1 | 2.3 | 1 | 60 | 12 | 6 | 16.8 | 6 | 13.8 | 6 |
| 104488 | Navicula | gregaria | 32 | | 5 | 1 | 1 | 3.3 | 1 | 3.5 | 4 | 160 | 32 | 32 | 105.6 | 32 | 448 | 128 |
| 104488 | Navicula | lanceolata | 1 | | 5 | 2 | 1 | 2.8 | 0.5 | 3.5 | 4 | 10 | 2 | 1 | 1.4 | 0.5 | 14 | 4 |
| 104488 | Navicula | lanceolata | 7 | | 5 | 2 | 1 | 2.8 | 0.5 | 3.5 | 4 | 70 | 14 | 7 | 9.8 | 3.5 | 98 | 28 |
| 104488 | Navicula | menisculus | 6 | | 5 | 2 | 1 | 3.1 | 5 | 2.7 | 2 | 60 | 12 | 6 | 93 | 30 | 32.4 | 12 |
| 104488 | Navicula | reichardtiana | 9 | | 5 | 2 | 1 | 2.8 | 1 | 2.3 | 1 | 90 | 18 | 9 | 25.2 | 9 | 20.7 | 9 |
| 104488 | Navicula | small species | 3 | | 5 | 1 | 1 | 3.6 | 1 | 0 | 0 | 15 | 3 | 3 | 10.8 | 3 | 0 | 0 |
| 104488 | Navicula | tenelloides | 1 | | 5 | 1 | 1 | 2.6 | 1 | 2.9 | 2 | 5 | 1 | 1 | 2.6 | 1 | 5.8 | 2 |
| 104488 | Navicula | tripunctata | 7 | | 4 | 2 | 1 | 3 | 2 | 3.1 | 3 | 56 | 14 | 7 | 42 | 14 | 65.1 | 21 |
| 104488 | Navicula | veneta | 1 | | 4 | 1 | 1 | 3.8 | 5 | 3.5 | 5 | 4 | 1 | 1 | 19 | 5 | 17.5 | 5 |
| 104488 | Nitzschia | capitellata | 3 | | 4 | 1 | 1 | 3.8 | 5 | 3.8 | 5 | 12 | 3 | 3 | 57 | 15 | 57 | 15 |
| 104488 | Nitzschia | dissipata | 4 | | 5 | 2 | 1 | 2.8 | 1 | 2.4 | 2 | 40 | 8 | 4 | 11.2 | 4 | 19.2 | 8 |
| 104488 | Nitzschia | fonticola | 5 | | 3 | 2 | 1 | 3 | 3 | 1.9 | 0 | 30 | 10 | 5 | 45 | 15 | 0 | 0 |
| 104488 | Nitzschia | frustulum | 3 | | 4 | 1 | 1 | 4 | 10 | 3.3 | 4 | 12 | 3 | 3 | 120 | 30 | 39.6 | 12 |
| 104488 | Nitzschia | gracilis | 1 | | 4 | 1 | 1 | 4 | 10 | 2.5 | 2 | 4 | 1 | 1 | 40 | 10 | 5 | 2 |
| 104488 | Nitzschia | palea | 5 | | 5 | 1 | 1 | 4 | 1 | 3.3 | 3 | 25 | 5 | 5 | 20 | 5 | 49.5 | 15 |
| 104488 | Nitzschia | paleacea | 1 | | 4 | 1 | 1 | 3.2 | 1 | 2.3 | 2 | 4 | 1 | 1 | 3.2 | 1 | 4.6 | 2 |
| 104488 | Nitzschia | recta | 1 | | 4 | 1 | 1 | 2.8 | 1 | 3 | 3 | 4 | 1 | 1 | 2.8 | 1 | 9 | 3 |
| 104488 | Nitzschia | sociabilis | 2 | | 4 | 1 | 1 | 3 | 3 | 2.8 | 1 | 8 | 2 | 2 | 18 | 6 | 5.6 | 2 |
| 104488 | Nitzschia | sp. | 6 | | 4 | 1 | 1 | 3.2 | 1 | 0 | 0 | 24 | 6 | 6 | 19.2 | 6 | 0 | 0 |
| 104488 | Placoneis | clementoides | 1 | | 4 | 1 | 1 | 2.6 | 1 | 0 | 0 | 4 | 1 | 1 | 2.6 | 1 | 0 | 0 |
| 104488 | Planothidium | frequentissimum | 9 | | 5 | 2 | 0 | 3.4 | 1 | 2.8 | 3 | 90 | 18 | 0 | 30.6 | 9 | 75.6 | 27 |
| 104488 | Planothidium | lanceolatum | 5 | | 5 | 2 | 0 | 3.4 | 1 | 3.3 | 3 | 50 | 10 | 0 | 17 | 5 | 49.5 | 15 |
| 104488 | Psammothidium | lauenburgianum | 1 | | 4 | 2 | 0 | 3 | 3 | 1.8 | 3 | 8 | 2 | 0 | 9 | 3 | 5.4 | 3 |
| 104488 | Reimeria | sinuata | 2 | | 4 | 3 | 0 | 2 | 1 | 2.1 | 1 | 24 | 6 | 0 | 4 | 2 | 4.2 | 2 |
| 104488 | Staurosira | construens | 1 | var. binodis | 5 | 2 | 1 | 2.8 | 5 | 2.3 | 2 | 10 | 2 | 1 | 14 | 5 | 4.6 | 2 |

| Site code | Genus | Species | | Infraspecific taxon | TDI-s | TDI-v | motile | TDI-D (s) | TDI-D (v) | TI (s) | TI (v) | TDI-asv | TDI-av | motile | TDI-D-asv | TDI-D-av | TI-asv | TI-av |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 104488 | Surirella | angusta | 1 | | 3 | 1 | 1 | 2.8 | 1 | 3.7 | 3 | 3 | 1 | 1 | 2.8 | 1 | 11.1 | 3 |
| 104488 | Surirella | brebissoni | 7 | | 3 | 1 | 1 | 2.8 | 1 | 3.6 | 5 | 21 | 7 | 7 | 19.6 | 7 | 126 | 35 |
| 104488 | Synedra | parasitica | 1 | | 4 | 1 | 0 | 3.2 | 3 | 2.3 | 2 | 4 | 1 | 0 | 9.6 | 3 | 4.6 | 2 |
| | | | 204 | 0 | 175 | 67 | 28 | 129 | 88 | 106.8 | 101 | 1417 | 334 | 121 | 912.15 | 290 | 1541.2 | 500 |
| 104488 | | | | | | | | | | | | | 81.063 | 59.31 | | 3.14534 | | 3.082 |
| 104489 | Achnanthes | conspicua | 1 | | 5 | 2 | 0 | 2.7 | 3 | 1.7 | 0 | 10 | 2 | 0 | 8.1 | 3 | 0 | 0 |
| 104489 | Achnanthidium | biasolettiana | 10 | | 2 | 2 | 0 | 1 | 10 | 1.3 | 1 | 40 | 20 | 0 | 100 | 100 | 13 | 10 |
| 104489 | Achnanthidium | microcephalum | 3 | | 2 | 2 | 0 | 1.6 | 1 | 0.6 | 3 | 12 | 6 | 0 | 4.8 | 3 | 5.4 | 9 |
| 104489 | Achnanthidium | minutissimum | 69 | | 2 | 2 | 0 | 1.6 | 1 | 1.2 | 1 | 276 | 138 | 0 | 110.4 | 69 | 82.8 | 69 |
| 104489 | Achnanthidium | subatomus | 2 | | 2 | 2 | 0 | 1 | 10 | 1.3 | 1 | 8 | 4 | 0 | 20 | 20 | 2.6 | 2 |
| 104489 | Amphora | pediculus | 2 | | 5 | 2 | 0 | 2.8 | 0.5 | 2.8 | 2 | 20 | 4 | 0 | 2.8 | 1 | 11.2 | 4 |
| 104489 | Cocconeis | placentula | 12 | var. euglypta | 3 | 2 | 0 | 2 | 0.5 | 2.3 | 2 | 72 | 24 | 0 | 12 | 6 | 55.2 | 24 |
| 104489 | Cocconeis | placentula | 2 | var. placentula | 3 | 2 | 0 | 2 | 0.5 | 2.6 | 2 | 12 | 4 | 0 | 2 | 1 | 10.4 | 4 |
| 104489 | Craticula | accomoda | 1 | | 5 | 1 | 1 | 4 | 10 | 3.9 | 5 | 5 | 1 | 1 | 40 | 10 | 19.5 | 5 |
| 104489 | Ctenophora | pulchella | 1 | | 2 | 1 | 0 | 3.2 | 3 | 3.5 | 2 | 2 | 1 | 0 | 9.6 | 3 | 7 | 2 |
| 104489 | Cyclotella | meneghiniana | 1 | | 0 | 0 | 0 | 2.2 | 1 | 2.8 | 5 | 0 | 0 | 0 | 2.2 | 1 | 14 | 5 |
| 104489 | Diploneis | oblongella | 4 | | 1 | 1 | 1 | 2.2 | 1 | 1 | 2 | 4 | 4 | 4 | 8.8 | 4 | 8 | 8 |
| 104489 | Eunotia | bilunaris | 1 | | 1 | 3 | 0 | 1 | 10 | 0.7 | 0 | 3 | 3 | 0 | 10 | 10 | 0 | 0 |
| 104489 | Eunotia | pectinalis | 6 | | 1 | 3 | 0 | 1 | 10 | 1.1 | 0 | 18 | 18 | 0 | 60 | 60 | 0 | 0 |
| 104489 | Eunotia | sp. | 1 | | 1 | 3 | 0 | 1 | 10 | 0 | 0 | 3 | 3 | 0 | 10 | 10 | 0 | 0 |
| 104489 | Fragilaria | capucina | 10 | var. capucina | 2 | 2 | 0 | 1.5 | 1 | 1.8 | 2 | 40 | 20 | 0 | 15 | 10 | 36 | 20 |
| 104489 | Fragilaria | capucina | 9 | var. intermedia | 2 | 2 | 0 | 1.5 | 1 | 1.8 | 2 | 36 | 18 | 0 | 13.5 | 9 | 32.4 | 18 |
| 104489 | Fragilaria | vaucheriae | 1 | | 3 | 2 | 0 | 3.2 | 1 | 1.8 | 1 | 6 | 2 | 0 | 3.2 | 1 | 1.8 | 1 |
| 104489 | Gomphonema | gracile | 5 | | 3 | 1 | 0 | 1.5 | 1 | 0 | 0 | 15 | 5 | 0 | 7.5 | 5 | 0 | 0 |
| 104489 | Gomphonema | minutum | 1 | | 4 | 2 | 0 | 2.8 | 1 | 2.2 | 1 | 8 | 2 | 0 | 2.8 | 1 | 2.2 | 1 |
| 104489 | Gomphonema | parvulum | 7 | | 5 | 3 | 0 | 4 | 1 | 3.6 | 2 | 105 | 21 | 0 | 28 | 7 | 50.4 | 14 |
| 104489 | Gomphonema | truncatum | 1 | var. capitata | 3 | 1 | 0 | 2 | 1 | 1.9 | 1 | 3 | 1 | 0 | 2 | 1 | 1.9 | 1 |

| Site code | Genus | Species | | Infraspecific taxon | TDI-s | TDI-v | motile | TDI-D (s) | TDI-D (v) | TI (s) | TI (v) | TDI-asv | TDI-av | motile | TDI-D-asv | TDI-D-av | TI-asv | TI-av |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 104489 | Hantzschia | amphioxys | 2 | | 5 | 1 | 1 | 4 | 1 | 3.6 | 3 | 10 | 2 | 2 | 8 | 2 | 21.6 | 6 |
| 104489 | Lemnicola | hungarica | 1 | | 3 | 1 | 0 | 1.4 | 5 | 3.4 | 2 | 3 | 1 | 0 | 7 | 5 | 6.8 | 2 |
| 104489 | Melosira | varians | 2 | | 4 | 2 | 0 | 3.2 | 1 | 2.9 | 4 | 16 | 4 | 0 | 6.4 | 2 | 23.2 | 8 |
| 104489 | Navicula | capitata | 1 | var. hungarica | 4 | 1 | 1 | 3.2 | 5 | 2.7 | 2 | 4 | 1 | 1 | 16 | 5 | 5.4 | 2 |
| 104489 | Navicula | cryptotenella | 10 | | 5 | 2 | 1 | 2.8 | 1 | 2.3 | 1 | 100 | 20 | 10 | 28 | 10 | 23 | 10 |
| 104489 | Navicula | gregaria | 9 | | 5 | 1 | 1 | 3.3 | 1 | 3.5 | 4 | 45 | 9 | 9 | 29.7 | 9 | 126 | 36 |
| 104489 | Navicula | lanceolata | 1 | | 5 | 2 | 1 | 2.8 | 0.5 | 3.5 | 4 | 10 | 2 | 1 | 1.4 | 0.5 | 14 | 4 |
| 104489 | Navicula | minima | 4 | | 5 | 1 | 1 | 3.6 | 1 | 2.9 | 2 | 20 | 4 | 4 | 14.4 | 4 | 23.2 | 8 |
| 104489 | Navicula | reinhardtii | 2 | | 4 | 1 | 1 | 2.6 | 1 | 2.3 | 1 | 8 | 2 | 2 | 5.2 | 2 | 4.6 | 2 |
| 104489 | Navicula | rhynchocephala | 2 | | 4 | 1 | 1 | 2.6 | 1 | 2.3 | 1 | 8 | 2 | 2 | 5.2 | 2 | 4.6 | 2 |
| 104489 | Navicula | tenelloides | 1 | | 5 | 1 | 1 | 2.6 | 1 | 2.9 | 2 | 5 | 1 | 1 | 2.6 | 1 | 5.8 | 2 |
| 104489 | Navicula | veneta | 1 | | 4 | 1 | 1 | 3.8 | 5 | 3.5 | 5 | 4 | 1 | 1 | 19 | 5 | 17.5 | 5 |
| 104489 | Nitzschia | dissipata | 1 | | 5 | 2 | 1 | 2.8 | 1 | 2.4 | 2 | 10 | 2 | 1 | 2.8 | 1 | 4.8 | 2 |
| 104489 | Nitzschia | fonticola | 1 | | 3 | 2 | 1 | 3 | 3 | 1.9 | 0 | 6 | 2 | 1 | 9 | 3 | 0 | 0 |
| 104489 | Nitzschia | frustulum | 1 | | 4 | 1 | 1 | 4 | 10 | 3.3 | 4 | 4 | 1 | 1 | 40 | 10 | 13.2 | 4 |
| 104489 | Nitzschia | gracilis | 1 | | 4 | 1 | 1 | 4 | 10 | 2.5 | 2 | 4 | 1 | 1 | 40 | 10 | 5 | 2 |
| 104489 | Nitzschia | sp. | 2 | | 4 | 1 | 1 | 3.2 | 1 | 0 | 0 | 8 | 2 | 2 | 6.4 | 2 | 0 | 0 |
| 104489 | pennate | undifferentiated | 2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 104489 | Pinnularia | sp. | 1 | | 1 | 3 | 1 | 1 | 5 | 0 | 0 | 3 | 3 | 1 | 5 | 5 | 0 | 0 |
| 104489 | Planothidium | frequentissimum | 4 | | 5 | 2 | 0 | 3.4 | 1 | 2.8 | 3 | 40 | 8 | 0 | 13.6 | 4 | 33.6 | 12 |
| 104489 | Planothidium | lanceolatum | 1 | | 5 | 2 | 0 | 3.4 | 1 | 3.3 | 3 | 10 | 2 | 0 | 3.4 | 1 | 9.9 | 3 |
| 104489 | Pseudostaurosira | brevistriata | 1 | | 2 | 1 | 0 | 1.5 | 5 | 3 | 1 | 2 | 1 | 0 | 7.5 | 5 | 3 | 1 |
| 104489 | Sellaphora | bacillum | 1 | | 4 | 1 | 1 | 2.6 | 1 | 2.3 | 3 | 4 | 1 | 1 | 2.6 | 1 | 6.9 | 3 |
| 104489 | Sellaphora | pupula | 2 | | 4 | 1 | 1 | 2.6 | 1 | 3.7 | 5 | 8 | 2 | 2 | 5.2 | 2 | 37 | 10 |
| 104489 | Sellaphora | seminulum | 1 | | 5 | 1 | 1 | 3.6 | 1 | 3.2 | 2 | 5 | 1 | 1 | 3.6 | 1 | 6.4 | 2 |
| 104489 | Staurneis | smithii | 1 | | 5 | 2 | 1 | 1.6 | 1 | 3.3 | 2 | 10 | 2 | 1 | 1.6 | 1 | 6.6 | 2 |
| 104489 | Staurosirella | pinnata | 1 | | 4 | 1 | 0 | 2.8 | 5 | 2.2 | 1 | 4 | 1 | 0 | 14 | 5 | 2.2 | 1 |
| 104489 | Surirella | brebissoni | 1 | | 3 | 1 | 1 | 2.8 | 1 | 3.6 | 5 | 3 | 1 | 1 | 2.8 | 1 | 18 | 5 |
| 104489 | Synedra | parasitica | 1 | var. subconstricta | 4 | 1 | 0 | 3.2 | 3 | 2.3 | 2 | 4 | 1 | 0 | 9.6 | 3 | 4.6 | 2 |

| Site code | Genus | Species | | Infraspecific taxon | TDI-s | TDI-v | motile | TDI-D (s) | TDI-D (v) | TI (s) | TI (v) | TDI-asv | TDI-av | motile | TDI-D-asv | TDI-D-av | TI-asv | TI-av |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 209 | | 172 | 79 | 23 | 127.2 | 152 | 115.5 | 101 | 1056 | 381 | 51 | 782.7 | 437.5 | 780.7 | 333 |
| 104489 | | | | | | | | | | | | | 44.291 | 24.4 | | 1.78903 | | 2.344 |
| 104490 | Achnanthidium | biasolettiana | 10 | | 2 | 2 | 0 | 1 | 10 | 1.3 | 1 | 40 | 20 | 0 | 100 | 100 | 13 | 10 |
| 104490 | Achnanthidium | minutissimum | 57 | | 2 | 2 | 0 | 1.6 | 1 | 1.2 | 1 | 228 | 114 | 0 | 91.2 | 57 | 68.4 | 57 |
| 104490 | Amphora | pediculus | 1 | | 5 | 2 | 0 | 2.8 | 0.5 | 2.8 | 2 | 10 | 2 | 0 | 1.4 | 0.5 | 5.6 | 2 |
| 104490 | Cocconeis | placentula | 7 | var. euglypta | 3 | 2 | 0 | 2 | 0.5 | 2.3 | 2 | 42 | 14 | 0 | 7 | 3.5 | 32.2 | 14 |
| 104490 | Eunotia | pectinalis | 1 | | 1 | 3 | 0 | 1 | 10 | 1.1 | 0 | 3 | 3 | 0 | 10 | 10 | 0 | 0 |
| 104490 | Fragilaria | capucina | 3 | var. capucina | 2 | 2 | 0 | 1.5 | 1 | 1.8 | 2 | 12 | 6 | 0 | 4.5 | 3 | 10.8 | 6 |
| 104490 | Fragilaria | capucina | 8 | var. intermedia | 2 | 2 | 0 | 1.5 | 1 | 1.8 | 2 | 32 | 16 | 0 | 12 | 8 | 28.8 | 16 |
| 104490 | Fragilaria | vaucheriae | 3 | | 3 | 2 | 0 | 3.2 | 1 | 1.8 | 1 | 18 | 6 | 0 | 9.6 | 3 | 5.4 | 3 |
| 104490 | Fragilariforma | virescens | 1 | | 2 | 1 | 0 | 1.3 | 5 | 1.4 | 1 | 2 | 1 | 0 | 6.5 | 5 | 1.4 | 1 |
| 104490 | Gomphonema | clavatum | 2 | | 3 | 1 | 0 | 2 | 1 | 0 | 0 | 6 | 2 | 0 | 4 | 2 | 0 | 0 |
| 104490 | Gomphonema | minutum | 2 | | 4 | 2 | 0 | 2.8 | 1 | 2.2 | 1 | 16 | 4 | 0 | 5.6 | 2 | 4.4 | 2 |
| 104490 | Gomphonema | parvulum | 13 | | 5 | 3 | 0 | 4 | 1 | 3.6 | 2 | 195 | 39 | 0 | 52 | 13 | 93.6 | 26 |
| 104490 | Gomphonema | pumilum | 2 | | 3 | 1 | 0 | 1.8 | 1 | 1.1 | 1 | 6 | 2 | 0 | 3.6 | 2 | 2.2 | 2 |
| 104490 | Gomphonema | truncatum | 1 | var. truncatum | 3 | 1 | 0 | 2 | 1 | 1.9 | 1 | 3 | 1 | 0 | 2 | 1 | 1.9 | 1 |
| 104490 | Lemnicola | hungarica | 3 | | 3 | 1 | 0 | 1.4 | 5 | 3.4 | 2 | 9 | 3 | 0 | 21 | 15 | 20.4 | 6 |
| 104490 | Luticola | goeppertiana | 1 | | 5 | 2 | 1 | 3.2 | 3 | 3.6 | 5 | 10 | 2 | 1 | 9.6 | 3 | 18 | 5 |
| 104490 | Melosira | varians | 11 | | 4 | 2 | 0 | 3.2 | 1 | 2.9 | 4 | 88 | 22 | 0 | 35.2 | 11 | 127.6 | 44 |
| 104490 | Navicula | capitata | 11 | var. capitata | 4 | 1 | 1 | 3.2 | 5 | 3.4 | 3 | 44 | 11 | 11 | 176 | 55 | 112.2 | 33 |
| 104490 | Navicula | cari | 1 | | 4 | 1 | 1 | 3.2 | 1 | 2.6 | 1 | 4 | 1 | 1 | 3.2 | 1 | 2.6 | 1 |
| 104490 | Navicula | gregaria | 9 | | 5 | 1 | 1 | 3.3 | 1 | 3.5 | 4 | 45 | 9 | 9 | 29.7 | 9 | 126 | 36 |
| 104490 | Navicula | minima | 1 | | 5 | 1 | 1 | 3.6 | 1 | 2.9 | 2 | 5 | 1 | 1 | 3.6 | 1 | 5.8 | 2 |
| 104490 | Navicula | slesvicensis | 3 | | 4 | 1 | 1 | 3.2 | 5 | 3 | 2 | 12 | 3 | 3 | 48 | 15 | 18 | 6 |
| 104490 | Navicula | small species | 2 | | 5 | 1 | 1 | 3.6 | 1 | 0 | 0 | 10 | 2 | 2 | 7.2 | 2 | 0 | 0 |
| 104490 | Nitzschia | amphibia | 1 | | 5 | 3 | 1 | 4 | 10 | 3.8 | 5 | 15 | 3 | 1 | 40 | 10 | 19 | 5 |
| 104490 | Nitzschia | capitellata | 1 | | 4 | 1 | 1 | 3.8 | 5 | 3.8 | 5 | 4 | 1 | 1 | 19 | 5 | 19 | 5 |

| Site code | Genus | Species | | Infraspecific taxon | TDI-s | TDI-v | motile | TDI-D (s) | TDI-D (v) | TI (s) | TI (v) | TDI-asv | TDI-av | motile | TDI-D-asv | TDI-D-av | TI-asv | TI-av |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 104490 | Nitzschia | dissipata | 1 | | 5 | 2 | 1 | 2.8 | 1 | 2.4 | 2 | 10 | 2 | 1 | 2.8 | 1 | 4.8 | 2 |
| 104490 | Nitzschia | linearis | 1 | | 4 | 1 | 1 | 2.8 | 1 | 3.4 | 4 | 4 | 1 | 1 | 2.8 | 1 | 13.6 | 4 |
| 104490 | Nitzschia | palea | 2 | | 5 | 1 | 1 | 4 | 1 | 3.3 | 3 | 10 | 2 | 2 | 8 | 2 | 19.8 | 6 |
| 104490 | Nitzschia | paleacea | 2 | | 4 | 1 | 1 | 3.2 | 1 | 2.3 | 2 | 8 | 2 | 2 | 6.4 | 2 | 9.2 | 4 |
| 104490 | Nitzschia | sp. | 1 | | 4 | 1 | 1 | 3.2 | 1 | 0 | 0 | 4 | 1 | 1 | 3.2 | 1 | 0 | 0 |
| 104490 | Planothidium | frequentissimum | 22 | | 5 | 2 | 0 | 3.4 | 1 | 2.8 | 3 | 220 | 44 | 0 | 74.8 | 22 | 184.8 | 66 |
| 104490 | Planothidium | lanceolatum | 10 | | 5 | 2 | 0 | 3.4 | 1 | 3.3 | 3 | 100 | 20 | 0 | 34 | 10 | 99 | 30 |
| 104490 | Sellaphora | pupula | 3 | | 4 | 1 | 1 | 2.6 | 1 | 3.7 | 5 | 12 | 3 | 3 | 7.8 | 3 | 55.5 | 15 |
| 104490 | Sellaphora | seminulum | 1 | | 5 | 1 | 1 | 3.6 | 1 | 3.2 | 2 | 5 | 1 | 1 | 3.6 | 1 | 6.4 | 2 |
| 104490 | Stauroneis | smithii | 7 | | 5 | 2 | 1 | 1.6 | 1 | 3.3 | 2 | 70 | 14 | 7 | 11.2 | 7 | 46.2 | 14 |
| 104490 | Staurosira | construens | 2 | var. binodis | 5 | 2 | 1 | 2.8 | 5 | 2.3 | 2 | 20 | 4 | 2 | 28 | 10 | 9.2 | 4 |
| 104490 | Synedra | acus | 2 | | 4 | 1 | 0 | 2.8 | 1 | 1.8 | 2 | 8 | 2 | 0 | 5.6 | 2 | 7.2 | 4 |
| 104490 | Synedra | ulna | 3 | | 3 | 1 | 0 | 2.8 | 1 | 3.5 | 4 | 9 | 3 | 0 | 8.4 | 3 | 42 | 12 |
| 104490 | Tryblionella | hungarica | 1 | | 4 | 1 | 1 | 4 | 8 | 3.9 | 3 | 4 | 1 | 1 | 32 | 8 | 11.7 | 3 |
| | | | 213 | 0 | 150 | 60 | 19 | 107.2 | 98 | 96.4 | 87 | 1343 | 388 | 51 | 930.5 | 410 | 1245.7 | 449 |
| 104490 | | | | | | | | | | | | | 61.534 | 23.94 | | 2.26951 | | 2.774 |

## Appendix VII: Chemical water quality sampling data

## Table VII.1: Farm A sampling event 1

| Sample point number | Grid Ref | Sample type | Sampling Time | Ammonia (mg/l) | Phenoxy-acids | Synthetic Pyrethroids (ug/l in water and ug/kg in sediment) | Glyphosate (ug/l) | Isoproturon (ug/l) | Gen Scan Semi-quantitative (ug/l) |
|---|---|---|---|---|---|---|---|---|---|
| **1** | TG486157 | Water | 09:00 | 0.129 | N/A | <0.001 Cis permethrin<br><0.001 Trans permethrin<br><0.001 Flumethrin<br><0.001 Alphamethrin<br><0.001 Deltamethrin<br><0.002 Cyfluthrin | <0.1 | N/A | 0.02 Benzophenone<br>0.02 Chloropropham<br>0.06 Atrazine<br>0.04 Caffeine<br>0.05 Pyrene<br><0.01 Benzo(a)anthracene<br><0.01 Chrysene<br>0.04 Benzo(k)fluoranthene<br>0.06 Benzo(a)pyrene<br><0.01 Indeno(1,2,3-cd)pyrene<br>0.04 Benzo(ghi)perylene<br>0.21 Acetophenone<br>0.04 Apiol(parsley)<br>0.2 Benzenesulfonamide, N-butyl-<br>0.17 Neophytadiene<br>0.11 Bromacil<br>0.03 Fluoranthene<br>0.27 Squalene<br>Some hydrocarbons detected |
| **1** | TG486157 | Sediment | 09:00 | N/A | N/A | <1.00 Flumethrin<br><1.00 Alphamethrin<br><1.00 Deltamethrin | N/A | N/A | N/A |
| **2** | TG483156 | Water | 10:00 | 0.087 | N/A | <0.001 Cis permethrin<br><0.001 Trans permethrin<br><0.001 Flumethrin<br><0.001 Alphamethrin<br><0.001 Deltamethrin<br><0.002 Cyfluthrin | N/A | N/A | 0.01 Benzophenone<br>0.04 Atrazine<br>0.02 Caffeine<br>0.01 Pyrene<br>0.15 2,6-di-(t-butyl)4-hydroxy-4-methyl-2,5-cyclohexadien-1-one<br>0.09 Butylated hydroxytouene<br><0.01 Benzothiazole<br>0.17 Benzenesulfonamide, N-butyl-<br>0.1 Isopropyl myristate<br>0.03 Bromacil |
| **2** | TG483156 | Sediment | 10:00 | N/A | N/A | <1.00 Flumethrin<br><1.00 Alphamethrin<br><1.00 Deltamethrin | N/A | N/A | N/A |

| Sample point number | Grid Ref | Sample type | Sampling Time | Ammonia (mg/l) | Phenoxy-acids | Synthetic Pyrethroids (ug/l in water and ug/kg in sediment) | Glyphosate (ug/l) | Isoproturon (ug/l) | Gen Scan Semi-quantitative (ug/l) |
|---|---|---|---|---|---|---|---|---|---|
| **3** | TG484157 | No samples taken, ditches dry | | | | | | | |
| **4** | TG493157 | No samples taken, ditches dry | | | | | | | |
| **5** | TG488152 | No samples taken, ditches dry | | | | | | | |

## Table VII.2: Farm A sampling event 2

| Sample point number | Grid Ref | Sample type | Sampling Time | Ammonia (mg/l) | Pendimethalin (ng/l in water/ ug/kg in sediment) | Synthetic Pyrethroids (ug/l in water and ug/kg in sediment) | Glyphosate (ug/l) | Isoproturon (ug/l) |
|---|---|---|---|---|---|---|---|---|
| **1** | TG486157 | Water | 08:30 | 0.1 | <10.0 | <0.002 Cis Permethrin<br><0.002 Trans permethrin<br><0.002 Flumethrin<br><0.002 Alphamethrin<br><0.002 Deltamethrin<br><0.004 Cyfluthrin<br><0.004 Lambda Cyhalothrin | <0.1 | <0.02 |
| **1** | TG486157 | Sediment | 08:30 | N/A | <37.7 | <2.5 Cis Permethrin<br><2.5 Trans permethrin<br><1.00 Flumethrin<br><1.00 Alphamethrin<br><1.00 Deltamethrin<br><5.00 Cyfluthrin<br><2.00 Lambda Cyhalothrin | N/A | N/A |
| **2** | TG483156 | Water | 10:00 | 0.046 | <10.0 | <0.002 Cis Permethrin<br><0.002 Trans permethrin<br><0.002 Flumethrin<br><0.002 Alphamethrin<br><0.002 Deltamethrin<br><0.004 Cyfluthrin<br><0.004 Lambda Cyhalothrin | <0.1 | <0.02 |
| **2** | TG483156 | Sediment | 10:00 | N/A | <6.4 | <2.5 Cis Permethrin<br><2.5 Trans permethrin<br><1.00 Flumethrin<br><1.00 Alphamethrin<br><1.00 Deltamethrin<br><5.00 Cyfluthrin<br><2.00 Lambda Cyhalothrin | N/A | N/A |
| **3** | TG484157 | No samples taken, ditches dry | | | | | | |
| **4** | TG493157 | No samples taken, ditches dry | | | | | | |
| **5** | TG488152 | No samples taken, ditches dry | | | | | | |

## Table VII.3: Farm A sampling event 3

| Sample point number | Grid Ref | Sample type | Sampling Time | Ammonia (mg/l) | Pendimethalin (ng/l in water/ ug/kg in sediment) | Synthetic Pyrethroids (ug/l in water and ug/kg in sediment) | Glyphosate (ug/l) | Isoproturon (ug/l) |
|---|---|---|---|---|---|---|---|---|
| **1** | TG486157 | Water | 09:00 | 0.076 | <10.0 | <0.002 Cis permethrin<br><0.002 Trans permethrin<br><0.002 Flumethrin<br><0.002 Alphamethrin<br><0.002 Deltamethrin<br><0.004 Cyfluthrin<br><0.004 Lambda cyhalothrin | <0.1 | <0.02 |
| **1** | TG486157 | Sediment | 09:00 | N/A | <40.2 | <2.50 Cis permethrin<br><2.50 Trans permethrin<br><1.00 Flumethrin<br><1.00 Alphamethrin<br><1.00 Deltamethrin<br><5.00 Cyfluthrin<br><2.00 Lambda cyhalothrin | N/A | N/A |
| **2** | TG483156 | Water | 10:00 | 0.032 | <10.0 | <0.002 Cis permethrin<br><0.002 Trans permethrin<br><0.002 Flumethrin<br><0.002 Alphamethrin<br><0.002 Deltamethrin<br><0.004 Cyfluthrin<br><0.004 Lambda cyhalothrin | <0.1 | <0.02 |
| **2** | TG483156 | Sediment | 10:00 | N/A | <46.8 | <2.50 Cis permethrin<br><2.50 Trans permethrin<br><1.00 Flumethrin<br><1.00 Alphamethrin<br><1.00 Deltamethrin<br><5.00 Cyfluthrin<br><2.00 Lambda cyhalothrin | N/A | N/A |
| **3** | TG484157 | No samples taken, ditches dry | | | | | | |
| **4** | TG493157 | No samples taken, ditches dry | | | | | | |
| **5** | TG488152 | No samples taken, ditches dry | | | | | | |

## Table VII.4: Farm A sampling event 4

| Sample point number | Grid Ref | Sample type | Sampling Time | Ammonia (mg/l) | Pendimethalin (ng/l in water/ ug/kg in sediment) | Synthetic Pyrethroids (ug/l in water and ug/kg in sediment) | Glyphosate (ug/l) | Isoproturon (ug/l) |
|---|---|---|---|---|---|---|---|---|
| **1** | TG486157 | Water | 09:00 | 0.064 | <10.0 | <0.002 Cis permethrin<br><0.002 Trans permethrin<br><0.002 Flumethrin<br><0.002 Alphamethrin<br><0.002 Deltamethrin<br><0.004 Cyfluthrin<br><0.004 Lambda cyhalothrin | <0.1 | <0.02 |
| **1** | TG486157 | Sediment | 09:00 | N/A | <5.0 | <2.50 Cis permethrin<br><2.50 Trans permethrin<br><1.00 Flumethrin<br><1.00 Alphamethrin<br><1.00 Deltamethrin<br><5.00 Cyfluthrin<br><2.00 Lambda cyhalothrin | N/A | N/A |
| **2** | TG483156 | Water | 10:00 | <0.030 | <10.0 | <0.002 Cis permethrin<br><0.002 Trans permethrin<br><0.002 Flumethrin<br><0.002 Alphamethrin<br><0.002 Deltamethrin<br><0.004 Cyfluthrin<br><0.004 Lambda cyhalothrin | <0.1 | <0.02 |
| **2** | TG483156 | Sediment | 10:00 | N/A | <5.0 | <2.50 Cis permethrin<br><2.50 Trans permethrin<br><1.00 Flumethrin<br><1.00 Alphamethrin<br><1.00 Deltamethrin<br><5.00 Cyfluthrin<br><2.00 Lambda cyhalothrin | N/A | N/A |
| **3** | TG484157 | No samples taken, ditches dry | | | | | | |
| **4** | TG493157 | No samples taken, ditches dry | | | | | | |
| **5** | TG488152 | No samples taken, ditches dry | | | | | | |

## Table VII.5: Farm B sampling event 1

| Sample point number | Grid Ref | Sample type | Sampling Time | Ammonia (mg/l) | Phenoxy-acids | Synthetic Pyrethroids (ug/l in water and ug/kg in sediment) | Glyphosate (ug/l) | Isoproturon (ug/l) | Gen Scan Semi-quantitative (ug/l) |
|---|---|---|---|---|---|---|---|---|---|
| **1** | ST26403630 | Water | 12:30 | 0.03 | N/A | <0.001 Cis permethrin<br><0.001 Trans permethrin<br><0.001 Flumethrin<br><0.001 Alphamethrin<br><0.001 Deltamethrin<br><0.002 Cyfluthrin | <0.1 | <0.02 | 0.03 Benzophenone<br>0.27 Caffeine<br>0.05 Pyrene<br>0.04 Bispheonol A<br><0.01 Benzo(a)anthracene<br><0.01 Chrysene<br><0.01 Benzo(a)pyrene<br>0.76 alpha-Turpineol<br>0.06 Formamide, N,N-dibutyl-<br>1.39 Chloroxylenol<br>0.08 2,6-di(t-butyl)-4-hydroxy-4-methyl-2,5-cyclohexadien-1-one<br>0.05 Benzenesulfonamide, N-ethyl-2-methyl<br>0.32 Benzenesulfonamide, N-butyl-<br>0.01 Phenol, 4-(3,4-dihydro-2,2,4-trimethyl)-2H-1-benzopyran-4-yl |
| **1** | ST26403630 | Sediment | 12:30 | N/A | N/A | <1.00 Flumethrin<br><1.00 Alphamethrin<br><1.00 Deltamethrin | N/A | N/A | N/A |
| **2** | ST26463639 | Water | 13:45 | <0.03 | N/A | <0.001 Cis permethrin<br><0.001 Trans permethrin<br><0.001 Flumethrin<br><0.001 Alphamethrin<br><0.001 Deltamethrin<br><0.002 Cyfluthrin | <0.1 | <0.02 | 0.04 2H-1-Benxopyran-2-one<br>0.17 2,6-di(t-butyl)-4-hydroxy-4-methyl-2,5-cyclohexadien-1-one<br>0.35 Benzenesulfonamide, N-butyl-<br>0.02 Phenol, 4-(3,4-dihydro-2,2,4-trimethyl)-2H-1-benzopyran-4-yl<br>0.02 Phosphoric acid, (1-methylethyl) phenyl diphenyl |
| **2** | ST26463639 | Sediment | 13:45 | N/A | N/A | <1.00 Flumethrin<br><1.00 Alphamethrin<br><1.00 Deltamethrin | N/A | N/A | N/A |

| Sample point number | Grid Ref | Sample type | Sampling Time | Ammonia (mg/l) | Phenoxy-acids | Synthetic Pyrethroids (ug/l in water and ug/kg in sediment) | Glyphosate (ug/l) | Isoproturon (ug/l) | Gen Scan Semi-quantitative (ug/l) |
|---|---|---|---|---|---|---|---|---|---|
| **3** | ST25823627 | Water | 14:30 | 0.044 | N/A | <0.001 Cis permethrin<br><0.001 Trans permethrin<br><0.001 Flumethrin<br><0.001 Alphamethrin<br><0.001 Deltamethrin<br><0.002 Cyfluthrin | <0.1 | <0.02 | 0.26 Caffeine<br>0.14 Pyrene<br>0.02 Benzo(a)anthracene<br><0.01 Chrysene<br>0.02 Benzo(a)pyrene<br>0.06 2,6-di(t-butyl)-4-hydroxy-4-methyl-2,5-cyclohexadien-1-one<br>0.11 Benzenesulfonamide, N-butyl- |
| **3** | ST25823627 | Sediment | 14:30 | N/A | N/A | <1.00 Flumethrin<br><1.00 Alphamethrin<br><1.00 Deltamethrin | N/A | N/A | N/A |
| **4** | ST256365 | Water | 15:15 | 0.048 | N/A | <0.001 Cis permethrin<br><0.001 Trans permethrin<br><0.001 Flumethrin<br><0.001 Alphamethrin<br><0.001 Deltamethrin<br><0.002 Cyfluthrin | <0.1 | <0.02 | <0.01 Benzophenone<br>0.01 Caffeine<br>0.06 Metazochlor<br>0.04 Pyrene<br>0.01 Benzo(a)anthracene<br><0.01 Chrysene<br>0.01 Benzo(a)pyrene<br>0.13 Formamide, N,N-dibutyl-<br>0.06 2,6-di(t-butyl)-4-hydroxy-4-methyl-2,5-cyclohexadien-1-one<br>0.04 Apiol (parsley)<br>0.27 Benzenesulfonamide, N-butyl-<br><0.01 Phenol, 4-(3,4-dihydro-2,2,4-trimethyl)-2H-1-benzopyran-4-yl<br>0.01 Phosphoric acid, (1-methylethyl) phenyl diphenyl |
| **4** | ST256365 | Sediment | 15:15 | N/A | N/A | <1.00 Flumethrin<br><1.00 Alphamethrin<br><1.00 Deltamethrin | N/A | N/A | N/A |
| **5** | ST264367 | No samples taken, ditches dry | | | | | | | |

## Table VII.6: Farm B sampling event 2

| Sample point number | Grid Ref | Sample type | Sampling Time | Ammonia (mg/l) | Pendimethalin (ng/l in water/ ug/kg in sediment) | Synthetic Pyrethroids (ug/l in water and ug/kg in sediment) | Glyphosate (ug/l) | Isoproturon (ug/l) |
|---|---|---|---|---|---|---|---|---|
| **1** | ST26403630 | Water | 09:30 | <0.03 | <10.6 | <0.001 Cis permethrin<br><0.001 Trans permethrin<br><0.001 Flumethrin<br><0.001 Alphamethrin<br><0.001 Deltamethrin<br><0.002 Cyfluthrin<br><0.002 Lambda cyhalothrin | <0.10 | 0.0293 |
| **1** | ST26403630 | Sediment | 09:30 | N/A | <22.7 | <2.50 Cis permethrin<br><2.50 Trans permethrin<br><1.00 Flumethrin<br><1.00 Alphamethrin<br><1.00 Deltamethrin<br><5.00 Cyfluthrin<br><2.00 Lambda cyhalothrin | N/A | N/A |
| **2** | ST26463639 | Water | 10:15 | <0.03 | <10.0 | <0.001 Cis permethrin<br><0.001 Trans permethrin<br><0.001 Flumethrin<br><0.001 Alphamethrin<br><0.001 Deltamethrin<br><0.002 Cyfluthrin<br><0.002 Lambda cyhalothrin | <0.10 | 0.02 |
| **2** | ST26463639 | Sediment | 10:15 | N/A | <15.9 | <2.50 Cis permethrin<br><2.50 Trans permethrin<br><1.00 Flumethrin<br><1.00 Alphamethrin<br><1.00 Deltamethrin<br><5.00 Cyfluthrin<br><2.00 Lambda cyhalothrin | N/A | N/A |
| **3** | ST25823627 | Sediment | 11:30 | <0.03 | <10.0 | <0.001 Cis permethrin<br><0.001 Trans permethrin<br><0.001 Flumethrin<br><0.001 Alphamethrin<br><0.001 Deltamethrin<br><0.002 Cyfluthrin<br><0.002 Lambda cyhalothrin | <0.10 | 0.02 |

| Sample point number | Grid Ref | Sample type | Sampling Time | Ammonia (mg/l) | Pendimethalin (ng/l in water/ ug/kg in sediment) | Synthetic Pyrethroids (ug/l in water and ug/kg in sediment) | Glyphosate (ug/l) | Isoproturon (ug/l) |
|---|---|---|---|---|---|---|---|---|
| **3** | ST25823627 | Sediment | 11:30 | N/A | <22.3 | <2.50 Cis permethrin<br><2.50 Trans permethrin<br><1.00 Flumethrin<br><1.00 Alphamethrin<br><1.00 Deltamethrin<br><5.00 Cyfluthrin<br><2.00 Lambda cyhalothrin | N/A | N/A |
| **4** | ST256365 | Sediment | 12:30 | <0.03 | <10.0 | <0.001 Cis permethrin<br><0.001 Trans permethrin<br><0.001 Flumethrin<br><0.001 Alphamethrin<br><0.001 Deltamethrin<br><0.002 Cyfluthrin<br><0.002 Lambda cyhalothrin | <0.10 | 0.0432 |
| **4** | ST256365 | Sediment | 12:30 | N/A | <24.4 | <2.50 Cis permethrin<br><2.50 Trans permethrin<br><1.00 Flumethrin<br><1.00 Alphamethrin<br><1.00 Deltamethrin<br><5.00 Cyfluthrin<br><2.00 Lambda cyhalothrin | N/A | N/A |
| **5** | ST264367 | No samples taken, ditches dry | | | | | | |

## Table VII.7: Farm B sampling event 3

| Sample point number | Grid Ref | Sample type | Sampling Time | Ammonia (mg/l) | Pendimethalin (ng/l in water/ ug/kg in sediment) | Synthetic Pyrethroids (ug/l in water and ug/kg in sediment) | Glyphosate (ug/l) | Isoproturon (ug/l) |
|---|---|---|---|---|---|---|---|---|
| **1** | ST26403630 | Water | 10:00 | <0.03 | <10.0 | <0.002 Cis permethrin<br><0.002 Trans permethrin<br><0.002 Flumethrin<br><0.002 Alphamethrin<br><0.002 Deltamethrin<br><0.004 Cyfluthrin<br><0.004 Lambda cyhalothrin | <0.011 | 0.0227 |
| **1** | ST26403630 | Sediment | 10:00 | N/A | <23.3 | <2.50 Cis permethrin<br><2.50 Trans permethrin<br><1.00 Flumethrin<br><1.00 Alphamethrin<br><1.00 Deltamethrin<br><5.00 Cyfluthrin<br><2.00 Lambda cyhalothrin | N/A | N/A |
| **2** | ST26463639 | Water | 11:00 | 0.056 | 29.3 | <0.002 Cis permethrin<br><0.002 Trans permethrin<br><0.002 Flumethrin<br><0.002 Alphamethrin<br><0.002 Deltamethrin<br><0.004 Cyfluthrin<br><0.004 Lambda cyhalothrin | <0.100 | <0.02 |
| **2** | ST26463639 | Sediment | 11:00 | N/A | <17.0 | <2.50 Cis permethrin<br><2.50 Trans permethrin<br><1.00 Flumethrin<br><1.00 Alphamethrin<br><1.00 Deltamethrin<br><5.00 Cyfluthrin<br><2.00 Lambda cyhalothrin | N/A | N/A |
| **3** | ST25823627 | Sediment | 12:30 | 0.036 | <10.0 | <0.002 Cis permethrin<br><0.002 Trans permethrin<br><0.002 Flumethrin<br><0.002 Alphamethrin<br><0.002 Deltamethrin<br><0.004 Cyfluthrin<br><0.004 Lambda cyhalothrin | <0.100 | <0.02 |

| Sample point number | Grid Ref | Sample type | Sampling Time | Ammonia (mg/l) | Pendimethalin (ng/l in water/ ug/kg in sediment) | Synthetic Pyrethroids (ug/l in water and ug/kg in sediment) | Glyphosate (ug/l) | Isoproturon (ug/l) |
|---|---|---|---|---|---|---|---|---|
| **3** | ST25823627 | Sediment | 12:30 | N/A | <25.9 | <2.50 Cis permethrin<br><2.50 Trans permethrin<br><1.00 Flumethrin<br><1.00 Alphamethrin<br><1.00 Deltamethrin<br><5.00 Cyfluthrin<br><2.00 Lambda cyhalothrin | N/A | N/A |
| **4** | ST256365 | Sediment | 13:30 | <0.03 | <10.0 | <0.002 Cis permethrin<br><0.002 Trans permethrin<br><0.002 Flumethrin<br><0.002 Alphamethrin<br><0.002 Deltamethrin<br><0.004 Cyfluthrin<br><0.004 Lambda cyhalothrin | <0.100 | 0.619 |
| **4** | ST256365 | Sediment | 13:30 | N/A | <32.6 | <2.50 Cis permethrin<br><2.50 Trans permethrin<br><1.00 Flumethrin<br><1.00 Alphamethrin<br><1.00 Deltamethrin<br><5.00 Cyfluthrin<br><2.00 Lambda cyhalothrin | N/A | N/A |
| **5** | ST264367 | No samples taken, ditches dry | | | | | | |

## Table VII.8: Farm B sampling event 4

| Sample point number | Grid Ref | Sample type | Sampling Time | Ammonia (mg/l) | Pendimethalin (ng/l in water/ ug/kg in sediment) | Synthetic Pyrethroids (ug/l in water and ug/kg in sediment) | Glyphosate (ug/l) | Isoproturon (ug/l) |
|---|---|---|---|---|---|---|---|---|
| **1** | ST26403630 | Water | 10:30 | 0.60 | 51.4 | <0.002 Cis Permethrin<br><0.002 Trans permethrin<br><0.002 Flumethrin<br><0.002 Alphamethrin<br><0.002 Deltamethrin<br><0.004 Cyfluthrin<br><0.004 Lambda Cyhalothrin | <0.10 | 0.849 |
| **1** | ST26403630 | Sediment | 10:30 | N/A | <5.0 | <2.5 Cis Permethrin<br><2.5 Trans permethrin<br><1.0 Flumethrin<br><1.0 Alphamethrin<br><1.0 Deltamethrin<br><5.0 Cyfluthrin<br><2.0 Lambda Cyhalothrin | N/A | N/A |
| **2** | ST26463639 | Water | 11:00 | 0.063 | >100 | <0.002 Cis Permethrin<br><0.002 Trans permethrin<br><0.002 Flumethrin<br><0.002 Alphamethrin<br><0.002 Deltamethrin<br><0.004 Cyfluthrin<br><0.004 Lambda Cyhalothrin | <0.10 | 4.37 |
| **2** | ST26463639 | Sediment | 11:00 | N/A | <5.0 | <2.5 Cis Permethrin<br><2.5 Trans permethrin<br><1.0 Flumethrin<br><1.0 Alphamethrin<br><1.0 Deltamethrin<br><5.0 Cyfluthrin<br><2.0 Lambda Cyhalothrin | N/A | N/A |
| **3** | ST25823627 | Sediment | 11:45 | 0.321 | 20.8 | <0.002 Cis Permethrin<br><0.002 Trans permethrin<br><0.002 Flumethrin<br><0.002 Alphamethrin<br><0.002 Deltamethrin<br><0.004 Cyfluthrin<br><0.004 Lambda Cyhalothrin | <0.10 | 0.397 |

| Sample point number | Grid Ref | Sample type | Sampling Time | Ammonia (mg/l) | Pendimethalin (ng/l in water/ ug/kg in sediment) | Synthetic Pyrethroids (ug/l in water and ug/kg in sediment) | Glyphosate (ug/l) | Isoproturon (ug/l) |
|---|---|---|---|---|---|---|---|---|
| **3** | ST25823627 | Sediment | 11:45 | N/A | <5.0 | <2.5 Cis Permethrin<br><2.5 Trans permethrin<br><1.0 Flumethrin<br><1.0 Alphamethrin<br><1.0 Deltamethrin<br><5.0 Cyfluthrin<br><2.0 Lambda Cyhalothrin | N/A | N/A |
| **4** | ST256365 | Sediment | 12:30 | 0.396 | 22.0 | <0.002 Cis Permethrin<br><0.002 Trans permethrin<br><0.002 Flumethrin<br><0.002 Alphamethrin<br><0.002 Deltamethrin<br><0.004 Cyfluthrin<br><0.004 Lambda Cyhalothrin | <0.10 | 2.77 |
| **4** | ST256365 | Sediment | 12:30 | N/A | <5.0 | <2.5 Cis Permethrin<br><2.5 Trans permethrin<br><1.0 Flumethrin<br><1.0 Alphamethrin<br><1.0 Deltamethrin<br><5.0 Cyfluthrin<br><2.0 Lambda Cyhalothrin | N/A | N/A |
| **5** | ST264367 | No samples taken, ditches dry | | | | | | |

## Table VII.9: Farm C sampling event 1

| Sample point number | Grid Ref | Sample type | Sampling Time | Ammonia (mg/l) | Trifluralin (ng/l) | Phenoxy-acids | Synthetic Pyrethroids (ug/l in water and ug/kg in sediment) | Glyphosate (ug/l) | Isoproturon (ug/l) | Gen Scan Semi-quantitative (ug/l) |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | SP 2447 4734 | Water | 12:00 | 0.046 | <11.4 | <0.040 (2,4,5-Trichlorophenoxy) Ethanoic Acid<br><0.050 (2,4-Dichlorophenoxy) Ethanoic Acid<br><0.040 2,3,6-Trichlorobenzoid Acid<br><0.040 2,4-DB<br><0.050 4-Chlorophenoxy Acetic Acid<br><0.040 Benazolin<br><0.040 Bentazone<br><0.040 Bromoxynil<br><0.040 Clopyralid<br><0.040 3,6-Dichloro(O-methoxybenzoic Acid)<br><0.040 Dichlorprop<br><0.040 Fenoprop<br><0.050 Fluroxypyr<br>N/R Imazapyr<br><0.040 Ioxynil<br><0.040 MCPA<br><0.060 MCPB<br><0.040 Mecoprop<br><0.040 Triclopyr | <0.001 Cis permethrin<br><0.001 Trans permethrin<br><0.001 Flumethrin<br><0.001 Alphamethrin<br><0.001 Deltamethrin<br><0.002 Cyfluthrin<br><0.002 Lamda cyhalothrin | <0.1 | 0.148 | 0.02 Simazine<br>0.07 Propyzamide<br>0.37 Caffeine<br>0.21 Isoproturon<br>0.03 Metazachlor<br>0.57 Benzenesulfonamide<br>Some hydrocarbons detected |
| **1** | SP 2447 4734 | Sediment | 12:00 | N/A | N/A | N/A | <2.50 Cis permethrin<br><2.50 Trans permethrin<br><1.00 Flumethrin<br><1.00 Alphamethrin<br><1.00 Deltamethrin<br><5.00 Cyflutrhin<br><2.0 Lambda Cyhalothrin | N/A | N/A | N/A |

| Sample point number | Grid Ref | Sample type | Sampling Time | Ammonia (mg/l) | Trifluralin (ng/l) | Phenoxy-acids | Synthetic Pyrethroids (ug/l in water and ug/kg in sediment) | Glyphosate (ug/l) | Isoproturon (ug/l) | Gen Scan Semi-quantitative (ug/l) |
|---|---|---|---|---|---|---|---|---|---|---|
| **2** | SP 2297 4860 | Water | 11:00 | 0.042 | <11.4 | <0.040 (2,4,5-Trichlorophenoxy) Ethanoic Acid<br><0.050 (2,4-Dichlorophenoxy) Ethanoic Acid<br><0.040 2,3,6-Trichlorobenzoid Acid<br><0.040 2,4-DB<br><0.050 4-Chlorophenoxy Acetic Acid<br><0.040 Benazolin<br><0.040 Bentazone<br><0.040 Bromoxynil<br><0.040 Clopyralid<br><0.040 3,6-Dichloro(O-methoxybenzoic Acid)<br><0.040 Dichlorprop<br><0.040 Fenoprop<br><0.050 Fluroxypyr<br>N/R Imazapyr<br><0.040 Ioxynil<br><0.040 MCPA<br><0.060 MCPB<br><0.040 Mecoprop<br><0.040 Triclopyr | <0.001 Cis permethrin<br><0.001 Trans permethrin<br><0.001 Flumethrin<br><0.001 Alphamethrin<br><0.001 Deltamethrin<br><0.002 Cyflutrhin<br><0.002 Lambda Cyhalothrin | <0.1 | 0.125 | 0.05 Simazine<br>0.40 Caffeine<br>0.03 Metazachlor<br>0.07 Propyzamide<br>0.79 Acetophenone<br>0.94 Benzenesulfonamide<br>0.18 Isoproturon |
| **2** | SP 2297 4860 | Sediment | 11:00 | N/A | N/A | N/A | <10.0 Cis permethrin<br><10.0 Trans permethrin<br><1.00 Flumethrin<br><1.00 Alphamethrin<br><1.00 Deltamethrin<br><20.0 Cyflutrhin<br><2.0 Lambda Cyhalothrin | N/A | N/A | N/A |

| Sample point number | Grid Ref | Sample type | Sampling Time | Ammonia (mg/l) | Trifluralin (ng/l) | Phenoxy-acids | Synthetic Pyrethroids (ug/l in water and ug/kg in sediment) | Glyphosate (ug/l) | Isoproturon (ug/l) | Gen Scan Semi-quantitative (ug/l) |
|---|---|---|---|---|---|---|---|---|---|---|
| **3** | SP 2238 4897 | Water | 09:30 | 0.042 | <11.4 | <0.040 (2,4,5-Trichlorophenoxy) Ethanoic Acid<br><0.050 (2,4-Dichlorophenoxy) Ethanoic Acid<br><0.040 2,3,6-Trichlorobenzoid Acid<br><0.040 2,4-DB<br><0.050 4-Chlorophenoxy Acetic Acid<br><0.040 Benazolin<br><0.040 Bentazone<br><0.040 Bromoxynil<br><0.040 Clopyralid<br><0.040 3,6-Dichloro(O-methoxybenzoic Acid)<br><0.040 Dichlorprop<br><0.040 Fenoprop<br><0.050 Fluroxypyr<br>N/R Imazapyr<br><0.040 Ioxynil<br><0.040 MCPA<br><0.060 MCPB<br><0.040 Mecoprop<br><0.040 Triclopyr | <0.001 Cis permethrin<br><0.001 Trans permethrin<br><0.001 Flumethrin<br><0.001 Alphamethrin<br><0.001 Deltamethrin<br><0.002 Cyflutrhin<br><0.002 Lambda Cyhalothrin | <0.1 | 0.136 | 0.06 Simazine<br>0.08 Propyzamide<br>0.41 Caffeine<br>0.23 Isoproturon<br>0.01 Bisphenol A<br>0.02 Metazachlor<br>0.22 1H-Benzotriazone |
| **3** | SP 2238 4897 | Sediment | 09:30 | N/A | N/A | N/A | <2.5 Cis permethrin<br><2.5 Trans permethrin<br><1.00 Flumethrin<br><1.00 Alphamethrin<br><1.00 Deltamethrin<br><5.00 Cyflutrhin<br><2.0 Lambda Cyhalothrin | N/A | N/A | N/A |

| Sample point number | Grid Ref | Sample type | Sampling Time | Ammonia (mg/l) | Trifluralin (ng/l) | Phenoxy-acids | Synthetic Pyrethroids (ug/l in water and ug/kg in sediment) | Glyphosate (ug/l) | Isoproturon (ug/l) | Gen Scan Semi-quantitative (ug/l) |
|---|---|---|---|---|---|---|---|---|---|---|
| **4** | SP234 482 | Water | 13:30 | 0.067 | 111 | <0.040 (2,4,5-Trichlorophenoxy) Ethanoic Acid<br><0.050 (2,4-Dichlorophenoxy) Ethanoic Acid<br><0.040 2,3,6-Trichlorobenzoid Acid<br><0.040 2,4-DB<br><0.050 4-Chlorophenoxy Acetic Acid<br><0.040 Benazolin<br>0.090 Bentazone<br><0.040 Bromoxynil<br>0.390 Clopyralid<br><0.040 3,6-Dichloro(O-methoxybenzoic Acid)<br><0.040 Dichlorprop<br><0.040 Fenoprop<br><0.050 Fluroxypyr<br>N/R Imazapyr<br><0.040 Ioxynil<br><0.040 MCPA<br><0.060 MCPB<br><0.040 Mecoprop<br><0.040 Triclopyr | <0.001 Cis permethrin<br><0.001 Trans permethrin<br><0.001 Flumethrin<br><0.001 Alphamethrin<br><0.001 Deltamethrin<br><0.002 Cyflutrhin<br><0.002 Lambda Cyhalothrin | 0.459 | 2.090 | 0.3 Acenapthylene<br>0.09 Trifluralin<br>0.13 Simazine<br>13 Propyzamide<br>0.03 Anthracene<br>0.33 Caffeine<br>1.54 Isoproturon<br>0.35 Terbutryne<br>0.52 Ehtofumesate<br>0.06 Bentazone<br><0.01 Sulfur S8<br>0.76 Pendimethalin<br><0.01 Triadimenol<br>0.14 Pyrene<br>0.04 Flutriafol<br><0.01 Bisphenol A<br>0.07 Flusilazole<br>0.07 Tebuconazole<br>0.34 Epoxiconazole<br>0.07 Benzo(a)anthracene<br>0.12 Chrysene<br>0.1 Benzo(k)fluoranthene<br>0.1 Benzo(a)pyrene<br>0.06 Perylene<br>0.1 Indeno(1,2,3-cd)pyrene<br>0.02 Dibenzo(a,h)anthracene<br>0.17 Benzo(ghi)perylene<br>0.7 Benzoic Acid, p-tert-butyl-<br>0.87 2(3H)-Benzothiazolone<br>1.06 Benzenesulfonamide, N-butyl<br>0.17 Fluoranthene |
| **4** | SP234 482 | Sediment | No sediment samples taken | | | | | | | |

## Table VII.10: Farm C sampling event 2

| Sample point number | Grid Ref | Sample type | Sampling Time | Ammonia (mg/l) | Trifluralin (ng/l) | Pendimethalin (ng/l in water/ ug/kg in sediment) | Synthetic Pyrethroids (ug/l in water and ug/kg in sediment) | Glyphosate (ug/l) | Isoproturon (ug/l) |
|---|---|---|---|---|---|---|---|---|---|
| **1** | SP24474734 | Water | 12:30 | 0.036 | <57.0 | 384 | <0.001 Cis permethrin<br><0.001 Trans permethrin<br><0.001 Flumethrin<br><0.001 Alphamethrin<br><0.001 Deltamethrin<br><0.002 Cyfluthrin<br><0.002 Lambda cyhalothrin | 3.34 | 3.144 |
| **1** | SP24474734 | Sediment | 12:30 | N/A | N/A | <24.5 | <2.50 Cis permethrin<br><2.5 Trans permethrin<br><1.00 Flumethrin<br><1.00 Alphamethrin<br><1.00 Deltamethrin<br><5.00. Cyfluthrin<br><2.00 Lambda cyhalothrin | N/A | N/A |
| **2** | SP22974860 | Water | 11:00 | 0.032 | <11.4 | 19.1 | <0.001 Cis permethrin<br><0.001 Trans permethrin<br><0.001 Flumethrin<br><0.001 Alphamethrin<br><0.001 Deltamethrin<br><0.002 Cyfluthrin<br><0.002 Lambda cyhalothrin | <0.1 | 0.134 |
| **2** | SP22974860 | Sediment | 11:00 | N/A | N/A | <21.0 | <2.50 Cis permethrin<br><2.5 Trans permethrin<br><1.00 Flumethrin<br><1.00 Alphamethrin<br><1.00 Deltamethrin<br><5.00. Cyfluthrin<br><2.00 Lambda cyhalothrin | N/A | N/A |

| Sample point number | Grid Ref | Sample type | Sampling Time | Ammonia (mg/l) | Trifluralin (ng/l) | Pendimethalin (ng/l in water/ ug/kg in sediment) | Synthetic Pyrethroids (ug/l in water and ug/kg in sediment) | Glyphosate (ug/l) | Isoproturon (ug/l) |
|---|---|---|---|---|---|---|---|---|---|
| **3** | SP22384897 | Water | 10:00 | 0.032 | <11.4 | 18.5 | <0.001 Cis permethrin<br><0.001 Trans permethrin<br><0.001 Flumethrin<br><0.001 Alphamethrin<br><0.001 Deltamethrin<br><0.002 Cyfluthrin<br><0.002 Lambda cyhalothrin | <0.1 | 0.129 |
| **3** | SP22384897 | Sediment | 10:00 | N/A | N/A | <25.3 | <5.00 Cis permethrin<br><5.00 Trans permethrin<br><1.00 Flumethrin<br><1.00 Alphamethrin<br><1.00 Deltamethrin<br><10.0 Cyfluthrin<br><2.00 Lambda cyhalothrin | N/A | N/A |
| **4** | SP234 482 | Water | 13:00 | 0.220 | <11.4 | 21.4 | <0.005 Cis permethrin<br><0.005 Trans permethrin<br><0.005 Flumethrin<br><0.005 Alphamethrin<br><0.005 Deltamethrin<br><0.010 Cyfluthrin<br><0.010 Lambda cyhalothrin | <0.1 | 0.115 |
| **4** | SP234 482 | Sediment | No sediment samples taken | | | | | | |

## Table VII.11: Farm C sampling event 3

| Sample point number | Grid Ref | Sample type | Sampling Time | Ammonia (mg/l) | Trifluralin (ng/l) | Pendimethalin (ng/l in water/ ug/kg in sediment) | Synthetic Pyrethroids (ug/l in water and ug/kg in sediment) | Glyphosate (ug/l) | Isoproturon (ug/l) |
|---|---|---|---|---|---|---|---|---|---|
| **1** | SP24474734 | Water | 10:30 | 0.033 | <11.4 | 29.7 | <0.001 Cis Permethrin<br><0.001 Trans Permethrin<br><0.001 Flumethrin<br><0.001 Alphamethrin<br><0.001 Deltamethrin<br><0.002 Cyfluthrin<br><0.002 Lamda Cyhalothrin | <0.1 | 0.765 |
| **1** | SP24474734 | Sediment | 10:30 | N/A | N/A | <30.0 | <2.50 Cis Permethrin<br><2.50 Trans Permethrin<br><1.00 Flumethrin<br><1.00 Alphamethrin<br><1.00 Deltamethrin<br><5.00 Cyfluthrin<br><2.00 Lamda Cyhalothrin | N/A | N/A |
| **2** | SP22974860 | Water | 11:30 | <0.030 | <11.4 | 32.5 | <0.001 Cis Permethrin<br><0.001 Trans Permethrin<br><0.001 Flumethrin<br><0.001 Alphamethrin<br><0.001 Deltamethrin<br><0.002 Cyfluthrin<br><0.002 Lamda Cyhalothrin | <0.1 | 0.866 |
| **2** | SP22974860 | Sediment | 11:30 | N/A | N/A | <23.9 | <2.50 Cis Permethrin<br><2.50 Trans Permethrin<br><1.00 Flumethrin<br><1.00 Alphamethrin<br><1.00 Deltamethrin<br><5.00 Cyfluthrin<br><2.00 Lamda Cyhalothrin | N/A | N/A |

| Sample point number | Grid Ref | Sample type | Sampling Time | Ammonia (mg/l) | Trifluralin (ng/l) | Pendimethalin (ng/l in water/ ug/kg in sediment) | Synthetic Pyrethroids (ug/l in water and ug/kg in sediment) | Glyphosate (ug/l) | Isoproturon (ug/l) |
|---|---|---|---|---|---|---|---|---|---|
| **3** | SP22384897 | Water | 13:00 | <0.030 | <11.4 | 31.6 | <0.001 Cis Permethrin<br><0.001 Trans Permethrin<br><0.001 Flumethrin<br><0.001 Alphamethrin<br><0.001 Deltamethrin<br><0.002 Cyfluthrin<br><0.002 Lamda Cyhalothrin | <0.1 | 0.859 |
| **3** | SP22384897 | Sediment | 13:00 | N/A | N/A | <25.8 | <2.50 Cis Permethrin<br><2.50 Trans Permethrin<br><1.00 Flumethrin<br><1.00 Alphamethrin<br><1.00 Deltamethrin<br><5.00 Cyfluthrin<br><2.00 Lamda Cyhalothrin | N/A | N/A |
| **4** | SP234 482 | Water | 14:00 | 0.083 | 82.1 | 102 | <0.001 Cis Permethrin<br><0.001 Trans Permethrin<br><0.001 Flumethrin<br><0.001 Alphamethrin<br><0.001 Deltamethrin<br><0.002 Cyfluthrin<br><0.002 Lamda Cyhalothrin | <0.1 | 0.746 |
| **4** | SP234 482 | Sediment | No sediment samples taken | | | | | | |

## Table VII.12: Farm C sampling event 4

| Sample point number | Grid Ref | Sample type | Sampling Time | Ammonia (mg/l) | Trifluralin (ng/l) | Pendimethalin (ng/l in water/ ug/kg in sediment) | Synthetic Pyrethroids (ug/l in water and ug/kg in sediment) | Glyphosate (ug/l) | Isoproturon (ug/l) |
|---|---|---|---|---|---|---|---|---|---|
| **1** | SP24474734 | Water | 11:30 | <0.03 | 17.4 | 34.0 | <0.002 Cis permethrin<br><0.002 Trans permethrin<br><0.002 Flumethrin<br><0.002 Alphamethrin<br><0.002 Deltamethrin<br><0.004 Cyfluthrin<br><0.004 Lambda cyhalothrin | <0.10 | 0.163 |
| **1** | SP24474734 | Sediment | 11:30 | N/A | N/A | <5.0 | <2.50 Cis permethrin<br><2.50 Trans permethrin<br><1.00 Flumethrin<br><1.00 Alphamethrin<br><1.00 Deltamethrin<br><5.00 Cyfluthrin<br><2.00 Lambda cyhalothrin | N/A | N/A |
| **2** | SP22974860 | Water | 11:00 | <0.03 | 21.4 | 32.1 | <0.002 Cis permethrin<br><0.002 Trans permethrin<br><0.002 Flumethrin<br><0.002 Alphamethrin<br><0.002 Deltamethrin<br><0.004 Cyfluthrin<br><0.004 Lambda cyhalothrin | <0.10 | 0.167 |
| **2** | SP22974860 | Sediment | 11:00 | N/A | N/A | <5.0 | <2.50 Cis permethrin<br><2.50 Trans permethrin<br><1.00 Flumethrin<br><1.00 Alphamethrin<br><1.00 Deltamethrin<br><5.00 Cyfluthrin<br><2.00 Lambda cyhalothrin | N/A | N/A |

| Sample point number | Grid Ref | Sample type | Sampling Time | Ammonia (mg/l) | Trifluralin (ng/l) | Pendimethalin (ng/l in water/ ug/kg in sediment) | Synthetic Pyrethroids (ug/l in water and ug/kg in sediment) | Glyphosate (ug/l) | Isoproturon (ug/l) |
|---|---|---|---|---|---|---|---|---|---|
| **3** | SP22384897 | Water | 10:00 | <0.03 | 21.9 | 31.9 | <0.002 Cis permethrin<br><0.002 Trans permethrin<br><0.002 Flumethrin<br><0.002 Alphamethrin<br><0.002 Deltamethrin<br><0.004 Cyfluthrin<br><0.004 Lambda cyhalothrin | <0.10 | 0.164 |
| **3** | SP22384897 | Sediment | 10:00 | N/A | N/A | <5.0 | <2.50 Cis permethrin<br><2.50 Trans permethrin<br><1.00 Flumethrin<br><1.00 Alphamethrin<br><1.00 Deltamethrin<br><5.00 Cyfluthrin<br><2.00 Lambda cyhalothrin | N/A | N/A |
| **4** | SP234 482 | Water | 12:00 | 0.298 | 12.1 | 34.0 | <0.002 Cis permethrin<br><0.002 Trans permethrin<br><0.002 Flumethrin<br><0.002 Alphamethrin<br><0.002 Deltamethrin<br><0.004 Cyfluthrin<br><0.004 Lambda cyhalothrin | 0.240 | 0.798 |
| **4** | SP234 482 | Sediment | No sediment samples taken | | | | | | |