Environmental Protection Report

AN ASSESSMENT OF WATER QUALITY IN THE RIVER YARTY CATCHMENT

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Authors: T R Geatches and L A Wilcock
Freshwater Biologist and Technician

C.V.M. Davies
Environmental Protection Manager

NRA
National Rivers Authority
South West Region

Typical land use in the upper Yarty catchment

Slurry spreading in the River Yarty catchment

Farm drainage entering the Whitestaunton Stream

Sphaerotilus natans (Sewage fungus) growth downstream
of septic tank discharges at Whitestaunton

This investigation and report was undertaken by staff of the Freshwater Investigations Team (FWIT) and Task Force. Andy Locke (Warden) and Andrew Sweetapple (Pollution Inspector) provided background information on pollution problems in the catchment.

AN ASSESSMENT OF WATER QUALITY IN THE RIVER YARTY CATCHMENT.

SUMMARY

Routine water quality monitoring in the River Yarty has identified non-compliance with quality standards specified in the EC Freshwater Fish directive and the National Water Council (NWC) classification system during 1990.

Chemical and biological surveys were carried out during December 1991 to determine the cause of poor water quality and to determine the general water quality status throughout the catchment.

Biological samples were collected at 42 sites and grouped according to their similarity. 4 sites were classed as significantly polluted, 22 as slightly polluted, 8 as unpolluted and 8 did not fall into any clear grouping.

Chemical samples collected during high river flows did not have BOD and ammonia concentrations above quality standards except at one site in the Stockland Stream. It is thought that during this one-off chemical survey land run off was at a minimum due to the low level of rainfall throughout the catchment.

Areas of poor water quality identified in the initial screening survey were further investigated to locate the sources of poor water quality using biological indicators and the NRA Task Force.

34 pollution sources were located in the River Yarty catchment. Farm drainage contributed to the majority of pollution sources with 20 sources attributable to this category of pollution. Yard run off was the main cause, with field run off of slurry, silage run off and dairy washings also identified in a few cases.

Other pollution sources were attributed to septic tank discharges (7 sources), a fish farm discharge, siltation from duck ponds (2 sources), oil (2 sources) and slight metalliferous pollution due to natural drainage of metalliferous soils and disturbance of the soil due to recently constructed ponds.

This study has highlighted the effectiveness of using biological indicators to locate polluting discharges. Aquatic macroinvertebrates and growth of sewage fungus are sensitive to long-term chronic pollution which is easily missed during one-off chemical surveys and by visual inspection.

It is recommended that the unconsented discharges are controlled and consented where appropriate.

FWI/92/006

T.R. Geatches & L.A. Wilcock
Environmental Protection
Freshwater Investigations Team
NRA South West Region
Manley House
EXETER

CONTENTS.

AN ASSESSMENT OF WATER QUALITY IN THE RIVER YARTY CATCHMENT

1. INTRODUCTION.

In recent years the salmonid fishery of the River Axe has declined and concern has been expressed over the low fish densities found in the 1990 survey of the River Yarty, a major sub-catchment of the River Axe and an important nursery area.

Water quality at the designated EC Freshwater Fish Directive monitoring site on the River Yarty did not comply with the criteria for total ammonia in 1989. In addition, the 1990 National Water Council (NWC) Classification of water quality showed non-compliance with quality standards appropriate to a NWC Class 1B watercourse.

In response to concern expressed over deteriorating river water quality and the declining salmonid fishery, the Axe Catchment Action Plan reported that the NRA would investigate the reasons for non-compliance in the River Yarty catchment with the EC Freshwater Fish Directive by the end of 1991.

Therefore, this study sets out to :

1. determine the reasons and causes of non-compliance with the EC Freshwater Fish Directive in the River Yarty catchment.

2. determine the cause of non-compliance with NWC standards in the River Yarty catchment.

3. determine the general water quality status throughout the catchment.

4. identify the sources of any water quality problems.

5. make recommendations to improve water quality.

2. STUDY AREA.

The River Yarty and the Corry Brook form the Yarty Catchment and drain the north-west part of the River Axe Catchment. The River Yarty rises at the eastern end of the Blackdown Hills (300m) and flows southwards to join the River Axe south west of Axminster.

The River Yarty catchment covers an area of 96.1 km^2 and is formed mainly of Keuper Marls with some outcrops of sandstone. The catchment is generally of a rural nature with dairy farming the predominant land use.

The River Yarty receives significant effluents from 4 SWWS Plc sewage treatment works (STW) and a fish farm. A SSWS Plc STW and a private STW are the significant effluents in the Corry Brook sub-catchment (see Figure 1).

2.1. River Quality Objectives.

The Yarty catchment, which includes the River Yarty and the Corry Brook, has been assigned a river quality objective (RQO) of Class 1B - lesser good quality. Water quality is routinely monitored at 6 sites in the Yarty Catchment (see Figure 1).

Designated reach compliance with the EC Freshwater Fish Directive is monitored at two sites in the catchment; at Gammon's Hill (NGR SY 2815 9801) on the River Yarty and prior to the confluence with the Yarty (NGR SY 2808 9820) on the Corry Brook.

2.2. River Uses.

The National Rivers Authority-South West (NRA-SW) have adopted the following use-related Environmental Quality Objectives for the Yarty Catchment:

* Protection of Aesthetic Quality
* Protection of Direct Abstraction for Potable Supply
* Protection of Salmonid Fish
* Protection of Other Aquatic Life/Dependent Organisms
* Protection of Livestock Watering
* Protection of Irrigation of Crops

3. BACKGROUND.

3.1. Review of Routine River Water Quality Data.

3.1.1. Historical Water Quality - NWC Classification.

TABLE 1. NWC Classification since 1985.

Site	1985	1986	1987	1988	1989	1990
Newhaven Bridge	1B	2	2	2	1B	1B
Longbridge	2	3	3	2	2	1B
Beckford Bridge	2	3	3	2	2	2
Gammon's Hill	2	2	2	1B	2	2
Rose Farm	2	1B	3	3	2	1B
Prior to Yarty	1B	1B	1B	1B	2	2

1. The upper routine water quality monitoring sites - Newhaven and Longbridge of the River Yarty comply with the 1B RQO in the 1990 Classification, but have not complied in all previous years.

2. From Beckford Bridge downstream to the River Axe confluence the River Yarty's water quality has been Class 2 in both the 1989 and 1990 Classification.

3. The reach above Rose Farm on the Corry Brook complied with the 1B RQO in 1990, although previously it has been Class 2 or 3. The reach

on the Corry Brook prior to the Yarty was Class 2 in 1990 and 1989 although it had previously been 1B.

3.1.2. Non-compliant Determinands.

Table 2. Determinands causing non-compliance in the 1990 NWC Classification.

River	Site	BOD	Total Ammonia	RQO
		Quality Class		
Yarty	Beckford Bridge	2		1B
	Gammon's Hill	2		1B
Corry	Prior to River Yarty		2	1B

1. Total ammonia, suspended solids and BOD concentrations in excess of the standards for a 1B river were recorded at Beckford Bridge and Gammon's Hill on 10 April 1989. These were associated with rainfall and caused non-compliance with the RQO in 1989 and 1990 and the standards of the EC Freshwater Fish Directive in 1989.

2. Two high total ammonia concentrations associated with rainfall events were recorded on 17 November 1989 and 2 January 1990 in the Corry Brook prior to the Yarty confluence. BOD complied with the RQO's on these occasions. The main River Yarty downstream of the Corry Brook confluence was not sampled on these occasions and therefore the impact on the River Yarty was not recorded.

3.2. Routine Biological Data.

Routine biological data is analysed by RIVPACS (River InVertebrate Prediction And Classification System). RIVPACS is a computer model which allows a prediction to be made of the composition of the invertebrate community that would be expected for an unpolluted site according to its geographical location, and certain natural physical and chemical properties of the river. Environmental quality indices (EQI) are calculated by dividing an observed biotic score by a predicted biotic score. Therefore, an EQI of 1 or greater is usually regarded to indicate unpolluted conditions.

Good BMWP and ASPT scores were found throughout the catchment during routine aquatic macroinvertebrate surveys (see Table 3.). The environmental quality indices (EQI) for ASPT as predicted by RIVPACS were good for all sites (see Table 3). However, the abundance of Asellidae at many of the sites indicated signs of organic enrichment.

Table 3. Biotic scores calculated from macroinvertebrate samples collected during 1990.

Site	BMWP	ASPT	ASPT EQI
100m U/S Newhaven Bridge	219	6.4	1.01
100m U/S A35 Bridge Gammons Hill	252	6.1	1.02
100m U/S Beckford Bridge	213	6.3	0.99
40m U/S Road Bridge Rose Farm	213	6.4	1.01
100m U/S Road Bridge Old Coryton	227	6.0	0.95

N.B. These scores are derived from the combination of three separate samples taken from each site during spring, summer and autumn.

3.3. Routine Fisheries Data.

Recent fisheries surveys, including 1990, detail the collapse of the salmon fishery and deterioration of the trout populations in the Yarty. Trout population densities were higher in the upper reaches of the Yarty, but the densities recorded in the 1979 survey had deteriorated by 1986.

3.4. Farm Campaign data.

215 farms in the catchment were visited in the winter of 1986/87 as part of the Farm Campaign. Of the farms visited 18% were found to be polluting, 20% were at high risk of polluting and 62% were at low risk of polluting. Follow up work between 1987 and 1989 was carried out to ensure remedial measures had been undertaken.

4. METHODS.

As non-compliance with the standards of the EC Freshwater Fish Directive and RQO's in the River Yarty catchment occurred during winter it was decided to undertake this study during winter. An initial screen of the catchment using chemical and biological surveys was used. The objectives of the screening survey were to assist in the location of areas of poor water quality and to identify pollution indicators which could be used in locating the causes.

4.1. Identification of poor water quality areas.

The screening survey covered 21 sub-catchments (see Figure 2). It was decided to sample major tributaries (ie, those identified on a 1:50000 OS map) prior to their confluence with the main River Yarty and Corry Brook. The main River Yarty and Corry Brook upstream and downstream of the tributaries were also sampled. Aquatic macroinvertebrates samples were only collected at sites in the main river downstream of the tributary confluences where problems were detected in the tributaries.

Chemical methods

Previous experience has shown that poor water quality in intensive agricultural catchments is associated with land runoff during heavy rainfall. The chemical survey was therefore carried out following a period of significant rainfall.

Three sampling runs were carried out simultaneously within the catchment to minimise the time lag between sample collection. The runs were carried out before the river reached full spate to coincide with maximum land runoff. The survey was carried out on the 17 December 1991.

Spot samples were analysed for a general sanitary determinand suite including suspended solids. Dissolved oxygen and temperature readings were taken with WTW Oxi 196 meters on site.

Biological methods

Aquatic macroinvertebrate samples were taken using a 1.0 mm mesh pond net. A kick sampling technique was employed in a riffle area of the site for one minute duration. Samples were examined on site and macroinvertebrates were identified to family level. Standard abundance categories were assigned to each recorded taxon. Macrophytes, algae, sewage fungus cover and physical details of the sample area were all recorded on site. The survey was carried out between 4 and 13 of December 1991.

It was decided to analyse the macroinvertebrate data by grouping the sites according to similarities in their macroinvertebrate communities. Each group could then be given a pollution code according to the macroinvertebrates common to a particular group. A similar methodology is being developed by the Water Research Centre (WRc) for the NRA, where indicator taxa are used to classify a site into different classes according the severity of organic pollution from farm drainage. The WRc method was not used in this study but the concept modified so that the total macroinvertebrate community was examined. It was felt that this would enable more information to be gained at the expense of little extra time spent in the field.

The macroinvertebrate samples from the 42 sites were classified using Jaccard's Similarity Index to give a measure of similarity between sites. Sewage fungus was also included as a variable in the analysis. The cluster analysis was run so that taxa in abundance categories 10-99 and 100-999 were counted as additional taxa. This was done in order to increase similarity between sites with similar taxa dominance. Sewage fungus was similarly weighted by using relative abundance categories (0-1%, 1-10% and 11-100%).

4.2. Causes of poor water quality.

4.2.1. Biological and Task Force methods.

Areas of poor water quality identified in the screening survey were further investigated to locate the causes. Two methods were employed to locate sources of pollution. The Task Force covered the Stockland Stream,

Andrewhayes Stream and parts of the Corry Brook. All other areas within the catchment were covered by FWIT Biologists.

FWIT Biologists

Biological indicators of poor water quality identified in the screening survey were used to locate sources of pollution. Some sources of pollution were sampled chemically to confirm their nature and effect. Survey work was carried out between 21 January and 4 March 1992.

Pollution Inspectors and Wardens (Task Force)

The Task Force's role is to enforce identified pollution sources (unsatisfactory consented and unconsented sources) and aims at an intensive coverage of selected watercourses. Any significant effluent was formally sampled with a view to prosecution. Survey work was carried out between 19 December 1991 and 22 January 1992.

4.2.2. Chemical methods.

A pHOX 100DPM continuous water quality monitor linked to a Meteorburst telemetry system was installed at Gammons Hill Bridge on the River Yarty. This had been already identified as an area of poor water from the routine water quality data. This system acted as an early warning system of episodic pollution. When the monitor alarmed a chemical survey was carried out to sample effluents identified by the biological survey or task force as being of high risk of causing non-compliance at the EC Fish directive sites.

5. RESULTS.

5.1. Identification of poor water quality areas.

BOD concentrations did not exceed the standards for a NWC Class 1B river (5mg/1) and the guideline value for a designated salmonid fishery at all main river and tributary sites during the screening survey. The total ammonia concentrations exceeded the 1B standard (0.7 mg/lN) at site 29 only in the Stockland Stream (see Figure 3 and Appendix 2).

Distinct groupings of sites were found using the biological analysis (see Appendix 3 and Figure 4). Common biological and chemical characteristics of the sites are as follows:

Group A - significant organic pollution

This group consisted of 4 tributary sites with 50% or greater similarity. At least 10 Asellidae, 10 Oligocheata and 10% sewage fungus cover was recorded at all sites. Baetidae, Chironomidae, Elmidae and Gammaridae were common to all sites in this group. Plecoptera were not recorded at any site.

The mean total ammonia concentration was 0.62 mg/1 N (range 0.18 to 1.20 mg/1 N). The mean BOD was 2.6 mg/1 (range 1.7 to 3.4 mg/1).

Group B - slight organic pollution

This group consisted of 7 main river sites (Corry Brook and River Yarty) with 50% or greater similarity. An additional site (site 44) was 40% similar to this group. At least 10 Baetidae and 10 Oligocheata were recorded at all sites. Heptageniidae, Athericidae, Chironomidae, Simuliidae, Tipulidae, Elmidae, Gyrinidae and Ancylidae were common to all sites in this group. The sites tended to be in the lower reaches of the catchment and taxa typical of larger rivers were well represented.
The mean total ammonia concentration was 0.08 mg/l N (range 0.07 to 0.09 mg/l N). The mean BOD was 1.5 mg/l (range 1.3 to 1.6 mg/l).

Group C - slight organic pollution

This group consisted of 12 main river sites and 3 tributary sites with 50% or greater similarity. At least 10% sewage fungus cover was recorded at all sites. Baetidae, Heptageniidae, Rhyacophilidae, Sericostomatidae, Chironomidae, Simuliidae, Tipulidae, Gammaridae and Oligocheata were common to all sites in this group.

The sites in this group tended to be in the middle and upper reaches of the catchment. This was reflected in the macroinvertebrate communities since taxa associated with larger rivers recorded at group B sites where not present.

The mean total ammonia concentration was 0.15 mg/l N (range 0.04 to 0.53 mg/l N). The mean BOD was 1.6 mg/l (range 1.0 to 2.0 mg/l).

Group D - unpolluted

This group consisted of 1 main river site and 7 tributary sites with 40% or greater similarity. 5 of these sites were 45% similar to Group C sites. At least 10 Heptageniidae was recorded at all sites. Baetidae, Leuctridae, Perlodidae, Hydropsychidae and Gammaridae were common to all sites in this group. Sewage fungus was absent or <1% at all sites.

The mean total ammonia concentration was 0.03 mg/l N (range 0.02 to 0.04 mg/l N). The mean BOD was 1.1 mg/l (range 1.0 to 1.3 mg/l).

Ungrouped sites

8 sites did not fall into any clear group due to habitat differences or pollution problems.

5.2. Causes of poor water quality.

5.2.1. Biological and task force methods.

34 pollution sources were located in the River Yarty catchment and were of the following types (see Figures 6 to 17 for location and extent of impact):

1. Farms - 20 sources
2. Septic tanks - 7 sources
3. Fish farm - 1 source
4. Duck ponds - 2 sources
5. Oil - 2 sources
6. Metalliferous runoff - 1 source
7. Other organic effluent - 1 source

5.2.2. Chemical methods.

The ammonium concentrations recorded by the 100 DPM continuous monitoring unit at Gammons Hill Bridge did not exceed the NWC Class 1B standard (0.70 mg/l N). However a peak of 0.30 mg/l N occurred between 25-27 January 1992 and a peak of 0.45 mg/l N on 11 February 1992. These peaks coincided with rainfall events in the catchment (see Figure 5).

Spot sampling upstream of the monitor on 12 February 1992 identified run off of organic waste from a farm in the lower Corry Brook to be the most likely cause of the ammonium peaks recorded at Gammons Hill Bridge (see Figure 17).

6. DISCUSSION.

Screening chemical and biological surveys of the River Yarty catchment found evidence of widespread organic pollution (=34 out of 42 sites) during the screening survey. However, most of these sites (=30 sites) were classed as being only slightly polluted.

Good agreement was found between the chemical survey and biological classification. The highest total ammonia concentrations and BOD values were found at the Group A sites (significant pollution). The lowest ammonia concentrations and BOD values were found at the Group D sites (unpolluted).

Although widespread pollution was found during the biological screening survey, exceedence of the quality standards for Class 1B for total ammonia or BOD during the chemical screening survey was only recorded at one site. It is thought that during this one-off chemical survey farm drainage was at a minimum due to low intensity of rainfall. The biological information represents more chronic long-term problems. The dry winter has also enabled farmers to spread slurry onto fields and therefore the amount of slurry stored in lagoons, where pollution risk is highest, has been at a minimum.

Follow-up work into the cause of the poor water quality, identified in the biological screening survey, located a total of 34 significant sources of pollution (see Figures 6 to 17 for nature and extent of impact).

Run off of slurry from farmyards and storage lagoons was the main source of organic pollution from farms. Run off of slurry from fields was also found because slurry had been spread too close to the watercourse and had been applied too thickly. Pollution by silage liquor and dairy washing were identified at a few farms but none were considered a major source of pollution.

Pollution from septic tanks was widespread in the upper River Yarty catchment (7 sources). This was particularly severe in the Whitestaunton Stream, where a number of septic tanks from Whitestaunton village and probably Northay village discharge to the stream with minimal treatment (see Figure 8). There is no sewerage system or treatment works in this area at present. A toxic impact was suspected from one septic tank in the Blindmoor Stream (see Figure 7).

Biological and chemical evidence of severe organic pollution was found in the Membury Stream downstream of a fish farm (see Figure 13). This was probably a consequence of too intensive an operation at the fish farm. All of the Membury Stream was diverted into the fish farm, which would allow little or no control over the discharge of waste to the Membury Stream and consequently provided no dilution for the trade effluent from the fish farm.

Slight metalliferous pollution was identified in the Corrymoor Stream (see Figure 14). The macroinvertebrates in the headwaters of the stream upstream of recently constructed ponds were scarce and taxa known to be sensitive to metalliferous pollution were not recorded. Pedology of the headwaters consists of permeable peaty-topped soils and patches of ochre were widespread indicating natural metalliferous drainage. Downstream of the ponds chemical spot samples detected a slight increase in aluminium, copper and zinc probably as a consequence of soil disturbance. Visual evidence of siltation downstream of the ponds was supported by the macroinvertebrate community recorded.

Other sources of pollution located in the River Yarty catchment included leakage of fuel oil and turbid water from constructed duck ponds. The impact of these sources were local and minor in comparison to other pollution sources.

Siltation was identified in the Moorhayne Stream, probably as a consequence of recent building work and/or culverting upstream. The siltation had been recorded further upstream the year before, suggesting that the silt is gradually being washed downstream.

The evidence of widespread pollution found in this study may account for the deterioration in the salmonid fishery. Most of the discharges identified were insidious and relatively small but occurred throughout the catchment. These types of pollution are constantly changing from year to year as land-use practises vary. However, the overall effect results in eutrophication and long term changes in water quality.

The use of biological indicators to locate pollution.

The use of biological indicators of pollution has been particularly effective in locating sources of pollution in the River Yarty catchment. Macroinvertebrates are sensitive to long-term chronic pollution which is easily missed during one-off chemical monitoring surveys and by visual inspection. Biological sampling can be quick, effective and cheap. The biological screening survey took 6 days to complete with a further 14 days to locate the causes of pollution. This provided a comprehensive coverage of the catchment and detailed evidence of the nature and effects of pollution sources.

The use of RIVPACS for routine biological data analysis has indicated water quality in the River Yarty catchment to be of good quality (see Section 3.2). However, this study has clearly demonstrated widespread pollution. Several reasons can be put forward for this discrepancy:

1. Three seasons data are used in the RIVPACS analysis. Therefore, winter pollution could be masked by unpolluted conditions in summer or autumn.

2. It must also be noted that the predicted fauna for an unpolluted site in the RIVPACS programme may not necessarily represent truly unpolluted conditions. Macroinvertebrate samples were collected from the River Yarty catchment for use in the RIVPACS database to represent unpolluted conditions. This is now known to have been unlikely.

7. CONCLUSIONS.

1. A macroinvertebrate screening survey revealed poor water quality at 34 out of 42 sites throughout the River Yarty catchment.

2. The chemical survey revealed exceedance of NWC Class 1B standards for ammonia and BOD at only 1 site. It was thought more widespread non-compliance was not detected as a consequence of the timing of the survey during a period of low intensity rainfall.

3. Continuous monitoring in the River Yarty at Gammons Hill showed ammonia concentrations to increase during rainfall at the EC Freshwater Fish Directive site at Gammons Hill. The source was traced back to farm drainage in the Corry Brook.

4. Follow-up work of the cause of poor water quality, identified in the screening survey, located farms as a major source of organic pollution throughout the catchment (20 sources). Run off of slurry was the primary source.

5. Significant sources of pollution from domestic septic tanks were identified in the upper reaches of the River Yarty, the Blindmoor Stream and Whitestaunton Stream (7 sources).

6. A Fish Farm was found to be contributing a significant organic impact on the Membury Stream.

7. Slight pollution was identified in the Corrymooor Stream catchment as a result of natural drainage and disturbance of metalliferous soils.

8. Evidence of siltation was recorded in the Moorhayne Stream and downstream of constructed ponds throughout the catchment.

8. RECOMMENDATIONS.

1. Unconsented effluents identified in this study should be controlled and consented as appropriate.

   Action - Pollution Officer (Exeter)/Quality Regulation Officer

2. The operation of individual septic tanks identified as causing pollution should be investigated and appropriate measures taken to prevent pollution.

   Action - Pollution Officer (Exeter)/Quality Regulation Officer

3. Alternative treatment should be considered for the septic tank effluents from Whitestaunton. Plans for the construction of a sewerage scheme for Whitestaunton by South Somerset District Council should be investigated.

   Action - Quality Regulation Officer

4. Investigation of the source of organic pollution from Northay village should be undertaken. If this is proved also to be from septic tanks similar action to Whitestaunton village should be considered.

   Action - Pollution Officer (Exeter)/Quality Regulation Officer

5. A review of the consent to discharge for the Fish Farm on Membury Stream should be undertaken.

   Action - Quality Regulation Officer

Figure 1. Routine sampling points and major discharges in the River Yarty catchment

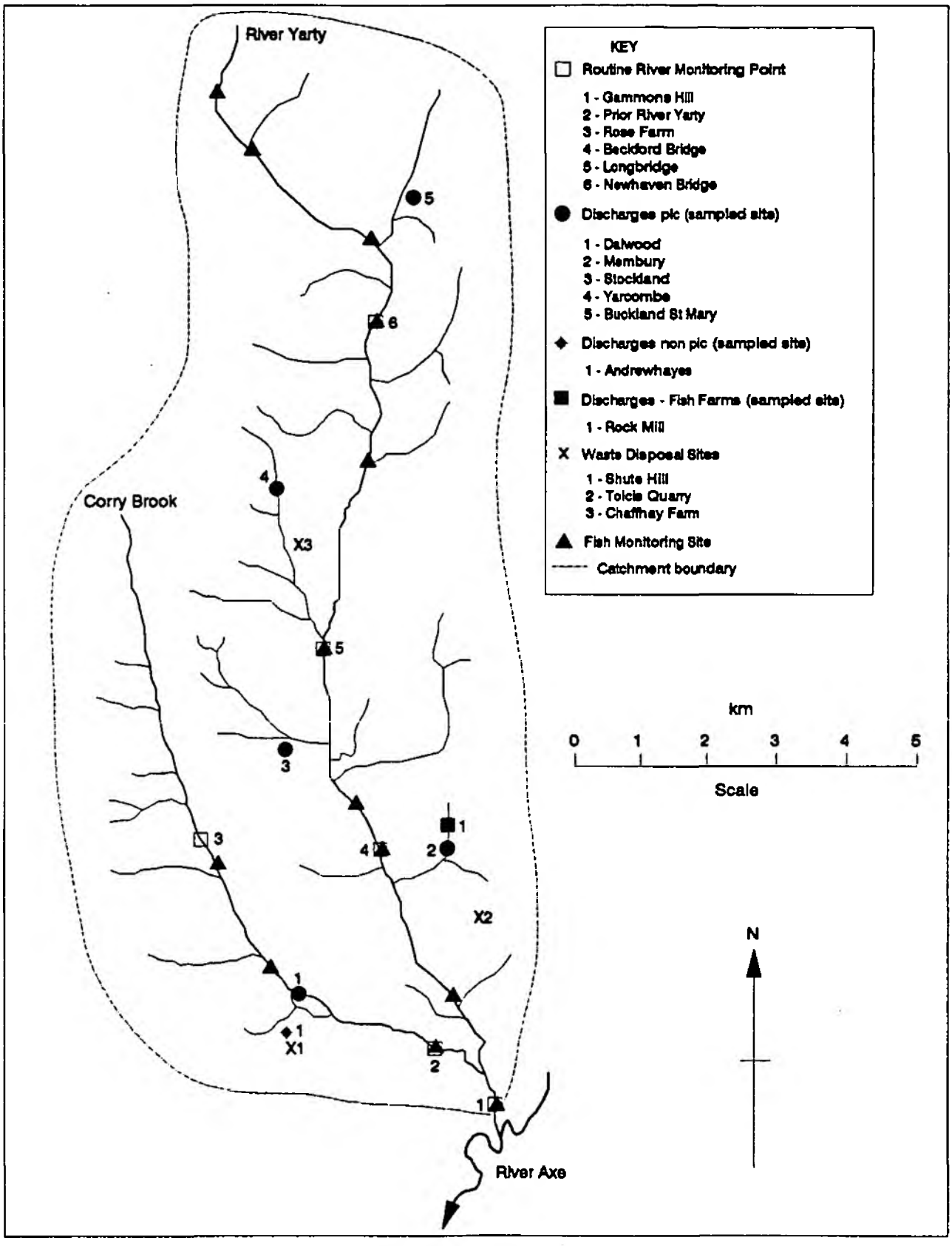


Figure 2. Biological and chemical sampling sites - screening survey

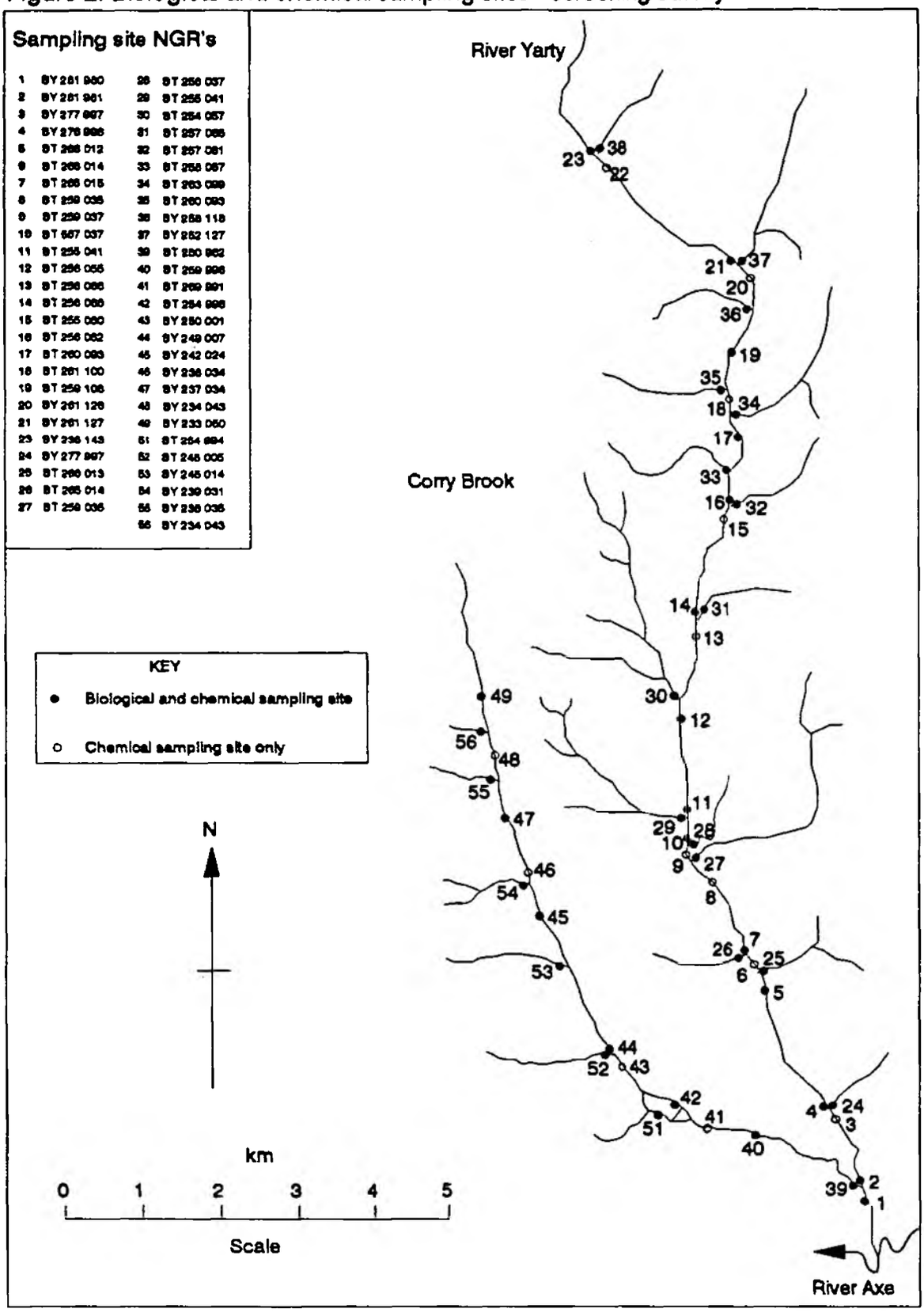


Figure 3. Comparable NWC chemical class indicated by chemical screening survey

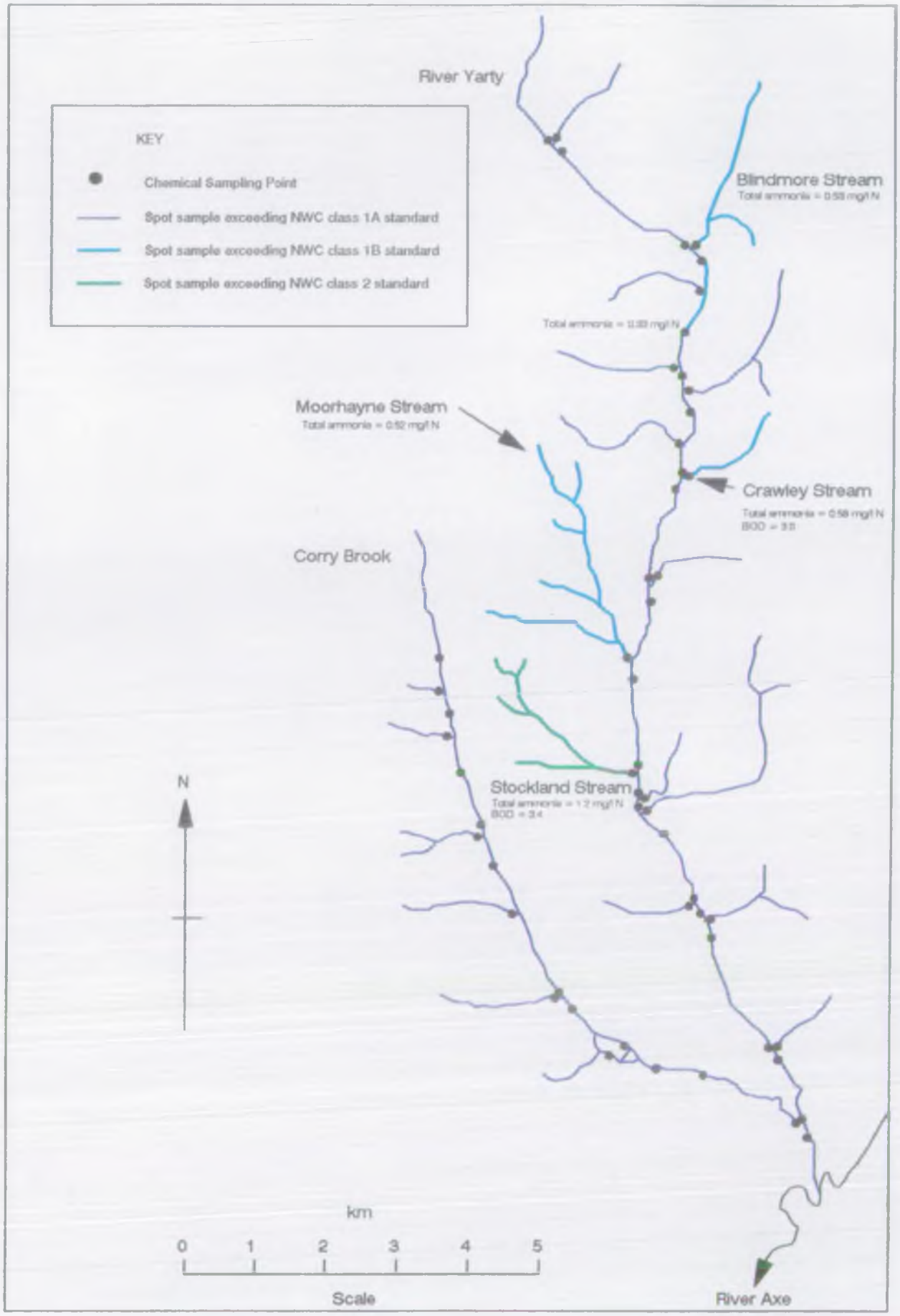


Figure 4. Summary of water quality indicated by the biological screening survey

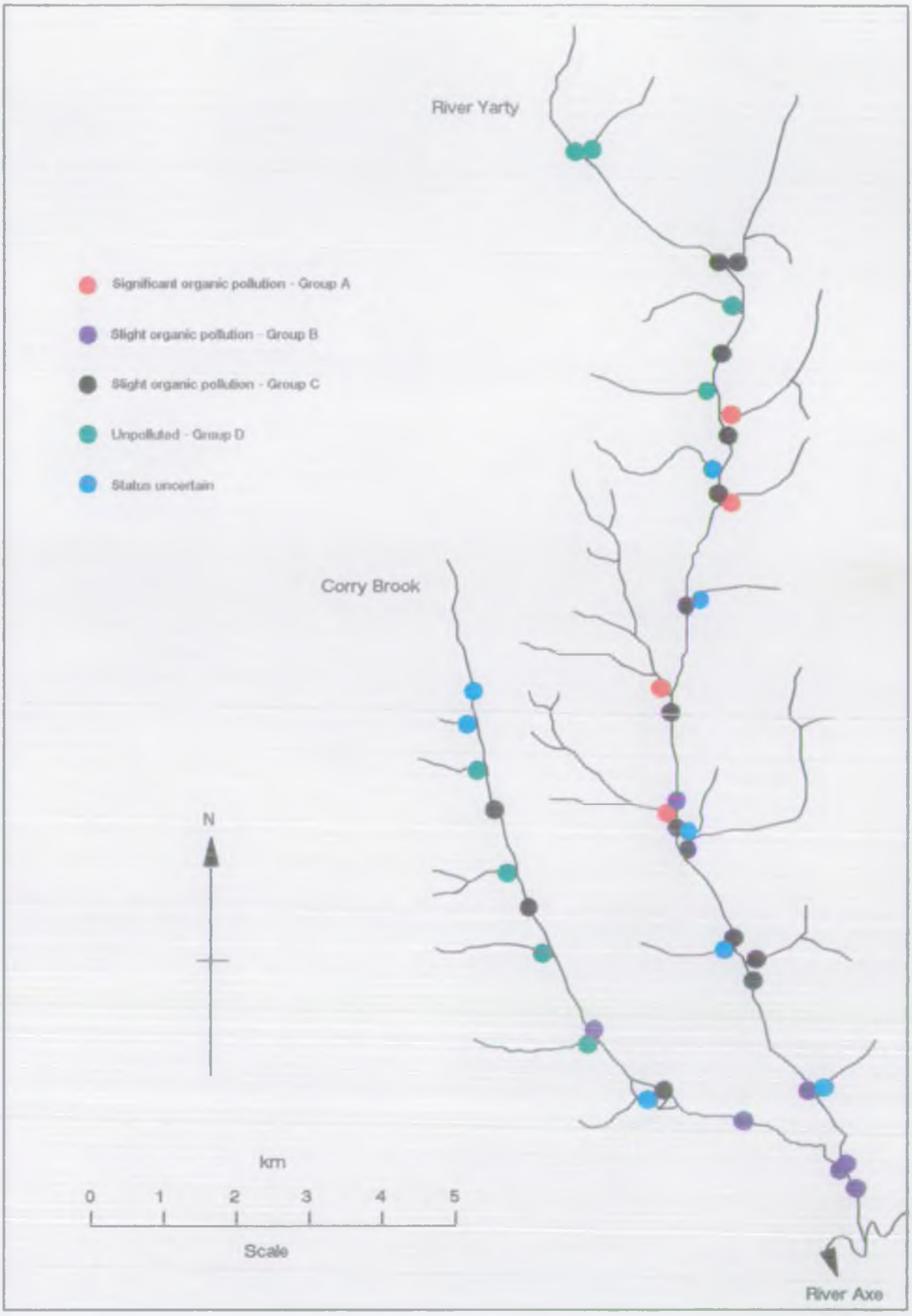


Figure 5. Ammonia concentrations and river stage height data in the River Yarty at Gammons Hill during January and February 1992.

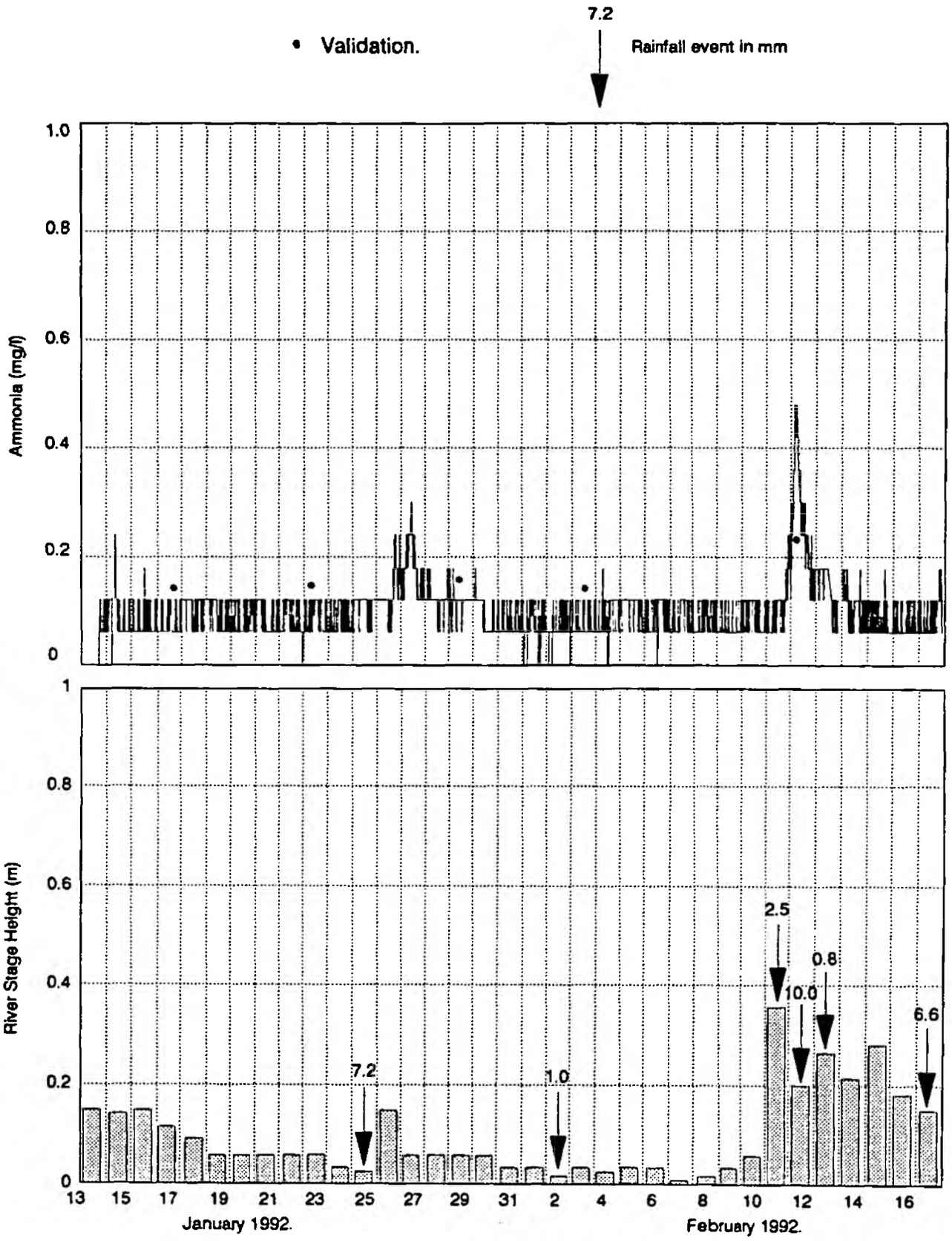


Figure 6. Areas of poor water quality with chronic discharges

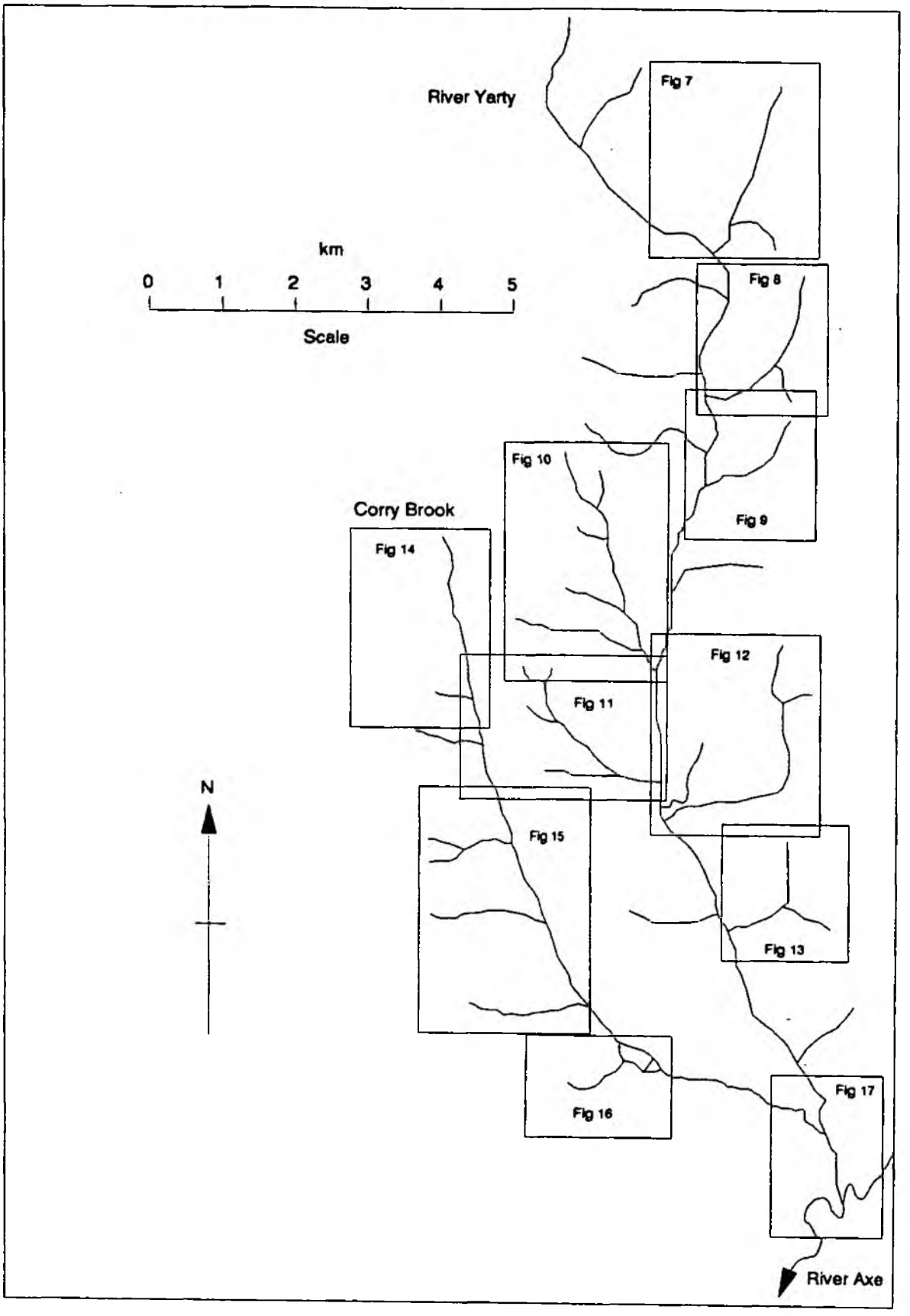


Figure 7. Pollution sources located in the Blindmoor Stream and upper River Yarty

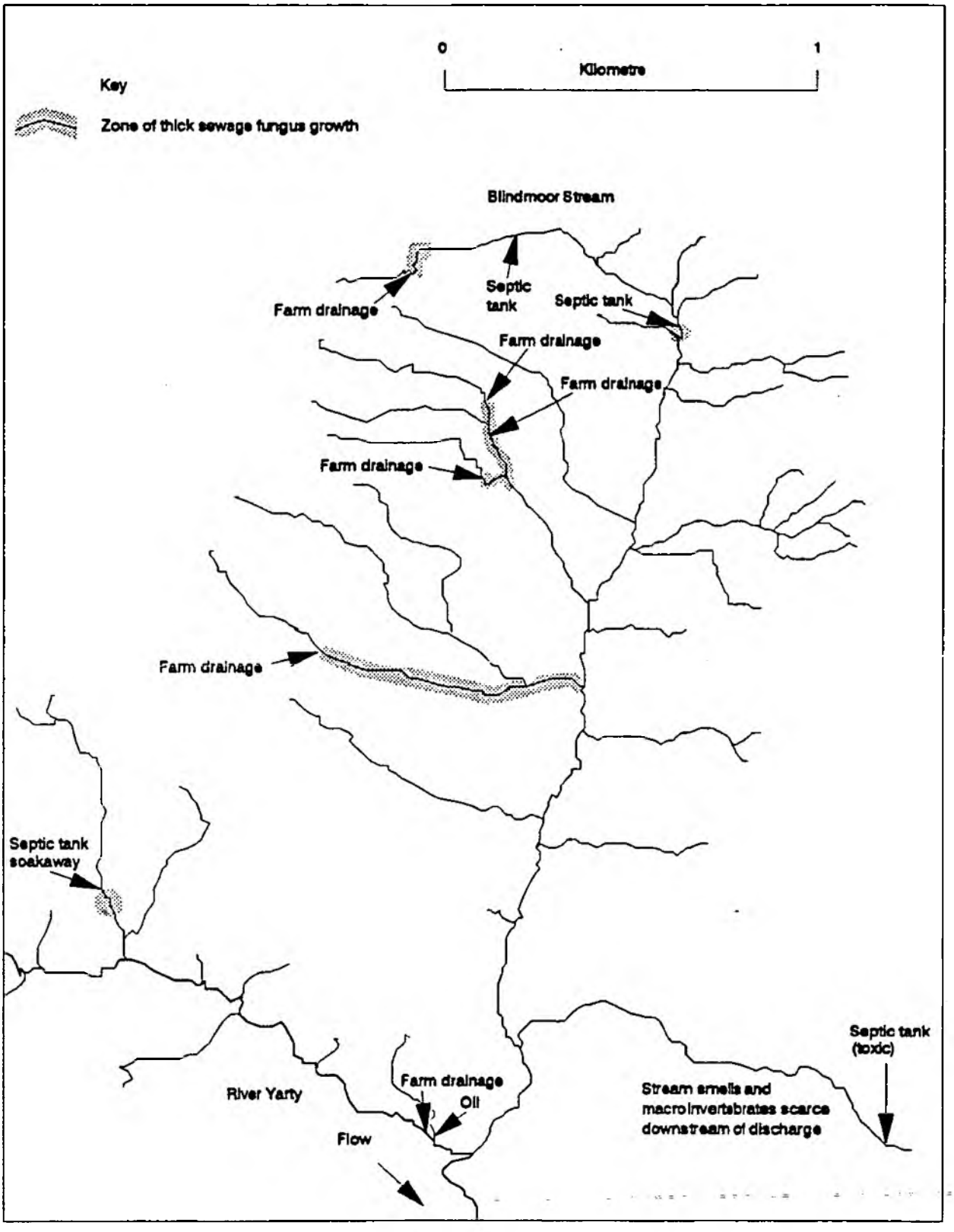


Figure 8. Pollution sources located in the Whitestaunton Stream

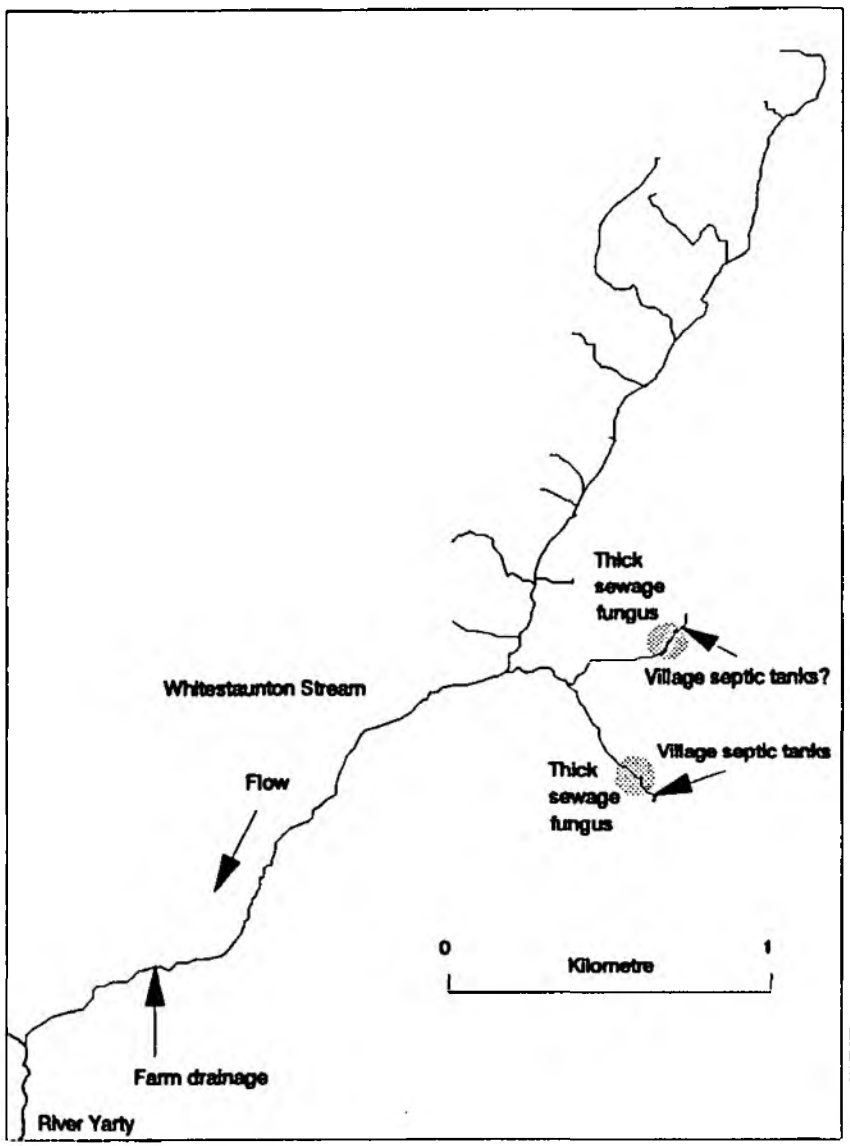


Figure 9. Pollution sources located in the Crawley Stream

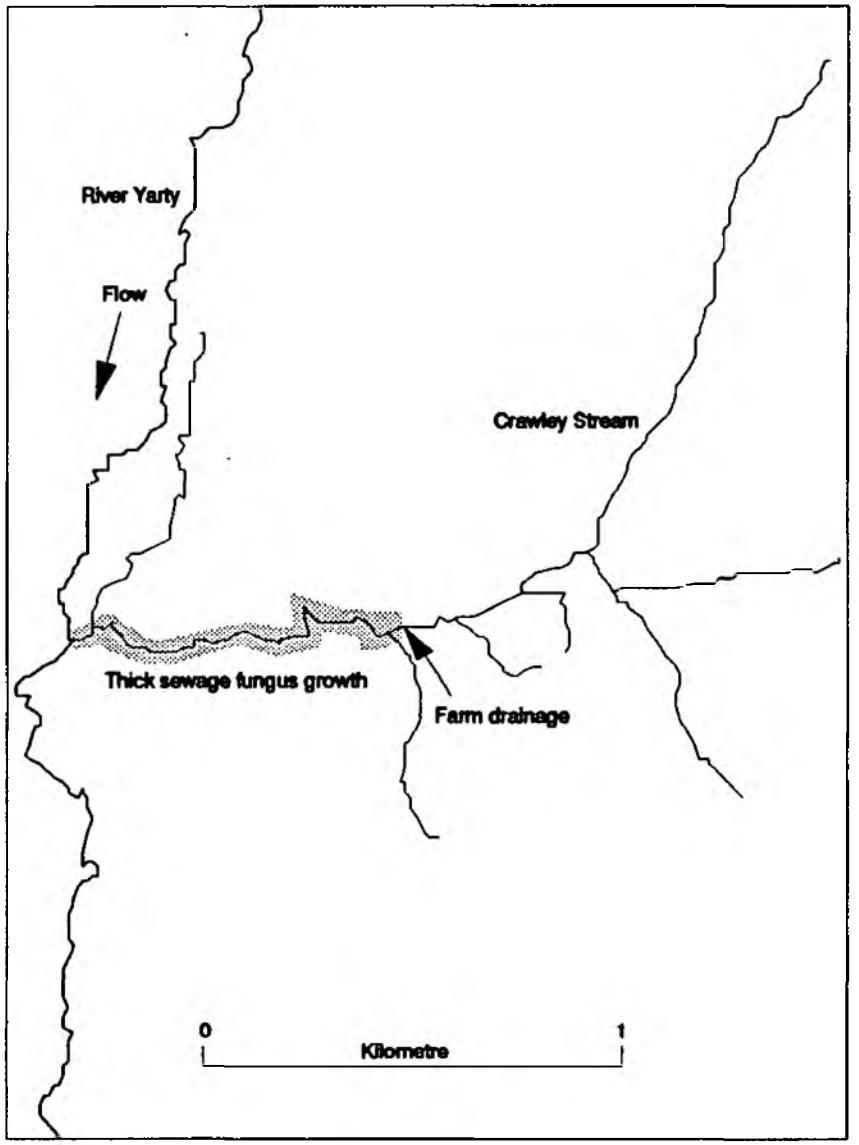


Figure 10. Pollution sources located in the Moorhayne Stream

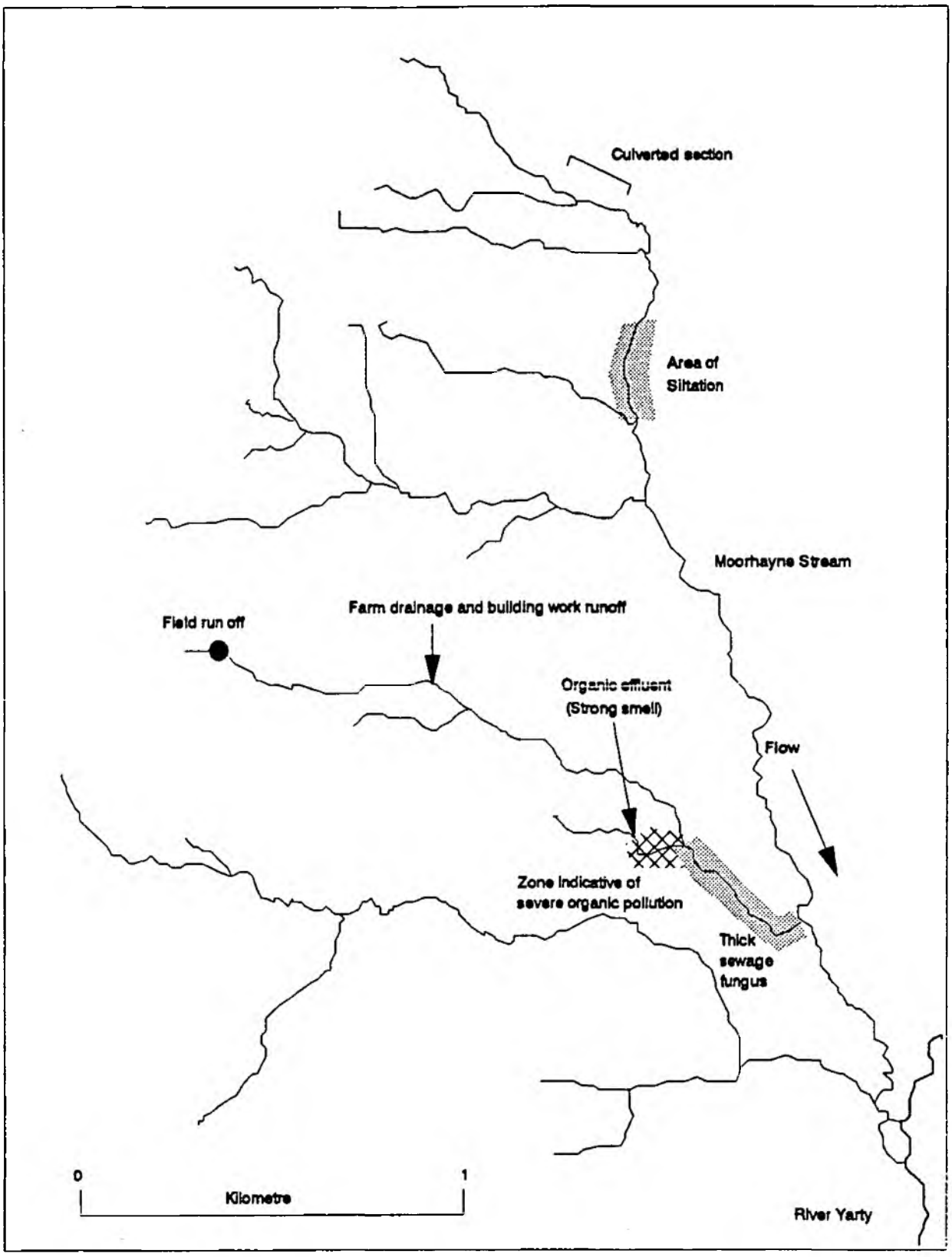


Figure 11. Pollution sources located in the Stockland Stream

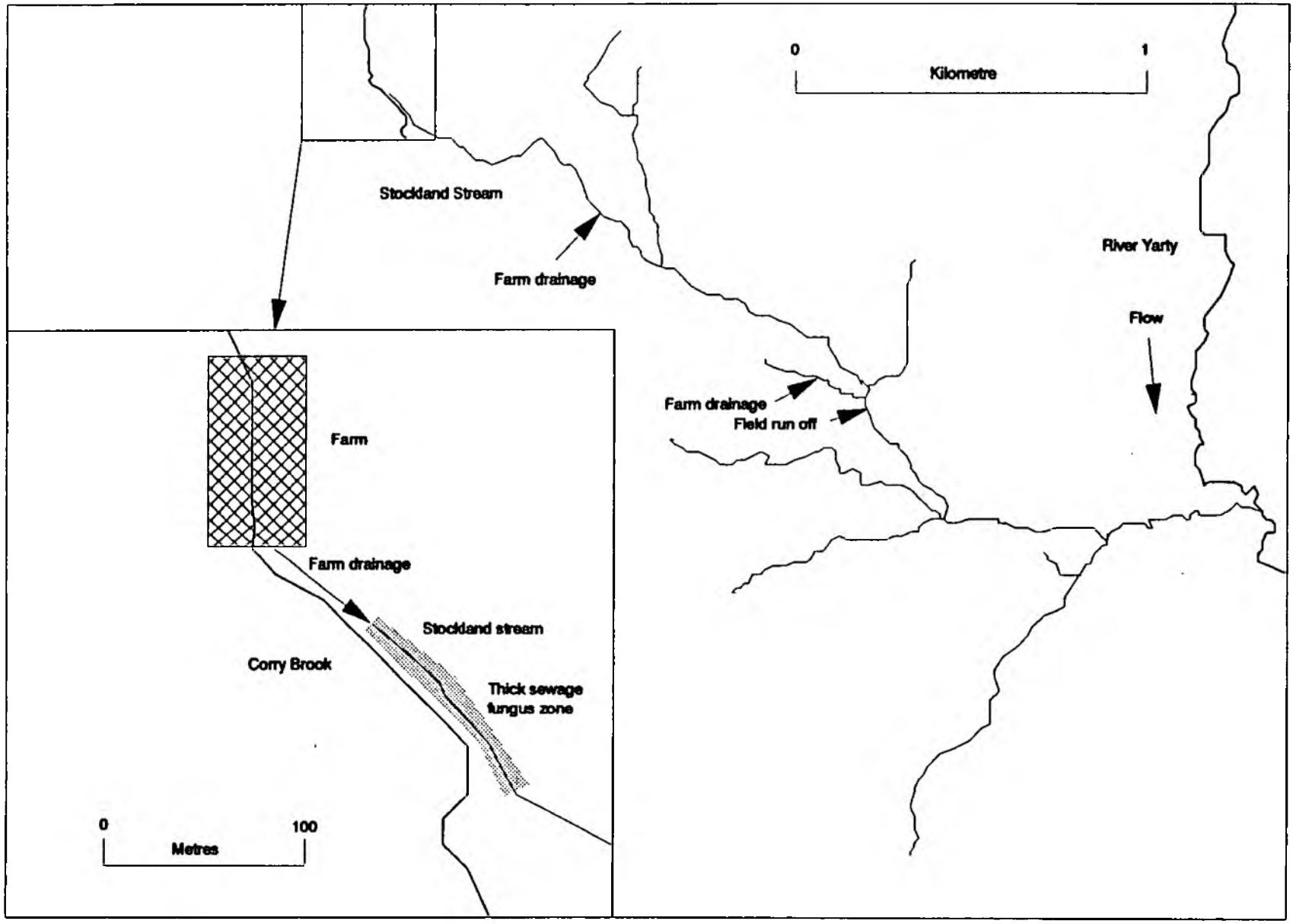


Figure 12. Pollution sources located in the Furley Stream

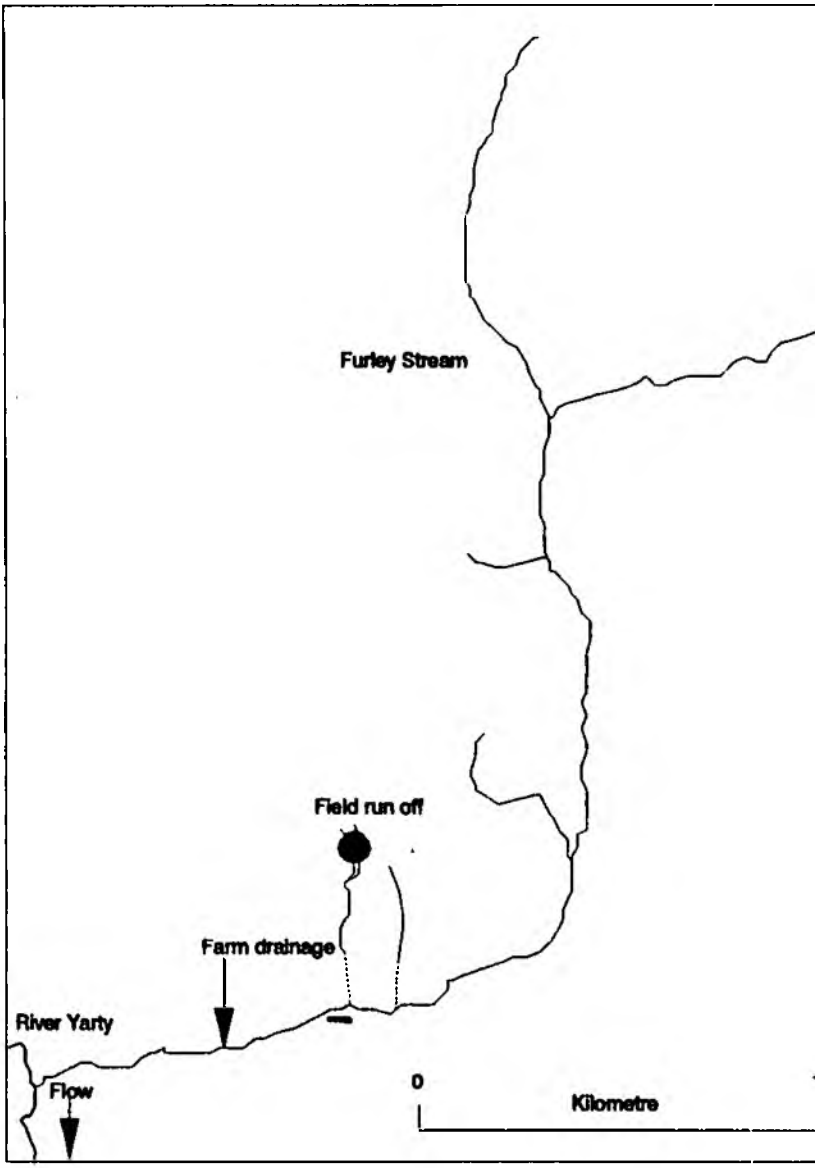
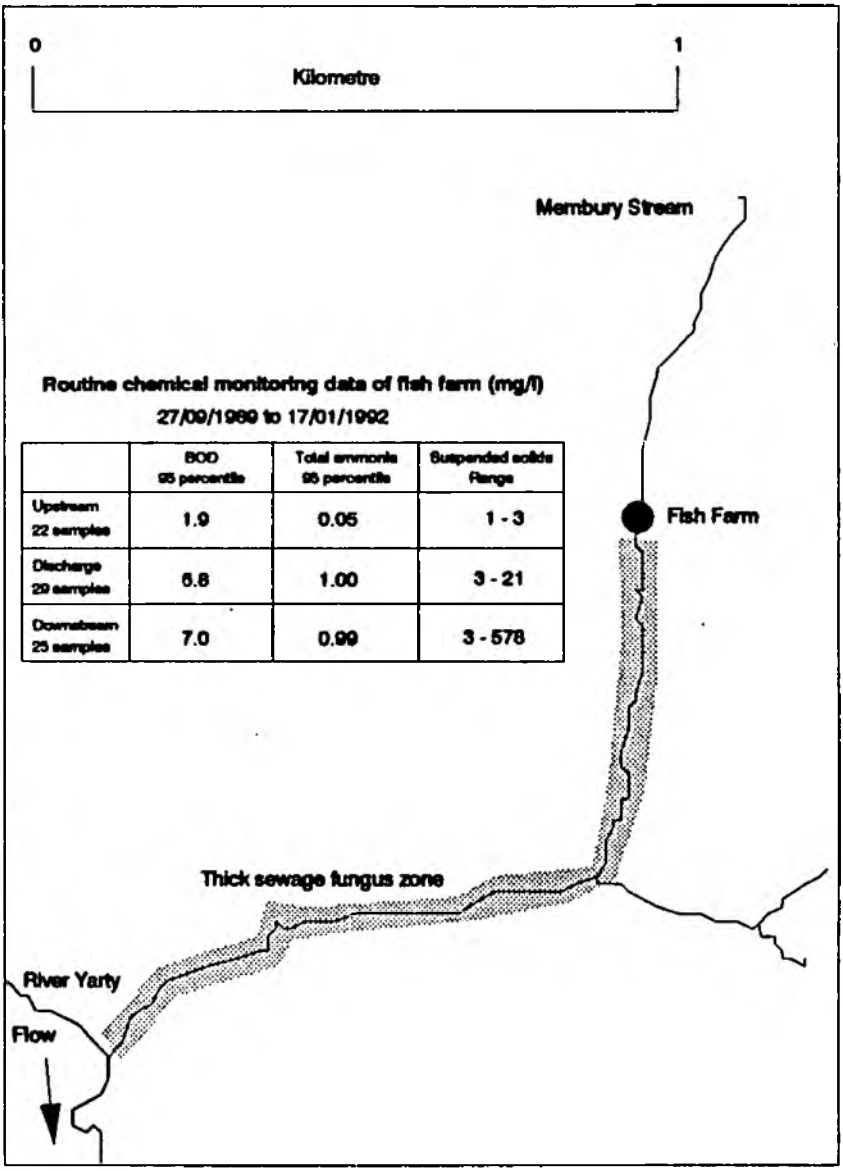


Figure 13. Pollution sources located in the Membury Stream



	BOD 95 percentile	Total ammonia 95 percentile	Suspended solids Range
Upstream 22 samples	1.9	0.05	1 - 3
Discharge 29 samples	6.8	1.00	3 - 21
Downstream 25 samples	7.0	0.99	3 - 578

Figure 14. Pollution sources located in the upper Corry Brook

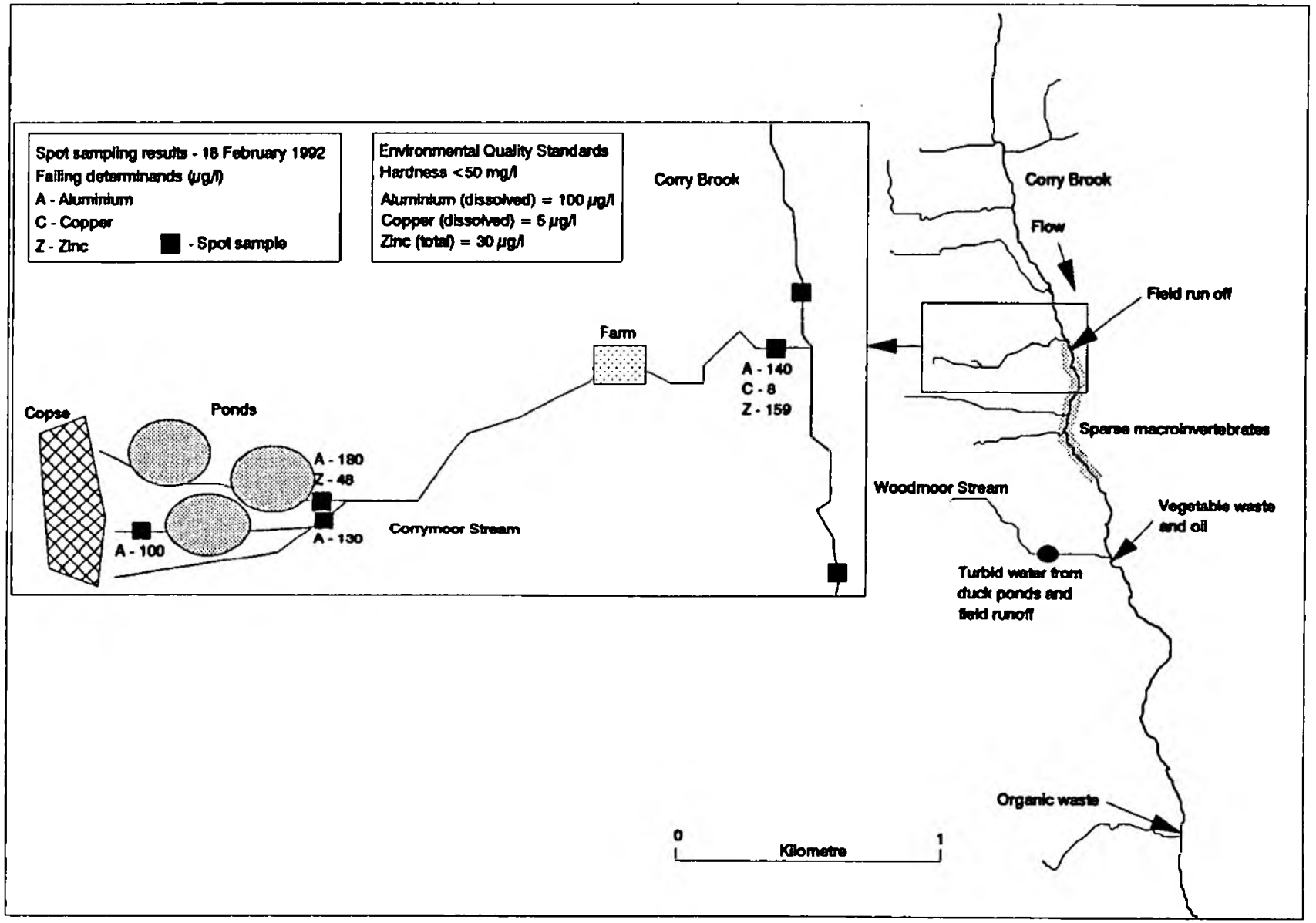


Figure 15. Pollution sources located in the middle Corry Brook

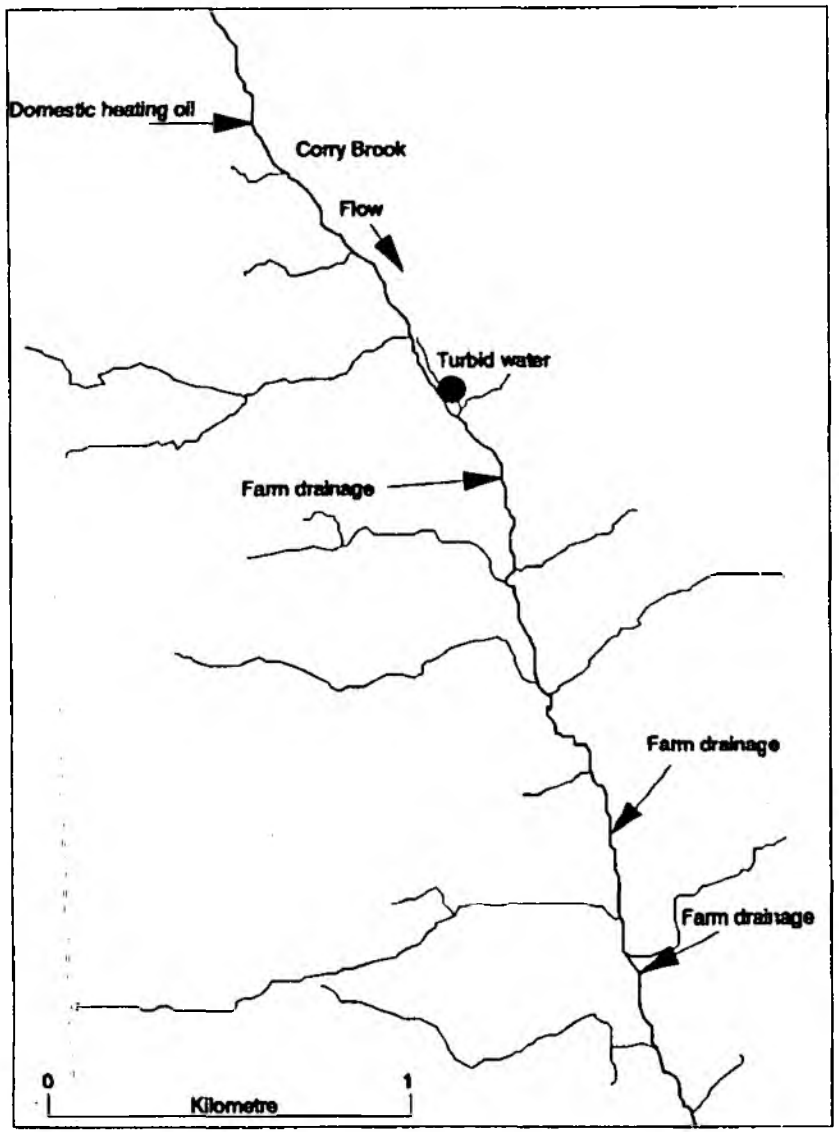


Figure 16. Pollution sources located in the Andrewhayes Stream

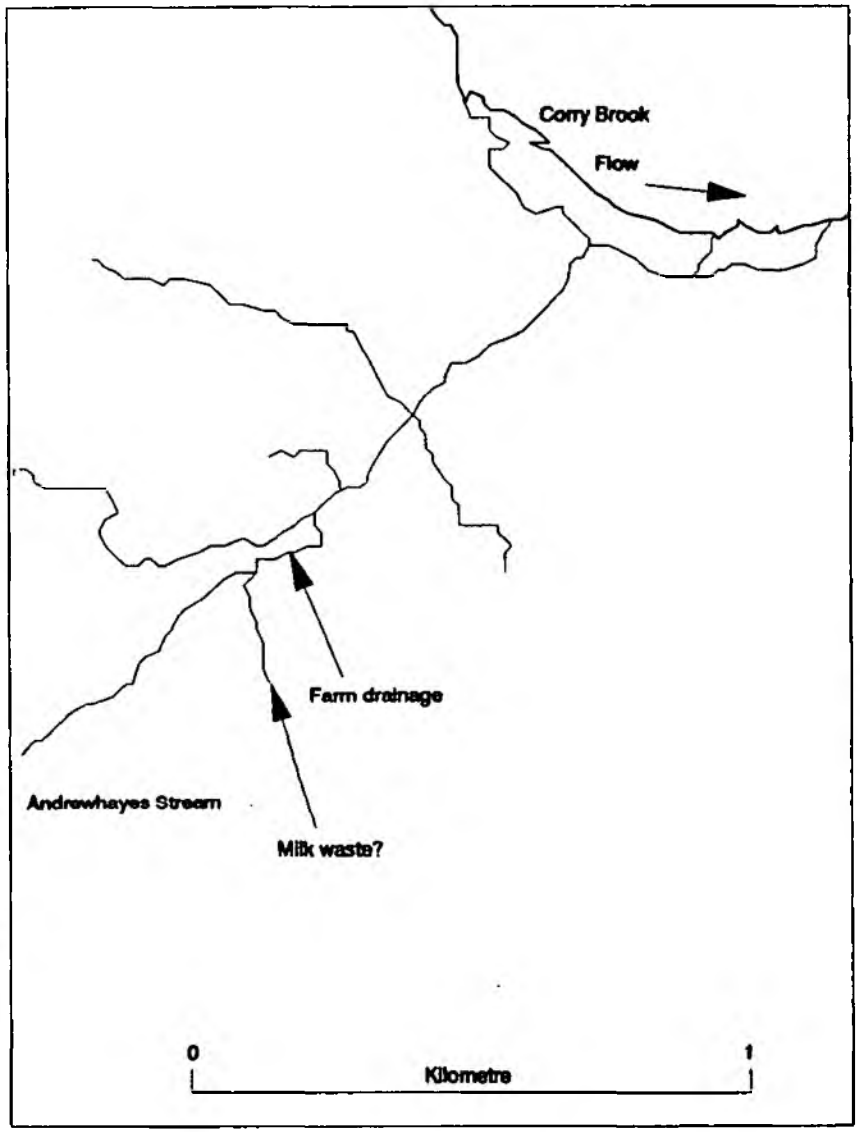
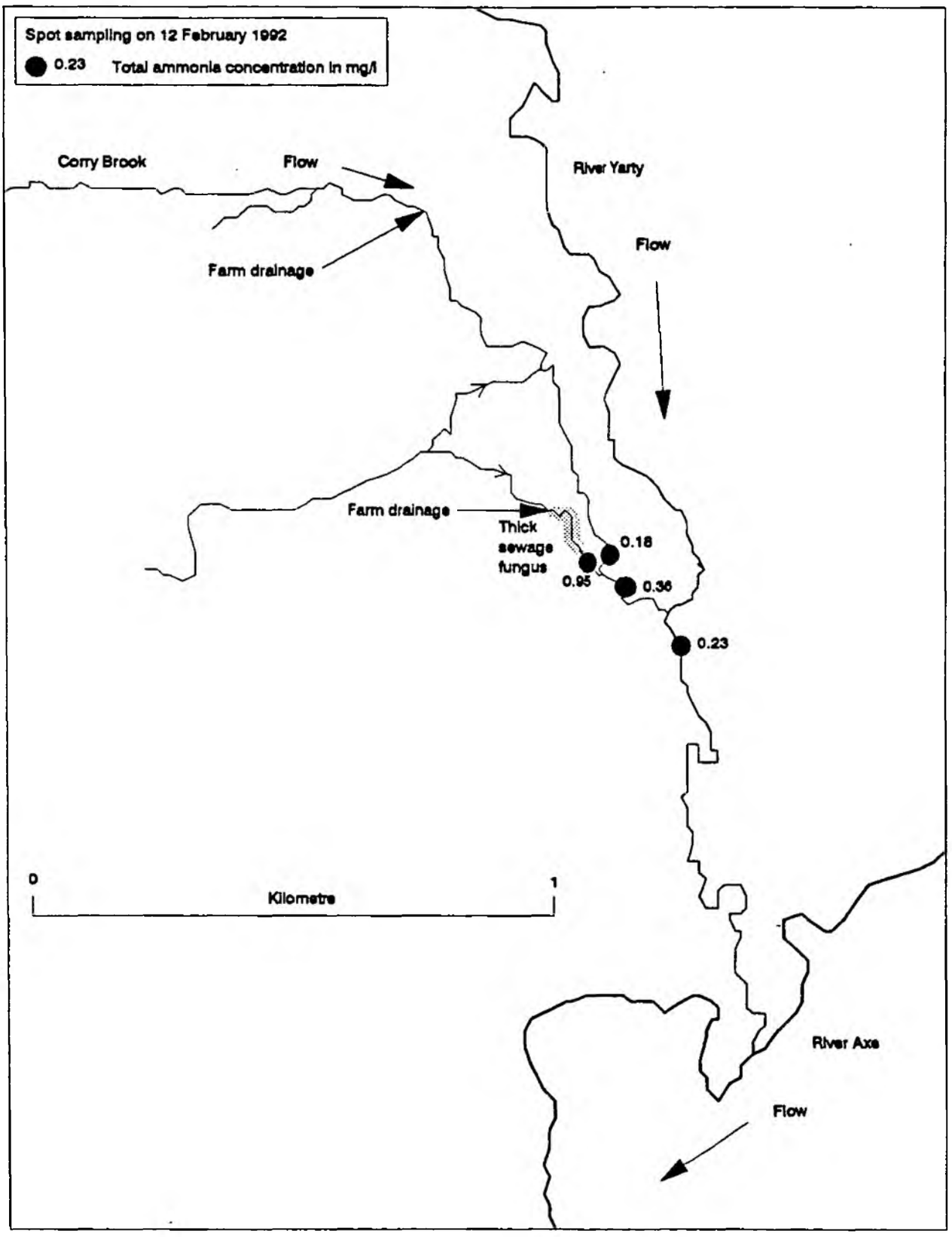


Figure 17. Pollution sources located in the lower Corry Brook

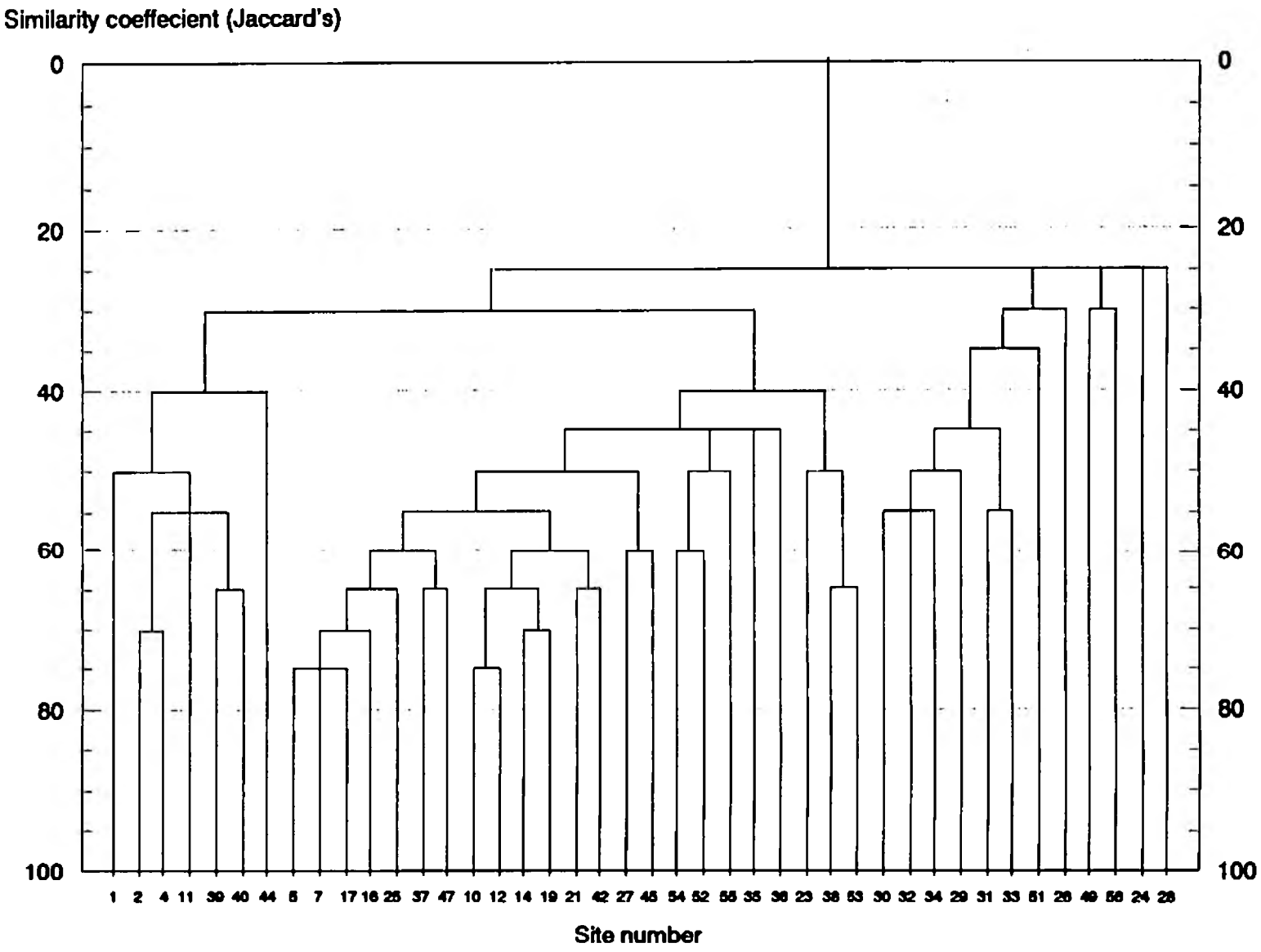


Appendix 1. Occurrence and abundance of macroinvertebrate taxa – screening survey

SITE NUMBER (SEE MAP)	1	11	21	41	51	7	10	11	12	14	16	17	19	20	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	42	44	45	47	49	51	52	53	54	55	56
EPHEMEROPTERA																																											
BAETIDAE	C	C	C	C	C	B	C	B	C	C	B	B	B	A	A	B	A	B	A	A	A	B	B	C	B	C	B	A	C	B	C	C	C	B	A	B	–	C	B	B	B	A	–
EPHEMERELLIDAE	–	–	–	–	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	A	–
EPHEMERIDAE	–	–	–	–	–	A	–	A	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	A	–	–	–	A	A	A	–	–	A	–	–	A	–	–	A	–	–	–
HEPTAGENIIDAE	A	A	A	A	B	B	A	B	B	A	A	B	B	B	–	A	A	B	–	–	A	A	–	B	A	B	B	A	C	A	A	B	B	B	A	–	A	C	C	C	C	–
LEPTOPHLEBIIDAE	–	–	–	–	–	–	–	–	A	A	–	A	–	–	–	A	A	A	–	–	–	–	–	A	A	A	–	–	–	–	–	–	A	A	A	A	A	–	–	–	A	–
PLECOPTERA																																										
CHLOROPERLIDAE	–	–	–	–	–	–	–	–	–	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	A	–	–	–	–	–	–	–	–	A	–	–	–
LEUCTRIDAE	–	–	–	–	–	–	–	A	–	–	–	–	–	C	–	–	–	A	–	–	–	–	–	–	–	–	A	A	A	B	–	–	–	–	A	A	–	–	A	B	A	B	–
NEMOURIDAE	–	–	–	–	–	–	–	–	–	–	–	A	A	A	C	–	–	–	–	–	–	–	–	–	–	–	A	A	–	A	–	–	–	–	–	–	–	–	A	A	–	–	–
PERLODIDAE	–	A	A	–	A	A	A	A	A	A	A	A	–	A	A	–	–	A	–	–	–	–	–	–	–	–	B	A	–	A	–	A	A	A	–	–	–	–	A	A	A	A	–
MEGALOPTERA																																										
SIALIDAE	A	–	–	–	–	–	–	–	–	–	–	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
TRICHOPTERA																																										
BERAEIDAE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
GLOSSOSOMATIDAE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
GOERIDAE	–	–	–	–	–	–	–	–	–	–	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
HYDROPSYCHIDAE	A	B	C	A	A	A	–	B	A	B	B	A	A	A	–	–	–	A	–	–	A	–	A	–	A	–	A	A	A	A	A	–	A	A	A	A	–	–	A	A	B	A	A	A
HYDROPTILIDAE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	A	–	–	–	–	–
LEPIDOSTOMATIDAE	–	–	–	–	–	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LEPTOCERIDAE	–	A	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LIMNEPHILIDAE	–	–	–	–	–	–	–	–	–	–	–	–	A	A	–	–	A	–	–	–	–	–	–	–	–	–	A	A	A	–	–	A	–	A	–	–	–	–	–	A	–	A	–
ODONTOCERIDAE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
PHILOPOTAMIDAE	–	–	–	–	–	–	–	–	–	–	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	A	A	–	–
POLYCENTROPODIDAE	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	A	–	A	–	–	A	–	A	–	–	–	–
PSYCHOMIIDAE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
RHYACOPHILIDAE	–	A	B	A	A	A	–	A	A	A	A	A	A	A	–	A	–	A	–	–	–	A	–	A	–	A	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
SERICOSTOMATIDAE	–	–	A	A	A	A	–	A	A	A	A	A	A	A	–	A	A	A	–	–	A	A	A	A	A	A	A	–	A	A	–	A	A	A	A	A	A	–	A	A	A	–	–
DIPTERA																																											
ATHERIIDAE	A	A	A	A	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	A	A	A	A	A	–	–	–	–	–	–	–	–	–	–
CERATOPOGONIDAE	–	–	–	–	–	–	–	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	A	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
CHIRONOMIDAE	A	A	A	A	A	A	A	A	B	A	A	A	A	A	B	A	A	B	A	A	A	A	A	B	A	B	A	A	A	–	A	A	A	–	B	B	A	A	A	–	A	A	A
DIXIDAE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	A	–	–	–	–	A	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–
EMPIDIDAE	A	–	–	–	–	A	–	A	–	–	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–
MUSCIDAE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	A	–	–	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–
PSYCHODIDAE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	A	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
PTYCHOPTERIDAE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	A	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
SIMULIIDAE	C	A	A	A	A	A	A	A	A	A	A	A	–	B	A	A	A	–	–	A	–	B	A	A	–	A	–	A	A	A	B	C	A	–	A	A	A	A	–	A	A	A	A
STRATIOMYIDAE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
SYRPHIDAE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
TABANIDAE	A	–	–	–	–	–	–	A	A	–	–	A	–	–	–	–	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
THAUMALEIDAE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
TIPULIDAE	A	A	A	A	A	A	B	B	A	A	B	A	A	A	A	A	A	A	A	A	–	–	A	A	A	B	A	–	A	B	B	B	B	–	A	A	–	A	A	A	A	A	A
COLEOPTERA																																											
DYTISCIDAE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	A	–	–	–	–	–	–	–	–	–	A	–	–	–	–	–	–	–	–	–	–	A	–	–	–	–	–
ELMIDAE	B	B	B	B	A	B	B	B	B	A	B	B	A	A	B	A	A	–	–	A	B	–	A	B	A	B	A	A	–	A	A	A	A	A	A	–	–	A	–	A	A	–
GYRINIDAE	A	B	A	A	A	A	A	A	A	A	A	–	A	–	–	–	–	A	–	–	–	–	–	–	–	–	–	–	A	A	A	A	A	A	A	A	–	A	A	A	A	A	–
HALIPLIDAE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	A	–	–	–	–	–
HYDRAENIDAE	A	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	A	–	–	A	A	–	–	–	–	–	–	–	–	–
HYDROPHILIDAE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	A	–	–	–	–	–
SCIRTIDAE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	A	–	–	–	–	–	–	A	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	A
CRUSTACEA																																											
ASELLIDAE	–	A	–	A	–	A	A	–	A	–	A	A	–	–	–	–	A	A	A	–	B	B	C	B	A	B	A	–	A	–	C	A	–	–	–	A	–	C	–	–	A	–	–
GAMMARIDAE	A	A	A	B	B	B	–	B	B	B	B	B	A	A	A	C	B	B	B	B	B	B	C	B	B	A	B	B	A	A	A	A	A	–	A	A	A	A	A	A	B	B	A
CHELICERATA																																											
ACARI	–	–	–	–	–	–	–	–	A	–	–	–	–	–	–	–	–	A	A	–	–	–	–	–	–	–	A	–	–	–	–	–	–	–	–	A	–	–	–	–	–	–	–
MOLLUSCA																																											
ANCYLIDAE	A	A	A	A	A	A	A	A	A	A	A	A	A	–	A	A	–	–	–	A	A	A	–	–	A	A	A	A	A	A	A	A	–	–	A	A	–	–	A	–	–	–	–
BITHYNIIDAE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–
HYDROBIIDAE	–	–	–	–	–	–	–	–	A	–	A	–	–	A	A	–	–	A	A	–	C	A	B	–	B	A	–	–	–	–	–	–	–	–	–	A	–	–	A	A	–	–	–
LYMNAEIDAE	–	–	–	–	–	–	–	–	A	–	A	–	–	–	–	A	–	–	–	–	A	–	–	–	A	A	–	–	–	–	–	–	–	–	–	A	–	–	–	–	–	–	–
NERITIDAE	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
PHYSIDAE	–	–	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
PLANORBIDAE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	A	A	–	–	–	–	–	–	–	–	–	–	–
SPHAERIIDAE	A	A	A	–	–	–	A	A	–	A	–	–	–	–	–	–	–	–	–	–	A	A	A	–	A	A	–	–	–	A	A	–	–	–	A	A	A	A	–	–	A	–	–
OLIGOCHEATA	B	B	B	A	A	A	B	B	A	A	A	A	A	A	A	A	A	A	A	A	B	C	B	B	B	B	A	A	B	B	C	B	A	B	A	A	A	B	A	A	B	–	B
HIRUDINEA																																											
ERPOBDELLIDAE	A	A	–	–	–	A	A	A	A	–	–	A	–	–	–	–	–	–	–	–	–	A	–	A	–	A	A	–	–	–	A	A	–	A	–	–	–	A	–	A	–	–	–
GLOSSIPHONIIDAE	–	A	A	–	–	–	–	–	A	–	–	–	–	–	–	–	A	–	A	A	A	A	A	–	A	–	–	–	A	A	–	A	A	–	–	B	A	–	–	–	A	–	–
PISCICOLIDAE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	A	–	–	–	–	–	–	–	A	A	–	–	–	–	–	–	–	–	–	A	–	–	–	–	–	–
NEMATOMORPHA	–	–	–	–	–	–	–	–	–	–	–	–	–	A	–	–	–	–	–	–	–	–	–	A	–	–	–	–	–	A	–	–	–	–	–	–	–	A	–	–	–	–	–
PLATYHELMINTHES																																											
PLANARIIDAE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
TOTAL NUMBER OF TAXA	19	21	18	15	14	19	13	22	20	19	16	19	15	18	13	14	18	18	11	10	17	15	16	14	20	25	18	15	20	19	20	18	14	18	17	9	22	17	20	19	16	9	

A=1–9 B=10–99 C=100–999 D=1000–9999 E=10000+

Appendix 2. Cluster analysis of sites sampled in screening survey



Appendix 3. High Flow Water Quality Survey of the River Yarty Catchment 17 December 1991

	BOD	Ammonia as N	Suspended Solids
1. D/S Corry Brook	1.6	0.07	6.3
2. U/S Corry Brook	1.3	0.08	6.3
3. D/S Tolcis Stream	1.7	0.10	7.5
4. U/S Tolcis Stream	1.6	0.11	11.0
5. D/S Membury Stream	1.7	0.14	9.4
6. U/S Membury Stream	1.9	0.17	8.7
7. U/S Ashcombe Stream	2.0	0.17	8.3
8. D/S Furley Stream	2.0	0.21	10.0
9. U/S Furley Stream	2.3	0.19	10.0
10. U/S Osmore Stream	2.0	0.19	10.0
11. U/S Stockland Stream	-	-	9.0
12. D/S Moorhayne Stream	1.5	0.14	13.0
13. D/S Haverlands Stream	2.0	0.16	11.0
14. U/S Haverlands Stream	1.7	0.17	10.0
15. D/S Crawley Stream	1.6	0.22	9.6
16. U/S Crawley Stream	1.3	0.18	8.2
17. U/S Pithayne Stream	1.2	0.12	6.3
18. U/S Whitestaunton Stream	1.4	0.09	6.5
19. U/S Knighthayes Stream	2.0	0.33	7.7
20. D/S Blindmore Stream	1.6	0.19	9.2
21. U/S Blindmore Stream	1.3	0.04	5.0
23. U/S Buckland Stream	1.3	0.03	12.0
TRIBUTARIES			
24. Tolcis Stream	1.5	0.11	11.0
25. Membury Stream	1.7	0.12	8.5
26. Ashcombe Stream	1.0	0.02	3.0
27. Furley Stream	1.1	0.04	7.3
28. Osmore Stream	1.0	0.03	12.0
29. Stockland Stream	3.4	1.2	13.0
30. Moorhayne Stream	2.5	0.52	13.0
31. Haverlands Stream	1.0	0.04	42.0
32. Crawley Stream	3.0	0.58	10.0
33. Pithayne Stream	1.2	0.03	15.0
34. Whitestaunton Stream	1.7	0.18	7.9
35. Knightayes Stream	1.1	0.02	6.6
36. Coburns Stream	1.0	0.02	1.0
37. Blindmore Stream	1.7	0.53.	9.2
CORRY BROOK			
39. U/S Yarty confluence	1.5	0.09	8.6
40. D/S Andrewhayes Stream	1.5	0.08	6.5
41. Old Corryton	1.5	0.07	7.5
42. U/S Andrewhayes Stream	1.7	0.07	9.4
43. D/S Hawley Stream	1.4	0.08	14.0
44. U/S Hawley Stream	1.3	0.08	9.2
45. U/S Ham Stream	1.2	0.04	5.2
46. U/S Shore Stream	1.2	0.16	6.7
48. U/S Quantock Stream	1.0	0.07	6.2
49. U/S Woodmore Stream	1.7	0.05.	11.0
TRIBUTARIES			
Andrewhayes D/S roadbridge	1.5	0.09	8.6
51. Andrewhayes U/S roadbridge	1.3	0.11	13.0
52. Hawley Stream	1.0	0.04	4.5
53. Ham Stream	1.0	0.02	12.0
54. Shore Stream	1.0	0.02	7.7
56. Woodmore Stream	1.0	0.24	38.0

All Concentrations in mg/l