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Birmingham Airport Link Pipeline
Environmental Assessment of Watercourse Crossings
Initial Report with reconnaissance surveys

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1. Introduction

1.1 Background

A multi product pipeline has been proposed by Esso Petroleum Co Ltd to transport refined products from a junction on the Midline pipeline at Astwood to the Bromford Terminal passing through Birmingham Airport. The new pipeline should be 12 inch nominal bore and approximately 50 km in length. It will be tied into the existing manifold and metering facilities at Bromford. The spur will be operated from Fawley, via a SCADA system, with the additional facilities being unmanned.

The Astwood tee junction will have manual isolation valves placed in the three legs, in order that the installation may be isolated for maintenance purposes. Non-return valves, which are remotely operated block valves, will be positioned in the Seisdon and Birmingham branches, to allow total diversion of flow with minimum interface mixing.

A sump tank will be installed to allow pipework within the site to be drained down for maintenance purposes. A remotely operated high pressure pumps will enable the contents to be pumped back into the pipeline. Surface water from the site will be routed through an interceptor pit to trap any hydrocarbons. A remotely operated pump will enable the contents to be pumped into the sump tank.

Birmingham Airport Terminal Branch. The valve systems will be similar in many respects to the Astwood tee, having manual isolating valves for each leg and a remotely operated isolating valve in the airport leg together with a control valve. In addition, the airport leg will be equipped with a gas operated fail-safe valve. It may be assumed that sump tank, interceptor and pump back facilities will be required.

The Birmingham (Bromford) Terminal Tie-in. The Birmingham Terminal, being an existing facility is already equipped with power supplies, sump tanks etc. The tie in equipment will need to be connected into the existing drains. The Birmingham Airport Link will be tied into the existing storage manifold system such that product can be directed to existing storage.

Pipeline data and design specification

Pipe Outside Diameter: 12.75 inches.

Minimum Pipe Wall Thickness:

Cross Country	0.200"
Built up, Residential and Industrial areas	0.375" (formerly 0.250")
Road, Rail and Special Water Crossings	0.250"

The pipeline to be Epoxy lined with the lining terminating 3 inches from the end of each section to facilitate welding.

Pipe Mill Test Pressure: 90% smys calculated on nominal thickness.

Depth of cover: 1.0 m normal, 0.6 m in rock. 1.2 m in areas of particular concern with plastic identification tape to be placed above the line.

External Coating:

Type	Extruded Polyethylene Securiclad or similar
	Polyurethane tar on sections to be thrust bored Protegol 32-10 or similar

Temporary cathodic protection will be installed during the period of pipeline construction with appropriate anodes chosen to take account of soil acidity, foreign pipeline crossings, overhead power lines, electrified railway crossings etc. Isolating joints and jump over connections will be installed at Astwood, Birmingham Airport and Bromford. The pipeline will be X-rayed to British Standard Specification 2910 at a minimum of 10% (updated to 100%) of the length with 100% at crossings, tie-ins and areas of particular concern.

Route check. From the air: once every two weeks. From the ground: areas which cannot be easily seen from the air at intervals appropriate to the need.

1.2 Environmental Requirements

This work seeks to:

1. Identify all water courses within 1 km of the pipeline.

2. Describe those watercourses crossed and/or susceptible to pollution in terms of recreation, fisheries, freshwater ecology, channel stability, water use and abstraction, and water quality.

3. Predict the impact during construction, commissioning and operation (including the implications of pipeline failure) and including discussion on the toxic qualities of the products, the magnitude of the impact, the acceptability and mitigation measures.

4. Describe the ground water aquifers and recharge zones.

5. Identify abstraction points, volumes abstracted, nature of use etc.

6. Predict the impact on the ground water aquifers during construction, commissioning and operation (including the implications of pipeline failure).

7. Determine the magnitude of the impact, acceptability and mitigation measures.

Produce maps showing:

- Catchment areas and drainage basins.
- Water course crossings, other water bodies, canals and lakes within 1 km of the route and water abstraction points (Scale 1:10,000).

and make recommendations for any further hydrological studies within a wider belt along the proposed route.

Data supplied for use in surveys included:

- Route maps at 1:10,000 and 1:50,000.
- NRA fishing guide 1990 and other NRA literature.
- Severn Trent Water "Principle River Basins and Sub-Catchments Plan".
- List of the Water Companies and NRA offices affected by the BAL route.
- NCC information on the River Blythe SSSI and other SSSIs in the vicinity of the pipeline.
- Technical information (Section 6) of the BAL pipeline from the tender documents.

Minutes of meetings:

on 10.7.90 with main NRA contract coordinator Dr R. Wade, Principal, Catchment Management, NRA Severn Trent, Tewkesbury.(0684 850951)
(In addition, FHD had a brief meeting with RW.)

and data on meetings with:

Worcester Trust for Nature Conservation (5.7.90);
Nature Conservancy Council, Altringham Park, Shrewsbury (5.7.90).

1.3 Methods

1.3.1 **Site reconnaissance**, of the approved list of watercourse crossing sites was undertaken to determine the relevant ecological or conservation characteristics of the watercourse by an on-site assessment of the following:

- Flora and fauna
- Bank, sediment and bed characteristics
- Watercourse size
- Adjacent land use
- On-site evidence of recreational use
- Proximity to designated sites of conservation importance
- Other potential problems including reinstatement and long-term morphological changes

At each site a water sample was filtered for laboratory analysis.

Sites visited to assess if full reconnaissance survey was necessary or practical, are also included but only with a location map and a very much reduced data set of morpho-biotic parameters, together with a subjective assessment of value.

The flora, including mosses, liverworts and macroscopic algae, was recorded within the 200 m section of watercourse and notes were made to assist in the assignment of a value for its relative quality. Separate assessments on a scale of 0 - 5, were made for submerged aquatic plants and for bank or emergent species; these two scores were added together to produced a score from 0 - 10 for flora for each site.

Invertebrates were sampled at each crossing point. All habitats were sampled where possible. Kick samples were taken when the water depth was <60cm at some point. Three minute samples were taken were practicable; small streams were sampled for shorter periods. Where the water was too deep to wade, a dredge was used to collect the sample. In some cases the substratum was unsuitable for the dredge and a pond net sample was taken from the bank. The samples were sorted on the bank by spreading them out in a tray and picking out individuals of each family present and different species of each family where possible. A score (0-10) based on the results was assessed for each site in the field. In the laboratory, identifications were checked and scores amended where necessary.

Bank sediment and bed characteristics were assessed in two ways, by
a) cover of the stream bed in the invertebrate sample area, and by the
b) relative proportions of various materials in the banks and adjacent areas in the general sample area;
but in addition rock as bed rock or outcrops, was specifically searched for.

Reconnaissance survey data sheets contain information on:
1. watercourse name with nearest village etc., as necessary;
2. reconnaissance survey number - numeric order;
3. numeric National Grid Reference number (NGR);
4. distance from source of watercourse;
5. altitude of survey section to c5m;
6. latitude and longitude.

Physical characteristics (estimated) :

7. size as estimated mean width and mean depth of water at survey and at the bankfull condition of the watercourse, the mean depth of pools are recorded in brackets if appropriate, additional comments relate to obvious recent events as seen from debris stranded on the banks or adjacent vegetation and this is recorded as the additional height above that at survey;
8. flow of water in watercourse at survey in cubic metres per second
9. velocity of water (estimated mean);
10. slope of channel bed over survey length (estimated to $c1^{\circ}$);
11. type of bed or water flow - waterfall, stepped, long riffle, riffle-pool with sequence distance in metres, glide or run, smooth, static or ponded;
12. relative stream power - estimated on scale of 0 to 10 based to cover the range of British rivers, broadly, 0-3 indicate bed and bank stable rivers and streams, 4-5 rivers or large streams with some bed scour or bank erosion or lateral migration, 6-8 active rivers with rock or worked gravels and erosion or migration or both; and a comment;
13. channel form in plan - straight, meandering, braided;
14. channel sinuosity current and previous where the situation may have changed - straightened, slight, moderate, extreme ; with a value in meters of actual and previous amplitude - this relates to the length of buried pipe;
15. channel section - slope, steep, vertical, or trapezoid if managed, dredged or resectioned;
16. erosion of stream bank as percentage of stream bank of section - incising, flake or slab, slump or slide, undercut or block fall, or depositions with type of material and position;

17. substratum as percentage to 10% for major components, or subjectively as proportions indicated by asterisks (* = *c* 20%), of watercourse bed for - bedrock or outcrops, boulders (>256mm), cobbles (65 - 255mm), pebbles and gravel (2.1-64mm), sand (.06-2mm), silt & clays (.06-.004mm), and organic or peat; occasionally in addition the adjacent soils of stream banks and appropriate adjacent areas where considered relevant or different.
18. the colour and nature of the water eg presence of particles etc.

Adjacent features:

19. land use on watercourse banks together with visual features within .5km;
20. upstream features;
21. downstream features;
22. maintenance;
23. fishery interest including other data obtained from various sources.

Environmental data on physical parameters, flora and animals were summarised together with a score for environmental quality based on scales of 0-10 for flora and 0-10 for invertebrates together with a correction for maintenance. Maintenance effects were scored on a $-2\frac{1}{2}$ to +2 scale broadly based on:

-2 for channel resectioning and realignment
$-1\frac{1}{2}$ for either channel realignment / channel resectioning both banks
$-\frac{1}{2}$ one bank
0 a neutral score, for possible or historical management
+1 for unmanaged but agricultural banks especially rough grazing etc.
+2 near natural conditions
(Combinations of these scores were also used.)

The overall score was calculated by adding floral (0-10) to invertebrate (0-10) scores and dividing by two. This value is then corrected by adding the maintenance score ($-2\frac{1}{2}$ to +2). Where scores were not available through difficulty in sampling or inappropriateness, eg dry ditches, an estimate (in brackets) was made for the overall score. Artificial water courses especially canals present difficulties and two scores are normally calculated, one incorporating the actual management ($-2\frac{1}{2}$) and the other a null score (0) and given for example as '$(1/3\frac{1}{2})$'.

This method of assessment is still being developed but can in theory be seen to give values less than zero, for low biotic score (polluted) and highly managed sites, or higher than 10; this has not been revised as it allows better discrimination among the middle range of sites. The ultimate score for pristine sites or indeed values over 10 have not yet been achieved in over 250 sites within Britain.

A summary at the bottom of each sheet gives the advised method of construction, key points and further survey recommendations together with the overall score.

The use of question marks primarily indicates uncertainty about a value or statement eg water depth where the river was to deep to measure without a boat.

1.3.2 Chemical analysis was carried out to determine the character of the water in order to indicate biotic potential. Water analysis at survey sites included:

- pH (Hydrogen ion)
- Total salts as conductivity

and later on return to the laboratory on the filtered water:

- Anion to Cation balance for common ions (in milli equivalents pre litre)
- The nutrients nitrate and phosphorus

Anions included Alkalinity as bicarbonate (in milli-equivalents per litre), chloride, sulphate, nitrate-nitrogen, phosphate-phosphorus (soluble or orthophosphate), silicate-silicon; cations included calcium, magnesium, sodium, and potassium, reported as milligrams per litre.

2.Results and Discussion

Field survey and desk studies were undertaken to fulfill the objectives of the project:

2.1 **Identification of watercourses within 1km of the pipeline** (Appendix III, Maps 1-3). Water courses and aquatic areas were identified from maps and the route was then visited to confirm the dimension, the actual or potential water capacity and purpose of the smaller channels (mainly ditches, survey reports with letter designations p18-42, Appendix I).
Larger watercourses were subjected to reconnaissance morpho-biotic surveys (see below, Appendix I).

2.2 **Morpho-biotic reconnaissance surveys combined with the results of chemical analysis of water samples for the determination of overall quality of the sites crossed,their susceptibility to pollution (degradation) and assessments of water quality, recreation, fisheries, freshwater ecology, channel stability, water use, abstraction** (Appendix I).
The proposed pipeline route passes from predominantly agricultural land in the West around the urbanizing area of Redditch and other villages, to pass alongside the South Birmingham Motorway link, M46, but also in the river plain of the River Blythe, a SSSI, before reaching the airport. Subsequently the route passes alongside several large housing estates before crossing the Rivers Cole and Tame, which drain water from Birmingham , and then running parallel to the Motorway and main railway from London, to the Bromford area.

Analysis of water samples for susceptibility to pollution indicated that some sites eg. Rivers Arrow, Alne and to some extent the River Blythe, are enriched with nutrients nitrate and phosphate whilst a ditch at Heath Farm is polluted. The other sites reflect geology and smaller less obvious local use whilst evapo-transpiration effects have concentrated the salts some of the smaller watercourses. Therefore whilst most sites are susceptible to pollution, particular concern must be expressed for the better quality River Blythe and the smaller sites Batchley Brook and Dagnell Brook. The Rivers Tame and Cole continue to be improved from their former higher levels of pollution and any degradation is to be avoided.

The season of construction operation will be critical and whereas summer flows would be better for the smaller and dry channels, any pollution will have a concentrated and more devastating effect.

Hydrotesting will be best undertaken in the wetter conditions of the early or late year when natural water supplies are more available. The Rivers Cole and Tame, and possibly the River Blythe, are likely to be the only sources of natural water. If the former two are used then the effects of Sulphate Reducing Bacteria (SRBs) and other contaminants degrading the unlined internal sections of the pipeline during hydrotesting must be considered and assessed. Discharges would only be allowed back to source rivers if biocides are not used. It is possible that water from the River Blythe could be released back into either (or the canals or even to the dryer zones in the south western part of the pipeline).
Abstraction licences and discharge consents will be required even for the canals; these may take six months.

Recreational areas on the route are limited but many footpaths exist which are adjacent to or cross the route. Conservation areas and canals could also be included in this division but they are considered below.

Fisheries interest in the sites crossed is classified as generally low but the role of the River Blythe, in particular, as a area for spawning and for growth, should be seriously considered and relevant precautions implemented especially during construction eg to minimise suspended solids and their settlement. The canals are likely to be coarse fisheries but at least one, the Grand Union, would be simpler to be crossed by lateral thrust boring and therefore subjected to minimum impact.

Freshwater ecological interest in the sites could be considered higher than average on a national scale but the quality is generally lower than average; sites of local interest include particularly the River Blythe but also the Batchley Brook and possibly Dagnell Brook and the River Alne. It was noted that the River Arrow was generally thought to be interesting but the reason for this was not apparent at this preliminary survey.

Channel stability was generally good as expected for this region although reinstatement on high banked stream and rivers will require care together with the sympathetic of materials if continued erosion and lateral migration is to be minimised ie. River Alne, parts or the River Blythe, River Cole and River Tame and possibly Batchley Brook and Dagnell valley site. Lateral migration of channels with the exposure of buried pipelines or the requirement for excessive quantities of stabilizing materials is not uncommon and often results from the ill-considered or unsympathetic use of reinstatement materials, particularly concrete, sand bags or cracked rock; such effects can be more easily undertaken with materials such as brush wood and wattles or well planted and nurtured bankside vegetation.
It is presumed (and recommended) that the whole route including both watercourse banks and the possibly the stream bed should be surveyed for surface geology and soil stability. Care should be taken to provide sympathetic reinstatement of stream banks and beds in and near conservation areas as the reconnaissance surveys showed that there were obvious signs of inadequate advice having been sought previously on the prime river, the Blythe.

Water use and abstraction was limited to *c* ten specific sites of which three were for water supply and the remainder mainly for irrigation (Table 2, map 4). Protection will be required for these sites although little interference except during actual construction is envisaged.

Two main abstraction sites within higher grade protection zones were crossed by the proposed route at Cur Lane, Foxlydiate (Grade 1, the highest grade) ($7.25\ Ml\ day^{-1}$) and a narrow corridor alongside the River Tame (Grade 3). At the former the shorter route is to the north but passes uphill through a lower grade protection zone but a route downhill and to the south, without any special zone, would be better in terms of construction impact and pipeline failure. The latter would require a 1 km diversion and still be within 500m of the bore hole and the expanding urban area of Redditch. The abstraction zone around the River Tame is a lower grade aquifer protection site, lies in river gravels and is, in any case, above a major sewage outfall.

There are at least eight conservation sites of aquatic interest adjacent, close to or crossed by the route; these do not necessarily represent all the best quality environmental sites on the route but those locally accepted as such. These conservation sites are:

- Dagnell Brook, nr Beoley (rare crayfish - needs confirmation)
- River Blythe (SSSI)
- meadow nr River Blythe, Kineton Lane, Illshaw
- The Terrets and pools, River Blythe nr Ravenshaw Hall
- Halfmoon Coppice, River Blythe adjacent M42 and Brueton Park
- Meadows near River Blythe nr Ravenshaw Hall
- ditches near meadows, West of Bickenhill

Other aquatic sites of conservation interest include:

- ditch near Brockhill Wood (- probably needs full survey)

2.3 Prediction of impact of construction, commissioning, operation and pipeline failure with discussion on toxicity of products, magnitude, acceptability and mitigation measures.

Construction impacts are primarily related to the dredging of open trenches in the beds of water courses (wet construction). These typically produce:
1. elevated levels of suspended material which in suspension have varying degrees of oxygen demand and which, dependant upon organic content, consume dissolved oxygen leading on occasion to fish kills at sites downstream of construction;
2. settlement of fine materials on fish spawning areas especially clogging the open gravels required by eg salmonids(fish surveys were not undertaken).

Many other construction operations such as bank removal and reinstatement elevate suspended sediment levels but water returned to watercourses, directly or indirectly, from dewatering pipeline ditches has been found the most common apart from thoughtlessness eg such as refueling on bridges. A detailed worker-awareness programme is advised. Site specific advice on the siting and treatment of trench discharges is advised.
The crossing and reinstatement of wet meadows especially adjacent to watercourses is the most important construction aspect requiring previous and on-site advice due to the rich organic nature and consistency of their soils.
Reconnaissance surveys showed that at least six sites should be subject to further considered for the monitoring of suspended materials and oxygen demand throughout construction and also prior to construction for baseline levels and predictions of the effects of various construction scenarios in minimising the impact on these watercourses (and to protect the companies interests); these watercourses include Dagnell Brook, the River Blythe at Valentines Farm, M42 junction 5, M42 nr Blythe Hall, and River Tame.

Commissioning and Operational Impacts are likely to be limited to supply and discharge of hydrotest water under normal conditions and correct bunding for valve sites if sited near watercourses.

The products proposed for transfer in this pipeline, gasoline, kerosene, aviation fuel, low and high sulphur gas oils, are all less dense than water. Only the gasolines have a high vapour pressure and would soon be lost in contact with the atmosphere albeit with some risk of fire. The latter however are likely to contain lead (<0.2 kg m^{-3} of gasoline) and locally high levels of contamination of soils is likely but its mobility will depend particularly upon the acidity of the soil. Removal of soils will be necessary to decontaminate such areas. All the proposed products rise to the surface in wet or waterlogged conditions and may be rapidly observed as films or emulsions especially in flowing waters. In wet areas the low density of these partially miscible fluids can readily spread and contaminate aquatic areas killing wildlife; access to oil skimming equipment may need to be considered but a high degree of prevention is advocated, ie thicker pipes cased in concrete cladding not only for protection but to prevent buoyancy, and to extend this cladding back from water course margins. In most soils the risk of long term contamination is moderate because, as these organic liquids migrate through the unsaturated zone towards the water table, a portion of the fluid is trapped within the soil particles due to capillary forces ('the residual or irreducible retention'). The retention of organics in the unsaturated zone subsoils depends markedly upon the relative wettability of the fluids present. Thus if the soil is relatively dry, the contaminant tends to wet the soil by capillary action. However when the soil is moist a three phase fluid system develops and considerably less can be contained within the soil particles. Considerable amounts of organic liquids can be contained by sands in particular but are related to the pore volume of the actual soil. The retention of organics in the water table following seasonal drawdown and recharge, is mainly in the form of small globules within the water phase but the amount depends upon the pore structure of the soil and also its saturation history. Considerable and expensive decontamination will be required for any contaminated areas.(See also CONCAWE Reports 9/80 & 7/81)

The magnitude of pipeline failure may simply be related to the content of the length of pipe higher and to either side of the fault back as far as the valve stations. Thus some 70 m^3 per kilometer could be released in a surge if valve stations were spaced at for example 16 km intervals. However, the proposed consideration of detailed design, safety and general environmental factors including elevational changes along the line, make it unlikely that more than 200m^3 would be released.

The contamination of the rivers and watercourses is only likely to be acceptable at a very low risk level as they flow to major catchments and contaminants are unlikely to be observed rapidly enough to avoid contamination of major lengths of water and its associated fisheries, wildlife and other uses. Although the installation of monitoring equipment at relevant positions should be considered, a balance between water flow and response time must be considered. Thus following the start of any loss a surface film of the product would have flowed *c* 2km in one hour at a typical stream water flow of 0.5 m s^{-1}. Such flow rates would probably require decontamination equipment eg skimmers, to be permanently on-site and available for immediate use. The contamination of soils is of less immediate significance except in the two main aquifer protection zones. The Spring Brook, Cur Lane site, would be rapidly and seriously contaminated whilst the leakage near the River Tame would flow through the river gravels to contaminate the catchment downstream. Contamination of the small bore holes requires more detailed individual examination in relation to water use and volume extracted.

Consideration should be given to the bunding of valve sites if sited watercourses and nature reserves areas, etc. Bunds should have oil traps and

filters to reduce loss of contaminated rain water during severe storms. In addition, consideration should be given to raised bank bunding for low-lying critical areas eg alongside parts of the River Blythe, to reduce the risk of their contamination in the event of full bore rupture.

Pipeline leakage detection is likely to require on-site monitoring systems, in addition to the regular inspections planned by foot or air. Consideration should be given to further geomorphological survey work to determine the optimum siting of valve stations in relation to full-bore rupture and flow but initially due to the scattered nature of susceptible areas, ie aquifer protection zones, conservation sites, etc., a greater frequency of valves should be considered. Contingency planning for full-bore rupture will need to be developed as most rivers and streams flow to one catchment ie the Tame Cole Blythe.

2.4 Identification of ground water aquifers and recharge zones, abstraction points, (volumes), (nature of use) and prediction of impact during construction, commissioning and operation and pipeline failure.

Aquifers, recharge zones and abstraction points have been identified and following agreement with NRA on routes, the likely impacts will have been reduced to an acceptable level.

Thicker walled pipes are advised in some sections including:
- alongside River Tame and the main line railway track near Castle Vale (site 12), which is also a zone 3 groundwater protection zone (with potential leakages feeding directly to the river)
- near the motorways and especially the access roads (eg site 5, 6)

3. Summary with recommendations

The proposed pipeline route passes from mainly agricultural land in the West around urban Redditch and other villages, to pass alongside the M42 Motorway, and in the river plain of the SSSI River Blythe before reaching the airport. After this the route passes several large housing estates and it crosses two rivers, the Tame and Cole, both of which drain Birmingham. The route then runs parallel to a Motorway M6 and railway before finally reaching the Bromford terminal in Birmingham.
Watercourses and aquatic areas within 1km of the proposed pipeline route, aquifer protection zones and abstraction points, were identified from maps. These were visited and assessed to establish biotic, morphological and other relevant parameters.
Of the 23 site areas visited, 12 were subjected to reconnaissance morpho-biotic surveys to establish overall environmental quality; the remainder were recharge zones, small ditches or dry watercourses when visited (Appendix I, Table 3). These sites are likely to be dry in summer and autumn of the proposed year of construction.
Analysis of water samples for susceptibility to pollution indicates that some sites are enriched with nutrients whilst one ditch at Heath Farm, Chelmsley Wood, is polluted; other sites reflect geology and smaller less obvious local use, etc. Most sites are susceptible to pollution during construction but particular concern must be expressed for the River Blythe, the improving water quality in the rivers Tame and Cole and the smaller sites Batchley Brook and Dagnell Brook.
This preliminary survey technique indicated that there was wide variation in quality of the aquatic sites and these ranged from bad to fairly good (but not excellent) and that there was scope for amelioration or minimisation of environmental impact in a variety of ways throughout construction eg by choice of site, revegetation etc. in combination with several minor route variations; further field surveys are advised. The season of construction

operation will be critical and whereas summer flows would be better for the smaller and dry channels, however any pollution will have a concentrated and more devastating effect.
Hydrotest water supply will be best undertaken in wetter conditions in the early or late year but a careful choice of source and discharge site needs to be negotiated. If the pipe is fully lined then the degrading actions of Sulphate Reducing Bacteria on the unlined internal sections are not considered to be a problem.
Abstraction licences and discharge consents need to be obtained in good time.
Recreational areas on the route are mainly limited to footpaths, conservation areas and canals.
Fisheries interest in the rivers and streams sites crossed were classified as generally low except for the River Blythe although some concern was expressed over specific small areas; the canals are likely to be coarse fisheries but are likely to be thrust bored.
Freshwater ecological interest was high but the quality was lower than average on the national scale; sites of local interest include particularly the River Blythe, Batchley Brook (and possibly Dagnell Brook and the River Alne).
[Consideration should be given to other biological surveys which should include wildlife especially badgers.]
Channel stability was generally good although reinstatement of the high banks of several rivers especially the Rivers Arrow, Cole and Tame will require care and the sympathetic use of materials if continued erosion and lateral migration is to be minimised; it is assumed that surface geological surveys will be undertaken prior to the start of construction. Reinstatement surveys and advice are necessary around conservation areas.
There are several licensed abstraction sites near the route most of which are for agricultural or industrial water supply and although due care will be required for these sites, little interference is envisaged even during construction.
The proposed route crosses two abstraction areas one of which is within a high grade aquifer protection zone and the other is in the lower grade zone within the River Tame corridor. The former at Cur Lane, Foxlydiate nr. Redditch will either require a diversion of *c*150 m to the North (avoiding new farm buildings) or further negotiation with the NRA to allow passage across the protection zone but more than 500 m from any borehole; the latter is uphill of the protection zone in the event of a full bore rupture. Any diversion to the south for increased safety from pipeline rupture would require a 1 km diversion to avoid an Aquifer Protection Zone to the West of Redditch and be too close to Redditch (Map 4).
There are at least eight conservation sites of aquatic interest adjacent, close to or crossed by the route; these are not all the best quality environmental sites but those locally accepted as such.

Consideration should be given to the casing in concrete (200 mm) of all pipes at watercourse crossings or sites considered to be adjacent to water courses (ie within *c* 20 m) to minimise accidental damage eg dredging.

Construction impacts are primarily related to the construction of wet open dredged trenches in the beds of water courses and will elevate levels of suspended material to cause increased oxygen demand and possibly fish kills downstream of the construction site and settlement of fine materials on fish spawning areas.

A detailed environmental awareness programme is advised for workers.

Site specific advice on the siting and treatment of trench discharges is advised.

The crossing and reinstatement of wet meadows especially adjacent to watercourses is likely to require prior and on-site advice.

Consideration should be given to should be monitoring the six special sites for suspended materials and oxygen demand prior to (for baseline values) and throughout construction.

Commissioning impacts are likely to be limited to the supply and discharge of hydrotest water although further geomorphological survey work should be considered to determine the optimum siting and frequency of valve stations because of the scattered nature of susceptible areas. Detailed contingency planning for full-bore rupture will need to be developed because watercourses flow to the Trent catchment. Although following pipeline failure evaporation of the lighter products is expected, lead will be retained in the soils and will require removal. Heavier products are likely to contaminate soils and water. Contamination of soils is to be avoided but may not require an very lowlevel of risk except near and in abstraction zones where it is a much lower level of risk should be incorporated.

Aquifers, recharge zones and abstraction points (plus a spring site, k) have been identified and if agreements can be made with NRA then impacts may be minimised to an acceptable level.

Care, early planning and further consultation with NRA on routes and for Method Statements prior to construction is advised at all stages of construction to operation at sites in the areas around:
- Batchley Brook nr Brockhill Wood;
- Dagnell Brook at Beoley, north of Redditch;
- Low Brook at the southern end of Birmingham Airport,and;
- the River Blythe from Cheswick Green to Solihull (and downstream);
  the latter is designated a Site of Special Scientific Interest and although good within this area, it could only be classified as average on a national basis. Further environmental degradation is to be avoided.

Consideration should be given to full biological surveys at the above sites to determine the optimum route within the 200m deviation limit.

Canals were also surveyed but it is presumed that these will be laterally thrust-bored and that construction will not be 'wet' (ie open ditching).

The overall impact of the route is likely to be acceptable if
- initial major and minor route optimisation is undertaken (Spring Brook Aquifer Protection Zone, Batchley Brook, Dagnell Brook, River Blythe Junction 4 on M42, R. Blythe at Blythe Hall),
- detailed surveys at the better sites to fine tune actual crossing points,
- further consideration is given to the proposals for pipe wall thickness especially at watercourse crossings and in aquifer protection zones unless the pipeline is rerouted downhill of such zones
- due or special regard is paid to precautions, special techniques and appropriate monitoring of oxygen and suspended materials are undertaken during construction (Dagnell Brook, River Blythe at Valentines Far mm at Junction 4 M42, at Blythe Hall, at Ravenshall Hall, and the River Tame), and
- appropriate monitoring during operation (air and foot) and oil spill and full bore rupture contingency plans are developed

The precedent of previous construction and existing pipelines within an area is not to be considered a benefit in the current climate of increasing environmental awareness.
The Optimum time for construction would seem to be between late spring to early autumn to avoid high flows in particular.

Table 1. Survey of potential crossing sites on water courses etc. with overall morpho-biotic values (0-10) and comments resulting from the reconnaissance surveys of early July 1990.

Survey sites are indicated by number for sites at which reconnaissance surveys were undertaken or by letter for sites only visited with a subjective score given in brackets.

Some sites were scored on a double system to indicate the range of assessment, for example canals in which, being artificial should have the lowest management factor but this is considered to distort the system and the alternative value is given using a null value for management and morphology.

Survey No.	Site/Watercourse	Score				Comment
		Management	Plants	Animals	Overall	
A	ditch, Astwood Farm, Dodderhill	–	(2)	–	(2)	
B	stream, Vicarage Farm, Woodyates	–	(2)	–	(2)	
C	Swans Brook, nr Bentley House	(0)	(4)	–	(4)	
C-d	Spring Brook	–	–	–	–	Aquifer protection zone
d	Batchley Brook, Hewell Park	(+1)	(4+)	(6?)	(6?)	
1	River Arrow, Bordesley	0	4	4½	4¼	
e	pond, Bordesley Park Farm	–	(1)	–	(1)	
2	Dagnell Brook	+2	4½	7½	8	Good stream
f1/f2	streams, Holt End	–	–	–	–	Survey
g	ditch, Alderhanger Wood	(0)	(1)	–	(2?)	
h	ditch, Tanworth-in-Arden	–	–	–	(2)	not crossed
3	River Alne, Brook House Farm	+1	3½	5	5¼	
4	Stratford on Avon canal, Hockley Heath	(-2½/0)	1+	3½	(0/2+)	
5	River Blythe, Valentines Farm, Illshaw	(-2½/0)	0/4	6	(½/5)	

i	River Blythe, M42 Junction 4				(6?)	survey
6	River Blythe, M42, nr Blythe Hall	-2	$5\frac{1}{2}$	$5\frac{1}{2}$	$3\frac{1}{2}$	
7	River Blythe, nr Ravenshaw Hall	+1	$2\frac{1}{2}$	$4\frac{1}{2}$	$4\frac{1}{2}$	
8	Grand Union Canal, Catherine de Barnes	$-2\frac{1}{2}/0$	$4\frac{1}{2}$	$3\frac{1}{2}$	$(1\frac{1}{2}/4)$	Thrust bore
9	ditch to Low Brook Elmdon	+1	5	5	6	
10	Low Brook, Marston Hall	-2	$2\frac{1}{2}$	4	$1\frac{1}{4}$	
j	ditch at Heath Farm, nr Chelmsley Wood	–	–	–	(0)	
11	River Cole, nr Chelmsley Wood	-1	$4\frac{1}{2}$	3	$2\frac{3}{4}$	
k	spring, near Kingshurst	–	–	–	–	protect?
12	River Tame, Castle Bromwich	-2	$4\frac{1}{2}$	$3\frac{1}{2}$	2	

Table 2. Abstraction licences, sites and uses along the proposed pipeline route

Licence No.	Name	National Grid Reference	Use
UPPER TRENT			
3/28/11/122/S	Shirley Golf Course	SP 144758	Recently built pumphouse
3/28/11/94/S/R	Arthur Caldicutt & Sons	SP 162778	Sump in the water course
3/28/12/10/G/R	Birmingham City Council	SP 180842	Well & minor abstraction
3/28/10/32/G	Dunlop Holdings Ltd	SP 1285 8985	Borehole water for ind.cooling
UPPER SEVERN			
7/218	Mr Aylett		Spray irrigation
7/165	Mrs Horton		Borehole for agriculture
7/105	W V Starkey		Spray irrigation from reservoir
7/21	Hereford & Worcester Council		Borehole for agriculture
7/10	Mr B G Barber		Borehole for agriculture
7/45	Lt Col L G Gray-Cheap		Borehole for agriculture
LOWER SEVERN AREA			
Not yet available			

APPENDIX I

Reconnaissance Survey Sheets (a-12) with inset detail site location maps

Table 3 Invertebrate families found on reconnaissance survey

ditch, Astwood Farm, Dodderhill
week of 2.7.90 SO 945 653
km from source 1 km Altitude 50 m
Lat 52° 17'N, Log 2° 05'W

PHYSICAL CHARACTERISTICS
Size at survey: Width 1 m; depth .05m
bank full: Width 1.5m; depth 0.6m

Flow at survey-discharge c $m^3 s^{-1}$
-velocity c $m\ s^{-1}$
Bed slope <1°, type:
Rel. Stream Power:
Channel- plan form: straightened
- sinuosity now: , m
previous: , m
- section:
Erosion %, type:

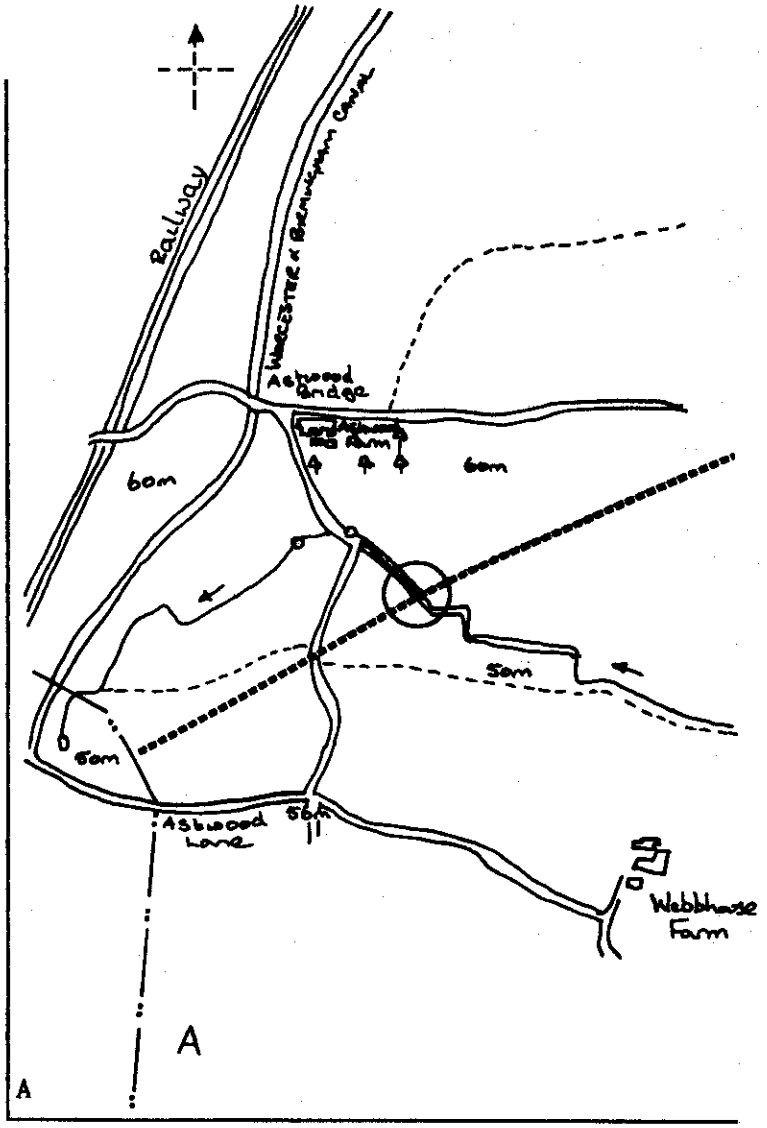
Substratum (cover)	bed	banks	adjacent
bed rock			
boulder/cobble			
pebbles/gravel	xx		
sand	xx		
silt/clay/(peat)	x		

WATER CHARACTERISTICS Colour:

pH ,Conduct. $\mu S\ cm^{-1}$, Temp °C

Anions, mg l^{-1}	Cations, mg l^{-1}
Alkalinity	Calcium
Chloride	Magnesium
Sulphate	Sodium
Nitrate N	Potassium
Phosphate P	(Iron)
Silicate Si	
Ion balance : m equiv.	

Assessment:



ADJACENT FEATURES etc.
Land use grazing sheep and cattle
Upstream -
Downstream (Manure heap by gate)
Maintenance occasional
Fishery interest nil

PHYSICAL Maintenance Factor -
Small static water ditch with cattle drink adjacent.

PLANT (shade %:cover; algae -%, moss %, macrophytes %) 1 + 1 = Score 2
Dense ancient hawthorn hedge on sandy soil; alder, oak and thorn adjacent. Mainly agricultural weeds.

ANIMAL - Score

SUMMARY (incl. potential problems, conservation, long-term morphological changes)
Damp ditch in agricultural land, straightforward crossing. Minimum width proposed to reduce loss of old hawthorn hedge and oak.

CONSTRUCTION Avoid cutting down large oak tree. OVERALL SCORE (2)

stream, Vicarage Farm, Woodyate
week of 2.7.90 SO 966 657
km from source 0.5 km Altitude 80 m
Grad. 0 Lat 52° 17'N, Log 2° 03'W
PHYSICAL CHARACTERISTICS
Size at survey: Width 1 m; depth .1 m
bank full: Width 2.5m; depth 1.5m

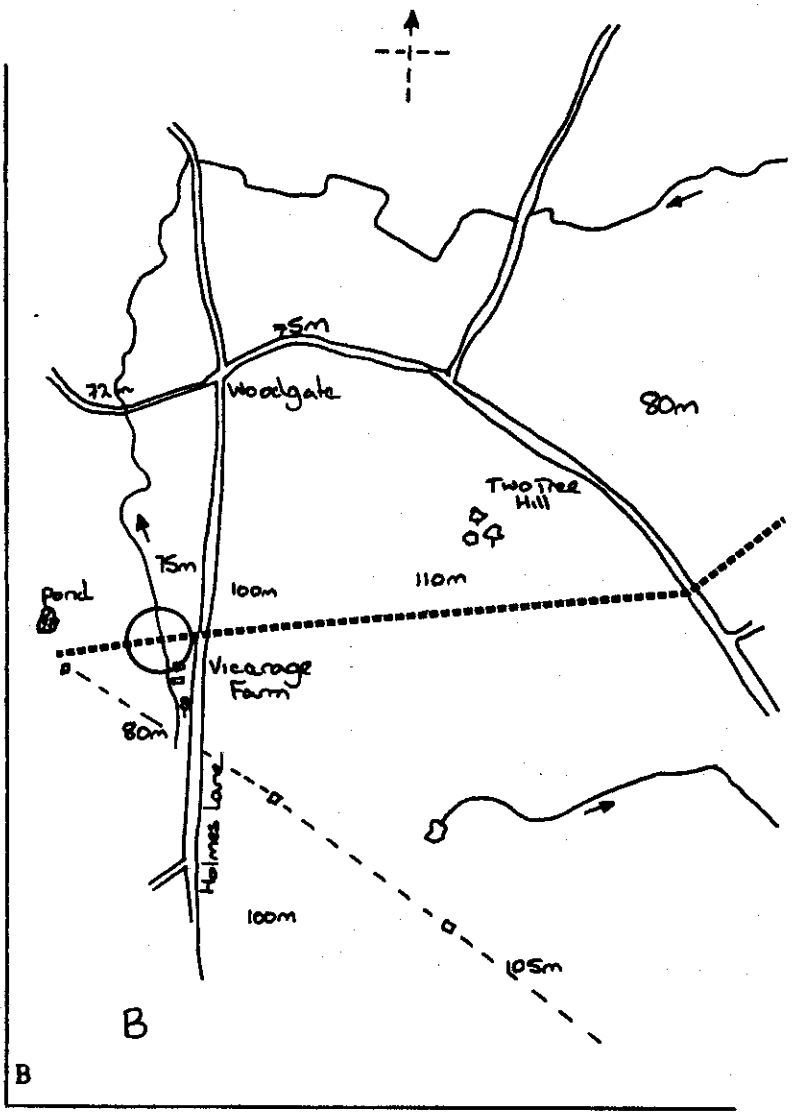
Flow at survey-discharge c $m^3 s^{-1}$
-velocity c $m\ s^{-1}$
Bed slope <1 °, type:
Rel. Stream Power:
Channel- plan form: near straight
- sinuosity now: - , m
previous: - , m
- section:
Erosion 50%, type: trampled

Substratum (cover)	bed	banks adjacent
bed rock		
boulder/cobble		
pebbles/gravel	XX	
sand	XXX	
silt/clay/(peat)	X	
	sandy soils	

WATER CHARACTERISTICS Colour:

pH ,Conduct. $\mu S\ cm^{-1}$, Temp °C

Anions, mg l^{-1}	Cations, mg l^{-1}
Alkalinity	Calcium
Chloride	Magnesium
Sulphate	Sodium
Nitrate N	Potassium
Phosphate P	(Iron)
Silicate Si	
Ion balance : m equiv.	
Assessment:	



B

ADJACENT FEATURES etc.
Land use farm close to old corrugated fencing
Upstream farmyard
Downstream sheep grazing
Maintenance ? part fenced
Fishery interest nil

PHYSICAL Maintenance Factor
Static small stream of deep section with animal trodden banks and debris in stream.

PLANT (shade %:cover; algae -%, moss %, macrophytes %) 1 + 1= Score 2
Dense and fenced hedgeline of Hawthorn, Willow, field maple.

ANIMAL Score -

SUMMARY (incl. potential problems, conservation, long-term morphological changes)
(Steep hillside (25m) to East - possible diversion?)

CONSTRUCTION Avoid crossing too close to pond to W. OVERALL SCORE (2)
Cross in summer.

Swans Brook nr Bently House
week of 2.7.90 SO 994 669
km from source 0.25 Altitude 123 m
Lat 52° 18'N, Log 2° 01'W

PHYSICAL CHARACTERISTICS
Size at survey: Width m; depth m
bank full: Width 2 m; depth 1 m

Flow at survey-discharge c - $m^3 s^{-1}$
-velocity c - $m\ s^{-1}$
Bed slope <1°, type: -
Rel. Stream Power: -
Channel- plan form: near straight
- sinuosity now: - , m
previous: - , m
- section: -
Erosion %, type:

Substratum (cover)	bed	banks	adjacent
bed rock			
boulder/cobble			
pebbles/gravel	x		
sand	xxx		
silt/clay/(peat)	x		

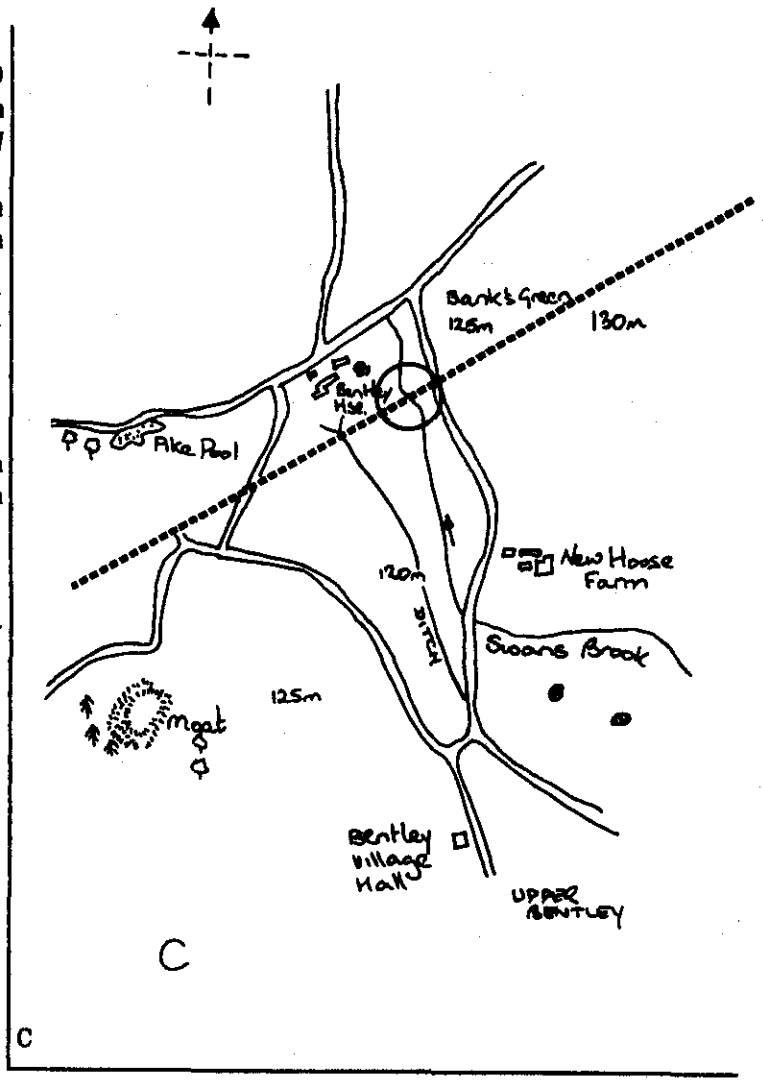
sandy soils

WATER CHARACTERISTICS Colour:

pH ,Conduct. $\mu S\ cm^{-1}$, Temp °C

Anions, mg l^{-1}	Cations, mg l^{-1}
Alkalinity	Calcium
Chloride	Magnesium
Sulphate	Sodium
Nitrate N	Potassium
Phosphate P	(Iron)
Silicate Si	
Ion balance : m equiv.	

Assessment:



ADJACENT FEATURES etc.
Land use grazing sheep, horses & cows (+ bull)
Upstream farm and road
Downstream farm and road
Maintenance minimal
Fishery interest nil

PHYSICAL Maintenance Factor 0
Damp deepened ditch/stream

PLANT (shade %:cover; algae -%, moss %, macrophytes %) 1 + 3 = Score 4
Some emergent aquatic plants and agricultural weeds along grazed and fenced stream.

ANIMAL - Score -

SUMMARY (incl. potential problems, conservation, long-term morphological changes)
Straightforward crossing.

CONSTRUCTION Cross in summer, powerline adjacent, avoid oak tree. OVERALL SCORE (4)

Spring Brook area, Cur Lane at X
week of 2.7.90 SO 005 676
km from source - Altitude 125 m
Lat 52° 18'N, Log 1° 59'W

PHYSICAL CHARACTERISTICS
Size at survey: Width 1 m; depth .1 m
bank full: Width 22 m; depth 1 m

Flow at survey-discharge c $m^3 s^{-1}$
-velocity c $m\ s^{-1}$
Bed slope - °, type:
Rel. Stream Power:
Channel- plan form:
- sinuosity now: , m
previous: , m
- section:
Erosion %, type:

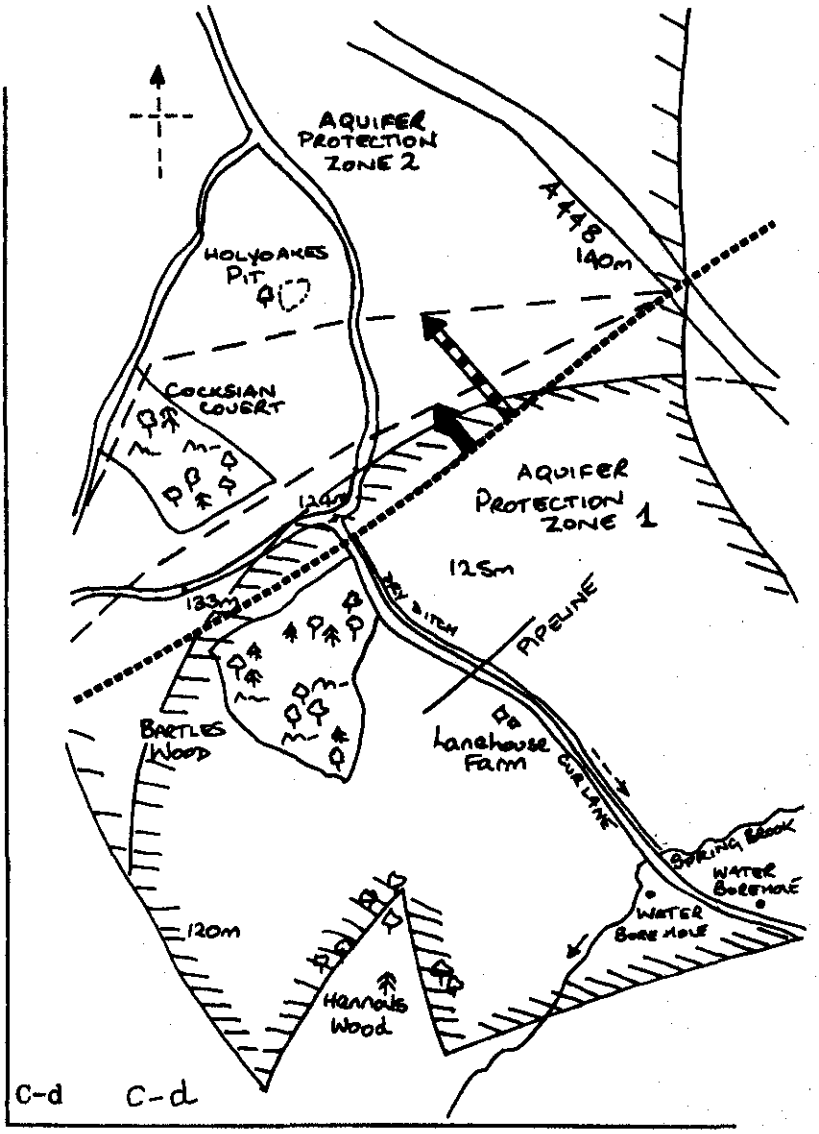
Substratum (cover)	bed	banks	adjacent
bed rock			
boulder/cobble			
pebbles/gravel	x		
sand	xxx		
silt/clay/(peat)	x		

WATER CHARACTERISTICS Colour:

pH ,Conduct. $\mu S\ cm^{-1}$, Temp °C

Anions, $mg\ l^{-1}$ Cations, $mg\ l^{-1}$

Alkalinity	Calcium
Chloride	Magnesium
Sulphate	Sodium
Nitrate N	Potassium
Phosphate P	(Iron)
Silicate Si	
Ion balance	: m equiv.
Assessment:	



ADJACENT FEATURES etc.
Land use
Upstream
Downstream
Maintenance
Fishery interest

PHYSICAL Maintenance Factor

PLANT (shade %:cover; algae -%, moss %, macrophytes %) + = Score

ANIMAL Score

SUMMARY (incl. potential problems, conservation, long-term morphological changes)
Near static stream to south of route by pumping station, stream not crossed but in highest grade aquifer protection zone, move to N (300+ m) to lower grade zone (the alternative to the south required a 1 km diversion closer to Redditch, with little additional benefit). Dry ditch running South East to bore hole pumping station.

CONSTRUCTION negotiate with NRA OVERALL SCORE

Batchley Brook, Newell Park
week of 2.7.90 SO 014 686
km from source 0.5 Altitude 112 m
Lat 52° 19'N, Log 1° 59'W

PHYSICAL CHARACTERISTICS
Size at survey: Width 2 m; depth .2 m
bank full: Width 4 m; depth 1 m

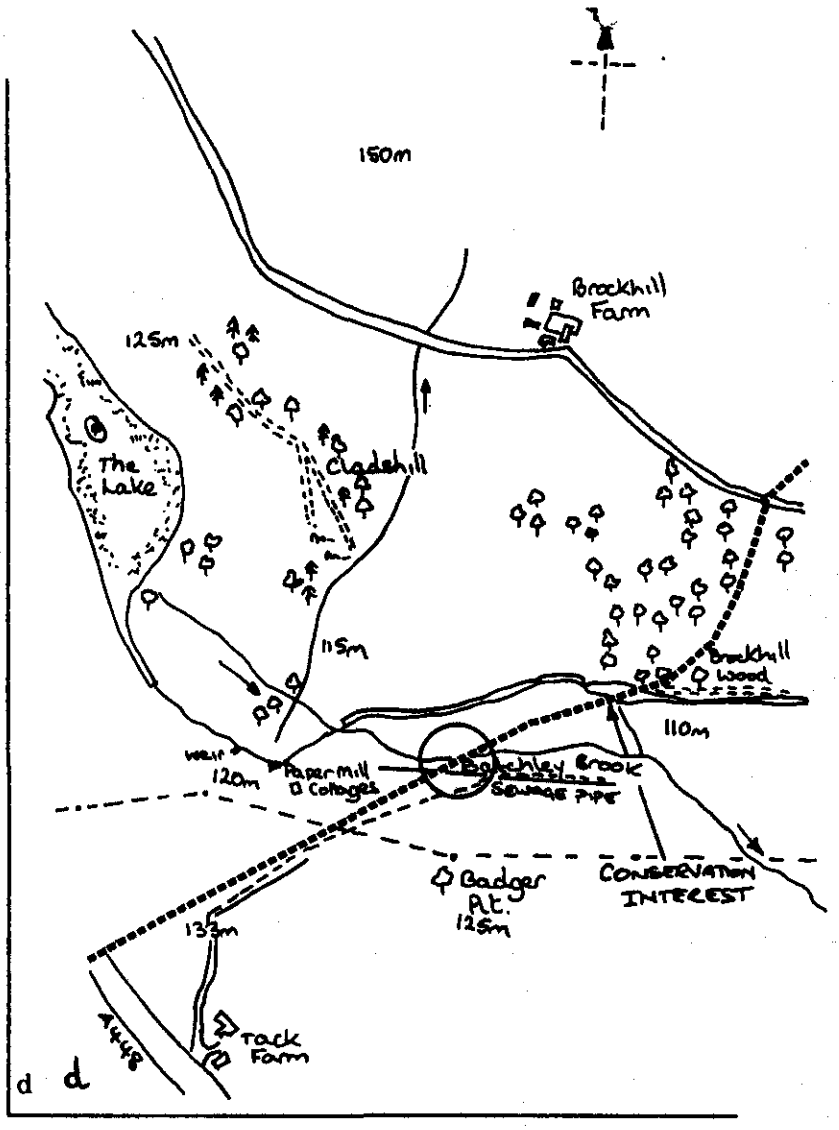
Flow at survey-discharge *c* 0 $m^3 s^{-1}$
-velocity *c* m s^{-1}
Bed slope 5m/km, type:
Rel. Stream Power:
Channel- plan form: some straightening
- sinuosity now: , m
previous: , m
- section:
Erosion %,type:

Substratum (cover)	bed	banks	adjacent
bed rock			
boulder/cobble			
pebbles/gravel	x		
sand	x		
silt/clay/(peat)	xxx		

WATER CHARACTERISTICS Colour:

pH ,Conduct. $\mu S\ cm^{-1}$,Temp °C

Anions, mg l^{-1}	Cations, mg l^{-1}
Alkalinity	Calcium
Chloride	Magnesium
Sulphate	Sodium
Nitrate N	Potassium
Phosphate P	(Iron)
Silicate Si	
Ion balance : m equiv.	
Assessment:	



ADJACENT FEATURES etc.
Land use poor grazing
Upstream lake
Downstream ditch of conservation interest
Maintenance minimal
Fishery interest nil

PHYSICAL Maintenance Factor +1
Damp ditch/brook, south of Hewel Park Lake.

PLANT (shade %:cover; algae -%, moss %, macrophytes %) 1 + 3+ = Score 4+
Damp highly vegetated ditch with rich flora but some agricultural weeds. 'Ancient' hedgerow and ditch of conservation interest to East.

ANIMAL - Score (6?)

SUMMARY (incl. potential problems, conservation, long-term morphological changes)
Nice ditch. Power cables cross 300 m N on pipeline route. Large sewage(?) pipe adjacent to brook.

CONSTRUCTION Ensure no discharge from lake during construction. OVERALL SCORE (6?)
Adjacent sewage pipeline. No preferred position for crossing brook.

River Arrow, Bordesley
week of 2.7.90 SP 037 695
km from source 5.5 Altitude 100 m
Lat 52° 19'N, Log 1° 56'W

PHYSICAL CHARACTERISTICS
Size at survey: Width 5 m; depth .2 m
bank full: Width 10 m; depth 3 m

Flow at survey-discharge *c* .2 $m^3 s^{-1}$
-velocity *c* .25 $m\ s^{-1}$
Bed slope 10m/km, type: long riffle/run
Rel. Stream Power: 2-3
Channel- plan form: near straight
- sinuosity now: straightened m
previous: - , m
- section: deep regular
Erosion 15%, type: undercut

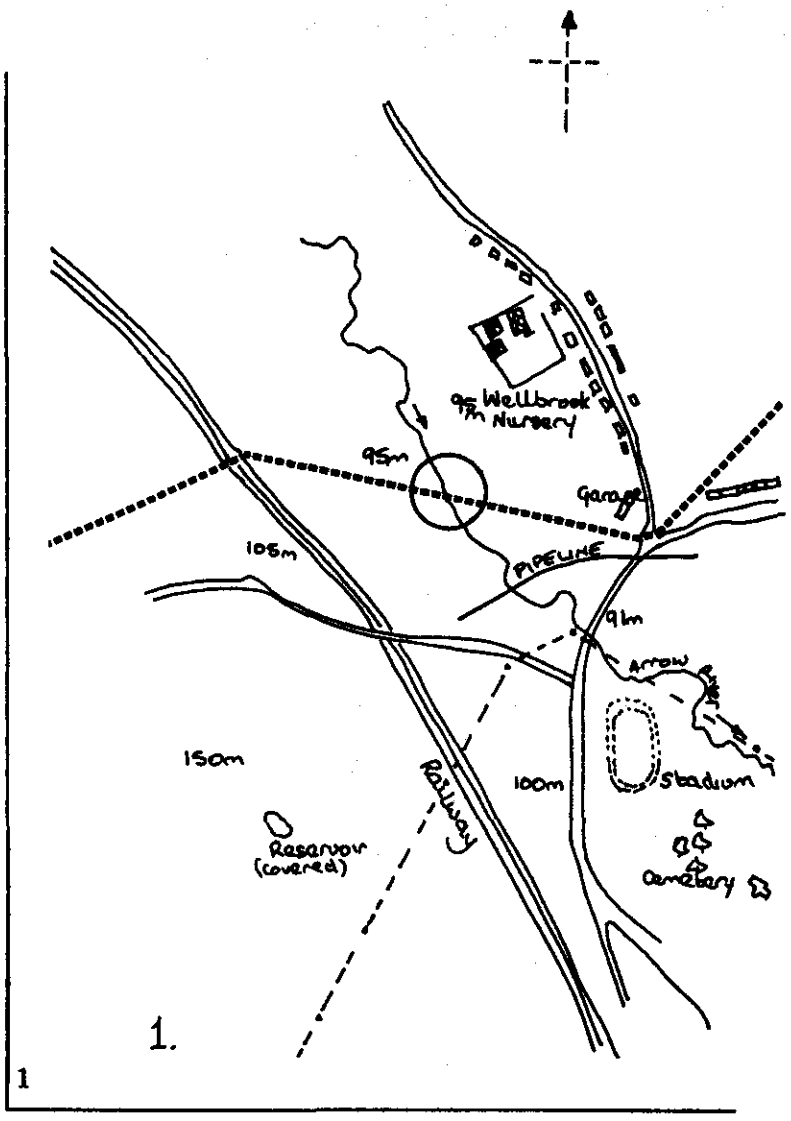
Substratum (cover)	bed	banks	adjacent
bed rock			
boulder/cobble			
pebbles/gravel	XXX	X	X
sand	X	XXX	XX
silt/clay/(peat)		X	X
	50 mm gravels	sand	till

WATER CHARACTERISTICS Colour: haze

pH 8.2, Conduct. 894 $\mu S\ cm^{-1}$, Temp. 14.5°C

Anions, mg l^{-1}		Cations, mg l^{-1}	
Alkalinity	4.2	Calcium	89
Chloride	51	Magnesium	35
Sulphate	178	Sodium	34
Nitrate N	6.0	Potassium	9.1
Phosphate P	2.5	(Iron)	0.65
Silicate Si	7.0		

Ion balance 9.21 : 9.00 m equiv.
Assessment: Excessive nutrient, rich in calcium, eutrophic or polluted
PHYSICAL oily smell.



ADJACENT FEATURES etc.
Land use sheep grazing
Upstream agricultural grazing
Downstream existing pipeline bridge 200 m d/s
Maintenance probably regular but not extreme
Fishery interest low-nil
Maintenance Factor 0

A deep cut slightly embanked stream lined with trees.

PLANT (shade %:cover; algae -%, moss %, macrophytes %) 1 + 3 = Score 4
Slow flowing stream with dense but thin layer of organic silt (or diatom algae) and densely shaded by trees of alder, ash, willow, field maple, hawthorn; banks with some nettles and other agricultural weeds.

ANIMAL Score $4\frac{1}{2}$
There was a low number of taxa present which was not sujrprising considering sewage fungus indicated a polluted environment. Chironomidae were abundant and *Baetis* species were common. *Ephemerella ignita* was the most notable species present.

SUMMARY (incl. potential problems, conservation, long-term morphological changes)
Reasonable quality stream but suffering from enriched water. Existing pipeline close but as bridge; suggest crossing close to this. Care in reinstating banks if buried crossing.

CONSTRUCTION Bridge or wet crossing in summer low flows. OVERALL SCORE $4\frac{1}{2}$

pond, Bordesley Park Farm
week of 2.7.90 SP 048 698
km from source - Altitude 105 m
Lat 52° 19'N, Log 1° 56'W

PHYSICAL CHARACTERISTICS
Size at survey: Width m; depth m
bank full: Width m; depth m

Flow at survey-discharge c $m^3 s^{-1}$
-velocity c $m\ s^{-1}$
Bed slope - °, type:
Rel. Stream Power:
Channel- plan form: piped?
- sinuosity now: , m
previous: , m
- section:
Erosion %, type:

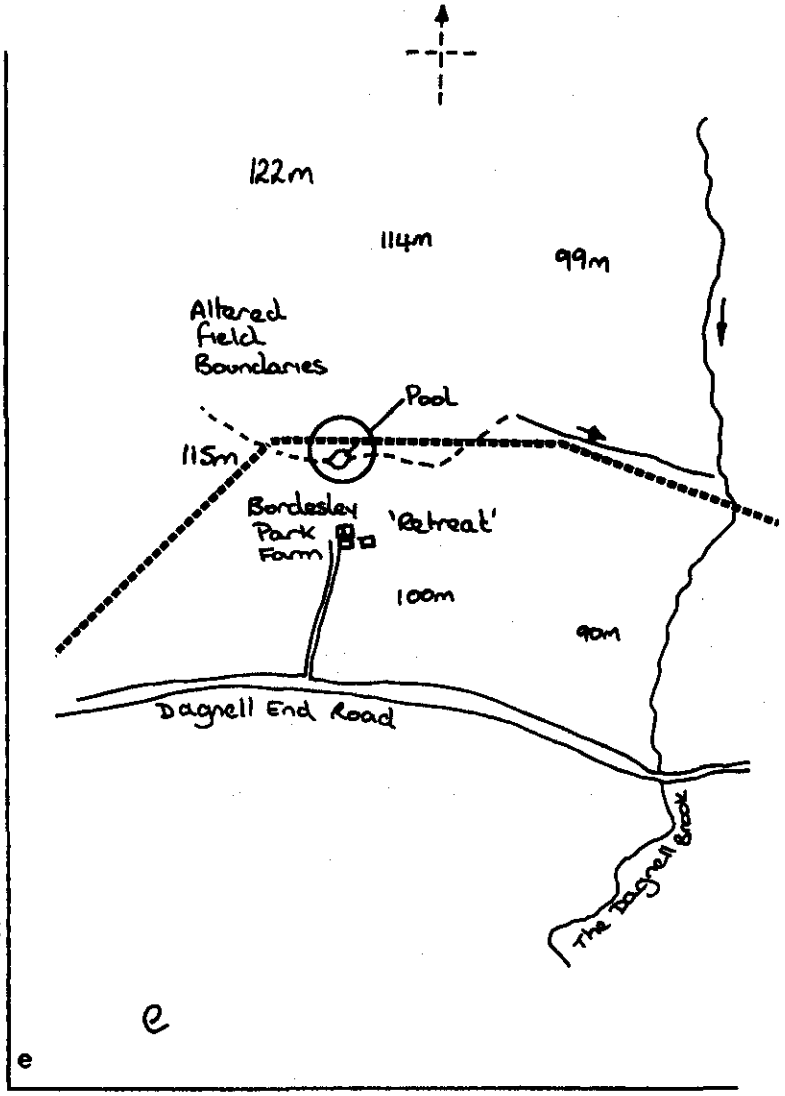
Substratum (cover) bed banks adjacent
bed rock
boulder/cobble
pebbles/gravel
sand
silt/clay/(peat)

WATER CHARACTERISTICS Colour:

pH ,Conduct. $\mu S\ cm^{-1}$, Temp °C

Anions, $mg\ l^{-1}$ Cations, $mg\ l^{-1}$

Alkalinity	Calcium
Chloride	Magnesium
Sulphate	Sodium
Nitrate N	Potassium
Phosphate P	(Iron)
Silicate Si	
Ion balance	: m equiv.
Assessment:	



ADJACENT FEATURES etc.
Land use stock watering pond
Upstream grazing
Downstream
Maintenance -
Fishery interest -

PHYSICAL Maintenance Factor

PLANT (shade 0%:cover; algae -%, moss %, macrophytes %) $\frac{1}{2} + \frac{1}{2}$ = Score 1
Agricultural grasses around margins, but some duckweed present.

ANIMAL Score

SUMMARY (incl. potential problems, conservation, long-term morphological changes)
Small nutrient-rich turbid stock watering pool with trampled margins.
Field boundaries altered and ditches probably now land drains.

CONSTRUCTION OVERALL SCORE (1)

Dagnell Brook
week of 2.7.90 SP 056 698
km from source 4 Altitude 95 m
Lat 52° 19'N, Log 1° 55'W

PHYSICAL CHARACTERISTICS
Size at survey: Width 2 m; depth .1 m
bank full: Width 3 m; depth .6 m

Flow at survey-discharge *c* .2 $m^3 s^{-1}$
-velocity *c* .3 $m\ s^{-1}$
Bed slope 10m/km, type: long riffle-pool
Rel. Stream Power: 3 \of 10m, in gulley
Channel- plan form: meander in wide
- sinuosity now: slight , 10 m
previous: , 10 m
- section: shallow
Erosion %, type: undercut

Substratum (cover)	bed	banks adjacent (downstream)
bed rock		
boulder/cobble	10	
pebbles/gravel	75	
sand	10	
silt/clay/(peat)	5	(sediment in pools)

pebbles to 100 mm

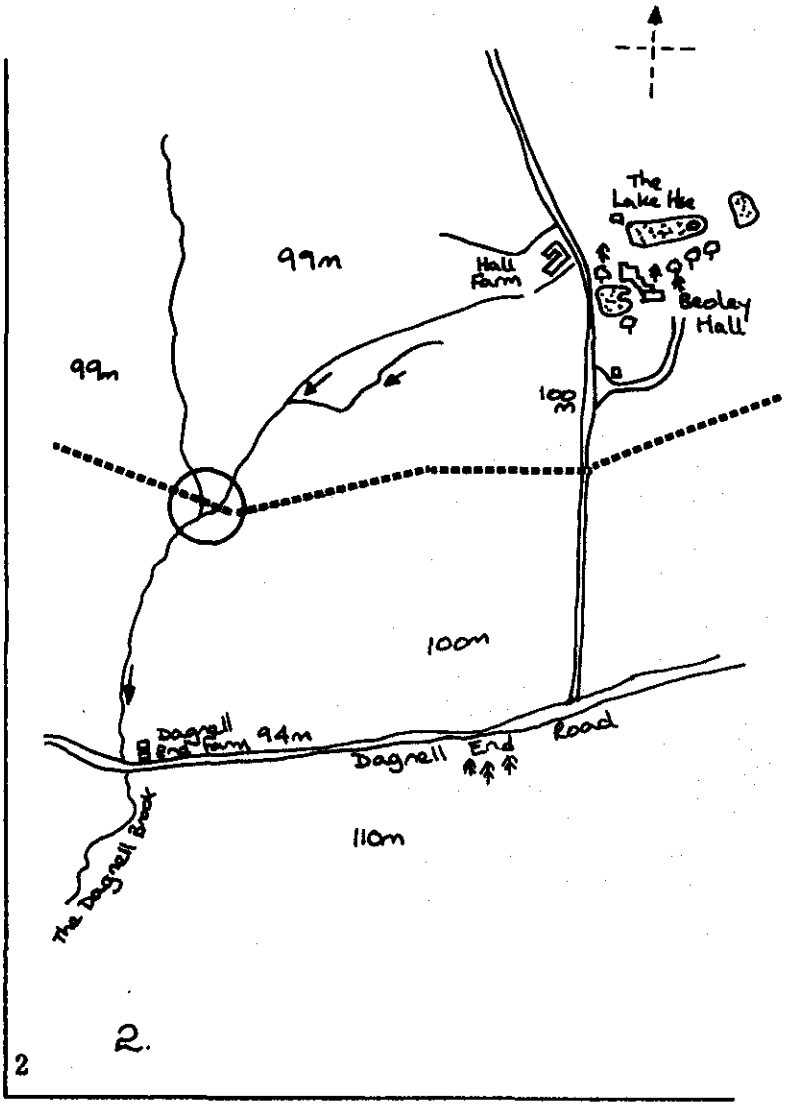
WATER CHARACTERISTICS Colour: clear

pH 7.9, Conduct. 860 $\mu S\ cm^{-1}$, Temp. 13.1°C

Anions, mg l^{-1}		Cations, mg l^{-1}	
Alkalinity	7.3	Calcium	76
Chloride	21	Magnesium	49
Sulphate	90	Sodium	15
Nitrate N	1.5	Potassium	5.1
Phosphate P	.27	(Iron)	-
Silicate Si	6.7		

Ion balance 9.78 : 8.65 *m equiv.*

Assessment:
high calcium low nutrient water



ADJACENT FEATURES etc.
Land use shelter belt in cereal fields
Upstream shelter belt
Downstream shelter belt and farm
Maintenance nil
Fishery interest low-nil

PHYSICAL Maintenance Factor +2
Shallow stream in broad valley with 5-10m high sides. Proposed crossing above confluence with tributary.

PLANT (shade 70%:cover; algae 20%, moss – %, macrophytes 5%) $1\frac{1}{2} + 3$ = Score $4\frac{1}{2}$
In shelter belt of maturing trees and bushes, but with surprising amount of weeds particularly nettles present.
Filamentous algae in unshaded areas.

ANIMAL Said to be only occurrence of a county rare crayfish. Score $7\frac{1}{2}$
The large area of bedrock limited the habitat for invertebrates. *Baetis* sp. were abundant and *Ephemerella ignita* & *Simulium* sp. were common. *Ephemera* was also present and with *E. ignita* were the only 10-scoring taxa present. Most taxa present were low scoring (5 or less).

SUMMARY (incl. potential problems, conservation, long-term morphological changes)
Good quality stream, requires care.

CONSTRUCTION Dry (re. conservation interest). OVERALL SCORE 8
Monitor construction activities for suspended materials.

stream Holt End
week of 2.7.90 SP 075 699
km from source 1 km Altitude 110 m
Lat 52° 19'N, Log 1° 54'W
PHYSICAL CHARACTERISTICS
Size at survey: Width 1 m; depth .1 m
bank full: Width 1.5m; depth .7 m

Flow at survey-discharge c $m^3 s^{-1}$
-velocity c $m\ s^{-1}$
Bed slope 20 m/km, type:
Rel. Stream Power:
Channel- plan form:
- sinuosity now: , m
previous: , m
- section:
Erosion %,type:

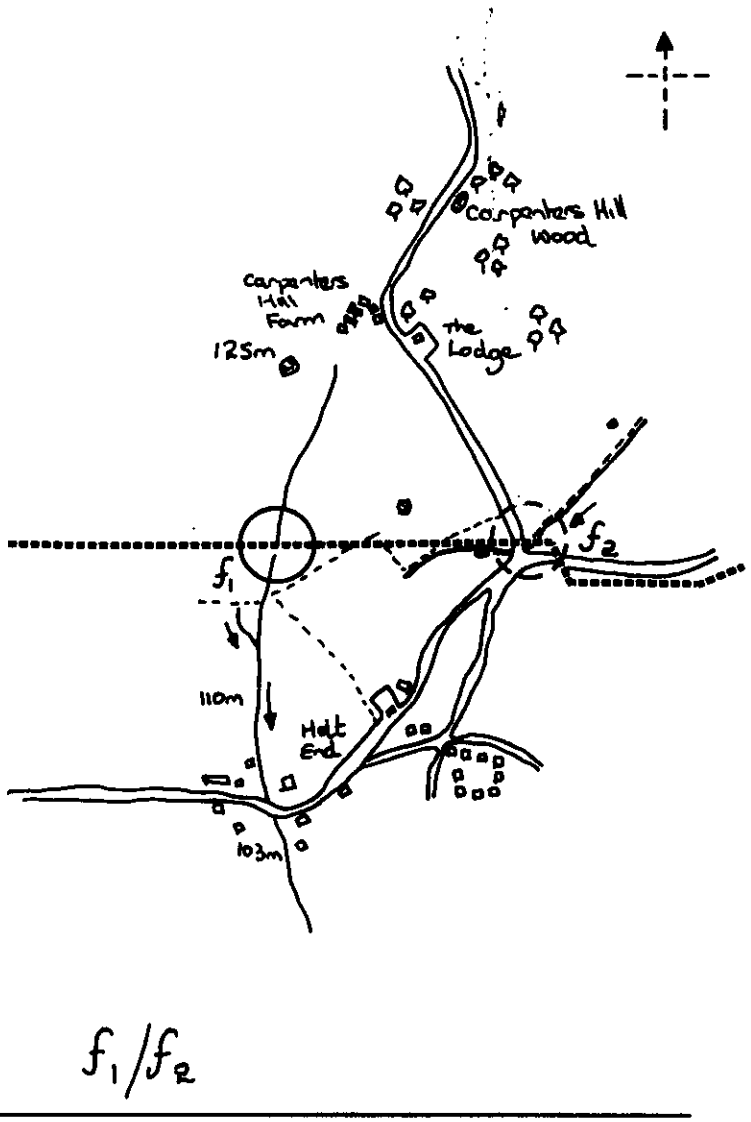
Substratum (cover)	bed	banks	adjacent
bed rock			
boulder/cobble			
pebbles/gravel			
sand	xxx		
silt/clay/(peat)	xx		

WATER CHARACTERISTICS Colour:

pH ,Conduct. $\mu S\ cm^{-1}$,Temp °C

Anions, $mg\ l^{-1}$ Cations, $mg\ l^{-1}$

Alkalinity	Calcium
Chloride	Magnesium
Sulphate	Sodium
Nitrate N	Potassium
Phosphate P	(Iron)
Silicate Si	
Ion balance :	m equiv.
Assessment:	



ADJACENT FEATURES etc.
Land use agricultural
Upstream farm
Downstream village
Maintenance
Fishery interest nil

PHYSICAL Maintenance Factor
Small nearly dry ditch.

PLANT (shade %:cover; algae -%, moss %, macrophytes %) + = Score
Many agricultural weeds.

ANIMAL Score

SUMMARY (incl. potential problems, conservation, long-term morphological changes)
Many paths. Wet meadows to East. Straightforward crossing.
Site to East not surveyed.

CONSTRUCTION Resurvey to optimize crossing point; survey f2. OVERALL SCORE

ditch, Alderhanger Wood
week of 2.7.90 SP 102 703
km from source 1.5 Altitude 150 m
Lat 52° 20'N, Log 1° 51'W

PHYSICAL CHARACTERISTICS
Size at survey: Width .1 m; depth .05m
bank full: Width 1.5m; depth 1 m

Flow at survey-discharge *c* $m^3 s^{-1}$
10 m/km -velocity *c* $m\ s^{-1}$
Bed slope 10 m/km , type:
Rel. Stream Power:
Channel- plan form:
- sinuosity now: , m
previous: , m
- section:
Erosion <5%,type:

Substratum (cover)	bed	banks	adjacent
bed rock			
boulder/cobble			
pebbles/gravel	xxx	xx	x
sand	x	xx	xx
silt/clay/(peat)	x		x

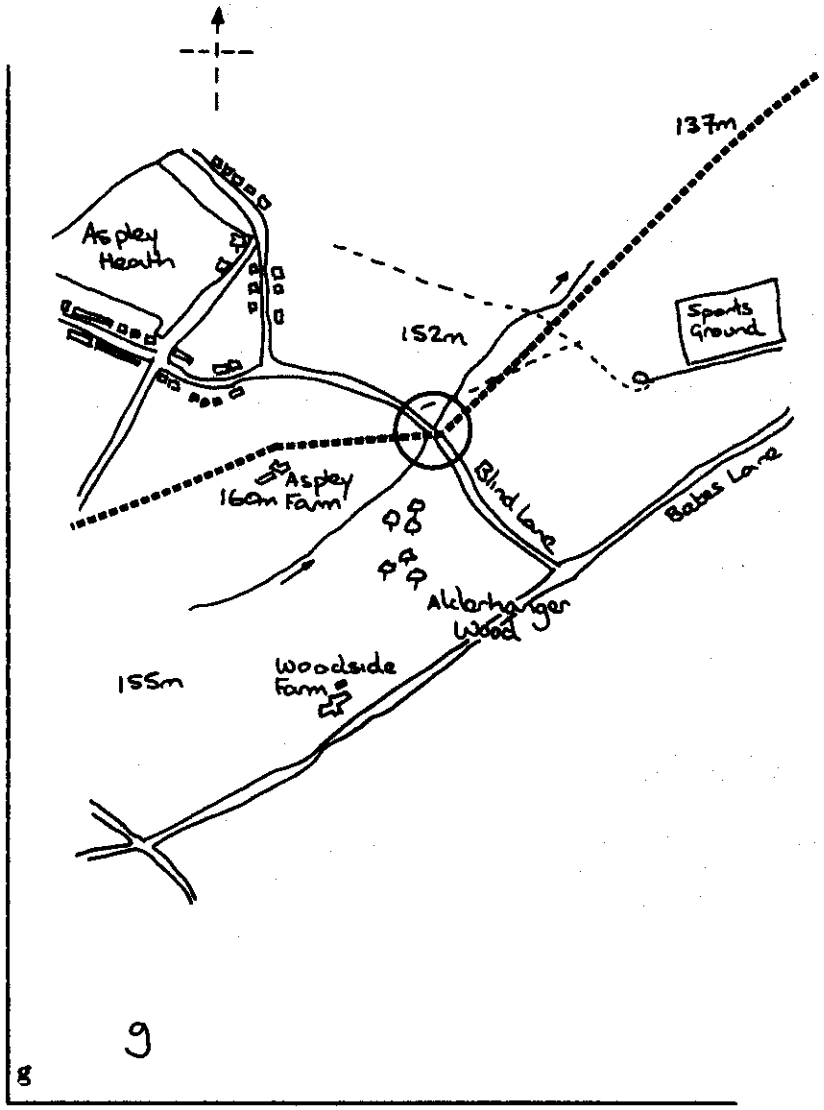
WATER CHARACTERISTICS Colour:

pH ,Conduct. $\mu S\ cm^{-1}$,Temp °C

Anions, mg l^{-1} Cations, mg l^{-1}

Alkalinity	Calcium
Chloride	Magnesium
Sulphate	Sodium
Nitrate N	Potassium
Phosphate P	(Iron)
Silicate Si	
Ion balance : m equiv.	

Assessment: Seen during rain with oil films from road runoff.



ADJACENT FEATURES etc.
Land use grazing sheep
Upstream road, pipes, erosion control
Downstream long ditch
Maintenance low
Fishery interest nil

PHYSICAL Maintenance Factor 0
Dry ditch crosses near erosion control structure and outlet pipe.

PLANT (shade 90%:cover; algae -%, moss %, macrophytes %) $\frac{1}{2} + \frac{1}{2}$ = Score 1
Ditch through long line of mature trees in well grazed pasture.

ANIMAL - Score

SUMMARY (incl. potential problems, conservation, long-term morphological changes)
Straightforward crossing.

CONSTRUCTION OVERALL SCORE (2)?

ditch, Tanworth-in-Arden
week of 2.7.90 SP 111 708
km from source Altitude 150 m
Lat 52° 20'N, Log 1° 50'W

PHYSICAL CHARACTERISTICS
Size at survey: Width m; depth m
bank full: Width m; depth m

Flow at survey-discharge *c* $m^3 s^{-1}$
-velocity *c* $m\ s^{-1}$
Bed slope °, type:
Rel. Stream Power:
Channel- plan form:
- sinuosity now: , m
previous: , m
- section:
Erosion %,type:

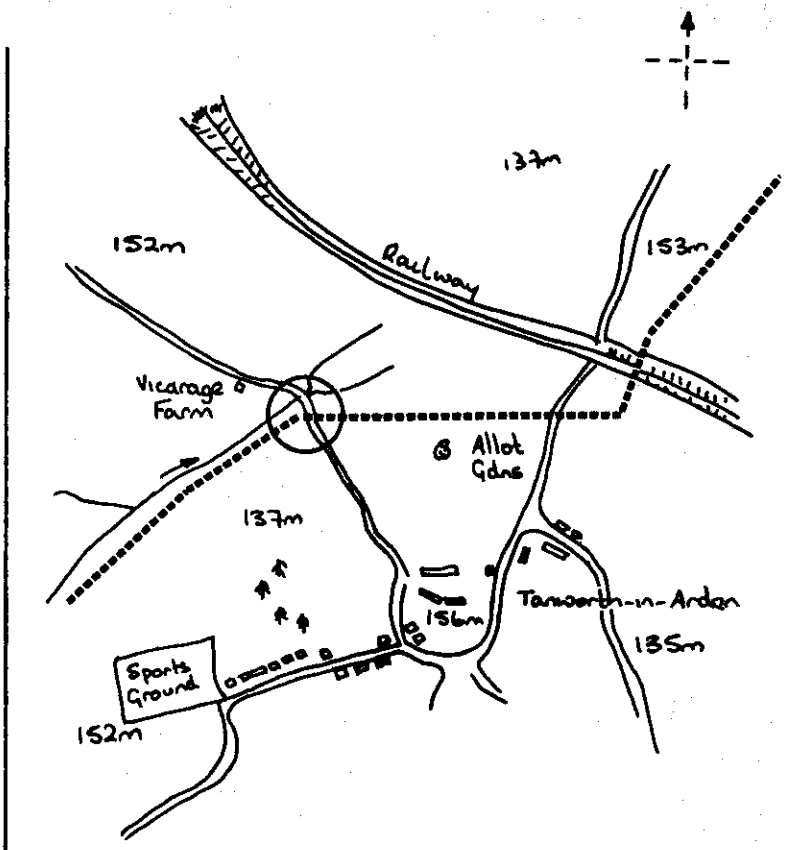
Substratum (cover)	bed	banks	adjacent
bed rock			
boulder/cobble			
pebbles/gravel	xxx		
sand	xx		
silt/clay/(peat)			

sandy soils

WATER CHARACTERISTICS Colour:

pH ,Conduct. $\mu S\ cm^{-1}$, Temp °C

Anions, mg l^{-1}	Cations, mg l^{-1}
Alkalinity	Calcium
Chloride	Magnesium
Sulphate	Sodium
Nitrate N	Potassium
Phosphate P	(Iron)
Silicate Si	
Ion balance :	m equiv.
Assessment:	



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ADJACENT FEATURES etc.
Land use grazing
Upstream grazing
Downstream grazing and road
Maintenance
Fishery interest

PHYSICAL Maintenance Factor
Dry ditch in open grazed field.

PLANT (shade %:cover; algae -%, moss %, macrophytes %) + = Score
Hawthorn hedge.

ANIMAL - Score

SUMMARY (incl. potential problems, conservation, long-term morphological changes)
Route adjacent to ditch.

CONSTRUCTION Ditch not crossed. OVERALL SCORE (2)

River Alne, Brook House Farm
week of 2.7.90 SP 115 712
km from source 3 km Altitude 130 m
Lat 52° 20'N, Log 1° 50'W

PHYSICAL CHARACTERISTICS
Size at survey: Width 2 m; depth .2 m
bank full: Width 5 m; depth 1.6m

Flow at survey-discharge *c* .3 $m^3 s^{-1}$
-velocity *c* .5 $m s^{-1}$
Bed slope 10 m/km, type: long run
Rel. Stream Power: 3
Channel- plan form: straightened
- sinuosity now: - , m
previous: - , m
- section: -
Erosion <5%,type:

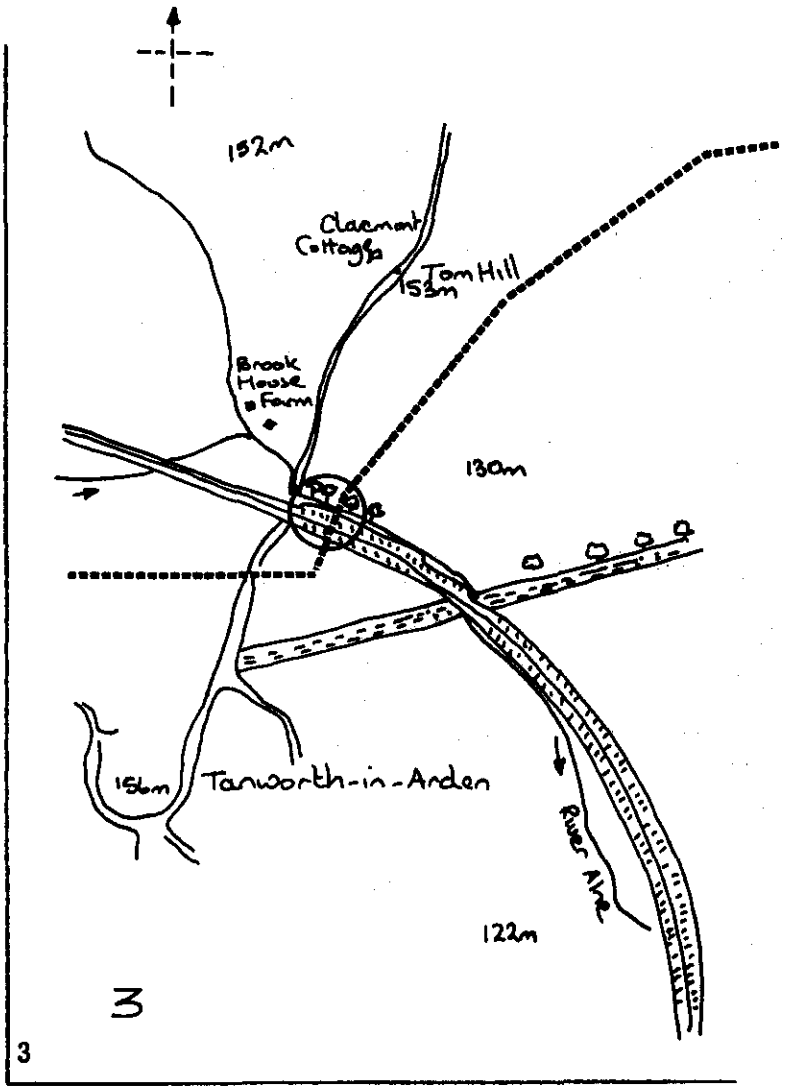
Substratum (cover)	bed	banks	adjacent
bed rock	(x?)		
boulder/cobble	25		
pebbles/gravel	35	x	
sand	10	xx	xxx
silt/clay/(peat)	20	x	xx

hard clay bed & occ. large boulders
WATER CHARACTERISTICS Colour:sl. haze

pH 8.2,Conduct.750 µS cm^{-1},Temp.13.5°C

Anions, mg l^{-1}		Cations, mg l^{-1}	
Alkalinity	6.0	Calcium	60
Chloride	26	Magnesium	44
Sulphate	64	Sodium	11
Nitrate N	4.5	Potassium	4.4
Phosphate P	.24	(Iron)	-
Silicate Si	11.5		

Ion balance 8.09 : 7.16 m equiv.
Assessment: Nutrient rich water
(sampled following shower of rain)



ADJACENT FEATURES etc.
Land use shelter belt alongside railway
Upstream tunnel under road
Downstream railway embankment
Maintenance low
Fishery interest low

PHYSICAL Maintenance Factor +1
Long pebble bed riffle with some boulders (from railway or road construction?) and hard clay bed and bank. Debris dams in stream.

PLANT (shade 100%:cover; algae -%, moss %, macrophytes %) 1 + $1\frac{1}{2}$ = Score $3\frac{1}{2}$
Densely shaded stream with variety of trees and bushes including alder, hawthorn, elder, etc and with short herbs, dogs mercury but with nettles and other weeds.

ANIMAL Score 5
The substratum of the riffles was mainly pebbles and gravel. There were some boulders in the pools but mainly a silt substratum dominated. No invertebrate taxa was abundant or common. The fauna was reasonably diverse with *Ephemerella ignita* the only 10-scoring taxa present. Ancylidae were present on stones in the riffles.

SUMMARY (incl. potential problems, conservation, long-term morphological changes)
Straightforward crossing.

CONSTRUCTION Wet. OVERALL SCORE $5\frac{1}{2}$

Stratford on Avon Canal, Hockley Heath
week of 2.7.90 SP 144 733
km from source Altitude 137 m
Lat 52° 21'N, Log 1° 47'W

PHYSICAL CHARACTERISTICS
Size at survey: Width 14 m; depth 1 m
bank full: Width - m; depth - m

Flow at survey-discharge c - $m^3 s^{-1}$
-velocity c .1? m s^{-1}
Bed slope 0^0, type:
Rel. Stream Power:
Channel- plan form:
- sinuosity now: , m
previous: , m
- section:
Erosion %, type:

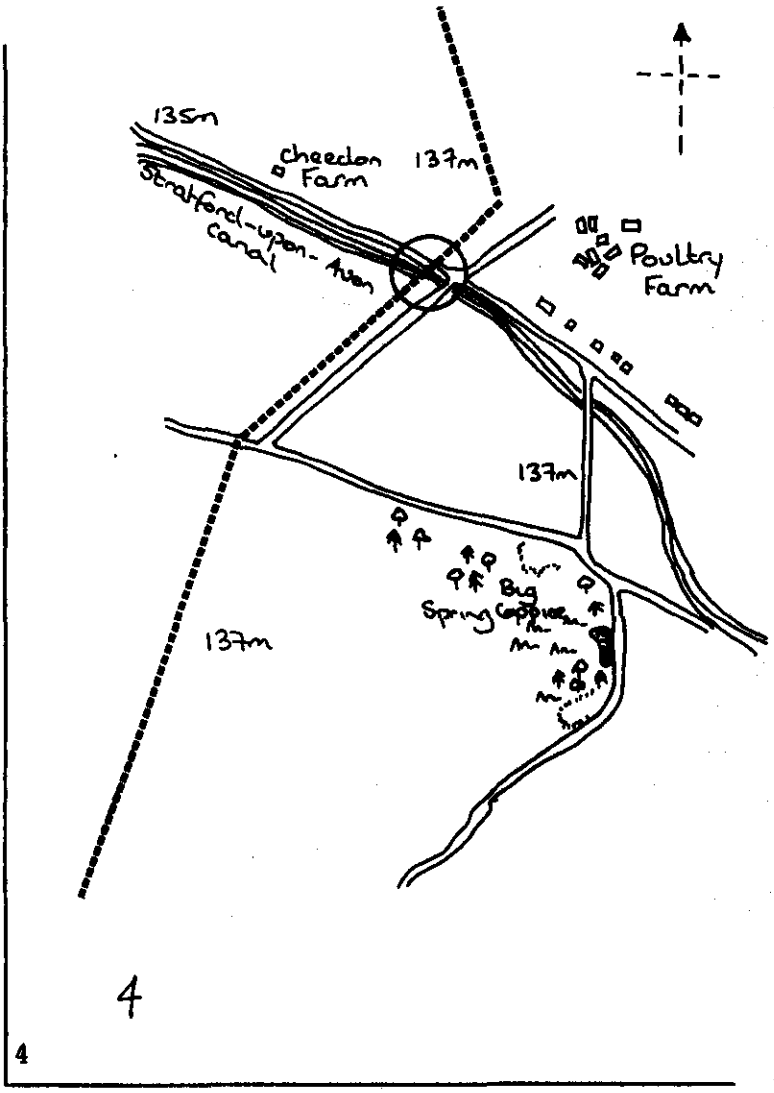
Substratum (cover)	bed	banks	adjacent
bed rock			
boulder/cobble	10		
pebbles/gravel			
sand	80		
silt/clay/(peat)	10		

WATER CHARACTERISTICS Colour: turbid

pH 7.8, Conduct. 530 µS cm^{-1}, Temp. 15.3°C

Anions, mg l^{-1}		Cations, mg l^{-1}	
Alkalinity	2.6	Calcium	58
Chloride	35	Magnesium	12
Sulphate	77	Sodium	29
Nitrate N	<.1	Potassium	6.8
Phosphate P	.095	(Iron)	-
Silicate Si	2.6		

Ion balance 5.17 : 5.24 m equiv.
Assessment: Nutrient poor and turbid water, smell of anaerobic mud.



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ADJACENT FEATURES etc.
Land use trees, road to N, arable to S
Upstream East -
Downstream West - Bridge
Maintenance regular
Fishery interest coarse fishery expected

PHYSICAL Maintenance Factor (0) or (-2½)
Tree lined section of canal by bridge, boat traffic (3 boats in 20 mins).

PLANT (shade 60%:cover; algae -%, moss %, macrophytes %) 0 + 1+ = Score 1+
Variety of bank species but mainly weeds.

ANIMAL Score 3½
Anaerobic silt in the deep parts of the canal contained only *Chironomus* and tubificid worms. The margins contained other species of chironomids and Oligochaeta. Limnephilidae was the only other taxa found in a canal that apeared to have very few invertebrates.

SUMMARY (incl. potential problems, conservation, long-term morphological changes)
Canal in level adjacent land, lateral boring would be less difficult than open dredging; canal lining unknown.

CONSTRUCTION Lateral thrust bore suggested (but wet possible) OVERALL SCORE (2+)

R. Blythe, Valentines Farm, Illshaw
week of 2.7.90 SP 141 745
km from source 2.5 Altitude 140 m
Lat 52° 22'N, Log 1° 48'W

PHYSICAL CHARACTERISTICS
Size at survey: Width 1-2m; depth 1-3m
bank full: Width - m; depth - m

Flow at survey-discharge *c* .1 $m^3 s^{-1}$
-velocity *c* .2 m s^{-1}
Bed slope <1°, type: modified
Rel. Stream Power: -
Channel- plan form: straightened
- sinuosity now: - , m
previous: - , m
- section: -
Erosion - %, type: -

Substratum (cover)	bed	banks	adjacent
bed rock			
boulder/cobble			
pebbles/gravel	(xx)		
sand	(x)		
silt/clay/(peat)	(xx)		

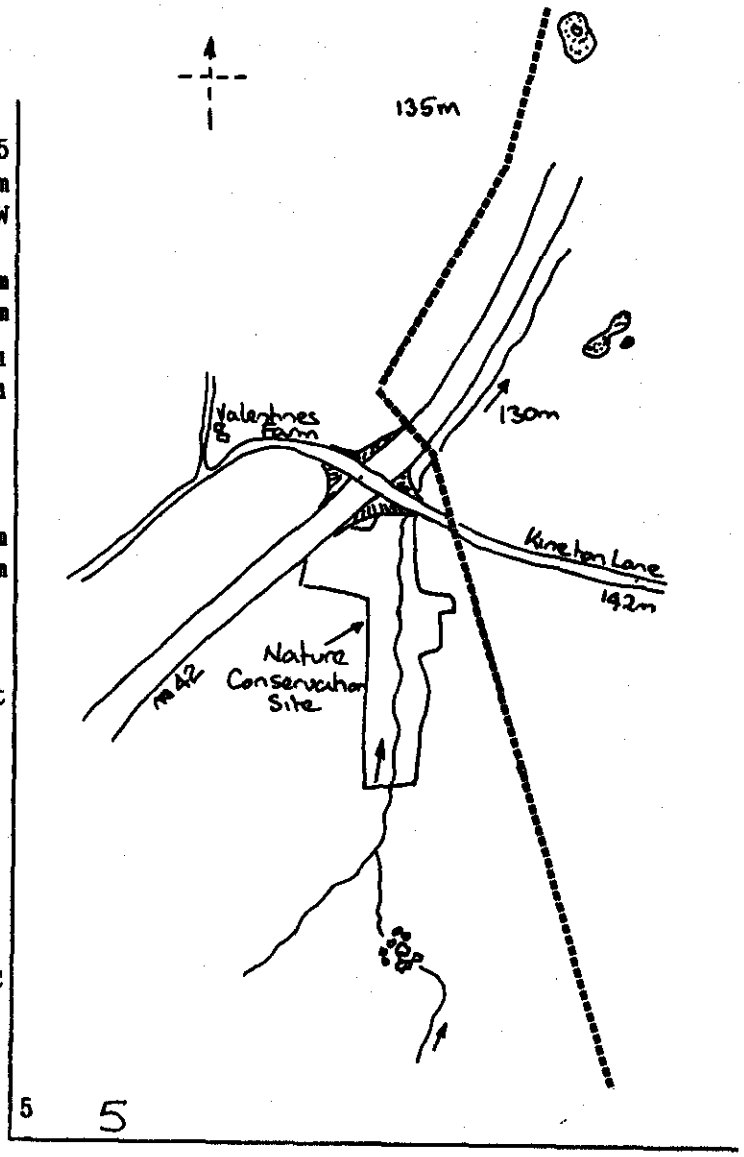
varied bed and banks

WATER CHARACTERISTICS Colour: clear

pH ,Conduct. $\mu S\ cm^{-1}$, Temp °C

Anions, mg l^{-1}	Cations, mg l^{-1}
Alkalinity	Calcium
Chloride	Magnesium
Sulphate	Sodium
Nitrate N	Potassium
Phosphate P	(Iron)
Silicate Si	
Ion balance :	m equiv.

Assessment: see Survey 6



ADJACENT FEATURES etc.
Land use Motorway, grazing
Upstream: conservation site, pipe under overpass
Downstream motorway, conservation river. \road Maintenance
Fishery interest low, sticklebacks

PHYSICAL
Maintenance Factor -2½-0
Varied from pipe outlet through trampled muddy section to near realigned and resectioned channel alongside motorway.

PLANT (shade %:cover; algae -%, moss %, macrophytes %) 0-1 + 0-3 = Score 0-4
Varied from nil to a fair variety of emergent water plants. Planted Willow etc on embankments of motorway. Some invasive water plants including Balsam.

ANIMAL
Score 6
The area was completely covered with *Apium* and sampling was confined to pond netting among the plants. Limnephilidae were very abundant and Dytiscidae were common. There was a disappointing number of taxa recorded.

SUMMARY (incl. potential problems, conservation, long-term morphological changes)
A much altered area with channalised stream running alongside motorway; reasonable reinstatement following construction.

CONSTRUCTION Straightforward (most of section has already been reconstructed). Minimise and monitor both suspended material and oxygen levels during construction as upstream of SSSI river.

OVERALL SCORE (½-5)

R. Blythe, M42 Junction 4
week of 2.7.90 SP 145 758
km from source 4 Altitude 125 m
Lat 52° 22'N, Log 1° 45'W

PHYSICAL CHARACTERISTICS
Size at survey: Width m; depth m
bank full: Width m; depth m

Flow at survey-discharge *c* $m^3 s^{-1}$
-velocity *c* $m\ s^{-1}$
Bed slope 5 m/km, type: riffle pool
Rel. Stream Power: 3
Channel-plan form: meander/straightened
- *sinuosity now:* – , – m
previous: – , – m
- section: regular/trapezoid
Erosion <5%, type:

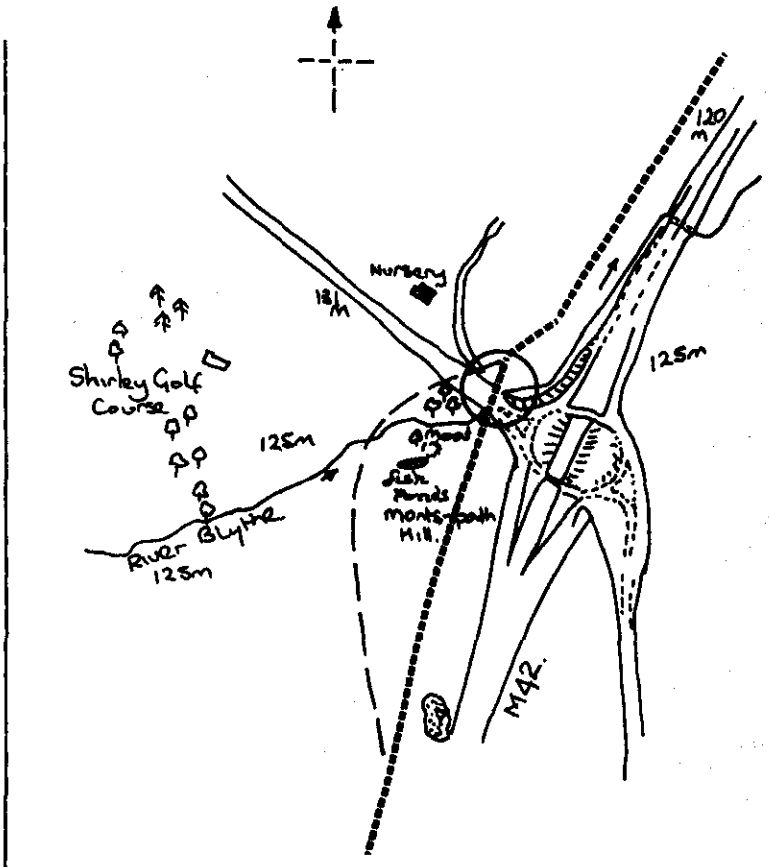
Substratum (cover)	bed	banks	adjacent
bed rock			
boulder/cobble			
pebbles/gravel	xxx		
sand	xx		
silt/clay/(peat)			

WATER CHARACTERISTICS Colour:

pH ,Conduct. $\mu S\ cm^{-1}$, Temp °C

Anions, mg l^{-1}	Cations, mg l^{-1}
Alkalinity	Calcium
Chloride	Magnesium
Sulphate	Sodium
Nitrate N	Potassium
Phosphate P	(Iron)
Silicate Si	
Ion balance : m equiv.	

Assessment:



ADJACENT FEATURES etc.
Land use motorway and access road, parkland
Upstream Conservation river
Downstream " "
Maintenance
Fishery interest medium – low

PHYSICAL Maintenance Factor
Adjacent or under motorway access road tunnel

PLANT (shade %:cover; algae -%, moss %, macrophytes %) + = Score

ANIMAL Score

SUMMARY (incl. potential problems, conservation, long-term morphological changes)
A good site, details of proposed construction and route under road access area required before survey.

CONSTRUCTION Details of construction required before resurvey. OVERALL SCORE (6?)
Suggest if tunnel under Motorway access road not used then 40 m to West be considered, ie by gateway with route to South passing along meadowland (– –).

R. Blythe, M42, nr Blythe Hall
week of 2.7.90 SP 155 771
km from source 5.5 Altitude 120 m
Lat 52° 23'N, Log 1° 46'W

PHYSICAL CHARACTERISTICS
Size at survey: Width 2.5m; depth .3 m
bank full: Width 4 m; depth 1.3m

Flow at survey-discharge *c* .3 $m^3 s^{-1}$
-velocity *c* .4 $m\ s^{-1}$
Bed slope 10m/km, type: long run
Rel. Stream Power: 3 but banks lined
Channel- plan form: long meanders
- sinuosity now: low , 10 m
previous: ? , — m
- section: trapezoid
Erosion — %, type:

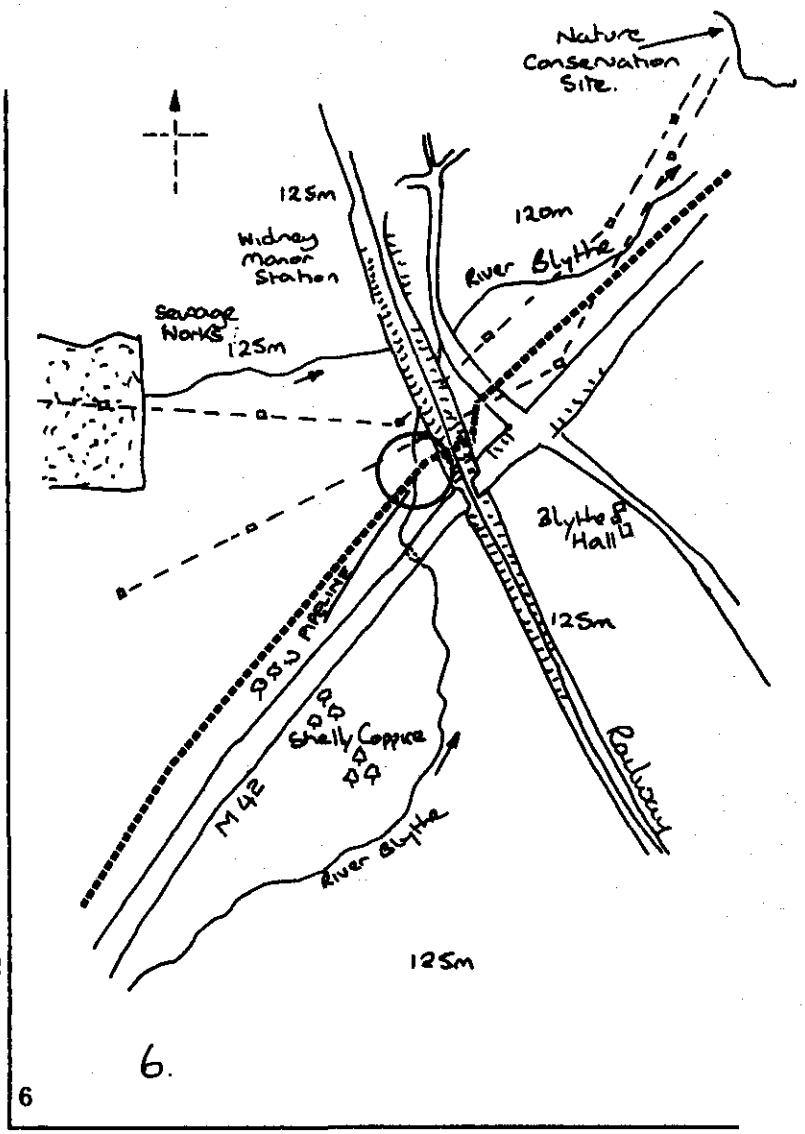
Substratum (cover)	bed	banks	adjacent
bed rock			
boulder/cobble			
pebbles/gravel	50	x	x
sand	20	xx	xx
silt/clay/(peat)	30	x	x
	much silt		

WATER CHARACTERISTICS Colour: clear

pH 8.3, Conduct. 620 $\mu S\ cm^{-1}$, Temp. 15.2°C

Anions, mg l^{-1}		Cations, mg l^{-1}	
Alkalinity	2.9	Calcium	55
Chloride	35	Magnesium	21
Sulphate	95	Sodium	2.7
Nitrate N	4.2	Potassium	7.1
Phosphate P	1.7	(Iron)	—
Silicate Si	6.8		

Ion balance 5.88 : 5.81 m equiv.
Assessment: Phosphate excessive nutrient rich river (evaporative \concentration?).



ADJACENT FEATURES etc.
Land use wet meadows, grazing, railway, motor
Upstream motorway. Conservation river. \way
Downstream: railway embankment. " "
Maintenance low, but channel partly lined.
Fishery interest medium — low

PHYSICAL Maintenance Factor -2
Realigned, lined and resectioned river, with only a small natural section between railway and motorway.

PLANT (shade 60%: cover; algae -%, moss %, macrophytes %) $2\frac{1}{2} + 3$ = Score $5\frac{1}{2}$
Rich variety of aquatic and emergent aquatic plants with bush cover of willow, alder, hawthorn, field maple etc. Rich meadow adjacent. Good section of hedge near proposed crossing.

ANIMAL Score $5\frac{1}{2}$
The sampling area was resectioned with a block-walled bank on one side. The substratum was covered in filamentous algae and silt. Sampling was intensive in the marginal vegetation on the side of the natural bank. Three families of molluscs were present with Lymnaeidae common. Agriidae was the most notable family present. Downstream in a natural section, Simuliidae were present on the macrophyte *Ranunculus*.

SUMMARY (incl. potential problems, conservation, long-term morphological changes)
Good section of river spoilt by excessive channel or bank lining despite being a conservation river. Not established if sewage input to ditch to N entering downstream of railway.

CONSTRUCTION Move crossing to already lined section of river. OVERALL SCORE $3\frac{1}{2}$
Avoid existing pipelines, sewers and power lines.

R. Blythe, nr Ravenshaw Hall
week of 2.7.90 SP 173 795
km from source 9 Altitude 110 m
Lat 52° 24'N, Log 1° 45'W

PHYSICAL CHARACTERISTICS
Size at survey: Width 4 m; depth .7m
bank full: Width 5 m; depth 1.2m

Flow at survey-discharge c 1 $m^3 s^{-1}$
-velocity c .15 m s^{-1}
Bed slope 5 m/km, type:
Rel. Stream Power: 2
Channel- plan form:
- sinuosity now: , m
previous: , m
- section:
Erosion <10%, type:

Substratum (cover)	bed	banks	adjacent
bed rock			
boulder/cobble	(40)		
pebbles/gravel	(30)		
sand	(10)		
silt/clay/(peat)	(10)		

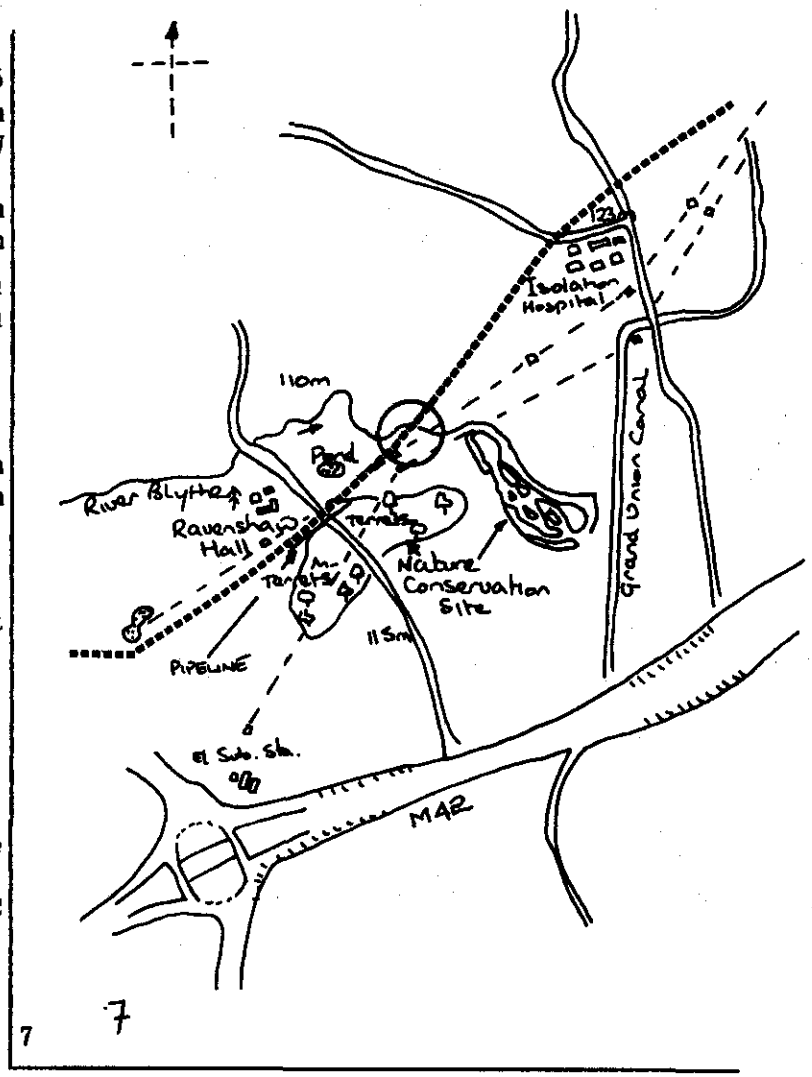
sediment on bed overlying pebbles

WATER CHARACTERISTICS Colour: sl. haze

pH 7.7, Conduct. 235 µS cm^{-1}, Temp. 14.8°C

Anions, mg l^{-1}		Cations, mg l^{-1}	
Alkalinity	2.4	Calcium	46
Chloride	29	Magnesium	16
Sulphate	67	Sodium	18
Nitrate N	.91	Potassium	5.9
Phosphate P	1.1	(Iron)	-
Silicate Si	5.3		

Ion balance 4.64 : 4.58 m equiv.
Assessment: Phosphate excessive nutrient high stream water.



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ADJACENT FEATURES etc.
Land use
Upstream
Downstream
Maintenance
Fishery interest

PHYSICAL Maintenance Factor +1

PLANT (shade %:cover; algae -%, moss %, macrophytes %) 1 + $1\frac{1}{2}$ = Score $2\frac{1}{2}$
Stream shaded by continuous bands of trees of alder, willow, ash, thorn (or sloe).

ANIMAL Score $4\frac{1}{2}$
This site was sampled from the bank and mainly confined to marginal areas due to its depth. No notable animals were found and all were low scoring (5 or less).

SUMMARY (incl. potential problems, conservation, long-term morphological changes)
Adjacent to Terrets conservation area. Route very close to pylons and to existing pipeline.

CONSTRUCTION Wet crossing but monitor suspended material during construction. OVERALL SCORE $4\frac{1}{2}$

Grand Union Canal, Catherine de Barnes
week of 2.7.90 SP 182 799
km from source Altitude 110 m
Lat 52° 25'N, Log 1° 44'W

PHYSICAL CHARACTERISTICS
Size at survey: Width 15 m; depth 1.2m
bank full: Width - m; depth - m

Flow at survey-discharge *c* $m^3 s^{-1}$
-velocity *c* <.05 $m\ s^{-1}$
Bed slope 0°, type: canal
Rel. Stream Power: -
Channel- plan form: -
- sinuosity now: - , m
previous: - , m
- section: -
Erosion %, type: -

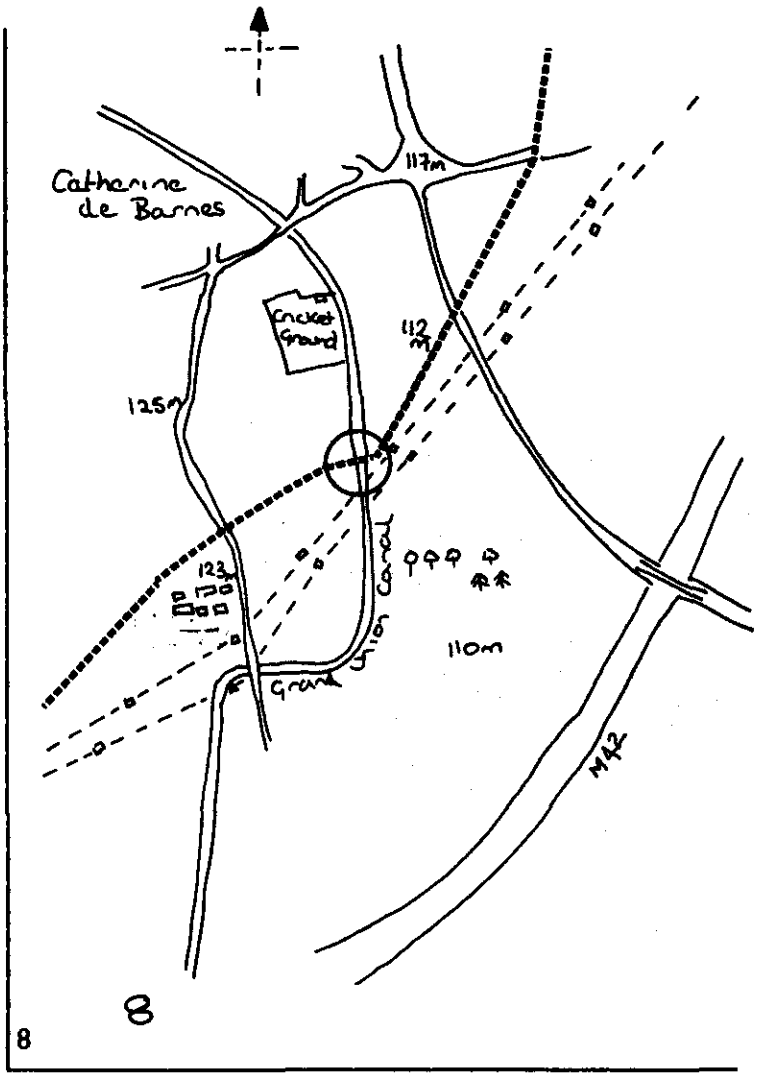
Substratum (cover)	bed	banks	adjacent
bed rock			
boulder/cobble	15		
pebbles/gravel	30		
sand	5		
silt/clay/(peat)	50		

WATER CHARACTERISTICS Colour: sl.green

pH 7.5, Conduct. *c*200 $\mu S\ cm^{-1}$, Temp 16.2°C

Anions, mg l^{-1}		Cations, mg l^{-1}	
Alkalinity	1.7	Calcium	42
Chloride	46	Magnesium	14
Sulphate	79	Sodium	30
Nitrate N	.21	Potassium	4.9
Phosphate P	.048	(Iron)	.015
Silicate Si	2.0		

Ion balance 4.65 : 4.65 m equiv.
Assessment: Nutrient low clearish water.



ADJACENT FEATURES etc.
Land use rough woodland, cereals
North, village
South, open access-pit to canal, pylons
Maintenance regular? boats, 1 in 30 min
Fishery interest

PHYSICAL Maintenance Factor $(-2\frac{1}{2}) - (0)$
Canal, shallow to West, deeper to East where bank is lined with concrete piles.

PLANT (shade %: cover; algae -%, moss %, macrophytes %) $2\frac{1}{2} + 2$ = Score $4\frac{1}{2}$
Stands of macrophytes to West including a five leaved Pond weed, but stands of bushes and occasional trees.

ANIMAL Score $3\frac{1}{2}$
Overall, the substratum was 99% silt but sampling was confined to marginal macrophytes, stony areas in shallow water and macrophytes in deeper water. Hydracarina were abundant and Corixidae, Lymnaeidae and Asellidae common. Free swimming *Argulus*, a fish parasite, were also found.

SUMMARY (incl. potential problems, conservation, long-term morphological changes)
Quite an acceptable site for a canal with some boat traffic, straightforward crossing, lateral thrust bore expected.

CONSTRUCTION Lateral bore from downhill Eastern side. OVERALL SCORE $(1\frac{1}{2}-4)$

ditch to Low Brook, Elmdon
week of 2.7.90 SP 179 829
km from source 2 Altitude 100 m
Lat 52° 26'N, Log 1° 44'W

PHYSICAL CHARACTERISTICS
Size at survey: Width 1 m; depth .05m
bank full: Width 2.5m; depth .8 m

Flow at survey-discharge *c* <.05 $m^3 s^{-1}$
-velocity *c* <.05 m s^{-1}
Bed slope 10 m/km, type:
Rel. Stream Power: 1
Channel- plan form: straight ditch
- sinuosity now: - , m
previous: - , m
- section: -
Erosion <10%, type:

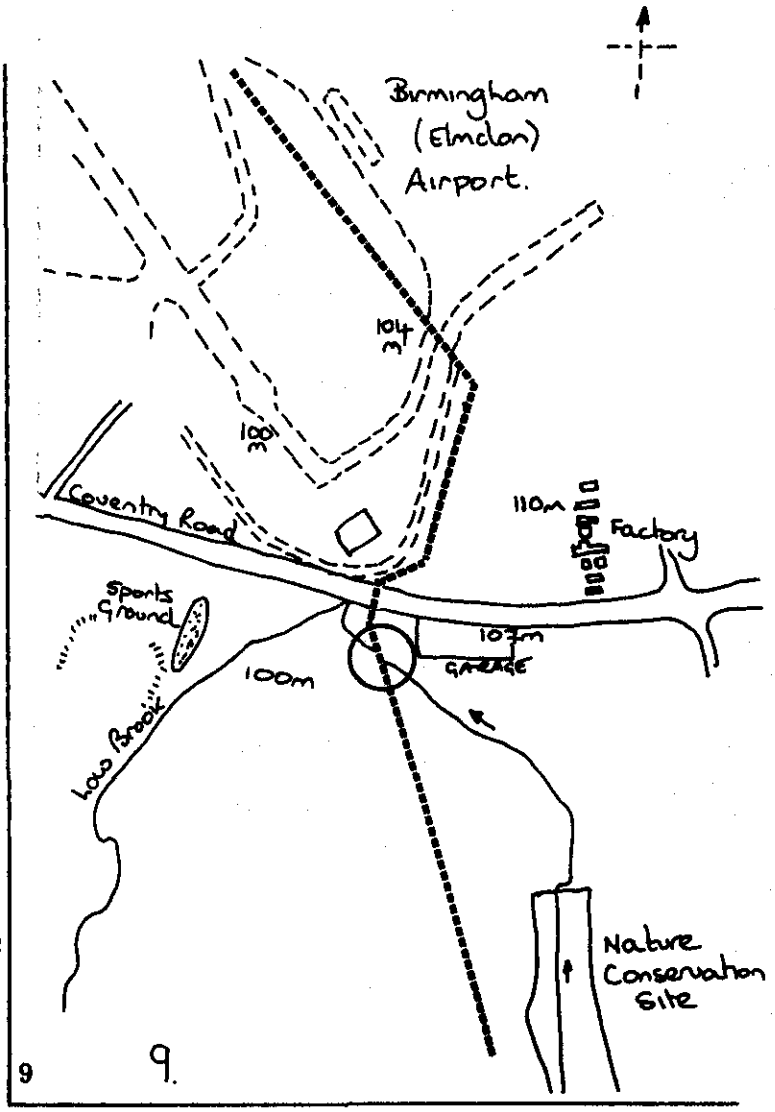
Substratum (cover)	bed	banks	adjacent
bed rock			
boulder/cobble			
pebbles/gravel			
sand			
silt/clay/(peat)	100		

WATER CHARACTERISTICS Colour: clear

pH 8.3, Conduct. *c*600µS cm^{-1}, Temp11.7.°C

Anions, mg l^{-1}		Cations, mg l^{-1}	
Alkalinity	6.6	Calcium	80
Chloride	38	Magnesium	52
Sulphate	114	Sodium	15
Nitrate N	5.8	Potassium	2.9
Phosphate P	.099	(Iron)	-
Silicate Si	9.0		

Ion balance 10.08 : 9.00 m equiv.
Assessment: nitrate-rich clear water
(evaporative concentration?)



ADJACENT FEATURES etc.
Land use grazing, adjacent landing lights
Upstream pasture
Downstream dual carriageway, airport
Maintenance minimum
Fishery interest nil

PHYSICAL Maintenance Factor +1
Overgrown part fenced ditch to main stream, Low Brook.

PLANT (shade 60%:cover; algae -%, moss %, macrophytes 95%) 2 + 3 = Score 5
Good variety of emergent aquatic plants together with rich adjacent grazed meadow; occasional agricultural weeds. Shaded by light cover of willow, hawthorn and thorn bushes.

ANIMAL Score 5
This small stream contained few animals of any families. Only 6 taxa were recorded of which Gammaridae and Dytiscidae were the most notable.

SUMMARY (incl. potential problems, conservation, long-term morphological changes)
Reasonably good site despite being in airport pathway.

CONSTRUCTION Straightforward crossing, avoid oaks. OVERALL SCORE 6

Low Brook, Marston Hall
week of 2.7.90 SP 179 845
km from source 4 Altitude m
Lat 52° 27'N, Log 1° 44'W

PHYSICAL CHARACTERISTICS
Size at survey: Width 1.5m; depth <.1m
bank full: Width 3 m; depth 1? m

Flow at survey-discharge *c* $m^3 s^{-1}$
-velocity *c* $m\ s^{-1}$
Bed slope 5 m/km, type:
Rel. Stream Power:
Channel- plan form:
- sinuosity now: , m
previous: , m
- section:
Erosion %,type:

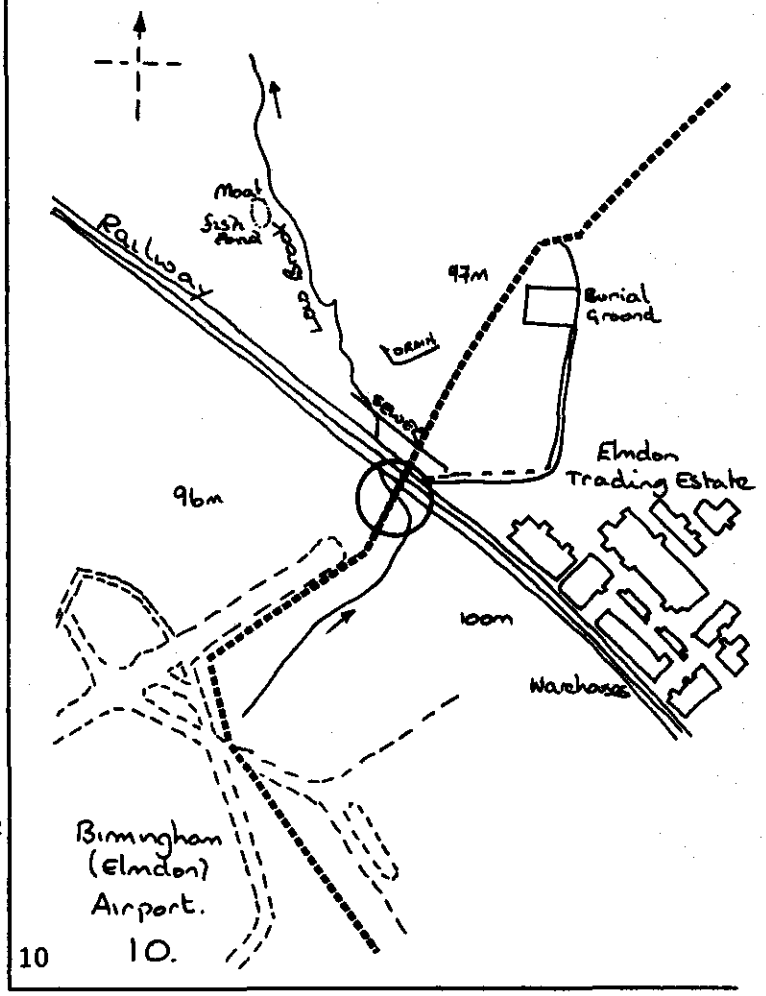
Substratum (cover)	bed	banks	adjacent
bed rock			
boulder/cobble	15		
pebbles/gravel	45		
sand	10		
silt/clay/(peat)	30		

WATER CHARACTERISTICS Colour:

pH 8.1, Conduct. *c*400μS cm^{-1}, Temp. 16.6°C

Anions, mg l^{-1}		Cations, mg l^{-1}	
Alkalinity	5.0	Calcium	87
Chloride	34	Magnesium	47
Sulphate	213	Sodium	16
Nitrate N	2.4	Potassium	4.4
Phosphate P	.18	(Iron)	-
Silicate Si	5.0		

Ion balance 9.71 : 8.96 m equiv.
Assessment: nutrient rich water contaminated with sewage.



ADJACENT FEATURES etc.
Land use Airport and railway embankment
Upstream Airport runway
Downstream open grazing, cemetery, grid to
Maintenance low \reduce access via tunnel
Fishery interest

PHYSICAL Maintenance Factor -2
Realigned and sectioned river, entering a tunnel; much debris in river downstream.

PLANT (shade 10%:cover; algae 20%, moss %, macrophytes %) $\frac{1}{2} + 2 =$ Score $2\frac{1}{2}$
Some filamentous algae but also short emergent plants. Rich damp meadow with many butterflies to East of railway.

ANIMAL Score 4
The stony substratum was covered with filamentous algae. Lymnaeidae and Asellidae were extremely abundant and Chironomidae were common. Overall a poor fauna indicating a polluted site.

SUMMARY (incl. potential problems, conservation, long-term morphological changes)
Viewed by access through railway embankment tunnel. Large tunnel available for route but contains other services in crude bundle. Surface water/sewage pipe downstream to East of railway.

CONSTRUCTION Lateral bore of railway embankment and stream away from existing services etc. OVERALL SCORE $1\frac{1}{4}$

ditch at Heath farm nr. Chelmsley Wood
week of 2.7.90 SP 188 858
km from source Altitude 100 m
Lat 52° 28'N, Log 1° 44'W

PHYSICAL CHARACTERISTICS
Size at survey: Width 1 m; depth .2 m
bank full: Width 2 m; depth 1 m

Flow at survey-discharge $m^3 s^{-1}$
-velocity $m\ s^{-1}$
Bed slope <1°, type:
Rel. Stream Power:
Channel- plan form:
- sinuosity now: , m
previous: , m
- section:
Erosion %, type:

Substratum (cover)	bed	banks	adjacent
bed rock			
boulder/cobble			
pebbles/gravel			
sand			
silt/clay/(peat)			

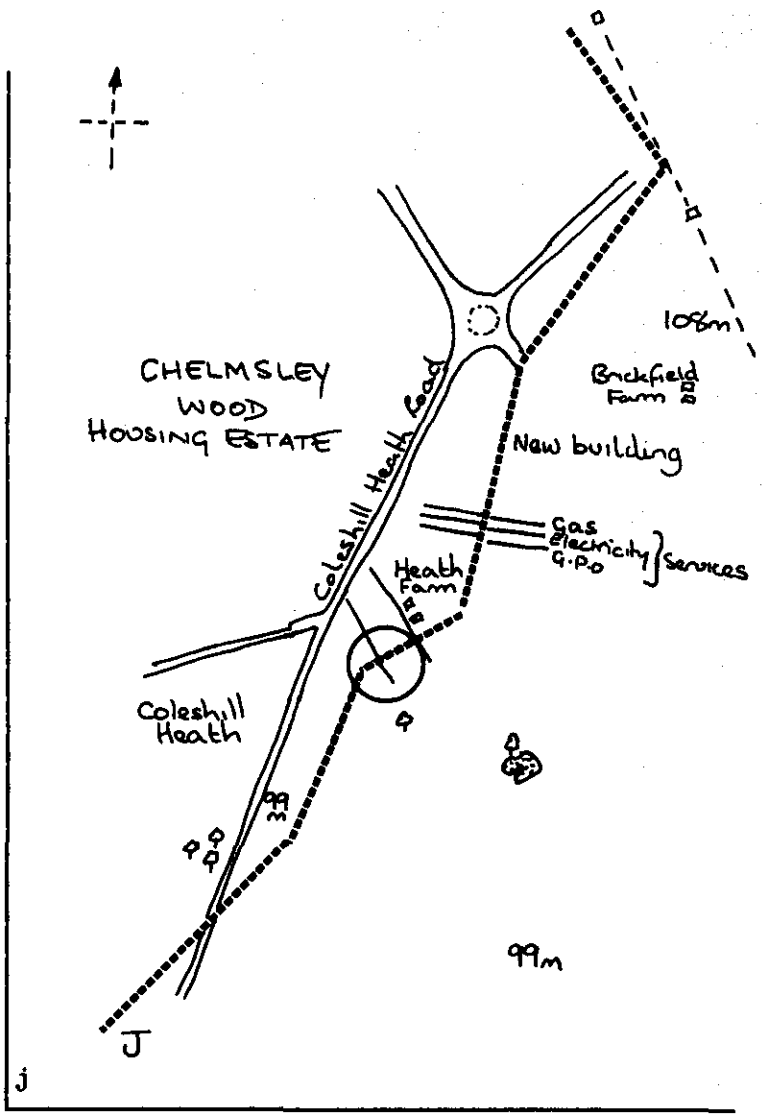
WATER CHARACTERISTICS Colour:

pH ,Conduct. $\mu S\ cm^{-1}$, Temp °C

Anions, $mg\ l^{-1}$ Cations, $mg\ l^{-1}$

Alkalinity	Calcium
Chloride	Magnesium
Sulphate	Sodium
Nitrate N	Potassium
Phosphate P	(Iron)
Silicate Si	
Ion balance :	m equiv.

Assessment: grossly polluted by domestic sewage, etc?



ADJACENT FEATURES etc.
Land use
Upstream
Downstream
Maintenance
Fishery interest

PHYSICAL Maintenance Factor

PLANT (shade %:cover; algae -%, moss %, macrophytes %) + = Score

ANIMAL Score

SUMMARY (incl. potential problems, conservation, long-term morphological changes)
Grossly polluted ditch at burnt-down farm; landscaped area adjacent but with many services crossing the proposed route

CONSTRUCTION OVERALL SCORE 0

River Cole, nr Chelmsley Wood
week of 2.7.90 SP 187 877
km from source 30 Altitude 90 m
Lat 52° 29'N, Log 1° 44'W

PHYSICAL CHARACTERISTICS
Size at survey: Width 15 m; depth .4 m
bank full: Width 24 m; depth 4 m

Flow at survey-discharge *c* 4 $m^3 s^{-1}$
5/10 m/km -velocity *c* .5 m s^{-1}
Bed slope 5-10m/km, type: long riffle
Rel. Stream Power: 4
Channel- plan form: large meanders
- sinuosity now: high , 600m
previous: - , - m
- section: trapezoid
Erosion <5%,type:

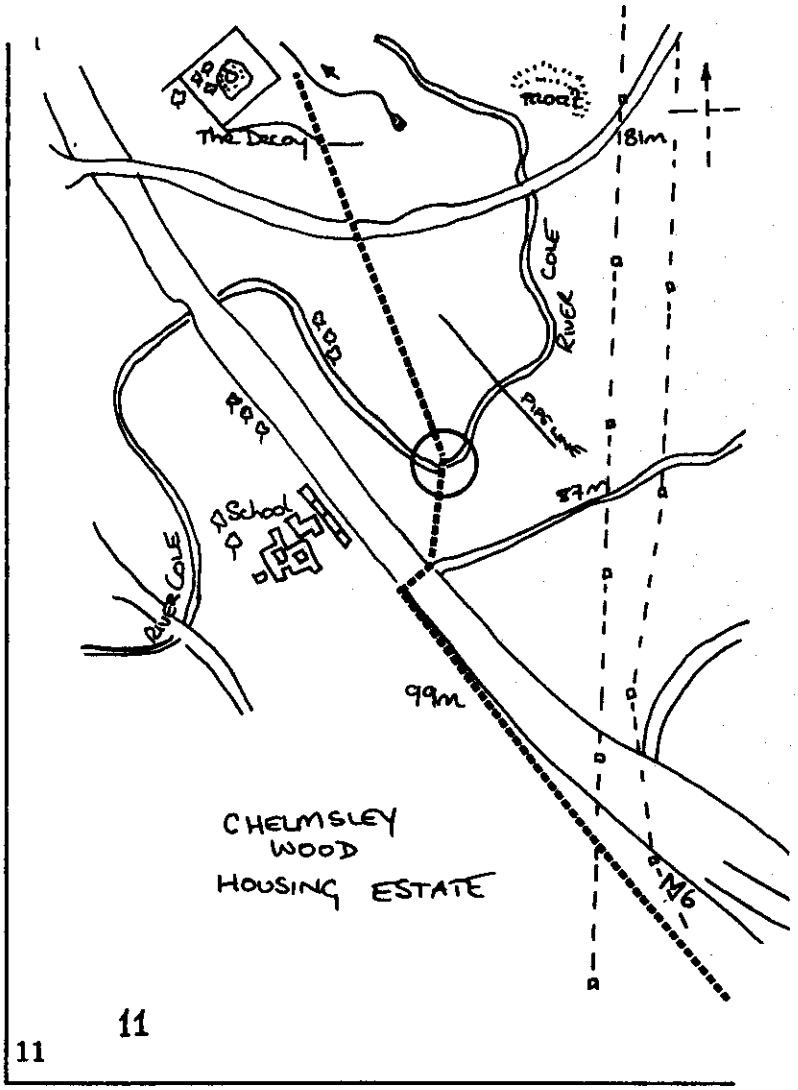
Substratum (cover)	bed	banks	adjacent
bed rock			
boulder/cobble		x	
pebbles/gravel	55	x	x
sand	30	xx	xx
silt/clay/(peat)	15	xx	xx

WATER CHARACTERISTICS Colour:

pH 9.3,Conduct. $\mu S\ cm^{-1}$,Temp18.3°C

Anions, mg l^{-1}		Cations, mg l^{-1}	
Alkalinity	3.0	Calcium	62
Chloride	32	Magnesium	25
Sulphate	152	Sodium	19
Nitrate N	1.4	Potassium	3.8
Phosphate P	.32	(Iron)	-
Silicate Si	1.7		

Ion balance 6.20 : 6.08 m equiv.
Assessment: Nutrient rich water
Some bacterial contamination.



ADJACENT FEATURES etc.
Land use rough grazing & arable, ditch to SE
Upst. large town \with flow control strictures
Downstream confluence with R. Tane and Blythe
Maintenance greatly enlarged, low
Fishery interest low

PHYSICAL Maintenance Factor -1
Greatly enlarged and regular river; much debris in river esp. car tyres. Dried debris layer over bank vegetation to +0.5 m above water.

PLANT (shade 20%:cover; algae 30%, moss %, macrophytes 40%) $2\frac{1}{2}$ + 2 = Score $4\frac{1}{2}$
Shaded by bushes of willow and hawthorn, with dense growths of fine leaved and broad leavedpond weeds in water in part overgrown by filamentous algae. A variety of bank plants including balsam and agricultural weeds.

ANIMAL Score 3
Only 5 taxa were found at this site. Filamentous algae covered the stony substratum. Chironomidae were extremely abundant and Asellidae was common. The sparse fauna indicates a polluted site.

SUMMARY (incl. potential problems, conservation, long-term morphological changes)
No special reinstatement apart from bank consolidation and revegetation.
Adjacent to large ditch with flow control structures

CONSTRUCTION Wet OVERALL SCORE $2\frac{3}{4}$

spring, near Kingshurst
week of 2.7.90 SP 184 889
km from source Altitude 80 m
Lat 52° 29'N, Log 1° 43'W

PHYSICAL CHARACTERISTICS
Size at survey: Width m; depth m
bank full: Width m; depth m

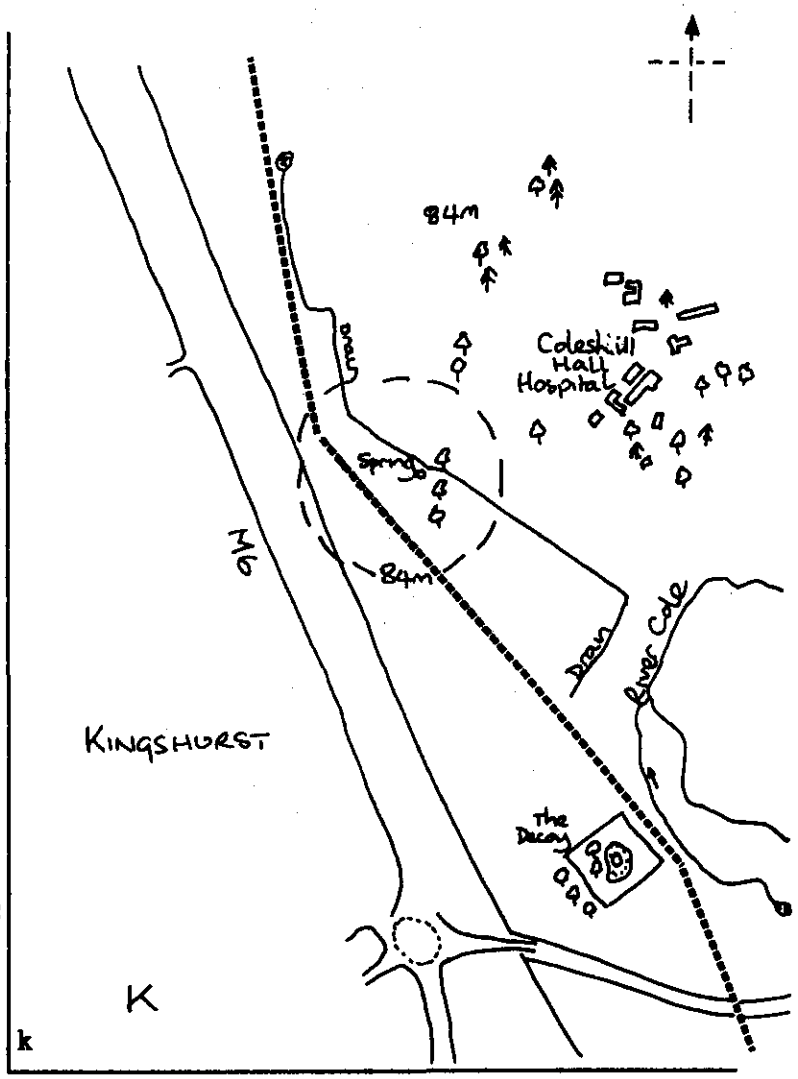
Flow at survey-discharge *c* 0.05 $m^3 s^{-1}$
-velocity *c* 0.4 $m\ s^{-1}$
Bed slope - °, type:
Rel. Stream Power:
Channel- plan form:
- sinuosity now: , m
previous: , m
- section:
Erosion %, type:

Substratum (cover)	bed	banks	adjacent
bed rock			
boulder/cobble			
pebbles/gravel			
sand		xxx	
silt/clay/(peat)		xx	

WATER CHARACTERISTICS Colour:

pH ,Conduct. $\mu S\ cm^{-1}$, Temp °C

Anions, $mg\ l^{-1}$	Cations, $mg\ l^{-1}$
Alkalinity	Calcium
Chloride	Magnesium
Sulphate	Sodium
Nitrate N	Potassium
Phosphate P	(Iron)
Silicate Si	
Ion balance :	m equiv.
Assessment:	



ADJACENT FEATURES etc.
Land use
Upstream
Downstream
Maintenance
Fishery interest

PHYSICAL Maintenance Factor

PLANT (shade %:cover; algae -%, moss %, macrophytes %) + = Score

ANIMAL Score

SUMMARY (incl. potential problems, conservation, long-term morphological changes)
Spring flow from ground or pipe to downhill side of pipeline route, to a running stream.

CONSTRUCTION OVERALL SCORE

River Tame, Castle Bromwich
week of 2.7.90 SP 149 907
km from source 10+ Altitude 90 m
Lat 52° 30'N, Log 1° 47'W

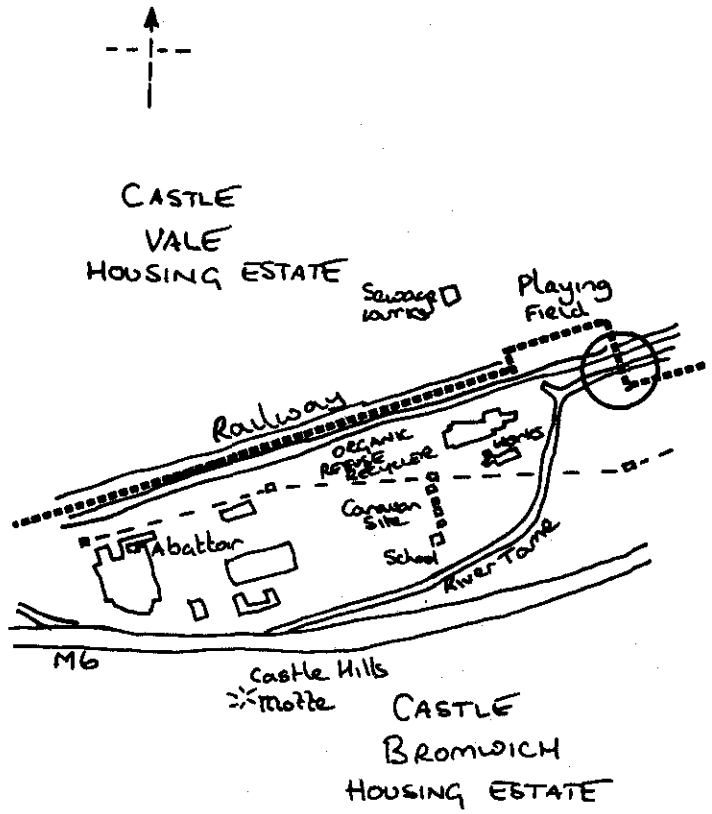
PHYSICAL CHARACTERISTICS
Size at survey: Width 25 m; depth 1 m
bank full: Width 30+m; depth 3 m
(50) (5)
Flow at survey-discharge *c* 3 $m^3 s^{-1}$
-velocity *c* 4-1.5 m s^{-1}
Bed slope 1°, type: riffle pool
Rel. Stream Power: 5 \200m +
Channel- plan form: long meanders
- sinuosity now: low , 300m
previous: – , – m
- section:trapezoid, 1 bank
Erosion 10%,type: slump \lined, berms

Substratum (cover)	bed	banks	adjacent
bed rock			
boulder/cobble	10		
pebbles/gravel	65	xxx	xxx
sand	10	xx	xx
silt/clay/(peat)	15		

WATER CHARACTERISTICS Colour:
colloidal haze
pH 8.1,Conduct. *c*400 µS cm^{-1},Temp17.9°C

Anions, mg l^{-1}		Cations, mg l^{-1}	
Alkalinity	3.6	Calcium	113
Chloride	123	Magnesium	18
Sulphate	193	Sodium	75
Nitrate N	7.4	Potassium	8.8
Phosphate P	2.8	(Iron)	
Silicate Si	6.1		

Ion balance 11.15 : 10.61m equiv.
Assessment: Excessive nutrient and chloride levels (some bacterial \contamination).



12. 12

ADJACENT FEATURES etc.
Land use various, railway etc.
Upstream large town, sewage works, recycler
Downstream sewage works
Maintenance regular, some lining
Fishery interest low - nil

PHYSICAL Maintenance Factor -2
A large resectioned and realigned and embanked/bermed river, with much debris in river.

PLANT (shade %:cover; algae -%, moss %, macrophytes %) $1\frac{1}{2} + 3$ = Score $4\frac{1}{2}$
A surprising variety of emergent and aquatic plants; banks are regularly maintained by cutting.

ANIMAL Score $3\frac{1}{2}$
A polluted site characterised by low scoring taxa. Lymnaeidae were very abundant and Asellidae and Chironomidae abundant. Apart from these families, a few specimenws of Erpobdellidae and one specimen of Baetidae, no other animals were found.

SUMMARY (incl. potential problems, conservation, long-term morphological changes)
Site access difficult either across railway, by recycler or under motorway.

CONSTRUCTION Wet but monitor suspended material. OVERALL SCORE 2

Table 3. Invertebrate families found on reconnaissance survey

	1	2	3	4	5	6	7	8	9	10	11	12
HEPTAGENIIDAE												
LEPTOPHLEBIIDAE												
EPHEMERIDAE		X										
EPHEMERELLIDAE	X	X	X									
TAENIOPTERYGIDAE												
LEUCTRIDAE												
CAPNIIDAE												
PERLODIDAE												
PERLIDAE												
CHLOROPERLIDAE												
ODONTOCERIDAE												
LEPIDOSTOMATIDAE												
BRACHYCENTRIDAE												
SERICOSTOMATIDAE												
ASTACIDAE												
AGRIIDAE						X						
PHILOPOTAMIDAE												
CAENIDAE												
NEMOURIDAE												
RHYACOPHILIDAE												
POLYCENTROPIDAE												
LIMNEPHILIDAE				X	X							
ANCYLIDAE			X									
GAMMARIDAE	X		X					X	X	X	X	
COENAGRIIDAE												
VELIIDAE												
CORIXIDAE						X		X				
HALIPLIDAE								X				
DYTISCIDAE		X	X		X		X	X	X	X		
GYRINIDAE												
HYDROPHILIDAE					X							
HELODIDAE												
ELMINTHIDAE												
HYDROPSYCHIDAE												
TIPULIDAE		X										
SIMULIIDAE		X	X			X						
PLANARIIDAE			X									
BAETIDAE	X	X	X									X
SIALIDAE		X				X	X					
PISCICOLIDAE								X				
HYDROBIIDAE		X				X	X		X			
LYMNAEIDAE	X					X	X	X	X	X	X	X
PLANORBIDAE					X	X						
SPHAERIDAE					X		X	X				
GLOSSIPHONIIDAE		X	X		X	X	X	X		X		
ERPOBDELLIDAE			X			X		X			X	X
ASELLIDAE	X	X				X	X	X		X	X	X
CHIRONOMIDAE	X	X	X	X	X	X	X	X	X	X	X	X
OLIGOCHAETA				X		X		X	X	X	X	

APPENDIX II -

Maps showing pipeline route, positions of reconnaissance survey and sites visited, watercourses within 1 km and major roads etc for location of route.

Dashed line - pipeline route

• - bore hole

Hatched - aquifer protection zone

Map 1 Droitwich-Redditch area showing pipeline route, positions of reconnaissance survey and sites visited, watercourses within 1 km and major roads etc for location of route.

Map 1a Droitwich-Redditch area showing pipeline route, positions of reconnaissance survey and sites visited, watercourses within 1 km and major roads etc for location of route, with boreholes, aquifer protection zones and protected bore hole zones.

Map 2 Redditch-Solihull area showing pipeline route, positions of reconnaissance survey and sites visited, watercourses within 1 km and major roads etc. for location of route.

Map 2a Redditch-Solihull area showing pipeline route, positions of reconnaissance survey and sites visited, watercourses within 1 km and major roads etc for location of route with boreholes, aquifer protection zones and protected bore hole zones.

Map 3 Birmingham Airport to Bromford, Birmingham, showing pipelineroute, positions ofreconnaissance survey and sites visited, watercourses within 1 km and major roads etc for location of route.

Map 3a Birmingham Airport to Bromford, Birmingham, showing pipeline route, positions of reconnaissance survey and sites visited, watercourses within 1 km and major roads etc for location of route with boreholes, aquifer protection zones and protected bore hole zones.

Map 4 Alternative recommended diversions around Spring Brook aquifer protection zone 1, near Redditch showing pipeline route, positions of reconnaissance survey and sites visited, watercourses within 1 km and major roads etc for location of route with boreholes, aquifer protection zones and protected bore hole zones (0.5 and 1.0 km).

Map 5 Map of catchment areas with general pipeline route.

N

74
06

M5

A448

M42

BROMSGROVE

WORCESTER AND BIRMINGHAM CANAL

A38(T)

A442

R. SALWARPE

DROITWICH

M5

WORCESTER AND BIRMINGHAM CANAL

A38(T)

A

B

C

C-d

d

1

2

e

RIVER ARROW

THE DAGNELL BROOK

BATCHLEY BROOK

SPRING BROOK

SWAN BROOK

SEELEY BROOK

ARROW VALLEY LAKE

REDDITCH

A448

A441

SCALE
1/50000

MAP 1

N

24

SOLIHULL

GRAND UNION CANAL

A34

A435

STRATFORD-UPON-AVON CANAL

RIVER BLYTHE

M42

A452

A41(T)

A34(T)

SPRING BROOK

RIVER ALNE

2

f

g

h

3

4

5

6

7

8

i

SCALE
1/50000

MAP 2

N

GRAND UNION CANAL

SOLIHULL

A452

M42

RIVER BLYTHE

A34

STRATFORD-UPON-AVON CANAL

A435

RIVER BLYTHE

M42

SPRING BROOK

A34(T)

STRATFORD-UPON-AVON CANAL

GRAND UNION CANAL

A45(T)

RIVER ALNE

SCALE
1/50000

MAP 2a

N

A452(T)

A38(T)

ESSO BROMFIELD TERMINAL
FINISH OF PIPELINE

RIVER TAME

M42

12

A38(M)

A5123

A16

A4040

A47

K

RIVER COLE

BIRMINGHAM

11

A452

J

BIRMINGHAM
INTERNATIONAL
AIRPORT

A45

10

A441(T)

RIVER BLYTHE

M6

9

LOW BROOK

SCALE
1/50000

MAP 3

95
27

N

A452(T)

A38(T)

ESSO BROMFIELD TERMINAL
FINISH OF PIPELINE

M42

River Anker

12

A38(M)

A5127

M6

A47

A4040

River Cole

K

11

BIRMINGHAM

A452

J

9

River Rhea

M6

Birmingham International Airport

A441(T)

10

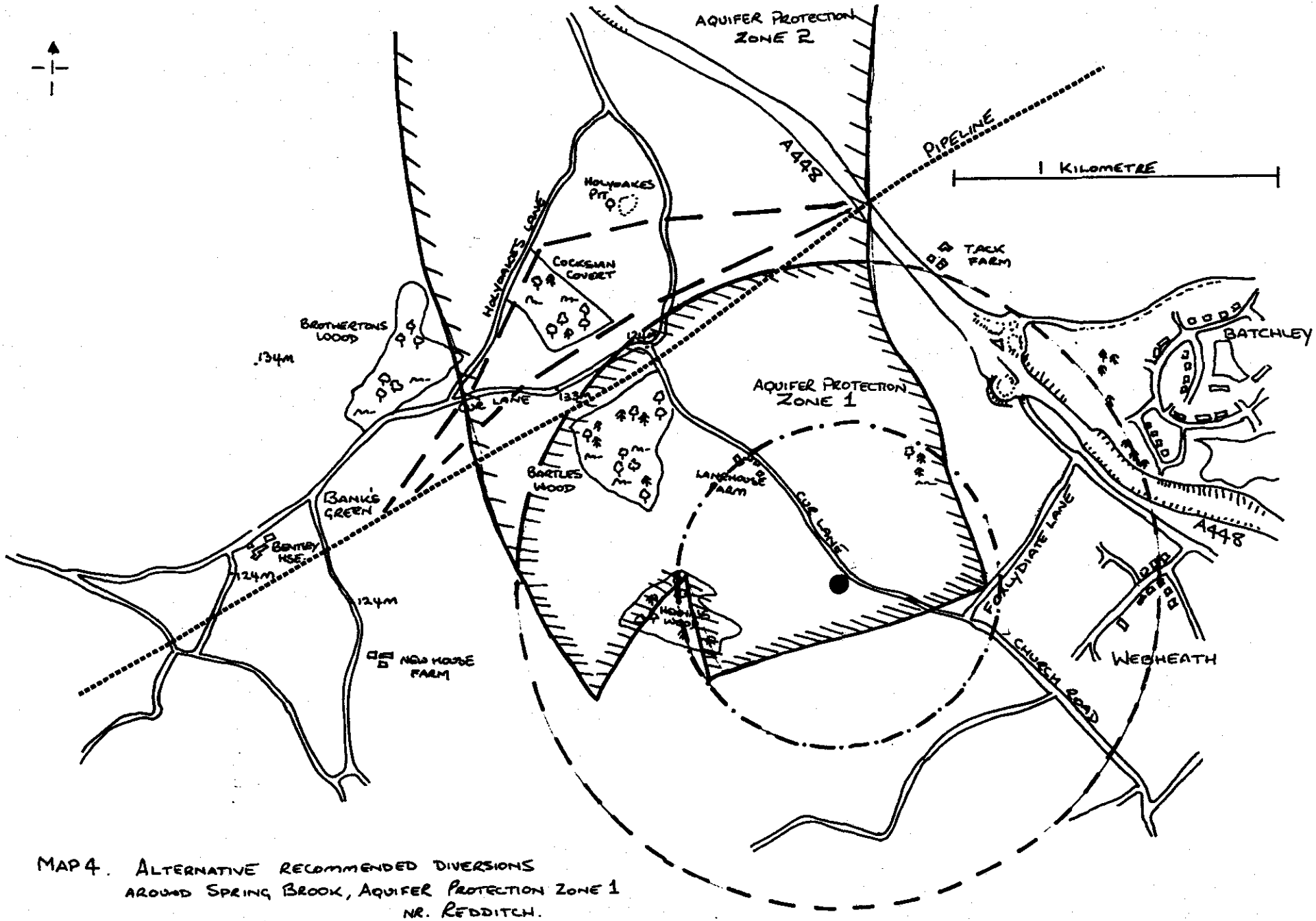
A45

9

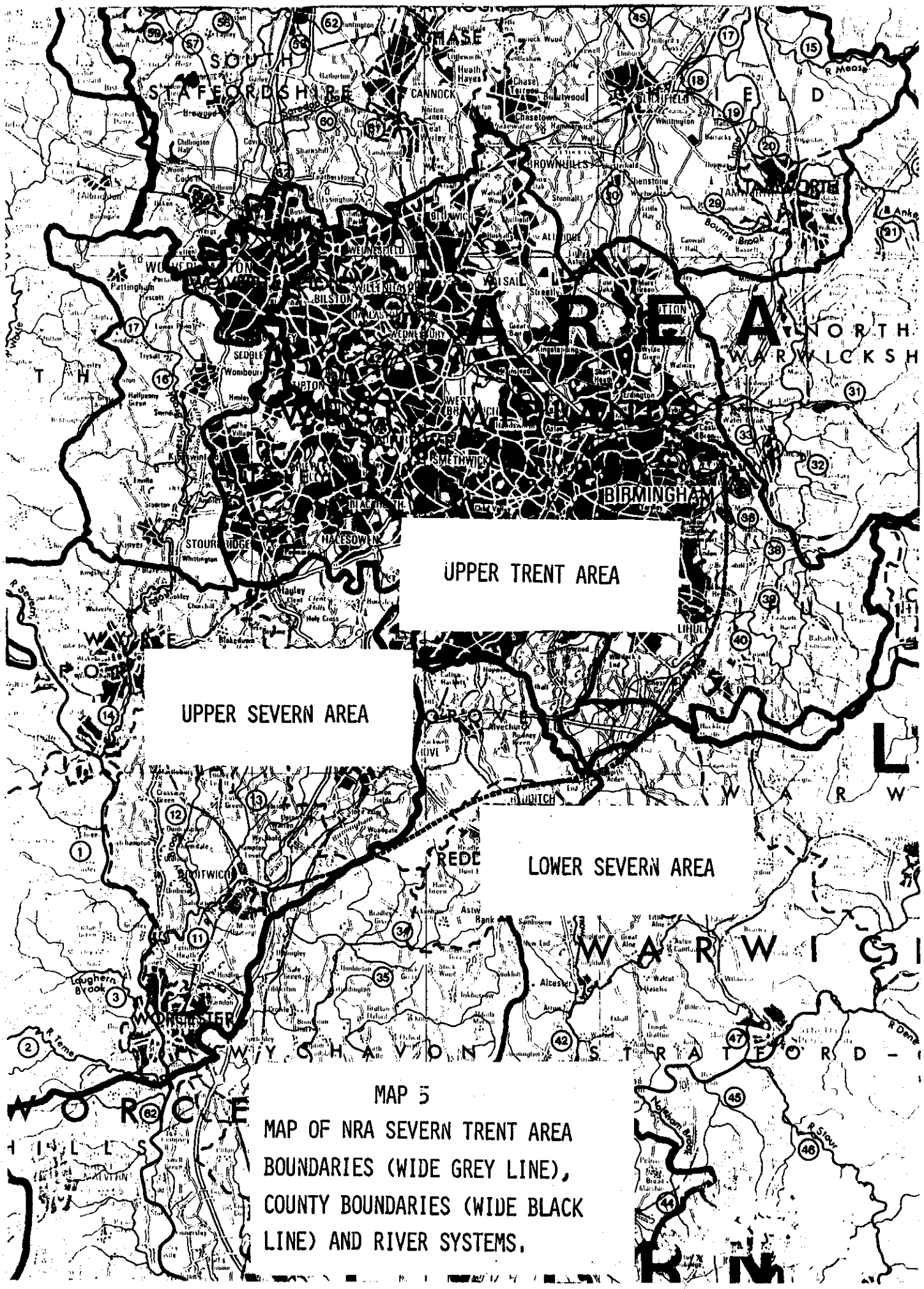
Low Brook

SCALE
1/50000

MAP 30



MAP 4. ALTERNATIVE RECOMMENDED DIVERSIONS AROUND SPRING BROOK, AQUIFER PROTECTION ZONE 1 NR. REDDITCH.



MAP 5

MAP OF NRA SEVERN TRENT AREA BOUNDARIES (WIDE GREY LINE), COUNTY BOUNDARIES (WIDE BLACK LINE) AND RIVER SYSTEMS.