RA Severn-Trent 12

Flooding Survey June 1990

River Avon Catchment

NRA

National Rivers Authority
Severn-Trent Region

RIVER CATCHMENT AREAS

Severn-Trent Region Boundary

Catchment Boundaries

Adjacent NRA Regions

1. Upper Severn **2.** Lower Severn **3.** Avon **4.** Soar
5. Lower Trent **6.** Derwent **7.** Upper Trent **8.** Tame

NRA

National Rivers Authority
Severn-Trent Region

ENVIRONMENT AGENCY

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FLOODING SURVEY

JUNE 1990

SECTION 136(1) WATER ACT 1989

(Supersedes Section 24(5) Water Act 1973

Land Drainage Survey dated January 1986)

RIVER AVON CATCHMENT

AND WARWICKSHIRE

ENVIRONMENT AGENCY
099804

FLOOD DEFENCE DEPARTMENT
NATIONAL RIVERS AUTHORITY
SEVERN-TRENT REGION
SAPPHIRE EAST
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SOLIHULL
W MIDLANDS B91 1QT

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REFERENCES

1 "Interim Report - Section 24(5) Survey" - Published by Severn-Trent Water Authority, July 1978.

2 "Flood Studies Report" Vols I-V, Natural Environmental Research Council (1975).

3 "The Benefits of Flood Alleviation" - E C Penning- Rowsell and J B Chatterton, published by Saxon House, Teakfield Ltd.

4 "Medway Letter" - Ministry of Agriculture and Fisheries (1933). Available in Wisdom's "Land Drainage", Sweet and Maxwell, London (1966).

5 DoE Circular 17/82 - "Development in Flood Risk Areas - Liaison between Planning Authorities and Water Authorities" published in 1982.

GLOSSARY OF TERMS

ADAS	– Agricultural Development and Advisory Service: part of the Ministry of Agriculture, Fisheries and Food (MAFF).
Arterial drainage	– The drainage channels conveying surface water run-off, effluent, etc. (excluding farm ditches, underdrainage and sewers) to the estuaries.
Benefit	– The return from investment in flood alleviation and land drainage improvement schemes.
Benefit area	– The geographical area in which direct benefit is obtained, usually either the maximum extent of flooding in an urban area or the land below the 'Medway Letter Line' in an agricultural area.
Catchment	– The geographical area from which rainfall will drain, by gravity, to a particular river and its tributaries.
Design flood	– The maximum flood for which the flood alleviation works will provide protection.
Discount rate	– The rate for converting all current and future benefits to present values.
Flood Q (T)	– The flood with a recurrence interval or return period of T years.
Floodplain	– The area of land adjacent to a watercourse which is inundated when the flow in the watercourse exceeds the capacity of the channel. The outer limit is usually the maximum extent of past recorded floods.
Freeboard	– See section 2.6.3.
Gross margin	– The gross output of an agricultural enterprise less the variable costs.
Intangible benefits	– The benefits that result indirectly from flood alleviation works, but which are not normally financially quantifiable. These can include freedom from anxiety, potential loss of life, cost of emergency services, etc.
Land potential	– An indication of soil profile characteristics such as structure, texture, depth, stoniness, etc which determines the ability of a soil to produce crop growth.
Main river	– The watercourses shown on the statutory 'main river maps' held by the National Rivers Authority and the Ministry of Agriculture, Fisheries and Food. The NRA has permissive powers to carry out works of maintenance and improvement on these rivers.
Mean annual flood Q	– The arithmetic average of annual maximum floods.
Normal water level	– The water level under average flow conditions.
Return Period	– The average length of time separating flood events of the same magnitude.
Underdrainage	– The drainage required in fields to ensure that the whole area drains satisfactorily to farm ditches or arterial watercourses. This may be tile drains, mole drains or subsoiling.
Variable costs	– Costs incurred in producing a crop, excluding fixed costs such as rent, rates and permanent labours. Variable costs include costs of seed, fertiliser, concentrates, vetinary costs, sprays and casual labour.

PREFACE

THE NATIONAL RIVERS AUTHORITY

The National Rivers Authority was established in September 1989 to be responsible for protecting and improving the water environment. It is an independent public body responsible for the regulatory functions formerly carried out by the water authorities, along with other important statutory duties. Its main tasks are:

- flood defence
- water quality and pollution control
- water resource management
- fisheries, conservation and recreation
- navigation

The NRA is a national body with a small central policy unit. Most of the employees work for the ten regional units which undertake day-to-day operations.

The NRA has a chairman, who along with other members is appointed by the Government - 12 by the Department of the Environment, 2 by the Ministry of Agriculture, Fisheries and Food and one by the Welsh Office. The MAFF appointees have a special responsibility for representing land drainage and fisheries interests.

SEVERN-TRENT REGION

The Severn-Trent Region is the second largest of the 10 regional units of the NRA both in size and population. It covers a diverse area of more than 8,000 square miles (21,600 sq km) and includes nearly 4,000 miles of rivers and watercourses.

The region is based upon the catchments of the Rivers Severn and Trent. The borders stretch from the Bristol Channel in the south to the Humber Estuary in the north, from Mid-Wales to the East Midlands.

The NRA is not responsible for navigation in the Severn-Trent Region. This is the responsibility of the British Waterways Board and a number of navigation trusts.

The headquarters of the NRA Severn-Trent Region is in Solihull, West Midlands. The Area organisation is catchment based with four areas of roughly equal size, achieved by dividing the Severn catchment at the confluence of the Severn and Teme and the Trent catchment at the Trent-Dove confluence. These areas are called Upper Severn, Lower Severn, Upper Trent and Lower Trent, with area offices at Shrewsbury, Tewkesbury, Burton-on-Trent and Nottingham. Within each area there are smaller sub-offices and depots.

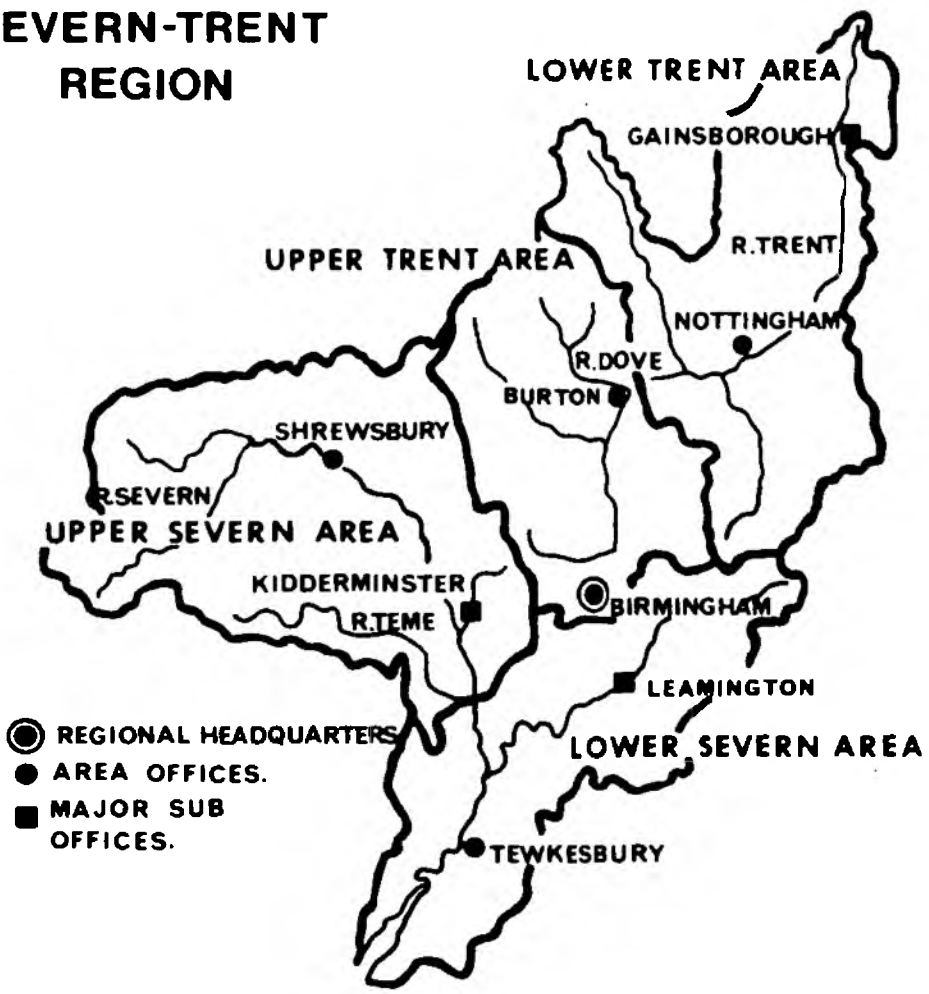
The NRA in the region works with three statutory committees which meet in public three or four times a year:-

Flood Defence Committee - This committee has 21 members appointed by the NRA, MAFF and local authorities. The committee has executive powers to discharge the NRA's flood defence and land drainage functions.

Rivers Advisory Committee - This committee is appointed by the NRA to advise on the broad framework of river basin management. It consists of representatives of local authorities, leisure groups, conservation interests, industry and agriculture and other interested parties.

Fisheries Advisory Committee - This committee has 15 members and advises the NRA on the discharge of statutory duties to maintain, develop and improve fisheries.

NRA SEVERN-TRENT REGION



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CHAPTER 1

SUMMARY

1.0 SUMMARY

1.1 Introduction

1.1.1 This updated survey is one of eight surveys on the major river catchments in the Severn-Trent Region. Each survey provides information appertaining principally to a major catchment, extended to include the whole of the major County associated with it.

1.1.2 The primary purpose of the surveys is the identification and evaluation of flooding and land drainage problems and this summary provides information to facilitate rapid assimilation and comparison of costs, benefit/cost ratios and priority categories of these problems.

1.1.3 This survey supersedes the 1980 survey and the 1982 and 1986 revisions

1.2 Coding System

1.2.1 Every problem identified has been given a code number. The code numbers appropriate to each problem were originally classified in the "Interim Report of Survey"[1] of July 1978. That original classification remains unchanged for this Report but numbers have been added where new problems have been identified since the publication of the Interim Report. The codes applicable to catchments and County and District Councils are shown in Appendix A4 and the format of the code is as follows:

	x	xx	xxx	xx
	Catchment	County	District	Number
eg	1	83	310	27
	Upper Severn	Salop	Oswestry	Problem No.

1.3 Priority Categories

1.3.1 In order to establish a range of priorities to which an individual improvement scheme can relate, all improvement schemes have been categorised on the basis of:

(i) the size of the benefit/cost ratio
(ii) the cost of the arterial part of the improvement works (ie. excluding field drainage and ditching costs).

These categories are shown below.

Category by Benefit/Cost Ratio

CATEGORY	BENEFIT/COST RATIO	
	GREATER THAN	LESS THAN
1	2.0	
2	1.0	2.0
3		1.0

Category by Arterial Costs

CATEGORY	ARTERIAL COST (£'000)	
	GREATER THAN	LESS THAN
A	1000	
B	500	1000
C	100	500
D	50	100
E	10	50
F		10

1.4 Summary of Problem Evaluations

1.4.1 The problem evaluations which are shown in detail in Appendix A1 are summarised in Table 1. This Table shows costs, benefit/cost ratios and priority categories for every problem identified, and enables District Councils and County Councils to assimilate rapidly the total extent of improvements required in their areas and the priorities of the individual requirements within that total.

1.4.2 The page number within Appendix A1 of the evaluation of every identified problem is shown adjacent to the problem number in column 2 of Table 1.

1.4.3 It should be noted that the costs and benefits are to a December 1989 price base and that the watercourses marked * are main river or partly main river.

1.4.4 In some cases a single solution covers a number of identified problems. In these cases, the solution is detailed under the first problem number and all other relevant problem numbers are referred to it.

1.5 Summary by Priority Category

1.5.1 Tables 2 and 3 summarise, for both main river and non-main river, the numbers of problems in each category and the total cost of their associated improvement works. This summary includes only those problems in the catchment area and has been prepared primarily to provide the Ministry of Agriculture, Fisheries and Food with an overall appraisal of the total cost of improvements required throughout the Region. The total cost includes anticipated capital expenditure on current main river schemes and therefore represents a global summary of ongoing and future capital expenditure.

1.6 Identification of problems and their evaluation

1.6.1 The primary purpose of this Survey is to enable rapid identification of problems and the improvement works required to these problems. This can be done using the following system:

i) EITHER
Identify on the 1:25,000 scale maps, which accompanied the 1980 Report, the area of interest and note the code number of the benefit area or point source shown.
OR
Knowing the District or County Council in which the interest lies identify the relevant code number (see Section 1.2 of this Report and Appendix A4).

ii) Refer to the "Summary of Problem Evaluations" in Table 1 for brief details of costs, benefit/cost ratios and priority categories for the requisite watercourses in that District. All costs and benefits are at a December 1989 price base.

iii) Further information on individual schemes will be found in the detailed reports in Appendix A1. The relevant page is shown in the "Summary of Problem Evaluations".

1.6.2 The sheet numbers on the 1:25,000 scale maps in the 1980 album can be located by reference to the grid system shown on the rainfall map at the front of that album. The following diagram shows, as an example, the method for locating sheet number SK 46.

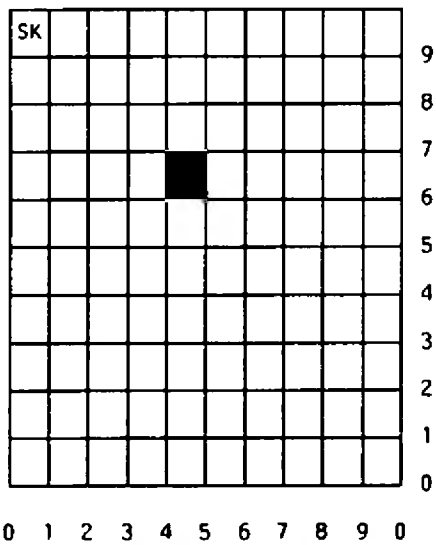

TABLE 1

SUMMARY OF PROBLEM EVALUATIONS

Note: All costs and benefits are to December 1989 price base
* Main River
# New problems since 1986 revision

Code Number	Appendix A1 Page No.	Watercourse	Location	Arterial Cost (£'000)	Benefit/ Cost	Priority Category
BROMSGROVE DISTRICT COUNCIL						
3-87-210-1	-	None	SP 025 734	Problem alleviated		
3-87-210-2	-	None	SP 028 727	Problem alleviated		
3-87-210-3	1	River Arrow	SO 999 759	14	1.4	2E
REDDITCH DISTRICT COUNCIL						
3-87-410-1	2	Dagnell End Brook	SP 053 695	26	1.4	2E
3-87-410-2	3	River Arrow	SP 030 709	118	0.9	3C
3-87-410-3	4	Hewell Brook	SP 011 688	69	0.8	3D
3-87-410-4	5	*Bow Brook & tributaries	SO 943 573	793	1.0	2B
3-87-410-5	7	Un-named	SP 032 623	Highway problem		
3-87-410-6	-	Tributary of Piddle Brook	SP 038 600	Re-numbered as 3-87-810-54		
3-87-410-11	-	*Bow Brook & tributaries	included with 3-87-410-4			
3-87-410-12	-	Hewell Brook	included with 3-87-410-3			
3-87-410-13)						
3-87-410-14)	-	*Bow Brook & tributaries	included with 3-87-410-4			
WYCHAVON DISTRICT COUNCIL						
3-87-810-1	-	Bretforton Brook	SP 089 440	Problem alleviated		
3-87-810-2	-	*Littleton Brook	SP 083 477	Problem alleviated		
3-87-810-3	8	Coombe Brook	SP 102 432	78	5.4	1D
3-87-810-4	9	Merry Brook	SP 088 456	1	0	3F
3-87-810-5	-	Stock Green Brook	SO 956 599	Problem alleviated		
3-87-810-6)						
3-87-810-7)	-	*Littleton Brook	included with 3-87-810-2			
3-87-810-8	10	Bourne Brook	SO 906 415			
3-87-810-9	11	*Piddle/Whitsun/Cowsden Bks	SP 020 560	937	0.5	3B
3-87-810-10	13	Haw Brook	SO 908 491	75	0.7	3D
3-87-810-11	14	*Bow Brook	SO 920 425	303	0.3	3C
3-87-810-12	15	None	SP 963 543	Highway problem		
3-87-810-13)						
3-87-810-14)	-	*Piddle/Whitsun/Cowsden Bks	included with 3-87-810-9			
3-87-810-15	-	*Bow Brook	included with 3-87-810-11			
3-87-810-16	-	*Piddle/Whitsun/Cowsden Bks	included with 3-87-810-9			
3-87-810-17	-	Haw Brook	included with 3-87-810-10			
3-87-810-18	16	Trib. of Littleton Brook	SP 089 493	692	0	3B
3-87-810-19	17	None	SP 904 576	Highway problem		
3-87-810-20	18	None	SO 948 373	6	3.0	1F
3-87-810-21)						
3-87-810-22)	-	*Bow Brook	included with 3-87-810-11			
3-87-810-23	19	Bully Brook	SP 093 409	176	1.2	2C
3-87-810-24	20	Trib. of Broadway Brook	SP 051 455	69	1.9	2D
3-87-810-25	-	Trib. of Piddle Brook	SP 017 565	Problem alleviated		

Code Number	Appendix A1 Page No.	Watercourse	Location	Arterial Cost (£'000)	Benefit/ Cost	Priority Category
3-87-810-26	-	*Bow Brook and tributaries	included with 3-87-410-4			
3-87-810-27	21	Trib. of River Isbourne	SP 054 374	110	1.1	2C
3-87-810-28	22	*Noleham Brook	SP 142 458			
3-87-810-29	-	*Bow Brook and tributaries	included with 3-87-410-4			
3-87-810-30	23	Gate Inn Brook	SP 117 441	49	0.9	3E
3-87-810-34)						
3-87-810-35)	24	*Carrant Brook	SO 974 355	236	0.7	3C
3-87-810-37	25	None	SO 922 525	Highway problem		
3-87-810-38	26	Seeley Brook	SO 967 605	173	0.4	3C
3-87-810-39	27	Badsey Brook	SP 071 388	52	1.2	2D
3-87-810-40	28	*River Avon	SP 040 435	98	0.8	3D
3-87-810-41	29	Trib. of Badsey Brook	SP 050 384	32	1.5	2E
3-87-810-42	-	Bully Brook	included with 3-87-810-23			
3-87-810-43	30	Battleton/Merry Brooks	SP 038 402	89	1.6	2D
3-87-810-44	-	*Piddle/Whitsun/Cowsden Bks	included with 3-87-810-9			
3-87-810-45	31	Crowle Brook	SO 918 589			
3-87-810-46	-	Piddle Brook	SP 030 541	Problem alleviated		
3-87-810-47	-	*Bow Brook and tributaries	included with 3-87-410-4			
3-87-810-48	-	*River Isbourne	SP 024 406	Scheme completed		
3-87-810-49	-	*Badsey Brook	SP 068 428	Scheme completed		
3-87-810-50	-	*Bow Brook and tributaries	included with 3-87-410-4			
3-87-810-51	32	Littleton Brook	SP 079 461			
3-87-810-52	33	Trib. of Piddle Brook	SO 980 560	1	73.7	1F
3-87-810-53	-	Trib. of Bow Brook	SO 939 505	Problem alleviated		
3-87-810-54	34	Tributary of Piddle Brook	SP 038 600	Highway problem		
TEWKESBURY BOROUGH COUNCIL						
3-88-510-1	35	River Isbourne	SP 034 326	72	0.6	3D
3-88-510-2	-	River Isbourne	SP 018 277	Problem alleviated		
3-88-510-3	-	Trib. of River Isbourne	SP 010 270	Problem alleviated		
3-88-510-4	36	Trib. of Carrant Brook	SP 008 302	56	3.0	1D
COTSWOLD DISTRICT COUNCIL						
3-88-610-1	-	Knee Brook	SP 184 375	Problem alleviated		
3-88-610-2)						
3-88-610-3)	37	River Cam	SP 145 388	32	0.9	3E
3-88-610-4)						
3-88-610-5)						
3-88-610-6)						
3-88-610-7)	-	Coombe Brook	SP 127 410	Problem alleviated		
3-88-610-8)						
3-88-610-9)						

Code Number	Appendix A1 Page No.	Watercourse	Location	Arterial Cost (£'000)	Benefit/ Cost	Priority Category
DAVENTRY DISTRICT COUNCIL						
3-90-110-1	38	*River Avon & Clay Coton Bk	SP 560 775			
3-90-110-2	39	None	SP 613 810	Highway problem		
3-90-110-3)						
3-90-110-4)	40	Trib. of Clay Coton Brook	SP 597 756	115	0	3C
3-90-110-5	41	Winwick Brook	SP 626 738	9	0.6	3F
3-90-110-6	-	*Clay Coton Brook	SP 590 770	Scheme completed		
3-90-110-8	-	*River Avon & Clay Coton Bk	included with 3-90-110-1			
3-90-110-9	-	River Avon	SP 688 781	Problem alleviated		
3-90-110-10	42	Trib. of Rainsbrook	SP 522 694			
NUNEATON & BEDWORTH BOROUGH COUNCIL						
3-91-110-1	-	None	SP 341 878	Problem alleviated		
3-91-110-2	43	Breach Brook	SP 321 859			
3-91-110-3	44	#Un-named	SP 363 852			
3-91-110-4	45	#Un-named	SP 331 871			
8-91-110-1	-	Wem Brook	SP 374 893	Problem alleviated		
8-91-110-2	-	Un-named	SP 400 867	Problem alleviated		
8-91-110-3)						
8-91-110-4)	46	Wem Brook	SP 368 882	196	1.5	2C
8-91-110-5	47	Whittleford Brook	SP 315 919	37	0.2	3E
8-91-110-6	-	Change Brook	SP 377 930	Problem alleviated		
8-91-110-7	48	Trib. of Harrow Brook	SP 390 928			
8-91-110-8	49	Trib. of River Anker	SP 398 889			
8-91-110-9	50	Bar Pool Brook	SP 342 922			
8-91-110-10	51	#Un-named	SP 438 288			
RUGBY BOROUGH COUNCIL						
3-91-210-1)						
3-91-210-2)	52	Sow Brook	SP 492 737	118	0.3	3C
3-91-210-3	54	Rainsbrook	SP 492 692	464	1.8	2C
3-91-210-4	-	*River Avon	SP 520 765	Problem alleviated		
3-91-210-5	-	*River Avon	SP 502 763	Problem alleviated		
3-91-210-6	-	*River Avon	SP 493 768	Scheme completed		
3-91-210-7	-	Trib. of River Leam	SP 408 726	Problem alleviated		
3-91-210-8	55	*River Avon	SP 410 759	156	0.7	3C
3-91-210-9	-	Sow Brook	included with 3-91-210-1			
3-91-210-10	-	*River Avon	SP 430 770	Problem alleviated		
3-91-210-11	56	Clifton Brook	SP 530 748	58	2.3	1D
3-91-210-12	-	Trib. of River Leam	SP 428 677	Problem alleviated		
3-91-210-13	-	Trib. of Rainsbrook	included with 3-90-110-10			
3-91-210-14	57	*River Leam	SP 320 655			
3-91-210-15	58	Smite/Pailton Brooks	SP 463 828	63	2.8	1D
3-91-210-16	59	River Leam & tributaries	SP 494 672	444	2.3	1C
3-91-210-17	-	Rainsbrook	included with 3-91-210-3			
3-91-210-18	-	*River Leam	included with 3-91-210-14			

Code Number	Appendix A1 Page No.	Watercourse	Location	Arterial Cost (£'000)	Benefit/ Cost	Priority Category
3-91-210-19	-	River Leam & tributaries	included with 3-91-210-16			
3-91-210-20	-	Trib. of River Leam	SP 400 708	Problem alleviated		
3-91-210-21	61	Trib. of River Avon	SP 527 775	Highway problem		
3-91-210-22	62	*River Avon	SP 532 772			
3-91-210-23	-	*River Avon	included with 3-91-210-4			
3-91-210-24	-	Rainsbrook	included with 3-91-210-3			
3-91-210-25	-	*River Leam	included with 3-91-210-14			
3-91-210-26	63	Trib. of Millholme Brook	SP 454 658	20	3.3	1E
3-91-210-27	-	River Leam & tributaries	included with 3-91-210-16			
3-91-210-28	64	Trib. of River Avon	SP 480 800	58	2.2	1D
3-91-210-29	-	Rainsbrook	included with 3-91-210-3			
3-91-210-30	-	*Withybrook	SP 416 830	Problem alleviated		
3-91-210-31	-	Sow Brook	included with 3-91-210-1			
8-91-210-1	65	River Anker	SP 418 886			
8-91-210-2	66	Trib. of River Anker	SP 389 912			
STRATFORD-UPON-AVON DISTRICT COUNCIL						
3-91-310-1)						
3-91-310-2)	67	Trib. of River Itchen	SP 416 522	46	0.2	3E
3-91-310-3	68	Trib. of River Itchen	SP 427 529	9	0	3F
3-91-310-4)						
3-91-310-5)	69	Trib. of Noleham Brook	SP 154 492			
3-91-310-6	70	None	SP 305 578	Sewerage problem		
3-91-310-7	71	Thelsford Brook	SP 260 573	326	1.5	2C
3-91-310-8)						
3-91-310-9)	72	Ban Brook	SP 081 514	9	1.2	2F
3-91-310-10)						
3-91-310-11)						
3-91-310-12)	73	*River Stour	SP 197 528	663	2.3	1B
3-91-310-13)						
3-91-310-14)						
3-91-310-15)						
3-91-310-16	75	Sherbourne (Bell) Brook	SP 211 595	259	0.1	3C
3-91-310-17	-	*River Alne	SP 148 655	Scheme completed		
3-91-310-18	-	Wellesbourne Brook	SP 289 555	Problem alleviated		
3-91-310-19	76	Hog Brook	SP 328 594	124	2.3	1C
3-91-310-20)						
3-91-310-21)	77	River Itchen	SP 406 620	605	3.9	1B
3-91-310-22	78	Trib. of Tach Brook	SP 345 589	43	1.5	2E
3-91-310-23	79	Trib. of River Dene	SP 331 471	69	1.3	2D
3-91-310-24	-	Trib. of River Dene	SP 373 530	Problem alleviated		
3-91-310-25	80	*River Stour & Sutton Brook	SP 259 379	346	0.7	3C
3-91-310-26	81	*River Arrow	SP 082 553			
3-91-310-27)						
3-91-310-28)	-	*River Stour & Sutton Brook	included with 3-91-310-25			
3-91-310-29	82	Combrook	SP 300 510	29	0.9	3E
3-91-310-30	83	Langley Brook	SP 164 608	430	0.8	3C

Code Number	Appendix A1 Page No.	Watercourse	Location	Arterial Cost (£'000)	Benefit/ Cost	Priority Category
3-91-310-31	-	River Itchen	included with 3-91-310-20			
3-91-310-32	84	Un-named watercourses	SP 178 472	14	0.5	3E
3-91-310-33	85	Preston,Fox,Lowsonford Bks	SP 158 638	444	2.6	1C
3-91-310-34	86	River Dene	SP 338 509			
3-91-310-35	87	Trib. of River Alne	SP 140 596	14	0.5	3E
3-91-310-36	88	Wagstaffe & Humber Bks	SP 258 439	490	1.4	2C
3-91-310-37	-	Spittle Brook	SP 085 571	Problem alleviated		
3-91-310-38	89	Bearley Brook	SP 177 588			
3-91-310-39	-	Trib. of River Itchen	SP 414 657	Problem alleviated		
3-91-310-40	90	Nethercote Brook	SP 288 331	Highway problem		
3-91-310-41	91	Trib. of Oxhill Brook	SP 339 442	35	0.3	3E
3-91-310-42	92	Humber Brook	SP 201 442	Highway problem		
3-91-310-43	93	River Dene	SP 291 509	Highway problem		
3-91-310-44	-	*River Avon	SP 110 510	Scheme completed		
3-91-310-45	-	Wellesbourne Brook	included with 3-91-310-18			
3-91-310-46	94	*River Alne	SP 126 586			
3-91-310-47	95	River Alne	SP 109 590	Highway problem		
3-91-310-48	96	None	SP 103 587	Highway problem		
3-91-310-49	-	*Noleham Brook	included with 3-87-810-28			
3-91-310-50	97	*River Avon	SP 145 530	259	0.1	3C
3-91-310-51	98	None	SP 143 531	Highway problem		
3-91-310-52	99	None	SP 061 643	Highway problem		
3-91-310-53	100	None	SP 051 627	Highway problem		
3-91-310-54	101	Ullenhall Brook	SP 126 660			
3-91-310-55	102	Trib. of River Alne	SP 147 692	9	0	3F
3-91-310-56	-	*River Alne	SP 142 611	Problem alleviated		
3-91-310-57	103	*River Alne	SP 149 620			
3-91-310-58	-	Bearley Brook	included with 3-91-310-38			
3-91-310-59	-	Un-named watercourses	SP 191 621	Problem alleviated		
3-91-310-60	104	None	SP 082 593	Highway problem		
3-91-310-61	105	None	SP 078 532	Highway problem		
3-91-310-62	106	*River Avon	SP 099 518	17	1.2	2E
3-91-310-63	-	*River Dene	SP 278 553	Scheme completed		
3-91-310-64	-	*Shottery Brook	SP 183 534	Problem alleviated		
3-91-310-65	-	*River Stour	included with 3-91-310-10			
3-91-310-66	107	Pig Brook	SP 243 390	101	1.1	2C
3-91-310-67	-	Bearley Brook	included with 3-91-310-38			
3-91-310-68	108	Trib. of River Alne	SP 115 583			
3-91-310-69	109	Cod & Tus Brooks	SP 267 416	219	2.4	1C
3-91-310-70	-	Wagstaffe & Humber Brooks	included with 3-91-310-36			
3-91-310-71	-	River Itchen	included with 3-91-310-20			
3-91-310-72	-	Trib. of River Dene	included with 3-91-310-24			
3-91-310-73	-	Hog Brook	included with 3-91-310-19			
3-91-310-74	-	Preston,Fox,Lowsonford Bks	included with 3-91-310-33			
3-91-310-75	-	Langley Brook	included with 3-91-310-30			
3-91-310-76	-	Bearley Brook	included with 3-91-310-38			
3-91-310-77	110	River Stowe	SP 417 617	101	5.3	1C
3-91-310-78	-	River Itchen	included with 3-91-310-20			

Code Number	Appendix A1 Page No.	Watercourse	Location	Arterial Cost (£'000)	Benefit/ Cost	Priority Category
3-91-310-79	-	*River Arrow	SP 085 622	Problem alleviated		
3-91-310-80	-	*River Arrow	SP 072 649	Problem alleviated		
3-91-310-81	111	Cain Brook	SP 065 623	Highway problem		
3-91-310-82	112	Trib. of Cain Brook	SP 057 625			
3-91-310-83	113	Racecourse Brook	SP 194 533			
3-91-310-84	-	Alveston Brook	SP 242 562	Problem alleviated		
3-91-310-85	114	*River Avon	SP 203 548	66	0.7	3D
3-91-310-86	115	*River Itchen	SP 406 690			
3-91-310-87	116	Trib. of Noleham Brook	SP 119 498	50	2.0	1D
3-91-310-88	117	Trib. of River Stour	SP 305 443	52	4.3	1D
3-91-310-89	-	Trib. of River Dene	SP 363 540	Problem alleviated		
3-91-310-90	118	Trib. of River Avon	SP 145 515			
WARWICK DISTRICT COUNCIL						
3-91-410-1	119	None	SP 197 703	Highway problem		
3-91-410-2	120	None	SP 202 668	Highway problem		
3-91-410-3	121	Tach Brook	SP 316 617	86	5.3	1D
3-91-410-4	-	Horse Brook	SP 264 625	Problem alleviated		
3-91-410-5)						
3-91-410-6)	-	Preston,Fox,Lowsonford Bks	included with 3-91-310-33			
3-91-410-7	122	*River Avon	SP 286 647	12	0.8	3E
3-91-410-8	123	Trib. of River Avon	SP 311 705			
3-91-410-9	124	Inchford/Finham Brooks	SP 250 688	187	1.2	2C
3-91-410-10	125	Trib. of Gog Brook	SP 247 670	Highway problem		
3-91-410-11	-	Preston,Fox,Lowsonford Bks	included with 3-91-310-33			
3-91-410-12	-	Inchford/Finham Brooks	included with 3-91-410-9			
3-91-410-13	-	Langley Brook	included with 3-91-310-30			
3-91-410-14	-	Preston,Fox,Lowsonford Bks	included with 3-91-310-33			
3-91-410-15	126	Trib. of River Leam	SP 335 624	101	1.7	2C
3-91-410-16	-	Tach Brook	included with 3-91-410-3			
3-91-410-17	127	Finham Brook	SP 307 730	210	0.5	3C
3-91-410-18	-	Canley/Westwood Heath/ Tocil Brooks	SP 282 769	Problem alleviated		
3-91-410-19	128	*River Avon	SP 301 658	58	0.2	3D
3-91-410-20	129	*River Avon	SP 291 671	12	0.4	3E
3-91-410-21	130	Trib. of River Avon	SP 280 660			
3-91-410-22	-	*River Leam	included with 3-91-210-14			
3-91-410-23	131	Trib. of River Avon	SP 269 627	12	5.7	1E

Code Number	Appendix A1 Page No.	Watercourse	Location	Arterial Cost (£'000)	Benefit/ Cost	Priority Category
NORTH WARWICKSHIRE BOROUGH COUNCIL						
3-91-510-1	132	None	SP 295 873	Highway problem		
3-91-510-2	133	None	SP 294 863	Highway problem		
8-91-510-1	134	Bourne Brook	SP 282 872			
8-91-510-2	135	Bourne Brook	SP 281 871	Highway problem		
8-91-510-3	136	*River Tame	SP 188 919			
8-91-510-4	137	*River Anker	SK 261 023			
8-91-510-5	138	Un-named	SK 294 065	6	0	3F
8-91-510-6	139	Langley Brook	SP 188 982			
8-91-510-7	140	Penmire Brook	SK 285 002			
8-91-510-8	141	River Bourne	SP 258 898			
8-91-510-9	142	Trib. of Bar Pool Brook	SP 320 926	Highway problem		
8-91-510-10	143	*River Bourne	SP 248 913			
8-91-510-11	144	Un-named	SP 218 883			
CITY OF COVENTRY COUNCIL						
3-92-110-1	145	Trib. of Canley Brook	SP 294 781			
3-92-110-2	146	River Sherbourne	SP 328 788	64	20.7	1D
3-92-110-3	147	Trib. of River Sherbourne	SP 272 798	346	0.2	3C
3-92-110-4	148	Springfield Brook	SP 337 814	1643	0	3A
3-92-110-5)						
3-92-110-6)	-	River Sowe	SP 349 834	Problem alleviated		
3-92-110-7	149	Trib. of Canley Brook	SP 306 775	14	0.1	3E
3-92-110-8	150	River Sherbourne	SP 294 821	9	0	3F
3-92-110-9	151	R.Sherbourne/Pickford Brook	SP 307 803			
3-92-110-10	-	Canley/Westwood Heath/ Tocil Brooks	included with 3-91-410-18			
3-92-110-11	-	Withy Brook	included with 3-91-210-30			
3-92-110-12	-	Stoke Brook	SP 363 792	Problem alleviated		
3-92-110-13	-	Pickford Brook	SP 312 792	Problem alleviated		
3-92-110-14	-	Trib. of River Sow	SP 360 782	Sewerage problem		
HARBOROUGH DISTRICT COUNCIL						
3-93-410-1	152	River Swift	SP 587 864	33	1.3	2E
3-93-410-2	153	Bitteswell Brook	SP 542 868	78	2.3	1D
3-93-410-3	-	Trib. of River Swift	SP 567 837	Problem alleviated		
3-93-410-4	-	Bitteswell Brook	included with 3-93-410-2			
3-93-410-5	154	Trib. of River Avon	SP 601 820	40	0.8	3E

TABLE 2

SUMMARY BY PRIORITY CATEGORY - AVON CATCHMENT
NON-MAIN RIVER

	A		B		C		D		E		F	
	NUMBER OF SCHEMES	TOTAL COST (£000s)	NUMBER OF SCHEMES	TOTAL COST (£000s)	NUMBER OF SCHEMES	TOTAL COST (£000s)	NUMBER OF SCHEMES	TOTAL COST (£000s)	NUMBER OF SCHEME	TOTAL COST (£000s)	NUMBER OF SCHEMES	TOTAL COST (£000s)
1	-	-	1	605	5	1,332	10	643	2	32	2	7
2	-	-	-	-	8	1,955	4	279	5	148	1	9
3	1	1,643	1	692	8	1,769	3	216	9	273	5	37
TOTAL	1	1,643	2	1,297	21	5,056	17	1,138	16	453	8	53
										TOTAL	65	9,640

TABLE 3

SUMMARY BY PRIORITY CATEGORY - AVON CATCHMENT
MAIN RIVER

	A		B		C		D		E		F	
	NUMBER OF SCHEMES	TOTAL COST (£000s)	NUMBER OF SCHEMES	TOTAL COST (£000s)	NUMBER OF SCHEMES	TOTAL COST (£000s)	NUMBER OF SCHEMES	TOTAL COST (£000s)	NUMBER OF SCHEME	TOTAL COST (£000s)	NUMBER OF SCHEMES	TOTAL COST (£000s)
1	-	-	-	663	-	-	-	-	-	-	-	-
2	-	-	1	793	-	-	-	-	1	17	-	-
3	-	-	1	937	5	1,300	3	222	2	24	-	-
TOTAL	-	-	2	2,393	5	1,300	3	222	3	41	-	-
										TOTAL	13	3,956

CHAPTER 2

THE SURVEY

2.0 THE SURVEY

2.1 Introduction

2.1.1 The requirement for a Survey results from the Water Act 1989, which also created the National Rivers Authority. Under Section 136(1) of the above Act the National Rivers Authority has a duty to carry out from time to time, a survey of its area in relation to flood defence functions.

2.1.2 The Ministry of Agriculture, Fisheries and Food issued Guidance Notes for Water Authorities in carrying out the original Survey and, wherever possible, suggested procedures were adopted and information incorporated within the reports.

2.1.3 In carrying out the Survey the Authority was required to:

1 Consult every local authority whose area is wholly or partially included in the area of the Water Authority.

2 Have regard to structure plans and local plans under the Town and Country Planning Act 1971.

2.2 Purposes of the Survey

2.2.1 The primary purpose of the Survey is to identify and evaluate flooding problems, both for existing problems and for potential problems which may occur as a result of increased run-off from development. Information is provided which summarises the principal solutions, costs, benefits and priorities.

2.2.2 The Surveys are required by the Ministry of Agriculture, Fisheries and Food to provide a comprehensive and logical basis for long-term planning of drainage improvements and flood alleviation.

2.2.3 The Survey will be used by this Authority to ensure rational phasing of improvements on main river, and will provide a firm basis for the supervisory role exercised by the Authority over all matters relating to its flood defence functions on all watercourses throughout the region.

2.2.4 The Survey provides comprehensive information on both main river and non-main river and can, therefore, be used by all drainage authorities and drainage bodies (local authorities) for determining capital works programmes of watercourse improvements in conjunction with the Authority's own programme of works.

2.2.5 The Authority will make use of the survey in considering any changes to the main river network.

2.3 Extent of the Survey

2.3.1 The Authority exercises a general supervisory role over all matters relating to land drainage. The Survey, therefore, identifies and examines not only problems on main river but also on other watercourses having existing or potential land drainage and flood alleviation problems.

2.3.2 No limit has been fixed by the Ministry of Agriculture, Fisheries and Food for a lower order of problems which should be considered by the Survey, but it has been indicated that a "broad brush" approach is preferable to detailed investigations of a minority of large problems. This accords with the Authority's view of its own requirements and thus the lower limit has been fixed as flooding affecting a single property or inadequate arterial conditions affecting twenty hectares of agricultural land. However, where specific requests have been made to investigate problems of lesser order these have been included wherever possible.

2.3.3 The Survey has investigated those watercourses which are currently in a satisfactory condition but where future development could necessitate improvements. This has been limited to those developments which have planning permission or have been identified in Structure and Local Plans and are likely to proceed in the near future.

2.3.4 The Survey covers only those drainage inadequacies which occur on arterial watercourses. Where drainage inadequacies on agricultural land can be resolved by underdrainage alone, these have not been included within the Survey.

2.4 Procedure

2.4.1 Of the information on drainage deficiencies required for this Survey, a considerable proportion was available within this Authority. This is particularly so of the problems on main river but also applies to major problems on non-main river. There are, however, many kilometres of non-main river on which this Authority had no information and which have, in many cases, had little or no maintenance work carried out on them. In order to ensure comprehensive coverage on such watercourses, in addition to main river, all bodies having land drainage interests were asked to provide information on drainage deficiencies. These include:

1 Ministry of Agriculture, Fisheries and Food.

2 Internal Drainage Boards.

3 County Councils.

4 District Councils.

5 Parish Councils.

6 British Waterways Board.

7 National Farmers' Union.

8 Country Landowners Association.

9 British Coal.

2.4.2 In July 1978, an 'Interim Report' was circulated to local authorities and many other organisations and bodies as part of the Authority's statutory duty under Section 24 of the Water Act 1973. This Report identified all drainage deficiencies which had been notified to the Authority and provided brief details of location and type of problem.

2.4.3 The primary purpose of the Interim Report was to seek views and comments on the identified problems so that these could be taken into account in determining solutions. Provision was also made to incorporate additional problem areas in subsequent Reports to ensure their comprehensiveness. All relevant comments have, therefore, been incorporated in the problem evaluations in Appendix A1 including those of the Nature Conservancy Council, County Conservation Trusts, Countryside Commission and fisheries, navigation and many other interests, in addition to those scheduled in Section 2.4.1. Wherever possible, the costs identified for the improvement works have included the cost of making provision for all interests which have been notified.

2.4.4 Every problem identified in the Interim Report and those notified since its publication have been investigated by visiting the site and carrying out land surveys as necessary. The extent of the investigation has largely been determined by the extent of the problems and the benefits which will result. Many minor problems have, therefore, not been examined in detail because of the high cost of providing the necessary improvement works. There are also many cases where flooding cannot be attributed to inadequacies in the arterial watercourse drainage system. In these situations, the solutions to the problems are outside the scope of this Survey and have not been determined. However, an indication is given, in each case, of the cause of the problem and these have been brought to the attention of the appropriate authority (eg. Highway Authority, British Coal, etc).

2.5 Hydrological Criteria

2.5.1 The mean annual flow for all sites of major importance, for which flow records are available, have been calculated using the appropriate method formulated in the "Flood Studies Report"[2].

2.5.2 For sites of minor importance and sites having no available flow records, the mean annual flood has been calculated from catchment characteristics using the "Flood Studies Report" six parameter equation.

2.5.3 In all cases, the relationship between $Q(T)$ (the flood of return period T) and $\bar{Q}$ (the mean annual flood) has been derived from the "Flood Studies Report" regional growth curves.

2.6 Hydraulic Criteria

2.6.1 Urban flood alleviation schemes have been designed, wherever possible, to contain the 1 in 100 years flood. It is recognised that, in the final analysis, the design frequency chosen will be that which maximises the excess of benefit over cost but, within the scope of this Survey, this has not been possible other than in schemes of the very highest priority.

2.6.2 Culverts have generally been designed for the following flood return frequencies. (These standards have varied dependent upon economic or physical constraints):

1 Flooding of property and urban areas in general - 1 in 100 years.

2 All areas of high agricultural value including horticultural areas - 1 in 100 years.

3 Other agricultural areas - 1 in 25 years.

4 A combination of flooding transport systems and agricultural areas may justify a standard of up to 1 in 50 years.

2.6.3 For the Survey purposes the following criteria have been adopted:

1 In agricultural areas the pipe outfalls for field drainage systems are designed to be 150mm above normal water level. Where there is no field drainage system an average freeboard of 1,500mm between normal water level and ground level has been used. The freeboard requirements for under-drainage purposes may result in larger channel capacities than those required purely for flood alleviation purposes.

2 For the construction of floodbanks freeboard is dependent on the confidence limits of data used for design purposes, and for major floodbanks is normally 500mm. Small freeboards have been considered in appropriate cases. In all other cases, channel capacity is the design flood discharge with no additional freeboard.

2.7 Land Potential Category

2.7.1 The successful growth of crops depends on a suitable soil environment for germination, root anchorage and plant growth. Cropping systems are dependent on soil potential and similarly drainage standards can be linked to soil profile characteristics such as structure, texture, depth, stoniness and wetness. The Ministry of Agriculture, Fisheries and Food has assessed standards for field drainage and flood protection based upon the relationship between cropping and soil or land potential as indicated in Table 4. In providing these individual assessments the Ministry has pointed out that they are subjective and will need to be verified by detailed in-field investigations before any scheme can be agreed for grant aid purposes.

Table 4 Land Potential Categories

a	Land potential low (Normally pasture land)	1 in 2 years
a5	Land potential low/medium (Normally low grade arable land)	1 in 5 years
b	Land potential medium/high (Normally high grade arable land)	1 in 5/10 years
c	Land potential very high (Very high grade arable and horticultural land)	1 in 25/100 years

2.8 Improvement Costs

2.8.1 Costs of improvement schemes have been estimated on a standard unit cost basis wherever possible and appropriate in order to ensure uniformity and comparability of all schemes. The unit cost approach has been adopted for excavation of new channels, construction of floodbanks, bridges, pumping stations, culverts, revetment work, etc. It has not been possible to use unit costing for regrading and remodelling of existing channels or for channel clearance of undergrowth and trees as these are items which vary from watercourse to watercourse.

2.8.2 All costs include for design and supervision which on average is approximately 10% of the cost of the improvement works.

2.8.3 All costs are at a price base of December 1989.

2.8.4 The cost of field drainage for existing problems has been assessed by the Ministry of Agriculture, Fisheries and Food and has been included within the total cost of the improvement works. Field drainage costs for new problems have been assessed using a nomograph produced by Silsoe College for the Authority in 1984. Ditching costs have not been included unless this constitutes a significant proportion of the overall cost.

2.8.5 Wherever possible, the total cost of the improvement works includes the cost of making provision for navigation, fisheries, conservation and other interests of which the Authority has been notified.

2.9 Benefit Assessment

2.9.1 Benefit areas for urban problems have been determined largely from local knowledge of the extent and depth of past floods. These have been extrapolated where necessary to estimate the extent of floods with return periods in excess of recorded events. The stage/damage estimates and subsequent evaluation of annual average benefits have been derived from methods formulated in the manual entitled "The Benefits of Flood Alleviation: A Manual of Assessment Techniques"[3].

2.9.2 The areas which are likely to benefit in both agricultural and urban areas are shown on the overlays to the maps in the 1980 album. The locations of small areas of urban flooding and miscellaneous minor flooding problems are shown with a dot enclosed in a circle and identified with the appropriate code number. In the case of large urban flooding problems and agricultural drainage problems, the areas shown on the overlays and identified by code numbers are the areas which will benefit from drainage improvements.

2.9.3 Areas of inland agricultural land which will derive benefit from drainage operations have been defined, for the purpose of this Survey, as follows:

i) Land within an area bounded by a line 2.4m above the highest recorded flood level as defined in the "Medway Letter"[4].

ii) Where no flooding has occurred but normal water levels restrict outfall conditions for field drains, the benefit area is the area bounded by a line 2.4m above bank top level.

2.9.4 Annual average benefits for agricultural areas have been assessed by the Ministry of Agriculture, Fisheries and Food from the land potential (see Table 4) and from the potential change in gross margin which will result from improved drainage. These assessments will require verification by detailed studies if schemes are incorporated in capital programmes.

2.9.5 The maximum benefits from most agricultural improvement schemes can be achieved only if the individual farmers carry out ditching and install field drainage following the improvement to the receiving watercourses. In practise the benefits will, therefore, be phased in as field drainage is installed and due account will be taken of this phasing when individual detailed schemes are prepared.

2.9.6 If the improvement of a watercourse is an essential pre-requisite of planning permission for any housing or industrial development, such that without the improvement planning permission would not be approved, then the benefits attributable to future development by the off-site improvement of watercourse have been assessed as a proportion of the increase in the value of the land after planning permission is granted.

2.9.7 The benefits have been assessed, for both urban and agricultural problems, using a base date of December 1989. It should be appreciated that benefits, particularly in agricultural schemes, may not follow normal inflationary trends.

2.10 Test Discount Rate

2.10.1 The test discount rate which has been used for the assessment of the net present value of future costs and benefits is the Government's recommended current rate for public investment of 6%. The life of improvement schemes, other than those involving pumping stations, has been assumed as 50 years for the purpose of the net present value analysis.

2.10.2 Maintenance costs after improvements have been carried out are assumed, on average, to be of a similar order to those before. In some cases, maintenance costs will be lower whereas in others, particularly where maintenance has been neglected in the past, costs will be higher.

2.11 Benefit/Cost Ratios

2.11.1 The comparison of benefit with cost enables an assessment to be made of the worthwhileness of any proposed improvement. For the purpose of this Survey a scheme is considered as being possibly viable if the benefit to cost ratio is greater than unity. However, if an improvement scheme progresses to a capital programme it may be necessary to compare it with benefit/cost ratios for other competing schemes to enable a choice to be made.

2.11.2 The greater the excess of benefit over cost the higher the return for capital employed and, therefore, in purely economic terms, a scheme having a high benefit/cost ratio would have a higher priority than a scheme having a lower value. However, due weight must also be given to other factors such as risk to human life, amenity and environmental considerations. These factors are intangible and require a subjective assessment, in conjunction with economic factors, to determine the overall priorities of schemes.

2.12 Priority Category

2.12.1 The Survey has made no attempt to determine priorities which take into account intangible benefits; schemes have been categorised solely on the basis of tangible benefits which can be assessed in purely economic terms. It will be the responsibility of the promoting authority to determine the weight to be given to intangible benefits and, therefore, the overall priorities to be attached to schemes in its area.

2.13 Inflation Factors

2.13.1 Costs and Benefits for problems contained in the 1986 revision have been updated to a December 1989 price base as follows:

Arterial Costs - Baxter (Regional) Index

Underdrainage Costs - Retail Price Index

Agricultural Benefit - Using information supplied by Silsoe College based on changes in weighted gross margins

Urban and Road Benefits - Retail Price Index.

CHAPTER 3

GENERAL DESCRIPTION

3.0 GENERAL DESCRIPTION

3.1 Description of the Region

3.1.1 The boundary of the Severn-Trent Region of the National Rivers Authority is formed by the watersheds of the River Trent and the River Severn. The area of 21,600 sq. km extends from the Humber estuary in the north to the Severn estuary in the south, and is bounded by the Anglian, Yorkshire, North West, Welsh, Wessex and Thames Regions of the NRA. The Severn-Trent Region is divided into eight catchments the boundaries of which are the watersheds of the major sub-catchments of the River Severn and the River Trent. These catchments and the location of the region is shown in Fig.1.

3.1.2 The Severn-Trent Region of the National Rivers Authority is responsible for the two major tidal estuaries of the River Severn and the River Trent but other than these areas it has no coast line. The River Trent is tidal as far as Cromwell Lock, about eight kilometres downstream of Newark, and the River Severn is tidal as far as Gloucester.

3.1.3 The highest part of the Trent region is the Pennines in the north west where the River Derwent rises at an altitude of 630 metres. Altitude decreases across the Trent basin to the River Trent itself and then rises in the east to a height of between 60 metres and 120 metres. In the central region the catchments of the Rivers Severn and Trent are separated at the headwaters of the River Tame and the River Stour by a ridge of between 200 metres and 270 metres high.

3.1.4 The topography of the Severn basin is dominated by the Welsh Hills in the west at a maximum elevation of 830 metres and the Cotswold Hills in the south-east at an elevation of 330 metres. A prominent feature in the south-west is the Malvern Hills which rise to a height of 430 metres.

3.1.5 The average annual rainfall over the whole of the region is 775mm and this ranges from a maximum of over 2,000mm in the Welsh Hills to approximately 600mm in the Trent Valley in the rain shadow of the Pennines. The variation is largely associated with altitude. The lowlands generally have little seasonal variation but upland areas are wetter in winter than in summer. Similarly, in the upland areas, snowfall is a significant form of precipitation.

3.1.6 The geology of the region varies from the resistant Pre-Cambrian and Palaeozoic rocks in west Shropshire to the softer clays, shales and limestone bands of the Lower Lias in east Leicestershire and Warwickshire. The Pre-Cambrian and Palaeozoic rocks are characterised by the rugged landscape of Wales, the Border Counties and the carboniferous limestone formations in Derbyshire, while the more recent formations in the east have weathered to form the rolling scarps and vales typical of Leicestershire.

3.1.7 The total population of the Region is 8.3 million people with some 2.5 million in the Severn catchment and 5.8 millions in the Trent. Approximately 2.6 million people live in the West Midlands conurbation which straddles both catchments. The other major centres of population are Nottingham (280,000), Leicester (282,000), Stoke-on-Trent (250,000) and Derby (215,000). Many of these conurbations, and particularly that of the Black Country area, are situated in the vicinity of the headwaters of major rivers and have a significant effect on the river flows throughout their lengths.

3.1.8 The National Rivers Authority assumes a direct responsibility for 3,573 km of main river on which capital improvements and maintenance are carried out as necessary. Areas which have been protected from flooding, to various standards, on this length of main river total over 1,000 sq. km. Much of this area is protected by floodbanks of which the total length is 820 km, all of which is maintained on a regular basis by the Authority.

3.2 Description of Avon Basin

3.2.1 The Avon Basin comprises the catchment area of the River Avon and its major tributaries the Rivers Stour, Arrow, Leam, Sowe and Swift. The area of the basin is approximately 2,850 sq.km and other than the area around Coventry, is mainly rural in character.

3.2.2 The River Avon rises in Northamptonshire at over 130 metres above sea level and discharges to the River Severn at Tewkesbury at about 14 metres above sea level. Most of the catchment is covered by impermeable Keuper Marl and Lias clays which results in the rivers having rapid response to rainfall but, conversely in dry weather, the stream flows diminish rapidly.

3.2.3 The River Avon is navigable between Tewkesbury and Stratford-upon-Avon and there are proposals to extend this upstream to Warwick. The section of the river between Tewkesbury and Evesham is very flat with the river having an average slope of only 1 in 2000. This results in serious flooding to agricultural land at frequent intervals which is exacerbated by the weirs required to provide navigable depth in the river. These weirs retain high water levels, even at normal flows, in relation to adjacent land levels and cause inadequate drainage of agricultural land. A detailed feasibility study of the reach between Tewkesbury and Evesham has been carried out but, in accordance with revised priorities, no further capital improvements will be carried out on this reach. However essential maintenance works will be required to certain channel reaches and structures.

3.2.4 The River Arrow rises on the outskirts of Birmingham and drains the expanding town of Redditch. The flows in the river are restricted by the provision of balancing areas in the upper reaches in the designated area of the town which store floodwater and reduce the peak discharge from the town. Major improvements to cater for increased run-off from development were completed in 1976.

3.2.5 The largest urban area in the catchment is Coventry (population 314,000) and this is drained by the River Sowe and its tributary the River Sherbourne. There are no major drainage problems in this sub-catchment but regular removal of urban debris from the river is necessary.

CHAPTER 4

THE NATIONAL RIVERS AUTHORITY'S SUPERVISORY ROLE

4.0 THE NATIONAL RIVERS AUTHORITY'S SUPERVISORY ROLE

4.1 Introduction

4.1.1 Section 136(1) of the Water Act 1989 states that the National Rivers Authority shall exercise a general supervision over all matters relating to flood defence. This general supervision includes all watercourses, both main and non-main, and is exercised in part by consenting to works on or in watercourses, by the enforcement of bye-laws and by liaison with Planning Authorities responsible for development control.

4.2 Land Drainage Bye-laws

4.2.1 Section 34 of the Land Drainage Act 1976 (as amended by the Water Act 1989) allows Drainage Authorities to "make such bye-laws as they consider necessary for securing the efficient working of the drainage system in their area". Consent is required in compliance with particular bye-laws covering control of certain operations in or adjacent to rivers or the floodplain of rivers (generally confined to main rivers). Such operations include erection of fences, tree planting, disposal of rubbish, excavation affecting the bed and banks of rivers, erection of jetties or walls, etc.

4.2.2 In order to eliminate minor inconsistencies in the bye-laws inherited from the Severn and Trent River Authorities, the Severn Trent Water Authority made new bye-laws which were confirmed by the Ministry of Agriculture, Fisheries and Food on the 26 April 1979. By the provisions of the Water Act 1989 these Byelaws are now enforced by the National Rivers Authority, Severn-Trent Region. All references to Severn Trent Water Authority, STWA or Water Authority should now read National Rivers Authority.

4.3 Statutory Consents

4.3.1 It is essential that a rational and consistent approach is adopted for standards not only on main rivers but also on non-main rivers, where alterations to existing conditions can seriously affect the main river system downstream. The maximum benefits can be achieved only if all works which require consent are identified, so that a consistent standard can be attained throughout the region.

4.3.2 The issue of a Land Drainage Consent implies that, if the work is carried out in accordance with the drawings and documents submitted, there will be no detriment to land drainage operations or consequential flooding. Prior to issue of a consent Local Authorities, Internal Drainage Boards, Navigation Authorities and others are consulted as necessary.

4.3.3 A Consenting Manual has been produced for the Authority's internal use which details principles to be adopted and formalises the Authority's policy on various types of development so that consistent advice can be given to planners.

4.4 Planning Liaison and Development Control

4.4.1 In addition to exercising control over drainage works by consenting procedures, the Authority also seeks to control operations likely to adversely affect drainage interests through its planning consultation with Local Authorities. The Town & Country Planning General Development Order 1988 obliges local planning authorities to consult the NRA before determining planning applications. The majority of new developments which require land drainage improvements are identified in this way and advice is given to the planners about the effects of the proposals in relation to flooding and land drainage.

4.4.2 The Department of the Environment Circular 17/82[5] issued in 1982 emphasised the need for Planning Authorities to consult the Water Authorities in respect of development and caravan and camping sites in flood risk areas, and the effects of run-off from new developments. The National Rivers Authority must now be consulted on such matters.

4.4.3 The major floodplain areas are identified on the maps which accompanied the 1980 report. In general, the areas shown envelop those areas which have been flooded by past recorded events. They do not, therefore, relate to a particular frequency flood event.

4.4.4 Many areas within floodplains have been protected by improvement schemes which will, in general terms, consist of either channel improvements or flood embankments. These areas are also identified on the maps and the level of protection is indicated.

4.4.5 In particular, Local Authorities are advised that, for developments which are likely to increase the risk of flooding, the developer should be informed that works will be required to watercourses to remedy the situation. If these works are outside the area of the application, the developer is required to show that provision has been made to carry out the works, as conditions applicable to such works cannot be applied to planning permissions. If the developer does not make arrangements for the watercourse improvement the Planning Authority can refuse the application.

4.4.6 Where works are required to a non-main watercourse to accommodate the additional run-off from developments, the developer may carry out the work, by agreement with the riparian owners, at his own expense. If agreement is not possible he may request the Local Authority to carry out the works and reimburse the authority accordingly. In the case of main river, works will normally be carried out by the National Rivers Authority with an appropriate contribution from the developer.

4.4.7 At the present time, negotiations take place between the developer(s) and the National Rivers Authority or Local Authority into the proportion of the improvement cost of the off-site watercourse which is to be met by the developer(s).

CHAPTER 5

MAIN RIVER SYSTEM

5.0 MAIN RIVER SYSTEM

5.1 Statutory Provisions

5.1.1 The main river system is the system of watercourses identified on the statutory set of main river maps held by the National Rivers Authority and the Ministry of Agriculture, Fisheries and Food (MAFF). Main river powers extend to any structure in the bed or bank of the watercourse which controls the flow of water into or out of the watercourse. Powers for carrying out work on main river are exercisable by the National Rivers Authority and by others with the Authority's consent.

5.1.2 The main river map may be altered by the Ministry of Agriculture, Fisheries and Food at the request of the National Rivers Authority. Before doing so, the Minister must give notice of his intention and this is usually carried out by advertising in local newspapers. All objections to the proposals will be considered by the Minister.

5.1.3 In relation to watercourses which are not designated as main river the Authority has certain regulatory powers but has no powers to carry out work using Flood Defence finance.

5.1.4 A 1:250,000 scale map showing the main river system within the Severn-Trent Region as at January 1990 is available.

5.2 Principles for Main River Extension

5.2.1 The following criteria are used by the National Rivers Authority, Severn-Trent Region in deciding whether to make an application to MAFF for changing the status of a watercourse from non-main to main river.

1 Main River shall be continuous from the estuary to a suitable point (eg a bridge or other structure) where:-

(a) the population in the remainder of the upstream catchment is less than 10,000

or

(b) the average width of flood plain in the remainder of the upstream catchment is less than 300 metres per kilometre of watercourse

or

(c) there is no single community greater than 3,000 persons further upstream.

Whichever is the furthest point upstream.

2 Main river shall also extend upstream to the point of discharge of:-

(a) outfalls from sewage works with an average daily flow greater than 5 megalitres

(b) untreated water reservoirs that impound more than 1,000 megalitres

(c) the downstream outfall of an internal drainage board.

3 Where balancing storage is provided as an essential part of the system of surface water drainage, consideration should be given to extending main river up to the point of intake of such balancing storage.

4 However, a flexible approach will be adopted and consideration may also be given to extension of main river in particular circumstances (eg to receive the surface water drainage from a motorway, an embanked watercourse or to be the upstream boundary of urban areas for development control and byelaw purposes).

5.3 Local Authority Improvements

5.3.1 Where non-main watercourses accord with the above policy, and improvements are carried out by Local Authorities to standards approved by this Authority, the Authority may recommend to the Ministry of Agriculture, Fisheries and Food that the watercourses should be included as part of the main river system.

CHAPTER 6

THE LAND DRAINAGE ROLE OF LOCAL AUTHORITIES

6.0 THE LAND DRAINAGE ROLE OF LOCAL AUTHORITIES

6.1 Interaction with the National Rivers Authority's role

6.1.1 The powers available to Local Authorities (both District and County Councils) under the Land Drainage Act 1976 (as amended by the Water Act 1989) for carrying out works of maintenance and improvement on non-main rivers are complementary to those of the National Rivers Authority on main river. In almost all cases the powers are permissive, but most Councils now accept the responsibility that this implies and are prepared to carry out improvement schemes in conjunction with those of the National Rivers Authority on main river. In this way, many serious impediments to the overall drainage system are gradually being eliminated.

6.2 Powers of District Councils

6.2.1 District and Metropolitan District Councils have powers under Section 98 of the Land Drainage Act 1976 (as amended by the Water Act 1989) to carry out works on non-main river for the purpose of preventing flooding or remedying or mitigating any damage caused by flooding.

6.3 Powers of County Councils

6.3.1 County Councils have powers under Section 99 of the Land Drainage Act 1976 (as amended by the Water Act 1989) to execute land drainage schemes, at the request of owners and occupiers who will benefit from the schemes.

6.3.2 Section 100 of the Land Drainage Act 1976 (as amended by the Water Act 1989) enables County Councils to execute land drainage works compulsorily for the improvement of agricultural land, and apportion any expenses among the beneficiaries.

6.3.3 County Councils may exercise Section 98 powers by agreement with, or by default of, a District Council.

6.4 Maintenance of the Flow of Watercourses

6.4.1 Where the proper flow of water in a non-main river is impeded, both District and County Councils may, under Section 18, of the Land Drainage Act 1976 (as amended by the Water Act 1989), serve notice on the person concerned to remedy the situation.

CHAPTER 7

INTERNAL DRAINAGE BOARDS

7.0 INTERNAL DRAINAGE BOARDS

7.1 Constitution

7.1.1 Many Internal Drainage Boards were first constituted in the nineteenth century by individual Acts of Parliament. However, all Internal Drainage Boards are today constituted, or continued in being, in accordance with the provisions of the Land Drainage Act 1976 (as amended by the Water Act 1989) which defines Internal Drainage Districts as such areas as will derive benefit or avoid danger as a result of drainage operations. These areas are generally located in lowland regions where special drainage problems exist and where collective benefit will be derived from drainage operations.

7.1.2 Within the Region there are 32 Internal Districts of which 24 are in the Trent catchment and eight are in the Severn catchment. In most cases a District is administered by a Board consisting of elected members but the Sow and Penk District is administered directly by this Authority.

7.1.3 The basis for the determination of Internal Drainage District boundaries was laid down by the Minister of Agriculture and Fisheries in 1933 in a decision letter known as the "Medway Letter" [4]. This letter, which is now regarded as the authoritative pronouncement for all cases which have arisen since then, identified the area of benefit or avoidance of danger by reason of drainage operations by reference to flood contours (in relation to freshwater drainage) or tide levels (in relation to sea defence and salt water inundations).

7.2 Income

7.2.1 The income of Internal Drainage Boards is derived in the main from:

i) Drainage rates levied on land and buildings within the Drainage District.
ii) Ministry of Agriculture, Fisheries and Food grant aid for capital schemes undertaken by the Boards.
iii) Contributions, in appropriate cases, from the National Rivers Authority towards the cost incurred by the Boards in handling water flowing through the District from upland areas.

7.3 Designated Watercourses

7.3.1 The Boards are empowered under Section 6 of the Land Drainage Act 1976 (as amended by the Water Act 1989) to exercise a general supervision over all matters relating to the drainage of land within their Districts, and are empowered by Section 17 of that Act to carry out work on all non-main river watercourses within their area. In practice, most Boards designate certain watercourses in their area on which they carry out regular maintenance and other minor watercourses are left to riparian owners to maintain or improve.

7.4 Maintenance of the Flow of Watercourses

7.4.1 Where the proper flow of water is impeded, an Internal Drainage Board may serve notice under Section 18, Land Drainage Act 1976 (as amended by the Water Act 1989), on the person concerned to remedy the situation. This applies to all watercourses in the Drainage District other than main river on which notice would normally be served by the National Rivers Authority.

CHAPTER 8

FLOOD DEFENCE MAINTENANCE

8.0 FLOOD DEFENCE MAINTENANCE

8.1 Objectives

The main objectives for flood defence maintenance can be summarised as follows:

- to preserve the stability, continuity and integrity of flood defences

- to ensure the satisfactory operation of pumping stations, outfalls, sluices and other flood defence structures.

- to ensure that the river systems (channels, floodplain and washland) are capable of containing and transmitting flood waters and tidal surges up to the appropriate target return period.

- in carrying out its operations to preserve and 'further' the river environment.

8.2 Responsibility for Maintenance

The Authority is given powers under Section 17, Land Drainage Act 1976 (as amended by the Water Act 1989) to maintain watercourses designated as main river. It does not have similar powers for the maintenance of non-main rivers which are normally considered the responsibility of the riparian owners although Internal Drainage Boards, District Councils and, in certain cases County Councils have permissive powers on these watercourses.

8.3 Maintenance Programmes

An Asset Management Plan is being developed which will identify maintenance expenditure profiles which will ensure an appropriate Level of Service (LOS) for Flood Defence.

This Level of Service is expressed in terms of a target flood capacity which is calculated from an analysis of the land use benefiting from flood protection.

A major survey of Flood Defence Assets will be carried-out as part of this Asset Management Plan. Many of these assets are approaching the end of their original design life, therefore, this survey will confirm whether the current maintenance practices are adequate or not.

The Asset Management Plan will determine:-

- the target Level of Service

- the existing Level of Service

- the gap or shortfall between the target and existing Level of Service

- objective maintenance programmes appraised by cost benefit techniques. These will be further refined, following full consultation, to ensure that balanced programmes are produced which accommodate environmental interests.

The Region has recently commissioned a new Rivers Information and Maintenance System (RIMS) which assists this development of objective maintenance programmes.

In addition the Region carries out Best Operational Practice Reviews to ensure that full benefit is taken of any new developments in the industry; the resultant cost savings enable our operations to extend over more of the main river network.

Furthermore, post project appraisals are carried-out to ensure that the various models and techniques which have been developed and used are valid.

The Region also funds an annual environmental enhancement programme.

CHAPTER 9

FLOOD DEFENCE AND CONSERVATION

9.0 FLOOD DEFENCE AND CONSERVATION

9.1 Introduction

9.1.1 When carrying out improvements to watercourses due regard is taken of other interests which may be affected by such improvements. Other functions of the NRA are consulted during the detailed design phase of schemes. However, in the past, conservation interests relating to watercourses have not always received their due regard and for this reason particular emphasis has been given in this Survey to these aspects. Therefore, the problem evaluations in Appendix A1 give specific information on conservation and environmental interests where these may be affected by the suggested improvements. In addition, statutory conservation sites and County Trust Reserves are delineated on the maps which accompanied the 1980 report and scheduled in Appendix A3.

9.2 Statutory Provisions for Nature Conservation

9.2.1 Section 8(1) of the Water Act 1989 states that the National Rivers Authority has a duty to "further the conservation and enhancement of natural beauty and the conservation of flora, fauna and geological and physiographical features of special interest".

9.2.2 Guidance notes on land drainage and conservation have been circulated jointly by the Department of the Environment, MAFF and the Welsh Offices to all Water Authorities and Internal Drainage Boards in relation to duties under previous legislation. These guidelines are currently being updated to take into account the Water Act 1989.

9.2.3 The relevant functions of the Nature Conservancy Council and the Countryside Commission are given in Appendix A6.

9.2.4 The Authority's standard land drainage consent form has been amended to inform applicants of the need to comply with any duties or responsibilities for the conservation or protection of the environment (including flora and fauna).

9.3 Liaison with Conservation Interests

9.3.1 The Authority attaches great importance to liaison with conservation interests for all land drainage proposals which affect watercourses. These may be summarised as:

i) Improvement schemes identified in the 5 year capital programme for flood defence.

ii) Maintenance work on watercourses.

iii) Proposals for main river variations.

iv) Water Act 1989, Section 136(1) Flooding Survey.

9.3.2 The Authority's area staff have been issued with guidelines on the consultation which is necessary between area staff and conservation/recreation staff where works involve improvement or maintenance of rivers and watercourses.

9.3.3 The principal links between the area offices and conservation and amenity bodies are the Area Conservation and Recreation Officers.

CHAPTER 10

FLOOD WARNING SYSTEM

10.0 FLOOD WARNING SYSTEM

10.1 Investigations have shown that within the Severn-Trent Region of the National Rivers Authority considerable public benefit can accrue from accurate, reliable and well disseminated flood forecasts which provide the general public with adequate warning of flood events. The warnings can provide time for items to be moved from ground floors of residential and commercial properties, for boat owners to secure their crafts, campers and caravanners to evacuate sites, etc.

10.2 The National Rivers Authority has powers to provide and operate a flood warning system by Section 32 of the Land Drainage Act, 1976 (as amended by the Water Act 1989). The main provisions of the system which operates throughout the Region are:

i) To monitor weather conditions and flows and levels in rivers and to forecast future water levels.
ii) To provide warnings of potential floods in areas likely to be affected.
iii) To provide an advice and information service to the general public.
iv) To deploy area staff and equipment as necessary.
v) To liaise with other emergency services.

10.3 The procedure for issuing warnings is normally initiated by the Meteorological Office providing forecasts of rainfall or snowmelt. This information, together with the continual assessment of the detailed catchment situation by the interrogation of the network of rainfall and river flow and level recorders, enables the Authority to forecast and monitor the progression of floods through the river basins.

10.4 When danger areas have been assessed this information has to be passed to the public in those areas. This service is normally provided by the Police who advise the public by loudspeaker, local radio broadcasts and other appropriate methods. This system, however, cannot operate in some areas where localised storms can outpace the forecasting and warning procedure. Therefore, the service is limited to those areas where more than 4 hours warning can be given.

10.5 It is particularly difficult to provide warnings for transient groups of people such as caravanners, campers and boaters. When sites for caravans and camping are being considered the Authority will always advise planning authorities against their location in areas which are subject to periodic inundation. The protection of such sites from flooding is normally difficult, expensive and contrary to Authority policy regarding the use and management of floodplains. The joint DoE/MAFF/WO Circular 17/82 highlights this special risk problem.

10.6 Although major benefits can be attributed to a reliable flood warning system, such a system cannot, in itself, be considered as a satisfactory alternative to structural improvements which will reduce the risk of flooding. The Authority's policy is to continue to provide increased flood alleviation measures, at the same time as providing an effective flood forecasting service, which will give early warning of flooding in unprotected areas and also in the event that flood defences are likely to be overtopped.

CHAPTER 11

PROGRAMMING OF FUTURE WORK

11.0 PROGRAMMING OF FUTURE WORK

11.1 This Survey has identified and evaluated a wide range of flood defence problems throughout the Region. The responsibility for resolving the problems and financing the improvement works falls initially upon the riparian owner although drainage authorities have permissive powers to undertake works.

11.2 In many cases, the necessity for improvement is often due to increased channel flows resulting from developments in the upstream catchment, which, in recent years, have been approved by planning departments of Local Authorities. Where improvements due to development are required on main river, responsibility is normally accepted by this Authority, whereas on non-main river the responsibility is normally that of the District Council in urban areas, and the County Council in agricultural areas (other than in Drainage Districts where the Internal Drainage Board has a responsibility).

11.3 Improvement works on watercourses in individual catchments need to be co-ordinated to ensure that works in one area are compatible with those in another. This Authority is the body responsible for the co-ordination and supervision of flood defence throughout the area, and publishes annually its 5 year programme. The co-ordinating role can be carried out effectively only if all drainage bodies produce programmes of work which satisfactorily integrate to provide the maximum benefit to flood defence. This Survey provides the basis for the determination of such programmes of work.

11.4 Financing of flood defence works varies, dependent on the drainage body promoting the work. Most improvements, other than those needed as a requirement of future development, are eligible for grant aid from the Ministry of Agriculture, Fisheries and Food providing the improvement can be shown to have a satisfactory benefit/cost ratio (see Section 2.11). The sources of finance generally available to drainage bodies are indicated in Appendix A5.

11.5 In the future, the Survey will be updated at intervals of approximately three years. In order to ensure this operation is kept to a minimum in terms of manpower and financial resources, the Authority wishes to be kept informed of all improvement schemes which have been completed and of any additional problems which may be identified from time to time.

APPENDIX A1

PROBLEM DESCRIPTIONS

AND EVALUATIONS

IDENTIFICATION

Problem code number(s):	3-87-210-3
Watercourse:	River Arrow (non-main river)
Location:	Rednall (Bromsgrove District Council)
OS Map reference:	SO 999 759

NATURE OF PROBLEM

A youth club dormitory, basement bedroom and basement workshops flood, the latter annually, together with the B4096 road for periods up to 12 hours. The most serious events occurred in 1968, '71 and '77 with the maximum recorded flood estimated to have a frequency of 1 in 15 years. Flooding occurs when the Arrow overtops upstream of the youth club and is aggravated because the surface water drains at the youth club cannot discharge properly.

The highway Authority have recently carried out works to improve the road drainage and this has considerably reduced road flooding.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in 50 years
	(ii)	Structures	1 in years
(b) **Agricultural**	(i)	Channel	1 in years
	(ii)	Structures	1 in years
(c) **Land potential category**			

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	14,410	
	(ii)	Field drainage	£		£14,410
(b) **Present value of benefits**	(i)	Agriculture	£	19,810	
	(ii)	Buildings	£		
	(iii)	Roads/Railways	£	negligible	£19,810
(c) **Benefit/cost ratio**					1.4
(d) **Priority category**					2E

IMPROVEMENT WORKS

It is recommended that 300m of watercourse adjacent to the road culvert at the B4096/B4120 junction is resectioned. Stone pitching revetment would also be required to protect approximately 150m of the resectioned channels. These improvements will provide a channel design capacity of 4.2 cumecs.

Although the watercourse is inadequate to receive the run-off from the Lickey Hills, maintenance appears to be an equally important problem. The adjacent woodland is used for recreational purposes and consequently the watercourse is apt to be blocked by leaves, dams, debris etc. Regular maintenance is required to keep the watercourses and existing screens free form obstructions.

Maintenance works have been carried out on the watercourse but the degree of alleviation has not yet been assessed.

BENEFITS

Benefits to road traffic are negligible as the road is not impassable during flood events.

CONSERVATION

This small stream flowing beside the B4096 through the Lickey Hills has several specimens of a rare fern growing beside it. Any remedial works proposed should avoid damaging this rarity and site liaison is imperative to avoid damage.

IDENTIFICATION

Problem code number(s):	3-87-410-1
Watercourse:	Dagnell End Brook (non-main river)
Location:	Redditch (Redditch Borough Council)
OS Map reference:	SP 053 695 to SP 052 688

NATURE OF PROBLEM

Restricted discharge conditions cause backing up, creating annual localised flooding to farmland and flooding of the B4101 road on average once very three years. The arterial drainage of 15 ha of agricultural land is also inadequate.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in	years
	(ii)	Structures	1 in	years
(b) **Agricultural**	(i)	Channel	1 in	5 years
	(ii)	Structures	1 in	25 years
(c) **Land potential category**			a5	

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	25,950	
	(ii)	Field drainage	£	10,010	£35,960
(b) **Present value of benefits**	(i)	Agriculture	£	38,900	
	(ii)	Buildings	£		
	(iii)	Roads/Railways	£	10,010	£48,910
(c) **Benefit/cost ratio**					1.4
(d) **Priority category**					2E

IMPROVEMENT WORKS

The Brook discharges into the mill stream of a dis-used paper mill with an overflow to discharge high flows direct to the River Arrow.

It is suggested that the watercourse is re-sectioned for 700m from the overflow weir up to the B4101, providing a channel design discharge of 2.2 cumecs and allowing satisfactory freeboard for the installation of field drains where appropriate.

Only limited improvements will be possible unless water levels in the mill stream can be lowered and the overflow weir significantly lengthened.

CONSERVATION

Dagnell End Meadow is of SSSI status. The meadow is an area of wet low lying pasture containing a number of rare and uncommon wetland plants. It is also important for bird species which like a damp habitat. The Nature Conservancy Council have commented that any improvements to the watercourse should take into account the need to maintain the existing water table on which the present plant and animal communities depend.

FISHERIES

The mill stream is an important fishing site, containing stocks of trout and for this reason the water levels are required to be kept relatively high.

IDENTIFICATION

Problem code number(s):	3-87-410-2
Watercourse:	River Arrow (non-main river)
Location:	Redditch (Redditch Borough Council)
OS Map reference:	SP 030 709 to SP 053 687

NATURE OF PROBLEM

52 ha of farmland suffered from inadequate arterial drainage and localised flooding for up to 48 hours five times since 1968.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in	years
	(ii)	Structures	1 in	years
(b) **Agricultural**	(i)	Channel	1 in	2 years
	(ii)	Structures	1 in	years
(c) **Land potential category**			a5	

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	118,200	
	(ii)	Field drainage	£	20,020	£138,220
(b) **Present value of benefits**	(i)	Agriculture	£	130,580	
	(ii)	Buildings	£		
	(iii)	Roads/Railways	£		£130,580
(c) **Benefit/cost ratio**					0.9
(d) **Priority category**					3C

IMPROVEMENT WORKS

It is suggested that channel improvements are carried out from SP 053 687 for 4 km to SP 030 709 providing a channel design capacity of about 6 cumecs and allowing satisfactory freeboard for the installation of field drains where appropriate (upstream of the A441). Downstream of the A441 a number of new cuts will be required to straighten out the watercourse.

BENEFITS

At present the benefit area is used mostly for sheep grazing. Downstream of the A441 will remain as sheep grazing being part of a recreational area.

CONSERVATION

Dagnell End Meadow is of SSSI status. See comments on 3-87-410-1.

IDENTIFICATION

Problem code number(s):	3-87-410-3/12
Watercourse:	Hewell Brook (non-main river)
Location:	Redditch (Redditch Borough Council)
OS Map reference:	SP 011 688 to SP 024 680

NATURE OF PROBLEM

Inadequate outfall conditions adversely affect the drainage of 30 ha of agricultural land. The B4184 floods on average once every five years and localised flooding to agricultural land occurs annually. However road flooding has not occurred since improvements have been carried out on the watercourse downstream of the B4184.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in	years
	(ii)	Structures	1 in	years
(b) **Agricultural**	(i)	Channel	1 in 5	years
	(ii)	Structures	1 in	years
(c) **Land potential category**			a5	

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	69,190	
	(ii)	Field drainage	£	20,020	£89,210
(b) **Present value of benefits**	(i)	Agriculture	£	75,010	
	(ii)	Buildings	£		
	(iii)	Roads/Railways	£		£75,010
(c) **Benefit/cost ratio**					0.8
(d) **Priority category**					30

IMPROVEMENT WORKS

It is recommended that the watercourse is resectioned for 1.8 km between Hewell Grange Lake and the B4184 to provide a design standard of 2 cumecs allowing satisfactory freeboard for field drainage under average flow conditions. Four farm access bridges and one footbridge will require replacing and wing walls on the upstream side of the culvert crossing the B4184 should be constructed.

DEVELOPMENT

The area is presently under consideration as a potential development site for up to 1,000 dwellings and ancillary development.

IDENTIFICATION

Problem code number(s):	3-87-410-4/11/13/14; 3-87-810-26/29-47-50
Watercourse:	Bow Brook (main river), Bow Brook (non-main river), Shell Brook, Dean Brook, Brandon Brook, Hanbury tributaries of Seeley Brook, Seeley brook, Swansbrook (non-main rivers)
Location:	Huddington to Feckenham (Wychavon and Redditch District Councils)
OS Map reference:	SO 943 573 to SP 010 645

NATURE OF PROBLEM

Inadequacies in Bow Brook and its tributaries cause localised flooding to agricultural land several times a year for up to twelve hours duration. Inadequate outfall conditions exist on most lengths. Flooding of 3 houses occurs during a 1 in 2 years event from a minor tributary of Bow Brook at Feckenham (SP 012 618). One house is affected during the 1 in 10 years event from the Brandon Brook at Feckenham (SP 020 607). 1 workshop is affected during the 1 in 10 years event from a tributary of the Seeley Brook at Hanbury (SO 960 626). 4 houses are affected at Himbleton during the 1 in 18 years flood event and a total of 9 houses would be affected during the 1 in 50 years event at the same location. Class 'C' roads are affected by floodwater, generally becoming impassable during a 1 in 2 years event at Priest Bridge (SO 990 599), Himbleton (SO 946 585), Shell Ford (SO 951 597) and Feckenham (SP 013 627).

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in 5 years
	(ii)	Structures	1 in 50 years
(b) **Agricultural**	(i)	Channel	1 in 5 years
	(ii)	Structures	1 in 25 years
(c) **Land potential category**			a5

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	792,800	
	(ii)	Field drainage	£	210,180	£1,002,980
(b) **Present value of benefits**	(i)	Agriculture	£	1,033,530	
	(ii)	Buildings	£	17,510	
	(iii)	Roads/Railways	£	negligible	£1,051,040
(c) **Benefit/cost ratio**					1.0
(d) **Priority category**					2B

IMPROVEMENT WORKS

It is suggested that Bow Brook and various tributaries should be re-sectioned to provide a design standard of 14.8 cumecs at Himbleton, and allowing satisfactory freeboard for land drains to be installed, where necessary. It is suggested that the following lengths of watercourse are improved: Bow Brook, Shell Brook and Swansbrook from Huddington (SO 943 573) to Elcock's Brook (SP 010 645), Dean Brook from the Shell Brook confluence to the railway line at SO 922 608, Brandon Brook from the Bow Brook confluence to Shurnock (SP 028 609) and the downstream part of Seeley Brook from the Shell Brook confluence to and including the tributaries form Woolmere green and Skirgens Farm at Hanbury, (SO 966 630 and SO 978 623).

Improvements would consist of re-sectioning channels, underpinning or replacing approximately 30 footpath or farm access bridges/culverts, construction of a new highway bridge at Huddington, several new cuts to straighten out varous sections of the watercourse and the removal or alteration of several weirs.

DEVELOPMENT

The top end of the Bow Brook catchment receives surface water from south-western areas of Redditch.

Development recently constructed or under construction in the town will increase surface water flows to Bow Brook although this run-off has been balanced on Wharrage Brook, a tributary of Bow Brook at Feckenham. There is one more site within the Bow Brook catchment at Redditch to be developed and surface water from this site will also have to be balanced on the Wharrage Brook. The existing systems are designed to balance flows up to a 1 in 50 year flood.

BENEFITS

A comprehensive scheme on Bow Brook and its tributaries would benefit approximately 475 hectares of agricultural land.

It is estimated that channel improvements to a 1 in 5 year design with satisfactory freeboard together with improvements to bridges, culverts and weirs would afford protection to property to between a 1 in 30 years and a 1 in 50 years flood event.

Benefits to road flooding are negligible although there are some 'intangible' benefits to be considered, such as the road flooding at Himbleton that occurs every year and cuts off the village school necessitating ferrying of children in vehicles through the flood.

CONSERVATION

3-87-410-4 & 3-87-410-13
Any remedial work should avoid damage to the habitat of alders and willows.

3-87-810-47
The Bow Brook and Shell Brook up and downstream of Himbleton have very undisturbed sections. This is one of the best stretches of streamside habitat in Worcestershire.

3-87-810-26
This area is of special ornithological interest.

FISHERIES

Not very important as a fishery but trout are fished for by individual anglers. These brooks could benefit from sensible tree clearance with improved access to the brooks.

IDENTIFICATION

Problem code number(s):	3-87-410-5
Watercourse:	Un-named farm ditches
Location:	Astwood Bank (Redditch Borough Council)
OS Map reference:	SP 032 623 and SP 031 624

NATURE OF PROBLEM

Highway drains block frequently causing flooding outside 'Seven Elms'. In addition, inadequate drains running from a catch pit in Astwood Lane overflow onto the roadway. Flooding in both cases is annual and for periods up to 12 hours. The problem has been intensified recently as agricultural drainage works have diverted considerable amounts of water towards these drains.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IMPROVEMENT WORKS

No solution is recommended as the drains are the responsibility of the Highway Authority. The two problems ought to receive priority as flooding occurs immediately round the bend of the road and can produce a major hazard to traffic.

The County Council carried out improvements to the culverts in 1988 which have lessened the problems.

IDENTIFICATION

Problem code number(s):	3-87-810-3
Watercourse:	Coombe Brook (non-main river)
Location:	Bretforton (Wychavon District Council)
OS Map reference:	SP 102 432 to SP 098 442

NATURE OF PROBLEM

29 ha of agricultural land suffer from inadequate arterial drainage and localised flooding of the Honeybourne to Bretforton Road and adjacent farmland. Flooding occurs on average every two to three years for periods up to three hours.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in years
		(ii)	Structures	1 in years
(b)	**Agricultural**	(i)	Channel	1 in 25 years
		(ii)	Structures	1 in 26 years
(c)	**Land potential category**			a5

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	77,840	
		(ii)	Field drainage	£	27,520	£105,360
(b)	**Present value of benefits**	(i)	Agriculture	£	569,550	
		(ii)	Buildings	£		
		(iii)	Roads/Railways	£	negligible	£569,550
(c)	**Benefit/cost ratio**					5.4
(d)	**Priority category**					10

IMPROVEMENT WORKS

It is recommended that approximately 1.5 km of watercourse is re-sectioned to provide satisfactory freeboard for land drainage and provide a design capacity of 3.9 cumecs. The road culvert at SP 101 432 has been reduced in area by the construction of 12" and 4" pipes across the inlet. This culvert will be broken out and a 1600 mm by 1400 mm box culvert constructed to a lower invert.

BENEFITS

Summer flooding has seriously affected glasshouse production and at least two growers have postponed the erection of new glass until the watercourse is improved. Benefits are high as the land is valuable horticultural land. In view of the high benefit potential, it may be desirable to improve Coombe Brook to the confluence with Bretforton Brook.

IDENTIFICATION

Problem code number(s):	3-87-810-4
Watercourse:	Merry Brook (non-main river)
Location:	Charlton (Wychavon District Council)
OS Map reference:	SP 088 456

NATURE OF PROBLEM

The road through the village floods on average once every five years for up to two hours.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in 10 years
		(ii)	Structures	1 in years
(b)	**Agricultural**	(i)	Channel	1 in years
		(ii)	Structures	1 in years
(c)	**Land potential category**			

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	1,450	
		(ii)	Field drainage	£		£1,450
(b)	**Present value of benefits**	(i)	Agriculture	£		
		(ii)	Buildings	£		
		(iii)	Roads/Railways	£		negligible
(c)	**Benefit/cost ratio**					0
(d)	**Priority category**					3F

IMPROVEMENT WORKS

The culverts in the village are theoretically capable of discharging a 50 year flow although the open watercourse can only carry the mean annual flood before discharging onto the village green. The proposed solution is therefore to re-section approximately 250 m of watercourse to provide a design capacity of 3.9 cumecs.

A section of the ditch has been cleared out, but the degree of alleviation has not yet been assessed.

BENEFITS

The benefits are negligible as an alternative road exit is available from the village.

CONSERVATION

The benefit area is close to an area of outstanding ornithological importance. It is imperative that consultations take place before any work is undertaken. The watercourse runs through the centre of a conservation area.

IDENTIFICATION

Problem code number(s):	3-87-810-8
Watercourse:	Bourne Brook (non-main river)
Location:	Lower Strensham (Wychavon District Council)
OS Map reference:	SO 906 415

NATURE OF PROBLEM

A 'C' Class road floods for up to five hours with an estimated recurrence interval of once in 15 years.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£_____
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£_____
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IMPROVEMENT WORKS

The existing culvert and watercourse are capable of containing a 1 in 50 year and 1 in 10 year flood respectively. However, the Bourne Brook level is entirely controlled by the level in the River Avon and no easy solution is forseen.

CONSERVATION

This is adjacent to an area of outstanding ornithological importance. It is imperative that consultations take place before remedial works are undertaken.

IDENTIFICATION

Problem code number(s):	3-87-810-9/13/14/16/44
Watercourse:	Piddle Brook, Whitsun Brook (main river), Cowsden Brook (non-main river)
Location:	Pershore, Kington, North Piddle (Wychavon District Council)
OS Map reference:	SP 020 560 to SO 954 465

NATURE OF PROBLEM

The inadequate arterial drainage of 393 ha of the Piddle Brook; 129 ha of the Whitsun Brook and 30 ha of the Cowsden Brook suffer from inadequate arterial drinage. Localised flooding to farmland for up to 48 hours occurs annually, particularly around Kington, Bishampton and the confluence of the Whitsun and Piddle Brooks. Below Wyre Piddle the watercourse is affected by the level of the Avon and improvements will be limited unless a solution to lower water levels is found.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in years
	(ii)	Structures	1 in years
(b) **Agricultural**	(i)	Channel	1 in 5 years
	(ii)	Structures	1 in 25 years
(c) **Land potential category**			a5

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	936,940	
	(ii)	Field drainage	£	177,650	£1,114,590
(b) **Present value of benefits**	(i)	Agriculture	£	591,780	
	(ii)	Buildings	£		
	(iii)	Roads/Railways	£		£591,780
(c) **Benefit/cost ratio**					0.5
(d) **Priority category**					3B

IMPROVEMENT WORKS

It is suggested that a comprehensive scheme is required on the Piddle Brook for 19 km from the River Avon confluence to SP 019 554 including Whitsun Brook to Slakumford Bridge (SP 008 524) and Cowsden Brook to the B4082 (SP 951 538). The watercourses will require re-sectioning to provide a channel design standard at the downstream end of 14 cumecs also allowing satisfactory freeboard for land drainage under normal flow conditions. In association with these works about 30 road/farm access bridges will require underpinning and five road/farm bridges will require replacement. Flat gradients account for the high improvement costs.

Improvement works are unlikely to proceed due to a re-assessment of priorities.

CONSERVATION

Piddle Brook and Whitsun Brook are important lowland streams in Worcestershire with interesting aquatic vegetation.

Two SSSI's are situated adjacent to Piddle Brook and must be considered along with any improvement works. Long Meadow, Thorne is a species rich brookside meadow with a south facing bank of thorn bushes which provides a valuable habitat for insects. The site is also a Worcestershire County Trust Reserve and conservation interests request that engineering works are kept to a minimum to preserve the natural habitats.

The second site, Grafton Wood, is a large oak woodland on wet, clay soils particularly important for Lepidoptera. The Nature Conservancy wish to see the wet character of the wood retained and special precautions taken to ensure that deepening of the watercourse in this area does not lower the water table. At SO 994 518 is a small area of wet meadow on peaty soils and at SP 005 526 is an important reed bed containing a rare species of rush also to be found on the east side of the brook at SP 006 526.

FISHERIES

Not very important as fisheries, but could benefit from sensible tree clearance to improve access to the woods.

IDENTIFICATION

Problem code number(s):	3-87-810-10/17
Watercourse:	Haw Brook (non-main river)
Location:	Drakes Broughton and Wadborough (Wychavon District Council)
OS Map reference:	SP 908 491 to SO 926 467

NATURE OF PROBLEM

Inadequate outfall conditions exist on the watercourse and localised flooding to agricultural land occurs for up to twelve hours on average once a year.

4 houses are affected by a 1 in 2 year flood event (3 cumecs) from a small tributary at Hawbridge (SO 906 491).

A class 'C' road at SO 913 480 becomes impassable at a 1 in 20 year flood event.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in 50 years
	(ii)	Structures	1 in 50 years
(b) **Agricultural**	(i)	Channel	1 in 5 years
	(ii)	Structures	1 in 25 years
(c) **Land potential category**			a5

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	74,960	
	(ii)	Field drainage	£	15,010	£89,970
(b) **Present value of benefits**	(i)	Agriculture	£	38,900	
	(ii)	Buildings	£	27,520	
	(iii)	Roads/Railways	£	negligible	£66,420
(c) **Benefit/cost ratio**					0.7
(d) **Priority category**					3D

IMPROVEMENT WORKS

It is suggested that the watercourse is re-sectioned from the Bow Brook confluence to Hawbridge, providing a design capacity of 3 cumecs, allowing satisfactory freeboard for land drains to be installed, where necessary.

Although initial design is based on a 1 in 2 years discharge, increasing the channel depth sufficiently for land drains will provide a channel capacity in excess of 1 in 50 years, thus providing protection to the affected houses to a desirable standard.

Some works have been carried out which may have improved the situation.

BENEFITS

Approximately 30 ha of agricultural land would benefit from an improvement scheme.

CONSERVATION

The meadow at SO 914 483 could be adversely affected by drainage works.

IDENTIFICATION

Problem code number(s):	3-87-810-11/15/21/22
Watercourse:	Bow Brook (main river)
Location:	Defford to Stonebow (Wychavon District Council)
OS Map reference:	SO 920 425 to SO 935 495

NATURE OF PROBLEM

Inadequate outfall conditions exist on the watercourse affecting 75 ha of agricultural land and localised flooding occurs for up to 48 hours on average every year. A class 'C' road at Besford Bridge floods during a 1 in 5 years flood event (26 cumecs) and the A4104 at Defford floods during a 1 in 10 years flood event (31 cumecs). These roads become impassable during the 1 in 25 years flood event.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in years
	(ii)	Structures	1 in years
(b) **Agricultural**	(i)	Channel	1 in 5 years
	(ii)	Structures	1 in 25 years
(c) **Land potential category**			a

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	302,700	
	(ii)	Field drainage	£	35,030	£337,730
(b) **Present value of benefits**	(i)	Agriculture	£	88,910	
	(ii)	Buildings	£	Nil	
	(iii)	Roads/Railways	£	10,010	£98,920
(c) **Benefit/cost ratio**					0.3
(d) **Priority category**					3C

IMPROVEMENT WORKS

The mean annual flood for Bow Brook at Besford = 21.6 cumecs. This has been obtained by statistical analysis of gauged flows.

It is suggested that the watercourse is re-sectioned from the confluence with the River Avon to Stonebow, providing a channel design discharge of 26 cumecs, and allowing satisfactory freeboard for land drains to be installed where necessary.

Heavy maintenance was carried out in 1986/87.

CONSERVATION

3-87-810-11
The Bow Brook is one of the most important streams in Worcestershire and any proposals affecting it need to be considered in detail.

3-87-810-22
This is an outstanding area of nature conservation importance and is managed as a reserve by the Worcestershire Nature Conservation Trust who wish that no drainage works should be carried out here.

IDENTIFICATION

Problem code number(s):	3-87-810-12
Watercourse:	None
Location:	North Piddle (Wychavon District Council)
OS Map reference:	SP 963 543 to SP 965 543

NATURE OF PROBLEM

A road floods every six months for periods up to four hours due to inadequate highway ditches.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£_____
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£_____
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IMPROVEMENT WORKS

This is a Highway Authority problem and is outside the scope of this Survey.

IDENTIFICATION

Problem code number(s):	3-87-810-18
Watercourse:	Un-named tributary of Littleton Brook (non-main river)
Location:	Cleeve Prior (Wychavon District Council)
OS Map reference:	SP 089 493 to SP 087 490

NATURE OF PROBLEM

Flooding occurred in December 1976, February and June 1977 and May 1979. There had been no previous history of flooding. Flooding occurred to roads and three houses, one from foul sewage and two from surface water run-off from adjacent fields. The District Council is currently investigating improvements to the foul sewerage system.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in years
		(ii)	Structures	1 in 50 years
(b)	**Agricultural**	(i)	Channel	1 in years
		(ii)	Structures	1 in years
(c)	**Land potential category**			

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	691,900	
		(ii)	Field drainage	£		£691,900
(b)	**Present value of benefits**	(i)	Agriculture	£		
		(ii)	Buildings	£	7,427	
		(iii)	Roads/Railways	£		£7,427
(c)	**Benefit/cost ratio**					0
(d)	**Priority category**					3B

IMPROVEMENT WORKS

The culvert running through the village is inadequate and possibly blocked and even in good condition can only discharge approximately the mean annual flood. It is suggested that to solve the surface water flooding problems a new 675 mm culvert should be constructed through the village to provide a design capacity of 0.8 cumecs.

BENEFITS

Benefits to properties are small, and as the proposed solution is not thought to be a complete solution, flood proofing the houses is suggested as an intermediate measure.

CONSERVATION

The culvert runs through a conservation area and any improvement works should be designed accordingly.

IDENTIFICATION

Problem code number(s):	3-87-810-19
Watercourse:	None
Location:	Tibberton (Wychavon District Council)
OS Map reference:	SO 904 576 and SO 907 582

NATURE OF PROBLEM

5 houses on the west side of Plough Road and 3 houses near the canal to the north of the village are affected by flood water from ditches and highway drainage. Flooding starts approximately at a 1 in 10 years flood event.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£_____
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£_____
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IMPROVEMENT WORKS

Both flooding points appear to be due to poor ditch maintenance and drainage to the highway drainage system. A comprehensive investigation is required beyond the scope of this survey and this is currently being undertaken by Wychavon District Council and Hereford and Worcester County Council.

IDENTIFICATION

Problem code number(s):	3-87-810-20
Watercourse:	None
Location:	Kemerton (Wychavon District Council)
OS Map reference:	SO 948 373

NATURE OF PROBLEM

An estimated 1 in 7 years flood event in February 1977 flooded nine properties, including a general stores, as a result of high surface water run-off from a field on the slopes of Bredon Hill, possibly exacerbated by a blockage in the main watercourse at the road culvert (SP 942 372).

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in 10 years
	(ii)	Structures	1 in years
(b) **Agricultural**	(i)	Channel	1 in years
	(ii)	Structures	1 in years
(c) **Land potential category**			

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	5,770	
	(ii)	Field drainage	£		£5,770
(b) **Present value of benefits**	(i)	Agriculture	£		
	(ii)	Buildings	£	17,510	
	(iii)	Roads/Railways	£		£17,510
(c) **Benefit/cost ratio**					3.0
(d) **Priority category**					1F

IMPROVEMENT WORKS

It is proposed to construct a cut-off channel to intercept the field run-off, some 1 m deep and 0.3 m wide. This will replace the ditch which was filled in some years ago.

IDENTIFICATION

Problem code number(s):	3-87-810-23/42
Watercourse:	Bully Brook (non-main river)
Location:	Badsey (Wychavon District Council)
OS Map reference:	SP 093 409 to SP 068 428

NATURE OF PROBLEM

106 ha of agricultural land suffer from inadequate arterial drainage, and localised flooding in 1968, '72 and '77 affected land adjacent to the downstream end of the watercourse.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in years
		(ii)	Structures	1 in years
(b)	**Agricultural**	(i)	Channel	1 in 5 years
		(ii)	Structures	1 in 50 years
(c)	**Land potential category**			a5

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	175,860	
		(ii)	Field drainage	£	52,540	£228,400
(b)	**Present value of benefits**	(i)	Agriculture	£	263,940	
		(ii)	Buildings	£		
		(iii)	Roads/Railways	£		£263,940
(c)	**Benefit/cost ratio**					1.2
(d)	**Priority category**					2C

IMPROVEMENT WORKS

The solution suggested is to re-section approximately 3 km of watercourse from the confluence with Badsey Brook including straightening out 500 m with new cuts to provide a design capacity of 1.9 cumecs but freeboard criteria, however, will allow a maximum capacity of 3.3 cumecs. Two farm access culverts will require underpinning and one farm access culvert replaced by a new box culvert. A new box culvert under the road at SP 083 416 is also necessary.

The 300 m of channel upstream of the confluence to the road bridge at SP 071 428 should be widened, rather than deepened, as, firstly, Badsey Brook will have an effect on this length preventing free outfall and, secondly, a smaller increase in depth will allow underpinning rather than the replacement of the road culvert.

IDENTIFICATION

Problem code number(s):	3-87-810-24
Watercourse:	Un-named tributary of Broadway Brook (non-main river)
Location:	Offenham (Wychavon District Council)
OS Map reference:	SP 051 455

NATURE OF PROBLEM

The inadequate drainage of 9 ha of high grade arable/horticultural land together with localised flooding for up to four hours most recently in 1968, '71 and '75 is due to an undersized culvert at SP 051 455. In 1968 a class 'C' road also flooded.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in	years
	(ii)	Structures	1 in	years
(b) **Agricultural**	(i)	Channel	1 in	50 years
	(ii)	Structures	1 in	50 years
(c) **Land potential category**				c

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	69,190	
	(ii)	Field drainage	£	2,500	£71,690
(b) **Present value of benefits**	(i)	Agriculture	£	136,140	
	(ii)	Buildings	£		
	(iii)	Roads/Railways	£	negligible	£136,140
(c) **Benefit/cost ratio**					1.9
(d) **Priority category**					2D

IMPROVEMENT WORKS

The existing culvert is approximately 170 m long and consists of a partially silted up 300 mm pipe with a 100 mm overflow. It is suggested that this should be replaced by a 825 mm diameter pipe to provide a design discharge of 9.0 cumecs. The upstream length of watercourse is theoretically capable of conveying this discharge but the length of watercourse downstream which discharges into the Broadway Brook after some 30 m requires re-sectioning. The culvert falls steeply creating very high velocities in the last 30 to 40 m of pipe necessitating some form of stilling basin (energy dissipator) to be incorporated in the proposed work.

BENEFITS

The benefit area is first class horticultural land.

DEVELOPMENT

The construction of 23 houses in Offenham has increased the occurrence of flooding. Only minor improvements to the open length of watercourse were carried out by the developer.

IDENTIFICATION

Problem code number(s):	3-87-810-27
Watercourse:	Tributary of River Isbourne (non-main river)
Location:	Aston Somerville (Wychavon District Council)
OS Map reference:	SP 054 374 to SP 033 382

NATURE OF PROBLEM

The arterial drainage of 55 ha of agricultural land is inadequate and localised flooding two or three times a year for durations up to 12 hours affects farmland.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in years
		(ii)	Structures	1 in years
(b)	**Agricultural**	(i)	Channel	1 in years
		(ii)	Structures	1 in 25 years
(c)	**Land potential category**			a5

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	109,550	
		(ii)	Field drainage	£	17,510	£127,060
(b)	**Present value of benefits**	(i)	Agriculture	£	138,920	
		(ii)	Buildings	£		
		(iii)	Roads/Railways	£		£138,920
(c)	**Benefit/cost ratio**					1.1
(d)	**Priority category**					2C

IMPROVEMENT WORKS

The proposed scheme includes re-sectioning the watercourse to provide a design capacity of 4.7 cumecs and allowing satisfactory freeboard for drainage under average flow conditions. The watercourse is divided into two channels through Aston Somerville, one arm being controlled by a weir used to maintain water levels in an adjacent pond. It is recommended that a culvert immediately upstream of the weir is underpinned and that the culvert on the other arm is replaced by a new box culvert. Two footbridges will also be replaced.

CONSERVATION

There is a small pool at Childswicken of some nature conservation interest.

IDENTIFICATION

Problem code number(s):	3-87-810-28 and 3-91-310-49
Watercourse:	Noleham Brook (main river)
Location:	Broad Marston to Welford-on-Avon (Wychavon and Stratford-on-Avon District Councils)
OS Map reference:	SP 142 458 to SP 118 515

NATURE OF PROBLEM

Localised annual flooding occurs to farmland from SP 142 458 to the River Avon confluence and affects one house in Broad Marston and the Welford to Barton road. In 1968 the 1 in 20 years flood event flooded nine houses in Broad Marston and all village roads. Following the 1968 floods an improvement scheme was carried out by the County Land Agent. 200 ha of agricultural land also suffers from inadequate arterial drainage.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in	years
	(ii)	Structures	1 in 75	years
(b) **Agricultural**	(i)	Channel	1 in 2	years
	(ii)	Structures	1 in	years
(c) **Land potential category**			a5	

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	
	(ii)	Field drainage	£	£_____
(b) **Present value of benefits**	(i)	Agriculture	£	
	(ii)	Buildings	£	
	(iii)	Roads/Railways	£	£_____

(c) **Benefit/cost ratio**

(d) **Priority category**

IMPROVEMENT WORKS

By 1973 the improved watercourse began to deteriorate and is severely restricted along its length downstream of Broad Marston with only the capacity of a mean annual flood in places. There are a number of bends that restrict the flow and earth slips have reduced the workway area in many places. It is proposed to carry out channel works from Broad Marston to the River Avon confluence including underpinning four road culverts and 14 farm access roads and footbridges to provide a channel design capacity of 10.6 cumecs at the Avon confluence whilst providing satisfactory freeboard for field drains under average flow conditions.

It is also proposed to construct an earth floodbank 1 m high and 1 km long to protect Broad Marston to a design standard of 21 cumecs.

A heavy maintenance scheme has been completed and the original proposal has been withdrawn from the capital programme due to the low benefits.

IDENTIFICATION

Problem code number(s):	3-87-810-30
Watercourse:	Gate Inn Brook (non-main river)
Location:	Church Honeybourne (Wychavon District Council)
OS Map reference:	SP 117 441

NATURE OF PROBLEM

A house, a public house and a class C road suffer from flooding twice a year for durations up to 10 hours. It is estimated that the maximum recorded flood has a 1 in 15 years recurrence interval. The main problem causing flooding is the culvert beneath the cross-roads.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in		years
	(ii)	Structures	1 in	50	years
(b) **Agricultural**	(i)	Channel	1 in		years
	(ii)	Structures	1 in		years
(c) **Land potential category**					

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£ 49,010	
	(ii)	Field drainage	£	£49,010
(b) **Present value of benefits**	(i)	Agriculture	£	
	(ii)	Buildings	£ 42,540	
	(iii)	Roads/Railways	£ negligible	£42,540
(c) **Benefit/cost ratio**				0.9
(d) **Priority category**				3E

IMPROVEMENT WORKS

The upstream end of the culvert is a 1 m high by 2.75 m wide box culvert but changes to a brick arch culvert 1 m high by 2.2 m wide and it is this length that can only discharge about the annual flood. The situation is aggravated by a bend in the culvert and two right angled bends, one upstream and one downstream of the culvert. The open channel is also choked by weeds and grass and road drainage is discharged freely at the downstream end of the culvert. It is therefore recommended to replace the culvert with a box culvert capable of containing a design discharge of 5.8 cumecs, construct some stone pitch revetment to the upstream side of the culvert and carry out light pioneering work on the open section of watercourse.

DEVELOPMENT

Housing development in Honeybourne in recent years has increased the flows in the watercourse but there are no proposals for more development other than infilling.

IDENTIFICATION

Problem code number(s):	3-87-810-34/35
Watercourse:	Carrant Brook (main river/non-main river)
Location:	Beckford to Tewkesbury (Wychavon District Council)
OS Map reference:	SO 974 355 to SO 895 334

NATURE OF PROBLEM

239 ha of agricultural land suffer from inadequate arterial drainage and farmland suffers from annual localised flooding for durations up to 12 hours. The road at Beckford flooded in 1968 and 1971.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in years
		(ii)	Structures	1 in years
(b)	**Agricultural**	(i)	Channel	1 in 2 years
		(ii)	Structures	1 in 25 years
(c)	**Land potential category**			a5

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	236,400	
		(ii)	Field drainage	£	120,100	£356,500
(b)	**Present value of benefits**	(i)	Agriculture	£	263,940	
		(ii)	Buildings	£		
		(iii)	Roads/Railways	£	negligible	£263,940
(c)	**Benefit/cost ratio**					0.7
(d)	**Priority category**					3C

IMPROVEMENT WORKS

Improvements on the Carrant Brook have taken place over the years. These improvements should be uprated and integrated into a comprehensive scheme.

It is recommended that the watercourse is re-sectioned to provide a design capacity of 12 cumecs allowing satisfactory freeboard for drainage under average flow conditions. Road culverts at Beckford and Aston-on-Carrant have been improved but may require further improvement. The railway culvert at SP 926 350 requires underpinning and four farm access bridges and five footbridges require replacing.

It is not proposed to improve the lower reaches of the brook (27 ha) as drainage conditions are affected by levels in the Avon.

STWA carried out a heavy maintenance scheme in 1985/86.

CONSERVATION

The Carrant Brook is relatively unspoilt and of good nature conservation value. It has a margin of pollarded willows and alders as well as deep meanders and high banks which should be protected.

IDENTIFICATION

Problem code number(s):	3-87-810-37
Watercourse:	None
Location:	White Ladies Aston (Wychavon District Council)
OS Map reference:	SO 922 525

NATURE OF PROBLEM

After heavy rain, minor flooding occurs at approximately six points on the village road system. This is caused by inadequate highway drainage, not helped by the poor gradients of the surrounding agricultural ditch drainage system.

In the area near Moat Farm (SO 924 518) flooding occurs in three places due to inadequate drainage of the unadopted unmade road system.

The general area could be affected by any future development to the south-east of Worcester.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£____
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£____
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IMPROVEMENT WORKS

This is a Highway Authority problem and is outside the scope of this Survey.

DEVELOPMENT

The area could be adversely affected by any future development to the south-east of Worcester.

IDENTIFICATION

Problem code number(s):	3-87-810-38
Watercourse:	Seeley Brook (non-main river)
Location:	Hanbury (Wychavon District Council)
OS Map reference:	SO 967 605 to SO 985 645

NATURE OF PROBLEM

Inadequate oufall conditions affecting 90 ha exist on the watercourse and localised flooding to agricultural land occurs for up to twelve hours on average once a year.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in	years
	(ii)	Structures	1 in	years
(b) **Agricultural**	(i)	Channel	1 in	2 years
	(ii)	Structures	1 in	25 years
(c) **Land potential category**				a

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	172,970	
	(ii)	Field drainage	£	30,030	£203,000
(b) **Present value of benefits**	(i)	Agriculture	£	80,570	
	(ii)	Buildings	£	nil	
	(iii)	Roads/Railways	£	nil	£80,570
(c) **Benefit/cost ratio**					0.4
(d) **Priority category**					3C

IMPROVEMENT WORKS

It is suggested that approximately 6.3 km of watercourse are re-sectioned to provide a channel design capacity of about 4 cumecs and allowing sufficient depth for land drains to be installed where necessary.

CONSERVATION

As a tributary of the Bow Brook these banks are important for wildlife and need to be given consideration.

IDENTIFICATION

Problem code number(s):	3-87-810-39
Watercourse:	Badsey Brook (non-main river)
Location:	Childswickham (Wychavon District Council)
OS Map reference:	SP 071 388 to SP 074 386

NATURE OF PROBLEM

Two detached houses flood on average every five years and in 1968 (in 15 years event) they flooded to a depth of 1.4 m for 10 hours.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in 10 years
		(ii)	Structures	1 in 50 years
(b)	**Agricultural**	(i)	Channel	1 in years
		(ii)	Structures	1 in years
(c)	**Land potential category**			

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	51,890	
		(ii)	Field drainage	£		£51,890
(b)	**Present value of benefits**	(i)	Agriculture	£		
		(ii)	Buildings	£	60,050	
		(iii)	Roads/Railways	£		£60,050
(c)	**Benefit/cost ratio**					1.2
(d)	**Priority category**					20

IMPROVEMENT WORKS

It is recommended that the two existing culverts be replaced with larger box culverts and the existing watercourse (currently with vertical sides and patches of concrete revetment) resectioned. However, the gravel channel sides are falling in and will need to be sloped back to keep the channel in good condition. The culvert improvements will provide a design standard of 11 cumecs (1 in 50 years).

DEVELOPMENT

In recent years there has been some housing development in the village. The watercourse has been cleared out to avoid aggravating the flooding. No further development is proposed.

IDENTIFICATION

Problem code number(s):	3-87-810-40
Watercourse:	River Avon (main river)
Location:	Evesham (Wychavon District Council)
OS Map reference:	SP 040 435

NATURE OF PROBLEM

The 1 in 5 years flood event affects the A44 road for up to 48 hours. The 1 in 20 years event as experienced in 1968 affects 25 commercial properties and houses and causes serious traffic disruption to through traffic, diversions adding some 10 miles to a journey in some cases. A 1 in 100 years event would affect a further 10 properties.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in	years
	(ii)	Structures	1 in 100	years
(b) **Agricultural**	(i)	Channel	1 in	years
	(ii)	Structures	1 in	years
(c) **Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	98,020	
	(ii)	Field drainage	£		£98,020
(b) **Present value of benefits**	(i)	Agriculture	£		
	(ii)	Buildings	£	62,550	
	(iii)	Roads/Railways	£	22,520	£85,070
(c) **Benefit/cost ratio**					0.8
(d) **Priority category**					3D

IMPROVEMENT WORKS

A full investigation of the problem at Evesham is not in the scope of this Survey though it is suggested that a flood bank is constructed adjacent to the road allowing the maximum area of flood plain to remain on the open parkland adjacent to the river. This scheme will contain a design discharge of at least 40 cumecs. In conjunction with the construction of a flood bank a drainage scheme, including a pumping station, will be required to protect the area behind the floodbank from surcharged surface water sewers.

FISHERIES

Jubilee Meadows, Evesham, is extremely important as an angling venue. A floodbank constructed on the left bank would be unlikely to affect fishing. However, if material for construction of the bank was taken from the river bed, this would obviously affect the important contest fisheries downstream towards Hampton Ferry due to excessive silt loads.

IDENTIFICATION

Problem code number(s):	3-87-810-41
Watercourse:	Un-named tributary of Badsey Brook (non-main river)
Location:	Aston Somerville (Wychavon District Council)
OS Map reference:	SP 050 384 to SP 056 393

NATURE OF PROBLEM

The arterial drainage of 46 ha of agricultural land is inadequate.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in	years
	(ii)	Structures	1 in	years
(b) **Agricultural**	(i)	Channel	1 in 5	years
	(ii)	Structures	1 in 50	years
(c) **Land potential category**			a5	

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	31,710	
	(ii)	Field drainage	£	15,010	£46,720
(b) **Present value of benefits**	(i)	Agriculture	£	72,240	
	(ii)	Buildings	£		
	(iii)	Roads/Railways	£		£72,240
(c) **Benefit/cost ratio**					1.5
(d) **Priority category**					2E

IMPROVEMENT WORKS

It is not feasible to underpin the road culvert at SP 057 393 (1 m high by 1.5 m wide by 30 m long) and the cost of replacing the culvert would be prohibitively expensive. The benefit area has therefore been reduced to 29 ha. It is therefore proposed to re-section the existing watercourse for 1.3 km downstream to this culvert to provide a design capacity of 0.6 cumecs, but the maximum channel capacity allows satisfactory freeboard under average flow conditions. 50 m of watercourse downstream of the culvert will require maintenance in the form of bush and tree cutting.

IDENTIFICATION

Problem code number(s):	3-87-810-43
Watercourse:	Battleton Brook and Merry Brook (non-main river)
Location:	Evesham and Hinton-on-the-Green (Wychavon District Council)
OS Map reference:	SP 038 402 to SP 043 428

NATURE OF PROBLEM

65 ha of Battleton Brook and 14 ha of Merry Brook suffer from inadequate arterial drainage. The A44 road floods every year for short periods but is not impassable.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in	years
	(ii)	Structures	1 in	years
(b) **Agricultural**	(i)	Channel	1 in 5	years
	(ii)	Structures	1 in 50	years
(c) **Land potential category**			a5	

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£ 89,370		
	(ii)	Field drainage	£ 37,530	£126,900	
(b) **Present value of benefits**	(i)	Agriculture	£ 197,260		
	(ii)	Buildings	£		
	(iii)	Roads/Railways	£ negligible	£197,260	
(c) **Benefit/cost ratio**				1.6	
(d) **Priority category**				2D	

DEVELOPMENT

Downstream lengths of the watercourse were improved in 1978 in connection with housing and industrial development in the Four Pools Farm area of Evesham.

IMPROVEMENT WORKS

The solution recommended is to re-section Battleton Brook for 2.5 km upstream of Four Pools Farm and Merry Brook for 500 m upstream of SP 049 427. The criteria will be to increase the depth of the watercourse to allow free outfalls for land drainage in average flow conditions providing a design capacity of 1.2 cumecs.

The two culverts beneath the A44 are adequate to carry the design discharge and the road flooding is attributable to an inadequate culvert on a private road 5 m upstream of the A44. The existing culvert (300 mm diameter) requires an additional 825 mm diameter pipe to carry the design discharge.

IDENTIFICATION

Problem code number(s):	3-87-810-45
Watercourse:	Crowle Brook (non-main river)
Location:	Tibberton (Wychavon District Council)
OS Map reference:	SO 918 589 to SO 936 550

NATURE OF PROBLEM

The inadequate capacity of the brook causes poor drainage. This has been partly rectified as the County Land Agent has promoted two improvement schemes, between SO 914 553 and SO 916 565 and on the section above. A further scheme to cover the section below down to the confluence with the Bow Brook has been prepared, and awaits agreement with the riparian owners.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in	years
	(ii)	Structures	1 in	years
(b) **Agricultural**	(i)	Channel	1 in	years
	(ii)	Structures	1 in	years

(c) **Land potential category**

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	
	(ii)	Field drainage	£	£_____
(b) **Present value of benefits**	(i)	Agriculture	£	
	(ii)	Buildings	£	
	(iii)	Roads/Railways	£	£_____

(c) **Benefit/cost ratio**

(d) **Priority category**

IDENTIFICATION

Problem code number(s):	3-87-810-51
Watercourse:	Littleton Brook (main river)
Location:	South Littleton (Wychavon District Council)
OS Map reference:	SP 079 461 and SP 079 464

NATURE OF PROBLEM

Flooding occurs to land on north side of Farm Lane adjoining developments at Manor Farm. Flooding also affects allotments on south side of Blacksmiths Lane.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£_____
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£_____
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IMPROVEMENT WORKS

The problem is due to overgrown channel. The Brook undergoes maintenance every 1-2 years. A greater frequency of maintenance would reduce flooding. Alternatively another method of weed control could give maintenance a longer lasting effect.

IDENTIFICATION

Problem code number(s):	3-87-810-52
Watercourse:	Tributary of Piddle Brook (non-main river)
Location:	Kington (Wychavon District Council)
OS Map reference:	SO 980 560

NATURE OF PROBLEM

Inadaequate channel. 2 semi-detached bungalows flooded 0.15 m deep, 4 times in 5 years, for approximately 6 hours.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	1,270	
		(ii)	Field drainage	£		£1,270
(b)	**Present value of benefits**	(i)	Agriculture	£		
		(ii)	Buildings	£	93,630	
		(iii)	Roads/Railways	£		£93,630
(c)	**Benefit/cost ratio**					73.7
(d)	**Priority category**					1F

IMPROVEMENT WORKS

Divert ditch immediately behind properties into one, a few metres away. 100 m of new channel (2 m^2 total channel area).

COMMENT

Some minor remedial works have been carried out by landowners.

IDENTIFICATION

Problem code number(s):	3-87-810-54
Watercourse:	Un-named tributary of Piddle Brook
Location:	Astwood Bank (Wychavon District Council)
OS Map reference:	SP 038 600

NATURE OF PROBLEM

The B4092 floods annually for up to two hours due to an inadequate highway culvert.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	140
		(ii)	Field drainage	£	£140
					(for pioneering work only)
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IMPROVEMENT WORKS

About 20m of medium pioneering work is required to remove trees and debris. However, this is principally a Highway Authority problem and the construction of an additional 600mm diameter pipe in parallel with the existing culvert is needed to alleviate flooding.

IDENTIFICATION

Problem code number(s):	3-88-510-1
Watercourse:	River Isbourne (non-main river)
Location:	Toddington (Tewkesbury Borough Council)
OS Map reference:	SP 034 326 to SP 032 339

NATURE OF PROBLEM

Two houses flooded in 1968 and again in 1972 for up to 12 hours. In addition there is localised flooding to parkland and agricultural land and the arterial drainage of 24 ha of agricultural land is inadequate.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in 100 years
	(ii)	Structures	1 in years
(b) **Agricultural**	(i)	Channel	1 in 2 years
	(ii)	Structures	1 in years
(c) **Land potential category**			a

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	72,070	
	(ii)	Field drainage	£	20,020	£92,090
(b) **Present value of benefits**	(i)	Agriculture	£	47,230	
	(ii)	Buildings	£	7,510	
	(iii)	Roads/Railways	£		£54,740
(c) **Benefit/cost ratio**					0.6
(d) **Priority category**					3D

IMPROVEMENT WORKS

A lake was built on Toddington Estate at the beginning of this century by constructing two weirs across the River Isbourne. A by-pass tunnel/channel was constructed to the rest of the lake to prevent flood flows passing through the lake. A control structure downstream of the A438 road bridge existed to allow part of the flow to pass through the lake whilst allowing most of the water to pass down the by-pass. Lack of use and maintenance has resulted in the breaching of the main control structure and filling in with debris the by-pass channel. Virtually all flows now pass down the main branch of the Isbourne and the by-pass is incapable of carrying any flows with the result that:

(i) field and farm drainage to the by-pass have either submerged outfalls or no outfalls at all exist;

(ii) the incidence of flooding in the Isbourne valley has increased.

The tunnel section of the by-pass (3 m diameter) is sound, and it is suggested that new open channel sections are cut to link up with the existing tunnel sections to provide a combined channel design discharge of 24 cumecs. A farm access culvert has been constructed across the start of the by-pass and will require replacing with a larger capacity culvert or bridge. A new weir control structure will also be necessary across the river at the start of the by-pass.

BENEFITS

Following drainage the benefit area will probably remain as parkland with improvement limited to grazing store animals. However, a chicken battery farm is located close to the by-pass and although not flooded in the past a high frequency flood could cause several thousand pounds worth of damage.

IDENTIFICATION

Problem code number(s):	3-88-510-4
Watercourse:	Tributary of Carrant Brook (non-main river)
Location:	Duglynch Lane, Gretton (Tewkesbury Borough Council)
OS Map reference:	SP 008 302

NATURE OF PROBLEM

An inadequate/collapsed culvert results in 2 houses flooding to a depth of up to 0.3 m 1-2 times a year for approximately 2 hours. Duglynch Lane has flooded for up to 2 hours and became impassable.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	55,880	
		(ii)	Field drainage	£		£55,880
(b)	**Present value of benefits**	(i)	Agriculture	£		
		(ii)	Buildings	£	168,860	
		(iii)	Roads/Railways	£		£168,860
(c)	**Benefit/cost ratio**					3.0
(d)	**Priority category**					10

IMPROVEMENT WORKS

The culvert at the Mill requires replacing with 750 mm diameter pipes. The culvert at the Buggatti PH also requires replacing with 900 mm diameter pipes.

IDENTIFICATION

Problem code number(s):	3-88-610-2/3/4
Watercourse:	River Cam (non-main river)
Location:	Chipping Campden (Cotswold District Council)
OS Map reference:	SP 145 388 to SP 150 389

NATURE OF PROBLEM

In July 1968 eight houses, two shops, a warehouse and blacksmiths together with class 'B' and 'C' roads were flooded for durations up to 12 hours. The flood is estimated to have a 1 in 15 years recurrence interval. The flooding was due to the blockage of a tunnel section of watercourse through the centre of the village and a subsequent build up of water causing a collapsed wall. At the same time water flowed out of bank upstream of SP 145 388 and into the main street.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in	50	years
	(ii)	Structures	1 in	50	years
(b) **Agricultural**	(i)	Channel	1 in		years
	(ii)	Structures	1 in		years
(c) **Land potential category**					

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	31,710	
	(ii)	Field drainage	£		£37,710
(b) **Present value of benefits**	(i)	Agriculture	£		
	(ii)	Buildings	£	27,520	
	(iii)	Roads/Railways	£		£27,520
(c) **Benefit/cost ratio**					0.9
(d) **Priority category**					3E

IMPROVEMENT WORKS

Since the flood in 1968 the District Council have cleaned out the channel and constructed a grid to the upstream end of the tunnel.

The mill house (SP 153 392) has now been converted into a private house and the mill channel diverted so that all the water now passes down the main channel with an overflow pipe available for storm conditions. A flood wall built by the owner around the house would not contain a flood of the 1968 magnitude. A 2 m high fence across the river at this point erected to demark the property boundary will reduce the capacity of the watercourse in flood conditions.

It is suggested that the two inadequate culverts (SP 145 388 and SP 150 389) are replaced with new box culverts to provide a design capacity of 5.9 cumecs (using Packman methods). The cost of these culverts includes the diversion of public utilities. Some works have been carried out, but the degree of alleviation has not yet been assessed.

IDENTIFICATION

Problem code number(s):	3-90-110-1/8
Watercourse:	River Avon and Clay Coton Brook (main river)
Location:	Lilbourne to Clay Coton (Daventry District Council)
OS Map reference:	SP 560 775 to SP 592 770

NATURE OF PROBLEM

The drainage of 345 ha of agricultural land is inadequate and a 'C' class road at Lilbourne suffers from annual localised flooding for up to 10 hours.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	5 years
		(ii)	Structures	1 in	25 years
(c)	**Land potential category**				b

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£_____
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£_____
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IMPROVEMENT WORKS

The suggested solution is to straighten out the meandering section of the watercourse with new cuts (80 per cent of Clay Coton Brook and 50 per cent of the River Avon) and re-section the remaining lengths. Three bridges will have to be underpinned and three tributaries of the Avon will require re-sectioning to drain the area adequately. These improvements will provide a maximum design discharge of 10.5 cumecs on the Clay Coton Brook and 28.3 cumecs on the River Avon. The Clay Coton Brook discharge includes the discharge from two side weir overflows on the Grand Union Canal, both rated at 0.9 cumecs, and the River Avon discharge includes the surface water run-off from the M6/M1 contributing at SP 564 778.

The Upper Avon Improvement Scheme Feasibility Study was completed in 1981 but it was found that farmers generally did not wish to change from pasture to more profitable arable farming. STWA have carried out a heavy maintenance scheme on the Clay Coton Brook.

Improvement works are unlikely to proceed due to a re-assessment of priorities.

DEVELOPMENT

The A1/M1 link road will probably cross the catchments of both watercourses. The surface water run-off from this road will have to be considered in any proposed watercourse improvement scheme.

CONSERVATION

This section of watercourse has important marsh habitats.

FISHERIES

The Coton Brook is of no importance as a fishery, but the Avon itself is fished by Rugby Federation. During the summer heavy weedgrowth prevents the fishery being used, and any improvements would probably be welcomed by angling interest.

IDENTIFICATION

Problem code number(s):	3-90-110-2
Watercourse:	None
Location:	Stanford Reservoir (South Kilworth) (Daventry District Council)
OS Map reference:	SP 613 810

NATURE OF PROBLEM

The road floods annually. This problem is due to an inadequate highway culvert and highway ditches. This is a Highway Authority problem and the solution falls outside the scope of this Survey.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IDENTIFICATION

Problem code number(s):	3-90-110-3/4
Watercourse:	Un-named tributary of Clay Coton Brook (non-main river)
Location:	Yelvertoft (Daventry District Council)
OS Map reference:	SP 597 756 to SP 599 758

NATURE OF PROBLEM

Five houses, roads and gardens flooded in 1968 and to a lesser extent in 1971 for periods up to seven hours. The 1968 event is estimated to have a recurrence interval of 1 in 25 years. The flooding was caused by an inadequate culvert that is in a state of collapse.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in 50 years
		(ii)	Structures	1 in 50 years
(b)	**Agricultural**	(i)	Channel	1 in years
		(ii)	Structures	1 in years
(c)	**Land potential category**			

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	115,320	
		(ii)	Field drainage	£		£115,320
(b)	**Present value of benefits**	(i)	Agriculture	£		
		(ii)	Buildings	£	5,000	
		(iii)	Roads/Railways	£		£5,000
(c)	**Benefit/cost ratio**					0
(d)	**Priority category**					3C

DEVELOPMENT

In 1970 a planning application for 12 houses was refused but subsequently allowed at appeal with a reduction in the number of houses. The former Severn River Authority's requirements were that the tipping of material should be avoided within 50 feet of Clay Coton Brook and that the existing brick culvert across the site should be replaced by a 48" diameter pipe laid to a new line. In 1977 application for the development of 19 houses was refused but an appeal was upheld and the number of houses reduced to 11. STWA requirements were the same as the SRA.

IMPROVEMENT WORKS

Following the 1968 floods the District Council proposed to replace the culvert along Swinnertons Lane with a box culvert or 48" diameter pipe, to the same standard as that proposed for the downstream development area. This would provide a design standard of 2.2 cumecs.

The proposed development and consequent improvements to the downstream section of the watercourse have not yet taken place, and the District Council proposals for improving the upstream length are static within the District Council's capital programme because contributions from MAFF, or the County Council, have not been forthcoming.

IDENTIFICATION

Problem code number(s):	3-90-110-5
Watercourse:	Winwick Brook (non-main river)
Location:	Winwick (Daventry District Council)
OS Map reference:	SP 626 738

NATURE OF PROBLEM

A cottage floods annually for up to 10 hours, together with class 'C' roads in the village.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in 10 years
	(ii)	Structures	1 in 50 years
(b) **Agricultural**	(i)	Channel	1 in years
	(ii)	Structures	1 in years
(c) **Land potential category**			

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	8,650	
	(ii)	Field drainage	£		£8,650
(b) **Present value of benefits**	(i)	Agriculture	£		
	(ii)	Buildings	£	5,000	
	(iii)	Roads/Railways	£	negligible	£5,000
(c) **Benefit/cost ratio**					0.6
(d) **Priority category**					3F

IMPROVEMENT WORKS

Re-sectioning of approximately 600m of watercourse through the village is required to relieve flooding to provide a design standard of 2 cumecs. A culvert in the village centre is theoretically capable of conveying a 1 in 50 years discharge.

BENEFIT

Benefits are based on the cottage flooding only as there are other exits available from the village.

IDENTIFICATION

Problem code number(s):	3-90-110-10 and 3-91-210-13
Watercourse:	Onley Fields, Tributary of Rainsbrook (non-main river)
Location:	Barby (Rugby Borough Council and Daventry District Council)
OS Map reference:	SP 522 694 to SP 532 695

NATURE OF PROBLEM

The arterial drainage of 20 ha of agricultural land is inadequate and upstream of the Oxford Canal suffers from localised flooding for durations up to 12 hours. Flooding is attributable to the inadequate capacity of the watercourse and old brick arch culvert beneath the canal.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in	years
	(ii)	Structures	1 in	years
(b) **Agricultural**	(i)	Channel	1 in	5 years
	(ii)	Structures	1 in	25 years
(c) **Land potential category**				b

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	
	(ii)	Field drainage	£	£
(b) **Present value of benefits**	(i)	Agriculture	£	
	(ii)	Buildings	£	
	(iii)	Roads/Railways	£	£
(c) **Benefit/cost ratio**				
(d) **Priority category**				

IMPROVEMENT WORKS

It is suggested that a new culvert is constructed beneath the Oxford Canal and the watercourse upstream is re-sectioned for 1.2 km to provide a design discharge of 1.9 cumecs, allowing satisfactory freeboard for field drains under average flow conditions. The watercourse downstream of this culvert has recently been improved and no further work is required.

CONSERVATION

The canal in this area is rich in flora and fauna.

IDENTIFICATION

Problem code number(s):	3-91-110-2
Watercourse:	Breach Brook (non-main river)
Location:	Keresley (Nuneaton & Bedworth Borough Council)
OS Map reference:	SP 321 859 to SP 342 850

NATURE OF PROBLEM

Road flooding occurs annually at Exhall for up to two hours. 52 ha of agricultural land suffer from inadequate arterial drainage.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in years
		(ii)	Structures	1 in years
(b)	**Agricultural**	(i)	Channel	1 in 5 years
		(ii)	Structures	1 in 50 years
(c)	**Land potential category**			b

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IMPROVEMENT WORKS

It is proposed to re-section the watercourse from SP 321 859 to the confluence of the River Sowe to enable drains to have satisfactory outfall under average flow conditions allowing a channel design discharge of 3.4 cumecs. Three road bridges will need underpinning.

The existing watercourse is theoretically capable of containing a 1 in 10 years discharge and the existing culverts up to a 1 in 25 years discharge. However these run-off figures do not include the surface water run-off from the M6 motorway and Corley service area which add considerably to the flow in the watercourse.

Regrading work to the Breach Brook was carried out by this Council with NCB finance, in 1979. The work terminated at Royal Oak Lane on the downstream side and has apparently cured the flooding of agricultural land.

Culvert lowering and cleaning carried out in 1988 near Exhall Church has eased a local problem there but the road lay-by still floods.

MINING SUBSIDENCE

Mining subsidence is thought to be part of the reason for road flooding.

IDENTIFICATION

Problem code number(s):	3-91-110-3
Watercourse:	Un-named (non-main river)
Location:	Hawkesbury Colliery Farm (Nuneaton & Bedworth Borough Council)
OS Map reference:	SP 363 852

NATURE OF PROBLEM

Agricultural land and property are affected by an inadequate outfall under the canal, complicated by canal weir discharge.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£_____
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£_____
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IMPROVEMENT WORKS

Problem may be resolved as part of development of the site for a golf course and residential area.

IDENTIFICATION

Problem code number(s):	3-91-110-4
Watercourse:	Un-named (non-main river)
Location:	Astley Lane (Nuneaton & Bedworth Borough Council)
OS Map reference:	SP 331 871

NATURE OF PROBLEM

A class 'C' road is flooded approximately twice a year. This is probably due to mining subsidence affecting a culvert under the road.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£_____
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£_____
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IMPROVEMENT WORKS

IDENTIFICATION

Problem code number(s):	8-91-110-3/4
Watercourse:	Wem Brook (non-main river)
Location:	Bulkington (Nuneaton & Bedworth Borough Council)
OS Map reference:	SP 368 882 to SP 388 858

NATURE OF PROBLEM

Flooding occurs to a class 'C' road and inadequate drainage of agricultural land affects 175 ha. The Warwickshire County Council planned an improvement scheme involving channel improvements and improvement to various bridges and culverts, particularly the culverts under the Ashby-de-la-Zouch Canal and Bedworth Road.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in	years
	(ii)	Structures	1 in	years
(b) **Agricultural**	(i)	Channel	1 in	10 years
	(ii)	Structures	1 in	25 years
(c) **Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	196,040	
	(ii)	Field drainage	£	47,540	£243,580
(b) **Present value of benefits**	(i)	Agriculture	£	344,510	
	(ii)	Buildings	£	22,520	
	(iii)	Roads/Railways	£		£367,030
(c) **Benefit/cost ratio**					1.5
(d) **Priority category**					2C

IMPROVEMENT WORKS

An improvement scheme was carried out by the Borough Council adjacent to Bedworth Water Reclamation Works in 1982. These works were sponsored from sewerage funds and provide localised land drainage improvements. The Warwickshire County Land Agent scheme was not proceeded with, due to lack of agreement from riparian owners.

The culvert under Coventry Road (SP 384 859) was cleaned out in 1988 and the flooding problem in this vicinity apparently resolved.

IDENTIFICATION

Problem code number(s):	8-91-110-5
Watercourse:	Whittleford Brook (non-main river)
Location:	Galley Common (Nuneaton & Bedworth Borough Council)
OS Map reference:	SP 315 919

NATURE OF PROBLEM

Flooding occurred in July 1968 and June 1979 to a detached house and class 'C' road (not impassable). Flooding has occurred on a number of occasions at the culvert under Bucks Hill due to debris accumulation.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in years
		(ii)	Structures	1 in 25 years
(b)	**Agricultural**	(i)	Channel	1 in years
		(ii)	Structures	1 in years
(c)	**Land potential category**			

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	37,480	
		(ii)	Field drainage	£		£37,480
(b)	**Present value of benefits**	(i)	Agriculture	£		
		(ii)	Buildings	£	6,260	
		(iii)	Roads/Railways	£		£6,260
(c)	**Benefit/cost ratio**					0.2
(d)	**Priority category**					3E

IMPROVEMENT WORKS

The proposed remedial works include an additional culvert under the Hickman Road/Tunnel Road junction together with regrading works downstream from this point to approximately 500 m downstream of Park Lane. Some maintenance work will also be required under Park Lane.

Nuneaton & Bedworth Borough Council have carried out minor works to lessen the possibility of debris causing blockages.

Since the flooding of 2 properties in 1981 major improvements to the Whittleford Brook downstream of Hickman Road/Tunnel Road culvert have been undertaken. This work has improved the general situation considerably, however, the culvert (part Highway Authority and part private) can only pass the 1 or 2 year event and subsequent flooding of residential property has occurred.

BENEFITS

As the road is not impassable to vehicles the benefits from the alleviation of flooding are small and have not been assessed.

IDENTIFICATION

Problem code number(s):	8-91-110-7
Watercourse:	Tributary of Harrow Brook (non-main river)
Location:	Long Shoot, Nuneaton (Nuneaton & Bedworth Borough Council)
OS Map reference:	SP 390 928

NATURE OF PROBLEM

A number of houses on the Long Shoot are affected. Flooding of gardens to 140-160 Long Shoot and water to threshold level at 148 occurred on 31 December 1981.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£_____
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£_____
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IMPROVEMENT WORKS

The problem is due to:

(a) properties being low relative to road and adjacent fields
(b) ditch behind the houses being badly maintained and inadequately piped in parts
(c) very shallow surface water sewerage system.

The outfall of the system was improved as a result of works carried out to Harrow Brook by Hinckley and Bosworth Borough Council. Some of the householders are now attending to the ditch, but the problem remains. Nuneaton & Bedworth Borough Council have no proposals for remedial work.

IDENTIFICATION

Problem code number(s):	8-91-110-8
Watercourse:	Tributary of River Anker from Bulkington (non-main river)
Location:	Burton Hastings (Nuneaton & Bedworth Borough Council)
OS Map reference:	SP 398 889 to SP 398 879

NATURE OF PROBLEM

Farmland adjacent to the watercourse is subject to flooding.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£_____
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£_____
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IDENTIFICATION

Problem code number(s):	8-91-110-9
Watercourse:	Bar Pool Brook (non-main river)
Location:	Nuneaton (Nuneaton & Bedworth Borough Council)
OS Map reference:	SP 342 922

NATURE OF PROBLEM

In 1983, a 1 in 3/4 year flood made Queen Elizabeth Road impassable to traffic and inundated several gardens. The problem was caused by the blockage of an inadequate culvert which outfalls to the Coventry Canal.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£_____
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£_____
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IMPROVEMENT WORKS

The cost of the remedial scheme would be very high (far in excess of the value of the property affected). Therefore, no scheme is programmed, although ameliorative works will be undertaken as and when development in the catchment takes place.

CONSERVATION

The Barpool Valley and adjacent Bucks Hill clay pit are important wildlife areas especially for willow scrub and wetland areas - where many warblers occur. Any proposed maintenance should not be allowed to interfere or disrupt the ecology of this area.

IDENTIFICATION

Problem code number(s):	8-91-110-10
Watercourse:	Un-named (non-main river)
Location:	Bulkington (Nuneaton & Bedworth Borough Council)
OS Map reference:	SP 438 288

NATURE OF PROBLEM

Deficiencies in a piped-in ditch or watercourse discharging into Ashby Canal causes flooding in gardens etc.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in	years
	(ii)	Structures	1 in	years
(b) **Agricultural**	(i)	Channel	1 in	years
	(ii)	Structures	1 in	years
(c) **Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	
	(ii)	Field drainage	£	£_____
(b) **Present value of benefits**	(i)	Agriculture	£	
	(ii)	Buildings	£	
	(iii)	Roads/Railways	£	£_____
(c) **Benefit/cost ratio**				
(d) **Priority category**				

IDENTIFICATION

Problem code number(s):	3-91-210-1/2/9/31
Watercourse:	Sow Brook (non-main river)
Location:	Rugby (Rugby Borough Council)
OS Map reference:	SP 492 737 to SP 486 760

NATURE OF PROBLEM

A steel stockholding warehouse floods on average once very five years and four houses flood on average once every two years for durations up to four hours. Close to the confluence with the River Avon an inadequate culvert causes flooding to farmland. The maximum recorded flood has a recurrence interval of 1 in 25 years.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	10	years
		(ii)	Structures	1 in	50	years
(b)	**Agricultural**	(i)	Channel	1 in		years
		(ii)	Structures	1 in		years
(c)	**Land potential category**					

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	118,200	
		(ii)	Field drainage	£		£118,200
(b)	**Present value of benefits**	(i)	Agriculture	£		
		(ii)	Buildings	£	34,660	
		(iii)	Roads/Railways	£		£34,660
(c)	**Benefit/cost ratio**					0.3
(d)	**Priority category**					3C

DEVELOPMENT

Considerable development has taken place within the Sow Brook catchment, and evidence of the impact of this development can be seen by the many culverts which have a second, and in one case a third, barrel added parallel to the original, and many of these culverts are prone to blockage especially from urban debris.

It is therefore suggested that a comprehensive scheme is required on the Sow Brook to the confluence of the Avon.

Developers have been asked to contribute towards improvements in the downstream section which provides the least level of protection.

IMPROVEMENT WORKS

The proposed works involve re-sectioning 2.5 km of watercourse from SP 493 737 to SP 485 756, re-sectioning the channel beneath the railway culvert, constructing an additional box culvert at SP 488 745 (included in Rugby Borough Council's 1978/79 programme) and constructing a parallel 1050 mm diameter pipe for 110 m downstream of the railway line. In addition two footbridges need underpinning, a farm access culvert 100 m from the confluence of the River Avon needs replacing, and two new box culverts will be required inside the Rugby Portland Cement Works.

Rugby Borough Council has re-sectioned and regraded the watercourse from Lawford Road to the Rugby-Leamington railway line and carried out some bank stabilisation. The box culvert adjacent to Macready Metals has been cleaned out and the open channel under the railway bridge has been replaced with a box culvert of greater capacity. These works have improved the situation but have not removed the problem.

At problem location 3-91-210-1 the screens on the upstream side of the culvert beneath Addison Road were removed in 1988 and flooding has been virtually eliminated. Debris on the screens caused backing up and flooding of land between Addison Road and Bilton Road and also caused flooding at problem location 3-91-210-2. Regular maintenance of the screens at this latter location has reduced the incidence of flooding but it still occurs during exceptional rainfall. The flooding is invariably due to an accumulation of debris which has been washed down the watercourse during the storm rather than the culvert beneath Bilson Road being overloaded.

IDENTIFICATION

Problem code number(s):	3-91-210-3/17/24/29
Watercourse:	Rainsbrook (non-main river)
Location:	Dunchurch (Rugby Borough Council)
OS Map reference:	SP 492 692 to SP 538 728

NATURE OF PROBLEM

The arterial drainage of 200 ha of agricultural land is inadequate and suffers from annual localised flooding for up to 12 hours. In addition to inadequate outfalls, the A45 at SP 491 701 and a 'C' class road at SP 520 720 are subject to flooding several times a year. Rainsbrook has recently been improved for 500 m upstream of the Leam confluence.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in years
		(ii)	Structures	1 in years
(b)	**Agricultural**	(i)	Channel	1 in 5 years
		(ii)	Structures	1 in years
(c)	**Land potential category**			b

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£ 464,150	
		(ii)	Field drainage	£ 50,040	£514,190
(b)	**Present value of benefits**	(i)	Agriculture	£ 900,170	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£ negligible	£900,170
(c)	**Benefit/cost ratio**				1.8
(d)	**Priority category**				2C

IMPROVEMENT WORKS

Proposals consist of re-sectioning the channel and straightening 50 per cent of Rainsbrook upstream of the M45 to provide a channel design standard of 6 cumecs allowing satisfactory freeboard for field drains under average flow conditions. Several bridges along the watercourse will require either underpinning or replacing and the brick culvert beneath the disused railway at SP 518 718 will require re-lining. No improvements are proposed by Rugby Borough Council.

DEVELOPMENT

In 1977 a housing development site of 80 ha at Hillmorton on the north bank of Rainsbrook was refused. However, since then the County Structure Plan for Rugby has been published and confirms that the area is not designated for residential use. However there is a possibility that 4 ha, allocated as residential use in the former Town Review Map, may be developed in the future necessitating improvements to Rainsbrook.

BENEFITS

An increase in gross margin is expected following drainage improvements. Benefits to road flooding are negligible as the roads are never impassible.

CONSERVATION

The benefit area is adjacent to a private nature reserve.

IDENTIFICATION

Problem code number(s):	3-91-210-8
Watercourse:	River Avon (main river)
Location:	Brandon and Wolston (Rugby Borough Council)
OS Map reference:	SP 410 759

NATURE OF PROBLEM

Between Warwick and Rugby the River Avon has many structures associated with farm mill sites. Most have bifurcation channels still in use and many cause land drainage problems due to impounded water levels or require repair work to the weirs, etc for example at Wolston Fields, SP 403 757. The 1 in 5 years flood event affects farm buildings and agricultural machinery; a class 'C' road is impassable annually. The 1 in 20 years 1968 event affected six houses adjacent to the river mainly due to surface water drains being unable to discharge when the river level was high, and a cycle component factory was also affected, flooding a canteen and store buildings. In addition 12 ha of agricultural land upstream of the mill site floods annually and suffers from inadequate arterial drainage.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in years
	(ii)	Structures	1 in years
(b) **Agricultural**	(i)	Channel	1 in 5 years
	(ii)	Structures	1 in 20 years
(c) **Land potential category**			b

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	155,680	
	(ii)	Field drainage	£	7,510	£163,190
(b) **Present value of benefits**	(i)	Agriculture	£	61,120	
	(ii)	Buildings	£	57,550	
	(iii)	Roads/Railways	£	negligible	£118,670
(c) **Benefit/cost ratio**					0.7
(d) **Priority category**					3C

IMPROVEMENT WORKS

Proposals have been put forward by the riparian owner to reinstate the weir at Wolston Fields Mill and use the bifurcation channel as an amenity lake. It is suggested that along with these works the main channel capacity should be enlarged to provide a design flow discharge of 45 cumecs. Although no direct protection can be afforded to the houses and factory from backing up in the drainage system the increased channel capacity should substantially reduce the frequency of flooding to these properties as well as the farm buildings and road.

FISHERIES

This section is one of the best and most fished sections in the upper Avon. Chub and Dace predominate with some Roach. The important clubs are the Plough AC and Coventry and District AA. The fullest consultations with angling interest would be essential.

IDENTIFICATION

Problem code number(s):	3-91-210-11
Watercourse:	Clifton Brook (non-main river)
Location:	Hillmorton (Rugby Borough Council)
OS Map reference:	SP 530 748 to SP 537 748

NATURE OF PROBLEM

Localised annual flooding for periods up to 18 hours and inadequate land drainage affects 14 ha of agricultural land. The poor drainage is due to several springs in the area creating a high water table and a road culvert at SP 530 748 being set too high.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in	years
	(ii)	Structures	1 in	years
(b) **Agricultural**	(i)	Channel	1 in	5 years
	(ii)	Structures	1 in	25 years
(c) **Land potential category**				b

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	57,660	
	(ii)	Field drainage	£	12,510	£70,170
(b) **Present value of benefits**	(i)	Agriculture	£	158,360	
	(ii)	Buildings	£		
	(iii)	Roads/Railways	£		£158,360
(c) **Benefit/cost ratio**					2.3
(d) **Priority category**					1D

IMPROVEMENT WORKS

It is suggested that the watercourse is re-sectioned to provide a maximum channel design standard of 7.7 cumecs and allow sufficient freeboard for land drains to be installed. The culvert beneath the road should be replaced by a new one constructed with a lower invert and the channel beneath the railway arch will require deepening to provide adequate fall along the watercourse. Rugby Borough Council do not propose to carry out any improvement works.

BENEFITS

The land is only suitable at present for poor pasture land. Following arterial drainage improvements and the installation of an efficient field drainage system an increase in gross margin will be possible.

IDENTIFICATION

Problem code number(s):	3-91-210-14/18/25, 3-91-410-22
Watercourse:	River Leam (main river)
Location:	Leamington Spa to Grandborough (Rugby Borough Council)
OS Map reference:	SP 320 655 to SP 495 673

NATURE OF PROBLEM

Upstream of Leamington pasture land is prone to frequent flooding and 968 ha suffer from inadequate arterial drainage. Road crossings at Kites Hardwick, Marton, Eathorpe, Hunningham and Offchurch are liable to be blocked by floodwater. In addition, in 1968 the 25 year flood event affected a petrol station and two houses at Kites Hardwick and two or three properties in Grandborough. The latter problem has been alleviated by improvements to the watercourse by the Borough Council. In 1976 the County Land Agent improved the Millholme Brook and in order to provide a more satisfactory outfall a short section of the Leam was dredged. In 1973 maintenance dredging of a small stretch of the Leam upstream of Kites Hardwick was carried out, but no systematic maintenance works have been executed.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in	years
	(ii)	Structures	1 in	years
(b) **Agricultural**	(i)	Channel	1 in	5 years
	(ii)	Structures	1 in	25 years
(c) **Land potential category**				b

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	
	(ii)	Field drainage	£	£
(b) **Present value of benefits**	(i)	Agriculture	£	
	(ii)	Buildings	£	
	(iii)	Roads/Railways	£	£

(c) **Benefit/cost ratio**

(d) **Priority category**

IMPROVEMENT WORKS

The general state of the river is poor except for the middle reaches, where fallen trees etc are numerous and a limited improvement could be affected by maintenance work but would not provide five year flood protection. It is suggested that the River Leam is improved by dredging and flood embankments (including drainage behind the banks) to provide a design discharge of 58 cumecs from the eastern side of Leamington upstream to Grandborough. The lowering and greater control of river water levels will improve the situation and result in little need for a large scale tile drainage scheme.

More detailed examination of benefits by MAFF indicates the existing scheme is not cost effective and has been withdrawn from the Capital Programme.

FISHERIES

Between Leamington Spa and Birdingbury, there are about half a dozen Angling Clubs. Any improvement works would, therefore have to take this into consideration. There are no specific points that can be made until plans are put forward, other than to say that bank clearance between Marton and Leamington Hastings would be an advantage.

IDENTIFICATION

Problem code number(s):	3-91-210-15
Watercourse:	Smite Brook and Pailton Brook (non-main river)
Location:	Monks Kirby (Rugby Borough Council)
OS Map reference:	SP 463 828 to SP 474 825

NATURE OF PROBLEM

40 ha of agricultural land suffer from inadequate drainage and three hectares of land suffer from flooding for periods up to three hours.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in	years
	(ii)	Structures	1 in	years
(b) **Agricultural**	(i)	Channel	1 in	5 years
	(ii)	Structures	1 in	50 years
(c) **Land potential category**				b

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	63,420	
	(ii)	Field drainage	£	30,030	£93,450
(b) **Present value of benefits**	(i)	Agriculture	£	258,380	
	(ii)	Buildings	£		
	(iii)	Roads/Railways	£		£258,380
(c) **Benefit/cost ratio**					2.8
(d) **Priority category**					10

IMPROVEMENT WORKS

The recommended improvement scheme is to re-section the two watercourses from Pailton through Monks Kirby to a point 100 m beyond the road culvert at the Bell Inn to provide a design discharge of 3.6 cumecs thus creating satisfactory outfall conditions under average flow conditions. The culvert at SP 464 829 is theoretically capable of passing in excess of the 1 in 50 years discharge and underpinning this and three footbridges is the only work required to the watercourse structures.

IDENTIFICATION

Problem code number(s):	3-91-210-16/19/27
Watercourse:	River Leam and tributaries (non-main river)
Location:	Grandborough Mill to Willoughby Viaduct (Rugby Borough Council)
OS Map reference:	SP 494 672 to SP 523 661

NATURE OF PROBLEM

The inadequate channel capacity causes both localised flooding for up to 18 hours and drainage problems to 200 ha on the Leam and its tributaries especially those from Willoughby and Braunston. In the latter case unfenced cattle are causing the watercourse to disappear in places and the culvert beneath the viaduct (SP 523 661) is completely full in normal flow conditions. Road flooding occurs in Willoughby and Sawbridge about once every five years. The surface water from the roads in Willoughby discharges to a sub-tributary of the Leam which has been recently improved to Fox Covert (SP 503 667). However, downstream to the Leam the channel is in very poor condition causing backing up to Willoughby. The road at Sawbridge is affected by direct flooding from the Leam caused by backing up from Granborough Mill Weir.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in	years
	(ii)	Structures	1 in	years
(b) **Agricultural**	(i)	Channel	1 in	5 years
	(ii)	Structures	1 in	years
(c) **Land potential category**			b	

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	443,970	
	(ii)	Field drainage	£	67,560	£511,530
(b) **Present value of benefits**	(i)	Agriculture	£	1,186,330	
	(ii)	Buildings	£		
	(iii)	Roads/Railways	£	negligible	£1,186,330
(c) **Benefit/cost ratio**					2.3
(d) **Priority category**					1C

IMPROVEMENT WORKS

It is suggested that 600m of the River Leam between Granborough Mill and Willoughby Viaduct together with the Willoughby tributary to SP 511 679, 300 m of the Braunston tributary to the viaduct and 30 m of the Sawbridge tributary to Sawbridge village are re-sectioned to provide design discharges of 11.6 cumecs and 1.2 cumecs on the Leam and Willoughby tributaries respectively. These works will allow satisfactory freeboard for field drainage outfalls under average flow conditions.

Ideally the weir at Grandborough Mill should be removed and improvements channelled back from this, though this would necessitate purchase of water rights at the mill. Three more weirs along this stretch of the Leam should also be removed to facilitate proper regrading works.

The two circular culverts beneath the access road to Willoughby Pumping Station were replaced by a box culvert 2.4m x 1.2m in 1984. In 1985 some deepening and widening work was carried out from Lower Street, Willoughby, downstream for approximately 400 metres. Recently this section has been cleared out by Warwickshire County Council. The replacement of the culvert appears to have lessened the frequency and severity of the flooding.

FISHERIES

Only fished in the Braunston Area - otherwise of no importance as a fishery.

IDENTIFICATION

Problem code number(s):	3-91-210-21
Watercourse:	Un-named tributary of River Avon (non-main river)
Location:	Newton (Rugby Borough Council)
OS Map reference:	SP 527 775

NATURE OF PROBLEM

A road floods annually for up to three hours.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£_____
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£_____
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IMPROVEMENT WORKS

The mean annual flood is 0.8 cumecs though the existing 450 mm diameter pipe beneath the road can only discharge 0.2 cumecs. The watercourse is affected by the level in the River Avon and improvements to the watercourse to improve the capacity would not solve the problem. The best solution is for the Highway Authority to provide a larger culvert.

IDENTIFICATION

Problem code number(s):	3-91-210-22
Watercourse:	River Avon (main river)
Location:	Clifton-on-Dunsmore (Rugby Borough Council)
OS Map reference:	SP 532 772

NATURE OF PROBLEM

The B5414 floods on average once every ten years for periods up to three hours.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£_____
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£_____
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IMPROVEMENT WORKS

The existing culvert is capable of passing about the 1 in 12 years discharge (58 cumecs) and the road flooding is probably attributable to the low spot in the road where the gullies cannot discharge adequately when river levels are high. A recently constructed by-pass channel and pipe culvert has allowed gullies to discharge better and theoretically increased the total discharge to 65 cumecs. If protection above this level is required a comprehensive scheme to raise road levels would be the best solution. However, the present standard of protection appears to be acceptable.

CONSERVATION

This site is rich in flora and fauna.

IDENTIFICATION

Problem code number(s):	3-91-210-26
Watercourse:	Un-named tributary of Millholme Brook (non-main river)
Location:	Leamington Hastings (Rugby Borough Council)
OS Map reference:	SP 454 658 to SP 465 664

NATURE OF PROBLEM

45 ha of agricultural land suffer from inadequate outfall conditions. A 'B' class road also floods for up to 18 hours but was only impassable in 1968. The downstream section of the tributary from SP 446 663 has been recently improved together with Millholme Brook and only 25 ha now suffer from inadequate arterial drainage.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	5 years
		(ii)	Structures	1 in	years
(c)	**Land potential category**			b	

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	20,180	
		(ii)	Field drainage	£	7,510	£27,690
(b)	**Present value of benefits**	(i)	Agriculture	£	91,680	
		(ii)	Buildings	£		
		(iii)	Roads/Railways	£	negligible	£91,680
(c)	**Benefit/cost ratio**					3.3
(d)	**Priority category**					1E

IMPROVEMENT WORKS

It is suggested that the watercourse is re-sectioned from Broadwell for 1.1 km to the extent of the existing improvements to provide a channel design capacity of 1.5 cumecs, which should allow satisfactory freeboard for land drainage under average flow conditions.

IDENTIFICATION

Problem code number(s):	3-91-210-28
Watercourse:	Un-named tributary of River Avon (non-main river)
Location:	Harborough Magna (Rugby Borough Council)
OS Map reference:	SP 480 800 to SP 481 780

NATURE OF PROBLEM

67 ha of agricultural land suffers from inadequate arterial drainage.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in	years
	(ii)	Structures	1 in	years
(b) **Agricultural**	(i)	Channel	1 in	5 years
	(ii)	Structures	1 in	50 years
(c) **Land potential category**				b

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	57,660	
	(ii)	Field drainage	£	55,050	£112,710
(b) **Present value of benefits**	(i)	Agriculture	£	247,270	
	(ii)	Buildings	£		
	(iii)	Roads/Railways	£		£247,270
(c) **Benefit/cost ratio**					2.2
(d) **Priority category**					10

IMPROVEMENT WORKS

The existing channel is already capable of conveying the design discharge (1.2 cumecs). However, the channels require deepening to allow satisfactory freeboard under average flow conditions. It is suggested to re-section all the lengths of watercourse to the canal/road culvert at SP 481 780. This culvert is theoretically capable of conveying a 1 in 50 years discharge and it will be necessary to grade the channel invert down to the culvet invert level. The same applies to the culvert at SP 480 796.

CONSERVATION

There is a small marshy area of significance.

IDENTIFICATION

Problem code number(s):	8-91-210-1
Watercourse:	River Anker (non-main river)
Location:	Wolvey (Rugby Borough Council)
OS Map reference:	SP 418 886 to SP 428 872

NATURE OF PROBLEM

Farmland adjoining the river suffers from inadequate arterial drainage.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£_____
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£_____
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IMPROVEMENT WORKS

The Warwickshire County Land Agent is considering a scheme.

IDENTIFICATION

Problem code number(s):	8-91-210-2
Watercourse:	River Anker/Tributary Stretton Baskerville (non-main river)
Location:	Stretton Baskerville (Rugby and Nuneaton & Bedworth Borough Council)
OS Map reference:	SP 389 912 to SP 419 918

NATURE OF PROBLEM

Some 88 ha of agricultural land on the River Anker and 62 on the Stretton Baskerville tributary suffer from inadequate arterial drainage.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£_____
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£_____
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IMPROVEMENT WORKS

The Warwickshire County Land Agent carried out a Section 99 scheme from head of main river at Paul's Ford on the River Anker to 1.65 km upstream as far as the Stretton Baskerville tributary. It was completed in 1983 and mained in 1985. This has alleviated the problem on the River Anker and has provided a good outfall facility for the Stretton Baskerville tributary.

No work is proposed or has been carried out on this watercourse by Rugby Borough Council. The flow in the watercourse is being increased by development in Sketchley Lane which is in the area of Hinckley & Bosworth District Council. The devloper of the latest phase of this industrial estate has installed storm water balaning facilities as an alternative to off-site watercourse improvements.

IDENTIFICATION

Problem code number(s):	3-91-310-1/2
Watercourse:	Un-named tributary of River Itchen (non-main river)
Location:	Fenny Compton (Stratford-upon-Avon District Council)
OS Map reference:	SP 416 522 to SP 418 525

NATURE OF PROBLEM

Roads in the village are flooded for periods of up to three hours about twice a year and, in 1968 and 1971, 14 houses were flooded mainly from the wash produced by traffic. The estimated frequency of the maximum recorded flood is 1 in 15 years.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in	10	years
	(ii)	Structures	1 in	50	years
(b) **Agricultural**	(i)	Channel	1 in		years
	(ii)	Structures	1 in		years
(c) **Land potential category**					

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	46,130	
	(ii)	Field drainage	£		£46,130
(b) **Present value of benefits**	(i)	Agriculture	£		
	(ii)	Buildings	£	7,510	
	(iii)	Roads/Railways	£	negligible	£7,510
(c) **Benefit/cost ratio**					0.2
(d) **Priority category**					3E

IMPROVEMENT WORKS

The proposed solution is to re-section about 200 m of open watercourse and replace four inadequate road culverts to provide a channel design capacity of 1.5 cumecs. The cost of works will be high because the watercourse is located in rear gardens and access is very limited.

IDENTIFICATION

Problem code number(s):	3-91-310-3
Watercourse:	Un-named tributary of River Itchen (non-main river)
Location:	Fenny Compton (Stratford-upon-Avon District Council)
OS Map reference:	SP 427 529

NATURE OF PROBLEM

A 'C' class road adjacent to Fenny Compton railway station floods on average every six months for durations up to 24 hours. During floods with a return period of greater than 1 in 10 years the railway station is affected with the office flooding during events greater than 1 in 50 years.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in 10 years
		(ii)	Structures	1 in years
(b)	**Agricultural**	(i)	Channel	1 in years
		(ii)	Structures	1 in years
(c)	**Land potential category**			

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	8,650	
		(ii)	Field drainage	£		£8,650
(b)	**Present value of benefits**	(i)	Agriculture	£		
		(ii)	Buildings	£		
		(iii)	Roads/Railways	£		£negligible
(c)	**Benefit/cost ratio**					0
(d)	**Priority category**					3F

IMPROVEMENT WORKS

To provide the design discharge of 0.7 cumecs only nominal clearing out and slight re-sectioning is required over about 600 m of the watercourse. The River Itchen requires improvement to its upper reaches before any minor tributaries can discharge freely (see 3-19-310-21/71 & 78).

BENEFITS

Benefits for the scheme are negligible as alternative routes are available which only marginally increase travel time.

IDENTIFICATION

Problem code number(s):	3-91-310-4/5
Watercourse:	Un-named tributary of Noleham Brook (non-main river)
Location:	Long Marston (Stratford-upon-Avon District Council)
OS Map reference:	SP 154 492 to SP 153 487

NATURE OF PROBLEM

In 1968, 22 houses and a shop flooded for up to 10 hours with an estimated 15 year return period. Since then Warwickshire County Council have replaced an undersized section of pipe and the District Council have constructed a new foul sewer, relieving the pipe of the original septic tank discharges connected to it. It now appears that the problem has been alleviated.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in	years
	(ii)	Structures	1 in	years
(b) **Agricultural**	(i)	Channel	1 in	years
	(ii)	Structures	1 in	years

(c) **Land potential category**

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£		
	(ii)	Field drainage	£		£____
(b) **Present value of benefits**	(i)	Agriculture	£		
	(ii)	Buildings	£		
	(iii)	Roads/Railways	£		£____

(c) **Benefit/cost ratio**
(d) **Priority category**

IMPROVEMENT WORKS

Despite the improvement works already carried out, 200 m re-sectioning will be required to enable the watercourse to contain at least a 1 in 10 year flood (0.5 cumecs).

BENEFITS

With channel improvements to a 1 in 50 year standard the channel would still not have sufficent depth to allow field drains to be installed, hence no benefit from increased yield to adjacent agricultural land can be attributed to any improvements.

IDENTIFICATION

Problem code number(s):	3-91-310-6
Watercourse:	None
Location:	Ashorne (Stratford-upon-Avon District Council)
OS Map reference:	SP 305 578

NATURE OF PROBLEM

Two houses and a road have flooded five times since 1968 from an old village drain/highway drain that is legally a sewer, as it received sewage from properties before 1936. This problem has no land drainage implication and is therefore outside the scope of this Survey.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£ ____
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£ ____
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IDENTIFICATION

Problem code number(s):	3-91-310-7
Watercourse:	Thelsford Brook (non-main river)
Location:	Newbold Pacey (Stratford-upon-Avon District Council)
OS Map reference:	SP 260 573 to SP 305 575

NATURE OF PROBLEM

130 ha of pasture land and a 'C' class road flood for periods up to three hours most seriously in 1968, '71 and '72. The maximum recorded flood has been estimated as a 1 in 20 years event. The area also suffers from inadequate arterial drainage.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in	years
	(ii)	Structures	1 in	years
(b) **Agricultural**	(i)	Channel	1 in 5	years
	(ii)	Structures	1 in 50	years
(c) **Land potential category**			b	

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£ 325,770	
	(ii)	Field drainage	£ 35,030	£360,800
(b) **Present value of benefits**	(i)	Agriculture	£ 552,880	
	(ii)	Buildings	£	
	(iii)	Roads/Railways	£ negligible	£552,880
(c) **Benefit/cost ratio**				1.5
(d) **Priority category**				2C

IMPROVEMENT WORKS

Although the theoretical discharge at Woozeley Bridge (SP 296 578) is 6.6 cumecs (1 in 50 years) flooding appears to be due to an inadequate channel and obstructions in the watercourse upstream. It is suggested, therefore, to resection about 6 km of watercourse to the confluence with the River Avon, including two new cuts to straighten out the meandering section, to provide a design capacity of 3.7 cumecs at Woozeley Bridge. In addition, Woozeley Bridge and Thelsford Bridge (SP 272 584) require underpinning and certain lengths of the watercourse will require some pioneering work.

IDENTIFICATION

Problem code number(s):	3-91-310-8/9
Watercourse:	Ban Brook (non-main river)
Location:	Salford Priors (Stratford-upon-Avon District Council)
OS Map reference:	SP 081 514

NATURE OF PROBLEM

In July 1968 a flood lasting for 24 hours, with an estimated recurrence interval of 1 in 25 years, affected the workshops of an agricultural and industrial machine manufacturing company. A scheme to improve Ban Brook was carried out after 1968 by the County Land Agent, but mainly to improve drainage to upstream agricultural land. Inadequate culverts upstream of the factory and contributing to the flooding were not improved at this time. The A439 outside the factory floods on average every 10 years owing to the highway drains being unable to discharge when the water level rises in the River Arrow.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in	years
	(ii)	Structures	1 in 50	years
(b) **Agricultural**	(i)	Channel	1 in	years
	(ii)	Structures	1 in	years
(c) **Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	8,650	
	(ii)	Field drainage	£		£8,650
(b) **Present value of benefits**	(i)	Agriculture	£		
	(ii)	Buildings	£	10,010	
	(iii)	Roads/Railways	£		£10,010
(c) **Benefit/cost ratio**					1.2
(d) **Priority category**					2F

IMPROVEMENT WORKS

Duplication or replacement of the culverts is required but, because of the high cost involved, it is suggested that more viable protection works can be carried out by the construction of earth banks, to divert flood water from the main factory complex onto adjacent fields, providing a design standard of 5.3 cumecs.

Warwickshire County Council propose to construct a new road across the Arrow. These improvements include new surface water gullies and it is suggested that a review of the road flooding is made after construction of the new road.

BENEFITS

Flood damages in 1968 were mainly caused by three days loss of production and clearing up costs. No damage occurred to machines and manufactured goods.

CONSERVATION

3-91-310-9
This is an important site rich in flora and fauna.

IDENTIFICATION

Problem code number(s):	3-91-310-10/11/12/13/14/15/65
Watercourse:	River Stour (main river)
Location:	Clifford Chambers to Burmington (Stratford-upon-Avon District Council)
OS Map reference:	SP 197 528 to SP 258 379

NATURE OF PROBLEM

The arterial drainage of 350 ha of agricultural land is inadequate and annual localised flooding occurs in many places from Burmington to the Avon confluence. At Shipston-on-Stour a 25 year flood event affected three shops, a doctor's surgery, a petrol/service garage, two houses and the A34 road for periods up to 18 hours. Six houses were also affected in Treddington and the mill houses at Halford and Clifford Chambers. A former mill at Shipston, now connected to a restaurant, floods at least once a year.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in years
	(ii)	Structures	1 in 100 years
(b) **Agricultural**	(i)	Channel	1 in 5 years
	(ii)	Structures	1 in years
(c) **Land potential category**			b

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	663,070	
	(ii)	Field drainage	£	315,260	£978,330
(b) **Present value of benefits**	(i)	Agriculture	£	2,236,530	
	(ii)	Buildings	£	17,510	
	(iii)	Roads/Railways	£	27,520	£2,281,560
(c) **Benefit/cost ratio**					2.3
(d) **Priority category**					18

IMPROVEMENT WORKS

It is suggested that regrading of the bed from Burmington to Clifford Chambers is necessary to provide a design discharge of 45 cumecs at the downstream end. In the past a considerable number of mills were in operation. The structures still remain although several weirs and sluices have been swept away. In some cases the main flow completely by-passes the old mills except in times of flood. Although regrading is necessary in some places, the rebuilding and modifying of the weirs at the various sites would do most to alleviate flooding, yet retain the same, or slightly lower, water levels than at present for fishing and amenity purposes.

It will also be necessary to construct flood banks on the left bank through Shipston to provide a design standard of 98 cumecs. Channel works and clearing of the flood arches under the A34 in Shipston would do most to alleviate flooding to the Old Mill Restaurant although a certain amount of sheet pile revetment would be desirable to raise the existing level of wall defences adjacent to the river at this point.

STWA completed heavy maintenance works in 1983 and Stratford District Council completed a surface water scheme at Shipston in 1985/86.

FISHERIES AND AMENITY

It is likely that the water levels required for fishing and amenity purposes will substantially reduce the benefits for land drainage.

BENEFITS

It is unlikely that the present sheep/cattle farming system could be transformed to a cereals system throughout the whole benefit area. On 50 ha there would be no improvement to the existing system.

CONSERVATION

This is an important river system of high conservation value. Consultation is desirable before any drainage works.

FISHERIES

Between Burmington & Fell Mill, the Stour is predominantly a trout fishery. Below Fell mill, coarse fish become increasingly important. Angling Clubs fish the whole stretch and it is, therefore, of great importance, that full consultations take place. River levels should be maintained as far as possible.

IDENTIFICATION

Problem code number(s):	3-91-310-16
Watercourse:	Sherbourne Brook (Bell Brook) (non-main river)
Location:	Snitterfield (Stratford-upon-Avon District Council)
OS Map reference:	SP 211 595 to SP 214 600

NATURE OF PROBLEM

In 1968 18 houses were flooded for 10 hours by the 1 in 15 years event. Since then minor flooding has also occurred.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in years
		(ii)	Structures	1 in 50 years
(b)	**Agricultural**	(i)	Channel	1 in years
		(ii)	Structures	1 in years
(c)	**Land potential category**			

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	259,460	
		(ii)	Field drainage	£		£259,460
(b)	**Present value of benefits**	(i)	Agriculture	£		
		(ii)	Buildings	£	20,020	
		(iii)	Roads/Railways	£		£20,020
(c)	**Benefit/cost ratio**					0.1
(d)	**Priority category**					3C

IMPROVEMENT WORKS

An inadequate culvert beneath the houses is showing signs of breaking up and it is recommended that this is replaced over a 500 m length to provide a maximum design discharge of 2.7 cumecs.

An improvement scheme is in the District Council's capital programme for 1991/92 and future and is not currently being afforded any great priority. Responsibility for the culvert under the properties is not clear, the riparian owners may have some responsibility.

IDENTIFICATION

Problem code number(s):	3-91-310-19/73
Watercourse:	Hogg Brook (non-main river)
Location:	Newbold Pacey (Stratford-upon-Avon District Council)
OS Map reference:	SP 328 594 to SP 313 571

NATURE OF PROBLEM

75 ha of agricultural land suffer from inadequate arterial drainage and annual flooding for up to three hours duration. The A41 road also occasionally floods.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in years
		(ii)	Structures	1 in years
(b)	**Agricultural**	(i)	Channel	1 in 5 years
		(ii)	Structures	1 in 50 years
(c)	**Land potential category**			b

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	123,960	
		(ii)	Field drainage	£	42,540	£166,500
(b)	**Present value of benefits**	(i)	Agriculture	£	375,070	
		(ii)	Buildings	£		
		(iii)	Roads/Railways	£		£375,070
(c)	**Benefit/cost ratio**					2.3
(d)	**Priority category**					1C

IMPROVEMENT WORKS

The suggested solution is to re-section the watercourse to provide a design capacity of 1.7 cumecs, also allowing satisfactory freeboard under average flow conditions. In addition, two inadequate road culverts will be replaced with 1,400 mm pipes and a number of farm bridges will have to be underpinned.

BENEFITS

The A41 is not impassable during flood events, therefore no benefits are assumed.

IDENTIFICATION

Problem code number(s):	3-91-310-20/21/31/71/78
Watercourse:	River Itchen (non-main river)
Location:	Stoneythorpe to Fenny Compton (Stratford-upon-Avon District Council)
OS Map reference:	SP 406 620 to SP 430 539

NATURE OF PROBLEM

450 ha of agricultural land (mostly pasture) suffer from inadequate arterial drainage and localised flooding about twice a year. Three cottages were flooded in Ladbroke in 1968 (the 1 in 25 years event) but this problem should now be alleviated by channel works carried out in Ladbroke following the floods.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in years
		(ii)	Structures	1 in years
(b)	**Agricultural**	(i)	Channel	1 in 5 years
		(ii)	Structures	1 in 50 years (maximum)
(c)	**Land potential category**			b

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£ 605,410	
		(ii)	Field drainage	£ 100,080	£705,490
(b)	**Present value of benefits**	(i)	Agriculture	£ 2,764,410	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£2,764,410
(c)	**Benefit/cost ratio**				3.9
(d)	**Priority category**				1B

IMPROVEMENT WORKS

It is suggested that the River Itchen upstream of Stoneythorpe and certain lengths of its tributaries are re-sectioned to provide a maximum channel design capacity of 12.3 cumecs and, where necessary, allowing satisfactory freeboard for land drainage under normal flow conditions. In conjunction with the re-sectioning work, light to medium pioneering work will be required, six road or railway bridges will require underpinning, eight farm access bridges will require replacing and three new pipe culverts are required to replace existing inadequate road culverts. A weir at the Bishops Itchington Cement Works (SP 396 585) is no longer used to impound water and, if possible, should be removed. The level of the River Itchen above Stoneythorpe is controlled by the weir at Stoneythorpe Hall and it is suggested that conditions could be considerably improved if this weir were lowered or lengthened. This work has not been costed in the above estimate.

Existing road flooding in the village, caused by highway drains being unable to discharge when the water level in the watercourse rises, should be alleviated if a scheme is carried out on the Itchen and its tributaries.

The County Land Agent completed tree clearance and maintenance work in 1984.

CONSERVATION

3-91-310-20 & 3-91-310-21
This is an important river section rich in flora and fauna. Consultation is desirable before any remedial work should proceed.

3-91-310-71 & 3-91-310-78
This is an important site with rich fauna and moderate flora.

IDENTIFICATION

Problem code number(s):	3-91-310-22
Watercourse:	Tributary of Tach Brook (non-main river)
Location:	Chesterton and Kingston (Stratford-upon-Avon District Council)
OS Map reference:	SP 345 589 to SP 354 583

NATURE OF PROBLEM

18 ha of agricultural land suffer from inadequate arterial drainage, and localised flooding occurs three or four times a year for durations up to 48 hours. The main channel of the watercourse has been diverted around Chesterton Mill Pool through a 27" diameter pipe which is too small and flooding occurs when water backs up in the open channel upstream.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in	years
	(ii)	Structures	1 in	years
(b) **Agricultural**	(i)	Channel	1 in	5 years
	(ii)	Structures	1 in	50 years
(c) **Land potential category**				b

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	43,240	
	(ii)	Field drainage	£	2,500	£45,740
(b) **Present value of benefits**	(i)	Agriculture	£	66,680	
	(ii)	Buildings	£		
	(iii)	Roads/Railways	£		£66,680
(c) **Benefit/cost ratio**					1.5
(d) **Priority category**					2E

IMPROVEMENT WORKS

The recommended improvement scheme is to construct a 975 mm pipe parallel to the existing pipe to provide a maximum capacity of 5.2 cumecs, and carry out channel improvements for approximately 600 m upstream and downstream of the piped section, to give a channel capacity of 2.6 cumecs, and also allow satisfactory freeboard under average flow conditions.

CONSERVATION AND AMENITY

Chesterton Mill Pool is important as a winter refuge and breeding habitat for birds. The proposed works are not expected to debilitate this site in any way providing disturbance to the pool and fringing vegetation is kept to a minimum.

IDENTIFICATION

Problem code number(s):	3-91-310-23
Watercourse:	Un-named tributary of the River Dene (non-main river)
Location:	Oxhill (Stratford-upon-Avon District Council)
OS Map reference:	SP 331 471 and SP 341 485

NATURE OF PROBLEM

Unsatisfactory outfall conditions exist causing inadequate arterial drainage to 33 ha of agricultural land.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in	years
	(ii)	Structures	1 in	years
(b) **Agricultural**	(i)	Channel	1 in	5 years
	(ii)	Structures	1 in	25 years
(c) **Land potential category**				b

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	69,190	
	(ii)	Field drainage	£	7,510	£76,700
(b) **Present value of benefits**	(i)	Agriculture	£	100,020	
	(ii)	Buildings	£		
	(iii)	Roads/Railways	£		£100,020
(c) **Benefit/cost ratio**					1.3
(d) **Priority category**					2D

IMPROVEMENT WORKS

The proposed solution involves replacing two inadequate road culverts at SP 338 478 and SP 334 473 and re-sectioning the watercourse to provide a channel design capacity of 0.8 cumecs, allowing sufficient depth for field drains to discharge freely under average flow conditions.

IDENTIFICATION

Problem code number(s):	3-91-310-25/27/28
Watercourse:	River Stour and Sutton Brook (main river to Mitford Bridge - SP 263 371)
Location:	Sutton-under-Brailes (Stratford-upon-Avon District Council)
OS Map reference:	SP 259 379 to SP 293 313

NATURE OF PROBLEM

27 ha of farmland adjacent to Sutton Brook and 65 ha adjacent to the River Stour are subject to localised flooding annually for durations up to 12 hours. In addition, two properties at Cherington and Stourton, and six properties at Lower Brailes, were flooded in 1968 from floods with estimated return periods of 10 and 20 years respectively.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in years
	(ii)	Structures	1 in 100 years
(b) **Agricultural**	(i)	Channel	1 in 2 years
	(ii)	Structures	1 in years
(c) **Land potential category**			a

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	345,950	
	(ii)	Field drainage	£	10,010	£355.960
(b) **Present value of benefits**	(i)	Agriculture	£	244,490	
	(ii)	Buildings	£	7,510	
	(iii)	Roads/Railways	£		£252.000
(c) **Benefit/cost ratio**					0.7
(d) **Priority category**					3C

IMPROVEMENT WORKS

A comprehensive scheme is recommended to re-section the Stour from Burmington to Sutton-under-Brailes, and Sutton Brook from the confluence with the Stour to Lower Brailes, to provide a channel design capacity of 7.1 cumecs at Mitford Bridge, allowing satisfactory freeboard under average flow conditions. Removal of weirs at Cherington and Stourton will create better outfall conditions but would increase velocities in the channel causing serious bank erosion. It is therefore proposed to regrade the channels from these weirs. The channel at Lower Brailes could theoretically contain a 100 year discharge if the twin road culverts are regularly maintained. In addition, alleviation of urban flooding will be achieved if the watercourse is straightened and a wing wall constructed to form a proper inlet control to the culverts.

BENEFITS

The Stour and Sutton Brook catchments support mainly dairy cows and sheep. The urban benefits relate to the protection of Lower Brailes only.

CONSERVATION AND AMENITY

Mere Furlong Coppice is located at SP 282 370. This site consists of one of the largest colonies of Monkshood in the Midlands, some plants growing on the banks of the watercourse. Channel improvements could have a detrimental effect on this site.

IDENTIFICATION

Problem code number(s):	3-91-310-26
Watercourse:	River Arrow (main river)
Location:	Arrow to Wixford (Stratford-upon-Avon District Council)
OS Map reference:	SP 082 553

NATURE OF PROBLEM

Agricultural land in the floodplain floods annually for up to 48 hours and approximately 20 ha suffer from inadequate arterial drainage. Improvements in 1974 provided protection for a mean annual flood.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IMPROVEMENT WORKS

The land is in the River Arrow floodplain and further improvements to alter this area are not recommended.

CONSERVATION

North of SP 083 553 the site is of valuable conservation interest.

IDENTIFICATION

Problem code number(s):	3-91-310-29
Watercourse:	Combrook (non-main river)
Location:	Combrook (Stratford-upon-Avon District Council)
OS Map reference:	SP 300 510 to SP 305 516

NATURE OF PROBLEM

8 ha of agricultural land suffer from inadequate arterial drainage and flooding on average every six months for periods up to three hours.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in	years
	(ii)	Structures	1 in	years
(b) **Agricultural**	(i)	Channel	1 in	2 years
	(ii)	Structures	1 in	years
(c) **Land potential category**			a	

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	28,830	
	(ii)	Field drainage	£		£28,830
(b) **Present value of benefits**	(i)	Agriculture	£	25,000	
	(ii)	Buildings	£		
	(iii)	Roads/Railways	£		£25,000
(c) **Benefit/cost ratio**					0.9
(d) **Priority category**					3E

IMPROVEMENT WORKS

The recommended improvement scheme is to re-section 1 km of watercourse to provide a channel design capacity of 1.8 cumecs, also allowing satisfactory freeboard under average flow conditions. Some light to medium pioneering work will also be required, including the removal of dead trees and debris from the channels.

CONSERVATION

An SSSI and nature reserve fall within the benefit area (Oxhouse Farm).

IDENTIFICATION

Problem code number(s):	3-91-310-30/75 & 3-91-410-13
Watercourse:	Langley Brook (non-main river)
Location:	Langley and Claverdon (Stratford-upon-Avon District Council)
OS Map reference:	SP 164 608 to SP 224 658

NATURE OF PROBLEM

Unsatisfactory outfall conditions cause inadequate arterial drainage to 341 ha of agricultural land and annual localised flooding for durations up to 10 hours.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in years
		(ii)	Structures	1 in years
(b)	**Agricultural**	(i)	Channel	1 in 5 years
		(ii)	Structures	1 in 25 years
(c)	**Land potential category**			b

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	430,100	
		(ii)	Field drainage	£	155,130	£585,230
(b)	**Present value of benefits**	(i)	Agriculture	£	438,970	
		(ii)	Buildings	£		
		(iii)	Roads/Railways	£		£438,970
(c)	**Benefit/cost ratio**					0.8
(d)	**Priority category**					3C

IMPROVEMENT WORKS

The recommended improvement scheme is to re-section the watercourse for 9 km from the confluence with Bearley Brook to the road culvert at SP 220 650 (Pinley Farm). Upstream the watercourse passes through several old, restricting culverts with fixed inverts which would be extremely expensive to replace. The benefit area has therefore been terminated at Pinley Farm. A number of culverts downstream are however to be replaced or improved. At Langley Ford a new culvert is suggested, an existing arch culvert beneath the railway will either be underpinned or a new pipe thrust bored through the embankment, and twin brick arch culverts at SP 211 643 will require breaking out and the sides made good, as the road has now been by-passed and a new culvert constructed 30m upstream. These works will provide a channel design capacity of 7.2 cumecs at the downstream end but freeboard criteria, however, will allow a higher maximum capacity.

CONSERVATION

3-91-310-75
This is an important site for birds registered by the British Trust for Ornithology.

IDENTIFICATION

Problem code number(s):	3-91-310-32
Watercourse:	Three un-named watercourses (non-main river)
Location:	Lower Quinton (Stratford-upon-Avon District Council)
OS Map reference:	SP 178 472

NATURE OF PROBLEM

In 1968, old people's flats, a shop, six houses, roads and adjacent pasture land flooded for up to six hours. The flood is estimated to have had a 1 in 20 years return period. Flooding of the houses and shop was the result of the culverted watercourse on the west side of Goose Lane being inadequate and culverted with different size pipes, and inadequate size pipes across the road at the north end of Goose Lane. Since 1968 the pipes have been replaced with 12" diameter pipes and the problem here alleviated.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in	10 years
	(ii)	Structures	1 in	50 years
(b) **Agricultural**	(i)	Channel	1 in	years
	(ii)	Structures	1 in	years
(c) **Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	14,410	
	(ii)	Field drainage	£		£14,410
(b) **Present value of benefits**	(i)	Agriculture	£		
	(ii)	Buildings	£	7,510	
	(iii)	Roads/Railways	£		£7,510
(c) **Benefit/cost ratio**					0.5
(d) **Priority category**					3E

IMPROVEMENT WORKS

It is recommended that the existing 450 mm pipe across the road on the east of Goose Lane is duplicated to carry the design discharge of 0.5 cumecs for the central watercourse. This will solve the re-occurring road flooding. The flooding of the old people's flats was due to blocked culverts which, when clear, are theoretically capable of containing the design discharge (1 cumec) if 1 km of the downstream watercourse as far as the A46 is also cleared out. An old brick culvert down the main street (eastern watercourse) is prone to collapse and may also have its capacity reduced by siltation. Comprehensive investigation is required.

Warwickshire County Council have constructed an additional crossing of the main street from Goose Lane to their school reducing the discharge westwards towards the A46.

HYDROLOGY

The catchment area is too small to use the Flood Studies Report six-parameter equation and the design discharges were calculated using Martin's analysis.

BENEFITS

Benefits to existing pasture land would be limited.

IDENTIFICATION

Problem code number(s):	3-91-310-33/74 and 3-91-410-5/6/11/14
Watercourse:	Preston, Fox and Lowsonford Brooks (non-main river)
Location:	Rowington and Preston Bagot (Stratford-upon-Avon and Warwick District Councils)
OS Map reference:	SP 158 638 to SP 212 700

NATURE OF PROBLEM

The arterial drainage of 367 ha of agricultural land (mostly pasture) is inadequate and suffers from localised flooding. One house immediately downstream of the Fox Brook/Lowsonford Brook confluence flooded in 1968. Since this flood the riparian owner has increased his protection.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in years
		(ii)	Structures	1 in years
(b)	**Agricultural**	(i)	Channel	1 in 5 years
		(ii)	Structures	1 in 25 years
(c)	**Land potential category**			b

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	443,970	
		(ii)	Field drainage	£	257,720	£701,690
(b)	**Present value of benefits**	(i)	Agriculture	£	1,836,460	
		(ii)	Buildings	£		
		(iii)	Roads/Railways	£		£1,836,460
(c)	**Benefit/cost ratio**					2.6
(d)	**Priority category**					1C

IMPROVEMENT WORKS

It is suggested that the Preston Brook is re-sectioned from the Alne confluence to Bushwood (SP 173 683), Fox Brook re-sectioned from the Preston Brook confluence to the Grand Union Canal at Rowington (SP 205 689) and Lowsonford Brook re-sectioned from the Fox Brook confluence to Kingswood (SP 193 718). These improvements will provide a channel design capacity of 11 cumecs at the downstream end. A number of bridges will require underpinning and a few farm access bridges will require replacement. Pioneering works on certain lengths to remove tree obstruction will alleviate some of the flooding.

The watercourse follows closely to both the Grand Union and Stratford-upon-Avon Canals. Benefit to land on the appropriate side of the canals depends very largely on the culverts beneath the canals. Most of these culverts are theoretically capable of discharging a 1 in 25 years flow, though further investigation may find these to be in poor condition. Any replacement of these culverts could considerably increase the cost of improvement works.

IDENTIFICATION

Problem code number(s): 3-91-310-34
Watercourse: River Dene (non-main river)
Location: Kineton (Stratford-upon-Avon District Council)
OS Map reference: SP 338 509

NATURE OF PROBLEM

The outbuildings of a house and the gardens of one or two other houses flooded for up to 48 hours in July 1968 by the 1 in 25 years event.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£_____
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£_____
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IMPROVEMENT WORKS

The recommended solution is for riparian owners to raise their garden levels adjacent to the river if they require further protection. No other remedy is suggested.

CONSERVATION

The watercourse is of moderate importance but good osier beds are in the vicinity.

IDENTIFICATION

Problem code number(s):	3-91-310-35
Watercourse:	Un-named tributary of River Alne (non-main river)
Location:	Aston Cantlow (Stratford-upon-Avon District Council)
OS Map reference:	SP 140 596

NATURE OF PROBLEM

Minor roads flood for periods up to 12 hours on average about once every five years. One cottage is affected when heavy vehicles drive through the flood water and force it through the front door. A second cottage is affected when the high water level in the adjacent watercourse causes water to seep up through the stone floor. Flooding has been reduced by recent improvements to the watercourse down to the Alne confluence and by recently constructed highway drains.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in	years
	(ii)	Structures	1 in	years
(b) **Agricultural**	(i)	Channel	1 in	years
	(ii)	Structures	1 in	years
(c) **Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	14,410	
	(ii)	Field drainage	£		£14,410
(b) **Present value of benefits**	(i)	Agriculture	£		
	(ii)	Buildings	£		
	(iii)	Roads/Railways	£	7,510	£7,510
(c) **Benefit/cost ratio**					0.5
(d) **Priority category**					3E

IMPROVEMENT WORKS

It is suggested that further improvements can be achieved by lowering or widening the weir on the River Alne located immediately downstream by the confluence with the Aston Cantlow tributary, as the impounded water level in the River Alne causes backing up in the tributary and restricts highway drain outfalls.

Further investigation is required before the standard of works can be determined.

FLOOD PROOFING

The property that floods when the water table rises is a pre-war cottage with no damp proofing. Some form of damp proofing carried out to the walls and floor could partially protect the cottage.

IDENTIFICATION

Problem code number(s):	3-91-310-36/70
Watercourse:	Wagstaffe and Humber Brooks (non-main river)
Location:	Oxhill and Halford (Stratford-upon-Avon District Council)
OS Map reference:	SP 258 439 to SP 316 461

NATURE OF PROBLEM

96 ha of farmland adjacent to Wagstaffe Brook and 63 ha adjacent to Humber Brook suffer from inadequate arterial drainage and localised flooding. In 1978 a grant aided scheme prepared by Warwickshire County Land Agent was carried out to lengths of watercourse upstream of Oxhill.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in years
		(ii)	Structures	1 in years
(b)	**Agricultural**	(i)	Channel	1 in 5 years
		(ii)	Structures	1 in 25 years
(c)	**Land potential category**			b

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	490,090	
		(ii)	Field drainage	£	65,050	£555,140
(b)	**Present value of benefits**	(i)	Agriculture	£	789,040	
		(ii)	Buildings	£		
		(iii)	Roads/Railways	£		£789,040
(c)	**Benefit/cost ratio**					1.4
(d)	**Priority category**					2C

IMPROVEMENT WORKS

The proposed solution is to re-section Wagstaffe Brook from Oxhill to the confluence of the Stour, and about 3 km of Humber Brook from the confluence with Wagtail Brook, to provide a maximum design capacity of 4.1 cumecs at the downstream end. In association with the channel works two culverts will require replacement and four more require underpinning.

CONSERVATION

3-91-310-36
This is an important site for aquatic flora and fauna.

IDENTIFICATION

Problem code number(s):	3-91-310-38/58/67/76
Watercourse:	Bearley Brook (non-main river)
Location:	Bearley (Stratford-upon-Avon District Council)
OS Map reference:	SP 177 588 to SP 163 609

NATURE OF PROBLEM

The arterial drainage of 265 ha of agricultural land was considered to be inadequate as localised flooding occurs annually for periods up to 12 hours. A minor road is also affected at the junction of Bearley Brook and Langley Brook.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£ negligible	£negligible
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IMPROVEMENT WORKS

No improvements can be recommended.

BENEFITS

Most of the benefit area is used for dairying. MAFF indicate that the area should be maintained as dairy farming because annual benefits are higher than would accrue from a change to arable farming. Therefore, no benefits would be gained from watercourse improvements as existing gross margins are not inhibited by the inadequacy of the drainage.

CONSERVATION

3-91-310-67
This is an important bird site registered by the British Trust for Ornithology with some good flora.

IDENTIFICATION

Problem code number(s):	3-91-310-40
Watercourse:	Nethercote Brook (non-main river)
Location:	Long Compton (Stratford-upon-Avon District Council)
OS Map reference:	SP 288 331

NATURE OF PROBLEM

The A34 at Crow Bridge has flooded five times since 1968 for up to 12 hours. The road is not impassable, though lorries driving through the water at speed create a slight problem. 25 houses have been flooded.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£_____
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£_____
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IMPROVEMENT WORKS

The District Council cleaned and regraded Nethercote Brook downstream of Crow Bridge in 1985. No problems have been notified to the District Council since 1985 and therefore no further works are proposed.

IDENTIFICATION

Problem code number(s):	3-91-310-41
Watercourse:	Un-named tributary of Oxhill Brook (non-main river)
Location:	Middle Tysoe (Stratford-upon-Avon District Council)
OS Map reference:	SP 339 442 to SP 340 443

NATURE OF PROBLEM

Village roads and two cottages are subject to annual flooding for durations up to two hours. Floodwaters would enter the properties each year if sandbags were not employed.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in 10 years
	(ii)	Structures	1 in 50 years
(b) **Agricultural**	(i)	Channel	1 in years
	(ii)	Structures	1 in years
(c) **Land potential category**			

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	34,590	
	(ii)	Field drainage	£		£34,590
(b) **Present value of benefits**	(i)	Agriculture	£		
	(ii)	Buildings	£	10,010	
	(iii)	Roads/Railways	£		£10,010
(c) **Benefit/cost ratio**					0.3
(d) **Priority category**					3E

IMPROVEMENT WORKS

The recommended improvement scheme is to replace the existing 12" diameter pipe culvert with a 525 mm diameter pipe some 200 m in length to carry a design discharge of 0.4 cumecs, although upstream and downstream the channel capacity will be 0.3 cumecs.

The District Council is not proposing to investigate or undertake any works in connection with this problem at the current time.

IDENTIFICATION

Problem code number(s):	3-91-310-42
Watercourse:	Humber Brook (non-main river)
Location:	Ilmington (Stratford-upon-Avon District Council)
OS Map reference:	SP 201 442

NATURE OF PROBLEM

A minor road floods for durations up to 12 hours, most recently in 1968, '72 and '77. The most severe flooding has an estimated recurrence interval of 1 in 15 years.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IMPROVEMENT WORKS

The existing 450 mm diameter culvert has only a maximum capacity of 1 cumec (1 in 10 year discharge). This is a Highway Authority culvert, however, with no land drainage implications. A solution to this problem is therefore, outside the scope of this Survey.

IDENTIFICATION

Problem code number(s):	3-91-310-43
Watercourse:	River Dene (non-main river)
Location:	Wellesbourne Hastings (Stratford-upon-Avon District Council)
OS Map reference:	SP 291 509

NATURE OF PROBLEM

A 'C' class road floods annually for up to 48 hours some 50 m south of Fosse Bridge. The flooding is caused by surcharged highway drains and ditches when the water level rises in the receiving watercourse.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IMPROVEMENT WORKS

The River Dene is impounded 3 km downstream at Walton, to form a lake. It is unlikely that this affects levels at Fosse Bridge. It is suggested that the frequency of flooding can be reduced by minor alterations to the highway drainage system, such as increasing depths and lengths of ditches and providing a new outfall pipe for an existing gully that surcharges very quickly at present. No assessment of costs and benefits have been made as this Highway Authority problem is outside the scope of this Survey.

BENEFITS

Any benefits to adjacent agricultural land for an improvement scheme up to the lake would be small as the land is undulating and free draining.

CONSERVATION

This area is adjacent to the Combroke Old Railway Line and Meadow conservation site.

IDENTIFICATION

Problem code number(s):	3-91-310-46
Watercourse:	River Alne (main river)
Location:	Haselor (Stratford-upon-Avon District Council)
OS Map reference:	SP 126 586

NATURE OF PROBLEM

A 'C' class road floods during the 1 in 5 years flood event caused by the impounded water level of the River Alne at Great Alne Mill, preventing discharge of highway drains and overtopping of the channel adjacent to the road.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£not estimated
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£negligible
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IMPROVEMENT WORKS

The cost of alterations to the mill weir or protection wall would be very high in relation to the benefits, therefore, no works can be recommended.

CONSERVATION

The watercourse is of good quality with diverse flora and fauna.

IDENTIFICATION

Problem code number(s): 3-91-310-47
Watercourse: River Alne (non-main river)
Location: Kinwarton (Stratford-upon-Avon District Council)
OS Map reference: SP 109 590

NATURE OF PROBLEM

The B4089 road floods every six months due to inadequate highway drainage.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in	years
	(ii)	Structures	1 in	years
(b) **Agricultural**	(i)	Channel	1 in	years
	(ii)	Structures	1 in	years

(c) **Land potential category**

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	
	(ii)	Field drainage	£	£
(b) **Present value of benefits**	(i)	Agriculture	£	
	(ii)	Buildings	£	
	(iii)	Roads/Railways	£	£

(c) **Benefit/cost ratio**
(d) **Priority category**

IMPROVEMENT WORKS

This is a Highway Authority problem and is outside the scope of this Survey.

IDENTIFICATION

Problem code number(s): 3-91-310-48
Watercourse: None
Location: Kinwarton (Stratford-upon-Avon District Council)
OS Map reference: SP 103 587

NATURE OF PROBLEM

The B4089 road floods twice a year due to inadequate highway drainage.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£_____
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£_____
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IMPROVEMENT WORKS

This is a Highway Authority problem and is outside the scope of this Survey.

IDENTIFICATION

Problem code number(s):	3-91-310-50
Watercourse:	River Avon (main river)
Location:	Binton/Welford-on-Avon (Stratford-upon-Avon District Council)
OS Map reference:	SP 145 530

NATURE OF PROBLEM

Binton Bridges becomes impassable on average once every five years for durations up to 48 hours. 13 ha of floodplain pasture land suffer from periodic flooding.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in years
	(ii)	Structures	1 in years
(b) **Agricultural**	(i)	Channel	1 in years
	(ii)	Structures	1 in 50 years
(c) **Land potential category**			a

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	259,460	
	(ii)	Field drainage	£		£259,460
(b) **Present value of benefits**	(i)	Agriculture	£	16,670	
	(ii)	Buildings	£		
	(iii)	Roads/Railways	£	negligible	£16,670
(c) **Benefit/cost ratio**					0.1
(d) **Priority category**					3C

IMPROVEMENT WORKS

Replacement of the road bridge is required to alleviate flooding. However, this is expensive in relation to the minimal benefits. Warwickshire County Council have widened the bridge with the same size arches.

CONSERVATION

This section of watercourse has a diverse flora and fauna.

IDENTIFICATION

Problem code number(s):	3-91-310-51
Watercourse:	None
Location:	Binton (Stratford-upon-Avon District Council)
OS Map reference:	SP 143 531

NATURE OF PROBLEM

The A429 (Stratford to Evesham Road) floods twice a year due to inadequate highway drainage.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£____
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£____
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IMPROVEMENT WORKS

This is a Highway Authority problem and is outside the scope of this Survey.

CONSERVATION

This section of watercourse has a diverse flora and fauna.

IDENTIFICATION

Problem code number(s):	3-91-310-52
Watercourse:	None
Location:	Studley (Stratford-upon-Avon District Council)
OS Map reference:	SP 061 643

NATURE OF PROBLEM

A 'B' class road floods annually for periods up to three hours due to inadequate highway drainage.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IMPROVEMENT WORKS

This is a Highway Authority problem and is outside the scope of this Survey.

CONSERVATION

This section of watercourse has a diverse flora and fauna.

IDENTIFICATION

Problem code number(s):	3-91-310-53
Watercourse:	None
Location:	Astwood Bank (Stratford-upon-Avon District Council)
OS Map reference:	SP 051 627

NATURE OF PROBLEM

The B4092 road floods annually for periods up to four hours due to inadequate highway drainage.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£_____
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£_____
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IMPROVEMENT WORKS

This is a Highway Authority problem and is ouside the scope of this Survey.

IDENTIFICATION

Problem code number(s):	3-91-310-54
Watercourse:	Ullenhall Brook (non-main river)
Location:	Oldberrow to Henley-in-Arden (Stratford-upon-Avon District Council)
OS Map reference:	SP 126 660 to SP 153 655

NATURE OF PROBLEM

Inadequate watercourse conditions cause three houses and a shop to flood during the 1 in 20 years flood event. The B4095 at Oldberrow floods during the 1 in 10 years event and is impassible for up to 6 hours. Localised flooding to agricultural land occurs on average once a year.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in 50 years
	(ii)	Structures	1 in 50 years
(b) **Agricultural**	(i)	Channel	1 in 5 years
	(ii)	Structures	1 in 50 years
(c) **Land potential category**			a5

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	
	(ii)	Field drainage	£	£_____
(b) **Present value of benefits**	(i)	Agriculture	£	
	(ii)	Buildings	£	
	(iii)	Roads/Railways	£	£_____

(c) **Benefit/cost ratio**
(d) **Priority category**

IMPROVEMENT WORKS

It is suggested that the watercourse is re-sectioned to provide a channel design standard of 4.4 cumecs in agricultural areas, and to provide a design standard of 9.2 cumecs from the A34 road in Henley-in-Arden down to the confluence with the River Alne.

The District Council has completed appropriate improvement works to the brook between the A34 and a point just prior to the River Alne confluence. The works were finished in 1987 and no subsequent flooding events have been recorded by the the Council. Adjacent to the confluence with the River Alne the Brook course is partially obstructed by concrete elements previously part of the highway retaining wall to the Warwick Road, this has been reported to the Warwickshire County Council.

IDENTIFICATION

Problem code number(s):	3-91-310-55
Watercourse:	Un-named tributary of River Alne (non-main river)
Location:	Mows Hill Farm (Stratford-upon-Avon District Council)
OS Map reference:	SP 147 692

NATURE OF PROBLEM

A 'C' class road floods for up to 12 hours on average once a year. The flooding point is at the low spot in the road which receives rapid surface run-off.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	10 years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	8,650	
		(ii)	Field drainage	£		£8,650
(b)	**Present value of benefits**	(i)	Agriculture	£		
		(ii)	Buildings	£		
		(iii)	Roads/Railways	£		£negligible
(c)	**Benefit/cost ratio**					0
(d)	**Priority category**					3F

IMPROVEMENT WORKS

Highway ditches and culverts require clearing out and a short length of receiving watercourse requires minor re-sectioning.

BENEFITS

Benefits are negligible as the road does not become impassable.

IDENTIFICATION

Problem code number(s):	3-91-310-57
Watercourse:	River Alne (main river)
Location:	Wootton Wawen (Stratford-upon-Avon District Council)
OS Map reference:	SP 149 620

NATURE OF PROBLEM

A minor road has flooded five times since 1968 for periods up to 18 hours when the River Alne overtops adjacent to the road.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£not estimated
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£negligible
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IMPROVEMENT WORKS

Channel works on floodbanks to alleviate flooding would be costly and costs have not been estimated.

BENEFITS

The road is only used for access and an alternative route is available; benefits are therefore negligible.

CONSERVATION

The watercourse is rich in flora and fauna.

IDENTIFICATION

Problem code number(s):	3-91-310-60
Watercourse:	None
Location:	Alcester (Stratford-upon-Avon District Council)
OS Map reference:	SP 082 593

NATURE OF PROBLEM

The A435 road floods twice a year for up to three hours due to inadequate highway drainage.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£_____
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£_____
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IMPROVEMENT WORKS

This is a Highway Authority problem and is outside the scope of this Survey.

IDENTIFICATION

Problem code number(s): 3-91-310-61
Watercourse: None
Location: Broom (Stratford-upon-Avon District Council)
OS Map reference: SP 078 532

NATURE OF PROBLEM

A 'B' class road floods twice a year for periods up to two hours due to inadequate highway drainage.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in	years
	(ii)	Structures	1 in	years
(b) **Agricultural**	(i)	Channel	1 in	years
	(ii)	Structures	1 in	years
(c) **Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	
	(ii)	Field drainage	£	£_____
(b) **Present value of benefits**	(i)	Agriculture	£	
	(ii)	Buildings	£	
	(iii)	Roads/Railways	£	£_____

(c) **Benefit/cost ratio**
(d) **Priority category**

IMPROVEMENT WORKS

This is a Highway Authority problem and is outside the scope of this Survey.

IDENTIFICATION

Problem code number(s):	3-91-310-62
Watercourse:	River Avon (main river)
Location:	Bidford-on-Avon (Stratford-upon-Avon District Council)
OS Map reference:	SP 099 518

NATURE OF PROBLEM

In 1968 a flood approximating to a 1 in 25 years event affected two shops, a cafe, two public houses and four terraced houses. A class 'A' road was also impassable for 48 hours. Flooding also affected a foul water pumping station causing unnecessary wear to the pumps and damage to electrical control panels, as well as contaminating the flood water by foul sewage. The flooding was caused by the River Avon overtopping its banks upstream and downstream of the B4085 road bridge.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in years
	(ii)	Structures	1 in 100 years
(b) **Agricultural**	(i)	Channel	1 in years
	(ii)	Structures	1 in years
(c) **Land potential category**			

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£ 17,300	
	(ii)	Field drainage	£	£17,300
(b) **Present value of benefits**	(i)	Agriculture	£	
	(ii)	Buildings	£ 20,020	
	(iii)	Roads/Railways	£ negligible	£20,020
(c) **Benefit/cost ratio**				1.2
(d) **Priority category**				2E

IMPROVEMENT WORKS

It is suggested that an increase in height of the existing hard walls by 0.5m at the edge of the river is required to provide a design capacity of 314 cumecs. There is a large recreational ground on the opposite bank of the river where flood water can be contained with little damage being caused. The actual length of wall to be heightened would have to be ascertained by a comprehensive level survey. 100m of wall, together with alterations to steps, railings etc has been costed for this Survey.

BENEFITS

Benefits to road flooding are negligible as a new by-pass for Bidford has been constructed. A new surface water outfall to drain the new and existing road has been constructed and is designed to discharge under hydraulic head given 1968 flood levels. Higher magnitude events would produce some flooding, although the larger sized pipes constructed would provide greater storage than was available before.

COMMENT

Blockage of a bridge opening may have been the major cause of the 1968 flooding.

IDENTIFICATION

Problem code number(s):	3-91-310-66
Watercourse:	Pig Brook (non-main river)
Location:	Tidmington (Stratford-upon-Avon District Council)
OS Map reference:	SP 243 390 to SP 263 398

NATURE OF PROBLEM

40 ha of agricultural land suffer from inadequate arterial drainage.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	5 years
		(ii)	Structures	1 in	years
(c)	**Land potential category**			b	

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	100,900	
		(ii)	Field drainage	£	10,010	£110,910
(b)	**Present value of benefits**	(i)	Agriculture	£	119,470	
		(ii)	Buildings	£		
		(iii)	Roads/Railways	£		£119,470
(c)	**Benefit/cost ratio**					1.1
(d)	**Priority category**					2C

IMPROVEMENT WORKS

The proposed solution is to re-section approximately 2 km of watercourse upstream of the A34 road culvert to provide a design capacity of 1.4 cumecs and also allowing satisfactory freeboard under average flow conditions. It is not proposed to re-section the watercourse downstream of the A34, as this section is affected by the water level in the River Stour preventing proper discharge in times of flood and, secondly, the culvert under the A34 has a concrete invert and would have to be replaced if improvements were carried out downstream. Underpinning a road bridge at SP 259 394 and three footbridges will also be required.

BENEFITS

32 ha would benefit from this improvement scheme.

IDENTIFICATION

Problem code number(s):	3-91-310-68
Watercourse:	Un-named tributary of the River Alne (non-main river)
Location:	Haselor (Stratford-upon-Avon District Council)
OS Map reference:	SP 115 583

NATURE OF PROBLEM

It was originally thought that 57 ha suffer from inadequate arterial drainage. However, the main watercourse in the benefit area has recently been piped in and the upstream flow diverted to an outfall at SP 119 584.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in	years
	(ii)	Structures	1 in	years
(b) **Agricultural**	(i)	Channel	1 in	years
	(ii)	Structures	1 in	years
(c) **Land potential category**			a 5/b	

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	
	(ii)	Field drainage	£	£_____
(b) **Present value of benefits**	(i)	Agriculture	£	
	(ii)	Buildings	£	
	(iii)	Roads/Railways	£	£_____
(c) **Benefit/cost ratio**				
(d) **Priority category**				

IMPROVEMENT WORKS

Two culverts are adequate to contain a design flood of 2 cumecs and although a third surcharges, the water quickly flows back into the watercourse. The existing watercourse sizes are capable of containing the mean annual flood though the depths are not sufficient to give the freeboard necessary for adequate field drainage. No works are proposed (see Benefits).

BENEFITS

MAFF information indicates that no benefit would be achieved by installing land drains and further improving outfall conditions. In parts the gross margin would fall if the area changed to arable from the existing dairying.

IDENTIFICATION

Problem code number(s):	3-91-310-69
Watercourse:	Cod Brook and Tus Brook (non-main river)
Location:	Honington (Stratford-upon-Avon District Council)
OS Map reference:	SP 267 416 to SP 297 415

NATURE OF PROBLEM

120 ha of agricultural land suffer from inadequate arterial drainage.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in years
		(ii)	Structures	1 in years
(b)	**Agricultural**	(i)	Channel	1 in 5 years
		(ii)	Structures	1 in 25 years
(c)	**Land potential category**			b

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	219,100	
		(ii)	Field drainage	£	57,550	£276,650
(b)	**Present value of benefits**	(i)	Agriculture	£	661,240	
		(ii)	Buildings	£		
		(iii)	Roads/Railways	£		£661,240
(c)	**Benefit/cost ratio**					2.4
(d)	**Priority category**					1C

IMPROVEMENT WORKS

The recommended improvement work is to re-section 6 km of the watercourses to provide a design capacity of 1.9 cumecs, but with sufficient freeboard for land drain outfalls to discharge freely in average winter flow conditions. In addition three farm access culverts require underpinning, though the two road culverts are able to convey a 1 in 25 year maximum discharge.

Downstream of the road culvert at SP 269 416 the River Stour holds up flow from the tributaries and unless the water levels are lowered in the main river no benefits can be obtained adjacent to this length of watercourse.

IDENTIFICATION

Problem code number(s):	3-91-310-77
Watercourse:	River Stowe (non-main river)
Location:	Southam (Stratford-upon-Avon District Council)
OS Map reference:	SP 417 617 to SP 446 634

NATURE OF PROBLEM

127 ha of agricultural land, mainly pasture, suffer from inadequate arterial drainage and localised flooding for periods up to 36 hours. Several roads in Southam are also subject to inundation.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in	years
	(ii)	Structures	1 in	years
(b) **Agricultural**	(i)	Channel	1 in 10	years
	(ii)	Structures	1 in	years
(c) **Land potential category**			b	

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	100,900	
	(ii)	Field drainage	£	20,020	£120,920
(b) **Present value of benefits**	(i)	Agriculture	£	636,230	
	(ii)	Buildings	£		
	(iii)	Roads/Railways	£		£636,230
(c) **Benefit/cost ratio**					5.3
(d) **Priority category**					1C

DEVELOPMENT

The Warwickshire County Structure Plan (1975) identified Southam as a key settlement suitable for moderate expansion and the Southam District Plan includes new housing and industrial development. 8.5 ha of housing development land has been allocated adjacent to the River Stowe and surface water would drain direct to the river from this site. Other sites would also discharge surface water into the river via the sewerage system. The river site will only be developed after the proposed Southam by-pass road has been constructed, and no date is available for this at present. In view of this proposed urban development it is suggested that the River Stowe is improved to at least the 1 in 10 years design standard (7.5 cumecs).

IMPROVEMENT WORKS

Improvements would consist of regrading the channel from Southam (SP 417 617) to SP 446 634, to provide satisfactory freeboard under average flow conditions. Various road and farm access culverts would require either replacement or underpinning and the existing weir at Southam Zoo needs lowering.

CONSERVATION

This is an important site with rich flora and fauna.

IDENTIFICATION

Problem code number(s): 3-91-310-81
Watercourse: Cain Brook (non-main river)
Location: Sambourne (Stratford-upon-Avon District Council)
OS Map reference: SP 065 623

NATURE OF PROBLEM

A 'B' class road flooded in 1968, 1972 and 1975 for up to three hours due to an inadequate highway gulley system.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£___
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£___
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IMPROVEMENT WORKS

The watercourse and culvert are theoretically capable of containing a 1 in 50 year discharge. This is a Highway Authority problem and is outside the scope of the Survey.

IDENTIFICATION

Problem code number(s):	3-91-310-82
Watercourse:	Un-named tributary of Cain Brook (non-main river)
Location:	Sambourne (Stratford-upon-Avon District Council)
OS Map reference:	SP 057 625

NATURE OF PROBLEM

A 'B' class road flooded in 1968, 1972 and 1975 for periods up to three hours.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£_____
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£_____
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IMPROVEMENT WORKS

The culvert and watercourse are theoretically capable of containing a 1 in 50 year discharge (0.8 cumecs). However, regular maintenance is required on the watercourse either side of the culvert to keep it free of weed growth.

IDENTIFICATION

Problem code number(s):	3-91-310-83
Watercourse:	Racecourse Brook (non-main river)
Location:	Stratford (Stratford-upon-Avon District Council)
OS Map reference:	SP 194 533 to SP 195 560

NATURE OF PROBLEM

There has been no flooding to property since improvements to the watercourse by the District Council between 1980 an 1982 from the Brook. However, Structure Plan Proposals for new development sites have highlighted the inadequacies of the present system. The problems are made worse by culverts under two highways which are in a poor structural condition and of inadequate capacity.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in 25 years
	(ii)	Structures	1 in 50/100 years (depending on locality)
(b) **Agricultural**	(i)	Channel	1 in years
	(ii)	Structures	1 in years
(c) **Land potential category**			

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	
	(ii)	Field drainage	£	£
(b) **Present value of benefits**	(i)	Agriculture	£	
	(ii)	Buildings	£	
	(iii)	Roads/Railways	£	£
(c) **Benefit/cost ratio**				
(d) **Priority category**				

DEVELOPMENT

The majority of development which could contribute to the brook has now been completed. Some redevelopment of sites is possible.

IMPROVEMENT WORKS

Using the Packman method the 1 in 25 year discharge is 3.7 cumecs, the 1 in 50 year discharge 4.4 cumecs and the 1 in 100 year discharge 5.2 cumecs. The existing 36" diameter pipe discharging to the Stratford-upon-Avon canal at Birmingham Road has a discharge of about 1 cumec. This can be subtracted from the above discharge values to be catered for by downstream lengths of the watercourse. To achieve these capacities all the culverts from Birmingham Road to the Stratford Racecourse have been replaced. The existing culvert beneath the railway line and canal at SP 195 555 still have to be replaced. Most of the open watercourse sections are adequate, requiring only silt and debris removal and pioneering work, though the sections at the rear of houses in Brookvale Road will require re-sectioning.

The District Council is due to culvert a section of brook between Hertford Road and Evesham Road, and is encouraging the Highway Authority to reconstruct its highway culverts. The riparian owners along Brookvale Road are being encouraged to improve the length of brook to the rear of their properties.

IDENTIFICATION

Problem code number(s):	3-91-310-85
Watercourse:	River Avon (main river)
Location:	Stratford - Waterside (Stratford-upon-Avon District Council)
OS Map reference:	SP 203 548

NATURE OF PROBLEM

18 houses, a hotel, a restaurant, a jewellers, a public house, lavatories and a theatre are subject to flooding for durations up to 48 hours by events in excess of the 1 in 10 year return period. Most severe flooding has occurred in 1901, 1932 and 1968, the latter event estimated to have a 20 year return period.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in	years
	(ii)	Structures	1 in 100	years
(b) **Agricultural**	(i)	Channel	1 in	years
	(ii)	Structures	1 in	years
(c) **Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	66,310	
	(ii)	Field drainage	£		£66,310
(b) **Present value of benefits**	(i)	Agriculture	£		
	(ii)	Buildings	£	45,040	
	(iii)	Roads/Railways	£		£45,040
(c) **Benefit/cost ratio**					0.7
(d) **Priority category**					3D

IMPROVEMENT WORKS

It is proposed to construct a 1 m high floodbank adjacent to the road at Waterside, but retaining the maximum flood plain area on the parkland next to the river.

To protect the road and properties from surface water behind the floodbank due to surcharged surface water sewers, a pumping station will be installed. As an estimate a 100 litres/second pump capacity has been used for costing purposes. The pumping station would be a major cost of the scheme and the scheme costs could change significantly following a detailed investigation of pumping requirements.

COMMENT

The District council has carried out, and intends over the next two years, to continue to carry out various river bank wall improvements in this vicinity.

IDENTIFICATION

Problem code number(s):	3-91-310-86
Watercourse:	River Itchen (main river)
Location:	Marton to Stoneythorpe (Stratford-upon-Avon District Council)
OS Map reference:	SP 406 690 to SP 406 621

NATURE OF PROBLEM

422 ha of agricultural land (mostly pasture) suffer from inadequate arterial drainage and localised flooding for up to 48 hours. Flood banks at Long Itchington, built to a 1 in 50 years design standard, protect property that used to flood.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in years
		(ii)	Structures	1 in years
(b)	**Agricultural**	(i)	Channel	1 in 5 years
		(ii)	Structures	1 in 25 years
(c)	**Land potential category**			b

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IMPROVEMENT WORKS

It is proposed that the River Itchen is re-sectioned from Marton to Stoneythorpe to provide a maximum design discharge of 19 cumecs at the downstream end. Existing road culverts will be underpinned except for those on the Long Itchington to Offchurch route (SP 407 650) where a new highway bridge will be required. A number of footbridges and farm accesses will require underpinning or replacement and light to medium pioneering work will be required along certain reaches. Four culverts beneath the railways and one beneath the canal have sufficient capacity to discharge the 1 in 100 years event and will require only minor dredging work.

FISHERIES

This reach is fished by the Long Itchington AC Improvement works which provide better access to the river could be positively beneficial to angling clubs.

COMMENT

Due to a reassessment of priorities, it is unlikely that this scheme will proceed.

IDENTIFICATION

Problem code number(s):	3-91-310-87
Watercourse:	Tributary of Noleham Brook (non-main river)
Location:	Bickmarsh, Nr Dorsington (Stratford-upon-Avon District Council)
OS Map reference:	SP 119 498

NATURE OF PROBLEM

Flooding as a result of inadequate outfall conditions affects 62 ha of agricultural land.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	2 years
		(ii)	Structures	1 in	years
(c)	**Land potential category**			a5	

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	50,200	
		(ii)	Field drainage	£	19,010	£69,210
(b)	**Present value of benefits**	(i)	Agriculture	£	141,030	
		(ii)	Buildings	£		
		(iii)	Roads/Railways	£		£141,030
(c)	**Benefit/cost ratio**					2.0
(d)	**Priority category**					1D

IMPROVEMENT WORKS

Problems are due to an inadequately sized channel and shallow gradient. The watercourse should be regraded/resectioned to its confluence with tributary of Noleham Brook at SP 117 500. This tributary should be cleared out to its confluence with Noleham Brook.

IDENTIFICATION

Problem code number(s):	3-91-310-88
Watercourse:	Minor tributary of River Stour (non-main river)
Location:	Whatcote (Stratford-upon-Avon District Council)
OS Map reference:	SP 305 443

NATURE OF PROBLEM

Occasional flooding of up to 63 ha results from inadequate outfall conditions on this overgrown watercourse with shallow gradient. The ford downstream of confluence with tributary of River Stour keeps levels back to a certain extent.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in	years
	(ii)	Structures	1 in	years
(b) **Agricultural**	(i)	Channel	1 in	2 years
	(ii)	Structures	1 in	years
(c) **Land potential category**			b	

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	52,060	
	(ii)	Field drainage	£	15,330	£67,390
(b) **Present value of benefits**	(i)	Agriculture	£	291,100	
	(ii)	Buildings	£		
	(iii)	Roads/Railways	£		£291,100
(c) **Benefit/cost ratio**					4.3
(d) **Priority category**					10

IMPROVEMENT WORKS

The watercourse needs cleaning out and regrading to confluence with tributary of River Stour at SP 286 456.

IDENTIFICATION

Problem code number(s):	3-91-310-90
Watercourse:	Tributary of River Avon (non-main river)
Location:	Welford on Avon (Stratford-upon-Avon District Council)
OS Map reference:	SP 145 515

NATURE OF PROBLEM

Inadequate culvert. 1 house flooded. 1 in 5 years return period. Caravan site and Market Garden (total 3 ha) flooded and waterlogged 2-3 times a year. 1 road flooded but not impassable.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£_____
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£_____
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IMPROVEMENT WORKS

The District Council have replaced the culvert and are not aware of any problems since completion of the scheme in 1987.

IDENTIFICATION

Problem code number(s):	3-91-410-1
Watercourse:	None
Location:	Kingswood (Warwick District Council)
OS Map reference:	SP 197 703

NATURE OF PROBLEM

A 'C' class road floods due to inadequate highway drainage.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£_____
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£_____
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IMPROVEMENT WORKS

This is a Highway Authority problem and is outside the scope of this Survey.

IDENTIFICATION

Problem code number(s):	3-91-410-2
Watercourse:	None
Location:	Holywell to Shrewley (Warwick District Council)
OS Map reference:	SP 202 668

NATURE OF PROBLEM

A class 'C' road floods every year for periods up to 12 hours.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IMPROVEMENT WORKS

There are no highway ditches or gullies available and no watercourse in the near vicinity. This is a Highway Authority problem and is outside the scope of this Survey.

IDENTIFICATION

Problem code number(s):	3-91-410-3/16
Watercourse:	Tachbrook (non-main river)
Location:	Bishops Tachbrook (Warwick District Council)
OS Map reference:	SP 316 617 to SP 285 634

NATURE OF PROBLEM

60 ha of agricultural land suffer from inadequate arterial drainage, some 10-20 ha of land are permanently flooded and the A452 road suffers from periodic flooding. The road flooding has now been alleviated by the construction of a new road bridge by Warwickshire County Council.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	5 years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				b

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	86,490	
		(ii)	Field drainage	£	27,520	£114,010
(b)	**Present value of benefits**	(i)	Agriculture	£	600,110	
		(ii)	Buildings	£		
		(iii)	Roads/Railways	£		£600,110
(c)	**Benefit/cost ratio**					5.3
(d)	**Priority category**					1D

IMPROVEMENT WORKS

There are two main causes of the inadequate drainage:

(i) The osier beds (SP 297 635) have been used as a private tip and the resultant ground pressure due to the tipped material and the heavy plant used, has caused the channel width to be reduced from 3m to 1m in places.

(ii) New Waters (SP 290 634) once a lake controlled by a downstream weir has now completely silted up. The proposed solution, therefore, includes lowering the control weir to New Waters by 450mm, cutting a new channel through the silted up bed and resectioning 1 km of channel further upstream.

BENEFITS

At present 48 ha of land is used as permanent pasture. Increases in gross margin are anticipated with improved drainage, and benefits are high as 12 ha of land are under water and currently have zero productivity.

IDENTIFICATION

Problem code number(s):	3-91-410-7
Watercourse:	River Avon (main river)
Location:	Bridge End (Warwick District Council)
OS Map reference:	SP 286 647

NATURE OF PROBLEM

Three cottages flooded in 1968, 1971 and 1975 for up to 12 hours. The maximum recorded flood is estimated to have a frequency of 1 in 25 years. The problem is caused by the high water level in the River Avon impounded by the weir adjacent to Warwick Castle.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in years
		(ii)	Structures	1 in 100 years
(b)	**Agricultural**	(i)	Channel	1 in years
		(ii)	Structures	1 in years
(c)	**Land potential category**			

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	15,530	
		(ii)	Field drainage	£		£11,530
(b)	**Present value of benefits**	(i)	Agriculture	£		
		(ii)	Buildings	£	10,010	
		(iii)	Roads/Railways	£		£10,010
(c)	**Benefit/cost ratio**					0.8
(d)	**Priority category**					3E

IMPROVEMENT WORKS

Proposals have been formulated by the Higher Avon Navigation Trust to open the River Avon to leisure craft to Warwick. Navigation works include dredging up to the weir but require that the weir level is not significantly altered.

The dredging works should reduce the frequency of flooding, but it is suggested that in addition a protection bank is required in the rear garden of the properties, to provide a design standard of 203 cumecs.

Flooding is also caused by backing up and surcharging in the drainage system and any sewerage works to protect properties from this cause will increase the cost of alleviation works.

IDENTIFICATION

Problem code number(s):	3-91-410-8
Watercourse:	Un-named tributary of River Avon (non-main river)
Location:	Ashow (Warwick District Council)
OS Map reference:	SP 311 705

NATURE OF PROBLEM

In July 1968 roads in the village, a house and a post office were flooded for up to eight hours from an event estimated to have a 20 year return period. The flooding was primarily caused by a blockage in the existing culvert and by the lack of road gullies in the village.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£_____
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£_____
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IMPROVEMENT WORKS

The watercouse is culverted in the vicinity where the flooding occurred. This brick arch culvert is theoretically capable of conveying a 1 in 50 year discharge (1 cumec) although septic tank dscharges and surface water run-off from the Kenilworth by-pass further up the catchment, probably marginally reduces this capacity. A new inlet works comprising wing walls and a screen has been constructed since the flooding occurred and additional works are not recommended.

IDENTIFICATION

Problem code number(s):	3-91-410-9/12
Watercourse:	Inchford Brook and Finham Brook (non-main river)
Location:	Kenilworth (Warwick District Coucil)
OS Map reference:	SP 250 688 to SP 280 722

NATURE OF PROBLEM

The arterial drainage of 280 ha of agricultural land is inadequate. Agricultural land has also flooded for periods up to 48 hours, six times since 1968 and a 'B' road floods three to four times each year.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in years
		(ii)	Structures	1 in years
(b)	**Agricultural**	(i)	Channel	1 in 5 years
		(ii)	Structures	1 in 25 years
(c)	**Land potential category**			b

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	187,390	
		(ii)	Field drainage	£	190,160	£377,550
(b)	**Present value of benefits**	(i)	Agriculture	£	516,760	
		(ii)	Buildings	£		
		(iii)	Roads/Railways	£		£516,760
(c)	**Benefit/cost ratio**					1.2
(d)	**Priority category**					2C

IMPROVEMENT WORKS

The only solution to alleviate the road flooding at Finham Brook ford (SP 282 722) is a comprehensive road scheme to raise levels and the construction of a new road bridge. In view of the high cost of these proposals in relation to minimal benefits it is suggested that improvements are carried out upstream only and channelled down to the existing ford. This would create better outfall conditions further up the catchment but would marginally increase flooding at the ford. Channel improvements would provide a channel discharge of 9.8 cumecs at the confluence of the Finham and Inchford Brook. Three culverts will also need to be underpinned.

IDENTIFICATION

Problem code number(s): 3-91-410-10
Watercourse: Un-named tributary of Gog Brook (non-main river)
Location: Hatton (Warwick District Council)
OS Map reference: SP 247 670

NATURE OF PROBLEM

A minor road floods annually for periods up to two hours due to inadequate highway drainage or possibly a blockage in the road culvert.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in	years	
	(ii)	Structures	1 in	years	
(b) **Agricultural**	(i)	Channel	1 in	years	
	(ii)	Structures	1 in	years	
(c) **Land potential category**					

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	
	(ii)	Field drainage	£	£
(b) **Present value of benefits**	(i)	Agriculture	£	
	(ii)	Buildings	£	
	(iii)	Roads/Railways	£	£
(c) **Benefit/cost ratio**				
(d) **Priority category**				

IMPROVEMENT WORKS

This is a Highway Authority problem, no improvement works are proposed. Existing culverts and channels are theoretically capable of containing discharges in excess of the 1 in 50 years event.

IDENTIFICATION

Problem code number(s):	3-91-410-15
Watercourse:	Un-named tributary of River Leam (non-main river)
Location:	Radford Semele (Warwick District Council)
OS Map reference:	SP 335 624 to SP 338 651

NATURE OF PROBLEM

The arterial drainage of 40 ha of agricultural land is inadequate.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in years
		(ii)	Structures	1 in years
(b)	**Agricultural**	(i)	Channel	1 in 5 years
		(ii)	Structures	1 in years
(c)	**Land potential category**			b

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	100,900	
		(ii)	Field drainage	£	7,510	£108,410
(b)	**Present value of benefits**	(i)	Agriculture	£	180,590	
		(ii)	Buildings	£		
		(iii)	Roads/Railways	£		£180,590
(c)	**Benefit/cost ratio**					1.7
(d)	**Priority category**					2C

IMPROVEMENT WORKS

The proposed solution is to re-section approximately 2.5 km of the watercourse upstream from the canal culvert at SP 338 649, to provide a design capacity of 3.8 cumecs (plus 0.9 cumecs, which represents the maximum discharge fom the overflow on the Grand Union Canal at SP 338 649). No proposals are suggested downstream of this point because of the effect of the River Leam and the restrictions of the road and canal culverts, which are adequate at present but costly to underpin if a deeper channel is required downstream.

IDENTIFICATION

Problem code number(s):	3-91-410-17
Watercourse:	Finham Brook (non-main river)
Location:	Stoneleigh (Warwick District Council)
OS Map reference:	SP 307 730 to SP 333 740

NATURE OF PROBLEM

62 ha of agricultural land suffer from inadequate arterial drainage and localised flooding from discharges greater than the 1 in 3 years event.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in	years
	(ii)	Structures	1 in	years
(b) **Agricultural**	(i)	Channel	1 in	5 years
	(ii)	Structures	1 in	25 years
(c) **Land potential category**				b

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	210,450	
	(ii)	Field drainage	£	42,540	£252,990
(b) **Present value of benefits**	(i)	Agriculture	£	113,910	
	(ii)	Buildings	£		
	(iii)	Roads/Railways	£		£113,910
(c) **Benefit/cost ratio**					0.5
(d) **Priority category**					3C

DEVELOPMENT

Increased surface water discharge can be expected from the moderate development in the Canley Brook catchment discharging to Finham brook at SP 307 730, and from infilling development in Kenilworth. New development has also restricted the area of floodplain.

IMPROVEMENT WORKS

To cater for this increased discharge and alleviate the existing problems it is suggested that the watercourse is re-sectioned to provide a maximum channel design discharge of 19 cumecs at the downstream end. Work will also include the replacement of two bridges, a highway bridge and a farm access culvert.

BENEFITS

The benefit area associated with improvements to this length is very narrow because the land rises steeply away from the watercourse, and here land drainage is not adversely affected.

Although the Finham Brook does not cause flooding through Kenilworth, one or two houses have experienced garden flooding from the 1 in 7 years event and benefits from the alleviation of potential flooding of the houses could be included in a further feasibility study.

HYDROLOGY

Some 17 percent of the Finham Brook catchment area is urbanised and discharge calculations have been adjusted in accordance with Packman's method.

IDENTIFICATION

Problem code number(s):	3-91-410-19
Watercourse:	River Avon (main river)
Location:	Warwick (Warwick District Council)
OS Map reference:	SP 301 658

NATURE OF PROBLEM

Flooding occurs to the offices, storerooms and car parks of Pottertons (boilermakers) factory during flood events in excess of the 1 in 5 year return period. Flooding occurred in 1968, '71, '75, '77 and '79; the 1968 flood estimated at the 1 in 20 year event with a duration of 48 hours.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in 100 years
		(ii)	Structures	1 in years
(b)	**Agricultural**	(i)	Channel	1 in years
		(ii)	Structures	1 in years
(c)	**Land potential category**			

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	57,660	
		(ii)	Field drainage	£		£57,660
(b)	**Present value of benefits**	(i)	Agriculture	£		
		(ii)	Buildings	£	11,270	
		(iii)	Roads/Railways	£		£11,270
(c)	**Benefit/cost ratio**					0.2
(d)	**Priority category**					30

IMPROVEMENT WORKS

The recommended works require the construction of a flood bank/wall adjacent to the river to provide a channel design standard of 139 cumecs. A pumping station will have to be installed to pump surface water over the wall which will increase costs substantially.

IDENTIFICATION

Problem code number(s):	3-91-410-20
Watercourse:	River Avon (main river)
Location:	Guy's Cliffe to Rock Mill (Warwick District Council)
OS Map reference:	SP 291 671 to SP 301 262

NATURE OF PROBLEM

In 1968 a flood estimated to have a 1 in 20 years recurrence interval affected a greyhound racing track together with associated offices and kennels. In addition, 10 ha of land suffer from inadequate arterial drainage. The problem is due to the impounded level of the River Avon at Rock Mill.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years - not estimated
(c)	**Land potential category**			a	

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	11,530	
		(ii)	Field drainage	£	7,510	£19,040
(b)	**Present value of benefits**	(i)	Agriculture	£	6,950	
		(ii)	Buildings	£	negligible	
		(iii)	Roads/Railways	£		£6,950
(c)	**Benefit/cost ratio**					0.4
(d)	**Priority category**					3E

IMPROVEMENT WORKS

At present there is just over 300mm of fall in normal water level between Rock Mill and the downstream side of Guy's Cliffe Mill (a distance of 1.5km). A lowering of the present weir levels at Rock Mill is required to improve land drainage conditions and reduce the frequency of flooding. Any scheme would have to take account of increased velocities and levels that would be created downstream. The greyhound track is in the Avon floodplain and any proposals to alter this floodplain to protect the track would increase flooding downstream.

FISHERIES

The river has changed from being virtually fishless in 1974 to one supporting a fairly good population. It is likely, therefore, that any extensive channel works downstream of the weir would be viewed with suspicion by the anglers. However, it is more likely that a lowering of the weir level at Rock Mill would improve the fishery downstream if it resulted in increased velocities.

IDENTIFICATION

Problem code number(s):	3-91-410-21
Watercourse:	Un-named tributary of the River Avon (non-main river)
Location:	Millers Road (Warwick District Council)
OS Map reference:	SP 280 660

NATURE OF PROBLEM

Flooding occurs to a machine tool manufacturing workshop and a car bodies repair workshop, together with associated yards and car parks, for periods up to 12 hours, most recently in 1975, '77 and '79. The maximum recorded flood is estimated to have a 1 in 7 years recurrence interval.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IMPROVEMENT WORKS

Flooding occurs from an open watercourse section through the Millers Road industrial estate where the majority of the watercourse has been culverted. The upstream length is culverted in a smaller size pipe than recommended by the former SRA. Although flooding in 1975 may have been partly caused by a blockage in the downstream culvert, because the watercourse collects water from a completely built up urban area, it is suggested that a detailed investigation is required on the whole length of watercourse to ascertain gradients, capacities and surcharge levels. This type of comprehensive survey is not within the scope of this Survey although an initial investigation based on run-off from the natural catchment suggests that capacities in the watercourse are not sufficient.

Difficulties may arise from any scheme because of the many riparian owners involved, and because the riparian owners of the section of watercourse that causes flooding are not affected by flood waters themselves.

IDENTIFICATION

Problem code number(s):	3-91-410-23
Watercourse:	Tributary of River Avon (non-main river)
Location:	Longbridge (Warwick District Council)
OS Map reference:	SP 269 627

NATURE OF PROBLEM

Inadequate gradient of the watercourse causes water to stand and leads to flooding of up to 14 ha of agricultural land.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in 2	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**			b	

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	11,620	
		(ii)	Field drainage	£	6,130	£17,750
(b)	**Present value of benefits**	(i)	Agriculture	£	101,250	
		(ii)	Buildings	£		
		(iii)	Roads/Railways	£		£101,250
(c)	**Benefit/cost ratio**					5.7
(d)	**Priority category**					1E

IMPROVEMENT WORKS

Regrading of the watercourse to upstream side of A41 culvert is required.

IDENTIFICATION

Problem code number(s): 3-91-510-1
Watercourse: None
Location: Fillongley (North Warwickshire Borough Council)
OS Map reference: SP 295 873

NATURE OF PROBLEM

A 'B' class road floods due to inadequate highway drainage. (Wood End Lane).

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£_____
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£_____
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IMPROVEMENT WORKS

This is a Highway Authority problem and is outside the scope of this survey.

IDENTIFICATION

Problem code number(s):	3-91-510-2
Watercourse:	None
Location:	Fillongley (North Warwickshire Borough Council)
OS Map reference:	SP 294 863

NATURE OF PROBLEM

A 'B' class road floods due to inadequate highway drainage. (Square Lane).

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£_____
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£_____
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IMPROVEMENT WORKS

This is a Highway Authority problem and is outside the scope of this survey.

IDENTIFICATION

Problem code number(s):	8-91-510-1
Watercourse:	Bourne Brook (non-main river)
Location:	Fillongley (North Warwickshire Borough Council)
OS Map reference:	SP 281 871

NATURE OF PROBLEM

Flooding has occurred to a class 'C' road and a public house twice in the last 10 to 15 years and was caused by the blockage of the inlet screen to a culverted section of the Brook. The screen is now regularly maintained and, in addition, the culvert was cleaned out by Warwickshire County Council Highways Division. No flooding has occurred in recent years and no further work can be recommended. Flooding occurs regularly in the centre of Fillongley. The last event was on 31 December 1981 affecting the Post Office. Flooding is attributable to debris collection on an inadequately designed inlet screen and the possible inadequate capacity of the culvert.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£____
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£____
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IMPROVEMENT WORKS

Warwickshire County Council as Highway Authority carried out maintenance and cleaning out work of the culvert adjacent to the Post Office and there has been no recurrence of flooding there. They are monitoring the situation.

IDENTIFICATION

Problem code number(s):	8-91-510-2
Watercourse:	Bourne Brook (non-main river)
Location:	Fillongley (North Warwickshire Borough Council)
OS Map reference:	SP 281 871

NATURE OF PROBLEM

Flooding occurs to a class 'C' road and results from surface water run-off from the highway. Works to watercourses will not alleviate the problem and the solution is, therefore, outside the scope of this Survey.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IDENTIFICATION

Problem code number(s):	8-91-510-3
Watercourse:	River Tame (main river)
Location:	Water Orton (North Warwickshire Borough Council)
OS Map reference:	SP 188 919

NATURE OF PROBLEM

Flooding occurred twice in 1960 and again in 1968 to Minworth Water Reclamation Works and a class 'B' road. This area is within the normal floodplain of the River Tame but a higher standard of protection was provided by the Trent River Authority when an improvement scheme was carried out on the Tame to provide for flows up to 113 cumecs between Curdworth Bridge and Parkhall Farm.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£____
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£____
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

COMMENT

A feasibility exercise has been carried out by the Authority and capital works are programmed to commence in 1991.

IDENTIFICATION

Problem code number(s):	8-91-510-4
Watercourse:	River Anker (main river)
Location:	Polesworth (North Warwickshire Borough Council)
OS Map reference:	SK 261 023

NATURE OF PROBLEM

When the River Anker overtops its banks a class 'B' road floods for periods of about two hours. The flooding occurs to washland only and this is essential in order not to exacerbate flooding downstream. Maintenance work on the river has been carried out and this will alleviate the incidence of flooding to a limited extent.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IDENTIFICATION

Problem code number(s):	8-91-510-5
Watercourse:	Un-named (non-main river)
Location:	Austrey (North Warwickshire Borough Council)
OS Map reference:	SK 292 067

NATURE OF PROBLEM

Gardens are flooded approximately twice a year and a class 'C' road is also flooded but not to such a depth that it is impassable to vehicles.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in 50 years
		(ii)	Structures	1 in years
(b)	**Agricultural**	(i)	Channel	1 in years
		(ii)	Structures	1 in years
(c)	**Land potential category**			

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	5,770	
		(ii)	Field drainage	£		£5,770
(b)	**Present value of benefits**	(i)	Agriculture	£		
		(ii)	Buildings	£		
		(iii)	Roads/Railways	£		£
(c)	**Benefit/cost ratio**					0
(d)	**Priority category**					3F

IMPROVEMENT WORKS

Resectioning works to a small watercourse will provide alleviation.

IDENTIFICATION

Problem code number(s):	8-91-510-6
Watercourse:	Langley Brook (non-main river)
Location:	Middleton (North Warwickshire District Council)
OS Map reference:	SP 188 982 to SP 148 955

NATURE OF PROBLEM

Inadequate outfalls for field drainage to the Langley Brook result in poor drainage of 115 ha of agricultural land.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in - years
	(ii)	Structures	1 in years
(b) **Agricultural**	(i)	Channel	1 in 5 years
	(ii)	Structures	1 in 25 years
(c) **Land potential category**			a5

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	115,320	
	(ii)	Field drainage	£	105,090	£220,410
(b) **Present value of benefits**	(i)	Agriculture	£	344,510	
	(ii)	Buildings	£		
	(iii)	Roads/Railways	£		£344,510
(c) **Benefit/cost ratio**					1.6
(d) **Priority category**					2C

IMPROVEMENT WORKS

It is recommended that the channel should be enlarged and regraded over a length of 5 km to provide a maximum design discharge of 7 cumecs. Two new box culverts will be required where the minor roads from Middleton cross the Brook.

FISHERIES

The Fisheries Office should be notified prior to the commencement of any works.

IDENTIFICATION

Problem code number(s):	8-91-510-7
Watercourse:	Penmire Brook (non-main river)
Location:	Grendon (North Warwickshire District Council)
OS Map reference:	SK 285 002

NATURE OF PROBLEM

Minor highway flooding and flooding of a school playground occurs approximately twice per year.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IMPROVEMENT WORKS

The Penmire Brook at Grendon has a complex drainage system involving a canal feeder, two road crossings, two rail crossings and a canal crossing. Maintenance work is required at these structures together with some structural repair work. The existing flooding situation will be improved by clearance of these structures. At present it is difficult to survey the structures and, therefore, their maximum capacity is uncertain.

The Warwickshire County Land Agent's proposed scheme was not proceeded with due to lack of co-operation from riparian owners. The possible contribution from British Coal failed to materialise as they abandoned proposals for "The Orchard" opencast site. North Warwickshire District Council are monitoring the situation.

IDENTIFICATION

Problem code number(s):	8-91-510-8
Watercourse:	River Bourne (non-main river)
Location:	Fillongley (North Warwickshire District Council)
OS Map reference:	SP 258 898 to SP 273 888

NATURE OF PROBLEM

A limited area of grade two farmland is subject to flooding and inadequate arterial drainage.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in	years
	(ii)	Structures	1 in	years
(b) **Agricultural**	(i)	Channel	1 in	years
	(ii)	Structures	1 in	years
(c) **Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	
	(ii)	Field drainage	£	£
(b) **Present value of benefits**	(i)	Agriculture	£	
	(ii)	Buildings	£	
	(iii)	Roads/Railways	£	£
(c) **Benefit/cost ratio**				
(d) **Priority category**				

IMPROVEMENT WORKS

Warwickshire County Land Agents are considering a possible scheme despite the low benefits attributable.

IDENTIFICATION

Problem code number(s):	8-91-510-9
Watercourse:	Un-named Tributary of Bar Pool Brook (non-main river)
Location:	Plough Hill, Nuneaton (North Warwickshire District Council)
OS Map reference:	SP 320 926

NATURE OF PROBLEM

13 and 15 Plough Hill Road were flooded to 0.6 m in December and July 1981. Flooding is caused by an undersized culvert.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£____
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£____
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IMPROVEMENT WORKS

The Highway Authority carried out maintenance work on their culvert and no flooding has occurred since. North Warwickshire District Council are monitoring the situation.

IDENTIFICATION

Problem code number(s):	8-91-510-10
Watercourse:	River Bourne (main river)
Location:	Furnace End (North Warwickshire District Council)
OS Map reference:	SP 248 913

NATURE OF PROBLEM

Mill Garage premises, a road and adjoining farmland flooded on 31 December 1981.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

COMMENT

The flooding at Mill Garage premises on 31 December 1981 was not considered to be attributable to lack of channel capacity on the River Bourne downstream of Furnace End, but due to channel inadequacy of the upstream section which is non-main river.

The problem has been partially alleviated by improvements to the B4114 Road Bridge.

IDENTIFICATION

Problem code number(s):	8-91-510-11
Watercourse:	Un-named watercourse (non-main river)
Location:	Duke End, Maxstoke Hill Farm (North Warwickshire District Council)
OS Map reference:	SP 218 883

NATURE OF PROBLEM

Farmland adjoining the River Blythe is permanently waterlogged upstream of Duke Bridge.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IMPROVEMENT WORKS

Approximately 50 ha of pasture land upstream of Duke Bridge has a field drainage system drained via a carrier drain crossing the Blythe by two syphons and outfalling downstream of Duke Bridge weir. The Authority's River Blythe Capital Improvement Scheme from Castle Farm to the M6 (completed 1982) has provided an outfall for the 50 ha of pasture land upstream of Duke Bridge and there is now an opportunity for a riparian owners' voluntary scheme to be undertaken.

IDENTIFICATION

Problem code number(s):	3-92-110-1
Watercourse:	Tributary of Canley Brook (non-main river)
Location:	Templar Avenue, Coventry (City of Coventry Council)
OS Map reference:	SP 294 781

NATURE OF PROBLEM

A pharmaceutical warehouse flooded regularly from 1974-1976 for periods up to 12 hours as the warehouse was built on an existing culverted watercourse to wrong levels. The riparian owner has since kept the watercourse free from debris and no recent flooding has been reported. No further works are proposed.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£_____
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£_____
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IDENTIFICATION

Problem code number(s):	3-92-110-2
Watercourse:	River Sherbourne (non-main river)
Location:	Coventry City Centre (City of Coventry Council)
OS Map reference:	SP 328 788 to SP 342 788

NATURE OF PROBLEM

Shops, commercial premises and roads are at risk from flooding. The degree of risk has not been determined but extensive flooding occurred in 1900. Sime improvements to the River Sherbourne have been made since then.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	63,500	
		(ii)	Field drainage	£		£63,500
(b)	**Present value of benefits**	(i)	Agriculture	£		
		(ii)	Buildings	£	1,277,250	
		(iii)	Roads/Railways	£	41,920	£1,319,170
(c)	**Benefit/cost ratio**					20.7
(d)	**Priority category**					1D

IMPROVEMENT WORKS

The City of Coventry Council have carried out a survey into the capacity and condition of the culverted and open channel sections of the River Sherbourne through the City Centre. The survey covered existing protection levels to houses, shops and industrial premises.

Costs based on a balancing pond at Four Pounds Avenue.

IDENTIFICATION

Problem code number(s):	3-92-110-3
Watercourse:	Un-named Tributary of River Sherbourne (non-main river)
Location:	Broad Lane, Hockley Lane (City of Coventry Council)
OS Map reference:	SP 272 798

NATURE OF PROBLEM

A petrol filling station and adjacent roads are subject to annual flooding for periods up to six hours. The maximum recorded flood is estimated to have a 25 year recurrence interval. The City Council have carried out a feasibility study.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in 5 years (Storm frequency)
	(ii)	Structures	1 in years
(b) **Agricultural**	(i)	Channel	1 in years
	(ii)	Structures	1 in years
(c) **Land potential category**			

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	345,950	
	(ii)	Field drainage	£		£345,950
(b) **Present value of benefits**	(i)	Agriculture	£		
	(ii)	Buildings	£	15,010	
	(iii)	Roads/Railways	£	45,040	£60,050
(c) **Benefit/cost ratio**					0.2
(d) **Priority category**					3C

IMPROVEMENT WORKS

The recommended improvement is to culvert the entire length of the watercourse (300m) to a 1 in 5 year storm frequency standard. It is proposed that the works are carried out as part of the Hawkehurst Moor Deep Mine project.

IDENTIFICATION

Problem code number(s):	3-92-110-4
Watercourse:	Springfield Brook (non-main river)
Location:	Coventry (City of Coventry Council)
OS Map reference:	SP 337 814

NATURE OF PROBLEM

Two houses flood on average every three years, four houses and a church on average every five years and a factory on average every 25 years. The City Council have carried out a feasibility study of the problem. Recent flooding has occurred in 1968 and 1972 for a maximum duration of 12 hours.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in years
	(ii)	Structures	1 in 5 years (Storm frequency)
(b) **Agricultural**	(i)	Channel	1 in years
	(ii)	Structures	1 in years
(c) **Land potential category**			

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	1,643,250	
	(ii)	Field drainage	£		£1,643,250
(b) **Present value of benefits**	(i)	Agriculture	£		
	(ii)	Buildings	£	15,010	
	(iii)	Roads/Railways	£		£15,010
(c) **Benefit/cost ratio**					0
(d) **Priority category**					3A

IMPROVEMENT WORKS

The recommended improvement is to reconstruct the existing culverted watercourse in a 1.5m diameter tunnel. Associated surface water sewerage will cost a further £230,000. Flooding of the factory and the church will be relieved by the sewerage improvements.

IDENTIFICATION

Problem code number(s):	3-92-110-7
Watercourse:	Un-named Tributary of Canley Brook (non-main river)
Location:	Canley (City of Coventry Council)
OS Map reference:	SP 306 775

NATURE OF PROBLEM

A 'C' class road and three gardens flood on average every five years for periods up to four hours due to blockage of the road culvert.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in 50 years
	(ii)	Structures	1 in years
(b) **Agricultural**	(i)	Channel	1 in years
	(ii)	Structures	1 in years
(c) **Land potential category**			

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	14,410	
	(ii)	Field drainage	£		£14,410
(b) **Present value of benefits**	(i)	Agriculture	£		
	(ii)	Buildings	£	1,260	
	(iii)	Roads/Railways	£	negligible	£1,260
(c) **Benefit/cost ratio**					0.1
(d) **Priority category**					3E

IMPROVEMENT WORKS

The suggested improvement is to construct 20m of new culvert to divert the watercourse into Canley Brook, thus by-passing the existing road culvert providing a design discharge of six cumecs. A more expensive alternative proposal involves building a larger culvert beneath the road.

IDENTIFICATION

Problem code number(s):	3-92-110-8
Watercourse:	River Sherbourne (non-main river)
Location:	Washbrook Lane (City of Coventry Council)
OS Map reference:	SP 294 821

NATURE OF PROBLEM

A 'C' class road flooded in 1968, 1970 and 1975 for periods up to four hours due to both inadequate highway drainage and overtopping of the River Sherbourne.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in 10 years
		(ii)	Structures	1 in 25 years
(b)	**Agricultural**	(i)	Channel	1 in years
		(ii)	Structures	1 in years
(c)	**Land potential category**			

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£ 8,650	
		(ii)	Field drainage	£	£8,650
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£negligible	£negligible
(c)	**Benefit/cost ratio**				0
(d)	**Priority category**				3f

IMPROVEMENT WORKS

Approximately 100m of watercouse requires re-sectioning, and a culvert beneath the entry to 'Stone House' requires replacement to provide a channel design capacity of 3.4 cumecs.

IDENTIFICATION

Problem code number(s):	3-92-110-9
Watercourse:	River Sherbourne/Pickford Brook (non-main river)
Location:	Allesley (City of Coventry Council)
OS Map reference:	SP 307 803

NATURE OF PROBLEM

Approximately five ha of agricultural land suffer from inadequate arterial drainage and have flooded five times since 1968 for periods up to 48 hours. The land is within the floodplain of the River Sherbourne and improvements cannot be recommended as this could worsen conditions in other parts of the catchment.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(c)	**Land potential category**				

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	
		(ii)	Field drainage	£	£_____
(b)	**Present value of benefits**	(i)	Agriculture	£	
		(ii)	Buildings	£	
		(iii)	Roads/Railways	£	£_____
(c)	**Benefit/cost ratio**				
(d)	**Priority category**				

IDENTIFICATION

Problem code number(s):	3-93-410-1
Watercourse:	River Swift (non-main river)
Location:	Walton (Harborough District Council)
OS Map reference:	SP 587 864 to SP 600 864

NATURE OF PROBLEM

The arterial drainage of 9 ha of agricultural land is inadequate and pastureland floods on average every five years for periods up to 10 hours.

DESIGN STANDARDS

(a)	**Urban**	(i)	Channel	1 in	years
		(ii)	Structures	1 in	years
(b)	**Agricultural**	(i)	Channel	1 in	5 years
		(ii)	Structures	1 in	years
(c)	**Land potential category**			a5	

ECONOMIC EVALUATION (December 1989 price base)

(a)	**Costs**	(i)	Arterial works	£	23,060	
		(ii)	Field drainage	£	10,010	£33,070
(b)	**Present value of benefits**	(i)	Agriculture	£	41,670	
		(ii)	Buildings	£		
		(iii)	Roads/Railways	£		£41,670
(c)	**Benefit/cost ratio**					1.3
(d)	**Priority category**					2E

IMPROVEMENT WORKS

The proposed solution consists of re-channelling sections, pioneering work and fence removal and re-erection to provide a design capacity of 2.4 cumecs.

IDENTIFICATION

Problem code number(s):	3-93-410-2/4
Watercourse:	Bitteswell Brook (non-main river)
Location:	Lutterworth (Harborough District Council)
OS Map reference:	SP 542 868 to SP 519 822

NATURE OF PROBLEM

90 ha of agricultural land suffer from inadequate arterial drainage and localised annual flooding for periods up to 12 hours.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in	years
	(ii)	Structures	1 in	years
(b) **Agricultural**	(i)	Channel	1 in	5 years
	(ii)	Structures	1 in	50 years
(c) **Land potential category**				a5

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	77,840	
	(ii)	Field drainage	£	95,080	£172,920
(b) **Present value of benefits**	(i)	Agriculture	£	405,630	
	(ii)	Buildings	£		
	(iii)	Roads/Railways	£		£405,630
(c) **Benefit/cost ratio**					2.3
(d) **Priority category**					1D

IMPROVEMENT WORKS

The recommended improvement is to re-section the watercourse from Bitteswell Hall Park (SP 542 868) to the confluence with the River Swift at Bransford Bridge (SP 519 822), to provide a channel design capacity of 3.9 cumecs allowing satisfactory freeboard for field drainage under average flow conditions. Two roadbridges and one footbridge will require replacing.

DEVELOPMENT

Since 1986, 250 houses have been constructed on 9.5 ha of land off Bitteswell Road. The permission was granted on appeal and the reserved matters application provided for a surface water balancing reservoir to serve the site.

A further site of 3.96 ha south of Maino Crescent has also been developed. STWA also indicated that improvements were required to the watercourse to cater for additional surface water run-off from the development but the developor could not obtain the cooperation of downstream riparion owners.

Surface water balancing was again carried out with no improvements to the watercourse.

The downstream flooding problems still exist.

IDENTIFICATION

Problem code number(s):	3-93-410-5
Watercourse:	Un-named tributary of River Avon (non-main river)
Location:	South Kilworth (Harborough District Council)
OS Map reference:	SP 601 820 to SP 606 810

NATURE OF PROBLEM

24 ha of agricultural land suffer from inadequate arterial drainage.

DESIGN STANDARDS

(a) **Urban**	(i)	Channel	1 in	years
	(ii)	Structures	1 in	years
(b) **Agricultural**	(i)	Channel	1 in	5 years
	(ii)	Structures	1 in	years
(c) **Land potential category**			a5	

ECONOMIC EVALUATION (December 1989 price base)

(a) **Costs**	(i)	Arterial works	£	40,360	
	(ii)	Field drainage	£	25,020	£65,380
(b) **Present value of benefits**	(i)	Agriculture	£	55,570	
	(ii)	Buildings	£		
	(iii)	Roads/Railways	£		£55,570
(c) **Benefit/cost ratio**					0.8
(d) **Priority category**					3E

IMPROVEMENT WORKS

The recommended improvement is to re-section the watercourse for approximately 750m and to carry out medium to heavy pioneering work to 350m of the downstream length, to provide a design capacity of about 1.2 cumecs. The watercourse discharges to the Stanford Reservoir via a syphon beneath the River Avon. At times of flood a central valve is manually operated to divert the discharge to the Avon.

BENEFITS

Because of the discharge conditions at Stanford Reservoir causing backup there will be little benefit to about 8 ha of the downstream section of the benefit area. At present the area is mainly arable except for an area of rough pasture to the north of the B5414.

CONSERVATION

There are three small marshes of botanical interest at SP 601 817, SP 602 816 and SP 601 818.

APPENDIX A2

SCHEDULE OF MAIN RIVER

SCHEDULE OF MAIN RIVERS IN THE UPPER SEVERN AREA - JANUARY 1990

WATERCOURSE	LOCATION	FROM NGR	TO NGR	LENGTH (KM)	CATCHMENT NO
ACRE BROOK	R Severn confluence to upstream face of outfall structure	SJ 316 160	SJ 315 159	0.28	1
ADFORTON BROOK	Wigmore Main Drain confluence to a point upstream of Green Lane Bridge, Adforton	SO 420 706	SO 415 704	0.48	2
ALLCOCKS BROOK	Wigmore Main Drain confluence to Allcocks Bridge	SO 420 706	SO 425 693	1.45	2
BACK BROOK	R Roden confluence to Stang's Plantation	SJ 514 286	SJ 484 291	3.70	1
BAILEY BROOK	R Tern confluence to Hoarstone Lane Bridge	SJ 629 315	SJ 610 337	4.67	1
BELE BROOK	R Severn confluence to Wern Bridge	SJ 283 158	SJ 253 137	4.14	1
BLACK BROOK	Smestow Brook confluence to the A454 road bridge	SO 839 959	SO 836 967	1.00	2
BROMLEY BROOK	R Perry confluence to Bagley-Shade Oak road bridge	SJ 399 252	SJ 410 274	3.70	1
BUCKLEY FARM BROOK	R Severn confluence to upstream face of Buckley Farm outfall	SJ 363 166	SJ 364 167	0.20	1
RIVER CAMLAD	R Severn confluence to Snead Bridge	SJ 209 006	SO 320 918	29.23	1
RIVER CERIST	R Severn confluence to Van road bridge (B4518)	SO 025 915	SN 915 874	9.50	1
RIVER CLYWEDOG	R Severn confluence to Clywedog Dam	SN 954 848	SN 913 869	5.31	1
COMMISSION DRAIN	R Tern confluence to Kynnersley road bridge	SJ 615 149	SJ 650 176	5.25	1
RIVER CORVE	R Teme confluence to Beam Bridge	SO 506 750	SO 532 882	22.85	2
CRIGGION BROOK	R Severn confluence to upstream face of outfall structure	SJ 314 161	SJ 313 161	0.04	1
CRUCKTON BROOK	Rea Brook confluence to upstream of confluence with right bank tributary	SJ 432 098	SJ 428 102	0.70	1
DUNKETT BROOK	R Severn confluence to upstream face of Dunkett outfall	SJ 356 170	SJ 357 174	0.40	1
RIVER EIRTH	R Tanat confluence to 250m upstream of B4391 bridge at Llangynog	SJ 055 260	SJ 051 263	0.56	1
ELMBRIDGE BROOK	R Salwarpe confluence to road bridge near Cooksey Green	SO 885 629	SO 894 696	8.69	2
RIVER GARNO	R Severn confluence to Wig Bridge	SO 027 917	SO 017 926	1.50	1
GUILSFIELD BROOK	Bele Brook confluence to Lower Varchoel Farm	SJ 253 137	SJ 236 126	2.30	1
GWYFER BROOK	R Severn confluence to upstream face of outfall structure	SJ 292 166	SJ 291 166	0.07	1
HADLEY BROOK	R Salwarpe confluence to the B4192 road bridge	SO 869 620	SO 869 713	14.64	2
HEN AFON	R Vyrnwy confluence to outfall structure	SJ 155 127	SJ 153 128	0.26	1
HOO BROOK	R Stour confluence to A448	SO 829 746	SO 847 755	2.25	2
HURLEY BROOK	Commission Drain confluence to overflow structure on Northern Interceptor sewer	SJ 641 159	SJ 653 151	1.17	1
KYRE BROOK	R Tame confluence to confluence with a minor watercourse downstream of Splash Bridge	SO 599 685	SO 602 672	1.88	2
LAUGHERN BROOK	R Teme confluence to the Worcester - Martley road bridge near Kenswick Manor	SO 834 526	SO 796 580	12.71	2
LONCO BROOK	R Meese confluence to Whitleyford Bridge	SJ 737 217	SJ 746 238	4.83	1
RIVER MEESE	R Tern confluence to Aqualate Mere	SJ 638 208	SJ 765 208	22.60	1
RIVER MORDA	R Vyrnwy confluence to Newbridge road bridge	SJ 293 207	SJ 304 254	14.80	1
RIVER ONNY	R Teme confluence to confluence of Quinny Brook	SO 485 766	SO 436 843	12.34	2
OSWESTRY BROOK	R Morda confluence to the major surface water outfalls at Oswestry	SJ 316 238	(SJ 302 290) (SJ 300 284)	7.40	1

SEC24/35

SCHEDULE OF MAIN RIVERS IN THE UPPER SEVERN AREA (CONTINUED)

WATERCOURSE	LOCATION	FROM NGR	TO NGR	LENGTH (KM)	CATCHMENT NO
PENTRE BROOK	R Vyrnwy confluence to downstream face of road culvert at Pentre	SJ 166 137	SJ 151 135	1.74	1
RIVER PERRY	R Severn confluence to Hillyards Plantation	SJ 440 166	SJ 315 334	30.09	1
POTFORD BROOK	R Tern confluence to the downstream face of A442 culvert	SJ 638 208	SJ 634 223	2.30	1
REA BROOK	R Severn confluence to Marton Pool	SJ 496 123	SJ 298 028	37.65	1
RIVER REA	R Teme confluence to the A4117 road bridge at Cleobury Mortimer	SO 636 686	SO 680 763	18.02	2
RIVER RED STRINE	R Strine confluence to Humber Brook confluence	SJ 644 174	SJ 685 165	5.31	1
RIVER RODEN	R Tern confluence to Blackhurstford Bridge	SJ 593 124	SJ 462 334	43.44	1
RIVER SALWARPE	R Severn confleunce to Upton Warren Bridge	SO 841 601	SO 933 674	23.01	2
RIVER SEVERN	R Teme confluence to R Clywedog confluence	SO 850 521	SN 954 848	218.00	1 + 2
SLEAP BROOK	R Roden confluence to bridge on minor road from Brandwood to Noneley	SJ 505 281	SJ 471 271	4.30	1
SMESTOW BROOK	R Stour confluence to the upstream face of the canal culvert	SO 863 855	SJ 898 006	25.27	2
SOULTON BROOK	R Roden confluence to Creamery Bridge	SJ 545 294	SJ 541 337	5.15	1
RIVER STOUR	R Severn confluence to the downstream end of Overend Tunnel, Cradley	SO 812 708	SO 949 851	41.79	2
STRINE BROOK	Soulton Brook confluence to road bridge at Steel Heath	SJ 550 308	SJ 554 363	6.35	1
RIVER STRINE	R Tern confluence to downstream face of canal culvert	SJ 629 176	SJ 752 200	15.00	1
RIVER TANAT	R Vyrnwy confluence to 300m downstream of Llangynog bridge	SJ 243 207	SJ 055 260	26.00	1
RIVER TEME	R Severn confluence to sewage works outfall at Knighton	SO 850 521	SO 301 724	107.07	2
RIVER TERN	R Severn confluence to Walkmill Bridge, Market Drayton	SJ 553 091	SJ 672 335	45.21	1
TETCHILL AND NEWNES BROOK	R Perry confluence to upstream face of culvert at Dudleston Heath	SJ 380 296	SJ 365 363	10.70	1
RIVER TRANNON	R Cerist confluence to the B4569 road bridge at Trefeglwys	SO 012 910	SN 969 903	5.52	1
RIVER VYRNWY	R Severn confluence to downstream end of the Vyrnwy dam spillway	SJ 328 159	SJ 019 192	66.06	1
WALL BROOK	R Strine confluence to syphon at junction of Kynnersley Drive and Shropshire Union Canal	SJ 675 181	SJ 687 165	2.14	1
WEIR BROOK	R Severn confluence to upstream face of outfall structure	SJ 345 169	SJ 344 169	0.05	1
WEIR BROOK (new cut)	R Severn confluence to upstream face of outfall structure	SJ 345 171	SJ 344 171	0.04	1
WERN-DDU BROOK	R Vyrnwy confluence to the Melverley IDB outfall on the B4398	SJ 283 202	SJ 282 206	0.56	1
WIGMORE MAIN DRAIN	R Teme confluence to the head of the drain	SO 431 717	SO 415 696	3.22	2
RIVER WORFE	R Severn confluence to Broad Bridge, Stapleford	SO 725 952	SO 762 982	15.14	1
WORTHEN BROOK	Rea brook confluence to the Ford at Worthen	SJ 334 042	SJ 327 045	0.80	1
TOTAL				960.83	

SCHEDULE OF MAIN RIVERS IN THE LOWER SEVERN AREA - JANUARY 1990

WATERCOURSE	LOCATION	FROM NGR	TO NGR	LENGTH (KM)	CATCHMENT NO
RIVER ALNE	R Arrow confluence to Botley Mill Farm Bridge	SP 093 573	SP 144 684	22.69	3
RIVER ARROW	R Avon confluence to Coventry Highway Bridge, Redditch	SP 083 507	SO 055 680	25.00	3
RIVER AVON	R Severn confluence to road bridge at Welford	SO 888 331	SP 645 808	180.94	3
BADSEY BROOK	R Avon confluence to A44 road bridge, Wickhamford	SP 050 454	SP 065 413	6.27	3
BIRDINGBURY BROOK	R Leam confluence to upstream face of culvert on Birdingbury-Offchurch Road	SP 418 685	SP 427 677	1.40	3
BOW BROOK	R Avon confluence to Shell Ford, Himbleton	SP 919 426	SO 951 596	25.90	3
BRETFORTON BROOK	Badsey Brook confluence to Stoneford Barn	SP 066 443	SP 097 426	4.32	3
RIVER CAM	Gloucester and Sharpness Canal to Lower Cam	SO 739 051	SO 752 002	7.15	2
CAPEHALL BROOK	Wicksters Brook confluence to upstream face of M5 Motorway culvert	SO 756 048	SO 762 038	1.45	2
CAREYS BROOK	R Severn confluence to upstream face of A4021 road bridge	SO 849 506	SO 834 507	2.50	2
CARRANT BROOK	R Avon confluence to Aston on Carrant road bridge	SO 895 334	(SO 940 349) (SO 940 348)	8.10	3
RIVER CHELT	R Severn confluence to railway bridge, Cheltenham	SO 848 262	SO 936 232	14.81	2
CLAYCOTON BROOK	R Avon confluence to unnamed tributary flowing from Elkington	SP 564 778	SP 607 754	8.20	3
CLIFTON BROOK	R Avon confluence to Clifton road bridge	SP 515 775	SP 521 759	0.90	3
COLLIERS BROOK	R Leadon confluence to upstream face of the A417 road bridge	SO 776 235	SO 799 260	4.00	2
DEAN BROOK	R Swilgate confluence to the A435 road bridge	SO 911 283	SO 955 286	4.83	2
DEERHURST PARISH DRAIN	R Severn confluence to the drain head	SO 846 264	SO 878 271	3.22	2
RIVER DENE	R Avon confluence to Wellesbourne Mill	SP 258 563	SP 284 544	4.83	3
DIMORE BROOK	R Severn confluence to upstream face of the A38 road bridge	SO 794 150	SO 807 131	2.94	2
DOVERTE BROOK	R Little Avon confluence to upstream face of the B4509 road bridge at Berkeley	ST 677 992	ST 684 990	0.84	2
ELL BROOK	R Leadon confluence to upstream face of Ell Bridge, Newent	SO 774 245	SO 721 264	6.80	2
RIVER FROME	R Severn confluence to bridge on Frampton Mansell - Trillis road	SO 751 106	SO 929 030	34.59	2
GLYNCH BROOK	R Leadon confluence to upstream face of Berry Bridge, Staunton	SO 771 275	SO 783 294	4.00	2
HASFIELD DRAIN	R Severn confluence to upstream face of B4213 road culvert	SO 844 270	SO 842 281	1.58	2
HATHERLEY BROOK	R Severn confluence to upstream face of Arle Bridge	SO 826 210	SO 914 218	11.53	2
HORSBERE BROOK	R Severn confluence to upstream face of Brockworth road bridge	SO 828 209	SO 892 169	9.84	2
RIVER ISBOURNE	R Avon confluence to Wormington Bridge	SP 031 431	SP 037 364	9.07	3
RIVER ITCHEN	R Leam confluence to R Stowe confluence	SP 406 690	SP 406 620	12.55	3
RIVER LEADON	R Severn confluence to England's Bridge near Bosbury	SO 817 199	SO 692 440	39.00	2
RIVER LEAM	R Avon confluence to road bridge on Grandborough-Woolscott road	SP 301 657	SP 495 672	39.09	3
LEIGH BROOK	R Chelt confluence to Knight's Bridge	SO 853 259	SO 893 268	5.40	2

SCHEDULE OF MAIN RIVERS IN THE LOWER SEVERN AREA - (CONTINUED)

WATERCOURSE	LOCATION	FROM NGR	TO NGR	LENGTH (KM)	CATCHMENT NO
LEIGH PARISH DRAIN	R Chelt confluence to approx 300m downstream of footbridge on Coombe Hill Canal (disused)	SO 851 261	SO 877 270	3.38	2
RIVER LITTLE AVON	R Severn confluence to upstream face of railway bridge	SO 661 006	ST 728 902	20.04	2
LITTLETON BROOK	Bretforton Brook confluence to tributary upstream of North Littleton	SP 073 443	SP 084 478	4.34	3
LONGDON BROOK	R Severn confluence to confluence with Berry Meadow Brook	SO 868 362	SO 810 335	9.87	2
MARCHFONT BROOK	R Avon confluence to Clifford Chambers - Long Marston road bridge	SP 159 521	SP 169 513	1.61	3
MILL AVON	R Severn confluence to downstream face of Abbey Mill sluice	SO 879 317	SO 892 330	1.80	2
MILLHOLME BROOK	R Leam confluence to downstream side of bridge on road running SW from Grandborough	SP 460 681	SP 483 659	4.02	3
MYTHE BROOK	R Severn confluence to upstream face of Bow Bridge	SO 886 342	SO 879 364	2.69	2
NOLEHAM BROOK	R Avon confluence to access bridge at Pitchell Farm, south of Broad Marston	SP 117 514	SP 145 454	9.81	3
NORMANS BROOK	Hatherley Brook confluence to railway bridge at Churchdown	SO 874 222	SO 895 204	3.38	2
PIDDLE BROOK	R Avon confluence to the A442 at Grafton Flyford	SO 954 465	SO 964 555	14.48	3
RED BROOK	R Leadon confluence to upstream face of road bridge at Taynton	SO 776 222	SO 751 231	4.12	2
RIVER SEVERN	Avonmouth (East bank) and Beachley Point (West Bank) to R Teme confluence	(ST 513 798) (ST 550 903)	SO 850 521	130.00	1 + 2
SHELL BROOK	Shell Ford to Brandon Brook confluence	SO 951 596	SO 006 602	6.40	3
RIVER SHERBOURNE	R Sowe confluence to Whitley Bridge	SP 346 757	SP 349 771	2.74	3
SHORN BROOK	Gloucester and Sharpness Canal to minor road at Hardwicke	SO 791 128	SO 794 125	0.40	2
SHOTTERY BROOK	R Avon confluence to upstream face of culvert under the Stratford-on-Avon canal	SP 184 535	SP 187 560	3.00	3
RIVER SOWE	R Avon confluence to Longford Bridge (A444)	SP 324 724	SP 349 832	24.94	3
STOCK GREEN BROOK	Shell Brook confluence to downstream face of road culvert in Stock Green	SO 956 599	SO 981 587	3.15	3
RIVER STOUR	R Avon confluence to Mitford Bridge	SP 183 534	SP 263 371	36.42	3
RIVER STOWE	R Itchen confluence to Daventry road bridge, Southam	SP 406 620	SP 423 619	2.48	3
STROUD WATER	R Frome confluence to Wall Bridge culvert, Stroud	SO 831 047	SO 848 051	1.77	2
RIVER SWIFT	R Avon confluence to Lutterworth water reclamation works outfall	SP 505 768	SP 541 835	11.50	3
RIVER SWILGATE	Mill Avon confluence to Stoke Orchard Bridge	SO 887 323	SO 914 281	7.00	2
TIBBERTON BROOK	Red Brook confluence to upstream face of Wynford Bridge	SO 756 231	SO 752 226	0.68	2
TIRLE BROOK	R Swilgate confluence to Aston Cross Bridge	SO 897 325	SO 942 336	5.95	2
WHADDON BROOK	Gloucester and Sharpness Canal to downstream end of culvert, Lower Tuffley	SO 815 157	SO 824 146	1.40	2
WHITSUN BROOK	Piddle Brook confluence to Bishampton - Abberton road bridge	SO 962 510	SO 991 522	4.40	3

SCHEDULE OF MAIN RIVERS IN THE LOWER SEVERN AREA – (CONTINUED)

WATERCOURSE	LOCATION	FROM NGR	TO NGR	LENGTH (KM)	CATCHMENT NO
WICKSTERS BROOK	R Cam confluence to upstream face of M5 Motorway culvert	SO 742 049	SO 766 049	2.85	2
WITHY BROOK	R Sowe confluence to B4029	SP 385 802	SP 410 827	4.00	3
WOTTON BROOK	Horsbere Brook confluence to Cole Bridge, Gloucester	SO 833 210	SO 847 191	2.57	2
TOTAL				834.93	

SCHEDULE OF MAIN RIVERS IN THE UPPER TRENT AREA - JANUARY 1990

WATERCOURSE	LOCATION	FROM NGR	TO NGR	LENGTH (KM)	CATCHMENT NO
RIVER ANKER	R Tame confluence to Stretton Baskerville Brook confluence	SK 206 038	SP 403 909	38.34	8
BELL BROOK	R Penk confluence to Pillaton Bridge	SJ 923 145	SJ 940 130	2.41	7
BENTLEY (BRADBOURNE) BROOK	R Dove confluence to Woodeaves Mill Bridge	SK 160 462	SK 185 503	6.44	6
RIVER BLITHE	R Trent confluence to north of Blythe Bridge	SK 114 176	SJ 951 416	39.00	7
RIVER BLYTHE	R Tame confluence to Earlswood Reservoir	SP 212 916	SP 114 742	40.47	8
BOURNE BROOK	R Tame confluence to Footherley Brook confluence	(SK 210 017) (SK 209 016)	SK 108 051	18.83	8
RIVER BOURNE	R Tame confluence to Furnace End Bridge	SP 216 916	SP 248 912	4.10	8
BRAMCOTE BROOK	R Anker confluence to downstream face of M42 culverts	SK 264 040	(SK 276 056) (SK 279 061)	3.85	8
CHURCH EATON BROOK	R Penk confluence to Mitton Manor Farm	SJ 916 142	SJ 889 148	3.68	7
RIVER CHURNET	R Dove confluence to Tittesworth Reservoir	SK 102 375	SJ 994 586	40.50	6
RIVER COLE	R Blythe confluence to Cole Ford, near Shard End	SP 212 912	SP 143 885	14.11	8
COLESHILL HALL BROOK	R Cole confluence to the M42 outfall	SP 190 882	SP 195 877	1.00	8
COMBERFORD BROOK	R Tame confluence to field boundary upstream of footbridge north-west of Wigginton	SK 190 075	SK 204 072	1.80	8
CURBOROUGH BROOK	R Trent confluence to Curborough reclamation works outfall	SK 166 155	SK 127 129	5.70	7
DARLASTON BROOK	R Tame confluence to downstream face of Murdoch Road culvert	SO 981 982	SO 961 967	2.85	8
DOLEY BROOK	Church Eaton Brook confluence to Norbury Park, north-west of Gnossall	SJ 892 150	SJ 808 225	13.68	7
RIVER DOVE	R Trent confluence to Okeover Bridge	SK 280 261	SK 164 481	54.86	6
ENDON BROOK	R Churnet confluence to flood wall 40m above railway culvert	SJ 968 534	SJ 928 531	5.82	6
FEATHERSTONE BROOK	R Penk confluence to Cat and Kittens Lane, Featherstone	SJ 905 066	SJ 923 050	2.90	7
FOOTHERLEY BROOK	Bourne Brook confluence to Blake Street Culvert	SK 108 051	SK 105 008	5.95	8
FORS BROOK	R Blithe confleunce to downstream face of the footbridge, Forsbrook	SJ 960 406	SJ 965 417	1.36	7
FOSTON BROOK	R Dove confluence to Boylestone	SK 195 299	SK 179 359	8.45	6
GILWISKAW BROOK	R Meese confluence to near Nook Farm, Ashby-de-la-Zouch	SK 336 101	SK 359 155	6.91	7
GROVELAND BROOK	R Tame confluence to manhole 80m north of Tividale Road	SO 974 916	SO 964 908	1.50	8
HARROW BROOK	R Anker confluence to downstream face of Brodick Road Bridge	SP 389 911	SP 409 938	4.15	8
HATCHFORD BROOK	Kingshurst Brook confluence to the downstream face of Eastern Bridge	SP 167 860	SP 166 860	0.60	8
HENMORE BROOK	R Dove confluence to Carsington Reservoir	SK 160 447	SK 244 504	13.53	6
HILTON BROOK	R Dove confluence to Longford	SK 265 274	SK 219 369	13.52	6
HOLLYWELL BROOK	R Blythe confluence to M42 outfall	SP 214 839	SP 199 836	1.75	8
HORTON BROOK	Endon Brook confluence to A53 road bridge	SJ 936 540	SJ 934 541	0.41	6
KINGSHURST BROOK	R Cole confluence to Hatchford Brook confluence	SP 179 874	SP 167 860	1.50	8
KINGSTON BROOK	R Penk confluence to upstream face of A513 road bridge	SJ 946 229	SJ 939 242	1.45	7
LEASOW BROOK	R Tame confluence to Birmingham & Fazeley Canal	SK 189 082	SK 178 077	1.30	8

SCHEDULE OF MAIN RIVERS IN THE UPPER TRENT AREA – (CONTINUED)

WATERCOURSE	LOCATION	FROM NGR	TO NGR	LENGTH (KM)	CATCHMENT NO
LONGNOR BROOK	Wheaton Aston Brook confluence to Station Road, Wheaton Aston	SJ 869 141	SJ 855 124	2.05	7
LOW BROOK	Kingshurst Brook confluence to downstream face of railway culvert	SP 172 864	SP 179 846	2.00	8
MARE BROOK	R Tame confluence to upstream face of A38(T) road culvert	SK 174 115	SK 141 096	4.80	8
MARSTON BROOK	Wheaton Aston Brook confluence to Birchmoor Lane	SJ 845 141	SJ 827 143	1.98	7
RIVER MEASE	R Trent confluence to Gilwiskaw Brook confluence	SK 196 147	SK 336 101	25.57	7
MEECE BROOK	R Sow confluence to Swinchurch Brook confluence	SJ 874 282	SJ 823 363	16.94	7
MOAT BROOK	R Penk confluence to 200m above Wood Road, Codsall	SJ 890 037	SJ 859 037	4.30	7
MOTTY MEADOWS BROOK	Wheaton Aston Brook confluence to Wrestlers Wood	SJ 845 141	SJ 825 133	1.60	7
NUNEATON FLOOD RELIEF CHANNEL	R Anker confluence to inlet from the R Anker	SP 365 927	SP 379 917	1.80	8
OTHERTON BROOK	R Penk confluence to railway bridge near Lyne Hill	SJ 922 144	SJ 923 129	1.61	7
RIVER PENK	R Sow confluence to Pendeford Mill Lane bridge	SJ 946 229	SJ 891 036	26.87	7
PICKNALL BROOK	R Dove confluence to confluence 260m downstream of Loxley Lane	SJ 116 319	SK 066 326	6.31	6
RAVENSHAW BROOK	R Blythe confluence to M42 outfall	SP 178 792	SP 173 789	0.80	8
RISING BROOK	R Penk confluence to A449 culvert	SJ 936 212	SJ 920 214	2.60	7
ROLLESTON BROOK	Tutbury Mill Fleam confluence to 200m upstream of Bushton Bridge	SK 242 282	SK 206 262	4.41	6
SAREDON BROOK	R Penk confluence to Golly Brook confluence	SJ 903 075	SJ 972 087	8.35	7
SCOTCH BROOK	R Trent confluence to downstream face of canal culvert	SJ 902 334	SJ 902 337	0.26	7
SENCE BROOK	R Sence confluence to confluence of R Tweed and Stapleton Brook	SP 326 999	SP 409 989	12.47	8
RIVER SENCE	R Anker confluence to B591 at Heather	SP 315 991	SK 394 109	20.33	8
SHADOW BROOK	R Blythe confluence to M42 outfall	SP 216 825	SP 192 809	3.00	8
SKETCHLEY BROOK	Harrow Brook confluence to downstream face of Brookfield Road Bridge	SP 392 916	SP 421 928	3.50	8
RIVER SOW	R Trent confluence to Pershall	SJ 995 226	SJ 818 297	28.83	7
SWAN BROOK	Tipton Brook confluence to downstream face of manhole adjacent Birmingham New Road	SO 963 927	SO 947 918	3.00	8
RIVER TAME	R Trent confluence to Ashes Road, Oldbury and downstream face of James Bridge, Willenhall	SK 192 149	(SO 985 875) (SO 976 987)	87.72	8
TATENHILL BROOK	R Trent confluence to SK 220 203	SK 227 209	SK 220 203	1.00	7
RIVER TEAN	R Dove confluence to footbridge near Noah's Ark Farm	(SK 102 355) (SK 106 344)	SK 062 360	7.80	6
TIPTON BROOK	R Tame confluence to Swan Brook confluence	SO 979 935	SO 963 927	1.90	8
RIVER TRENT	R Dove confluence to footbridge at Stoke-on-Trent	SK 280 261	SJ 901 513	87.00	5 + 7
TUTBURY MILL FLEAM	R Dove confluence to sluice at Dove confluence	SK 249 284	SK 204 294	6.40	6
WHEATON ASTON BROOK	Church Eaton Brook confluence to Motty Meadows Brook confluence	SJ 889 148	SJ 845 141	4.30	7

SCHEDULE OF MAIN RIVERS IN THE UPPER TRENT AREA - (CONTINUED)

WATERCOURSE	LOCATION	FROM NGR	TO NGR	LENGTH (KM)	CATCHMENT NO
WITHERLEY BROOK	R Anker confluence to upstream face of Chapel Lane road bridge	SP 323 981	SP 328 976	0.80	8
WYRLEY BROOK	Golly Brook confluence to Charrington Drive	SJ 972 087	SJ 986 078	1.85	7
TOTAL				744.87	

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SCHEDULE OF MAIN RIVERS IN THE LOWER TRENT AREA (CONTINUED)

WATERCOURSE	LOCATION	FROM NGR	TO NGR	LENGTH (KM)	CATCHMENT NO
RATCLIFFE-ON-SOAR POWER STATION DRAIN	R Soar confluence to upstream face of railway culvert	SK 491 298	SK 497 296	0.70	4
RATCLIFFE-ON-SOAR VILLAGE DRAIN	R Soar confluence to upstream face of railway culvert	SK 493 289	SK 497 285	1.29	4
REPTON BROOK	R Trent confluence to Lawn Bridge	SK 317 285	SK 313 252	4.50	7
ROTHLEY BROOK	R Soar confluence to the A50	SK 592 132	SK 542 070	11.26	4
RIVER RYTON	R Idle confluence to Bracebridge, Worksop	SK 658 921	SK 585 790	28.96	5
SAUNDBY BECK	R Trent confluence to Laneham IDD boundary	SK 807 881	SK 790 879	1.74	5
RIVER SENCE	R Soar confluence to Great Glen	SP 552 985	SP 656 981	19.31	4
SILEBY BROOK	R Soar confluence to Sileby Village	SK 591 148	SK 602 150	1.00	4
SNOW SEWER	R Trent confluence to Snow Sewer pumping station	SK 813 994	SK 731 986	9.01	5
RIVER SOAR	R Trent confluence to footbridge upstream of Sharnford	SK 494 309	SP 463 909	75.73	4
SODBRIDGE DRAIN	Middle Beck confluence to upstream face of railway culvert	SK 805 508	SK 816 528	2.53	5
SOUTH LEVEL ENGINE DRAIN	Keadby pumping station to Bull Hassocks pumping station	SE 835 113	SE 731 017	17.25	5
SOUTH LEVEL ENGINE SOAK DRAIN	South Idle Drain to north of Aucklands Farm	SE 735 040	SE 738 034	2.00	5
SOUTH SOAK DRAIN	Keadby pumping station to Thorne	SE 835 113	SE 681 132	16.57	5
RIVER TORNE	R Trent confluence to the A60 at Styrrup Carr	SE 836 113	SE 588 906	39.42	5
RIVER TORNE SOAK DRAIN (CANDY FARM)	Ring Drain confluence to Blaxton Banks	SE 704 037	SE 673 028	3.94	5
RIVER TORNE SOAK DRAIN (TUNNEL PITS)	Southern side of Syphon under R Torne into Tunnel Pits pumping station to Wroot Common	SE 735 040	SE 717 040	2.20	5
RIVER TRENT	R Humber confluence to R Dove confluence	SE 863 235	SK 280 261	193.00	5 + 7
TUNNEL PITS SUCTION DRAIN	Tunnel Pits pumping station to North Idle Drain at East Ring Drain	SE 735 040	SE 736 044	0.55	5
TWYFORD BROOK	Queniborough Brook confluence to the Dairy Farm	SK 643 131	SK 736 094	15.89	4
WATERTON DRAIN	Woodhouse Sewer confluence to Diggin Dyke confluence	SE 662 066	SE 662 064	0.21	5
WENSLEY BROOK	R Derwent confluence to upstream face of Oldfield Lane Bridge	SK 270 621	SK 269 619	0.13	6
WHETSTONE BROOK	R Soar confluence to Bottom End Bridge, Countesthorpe	SP 548 974	SP 558 969	1.34	4
WILNE DRAIN	R Derwent outfall to 230m north-east of Beech cottage	SK 452 314	SK 440 307	1.59	6
WOODCARR SUCTION DRAIN	Woodcarr pumping station to junction with Woodcarr Small Drain	SE 753 088	SE 754 088	0.06	5
WOODHOUSE SEWER	Hatfield Waste Drain to Green Lane, Waterton Carr	SE 685 082	SE 660 066	3.22	5
RIVER WREAKE	R Soar confluence to Stapleford Park	SK 596 127	SK 815 187	40.42	4
RIVER WYE	R Derwent confluence to the A6 upstream of Ashford-in-the-Water	SK 260 655	SK 179 698	17.29	6
TOTAL				1,032.40	

SCHEDULE OF MAIN RIVERS IN THE LOWER TRENT AREA - JANUARY 1990

WATERCOURSE	LOCATION	FROM NGR	TO NGR	LENGTH (KM)	CATCHMENT NO
ALFRETON BROOK	R Amber confluence to Fordbridge Lane	SK 387 564	SK 440 577	6.84	6
RIVER AMBER	R Derwent confluence to Ogston Reservoir	SK 347 515	SK 380 598	16.03	6
BAR BROOK	R Derwent confluence to tributary confluence 60m upstream of Derwent Valley Aqueduct, near Baslow	SK 256 712	SK 262 725	1.77	6
BARROW DRAIN	Main Drain confluence to SK 350 302	SK 368 303	SK 350 302	1.80	6
BENTLEY BROOK	R Derwent confluence to stilling pond south of Lumsdale	SK 300 598	SK 312 605	1.78	6
RIVER BIAM	Downstream confluence with R Soar to upstream confluence with R Soar	SK 579 028	SK 577 024	0.48	4
BLACK BROOK	R Soar confluence to Grace Dieu Brook	SK 521 220	SK 487 209	5.15	4
BOTTESFORD BECK	R Trent confluence to Emanuel Bridge	SE 837 061	SE 925 084	9.98	5
BOTTLE BROOK	R Derwent confluence to Smithy Houses (North) & Bottlebrook Houses (South)	SK 359 407	(SK 386 471) (SK 389 460)	9.00	6
BROUGHTON ASTLEY BROOK	R Soar confluence to surface water outlet from Harborough DC housing development	SP 520 963	SP 528 923	5.00	4
BURTON BROOK	R Sence confluence to Burton Overy	SP 654 974	SP 675 980	2.41	4
CANDY FARM SUCTION DRAIN	Candy Farm pumping station to Hatfield Chase IDB Boundary	SE 698 031	SE 698 037	0.60	5
CASTLE DONINGTON BROOK	R Trent confluence to outfall of surface water sewer	SK 455 300	(SK 449 284) (SK 448 277)	3.33	7
CHADDESDEN BROOK	R Derwent confluence to Lees Brook confluence	SK 375 358	SK 384 372	1.83	6
COSBY BROOK	R Soar confluence to Cambridge Road, Cosby	SP 536 970	SP 547 952	3.22	4
CUTTLE BROOK	R Trent confluence to Sinfin Moor	SK 377 281	SK 370 302	2.41	6
RIVER DERWENT	R Trent confluence to outfall from Ladybower Reservoir	SK 459 308	SK 199 853	88.78	6
RIVER DEVON	R Trent confluence to Knipton reservoir	SK 790 533	SK 818 309	32.94	5
DIGGIN DYKE	Waterton Drain confluence to balancing area	SE 662 064	SE 657 050	2.03	5
DOVER BECK	R Trent confluence to Lowdham Mill (downstream limit of control structures)	SK 695 451	(SK 666 474) (SK 666 473)	5.20	5
RIVER EAU	R Trent confluence to Dunstall Beck	SE 837 033	SK 891 940	16.41	5
RIVER ECCLESBOURNE	R Derwent confluence to weir upstream of Windley Bridge	SK 350 432	SK 319 447	5.28	6
EGGINTON BROOK	R Trent confluence to Radbourne Brook, Etwall	SK 285 269	SK 264 336	9.36	6
EMINSONS DYKE	R Eau confluence to Messingham Catchwater Drain confluence	SE 879 026	SE 884 027	0.50	5
RIVER EREWASH	R Trent confluence to downstream face of B6018 road bridge, Kirkby-in-Ashfield	SK 514 330	SK 485 548	39.66	5
FAIRHAM BROOK	R Trent confluence to surface water outfall from new development on left bank	SK 560 366	SK 556 328	4.60	5
FOSSE DYKE	R Trent confluence to Torksey road bridge	SK 834 781	SK 838 781	0.32	5
GRASSTHORPE BECK	R Trent confluence to downstream end of control structure at Grassthorpe Mill	SK 816 673	SK 792 676	3.12	5
GREAT CATCHWATER DRAIN	Ravensfleet pumping station to the A159 at Wharton	SK 800 960	SK 839 934	6.40	5
RIVER GREET	R Trent confluence to outfall at Lower Kirklington Road, Southwell	SK 743 515	SK 705 547	6.80	5
GREYTHORNE DYKE	R Trent confluence to upstream of Wilford Road	SK 575 375	SK 572 368	0.81	5
HALLOUGHTON DUMBLE DRAIN	Marlock Dyke confluence to Southwell reclamation works	SK 737 523	SK 726 526	1.37	5

SCHEDULE OF MAIN RIVERS IN THE LOWER TRENT AREA - (CONTINUED)

WATERCOURSE	LOCATION	FROM NGR	TO NGR	LENGTH (KM)	CATCHMENT NO
HARWORTH DYKE	R Torne confluence to major surface water outfall from Harworth	SK 606 926	SK 614 916	1.50	5
HATFIELD WASTE DRAIN	Keadby pumping station to Woodhouse Sewer, Hatfield Woodhouse	SE 835 113	SE 685 082	17.70	5
HERMITAGE BROOK	R Soar confluence to railway and Moor Lane	SE 544 215	(SK 553 196) (SK 551 194)	3.30	4
RIVER IDLE	R Trent confluence to Twyford Bridge, Gamston	SK 790 947	SK 699 752	48.75	5
KILBY BROOK	R Sence confluence to downstream face of Kilby Road culvert	SP 616 963	SP 618 955	1.00	4
LANEHAM BECK	R Trent confluence to Askham Drain	SK 815 770	SK 774 740	5.60	5
LEAS BROOK	R Meden confluence to surface water outfall at Mansfield Woodhouse	SK 555 672	SK 547 642	3.60	5
RIVER LEEN	R Trent confluence to Linby Mill, Papplewick	SK 566 381	SK 546 510	17.52	5
LEES BROOK	Chaddesden Brook confluence to minor watercourse confluence	SK 384 372	SK 387 373	0.35	6
LOW BANK SUCTION) DRAIN/ANCHOR DRAIN)	Low Bank pumping station to the M180	SE 739 086	SE 729 090	1.06	5
LUBBESTHORPE BROOK	R Soar confluence to downstream face of Meridian Park culvert	SK 564 007	SK 552 008	1.43	4
MAIN DRAIN	Osmaston Drain confluence to outfall from balancing pond, Sinfin Moor	SJ 370 302	SK 348 309	2.30	6
MARLOCK DYKE	R Greet confluence to Halloughton Dumble Drain confluence	SK 741 518	SK 737 523	0.76	5
RIVER MAUN	R Idle confluence to King's Mill reservoir	SK 701 754	SK 519 597	32.61	5
MEADOW DRAIN	Osmaston Drain confluence to southern boundary of golf course, Sinfin	SK 363 312	SK 356 315	0.95	6
RIVER MEDEN	R Maun confluence to Newbound Mill Bridge, Pleasley	SK 703 751	SK 496 633	29.50	5
MESSINGHAM CATCHWATER DRAIN	Bottesford Beck confluence to the Messingham IDD boundary	SE 878 060	SE 884 027	3.50	5
MIDDLE BECK	R Devon confluence to upstream face of railway culvert	SK 785 514	SK 805 508	2.27	5
MILTON BROOK	R Trent confluence to overspill weir at Foremark reservoir	SK 340 273	SK 329 245	4.80	7
NETHERGATE BROOK	Fairham Brook confluence to downstream face of A453 culvert	SK 564 345	SK 548 348	1.70	5
NORTH ENGINE DRAIN	Keadby pumping station to Dirtness pumping station	SE 835 113	SE 747 096	9.01	5
NORTH SOAK DRAIN	Keadby pumping station to Wike Well Bridge, Thorne	SE 835 113	SE 696 121	13.68	5
OCK BROOK	R Derwent confluence to upstream face of Hawthorn Avenue bridge, Borrowash	SK 420 338	SK 422 349	1.44	6
OLDCOATES DYKE	R Ryton confluence to the A60 at Oldcoates	SK 630 872	(SK 588 885) (SK 588 884)	5.79	5
OSMASTON DRAIN	Cuttle brook confluence to culvert under disused railway line	SK 370 302	SK 364 316	1.66	6
OUSE DYKE	R Trent confluence to downstream end of Netherfield railway culvert	SK 648 420	SK 629 411	3.50	5
RIVER POULTER	R Idle confluence to weir upstream of the A614	SK 699 752	SK 646 754	7.24	5
QUENIBOROUGH BROOK	R Wreake confluence to St Mary's Church Bridge	SK 628 133	SK 653 120	3.56	4

SUMMARY OF MAIN RIVER – JANUARY 1990

AREA	LENGTH (KM)
Upper Severn	960.83
Lower Severn	834.93
Upper Trent	744.87
Lower Trent	1,032.40
TOTAL	3,573.03

SEC24/35

APPENDIX A3

CONSERVATION SITES

SSSI - Site of Special Scientific Interest
NNR - National Nature Reserve
LNR - Local Nature Reserve
CTR - County Trust Reserve

CONSERVATION SITES IN THE RIVER AVON CATCHMENT AND WARWICKSHIRE AT APRIL 1990

SITE NAME	STATUS	NATIONAL GRID REFERENCE	DESCRIPTION
Avon Valley	SSSI/CTR	SO 900 400	Last major breeding areas for Marsh Warbler in Britain.
Bannam's Wood	SSSI	SP 114 642	A deciduous wood and open grassland.
Bentley Park Wood	SSSI	SP 289 955	Oak wood providing habitat for some uncommon plant species.
Bittell Reservoirs	SSSI	SP 018 750	Important for water fowl.
Boon's Quarry	SSSI	SP 330 947	Geological interest.
Brandon Marsh	SSSI	SP 385 755	Active quarry providing habitat for birds.
Bredon Hill	SSSI	SO 953 400	Noted for flora, insects, birds and particularly badgers.
Broadway Hill	SSSI	SP 107 368	Limestone grassland with rich variety of grasses and herbs.
Broom Railway Cutting	SSSI	SP 081 529	Geological interest.
Calcutt Locks Meadows	SSSI	SP 466 633	Unimproved hay meadows.
Campden Tunnel Gravel Pit	SSSI	SP 161 408	Geological interest.
Cave's Inn Pits	SSSI	SP 538 795	Base-rich wetland community.
Coleshill and Bannerley Pools	SSSI	SP 200 860	Artifical pool and rare wooded peat bog.
Combe Pool	SSSI	SP 392 794	Important for water fowl and as a heronry.
Cooksholme Meadows	SSSI	SO 889 505	Unimproved grassland site.
Copmill Hill	SSSI	SP 153 579	Grassland with rich flora.
Coten End Quarry	SSSI	SP 290 665	Important fossiliferous sandstone layers.
Dagnell End Meadow	SSSI/LNR	SP 052 692	Wet pasture of importance for flora and birds.
Draycote Meadows	SSSI	SP 451 708	Meadows with rich flora.
Feckenham Wylde Moor	SSSI/CTR	SP 011 603	
Fosters Green Meadow	SSSI/CTR	SO 978 648	A complex of six permanent lowland meadows.
Grafton Wood	SSSI	SO 972 560	Oakwood supporting rich ground flora.
Harbury Railway Cutting	SSSI	SP 377 603	Grassland with rich flora.
Herald Way Marsh	SSSI	SP 380 769	Range of wetlands containing assemblage of rare invertebrates.
Hewell Park Lake	SSSI	SP 010 690	Important habitat for birds.
Hoar Park Wood	SSSI	SP 265 933	Ancient woodland.
Hopwood Dingle	SSSI/CTR	SO 035 761	Woodland habitat for birds.
Illing's Trenches	SSSI	SP 324 943	Geological interest.
Ipsley Alders Marsh	SSSI/LNR	SP 078 676	A fen meadow with rich flora.
Jackdaw Quarry	SSSI	SP 077 309	Outstanding exposures of Middle Jurassic rocks.
Knavenhill Wood	SSSI	SP 246 492	Deciduous woodland with important fungi.
Long Itchington and Ufton Woods	SSSI	SP 388 627	Woodland with rich flora.
Long Meadow, Thorn	SSSI/CTR	SP 015 553	Meadow with rich flora and badger set.
Loxley Church Meadow	SSSI	SP 259 533	Species rich lowland meadow.

SITE NAME	STATUS	NATIONAL GRID REFERENCE	DESCRIPTION
Merrimans Hill Farm Meadows	SSSI	SP 135 686	Site of species rich neutral meadows.
Midsummer Meadow	SSSI	SP 239 411	Unimproved grassland.
Misterton Marshes	SSSI	SP 557 852	Large block of unimproved wetland habitat.
Napton Hill Quarry	SSSI	SP 457 613	Geological interest.
Oxhouse Farm	SSSI/CTR	SP 300 509	Habitat for wildlife.
Rabbit Wood	SSSI	SO 958 578	Oakwood with rich flora.
River Blythe	SSSI	SP 109 729 TO SP 212 916	Diverse river with clear succession of plant communities.
Ryton Wood	SSSI	SP 381 725	Woodland with important flora and fauna.
Salt Meadow, Earl's Common	SSSI	SO 962 591	Meadow with rich flora.
Shrewley Canal Cutting	SSSI	SP 212 674	Fossiliferous site.
Snitterfield & Bearley Bushes	SSSI	SP 199 605	Woodland with rich flora.
Stanford Park	SSSI	SP 587 793	Important lichen site.
Stockton Railway Cutting & Quarry	SSSI/LNR/CTR	SP 440 650	Geological interest with rich flora and fauna.
Stretton-on-Fosse Pit	SSSI	SP 220 381	Geological interest.
Tiddesley Wood	SSSI/CTR	SP 928 455	Ash-maple woodland on basic soils.
Tilehill Wood	SSSI	SP 279 790	Woodland with botanical, entomological and ornithological interest.
Trench Wood	SSSI/CTR	SO 926 588	Ancient woodland site.
Tunnel Hill Meadow	SSSI	SP 021 474	Grassland with rich flora and insects.
Ufton Fields	SSSI/LNR	SP 381 615	Rich flora and insects.
Ullenhall Meadows	SSSI	SP 122 678	Species rich neutral grassland.
Webster's Claypit	SSSI	SP 340 805	Geological site.
Wellacre Quarry	SSSI	SP 180 370	Richly fossiliferous exposure.
Whichford Wood	SSSI	SP 305 342	Woodland with uncommon flora.
Whitacre Heath	SSSI/CTR	SP 208 928	Ornithological interest.
Wilmcote Quarry	SSSI	SP 151 594	Geological interest.
Windmill Hill	SSSI/CTR	SP 070 472	Rough pasture escarpment.
Windmill Naps Wood	SSSI	SP 093 724	Ancient semi-natural woodland.
Wolford Wood & Old Covert	SSSI	SP 237 335	Rich flora, mosses and fungi.
Wolston Gravel Pit	SSSI	SP 411 747	Geological interest.
Wylde Moor	SSSI/CTR	SP 011 603	Important breeding area for marshland birds.

APPENDIX A4

CODING SYSTEM

CODING SYSTEM

	x	xx	xxx	xx
	CATCHMENT	COUNTY	DISTRICT	NUMBER
eg	6	98	510	23
	Derwent	Derbyshire	High Peak	Problem No.

CATCHMENT	Code
UPPER SEVERN	1
LOWER SEVERN	2
AVON	3
SOAR	4
LOWER TRENT	5
DERWENT	6
UPPER TRENT	7
TAME	8

County/District Councils	County Code	District Code
AVON COUNTY COUNCIL		
Bristol	82	310
Northavon	82	410
SHROPSHIRE COUNTY COUNCIL		
Bridgnorth	83	110
North Shropshire	83	210
Oswestry	83	310
South Shropshire	83	410
Shrewsbury and Atcham	83	510
Telford Development Corporation	83	610
Wrekin	83	710
CLWYD COUNTY COUNCIL		
Glyndwr	84	110
Wrexham Maelor	84	210
GWYNEDD COUNTY COUNCIL		
Meirionnydd	85	110
POWYS COUNTY COUNCIL		
Mid Wales Development Corporation	86	110
Montgomery	86	210
Radnor	86	310

HEREFORD AND WORCESTER COUNTY COUNCIL		
Leominster	87	110
Bromsgrove	87	210
Malvern Hills	87	310
Redditch	87	410
Redditch Development Corporation	87	510
South Herefordshire	87	610
Worcester	87	710
Wychavon	87	810
Wyre Forest	87	910
GLOUCESTERSHIRE COUNTY COUNCIL		
Cheltenham	88	110
Forest of Dean	88	210
Gloucester	88	310
Stroud	88	410
Tewkesbury	88	510
Cotswold	88	610
OXFORDSHIRE COUNTY COUNCIL		
Cherwell	89	110
NORTHAMPTONSHIRE COUNTY COUNCIL		
Daventry	90	110
WARWICKSHIRE COUNTY COUNCIL		
Nuneaton & Bedworth	91	110
Rugby	91	210
Stratford-upon-Avon	91	310
Warwick	91	410
North Warwickshire	91	510
WEST MIDLANDS		
Coventry	92	110
Birmingham	92	210
Dudley	92	310
Sandwell	92	410
Solihull	92	510
Walsall	92	610
Wolverhampton	92	710
LEICESTERSHIRE COUNTY COUNCIL		
Blaby	93	110
Hinckley and Bosworth	93	210
Charnwood	93	310
Harborough	93	410
Leicester	93	510
Melton	93	610
North West Leicestershire	93	710
Oadby and Wigston	93	810
Rutland	93	910

NOTTINGHAMSHIRE COUNTY COUNCIL		
Ashfield	94	110
Bassetlaw	94	210
Broxtowe	94	310
Gedling	94	410
Mansfield	94	510
Newark and Sherwood	94	610
Nottingham	94	710
Rushcliffe	94	810
LINCOLNSHIRE COUNTY COUNCIL		
North Kesteven	95	110
South Kesteven	95	210
West Lindsey	95	310
HUMBERSIDE COUNTY COUNCIL		
Boothferry	96	110
Glanford	96	210
Scunthorpe	96	310
SOUTH YORKSHIRE		
Doncaster	97	110
Rotherham	97	210
Sheffield	97	310
DERBYSHIRE COUNTY COUNCIL		
Bolsover	98	110
Erewash	98	210
Amber Valley	98	310
Derby	98	410
High Peak	98	510
North East Derbyshire	98	610
Derbyshire Dales	98	710
South Derbyshire	98	810
Chesterfield	98	910
STAFFORDSHIRE COUNTY COUNCIL		
Staffordshire Moorlands	99	110
Cannock Chase	99	210
East Staffordshire	99	310
Lichfield	99	410
Newcastle under Lyme	99	510
South Staffordshire	99	610
Stafford	99	710
Stoke on Trent	99	810
Tamworth	99	910

APPENDIX A5

SOURCES OF FINANCE

1 Levy on County Councils, Metropolitan District Councils and Internal Drainage Boards

The Authority's flood defence and land drainage revenue income derives in the main from contributions from County Councils, Metropolitan District Councils and Internal Drainage Boards collected by a regional levy. The total amount required to be collected is apportioned between the Councils on the basis of relevant population (for Community Charge purposes) after taking into account the amounts to be raised from Internal Drainage Boards. The amount paid by Councils for flood defence levies is reimbursed in full by the Department of the Environment the following year through the revenue support grant for local authorities. Internal Drainage Boards' contributions to the National Rivers Authority expenditure are assessed on the basis of the benefit which the Boards derive as a result of the Authority's operations.

2 Loans

The Authority's flood defence capital expenditure is self-financed and loans will be sought in exceptional circumstances only, to deal with unforeseen emergencies.

3 General and Special Drainage Charges

General drainage charges are a means by which revenue, to meet land drainage expenditure, can be raised on agricultural land which lies outside Internal Drainage Districts. The Land Drainage Act (as amended by the Water Act 1989) prescribes a procedure designed to secure that the amount of the charge shall be as near as practicable equivalent to what would be paid in respect of the chargeable land if the land were rated.

Special drainage charges can be levied on specified areas outside Internal Drainage Districts where it appears to the Authority that drainage works on any watercourses in that area should be carried out in the interests of agriculture.

Because of the limits which are statutorily imposed, General and Special charges would provide only a small addition to current income. The Authority has, therefore, decided that, in view of the high adminstrative costs, such charges would not be justified at present.

4 Grant Aid to the National Rivers Authority

(a) Section 90 of the Land Drainage Act 1976 (as amended by the Water Act 1989) enables grants to be paid by the Ministry of Agriculture, Fisheries and Food in respect of approved land drainage schemes for the improvement of existing works or the construction of new works. In the Severn-Trent Region grant is currently paid at 15% of qualifying expenditure. A supplement of 20% may also be payable for tidal defence schemes.

(b) Grants are available under Section 92 of the Land Drainage Act 1976 (as amended by the Water Act 1989) for providing apparatus for carrying out engineering operations for the installation of flood warning systems.

5 Grant Aid to Local Authorities and Internal Drainage Boards

By virtue of Section 91, Land Drainage Act 1976 (as amended by the Water Act 1989) grants are payable by the Ministry of Agriculture, Fisheries and Food to Internal Drainage Boards and County, Metropolitan and District Councils in respect of expenditure incurred on drainage schemes carried out under Sections 17, 22, 98, 99

and 100 of the Land Drainage Act 1976 (as amended by the Water Act 1989). Such grants are available in respect of expenditure on approved land drainage schemes for the improvement of existing works and for the construction of new works, and, in the case of Internal Drainage Boards, on works (other than routine maintenance) on the rebuilding or repair of any bridge maintained by a Board.

The Authority must be consulted, as required by Section 98(8) of the Land Drainage Act 1976 (as amended by the Water Act 1989), before such schemes are submitted to the Ministry.

Grant aid is currently payable up to a maximum of 26% of the cost of the scheme for Internal Drainage Boards and Local Authorities. A supplement of 20% may also be payable for tidal defence schemes.

6 European Regional Development Fund

Certain areas within the region, principally the West Midlands, have been designated as intermediate areas and schemes which are designed to serve those areas by the provision of infrastructure for industry/commerce may be eligible for grant aid from the European Regional Development Fund.

APPENDIX A6

CONSERVATION

1 **CONSERVATION DUTIES UNDER THE WATER ACT 1989**

The following excerpts from the Water Act 1989 define the NRA's statutory conservation duties, as relating to flood defence/land drainage operations.

8. (1) It shall be the duty of each of the following, that is to say, the Secretary of State, the Minister, the Director and every relevant body, in formulating or considering any proposals relating to the functions of any relevant body or, as the case may be, that body:-

a) so far as may be consistent with the purposes of any enactment relating to the functions of that body and, in the case of the Secretary of State and the Director, with their duties under section 7 above, so to exercise any power conferred on him or it with respect to the proposals as to further the conservation and enhancement of natural beauty and the conservation of flora, fauna and geological and physiographical features of special interest;

b) to have regard to the desirability of protecting and conserving buildings, sites and objects of archaeological, architectural or historic interest; and

c) to take into account any effect which the proposals would have on the beauty or amenity of any rural or urban area or on any such flora, fauna, features, buildings, sites or objects.

(2) Subject to subsection (1) above, it shall be the duty of each of the following, that is to say, the Secretary of State, the Minister, the Director and every relevant body, in formulating or considering any proposals relating to the functions of a relevant body or, as the case may be, that body:-

a) to have regard to the desirability of preserving for the public any freedom of access to areas of woodland, mountains, moor, heath, down, cliff or foreshore and other places of natural beauty;

b) to have regard to the desirability of maintaining the availability to the public of any facility for visiting or inspecting any building, site or object of archaeological, architectural or historic interest; and

c) to take into account any effect which the proposals would have on any such freedom of access or on the availability of any such facility.

9. (1) Where the Nature Conservancy Council are of the opinion that any area of land:-

a) is of special interest by reason of its flora, fauna or geological or physiographical features; and

b) may at any time be affected by schemes, works, operations or activities of a relevant body or by an authorisation given by the Authority,

the Council shall notify the fact that the land is of special interest for that reason to every relevant body whose works, operations or activities may affect the land or, as the case may be, to the Authority.

(2) Where a National Park authority or the Broads Authority is of the opinion that any area of land in a National Park or in the Broads:-

a) is land in relation to which the matters for the purposes of which section 8 above has effect are of particular importance; and

b) may at any time be affected by schemes, works, operations or activities of a relevant body or by an authorisation given by the Authority, the National Park authority or Broads Authority shall notify the fact that land is such land, and the reasons why those matters are of particular importance in relation to the land, to every relevant body whose works, operations or activities may affect the land or, as the case may be, to the Authority.

(3) Where a relevant body has received a notification under subsection (1) or (2) above with respect to any land, that body shall consult the notifying body before carrying out, or (in the case of the Authority) carrying out or authorising, any works, operations or activities which appear to that relevant body to be likely:-

a) to destroy or damage any of the flora, fauna, or geological or physiographical features by reason of which the land is of special interest; or

b) significantly to prejudice anything the importance of which is one of the reasons why the matters mentioned in subsection (2) above are of particular importance in relation to that land.

(4) Subsection (3) above shall not apply in relation to anything done in an emergency where particulars of what is done and of the emergency are notified to the Nature Conservancy Council, the National Park authority in question or, as the case may be, the Broads Authority as soon as practicable after that thing is done.

2 RELEVANT FUNCTIONS OF THE NATURE CONSERVANCY COUNCIL

1 The Nature Conservancy Council was established by the Nature Conservancy Council Act 1973 for the purposes of nature conservation and fostering the understanding thereof. The major functions prescribed by the Act are:-

i) the establishment, maintenance and management of nature reserves in Great Britain;

ii) the provision of advice to Ministers on the development and implementation of policies for or affecting nature conservation in Great Britain;

iii) the provision of advice and dissemination of knowledge about nature conservation;

iv) the commissioning or support of relevant research.

2 The NCC also inherited a number of powers and duties formerly exercised by the Nature Conservancy among which are:-

i) a duty to notify land of special interest (SSSIs) to local planning authorities (Section 23 of the National Park and Access to the Countryside Act 1949 now superseded by Section 28 of the Wildlife and Countryside Act 1981 - see below);

ii) power to enter into agreements to conserve SSSIs (Section 15 of the Countryside Act 1968);

iii) powers of entry for survey in connection with acquisition of land (Section 108 of the 1949 Act).

3 The Town and Country Planning General Development Order 1977 obliges local planning authorities to consult the NCC before granting planning permission for development in an SSSI.

4 The Wildlife and Countryside Act 1981 placed a number of additional duties on the NCC, some of which replace similar duties in earlier legislation, including:

i) duty to notify internal drainage boards and the NRA of land of special interest and to advise those bodies when consulted on their proposals affecting such sites. (Section 48);

ii) duty to notify land of special interest (SSSIs) not only to local planning authorities but also to every owner or occupier and to the Secretary of State, specifying the nature of the scientific interest and any operations likely to damage the interest (Section 28);

iii) duty to offer a management agreement where the NCC has objected to a farm capital grant and it is subsequently refused by agriculture ministers on nature conservation grounds (Section 32).

3 RELEVANT FUNCTIONS OF COUNTRYSIDE COMMISSION

1 Under Section 2 of the Countryside Act 1968, the Countryside Commission has the statutory duty of keeping under review all matters relating to the provision and improvement of facilities for the enjoyment of the countryside, the conservation and enhancement of the natural beauty and amenity of the countryside, and the need to secure public access to the countryside for the purposes of open-air recreation. It is required to consult with such local planning authorities and other bodies as appear to the Commission to have an interest in those matters, and to encourage, assist, concert or promote the implementation of any proposals with respect to those matters made by any person or body, being proposals which the Commission consider to be suitable. The Commission is also required to advise any Minister having functions under the Countryside Act 1968, or any other Minister or any public body, on such matters relating to the countryside as he or they may refer to the Commission, or as the Commission may think fit.

2 Under Section 9 of the Local Government Act, 1974, the Commission, in accordance with arrangements approved by the Secretary of State and the Treasury, may give financial assistance by way of grant or loan, to any person in respect of expenditure incurred by him in doing anything which, in the opinion of the Commission, is conducive to the attainment of any of the purposes of the Countryside Act 1968 or the National Parks and Access to the Countryside Act 1949.

NRA

National Rivers Authority
Severn-Trent Region