North West Region: River Wampool, Pilling Water

Annex of R&D Note 456

Silsoe College, Cranfield University

R&D Project Record 317/20/ST

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North West Region: River Wampool, Pilling Water

Annex of R&D Note 456

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This document describes methods, results and conclusions of a study to evaluate the impacts of alternative river maintenance strategies on the River Wampool and Pilling Water in the North Western Region. Its main purposes are to provide supporting information for R&D Note 456 'River Maintenance Evaluation' and to provide data which support routines for the prioritisation and programming of river maintenance.

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RIVER WAMPOOL

R&D 317/20/ST

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NORTH WEST RIVER WAMPOOL

1. BACKGROUND

1.1 Introduction

The River Wampool rises in Cardew Mires, 1 km west of Dalston, to the south west of Carlisle. The river forms an arterial drain running through mainly pasture land with a little arable and a small area of turf production. It runs for 28.5 km from its source to its mouth at Newton Marsh in Moricambe. The river is tidal for the first 11.2 km upstream, to Wampool Bridge; the upper limit of the study reach. The catchment area of the River Wampool and its tributaries is estimated to be 2082 ha.

1.2 Study Reach

The study reach runs for 6 km between Wampool Bridge and Howwath Bridge (GR. 240 543 to 238 574, Figure 1). This site is characteristic of the main rivers in the region on which river maintenance in the form of weed clearance is regularly performed. The River Wampool was maintained by the Internal Drainage Board until 1985 when it was taken over by the National Rivers Authority (NRA). The area of benefit is difficult to determine, the area being large with little relief. Land influenced by the River Wampool (224 ha) and three tributaries, Sally Sough (309 ha), Redmire Sough (383 ha) and Finglandrigg Sough (446 ha) has been studied to provide a representative cover of land use within the benefit area. An area of 233 ha served by the River Wampool and the Sally Sough was studied in detail and the results extrapolated to the larger area. The former is referred to as the detailed study area. The area of land influenced by the 6 km reach of the Wampool and three tributaries benefiting from river maintenance in the study reach is estimated to be 1362 ha (Figure 1). This area is referred to as the extended study area.

1.3 River Characteristics

The River Wampool is typical of a lowland river flowing over a wide floodplain. The meander belt is 600 m wide containing both large sweeping meanders and those forming tight bends.

The latter are reaching the stage in which under conditions of a large flood the meander may be temporarily cut off creating an oxbow lake.

The channel is trapezoidal in shape. Embankments flank the channel for 1 km between GR. 240 557 and GR. 240 553. The width varies between 8 m at Wampool bridge to 18 m at Howwath Bridge, although at the latter, this width is confined to the vicinity of the bridge. The average width and freeboard are 5m and 3m respectively. The gradient of the channel is slight, hence the slow flows which typically average 10 - 12 cumecs.

Bed substrates are variable. Silty clay is characteristic of the upper limit of the study reach around Wampool Bridge. Gravel is more common around Laythes Bridge. This gravel however, is not a legacy of the widening of the bridge as is sometimes thought, but is naturally occurring. Sand is the dominant substrate in the vicinity of Howwath Bridge.

1.4 Land Drainage

The Sally Sough, Finglandrigg Sough and Redmire Sough are the three major tributaries of the River Wampool which join the river within the study reach. Public Drains Number One and Two drain the site of the disused Kirkbride Airfield. Numerous farm ditches or gutters as they are locally named, feed into the River Wampool at various points through flapped and unflapped outfalls. Figure 1 shows the location of the tributaries. Figure 2 shows areas of the River Wampool and Sally Sough benefit area which are drained by pipes. All the field drains discharge water directly into the River Wampool. Further information is provided in Section 2.5.

1.5 Geology, Soils and Land Capability

The underlying geology within the meander belt is characterised by boulder clay and gravel deposits of glacial origin. The floodplain consists of marine alluvium in the form of two terraces, both deposited in recent times (since the last Ice Age). The first terrace, adjacent to the river, is younger in age than the second terrace and is the result of the river meandering over the second terrace thus eroding it. The first terrace is only in evidence downstream of Laythes Bridge. This is the area of the largest and narrowest necked meanders, where the erosion of the floodplain is at its greatest.

The soils within the study reach are characterised by three series; Rockcliffe, Tanvats and Snargate, all of which belong to the Rockcliffe Association. These series typify stoneless marine alluvium which has been reclaimed. Coarse and fine silty alluvial gley soils are characteristic of the Rockcliffe and Tanvats series. The Snargate series is typified by a coarse silty gleyic brown alluvial soil. Both the Rockcliffe and Tanvats series have a strongly mottled subsoil.

Soil profiles taken at three points within the study reach are shown in Figure 3. Sandy silt loams dominate the area.

Rainfall data from the nearest meteorological station to the site, Wiggonby School House (GR. 597 028) suggests that the mean annual rainfall for the area is 1093 mm. With this level of rainfall, the soils of the Rockcliffe and Snargate series are said to be waterlogged within 70 cm of the surface for 90 - 180 days in most years where no field drainage is present. The Soil Survey of England and Wales (SSEW) classify this soil wetness regime as Wetness Class III (Jarvis et al, 1984). Where field drainage is installed, the soil is given a Wetness Class of II as it is commonly waterlogged within 70 cm for only 30 to 90 days in most years. The Tanvats series is given a Wetness Class of IV as it is waterlogged within 40 cm for 180 days in most years. Whilst the other two series respond well to draining due to a permeable subsoil, the Tanvats series does not owing to a weaker structure and less permeable subsoil.

According to the Agricultural Land Classification system of the Ministry of Agriculture, Fisheries and Food (MAFF), the land within the benefit area is classed as Grade 3 agricultural land. This is land of good to moderate agricultural quality. Pasture is the dominant land use for the fattening of dairy, beef and sheep. Cereals and roots are grown on the drier soils.

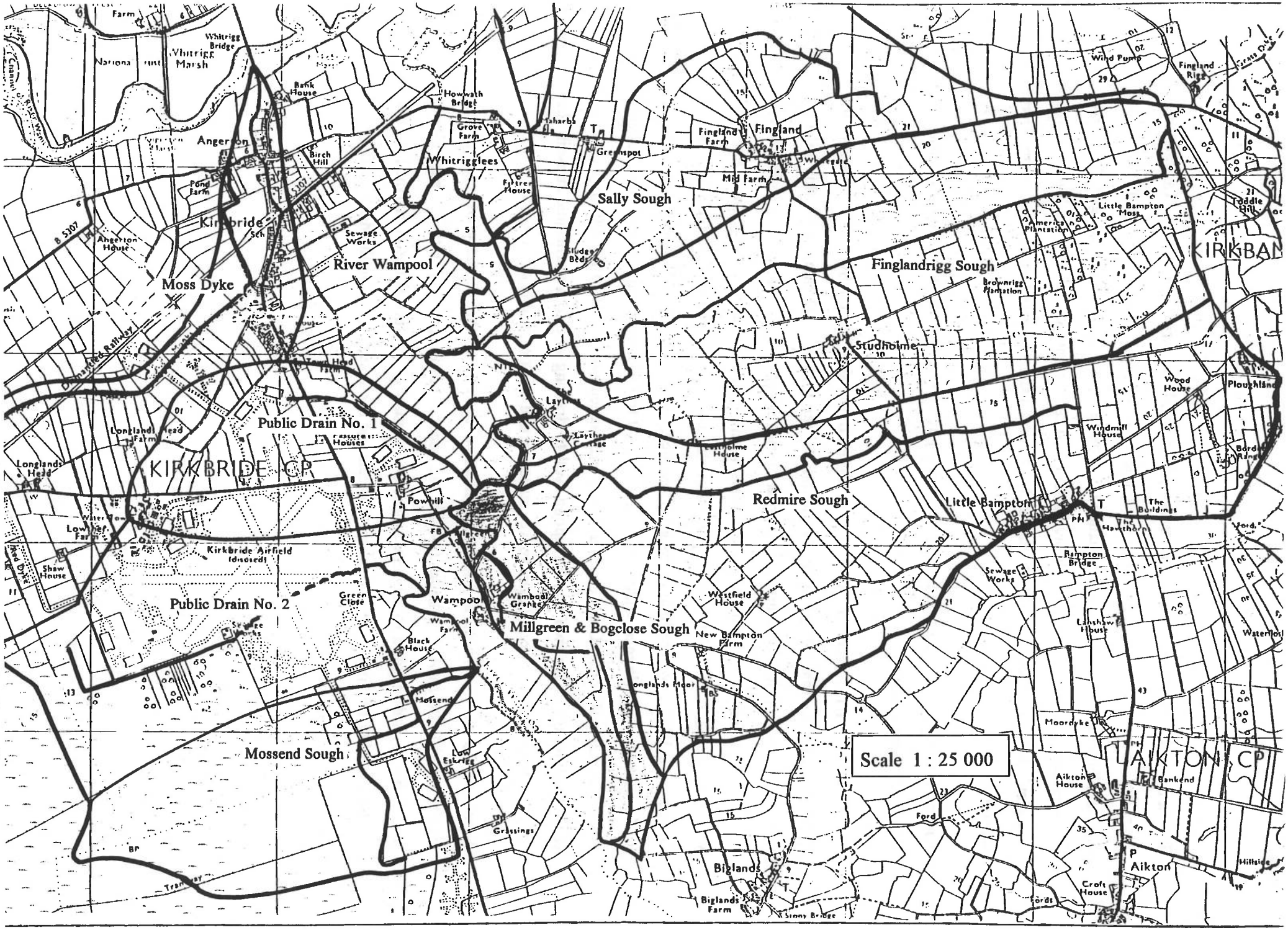
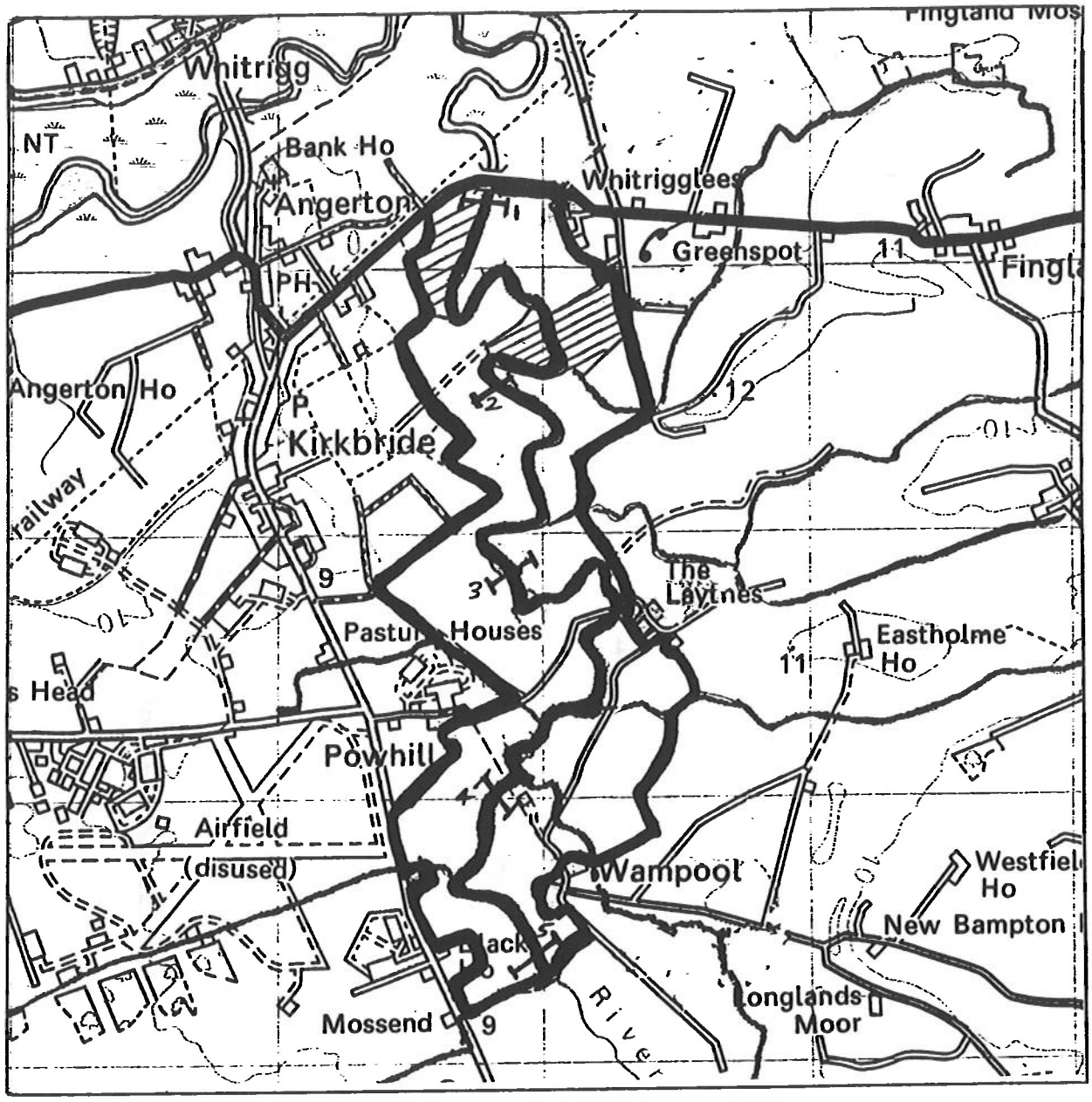


Figure 1 Location and benefit area of the River Wampool and tributaries



Legend :

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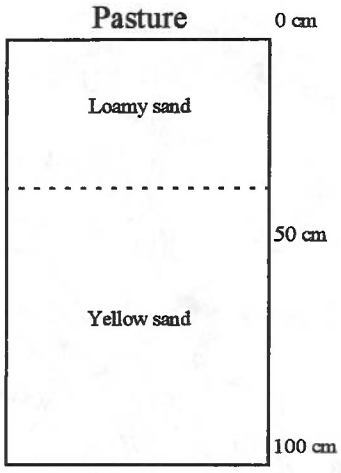
Piped drainage

Natural drainage

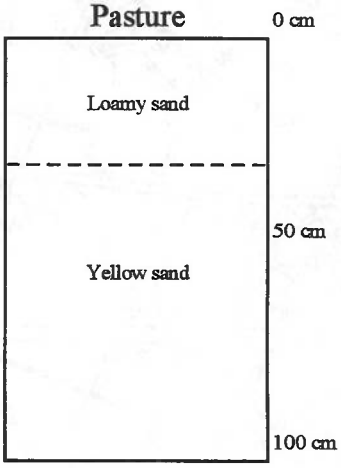
Cross-sections

Figure 2 Land drainage in the River Wampool benefit area and cross-section location

Grid Reference	238 574
Soil Core Number	1
Soil Colour	Yellowish brown
Comments	Sandy loam soil



Grid Reference	239 544
Soil Core Number	2
Soil Colour	Dark yellowish brown
Comments	Sandy silt loam soil



Grid Reference	238 563
Soil Core Number	3
Soil Colour	Dark yellowish brown
Comments	Sandy silt loam soil

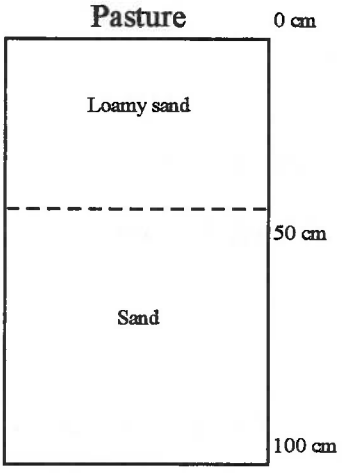


Figure 3 Soil profiles

1.6 Capital Works

No capital works of any kind have been carried out on the River Wampool between Wampool Bridge and Howwath Bridge.

In 1983 plans for a flood alleviation scheme proposed that an embankment be erected down a 2.3 km length on the east side of the river between GR. 241 561 and GR. 246 545. Five ditches within the study area were to have their outfalls into the river flapped. Although the actual scheme did not proceed due to economic constraints, two of these ditches have now been given flapped outfalls into the River Wampool.

1.7 River Maintenance

The study reach of the River Wampool is subjected to a regular programme of maintenance works. Desilting using a JCB 818 with a dredging bucket attachment is performed every three to four years. Repairs to the river banks are carried out as and when necessary. The most recent repair work was to protect various sections of the bank from further erosion by repairing slips with stone blocks.

Prior to this river maintenance study, weed clearance had not previously been performed on this stretch of the river. Throughout the period of the study, all the channel vegetation between Howwath Bridge and upstream of Laythes Bridge (GR. 243 555) has been removed using a JCB 818 with a weeding bucket attachment. In 1994, vegetation was removed using a weed boat. The river banks are flail mown. Maintenance takes place on an annual basis in August/September.

The three tributaries Sally Sough, Finglandrigg Sough and Redmire Sough all have timber revetments along the lower sections of the watercourse. Weed clearance is carried out by hand on Finglandrigg Sough and Redmire Sough. The first metre of bank above the water level is flail mown once a year on both these watercourses, although on the Redmire Sough, only one bank is mown. The Sally Sough is subject to weed clearance and flail mowing from its source to the road bridge at GR. 244 564. Downstream of this point as far as possible the Sally Sough has not been maintained for the duration of the project in order to act as a control section. However, in early 1994, part of this section of the Sally Sough was cleared of brambles and scrub as the water level was being retained at an unacceptably high level.

The reasons for performing maintenance on the River Wampool are threefold. Firstly, maintenance is scheduled into the regular work programme for the north west area. Recent inspection may highlight the need for maintenance and thirdly, maintenance may be performed as a response to customer demand.

The criteria for the standards of service provided by the maintenance is based on proven suitability. All landowners and tenants with frontages on the river are notified prior to any maintenance procedure via a telephone call or visit. Conservation and fisheries bodies are invited to a meeting to discuss the maintenance programme.

1.7.1 Farmers views on maintenance

The majority of farmers interviewed expressed satisfaction with the type and level of maintenance currently performed on the River Wampool. However, one voiced the opinion that since the river was desilted, the banks have become more unstable and bank slippage and increased rate of erosion are the result. One farmer stated that erosion is also the result of the removal of willows and bushes from the banks which was carried out to allow for machinery access to the river.

1.7.2 Alternative maintenance strategies

Various alternative maintenance strategies were suggested by the farmers. Several think that the banks should be flail mown in the spring and not the autumn. This is thought to leave a denser cover of vegetation on the banks during the winter months which would reduce erosion. If the banks were mown twice a year and/or sprayed with herbicides as well as cut, some farmers think that this would reduce the population of thistles which are invading their pasture. One stated that the meanders in the vicinity of Laythes Bridge should be cut through to allow the river a straighter, faster route through the area. It is suggested by the farmers that this would reduce the risk of flooding and erosion.

1.8 Climate

The impact of river maintenance on watertable depth and river levels depends on the particular weather conditions, especially rainfall, which vary from season to season and year to year. The seasonal and yearly rainfall totals for the period of the study are presented in Table 1.1.

Table 1.1 Rainfall totals

Period	Season	Actual Rainfall (mm)	Average * Rainfall (mm)	% Average Rainfall
1992	Spring	146.7	150.16	97.7
	Summer	179.3	211.48	84.8
	Autumn	277.2	256.93	107.9
1993	Spring	137.9	150.16	91.8
	Summer	152.2	211.48	71.9
	Autumn	66.4	256.93	25.8
1994	Spring	160.2	150.16	106.7
	Summer	220.5	211.48	104.3
	Autumn	166.0	256.93	64.6
1995	Spring	141.7	150.16	94.4
Total	1992	821.2	818.77	100.3
	1993	712.1	818.77	86.9
	1994	874.4	818.77	106.8

* Based on 20 year record from 1973 - 1993, Wiggonby School House

The summer and autumn of 1993 and autumn of 1994 were particularly dry when compared to the long term average rainfall totals. This is confirmed by farmers who reported dry conditions on the land and a long grazing season. The remaining seasons throughout the duration of the study, received approximately the average rainfall totals.

Monthly rainfall records from Wiggonby School House (GR. 597 028), the nearest meteorological station to the study site, covering a period of 20 years (1973 - 1993) have been analysed in order to determine the probability of a dry, average and wet season and year occurring. The classification of the Food and Agricultural Organisation (FAO) was used to do this. Dry and wet seasons and years are classed as those with less than 75 % and greater than 125 % of the average rainfall total respectively. The probabilities of wet, average and dry climatic conditions occurring are shown in Table 1.2.

Table 1.2 Probability of climatic conditions

Season	Dry *	Average *	Wet *
Spring	0.38	0.56	0.06
Summer	0.06	0.63	0.31
Autumn	0.06	0.56	0.38
Year	0.06	0.69	0.25

* Based on records 1973 - 1993

The process by which financial benefits of maintenance are calculated according to the probability of each type of weather season and year occurring is explained in the R&D Note 456, Section 3.5.4.

1.9 Aquatic Vegetation

Aquatic vegetation within the channel was identified prior to maintenance (Section 1.9.1 to 1.9.3). This vegetation has both hydraulic and environmental implications for the channel.

1.9.1 Submerged vegetation

The Canadian water weed or Water-thyme *(Elodea canadensis)* and *Potamogeton natans*; commonly known as Dogs Tongue or pondweed are the dominant species of aquatic weed within the study reach. The preferred habitats of both weeds are areas of sluggish to moderate flows such as drainage channels, lakes and ponds.

Elodea canadensis is a weekly rooted submerged weed with branched stems ranging from 3 to 10 cm in length. The plant is streamlined in the direction of flow. Weed cutting is an effective method of controlling the *Elodea.*

1.9.2 Emergent vegetation

The pondweed is the dominant aquatic plant found within the three tributaries of the River Wampool in the study. The pondweed, with oval dark green leaves is classed as a broad-leaved emergent plant although it often may have some submerged leaves, which are linear in form. It is streamlined in the direction of flow.

The greater the discharge, the lower the resistance of the pondweed to flow. *Potamogeton natans* is the commonest of the Pondweed species with floating leaves. Unlike other pond weeds, its' leaves are jointed at their junction with a long stalk. As the *Potamogeton* regenerates through rhizomes it is more difficult to control than *Elodea.* Desilting may be necessary at times in order to reduce or remove the 'seed bank' of *Potamogeton* from the river.

The tall emergent grasses *Glyceria* (Reed Sweet-grass) and *Phalaris* (Reed Canary Grass) are found within the River Wampool. These grasses may reach up to 2 m in height and grow in dense stands in slow moving water. They provide greater resistance to flow than some

submerged plants as they can create a fairly impermeable barrier to the flow of water, depending on the density of the vegetation stand.

Control of *Glyceria* may be difficult as it reproduces through a system of rhizomes (underground stems) which are buried in the mud and silt of the channel bed. Any form of control which leaves these rhizomes intact will have only a short term benefit. Unless these are removed through desilting, *Glyceria* will regrow the following year.

1.9.3 Algae

Filamentous algae is common within the Sally Sough and River Wampool. This algae grows in long chains from the hydrosoil. It is difficult to control as it can be found anywhere and grows rapidly through simple fission by which each cell divides. Algae is common in nutrient rich waters and frequently invades areas where other aquatic plants have been controlled or eradicated.

2. FARM SURVEY

2.1 Introduction

The area deriving a benefit from the river maintenance work on the River Wampool and major tributaries (Sally Sough, Redmire Sough, Finglandrigg Sough) in terms of its impact on land drainage and flooding is estimated to be 1362 ha. This benefit area (BA) includes the land which was inundated by the 1983 flood which prompted research into a flood alleviation scheme. Interviews and discussions have been held with 12 farmers within the detailed study area, covering an area of 233 ha, associated with the Wampool and Sally Sough only. The detailed study area has been divided into separate blocks (Figure 4) according to drainage, land use and management practices. The extended study area was surveyed using rapid rural appraisal techniques.

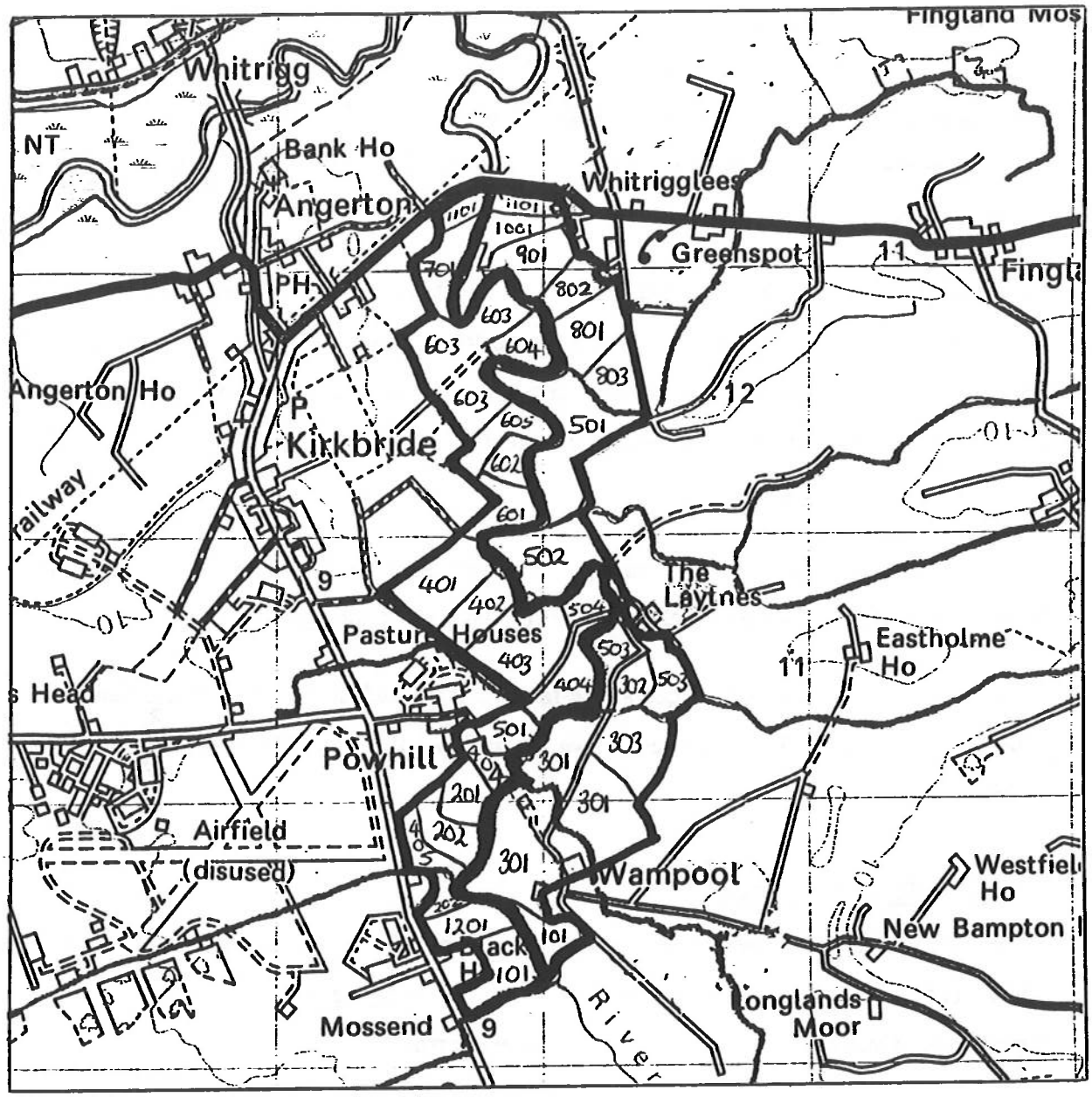
2.2 Farm Type, Size and Tenure

Five of the 12 farms are classed as dairy farms, four as beef farms, two as mixed and one as a general cropping farm according to the classification system of the European Union (EU).

Farm size ranges from 4 to 145 ha, averaging 71 ha. The smallest, 4 ha, is a small holding consisting of two fields under permanent extensive grassland. The Standard Man Day (SMD) or Man-Work-Unit requirement ranges from 4 to 1964 with an average of 753. This requirement may be used to assess the labour requirement of agricultural enterprises. In general, the higher the SMD value, the greater the amount of labour required.

Four of the farms are run as a partnership. The remainder are under sole proprietorship. Three farmers have more than one holding but in each case they are farmed under the same holding number. Only one farmer has two holdings which are farmed independently.

The majority of the land within the 233 ha is owner occupied (81 %). The remaining 19 % is held under a summer grazing agreement. Translated into terms of farms and area, one farm contains 41 ha of rented land and the remaining farms are totally owned by the farmer.



Legend :

Scale 1 : 25 000

101 Land use blocks

Figure 4 Land use blocks within the River Wampool benefit area

2.3 Livestock Enterprises

Five of the farms are classified as dairy farms. Herd sizes range from 120 to 200 cows. Milk yields range from 6400-7500 litres/cow/year. The average milk yield is 6840 litres/cow/year. All these farms have a follower herd of various sizes. Four of these dairy farms also have arable enterprises.

Five farms have beef herds. Of these, two are suckler herds, two are fattening and one is a 12 month intensive indoor system. Herd sizes range from 40 in the case of the sucklers to 210 beasts under the fattening system which are finished off grass. Stocking rates are high, being in the region of 13.5 beasts/ha. The intensive system consists of 120 heads of cattle fed indoors on silage over a 12 month period.

Only one farm is involved in sheep enterprises. The flock consists of 800-1000 sheep under the fat lamb system. The lambs are fattened off grass. The lambing rate is medium being 1.5.

Poultry are kept on one farm under a free-range system and another has diversified into turf production. A total of 32 ha has been sown for turf. Of this area, 5.5 ha of turf lie within the benefit area.

2.4 Arable Enterprises

Seven of the farms have some arable enterprises. Spring barley is cultivated by four of them. Winter barley and winter wheat are less common, being grown on two and one farm respectively. Oats are also under cultivation on one farm.

The typical rotation pattern followed by the arable farms is spring barley, followed by winter wheat and winter barley. One farm practices a grass/arable rotation in which the grass is cut for silage. Yields are high for spring barley, being 7 t/ha. Yields for winter wheat and winter barley average 6 and 4 t/ha respectively.

2.5 Land Use In The Benefit Area

A survey of land use within the benefit area shows the majority of land within the 233 ha area (Figure 5) is under a grassland system (86 %) including that within the grass / arable rotation. Intensive grassland is characterised by long grazing seasons, higher rates of nitrogen input (>

50 kg N/ha) and is commonly grazed with dairy cattle. Grassland under the extensive system is used for permanent grazing of sheep and beef over a short season. Little, if any grass is conserved and nitrogen inputs are low.

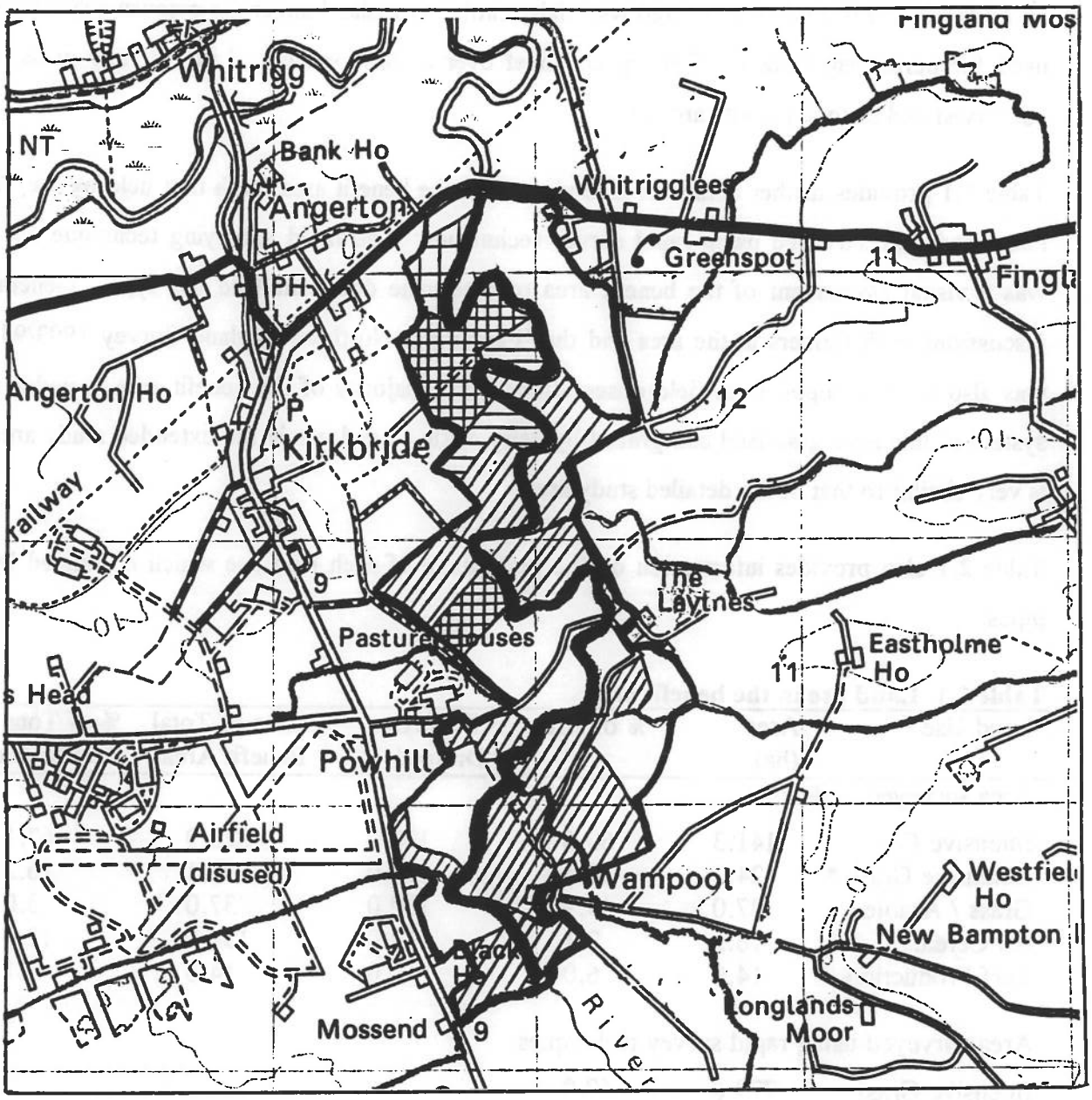
Table 2.1 provides further details of land use within the benefit area, both that held by the 12 farms and that surveyed using rapid survey techniques. The rapid surveying technique used was a visual assessment of the benefit area to determine dominant land use type. General discussions with farmers in the area and the 'Farming in Northern England Survey 1993/94' was also used to support the field observations. The majority of the benefit area is under a system of intensive grassland and grazed by dairy cattle. Land use in the extended study area is very similar to that of the detailed study area.

Table 2.1 also provides information on the percentage of each land use which is drained by pipes.

Table 2.1 Land use in the benefit area

Land Use	Area (ha)	% of Area	% of Area Drained	Area of Total Benefit Area	% of Total Benefit Area
Area surveyed in detail					
Intensive Grass	141.3	60.6	100.0	820.9	67.1
Extensive Grass *	24.2	10.4	100.0	198.1	16.2
Grass / Arable	37.0	15.9	100.0	37.0	3.0
All Cereal	16.5	7.1	19.0	154.0	12.6
Turf Production	14.0	6.0	0.0	14.0	1.1
Area surveyed using rapid survey techniques					
Intensive Grass	779.6	69.0			
Extensive Grass *	192.9	17.0			
Cereals	156.5	14.0			

NB: * including turf production



Legend :

Scale 1 : 25 000

- Intensive grass
- Extensive grass
- Grass / arable rotation
- Cereal / oilseed rotation
- Other

Figure 5 Land use in benefit area of the River Wampool

2.6 Turnout and Yarding Dates

Throughout the 233 ha area the dates for the turnout and yarding of livestock follow a similar pattern. The most common grazing season followed is from April to October. Stock is turned out to grass in April over 44 % of the grassland area and yarded in October over 41 %. (Tables 2.2 and 2.3). The remainder of the grassland is grazed in May or after the first cut of silage has been taken. Only one farmer allows his stock to graze land which is to be cut for grass conservation. This pasture is closed up six weeks before the first cut is taken. No livestock are overwintered out at grass.

Table 2.2 Turnout dates

Turnout Date	% Grassland Area
Early/mid April	7.4
Mid/late April	37.0
Early/mid May	18.6
After 1st silage cut	18.5
Not grazed	18.5

Table 2.3 Yarding dates

Yarding Date	% Grassland Area
Mid/late October	40.8
Early/mid November	29.6
Mid/late November	3.7
Mid/late December	7.4
Not grazed	18.5

2.7 Grass Conservation

The majority of grassland is grazed only, with the exception of the area of turf production and a 4.5 ha area of grass which are not grazed. The areas which are cut for grass conservation are small. The main reason for this is that the land provides good pasture for dairy cattle which need to be grazed close to the farm for ease of milking. Of the land that is cut for silage, one, two and three cuts are taken. A small area (4.5 ha) is cut for both hay and silage. Table 2.4 provides further information as to the areas which are conserved. The first cuts of silage are taken in mid May with the second in June. The third is cut in July.

Table 2.4 Grass conservation

Conservation System	Grassland Area (ha)
Hay	3.7
Silage	29.6
Grazed only	59.3
No grazing or conservation	7.4

2.8 Nitrogen Application

Only 26 % of the grassland receives no application of fertiliser (Table 2.5). The commonest type of fertiliser which is applied is the compound NPK fertiliser in the proportion 20:10:10. Straight nitrogen and farm yard manure are also applied to some of the land. The highest rates of nitrogen application correspond with the areas of multiple silage cutting.

Table 2.5 Nitrogen application rates

Rate (kg N/ha)	Grassland Area (ha)
0.0	25.9
20 - 30	22.2
31 - 40	14.8
41 - 50	22.2
51 - 60	14.8

2.9 Flooding

Within the study reach, 11 of the 12 farmers who farm land within the 233 ha area have reported flooding on their land. In each case the source of the flood water is said to be the river whose high levels are due to a combination of high rainfall and high tides. The area which typically floods is shown in Figure 6. One farmer also reported that a blocked drainage ditch contributed to the flooding on his fields. Flooding from surface runoff does not appear to contribute to the flooding.

According to the farmers, the last floods were in April 1992 and early spring in 1995. Nine of the farmers experienced flooding of their land at this time. Two could not remember the last flood and one thought it was three or four years ago.

Nine farmers reported the duration of flooding to be one to two days. One said three to four days with one stating the flood water remained on his fields for between 10 and 14 days. The main consequences of the flooding are reported to be litter and debris on the land. This may be time consuming to remove as it has to be cleared by hand.

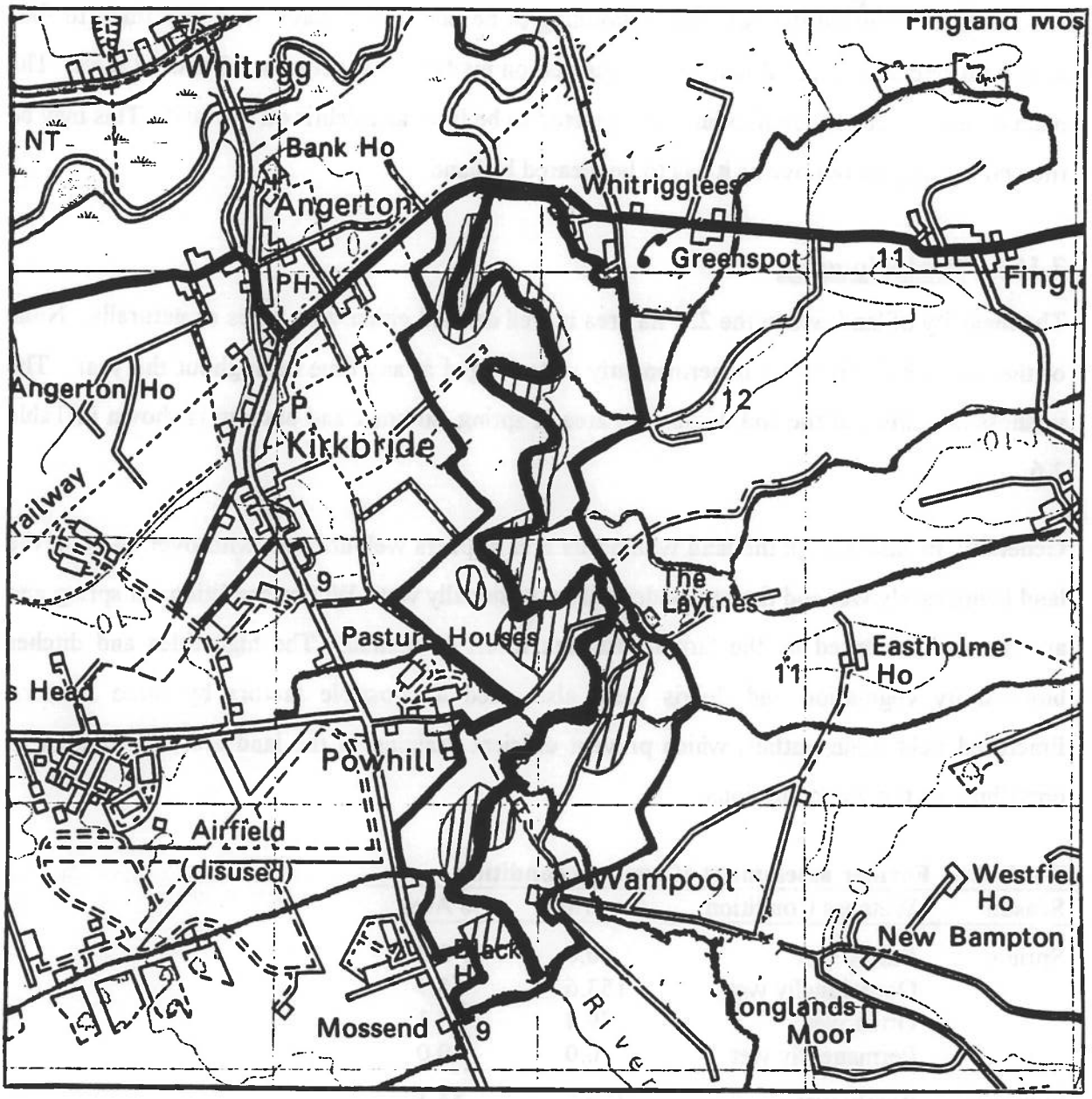
2.10 Waterlogging

The majority of land within the 233 ha area is well drained either with pipes or naturally. None of the land within this area is permanently waterlogged at any time throughout the year. The wetness condition of the soil within this area in spring, summer and autumn is shown in Table 2.6.

Generally, in summer, all the land within this area appears well drained, with over 54 % of the land being rarely wet and the remainder only occasionally wet. Wetter conditions in spring and autumn are attributed by the farmers to high levels of rainfall. The high tides and ditches blocked by vegetation and debris were also cited as possible factors by three farmers. Fractured field drain outfalls which prevent efficient draining of the land are also thought to contribute to the wet conditions.

Table 2.6 Farmer assessment of wetness condition

Season	Wetness Condition	Area (ha)	% Area
Spring	Rarely wet	0.0	0.0
	Occasionally wet	153.6	65.9
	Often wet	79.4	34.1
	Permanently wet	0.0	0.0
Summer	Rarely wet	126.0	54.1
	Occasionally wet	107.0	45.9
	Often wet	0.0	0.0
	Permanently wet	0.0	0.0
Autumn	Rarely wet	0.0	0.0
	Occasionally wet	105.1	45.1
	Often wet	127.9	54.9
	Permanently wet	0.0	0.0



Legend :

Scale 1 : 25 000

Flooded areas

Figure 6 Areas prone to flooding

2.11 Statistical Analysis

It is apparent that land use, farming practice and drainage are interrelated. Statistical methods were used to determine whether these relationships occurred more frequently than might be expected by pure chance. Full details of this analysis in which the 12 sites were grouped according to NRA Region, are presented in the Interim Report R&D 317/13/ST, presented to the NRA in December 1994.

The following observations can be made from the statistical analysis of fields in the benefit area of the River Wampool maintenance programme:

- The dominant farming system influences land use within the benefit area. In this case, the dominant farm type is dairy. This farm type combined with the good drainage and high rainfall which encourages good grass growth determines the land use, which is unlikely to change from grass to arable.

- A strong relationship exists between land use and the presence of field drainage. Intensive grass within the 233 ha area is all underdrained by pipes as are the arable areas, compared to extensive grassland which is often naturally draining. (Statistically there is an 89 % chance of correctly predicting the installation of field drainage on the basis of land use).

- Turnout dates for livestock are related to the field wetness condition in the spring. Land which is rarely wet in the spring is grazed from early April, compared to occasionally wet and often wet land which is grazed from May. (Statistically there is an 84 % chance of correctly predicting livestock turnout dates on the basis of spring field wetness conditions).

- Livestock yarding dates are related to autumn field wetness conditions. Land which is often wet in the autumn is closed to grazing in mid October, compared to land which is only occasionally wet which is grazed until late November. (Statistically there is a 60 % chance of correctly predicting livestock yarding dates on the basis of field wetness conditions in the autumn).

3 HYDRAULIC AND HYDROLOGICAL INFORMATION

3.1 Introduction

Information on channel hydraulics and hydrological data has been used to determine the impact of maintenance on channel capacity and flood return periods.

3.2 Cross-section Surveys

Cross sectional surveys of the river channel were taken at five points along the study reach at an average interval of 1400 m (Figure 2). Channel capacity and freeboard were determined from these cross-sections. The channel cross-section remained unchanged following the regular weed clearance programme and so a post-maintenance cross-sectional survey was not necessary.

Prior to weed clearance, the channel roughness was expressed in terms of the Manning's n coefficient, in accordance with the methodology developed by Cowan (1956). This coefficient is composed of six elements which include the degree of irregularity of the channel bed, level of vegetation growth, predominant bed material and channel sinuosity. Further details of this methodology are contained within the R&D Note 456, Appendix IV. Friction values were determined for the channel following maintenance using the same procedure in order to identify roughness values for the 'with' and 'without' maintenance situation.

Stage/discharge curves for the 'with' and 'without' maintenance situation have been constructed for each cross-section using the different values of Manning's 'n'. Channel cross-section information, stage/discharge curves and channel information are presented in Figure 7. The bankfull channel capacities and associated return periods for the 'with' and 'without' maintenance scenario are presented in Table 3.1.

The bankfull capacity figures obtained from the cross-sections indicate an average increase in capacity attributable to maintenance of 42 % and an average increase in the interval between flood events of 71 %.

Table 3.1 Bankfull capacity and return periods

Cross-Section	Without Maintenance Bankfull Capacity (m^3/s)	Return Period (years)	With Maintenance Bankfull Capacity (m^3/s)	Return Period (years)
1	10.0	0.6	14.9	1.2
2	17.7	1.9	39.8	7.3
3	46.2	10.0	76.2	58.0
4	12.1	0.8	21.9	22.2
5	13.2	0.9	20.9	2.0
Sally Sough	0.8	0.5	1.9	5.0

(Source: modelled estimates)

3.3 Flood Return Period

Throughout the period of study (1992 to 1995) river water level information was collected on a regular basis through the reading of gauge boards which were installed in the reach and from a gauging station at Laythes Bridge.

Information regarding frequency, duration and magnitude of flood flows has been collected from interviews with local farmers and NRA staff. Flood return period curves for the River Wampool and Sally Sough have been compiled from this information, using the methodology contained within the Flood Studies Report (NERC, 1975). The frequency of floods of different magnitudes can be estimated from these flood return period curves (Figures 8 and 9).

The flood return period for each block which floods and associated flooded areas, are shown in Table 3.2. The 'without' maintenance return period is estimated by the farmer, the 'with' maintenance value is a modelled estimate using the cross-section information and Manning's n coefficient. It is assumed that the flooded area remains unchanged following maintenance.

Table 3.2 Flood return periods and flooded areas

Block No. (Size, ha)	Flooded Area (ha)	Flood Return Period (Years) Without	With	Block No. (Size, ha)	Flooded Area (ha)	Flood Return Period (Years) Without	With
201 (4.9)	4.41	0.8	2.0	701 (14.0)	4.90	0.6	1.2
202 (7.04)	2.82	0.9	2.0	801 (7.4)	0.74	0.6	1.2
301 (23.6)	8.26	0.8	1.0	802 (3.7)	0.74	0.6	1.2
302 (2.82)	2.82	0.8	1.0	803 (3.9)	0.16	1.9	3.0
402 (11.1)	4.44	1.0	2.0	901 (5.2)	1.56	0.6	1.2
403 (8.8)	4.40	1.0	2.0	1001 (2.4)	0.24	0.6	1.2
405 (3.3)	0.50	0.9	2.0	1101 (2.3)	0.46	0.6	1.2
501 (16.6)	4.98	1.9	3.0	1201 (4.5)	3.60	0.6	2.0
502 (9.8)	5.88	3.0	5.0				
503 (8.6)	6.88	3.0	5.0				

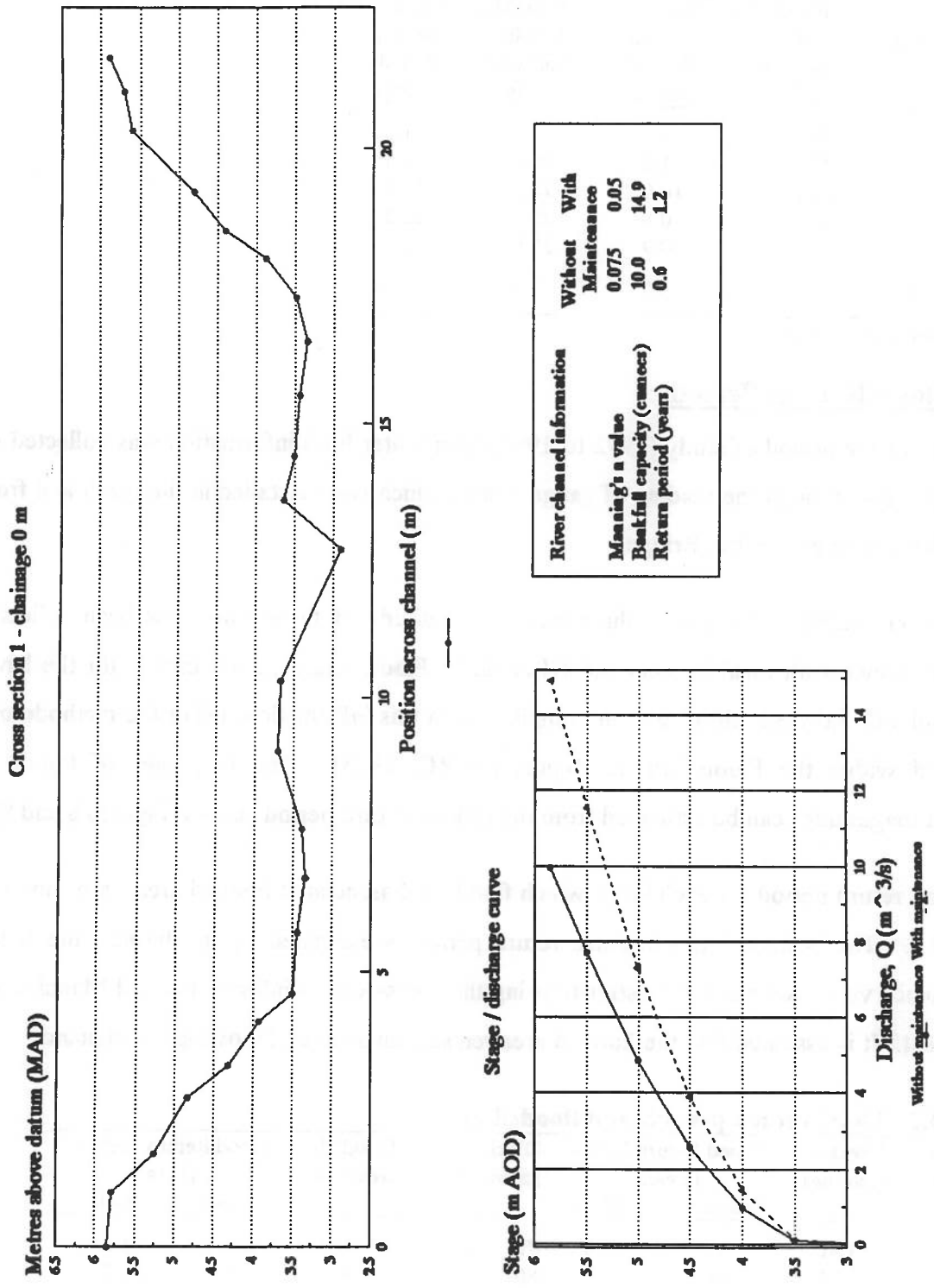
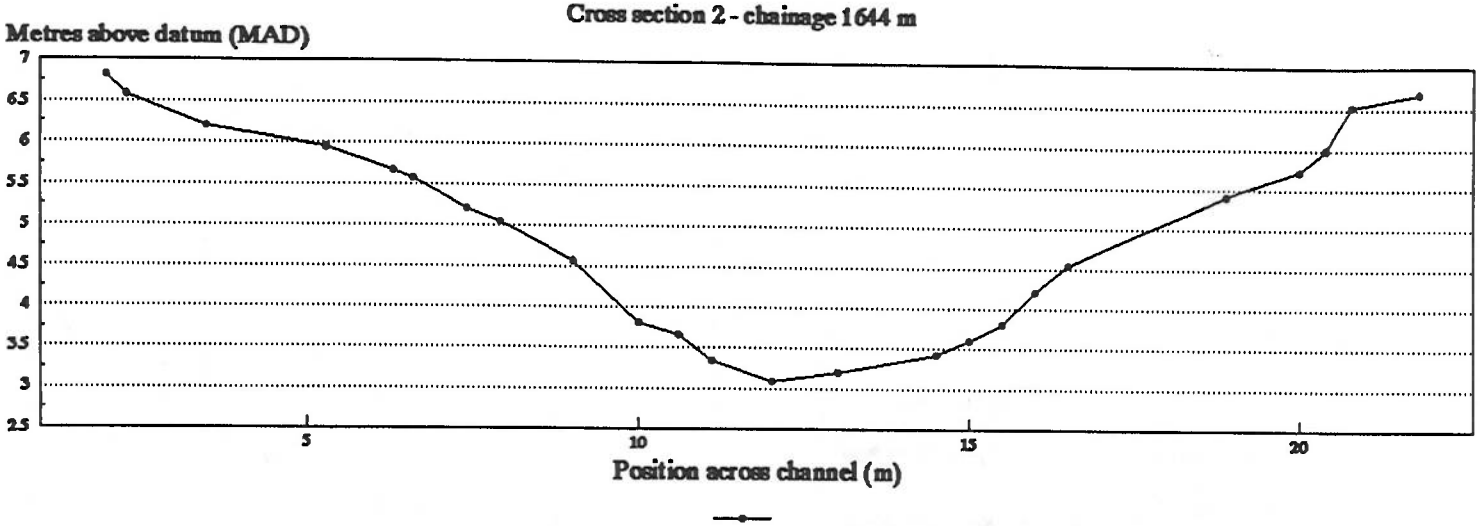
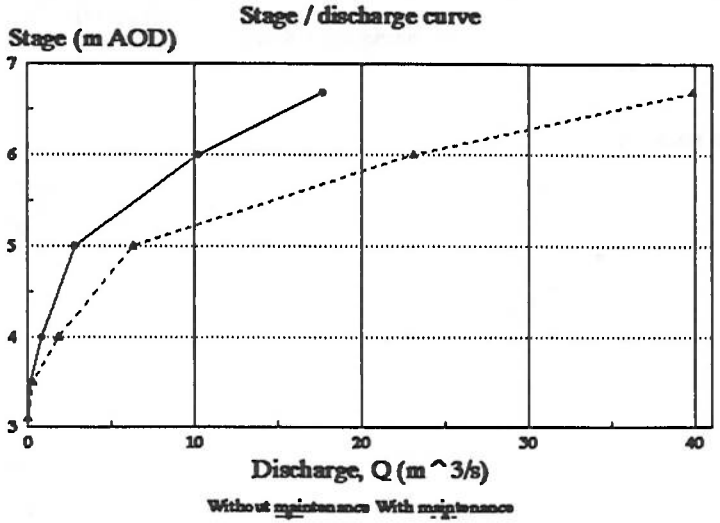
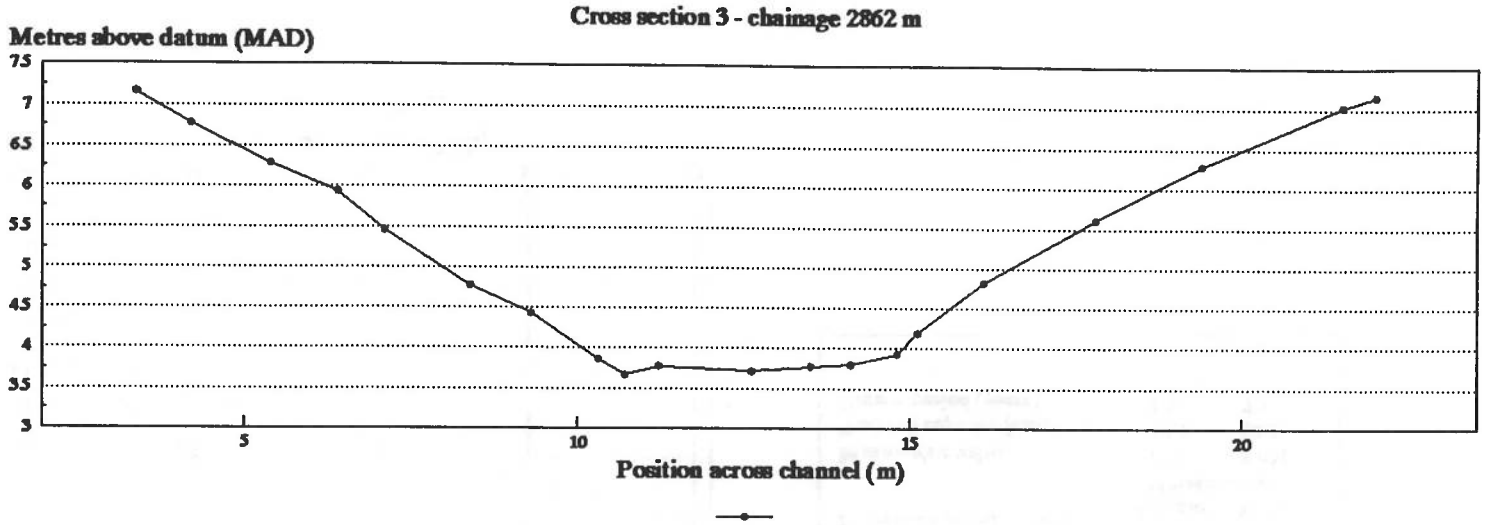


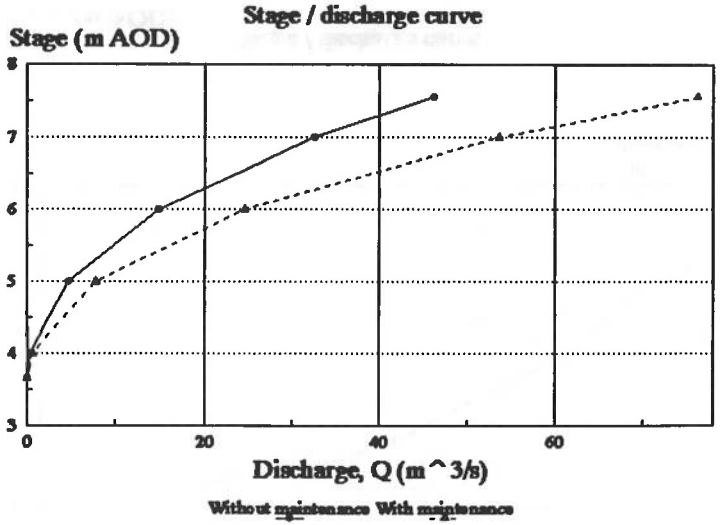
Figure 7 **River Wampool channel information**



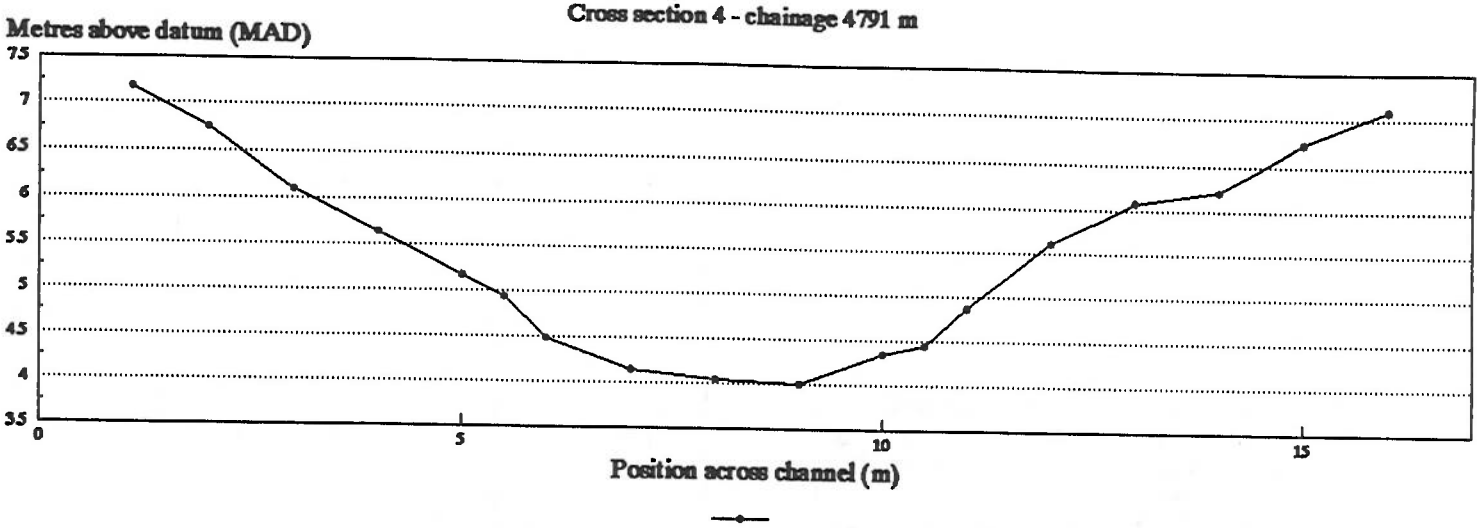


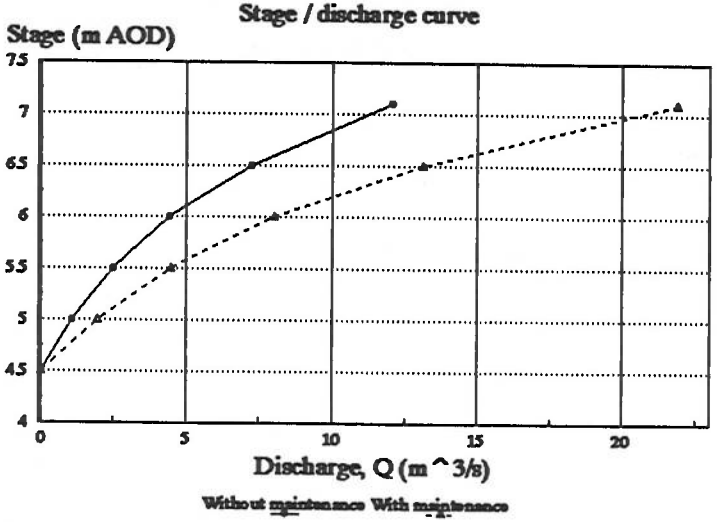
River channel information	Without Maintenance	With
Manning's n value	0.07	0.031
Bankfull capacity (cumecs)	17.7	39.8
Return period (years)	1.9	7.3



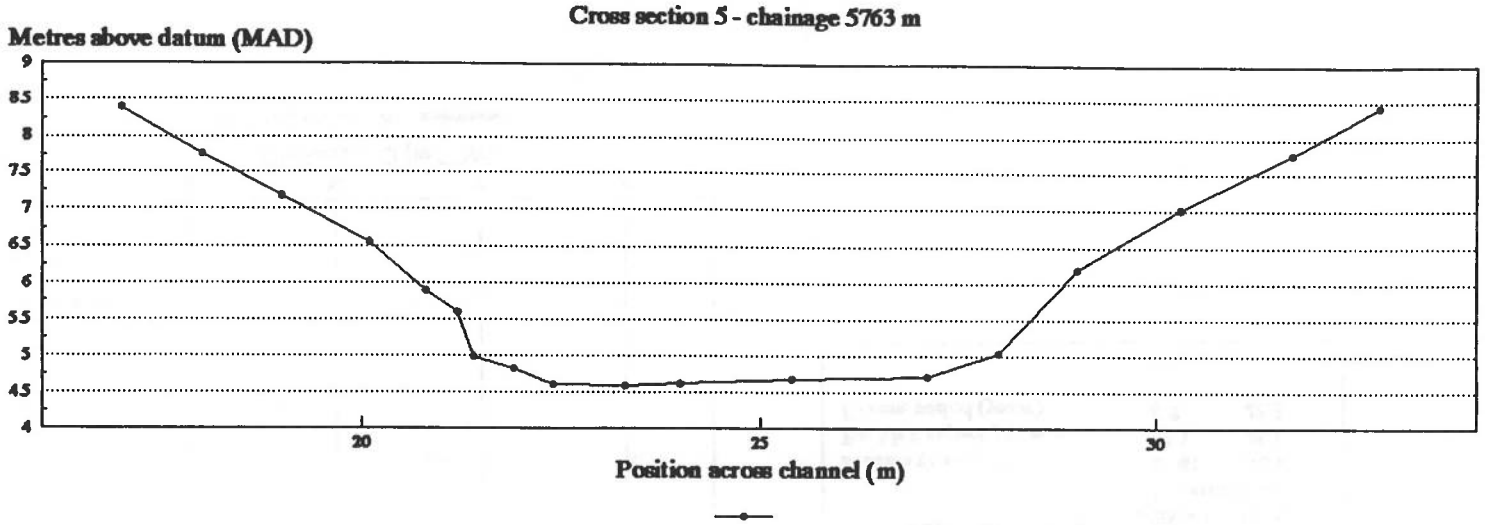


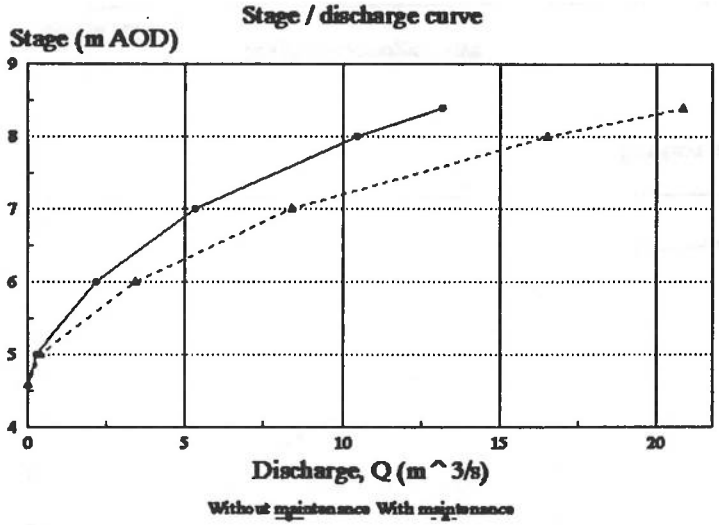
River channel information	Without Maintenance	With
Manning's n value	0.066	0.04
Bankfull capacity (cumecs)	46.2	76.2
Return period (years)	10	58





River channel information	Without Maintenance	With
Manning's n value	0.069	0.038
Bankfull capacity (cumecs)	12.1	21.9
Return period (years)	0.8	22.2





River channel information	Without Maintenance	With
Manning's n value	0.087	0.055
Bankfull capacity (cumecs)	13.2	20.9
Return period (years)	0.9	2.0

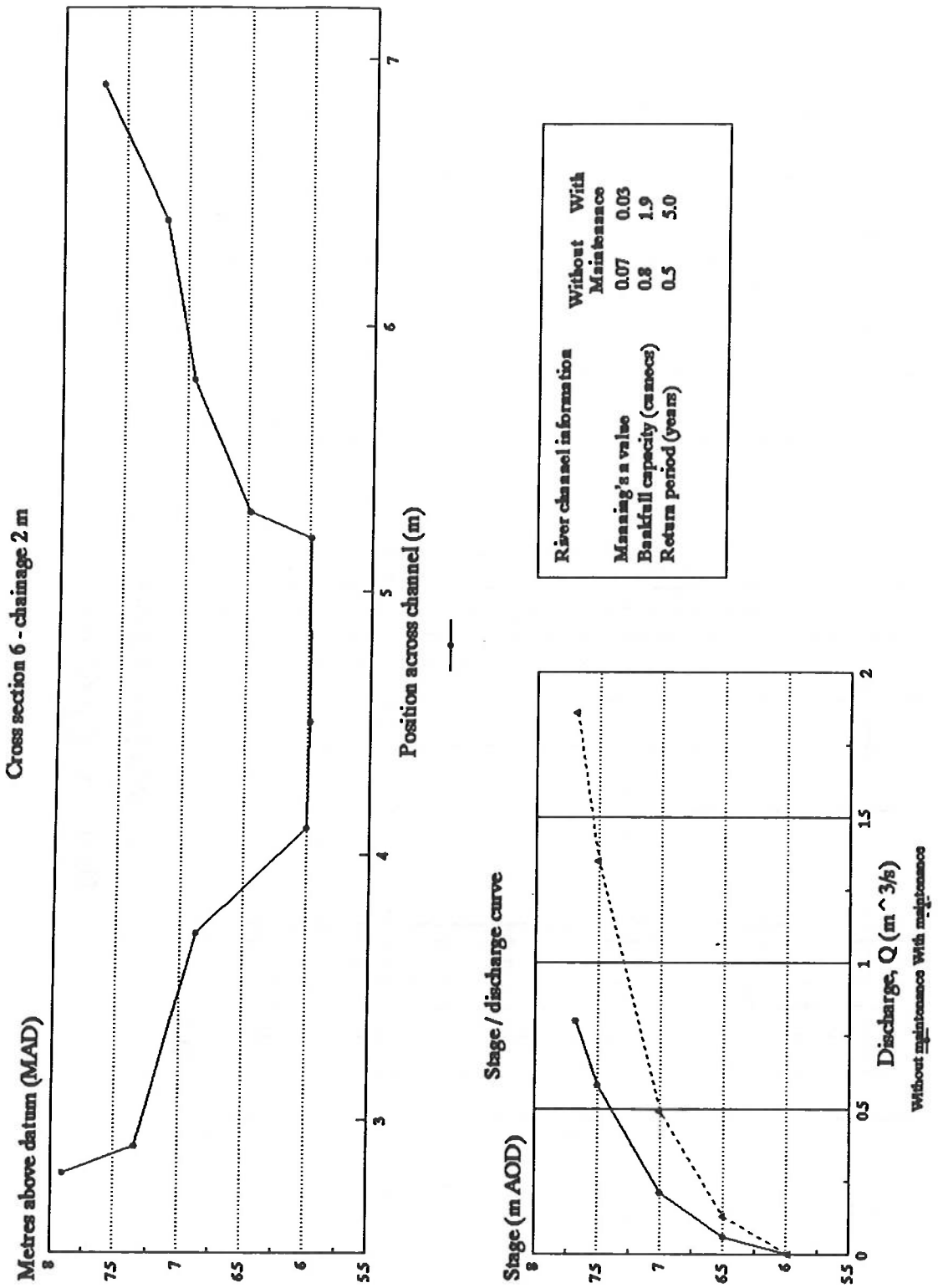


Figure 7 **Sally Sough channel information**

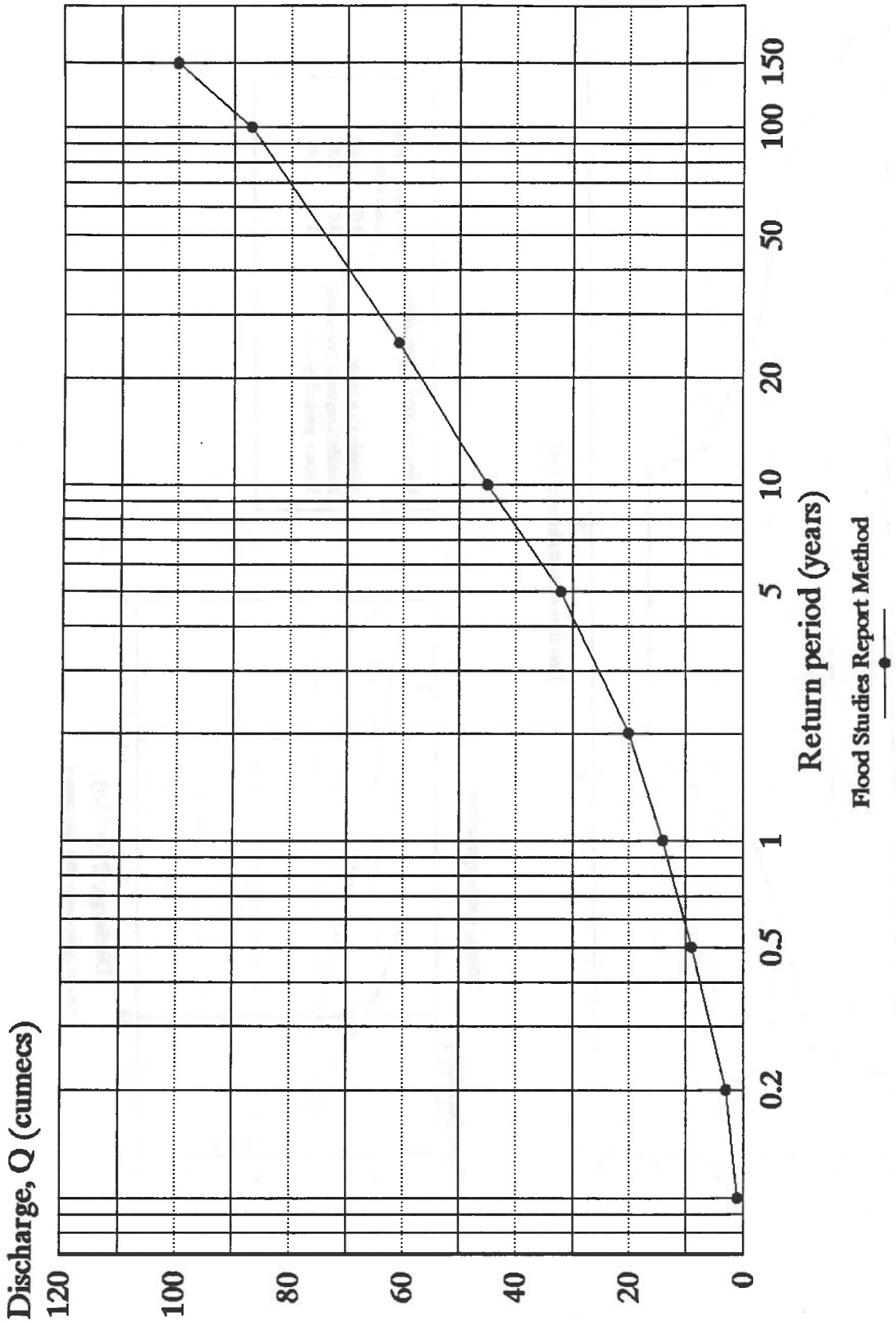


Figure 8 **River Wampool flood return period curve**

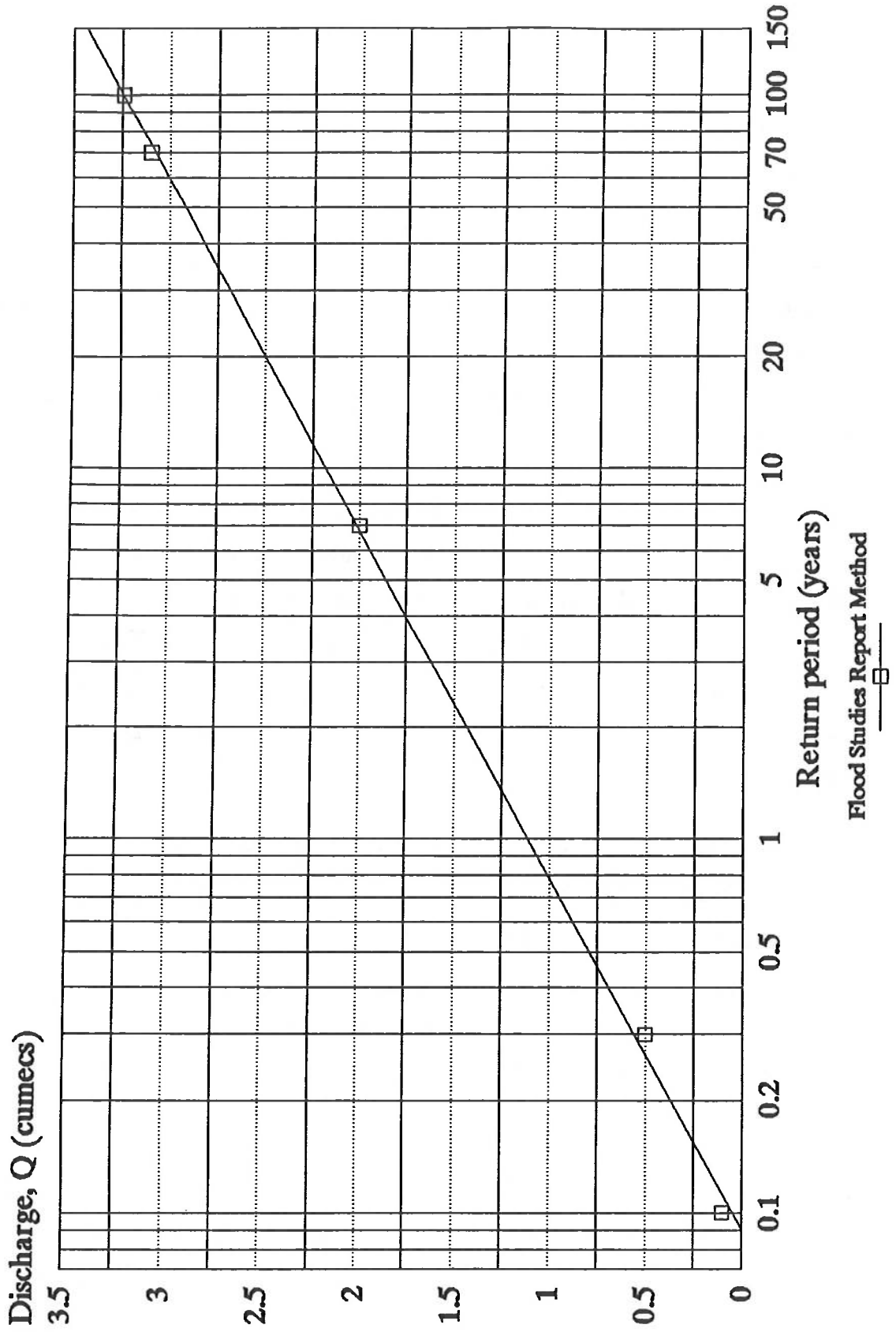


Figure 8 **Sally Sough flood return period curve**

4. LAND DRAINAGE

4.1 Field Drainage Status

Through an extensive literature and farmer survey, drainage status of the land has been classified into three standards according to watertable depth. These watertable bands have been identified as > 0.5 m from the surface, between 0.3 and 0.5 m from the surface and < 0.3 m from the surface. According to the time the watertable lies within these bands, the drainage standard is classed as good (G, no limitations on land use), bad (B, some restrictions on agriculture) or very bad (VB, severe limitations to agriculture). Further details are presented in the R&D Note 456, Section 3.5.2.

The drainage status of land within the benefit area has been determined on a seasonal basis using a non-steady state watertable model which relates infield watertable levels (and hence drainage conditions) to observed water levels in the river and ditch system (see R&D Note 456, Section 3.5.2 for further details). The model has been run using river water levels for the 'with' and 'without' maintenance scenario and the same climatic data in order to isolate the impact of maintenance on drainage status. An example of the input and output data of the model is shown in Appendix 1.

The results of the watertable model and the assessment of drainage status made by farmers are shown in Table 4.1. In some cases, there may be a change in the number of weeks that the watertable lies within the good, bad and very bad drainage bands following maintenance. However, these changes may not be of sufficient magnitude to change the drainage status classification. Where a sufficient change in drainage status has occurred due to maintenance, the changes appear in bold print in Table 4.1.

These assessments confirm that the drainage status in the benefit area with maintenance is generally good under wet, average and dry climatic conditions. Under average and dry conditions, there is a 100 % agreement between farmer and modelled assessment of field drainage conditions. In wet conditions, there is 57 % agreement between the farmer and modelled assessment - the farmers tend to over estimate the areas suffering from bad drainage in a wet season compared to that predicted by the model.

Table 4.1 Drainage status for wet, average and dry seasons, without/with maintenance

Block No		Wet Season *		Average Season *		Dry Season *		Farmer Assessment With Maintenance			Without
		Without	With	Without	With	Without	With	Wet	Average	Dry	
101	Y	G	G	G	G	G	G	G	G	G	B
201	Y	G	G	G	G	G	G	*B*	G	G	VB
202	Y	G	G	G	G	G	G	*B*	G	G	VB
301	Y	G	G	G	G	G	G	*B*	G	G	B
302	Y	G	G	G	G	G	G	*B*	G	G	B
303	Y	G	G	G	G	G	G	*B*	G	G	B
401	Y	G	G	G	G	G	G	G	G	G	B
402	Y	G	G	G	G	G	G	G	G	G	B
403	Y	G	G	G	G	G	G	G	G	G	B
404	Y	G	G	G	G	G	G	G	G	G	B
405	Y	G	G	G	G	G	G	G	G	G	B
501	Y	**VB**	**B**	**B**	**G**	**B**	**G**	B	G	G	B
502	Y	G	G	G	G	G	G	G	G	G	G
503	Y	G	G	G	G	G	G	G	G	G	B
504	Y	G	G	G	G	G	G	G	G	G	B
601	Y	G	G	G	G	G	G	G	G	G	B
602	Y	**B**	**G**	**B**	**G**	G	G	*B*	G	G	B
603	Y	**B**	**G**	**B**	**G**	G	G	*B*	G	G	B
604	N	**VB**	**B**	**B**	**G**	G	G	B	G	G	B
605	Y	**B**	**G**	**B**	**G**	G	G	*B*	G	G	B
701	N	**VB**	**B**	**B**	**G**	G	G	*G*	G	G	G
801	N	G	G	G	G	G	G	G	G	G	G
802	Y	G	G	G	G	G	G	G	G	G	G
803	Y	**B**	**G**	**B**	**G**	G	G	G	G	G	B
901	Y	G	G	G	G	G	G	*B*	G	G	B
1001	Y	B	B	**B**	**G**	G	G	G	G	G	G
1101	Y	G	G	G	G	G	G	G	G	G	G
1201	Y	G	G	G	G	G	G	*B*	G	G	VB

NB : * Modelled results
Y or N refers to the presence or absence of field drainage
Bold type indicates a change in drainage status due to maintenance
Italics indicate a difference in farmer and modelled assessment of drainage status with maintenance

There is only 36 % agreement between farmers' assessment and modelled assessment of field wetness conditions in the without maintenance situation under average climatic conditions. Under conditions of no maintenance, farmers perceive the drainage condition to be worse than the model predicts.

River maintenance results in the prevention of a deterioration of drainage status on 7 blocks of land in a wet season, 7 in an average season and 1 in a dry season.

- In a wet season maintenance prevents deterioration from :

  B to VB over 35 ha (15 % of BA)

  G to B over 30 ha (13 % of BA)

- In an average season maintenance prevents deterioration from :

  G to B over 68 ha (29 % of BA)

- In a dry season maintenance prevents deterioration from :

  G to B over 17 ha (7 % of BA)

Farmer perception of drainage deterioration due to lack of maintenance (under average conditions) was good to bad on 75 % of the benefit area and bad to very bad on 7 %.

5 SCHEME APPRAISAL

5.1 Maintenance Benefits

For each block of land, agricultural production scenarios were created which reflect different levels of field management under conditions of good, bad and very bad drainage (see R&D Note 456 Section 3.5.4). These scenarios are based on discussions with farmers in the benefit area over the period 1992-1994.

Changes in field drainage status as a result of maintenance under dry, average and wet climatic conditions have been identified. Changes in flood risk due to maintenance have also been determined. Estimates have been derived of the monetary value of changes in field management and productivity associated with changes in the standards of drainage service.

Two perspectives have been used to value agricultural performance. The first perspective is that of financial analysis which uses the prices paid and received by farmers to estimate the added-value associated with drainage. Financial analysis shows the benefits of maintenance to farmers in the benefit area.

The second perspective is that of economic analysis which modifies the financial analysis to make allowance for the direct and indirect subsidies paid to farmers by Government. In accordance with the MAFF Project Appraisal Guidance Notes on Flood Defence (PAGN, 1993), these modifications involve reductions in the financial value of output (including subsidies) by 10 % in the case of cereals, oil seeds and grain legumes, 35 % for beef and 25 % for sheep. Commodities subject to quota such as potatoes, sugar beet and milk are treated as winter wheat. The set aside areas are also treated as wheat. The reasons for these adjustments are discussed in the R&D Note 456 Section 2.7.2.

Using the results of watertable modelling, Table 5.1 shows the financial net returns (1995/96 prices) for each block of land within the detailed study area under conditions of good, bad and very bad drainage. Changes in net returns relating to a change in drainage status are also shown. Table 5.2 presents similar data using economic prices. Table 5.3 shows the flood costs for each block of land assuming 'with' and 'without' maintenance and specified field drainage conditions. It is assumed that there is no difference between financial and economic

values in the case of flood damage to standing crops. Negative values in Table 5.3 indicate a reduction in flood damage costs, mainly because the cost of a flood when it does occur, is lower on land which is badly drained than on that which is well drained.

Table 5.4 combines data on changes in drainage status, flood risk and financial performance to determine the financial benefits and change in financial net returns due to maintenance for wet, average and dry weather conditions for each block of land in the benefit area. These benefits are the avoidance of losses which would occur in the absence of maintenance. Benefits weighted by field size for wet, average and dry seasons are multiplied by the relative probability of the occurrence of the season to give an average expected annual benefit. These are summed for the benefit area as a whole.

Table 5.4 estimates a total expected annual benefit for the detailed study area of about £ 2850 in 1995 financial prices, equivalent to about £ 12/ha per year. Table 5.5 shows the benefits attributable to maintenance using economic prices based on the current MAFF Project Appraisal Guidance Notes. Total average expected annual benefits are about £ 3570 in economic prices for the detailed study area, equivalent to £ 15/ha. On this basis, the benefit to the national economy is 126 % of the benefits which accrue to farmers. This difference reflects the adjustments required by MAFF to treat dairy land as wheat equivalent. The economic penalties to lost wheat production are greater than the financial costs to dairy farmers in this case.

As an alternative estimate to that based on watertable modelling, Table 5.6 estimates the benefits due to maintenance which were perceived by farmers (earlier reported in Table 4.1) where they identified a change in drainage conditions between the 'with' and 'without' maintenance situations in an average, representative season. These estimates include the flood damage costs identified above in Table 5.3, which were based on a combination of farmer and modelled data. Farmer assessment gave an average annual financial benefit in the detailed study area of £ 11640 (£ 50/ha) and an economic benefit of £ 15410 (£ 66/ha). These benefits are about four times higher than those obtained by modelling. Farmers' assessment of benefits on the Wampool are much higher because they are based on average weather conditions and do not distinguish those times when maintenance has limited impact.

Table 5.1 Financial net returns

Block	Area	Net Return (£/ha)			Change in net return (£/ha)		
	(ha)	G	B	VB	G-B	B-VB	G-VB
101	16.10	442	360	293	83	67	149
201	4.90	390	326	224	64	102	166
202	7.04	328	276	230	52	45	97
301	23.60	392	315	257	77	58	135
302	2.82	299	273	226	26	48	73
303	20.60	390	385	266	4	119	124
401	9.50	495	471	315	24	156	179
402	11.10	511	433	356	78	76	155
403	8.80	445	402	347	43	55	98
404	3.97	463	357	285	106	72	178
405	3.30	463	429	282	34	146	181
501	16.60	435	414	267	21	146	167
502	9.80	423	343	231	80	112	193
503	8.60	438	345	279	93	66	159
504	2.90	438	345	279	93	66	159
601	9.05	489	375	293	114	81	195
602	2.30	411	399	259	12	141	152
603	20.70	354	308	269	46	39	85
604	4.50	440	387	308	53	79	132
605	3.20	440	387	308	53	79	132
701	14.00	123	93	71	30	22	51
801	7.40	145	116	89	29	27	56
802	3.70	145	116	89	29	27	56
803	3.90	112	88	51	23	37	60
901	5.20	503	408	319	95	89	184
1001	2.40	123	93	71	30	22	51
1101	2.30	364	286	231	78	55	133
1201	4.50	44	35	31	9	4	13

Table 5.2 Economic net returns

Block	Area	Net Return (£/ha)			Change in net return (£/ha)		
	(ha)	G	B	VB	G-B	B-VB	G-VB
101	16.10	394	321	188	73	133	206
201	4.90	394	321	188	73	133	206
202	7.04	394	321	188	73	133	206
301	23.60	394	321	188	73	133	206
302	2.82	394	321	188	73	133	206
303	20.60	394	321	188	73	133	206
401	9.50	394	321	188	73	133	206
402	11.10	442	331	227	111	104	215
403	8.80	393	343	275	51	68	118
404	3.97	394	321	188	73	133	206
405	3.30	394	321	188	73	133	206
501	16.60	394	321	188	73	133	206
502	9.80	30	21	7	10	14	23
503	8.60	394	321	188	73	133	206
504	2.90	394	321	188	73	133	206
601	9.05	394	321	188	73	133	206
602	2.30	394	321	188	73	133	206
603	20.70	394	325	201	69	124	193
604	4.50	384	327	238	57	89	146
605	3.20	384	327	238	57	89	146
701	14.00	-7	-11	-15	4	5	9
801	7.40	-4	-7	-13	2	6	8
802	3.70	-4	-7	-13	2	6	8
803	3.90	-64	-57	-50	-7	-6	-14
901	5.20	399	320	254	79	66	145
1001	2.40	-7	-11	-15	4	5	9
1101	2.30	58	34	22	24	13	36
1201	4.50	-55	-47	-43	-8	-4	-11

Table 5.3 Flood costs

Block Number	Without maintenance FRP	With maintenance FRP	GOOD DRAINAGE Without maintenance flood cost	GOOD DRAINAGE With maintenance flood cost	BAD DRAINAGE Without maintenance flood cost	BAD DRAINAGE With maintenance flood cost	VERY BAD DRAINAGE Without maintenance flood cost	VERY BAD DRAINAGE With maintenance flood cost	CHANGE IN FLOOD COSTS GOOD Without -with	CHANGE IN FLOOD COSTS BAD Without -with	CHANGE IN FLOOD COSTS VERY BAD Without -with	CHANGE IN FLOOD COSTS GOOD TO BAD Without -with	CHANGE IN FLOOD COSTS BAD TO VERY BAD Without -with	CHANGE IN FLOOD COSTS GOOD TO VERY BAD Without -with
201	0.80	2.00	11.25	4.50	9.70	3.88	7.08	2.83	6.75	5.82	4.25	5.20	3.20	2.58
202	0.90	2.00	2.82	1.27	2.53	1.14	2.29	1.03	1.55	1.39	1.26	1.26	1.15	1.02
301	0.80	1.00	3.01	2.41	2.66	2.13	2.35	1.88	0.60	0.53	0.47	0.25	0.22	-0.06
302	0.80	1.00	12.88	10.30	11.00	8.80	8.43	6.74	2.58	2.20	1.69	0.70	-0.38	-1.88
402	1.00	2.00	13.46	6.73	11.92	5.96	10.52	5.26	6.73	5.96	5.26	5.19	4.56	3.79
403	1.00	2.00	29.16	14.58	26.42	13.21	23.76	11.88	14.58	13.21	11.88	11.84	10.55	9.18
405	0.90	2.00	2.11	0.95	1.78	0.80	1.24	0.56	1.16	0.98	0.68	0.83	0.44	0.29
501	1.90	3.00	1.86	1.18	1.69	1.07	1.11	0.70	0.68	0.62	0.41	0.51	0.04	-0.07
502	3.00	5.00	2.52	1.51	2.07	1.24	1.43	0.86	1.01	0.83	0.57	0.56	0.19	-0.08
503	3.00	5.00	2.00	1.20	1.72	1.03	1.50	0.90	0.80	0.69	0.60	0.52	0.47	0.30
701	0.60	1.20	1.18	0.59	2.36	1.18	2.06	1.03	0.59	1.18	1.03	1.77	0.88	1.47
801	0.60	1.20	1.32	0.66	1.12	0.56	0.96	0.48	0.66	0.56	0.48	0.46	0.40	0.30
802	0.60	1.20	2.64	1.32	2.24	1.12	1.92	0.96	1.32	1.12	0.96	0.92	0.80	0.60
803	1.90	3.00	0.27	0.17	0.22	0.14	0.16	0.10	0.10	0.08	0.06	0.05	0.02	-0.01
901	0.60	1.20	7.34	3.67	6.26	3.13	5.26	2.63	3.67	3.13	2.63	2.59	2.13	1.59
1001	0.60	1.20	1.18	0.59	2.36	1.18	2.06	1.03	0.59	1.18	1.03	1.77	0.88	1.47
1101	0.60	1.20	2.12	1.06	1.78	0.89	1.54	0.77	1.06	0.89	0.77	0.72	0.65	0.48
1201	0.90	2.00	6.73	3.03	6.20	2.79	4.64	2.09	3.70	3.41	2.55	3.17	1.85	1.61

Table 5.4 Changes in net returns due to maintenance and climate, 1995/96 financial prices

Block	Area (ha)	Wet Season			Average Season			Dry Season			Total Change (£/yr)
		Benefit due to drainage (£/ha/yr)	Benefits of flood alleviation (£/ha)	Change in net return due to maintenance	Benefit due to drainage (£/ha/yr)	Benefits of flood alleviation (£/ha)	Change in net return due to maintenance	Benefit due to drainage (£/ha/yr)	Benefits of flood alleviation (£/ha)	Change in net return due to maintenance	
101	16.10	0	0.00	0	0	0.00	0	0	0.00	0	0
201	4.90	0	6.75	7	0	6.75	7	0	6.75	7	33
202	7.00	0	1.55	2	0	1.55	2	0	1.55	2	11
301	23.60	0	0.60	1	0	0.60	1	0	0.60	1	14
302	2.80	0	2.58	3	0	2.58	3	0	2.58	3	7
303	20.60	0	0.00	0	0	0.00	0	0	0.00	0	0
401	9.50	0	0.00	0	0	0.00	0	0	0.00	0	0
402	11.10	0	6.73	7	0	6.73	7	0	6.73	7	75
403	8.80	0	14.58	15	0	14.58	15	0	11.84	12	124
404	3.90	0	0.00	0	0	0.00	0	0	0.00	0	0
405	3.30	0	1.16	1	0	1.16	1	0	1.16	1	4
501	16.60	146	0.04	146	21	0.51	22	21	0.68	22	877
502	9.80	0	1.01	1	0	1.01	1	0	1.01	1	10
503	8.60	0	0.80	1	0	0.80	1	0	0.80	1	7
504	2.90	0	0.00	0	0	0.00	0	0	0.00	0	0
601	9.10	0	0.00	0	0	0.00	0	0	0.00	0	0
602	2.30	12	0.00	12	12	0.00	12	0	0.00	0	23
603	20.70	46	0.00	46	46	0.00	46	0	0.00	0	789
604	4.50	79	0.00	79	53	0.00	53	0	0.00	0	227
605	3.20	53	0.00	53	53	0.00	53	0	0.00	0	141
701	14.00	22	0.88	23	30	1.77	32	0	0.59	1	339
801	7.40	0	0.66	1	0	0.66	1	0	0.66	1	5
802	3.70	0	1.32	1	0	1.32	1	0	1.32	1	5
803	3.90	23	0.05	23	23	0.05	23	0	0.10	0	76
901	5.20	0	3.67	4	0	3.67	4	0	3.67	4	19
1001	2.40	0	1.18	1	30	0.59	31	0	0.59	1	44
1101	2.30	0	1.06	1	0	1.06	1	0	1.06	1	2
1201	4.50	0	3.70	4	0	3.70	4	0	3.70	4	17
Total	233									Total	2848
Probability of :		Wet season		0.25						Benefit (£/ha)	12
		Average season		0.58							
		Dry season		0.17							

Table 5.5 Changes in net returns due to maintenance and climate, 1995/96 economic prices

Block	Area (ha)	Wet Season			Average Season			Dry Season			Total Change (£/yr)
		Benefit due to drainage (£/ha/yr)	Benefits of flood alleviation (£/ha)	Change in net return due to maintenance	Benefit due to drainage (£/ha/yr)	Benefits of flood alleviation (£/ha)	Change in net return due to maintenance	Benefit due to drainage (£/ha/yr)	Benefits of flood alleviation (£/ha)	Change in net return due to maintenance	
101	16.10	0	0.00	0	0	0.00	0	0	0.00	0	0
201	4.90	0	6.75	7	0	6.75	7	0	6.75	7	33
202	7.00	0	1.55	2	0	1.55	2	0	1.55	2	11
301	23.60	0	0.60	1	0	0.60	1	0	0.60	1	14
302	2.80	0	2.58	3	0	2.58	3	0	2.58	3	7
303	20.60	0	0.00	0	0	0.00	0	0	0.00	0	0
401	9.50	0	0.00	0	0	0.00	0	0	0.00	0	0
402	11.10	0	6.73	7	0	6.73	7	0	6.73	7	75
403	8.80	0	14.58	15	0	14.58	15	0	11.84	12	124
404	3.90	0	0.00	0	0	0.00	0	0	0.00	0	0
405	3.30	0	1.16	1	0	1.16	1	0	1.16	1	4
501	16.60	133	0.04	133	73	0.51	73	73	0.68	73	1464
502	9.80	0	1.01	1	0	1.01	1	0	1.01	1	10
503	8.60	0	0.80	1	0	0.80	1	0	0.80	1	7
504	2.90	0	0.00	0	0	0.00	0	0	0.00	0	0
601	9.10	0	0.00	0	0	0.00	0	0	0.00	0	0
602	2.30	73	0.00	73	73	0.00	73	0	0.00	0	139
603	20.70	69	0.00	69	69	0.00	69	0	0.00	0	1187
604	4.50	89	0.00	89	57	0.00	57	0	0.00	0	248
605	3.20	57	0.00	57	57	0.00	57	0	0.00	0	151
701	14.00	5	0.88	6	4	1.77	6	0	0.59	1	69
801	7.40	0	0.66	1	0	0.66	1	0	0.66	1	5
802	3.70	0	1.32	1	0	1.32	1	0	1.32	1	5
803	3.90	-7	0.05	-7	-7	0.05	-7	0	0.10	0	-24
901	5.20	0	3.67	4	0	3.67	4	0	3.67	4	19
1001	2.40	0	1.18	1	4	0.59	5	0	0.59	1	7
1101	2.30	0	1.06	1	0	1.06	1	0	1.06	1	2
1201	4.50	0	3.70	4	0	3.70	4	0	3.70	4	17
Total	233									Total	3574
Probability of :		Wet season		0.25						Benefit (£/ha)	**15**
		Average season		0.58							
		Dry season		0.17							

Table 5.6 Farmer asessment of maintenance benefits

Block	Area (ha)	Average Season Financial Prices			Average Season Economic Prices		
		Benefit due to drainage (£/ha/yr)	Benefits of flood alleviation (£/ha)	Change in net return due to maintenance	Benefit due to drainage (£/ha/yr)	Benefits of flood alleviation (£/ha)	Change in net return due to maintenance
101	16.10	83	0.00	1336	73	0.00	1175
201	4.90	166	6.75	846	206	6.75	1042
202	7.00	97	1.55	690	206	1.55	1453
301	23.60	77	0.60	1831	73	0.60	1737
302	2.80	26	2.58	80	73	2.58	212
303	20.60	4	0.00	82	73	0.00	1504
401	9.50	24	0.00	228	73	0.00	694
402	11.10	78	6.73	941	111	6.73	1307
403	8.80	43	14.58	507	51	14.58	577
404	3.90	106	0.00	413	73	0.00	285
405	3.30	34	1.16	116	73	1.16	245
501	16.60	21	0.04	349	73	0.51	1220
502	9.80	0	1.01	10	0	1.01	10
503	8.60	93	0.80	807	73	0.80	635
504	2.90	93	0.00	270	73	0.00	212
601	9.10	114	0.00	1037	73	0.00	664
602	2.30	12	0.00	28	73	0.00	168
603	20.70	46	0.00	952	69	0.00	1428
604	4.50	53	0.00	239	57	0.00	257
605	3.20	53	0.00	170	57	0.00	182
701	14.00	0	0.88	12	0	1.77	25
801	7.40	0	0.66	5	0	0.66	5
802	3.70	0	1.32	5	0	1.32	5
803	3.90	23	0.05	90	-7	0.05	-27
901	5.20	95	3.67	513	79	3.67	430
1001	2.40	0	1.18	3	0	0.59	1
1101	2.30	0	1.06	2	0	1.06	2
1201	4.50	13	3.70	75	-11	3.70	-33
Total	233	Total financial benefit (£)		11637	Total economic benefit (£)		15414
		Benefit (£/ha)		50	Benefit (£/ha)		66

According to the criteria used, these financial and economic benefit estimates show the limits which farmers and the nation respectively could justifiably spend on maintenance. These estimates require cautious interpretation as explained in the R&D Note 456 Section 2.7.2.

5.2 Maintenance Costs

Prior to the study period, maintenance operations on the 6 km reach of the River Wampool involved desilting every four years plus annual bank flailing. This was substituted by annual weed clearance on 4 km and flailing along alternative banks each year. Reported costs were £ 0.15 and £ 1.30 per m length for flailing and weed clearance respectively in 1994 prices. This equates to £ 620 and £ 1930 in 1995 prices; a total of £ 2550. Annual weed cutting is expected to extend the life of the desilting operation to about one in 15 years. Desilting costs

are about £ 1.91/m, £ 11 500 for the 6 km length, over 15 years at 6 %. This equates to an annual charge of £ 1180.

Annual bank flailing and weed clearance are carried out on the tributary sough system, with desilting when required. Estimated costs in 1995 were £ 530 and £ 1610 for grass cutting and weed cutting respectively on the Sally Sough (3.4 km), £ 770 and £ 1520 on the Finglandrigg Sough (3.8 km) and £ 774 and £ 2000 on the Redmire Sough (3.5 km).

Desilting operations if carried out on these soughs would cost £ 2140, £ 2740 and £ 2200 respectively, a total of £7080. Over 10 years at 6 %, this is equivalent to about £ 960/year.

Total annual costs on the Wampool are £ 3730 (including desilting every 15 years) and on the three soughs about £ 8160 (including desilting every 10 years) - a grand total of £ 11 894 in 1995 prices, equivalent to about £ 9/ha.

5.3 Scheme Appraisal

Table 5.7 shows the estimated benefits and costs for the detailed study area (233 ha) and the extended study area (1362 ha). This assumes that benefits on the detailed study area can be extrapolated to the extended area because land use and field drainage conditions were very similar throughout. The costs of maintenance relate to the benefit areas served.

Table 5.7 Maintenance scheme appraisal: River Wampool

Average Annual Benefit (£)	Average Annual Benefits (£)	Average Annual Costs (£)	Benefit: Cost Ratio
DETAILED STUDY AREA			
Modelled Estimates			
Financial Prices	2850	3730	0.76
Economic Prices	3570	3730	0.96
Farmer Estimates			
Financial Prices	11640	3730	3.12
Economic Prices	15414	3730	4.13
EXTENDED STUDY AREA			
Modelled Estimates			
Financial Prices	16660	11890	1.40
Economic Prices	20870	11890	1.75
Farmer Estimates			
Financial Prices	68040	11890	5.72
Economic Prices	90100	11890	7.57

Table 5.7 shows that the maintenance programme on the River Wampool is economically worthwhile, especially if the extended area is taken as the basis for estimation. This allows the cost of maintenance to be spread across a large benefit area. The economic benefit : cost ratio is 1.75.

The farmers gave much higher estimates of benefits. They identified benefits of maintenance in weather conditions when the impact of maintenance is likely to be small. Their response is also likely to have been favourably biased in order to emphasise the importance to them of continued NRA maintenance. Overall, the maintenance programme appears justified.

These conclusions must be interpreted cautiously as discussed in the R&D Note 456 Section 2.7.2.

6 ENVIRONMENT

6.1 Introduction

The environmental quality of the River Wampool is outlined in this chapter. Reference is made to river corridor surveys, public consultation and farmer assessment.

6.2 River Corridor Survey

A river corridor survey was completed for each 500 m section of the study reach prior to river maintenance in 1992. The survey methodology developed by the Nature Conservancy Council, (NCC, now English Nature, EN) was followed. A record card and sketch map was completed for each section. The maps and cards can be found in Appendix II.

Following maintenance, a full river corridor survey was not necessary in order to determine the impact of maintenance as the channel dimensions were not altered. The post-maintenance survey took the form of a vegetational survey which concentrated on the location and cover of aquatic plants. This survey is presented in Appendix II.

6.3 Public Consultation

Details of all heavy maintenance work to be performed in the region throughout the following year are presented in an annual report. This is circulated to various departments within the NRA and each scheme is assessed from an environmental point of view. An annual liaison meeting is held to discuss the programme. Interested parties such as English Nature and the Royal Society for the Protection of Birds (RSPB) are invited to attend. Objections to the programme can be raised and if necessary changes may be made to the scheduled programme. If major works are to take place, such as desilting, a river corridor survey will be completed prior to the works.

In the future, a method of post-project appraisal is to be set up in order to evaluate the environmental effect of river maintenance works. This will take the form of river corridor surveys and supporting information. A standard format for the post project appraisal will be created.

6.4 Farmer Assessment

Farmers interviewed along the study reach were asked if they were aware of any flora or fauna of environmental interest along this section. Most farmers were aware of trout in the River Wampool. Ducks, swans and moorhens are said to be increasing in number throughout the study reach after being almost wiped out by mink.

6.5 Water Quality

The water quality is classified as Class 1b (good). This is inferred from the National Water Council (NWC) classification system and routine monitoring of invertebrate samples through the BMWP (Biological Monitoring Working Party) and ASPT values (Average Score Per Taxa).

This river is of good quality and the water may be used for drinking after treatment. The average ASPT value is 3.73, with values ranging from 3.5 to 4.25. Over the period 1988 to 1992, the BMWP varied from 45 to 68. The average value is 54.8

There is a rich variety of invertebrate life within the River Wampool. Water boatmen (*Corixidae*), water fleas (*Cladocera*), and beetles (*Haliplidae* and *Dytiscidae*) are common. Game fish such as trout are found within this reach.

6.6 Channel and Bank Quality

The environmental quality of the River Wampool has been determined by following the procedure outlined in the 'Guidelines for the Justification of River Maintenance' (R&D Note 511) produced within the framework of the NRA R&D Note 456 (River Maintenance Evaluation).

The quality of both the river channel and banks is classed as low. There is no transitional zone between the channel edge and the river at times of low flow, the sediment is uniform, no riffles and pools are present and the channel is of a uniform habitat.

The banks are of uniform structure, consisting of predominantly one vegetation type and no trees or scrub. Bank width is typically 5 to 10 m. They are grazed by sheep and dairy cattle.

7 CONCLUSIONS

7.1 Scheme Appraisal

The existing maintenance scheme is marginal in economic terms over the detailed study area and viable over the extended study area. The average annual economic benefits of maintenance are £ 3570 and £ 20870 over the detailed and extended study area respectively. The economic benefit : cost ratios are 0.96 and 7.57 over the detailed and extended study areas respectively.

7.2 Guidelines for River Maintenance

The 'Guidelines for the Justification of River Maintenance' (R&D Note 511), produced as a result of this River Maintenance Evaluation Study were used to provide an alternative method for justification of river maintenance on the River Wampool.

According to this method, the economic benefit : cost ratio for the detailed study area is 1.03. This value is approximately the same as that obtained through the detailed analysis; the results of which are summarised in Section 7.1. Using these maintenance guidelines, the current maintenance scheme is profitable in economic prices.

7.3 Impact of Maintenance on Channel Vegetation

The types of vegetation found within the River Wampool are discussed in Section 1.9. The impact of the submerged, emergent and floating vegetation on channel capacity is also discussed. Different vegetation types respond to maintenance in different ways.

The Canadian pondweed (*Elodea*) and sweet-grass (*Glyceria*) reproduce through a system of rhizomes (underground stems). The current method of maintenance - regular cutting, actually stimulates regrowth of this vegetation. The waterweed (*Potamogeton*) is a rooted plant. Desilting of the channel every few years is necessary in order to remove the rhizomes and to reduce the *Potamogeton* seed bank in the channel sediments.

The current maintenance regime may stimulate regrowth of the aquatic vegetation, however, desilting which is performed every three to four years will reduce the seed and rhizome bank in the channel bed.

7.4 Maintenance Best Practice

The 'best practice' vegetation maintenance methods for the River Wampool were determined using procedures outlined in the Guidelines (R&D Note 511), produced as a result of the Environmental Impact Assessment Study.

Channel

Best practice maintenance operations for emergent weed are identified as :

- Annual cutting in the autumn;
- Biennial cutting;
- Cutting on a 3 to 5 year rotation; and,
- Desilting / raking at an interval of 2 to 7 years.

Best practice maintenance operations for floating and submerged weed are identified as :

- Multiple annual cutting in the summer / autumn;
- Biennial cutting;
- Cutting on a 3 to 5 year rotation; and,
- Desilting / raking on a 2 - 7 year cycle.

All these maintenance operations should be selective, concentrating on those areas which are particularly choked by vegetation or areas in which the weed is liable to cause an obstruction, hazard or restriction to flow.

Since the beginning of this study, annual weed maintenance in the summer / autumn has taken place. All the vegetation is removed - the maintenance is not selective. Generally, the maintenance regimes recommended as best practice in environmental terms for vegetation management are currently being applied to this reach of the River Wampool. However, if some vegetation were left un-cut along the channel margins this would improve the environmental quality of the channel.

Bank

Best practice maintenance operations for bank vegetation are identified as :

- Bank mowing / flailing leaving a toe strip over 1 m wide; and,

- Light grazing.

The majority of the banks are grazed by dairy, sheep and beef cattle and are not mown. However, the grazing regimes are intensive and if the bank is un-fenced, the bank vegetation remains short and uniform in structure.

If the bank maintenance regime recommended as best practice in environmental terms were implemented, the grazing intensity of the banks would be reduced and a toe strip of un-cut and un-grazed vegetation left.

7.5 Recommendations

It is recommended that further research is carried to examine :-

- the impact of a reduced maintenance frequency on land drainage and flooding within the benefit area of the tributaries of the River Wampool;
- the impact of reduced channel maintenance on channel environmental quality; and,
- the impact of leaving a toe strip of vegetation on channel hydraulics, flooding, land drainage and environmental quality.

7.6 Epilogue

This report has assessed the impacts of the current maintenance regime on the study reach. It has been used along with other study sites to formulate guidelines on the appraisal of maintenance works and best environmental practice. These draft guidelines are summarised in Chapter 5 of the R&D Note 456 and presented in full under separate covers.

8. REFERENCES

Jarvis, R.A. Bendelow, V.C. Bradley, R.I. Carroll, D.M. Furness, R.R. Kilgour, I.N.L. and King, S.J. (1984). Soils and their Use in Northern England. SSEW, Harpenden.

MAFF (1993). Farm Incomes in the UK, 1991/92 Edition (1993). HMSO, London.

Met Office (1979). Monthly and Annual Totals of Rainfall 1969 for the UK. The Met Office, Bracknell, Berks.

NERC (1975). Flood Studies Report. NERC, London.

Nix, J (1994). Farm Management Pocket Book, 25th ed. 1994/95., MAFF, HMSO, London.

NRA (1991). The Quality of Rivers, Canals and Estuaries in England and Wales. Report of the 1990 Survey. NRA, Water Quality Series No. 4, NRA, Rivers House, Bristol.

Spencer-Jones, D and Wade, M (1986). Aquatic Plants - a guide to recognition. ICI Professional Products, Surrey.

University of Newcastle upon Tyne, Department of Economics and Food Marketing (1994). Farm Incomes in the North of England. University of Newcastle.

Map: Agricultural Land Classification, 1: 250 000 Series. Northern Region, MAFF (1976), HMSO, London.

Map: Landranger 85. Carlisle and the Solway Firth. 1: 50 000, Ordnance Survey Southampton (1988).

APPENDIX I

Example of input and output data for the watertable model

River Wampool
Block Number 501
Cross-section 2

Week 1993	Input Data: River height (m AOD)	Output Data: Watertable height (m AOD)
1	7.00	6.69
2	6.70	6.69
3	6.70	6.69
4	6.57	6.69
5	6.04	6.58
6	5.98	6.29
7	6.05	6.15
8	6.13	6.11
9	6.12	6.12
10	6.09	6.09
11	5.99	6.11
12	6.70	6.32
13	6.07	6.32
14	6.70	6.29
15	6.57	6.44
16	6.06	6.33
17	6.06	6.15
18	6.70	6.19
19	6.15	6.57
20	6.70	6.59
21	5.90	6.38
22	5.90	6.26
23	6.41	6.11
24	6.41	6.23
25	6.42	6.21
26	6.70	6.29
27	6.69	6.43
28	6.70	6.66
29	6.69	6.61

Example of drainage status classification, River Wampool

With maintenance

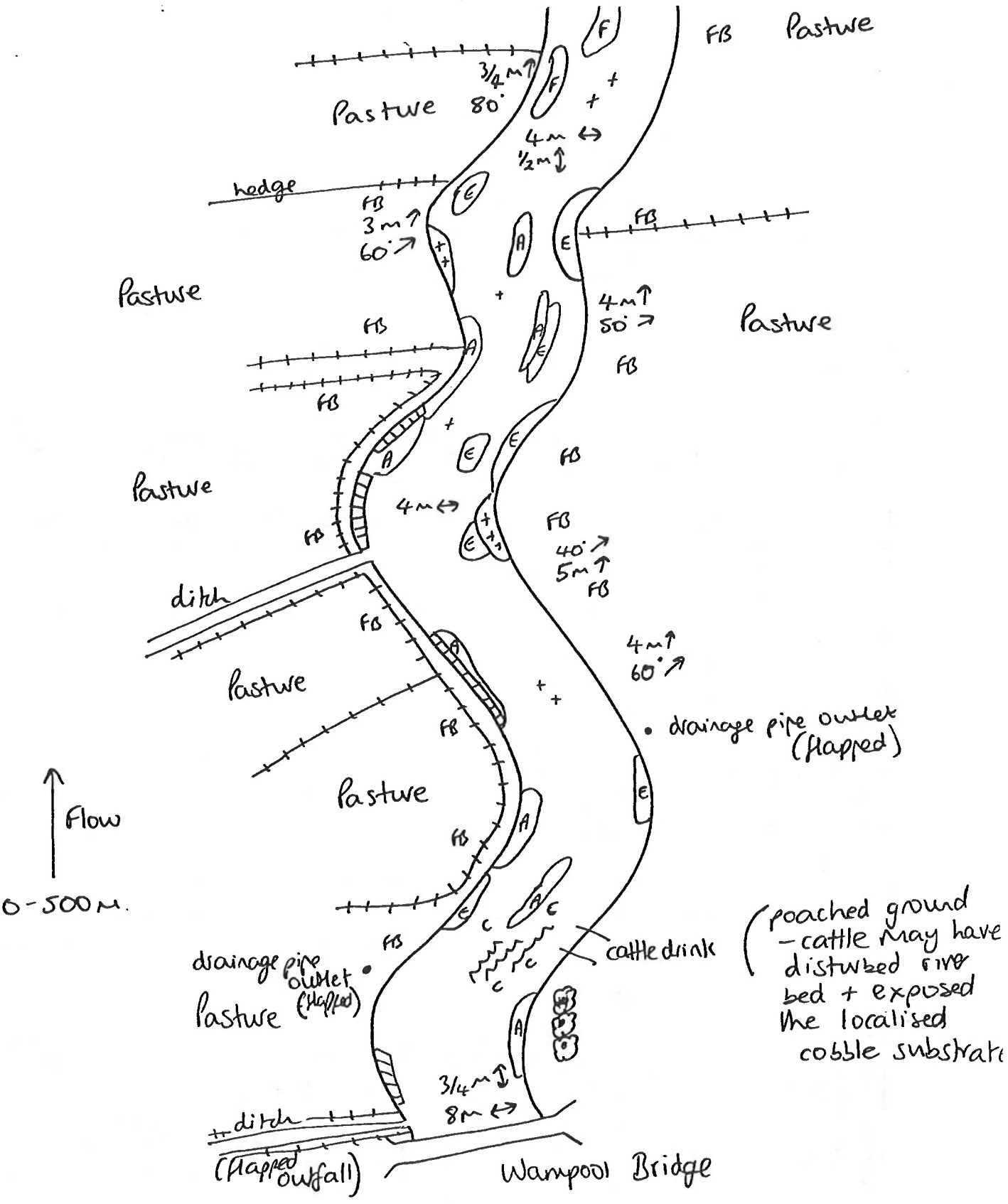
Block 501	Watertable depth (m)	No. of weeks 1993	Spring 1993	No. of weeks	Summer 1993	No. of weeks	Autumn 1993	No. of weeks
>0.5	6.19	42	6.19	13	6.19	13	6.19	11
0.3><0.5m	6.39	4	6.39	0	6.39	0	6.39	1
<0.3m	6.69	6	6.69	0	6.69	0	6.69	1
Drainage status classification, according to time watertable is within the G, B, VB drainage bands				Good		Good		Bad

Without maintenance

	Watertable depth (m)	No. of weeks 1993	Spring 1993	No. of weeks	Summer 1993	No. of weeks	Autumn 1993	No. of weeks
>0.5	6.19	14	6.19	5	6.19	2	6.19	4
0.3><0.5m	6.39	13	6.39	5	6.39	5	6.39	2
<0.3m	6.69	25	6.69	3	6.69	6	6.69	7
Drainage status classification, according to time watertable is within the G, B, VB drainage bands				Bad		Bad		Very Bad

APPENDIX II

River Wampool
Pre-Maintenance



	LB	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved	100	100
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

RIVER Wampool

Km No. 0 – 500 M

Date 27/5/92

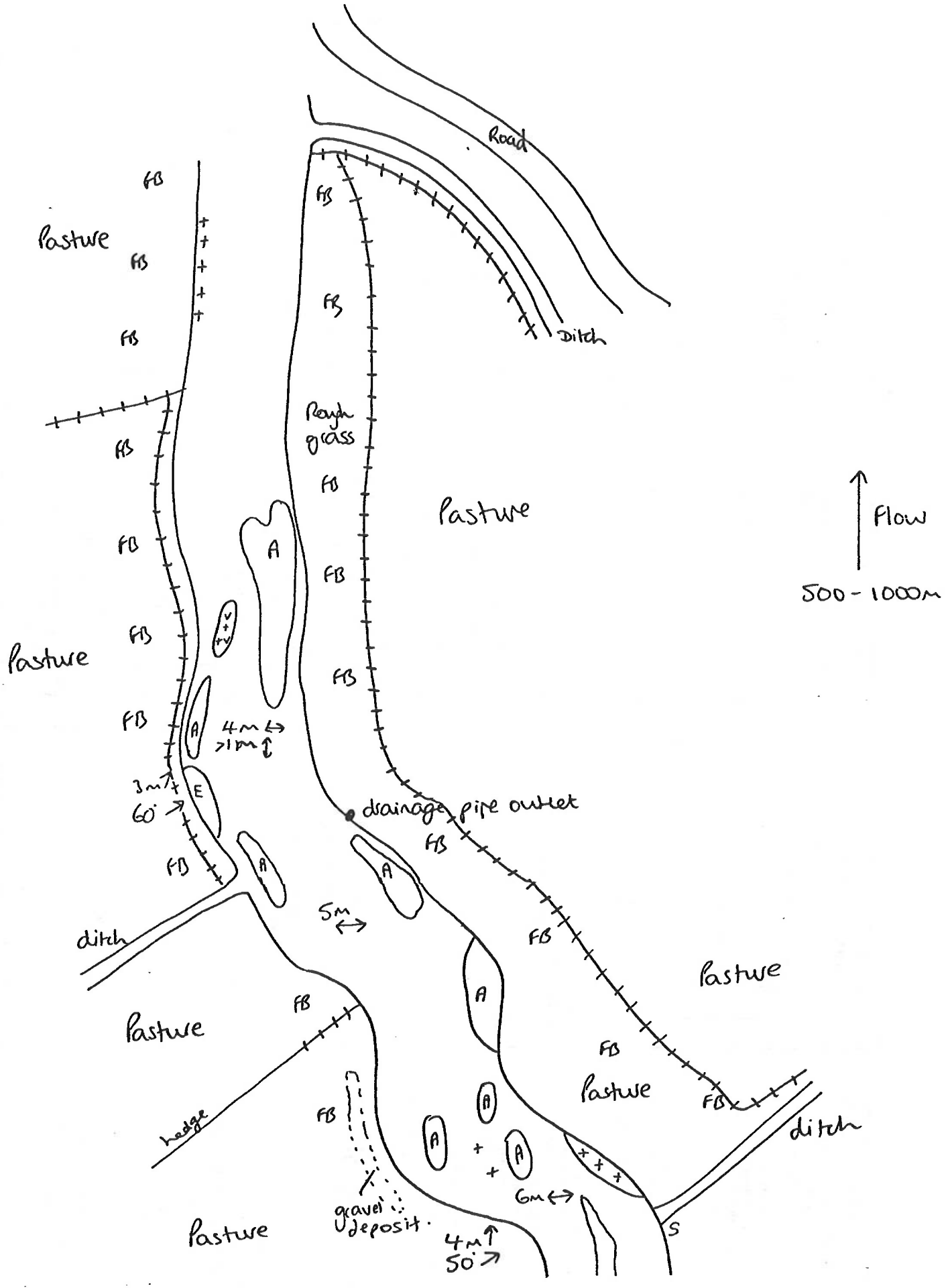
Surveyor JALD

	LB	RB
G. OPEN WATER		
1. Standing - canal +		
canal =	% of adj. land in each stretch	
ditch	1	
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		
hedge +	2	
hedge =		
fence on bank	60	2
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other cattle drinks		1

BANK FEATURES %	LB	RB
shell %		
solid earth cliff 1m↑		
soft earth cliff >80°		
rock cliff		
artificial	12	
FB flood bank adj.	80	50
FB flood bank set back		
levee		
Height <1m	20	
1-<2m		
>2m	80	100
Width <1m		
1-<2.5m		
2.5-<5m	100	100
>5m		
Slope: <30°		
30-<60°	80	100
60-<90°	20	
>90°		
mud	2	
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		3
P Willow recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %		
Sparse Scrub/shrubs %		
Reed/Sedge %		
Dense open %		
Sparse open %		
Reseeded or mown %,		
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

RIVER HABITATS	RIVER
bridges/500m	1
weirs/500m	
locks/500m	
inlet/500m	
Depth <.25m %	
.25-<.5	100
.5-<1.0	
>1.0m	
Width <1	90
1-<5	10
5-<10	
10-<20	
>20	
Substrates	
BR bed rock	
b boulders	20
c cobbles	
p pebbles	
g gravel	
s sand	
+ silt/mud	80
clay	
peat	
Habitats and Flow	
pool	80
slack	20
riffle	
rapids	
run	
waterfall	
protruding rocks	
Margins	
shingle ± bare	
shingle, vegetated	
mud	10
sand	
FLORA %	
emergent veg < 1m wide	100
emergent 1-2m wide	
emergent >2m wide	
total vegel area	25
B bryophytes	
E emergents 50	
A submerged 40	
F floating 10	
algae % of stretch	

total to 100%


Road
Ditch
Rough grass
Pasture
Pasture
Pasture
Pasture
Pasture
Pasture
Pasture
FB
A
E
4m ↔
>1m ↕
3m ↑
60°
5m ↔
drainage pipe outlet
ditch
ditch
hedge
gravel deposit
6m ↔
4m ↑
50°
S
Flow
500 - 1000m

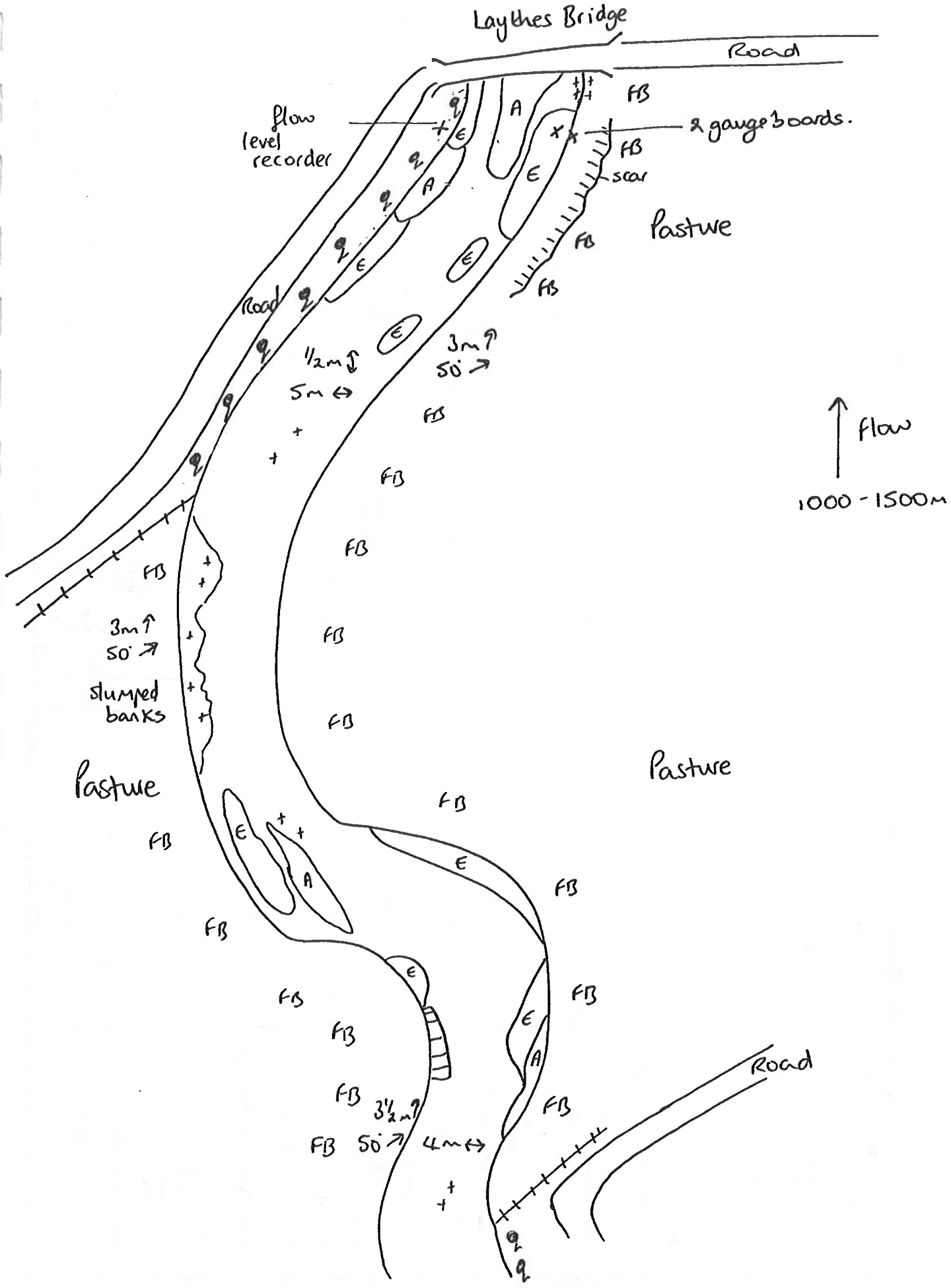
	LB	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		10
Neutral unimproved	100	88
semi-improved		
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

RIVER Wampool
Km No. 500 – 1000 M
Date 27/5/92
Surveyor JALD.

	LB	RB
G. OPEN WATER		
1. Standing - canal + (% of adj land in each stretch)		
canal =	1	1
ditch		
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		
hedge +	1	
hedge =		
fence on bank	49	
fence set back		90
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		2
railway disused		
used		
other		

	LB	RB
BANK FEATURES %		
shelf %		
solid earth cliff 1M↑		
soft earth cliff >80°		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m		
1-<2m		
>2m	100	100
Width <1m		
1-<2.5m		
2.5-<5m	100	100
>5m		
Slope <30°		
30-<60°	100	100
60-<90°		
>90°		
mud		
sand		
bare shingle	2	
vegetated shingle		
earth		
natural cobbles	98	100
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow recent pollard		
W Willow old, not pollard		
S Standard willows		1
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %		
Sparse Scrub/shrubs %		
Reed/Sedge %		
Dense open %		
Sparse open %		
Reseeded or mown %		
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
width etc too rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

	RIVER
RIVER HABITATS	
bridges/500m	
weirs/500m	
locks/500m	
inlet/500m	
Depth <.25m %	
.25-<.5	
0.5-<1.0	
>1.0m	100
Width <1	80
1-<5	20
5-<10	
10-<20	
>20	
Substrates	
BR bed rock	
b boulders	
c cobbles	
p pebbles	
g gravel	
s sand	
si silt/mud	100
cl clay	
peat	
Habitats and Flow	
pool	
slack	100
riffle	
rapids	
run	
waterfall	
protruding rocks	
Margins	
shingle ± bare	
shingle, vegetated	
mud	3
sand	
FLORA %	
emergent veg <1m wide	10
emergent 1-2m wide	
emergent >2m wide	
total veget area	22
B bryophytes	
E emergents 10	
A submerged 90	(total to 100%)
F floating	
algae % of stretch	


Laythes Bridge
Road
flow level recorder
2 gauge boards.
FB
scar
Pasture
Road
1½m ↕
5m ↔
3m ↑
50° ↗
Flow
1000 - 1500m
3m ↑
50° ↗
stumped banks
Pasture
Pasture
Road
3½m ↑
50° ↗
4m ↔

RIVER Wampool

Km No. 1000 – 1500 M

Date 27/5/92

Surveyor JALD

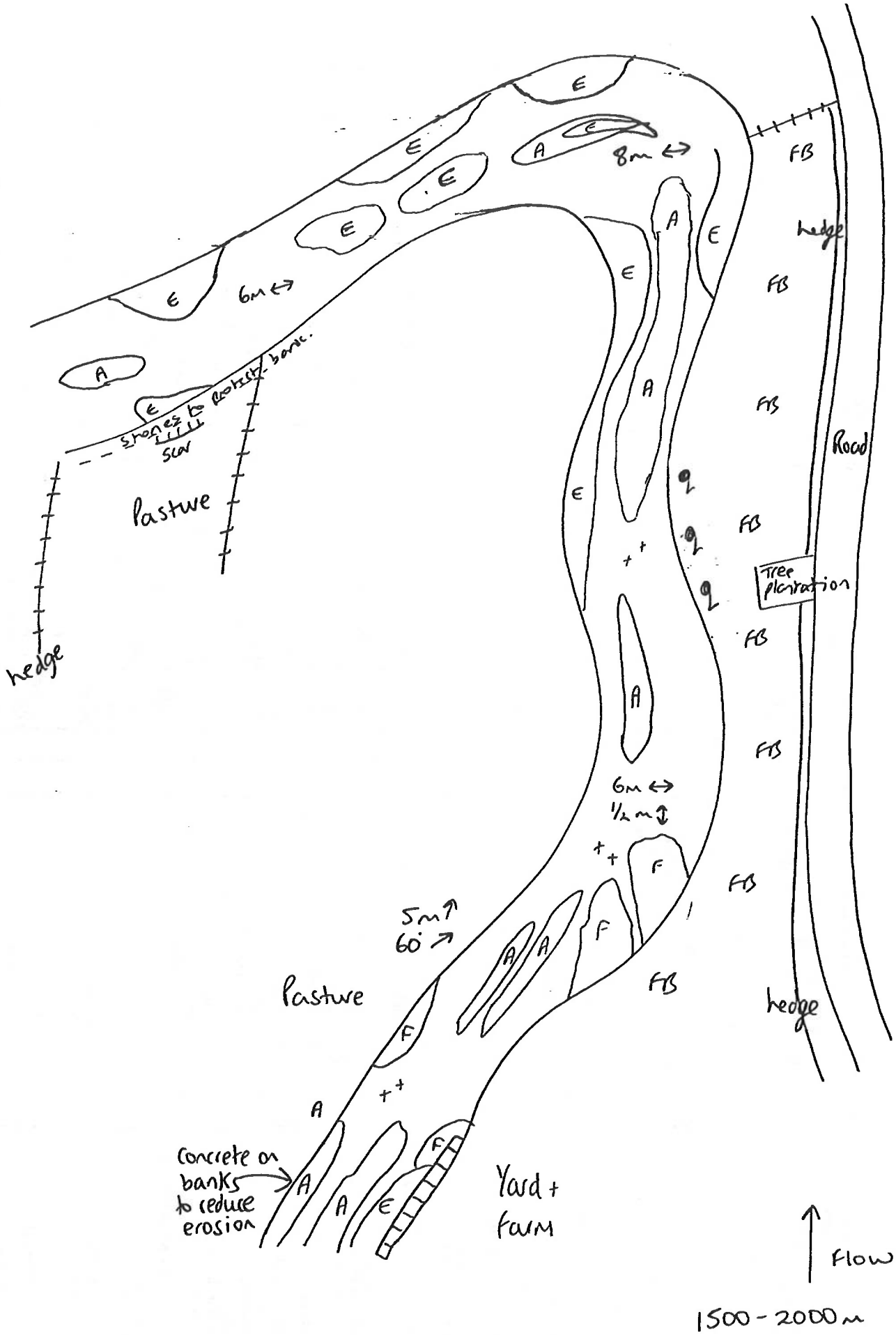
	LB	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved	60	80
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Health/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires - bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

	LB	RB
G. OPEN WATER		
1. Standing - canal + (% of adj. land in each stretch)		
canal =		
ditch		
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		
hedge +		
hedge =		
fence on bank	1	1
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road	39	4
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shell %		
solid earth cliff (1m↑ soft earth cliff >80°)		
rock cliff		
artificial	1	
FB flood bank adj.	60	95
FB flood bank set back levee		
Height <1m		
1-<2m		
>2m	100	100
Width <1m		
1-<2.5m		
2.5-<5m	100	100
>5m		
Slope <30°		
30-<60°	100	100
60-<90°		
>90°		
mud	1	
sand		
bare shingle		
vegetated shingle		
earth	100	99
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %		
Sparse Scrub/shrubs %		
Reed/Sedge %		
Dense open %	40	3
Sparse open %		
Reseeded or mown %		
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

RIVER HABITATS		RIVER
bridges/500m		1
weirs/500m		
locks/500m		
inlet/500m	1	
Depth <.25m	%	
.25-<.5		100
0.5-<1.0		
>1.0m		
Width <1		70
1-<5		30
5-<10		
10-<20		
>20		
Substrates		
BR bed rock		
b boulders		
c cobbles		
p pebbles		
g gravel		
s sand		
silt/mud		100
clay		
peat		
Habitats and Flow		
pool		
slack		100
riffle		
rapids		
run		
waterfall		
protruding rocks		
Margins		
shingle ± bare		
shingle, vegetated		
mud		4
sand		
FLORA %		
emergent veg < 1m wide		78
emergent 1-2m wide		2
emergent >2m wide		
total veget. area		20
B bryophytes		
E emergents	80	
A submerged	20	
F floating		
algae % of stretch		

(total to 100%)


E
A
8m ↔
FB
hedge
6m ↔
stones to protect bank
scar
Pasture
Road
hedge
Tree plantation
6m ↔
½m ↕
F
5m ↑
60° ↗
Pasture
hedge
Concrete on banks to reduce erosion
Yard + farm
Flow
1500 - 2000m

	LB	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		3
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved	100	70
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

RIVER Wampool

Km No. 1500–2000 m

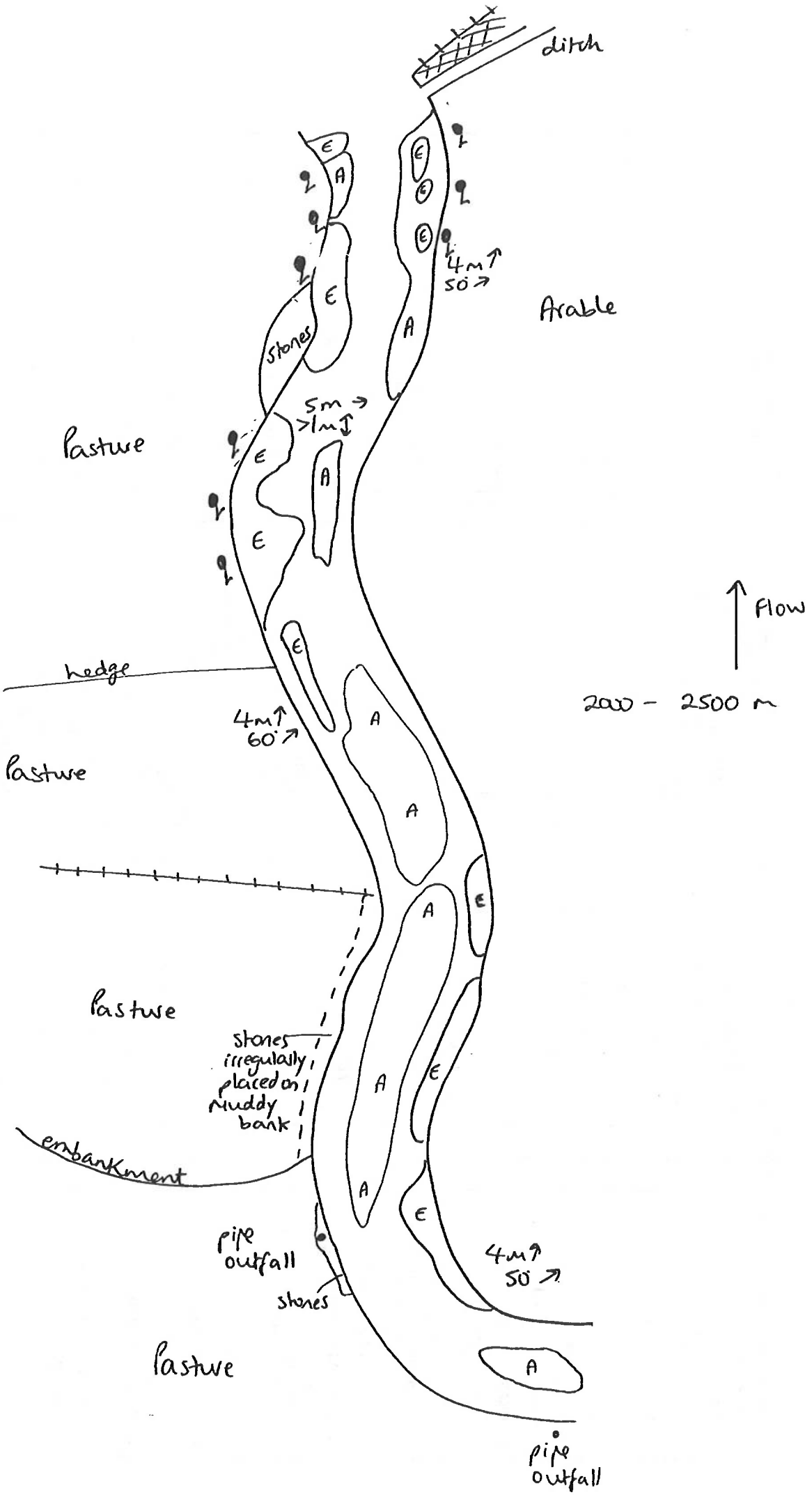
Date 28/5/92

Surveyor JALD.

	LB	RB
G. OPEN WATER		
1. Standing - canal +	% of adj land in each stretch	
canal =		
ditch		
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %.		
2. Running		
stream < 1m wide		
1·5m		
5·10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		
hedge +		
hedge =		30
fence on bank		
fence set back	4	1
wall		
building		20
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shell %		
solid earth cliff		
soft earth cliff		
rock cliff	5	3
artificial		35
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m		
1·<2m		
>2m	100	100
Width <1m		
1·<2·5m		
2·5·<5m	100	100
>5m		
Slope <30°		
30·<60°	100	100
60·<90°		
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %.		
Sparse Scrub/shrubs %.		
Reed/Sedge %.		
Dense open %.		
Sparse open %.		4
Reseeded or mown %.		
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

RIVER HABITATS		RIVER
bridges/500m		
weirs/500m		
locks/500m		
inlet/500m		
Depth <.25m	%	100
.25·<.5		
0·5·<1.0		
>1.0m		
Width <1		
1·<5		
5·<10		100
10·<20		
>20		
Substrates		
BR bed rock		
b boulders		
c cobbles		
p pebbles		
g gravel		
s sand		
+ silt/mud		100
clay		
peat		
Habitats and Flow		
pool		
slack		100
riffle		
rapids		
run		
waterfall		
protruding rocks		
Margins		
shingle ± bare		
shingle, vegetated		
mud		
sand		
FLORA %		
emergent veg < 1m wide		30
emergent 1·2m wide		20
emergent >2m wide		
total veget area		40
B bryophytes		
E emergents	50	
A submerged	35	total to 100%
F floating		
algae % of stretch		


ditch
E
A
4m ↑
50 ↗
Arable
stones
5m →
>1m ↕
Pasture
hedge
4m ↑
60 ↗
Pasture
Flow
200 - 2500 m
Pasture
stones irregularly placed on muddy bank
embankment
pipe outfall
stones
4m ↑
50 ↗
Pasture
pipe outfall

	LB	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved	100	
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

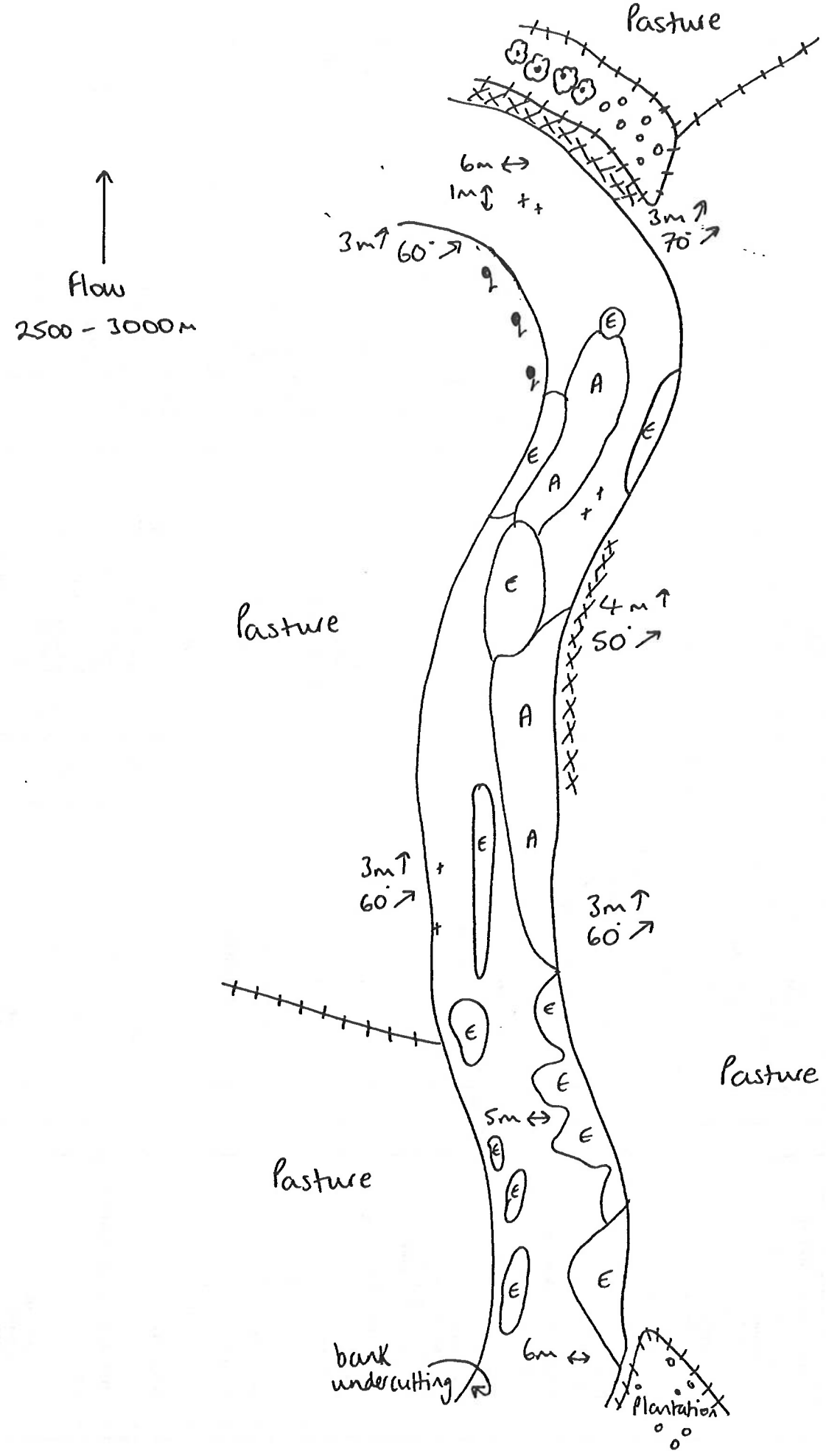
RIVER Wampool
Km No. 2000-2500 M
Date 28/5/92
Surveyor JALD

	LB	RB
G. OPEN WATER		
1. Standing - canal + (% of adj land in each stretch)		
canal =		1
ditch		
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		100
amenity grassland		
ephemeral/short herb		
hedge +		
hedge =	2	
fence on bank	2	1
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shelf %		
solid earth cliff 1M↑		
soft earth cliff >80°		
rock cliff		
artificial	30	
FB flood bank adj		
FB flood bank set back	2	
levee		
Height <1m		
1-<2m		
>2m	100	100
Width <1m		
1-<2.5m		
2.5-<5m		
>5m	100	100
Slope <30°		
30-<60°	100	100
60-<90°		
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %.		
Sparse Scrub/shrubs %.		
Reed/Sedge %.		
Dense open %.	15	5
Sparse open %.		
Reseeded or mown %.		
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

RIVER HABITATS	RIVER
bridges/500m	
weirs/500m	
locks/500m	
inlet/500m	1
Depth <.25m %	
.25-<.5	
0.5-<1.0	
>1.0m	100
Width <1	
1-<5	
5-<10	100
10-<20	
>20	
Substrates	
BR bed rock	
b boulders	
c cobbles	
p pebbles	
g gravel	
s sand	
+ silt/mud	100
clay	
peat	
Habitats and Flow	
pool	
slack	100
riffle	
rapids	
run	
waterfall	
protruding rocks	
Margins	
shingle ± bare	
shingle, vegetated	
mud	
sand	
FLORA %	
emergent veg < 1m wide	40
emergent 1-2m wide	20
emergent >2m wide	
total veget area	40
B bryophytes	
E emergents 60	
A submerged 40	
F floating	
algae % of stretch	

(total to 100%)


Pasture
6m ↔
1m ↕
3m ↑
70°
3m ↑
60°
Flow
2500 - 3000m
A
E
Pasture
4m ↑
50°
3m ↑
60°
3m ↑
60°
Pasture
5m ↔
Pasture
bank undercutting
6m ↔
Plantation

	LB	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		14
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved	100	86
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

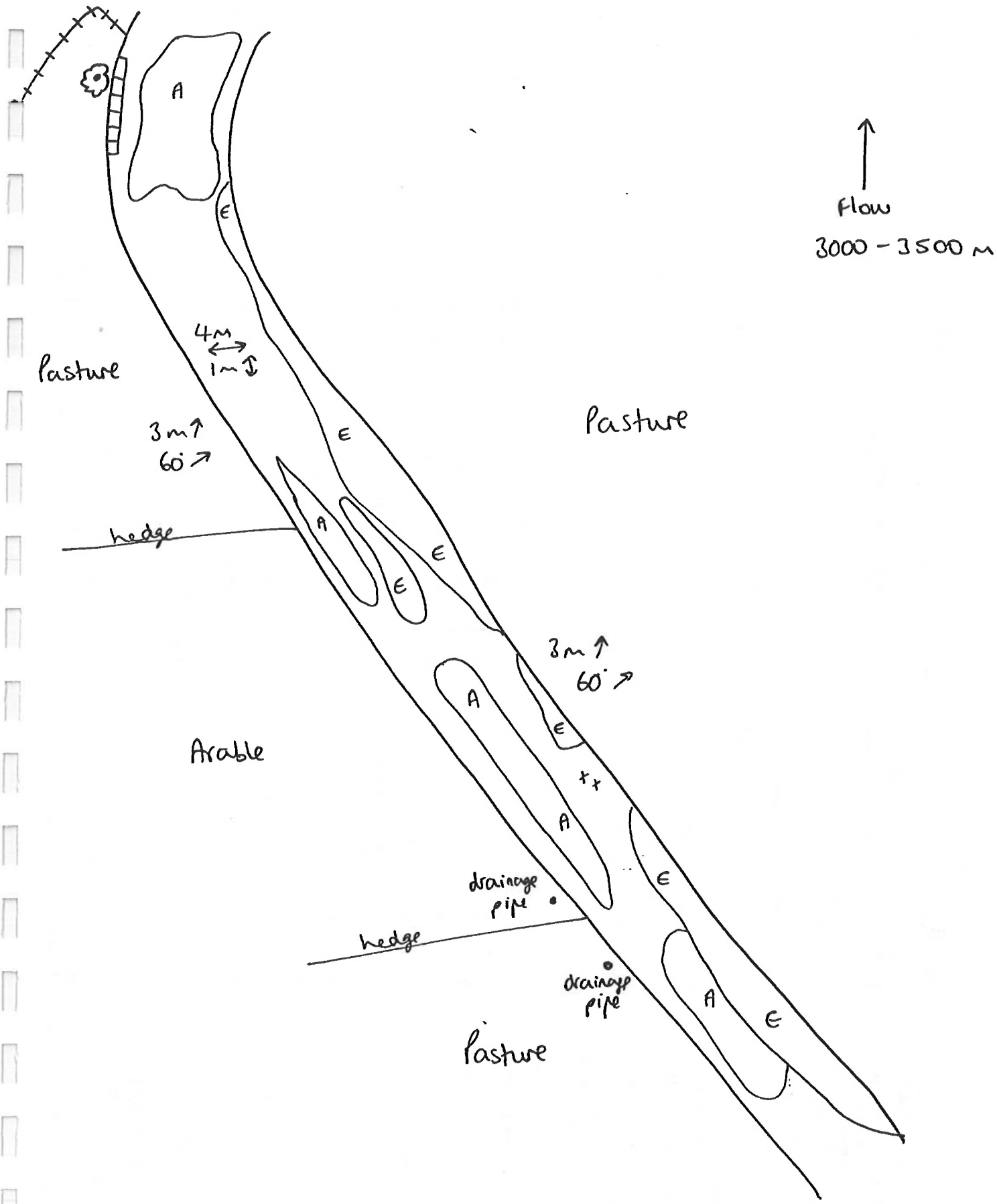
RIVER Wampool
Km No. 2500 – 3000 m
Date 28/5/92
Surveyor JALD

	LB	RB
G. OPEN WATER		
1. Standing - canal + canal = (% of adj land in each stretch)		
ditch		
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		
hedge +		
hedge =		
fence on bank	1	4
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

	LB	RB
BANK FEATURES %		
shell %		
solid earth cliff 1M↑		
soft earth cliff >80°		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m		
1-<2m		
>2m	100	100
Width <1m		
1-<2.5m		
2.5-<5m		
>5m	100	100
Slope <30°		
30-<60°		
60-<90°	100	100
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		4
P Willow recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees	15	
Thick Scrub/shrubs %		
Sparse Scrub/shrubs %		
Reed/Sedge %		15
Dense open %	15	
Sparse open %		
Reseeded or mown %		
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

	RIVER
RIVER HABITATS	
bridges/500m	
weirs/500m	
locks/500m	
inlet/500m	
Depth <25m %	
.25-<.5	
0.5-<1.0	
>1.0m	100
Width <1	
1-<5	
5-<10	100
10-<20	
>20	
Substrates	
BR bed rock	
b boulders	
c cobbles	
p pebbles	
g gravel	
s sand	
+ silt/mud	100
clay	
peat	
Habitats and Flow	
pool	
slack	100
riffle	
rapids	
run	
waterfall	
protruding rocks	
Margins	
shingle ± bare	
shingle, vegetated	
mud	
sand	
FLORA %	
emergent veg <1m wide	50
emergent 1-2m wide	10
emergent >2m wide	
total vegel area	30
B bryophytes	
E emergents 60	
A submerged 40	
F floating	
algae % of stretch	

(total to 100%)


A
E
Flow
3000 - 3500 m
4m
1m
Pasture
3m
60°
Pasture
hedge
A
E
E
E
3m
60°
A
E
Arable
A
E
drainage pipe
hedge
drainage pipe
A
E
Pasture

	LB	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved	60	
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich vegel.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

RIVER Wampool

Km No. 3000 - 3500 M

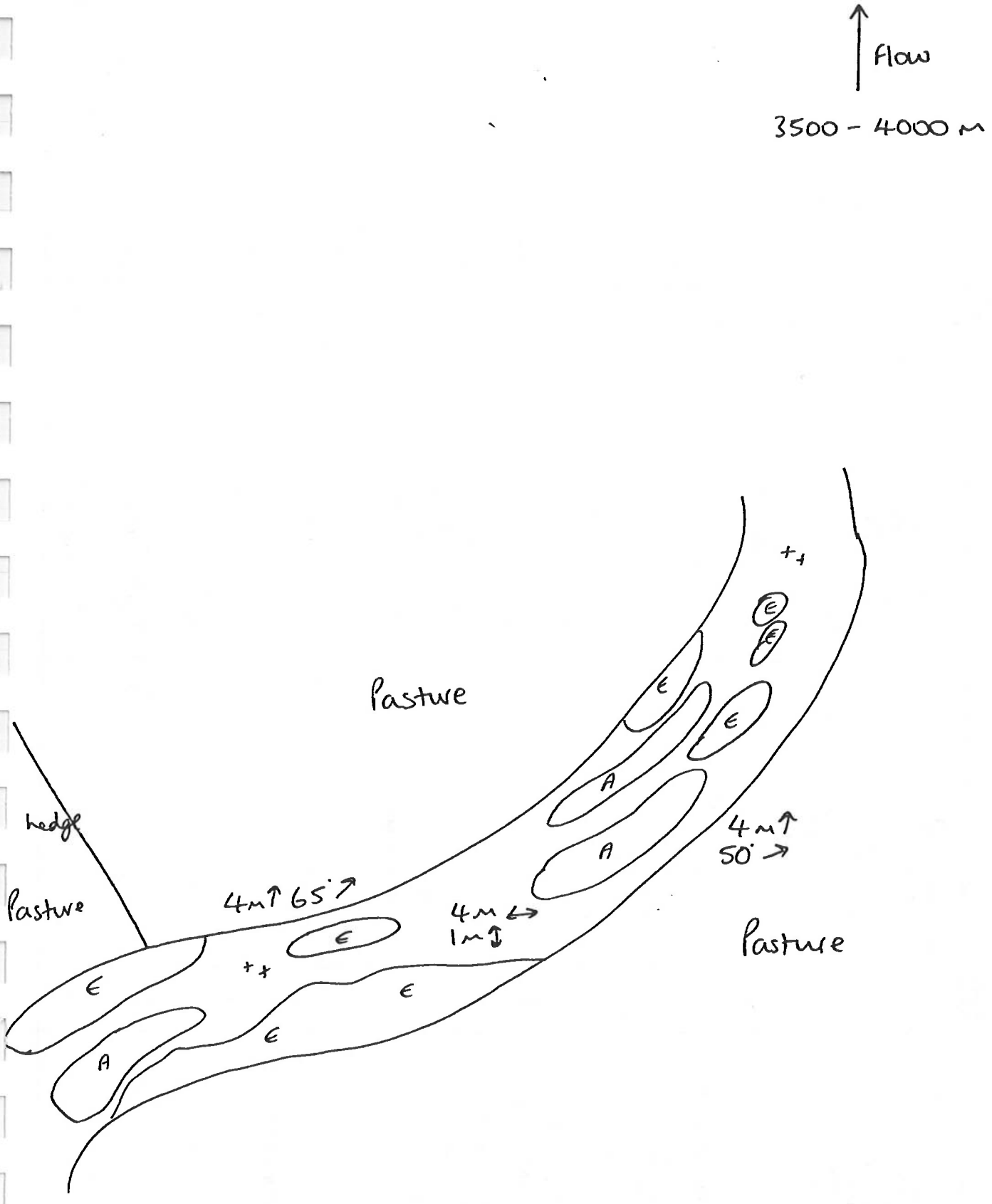
Date 29/5/92

Surveyor JALD.

	LB	RB
G. OPEN WATER		
1. Standing - canal + % of adj land in each stretch		
canal =		
ditch		
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %.		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable	40	
amenity grassland		
ephemeral/short herb		
hedge +	2	
hedge =		
fence on bank	1	
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shell %		
solid earth cliff	3	
soft earth cliff		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m		
1 <2m	100	100
>2m		
Width <1m		
1-<2.5m		
2.5-<5m	100	100
>5m		
Slope <30°		
30 <60°	100	100
60 <90°		
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore	1	
P Willow recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %		
Sparse Scrub/shrubs %		
Reed/Sedge %		
Dense open %.		
Sparse open %.		
Reseeded or mown %.		
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

	RIVER
RIVER HABITATS	
bridges/500m	
weirs/500m	
locks/500m	
inlet/500m	
Depth <.25m %	
.25-<.5	
0.5-<1.0	
>1.0m	100
Width <1	
1-<5	
5-<10	100
10-<20	
>20	
Substrates	
BR bed rock	
b boulders	
c cobbles	
p pebbles	
g gravel	
s sand	100
+ silt/mud	
clay	
peat	
Habitats and Flow	
pool	
slack	100
riffle	
rapids	
run	
waterfall	
protruding rocks	
Margins	
shingle ± bare	
shingle, vegetated	
mud	
sand	
FLORA %	
emergent veg < 1m wide	20
emergent 1-2m wide	30
emergent >2m wide	
total veget area	50
B bryophytes	
E emergents 50	
A submerged 50	total to 100%
F floating	
algae % of stretch	


Flow
3500 - 4000 m
Pasture
hedge
Pasture
4m↑ 65°↗
4m ↔
1m ↕
4m↑
50°↗
Pasture
A
A
A

	LB	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved	100	100
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

RIVER Wampool

Km No. 3500 – 4000 m

Date 29/5/92

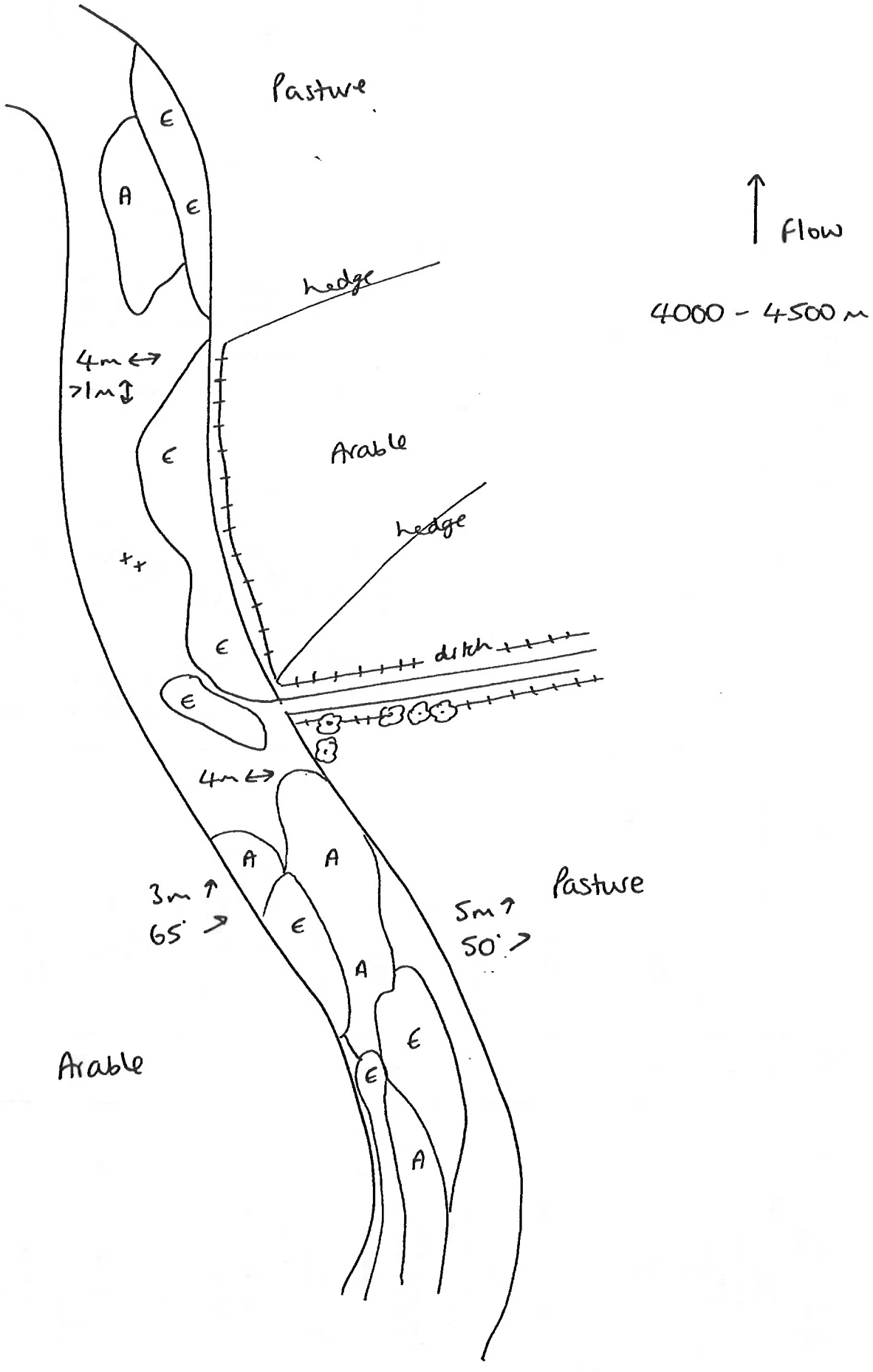
Surveyor JALD

	LB	RB
G. OPEN WATER		
1. Standing - canal + % of adj land in each stretch		
canal =		
ditch		
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %.		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		
hedge +	1	
hedge =		
fence on bank		
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shell %		
solid earth cliff 1M↑		
soft earth cliff >80°		
rock cliff		
artificial		
FB flood bank ash		
FB flood bank set back		
levee		
Height <1m		
1-<2m		
>2m	100	100
Width <1m		
1-<2.5m		
2.5-<5m		
>5m	100	100
Slope <30°		
30-<60°		100
60-<90°	100	
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth		
natural cobbles	100	100
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %.		
Sparse Scrub/shrubs %.		
Reed/Sedge %.		
Dense open %.		
Sparse open %.		
Reseeded or mown %.		
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

RIVER HABITATS		RIVER
bridges/500m		
weirs/500m		
locks/500m		
inlet/500m		
Depth <.25m	%	
.25-<.5		
0.5-<1.0		
>1.0m		100
Width <1		
1-<5		
5-<10		100
10-<20		
>20		
Substrates		
BR bed rock		
b boulders		
c cobbles		
p pebbles		
g gravel		
s sand		
+ silt/mud		100
clay		
peat		
Habitats and Flow		
pool		
slack		100
riffle		
rapids		
run		
waterfall		
protruding rocks		
Margins		
shingle ± bare		
shingle, vegetated		
mud		
sand		
FLORA %		
emergent veg < 1m wide		30
emergent 1-2m wide		30
emergent >2m wide		
total veget area		45
B bryophytes		
E emergents	60	
A submerged	40	
F floating		
algae % of stretch		

total to 100%


Pasture
E
A
E
Flow
4000 - 4500 m
hedge
4m ↔
>1m ↕
E
Arable
hedge
E
ditch
E
4m ↔
A
A
3m ↑
65° ↗
E
5m ↑
50° ↗
Pasture
A
E
Arable
E
A

RIVER Wampool

Km No. 4000-4500m

Date 29/5/92

Surveyor JALD.

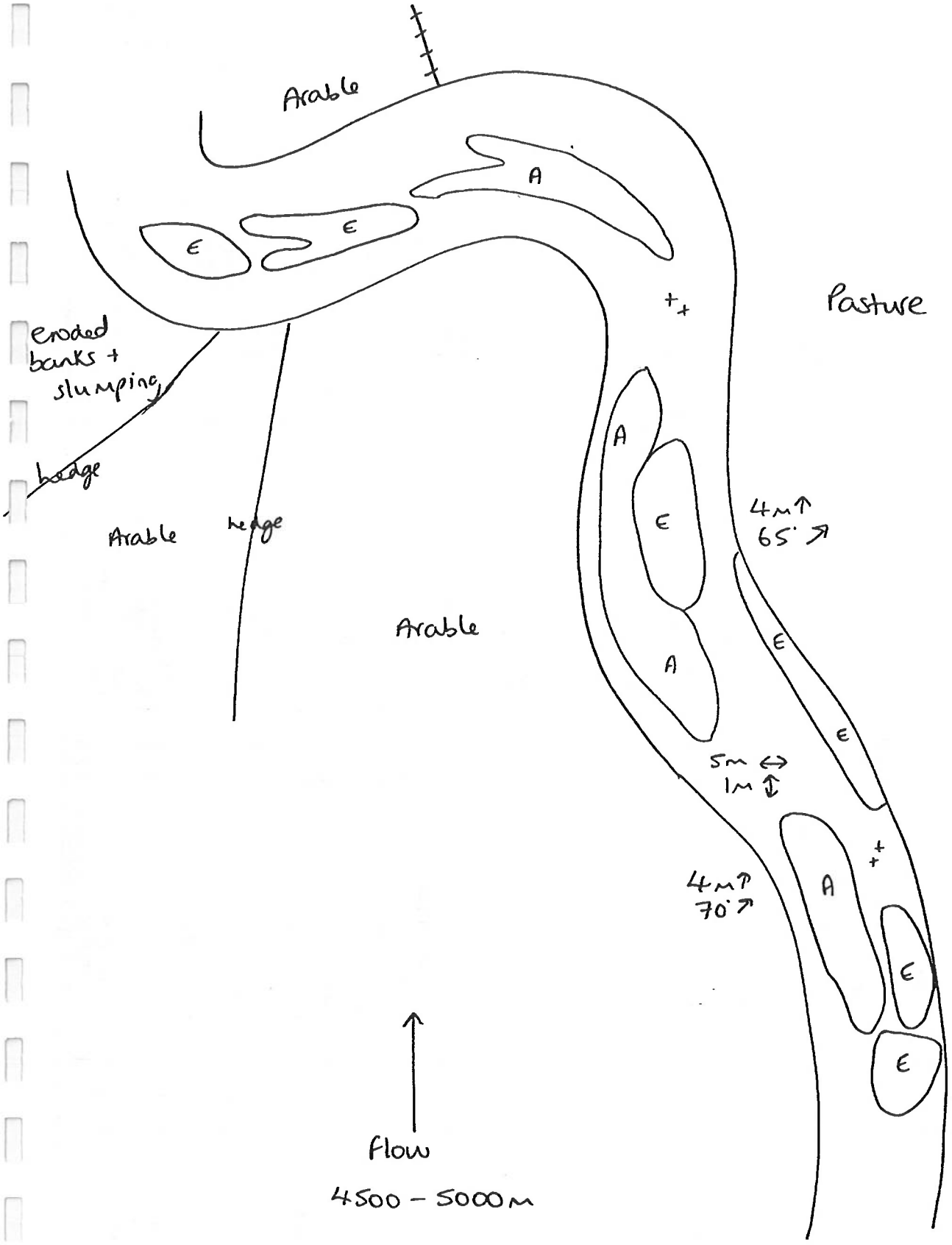
	LB	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved	65	
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

	LB	RB
G. OPEN WATER		
1. Standing - canal + (% of adj land in each stretch)		1
canal =		
ditch		
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream <1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable	100	35
amenity grassland		
ephemeral/short herb		
hedge +		1
hedge =		
fence on bank		25
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shelf %		
solid earth cliff (1m↑)		
soft earth cliff (>80°)		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m		
1-<2m		
>2m	100	100
Width <1m		
1-<2.5m		
2.5-<5m		
>5m	100	100
Slope <30°		100
30-<60°		
60-<90°	100	
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		5
Young trees		
Thick Scrub/shrubs %		
Sparse Scrub/shrubs %		
Reed/Sedge %		
Dense open %		
Sparse open %		
Reseeded or mown %		
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

RIVER HABITATS	RIVER
bridges/500m	
weirs/500m	
locks/500m	
inlet/500m	
Depth <25m %	
.25-<.5	
0.5-<1.0	
>1.0m	100
Width <1	
1-<5	100
5-<10	
10-<20	
>20	
Substrates	
BR bed rock	
b boulders	
c cobbles	
p pebbles	
g gravel	
s sand	
+ silt/mud	100
clay	
peat	
Habitats and Flow	
pool	
slack	100
riffle	
rapids	
run	
waterfall	
protruding rocks	
Margins	
shingle ± bare	
shingle, vegetated	
mud	
sand	
FLORA %	
emergent veg <1m wide	20
emergent 1-2m wide	20
emergent >2m wide	
total veget area	
B bryophytes	
E emergents 40	
A submerged 60	
F floating	
algae % of stretch	

(total to 100%)


Arable
A
E
E
Pasture
eroded banks + slumping
hedge
Arable
hedge
A
E
4m ↑
65° ↗
Arable
A
E
E
5m ↔
1m ↕
4m ↑
70° ↗
A
E
E
Flow
4500 – 5000m

	LB	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved		90
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

RIVER Warrgool

Km No. 4500 – 5000 M

Date 29/5/92

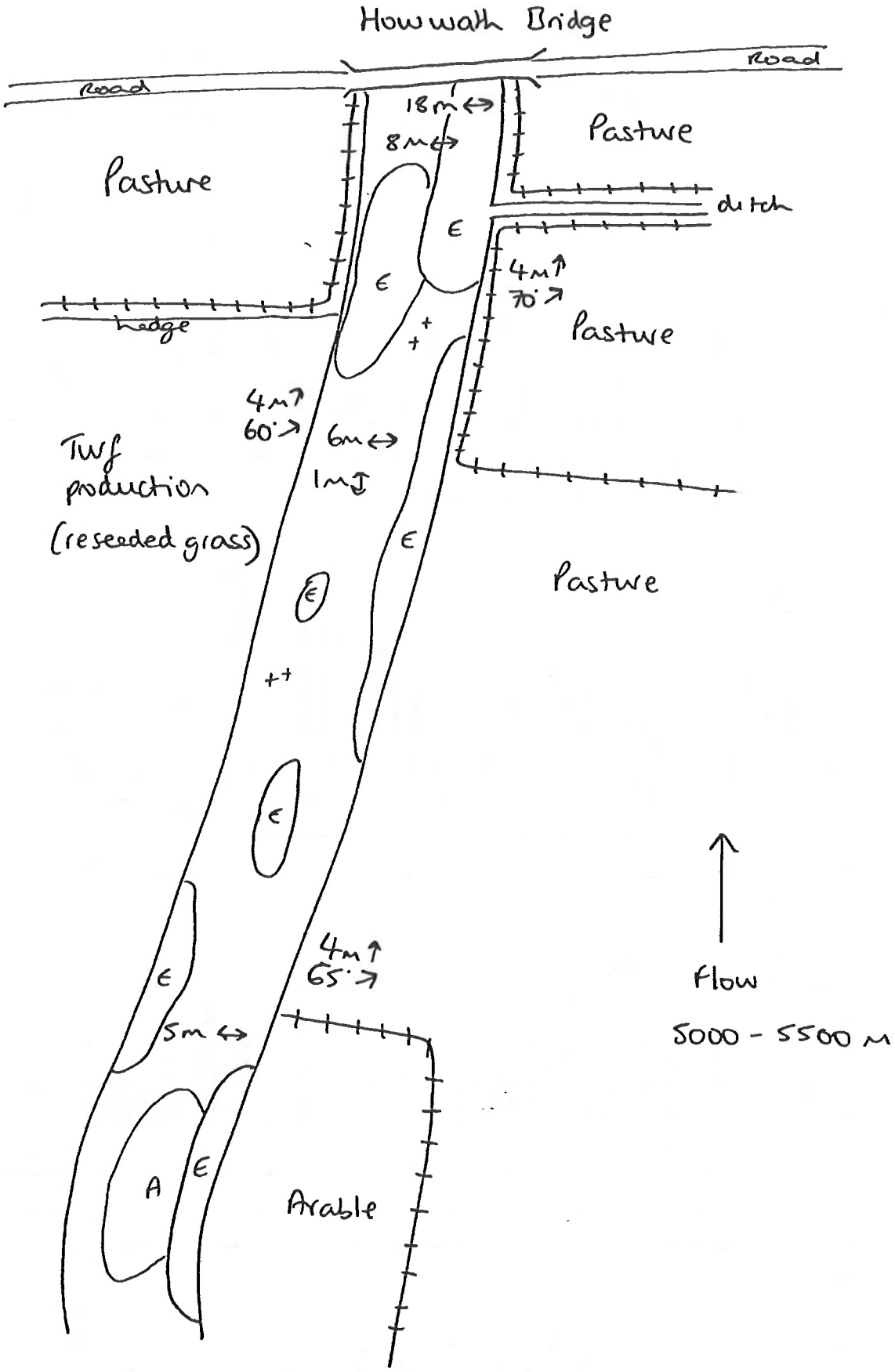
Surveyor JALD

	LB	RB
G. OPEN WATER		
1. Standing - canal +	% of adj land in each stretch	
canal =		
ditch		
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %.		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable	90	10
amenity grassland		
ephemeral/short herb		
hedge +	2	
hedge =		
fence on bank		1
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other Turf. production	10	

BANK FEATURES %	LB	RB
shell %		
solid earth cliff (1m↑ soft earth cliff >80°		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back levee		
Height <1m		
1-<2m		
>2m	100	100
Width <1m		
1-<2.5m		
2.5-<5m		
>5m	100	100
Slope <30°		
30-<60°		
60-<90°	100	100
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %.		
Sparse Scrub/shrubs %.		
Reed/Sedge %.		
Dense open %.		
Sparse open %.		
Reseeded or mown %.		
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
width <1m rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

RIVER HABITATS		RIVER
bridges/500m		
weirs/500m		
locks/500m		
inlet/500m		
Depth <.25m	%	
.25-<.5		
.5-<1.0		100
>1.0m		
Width <1		
1-<5		
5-<10		100
10-<20		
>20		
Substrates		
BR bed rock		
b boulders		
c cobbles		
p pebbles		
g gravel		
s sand		
si silt/mud		100
cl clay		
peat		
Habitats and Flow		
pool		
slack		100
riffle		
rapids		
run		
waterfall		
protruding rocks		
Margins		
shingle ± bare		
shingle, vegetated		
mud		
sand		
FLORA %		
emergent veg < 1m wide		60
emergent 1-2m wide		
emergent >2m wide		
total veget area		40
B bryophytes		
E emergents	60	
A submerged	40	
F floating		
algae % of stretch		

total to 100%


Howwath Bridge
Road
Road
18m
8m
Pasture
Pasture
ditch
hedge
4m
70°
Pasture
4m
60°
6m
1m
TWf
production
(reseeded grass)
Pasture
4m
65°
5m
A
Arable
Flow
5000 - 5500 m

	LB	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved	20	80
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

RIVER Warnpool

Km No. 5000 – 5500 m

Date 29/5/92

Surveyor JALD.

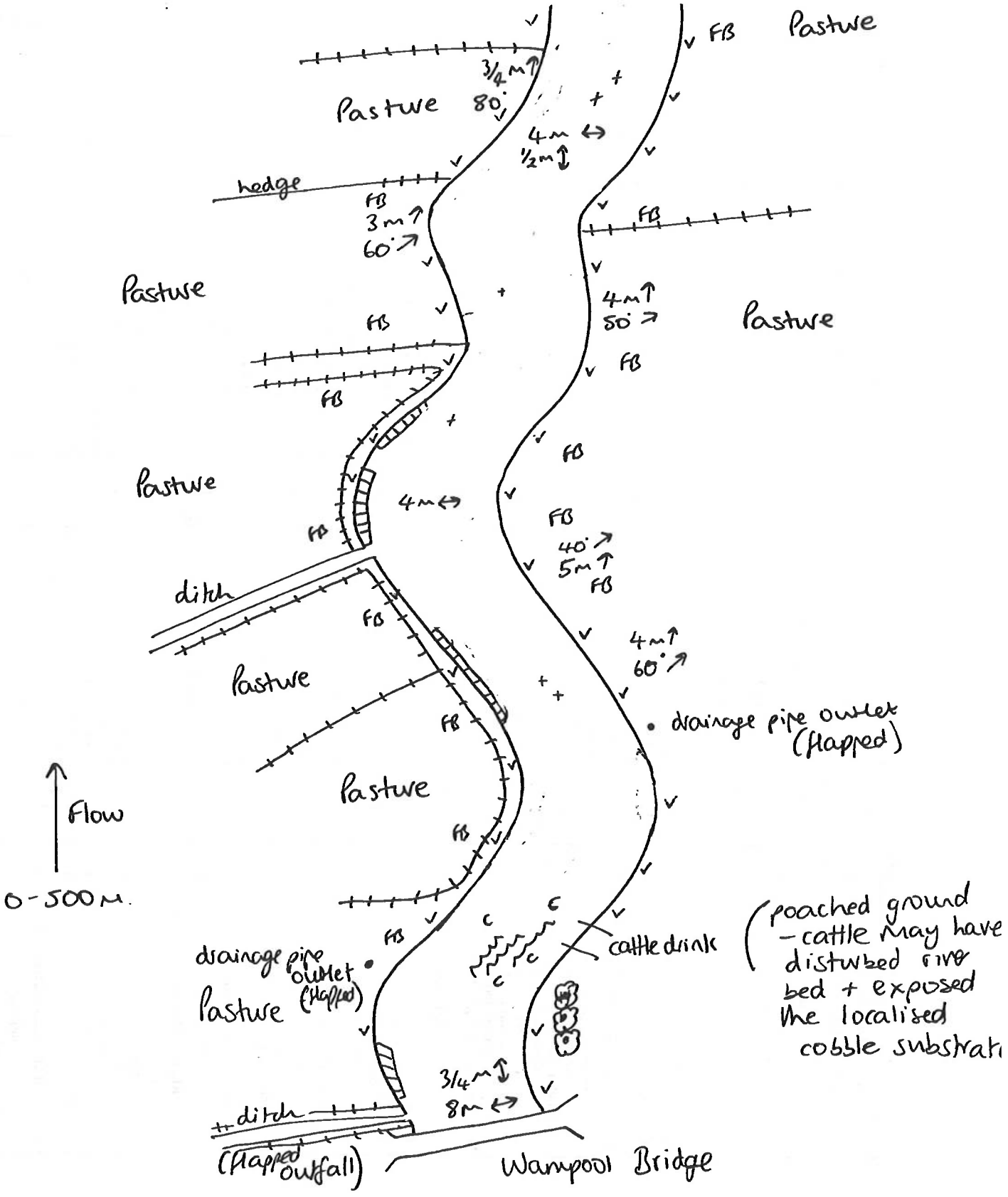
	LB	RB
G. OPEN WATER		
1. Standing - canal + % of adj land in each stretch		
canal =		1
ditch		
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %.		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		20
amenity grassland		
ephemeral/short herb		
hedge +	1	
hedge =		
fence on bank	20	30
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other Turf production	80	

BANK FEATURES %.	LB	RB
shell %		
solid earth cliff (1M ↑)		
soft earth cliff (> 80°)		
rock cliff		
artificial		
FB flood bank adj.		
FB flood bank set back		
levee		
Height <1m		
1-<2m		
>2m	100	100
Width <1m		
1-<2.5m		
2.5-<5m		
>5m	100	100
Slope: <30°		
30-<60°		
60-<90°	100	100
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %.		
Sparse Scrub/shrubs %.		
Reed/Sedge %.		
Dense open %.		
Sparse open %.		
Reseeded or mown %.		
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

	RIVER
RIVER HABITATS	
bridges/500m	1
weirs/500m	
locks/500m	
inlet/500m	
Depth <.25m %	
.25-<.5	
0.5-<1.0	100
>1.0m	
Width <1	
1-<5	96
5-<10	4
10-<20	
>20	
Substrates	
BR bed rock	
b boulders	
c cobbles	
p pebbles	
g gravel	
s sand	
+ silt/mud	100
clay	
peat	
Habitats and Flow	
pool	
slack	100
riffle	
rapids	
run	
waterfall	
protruding rocks	
Margins	
shingle ± bare	
shingle, vegetated	
mud	
sand	
FLORA %	
emergent veg < 1m wide	60
emergent 1-2m wide	20
emergent >2m wide	
total veget area	30
B bryophytes	
E emergents 80	
A submerged 20	
F floating	
algae % of stretch	

total to 100%

River Wampool
Post-Maintenance



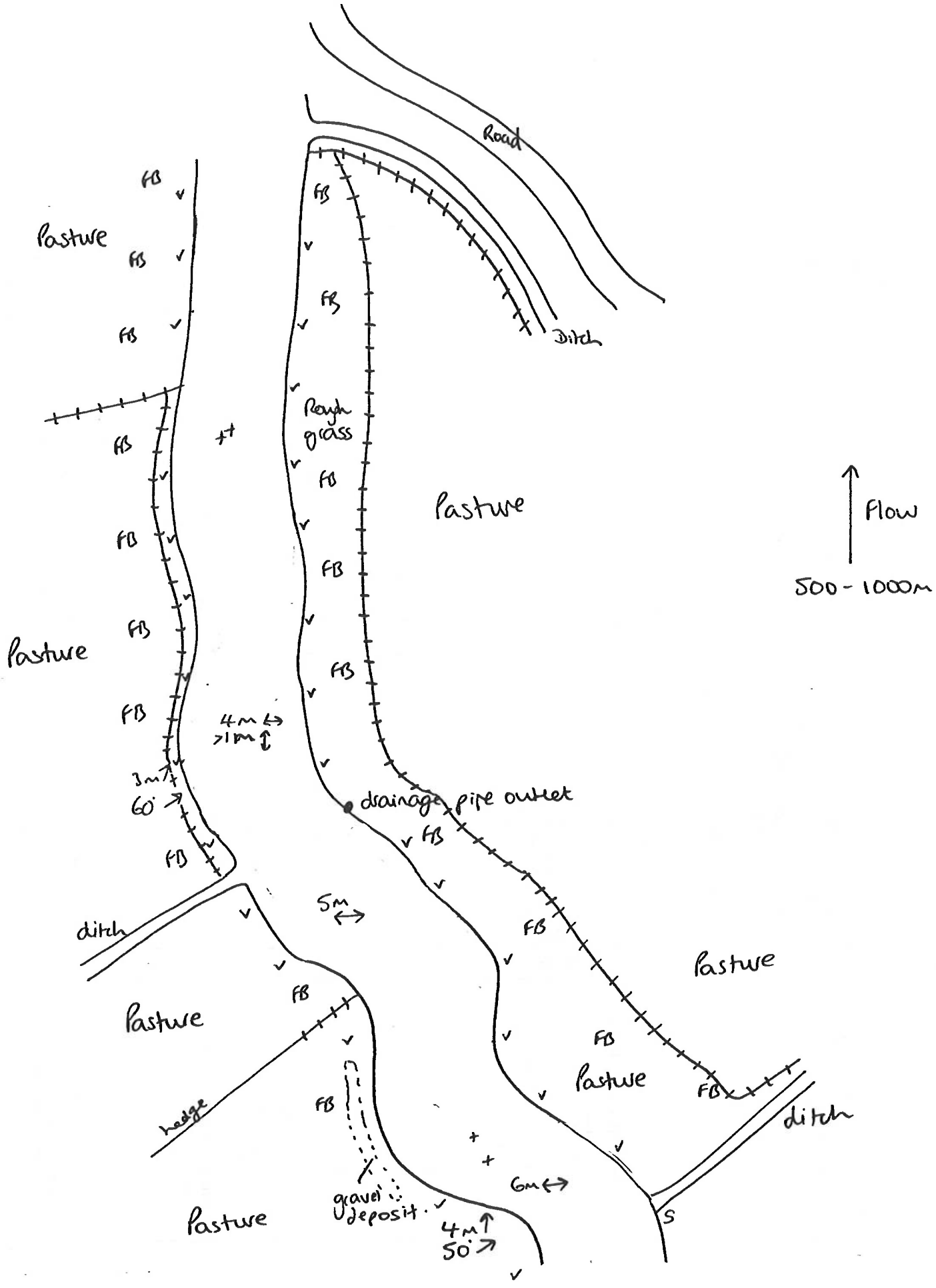
	LG	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic uninproved		
semi-improved		
Neutral uninproved		
semi-improved	100	100
Calcareous uninproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp rich veget		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

RIVER Wampool
Km No. 0 - 0·5 km
Date October 1992
Surveyor JALD

	LB	RB
G. OPEN WATER		
1. Standing - canal <	% of adj bank in each stretch	
canal =		
ditch		
dyke		
pond, pool, cut off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		
hedge <	2	
hedge =		
fence on bank	60	2
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway ceased		
used		
other		1

BANK FEATURES %	LB	RB
shell %		
solid earth cliff (A↑)		
soft earth cliff >80°		
rock cliff		
artificial	12	
FB flood bank adj	80	50
FB flood bank set back		
levee		
Height <1m	20	
1-<2m		
>2m	80	100
Width <1m		
1-<2.5m		
2.5-<5m	100	100
>5m		
Slope <30°		
30-<60°	80	100
60-<90°	20	
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		3
P Willow recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %		
Sparse Scrub/shrubs %		
Reed/Sedge %		
Dense open %		
Sparse open %		
Reseeded or mown %	100	100
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, 1 bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

RIVER HABITATS	RIVER
bridges/500m	1
weirs/500m	
locks/500m	
inlet/500m	
Depth <.25m %	
.25-<.5	
0.5-<1.0	100
>1.0m	
Width <1	
1-<5	90
5-<10	10
10-<20	
>20	
Substrates	
BR bed rock	
b boulders	
c cobbles	20
p pebbles	
g gravel	
s sand	
si silt/mud	
cl clay	80
peat	
Habitats and Flow	
pool	
slack	80
riffle	20
rapids	
run	
waterfall	
protruding rocks	
Margins	
shingle ± bare	
shingle, vegetated	
mud	
sand	
FLORA %	
emergent veg < 1m wide	
emergent 1-2m wide	
emergent >2m wide	
total veget area	total 10 to 100%
B bryophytes	
E emergents	
A submerged	
F floating	
algae % of stretch	


Road
Ditch
Pasture
FB
Rough grass
Pasture
Flow
500 - 1000m
Pasture
4m ↔
>1m ↕
3m
60°
drainage pipe outlet
ditch
5m ↔
Pasture
Pasture
hedge
gravel deposit
6m ↔
4m ↑
50°
Pasture
ditch
S

	LB	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		10
Neutral unimproved		
semi-improved	100	88
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp rich veget		
3. Other – tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

RIVER Wampool

Km No. 0-5 – 1 Km

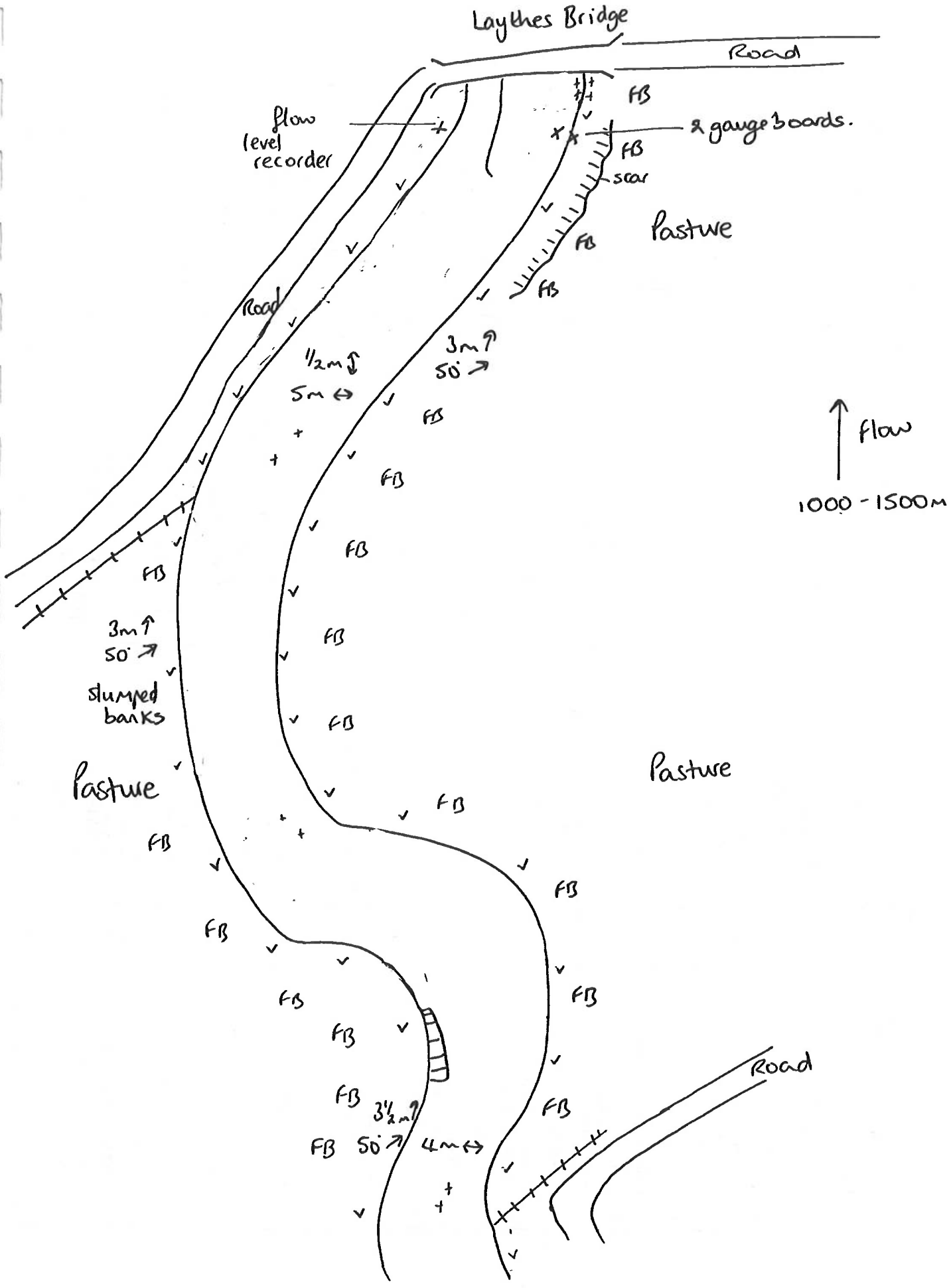
Date October 1992

Surveyor JALD

	LB	RB
G. OPEN WATER		
1. Standing – canal ↑ % of adj bank in each stretch		
canal =		
ditch	1	1
dyke		
pond, pool, cut off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		
hedge ↑	1	
hedge =		
fence on bank	49	
fence set back		90
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		2
used		
other		

BANK FEATURES %	LB	RB
shell %		
solid earth cliff 1m↑		
soft earth cliff >80°		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m		
1-<2m		
>2m	100	100
Width <1m		
1-<2.5m		
2.5-<5m	100	100
>5m		
Slope <30°		
30-<60°	100	100
60-<90°		
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow recept pollard		
W Willow old, not pollard		
S Standard willows		1
Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %		
Sparse Scrub/shrubs %		
Reed/Sedge %		
Dense open %		
Sparse open %		
Reseeded or mown %	100	100
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth – maturing		
earth – with trees		
developed		

RIVER HABITATS	RIVER
bridges/500m	
weirs/500m	
locks/500m	
inlet/500m	
Depth <.25m %	
.25-<.5	
0.5-<1.0	
>1.0m	100
Width <1	
1-<5	80
5-<10	20
10-<20	
>20	
Substrates	
BR bed rock	
b boulders	
c cobbles	
p pebbles	
g gravel	
s sand	
si silt/mud	100
cl clay	
peat	
Habitats and Flow	
pool	
slack	100
riffle	
rapids	
run	
waterfall	
protruding rocks	
Margins	
shingle ± bare	
shingle, vegetated	
mud	
sand	
FLORA %	
emergent veg < 1m wide	
emergent 1-2m wide	
emergent >2m wide	
total veget. area	
B bryophytes	
E emergents	
A submerged	
F floating	
algae % of stretch	


Laythes Bridge
Road
FB
flow level recorder
2 gauge boards.
scar
Pasture
Road
1½m
5m
3m
50°
Flow
1000 - 1500m
stumped banks
Pasture
Pasture
3½m
4m
Road

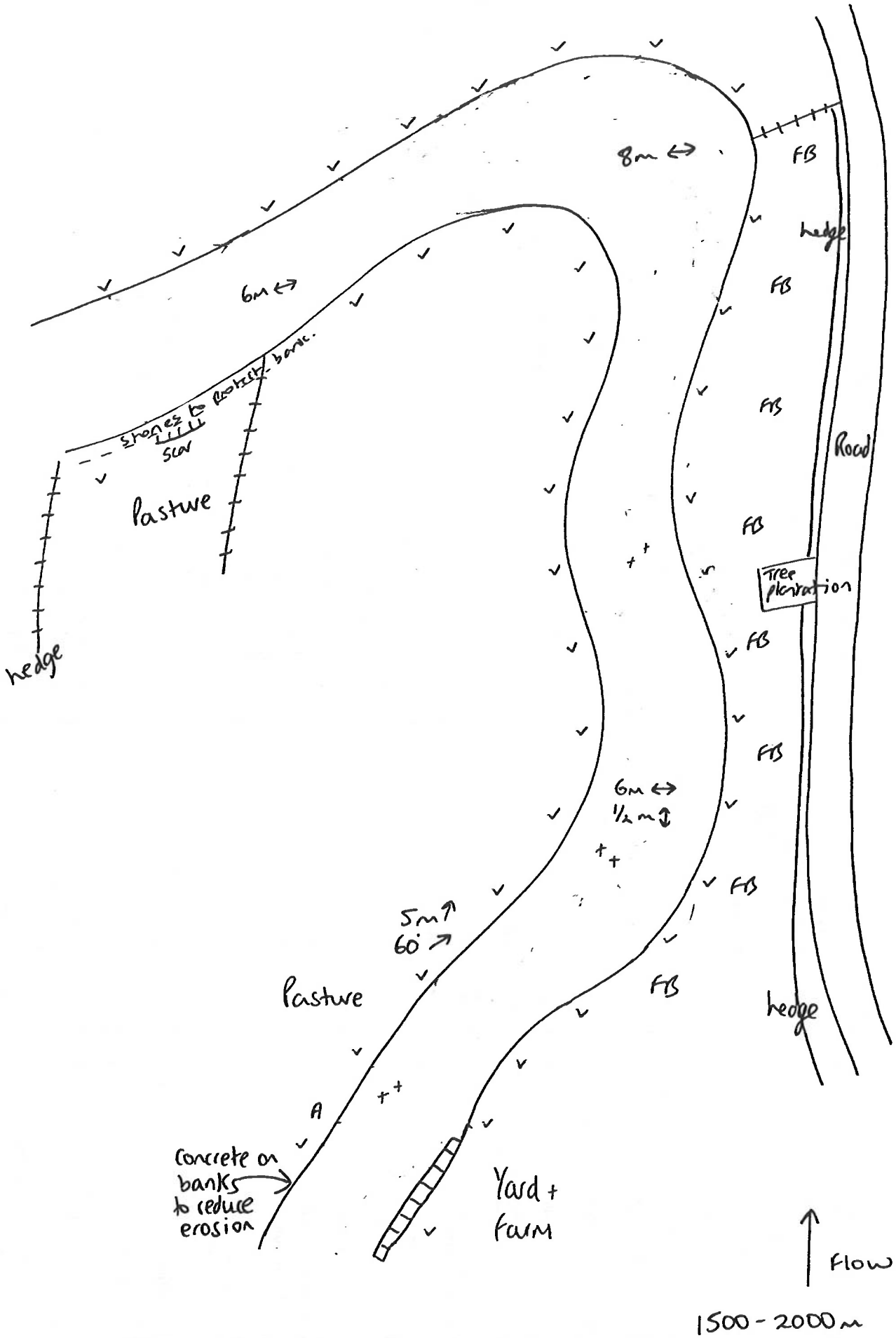
	LG	RG
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic uninproved		
semi-improved		
Neutral uninproved		
semi-improved	60	80
Calcareous uninproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget		
3. Other – tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

RIVER Wampool
Km No. 1-1-5 km
Date October 1992
Surveyor JALD

	LB	RB
G. OPEN WATER		
1. Standing – canal + (% of adj land in each stretch)		
canal =		
ditch		
dyke		
pond, pool, cut off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		
hedge +		
hedge =		
fence on bank	1	1
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road	39	4
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shell %		
solid earth cliff (as ↑)		
soft earth cliff >80°		
rock cliff		
artificial		
FB flood bank adj	60	95
FB flood bank set back		
levee		
Height <1m	1	
1-<2m		
>2m	100	100
Width <1m		
1-<2.5m		
2.5-<5m	100	100
>5m		
Slope <30°		
30-<60°	100	100
60-<90°		
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	99
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %		
Sparse Scrub/shrubs %		
Reed/Sedge %		
Dense open %		
Sparse open %		
Reseeded or mown %		
Exposed tree roots	100	100
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

	RIVER
RIVER HABITATS	
bridges/500m	1
weirs/500m	
locks/500m	
inlet/500m	
Depth <.25m %	
.25-<.5	
0.5-<1.0	100
>1.0m	
Width <1	
1-<5	70
5-<10	30
10-<20	
>20	
Substrates	
BR bed rock	
b boulders	
c cobbles	
p pebbles	
g gravel	
s sand	
si silt/mud	100
cl clay	
pe peat	
Habitats and Flow	
pool	
slack	100
riffle	
rapids	
run	
waterfall	
protruding rocks	
Margins	
shingle ± bare	
shingle, vegetated	
mud	
sand	
FLORA %	
emergent veg < 1m wide	
emergent 1-2m wide	
emergent >2m wide	
total veget area	
B bryophytes	(total) 100%
E emergents	
A submerged	
F floating	
algae % of stretch	


8m ↔
FB
hedge
6m ↔
FB
stones to protect bank
scar
FB
Road
Pasture
FB
Tree plantation
hedge
FB
FB
6m ↔
½m ↕
FB
5m ↗
60° ↗
Pasture
FB
hedge
A
Concrete on banks to reduce erosion
Yard + Farm
Flow
1500 - 2000m

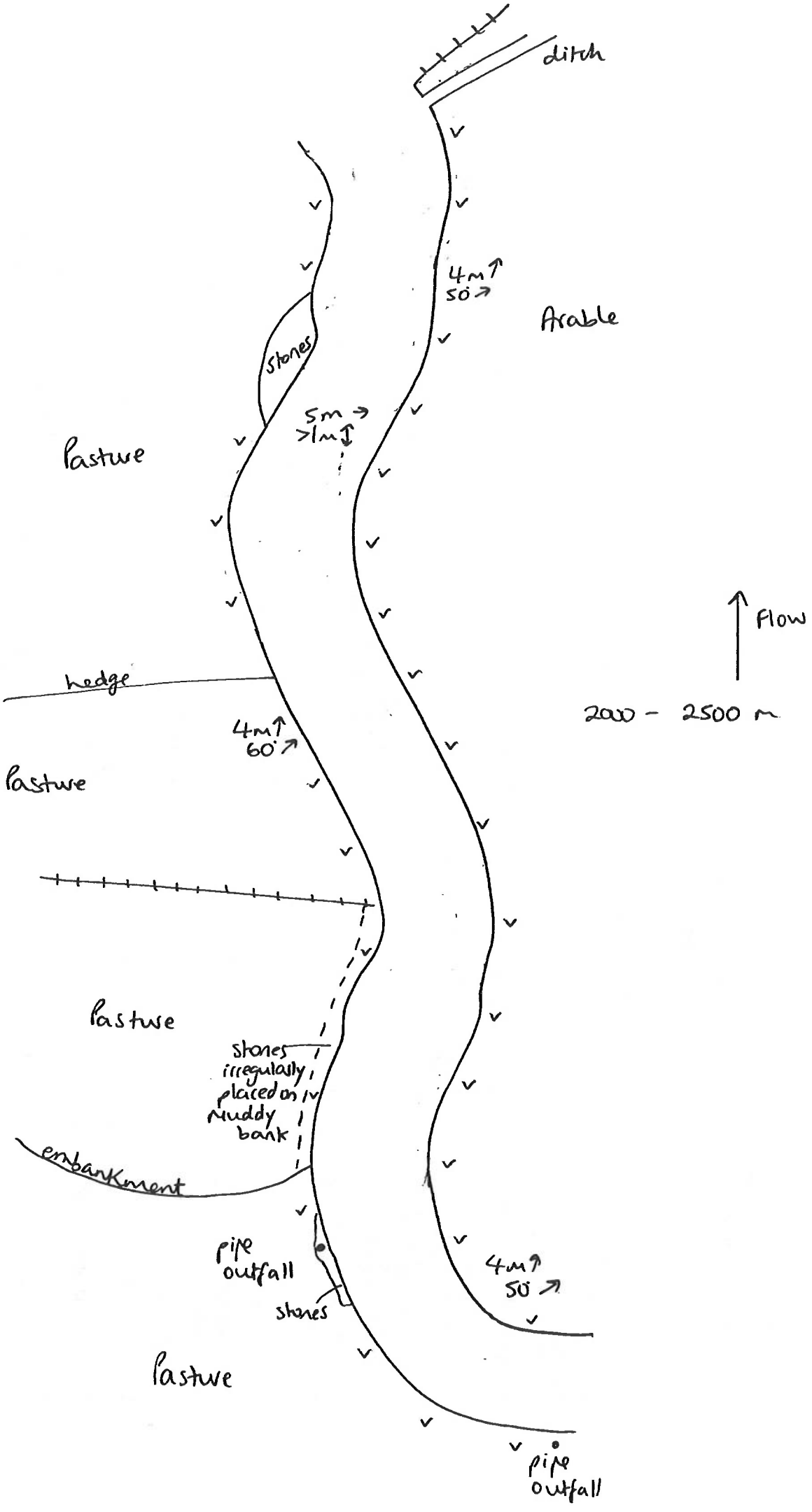
	LB	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		3
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved	100	70
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp rich veget		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

RIVER Wampool
Km No. 1·5 – 2 km
Date October 1992
Surveyor JALD

	LB	RB
G. OPEN WATER		
1. Standing – canal ↑ % of adj land in each stretch		
canal =		
ditch		
dyke		
pond, pool, cut off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		
hedge ↑		
hedge =		30
fence on bank		
fence set back	4	1
wall		
building		20
caravans		
fish farm		
silage clamp		
sewage works		
garden		
slack pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shell %		
solid earth cliff [as ↑]		
soft earth cliff > 80°		
rock cliff	5	3
artificial		35
FB flood bank adj		
FB flood bank: set back		
levee		
Height <1m		
1-<2m		
>2m	100	100
Width <1m		
1-<2.5m		
2.5-<5m	100	100
>5m		
Slope <30°		
30-<60°	100	100
60-<90°		
>90°		
mud		
sand		
bare shingle		
vegetated shingle	100	100
earth		
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow – recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %		
Sparse Scrub/shrubs %		
Reed/Sedge %		
Dense open %		
Sparse open %		
Reseeded or mown %		
Exposed tree roots	100	100
ISLANDS		
Rocky, vegetated		
rocky, ↑ bare		
shingle and rock		
shingle, rock ↑ veg		
earth - maturing		
earth - with trees		
developed		

RIVER HABITATS	RIVER
bridges/500m	
weirs/500m	
locks/500m	
inlet/500m	
Depth <.25m %	
.25-<.5	
.5-<1.0	100
>1.0m	
Width <1	
1-<5	100
5-<10	
10-<20	
>20	
Substrates	
BR bed rock	
b boulders	
c cobbles	
p pebbles	
g gravel	
s sand	
si/mud	100
cl clay	
peat	
Habitats and Flow	
P pool	
slack	100
riffle	
rapids	
run	
waterfall	
protruding rocks	
Margins	
shingle ± bare	
shingle, vegetated	
mud	
sand	
FLORA %	
emergent veg < 1m wide	
emergent 1-2m wide	
emergent >2m wide	
total veget area	
B bryophytes	total 10-100%
E emergents	
A submerged	
F floating	
algae % of stretch	


ditch
4m↑
50↗
Arable
stones
5m →
>1m↕
Pasture
Flow
2000 - 2500 m
hedge
4m↑
60↗
Pasture
Pasture
stones
irregularly
placed on
muddy
bank
embankment
pipe
outfall
stones
4m↑
50↗
Pasture
pipe
outfall

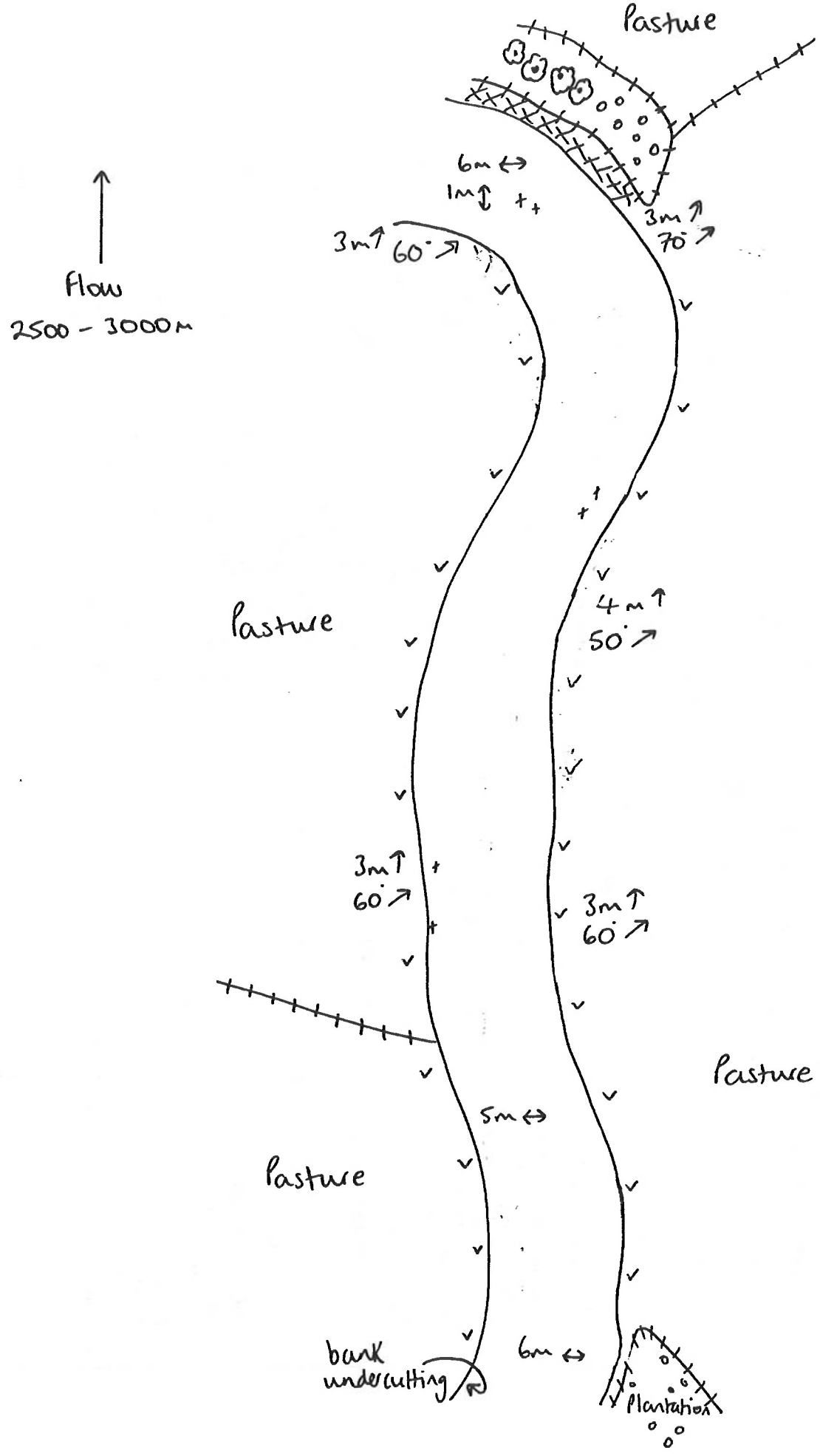
	LB	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved	100	
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget		
3. Other – tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

RIVER Wampool
Run No. 2 – 2·5 km
Date October 1992
Surveyor JALD.

	LB	RB
G. OPEN WATER		
1. Standing – canal + % of adj. land in each stretch		
canal =		1
ditch		
dyke		
pond, pool, cut off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1–5m		
5–10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		100
amenity grassland		
ephemeral/short herb		
hedge +		
hedge =	2	
fence on bank	2	1
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway – disused		
used		
other		

BANK FEATURES %	LB	RB
shell %		
solid earth cliff (>1m)		
soft earth cliff (>80°)		
rock cliff		
artificial	30	
FB flood bank adj		
FB flood bank set back	2	
levee		
Height <1m		
1–<2m		
>2m	100	100
Width <1m		
1–<2.5m		
2.5–<5m		
>5m	100	100
Slope <30°	100	100
30–<60°		
60–<90°		
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow – recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %		
Sparse Scrub/shrubs %		
Reed/Sedge %		
Dense open %		
Sparse open %		
Reseeded or mown %	100	100
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth – maturing		
earth – with trees		
developed		

RIVER HABITATS	RIVER
bridges/500m	
weirs/500m	
locks/500m	
inlet/500m	
Depth <.25m %	
.25–<.5	
.5–<1.0	100
>1.0m	
Width <1	
1–<5	100
5–<10	
10–<20	
>20	
Substrates	
BR bed rock	
b boulders	
c cobbles	
p pebbles	
g gravel	
s sand	
si/mud	100
cl clay	
peat	
Habitats and Flow	
pool	
slack	100
riffle	
rapids	
run	
waterfall	
protruding rocks	
Margins	
shingle ± bare	
shingle, vegetated	
mud	
sand	
FLORA %	
emergent veg < 1m wide	
emergent 1–2m wide	
emergent >2m wide	
total veget. area	
B bryophytes	(total) 10–100%
E emergents	
A submerged	
F floating	
algae % of stretch	


Pasture
6m ↔
1m ↕
3m ↑
70°
3m ↑
60°
Flow
2500 - 3000m
Pasture
4m ↑
50°
3m ↑
60°
3m ↑
60°
Pasture
5m ↔
Pasture
bank undercutting
6m ↔
Plantation

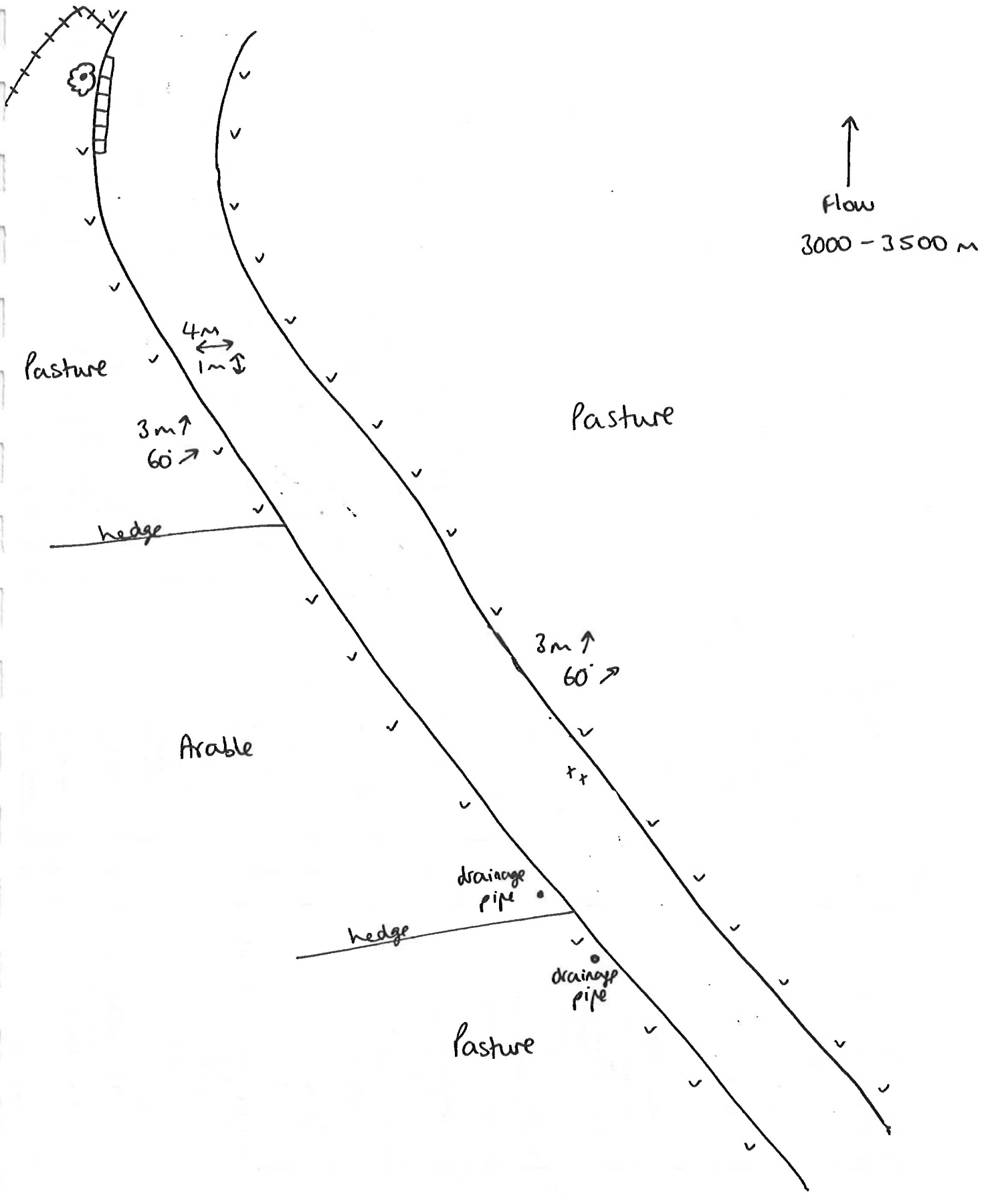
	LG	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		14
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved	100	86
semi-improved		
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich vegetn.		
3. Other – tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

RIVER Wampool
Km No. 2-5 – 3 Km
Date October 1992
Surveyor JALD.

	LB	RB
G. OPEN WATER		
1. Standing – canal + (% of adj. land in each stretch)		
canal =		
ditch		
dyke		
pond, pool, cut off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running/		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		
hedge +		
hedge =		
fence on bank	1	4
fence set back		
wall		
building		
caravans		
holiday farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shelf %		
solid earth cliff (1m ↑)		
soft earth cliff >80°		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m		
1-<2m		
>2m	100	100
Width <1m		
1-<2.5m		
2.5-<5m		
>5m	100	100
Slope <30°		
30-<60°		
60-<90°	100	100
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		4
P Willow recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		15
Thick Scrub/shrubs %		
Sparse Scrub/shrubs %		
Reed/Sedge %		15
Dense open %		
Sparse open %		
Reseeded or mown %		
Exposed tree roots	100	85
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees developed		

RIVER HABITATS	RIVER
bridges/500m	
weirs/500m	
locks/500m	
inlet/500m	
Depth <.25m %	
.25-<.5	
0.5-<1.0	
>1.0m	100
Width <1	
1-<5	
5-<10	100
10-<20	
>20	
Substrates	
BR bed rock	
b boulders	
c cobbles	
p pebbles	
g gravel	
s sand	
si silt/mud	100
cl clay	
peat	
Habitats and Flow	
pool	
slack	100
riffle	
rapids	
run	
waterfall	
protruding rocks	
Margins	
shingle ± bare	
shingle, vegetated	
mud	
sand	
FLORA %	
emergent veg < 1m wide	
emergent 1-2m wide	
emergent >2m wide	
total vegel area	
B bryophytes	
E emergents	
A submerged	
F floating	
algae % of stretch	


Flow
3000 - 3500 m
4m
1m
Pasture
3m
60°
Pasture
hedge
3m
60°
Arable
drainage pipe
hedge
drainage pipe
Pasture

River Wampool

Km No. 3 - 3.5 km

Date October 1992

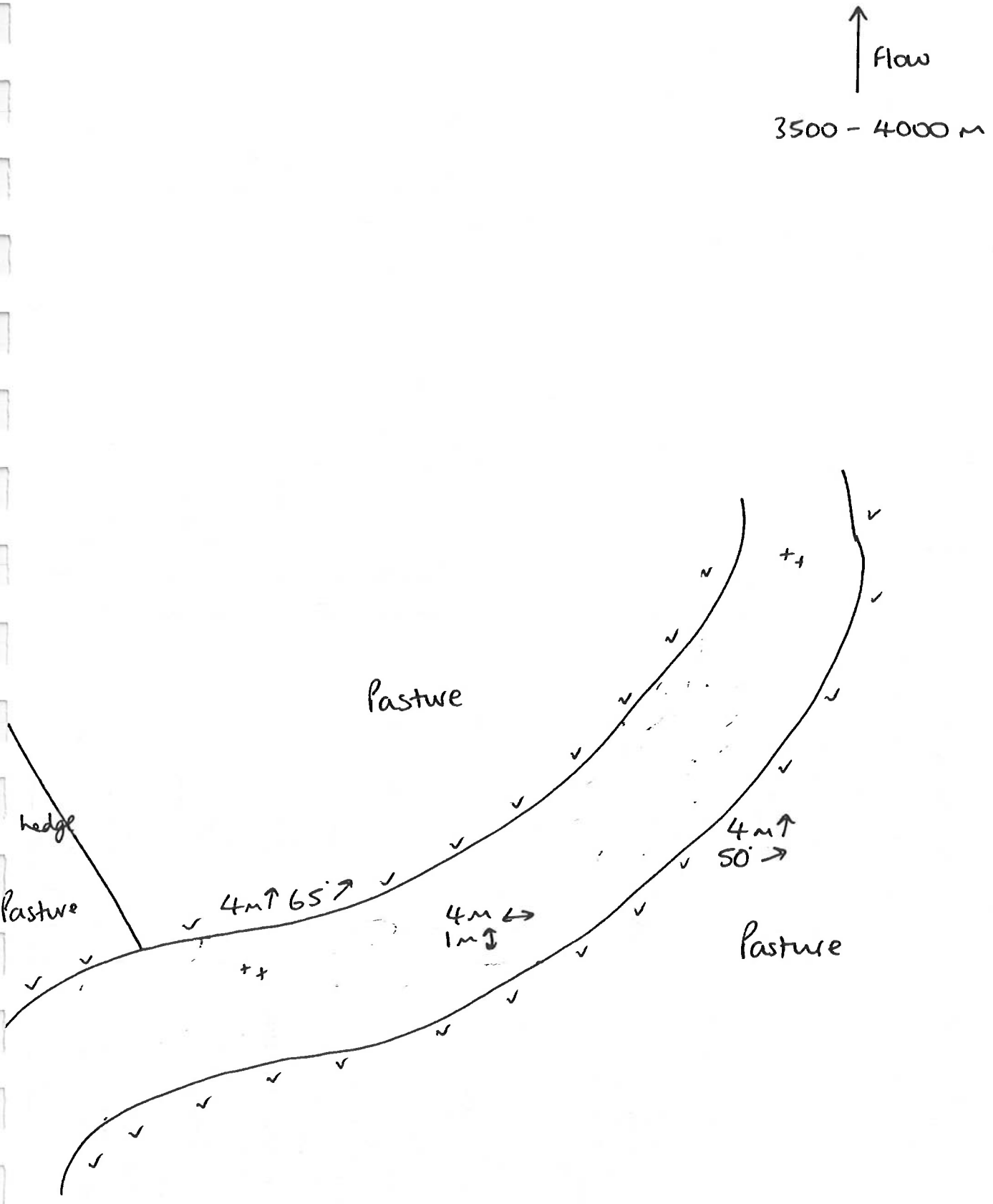
Surveyor JALD

	LG	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub - dense		
scattered		
Carr - alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved	60	
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp rich veget		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub - dry		
wet		
3. lichen/bryophyte		
4. Montane		
5. Heath/grassland - dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires - bog		
Fen - reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp - single sp. dom.		
Tall mixed assemblage		

	LB	RB
G. OPEN WATER		
1. Standing - canal ↑ (% of adj bank in each stretch)		
canal =		
ditch		
dyke		
pond, pool, cut off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable	40	
amenity grassland		
ephemeral/short herb		
hedge ↑	2	
hedge =		
fence on bank	1	
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shell %		
solid earth cliff (1m ↑, > 80°)		
soft earth cliff		
rock cliff		
artificial	3	
FB flood bank adj		
FB flood bank set back		
levee		
Height < 1m		
1-<2m		
>2m	100	100
Width < 1m		
1-<2.5m		
2.5-<5m		
>5m	100	100
Slope <30°		
30-<60°		
60-<90°	100	100
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore	1	
P Willow recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %		
Sparse Scrub/shrubs %		
Reed/Sedge %		
Dense open %		
Sparse open %		
Reseeded or mown %	100	100
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees developed		

RIVER HABITATS	RIVER
bridges/500m	
weirs/500m	
locks/500m	
inlet/500m	
Depth < 25m %	
.25-<.5	
0.5-<1.0	
>1.0m	100
Width <1	
1-<5	
5-<10	100
10-<20	
>20	
Substrates	
BR bed rock	
b boulders	
c cobbles	
p pebbles	
g gravel	
s sand	
si silt/mud	100
cl clay	
peat	
Habitats and Flow	
P pool	
slack	100
riffle	
rapids	
run	
waterfall	
protruding rocks	
Margins	
shingle ± bare	
shingle, vegetated	
mud	
sand	
FLORA %	
emergent veg < 1m wide	
emergent 1-2m wide	
emergent >2m wide	
total vegel area	
B bryophytes	total 10-100%
E emergents	
A submerged	
F floating	
algae % of stretch	


Flow
3500 - 4000 m
Pasture
hedge
Pasture
4m↑ 65°↗
4m ↔
1m ↕
4m↑
50°→
Pasture

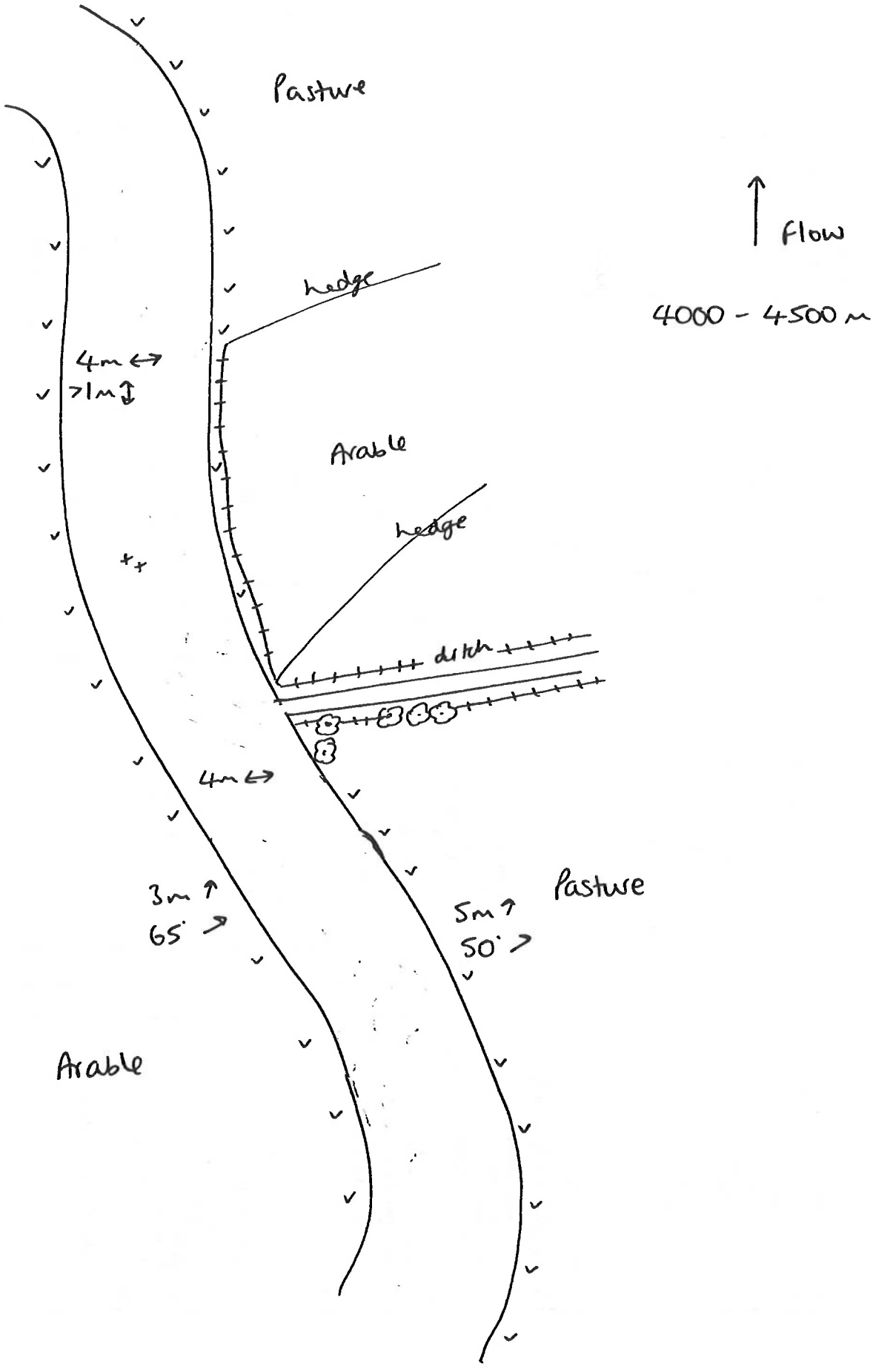
	LB	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved	100	100
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget		
3. Other – tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

RIVER Wampool
Km No. 3·5 – 4 km
Date October 1992
Surveyor JALD

	LB	RB
G. OPEN WATER		
1. Standing – canal ↑ % of adj. bank in		
canal = each stretch		
ditch		
dyke		
pond, pool, cut off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		
hedge ↑	1	
hedge =		
fence on bank		
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shelf %		
solid earth cliff 1m↑		
soft earth cliff > 80°		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height < 1m		
1 - <2m		
>2m	100	100
Width < 1m		
1 - <2.5m		
2.5 - <5m		100
>5m	100	100
Slope < 30°		
30 - <60°		
60 - <90°	100	
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %		
Sparse Scrub/shrubs %		
Reed/Sedge %		
Dense open %		
Sparse open %		
Reseeded or mown %	100	100
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, ↑ bare		
shingle and rock		
shingle, rock ↑ veg		
earth - maturing		
earth - with trees		
developed		

RIVER HABITATS	RIVER
bridges/500m	
weirs/500m	
locks/500m	
inlet/500m	
Depth < 25m %	
.25 - <.5	
0.5 - <1.0	
>1.0m	100
Width < 1	
1 - <5	
5 - <10	100
10 - <20	
>20	
Substrates	
BR bed rock	
b boulders	
c cobbles	
p pebbles	
g gravel	
s Sand	
ı silt/mud	100
(cl) clay	
peat	
Habitats and Flow	
(P) pool	
slack	100
rifle	
rapids	
run	
waterfall	
protruding rocks	
Margins	
shingle ± bare	
shingle, vegetated	
mud	
sand	
FLORA %	
emergent veg < 1m wide	
emergent 1-2m wide	
emergent >2m wide	
total veget. area	
B bryophytes	
E emergents	
A submerged	
F floating	
algae % of stretch	total 10 100%


Pasture
Flow
4000 - 4500 m
hedge
4m ↔
>1m ↕
Arable
hedge
ditch
4m ↔
3m ↑
65° ↗
Pasture
5m ↑
50° ↗
Arable

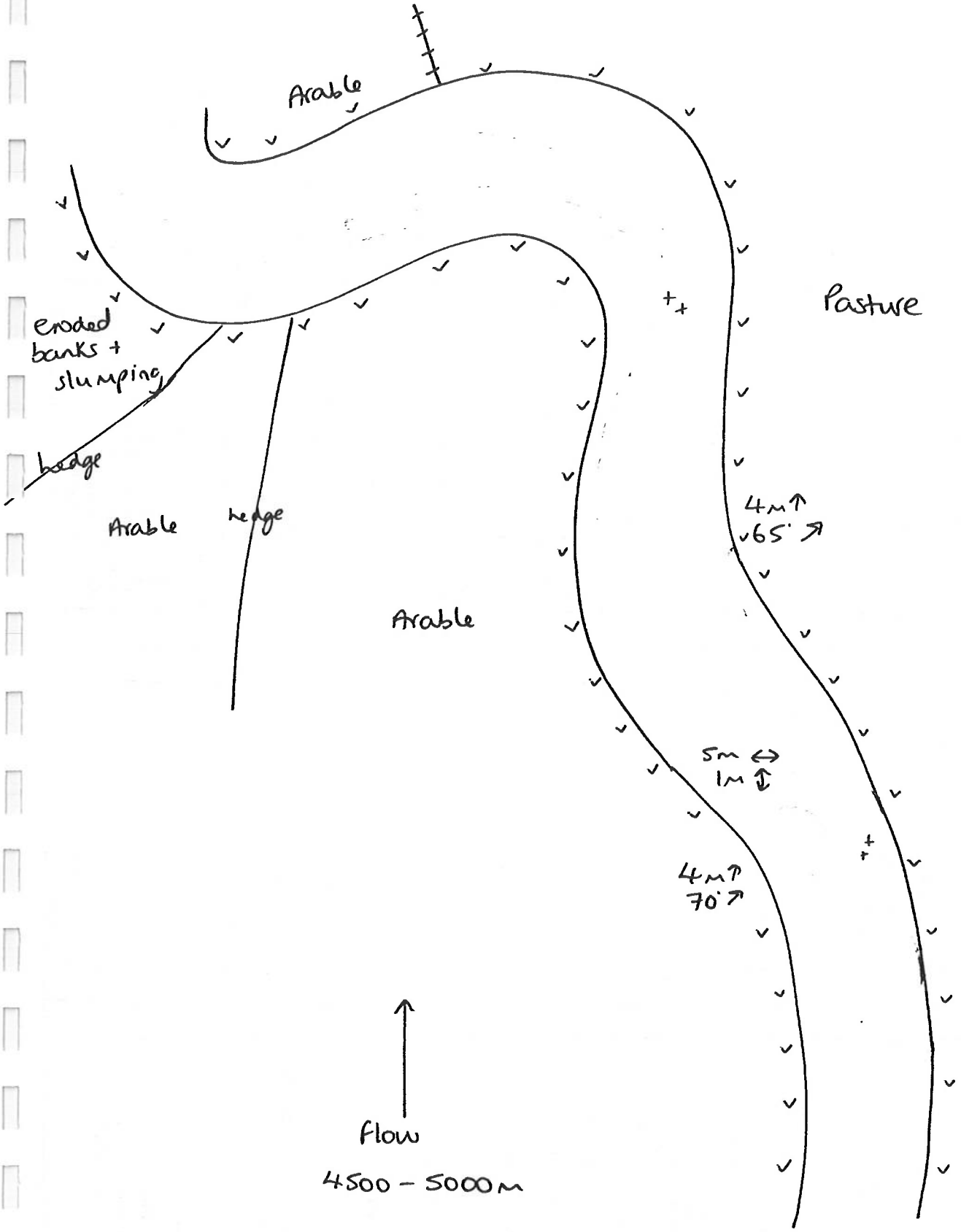
	LG	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub - dense		
scattered		
Carr - alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved		65
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub - dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires - bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

RIVER Wampool
Km No. 4 – 4.5 km
Date October 1992
Surveyor JAD

	LB	RB
G. OPEN WATER		
1. Standing - canal + (% of adj. land in each stretch)		
canal =		1
ditch		
dyke		
pond, pool, cut off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable	100	35
amenity grassland		
ephemeral/short herb		
hedge +		1
hedge =		
fence on bank		25
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shelf %		
solid earth cliff 1m↑		
soft earth cliff >80°		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m		
1-<2m		
>2m	100	100
Width <1m		
1-<2.5m		
2.5-<5m		
>5m	100	100
Slope <30°		100
30-<60°		
60-<90°	100	
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow recent pollard		
W Willow old, not pollard		
S Standard willows		
Alder		
Other trees		5
Young trees		
Thick Scrub/shrubs %		
Sparse Scrub/shrubs %		
Reed/Sedge %		
Dense open %		
Sparse open %		
Reseeded or mown %	100	100
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

RIVER HABITATS		RIVER
bridges/500m		
weirs/500m		
locks/500m		
inlet/500m		
Depth <.25m	%	
.25-<.5		
0.5-<1.0		
>1.0m		100
Width <1		
1-<5		100
5-<10		
10-<20		
>20		
Substrates		
BR bed rock		
b boulders		
c cobbles		
p pebbles		
g gravel		
s sand		
si/mud		100
clay		
peat		
Habitats and Flow		
pool		
slack		100
riffle		
rapids		
run		
waterfall		
protruding rocks		
Margins		
shingle ± bare		
shingle, vegetated		
mud		
sand		
FLORA %		
emergent veg < 1m wide		
emergent 1-2m wide		
emergent >2m wide		
total veget. area		
B bryophytes		
E emergents		
A submerged		
F floating		
algae % of stretch		


Arable
Pasture
eroded banks + slumping
hedge
Arable
hedge
Arable
4m ↑ 65° ↗
5m ↔
1m ↕
4m ↑ 70° ↗
Flow
4500 - 5000m

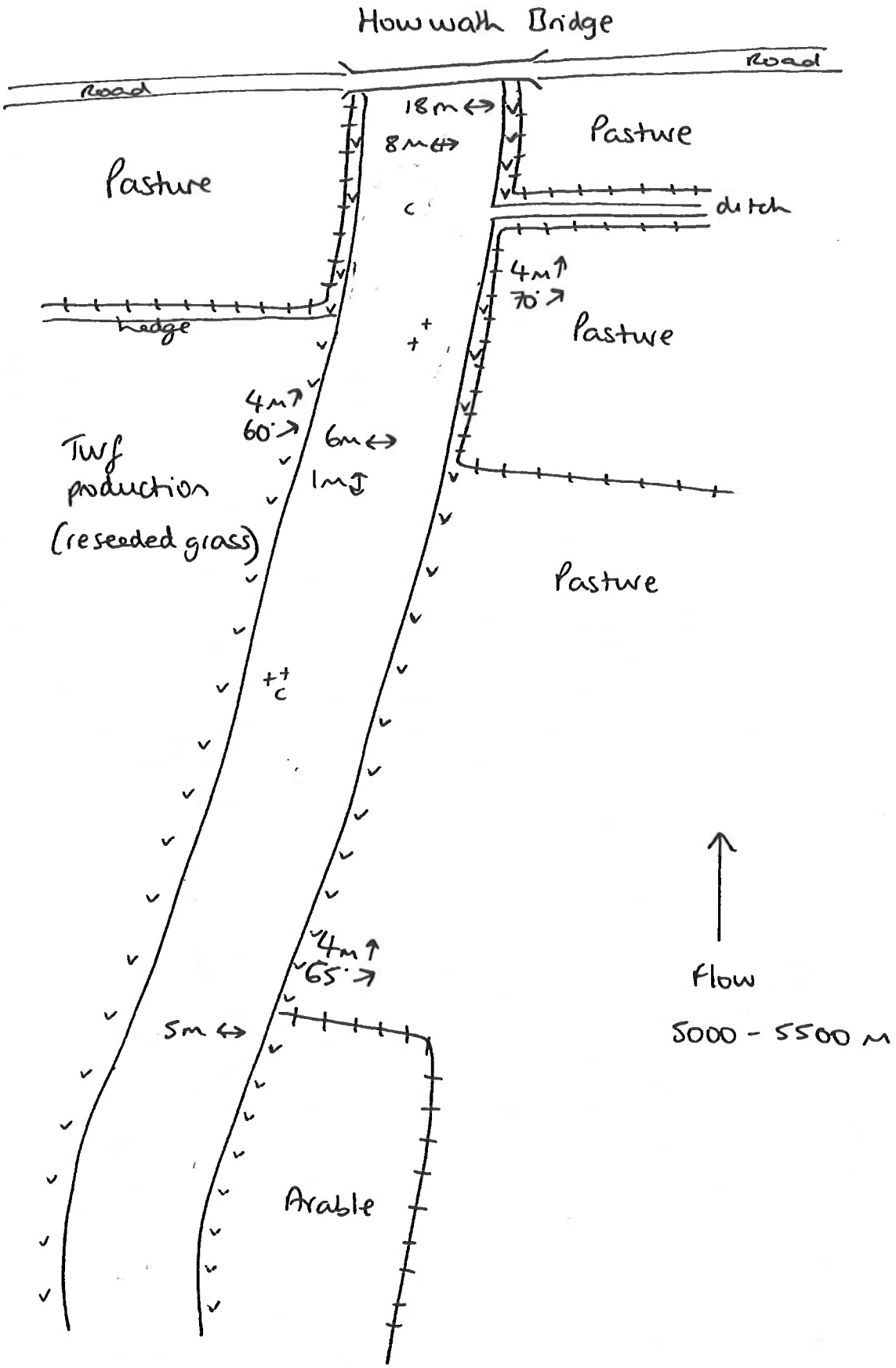
	LG	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved		90
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget		
3. Other – tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

RIVER Wampool
Km No. 4·5 – 5 Km
Date October 1992
Surveyor JALD.

	LB	RB
G. OPEN WATER		
1. Standing – canal ‡ % of adj. land in each stretch		
canal =		
ditch		
dyke		
pond, pool, cut off %		
lake %		
gravel pit %		
reservoir %		
marina %.		
2. Running		
stream < 1m wide		
1·5m		
5·10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable	90	10
amenity grassland		
ephemeral/short herb		
hedge ‡	2	
hedge =		1
fence on bank		
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other	10	

BANK FEATURES %	LB	RB
shell %		
solid earth cliff 1m↑		
soft earth cliff >80°		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m		
1·<2m		
>2m	100	100
Width <1m		
1·<2.5m		
2.5·<5m		
>5m	100	100
Slope <30°		
30°·<60°		
60°·<90°	100	100
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow recept pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %.		
Sparse Scrub/shrubs %.		
Reed/Sedge %.		
Dense open %.		
Sparse open %.		
Reseeded or mown %.	100	100
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, ‡ bare		
shingle and rock		
shingle, rock ‡ veg		
earth - maturing		
earth - with trees		
developed		

RIVER HABITATS		RIVER
bridges/500m		
weirs/500m		
locks/500m		
inlet/500m		
Depth <.25m %		
.25·<.5		
0·5·<1.0		100
>1.0m		
Width <1		
1·<5		
5·<10		100
10·<20		
>20		
Substrates		
BR bed rock		
b boulders		
c cobbles		
p pebbles		
g gravel		
s sand		
si/mud		100
cl clay		
peat		
Habitats and Flow		
pool		
slack		100
riffle		
rapids		
run		
waterfall		
protruding rocks		
Margins		
shingle ‡ bare		
shingle, vegetated		
mud		
sand		
FLORA %		
emergent veg < 1m wide		
emergent 1·2m wide		
emergent >2m wide		
total veget. area		
B bryophytes		
E emergents		total 100%
A submerged		
F floating		
algae % of stretch		


Howwath Bridge
Road
Road
18m ↔
8m ↔
Pasture
Pasture
ditch
hedge
4m ↑
70° ↗
Pasture
4m ↑
60° ↗
6m ↔
1m ↕
Turf production
(reseeded grass)
Pasture
4m ↑
65° ↗
5m ↔
Arable
Flow
5000 - 5500 m

	LG	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved	20	80
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other – tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

RIVER Wampool
Km No. 5–5·5 km
Date October 1992
Surveyor JALD

	LB	RB
G. OPEN WATER		
1. Standing – canal < (% of adj land in each stretch)		
canal =		
ditch		1
dyke		
pond, pool, cut off %		
lake %		
gravel pit %		
reservoir %		
marina %.		
2. Running		
stream < 1m wide		
1–5m		
5–10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		20
amenity grassland		
ephemeral/short herb		
hedge <	1	
hedge =		
fence on bank	20	30
fence set back		
wall		
bankling		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other	80	

BANK FEATURES %	LB	RB
shell %		
solid earth cliff 1m ↑		
soft earth cliff >80°		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m		
1–<2m		
>2m	100	100
Width <1m		
1–<2.5m		
2.5–<5m		
>5m	100	100
Slope <30°		
30–<60°		
60–<90°	100	100
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow recept pollard		
W Willow old, not pollard		
S Standard willows		
Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %.		
Sparse Scrub/shrubs %.		
Reed/Sedge %.		
Dense open %.		
Sparse open %.		
Reseeded or mown %.	100	100
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, < bare		
shingle and rock		
shingle, rock < veg		
earth – maturing		
earth – with trees		
developed		

RIVER HABITATS	RIVER
bridges/500m	1
weirs/500m	
locks/500m	
inlet/500m	
Depth < .25m %	
.25–<.5	
0.5–<1.0	100
>1.0m	
Width <1	
1–<5	
5–<10	96
10–<20	4
>20	
Substrates	
BR bed rock	
b boulders	
c cobbles	
p pebbles	
g gravel	
s sand	
si silt/mud	100
cl clay	
peat	
Habitats and Flow	
pool	
slack	100
riffle	
rapids	
run	
waterfall	
protruding rocks	
Margins	
shingle ± bare	
shingle, vegetated	
mud	
sand	
FLORA %	
emergent veg < 1m wide	
emergent 1–2m wide	
emergent >2m wide	
total veget. area	
B bryophytes	
E emergents	
A submerged	
F floating	
algae % of stretch	total 10 100%

PILLING WATER

R&D 317/20/ST

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NORTH WEST BROADFLEET / PILLING WATER

1. BACKGROUND

1.1 Physical Background

The Broadfleet / Pilling Water is an agricultural arterial drain rising in Rawcliffe Moss, 4 km south west of Garstang, in Lancashire It runs for 8 km from its source to its mouth through a flapped outfall in an embankment onto Pilling Sands in Morecambe Bay. It is a tide-locked river as tidal doors in the embankment shut when the tide is in thus preventing sea water from entering the river channel.

From its source to Broadfleet Bridge the watercourse is known as the Pilling Water. The last 0.75 km from Broadfleet Bridge to the outfall is The Broadfleet.

1.2 Study Reach

The 5.75 km study reach (Figure 1) runs from the footbridge at Northwoods Farm (GR. 453 456) to Broadfleet Bridge (GR. 406 488). This site was selected for inclusion within the study as it is characteristic of main rivers in the area on which typical river maintenance is performed. The area deriving benefit from the river maintenance work in terms of its effect on land drainage and flooding is difficult to determine, the area being large with little relief. Land within the catchment area of the Pilling Water and all its tributaries is estimated to be 3783 ha. The whole of the catchment of the Pilling Water (296 ha) has been surveyed in detail. For the purpose of this study, the area deriving benefit (Benefit Area, BA) from maintenance in terms of its effect on land drainage and flooding is taken as the catchment of the Pilling Water (296 ha). The catchment area of the Pilling Water is shown in Figure 1.

1.3 River Characteristics

The channel character is one of straight sections interspersed with meandering reaches. The meanders are in some cases little more than slight bends in the channel but around Stake Pool they become quite tight. The meander belt is 200 m in width.

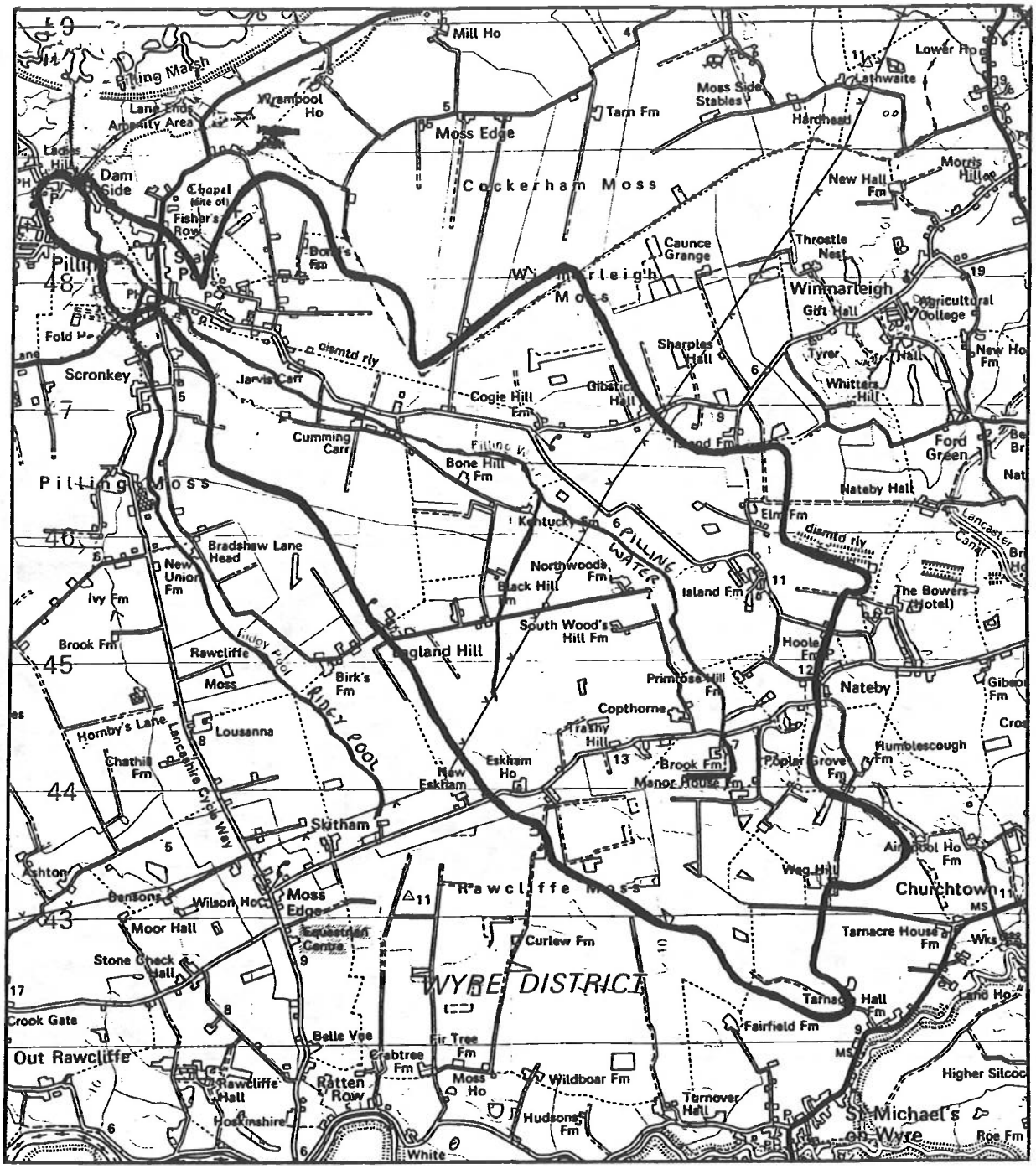
The channel is trapezoidal in shape with the bank angle ranging from 50 - 70 degrees with a mean height of 3 m (ranging from 2.5 - 4 m). The freeboard is consistently high with a mean of 2 m. The width of the river is variable, widening from 2.5 m at the upstream limit to 4 m at Broadfleet Bridge. Through Pilling Village the channel widens to 7 m. The channel gradient is very small hence the flow of water is slow. Average flows are 10 - 12 cumecs. The dominant bed substrates are sands and silt.

1.4 Land Drainage

Several tributaries and farm ditches feed the Pilling Water. The confluence of the major tributary, Ridgy Pool is at Stake Pool. The catchment of Pilling Water itself is 296 ha. The combined catchment areas of all the tributaries flowing into this watercourse and through the flapped outfall is 3783 ha. Figure 1 illustrates the location of the main tributary Ridgy Pool.

The Broadfleet / Pilling Water is a tide-locked river. When the tide is in, the tidal doors are closed thus the river water level rises as it cannot discharge into the sea. As the tide recedes, the doors open and the river level falls as water is discharged out onto Pilling Sands.

The degree of field drainage installation is high within the benefit area. Areas with field drainage installed are shown in Figure 2. The majority of field drains discharge directly into the river. Forty one percent of drainage pipes discharge into ditches. Further information is provided in Section 2.5.

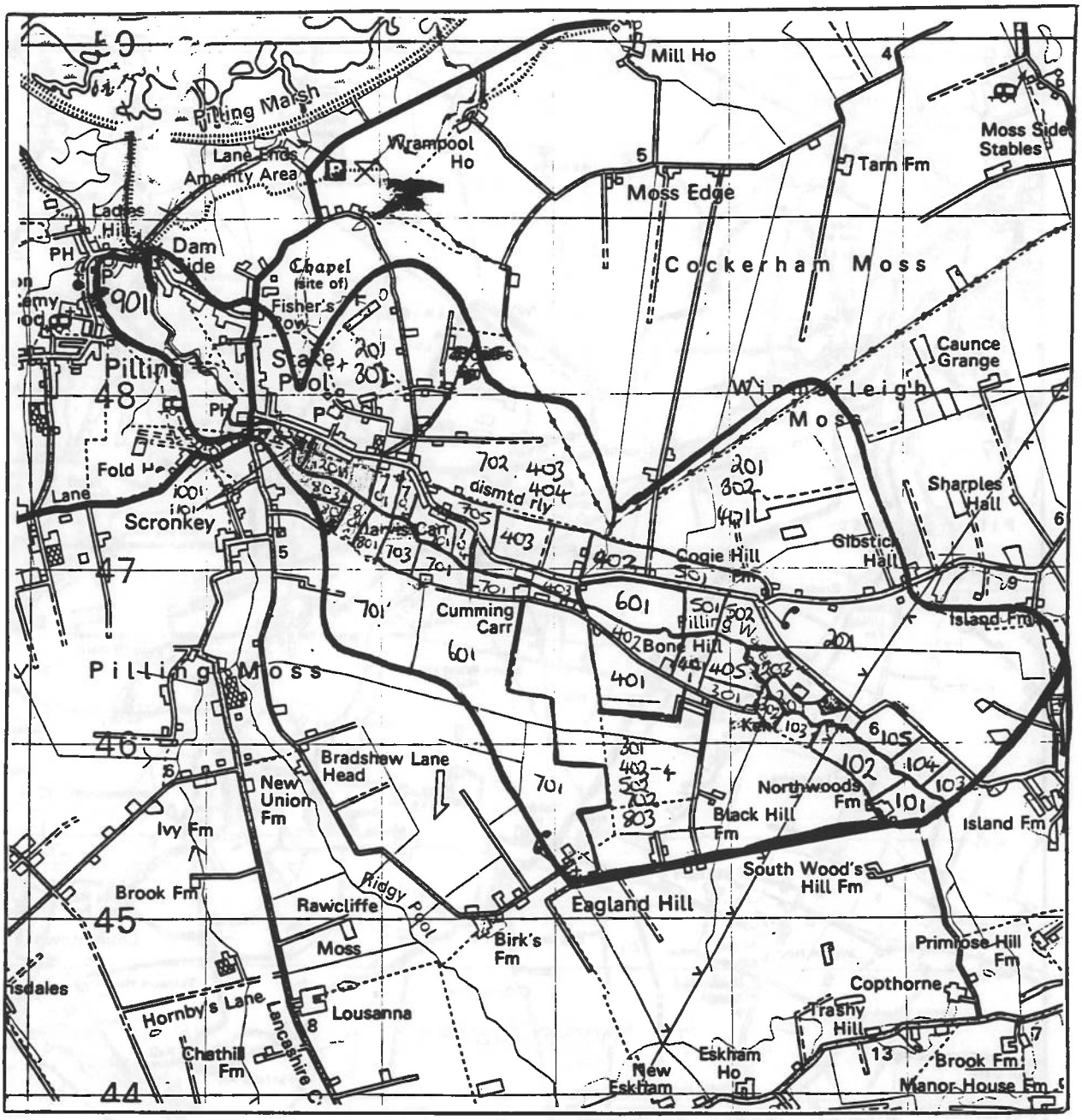


Legend :

Scale 1 : 50 000

Benefit area

Figure 1 Location of the Pilling Water site, Ridgy Pool tributary and benefit area



Legend :

Scale 1 : 33 750

Piped drainage

Natural drainage

101 Land use block

Figure 2 Land drainage and location of land use blocks in the benefit area

1.5 Geology, Soils and Land Capability

The geology of the reach is characterised by sandstones of Permo-Triassic age. They are commonly reddish in colour, soft and of medium grain.

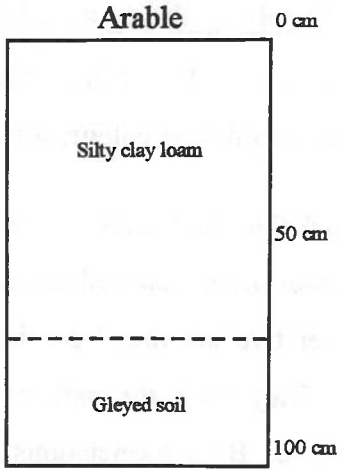
The Rockcliffe and Downholland 2 Soil Associations are present within the reach. Within these Associations, the soil series Rockcliffe, Downholland, Chatteris and Wisbech are present. The latter two are found on ridges which protrude above the more extensive Downholland series. They mark the path of tidal creeks which crossed the former salt marsh prior to reclamation. Both Associations are characteristic of reclaimed stoneless marine alluvium with silty clay definition.

Soil profiles taken within the reach are shown in Figure 3. The wetter soils are characterised by a gleyed subsoil with some mottling in the upper horizons.

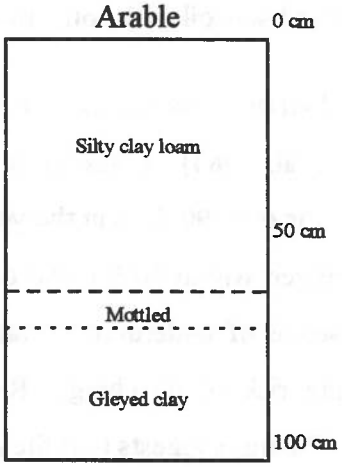
The soil wetness class ranges from I to IV, characteristically III to IV on the Rockcliffe Series (Jarvis et al, 1984). Class III is given to soil which is waterlogged within 70 cm depth of the surface for over 90 days in the year. A Wetness Class of IV is given to soil which is commonly waterlogged within 40 for 180 days in a year. The response to artificial drainage is good. In the absence of underdrains, waterlogging throughout the winter is common and there is a moderate risk of poaching. Rainfall data from the nearest meteorological station, Abram House, Pilling, suggests that the mean annual rainfall is approximately 1003 mm.

The land is classed as Grade 2 agricultural land according to the Ministry of Agriculture, Fisheries and Food (MAFF) Agricultural Land Classification system. This very good quality agricultural land is dominated by pasture on which dairying with beef under a fattening system are common. Arable crops are grown, commonly barley with winter wheat and potatoes.

Grid Reference	442 464
Soil Core Number	1
Soil Colour	Very dark brown
Comments	Uniform profile



Grid Reference	433 469
Soil Core Number	2
Soil Colour	Very dark brown
Comments	Increasingly gleyed with depth



Grid Reference	406 495
Soil Core Number	3
Soil Colour	Light brownish grey
Comments	Uniform profile

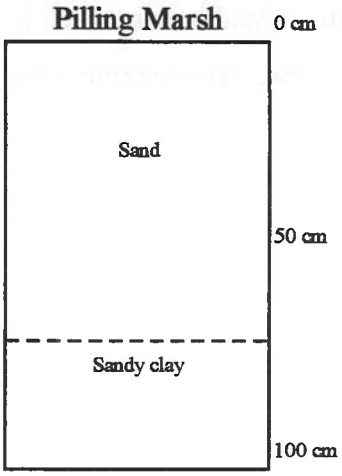


Figure 3 Soil profiles

1.6 Capital Works

Major capital works were carried out on the channel between 1971 to 1973 when it was re-graded and re-sectioned. The embankment along the right bank of The Broadlfeet from the outfall to Broadfleet Bridge (GR. 406 495 to GR. 407 489) was constructed in 1982 as part of the Pilling Sea Embankment Scheme. A new outfall into the sea was also built at this time (GR. 406 495).

1.7 River Maintenance

A regular programme of weed clearance takes place on the Broadfleet/Pilling Water for the benefit of flood alleviation. Recent inspections which highlight the need for maintenance and response to customer demand ensure the regular programme of weed clearance continues. The criteria for the standard of service provided by the maintenance is set by a supervisors inspection, watercourse condition and as a result of proven suitability. All landowners and tenants are informed of impending maintenance through a combination of letters and/or visits. Conservation bodies are invited to attend a meeting to discuss the proposed work.

Weed clearance takes place on an annual basis. In early May the aquatic weeds are sprayed with Dichlobenil. Between August and September the weeds are removed using a weed bucket and by hand in places where access with machinery is difficult. The river banks are flail mown. All the channel vegetation is removed during the operation with the exception of the first kilometre upstream of Broadfleet Bridge in which 75 % of the vegetation is cut in a strip down the centre of the channel.

Occasionally the channel vegetation is cut twice a year. This was the case in 1994. The second cut was made as farmers were concerned about the high level of flood risk brought about by high rainfall which raised water levels in the channel.

Desilting is carried out every 5 to 10 years. The last dredging work was performed on the Pilling Water in 1985 and in 1991 on The Broadfleet. Repairs to the banks are carried out as required. Timber revetments are used to repair bank slips which are backed up with stone at the toe.

1.7.1 Farmers views on maintenance

Farmers interviewed within the study reach expressed satisfaction with the level and type of river maintenance performed. The view that maintenance was both necessary and beneficial were expressed by several. If the weeds were not cleared from the channel, farmers expressed the opinion that flooding would be more frequent and would affect a wider area. One farmer stated that since the new sea embankment and outfall have been constructed the growth of vegetation in the channel has been more excessive. He attributes this to the prevention of saline intrusion which did restrict vegetation growth.

1.7.2 Alternative maintenance strategies

Some farmers perceive that in a wet year, removal of the vegetation once a year is insufficient. Twice a year in wet years would be more effective. One farmer suggested that the ditches which discharge into the Pilling Water should be cleared of vegetation at the same time as the main river. In order to enhance the wildlife of the area, some have expressed a wish for the top metre of the banks to be left un-mown to provide habitats for birds and small mammals.

1.8 Climate

The impact of maintenance on watertable depth and river levels depends on the particular weather conditions, particularly rainfall, which vary from season to season and year to year. The yearly and seasonal rainfall totals obtained from the meteorological station at Abram House, Pilling, for the period of the study, are presented in Table 1.1.

The spring of 1993 and 1994 were particularly wet when compared with the average spring rainfall. The summer of 1992 and summer and autumn of 1993 were exceptionally dry, receiving on average only 38 % of the average rainfall. This is confirmed by the farmers who reported exceptionally dry conditions underfoot.

Table 1.1 Rainfall totals

Period	Season	Actual Rainfall (mm)	Average * Rainfall (mm)	% Average Rainfall
1992	Spring	221.3	190.3	116.3
	Summer	67.6	224.2	30.2
	Autumn	360.3	305.2	118.1
1993	Spring	243.0	190.3	127.7
	Summer	123.1	224.2	54.9
	Autumn	96.2	305.2	31.5
1994	Spring	245.5	190.3	129.0
	Summer	201.3	224.2	89.8
	Autumn	211.8	305.2	69.4
1995	Spring	175.0	190.3	92.0
Total	1992	1061.0	1003.25	105.8
	1993	934.2	1003.25	93.1
	1994	1127.3	1003.25	112.4

* Based on 16 Year record from 1978 to 1993

Monthly rainfall records covering a period of 16 years from Abram House, Pilling, have been used to determine the probability of average, dry and wet seasons and years occurring. The classification system of the Food and Agricultural Organisation (FAO) has been used for this purpose. Wet and dry seasons are classified as those with greater than 125 % and less than 75 % of the average rainfall value respectively. The probability of each type of season and year occurring in the proximity of the Pilling Water is shown in Table 1.2

Table 1.2 Probability of climatic condition

Season	Dry *	Average *	Wet *
Spring	0.25	0.12	0.63
Summer	0.25	0.50	0.25
Autumn	0.06	0.69	0.25
Year	0.25	0.69	0.06

* Based on records since 1978

The R&D Note 456, Section 3.5.4 describes the process by which financial benefits of maintenance are calculated according to the probability of average, dry and wet seasons and years occurring.

1.9 Aquatic Vegetation

Aquatic vegetation within the channel was identified prior to maintenance (Section 1.9.1 to 1.9.3). This vegetation has both hydraulic and environmental implications for the channel.

1.9.1 Submerged vegetation

The dominant aquatic weeds in the study reach are *Potamogeton* sp. (waterweed) and *Elodea* sp. (Canadian pondweed). *Elodea* is a submerged plant characterised by branched stems which can range in length from 10 cm to 3 m. *Potamogeton* is a rooted plant with oval dark green leaves. Although it is classed as a floating broad-leaved aquatic plant it often has some submerged leaves.

Weed cutting is an effective method of controlling the Canadian pondweed. The waterweed however, reproduces through rhizomes and is therefore more difficult to control. Desilting may be necessary in order to reduce or remove the seed bank of *Potamogeton* from the river bed.

Juncus (Rush), is a narrow-leaved submerged plant common within this river. This many branched, plant may reach 2 m in length with individual hair-like leaves growing to 60 cm in length. It remains streamlined in the direction of flow and acts as a silt trap in areas of slow flow as suspended fines settle out from the flow and become trapped in the hair like network of leaves.

1.9.2 Emergent vegetation

Phalaris (Reed Canary Grass) is abundant within the Pilling Water. This tall narrow-leaved emergent grass with bluish leaves, may reach 1.2 m in height and grows in stands along the shallow waters edge.

This plant provides a greater resistance to flow than some submerged plants as it can provide a fairly impermeable barrier to the flow of water, depending on the density of the vegetation stand.

1.9.3 Algae

Filamentous algae is common within the Pilling Water. The long chains of this algae grow up from the hydrosoil. It is difficult to control as it can be found anywhere and grows rapidly through simple fission by which each cell divides. Algae is common in nutrient rich waters and frequently invades areas where other aquatic plants have been controlled or eradicated.

2. FARM SURVEY

2.1 Introduction

Through structured interviews and informal discussions with farmers along the selected reach and through topographical surveys, the area deriving benefit from river maintenance on the Pilling Water in terms of land drainage and flooding is estimated to be 296 ha. This area is termed the benefit area (BA). Of this area, 83 % was surveyed in detail. The remainder was surveyed using rapid survey techniques. The benefit area is divided into blocks according to land use, drainage and land management (Figure 2).

2.2 Farm Type, Size and Tenure

Of the 12 farms surveyed within the Pilling Water catchment, six are classified as dairy farms according to the European Union (EU) classification system. Two farms are general cropping arable farms, one a beef farm, one specialised cropping and one a lowland and livestock enterprise. The remaining farm is a small holding consisting of one (0.8 ha) field grazed by horses.

Nine of the 12 farms are under sole proprietorship. Two are run as partnerships and one is a managed farm. Two of the farmers have two holdings. In both cases these are farmed under the same holding number and run as one unit. The majority of land within the surveyed benefit area is owner occupied (61 %, 146 ha). Fourteen percent (34 ha) is held under a full tenancy whilst the remaining 25 % (60 ha), is farmed under a 364 day tenancy agreement.

The Standard Man Day (SMD) requirement ranges from one to 2469. This latter is for a mixed farm of 93 ha. The average SMD requirement is 522. The SMD (Man - Work Units) is an approximate method for assessing the labour requirements of regular staff. It is assumed that each man provides 300 SMD annually. Table 2.1 provides further information regarding farm size.

Table 2.1 Farm size by area

Size Class (ha)	No. of Farms
< 30	6
30 - 60	3
60 - 110	3

2.3 Livestock Enterprises

Six of the 12 farms are classified as dairy enterprises, five of which have Fresian herds and one Ayrshire. Herd sizes range from 18 to 80 cows. All the farms have a follower herd. Milk yields range from 5500 to 7500 l/cow/year. Stocking rates for dairy followers are in the region of 4.5 beasts/ha. On average 22 livestock units are kept on each dairy farm.

Six farms have spring calving beef herds. They all follow an indoor, intensive system. Three herds are under a 12 month system, two under an 18 month system and one 12 to 15 months. All beef stock are fattened on silage. The average herd size is 45.

Two farms have sheep enterprises. Both are following the fat lamb system in which lambs are fattened off grass. The lambing rates are medium to high, ranging from 1.6 to 2 lambs per ewe tupped. The flock sizes range from 20 to 300. The smaller flock has the highest lambing rate.

A total of 360 pigs are kept under a system of fattening and 30 000 pullets are reared in a battery farm. Both these enterprises are being followed on the same farm.

2.4 Arable Enterprises

Two farms within the Pilling Water catchment area are classed as general cropping farms. Both holdings are small, being 26 and 5.8 ha in size. A single crop of spring barley and wheat is grown in each case and no fixed rotation is followed.

Five other farms have some arable enterprises. A five year arable/grass rotation is typically followed under which winter barley, spring barley, winter and spring wheat, fodder beet or potatoes are grown. Field beans and oats are also grown on two farms. Farmers following the cereal/oilseed rotation substitute oilseed rape for the root crops in this rotation. Yields for the winter wheat and barley range between 6 to 7 tonnes/ha. Spring wheat yields average 4.75 tonnes/ha and potatoes 33 tonnes/ha. The yield for winter oats is 5 tonnes/ha, slightly lower than the national average yield of 5.5 tonnes/ha for this crop. This may be due to very wet conditions in the spring which hinder growth.

2.5 Land Use In The Benefit Area

Figure 4 shows the areas of the benefit area of the Pilling Water which are under different land use scenarios. Table 2.2 provides a breakdown of these different land uses by area. The dominant land uses are grassland, for the grazing of beef and dairy herds and land under a cereal / root crop rotation.

Table 2.2 Land use within the benefit area

Land Use	Area (ha)	% of Benefit Area
Extensive grass	45	15.2
Intensive grass	91	30.8
Cereal / oilseeds	25	8.4
Cereal / roots	60	20.3
Grass / arable	75	25.3

Intensive grassland is associated with long grazing seasons, high rates of nitrogen application (typically > 50 kg N/ha) and multiple cuts of conservation. Dairy cattle are the commonest stock type usually grazing intensive grassland. Extensive grassland is characteristically used for the permanent grazing of beef cattle and sheep. Grazing seasons are short. Rates of nitrogen application are low or non existent and if grass is conserved, hay rather than silage is made.

The installation of field drains within the benefit area is generally quite low as the area is well drained naturally.

2.6 Turnout and Yarding Dates

Throughout the benefit area, turnout dates for livestock fall into two categories. On 15 % of the grassland area (excluding that within arable/grass rotations) livestock are turned out to graze in April. The remainder of the grassland area, again excluding the land under a grass/arable rotation is grazed after silage or hay has been cut. In all such cases, the date of close up for the pasture is early to mid April. Fifty eight percent of the grassland area is not grazed. Further information is presented in Table 2.3.

Table 2.3 Turnout dates

Turnout Date	% Grassland Area	% of Pilling Benefit Area
Early/mid April	2.9	1.3
Mid/late April	11.8	5.5
After silage cut	23.5	10.9
After hay cut	2.9	1.3
Not grazed	58.8	27.0

No stock is over-wintered out at grass within the benefit area. The yarding dates are detailed in Table 2.4. The grassland under the grass/arable rotation is not included within these yarding date calculations as this grass is not grazed.

Table 2.4 Yarding dates

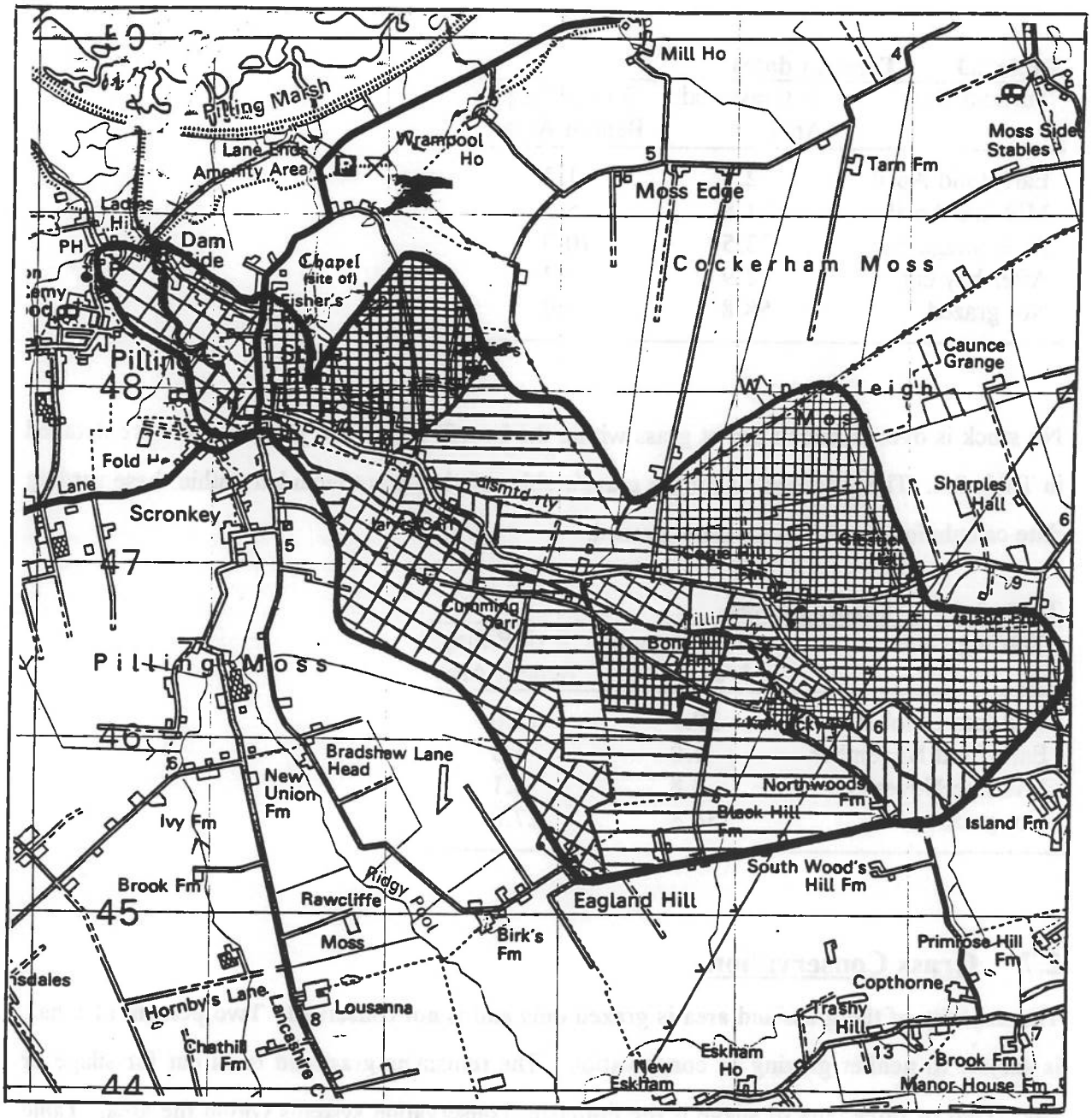
Yarding Date	% Grassland Area	% of Pilling Benefit Area
Mid/late October	29.4	13.6
Early/mid November	2.9	1.3
Mid/late November	8.8	4.1
Not grazed	58.8	27.0

2.7 Grass Conservation

The majority of the grassland area is grazed only and is not conserved. Two percent (1.5 ha), is subject to neither grazing or conservation. The remaining grassland is all cut for silage or hay. Two or three cuts of silage is the dominant conservation systems within the area. Table 2.5 provides further information. The first cut of silage is taken in mid to late May. The second cut is taken six weeks later and the third in July. The first cut of hay is taken in mid June.

Table 2.5 Grass conservation

Conservation System	Grassland Area (ha)	% Grassland Area
Grazed only	44.1	32.4
1 cut silage	9.7	7.1
2 cuts silage	43.8	32.2
3 cuts silage	34.9	25.7
2 cut hay	3.5	2.6



Legend :

Scale 1 : 33 750

- Intensive grass
- Extensive grass
- Grass / arable rotation
- Cereal / root crop rotation
- Cereal / oilseed rotation

Figure 4 Land use in the benefit area

2.8 Nitrogen Application

Nitrogen is applied to the majority of the grassland in the benefit area. Rates of application vary between 21 to 65 kg/ha. Table 2.6 provides a breakdown of the application rates for the intensive and extensive grassland.

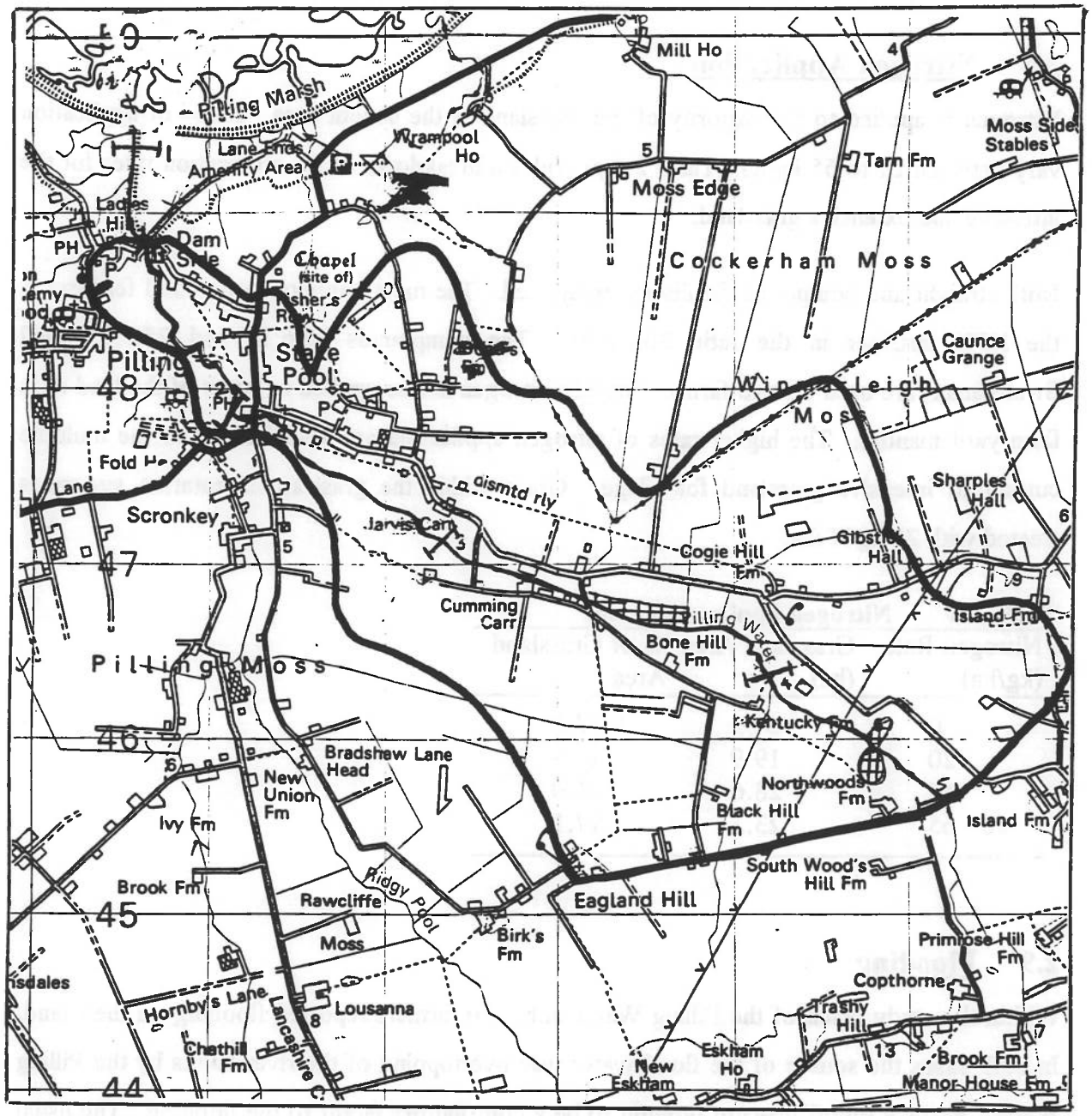
Both straight and compound fertilisers are applied. The most common compound fertiliser is the NPK fertiliser in the ratio 20:10:10. The compounds 20:6:12 and 25:5:5 (Shell Swardsman) are used on two farms. Straight nitrogen is also applied to some of the land as is farm yard manure. The higher rates of nitrogen application are associated with the multiple cutting of intensive grassland for silage. Grass within the grass/arable rotation system is treated with 20 kg N /ha.

Table 2.6 Nitrogen application rates

Nitrogen Rate (kg/ha)	Grassland Area (ha)	% of Grassland Area
0	64.3	47.3
20	19.9	14.6
45	28.6	21.0
46 - 65	23.2	17.1

2.9 Flooding

Within the study reach of the Pilling Water only two farmers reported flooding on their land. In both cases the source of the flood water was overtopping of the river banks by the Pilling Water. Surface runoff was not thought to be a contributory factor to the flooding. The usual area inundated by flooding is 24 ha (Figure 5) which is 8 % of the Pilling Water benefit area. Ninety percent of flooding in the area is said to occur during the autumn and winter months. Both farmers reported the duration of flooding to be two or three days. Crop damage is reported to be the major consequence of flooding.



Legend :

Scale 1 : 33 750

Flooded areas

Cross-sections

Figure 5 Areas of the benefit area prone to flooding and location of cross-sections

2.10 Waterlogging

Throughout the spring and summer the majority of land within the benefit area of the Pilling Water is well drained, either naturally or by pipes. Waterlogging of the ground at this time is not considered to be a problem. The wetness condition of the soil in the spring, summer and autumn is shown in Table 2.7.

During the spring and summer 94 % and 98 % of land within this area is rarely or occasionally wet. In the autumn 5 % of the land within the benefit area remains well drained and is rarely wet. The majority of land is often wet (77 %). No land surveyed is permanently wet during any of these seasons.

Table 2.7 Farmer assessment of wetness condition

Season	Wetness Condition	Area (ha)	% Pilling Benefit Area
Spring	Rarely wet	79.4	26.8
	Occasionally wet	198.4	67.0
	Often wet	18.2	6.2
	Permanently wet	0.0	0.0
Summer	Rarely wet	116.9	39.5
	Occasionally wet	174.1	58.8
	Often wet	5.0	1.7
	Permanently wet	0.0	0.0
Autumn	Rarely wet	15.2	5.1
	Occasionally wet	53.1	17.9
	Often wet	227.7	77.0
	Permanently wet	0.0	0.0

The farmers have attributed wetter conditions in the autumn to rainfall causing surface ponding and due to the low lying nature of the area. The presence of aquatic weeds in the channel is thought by one farmer to raise river water levels to such an extent that the outfall of field drains into the river become submerged causing water to back up the drains and thus to hinder field drainage.

2.11 Statistical Analysis

It is apparent that land use, farming practice, drainage and flooding are interrelated. Statistical methods were used to determine whether these relationships occurred more frequently than

might be expected by pure chance. Full details of this analysis in which the 12 sites were grouped according to NRA Region, are presented in the Interim Report R&D 317/13/ST, presented to the NRA in December 1994.

The following observations can be made from the statistical analysis of fields in the benefit area of the Pilling Water maintenance programme:

- A strong relationship exists between the presence of field drainage and land use. The more intensive land such as intensive grassland and cereal / oilseed rotations have a higher proportion of field drainage installation than less intensive land use. Land under a cereal/root rotation in which field drainage is critical for the development and harvest of the root crop has the highest incidence of field drainage of all the land use types surveyed in the benefit area. (Statistically there is a 73 % chance of correctly predicting the installation of field drainage on the basis of land use).

- A strong relationship exists between the rate of nitrogen application and the conservation system practised. Land which is cut for silage receives higher rates of nitrogen/ha than grass which is cut for hay, or grazed and not cut. (Statistically there is a 99 % chance of correctly predicting the conservation system followed on the basis of nitrogen application rates).

- Turnout dates for livestock in the spring are strongly associated with the field wetness condition. Livestock are turned out earlier (April) on land which is drier (rarely wet) than on land which is occasionally or often wet (after hay or silage cut). (Statistically there is an 82 % chance of correctly predicting turnout dates based on spring field wetness condition).

- No significant relationship appears to exist between the field wetness condition in the autumn and livestock yarding dates. Yarding dates appear to be a function of the farming system followed. (Statistically there is a 27 % chance of correctly predicting livestock yarding dates on the basis of field wetness conditions).

3 HYDRAULIC AND HYDROLOGICAL INFORMATION

3.1 Introduction

Information on channel hydraulics and hydrological data has been used to determine the impact of maintenance on channel capacity and flood return periods.

3.2 Cross-section Surveys

Cross-sectional surveys of the river channel were taken at five points along the study reach at an average interval of 1400 m (Figure 5). Channel capacity and freeboard were determined from these cross-sections. The channel cross-section remained unchanged following the regular weed clearance programme and so a post-maintenance cross-sectional survey was not necessary.

Prior to weed clearance, channel roughness was expressed in terms of Manning's n coefficient in accordance with the methodology developed by Cowan (1956). This coefficient is composed of six elements which include the degree of irregularity of the channel bed, level of vegetation growth and predominant bed material. Further details of this methodology are contained within the R&D Note 456, Appendix IV. The same procedure was followed post-maintenance in order to determine friction values for the 'with' and 'without' maintenance situation.

Stage/discharge curves for the 'with' and 'without' maintenance situation have been constructed for each cross-section using the different values of Manning's 'n'. Channel cross-section information, stage/discharge curves and channel information are presented in Figure 6. The bankfull channel capacities and associated return periods for the 'with' and 'without' maintenance scenario are presented in Table 3.1.

Table 3.1 Bankfull capacity and return periods

Cross-Section	Without Maintenance		With Maintenance	
	Bankfull Capacity (m^3/s)	Return Period (years)	Bankfull Capacity (m^3/s)	Return Period (years)
1	1.9	1.7	4.5	8.1
2	1.3	0.9	2.5	2.7
3	6.5	20.0	12.6	140.0
4	1.6	1.2	3.0	3.9
5	1.0	0.6	1.9	1.7

(Source: modelled estimates)

The bankfull capacity figures obtained from the cross-sections indicate an average increase in capacity attributable to maintenance of 50 % and an average increase in the interval between flood events of 73 %.

3.3 Flood Return Period

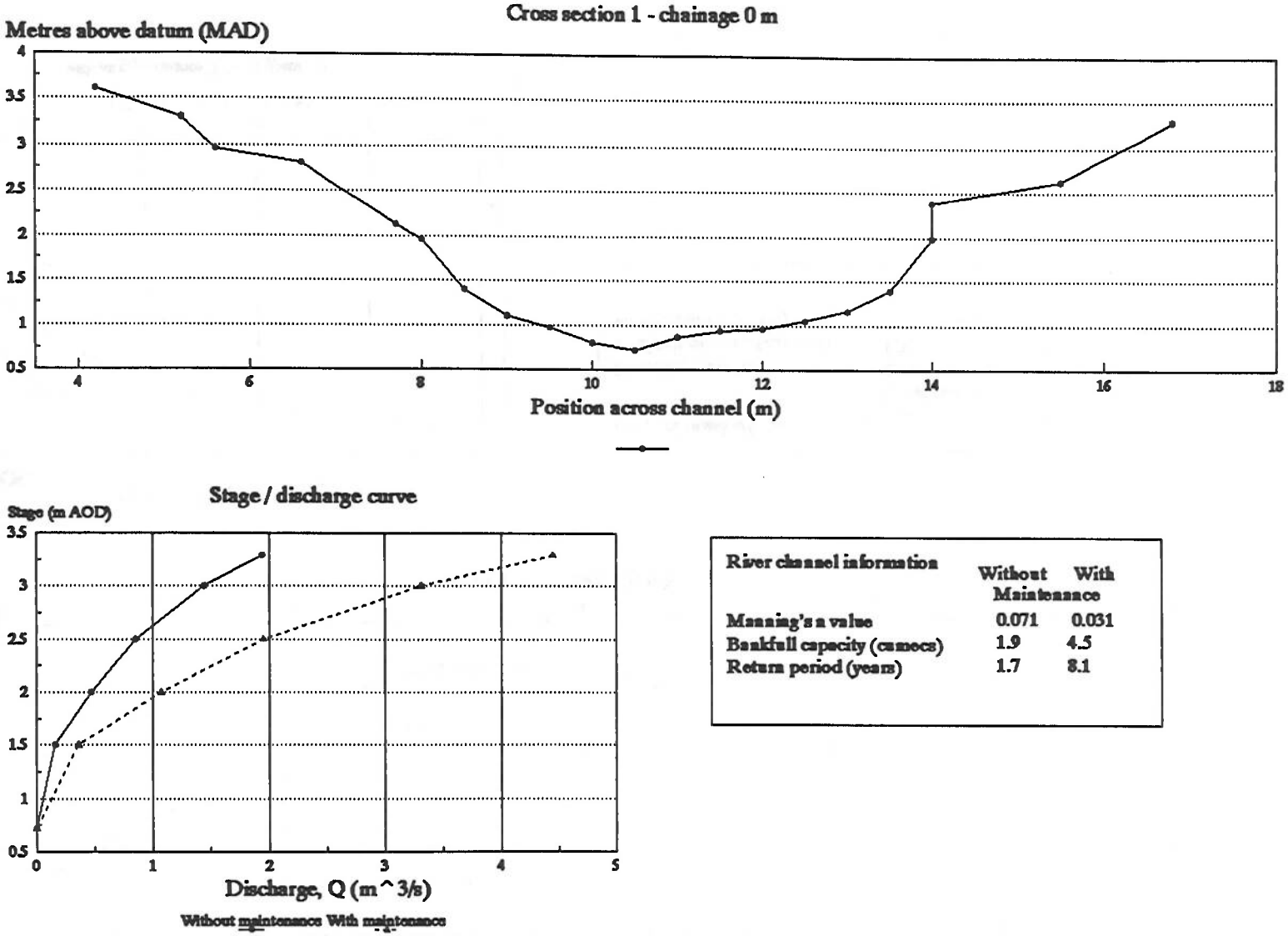
Throughout the period of study (1992 to 1995) river water level information was collected on a regular basis through the reading of three gauge boards which were installed in the study reach.

Information regarding frequency, duration and magnitude of flood flows were collected from interviews with local farmers and NRA staff. A flood return period curve has been compiled from this information, using the methodology contained within the Flood Studies Report (NERC, 1975). The frequency of floods of different magnitudes can be estimated from the flood return period curve (Figure 7).

The flood return period for each block which floods and flooded areas are shown in Table 3.2. The 'without' maintenance return period is estimated by the farmer, the 'with' maintenance value is a modelled estimate using the cross-section information and Manning's n coefficient. It is assumed that the flooded area remains unchanged following maintenance.

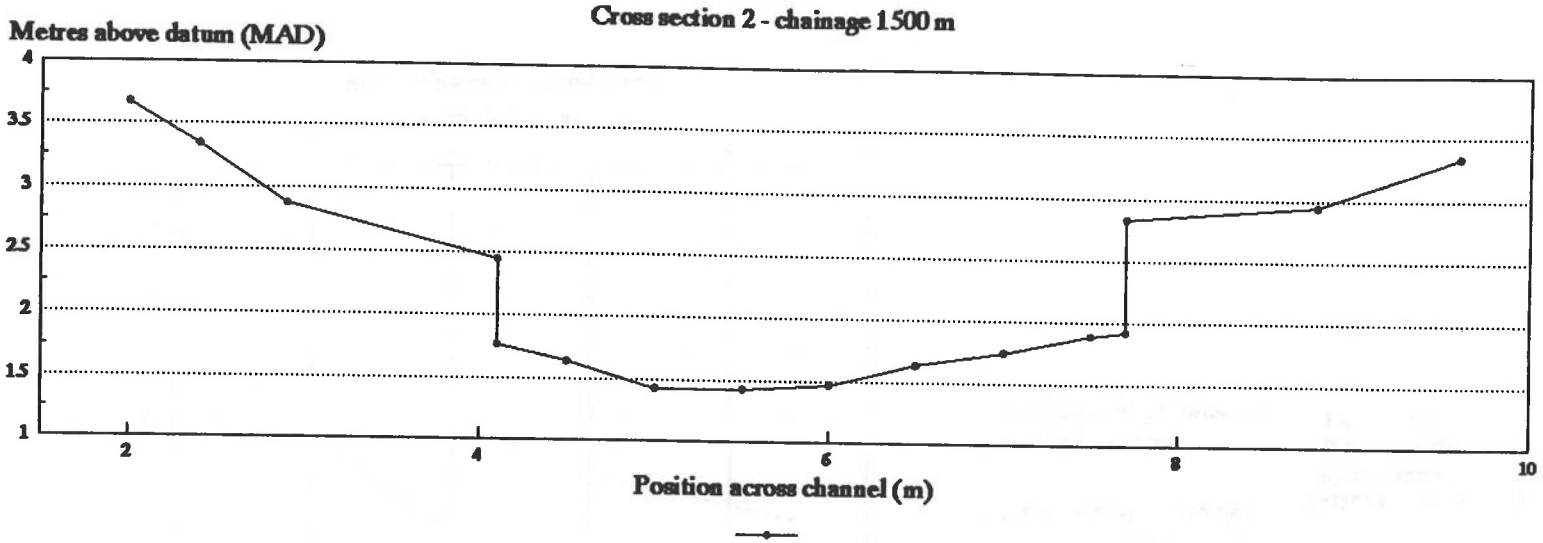
Table 3.2 Flood return periods and flooded areas

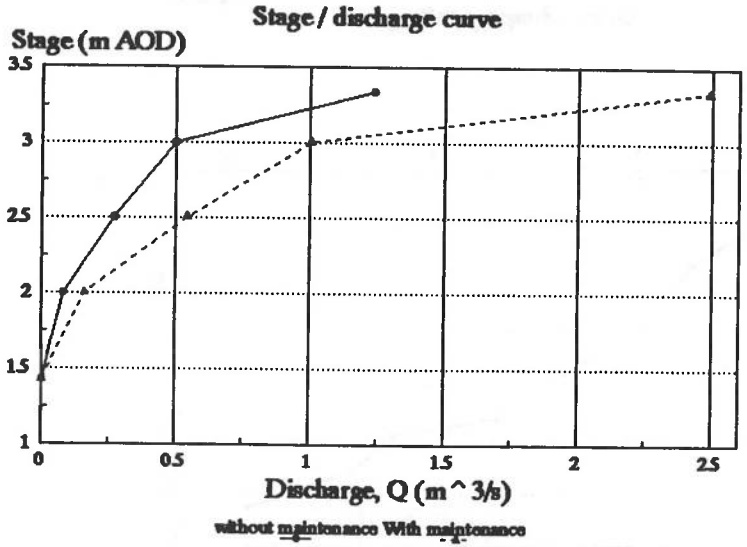
Block No.	Block Size (ha)	Flooded area (ha)	Flood Return Period (Years)	
			Without Maintenance	With Maintenance
101	7.1	1.42	0.5	1.5
102	10.6	2.12	0.5	1.5
103	15.1	0.76	0.5	1.5
104	11.5	10.35	0.5	1.5
105	7.3	1.46	0.5	1.5
601	15.0	4.95	1.0	3.9



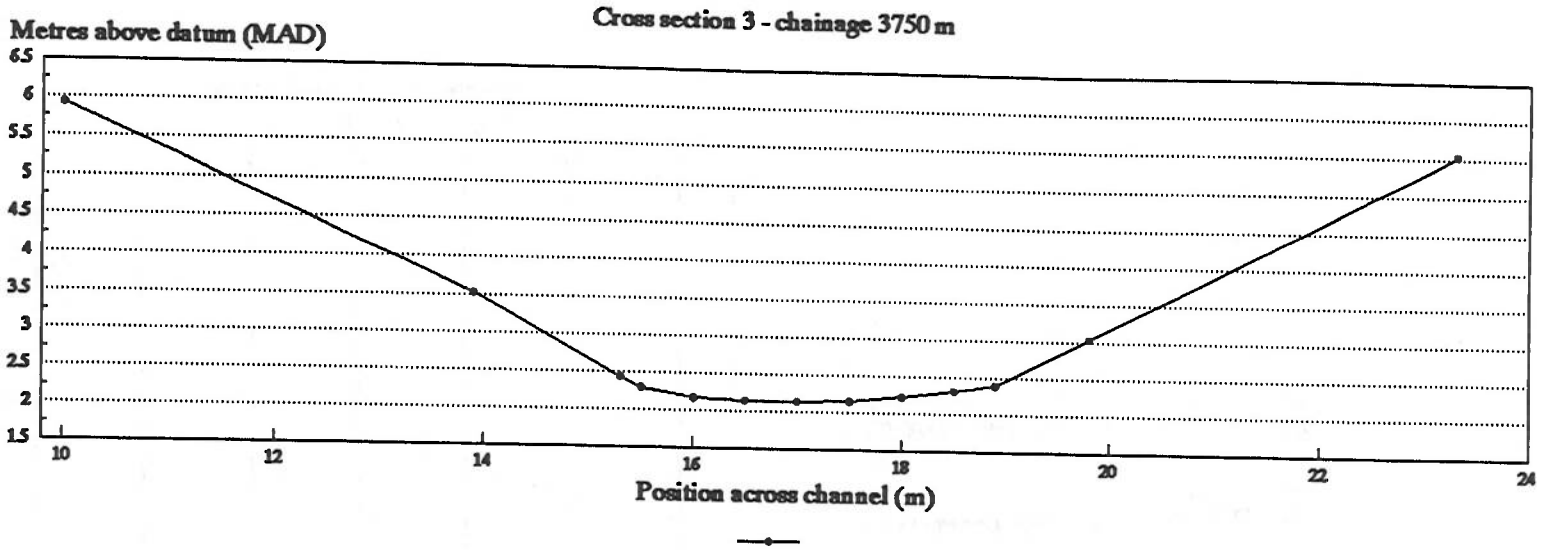
River channel information	Without Maintenance	With
Manning's n value	0.071	0.031
Bankfull capacity (cumecs)	1.9	4.5
Return period (years)	1.7	8.1

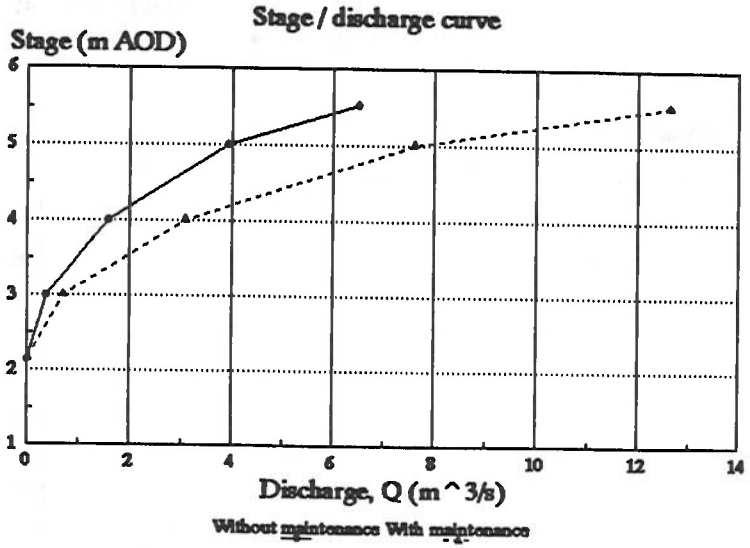
Figure 6 Pilling Water channel information



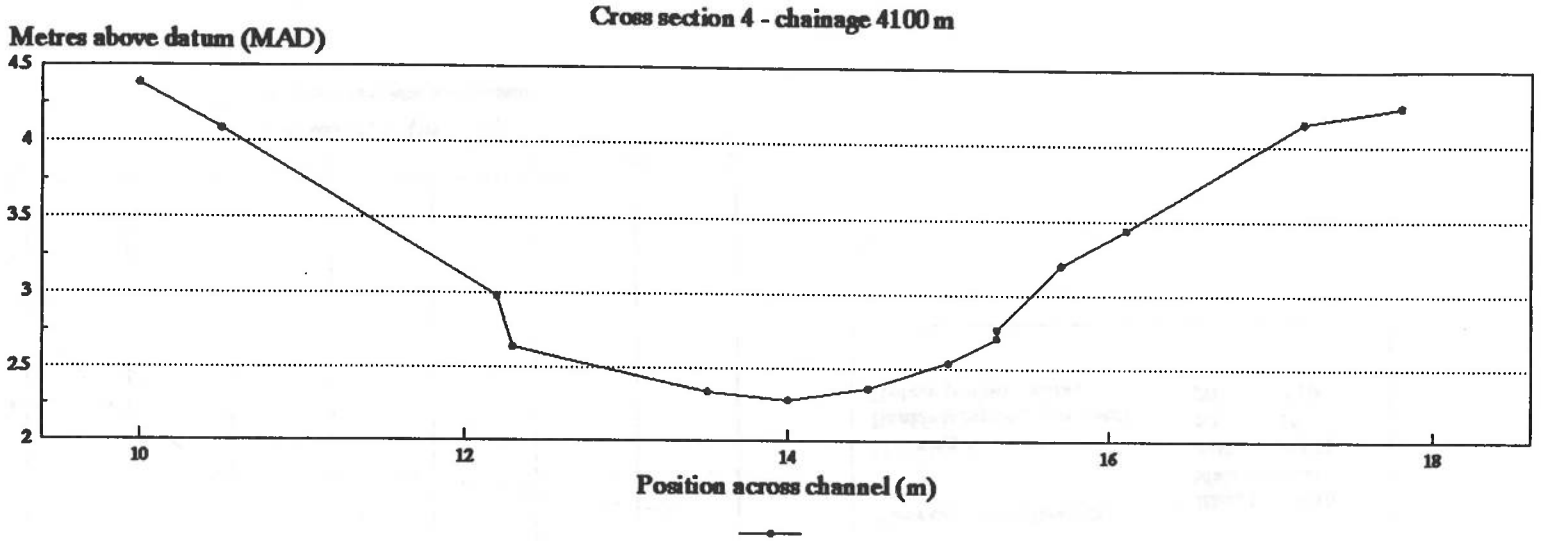


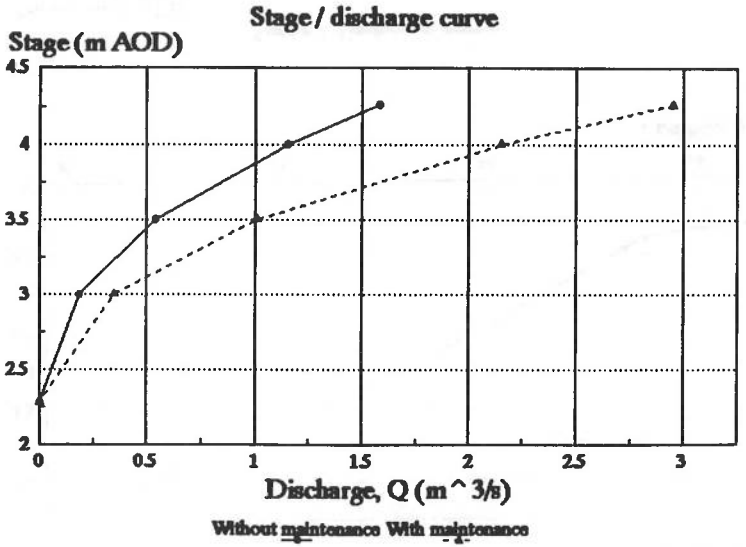
River channel information	Without Maintenance	With
Manning's n value	0.06	0.03
Bankfull capacity (cumecs)	1.3	2.5
Return period (years)	0.9	2.7



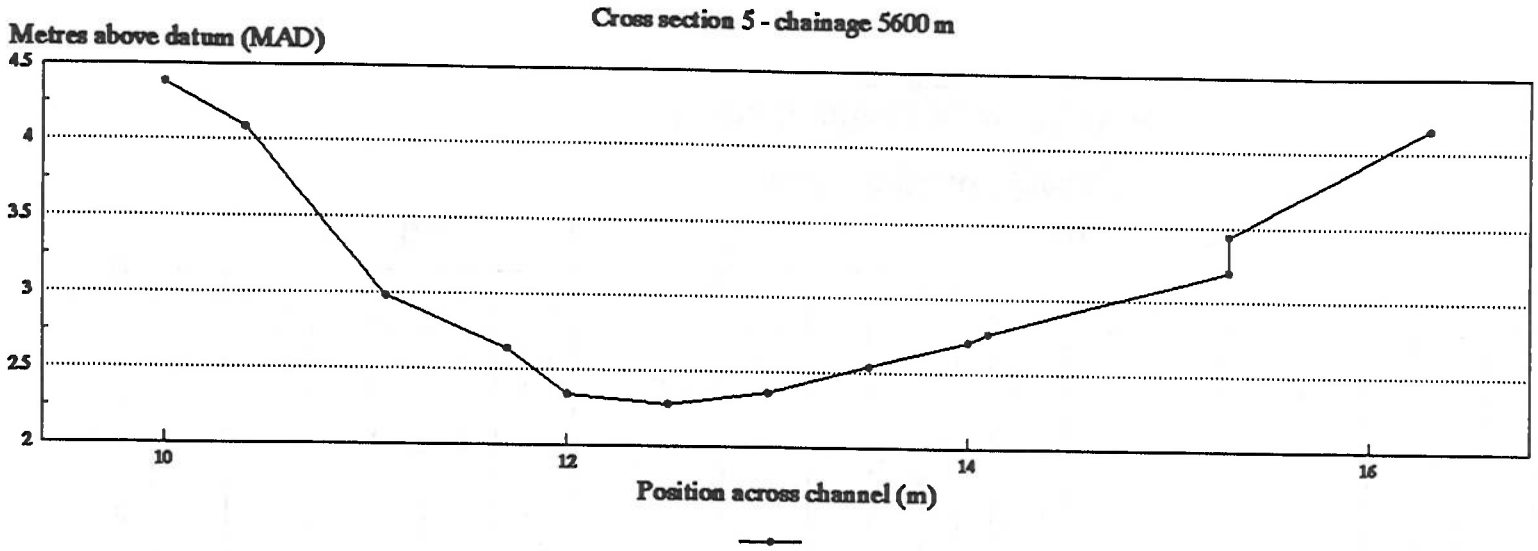


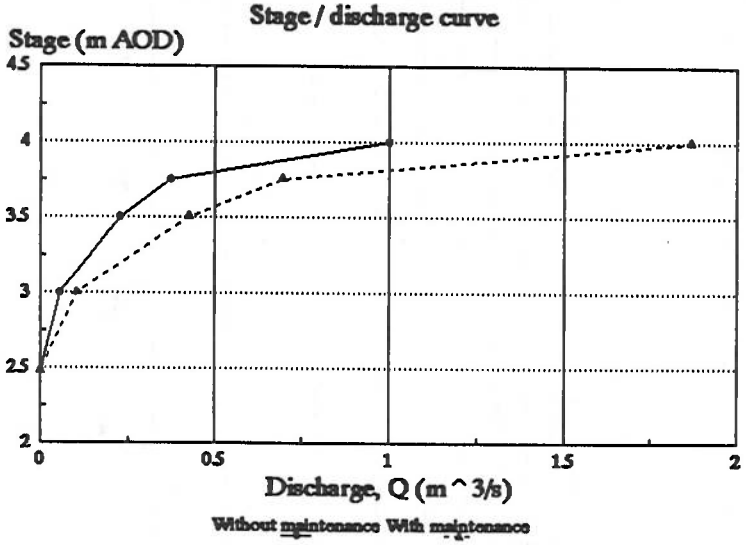
River channel information	Without Maintenance	With
Manning's n value	0.07	0.036
Bankfull capacity (cumecs)	6.5	12.6
Return period (years)	20	140





River channel information	Without Maintenance	With
Manning's n value	0.056	0.03
Bankfull capacity (cumecs)	1.6	3.0
Return period (years)	1.2	3.9





River channel information	Without Maintenance	With
Manning's n value	0.056	0.031
Bankfull capacity (cumecs)	1.0	1.9
Return period (years)	0.6	1.7

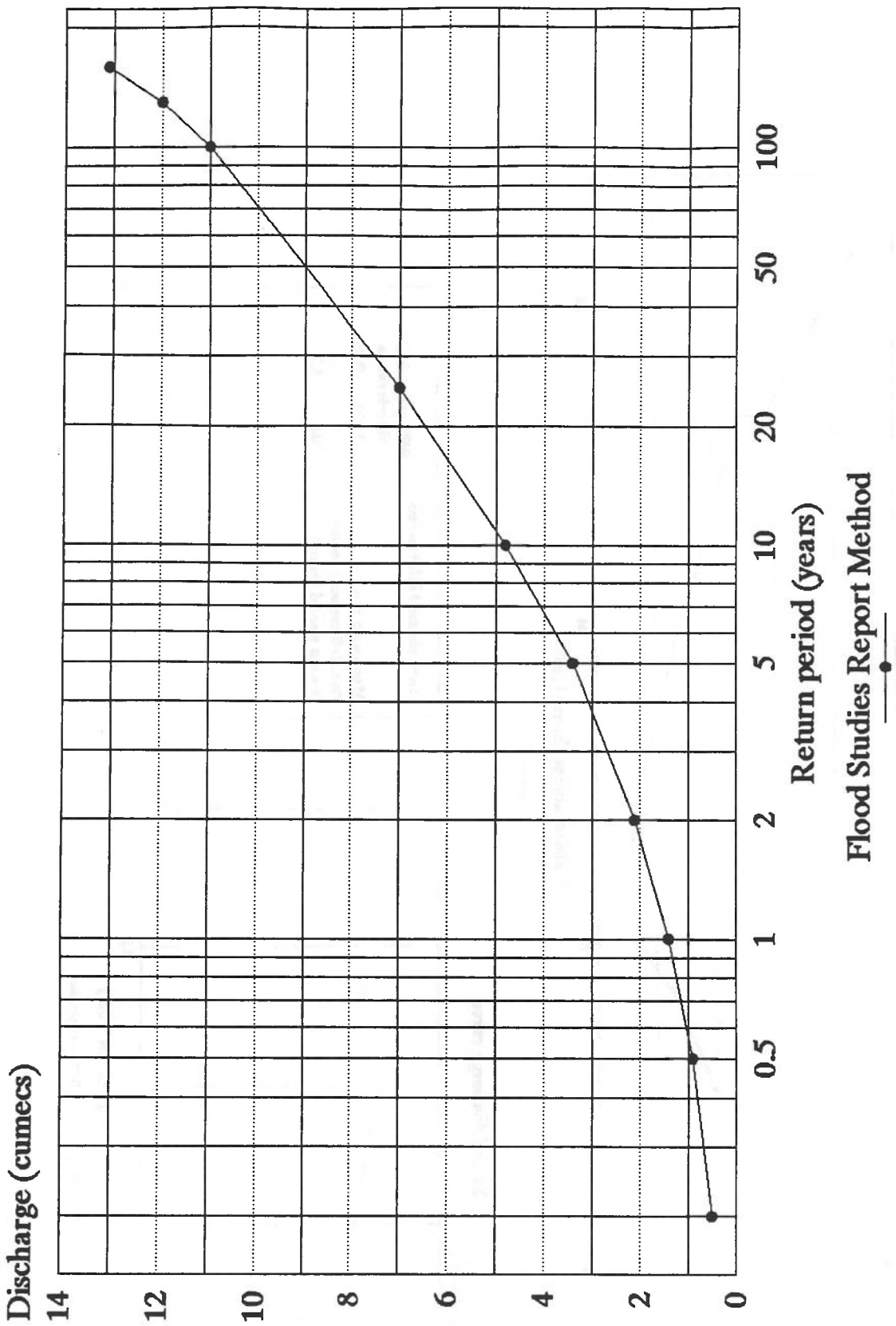


Figure 7 Flood return period curve

4. LAND DRAINAGE

4.1 Field Drainage Status

The drainage standard of land has been classified into three according to watertable depth. An extensive literature review and farmer survey enabled three watertable bands to be identified:- > 0.5 m from the surface, between 0.3 and 0.5 m from the surface and < 0.3 m from the surface. According to the time the watertable lies within these bands, the drainage standard is classed as good (G, no limitations to land use), bad (B, some restrictions on land use) or very bad (VB, severe restrictions on agricultural productivity). Further details are presented in the R&D Note 456, Section 3.5.2.

The drainage status of the land blocks within the benefit area has been determined on a seasonal basis using a non-steady state watertable model which relates infield watertable levels (and hence drainage conditions) to observed water levels in the river and ditch system (see R&D Note 456, Section 3.5.2 for further details). The model has been run using river water levels for the 'with' and 'without' maintenance situation using the same climatic data to enable the isolation of the impact of weed clearance on drainage status. An example of the input and output of the model is shown in Appendix 1.

The results of the model and the assessment of drainage status made by farmers are shown in Table 4.1. The results from the watertable model are generally consistent with the farmer assessment of drainage condition under wet, average and dry weather conditions. For the 'with' maintenance situation there is a 100 % agreement between farmer and modelled assessment of field drainage under dry conditions, 89 % agreement under average conditions and 68 % agreement under wet conditions.

In the 'without' maintenance situation, under average weather conditions, there is 57 % agreement between the farmer and modelled assessments of field drainage condition.

In some cases, there may be a change in the number of weeks that the watertable lies within the good, bad and very bad drainage bands following maintenance. However, these changes may not be of sufficient magnitude to change the drainage status classification. Where a change in drainage status has occurred due to maintenance, the changes appear in bold print in Table 4.1.

Table 4.1 Drainage status for wet, average and dry seasons, without/with maintenance

Block No		Wet Season *		Average Season *		Dry Season *		Farmer Assessment With Maintenance			Without
		Without	With	Without	With	Without	With	Wet	Average	Dry	
101	Y	B	B	**B**	**G**	G	G	B	G	G	B
102	Y	B	B	**B**	**G**	G	G	B	G	G	B
103	Y	**B**	**G**	G	G	G	G	G	G	G	B
104	Y	**B**	**G**	G	G	G	G	*B*	G	G	B
105	Y	**B**	**G**	G	G	G	G	*B*	G	G	B
201	Y	**B**	**G**	G	G	G	G	G	G	G	B
202	N	B	B	G	G	G	G	*G*	G	G	B
203	Y	**B**	**G**	G	G	G	G	G	G	G	B
204	Y	G	G	G	G	G	G	G	G	G	B
205	Y	G	G	G	G	G	G	G	G	G	B
301	Y	VB	VB	**B**	**G**	G	G	*B*	G	G	B
302	Y	VB	VB	**B**	**G**	G	G	*B*	G	G	B
401	Y	**VB**	**B**	B	B	G	G	B	*G*	G	B
402	Y	B	B	**B**	**G**	G	G	B	G	G	B
403	Y	G	G	G	G	G	G	G	G	G	B
404	Y	G	G	G	G	G	G	G	G	G	B
405	Y	G	G	G	G	G	G	G	G	G	B
501	Y	B	B	B	B	G	G	*G*	*G*	G	B
502	Y	**B**	**G**	G	G	G	G	G	G	G	B
601	Y	**B**	**G**	G	G	G	G	*B*	G	G	G
701	Y	G	G	G	G	G	G	G	G	G	G
702	Y	G	G	G	G	G	G	G	G	G	G
703	Y	G	G	G	G	G	G	G	G	G	G
704	Y	G	G	G	G	G	G	G	G	G	G
705	N	**B**	**G**	G	G	G	G	G	G	G	G
706	Y	G	G	G	G	G	G	G	G	G	G
801	Y	G	G	G	G	G	G	G	G	G	B
802	N	G	G	G	G	G	G	G	G	G	B
803	N	B	B	**B**	**G**	G	G	*G*	G	G	B
804	N	B	B	**B**	**G**	G	G	*G*	G	G	B
805	N	B	B	**B**	**G**	G	G	*G*	G	G	B
901	Y	**VB**	**B**	**B**	**G**	**B**	**G**	B	G	G	G
1001	Y	G	G	G	G	G	G	*B*	G	G	B
1101	N	VB	VB	**VB**	**B**	**B**	**G**	VB	*G*	G	VB
1201	N	VB	VB	B	B	**B**	**G**	B	*G*	G	B
1301	N	B	B	G	G	G	G	*G*	G	G	G
1302	N	G	G	G	G	G	G	G	G	G	G

NB : * Modelled results, Y or N refers to the presence or absence of field drainage, bold type indicates a change in drainage status due to maintenance, italics show differences in farmer and modelled assessments of drainage with maintenance

River maintenance results in the prevention of a deterioration of drainage status on 10 blocks in a wet season, 10 blocks in an average season and 3 blocks in a dry season.

- In a wet season, maintenance prevents deterioration from :

  B to VB over 15 ha (5 % of BA)

  G to B over 94 ha (32 % of BA)

- In an average season, maintenance prevents deterioration from :

  B to VB over 1 ha (0.4 % of BA)

  G to B over 63 ha (21 % of BA)

- In a dry season, maintenance prevents deterioration from :

  G to B over 16 ha (5 % of BA).

Farmer perception of drainage deterioration due to lack of maintenance (under average conditions) was from good to bad on 67 % of the benefit area and good to very bad on 0.4 %.

5 SCHEME APPRAISAL

5.1 Maintenance Benefits

For each block of land, agricultural production scenarios were created which reflect different levels of field management under conditions of good, bad and very bad drainage (see R&D Note 456 Section 3.5.4). These scenarios are based on discussions with farmers in the benefit area over the period 1992-1994.

Changes in field drainage status as a result of maintenance under dry, average and wet climatic conditions have been identified. Changes in flood risk associated with maintenance have also been determined. Estimates have been derived of the monetary value of changes in field management and productivity associated with these changes in the standards of drainage service.

Two perspectives have been used to value agricultural performance. The first perspective is that of financial analysis which uses the prices paid and received by farmers to estimate the added-value associated with drainage. Financial analysis shows the benefits of maintenance to farmers in the benefit area.

The second perspective is that of economic analysis which modifies the financial analysis to make allowance for the direct and indirect subsidies paid to farmers by Government. In accordance with the MAFF Project Appraisal Guidance Notes on Flood Defence (PAGN, 1993), these modifications involve reductions in the financial value of output (including subsidies) by 10 % in the case of cereals, oil seeds and grain legumes, 35 % for beef and 25 % for sheep. Commodities subject to quota such as potatoes, sugar beet and milk are treated as winter wheat. The set aside areas are also treated as wheat. The reasons for these adjustments are discussed in the R&D Note 456 Section 2.7.2.

Table 5.1 shows the financial net returns (1995/96 prices) for each block of land within the benefit area under conditions of good, bad and very bad drainage. Changes in net returns relating to a change in drainage status are also shown. Table 5.2 presents similar data using economic prices. Table 5.3 shows the flood costs for each block of land assuming 'with' and 'without' maintenance and specified field drainage conditions. It is assumed that there is no

difference between financial and economic values in the case of flood damage to standing crops.

Table 5.4 combines data on changes in drainage status, flood risk and financial performance to determine the financial benefits and change in financial net returns due to maintenance for wet, average and dry weather conditions for each block of land in the benefit area. These benefits are the avoidance of losses which would occur in the absence of maintenance. Benefits, weighted by field size for wet, average and dry seasons are multiplied by the relative probability of the occurrence of the season to give an average expected annual benefit. These are summed for the benefit area as a whole.

Table 5.4 estimates a total expected annual benefit of about £ 13200 in 1995 financial prices, equivalent to about £ 45/ha per year on 296 ha. Table 5.5 shows the benefits attributable to maintenance using economic prices based on the current MAFF Project Appraisal Guidance Notes. Total average expected annual benefits are approximately £ 8080 in economic prices for the benefit area, equivalent to £ 27/ha. On this basis, the benefit to the national economy is about 60 % of the benefits which accrue to farmers. This difference reflects the adjustments required by MAFF to remove government subsidy from the assessment of benefits. These financial and economic benefit estimates show the limits which farmers and the nation respectively should justifiably spend on maintenance. These estimates require cautious interpretation as explained in the R&D Note 456 Section 2.7.2.

As an alternative estimate to that based on watertable modelling, Table 5.6 estimates the benefits due to maintenance which were perceived by farmers (earlier reported in Table 4.1) where they identified a change in drainage conditions between the 'with' and 'without' maintenance situations in an average, representative season. These estimates include the flood damage costs identified in Table 5.3 which were based on a combination of farmer and modelled data.

Table 5.1 Financial net returns, 1995/96 prices

Block	Area (ha)	Net Return (£/ha) G	B	VB	Change in Net Return (£/ha) G-B	G-VB	B-VB
101	7.10	271	253	209	18	62	44
102	10.60	338	200	26	138	312	174
103	15.10	338	196	71	141	266	125
104	11.50	390	254	119	136	271	135
105	7.30	394	212	32	182	362	180
201	17.50	474	369	297	105	177	72
202	1.30	476	445	299	30	177	146
203	9.80	462	432	285	30	177	147
204	5.80	476	445	299	30	177	146
205	8.70	554	416	215	138	338	200
301	12.90	486	307	151	180	336	156
302	2.20	453	451	314	3	139	137
401	3.50	391	318	267	73	125	51
402	8.40	562	300	77	261	485	224
403	16.80	566	301	73	265	493	228
404	3.90	562	300	77	262	485	223
405	4.00	224	199	123	25	101	76
501	22.80	424	376	294	48	129	82
502	12.10	490	328	160	162	330	168
601	15.00	445	437	300	8	144	137
701	13.10	586	544	360	41	226	184
702	3.10	516	306	128	210	388	178
703	5.70	683	544	360	139	323	184
704	1.90	586	544	360	41	226	184
705	5.20	603	369	135	234	468	234
706	6.10	604	473	374	131	230	99
801	1.70	413	407	285	5	128	123
802	1.60	389	326	285	63	105	42
803	2.60	527	315	132	212	396	184
804	2.10	413	407	285	5	128	123
805	5.40	154	146	84	9	70	61
901	11.50	542	425	332	117	210	93
1001	0.80	103	98	74	5	29	24
1101	0.80	236	206	170	30	65	35
1201	3.40	448	417	386	31	62	31
1301	10.10	389	326	285	63	104	42
1302	24.90	453	451	314	3	139	137

Table 5.2 Economic net returns, 1995/96 financial prices

Block	Area	Net Return (£/ha)			Change in Net Return (£/ha)		
	(ha)	G	B	VB	G-B	G-VB	B-VB
101	7.10	195	171	123	24	72	48
102	10.60	199	170	124	29	75	46
103	15.10	199	173	122	26	77	50
104	11.50	237	197	107	39	129	90
105	7.30	237	196	122	41	115	74
201	17.50	106	68	49	38	57	19
202	1.30	42	41	17	1	24	24
203	9.80	28	28	3	1	25	24
204	5.80	42	41	17	1	24	24
205	8.70	181	159	124	22	57	35
301	12.90	354	310	245	44	109	65
302	2.20	55	62	38	-7	18	25
401	3.50	92	63	47	30	45	15
402	8.40	370	308	195	62	175	113
403	16.80	370	307	199	63	171	108
404	3.90	370	307	199	63	171	108
405	4.00	128	98	39	30	89	59
501	22.80	362	313	220	49	142	93
502	12.10	360	310	215	49	145	96
601	15.00	46	48	24	-2	23	24
701	13.10	367	300	169	67	198	131
702	3.10	367	300	169	67	198	131
703	5.70	367	300	169	67	198	131
704	1.90	367	300	169	67	198	131
705	5.20	363	303	194	60	169	109
706	6.10	367	300	169	67	198	131
801	1.70	367	300	169	67	198	131
802	1.60	367	300	169	67	198	131
803	2.60	367	300	150	67	217	150
804	2.10	367	300	169	67	198	131
805	5.40	46	30	-6	16	52	37
901	11.50	367	300	169	67	198	131
1001	0.80	16	4	-3	13	20	7
1101	0.80	119	99	75	21	44	24
1201	3.40	390	355	305	36	85	49
1301	10.10	367	300	169	67	198	131
1302	24.90	55	62	38	-7	18	25

Table 5.3 Flood costs

			GOOD DRAINAGE		BAD DRAINAGE		VERY BAD DRAINAGE		CHANGE IN FLOOD COSTS					
Block No.	Without maintenance FRP	With maintenance FRP	Without maintenance flood cost	With maintenance flood cost	Without maintenance flood cost	With maintenance flood cost	Without maintenance flood cost	With maintenance flood cost	GOOD Without -with	BAD Without -with	VERY BAD Without -with	GOOD TO BAD Without -with	BAD TO VERY BAD Without -with	GOOD TO VERY BAD Without -with
101	0.50	1.50	47.97	15.99	41.61	13.87	38.28	12.76	31.98	27.74	25.52	25.62	24.41	22.29
102	0.50	1.50	102.03	34.01	84.24	28.08	83.31	27.77	68.02	56.16	55.54	50.23	55.23	49.30
103	0.50	1.50	25.50	8.50	23.07	7.69	17.07	5.69	17.00	15.38	11.38	14.57	9.38	8.57
104	0.50	1.50	468.15	156.05	373.32	124.44	260.70	86.90	312.10	248.88	173.80	217.27	136.26	104.65
105	0.50	1.50	126.78	42.26	114.24	38.08	81.30	27.10	84.52	76.16	54.20	71.98	43.22	39.04
601	1.00	3.90	31.94	8.19	28.31	7.26	20.36	5.22	23.75	21.05	15.14	20.12	13.10	12.17

Table 5.4 Changes in net returns due to maintenance and climate, 1995/96 financial prices

Block	Area (ha)	Wet Season			Average Season			Dry Season			Total Change (£/yr)
		Benefit due to drainage (£/ha/yr)	Benefits of flood alleviation (£/ha)	Change in net return due to maintenance	Benefit due to drainage (£/ha/yr)	Benefits of flood alleviation (£/ha)	Change in net return due to maintenance	Benefit due to drainage (£/ha/yr)	Benefits of flood alleviation (£/ha)	Change in net return due to maintenance	
101	7.10	0	28	28	18	26	44	0	32	32	252
102	10.60	0	56	56	138	50	188	0	68	68	1414
103	15.10	141	15	156	0	17	17	0	17	17	813
104	11.50	136	217	353	0	312	312	0	312	312	3714
105	7.30	182	72	254	0	85	85	0	85	85	945
201	17.50	105	0	105	0	0	0	0	0	0	486
202	1.30	0	0	0	0	0	0	0	0	0	0
203	9.8	30	0	30	0	0	0	0	0	0	79
204	5.80	0	0	0	0	0	0	0	0	0	0
205	8.7	0	0	0	0	0	0	0	0	0	0
301	12.9	0	0	0	180	0	180	0	0	0	1328
302	2.2	0	0	0	3	0	3	0	0	0	3
401	3.5	51	0	51	0	0	0	0	0	0	48
402	8.4	0	0	0	261	0	261	0	0	0	1256
403	16.8	0	0	0	0	0	0	0	0	0	0
404	3.9	0	0	0	0	0	0	0	0	0	0
405	4	0	0	0	0	0	0	0	0	0	0
501	22.8	0	0	0	0	0	0	0	0	0	0
502	12.1	162	0	162	0	0	0	0	0	0	519
601	15	8	20	28	0	24	24	0	24	24	373
701	13.1	0	0	0	0	0	0	0	0	0	0
702	3.10	0	0	0	0	0	0	0	0	0	0
703	5.7	0	0	0	0	0	0	0	0	0	0
704	1.9	0	0	0	0	0	0	0	0	0	0
705	5.20	234	0	234	0	0	0	0	0	0	323
706	6.1	0	0	0	0	0	0	0	0	0	0
801	1.7	0	0	0	0	0	0	0	0	0	0
802	1.06	0	0	0	0	0	0	0	0	0	0
803	2.6	0	0	0	212	0	212	0	0	0	315
804	2.1	0	0	0	5	0	5	0	0	0	7
805	5.4	0	0	0	9	0	9	0	0	0	26
901	11.5	93	0	93	117	0	117	117	0	117	1272
1001	0.8	0	0	0	0	0	0	0	0	0	0
1101	0.8	0	0	0	35	0	35	30	0	30	20
1201	3.4	0	0	0	0	0	0	31	0	31	17
1301	10.1	0	0	0	0	0	0	0	0	0	0
1302	24.9	0	0	0	0	0	0	0	0	0	0
Total	296									Total	13209
Probability of :		Wet season		0.38						Benefit (£/ha)	45
		Average season		0.44							
		Dry season		0.18							

Table 5.5 Changes in net returns due to maintenance and climate, 1995/96 economic prices

Block	Area (ha)	Wet Season			Average Season			Dry Season			Total Change (£/yr)
		Benefit due to drainage (£/ha/yr)	Benefits of flood alleviation (£/ha)	Change in net return due to maintenance	Benefit due to drainage (£/ha/yr)	Benefits of flood alleviation (£/ha)	Change in net return due to maintenance	Benefit due to drainage (£/ha/yr)	Benefits of flood alleviation (£/ha)	Change in net return due to maintenance	
101	7.10	0	28	28	24	26	50	0	32	32	271
102	10.60	0	56	56	29	50	79	0	68	68	756
103	15.10	26	15	41	0	17	17	0	17	17	352
104	11.50	39	217	257	0	312	312	0	312	312	3420
105	7.30	41	72	113	0	85	85	0	85	85	672
201	17.50	38	0	38	0	0	0	0	0	0	175
202	1.30	0	0	0	0	0	0	0	0	0	0
203	9.8	1	0	1	0	0	0	0	0	0	2
204	5.80	0	0	0	0	0	0	0	0	0	0
205	8.7	0	0	0	0	0	0	0	0	0	0
301	12.9	0	0	0	44	0	44	0	0	0	328
302	2.2	0	0	0	-7	0	-7	0	0	0	-9
401	3.5	15	0	15	0	0	0	0	0	0	14
402	8.4	0	0	0	62	0	62	0	0	0	295
403	16.8	0	0	0	0	0	0	0	0	0	0
404	3.9	0	0	0	0	0	0	0	0	0	0
405	4	0	0	0	0	0	0	0	0	0	0
501	22.8	0	0	0	0	0	0	0	0	0	0
502	12.1	49	0	49	0	0	0	0	0	0	158
601	15	-2	20	18	0	24	24	0	24	24	335
701	13.1	0	0	0	0	0	0	0	0	0	0
702	3.10	0	0	0	0	0	0	0	0	0	0
703	5.7	0	0	0	0	0	0	0	0	0	0
704	1.9	0	0	0	0	0	0	0	0	0	0
705	5.20	60	0	60	0	0	0	0	0	0	83
706	6.1	0	0	0	0	0	0	0	0	0	0
801	1.7	0	0	0	0	0	0	0	0	0	0
802	1.06	0	0	0	0	0	0	0	0	0	0
803	2.6	0	0	0	67	0	67	0	0	0	100
804	2.1	0	0	0	67	0	67	0	0	0	80
805	5.4	0	0	0	16	0	16	0	0	0	48
901	11.5	131	0	131	67	0	67	67	0	67	966
1001	0.8	0	0	0	0	0	0	0	0	0	0
1101	0.8	0	0	0	24	0	24	21	0	21	14
1201	3.4	0	0	0	0	0	0	36	0	36	20
1301	10.1	0	0	0	0	0	0	0	0	0	0
1302	24.9	0	0	0	0	0	0	0	0	0	0
Total	296									Total	8080
Probability of :		Wet season		0.38						Benefit (£/ha)	27
		Average season		0.44							
		Dry season		0.18							

Table 5.6 Farmer asessment of maintenance benefits

Block	Area (ha)	Average Season Financial Prices: Benefit due to drainage (£/ha/yr)	Average Season Financial Prices: Benefits of flood alleviation (£/ha)	Average Season Financial Prices: Change in net return due to maintenance	Average Season Economic Prices: Benefit due to drainage (£/ha/yr)	Average Season Economic Prices: Benefits of flood alleviation (£/ha)	Average Season Economic Prices: Change in net return due to maintenance
101	7.10	18	28	325	25	26	359
102	10.60	138	56	2058	29	50	840
103	15.10	141	15	2349	26	17	649
104	11.50	136	217	4063	39	312	4037
105	7.30	182	72	1854	41	85	916
201	17.50	105	0	1838	38	0	665
202	1.30	30	0	39	1	0	1
203	9.8	30	0	294	1	0	10
204	5.80	30	0	174	1	0	6
205	8.7	138	0	1201	22	0	191
301	12.9	180	0	2322	44	0	568
302	2.2	3	0	7	-7	0	-15
401	3.5	0	0	0	0	0	0
402	8.4	261	0	2192	62	0	521
403	16.8	265	0	4452	63	0	1058
404	3.9	262	0	1022	63	0	246
405	4	25	0	100	30	0	120
501	22.8	0	0	0	0	0	0
502	12.1	162	0	1960	49	0	593
601	15	0	20	302	0	24	356
701	13.1	0	0	0	0	0	0
702	3.10	0	0	0	0	0	0
703	5.7	0	0	0	0	0	0
704	1.9	0	0	0	0	0	0
705	5.20	0	0	0	0	0	0
706	6.1	0	0	0	0	0	0
801	1.7	5	0	9	67	0	114
802	1.06	63	0	67	67	0	71
803	2.6	212	0	551	67	0	174
804	2.1	5	0	11	67	0	141
805	5.4	9	0	49	16	0	86
901	11.5	0	0	0	0	0	0
1001	0.8	5	0	4	13	0	10
1101	0.8	35	0	28	24	0	19
1201	3.4	0	0	0	0	0	0
1301	10.1	0	0	0	0	0	0
1302	24.9	0	0	0	0	0	0
Total	296	Total financial benefit (£)		27268	Total economic benefit (£)		11737
		Benefit (£/ha)		92	Benefit (£/ha)		40

5.2 Maintenance Costs

Maintenance activities on the Pilling Water involve the annual control of in-channel and bankside vegetation. Actual annual costs for the study reach varied according to need. Adjusted to 1995 prices, they were £ 8300, £ 12158 and £ 10985 in 1992, 1993, and 1994 respectively, equivalent to an average of £ 10384. In addition, about £ 6000 is spent every 8 years on desilting the main channel, equivalent to an average annual cost at 6 % interest of £ 960. Total average maintenance costs are therefore about £ 11344 in 1995 prices.

5.3 Scheme Appraisal

The estimated benefits attributable to maintenance can be compared with estimated costs to determine the justification for expenditure. Because the main maintenance activity is performed annually, the appraisal involves a simple comparison of annual benefits and costs.

Table 5.7 Maintenance scheme appraisal: Pilling Water

Average Annual Benefit (£)	Average Annual Benefits (£)	Average Annual Costs (£)	Benefit: Cost Ratio
Modelled Estimates			
Financial Prices	13200	11344	1.16
Economic Prices	8080	11344	0.71
Farmer Estimates in an Average Year			
Financial Prices	27268	11344	2.40
Economic Prices	11737	11344	1.04

Table 5.7 shows that the existing maintenance scheme is viable in financial terms. Benefits to farmers exceed the costs of the scheme. In economic terms, however, the benefits to the economy do not appear to fully recover the costs of maintenance. Farmer assessment gave an average annual financial benefit of £ 27268 (£ 92/ha) and an economic benefit of £ 11737 (£ 40/ha). The annual benefit : cost ratio is thus 2.4 and 1.04 in financial and economic terms respectively.

The application of MAFF Guidance Notes on economic analysis suggests that the maintenance programme is not justified. This conclusion must be interpreted cautiously as discussed in the R&D Note 456 Section 2.7.2.

6 ENVIRONMENT

6.1 Introduction

The environmental quality of the Pilling Water is outlined in this chapter. Reference is made to river corridor surveys, public consultation and farmer assessment.

6.2 River Corridor Survey

A river corridor survey was completed for each 500 m stretch of river within the study reach prior to the maintenance of 1992. The river corridor survey methodology developed by the Nature Conservancy Council (NCC, now English Nature, EN) was used. A record card and sketch map was completed for each 500 m section. Both the record cards and maps are presented in Appendix II.

Following maintenance, a vegetational survey was completed. This concentrated on the position and type of aquatic vegetation present within the channel. A full post-maintenance river corridor survey was not necessary as the channel dimensions were not altered during maintenance. The post-maintenance survey is presented in Appendix II.

6.3 Public Consultation

An annual report detailing all the heavy maintenance operations (e.g. dredging, resectioning etc.) to be carried out within the region during the following year is produced and circulated within the NRA Departments. A copy is also presented to English Nature, RSPB and other local interested groups.

Comments can be made on the programme and objections to the work raised. As a result, the planned maintenance work may be modified. As yet, river maintenance in the form of weed clearance is not a priority for the 'in house' conservationists due to resources constraints. However, if weed maintenance is to take place within a designated area of high environmental value, such as within a Site of Special Scientific Interest (SSSI), river corridor surveys are carried out and recommendations made.

6.4 Farmer Assessment

Each farmer within the benefit area was asked their opinion as to the effect river maintenance would have on the environmental features of the river and its banks. No environmental features were thought to be affected by the works.

All the farmers were aware of wildlife within the river channel and its vicinity. Eels, roach, stickleback, weasels and wildfowl were reported as being abundant. Flowers and butterflies were also noted by the farmers as being of interest. Crabs have also been seen by one farmer on various occasions.

6.5 Channel and Bank Quality

The environmental quality of the river channel and banks has been determined by following the procedure outlined in the 'Guidelines for the Justification of River Maintenance' (R&D Note 511) produced within the framework of the NRA R&D Note 456 (River Maintenance Evaluation).

The quality of both the river channel and banks is classed as low. There is no transitional zone between the channel edge and the river at times of low flow, the sediment is uniform, no riffles and pools are present and the channel is of a uniform habitat.

The banks are of uniform structure, consisting of predominantly one vegetation type and no trees or scrub. Bank width is typically 2 to 5 m. The banks consist of uniform grass cover which is mown. The bank structure is not varied and there are no dense stands of single species or flowering herbs.

7 CONCLUSIONS

7.1 Scheme Appraisal

The existing maintenance scheme of annual weed clearance, and desilting every eight years is viable in financial terms. The average annual benefit of maintenance in terms of its prevention in a deterioration in drainage status and increase in flooding is £ 13 200. Average annual maintenance costs are approximately £ 11 344. The benefit : cost ratio is therefore 1.16.

7.2 Guidelines for River Maintenance

The 'Guidelines for the Justification of River Maintenance' (R&D Note 511), produced as a result of this River Maintenance Evaluation Study were used to provide an alternative method for justification of river maintenance on the Pilling Water.

According to this method, the benefit : cost ratio is 0.2. This value is less than that derived from the detailed analysis; the results of which are summarised in Section 7.1. However, under both systems of analysis, the maintenance scheme is not justifiable in economic terms. The differences in result may be due to the fact that average channel dimensions were taken for the whole study reach. If the study reach is divided up into sub-reaches, the benefit : cost ratio produced using the Guidelines is more comparable to that produced under detailed analysis.

7.3 Impact of Maintenance on Channel Vegetation

The types of vegetation found within the Pilling Water are discussed in Section 1.9. The impact of the submerged and emergent vegetation on channel capacity is also discussed. Different vegetation types respond to maintenance in different ways.

The Canadian Pondweed (*Elodea*) reproduces through a system of rhizomes (underground stems). The current method of maintenance - regular cutting, actually stimulates regrowth of this vegetation. The waterweed (*Potamogeton*) is a rooted plant. Desilting of the channel every few years is necessary in order to remove the rhizomes and to reduce the *Potamogeton* seed bank in the channel sediments.

The current maintenance regime therefore is appropriate in controlling the channel vegetation. The vegetation is cut and removed from the channel annually and the channel is desilted every five to 10 years. This reduces the rhizome and seed bank in the channel sediments.

7.4 Maintenance Best Practice

The 'best practice' vegetation maintenance methods for the Pilling Water were determined using the procedures outlined in the Guidelines (R&D Note 511), produced as a result of the Environmental Impact Assessment Study.

Channel

Best practice maintenance operations for emergent weed are identified as :

- Biennial cutting;
- Cutting on a 3 to 5 year rotation; and,
- Desilting / raking at an interval of 2 to 7 years.

Best practice maintenance operations for floating and submerged weed are identified as :

- Annual cutting in the autumn;
- Biennial cutting; and,
- Cutting on a 3 to 5 year rotation.

All these maintenance operations should be selective, concentrating on those areas which are particularly choked by vegetation or areas in which the weed is liable to cause an obstruction, hazard or restriction to flow.

Since the beginning of this study, annual weed maintenance in the summer / autumn has taken place. In the lower 0.75 km of the study reach, 75 % of the vegetation is removed. In the remainder of the reach, 100 % of the vegetation is removed - the maintenance in this area is not selective. Generally, the maintenance regimes recommended as best practice in environmental terms for vegetation management are currently being applied to this reach of the Pilling Water. However, if some vegetation were left un-cut along the channel margins this would improve the environmental quality of the channel.

Bank

Best practice maintenance operations for bank vegetation are identified as :

- Light grazing.

The majority of the banks in the grassland areas are grazed by sheep and cattle and are flail mown. In arable areas, the banks are flail mown and not grazed. Grazing regimes are relatively intensive and if the bank is un-fenced, the bank vegetation remains short and uniform in structure.

If the bank maintenance regime recommended as best practice in environmental terms were implemented, the grazing intensity of the banks would be reduced. This may entail the fencing of all banks adjacent to the watercourse.

7.5 Recommendations

It is recommended that further research examines :-

- the impact of a reduced maintenance frequency on land drainage and flooding within the benefit area;
- the impact of reduced channel maintenance on channel environmental quality; and,
- the impact of cutting the vegetation on one bank only on channel hydraulics, flooding, land drainage and environmental quality.

7.6 Epilogue

This report has assessed the impacts of the current maintenance regime on the study reach. It has been used along with other study sites to formulate guidelines on the appraisal of maintenance works and best environmental practice. These draft guidelines are summarised in Chapter 5 of the R&D Note 456 and presented in full under separate covers.

8. REFERENCES

Jarvis, R.A. Bendelow, V.C. Bradley, R.I. Carroll, D.M. Furness, R.R. Kilgour, I.N.L. and King, S.J. (1984). Soils and their Use in Northern England. SSEW, Harpenden.

MAFF (1993). Farm Incomes in the UK, 1991/92 Edition (1993). HMSO, London.

MAFF (1993). Project Appraisal Guidance Notes. HMSO, London.

Met Office (1979). Monthly and Annual Totals of Rainfall 1969 for the UK. The Met Office, Bracknell, Berks.

NERC (1975). Flood Studies Report. NERC, London.

Nix, J (1994). Farm Management Pocket Book, 25th ed. 1994/95., MAFF, HMSO, London.

Spencer-Jones, D and Wade, M (1986). Aquatic Plants - a guide to recognition. ICI Professional Products, Surrey.

Map: Agricultural Land Classification, 1: 250 000 Series. Northern Region, MAFF (1976), HMSO, London.

Map: Landranger 102, Preston, Blackpool and Surrounding Area. 1: 50 000, Ordnance Survey, Southampton.

APPENDIX I

Example of input and output data for the watertable model

Pilling Water
Block Number 901
Cross-section 1

	Input Data	Output Data
Week 1993	River height (m AOD)	Watertable height (m AOD)
1	2.94	3.35
2	3.05	3.37
3	3.05	3.39
4	3.25	3.44
5	2.95	3.35
6	3.16	3.28
7	2.76	3.23
8	3.20	3.22
9	3.16	3.19
10	3.18	3.16
11	3.30	3.19
12	3.30	3.19
13	3.30	3.23
14	2.89	3.37
15	2.89	3.27
16	3.25	3.30
17	3.13	3.26
18	3.06	3.15
19	3.20	3.23
20	3.26	3.26
21	3.20	3.27
22	3.26	3.26
23	3.00	3.23
24	3.00	3.18
25	2.95	3.11
26	3.05	3.03
27	3.05	3.00
28	3.02	3.16

Example of drainage status classification, Pilling Water

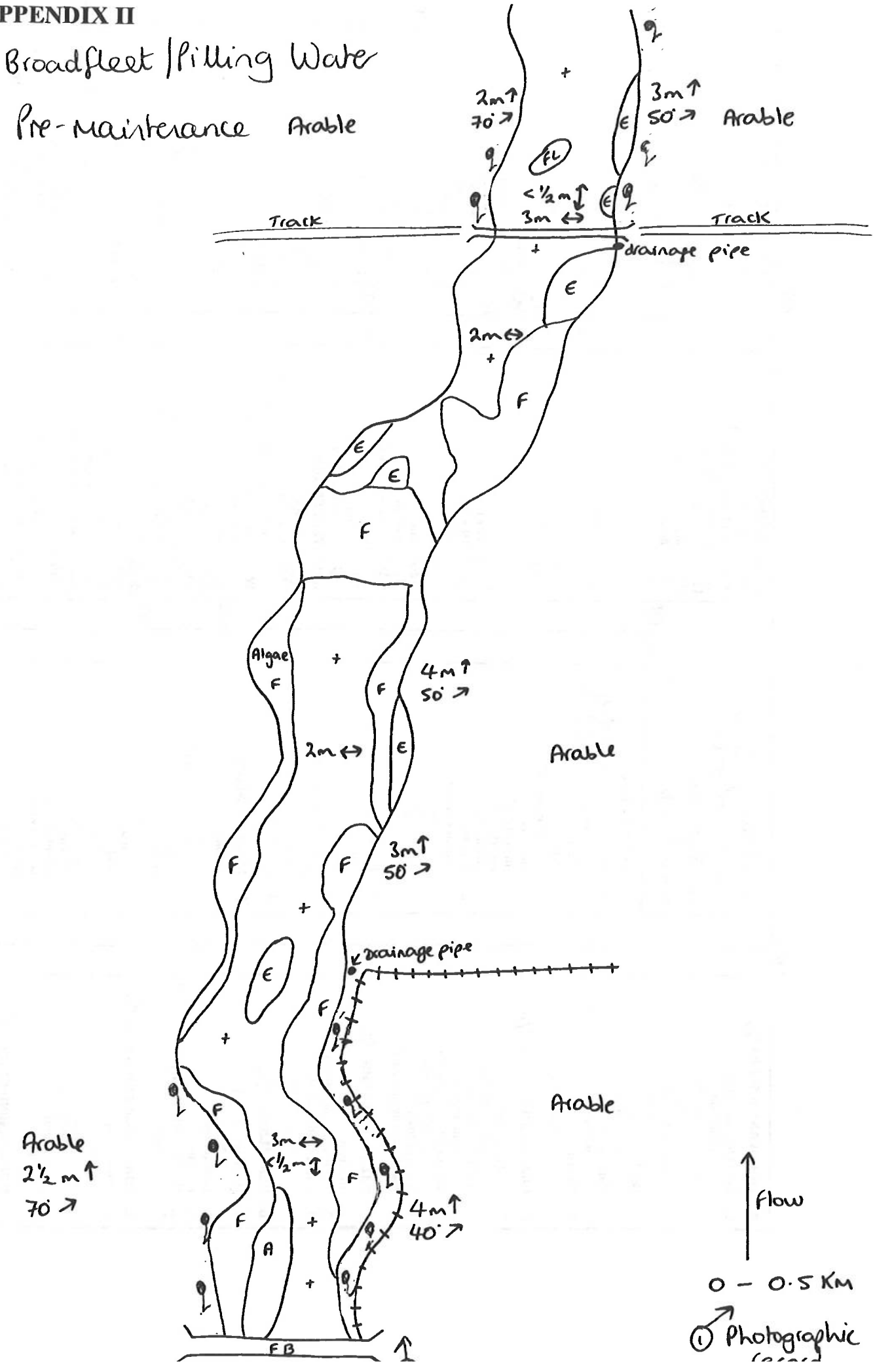
With maintenance

Block 901	Watertable depth (m)	No. of weeks 1993	Spring 1993	No. of weeks	Summer 1993	No. of weeks	Autumn 1993	No. of weeks
>0.5	3.11	41	3.11	10	3.11	13	3.11	13
0.3><0.5m	3.31	6	3.31	2	3.31	0	3.31	0
<0.3m	3.61	5	3.61	1	3.61	0	3.61	0
Drainage status classification, according to time watertable is within the G, B, VB drainage bands				Bad		Good		Good

Without maintenance

	Watertable depth (m)	No. of weeks 1993	Spring 1993	No. of weeks	Summer 1993	No. of weeks	Autumn 1993	No. of weeks
>0.5	3.11	13	3.11	0	3.11	5	3.11	7
0.3><0.5m	3.31	30	3.31	12	3.31	8	3.31	6
<0.3m	3.61	9	3.61	1	3.61	0	3.61	0
Drainage status classification, according to time watertable is within the G, B, VB drainage bands				Bad		Bad		Bad

APPENDIX II


Broadfleet / Pilling Water
Pre-Maintenance
Arable
2m↑ 70°↗
3m↑ 50°↗
Arable
FL
<½m↕ 3m↔
Track
Track
drainage pipe
2m↔
F
Algae
4m↑ 50°↗
2m↔
Arable
3m↑ 50°↗
drainage pipe
Arable
Arable 2½m↑ 70°↗
3m↔ <½m↕
4m↑ 40°↗
FB
Flow
0 – 0·5 KM
Photographic

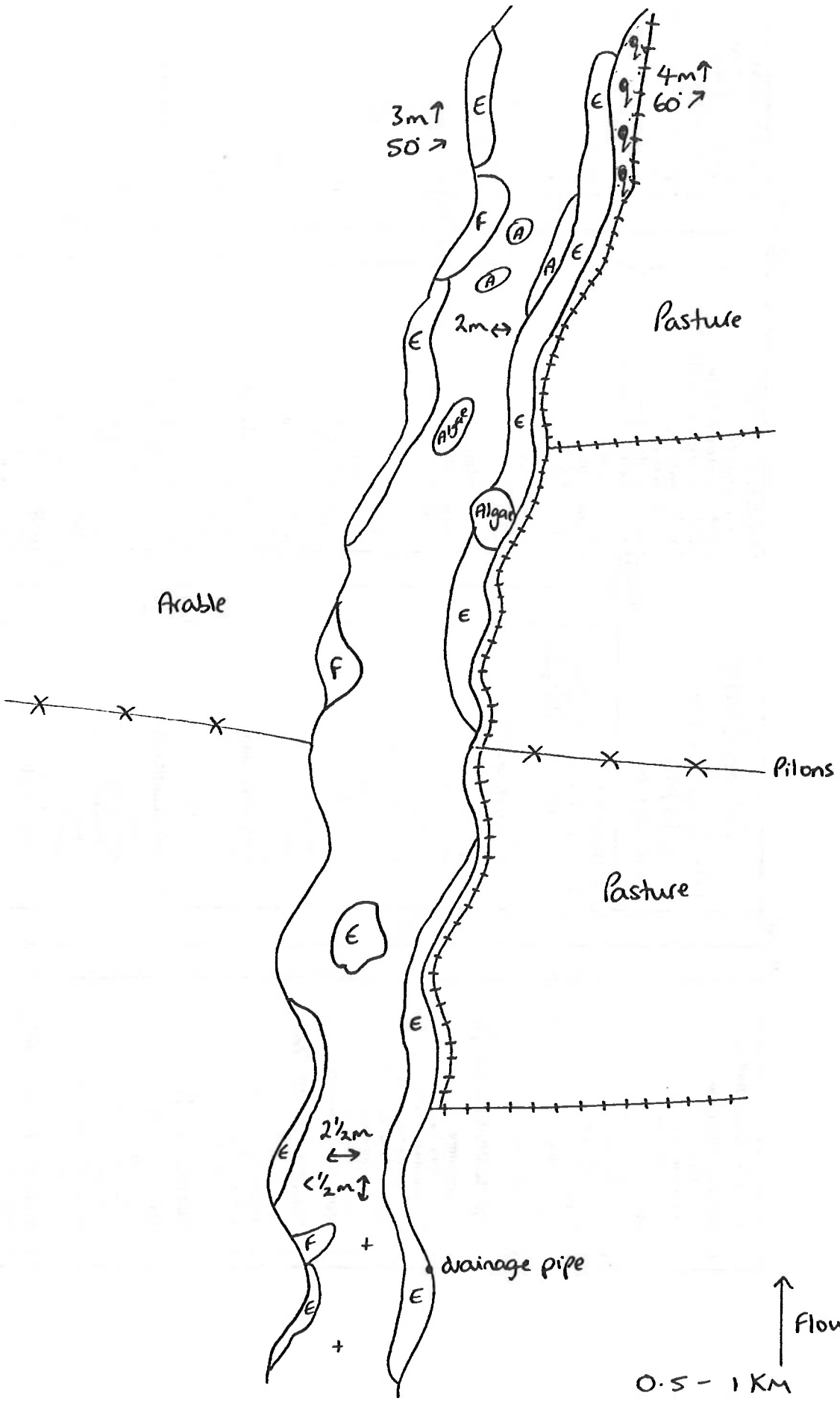
RIVER Pilling Water
Km No. 0-0-5 km.
Date 21/5/92
Surveyor JALD.

	LB	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved		
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

	LB	RB
G. OPEN WATER		
1. Standing - canal + % of adj land in each stretch		
canal =		
ditch		
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %.		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable	100	100
amenity grassland		
ephemeral/short herb		
hedge +		
hedge =		
fence on bank		20
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road	1	1
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shell %		
solid earth cliff	1M↑	
soft earth cliff	>80°	
rock cliff		
artificial		
FB flood bank adj.		
FB flood bank set back		
levee		
Height <1m		
1-<2m		
>2m	100	100
Width <1m		
1-<2.5m		70
2.5-<5m	100	30
>5m		
Slope <30°		100
30-<60°	100	
60-<90°		
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow - recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %.		
Sparse Scrub/shrubs %.		
Reed/Sedge %.		
Dense open %.	10	20
Sparse open %.		
Reseeded or mown %.		
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
width <1m rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

RIVER HABITATS		RIVER
bridges/500m		2
weirs/500m		
locks/500m		
inlet/500m		
Depth <.25m	%	100
.25-<.5		
0.5-<1.0		
>1.0m		
Width <1		100
1-<5		
5-<10		
10-<20		
>20		
Substrates		
BR bed rock		
b boulders		
c cobbles		
p pebbles		
g gravel		
s sand		
si silt/mud		100
cl clay		
peat		
Habitats and Flow		
P pool		100
slack		
riffle		
rapids		
run		
waterfall		
protruding rocks		
Margins		
shingle ± bare		
shingle, vegetated		
mud		
sand		
FLORA %		
emergent veg < 1m wide		20
emergent 1-2m wide		
emergent >2m wide		
total veget. area		30
B bryophytes		total to 100%
E emergents	10	
A submerged	10	
F floating	80	
algae % of stretch		1


3m↑
50°↗
4m↑
60°↗
2m↔
Pasture
Algae
Algae
Arable
Pilons
Pasture
2½m
↔
<½m↕
drainage pipe
Flow
0·5 - 1 KM

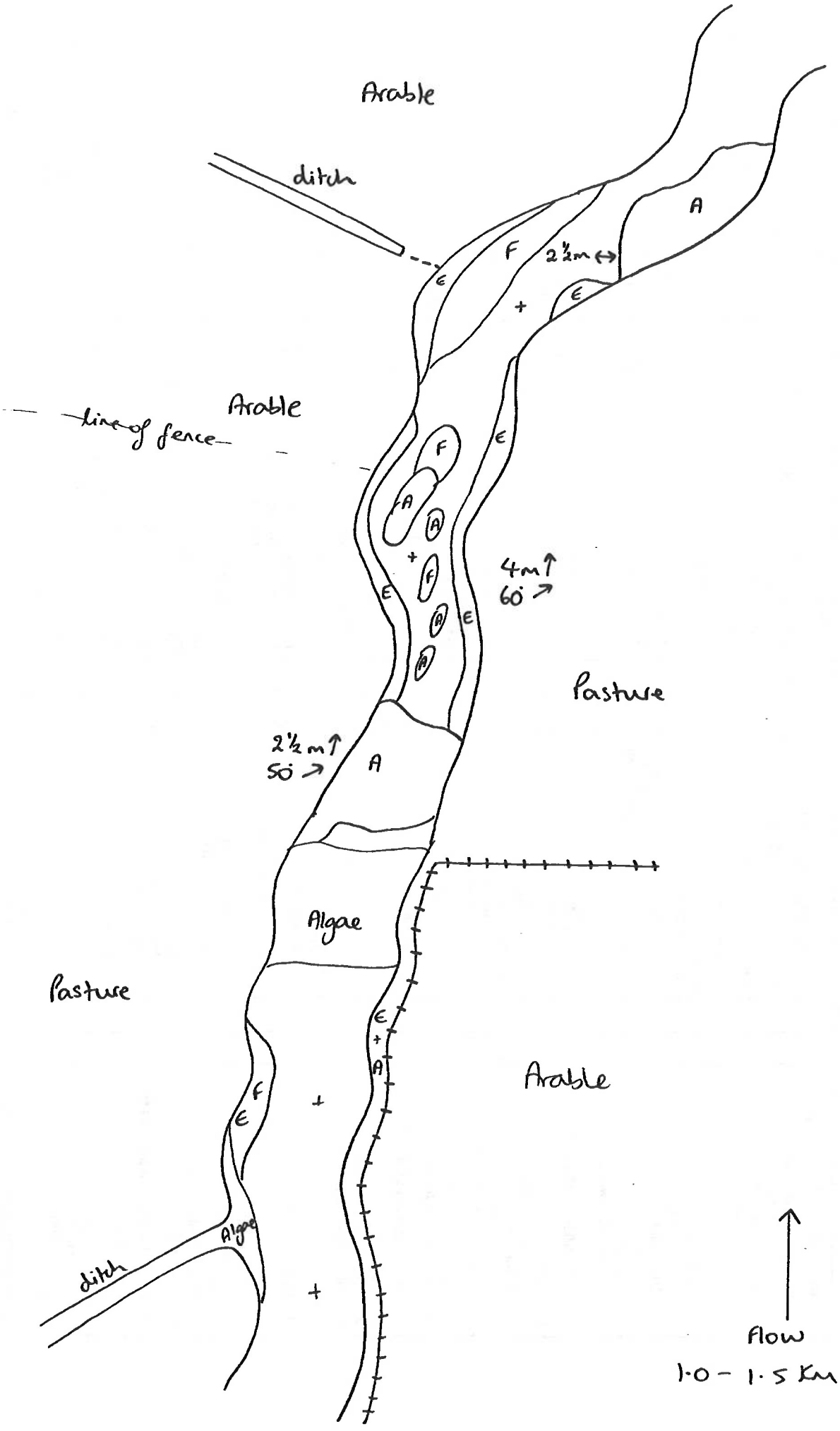
RIVER Pilling Water
Km No. 0.5–1 km
Date 21/5/92
Surveyor JALD

	LB	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved		100
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

	LB	RB
G. OPEN WATER		
1. Standing - canal +	% of adj land in each stretch	
canal =		
ditch		
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %.		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		100
amenity grassland		
ephemeral/short herb		
hedge +		
hedge =		
fence on bank		80
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
sheet %		
solid earth cliff		
soft earth cliff		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m		
1-<2m		
>2m	100	100
Width <1m		
1-<2.5m		
2.5-<5m	100	
>5m		100
Slope <30°		
30-<60°	100	100
60-<90°		
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow - recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %.		
Sparse Scrub/shrubs %.		
Reed/Sedge %.		
Dense open %.		80
Sparse open %.		
Reseeded or mown %.		
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

RIVER HABITATS		RIVER
bridges/500m		
weirs/500m		
locks/500m		
inlet/500m		
Depth <.25m	%	100
.25-<.5		
0.5-<1.0		
>1.0m		
Width <1		100
1-<5		
5-<10		
10-<20		
>20		
Substrates		
BR bed rock		
b boulders		
c cobbles		
p pebbles		
g gravel		
s sand		100
silt/mud		
clay		
peat		
Habitats and Flow		
pool		
slack		100
riffle		
rapids		
run		
waterfall		
protruding rocks		
Margins		
shingle ± bare		
shingle, vegetated		
mud		
sand		
FLORA %		
emergent veg < 1m wide		30
emergent 1-2m wide		60
emergent >2m wide		
total veget. area		20
B bryophytes		
E emergents	50	
A submerged	10	
F floating	40	total to 100%
algae % of stretch		2


Arable
ditch
A
F
2½m
E
Arable
line of fence
F
A
A
F
4m
60°
E
E
Pasture
2½m
50°
A
Algae
Pasture
E
A
Arable
F
E
Algae
ditch
Flow
1·0 – 1·5 Km

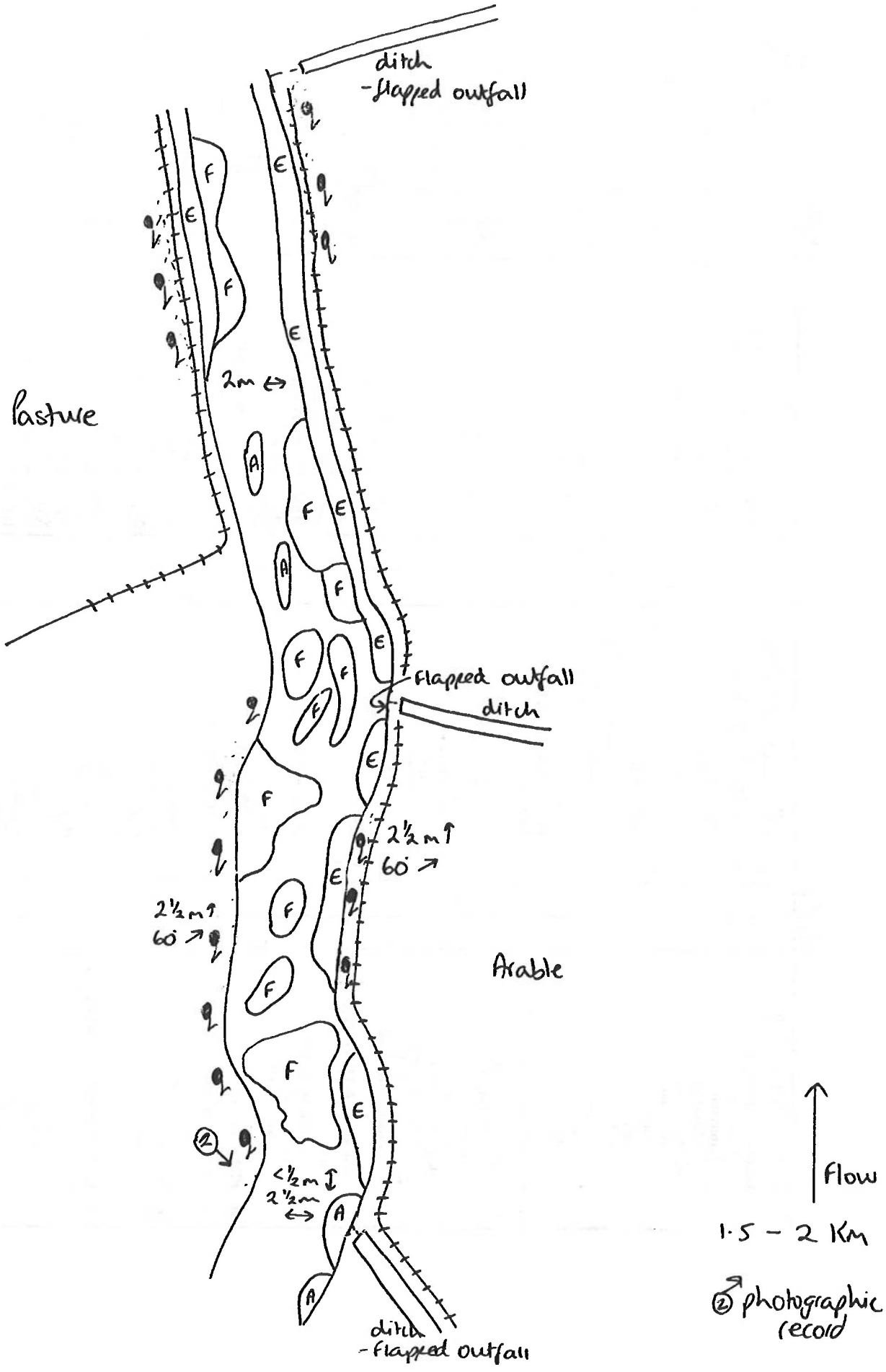
RIVER Pilling Water
Km No. 1 – 1·5 KM
Date 21/5/92
Surveyor JALD

	LB	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved	60	60
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

	LB	RB
G. OPEN WATER		
1. Standing - canal + (% of adj land in each stretch)		
canal =		
ditch	1	
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1·5m		
5·10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable	40	40
amenity grassland		
ephemeral/short herb		
hedge +		
hedge =		
fence on bank		40
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shell %		
solid earth cliff (1M↑)		
soft earth cliff (>80°)		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m		
1·<2m		
>2m	100	100
Width <1m		
1·<2.5m		
2.5·<5m	100	
>5m		100
Slope <30°		
30·<60°	100	100
60·<90°		
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow - recept pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %.		
Sparse Scrub/shrubs %.		
Reed/Sedge %.		
Dense open %.		
Sparse open %.		
Reseeded or mown %.		
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

	RIVGR
RIVER HABITATS	
bridges/500m	
weirs/500m	
locks/500m	
inlet/500m	
Depth <.25m %	100
.25·<.5	
0.5·<1.0	
>1.0m	
Width <1	100
1·<5	
5·<10	
10·<20	
>20	
Substrates	
BR bed rock	
b boulders	
c cobbles	
p pebbles	
g gravel	
s sand	100
+ silt/mud	
clay	
peat	
Habitats and Flow	
pool	
slack	100
riffle	
rapids	
run	
waterfall	
protruding rocks	
Margins	
shingle ± bare	
shingle, vegetated	
mud	
sand	
FLORA %	
emergent veg < 1m wide	10
emergent 1·2m wide	
emergent >2m wide	
total veget. area	30
B bryophytes	
E emergents 10	
A submerged 20	total to 100%
F floating	
algae % of stretch	9


ditch
-flapped outfall
Pasture
2m ↔
Flapped outfall
ditch
2½m ↑
60° ↗
2½m ↑
60° ↗
Arable
<½m ↕
2½m ↔
ditch
-Flapped outfall
Flow
1·5 – 2 Km
② photographic record

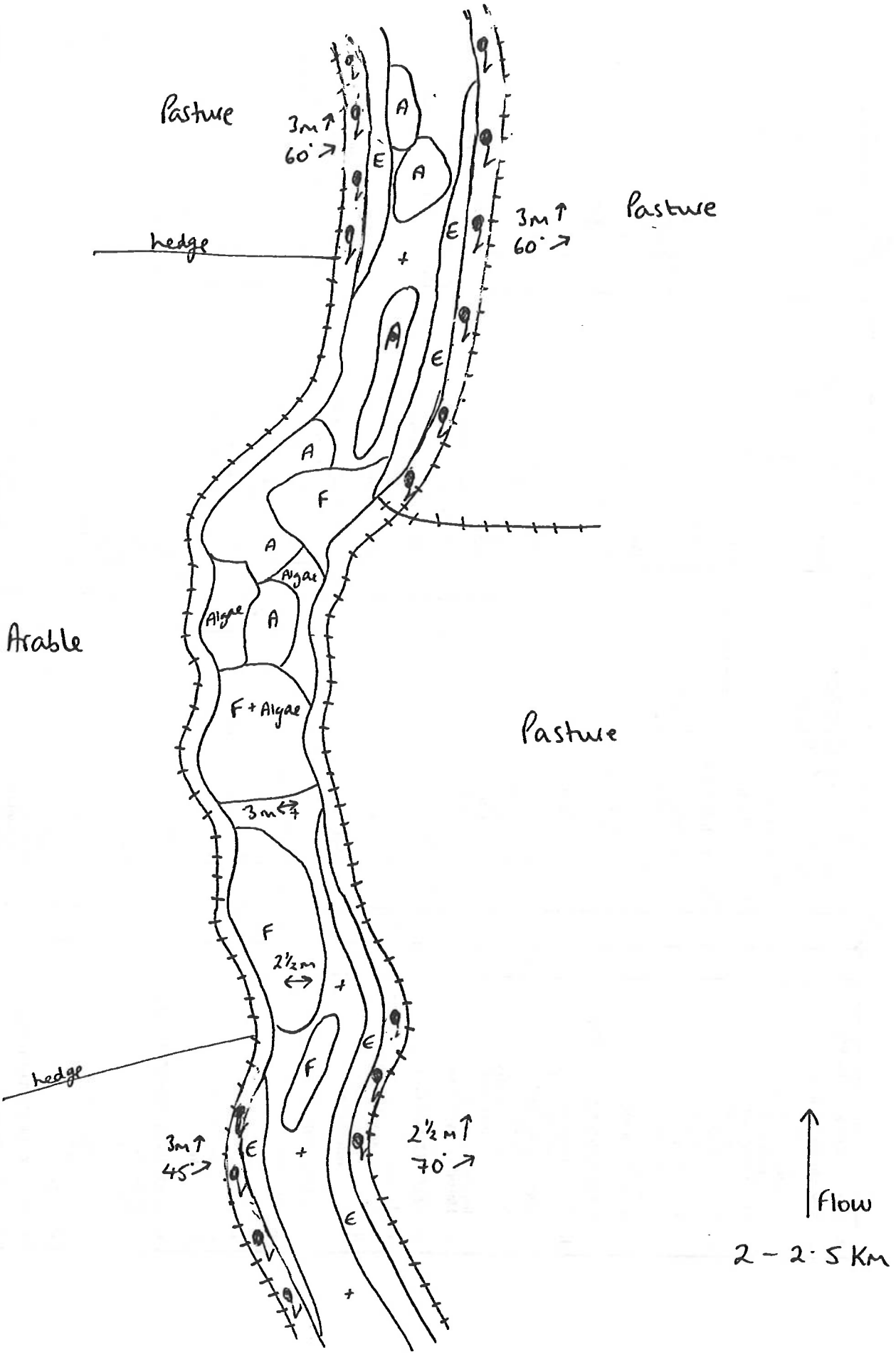
	LB	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved	40	100
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

RIVER Pilling Water
Km No. 1-5 – 2 km
Date 21/5/92
Surveyor JALD

	LB	RB
G. OPEN WATER		
1. Standing - canal + % of adj land in each stretch		
canal =		3
ditch		
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %.		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable	60	
amenity grassland		
ephemeral/short herb		
hedge +		
hedge =		
fence on bank	30	100
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

	LB	RB
BANK FEATURES %		
shell %		
solid earth cliff (1m↑)		
soft earth cliff (>80°)		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m		
1-<2m		
>2m	100	100
Width <1m		
1-<2.5m		
2.5-<5m	100	100
>5m		
Slope <30°		
30-<60°	100	
60-<90°		100
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow - except pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %.		
Sparse Scrub/shrubs %.		
Reed/Sedge %.		
Dense open %.	30	50
Sparse open %.		
Reseeded or mown %.		
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

	RIVER
RIVER HABITATS	
bridges/500m	
weirs/500m	
locks/500m	
inlet/500m	
Depth <.25m %	100
.25-<.5	
0.5-<1.0	
>1.0m	
Width <1	
1-<5	
5-<10	100
10-<20	
>20	
Substrates	
BR bed rock	
b boulders	
c cobbles	
p pebbles	
g gravel	
s sand	
si silt/mud	100
cl clay	
peat	
Habitats and Flow	
pool	
slack	100
riffle	
rapids	
run	
waterfall	
protruding rocks	
Margins	
shingle ± bare	
shingle, vegetated	
mud	
sand	
FLORA %	
emergent veg < 1m wide	20
emergent 1-2m wide	
emergent >2m wide	
total veget area	40
B bryophytes	
E emergents 30	
A submerged 15	
F floating 65	total to 100%
algae % of stretch	


Pasture
3m↑
60°↗
hedge
3m↑
60°↗
Pasture
Arable
Algae
Algae
F + Algae
Pasture
3m↔
F
2½m↔
hedge
3m↑
45°↗
2½m↑
70°↗
Flow
2 - 2·5 Km

RIVER Pilling Water
Km No. 2 - 2.5 kms
Date 21/5/92
Surveyor JALD

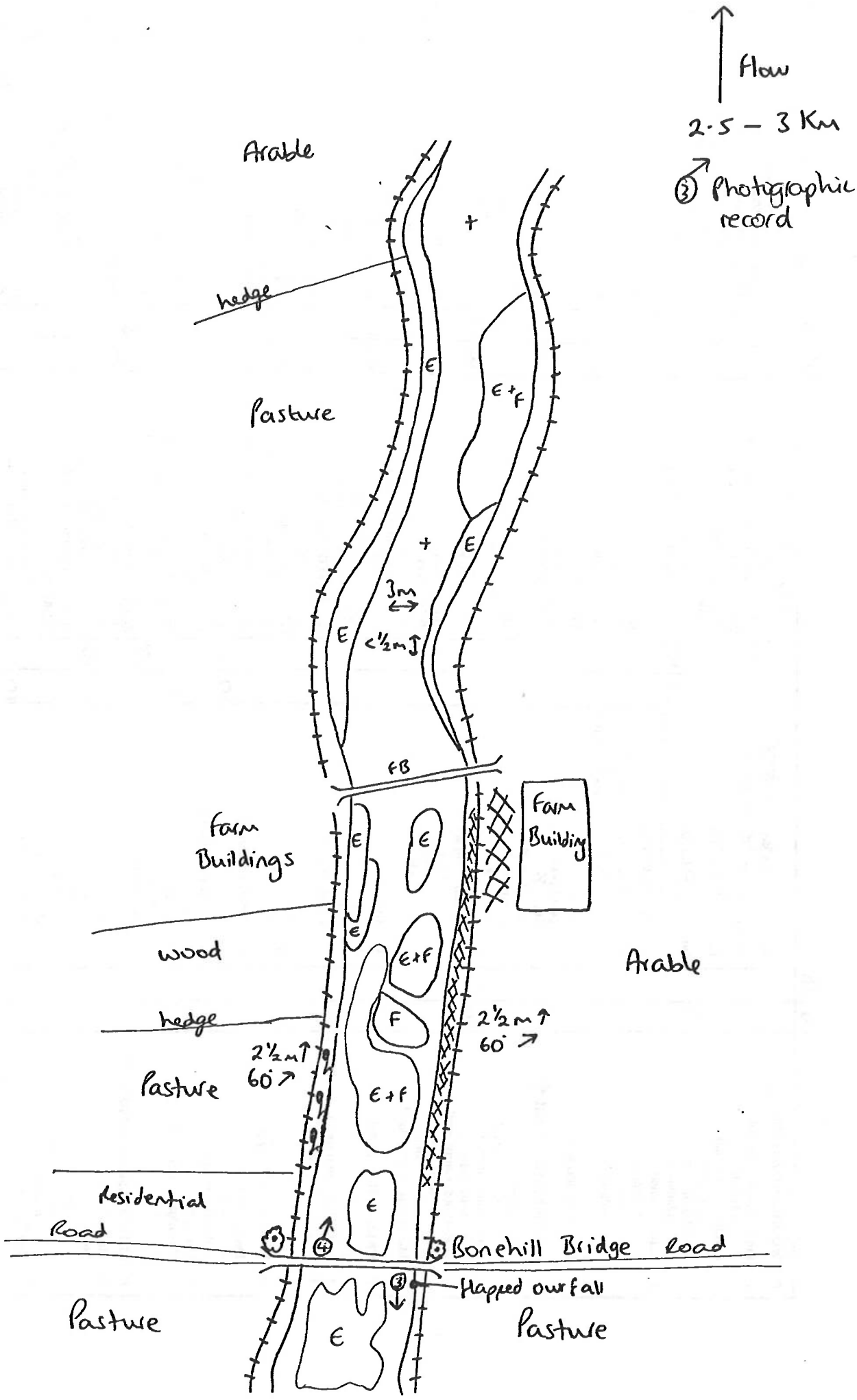
	LB	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved	30	100
semi-improved		
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

	LB	RB
G. OPEN WATER		
1. Standing - canal + (% of adj land in each stretch)		
canal =		
ditch		
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable	70	
amenity grassland		
ephemeral/short herb		
hedge +	2	
hedge =		
fence on bank	100	100
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shell %		
solid earth cliff 1m↑		
soft earth cliff >80		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m		
1-<2m		
>2m	100	100
Width <1m		
1-<2.5m	100	100
2.5-<5m		
>5m		
Slope <30°		
30-<60°	100	
60-<90°		100
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %		
Sparse Scrub/shrubs %		
Reed/Sedge %		
Dense open %	25	25
Sparse open %		
Reseeded or mown %		
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
width of top rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

RIVER HABITATS		RIVER
bridges/500m		
weirs/500m		
locks/500m		
inlet/500m		
Depth <.25m	%	
.25-<.5		100
0.5-<1.0		
>1.0m		
Width <1		
1-<5		100
5-<10		
10-<20		
>20		
Substrates		
BR bed rock		
b boulders		
c cobbles		
p pebbles		
g gravel		
s sand		
+ silt/mud		100
clay		
peat		
Habitats and Flow		
pool		
slack		100
riffle		
rapids		
run		
waterfall		
protruding rocks		
Margins		
shingle ⊥ bare		
shingle, vegetated		
mud		
sand		
FLORA %		
emergent veg < 1m wide		100
emergent 1-2m wide		
emergent >2m wide		
total veget. area		80
B bryophytes		
E emergents		
A submerged		
F floating	160	
algae % of stretch		

(total to 100%)


Flow
2·5 – 3 Km
③ Photographic record
Arable
hedge
Pasture
E
E+F
E
3m
<½m
FB
Farm Buildings
Farm Building
E
E
E
wood
E+F
Arable
hedge
F
2½m
60°
2½m
60°
Pasture
E+F
Residential
E
Road
④
Bonehill Bridge
road
③
Flapped outfall
Pasture
E
Pasture

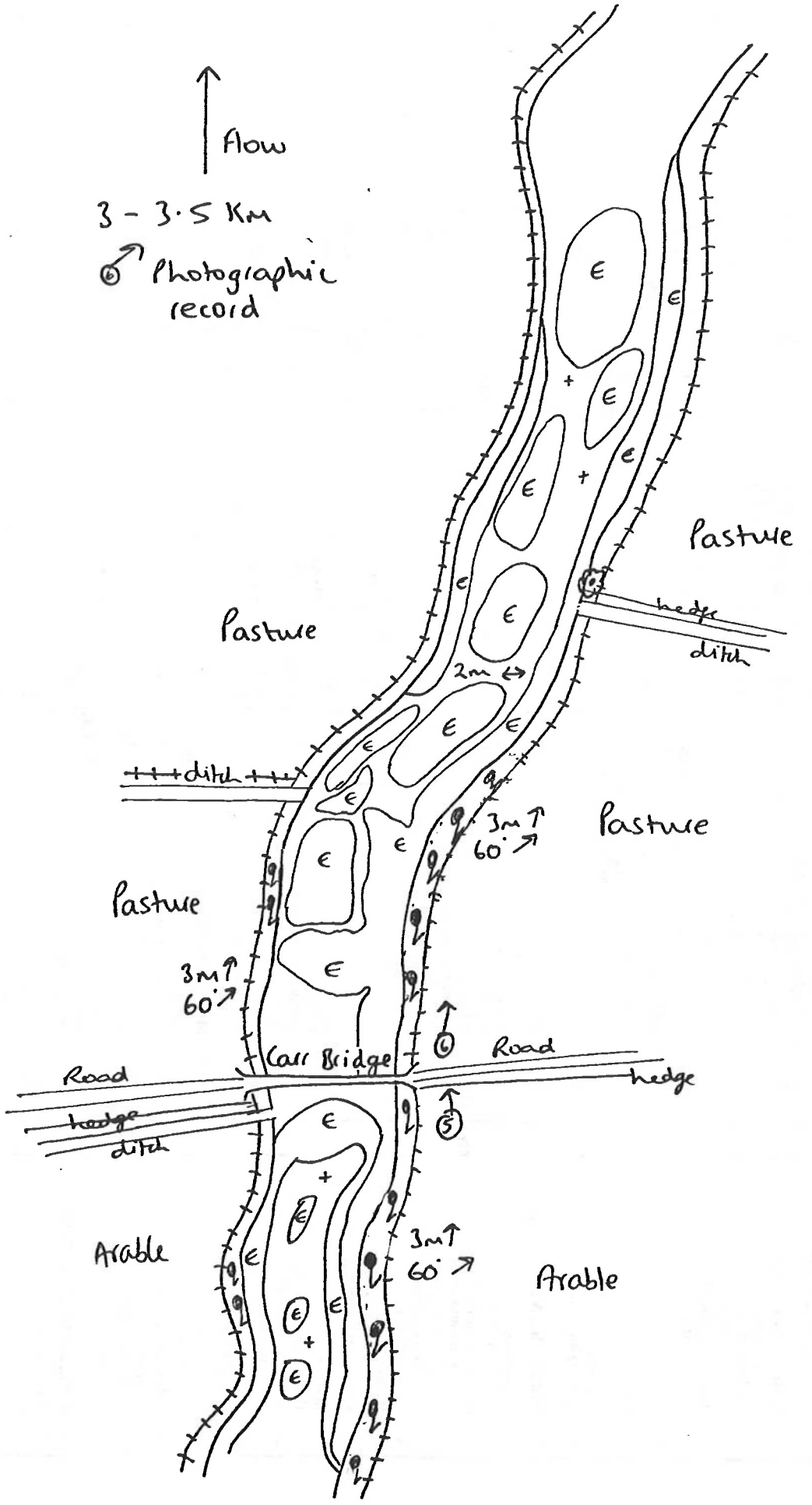
RIVER Pilling Water
Km No. 2-5 – 3 km
Date 21/5/92
Surveyor JALD.

	LB	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation	15	
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved	50	10
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

	LB	RB
G. OPEN WATER		
1. Standing - canal + % of adj. land in each stretch		
canal =		
ditch		
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream <1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable	10	79
amenity grassland		
ephemeral/short herb		
hedge +	1	
hedge =		
fence on bank	100	100
fence set back		
wall		
building	14	10
caravans		
fish farm		
silage clamp		
sewage works		
garden	10	
stick pile		
flood debris		
road	1	1
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shell %		
solid earth cliff 1m↑		
soft earth cliff >80°		
rock cliff		
artificial		
FB flood bank adj.		
FB flood bank set back		
levee		
Height <1m		
1-<2m		
>2m	100	100
Width <1m		
1-<2.5m		
2.5-<5m	100	100
>5m		
Slope <30°		
30-<60°		
60-<90°	100	100
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore	1	1
P Willow recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %		
Sparse Scrub/shrubs %		
Reed/Sedge %		
Dense open %		
Sparse open %	5	35
Reseeded or mown %		
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

RIVER HABITATS		RIVER
bridges/500m		2
weirs/500m		
locks/500m		
inlet/500m		
Depth <.25m %		
.25-<.5		100
0.5-<1.0		
>1.0m		
Width <1		
1-<5		
5-<10		100
10-<20		
>20		
Substrates		
BR bed rock		
b boulders		
c cobbles		
p pebbles		
g gravel		
s sand		
+ silt/mud		100
clay		
peat		
Habitats and Flow		
pool		
slack		100
riffle		
rapids		
run		
waterfall		
protruding rocks		
Margins		
shingle ± bare		
shingle, vegetated		
mud		
sand		
FLORA %		
emergent veg <1m wide		70
emergent 1-2m wide		10
emergent >2m wide		
total veget. area		45
B bryophytes		
E emergents	80	
A submerged		total to 100%
F floating	20	
algae % of stretch		


Flow
3 - 3·5 Km
Photographic record
Pasture
Pasture
hedge
ditch
2m
ditch
3m
60°
Pasture
Pasture
3m
60°
Carr Bridge
Road
Road
hedge
hedge
ditch
Arable
3m
60°
Arable

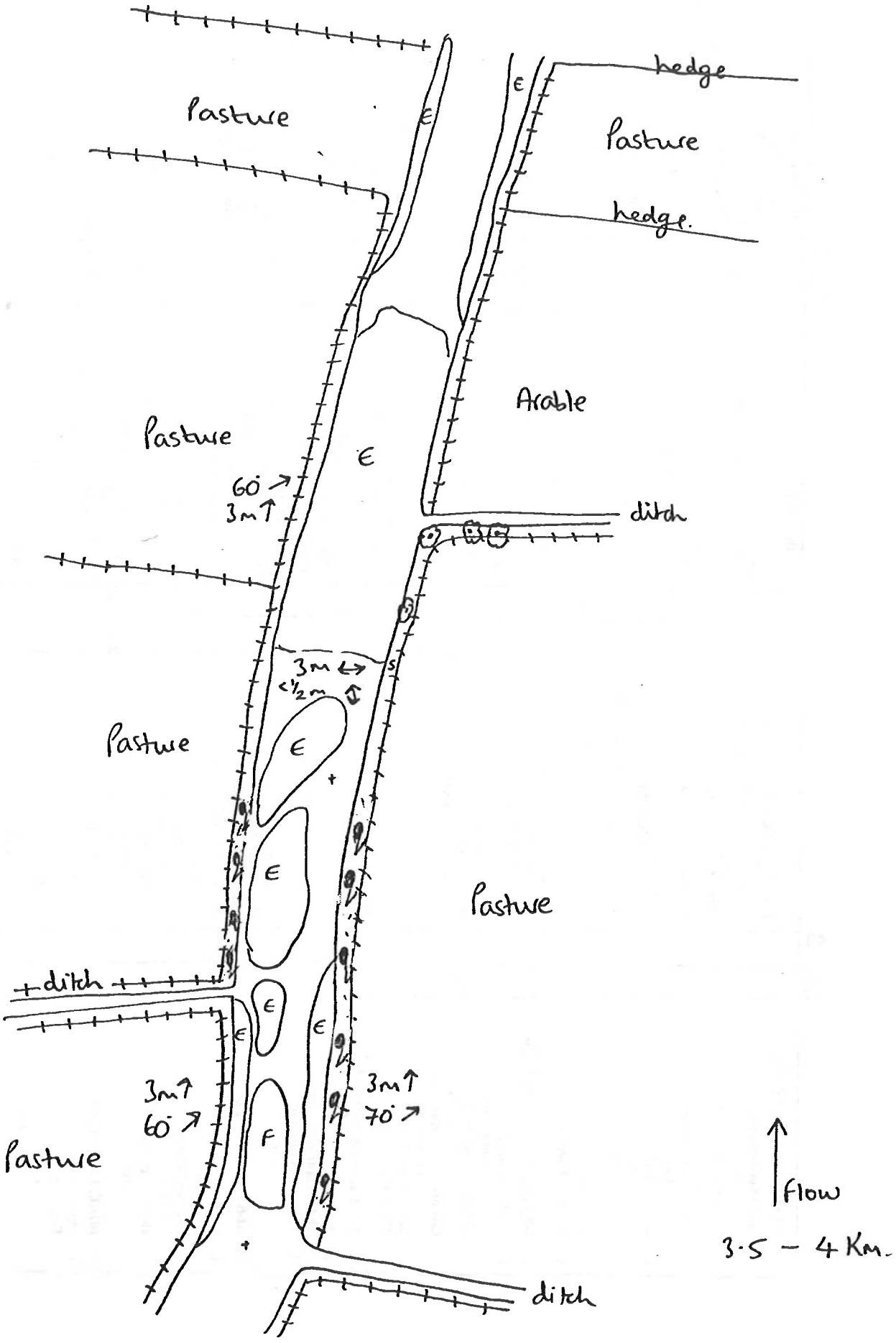
	LB	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved	80	79
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

RIVER Pilling Water
Km No. 3 – 3.5 km
Date 22/5/92
Surveyor JALD

	LB	RB
G. OPEN WATER		
1. Standing - canal +	% of adj land in each stretch	
canal =	2	1
ditch		
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %.		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable	20	21
amenity grassland		
ephemeral/short herb		
hedge +	1	1
hedge =		
fence on bank	100	100
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road	1	1
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shell %		
solid earth cliff 1M↑		
soft earth cliff >80°		
rock cliff		
artificial		
FB flood bank adj.		
FB flood bank set back		
levee		
Height <1m		
1-<2m		
>2m	100	100
Width <1m		
1-<2.5m		
2.5-<5m	100	100
>5m		
Slope <30°		
30-<60°	100	100
60-<90°		
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		1
P Willow recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %.		
Sparse Scrub/shrubs %.		
Reed/Sedge %.		
Dense open %.	5	40
Sparse open %.		
Reseeded or mown %.		
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

RIVER HABITATS		RIVER
bridges/500m		1
weirs/500m		
locks/500m		
inlet/500m		
Depth <.25m	%	100
.25-<.5		
0.5-<1.0		
>1.0m		
Width <1		100
1-<5		
5-<10		
10-<20		
>20		
Substrates		
BR bed rock		
b boulders		
c cobbles		
p pebbles		
g gravel		
s sand		100
si silt/mud		
cl clay		
peat		
Habitats and Flow		
pool		
slack		100
riffle		
rapids		
run		
waterfall		
protruding rocks		
Margins		
shingle ± bare		
shingle, vegetated		
mud		
sand		
FLORA %		
emergent veg < 1m wide		80
emergent 1-2m wide		18
emergent >2m wide		2
total veget area		60
B bryophytes		
E emergents	100	total to 100%
A submerged		
F floating		
algae % of stretch		


hedge
Pasture
Pasture
hedge.
Arable
Pasture
60°
3m
ditch
3m
<½m
Pasture
Pasture
ditch
3m
60°
3m
70°
Pasture
Flow
3·5 – 4 Km.
ditch

	LB	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic uninproved		
semi-improved		
Neutral uninproved		
semi-improved	100	100
Calcareous uninproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

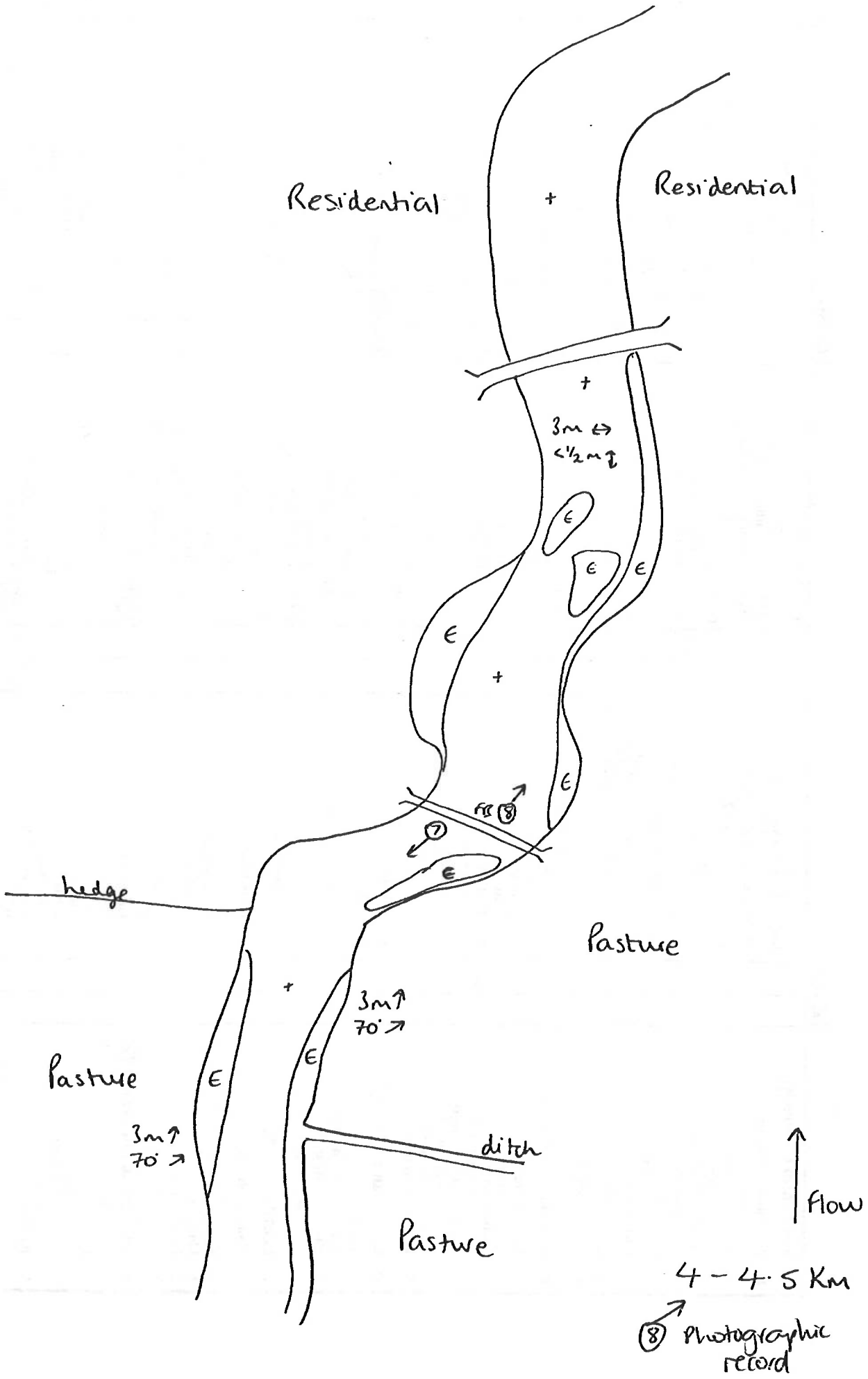
RIVER Pilling Water
Km No. 3-5 – 4 Km
Date 22/5/92
Surveyor JALD

	LB	RB
G. OPEN WATER		
1. Standing - canal + (% of adj land in each stretch)	1	1
canal =		
ditch		
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %.		
2. Running		
stream <1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		30
amenity grassland		
ephemeral/short herb		
hedge +		1
hedge =		
fence on bank	90	100
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shelf %		
solid earth cliff (1m↑)		
soft earth cliff (>80°)		
rock cliff		
artificial		
FB flood bank adj.		
FB flood bank set back		
levee		
Height <1m		
1-<2m		
>2m	100	100
Width <1m		
1-<2.5m		
2.5-<5m		
>5m	100	100
Slope <30°		
30-<60°		
60-<90°	100	100
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		4
P Willow - recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %.		
Sparse Scrub/shrubs %.		
Reed/Sedge %.		
Dense open %.	10	30
Sparse open %.		
Reseeded or mown %.		
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

	RIVER
RIVER HABITATS	
bridges/500m	
weirs/500m	
locks/500m	
inlet/500m	
Depth <.25m %	100
.25-<.5	
0.5-<1.0	
>1.0m	
Width <1	
1-<5	
5-<10	100
10-<20	
>20	
Substrates	
BR bed rock	
b boulders	
c cobbles	
p pebbles	
g gravel	
s sand	
si silt/mud	100
cl clay	
peat	
Habitats and Flow	
pool	
slack	100
riffle	
rapids	
run	
waterfall	
protruding rocks	
Margins	
shingle ± bare	
shingle, vegetated	
mud	
sand	
FLORA %	
emergent veg <1m wide	80
emergent 1-2m wide	15
emergent >2m wide	
total veget. area	50
B bryophytes	
E emergents 95	
A submerged	
F floating 5	
algae % of stretch	

(total to 100%)


Residential
Residential
3m ↔
<½m ↕
hedge
Pasture
Pasture
Pastwe
3m↑
70°↗
3m↑
70°↗
ditch
Flow
4 - 4·5 Km
⑧ Photographic record

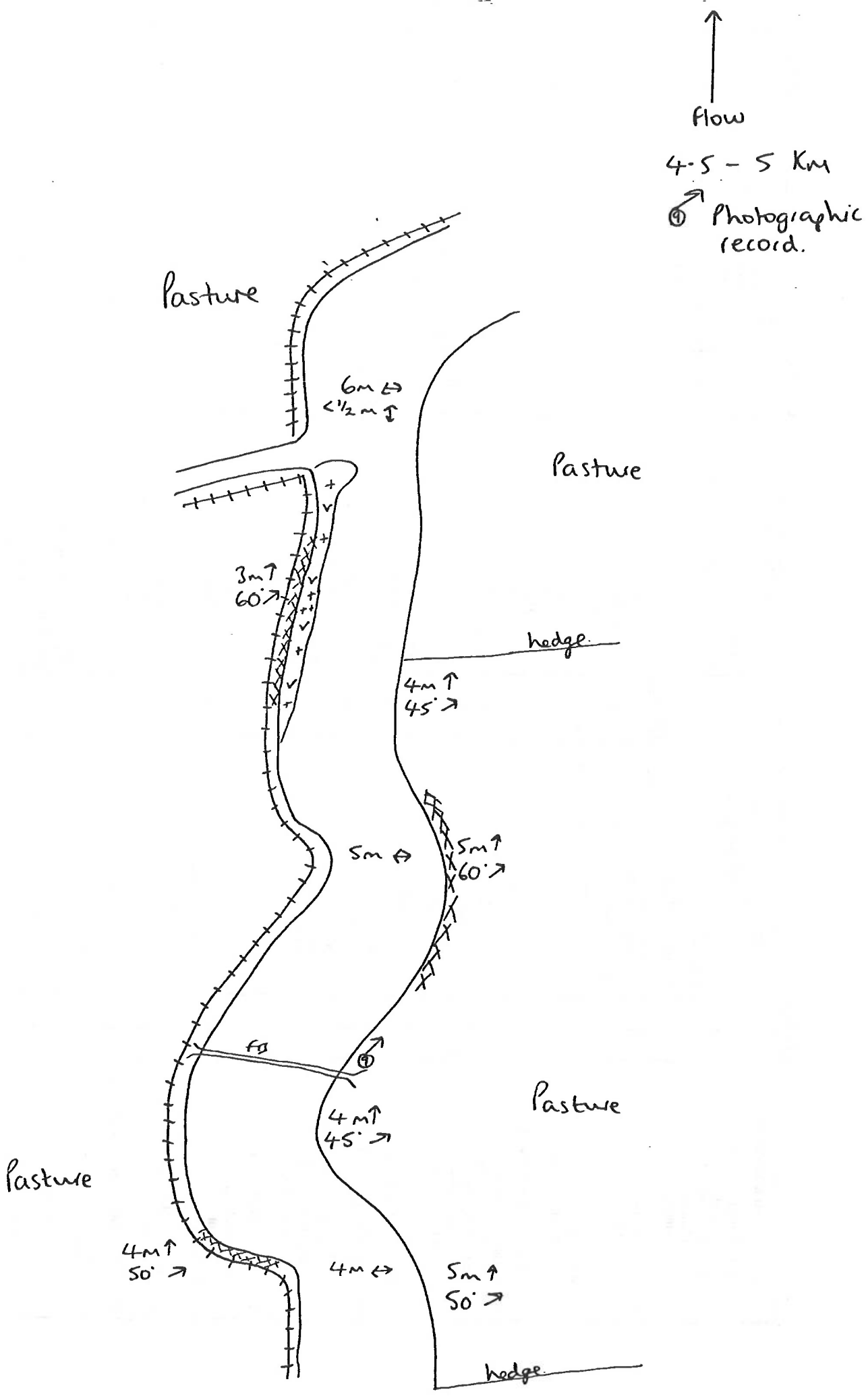
RIVER Pilling Water
Km No. 4 – 4.5 km
Date 22/5/92
Surveyor JALD.

	LB	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved	35	80
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires - bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

	LB	RB
G. OPEN WATER		
1. Standing - canal + (% of adj land in each stretch)		
canal =		1
ditch		
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		
hedge +	1	
hedge =		
fence on bank		
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden	60	20
stick pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shell %		
solid earth cliff (1m ↑)		
soft earth cliff (> 80°)		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m		
1-<2m		
>2m	100	100
Width <1m		
1-<2.5m		
2.5-<5m		
>5m	100	100
Slope <30°		
30-<60°		
60-<90°	100	100
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow - recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %		
Sparse Scrub/shrubs %		
Reed/Sedge %		
Dense open %		
Sparse open %		
Reseeded or mown %		
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

	RIVER/GR
RIVER HABITATS	2
bridges/500m	
weirs/500m	
locks/500m	
inlet/500m	
Depth <.25m %	100
.25-<.5	
0.5-<1.0	
>1.0m	
Width <1	
1-<5	
5-<10	100
10-<20	
>20	
Substrates	
BR bed rock	
b boulders	
c cobbles	
p pebbles	
g gravel	
s sand	
si silt/mud	100
cl clay	
peat	
Habitats and Flow	
pool	
slack	100
riffle	
rapids	
run	
waterfall	
protruding rocks	
Margins	
shingle ± bare	
shingle, vegetated	
mud	
sand	
FLORA %	
emergent veg < 1m wide	100
emergent 1-2m wide	
emergent >2m wide	
total veget. area	20
B bryophytes	
E emergents 100	(total to 100%)
A submerged	
F floating	
algae % of stretch	


Flow
4·5 - 5 Km
Photographic record.
Pasture
6m ↔
<½m ↕
Pasture
3m ↑
60° ↗
hedge
4m ↑
45° ↗
5m ↔
5m ↑
60° ↗
Pasture
4m ↑
45° ↗
Pasture
4m ↑
50° ↗
4m ↔
5m ↑
50° ↗
hedge

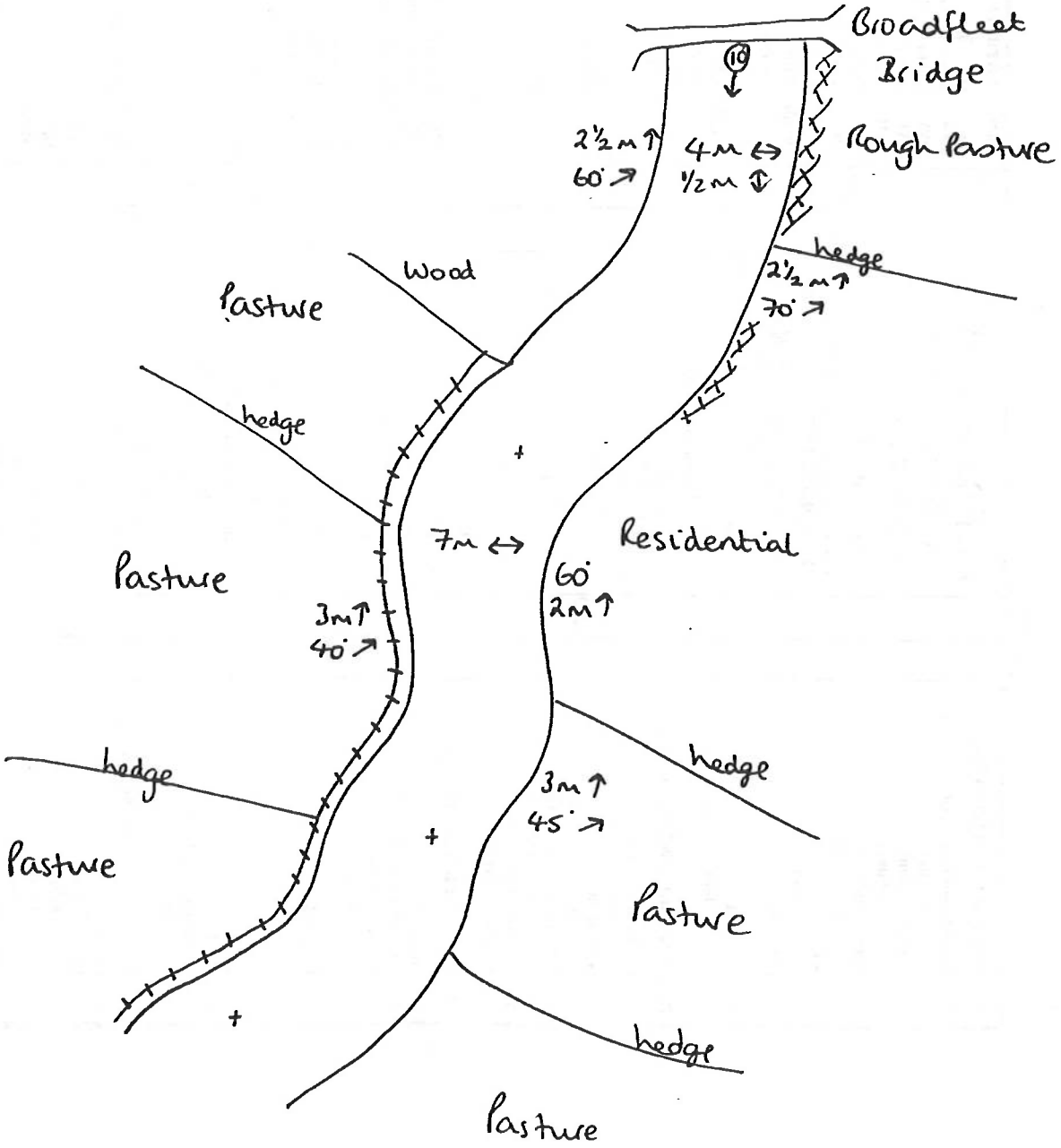
	LB	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved	100	100
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

RIVER Pilling Water
Km No. 4-5 = 5 KM.
Date 22/5/92
Surveyor JALD

	LB	RB
G. OPEN WATER		
1. Standing - canal + (% of adj land in each stretch)		
canal =		
ditch	1	
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %.		
2. Running		
stream <1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		1
hedge +		
hedge =		
fence on bank	100	
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

	LB	RB
BANK FEATURES %.		
shell %.		
solid earth cliff	1M↑	
soft earth cliff	>80°	
rock cliff		
artificial		
FB flood bank adj.		
FB flood bank set back		
levee		
Height <1m		
1-<2m		
>2m	100	100
Width <1m		
1-<2.5m		
2.5-<5m		
>5m	100	100
Slope <30°		
30-<60°	100	100
60-<90°		
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %.		
Sparse Scrub/shrubs %.		
Reed/Sedge %.	15	10
Dense open %.		
Sparse open %.		
Reseeded or mown %.		
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

	RIVER
RIVER HABITATS	
bridges/500m	1
weirs/500m	
locks/500m	
inlet/500m	
Depth <.25m %	100
.25-<.5	
0.5-<1.0	
>1.0m	
Width <1	
1-<5	
5-<10	100
10-<20	
>20	
Substrates	
BR bed rock	
b boulders	
c cobbles	
p pebbles	
g gravel	
s sand	
+ silt/mud	100
clay	
peat	
Habitats and Flow	
pool	
slack	100
riffle	
rapids	
run	
waterfall	
protruding rocks	
Margins	
shingle ± bare	
shingle, vegetated	
mud	11
sand	
FLORA %	
emergent veg <1m wide	
emergent 1-2m wide	
emergent >2m wide	
total veget. area	
B bryophytes	total
E emergents	not
A submerged	to
F floating	100%
algae % of stretch	


Flow
5 - 5·5 Km.
10 Photographic record.
Broadfleet Bridge
10
2½m↑
60↗
4m↔
½m↕
Rough Pasture
hedge
2½m↑
70↗
Wood
Pasture
hedge
7m↔
Residential
Pasture
3m↑
40↗
60
2m↑
hedge
hedge
3m↑
45↗
Pasture
Pasture
hedge
Pasture

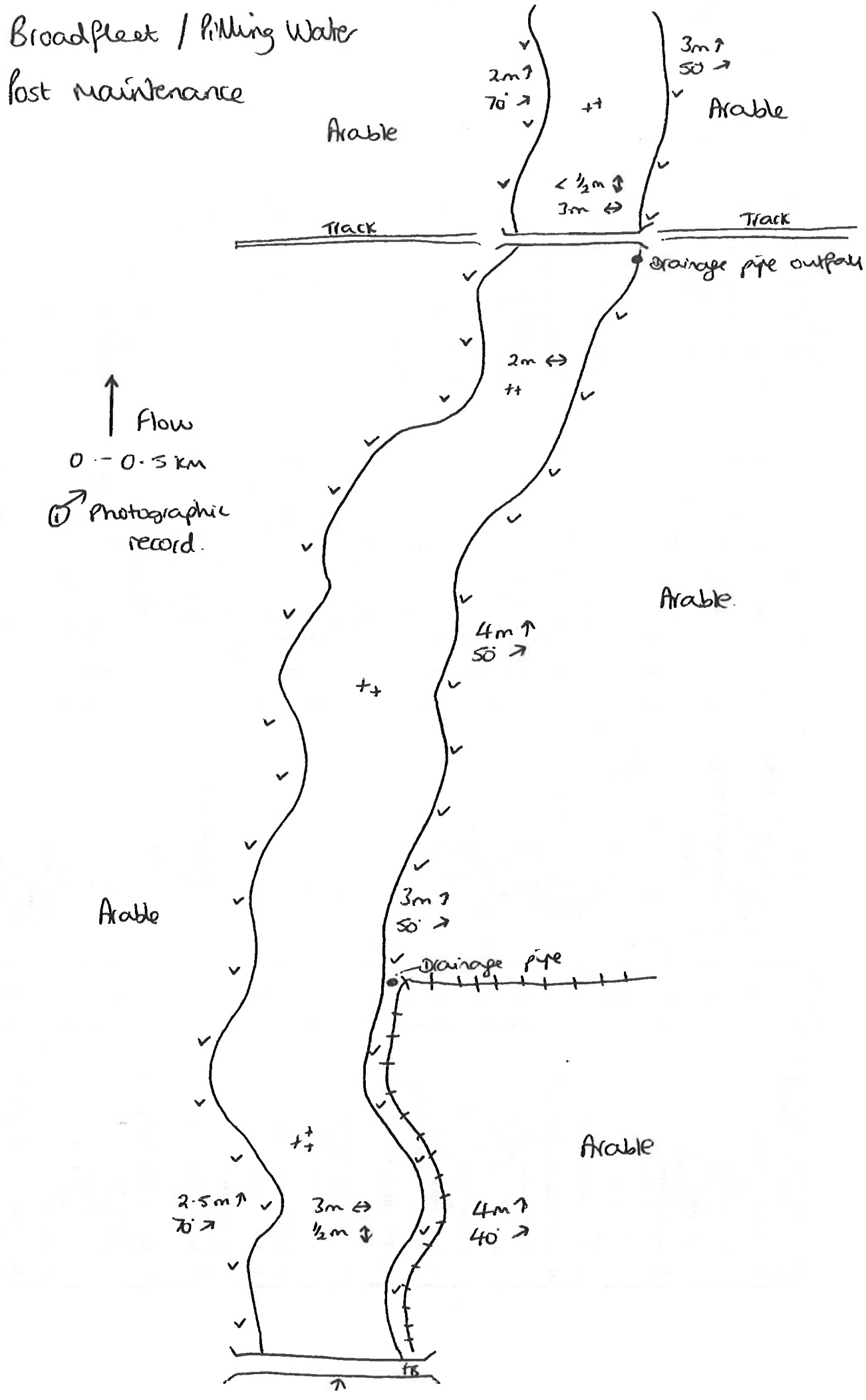
	LB	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation	20	
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic uninproved		
semi-improved		20
Neutral uninproved		
semi-improved	80	40
Calcareous uninproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

RIVER Pilling Water
Km No. 5 – 5·5 km
Date 22/5/92
Surveyor JALD.

	LB	RB
G. OPEN WATER		
1. Standing - canal + (% of adj land in each stretch)		
canal =		
ditch		
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %.		
2. Running		
stream < 1m wide		
1·5m		
5·10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		
hedge +	1	2
hedge =		
fence on bank	80	
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

	LB	RB
BANK FEATURES %		
shell %		
solid earth cliff (1m↑)		
soft earth cliff (>80°)		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m		
1·<2m		
>2m	100	100
Width <1m		
1·<2.5m		
2.5·<5m	100	80
>5m		20
Slope <30°		
30·<60°	100	30
60·<90°		70
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow - recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %.		
Sparse Scrub/shrubs %.		
Reed/Sedge %.		40
Dense open %.		
Sparse open %.		
Reseeded or mown %.		
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

	RIVER
RIVER HABITATS	
bridges/500m	1
weirs/500m	
locks/500m	
inlet/500m	
Depth <.25m %	
.25·<.5	100
0.5·<1.0	
>1.0m	
Width <1	
1·<5	
5·<10	100
10·<20	
>20	
Substrates	
BR bed rock	
b boulders	
c cobbles	
p pebbles	
g gravel	
s sand	
+ silt/mud	100
clay	
peat	
Habitats and Flow	
pool	
slack	100
riffle	
rapids	
run	
waterfall	
protruding rocks	
Margins	
shingle ± bare	
shingle, vegetated	
mud	
sand	
FLORA %	
emergent veg < 1m wide	
emergent 1·2m wide	
emergent >2m wide	
total veget. area	
B bryophytes	} total = 100%
E emergents	
A submerged	
F floating	
algae % of stretch	


Broadfleet / Pilling Water
Post Maintenance
Arable
2m ↑
70° ↗
3m ↑
50 ↗
Arable
< ½m ↕
3m ↔
Track
Track
Drainage pipe outfall
2m ↔
Flow
0 - 0.5 km
Photographic record.
Arable
4m ↑
50 ↗
3m ↑
50 ↗
Drainage pipe
Arable
2.5m ↑
70 ↗
3m ↔
½m ↕
4m ↑
40 ↗
FB

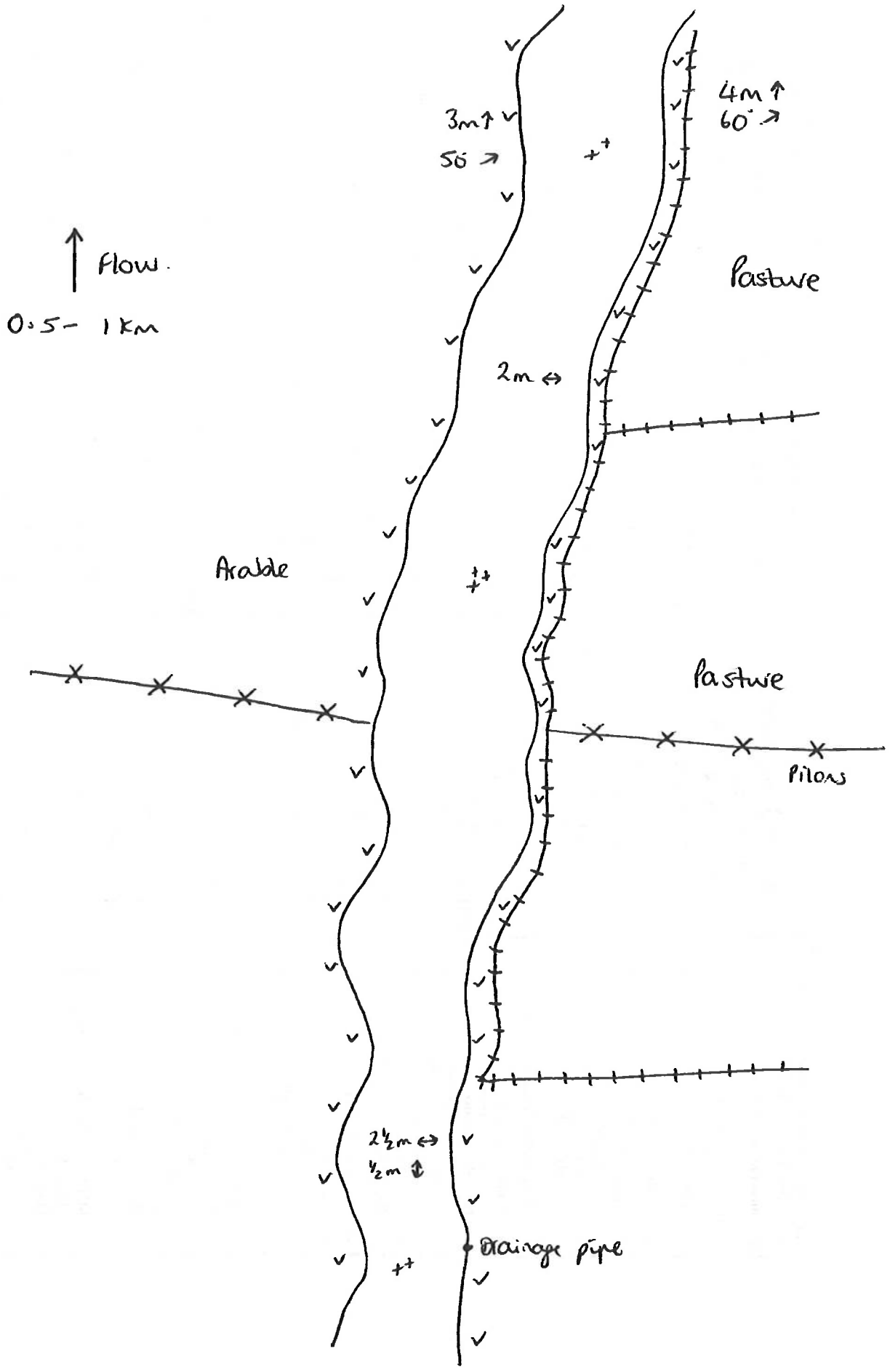
	LB	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved		
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other – tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

RIVER Pilling Water
Km No. 0-0.5
Date October 1992
Surveyor JALD.

	LB	RB
G. OPEN WATER		
1. Standing – canal + (% of adj. land in each stretch)		
canal =		
ditch		
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable	100	100
amenity grassland		
ephemeral/short herb		
hedge +		
hedge =		
fence on bank		20
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road	1	1
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shell %		
solid earth cliff 1M↑		
soft earth cliff >80°		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m		
1-<2m		
>2m		
Width <1m	100	100
1-<2.5m		70
2.5-<5m	100	30
>5m		
Slope <30°		100
30-<60°	100	
60-<90°		
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %		
Sparse Scrub/shrubs %		
Reed/Sedge %		
Dense open %		
Sparse open %		
Reseeded or mown %	100	100
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth – maturing		
earth – with trees		
developed		

RIVER HABITATS		RIVER
bridges/500m		2
weirs/500m		
locks/500m		
inlet/500m		
Depth <.25m %		
.25-<.5		100
0.5-<1.0		
>1.0m		
Width <1		
1-<5		100
5-<10		
10-<20		
>20		
Substrates		
BR bed rock		
b boulders		
c cobbles		
p pebbles		
g gravel		
s sand		
si silt/mud		100
cl clay		
peat		
Habitats and Flow		
pool		
slack		100
riffle		
rapids		
run		
waterfall		
protruding rocks		
Margins		
shingle ± bare		
shingle, vegetated		
mud		
sand		
FLORA %		
emergent veg < 1m wide		
emergent 1-2m wide		
emergent >2m wide		
total veget. area		
B bryophytes		total 10 to 100%
E emergents		
A submerged		
F floating		
algae % of stretch		


Flow.
0.5 - 1 km
3m ↑
50 ↗
4m ↑
60° ↗
Pasture
2m ↔
Arable
Pasture
Pilons
2½m ↔
½m ↕
Drainage pipe

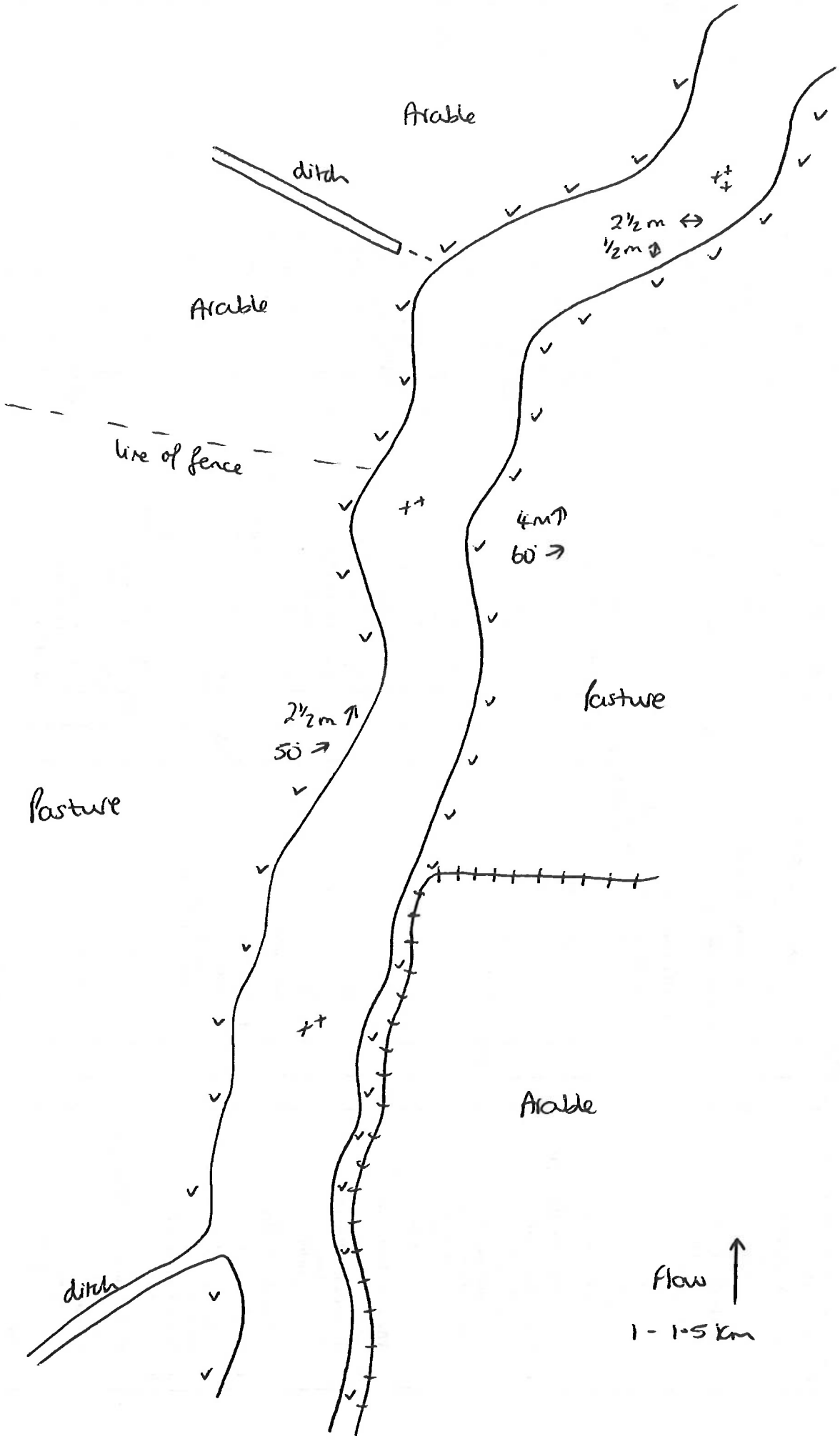
	LB	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub - dense		
scattered		
Carr - alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic uninproved		
semi-improved		
Neutral uninproved		
semi-improved		100
Calcareous uninproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp rich veget.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub - dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires - bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

RIVER Filling Water
Km No. 0.5 – 1
Date October 1992
Surveyor JALD

	LB	RB
G. OPEN WATER		
1. Standing - canal ↑ % of adj land in each stretch		
canal =		
ditch		
dyke		
pond, pool, cut off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable	100	
amenity grassland		
ephemeral/short herb		
hedge ↑		
hedge =		
fence on bank		80
fence set back		
wall		
building		
caravans		
fish farm		
sludge dump		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shell %		
solid earth cliff ↑		
soft earth cliff > 80°		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m		
1-<2m		
>2m	100	100
Width <1m		
1-<2.5m		
2.5-<5m	100	
>5m		100
Slope <30°		
30 - 60°	100	100
60 -<90°		
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %		
Sparse Scrub/shrubs %		
Reed/Sedge %		
Dense open %		
Sparse open %		
Reseeded or mown %	100	100
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

RIVER HABITATS		RIVER
bridges/500m		
weirs/500m		
locks/500m		
inlet/500m		
Depth <.25m %		
.25-<.5		100
0.5-<1.0		
>1.0m		
Width <1		
1-<5		100
5-<10		
10-<20		
>20		
Substrates		
BR bed rock		
b boulders		
c cobbles		
p pebbles		
g gravel		
s sand		
si silt/mud		100
cl clay		
peat		
Habitats and Flow		
pool		
slack		100
riffle		
rapids		
run		
waterfall		
protruding rocks		
Margins		
shingle ± bare		
shingle, vegetated		
mud		
sand		
FLORA %		
emergent veg < 1m wide		
emergent 1-2m wide		
emergent >2m wide		
total veget area		
B bryophytes		total 10 to 100%
E emergents		
A submerged		
F floating		
algae % of stretch		


Arable
ditch
Arable
2½m ↔
½m ↕
line of fence
4m ↑
60° →
Pasture
2½m ↑
50° →
Pasture
Arable
ditch
Flow
1 - 1·5 km

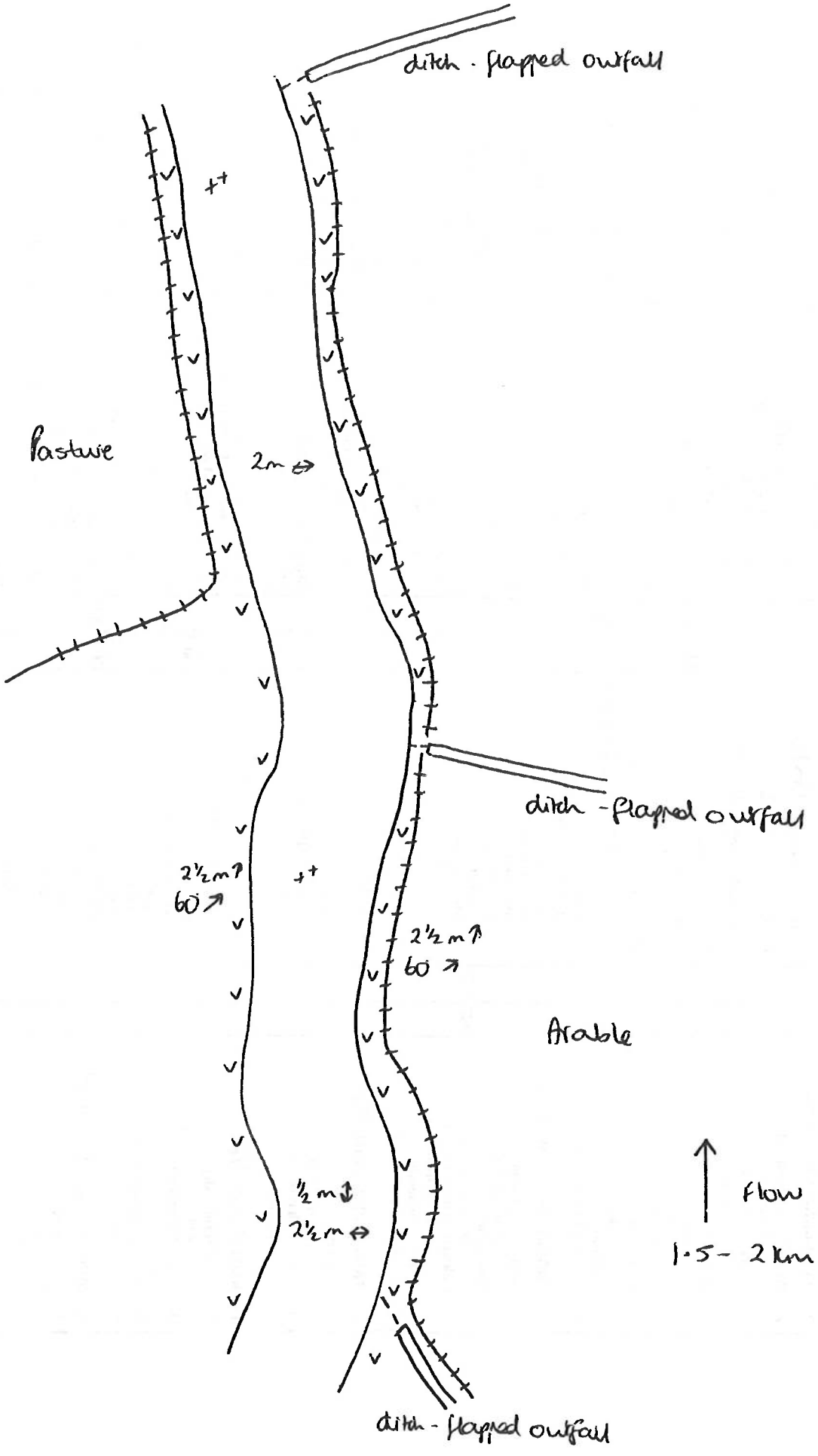
	LG	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved	60	60
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget		
3. Other – tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

RIVER Pilling Water
Km No. 1 - 1 - 5
Date October 1992
Surveyor JALD

	LB	RB
G. OPEN WATER		
1. Standing – canal + (% of adj. bank in each stretch)		
canal =		
ditch	1	
dyke		
pond, pool, cut off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable	40	40
amenity grassland		
ephemeral/short herb		
hedge +		
hedge =		
fence on bank		40
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shelf %		
solid earth cliff 1m↑		
soft earth cliff >80°		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m		
1-<2m		
>2m	100	100
Width <1m		
1-<2.5m		
2.5-<5m	100	
>5m		100
Slope <30°		
30-<60°	100	100
60-<90°		
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow recent pollard		
W Willow old, not pollard		
S Standard willows		
Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %		
Sparse Scrub/shrubs %		
Reed/Sedge %		
Dense open %		
Sparse open %		
Reseeded or mown %	100	100
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

RIVER HABITATS	RIVER
bridges/500m	
weirs/500m	
locks/500m	
inlet/500m	
Depth <.25m %	
.25-<.5	
0.5-<1.0	100
>1.0m	
Width <1	
1-<5	100
5-<10	
10-<20	
>20	
Substrates	
BR bed rock	
b boulders	
c cobbles	
p pebbles	
g gravel	
s sand	
si silt/mud	100
cl clay	
peat	
Habitats and Flow	
pool	
slack	100
riffle	
rapids	
run	
waterfall	
protruding rocks	
Margins	
shingle ± bare	
shingle, vegetated	
mud	
sand	
FLORA %	
emergent veg < 1m wide	
emergent 1-2m wide	
emergent >2m wide	
total veget. area	
B bryophytes	100
E emergents	
A submerged	
F floating	
algae % of stretch	


ditch - flapped outfall
Pasture
2m ↔
ditch - flapped outfall
2½m ↑
60 ↗
2½m ↑
60 ↗
Arable
½m ↕
2½m ↔
Flow
1.5 - 2km
ditch - flapped outfall

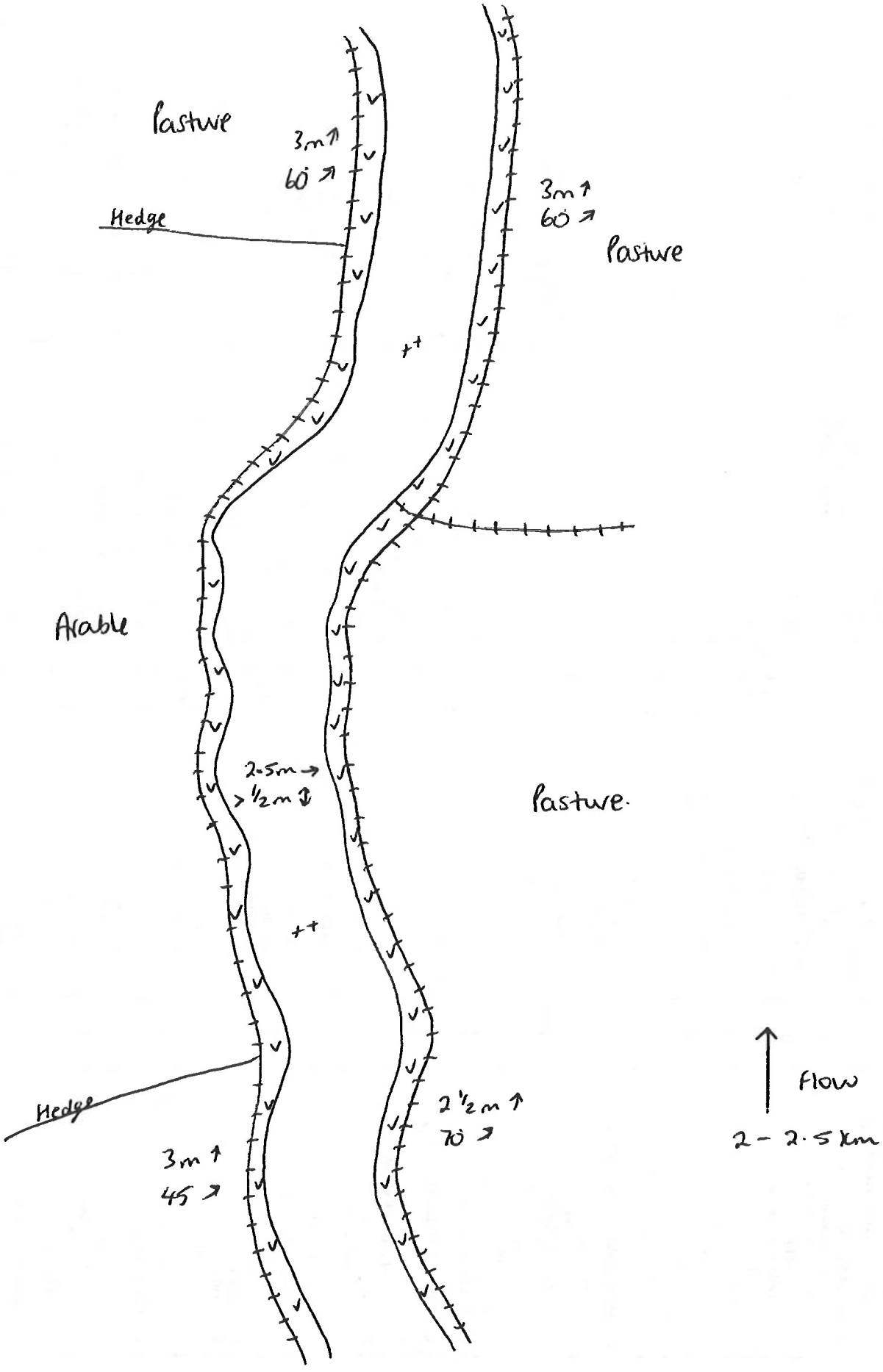
	LG	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic uninproved		
semi-improved		
Neutral uninproved		
semi-improved	40	100
Calcareous uninproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp rich veget		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

RIVER Pilling Water
Km No. 1-5-2
Date October 1992
Surveyor JALD

	LB	RB
G. OPEN WATER		
1. Standing – canal + (% of adj bank in each stretch)		3
canal =		
ditch		
dyke		
pond, pool, cut off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable	60	
amenity grassland		
ephemeral/short herb		
hedge +		
hedge =		
fence on bank	30	100
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shell %		
soiled earth cliff 1-80°		
soft earth cliff >80°		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m		
1-<2m		
>2m	100	100
Width <1m		
1-<2.5m		
2.5-<5m	100	
>5m		100
Slope <30°		
30-<60°	100	
60-<90°		100
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow recept pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %		
Sparse Scrub/shrubs %		
Reed/Sedge %		
Dense open %		
Sparse open %		
Reseeded or mown %	100	100
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

RIVER HABITATS	RIVER
bridges/500m	
weirs/500m	
locks/500m	
inlet/500m	
Depth <.25m %	
.25-<.5	
0.5-<1.0	100
>1.0m	
Width <1	
1-<5	100
5-<10	
10-<20	
>20	
Substrates	
BR bed rock	
b boulders	
c cobbles	
p pebbles	
g gravel	
s sand	
si silt/mud	100
cl clay	
peat	
Habitats and Flow	
pool	
slack	100
riffle	
rapids	
run	
waterfall	
protruding rocks	
Margins	
shingle ± bare	
shingle, vegetated	
mud	
sand	
FLORA %	
emergent veg < 1m wide	
emergent 1-2m wide	
emergent >2m wide	
total veget area	
B bryophytes	total 100%
E emergents	
A submerged	
F floating	
algae % of stretch	


Pasture
3m ↑
60 ↗
Hedge
3m ↑
60 ↗
Pasture
Arable
2·5m →
> ½m ↕
Pasture.
Hedge
3m ↑
45 ↗
2½m ↑
70 ↗
Flow
2 - 2·5 km

	LB	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved	30	100
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp rich veget.		
3. Other – tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

RIVER Pilling Water

Rm No. 2 – 2·5

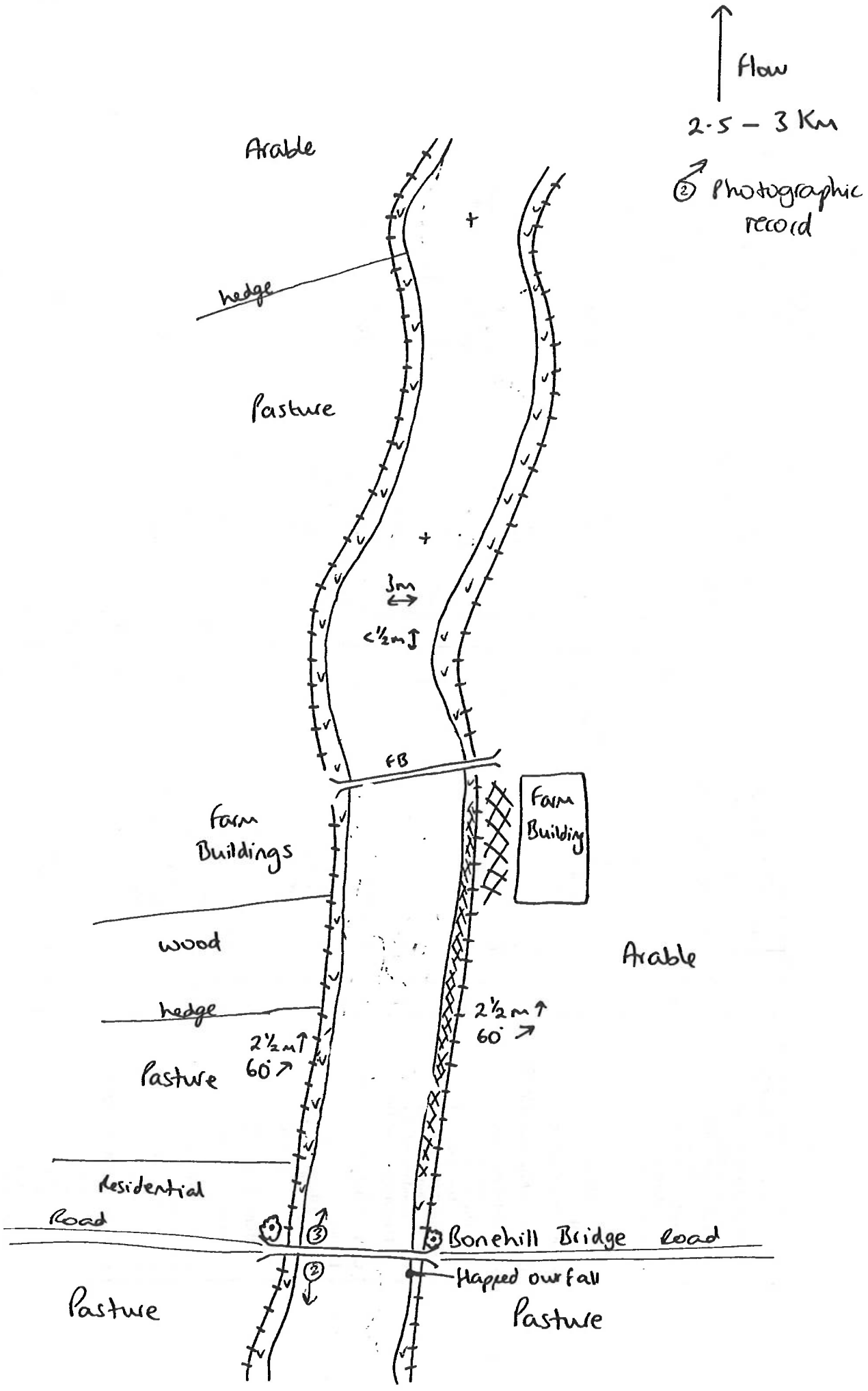
Date October 1992

Surveyor JALD.

	LB	RB
G. OPEN WATER		
1. Standing – canal + (% of adj bank in each stretch)		
canal =		
ditch		
dyke		
pond, pool, cut off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable	70	
amenity grassland		
ephemeral/short herb		
hedge +	2	
hedge =		
fence on bank	100	100
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway – disused		
used		
other		

BANK FEATURES %	LB	RB
shell %		
solid earth cliff (1m ↑)		
soft earth cliff (> 80°)		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height < 1m		
1-<2m		
>2m	100	100
Width < 1m		
1-<2.5m	100	100
2.5-<5m		
>5m		
Slope < 30°		
30-<60°	100	
60-<90°		100
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow – recent pollard		
W Willow old, not pollard		
S Standard willows		
Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %		
Sparse Scrub/shrubs %		
Reed/Sedge %		
Dense open %		
Sparse open %		
Reseeded or mown %	100	100
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth – maturing		
earth – with trees		
developed		

RIVER HABITATS	RIVER
bridges/500m	
weirs/500m	
locks/500m	
inlet/500m	
Depth < 25m %	
.25-<.5	100
0.5-<1.0	
>1.0m	
Width <1	
1-<5	100
5-<10	
10-<20	
>20	
Substrates	
BR bed rock	
b boulders	
c cobbles	
p pebbles	
g gravel	
s sand	
si/mud	100
cl clay	
peat	
Habitats and Flow	
pool	
slack	100
riffle	
rapids	
run	
waterfall	
protruding rocks	
Margins	
shingle ± bare	
shingle, vegetated	
mud	
sand	
FLORA %	
emergent veg < 1m wide	
emergent 1-2m wide	
emergent >2m wide	
total veget. area	
B bryophytes	total 100%
E emergents	
A submerged	
F floating	
algae % of stretch	


Flow
2·5 – 3 Km
② Photographic record
Arable
hedge
Pasture
3m
<½m
FB
Farm Buildings
Farm Building
wood
Arable
hedge
2½m
60°
2½m
60°
Pasture
Residential
Road
Bonehill Bridge
road
Flapped outfall
Pasture
Pasture

	LG	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation	15	
2. Scrub - dense		
scattered		
Carr - alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved	50	10
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub - dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland - dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires - bog		
Fen - reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp - single sp. dom.		
Tall mixed assemblage		

River Pilling Water

Km No. 2·5–3

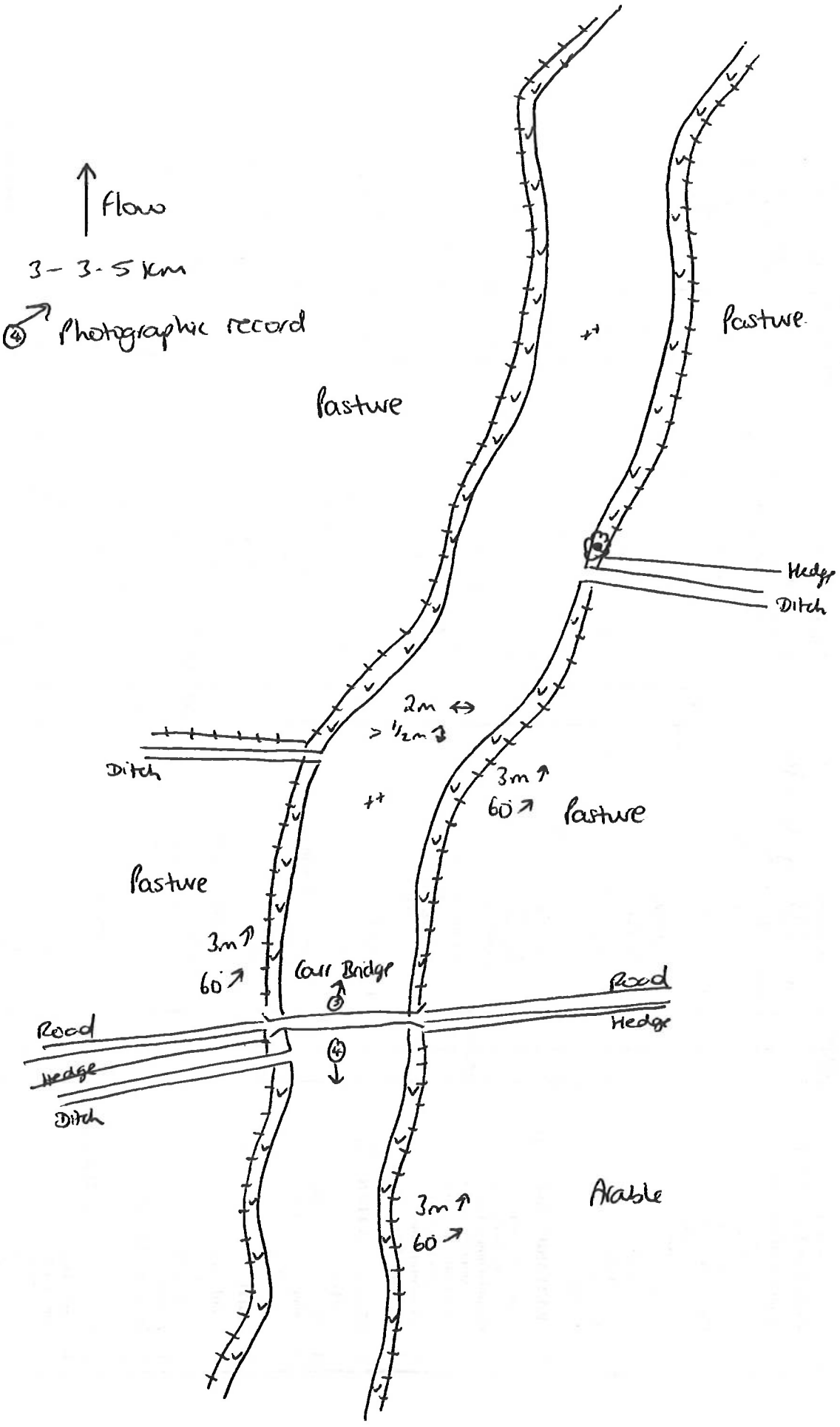
Date October 1992

Surveyor JALD.

	LB	RB
G. OPEN WATER		
1. Standing - canal + (% of adj bank in each stretch)		
canal =		
ditch		
dyke		
pond, pool, cut off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1–5m		
5–10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable	10	79
amenity grassland		
ephemeral/short herb		
hedge +	1	
hedge =		
fence on bank	100	100
fence set back		
wall		
building	14	10
caravans		
fish farm		
silage clamp		
sewage works		
garden	10	
stick pile		
flood debris		
road	1	1
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shell %		
solid earth cliff 1–<80°		
soft earth cliff >80°		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m		
1–<2m		
>2m	100	100
Width <1m		
1–<2.5m		
2.5–<5m	100	100
>5m		
Slope <30°		
30–<60°		
60–<90°	100	100
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore	1	1
P Willow recept pollard		
W Willow old, not pollard		
S Standard willows		
Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %		
Sparse Scrub/shrubs %		
Reed/Sedge %		35
Dense open %		
Sparse open %		
Reseeded or mown %	100	65
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

RIVER HABITATS		RIVER
bridges/500m		2
weirs/500m		
locks/500m		
inlet/500m		
Depth <.25m	%	
.25–<.5		100
0.5–<1.0		
>1.0m		
Width <1		
1–<5		
5–<10		100
10–<20		
>20		
Substrates		
BR bed rock		
b boulders		
c cobbles		
p pebbles		
g gravel		
s sand		
si silt/mud		100
cl clay		
peat		
Habitats and Flow		
pool		
slack		100
riffle		
rapids		
run		
waterfall		
protruding rocks		
Margins		
shingle ± bare		
shingle, vegetated		
mud		
sand		
FLORA %		
emergent veg < 1m wide		
emergent 1–2m wide		
emergent >2m wide		
total veget. cover		
B bryophytes		100
E emergents		
A submerged		
F floating		
algae % of stretch		


Flow
3 - 3.5 km
Photographic record
Pasture
Pasture
Hedge
Ditch
2m
> 1/2m
Ditch
3m
60
Pasture
Pasture
3m
60
Carr Bridge
Road
Road
Hedge
Hedge
Ditch
3m
60
Arable

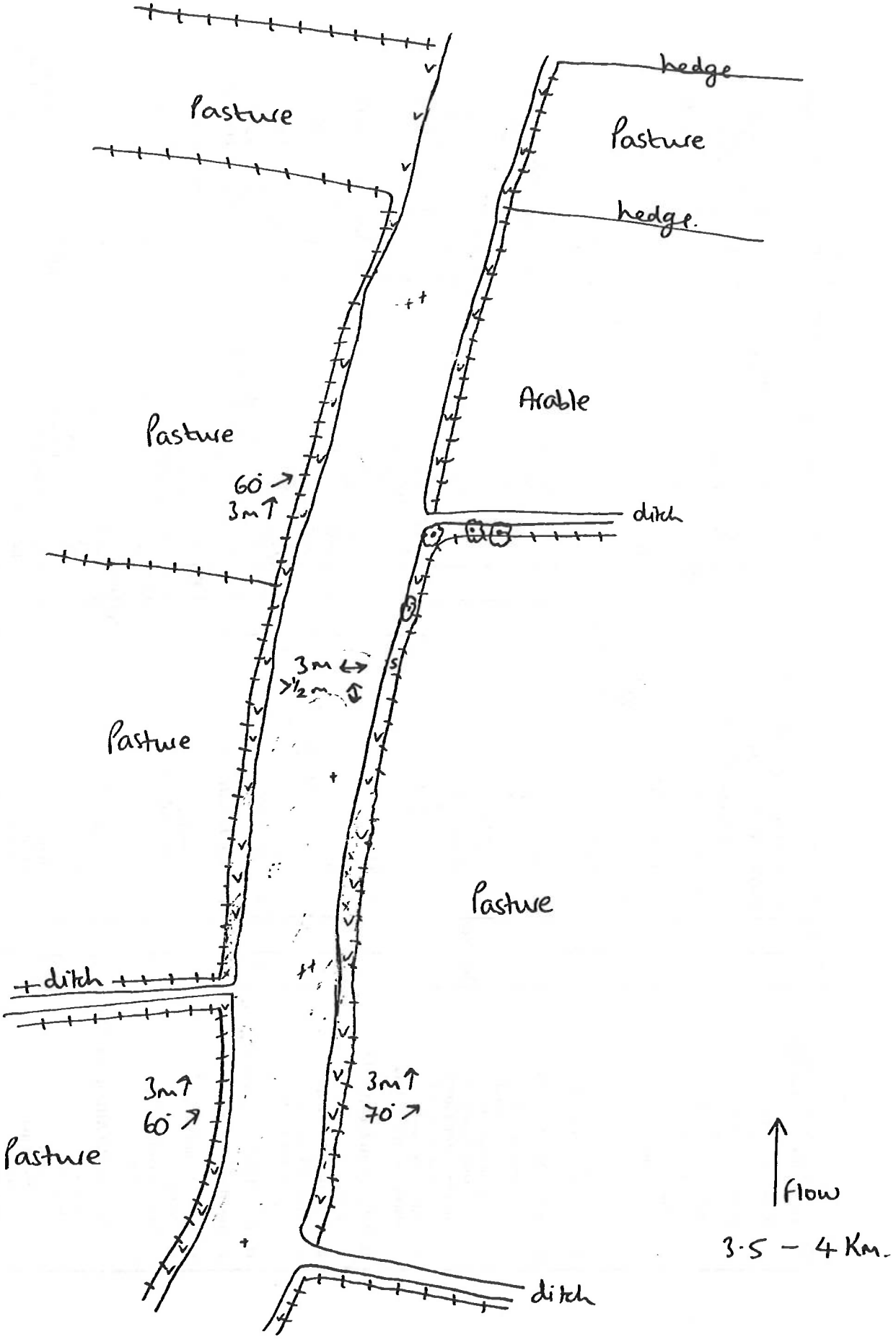
	LB	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic uninproved		
semi-improved		
Neutral uninproved		
semi-improved	80	79
Calcareous uninproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other – tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

RIVER Pilling Water
Km No. 3-3-5
Date October 1992
Surveyor JALD

	LB	RB
G. OPEN WATER		
1. Standing – canal ↑ % of adj. bank in each stretch		
canal =	2	1
ditch		
dyke		
pond, pool, cut off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable	20	21
amenity grassland		
ephemeral/short herb		
hedge ↑	1	1
hedge =		
fence on bank	100	100
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road	1	1
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shell %		
solid earth cliff ↑M }		
soft earth cliff >80° }		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m		
1-<2m		
>2m	100	100
Width <1m		
1-<2.5m		
2.5-<5m	100	100
>5m		
Slope <30°		
30-<60°	100	100
60-<90°		
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		1
P Willow recent pollard		
W Willow old, not pollard		
S Standard willows		
Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %		
Sparse Scrub/shrubs %		
Reed/Sedge %		
Dense open %		
Sparse open %		
Reseeded or mown %	100	100
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

RIVER HABITATS	RIVER
bridges/500m	1
weirs/500m	
locks/500m	
inlet/500m	
Depth <.25m %	
.25-<.5	
.5-<1.0	100
>1.0m	
Width <1	
1-<5	100
5-<10	
10-<20	
>20	
Substrates	
BR bed rock	
b boulders	
c cobbles	
p pebbles	
g gravel	
s sand	
si silt/mud	100
cl clay	
peat	
Habitats and Flow	
P pool	
slack	100
riffle	
rapids	
run	
waterfall	
protruding rocks	
Margins	
shingle ± bare	
shingle, vegetated	
mud	
sand	
FLORA %	
emergent veg < 1m wide	
emergent 1-2m wide	
emergent >2m wide	
total veget. area	
B bryophytes	total 10 to 100%
E emergents	
A submerged	
F floating	
algae % of stretch	


Pasture
hedge
Pasture
hedge.
Arable
Pasture
60°
3m
ditch
3m ↔
>½m ↕
Pasture
Pasture
ditch
3m
60°
3m
70°
Pasture
ditch
Flow
3·5 – 4 Km.

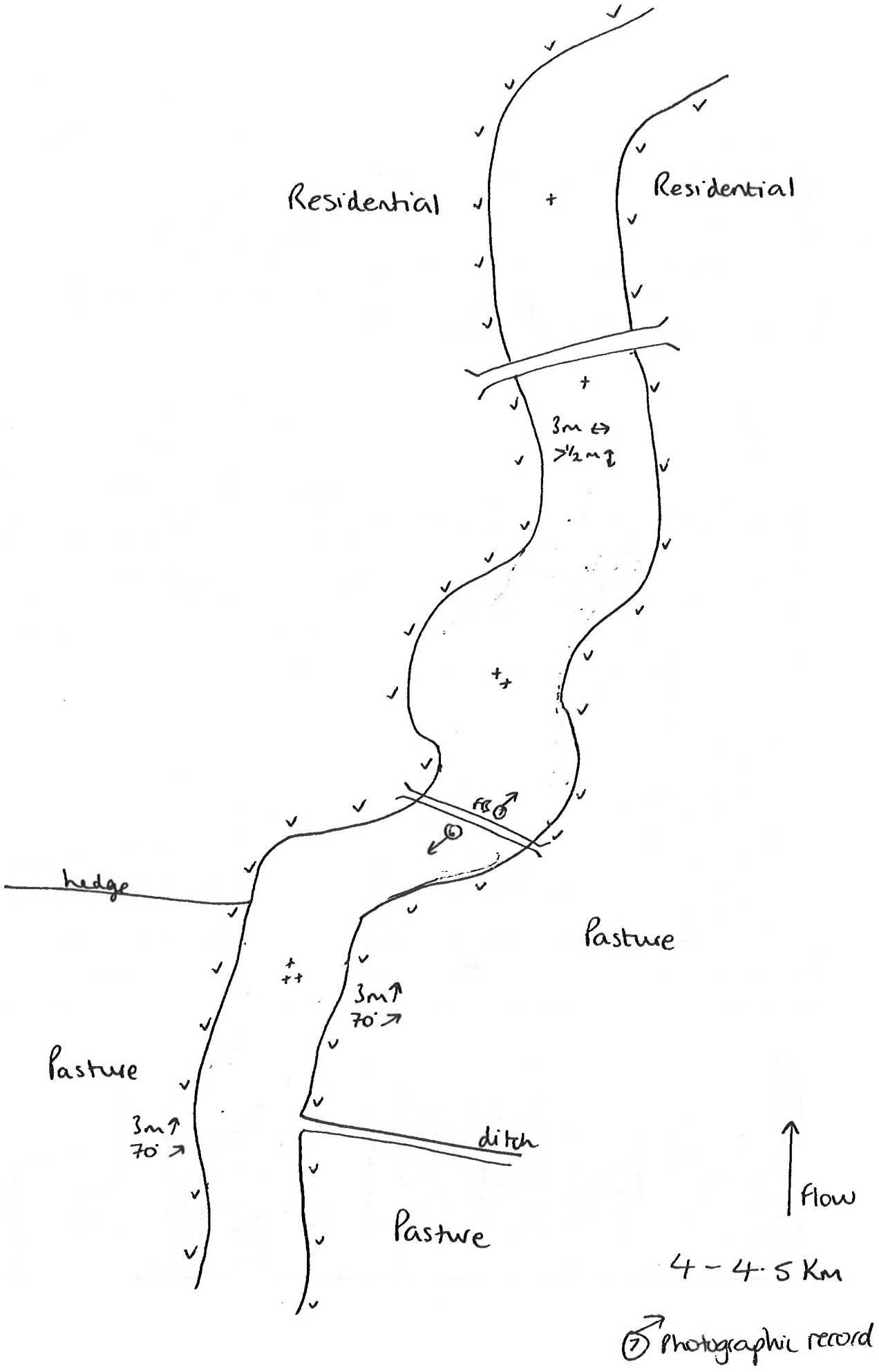
	LG	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved	100	70
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget		
3. Other – tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/Bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

River: Pilling Water
Km No.: 3-5 - 4
Date: October 1992
Surveyor: JALD

	LB	RB
G. OPEN WATER		
1. Standing – canal + (% of adj. bank in each stretch)		
canal =		
ditch	1	2
dyke		
pond, pool, cut off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		30
amenity grassland		
ephemeral/short herb		
hedge +		1
hedge =		
fence on bank	90	100
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
~~ shelf %		
AAA solid earth cliff (1m↑)		
^^^ soft earth cliff >80°		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m		
1-<2m		
>2m	100	100
Width <1m		
1-<2.5m		
2.5-<5m		
>5m	100	100
Slope <30°		
30-<60°		
60-<90°	100	100
>90°		
mud		
sss sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		4
P Willow recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %		
Sparse Scrub/shrubs %		
Reed/Sedge %		
Dense open %		
Sparse open %		
Reseeded or mown %	100	100
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

RIVER HABITATS	RIVER
bridges/500m	
weirs/500m	
locks/500m	
inlet/500m	
Depth <.25m %	
.25-<.5	
0.5-<1.0	100
>1.0m	
Width <1	
1-<5	
5-<10	100
10-<20	
>20	
Substrates	
BR bed rock	
b boulders	
c cobbles	
p pebbles	
g gravel	
s sand	
si silt/mud	100
cl clay	
peat	
Habitats and Flow	
P pool	
slack	100
riffle	
rapids	
run	
waterfall	
protruding rocks	
Margins	
shingle ± bare	
shingle, vegetated	
mud	
sss sand	
FLORA %	
emergent veg < 1m wide	
emergent 1-2m wide	
emergent >2m wide	
total veget. area	
B Bryophytes	total
E emergents	
A submerged	≤ 100%
F floating	
algae % of stretch	


Residential
Residential
3m ↔
>½m ↕
hedge
Pasture
3m ↑
70° ↗
Pasture
3m ↑
70° ↗
ditch
Pastwe
Flow
4 - 4·5 Km
⑦ Photographic record

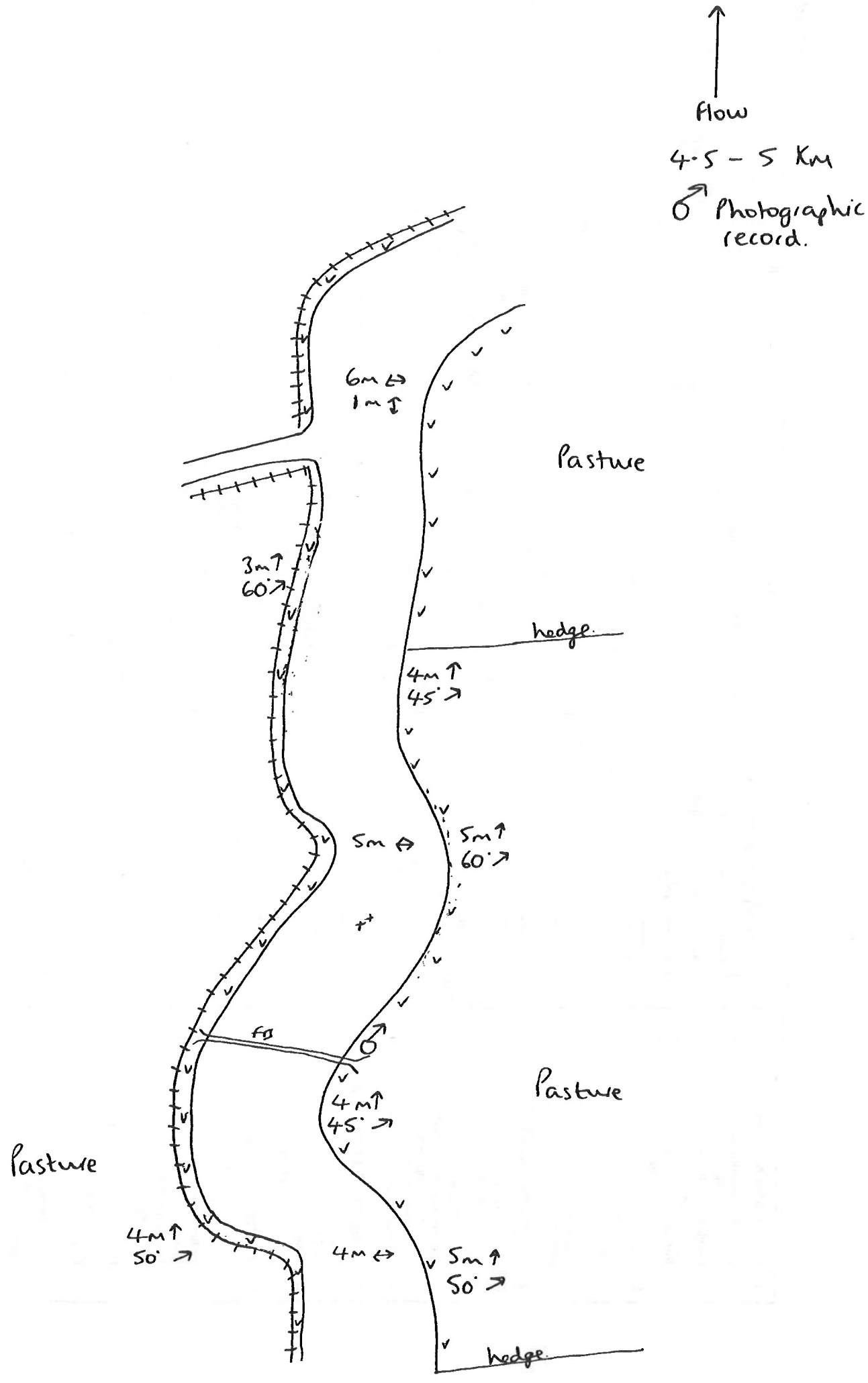
	LG	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved	35	80
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget		
3. Other – tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

River: Pilling Water
Km No.: 4 - 4.5
Date: October 1992
Surveyor: JALD

	LB	RB
G. OPEN WATER		
1. Standing – canal (% of adj. bank in each stretch)		
canal =		1
ditch		
dyke		
pond, pool, cut off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		
hedge <		1
hedge =		
fence on bank		
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden	60	20
stick pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shell %		
solid earth cliff (1m↑)		
soft earth cliff (>80°)		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m		
1-<2m		
>2m	100	100
Width <1m		
1-<2.5m		
2.5-<5m		
>5m	100	100
Slope <30°		
30-<60°		
60-<90°	100	100
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow recept pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %		
Sparse Scrub/shrubs %		
Reed/Sedge %		
Dense open %		
Sparse open %		
Reseeded or mown %	100	100
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, 1 bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

RIVER HABITATS	RIVER
bridges/500m	2
weirs/500m	
locks/500m	
inlet/500m	
Depth <.25m %	
.25-<.5	
0.5-<1.0	100
>1.0m	
Width <1	
1-<5	
5-<10	100
10-<20	
>20	
Substrates	
BR bed rock	
b boulders	
c cobbles	
p pebbles	
g gravel	
s sand	
i silt/mud	100
clay	
peat	
Habitats and Flow	
pool	
slack	100
riffle	
rapids	
run	
waterfall	
protruding rocks	
Margins	
shingle ± bare	
shingle, vegetated	
mud	
sand	
FLORA %	
emergent veg < 1m wide	
emergent 1-2m wide	
emergent >2m wide	
total veget. area	
B bryophytes	total 100%
E emergents	
A submerged	
F floating	
algae % of stretch	


Flow
4·5 – 5 Km
Photographic record.
6m ↔
1m ↕
Pasture
3m ↑
60° ↗
hedge.
4m ↑
45° ↗
5m ↔
5m ↑
60° ↗
fd
Pasture
4m ↑
45° ↗
Pasture
4m ↑
50° ↗
4m ↔
5m ↑
50° ↗
hedge.

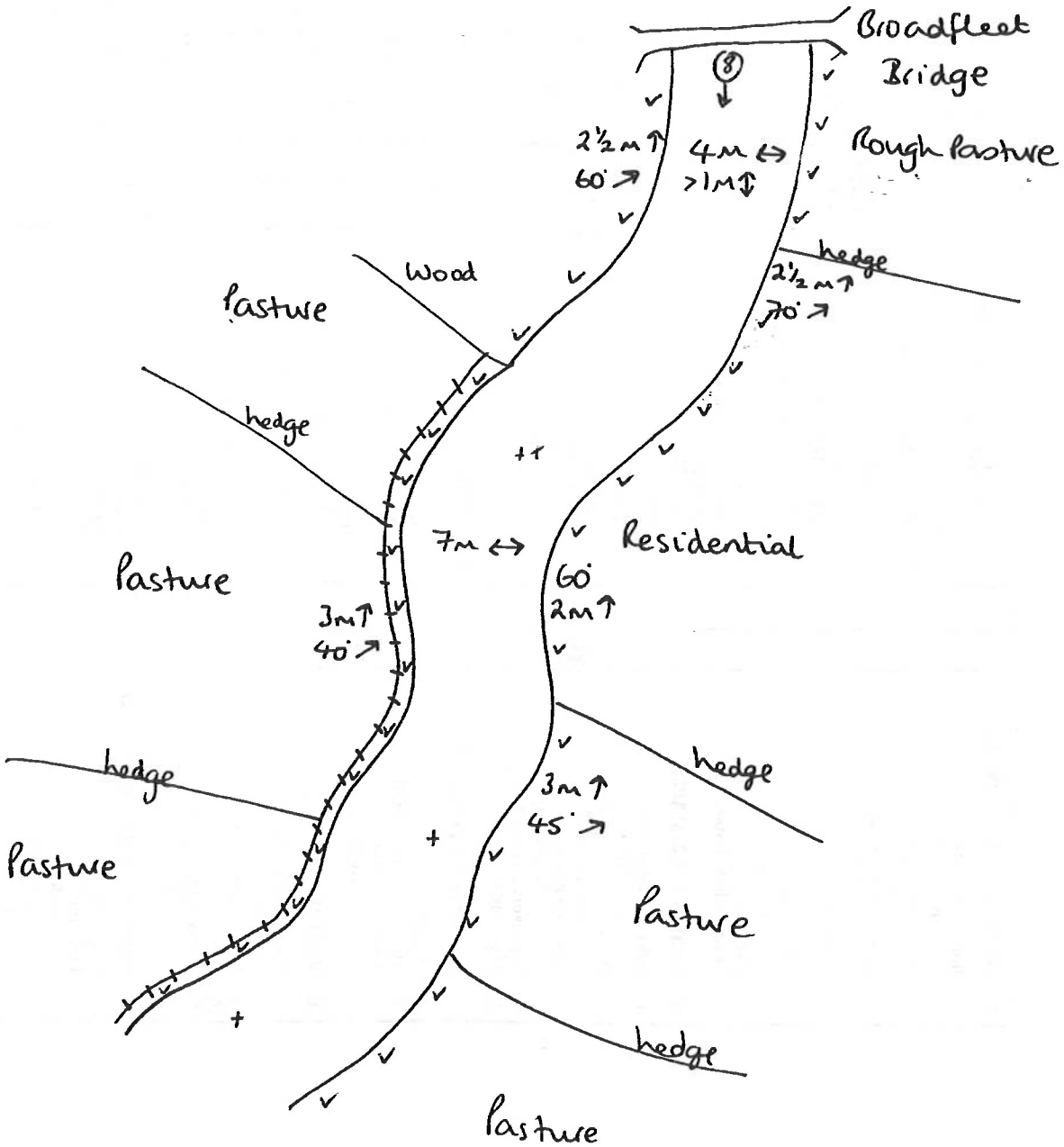
	LG	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved	100	100
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp rich veget		
3. Other – tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

RIVER Pilling Water
Km No. 4 – 4.5
Date October 1992
Surveyor JALD

	LB	RB
G. OPEN WATER		
1. Standing – canal <	% of adj bank in each stretch	
canal =	1	
ditch		
dyke		
pond, pool, cut off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		
hedge <		1
hedge =		
fence on bank	100	
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shelf %		
solid earth cliff 1m↑		
soft earth cliff >80°		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m		
1-<2m		
>2m	100	100
Width <1m		
1-<2.5m		
2.5-<5m		
>5m	100	100
Slope <30°		
30-<60°	100	100
60-<90°		
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %		
Sparse Scrub/shrubs %		
Reed/Sedge %		
Dense open %		
Sparse open %		
Reseeded or mown %		
Exposed tree roots	100	100
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth – maturing		
earth – with trees		
developed		

RIVER HABITATS	RIVER
bridges/500m	1
weirs/500m	
locks/500m	
inlet/500m	
Depth <.25m %	
.25-<.5	
.5-<1.0	100
>1.0m	
Width <1	
1-<5	
5-<10	100
10-<20	
>20	
Substrates	
BR bed rock	
b boulders	
c cobbles	
p pebbles	
g gravel	
s sand	
si silt/mud	100
cl clay	
peat	
Habitats and Flow	
pool	
slack	100
riffle	
rapids	
run	
waterfall	
protruding rocks	
Margins	
shingle ± bare	
shingle, vegetated	
mud	
sand	
FLORA %	
emergent veg < 1m wide	
emergent 1-2m wide	
emergent >2m wide	
total veget area	
B bryophytes	
E emergents	
A submerged	
F floating	
algae % of stretch	


Flow
5 - 5·5 Km.
8 Photographic record
Broadfleet Bridge
8
2½m↑
60°↗
4m↔
>1M↕
Rough Pasture
hedge
2½m↑
70°↗
Wood
Pasture
hedge
7m↔
Residential
Pasture
60'
2m↑
3m↑
40°↗
hedge
hedge
3m↑
45°↗
Pasture
Pasture
hedge
Pasture

	LB	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation	20	
2. Scrub - dense		
scattered		
Carr - alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		20
semi-improved	80	40
Neutral unimproved		
semi-improved		
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub - dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland - dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires - bog		
Fen - reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp - single sp. dom.		
Tall mixed assemblage		

RIVER Pilling Water
Km No. 5– 5·5
Date October 1992
Surveyor JALD

	LB	RB
G. OPEN WATER		
1. Standing - canal ↑ % of adj. bank in each stretch		
canal =		
ditch		
dyke		
pond, pool, cut off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		
hedge ↑	1	2
hedge =		
fence on bank	80	
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		40
stick pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shelf %		
solid earth cliff 1m↑		
soft earth cliff >80°		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m		
1-<2m		
>2m	100	100
Width <1m		
1-<2.5m	100	80
2.5-<5m		20
>5m		
Slope <30°		
30-<60°	100	30
60-<90°		70
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow recept pollard		
W Willow old, not pollard		
S Standard willows		
Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %		
Sparse Scrub/shrubs %		
Reed/Sedge %		
Dense open %		
Sparse open %		
Reseeded or mown %	100	100
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

RIVER HABITATS	RIVER
bridges/500m	1
weirs/500m	
locks/500m	
inlet/500m	
Depth <.25m %	
.25-<.5	
.05-<1.0	100
>1.0m	
Width <1	
1-<5	100
5-<10	
10-<20	
>20	
Substrates	
BR bed rock	
b boulders	
c cobbles	
p pebbles	
g gravel	
s sand	
si silt/mud	100
cl clay	
peat	
Habitats and Flow	
pool	
slack	100
riffle	
rapids	
run	
waterfall	
protruding rocks	
Margins	
shingle ± bare	
shingle, vegetated	
mud	
sand	
FLORA %	
emergent veg <1m wide	
emergent 1-2m wide	
emergent >2m wide	
total veget. area	
B bryophytes	100
E emergents	
A submerged	
F floating	
algae % of stretch	



https://dspace.org/

North West region: River Wampool, Pilling Water

Dunderdale, J. A. L.; Morris, J.

1996
National Rivers Authority
https://dspace.lib.cranfield.ac.uk/handle/1826/20882
Dunderdale JAL, Morris J. (1996) North West region: River Wampool, Pilling Water, Annex of R&D note 456

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