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Stream survey and assessment in the Ashford and Folkestone areas

by

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CONTENTS

1. INTRODUCTION

1.1 The proposed clearance depot east of Ashford and the rail terminal north of Folkestone are the two major inland construction activities associated with the Channel Tunnel Project.

1.2 Construction and operation of the above may affect some small streams and ditches in the Ashford and Folkestone areas.

1.3 Prior to construction the Freshwater Biological Association was contracted to undertake a survey of benthic invertebrates and macrophytes in selected freshwater habitats in order to a) assess the biological quality of the streams which may be affected by construction work and b) provide a baseline of biological data for future assessments.

1.4 Benthic fauna and macrophytes were sampled three times per year at 14 sites. Faunal and plant lists were compiled. Faunal lists were used to calculate biological quality indices and assess the status of the sites by reference to the FBA's existing data base.

2. STUDY AREA

2.1 The characteristics of the Ashford and Folkestone areas have been the subject of several reports to Eurotunnel and for general information on chemical water quality, hydrology, groundwater, and possible residues and emissions arising from construction of the tunnel, the reports listed in the reference section should be examined. In addition the terrestrial ecology (Helliwell 1985) and vegetation (Haslam 1986) of freshwater streams in the areas are

the subjects of two further reports. More detailed data on the environmental characteristics of the sites examined in this study are presented below.

2.2 Ashford. Three sites were examined, two on the Waterbrook and one on the East Stour (Fig. 1).

2.2.1 The Waterbrook is a small ditch-like stream flowing through arable land. Dense growths of macrophytes fill the channel at both sites (see Table 1) and surface velocity is less than 10 cm s^{-1}.

2.2.2 The East Stour at the sample site is about 5 m wide with a mean depth of about 60 cm. It flows through arable land between highly managed banks and is dredged periodically. The river receives both agricultural and domestic pollution. In the summer about 95% of the bottom is covered with 'blanket' weed.

2.3 Folkestone. Eleven sites on three streams, Saltwood, Seabrook and Pent, were sampled (Fig. 2). All three streams are fed from spring seepage at the junction of the lower chalk and gault clay.

2.3.1 The Saltwood stream is small and steeply sloped. After emerging from the chalk/clay interface it flows through grassland and deciduous woodland. At Oak Banks Wood between sites 1 and 2 an artificial pond has been created. Site 3 is situated at the edge of Hythe upstream of another ponded area. All sites are shaded by trees and rooted macrophytes are absent. The channel is deeply incised at all three sample locations and substrate material is derived from the Folkestone Beds.

2.3.2 The Seabrook stream is slightly less steep than Saltwood but the geology and basic characteristics of the catchments are very similar. Site 1 above the village of Frogholt is situated in pasture on the Gault and Folkestone Beds Footslopes. Below Frogholt the channel starts to incise into the Folkestone Beds and underlying Sandgate Beds. Between the M20 and railway culvert the Seabrook receives settled runoff via a storage lagoon, from a 2.3 mile length of the M20 motorway. Site 2 is situated just downstream of the motorway input (Fig. 3). Site 3 is downstream of a quarry in a wooded stretch. Site 4 flows through pasture land and site 5 is located downstream of a new trout farm. Site details are presented in Table 1.

2.3.3 Pent. This stream arises, as do the others, from the chalk/clay interface and flows alongside Biggins Wood where site 1 is located. Subsequently the stream flows under the motorway (Fig. 4) and is extensively culverted as it runs through Folkestone town. Site 2 is situated in an unlined open section flowing through an allotment area and site 3 is an open unlined ditch running alongside Parkfield Road. (See Table 1 for site details.)

3. METHODS

3.1 Time variant physical data such as flow, depth and substrate composition, were collected at each site on each sampling visit in 'Spring', 'Summer' and 'Autumn'. Additional time invariant data (slope, altitude, distance from source) were derived from maps. Chemical data, where available, were collated from a report to Eurotunnel (Wimpey Laboratories Ltd 1986). Some additional chemical data on the East Stour were provided by Southern Water Authority. All this information is summarised in Table 1.

3.2.1 Faunal data. The FBA standard methodology (Furse et al. 1981) was used to obtain invertebrate samples. All available habitats at each site were sampled in proportion to their occurrence. Three minutes of searching and substrate disturbance upstream of a net (230 x 255 mm frame, 900 µm mesh) constituted a sample.

3.2.2 Sample processing of the preserved fauna took place in the laboratory. The fauna of eight sites (Waterbrook 1 and 2, East Stour 1, Saltwood 3, Seabrook 5 and Pent 1, 2 and 3) was identified to family level. However, Hydracarina (water mites) were recorded as such and Chironomidae (midge larvae) were taken to subfamily or tribe level. Estimates of abundance were made for each 'family' and expressed in five categories according to an approximate logarithmic scale as follows: 1-9 animals = 1, 10-99 = 2, 100-999 = 3, 1000-9999 = 4, ≥10,000 = 5. The fauna of six sites* (Saltwood 1 and 2, and Seabrook 1, 2, 3 and 4) was identified to species level but some juvenile organisms, dipteran larvae and animals for which no taxonomic keys are available were identified to family or genus level.

*(Only five sites were stipulated for species identification in the original research proposal but the location of Seabrook 2 downstream of a motorway runoff lagoon warranted a more detailed examination at this site.)

3.3 Macrophytes at each site were collected on each sampling occasion and identified to species where possible. Bankside estimates of the proportion of the site area covered with macrophytes were made at each visit (Table 2).

3.4.1 Data analysis. The FBA River Laboratory system for the classification and prediction of macroinvertebrate communities in running water (Wright et al. 1984, Furse et al. 1987, Moss et al. 1987, Armitage et al. 1987) was used to analyse the results obtained during this survey.

3.4.2 Over the past 10 years about 600 species of macroinvertebrate have been identified from more than 400 substantially unpolluted sites throughout Great Britain. The species lists are being used to construct a national classification of running-water sites and to develop a technique for predicting the probabilities of occurrence of individual taxa at sites of known environmental characteristics. This large data base provides a standard against which to assess the fauna of new sites and also places the site in a national context.

3.4.3 The FBA data base and associated computer package, RIVPACS, was used in this survey to predict the faunal composition of all sites using environmental data (3.1) collected for each site. A warning message is shown on the screen and printout if on the basis of the physical and chemical data, the site has a probability of less than 5% of belonging to any of the classification groups. Families or species are listed on a printout together with their probability of occurrence at the site. The list is terminated at 50% probability but could be extended to 0% probability if required. If the site was unperturbed by pollution most families or species at the head of the column would be present but at the 50% level only 1 in 2 of the families listed could be expected after the standard sampling effort. The sum of the probabilities for each taxon is the expected number of families. If this is compared with the observed number of families or species an index (I) can be derived which provides a

measure of the site's deviation from the expected. If the observed results agree with the expected, the values of the index will be 1.0 but this value can be exceeded if more than the expected number of taxa are captured. Conversely, values less than unity indicate that fewer families or species were captured than expected. A comparison of predicted and observed fauna provides an objective indication of the 'biological' water quality of each site.

3.4.4 The National Water Council 'BMWP' biotic index (Biological Monitoring Working Party 1978, Chesters 1980, Armitage et al. 1983) was also predicted for each site and compared with observed values. This is a score system in which score values for individual families reflect their pollution tolerance and as such provides data on the biological condition of the site.

4. RESULTS

4.1 Ashford sites - Waterbrook Stream and East Stour

4.1.1 Waterbrook 1. A total of 33 families of invertebrates were recorded in the three seasons samples (Table 2). Mollusca, Diptera and tubificid worms were the most abundant groups. Odonata were represented by only one family, Libellulidae. A comparison of observed and predicted taxa indicate that the site is in good biological condition. Of the 28.3 families predicted to occur 26 were present giving a site faunal index (I) of 0.92.
Additional information from the calculation of the BMWP biotic score (S) and average score per taxon (A) (Table 4) also indicates a non-polluted site. However the fauna is not especially diverse or abundant.

Vegetation was well developed at the site and nine taxa were recorded, of which Callitriche sp. and Elodea nuttallii were the dominant forms (Table 2).

4.1.2 Waterbrook 2. This site supported a similar fauna to that of Waterbrook 1. Thirty-one families were recorded and Mollusca, Diptera and tubificid worms were again the most abundant groups (Table 5). Vegetation was less diverse with only five taxa recorded, of which Myosotis spp. and Callitriche sp. were the dominant forms (Table 2). The values of I, S and A (Table 4) all indicated good biological condition but again the fauna was not especially diverse or rich.

4.1.3 Waterbrook 1 and 2 are therefore characteristic lowland streams not exhibiting any evidence of pollution. The fauna is not remarkable and no rare or unusual families were recorded. The low diversity at these sites may in part be attributable to the lack of substrate heterogeneity. Vegetation cover of nearly 100% overlying an organic silty mud excludes open water organisms and reduces the habitats available for colonization. Juvenile newts were, however, found at Waterbrook 2 and these can be considered as indicators of a 'healthy' habitat.

4.1.4 East Stour. This was the largest river sampled in this study and also the most obviously managed. Thirty-six families were recorded and Mollusca, worms, Crustacea, Coleoptera and Diptera were all well represented. No Plecoptera were recorded and Trichoptera and Ephemeroptera were each represented by only two families (Table 6). Vegetation was sparse and only six taxa were found. The values of I, S and A (Table 4) were all low and the fauna was slightly impoverished but no major pollution was indicated. It is

not possible to explain this lack of faunal richness with the available data but it is probable that the dense summer growths of filamentous algae, indicating some organic enrichment, will reduce faunal diversity and dredging activities upstream have removed potential colonizers. Also the small proportion of larger stones reduces the niches available for colonization by, for example, caseless caddis larvae. Polycentropodidae, Psychomyiidae and Rhyacophilidae were all absent from samples and Hydropsychidae were found only in spring in low numbers.

4.2 Folkestone sites - Saltwood stream

4.2.1 Saltwood 1 lies just upstream of an artificial pond in dense deciduous woodland. Forty families of invertebrates were recorded at the site in the three seasons samples (Table 7). The most abundant taxa were Hydrobiidae (molluscs), tubificid worms, Gammarus pulex, Elminthidae, Orthocladiinae and Simuliidae. The I, S and A values (Table 4) all indicate the good biological condition of the site. The Saltwood 1 fauna was further identified to species level where possible (Table 8). Sixty-seven taxa were found including 26 Diptera. The faunal index (I) based on species is slightly lower (0.88) than that based on families (0.93) but still indicates good water quality. No macrophytes were found, but some filamentous algal growth was noted in the summer.

4.2.2 Saltwood 2 is a shaded site downstream of the artificial pond. The stream channel is deeply incised and the substrate is dominated by pebbles and gravel. Only 28 families were recorded at the site. Gammaridae, Hydrobiidae, Sphaeriidae, worms, Elminthidae and Simuliidae were the most abundant groups (Table 9). Identification to species level produced only 43 taxa (Table 8) and a

corresponding I value of 0.61 compared with 0.67 for the family site index. The low I and S values indicate that the site has an impoverished fauna (Table 4). The reasons for this are not clear. The site is not organically polluted and the presence of a range of families suggests that a pesticide polluting agent is not present. It is more likely that a combination of shading and substrate conditions together with the 'flashy' runoff characteristics (as witnessed by the deeply incised channel and debris stranded on bankside shrubs) work together to reduce faunal diversity. Macrophytes and filamentous algae were absent.

4.2.3 Saltwood 3 is situated just upstream of a pond on the borders of the town of Hythe. The site is shaded and the stream channel is deeply incised. The substrate is coarser and water velocity higher than at Saltwood 2. Only 20 families were recorded. Gammaridae, Elminthidae, lumbriculid worms and Baetidae were the most abundant groups (Table 10).

Values of I, S and A (Table 4) were all slightly lower than at Saltwood 2 indicating an impoverished fauna. There were no obvious signs of pollution and it is probable that the physical attributes of the stream, as at Saltwood 2, are in some way responsible for the low faunal diversity. No macrophytes were recorded at the site, but filamentous algae were observed in the summer.

4.2.4 With the exception of Saltwood 1 sites on this stream supported a poor diversity of fauna. It is beyond the scope of this report to explain the impoverishment but the absence of any obvious polluting agents suggests that the reasons for this paucity are the physical characteristics of the sites. No rare or unusual taxa were recorded at any of the sites.

4.3 Folkestone sites - Seabrook stream

4.3.1 Seabrook 1, situated upstream of the village of Frogholt, is a rapidly flowing, highly calcareous stream with relatively small substrate particle size (mostly gravel and sand). A total of 30 taxa were identified at family level (45 at species level, Table 8). Gammaridae, Baetidae, Orthocladiinae, Simuliidae and tubificid worms were the most abundant groups (Table 11).
I and S values based on families were both 0.74 and species-based I was 0.57 which suggest that the fauna is somewhat impoverished. The value of A is high (1.08) which indicates that high scoring (intolerant to pollution) taxa are present. So again, in the absence of any obvious sources of pollution, the physical characteristics of the site and low habitat diversity may be responsible for the low I and S values.

4.3.2 Seabrook 2 is situated just downstream of a lagoon receiving motorway runoff. Runoff from the lagoon is controlled and is periodically released into Seabrook stream. Applications of road salt in the winter months result in very high chloride and sodium levels (>8000 mg l^{-1}) in water entering the lagoon. According to a report by Wimpey Laboratories Ltd, May 1986, these values are reduced in the outlet water and chloride and sodium, and associated sulphate and potassium levels, are not abnormally high in the Seabrook stream below the lagoon. A total of 42 taxa were identified at family level (63 to species level, Table 8). Gammaridae, Sphaeriidae, Tubificidae, Baetidae, Elminthidae and Tipulidae were the most abundant groups (Table 12). Two species, the damsel fly Ischnura elegans and the water scorpion Nepa cinerea are more often associated with slower-flowing water and may have colonised Seabrook 2 from the lagoon. I, S and A values

are all less than 1.0 (Table 4) but not low enough to indicate major pollution effects. The physical characteristics of the site, wide range of substrate particle sizes and a variety of macrophytes (eight taxa), should support a rich and diverse fauna and it is possible that periodic flushings with high conductivity water from the lagoon have had a detrimental effect on the fauna.

4.3.3 Seabrook 3 is situated just downstream of a quarry. At the spring sampling date the stream was in high flow and carried a high load of suspended clay particles. A total of 32 taxa were identified at family level (Table 13) (45 to species level, Table 8) none of which was rare or notable in the Nature Conservancy Council (NCC) classification. Only one species of macrophyte, Phalaris arundinacea, was recorded and filamentous algae were present in the summer at low densities. The I, S and A values were again relatively low (Table 4) despite the high habitat diversity observed at the site and the periodic high loads of suspended solids and flushing of salt-rich water from the lagoon may be contributing factors to the low faunal diversity of the site.

4.3.4 Seabrook 4 is situated in pasture land and has a substrate dominated by sand. A total of 31 taxa were identified at family level (Table 14) (52 at species level, Table 8). Tubificid worms, Orthocladiinae, Gammaridae and Baetidae were the most abundant groups. No rare or NCC notable species were recorded. Values of I, S and A (Table 4) were again low but at this site this may in part be attributable to the low habitat diversity associated with sandy substrates. Four species of macrophyte and some filamentous algae (in summer) were found at the site but none was abundant.

4.3.5 Seabrook 5 is situated just below a recently constructed (1986?) trout farm. The substrate is varied and boulders and cobbles, pebbles and gravel, and sand are nearly equally represented. A total of 34 taxa were identified at family level (Table 15). The most abundant groups were Gammaridae, Baetidae and lumbriculid worms. The I, S and A values were the lowest of any on the Seabrook sites (Table 4). Habitat diversity was high but macrophytes and algae were poorly represented by only four taxa. Nevertheless, the physical conditions at Seabrook 5 should have been able to support a diverse fauna and the relatively impoverished list of taxa suggest that other factors, possibly associated with the construction and operation of the trout farm, may be affecting this site.

4.3.6 The Seabrook stream does not support a wide range of taxa. None of the recorded forms was particularly rare or NCC notable. The stream may be affected by runoff from the lagoon, runoff from the quarry leading to high loads of suspended solids, agricultural activity in the catchment or, in the case of the bottom site, by operation of the trout farm and urban drainage.

4.4 Folkestone sites - Pent stream

4.4.1 Pent 1 is situated near Biggins Wood very close (0.2 km) to the spring source. The stream is bordered by woodland on one bank and by arable land on the other. The substrate is silty sand. A total of 31 families were identified in combined seasons samples. Gammaridae, Hydrobiidae and Sphaeriidae were the most abundant groups (Table 16). Various dipteran families were also common. The macrophyte Berula erecta was the only recorded species. The physical characteristics of the site are unlike any in the FBA data

base with the result that a warning notice is given on the printout of predicted families. The values of I, S and A should therefore be treated with circumspection. The I and S values indicate faunal impoverishment but A suggests that the organic polluting agents are not the cause.

4.4.2 Pent 2 is situated along a stretch of the stream bordered by allotments on one bank and water company grounds on the other. The flow is interrupted in many places by small man-made dams constructed of debris (to provide deeper water for allotment users?). The substrate is basically silt but with larger stones also present. A warning notice was given with the faunal prediction. Only 14 families were recorded. Tubificidae, Gammaridae and Sphaeriidae were the most abundant groups (Table 17). Gastropod molluscs were notably absent from a site which physically seemed very suitable. This suggests that a polluting agent may be present possibly originating from the allotments. Values of I and S were the lowest of any recorded in the survey (Table 4).

4.4.3 Pent 3 is an open unlined ditch bordered by concrete banks flowing through urban conditions. The substrate is dominated by boulders and cobbles and flow is rapid. There are no rooted macrophytes in the main channel but Carex paniculata was recorded at the margins. The species of Nuphar and Phragmites found at the site originated from a pond in the park upstream and were trapped amongst boulders. Pent 3 offers a range of habitats in the relatively coarse substrate but only 22 families were recorded at the site (Table 18). Gammaridae, Baetidae and lumbriculid worms were the most abundant groups. Values of I, S and A were all low (Table 4) indicating that the fauna is impoverished. Pent 3 receives much road and runoff drainage and this may carry pollutants which would affect sensitive organisms.

4.4.4 The Pent stream for the most part is very urbanised and supports no rare or notable species. The top site is not affected by urban runoff but lack of habitat diversity and shading in the summer and autumn may account for the relatively sparse fauna.

4.5 Prediction from physical or physical and chemical variables.

4.5.1 Chemical data were not available for the Saltwood stream or the Pent and the Waterbrook data were assumed to be 'similar' to that of the East Stour. In view of this situation all predictions were made with 11 physical variables. However, where chemical data were available further predictions were run using 11 physical and chemical variables. Table 19 presents the results of comparing the values of I obtained from predictions based on the two sets of variables. It is clear that the predicted values of the indices are very similar and the value of the Spearman rank correlation coefficient for the 12 pairs of values is 0.867. This provides a measure of confidence in the use of physical variables alone.

5. OVERALL ASSESSMENT

5.1 Ten of the 14 sites had physical characteristics similar to those in the FBA data base and predictions of the probability of taxa occurring at a site could be made. The physical characteristics of the remaining four sites (Waterbrook 1, Saltwood 3 and Pent 1 and 2) resulted in 'warning' messages appearing on the printout and although predictions were possible it is best in these cases to consider the actual values of score, average score and numbers of taxa to assess the quality of the site.

5.2 None of the sites had faunal indices (I) greater than 1 and values as low as 0.52 and 0.47 were recorded at the bottom sites on the Saltwood and Pent, respectively. Score values were lower than predicted at every site and average score values were lower than predicted at 9 of the 14 sites. These trends are illustrated in Fig. 5 which clearly shows the general deterioration in biological quality of most of the streams from source to mouth.

5.3 No rare or NCC notable taxa of plant or animal were recorded at any site during this survey. Haslam (1987) refers to information provided by Dr C.M. Drake from collections made in "Seabrook Valley" in which five "rare or notable species" were recorded. Two of these Amphinemura standfussi and Nemoura erratica (stoneflies) are frequent inhabitants of the upper reaches of small lowland streams along the south coast. Two other species, Rhyacophila septentrionis (caddis) and Riolus cupreus (riffle beetle) are more uncommon but in this present survey two closely similar but widespread species, Rhyacophila dorsalis and Riolus subviolaceus were found. The fifth species recorded by Drake was a dipteran Pteromicra angustipennis and no representative of this family (Sciomyzidae) was recorded in the current survey of Seabrook. Additional unusual species (Diptera) were recorded by Drake from wet areas adjacent to the streams but these were not sampled in the present survey. The fauna of only six sites was identified to species level in the present study and it is possible that further identification at the other sites may reveal some rare or notable species/taxa. However, observations during sample-sorting and family identification at the remaining eight sites did not indicate the presence of any unusual animals.

5.4 Despite the unremarkable fauna and flora of the streams there were no obvious sources of pollution. It is beyond the scope of this survey to account for the general paucity of taxa but various reasons have been alluded to in the text. The main objective of the present survey is to present a description of the fauna and flora which will provide a data base for future comparisons and assessments.

5.5 The lack of rarities and species richness does not mean that the sites should not be subject to sympathetic management. With the exception of the Pent sites 2 and 3, which are much affected by urbanisation, the sites should be protected and conserved where possible. Previous studies (Haslam 1986) have shown that wet flushes bordering the streams and spring areas may support rare taxa of both plants and animals. Sensitive management of the catchment with safeguards to prevent drainage into the streams of toxic substances and high suspended solid loads may help to increase faunal diversity.

6. FUTURE MONITORING

6.1 This survey has established a data base which can be used to assess the impacts of future construction work.

6.2 Annual examination of the fauna of paired sites above and below major disturbances on relevant streams would provide a watching brief on the effects of construction and suggest methods for improving operational procedures which affect the stream biota. Examination of the benthic fauna provides a "summary" of the state of the catchment. The effects of shading on most of the

Folkestone sites and consequent lack of rooted vegetation in the stream channels precludes the use of macrophytes as a monitoring tool.

6.3 The annual faunal surveys could be single season on a smaller number of sites during the construction phase to reduce cost but a repeat of the present 14 site survey at the end of the construction period would provide data for a clear comparison in order to assess the total effect of construction.

6.4 Chemical monitoring sites should be established on all streams likely to be affected by construction activity. To date there is little information available from any source and it is in the interests of Eurotunnel and others to establish a chemical data base equivalent to the faunal data base in order to assess the effects of building the terminals. Monthly analyses of major ions and other substances (to be decided upon by chemists) from one site downstream of the construction activity on the Waterbrook, Saltwood (if affected), Seabrook and Pent, would provide necessary information on the state of the catchment.

7. SUMMARY

7.1 The Freshwater Biological Association was contracted to undertake a survey of benthic invertebrates and macrophytes in streams in the Ashford and Folkestone areas which may be affected by construction activities associated with the Channel Tunnel project.

7.2 The objectives of the survey were a) to assess the biological quality of the streams and b) to provide a base-line of biological data for future assessments.

7.3 Fourteen sites (3 at Ashford and 11 at Folkestone) were sampled three times per year in 'spring', 'summer' and 'autumn'. Existing FBA methodology was employed so that the data obtained would be compatible with the FBA's data base. Environmental characteristics of all sites were collated.

7.4 Faunal and plant lists were compiled. Environmental characteristics of the sites were used in RIVPACS (the FBA classification and prediction system) to predict faunal composition. The fauna observed at a site was then compared with that predicted in order to derive an index of biological quality (I). Additional measures of water quality were provided by predictions of biotic score and average score per taxon. Values of 1 or more indicated good quality sites.

7.5 Macrophytes were poorly represented in most streams. An exception was the Waterbrook which supported a wide variety of species. However, no site supported more than nine taxa. The effects of shading and consequent lack of macrophytes at many sites lessen their use as monitoring tools in this area.

7.6 All the sites had faunal indices less than 1. Score values were lower than predicted at every site and the observed average score per taxon exceeded the predicted at only five sites. In general there was a deterioration in the biological quality of the streams from source to mouth. No rare or NCC notable species were recorded.

7.7 Despite the low indices there was no evidence in the non-urbanised stream sections of major pollution sources although the runoff from the 'M20 lagoon' may affect sites on the Seabrook.

7.8 The survey has established a data base comprising both faunal and floral information which can be used in future assessments of the possible effects of construction work. Objective assessments of biological quality are available for all sites and will provide useful standards to judge any subsequent changes in water quality.

7.9 A future monitoring programme is outlined and the need to set up a chemical data-base is stressed.

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9. REFERENCES

Armitage, P.D., Gunn, R.J.M., Furse, M.T., Wright, J.F. & Moss, D. (1987) The use of prediction to assess macroinvertebrate response to river regulation. Hydrobiologia 144, 25-32.

Armitage, P.D., Moss, D., Wright, J.F. & Furse, M.T. (1983) The performance of a new biological water quality score system based on macroinvertebrates over a wide range of unpolluted running-water sites. Water Research 17, 333-347.

Biological Monitoring Working Party (1978) Final report: Assessment and presentation of the biological quality of rivers in Great Britain. December 1978. Unpublished report, Department of the Environment, Water Data Unit, 37 pp.

Chesters, R.K. (1980) Biological Monitoring Working Party. The 1978 national testing exercise. Department of the Environment, Water Data Unit, Technical Memorandum 19, 1-37.

Furse, M.T., Moss, D., Wright, J.F. & Armitage, P.D. (1987) Freshwater site assessment using multi-variate techniques. In: The use of invertebrates in site assessment for conservation (ed. M.L. Luff). Proceedings of a meeting held at the University of Newcastle-upon-Tyne, 7 January 1987. Agricultural Environment Research Group, University of Newcastle-upon-Tyne.

Furse, M.T., Wright, J.F., Armitage, P.D. & Moss, D. (1981) An appraisal of pond-net samples for biological monitoring of lotic macro-invertebrates. Water Research 15, 679-689.

Moss, D., Furse, M.T., Wright, J.F. & Armitage, P.D. (1987) The prediction of the macro-invertebrate fauna of unpolluted running-water sites in Great Britain using environmental data. Freshwater Biology 17, 41-52.

Wright, J.F., Moss, D., Armitage, P.D. & Furse, M.T. (1984) A preliminary classification of running-water sites in Great Britain based on macro-invertebrate species and the prediction of community type using environmental data. Freshwater Biology 14, 221-256.

The Channel Tunnel Group. Environmental effects in the UK. Environmental Impact Assessment. Specialist reports and other relevant texts.

Haslam, S.M. (1987) Stream quality and vegetational interest. February 1987.

Helliwell, D.R. (1985) The Channel Tunnel Group Environmental Impact Assessment. Report No. 4, Terrestrial Ecology, September 1985.

Wimpey Laboratories Ltd. (1985) Report No. 2, Groundwater and Hydrogeology, October 1985.

Wimpey Laboratories Ltd. (1985) Report No. 17, Residues and Emissions - Water, September 1985.

Wimpey Laboratories Ltd. (1986) Report on an assessment of the hydrology of the Pent, Seabrook, Newington and Enbrook catchments, April 1986.

Wimpey Laboratories Ltd. (1986) Report on a baseline study of water quality in the Seabrook Stream/Royal Military Canal and East Stour River, May 1986.

Wimpey Laboratories Ltd. (1986) Channel Tunnel Parliamentary Advice Groundwater studies, September 1986.

Table 1. Location and summary of the environmental characteristics of the Ashford and Folkestone sites.

Site Name	NGR	Water width (m)	Mean depth (dm)	Velocity (category)#	Boulders & cobbles (%)	Pebbles & gravel (%)	Sand (%)	Silt & clay (%)	Altitude (m)	Longitude (°')	Latitude (°')	Distance from source (km)	Slope (m km^{-1})	Discharge (category)*	Air temperature range (°C)	Mean air temperature (°C)	Total oxidised N_2 (mg l^{-1} N)	Alkalinity (mg l^{-1} $CaCO_3$)	Chloride (mg l^{-1} Cl)
Waterbrook 1	TR 0276 4020	1.1	16.0	1	0	0	0	100	38	0.54	51.08	1.0	0.8	1	13.06	10.25	6.14	218	50
Waterbrook 2	TR 0217 4070	2.3	38.0	1	0	0	0	100	37	0.53	51.08	2.0	0.8	1	13.05	10.20	6.14	218	50
East Stour 1	TR 0201 4050	4.7	63.1	2	4	51	30	15	37	0.53	51.08	15.5	0.9	2	13.05	10.21	6.14	218	50
Saltwood 1	TR 1662 3660	1.3	15.6	3	9	61	18	12	45	1.06	51.05	1.7	23.8	1	12.94	10.55	-	-	-
Saltwood 2	TR 1673 3640	1.1	11.1	3	6	62	28	4	40	1.06	51.05	2.0	8.3	1	12.94	10.55	-	-	-
Saltwood 3	TR 1665 3515	1.8	14.0	4	41	48	6	5	15	1.06	51.04	3.3	23.8	1	12.94	10.55	-	-	-
Seabrook 1	TR 1750 3770	1.1	14.6	4	3	47	43	7	57	1.07	51.06	2.0	6.3	1	12.93	10.53	3.5	241	29
Seabrook 2	TR 1780 3715	2.2	16.7	4	17	65	13	5	50	1.07	51.05	2.8	16.7	1	12.93	10.55	3.8	249	85
Seabrook 3	TR 1810 3671	3.1	11.4	4	25	54	20	1	38	1.07	51.05	3.4	13.9	1	12.93	10.55	2.63	216	59
Seabrook 4	TR 1865 3620	2.2	20.5	3	<1	6	81	13	27	1.07	51.05	4.3	10.9	1	12.93	10.54	2.63	216	59
Seabrook 5	TR 1862 3534	3.0	22.9	4	35	25	37	3	10	1.07	51.04	5.5	11.1	1	12.92	10.54	4.52	330	41
Pent 1	TR 2045 3775	1.1	8.9	2	0	0	62	38	50	1.09	51.06	0.2	13.2	1	12.89	10.54	-	-	-
Pent 2	TR 2090 3730	0.9	15.2	2	8	17	23	52	38	1.09	51.06	0.9	16.1	1	12.88	10.54	-	-	-
Pent 3	TR 2230 3675	1.7	11.9	4	53	33	12	2	20	1.11	51.05	2.4	9.8	1	12.93	10.55	-	-	-

#1 = ≤10, 2 = >10-25, 3 = >25-50, 4 >50-100 cm s^{-1} *1 = <0.31 m^3s^{-1}, 2 = >0.31-0.62 m^3s^{-1}

Table 2. Macrophytes/algae recorded at the Ashford and Folkestone sites, together with estimates of percentage cover (mean of three seasons)

Macrophytes	Water-brook 1	Water-brook 2	E.Stour 1	Salt-wood 1	Salt-wood 2	Salt-wood 3	Sea-brook 1	Sea-brook 2	Sea-brook 3	Sea-brook 4	Sea-brook 5	Pent 1	Pent 2	Pent 3
Agrostis stolonifera	-	-	-	-	-	-	-	+	-	-	-	-	-	-
Alisma plantago-aquatica	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Apium nodiflorum	-	-	-	-	-	-	-	-	-	+	-	-	-	-
Apium/Berula	-	-	-	-	-	-	-	+	-	-	-	-	-	-
Berula erecta	-	-	-	-	-	-	-	-	-	-	-	+	-	-
Callitriche stagnalis	-	+	-	-	-	-	-	-	-	-	-	-	-	-
Callitriche stagnalis/ platycarpa	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex paniculata	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Carex sp.	-	-	-	-	-	-	-	+	-	-	-	-	-	-
Elodea nuttallii	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Enteromorpha sp.	-	-	+	-	-	-	-	-	-	-	-	-	-	-
Epilobium hirsutum	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Equisetum telmatiae	-	-	-	-	-	-	-	+	-	-	-	-	-	-
Glyceria fluitans	-	-	-	-	-	-	-	+	-	-	-	-	-	-
Glyceria maxima	+	-	-	-	-	-	-	-	-	+	-	-	-	-
Iris pseudacorus	-	-	-	-	-	-	-	-	-	-	+	-	-	-
Lemna minor	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Myosotis caespitosa?	-	+	-	-	-	-	-	-	-	-	-	-	-	-
Myosotis scorpioides?	-	+	-	-	-	-	-	-	-	-	-	-	-	-
Myriophyllum spicatum	-	-	+	-	-	-	-	-	-	-	-	-	-	-
Nuphar lutea	-	-	-	-	-	-	-	-	-	-	-	-	-	(+)*
Phalaris arundinacea	+	+	+	-	-	-	-	-	+	-	-	-	-	-
Phragmites communis	-	-	-	-	-	-	-	-	-	-	-	-	-	(+)*
Potamogeton crispus	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Rorippa nasturtium-aquaticum agg.	+	-	-	-	-	-	-	-	-	-	+	-	-	-
Sparganium erectum	-	-	-	-	-	-	-	+	-	-	-	-	-	-
Vaucheria sp.??	-	-	+	-	-	-	-	-	-	-	-	-	-	-
Veronica anagallis-aquatica	-	-	-	-	-	-	-	-	-	+	-	-	-	-
Veronica beccabunga	-	-	-	-	-	-	-	+	-	+	+	-	-	-
Veronica scutellata	-	+	-	-	-	-	-	-	-	-	-	-	-	-
Indet filamentous algae	-	-	+	+	-	+	-	+	+	+	+	-	-	-
Total no. taxa per site	9	5	6	1	0	1	0	8	2	5	4	1	0	1
% cover including indet. filamentous algae	67	97	36	2	0	3	0	24	3	2	12	7	0	<1

*not rooted

Table 3. Waterbrook 1. 'Families' recorded in 'Spring' (Sp), 'Summer' (Su), 'Autumn' (Au) and Combined (Co) samples. Log categories of abundance (see text for details) are shown for each season and the sum of these categories is provided for combined samples for comparative purposes.

Family	Sp	Su	Au	Co
Planariidae	2	2	1	5
Dendrocoelidae	1	-	-	1
Valvatidae	-	1	-	1
Hydrobiidae	4	2	-	6
Lymnaeidae	2	3	3	8
Planorbidae	-	2	3	5
Sphaeriidae	3	3	4	10
Naididae	1	1	3	5
Tubificidae	3	3	2	8
Lumbriculidae	1	1	-	2
Glossiphoniidae	1	1	1	3
Asellidae	1	2	3	6
Gammaridae	2	1	1	4
Ostracoda	-	-	3	3
Baetidae	2	2	-	4
Leptophlebiidae	-	1	-	1
Libellulidae	-	2	-	2
Notonectidae	-	1	-	1
Corixidae	-	1	-	1
Dytiscidae	1	1	2	4
Hydrophilidae	1	1	-	2
Helodidae	-	1	-	1
Sialidae	1	1	2	4
Limnephilidae	2	1	-	3
Tipulidae	-	1	-	1
Ceratopogonidae	2	1	-	3
Tanypodinae	3	3	3	9
Prodiamesinae	3	-	-	3
Orthocladiinae	4	2	2	8
Chironomini	-	3	4	7
Tanytarsini	3	2	4	9
Simuliidae	1	-	-	1
Stratiomyidae	1	-	-	1

1 = 1-9 animals
2 = 10-99
3 = 100-999
4 = 1000-9999
5 ≥ 10000

Table 4. The ratio of observed (O) to predicted (P) values of score (S), average score per taxon (A), and family complement (I). [See text for details.]

Indices	SCORE			ASPT			FAMILIES		
	O	P	O/P	O	P	O/P	O	P	O/P
Sites			S			A			I
Waterbrook 1 #	105	121	0.87	4.56	4.55	1.00	26	28.3	0.92
Waterbrook 2	85	120	0.71	4.05	4.70	0.86	26	26.8	0.97
East Stour 1	114	168	0.68	4.38	5.14	0.85	30	34.3	0.87
Saltwood 1	142	188	0.76	5.46	5.33	1.02	33	35.6	0.93
Saltwood 2	75	155	0.48	4.41	5.13	0.86	23	34.2	0.67
Saltwood 3 #	64	195	0.33	4.27	5.40	0.79	19	36.0	0.53
Seabrook 1	110	148	0.74	5.50	5.07	1.08	24	32.4	0.74
Seabrook 2	138	196	0.70	5.11	5.40	0.95	31	36.3	0.85
Seabrook 3	126	204	0.62	5.48	5.39	1.01	28	37.2	0.75
Seabrook 4	88	215	0.41	4.89	4.99	0.98	27	37.6	0.72
Seabrook 5	85	215	0.40	4.47	5.25	0.85	25	38.1	0.66
Pent 1#	106	163	0.65	5.30	5.13	1.03	22	36.8	0.6
Pent 2#	38	195	0.19	4.22	5.03	0.84	10	35.7	0.28
Pent 3	55	163	0.34	3.93	5.33	0.74	17	36.4	0.47

# indicates the presence of a warning notice on the prediction.

Table 5. Waterbrook 2. 'Families' recorded in 'Spring' (Sp), 'Summer' (Su), 'Autumn' (Au) and Combined (Co) samples. Log categories of abundance (see text for details) are shown for each season and the sum of these categories is provided for combined samples for comparative purposes.

Family	Sp	Su	Au	Co
Planariidae	2	2	2	6
Dendrocoelidae	1	-	1	2
Hydrobiidae	2	3	4	9
Lymnaeidae	-	2	2	4
Physidae	2	3	3	8
Planorbidae	2	3	3	8
Succineidae	-	-	1	1
Sphaeriidae	3	3	3	9
Naididae	-	3	2	5
Tubificidae	4	4	3	11
Lumbriculidae	3	2	1	6
Glossiphoniidae	2	2	2	6
Erpobdellidae	2	2	2	6
Hydracarina	-	1	-	1
Asellidae	2	2	3	7
Gammaridae	1	1	2	4
Baetidae	1	1	1	3
Coenagriidae	1	1	2	4
Notonectidae	-	1	-	1
Corixidae	1	-	-	1
Haliplidae	-	1	1	2
Dytiscidae	1	1	1	3
Hydrophilidae	-	1	1	2
Noteridae	-	-	1	1
Limnephilidae	2	-	-	2
Tanypodinae	2	1	2	5
Prodiamesinae	1	-	-	1
Orthocladiinae	3	-	-	3
Chironomini	2	1	1	4
Stratiomyidae	-	-	1	-
Culicidae	-	-	1	1

Table 6. East Stour 1. 'Families' recorded in 'Spring' (Sp), 'Summer' (Su), 'Autumn' (Au) and Combined (Co) samples. Log categories of abundance (see text for details) are shown for each season and the sum of these categories is provided for combined samples for comparative purposes.

Family	Sp	Su	Au	Co
Valvatidae	-	-	1	1
Hydrobiidae	1	2	3	6
Lymnaeidae	1	1	1	3
Planorbidae	-	1	2	3
Sphaeriidae	3	3	3	9
Naididae	-	1	3	4
Tubificidae	3	3	3	9
Lumbriculidae	-	2	3	5
Glossiphoniidae	2	2	2	6
Erpobdellidae	2	2	2	6
Hydracarina	-	2	2	4
Asellidae	2	2	3	7
Gammaridae	2	3	2	7
Baetidae	1	2	2	5
Caenidae	3	3	2	8
Coenagriidae	1	-	1	2
Veliidae	-	-	1	1
Gerridae	-	-	1	1
Notonectidae	-	1	1	2
Corixidae	1	1	1	3
Haliplidae	1	2	3	6
Dytiscidae	2	2	3	7
Gyrinidae	-	1	1	2
Hydrophilidae	-	-	1	1
Elminthidae	-	1	2	3
Sialidae	1	-	1	2
Hydropsychidae	1	-	-	1
Leptoceridae	3	2	3	8
Ceratopogonidae	3	2	-	5
Tanypodinae	1	2	2	5
Diamesinae	1	-	-	1
Prodiamesinae	1	-	-	1
Orthocladiinae	3	2	1	6
Chironomini	4	2	1	7
Tanytarsini	4	2	3	9
Simuliidae	1	-	1	2

Table 7. Saltwood 1. 'Families' recorded in 'Spring' (Sp), 'Summer' (Su), 'Autumn' (Au) and Combined (Co) samples. Log categories of abundance (see text for details) are shown for each season and the sum of these categories is provided for combined samples for comparative purposes.

Family	Sp	Su	Au	Co
Planariidae	1	-	-	1
Hydrobiidae	4	5	5	14
Ancylidae	2	2	1	5
Succineidae	-	1	-	1
Sphaeriidae	1	1	2	4
Naididae	1	-	-	1
Tubificidae	2	2	3	7
Lumbriculidae	1	1	-	2
Lumbricidae	1	1	2	4
Glossiphoniidae	1	1	2	4
Erpobdellidae	-	1	-	1
Hydracarina	-	1	-	1
Gammaridae	2	3	2	7
Baetidae	2	2	1	5
Leptophlebiidae	-	1	-	1
Nemouridae	2	2	1	5
Corixidae	1	-	-	1
Dytiscidae	-	1	-	1
Hydrophilidae	1	-	-	1
Helodidae	1	1	-	2
Elminthidae	2	2	3	7
Rhyacophilidae	1	-	1	2
Polycentropodidae	1	1	1	3
Psychomyiidae	1	1	-	2
Hydropsychidae	1	1	-	2
Limnephilidae	1	1	2	4
Goeridae	1	-	-	1
Lepidostomatidae	1	1	-	2
Tipulidae	2	1	1	4
Psychodidae	1	-	-	1
Ptychopteridae	-	-	1	1
Ceratopogonidae	2	-	-	2
Tanypodinae	1	1	2	4
Prodiamesinae	2	-	2	4
Orthocladiinae	2	2	2	6
Chironomini	1	-	1	2
Tanytarsini	-	2	2	4
Simuliidae	2	2	2	6
Stratiomyidae	-	1	1	2
Empididae	1	-	1	2

Table 8. Taxa recorded at sites on the Saltwood and Seabrook streams from samples taken in 'spring', 'summer' and 'autumn' 1987.

	SW1	SW2	SB1	SB2	SB3	SB4
HYDRAZOA						
Hydrididae	-	-	-	-	-	+
TRICLADIDA (flatworms)						
Planariidae						
Polycelis felina	+	+	-	+	+	-
Dugesia polychroa group	-	-	-	+	-	-
Dugesia tigrina	-	-	-	+	-	-
MOLLUSCA (freshwater snails)						
Hydrobiidae						
Potamopyrgus jenkinsi	+	+	+	+	+	+
Lymnaeidae						
Lymnaea peregra	-	-	-	+	-	-
Ancylidae						
Ancylus fluviatilis	+	-	-	-	+	-
Succineidae						
Succinea sp.	+	-	-	+	-	-
Zonitidae						
Zonitoides sp.	-	-	-	+	-	-
Sphaeriidae						
Sphaerium lacustre	-	-	-	+	-	-
Pisidium casertanum	+	+	+	+	+	+
Pisidium nitidum	-	+	-	+	-	+
Pisidium personatum	+	-	-	-	-	-
Pisidium subtruncatum	+	+	+	+	+	+
Pisidium milium	-	-	-	+	-	-
OLIGOCHAETA						
Naididae						
Ophidonais serpentina	-	-	-	-	-	+
Nais elinguis	+	-	-	-	+	+
Tubificidae						
Aulodrilus pluriseta	+	-	-	+	+	+
Limnodrilus claparedeianus	+	-	-	-	-	-
Limnodrilus hoffmeisteri	+	-	-	-	-	+
Limnodrilus udekemianus	+	-	-	-	-	-
Potamothrix hammoniensis	-	-	-	+	-	-
Psammoryctides barbatus	-	-	+	+	-	+
Rhyacodrilus coccineus	+	-	+	+	+	+
Spirosperma velutinus	-	-	+	-	+	+
Tubifex ignotus	-	-	-	-	+	-
Tubifex tubifex	+	-	-	-	+	-
indet Tubificidae	+	+	+	+	+	+
Enchytraeidae	-	-	+	+	+	+
Lumbriculidae						
Lumbriculus variegatus	-	-	-	+	-	-
Stylodrilus heringianus	+	+	-	-	+	-
Stylodrilus lemani	-	-	-	+	-	-
indet Lumbriculidae	+	-	+	+	-	-
Lumbricidae						
Eiseniella tetraedra	+	-	+	+	+	-
indet Lumbricidae	+	+	-	+	+	+

	SW1	SW2	SB1	SB2	SB3	SB4
HIRUDINEA (leeches)						
Glossiphoniidae						
Batracobdella paludosa	-	+	-	-	-	-
Glossiphonia complanata	+	+	+	+	+	+
Erpobdellidae						
Erpobdella octoculata	+	+	-	+	+	+
HYDRACARINA (freshwater mites)	+	-	-	+	-	-
CRUSTACEA (water slaters and freshwater shrimps)						
Asellidae						
Asellus meridianus	-	-	-	+	-	-
Gammaridae						
Gammarus pulex	+	+	+	+	+	+
EPHEMEROPTERA						
Baetidae						
Baetis rhodani	+	+	+	+	+	+
Baetis vernus	+	+	+	+	+	+
Centroptilus luteolum	-	-	-	+	-	-
Leptophlebiidae						
Habrophlebia fusca	+	-	-	+	+	+
Paraleptophlebia submarginata	-	-	+	-	-	+
Ephemeridae						
Ephemera danica	-	-	+	+	-	-
PLECOPTERA						
Nemouridae						
Amphinemura standfussi	+	-	-	+	-	-
Nemoura cinerea	-	-	-	+	-	-
Nemoura erratica	+	-	-	+	+	-
Nemurella picteti	+	-	-	-	+	+
indet Nemouridae	+	-	-	-	-	-
Leuctridae						
Leuctra fusca	-	-	+	-	-	-
ODONATA (dragonflies and damselflies)						
Coenagriidae						
Ischnura elegans	-	-	-	+	-	-
HEMIPTERA (water bugs)						
Veliidae						
Velia caprai	-	+	-	+	-	+
Velia sp.	-	+	-	+	-	+
Corixidae						
Sigara distincta	+	-	-	-	-	-
Nepidae						
Nepa cinerea	-	-	-	+	-	-
COLEOPTERA (water beetles)						
Dytiscidae						
Ilybius fuliginosus	-	-	-	-	-	+
indet Dytiscidae	+	-	-	-	-	-
Hydrophilidae						
Anacaena globulus	-	+	-	-	-	-
Helophorus brevipalpis	-	-	-	-	-	+
Limnebius truncatellus	-	+	-	-	-	-
indet Hydrophilidae	+	-	-	-	-	-

	SW1	SW2	SB1	SB2	SB3	SB4
COLEOPTERA (water beetles) contd						
Helodidae						
Helodes sp.	+	+	+	+	-	-
Elmidae						
Elmis aenea	+	+	+	+	+	+
Limnius volckmari	+	+	+	+	+	+
Riolus subviolaceus	+	-	+	+	+	-
MEGALOPTERA (alderflies)						
Sialidae						
Sialis fuliginosa	-	-	+	+	+	-
NEUROPTERA (lace-wings)						
Osmylidae						
Osmylus fulvicephalus	-	+	-	-	-	-
TRICHOPTERA (caddis flies)						
'caseless'						
Hydropsychidae						
Hydropsyche fulvipes	-	-	+	-	-	-
Hydropsyche siltalai	+	-	+	+	+	-
Philopotamidae						
Wormaldia sp.	-	-	-	-	+	-
Polycentropodidae						
Plectrocnemia conspersa	+	-	+	+	+	+
Plectrocnemia sp.	+	-	-	-	+	-
indet Polycentropodidae	+	-	-	+	-	-
Psychomyiidae						
Lype reducta	+	-	-	-	-	-
Lype sp.	-	-	+	-	-	-
Tinodes unicolor	-	-	+	-	-	-
Tinodes waeneri	-	-	-	+	-	-
Tinodes sp.	+	-	+	-	-	-
Rhyacophilidae						
Agapetus sp.	+	-	+	-	-	-
Rhyacophila dorsalis	+	+	+	+	+	+
'cased'						
Goeridae						
Silo pallipes	+	-	-	-	-	-
Silo sp.	-	-	-	-	+	-
Hydroptilidae						
Hydroptila sp.	-	-	-	+	-	-
Lepidostomatidae						
Crunoecia irrorata	+	-	-	-	+	-
Limnephilidae						
Halesus digitatus/radiatus	-	-	-	+	-	+
Micropterna sequax	+	+	+	+	-	
Potamophylax cingulatus/latipennis	+	+	+	+	+	+
DIPTERA (true flies)						
Ceratopogonidae	+	+	-	-	-	+
Chironomidae/Tanypodinae						
Apsectrotanypus trifascipennis	+	-	+	+	-	+
Macropelopia sp.	+	-	-	+	+	+
Natarsia sp.	+	-	-	-	-	-
Procladius sp.	+	-	-	-	-	-
Thienemannimyia group	+	-	-	-	-	+
Zavrelimyia group	+	-	-	-	-	-

	SW1	SW2	SB1	SB2	SB3	SB4
DIPTERA (true flies) contd						
Chironomidae/Prodiamesinae						
Odontomesa fulva	-	-	-	-	-	+
Prodiamesa oliveacea	+	+	+	+	+	+
Chironomidae/Orthocladiinae						
Brillia modesta	+	-	+	+	+	+
Chaetocladius sp.	+	-	-	-	-	+
Eukiefferiella sp.	-	+	-	-	-	-
Orthocladius/Cricotopus sp.	+	+	+	+	+	+
Parametriocnemus stylatus	-	-	+	+	+	+
Paratrissocladius	+	-	-	-	-	+
Rheocricotopus	+	+	-	+	+	+
Symposiocladius	+	-	+	-	-	-
Tvetenia calvescens	+	-	-	-	-	-
Tvetenia sp.	-	-	-	+	-	+
Chironomidae/Chironomini						
Polypedilum sp.	+	+	+	+	-	+
Chironomidae/Tanytarsini						
Micropsectra/Tanytarsus	+	-	+	+	-	+
Rheotanytarsus	-	+	+	-	-	-
Stempellinella	-	-	+	-	-	-
Dixidae						
Dixa nubilipennis	-	-	+	+	-	-
Empididae						
Chelifera 'type'	+	-	-	+	+	+
Hemerodromia 'type'	+	-	+	+	+	-
Muscidae						
Limnophora sp.	-	+	-	+	-	+
Psychodidae						
Pericoma diversa	-	-	-	-	-	+
Pericoma trivalis	+	-	-	-	-	-
Pericoma sp.	-	-	-	-	+	+
Ptychopteridae						
Ptychoptera lacustris	+	+	+	-	-	-

Table 9. Saltwood 2. 'Families' recorded in 'Spring' (Sp), 'Summer' (Su), 'Autumn' (Au) and Combined (Co) samples. Log categories of abundance (see text for details) are shown for each season and the sum of these categories is provided for combined samples for comparative purposes.

Family	Sp	Su	Au	Co
Planariidae	2	-	-	2
Hydrobiidae	3	3	5	11
Ancylidae	-	-	1	1
Sphaeriidae	2	2	3	7
Tubificidae	1	1	2	4
Lumbriculidae	3	2	3	8
Lumbricidae	1	1	2	4
Glossiphoniidae	2	2	1	5
Erpobdellidae	1	1	2	4
Gammaridae	3	4	4	11
Baetidae	2	2	1	5
Veliidae	1	1	1	3
Hydrophilidae	-	-	2	2
Helodidae	1	1	2	4
Elminthidae	2	2	3	7
Osmylidae	-	-	1	1
Rhyacophilidae	-	1	1	2
Limnephilidae	1	1	2	4
Tipulidae	1	2	2	5
Ptychopteridae	1	-	-	1
Ceratopogonidae	-	-	1	1
Prodiamesinae	-	-	1	1
Orthocladiinae	2	-	2	4
Chironomini	-	-	1	1
Tanytarsini	-	-	2	2
Simuliidae	2	2	3	7
Stratiomyidae	-	1	-	1
Muscidae	1	-	-	1

Table 10. Saltwood 3. 'Families' recorded in 'Spring' (Sp), 'Summer' (Su), 'Autumn' (Au) and Combined (Co) samples. Log categories of abundance (see text for details) are shown for each season and the sum of these categories is provided for combined samples for comparative purposes.

Family	Sp	Su	Au	Co
Hydrobiidae	2	2	3	7
Sphaeriidae	1	-	1	2
Tubificidae	2	2	3	7
Lumbriculidae	3	3	3	9
Lumbricidae	1	1	2	4
Glossiphoniidae	2	1	2	5
Erpobdellidae	2	2	3	7
Gammaridae	3	3	4	10
Baetidae	3	3	3	9
Helodidae	2	-	-	2
Elminthidae	3	3	4	10
Rhyacophilidae	2	1	1	4
Hydropsychidae	2	2	3	7
Limnephilidae	-	-	2	2
Tipulidae	1	-	-	1
Ceratopogonidae	-	-	1	1
Orthocladiinae	2	2	3	7
Tanytarsini	-	-	2	2
Simuliidae	1	1	3	5
Empididae	2	2	-	4

Table 11. Seabrook 1. 'Families' recorded in 'Spring' (Sp), 'Summer' (Su), 'Autumn' (Au) and Combined (Co) samples. Log categories of abundance (see text for details) are shown for each season and the sum of these categories is provided for combined samples for comparative purposes.

Family	Sp	Su	Au	Co
Hydrobiidae	-	1	-	1
Sphaeriidae	2	1	-	3
Tubificidae	2	2	2	6
Enchytraeidae	-	-	1	1
Lumbriculidae	-	-	1	1
Lumbricidae	-	1	-	1
Glossiphoniidae	-	-	1	1
Gammaridae	3	3	4	10
Baetidae	3	3	3	9
Leptophlebiidae	1	-	-	1
Ephemeridae	1	-	1	2
Leuctridae	-	-	2	2
Helodidae	1	1	1	3
Elminthidae	1	1	1	3
Sialidae	1	-	1	2
Rhyacophilidae	1	2	1	4
Polycentropodidae	1	1	1	3
Psychomyiidae	1	2	1	4
Hydropsychidae	1	-	1	2
Limnephilidae	1	1	-	2
Tipulidae	1	1	2	4
Ptychopteridae	1	-	-	1
Dixidae	-	-	1	1
Tanypodinae	-	-	1	1
Prodiamesinae	1	-	-	1
Orthocladiinae	2	2	2	6
Chironomini	1	1	-	2
Tanytarsini	1	-	2	3
Simuliidae	3	2	2	7
Empididae	1	-	1	2

Table 12. Seabrook 2. 'Families' recorded in 'Spring' (Sp), 'Summer' (Su), 'Autumn' (Au) and Combined (Co) samples. Log categories of abundance (see text for details) are shown for each season and the sum of these categories is provided for combined samples for comparative purposes.

Family	Sp	Su	Au	Co
Planariidae	1	2	2	5
Hydrobiidae	1	2	3	6
Lymnaeidae	-	1	2	3
Succineidae	-	-	1	1
Zonitidae	-	-	1	1
Sphaeriidae	2	3	4	9
Tubificidae	3	3	3	9
Enchytraeidae	-	-	1	1
Lumbriculidae	2	2	3	7
Lumbricidae	2	1	-	3
Glossiphoniidae	2	1	2	5
Erpobdellidae	1	1	1	3
Hydracarina	1	-	-	1
Asellidae	-	1	2	3
Gammaridae	3	4	4	11
Baetidae	3	3	3	9
Leptophlebiidae	-	1	-	1
Ephemeridae	1	-	-	1
Nemouridae	1	-	-	1
Coenagriidae	-	-	1	1
Veliidae	-	1	2	3
Nepidae	-	-	1	1
Helodidae	1	2	-	3
Elminthidae	3	3	3	9
Sialidae	-	1	1	2
Rhyacophilidae	2	1	2	5
Polycentropodidae	2	1	1	4
Psychomyiidae	-	1	-	1
Hydropsychidae	2	2	-	4
Hydroptilidae	-	1	-	1
Limnephilidae	2	1	1	4
Tipulidae	2	3	2	7
Dixidae	-	-	2	2
Ceratopogonidae	-	-	1	1
Tanypodinae	-	2	2	4
Prodiamesinae	-	2	1	3
Orthocladiinae	2	2	1	5
Chironomini	-	-	1	1
Tanytarsini	-	3	2	5
Simuliidae	2	2	2	6
Empididae	1	1	-	2
Muscidae				

Table 13. Seabrook 3. 'Families' recorded in 'Spring' (Sp), 'Summer' (Su), 'Autumn' (Au) and Combined (Co) samples. Log categories of abundance (see text for details) are shown for each season and the sum of these categories is provided for combined samples for comparative purposes.

Family	Sp	Su	Au	Co
Planariidae	1	1	-	2
Hydrobiidae	1	2	2	5
Ancylidae	1	-	-	1
Sphaeriidae	1	1	2	4
Naididae	2	-	-	2
Tubificidae	2	2	2	6
Enchytraeidae	2	-	-	2
Lumbriculidae	1	-	2	3
Lumbricidae	1	2	1	4
Glossiphoniidae	1	-	-	1
Erpobdellidae	-	1	-	1
Gammaridae	3	4	3	10
Baetidae	3	3	3	9
Leptophlebiidae	-	1	-	1
Nemouridae	2	-	-	2
Elminthidae	2	2	2	6
Sialidae	1	-	-	1
Rhyacophilidae	1	2	2	5
Philopotamidae	-	1	-	1
Polycentropodidae	1	1	-	2
Hydropsychidae	2	2	-	4
Limnephilidae	1	1	-	2
Goeridae	-	-	1	1
Lepidostomatidae	1	-	-	1
Tipulidae	1	2	1	4
Psychodidae	1	-	-	1
Tanypodinae	-	1	-	1
Prodiamesinae	-	1	2	3
Orthocladiinae	2	2	-	4
Simuliidae	1	2	2	5
Stratiomyidae	-	1	-	1
Empididae	2	1	-	3

Table 14. Seabrook 4. 'Families' recorded in 'Spring' (Sp), 'Summer' (Su), 'Autumn' (Au) and Combined (Co) samples. Log categories of abundance (see text for details) are shown for each season and the sum of these categories is provided for combined samples for comparative purposes.

Family	Sp	Su	Au	Co
Hydridae	-	-	1	1
Hydrobiidae	-	1	1	2
Sphaeriidae	3	1	1	5
Naididae	1	-	2	3
Tubificidae	3	3	3	9
Enchytraeidae	1	-	-	1
Lumbricidae	-	1	-	1
Glossiphoniidae	-	1	-	1
Erpobdellidae	-	2	1	3
Gammaridae	2	2	3	7
Baetidae	2	3	2	7
Leptophlebiidae	-	1	-	1
Nemouridae	1	-	-	1
Veliidae	-	1	1	2
Dytiscidae	-	-	1	1
Hydrophilidae	-	1	-	1
Elminthidae	-	1	1	2
Rhyacophilidae	1	1	-	2
Polycentropodidae	-	-	1	1
Limnephilidae	1	1	-	2
Tipulidae	1	2	2	5
Psychodidae	2	1	-	3
Ceratopogonidae	1	1	1	3
Tanypodinae	-	-	2	2
Prodiamesinae	2	3	3	8
Orthocladiinae	-	3	2	5
Chironomini	-	2	1	3
Tanytarsini	-	2	1	3
Simuliidae	1	3	2	6
Empididae	-	1	1	2
Muscidae	-	-	1	1

Table 15. Seabrook 5. 'Families' recorded in 'Spring' (Sp), 'Summer' (Su), 'Autumn' (Au) and Combined (Co) samples. Log categories of abundance (see text for details) are shown for each season and the sum of these categories is provided for combined samples for comparative purposes.

Family	Sp	Su	Au	Co
Planariidae	1	-	-	1
Hydrobiidae	1	3	1	5
Ancylidae	1	-	1	2
Zonitidae	-	1	-	1
Succineidae	-	-	1	1
Sphaeriidae	-	1	1	2
Naididae	1	-	-	1
Tubificidae	1	3	2	6
Lumbriculidae	3	3	2	8
Lumbricidae	1	1	1	3
Glossiphoniidae	-	-	1	1
Erpobdellidae	1	2	-	3
Hydracarina	-	1	-	1
Gammaridae	3	3	3	9
Baetidae	3	3	3	9
Nemouridae	-	1	-	1
Veliidae	-	-	1	1
Haliplidae	-	1	-	1
Helodidae	-	1	-	1
Elminthidae	3	3	3	9
Sialidae	1	-	-	1
Rhyacophilidae	2	3	1	6
Hydroptilidae	-	1	-	1
Tipulidae	1	2	1	4
Psychodidae	-	1	-	1
Dixidae	-	1	1	2
Ceratopogonidae	1	1	-	2
Tanypodinae	1	1	-	2
Prodiamesinae	-	2	-	2
Orthocladiinae	2	3	1	6
Chironomini	1	1	-	2
Tanytarsini	-	1	2	3
Simuliidae	1	1	2	4
Empididae	1	1	-	2

Table 16. Pent 1. 'Families' recorded in 'Spring' (Sp), 'Summer' (Su), 'Autumn' (Au) and Combined (Co) samples. Log categories of abundance (see text for details) are shown for each season and the sum of these categories is provided for combined samples for comparative purposes.

Family	Sp	Su	Au	Co
Planariidae	2	3	3	8
Hydrobiidae	2	4	4	10
Sphaeriidae	3	3	3	9
Tubificidae	1	1	2	4
Lumbriculidae	-	1	-	1
Lumbricidae	1	-	-	1
Glossiphoniidae	1	1	1	3
Erpobdellidae	1	-	-	1
Hydracarina	-	2	1	3
Gammaridae	3	4	4	11
Baetidae	1	1	-	2
Nemouridae	1	-	-	1
Veliidae	-	1	-	1
Helodidae	1	1	1	3
Curulionidae	-	-	1	1
Rhyacophilidae	1	1	-	2
Polycentropodidae	1	3	1	5
Psychomyiidae	1	1	-	2
Limnephilidae	2	2	1	5
Lepidostomatidae	1	-	-	1
Sericostomatidae	-	2	1	3
Tipulidae	1	2	1	4
Ptychopteridae	2	2	2	6
Dixidae	-	-	1	1
Ceratopogonidae	2	3	2	7
Tanypodinae	2	3	-	5
Prodiamesinae	1	2	-	3
Orthocladiinae	2	2	-	4
Chironomini	1	-	-	1
Tanytarsini	2	2	2	6
Simuliidae	2	3	1	6

Table 17. Pent 2. 'Families' recorded in 'Spring' (Sp), 'Summer' (Su), 'Autumn' (Au) and Combined (Co) samples. Log categories of abundance (see text for details) are shown for each season and the sum of these categories is provided for combined samples for comparative purposes.

Family	Sp	Su	Au	Co
Planariidae	1	1	1	3
Sphaeriidae	2	3	2	7
Tubificidae	3	3	3	9
Lumbricidae	1	1	1	3
Gammaridae	3	-	4	7
Baetidae	2	3	-	5
Veliidae	-	-	1	1
Curculionidae	-	-	1	1
Limnephilidae	1	-	-	1
Tipulidae	1	-	-	1
Ceratopogonidae	-	-	1	1
Tanypodinae	1	-	-	1
Prodiamesinae	1	1	-	2
Dolichopodidae	1	-	-	1

Table 18. Pent 3. 'Families' recorded in 'Spring' (Sp), 'Summer' (Su), 'Autumn' (Au) and Combined (Co) samples. Log categories of abundance (see text for details) are shown for each season and the sum of these categories is provided for combined samples for comparative purposes.

Family	Sp	Su	Au	Co
Planariidae	-	1	1	2
Hydrobiidae	-	-	1	1
Lymnaeidae	-	1	-	1
Succineidae	-	-	1	1
Sphaeriidae	2	1	1	4
Tubificidae	2	2	1	5
Lumbriculidae	3	2	2	7
Lumbricidae	1	-	-	1
Glossiphoniidae	3	-	-	3
Erpobdellidae	1	1	1	3
Gammaridae	3	3	4	10
Baetidae	1	3	3	7
Veliidae	-	1	-	1
Hydropsychidae	1	-	-	1
Limnephilidae	1	1	2	4
Tipulidae	1	-	-	1
Tanypodinae	-	1	-	1
Orthocladiinae	2	1	1	4
Chironomini	1	-	-	1
Simuliidae	-	-	1	1
Stratiomyidae	1	-	-	1
Empididae	1	-	-	1

Table 19. A comparison of values of I derived from predictions using 11 physical (11P) and 11 physical and chemical (11PC) variables.

	11P	11PC
Family predictions		
Waterbrook 1	0.918	0.967
Waterbrook 2	0.970	0.957
East Stour 1	0.875	0.914
Seabrook 1	0.741	0.667
Seabrook 2	0.854	0.954
Seabrook 3	0.753	0.784
Seabrook 4	0.718	0.760
Seabrook 5	0.656	0.697
Species predictions		
Seabrook 1	0.573	0.557
Seabrook 2	0.885	0.807
Seabrook 3	0.588	0.693
Seabrook 4	0.661	0.507

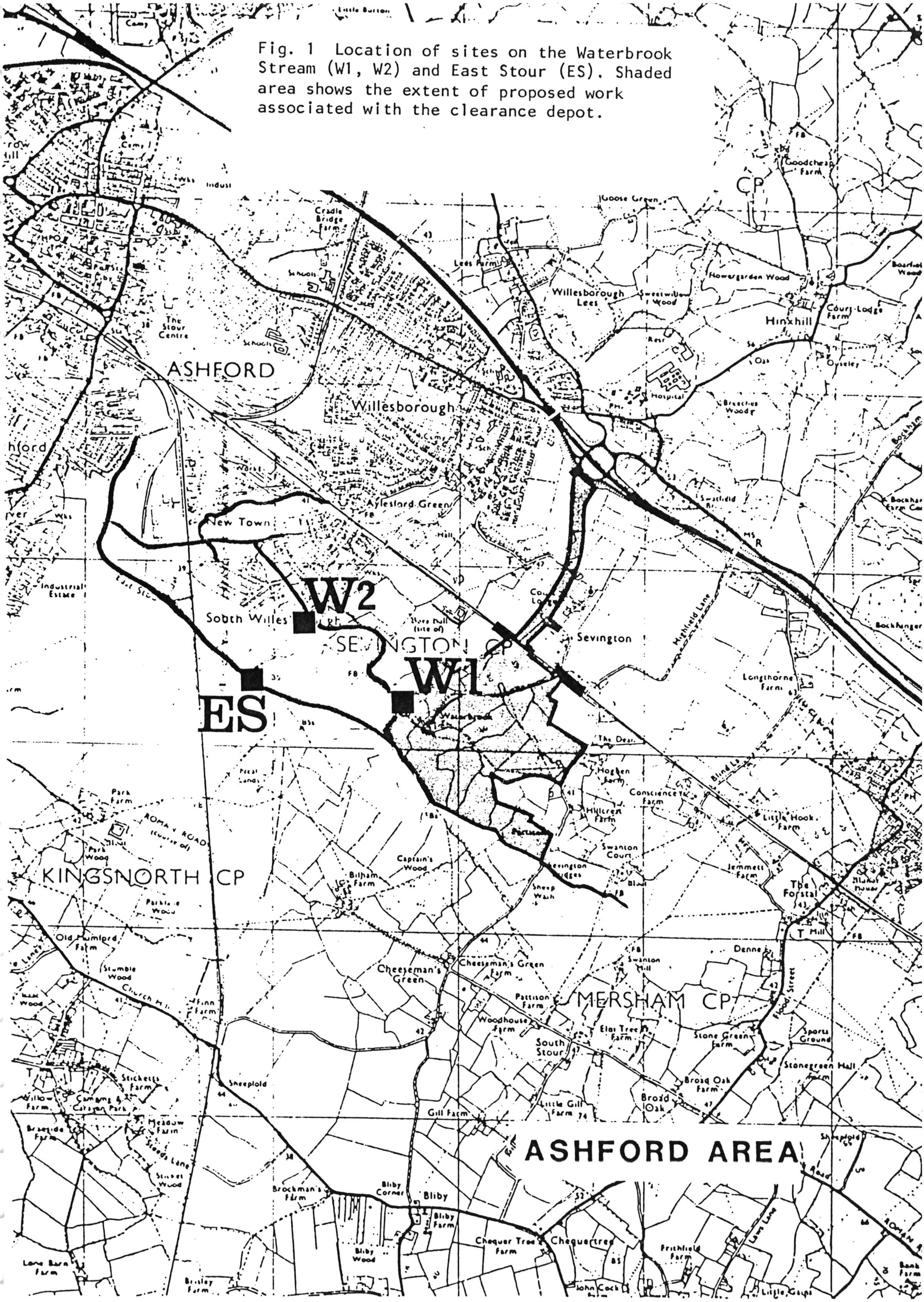

Fig. 1 Location of sites on the Waterbrook Stream (W1, W2) and East Stour (ES). Shaded area shows the extent of proposed work associated with the clearance depot.

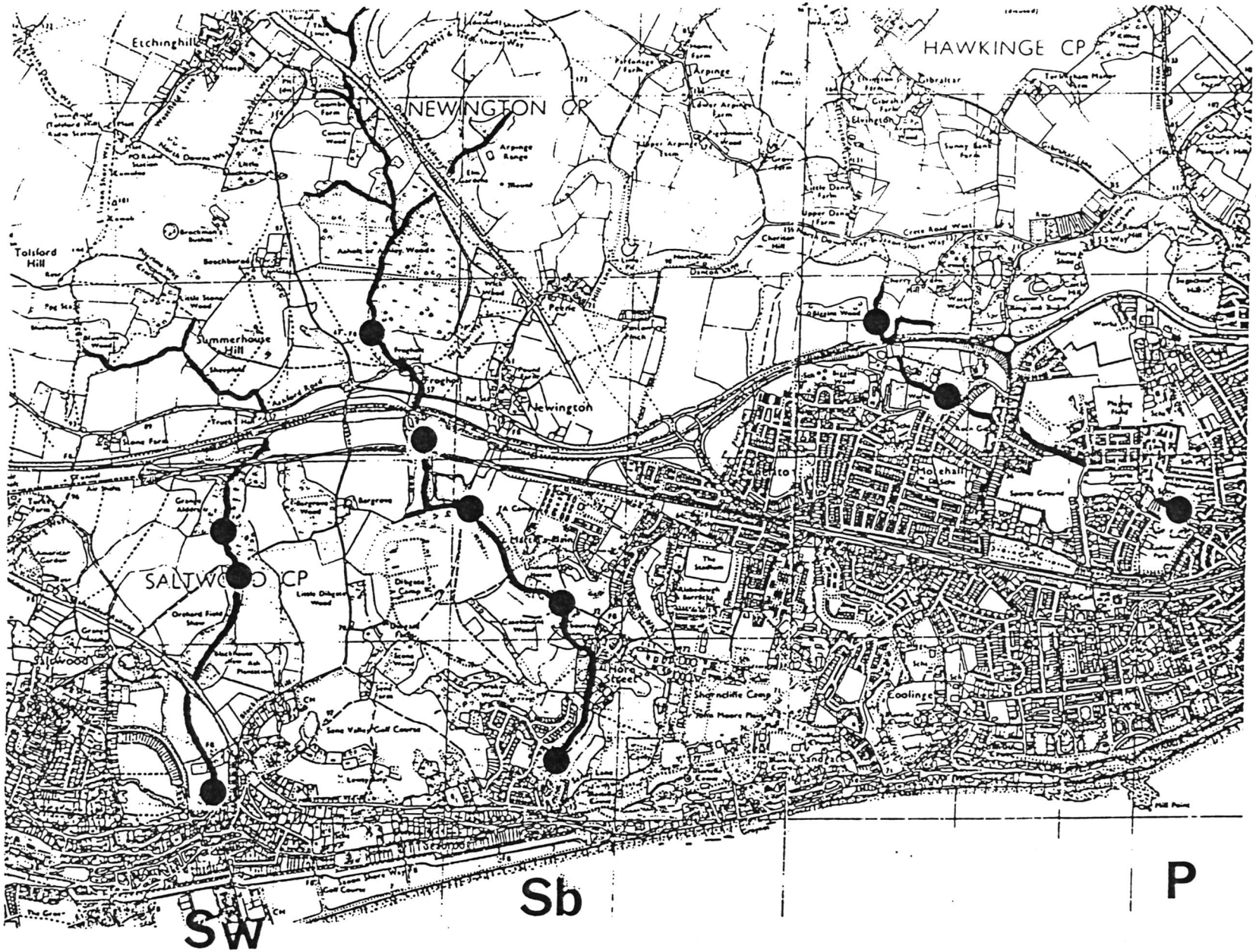

Fig. 2 Location of sites in the Folkestone area (Sw = Saltwood, Sb = Seabrook, P = Pent)

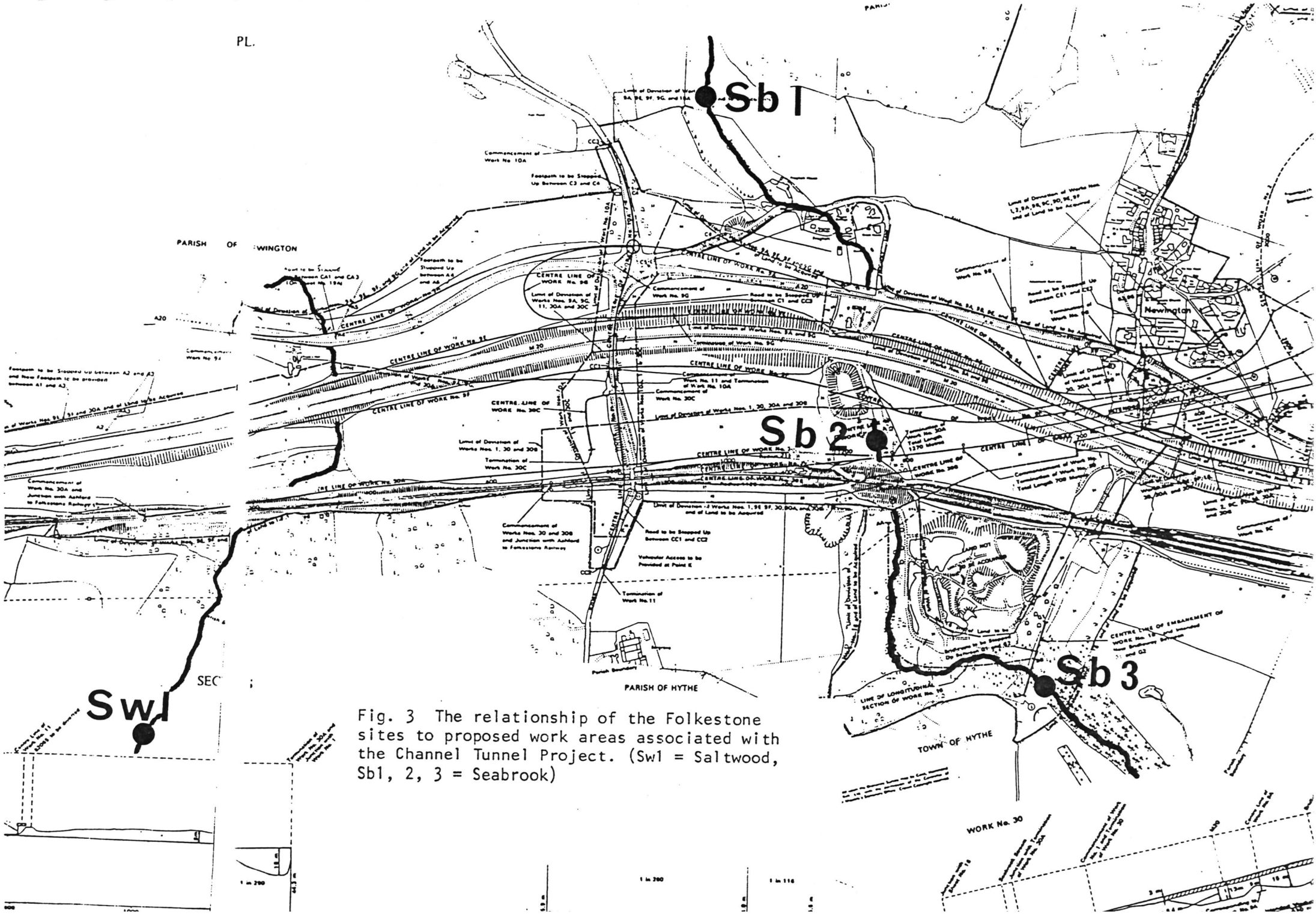

Fig. 3 The relationship of the Folkestone sites to proposed work areas associated with the Channel Tunnel Project. (Sw1 = Saltwood, Sb1, 2, 3 = Seabrook)

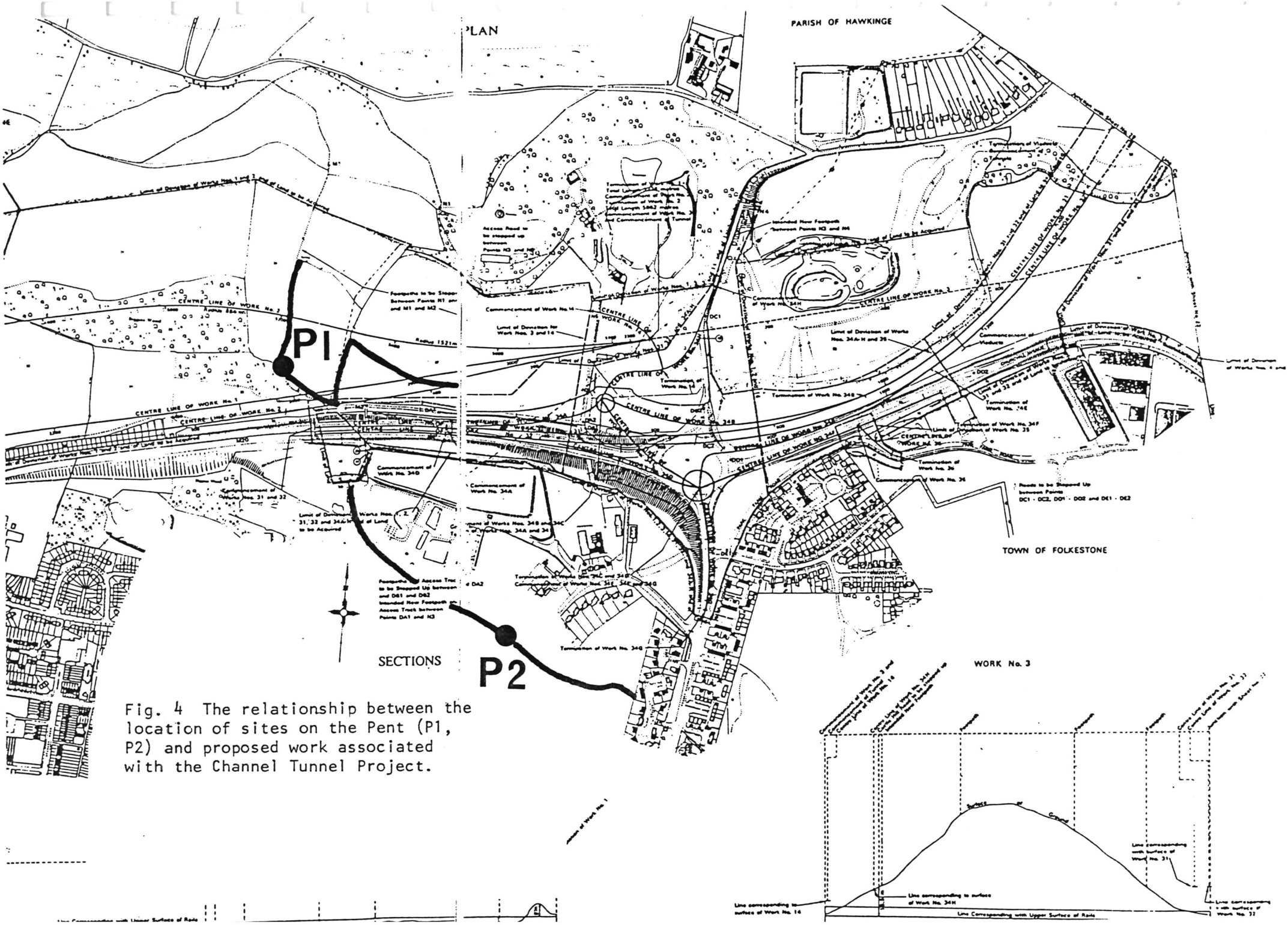

Fig. 4 The relationship between the location of sites on the Pent (P1, P2) and proposed work associated with the Channel Tunnel Project.

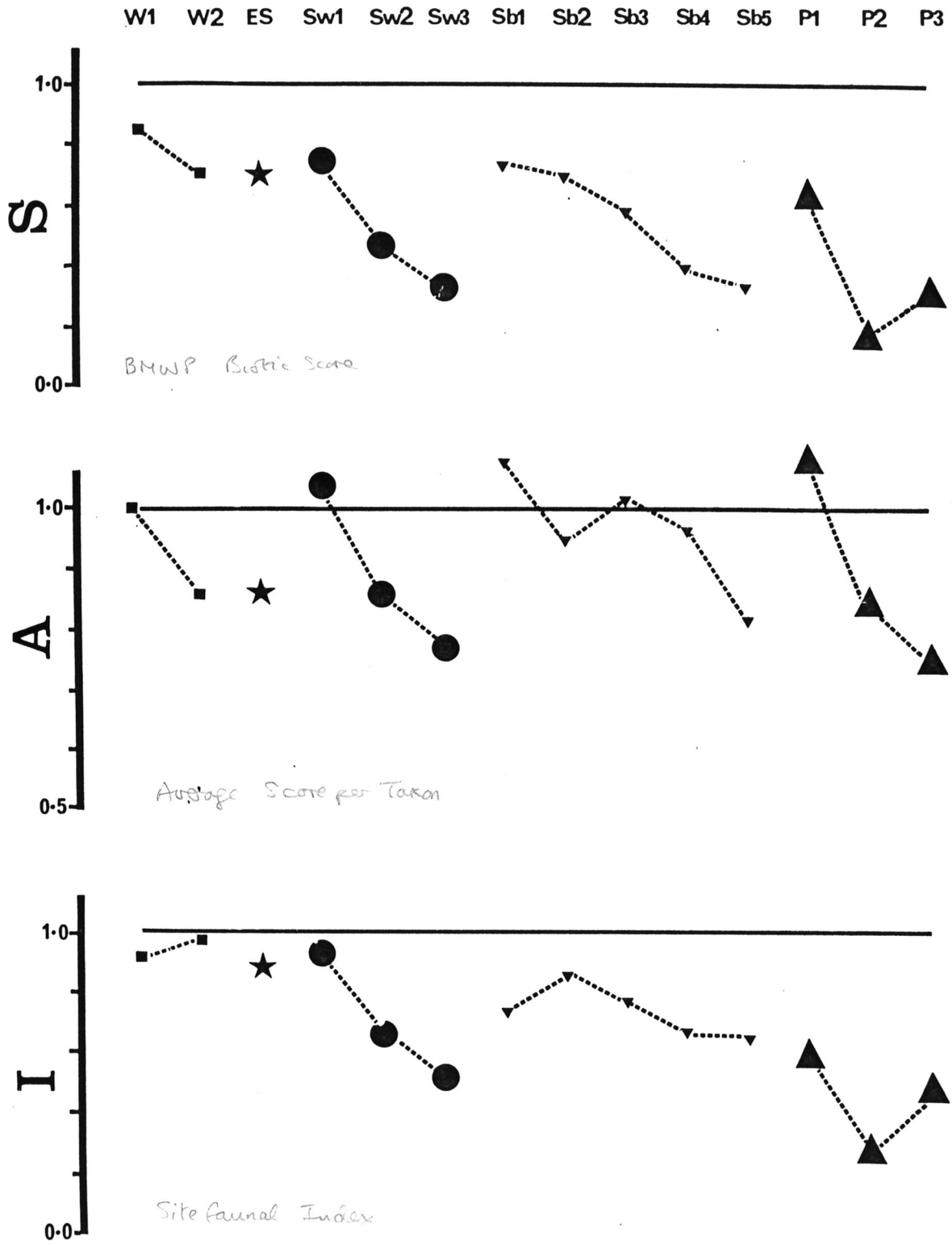

Fig. 5 The values of the indices I, A and S at the 14 sites, based on family predictions from 11 physical variables (W = Waterbrook, ES = East Stour, Sw = Saltwood, Sb = Seabrook)