INSECT NUISANCE ASSOCIATED WITH SEWAGE TREATMENT WORKS

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CONTENTS

		Page
	SUMMARY	5
1	INTRODUCTION	6
1.1	Sewage treatment in the UK	6
1.2	Statutory Nuisance vs nuisance	10
1.2.1	Statutory Nuisance	10
1.2.2	Statutory Nuisance from insects	11
1.2.3	The Statutory Nuisance regime	11
1.2.4	Complaints	12
2	REVIEW OF THE LITERATURE	13
2.1	Insects associated with STW filter beds	14
2.2	Factors influencing insect species present in filter beds	16
2.2.1	Filter bed medium	16
2.2.2	Loading of filter bed and film accumulation	16
2.2.3	Filter bed dosing frequency	17
2.3	Control mechanisms	18
2.3.1	Chemical and biological control	18
2.3.2	Physical control	20
3	SURVEYS	21
4	SURVEY RESULTS	22
5	SITE VISITS / WCO EMPLOYEE INTERVIEWS	31
6	DISCUSSION	38
7	CONCLUSIONS	44
8	RECOMMENDATION	45
8.1	Local Authorities	45
8.2	General Public	46
8.3	Water companies	47
9	ACKNOWLEDGEMENTS	48

10	REFERENCES	49
11	APPENDICES	60
	Appendix I	60
	Appendix II	63
	Appendix III	67
	Appendix IV	71
	Appendix V	72
	Appendix VI	73
	Appendix VII	75
	Appendix VIII	78

SUMMARY

Surveys were undertaken to assess the extent that insects derived from sewage treatment works (STWs) cause annoyance that may result in statutory nuisance. Questionnaires were sent to all local authorities (LAs) within the UK, and to all water companies with responsibility for sewage treatment. An extensive literature search provided additional information on the extent of such problems and mechanisms for abatement.

Responses from the LAs (190 replies) indicated that only a small proportion (19%) received complaints of STW-derived flies causing annoyance to residents. Only 1.5% of responding LAs indicated that such problems were significant when compared to other insect-related problems. In most cases where the species was indicated, flies that develop within trickling filters, such as *Tinearia alternata*, *Psychoda* sp. and *Sylivicola fenestralis*, were the cause of nuisance. In London, however, mosquitoes (*Culex pipiens* form *molestus*) were reported to cause annoyance to residents living close to a large activated sludge facility. Elsewhere in the UK, activated sludge plants were not reported as sources of insects and were occasionally cited as the reason why STW-derived insect complaints were not received.

Only a small number of questionnaire responses were received from water companies. However, interviews with staff, and site visits, allowed the extent that nuisance insects cause problems to be ascertained. Outside the London area all STW insect problems were reported as being associated with those that develop within trickling filter beds (confirming the findings of the LA survey) and no mosquito problems were reported. Large filter bed STWs are becoming increasingly rare as they are replaced by activated sludge facilities, and it is the smaller filter bed plants, that make up approximately half of all STWs in the UK, that typically give rise to insects. The close proximity of housing to such STWs was frequently reported as the reason why problems arose. Where problems occur, the control of flies associated with trickling filters is undertaken by use of netting placed on the filter's surface and/or the applications of VectoBac, a *Bacillus thurigiensis* var. *israelensis* formulation. VectoBac is also used to control mosquito larvae. No other forms of control were reported.

INTRODUCTION

1.1 Sewage treatment in the UK

There are over 9000 sewage treatment works (STWs) in the UK[1-12]. A large proportion of these STWs (ca. 50%) employ trickling filters (bacterial beds/percolating filters) for the biological oxidation and purification of presettled sewage.[13] Plants of this type remain extremely common in the UK and can range from very high volume facilities taking several hundred thousand population equivalents (PEs) of waste water daily, such as the facility at Esholt, West Yorkshire (Fig. 1), to facilities serving small towns and villages (Figs 2 and 3). As sewage percolates through the stone beds of the filters, a zoogloeal growth made up of dense populations of film-forming bacteria, fungi and protozoa develops.[14] These microorganisms remove the organic matter from the sewage and utilize it as a nutrient. A large number of macroinvertebrate species have been reported to feed upon, and breed within, this biofilm.[14-17] These organisms graze the biological film and are integral to the purification of the sewage, and to the maintenance of the zoogloea at a level that does not clog the filter.[18-20] Such organisms include oligochaete worms, molluscs, arachnids and insect larvae and there is general agreement that the presence of a mixed and diverse micro- and macrofauna is highly desirable for the efficient working of a filter bed.[18; 21,22]

Alternative methods for the oxidative treatment of sewage, such as the activated sludge process (ASP), are widely used. This procedure is generally used in higher volume plants and older high volume filter bed plants are gradually being replaced with newer facilities using this process.[4] Significant investment by the industry has seen conversion of several very large STWs to this process over the last decade, including the 1.7 million population equivalent (PE) plant at Minworth.[4] ASP plants produce an essentially aquatic environment that is in constant motion and not conducive to the development of insects[19,23], although some do occur. Where insects do occur at ASP plants, the source is generally due to the presence of stagnant water at locations removed from the aeration tanks.[7]

Occasionally, populations of some of the insects present in filter beds can rise to the extent that, on egression as adults, they may cause annoyance

to residents living near STWs. However, the species reported to be nuisance pests are relatively few in number and are exclusively dipteran flies. The most frequently occurring pest species belong to the nematoceran families Psychodidae, Chironomidae and Anisopidae. Occasionally, mosquitoes (Culicidae) have been reported as SWT-derived nuisance insects[24,25], although development of these insects is not directly related to the percolating filters, whilst various other diperan species may also occur in high numbers. Whilst control may be required at source, it is generally accepted that insecticide treatments upset the ecological balance present within the matrix of the percolating filter and may result in a reduction in its efficiency, which is highly reliant on the scouring action of insect larvae and the other organisms present. In the case of mosquitoes, control requires applications of insecticides to areas removed from the sewage treatment process, such as where standing water occurs, and therefore abatement does not usually interfere with the treatment process.

A.

B

C.

Figure 1. (A.) The filter bed at Esholt STW (West Yorkshire) showing one of the 52 acres of filter bed present at this site. (B) A typical medium sized plant at Marehay, Derbyshire, consisting of four filter beds. (C) A small STW at Huggate, East Yorkshire, consisting of two small filter beds and serving a village of approx. 500 inhabitants.

A.

B.

Fig. 2. The activated sludge process at Derby STW (a modern five year-old plant that replaced a large filter bed facility). Aeration ponds (A) comprise of constantly moving sewage that do not allow for the breeding of insects. Similarly, the final settlement ponds (B) have never given rise to insect problems. The surrounding area, where filter beds had previously been present, provided no obvious breeding sites for aquatic insects.

1.2 Statutory Nuisance vs nuisance

1.2.1 Statutory Nuisance

Statutory nuisance is a term in law. Section 79 to Part III of the Environmental Protection Act 1990 provides a list of factors that are capable of being a statutory nuisance – which are “prejudicial to health or a nuisance”. The list includes: premises; smoke; fumes or gases; dust, steam, smell or effluvia; accumulations or deposits; animals; noise; artificial light; and insects. Artificial light and insects are added through the Clean Neighbourhoods and Environment Act 2005 which amends section 79 of the Environmental Protection Act 1990.

In essence, a statutory nuisance is such that it materially affects someone’s use of their property, and/or is injurious to their health (or may be), as assessed on a case by case basis by the local authority or the courts.

A statutory nuisance may also be an "ordinary" nuisance at common law, in which event it may still be possible for tort proceedings to be brought by persons aggrieved by the common law nuisance, but without recourse to the streamlined procedures, or the requirement for local authority intervention and enforcement, that distinguish statutory nuisance.

In circumstances where a local authority is of the opinion that prosecution (for ignoring an abatement notice) under section 80(4) of the Environmental Protection Act 1990 would afford an inadequate remedy, section 81(5) of the Environmental Protection Act 1990 allows injunctive action to be taken. This would entail the local authority taking proceedings in the High Court and circumvents the “best practicable means” defence at section 80 (7).

A “nuisance” – not in the legal sense – might be defined as being inconvenient or annoying.

1.2.2 Statutory Nuisance from insects

Insects “emanating from relevant industrial, trade or business premises and being prejudicial to health or a nuisance” are capable of being a statutory nuisance. Protected species listed in Schedule 5 to the Wildlife and Countryside Act 1981 are exempt (unless they are included only to prevent their sale).

Certain land types are exempt, i.e. land which is used as arable, grazing, meadow, pasture, osier land, reed beds, woodland, market gardens, nursery grounds, orchards, and land in a site of special scientific interest, as well as land covered by, and the waters of, any river, watercourse (that is neither a sewer nor drain), and lakes and ponds. In addition, land in respect of which payments are made under specified land management schemes are exempt under the Schedule to the Statutory Nuisances (Insects) Regulations 2006.

1.2.3 The Statutory Nuisance regime

The statutory nuisance regime is set out at Part III of the Environmental Protection Act 1990 (as amended by the Noise and Statutory Nuisance Act 1993 and the Clean Neighbourhoods and Environment Act 2005, which introduces statutory nuisance from insects on relevant premises).

The statutory nuisance regime requires local authorities to check their areas periodically for actual and potential statutory nuisances, and to take reasonably practicable steps to investigate complaints of nuisance. Local authorities must issue an abatement notice once satisfied that a statutory nuisance exists or may occur or recur, requiring the cessation or abatement of the nuisance within a specified timescale. The abatement notice may (but does not have to) require works or steps necessary to abate the nuisance or restrict its occurrence or recurrence.

Private action may also be taken through the magistrates court under section 82 (1) of the Environmental Protection Act 1990.

Operators or business, trade and industrial premises may use the defence of “best practicable means”- that “best practicable means” have been used to prevent or counteract a statutory nuisance – in an appeal to the courts against an abatement notice, or as a defence in court for breaching or failing

to comply with an abatement notice. It is up to the operator to demonstrate "best practicable means", and for the courts to decide if they agree, on a case by case basis.

The concept of "best practicable means" is defined at section 79 (9) of the Environmental Protection Act 1990. It takes into account local conditions and circumstances; technical knowledge; financial implications; design, installation, maintenance and operation of plant and machinery; design, construction, and maintenance of buildings and structures; statutory duties; and health and safety. "Best practicable means" are not fixed and may change, e.g. over time and with advances in technology.

1.2.4 Complaints

The local authority should have in place a procedure specifying how any complaints will be administered, validated, monitored and progressed. The procedure should show who is responsible for dealing with the different aspects of the complaint – e.g. where complaints will be directed, who will manage the assessment and resolution of complaints, who has technical responsibility, what steps the local authority will follow from receipt of complaint to a decision on whether or not a statutory nuisance does or may exist.

Each complaint is assessed on a case by case using a range of criteria including frequency, duration, local environment, time of day, impact on sufferer, and motive and sensitivity of sufferer.

There should be regular communication and liaison between the local authority, operator, regulator (if there is one), complainants and other stakeholders on progress towards a resolution.

For the purpose of this report, "nuisance" is used, unless otherwise stated, in the non-legal sense i.e. inconvenience or annoyance resulting from the presence of insects that may lead to statutory nuisance. Similarly, "nuisance insects" are those species that have the potential to cause annoyance to the public should they occur in sufficiently large numbers.

2. REVIEW OF THE LITERATURE

Despite there being a significant amount of literature available on the species diversity of filter beds, their biology and ecology, and their incidence as nuisance pests, much of the work predates the 1970s. Even some of the more recently published work, such as Learner and Chawner[16] and Learner[17], relies on data generated in the 1960s. Very little original work has been undertaken post-1990 and the following review of the literature is heavily reliant on older sources. The Web of Knowledge, CAB Abstracts and BIOSIS databases were all searched and, of the search terms used, the most useful proved to be "*Psychoda*", "*Sylvicola"* and "sewage AND chironomid". These terms returned totals of 65 (WoK), 175 (CAB), and 225 (BIOSIS) hits, respectively, although duplication and lack of relevance resulted in only about 20 of these being of any real use (i.e. those applicable to the STW environment or fly control in aquatic environments). *Psychoda alternata* associated has recently been reclassified as *Tinearia alternata*. A small number of references were found using this search term although non were relevant.

An extensive search of other databases, conducted by the CSL information centre, identified 223 potential sources although only 16 sources were in anyway relevant and added only one reference not previously identified. This review of the existing literature draws heavily on sources cited by Painter[26], who provides approximately 100 relevant sources, although due to the age and duplication of much of this information, only relevant sources have been cited here.

A summary of search terms used for the major bibliographic databases, and the hits they returned is tabulated in Table 1. A number of web-based resources were also identified and are discussed here, although only those considered of high quality or relevance are used.

2.1 Insects associated with STW filter beds.

The incidence of insects at any given STW is variable and changes both during the year and through different years.[26] However, the evidence from the available literature is unequivocal in reporting that the major sources of insect nuisance associated with STWs are caused by psychodid, anisopid and chironomid flies. The major nuisance species derived from STW filter beds are the moth fly, *Tinearia (=Psychoda*) *alternata* Say (= filter/drain fly), and the window gnat, *Sylvicola* (=*Anisopus*) *fenestralis* (Scopoli).[17] Other *Psychoda* species, such as *Psychoda albipennis* Zetterstedt (=*Psychoda severini* Tonnoir) and *Psychoda cinerea* Banks, may also occasionally emerge in high numbers and are frequently reported as nuisance pests in the literature.[17,27] No recent evidence referring to the degree that these insects occur as nuisance pests in the UK is available in peer-reviewed publications. However, some indications of fly outbreaks have been reported in the popular press and magazine articles.[28,29]

Whilst none of the filter-derived insects sting or suck blood, they cause annoyance when found in, and around, the house. Similarly, whilst there is no evidence that they transmit disease, in the case of *Tinearia* / *Psychoda* species, enteric bacteria have been found on their bodies[30] and they may cause allergic reactions through the shedding of hairs and scales and through post-mortem disintegration.[32,32] More seriously, there have been reports of human urogenital myiasis caused by psychodids[33] although there are no reports from the United Kingdom, probably because infected humans are required to have an intimate association with polluted water for infection to occur. The biology, ecology and thermal requirements of the *Tinearia* / *Psychoda* species and *S. fenestralis* have been extensively researched[23, 34-38] and allows for predictions on the likelihood of high population outbreaks to be made. The chironomids *Lymnophyes minimus* (Meigen) and *Metriocnemus* sp. may also occur in numbers sufficiently high to cause annoyance to the general public on occasion.[26] Learner[17] provides an extensive list of dipterans found in association with filter beds that also include sphaerocerid, ephydrid, ceratopogonid and sepsid flies. However, species in these latter families generally occur far less frequently[17] and are only rarely pests.

Mosquitoes (Culicidae) have been reported as being associated with SWTs but their larval development is not typically associated with the filter bed. Where problems occur, these can be related to other niches created in and around the STWs where areas of standing stagnant water are present.[24,25] Mosquitoes are rarely cited as associated with STWs in the UK. However, the case of the Mogden facility in London, where *Culex pipiens* form *molestus* occurs in numbers sufficient to generate complaints from the public, illustrates that they can pose a significant and persistent problem in certain scenarios.[24,25]

The interactions within, and between, macro invertebrate species in STW filter beds has been extensively investigated[35,39,40] and indicates that species competition plays an important regulatory role in populations of any given insect species, and that the likelihood of the numbers of any given insect species rising to pest status may be governed by what other species co-occur within a given filter bed. An example of this interaction being illustrated by the observation that chironomids exert a control over the abundance of psychodids.[41] Therefore, species richness can be seen as an important factor in regulating fly populations and also in maintaining the efficiency of the filter through preventing the excess accumulation of film. Low, but variable, thermal thresholds ensure that most of the major nuisance insects can be found throughout the year although they typically egress as adults in large numbers at defined points, depending on each species' developmental rate and the prevailing thermal regimes.[30,36-38] Wind speed, precipitation and diurnal rhythms also play important factors in governing the egress of flies from filter beds.[38,42]

It is important to remember that insects associated with STWs have adapted from other ecological niches[15] and the presence of psychodids, mosquitoes and other fly species around residential properties may not necessarily be as a result of proximity to a STW. *Tinearia alternata* and *Psychoda* species, for example, will readily breed in drains and other similar environments[43] and problems may result directly from these sources.[44] *Culex pipiens*, which can develop in water grossly polluted water with a high organic content, may similarly take advantage of aquatic niches created by STWs.

The availability of niches in the general urban environment for this insect, however, are manifold.

2.2 Factors influencing insect species present in filter beds

2.2.1 Filter bed medium

The medium used in the percolating filters has frequently been seen as a significant determinant of species diversity. Factors include both the size and derivation of the substrate used. Physical characteristics, such as smoothness of the substrate have also been seen as a factor and are variable between STWs.[14] Typically, the filter beds of STWs are constructed using a rocky substrate, such as gravel, blast furnace slag, klinker, pebbles etc. The use of such materials is typically determined by local availability[16] and filter beds may be variable in depth, area and shape.[14] More recently constructed facilities, however, occasionally use artificial substrates made from plastic.

Insect populations have been widely reported to be affected by the type and grade of filter substrate used. An important factor appears to be the size of the matrix, although taking single factors in isolation can be misleading. This notwithstanding, it appears that that the major psychodid pest species favour larger stones, of greater than 5 cm in diameter, that generally facilitate higher emergence rates of the imago.[45] Similarly, using a smaller grade of medium is also seen as a factor in reducing the emergence of the window gnat, *S. fenestralis*.[46]

2.2.2 Loading of bed and film accumulation

The quantity of organic material loaded onto the bed can have a marked impact on the invertebrate populations present within a given filter bed. Furthermore, the presence of industrial and agricultural effluents within the settled sewage applied to the beds can also manifestly alter species composition, usually through creating an impoverished faunal structure. For example, *T. alternata* is favoured by the relatively high loading provided by “strong” sewage.[14] When chemical pollutants are present *T. alternata* may be the only dipteran species present which, in the absence of competition, can lead to very high population levels.[47] However, the quantity of film present in a given filter is reliant on the dynamics between species present, the extent of

scouring and the time of year.[48] Therefore, the availability of food present for developing psychodids may not necessarily be correlated with the physical loading of the bed and competition with other species may become a factor. In the case of *S. fenestralis*, largest populations occur at high organic matter levels[49] but film levels are quickly reduced. As a consequence of the removal of film, numbers subsequently become severely limited by low food availability, a scenario that frequently occurs following high population levels of this insect at certain times of the year.[37] However, recirculation of effluent to reduce the quantity of organic matter can also reduce populations.[38]

2.2.3 Filter bed dosing frequency

Filter beds typically receive a volume of effluent periodically via nozzles on a rotating distributor arm. Various types of distribution mechanisms are used (Figs 1-3). The volume applied, and the frequency of passes, varies between STWs and can manifestly affect filter efficiency[50] as well as species richness and the outbreak of a given insect as a pest.[36,48] For example, Hawkes and Shepard[51] indicated that a low dosing frequency inhibited all dipteran fly populations when compared to higher dosing rates, a finding somewhat at odds with den Otter's[45] findings. Importantly, dosing rate was also seen to affect which species were present, with *Tinearia alternata* and *Psychoda* species more prevalent in higher dosing regimes, whilst at lower dose rates chironomids were more prevalent. There is also evidence that, where psychodids are rare, *S. fenestralis* invasion of the filter bed may occur and may further suppress the filter fly populations.

It has been noted that the efficiency of application of sewage to filters is also a factor in species success. For example, den Otter[45] demonstrated that poor distribution over the filter bed leads to drier lanes forming from which egression of *Tinearia* and *Psychoda* occurs. Similarly, whilst *S. fenestralis* larvae are more common in the subjet areas of filter beds, the pupae are more commonly found in the drier interjet regions from where the adults egress.[36; 49] Efficient distribution of liquid over the whole bed, through the installation of splash plates for example, allows for a more even wetting of the filter which can suppress fly emergence to a degree, although Hawkes[21] suggests that

better spacing of jets, without the use of splash plates, constitutes a better distribution mechanism.

2.3 Control mechanisms for STW-derived insects

Control of flies deriving from the filter beds of STWs can largely be seen as a choice between either a chemical or physical approach. The options available for mosquito control, however, may be broader due to their breeding sites being located away from the treatment process.

Whilst chemical control of filter-breeding flies may be necessary in certain circumstances, the damage done to the ecological balance of the beds is undesirable and may lead to the build up of organic matter within the filter and a reduction in faunal diversity[49,51] leading to reduced efficiency. Many of the extensive studies into the biology and ecology of the major insect species associated with STWs have yielded findings that allow for the manipulation of the filter beds in such a way as to minimize insect nuisance occurrence through physical or operational means. Despite this, chemical control techniques have been widely explored and, more recently, biorational techniques using biological control agents and insect growth regulators have been investigated. However, despite there being a number of control strategies available, it has generally been thought that none of the control measures that have been implemented for the control of dipterans that develop in percolating filters have been entirely satisfactory.[25,52,53] The paucity of peer-reviewed literature concerning the control of these pests after the early to mid 1990s, suggests that little research has been undertaken to alter this standpoint.

2.3.1 Chemical and biological control

Prior to the advent of synthetic insecticides, a number of chemical techniques were employed at STWs, primarily for the control of *Tinearia alternata* and *Psychoda* species developing in biological filters. These techniques used the application of creosote, paraffin and calcium chloride to the filter beds.[54,55] However, during the 1940s, the use of organochlorine insecticides (e.g. BCH, DDT) became prevalent and showed some degree of efficacy[42,56-61] although exposures rapidly led to resistance in the target insects[60] and to

environmental concerns. Later control measures utilised organophosphate insecticides, such as malathion and pirimiphos-methyl, and whilst effective in some cases[46,62], their use was again restricted due to environmental concerns, particularly regarding non-target toxicity.[61] The benzoyl urea insecticide diflubenzuron (dimilin), a compound that inhibits the synthesis of chitin, a component of the insect cuticle, has also been evaluated but showed poor efficacy against *S. fenestralis*[14] whilst against psychodids some activity has been recorded, although not in STW applications.[63] A second chitin synthesis inhibitor, cyromazine, has also been explored as a potential midge control agent in the STW environment, albeit with variable degrees of control[64] and in the context of the activated sludge process.

More recently, alternative (biorational) methods for the control of insects associated with STW filter beds have been evaluated. Coombs *et al.*[65] reported trials using the insect growth regulator (IGR) pyriproxyfen, a compound that mimics the activity of an insect's own endogenous juvenile hormones (JH). This JH analogue (JHA) was seen to provide a measure of control of *T. alternata* for periods of approximately one month at a Manchester STW, with no adverse effects observed in non-dipteran fauna. This IGR has similarly shown potential against mosquitoes in related aquatic environments.[66] Similarly, other workers have evaluated a second JHA, methoprene, against *T. alternata* and, although they provided no data on efficacy when applied to filter beds, showed that control of filter flies could be achieved in some scenarios[67] and not in others.[63] A methoprene-based product specifically for midge/filter fly control in filter beds is available in the USA as the formulation "Strike".[68] Approaches using a JHA-based strategy are particularly attractive as these compounds only act against late stage larvae and, as a result, allow grazing juvenile populations to persist, which is beneficial for the efficient functioning of the filter beds.

Further work has involved the use of the entomopathogenic bacterium *Bacillus thuringiensis* (*Bt*). A dipteran specific isolate of this bacillus, *Bacillus thuringiensis* var. *israelensis* (*Bti*), was tested against several nuisance fly species in both laboratory and field situations [52,53,69,70], and was shown to be efficacious in reducing numbers of both *S. fenestralis* and psychodid species, amongst others. Research in Japan has indicated that several other *Bt*

isolates may also have potential against a range of nematocerans, including filter flies.[71] The use of strains of this bacterium is typically environmentally benign as it is highly host specific, rapidly kills fly larvae, and the likelihood of non-target effects, particularly to aquatic fauna, is negligible. Currently, *Bti* is the only larvicide (available as the formulation VectoBac) used against insects developing in percolating filters and other aquatic environments associated with STWs.

For mosquitoes, that breed in still water, a wide range of insecticides, including conventional, biological, botanical and biorational formulations, have been used over the years that include both JHAs, such as methoprene, and *Bti* formulations. In the case of *Bti*, a major limitation is the very short window of opportunity for effective use whilst, although it has a broader window for treatment, the efficacy of methoprene cannot be gauged until it is too late to retreat.[72] *Bti* suffers the additional disadvantage that it is not recycled within insect populations, shows very limited persistence, and efficacy against mosquito larvae has been negatively correlated with organic pollution.[73] Methoprene, on the other hand, has been reported to have better persistence and, in most cases, shows higher efficacy against mosquito larvae.[74] Currently in the UK, as with the filter-derived flies, control at STWs is achieved through the use of VectoBac.

2.3.2 Physical control

Many of the suggested methods for physical control have been inferred from observations and research into the biologies of the major dipteran species associated with STWs filter beds. These include manipulations of the size of the matrix used in the filter, and by default, the interstitial spaces. Such research has indicated that stone sizes below a certain diameter can be deleterious to *T. alternata* and *Psychoda* species resulting in inhibition of adult emergence.[30] However, reduced interstitial spaces can lead to clogging of the filter through build up of organic matter, leading to surface ponding of the sewage.[14]

Flooding of filters for periods of time have been considered a potential control for *Psychoda* species[45,75], although periods of 24-48 hrs are typically required to eliminate all filter fly larvae.[75] There is some evidence in the

literature that this procedure can be effective, although it requires a watertight filter[14,31] and the filter bed to be capable of physically withstanding the weight of water held. Conversely, the complete drying of the filter has also been considered, but practicalities limit its potential. Firstly, drying periods may be long and require the filter to be withdrawn from use for periods in excess of a week. Secondly, drying of the filter is severely deleterious to the zoogloea and associated no-dipterans, leading to the beneficial fauna of the filter being effectively destroyed.[45] Enclosure of the filters was first attempted prior to World War II[55] as a means of preventing the emerged of flies from escaping although cost and other factors largely limited the uptake of this method for the prevention of insect nuisance.[26] Withdrawal of available insecticides has, however, led to widespread use of netting as a means of physically enclosing filter beds in the UK in recent years.

Dosing frequency has frequently been evaluated as a mechanism for regulating the egress of flies from filter beds. This serves both to regulate the wetness of the filter at any given time, and the biological loading. The evidence, however, is somewhat contradictory as to which regime is best although there are indications that the even distribution of sewage over the bed is beneficial is inhibiting filter fly emergence, whist higher organic loading may benefit them.[49] A low dosing rate, in terms of the volume applied has the opposite effect and is frequently cited as a factor in the inhibition of egression of both *T. alternata*, *Psychoda* sp. and *S. fenestralis* adults.[51]

3. SURVEYS

To ascertain the frequency of occurrence of insect nuisance associated with STWs, targeted questionnaires were developed and submitted to accrue information from local authorities (LAs), water companies (WCOs) and pest control operators (PCOs) (Appendices I-III). A list of the consultation criteria, and a freedom of information statement, were appended to all surveys, (Appendix IV). In the case of the local authority questionnaires, the surveys were designed to determine whether there is an existing problem, how the problem is dealt with, what legislation is referred to if outbreaks prove problematic and what insects are considered a problem. The water authority

questionnaires, and those sent to the pest control companies, followed a similar line of enquiry, albeit with slightly different emphases.

All of the local authorities in the UK, as listed in the http://www.direct.gov.uk/ website, received a survey (a total of 464). Similarly, the ten water and sewerage companies of England and Wales listed on the http://www.ofwat.gov.uk/ website (and the single water companies of Scotland and Northern Ireland) also received questionnaires. A semi-random selection (geographic distribution was considered in the selection process) of pest control companies listed on the British Pest Control Association (BPCA) website (http://www.bpca.org.uk/) also received a questionnaire (80 companies).

Facilities for electronic data capture via an internet-based survey system was provided as an alternative to completing the paper questionnaires. All data from the paper surveys was inputted and archived using this system.

4. SURVEY RESULTS

A total of 190 replies were received from the LA questionnaire by 17/03/2006 (41% of surveys). Replies were obtained across the UK with approximately 80% of the responses derived from England, 8% from Scotland, 6% from Wales and 5% from Northern Ireland (Fig. 3). A further two respondents failed to indicate their addresses.

Almost all responses were produced by council staff concerned with either environmental/public health (ca. 74%) or pest control, although a number of responders gave less specific titles, or failed to designate (Fig. 4). The majority of responders (86%) indicated that insect nuisance associated with STWs was their authority's responsibility, whilst 8% thought it beyond their remit; only 6% did not know (Fig. 5). Approximately 19% of responding LAs indicated that they received complaints from the general public over insects associated with STWs (Fig. 6) although only a small proportion of these (6% of positive responses; 1.5% of all responses) thought that this constituted a major part of the insect problems dealt with by their authority (all in South East England). The geographical distribution of all responses is

shown in Figure 7 and indicates that all positive responses were obtained from England and Northern Ireland.

The majority of those that responded positively to the survey indicated that any action taken would be under legislation set out in the EPA 1990 (64% of LAs. Several responders indicated that other legislation may apply (Fig. 8) and the EPA 1990 comprised 58% of all answers given. Two responding authorities indicated that they had both invoked legislation (EPA 1990); in one case the LA was advised by counsel that the legislation was not applicable (Hounslow), whilst the second issued an abatement order under statutory nuisance (Sheffield). Further responses indicated that the EPA was insufficient or did not cover statutory insect nuisance (Gateshead, Devon, Tondbridge and Malling). One response indicated that the Clean Neighbourhoods and Environment Act would strengthen this area of legislation (Stockton on Tees) whilst another (Mid-Devon) doubted that the new legislation would be of any improvement over the existing Act. A list of LAs that responded positively to the questionnaire is tabulated in Appendix VII. A full list of comments is included as an Excel spreadsheet supplied with this report.

A number of the LAs that did not report any complaints for nuisance insects associated with STWs provided additional generic information (i.e. how they deal with insect pests generally). Again, most indicated that the EPA 1990 would be used if insect nuisance associated with STW occurred. However, several responders indicated that several pieces of legislation might apply. Again, a number of responses suggested that the EPA as it stood was insufficient for dealing with statutory nuisance caused by insects (Appendix VIII).

Response as to how sources of nuisance were identified often followed the logical procedure of identifying common insects at both the complainant's premises and the potential source, surveying for insects etc. In approximately 74% of cases where complaints over the occurrence of nuisance insects were received, this procedure was followed. A variety of other answers indicated that sources were rarely in doubt and that further proof of insect origin was not needed. Almost all authorities with STW-derived insect problems indicated that they initially attempted to identify insects using their own experts or used

trained entomologists, either at academic establishments or pest control companies. Only two of the LAs that reported STW-derived fly problems failed to state how insects were identified.

Where specified, virtually all complaints over STW-derived insects arose from either the presence of *Tinearia* / *Psychoda* sp. (22% of LAs with STW insect complaints), *Sylvicola fenestralis* (19%) or chironomids (11%); four responses (11%) indicated that mosquitoes were a problem. In the case of the mosquito reports, three were from South East England (South Bucks, Houslow, Richmond) whilst the fourth originated in West Yorkshire (Bradford). In several cases, where species were specified, more than one pest species was identified (e.g. psychodids and *Sylvicola* co-occurring). A number of responses indicated that annoyance to the public was caused by "sewage flies" of "filter flies" and, on the assumption that these are psychodids, flies associated with filters were named as pests in the majority of cases (85%).

Control measures were largely reported as dealing with the problem at source through liaising with the water company. Usually, advice alone was provided to the complainant on what actions may be taken to alleviate the problem within residential premises (e.g. proofing, the use of domestic insecticidal products), with no other actions generally deemed necessary. In the case of the mosquito problems in London, more concerted efforts have been made to deal with the problem including the production of public information leaflets for distribution around the Mogden STW (Richmond) by Thames Water, the LAs of Hounslow and Richmond.

A small number of the negative responses indicated that, whilst STWs were not a source of insects that cause annoyance to the public, animal houses, manure spreading and landfill led to complaints within their authority (6 instances). A number of LAs indicated that no STWs were sited in their authority (12 responses) whilst some responders indicated that those STWs present used the activated sludge process, were enclosed or located away from housing, and did not give rise to insect pests (8 responses). A further five responses indicated that the major problem associated with STW is odour.

Only two replies were received from water companies and provided only limited information. However, informal telephone interviews and site

visits provided some or all of the required information from approximately 75% WCOs. Information from the LAs was also valuable in identifying which water companies have had recent problems with STW-derived flies.

For the PCO questionnaires, at total of 14 responses were received (17.5%). Only one responder (Terminix) indicated that it dealt with STW-derived insects. In this case, the primary insects treated were psychodids and all treatments were undertaken outside the STW. Little further information of relevance was obtained and results are not shown.

Table 1. Summary of the results of some of the search terms used in the literature searches of three significant agri-science bibliographic databases. Relevant results are restricted to those directly applicable to insects associated with sewage (including mosquitoes) and methods for their control.

Search Term	**Web of Knowledge***		**CAB Abstracts****		**BIOSIS‡**	
	Hits	**Relevant**	**Hits**	**Relevant**	**Hits**	**Relevant**
Sewage treatment	2997	ND†	5684	ND	31562	ND
Sewage treatment AND Insects	6	1	51	13	36	3
Sewage AND insect	21	3	124	18	117	7
Sewage AND fly	210	ND	137	ND	962	ND
Sewage AND pest	11	0	457	ND	2559	ND
Sewage AND *Psychoda*	5	5	14	10	9	6
Sewage AND *Sylvicola*	3	2	3	2	4	2-
Sewage AND chironomid(ae)	10	1	29	4	53	5
Psychoda	35	7	101	13	74	9
Sylvicola	20	2	45	2	98	2
Tinearia	4	0	7	0	11	0
Tinearia alternata	3	0	6	0	9	0

* References since 1981

** References since 1973

‡ References since 1985

† ND – Not determined, search terms refined.

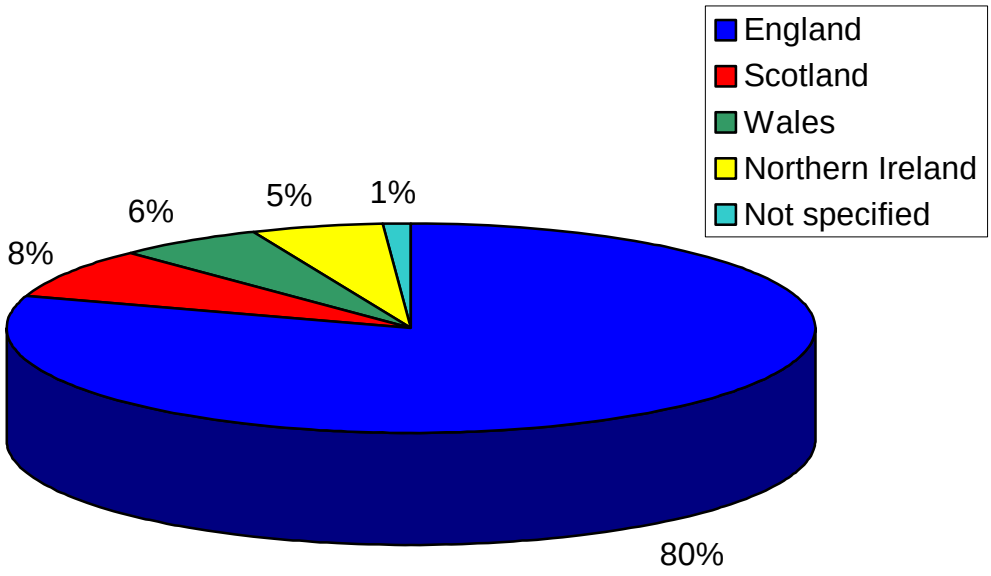

Fig. 3. Proportions of responses to the LA questionnaire by region.

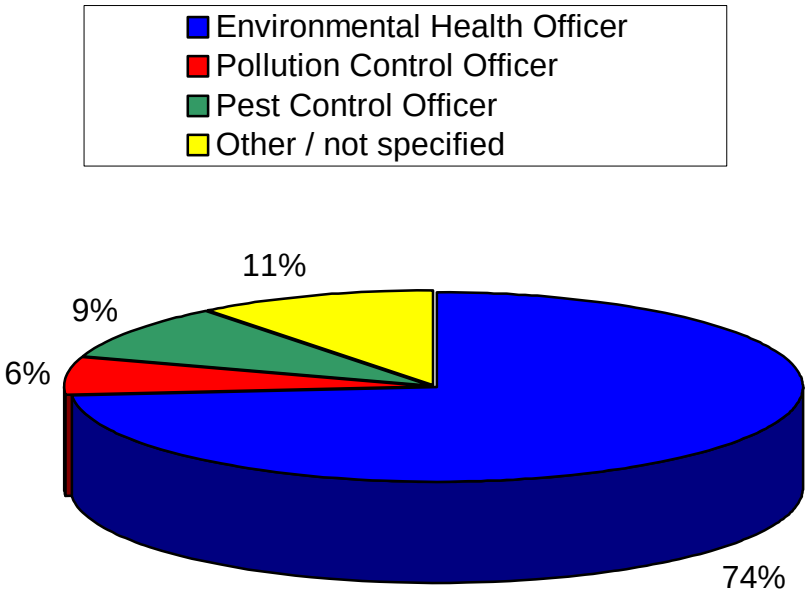

Fig. 4. Positions of responding individuals within local authorities.

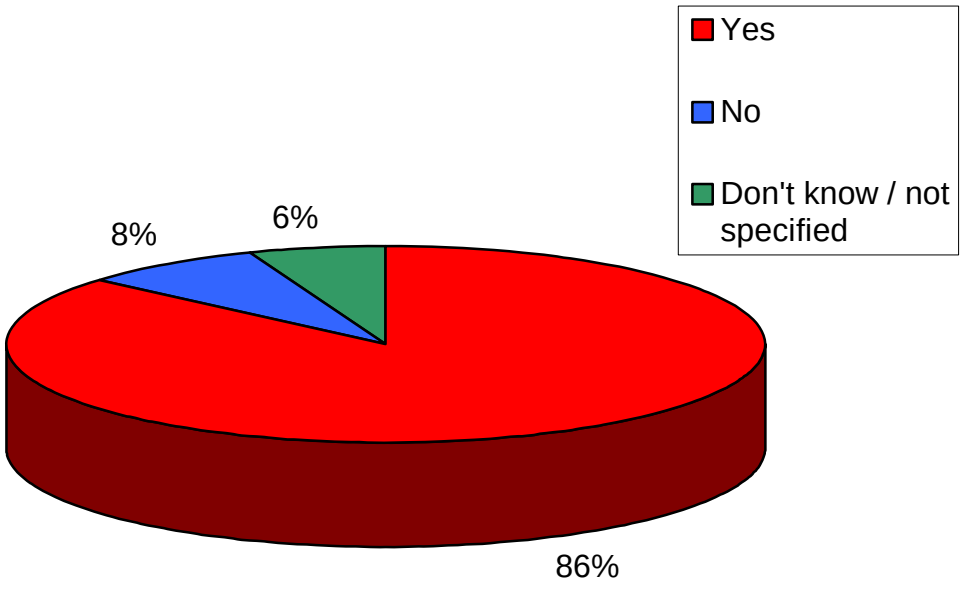

Fig. 5. Responses to LA questionnaire question 1 “Does the issue of insect nuisance associated with sewage treatment works come under your departments jurisdiction?”

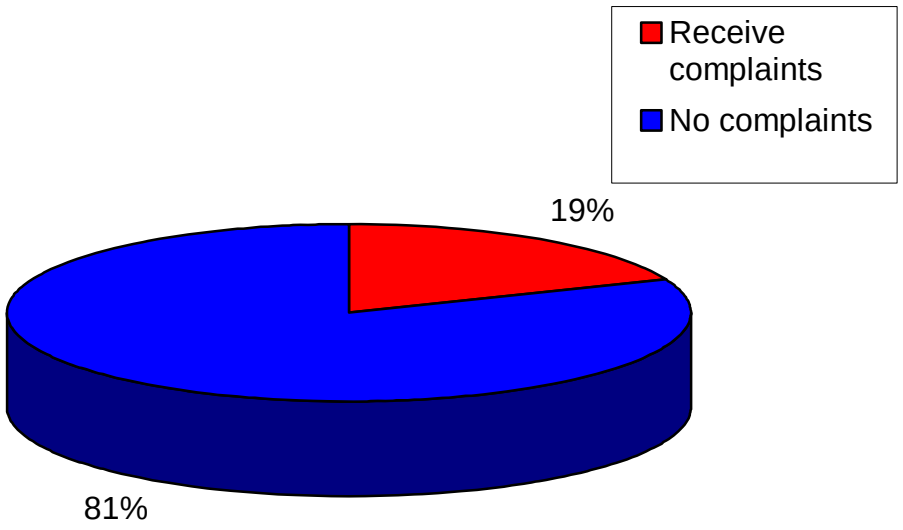

Fig. 6. Responses to LA questionnaire question 2 “Do you receive complaints from the general public about insect pests associated with sewage treatment works?”

Fig. 7. The distribution of LA survey responses. Red diamonds indicate LAs that reported complaints over nuisance insects derived from STWs.

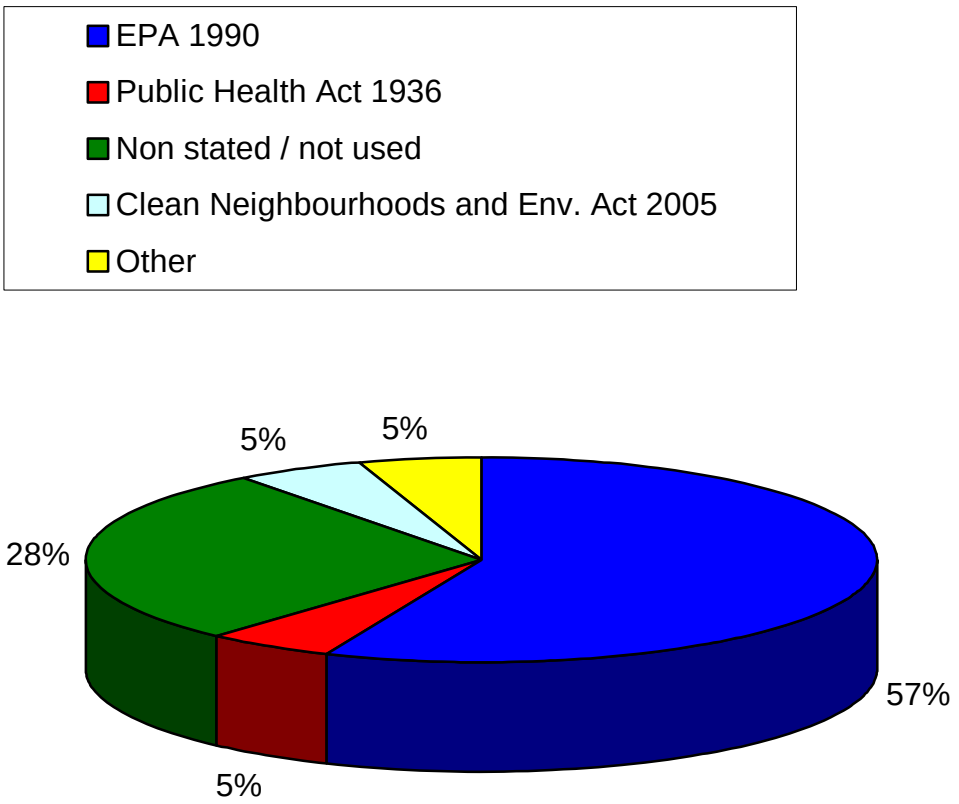

Fig. 8. Responses to LA questionnaire question 5 “When legislation is required, which do you use or refer to.” (Positive replies only; some responses suggested more than one alternative piece of legislation, and the information graphed refers to the proportion of times a given piece of legislation was cited).

5. SITE VISITS / WCO EMPLOYEE INTERVIEWS

Only two completed surveys were received from WCOs which, together, provided very limited information. However, written requests for interviews and information, and site visits, allowed detailed information to be gathered on approximately half the WCOs in the UK. A number of site visits were arranged, whilst staff from several WCOs were interviewed by telephone, or queried by e-mail. Whilst a number of WCOs responded with contact details, no further information was forthcoming. The information requested is listed in Appendix V and a summary of the findings tabulated in Table 2.

A number of important findings were produced by the visits and interviews. Employees of all WCOs that responded to our request for information indicated that bacterial filter bed facilities would continue to process large quantities of wastewater for the foreseeable future. For example, Yorkshire Water operate over 400 filter bed STWs (out of a total of 630) treating over 3.7 million PEs of waste water, approximately 44% of the total, a value considered typical of the UK as a whole (Interview, T. Taylor, Yorkshire Water). Where data was obtained, it was clear that filter bed facilities comprise approx. 50-60% of the STWs within a given WCO with Wessex water indicating biological filters are the primary mode of secondary treatment used (Interview M. Robinson, Wessex Water). In the case of Wessex Water, all sites giving rise to insects in large numbers (13 in total) were identified (ranging from 1.300 – 70,000 PEs) and protocols for dealing with complaints and the control of insects were in place.

Trickling filter facilities have operational life spans of over 100 years, the majority of which serve small communities (e.g. 60% of filter plants operated by Yorkshire Water serve towns of less than 1000 people) where replacement with ASP plants is not viable. This type of secondary treatment will continue to be used for well into the 21st century. Water companies were universally aware of the STWs within their region that had insect problems and typically named psychodids, *Sylvicola* and chironomids as the major pests. All responding WCOs acknowledged that they received complaints from the public and were sensitive to their concerns. Control measures

employed were either the enclosure of the filter beds with netting (Fig. 9b) or application of the *Bti* formulation VectoBac.

Netting is seen as an effective curative step for preventing the large-scale emergence of flies with Severn-Trent Water indicating 80-95% efficiency. However, it is difficult to ensure the total enclosure of filter beds and insect numbers can still be problematic. The maintenance of breeding populations of flies is generally seen as beneficial to the efficient working of the filter and further control steps were seen as necessary only when the insects became highly problematic. In such cases where netting proves to be inefficient VectoBac acts as an efficient and environmentally acceptable larvicide. A novel approach undertaken by Yorkshire Water at Esholt, in response to complaints arising from large scale chironomid emergences has been the installation of large numbers of “Insectocutors” comprising of a UV-light attractor and an electrical killing grid (Fig. 9c). The effectiveness of these measures is unknown but is likely to be marginal. In addition to the control measures outlined above, flooding of filters was considered at the Esholt facility although, due to the weight of water compromising the integrity of the filter bed retaining walls when tried, it was not pursued (Interview, T. Taylor, Yorkshire Water).

Of the WCOs that we were able to conduct interviews and site visits with, only Thames Water indicated any problems with mosquitoes. In this case, only the Mogden and Beckton plants, both ASP facilities processing approximately 1.8 and 3.0 PEs of wastewater, respectively, in London produced insects in numbers considered to be problematic. A variety of sources indicated that the breeding sites of the mosquitoes were removed from the treatment process, with insects emerging from stagnant water around the site at Mogden and not from the aeration or settling ponds. Such sites were identified as the sumps for the storm tanks, bunds around sludge tanks, stationary water in the grit lanes and leakage around the aeration tanks (Figs 10a-d). None of these areas constitute an intractable problem and none are unique to this site. Engineering solutions are being implemented for many of the breeding sites currently (Interview, K. Gardner, Thames Water). A regular mosquito audit is carried out to monitor breeding sites and a general

year-on-year decline in the number of sites supporting the development of mosquitoes has been achieved.

The findings of interviews, site visits and information gained from the surveys is tabulated in Table 2.

A.

B.

C.

Fig 9. (A) The filter bed matrix typically comprises of stones over which the zoogloeal growth forms. Egression of flies in problematic filters is frequently prevented by enclosing the entire filter with netting (B). The netting becomes efficient only when the zoogloeal growth permeates the perforations in the net. UV/electrical killing grids located downwind of the filter beds at Esholt STW, West Yorkshire.

A.

B.

C.

D.

Fig 10. Mosquito breeding sites at Mogden STW, London. Stationary grit removal channels (A) and the sumps (B) of the storm tanks (C) can all provide larval breeding sites. The areas beneath the aeration tanks (D) can provide adult overwintering sites and, where leaks occur, intermittent larval breeding sites. These potential breeding sites are common to many STWs.

Table 2. Summary of discussions with Water Company staff and findings of visits/surveys.

Water Company	No. of STWs	Filter plants	Population equivalents (filters)	No. with insect problems	Insect problems	Mosquit-oes	Control	Complaints	Comments
Anglian Water	1077	>300	5 million	"Very limited number"	*Tinearia/Psychoda*	No	Netting only	Yes	Biggest problem housing creep bringing housing near to STWs
Northumbrian Water	427	246	3.2 million (0.63 million)	"Very few"	*Tinearia/Psychoda/ Sylvicola*	No	Netting only	Yes	Few complaints, mostly an historical problem. Housing creep not such a problem
Severn-Trent Water	1018	>500		Ca. 20	Chironomids *Sylvicola* *Tinearia/Psychoda*	No	VectoBac Netting	Yes	Chironomids (several species) major problem. *Sylvicola* also quite common though *T. alternata*/*Psychoda* rare. Housing creep a problem.
South West Water	>600								
Southern Water Services	370	278	6.3 million (2.2 million)	<10	*Tinearia/Psychoda/ Sylvicola*	No	VectoBac Netting	Yes	Housing creep a potential problem
Thames Water	350				*Culex pipiens*	Yes		Yes	Housing creep a slight problem. Mosquito problems at Mogden and Beckton only
United Utilities	600								
Welsh Water	850	Ca. 590	>3 million (ca. 2.8 million)	5	*Sylvicola*	No	Netting VectoBac	Yes	Mesh sometimes found unsuitable and removed (used at only 1 STW). Housing creep for 1 STW only

Table 2 Continued

Water Company	No. of STWs	Filter plants	Population equivalents (filters)	No. with insect problems	Insect problems	Mosquit-oes	Control	Complaints	Comments
Wessex	412	290	3.4 million	13	*Sylvicola* *Tinearia/Psychoda*	No	VectoBac Netting	Yes	*T. alternata, Psychoda and Sylvicola* all problems. Housing creep a problem.
Yorkshire water	630	>400	8.4 million (3.7 million)	15-20	*Metriocnemus* *Sylvicola* *Tinearia/Psychoda*	No	VectoBac Netting	Yes	Mosquitoes only once at Esholt – no current problems. Low organic loading does not favour *Tinearia/Psychoda* currently
Scottish water	1807								
Northern Irish Water Service	918			"Very few problems"	*Tinearia/Psychoda* *Sylvicola*	No		No	Conversion of plants to ASP has reduced problems.

6. DISCUSSION

There are over 9000 STWs in the UK, ranging from small village works, dealing with low volumes of sewage, to large city plants catering for over one million people. Sewage treatment works for the most part use either trickling filter beds or the activated sludge process; the former process being typically used in smaller plants or where land availability is not limiting, and the latter at higher throughput works serving larger populations.[76] A number of plants use variants of either procedure or run both procedures in tandem. The information provided by water companies indicates that at least half of STWs in the UK currently employ trickling filters, with Welsh Water indicating that the majority of facilities are of this type. Many larger plants have been converted to the ASP process in recent years. For example, Derby STW treating approximately 500,000 population equivalents was converted to the ASP recently (in 2000)[4], the large Minworth plant between 1999-2000[4] whilst the Esholt facility in West Yorkshire will be partially replaced with an ASP plant in the near future (Interview, T. Taylor, Yorkshire water). This notwithstanding, trickling filter plants still constitute the greater proportion of STW plants in the UK, and will continue to do so for some time, particularly for small-scale operations.

The incidence of nuisance insects associated with these wastewater treatment facilities only becomes a problem if plants are located in fairly close proximity to residential housing i.e. within 1-2 km.[14] Furthermore, the development of large insect populations is primarily associated with STWs using trickling filters and not those using the activated sludge process, a fact that was substantiated by both the LA surveys and interviews with WCO staff. In the case of LA responses, several responders explicitly stated that the use of the ASP process was the reason why no problems were incurred. Clearly, the location of STWs away from residential housing can negate any potential insect nuisance. Enclosure of some modern plants may similarly reduce the egress of flies. However, many existing plants are sited in population centres and the risk of flies causing annoyance to the public in some situations is inevitable. Locating new sewage treatment facilities at a reasonable distance away from housing would effectively restrict the production of new sources of

insect nuisance[14] although WCO staff indicted that the “creep” of housing towards STWs probably means that more housing than ever before is located in close proximity to these facilities. Proximity of housing was indicated as a cause of certain STWs becoming problematic by most WCO employees interviewed.

A review of the available literature has revealed that very little peer-reviewed research has been conducted over the last 20 years into the degree of insect nuisance associated with STWs and mechanisms for abatement of the nuisance. The older references (pre-1970), many of extremely high quality and detail, do however provide valuable resources for the biology and habits of the major pest species. It is unlikely that many of these basic papers on the biology, ecology and interactions of potential nuisance species will be bettered as fundamental reference materials, and much of the information contained in these papers remains highly relevant today. Such information allows the likelihood of insect nuisance outbreak to be predicted, to a degree, based on factors such as filter type, loading, locale etc. However, as noted by Bruce[76], the complexity of the interactions are such that it is extremely difficult to make entirely accurate predictions on the efficiency of a given filter bed and its likelihood of generating nuisance pests. However, lighter filter loading was considered by WCO employees a potential reason why the traditionally problematic pest *T. alternata*, and related *Psychoda* species, are less of a problem currently than when much of the classic research was conducted.

A major area of the literature that is currently lacking is information into the control procedures currently utilised for the control of the nuisance insects and the relevance and degree of success of these methods. Whilst older references provide a wealth of outmoded or contraindicated chemical procedure, currently utilised methods and chemicals are barely reported upon. Currently, insecticide control of flies in the filter bed is exclusively conducted using the *Bti* formulation VectoBac and all WCO employees queried indicated that performance of this larvicide was satisfactory where used. There is no use of IGRs, such as methoprene, currently although the availability of formulations for the control of filter flies in the USA indicates their potential as an alternative to VectoBac.[57] There is widespread evidence that screening of STW filter beds with netting is widely employed as an effective fly control

measure. Some doubts were raised by WCO employees as to the performance of the filter beds following enclosure and, in some cases, netting performance was deemed unsatisfactory with degradation and pooling a problem. However, correct installation and use was seen as the major factor in using this strategy for abatement of fly problems. A need for an effective adulticide was, however, seen as a future requirement for more effective control of filter breeding flies. Information provided by Wessex Water indicated that problems with insect nuisance typically occurred at smaller plants treating around 20,000 PEs .

The responses to the LA survey (>40%) were sufficient to draw some conclusions as to the incidence of nuisance currently occurring. It would seem that the problem is relatively minor and only a small proportion of authorities indicated that they received complaints over nuisance insects associated with STWs. In several cases, positive responses related to only a single incidence, in one case over 15 years previously. In only three of the positive response was there any indication that insects associated with STW comprised a significant amount of the complaints received about insects in general.

Importantly, almost all surveys were completed by LA staff in some way connected to environmental health or pest control. Almost all responders indicated that insect nuisance was the responsibility of their authority. The proportion of LAs responding varied from 38.5% (Northern Ireland) to 57.9% (Scotland) with an overall response of 40.5%

Local authority procedures for dealing with insect pests in general seem very good. Logical procedures are in place for determining sources of insect pests, either as nuisances or otherwise. Furthermore, the accurate identification of insects seems to be a priority and trained personnel appeared to be available to most of the LAs that responded to the relevant question. Inability to identify insects “in-house” almost universally was reported to be alleviated by the use of trained personnel elsewhere (university, PCO, commercial service).

The small proportion of positive responses (i.e. those with insect nuisance problems) indicated that the major insect problems were due to *T. alternata* / *Psychoda* sp*., Sylvicola fenestralis,* chironomids and mosquitoes

although several responders did not specify species. In one case, flies (*Musca* sp.) that more probably derived from landfill sites were included, raising a degree of uncertainty of the ability of the LAs to accurately associate the source of pests (this report was considered erroneous for the purposes of this study). Where a species was specified, *Tinearia* / *Psychoda* sp. and *S. fenestralis* were specifically mentioned most frequently, whilst the incidence of chironomids was indicated in several responses. A number of answers simply indicated “sewage” or “filter” flies and it is likely that these insects are filter-derived. Mosquitoes were only specified in a small number of cases, all but one of which were from the London area.

A further finding of the surveys was the almost universal indication that the EPA 1990 would be applied if legislation were necessary. However, a proportion of responders noted that the EPA 1990 was inadequate and, in some cases, not applicable and that new legislation is required. The Clean Neighbourhoods and Environment Act was seen applicable (or a remedy to the inadequacy of current legislation) to the problem, both from those with STW-derived fly problems, and those who responded to the surveys in the absence of problems. It would therefore seem necessary that legislation associated with insects as a statutory nuisance is clarified in such a way as to facilitate legal proceedings against nuisance sources when required.

The response from PCOs was negative, in respect to whether STW-derived insects were treated, in all but one case. However, the response to this survey was very poor. The one positive response referred to the treatment of psychodids in private homes and not at STWs. Interviews with WCO staff indicated that, for the most part, control measures were undertaken in-house and only Thames Water indicated the use of contracted PCOs. In this case, at the Mogden STW, control measures were instigated for control of mosquitoes using VectoBac.

Clearly, the majority of incidents of STWs producing insects in sufficient numbers to annoy the public are largely associated with treatment plants using trickling filters, typically medium sized plants. The insects associated with such filters comprise largely of psychodid. chironomid and anisopid species. The paucity of recent reports of these insects causing annoyance[28,29,77] largely reflects the LA survey findings in that they constitute,

for the most part, a relatively minor problem (as was the case when the situation was reviewed by Painter in 1980[26]). These insects are ubiquitous[78] and have simply adapted to the new niche provided by such facilities and perhaps the most significant risk they pose to residents is one of inducing allergy.[79]

No evidence, apart from one spurious report of mosquitoes in Bradford, was found for any other type of nuisance fly outside the Greater London area. In London, two large ASP STWs (Mogden and Beckton) provide known breeding sites for mosquitoes. The insects breeding in these scenarios are exploiting niches that are not unique to the treatment process and other breeding sites external to the STWs are equally capable of giving rise to insects.[12,13] However, it is unlikely that STWs provide a single point source for mosquitoes in London and there is evidence for breeding of *Cx. pipiens* form *molestus* in a number of other areas[24,25], including the London underground.[80] This insect is widely distributed and is reported to be the third most important nuisance mosquito species country-wide.[81]

An additional concern over the presence of mosquitoes around STWs is the potential for the vectoring of arthropod-borne viruses, such as West Nile virus.[82] Such concerns are becoming widespread and have been widely reported in the London press.[83,84] The fact that this disease is now common in Southern Europe[85] lends credence to these concerns. Such concerns, coupled with the historical association with Mogden STW as a source of mosquitoes, is probably a factor in the ongoing campaign of the Mogden Residents Action Group (MRAG) for abatement of the mosquitoes around this site despite the significant efforts of Thames Water to resolve the problem. The considerable efforts by Thames Water[7] and investment in infrastructure at the Mogden facility[86] is likely to reduce significantly the potential for this site to give rise to mosquitoes in the future. The large number of breeding sites in the urban area around this STW[24,25] however, and the public's perception that the facility is the single point source of mosquitoes in the area, will probably lead to the plant being blamed in the future for insects that do not necessarily derive from breeding sites therein. The data collection mechanism operated by MRAG[87] produces an unreliable picture of the problem due to complaints logged over any given month being generated by multiple entries from a

smaller number of people. The Mosquito Watch campaign[88] run by Chartered Institute of Environmental Health (CIEH), however, is a more reliable indicator of the general occurrence of mosquitoes in the UK as it is aimed for use by EHOs and similar professionals.

The resolution of the Mogden issue can be only achieved through investigations by an impartial third party and more research into this specific case is indicated. Most importantly, the general occurrence of mosquitoes throughout London, and mechanisms for their effective control, both within and external to STWs, needs to be rigorously examined.

7. CONCLUSIONS

1. Filter bed facilities are the major cause of insect nuisance from STWs across the UK. Despite being gradually phased out in favour of ASP facilities, at least half STWs in the UK continue to use trickling filters.
2. Minor problems are reported to be associated with nuisance insects emanating from STW filter beds. Generally, the indications obtained from WCOs suggested that the problem is declining.
3. Window gnats, filter flies and chironomids are the primary causes of nuisance.
4. Mosquitoes were not seen as a problem by any of the WCOs who responded to inquiries except for Thames Water, or by LAs outside London.
5. Control procedures employed by the WCOs, where identified, appeared appropriate and largely effective. WCOs treat insect nuisance seriously and invest significantly in control measures.
6. A major problem cited by WCO employees was the location of new housing and/or business premises in close proximity to STWs
7. The issue of STW-derived insect nuisance rarely requires legislation to be invoked and LA interaction with the water company involved is the usual procedure employed for abatement of the problem.
8. LA procedures associated with the location of pest sources, and the identification of the pest species appear to be, for the most part, adequate.
9. There is an indication that the EPA 1990 has proved inadequate and that the Clean Neighbourhoods and Environment Act should address this problem.
10. Recent literature on all facets of nuisance insects associated with STWs is sparse and the literature review yielded little information on the current occurrence of either *Tinearia/Psychoda* sp., *S. fenestralis* or chironomids as nuisance insects in the United Kingdom.
11. There is a requirement for an effective adulticide that can be applied when large numbers emerge from the filters.

8. RECOMMENDATIONS

8.1 Local Authorities

I. The planning of new residential housing, camp sites, caravan parks etc, should always take into consideration the location of STWs and should preferably not be located within 1 km of an established works.
II. A complaints procedure should be put in place to deal with STW-related issues.
III. Trained personnel should be available to identify insects causing nuisance and to relate them back to a potential source with a high degree of certainty.
IV. Record keeping of insect related incidents associated with STWs should be rigorous and made readily available.
V. Information on mechanisms for the control or prevention of insect nuisance within homes should be made available to the public (i.e. screening, proofing etc).
VI. Standardized mechanisms for resolving fly nuisance problems associated with STWs should be developed in concert with water companies

8.2 General public

I. The public are advised to submit complaints concerning the suspected incidence of nuisance flies derived from STWs to their LA enforcement officer or relevant department.
II. The public are advised that the majority of nuisance insects associated with STWs are harmless, non-biting, flies, that are weak fliers and unlikely to cause long-term adverse effects.
III. Simple screening measures (i.e. keeping windows and doors closed at peak times will normally suffice to reduce the incidence of nuisance insects in the home.
IV. Where this is impractical, other simple measures, such as fly screens and deterrents (e.g. Deet) may be equally effective.
V. Persistent problems with nuisance insects may arise from many different sources (e.g. nearby lakes, streams, standing water, drains, garden ponds, water butts and decaying plant matter) and the public are advised to contact their LA and seek help in ascertaining the most likely origin of insects that occur in or near the home (this will not necessarily be an STW).
VI. The collection of insect specimens, where possible, to facilitate correct identification of the species (via the LA), is recommended in order to aid the correct identification of the insect's source.
VII. Where mosquitoes are identified as the problem, it is recommended that all potential breeding sites on the complainant's property are removed or enclosed (e.g. water butts, blocked drains and guttering, garden water features etc) to ensure that the source is not local to the complainant.
VIII. Complainants are encouraged to record as accurately as possible the date, time and location that nuisance due to the presence of insects was incurred. The recording of additional information, such as wind direction and general weather conditions, that may influence insect dispersal, is also recommended. Such information should be passed on to the relevant LA official(s) when submitting a complaint.

8.2 Water Companies

I. Where new STWs are planned, consideration for local residents should be made and provisions for the prevention of insect nuisance included in the design of the works.
II. A readily accessible complaints mechanism should be made available (e.g. via company websites).
III. Regular surveys of insects should be undertaken at STWs known to generate insect numbers sufficient to cause nuisance to the public.
IV. Breeding sites for mosquitoes (i.e. stationary water) should be prevented or removed.
V. Insect pest control at STWs should be proactive and undertaken routinely as part of the usual operation of the plants and not solely in response to complaints.
VI. Simple screening measures should be implemented where feasible (netting, enclosure) and the planting of barrier vegetation (tall trees/shrubs).
VII. Where problems prove to be intractable and ongoing, third party organisations should be used to investigate and determine source, causes and resolution.
VIII. The development/investigation of effective adulticides should be considered to alleviate problems when larvicides and physical control procedures prove insufficient to prevent the egress of large numbers of adult flies.
IX. More effective strategies and products for the control of mosquitoes need to be investigated in the light of ongoing concerns.

9. ACKNOWLEDGEMENTS

The authors of this report are grateful for time and information provided by employees of the following water companies: Anglian Water, Water Service Northern Ireland, Northumbrian Water, Severn-Trent Water, Welsh Water, Wessex Water and Yorkshire Water.

Those individuals who kindly gave their time to provide information are listed in Appendix VI.

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11. APPENDICES

Appendix I.

LOCAL AUTHORITY QUESTIONNAIRE INTO THE INCIDENCE OF INSECT NUISANCE ASSOCIATED WITH SEWAGE TREATMENTS WORKS

On behalf of the Department for Environment, Food and Rural Affairs (Defra), and the devolved administrations of the Scottish Executive, the National Assembly of Wales, and the Department for the Environment in Northern Ireland, we are conducting a survey into the sources of insect nuisance associated with sewage treatment works. We would be grateful if you could take the time to answer the following questions and return the questionnaire as indicated below.

We are very pleased to receive electronic or written responses. This form is available at http://sis.csl.gov.uk/localauthority/ and can be completed online.

Response form

	Respondent details	Please return by: 28/02/06 To:
Name		Howard Bell Room 06FA04 CSL Sand Hutton York YO41 1LZ Tel. 01904462669 Fax. 01904 462111 h.bell@csl.gov.uk
Authority		
Address		
Town/City		
County & Postcode		
Tel.		
Fax		
E-mail		

Position held within Authority

Is the response confidential? Yes ☐ No ☐

Q1. Does the issue of insect nuisance associated with sewage treatment works come under your department's jurisdiction?

Yes ☐ No ☐ *Unsure/don't know* ☐

Q2. Do you receive complaints from the general public about insect pests associated with sewage treatment works?

Yes ☐ No ☐ *Unsure/don't know* ☐

Q3. If yes, what action do you take?

Q4. Is this a significant part of your work *versus* other insect-based complaints?

Yes ☐ No ☐ *Unsure/don't know* ☐

Q5. When legislation is required, which do you use or refer to?

Q6. How do you establish a link between the 'potential source' (e.g. STW) and complainant?

Q7. How do you identify the nuisance pest? What species commonly cause problems and are species verified by a recognised authority (e.g. entomologist/pest control operator)?

Q8. What preventative/curative measures do you recommend to residents suffering insect nuisance if any (proofing, flypaper, residual pesticides, spraying) and are any other authorities/bodies involved? e.g. Pesticides Safety Directorate (PSD), Health and Safety Executive (HSE), Health Protection Agency (HPA), Pest Control Companies.

Q9. Do you have any further comments?

Thank you for your co-operation

Appendix II.

WATER COMPANY QUESTIONNAIRE INTO THE INCIDENCE OF INSECT NUISANCE ASSOCIATED WITH SEWAGE TREATMENTS WORKS

On behalf of the Department for Environment, Food and Rural Affairs (Defra), and the devolved administrations of the Scottish Executive, the National Assembly of Wales, and the Department for the Environment in Northern Ireland, we are conducting a survey into the sources of insect nuisance associated with sewage treatment works. We would be grateful if you could take the time to answer the following questions and return the questionnaire as indicated below.

We are very pleased to receive electronic or written responses. This form is available at http://sis.csl.gov.uk/watercompany/ and can be completed online.

Response form

	Respondent details	Please return by: 28/02/06 To:
Name		Howard Bell Room 06FA04
Company		CSL
Address		Sand Hutton
Town/City		York
County & Postcode		YO41 1LZ
Tel.		Tel. 01904462669
Fax		Fax. 01904 462111
E-mail		h.bell@csl.gov.uk

Position held within Water Company

Is the response confidential? Yes ☐ No ☐

Q1. Are nuisance insects a problem at your sewage treatment works?

Yes ☐ No ☐ *Unsure/don't know* ☐

Q2. Do you receive complaints about insect pests associated with sewage treatment works?

Yes ☐ No ☐ *Unsure/don't know* ☐

Q3. If yes, are these problems increasing, declining or relatively constant?

Increasing ☐ Declining ☐ *Constant* ☐

Q4. If you suffer from insect nuisance at sewage treatment works, are any of the following thought to be a problem?

a. Filter flies (*Psychoda* sp.) ☐
b. Mosquitoes (*Culex* sp.) ☐
c. Midges (Chironomidae) ☐
d. Window gnats (*Sylvicola* sp.) ☐
e. Others

(Details)……..

Q5. Are control measures undertaken by?

a. In house operators ☐
b. Pest control company ☐
c. Local authority ☐

Q.6. What actions do you take to prevent and control insect populations? Please specify treatments, timing and effectiveness of each method.

Q7. Are any complaints resulting from insect nuisance received from either?

a. Local authorities ☐
b. Members of the public ☐

Q8. If you receive complaints, what action do you take?

Q9. How do you establish a link between the ‘potential source’ (e.g. STW) and complainant?

Q10. How do you identify the nuisance pest? Are species verified by recognised authority?

Q11. Do you have any other information related to this subject?

Thank you for you time.

Appendix III

PEST CONTROL COMPANY QUESTIONNAIRE INTO THE INCIDENCE AND TREATMENT OF INSECT NUISANCE ASSOCIATED WITH SEWAGE TREATMENTS WORKS

On behalf of the Department for Environment, Food and Rural Affairs (Defra), and the devolved administrations of the Scottish Executive, the National Assembly of Wales, and the Department for the Environment in Northern Ireland, we are conducting a survey into the sources of insect nuisance associated with sewage treatment works. We would be grateful if you could take the time to answer the following questions and return the questionnaire as indicated below.

We are very pleased to receive electronic or written responses. This form is available at http://sis.csl.gov.uk/pestcontrol/ and can be completed online.

Response form

	Respondent details	Please return by: 28/02/06 To:
Name		Howard Bell Room 06FA04
Company		CSL
Address		Sand Hutton
Town/City		York
County & Postcode		YO41 1LZ
Tel.		Tel. 01904462669
Fax		Fax. 01904 462111
E-mail		h.bell@csl.gov.uk

Position held within Pest Control Company

Is the response confidential? Yes ☐ No ☐

Q1. Has your company been involved with the control of nuisance insects at or related to sewage treatment works?

Yes ☐ No ☐ *Unsure/don't know* ☐

Q2. If yes, are these problems increasing, declining or relatively constant?

Increasing ☐ Declining ☐ *Constant* ☐

Q3. Please specify which of the following are thought to be a problem.

d. Filter flies (*Psychoda* sp.) ☐
e. Mosquitoes (*Culex* sp.) ☐
f. Midges (Chironomidae) ☐
d. Window gnats (*Sylvicola* sp.) ☐
e. Others?
(Details)……..

Q4. What control measures do you take or have you taken to prevent or control insect populations at sewage treatment works? Please specify treatments, timing and effectiveness of each method.

Q5. Do treatments differ depending on the pest species or other factors?

Yes ☐ No ☐ *Unsure* ☐

If “yes”, do you know why?

Q6. How do you identify the nuisance pest? Are species verified by recognised authority?

Q7. Please specify if there are any problems associated with the control of pest insects at water treatment works?

Q8. Do you have any other information related to this subject?

Thank you for you time.

Appendix IV

The six consultation criteria.

1. Consult widely throughout the process, allowing a minimum of 12 weeks for written consultation at least once during the development of the policy.

2. Be clear about what your proposals are, who may be affected, what questions are being asked and the timescale of the responses.

3. Ensure that your consultation is clear, concise and widely accessible.

4. Give feedback regarding the responses received and how the consultation process influences the policy.

5. Monitor your department's effectiveness at consultation, including through the use of a designated consultation co-ordinator.

6. Ensure your consultation follows better regulation practice, including carrying out a Regulatory Impact Assessment if appropriate.

Summary information from this survey will be made available upon request to all responders once the survey has been completed. Defra/CSL may be required to release information, including personal data and commercial information, on request under Environmental Information Regulations or the Freedom of Information Act 2000. However, Defra (and its appointed agents) will not permit any unwarranted breach of confidentiality or act in contravention of its obligations under the Data Protection Act 1998. Defra or its appointed agents may use the name, address and other details on your form to contact you and to provide follow up information in respect to this survey.

Appendix V

A secondary survey to WCOs based on interview with employees, site vists and written consultations. The following information was sought.

Q1. What proportion of the STWs that your company operates are filter bed facilities (absolute numbers and population equivalents).

Q2. Do you have problems with insects emerging from the filter bed (and receive complaints) at you STWs. If so, which insects species are problematic

Q3. If have problems, approximately how many STWs are affected.

Q4. If insects are problematic, what actions do you take (netting / VectoBac)

Q5. Are mosquitoes a problem at your STWs?

Q6. Does the location of new housing increase the problems?

APPENDIX VI

Site visits and interviews/correspondents.

1. Anglian Water

Interview: Anonymous (by request) (9/02/06)

2. Northumbrian Water

Interview: Mark Woolley (7/03/06)

3. Water Sevice Northern Ireland

Correspondence: A. McQuillan / R. Lorimer (13/2/2006 *et seq.*)

4. Welsh Water (Dwr Cymru Cyfyngedid)

Correspondence: Stuart Griffiths / Colin Parry (8/03/06 *et seq.*)

5. Scottish Water

6. Severn-Trent Water

Interview: Dr Helen Pickett

Visit: Derby STW / Marehay STW(15/02/06)

7. South West Water

8. Southern Water Services

Correspondence: Richard Reeves (04/04/2006)

9. Thames Water

Interview: Keith Gardner (Mogden STW)

Visit: Mogden STW (15/03/05)

10. United Utilities

11. Wessex Water

Interview and correspondence: Dr. Mike Robinson (1/03/06 *et seq.*)

12. Yorkshire Water

Interview with: Tom Taylor / Helen Oxley

Visit: Esholt STW (2/02/06)

Appendix VII. Summary of positive answers to LA survey (a presence of a 1 indicates a positive response).

	LA details		Country				Position held				Jursidiction			Sig. problem	Legislation					Problematic species					
DB ID	Name	LA	E	S	W	NI	EHO	Poll. control officer	Pest control officer	other	Yes	No	DK	Signifi-cant?	EPA 1990	Public health act	Non stated / not used	CN&E. Act 2005	Other	*Tinearia / Psy.*	*Sylv.*	Chir.	Sewage flies general	Mosq.	Not spec
3	Earl d'Hulst	Belfast City Council				1			1		1						1								1
19	Tim Sneddon	North Shropshire D C	1				1				1				1										1
20	Holly Appleton	Waverly B.C.	1				1				1			1	1						1				
26	John Allan	Huntingdon shire District Council	1				1				1				1			1	1						1
39	Tony Bull	London Borough of Hounslow	1						1		1			1	1									1	
40	Steve Richmod	Ryedale D.C.	1				1				1				1			1		1		1			
52	Tim Bassett	Craven D.C.	1				1				1				1					1	1	1			
65	Phillip Joseph Harris	Ashfield D.C.	1				1				1						1						1		
80	Gwyn Jenson	Norwich Ci.C.	1							1			1				1								1
82	Dave Addy	Rochford D.C.	1				1				1				1										1
83	D. Kitching	North East Derbyshire	1				1				1				1							1			
84	Keith Fulcher	Boston B.C.	1				1				1				1								1		

	LA details		Country				Position held				Jursidiction			Sig. problem	Legislation					Problematic species					
DB ID	Name	LA	E	S	W	NI	EHO	Poll. control officer	Pest control officer	other	Yes	No	DK	Signifi-cant?	EPA 1990	Public health act	Non stated / not used	CN&E. Act 2005	Other	*Tinearia / Psy.*	*Sylv.*	Chir.	Sewage flies general	Mosq.	Not spec
85	David Bithell	Wigan Council	1				1				1				1										1
86	Martyn Manning	East Staffordshire B.C.	1					1			1				1					1	1				
87	David Gilmour	South Bucks	1				1				1				1									1	
109	Mark Berry	Stockton on Tees B.C.	1				1				1				1										1
110	Philip Roberts	Mid-Devon B.C.	1				1				1						1								1
132	Nick Nawell	Slough B.C.	1				1				1				1										1
135	Verna Zinclair	Rugby B.C.	1							1	1						1								1
138	Palden Dorjé	East Northamptonshire	1				1				1				1					1	1				
141	Dennis Shipway	Bradford M.D.C.	1						1				1				1							1	
153	A. Riley	Rossendale B.C.	1				1						1				1								1
161	Neil Wilkinson	Sheffield C.C.	1						1		1				1						1				
164	Alison Black	Gateshead	1						1		1				1	1				1	1				
165	-	-					1				1				1										
168	Robin Goundry	Bromsgrove D.C.	1				1				1				1					1					
170	D. Haynes	Wellingborough BC	1				1				1						1								

	LA details		Country				Position held				Jursidiction			Sig. problem	Legislation					Problematic species					
DB ID	Name	LA	E	S	W	NI	EHO	Poll. control officer	Pest control officer	other	Yes	No	DK	Signifi-cant?	EPA 1990	Public health act	Non stated / not used	CN&E. Act 2005	Other	*Tinearia / Psy..*	*Sylv.*	Chir.	Sewage flies general	Mosq.	Not spec
174	Angela Smith	Kirklees M.C.	1				1				1				1										
177	Carole Gallagher	New Forest DC	1				1				1				1										
182	Neil Evans	East Riding of Yorkshire Council	1						1		1					1				1		1			
183	Anne Caldwell	Cookstown D.C				1	1				1								1						
184	Crispin Kennard	Tonbridge and Malling Borough Council	1				1				1						1			1			1		
185	Martin Mooney	Newry & Mourne				1	1				1						1								
187	D. Wraith	Shrewsbury and Atcham B.C.	1				1				1				1						1				
189	C Rimmer	St Helens Council	1							1	1						1								
190	Shaun Case	LB Richmond	1				1				1			1	1									1	
		Total	**32**	**0**	**0**	**3**	**26**	**1**	**6**	**3**	**187**	**0**	**3**	**3**	**23**	**2**	**11**	**2**	**2**	**8**	**7**	**4**	**3**	**4**	**11**

Appendix VIII. Negative LA responses (a presence of a 1 indicates a response to the relevant question).

	LA details		Country				Position held				Jurisdiction			Legislation used					Other information			
DB ID	Name	Authority	E	S	W	NI	EHO	Pollution control officer	Pest control officer	other	Yes	No	Don't know	EPA 1990	Public health Act	Non stated / not used	CN&E. Act 2005	Other	No STWs	Location or ASP	Odour	Animals / refuse
1	Paul Williams	Canterbury City Council	1				1				1					1						
2	Mr A W Hall	Wolverhampton	1				1				1					1				1		
4	Alistair Cain	London borough Hammersmith and Fulham	1				1				1					1			1			
5	K McBride	Hinckley and Bosworth B.C.	1				1				1					1						
6	Richard Whitehead	St. Endmundsbury B.C.	1				1				1			1								
7	Hedley Trembath	Eastleigh B.C.	1				1				1					1						
8	Mr C R Adams	Vale Royal BC	1				1				1						1					
9	Geoff Carpenter	Wychavon D.C.	1				1					1		1			1					
10	Neil A. Vann	Southend on Sea	1				1				1											
11	David Bribben	Wear Valley D.C.	1				1				1					1						
12	Craig Howat	Rutland County Council	1				1				1					1						
13	David Bryant	Tandridge D.C.	1				1				1					1						
14	John Pearson	Teesdale D.C.	1				1				1					1						
15	Ed Rowley	Epsom and Ewell B.C.	1				1					1				1			1			
16	Martin Lowe	Southampton CC	1				1				1					1						
17	Andrew Grimley	Breckland Council	1				1				1			1								1
18	Matthew Halford	Charnwood B.C.	1				1				1					1						
21	Peter Brett	Corporation of London	1				1				1			1					1			
22	S. J. Bruce	Oadby and Wigston B.C.	1				1				1					1						

	LA details		Country				Position held				Jurisdiction			Legislation used					Other information			
	Name	Authority	E	S	W	NI	EHO	Pollution control officer	Pest control officer	other	Yes	No	Don't know	EPA 1990	Public health Act	Non stated / not used	CN&E. Act 2005	Other	No STWs	Locaton or ASP	Odour	Animals / refuse
23	D.J. Ingham	Carlisle C.C.	1				1				1					1						
24	Steve Lawson	Preston C.C.	1						1		1					1			1			
25	Wendy Brolly	Newtownabbey Borough Council				1	1				1					1						
27	Mrs Lucy Moffatt	Richmondshire District Council	1				1				1			1	1		1					
28	Keith Smith	Newcastle-upon-Tyne	1							1		1				1						
29	John Murray	North Ayrshire Council		1			1				1					1						
30	Linda Cummins	Middlesbrough Council	1				1				1					1						
31	Shirley Craig	Distric of Easington	1							1	1					1				1		
32	Mark Whitmore	North Norfolk District Council	1				1				1					1						1
33	John Rogers	Hull City Council	1						1		1					1			1			
34	ian wright	oxford city council	1				1				1					1						
35	Robert Beattie	Megherafelt D.C.				1	1				1							1				
36	Shona McQuade	Dartford B.C.	1				1					1				1				1		
37	Pat Hoey	West Dunbartonshire		1			1				1			1				1				
38	Richard Pollitt	Stockport M.B.C.	1				1				1			1								
41	David Hoshe	Chester C.C.	1				1				1					1						1
42	Les Barker	Ipswich B.C.	1				1				1			1							1	
43	J.L. Tweddle	Alnwick D.C.	1				1				1					1						
44	Richard Farr	Brentwood B.C.	1				1				1					1						
45	Kate Eveleigh	Southams D.C.	1				1				1					1						
46	T. Ford	Worcester C.C.	1					1			1			1								
47	T. O'leary	Islington	1						1				1			1			1			
48	Richard Bevan	Bristol C.C.	1						1		1					1						

	LA details		Country				Position held				Jurisdiction			Legislation used					Other information			
	Name	Authority	E	S	W	NI	EHO	Pollution control officer	Pest control officer	other	Yes	No	Don't know	EPA 1990	Public health Act	Non stated / not used	CN&E. Act 2005	Other	No STWs	Locaton or ASP	Odour	Animals / refuse
49	Chris Stopford	Ketterin B.C.	1				1				1			1			1					
50	Derek Williams	Wyre B.C.	1				1				1					1					1	
51	Lucy Cornfield	Cannock Chase D.C.	1					1			1			1								
53	Alan Jones	Spelthorne B.C.	1				1				1					1			1			
54	Tony Fenter	Scarborough B C	1				1				1					1						
55	Mr John Lang	Glasgow City Council		1					1		1					1						
56	Tony Bryant	Macclesfield Borough Council	1				1				1					1						
57	G. Mitchell	Sefton Council	1				1				1			1								
58	Gloria Gillespie	Three Rivers D.C.	1						1		1			1								
59	David Bright	London Borough of Lambeth	1				1				1					1			1			
60	Peter Watkins	Gloucester C.C.	1					1			1			1						1		
61	Bob Howard	London Borough of Ealing	1						1				1			1						
62	Allan Taylor	Kerrier D.C.	1				1					1				1						
63	Nick Ravine	Daventry District Council	1				1				1					1						
64	Paul Smith	Erewash B.C.	1							1	1					1						
66	David Dier	Methyr Tydfil			1		1						1	1				1				
67	R.J. Wells	Salisbury	1				1					1		1								1
68	Mrs. L. Burdett	Castle Point Borough Council	1				1				1					1						
69	R. Johnson	Corby B.C.	1				1				1					1						
70	G Hobson	Caerphilly B.C.			1					1			1			1			1			
71	John Lawton	South Tyneside M.B.C.	1							1			1			1			1			
72	J. Mullin	South Ribble B.C.	1				1				1			1								
73	Adrian Albon	Eastbourne B.C.	1						1		1					1						

	LA details		Country				Position held				Jurisdiction			Legislation used					Other information			
	Name	Authority	E	S	W	NI	EHO	Pollution control officer	Pest control officer	other	Yes	No	Don't know	EPA 1990	Public health Act	Non stated / not used	CN&E. Act 2005	Other	No STWs	Locaton or ASP	Odour	Animals / refuse
74	P. Hughes	East Hants D.C.	1				1				1					1						
75	Vic Emmerson	Copeland B.C.	1				1				1			1								
76	Graham Bannister	Basildon D.C.	1				1				1			1								
77	Peter Daley	Allerdale B.C.	1				1				1					1						
78	Jacky Cantello	Rhondda Cynon Taf			1		1				1			1								
79	Andrew Young	Clackmannanshire		1			1				1					1						
81	Nick Darracott	Restormel Borough Council	1							1	1					1						
88	David Oldbury	Manchester City Council	1				1					1				1			1			
89	Paul Hunt	Portsmouth CC	1							1	1					1			1			
90	C. Salisbury	Cheltenham B.C.	1					1			1											
91	P. Legge	Vale of Whitehorse D.C.	1				1				1					1						
92	Paul Briggs	Warwick D.C.	1							1	1					1						
93	Simon Teesdale	Milton Keynes Council	1				1				1					1					1	
94	D.J. Gould	Blaby D.C.	1				1				1					1					1	
95	Zoe Witham	Wrexham C.B.C.			1		1				1					1						
96	Ken Jones	Scottish Borders Council		1			1				1					1						
97	Mike Barrett	London Borough of Merton	1				1				1					1						
98	P.Dent	Fylde B.C.	1				1				1			1								
99	Peter Mandsley	Moyle D.C.				1				1	1					1						
100	Bryden Simpson	Pendle B.C.	1					1			1					1						
101	K. Pitt-Kerby	North Dorest D.C.	1							1	1					1						
102	Stuart Athol	Chelmsford	1				1				1			1								

	LA details		Country				Position held				Jurisdiction			Legislation used					Other information			
	Name	Authority	E	S	W	NI	EHO	Pollution control officer	Pest control officer	other	Yes	No	Don't know	EPA 1990	Public health Act	Non stated / not used	CN&E. Act 2005	Other	No STWs	Locaton or ASP	Odour	Animals / refuse
103	Peter Snart Smith	Torridge D.C.	1				1				1			1								
104	Tony Akrigg	Hyndburn B.C.	1				1				1					1						
105	E. Rowntree	Chester-Le-Street D.C.	1				1				1					1						
106	V. Thomas	South Bedfordshire D.C.	1							1	1					1						
107	Andrew Gubley	Rochdale M.B.C	1				1					1				1						
108	A. Buchanan	Ards B.C.				1				1		1				1						
111	John Leech	Exeter City Council	1				1				1					1						
112	David Grant	Dumfries and Galloway		1			1				1					1						
113	John Gallop	Wealden DC	1					1			1					1						
114	Will Cockerell	Uttlesford DC	1				1				1					1					1	
115	Richard Haswell	City of York	1							1	1					1						
116	Jo Hitchens	Borough of Poole	1				1				1					1						
117	Diane Clark	South Lakeland D.C.	1					1			1			1								
118	Derek Howard	Wirral B.C.	1				1				1					1						
119	Frances McClen	North Tyneside Council	1							1	1			1								
120	Sharon Lindsay	Inverclyde		1			1				1					1						
121	P. H. Dimmock	Monmouthshire C.C.			1		1				1					1						
122	Michael Lavender	Adur D.C.	1				1				1					1						
123	P. Stanton	Bridgend C.B.C.			1		1				1			1								
124	Fiona Vosper	North Witlshire D.C.	1				1				1					1						
125	Pete Haikin	Wokingham D.C.	1				1				1			1								
126	Donald Cameron	Midlothian Council		1					1			1				1						

	LA details		Country				Position held				Jurisdiction			Legislation used					Other information			
	Name	Authority	E	S	W	NI	EHO	Pollution control officer	Pest control officer	other	Yes	No	Don't know	EPA 1990	Public health Act	Non stated / not used	CN&E. Act 2005	Other	No STWs	Locaton or ASP	Odour	Animals / refuse
127	Karen Brett	Fareham B.C.	1				1				1					1						
128	Duncan Carins	Mole Vallley D.C.	1				1				1			1			1					
129	Maria Hickman	Stroud D.C.	1				1				1					1						
130	Barry Pearson	Darlington B.C.	1				1				1					1				1		
131	Non given	Non given								1	1					1						
133	Vanessa Nourse	Maidstone B.C.	1				1				1			1								
134	Clive Bryant	Cardiff C.C.			1				1		1					1						
136	Gary Pickering	Rushcliffe BC	1				1				1					1						
137	William G. Berry	Isle of Wight Council	1				1				1					1						
139	non given	Isle of Anglesey C.C.			1					1	1			1								
140	Selwyn Anderson	Cambridge City Council	1					1			1					1						
142	Mrs A. Carson	Christchurch B.C.	1				1				1			1								
143	John Tildesley	Staffordshire Moorlands D.C.	1				1				1			1						1		
144	Steve Dommett	Worthing B.C.	1				1				1					1						
145	N. Jones	Conwy C.C.			1		1				1			1								
146	Dan Gorvin	Havant B.C.	1				1				1			1								
147	Cyril Mumby	North East Lincolnshire Council	1				1				1			1								
148	Neil Laws	City of Durham C.C.	1				1				1					1						
149	Brian Gilmour	Dundee C.C.		1					1				1			1						
150	Derrick Wakefield	Penwith	1				1				1					1					1	
151	A.D. Marsh	Orkney Islands Council		1			1				1					1						

	LA details		Country				Position held				Jurisdiction			Legislation used					Other information			
	Name	Authority	E	S	W	NI	EHO	Pollution control officer	Pest control officer	other	Yes	No	Don't know	EPA 1990	Public health Act	Non stated / not used	CN&E. Act 2005	Other	No STWs	Locaton or ASP	Odour	Animals / refuse
152	Karen Hinksman	Sanwell B.C.	1				1				1			1								1
154	Tony Beeson	Weymouth and Portland	1				1				1					1				1		
155	Peter Ewen	Aberdeen City Council		1			1				1					1						
156	Mrs S Cloves	Lancaster C.C.	1				1				1					1						
157	Brian Seditas	South Ayrshire Council		1			1				1					1						
158	Mike Holloway	Newport C.C.			1					1		1				1						
159	Tom Payne	Basingstoke and Deane B.C.	1				1				1			1			1					
160	David Steele	Hambleton District Council	1				1				1					1						
162	Peter Devlin	Omagh D.C.				1	1				1							1				
163	Frank Goodall	Bracknell Forest	1				1				1			1								
166	I Richardson	Wansbeck D.C.	1				1					1				1						
167	Tim Bartlett	Lewes D.C.	1				1				1					1						
169	C. McNally	Coleraine B.C.				1	1					1						1				
171	David Williams	Gwynedd Council			1			1			1					1						
172	Fiona Hamilton	East Renfrewshire		1				1				1				1						
173	John Scuttor	Melton B.C.	1				1				1					1						
175	Maureen M'Ginley	East Dumbartonshire		1			1						1			1						
176	Trevor Stewart	Antrim B.C.				1	1						1			1						
178	Wendy Hallam	Elmbridge Borough Council	1				1				1					1						
179	Mike Rooney	East Ayrshire Council		1				1			1					1				1		
180	Mark Wilde	Blackburn with Derwent	1						1		1					1						
181	John Tanswell	East Cambridgeshire D.C.	1				1				1					1						

	LA details		Country				Position held				Jurisdiction			Legislation used					Other information			
	Name	Authority	E	S	W	NI	EHO	Pollution control officer	Pest control officer	other	Yes	No	Don't know	EPA 1990	Public health Act	Non stated / not used	CN&E. Act 2005	Other	No STWs	Location or ASP	Odour	Animals / refuse
186	Jon Elsey	Barbergh D.C.	1				1					1						1				1
188	Robert Draper	Kennet D.C.	1				1				1					1					1	
	Totals		120	15	11	7	114	11	12	17	167	15	8	38	1	109	6	6	12	8	5	6