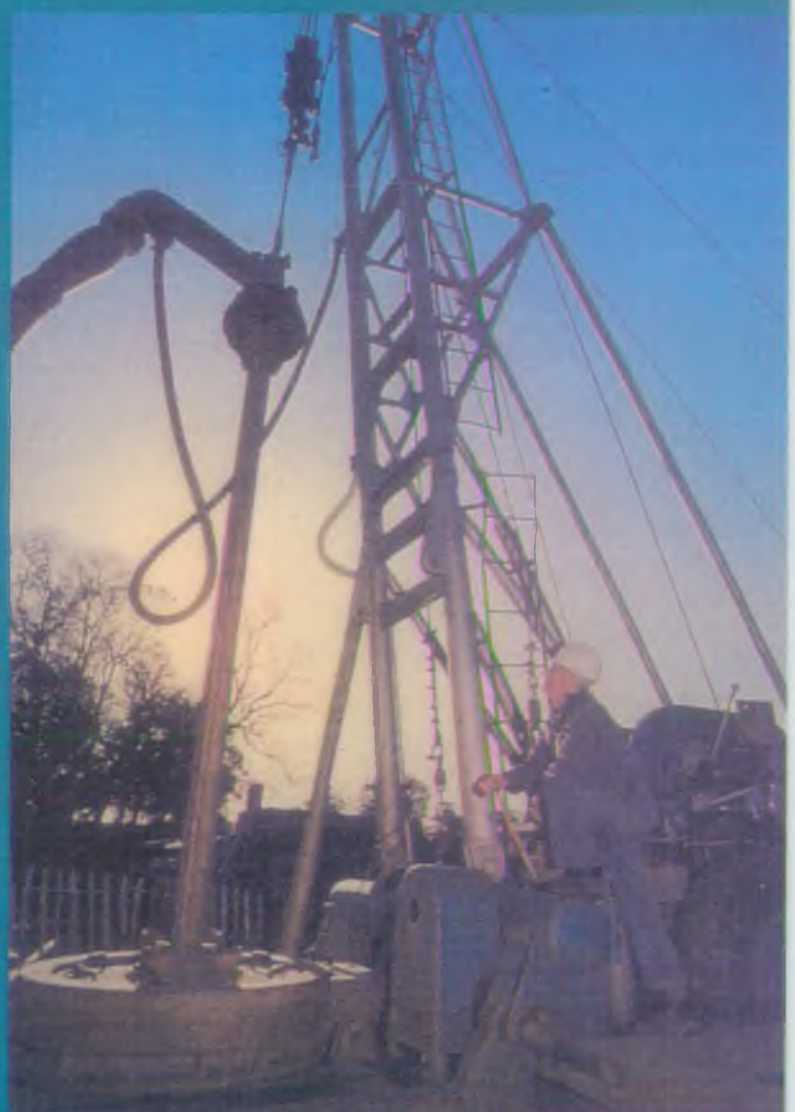
Box 3

# Policy and Practice For The Protection of Groundwater

## Regional Appendix Thames Region



Environment Agency

# POLICY AND PRACTICE FOR THE PROTECTION OF GROUNDWATER

# THAMES REGION APPENDIX

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# POLICY AND PRACTICE FOR THE PROTECTION OF GROUNDWATER

## THAMES REGION APPENDIX

## 1. INTRODUCTION

### 1.1 Purpose of the Regional Appendix

This is one of ten appendices to the Environment Agency's "Policy and Practice for the Protection of Groundwater" (NRA 1992). Its purpose is to give consideration to matters specific to Thames Region which are not included in the national document. The regional appendices should be read in conjunction with the main document.

### 1.2 Thames Region (catchment boundary)

Thames Region comprises the main drainage basin of the River Thames and its tributaries. Major sub-catchments include the Colne, Lee, Kennet, Wey and Loddon. Main rivers within the Region are shown in the figure 1.

The Region covers an area of more than 12000km$^2$ with a population of over 12 million. 11 counties and 78 districts and boroughs lie fully or partly within the Thames Region catchment boundary. These administrative areas are shown in figure 2.

Much of the Region, particularly in the west, is rural in character, where the dominant land-use is agricultural. Population density in the Region, however, is high and there are many important urban areas with long histories of industrial development. The resulting economic and social considerations can present particular pressures regarding protection of groundwater.

### 1.3 The Importance of Groundwater in the Thames Region

There are many hundreds of private, domestic and commercial boreholes and springs in regular use. The total volume of groundwater licensed for abstraction amounts to about 2262 Ml/d, of which approximately 83% is used for potable supply.

Water companies in the Region operate over 300 public supply sources from groundwater with licensed abstraction rates for individual sources exceeding 20 Ml/d in many cases. The locations of these sources are shown on figure 3. The companies with sources in Thames Region are:

Thames Water Utilities Ltd; Southern Water Services Ltd; Wessex Water Plc; Three Valleys Water Services Plc; Essex and Suffolk Water Plc; Sutton and East Surrey Water Plc; Mid Southern Water Plc; North Surrey Water Ltd; Severn Trent Water Ltd.

Groundwater also provides a considerable base flow component to many rivers, particularly in the upper reaches of the catchment. It is therefore clearly of great

importance to ensure that groundwater is afforded adequate protection from pollution.

1.4 Water Resources Considerations

Approximately two-thirds of the catchment is permeable and subject to direct recharge from rainfall. Polluting discharges may also infiltrate into ground in these areas. The remainder of the catchment consists mainly of low permeability strata and is dominated by surface run-off into watercourses.

Rainfall varies from 850 mm/a in western parts of the catchment to less than 650 mm/a in eastern parts. Rates of recharge to groundwater vary considerably from 524 mm/a in the north-west to 124 mm/a in the east. Where groundwater lies at depth, particularly in granular aquifers, recharge may take months following rainfall infiltration. Where fissures are well developed or the water table is at a shallow depth, recharge may occur within days or weeks. Such recharge characteristics are important factors in assessing pollution risks.

In much of the catchment a situation has been reached where there is no remaining capacity for abstraction because of the need to protect stream flows and the valley environment. In some areas the resource has experienced historic over-abstraction leading to reduced flows and drying up of some groundwater fed rivers, particularly on the Chalk aquifer. This also has consequences for groundwater quality since potentially polluting discharges made to such rivers would tend to soak into aquifers. Abstraction in proximity to the Thames estuary has resulted in the ingress of saline waters several kilometres inland.

A notable exception to the above trend is the Chalk aquifer in the London Basin. The considerable reduction in abstractions over the last 25 years has resulted in rising groundwater levels. This is likely to increase the mineral content of groundwater as it rises into previously dewatered strata above the Chalk.

In addition to a natural rise in groundwater level artificial recharge of the Chalk aquifer for subsequent abstraction takes place intermittently in the Lower Lee Valley and in North London between Stoke Newington and Enfield.

## 2. GEOLOGY AND HYDROGEOLOGY

2.1 The main geological feature of note is the London Basin where the Chalk dips below a Tertiary cover of mainly clays and silts. To the north of the Region Jurassic and Cretaceous strata dip south-easterly towards the London Basin. In the south, Cretaceous strata dip northwards. Regional groundwater flow direction corresponds generally with the direction of strata dip.

Other significant geological features are the escarpments at the boundary between the Chalk and underlying clays, in the north formed by the Berkshire and Wiltshire Downs and Chiltern Hills and in the south the North Downs.

The geological sucession in Thames Region is shown in detail in table 1. Table 2 shows strata classified according to their importance as aquifers.

## 2.2 Major Aquifers

The Chalk is the most important aquifer. The three major divisions, the Lower, Middle and Upper, are all of important occurrence within Thames Region. The water table varies in depth from surface springflow to more than 100m below ground level. The Chalk is relatively porous but the interstices are so small that water movement is predominantly through fissures which can allow very rapid flow rates. Fissures are far better developed under valleys than high ground, with correspondingly higher flow rates and greater yields. Swallow holes, allowing rapid infiltration into the aquifer, are common particularly at the junction with the overlying Reading Beds. The Chalk is essentially a pure white fine-grained limestone and in consequence its capacity for attenuation of pollution is limited to dilution and oxygenation. The Lower Chalk is more clayey and less-well fissured.

The Jurassic Limestones are a complex series of mainly limestones and clays occurring in the west of the region. The two main aquifers are the Great Oolite and Inferior Oolite, other strata being of minor importance. Water movement is predominantly via a small number of large fissures and rapid flow rates are possible. Springflow is common as is the tendency for streams to lose water to ground in certain sections. Pollution attenuation mechanisms are limited to dilution and oxygenation. This, combined with the complicated hydrogeology presents particular difficulties in assessing pollution risks. To the north east these strata are of lesser importance and may be considered as minor aquifers.

The Lower Greensand is of major importance in the south of the catchment. Water is drawn from the Hythe Beds and Folkestone Beds, which in some areas form distinct aquifer units, being largely separated by the sandy clays and silts of the Sandgate Beds. The aquifers comprise mainly fine to medium grained sand. Flow is predominantly intergranular although fissure flow is also of some importance in the Hythe Beds. These strata can afford good natural filtration and degradation of some pollutants will occur.

In the north-west of the region small remnant outcrops of Lower Greensand are in local hydraulic continuity with similar occurrences of Portland Beds. They form the composite Portlandian - Lower Greensand minor aquifer.

River gravels, where they overlie impermeable strata, constitute distinct aquifers, in total providing resources of major importance which are being increasingly utilised. River gravels in the Middle Thames Valley are classed as a major aquifer. Those in the upper Thames Valley and the Lee and Lower Thames Valleys constitute minor aquifers.

Groundwater flow is intergranular and is generally oblique towards the main rivers. A degree of hydraulic continuity between rivers and groundwater is common. Mineralogy is variable but where the silt/clay content is significant there is some

potential for attenuation of pollution. However the water table is normally high and groundwater has a corresponding susceptibility to pollution.

## 2.3 Minor aquifers

The Lias is predominantly clay or shale but contains a number of thin limestone bands which can yield small supplies. The most notable of these is the Marlstone rock which is heavily exploited in the North Oxfordshire and Banbury area. Flow is via fissures and pollution attenuation potential is restricted springflow is common.

The Corallian is one of the more important minor aquifers. Its main area of use is around Abingdon where it supports a number of industrial abstractions; public supply abstractions have ceased in recent years. Fissure flow dominates with consequent limited potential for pollution attenuation.

The Portlandian - Lower Greensand aquifer occurs only on the north side of the London Basin. It is a composite unit comprising discontinuous patches of four different formations, Portland Beds, Purbeck Beds, Wealden Sands and Lower Greensand. Flow in the Portland and Purbeck Beds is via fissures, in the Wealden Sands and Lower Greensand intergranular. Potential for pollution attenuation is consequently higher in the latter two formations.

The Wealden Series includes two separate groups of water-bearing strata in North Sussex and West Kent but little water is taken from either of them. However there are many significant springs rising from the limestones and sandstone bands within the Weald Clay which feed small streams.

The Upper Greensand is, in places, in hydraulic continuity with the overlying Chalk eg. west of Wantage, east of Farnham and the two aquifers are often penetrated by the same borehole. Elsewhere, the Upper Greensand outcrop is wider, receives significant recharge and is used as a separate aquifer, particularly for local private supply purposes. Both intergranular and fissure flow take place.

The Lower London Tertiaries group of strata include several permeable units of which the most consistent is the Thanet Beds. For the most part this unit behaves effectively as an upward extension of the Chalk aquifer. Abstractions have also occasionally been made exclusively from other horizons within the group. Groundwater flow, where this occurs is intergranular. Silty and clayey horizons exist which act as aquitards or aquicludes. Generally the potential for pollution migration is limited except where there is direct hydraulic continuity with underlying Chalk.

The Bagshot Beds have an extensive outcrop although this gives a misleading impression of its importance as an aquifer. Due to the fineness of the sands, yields are usually low and its use is normally restricted to small domestic supplies. It is noteworthy for the very acidic nature of the groundwater held within it. This characteristic may enhance solubility and migration of certain pollutants.

River gravels in the Middle Thames are considered a major aquifer in Thames Region. Those in the Upper Thames Valley and the Lee, Lower Thames Valleys constitute minor aquifers. The characteristics of river gravel aquifers are considered above under major aquifers.

The glacial gravels are extensive in Hertfordshire and Buckinghamshire. They are usually only recognised as a separate aquifer where they overlie clay formations. However, generally they overlie the Chalk and are often dry.

### 2.4 Non-Aquifers

Dominantly clay strata cover more than one third of the catchment. They are normally fine-grained strata which effectively act as impermeable barriers to water movement. In theory there should be little risk to groundwater supplies from such areas, but due to the low permeabilities, problems of polluted surface run-off may occur with consequent damage to nearby river systems or groundwater recharge areas downstream.

## 3. GROUNDWATER QUALITY MONITORING

3.1 The Region operates an area based network of approximately 950 groundwater level monitoring sites. The majority of these consist of purpose drilled observation boreholes, which continue to be developed in small numbers each year, but privately owned wells and boreholes also make up about 40% of the total. Data collection remains predominantly manually based, reflecting the needs of the task and the data users. At approximately 600 primary sites, monthly level measurements are made with acoustic level meters (dippers) from surface reference points at each well head. At secondary sites, where trends in levels are more predictable a mixture of three-monthly or twice yearly measurements prove adequate. The groundwater network also includes approximately 200 sites which are fitted with instrumentation, either as autographic chart recorders or more modern data loggers. In this way there is a smaller network of sites where higher resolution data is derived. Ten of these instrumented boreholes are also fitted with telephone telemetry and these 'key' or 'indicator' wells allow an immediate record of levels to be obtained for up to the minute reporting of the groundwater situation in each aquifer unit. Regular reviews are made of the network and frequency of records required.

3.2 A groundwater quality monitoring programme is being established across Thames Region in order that 'background' groundwater quality in aquifers may be ascertained. There will be approximately 500 abstraction points monitored in total, including public supply sources and privately owned boreholes/wells and springs. Analyses include major ions, metals, pesticides and other trace organics. Data are available from the computerised public register archive.

Technical reports summarising results are being produced on an ongoing basis (eg. reports on the Chalk of the Berkshire and Marlborough Downs, the Middle and Upper Lee Valley catchments).

Monitoring is also undertaken for specific areas where groundwater quality is of concern, eg. around waste disposal facilities, contaminated land site etc.

## 4. PARTICULAR GROUNDWATER PROBLEMS IN THE REGION RELATED TO THE POLICY STATEMENTS

In view of the number of groundwater abstractions in Thames Region groundwater source protection zones cover large areas of aquifer outcrop. This can impose severe constraints on potentially polluting activities over many parts of the catchment. In addition restrictions of a more limited nature may be required for the remaining areas of aquifer outcrop. There may be significant consequences for a range of activities and the following matters are highlighted with regard to particular policy issues.

### 4.1 Control of Groundwater Abstraction (Policy A)

It is recognised that flows in a number of rivers are depleted by abstraction from groundwater close to the headwaters or along the river valley. An Alleviation of Low Flows (ALF) programme has been put in place to investigate potential solutions and, where possible, implement them. Solutions have been implemented on the rivers Ver, Pang and Letcombe Brook and a scheme to improve flows in the River Misbourne will be completed in 1998. Other rivers in the ALF programme include the Wey at Alton, Beane, Bulbourne, Wye, Churn, Ampney Brook and Cherwell at Banbury. Any proposal to increase abstraction in these river valleys will warrant particularly careful scrutiny.

In addition to the ALF programme the Agency has duties under the Birds Directive and the Habitats Directive to review the effects of abstraction on Special Protection Areas (SPAs) and Special Areas of Conservation (SACs).

Consumptive abstractions from unconfined groundwaters are generally licensable, provided that the resources of the locality are not already fully committed. In most cases a condition will be imposed restricting or prohibiting abstraction at times when local river flows dependant on the same aquifer are below a critical level. Where a groundwater fed river is very close (generally within 250 metres) abstractions will only be permitted in the winter months. Where sites of special environmental interest (eg. SSSI's) could be adversely affected the Agency seeks the views of environmental bodies such as English Nature and would refuse an application if there were remaining doubts about its sustainability.

Where groundwater has been affected by saline intrusion along the River Thames there will be limited scope for resource development in order to avoid exacerbating the existing situation.

4.2 Waste Disposal to Land (Policy C)

Most sites used for landfill in the past are quarries located on aquifers, such as sand and gravel quarries overlying the Chalk aquifer. However in many of these areas, such as south Herfordshire, groundwater is used extensively for public supply. In these circumstances there will be strict limitations on landfilling activities.

4.3 Contaminated Land (Policy D)

There is continued pressure for redevelopment of former industrial sites many of which occupy prime locations in urban areas. The land is frequently contaminated and there is often associated groundwater pollution, with possibly considerable pollution potential remaining. These sites are often close to groundwater sources of supply. Extensive works may be necessary to decontaminate ground and remediate groundwater. Requirements are likely to be more stringent on the more important aquifers such as the Chalk than for example the Lower Thames Gravels.

4.4 Discharges to Underground Strata (Policy F)

All discharges of sewage and trade effluent going to controlled waters are considered under the consent procedures in Water Resources Act 1991. Discharges of domestic sewage with a volume of less than 5 $m^3$/day entering the unsaturated zone may be controlled by means of a Conditional Prohibition Notice unless the Agency wishes to ensure a stronger degree of ongoing control. All other discharges of sewage or trade effluent, whether to the saturated or unsaturated zone, will require a consent. Consent will not usually be granted for any discharge, including surface water run-off, which is to be made directly to groundwater.

4.5 Diffuse Pollution of Groundwater (Policy G)

Nitrate Sensitive Areas (NSAs) have been established for public supply sources at Ogbourne St. George and old Chalford. In these areas farmers have been encouraged to join a voluntary scheme to change farming practice and limit the amount of nitrate leached. Payments are available according to amendments made.

A consequence of the EU Nitrate Directive has been the delineation of Nitrate Vulnerable Zones (NVZs), see figure 4. These have been implemented partly through the Protection of Water Against Agricultural Nitrate Pollution (England & Wales) Regulations 1996. In contrast to NSAs, affected farmers must comply with statutory regulations to be implemented by 1999.

Other chemicals, such as pesticides, are in widespread usage across the catchment and the frequency of detection in groundwater has risen. Thames Region will continue to discuss pesticide application with relevant parties, such as Highway Authorities and the farming community. The Region will seek to limit pesticide application within sensitive areas on aquifers and pesticide types to those least harmful to groundwater.

Groundwater in some urban areas has been contaminated through widespread usage

of chemicals such as solvents and by leakage from sewers. Thames Region will seek to reduce incidences of contamination by liaising with relevant parties and has instigated a programme of site visits aimed at pollution prevention.

## 5. MAIN OFFICE LOCATIONS AND CONTACTS RELATING TO GROUNDWATER MATTERS

5.1 Thames Region is divided into three Operational Areas as shown in figure 1 with groundwater protection staff based at offices in Wallingford, Hatfield and Abbey Wood. Normally all day to day matters concerning groundwater quality will be dealt with in the Area offices. A team providing support on policy and strategy is based at Reading. The 'background' groundwater quality monitoring network and liaison with water companies are also dealt with centrally at Reading.

5.2 All matters concerning groundwater quantity, such as resource assessment and abstraction licensing, are dealt with by the Water Resources Section based at the Regional Office in Reading. Principal points of contact are shown in table 3.

5.3 Figure 1 and tables 3 and 4 show the appropriate Environment Agency office to contact for groundwater matters falling within the various local authority areas in the Region.

## 6. HOW TO USE THE POLICY AND PRACTICE FOR THE PROTECTION OF GROUNDWATER

Protection of groundwater is in accordance with the concept of aquifer vulnerability and different levels of protection for specified aquifers and areas around boreholes. These concepts are given full explanation in the main policy document. Maps showing groundwater vulnerability have now been published for Thames Region (available from The Stationery Office). Source protection zones have been delineated for the majority of public supply boreholes within the region and information is available from the Environment Agency contacts.

### 6.1 Groundwater Vulnerability Maps

These are produced at a scale of 1:100 000, ultimately covering the whole of England and Wales. In providing an assessment of vulnerability the maps take account of soil type, drift cover and nature of strata. The depth of the unsaturated zone should also be considered when assessing groundwater vulnerability, information on which can be obtained from the Water Resources teams in each area. Local factors affecting groundwater vulnerability must be considered when assessing development proposals on a site by site basis.

## 6.2 Geological Classification

The following classes of protection for aquifers are referred to in the policy document.

| | | |
|---|---|---|
| Major Aquifer | ) | |
| Minor Aquifer | ) | Geological Classification |
| Non-Aquifer | ) | |

Strata have been identified under the above classes in the section, "Geology and Hydrogeology" and locations are shown in figures 3 and 5. Summary information is also provided in tables 1 and 2. Detailed information is given on vulnerability maps.

## 6.3 Source Protection Zones

The policy identifies the following Source Protection Zones.

Zone I - Inner Source Protection
(based on 50 day travel time within saturated aquifer)

Zone II - Outer Source Protection
(based on 400 day travel time or 25% of the recharge catchment area)

Zone III - Source Catchment
(based on the area for long term annual recharge to support the abstraction.

The definition of source protection zones in the Thames Region will be completed by September 1997 for all public supply sources and for all major commercial potable sources using nationally approved methods including 'Modflow' and 'Flowpath' models. Maps of each set of zones will be available for inspection. Figure 3 shows locations of public supply groundwater sources in Thames Region.

To aid in assessment of developments close to boreholes which have not had groundwater source protection zones delineated, sensitive areas are considered with reference to 400 and 50 day travel times in the saturated aquifer. Standard hydrogeological techniques are employed with consideration given to the following parameters:

abstraction rate
hydraulic gradient
transmissivity
hydraulic conductivity
specific yield
saturated thickness

Given that many parameters cannot be defined exactly, simplified assessment methods are normally adopted. The zone width and distance downgradient of the borehole to the stagnation point are based on steady state theory. Methods for assessing upgradient distances include those which take account of abstraction rates and those based on regional groundwater flow rates.

Final assessment of sensitive zones will take account of local geology, including drift cover, topography, and proximity of river and valley systems. Due regard will be given to local knowledge and experience.

It must be borne in mind that groundwater flow and pollution risk cannot easily be defined. Definition of the theoretical extent of zones will continue to be in accordance with established hydrogeological methods using the best available data. Certain principles of assessment have been outlined above; this will not preclude the refining of zone boundaries where improved knowledge of aquifer behaviour becomes available. If, in connection with their proposals, developers and applicants wish to submit data they may have in relation to protection zones this information will be given due consideration.

Documents available from The Stationery Office (Tel. 0171 873 9090):

*Groundwater Vulnerability Maps, 1:100 000 scale*
Sheets 29, 30 ,31, 32, 37, 38, 39, 40, 44, 45 & 46 cover the whole of Thames Region

*Guide to Groundwater Vulnerability Mapping in England & Wales, NRA 1995*

*Guide to Groundwater Protection Zones in England & Wales, NRA 1995*

*The Policy and Practice for the Protection of Groundwater, NRA 1992*

| AGE | FORMATIONS | PRINCIPAL DIVISIONS | DESCRIPTION | THICKNESS m | FLOW MECHANISM | GEOLOGICAL CLASSIFICATION |
|---|---|---|---|---|---|---|
| QUATERNARY | Plateau gravels | Not in order of age | Gravel, clayey gravel | 0-5 | I | Mi |
| | Glacial sand and gravel | | Sand, gravel | 0-10 | I | Mi |
| | Flood plain gravels<br>Terrace gravels | | Flint gravel, limestone, gravel, brickearth | 0-10 | I | Ma or Mi |
| | Alluvium | | Clay, silt, peat | 0-3 | | dependent on underlying strata |
| | Boulder clay | | Clay with rock fragments (mainly chalk and flint) | 0-50 | | |
| | Clay-with-flints | | Clay, silt, sand, gravel | 0-10 | | |
| TERTIARY | Lenham Beds | | Sand | 0-5 | I | Mi |
| | Bagshot Beds | Barton Beds | Fine sand | 15 | | |
| | | Brackleshan Beds | Clay, silt, sand | 15-20 | I | Mi |
| | | Bagshot Beds | Fine sand with clay | 15•35 | | |
| | London Clay | Claygate Beds | (Clay, sand - Claygate Beds)<br>Clay, sandy at top and bottom | 5-150 | | N |
| | Woolwich & Reading Beds | Blackheath Beds | (Sand, pebbly sand - Blackheath Beds)<br>Mottled clay, silt, sand | 15-25 | | N or Mi |
| | Thanet Beds | | Silty sands | 0-25 | I | Mi |
| CRETACEOUS | Chalk | Upper Chalk | White chalk with flint; Chalk Rock at base | 50-130 | | |
| | | Middle Chalk | Off-white chalk, little flint; Melbourn Rock at base | 50-70 | F | Ma |
| | | Lower Chalk | Grey or buff chalk, very clayey towards base; including Totternhoe Stone and "Glauconitic Marl" at base | 45-90 | | |
| | Upper Greensand | | Fine sand, sandy silt, malmstone | 0-45 | I<br>F | Mi |
| | Gault | | Clay, silty clay | 30-85 | | N |

Continued at (A) or (B) on following pages

**TABLE 1 GEOLOGICAL SUCCESSION**

(A) NORTH SIDE OF LONDON BASIN

| AGE | FORMATIONS | | PRINCIPAL DIVISIONS | | DESCRIPTION | | THICKNESS | FLOW MECHANISM | GEOLOGICAL CLASSIFICATION |
|---|---|---|---|---|---|---|---|---|---|
| CRETACEOUS | Lower Greensand | | | | Sand, gravel, clay | | 0-60 | I | |
| | Wealden | | Shotover Sands | | Sand | | 0-15 | I | Mi |
| | Purbeck Beds | | | | Limestone, marl | | 0-3 | F | |
| | Portland Beds | | Whitchurch Sand | | Sand, limestone | | 0-12 | F | |
| | Kimmeridge Clay | | | | Shale, clay | | 45-90 | | N |
| | Corallian | | | | Very variable; sand, silt, clay, limestone | | 25-30 | F | Mi |
| | Oxford Clay | | Kellaways Beds | | Clay, shaly clay (Sand, sandstone, clay - Kellaways Beds) | | 120-175 | | N |
| | Cornbrash | | | | Limestone, clay | | 2-5 | F | Mi |
| JURASSIC | "Forest Marble" | GREAT OOLITE | Forest Marble Clay<br>Forest Marble Limestone | | Clay<br>Limestone | | | | N |
| | Great Oolite | | White Limestone | Oolitic | | | Ind. members very variable | | |
| | | | Hampden Beds | Marl | U. Deltaic Series | Sandstone, shale | | F | |
| | | | Taynton Stone | Limestone | Sharps Hill Beds | Limestone, marl | Overall 25-60 m | | Ma |
| | | | Stonesfield Slate | Limestone | | | | | |
| | Fullers Earth Series | | Fullers Earth Clay | Clay, limestone | Chipping Norton Limestone | | 0-30 | | N |
| | Inferior Oolite | COTSWOLDS | U. Inferior Oolite | Oolitic/ shelly | U. Inferior Oolite | Limestone | | | |
| | | | L. Inferior Oolite | Limestone | L. Deltaic Series | Sandstone shale | 0-85 | F | |
| | | | Scissum beds | Sandy limestone | Northampton Sands | | | | Ma |
| | Upper Lias | | Cotteswold Sands | | Fine sand, sometimes clayey | | 0-85 | F | |
| | | | Upper Lias Clays | | Clay and shale with thin limestones | | | | |
| | Middle Lias | | Marlstone Rock | | (Ferruginous limestone - Marlstone Rock)<br>Silt, clay, shale | | 0-85 | F | |
| | Lower Lias | | | | Clay, shale, thin limestones near base | | 90-290 | F | Mi |

NORTH OXON.

TABLE 1 GEOLOGICAL SUCCESSION (Cont)

(B) SOUTH SIDE OF LONDON BASIN

| AGE | FORMATIONS | | PRINCIPAL DIVISIONS | DESCRIPTION | THICKNESS m | FLOW-MECHANISM | GEOLOGICAL CLASSIFICATION |
|---|---|---|---|---|---|---|---|
| CRETACEOUS | Lower Greensand | | Folkestone Beds | Fine to coarse sand; occ. clay | 0–80 | | |
| | | | Sandgate Beds | Clay/silty clay or sand/stone | 0–45 | | Ma |
| | | | Bargate Beds) | | | F | |
| | | | ) | Sand and Sandstone often calcareous or cherty | 0–90 | I | |
| | | | Hythe Beds ) | | | | |
| | | | Atherfield Clay | Clay, silty clay | 0–20 | | |
| | Weald Clay | WEALDEN S. | | Clay, shale and mudstone with thin bands of sandstone and limestone | 245–455 | | N |
| | Hastings Beds | | U. Tun. Wells Sand | Sand, sandstone, silt | c.70 | I | Mi |
| | | | Grinstead Clay | Clay | c.20 | F | |

ABBREVIATIONS:

| | | | | | |
|---|---|---|---|---|---|
| U. | Upper | Ma | Major Aquifer | F | Fissure flow |
| L. | Lower | Mi | Minor Aquifer | I | Intergranular flow |
| S. | Series | N | Non Aquifer | | |

TABLE 1 GEOLOGICAL SUCCESSION (Cont)

**TABLE 2**
**ENVIRONMENT AGENCY - GROUNDWATER PROTECTION POLICY**
**GEOLOGICAL CLASSIFICATION IN THAMES REGION**

| MAJOR AQUIFERS | MINOR AQUIFERS | | NON-AQUIFERS |
|---|---|---|---|
| Highly permeable formations usually with the known or probable presence of significant fracturing. High productive strata of regional importance. Often used for large potable abstractions. | Fractured or potentially fractured but without high intergranular permeability. Generally only support locally important abstractions | Variably porous/ permeable but without significant fracturing. Generally only support locally important abstractions. | Formations with negligible permeability. Only support very minor abstractions, if any. |
| *Middle Thames Valley River Gravels*<br>*Chalk and Upper Greensand*<br>*Lower Greensand*<br>*Great Oolite*<br>*Inferior Oolite* | *Wealden Series*<br>*Portlandian*<br>*Corallian*<br>*Lias* | *Other river gravels*<br>*Glacial sands and gravels*<br>*Bagshot Beds*<br>*Thanet Beds*<br>*Other Tertiary Sands*<br>*Upper Greensand (where not in hydraulic continuity with the Chalk)* | *All clays, shales, marls and siltstones*<br>*London Clay*<br>*Gault Clay*<br>*Atherfield Clay*<br>*Weald Clay*<br>*Kimmeridge Clay*<br>*Oxford Clay* |

**TABLE 3**
**MAIN CONTACTS AND RESPONSIBILITIES - REGIONAL OFFICE, READING**

| ADDRESS |
| --- |
| Environment Agency Thames Region, Kings Meadow House, Kings Meadow Road, Reading, Berkshire, RG1 8DG.<br>Tel: (0118) 953 5000 Fax: (0118) 950 0388 |
| **WATER QUALITY DEPARTMENT -**<br>*Groundwater Quality Section:*<br>- all matters concerning policy and strategy for groundwater quality including waste disposal proposals; discharges to ground; Nitrate Sensitive Areas; Nitrate Vulnerable Zones; contaminated land and groundwater; groundwater quality monitoring.<br>*Quality Regulation Section:*<br>- issuing of all discharge consents.<br>*Principal Pollution Officer:*<br>- expertise on pollution prevention.<br>To report pollution incidents and other emergencies, Tel: 0800 80706 |
| **WATER RESOURCES DEPARTMENT-**<br>*Abstraction Licensing Section:*<br>- issuing of licences for abstraction of groundwater and surface water; register of abstraction licences.<br>*Hydrometry/Hydrology Section:*<br>- archiving of meterological and hydrometric data; matters concerning policy and strategy.<br>*Hydrogeology Section:*<br>- matters concerning groundwater quantity; groundwater management schemes; proposals for large abstractions; groundwater levels and flow; groundwater source protection zone delineation; borehole and hydrogeological database. |
| **PUBLIC REGISTER DEPARTMENT -**<br>- process requests from the public wanting information held on public registers (including groundwater quality data, source protection zone and abstraction licence information). Tel: (0118) 953 5426 |

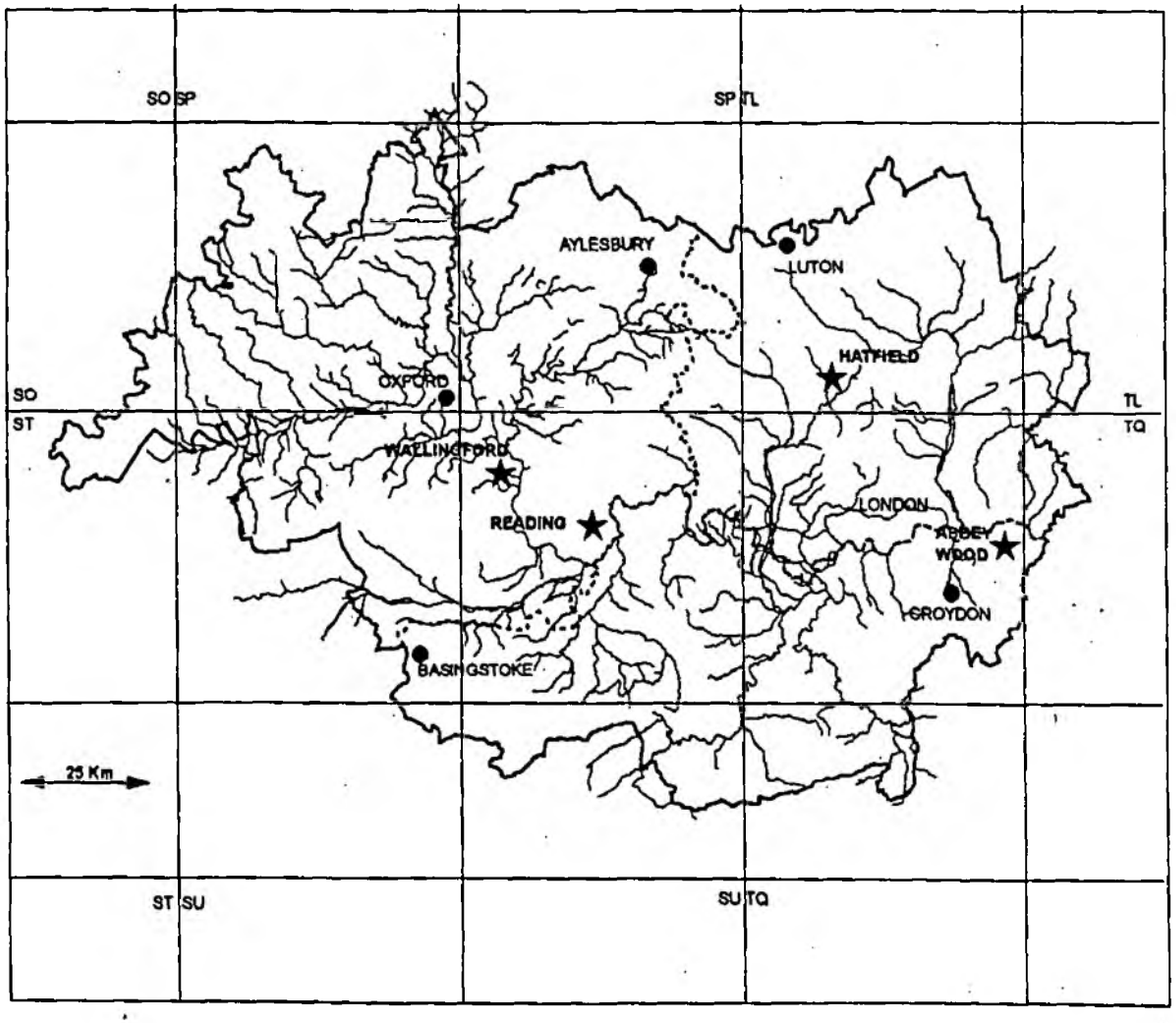
## TABLE 4
## MAIN CONTACTS AND RESPONSIBILITIES: AREA OFFICES

| Address | Main Contact | District Councils (See Fig. 2) |
|---|---|---|
| Environment Agency<br>Thames Region<br>Rivers House<br>Belvedere Road<br>Abbey Wood<br>LONDON<br>SE2 9AQ<br><br>Tel. 0181 310 5500<br>Fax. 0181 311 9778 | **Scientific Support**<br><br>- all matters concerning groundwater quality and protection for south east area<br><br>**Water Resources**<br><br>- all matters concerning water quantity and protection for south east area | **Berkshire,** Bracknell, Slough, Windsor & Maidenhead, Wokingham<br>**Hampshire,** Basingstoke & Deane, Hart, Rushmoor<br>**Surrey,** Elmbridge, Epsom & Ewell, Guildford, Mole Valley, Reigate & Banstead, Runnymede, Spelthorne, Surrey Heath, Waverley, Woking<br>**West Sussex,** Crawley<br>**Boroughs:** Bexley, Bromley, Croydon, Greenwich, Lambeth, Lewisham, Merton, Richmond, Southwark, Sutton, Wandsworth |
| Environment Agency<br>Thames Region<br>Apollo Court<br>2 Bishops Square<br>St. Albans Road West<br>HATFIELD<br>Herts.<br>AL10 9NE<br><br>Tel. 01707 632300<br>Fax. 01707 632533 | **Scientific Support**<br><br>- all matters concerning groundwater quality and protection for north east area<br><br>**Water Resources**<br><br>- all matters concerning water quantity and protection for north east area | **Bedfordshire,** Luton, South Beds<br>**Buckinghamshire,** Chiltern, South Bucks<br>**Essex,** Epping Forest, Harlow<br>**Hertfordshire,** Broxbourne, Dacorum, Hertsmere, North Herts, St. Albans, Stevenage, Three Rivers, Watford, Welwyn Hatfield<br>**Boroughs:** Barking & Dagenham, Barnet, Brent, Camden, City of London, City of Westminster, Ealing, Enfield, Hackney, Hammersmith & Fulham, Haringey, Harrow, Havering, Hillingdon, Hounslow, Islington, Kensington & Chelsea, Newham, Redbridge, Tower Hamlets, Waltham Forest |
| Environment Agency<br>Thames Region<br>Isis House<br>Howbery Park<br>WALLINGFORD<br>Oxon<br>OX10 8BD<br><br>Tel. 0118 953 5000<br>Fax. 0118 953 5900 | **Scientific Support**<br><br>- all matters concerning groundwater quality and protection for west area<br><br>**Water Resources**<br><br>- all matters concerning water quantity and protection for west area | **Berkshire,** Newbury, Reading<br>**Buckinghamshire,** Aylesbury Vale, Wycombe<br>**Gloucestershire,** Cotswold<br>**Oxfordshire,** Cherwell, Oxford, South Oxon, Vale of White Horse, West Oxon<br>**Wiltshire,** Thamesdown |

**TO REPORT POLLUTION INCIDENTS AND OTHER EMERGENCIES, TELEPHONE 0800 807060**

# FIGURE 1

THAMES CATCHMENT AND MAIN OFFICES




REGIONAL BOUNDARY (PUBLIC FACE)

ADMINISTRATIVE AREA BOUNDARY

MAIN RIVERS

MAJOR TOWN

MAIN OFFICE

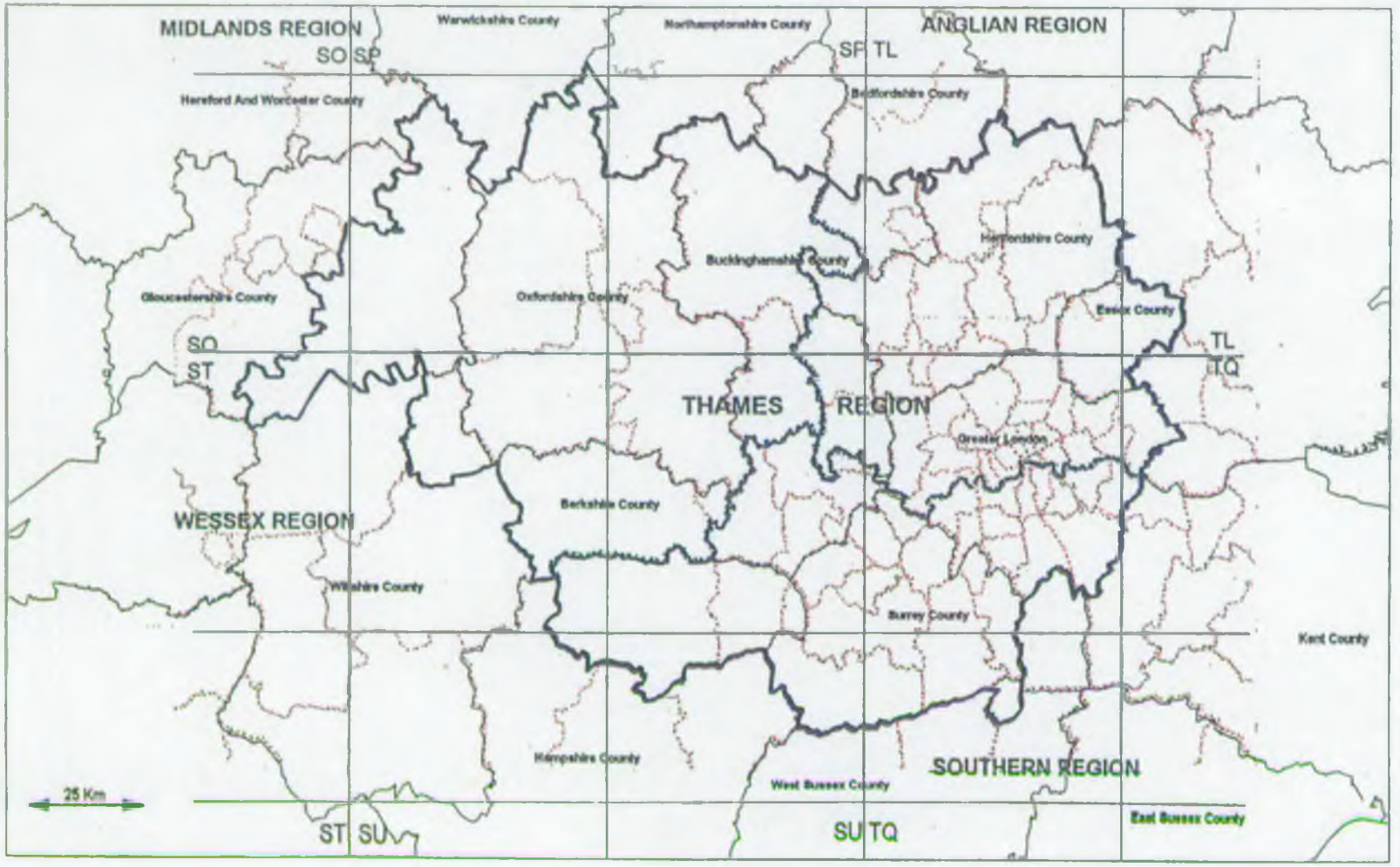
ENVIRONMENT AGENCY



JUNE 1997

# FIGURE 2

ADMINISTRATIVE AREAS AND COUNTY COUNCILS WITHIN THAMES REGION




REGIONAL BOUNDARY (PUBLIC FACE)

COUNTY COUNCIL BOUNDARY

ADMINISTRATIVE AREA BOUNDARY

DISTRICT COUNCIL BOUNDARY

ENVIRONMENT AGENCY



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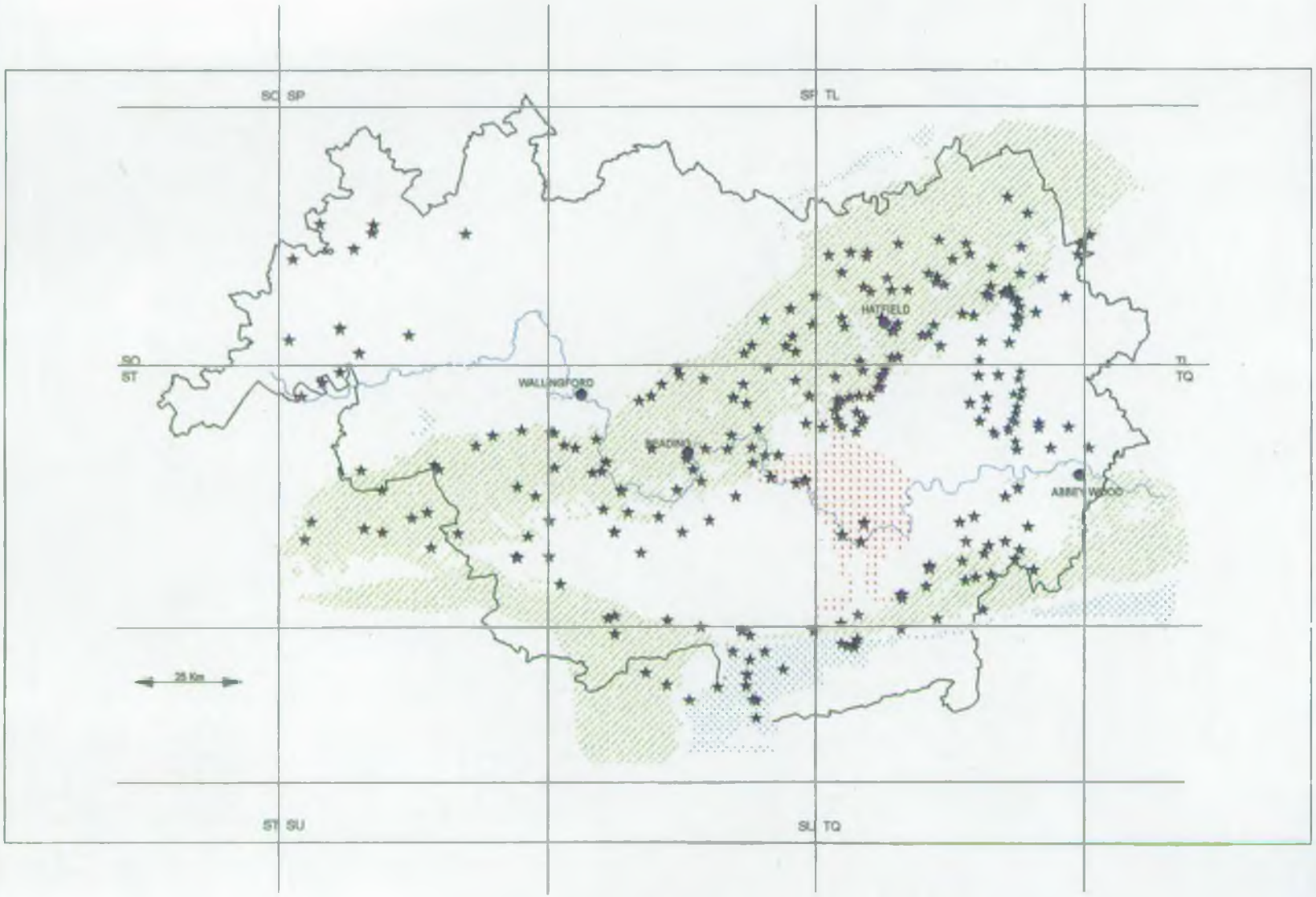
# FIGURE 3

PUBLIC WATER SUPPLY BOREHOLES AND THE CHALK, LOWER GREENSAND AND GRAVEL AQUIFERS




Chalk

Lower Greensand

Middle Thames Valley Gravels

Public Water Supply Borehole

ENVIRONMENT AGENCY



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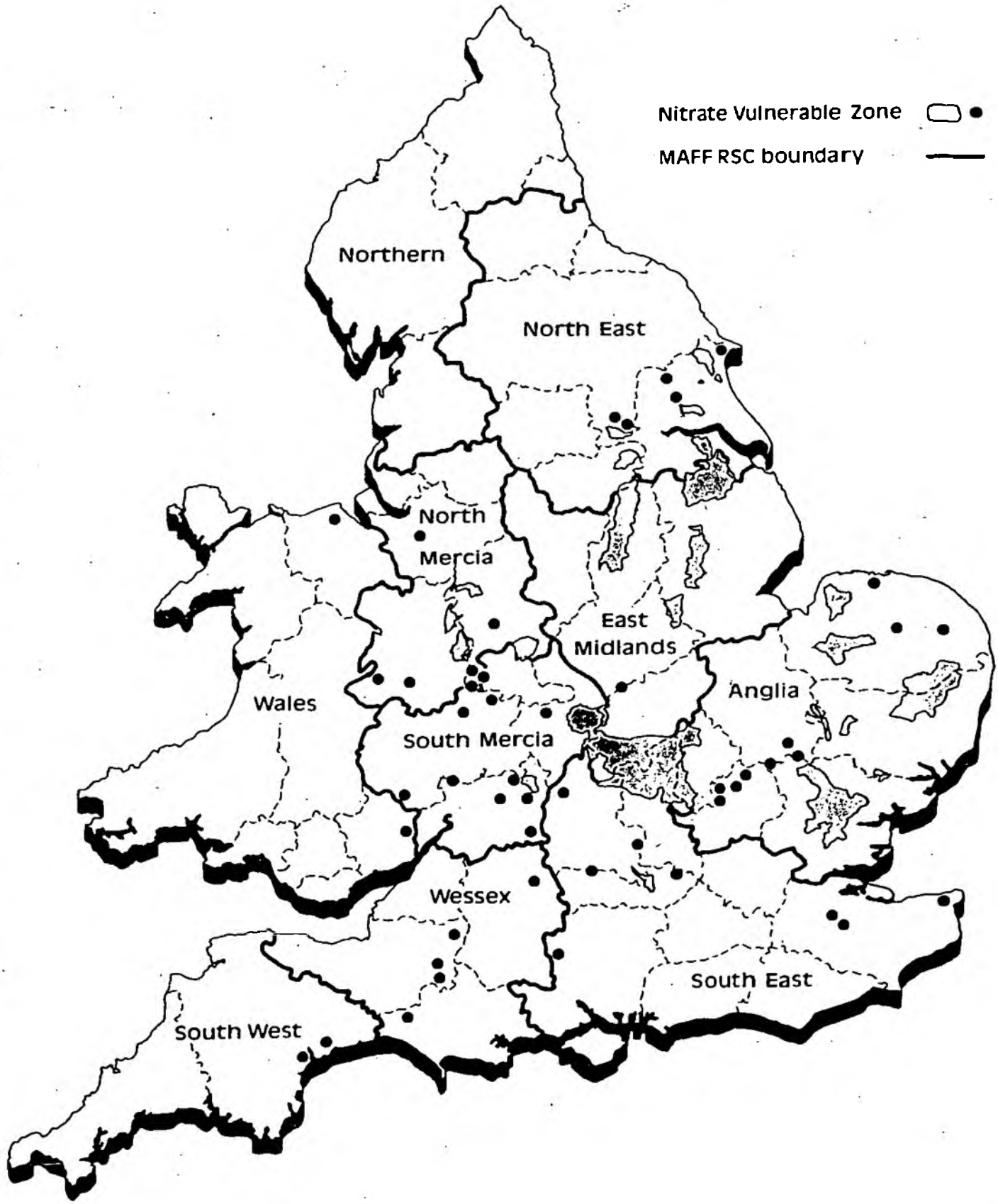
FIGURE 4

MAFF Ministry of Agriculture Fisheries and Food

# NITRATE VULNERABLE ZONES in ENGLAND AND WALES




Produced by ADAS Cartography, Gloucester GL3 1AG CUH 993/381



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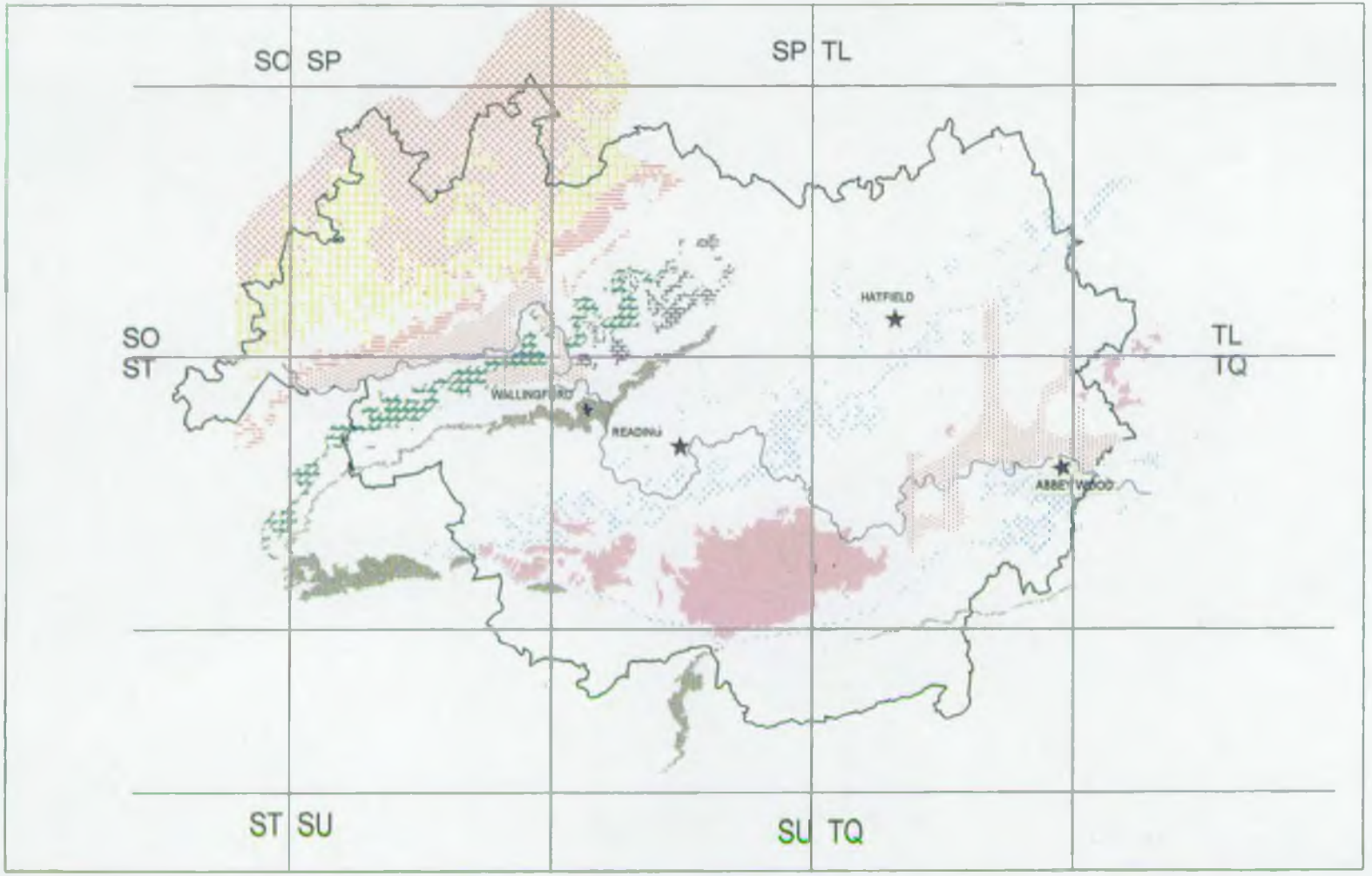
# FIGURE 5

## OUTCROPS OF OTHER AQUIFERS




- Bagshot Beds
- Thanet Sands, Woolwich and Reading Beds
- Upper Greensand
- Portlandian - Lower Greensand
- Corallian
- Combrash
- Great and Inferior Oolite
- Lias
- Gravels

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