NATURAL ENVIRONMENT RESEARCH COUNCIL

INSTITUTE OF GEOLOGICAL SCIENCES

Report No. 72/6

ASSESSMENT OF BRITISH SAND AND GRAVEL RESOURCES No. 2

The sand and gravel resources of the country around Witham, Essex

Description of 1 : 25 000 resource sheet TL 81

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London: Her Majesty's Stationery Office 1972

The Institute of Geological Sciences was formed by the incorporation of the Geological Survey of Great Britain and the Museum of Practical Geology with Overseas Geological Surveys and is a constituent body of the Natural Environment Research Council.

It is recommended that reference to this report be made in the following form:

HAGGARD, H. J. E. 1972. The sand and gravel resources of the country around Witham, Essex: Description of 1:25 000 resource sheet TL 81. *Rep. No.* 72/6, *Inst. geol. Sci.* 90 pp.

SBN 11 880588 6

Preface

It has become increasingly clear in recent years that an assessment of resources of many minerals should be undertaken. This is the second Report of the Mineral Assessment Unit which was set up in May 1968 to undertake such work. It describes and quantifies the resources of sand and gravel of 100 km^2 of country around Witham, Essex, shown on the accompanying 1 : 25 000 Resource Map TL 81.

This survey is concerned with assessing sand and gravel resources on a regional scale at the indicated level: the deposits are not outlined completely nor their grade established throughout. The work may be regarded as the application to large areas of methods used commercially for evaluating reserves on small sites. It may also be regarded as an extension of geological mapping by providing information about the thickness and quality of deposits.

The survey was conducted by Mr. H. J. E. Haggard, assisted by Mr. J. D. Ambrose, Mr. A. R. Clayton and Mr. E. F. P. Nickless as field officers who supervised the drilling and sampling programme. Mr. Clayton and Mr. C. H. Eaton helped in the preparation of data for this publication. Mr. J. H. Hull contributed to and compiled Appendix A. The work is based on a geological survey at 1 : 10 560 in 1967 by Dr. C. R. Bristow (East Anglia and South-East England Unit) who has also helped in the geological interpretation.

Mr. J. W. Gardner, C.B.E. (Land Agent) has been responsible for negotiating access to land for drilling. The ready cooperation of land owners and tenants in this work is gratefully acknowledged. Special thanks are due to Dr. T. L. Thomas of the Royal School of Mines, London for his advice on methods of resource calculation.

Financial support for the survey was provided by the Department of the Environment.

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1 June 1972

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Summary

The geological maps of the Institute of Geological Sciences, pre-existing borehole information, and sixty-nine boreholes drilled for the Mineral Assessment Unit form the basis of the assessment of sand and gravel resources in the Witham area, Essex.

All deposits in the area which might be potentially workable for sand and gravel (mineral) have been investigated geologically and a simple statistical method has been used to estimate the volume. The reliability of the volume estimates is given at the 95 per cent confidence level.

The mineral-bearing ground shown on the 1 : 25 000 map is divided into resource blocks, each ideally containing approximately 10 km² of sand and gravel. For each block the mineral-bearing area, the mean thickness of overburden and mineral, and the mean grading are given and the geomorphology and geology of the deposits described.

The position of the boreholes and exposures, the geology and topography and the outlines of the blocks are shown on the accompanying map TL 81. Detailed borehole data are given.

Sommaire

Les cartes géologiques de l'Institute of Geological Sciences, les renseignements sur des trous de sonde qui existaient déjà, et soixante-neuf trous de sonde, forés pour le Mineral Assessment Unit, constituent la base de l'évaluation des ressources en sable et en gravier dans la région de Witham, Essex.

Tous les dépôts dans la région, qui présentent la possibilité d'exploitation pour le sable et le gravier (mineral) ont été étudiés du point de vue géologique, et on s'est servi d'une methode statistique simple pour en évaluer le volume. Les évaluations de volume sont tenues d'être a 95% exactes.

Le terrain minéralisé montré à la carte 1 : 25 000 est divisés en blocs de ressources, chacun d'eux ayant idéalement environ 10 km² de sable et de gravier. On donne pour chaque bloc l'étendue minéralisée, l'epaisseur moyenne de recouvrement et de minéral, et la gradation moyenne. On décrit la géomorphologie et la géologie des dépôts.

La situation des trous de sonde et des affleurements, la géologie et la topographie, et la configuration des blocs sont montrés sur la carte TL 81. Des données détaillées des trous de sonde sont données.

Zusammenfassung

Die geologischen Karten von der Institute of Geological Sciences, die vorher existierende Information in Bezug auf Bohrlöchern, und 69 Bohrlöcher, die für das Mineral Assessment Unit gemacht waren, bilden den Grund für die Einschätzung der Sand- und Schotter-mittel im Witham Gebiet, Essex.

Man hat im Gebiet alle Ablagerungen, die möglich bearbeitbar für Sand und Schotter (Mineral) sind, geologisch untersucht, und man hat auch eine einfache statistische Methode benutzt, um das Volumen zu schätzen. Man gibt die Zuverlässigkeit der Volumenschätzungen mit 95% Vertrauensgrenzwerten.

Man teilt den mineralhaltigen Grund auf der 1 : 25 000 Karte in Mittelsblöcke, wovon feder idealisch ungefähr 10 km² von Sand und Schotter einschliesst.

Für jeden Block gibt man das mineralhaltige Gebiet, die Durchschnittsdicke von Überlastung und Mineral und die Durchschnittsklassifizierung. Man beschreibt auch die Geomorphologie und Geologie der Ablagerung.

Man zeigt die Lage von den Bohrlöchern und Aufschlüssen, die Geologie und Topographie, auch die Skizzen von den Blöcken auf der Begleitkarte TL 81. Man gibt ausführliche Bohrlöcherdaten.

The sand and gravel resources of the country around Witham, Essex.

Description of 1 : 25 000 resource sheet TL 81

H. J. E. HAGGARD,[1] BSc, MIMM

Introduction

AIMS AND LIMITATIONS

National resources of many of the 'bulk' or 'industrial' minerals may seem so large that stock-taking is unnecessary, but the demand for land for all purposes and for minerals is intensifying. In contrast with other developments of land there may be little or no choice of area for the working of minerals and in the case of low-price materials such as sand and gravel transport costs will be an important factor. Whereas the economic benefit of using land for many other purposes can be assessed, hitherto little has been known of the potential value, on a regional scale, of any mineral resources which may be present. An important aim of the work is to improve the factual background against which planning policies can be decided (Archer, 1969; Thurrell, 1971).

Sand and gravel, considered together as naturally occurring aggregate, was selected as the bulk mineral demanding the most urgent attention, particularly in the south-east of England, where about half the national output is won and very few sources of alternative aggregates are available. Following a short feasibility project, initiated in 1966 by the Ministry of Land and Natural Resources, the Mineral Assessment Unit began systematic surveys on a regional scale in Essex, Suffolk, and Norfolk in May 1968. This work is being supported by the Department of the Environment (which incorporates the former Ministry of Housing and Local Government and the Ministry of Public Building and Works) with the cooperation of the Sand and Gravel Association of Great Britain (SAGA). The detail is at the 'indicated' level, a term introduced in the United States in connection with the estimation of national mineral resources. The level is that 'for which tonnage and grade are computed partly from specific measurements, samples, or production data and partly from projection for a reasonable distance on geologic evidence. The sites available for inspection, measurement, and sampling are too widely or otherwise inappropriately spaced to permit the mineral bodies to be outlined completely or the grade established throughout.' (Anon., 1948, page 15).

The survey is therefore concerned not with the estimation of reserves (which can only be assessed in the light of particular or existing economic considerations), but rather with resources, which include deposits not currently exploitable but having a foreseeable use. Clearly, the social and economic criteria used to decide whether a deposit may be workable at some time in the future cannot be rigorously defined. After discussion with the industry, the following arbitrary physical criteria were adopted for this survey:

a. the deposit should average at least 3 ft (0.9 m) in thickness.
b. the ratio of overburden to sand and gravel should be no more than 3:1.
c. the proportion of fines (that is, particles passing 1/16 mm (approximately No.200 mesh B.S. sieve)) should not exceed 40 per cent.

Ground below 80 ft (24.4 m) from the surface is seldom explored, this being taken as the likely maximum working depth under most circumstances. It follows that boreholes are drilled no deeper than 60 ft (18.3 m) if they are still in overburden.

A deposit of sand and gravel that broadly fulfils the above criteria is considered to be 'potentially workable' and is assessed as 'mineral'. It is recognised that small parts of such a deposit may not satisfy all the requirements.

The volume and chief characteristics of sand and gravel within defined but relatively large areas, referred to as resource blocks, are assessed. Ideally, each resource block contains roughly 10 km^2 of sand and gravel.

The consequent limitation of the use to which the results can be put must be emphasised. The assessments of quantity and composition apply to the resource block as a whole.

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Valid conclusions cannot be drawn about the mineral in parts of a block, except in the immediate vicinity of the actual sample points.

It follows that reserves, which are accurately demarcated areas of economically workable mineral, must be proved by the customary detailed exploration undertaken by the industry. However, the information provided about the resource blocks in an area may assist in the selection of the best targets for such commercial exploration and evaluation.

Thus the work can be regarded as the statistically controlled application to large areas of methods similar to those applied by industry to establish the existence of workable reserves on a relatively small site, and also as an extension of conventional geological mapping techniques, which delineate (with varying degrees of accuracy, depending, for example, on the presence of cover) the areal extent of deposits.

PROCEDURE

Trial and error during preliminary studies showed that for the complex and variable glacial deposits of East Anglia and Essex, an absolute minimum of five sample-points evenly distributed across the sand and gravel are needed to provide a worthwhile statistical assessment, but that, ideally, there should be no fewer than ten. Sample-points are any points for which there exists adequate information about the nature and thickness of the deposit and, apart from the holes drilled during the survey, may include exposures and other boreholes. In particular, the cooperation of sand and gravel operators has ensured that boreholes have not been drilled where reliable information was already available. Such data are held confidentially by the Institute and cannot be disclosed, although they may have been used in the calculations.

The mineral on each 1 : 25 000 sheet is divided into resource blocks. The arbitrary size selected, 10 km^2, is a compromise to meet the aims of the survey and to provide sufficient sample-points in each block. As far as possible the block boundaries are determined by geological boundaries; for example, wherever practicable plateau and river terrace gravels are separated. Otherwise division is by arbitrary lines, which may bear no relationship to the geology. The blocks are drawn provisionally before drilling begins.

A reconnaissance of the ground is carried out to establish whether there are any exposures, and inquiries are made to ascertain what borehole information is available. Borehole sites are then selected to provide an even pattern of sample-points at a density of approximately one per square kilometre. Ideally the distribution should be unbiassed with respect to the geology, to ensure that the data obtained are representative of any broad trend in the variation in thickness or grading, as this will govern spot values.

However, because broad trends are independently overlaid by smaller scale variations, characteristically random in form, it is unnecessary to adhere to a square grid pattern. Thus such factors as ease of access and the need to minimise disturbance to land and the public have been taken into account in siting the holes: at the same time it has been necessary to guard against the possibility that ease of access (that is, the positions of roads and farms) may reflect particular geological conditions, which may bias the drilling results. The built-up area of Witham has been avoided, but otherwise in siting the boreholes and in the subsequent calculations, no account is taken of any factors, for example, roads, villages and areas of high agricultural and landscape value, which might stand in the way of sand and gravel being exploited. The estimate of total volume of sand and gravel therefore bears no simple relationship to the amount that could be extracted in practice.

Ideally the drilling machine employed should be capable of providing a continuous sample representative of all unconsolidated deposits, so that the in-situ grading can be determined, if necessary, to a depth of 100 ft (30 m) at a diameter of about 8 in (200 mm), and beneath different types of overburden. It should be reliable, quiet, mobile and relatively small (so that it can be moved to sites of difficult access) and it should be fast. Although uncased continuous flight power augers can meet these requirements in some ground, they fail below the water table in some clay-free sand and gravel when the mineral does not stay on the flights or when the borehole caves. On the area covered by this sheet the German Wirth B1 drill (or B0 modified) was used extensively. With this machine, casing can be advanced at the same time as the hole is being drilled, thus minimising disturbance to the ground, and avoiding contamination and caving. In difficult ground a bailer can be substituted for the auger although this method suffers from the disadvantage that there is a tendency for the pumping action to draw unwanted material into the hole either from the sides or the bottom. Other machines, including conventional 'shell and augers', were also used.

A continuous series of bulk samples is taken throughout the thickness of sand and gravel. Ideally, samples are composed exclusively of the whole of the material previously occupying the space defined by the hole's ideal dimensions, as determined by the internal diameter of the casing and the thickness penetrated. A new sample is commenced whenever there is an appreciable lithological change within the sand and gravel, or for every 3 ft (0.9 m) depth. The samples are despatched in heavy-duty polythene bags to a laboratory for grading. Care is taken to discard, as far as possible, material which has caved, or been pumped from the bottom of a hole. The samples sent for analysis each weigh 60-100 lb. The grading procedure is based on BS

1377: 1967. Random checks are made on the accuracy of the laboratory grading.

All data, including mean grading analysis figures calculated for the total thickness of the mineral, are entered on standard record sheets, abbreviated copies of which are reproduced in Appendix C. Detailed records may be consulted at the appropriate offices of the Institute, upon application to the Director.

The method used in estimating the volume of mineral and other statistics for each of the resource blocks is described in Appendix A and the results are quoted on p. 8.

THE MAP

The sand and gravel resource map is folded into the pocket at the end of this report. The base map is the Ordnance Survey 1 : 25 000 Outline Edition in grey, on which the topography is shown by contours in green, the geological data in black and the mineral resource information in shades of red.

Geological data: The geological boundary lines, symbols, etc. shown are taken from the geological map of the area, which was surveyed recently at the scale of 1 : 10 560. This information was obtained by detailed application of field mapping techniques by the field staff in the Institute's East Anglia and South-East England Unit. Borehole data, which include the stratigraphic relations and mean particle size distribution of the sand and gravel samples collected during the survey, are also shown.

The geological boundaries are regarded as the best interpretation of the information available at the time of survey. However, it is inevitable, particularly with glacial deposits (such as those included in the area of Sheet TL 81) which change rapidly vertically and laterally, that local irregularities or discrepancies will be revealed by some boreholes (for example, at borehole SE 9) These are taken into account in the assessment of resources (see below and Appendix A).

Mineral resource information: For assessment purposes the map is divided into areas of mineral and areas where sand and gravel is either not potentially workable or absent. (For definitions of 'mineral' and 'potentially workable' see page 1).

The mineral on TL 81 is subdivided into areas where it crops out, and areas where it is present in continuous (or almost continuous) spreads beneath overburden. The whole area of exposed sand and gravel as mapped is considered as mineral, although there may be small patches where sand and gravel is not present or is not potentially workable.

Beneath overburden mineral may be continuous (or almost continuous) or discontinuous. The recognition of these categories is subjective, depending on the importance attached to the proportion of boreholes which did not find potentially workable sand and gravel and the distribution of barren boreholes within a block. The mineral is described as 'almost continuous' if it is present in 75 per cent or more of the boreholes in a resource block. The 'discontinuous' category has not been recognised on the present sheet.

Areas where bedrock crops out, where boreholes indicate absence of sand and gravel beneath cover, where sand and gravel beneath cover is interpreted to be not potentially workable, and areas not assessed are uncoloured on the map, and where appropriate the relevant criterion is noted. In such areas it is assumed that mineral is absent except in infrequent and relatively minor patches which can neither be outlined nor assessed quantitatively in the context of this survey.

The area of exposed sand and gravel is measured from the mapped geological boundary lines. Inferred boundaries have been inserted around areas where sand and gravel beneath cover is interpreted to be not potentially workable or absent. Such boundaries, for which a distinctive symbol is used, are drawn primarily for the purpose of volume estimation. The symbol is intended to convey an approximate location within a likely zone of occurrence rather than to represent the breadth of the zone, its size being limited only by cartographic considerations. For the purpose of measuring areas the centre-line of the symbol is used.

Description of Sheet TL 81

GENERAL

Sheet TL 81 shows 100 km^2 (about 39 square miles) of country around Witham, a town of about 13 000 people, lying 14 km north-east of Chelmsford in Essex. The A12 trunk road and the main railway into East Anglia from London cross the area. Although there are light industries around Witham, the area is essentially rural. Sand and gravel occupies 61 per cent of the area of the sheet, excluding deposits lying beneath the built-up area of Witham.

TOPOGRAPHY

The chief feature is the broad valley of the Blackwater River, which flows southward across the sheet in a wide arc from Kelvedon to Wickham Hall [831 106][1]. It becomes tidal 3 km downstream of the southern edge of the sheet (Fig. 1).

There is contrast between the land west of the Blackwater and that east of it, as shown in cross-section (Fig. 2). West of the river, an almost continuous sheet of boulder clay overlying glacial sand and gravel forms a plateau at between 150 and 200 ft O. D. A number of relatively deep narrow valleys tributary to that of the Blackwater have cut through to the London Clay in some places. The principal stream is the River Brain, flowing south-

[1]National Grid References in this publication all lie within the 100 km square TL (52)

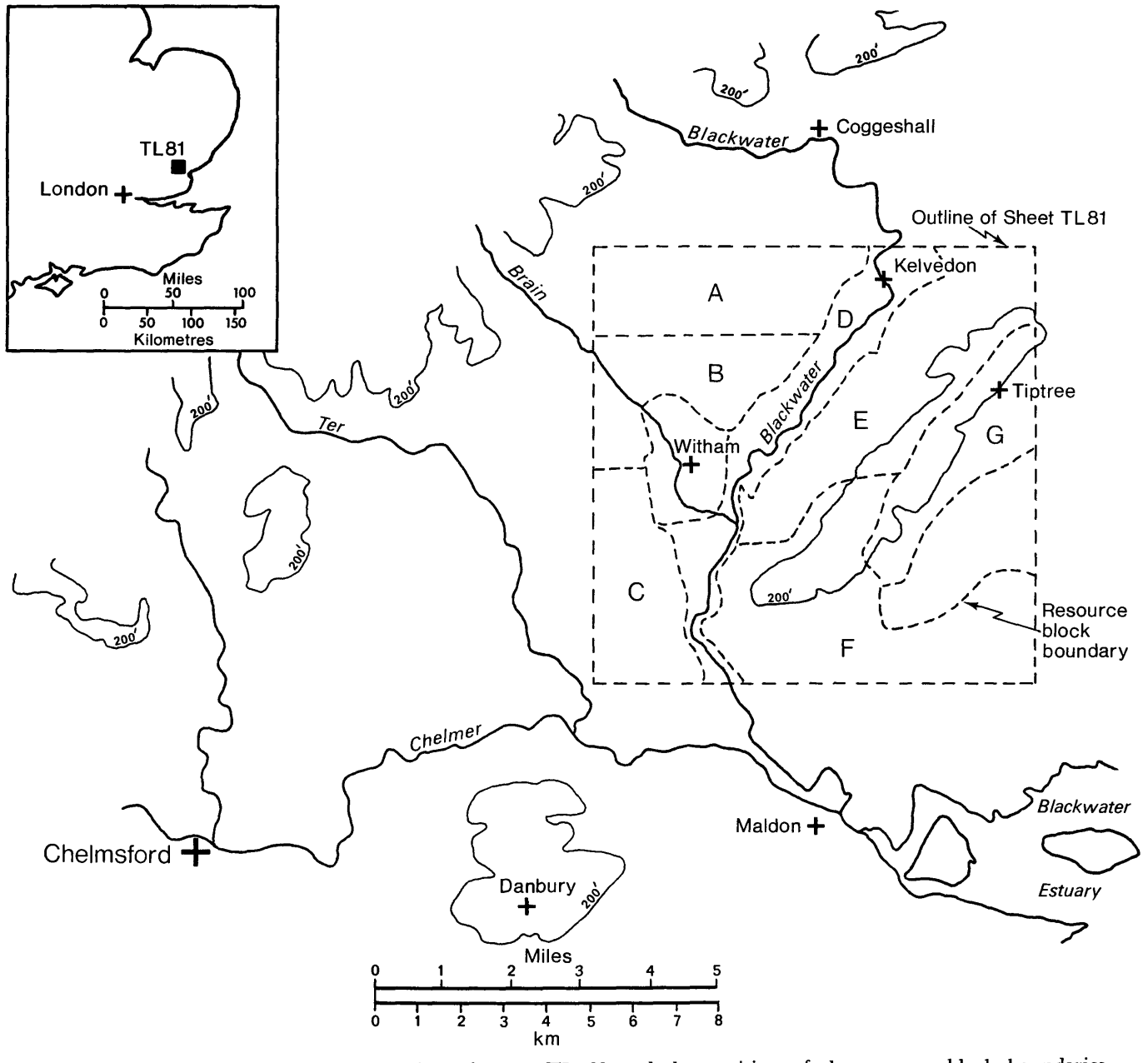


Figure 1. Sketch-map showing the location of Sheet TL 81 and the position of the resource block boundaries.

eastward through Witham.

East of the Blackwater, the land rises steeply above the plateau level to a prominent ridge, trending north-eastward from Great Totham and passing just west of Tiptree. It maintains a height of about 200 ft and reaches a maximum at Beacon Hill [856 128] of 282 ft.

GEOLOGY

The sheet area was geologically surveyed on the 6-inch scale in 1967 by Dr. C. R. Bristow of the East Anglia and South-East England Unit of the Institute and a drift edition of this map, to the scale of 1 : 25 000, is expected to be published during 1972.

The area is notable for its complex Pleistocene geology. By contrast the solid geology is relatively simple, because London Clay is virtually the only formation occurring, either at outcrop or as bedrock to the drift, except in the floor of a deep drift-filled depression in the Blackwater Valley where boreholes have recently proved Lower London Tertiary formations beneath till (Bristow *in* Anon., 1971, pp. 20-21).

The deposits mapped are classified as shown in Table 1, where they are listed as far as possible in order of increasing age.

The relationship of the deposits is illustrated in the schematic cross-section, Fig. 2, which is drawn at right angles to the generally south-west

Table 1. Classification of mapped deposits

DRIFT	
Recent and Pleistocene	Deposits of varied origin and age: Head, brickearth and, in small occurrences, peat and calcareous tufa Blackwater River deposits: floodplain alluvium and five levels of river terrace deposits, including sand and gravel; lacustrine deposits Boulder clay: divisible into an upper Springfield Till, and a lower Maldon Till, separated by the Chelmsford Gravels Glacial sand and gravel: Chelmsford Gravels, including the deposits at Tiptree (= Danbury Gravels of Clayton, 1957)
SOLID	
Eocene	London Clay Lower London Tertiaries (Oldhaven Beds, Woolwich and Reading Beds, Thanet Beds) have been proved in boreholes to have sub-drift incrops which are shown on 1 : 25 000 geological map TL 81 (Witham, Essex), solid and drift edition, in the press.

to north-east trend of both the geology and the topography.

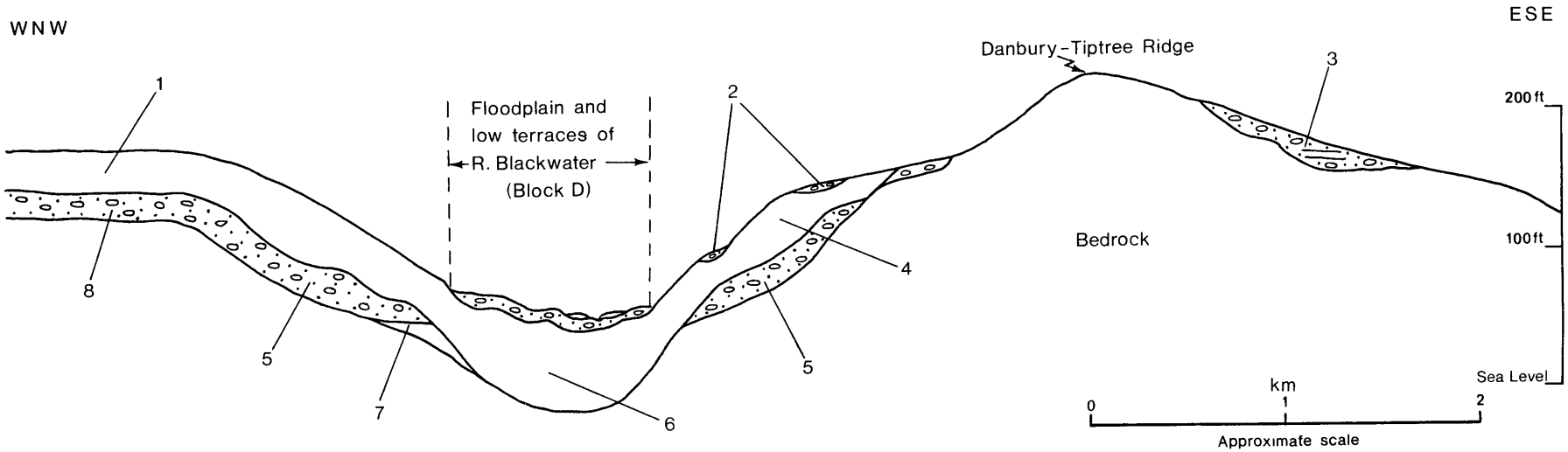
Bedrock to the drift deposits is London Clay, except beneath the deepest parts of the buried channel of the Blackwater River Valley, discussed on p. 7, where several boreholes have passed directly into Thanet Beds (Whitaker and Thresh, 1916; Anon, 1971). The London Clay is a stiff bluish-grey silty clay, weathering to brown, generally free of sand-sized particles and frequently containing cementstone nodules.

To the north-west the boulder clay of the plateau which lies at about 150 ft above O. D., belongs to the main spread of Essex, referred to by Clayton (1957) as the Springfield Till. It is a bluish-grey clay, weathering to a buff or cream colour, usually readily distinguished from London Clay by the presence of pellets and larger fragments of chalk and flints. A wide variety of foreign rock types occur as glacial erratics. Boulders are rare and always small, composed mainly of chalk, flint and quartzite. The thickness of the Springfield Till is commonly about 7 m.

Beneath the Springfield Till lies an almost continuous sheet of glacial sand and gravel, named the Chelmsford Gravels by Clayton (1957). Boreholes show that they exceed 56 ft (17 m) in thickness in places, with a mean of about 23 ft (7 m). They are generally considered to be outwash deposits derived from the ice-sheet that produced the boulder clay and constitute the major sand and gravel resource of the area. Typically they consist of slightly sandy pebble gravel interbedded with seams of fairly gravel-free medium sand. The gravel components are limited exclusively to durable rock-types, principally unflawed fragments of flint and quartz, always water-worn though not necessarily rounded. There is a tendency for the largest particles, of cobble size, to be concentrated near the base of the deposit, although exceptions are common. Indeed, apart from this, there is no recognisable system of size distribution with depth and mean grading curves for the whole thickness are very consistent.

Deposition of the Chelmsford Gravels was apparently much less regular along the valley sides of the River Blackwater than on the plateau, where the spread is fairly regular in thickness and elevation. Borehole results from near the Blackwater, however, reveal sharp variations both in thickness of gravel beneath the boulder clay (for example, 58 ft + (17.7 m+) at NW 44, absent at SW 91) and in bedrock surface levels. A possible explanation is that these occurrences represent irregular deposition of the gravels of the plateau into short, possibly steep-sided channels draining to a low base level. Subsequent deposition of the boulder clay has evidently preserved a pre-existing sand and gravel terrain.

South-east of the Blackwater Valley the drift cover is patchy and there are wide stretches of exposed London Clay including much of the crest of the Danbury-Tiptree ridge. The largest spread of sand and gravel forms the deposits at Tiptree, the Danbury Gravels of Clayton (1957), a nearly continuous belt of pebbly sands laid along the more gently sloping eastern flank of the ridge. The beds are more sandy than the Chelmsford Gravels, and contain clay partings. The greatest thickness known is 35 ft (11 m), proved by borehole NE 12. At least some of the deposit is older than the Springfield Till, which covers it north of Tiptree.



1 Springfield Till (boulder clay)

2 Thin high terrace remnants of R. Blackwater

3 Chelmsford Gravels (= Danbury Gravels)

4 Springfield Till

5 Chelmsford Gravels (irregular deposition)

6 Boulder clay, with lake sediments

7 Maldon Till (boulder clay)

8 Chelmsford Gravels

Figure 2. Schematic cross-section across Sheet TL 81.

To the south of the sheet, patches of sand and gravel are found scattered across the slopes of the Danbury-Tiptree ridge where it has been breached by the River Blackwater. The more low-lying deposits are covered by Springfield Till and may be identified with the Chelmsford Gravels, and adjacent deposits on the higher slopes are presumably of the same age.

The deposits of the Blackwater Valley are thick and complex. The Witham Borehole (TL 81 NW 56 at 8244 1534) drilled in 1970 by the Institute proved the base of the drift (chalky boulder clay) at −178 ft O. D. and another, the Kelvedon Borehole (TL 81 NE 75 at 8602 1797), proved the base at −147 ft O. D. (Bristow *in* Anon., 1971). Boreholes for the present survey have encountered various kinds of deeply buried drift deposits, including silt, laminated lake clay, shell beds and peat, in addition to sand and gravel and boulder clay. Geological mapping has demonstrated that a boulder clay, lithologically identical with the Springfield Till and termed Maldon Till by Clayton (1957, p. 3), crops out on the west bank of the River Brain from beneath Chelmsford Gravels and may possibly represent an early local advance of the Springfield Till. It has also been proved in borehole NW 45. Of the older drift deposits, it is likely that the chalky boulder clay and associated glacial lake sediments were deposited in the valley of the Blackwater River after glacial scour had caused the valley to be deepened to well below present sea level. No outlet for a deep channel has so far been proved and the situation lends support to Woodland's theory of deep, buried 'tunnel-valleys', eroded by subglacial streams in main river-valleys during the melting of the ice (Woodland, 1970). There is, however, no evidence in the present area that such overdeepened valleys may contain significant deposits of sand and gravel.

The floodplain and three lowest terrace deposits of the River Blackwater together constitute the single Resource Block D. They form a nearly continuous spread of sand and gravel, averaging 3 m in thickness, covered by overburden usually 1-2 m thick. The two lower terraces are the most extensive, their surfaces lying within about 5 m of the level of the present floodplain.

All the older drift deposits may be covered locally by brickearth, which is a fine sandy or silty loam, or by Head, a clayey deposit formed from local materials redistributed under periglacial conditions.

COMPOSITION OF THE SAND AND GRAVEL DEPOSITS

It is likely that the glacial deposits of sand and gravel in this part of Essex are the products of outwash streams that drained the ice-sheet responsible for the emplacement of the Springfield Till. Certainly the gravels include much material that can have come only from the north, whence the ice originated. There is no clear evidence from the present work to support the suggestion that a single large stream (the 'proto-Thames' of Wooldridge and Linton, 1955, pp. 106, 117 and 133) flowed across this part of northern Essex during Chelmsford Gravel times. The gravel-sized components have been subjected to considerable abrasion and attrition in a fluviatile environment. They consist almost exclusively of tough, unflawed pebbles of a variety of rock types displaying varying degrees of rounding. The exception is a relatively small proportion of unworn flints, often of cobble size, which were evidently brought into the area in glacial moraine from nearby chalk outcrops.

The normal composition of the gravel fraction, considered as all material coarser than 4 mm, is as follows:

1. Flint is the commonest constituent, averaging over 80 per cent by volume and almost all of it is smaller than 60 mm. Unworn cobbles of flint 150 mm across, commonly of very irregular shape, evidently have been derived almost directly from boulder clay. Smaller sizes tend to be either rounded or more commonly subangular.
2. Vein-quartz, the second most common rock-type, although found in all sizes up to cobble-size, is particularly noticeable in the fine gravel range (−16 + 4 mm) where well-rounded pebbles may be common.
3. Quartzite is conspicuous, commonly in sub-rounded pebbles and cobbles, often broadly tabular in shape, grey or orange-brown in colour, of coarse massive texture, and very tough.
4. Other rocks of many different kinds, igneous, metamorphic and sedimentary, are found in trace amounts.

The sands are coarse to fine-grained, but the average compositions for the total mineral thickness tend to be uniform, with the dominant or modal size for the sands of the Chelmsford Gravels lying between ½ and 1 mm, as demonstrated by the grading curves of Fig. 3.

The sand particles consist mainly of subangular quartz, with subordinate well-rounded, probably wind-blown, grains and angular flint particularly in the −4 + 1 mm range.

Most deposits show moderate iron-staining, which is, however, less apparent in the sand and gravel sizes than in the fines. Sometimes beds are quite white or they may be deeply iron-stained, even iron-cemented. The higher beds of the Chelmsford Gravels of the plateau tend to be more iron-stained than the lower ones, which are commonly referred to as 'Essex white ballast' and probably represent a distinct, earlier phase of deposition; but the Chelmsford Gravels of the valley sides and all later deposits do not show systematic arrangement in this respect.

Table 2. Statistical results

Resource block	Area		Mean thickness				Volume of mineral				Mean grading percentage		
	Block	Mineral	Overburden		Mineral				Limits at the 95 per cent confidence level		Fines	Sand	Gravel
	km^2	km^2	m	ft	m	ft	million m^3	million yd^3	±%	±Vol. million m^3	−1/16 mm	−4 + 1/16 mm	+4 mm
A	11.2	11.0	7.2	24	7.5	25	83	109	38	32	5	53	42
B	9.4	9.2	6.4	21	5.7	19	52	68	47	24	5	45	50
C	8.9	7.4	3.7	12	3.7	12	28	37	46	13	1	42	57
D	11.3	11.1	1.6	5	3.5	11	39	51	25	10	5	51	44
E	17.0	7.2	7.2	24	6.4	21	46	60	55	25	2	67	31
F	20.8	9.6	2.0	7	3.5	11	34	44	49	17	5	47	48
G	9.3	5.3	0.9	3	4.8	16	25	33	30	7	8	72	20
4.9 Witham built-up area—no assessment													
7.2 Barren area													
	100.0	60.8			5.1	17	307	402	15	46			

RESULTS

The statistical results are summarised in Table 2. Fuller grading particulars are shown in Fig. 3.

Accuracy of Results

For the seven resource blocks on Sheet TL 81, the accuracy of the results at the 95 per cent confidence level (that is, the probability that nineteen times out of twenty the true volume present lies within the given limits) varies between 25 per cent and 55 per cent. It should be remembered, however, that the true values are more likely to be nearer the figure estimated than either of the limits. Moreover, it is probable that roughly the same percentage limits would apply for the estimate of volume of a very much smaller parcel of ground (say 200 acres) containing similar sand and gravel deposits if the results from the same number of sample-points (as provided by, say, ten boreholes) were used in the calculation. Thus, if closer limits are needed for quotation of reserves of part of a block, it can be expected that data from more than ten sample-points are required, even if the area were quite small. This point can be illustrated by considering the whole of the potentially workable sand and gravel (as already defined) on Sheet TL 81. The volume (307 million m^3) of this can be estimated to limits of ± 15 per cent at the 95 per cent confidence level, by a calculation based on the data from as many as 91 sample-points spread across the seven resource blocks. However, it must again be emphasised that the quoted volume of sand and gravel has no simple relationship with the amount that could be extracted in practice, as no allowance has been made in the calculations for any restraints (such as existing buildings and roads) on the use of the land for mineral working.

NOTES ON RESOURCE BLOCKS

Block A

The block contains an almost continuous spread of Chelmsford Gravels of 25 ft (7.5 m) mean thickness beneath an overburden of Springfield Till averaging 24 ft (7.2 m) in thickness. Tributaries of the Blackwater River have cut narrow, steep-sided valleys through both deposits into the London Clay bedrock, but the area affected is only a small proportion of the total area.

Every borehole met sand and gravel, ranging in thickness from 6 ft (2 m) to over 58 ft (17 m).The latter figure relates to borehole NW 44, lying close to the Blackwater at the edge of the plateau where sharp variations in the thickness of both the boulder clay overburden and the underlying mineral have been demonstrated. The main body of the gravels of the plateau to the west of the block is more constant in thickness and form.

Block B

The geology of this area is basically the same as in Block A: the mean thickness of overburden is 21 ft (6.4 m) and that of mineral 19 ft (5.7 m). Only one borehole, NW 36 at Glebe Farm, failed to prove a significant thickness of mineral, the recorded thickness of 3 ft (0.9 m) of sand and gravel near the surface probably representing only a local variation of the main deposit.

Block C

In the northern part of the block Springfield Till overlies Chelmsford Gravels, but southward both deposits are reduced in thickness and become discontinuous, so that London Clay bedrock is sporadically exposed along the western slopes of the Blackwater Valley, southward of Dengie Farm [814 128]. Spreads of brickearth and Head deposits conceal probable sand and gravel-bearing ground locally. Only one borehole, SW 88, failed to find mineral, but none showed a thickness of more than 23 ft (7.0 m). The mean for the block is 12 ft (3.7 m).

Block D

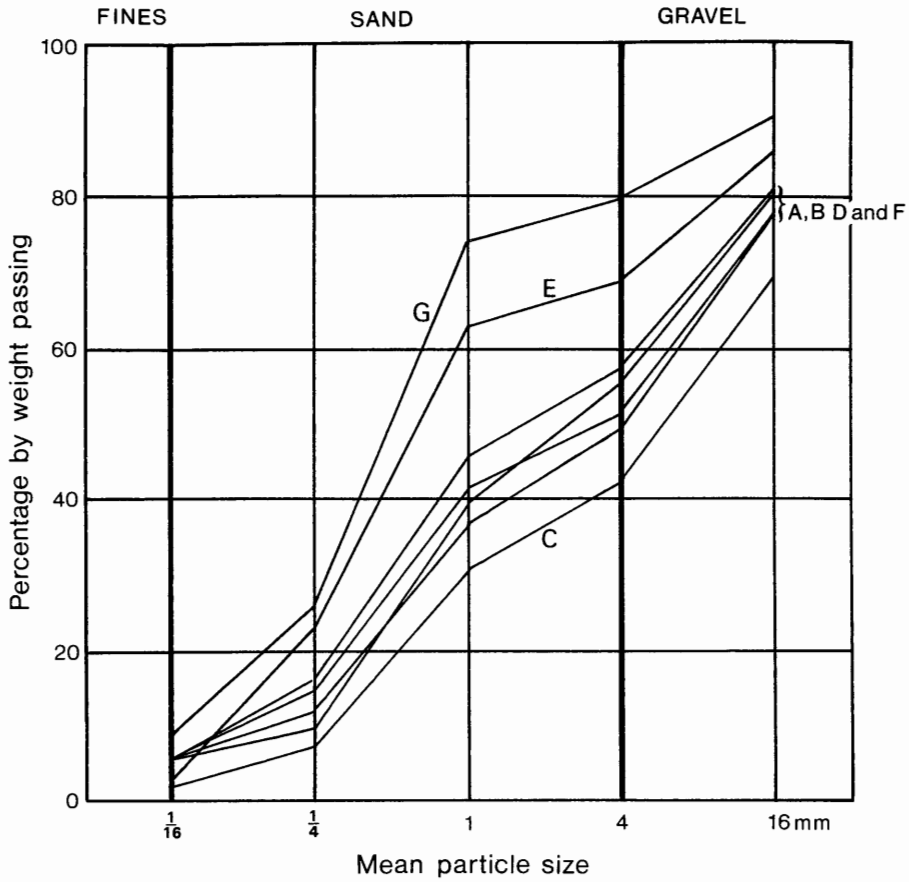
Although the valley-fill of the Blackwater River is thick, as shown in Fig. 2, the only significant sand and gravel resource is provided by the moderately thick, near surface deposits of the floodplain and three lowest river terraces, whose composite outline forms the boundary of the block. The boreholes indicate that the mineral forms a uniform and nearly continuous spread, the thicknesses recorded showing little variation for floodplain and terraces alike. Except near existing or former streams the clay overburden rarely exceeds 6 ft (2 m): the mineral normally measures between 6 ft (2 m) and 16 ft (5 m).

The gravels are locally poorly developed or absent only from the highest, third terrace level, where fine-grained, thinly bedded lake sediments or patches of Head may be found instead. But such occurrences are small.

The more deeply buried drift deposits showed sand and pebbly sand in several boreholes. For example, in boreholes NW 37 and NE 3, sand was encountered beneath lake sediments at a depth of 40 ft (12 m) and has been omitted from the assessment. But in the north, at borehole NE 8, sand and gravel in the same context lies at rather shallower depth, seeming to correlate with the lower part of the 24 ft (7.3 m) of sand and gravel met in borehole NE 5 nearby, and both these occurrences have been assigned to the mineral thickness assessed.

Block E

A belt of deeply buried, thick Chelmsford Gravels lies beneath the evenly rising eastern slope of the Blackwater Valley. The deposits are partly covered by Springfield Till, which also is often thick (44 ft (13.4 m) in borehole NE 7). The sand and gravel rests on an apparently very irregular surface of London Clay. The sand and gravel aver-



Resource Block	Percentage by weight passing				
	$\frac{1}{16}$ mm	$\frac{1}{4}$ mm	1 mm	4 mm	16 mm
A	5	16	46	58	82
B	5	12	37	50	79
C	1	7	31	43	70
D	5	10	40	56	81
E	2	23	63	69	86
F	5	15	42	52	79
G	8	26	74	80	91

Figure 3. Particle size distribution for the assessed thickness of sand and gravel in resource blocks A to G of Sheet TL 81

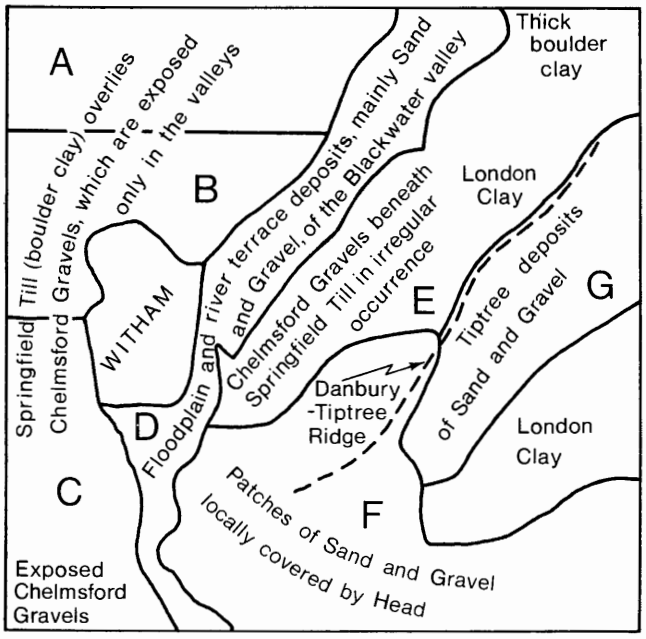


Figure 4. The drift geology of Sheet TL 81 summarised in relation to the resource block boundaries.

ages 21 ft (6.4 m) for the defined areas, beneath a mean thickness of 24 ft (7.2 m) of overburden. But in marked contrast to the Chelmsford Gravels to the west of the Blackwater, the ratio of gravel to sand is 1:2. Possibly the deposits were largely derived from extensive sandy spreads that previously existed higher up the side of the ridge, where remnants are now preserved. It may be that these sandy gravels were similar in origin and composition to those described from the Tiptree area (in Block G).

A buried channel appears to have been met at borehole NE 14 at Messing school.

In the north of the block, the boulder clay is shown to be over 60 ft (18 m) thick in two adjacent boreholes, NE 10 and NE 13, and an area of approximately 1.5 square kilometres has, therefore, been omitted from the assessment.

The records of site investigation boreholes for the A12 trunk road improvements confirm that the thick gravels of the lower valley-slopes extend to the edge of the Blackwater floodplain.

Locally the ground is capped by relics of the two highest terraces of the Blackwater River often separated from the underlying Chelmsford Gravels by a considerable thickness of Springfield Till. They are mostly unimportant as sources of sand and gravel, with the exception of a spread of terrace gravels of undecided affinities situated on rising ground west of Great Braxted. Two boreholes here, NW 47 and SW 93, penetrated 25 ft (7.7 m) and 21 ft (6.3 m) of mineral respectively. The deposit may amount to about 1½ million m^3 in volume.

Block F

This block contains scattered residual patches of sand and gravel, ranging in elevation from 50 ft at the edge of the Blackwater floodplain to 282 ft at Beacon Hill on the Danbury-Tiptree Ridge. The deposit margins are often obscured by irregular spreads of clayey Head. In the west the presence of Springfield Till mapped at the surface and proved in borehole SW 96 suggests that the underlying sand and gravel may be regarded as Chelmsford Gravels. It has similar grading characteristics (Fig. 3).

Block G

This block encloses the deposits at Tiptree, a belt of sand and gravel that may represent the finer grades of the glacial outwash material. On average there is less than a metre of overburden, covering 16 ft (4.8 m) of predominantly sandy mineral often divided by seams of clay. Although the ground surface slopes everywhere to the south-east, the base of the sand and gravel occupies a shallow depression in the London Clay (see Fig. 2), and the groundwater table tends to be high.

An area of 7.2 km^2 between Blocks F and G is occupied largely by London Clay in outcrop. In the context of this Report the area is considered to be barren.

LIST OF QUARRIES

Active

Bradwell Aggregates Ltd., Inworth Grange [88 16]

Peters and Barham Ltd., Sandford's Farm [81 12]

B. Dannatt Ltd., Barnards [81 11]

Disused

St.Ives Sand and Gravel Co. Ltd., Godfrey's Farm [87 11]

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Appendix A: Statistical Procedure

A statistical assessment (see below) is made for a resource block in which there is more than 2 km² of mineral, and which will contain a minimum of five evenly-spaced boreholes.

If the area of mineral is between 0.25 and 2 km² an inferred assessment is made based on geological and topographical information supported by the data from one or two suitably sited boreholes; no specific level of accuracy is claimed for such assessments.

No assessment is attempted for an area of mineral less than 0.25 km².

Statistical Assessment

1. The simple methods used in the calculations are consistent with the amount of data provided by the survey. Conventional confidence limits (that is, the tolerance on the estimate or the range within which the error is likely to fall) have been calculated at the 95 per cent confidence level.

2. The volume estimate for the mineral in a given resource block may be derived from the two variables, area and mean thickness. Errors in these variables will combine to give a total error in the volume estimate; these errors will be reflected in the assigned confidence limits at the 95 per cent level such that:

$$L_V = \sqrt{L_A^2 + L_T^2}$$

where L_V^2, L_A^2 and L_T^2 are variances for volume, area and thickness respectively.

3. The above relationship may be transposed such that:

$$L_V = L_T \sqrt{\left[1 + \left(\frac{L_A}{L_T}\right)^2\right]}$$

From this it can be seen that as $\left(\frac{L_A}{L_T}\right)$ tends to zero, L_V tends to L_T. If, therefore, the errors in the estimation of area are small with respect to those inherent in the thickness estimate, then the variances, hence the confidence limits, associated with the volume estimate will approximate to those for the thickness estimate.

4. Whereas the confidence limits associated with thickness usually lie within the range ± 20 and ± 60 per cent of the mean, experience suggests that the area can be estimated to within limits of ± 10 per cent. Thus, for most practical purposes, when the ratios of confidence limits for area and thickness are considered to be sufficiently small the latter may be directly assigned, as an approximation, to the estimated volume. The reliability of the mean thickness is a function of the number and variation of measured thicknesses. It follows, therefore, that the confidence limits assigned to a volume estimate are directly influenced by the number of sample points within any block.

5. The procedure adopted for the calculation of confidence limits is as follows:

Given that the number of sample thicknesses in the block is n, with thickness measurements $t_1, t_2, \ldots . t_n$ metres, then the best estimate of mean thickness, $\bar{t} = \frac{\Sigma (t_1 + t_2 \ldots . t_n)}{n}$ metres and the sample standard deviation = S, where

$$S = \sqrt{\frac{\Sigma (t - \bar{t})^2}{n}}$$

For cases where n is small Bessel's correction is applied and the best estimate ($\hat{\sigma}$) of the standard deviation for the mean thickness of the block is

$$\hat{\sigma} = \sqrt{\frac{\Sigma (t - \bar{t})^2}{(n - 1)}} \text{ metres}$$

The 95 per cent confidence limits for the estimate of mean thickness of the block of sand and gravel, $L_{\bar{t}}$, may be expressed either in absolute units

$$= \bar{t} \pm \propto \hat{\sigma} \text{ metres}$$

or as a percentage

$$= \bar{t} \text{ metres} \pm \frac{100 \propto \hat{\sigma}}{\bar{t}} \text{ per cent}$$

where

$$\propto = \frac{\theta}{\sqrt{n}}$$

and is evaluated by reference to statistical tables for the distribution of 'Student's t' from which the value of θ corresponding to the 95 per cent confidence level and $(n - 1)$ degrees of freedom is obtained.

6. Values of $\propto$ for values of n up to 20 are set out below:

n	$\propto$	n	$\propto$
1	∞	11	0.67
2	9.0	12	0.64
3	2.49	13	0.60
4	1.59	14	0.58
5	1.24	15	0.55
6	1.05	16	0.53
7	0.92	17	0.51
8	0.83	18	0.50
9	0.77	19	0.48
10	0.72	20	0.47

7. If the calculated limits $L_{\bar{t}}$ are large with respect to the confidence limits for the estimate of area, they may be assigned directly as approximate limits (L_V) to volume estimate (see Paragraph 4). Experience suggests, however, that a better relationship may exist such that

$$L_V \ll 1.05 \, L_{\bar{t}}$$

This relationship is used in the example, Fig. 6.

8. In practice the mean thickness $\bar{t}$ is used in the calculation of thickness confidence limits, but not in the direct computation of volume. To avoid bias and because irregular sampling grids are used, a weighted mean thickness is computed for each block. The thickness measured at the sample-points is weighted by a factor, w, equal to the area of influence of each point.

9. Normally the concept of area of influence is based on the assumption that the value of the thickness at any point is governed only by the position of the point in relation to the broad trend of variation of thickness across the block. However, most sand and gravel deposits also exhibit a random pattern of local, and sometimes considerable, variation in thickness, and thus the distribution of the values of thickness within a block is the result of both the trend of variations and random variations, so that only the use of simple weighting factors is justified and the distribution of sample-points within a block need be only approximately regular.

In practice, equal weighting can often be applied to thicknesses at all sample-points within a block. If, however, there is unequal distribution of points, the thicknesses must be weighted by areas to avoid the bias this creates. Weighting factors are determined by first dividing the block into broad zones, to each of which a value roughly proportional to its area is assigned. This value is then shared between the sample-points within the zone.

10. A distinction based on field evidence may be made between the central parts of the block and the margins, where the deposit is best represented by a triangular cross-section (Fig. 5) with thicknesses varying from that (t_c) of the central portion to zero at the feather edge; the mean thickness is therefore $\frac{t_c}{2}$

11. If the areas of the central and marginal parts of a deposit within a block are a_c and a_b respectively, then the mean thickness for the whole block is computed by dividing the combined volumes by the combined areas and is equal to:

$$\frac{a_c \, t_c + \tfrac{1}{2} a_b \, t_c}{a_c + a_b}$$

12. In some circumstances, the cross-section of the marginal area is better considered as a trapezium, a positive value, t_e, being ascribed to the thickness at the edge of the deposit (Fig. 5). The mean height of the marginal area is then $\frac{1}{2}(t_c + t_e)$.

13. Although the assumptions on which the volume of the marginal areas is based may seem arbitrary, analysis suggests that generally they will improve the accuracy of the calculation and that conversely they cannot introduce any significant error.

14. In some circumstances, the above proced-

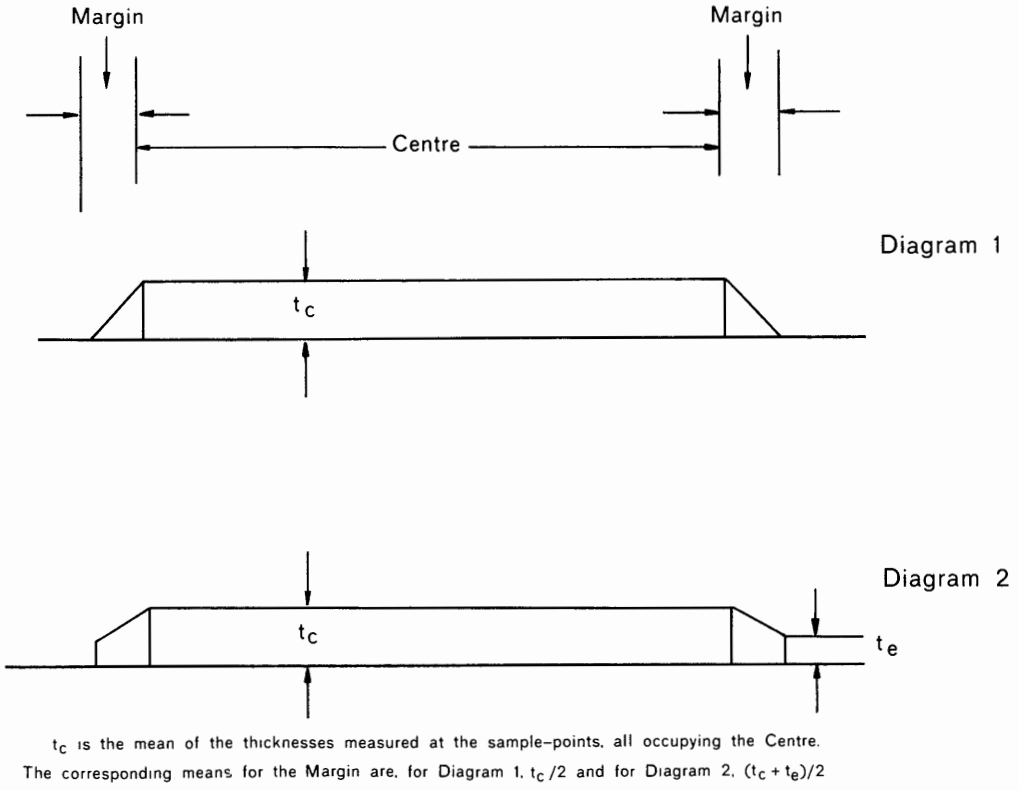


Figure 5. Diagrams showing how a deposit of sand and gravel may be resolved into two parts, centre and margin.

ures, and particularly the practice stated in paragraph 8, may be replaced by the following. If the distribution of the values of thickness at the sample points approximates sufficiently closely to a normal distribution, then the theory of normal distribution, and the tables relating to it may be used to calculate confidence limits for the estimate of mean thickness, and thence the volume. It should be added that whatever form the distribution may take, the means of the values for increasingly large groups of samples rapidly distribute themselves normally. The limits (L_T) calculated by this method may be substituted either into the equation in paragraph 3 or directly assigned to the volume estimate if L_A/L_T is sufficiently small.

15. An illustration of the procedures outlined above is given in Figs. 6. and 7, where a volume estimate with confidence limits is derived for fictitious data.

Appendix B: Classification and Description of Sand and Gravel

The terminology commonly used by geologists when describing sedimentary rocks (Wentworth, 1922) is not entirely satisfactory for the purposes of this Report. For example, Wentworth proposed that a deposit should be described as a 'gravelly sand' when the proportion of sand is greater than that of gravel which must exceed 10 per cent, fines and oversize materials (that is, with diameter greater than 64 mm) being less than 10 per cent. Because deposits containing more than 10 per cent fines (material less than 1/16 mm) are not embraced by this system a modified binary classification based on Willman (1942) has been adopted.

For the purposes of assessing resources of sand and gravel a classification should take account of economically important characteristics of the deposit, in particular the absolute content of fines and the ratio of sand to gravel.

When the fines content exceeds 40 per cent the material is considered to be not potentially workable and falls outside the definition of mineral. Deposits which contain less than 40 per cent fines are classified primarily on the ratio of sand to gravel and qualified in the light of the fines content, as follows: 0 to 10 per cent fines—no qualification; 10 to 20 per cent fines—'clayey'; 20 to 40 per cent fines—'very clayey'.

The term 'clay' (as written, with single quote marks), is used to describe all material passing 1/16 mm. Thus it has no mineralogical significance and includes particles falling within the size

EXAMPLE OF RESOURCE BLOCK ASSESSMENT

Statement and Calculation

BLOCK CALCULATION

1 : 25 000 Sheet } Fictitious
Block }

Area

Block : 11.08 km²

Mineral : 8.32 km²

Volume

Overburden : 21 million m³

Mineral : 37 million m³

Thickness

Overburden : 2.5 m

Mineral : 4.4 m

95 per cent Confidence Limits of the estimate of Mineral Volume

Percentage : ± 48 per cent

Units of volume : ± 18 million m³

Thickness Estimate (t = thickness). Measurements in Metres

	Sample-point	Weighting w	Overburden t_o	Overburden wt_o	Mineral t_m	Mineral wt_m	Remarks
Centre Calculation	SE 14	1	1.5	1.5	5.2	5.2	
	SE 17	½	1.2	0.6	4.2	2.1	Complete with 123/45 } M.A.U boreholes
	SE 18	1	3.3	3.3	Nil	–	
	SE 20	1	Nil	–	2.1	2.1	
	SE 22	1	0.7	0.7	9.3	9.3	
	SE 23	1	6.2	6.2	5.7	5.7	
	SE 24	1	4.3	4.3	6.5	6.5	
	1	¼	2.4	0.6	3.4	0.8 (5)	Close group of 4 boreholes (commercial)
	2	¼	4.5	1.1 (2)	0.8	0.2	
	4	¼	0.4	0.1	4.3	1.0 (8)	
	5	¼	2.8	0.7	6.0	1.5	
	123/45	½	2.0	1.0	3.6	1.8	Water Dept. record
Margin Correction	Totals	8	–	20.1	–	36.3	
	Averages	–	2.51	–	4.54	–	Centre estimates
	Centre	19	2.51	47.7	4.54	86.3	
	Border	1	1.6	1.6	2.3	2.3	
	Total	20	–	49.3	–	88.6	
	Averages	–	2.46	–	4.43	–	Corrected estimates

Calculation of Confidence Limits

t	$(t - \bar{t})$	$(t - \bar{t})^2$
5.2	0.7	0.5
4.2	0.3	0.1
Nil	4.5	20.2
2.1	2.4	5.8
9.3	4.8	23.0
5.7	1.2	1.4
6.5	2.0	4.0
3.6	0.9	0.8
3.6	0.9	0.8
9 | 40.2		8 | 56.6
$\bar{t} = 4.47$		$\hat{\sigma}^2 = 7.07$
		$\hat{\sigma} = 2.66$

$n = 9$

$\alpha = 0.77$

$\hat{\sigma} = 2.66$

$t = 4.47$

$L_t = \frac{\alpha \hat{\sigma}}{\bar{t}} . 100 = 45.8$

$L_{\bar{t}} = 1.05\, L_t = 48\%$

Figure 6. Example of resource block assessment: statement and calculation.

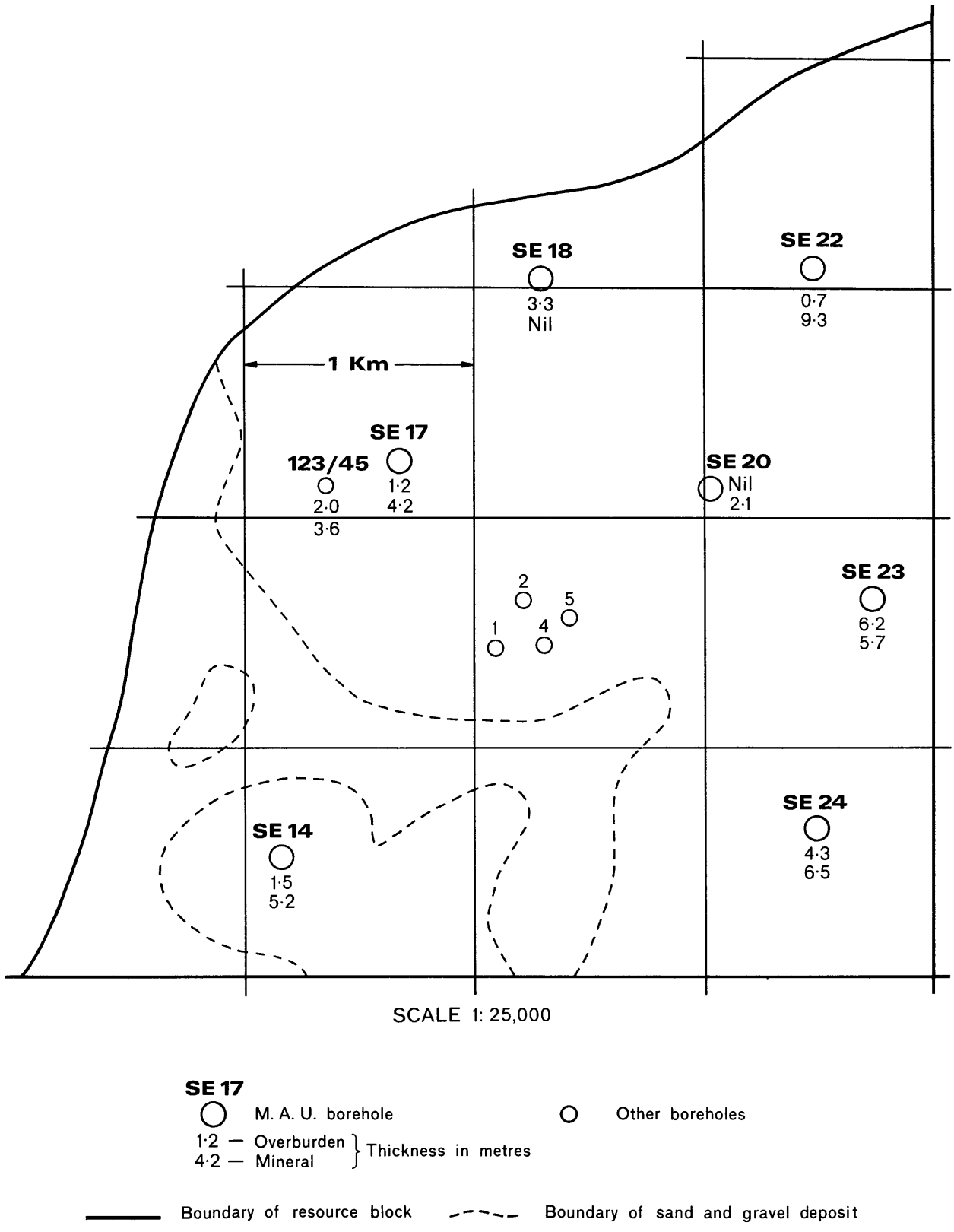


Figure 7. Example of resource block assessment: map of a fictitious block.

limits of silt. Wherever the term clay does not appear in single quotation marks the normal meaning applies.

The ratio of sand to gravel defines the boundaries between Sand, Pebbly Sand, Sandy Gravel and Gravel (at 19:1, 3:1 and 1:1).

Thus it is possible to classify the mineral into one of twelve descriptive categories (see Fig. 8). The procedure is as follows.

1. Classify according to ratio of sand to gravel.
2. Describe fines.

For example, a deposit grading: gravel, 11 per cent; sand, 70 per cent; fines, 19 per cent is classified as 'clayey' pebbly sand. This short description is included in the borehole log (see Note 10, p. 20).

Many differing proposals exist for the classification of the grain size of sediments (Atterberg, 1905; Udden, 1914; Wentworth, 1922; Wentworth, 1935; Allen, 1936; Twenhofel, 1937; Lane and others, 1947). As Archer (1970) has emphasised, there is a pressing need for a simple metric scale acceptable to both scientific and engineering interests, for which the class limit sizes correspond closely with certain marked changes in the natural properties of mineral particles. For example, there is an important change in the degree of cohesion between particles at about the 1/16 mm size, which approximates to the generally accepted boundary between silt and sand. In this and other respects the system shown in Table 3, used in this report, is satisfactory. It is based on Udden's geometric scale and a simplified form of Wentworth's terminology.

The fairly wide intervals in the scale are consistent with the general level of accuracy of the quantitative assessments of the resource blocks. Three sizes of sand are recognised, fine (-¼ + 1/16 mm), medium (-1 + ¼ mm) and coarse (-4 +1 mm). The boundary at 16 mm distinguishes a range of finer gravel (-16 + 4 mm), often characterised by abundance of worn tough pebbles of vein quartz, from coarser ranges often of notably different average composition. The reading at 64 mm distinguishes pebbles from cobbles. The term 'gravel' is used loosely to denote both pebble-sized and cobble-sized material.

The size distribution of borehole samples is determined by sieve analysis, and is presented by the laboratory as logarithmic cumulative curves (see, for example, British Standard 1377:67). In this report the grading is tabulated on the borehole record sheets (Appendix C), the intercepts corresponding with the simple geometric scale 1/16 mm, ¼ mm, 1 mm, 4 mm, 16 mm, and so on as required. Original sample grading curves are available for reference at the appropriate office of the Institute.

Each bulk sample is described, subjectively, by a geologist at the borehole site. Being based on visual examination, the description of the grading is inexact, the accuracy depending on the experience of the observer. The descriptions recorded are modified, as necessary, when the laboratory results become available for inclusion in Appendix C.

The relative proportions of the rock types present in the gravel fraction are indicated by use of the words 'and' or 'with'. For example, 'flint and quartz' indicates very approximate equal proportions with neither constituent accounting for less than about 25 per cent of the whole; 'flint with quartz' indicates that flint is dominant and quartz, the accessory rock type, comprises 5 to 25 per cent of the whole. Where the accessory material accounts for less than 5 per cent of the whole, but is still readily apparent, the phrase 'with some' has been used. Rare constituents are referred to as 'trace'.

The terms used in the field to describe the degree of rounding of particles—which is concerned with the sharpness of the edges and corners of a clastic fragment and not the shape—(after Pettijohn, 1957) are as follows.

Angular: showing little or no evidence of wear; sharp edges and corners.

Subangular: showing definite effects of wear. Fragments still have their original form but edges and corners begin to be rounded off.

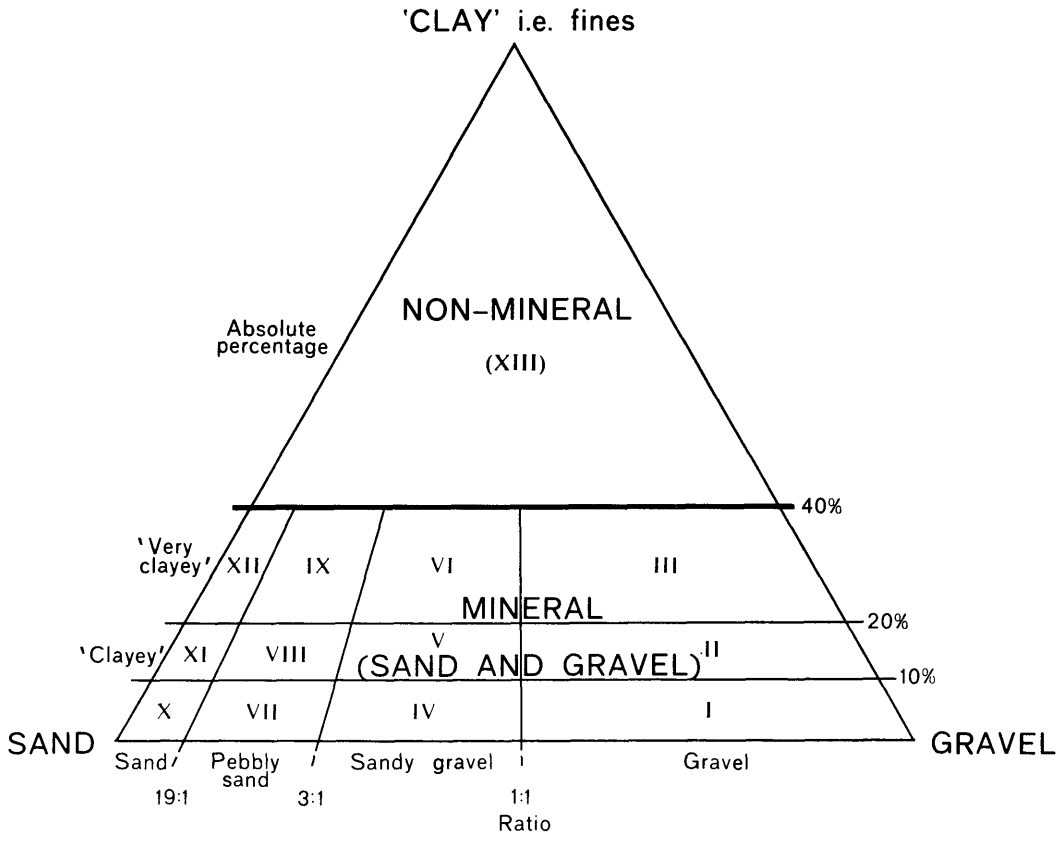
Subrounded: showing considerable wear. The edges and corners are rounded off to smooth curves. Original grain shape is still distinct.

Rounded: original faces almost completely destroyed, but some comparatively flat surfaces may still remain. All original edges and corners have been smoothed off to rather broad curves. Original shape is still apparent.

Well-rounded: no original faces, edges or corners left. The entire surface consists of broad curves; flat areas are absent. The original shape is suggested by the present form of the grain.

Table 3. Classification of Gravel, Sand and Fines

Size limits	Grain size description	Qualification	Primary classification
64 mm	Cobble		Gravel
16 mm	Pebble	Coarse (Medium) Fine	
4 mm	Sand	Coarse	Sand
1 mm		Medium	
¼ mm		Fine	
1/16 mm	Fines (silt and clay)		Fines



I	Gravel	MINERAL
II	'Clayey' gravel	
III	'Very clayey' gravel	
IV	Sandy gravel	
V	'Clayey' sandy gravel	
VI	'Very clayey' sandy gravel	
VII	Pebbly sand	
VIII	'Clayey' pebbly sand	
IX	'Very clayey' pebbly sand	
X	Sand	
XI	'Clayey' sand	
XII	'Very clayey' sand	
(XIII)	NON-MINERAL	

Figure 8. Diagram to show the descriptive categories used in the classification of sand and gravel.

Appendix C: Borehole Records

EXPLANATION

Annotated Example of Borehole Record

TL 81 NW 30[1] 8134 1910[2] Silver End, Essex[3]

Surface level (+44.8 m) +147 ft[4]
Water struck at (+37.2 m) +122 ft[5]
Wirth B1, 8 inch diameter
June 1968[6]

Overburden[7] (2.4 m) 8 ft
Mineral (1.4 m) 4.5 ft
Waste (1.1 m) 3.5 ft
Mineral (6.8 m) 22.5 ft
Bedrock (1.6 m +) 5 ft +[8]

			Thickness (m)	Thickness ft	Depth[11] (m)	Depth[11] ft
Springfield Till[9]		Soil and gravelly clay.[10]	(2.4)	8	(2.4)	8
Chelmsford Gravels with inter-bedded clay	(a)	Sandy gravel.	(1.4)	4.5	(3.8)	12.5
		Clay.	(1.1)	3.5	(4.9)	16
	(b)	Gravel, with cobbles at base.	(6.8)	22.5	(11.7)	38.5
London Clay		Clay, weathered at top.	(1.6+)	5+	(13.3)	43.5

			%
(a)[14] & (b)	Gravel 55%	+16 mm	: 26
		−16 + 4	: 29
	Sand 42%	− 4 + 1	: 11
		− 1 + ¼	: 20
		− ¼ + 1/16	: 11
	Fines 3%	− 1/16	: 3

	Depth below[12] surface (ft)	Percentage[13] Fines	Sand	Gravel
(a)	8 - 11	0	32	68
	11 - 12.5	21	60	19
(b)	16 - 19	8	55	37
	19 - 22	10	73	17
	22 - 25	1	41	58
	25 - 28	1	59	40
	28 - 31	0	18	82
	31 - 34	0	25	75
	34 - 37	1	35	64
	37 - 38.5	6	17	77

This list is arranged in the order in which information is given on the Borehole Records.

1. Borehole Registration Number.
Each MAU borehole is identified by a registration number. This consists of two statements.

1) The number of the 1 : 25 000 sheet on which the borehole lies, for example, TL 81.
2) The quarter of the 1 : 25 000 sheet on which the borehole lies and its number in a series for that quarter, for example, NW 30.

Thus the full Registration Number is TL 81 NW 30. Usually this is abbreviated to NW 30 in the text.

2. The National Grid Reference.
All National Grid References in this publication lie within the 100 km square TL unless otherwise stated. Grid references are given to eight figures, accurate to within 10 m, for borehole locations. (In the text, six-figure grid references are used for more approximate locations, for example, for farms).

3. Location.
The borehole location is referred to the nearest named locality on the 1 : 25 000 base map.

4. Surface Level.
The surface level at the borehole site is given in metres and feet above Ordnance Datum. All measurements were made in feet; approximate metric conversions are given in brackets.

5. Groundwater Conditions.
Three kinds of entry are made; either, the level at which groundwater was encountered is given in metres and feet above Ordnance Datum; or, where no groundwater was encountered, this is stated; or, where there is no record of the groundwater conditions, this is stated.

6. Type of Drill and Date of Drilling.
Two types of drilling machine have been used in this survey; a Shell and Auger rig and a Wirth B1 (a cased power auger). The type of machine, the external diameter of the casing used, and the month and year of the completion of the borehole are stated.

7. Overburden, Mineral, Waste and Bedrock.
Overburden is any material other than mineral which occurs between the ground surface and the top of the mineral.

Mineral is defined as sand and gravel which, as part of a deposit falls within the arbitrary definition of potentially workable material (see p. 1).

Waste is any material other than mineral or bedrock occurring below or between beds of mineral.

Bedrock is the formation, rock type, country rock or rock-head, below which potentially workable sand and gravel will not be found. In the Witham area the bedrock is London Clay.

Thicknesses are given in metres and feet.

8. The plus sign (+) indicates that the base of the deposit was not reached during drilling.

The Borehole Log

9. Geological Classification.
A geological classification of the strata encountered in drilling is given whenever possible. (For an explanation of the terms used see p. 5).

10. Lithological Description.
When sand and gravel (mineral) is recorded a general description based on the mean grading characteristics is followed by more detailed particulars. (For explanation of conventions see Appendix B). A description of other rock types is based on visual field examination.

11. Depth
The figures given relate to depths to base of the strata recorded on the log.

Note on metrication. -

1) All measurements were made in feet. Approximate metric conversions appear in brackets.
2) Metric conversions of measurements of the depth and thickness of beds have been rounded off to the nearest 0.1 m, because quotation to two places of decimals would imply a higher order of accuracy than could be justified by the original figures. To eliminate any discrepancy appearing after metrication between depth as recorded and depth as obtained by summing thicknesses, adjustment has been made where necessary to one or more of the thickness figures. However, the recorded mineral thickness is not adjusted.

Grading Information

12. Sampling.
A continuous series of bulk samples is taken throughout the thickness of sand and gravel. A new sample is commenced whenever there is an appreciable lithological change within the sand and gravel, or for every 3 ft of depth (see also p. 2).

13. Grading Results.
The limits are as follows: gravel, +4 mm; sand, -4+1/16 mm; fines -1/16 mm.

14. Mean Grading.
The mean grading for the mineral thickness is the mean of the individual sample gradings, but where the thicknesses of mineral represented by the samples are not constant each grading result is first weighted by its relative thickness.

The results are given both for the three main classes—gravel, sand and fines—and for the smaller ranges within these classes.

LIST OF MINERAL ASSESSMENT UNIT BOREHOLES

Borehole Number by sheet quadrant	Grid Reference (all fall in 100 km square TL)	Borehole Number	Grid Reference
NW 26	8039 1577	NE 15	8987 1756
27	8018 1512	16	8985 1666
28	8015 1817	17	8992 1572
29	8051 1762	SW 69	8088 1484
30	8134 1910	70	8086 1407
31	8101 1818	71	8015 1377
32	8144 1644	85	8001 1412
33	8229 1957	86	8186 1355
34	8224 1864	87	8188 1234
35	8222 1734	88	8127 1043
36	8250 1650	89	8282 1051
37	8250 1544	90	8332 1484
38	8345 1921	91	8375 1450
39	8346 1829	92	8395 1399
40	8363 1731	93	8473 1478
41	8368 1670	94	8274 1135
42	8363 1559	95	8347 1057
43	8455 1955	96	8396 1095
44	8467 1838	97	8448 1168
45	8456 1760	98	8421 1223
46	8450 1620	SE 6	8582 1334
47	8472 1564	7	8514 1163
NE 1	8599 1989	8	8514 1095
2	8544 1912	9	8638 1409
3	8556 1829	10	8693 1323
4	8554 1608	11	8606 1122
5	8639 1867	12	8704 1111
6	8675 1747	13	8651 1032
7	8607 1708	14	8741 1399
8	8710 1926	15	8775 1094
9	8776 1826	16	8804 1469
10	8831 1989	17	8816 1140
11	8860 1898	18	8932 1209
12	8893 1553		
13	8956 1940		
14	8946 1848		

THE RECORDS

TL 81 NW 26 8039 1577 South of Faulkbourne Hall, near Witham

Surface level (+39.9 m) +131 ft
Water struck at (+37.2 m) +122 ft
Wirth B1, 8 inch diameter
February 1967

Overburden (1.5 m) 5 ft
Mineral (2.2 m) 7 ft
Bedrock (1.5 m+) 5 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Springfield Till	Soil on chalky boulder clay.	(1.5)	5	(1.5)	5
Chelmsford Gravels	Gravel.	(2.2)	7	(3.7)	12
London Clay	Brown clay.	(0.6)	2	(4.3)	14
	Blue clay.	(0.9+)	3+	(5.2)	17

		%
	+16 mm	: 30
Gravel 63%	−16 + 4	: 33
	− 4 + 1	: 11
Sand 35%	− 1 + ¼	: 21
	− ¼ + 1/16	: 3
Fines 2%	−1/16	: 2

Depth below surface (ft)	Percentage Fines	Sand	Gravel
5 - 7	2	38	60
7 - 10	2	34	64
10 - 12	1	32	67

TL 81 NW 27 8018 1512 South of Faulkbourne Hall, near Witham

Surface level (+44.2 m) +145 ft
Water struck at (+39.0 m) +128 ft
Wirth B1, 8 inch diameter
February 1967

Overburden (1.2 m) 4 ft
Mineral (4.3 m) 14 ft
Bedrock (3.0 m +) 10 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Springfield Till	Soil on chalky boulder clay.	(1.2)	4	(1.2)	4
Chelmsford Gravels	Gravel.	(4.3)	14	(5.5)	18
London Clay	Brown clay.	(0.9)	3	(6.4)	21
	Blue clay.	(2.1+)	7+	(8.5)	28

		%
	+16 mm	: 29
Gravel 59%	−16 + 4	: 30
	− 4 + 1	: 12
Sand 39%	− 1 + ¼	: 21
	− ¼ + 1/16	: 6
Fines 2%	−1/16	: 2

Depth below surface (ft)	Percentage Fines	Sand	Gravel
4 - 5	Grading not available		
5 - 7	2	69	29
7 - 9	6	36	58
9 - 11	2	35	63
11 - 13	1	37	62
13 - 15	2	32	66
15 - 18	1	32	67

TL 81 NW 28 8015 1817 Cressing

Surface level (+46.6 m) +153 ft
Water not struck
Wirth B1, 8 inch diameter
May 1968

Overburden (3.8 m) 12.5 ft
Mineral (6.9 m) 22.5 ft
Bedrock (0.6 m +) 2 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Soil		(0.5)	1.5	(0.5)	1.5
Springfield Till	Chalky boulder clay with coarse flints.	(3.3)	11	(3.8)	12.5
Chelmsford Gravels	Gravel, with clayey bands.	(6.9)	22.5	(10.7)	35
London Clay	Clay	(0.6+)	2+	(11.3)	37

		%
	+16 mm	: 27
Gravel 59%	−16 + 4	: 32
	− 4 + 1	: 12
Sand 37%	− 1 + ¼	: 16
	− ¼ + 1/16	: 9
Fines 4%	−1/16	: 4

Depth below surface (ft)	Percentage Fines	Sand	Gravel
12.5 - 15.5	9	74	17
15.5 - 18.5	10	31	59
18.5 - 21.5	2	33	65
21.5 - 24.5	5	27	68
24.5 - 28	2	30	68
28 - 31	2	20	78
31 - 34	2	31	67
34 - 35	6	64	30

TL 81 NW 29 8051 1762 Chippinghill, Witham

Surface level (+44.8 m) +147 ft
Water struck at (+30.5 m) +100 ft
Wirth B1, 8 inch diameter
June 1968

Overburden (7.6 m) 25 ft
Mineral (7.3 m) 24 ft
Bedrock (1.3 m+) 4 ft+

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Springfield Till	Soil on chalky boulder clay with flints.	(7.6)	25	(7.6)	25
Chelmsford Gravels	Gravel, with clayey pellets in basal 3 ft (1 m). Gravel: flint, mainly subangular, with quartz and quartzite, both rounded. Sand: brown, becoming dark in the lower part.	(7.3)	24	(14.9)	49
London Clay	Clay, weathered at top.	(1.3+)	4+	(16.2)	53

		%
	+16 mm	: 27
Gravel 57%	−16 + 4	: 30
	− 4 + 1	: 19
Sand 37%	− 1 + ¼	: 15
	− ¼ + 1/16	: 3
Fines 6%	−1/16	: 6

Depth below surface (ft)	Percentage Fines	Sand	Gravel
25 - 28	13	51	36
28 - 31	8	32	60
31 - 34	15	28	57
34 - 36.5	0	40	60
36.5 - 39.5	3	35	62
39.5 - 42	2	40	58
42 - 46	3	46	51
46 - 49	1	36	63

TL 81 NW 30 8134 1910 Silver End, Essex

Surface level (+44.8 m) +147 ft
Water struck at (+37.2 m) +122 ft
Wirth B1, 8 inch diameter
June 1968

Overburden (2.4 m) 8ft
Mineral (1.4 m) 4.5 ft
Waste (1.1 m) 3.5 ft
Mineral (6.8 m) 22.5 ft
Bedrock (1.6 m +) 5 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Springfield Till	Soil and gravelly clay.	(2.4)	8	(2.4)	8
Chelmsford Gravels (a)	Sandy gravel.	(1.4)	4.5	(3.8)	12.5
(with interbedded	Clay.	(1.1)	3.5	(4.9)	16
clay) (b)	Gravel, with cobbles at base.	(6.8)	22.5	(11.7)	38.5
London Clay	Clay, weathered at top.	(1.6+)	5+	(13.3)	43.5

(a & b)

	%
	+16 mm : 26
Gravel 55%	−16 + 4 : 29
	− 4 + 1 : 11
Sand 42%	− 1 + ¼ : 20
	− ¼ +1/16 : 11
Fines 3%	− 1/16 : 3

	Depth below surface (ft)	Percentage Fines	Sand	Gravel
(a)	8 - 11	0	32	68
	11 - 12.5	21	60	19
(b)	16 - 19	8	55	37
	19 - 22	10	73	17
	22 - 25	1	41	58
	25 - 28	1	59	40
	28 - 31	0	18	82
	31 - 34	0	25	75
	34 - 37	1	35	64
	37 - 38.5	6	17	77

TL 81 NW 31 8101 1818 Whitehead's Farm, Silver End

Surface level (c+48.8 m) c+160 ft
Water struck at (c+32.9 m) c+108 ft
Wirth B0, 8 inch diameter

Overburden (10.4 m) 34 ft
Mineral (6.1 m) 20 ft
Bedrock (0.9 m +) 3 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Springfield Till	Soil on chalky boulder clay with flints; brown becoming grey at base.	(10.4)	34	(10.4)	34
Chelmsford Gravels	Gravel, more clayey above with cobbles at base. Gravel: flint, subangular to subrounded, with quartz, often subrounded, and quartzite, coarse rounded; some clayey fragments.	(6.1)	20	(16.5)	54
London Clay	Clay, weathered brown.	(0.6)	2	(17.1)	56
	Clay, blue.	(0.3+)	1+	(17.4)	57

		%	Depth below surface (ft)	Percentage Fines	Sand	Gravel
	+16 mm	: 20				
Gravel 56%	−16 + 4	: 36	34 - 37	5	35	60
			37 - 40	8	44	48
	− 4 + 1	: 14	40 - 43	2	46	52
Sand 41%	− 1 + ¼	: 23	43 - 46	6	49	45
	− ¼ + 1/16	: 4	46 - 49	0	36	64
			49 - 52	0	31	69
Fines 3%	−1/16	: 3	52 - 54	2	50	48

TL 81 NW 32 8144 1644 Chippinghill, Witham

Surface level (+36.9 m) +121 ft
Water not struck
Wirth B1, 8 inch diameter
June 1968

Overburden (4.6 m) 15 ft
Mineral (2.1 m) 7 ft
Bedrock (0.9 m+) 3 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Springfield Till	Soil on brown chalky boulder clay with flints.	(4.6)	15	(4.6)	15
Chelmsford Gravels	'Very clayey' sandy gravel. Gravel: flint, subangular, with quartz, rounded.	(2.1)	7	(6.7)	22
London Clay	Clay, weathered at top.	(0.9+)	3+	(7.6)	25

		%
	+16 mm	: 11
Gravel 27%	−16 + 4	: 16
	− 4 + 1	: 8
Sand 40%	− 1 + ¼	: 22
	− ¼ + 1/16	: 10
Fines 33%	− 1/16	: 33

Depth below surface (ft)	Percentage Fines	Sand	Gravel
15 - 17	45	39	16
17 - 20	38	32	30
20 - 22	14	51	35

TL 81 NW 33 8229 1957 Storey's Wood, Silver End

Surface level (+46.9 m) +154 ft
Water struck at (+35.7 m) +117 ft
Wirth B1, 8 inch diameter
June 1968

Overburden (7.0 m) 23 ft
Mineral (7.6 m) 25 ft
Bedrock (0.5 m +) 1.5 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Springfield Till	Brown chalky boulder clay.	(7.0)	23	(7.0)	23
Chelmsford Gravels	Gravel, with cobbles at base. Gravel: flint, mainly subangular (with fine rounded pebbles) and quartz, rounded, with traces of quartzite, rounded. Sand: either red or white, in bands.	(7.6)	25	(14.6)	48
London Clay	Clay, brown becoming blue.	(0.5+)	1.5+	(15.1)	49.5

		%
	+16 mm	: 34
Gravel 69%	−16 + 4	: 35
	− 4 + 1	: 11
Sand 29%	− 1 + ¼	: 15
	− ¼ + 1/16	: 3
Fines 2%	− 1/16	: 2

Depth below surface (ft)	Percentage Fines	Sand	Gravel
23 - 24	30	22	48
24 - 27	5	26	69
27 - 30	0	40	60
30 - 33	0	70	30
33 - 36	1	39	60
36 - 39	0	22	78
39 - 42	0	20	80
42 - 45	0	8	92
45 - 47	4	36	60
47 - 48	Grading not available		

TL 81 NW 34 8224 1864 Silver End

Surface level (+42.4 m) +139 ft
Water struck at (+35.4 m) +116 ft
Wirth B1, 8 inch diameter
June 1968

Overburden (6.7 m) 22 ft
Mineral (2.7 m) 9 ft
Bedrock (1.0 m +) 3 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Springfield Till	Soil on chalky boulder clay with flints.	(6.7)	22	(6.7)	22
Chelmsford Gravels	Gravel, with cobbles except at base. Gravel: flint, mainly subangular, some rounded, and quartz, rounded with some subangular; clay pellets towards base.	(2.7)	9	(9.4)	31
London Clay	Clay.	(1.0+)	3+	(10.4)	34

		%
	+16 mm	: 14
Gravel 46%	-16 + 4	: 32
	- 4 + 1	: 18
Sand 45%	- 1 + ¼	: 19
	- ¼ + 1/16	: 8
Fines 9%	-1/16	: 9

Depth below surface (ft)	Percentage Fines	Sand	Gravel
22 - 24	23	37	40
24 - 26	2	26	72
26 - 29	2	59	39
29 - 31	15	50	35

TL 81 NW 35 8222 1734 Rivenhall

Surface level (+45.7 m) +150 ft
Water struck at (+28.3 m) +93 ft
Wirth B1, 8 inch diameter
June 1968

Overburden (10.1 m) 33 ft
Mineral (8.6 m) 28.5 ft
Bedrock (0.8 m +) 2.5 ft+

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Springfield Till	Soil on chalky boulder clay with flints.	(10.1)	33	(10.1)	33
Chelmsford Gravels	Sandy gravel, with brown clay pellets at base. Gravel: flints, subangular, with quartz, rounded to subangular, and some quartzite, subangular. Sand: mainly brown, white central layer.	(8.6)	28.5	(18.7)	61.5
London Clay	Clay.	(0.8+)	2.5+	(19.5)	64

		%
	+16 mm	: 19
Gravel 45%	−16 + 4	: 26
	− 4 + 1	: 9
Sand 46%	− 1 + ¼	: 28
	− ¼ + 1/16	: 9
Fines 9%	−1/16	: 9

Depth below surface (ft)	Percentage Fines	Sand	Gravel
33 - 36	10	62	28
36 - 39	1	51	48
39 - 42	7	58	35
42 - 45	15	62	23
45 - 48	2	56	42
48 - 51	9	48	43
51 - 54	10	36	54
54 - 56	9	21	70
56 - 58	18	20	62
58 - 61	11	31	58

TL 81 NW 36 8250 1650 Rickstones Road, Witham

Surface level (+34.1 m) +112 ft
Water not struck
Wirth B1, 8 inch diameter
August 1968

Overburden (0.9 m) 3 ft
Mineral (0.9 m) 3 ft
Waste (11.3 m) 37 ft
Bedrock (0.6 m +) 2 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Head	Soil on sandy clay.	(0.9)	3	(0.9)	3
	'Clayey' gravel. Gravel: flint, subangular, with quartz, subrounded.	(0.9)	3	(1.8)	6
? Springfield Tull	Clay, brown, with flint at top.	(11.3)	37	(13.1)	43
London Clay	Clay, weathered at top.	(0.6+)	2+	(13.7)	45

		%
Gravel 60%	+16 mm	: 25
	-16 + 4	: 35
Sand 29%	- 4 + 1	: 11
	- 1 + ¼	: 15
	- ¼ + 1/16	: 3
Fines 11%	- 1/16	: 11

Depth below surface (ft)	Percentage Fines	Sand	Gravel
3 - 6	11	29	60

TL 81 NW 37 8250 1544 North-east of Witham

Surface level (c+24.4 m) c+80ft
Water struck at (c+12.2 m) c+40 ft
Wirth B1, 8 inch diameter
August 1968

Overburden (13.1 m) 43 ft
Sand and Gravel (2.7 m) 9 ft
Waste (8.6 m +) 28 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Soil		(0.9)	3	(0.9)	3
Head	Brown clay with sand	(3.4)	11	(4.3)	14
Lacustrine Deposits	Clays.				
	White, putty-like.	(1.2)	4	(5.5)	18
	Banded.	(2.1)	7	(7.6)	25
	Grey to greenish-brown, with shell fragments.	(2.8)	9	(10.4)	34
	Black, with bands of sand containing shell fragments.	(2.7)	9	(13.1)	43
? Chelmsford Gravels	Pebbly sand. Gravel: flint, subangular, with quartz, rounded. Sand: clayey, brown.	(2.7)	9	(15.8)	52
? Maldon Till	Grey, very chalky boulder clay.	(8.6+)	28+	(24.4)	80

		%
	+16 mm	: 3
Gravel 18%	−16 + 4	: 15
	− 4 + 1	: 13
Sand 76%	− 1 + ¼	: 51
	− ¼ + 1/16	: 12
Fines 6%	− 1/16	: 6

Depth below surface (ft)	Percentage Fines	Sand	Gravel
43 - 46	2	82	16
46 - 49	7	71	22
49 - 52	8	76	16

TL 81 NW 38 8345 1921 Porter's Farm, Kelvedon

Surface level (+45.4 m) +149 ft
Water not struck
Wirth B1, 8 inch diameter
July 1968

Overburden (10.4 m) 34 ft
Mineral (1.7 m) 5.5 ft
Bedrock (1.1 m+) 3.5 ft+

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Springfield Till	Soil on brown boulder clay, with sand and gravel	(10.4)	34	(10.4)	34
Chelmsford Gravels	'Clayey' gravel. Gravel: with clay pellets.	(1.6)	5.5	(12.0)	39.5
London Clay	Clay, weathered.	(1.1+)	3.5+	(13.1)	43

		%
	+16 mm	: 28
Gravel 57%	−16 + 4	: 29
	− 4 + 1	: 8
Sand 31%	− 1 + ¼	: 17
	− ¼ + 1/16	: 6
Fines 12%	− 1/16	: 12

Depth below surface (ft)	Percentage Fines	Sand	Gravel
34 - 36.5	11	29	60
36.5 - 39.5	12	32	56

TL 81 NW 39 8346 1829 Rivenhall

Surface level (+43.0 m) +141 ft
Water not struck
Wirth B1, 8 inch diameter
June 1968

Overburden (6.7 m) 22 ft
Mineral (10.7m) 35 ft
Bedrock (0.7 m+) 2.5 ft+

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Springfield Till	Soil on chalky boulder clay with flints.	(6.4)	21	(6.4)	21
	Silty clay.	(0.3)	1	(6.7)	22
Chelmsford Gravels (with interbedded clay)	'Clayey' sandy gravel. Sand and fine gravel in uppermost 11 ft (4 m), becoming coarse to cobble gravel with sand in lower 21 ft (6 m). Clay with fine sand between 30 and 33 ft (9.1 and 10.1 m). Gravel: flint, mainly subanbular, with quartz, rounded, mainly fine in upper part of deposit, and some quartzite.	(10.7)	35	(17.4)	57
London Clay	Clay, brown becoming blue with increasing depth.	(0.7+)	2.5+	(18.1)	59.5

		%
	+16 mm	: 16
Gravel 32%	−16 + 4	: 16
	− 4 + 1	: 8
Sand 52%	− 1 + ¼	: 24
	− ¼ + 1/16	: 20
Fines 16%	−1/16	: 16

Depth below surface (ft)	Percentage Fines	Sand	Gravel
22 - 25	10	63	27
25 - 28	18	76	6
28 - 30	21	78	1
30 - 33	90	10	0
33 - 36	17	70	13
36 - 39	5	61	34
39 - 42	8	50	42
42 - 45	7	44	49
45 - 48	4	56	40
48 - 51	11	49	40
51 - 54	2	25	73
54 - 57	1	38	61

TL 81 NW 40 8363 1731 Hoo Hall, near Witham

Surface level (+32.3 m) +106 ft
Water struck at (+23.2 m) +76 ft
Wirth B1, 8 inch diameter
May 1969

Overburden (5.5 m) 18 ft
Mineral (6.4 m) 21 ft
Bedrock (0.9 m+) 3 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Soil		(0.9)	3	(0.9)	3
Springfield Till	Brown clay.	(4.6)	15	(5.5)	18
Chelmsford Gravels	Sandy gravel. Gravel: flint, subangular to subrounded, with quartz and quartzite. Sand: brown.	(6.4)	21	(11.9)	39
London Clay	Clay, blue.	(0.9+)	3+	(12.8)	42

		%
	+16 mm	: 24
Gravel 40%	-16 + 4	: 24
	- 4 + 1	: 26
Sand 59%	- 1 + ¼	: 28
	- ¼ + 1/16	: 5
Fines 1%	- 1/16	: 1

Depth below surface (ft)	Percentage Fines	Sand	Gravel
18 - 21	2	62	36
21 - 24	0	62	38
24 - 27	2	56	42
27 - 30	0	60	40
30 - 33	1	64	35
33 - 36	0	56	44
36 - 39	0	58	42

TL 81 NW 41 8368 1670 Rivenhall End, near Witham

Surface level (c+21.3 m) c+70 ft
Water struck at (c+15.2 m) c+50 ft
Wirth B1, 8 inch diameter
August 1968

Overburden (6.1 m) 20 ft
Mineral (11.0 m) 36 ft
Waste (4.8 m) 16 ft
Bedrock (1.9 m+) 6 ft+

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Soil		(0.3)	1	(0.3)	1
?Springfield Till	Brown clay, perhaps boulder clay.	(5.8)	19	(6.1)	20
Chelmsford Gravels	Gravel, up to cobble size. Gravel: flint and quartz with quartzite. Sand: brown to light brown.	(11.0)	36	(17.1)	56
?Maldon Till	Brownish-grey clay, containing abundant cobbles and flecks of chalk or gypsum. May be boulder clay.	(4.8)	16	(21.9)	72
London Clay	Clay, unweathered.	(1.9+)	6+	(23.8)	78

		%
	+16 mm	: 19
Gravel 50%	−16 + 4	: 31
	− 4 + 1	: 13
Sand 49%	− 1 + ¼	: 26
	− ¼ + 1/16	: 10
Fines 1%	− 1/16	: 1

Depth below surface (ft)	Percentage Fines	Sand	Gravel
20 - 23	1	79	20
23 - 26	0	61	39
26 - 29	0	56	44
29 - 32	0	51	49
32 - 35	0	34	66
35 - 38	4	72	24
38 - 41	0	53	47
41 - 44	0	35	65
44 - 47	2	25	73
47 - 50	2	55	43
50 - 53	0	33	67
53 - 56	Grading not available		

TL 81 NW 42 8363 1559 Coleman's Farm, Witham

Surface level (+15.8 m) +52 ft
Water not struck
Wirth B1, 8 inch diameter
August 1968

Overburden (0.6 m) 2 ft
Mineral (6.4 m) 21 ft
Waste (15.9 m) 52 ft
Bedrock (1.5 m+) 5 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Soil		(0.6)	2	(0.6)	2
Blackwater River Terrace Deposits	Sandy gravel, up to cobble size between 14 and 17 ft (4 and 5 m) becoming fine gravel between 20 and 23 ft (6 and 7 m). Gravel: flint, subangular, with quartz, subrounded to rounded, and some quartzite. Sand: brown.	(6.4)	21	(7.0)	23
? Lacustrine Deposits with ? Springfield Till	Grey clay with chalk inclusions.	(15.9)	52	(22.9)	75
London Clay	Clay.	(1.5+)	5+	(24.4)	80

		%
	+16 mm	: 13
Gravel 35%	−16 + 4	: 22
	− 4 + 1	: 17
Sand 58%	− 1 + ¼	: 35
	− ¼ + 1/16	: 6
Fines 7%	−1/16	: 7

Depth below surface (ft)	Percentage Fines	Sand	Gravel
2 - 5	0	49	51
5 - 8	0	54	46
8 - 11	0	54	46
11 - 14	0	54	46
14 - 17	0	62	38
17 - 20	46	40	14
20 - 23	0	90	10

TL 81 NW 43 8455 1954 Kelvedon

Surface level (+38.4 m) +126 ft
Water not struck
Wirth B1, 8 inch diameter
July 1968

Overburden (8.2 m) 27 ft
Mineral (9.5 m) 31 ft
Bedrock (1.0 m +) 3.5 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Soil		(0.5)	1.5	(0.5)	1.5
Springfield Till	Boulder clay, brown, with thin bands of interbedded sand and gravel.	(7.7)	25.5	(8.2)	27
Chelmsford Gravels	Sandy gravel Gravel: flint, subangular, and quartz, subangular. Sand: clayey, orange.	(9.5)	31	(17.7)	58
London Clay	Clay, weathered.	(1.0+)	3.5+	(18.7)	61.5

		%
	+16 mm	: 17
Gravel 39%	−16 + 4	: 22
	− 4 + 1	: 12
Sand 52%	− 1 + ¼	: 29
	− ¼ + 1/16	: 11
Fines 9%	− 1/16	: 9

Depth below surface (ft)	Percentage Fines	Sand	Gravel
27 - 30	10	54	36
30 - 33	16	52	32
33 - 36	14	47	39
36 - 39	7	44	49
39 - 42	6	43	51
42 - 45	7	51	42
45 - 48	18	53	29
48 - 51	7	57	36
51 - 54	9	50	41
54 - 58	4	53	43

TL 81 NW 44 8467 1838 Clark's Farm, Kelvedon

Surface level (+34.7 m) +114 ft
Water struck at (+23.5 m) +77 ft
Wirth B1, 8 inch diameter
August 1968

Overburden (6.7 m) 22 ft
Mineral (17.7 m +) 58 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Soil		(0.3)	1	(0.3)	1
Springfield Till	Chalky boulder clay, brown becoming grey with depth.	(6.4)	21	(6.7)	22
Chelmsford Gravels	Sandy gravel, with cobbles in lower 30 ft (9 m). Gravel: flint, subangular, with fine quartz. Sand: yellow-brown, becoming orange-brown with increasing depth.	(17.7+)	58+	(24.4)	80

		%
	+16 mm	: 11
Gravel 39%	−16 + 4	: 28
	− 4 + 1	: 14
Sand 60%	− 1 + ¼	: 37
	− ¼ + 1/16	: 9
Fines 1%	− 1/16	: 1

Depth below surface (ft)	Percentage Fines	Sand	Gravel
22 - 25	19	64	17
25 - 28	0	58	42
28 - 31	1	69	30
31 - 34	0	75	25
34 - 37	1	85	14
37 - 40	0	60	40
40 - 43	1	59	40
43 - 46	0	14	86
46 - 49	1	62	37
49 - 52	0	46	54
52 - 55	0	64	36
55 - 58	0	80	20
58 - 61	Grading not available		
61 - 64	0	58	42
64 - 67	0	69	31
67 - 70	0	68	32
70 - 73	1	63	36
73 - 76	0	45	55
76 - 80	0	36	64

TL 81 NW 45 8456 1760 Sniveller's Lane, Kelvedon

Surface level (+30.5 m) +100 ft
Water struck at (+24.1 m) + 79 ft
Three holes, completed by different drilling contractors within (8 m) 26 ft of each other

Overburden (6.7 m) 22 ft
Mineral (9.1 m) 30 ft
Waste (4.6 m) 15 ft
Bedrock (1.2 m +) 4 ft+

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Soil		(0.3)	1	(0.3)	1
Springfield Till	Chalky boulder clay, brown becoming blue-grey with depth.	(6.4)	21	(6.7)	22
Chelmsford Gravels	Sandy gravel, grading fairly even throughout, with flint cobbles up to 120 mm diameter commoner near base. Gravel: flint, subangular to subrounded, with quartz, fine, subrounded.	(9.1)	30	(15.8)	52
Malden Till	Chalky boulder clay, grey, with abundant chalk. Encountered in only the most westerly of the three holes.	(4.6)	15	(20.4)	67
London Clay	Clay, weathered at the top.	(1.2+)	4+	(21.6)	71

		%
	+16 mm	: 25
Gravel 47%	−16 + 4	: 22
	− 4 + 1	: 9
Sand 51%	− 1 + ¼	: 33
	− ¼ + 1/16	: 9
Fines 2%	− 1/16	: 2

(Average for the three boreholes)

Depth below surface (ft)	Percentage * Fines	Sand	Gravel
21 - 24	2	90	8
24 - 27	2	90	8
27 - 30	9	26	65
30 - 33	2	53	45
33 - 36	2	58	40
36 - 39	4	76	20
39 - 42	2	57	41
42 - 45	3	53	44
45 - 48	1	57	42
48 - 51	1	61	38
51 - 54	0	42	58
54 - 56	0	22	78

* For one of the three holes

TL 81 NW 46 8450 1620 Appleford Farm, Rivenhall End

Surface level (c+21.3 m) c+70 ft
Water not struck
Wirth B1, 8 inch diameter
August 1968

Overburden (1.5 m) 5 ft
Mineral (3.7 m) 12 ft
Waste (16.1 m) 53 ft
Bedrock (1.6 m +) 5 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
	Soil on clay.	(1.5)	5	(1.5)	5
Blackwater River Terrace Deposits	Pebbly sand. Pebble size up to 35 mm. Gravel: flint, subangular to subrounded, with quartz, subrounded. Sand: brown notably rounded.	(3.7)	12	(5.2)	17
? Springfield Till	Grey chalky boulder clay.	(16.1)	53	(21.3)	70
London Clay	Clay, slightly weathered at top.	(1.6+)	5+	(22.9)	75

		%
	+16 mm	: 3
Gravel 16%	−16 + 4	: 13
	− 4 + 1	: 33
Sand 77%	− 1 + ¼	: 40
	− ¼ + 1/16	: 4
Fines 7%	−1/16	: 7

Depth below surface (ft)	Percentage Fines	Sand	Gravel
5 - 8	Grading not available		
8 - 11	16	69	15
11 - 14	1	86	13
14 - 17	5	76	19

TL 81 NW 47 8472 1564 Hill Broad Farm, Gt. Braxted

Surface level (+24.7 m) +81 ft
Water struck at (+21.6 m) +71 ft
Gryphon, 5 inch diameter
November 1968

Overburden (3.0 m) 10 ft
Mineral (7.7 m) 25 ft
Waste (7.6 m +) 25 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Blackwater River Terrace Deposits	Soil on sandy clay.	(3.0)	10	(3.0)	10
	Gravel, up to cobble size. Gravel: flint, subangular to subrounded, with quartz, subangular to rounded, mainly fine, and quartzite, subrounded. Sand: yellow-brown to straw coloured.	(7.7)	25	(10.7)	35
Springfield Till	Chalky boulder clay.	(7.6+)	25+	(18.3)	60

		%
	+16 mm	: 22
Gravel 55%	−16 + 4	: 33
	− 4 + 1	: 15
Sand 43%	− 1 + ¼	: 24
	− ¼ + 1/16	4
Fines 2%	− 1/16	: 2

Depth below surface (ft)	Percentage Fines	Sand	Gravel
10 - 12.5	12	33	55
12.5 - 15	2	63	35
15 - 20	1	57	42
20 - 25	1	59	40
25 - 30	1	15	84
30 - 35	2	33	65

TL 81 NE 1 8599 1989 Coggeshall Road, Kelvedon

Surface level (+32.9 m) +108 ft
Water struck at (+26.2 m) +86 ft
Gryphon, 5 inch diameter
October 1968

Overburden (4.6 m) 15 ft
Mineral (7.9 m) 26 ft
Bedrock (0.6 m +) 2 ft+

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Springfield Till	Soil on chalky boulder clay.	(4.6)	15	(4.6)	15
Chelmsford Gravels	Pebbly sand; at base less pebbly but with cobbles. Gravel: flint, subangular to subrounded, and quartz, subrounded, with quartzite, subrounded, and occasional sandstone. Sand: medium to coarse, yellow to brown.	(7.9)	26	(12.5)	41
London Clay	Clay.	(0.6+)	2+	(13.1)	43

		%
	+16 mm	: 9
Gravel 22%	-16 + 4	: 13
	- 4 + 1	: 7
Sand 78%	- 1 + ¼	: 44
	- ¼ + 1/16	: 27
Fines 0%	- 1/16	: 0

Depth below surface (ft)	Percentage Fines	Sand	Gravel
15 - 20	0	62	38
20 - 26.8	0	63	37
26.8 - 31.2	0	76	24
31.2 - 37	0	93	7
37 - 41	0	96	4

TL 81 NE 2 8544 1912 Park Farm, Kelvedon

Surface level (+35.7 m) +117 ft
Water struck at (+21.9 m) +72 ft
Wirth B1, 8 inch diameter
August 1968

Overburden (13.7 m) 45 ft
Mineral (10.7 m +) 35 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Springfield Till	Chalky boulder clay, brown becoming grey with increasing depth; with interbedded lenses of fine sand between 28 and 30 ft (8.5 – 9.0 m).	(13.7)	45	(13.7)	45
Chelmsford Gravels	Sandy gravel, up to cobble size. Gravel: flint with quartz.	(10.7+)	35+	(24.4)	80

		%
	+16 mm	: 14
Gravel 35%	–16 + 4	: 21
	– 4 + 1	: 13
Sand 64%	– 1 + ¼	: 39
	– ¼ + 1/16	: 12
Fines 1%	– 1/16	: 1

Depth below surface (ft)	Percentage Fines	Sand	Gravel
45 - 48	0	75	25
48 - 51	4	64	32
51 - 54	0	63	37
54 - 57	0	76	24
57 - 60	1	66	33
60 - 63	0	58	42
63 - 66	0	30	70
66 - 69	1	64	35
69 - 72	1	73	26
72 - 75	2	78	20
75 - 78	0	66	34
78 - 80	2	60	38

TL 81 NE 3 8556 1829 Church Hall Farm, Kelvedon

Surface level (+25.6 m) +84 ft
Groundwater conditions not recorded
Gryphon, 5 inch diameter
October 1968

Overburden (14.9 m) 49 ft
Mineral (9.5 m +) 31 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Soil on ? Head	Soil on clay.	(1.5)	5	(1.5)	5
Lacustrine Deposits	Lake beds.				
	Clay, plastic, silty, yellow to grey with black staining.	(1.5)	5	(3.0)	10
	Clay, plastic, grey to yellow.	(1.0)	3	(4.0)	13
	Silt, yellow to brown.	(1.5)	5	(5.5)	18
	Silt, dark grey, laminated, with wood fragments at 25 ft (7.6 m).	(3.6)	12	(9.1)	30
	Silt, light green, apparently unlaminated.	(3.7)	12	(12.8)	42
	Silt, light green, sometimes laminated.	(1.5)	5	(14.3)	47
	Silt, blue, with some sand and gravel	(0.6)	2	(14.9)	49
Channel-fill Deposits	Pebbly sand. Gravel up to cobble size with coarse sand in upper 1.5 ft (0.5 m), becoming medium sand with fine to medium gravel below. Gravel: flint, angular and subangular, with quartz, subrounded, mainly medium. Sand: silvery-grey.	(9.5+)	31+	(24.4)	80

Gravel 18%
Sand 79%
Fines 3%

	%
+16 mm	7
−16 + 4	11
− 4 + 1	15
− 1 + ¼	56
− ¼ + 1/16	8
− 1/16	3

Depth below surface (ft)	Percentage Fines	Sand	Gravel
49 - 50.7	5	27	68
50.7 - 55	4	63	33
55 - 60	2	84	14
60 - 65	5	87	8
65 - 70	10	81	9
70 - 75	0	84	16
75 - 80	0	88	12

TL 81 NE 4 8554 1608 Great Braxted Park

Surface level (+36.9 m) +121 ft
Water not struck
Shell, 7 inch diameter
October 1968

Overburden (1.5 m) 5 ft
Mineral (1.2 m) 4 ft
Waste (4.3 m) 14 ft
Mineral (9.3 m) 30.5 ft
Bedrock (0.9 m +) 3 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Blackwater River Terrace Deposits (a)	Soil on gravelly clay.	(1.5)	5	(1.5)	5
	Pebbly sand. Gravel: flint and quartz, subangular to subrounded. Sand: light brown with chalk fragments.	(1.2)	4	(2.7)	9
Springfield Till	Brown chalky boulder clay.	(4.0)	13	(6.7)	22
	Sand, silty and clayey, brown.	(0.3)	1	(7.0)	23
Chelmsford (b) Gravels	Sandy gravel. Gravel: flint, quartz and quartzite, subangular to subrounded, mainly coarse, up to cobble size between 39 ft (12 m) and 43 ft (13 m). n). Sand: slightly clayey with chalk fragments in the upper 11 ft (3 m), brown.	(9.3)	30.5	(16.3)	53.5
London Clay	Clay, brown.	(0.9+)	3+	(17.2)	56.5

(a) Gravel 25% Sand 74% Fines 1%

	%
+16 mm	: 14
−16 + 4	: 11
− 4 + 1	: 10
− 1 + ¼	: 45
− ¼ + 1/16	: 19
− 1/16	: 1

(b) Gravel 43% Sand 53% Fines 4%

	%
+16 mm	: 21
−16 + 4	: 22
− 4 + 1	: 27
− 1 + ¼	: 20
− ¼ + 1/16	: 26
− 1/16	: 4

Depth below surface (ft)	Percentage Fines	Sand	Gravel
5 - 8.5	1	73	26
8.5 - 9	2	83	15
23 - 25	10	90	0
25 - 28	21	79	0
28 - 31	5	95	0
31 - 34	2	98	0
34 - 37	1	56	43
37 - 40	1	43	56
40 - 43	0	43	57
43 - 46	2	18	80
46 - 49	2	17	81
49 - 52	1	25	74
52 - 53.5	1	13	86

TL 81 NE 5 8639 1867 Kelvedon

Surface level (+25.6 m) +84 ft
Water struck at (+19.2 m) +63 ft
Wirth B1, 8 inch diameter
July 1968

Overburden (0.9 m) 3 ft
Mineral (9.5 m) 31 ft
Waste (7.9 m +) 26 ft +

			Thickness (m)	Thickness ft	Depth (m)	Depth ft
Soil			(0.9)	3	(0.9)	3
Blackwater River Terrace Deposits	(a)	Gravel	(7.3)	24	(8.2)	27
?Channel-fill Deposits	(b)	'Clayey' pebbly sand; coarse sand with some gravel.	(2.2)	7	(10.4)	34
?Springfield Till		Dark grey chalky boulder clay.	(7.9+)	26+	(18.3)	60

		%
(a)	+16 mm	: 16
Gravel 50%	−16 + 4	: 34
	− 4 + 1	: 16
Sand 42%	− 1 + ¼	: 22
	− ¼ + 1/16	: 4
Fines 8%	−1/16	: 8
(b)	+ 16 mm	: 1
Gravel 11%	− 16 + 4	: 10
	− 4 + 1	: 10
Sand 72%	− 1 + ¼	: 48
	− ¼ + 1/16	: 14
Fines 17%	− 1/16	: 17

Depth below surface (ft)	Percentage Fines	Sand	Gravel
3 - 6	14	41	45
6 - 9	16	42	42
9 - 12	7	31	62
12 - 15	3	50	47
15 - 18	8	39	53
18 - 21	5	34	61
21 - 24	3	31	66
24 - 27	10	65	25
27 - 31	21	65	14
31 - 34	12	80	8

TL 81 NE 6 8675 1747 Highfields, Inworth

Surface level (+38.1 m) +125 ft
Groundwater conditions not recorded
Gryphon, 5 inch diameter
October 1968

Overburden (1.1 m) 3.5 ft
Mineral (0.9 m) 3 ft
Waste (13.2 m) 43.5 ft
Bedrock (1.6 m +) 5 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Blackwater River Terrace Deposits	Soil on clay.	(1.1)	3.5	(1.1)	3.5
	'Very clayey' gravel. Gravel: flint, medium to coarse subangular to subrounded, with quartz, coarse subrounded.	(0.9)	3	(2.0)	6.5
Springfield Till	Boulder clay, brown near the top becoming grey, then black and chalky with increasing depth.	(13.2)	43.5	(15.2)	50
London Clay	Clay, with septarian nodule inclusion.	(1.6+)	5+	(16.8)	55

	%	Depth below surface (ft)	Percentage Fines	Sand	Gravel
	+16 mm : 29				
Gravel 50%	−16 + 4 : 21	3.5 - 6.5	26	24	50
	− 4 + 1 : 8				
Sand 24%	− 1 + ¼ : 11				
	− ¼ + 1/16 : 5				
Fines 26%	− 1/16 : 26				

TL 81 NE 7 8607 1708 Near Ashman's Farm, Kelvedon

Surface level (+34.7 m) +114 ft
Water struck at (+21.0 m) +69 ft
Gryphon, 5 inch diameter
October 1968

Overburden (13.4 m) 44 ft
Mineral (7.9 m +) 26 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Soil and ? Head	Soil with some gravel	(0.8)	2.5	(0.8)	2.5
Springfield Till	Chalky boulder clay, yellow to grey.	(12.6)	41.5	(13.4)	44
Chelmsford Gravels	Pebbly sand. Gravel: flint, quartz and quartzite. Sand: medium, subangular, with white chalk fragments, silver-grey.	(7.9+)	26+	(21.3)	70

		%
	+16 mm	: 1
Gravel 8%	−16 + 4	: 7
	− 4 + 1	: 11
Sand 91%	− 1 + ¼	: 61
	− ¼ + 1/16	: 19
Fines 1%	− 1/16	: 1

Depth below surface (ft)	Percentage Fines	Sand	Gravel
44 - 50	0	100	0
50 - 55	0	85	15
55 - 60	0	85	15
60 - 65	1	99	0
65 - 70	2	86	12

TL 81 NE 8 8710 1926 Threshelfords Farm, Kelvedon

Surface level (+30.2 m) +99 ft
Water struck at (+19.5 m) +64 ft
Shell, 7 inch diameter
October 1968

Overburden (0.7 m) 2.2 ft
Mineral (1.0 m) 3.3 ft
Waste (2.3 m) 7.5 ft
Mineral (6.4 m) 21 ft
Waste (14.0 m +) 46 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Blackwater River Terrace Deposits (a)	Soil with gravelly clay.	(0.7)	2.2	(0.7)	2.2
	Gravel. Gravel: flint, subangular to subrounded, with quartz, subrounded, and quartzite, subrounded.	(1.0)	3.3	(1.7)	5.5
Lacustrine Deposits	Clays. Laminated, iron and manganese stained clays.	(2.3)	7.5	(4.0)	13
? Channel-fill Deposits (b)	Sandy gravel. Gravel: variable size range, up to cobble size between 25 ft (7.6 m) and 28 ft (8.5 m). Sand: brown to light brown.	(6.4)	21	(10.4)	34
?Springfield Till	Chalky boulder clay, brown becoming blue with depth	(14.0+)	46+	(24.4)	80

(a & b)
Gravel 39%
Sand 59%
Fines 2%

	%
+16 mm	: 17
−16 + 4	: 22
− 4 + 1	15
− 1 + ¼	: 35
− ¼ + 1/16	: 9
− 1/16	: 2

Depth below surface (ft)	Percentage Fines	Sand	Gravel
2.2 - 5.5	1	35	64
13 - 16	7	72	21
16 - 19	0	45	55
19 - 22	0	55	45
22 - 25	2	78	20
25 - 28	1	62	37
28 - 31	1	74	25
31 - 33	0	73	27
33 - 34	0	30	70

TL 81 NE 9 8776 1826 Inworth Hall, Inworth

Surface level (+44.5 m) +146 ft
Water not struck
Wirth B1, 8 inch diameter
December 1968

Overburden (2.7 m) 9 ft
Mineral (9.2 m) 30 ft
Bedrock (0.6 m +) 2 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Soil		(0.6)	2	(0.6)	2
Springfield Till	Brown chalky boulder clay.	(2.1)	7	(2.7)	9
Chelmsford Gravels	Sandy gravel. Gravel: flint, fine to medium subangular, and quartz, subrounded. Some flint cobbles in basal 4 ft (1.2 m). Sand: mainly medium, subangular, brown.	(9.2)	30	(11.9)	39
London Clay	Clay, weathered.	(0.6+)	2+	(12.5)	41

		%
	+16 mm	: 12
Gravel 33%	-16 + 4	: 21
	- 4 + 1	: 6
Sand 66%	- 1 + ¼	: 41
	- ¼ + 1/16	: 19
Fines 1%	- 1/16	: 1

Depth below surface (ft)	Percentage Fines	Sand	Gravel
9 - 12	3	88	9
12 - 15	1	96	3
15 - 18	5	89	6
18 - 21	0	41	59
21 - 23	1	53	46
23 - 26	0	48	52
26 - 29	1	48	51
29 - 32	0	70	30
32 - 35	1	54	45
35 - 38	0	67	33
38 - 39	0	60	40

TL 81 NE 10 8831 1989 Prested Hall, Kelvedon

Surface level (+27.4 m) +90 ft
Water struck at (+17.7 m) +58 ft
Shell, 6 inch diameter
November 1968

Waste (18.3 m +) 60 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Soil		(0.6)	2	(0.6)	2
Springfield Till	Boulder clay, brown becoming grey, with occasional pockets of sand and gravel; traces of chalk in the upper half becoming more prominent towards the base.	(17.7+)	58+	(18.3)	60

TL 81 NE 11 8860 1898 Yewtree Farm, Messing-cum-Inworth

Surface level (+34.7 m) +114 ft
Water struck at (+26.2 m) +86 ft
Shell, 8 inch and 6 inch diameters
October 1968

Overburden (8.5 m) 28 ft
Mineral (8.9 m) 29 ft
Bedrock (1.5 m +) 5 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Soil		(0.9)	3	(0.9)	3
Springfield Till	Boulder clay, brown with some chalk pellets in the upper 17 ft (5 m), becoming grey and more chalky in the lower 8 ft (2.4 m).	(7.6)	25	(8.5)	28
Chelmsford Gravels	Sandy gravel. Gravel: flint, subangular to subrounded, with quartz and quartzite, subrounded. Sand: fine to medium, brown	(8.9)	29	(17.4)	57
London Clay	Clay, weathered in upper 2 ft (0.6 m).	(1.5+)	5+	(18.9)	62

		%
	+16 mm	: 23
Gravel 44%	−16 + 4	: 21
	− 4 + 1	: 7
Sand 54%	− 1 + ¼	: 35
	− ¼ + 1/16	: 12
Fines 2%	− 1/16	: 2

Depth below surface (ft)	Percentage Fines	Sand	Gravel
28 - 31	3	97	0
31 - 34.5	0	98	2
34.5 - 38	0	98	2
38 - 41	1	24	75
41 - 44	2	35	63
44 - 50	Grading not available		
50 - 53	1	36	63
53 - 57	1	44	55

TL 81 NE 12 8893 1553 Peakes Close, Tiptree

Surface level (+55.2 m) +181 ft
Groundwater conditions not recorded
Gryphon, 5 inch diameter
October 1968

Overburden (0.9 m) 3 ft
Mineral (2.9 m) 9.5 ft
Waste (1.1 m) 3.5 ft
Mineral (5.8 m) 19 ft
Bedrock (0.7 m +) 2.5 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Soil and ? Head	Soil with clay.	(0.9)	3	(0.9)	3
Chelmsford Gravels (with interbedded clay seam) (a)	Pebbly sand. Gravel: flint and quartz, subangular to rounded. Sand: medium, brown.	(2.9)	9.5	(3.8)	12.5
	Light blue clay.	(1.1)	3.5	(4.9)	16
(b)	Sand. Becoming gravelly towards base. Gravel: flint, subangular to subrounded, with quartz and quartzite, rounded. Sand: medium to coarse, yellow.	(5.8)	19	(10.7)	35
London Clay	Blue clay.	(0.7+)	2.5+	(11.4)	37.5

(a & b)		%
Gravel 10%	+16 mm	: 5
	−16 + 4	: 5
	− 4 + 1	: 5
Sand 87%	− 1 + ¼	: 62
	− ¼ + 1/16	: 20
Fines 3%	− 1/16	: 3

Depth below surface (ft)	Percentage Fines	Sand	Gravel
3 - 4	20	50	30
4 - 5	1	89	10
5 - 7	20	62	18
7 - 10	0	92	8
10 - 12.5	1	75	24
16 - 17.5	9	89	2
17.5 - 24.8	1	99	0
24.8 - 32	0	100	0
32 - 35	0	57	43

TL 81 NE 13 8956 1940 Messing-cum-Inworth

Surface level (+34.7 m) +114 ft
Water struck at (+28.0 m) +92 ft
Shell, 6 inch diameter
November 1968

Waste (18.3 m +) 60 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Soil		(0.9)	3	(0.9)	4
Springfield Till	Boulder clay, brown with abundant flint and traces of chalk becoming grey with abundant chalk.	(17.4+)	57+	(18.3)	60

TL 81 NE 14 8946 1848 Primary School, Messing-cum-Inworth

Surface level (+61.0 m) +200 ft
Water struck at (+48.8 m) +160 ft
Wirth B0, 8 inch diameter
December 1968

Overburden (0.3 m) 1 ft
Mineral (16.8 m) 55 ft
Bedrock (0.9 m +) 3 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Soil		(0.3)	1	(0.3)	1
Chelmsford Gravels	Pebbly sand. Gravel: flint, fine becoming coarser with depth, subangular, with quartz, subrounded. Sand: brownish-orange becoming brown with depth.	(16.8)	55	(17.1)	56
London Clay	Weathered clay.	(0.9+)	3+	(18.0)	59

		%
	+16 mm	: 9
Gravel 17%	−16 + 4	: 8
	− 4 + 1	: 4
Sand 80%	− 1 + ¼	: 47
	− ¼ + 1/16	: 29
Fines 3%	− 1/16	: 3

Depth below surface (ft)	Percentage Fines	Sand	Gravel
1 - 4	4	90	6
4 - 7	3	84	13
7 - 10	2	76	22
10 - 13	2	95	3
13 - 16	12	84	4
16 - 19	0	68	32
19 - 22	2	86	12
22 - 25	2	95	3
25 - 28	2	98	0
28 - 31	2	93	5
31 - 34	2	93	5
34 - 37	Grading not available		
37 - 40	2	85	13
40 - 43	3	92	5
43 - 46	4	90	6
46 - 49	2	74	24
49 - 51	2	52	46
51 - 54	2	73	25
54 - 56	2	53	45

TL 81 NE 15 8987 1756 Pods Wood, Tiptree

Surface level (+59.4 m) +195 ft
Water struck at (+57.0 m) +187 ft
Wirth B1, 8 inch diameter
December 1968

Overburden (0.6 m) 2 ft
Mineral (2.8 m) 9 ft
Waste (1.8 m) 6 ft
Mineral (1.8 m) 6 ft
Bedrock (1.2 m +) 4 ft +

			Thickness (m)	Thickness ft	Depth (m)	Depth ft
Soil			(0.6)	2	(0.6)	2
Chelmsford Gravels (with interbedded clay seam)	(a)	Sandy gravel. Gravel: flint, often coarse, up to cobble size, with quartz, subrounded. Sand: brown.	(2.8)	9	(3.4)	11
		Clay, brown to yellow with occasional patches of sand and gravel.	(1.8)	6	(5.2)	17
	(b)	Sandy gravel. Gravel: up to cobble size, flint, subangular, and quartz, subrounded.	(1.8)	6	(7.0)	23
London Clay		Clay.	(1.2+)	4+	(8.2)	27

(a & b)

		%
	+16 mm	: 19
Gravel 38%	−16 + 4	: 19
	− 4 + 1	: 9
Sand 56%	− 1 + ¼	: 31
	− ¼ +1/16	: 16
Fines 6%	− 1/16	: 6

Depth below surface (ft)	Percentage Fines	Sand	Gravel
2 - 5	5	45	50
5 - 8	8	45	47
8 - 11	7	54	39
17 - 20	10	75	15
20 - 23	0	58	42

TL 81 NE 16 8985 1666 Barbrook Road, Tiptree

Surface level (+52.4 m) +172 ft
Water not struck
Shell, 6 inch diameter
November 1968

Overburden (1.2 m) 4 ft
Mineral (1.8 m) 6 ft
Waste (1.9 m) 6 ft
Bedrock (1.2 m +) 4 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Soil		(0.6)	2	(0.6)	2
?Head	Brown clay with occasional pebbles	(0.6)	2	(1.2)	4
Chelmsford Gravels	Gravel. Gravel: flint, subangular, with quartz, subrounded.	(1.8)	6	(3.0)	10
	Brown clay with occasional pebbles.	(1.9)	6	(4.9)	16
London Clay	Weathered clay.	(1.2+)	4+	(6.1)	20

		%
	+16 mm	: 35
Gravel 72%	−16 + 4	: 37
	− 4 + 1	: 9
Sand 27%	− 1 + ¼	: 17
	− ¼ + 1/16	: 1
Fines 1%	− 1/16	: 1

Depth below surface (ft)	Percentage Fines	Sand	Gravel
4 - 7	0	38	62
7 - 10	2	15	83

TL 81 NE 17 8992 1572 Wilkin's Factory, Tiptree

Surface level (+51.5 m) +169 ft
Water struck at (+50.6 m) +166 ft
Gryphon, 5 inch diameter
October 1968

Overburden (1.5 m) 5 ft
Mineral (5.2 m) 17 ft
Bedrock (0.9 m +) 3 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Soil and ? Head	Soil with some clay.	(1.5)	5	(1.5)	5
Chelmsford Gravels	'Clayey' pebbly-sand. Gravel content low between 10 and 19 ft (3.0 and 5.8 m). Gravel: medium and coarse flint and quartz, subangular to subrounded. Sand: medium to coarse, mainly quartz, silver.	(5.2)	17	(6.7)	22
London Clay	Blue clay.	(0.9+)	3+	(7.6)	25

		%
	+16 mm	: 5
Gravel 12%	−16 + 4	: 7
	− 4 + 1	: 6
Sand 75%	− 1 + ¼	: 54
	− ¼ + 1/16	: 15
Fines 13%	− 1/16	: 13

Depth below surface (ft)	Percentage Fines	Sand	Gravel
5 - 10	35	51	14
10 - 15	10	87	3
15 - 19	0	100	0
19 - 22	0	61	39

TL 81 SW 69 8088 1484 North of Blunt's Hall, Witham

Surface level (+33.2 m) +109 ft
Water struck at (+30.2 m) +99 ft
Wirth B1, 8 inch diameter
February 1967

Overburden (1.8 m) 6 ft
Mineral (3.7 m) 12 ft
Bedrock (1.8 m +) 6 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Springfield Till	Soil on chalky boulder clay.	(1.8)	6	(1.8)	6
Chelmsford Gravels	Gravel.	(3.7)	12	(5.5)	18
London Clay	Brown clay.	(0.6)	2	(6.1)	20
	Blue clay	(1.2+)	4+	(7.3)	24

		%
	+16 mm	: 25
Gravel 51%	−16 + 4	: 26
	− 4 + 1	: 11
Sand 48%	− 1 + ¼	: 29
	− ¼ + 1/16	: 8
Fines 1%	− 1/16	: 1

Depth below surface (ft)	Percentage Fines	Sand	Gravel
6 - 8	1	70	29
8 - 10	1	56	43
10 - 12	1	53	46
12 - 14	1	30	69
14 - 16	1	39	60
16 - 18	2	38	60

TL 81 SW 70 8086 1407 Blunt's Hall, Witham

Surface level (+31.1 m) +102 ft
Water struck at (+28.3 m) +93 ft
Wirth B1, 8 inch diameter
February 1967

Overburden (2.7 m) 9 ft
Mineral (3.7 m) 12 ft
Bedrock (1.8 m +) 6 ft

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Springfield Till	Soil on boulder clay.	(2.7)	9	(2.7)	9
Chelmsford Gravels	Sandy gravel. Gravel: noticeably coarser below 19 ft (5.8 m).	(3.7)	12	(6.4)	21
London Clay	Brown clay.	(0.9)	3	(7.3)	24
	Blue clay.	(0.9+)	3+	(8.2)	27

		%
	+16 mm	: 25
Gravel 46%	-16 + 4	: 21
	- 4 + 1	: 13
Sand 54%	- 1 + ¼	: 33
	- ¼ + 1/16	: 8
Fines 0%	- 1/16	: 0

Depth below surface (ft)	Percentage Fines	Sand	Gravel
9 - 11	1	56	43
11 - 13	0	53	47
13 - 15	0	60	40
15 - 17	0	28	72
17 - 19	0	60	40
19 - 21	2	65	33

TL 81 SW 71 8015 1377 Near Blunt's Hall, Witham

Surface level (+39.6 m) +130 ft
Water not struck
Wirth B1, 8 inch diameter
February 1967

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Springfield Till	Soil on chalky boulder clay.	(5.8)	19	(5.8)	19
	Sandy boulder clay.	(0.3)	1	(6.1)	20
	Brown boulder clay.	(0.6)	2	(6.7)	22
	Blue boulder clay with chalk fragments.	(1.2+)	4+	(7.9)	26

TL 81 SW 85 8001 1412 Blunt's Hall, Witham

Surface level (+41.8 m) +137 ft
Water not struck
Shell, 7 inch diameter
November 1968

Overburden (4.9 m) 16 ft
Mineral (6.2 m) 20.5 ft
Bedrock (0.9 m +) 3 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Springfield Till	Brown chalky boulder clay.	(4.9)	16	(4.9)	16
Chelmsford Gravels	Gravel. Gravel: flint, subangular, with a little quartz, subrounded, and quartzite. Sand: light brown.	(6.2)	20.5	(11.1)	36.5
London Clay	Weathered clay, brown.	(0.9+)	3+	(12.0)	39.5

		%
	+16 mm	: 36
Gravel 67%	-16 + 4	: 31
	- 4 + 1	: 12
Sand 31%	- 1 + ¼	: 16
	- ¼ +1/16	: 3
Fines 2%	- 1/16	: 2

Depth below surface (ft)	Percentage Fines	Sand	Gravel
16 - 19	10	32	58
19 - 22	2	38	60
22 - 25	1	39	60
25 - 28	1	17	82
28 - 31	2	15	83
31 - 34	2	36	62
34 - 36.5	0	36	64

TL 81 SW 86 8186 1355 Pondhallow Farm, Witham

Surface level (+22.9 m) +75 ft
Water struck at (+16.8 m) +55 ft
Gryphon, 5 inch diameter
December 1968

Overburden (6.0 m) 19.7 ft
Mineral (2.2 m) 7.3 ft
Waste (5.5 m +) 18 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Soil		(0.5)	1.5	(0.5)	1.5
Head	Clay.	(1.9)	6.5	(2.4)	8
	Clay with fine gravel.	(0.9)	3	(3.3)	11
	Brown clay, sandy in parts.	(2.7)	8.7	(6.0)	19.7
Blackwater River Terrace Deposits	Sandy gravel. Sand: yellow-brown.	(2.2)	7.3	(8.2)	27
? Springfield Till	Grey boulder clay.	(5.5+)	18+	(13.7)	45

		%
	+16 mm	: 13
Gravel 32%	-16 + 4	: 19
	- 4 + 1	: 15
Sand 66%	- 1 + ¼	: 43
	- ¼ + 1/16	: 8
Fines 2%	- 1/16	: 2

Depth below surface (ft)	Percentage Fines	Sand	Gravel
19.7 - 27	2	66	32

TL 81 SW 87 8188 1234 Maldon Road, Witham

Surface level (+15.8 m) +52 ft
Water struck at (+13.1 m) +43 ft
Shell, 8 inch diameter
January 1969

Overburden (2.1 m) 7 ft
Mineral (3.5 m) 11.5 ft
Bedrock (1.1 m +) 3.5 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Soil		(0.3)	1	(0.3)	1
Head	Brown clay with chalk fragments.	(1.8)	6	(2.1)	7
Blackwater River Terrace Deposits	Gravel, with some cobbles. Gravel: flint, subangular, with a little quartz, fine, subrounded. Sand: brown.	(3.5)	11.5	(5.6)	18.5
London Clay	Silty clay.	(0.2)	0.5	(5.8)	19
	Blue clay.	(0.9+)	3+	(6.7)	22

		%
	+16 mm	: 41
Gravel 73%	-16 + 4	: 32
	- 4 + 1	: 11
Sand 27%	- 1 + ¼	: 14
	- ¼ + 1/16	: 2
Fines 0%	- 1/16	: 0

Depth below surface (ft)	Percentage Fines	Sand	Gravel
7 - 10	0	22	78
10 - 13	0	25	75
13 - 16	0	28	72
16 - 18.5	0	32	68

TL 81 SW 88 8127 1043 Maldon Road, Ulting

Surface level (+34.4 m) +113 ft
Water not struck
Shell, 6 inch diameter
November 1968

Waste (6.4 m) 21 ft
Bedrock (0.9 m +) 3 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Soil	Clayey loam.	(0.9)	3	(0.9)	3
Springfield Till	Brown boulder clay with much chalk in upper part, becoming less chalky with depth.	(5.5)	18	(6.4)	21
London Clay	Clay, weathered to a depth of 6 in (0.2 m),	(0.9+)	3+	(7.3)	24

TL 81 SW 89 8282 1051 Wickham Hall, Wickham Bishops

Surface level (+8.5 m) +28 ft
Water struck at (+5.5 m) +18 ft
Shell, 7 inch diameter
January 1969

Overburden (2.1 m) 7 ft
Mineral (3.4 m) 11 ft
Waste (1.2 m) 4 ft
Bedrock (0.9 m +) 3 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Soil		(0.3)	1	(0.3)	1
Alluvium	Brown silty clay.	(0.9)	3	(1.2)	4
	Grey silt and peat	(0.9)	3	(2.1)	7
Sub-alluvium Gravel	Gravel. Gravel: flint, subangular, and quartz, subrounded, with quartzite, subangular to rounded.	(3.4)	11	(5.5)	18
	Black silt and peat.	(1.2)	4	(6.7)	22
London Clay	Blue-grey silty clay.	(0.9+)	3+	(7.6)	25

		%
	+16 mm	: 37
Gravel 73%	-16 + 4	: 36
	- 4 + 1	: 9
Sand 26%	- 1 + ¼	: 16
	- ¼ + 1/16	: 1
Fines 1%	- 1/16	: 1

Depth below surface (ft)	Percentage Fines	Sand	Gravel
7 - 10	6	24	70
10 - 13	0	28	72
13 - 16	0	25	75
16 - 18	0	25	75

TL 81 SW 90 8332 1484 Little Braxted

Surface level (+14.0 m) +46 ft
Water struck at (+11.6 m) +38 ft
Shell, 7 inch diameter
November 1968

Overburden (2.0 m) 6.7 ft
Mineral (3.5 m) 11.3 ft
Waste (12.8 m +) 42 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Blackwater River Terrace Deposits	Clay and silt.	(2.0)	6.7	(2.0)	6.7
	'Clayey' gravel, with cobbles between 11 and 14 ft (3.4 and 4.3 m). Gravel: flint, subangular to subrounded, with quartzite, subangular, and some quartz.	(3.5)	11.3	(5.5)	18
? Springfield Till	Dark grey chalky boulder clay.	(12.8+)	42+	(18.3)	60

		%
	+16 mm	: 27
Gravel 52%	-16 + 4	: 25
	- 4 + 1	: 9
Sand 36%	- 1 + ¼	: 24
	- ¼ + 1/16	: 3
Fines 12%	- 1/16	: 12

Depth below surface (ft)	Percentage Fines	Sand	Gravel
6.7 - 8.2	2	48	50
8.2 - 11	1	29	70
11 - 14	2	26	72
14 - 18	30	43	27

TL 81 SW 91 8375 1450 Little Braxted

Surface level (+31.1 m) +102 ft
Water not struck
Shell, 8 inch diameter
November 1968

Waste (10.7 m) 35 ft
Bedrock (1.5 m +) 5 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Soil		(0.3)	1	(0.3)	1
Springfield Till	Brown boulder clay with traces of chalk, becoming grey with abundant chalk at 15 ft (4.6 m).	(10.4)	34	(10.7)	35
London Clay	Clay, weathered to a depth of 2 ft (0.6 m)	(1.5+)	5+	(12.2)	40

TL 81 SW 92 8395 1399 Sewells Farm, Little Braxted

Surface level (+34.7 m) +114 ft
Water struck at (+28.0 m) +92 ft
Shell, 8 inch diameter
December 1968

Overburden (4.6 m) 15 ft
Mineral (3.3 m) 11 ft
Bedrock (1.2 m +) 4ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Soil		(0.9)	3	(0.9)	3
Springfield Till	Brown boulder clay with traces of chalk, becoming grey with abundant chalk at 10 ft (3.0 m).	(3.7)	12	(4.6)	15
Chelmsford Gravels	Gravel. Gravel: flint, subangular to subrounded, with quartz, fine, subrounded. Sand: brown.	(3.3)	11	(7.9)	26
London Clay	Clay, weathered to a depth of 1 ft (0.3 m).	(1.2+)	4+	(9.1)	30

		%
	+16 mm	: 40
Gravel 76%	−16 + 4	: 36
	− 4 + 1	: 8
Sand 21%	− 1 + ¼	: 11
	− ¼ + 1/16	: 2
Fines 3%	−1/16	: 3

Depth below surface (ft)	Percentage Fines	Sand	Gravel
15 - 18	8	36	56
18 - 21	0	13	87
21 - 24	0	18	82
24 - 26	2	18	80

TL 81 SW 93 8473 1478 Lealane Wood, Great Braxted

Surface level (+37.5 m) +123 ft
Water not struck
Shell, 7 inch diameter
January 1969

Mineral (2.4 m) 8 ft
Waste (6.1 m) 20 ft
Mineral (3.9 m) 13 ft
Waste (1.8 m) 6 ft
Bedrock (0.3 m +) 1 ft +

			Thickness (m)	Thickness ft	Depth (m)	Depth ft
Blackwater River Terrace Deposits (with clay seams)	(a)	Gravel. Gravel: flint, subangular with quartz, subrounded, and quartzite. Sand: brown.	(2.4)	8	(2.4)	8
		Brown sandy clay, becoming brown clay with no sand at 12 ft (3.7 m).	(6.1)	20	(8.5)	28
	(b)	'Very clayey' sandy gravel. Gravel: flint, fine, subangular to subrounded, and quartz. Sand: brown.	(3.9)	13	(12.4)	44
? Springfield Till		Stiff brown chalky clay	(1.8)	6	(14.2)	47
London Clay		Brown silty clay.	(0.3+)	1+	(14.5)	48

(a & b)

		%
	+16 mm	: 8
Gravel 18%	−16 + 4	: 10
	− 4 + 1	: 6
Sand 49%	− 1 + ¼	: 22
	− ¼ + 1/16	: 21
Fines 33%	− 1/16	: 33

Depth below surface (ft)	Percentage Fines	Sand	Gravel
0 - 8	0	45	55
28 - 32	36	55	9
32 - 35	40	39	21
35 - 38	28	49	23
38 - 41	28	52	20

TL 81 SW 94 8274 1135 Near St Peter's Church, Wickham Bishops

Surface level (+25.9 m) +85 ft
Water struck at (+16.8 m) +55 ft
Wirth B1, 8 inch diameter
November 1968

Overburden (0.9 m) 3 ft
Mineral (1.8 m) 6 ft
Waste (1.6 m) 5 ft
Mineral (7.0 m) 23 ft
Bedrock (0.9 m +) 3 ft

			Thickness (m)	Thickness ft	Depth (m)	Depth ft
Soil			(0.3)	1	(0.3)	1
? Head		Brown clay with some sand and gravel.	(0.6)	2	(0.9)	3
Chelmsford Gravels (with clay seam)	(a)	Sandy gravel. Gravel: mainly fine. Sand: brown.	(1.8)	6	(2.7)	9
		Sandy clay.	(1.6)	5	(4.3)	14
	(b)	Sandy gravel. Gravel: fine at top, to coarse at depth, flint, subangular, with quartz, subrounded. Sand: light brown, becoming brown with depth.	(7.0)	23	(11.3)	37
London Clay		Weathered clay.	(0.9+)	3+	(12.2)	40

(a & b)

Gravel 40%
Sand 56%
Fines 4%

	%
+16 mm	: 19
−16 + 4	: 21
− 4 + 1	: 9
− 1 + ¼	: 34
− ¼ + 1/16	: 13
− 1/16	: 4

Depth below surface (ft)	Percentage Fines	Sand	Gravel
3 - 6	6	46	48
6 - 9	20	75	5
14 - 17	0	80	20
17 - 20	3	81	16
20 - 23	2	86	12
23 - 26	2	43	55
26 - 29	0	36	64
29 - 32	2	41	57
32 - 35	2	36	62
35 - 37	2	40	58

TL 81 SW 95 8347 1057 Reigate Barn, Wickham Bishops

Surface level (+29.0 m) +95 ft
Water struck at (+26.2 m) +86 ft
Wirth B0, 8 inch diameter
November 1968

Overburden (0.9 m) 3 ft
Mineral (3.4 m) 11 ft
Bedrock (0.9 m +) 3 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Soil and ? Head	Soil on brown clay with flints.	(0.9)	3	(0.9)	3
Chelmsford Gravels	Sandy gravel. Gravel: up to cobble size, mainly flint, subangular. Sand: medium, brown.	(3.4)	11	(4.3)	14
London Clay	Weathered clay.	(0.9+)	3+	(5.2)	17

		%
	+16 mm	: 17
Gravel 48%	−16 + 4	: 31
	− 4 + 1	: 15
Sand 49%	− 1 + ¼	: 29
	− ¼ + 1/16	: 5
Fines 3%	− 1/16	: 3

Depth below surface (ft)	Percentage Fines	Sand	Gravel
3 - 6	1	34	65
6 - 9	2	69	29
9 - 12	2	30	68
12 - 14	7	71	22

TL 81 SW 96 8396 1095 Near Likely Wood, Wickham Bishops

Surface level (+39.9 m) +131 ft
Water not struck
Shell, 8 inch diameter
November 1968

Overburden (4.6 m) 15 ft
Mineral (6.4 m) 21 ft
Bedrock (1.8 m +) 6 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Soil		(1.2)	4	(1.2)	4
Springfield Till	Brown boulder clay with a little chalk.	(3.4)	11	(4.6)	15
Chelmsford Gravels	Gravel. Gravel: flint, subangular to subrounded, with quartz, fine, subrounded. Sand: brown.	(6.4)	21	(11.0)	36
London Clay	Clay, weathered in upper 3 ft (0.9 m).	(1.8+)	6+	(12.8)	42

		%
	+16 mm	: 27
Gravel 53%	-16 + 4	: 26
	- 4 + 1	: 7
Sand 45%	- 1 + ¼	: 24
	-¼ + 1/16	: 14
Fines 2%	- 1/16	: 2

Depth below surface (ft)	Percentage Fines	Sand	Gravel
15 - 18	11	78	11
18 - 21	2	56	42
21 - 24	0	34	66
24 - 27	0	50	50
27 - 30	0	28	72
30 - 33	3	30	67
33 - 36	1	36	63

TL 81 SW 97, 8448 1168 Crabb's Farm, Wickham Bishops

Surface level (+51.8 m) +170 ft
Water struck at (+47.2 m) +155 ft
Wirth B1, 8 inch diameter
November 1968

Mineral (8.2 m) 27 ft
Bedrock (0.9 m +) 3 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Soil	Sandy loam.	(0.2)	0.5	(0.2)	0.5
Chelmsford Gravels	Sand. Sand: fine to medium, brick-red in upper 9 ft (2.7 m), becoming yellow-brown with depth.	(8.0)	26.5	(8.2)	27
London Clay	Clay, weathered at top.	(0.9+)	3+	(9.1)	30

Gravel 2%
Sand 93%
Fines 5%

	%
+16 mm	1
−16 + 4	1
− 4 + 1	1
− 1 + ¼	48
− ¼ + 1/16	44
− 1/16	5

Depth below surface (ft)	Percentage Fines	Sand	Gravel
0.5 - 3.5	Grading not available		
3.5 - 6.5	15	78	7
6.5 - 9.5	3	97	0
9.5 - 12.5	8	92	0
12.5 - 15.5	6	94	0
15.5 - 18.5	3	97	0
18.5 - 21.5	2	98	0
21.5 - 24.5	0	97	3
24.5 - 27	2	94	4

TL 81 SW 98 8421 1223 High Hall, Wickham Bishops

Surface level (+71.6 m) +235 ft
Water struck at (+68.9 m) +226 ft
Shell, 8 inch diameter
November 1968

Overburden (2.7 m) 9 ft
Mineral (1.0 m) 3 ft
Bedrock (6.1 m +) 20 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Soil		(0.3)	1	(0.3)	1
? Head	Brown clay with lenses of sand and silty clay.	(2.4)	8	(2.7)	9
Chelmsford Gravels	Gravel. Gravel: flint. subangular, with quartz, fine, subrounded.	(1.0)	3	(3.7)	12
London Clay	Brown clay.	(5.1)	17	(8.8)	29
	Clay.	(1.0+)	3+	(9.8)	32

		%
	+16 mm	: 30
Gravel 72%	−16 + 4	: 42
	− 4 + 1	: 12
Sand 28%	− 1 + ¼	: 15
	− ¼ + 1/16	: 1
Fines 0%	− 1/16	: 0

Depth below surface (ft)	Percentage Fines	Sand	Gravel
9 - 12	0	28	72

TL 81 SE 6 8582 1334 Strowling Wood, Great Totham

Surface level (+87.8 m) +288 ft
Water not struck
Wirth B0, 8 inch diameter
December 1968

Overburden (2.4 m) 8ft
Mineral (2.2 m) 7 ft
Bedrock (0.9 m +) 3 ft+

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Head	Brown sandy clay	(2.4)	8	(2.4)	8
Chelmsford Gravels	'Very clayey' gravel. Gravel: flint, subangular to subrounded, with quartzite. Sand: reddish brown.	(2.2)	7	(4.6)	15
London Clay	Brown clay with some claystone.	(0.9+)	3+	(5.5)	18

		%
	+16 mm	: 22
Gravel 45%	-16 + 4	: 23
	- 4 + 1	: 5
Sand 31%	- 1 + ¼	: 19
	- ¼ + 1/16	: 7
Fines 24%	- 1/16	: 24

Depth below surface (ft)	Percentage Fines	Sand	Gravel
8 - 11	7	35	58
11 - 15	37	27	36

TL 81 SE 7 8514 1163 Near Great Totham

Surface level (+51.2 m) +168 ft
Water struck at (+35.1 m) +115 ft
Wirth B0, 8 inch diameter
December 1968

Overburden (3.4 m) 11 ft
Mineral (7.9 m) 26 ft
Waste (13.1 m +) 43 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Soil		(0.3)	1	(0.3)	1
Head	Brown sandy clay.	(3.1)	10	(3.4)	11
Chelmsford Gravels	Gravel, with sand and clay partings.				
	Gravel: flint, medium to coarse, subangular to subrounded, with occasional quartzite.	(0.9)	3	(4.3)	14
	Gravel: with clayey sand and carbonaceous matter.	(0.3)	1	(4.6)	15
	Gravel: flint, medium to fine, angular to subangular, with quartzite, subrounded.	(3.9)	13	(8.5)	28
	Silty sand with thin partings of grey clay.	(2.8)	9	(11.3)	37
	Brown silt, becoming blue-brown with depth.	(13.1+)	43+	(24.4)	80

		%
	+16 mm	: 25
Gravel 59%	−16 + 4	: 34
	− 4 + 1	: 10
Sand 37%	− 1 + ¼	: 23
	− ¼ + 1/16	: 4
Fines 4%	− 1/16	: 4

Average from 11 to 28 ft

Depth below surface (ft)	Percentage Fines	Sand	Gravel
11 - 14	10	26	64
14 - 15	40	28	32
15 - 18	0	53	47
18 - 21	1	42	57
21 - 24	0	34	66
24 - 27	1	36	63
27 - 28	1	46	53
28 - 31	55	45	0
31 - 34	0	100	0
34 - 37	25	75	0

TL 81 SE 8 8514 1095 Captain's Wood, Great Totham

Surface level (+79.6 m) +261 ft
Water not struck
Wirth B0, 8 inch diameter
February 1969

Waste (11.6 m) 38 ft
Bedrock (0.9 m +) 3 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Soil		(0.9)	3	(0.9)	3
Head	Brown clay.	(2.5)	8	(3.4)	11
	Clay with traces of gravel.	(4.2)	14	(7.6)	25
	Brown clay.	(1.5)	5	(9.1)	30
? Springfield Till	Grey chalky boulder clay.	(1.6)	5	(10.7)	35.
?Chelmsford Gravels	Clayey gravel.	(0.9)	3	(11.6)	38
London Clay	Brown clay.	(0.9+)	3+	(12.5)	41

TL 81 SE 9 8638 1409 Porter's Farm, Great Braxted

Surface level (+42.7 m) +140 ft
Water not struck , k k
Wirth B0, 8 inch diameter
January 1969

Waste (6.4 m) 21 ft
Bedrock (0.9 m +) 3 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Soil		(0.9)	3	(0.9)	3
Head	Brown sandy clay with lenses of sand occurring below 10 ft (3.0 m).	(5.5)	18	(6.4)	21
London Clay	Clay.	(0.9+)	3+	(7.3)	24

TL 81 SE 10 8693 1323 Mill Road, Great Totham

Surface level (+58.5 m) +192 ft
Water struck at (+55.5 m) +182 ft
Wirth B0, 8 inch diameter
December 1968

Overburden (0.9 m) 3 ft
Mineral (4.6 m) 15 ft
Waste (3.6 m) 12 ft
Bedrock (1.0)m +) 3 ft +

		Thickness (m)	ft	Depth (m)	ft
Soil and ? Head	Soil on stoney clay.	(0.9)	3	(0.9)	3
Chelmsford Gravels	Pebbly sand. Gravel: flint, subangular, and quartz, subrounded.	(4.6)	15	(5.5)	18
	Grey silt.	(3.6)	12	(9.1)	30
London Clay	Brown clay, becoming blue with depth.	(1.0+)	3+	(10.1)	33

		%
	+16 mm	: 8
Gravel 21%	-16 + 4	: 13
	- 4 + 1	: 7
Sand 77%	- 1 + ¼	: 48
	- ¼ + 1/16	: 22
Fines 2%	- 1/16	: 2

Depth below surface (ft)	Percentage Fines	Sand	Gravel
3 - 6	0	29	71
6 - 9	7	82	11
9 - 12	2	81	17
12 - 14	0	100	0
14 - 18	0	93	7

TL 81 SE 11 8606 1122 Great Totham Hall

Surface level (+33.5 m) + 110 ft
Water struck at (+31.4 m) +103 ft
Wirth B0, 8 inch diameter
January 1969

Overburden (0.3 m) 1 ft
Mineral (8.8 m) 29 ft
Bedrock (1.0 m +) 3 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Soil		(0.3)	1	(0.3)	1
Chelmsford Gravels	Sandy gravel. Gravel: up to cobble size; flint, subangular, with quartz, subrounded, and occasional quartzite, coarse, subrounded. Sand: brown.	(8.8)	29	(9.1)	30
London Clay	Clay.	(1.0+)	3+	(10.1)	33

		%
	+16 mm	: 19
Gravel 45%	−16 + 4	: 26
	− 4 + 1	: 10
Sand 53%	− 1 + ¼	: 31
	− ¼ + 1/16	: 12
Fines 2%	− 1/16	: 2

Depth below surface (ft)	Percentage Fines	Sand	Gravel
1 - 4	2	32	66
4 - 7	2	33	65
7 - 10	1	37	62
10 - 13	1	49	50
13 - 16	2	33	65
16 - 19	1	71	28
19 - 22	1	57	42
22 - 25	2	76	22
25 - 28	2	72	26
28 - 30	1	74	25

TL 81 SE 12 8704 1111 Jepcrack's Farm, Great Totham

Surface level (+19.2 m) +63 ft
Water not struck
Wirth B0, 8 inch diameter
December 1968

Waste (4.6 m) 15 ft
Bedrock (0.9 m +) 3 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Soil		(0.6)	2	(0.6)	2
Head	Brown clay with some chalk inclusions, becoming brown clay with blue lenses below 9 ft (2.7 m).	(4.0)	13	(4.6)	15
London Clay	Clay with septarian concretions.	(0.9+)	3+	(5.5)	18

TL 81 SE 13 8651 1032 Near Sain's Farm, Great Totham

Surface level (+14.9 m) +49 ft
Water not struck
Wirth B0, 8 inch diameter
February 1969

Waste (6.1 m) 20 ft
Bedrock (0.9 m +) 3 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Soil		(1.2)	4	(1.2)	4
Alluvium	Brown clay with traces of sand.	(2.2)	7	(3.4)	11
? Head	Brown clay with small chalk fragments, (perhaps race nodules in the top of the London Clay).	(2.7)	9	(6.1)	20
London Clay	Brown clay.	(0.9+)	3+	(7.0)	23

TL 81 SE 14 8741 1399 Shrub Hill Farm, Great Braxted

Surface level (+61.0 m) +200 ft
Water not struck
Wirth B0, 8 inch diameter
December 1968

Overburden (0.9 m) 3 ft
Mineral (3.7 m) 12 ft
Waste (1.2 m) 4 ft
Bedrock (0.9 m +) 3 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Soil and ? Head	Soil on gravelly clay.	(0.9)	3	(0.9)	3
Chelmsford Gravels	'Clayey' pebbly sand. Gravel: flint, subangular, with quartz, subrounded. Sand: brown and clayey.	(3.7)	12	(4.6)	15
	Blue to grey silt.	(1.2)	4	(5.8)	19
London Clay	Clay, weathered at top.	(0.9+)	3+	(6.7)	22

		%
	+16 mm	: 6
Gravel 17%	−16 + 4	: 11
	− 4 + 1	: 7
Sand 67%	− 1 + ¼	: 37
	− ¼ + 1/16	: 23
Fines 16%	− 1/16	: 16

Depth below surface (ft)	Percentage Fines	Sand	Gravel
3 - 6	16	57	27
6 - 9	15	73	12
9 - 12	23	60	17
12 - 15	12	76	12

TL 81 SE 15 8775 1094 Godfrey's Farm, Little Totham

Surface level (+16.8 m) +55 ft
Water struck at (+15.5 m) +51 ft
Wirth B0, 8 inch diameter
December 1968

Overburden (1.5 m) 5 ft
Mineral (3.4 m) 11 ft
Bedrock (0.9 m +) 3 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Soil		(0.6)	2	(0.6)	2
? Head	Brown clay with traces of sand.	(0.9)	3	(1.5)	5
Chelmsford Gravels	'Clayey' gravel. Gravel: flint, subangular, with a little quartz, fine, subrounded. Sand: slightly clayey.	(3.4)	11	(4.9)	16
London Clay	Clay, weathered at top.	(0.9+)	3+	(5.8)	19

		%
	+16 mm	: 20
Gravel 47%	-16 + 4	: 27
	- 4 + 1	: 10
Sand 43%	- 1 + ¼	: 26
	- ¼ + 1/16	: 7
Fines 10%	- 1/16	: 10

Depth below surface (ft)	Percentage Fines	Sand	Gravel
5 - 8	0	22	78
8 - 11	7	41	52
11 - 14	22	48	30
14 - 16	12	71	17

TL 81 SE 16 8804 1469 Tiptree Heath

Surface level (+59.4 m) +195 ft
Water struck at (+55.8 m) +183 ft
Wirth B0, 8 inch diameter
February 1969

Overburden (2.4 m) 8 ft
Mineral (5.5 m) 18 ft
Bedrock (0.9 m +) 3 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Soil		(0.6)	2	(0.6)	2
? Head	Brown sandy clay.	(1.8)	6	(2.4)	8
Chelmsford Gravels	'Clayey' pebbly sand. Gravel: flint, fine to medium, subangular, with a little quartz and quartzite. Sand: grey-brown in upper part, becoming yellow at depth.	(5.5)	18	(7.9)	26
London Clay	Weathered clay.	(0.9+)	3+	(8.8)	29

		%
	+16 mm	: 7
Gravel 12%	−16 + 4	: 5
	− 4 + 1	: 5
Sand 76%	− 1 + ¼	: 50
	− ¼ + 1/16	: 21
Fines 12%	− 1/16	: 12

Depth below surface (ft)	Percentage Fines	Sand	Gravel
8 - 11	20	77	3
11 - 14	17	79	4
14 - 17	15	64	21
17 - 20	18	68	14
20 - 23	2	84	14
23 - 26	2	84	14

TL 81 SE 17 8816 1140 Voucher's Farm, Little Totham

Surface level (+17.7 m) +58 ft
Water struck at (+11.6 m) +38 ft
Wirth B0, 8 inch diameter
January 1969

Overburden (0.9 m) 3 ft
Mineral (1.5 m) 5 ft
Waste (3.1 m) 10 ft
Bedrock (0.9 m +) 3 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Soil		(0.3)	1	(0.3)	1
Head	Brown sandy clay.	(0.6)	2	(0.9)	3
? Chelmsford Gravels	'Very clayey' gravel. Gravel: flint, subangular, with a little quartz, fine, subrounded.	(1.5)	5	(2.4)	8
	Brown clay with traces of fine sand.	(3.1)	10	(5.5)	18
London Clay	Weathered clay.	(0.9+)	3+	(6.4)	21

	%	
	+16 mm	: 10
Gravel 41%	−16 + 4	: 31
	− 4 + 1	: 7
Sand 31%	− 1 + ¼	: 17
	− ¼ + 1/16	: 7
Fines 28%	− 1/16	: 28

Depth below surface (ft)	Percentage		
	Fines	Sand	Gravel
3 - 6	Grading not available		
6 - 8	28	31	41

TL 81 SE 18 8932 1209 Sawyer's Farm, Little Totham

Surface level (+21.9 m) +72 ft
Water struck at (+19.8 m) +65 ft
Wirth B0, 8 inch diameter
January 1969

Overburden (4.9 m) 16 ft
Sand and Gravel (1.2 m) 4 ft
Bedrock (0.9 m +) 3 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Soil		(0.3)	1	(0.3)	1
Head	Brown clay with a little sand and gravel.	(4.6)	15	(4.9)	16
Chelmsford Gravels	Gravel. Gravel: flint, medium, subangular, and quartz, subrounded.	(1.2)	4	(6.1)	20
London Clay	Weathered clay.	(0.9+)	3+	(7.0)	23

		%
	+16 mm	: 31
Gravel 62%	−16 + 4	: 31
	− 4 + 1	: 8
Sand 36%	− 1 + ¼	: 25
	− ¼ + 1/16	: 3
Fines 2%	−1/16	: 2

Depth below surface (ft)	Percentage Fines	Sand	Gravel
16 - 20	2	36	62

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by Swift (P&D) Ltd., London, EC1M 5RE

INSTITUTE OF GEOLOGICAL SCIENCES

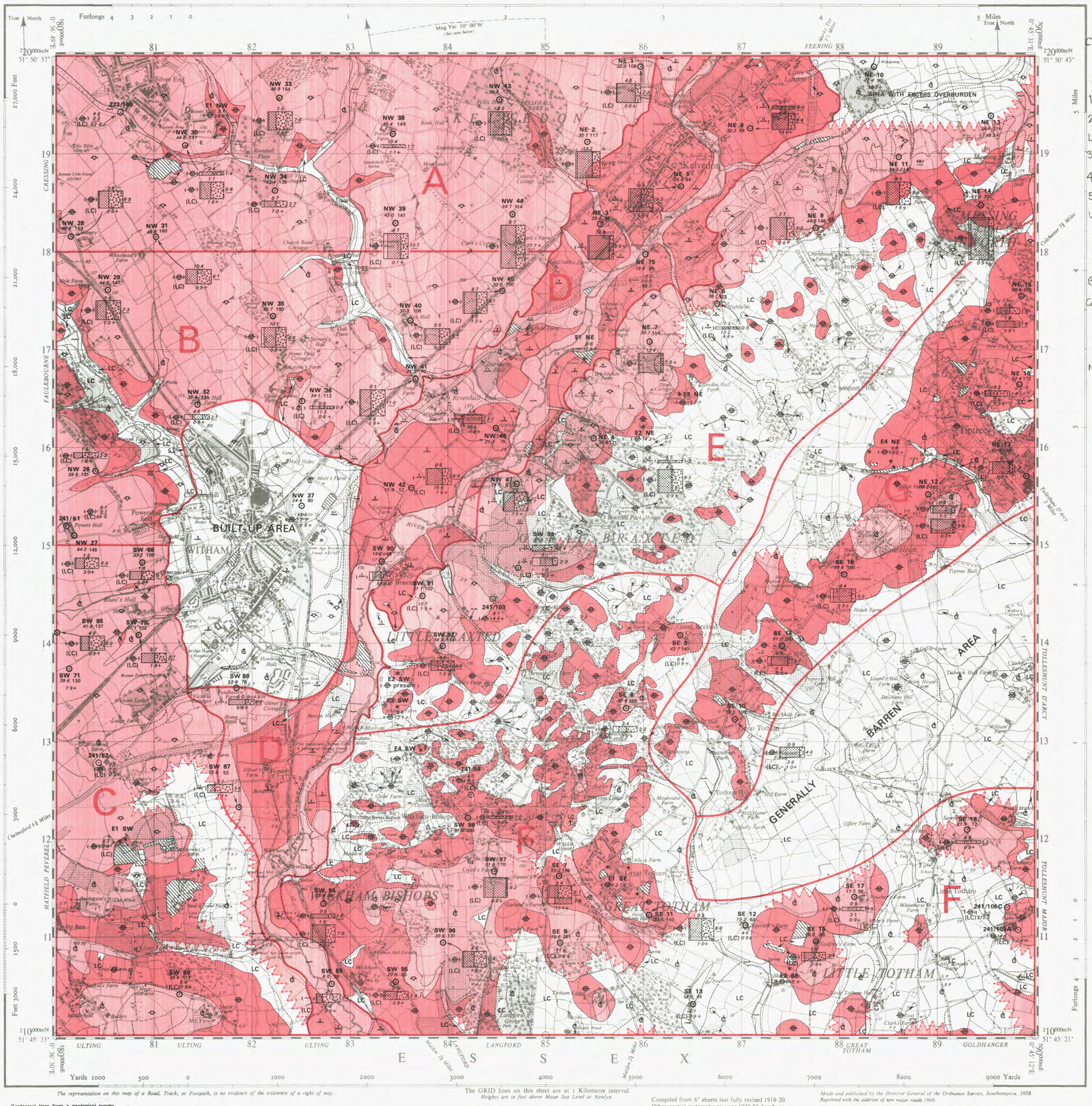
MINERAL ASSESSMENT UNIT

THE SAND & GRAVEL RESOURCES of SHEET TL 81 (WITHAM, ESSEX)

Scale 1:25,000 or about 2½ Inches to 1 Mile

ORDNANCE SURVEY
SHEET TL81
PROVISIONAL EDITION

This map should be read in conjunction with the accompanying Report which contains details of the assessment of resources.



The representation on this map of a Road, Track, or Footpath, is no evidence of the existence of a right of way.

Geological lines from a geological survey on the six-inch scale by C.R. Bristow in 1967. S.C.A. Holmes, District Geologist. Included in One-Inch Geological Sheets 223 and 241.

Sand and Gravel Survey by H.J.E. Haggard, J.D. Ambrose, A.R. Clayton and E.F.P. Nickless in 1967-69 A.A. Archer and R.G. Thurrell, Heads, Mineral Assessment Unit.

1:25,000 Sand and Gravel Resource Sheet published 1972.
K.C. Dunham, D.Sc., F.R.S., *Director, Institute of Geological Sciences incorporating the Geological Survey of Great Britain, the Museum of Practical Geology and Overseas Geological Surveys.*

The GRID lines on this sheet are at 1 Kilometre interval.
Heights are in feet above Mean Sea Level at Newlyn.

1 square inch on this map represents 99·639 acres on the ground.

Compiled from 6" sheets last fully revised 1919-20. Other partial systematic revision 1938-54 has been incorporated.
Major roads revised 1967.

Data quoted for an individual borehole refer strictly to that site. Reliable conclusions cannot be drawn about the thickness and grading elsewhere in the deposit, particularly in material as variable as sand and gravel. The volume and grading of the mineral, as a whole, in each Resource Block can be derived statistically at a given level of confidence. (see Report).

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Made and published by the Director General of the Ordnance Survey, Southampton, 1958. Reprinted with the addition of new major roads 1968.

TL72	TL 82	TL92 223
TL71	TL 81	TL91
TL70	TL80	TL 90 241

Diagram showing the relation of the National Grid 1:25,000 sheets with the New Series One-Inch Geological sheets 223 and 241.

EXPLANATION OF SYMBOLS AND ABBREVIATIONS

2

DRIFT

CT-2		**Calcareous Tufa**
P-1		**Peat**
A-6		**Alluvium** – clay, silt and fine sand, often overlying sand and gravel.
1T-6		**1st. Terrace** } **Terraces of the River Blackwater** – medium flint gravels.
2T-4		**2nd. Terrace**
LA-1		**Lacustrine Deposits** – grey silts and clays.
3T-3		**3rd. Terrace**
4T-2		**4th. Terrace** } **Terraces of the River Blackwater** – including sand and gravel in channel fill deposits.
5T-2		**5th. Terrace**
UT-2		**Undifferentiated Terrace and Channel-fill deposits**
H-5		**Head** – clayey material derived by solifluxion from adjacent deposits.
B-4		**Brickearth** – fine sandy or silty loams with few stones.
Bc-5		**Boulder Clay** – (divisible into **Springfield Till** above the Chelmsford Gravels and **Maldon Till** below them) – stiff clay, bluish-grey weathering to buff or brown, with fragments of chalk, flint and other erratics.
GS-11		**Glacial Sand and Gravel** – (**Chelmsford Gravels** including the **Danbury Gravels**) – medium flint gravels and pebbly sands.

RECENT AND PLEISTOCENE

SOLID

LC		**London Clay** – stiff silty clay, bluish-grey weathering to brown, with occasional cementstone nodules.

EOCENE

MG-2 **Made Ground**

BOUNDARY LINES

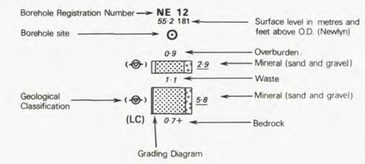
- Geological boundary, Drift.
- Inferred boundary between recognised categories of deposits.
- Resource Block boundary.

BOREHOLE DATA

SITE LOCATIONS

- ⊙ Mineral Assessment Unit (M.A.U.) Boreholes.
- ⊙ Other Boreholes.

M.A.U. BOREHOLES



Note:
(i) Figures underlined denote thicknesses used in the assessment of resources.
(ii) The + sign indicates that the base of the deposit was not reached.
(iii) The figures in *italics* are the metric conversions of measurements recorded in feet.
(iv) The Geological Classification is given only for mineral and bedrock.

Borehole Registration Number

Each M.A.U. borehole is identified by a Registration Number, eg. NE 12. The letters refer to the quarter sheet and the figures to the I.G.S. serial number for that quarter. The unique designation for borehole NE12 is TL 81 NE 12.

Grading Diagrams

Each grading diagram shows the mean particle size distribution of a distinct deposit of mineral.

The height of the diagram is proportional to the mineral thickness.

The widths of the divisions show the proportions of **Fines**, **Sand** and **Gravel**.

OTHER BOREHOLES

The layout of information is the same as for M.A.U. boreholes, although data available may not be as comprehensive. They are registered in the same series, except for records in the Hydrogeological Department - for example, **241/58** signifies Hydrogeological Department borehole 58 on New Series One-Inch Geological Sheet 241.

EXPOSURE RECORDS

Information from the inspection of exposures is shown in the same way as for boreholes, but they are located by an asterisk, thus ✱. Reference number and details of thickness are shown.

CATEGORIES OF DEPOSITS

- **Exposed sand and gravel, as mapped.** CAT-E3
- **Continuous or almost continuous spreads of mineral beneath overburden.** CAT-C1
- **Sand and gravel either not potentially workable (see Report) or absent.** CAT-A2

RESOURCE BLOCKS

For the purpose of assessment the mineral is divided into Resource Blocks (see Report). Each is designated by a letter.

Detailed records may be consulted on application to the Director, at the appropriate offices of the Institute of Geological Sciences.

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