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ASSESSMENT OF BRITISH SAND AND GRAVEL RESOURCES No. 10

The sand and gravel resources of the country west of Colchester, Essex

Description of 1 : 25 000 resource sheet TL 92

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PREFACE

It has become increasingly clear in recent years that an assessment of resources of many minerals should be undertaken. This Report of the Mineral Assessment Unit, which was set up in May 1968 to undertake such work, describes and quantifies the resources of sand and gravel of 90.6 km^2 of country west of Colchester, Essex, shown on the accompanying 1:25 000 resource sheet TL 92.

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 the late J.D. Ambrose, with Mr N.E. Bradbury as field officer in charge of the drilling and sampling programme and Mr G.M. Bladon, who helped in the preparation of data for publication. The work is based on a geological survey at the one-inch scale by W.H. Dalton, published in 1882 and 1883.

Mr J.W. Gardner, C.B.E. (Land Agent) has been responsible for negotiating access to land for drilling. The ready cooperation of landowners 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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The geological maps of the Institute of Geological Sciences, pre-existing borehole information, and 64 boreholes drilled for the Mineral Assessment Unit form the basis of the assessment of sand and gravel resources of the country west of Colchester, 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 1:25 000 map is divided into resource blocks containing between 3.2 and 12.6 km^2 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 are 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 92. 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 64 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 Colchester, Essex.

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

La carte 1:25 000 est divisée en blocs de ressources, contenants entre 3.2 à 12.6 km^2 de sable et de gravier. On donne pour chaque bloc l'étendue minéralisée, l'épaisseur moyenne de recouvrement et de mineral, et la gradation moyenne. On décrit aussi 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 montrées sur la carte TL 92. Des données détaillées des trous de sonde sont presentées.

Zusammenfassung

Die geologischen Karten von der Institute of Geological Sciences, die vorher existierende Information im Bezug auf Bohrlöchern, auch 64 Bohrlocher, die für das Mineral Assessment Unit, bilden den Grund für die Einschatzung der Sand-und Schottermittel im Colchester Gebiet, Essex.

Man hat im gebiet alle Ablagerungen, die möglich bearbeitbar für Sand und Shotter (Mineral) sind, geologisch untersucht, und man hat eine einfache statistische Methode benutzt, um das Volumen zu schätzen. Man gibt die Zuverlässigkeit der Volumenschatzungen mit 95 Prozent Vertrauens grenzwerten.

Man teilt die 1:25 000 Karte in Mittelsblocke, wovon jeder von 3.2 bis zu 12.6 km^2 von Sand und Schotter einschliesst. Für jeden Block gibt man das mineral haltige Gebiet, die Durchschmittsdicke von Überlastung und Mineral, und die Durchschnittsklassifizierung, und beschreibt die Geomorphologie und Geologie der Ablagerungen.

Man zeigt die Lage von Bohrlöchern und Aufschlüssen die Geologie und Topographie, und auch die Skizzen von den Blöcken auf der Begleitkarte TL 92. Man gibt auch ausführliche Bohrlöcherdaten.

The sand and gravel resources of the country west of Colchester, Essex

Description of 1:25 000 resource sheet TL 92

J. D. AMBROSE[1], BSc

Introduction

AIMS AND LIMITATIONS

National resources of many of the 'bulk' or 'industrial' minerals may seem so large that stocktaking 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) and is being undertaken 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, p. 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.

> 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

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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 shown 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 glacial 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 unbiased 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 Colchester 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 (27-45 kg). The grading procedure is based on BS 1377: 1967 (Anon., 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 are taken from the one-inch 'Old Series' geological maps of the area. Most of the 1:25 000 sheet TL 92 falls on O.S. Sheet 48 S.W., published in 1883; the extreme northern part is shown on Sheet 48 N.W., published in 1882. 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. In the light of both borehole data and field investigations some of the original geological lines have been remapped by the author and incorporated into the resource map.

Nevertheless, it is inevitable, particularly with glacial deposits (such as those included in this area) which change rapidly vertically and laterally, that local irregularities and discrepancies will be revealed by some boreholes (for example, at boreholes SE 8 and NE 65). These are taken into account in the assessment of resources.

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 92 is subdivided into areas where it outcrops, and areas where it is present beneath overburden. The whole area of exposed sand and gravel as mapped is considered as mineral, although there are parts where sand and gravel is absent or 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. Both categories have been recognised on the present sheet.

Areas where bedrock outcrops, 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. 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 92

GENERAL

This resource sheet covers a mainly agricultural part of north-east Essex, but includes the western half of the town of Colchester. The area is situated approximately 70 miles north-east of London and is crossed by the main railway line and one of the trunk roads leading to East Anglia and the East Coast.

The built-up area of Colchester, amounting to 9.4 km^2, has been excluded from the assessment of resources and the remaining 90.6 km^2 has been divided into seven resource blocks containing a total area of mineral of about 62 km^2.

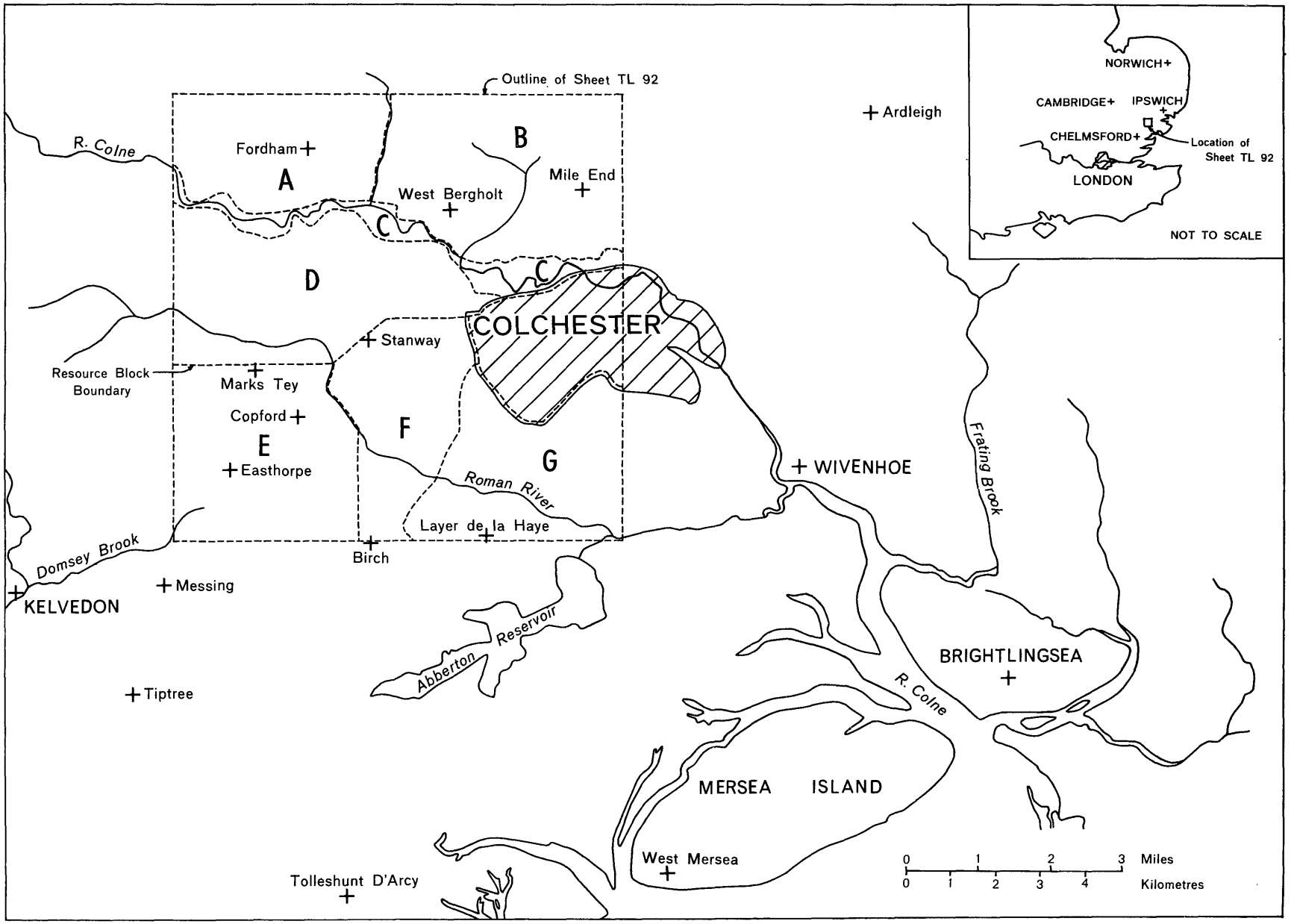


Fig. 1. Sketch map showing the location of sheet TL 92 and the position of the resource block boundaries

TOPOGRAPHY

The area consists of a plateau which slopes gently from north-west to south-east. It has been dissected by two rivers: the broad, asymetric valley of the River Colne runs from west to east across the northern part of the sheet and the narrower, steeper valley of the Roman River runs north-westward across the southern part.

In the extreme north, the plateau lies mainly at heights of between 150 ft (45.7 m) and 200 ft (61.0 m) above O.D. and attains a maximum of over 225 ft (68.6 m) in the north-west near Fordham. It slopes gently towards the River Colne and is divided into three by two southward flowing tributaries.

The southern slopes of the Colne valley are steeper than those to the north, and no major tributaries flow into the main valley from the south. The plateau in the south has a maximum height of over 175 ft (53.3 m) west of Aldham, but elsewhere it is mainly between 100 ft (30.5 m) and 150 ft (45.7 m), except where dissected by the Roman River and its few short tributaries.

GEOLOGY

The geological lines shown on the 1:25 000 resource sheet are based on the Old Series one-inch geological quarter sheets 48 SW and 48 NW, which were surveyed at that scale by W.H. Dalton and published in 1883 and 1882 respectively. The relevant memoirs were published in 1880 and 1885 (Dalton, 1880; Whitaker, 1885).

During the resource survey information from borehole results and field investigations, including mapping, has led to the incorporation of slight amendments to some of the geological lines on the resource map. The classification of the deposits has also been slightly amended (see Table 1).

Table 1. Geological classification

DRIFT - RECENT AND PLEISTOCENE

- Alluvium
- River Brickearth
- River Terrace Deposits
- Loam or Brickearth (Glacial or post-Glacial)
- Chalky Boulder Clay
- Glacial Sand and Gravel

SOLID - EOCENE

- London Clay

The Lower London Tertiaries and the Chalk have been proved in deep boreholes, but are nowhere present at the surface.

London Clay

Over the whole of the sheet London Clay forms the bedrock on which the drift deposits lie. The Old Series geological map shows it to be exposed mainly in the valleys and in an embayment in the Eight Ash Green area. When fresh, the London Clay is a stiff, bluish-grey, silty clay but it weathers at outcrop to brown. Where the clay is concealed beneath cover, boreholes commonly prove fresh, bluish-grey clay after only a few feet of brown, weathered clay, as for example in boreholes NE 65 and NE 66.

Recent field investigation has shown that patches of clayey and silty deposits rest on London Clay in places as noted on the resource map. It is believed that they represent a weathering product of the London Clay; where encountered in boreholes, they have been classified as ?London Clay.

The surface of the London Clay even where covered with drift, appears to be highest away from the valleys. Borehole evidence suggests that there may be drift-filled channels cut into the London Clay surface, but the wide borehole grid used during this survey has not enabled their number or extent to be determined.

Drift Deposits

A complex series of drift deposits rests on the London Clay and has been divided into Glacial Sand and Gravel, Loam and Chalky Boulder Clay. These are often difficult to recognise with certainty in boreholes because there is considerable variation in their lithology and they may grade imperceptibly into one another. The Chalky Boulder Clay and the Glacial Sand and Gravel are both parts of extensive sheets which cover much of East Anglia and Essex, but the Loam is of more localised extent.

Glacial Sand and Gravel

The Glacial Sand and Gravel, usually the basal member of the glacial sequence, rests directly on London Clay. It contains most of the mineral within the sheet area. The mineral consists normally of sandy gravels, commonly containing less than 10 per cent of fines (-1/16 mm diameter, that is, silt and clay grade material). The thickest Glacial Sand and Gravel deposits are in the parish of Stanway, to the west and south-west of Colchester, where they commonly exceed 50 ft (15.2 m). In the north and west of the sheet the deposits become considerably more patchy and the overburden thickens progressively.

The Glacial Sand and Gravel often becomes very clayey towards the top, especially in the south. In many boreholes, particularly in resource blocks F and G, the top 10 ft (3.0 m) to 15 ft (4.6 m) has been found to consist of very gravelly clays which are classified as overburden. Similar deposits are exploited in the upper parts of some of the working pits, for example, at Stanway [951 238][1], and the term 'hoggin' is used to describe them. Similar clayey gravels occur elsewhere, but they are commonest in the southern part of the sheet area.

Brickearth

The deposits classified as Loam or Brickearth (mainly the former on this sheet) consist of sandy, gravelly, or silty, brown clays ranging in thickness from 7 ft (2.1 m) to over 30 ft (9.1 m), and outcrop mainly on the eastern half of the sheet. Recent field work has shown that the precise extent of these deposits at outcrop is very difficult to establish and their origin is obscure. Evidence from this and other sheets indicates that they are probably of different origin to the underlying outwash sand and gravel, which they appear to cut into, and sometimes to cut out. They may have originated, like the Chalky Boulder Clay which outcrops on the western half of the sheet, as the product of the large ice sheet which at one time covered much of East Anglia and Essex.

Deposits mapped as brickearth in the Marks Tey-Stanway area are recorded by Shackleton and Turner (1967) as lacustrine deposits of Hoxnian age. They occupy a narrow trough floored with boulder clay. Boreholes and brickpit sections at Marks Tey [910 244] show them to be a series of laminated clays, clay-muds and silts with some sand and fine gravel in places.

Chalky Boulder Clay

The Loam and the Chalky Boulder Clay, come into contact only in the area north of West Bergholt, and their junction is indistinct (see Dalton, 1880, p. 4). The thickness of boulder clay recorded in the assessment boreholes is often over 30 ft (9.1 m): several boreholes were taken to 60 ft (18.3 m) without proving the base. It is normally greyish-brown or bluish-grey, depending on the degree of weathering, and contains chalk fragments, often becoming more abundant with depth, and flint pebbles which sometimes form gravelly seams. It can be sandy, especially near the surface, and soft, silty beds have also been recorded.

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

River Terrace Deposits

The younger drift deposits are River Terrace Deposits and River Brickearth. The former are confined to narrow belts along the floor of the valley of the River Colne. No assessment boreholes have been drilled through them, but the records of pre-existing boreholes show them to be between 5 ft (1.5 m) and 10 ft (3.0 m) thick, resting directly on London Clay. The only outcrop of river brickearth in the area assessed is near Colchester [998 265], where it rests directly on London Clay.

Alluvium

Alluvium, consisting of clays and silts with varying amounts of gravel and sand, is present as discontinuous spreads in the valleys of the Colne and other rivers. In the former the alluvium may well conceal mineral but in other valleys it rests on other deposits, for example, on London Clay in the valley of the Roman River.

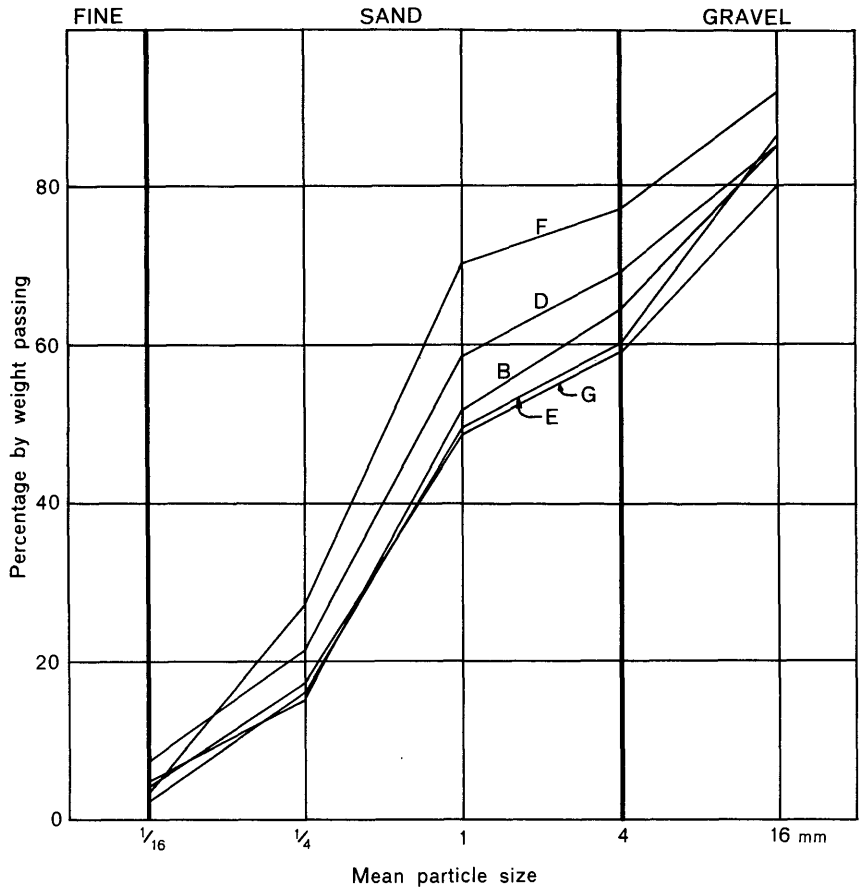
COMPOSITION OF THE SAND AND GRAVEL DEPOSITS

The mineral within this sheet area is almost entirely confined to the Glacial Sand and Gravel. Although some of the terrace deposits in block C may be potentially workable, they occupy too small an area to justify drilling resource assessment boreholes so that detailed information regarding their composition is not available; data from other boreholes has enabled the volume to be estimated.

Mean grading figures for the potentially workable Glacial Sand and Gravel deposits are fines 4 per cent, sand 64 per cent, gravel 32 per cent (for definitions of these terms see Appendix B). Almost all the mineral is classified as 'sandy gravel' except for that proved in certain boreholes in the southern part of the sheet area, where in some cases it is more gravelly and in others more sandy. The highest proportion of gravel (70 per cent) was found in borehole SE 14 whilst the highest proportion of sand (94 per cent) was in borehole SE 7. No consistent trend in the grading was identified.

The gravel fraction, consisting predominantly of flint and quartz, occasionally quartzite, is mostly fine, with subsidiary amounts of coarse grade pebbles, which are commonly subangular to subrounded in shape. Traces of chalk have been recorded in some boreholes; other rock types are rare. Cobble-size material is uncommon, being recorded in only three of the 64 assessment boreholes.

The sand fraction is predominantly of medium grade in all but a few boreholes, with varying subsidiary amounts of fine and coarse



Block	Percentage by weight passing				
	1/16 mm	1/4 mm	1mm	4mm	16mm
B	5	15	52	64	85
D	7	21	59	69	85
E	2	16	50	60	86
F	3	27	70	77	92
G	4	17	49	59	80

Fig. 2. Particle size distribution for the assessed thickness of sand and gravel in the resource blocks B, D, E, F and G.

sands. There is generally less than 10 per cent of fines. However, distinct bands of clayey material are recorded in borehole SE 6 and in many other boreholes, particularly in blocks F and G, the upper part of the Glacial Sand and Gravel is too dirty (that is, contains an excessive amount of fines) to be regarded as potentially workable but is classified as overburden or waste.

RESULTS

The statistical assessment of six resource blocks and the inferred assessment of the seventh are shown in Table 2.

Accuracy of Results

For five of the six resource blocks on sheet TL 92 which contain Glacial Sand and Gravel, the accuracy of volume estimates at the 95 per cent confidence level varies between ± 37 and ± 49 per cent; an inferred estimate is made for the sixth, block A. For the river terrace deposits of block C, the limits are ± 36 per cent. It should be remembered, however, that the true values are more likely to be near the figure quoted 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 will be required, even if the area is quite small. This point can be illustrated by considering the potentially workable Glacial Sand and Gravel of blocks B, D, E, F and G of this sheet, the volume (330.6 million m^3) of which can be estimated to limits of ± 23 per cent at the 95 per cent confidence level, using data from 57 sample-points spread across these blocks. The 7.4 million m^3 of terrace gravels in block C and the inferred volume of 15 million m^3 in block A are not included in this total.

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 A TO G

Block A

The main outcrops of Glacial Sand and Gravel are in the west near Rose Green [903 283] and in the valley west and south-west of Fordham [928 286]; smaller patches are mapped to the south and east of Fordham Hall [927 280]. In these areas the junction with the underlying London Clay can be traced, but elsewhere boulder clay is more extensive than the Glacial Sand and Gravel and rests directly on London Clay. Where this occurs the limit of the sand and gravel beneath cover has been inferred.

Potentially workable sand and gravel (mineral) was proved only in one, NW 9, of the nine assessment boreholes. The uppermost 12 ft (3.7 m) of the 30 ft (9.1 m) of Glacial Sand and Gravel in this borehole (the only hole drilled on exposed Glacial Sand and Gravel) was classified in the field as not potentially workable due to excessive fines content. In five of the remaining eight boreholes Glacial Sand and Gravel was present but is not classified as potentially workable as the overburden ratio is in excess of 3:1. The thickness of the sand and gravel in these five holes ranges from 6 ft (1.8 m) in NW 13 to 13 ft (4.0 m) in NW 18. In two of these, NW 12 and NW 18, parts of the sand and gravel were considered to contain more than 40 per cent of fines. The overburden, mainly Chalky Boulder Clay, varies in thickness from 11 ft (3.4 m) in NW 18 to 35 ft (10.7 m) in NW 17. Of the remaining Mineral Assessment Unit boreholes, NW 21 was terminated after 60 ft (18.3 m) of boulder clay had been proved, and in both NW 14 and NW 22 boulder clay was proved to rest directly on London Clay.

The only other information is in the record of a well [9279 2856] at Fordham, 223/20, (Sayer, Harvey and others, 1965) which shows 12 ft (3.7 m) of boulder clay on 14 ft (4.3 m) of sand and gravel. Because so much of the Glacial Sand and Gravel proved in boreholes has been found to be not potentially workable, the estimate of the volume of mineral in the block has been inferred. Assuming an area of 6 km^2, and an estimated mean thickness of about 2.5 m, the volume estimated obtained is 15 million m^3.

Block B

The mineral in this block occurs within the deposits mapped as Glacial Sand and Gravel which outcrop mainly on the sides of valleys of the River Colne and its tributaries. The junction between Glacial Sand and Gravel and London Clay is concealed by Loam only to the north-east of West Bergholt [965 287], in the Horkesley Heath area [979 292] and in the extreme east near the mental hospital [998 285].

Fourteen assessment boreholes, two Hydrogeological Department records, and 18 commercial drilling records form the basis of the assessment of resources in the block. The

Table 2. The sand and gravel resources of sheet TL 92

Statistical assessment: Glacial Sand and Gravel

Block	Area		Mean thickness		Volume of Sand and Gravel				Mean grading percentages		
	Block	Sand and gravel	Over-burden	Mineral	million	million	Limits at 95% confidence level		Fines -1/16 mm	Sand +1/16-4 mm	Gravel +4 mm
	km^2	km^2	m ft	m ft	m^3	yd^3	±%	± Vol million m^3			
B	19.7	12.6	5.6 18.5	2.8 9	35.3	46.2	43	15.2	5	59	36
D	16.7	7.9	3.7 12	3.9 13	30.8	40.3	42	16.9	7	62	31
E	15.1	11.9	6.8 22.5	7.0 23	83.3	109.0	42	35.0	2	58	40
F	10.8	9.7	3.8 12.5	12.1 39.5	117.4	153.5	37	43.4	3	74	23
G	13.1	11.2	3.3 11	5.7 18.5	63.8	83.5	49	31.3	4	55	41
Total	75.4	53.3			330.6	432.5	23	99.5			

Statistical assessment: terrace gravels

C	3.2	3.2	0.7 2.5	2.3 7.5	7.4	9.6	36	2.7	unknown

Inferred assessment for Glacial Sand and Gravel not included above

A	12.0	c.6.0	0.0 -	c.2.5 8	c.15	c.20	speculative	grading available for borehole NW 9 only

maximum thickness of mineral recorded is 27 ft (8.2 m) and the minimum 3 ft (0.9 m) with a mean of 11.5 ft (3.5 m), the corresponding overburden figures being 26 ft (7.9 m), 1 ft (0.3 m) and 7 ft (2.2 m).

The mineral-bearing ground is separated into two by the valley of St Botolph's Brook and Black Brook, in which London Clay, with occasional patches of clayey drift, are recorded. These deposits are also recorded in borehole NE 69 and in some of the boreholes drilled along the line of the proposed Colchester northern by-pass. To the west of the valley, boulder clay and Loam cover much of the area and three of the six assessment boreholes drilled through these deposits proved potentially workable sand and gravel to be absent, indicating that it is discontinuous and patchy beneath the cover. Two of these boreholes, NE 70 and NE 71, passed through Loam into London Clay. In the third, NE 64, brown clay, probably boulder clay, becoming gravelly and then silty downwards was recorded, the gravelly section probably representing Glacial Sand and Gravel. One borehole, NE 63, was terminated in boulder clay, at 60 ft (18.3 m). The two holes in which mineral was found, NE 67 and NE 68, proved thicknesses of 9 ft (2.7 m) and 14 ft (4.3 m) respectively. The overburden thickness in the former was 26 ft (7.9 m), of which the bottom 10 ft (3.0 m) was dirty sand and gravel not considered potentially workable, and in the latter it was 15 ft (4.6 m). Two further assessment boreholes, NW 25 and NE 65 were drilled on exposed Glacial Sand and Gravel, the top of which in both was too dirty to be classified as potentially workable. In NW 25 the uppermost 9 ft (2.7 m) was considered to fall into this category, whilst in NE 65, 24 ft (7.3 m) of 'non-mineral' sand and gravel was recorded beneath 8 ft (2.4 m) of clay, the latter being an isolated patch of drift which has not been shown on the geological map due to its apparently very limited extent.

To the east of the Black Brook valley mineral is probably more continuous than to the west, having been proved in four of the five assessment boreholes drilled. In the exception, NE 75, 12 ft (3.7 m) of Glacial Sand and Gravel recorded was considered to be not potentially workable due to excess fines and an excessive overburden ratio. Overburden was present in the other four holes; in NE 72 it consisted of sand and gravel not

considered potentially workable.

The limit of the mineral-bearing deposit is well defined, as the edge of the Glacial Sand and Gravel outcrop is concealed extensively only in the extreme east where information from site investigation boreholes drilled for the Colchester northern by-pass is available to assist in delimiting the extent of the mineral beneath cover.

The calculated volume of mineral in this block is 35.3 million m^3 ± 43 per cent and the mean grading is fines 5 per cent, sand 59 per cent, gravel 36 per cent. All the individual borehole grading figures lie close to the mean.

Block C

No assessment boreholes have been drilled in this block but the evidence of the Hydrogeological Department and commercial records has enabled an assessment to be made of the 3.2 km^2 of terrace and alluvial deposits which floor the valley of the River Colne.

In the west, near Fordstreet, 2.5 ft (0.8 m) of topsoil overlying just over 4.5 ft (1.4 m) of gravel is recorded in borehole 223/74. Farther east another Hydrogeological Department record, 223/71, shows 3 ft (0.9 m) of soil and loamy gravel on 6.5 ft (2.0 m) of gravel and sandy gravel and in the extreme east the log of borehole 224/94 records 2 ft (0.6 m) of brown clay and gravel on 10 ft (3.0 m) of sand and gravel. Further information is provided by boreholes drilled north of Lexden during site investigations for the Colchester northern by-pass, which show that between 7 ft (2.1 m) and 10 ft (3.0 m) of sand and gravel is overlain by 1 ft (0.3 m) to 5 ft (1.5 m) of overburden, mainly soil and alluvium. In general, therefore, the sand and gravel in this block probably increases from about 5 ft (1.5 m) thick in the west to over 10 ft (3.0 m) in the east, normally with less than 5 ft (1.5 m) of overburden.

The calculated volume of sand and gravel in the block is 7.4 million m^3 ± 36 per cent. The lithological descriptions of these deposits suggest that they may well be potentially workable, although no grading information is available.

Block D

The geological map shows that the outcrop of the Glacial Sand and Gravel in this block is irregular. These deposits occur mainly beneath boulder clay in the west, but in the east there are isolated patches exposed. London Clay is exposed mainly along the valley of the River Colne and south-westwards from the Colne valley, through the Eight Ash Green area, towards Marks Tey. Field evidence and the records of such boreholes as NW 15 and NW 26 show that in places patches of clayey drift, none of which contains potentially workable sand and gravel, rest on London Clay. Although they have not been mapped, their occurrence is noted on the resource map.

Mineral was proved in six of the twelve assessment boreholes; Glacial Sand and Gravel was recorded in a seventh borehole, NE 66, but was too dirty to be considered potentially workable. The thickness of mineral ranges between 10 ft (3.0 m) and 26 ft (7.9 m) with a mean of 17 ft (5.2 m). It is distributed irregularly and in the west, where only two boreholes have proved mineral beneath the boulder clay cover, the deposit has been classified as 'discontinuous spreads of mineral beneath overburden'.

The overburden has also been found to be variable both in thickness and composition. In the west boulder clay constitutes the main cover. Although borehole records have shown it to be normally less than 15 ft (4.6 m) thick, it thickens westwards where borehole NW 10 was terminated at 60 ft (18.3 m) in Chalky Boulder Clay. Other types of overburden include Loam (8 ft (2.4 m) in borehole NW 27) and sand and gravel not considered mineral (9 ft (2.7 m) in NW 19).

In the extreme south the brickearth is regarded by Shackleton and Turner (1967) as a series of lacustrine deposits. Although no assessment boreholes have been put down in this area, evidence from other boreholes indicates the presence of a depression containing a variable sequence of silts, clays and gravels, sporadically underlain by boulder clay. The thickness of sand and gravel recorded in boreholes in the area ranges from less than 3 ft (0.9 m) to over 30 ft (9.1 m) and the limited data available suggests that in the west near Marks Tey [916 238] the sand and gravel is commonly in excess of 20 ft (6.1 m) thick; in the east, near Stanway [935 242], it is often completely absent. A very approximate limit to the likely mineral-bearing ground, from a point near Marks Tey [921 243] to a point south of Stanway [932 235], has been inferred.

The mean grading figures for the block, using the results from the six assessment boreholes in which mineral was proved, are fines 7 per cent, sand 62 per cent, gravel 31 per cent. Boreholes NW 23 and NW 27 showed a higher proportion of gravel than the mean, 42 per cent and 61 per cent respectively, and borehole SW 87 contained a higher proportion of sand, 74 per cent, than the mean.

The total volume of mineral in the block is estimated to be 30.8 million m^3 ± 42 per cent.

Block E

The mineral-bearing deposit in this block is Glacial Sand and Gravel which, being concealed beneath Chalky Boulder Clay over most of the block, is exposed only in the extreme east where it rests on the London Clay in the middle slopes of the valleys of the Roman River and its tributaries. Besides isolated patches of Glacial Sand and Gravel (for example, at Copford Green [927 225]), the only other deposits mapped in the block are a thin strip of alluvium in the valley of Domsey Brook in the west and the margin of the spread of Brickearth already described in block D to the north.

Of the 13 assessment boreholes drilled in the block, six did not prove mineral and four of these are situated together in the south-west. The records of boreholes SW 71 and SW 74 show boulder clay resting directly on London Clay; SW 70 was stopped at 60 ft (18.3 m) when still in boulder clay. Borehole SW 77 showed 34 ft (10.4 m) of boulder clay resting on 11 ft (3.4 m) of sandy silty clay with gravel which may be Glacial Sand and Gravel but is too dirty to be potentially workable; the overburden ratio is also slightly greater than the 3:1 limit. The barren area consequently shown on the resource map is continuous with those outlined on adjacent sheets (Ambrose, 1973; Haggard, 1972). Sand and gravel was also not present in boreholes SW 75 and SW 80; in both boulder clay rests on London Clay.

The thickness of mineral recorded in the remaining seven boreholes ranges from 15 ft (4.6 m) in SW 86 and SW 79 to 36 ft (11.0 m) in SW 76 and SW 81, the mean being 25.5 ft (7.8 m). Overburden thicknesses range from 10 ft (3.0 m) in SW 73 to 52 ft (15.9 m) in SW 78, also with a mean of about 25 ft (7.6 m). The overburden is normally boulder clay, but in boreholes SW 76 and SW 79 the uppermost 14 ft (4.3 m) and 9 ft (2.7 m) respectively of the Glacial Sand and Gravel deposits are so dirty that they are classified as overburden.

The mean grading for this block is fines 2 per cent, sand 58 per cent, gravel 40 per cent. In boreholes SW 73 and SW 76 the proportion of gravel, 51 per cent and 58 per cent respectively, was higher than the mean and the mineral was also thicker than the mean. In boreholes SW 78, SW 79, and SW 81 the sand content was notably higher than the mean. The mineral contained more than 10 per cent of fines only in borehole SW 86.

The total volume of mineral is estimated to be 83.3 million m^3 ± 42 per cent.

Block F

In this block Glacial Sand and Gravel is exposed, together with London Clay in the valleys of the Roman River and its tributaries, two patches of Loam (in the extreme north and south-east of Stanway), a small patch of boulder clay on the valley side south of Stanway [936 231] and two very small outcrops of alluvium in the valley of the Roman River.

Seven assessment boreholes, two Hydrogeological Department records, and over 50 commercial records were used in the assessment of resources in this block. Only one assessment borehole (SW 82) did not prove mineral; it was stopped at 60 ft (18.3 m) having proved clays, clayey gravels and silty clay, probably representing Loam, Glacial Sand and Gravel, and London Clay, respectively.

The evidence from the remaining assessment boreholes shows the mean thickness of mineral to be 36.5 ft (11.1 m), which is thicker than the mean in the other resource blocks on the sheet. Boreholes often record over 50 ft (15.2 m) of mineral, the thickest being in borehole SE 5 which was terminated at 77 ft (23.5 m) whilst still in sand and gravel.

Although Glacial Sand and Gravel outcrops over much of this block, borehole evidence and field investigations have shown that the upper part of this deposit is usually very clayey and for assessment purposes must be classified as overburden. For example, the top 7 ft (2.1 m) of Glacial Sand and Gravel in SW 84, 13 ft (4.0 m) in SW 85 and 14 ft (4.3 m) in SE 5 are regarded as overburden. However, the fines content of this dirty sand and gravel is variable, as is shown by borehole SE 6 and the current workings in a pit at Stanway [951 238]. Other overburden encountered in the block includes 22 ft (6.7 m) of Loam in borehole SW 83, and 10 ft (3.0 m) of clay in borehole SE 7 which, on field evidence, can only be assumed to be part of the Glacial Sand and Gravel sequence.

The range in thickness of the overburden found in the boreholes is from 7 ft (2.1 m) in SW 84 to 25 ft (7.6 m) in SW 83, with a mean of 15 ft (4.6 m).

The mean grading figures for the mineral in the block are fines 3 per cent, sand 74 per cent, gravel 23 per cent. The highest percentage of gravel recorded is in borehole SE 5, where the 63 ft (19.2 m) of mineral had a mean gravel content of 34 per cent, whereas the 21 ft (6.4 m) of mineral in borehole SE 7 contained 94 per cent of sand. In assessment borehole SE 6 there are two beds of clayey waste, each 3 ft (0.9 m) thick, dividing the mineral into sections 9 ft (2.7 m), 6 ft (1.8 m) and 36 ft

(11.0 m) thick. The content of fines within the mineral is otherwise never greater than 5 per cent.

The total volume of mineral in the block is estimated to be 117.4 million m^3 ± 37 per cent.

Block G

As in block F, this block is occupied mainly by exposed Glacial Sand and Gravel resting on London Clay, which is exposed in the floors of the valleys. Loam is present in two adjacent spreads in the north, on the outskirts of Colchester, and in two small patches in the south near Layer-de-la-Haye [960 208 and 976 206]; narrow, sinuous bands of clayey alluvium, without sand and gravel, occupy some of the valleys.

The assessment of resources is based on information from nine assessment boreholes, two Hydrogeological Department records, and over 50 commercial records. Although Glacial Sand and Gravel is present over much of the block, only six of the eight assessment boreholes sited on this deposit proved mineral. In these six boreholes the thickness of mineral ranges from 9 ft (2.7 m) in SE 12 to 27 ft (8.2 m) in SE 13 with a mean of 18 ft (5.5 m). In two other boreholes, SE 10 and SE 16, the Glacial Sand and Gravel is too dirty to be classified as potentially workable.

Overburden thicknesses in the mineral-bearing boreholes range up to 21 ft (6.4 m) of clay and clayey Glacial Sand and Gravel in SE 8, the mean being 9.5 ft (2.9 m). The overburden in SE 13 is Loam but in boreholes SE 11, SE 14 and SE 15 is dirty Glacial Sand and Gravel; field investigations suggest that this is also the case in SE 8, in which the uppermost 21 ft (6.4 m), including 11 ft (3.4 m) recorded as 'brown clay', is part of the Glacial Sand and Gravel.

The mean grading figures for the block are fines 4 per cent, sand 55 per cent, gravel 41 per cent. The highest percentages of gravel are recorded in boreholes SE 11 and SE 14 with 67 per cent and 70 per cent respectively. In contrast, in borehole SE 13 the mineral contained 78 per cent of sand. Although a band of pale green clay (waste) was recorded between 2.1 m (7 ft) and 2.8 m (9 ft) in borehole SE 14, the mineral in all boreholes contained less than 10 per cent of fines.

The total volume of mineral in the block is estimated to be 63.8 million m^3 ± 49 per cent.

LIST OF QUARRIES

A list of sand and gravel pits, both operational and abandoned, known to exist on this sheet area is given in Table 3, together with their locations.

Table 3. List of quarries on sheet TL 92 and their locations

Working	Location
Warren Lane, Stanway	950 238
Shrub End	968 232
Bellhouse Farm (opened 1972, not shown on map)	947 223
Abandoned	
Wash Farm Pit	917 273

References

ALLEN, V.T. 1936. Terminology of medium-grained sediments. Rep. Natn. Res. Counc. Washington 1935-36, App. 1, Rep. Comm. Sedim., pp. 18-47.

AMBROSE, J.D. 1973. The sand and gravel resources of the country around Layer Breton and Tolleshunt D'Arcy, Essex; Description of 1:25 000 resource sheet TL 91 and part of TL 90. Rep. Inst. Geol. Sci., No. 73/8. 34 pp.

ANON. 1948. Mineral Resources of the United States. Bur. M. Geol. Surv. (Washington, D.C.: Public Affairs Press) pp. 14-17.

——— 1967. Methods of testing soils for civil engineering purposes. Br. Stand. No. 1377, 233 pp.

——— 1970. Metrication: two opposing views. Quarry Mgrs' J., Vol. 54, No. 6, p. 230.

ARCHER, A.A. 1969. Background and problems of an assessment of sand and gravel resources in the United Kingdom. Proc. 9th Commonw. Min. metall. Congr. 1969. Vol. 2, Mining and Petroleum Geology. Pp. 495-508 (London: the Institution of Mining and Metallurgy).

——————— 1970a. Standardisation of the size classification of naturally occurring particles. Geotechnique, Vol. 20, pp. 105-107.

——————— 1970b. Making the most of metrication. Quarry Mgrs' J., Vol. 54, No. 6, pp. 223-227.

ATTERBERG, A. 1905. Die rationelle Klassifikation der Sande und Kiese Chem. Z., Vol. 29, pp. 195-198.

DALTON, W.H. 1880. The geology of the neighbourhood of Colchester. Mem. Geol. Surv. G.B.

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. Inst. Geol. Sci. No. 72/6. 90 pp.

LANE, E.W. and others. 1947. Report of the sub-committee on sediment terminology. Trans. Am. Geophys. Un., Vol. 28, pp. 936-938.

PETTIJOHN, F.J. 1957. Sedimentary Rocks. 2nd Ed. (London: Harper and Row).

SAYER, A.R., HARVEY, B.I. and others. 1965. Records of wells in the area of New Series one-inch (Geological) Great Dunmow (222) and Braintree (223) sheets. Water Supply Pap. Geol. Surv., Well Cat. Ser.

SHACKLETON, N.J. and TURNER, C. 1967. Correlation between marine and terrestrial Pleistocene successions. Nature, Vol. 216, pp. 1079-1082.

THURRELL, R.G. 1971. The assessment of mineral resources with particular reference to sand and gravel. Quarry Mgrs' J., Vol. 55, pp. 19-25.

TWENHOFEL, W.H. 1937. Terminology of the fine-grained mechanical sediments. Rep. Natn. Res. Coun. Washington 1936-37, App. 1, Rep. Comm. Sedim. pp. 81-104.

UDDEN, J.A. 1914. Mechanical composition of clastic sediments. Bull. Geol. Soc. Am., Vol. 25, pp. 655-744.

WENTWORTH, C.K. 1922. A scale of grade and class terms for clastic sediments. J. Geol., Vol. 30, pp. 377-392.

——————— 1935. The terminology of coarse sediments. Bull. No. 98, Natn. Res. Coun., Washington, pp. 225-246.

WHITTAKER, W. 1885. The Geology of the country around Ipswich, Hadleigh and Felixstowe. Mem. Geol. Surv. G.B.

WILLMAN, H.B. 1942. Geology and mineral resources of the Marseilles, Ottawa and Streatar quadrangles. Bull. No. 66, I11. State Geol. Surv., pp. 343-344.

Appendix A: Assessment Procedure

1. Within a resource block, a statistical assessment is made for a sampled area of mineral greater than 2 km^2 and containing a minimum of five evenly-spaced boreholes.

2. If the sampled area of mineral is between 0.25 and 2 km^2 and contains one or two suitably sited boreholes an inferred assessment is made. An inferred assessment may also be attempted for any area where the deduced mineral content is small and which consequently has not been sampled by boreholes. No specific level of accuracy is claimed for such subjective assessments.

3. No assessment is attempted for an area of mineral less than 0.25 km^2.

Statistical Assessment

4. 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 result falls) are calculated at the two-sided 95 per cent confidence level, that is, there is a $2\frac{1}{2}$ per cent or 1 in 40 chance that the result exceeds the stated upper limit and a corresponding $2\frac{1}{2}$ per cent chance that it is less than the stated lower limit.

5. The volume estimate (V) for the sampled mineral in a given block is the product of the two variables, the sampled areas (A) and the mean thickness ($\bar{l}$) calculated from the individual thicknesses at the sample points. The standard deviations for these variables are related such that

$$S_V = \sqrt{S_A^2 + S_{\bar{l}}^2} \quad \ldots\ldots\ldots (1)$$

where S_V, S_A and $S_{\bar{l}}$ are the standard deviations for volume, area and mean thickness, expressed as proportions of V, A and $\bar{l}$, respectively.

6. The above relationship may be transposed such that

$$S_V = S_{\bar{l}} \sqrt{\left[1 + \left(\frac{S_A^2}{S_{\bar{l}}}\right)\right]} \quad \ldots\ldots\ldots (2)$$

From this it can be seen that as $\left(\frac{S_A}{S_{\bar{l}}}\right)$ tends to 0, S_V tends to $S_{\bar{l}}$. If, therefore, the standard deviation for area is small with respect to that for mean thickness, the standard deviation for volume approximates to that for mean thickness.

7. Given that the number of approximately evenly spaced sample points in the sampled area is n, with mineral thickness measurements l_1, l_2, ... l_n, then the best estimate of mean thickness, $\bar{l}$ = $\frac{\sum(l_1 + l_2 \ldots l_n)}{n}$

For groups of closely spaced boreholes a discretionary weighting factor may be applied to avoid bias (see note on weighting below). The standard deviation for mean thickness, $S_{\bar{l}}$ expressed as a proportion of the mean thickness is given by

$$S_{\bar{l}} = \frac{1}{\bar{l}} \sqrt{\frac{\sum(l - \bar{l})^2}{(n - 1)}}$$ where l is any value in the series l_1 to l_n.

8. The sampled area A in each resource block is coloured pink on the map. Wherever possible, calculations relate to the mineral within mapped geological boundaries (which may not necessarily correspond to the limits of a deposit). Generally, therefore, the only error in determining the area is the negligible planimetering error and S_A is 0. Where the area is not defined by a mapped boundary, that is, where the boundary is inferred (and the distinctive symbol is used), experience suggests that S_A is small relative to $S_{\bar{l}}$.

The relationship

$$\frac{S_A}{S_{\bar{l}}} \leqslant \frac{1}{3}$$ is assumed in all cases.

It follows from equation (2) that

$$S_{\bar{l}} \leqslant S_V \leqslant 1.05\, S_{\bar{l}} \quad \ldots\ldots\ldots (3)$$

9. The two-sided 95 per cent confidence limits, $L_{\bar{l}}$, for the estimate of mean thickness of mineral in the sampled area, for values of n between 5 and 20, may be expressed in absolute units.

$$\bar{l} \pm (t \times S_{\bar{l}} \times \bar{l}),$$

or as a percentage

$$\bar{l} \pm (t \times S_{\bar{l}} \times 100) \text{ per cent}$$

where t is Student's t at the two-sided 95 per cent confidence level for (n - 1) degrees of freedom and is evaluated by reference to statistical tables. In applying Student's t it is assumed that the measurements are distributed normally.

10. Values of t at the two-sided 95 per cent confidence level for values of n up to 20 are set out below:

BLOCK CALCULATION

1:25 000 Sheet } Fictitious
Block }

Area

Block: 11.08 km^2
Mineral: 8.32 km^2

Thickness

Overburden: 2.5 m
Mineral: 4.5 m

Volume

Overburden: 21 million m^3
Mineral: 38 million m^3

95 per cent confidence limits of the estimate of mineral volume

Percentage: ± 55 per cent
Units of volume: ± 20 million m^3

Thickness estimate (l = thickness)
Measurements in metres

Sample point	Weighting w	Overburden lo	Overburden wlo	Mineral lm	Mineral wlm	Remarks
SE 14	1	1.5	1.5	5.2	5.2	MAU 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	
SE 17	½	1.2	1.6	4.2	3.9	
123/45	½	2.0		3.6		Hydrogeol. Dept. record
1	¼	2.4	2.5(25)*	3.4	3.6(25)*	Close group of four boreholes (commercial)
2	¼	4.5		0.8		
4	¼	0.4		4.3		
5	¼	2.8		6.0		
Totals	∑w = 8		∑wlo = 20.1(25)*		∑wlm = 36.3(25)*	
Averages			$\bar{l}o$ = 2.5(16)*		$\bar{l}m$ = 4.5(41)*	

Calculation of Confidence Limits

l	$(l - \bar{l})$	$(l - \bar{l})^2$
5.2	0.7	0.49
nil	4.5	20.25
2.1	2.4	5.76
9.3	4.8	23.04
5.7	1.2	1.44
6.5	2.0	4.00
3.9	0.6	0.36
3.6	0.9	0.81
∑l = 36.3 (25)		$\sum(l - \bar{l})^2$ = 56.15
n = 8		
$\bar{l}$ = 4.5 (41)		
≃ 4.5		

n = 8
t = 2.365

$$L_V = 1.05 \frac{t}{\bar{l}} \sqrt{\frac{\sum(l - \bar{l})^2}{n(n-1)}} \times 100$$

$$= 1.05 \times \frac{2.365}{4.541} \sqrt{\frac{56.15}{8 \times 7}} \times 100$$

= 54.77

≃ 55%

* The figures in brackets are additional decimal places used only in the calculation of confidence limits.

Fig. 3. Example of resource block assessment: statement and calculation

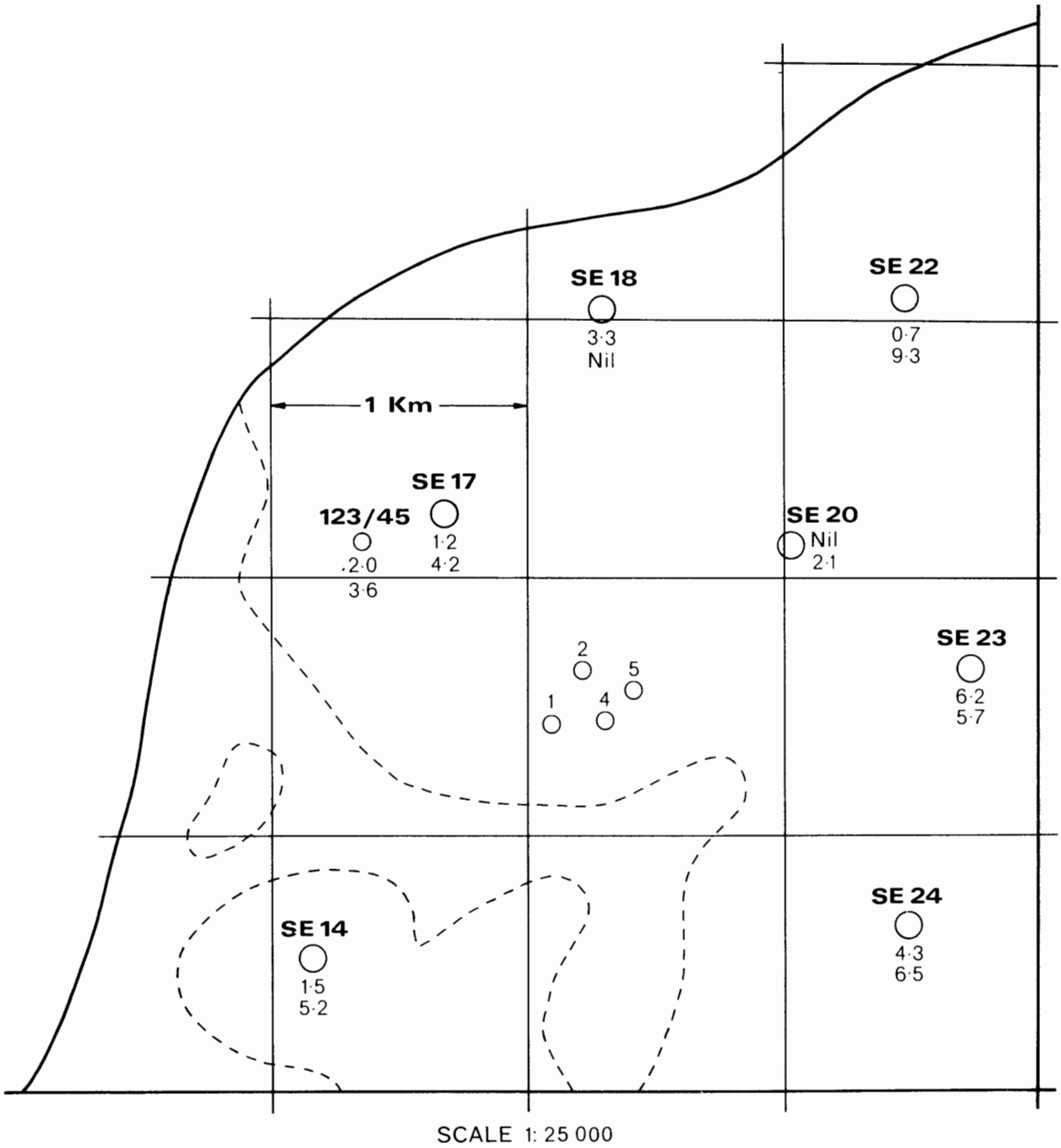


Fig. 4. Example of resource block assessment: map of a fictitious block

n	t	n	t
1	∞	11	2.228
2	12.706	12	2.201
3	4.303	13	2.179
4	3.182	14	2.160
5	2.776	15	2.145
6	2.571	16	2.131
7	2.447	17	2.120
8	2.365	18	2.110
9	2.306	19	2.101
10	2.262	20	2.093

(From Table 12, Biometrika Tables for Statisticians, Volume 1, Second Ed. Cambridge University Press, 1962).

The value of t, 1.96, when n is infinity is used when n is greater than 20.

11. In calculating the two-sided 95 per cent confidence limits for volume, L_V, the following inequality corresponding to (3) is applied:

$$L_{\bar{l}} \leqslant L_V \leqslant 1.05 \; L_{\bar{l}}$$

12. In summary, for values of n between 5 and 20, L_V is calculated as

$$\frac{1.05 \times t}{\bar{l}} \times \sqrt{\frac{\Sigma(l - \bar{l})^2}{n\,(n-1)}} \times 100 \text{ per cent}$$

and when n is greater than 20, as

$$\frac{1.05 \times 1.96}{\bar{l}} \times \sqrt{\frac{\Sigma(l - \bar{l})^2}{n\,(n-1)}} \times 100 \text{ per cent}$$

13. An illustration of the procedures outlined above is given in Figs. 3 and 4, where a volume estimate with confidence limits at the 95 per cent level of confidence is derived from fictitious data.

Inferred Assessments

14. If the sampled area of mineral in a resource block is between 0.25 km^2 and 2 km^2 an assessment is inferred based on geological and topographical information usually supported by the data from one or two suitably sited boreholes. The volume of mineral is calculated as the product of the sampled area, chosen from interpretation of field data as in the statistical assessment, and the judged average mineral thickness. Confidence limits are not calculated.

15. In some cases in addition to the sampled area of mineral a resource block includes an area left uncoloured on the map, generally based on interpretation of mapping and sample data. On occasions some mineral may be present in such areas and an assessment is made on the basis of the average mineral thickness deduced from exposures and any other evidence available.

Note on Weighting

16. The thickness of a deposit at any point in a sampled area may be governed solely by the position of the point in relation to a broad trend. However, most sand and gravel deposits in addition exhibit a random pattern of local, and sometimes considerable, variation in thickness.

17. Thus, in estimating mean thickness of sand and gravel from a number of data points in a sampled area only the use of simple weighting factors is justified, and the distribution of data points need be only approximately regular. In practice, equal weighting can often be applied to thicknesses at all data points within the sampled area. If, however, there is a distinctly unequal distribution of points, the thicknesses must be weighted to avoid the bias this creates. Weighting factors are determined by first dividing the sampled area into broad zones, to each of which a value roughly proportional to its area is assigned. This value is then shared between the data points within the zone.

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 40 per cent fines or less are classified primarily on the ratio of sand to gravel and qualified in the light of the fines content, as follows: less than 10 per cent fines—no qualification; 10 per cent or more, but less than 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 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 5). 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.21).

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 (1970a, b) 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 4, 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 boundary 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 4. Classification of gravel, sand and fines

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

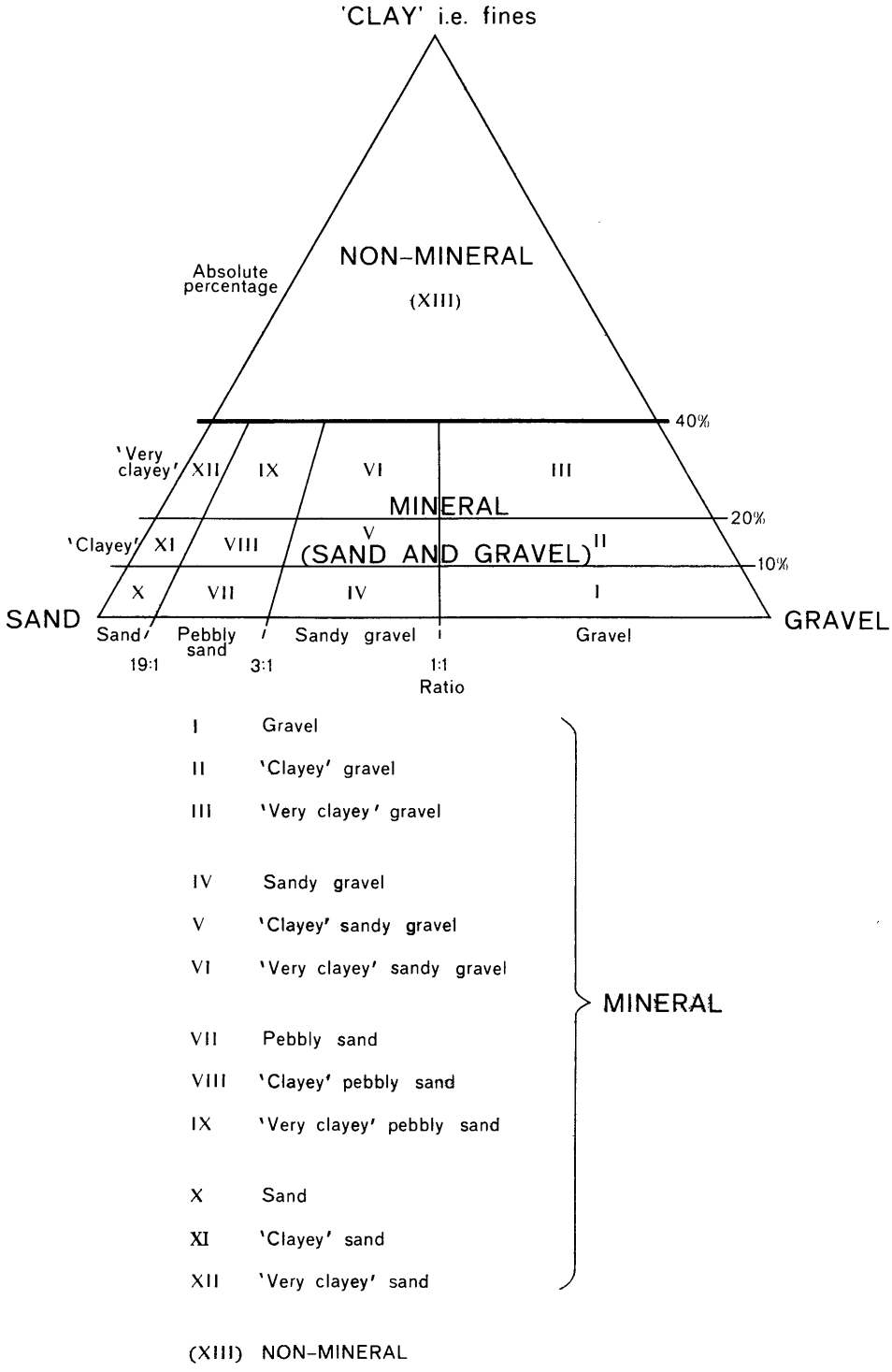


Fig. 5. Diagram showing the descriptive categories used in the classification of sand and gravel

Appendix C: Borehole Records

EXPLANATION

Annotated Example of Borehole Records

TL 92 NW 19[1] 9284 2631[2] near Bullbanks Farm Gallows Green[3]

Surface level (+44.8 m) +147 ft[4]
Water struck at (+39.3 m) +129 ft[5]
Wirth BO, 8 inch diam.[6]
September 1969

[7]Overburden (2.7 m) 9 ft
Mineral (4.9 m) 16 ft
Bedrock (0.9 m+) 3 ft+[8]

		Thickness (m)	Thickness ft	Depth[11] (m)	Depth ft
Glacial Sand[9] and Gravel	Soil and brown clay with gravel.[10]	(2.7)	9	(2.7)	9
	Sandy gravel. 'Clayey' between 12 ft (3.7 m) and 18 ft (5.5 m). Cobbles occur below 21 ft (6.4 m). Gravel: fine with coarse, subangular to subrounded flints and quartz, with occasional chalk in the top 9 ft (2.7 m). Sand: brown, chiefly medium.	(4.9)	16	(7.6)	25
London Clay	Brown, weathered clay passing down into fresh, blue clay.	(0.9+)	3+	(8.5)	28

	%	mm		%
		+64	:	1
Gravel	29[15]	-64+16	:	11
		-16+4	:	17
		-4+1	:	12
Sand	63	-1+¼	:	43
		-¼+1/16	:	8
Fines	8	-1/16	:	8

Depth below[12] surface (ft)	Percentages[13] Fines	Sand	Gravel
9 - 12	0	77	23
12 - 15	16	64	20
15 - 18	12	49	39
18 - 21	3	70	27
21 - 24	8	57	35
24 - 25	No grading available[14]		

The numbered paragraphs below correspond with the annotations given on the specimen record above.

1. Borehole Registration Number.
Each Mineral Assessment Unit (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 92.
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 19.

Thus the full Registration Number is TL 92 NW 19. Usually this is abbreviated to NW 19 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 generally 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 conversions to metres are given in brackets. The abbreviation 'c' (circa) indicates that the surface level has been estimated.

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

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

Waste is any material other than bedrock or mineral. Where waste occurs between the surface and a mineral horizon it is classified as overburden.

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.4).

10. Lithological Description.
When sand and gravel 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 relate to depths from surface to base of the strata recorded on the log.

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 or metre of depth.

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

14. Exceptionally the results of the grading of a sample or horizon may not be available. No attempt has been made to estimate the probable grading of such samples, and the grading diagram may not be shown on the map.

15. 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 mean grading figures relate to the mineral horizon(s) recognized on the log.

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

Since fully representative sampling of sand and gravel is difficult to achieve, particularly where groundwater levels are high, there may be differences between the gradings determined during the survey and the corresponding in-situ grading of the deposit. Comparison with exposures suggests that the proportion of sand in the samples collected from boreholes may be somewhat higher. Conversely the results suggest that the proportion of fines and of +16 mm material may be lower.

Note on metrication

1) Although most measurements were made in feet. some were recorded in metres. In each case conversions to metres or feet, as appropriate, appear in brackets in the logs.
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. Similarly, conversions from metres to feet have been rounded off to the nearest 0.5 ft. Where figures have been rounded in this way there may be an apparent slight discrepancy between the sum of the thicknesses and the depths as recorded.

LIST OF ASSESSMENT BOREHOLES

Borehole number by sheet quadrants	Grid Reference (all fall in 100 km square TL)	Borehole number by sheet quadrants	Grid Reference (all fall in 100 km square TL)
TL 92 NW		TL 92 SW	
8	9041 2955	70	9050 2131
9	9026 2834	71	9090 2020
10	9051 2650	72	9141 2224
11	9067 2562	73	9139 2151
12	9169 2973	74	9140 2085
13	9134 2888	75	9269 2338
14	9150 2804	76	9271 2256
15	9179 2652	77	9234 2165
16	9171 2541	78	9254 2049
17	9231 2929	79	9349 2255
18	9277 2761	80	9342 2181
19	9284 2631	81	9340 2040
20	9272 2540	82	9404 2386
21	9391 2927	83	9438 2209
22	9393 2799	84	9468 2203
23	9362 2675	85	9450 2079
24	9368 2559	86	9018 2351
25	9487 2834	87	9175 2487
26	9454 2643		
27	9458 2537	TL 92 SE	
		5	9572 2368
TL 92 NE		6	9525 2230
63	9541 2954	7	9558 2130
64	9555 2857	8	9556 2044
65	9547 2733	9	9648 2124
66	9572 2614	10	9663 2048
67	9677 2956	11	9749 2127
68	9633 2813	12	9799 2029
69	9687 2708	13	9861 2185
70	9771 2953	14	9866 2089
71	9774 2884	15	9998 2193
72	9770 2717	16	9964 2057
73	9860 2987		
74	9876 2840		
75	9854 2759		
76	9911 2919		

TL 92 NW 8 Block A 9041 2955 Near Newhouse Farm

Surface level (+c. 61.0 m) +c. 200 ft
Water struck at (+c. 51.8 m) +c. 170 ft
Wirth BO, 8 inch diam.
October 1969

Waste (12.5 m) 41 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
Chalky Boulder Clay	Soil and brown clay becoming chalky and pebbly below 11 ft (3.4 m)	(9.8)	32	(9.8)	32
Glacial Sand and Gravel	Sandy gravel. Fine and coarse, subangular to subrounded flints, and traces of subrounded quartzites, with pale to rusty-brown medium and fine sand.	(2.7)	9	(12.5)	41
London Clay	Brown, weathered clay	(0.9+)	3+	(13.4)	44

TL 92 NW 9 Block A 9026 2834 Near Rose Green

Surface level (+c. 39.6 m) +c. 130 ft
Water struck at (+c. 36.3 m) +c. 119 ft
Wirth BO, 8 inch diam.
September 1969

Overburden (3.7 m) 12 ft
Mineral (5.5 m) 18 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
Glacial Sand and Gravel	Soil and brown clay with gravel	(3.7)	12	(3.7)	12
	Gravel. 'Clayey' in the bottom half with cobbles common below 24 ft (7.3 m) Gravel: fine and coarse, subangular to subrounded flints and quartz. Traces of chalk? Sand: brown, medium with some coarse.	(5.5)	18	(9.1)	30
London Clay	Brown, weathered clay passing down into fresh, blue clay.	(0.9+)	3+	(10.1)	33

	%	mm		%	Depth below surface (ft)	Fines	Percentages Sand	Gravel
		+64	:	3	12 - 15	7	37	56
Gravel	53	-64+16	:	22	15 - 18	7	48	45
		-16+4	:	28	18 - 21	7	40	53
					21 - 24	12	31	57
		-4+1	:	13	24 - 27	9	27	64
Sand	37	-1+$\frac{1}{4}$	:	21	27 - 30	19	36	45
		-$\frac{1}{4}$+1/16	:	3				
Fines	10	-1/16	:	10				

TL 92 NW 10 Block D 9051 2650 Wick Farm

Surface level (+53.0 m) +174 ft
Water struck at (+44.2 m) +145 ft
Wirth BO, 8 inch diam.
September 1969

Waste (18.3 m+) 60 ft+

		Thickness (m)	ft	Depth (m)	ft
Chalky Boulder Clay	Soil and brown clay, becoming chalky and pebbly below 9 ft (2.7 m): grey and chalky from 29 ft (8.8 m) to 60 ft (18.3 m), with a 1 ft (0.3 m) thick brown, silty, clay band at 38 ft (11.6 m)	(18.3+)	60+	(18.3)	60

TL 92 NW 11 Block D 9067 2562 Near Hoe Farm

Surface level (+52.1 m) +171 ft
Water struck at (+47.5 m) +156 ft
Wirth BO, 8 inch diam.
September 1969

Overburden (2.7 m) 9 ft
Mineral (4.6 m) 15 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
Chalky Boulder Clay	Soil and brown, sandy clay	(2.7)	9	(2.7)	9
Glacial Sand and Gravel	Sandy gravel. The gravel content decreases downwards being almost absent in the bottom 'clayey' 3 ft (0.9 m). Gravel: mainly fine with some coarse, subangular and subrounded flints and quartz, with some subrounded chalk traces in the top 6 ft (1.8 m) Sand: brown to yellowish brown, medium, with coarse and fine down to 21 ft (6.4 m); fine and medium below.	(4.6)	15	(7.3)	24
London Clay	Brown weathered clay	(0.9+)	3+	(8.2)	27

	%	mm		%
Gravel	26	+16	:	7
		-16+4	:	19
		-4+1	:	12
Sand	65	-1+$\frac{1}{4}$	:	37
		-$\frac{1}{4}$+1/16	:	16
Fines	9	-1/16	:	9

Depth below surface (ft)	Percentages Fines	Sand	Gravel
9 - 12	8	50	42
12 - 15	7	59	34
15 - 18	8	68	24
18 - 21	7	68	25
21 - 24	17	78	5

TL 92 NW 12 Block A 9169 2973 Near Hammonds Farm

Surface level (+c. 65.5 m) +c. 215 ft
Water struck at (+c. 56.4 m) +c. 185 ft
Wirth BO, 8 inch diam.
September 1969

Waste (11.9 m) 39 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
Chalky Boulder Clay	Soil and brown clay, becoming chalky below 8 ft (2.4 m)	(8.2)	27	(8.2)	27
Glacial Sand and Gravel	Sandy gravel. 'Clayey' below 30 ft (9.1 m) Gravel: fine with coarse; subangular to subrounded flints and quartz. Sand: yellowish brown; medium.	(1.8)	6	(10.1)	33
	Gravelly clay.	(1.8)	6	(11.9)	39
London Clay	Brown, weathered clay passing down into fresh, blue clay.	(0.9+)	3+	(12.8)	42

TL 92 NW 13 Block A 9134 2888 Near 'Butts'

Surface level (+59.4 m) +195 ft
Water struck at (+52.1 m) +171 ft
Wirth BO, 8 inch diam.
September 1969

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

		Thickness (m)	ft	Depth (m)	ft
Chalky Boulder Clay	Soil and brown clay becoming chalky and pebbly below 12 ft (3.7 m)	(6.4)	21	(6.4)	21
Glacial Sand and Gravel	'Clayey' sandy gravel. Gravel: fine and coarse; subangular to subrounded flints and quartz with traces of quartzite and chalk. Sand: reddish-brown; medium, and some fine sand.	(1.8)	6	(8.2)	27
?London Clay	Silty clay passing down into grey silt below 33 ft (10.1 m)	(3.4)	11	(11.6)	38
London Clay	Brown, weathered clay passing down into fresh, blue clay.	(0.9+)	3+	(12.5)	41

TL 92 NW 14 Block A 9150 2804 Near Penlan Hall

Surface level (+41.8 m) +137 ft
Water not struck
Wirth BO, 8 inch diam.
October 1969

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

		Thickness (m)	ft	Depth (m)	ft
Chalky Boulder Clay	Soil and brown clay	(3.4)	11	(3.4)	11
?London Clay	Brown and grey, silty clay containing a few flint pebbles below 17 ft (5.2 m)	(3.0)	10	(6.4)	21
London Clay	Brown, weathered clay passing down into fresh, blue clay	(0.9+)	3+	(7.3)	24

TL 92 NW 15 Block D 9179 2652 Near Bourchier's Hall

Surface level (+26.2 m) +86 ft
Water not struck
Wirth BO, 8 inch diam.
September 1969

Waste (6.7 m) 22 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
?London Clay	Soil and brown clay becoming silty below 14 ft (4.3 m)	(6.7)	22	(6.7)	22
London Clay	Brown, weathered clay passing down into fresh, blue clay	(0.9+)	3+	(7.6)	25

TL 92 NW 16 Block D 9171 2541 North Road, Aldham

Surface level (+46.6 m) +153 ft
Water struck at (+42.4 m) +139 ft
Wirth BO, 8 inch diam.
September 1969

Waste (7.6 m) 25 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
Chalky Boulder Clay	Soil and brown, sandy clay	(4.0)	13	(4.0)	13
?London Clay	Grey silt passing into silty clay with gravel below 17 ft (5.2 m)	(3.7)	12	(7.6)	25
London Clay	Brown, weathered clay	(0.9+)	3+	(8.5)	28

TL 92 NW 17 Block A 9231 2929 Near Cattle's Barn

Surface level (+c. 54.9 m) +c. 180 ft
Water struck at (+c. 43.6 m) +c. 143 ft
Wirth BO, 8 inch diam.
October 1969

Waste (13.1 m) 43 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
Chalky Boulder Clay	Soil and brown clay with gravel becoming chalky below 8 ft (2:4 m) and passing down into brown, sandy clay at 21 ft (6.4 m)	(10.7)	35	(10.7)	35
?Glacial Sand and Gravel	Very gravelly clay	(2.4)	8	(13.1)	43
London Clay	Brown, weathered clay passing down into fresh, blue clay	(0.9+)	3+	(14.0)	46

TL 92 NW 18 Block A 9277 2761 Mill Road, Fordham

Surface level (+34.1 m) +112 ft
Water struck at (+29.6 m) +97 ft
Wirth BO, 8 inch diam.
October 1969

Waste (7.3 m) 24 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
Chalky Boulder Clay	Soil and brown, silty clay	(3.4)	11	(3.4)	11
Glacial Sand and Gravel	Very gravelly clay	(2.4)	8	(5.8)	19
	?Pebbly sand; medium and coarse sand, with fine to coarse flint gravel.	(1.5)	5	(7.3)	24
London Clay	Brown, weathered clay passing down into fresh, blue clay	(0.9+)	3+	(8.2)	27

TL 92 NW 19 Block D 9284 2631 Near Bullbanks Farm, Gallows Green

Surface level (+44.8 m) +147 ft
Water struck at (+39.3 m) +129 ft
Wirth BO, 8 inch diam.
September 1969

Overburden (2.7 m) 9 ft
Mineral (4.9 m) 16 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
Glacial Sand and Gravel	Soil and brown clay with gravel.	(2.7)	9	(2.7)	9
	Sandy gravel. 'Clayey' between 12 ft (3.7 m) and 18 ft (5.5 m). Cobbles occur below 21 ft (6.4 m) Gravel: fine with coarse, subangular to subrounded flints and quartz, with occasional chalk in the top 9 ft (2.7 m) Sand: brown, chiefly medium.	(4.9)	16	(7.6)	25
London Clay	Brown, weathered clay passing down into fresh, blue clay.	(0.9+)	3+	(8.5)	28

	%	mm		%
		+64	:	1
Gravel	29	-64+16	:	11
		-16+4	:	17
		-4+1	:	12
Sand	63	-1+$\frac{1}{4}$	:	43
		-$\frac{1}{4}$+1/16	:	8
Fines	8	-1/16	:	8

Depth below surface (ft)	Fines	Percentages Sand	Gravel
9 - 12	0	77	23
12 - 15	16	64	20
15 - 18	12	49	39
18 - 21	3	70	27
21 - 24	8	57	35
24 - 25	No grading available		

TL 92 NW 20 Block D 9272 2540 Near Chippetts Farm

Surface level (+33.2 m) +109 ft
Water struck at (+30.8 m) +101 ft
Wirth BO, 8 inch diam.
September 1969

Waste (5.8 m) 19 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
?London Clay	Soil and brown and blue silt.	(4.9)	16	(4.9)	16
	Gravelly, silty clay.	(0.9)	3	(5.8)	19
London Clay	Brown, weathered clay passing down into fresh, blue clay.	(0.9+)	3+	(6.7)	22

TL 92 NW 21 Block A 9391 2927 Place Farm

Surface level (+53.3 m) +175 ft
Water struck at (+38.7 m) +127 ft
Wirth BO, 8 inch diam.
October 1969

Waste (18.3 m+) 60 ft+

		Thickness (m)	ft	Depth (m)	ft
Chalky Boulder Clay	Soil and brown, chalky clay, with intermittent sand seams below 22 ft (6.7 m); becoming grey, chalky clay below 51 ft (15.5 m)	(18.3+)	60+	(18.3)	60

TL 92 NW 22 Block A 9393 2799 Near Kings Farm

Surface level (+25.6 m) +84 ft
Water not struck
Wirth BO, 8 inch diam.
October 1969

Waste (12.2 m) 40 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
Chalky Boulder Clay	Soil and brown clay with flint pebbles.	(3.4)	11	(3.4)	11
?London Clay	Brown clay with sandy traces.	(8.8)	29	(12.2)	40
London Clay	Brown, weathered clay, passing down into fresh, blue clay.	(0.9+)	3+	(13.1)	43

TL 92 NW 23 Block D 9362 2675 Near Little Porters Farm

Surface level (+41.5 m) +136 ft
Water not struck
Wirth BO, 8 inch diam.
September 1969

Overburden (4.9 m) 16 ft
Mineral (3.0 m) 10 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
Chalky Boulder Clay	Soil and brown, silty clay.	(4.9)	16	(4.9)	16
Glacial Sand and Gravel	'Clayey' sandy gravel Gravel: fine and coarse, subangular to subrounded flints, with subrounded quartz and occasional chalk fragments. Sand: rust brown to grey, medium with coarse.	(3.0)	10	(7.9)	26
London Clay	Brown, weathered clay.	(0.9+)	3+	(8.8)	29

	%	mm		%
Gravel	42	+16	:	19
		-16+4	:	23
		-4+1	:	14
Sand	47	-1+$\frac{1}{4}$	:	28
		-$\frac{1}{4}$+1/16	:	5
Fines	11	-1/16	:	11

Depth below surface (ft)	Fines	Percentages Sand	Gravel
16 - 19	14	40	46
19 - 22	8	51	41
22 - 25	10	48	42
25 - 26	13	50	37

TL 92 NW 24 Block D 9368 2559 Seven Star Green

Surface level (+47.5 m) +156 ft
Water struck at (+44.8 m) +147 ft
Wirth BO, 8 inch diam.
October 1969

Overburden (0.9 m) 3 ft
Mineral (7.9 m) 26 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
Glacial Sand and Gravel	Soil and brown, gravelly clay.	(0.9)	3	(0.9)	3
	Sandy gravel. 'Clayey' between 15 ft (4.6 m) and 18 ft (5.5 m) and between 21 ft (6.4 m) and 24 ft (7.3 m). Gravelly down to 15 ft (4.6 m), becoming sandy below. Trace of cobbles between 21 ft (6.4 m) and 24 ft (7.3 m) Gravel: fine and coarse, subangular to sub-rounded flints and occasional quartz. Sand: pale brown: mainly medium to 21 ft (6.4 m), medium with fine below.	(7.9)	26	(8.8)	29
London Clay	Brown, weathered clay passing down into fresh, blue clay.	(0.9+)	3+	(9.8)	32

	%	mm		%
Gravel	25	+16	:	12
		-16+4	:	13
		-4+1	:	9
Sand	69	-1+$\frac{1}{4}$	:	46
		-$\frac{1}{4}$+1/16	:	14
Fines	6	-1/16	:	6

Depth below surface (ft)	Fines	Percentages Sand	Gravel
3 - 6	2	53	45
6 - 9	1	58	41
9 - 12	2	71	27
12 - 15	8	46	46
15 - 18	13	70	17
18 - 21	6	79	15
21 - 24	11	76	11
24 - 27	1	89	10
27 - 29	9	83	8

TL 92 NW 25 Block B 9487 2834 NE of Hillhouse Wood

Surface level (+49.1 m) +161 ft
Water struck at (+41.8 m) +137 ft
Wirth BO, 8 inch diam.
October 1969

Overburden (2.7 m) 9 ft
Mineral (8.2 m) 27 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
Glacial Sand and Gravel	Soil and gravelly clay.	(2.7)	9	(2.7)	9
	Sandy gravel. 'Clayey' in the top 3 ft (0.9 m). Gravelly between 12 ft (3.7 m) and 21 ft (6.4 m). Trace of subangular, flint and quartzite cobbles below 18 ft (5.5 m) Gravel: fine and coarse, subangular to subrounded flints and quartz, with occasional quartzite. Sand: dark brown, medium and fine in the top 6 ft (1.8 m); dark brown to yellowish brown and mostly medium below.	(8.2)	27	(11.0)	36
London Clay	Brown, weathered clay passing down into fresh, blue clay.	(0.9+)	3+	(11.9)	39

	%	mm		%
Gravel	34	+16	:	18
		-16+4	:	16
		-4+1	:	9
Sand	58	-1+$\frac{1}{4}$	:	36
		-$\frac{1}{4}$+1/16	:	13
Fines	8	-1/16	:	8

Depth below surface (ft)	Fines	Percentages Sand	Gravel
9 - 12	16	69	15
12 - 15	10	39	51
15 - 18	9	36	55
18 - 21	9	38	53
21 - 24	7	69	24
24 - 27	6	54	40
27 - 30	7	62	31
30 - 33	5	73	22
33 - 36	3	78	19

TL 92 NW 26 Block D 9454 2643 Fordham Heath

Surface level (+39.9 m) +131 ft
Water struck at (+36.0 m) +118 ft
Wirth BO, 8 inch diam.
October 1969

Waste (5.8 m) 19 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
?London Clay	Soil and silty clay.	(4.3)	14	(4.3)	14
	Very gravelly clay.	(1.5)	5	(5.8)	19
London Clay	Brown, weathered clay.	(0.9+)	3+	(6.7)	22

TL 92 NW 27 Block D 9458 2537 Near Bridge Farm

Surface level (+41.5 m) +136 ft
Water struck at (+37.2 m) +122 ft
Wirth BO, 8 inch diam.
October 1969

Overburden (2.4 m) 8 ft
Mineral (4.6 m) 15 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
Loam	Soil and reddish brown, sandy clay with gravel.	(2.4)	8	(2.4)	8
Glacial Sand and Gravel	Gravel. The gravel content increases downwards. Gravel: fine and coarse, but predominantly coarse, subangular to subrounded flints, quartzites and quartz. Sand: dark reddish brown, mainly medium.	(4.6)	15	(7.0)	23
London Clay	Brown, weathered clay.	(0.9+)	3+	(7.9)	26

	%	mm		%
Gravel	61	+16	:	40
		-16+4	:	21
		-4+1	:	8
Sand	39	-1+$\frac{1}{4}$	:	26
		-$\frac{1}{4}$+1/16	:	5
Fines	0	-1/16	:	0

Depth below surface (ft)	Fines	Percentages Sand	Gravel
8 - 11	0	54	46
11 - 14	0	45	55
14 - 17	0	36	64
17 - 20	0	25	75
20 - 23	1	36	63

TL 92 NE 63 Block B 9541 2954 opposite Pond Farm

Surface level (+54.3 m) +178 ft
Water struck at (+44.8 m) +147 ft
Wirth BO, 8 inch diam.
October 1969

Waste (18.3 m+) 60 ft+

		Thickness (m)	ft	Depth (m)	ft
Chalky Boulder Clay	Soil and brown clay with gravel; silty clay below 12 ft (3.7 m), passing down into brown, chalky clay at 24 ft (7.3 m); becoming grey and chalky below 37 ft (11.3 m).	(18.3+)	60+	(18.3)	60

TL 92 NE 64 Block B 9555 2857 NW of West Bergholt

Surface level (+53.9 m) +177 ft
Water struck at (+45.4 m) +149 ft
Wirth BO, 8 inch diam.
October 1969

Waste (12.8 m) 42 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
Chalky Boulder Clay	Soil and brown clay.	(2.4)	8	(2.4)	8
?Glacial Sand and Gravel	Clay with gravel, becoming silty at 28 ft (8.5 m).	(10.4)	34	(12.8)	42
London Clay	Brown, weathered clay.	(0.9+)	3+	(13.7)	45

TL 92 NE 65 Block B 9547 2733 Near Grove Wood

Surface level (+34.7 m) +114 ft
Water struck at (+27.4 m) +90 ft
Wirth BO, 8 inch diam.
October 1969

Waste (9.8 m) 32 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
Glacial Sand and Gravel	Soil and brown, silty clay.	(2.4)	8	(2.4)	8
	Clay with gravel, passing down into silty clay at 14 ft (4.3 m), becoming gravelly below 26 ft (7.9 m).	(7.3)	24	(9.8)	32
London Clay	Brown, weathered clay passing down into fresh, blue clay.	(0.9+)	3+	(10.7)	35

TL 92 NE 66 Block D 9572 2614 Chitts Hills

Surface level (+21.0 m) +69 ft
Water not struck
Wirth BO, 8 inch diam.
September 1969

Waste (9.8 m) 32 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
?Glacial Sand and Gravel	Soil and brown clay with gravel.	(2.7)	9	(2.7)	9
?London Clay	Brown silty clay, becoming blue below 28 ft (8.5 m)	(7.0)	23	(9.8)	32
London Clay	Brown, weathered clay passing down into fresh, blue clay	(0.9+)	3+	(10.7)	35

TL 92 NE 67 Block B 9677 2956 North of Pitchbury Wood

Surface level (+53.3 m) +175 ft
Water struck at (+48.2 m) +158 ft
Wirth BO, 8 inch diam.
October 1969

Overburden (7.9 m) 26 ft
Mineral (2.7 m) 9 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
Loam	Soil and brown, silty clay.	(4.9)	16	(4.9)	16
Glacial Sand and Gravel	Grey silt with gravel.	(3.0)	10	(7.9)	26
	Sandy gravel. Gravel: mostly fine in the top 3 ft (0.9 m); becoming coarser downwards; subangular to subrounded flints and quartz. Sand: yellowish brown, mainly medium.	(2.7)	9	(10.7)	35
London Clay	Brown, weathered clay passing down into fresh, blue clay.	(0.9+)	3+	(11.6)	38

	%	mm		%
Gravel	34	+16	:	14
		-16+4	:	20
Sand	63	-4+1	:	10
		-1+¼	:	44
		-¼+1/16	:	9
Fines	3	-1/16	:	3

Depth below surface (ft)	Percentages Fines	Sand	Gravel
26 - 29	0	73	27
29 - 32	6	56	38
32 - 35	2	62	36

TL 92 NE 68 Block B 9633 2813 Sports Ground, Manor Road, West Bergholt

Surface level (+52.7 m) +173 ft
Water struck at (+47.2 m) +155 ft
Wirth BO, 8 inch diam.
October 1969

Overburden (4.6 m) 15 ft
Mineral (4.3 m) 14 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
Loam	Soil and brown clay with gravel.	(2.4)	8	(2.4)	8
	Brown sandy clay	(2.1)	7	(4.6)	15
Glacial Sand and Gravel	Sandy gravel. 'Clayey' in the bottom 5 ft (1.5 m). Gravelly between 18 ft (5.5 m) and 21 ft (6.4 m). Gravel: predominantly coarse in the top 6 ft (1.8 m), fine with coarse below; subangular to subrounded flints. Sand: brown, mainly medium.	(4.3)	14	(8.8)	29
London Clay	Brown, weathered clay passing down into fresh, blue clay.	(0.9+)	3+	(9.8)	32

	%	mm		%
Gravel	32	+16	:	16
		-16+4	:	16
		-4+1	:	9
Sand	63	-1+$\frac{1}{4}$	:	42
		-$\frac{1}{4}$+1/16	:	12
Fines	5	-1/16	:	5

Depth below surface (ft)	Percentages Fines	Sand	Gravel
15 - 18	1	80	19
18 - 21	1	46	53
21 - 24	2	80	18
24 - 27	11	50	39
27 - 29	13	54	33

TL 92 NE 69 Block B 9687 2708 Near Hill House Farm

Surface level (+c. 30.5 m) +c. 100 ft
Water struck at (+c. 25.0 m) +c. 82 ft
Wirth BO, 8 inch diam.
October 1969

Waste (5.2 m) 17 ft
Bedrock (4.6 m+) 15 ft+

		Thickness (m)	ft	Depth (m)	ft
?London Clay	Soil and brown, silty clay.	(5.2)	17	(5.2)	17
London Clay	Brown, weathered clay passing down into fresh, blue clay at 30 ft (9.1 m)	(4.6+)	15+	(9.8)	32

TL 92 NE 70 Block B 9771 2953 Near Tile House Farm

Surface level (+49.7 m) +163 ft
Water struck at (+45.1 m) +148 ft
Wirth BO, 8 inch diam.
October 1969

Waste (5.2 m) 17 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
Loam	Soil and brown, silty clay.	(5.2)	17	(5.2)	17
London Clay	Brown, weathered clay passing down into fresh, blue clay.	(0.9+)	3+	(6.1)	20

TL 92 NE 71 Block B 9774 2884 Near Kiln House, Horkesley Heath

Surface level (+46.3 m) +152 ft
Water not struck
Wirth BO, 8 inch diam.
October 1969

Waste (7.9 m) 26 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
Loam	Soil and brown clay, becoming silty at 9 ft (2.7 m).	(7.9)	26	(7.9)	26
London Clay	Brown, weathered clay passing down into fresh, blue clay	(0.9+)	3+	(8.8)	29

TL 92 NE 72 Block B 9770 2717 East of St Botolph's Bridge

Surface level (+39.3 m) +129 ft
Water struck at (+37.2 m) +122 ft
Wirth BO, 8 inch diam.
October 1969

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

		Thickness (m)	ft	Depth (m)	ft
Glacial Sand and Gravel	Soil and brown clay with gravel.	(2.4)	8	(2.4)	8
	Sandy gravel. 'Very clayey' in the bottom 2 ft (0.6 m). Gravel: fine, with some coarse especially at the base; subangular to subrounded flints, quartz and chalk. Sand: brown, chalky, medium with coarse; subangular flint and subordinate quartz.	(2.4)	8	(4.9)	16
London Clay	Brown, weathered clay passing down into fresh, blue clay.	(0.9+)	3+	(5.8)	19

	%	mm		%	Depth below surface (ft)	Percentages Fines	Sand	Gravel
Gravel	40	+16	:	15	8 - 11	1	56	43
		-16+4	:	25	11 - 14	1	62	37
					14 - 16	22	40	38
		-4+1	:	13				
Sand	54	-1+$\frac{1}{4}$	:	39				
		-$\frac{1}{4}$+1/16	:	2				
Fines	6	-1/16	:	6				

TL 92 NE 73 Block B 9860 2987 West of Brickhouse Farm

Surface level (+50.3 m) +165 ft
Water struck at (+45.1 m) +148 ft
Wirth BO, 8 inch diam.
October 1969

Overburden (4.0 m) 13 ft
Mineral (4.9 m) 16 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
Loam	Soil and brown clay.	(2.1)	7	(2.1)	7
Glacial Sand and Gravel	Sandy clay with gravel.	(1.8)	6	(4.0)	13
	Sandy gravel. Most gravelly in the lower half. Gravel; predominantly fine in the top 6 ft (1.8 m), fine with coarse below; subangular to subrounded flints and quartz. Sand: yellowish brown to greyish brown, medium with coarse.	(4.9)	16	(8.8)	29
London Clay	Brown, weathered clay passing down into fresh, blue clay.	(0.9+)	3+	(9.8)	32

	%	mm		%	Depth below surface (ft)	Fines	Percentages Sand	Gravel
Gravel	37	+16	:	12	13 - 16	8	64	28
		-16+4	:	25	16 - 19	6	68	26
					19 - 22	6	55	39
		-4+1	:	17	22 - 25	5	48	47
Sand	57	-1+$\frac{1}{4}$	:	33	25 - 28	4	54	42
		-$\frac{1}{4}$+1/16	:	7	28 - 29	4	52	44
Fines	6	-1/16	:	6				

TL 92 NE 74 Block B 9876 2840 Near Chapman's Farm

Surface level (+48.8 m) +160 ft
Water struck at (+43.6 m) +143 ft
Wirth BO, 8 inch diam.
October 1969

Overburden (4.3 m) 14 ft
Mineral (3.7 m) 12 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
Loam	Soil and clay with gravel.	(4.3)	14	(4.3)	14
Glacial Sand and Gravel	Sandy gravel. Gravel: fine, subrounded flints, quartz and chalk, with coarse sub-angular to subrounded flints. Sand: brown, medium with coarse.	(3.7)	12	(7.9)	26
London Clay	Brown, weathered clay passing down into fresh, blue clay.	(0.9+)	3+	(8.8)	29

	%	mm		%	Depth below surface (ft)	Percentages Fines	Sand	Gravel
Gravel	42	+16	:	13	14 - 17	4	49	47
		-16+4	:	29	17 - 20	6	56	38
					20 - 23	4	55	41
		-4+1	:	14	23 - 26	6	51	43
Sand	53	-1+$\frac{1}{4}$	:	32				
		-$\frac{1}{4}$+1/16	:	7				
Fines	5	-1/16	:	5				

TL 92 NE 75 Block B 9854 2759 Near Braiswick Farm

Surface level (+47.9 m) +157 ft
Water struck at (+38.1 m) +125 ft
Wirth BO, 8 inch diam.
October 1969

Waste (15.2 m) 50 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
Loam	Soil and brown clay, passing down into grey silt at 14 ft (4.3 m)	(11.6)	38	(11.6)	38
?Glacial Sand and Gravel	Very silty gravel.	(3.7)	12	(15.2)	50
London Clay	Brown, weathered clay passing down into fresh, blue clay.	(0.9+)	3+	(16.2)	53

TL 92 NE 76 Block B 9911 2919 Near Cuckoo Farm

Surface level (+48.8 m) +160 ft
Water struck at (47.1 m) +155 ft
Pilkon Shell, 6 inch diam.
November 1970

Overburden 2.0 m (6.5 ft)
Mineral 5.0 m (16.5 ft)
Bedrock 0.3 m+ (1 ft+)

		Thickness m	(ft)	Depth m	(ft)
Loam	Orange brown, clayey sand with greenish grey, sandy clay.	2.0	(6.5)	2.0	(6.5)
Glacial Sand and Gravel	Sandy gravel. Contains band of pale grey clay with occasional coarse and cobble sized gravel between 4.0 m (13 ft) and 4.6 m (15 ft). Becomes more sandy below this. Gravel: rounded, subrounded and sub-angular, mainly flint with subsidiary quartz and quartzite. Fine from 2.0 m (6.5 ft)to 4.0 m (13 ft) becoming coarser below clay band, then finer again towards base. Sand: mainly medium, orange brown becoming greyish brown or brown with depth.	5.0	(16.5)	7.0	(23)
?London Clay	Dark grey, tenacious, silty clay.	0.3+	(1+)	7.3	(24)

	%	mm		%
Gravel	34	+16	:	14
		-16+4	:	20
		-4+1	:	13
Sand	64	-1+$\frac{1}{4}$	:	39
		-$\frac{1}{4}$+1/16	:	12
Fines	2	-1/16	:	2

Depth below surface (m)	Percentages Fines	Sand	Gravel
2.0 - 3.0	No grading available		
3.0 - 4.0	3	51	46
4.6 - 5.6	2	48	50
5.6 - 6.6	No grading available		
6.6 - 7.0	2	85	13

TL 92 SW 70 Block E 9050 2131 Near Badcock's Farm

Surface level (+32.3 m) +106 ft
Water struck at (+24.7 m) +81 ft
Wirth BO, 8 inch diam.
August 1969

Waste (18.3 m+) 60 ft+

		Thickness (m)	ft	Depth (m)	ft
Chalky Boulder Clay	Soil and brown, chalky clay becoming grey from 16 ft (4.9 m)	(18.3+)	60+	(18.3)	60

TL 92 SW 71 Block E 9090 2020 East of Fan Wood

Surface level (+36.3 m) +119 ft
Water struck at (+30.5 m) +100 ft
Wirth BO, 8 inch diam.
September 1969

Waste (14.3 m) 47 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
Chalky Boulder Clay	Soil and brown clay; sandy from 9 ft (2.7 m) to 21 ft (6.4 m), becoming chalky below 21 ft (6.4 m) with a gravelly clay layer from 30 ft (9.1 m) to 31 ft (9.4 m); continuing in brown chalky clay which becomes gravelly for 4 ft (1.2 m) at the base.	(14.3)	47	(14.3)	47
London Clay	Brown, weathered clay passing down into fresh, blue clay.	(0.9+)	3+	(15.2)	50

TL 92 SW 72 Block E 9141 2224 Near Little Birch Holt Farm

Surface level (+44.5 m) +146 ft
Water struck at (+31.7 m) +104 ft
Wirth BO, 8 inch diam.
September 1969

Overburden (8.2 m) 27 ft
Mineral (10.1 m) 33 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
Chalky Boulder Clay	Soil and brown, chalky clay.	(8.2)	27	(8.2)	27
Glacial Sand and Gravel	Sandy gravel. Sandy layers occur between 33 ft (10.1 m) and 42 ft (12.8 m) and from 48 ft (14.6 m) to 54 ft (16.5 m). Gravelly band from 45 ft (13.7 m) to 48 ft (14.6 m) Gravel: fine with coarse, becoming mainly fine downwards, but with a coarse layer between 42 ft (12.8 m) and 51 ft (15.5 m); subangular to subrounded, black and reddened flints with some quartz. Sand: brown to yellow brown; mainly medium with some fine and coarse in parts.	(10.1)	33	(18.3)	60
London Clay	Brown, weathered clay.	(0.9+)	3+	(19.2)	63

	%	mm		%
Gravel	44	+16	:	17
		-16+4	:	27
		-4+1	:	10
Sand	55	-1+¼	:	34
		-¼+1/16	:	11
Fines	1	-1/16	:	1

Depth below surface (ft)	Percentages Fines	Sand	Gravel
27 - 30	8	45	47
30 - 33	0	47	53
33 - 36	2	58	40
36 - 39	1	66	33
39 - 42	1	72	27
42 - 45	1	49	50
45 - 48	0	27	73
48 - 51	1	80	19
51 - 54	0	64	36
54 - 57	0	49	51
57 - 60	1	49	50

TL 92 SW 73 Block E 9139 2151 Little Badcocks Farm, Easthorpe

Surface level (+37.2 m) +122 ft
Water struck at (+31.4 m) +103 ft
Wirth BO, 8 inch diam.
August 1969

Overburden (3.0 m) 10 ft
Mineral (5.2 m) 17 ft
Bedrock (0.3 m+) 1 ft+

		Thickness (m)	ft	Depth (m)	ft
Chalky Boulder Clay	Soil and boulder clay.	(3.0)	10	(3.0)	10
Glacial Sand and Gravel	Gravel. Particularly gravelly in bottom 2 ft (0.6 m). Gravel: mainly fine with some coarse, subangular, subrounded and rounded black flints and whitish or coloured quartzites. Sand: light brown, medium with coarse, occasionally silty.	(5.2)	17	(8.2)	27
London Clay	Brown, weathered clay passing after a few inches into fresh, blue clay.	(0.3+)	1+	(8.5)	28

	%	mm		%
Gravel	51	+16	:	14
		-16+4	:	37
		-4+1	:	15
Sand	47	-1+$\frac{1}{4}$	:	29
		-$\frac{1}{4}$+1/16	:	3
Fines	2	-1/16	:	2

Depth below surface (ft)	Fines	Percentages Sand	Gravel
10 - 13	5	41	54
13 - 16	2	46	52
16 - 19	0	51	49
19 - 22	1	51	48
22 - 25	1	62	37
25 - 27	2	25	73

TL 92 SW 74 Block E 9140 2085 Near Winterflood's Farm

Surface level (+31.4 m) +103 ft
Water not struck
Wirth BO, 8 inch diam.
September 1969

Waste (8.5 m) 28 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
Chalky Boulder Clay	Soil and brown clay with gravel passing down into brown chalky clay at 10 ft (3.0 m), becoming grey at 24 ft (7.3 m)	(8.5)	28	(8.5)	28
London Clay	Brown, weathered clay passing down into fresh, blue clay.	(0.9+)	3+	(9.4)	31

TL 92 SW 75 Block E 9269 2338 North of Copford Green

Surface level (+29.9 m) +98 ft
Groundwater conditions not recorded
Wirth B1, 8 inch diam.
February 1970

Waste (4.9 m) 16 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
Chalky Boulder Clay	Soil and brown, silty clay.	(4.9)	16	(4.9)	16
London Clay	Blue clay.	(0.9+)	3+	(5.8)	19

TL 92 SW 76 Block E 9271 2256 Copford Green

Surface level (+33.2 m) +109 ft
Water struck at (+21.6 m) +71 ft
Wirth BO, 8 inch diam.
September 1969

Overburden (4.3 m) 14 ft
Mineral (11.0 m) 36 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
Glacial Sand and Gravel	Soil and brown sandy clay.	(1.5)	5	(1.5)	5
	Very gravelly clay.	(2.7)	9	(4.3)	14
	Gravel. Gravel content high in top 3 ft (0.9 m) and below 32 ft (9.8 m) Gravel: predominantly coarse in the top 3 ft (0.9 m), fine and coarse below, with fine layer between 23 ft (9.0 m) and 35 ft (10.7 m); subangular to subrounded flints and occasional quartz. Sand: brown to yellowish brown, medium down to 35 ft (10.7 m) becoming medium to coarse, subangular flint and quartz below.	(11.0)	36	(15.2)	50
London Clay	Brown, weathered clay passing down into fresh, blue clay.	(0.9+)	3+	(16.2)	53

	%	mm		%
Gravel	58	+16	:	22
		-16+4	:	36
Sand	41	-4+1	:	10
		-1+$\frac{1}{4}$	:	27
		-$\frac{1}{4}$+1/16	:	4
Fines	1	-1/16	:	1

Depth below surface (ft)	Percentages Fines	Sand	Gravel
14 - 17	0	24	76
17 - 20	0	55	45
20 - 23	1	52	47
23 - 26	1	49	50
26 - 29	1	66	33
29 - 32	1	73	26
32 - 35	1	38	61
35 - 38	1	20	79
38 - 41	1	25	74
41 - 44	1	47	52
44 - 47	1	26	73
47 - 50	0	25	75

TL 92 SW 77 Block E 9234 2165 Near Mulberry Cottages, Copford

Surface level (+41.5 m) +136 ft
Water struck at (+37.2 m) +122 ft
Wirth BO, 8 inch diam.
September 1969

Waste (13.7 m) 45 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
Chalky Boulder Clay	Soil and brown, sandy clay, becoming gravelly below 9 ft (2.7 m) and passing into brown, chalky clay at 14 ft (4.3 m), which becomes grey at 26 ft (7.9 m)	(10.4)	34	(10.4)	34
?Glacial Sand and Gravel	Sandy, silty clay with gravel.	(3.4)	11	(13.7)	45
London Clay	Brown, weathered clay passing down into fresh, blue clay.	(0.9+)	3+	(14.6)	48

TL 92 SW 78 Block E 9254 2049 Shemmings Farm

Surface level (+41.8 m) +137 ft
Water struck at (+24.1 m) +79 ft
Wirth BO, 8 inch diam.
September 1969

Overburden (15.8 m) 52 ft
Mineral (8.2 m) 27 ft
Bedrock (0.3 m+) 1 ft+

		Thickness (m)	ft	Depth (m)	ft
Chalky Boulder Clay	Soil and brown clay, becoming chalky below 12 ft (3.7 m)	(15.8)	52	(15.8)	52
Glacial Sand and Gravel	Sandy gravel. Top 12 ft (3.7 m) very sandy. Gravel: fine, subangular flints and quartz, with some subrounded chalk and quartzites in the top 12 ft (3.7 m), fine with some coarse, subangular to subrounded flints and quartzites present below 64 ft (19.5 m) Sand: brown, medium with fine down to 73 ft (22.3 m); medium and coarse with fine in the bottom 6 ft (1.8 m).	(8.2)	27	(24.1)	79
London Clay	Brown, weathered clay becoming blue.	(0.3+)	1+	(24.4)	80

	%	mm		%
Gravel	25	+16	:	4
		-16+4	:	21
		-4+1	:	9
Sand	74	-1+$\frac{1}{4}$	:	41
		-$\frac{1}{4}$+1/16	:	24
Fines	1	-1/16	:	1

Depth below surface (ft)	Percentages Fines	Sand	Gravel
52 - 55	0	85	15
55 - 58	0	100	0
58 - 61	0	94	6
61 - 64	1	97	2
64 - 67	1	51	48
67 - 70	No grading available		
70 - 73	2	79	19
73 - 76	1	46	53
76 - 79	1	43	56

TL 92 SW 79 Block E 9349 2255 Near Copford Hall

Surface level (+32.6 m) +107 ft
Water struck at (+26.5 m) +87 ft
Wirth BO, 8 inch diam.
September 1969

Overburden (6.1 m) 20 ft
Mineral (4.6 m) 15 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
Chalky Boulder Clay	Soil and brown, sandy clay.	(3.4)	11	(3.4)	11
Glacial Sand and Gravel	Very clayey, fine sand.	(1.2)	4	(4.6)	15
	Sandy, silty clay with gravel.	(1.5)	5	(6.1)	20
	Sandy gravel. Gravel: fine with coarse, sub-angular to subrounded flints and quartz. Sand: yellow, medium with fine.	(4.6)	15	(10.7)	35
London Clay	Brown, weathered clay passing down into fresh, blue clay.	(0.9+)	3+	(11.6)	38

	%	mm		%
Gravel	35	+16	:	13
		-16+4	:	22
		-4+1	:	7
Sand	63	-1+$\frac{1}{4}$	:	42
		-$\frac{1}{4}$+1/16	:	14
Fines	2	-1/16	:	2

Depth below surface (ft)	Fines	Percentages Sand	Gravel
20 - 23	3	60	37
23 - 26	1	67	32
26 - 29	2	63	35
29 - 32	1	69	30
32 - 35	2	56	42

TL 92 SW 80 Block E 9342 2181 Near Walnuttree Farm

Surface level (+30.2 m) +99 ft
Water struck at (+27.2 m) +89 ft
Pilkon Shell, 8 inch diam.
November 1970

Waste 5.1 m (16.5 ft)
Bedrock 2.0 m+ (6.5 ft+)

		Thickness m	(ft)	Depth m	(ft)
Chalky Boulder Clay	Soil and dark brown, sandy clay, becoming orange-brown below (1.5 ft) 0.4 m	2.2	(7)	2.2	(7)
	Pale brown, stiff clay, with quartz and flint pebbles and chalk granules; chocolate brown from(9 ft) 2.8 m , becoming dark grey at(15 ft) 4.5 m	2.9	(9.5)	5.1	(16.5)
London Clay	Dark, bluish-grey clay, locally brownish-grey and silty.	2.0+	(6.5+)	7.1	(23.5)

TL 92 SW 81 Block E 9340 2040 Near Glebe Farm

Surface level (+30.8 m) +101 ft
Water struck at (+19.2 m) +63 ft
Wirth BO, 8 inch diam.
September 1969

Overburden (6.1 m) 20 ft
Mineral (11.0 m) 36 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
Chalky Boulder Clay	Soil and brown, pebbly clay becoming chalky below 9 ft (2.7 m)	(6.1)	20	(6.1)	20
Glacial Sand and Gravel	Sandy gravel. Almost entirely sand in top 12 ft (3.7 m). Gravel common below 12 ft (3.7 m) but decreasing in percentage below 47 ft (14.3 m) Gravel: fine with coarse; but almost entirely fine between 35 ft (10.7 m) and 38 ft (11.6 m), and in the bottom 9 ft (2.7 m); subangular to subrounded flints. Sand: yellow, fine sand to 26 ft (7.9 m), becoming fine to medium to 35 ft (10.7 m), then brown, medium to coarse to 41 ft (12.5 m), and brown to greyish-brown, mainly medium below.	(11.0)	36	(17.1)	56
London Clay	Brown, weathered clay passing down into fresh, blue clay.	(0.9+)	3+	(18.0)	59

	%	mm		%
Gravel	26	+16	:	7
		-16+4	:	19
		-4+1	:	10
Sand	72	-1+$\frac{1}{4}$	:	36
		-$\frac{1}{4}$+1/16	:	26
Fines	2	-1/16	:	2

Depth below surface (ft)	Percentages Fines	Sand	Gravel
20 - 23	2	98	0
23 - 26	3	97	0
26 - 29	1	97	2
29 - 32	2	98	0
32 - 35	9	48	43
35 - 38	6	34	60
38 - 41	1	55	44
41 - 44	2	53	45
44 - 47	1	46	53
47 - 50	1	70	29
50 - 53	1	76	23
53 - 56	0	82	18

TL 92 SW 82 Block F 9404 2386 Near Stanway Rectory

Surface level (+36.3 m) +119 ft
Water struck at (+21.6 m) +71 ft
Wirth BO, 8 inch diam.
September 1969

Waste (18.3 m+) 60 ft+

		Thickness (m)	ft	Depth (m)	ft
Loam	Soil and brown clay.	(5.8)	19	(5.8)	19
?Glacial Sand and Gravel	Clay with gravel.	(1.8)	6	(7.6)	25
?London Clay	Brown, silty clay, becoming pale greyish blue at 48 ft (14.6 m).	(10.7+)	35+	(18.3)	60

TL 92 SW 83 Block F 9438 2309 Near Bellhouse Farm

Surface level (+35.4 m) +116 ft
Water struck at (+20.4 m) +67 ft
Wirth BO, 8 inch diam.
September 1969

Overburden (7.6 m) 25 ft
Mineral (9.1 m) 30 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
Loam	Brown clay with flint pebbles, becoming chalky between 12 ft (3.7 m) and 17 ft (5.2 m), and sandy below 17 ft (5.2 m).	(6.7)	22	(6.7)	22
Glacial Sand and Gravel	Gravelly clay.	(0.9)	3	(7.6)	25
	Sandy gravel. Becoming generally more gravelly downwards. 'Clayey' in bottom 3 ft (0.9 m). Gravel: fine with coarse, subangular to subrounded flints and quartz. Sand: brown, medium with fine in the top 3 ft (0.9 m); mainly medium below.	(9.1)	30	(16.8)	55
London Clay	Brown, weathered clay.	(0.9+)	3+	(17.7)	58

	%	mm		%
Gravel	31	+16	:	9
		-16+4	:	22
		-4+1	:	10
Sand	67	-1+$\frac{1}{4}$	:	44
		-$\frac{1}{4}$+1/16	:	13
Fines	2	-1/16	:	2

Depth below surface (ft)	Percentages Fines	Sand	Gravel
25 - 28	3	86	11
28 - 31	1	88	11
31 - 34	1	86	13
34 - 37	1	76	23
37 - 40	1	61	38
40 - 43	1	71	28
43 - 46	1	46	53
46 - 49	1	47	52
49 - 52	1	53	46
52 - 55	11	53	36

TL 92 SW 84 Block F 9468 2203 North of Heckfordbridge

Surface level (+31.7 m) +104 ft
Water not struck
Wirth BO, 8 inch diam.
September 1969

Overburden (2.1 m) 7 ft
Mineral (16.8 m) 55 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
Glacial Sand and Gravel	Soil and dirty, gravelly clay.	(2.1)	7	(2.1)	7
	Pebbly sand. Gravelly in top 18 ft (5.5 m), becoming sandy with traces only of gravel below, but becoming gravelly again towards the base. 'Very clayey' between 55 ft (16.8 m) and 58 ft (17.7 m). Gravel: fine with coarse, subangular to subrounded flint, quartz and subordinate quartzite. Sand: yellow to brown, medium and fine.	(16.8)	55	(18.9)	62
London Clay	Brown, weathered clay passing down into fresh, blue clay.	(0.9+)	3+	(19.8)	65

	%	mm		%
Gravel	14	+16	:	4
		-16+4	:	10
		-4+1	:	6
Sand	81	-1+$\frac{1}{4}$	:	45
		-$\frac{1}{4}$+1/16	:	30
Fines	5	-1/16	:	5

Depth below surface (ft)	Percentages Fines	Sand	Gravel
7 - 10	2	69	29
10 - 13	1	66	33
13 - 16	1	83	16
16 - 19	3	55	42
19 - 22	1	83	16
22 - 25	3	67	30
25 - 28	3	91	6
28 - 31	3	92	5
31 - 34	4	90	6
34 - 37	6	94	0
37 - 40	6	88	6
40 - 43	4	96	0
43 - 46	3	88	9
46 - 49	2	89	9
49 - 52	3	97	0
52 - 55	7	87	6
55 - 58	30	59	11
58 - 61	2	67	31
61 - 62	2	88	10

TL 92 SW 85 Block F 9450 2079 Birch Hall Park

Surface level (+33.5 m) +110 ft
Water struck at (+20.1 m) +66 ft
Wirth BO, 8 inch diam.
September 1969

Overburden (4.0 m) 13 ft
Mineral (16.5 m) 54 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
Glacial Sand and Gravel	Gravelly clay.	(4.0)	13	(4.0)	13
	Pebbly sand. Gravelly near top, becoming mainly sand with little or no gravel below 19 ft (5.8 m), but becoming increasingly gravelly again from 40 ft (12.2 m) to the base. Gravel: mainly fine with some traces of coarse in places; subangular to subrounded flints with traces of quartz. Sand: rust brown to pale brown; mainly medium, but with increasing amounts of fine sand down to 37 ft (11.3 m), below which the medium sand becomes increasingly dominant again.	(16.5)	54	(20.4)	67
London Clay	Brown, weathered clay passing down into fresh, blue clay.	(0.9+)	3+	(21.3)	70

	%	mm		%
Gravel	19	+16	:	5
		-16+4	:	14
		-4+1	:	7
Sand	80	-1+$\frac{1}{4}$	:	49
		-$\frac{1}{4}$+1/16	:	24
Fines	1	-1/16	:	1

Depth below surface (ft)	Fines	Percentages Sand	Gravel
13 - 16	1	60	39
16 - 19	1	84	15
19 - 22	1	92	7
22 - 25	2	95	3
25 - 28	1	99	0
28 - 31	0	100	0
31 - 34	2	98	0
34 - 37	2	98	0
37 - 40	1	99	0
40 - 43	1	95	4
43 - 46	0	87	13
46 - 49	1	61	38
49 - 52	2	66	32
52 - 55	1	74	25
55 - 58	2	62	36
58 - 61	1	44	55
61 - 64	2	60	38
64 - 67	1	57	42

TL 92 SW 86 Block E 9018 2351 Near A120, Marks Tey

Surface level (+41.1 m) +135 ft
Water struck at (+36.3 m) +119 ft
Wirth BO, 8 inch diam.
May 1970

Overburden (9.4 m) 31 ft
Mineral (4.6 m) 15 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
Chalky Boulder Clay	Soil and brown, chalky clay becoming grey below 26 ft (7.9 m).	(9.4)	31	(9.4)	31
Glacial Sand and Gravel	Sandy gravel. Decrease in gravel content downwards with increasing fines. Cobbles occur between 40 ft (12.2 m) and 43 ft (13.1 m). Gravel: fine and coarse, subangular to subrounded flints and subordinate quartz. Sand: mainly medium, becoming fine to medium downwards.	(4.6)	15	(14.0)	46
London Clay	Brown, weathered clay passing down into fresh, blue clay.	(0.9+)	3+	(14.9)	49

%	mm		%
	+64	:	1
Gravel 35	-64+16	:	15
	-16+4	:	19
	-4+1	:	8
Sand 53	-1+$\frac{1}{4}$	:	26
	-$\frac{1}{4}$+1/16	:	19
Fines 12	-1/16	:	12

Depth below surface (ft)	Percentages Fines	Sand	Gravel
31 - 34	4	50	46
34 - 37	7	52	41
37 - 40	12	49	39
40 - 43	20	56	24
43 - 46	15	59	26

TL 92 SW 87 Block D 9175 2487 Near Aldham Hall

Surface level (+36.6 m) +120 ft
Water struck at (+32.0 m) +105 ft
Wirth BO, 8 inch diam.
May 1970

Overburden (3.4 m) 11 ft
Mineral (6.1 m) 20 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
Chalky Boulder Clay	Soil and orange-brown, sandy clay with scattered flint gravel.	(3.4)	11	(3.4)	11
Glacial Sand and Gravel	Pebbly sand. Gravelly in the top 3 ft (0.9 m), with a few cobbles. 'Clayey' in the top 3 ft (0.9 m) and 'very clayey' between 17 ft (5.2 m) and 20 ft (6.1 m). Gravel: fine with coarse; sub-angular, subrounded and rounded flints, with some quartzites below 23 ft (7.0 m). Sand: orange-brown; mainly medium with variable amounts of fine.	(6.1)	20	(9.4)	31
London Clay	Brown, weathered clay passing down into fresh, blue clay.	(0.9+)	3+	(10.4)	34

	%	mm		%
Gravel	16	+16	:	6
		-16+4	:	10
		-4+1	:	5
Sand	74	-1+$\frac{1}{4}$	:	39
		-$\frac{1}{4}$+1/16	:	30
Fines	10	-1/16	:	10

Depth below surface (ft)	Percentages Fines	Sand	Gravel
11 - 14	15	42	43
14 - 17	3	90	7
17 - 20	26	62	12
20 - 23	6	81	13
23 - 26	6	89	5
26 - 29	4	77	19
29 - 31	No grading available		

TL 92 SE 5 Block F 9572 2368 Five Ways

Surface level (+37.5 m) +123 ft
Water struck at (+16.8 m) +55 ft
Wirth BO, 8 inch diam.
September 1969

Overburden (4.3 m) 14 ft
Mineral (19.2 m+) 63 ft+

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Glacial Sand and Gravel	Soil and gravelly clay.	(3.7)	12	(3.7)	12
	Very silty fine sand.	(0.6)	2	(4.3)	14
	Sandy gravel. High gravel content in top 24 ft (7.3 m), becoming sandy below this but with an increase in gravel content again near the base. Gravel: fine with coarse, mostly subangular flints and quartz. Sand: brown sand to 38 ft (11.6 m), medium with some coarse near top; becoming red to pale brown medium with fine below.	(19.2+)	63+	(23.5)	77

	%	mm		%
Gravel	34	+16	:	13
		-16+4	:	21
		-4+1	:	8
Sand	65	-1+$\frac{1}{4}$	:	41
		-$\frac{1}{4}$+1/16	:	16
Fines	1	-1/16	:	1

Depth below surface (ft)	Percentages Fines	Sand	Gravel
14 - 17	1	51	48
17 - 20	1	44	55
20 - 23	1	46	53
23 - 26	1	46	53
26 - 29	1	53	46
29 - 32	3	52	45
32 - 35	1	23	76
35 - 38	1	24	75
38 - 41	1	81	18
41 - 44	2	88	10
44 - 47	0	93	7
47 - 50	1	95	4
50 - 53	0	94	6
53 - 56	1	80	19
56 - 59	1	65	34
59 - 62	5	78	17
62 - 65	1	72	27
65 - 68	1	57	42
68 - 71	0	58	42
71 - 74	1	89	10
74 - 77	3	75	22

Borehole terminated because of technical difficulties

TL 92 SE 6 Block F 9525 2230 Opposite Stanway Hall (Colchester Zoo)

Surface level (+35.1 m) +115 ft
Groundwater conditions not recorded
Wirth BO, 8 inch diam.
September 1970

Overburden (0.3 m) 1 ft
Mineral (2.7 m) 9 ft
Waste (0.9 m) 3 ft
Mineral (1.8 m) 6 ft
Waste (0.9 m) 3 ft
Mineral (11.0 m) 36 ft
Bedrock (0.3 m+) 1 ft+

		Thickness (m)	ft	Depth (m)	ft
Glacial Sand and Gravel	Soil	(0.3)	1	(0.3)	1
	(a) 'Clayey' sandy gravel. The gravel content increases downwards. Gravel: fine with coarse, subangular to subrounded flints and quartzites. Sand: orange-brown, mainly medium, rounded.	(2.7)	9	(3.0)	10
	'Very clayey' pebbly sand; fine to medium sand with scattered flint gravel.	(0.9)	3	(4.0)	13
	(b) Pebbly sand. 'Clayey'in the lower 3 ft (0.9 m). Sand: pale orange-brown; mainly medium in the upper 3 ft (0.9 m); medium with fine below. Gravel: fine with coarse, subangular to subrounded flints.	(1.8)	6	(5.8)	19
	Brown and yellow, mottled, sandy clay with traces of gravel.	(0.9)	3	(6.7)	22
	(c) Sandy gravel. Sand constitutes more than 90% of the mineral for 15 ft (4.6 m) down to 40 ft (12.2 m) below which there is a high concentration of gravel. Gravel: chiefly fine; subangular to sub-rounded flints down to 40 ft (12.2 m) fine and coarse; subangular to sub-rounded flints and quartzites below. Sand: yellow, medium with fine down to 40 ft (12.2 m); yellowish-brown below, medium with coarse.	(11.0)	36	(17.7)	58
London Clay	Brown, weathered clay.	(0.3+)	1+	(18.0)	59

Mean (a), (b) + (c):

Gravel	26	+16	: 10	(a)	1 - 4	15	69	16
		-16+4	: 16		4 - 7	12	63	25
					7 - 10	13	49	39
		-4+1	: 8		Mean	13	60	27
Sand	68	$-1+\frac{1}{4}$	: 40					
		$-\frac{1}{4}+1/16$	: 20	(b)	13 - 16	3	62	35
					16 - 19	12	81	7
Fines	6	-1/16	: 6		Mean	8	71	21
				(c)	22 - 25	4	75	21
					25 - 28	4	91	5
					28 - 31	5	93	2
					31 - 34	2	94	4
					34 - 37	5	94	1
					37 - 40	7	90	3
					40 - 43	2	36	62
					43 - 46	3	37	60
					46 - 49	4	50	46
					49 - 52	1	38	61
					52 - 58	(no samples taken)		
					Mean	4	70	26

TL 92 SE 7 Block F 9558 2130 South of Baymill Cottages

Surface level (+18.0 m) +59 ft
Water struck at (+11.6 m) +38 ft
Wirth BO, 8 inch diam.
September 1969

Overburden (4.6 m) 15 ft
Mineral (6.4 m) 21 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
Glacial Sand and Gravel	Soil and brown clay.	(3.0)	10	(3.0)	10
	Very clayey sand with some silt.	(1.5)	5	(4.6)	15
	Sand. 'Clayey' in the top 3 ft (0.9 m). Some gravel towards base. Sand: buff; medium and fine; fine predominates in the top 9 ft (2.7 m), medium predominates in the bottom 6 ft (1.8 m). Gravel: fine with coarse; flints and subordinate chalk.	(6.4)	21	(11.0)	36
London Clay	Brown, weathered clay passing down into fresh, blue clay.	(0.9+)	3+	(11.9)	39

	%	m		%
Gravel	3	+16	:	1
		-16+4	:	2
		-4+1	:	3
Sand	94	-1+$\frac{1}{4}$	:	39
		-$\frac{1}{4}$+1/16	:	52
Fines	3	-1/16	:	3

Depth below surface (ft)	Percentages Fines	Sand	Gravel
15 - 18	16	83	1
18 - 21	1	99	0
21 - 24	2	98	0
24 - 27	0	93	7
27 - 30	1	98	1
30 - 33	0	94	6
33 - 36	1	94	5

TL 92 SE 8 Block G 9556 2044 Near Conduit Farm

Surface level (+39.0 m) +128 ft
Water struck at (+31.7 m) +104 ft
Wirth BO, 8 inch diam.
September 1969

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

		Thickness (m)	ft	Depth (m)	ft
Glacial Sand and Gravel	Soil and brown clay.	(3.4)	11	(3.4)	11
	Gravelly clay.	(1.2)	4	(4.6)	15
	Grey, clayey silt.	(1.8)	6	(6.4)	21
	Sandy gravel. 'Clayey' in the bottom 3 ft (0.9 m). Gravel: fine with some coarse; mainly subangular to subrounded flints, with subordinate chalk. Sand: brown, medium with coarse and occasionally some fine.	(5.5)	18	(11.9)	39
London Clay	Brown, weathered clay passing down into fresh, blue clay.	(0.9+)	3+	(12.8)	42

	%	mm		%
Gravel	43	+16	:	19
		-16+4	:	24
		-4+1	:	14
Sand	54	-1+$\frac{1}{4}$	:	30
		-$\frac{1}{4}$+1/16	:	10
Fines	3	-1/16	:	3

Depth below surface (ft)	Percentages Fines	Sand	Gravel
21 - 24	1	50	49
24 - 27	3	57	40
27 - 30	1	47	52
30 - 33	1	47	52
33 - 36	1	63	36
36 - 39	12	56	32

TL 92 SE 9 Block G 9648 2124 South-West of Oliver's Farm

Surface level (+13.4 m) +44 ft
Water struck at (+10.1 m) +33 ft
Wirth BO, 8 inch diam.
October 1969

Waste (11.0 m) 36 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
?London Clay	Soil and brown, silty clay passing down into grey silt at 14 ft (4.3 m); gravelly for 2 ft (0.6 m) at the base.	(11.0)	36	(11.0)	36
London Clay	Brown, weathered clay passing down into fresh, blue clay.	(0.9+)	3+	(11.9)	39

TL 92 SE 10 Block G 9663 2048 Layer de la Haye Common

Surface level (+37.5 m) +123 ft
Water struck at (+31.4 m) +103 ft
Wirth BO, 8 inch diam.
September 1969

Waste (9.4 m) 31 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
?Glacial Sand and Gravel	Brown clay with fine to coarse gravel, passing down at 12 ft (3.7 m) into grey silt with subrounded flint gravel; clay with gravel for 5 ft (1.5 m) at the base.	(9.4)	31	(9.4)	31
London Clay	Brown, weathered clay passing down into fresh, blue clay.	(0.9+)	3+	(10.4)	34

TL 92 SE 11 Block G 9749 2127 Near King's Ford Farm

Surface level (+22.6 m) +74 ft
Water struck at (+17.1 m) +56 ft
Wirth BO, 8 inch diam.
September 1969

Overburden (3.4 m) 11 ft
Mineral (4.3 m) 14 ft
Bedrock (0.9 m+) 3 ft

		Thickness (m)	ft	Depth (m)	ft
Glacial Sand and Gravel	Soil and brown, sandy clay.	(3.4)	11	(3.4)	11
	Gravel. Gravel: fine and coarse, subangular to subrounded flints, quartz and quartzites. Sand: reddish-brown, medium to coarse.	(4.3)	14	(7.6)	25
London Clay	Brown, weathered clay passing down into fresh, blue clay.	(0.9+)	3+	(8.5)	28

	%	mm		%
Gravel	67	+16	:	35
		-16+4	:	32
		-4+1	:	15
Sand	30	-1+$\frac{1}{4}$	:	13
		-$\frac{1}{4}$+1/16	:	2
Fines	3	-1/16	:	3

Depth below surface (ft)	Percentages Fines	Sand	Gravel
11 - 14	3	31	66
14 - 17	0	22	78
17 - 20	3	23	74
20 - 23	7	38	55
23 - 25	2	34	64

TL 92 SE 12 Block G 9799 2029 Malting Green

Surface level (+31.1 m) +102 ft
Groundwater conditions not recorded
Wirth BO, 8 inch diam.
February 1970

Overburden (0.6 m) 2 ft
Mineral (2.7 m) 9 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
Glacial Sand and Gravel	Soil.	(0.6)	2	(0.6)	2
	Sandy gravel. A small proportion of fines is consistently present through the 9 ft (2.7 m) thickness of mineral. Gravel: fine and coarse, approaching cobble-size in the top 6 ft (1.8 m); subangular to subrounded, with some rounded, flints and subordinate quartz. Sand: brown, fine to medium with coarse in the top 3 ft (0.9 m); brown to greenish-brown, chiefly medium below; mainly subangular to subrounded quartz.	(2.7)	9	(3.4)	11
London Clay	Blue clay.	(0.9+)	3+	(4.3)	14

	%	mm		%
Gravel	45	+16	:	22
		-16+4	:	23
		-4+1	:	10
Sand	47	-1+¼	:	26
		-¼+1/16	:	11
Fines	8	-1/16	:	8

Depth below surface (ft)	Percentages Fines	Sand	Gravel
2 - 5	8	43	49
5 - 8	8	40	52
8 - 11	8	58	34

TL 92 SE 13 Block G 9861 2185 Near Maypole Farm

Surface level (+34.4 m) +113 ft
Water struck at (+28.7 m) +94 ft
Wirth BO, 8 inch diam.
October 1969

Overburden (3.4 m) 11 ft
Mineral (8.2 m) 27 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
Loam	Soil and brown clay.	(3.0)	10	(3.0)	10
Glacial Sand and Gravel	'Very clayey' sand.	(0.3)	1	(3.4)	11
	Pebbly sand. Gravelly at the base. Gravel: mainly fine, subangular to subrounded flints, quartz and subordinate chalk, with some coarse, subangular flints. Sand: brown; medium in the top 9 ft (2.7 m), medium with fine below.	(8.2)	27	(11.6)	38
London Clay	Brown, weathered clay.	(0.9+)	3+	(12.5)	41

	%	mm		%
Gravel	19	+16	:	8
		-16+4	:	11
		-4+1	:	7
Sand	78	-1+$\frac{1}{4}$	:	50
		-$\frac{1}{4}$+1/16	:	21
Fines	3	-1/16	:	3

Depth below surface (ft)	Fines	Percentages Sand	Gravel
11 - 14	2	90	8
14 - 17	3	70	27
17 - 20	1	70	29
20 - 23	7	72	21
23 - 26	2	79	19
26 - 29	1	92	7
29 - 32	5	88	7
32 - 35	1	79	20
35 - 38	7	56	37

TL 92 SE 14 Block G 9866 2089 South of Fridaywood Farm

Surface level (+29.9 m) +98 ft
Water struck at (+26.5 m) +87 ft
Pilcon Shell, 8 inch diam.
November 1970

Overburden 1.0 m (3.5 ft)
Mineral 6.1 m (20 ft)
Bedrock 0.2 m+ (0.5 ft+)

		Thickness m	(ft)	Depth m	(ft)
Glacial Sand and Gravel	Soil and brown, sandy clay with fine, rounded quartz and flint gravel.	1.0	(3.5)	1.0	(3.5)
	Gravel. Band of pale-green clay between 2.1 m (7 ft) and 2.8 m (9 ft) Gravel: fine and coarse with occasional cobbles; rounded to sub-rounded flints and subordinate quartz and quartzite with occasional subangular flints and quartz. Sand: yellow; medium to coarse; subangular to subrounded. Silt content increasing downwards.	6.1	(20)	7.1	(23.5)
London Clay	Clay, weathered chocolate-brown to reddish-brown at the top; bluish-grey below.	0.2+	(0.5+)	7.3	(24)

	%	mm		%
Gravel	70	+16	:	35
		-16+4	:	35
		-4+1	:	10
Sand	28	-1+$\frac{1}{4}$	:	14
		-$\frac{1}{4}$+1/16	:	4
Fines	2	-1/16	:	2

Depth below surface (m)	Percentages Fines	Sand	Gravel
1.0 - 2.1	1	39	60
Clay Band 0.7 m (2.5 ft) thick			
2.8 - 3.8	5	32	63
3.8 - 4.8	2	21	77
4.8 - 5.8	1	23	76
6.8 - 7.1	1	24	75

TL 92 SE 15 Block G 9998 2193 North of Berechurch Hall Road

Surface level (+32.9 m) +108 ft
Water struck at (+28.3 m) +93 ft
Wirth BO, 8 inch diam.
September 1969

Overburden (2.7 m) 9 ft
Mineral (7.0 m) 23 ft
Bedrock (0.9 m+) 3 ft+

		Thickness (m)	ft	Depth (m)	ft
Glacial Sand and Gravel	Soil and brown, sandy clay.	(2.7)	9	(2.7)	9
	Sandy gravel. 'Very clayey' in the top 3 ft (0.9 m). Gravel: fine and coarse, but mostly fine in the bottom 5 ft (1.5 m); sub-angular to subrounded flints and quartz. Sand: rust brown to brown, medium and fine, becoming mainly medium below 24 ft (7.3 m).	(7.0)	23	(9.8)	32
London Clay	Brown, weathered clay.	(0.9+)	3+	(10.7)	35

	%	mm		%
Gravel	29	+16	:	13
		-16+4	:	16
		-4+1	:	6
Sand	64	-1+$\frac{1}{4}$	:	38
		-$\frac{1}{4}$+1/16	:	20
Fines	7	-1/16	:	7

Depth below surface (ft)	Percentages Fines	Sand	Gravel
9 - 12	30	57	13
12 - 15	2	65	33
15 - 18	5	67	28
18 - 21	9	55	36
21 - 24	5	58	37
24 - 27	2	68	30
27 - 30	2	75	23
30 - 32	1	67	32

TL 92 SE 16 Block G 9964 2057 Near Park Farm

Surface level (+22.9 m) +75 ft
Water struck at (+15.5 m) +51 ft
Wirth BO, 8 inch diam.
September 1969

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

		Thickness (m)	ft	Depth (m)	ft
?Glacial Sand and Gravel	Soil and brown, sandy clay.	(5.5)	18	(5.5)	18
	Gravelly clay.	(2.7)	9	(8.2)	27
London Clay	Brown, weathered clay.	(0.9+)	3+	(9.1)	30

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INSTITUTE OF GEOLOGICAL SCIENCES

MINERAL ASSESSMENT UNIT

THE SAND & GRAVEL RESOURCES OF SHEET TL 92 (West of COLCHESTER, ESSEX)

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

ORDNANCE SURVEY
SHEET TL 92
PROVISIONAL EDITION

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

10

OVERBURDEN RATIO > 3:1
SAND AND GRAVEL ABSENT IN PARTS

PATCHES OF CLAYEY HEAD IN PLACES

PATCHY HEAD DEPOSITS ON LC

URBAN AREA — NOT ASSESSED

A FORDHAM
B WEST BERGHOLT
C COLCHESTER
D ALDHAM
E COPFORD
F MARKS TEY
G BIRCH

EXPLANATION OF SYMBOLS AND ABBREVIATIONS

DRIFT

A-4	~	**Alluvium**- river clays and silts, often with gravel and sand.
RB-1	≈	**River Brickearth**- clays and silts
RT-2	⊻	**River Terrace Deposits, undifferentiated**- gravels and sandy gravels
B-2	⊏	**Brickearth or Loam**- brown clay, containing variable amounts of sand, silt and pebbles.
CBC-1	⊹	**Chalky Boulder Clay**- brown, often chalky, clay with occasional flint pebbles.
GS-8	⊛	**Glacial Sand and Gravel**- sandy flint gravels, with quartz and occasional quartzites.

RECENT AND PLEISTOCENE

SOLID

LC		**London Clay**- blue-grey clay, weathering brown

EOCENE

The Lower London Tertiaries and the Chalk proved in deep boreholes only.

WO-6 Worked-out ground (mainly sand and gravel).

BOUNDARY LINES

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

BOREHOLE DATA

SITE LOCATIONS

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

M.A.U. BOREHOLES

Borehole Registration Number → SE 18 (29·9 98) ← Surface level in metres and feet above O.D. (Newlyn).
Borehole Site →
(⊙) 1·0 ← Overburden
(⊙) 1·1 ← Mineral (sand and gravel)
0·7 ← Waste
Geological Classification → (⊙) 4·3 ← Mineral (sand and gravel)
(LC) 0·2+ ← Bedrock
Grading Diagram

Note
1. Figures underlined denote thicknesses used in the assessment of resources.
2. The + sign indicates that the base of the deposit was not reached.
3. The figures in *italics* are conversions to metres of measurements recorded in feet.
4. 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. SE 14. 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 SE 14 is TL 92 SE 14.

Grading Diagrams

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

Sand (+1/16–4mm)
Fines (–1/16mm) Gravel (+4mm)

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 **223/20** signifies Hydrogeological Department borehole 20 on New Series One-Inch Geological Sheet 223.

The final depth of deep boreholes is given in metres above (+) or below (–) O.D.

EXPOSURE RECORDS

Information obtained from the inspection of exposures and used in assessment is shown in the same way as for boreholes, but the sites are located by an asterisk, thus *. Reference number and details of thicknesses are shown.

CATEGORIES OF DEPOSITS

- **Exposed sand and gravel, as mapped and assessed.** CAT-E4
- **Continuous, or almost continuous spreads of mineral beneath overburden.** CAT-C1
- **Discontinuous spreads of mineral beneath overburden.** CAT-D1
- **Sand and gravel either not potentially workable (see Report) or absent.** CAT-A2

RESOURCE BLOCKS

For the purpose of assessment the mineral-bearing land 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.

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

Geological lines, slightly amended, from a survey on the one-inch scale by W. H. Dalton, under the superintendence of W. Whitaker; H. W. Bristow F.R.S., Senior Director; Sir A. C. Ramsay LL.D. F.R.S. Director General. Published 1883. A. Geikie LL.D. F.R.S. Director General. Included in the New Series One-Inch sheets 223 (Braintree) and 224 (Colchester).

Sand and Gravel Survey by John D. Ambrose and N. E. Bradbury in 1969-70. R. G. Thurrell, Head, Mineral Assessment Unit.

1:25 000 Sand and Gravel Resource Sheet published 1973.
Sir Kingsley 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.

2050/73

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 1920-21. Other partial systematic revision 1938-53 has been incorporated.

Made and published by the Director General of the Ordnance Survey, Chessington, Surrey, 1955. Reprinted with minor corrections 1958.

Data quoted for an individual borehole refer strictly to that site, from which reliable conclusions cannot be drawn about the thickness and grading elsewhere in the deposit, particularly in material as variable as sand and gravel. However, estimates of the volume and mean grading of the mineral as a whole in each Resource Block are given in the Report.

	TL 83	TL 93	TM 03
	223 TL 82	TL 92	224 TM 02
	TL 81	TL 91	TM 01

Diagram showing the relation of the National Grid 1:25 000 sheets with the One-Inch Geological sheets 223 and 224

Made and published for the Institute of Geological Sciences by the Director General of the Ordnance Survey, Southampton.