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INSTITUTE OF GEOLOGICAL SCIENCES

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ASSESSMENT OF BRITISH SAND AND GRAVEL RESOURCES No. 1

The sand and gravel resources of the country south-east of Norwich, Norfolk

Description of 1 : 25 000 resource sheet TG 20

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with contributions by A. R. Clayton

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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 is the first Report of the Mineral Assessment Unit which was set up in May 1968 to undertake such work. It describes and quantifies the resources of sand and gravel of 77 km of country southward and eastward of Norwich, shown on the accompanying 1 : 25 000 Resource Map TG 20.

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

The survey was conducted by Mr. E.F.P. Nickless assisted by Mr. A.R. Clayton as field officer who supervised the drilling and sampling programme and helped in the preparation of data for this publication. The work is based on a geological survey at 1 : 10 560 in 1968-70 by Dr. F.C. Cox (East Anglia and South-East England Field Unit) who has also helped in the geological interpretation.

Mr. J.W. Gardner, C.B.E. (Land Agent) has been responsible for negotiating access to land for drilling. The ready cooperation of land owners and tenants in this work is gratefully acknowledged. Special thanks are due to Dr. T.L. Thomas of the Royal School of Mines, London, for his advice on methods of resources 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 eighty-five boreholes drilled for the Mineral Assessment Unit form the bases of the assessment of sand and gravel resources in the Norwich area, Norfolk.

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 limits.

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

The position of the boreholes and exposures, the geology and topography and the outlines of the blocks are shown on the accompanying map TG 20. 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 quatre-vingtcinq (85) 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 Norwich, Norfolk.

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

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

La situation des trous de sonde et des affleurements, la géologie et la topographie, et la configuration des blocs sont montrées sur la carte TG 20. Des données détaillées des trous de sonde se trouvent dans l'Annexe C.

Zusammenfassung

Die geologischen Karten von der Institute of Geological Sciences, die vorher existierende Information im Bezug auf Bohrlöchern, auch 85 Bohrlöcher, die für das Mineral Assessment Unit gemacht waren, bilden den Grund für die Einschätzung der Sand- und Schottermittel im Norwich Gebiet, Norfolk.

Man hat im Gebiet alle Ablagerungen, die möglich bearbeitbare für Sand und Schotter (Mineral) sind, geologisch untersucht, und man hat auch eine einfache statistische Methode (in Zusatz A beschrieben) benutzt, um das Volumen zu schätzen. Man gibt die Zuverlässigkeit der Volumenschatzungen mit 95 Prozent Vertrauensgrenzwerten.

Man teilt die 1 : 25 000 Karte in Mittelsblöcke, wovon jeder ungefähr 10 km² von Sand und Schotter einschliesst. Für jeden Bloch gibt man das mineralhaltige Gebiet, die Durchschnittsdiche von Überlastung und Mineral, und die Durchschnittsklassifizierung, und beschreibt die Geomorphologie und Geologie der Ablagerungen.

Man zeigt die Lage von den Bohrlöchern und Aufschlüssen, die Geologie und Topographie, auch die Skizzen von den Blöchen auf der Begleitkarte TG 20. Man gibt ausführliche Bohrlöcherdaten in Zusatz C.

The sand and gravel resources of the country south-east of Norwich, Norfolk

Description of 1 : 25 000 resource sheet TG 20

E. F. P. NICKLESS, B.Sc.

Introduction

Aims and Limitations

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

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

The survey is therefore not concerned 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 which are not currently exploitable but have 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 not 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 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.

[1]Institute of Geological Sciences, 199 Knightsbridge, London SW7 1DZ

Procedure

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

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

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

However, because broad trends are independently overlain 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 Norwich has been avoided, but otherwise in siting the boreholes or 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 will therefore bear 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 30 m (100 ft) at a diameter of about 200 mm (8 in), 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 either below the water table or in some clay-free sands and gravels when the mineral will not stay on the flights. In such circumstances materials can be recovered by bailing. However, not only is this method slow, but there is a tendency for the pumping action to draw unwanted material into the hole either from the sides or the bottom. On the area covered by the sheet here described, the German Wirth B1 drill (or B0 modified) has been 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. Other machines, including conventional 'shell and augers', have also been 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 1 m (3 ft) depth. The samples are despatched in heavyweight 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. 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 recorded on standard record sheets, abbreviated copies of which are appended to this report.

The methods used in computing the estimates of volume and other statistics for each of the resource blocks are described in Appendix A and the results are quoted on p. 8.

The Map

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

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

The geological boundaries are regarded as the

best interpretation of the information available at the time of survey. However, it is inevitable, particularly with glacial deposits (such as those included in the area of Sheet TG 20) which change rapidly vertically and laterally, that discrepancies will be revealed by some boreholes (for example, at boreholes NE 26 and NE 36). These are taken into account in the assessment of resources (see below and Appendix A).

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

On TG 20 the mineral is subdivided into areas where the mineral crops out, and areas where mineral is present in continuous or almost continuous spreads beneath overburden. The area of exposed sand and gravel as mapped is considered as mineral, although there may be small patches 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 proportion of boreholes which did not find potentially workable sand and gravel and their distribution within a block. The 'discontinuous' category has not been recognised on the present sheet.

Areas of outcropping bedrock, areas where boreholes indicate absence of sand and gravel beneath cover, areas where sand and gravel beneath cover is interpreted to be not potentially workable, and areas not assessed are shown uncoloured on the Map, and where appropriate the relevant criterion is noted. In all these areas it has been 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 areas of the exposed sand and gravel and of bedrock are determined 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 (shown by a distinctive symbol) are drawn primarily for the purpose of volume estimation. The symbol is intended to convey an approximate location within a likely zone of occurrence, its size being limited only by cartographic considerations: it is not intended to represent the breadth of the zone. For the purpose of measuring areas the centre-line of the symbol is used.

Description of Sheet TG 20

General

The city of Norwich extends over about 23 km² of this map and no assessment has been made for this area. The table of results shows that of the remaining 77 km² of the sheet area, 64 km² (about 83 per cent) are gravel bearing.

Topography

The area is fairly strongly dissected by the River Yare and its tributaries the Wensum and Tas. Below the confluence of the Yare and Wensum at Trowse Newton [247 068][1] the Yare Valley is broad and low-lying with large areas of peaty marsh—Whitlingham, Kirby and Postwick marshes. The Yare is tidal as far upstream as Trowse Newton but the Wensum, the larger stream above the confluence, is tidal for a further mile upstream.

To the south-east of Norwich the land rises away from the Yare valley to a boulder clay plateau at over 200 ft (60 m). The highest ground for many miles around at Framingham Earl, reaches 244 ft (74 m) [263 027] and is capped by Glacial Sand and Gravel, whence a number of springs feed a radiating stream pattern. Most of the streams eventually drain northwards to the Yare.

To the south-south-west of Norwich, the ground to the west of the valley of the now diminutive River Tas rises gently to reach about 150 ft (45 m) in the neighbourhood of Swardeston and Swainsthorpe.

On the north-eastern part of the street, north of the Yare lies a plateau of Norwich Brickearth at about 75 ft (23 m).

Geology

The relationship of one bed to another is in many cases complex, but an outline of the geology is essential to an understanding of the distribution of sand and gravel in this area.

Chalk: The Chalk, which crops out along the sides of the valley of the River Yare, forms the bedrock to the overlying, mainly unconsolidated, younger deposits, many of which are gravel bearing.

Although the Chalk now has an irregular upper surface resulting from dissection by present-day river valleys and older glacial channels (many of which are infilled with glacial deposits including sand and gravel), it is clear that formerly the surface of the Chalk was a fairly flat surface inclined eastwards at an average gradient of about 12 ft/mile (about 2.3 m/km). This older surface persists where overlying Norwich Crag has protected the Chalk from later erosion.

Norwich Crag: During Pleistocene times the sea advanced across this part of Norfolk depositing a basal residual cobble bed (The Stone Bed of older authors) and the Norwich Crag. The cobble bed, up to 0.3 m (1 ft) thick consists mostly of brown-coated, cobble-size flints (mean size varies from 100 to 300 mm (4 to 12 in)). Occasionally bones and shells can be found within it. The Norwich Crag comprises alternations of sands, gravelly and shelly sands and beds of clay which although usually no more than 2 cm (¾ in) thick range up to 1.5 m (5 ft). The type locality for the Norwich Crag has for long been regarded as Bramerton Common [294 059] (Taylor, 1823; Wood and Harmer, 1872; Woodward, 1882; Reid, 1890). At Bramerton Common the following lithological subdivisions (after Funnell, 1961) may be recognised reading from the top downwards: a clay bed up to 1.5 m (5 ft) thick; an upper shell bed up to 1 m (3 ft) thick; this is separated by about 1 m (3 ft) of sand from a bed of sand almost devoid of shells 3.5 to 4.5 m (11½ to 14¾ ft) thick;

[1]National Grid References in this publication all lie within the 100 km square TG (63)

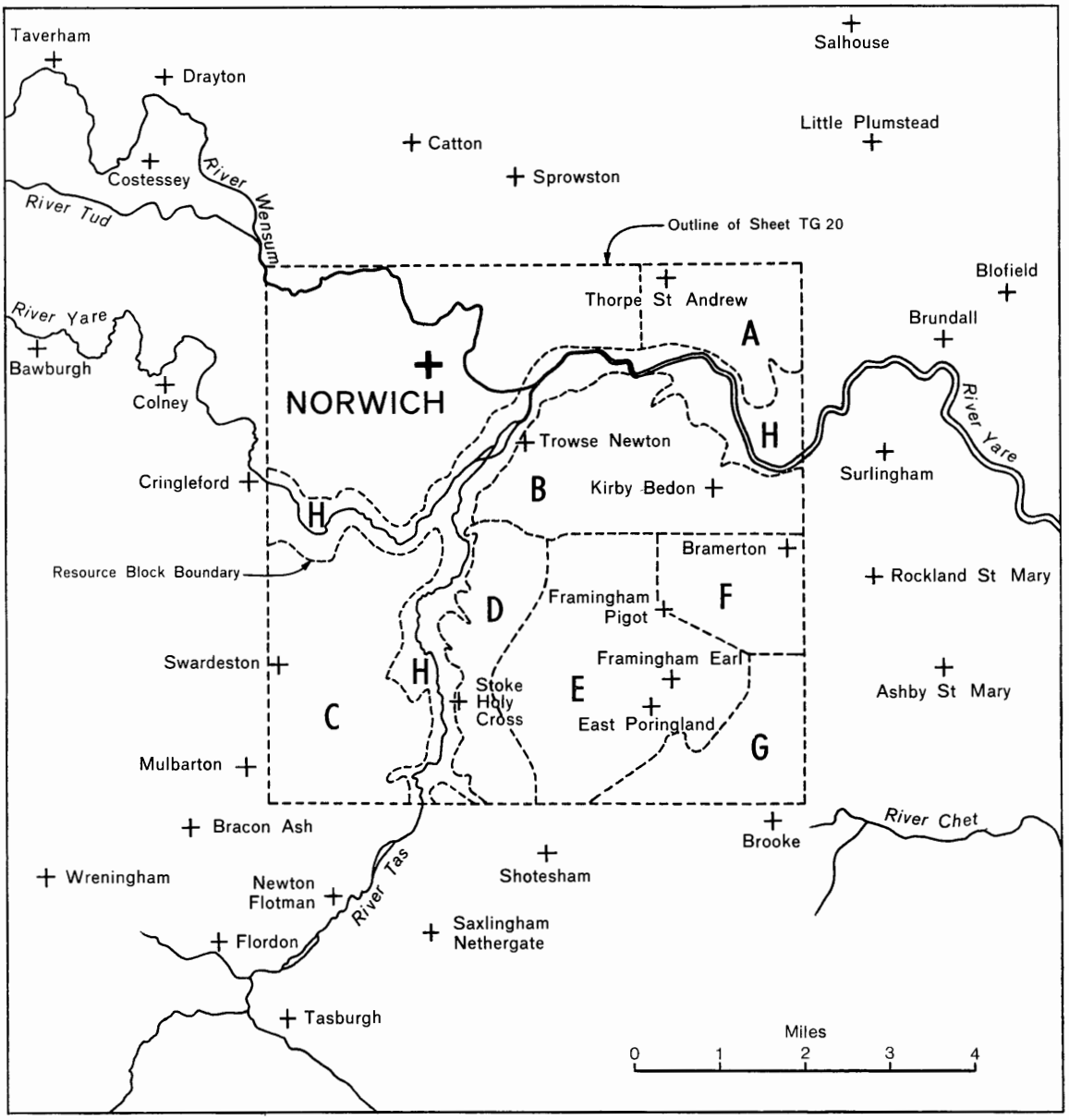


Figure 1. Sketch map showing the location of Sheet TG 20. The resource blocks are designated by the letters A-H. The area of Norwich has not been assessed.

a lower shell bed 1.5 to 2.5 m (5 to 8 ft) thick resting on a flint cobble bed.

Towards its top the Norwich Crag becomes increasingly gravelly, the gravels containing vein quartz, quartzite and flint. These gravels have been variously referred to as the Bure Valley Beds or Westleton Beds (see, for example, Baden-Powell and West, 1960). The only place where these beds have been recognised in the area is at Whitlingham Pit [268 077].

Westwards from Bramerton Common the Norwich Crag thins and becomes more gravelly and less clayey. The upper shell bed has not been found in any of the boreholes which penetrated the full thickness of Norwich Crag. It is probable that Norwich Crag was deposited over much of the area in the form of a continuous sheet. The proximity of the coastline of the Norwich Crag sea is responsible for the variation in thickness and also for the changes in grade. No trace of Norwich Crag has been found west of the River Tas, and it is possible that part of the present course of the river follows the western limit of the Norwich Crag sea. The Crag crops out along the eastern bank of the River Tas at Stoke Holy Cross, between [234 023] and [238 003], and also along the northern and southern banks of the River Yare, for example, at Trowse Newton [250 068] and Kirby Bedon [285 058]. It also underlies much of Norwich.

On Sheet TG 20, erosion has removed much of the Norwich Crag so that now only small isolated patches remain and in many places these are covered by later deposits. Thus, the extent of Norwich Crag beneath this cover is almost impossible to determine.

Norwich Brickearth: The Pleistocene Period was punctuated by a number of glacial episodes. Several glacial advances are known in eastern England, each

characterised by a sequence of boulder clays, glacial sands and gravels, outwash sands and various constructional features such as eskers and kames. During an amelioration of climate the ice fronts retreated and large spreads of outwash sand and gravel were deposited by meltwaters. These represent the major sand and gravel resources of the area.

The nature and complexity of deposition during glacial times varies considerably from place to place. A simplified explanation of the sequence of events throughout the area is given in Fig.2.

The earliest indisputably glacial deposit in the area is the Norwich Brickearth, a sandy clay, usually brown or orange-brown in colour, containing scattered pebbles of flint, quartz and quartzite. Occasional pebbles of more exotic rock types mainly of Scandinavian origin show that most of the North Sea Ice which deposited the Norwich Brickearth must have moved across the North Sea.

The Norwich Brickearth crops out on the northern part of the sheet area, north of the River Yare, where it overlies the Norwich Crag. It is thought to be a lateral equivalent of part of the North Sea Drift of the Cromer coast area of Norfolk (Woodward, 1882). The Norwich Brickearth rests on an irregular surface of the underlying beds and although it is thought that it was deposited directly from land ice, locally it exhibits features which are characteristic of deposition in water, for example, current bedding, ripple drift and dropstones.

The normal thickness of Norwich Brickearth is about 3 to 6 m (10 to 20 ft), but abnormally greater thicknesses of 14.3 m (47 ft) and 12.8 m (42 ft) were recorded in boreholes NE 29 and NE 40.

Chalky Boulder Clay: A line following the course of the Wensum and of the Yare below Trowse is almost coincident with the eastern edge of the Chalky Boulder Clay. It is probable that the Chalky Boulder Clay in the Norwich area—the product of the so-called Lowestoft Ice which moved from the north-west or west (West and Donner, 1956)—is of approximately the same age as the Norwich Brickearth, the product of the North Sea Ice which moved from the north-east.

The Chalky Boulder Clay is a stiff blue chalky clay with pebbles, cobbles and small boulders of chalk, flint and quartzite. Other rock types are also present, mainly of Jurassic and Lower Cretaceous origin, indicating that the Chalky Boulder Clay ice sheets passed over outcrops of formations now exposed in west Norfolk and Lincolnshire. Various authors (for example, Baden-Powell, 1948; West and Donner, 1956) have considered that the Chalky Boulder Clay, as a whole, is the product of two separate glaciations, the Lowestoft and the Gipping, which are separated from each other by an interglacial period, the Hoxnian. However, the existence of a Gipping glaciation is disputable. Laminated silty clays which have been identified by Dr. R. G. West (Subdepartment of Quaternary Research, Botany School, Cambridge) as Hoxnian in age, were found in borehole SW 20 at Dunston Common. Here terrace gravel, not boulder clay, overlies the interglacial sediments.

As the ice sheets decayed, meltwaters carried vast quantities of clay, sand and gravel and deposited them as outwash beyond the ice margin, for example, in the area of Thorpe St Andrew; at the same time boulder clay was dumped at or behind the ice margin in a completely unsorted and unstratified mass. Thus at the ice margin the relationship of boulder clay to sand and gravel (referred to as the Glacial Sand and Gravel) is complex, for example, in that area of the sheet south of the River Yare.

Glacial Sand and Gravel: The Glacial Sand and Gravel consists of ill-sorted slightly clayey sands and gravels which usually contain a little chalk (less than 1 per cent). The proportion of sand to gravel varies considerably, vertically and laterally. In some places the sand is devoid of stone whilst in others thick beds of gravel occur.

The last phase of sand and gravel deposition is represented by late-stage torrent gravels formerly the Cannon-shot gravels of Woodward (1882) which, as their name suggests, are ill-sorted, rapidly deposited gravels (for further details see p. 11). They consist predominantly of flint but some exotic rock types such as rhyolite, microgranite, felsite and porphyrite are also present.

River terrace and other deposits: By the end of Pleistocene time the discharging melt-waters had imposed a new drainage system within which a series of fluviatile deposits were formed and are still forming today. Only one terrace is known. The grading characteristics of the terrace and of the gravels which lie beneath the present floodplains (the 'sub-alluvium gravels') are almost identical, and they may represent a single phase of deposition prior to downcutting and formation of the present floodplain. A cover of alluvium up to 6.4 m (21 ft) thick forms the floodplains of the rivers. Downstream on the Yare, in the neighbourhood of Whitlingham, Kirby and Postwick marshes there are localised developments of peat (up to 6 m (20 ft) thick) within the alluvium.

Composition of the Sand and Gravel Deposits

There are four potentially workable mineral horizons represented on the Sheet area: terrace gravels; sub-alluvium gravels; Glacial Sand and Gravel; Norwich Crag.

The terrace gravels: The terrace gravels have a mean grading of fines 3 per cent, sand 53 per cent, gravel 44 per cent. The gravel consists predominantly of fine to coarse subangular flint, with minor amounts of fine to medium subrounded to rounded quartz and quartzite. The sand is composed of medium subangular to subrounded quartz and flint. The terrace gravels are chalk-free but are occasionally clayey, for example, in borehole NW 21. As a generalisation, there is no appreciable vertical variation in grading characteristics at any of the borehole sites. However, comparison of all boreholes drilled in terrace gravel shows lateral variation. The terrace gravels are covered by overburden, of 0.7 m mean thickness. (For the calculation of mean thickness, see Appendix A).

The sub-alluvium gravels: The sub-alluvium and terrace gravels are very similar in composition, and may belong to the same phase of deposition. A mean thickness of 2.7 m of overburden covers the sub-alluvium gravels.

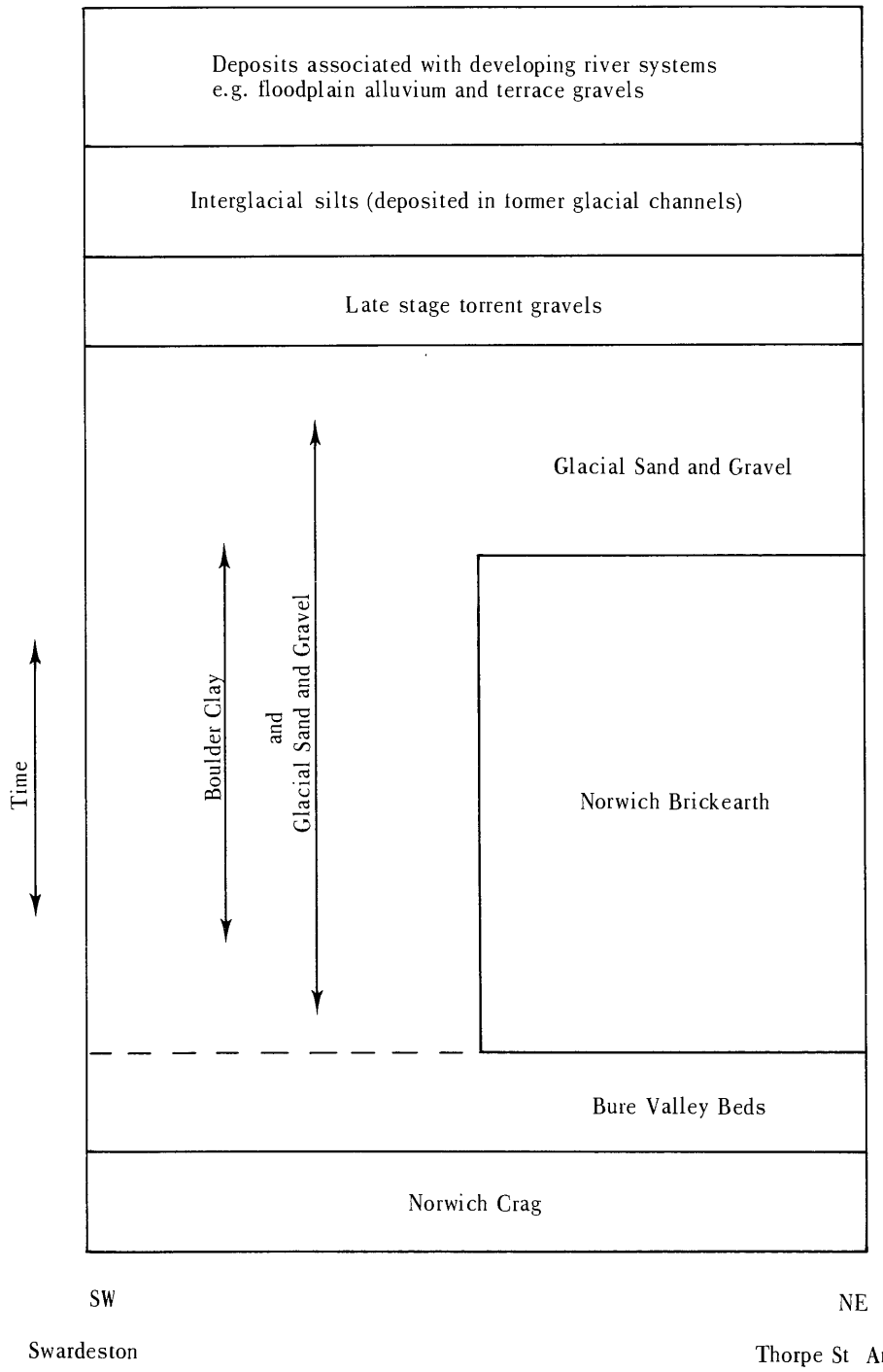
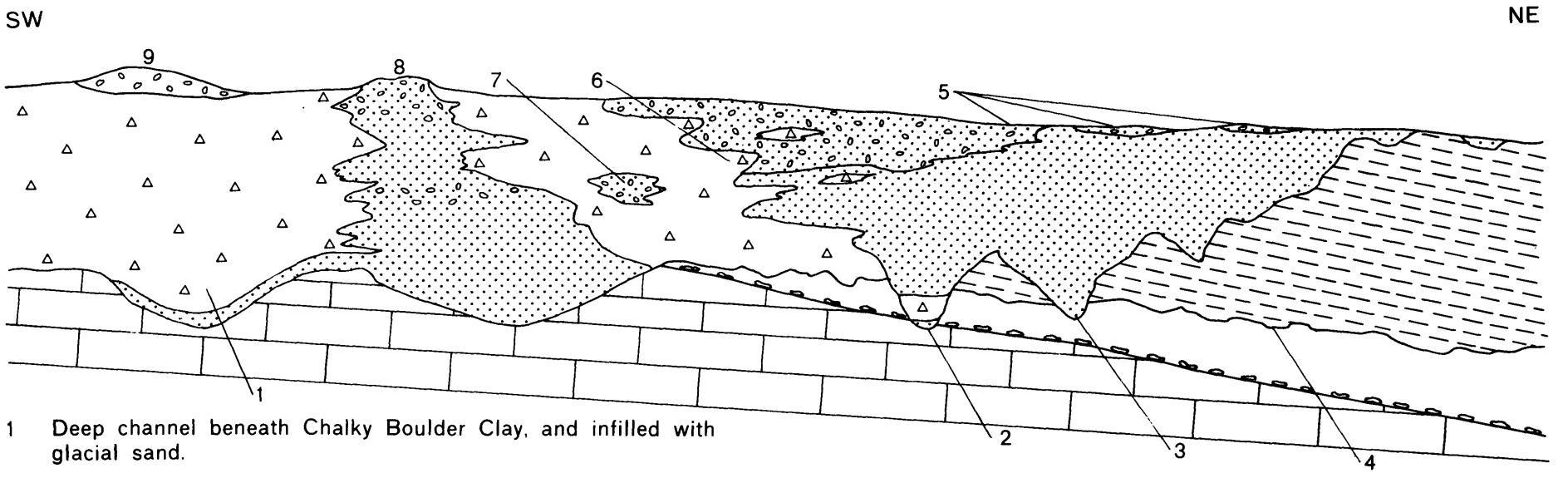


Figure 2. Diagram to show the general relationships of Pleistocene and Recent deposits in the area



1 Deep channel beneath Chalky Boulder Clay, and infilled with glacial sand.

2 Deep channel with long glacial history; shows early advance of Chalky Boulder Clay. (e.g. Tas Valley)

3 Channel formed by sandy outwash from Chalky Boulder Clay; frequently cuts out all earlier drifts

4 Contact of Norwich Brickearth with Norwich Crag; shows evidence of slight channel developement.

5 Torrent gravels deposited at final decay stage of Chalky Boulder Clay ice.

6 Margin of Boulder Clay interdigitating with outwash deposits.

7 Included mass of glacial sand and gravel. (e.g. Poringland)

8 Gravel mound , its margins interdigitating with Chalky Boulder Clay. (e.g. The Vale, Swainsthorpe)

9 High level torrent gravels. (e.g. Poringland)

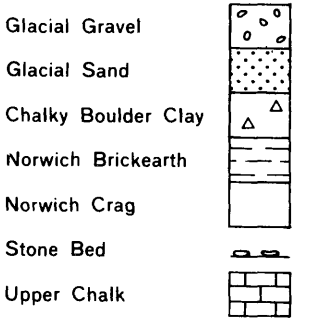


Figure 3. Schematic section across the Chalky Boulder Clay ice front, showing the stratigraphy of the Norwich area

The Glacial Sand and Gravel: In composition the Glacial Sand and Gravel varies from sand to gravel (as defined on page 20). Over some of the blocks it is possible to detect by inspection slight regional variation in grade, for example, in Block C (see page 10). On a local scale, however, there is rapid variation in grade both vertically and laterally, for example in Block E (see page 11).

The grain size of the sand is usually fine to medium, but is occasionally coarse. The sand is composed predominantly of quartz but flint is also often present. It is sometimes clayey and often contains trace amounts of chalk. The gravel is composed predominantly of medium to coarse grained, subangular to subrounded flint. Other constituents are fine to medium grained, rounded ?vein quartz and fine to medium grained, subrounded to rounded quartzite. Cobbles of subrounded quartzite and angular, or irregular shaped, flints have been recorded. Exotic rock types have been found in the Glacial Sand and Gravel, for example, pebbles of rhyolite, microgranite, felsite and porphyrite.

The Norwich Crag: The Norwich Crag consists of alternations of sands, gravelly and shelly sands and thin clay seams. It is, however, regarded as potentially workable for sand and gravel. The grading of the Norwich Crag shows east-west variation (see page 4). from a sandy gravel in the west to a series of beds with gravels, clays and sands in the east.

The sand is usually medium grained, subrounded, and is white or orange in colour.

The gravel is composed of medium grained subrounded to rounded flints with fine to medium grained subrounded to well rounded, quartz and quartzite. The proportion of quartz and quartzite in the gravel increases towards the top of the Norwich Crag.

Shells, where present, are restricted to the lower part of the Norwich Crag.

Results

Two methods of resource assessment are used. The results are summarised in Table 1.

Table 1. The Sand and Gravel Resources of Sheet TG 20

Statistical Assessment of Sand and Gravel Resources

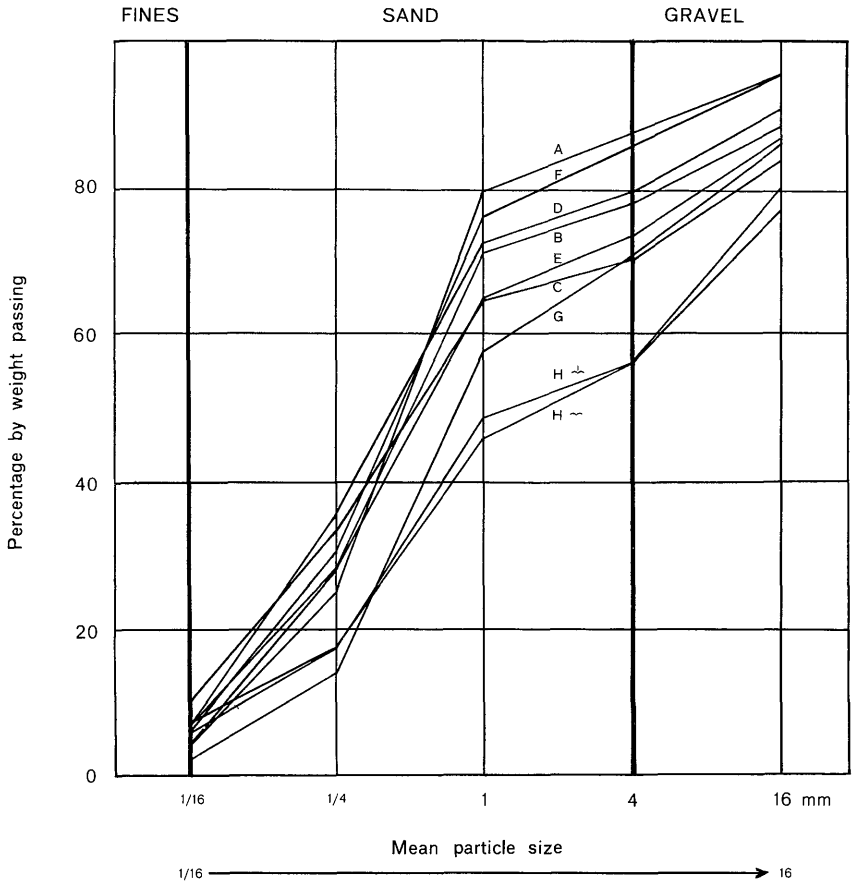
Block	Area		Thickness				Volume of Sand and Gravel				Grading Percentages		
	Block	Sand and Gravel	Overburden		Sand and Gravel		million	million	95% Confidence Limits		Fines	Sand	Gravel
	km²	km²	m	ft	m	ft	m³	yd³	±%	± Vol. million m³	−1/16 mm	+1/16−4 mm	+4−64 mm
A	5.7	5.3	7.3	24.0	8.9+	29.0+	47	62	46	22	4	83	13
B	12.0	12.0	5.3	17.5	8.8+	29.0+	106	138	19	20	7	72	21
C	13.5	12.4	2.3	7.5	6.6	21.5	82	107	32	27	9	62	29
D	6.7	5.9	2.5	8.0	6.9	23.0	41	53	39	16	6	74	20
E	14.7	5.7	0.6	2.0	7.6	25.0	43	58	51	22	4	70	26
F	5.7	4.6	5.1	17.0	14.9+	49.0+	68	89	49	33	6	80	14
G	5.5	4.7	3.7	12.0	11.2+	37.0+	53	69	57	30	1	71	28
H	13.0	13.0	2.0	6.5	4.6	15.0	60	79	22	13	5	53	42
Norwich	23.2	not assessed											
TOTAL	100.0	63.6	2.8	9.0	6.5+	21.0	500	655	13	65			

Subdivisions of Block H

Sub-alluvium Gravel	8.9	8.9	2.7+	9.0	4.5	15.0	40	52	35	14	7	54	39
Terrace Gravel	4.1	4.1	0.5	1.5	4.9	16.0	20	26	40	8	3	53	44

Inferred Assessment for Deposits (not included in statistical assessment above)

Part of A	5.7	c.1.0		unknown			3	4	speculative	unknown
Part of C	13.5	c.1.0	c.12.5?		c.6.4?		6	8	speculative	unknown
Northern Part of E		c.1.4	c.9.8?		c.14.4?		20	26	speculative	
Southern Part of E		2.15		unknown			13	17	speculative	



Block	% by weight passing				
	1/16 mm	1/4 mm	1mm	4mm	16mm
A	4	25	80	87	95
B	7	28	71	79	89
C	9	33	64	71	85
D	6	35	73	80	91
E	4	27	64	74	87
F	6	30	76	86	95
G	1	14	59	72	87
H~	6	17	46	57	81
H⌒	5	17	49	57	78

Figure 4. Particle size distribution for the assessed thickness of sand and gravel in the resource blocks A to H of sheet TG 20

Notes on Resource Blocks A to H

Block A: The Chalk crops out on the northern side of the valley of the River Yare at St.Andrew's Hospital. Otherwise Norwich Crag occurs over the whole area but is only exposed in the south. To the north, Norwich Brickearth rests on Norwich Crag but the outcrop is broken by the valley which runs north from St Andrew's Hospital. In the west Norwich Brickearth is overlain by Glacial Sand and Gravel. Near Ladas Plantation [278 090] the glacial gravels are channelled into Norwich Crag. A few patches of boulder clay are also present in this area. Small, remnant patches of Glacial Sand and Gravel, unlikely to exceed 3 m in thickness are scattered across the outcrops of both the Norwich Crag and Norwich Brickearth at 288 082, 291 084, 296 093 and 298 093.

A statistical assessment has been made only for the sand and gravel resources of the Norwich Crag. The Crag, of average thickness 8.9 m (29 ft), is overlain by Norwich Brickearth, of average thickness 7.3 m (24 ft). The thickness of cover varies from 0.3 m (1 ft) in borehole NE 35 to 18.6 m (61 ft) in borehole NE 29 (where 3.7 m (12 ft) of Glacial Sand and Gravel is also included in the cover). The thickness of Norwich Crag varies from 3.2 m (10 ft) in borehole NE 34 to 11 m (36 ft) in borehole NE 41. The estimate of the volume of Norwich Crag is 47 million m^3 ± 46 per cent at 95 per cent probability.

In borehole NE 29, 0.6 m (2 ft) of soil overlies 3.7 m (12 ft) of Glacial Sand and Gravel. Glacial Sand and Gravel occurs over about 1 km^2 of the western part of the Block. An inferred assessment of the volume of mineral in this area is 3 to 4 million m^3.

In this area the Norwich Crag is relatively clay-free: on average only 4 per cent of the material passed 1/16 mm. The only exception is in borehole NE 34 where 12 per cent of the material passed 1/16 mm. As in Block B the proportion of gravel present increases towards the west, but there is no corresponding increase in clay content eastwards. The average grading for the Block is: fines 4 per cent; sand 83 per cent; gravel 13 per cent.

Block B: The Chalk crops out to the north of the Block along the side of the valley of the Yare, and is overlain by Norwich Crag. Glacial deposits have been channelled into the Crag, and in places have cut down through the Crag to rest on Chalk. Near Red House, Bramerton [290 060], glacial sands and gravels rest on Chalk, while near Trowse Newton [245 063] boulder clay rests on Chalk. In the area of Kirby Bedon boulder clay, Glacial Sand and Gravel, Norwich Crag and Chalk, occur in simple downward stratigraphic sequence.

For the purposes of assessment it has not been practicable to separate the Glacial Sand and Gravel from Norwich Crag. In some places the glacial deposits are separated from Crag by a clay which may be either boulder clay or a clay seam within Norwich Crag. Although these sands and gravels are of different ages and origins they have been considered together as forming a single mineral horizon.

In Block B mineral of average thickness 8.8 m (29 ft) is overlain by 5.3 m (17 ft) of overburden (Chalky Boulder Clay). The total mineral thickness varies between 1.8 m (6 ft) in borehole 162/35b and 15.8 m (52 ft) in borehole NE 44. The thickness of overburden varies from 0.3 m (1 ft) in borehole NE 38 to 14 m (46 ft) in borehole NE 28. The mineral is exposed over most of the fringe area of the block. The thickness of overburden increases towards the south. The estimate of the volume of mineral is 106 million m^2 ± 19 per cent at 95 per cent probability.

The proportion of gravel present within the Norwich Crag increases towards the west. The Glacial Sand and Gravel does not show this trend. Within it the amount of gravel does not vary greatly except in the far east of the block, where both the Glacial Sand and Gravel and the Norwich Crag contain little stone. Generally, but not invariably, the former is richer in gravel. The average grading for the block is: fines 7 per cent; sand 72 per cent; gravel 21 per cent.

Block C: In this block Norwich Crag is absent and only glacial deposits overlie the Chalk, which is irregularly exposed along the sides of the valleys of the rivers Yare and Tas.

To the north, near Keswick, Glacial Sand and Gravel is exposed; southwards these thin and interdigitate with boulder clay. Near Mangreen Hall the boulder clay is more than 17.1 m (59 ft) thick and an area of ground which is considered not to be 'potentially workable' may be more or less extensive than has been outlined on the map. A second such area near Church Farm, Swainsthorpe, has also been outlined where there is reason to believe that the sand and gravel is usually less than 0.9 m (3 ft) thick. Apart from these areas, Glacial Sand and Gravel of various thickness and quality is thought to underlie the whole block. The estimate of the volume of mineral is 82 million m^3 ± 32 per cent at 95 per cent probability.

In some places, the relationship between Glacial Sand and Gravel and boulder clay is complex (see Fig.3, note 8). The relationship of the various beds is not always obvious from the geological map, and drilling has proved unexpected thicknesses of sand and gravel where one would suppose there to be only a thin cover of gravel. For example, at borehole SW 22, 16 m (52 ft) of sand and gravel are present. However, the scattered patches of sand and gravel at Bloy's Grove [212 005], behind Church Farm, Swainsthorpe [218 008], near Swainsthorpe Hall [227 010], and nearby at 218 022, 214 021 and 205 024, are likely to be thin and to overlie boulder clay.

In borehole SW 16 two seams of sand and gravel 5.8 m (19 ft) and 8.2 m (27 ft) thick are separated by 3.4 m (11 ft) of boulder clay. The same boulder clay, showing little variation in thickness or lithology, occurs at almost exactly the same position relative to Ordnance Datum in boreholes SW 11 and 12. By considering the logs of these boreholes, the topography and the outcrop of sand and gravel as mapped, it can be shown that the sand and gravel near The Vale Hospital, Swainsthorpe, has the form of a mound which is partially covered by boulder clay.

The lower sand and gravel occurring in boreholes SW 11, 12 and 16 thins rapidly to the south and east. It is probably present in borehole SW 17 but

is only 0.9 m (3 ft) thick. Within the area enclosed by these four boreholes (approximately 1 km^2) this lower sheet of sand and gravel, on average 6.4 m (21 ft) thick, is overlain by a mean thickness of 12.5 m (41 ft) of material which includes 5.2 m (17 ft) of an upper sand and gravel that has been assessed statistically. An inferred assessment of the volume of the lower sand and gravel deposit is 6 to 7 million m^3.

Where the sand and gravel and boulder clay interdigitate, as, for example, in boreholes SW 13 and 19 it has not always been possible to take account of a second bed of mineral in the resource calculation. Also near to the zone of interdigitation there are scattered interbedded clay seams each usually less than 2 m (6 ft) thick.

The mineral shows a slight north-south variation in grade. In the northern part of the block the mineral at the sample points tends to be sandier and to have a greater proportion of fines than in the south. Analysis of the mineral present in boreholes SW 9, 13 and 19 (in the north) shows on average 11 per cent of fines while in boreholes SW 11 and 12 (in the south) the average is 7 per cent. However, this trend is not simple, as grading analyses for boreholes SW 17 and 23 (in the south) show 15 per cent of fines.

The average grading for the block is: fines 9 per cent; sand 62 per cent; gravel 29 per cent.

Block D: Blocks B and D are geologically similar in that they both contain very variable deposits. In the northern parts of Block D glacial deposits cut down to rest on Chalk but in the south they are channelled into the Norwich Crag which in turn rests unconformably on Chalk. It is not possible to delimit precisely areas where only Glacial Sand and Gravel or Norwich Crag occurs. Because these deposits are contiguous and both are potentially workable no account has been taken of their different styles of deposition, and they have been quantitatively assessed as a single bed of mineral. The estimate of the volume of mineral is 41 million m^3 ± 39 per cent, at 95 per cent probability.

The Chalk crops out in small patches along the east bank of the River Tas. The Chalk is deeply channelled, the channels being infilled with boulder clay, for example, south of Caistor Pit [239 045], or Glacial Sand and Gravel, for example, north of Caistor Pit [238 049].

Thus, along the western margin of the block is a more or less continuous outcrop of mineral, with a few associated patches of boulder clay. To the east, there is a continuous cover of boulder clay, which in the north interdigitates with Glacial Sand and Gravel, but in the south, overlies Norwich Crag.

Away from its margin with the sand and gravel, the boulder clay rapidly increases in thickness and the angle of contact between the two must be steep if not vertical in many cases. At boreholes SW 31, only 200 m (650 ft) from an outcrop of sand and gravel, the boulder clay is thicker than 18 m (60 ft). The increase in thickness cannot be explained by topographic changes alone. A similar situation exists near borehole SW 35.

In boreholes SW 32 and SW 33 there are two seams of sand and gravel in boulder clay. Only the upper sand and gravel has been included in the assessment.

The grading results for the Glacial Sand and Gravel and the Norwich Crag differ. The amount of gravel present in the former varies from 3 to 62 per cent while in the latter the variation is only from 19 to 21 per cent. The heterogeneity of the former is likely to be due to there being at least two ages of Glacial Sand and Gravel present.

The average grading for the block is: fines 6 per cent; sand 74 per cent; gravel 20 per cent.

Block E: A dissected capping of sand and gravel rests on boulder clay and covers much of the ground above the 150 ft contour. This is considered to be a remnant of a more extensive sheet of late stage, high-level torrent gravels. These sands and gravels vary in thickness from 2.9 m (9½ ft) in borehole SE 9 to 30.4 m (100 ft) in borehole 161/103 with a mean thickness of 7.6 m (25 ft). The only overburden is soil which has a mean thickness of 0.6 m (2 ft). The proportion of gravel within the deposit varies from 3 per cent in borehole SE 3 to 53 per cent in borehole SE 8, while the mean is 26 per cent. Only the high-level torrent gravels have been statistically assessed in this block, the volume of mineral present being 43 million m^3 ± 51 per cent at 95 per cent probability.

A bed of sand and gravel underlies about 1.4 km^2 of the northern part of the block. It crops out near Framingham Cottage [265 043] and has been found in borehole SE 1, SE 6 and 161/11. The mean thickness of overburden is 9.8 m (32 ft) and the mean thick-

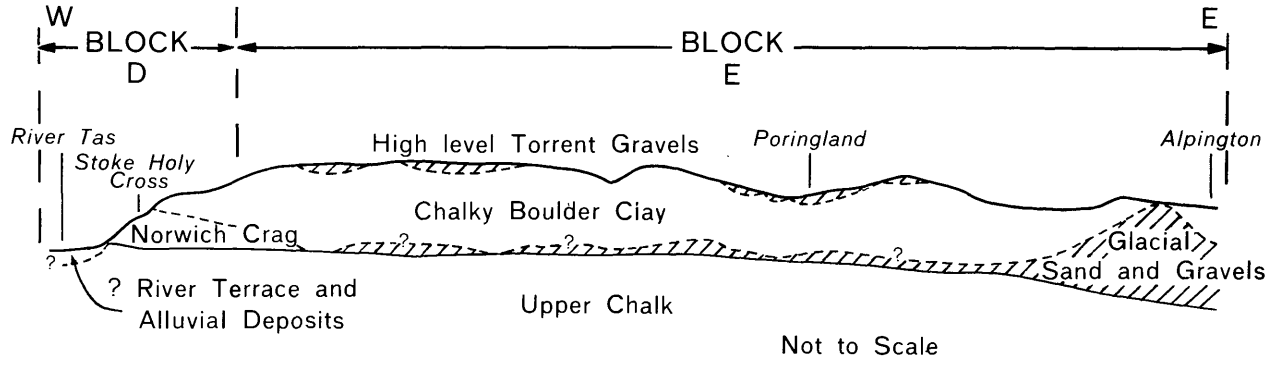


Figure 5. Section to show the general relationships of the deposits from Stoke Holy Cross to Alpington

ness of mineral exceeds 14.4 m (47 ft). An inferred assessment of the volume of mineral is 20 million m^3.

In the southern part of the block 2.15 km^2 of continuous mineral lies beneath overburden. There is insufficient borehole information for the statistical assessment of this area to be made, but the mean thickness of overburden is probably about 12 m (40 ft); the mean thickness of the underlying material is probably only about 6 m (20 ft) although it is as much as 12 m (40 ft) in places (for example, in borehole 161/297). An inferred assessment of the volume of mineral is 13 million m^3.

Sand and gravel may be present beneath boulder clay in the central part of the block but as the thickness of overburden exceeds 18 m, the ground there is considered to be not potentially workable. This buried sand and gravel extends into neighbouring Blocks, D, F and G (see Fig.5).

The grading characteristics of the high-level torrent gravels are: fines 4 per cent; sand 70 per cent; gravel 26 per cent. The available grading information for the buried sand and gravel deposits can be found in the borehole records for SE 1 and SE 6 (see Appendix C).

Block F: As in Block B, glacial deposits have been channelled into the Norwich Crag. The Crag crops out along the sides of the valley of the eastward draining stream called The Beck. It is thought that both to the north and south of The Beck a continuous spread of mineral is present beneath cover. Away from the valley the thickness of cover rapidly increases so that in two areas it probably exceeds 18 m (60 ft) in thickness. For this reason, two areas judged not to be 'potentially workable' have been outlined, south of Manor Farm [284 050], and along the south-western margin of the block.

The estimate of the volume of mineral is 68 million m^3 ± 49 per cent at 95 per cent probability. There is little variation in grading throughout the block. The average grading is: fines 6 per cent; sand 80 per cent; gravel 14 per cent.

Block G: This is the most geologically complex of the blocks as Norwich Crag and Glacial Sand and Gravel in two different modes of occurrence are present beneath cover.

Norwich Crag was found in three boreholes—SE 21, SE 22 and SE 27—where it consisted of grey, fine silty sands, occasionally micaceous and sometimes shelly. The full thickness of the Crag in these boreholes was not proved. However, it is unlikely that the Crag is potentially workable because of its high silt content. The mode of occurrence of the Glacial Sand and Gravel is very similar to that in Block C. Mounds of sand and Gravel, partially buried beneath boulder clay, are present in the area of the pit south of East Poringland [283 004]. More continuous spreads of sand and gravel, which are continuations of those underlying parts of neighbouring Blocks E and F, are present beneath overburden in the north and west of the block. In other areas the Glacial Sand and Gravel is abnormally thick, for example, in borehole 162/142, where 24 m (80 ft) were proved.

Because of the great variability in mode of occurrence of the mineral and the wide spacing of the borehole information, the estimate of volume at 95 per cent probability is relatively imprecise, being 53 million m^3 ± 57 per cent.

Only the Glacial Sand and Gravel has been mechanically analysed. The results show no marked variations in grading. The average grading is: fines 1 per cent; sand 71 per cent; gravel 28 per cent.

Block H: The limits of the block are defined by the extent of the alluvial tracts of the Rivers Tas, Wensum and Yare. Both the terrace and flood plain gravels are potentially workable.

The terrace forms a good feature standing about 2 m (6 ft) above the flood plain. The overburden of soil is, on average, 0.5 m (1.5 ft) thick. The mean thickness of the underlying gravel is 4.9 m. The estimate of the volume of mineral is 20 million m^3 ± 40 per cent at 95 per cent probability.

On the floodplain the thickness of overburden (consisting of alluvial clays, silts, sands and peat) is greater, and is, on average, 2.7 m thick (9 ft). The underlying gravel has a mean thickness greater than 4.5 m: a few boreholes did not prove the full thickness. The estimate of the volume of mineral is 40 million m^3 ± 35 per cent at 95 per cent probability.

The grading of both the terrace and sub-alluvium gravels is remarkably similar and it is probable that they are continuous, representing a single phase of deposition. The average grading is: fines 5 per cent; sand 53 per cent; gravel 42 per cent.

The Tas-Yare valley between Old Lakenham [236 062] and the New Cut at Thorpe-next-Norwich [254 082] follows the course of a glacial channel cut into the Chalk. Over-deepened by subglacial meltwaters it was later filled with boulder clay. The longitudinal profile is exceedingly irregular. The deepest part of the channel known on TG 20 is at Caistor St Edmund where the surface of the Chalk lies at −34.7 m (114 ft). No channel is known in the Yare valley below the New Cut or above Old Lakenham. In these reaches of the river alluvial deposits lie directly on the Chalk, whilst in the channel they lie on boulder clay.

List of Quarries

In 1970 only one sand and gravel quarry was known to be in operation in the area. All others have been abandoned. A list of operational and abandoned quarries is given in Table 2.

Location	*Grid Reference*
Working quarry	
Caistor St Edmunds	2396 0474
Abandoned quarries:	
Keswick Mill	213 051
near Keswick	214 042
Church Farm, Swainsthorpe	216 008
Gravel Pit Plantation	236 033
Fir Hill	202 046
Stoke Holy Cross	234 023
Dunston Hill	221 033
Tagus Farm	242 021
Skeets Hill	233 001
Poringland	262 022
Poringland	263 026
Dove Lane, Poringland	275 007
Gravel pit, near Welbeck Farm	285 003

Table 2. List of quarries and their locations.

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Appendix A: Statistical procedure

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

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

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

Statistical Assessment

1. The simple methods used in the calculations are consistent with the amount of data provided by the survey. Conventional confidence limits have been calculated for the 95 per cent probability level.

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

$$L_v = \sqrt{L_a^2 + L_t^2}$$

where L_v, L_a *and* L_t are confidence limits for volume, area and thickness respectively, expressed either as percentages or in absolute units.

3. The above relationship may be transposed such that:

$$L_v = L_t \sqrt{\left[1 + \left(\frac{L_a}{L_t}\right)^2\right]}$$

From this it can be seen that as $\left(\frac{L_a}{L_t}\right)$ tends to 0, L_v tends to L_t. If, therefore, the errors in the estimation of area are small with respect to those inherent in the thickness estimate, then the confidence limits associated with the volume estimate will approximate to those for the thickness estimate.

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

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

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

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

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

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

The 95 per cent confidence limits for the estimate of mean thickness of the block of sand and gravel, $L_{\bar{t}}$, may be expressed either in absolute units = $\bar{t} \pm \alpha\hat{\sigma}$ metres or as a percentage = $\bar{t}$ *metres* $\pm \frac{100 \alpha \hat{\sigma}}{\bar{t}}$ per cent where $\alpha = \frac{\theta}{\sqrt{n}}$ and is evaluated by reference to statistical tables for the distribution of "Student's t", from which the value of θ corresponding to the 95 per cent probability level and $(n-1)$ degrees of freedom is obtained.

6. Values of α for values of n up to 20 are set out below:

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

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

$$L_v \leqslant 1.05\, L_{\bar{t}}$$

This relationship is used in the example, Figure 7.

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

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

In practice, equal weighting can often be applied to thicknesses at all sample-points within a block. If however, there is unequal distribution of points, the thicknesses must be weighted to avoid the bias in trend this creates. Weighting factors are determined by first

dividing the block into broad zones, to each of which a value roughly proportional to its area is assigned. This value is then shared between the sample-points within the zone.

10. A distinction based on field evidence may be made between the central parts of the block and the margins, where the deposit is best represented by a triangular cross-section (Figure 6) with thicknesses varying from that (t_c) of the central portion to zero at the feather edge; the mean thickness is therefore $\frac{t_c}{2}$.

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

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

12. In some circumstances, the cross section of the marginal area is better considered as a trapezium, a positive value, t_e, being ascribed to the thickness at the edge of the deposit (Figure 6). The mean height of the marginal area is then $\frac{1}{2}(t_c + t_e)$.

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

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

15. An illustration of the procedures outlined above is given in Figures 7 and 8, where a volume estimate with confidence limits is derived for fictitious data.

Accuracy of Results

For the eight resource blocks on Sheet TG 20, the accuracy of the results at the 95 per cent confidence level (that is, the probability that nineteen times out of twenty, the true volume present lies within the given limits) varies between 19 per cent and 57 per cent. It should be remembered, however, that the true values are more likely to be nearer the figure estimated than either of the limits. Moreover, it is probable that roughly the same percentage limits would apply for the estimate of volume of a very much smaller parcel of ground (say 200 acres) containing similar sand and gravel deposits if the results from the same number of sample points (as provided by, say, ten boreholes) were used in the calculation. Thus, if closer limits are needed for quotation of reserves of part of a block, it can be expected that data from more than ten sample points are required, even if the area were quite small. This point can be illustrated by considering the whole of the potentially workable sand and gravel (as already defined) on Sheet TG 20. The volume (500 million m³) of this can be estimated to limits of ± 13 per cent at the 95 per cent confidence level, by a calculation based on the data from as many as 115 sample-points spread across the eight resource blocks. The inferred assessments of 39 million m³ are not included in this total of volume. However, it must again be

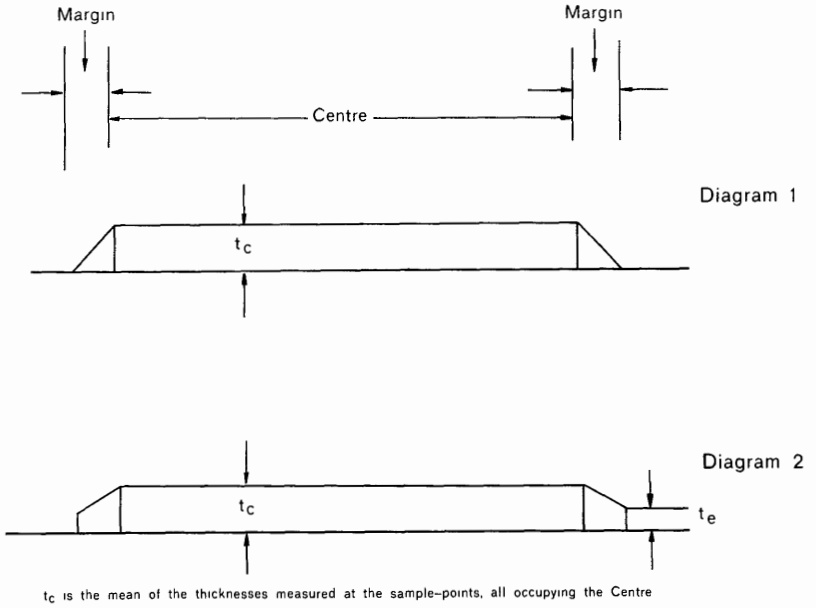


Figure 6. Diagrams showing how a deposit of sand and gravel may be resolved into two parts: centre and margin

EXAMPLE OF RESOURCE BLOCK ASSESSMENT

Statement and Calculation

BLOCK CALCULATION

1 : 25 000 Sheet } Fictitious
Block }

Area

Block : 11.08 km²

Mineral : 8.32 km²

Volume

Overburden : 21 million m³

Mineral : 37 million m³

Thickness

Overburden : 2.5 m

Mineral : 4.4 m

95 per cent Confidence Limits of the estimate of Mineral Volume

Percentage : ± 48 per cent

Units of volume : ± 18 million m³

Thickness Estimate (t = thickness). Measurements in Metres

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

Calculation of Confidence Limits

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

$n = 9$

$\alpha = 0.77$

$\hat{\sigma} = 2.66$

$t = 4.47$

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

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

Figure 7. Example of resource block assessment: statement and calculation

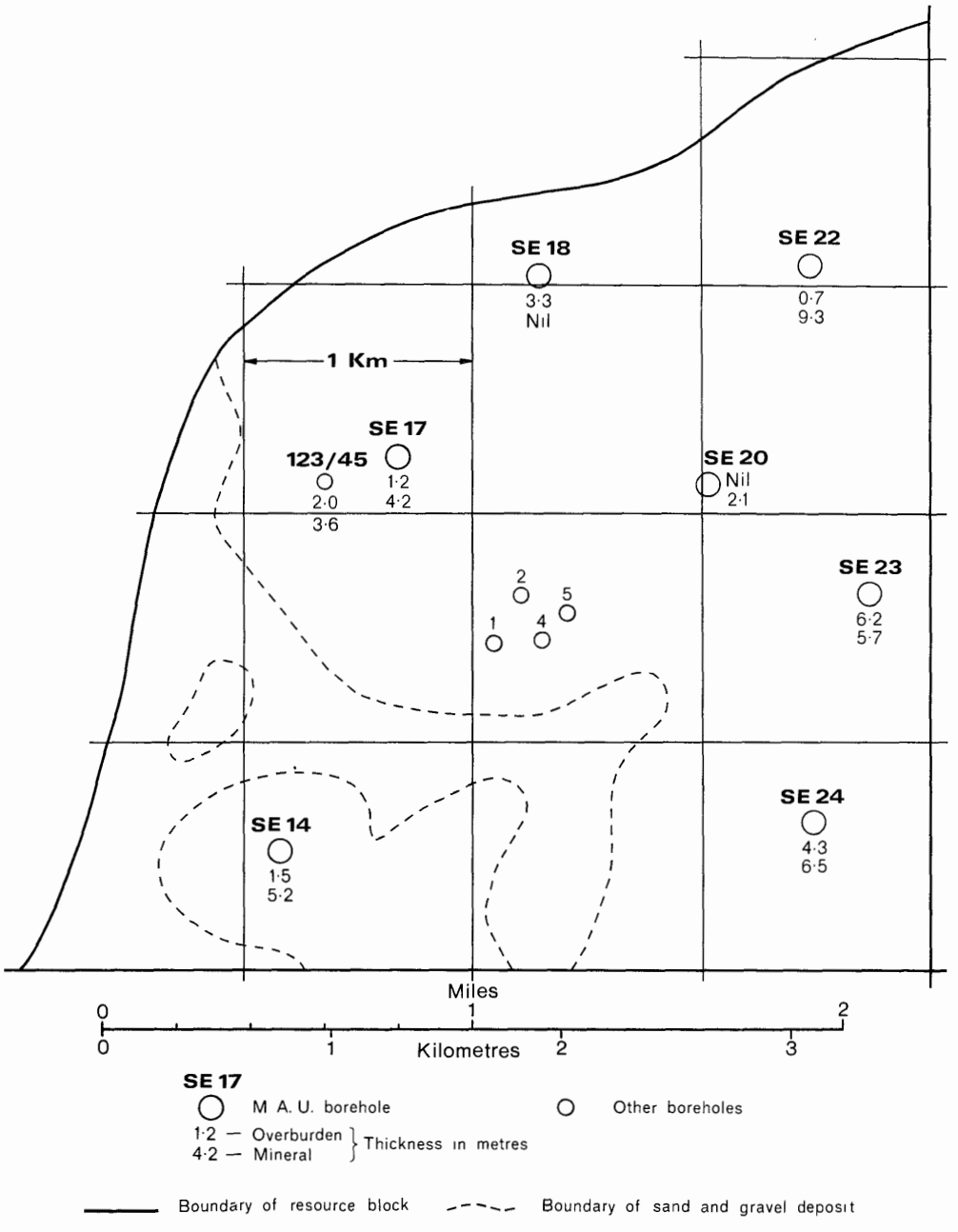


Figure 8. Example of resource block assessment: map of a fictitious block, to accompany the calculation presented in Fig. 7

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.

Appendix B: Particle size analysis

The size distribution of borehole samples is commonly presented as logarithmic cumulative curves (see, for example, British Standard 1377:67).

In this report the grading is shown on the borehole record sheets, the intercepts corresponding with the simple geometric scale 1/16 mm, ¼ mm, 1 mm, 4 mm, 16 mm, and so on as required.

The scale is based on the Wentworth classification. As Archer (1970) has emphasised, there is a pressing need for a simple metric scale acceptable to both scientific and engineering interests, for which the class limit sizes correspond closely with certain marked changes in the natural properties of mineral particles. For example, there is an important change in the degree of cohesion between particles at about the 1/16 mm size, which approximates to the generally accepted boundary between silt and sand. In this and other respects the chosen scale is satisfactory.

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 reading at 16 mm distinguishes

pebbles from cobbles. The term 'gravel' is used loosely to denote both pebble-sized and cobble-sized material.

Original sample grading curves are available for reference at the Institute.

Appendix C: Borehole records

Explanation

Annotated Example of a Borehole Record

TG 20 SE 5[1] 2594 0950[2] West Poringland[3]

Surface level (+ 50.3 m) + 165 ft[4] Water not struck[5]
Wirth B 1, 8 in diameter, August 1969.[6]

Overburden[7] (0.9 m) 3 ft
Mineral (9.1 m) 30 ft
Waste (11.6 m) 38 ft
Mineral (2.8 m+) 9 ft+[8]

			Thickness (m)	Thickness ft	Depth[11] (m)	Depth ft
		Soil[10]	(0.9)	3	(0.9)	3
Glacial Sand[9] and Gravel	(a)	Pebbly sand, clayey from 9 to 15 ft. Gravel: medium with fine and coarse, subrounded to subangular flint with a trace of subrounded quartz. Sand: medium with fine and coarse, subangular. Light brown.	(9.1)	30	(10.0)	33
Boulder Clay		Dark grey chalky clay, with traces of sand and gravel at the top, becoming brown and sandy near the base.	(11.6)	38	(21.6)	71
Glacial Sand and Gravel	(b)	Sand. Gravel: fine, subangular, mainly flint. Sand: fine and medium, subangular. Orange to brown. Traces of grey clay.	(2.8+)	9+	(24.4)	80

		%
(a)		
	+64 mm :	0
Gravel 23%[15]	−64 + 16 :	12
	−16 + ¼ :	11
	− 4 + 1 :	8
Sand 73%	− 1 + ¼ :	45
	− ¼ +1/16 :	20
Fines 4%	−1/16 :	4
(b)		
	+64 mm :	0
Gravel 2%	−64 + 16 :	0
	−16 + 4 :	2
	− 4 + 1 :	3
Sand 95%	− 1 + ¼ :	42
	− ¼ +1/16 :	50
Fines 3%	−1/16 :	3

	Depth below surface (ft)[12]	Percentage[13] Fines	Sand	Gravel
(a)	3 - 6	2	66	32
	6 - 9	1	83	16
	9 - 12	12	80	8
	12 - 15	10	78	12
	15 - 18	11	86	3
	18 - 21	(1	68	31)[14]
	21 - 24	1	53	46
	24 - 27	0	71	29
	27 - 30	1	73	26
	30 - 33	0	75	25
(b)	71 - 74	0	97	3
	74 - 77	1	99	0
	77 - 80	8	89	3

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

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

1) The number of the 1 : 25 000 sheet on which the borehole lies, for example, TG 20.
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, SE 5.

Thus the full Registration Number is TG 20 SE 5. Usually this is abbreviated to SE 5 in the text.

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

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

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

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

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

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

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

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

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

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. 3).

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

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

Note on metrication.

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

Grading Information

12. Sampling.
A continuous series of bulk samples is taken throughout the thickness of sand and gravel. A new sample is commenced whenever there is an appreciable lithological change within the sand and gravel, or for every 3 ft of depth (see also p. 17).

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 are not available but an attempt has been made to give grading information by comparing the grading and field descriptions of adjacent samples with the sample in question. Such estimates are shown in square brackets.

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

Classification and Description of Sand and Gravel on the Borehole Records.
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 ternary classification based on Willman (1942) has been adopted.

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

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

The term 'clay' (as written, with single quote marks), is used to describe all material passing 1/16 mm. Thus it has no mineralogical significance and includes particles falling within the size 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.9). The procedure is as follows.

1. Classify according to ratio of sand to gravel.
2. Describe fines in terms of above system.

The resultant adjectival qualification is stated first in the mineral description. 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. 19).

Description of Sand and Gravel

Each bulk sample of sand and gravel is described by a geologist at the borehole site. The description is a subjective visual appraisal of the proportion of gravel, sand and fines, and of the composition, size and degree of rounding of the mineral components.

Composition: The rock types present are identified. The relative proportions of the constituents in the gravel fraction are indicated by use of the words 'and' or 'with'. For example, 'flint and quartz' indicates very approximately 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'.

Size: 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).

In this Report, a classification based on Udden's geometric scale and using a simplified form of Wentworth's terminology is used (see Table 3).

Since the descriptions derive from a visual appraisal of size, they may be somewhat inexact, depending on the experience of the observer. The following qualifications of predominant pebble size have been used: pebbles are described as 'coarse' if their sizes obviously range from 64 to 16 mm; medium if their sizes are about 16 mm; and fine if their sizes obviously range from 16 to 4 mm.

Degree of rounding: The degree of rounding is concerned with the sharpness of the edges and corners of a clastic fragment. It is independent of shape. There is a continuous series from angular to well-rounded.

The terms used to describe the degree of rounding of particles (after Pettijohn, 1957) are as follows:

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

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

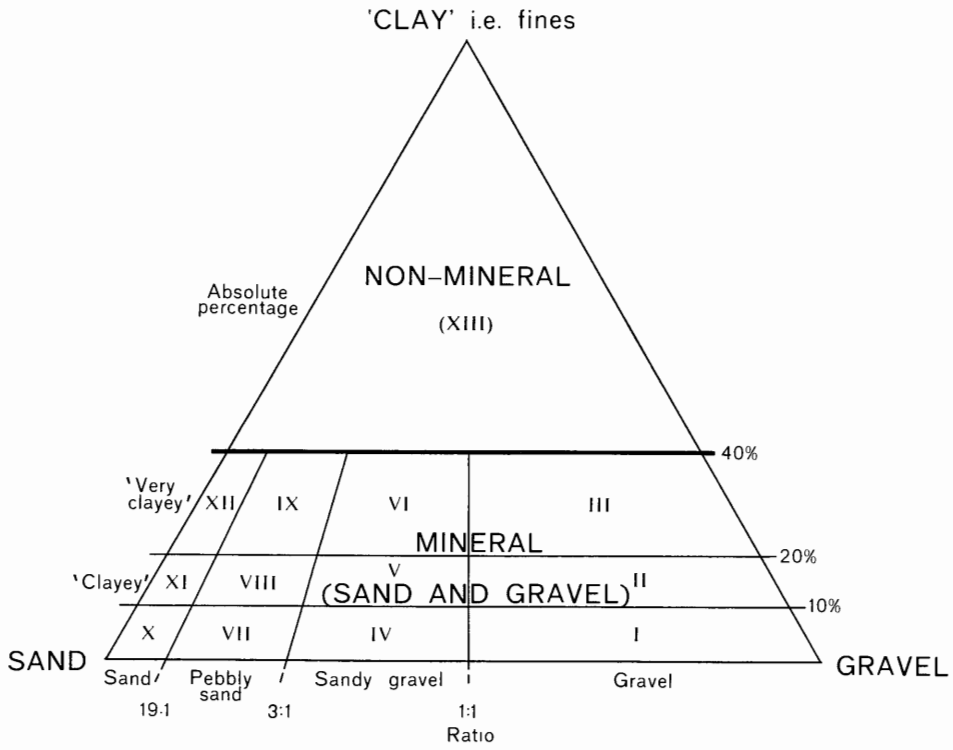
Subrounded: showing considerable wear. The edges and corners are rounded off to smooth curves. Original grain shape is still distinct.

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

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

Table 3. Classification of Gravel, Sand and Fines

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



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

MINERAL

(XIII) NON-MINERAL

Figure 9. Diagram to show the descriptive categories used in the classification of sand and gravel

Borehole No. by sheet quadrants	Grid Reference (all fall in 100km square TG)		Borehole No. by sheet quadrants	Grid Reference (all fall in 100km square TG)	
TG 20 NW			TG 20 NE		
19	2163	0518	23	2545	0764
20	2375	0572	24	2536	0632
21	2448	0636	25	2546	0563
22	2446	0542	26	2645	0735
23	2019	0552	27	2635	0662
			28	2659	0553
			29	2743	0952
			30	2737	0826
			31	2774	0741
			32	2736	0648
			33	2766	0542
			34	2835	0947
			35	2879	0889
			36	2878	0804
			37	2822	0800
			38	2827	0663
			39	2834	0554
			40	2948	0962
			41	2957	0872
			42	2971	0763
			43	2973	0684
			44	2916	0598
			45	2952	0523
TG 20 SW			TG 20 SE		
8	2028	0470	1	2558	0467
8a	2077	0441	2	2557	0356
9	2061	0372	3	2574	0260
10	2061	0257	4	2535	0167
11	2032	0141	5	2593	0094
12	2053	0047	6	2664	0486
13	2165	0411	7	2677	0383
14	2136	0318	8	2682	0281
15	2122	0222	9	2681	0219
16	2114	0165	10	2664	0129
17	2133	0041	11	2650	0035
18	2233	0431	12	2754	0468
19	2204	0359	13	2784	0362
20	2270	0267	14	2769	0234
21	2232	0218	15	2758	0154
22	2216	0148	16	2733	0042
23	2220	0035	17	2856	0475
24	2297	0030	18	2850	0371
25	2343	0487	19	2841	0268
26	2349	0406	20	2863	0171
27	2318	0311	21	2843	0090
28	2331	0187	22	2876	0033
29	2372	0169	23	2949	0414
30	2355	0068	24	2960	0330
31	2482	0432	25	2949	0252
32	2468	0365	26	2960	0133
33	2405	0272	27	2951	0045
34	2494	0255			
35	2425	0144			
36	2486	0060			

The Records

TG 20 ¹ NW 19 2163 0518 West of Keswick Mill

Surface level (+ 5.2 m) + 17 ft Water struck at (+ 3.0 m) + 10 ft
Wirth B 1, 8-in diameter, August 1969

Overburden (0.9 m) 3 ft
Mineral (7.3 m) 24 ft
Bedrock (0.9 m +) 3 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
	Topsoil and brown clayey subsoil.	(0.9)	3	(0.9)	3
Sub-alluvium Gravel	Sandy gravel. Clayey in parts. Gravel : medium, angular to subangular flint with fine and coarse subangular flint and subrounded quartz. Sand : predominantly medium with coarse, subangular white flint and with brown-grey, or green-grey clay; traces of chalk.	(7.3)	24	(8.2)	27
Upper Chalk	Chalk.	(0.9+)	3+	(9.1)	30

		%
	+ 64 mm	0
Gravel 23%	− 64 + 16	7
	− 16 + 4	16
	− 4 + 1	11
Sand 67%	− 1 + ¼	41
	− ¼ + 1/16	15
Fines 10%	− 1/16	10

Depth below surface (ft)	Percentage Fines	Sand	Gravel
3 - 6	15	66	19
6 - 9	8	72	20
9 - 12	7	73	20
12 - 15	3	66	31
15 - 18	16	55	29
18 - 21	17	68	15
21 - 24	3	64	33
24 - 27	8	75	17

TG 20 NW 20 2375 0572 South of Tas-Yare confluence

Surface level (+ 7.9 m) + 26 ft Groundwater conditions not recorded
Shell and auger, 8-in diameter, October 1969

Overburden (0.6 m) 2 ft
Mineral (5.5 m) 18 ft
Waste 24.4 m +) 80 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
	Soil.	(0.6)	2	(0.6)	2
Terrace Gravel	Gravel. Gravel: medium with fine and coarse angular to subrounded flint and subrounded quartzite. Subangular to well rounded fine quartz. Sand: medium to coarse with fine subangular to subrounded quartz; with angular flint granules.	(5.5)	18	(6.1)	20
Boulder Clay	Light blue-grey clays; fine to coarse, subrounded to well rounded chalk fragments; rare fine to coarse subangular flint gravel.	(24.4+)	80+	(30.5)	100

		%
	+ 64 mm	0
Gravel 62%	– 64 + 16	31
	– 16 + 4	31
	– 4 + 1	10
Sand 36%	– 1 + ¼	21
	– ¼ + 1/16	5
Fines 2%	– 1/16	2

Depth below surface (ft)	Percentage Fines	Sand	Gravel
2 - 5	4	44	52
5 - 8	1	40	59
8 - 11	1	36	63
11 - 14	0	33	67
14 - 17	2	28	70
17 - 20	1	41	58

TG 20 NW 21 2448 0636 Near Hospital Farm, Trowse Newton

Surface level (+ 6.9 m) + 23 ft Groundwater conditions not recorded
Shell and auger, 8-in diameter, October 1969

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

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
	Soil.	(0.6)	2	(0.6)	2
Terrace Gravel	'Very clayey' pebbly sand. Gravel: medium to coarse subangular to subrounded flint. Sand: fine and medium with coarse subrounded quartz; subangular flakes of flint.	(0.9)	3	(1.5)	5
Boulder Clay	Chalky clay with fine to coarse flints.	(0.9)	3	(2.4)	8
Upper Chalk	Chalk.	(0.9+)	3+	(3.3)	11

		%
	+ 64 mm	0
Gravel 6%	− 64 + 16	4
	− 16 + 4	2
	− 4 + 1	6
Sand 58%	− 1 + ¼	31
	− ¼ + 1/16	21
Fines 36%	− 1/16	36

Depth below surface (ft)	Percentage Fines	Sand	Gravel
2 - 5	36	58	6

TG 20 NW 22 2446 0542 Near Boundary Belt, Caistor St Edmunds

Surface level (+ 30.4 m) + 100 ft Groundwater conditions not recorded
Shell and auger, 8-in diameter, October 1969

Overburden (3.7 m) 12 ft
Mineral (9.4 m) 31 ft
Bedrock (0.9 m +) 3 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Boulder Clay	Soil on occasionally gravelly, brown, chalky clay.	(3.7)	12	(3.7)	12
Norwich Crag	Sandy gravel. Occasional clay bands. Gravel: fine to medium with coarse subangular to subrounded blue, yellow-red, yellow-brown flints. Subrounded quartz and quartzite; subrounded to well rounded quartzite and sandstone. Sand: medium, with coarse in upper part of deposit, to fine and medium in lower part. Subangular to subrounded quartz with subangular yellow-brown flint. Some grey clay.	(9.4)	31	(13.1)	43
Upper Chalk	Chalk.	(0.9+)	3+	(14.0)	46

		%
	+ 64 mm	0
Gravel 30%	– 64 + 16	12
	– 16 + 4	18
	– 4 + 1	13
Sand 61%	– 1 + ¼	32
	– ¼ + 1/16	16
Fines 9%	– 1/16	9

Depth below surface (ft)	Percentage Fines	Sand	Gravel
12 - 15	3	44	53
15 - 18	3	61	36
18 - 21	1	73	26
21 - 24	7	67	26
24 - 27	4	54	42
27 - 30	4	39	57
30 - 33	16	76	8
33 - 36	5	83	12
36 - 39	34	59	7
39 - 43	11	53	36

TG 20 NW 23 2019 0552 The Loke, Cringleford

Surface level (+ 6.7 m) + 22 ft Water struck at (+ 6.1 m) + 20 ft
Shell and auger, 8-in diameter, May 1970

Overburden (0.3 m) 1 ft
Mineral (4.0 m) 13 ft
Bedrock (0.9 m +) 3 ft +

		Thickness (m)	ft	Depth (m)	ft
	Stony soil.	(0.3)	1	(0.3)	1
Terrace Gravel	Gravel. Gravel: fine to coarse mainly subangular flint with some fine subrounded quartz, occasional subrounded to subangular flint and quartz cobbles. Sand: mainly medium and coarse subrounded quartz and subangular flint. Brown.	(4.0)	13	(4.3)	14
Upper Chalk	Chalk.	(0.9+)	3+	(5.2)	17

		%
	+ 64 mm:	0
Gravel 67%	– 64 + 16	40
	– 16 + 4	27
	– 4 + 1	13
Sand 32%	– 1 + ¼	15
	– ¼ + 1/16	4
Fines 1%	– 1/16	1

Depth below surface (ft)	Percentage Fines	Sand	Gravel
1 - 4	2	41	57
4 - 7	1	37	62
7 - 10	1	27	72
10 - 13	2	40	58
13 - 14	1	27	72

TG 20 NE 23 2545 0764 Trowse Newton Hall

Surface level (+ 7.6 m) + 25 ft Water not struck
Wirth B.1, 8-in diameter, October 1969

Overburden (0.3 m) 1 ft
Mineral (11.0 m) 36 ft
Bedrock (0.9 m +) 3 ft +

		Thickness (m)	ft	Depth (m)	ft
	Soil.	(0.3)	1	(0.3)	1
Terrace Gravel	Sandy gravel. Clayey between 16 and 19 ft. Gravel: medium to coarse, subangular flint; with subrounded quartz. Sand: fine to medium trace of coarse. Usually red-yellow, brown.	(11.0)	36	(11.3)	37
Upper Chalk	Chalk.	(0.9+)	3+	(12.2)	40

		%
	+ 64 mm	0
Gravel 33%	– 64 + 16	20
	– 16 + 4	13
	– 4 + 1	6
Sand 63%	– 1 + ¼	30
	– ¼ – 1/16	27
Fines 4%	– 1/16	4

Depth below surface (ft)	Percentage Fines	Sand	Gravel
1 - 4	1	37	62
4 - 7	1	41	58
7 - 10	1	67	32
10 - 13	1	39	60
13 - 16	1	84	15
16 - 19	15	84	1
19 - 22	3	97	0
22 - 25	5	73	22
25 - 28	2	64	34
28 - 34	9	66	25
34 - 37	2	44	54

TG 20 NE 24 2536 0632 Crown Point Dairy Farm, Trowse with Newton

Surface level (+ 30.5 m) + 100 ft Groundwater conditions not recorded
Shell and auger, 8-in diameter, October 1969

Overburden (7.0 m) 23 ft
Mineral (8.5 m) 28 ft
Bedrock (0.9 m +) 3 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Boulder Clay	Soil on silty sandy clays with chalk.	(7.0)	23	(7.0)	23
Glacial Sand and Gravel and Norwich Crag (undivided)	Sandy gravel. Shell in bottom 6 ft of deposit. Clayey in parts. Gravel: medium with fine and coarse, subangular to subrounded flint; with subrounded quartzite and fine to medium subrounded quartz. Sand: medium with fine and coarse. Brown or yellowish brown.	(8.2)	27	(15.2)	50
Norwich Crag	Flint cobbles.	(0.3)	1	(15.5)	51
Upper Chalk	Chalk.	(0.9+)	3+	(16.4)	54

		%
	+ 64 mm	0
Gravel 26%	– 64 + 16	10
	– 16 + 4	16
	– 4 + 1	9
Sand 65%	– 1 + ¼	34
	– ¼ + 1/16	22
Fines 9%	– 1/16	9

Depth below surface (ft)	Percentage Fines	Sand	Gravel
23 - 26	1	57	42
26 - 29	27	41	32
29 - 32	2	79	19
32 - 35	4	84	12
35 - 38	12	82	6
38 - 41	6	67	27
41 - 44	18	33	49
44 - 47	5	75	20
47 - 50	2	72	26

TG 20 NE 25 2546 0563 Near Valley Belt, Bixley

Surface level (+ 31.2 m) + 102 ft Groundwater conditions not recorded
Shell and auger, 8-in diameter, October 1969

Overburden (6.1 m) 20 ft
Mineral (9.9 m) 32.5 ft
Bedrock (0.9 m +) 3 ft +

			Thickness (m)	Thickness ft.	Depth (m)	Depth ft
Boulder Clay		Soil on brown or grey sandy clays with chalk and flint. Occasional partings of fine grey sand.	(6.1)	20	(6.1)	20
Norwich Crag	(a)	'Clayey' pebbly sand. Trace of shell. Gravel: fine subangular flint. Sand: fine to medium, silver or orange in colour.	(6.4)	21	(12.5)	41
	(b)	Gravel. Gravel: fine to coarse subrounded to well rounded flint; with subangular flint cobbles towards base and with subrounded to well rounded quartz and quartzite.	(3.5)	11.5	(16.0)	52.5
Upper Chalk		Chalk.	(0.9+)	3+	(16.9)	55.5

(a)

		%
	+ 64 mm	0
Gravel 6%	– 64 + 16	2
	– 16 + 4	4
	– 4 + 1	4
Sand 80%	– 1 + ¼	52
	– ¼ + 1/16	24
Fines 14%	– 1/16	14

(b)

	+ 64 mm	0
Gravel 82%	– 64 + 16	49
	– 16 + 4	33
	– 4 + 1	8
Sand 17%	– 1 + ¼	1
	– ¼ + 1/16	8
Fines 1%	– 1/16	1

Depth below surface (ft)	Percentage Fines	Sand	Gravel
20 - 23	29	81	0
23 - 26	12	86	2
26 - 29	12	80	8
29 - 32	12	76	12
32 - 35	29	65	6
35 - 38	4	92	4
38 - 41	1	89	10
41 - 44	1	8	91
44 - 47	0	4	96
47 - 49	0	6	94
49 - 52.5	3	50	47

TG 20 NE 26 2645 0735 Low Shed, Trowse with Newton

Surface level (+ 18.2 m) + 60 ft Water not struck
Wirth B1, 8-in diameter, October 1969

Overburden (4.0 m) 13 ft
Mineral (6.4 m) 21 ft
Bedrock (0.9 m +) 3 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
?Boulder Clay	Stony soil on brown stony clay.	(4.0)	13	(4.0)	13
?Norwich Crag	'Very clayey' sandy gravel. Proportion of gravel increasing with depth. Occasional chalk fragments near base of deposit. High clay content especially in upper part of deposit. Gravel: medium to coarse angular to subangular flint; with occasional subrounded flint, quartz and quartzite. Sand: fine to medium, occasionally coarse, subrounded quartz and subangular flint. Orange or yellowish brown.	(6.4)	21	(10.4)	34
Upper Chalk	Chalk.	(0.9+)	3+	(11.3)	37

		%
	+ 64 mm	: 4
Gravel 21%	- 64 + 16	: 9
	- 16 + 4	: 8
	- 4 + 1	: 5
Sand 55%	- 1 + ¼	: 20
	- ¼ + 1/16	: 30
Fines 24%	- 1/16	: 24

Depth below surface (ft)	Percentage Fines	Sand	Gravel
13 - 16	35	49	16
16 - 19	27	68	5
19 - 22	35	63	2
22 - 25	37	60	3
25 - 28	22	51	27
28 - 31	0	65	35
31 - 34	12	30	58

TG 20 NE 27 2635 0662 Near Big Wood, Trowse

Surface level (+ 30.6 m) 101 ft Groundwater conditions not recorded
Shell and auger, 8-in diameter, October 1969

Overburden (7.3 m) 24 ft
Mineral (9.2 m) 30 ft
Bedrock (1.8 m +) 6 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Boulder Clay	Soil on slightly gravelly clayey sand and brown stony clay.	(7.3)	24	(7.3)	24
Glacial Sand and Gravel	Sandy gravel. Clayey in parts and with blue mottled clay near the base of the deposit. Gravel: fine to coarse with occasional cobbles, subrounded and occasionally subangular flint and quartzite; with fine to medium subrounded quartz. Sand: fine to medium, occasionally coarse, subrounded, quartz. Brownish yellow.	(9.2)	30	(16.5)	54
Upper Chalk	Chalk.	(1.8+)	6+	(18.3)	60

		%
	+ 64 mm	0
Gravel 43%	−64 + 16	21
	−16 + 4	22
	− 4 + 1	7
Sand 52%	− 1 + ¼	29
	− ¼ + 1/16	16
Fines 5%	− 1/16	5

Depth below surface (ft)	Percentage Fines	Sand	Gravel
24 - 27	1	30	69
27 - 30	1	54	45
30 - 33	1	79	20
33 - 36	6	73	21
36 - 39	3	49	48
39 - 42	1	17	82
42 - 45	3	74	23
45 - 48	5	65	30
48 - 51	23	35	42
51 - 54	2	46	52

TG 20 NE 28 2659 0553 Trumpery Lane, Bixley

Surface level (+ 38.2 m) + 125 ft Water not struck Overburden (14.0 m) 46 ft
Wirth B1, 8-in diameter, October 1969 Mineral (10.4 m +) 34 ft +

			Thickness (m)	Thickness ft	Depth (m)	Depth ft
Boulder Clay		Soil on brown chalky clay with interbedded seam of clayey medium sand with fine gravel from 41 to 42 ft.	(14.0)	46	(14.0)	46
Glacial sand and Gravel	(a)	Sandy gravel. Gravel: coarse with some medium, occasional cobbles, subrounded to well rounded dark brown, blue and black flint; with subrounded quartzite and subrounded to well rounded quartz. Sand: fine to medium with coarse, silver-grey or yellowish.	(5.5)	18	(19.5)	64
Norwich Crag	(b)	Sand. Gravel: fine subrounded flint. Sand: fine and medium, subangular. Yellow, grey and brown.	(4.9+)	16+	(24.4)	80

(a)

		%
	+ 64 mm	0
Gravel 39%	- 64 + 16	27
	- 16 + 4	12
	- 4 + 1	8
Sand 56 %	- 1 + ¼	33
	- ¼ + 1/16	15
Fines 5%	- 1/16	5

(b)

		%
	+ 64 mm	0
Gravel 5%	- 64 + 16	3
	- 16 + 4	2
	- 4 + 1	5
Sand 94%	- 1 + ¼	36
	- ¼ + 1/16	53
Fines 1%	- 1/16	1

	Depth below surface (ft)	Percentage Fines	Sand	Gravel
(a)	46 - 49	1	77	22
	49 - 52	20	55	25
	52 - 55	0	33	67
	55 - 58	5	62	33
	58 - 61	6	46	48
	61 - 64	0	58	42
(b)	64 - 67	0	100	0
	67 - 70	0	88	12
	70 - 73	0	85	15
	73 - 76	1	99	0
	76 - 80	2	98	0

TG 20 NE 29 2743 0952 Pound Lane, Thorpe St Andrew

Surface level (+ 32.3 m) + 106 ft Water not struck
Wirth B 1, 8-in diameter, September 1969

Overburden (0.6 m) 2 ft
Mineral (3.7 m) 12 ft
Waste (14.3 m) 47 ft
Mineral (5.8 m +) 19 ft+

			Thickness (m)	Thickness ft	Depth (m)	Depth ft
		Soil.	(0.6)	2	(0.6)	2
Glacial Sand and Gravel	(a)	Pebbly sand. Gravel concentrated in the top 3 ft of the deposit. Gravel: fine and medium with coarse subrounded to well rounded quartz and subrounded to subangular flint. Sand: medium with fine and coarse Brown and orange.	(3.7)	12	(4.3)	14
Norwich Brickearth		Brown to orange clay with occasional flint pebbles.	(14.3)	47	(18.6)	61
Norwich Crag	(b)	Sandy gravel. Gravel: fine to coarse well rounded to subrounded quartz and subrounded to subangular flint. Sand: medium with fine and coarse, subangular to subrounded. Yellow.	(5.8+)	19+	(24.4)	80

(a)

		%
	+ 64 mm	0
Gravel 14%	− 64 + 16	4
	− 16 + 4	10
	− 4 + 1	9
Sand 85%	− 1 + ¼	68
	− ¼ + 1/16	8
Fines 1%	− 1/16	1

(b)

		%
	+ 64 mm	0
Gravel 26%	− 64 + 16	9
	− 16 + 4	17
	− 4 + 1	15
Sand 72%	− 1 + ¼	49
	− ¼ + 1/16	8
Fines 2%	− 1/16	2

	Depth below surface (ft)	Percentage Fines	Sand	Gravel
(a)	2 - 5	1	54	45
	5 - 8	2	92	6
	8 - 11	1	99	0
	11 - 14	1	94	5
(b)	61 - 64	8	67	25
	64 - 67	1	74	25
	67 - 70	2	61	37
	70 - 73	2	82	16
	73 - 76	0	76	24
	76 - 79	0	65	35
	79 - 80	0	87	13

TG 20 NE 30 2737 0826 Bungalow Lane, Thorpe St Andrew

Surface level (+c.3.0 m) +c.10 ft Water struck at (−c.0.3 m) −c.1 ft Overburden (6.4 m) 21 ft
Wirth B 1,8-in diameter, August 1969 Mineral (1.8 m +) 6 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Peat	Soil on peat.	(6.4)	21	(6.4)	21
Sub-alluvium Gravel	Gravel. Fines absent. Gravel: medium with coarse and fine subangular flint; with some subrounded quartz. Sand: medium with coarse subangular flint with chalk.	(1.8+)	6+	(8.2)	27

		%
	+ 64 mm	0
Gravel 54%	−64 + 16	20
	−16 + 4	34
	− 4 + 1	16
Sand 46%	− 1 + ¼	27
	− ¼ + 1/16	3
Fines 0%	−1/16	0

Depth below surface (ft)	Percentage Fines	Sand	Gravel
21 - 27	0	46	54

Borehole abandoned because of 'rising gravel'.

TG 20 NE 31 2774 0741 Near Whitlingham Hall, Bramerton

Surface level (+ 18.3 m) + 60 ft Water not struck
Wirth B 1, 8-in diameter, August 1969

Overburden (0.6 m) 2 ft
Mineral (13.1 m) 43 ft
Bedrock (1.5 m +) 5 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
	Soil.	(0.6)	2	(0.6)	2
Norwich Crag	Pebbly sand. Chalky near base. Shelly in lower half of the deposit. Clayey between 26 and 29 ft. Gravel: medium with fine and coarse subrounded flint with quartz. Sand: medium with fine and coarse, mainly subrounded. Orange or brown.	(13.1)	43	(13.7)	45
Upper Chalk	Chalk.	(1.5+)	5+	(15.2)	50

		%
	+ 64 mm	1
Gravel 13%	−64 + 16	4
	−16 + 4	8
	− 4 + 1	8
Sand 83%	− 1 + ¼	57
	− ¼ + 1/16	18
Fines 4%	− 1/16	4

Depth below surface (ft)	Percentage Fines	Sand	Gravel
2 - 5	1	92	7
5 - 8	4	90	6
8 - 11	0	71	29
11 - 14	0	89	11
14 - 17	0	89	11
17 - 20	1	58	41
20 - 23	5	85	10
23 - 26	3	93	4
26 - 29	30	55	15
29 - 32	6	82	12
32 - 35	2	89	9
35 - 38	0	98	2
38 - 41	1	90	9
41 - 44	2	87	11
44 - 45	1	90	9

TG 20 NE 32 2736 0648 Green Lane, Kirby Bedon

Surface level (+ 27.4 m) + 90 ft Water not struck
Wirth B 1, 8-in diameter, October 1969

Overburden (2.7 m) 9 ft
Mineral (13.8 m) 45 ft
Waste (2.1 m) 7 ft
Bedrock (0.9 m +) 3 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Boulder Clay	Soil on firm brown clay.	(2.7)	9	(2.7)	9
Glacial Sand and Gravel	Sandy gravel. Clayey in parts with interbedded clay seams. Gravel most abundant in upper part of deposit. Gravel: fine to coarse subangular to subrounded flint; with fine to coarse subrounded quartzite and fine subrounded quartz; occasional cobbles of subrounded quartzite and subangular flint. Coarsest in upper half of the deposit. Sand: medium, or fine to medium with coarse, mainly subrounded quartz with some flint. Yellow-brown. Clays: grey sandy clay at 14 to 16 ft and soft, brown clay at 43 to 46 ft.	(13.8)	45	(16.5)	54
Boulder Clay	Brown clay.	(2.1)	7	(18.6)	61
Upper Chalk	Chalk.	(0.9+)	3+	(19.5)	64

		%
	+ 64 mm	0
Gravel 24%	– 64 + 16	14
	– 16 + 4	10
	– 4 + 1	8
Sand 68%	– 1 + ¼	42
	– ¼ + 1/16	18
Fines 8%	– 1/16	8

Depth below surface (ft)	Percentage Fines	Sand	Gravel
9 - 12	12	61	27
12 - 14	8	37	55
		Sandy Clay	
16 - 19	8	72	20
19 - 22	1	54	45
22 - 25	0	44	56
25 - 28	0	50	50
28 - 31	1	69	30
31 - 34	4	86	10
34 - 43	8	82	10
		Clay	
46 - 49	10	85	5
49 - 51	22	75	3
51 - 54	16	81	3

TG 20 NE 33 2766 0542 Kirby Bedon

Surface level (+ 29.3 m) + 96 ft Water struck at (+ 17.1 m) + 56 ft
Wirth B 1, 8-in diameter, October 1969

Overburden (4.9 m) 16 ft
Mineral (10.7 m) 35 ft
Waste (8.8 m +) 29 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Boulder Clay	Soil on brown chalky clay.	(4.9)	16	(4.9)	16
Glacial Sand and Gravel (a)	Sandy gravel. Gravel: fine to coarse subangular flint; with fine to medium subrounded and well rounded quartz and quartzite; occasional flint cobbles. Sand: medium with fine and coarse, quartz with flint and chalk. Slightly clayey. Yellowish-brown.	(5.5)	18	(10.4)	34
Norwich Crag (b)	Very clayey pebbly sand. Gravel: fine, mainly flint. Sand: fine with medium and traces of coarse. Yellowish-brown to dark brown.	(5.2)	17	(15.6)	51
	Silty clays, usually grey but brown at the top.	(8.8+)	29+	(24.4)	80

(a)

		%
	+ 64 mm	: 0
Gravel 45%	− 64 + 16	: 28
	− 16 + 4	: 17
	− 4 + 1	: 8
Sand 51%	− 1 + ¼	: 32
	− ¼ + 1/16	: 11
Fines 4%	− 1/16	: 4

(b)

		%
	+ 64 mm	: 0
Gravel 4%	− 64 + 16	: 0
	− 16 + 4	: 4
	− 4 + 1	: 3
Sand 72%	− 1 + ¼	: 14
	− ¼ + 1/16	: 55
Fines 24%	− 1/16	: 24

	Depth below surface (ft)	Percentage Fines	Sand	Gravel
(a)	16 - 19	6	85	9
	19 - 22	7	51	42
	22 - 25	0	33	67
	25 - 28	0	33	67
	28 - 31	5	53	42
	31 - 34	8	50	42
(b)	34 - 37	20	68	12
	37 - 40	25	75	0
	40 - 43	28	72	0
	43 - 46	24	71	5
	46 - 49	36	62	2
	49 - 51	21	74	5

TG 20 NE 34 2835 0947 St Andrew's Hospital Annexe, Thorpe St Andrew

Surface level (+ 14.1 m) + 46 ft Groundwater conditions not recorded
Shell and auger, 8-in diameter, September 1969

Overburden (1.8 m) 6 ft
Mineral (6.4 m) 21 ft
Bedrock (0.9 m +) 3 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
	Soil on sandy clay with some fine to coarse gravel.	(1.8)	6	(1.8)	6
Norwich Crag	'Clayey' pebbly sand. Gravel: medium to coarse subangular to subrounded flint: with fine to medium subrounded quartz and quartzite. Sand: fine and medium with a little coarse, traces of chalk. Usually brown.	(6.4)	21	(8.2)	27
Upper Chalk	Chalk.	(0.9+)	3+	(9.1)	30

		%
	+ 64 mm	: 0
Gravel 16%	− 64 + 16	: 9
	− 16 + 4	: 7
	− 4 + 1	: 3
Sand 72%	− 1 + ¼	: 34
	− ¼ + 1/16	: 35
Fines 12%	− 1/16	: 12

Depth below surface (ft)	Percentage Fines	Sand	Gravel
6 - 9	26	51	23
9 - 12	13	73	14
12 - 15	16	69	15
15 - 18	7	90	3
18 - 21	3	82	15
21 - 24	4	71	25
24 - 27	12	68	20

TG 20 NE 35 2879 0889 Heath Farm, Postwick

Surface level (+ 18.7 m) + 62 ft Water not struck
Wirth B 1, 8-in diameter, September 1969

Overburden (0.3 m) 1 ft
Mineral (7.0 m) 23 ft
Waste (0.9 m) 3 ft
Mineral (4.6 m) 15 ft
Bedrock (2.4 m +) 8 ft +

			Thickness (m)	Thickness ft	Depth (m)	Depth ft
		Soil.	(0.3)	1	(0.3)	1
?Glacial Sand and Gravel	(a)	Pebbly sand. Fines usually absent. Gravel: fine and medium with occasional coarse subangular to subrounded flint with fine to medium subrounded quartz and chalk. Sand: medium with fine and a little coarse, subangular to subrounded. Brown, showing a little iron staining.	(6.7)	22	(7.0)	23
		Cobbles with gravel. Cobbles: subangular to subrounded flint. Gravel: coarse subangular to subrounded flint.	(0.3)	1	(7.3)	24
?Norwich Crag		Brown sandy clay with flint pebbles.	(0.9)	3	(8.2)	27
	(b)	Pebbly sand. Gravel mainly in upper 6 ft Gravel: fine and medium subangular to subrounded flint. Sand: fine with medium, traces of coarse, subangular. Orange or light brown.	(4.6)	15	(12.8)	42
Upper Chalk		Chalky pebbly sand. Gravel: fine to coarse with some cobbles, mainly subangular flint. Sand: medium subangular flint with chalk. Brown.	(1.5)	5	(14.3)	47
		Chalk. .	(0.9+)	3+	(15.2)	50

		%
(a)		
	+ 64 mm	0
Gravel 10%	− 64 + 16	4
	− 16 + 4	6
	− 4 + 1	6
Sand 88%	− 1 + ¼	62
	− ¼ + 1/16	20
Fines 2%	− 1/16	2
(b)		
	+ 64 mm	0
Gravel 9%	− 64 + 16	0
	− 16 + 4	3
	− 4 + 1	4
Sand 90%	− 1 + ¼	25
	− ¼ + 1/16	61
Fines 1%	− 1/16	1

	Depth below surface (ft)	Percentage Fines	Sand	Gravel
(a)	1 - 3	2	84	14
	3 - 5	0	85	15
	5 - 7	0	93	7
	7 - 9	0	97	3
	9 - 11	0	91	9
	11 - 14	2	83	15
	14 - 17	1	81	18
	17 - 20	[1	88	11]
	20 - 23	7	93	0
	23 - 24	No sample		
(b)	27 - 30	0	80	20
	30 - 33	[0	80	20]
	33 - 36	3	95	2
	36 - 39	0	98	2
	39 - 42	3	96	1

TG 20 NE 36 2878 0804 Wood Barn, Postwick

Surface level (+ 16.1 m) + 53 ft Water struck at (+ 8.2 m) + 27 ft
Shell and auger, 8 in diameter, September 1969

Overburden (4.1 m) 13.5 ft
Mineral (4.1 m) 13.5 ft
Bedrock (0.9 m +) 3 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Boulder Clay	Soil on brown chalky clay.	(4.1)	13.5	(4.1)	13.5
Norwich Crag	Pebbly sand. Slightly clayey in parts. Traces of chalk and shell. Gravel: fine to coarse angular to subrounded flint; with fine subrounded quartz and medium to coarse chalk. Sand: medium, or medium and fine with traces of coarse, subangular. Usually brown.	(4.1)	13.5	(8.2)	27
Upper Chalk	Chalk.	(0.9+)	3+	(9.1)	30

		%
	+ 64 mm	0
Gravel 7%	− 64 + 16	2
	− 16 + 4	5
	− 4 + 1	5
Sand 88%	− 1 + ¼	52
	− 1 + 1/16	31
Fines 5%	− 1/16	5

Depth below surface (ft)	Percentage Fines	Sand	Gravel
13.5 - 15	18	80	2
15 - 18	6	93	1
18 - 21	2	97	1
21 - 24	2	97	1
24 - 26	3	82	15
26 - 27	10	34	56

TG 20 NE 37 2822 0800 Whitlingham Marsh

Surface level (+ c. 2.1 m) + c. 7 ft Groundwater conditions not recorded
Shell and auger, 8-in diameter, October 1969

Overburden (5.2 m) 17 ft
Mineral (4.3 m) 14 ft
Bedrock (0.9 m +) 3 ft +

		Thickness (m)	ft	Depth (m)	ft
	Made ground.	(0.6)	2	(0.6)	2
Peat	Peat.	(4.6)	15	(5.2)	17
Sub-alluvium Gravel	Gravel. Gravel: medium to coarse at the top becoming finer with depth to fine and medium at the bottom. Top: fine to cobble, angular to subrounded blue flint with fine to coarse subrounded quartzite and fine to medium subrounded to well rounded quartz. Bottom: fine to medium, angular to subrounded, brown or yellowed flint with fine to medium subrounded to well rounded quartz and quartzite. Sand: medium, with fine and coarse, subangular. Greyish blue and silver brown.	(4.3)	14	(9.5)	31
Upper Chalk	Chalk.	(0.9+)	3+	(10.4)	34

		%
	+ 64 mm	0
Gravel 62%	– 64 + 16	29
	– 16 + 4	33
	– 4 + 1	12
Sand 37%	– 1 + ¼	19
	– ¼ + 1/16	6
Fines 1%	– 1/16	1

Depth below surface (ft)	Percentage Fines	Sand	Gravel
17 - 20	0	30	70
20 - 23	0	23	77
23 - 26	0	31	69
26 - 29	4	48	48
29 - 31	2	53	45

TG 20 NE 38 2827 0663 Kirby Marsh, Kirby Bedon

Surface level (+ 18.7 m) + 62 ft Water not struck
Wirth B 1, 8-in diameter, October 1969

Overburden (0.3 m) 1 ft
Mineral (8.9 m) 29 ft
Waste (3.0 m +) 10 ft +

			Thickness (m)	Thickness ft	Depth (m)	Depth ft
		Soil.	(0.3)	1	(0.3)	1
Glacial Sand and Gravel	(a)	Sandy gravel. Fines absent. Gravel: fine to coarse, subangular to subrounded flint with subrounded to well rounded quartz and quartzite. Sand: medium with fine and coarse subrounded to well rounded. Brown to orange-red.	(5.5)	18	(5.8)	19
Norwich Crag	(b)	'Very clayey' pebbly sand. Gravel: fine to coarse, subangular flint; subrounded quartz and quartzite. Sand: fine to medium with traces of coarse, subrounded. Brown.	(3.4)	11	(9.2)	30
		Brown clay.	(3.0+)	10+	(12.2)	40

(a)

		%
	+ 64 mm	0
Gravel 33%	– 64 + 16	21
	– 16 + 4	12
	– 4 + 1	6
Sand 67%	– 1 + ¼	50
	– ¼ + 1/16	11
Fines 0%	– 1/16	0

(b)

		%
	+ 64 mm	0
Gravel 10%	– 64 + 16	5
	– 16 + 4	5
	– 4 + 1	3
Sand 63%	– 1 + ¼	22
	– ¼ + 1/16	38
Fines 27%	– 1/16	27

	Depth below surface (ft)	Percentage Fines	Sand	Gravel
(a)	1 - 4	0	35	65
	4 - 7	1	79	20
	7 - 10	0	76	24
	10 - 13	1	63	36
	13 - 16	0	80	20
	16 - 19	0	65	35
(b)	19 - 22	11	86	3
	22 - 25	36	59	5
	25 - 28	37	47	16
	28 - 30	22	60	18

Borehole abandoned because of obstruction.

TG 20 NE 39 2834 0554 Easthill Lane, Kirby Bedon

Surface level (+ 23.3 m) + 76 ft Water struck at (+ 17.1 m) + 56 ft Overburden (0.9 m) 3 ft
Wirth B 1, 8-in diameter, August 1969 Mineral (15.6 m +) 51 ft +

			Thickness (m)	ft	Depth (m)	ft
		Soil.	(0.9)	3	(0.9)	3
Glacial sand and gravel	(a)	Pebbly sand. Fines almost absent. Gravel: medium with fine and coarse, occasionally entirely coarse, mainly subangular to subrounded flint with fine and medium subrounded quartz and traces of chalk. Sand: medium with fine and coarse, subangular and subrounded. Brown.	(10.1)	33	(11.0)	36
Norwich Crag	(b)	Sand. Gravel: fine with medium subangular to subrounded flint; with some fine subrounded quartz and chalk. Sand: medium with fine subangular with a little coarse subrounded. Brown. Clay bands particularly near the top. Clay: orange silty clay with traces of organic material.	(5.5+)	18+	(16.5)	54

(a)

		%
	+ 64 mm	0
Gravel 23%	− 64 + 16	15
	− 16 + 4	8
	− 4 + 1	12
Sand 76%	− 1 + ¼	59
	− ¼ + 1/16	5
Fines 1%	− 1/16	1

(b)

		%
	+ 64 mm	0
Gravel 3%	− 64 + 16	1
	− 16 + 4	2
	− 4 + 1	4
Sand 95%	− 1 + ¼	71
	− ¼ + 1/16	20
Fines 2%	− 1/16	2

	Depth below surface (ft)	Fines	Sand	Gravel
(a)	3 - 6	2	65	33
	6 - 9	2	65	33
	9 - 12	0	95	5
	12 - 15	0	85	15
	15 - 18	0	86	14
	18 - 21	0	65	35
	21 - 24	0	80	20
	24 - 27	2	77	21
	27 - 30	0	65	35
	30 - 33	1	89	10
	33 - 36	1	63	36
(b)	36 - 39	2	93	5
	39 - 42	2	97	1
	42 - 45	1	97	2
	45 - 48	5	88	7
	48 - 51	1	97	2
	51 - 54	2	98	0

Borehole abandoned because of 'rising sand'.

TG 20 NE 40 2948 0962 Near Smee Farm, Plumstead

Surface level (+ 26.2 m) + 86 ft Water not struck Overburden (12.8 m) 42 ft
Wirth B 1, 8-in diameter, August 1969 Mineral (9.4 m +) 31 ft +

		Thickness (m)	ft	Depth (m)	ft
Norwich Brickearth	Soil on brown slightly sandy clay.	(12.8)	42	(12.8)	42
Norwich Crag	Pebbly sand. Clayey band at the base of the sampled deposit. Gravel: medium with fine and coarse subangular flint and subrounded quartz and traces of chalk and clay-ironstone nodules. Sand: medium with fine and coarse, mainly subangular. Brown.	(9.4+)	31+	(22.2)	73

		%
	+ 64 mm	: 0
Gravel 8%	– 64 – 16	: 2
	– 16 + 4	: 6
	– 4 + 1	: 7
Sand 88%	– 1 + ¼	: 67
	– ¼ + 1/16	: 14
Fines 4%	– 1/16	: 4

Borehole abandoned for technical reasons.

Depth below surface (ft)	Percentage Fines	Sand	Gravel
42 - 45	1	85	14
45 - 48	0	92	8
48 - 51	2	91	7
51 - 54	0	81	19
54 - 57	1	91	8
57 - 60	1	91	8
60 - 63	1	96	3
63 - 66	0	92	8
66 - 69	1	95	4
69 - 72	36	64	0
72 - 73	No sample		

TG 20 NE 41 2957 0872 The Grange, Postwick

Surface level (+ 25.0 m) + 82 ft Water not struck
Wirth B 1, 8 in diameter, September 1969

Overburden (5.2 m) 17 ft
Mineral (11.0 m) 36 ft
Bedrock (0.9 m +) 3 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Norwich Brickearth	Soil on brown sandy clay with occasional flint pebbles.	(5.2)	17	(5.2)	17
Norwich Crag	Pebbly sand. Traces of clay. Gravel: medium with fine and coarse subangular with subrounded flints; with fine to medium subrounded quartz. Sand: medium with fine and coarse subangular with some subrounded. Usually brown. Clay: light grey in upper 3 ft, grey-green in lower 9 ft.	(11.0)	36	(16.2)	53
Upper Chalk	Chalk.	(0.9+)	3+	(17.1)	56

		%
	+ 64 mm	0
Gravel 13%	− 64 + 16	4
	− 16 + 4	9
	− 4 + 1	10
Sand 85%	− 1 + ¼	62
	− ¼ + 1/16	13
Fines 2%	− 1/16	2

Depth below surface (ft)	Percentage Fines	Sand	Gravel
17 - 20	5	91	4
20 - 23	5	91	4
23 - 26	1	69	30
26 - 29	2	73	25
29 - 32	1	74	25
32 - 35	0	78	22
35 - 38	1	90	9
38 - 41	1	94	5
41 - 44	1	92	7
44 - 47	0	88	12
47 - 50	4	86	10
50 - 53	6	91	3

TG 20 NE 42 2971 0763 Near Postwick

Surface level (+8.8 m) + 29 ft Groundwater conditions not recorded
Wirth B1, 8-in diameter, September 1969

Overburden (0.3 m) 1 ft
Mineral (4.7 m) 16 ft
Bedrock (1.4 m +) 4 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
	Soil.	(0.3)	1	(0.3)	1
Terrace gravel	Sandy gravel. Gravel mainly in upper 8 ft of the deposit. Gravel: fine, medium and coarse subangular flint, with medium subrounded flint and fine subrounded quartz. Sand: medium with fine and coarse, mainly subangular, with traces of mica flakes. Brown.	(4.7)	15.5	(5.0)	16.5
Upper Chalk	Chalk.	(1.4+)	4.5+	(6.4)	21

		%
	+ 64 mm	: 2
Gravel 28%	– 64 + 16	: 16
	– 16 + 4	: 10
	– 4 + 1	: 6
Sand 72%	– 1 + ¼	: 49
	– ¼ + 1/16	: 17
Fines 0%	– 1/16	: 0

Depth below surface (ft)	Percentage Fines	Sand	Gravel
1 - 3	1	75	24
3 - 5	0	54	46
5 - 7	0	51	49
7 - 9	0	35	65
9 - 11	0	85	15
11 - 13	0	92	8
13 - 16.5	0	90	10

TG 20 NE 43 2973 0684 Postwick Marsh

Surface (+ 1.5 m) + 5 ft Water struck at c. 0 ft OD
Shell and auger, 8 in diameter, September 1969

Overburden (0.5 m) 2 ft
Mineral (4.5 m) 15 ft
Bedrock (0.9 m +) 3 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
	Soil.	(0.5)	1.5	(0.5)	1.5
Sub-alluvium gravel	Gravel. Gravel: fine to coarse subrounded to subangular flint and fine to medium subrounded quartz. Sand: medium with fine and coarse, subangular, with traces of chalk. Light brown.	(4.5)	1.5	(5.0)	16.5
Upper Chalk	Chalk.	(0.9+)	3+	(5.9)	19.5

		%
	+ 64 mm	: 0
Gravel 52%	– 64 + 16	: 17
	– 16 + 4	: 35
	– 4 + 1	: 12
Sand 44%	– 1 + ¼	: 22
	– ¼ + 1/16	: 10
Fines 4%	– 1/16	: 4

Depth below surface (ft)	Percentage Fines	Sand	Gravel
1.5 - 3	25	48	27
3 - 6	1	46	53
6 - 9	1	41	58
9 - 12	2	44	54
12 - 15	2	39	59
15 - 16.5	3	55	42

TG 20 NE 44 2916 0598 Red House, Bramerton

Surface level (+ 38.1 m) + 125 ft Water not struck
Wirth B 1, 8-in diameter, August 1969

Overburden (5.8 m) 19 ft
Mineral (8.2 m) 27 ft
Waste (2.7 m) 9 ft
Mineral (7.7 m +) 25 ft

			Thickness (m)	Thickness ft	Depth (m)	Depth ft
		Soil on brown sandy clay.	(2.4)	8	(2.4)	8
Boulder clay		Brown chalky clay.	(3.4)	11	(5.8)	19
Glacial sand and gravel	(a)	Pebbly sand. Slightly chalky. Gravel: fine and medium, trace coarse, subrounded to subangular flint with quartz. Sand: medium with fine and a little coarse, mainly subangular. Brown or orange.	(8.2)	27	(14.0)	46
		Brown to cream clay with occasional sandy bands.	(2.7)	9	(16.7)	55
Norwich Crag	(b)	Pebbly sand. Abundantly shelly between 76 and 80 ft. Gravel: medium subrounded to subangular flint with subrounded quartz. Sand: medium with fine and a trace of coarse, subangular. Light brown.	(7.7+)	25+	(24.4)	80

(a)

		%
	+ 64 mm	: 0
Gravel 8%	– 64 + 16	: 2
	– 16 + 4	: 6
	– 4 + 1	: 7
Sand 90%	– 1 + ¼	: 63
	– ¼ + 1/16	: 20
Fines 2%	– 1/16	: 2

(b)

	+ 64 mm	: 0
Gravel 5%	– 64 + 16	: 2
	– 16 + 4	: 3
	– 4 + 1	: 3
Sand 93%	– 1 + ¼	: 55
	– ¼ + 1/16	: 35
Fines 2%	– 1/16	: 2

	Depth below surface (ft)	Percentage Fines	Sand	Gravel
(a)	19 - 22	2	79	19
	22 - 25	2	85	13
	25 - 28	2	82	16
	28 - 31	4	90	6
	31 - 34	2	92	6
	34 - 37	2	94	4
	37 - 40	0	96	4
	40 - 43	4	93	3
	43 - 46	4	93	3
(b)	55 - 58	4	89	7
	58 - 61	4	88	8
	61 - 64	3	79	18
	64 - 67	1	95	4
	67 - 70	1	97	2
	70 - 73	1	98	1
	73 - 76	0	98	2
	76 - 79	0	99	1
	79 - 80	0	99	1

TG 20 NE 45 2952 0523 Bramerton Hall

Surface level (+ 32.0 m) + 105 ft Water not struck
Wirth B 1,8-in diameter, August 1969

Overburden (5.8 m) 19 ft
Mineral (4.6 m) 15 ft
Waste (9.1 m) 30 ft
Mineral (4.9 m +) 16 ft +

			Thickness (m)	Thickness ft	Depth (m)	Depth ft
Boulder Clay		Soil on brown chalky clay.	(5.8)	19	(5.8)	19
Glacial Sand and Gravel	(a)	'Clayey' pebbly sand. Gravel: fine and medium with a trace of coarse, subangular to subrounded, flint, with fine subrounded quartz. Sand: fine with medium and coarse, subangular, traces of chalk. Light brown.	(4.6)	15	(10.4)	34
Boulder Clay		Brown chalky clay with traces of sand.	(9.1)	30	(19.5)	64
?Norwich Crag	(b)	Pebbly sand. Slightly chalky. Gravel: medium with fine and coarse, subangular flint with occasional subrounded quartz. Sand: medium with fine and traces of coarse subangular. Light brown to orange.	(4.9+)	16+	(24.4)	80

(a)

		%
	+ 64 mm	0
Gravel 11%	– 64 + 16	4
	– 16 + 4	7
	– 4 + 1	6
Sand 76%	– 1 + ¼	29
	– ¼ + 1/16	41
Fines 13%	– 1/16	13

(b)

		%
	+ 64 mm	0
Gravel 20%	– 64 + 16	9
	– 16 + 4	11
	– 4 + 1	4
Sand 79%	– 1 + ¼	66
	– ¼ + 1/16	9
Fines 1%	– 1/16	1

	Depth below surface (ft)	Percentage Fines	Sand	Gravel
(a)	19 - 22	6	87	7
	22 - 25	16	79	5
	25 - 28	30	68	2
	28 - 31	10	79	11
	31 - 34	2	68	30
(b)	64 - 67	2	72	26
	67 - 70	3	77	20
	70 - 73	0	85	15
	73 - 76	0	88	12
	76 - 80	0	72	28

TG 20 SW 8 2028 0470 Fir Hill, Keswick

Surface level (+ 20.6 m) +68 ft Water not struck Overburden (6.4 m) 21 ft
Wirth B 1, 8-in diameter, March 1969 Bedrock (0.9 m +) 3 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Made ground	Soil on clayey gravel with some sand and rootlets.	(6.4)	21	(6.4)	21
Upper Chalk	Chalk.	(0.9+)	3+	(7.3)	24

TG 20 SW 8a 2077 0441 Keswick Hall Farm

Surface level (+ 22.8 m) + 75 ft Groundwater conditions not recorded
Shell and auger, 8-in diameter, September 1969

Overburden (0.5 m) 1.5 ft
Mineral (8.4 m) 27 ft
Bedrock (0.9 m +) 3 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
	Soil.	(0.5)	1.5	(0.5)	1.5
Glacial sand and gravel	Pebbly sand. High fines content near top and bottom of deposit. Gravel: fine to coarse, subangular to subrounded flints, with fine to medium subrounded quartz. Sand: fine and medium with coarse, mainly subangular. Grey to brown.	(8.4)	27.5	(8.9)	29
Upper Chalk	Chalk.	(0.9+)	3+	(9.8)	32

		%
	+ 64 mm	0
Gravel 7%	– 64 + 16	2
	– 16 + 4	5
	– 4 + 1	6
Sand 85%	– 1 + ¼	49
	– ¼ + 1/16	30
Fines 8%	– 1/16	8

Depth below surface (ft)	Percentage Fines	Sand	Gravel
1.5 - 4	18	78	4
4 - 7	1	93	6
7 - 10	2	95	3
10 - 13	2	95	3
13 - 16	6	86	8
16 - 19	7	93	0
19 - 22	10	90	0
22 - 25	7	93	0
25 - 28	14	52	34
28 - 29	26	43	31

TG 20 SW 9 2061 0372 Near Keswick Hall

Surface level (+32.4 m) + 106 ft Water not struck
Wirth B 1, 8-in diameter, February 1969

Overburden (3.7 m) 12 ft
Mineral (3.3 m) 11 ft
Waste (6.1 m) 20 ft
Bedrock (0.9 m +) 3 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Boulder clay	Soil on brown to light grey chalky clay with sandy lenses towards the base.	(3.7)	12	(3.7)	12
Glacial Sand and Gravel	'Clayey' pebbly sand. Gravel: fine and medium subangular flint with occasional fine subrounded quartz. Sand: medium with fine and a little coarse, subangular. Light brown.	(3.3)	11	(7.0)	23
Boulder clay	Brown or grey chalky clay with abundant coarse flint pebbles. Clayey sand seam from 31 to 33 ft.	(6.1)	20	(13.1)	43
Upper Chalk	Chalk.	(0.9+)	3+	(14.0)	46

		%
	+ 64 mm	0
Gravel 6%	– 64 + 16	3
	– 16 + 4	3
	– 4 + 1	6
Sand 83%	– 1 + ¼	58
	– ¼ + 1/16	19
Fines 11%	– 1/16	11

Depth below surface (ft)	Percentage Fines	Sand	Gravel
12 - 15	6	92	2
15 - 18	18	79	3
18 - 21	11	81	8
21 - 23	9	78	13

TG 20 SW 10 2061 0257 Swardeston Hall Farm

Surface level (+ 28.9 m) + 95 ft Water not struck
Wirth B 1, 8-in diameter, March 1969

Overburden (0.3 m) 1 ft
Mineral (5.5 m) 18 ft
Waste (1.2 m) 4 ft
Bedrock (0.9 m +) 3 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
	Soil.	(0.3)	1	(0.3)	1
Glacial Sand and Gravel	Sandy gravel. Gravel content decreasing with depth. Thin silty clay from 15 to 15.25 ft. Fines absent at top, increasing in abundance with depth. Gravel: medium to coarse, subangular to subrounded flint with fine to medium subrounded quartz and medium to coarse subrounded quartzite. Sand: medium to coarse, with fine at the top grading to fine with medium and traces of coarse at the bottom, mainly subrounded. Yellowish.	(5.5)	18	(5.8)	19
Boulder Clay	Sandy clay with quartz and flint pebbles, becoming chalky at the base. Usually brown but grey in parts.	(1.2)	4	(7.0)	23
Upper Chalk	Chalk.	(0.9+)	3+	(7.9)	26

		%
	+ 64 mm	0
Gravel 42%	− 64 + 16	22
	− 16 + 4	20
	− 4 + 1	7
Sand 51%	− 1 + ¼	25
	− ¼ + 1/16	19
Fines 7%	− 1/16	7

Depth below surface (ft)	Percentage Fines	Sand	Gravel
1 - 3	0	40	60
3 - 5	0	47	53
5 - 8	5	53	42
8 - 11	6	30	64
11 - 14	6	38	56
14 - 15	8	72	20
15 - 15.25	Silty Clay		
15.25 - 18	17	79	4
18 - 19	13	74	13

TG 20 SW 11 2032 0141 Near Lodge Farm, Mulbarton

Surface level (+ 40.8 m) + 134 ft Water struck at (+27.7 m) + 91 ft
Wirth B 1, 8-in diameter, March 1969

Overburden (4.3 m) 14 ft
Mineral (4.6 m) 15 ft
Waste (3.0 m) 10 ft
Mineral (6.7 m) 22 ft
Bedrock (0.9 m +) 3 ft +

			Thickness (m)	Thickness ft	Depth (m)	Depth ft
Boulder clay		Made ground on light brown chalky clay with coarse flint pebbles.	(4.3)	14	(4.3)	14
Glacial sand and gravel	(a)	Pebbly sand. Gravel: fine to medium with coarse subangular flint, with fine to medium subrounded quartz. Sand: medium with fine and coarse, subangular; occasionally chalky. Light brown.	(4.6)	15	(8.9)	29
Boulder clay		Light brown sandy clay with traces of chalk and coarse flint pebbles.	(3.0)	10	(11.9)	39
Glacial sand and gravel	(b)	Sandy gravel. Clayey in upper 9 ft. Gravel: fine and medium with coarse subangular flint, with fine to medium subrounded quartz. Single large (70 mm) clay concretion with ironstone shell. Sand: mainly subangular. Light and dark brown.	(6.7)	22	(18.6)	61
Upper Chalk		Chalk.	(0.6+)	2+	(19.2)	63

(a)

		%
	+ 64 mm	0
Gravel 15%	− 64 + 16	5
	− 16 + 4	10
	− 4 + 1	8
Sand 77%	− 1 + ¼	55
	− ¼ + 1/16	14
Fines 8%	− 1/16	8

(b)

		%
	+ 64 mm	1
Gravel 25%	− 64 + 16	9
	− 16 + 4	15
	− 4 + 1	9
Sand 68%	− 1 + ¼	48
	− ¼ + 1/16	11
Fines 7%	− 1/16	7

	Depth below surface (ft)	Percentage Fines	Sand	Gravel
(a)	14 - 17	3	72	25
	17 - 20	11	72	17
	20 - 23	8	75	17
	23 - 26	9	81	10
	26 - 29	11	84	5
(b)	39 - 42	15	59	26
	42 - 45	13	67	20
	45 - 48	11	67	22
	48 - 51	0	50	50
	51 - 54	4	72	24
	54 - 57	3	79	18
	57 - 61	2	86	12

TG 20 SW 12 2053 0047 Near Kenningham Hall

Surface level (+ 43.7 m) + 143 ft Water struck at (+ 22.3 m) + 73 ft
Wirth B1, 8-in diameter, March 1969

Overburden (3.7 m) 12 ft
Mineral (8.2 m) 27 ft
Waste (2.7 m) 9 ft
Mineral (9.7 m +) 32 ft +

			Thickness (m)	ft	Depth (m)	ft
Boulder Clay		Made ground, on light brown clay with chalk and coarse flint pebbles.	(3.7)	12	(3.7)	12
Glacial Sand and Gravel	(a)	Gravel. Clayey in parts. Fines content decreasing with depth. Gravel: fine to coarse subangular and subrounded flint, (occasionally cobble sized); with fine to medium mainly subrounded quartz with traces of chalk. Sand: medium with fine and coarse, subangular. Brown.	(8.2)	27	(11.9)	39
Boulder Clay		Slightly sandy clay with fine chalk and coarse flint pebbles, mainly brown to grey colour.	(2.7)	9	(14.6)	48
Glacial Sand and Gravel	(b)	Sandy gravel. Clayey between 51 and 57 ft. Gravel: fine to coarse subangular, with coarse subrounded flint; with fine subrounded quartz and sandstone. Occasional hard chalk pebbles. Sand: medium with fine and coarse mainly subangular; with some trace of chalk. Brown.	(9.8+)	32+	(24.4)	80

(a)

		%
	+ 64 mm	2
Gravel 52%	– 64 + 16	31
	– 16 + 4	19
	– 4 + 1	10
Sand 41%	– 1 + ¼	26
	– ¼ + 1/16	5
Fines 7%	– 1/16	7

(b)

	+ 64 mm	0
Gravel 48%	– 64 + 16	24
	– 16 + 4	24
	– 4 + 1	12
Sand 45%	– 1 + ¼	24
	– ¼ + 1/16	9
Fines 7%	– 1/16	7

	Depth below surface (ft)	Percentage Fines	Sand	Gravel
(a)	12 - 15	25	32	43
	15 - 18	9	31	60
	18 - 21	6	25	69
	21 - 24	4	36	60
	24 - 27	10	32	58
	27 - 30	6	37	57
	30 - 33	5	50	45
	33 - 36	2	68	30
	36 - 39	0	57	43
(b)	48 - 51	3	71	26
	51 - 54	14	63	23
	54 - 57	30	47	23
	57 - 60	0	49	51
	60 - 63	8	50	42
	63 - 66	5	48	47
	66 - 69	4	26	70
	69 - 72	3	21	76
	72 - 75	0	21	79
	75 - 78	7	51	42
	78 - 80	6	40	54

TG 20 SW 13 2165 0411 East of Keswick

Surface level (+ 33.8 m) + 111 ft Water not struck
Wirth B 1, 8-in diameter, February 1969

Overburden (1.8 m) 6 ft
Mineral (3.7 m) 12 ft
Waste (1.8 m) 6 ft
Mineral (10.4 m) 34 ft
Bedrock (0.9 m +) 3 ft +

			Thickness (m)	Thickness ft	Depth (m)	Depth ft
		Soil on clayey sand containing chalk pellets.	(1.8)	6	(1.8)	6
Glacial Sand and Gravel	(a)	Pebbly sand. Clayey in parts. Gravel: medium subangular to subrounded flint and quartz. Sand: medium with fine and traces of coarse, mainly flint and quartz with occasional mica flakes. Yellow or orange.	(3.7)	12	(5.5)	18
Boulder Clay		White laminated clay with brown sandy clay becoming chalky and pebbly near the base.	(1.8)	6	(7.3)	24
Glacial Sand and Gravel	(b)	Sandy gravel. Gravel mainly in the upper part of the deposit. Clayey in parts with clay seam from 38 to 40 ft. Gravel: medium with fine and coarse, subangular to subrounded flint; with subrounded to well rounded quartz and quartzite. Sand: medium with fine and coarse at the top grading to fine and medium with a trace of coarse at the bottom. Yellowish brown and orange. Clay: dark brown with pellets of chalk and pebbles of flint and quartz.	(10.4)	34	(17.7)	58
Upper Chalk		Chalk.	(0.9+)	3+	(18.6)	61

(a)

		%
	+ 64 mm	0
Gravel 6%	– 64 + 16	2
	– 16 + 4	4
	– 4 + 1	3
Sand 84%	– 1 + ¼	58
	– ¼ + 1/16	23
Fines 10%	– 1/16	10

(b)

		%
	+ 64 mm	0
Gravel 32%	– 64 + 16	16
	– 16 + 4	16
	– 4 + 1	6
Sand 61%	– 1 + ¼	40
	– ¼ + 1/16	15
Fines 7%	– 1/16	7

	Depth below surface (ft)	Fines	Sand	Gravel
(a)	6 - 9	2	90	8
	9 - 12	18	71	11
	12 - 15	2	95	3
	15 - 18	17	80	3
(b)	24 - 27	3	41	56
	27 - 30	2	59	39
	30 - 33	2	19	79
	33 - 36	5	46	49
	36 - 38	7	31	62
	38 - 40		Clay	
	40 - 43	19	78	3
	43 - 46	5	68	27
	46 - 49	9	67	24
	49 - 52	1	93	6
	52 - 55	7	91	2
	55 - 58	20	64	16

TG 20 SW 14 2136 0318 Near Mangreen Hall, Swardeston

Surface level (+ 41.6 m) + 136 ft Water struck at (+ 36.9 m) + 121 ft Waste (17.2 m +) 56 ft +
Wirth B 1, 8-in diameter, February 1969

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Boulder Clay	Soil on orange to brown sandy clay with flint pebbles.	(2.7)	9	(2.7)	9
	Grey and brown clay with abundant chalk and occasional sandy lenses.	(12.5)	41	(15.2)	50
	Slightly sandy light brown clay.	(2.0+)	6.5+	(17.2)	56

Borehole abandoned because of obstruction.

TG 20 SW 15 2122 0222 The Grove, Swardeston

Surface level (+ 36.3 m) + 119 ft Water struck at (+ 32.9 m) + 108 ft
Wirth B.1, 8-in diameter, July 1969

Overburden (0.9 m) 3 ft
Mineral (6.4 m) 21 ft
Waste (1.8 m +) 6 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
	Made ground.	(0.9)	3	(0.9)	3
Glacial Sand and Gravel	Sandy gravel with clay seam from 9 to 11 ft. Gravel: fine and medium with a trace of coarse subangular flint; traces of fine subrounded quartz and chalk. Sand: medium with fine and coarse, subangular. Clay: slightly chalky, blue to grey, laminated.	(6.4)	21	(7.3)	24
Boulder Clay	Grey to black silty clay.	(1.2)	4	(8.5)	28
Glacial Sand and Gravel	Slightly silty and clayey sand.	(0.6+)	2+	(9.1)	30

		%
	+ 64 mm	: 0
Gravel 35%	– 64 + 16	: 6
	– 16 + 4	: 29
	– 4 + 1	: 12
Sand 62%	– 1 + ¼	: 30
	– ¼ + 1/16	20
Fines 3%	– 1/16	: 3

Depth below surface (ft)	Percentage Fines	Sand	Gravel
3 - 6	4	66	30
6 - 9	4	55	41
9 - 11	Clay		
11 - 14	[2	64	34]
14 - 17	[2	64	34]
17 - 20	2	64	34
20 - 24	No sample		

Borehole abandoned because of 'rising sand'

TG 20 SW 16 2114 0165 Near Hickling Lane, Swainsthorpe

Surface level (+ 38.3 m) + 126 ft Water struck at (+ c.20.7 m) + c.68 ft
Wirth B 1, 8-in diameter, March 1969

Overburden (0.3 m) 1 ft
Mineral (5.8 m) 19 ft
Waste (3.4 m) 11 ft
Mineral (8.2 m) 27 ft
Bedrock (1.2 m +) 4 ft +

			Thickness (m)	Thickness ft	Depth (m)	Depth ft
		Soil.	(0.3)	1	(0.3)	1
Glacial Sand and Gravel	(a)	Sandy gravel. Clayey near the top. Gravel: mainly medium, with fine and coarse subangular to subrounded flint; with fine to medium subrounded to well rounded quartz and quartzite. Sand: medium with fine and coarse subrounded with subangular. Orange to brown.	(5.8)	19	(6.1)	20
Boulder Clay		Brown clay with fine chalk pebbles and occasional sandy layers.	(3.4)	11	(9.5)	31
Glacial Sand and Gravel	(b)	Sandy gravel. Gravel: medium to coarse with fine, occasional cobble of subangular to subrounded flint; with medium and coarse well rounded and subrounded quartz and quartzite. Sand: medium with fine and coarse, subangular. Usually yellow, silver near top. Clayey in parts.	(8.2)	27	(17.7)	58
Upper Chalk		Chalk.	(1.2+)	4+	(18.9)	62

(a)

		%
	+ 64 mm	0
Gravel 30%	− 64 + 16	15
	− 16 + 4	15
	− 4 + 1	10
Sand 65%	− 1 + ¼	43
	− ¼ + 1/16	12
Fines 5%	− 1/16	5

(b)

		%
	+ 64 mm	2
Gravel 36%	− 64 + 16	20
	− 16 + 4	14
	− 4 + 1	9
Sand 60%	− 1 + ¼	40
	− ¼ + 1/16	11
Fines 4%	− 1/16	4

	Depth below surface (ft)	Percentage Fines	Sand	Gravel
(a)	1 - 4	11	48	41
	4 - 7	8	42	50
	7 - 10	3	59	38
	10 - 13	4	66	30
	13 - 15	3	66	31
	15 - 18	0	92	8
	18 - 20	4	90	6
(b)	31 - 33	8	52	40
	33 - 36	4	52	44
	36 - 39	5	47	48
	39 - 42	2	50	48
	42 - 45	1	59	40
	45 - 48	11	40	49
	48 - 51	5	84	11
	51 - 53	0	92	8
	53 - 56	0	66	34
	56 - 59	5	58	37

TG 20 SW 17 2133 0041 South of Swainsthorpe

Surface level (+ 33.7 m) + 111 ft Groundwater conditions not recorded
Wirth B 1, 8-in diameter, March 1969

Overburden (9.8 m) 32 ft
Mineral (1.8 m) 6 ft
Waste (2.4 m) 8 ft
Bedrock (0.9 m +) 3 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Boulder Clay	Soil on light brown slightly chalky clay with occasional sandy lenses. Clay becomes gravelly towards the base.	(9.8)	32	(9.8)	32
Glacial Sand and Gravel	'Clayey' pebbly sand. Gravel: fine and medium with subangular flint and subrounded quartz. Sand: medium with fine and coarse, subrounded with traces of ironstone. Brown.	(1.8)	6	(11.6)	38
Boulder Clay	Slightly sandy light brown clay with traces of chalk.	(2.4)	8	(14.0)	46
Glacial Sand and Gravel	'Clayey' pebbly sand.	(0.9)	3	(14.9)	49
Upper Chalk	Chalk.	(0.9+)	3+	(15.8)	52

		%
	+ 64 mm	0
Gravel 16%	– 64 + 16	4
	– 16 + 4	12
	– 4 + 1	7
Sand 69%	– 1 + ¼	45
	– ¼ + 1/16	17
Fines 15%	– 1/16	15

Depth below surface (ft)	Percentage Fines	Sand	Gravel
32 - 35	12	73	15
35 - 38	18	65	17

TG 20 SW 18 2233 0431 Chapel Hill, Caistor St Edmunds

Surface (+ 34.8 m) + 114 ft Water not struck
Wirth B 1, 8-in diameter, August 1969

Overburden (1.2 m) 4 ft
Mineral (14.6 m) 48 ft
Waste (7.7 m) 25 ft
Bedrock (0.9 m +) 3 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
	Soil on brown stony clay.	(1.2)	4	(1.2)	4
Glacial Sand and Gravel	Pebbly sand. Clay band from 31 to 34 ft. Gravel most abundant near the top. Gravel: medium with coarse and fine subangular flint, with fine and medium subrounded quartz and traces of chalk. Sand: medium and fine with traces of coarse, subangular, chalky. Brown or cream. Clay: sandy with some medium gravel. Brown.	(14.6)	48	(15.8)	52
Boulder Clay	Clays with interbedded pebbly sands. Clay: slightly sandy and chalky with a little gravel. Brown. Pebbly sand: sand is mainly medium; gravel is mainly medium with some coarse subangular flint.	(7.7)	25	(23.5)	77
Upper Chalk	Chalk.	(0.9+)	3+	(24.4)	80

		%
	+ 64 mm	0
Gravel 8%	– 64 + 16	3
	– 16 + 4	5
	– 4 + 1	4
Sand 89%	– 1 + ¼	47
	– ¼ + 1/16	38
Fines 3%	– 1/16	3

Depth below surface (ft)	Percentage Fines	Sand	Gravel
4 - 7	2	57	41
7 - 10	1	69	30
10 - 13	1	83	16
13 - 16	0	99	1
16 - 19	1	95	4
19 - 22	2	94	4
22 - 25	4	96	0
25 - 28	1	97	2
28 - 31	2	98	0
31 - 34		Clay	
34 - 37	7	93	0
37 - 40	[3	97	0]
40 - 43	3	97	0
43 - 46	4	95	1
46 - 49	6	75	19
49 - 52	4	87	9

TG 20 SW 19 2204 0359 Ipswich Road, Swardeston

Surface level (+ 33.1 m) + 108 ft Groundwater conditions not recorded
Wirth B 1, 8-in diameter, March 1969

Overburden (0.2 m) 0.5 ft
Mineral (6.5 m) 21.5 ft
Waste (3.4 m) 11 ft
Mineral (3.6 m) 12 ft
Bedrock (0.9 m +) 3 ft +

			Thickness (m)	Thickness ft	Depth (m)	Depth ft
		Soil.	(0.2)	0.5	(0.2)	0.5
Glacial Sand and Gravel	(a)	'Clayey' sandy gravel, including clay seam between 12 and 16 ft. Gravel: medium with fine and coarse subangular flint; with subrounded quartz and occasional hard chalk pebbles. Sand: medium with fine and coarse subangular to subrounded. Light brown. Clay: light brown with traces of chalk.	(6.5)	21.5	(6.7)	22
Boulder Clay		Light brown slightly chalky clay with occasional sandy lenses.	(3.4)	11	(10.1)	33
Glacial Sand and Gravel	(b)	'Clayey' sandy gravel. Gravel: medium and fine with coarse, subangular to subrounded flint with subrounded quartz. Sand: medium with fine and coarse, subangular to subrounded, chalky. Light brown.	(3.6)	12	(13.7)	45
Upper Chalk		Chalk.	(0.9+)	3+	(14.6)	48

(a)

		%
	+ 64 mm	0
Gravel 40%	– 64 + 16	21
	– 16 + 4	19
	– 4 + 1	10
Sand 49%	– 1 + ¼	30
	– ¼ + 1/16	9
Fines 11%	– 1/16	11

(b)

		%
	+ 64 mm	0
Gravel 36%	– 64 + 16	15
	– 16 + 4	21
	– 4 + 1	4
Sand 48%	– 1 + ¼	33
	– ¼ + 1/16	11
Fines 16%	– 1/16	16

	Depth below surface (ft)	Percentage Fines	Sand	Gravel
(a)	0.5 - 3	12	56	32
	3 - 6	12	77	11
	6 - 9	18	53	29
	9 - 12	5	38	57
	12 - 16		Clay	
	16 - 19	14	36	50
	19 - 22	4	34	62
(b)	33 - 37	5	38	57
	37 - 40	31	61	8
	40 - 43		No sample	
	43 - 45		No sample	

TG 20 SW 20 2270 0267 Dunston Common

Surface level (+ 9.6 m) + 31 ft Water struck between (+ 8.5 m) 28 ft and (+ 4.6 m) + 15 ft, and below (−0.9 m) − 3 ft
Wirth B 1, 8-in diameter, March 1969

Overburden (0.9 m) 3 ft
Mineral (4.0 m) 13 ft
Waste (13.4 m +) 44 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
	Soil.	(0.9)	3	(0.9)	3
Terrace Gravel	Sandy gravel. Traces of clay. Gravel: medium with fine and coarse subangular flints; occasional fine subrounded quartz and fine chalk. Sand: fine and medium with coarse, mainly subangular flint. Brown.	(4.0)	13	(4.9)	16
Glacial Lake Sediments	Grey to blue laminated silty clay.	(7.0)	23	(11.9)	39
	Interbedded lignite and grey silty clay.	(6.4+)	21+	(18.3)	60

		%
	+ 64 mm	: 0
Gravel 34%	− 64 + 16	: 19
	− 16 + 4	: 15
	− 4 + 1	: 6
Sand 62%	− 1 + ¼	: 32
	− ¼ + 1/16	: 24
Fines 4%	− 1/16	: 4

Depth below surface (ft)	Percentage Fines	Sand	Gravel
3 - 6	7	70	23
6 - 9	3	66	31
9 - 11	2	73	25
11 - 14	4	56	40
14 - 16	4	47	49

TG 20 SW 21 2232 0218 Near Dunston Hall

Surface level (+ 23.5 m) + 77 ft Groundwater conditions not recorded
Wirth B 1, 8 in diameter, March 1969

Overburden (4.0 m) 13 ft
Mineral (3.0 m) 10 ft
Bedrock (0.9 m +) 3 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Boulder clay	Soil on light brown chalky clay.	(4.0)	13	(4.0)	13
Glacial sand and gravel	Gravel. Clayey at top. Gravel: fine to coarse subangular to subrounded flint; with subrounded quartzite, and subrounded to well rounded fine and medium quartz. Occasional cobbles. Sand: medium and coarse with fine, subangular, with traces of chalk. Brown.	(3.0)	10	(7.0)	23
Upper Chalk	Chalk.	(0.9+)	3+	(7.9)	26

		%
	+ 64 mm	: 1
Gravel 60%	− 64 + 16	: 29
	− 16 + 4	: 30
	− 4 + 1	: 13
Sand 35%	− 1 + ¼	: 13
	− ¼ + 1/16	: 9
Fines 5%	− 1/16	: 5

Depth below surface (ft)	Percentage Fines	Sand	Gravel
13 - 15	10	33	57
15 - 18	3	35	62
18 - 21	1	27	72
21 - 23	7	51	42

TG 20 SW 22 2216 0148 Stoke Lane, Swainsthorpe

Surface level (+ 25.2 m) + 83 ft Water not struck, damp at (+c.24.4 m) +c.80 ft
Wirth B 1, 8-in diameter, March 1969

Overburden (0.2 m) 0.5 ft
Mineral (16.0 m) 52.5 ft
Bedrock 0.9 m +) 3 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
	Soil.	(0.2)	0.5	(0.2)	0.5
Glacial Sand and Gravel	Gravel. Gravel: medium and coarse with fine subangular to subrounded flint; and fine to medium subrounded quartz with a trace of subrounded flint cobbles. Sand: medium with fine and coarse, subangular. Brown.	(16.0)	52.5	(16.2)	53
Upper Chalk.	Chalk.	(0.9+)	3+	(17.1)	56

		%
	+ 64 mm	1
Gravel 54%	– 64 + 16	29
	– 16 + 4	24
	– 4 + 1	11
Sand 42%	– 1 + ¼	24
	– ¼ + 1/16	7
Fines 4%	– 1/16	4

Depth below surface (ft)	Percentage Fines	Sand	Gravel
0.5 - 3	0	53	47
3 - 6	0	75	25
6 - 9	0	50	50
9 - 12	4	47	49
12 - 15	0	45	55
15 - 18	0	32	68
18 - 21	3	31	66
21 - 24	2	36	62
24 - 27	4	53	43
27 - 30	0	31	69
30 - 33	8	47	45
33 - 36	10	45	45
36 - 39	5	55	40
39 - 42	3	47	50
42 - 45	0	55	45
45 - 48	8	17	75
48 - 51	10	32	58
51 - 53	8	22	70

TG 20 SW 23 2220 0035 Malthouse Farm, Swainsthorpe

Surface level (+ 32.3 m) + 106 ft Water not struck
Wirth B 1, 8-in diameter, March 1969

Overburden (3.4 m) 11 ft
Mineral (15.2 m) 50 ft
Bedrock (1.2 m +) 4 ft

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Boulder Clay	Soil on brown clay with traces of chalk and sand, becoming sandy at the base.	(3.4)	11	(3.4)	11
Glacial Sand and Gravel	'Clayey' sand. High fines content. 'Clayey' in the upper 10 and lower 18 ft of the deposit. Gravel: mainly fine subangular flint with subrounded quartz. Sand: fine and medium with a trace of coarse, subangular. Brown.	(15.2)	50	(18.6)	61
Upper Chalk	Chalk.	(1.2+)	4+	(19.8)	65

		%
	+ 64 mm	0
Gravel 3%	− 64 + 16	2
	− 16 + 4	1
	− 4 + 1	2
Sand 82%	− 1 + ¼	40
	− ¼ + 1/16	40
Fines 15%	− 1/16	15

Depth below surface (ft)	Percentage Fines	Sand	Gravel
11 - 14	40	55	5
14 - 17	35	61	4
17 - 20	30	51	19
20 - 23	6	82	12
23 - 26	6	92	2
26 - 29	15	84	1
29 - 32	2	97	1
32 - 35	12	86	2
35 - 38	8	91	1
38 - 41	5	93	2
41 - 44	8	90	2
44 - 47	15	85	0
47 - 50	17	80	3
50 - 53	13	87	0
53 - 56	16	82	2
56 - 59	15	85	0
59 - 61	13	85	2

TG 20 SW 24 2297 0030 Skeetshill Farm, Stoke Holy Cross

Surface level (+ 15.2 m) + 50 ft Water struck at (+ 9.4 m) + 31 ft
Wirth B 1, 8-in diameter, April 1969

Overburden (0.3 m) 1 ft
Mineral (2.4 m) 8 ft
Waste (8.6 m) 28 ft
Bedrock (0.9 m +) 3 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
	Soil.	(0.3)	1	(0.3)	1
Glacial Sand and Gravel	Sandy gravel. Gravel: fine to coarse subangular flint with fine to medium subrounded quartz and occasional fine subrounded chalk. Sand: medium with fine and coarse subangular, slightly chalky. Brown.	(2.4)	8	(2.7)	9
Boulder Clay	Brown to grey clay with fine chalk pebbles and sandy lenses.	(8.6)	28	(11.3)	37
Upper Chalk	Chalk.	(0.9+)	3+	(12.2)	40

		%
	+ 64 mm	0
Gravel 40%	– 64 + 16	20
	– 16 + 4	20
	– 4 + 1	10
Sand 56%	– 1 + ¼	36
	– ¼ + 1/16	10
Fines 4%	– 1/16	4

Depth below surface (ft)	Percentage Fines	Sand	Gravel
1 - 4	3	62	35
4 - 7	1	58	41
7 - 9	10	44	46

TG 20 SW 25 2343 0487 The Carr, Caistor St Edmunds

Surface level (+ 5.8 m) + 19 ft Water struck at (+ 3.7 m) + 12 ft
Wirth B 1, 8-in diameter, August 1969

Overburden (0.3 m) 1 ft
Mineral (6.4 m) 21 ft
Waste (9.5 m) 31 ft
Bedrock (0.9 m +) 3 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
	Soil.	(0.3)	1	(0.3)	1
Terrace Gravel	Gravel. Fines absent except at the base of the deposit. Gravel: medium with fine and coarse angular flint, with subrounded flint; fine to medium subrounded quartz and chalk. Sand: medium with coarse and a trace of fine, subangular. Brown.	(6.4)	21	(6.7)	22
Boulder Clay	Grey chalky clay.	(9.5)	31	(16.2)	53
Upper Chalk	Chalk.	(0.9+)	3+	(17.1)	56

		%
	+ 64 mm	0
Gravel 72%	– 64 + 16	49
	– 16 + 4	23
	– 4 + 1	7
Sand 26%	– 1 + ¼	15
	– ¼ + 1/16	4
Fines 2%	– 1/16	2

Depth below surface (ft)	Percentage Fines	Sand	Gravel
1 - 4	0	26	74
4 - 7	0	26	74
7 - 10	0	18	82
10 - 13	0	35	65
13 - 16	1	34	65
16 - 19	1	17	82
19 - 22	10	30	60

TG 20 SW 26 2349 0406 Near Markshall Farm, Caistor St Edmunds

Surface level (+ 5.2 m) + 17 ft Water struck at (+c.3.0 m) + c. 10 ft
Wirth B 1, 8-in diameter, March 1969

Overburden (2.1 m) 7 ft
Mineral (3.7 m) 12 ft
Waste (12.5 m +) 41 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Alluvium	Silty and sandy peat with occasional sand and gravel lenses.	(2.1)	7	(2.1)	7
Sub-alluvium Gravel	Gravel. Gravel: fine to coarse, mainly subangular flint with occasional fine subrounded quartz. Sand: medium with fine and coarse, subangular. Brown.	(3.7)	12	(5.8)	19
Boulder Clay	Grey clay with abundant chalk.	(12.5+)	41+	(18.3)	60

		%
	+ 64 mm	: 0
Gravel 52%	– 64 + 16	: 29
	– 16 + 4	: 23
	– 4 + 1	: 8
Sand 45%	– 1 + ¼	: 26
	– ¼ + 1/16	: 11
Fines 3%	– 1/16	: 3

Depth below surface (ft)	Percentage Fines	Sand	Gravel
7 - 10	1	61	38
10 - 13	0	43	57
13 - 16	5	37	58
16 - 19	5	39	56

TG 20 SW 27 2318 0311 Roman Town, Caistor St Edmunds

Surface level (+ 15.2 m) + 50 ft Water struck at (+ 13.4 m) + 44 ft
Wirth B 1, 8-in diameter, March 1969

Overburden (2.4 m) 8ft
Mineral (3.7 m) 12 ft
Bedrock (1.2 m +) 4 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Boulder Clay	Soil on light brown clay with chalk and flint pebbles.	(2.4)	8	(2.4)	8
Glacial Sand and Gravel	Gravel. Clayey in top 3 ft. Gravel: medium with fine and coarse subangular to subrounded flint, with occasional fine to medium subrounded quartz. Sand: medium with fine and coarse subangular to subrounded.	(3.7)	12	(6.1)	20
Upper Chalk	Chalk.	(1.2+)	4+	(7.3)	24

		%
	+ 64 mm	: 1
Gravel 62%	– 64 + 16	: 27
	– 16 + 4	: 34
	– 4 + 1	: 18
Sand 32%	– 1 + ¼	: 18
	– ¼ + 1/16	: 6
Fines 6%	– 1/16	: 6

Depth below surface (ft)	Percentage Fines	Sand	Gravel
8 - 11	12	35	53
11 - 14	1	31	68
14 - 17	6	28	66
17 - 20	3	33	64

TG 20 SW 28 2331 0187 Stoke Mill, Stoke Holy Cross

Surface level (+ 11.6 m) + 38 ft Water struck at (+ 8.2 m) + 27 ft Overburden (1.5 m) 5 ft
Wirth B 1, 8-in diameter, April 1969 Mineral (9.1 m +) 30 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
	Made ground.	(1.5)	5	(1.5)	5
Sub-alluvium Gravel	Sandy gravel. Clayey in parts. Gravel: medium with coarse subangular to angular flint, with subrounded quartz and quartzite and with some fine to medium subrounded chalk. Sand: medium with fine and coarse, mainly subangular. Chalky. Brown.	(9.1+)	30+	(10.6)	35

		%
	+ 64 mm	0
Gravel 25%	– 64 + 16	11
	– 16 + 4	14
	– 4 + 1	10
Sand 67%	– 1 + ¼	38
	– ¼ + 1/16	19
Fines 8%	– 1/16	8

Depth below surface (ft)	Percentage Fines	Sand	Gravel
5 - 8	11	48	41
8 - 11	4	63	33
11 - 14	7	61	32
14 - 17	6	60	34
17 - 20	7	70	23
20 - 23	0	73	27
23 - 26	4	74	22
26 - 28	1	70	29
28 - 29	20	76	4
29 - 32	16	74	10
32 - 35	15	81	4

Borehole abandoned because of 'rising sand'.

TG 20 SW 29 2372 0169 Stoke Holy Cross

Surface level (+ 28.8 m) 94 ft Water struck at (+ 8.2 m) + 27 ft
Wirth B 1, 8-in diameter, July 1969

Overburden (0.6 m) 2 ft
Mineral (13.4 m) 44 ft
Bedrock (1.2 m +) 4 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
	Soil.	(0.6)	2	(0.6)	2
Norwich Crag	Pebbly sand. Gravel mainly at the bottom of the deposit. Gravel: medium with fine and coarse subrounded and subangular flint, with medium and fine subrounded quartz. Fine and medium subrounded chalk. Sand: medium with fine and coarse, subangular, with traces of shelly material and chalk in parts. Cream colour.	(13.4)	44	(14.0)	46
Upper Chalk	Chalk.	(1.2+)	4+	(15.2)	50

		%
	+ 64 mm	: 0
Gravel 21%	– 64 + 16	: 12
	– 16 + 4	: 9
	– 4 + 1	: 9
Sand 76%	– 1 + ¼	: 41
	– ¼ + 1/16	: 26
Fines 3%	– 1/16	: 3

Depth below surface (ft)	Percentage Fines	Sand	Gravel
2 - 5	0	97	3
5 - 8	0	75	25
8 - 10	7	73	20
10 - 13	0	98	2
13 - 16	2	98	0
16 - 19	20	80	0
19 - 22	0	96	4
22 - 25	0	89	11
25 - 28	0	91	9
28 - 31	0	100	0
31 - 34	3	36	61
34 - 37	0	60	40
37 - 40	1	36	63
40 - 43	1	34	65
43 - 46	5	87	8

TG 20 SW 30 2355 0068 South of Church, Stoke Holy Cross

Surface level (+ 23.0 m) + 75 ft Water not struck
Wirth B 1, 8-in diameter, April 1969

Overburden (0.3 m) 1 ft
Mineral (5.8 m) 19 ft
Bedrock (0.9 m +) 3 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
	Soil.	(0.3)	1	(0.3)	1
Norwich Crag	Pebbly sand. Clayey in parts. Gravel: fine to coarse with cobble, subangular flint; with fine to coarse subrounded to well rounded quartz and quartzite. Sand: fine and medium with a trace of coarse, subrounded with subangular, rare shell fragments in parts. Light brown to orange.	(5.8)	19	(6.1)	20
Upper Chalk	Chalk.	(0.9+)	3+	(7.0)	23

		%
	+ 64 mm	0
Gravel 19%	– 64 + 16	8
	– 16 + 4	11
	– 4 + 1	2
Sand 72%	– 1 + ¼	40
	– ¼ + 1/16	30
Fines 9%	– 1/16	9

Depth below surface (ft)	Percentage Fines	Sand	Gravel
1 - 4	4	85	11
4 - 7	14	59	27
7 - 10	17	65	18
10 - 13	5	83	12
13 - 16	5	88	17
16 - 20	8	59	33

TG 20 SW 31 2482 0432 Hallback Lane, Caistor St Edmunds

Surface level (+ 45.3 m) + 149 ft Water not struck
Wirth B.1, 8-in diameter, September 1969

Waste (18.3 m +) 60 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Boulder clay	Soil on brown chalky clay.	(2.1)	7	(2.1)	7
	Dark grey chalky clay.	(16.2+)	53+	(18.3)	60

TG 20 SW 32 2468 0365 High Ash Farm, Caistor St Edmunds

Surface level (+ 36.7 m) + 120 ft Groundwater conditions not recorded
Wirth B 1, 8-in diameter, March 1969

Overburden (3.7 m) 12 ft
Mineral (8.2 m) 27 ft
Waste (5.2 m) 17 ft
Mineral (4.5 m +) 15 ft +

			Thickness (m)	Thickness ft	Depth (m)	Depth ft
Boulder Clay		Soil on light brown clay with flint pebbles and traces of chalk.	(3.7)	12	(3.7)	12
Glacial Sand and Gravel	(a)	Pebbly sand. Clayey in parts. Gravel: fine to medium subangular flint, with occasional fine with medium subrounded quartz. Sand: fine with medium and traces of coarse, mainly subangular. Light brown.	(8.2)	27	(11.9)	39
Boulder Clay		Brown and grey clay laminated at the top. Traces of chalk towards the base.	(5.2)	17	(17.1)	56
Glacial Sand and Gravel	(b)	'Clayey' sand. Gravel: fine subangular flint with fine subrounded quartz. Sand: fine with medium and traces of coarse, subangular. Light brown.	(4.5+)	15+	(21.6)	71

(a)

		%
	+ 64 mm	0
Gravel 5%	– 64 + 16	1
	– 16 + 4	4
	– 4 + 1	5
Sand 86%	– 1 + ¼	32
	– ¼ + 1/16	49
Fines 9%	– 1/16	9

(b)

		%
	+ 64 mm	0
Gravel 3%	– 64 +16	1
	– 16 + 4	2
	– 4 + 1	2
Sand 84%	– 1 + ¼	32
	– ¼ + 1/16	50
Fines 13%	– 1/16	13

	Depth below surface (ft)	Percentage Fines	Sand	Gravel
(a)	12 - 15	12	86	2
	15 - 18	4	95	1
	18 - 21	23	77	0
	21 - 24	10	90	0
	24 - 27	3	95	2
	27 - 30	12	86	2
	30 - 33	9	83	8
	33 - 36	3	79	18
	36 - 39	5	86	9
(b)	56 - 59	8	90	2
	59 - 62	11	86	3
	62 - 65	21	78	1
	65 - 68	22	76	2
	68 - 71	5	91	4

Borehole abandoned for technical reasons,

TG 20 SW 33 2405 0272 East of Upper Stoke

Surface level (+ 41.6 m) + 136 ft Groundwater conditions not recorded
Wirth B 1, 8-in diameter, March 1969

Overburden (8.2 m) 27 ft
Mineral (4.6 m) 15 ft
Waste (7.0 m) 23 ft
Mineral (4.6 m +) 15 ft +

			Thickness (m)	ft	Depth (m)	ft
Boulder Clay		Soil on light brown chalky clay with occasional sandy lenses.	(8.2)	27	(8.2)	27
Glacial Sand and Gravel	(a)	Pebbly sand. High fines content. Gravel: fine and medium with traces of coarse subangular flint, with fine to medium subrounded quartz and occasional fine to medium chalk. Sand: medium with fine and coarse subangular. Light brown.	(4.6)	15	(12.8)	42
Boulder Clay		Brown and grey chalky clay with occasional gravelly seams.	(7.0)	23	(19.8)	65
Glacial Sand and Gravel	(b)	'Clayey' sandy gravel. Gravel: medium with fine and coarse subangular flint, with occasional fine subrounded quartz and fine to medium chalk. Sand: medium with fine and coarse, mainly subangular. Light brown.	(4.6+)	15+	(24.4)	80

(a)

		%
	+ 64 mm	: 0
Gravel 14%	– 64 + 16	: 4
	– 16 + 4	: 10
	– 4 + 1	: 10
Sand 80%	– 1 + ¼	: 53
	– ¼ + 1/16	: 17
Fines 6%	– 1/16	: 6

(b)

		%
	+ 64 mm	: 0
Gravel 31%	– 64 + 16	: 15
	– 16 + 4	: 16
	– 4 + 1	: 12
Sand 57%	– 1 + ¼	: 34
	– ¼ + 1/16	: 11
Fines 12%	– 1/16	: 12

	Depth below surface (ft)	Percentage Fines	Sand	Gravel
(a)	27 - 30	0	86	14
	30 - 33	11	75	14
	33 - 36	7	76	17
	36 - 39	3	82	15
	39 - 42	8	81	11
(b)	65 - 68	14	67	19
	68 - 71	9	74	17
	71 - 74	2	54	44
	74 - 77	16	47	37
	77 - 79	20	43	37
	79 - 80	18	42	40

TG 20 SW 34 2494 0255 South of Upper Stoke

Surface level (+ 62.7 m) + 206 ft Water struck at (+ 57.0 m) + 187 ft
Wirth B 1, 8-in diameter, April 1969

Overburden (0.3 m) 1 ft
Mineral (5.2 m) 17 ft
Waste (9.1 m +) 30 ft +

		Thickness (m)	ft	Depth (m)	ft
	Soil with a little gravel.	(0.3)	1	(0.3)	1
Glacial Sand and Gravel	Sandy gravel. Fines mainly absent. Gravel: fine to medium angular to subrounded flint, with occasional chalk and fine to medium quartz and quartzite. Sand: medium with coarse and traces of fine, subangular with subrounded. Brown or yellow.	(5.2)	17	(5.5)	18
Boulder Clay	Light grey chalky clay becoming sandy with a little gravel at depth.	(9.1+)	30+	(14.6)	48

		%
	+ 64 mm	: 0
Gravel 33%	- 64 + 16	: 14
	- 16 + 4	: 19
	- 4 + 1	: 20
Sand 66%	- 1 + ¼	: 43
	- ¼ + 1/16	: 3
Fines 1%	- 1/16	: 1

Depth below surface (ft)	Percentage Fines	Sand	Gravel
1 - 4	0	72	28
4 - 7	0	73	27
7 - 10	1	85	14
10 - 13	5	61	34
13 - 16	0	51	49
16 - 18	1	49	50

Borehole abandoned because of obstruction.

TG 20 SW 35 2425 0144 West of Stoke Holy Cross

Surface level (+ 42.4 m) + 139 ft Water not struck
Wirth B 1, 8-in diameter, April 1969

Waste (18.3 m +) 60 ft +

		Thickness (m)	ft	Depth (m)	ft
Boulder Clay	Soil and brown and grey chalky clays.	(13.7)	4.5	(13.7)	45
Glacial Sand and Gravel	Pebbly sand. Gravel: fine and medium subangular flint, with some fine subrounded quartz. Sand: medium with coarse and fine, mainly subangular. Chalky. Brown	(0.6)	2	(14.3)	47
Boulder Clay	Grey clay with abundant chalk, becoming lighter grey with depth.	(4.0+)	13+	(18.3)	60

TG 20 SW 36 2486 0060 Near Stoke Hall, Stoke Holy Cross

Surface level (+ 30.5 m) + 100 ft Water not struck
Wirth B 1, 8-in diameter, May 1969

Overburden (3.0 m) 10 ft
Mineral (10.4 m) 34 ft
Bedrock (1.8 m +) 6 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Boulder Clay	Made ground on light brown chalky clay with traces of sand near the base.	(3.0)	10	(3.0)	10
Glacial Sand and Gravel	Pebbly sand, with clay seam from 27 to 28 ft. Fines almost absent. Gravel: fine to coarse subrounded to subangular flint, with subrounded quartz and traces of chalk. Sand: medium and fine with coarse, mainly subangular. Light brown. Clay: brown, sandy.	(10.4)	34	(13.4)	44
Upper Chalk	Chalk.	(1.8+)	6+	(15.2)	50

		%
	+ 64 mm	0
Gravel 15%	– 64 + 16	7
	– 16 + 4	8
	– 4 + 1	9
Sand 83%	– 1 + ¼	43
	– ¼ + 1/16	31
Fines 2%	– 1/16	2

Depth below surface (ft)	Percentage Fines	Sand	Gravel
10 - 12	0	98	2
12 - 15	4	91	5
15 - 18	0	86	14
18 - 21	0	94	6
21 - 24	0	70	30
24 - 27	0	66	34
27 - 28		Clay	
28 - 31	8	72	20
31 - 34	5	77	18
34 - 37	0	91	9
37 - 40	2	82	16
40 - 44	3	92	5

TG 20 SE 1 2558 0467 Bixley Park, Arminghall

Surface level (+ 33.7 m) + 110 ft Groundwater conditions not recorded
Shell and auger, 8-in diameter, October 1969

Overburden (9.5 m) 31 ft +
Mineral (9.1 m) 30 ft
Waste (4.0 m) 13 ft
Mineral (1.6 m) 5.5 ft
Bedrock (0.2 m +) 0.5 ft +

			Thickness (m)	Thickness ft	Depth (m)	Depth ft
Boulder Clay		Soil on mottled grey clay with occasional flint pebbles.	(9.5)	31	(9.5)	31
Glacial Sand and Gravel	(a)	Pebbly sand. Gravel mainly in the lower half of the deposit. Gravel: fine to medium subangular to subrounded flint, with fine to medium subrounded to well rounded quartz and subrounded quartzite. Sand: medium and fine with traces of coarse at the top, becoming slightly coarser towards the bottom, mainly subangular to subrounded. Yellow.	(9.1)	30	(18.6)	61
Boulder Clay		Brown silty clay with a little fine to coarse flint gravel.	(4.0)	13	(22.6)	74
Norwich Crag	(b)	Gravel. Gravel: medium with fine and coarse subrounded to well rounded flint, quartz and quartzite. Occasional medium subangular flint. Sand: fine to coarse, subangular with subrounded. Brown.	(1.6)	5.5	(24.2)	79.5
Upper Chalk		Chalk.	(0.2+)	0.5+	(24.4)	80

(a)		%
	+ 64 mm	: 0
Gravel 13%	– 64 + 16	: 5
	– 16 + 4	: 8
	– 4 + 1	: 8
Sand 84%	– 1 + ¼	: 55
	– ¼ + 1/16	: 21
Fines 3%	– 1/16	: 3

(b)		%
	+ 64 mm	: 0
Gravel 74%	– 64 + 16	: 26
	– 16 + 4	: 48
	– 4 + 1	: 8
Sand 22%	– 1 + ¼	: 7
	– ¼ + 1/16	: 7
Fines 4%	– 1/16	: 4

	Depth below surface (ft)	Fines	Sand	Gravel
(a)	31 - 34	2	96	2
	34 - 37	3	91	6
	37 - 40	2	93	5
	40 - 43	5	92	3
	43 - 46	4	92	4
	46 - 49	2	84	14
	49 - 52	1	63	36
	52 - 55	4	82	14
	55 - 58	2	76	22
	58 - 61	5	75	20
(b)	74 - 77	4	15	81
	77 - 79.5	4	28	68

TG 20 SE 2 2557 0356 Osier Carr, Caistor St Edmunds

Surface level (+ 51.3 m) + 168 ft Water struck at (+ 48.2 m) + 158 ft Waste (18.3 m +) 60 ft +
Wirth B 1, 8-in diameter, April 1969

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Boulder Clay	Made ground on light brown to grey clay with traces of sand and occasional pebbles.	(4.6)	15	(4.6)	15
	Blue and greenish-grey clay, laminated in parts, with traces of sand and pebbles.	(3.9)	13	(8.5)	28
	Grey chalky clay with abundant cobbles at the top.	(9.8+)	32+	(18.3)	60

TG 20 SE 3 2574 0260 Trolla Row, Framingham Earl

Surface level (+ 65.1 m) + 213 ft Water struck at (+ 61.9 m) + 203 ft Overburden (1.2 m) 4 ft
Wirth B 1, 8-in diameter, April 1969 Mineral (6.4 m) 21 ft
Waste (10.7 m +) 35 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
	Soil.	(1.2)	4	(1.2)	4
Glacial Sand and Gravel	Sand. Clayey between 10 and 13 ft. Gravel: fine, subangular mainly flint. Sand: fine and medium with traces of coarse, subangular. Brown.	(6.4)	21	(7.6)	25
Boulder Clay	Brown silty clay with traces of gravel.	(6.1)	20	(13.7)	45
Glacial Sand and Gravel	Gravel. Gravel: coarse to cobble subrounded and subangular flint. Sand: subangular. Brown.	(0.6)	2	(14.3)	47
Boulder Clay	Grey chalky clay with occasional flint pebbles.	(4.0+)	13+	(18.3)	60

		%
	+ 64 mm	: 0
Gravel 3%	– 64 + 16	: 0
	– 16 + 4	: 3
	– 4 + 1	: 5
Sand 91%	– 1 + ¼	: 45
	– ¼ + 1/16	: 41
Fines 6%	– 1/16	: 6

Depth below surface (ft)	Percentage Fines	Sand	Gravel
4 - 7	5	95	0
7 - 10	5	82	13
10 - 13	15	81	4
13 - 16	4	91	5
16 - 19	4	96	0
19 - 21	8	88	4
21 - 25	0	99	1

TG 20 SE 4 2535 0167 Blackford Hall, Upper Stoke

Surface level (+ 58.8 m) + 193 ft Water struck at (+ 56.1 m) + 184 ft
Wirth B 1, 8-in diameter, July 1969

Overburden (0.9 m) 3 ft
Mineral (3.1 m) 10 ft
Waste (15.8 m +) 52 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
	Soil.	(0.9)	3	(0.9)	3
Glacial Sand and Gravel	Pebbly sand. Gravel: fine subangular to subrounded flint, with fine subrounded quartz and chalk. Sand: fine and medium with coarse, subangular. Brown to orange. Traces of clay.	(3.1)	10	(4.0)	13
Boulder Clay	Dark brown clay with pebbles. Occasionally laminated.	(3.0)	10	(7.0)	23
	Chalk 'wash' with traces of brown clay.	(2.1)	7	(9.1)	30
	Grey chalky clay.	(10.7+)	35+	(19.8)	65

		%
	+ 64 mm	0
Gravel 6%	− 64 + 16	1
	− 16 + 4	5
	− 4 + 1	10
Sand 91%	− 1 + ¼	40
	− ¼ + 1/16	41
Fines 3%	− 1/16	3

Depth below surface (ft)	Percentage Fines	Sand	Gravel
3 - 6	5	88	7
6 - 9	3	97	0
9 - 11	[2	87	11]
11 - 13	2	87	11

TG 20 SE 5 2593 0094 West Poringland

Surface level (+ 49.6) + 165 ft Water not struck
Wirth B 1, 8-in diameter, August 1969

Overburden (0.9 m) 3 ft
Mineral (9.1 m) 30 ft
Waste (11.6 m) 38 ft
Mineral (2.7 m +) 9 ft +

			Thickness (m)	Thickness ft	Depth (m)	Depth ft
		Soil.	(0.9)	3	(0.9)	3
Glacial Sand and Gravel	(a)	Pebbly sand. Clayey between 9 and 18 ft. Gravel mainly in the lower half of the deposit. Gravel: medium with fine and coarse, subrounded to subangular flint with a trace of subrounded quartz. Sand: medium with fine and coarse subangular. Light brown.	(9.1)	30	(10.1)	33
Boulder Clay		Dark grey chalky clay, with traces of sand and gravel at the top, becoming brown and sandy near the base.	(11.6)	38	(21.7)	71
Glacial Sand and Gravel	(b)	Sand. Gravel: fine subangular, mainly flint. Sand: fine and medium, subangular. Orange to brown. Traces of grey clay.	(2.7+)	9+	(24.4)	80

(a)

		%
	+ 64 mm	: 0
Gravel 23%	– 64 + 16	: 12
	– 16 + 4	: 11
	– 4 + 1	: 8
Sand 73%	– 1 + ¼	: 45
	– ¼ + 1/16	: 20
Fines 4%	– 1/16	: 4

(b)

		%
	+ 64 mm	: 0
Gravel 2%	– 64 + 16	: 0
	– 16 + 4	: 2
	– 4 + 1	: 3
Sand 95%	– 1 + ¼	: 42
	– ¼ + 1/16	: 50
Fines 3%	– 1/16	: 3

	Depth below surface (ft)	Percentage Fines	Sand	Gravel
(a)	3 - 6	2	66	32
	6 - 9	1	83	16
	9 - 12	12	80	8
	12 - 15	10	78	12
	15 - 18	11	86	3
	18 - 21	[1	68	31]
	21 - 24	1	53	46
	24 - 27	0	71	29
	27 - 30	1	73	26
	30 - 33	0	75	25
(b)	71 - 74	0	97	3
	74 - 77	1	99	0
	77 - 80	8	89	3

TG 20 SE 6 2664 0486 Furze Close, Framingham Pigot

Surface level (+ 45.6 m) + 150 ft Groundwater conditions not recorded Overburden (14.0 m) 46 ft
Shell and auger, 8-in diameter, October 1969 Mineral (11.9 m +) 39 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Boulder Clay	Soil on brown and grey chalky clay.	(14.0)	46	(14.0)	46
Norwich Crag	Sandy gravel. Gravel absent from the upper 12 ft of the deposit. Gravel: medium with fine and coarse, black and brown subrounded to well rounded flint with subrounded quartz and quartzite. Sand: fine and medium at the top, coarsening to medium with fine and coarse with depth; mainly subangular, with occasional chalk. Silver to grey.	(11.9+)	39+	(25.9)	85

		%
	+ 64 mm	0
Gravel 28%	– 64 + 16	9
	– 16 + 4	19
	– 4 + 1	12
Sand 69%	– 1 + ¼	38
	– ¼ + 1/16	19
Fines 3%	– 1/16	3

Depth below surface (ft)	Percentage Fines	Sand	Gravel
46 - 49	3	96	1
49 - 52	2	98	0
52 - 55	2	98	0
55 - 58	2	98	0
58 - 61	1	64	35
61 - 64	1	51	48
64 - 67	1	49	50
67 - 70	2	37	61
70 - 73	1	43	56
73 - 76	6	50	44
76 - 79	1	66	33
79 - 82	1	72	27
82 - 85	11	83	6

TG 20 SE 7 2677 0383 Manor Farm, Framingham Pigot

Surface level (+ 51.6 m) + 169 ft Water struck at (+ 48.5 m) + 159 ft
Wirth B 1, 8-in diameter, July 1969

Overburden (0.9 m) 3 ft
Mineral (4.6m) 15 ft
Waste (14.3 m +) 47 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
	Made ground.	(0.9)	3	(0.9)	3
Glacial Sand and Gravel	Pebbly sand. Clayey at top. Gravel: fine to coarse subangular flint with fine to medium subrounded quartz. Sand: medium with fine and coarse, subangular. Brown.	(4.6)	15	(5.5)	18
Boulder Clay	Grey chalky clay, chalk content increases with depth.	(14.3+)	47+	(19.8)	65

		%
	+ 64 mm	: 0
Gravel 22%	- 64 + 16	: 12
	- 16 + 4	: 10
	- 4 + 1	: 10
Sand 71%	- 1 + ¼	: 44
	- ¼ + 1/16	: 17
Fines 7%	- 1/16	: 7

Depth below surface (ft)	Percentage Fines	Sand	Gravel
3 - 6	13	82	5
6 - 9	7	63	30
9 - 12	7	80	13
12 - 15	6	79	15
15 - 18	2	52	46

TG 20 SE 8 2682 0281 Forty Acre Plantation, Framingham Earl

Surface level (+ 67.7 m) + 222 ft Water struck at (+ 63.1 m) + 207 ft
Wirth B 1, 8-in diameter, August 1969

Overburden (1.5 m) 5 ft
Mineral (6.7 m +) 22 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
	Soil on brown stony clay.	(1.5)	5	(1.5)	5
Glacial Sand and Gravel	Gravel. Gravel: medium with fine and coarse subangular flint, with fine and medium subrounded quartz. Sand: medium with fine and coarse subangular. Light brown.	(6.7+)	22+	(8.2)	27

		%
	+ 64 mm	: 0
Gravel 53%	– 64 + 16	: 30
	– 16 + 4	: 23
	– 4 + 1	: 8
Sand 46%	– 1 + ¼	: 28
	– ¼ + 1/16	: 10
Fines 1%	– 1/16	: 1

Depth below surface (ft)	Percentage Fines	Sand	Gravel
5 - 8	2	45	53
8 - 11	1	34	65
11 - 14	2	42	56
14 - 17	0	32	68
17 - 20	1	47	52
20 - 23	2	61	37
23 - 26	0	64	36
26 - 27	3	37	60

Borehole abandoned because of 'rising sand'.

TG 20 SE 9 2681 0219 Parish Hall, Poringland

Surface level (+ 55.1 m) + 181 ft Water struck between (+ 54.6 m) + 179 ft and (+ 50.0 m) + 164 ft, and below (+ 49.1 m) + 161 ft
Wirth B 1, 8-in diameter, June 1969

Overburden (0.5 m) 1.5 ft
Mineral (2.9 m) 9.5 ft
Waste (21.0 m +) 69 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
	Soil.	(0.5)	1.5	(0.5)	1.5
Glacial Sand and Gravel	Pebbly sand. Traces of clay. Gravel: medium with fine and coarse subangular flint with occasional subrounded quartz. Sand: medium with fine and a little coarse, subangular to subrounded; occasional ironstaining. Brown.	(2.9)	9.5	(3.4)	11
Boulder Clay	Grey chalky clay, chalk content increasing with depth.	(21.0+)	69+	(24.4)	80

		%
	+ 64 mm	: 0
Gravel 20%	– 64 + 16	: 9
	– 16 + 4	: 11
	– 4 + 1	: 14
Sand 76%	– 1 + ¼	: 40
	– ¼ + 1/16	: 22
Fines 4%	– 1/16	: 4

Depth below surface (ft)	Percentage Fines	Sand	Gravel
1.5 - 5	3	79	18
5 - 8	5	71	24
8 - 11	5	77	18

TG 20 SE 10 2664 0129 Carr Lane, Poringland

Surface level (+ 46.6 m) + 153 ft Water struck at (+ 40.5 m) + 133 ft
Wirth B 1, 8 in diameter, June 1969

Overburden (0.3 m) 1 ft
Mineral 12.7 m) 42 ft
Waste (11.4 m +) 37 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
	Soil.	(0.3)	1	(0.3)	1
Glacial Sand and Gravel	Sandy gravel, with clay seam from 36 to 37 ft. Gravel absent between 28 and 36 ft. Clayey between 31 and 34 ft. Gravel: medium with fine and coarse subangular flint with subrounded quartz, with traces of subrounded flint cobbles and coarse subrounded quartzite. Sand: fine and medium with coarse, subangular. Brown.	(12.7)	41.5	(13.0)	42.5
Boulder Clay	Brown chalky clay with sandy bands in parts, becoming grey at depth.	(11.4+)	37.5+	(24.4)	80

		%
	+ 64 mm	1
Gravel 35%	– 64 + 16	18
	– 16 + 4	16
	– 4 + 1	13
Sand 61%	– 1 + ¼	23
	– ¼ + 1/16	25
Fines 4%	– 1/16	4

Depth below surface (ft)	Percentage Fines	Sand	Gravel
1 - 4	7	77	16
4 - 7	2	62	36
7 - 10	0	64	36
10 - 13	0	44	56
13 - 16	3	42	55
16 - 19	5	62	33
19 - 22	4	52	44
22 - 25	0	57	43
25 - 28	3	72	25
28 - 31	2	98	0
31 - 34	30	70	0
34 - 36	4	96	0
36 - 37		Clay	
37 - 40	1	13	86
40 - 42.5	2	33	65

TG 20 SE 11 2650 0035 Leafyoak Lane, West Poringland

Surface level (+ 34.4 m) + 113 ft Water struck at (+ c.23.8 m) + c. 78 ft Overburden (6.7 m) 22 ft
Wirth B 1, 8-in diameter, July 1969 Mineral (7.3 m +) 24 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
	Made ground.	(0.6)	2	(0.6)	2
Boulder Clay	Light brown clay with abundant chalk.	(6.1)	20	(6.7)	22
Glacial Sand and Gravel	Sandy gravel. Chalky in the upper half of the deposit. Fines almost absent. Gravel: coarse with medium and fine subrounded with subangular flint; with fine to coarse subrounded quartz and quartzite, with traces of chalk and occasional flint cobbles. Sand: medium with fine and coarse, subrounded with subangular. Mainly brown.	(7.3+)	24+	(14.0)	46

		%
	+ 64 mm	: 2
Gravel 28%	– 64 + 16	: 16
	– 16 + 4	: 10
	– 4 + 1	: 13
Sand 71%	– 1 + ¼	: 48
	– ¼ + 1/16	: 10
Fines 1%	– 1/16	: 1

Depth below surface (ft)	Percentage Fines	Sand	Gravel
22 - 24	2	70	28
24 - 26	1	92	7
26 - 28	1	80	19
28 - 30	0	30	70
30 - 33	0	64	36
33 - 36	2	45	53
36 - 39	0	63	37
39 - 42	1	88	11
42 - 44	0	90	10
44 - 46	2	96	2

Borehole abandoned because of 'rising sand'.

TG 20 SE 12 2754 0468 The Thicket, Framingham Earl

Surface level (+ 45.1 m) + 148 ft Water not struck Waste (18.3 m +) 60 ft +
Wirth B 1, 8 in diameter, July 1969

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Boulder Clay	Soil on brown chalky clay with abundant flint pebbles.	(3.1)	10	(3.1)	10
	Grey chalky clay with flint pebbles.	(15.2+)	50+	(18.3)	60

TG 20 SE 13 2784 0362 St Andrew's Church, Framingham Pigot

Surface level (+ 37.2 m) + 122 ft Water struck at (+ 31.1 m) + 112 ft
Wirth B 1, 8-in diameter, July 1969

Overburden (0.6 m) 2 ft
Mineral (19.5 m) 64 ft
Waste (4.3 m +) 14 ft

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
	Soil.	(0.6)	2	(0.6)	2
Glacial Sand and Gravel	Pebbly sand. Occasionally clayey. Gravel: fine to medium with a little coarse, subangular flint. Sand: fine and medium with coarse, coarse occasionally dominant, mainly subangular. Brown.	(19.5)	64	(20.1)	66
Boulder Clay	Grey clay with abundant chalk.	(4.3+)	14+	(24.4)	80

		%
	+ 64 mm	0
Gravel 19%	– 64 + 16	6
	– 16 + 4	13
	– 4 + 1	11
Sand 74%	– 1 + ¼	34
	– 1/16	29
Fines 7%	– 1/16	7

Depth below surface (ft)	Percentage Fines	Sand	Gravel
2 - 5	3	87	10
5 - 8	5	67	28
8 - 11	6	75	19
11 - 14	6	84	10
14 - 17	9	91	0
17 - 20	10	84	6
20 - 23	12	84	4
23 - 26	5	73	22
26 - 29	[8	84	8]
29 - 32	2	63	35
32 - 35	3	88	9
35 - 38	5	58	37
38 - 41	6	57	37
41 - 44	28	63	9
44 - 47	7	77	16
47 - 50	8	82	10
50 - 53	1	83	16
53 - 56	7	66	27
56 - 59	7	63	30
59 - 62	6	56	38
62 - 65	7	73	20
65 - 66	5	76	19

TG 20 SE 14 2769 0234 Poringland Upgate

Surface level (+ 58.6 m) + 192 ft Water struck at (+ 57.3 m) + 188 ft
Wirth B 1, 8-in diameter, August 1969

Overburden (0.6 m) 2 ft
Mineral (8.5 m) 28 ft
Waste (9.2 m +) 30 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
	Soil.	(0.6)	2	(0.6)	2
Glacial Sand and Gravel	Pebbly sand with clay seam from 11 to 12 ft. Clayey in parts. Gravel: fine and medium with coarse subangular flint, with fine subrounded quartz. Sand: fine and medium with coarse, subangular. Light brown. Clay: brown, slightly sandy.	(8.5)	28	(9.1)	30
Boulder Clay	Grey chalky clay.	(9.2+)	30+	(18.3)	60

		%
	+ 64 mm	0
Gravel 17%	– 64 + 16	4
	– 16 + 4	13
	– 4 + 1	7
Sand 74%	– 1 + ¼	38
	– ¼ + 1/16	29
Fines 9%	– 1/16	9

Depth below surface (ft)	Percentage Fines	Sand	Gravel
2 - 5	0	82	18
5 - 8	2	80	18
8 - 11	0	67	33
11 - 12		Clay	
12 - 15	1	69	30
15 - 18	33	44	23
18 - 21	7	91	2
21 - 24	6	84	10
24 - 27	1	90	9
27 - 30	29	65	6

TG 20 SE 15 2758 0154 Wash Lane, East Poringland

Surface level (+ 38.7 m) + 127 ft Water struck at (+ 36.9 m) + 121 ft
Wirth B 1, 8-in diameter, July 1969

Overburden (0.6 m) 2 ft
Mineral (3.4 m) 11 ft
Waste (15.8 m +) 52 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
	Soil.	(0.6)	2	(0.6)	2
Glacial Sand and Gravel	Sandy gravel. Gravel: fine to coarse with cobbles at the base, mainly subangular flint; with coarse to cobble subrounded flint and with fine subrounded quartz and chalk. Sand: medium with fine and coarse, subangular. Brown.	(3.4)	11	(4.0)	13
Boulder Clay	Grey chalky clay.	(10.6)	35	(14.6)	48
	Brown sandy clay with occasional flint pebbles.	(5.2+)	17+	(19.8)	65

		%
	+ 64 mm	0
Gravel 38%	– 64 + 16	19
	– 16 + 4	19
	– 4 + 1	8
Sand 60%	– 1 + ¼	34
	– 1 + 1	18
Fines 2%	– 1/16	2

Depth below surface (ft)	Percentage Fines	Sand	Gravel
2 - 5	3	77	20
5 - 8	4	64	32
8 - 12	1	54	45
12 - 13	0	15	85

TG 20 SE 16 2733 0042 Dove Lane, Howe

Surface level (+ 35.2 m) + 116 ft Water not struck
Wirth B 1, 8-in diameter, July 1969

Overburden (0.3 m) 1 ft
Mineral (2.1 m) 7 ft
Waste (6.7 m) 22 ft
Mineral (15.3 m +) 50 ft +

			Thickness (m)	Thickness ft	Depth (m)	Depth ft
		Soil.	(0.3)	1	(0.3)	1
Glacial Sand and Gravel	(a)	Sandy gravel. Gravel: medium with fine and coarse subangular flint with fine subrounded quartz. Sand: medium with coarse and a little fine, subangular. Brown.	(2.1)	7	(2.4)	8
Boulder Clay		Sandy brown clay with traces of gravel.	(3.0)	10	(5.4)	18
		Slightly sandy, brown to orange or blue to grey clay.	(3.7)	12	(9.1)	30
Glacial Sand and Gravel	(b)	Pebbly sand. Gravel: fine and medium with coarse subangular flint; with fine subrounded quartz and traces of fine chalk. Sand: medium with fine and coarse, mainly subangular. Proportion of fine sand increasing with depth. Slightly clayey in parts.	(15.3+)	50+	(24.4)	80

(a)

		%
	+ 64 mm	0
Gravel 31%	− 64 + 16	12
	− 16 + 4	19
	− 4 + 1	14
Sand 68%	− 1 + ¼	48
	− ¼ + 1/16	6
Fines 1%	− 1/16	1

(b)

		%
	+ 64 mm	0
Gravel 23%	− 64 + 16	8
	− 16 + 4	15
	− 4 + 1	10
Sand 75%	− 1 + ¼	48
	− ¼ + 1/16	17
Fines 2%	− 1/16	2

	Depth below surface (ft)	Percentage Fines	Sand	Gravel
(a)	1 - 4	0	60	40
	4 - 7	2	75	23
	7 - 8	no sample		
(b)	30 - 33	7	76	17
	33 - 36	1	73	26
	36 - 39	1	64	35
	39 - 42	0	82	18
	42 - 45	0	79	21
	45 - 48	1	76	23
	48 - 51	9	76	15
	51 - 54	3	68	29
	54 - 57	1	67	32
	57 - 60	0	70	30
	60 - 63	0	74	26
	63 - 66	4	76	20
	66 - 69	1	74	25
	69 - 72	3	88	9
	72 - 75	0	71	29
	75 - 78	2	77	21
	78 - 80	[2	78	20]

TG 20 SE 17 2856 0475 Manor Farm, Kirby Bedon

Surface level (+ 38.7 m) + 127 ft Water struck at (+ 33.2 m) + 109 ft Waste (12.5 m +) 41 ft +
Wirth B 1, 8-in diameter, July 1969

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Boulder Clay	Made ground on brown chalky clay with numerous flint cobbles.	(7.9)	26	(7.9)	26
	Grey chalky clay with a layer of flint cobbles from 36 to 41 ft.	(4.6+)	15+	(12.5)	41

Borehole abandoned because of obstruction.

TG 20 SE 18 2850 0371 Loddon Road, Framingham Pigot

Surface level (+ 20.6 m) + 68 ft Water struck at (+ 18.0 m) + 59 ft Overburden (0.9 m) 3 ft
Wirth B 1, 8 in diameter, July 1969 Mineral (11.0 m +) 36 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
	Made ground.	(0.9)	3	(0.9)	3
Norwich Crag	Pebbly sand. Gravel mainly in the upper 12 ft of the deposit. Traces of shell in lower 18 ft of the deposit. Gravel: fine to coarse subangular to subrounded flint with fine to medium subrounded quartz. Sand: medium with fine and a little coarse, subangular. Light brown.	(11.0+)	36+	(11.9)	39

		%
	+ 64 mm	: 0
Gravel 12%	– 64 + 16	: 5
	– 16 + 4	: 7
	– 4 + 1	: 7
Sand 86%	– 1 + ¼	: 61
	– ¼ + 1/16	: 18
Fines 2%	– 1/16	: 2

Depth below surface (ft)	Percentage Fines	Sand	Gravel
3 - 6	1	64	35
6 - 9	[2	71	27]
9 - 12	2	72	26
12 - 15	3	77	20
15 - 18	0	98	2
18 - 21	0	96	4
21 - 24	0	94	6
24 - 27	1	95	4
27 - 30	1	94	5
30 - 33	3	91	6
33 - 36	2	96	2
36 - 39	5	92	3

Borehole abandoned because of 'rising sand'.

TG 20 SE 19 2841 0268 Boundary Farm, Yelverton

Surface level (+ 49.7 m) 163 ft Water struck at (+ 46.9 m) + 154 ft Waste (18.3 m +) 60 ft +
Wirth B 1, 8-in diameter, June 1969

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Boulder Clay	Soil on brown clay with abundant chalk and coarse flint pebbles.	(3.7)	12	(3.7)	12
	Dark grey chalky clay, chalk content decreasing with depth.	(14.6+)	48+	(18.3)	60

TG 20 SE 20 2863 0171 Burgate Lane, Alpington

Surface level (+ 36.9 m) + 121 ft Water struck at (+ 33.8 m) + 111 ft Waste (18.3 m +) 60 ft +
Wirth B.1, 8 in diameter, June 1969

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Boulder Clay	Made ground on grey chalky clay.	(2.1)	7	(2.1)	7
	Grey to blue finely laminated silt. Clayey sand seam from 10 to 12 ft.	(3.1)	10	(5.2)	17
	Dark grey clay with abundant chalk fragments.	(13.1+)	43+	(18.3)	60

TG 20 SE 21 2843 0090 West of Alpington Hall

Surface level (+ 23.7 m) + 78 ft Water struck at (+ 22.9 m) + 75 ft
Wirth B 1, 8-in diameter, June 1969

Overburden (0.3 m) 1 ft
Mineral (6.4 m) 21 ft
Waste (3.9 m +) 13 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
	Soil.	(0.3)	1	(0.3)	1
Glacial Sand and Gravel	Pebbly sand. Gravel: fine and medium with coarse subrounded flint; with fine and medium subrounded quartz and quartzite. Sand: medium with fine and coarse, subangular to subrounded. Yellow or silver.	(6.4)	21	(6.7)	22
?Norwich Crag	Light grey silty laminated clay with traces of sand.	(2.4)	8	(9.1)	30
	Grey or silver sand, mainly fine and slightly clayey.	(1.5+)	5+	(10.6)	35

		%
	+ 64 mm	: 1
Gravel 18%	– 64 + 16	: 7
	– 16 + 4	: 10
	– 4 + 1	: 13
Sand 80%	– 1 + ¼	: 54
	– ¼ + 1/16	: 13
Fines 2%	– 1/16	: 2

Depth below surface (ft)	Percentage Fines	Sand	Gravel
1 - 4	4	77	19
4 - 5	1	69	30
5 - 6	2	65	33
6 - 8	0	85	15
8 - 11	1	57	42
11 - 14	5	86	9
14 - 17	1	92	7
17 - 20	0	90	10
20 - 22	3	91	6

Borehole abandoned because of 'rising sand'.

TG 20 SE 22 2876 0033 Wellbeck Farm, Brooke

Surface level (+ 29.6 m) + 97 ft Water struck at (+ 22.9 m) + 75 ft
Wirth B 1, 8-in diameter, May 1969

Overburden (0.6 m) 2 ft
Mineral (5.2 m) 17 ft
Waste (0.9 m) 3 ft
Mineral (14.0 m) 46 ft
Waste (1.2 m +) 4 ft +

			Thickness (m)	Thickness ft	Depth (m)	Depth ft
		Soil.	(0.6)	2	(0.6)	2
Glacial Sand and Gravel	(a)	Sandy gravel. Gravel: fine to coarse subangular to subrounded flint with fine to medium subrounded quartz and quartzite. Sand: medium with fine and coarse, subangular with subrounded. Orange to brown.	(5.2)	17	(5.8)	19
Boulder Clay		Light grey chalky clay with occasional flint pebbles.	(0.9)	3	(6.7)	22
Glacial Sand and Gravel	(b)	Sandy gravel. Fines absent. Gravel: medium with fine and coarse, with occasional cobble, subangular to subrounded flint; with fine to medium with coarse subrounded to well rounded quartz and quartzite. Sand: medium with coarse and a little fine, subangular. Mainly brown.	(14.0)	46	(20.7)	68
Norwich Crag		Silty black laminated clay, with some iron-staining.	(0.3)	1	(21.0)	69
		Shelly sand, mainly medium with fine and large shell fragments. Orange to brown colour.	(0.9+)	3+	(21.9)	72

(a)

		%
	+ 64 mm	: 0
Gravel 28%	– 64 + 16	: 10
	– 16 + 4	: 18
	– 4 + 1	: 18
Sand 70%	– 1 + ¼	: 42
	– ¼ + 1/16	: 10
Fines 2%	– 1/16	: 2

(b)

		%
	+ 64 mm	: 1
Gravel 39%	– 64 + 16	: 19
	– 16 + 4	: 19
	– 4 + 1	: 12
Sand 61%	– 1 + ¼	: 42
	– ¼ + 1/16	: 7
Fines 0%	– 1/16	: 0

	Depth below surface (ft)	Percentage Fines	Sand	Gravel
(a)	2 - 4	2	69	29
	4 - 7	5	55	40
	7 - 10	4	56	40
	10 - 13	2	71	27
	13 - 16	0	86	14
	16 - 19	0	80	20
(b)	22 - 25	0	39	61
	25 - 28	0	42	58
	28 - 31	1	57	42
	31 - 34	0	49	51
	34 - 37	1	39	60
	37 - 40	0	50	50
	40 - 43	0	20	80
	43 - 46	1	90	9
	46 - 49	1	89	10
	49 - 52	0	55	45
	52 - 55	0	89	11
	55 - 58	0	65	35
	58 - 61	0	76	24
	61 - 64	0	80	20
	64 - 67	0	74	26
	67 - 68	0	67	33

Borehole abandoned because of 'rising sand'.

TG 20 SE 23 2949 0414 Bullock Shed Lane, Bramerton

Surface level (+ 32.0 m) + 105 ft Water not struck
Wirth B 1, 8-in diameter, June 1969

Overburden (5.8 m) 19 ft
Mineral (18.6 m +) 61 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Boulder Clay	Soil on brown clay with abundant chalk and flint pebbles.	(5.8)	19	(5.8)	19
Glacial Sand and Gravel	Pebbly sand. Clayey from 19 to 25 and 37 to 43 ft. Gravel: fine and medium with coarse subangular to subrounded flint, with fine to medium subrounded quartz, traces of hard chalk pebbles. Sand: medium with fine and coarse, mainly subrounded, traces of chalk. Light brown.	(18.6+)	61+	(24.4)	80

		%
	+ 64 mm	: 0
Gravel 13%	– 64 + 16	: 5
	– 16 + 4	: 8
	– 4 + 1	: 16
Sand 80%	– 1 + ¼	: 48
	– ¼ + 16	: 16
Fines 7%	– 1/16	: 7

Depth below surface (ft)	Percentage Fines	Sand	Gravel
19 - 22	18	81	1
22 - 25	34	64	2
25 - 28	2	97	1
28 - 31	0	98	2
31 - 34	5	92	3
34 - 37	1	90	10
37 - 40	22	58	20
40 - 43	30	60	10
43 - 46	3	86	11
46 - 49	1	77	22
49 - 52	0	77	23
52 - 55	0	90	10
55 - 58	0	74	26
58 - 61	1	82	17
61 - 64	[0	82	18]
64 - 67	0	89	11
67 - 70	8	62	30
70 - 73	3	75	22
73 - 76	0	89	11
76 - 80	5	83	12

TG 20 SE 24 2960 0330 Loddon Road, Yelverton

Surface level (+ 28.0 m) + 92 ft Groundwater conditions not recorded
Wirth B 1, 8-in diameter, July 1969

Overburden (0.3 m) 1 ft
Mineral (9.8 m) 32 ft
Waste (1.2 m) 4 ft
Mineral (8.2 m) 27 ft
Waste (1.2 m) 4 ft
Mineral (3.7 m +) 12 ft +

			Thickness (m)	Thickness ft	Depth (m)	Depth ft
		Soil.	(0.3)	1	(0.3)	1
Glacial Sand and Gravel	(a)	Pebbly sand. Clayey in parts Gravel: fine and medium and a little coarse subangular to subrounded flint with traces of fine subrounded quartz. Sand: fine and medium with a little coarse, subangular. Orange or brown.	(9.8)	32	(10.1)	33
Norwich Crag		Dark brown and grey mottled clay.	(1.2)	4	(11.3)	37
	(b)	Pebbly sand. Gravel mainly between 40 and 52 ft. Traces of shell. Fines almost absent. Gravel: fine and medium subrounded flint and quartz, with a little coarse subangular flint. Sand: medium with fine and coarse (tending to be coarsest at the levels with a high gravel content, i.e., 40 to 52 ft), mainly subangular with subrounded, with traces of chalk and shell. Orange.	(8.2)	27	(19.5)	64
		Dark grey to black silty clay.	(1.2)	4	(20.7)	68
	(c)	Sand. Sand: medium with fine and a trace of coarse, subangular to subrounded; a trace of chalk. Orange.	(3.7+)	12+	(24.4)	80

		%
(a)		
	+ 64 mm	0
Gravel 12%	– 64 + 16	5
	– 16 + 4	7
	– 4 + 1	5
Sand 78%	– 1 + ¼	33
	– ¼ + 1/16	40
Fines 10%	– 1/16	10
(b)		
	+ 64 mm	0
Gravel 11%	– 64 + 16	3
	– 16 + 4	8
	– 4 + 1	9
Sand 88%	– 1 + ¼	59
	– ¼ + 1/16	20
Fines 1%	– 1/16	1
(c)		
	+ 64 mm	0
Gravel 3%	– 16 + 16	1
	– 16 + 4	2
	– 4 + 1	4
Sand 93%	– 1 + ¼	63
	– ¼ + 1/16	26
Fines 4%	– 1/16	4

	Depth below surface (ft)	Fines	Sand	Gravel
(a)	1 - 4	8	72	20
	4 - 7	10	75	15
	7 - 10	14	83	3
	10 - 13	3	91	6
	13 - 16	5	92	3
	16 - 19	0	86	14
	19 - 22	5	81	14
	22 - 25	6	78	16
	25 - 28	8	73	19
	28 - 31	42	47	11
	31 - 33	5	86	9
(b)	37 - 40	0	98	2
	40 - 43	0	88	12
	43 - 46	1	79	20
	46 - 49	0	64	36
	49 - 52	0	78	22
	52 - 55	0	98	2
	55 - 58	3	94	3
	58 - 61	5	93	2
	61 - 64	2	96	2
(c)	68 - 71	2	96	2
	71 - 74	5	91	4
	74 - 77	5	91	4
	77 - 80	3	95	2

TG 20 SE 25 2949 0252 Near Yelverton

Surface level (+ 37.3 m) + 123 ft Water struck at (+ 34.4 m) + 113 ft Waste (18.3 m +) 60 ft +
Wirth B 1, 8-in diameter, June 1969

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Boulder Clay	Soil on light brown chalky clay with abundant flint cobbles.	(7.6)	25	(7.6)	25
	Grey clay with abundant chalk fragments.	(10.7+)	35+	(18.3)	60

TG 20 SE 26 2960 0133 Church Meadow Lane, Alpington

Surface level (+ 30.3 m) + 99 ft Water struck at (+ 20.7 m) + 68 ft
Wirth B 1, 8-in diameter, June 1969

Overburden (1.2 m) 4 ft
Mineral (1.8 m) 6 ft
Waste (1.2 m) 4 ft
Mineral (5.2 m) 17 ft
Waste (2.7 m +) 9 ft +

			Thickness (m)	Thickness ft	Depth (m)	Depth ft
		Soil.	(1.2)	4	(1.2)	4
Glacial Sand and Gravel	(a)	Pebbly sand. Gravel: fine to medium subangular to subrounded flint with fine subrounded quartz. Sand: medium with fine and coarse, subangular to subrounded. Brown.	(1.8)	6	(3.0)	10
Boulder Clay		Chalky clay with a little chalk sand.	(1.2)	4	(4.2)	14
?Norwich Crag	(b)	Sandy gravel. Fines almost absent. Traces of shell. Gravel: fine and medium with coarse subangular flint with subrounded quartz and chalk. Sand: medium with coarse and fine, subangular, with traces of chalk and shelly material. Brown, ironstained.	(5.2)	17	(9.4)	31
		Grey and brown clay with grey silt and sand lenses.	(0.9)	3	(10.4)	34
		Clayey sand with a little gravel.	(0.3)	1	(10.7)	35
		Grey and brown laminated clay.	(0.3)	1	(11.0)	36
		Clayey sand with a little gravel.	(1.2+)	4+	(12.2)	40

(a)

		%
	+ 64 mm	0
Gravel 20%	– 64 + 16	6
	– 16 + 4	14
	– 4 + 1	18
Sand 75%	– 1 + ¼	38
	– ¼ + 1/16	19
Fines 5%	– 1/16	5

(b)

		%
	+ 64 mm	0
Gravel 28%	– 64 + 16	16
	– 16 + 4	12
	– 4 + 1	18
Sand 71%	– 1 + ¼	46
	– ¼ + 1/16	7
Fines 1%	– 1/16	1

	Depth below surface (ft)	Percentage Fines	Sand	Gravel
(a)	4 - 7	6	84	10
	7 - 10	4	65	31
(b)	14 - 16	5	72	23
	16 - 19	0	46	54
	19 - 23	0	68	32
	23 - 26	2	91	7
	26 - 29	0	77	23
	29 - 31	0	71	29

Borehole abandoned because of 'rising sand'.

TG 20 SE 27 2951 0045 Kiln Grove, Brooke

Surface level (+ 31.2 m) + 103 ft Water struck at (+ 23.8 m) + 78 ft
Wirth B 1, 8-in diameter, June 1969

Overburden (8.8 m) 29 ft
Mineral (4.3 m) 14 ft
Waste (2.7 m +) 9 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Boulder Clay	Made ground on brown sandy, chalky clay.	(5.8)	19	(5.8)	19
	Blue chalky clay with a brown band at the base.	(3.0)	10	(8.8)	29
Glacial Sand and Gravel	Pebbly sand. Clayey in the middle 3 ft of the deposit. Gravel: fine and medium with coarse, subrounded quartzite and flint with occasional quartz. Sand: medium with fine and coarse, fine dominant in the middle part of the deposit, mainly subrounded. Light brown.	(4.3)	14	(13.1)	43
Norwich Crag	Dark grey with traces of sand.	(1.8)	6	(14.9)	49
	Grey sand with traces of shelly material and clay.	(0.9+)	3+	(15.8)	52

		%
	+ 64 mm	: 0
Gravel 21%	– 64 + 16	: 7
	– 16 + 4	: 14
	– 4 + 1	: 16
Sand 77%	– 1 + ¼	: 36
	– ¼ + 1/16	: 25
Fines 2%	– 1/16	: 2

Depth below surface (ft)	Percentage Fines	Sand	Gravel
29 - 31	1	62	37
31 - 33	0	85	15
33 - 35	0	82	18
35 - 37	15	85	0
37 - 39	0	100	0
39 - 41	2	58	40
41 - 43	0	61	39

Borehole abandoned because of 'rising sand'.

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INSTITUTE OF GEOLOGICAL SCIENCES

MINERAL ASSESSMENT UNIT

THE SAND & GRAVEL RESOURCES of SHEET TG 20 (NORWICH, NORFOLK)

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

ORDNANCE SURVEY
SHEET TG20
PROVISIONAL EDITION

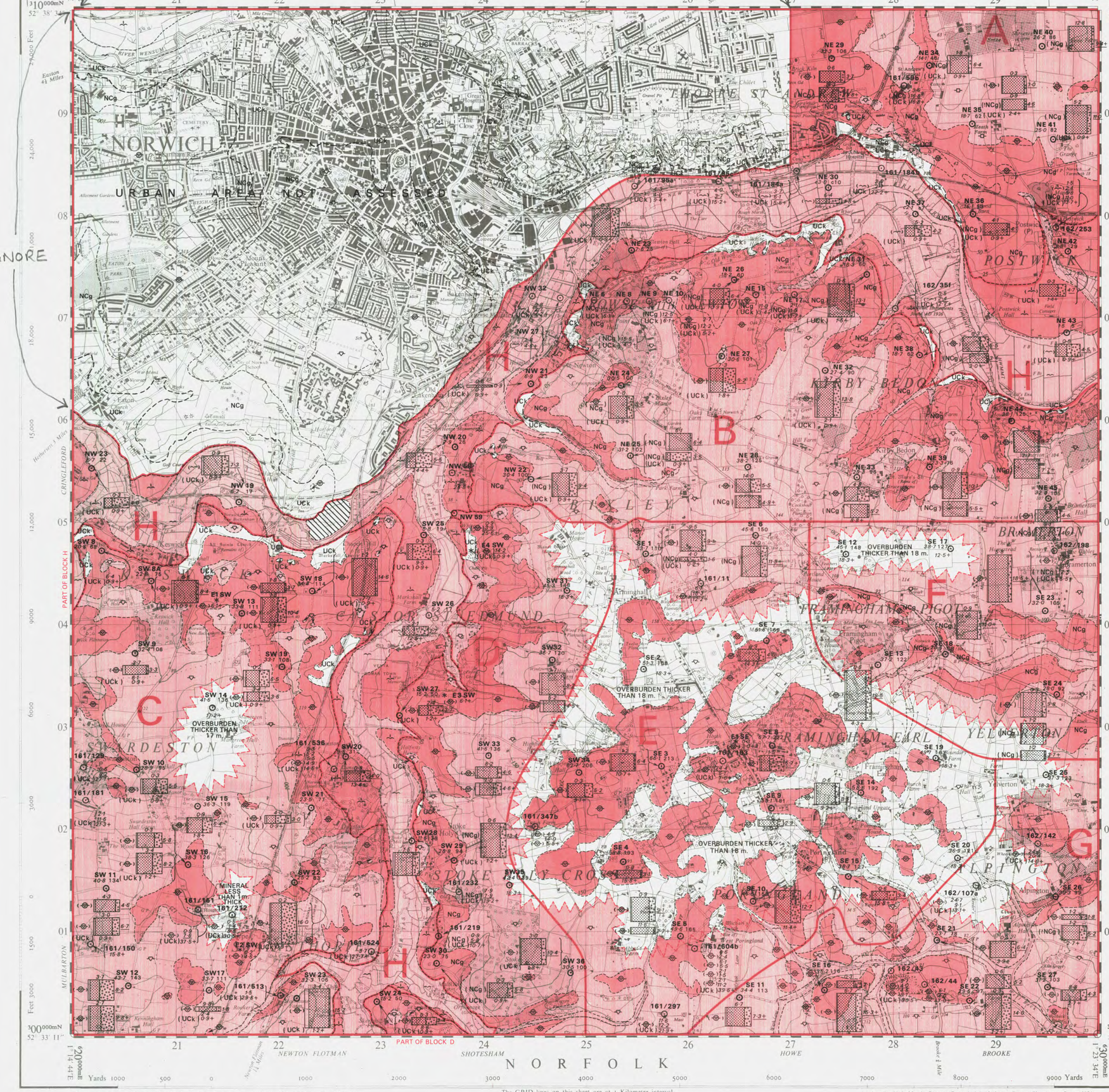
This map should be read in conjunction with the accompanying Report which contains details of the assessment of resources.

1

IGNORE THIS RESOURCE BOUNDARY (ON THIS MAP ONLY)

IGNORE

SEED THESE AREAS AS RB-A, RB-H etc..



EXPLANATION OF SYMBOLS AND ABBREVIATIONS

RECENT AND PLEISTOCENE / CRETACEOUS

DRIFT

A-11	~	**Alluvium** – fine sands, clay and peat, often overlying sand and gravel.
1T-3	⊥	**1st Terrace River Gravels** – slightly clayey, medium flint gravels, chalk free.
GS-2	⊛	**Glacial Sand and Gravel** – clean, ill-sorted sands and gravels, with some chalk.
BC-4	⊹	**Boulder Clay** – stiff blue clay with pebbles of chalk and flint.
NB-1	⊹	**Norwich Brickearth** – brown sandy clay and silt with occasional pebbles of flint.

SOLID

NC-1	NCg	**Norwich Crag** – sands and gravels with thin beds of clay. Sands occasionally shelly especially near base. Gravel content generally increases westwards.
	UCk	**Upper Chalk** – white, soft limestone containing black nodular flints with white patina.
MG-2	▨	**Made Ground.**

BOUNDARY LINES

- Geological boundary, Drift.
- Geological boundary, Solid. Broken line denotes uncertainty.
- 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 → NE 35 (18·7 62) ← Surface level in metres and feet above O.D. (Newlyn).
Borehole site →
0·3 Overburden
(⊙) 7·0 ← Mineral (sand and gravel).
0·9 Waste.
Geological Classification → (NCg) 4·6 ← Mineral (sand and gravel).
(UCk) 2·4+ ← Bedrock
Grading Diagram.

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

Borehole Registration Number

Each M.A.U. borehole is identified by a Registration Number, eg. NE 35. 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 NE 35 is TG 20 NE 35.

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, **161/297** signifies Hydrogeological Department borehole 297 on New Series One-Inch Geological Sheet 161.

EXPOSURE RECORDS

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

CATEGORIES OF DEPOSITS

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

Where appropriate on other sheets a fourth category, 'Discontinuous spreads of sand and gravel beneath overburden' is recognised.

RESOURCE BLOCKS

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

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

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

Geological lines from a six-inch survey by F.C.Cox, in 1968–9. S.C.A.Holmes, District Geologist. Included in One-Inch Geological Sheets 161 and 162.

Sand and Gravel Survey by E.F.P. Nickless and A.R.Clayton in 1968 to 1970. A.A.Archer and R.G.Thurrell, Heads, Mineral Assessment Unit.

1:25,000 Sand and Gravel Resource Sheet published 1971. K.C.Dunham, D.Sc., F.R.S., Director, Institute of Geological Sciences incorporating the Geological Survey of Great Britain, the Museum of Practical Geology and Overseas Geological Surveys.

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

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

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

Compiled from 6" sheets last fully revised 1905-26. Other partial systematic revision 1938-52 has been incorporated.

Made and published by the Director General of the Ordnance Survey, Chessington, Surrey, 1956. Reprinted with minor corrections 1958.

	TG 11	TG 21	TG 31	
	TG 10 161	TG 20	TG 30 162	
	TM 19	TM 29	TM 39	

Diagram showing the relation of the National Grid 1:25,000 sheets with the One-Inch Geological Sheets 161 and 162.

Drawn and reproduced by the Cartographic Department, Hunting Surveys Ltd., Elstree Way, Borehamwood, Herts.