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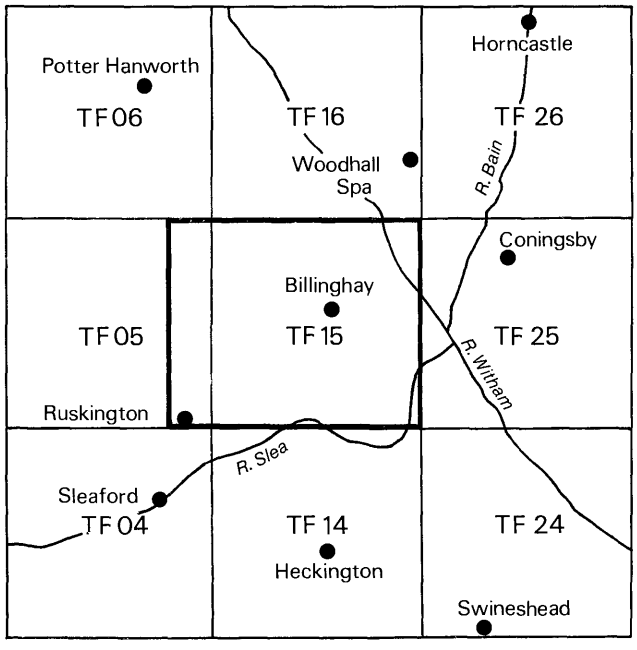


# The sand and gravel resources of the country around Billinghay, Lincolnshire

## Description of 1:25 000 sheets TF 15 and part of TF 05

J. B. L. Wild



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The first twelve reports on the assessment of British sand and gravel resources appeared in the Report Series of the Institute of Geological Sciences as a subseries. Report No. 13 and subsequent reports appear as Mineral Assessment Reports of the Institute.

Details of published reports appear at the end of this Report.

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## PREFACE

National resources of many industrial minerals may seem so large that stocktaking appears unnecessary, but the demand for minerals and for land for all purposes is intensifying and it has become increasingly clear in recent years that regional assessments of the resources of these minerals should be undertaken. The publication of information about the quantity and quality of deposits over large areas is intended to provide a comprehensive factual background against which planning decisions can be made.

Sand and gravel, considered together as naturally occurring aggregate, was selected as the bulk mineral demanding the most urgent attention, initially in the south-east of England, where about half the national output is won and very few sources of alternative aggregates are available. Following a short feasibility project, initiated in 1966 by the Ministry of Land and Natural Resources, the Industrial Minerals Assessment Unit (formerly the Mineral Assessment Unit) began systematic surveys in 1968. The work is now being financed by the Department of the Environment and is being undertaken with the cooperation of the Sand and Gravel Association of Great Britain.

This report describes the sand and gravel resources of 140 $km^2$ of country around Billinghay, Lincolnshire, shown on the accompanying 1:25 000 resource map TF 15 and part of TF 05. The survey was conducted by J. B. L. Wild under the supervision of I. Jackson and B. J. Taylor. The work is based on one-inch geological surveys by W. H. Dalton, S. B. J. Skertchly and A. J. Jukes-Browne and published (in 1886) as Old Series sheets 70 and 83, parts of which were republished in 1972 (as provisional editions) on the 1:50 000 scale as New Series sheets 114 and 127.

W. N. Pierce (Land Agent) was responsible for negotiating access to land for drilling. The ready cooperation of landowners and tenants in this work is gratefully acknowledged.

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18 August 1981

**CONTENTS**

# The sand and gravel resources of the country around Billinghay, Lincolnshire

## Description of parts of 1:25 000 sheets TF 15 and part of TF 05

J. B. L. WILD

**SUMMARY**

The geological maps of the Institute of Geological Sciences, pre-existing borehole information, and 80 boreholes drilled for the Industrial Minerals Assessment Unit form the basis of the assessment of the sand and gravel resources of the country around Billinghay, Lincolnshire.

The survey confirmed the existence of a broad, buried valley beneath the alluvial sediments of the present Witham floodplain. Sands and gravels up to 16.1 m thick, divisible into an upper flint and limestone unit and a lower quartzitic unit, infill this sub-alluvial valley. Less extensive patches of sand and gravel were also found on the flanks of the Witham floodplain.

The deposits of the resource sheet area are divided into six resource blocks containing between 2.5 and 15.9 $km^2$ of potentially workable sand and gravel. For each block the geology of the deposits is described and the mineral-bearing area, the mean thickness of overburden and mineral, and the mean grading of the mineral are stated. Detailed borehole data are given. The geology, the position of the boreholes and the outlines of the resource blocks are shown on the accompanying Map.

**Notes**

Each borehole registered with the Institute is identified by a four-element code (e.g. TF 15 SE 20). The first two elements define the 10-km square (of the National Grid) in which the borehole is situated; the third element defines a quadrant of that square, and the fourth is the accession number of the borehole. In the text of the report the borehole is normally referred to by the last three elements alone (e.g. 15 SE 20).

All National Grid references in this publication lie within the 100-km square TF unless otherwise stated. Grid references are given to eight figures, accurate to within 10 m for borehole locations (in the text, four- and six-figure grid references are used for more extensive locations, for example for farms).

**Bibliographical reference**

WILD, J. B. L. 1982. The sand and gravel resources of the country around Billinghay, Lincolnshire: description of 1:25 000 resource sheet TF 15 and part of TF 05. **Miner. Assess. Rep. Inst. Geol. Sci.,** No. 100.

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**INTRODUCTION**

The survey is concerned with the estimation of resources, which include deposits that are not currently exploitable but have a foreseeable use, rather than reserves, which can only be assessed in the light of current, locally prevailing, economic considerations. Clearly, neither the economic nor the social factors used to decide whether a deposit may be workable in the future can be predicted; they are likely to change with time. Deposits not currently economically workable may be exploited as demand increases, as higher-grade or alternative materials become scarce, or as improved processing techniques are applied to them. The improved knowledge of the main physical properties of the resource and their variability, which this survey seeks to provide, will add significantly to the factual background against which planning policies can be decided (Archer, 1969; Thurrell, 1971, 1981; Harris and others, 1974).

In this report the assessment is, in most cases, calculated at the indicated level. However, in those areas where the available information is insufficient, the assessment is conducted at the inferred level (see Appendix B, para. 12). In the former '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'.

At the inferred level 'quantitative estimates are based largely on broad knowledge of the geologic character of the deposit and for which there are few, if any, samples or measurements. The estimates are based on an assumed continuity or repetition, of which there is geologic evidence: this evidence may include comparison with deposits of a similar type. Bodies that are completely concealed may be included if there is specific geologic evidence of their presence' (Bureau of Mines and Geological Survey, 1948, p. 15).

It follows that the whereabouts of reserves must still be established and their size and quality proved by the customary detailed exploration and evaluation undertaken by the industry. However, the information provided by this survey should assist in the selection of the best targets for such further work. The following arbitrary physical criteria have been adopted:

a The deposit should average at least 1 m in thickness.
b The ratio of overburden to sand and gravel should be no more than 3:1.
c The proportion of fines (particles passing the No. 240-mesh B.S. sieve, about $\frac{1}{16}$ mm) should not exceed 40 per cent.
d The deposit should lie within 25 m of the surface, this being taken as the likely maximum working depth under most circumstances. It follows from the second criterion that boreholes are drilled no deeper than 18 m if no sand and gravel has been proved.

A deposit of sand and gravel that broadly meets these criteria is regarded as 'potentially workable' and is described and assessed as 'mineral' in this report.

For the particular needs of assessing sand and gravel resources, a grain-size classification based on the geometric scale $\frac{1}{16}$ mm, $\frac{1}{4}$ mm, 1 mm, 4 mm, 16 mm, 64 mm has been adopted. The boundaries between fines (that is, the clay and silt fractions) and sand, and between sand

and gravel grade material, are placed at $\frac{1}{16}$ mm and 4 mm, respectively (see Appendix C).

The volume and other characteristics are assessed within resource blocks, each of which, ideally, contains approximately 10 km$^2$ of sand and gravel. No account is taken of any factors, for example, roads, villages or land of high agricultural or landscape value, which might stand in the way of sand and gravel being exploited, although towns are excluded. The estimated total volume therefore bears no simple relationship to the amount that could be extracted in practice.

It must be emphasised that the assessment applies to the resource block as a whole; valid conclusions cannot be drawn about mineral in parts of a block, except in the immediate vicinity of the actual sample points.

## DESCRIPTION OF THE RESOURCE SHEET AREA

### GENERAL

Billinghay [157 549], the major area of settlement, is situated 32 km south-east of Lincoln (see Figure 1). A small town, it serves both the local farming community and a growing population of commuters. The surrounding countryside is intensively cultivated, particularly along the floodplain of the River Witham, and cereals and sugar beet are the chief crops. The district has both road and rail links with Lincoln.

### TOPOGRAPHY

The district is dominated by the Witham floodplain which extends over the southern part of the Fenlands of south

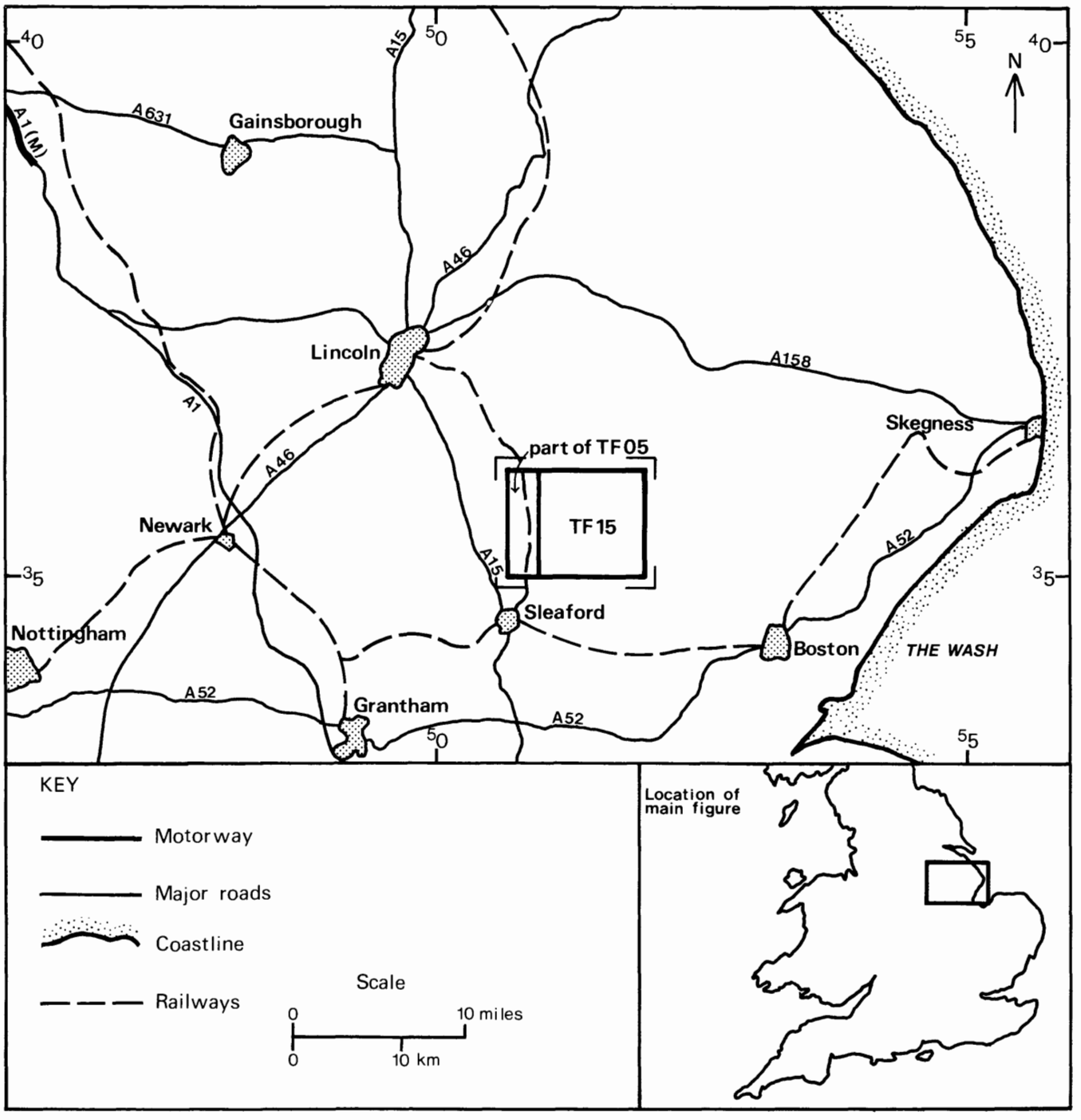



**Figure 1** Locality map.

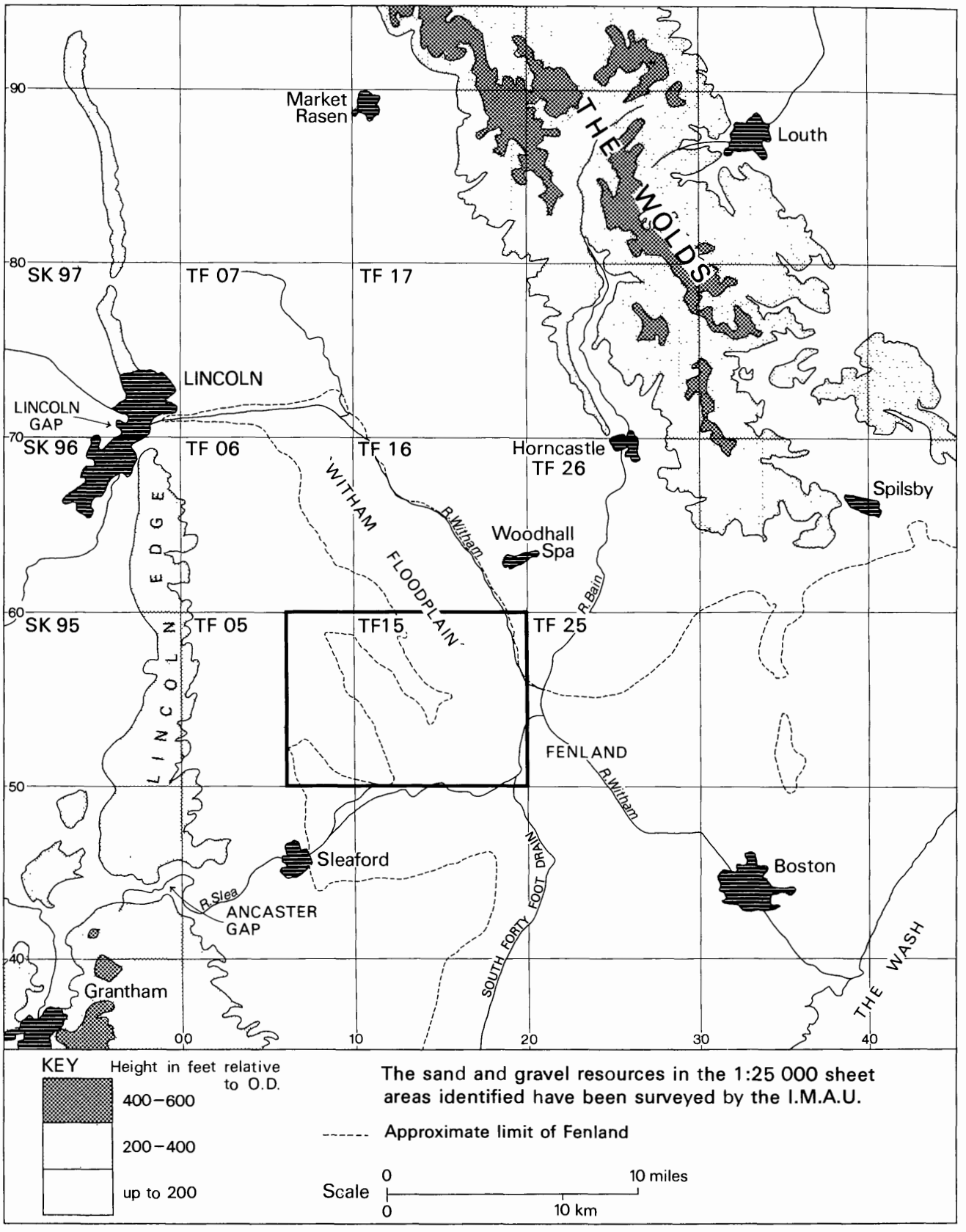



**Figure 2** The main physical features of central Lincolnshire.

Lincolnshire. This low-lying tract of country, which is generally less than 2.5 m (8 ft) above O.D., is approximately 6 km wide in the north but in excess of 10 km farther south. It is flanked by relatively higher ground to the north-east and west. Between Martin [124 599] and Billinghay a bevelled ridge, which rises gradually north-westwards to a maximum height of 18 m (59 ft) above O.D., forms a promontory into the Fenland (see Figure 2). Farther to the west, a gently undulating land surface rises progressively westwards, attaining an altitude of 23 m (76 ft) above O.D. near Scopwick [068 580]. This represents the easterly extension of the dip slope of the Lincoln Edge.

The district is now principally drained by the man-made channel of the River Witham, which is fed by numerous artificial drains, the most important being Walcot Delph, Billinghay Skirth and Kyme Eau. The

Kyme Eau now follows the former course of the River Slea.

GEOLOGY

The geological sequence is summarised in Table 1 where deposits are listed, as far as possible, in order of increasing age.

**Table 1** Geological succession.

| | | |
|---|---|---|
| DRIFT | | |
| **Quaternary** | | |
| Holocene and Pleistocene | | Marine or Estuarine Alluvium<br>River Gravels, undifferentiated<br>Fluvio-glacial and Older River Sand and Gravel<br>Till |
| SOLID | | |
| **Jurassic** | Upper | Ancholme Clay Group<br>Cornbrash<br>Blisworth Clay |
| | Middle | Great Oolite Limestone<br>Upper Estuarine 'Beds' or 'Series'<br>Lincolnshire Limestone (undivided) |

The descriptions of the Lincolnshire Limestone, Upper Estuarine 'Beds', Great Oolite Limestone, Blisworth Clay and Cornbrash are based on the more detailed accounts of the geology to be found in the Lincoln Memoir (Ussher, Jukes-Browne and Strahan, 1888) and the Regional Guide (Kent, 1980). Non-IMAU boreholes in the resource sheet area have proved strata older than the Lincolnshire Limestone but consideration of these is unnecessary for the purposes of this report. Schematic sections across the district illustrating the relationship between deposits are shown at the foot of the Map.

**Solid**

Lincolnshire Limestone (undivided) The Lincolnshire Limestone crops out only in a small area north-west of Scopwick, where it consists of pale yellow or grey, oolitic and shelly limestones with intercalated mudstones.

Upper Estuarine 'Beds' or 'Series' The Upper Estuarine 'Beds' have a similarly restricted but partly fault-bounded outcrop around Scopwick. Here the sequence consists of fine-grained sandstones and mudstones of estuarine origin, usually between 6.0 and 9.0 m thick.

Great Oolite Limestone The Great Oolite Limestone, which crops out around Kirkby Green [085 579] consists of two subdivisions: a lower part which is commonly fossiliferous and a less fossiliferous upper part with clay intercalations. Together they are approximately 4.6 m thick.

Blisworth Clay The Blisworth Clay, which ranges from 1.8 to 12.2 m thick, crops out sporadically around Kirkby Green, Rowston [084 564], Digby [082 548] and Bloxholm [067 537] and consists of dark blue and olive mudstones which weather to clay.

Cornbrash The Upper Cornbrash has extensive outcrops around Bloxholm and generally consists of thin (approximately 1 m) sandy limestones with marl. The Lower Cornbrash is represented in the resource sheet area by 0.3 m of blue-hearted shelly limestone which crops out around Kirkby Green.

Ancholme Clay Group The Ancholme Clay Group, comprising what were formerly the Oxford, Ampthill and Kimmeridge Clays, underlies the whole of TF 15 and part of the eastern margin of TF 05 (see Map). A thickness of approximately 200 m has been proved in non-IMAU boreholes. The strata dip gently to the east and are mostly mantled by Drift.

When unweathered, the Ancholme Clay Group consists of dark greenish grey or dark grey silty mudstone with thin bands of limestone; locally it is highly fossiliferous (for example in borehole 05 NE 18) with several specimens of ammonites and belemnites.

**Drift**

Till An extensive cover of Till previously infilled a large north-west to south-east trending trough (see Figure 3c), but most of it may have been eroded from beneath the Witham floodplain when ice diverted the River Trent through the Lincoln Gap.

The Till of the resource sheet area has been termed the Wragby Till (Straw, 1969), although patches of the laterally equivalent Heath Till (distinguished by its different colour) may be present to the west. Both tills are considered by others (for example, Perrin, Rose and Davies, 1979) to be coeval with the 'pre-Devensian Chalky Boulder Clay of East Anglia'.

Generally the Till is a stiff, silty clay containing erratics ranging in size from coarse sand (+1-4 mm) to coarse gravel (+4-16 mm) and consisting of chalk, flint, limestone, sandstone and Jurassic mudstone in varying proportions. The matrix is usually dark grey in colour, although greyish brown and reddish brown varieties were observed. The Till ranges from 0.2 to 17.1 m in thickness in boreholes 15 SE 19 and 15 NW 22, respectively. Sand and gravel within the Till was recorded in only one instance (borehole 15 SW 20).

Fluvio-glacial and Older River Sand and Gravel These deposits were formerly referred to as 'Fen Beds (Gravel)' on Old Series Sheet 70, as 'Ancient Gravels of old Rivers and Plateau Gravel' on Old Series Sheet 83 and as 'Older River Sand and Gravel' on New Series sheet 114. They occur both as patches capping the bevelled ridge along the western margin of the Witham floodplain and, at a lower topographical level, south of Kirkstead [189 616]. Here they are well developed with a maximum recorded thickness of 3.2 m (in borehole 15 NE 13) of sandy gravel containing pebbles of flint, quartzite and vein quartz. On the western flank of the Witham floodplain they are thinner (usually less than 2.0 m), often 'clayey' (for example, in borehole 15 NW 10) and with a predominance of quartzitic material in the gravel fraction.

The deposits between Martin and Billinghay have been termed the Martin Terrace (Straw, 1958), whereas those in the immediate vicinity of Billinghay and to the north-east of the Witham floodplain were attributed by Straw (loc. cit.) to the Southrey Terrace. Because of their altitude and the relative abundance of quartzitic ('Bunter') pebbles from the Sherwood Sandstone Group, several authors (for example, Clayton, 1957; Straw, 1958, 1963) have correlated these terraces with the Hilton and Beeston Terraces, respectively, of the River Trent. The Martin and Southrey Terraces were thus thought to relate to former phases of Trent drainage through the Lincoln Gap. However, the preponderance of flint proved in borehole 15 NE 13 sited on the Southrey Terrace suggests a relatively local origin for these gravels.

River Gravels (undifferentiated) River Gravels underlie the alluvial silts and clays of the Witham floodplain and infill a broad channel trending north-west to south-east channel (see the Map).

The component sands and gravels vary in thickness according to the morphology of the channel (compare Figures 3a and 3c). Data from IMAU boreholes suggest that the River Gravels may be broadly divisible into two

units; an upper unit of variable thickness (0.3-8.5 m) containing substantial amounts of flint and limestone and a lower, more widespread, quartzitic unit (0.3-9.0 m thick). The former may be of relatively local origin, resulting from a later phase of drainage, probably from the north-east, whereas the latter, probably representing a final period of River Trent drainage through the Lincoln Gap, has been correlated (Clayton, 1957) with the Floodplain Terrace of the upper and middle Trent. A radiocarbon analysis of a bovine thoracic vertebra (probably arthritic) from the gravels of the lower unit (borehole 15 NE 18) has yielded a date of 34,950 ± 550 years B.P. (SRR 1666)*.

Other River Gravels in the resource sheet area are thinner, distributed in patches, but usually occur beneath less than 1 m of overburden. In these, the prevalence of flint (probably from the Till) and Jurassic limestone pebbles suggests a local provenance.

Marine or Estuarine Alluvium Marine or Estuarine Alluvium, by far the most widespread Drift deposit, occurs on the low-lying ground surrounding the bevelled ridge. As proved in IMAU boreholes it is usually between 4.0 and 6.0 m thick, although exceptionally it may be in excess of 9.0 m (see Figure 3b). These soft, grey or olive-grey silty clays commonly incorporate much peat, characteristically in the form of thin lenses (usually less than 1.0 m) that crop out and occur towards the base of the deposit. Because of the sporadic distribution of the peats, no attempt has been made in this report to correlate them with the more extensive peat deposits of the Fenland to the south (see Gallois, 1979). Locally, the Marine or Estuarine Alluvium progressively coarsens towards the junction with the River Gravels, from a silty clay to a 'clayey' sand which is commonly micaceous. Where the grain sizes of the two deposits are lithologically similar, they can be distinguished by a

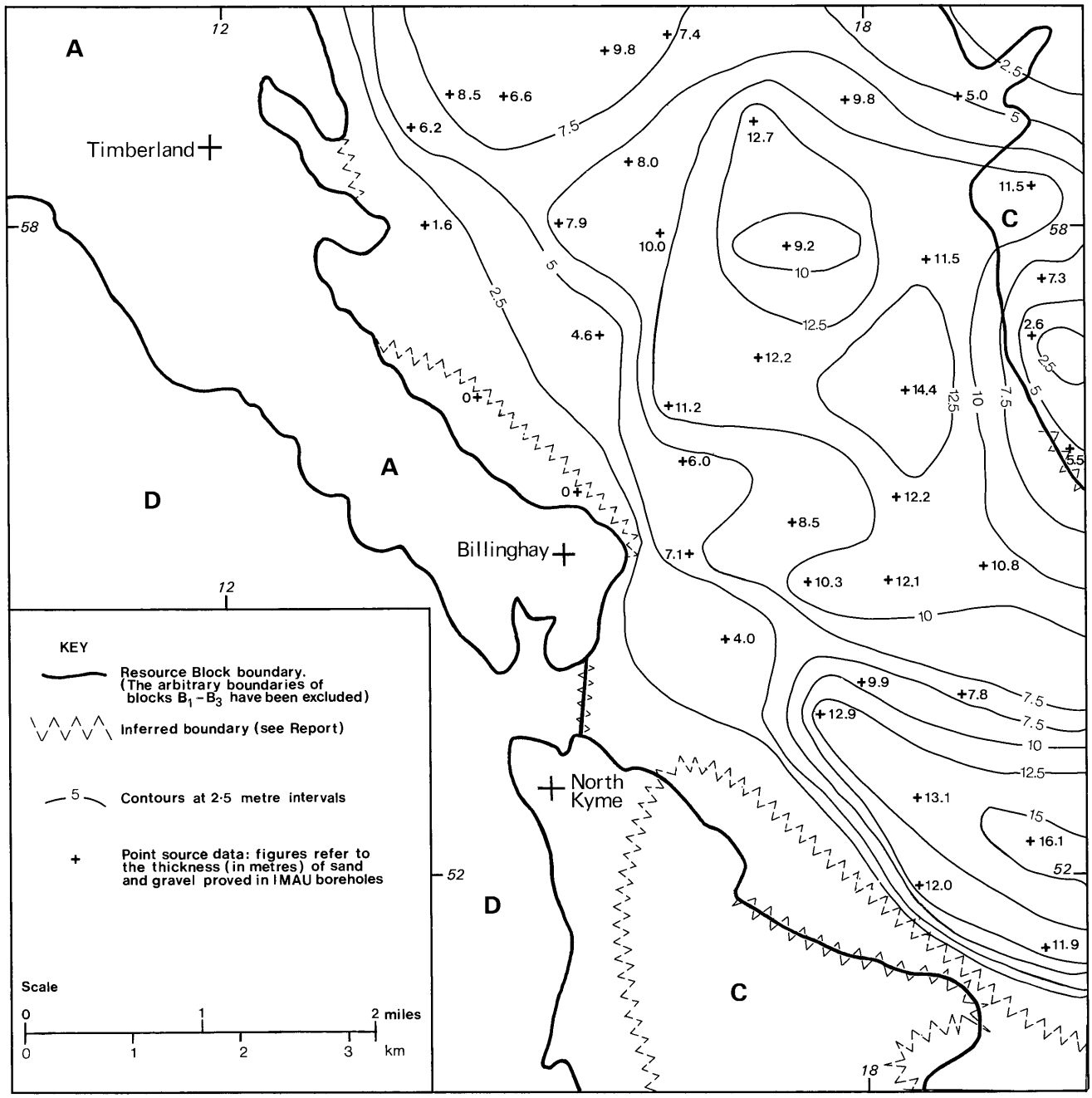



**Figure 3a** Isopachyte map of the River Gravels (including, locally, the lower part of the Marine or Estuarine Alluvium).

* Registration number accorded by the Scottish Universities Research and Reactor Centre.

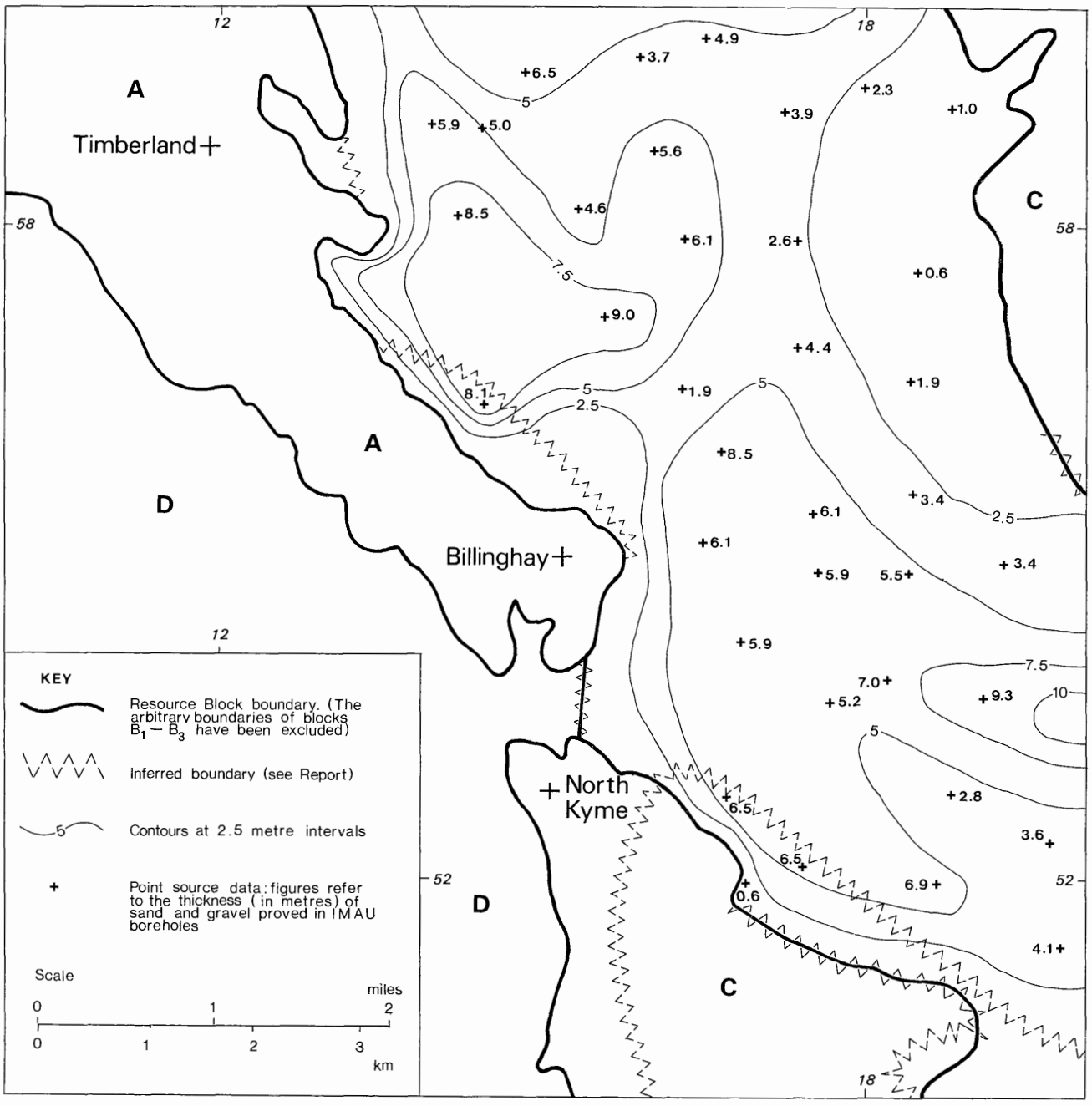



**Figure 3b** Isopachyte map of Marine or Estuarine Alluvium (excluding those parts identified as mineral) along the Witham floodplain.

sudden colour change from medium or light grey (Marine or Estuarine Alluvium) to yellowish brown (River Gravels).

Oscillations in sea level and migration of the river channels during the Holocene probably account for the variety of sedimentary environments exemplified in this sequence of deposits.

## COMPOSITION OF THE SAND AND GRAVEL DEPOSITS

The potentially workable sand and gravel deposits of the resource sheet area are Fluvio-glacial and Older River Sand and Gravel, River Gravels and, locally, Marine or Estuarine Alluvium. The composition of selected gravel samples (based on the size ranges 4-8 mm and 8-16 mm) from IMAU boreholes in the above deposits is presented in Appendix E (at the foot of the appropriate borehole logs). Data relating to differences in lithology between the two size ranges within the River Gravels are also shown in Figure 4.

Fluvio-glacial and Older River Sand and Gravel These deposits were encountered in six IMAU boreholes but in only four (15 NW 9, 15 NW 10, 15 NW 21 and 15 NE 13) were they classified as mineral. Consequently they form only about five per cent of the total volume of potentially workable sand and gravel in the resource sheet area. They have a mean grading of fines 10 per cent, sand 64 per cent and gravel 26 per cent, making the deposit as a whole a 'clayey' sandy gravel. The gravel fraction contains up to 60 per cent of subrounded quartzite with subordinate subangular to subrounded sandstone, subrounded vein quartz and angular flint. Flint, derived locally from the Till, is the predominant constituent in borehole 15 NE 13.

River Gravels This deposit, which forms the bulk of the potentially workable sand and gravel in the resource sheet area, consists predominantly of sandy gravels and gravels. The mean grading is fines 3 per cent, sand 63 per cent and gravel 34 per cent, but the composition

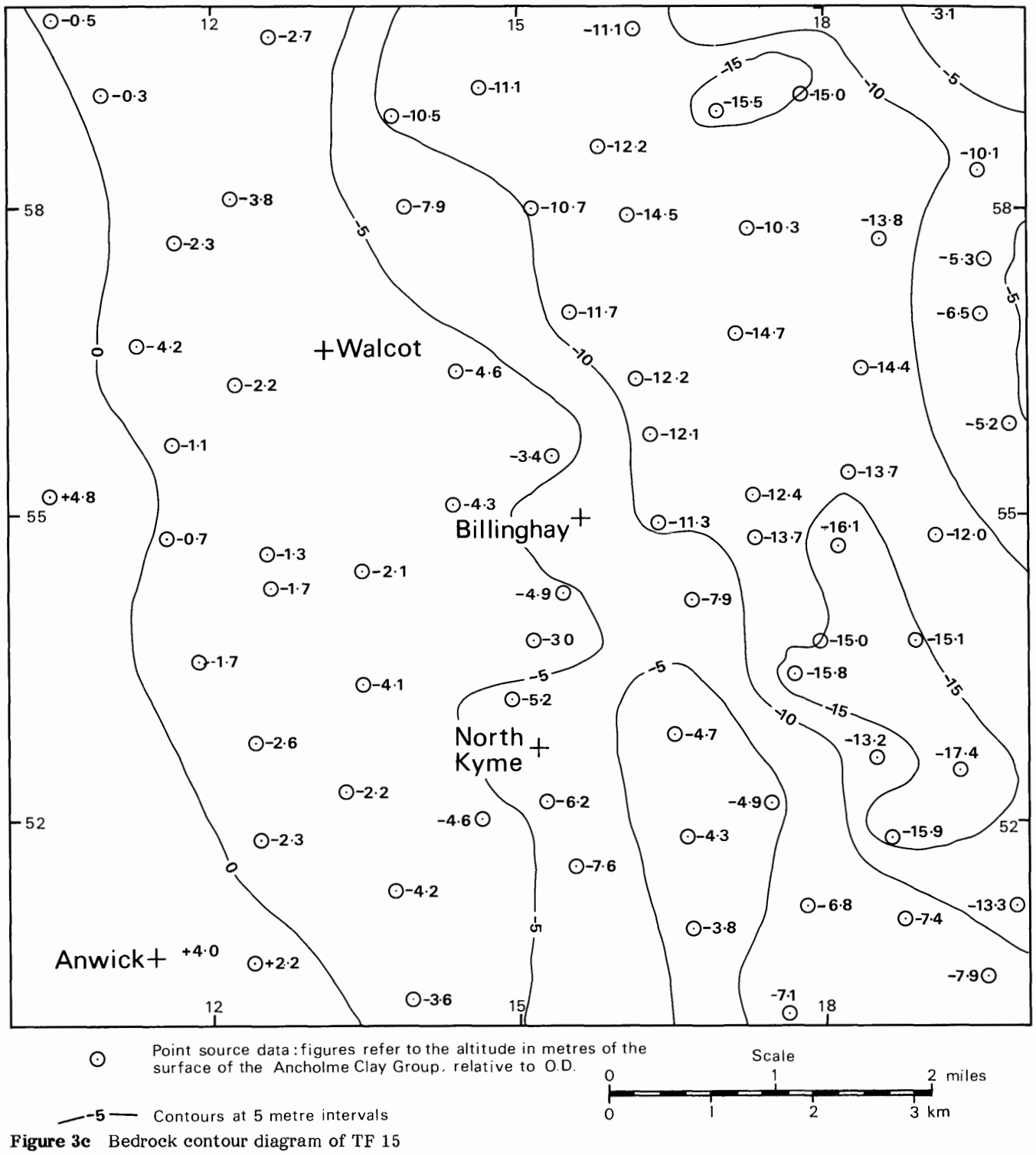



**Figure 3c** Bedrock contour diagram of TF 15

ranges from fines 24 per cent, sand 74 per cent and gravel 2 per cent (in borehole 15 NE 18) through fines 8 per cent and sand 92 per cent (in borehole 15 NE 24) to fines 1 per cent, sand 33 per cent and gravel 66 per cent (in borehole 15 SE 20). Within the Witham floodplain, the River Gravels are divisible (on lithological and grading criteria) into two units (described previously) and wherever possible, they are distinguished as such in the borehole logs (Appendix E). The upper unit comprises angular to subrounded flint and subangular to subrounded limestone with subordinate quartzite and vein quartz. Angular brown and black flint with some subangular to subrounded white varieties were the most commonly recorded colour types (for further information on the properties of flint in concrete, see Roeder, 1977). The shelly and oolitic pebbles of limestone were probably derived from the Lincolnshire Limestone which crops out on the western margin of the resource sheet area. In the 8-16 mm size range flint usually predominates, whereas in the 4-8 mm size range limestone is the chief constituent (see Figure 4).

The lower unit has a more uniform lithology (see Figure 4). Rounded pebbles of quartzite and vein quartz predominate in the gravel fraction, with subordinate flint and sandstone. Ironstone, which crops out along the flanks of both the Lincoln and Ancaster Gaps, is an accessory constituent in both units.

The sand fraction is principally of medium grade (+¼-1 mm) which, farther to the north (Jackson, 1982) comprises subrounded quartz with subordinate feldspar and haematite. However, particularly in the coarse fraction (+1-4 mm), lithic grains occur derived from larger pebbles in the gravel fraction.

Other areas of River Gravel deposits have a limestone/flint pebble assemblage similar to that of the upper unit. For example, the gravel fraction in borehole 15 NW 19 contains 100 per cent limestone which was probably derived from the adjacent outcrop of the Lincolnshire Limestone to the west of the borehole site.

Marine or Estuarine Alluvium In ten out of the 55 IMAU boreholes in the Marine or Estuarine Alluvium, the

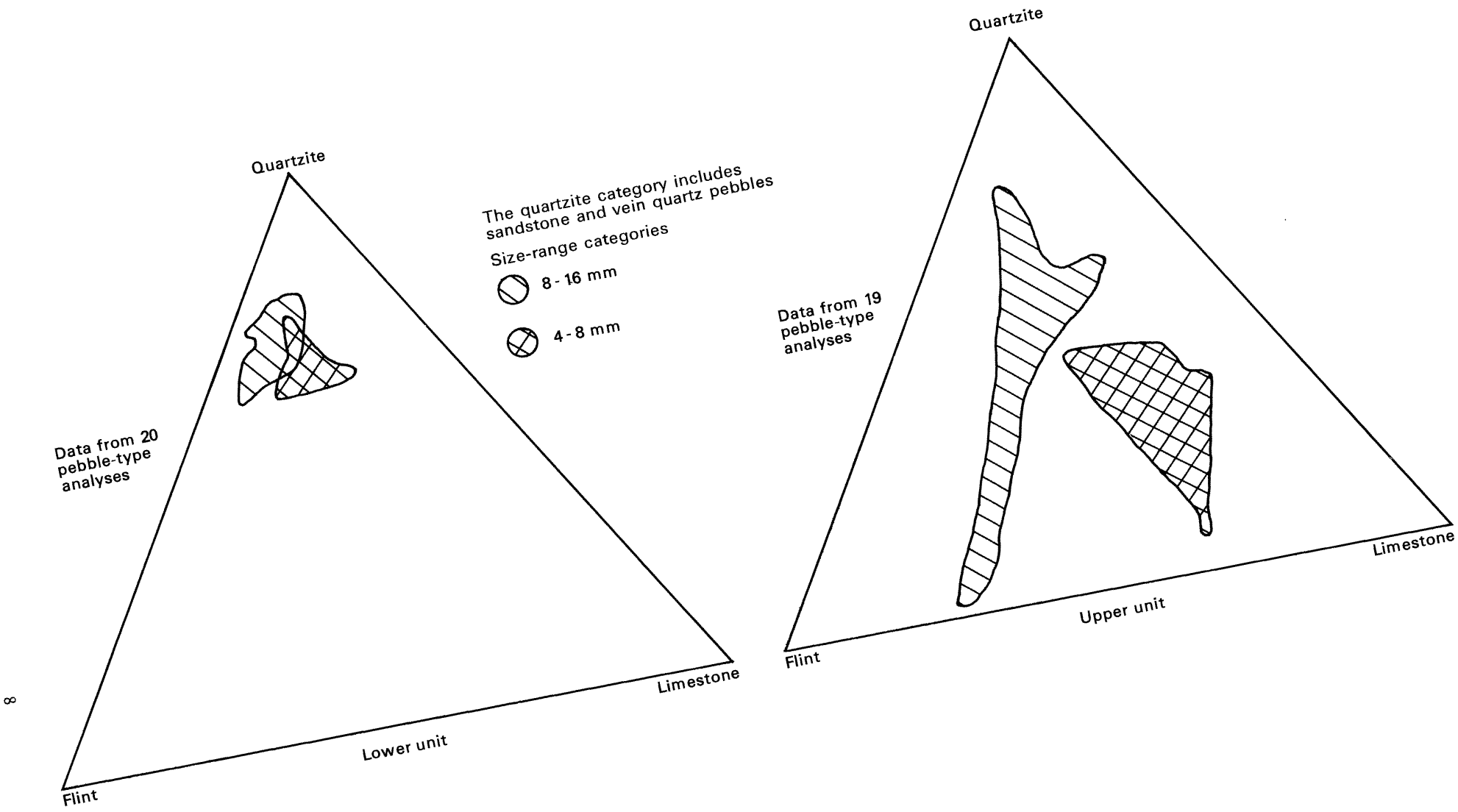



**Figure 4** Comparison of pebble types within the River Gravels.

deposit graded as 'very clayey' sand, 'clayey' sand or sand near its junction with the underlying River Gravels. The sediments consist mainly of fine ($+\frac{1}{16}-\frac{1}{4}$ mm) quartz sand, often micaceous, with a mean grading of fines 13 per cent, sand 86 per cent and gravel 1 per cent, classifying the deposit as a whole as a 'clayey' sand. Infrequently, flint pebbles were found towards the base of the deposit which were probably derived from the subjacent River Gravels.

## 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, on which the topography is shown in grey, the geological data in black and the mineral resource information in shades of red.

An extension of the survey westwards of TF 15 to encompass the eastern part of TF 05 (where River Gravels were mapped) proved a small area of potentially workable mineral around the village of Ruskington [083 510]. Consequently, an additional map showing this part of TF 05 is presented to the left of the main resource map.

Geological data The geological boundary lines shown are based on one-inch scale geological surveys for Old Series sheets 70 and 83, published in 1886 and part of the 1:50 000 scale geological survey of New Series sheets 114 and 127 published in 1972. As such they represent the best interpretation of the information available at the time of the survey. However, it is inevitable, considering the scale of the original surveys and the nature of the Drift deposits represented, that local irregularities and discrepancies will be revealed as new evidence from boreholes and excavations becomes available.

Borehole data, which include the stratigraphical relations, thicknesses and mean particle size distribution of the sand and gravel samples collected during the assessment survey, are also shown on the map.

Mineral resource information The mineral-bearing ground is divided into resource blocks (see Appendix A). Within a resource block the mineral is subdivided into areas where it is exposed, that is where the overburden averages less than 1 m in thickness, and areas where it is present in continuous, or almost continuous, spreads beneath overburden. The recognition of these categories is dependent upon the importance attached to the proportion of boreholes which did not find potentially workable sand and gravel and the distribution of barren boreholes within a block. The mineral is described as 'almost continuous' if it is present in 75 per cent or more of the boreholes in a resource block.

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

The area of the mineral-bearing ground is measured, where possible, from the mapped geological boundary lines. The whole of this area is considered as mineral-bearing, even though it may include small areas where sand and gravel is not present or is not potentially workable. Inferred boundaries have been inserted to delimit areas where sand and gravel beneath cover is interpreted to be not potentially workable or absent. Such boundaries (for which a distinctive zigzag symbol is used) are drawn primarily for the purpose of volume estimation. The symbol is intended to indicate an approximate location within a likely zone of occurrence rather than to represent the breadth of the zone, the width of the symbol being determined only by cartographical considerations. For the purpose of measuring areas, the centre line of the symbol is used.

## RESULTS

The statistical results are summarised in Table 2. Further grading particulars are shown in Figure 5 and the mean gradings and grading 'envelopes' for each resource block are given in Figures 6 to 11.

Four of the six resource blocks ($B_{1-3}$ and C) have been statistically assessed at the indicated level. Within these resource blocks the confidence limits at the

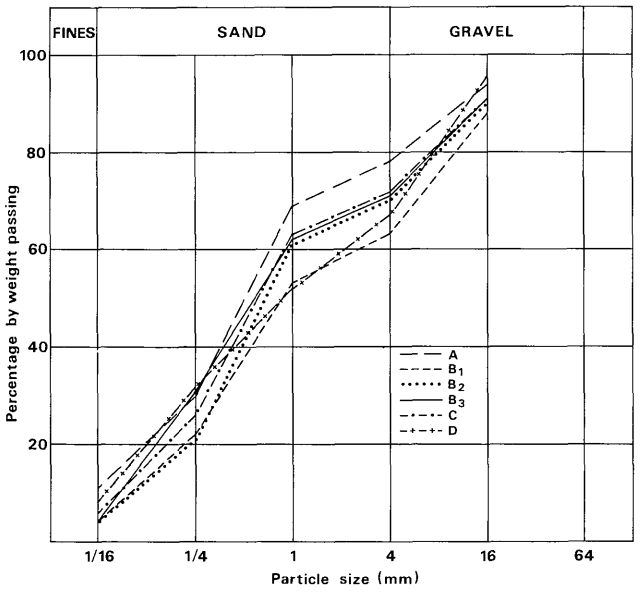
**Table 2** Sand and gravel resources of the area assessed.

| Block | Area | | Mean thickness | | | Volume of mineral (million $m^3$) | | | Mean grading percentage | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Block | Mineral | Mineral | Over-burden | Waste* | | Limits at the 95% probability level | | Fines $-\frac{1}{16}$ mm | Sand $+\frac{1}{16}-4$ mm | Gravel +4 mm |
| | $km^2$ | $km^2$ | m | m | m | $m^3 \times 10^6$ | ± % | ± $m^3 \times 10^6$ | | | |
| **a** Assessment of blocks $B_1$, $B_2$, $B_3$ and C at the indicated level | | | | | | | | | | | |
| $B_1$ [10]† | 12.2 | 11.8 | 7.7 | 4.5 | 0.5 | 91 | 30 | 28 | 4 | 59 | 37 |
| $B_2$ [10] | 15.3 | 14.0 | 9.5 | 4.6 | 0.5 | 133 | 23 | 31 | 4 | 66 | 30 |
| $B_3$ [13] | 18.4 | 15.9 | 10.8 | 5.3 | - | 172 | 18 | 31 | 4 | 67 | 29 |
| C [10] | 10.6 | 7.6 | 4.0 | 0.6 | 0.2 | 30 | 56 | 17 | 6 | 66 | 28 |
| Total [43] | 56.6 | 49.5 | 8.6‡ | 4.1‡ | 0.2‡ | 426 | 15 | 64 | 4‡ | 65‡ | 31‡ |
| **b** Assessment of blocks A and D at the inferred level | | | | | | | | | | | |
| A [5] | 14.8 | 2.5 | 1.6 | 0.7 | - | 4 | (speculative) | | 11 | 67 | 22 |
| D [3] | 68.7 | 5.3 | 1.6 | 0.5 | - | 9 | (speculative) | | 8 | 59 | 33 |
| Total [8] | 83.6 | 7.8 | 1.4‡ | 0.5‡ | - | 11 | | | 9‡ | 61‡ | 30‡ |

* Within mineral beds.

† Figures in square brackets show the number of sample points used in the assessment of volume resources.

‡ These totals are derived by weighting and rounding-off calculations.




| Resource block | Percentage by weight passing | | | | | |
|---|---|---|---|---|---|---|
| | 1/16 mm | 1/4 mm | 1 mm | 4 mm | 16 mm | 64 mm |
| $B_1$* | 4 | 22 | 53 | 63 | 88 | 100 |
| $B_2$* | 4 | 21 | 61 | 70 | 90 | 100 |
| $B_3$* | 4 | 31 | 62 | 71 | 90 | 100 |
| C* | 6 | 26 | 63 | 72 | 91 | 100 |
| A† | 11 | 30 | 69 | 78 | 94 | 100 |
| D† | 8 | 32 | 52 | 67 | 96 | 100 |

* Assessed at the indicated level
† Assessed at the inferred level

**Figure 5** Mean particle-size distribution for the assessed thickness of sand and gravel in resource blocks A to D

symmetrical 95 per cent probability level range from 18 to 56 per cent (that is, it is probable that 19 times out of 20 the true volume lies within the given limit of the mean). However, the true values are more likely to be nearer the figures estimated rather than the limits. Moreover, it is probable that in each block approximately the same percentage limits would apply for the estimates of volume of a very much smaller parcel of ground (say, 100 hectares) 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 required for the quotation of reserves of part of a block, it can be expected that data from more than ten sample points will be required, even if the area is quite small. This point can be illustrated by considering the whole of the potentially workable sand and gravel in blocks $B_1$, $B_2$, $B_3$ and C. The total volume (426 million $m^3$) at the indicated level can be estimated to limits of $\pm$ 15 per cent at the 95 per cent probability level by a calculation based on the data from the 43 sample points spread across the four resource blocks.

The total volume at the inferred level of assessment (in blocks A and D, see Table 2b) is estimated at 11 million $m^3$ by a calculation based on data from eight sample points; confidence limits are not quoted in this instance.

It must again be emphasised that the quoted volume of sand and gravel has no simple relationship with the amount that could be extracted in practice, because no allowance has been made in the calculations for any restraints (such as existing buildings and roads, etc.) on the use of land for mineral working.

NOTES ON THE RESOURCE BLOCKS

The sand and gravel deposits of the resource sheet area are divided into six resource blocks. In block A the mineral is assessed as exposed and rests on Till - which is also the case in block C, except in three boreholes. In blocks $B_1$-$B_3$ the mineral lies beneath thick overburden within the Witham floodplain to rest directly on bedrock (Ancholme Clay Group), whereas the mineral in block D, which also rests on bedrock, is assessed as exposed. In blocks $B_1$-$B_3$ the use of a subscript number is intended to convey the continuity of a deposit arbitrarily subdivided, using either lines of drainage or roads, into areas commensurate with the 'ideal' size of a resource block (Appendix A). The boundaries of blocks A, C and D are drawn, where possible, using geological criteria.

Block A (Table 3, Figure 6)

The outline of block A corresponds approximately with that of the bevelled ridge (see Topography section). Although the block is 14.8 $km^2$ in area, only 2.5 $km^2$ is mineral-bearing. Of the prospective occurrences of sand and gravel in the Fluvio-glacial and Older River Sand and Gravel, which is distributed along the ridge-top as five discrete outcrops, only those near Timberland [120 585] and Billinghay proved to be mineral. In the latter area, the extent of the mineral immediately north-west of Billinghay is limited by an inferred boundary which takes account of the absence of mineral in borehole 15 SE 5.

An inferred assessment is based on information from seven IMAU boreholes and two other (confidential) records. The mineral, which is present in three of the IMAU boreholes (see Table 3), is up to 2.1 m thick (borehole 15 NW 9) and has a mean thickness of 1.6 m. The inferred volume of mineral is estimated to be 4 million $m^3$. Proven thicknesses of overburden ranged from 0.5 m (borehole 15 NW 10) to 1.1 m (borehole 15 NW 9) with a mean of 0.7 m.

In the three IMAU boreholes that proved mineral, the fines content ranged from 3 per cent in borehole

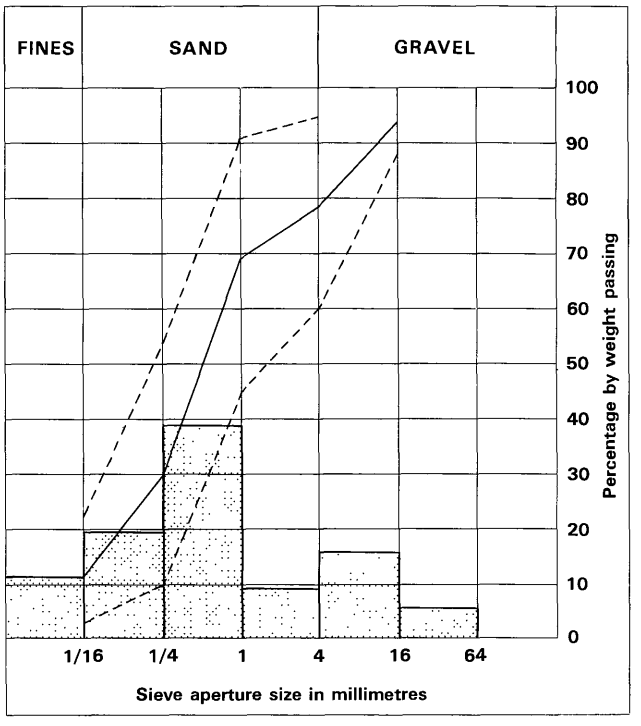



**Figure 6** Grading characteristics of the mineral in Block A.
(The continuous line is the cumalative frequency curve of the mean grading of the block as a whole: the broken lines denote the envelope within which the mean grading curves for indivdual boreholes fall. The mean grading of the block is also given as a histogram.)

**Table 3** Data from IMAU boreholes used in the assessment: Block A.

| Borehole | Recorded thickness (m) | | | Mean grading percentage | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mineral | Over-burden | Waste* | Fines $-\frac{1}{16}$ mm | Fine sand $+\frac{1}{16}-\frac{1}{4}$ mm | Medium sand $+\frac{1}{4}$ -1 mm | Coarse sand +1 -4 mm | Fine gravel +4 -16 mm | Coarse gravel +16 mm |
| 15 NW 9 | 2.1 | 1.1 | - | 3 | 7 | 36 | 14 | 28 | 12 |
| 15 NW 10 | 1.3 | 0.5 | - | 12 | 26 | 45 | 8 | 8 | 1 |
| 15 NW 21 | 1.3 | 0.6 | - | 22 | 32 | 37 | 3 | 6 | 0 |
| Mean | 1.6† | 0.7† | - | 11 | 19 | 39 | 9 | 16 | 6 |

* Within mineral beds.
† Additional information from two confidential boreholes was used in the calculation of these figures.

15 NW 9 to 22 per cent in borehole 15 NW 21. The proportion of sand ranged from 57 per cent (borehole 15 NW 9) to 79 per cent (borehole 15 NW 21) and the gravel proportion ranged from 6 per cent (borehole 15 NW 21) to 40 per cent (borehole 15 NW 9).

The mean grading for the block is fines 11 per cent, sand 67 per cent and gravel 22 per cent, making the overall mineral classification for the block a 'clayey' sandy gravel.

Block $B_1$ (Table 4, Figure 7)

This block, which lies entirely within the confines of the Witham floodplain, occupies 12.2 km$^2$ of country in the north of the resource sheet area, of which 11.8 km$^2$ is mineral-bearing. The cross-section on the Map border shows that the mineral thins out westwards against the rising bedrock surface, towards its junction with the Till, and an inferred boundary at [130 588] marks the approximate position where the mineral dies out.

The potentially workable sand and gravel consists of River Gravels and, in three boreholes (15 NW 13, 15 NE 10 and 15 NE 16), the lower part of the Marine or Estuarine Alluvium.

The assessment of resources is based on information from seven IMAU boreholes and three other (confidential) records. The mineral, which is present in all IMAU boreholes in this block, varies in thickness between 1.6 m (borehole 15 NW 15) and 12.7 m (borehole 15 NE 11) but is usually closer in thickness to the mean of 7.7 m. The estimated volume of mineral is 91 million m$^3$ ± 30 per cent at the 95 per cent confidence level. The thickness of overburden generally increases to the west (and conversely, the thickness of mineral tends to increase eastwards): proven thicknesses range from 2.3 m (borehole 15 NE 12) to 8.5 m (borehole 15 NW 15). The mean is 4.5 m.

Except for 1.6 m of gravel in borehole 15 NW 15, all other boreholes proved sandy gravel, which tended to coarsen downwards. For example, in borehole 15 NW 13 sand (between 6.5 and 9.1 m) overlay sandy gravel (9.1-11.5 m) which overlay gravel from 11.5 m to bedrock at 13.1 m. In the seven IMAU boreholes that proved mineral the fines content ranged from 2 per cent in boreholes 15 NW 12 and 15 NW 15 to 6 per cent in borehole 15 NE 10. The proportion of sand ranged from 47 per cent (borehole 15 NW 15) to 69 per cent (borehole 15 NE 10) and the gravel proportion ranged from 51 per cent (borehole 15 NW 15) to 25 per cent (borehole 15 NE 10).

The mean grading for the block is fines 4 per cent, sand 59 per cent and gravel 37 per cent making the block as a whole a sandy gravel.

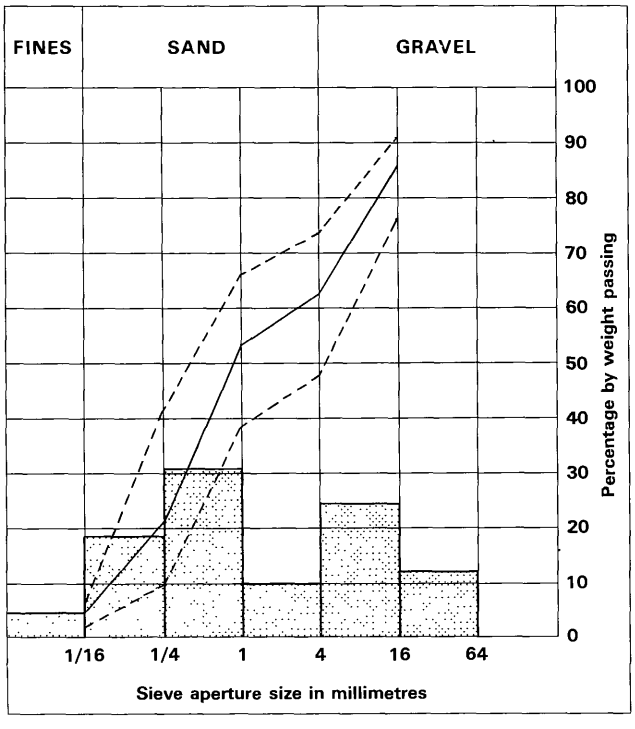



**Figure 7** Grading characteristics of the mineral in Block $B_1$ (for explanation see Figure 6).

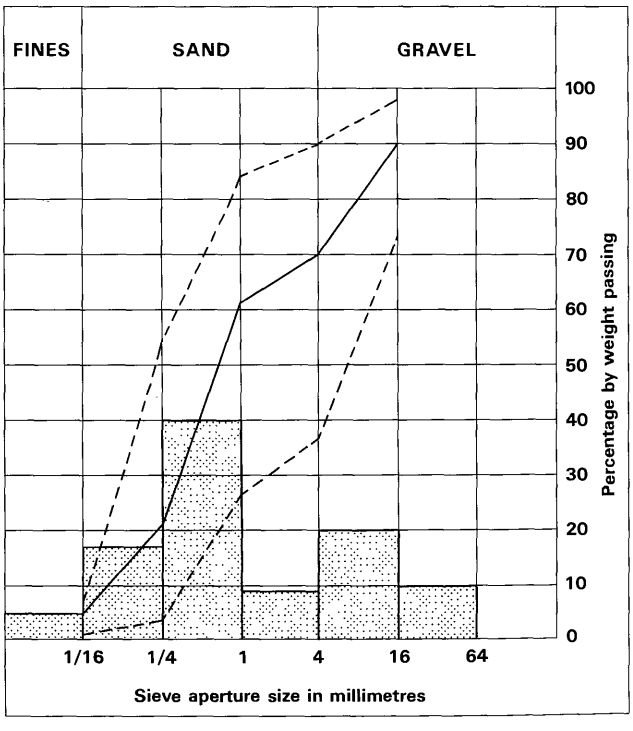



**Figure 8** Grading characteristics oif the mineral in Block $B_2$ (for explanation see Figure 6).

**Table 4** Data from IMAU boreholes used in the assessment: Block $B_1$.

| Borehole | Recorded thickness (m) | | | Mean grading percentage | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mineral | Over-burden | Waste* | Fines $-\frac{1}{16}$ mm | Fine sand $+\frac{1}{16}-\frac{1}{4}$ mm | Medium sand $+\frac{1}{4}$ -1 mm | Coarse sand +1 -4 mm | Fine gravel +4 -16 mm | Coarse gravel +16 mm |
| 15 NW 12 | 6.2 | 5.9 | - | 2 | 10 | 30 | 9 | 31 | 18 |
| 15 NW 13 | 6.6 | 6.5 | - | 4 | 38 | 20 | 7 | 20 | 11 |
| 15 NW 15 | 1.6 | 8.5 | - | 2 | 8 | 29 | 10 | 28 | 23 |
| 15 NE 10 | 7.4 | 4.9 | - | 6 | 21 | 40 | 8 | 16 | 9 |
| 15 NE 11 | 12.7 | 3.9 | - | 3 | 14 | 35 | 11 | 25 | 12 |
| 15 NE 12 | 9.8 | 2.3 | 3.6 | 4 | 14 | 27 | 14 | 30 | 11 |
| 15 NE 16 | 8.0 | 5.6 | - | 4 | 18 | 37 | 8 | 23 | 10 |
| Mean | 7.7† | 4.5† | 0.5† | 4 | 18 | 31 | 10 | 25 | 12 |

* Within mineral.
† Additional information from three confidential boreholes was used in the calculation of these figures.

**Table 5** Data from IMAU boreholes used in the assessment: Block $B_2$.

| Borehole | Recorded thickness (m) | | | Mean grading percentage | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mineral | Over-burden | Waste* | Fines $-\frac{1}{16}$ mm | Fine sand $+\frac{1}{16}-\frac{1}{4}$ mm | Medium sand $+\frac{1}{4}$ -1 mm | Coarse sand +1 -4 mm | Fine gravel +4 -16 mm | Coarse gravel +16 mm |
| 15 NE 15 | 7.9 | 4.6 | - | 8 | 46 | 22 | 5 | 12 | 7 |
| 15 NE 17 | 9.2 | 2.6 | - | 3 | 15 | 51 | 10 | 14 | 7 |
| 15 NE 19 | 10.0 | 6.1 | - | 4 | 15 | 36 | 9 | 22 | 14 |
| 15 NE 20 | 11.5 | 0.6 | 3.4 | 2 | 13 | 39 | 10 | 24 | 12 |
| 15 NE 22 | 4.6 | 9.0 | - | 1 | 3 | 23 | 10 | 39 | 24 |
| 15 NE 23 | 11.2 | 1.9 | 1.0 | 2 | 17 | 46 | 9 | 17 | 9 |
| 15 NE 24 | 12.0 | 4.4 | 0.2 | 7 | 33 | 45 | 5 | 8 | 2 |
| 15 NE 25 | 14.4 | 1.9 | - | 3 | 10 | 41 | 11 | 22 | 13 |
| 15 NE 28 | 6.0 | 8.5 | - | 1 | 7 | 39 | 13 | 30 | 10 |
| 15 NE 29 | 8.5 | 6.1 | - | 2 | 8 | 45 | 10 | 24 | 11 |
| Mean | 9.5 | 4.6 | 0.5 | 4 | 17 | 40 | 9 | 20 | 10 |

* Within mineral beds.

Block $B_2$ (Table 5, Figure 8)
Block $B_2$ lies immediately to the north-east of Billinghay and like block $B_1$, is contained within the limits of the Witham floodplain. Mineral thickness is fairly uniform in the eastern part of the block but thins noticably towards the west so that in boreholes 15 NW 18 and 15 NE 27 it is absent. An inferred boundary is drawn to delineate the area of non-mineral around these two boreholes, resulting in 14.0 $km^2$ of mineral within a total block area of 15.3 $km^2$.

The potentially workable sand and gravel consists predominantly of River Gravels with, in two boreholes (15 NE 15 and 15 NE 23), the lowermost part of the Marine or Estuarine Alluvium. In borehole 15 NE 23 the grading characteristics of the upper unit of the River Gravels and the overlying Marine or Estuarine Alluvium are similar, but a distinction between the two deposits was made in the field based on a distinctive colour change.

The assessment of resources is based on information from 12 IMAU boreholes. The mineral, which is present in ten of these, reaches a maximum thickness of 14.4 m in borehole 15 NE 25. The mean thickness of mineral is 9.5 m and the estimated volume is 133 million $m^3$ $\pm$ 23 per cent at the 95 per cent confidence level. As in block $B_1$ the overburden thickens to the west of the block with a maximum recorded thickness of 9.0 m in borehole 15 NE 22; the mean thickness is 4.6 m.

In the ten boreholes that proved mineral the fines content ranges from 1 per cent in boreholes 15 NE 22 and 15 NE 28 to 8 per cent in borehole 15 NE 15. The proportion of sand ranges from 59 per cent to 76 per cent in all but one borehole (15 NE 22), where it is 36 per

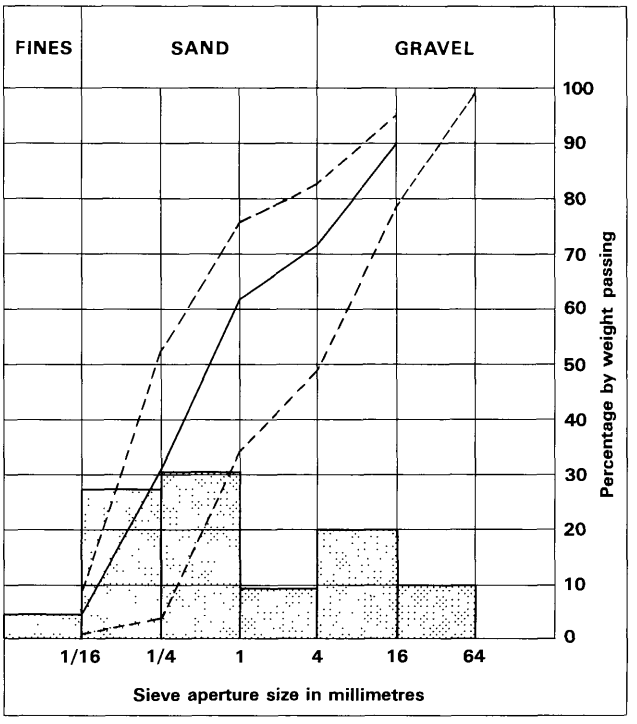



**Figure 9** Grading characteristics of the mineral in Block $B_3$ (for explanation see Figure 6).

**Table 6** Data from IMAU boreholes used in the assessment: Block $B_3$.

| Borehole | Recorded thickness (m) | | Mean grading percentage | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mineral | Overburden | Fines $-\frac{1}{16}$ mm | Fine sand $+\frac{1}{16}-\frac{1}{4}$ mm | Medium sand $+\frac{1}{4}-1$ mm | Coarse sand +1 -4 mm | Fine gravel +4 -16 mm | Coarse gravel +16 -64 mm | Cobbles +64 mm |
| 15 NE 31 | 12.2 | 3.4 | 2 | 11 | 47 | 11 | 20 | 9 | trace |
| 15 SE 4 | 10.8 | 3.4 | 2 | 20 | 46 | 9 | 16 | 7 | 0 |
| 15 SE 6 | 7.1 | 6.1 | 3 | 36 | 17 | 7 | 23 | 14 | 0 |
| 15 SE 7 | 10.3 | 5.9 | 4 | 21 | 29 | 11 | 21 | 13 | 1 |
| 15 SE 8 | 12.1 | 5.5 | 3 | 13 | 39 | 11 | 24 | 10 | 0 |
| 15 SE 10 | 4.0 | 5.9 | 1 | 3 | 31 | 14 | 34 | 17 | 0 |
| 15 SE 11 | 12.9 | 5.2 | 9 | 44 | 14 | 6 | 15 | 12 | 0 |
| 15 SE 12 | 9.9 | 7.0 | 4 | 8 | 26 | 14 | 31 | 17 | 0 |
| 15 SE 13 | 7.8 | 9.3 | 1 | 12 | 32 | 10 | 24 | 21 | 0 |
| 15 SE 17 | 13.1 | 2.8 | 8 | 43 | 24 | 6 | 13 | 6 | 0 |
| 15 SE 18 | 16.1 | 3.6 | 7 | 35 | 34 | 7 | 13 | 4 | 0 |
| 15 SE 22 | 12.0 | 6.9 | 3 | 29 | 26 | 13 | 23 | 6 | 0 |
| 15 SE 23 | 11.9 | 4.1 | 4 | 47 | 17 | 8 | 14 | 10 | 0 |
| Mean | 10.8 | 5.3 | 4 | 27 | 31 | 9 | 19 | 10 | trace |

cent; the gravel content ranges from 10 per cent (15 NE 24) to 63 per cent (15 NE 22) though it is usually nearer the mean of 30 per cent.

The mean grading for the block is fines 4 per cent, sand 66 per cent and gravel 30 per cent, making the block as a whole a sandy gravel.

Block $B_3$ (Table 6, Figure 9)
This block occupies 18.4 $km^2$ to the south-east of Billinghay of which 15.9 $km^2$ is mineral-bearing. As in blocks $B_1$ and $B_2$ the mineral thins towards the west and is absent in three boreholes (15 SE 15, 15 SE 16 and 15 SE 28) around which an inferred boundary is drawn. Inferred boundaries are also drawn along the boundaries with blocks C and D. The mineral of block C which is exposed and rests on Till, is separated by barren ground from that of block $B_3$ which lies beneath overburden and rests directly on bedrock. The inferred boundary between blocks $B_3$ and D denotes a degree of uncertainty as to the westerly extent of the mineral beneath the overburden of Marine or Estuarine Alluvium.

The potentially workable sand and gravel of the block comprises predominantly River Gravels with, in five assessment boreholes (15 SE 7, 11, 17, 18 and 23), the lower part of the Marine or Estuarine Alluvium.

The assessment of resources is based on data from 16 IMAU boreholes. The mineral is present in 13 of these and, unlike the mineral in blocks $B_1$ and $B_2$, thickens towards the south-east where it reaches a maximum thickness for the resource sheet area of 16.1 m in borehole 15 SE 18. Mineral is generally relatively thick across the block and the mean (10.8 m) is the highest within any of the resource blocks. The estimated volume of mineral is 172 million $m^3 \pm 18$ per cent at the 95 per cent confidence level. Proven thicknesses of overburden range from 2.8 m (in borehole 15 SE 17) to 9.3 m (in borehole 15 SE 13): the mean is 5.3 m.

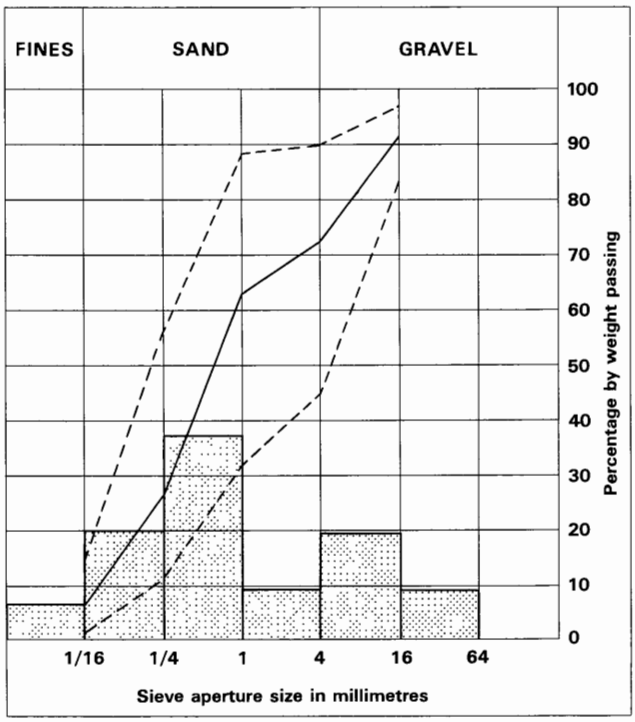



**Figure 10** Grading characteristics of the mineral in Block C (for explanation see Figure 6).

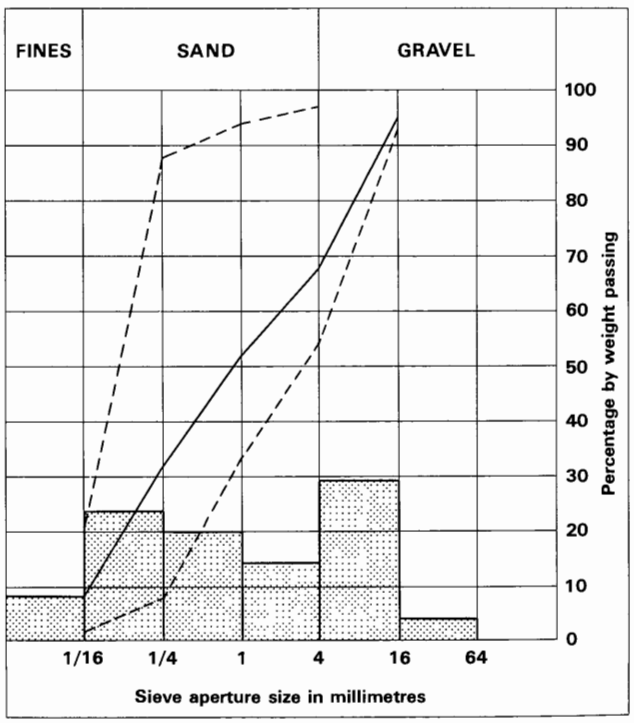



**Figure 11** Grading characteristics of the mineral in Block D (for explanation see Figure 6).

**Table 7** Data from IMAU boreholes used in the assessment: Block C.

| Borehole | Recorded thickness (m) | | | Mean grading percentage | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mineral | Over-burden | Waste* | Fines $-\frac{1}{16}$ mm | Fine sand $+\frac{1}{16}-\frac{1}{4}$ mm | Medium sand $+\frac{1}{4}$ -1 mm | Coarse sand +1 -4 mm | Fine gravel +4 -16 mm | Coarse gravel +16 mm |
| 15 NE 13 | 3.2 | 0.7 | - | 9 | 18 | 35 | 6 | 20 | 12 |
| 15 NE 18 | 11.5 | 0.9 | 0.8 | 11 | 25 | 30 | 8 | 17 | 9 |
| 15 NE 21 | 7.3 | 0.6 | - | 1 | 10 | 49 | 13 | 18 | 9 |
| 15 NE 26 | 2.6 | 0.5 | - | 1 | 15 | 30 | 14 | 24 | 16 |
| 15 NE 30 | 5.5 | 0.9 | - | 4 | 18 | 56 | 7 | 11 | 4 |
| 15 SE 20 | 4.9 | 0.6 | 1.6 | 4 | 13 | 14 | 14 | 43 | 12 |
| 15 SE 21 | 1.3 | 0.6 | - | 13 | 44 | 32 | 1 | 7 | 3 |
| 15 SE 25 | 2.1 | 0.7 | - | 3 | 8 | 53 | 9 | 18 | 9 |
| 15 SE 26 | 1.1 | 0.1 | - | 12 | 34 | 24 | 10 | 16 | 4 |
| 15 SE 27 | 3.4 | 0.4 | - | 4 | 31 | 45 | 6 | 10 | 4 |
| Mean | 4.0 | 0.6 | 0.2 | 6 | 20 | 37 | 9 | 19 | 9 |

* Within mineral beds.

**Table 8** Data from IMAU boreholes used in the assessment: Block D.

| Borehole | Recorded thickness (m) | | Mean grading percentage | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Mineral | Over-burden | Fines $-\frac{1}{16}$ mm | Fine sand $+\frac{1}{16}-\frac{1}{4}$ mm | Medium sand $+\frac{1}{4}$ -1 mm | Coarse sand +1 -4 mm | Fine gravel +4 -16 mm | Coarse gravel +16 mm |
| 05 SE 22 | 0.8 | 0.7 | No grading data available | | | | | |
| 05 SE 23 | 2.9 | 0.2 | 2 | 6 | 26 | 20 | 40 | 6 |
| 05 SE 24 | 1.2 | 0.6 | 21 | 66 | 7 | 3 | 3 | 0 |
| Mean | 1.6 | 0.5 | 8 | 24 | 20 | 15 | 29 | 4 |

In the boreholes that proved mineral the mean fines content is less that 10 per cent with a range of 1 per cent in boreholes 15 SE 10 and 15 SE 13 to 9 per cent in borehole 15 SE 11. The proportion of sand is not less than 48 per cent and reaches 76 per cent in borehole 15 SE 18. The gravel content ranges from 17 per cent in borehole 15 SE 18 to 51 per cent in borehole 15 SE 10. Cobble-sized (+64 mm) material was recorded in two boreholes (15 NE 31 and 15 SE 7).

The mean grading for the block is fines 4 per cent, sand 67 per cent and gravel 29 per cent, making the block as a whole a sandy gravel.

Block C (Table 7, Figure 10)

Block C is divided into two separate areas, one to the north and north-east of Tattershall Bridge [196 562], the other mainly to the south-east of North Kyme [157 527]. In the latter, an inferred boundary defines the area of mineral within the block. The total block area is 10.6 $km^2$ of which 7.6 $km^2$ is mineral-bearing (this excludes a small area of worked ground north-east of Thorpe Tilney Dales [182 589]).

The potentially workable sand and gravel consists mainly of River Gravels together with a small patch of Fluvio-glacial and Older River Sand and Gravel in the north-east of the resource sheet area.

The assessment of resources is based on data from 13 IMAU boreholes. The mineral, which is present in ten of these, varies in thickness from 1.1 m in borehole 15 SE 26 to 11.5 m in borehole 15 NE 18, thus reflecting to some extent irregularities in the underlying Till surface. The mean thickness of mineral is 4.0 m and the estimated volume is 30 million $m^3 \pm 56$ per cent at the 95 per cent confidence level. Proven thicknesses of overburden range from 0.1 m in borehole 15 SE 26 to 0.9 m in boreholes 15 NE 18 and 15 NE 30. As the mean is 0.6 m, the mineral has been assessed as exposed across the block.

The mean fines content of the mineral is less that 10 per cent in seven boreholes and between 11 and 13 per cent in the remaining three. The proportion of sand ranges from 59 per cent to 82 per cent in all but one borehole (15 SE 20) where it is 41 per cent; the gravel content ranges from 10 per cent in borehole 15 SE 21 to 55 per cent in borehole 15 SE 20.

The mean grading for the block is fines 6 per cent, sand 66 per cent and gravel 28 per cent, making the block as a whole a sandy gravel.

Block D (Table 8, Figure 11)

This block, which is 68.7 $km^2$ in area, is the largest of the resource blocks and occupies most of the western half of the resource sheet area. However, it is mostly barren and only 5.3 $km^2$ of sand and gravel south of Ruskington has been assessed as mineral although boreholes 15 NW 19 and 15 SE 18 proved two additional areas of sand and gravel. The potentially workable sand and gravel consists of a thin veneer of River Gravels resting on Till.

An inferred assessment is based on data from 25 IMAU boreholes. The mineral, present in three boreholes, is up to 2.9 m thick (borehole 05 SE 23) and has a mean thickness of 1.6 m. The inferred volume is estimated to be 9 million $m^3$. Proven thicknesses of overburden ranged from 0.2 m (borehole 05 SE 23) to 0.7 m (borehole 05 SE 22): the mean is 0.5 m and the mineral has consequently been assessed as exposed.

Grading data were available for only two of the three boreholes that proved mineral. Combined, they give a mean grading for the block of fines 8 per cent, sand 59 per cent and gravel 33 per cent, making the block as a whole a sandy gravel.

## CONCLUSIONS

1 The mineral within resource blocks A, C and D is exposed but occurs mainly as scattered patches. It consists of 15.4 km$^2$ of Fluvio-glacial and Older River Sand and Gravel and River Gravels. Mineral thicknesses range from 0.8 to 11.5 m, and grade from 'very clayey' sand to sandy gravel. Overburden is generally thin and usually comprises topsoil with a mean thickness of 0.6 m.

2 Most of the potentially workable mineral deposits occur within resource blocks $B_1$, $B_2$ and $B_3$, and consist mainly of River Gravels. They occupy an area of 41.7 km$^2$ along the floodplain of the River Witham and are divisible into two units. An upper unit, ranging in thickness from 0.3 to 8.5 m, consists predominantly of flint and limestone pebbles in the gravel fraction, whereas the lower unit is between 0.3 and 9.0 m thick and is mainly quartzitic. Both units grade consistently as sandy gravel with a marginally higher proportion of sand in the upper unit. The River Gravels lie beneath an overburden of Marine or Estuarine Alluvium whose mean thickness is 4.8 m.

3 Where the mineral rests on bedrock (for example, blocks $B_1$-$B_3$) mineral thicknesses are more predictable than where the mineral rests on Till (for example, in block C).

4 The lower part of the Marine or Estuarine Alluvium is assessed as mineral in ten boreholes within blocks $B_1$-$B_3$. Although up to 6.5 m thick, it is usually nearer the mean thickness of 3.5 m. It consists of sand or 'clayey' sand with peat lenses and locally, some flint pebbles towards the base.

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## APPENDIX A

## FIELD AND LABORATORY PROCEDURES

Trial and error during initial studies of the complex and variable glacial deposits of East Anglia and Essex showed that an absolute minimum of five sample points evenly distributed across the sand and gravel are needed to provide a worthwhile statistical assessment, but that, where possible, there should be not less than ten. Sample points are any points for which adequate information exists about the nature and thickness of the deposit and may include boreholes other than those drilled during the survey and exposures. In particular, the cooperation of sand and gravel operators ensures that boreholes are not drilled where reliable information is already available; although this may be used in the calculations, it is held confidentially by the Institute and cannot be disclosed.

The mineral shown on each 1:25 000 sheet is divided into resource blocks. The arbitrary size selected is a compromise to meet the aims of the survey by providing sufficient sample points in each block. As far as possible the block boundaries are determined by geological boundaries so that, for example, glacial and river terrace gravels are separated. Otherwise division is by arbitrary lines, which may bear no relationship to the geology.

A reconnaissance of the ground is carried out to record 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. However, because broad trends are independently overlain by smaller-scale characteristically random variations, 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 are taken into account in siting the holes; at the same time it is 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.

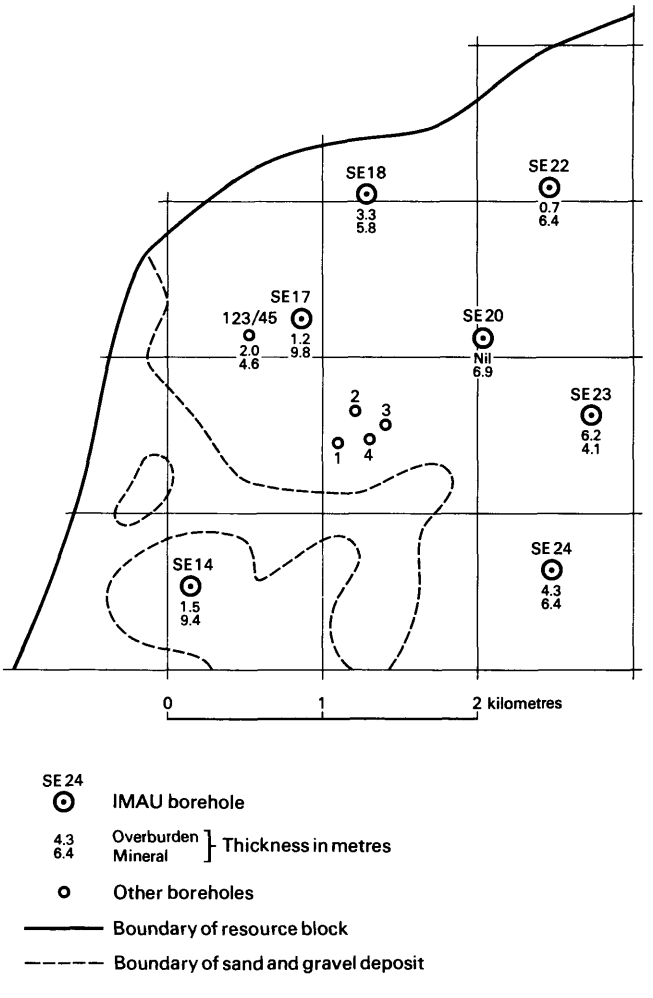
The drilling machine employed should be capable of providing a continuous sample representative of all unconsolidated deposits, so that the in-situ grading can be determined, if necessary, to a depth of 30 m (100 ft) at a diameter of about 152 mm (6 in), beneath different types of overburden. It should be reliable, quiet, mobile and relatively small (so that it can be moved to sites of difficult access). Shell and auger rigs have proved to be almost ideal.

The rigs are modified to enable deposits above the water table to be drilled 'dry', instead of with water added to facilitate the drilling, to minimise the amount of material drawn in from outside the limits of the hole. The samples thus obtained are representative of the in-situ grading, and satisfy one of the most important aims of the survey. Below the water table the rigs are used conventionally, although this may result in the loss of some of the fines fraction and the pumping action of the bailer tends to draw unwanted material into the hole from the sides or the bottom.

A continuous series of bulk samples is taken throughout the sand and gravel. Ideally samples are composed exclusively of the whole of the material encountered in the borehole between stated depths. However, care is taken to discard, as far as possible, material which has caved or has been pumped from the bottom of the hole. A new sample is commenced whenever there is an appreciable lithological change within the sand and gravel, or at every 1 m (3.3 ft) depth. The samples, each weighing between 25 and 45 kg (55 and 100 lb), are despatched in heavy-duty polythene bags to a laboratory for grading. The grading procedure is based on B.S. 1337 (British Standards Institution, 1967). Random checks of the accuracy of the grading are made in the Institute's laboratories.

All data, including mean grading analysis figures calculated for the total thickness of the mineral, are entered on standard record sheets, abbreviated copies of which are reproduced in Appendix E.

Detailed records may be consulted at the appropriate offices of the Institute, upon application to the Head, Industrial Minerals Assessment Unit.




Example of resource block assessment: map of a fictitious block

## APPENDIX B

## STATISTICAL PROCEDURE

### Statistical assessment

1 A statistical assessment is made of an area of mineral greater than 2 $km^2$, if there are at least five evenly spaced boreholes in the resource block (for smaller areas, see Paragraph 12 below).

2 The simple methods used in the calculations are consistent with the amount of data provided by the survey (Hull, 192-193 pp in Thurrell, 1981). Conventional symmetrical confidence limits are calculated for the 95 per cent probability level, that is, on average nineteen out of every twenty sets of limits constructed in this way contain the true value for the volume of mineral.

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

$$S_V = \sqrt{(S_A^2 + S_{\bar{l}_m}^2)} \qquad [1]$$

4 The above relationship may be transposed such that

$$S_V = S_{\bar{l}_m} \sqrt{(1 + S_A^2 / S_{\bar{l}_m}^2)} \qquad [2]$$

From this it can be seen that as $S_A^2 / S_{\bar{l}_m}^2$ tends to 0, $S_V$ tends to $S_{\bar{l}_m}$.

If, therefore, the standard deviation for area is small with respect to that for thickness, the standard deviation for volume approximates to that for mean thickness.

5 Given that the number of approximately evenly spaced sample points in the sampled area is $n$ with mineral thickness measurements $l_{m_1}, l_{m_2}, \ldots l_{m_n}$, then the best estimate of mean thickness, $\bar{l}_m$, is given by

$$\Sigma\ (l_{m_1} + l_{m_2} \ldots l_{m_n}) / n .$$

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

$$S_{\bar{l}_m} = (1/\bar{l}_m) \sqrt{\ [\Sigma (l_m - \bar{l}_m)^2/(n-1)]}$$

where $l_m$ is any value in the series $l_{m_1}$ to $l_{m_n}$.

6 The sampled area in each resource block is coloured pink on the map. Wherever possible, calculations relate to the mineral within mapped geological boundaries (which may not necessarily correspond to the limits of a deposit). Where the area is not defined by a mapped boundary, that is, where the boundary is inferred, a distinctive symbol is used. Experience suggests that the errors in determining area are small relative to those in thickness. The relationship $S_A / S_{\bar{l}_m} \leqq 0.\dot{3}$ is assumed in all cases. It follows from Equation [2] that

$$S_{\bar{l}_m} \leqq S_V \leqq 1.05\, S_{\bar{l}_m} \qquad [3]$$

7 The limits on the estimate of mean thickness of mineral, $L_{\bar{l}_m}$, may be expressed in absolute units

$\pm (t/\sqrt{n}) \times S_{\bar{l}_m}$ or as a percentage

$\pm (t/\sqrt{n}) \times S_{\bar{l}_m} \times (100/\bar{l}_m)$ per cent, where t is Student's t at the 95 per cent probability level for $(n-1)$ degrees of freedom, evaluated by reference to statistical tables. (In applying Student's t it is assumed that the measurements are distributed normally).

8 Values of t at the 95 per cent probability level for values of $n$ up to 20 are as follows:

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

(from Table 12 in *Biometrika Tables for Statisticians*, Volume 1, Second Edition, Cambridge University Press, 1962). When $n$ is greater than 20, 1.96 is used (the value of t when n is infinity).

9 In calculating confidence limits for volume, $L_V$, the following inequality, corresponding to Equation [3], is applied:

$$L_{\bar{l}_m} \leqq L_V \leqq 1.05\, L_{\bar{l}_m}.$$

10 In summary, for values of $n$ between 5 and 20, $L_V$ is calculated as

$$[(1.05 \times t)/\bar{l}_m] \times [\sqrt{\Sigma (l_m - \bar{l}_m)^2}/n\ (n-1)] \times 100$$

per cent,

and when $n$ is greater than 20, as

$$[(1.05 \times 1.96)/\bar{l}_m] \times [\sqrt{\Sigma (l_m - \bar{l}_m)^2}/n\ (n-1)] \times 100$$

per cent.

11 The application of this procedure to a fictitious area is illustrated in the accompanying Figure and example of a block calculation.

### Inferred assessment

12 If the sampled area of mineral in a resource block is between 0.25 $km^2$ and 2 $km^2$, an assessment is inferred on the basis of geological and topographical information, usually supported by the data from one or two boreholes. The volume of mineral is calculated as the product of the area, measured from field data, and the estimated thickness. Confidence limits are not calculated.

13 In some cases a resource block may include an area left uncoloured on the map, within which mineral (as defined) is interpreted to be generally absent. If there is reason to believe that some mineral may be present, an inferred assessment may be made.

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

15 Note on weighting The thickness of a deposit at any point may be governed solely by the position of the point in relation to a broad trend. However, most sand and gravel deposits also exhibit a random pattern of local, and sometimes considerable, variation in thickness. Thus the distribution of sample points needs to be only approximately regular and in estimating the mean thickness only simple weighting is necessary. In practice, equal weighting can often be applied to thicknesses at all sample points. If, however, there is a distinctly unequal distribution of points, bias is avoided by dividing the sampled area into broad zones, to each of which a value roughly proportional to its area is assigned. This value is then shared between the data points with the zone as the weighting factor.

**Block calculation**

Scale: 1:25 000
Block: Fictitious

Area
Block: 11.08 km²
Mineral: 8.32 km²

Mean thickness
Overburden: 2.5 m
Mineral: 6.5 m

Volume
Overburden: 21 million m³
Mineral: 54 million m³

Confidence limits of the estimate of mineral volume at the 95 per cent probability level: ± 20 per cent
That is, the volume of mineral (with 95 per cent probability): 54 ± 11 million m³

Thickness estimate (measurements in metres)
$l_o$= overburden thickness $l_m$ = mineral thickness

| Sample point | Weighting $w$ | Overburden $l_o$ | Overburden $wl_o$ | Mineral $l_m$ | Mineral $wl_m$ | Remarks |
|---|---|---|---|---|---|---|
| SE 14 | 1 | 1.5 | 1.5 | 9.4 | 9.4 | IMAU boreholes |
| SE 18 | 1 | 3.3 | 3.3 | 5.8 | 5.8 | |
| SE 20 | 1 | nil | - | 6.9 | 6.9 | |
| SE 22 | 1 | 0.7 | 0.7 | 6.4 | 6.4 | |
| SE 23 | 1 | 6.2 | 6.2 | 4.1 | 4.1 | |
| SE 24 | 1 | 4.3 | 4.3 | 6.4 | 6.4 | |
| SE 17 | ½ | 1.2 | 1.6 | 9.8 | 7.2 | Hydrogeology Unit record |
| 123/45 | ½ | 2.0 | | 4.6 | | |
| 1 | ¼ | 2.7 | 2.6 | 7.3 | 5.8 | Close group of four boreholes (commercial) |
| 2 | ¼ | 4.5 | | 3.2 | | |
| 3 | ¼ | 0.4 | | 6.8 | | |
| 4 | ¼ | 2.8 | | 5.9 | | |
| Totals | $\Sigma w = 8$ | $\Sigma wl_o = 20.2$ | | $\Sigma wl_m = 52.0$ | | |
| Means | | $\overline{wl}_o = 2.5$ | | $\overline{wl}_m = 6.5$ | | |

Calculation of confidence limits

| $wl_m$ | $\lvert(wl_m - \overline{wl}_m)\rvert$ | $(wl_m - \overline{wl}_m)^2$ |
|---|---|---|
| 9.4 | 2.9 | 8.41 |
| 5.8 | 0.7 | 0.49 |
| 6.9 | 0.4 | 0.16 |
| 6.4 | 0.1 | 0.01 |
| 4.1 | 2.4 | 5.76 |
| 6.4 | 0.1 | 0.01 |
| 7.2 | 0.7 | 0.49 |
| 5.8 | 0.7 | 0.49 |

$\Sigma(wl_m - \overline{wl}_m)^2 = 15.82$

$n = 8$

$t = 2.365$

$L_Y$ is calculated as

$1.05\ (t/\overline{wl}_m)\ \sqrt{[\Sigma(wl_m - \overline{wl}_m)^2 / n(n-1)]} \times 100$

$= 1.05 \times (2.365/6.5)\ \sqrt{[15.82/(8 \times 7)]} \times 100$

$= 20.3$

$\simeq 20$ per cent.

**APPENDIX C**

**CLASSIFICATION AND DESCRIPTION OF SAND AND GRAVEL**

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.

The terminology commonly used by geologists when describing sedimentary rocks (Wentworth, 1922) is not entirely satisfactory for this purpose. For example, Wentworth proposed that a deposit should be described as a 'gravelly sand' when it contains more sand than gravel and there is at least 10 per cent of gravel, provided that there is less than 10 per cent of material finer than sand (< $\frac{1}{16}$ mm) and coarser than pebbles (> 64 mm in diameter). Because deposits containing more than 10 per cent fines are not embraced by this system, a modified binary classification based on Willman (1942) has been adopted.

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

The term 'clay' (as written, with single quote marks) is used to describe all material passing $\frac{1}{16}$ mm. Thus it has no mineralogical significance and includes particles falling within the size range of silt. The normal meaning applies to the term clay where it does not appear in single quotation marks.

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 the accompanying Figure). The procedure is as follows:

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

For example, a deposit grading 11 per cent gravel, 70 per cent sand and 19 per cent fines is classified as 'clayey' pebbly sand. This short description is included in the borehole log (see Appendix D)

Many differing proposals have been made for the classification of the grain size of sediments (Atterberg, 1905; Udden, 1914; Wentworth, 1922; Wentworth, 1935; Allen, 1936; Twenhofel, 1937; Lane and others, 1947). As Archer (1970a, b) has emphasised, there is a pressing need for a simple metric scale acceptable to both scientific and engineering interests, for which the class limit sizes correspond closely with certain marked changes in the natural properties of mineral particles. For example, there is an important change in the degree of cohesion between particles at about the $\frac{1}{16}$-mm size, which approximates to the generally accepted boundary between silt and sand. These and other requirements are met by a system based on Udden's geometric scale and a simplified form of Wentworth's terminology (see the accompanying table), which is used in the Report.

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

The size distribution of borehole samples is determined by sieve analysis, which is presented by the laboratory as logarithmic cumulative curves (see, for example, British Standards Institution, 1967). In this report the grading is tabulated on the borehole record sheets (Appendix E), the intercepts corresponding with the simple geometric scale $\frac{1}{16}$ mm, $\frac{1}{4}$ mm, 1 mm, 4 mm, 16 mm and so on as required. Original sample grading curves are available for reference at the appropriate office of the Institute.

Each bulk sample is described by a geologist at the borehole site. Subsequently, the descriptive catogories of the mineral for each borehole are modified according to the results obtained from the mean particle size analysis of these samples.

The relative proportions of the rock types present in the gravel fraction are indicated by the use of the words 'and' or 'with'. For example, 'flint and quartz' indicates roughly 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 'flint with quartz' indicates that flint is dominant and quartz, the principal 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 constitutents are referred to as 'trace'.

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

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

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

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

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

Well rounded: not 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.

Classification of gravel, sand and fines

| Size limits | Grain-size description | Qualification | Primary classification |
|---|---|---|---|
| | Cobble | | |
| 64 mm | | | |
| | | Coarse | Gravel |
| 16 mm | Pebble | | |
| | | Fine | |
| 4 mm | | | |
| | | Coarse | |
| 1 mm | | | |
| | Sand | Medium | Sand |
| $\frac{1}{4}$ mm | | | |
| | | Fine | |
| $\frac{1}{16}$ mm | | | |
| | Fines (silt and clay) | | Fines |

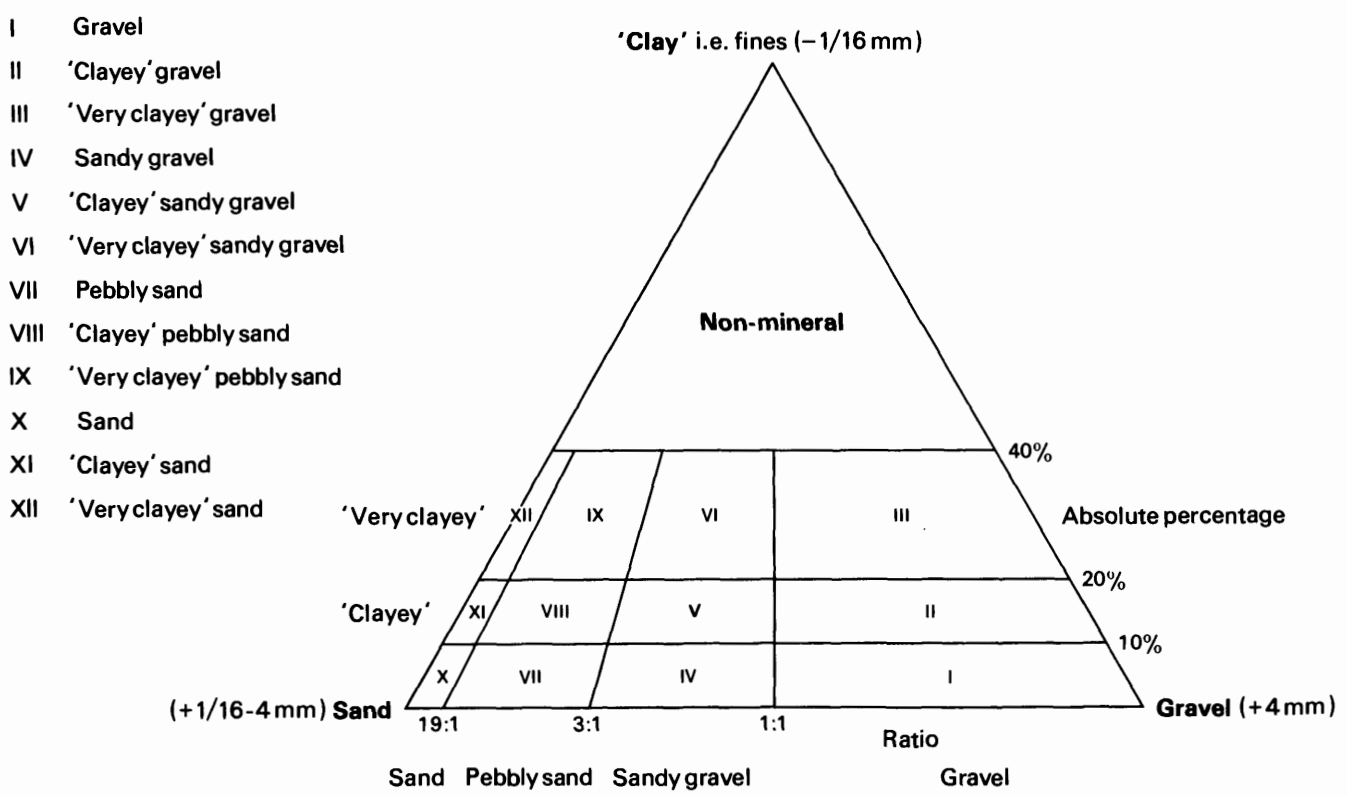



Diagram showing the descriptive categories used in the classification of sand and gravel

## APPENDIX D

## EXPLANATION OF THE BOREHOLE RECORDS

### Annotated example

**TF 15 SE 20**[1] **1668 5186**[2] **Damford Grounds**[3] **Block C**

Surface level +2.8 m (+9 ft)[4]
Water struck at +0.8 m[5]
March 1979[6]

Overburden[7] 0.6 m
Mineral 1.1 m
Waste 1.6 m
Mineral 3.8 m
Bedrock 1.3 m+[8]

**LOG**

| Geological classification[9] | Lithology[10] | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.6 | 0.6 |
| River Gravels | **a** 'Clayey' pebbly sand<br>Gravel: fine and coarse, angular to subrounded, grey and brown flint with some quartzite and vein quartz<br>Sand: fine, subangular to subrounded, quartz with some coarse flint and lithic grains | 1.1 | 1.7 |
| | Sandy clay, brownish yellow, soft | 1.6 | 3.3 |
| | **b** Gravel<br>Gravel: fine, subangular to subrounded, brown, purple and grey quartzite with white and brown flint, vein quartz and trace shell fragments<br>Sand: coarse and medium, quartz with some lithic grains and trace jasper | 3.8 | 7.1 |
| Ancholme Clay Group | Silty clay, dark greenish grey, stiff to hard | 1.3+ | 8.4 |

**GRADING**[11]

| | Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | +1 -4 | +4 -16 | +16 -64 | +64 mm |
| **a** | 13 | 69 | 18 | 0.6-1.7 | 13 | 47 | 18 | 4 | 11 | 7 | 0 |
| **b** | 1 | 33 | 66 | 3.3-4.4 | 2 | 5 | 12 | 11 | 53 | 17 | 0 |
| | | | | 4.4-5.4 | 1 | 2 | 13 | 17 | 50 | 17 | 0 |
| | | | | 5.4-6.4 | 1 | 3 | 12 | 20 | 54 | 10 | 0 |
| | | | | 6.4-7.1 | 0 | 1 | 18 | 21 | 50 | 10 | 0 |
| | | | | **Mean** | **1** | **3** | **13** | **17** | **52** | **14** | **0** |
| **a+b** | **4** | **41** | **55** | **Mean** | **4** | **13** | **14** | **14** | **43** | **12** | **0** |

**COMPOSITION**[12]

| Depth below surface (m) | percentages by weight in gravel fraction | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Flint | Quartzite | Limestone | Quartz | Sandstone | Ironstone | Igneous | Others |

---

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

1 Borehole Registration Number
Each Industrial Minerals Assessment (IMAU) borehole is identified by a Registration Number. This consists of two statements:

a The number of the 1:25 000 sheet on which the borehole lies, for example TF 15.

b The quarter of the 1:25 000 sheet on which the borehole lies and the number of the borehole in a series for that quarter, for example SE 20. Thus the full Registration Number is TF 15 SE 20.

2 The National Grid Reference
All National Grid References in this publication lie within the 100 km square TF. 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 position of the borehole is referred to the nearest named locality on the 1:25 000 base map and the resource block in which it lies is stated.

4 Surface level
The surface level of the borehole site is given in metres and feet above Ordnance Datum. All measurements were made in metres: approximate conversions to feet are given in brackets.

5 Groundwater conditions
If groundwater was present, the level at which it was encountered is normally given (in metres relative to Ordnance Datum).

6 Type of drill and date of drilling
Unless otherwise stated, all boreholes were drilled by a shell and auger rig using 6 inch casing. The month and year of completion of the hole are stated.

In this survey one assessment borehole (05 SE 24) was drilled using a Minuteman power auger rig. This machine, which is small and portable (it will fit into the rear of a long wheel-base landrover) may be operated by one person; its use was restricted to those occasions when access to land is not possible with shell and auger rigs or when information is required quickly.

7 Overburden, mineral, waste and bedrock
Mineral is sand and gravel which, as part of a deposit, falls within the arbitrary definitions of potentially workable material. Bedrock is the 'formation', 'country rock', or 'rockhead' below which potentially workable sand and gravel will not be found. Waste is any material other than bedrock or mineral. Where waste occurs between the surface and mineral it is classified as overburden.

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

9 Geological classification
The geological classification (Table 1) is given whenever possible.

10 Lithological description
When sand and gravel is recorded a general description based on the grading characteristics (for details see Appendix C) is followed by more detailed particulars of the gravel and/or sand fractions. The description of other rocks is based either on visual examination in the field, or, when available, on pebble count data. Where more than one mineral stratum is recognised, each is designated by a letter, eg. a, b, etc.

11 Grading data
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 or at every 1 m of depth.

For each bulk sample the percentages of fines (-$\frac{1}{16}$ mm), fine sand (+$\frac{1}{16}$-$\frac{1}{4}$ mm), medium sand (+$\frac{1}{4}$-1 mm), coarse sand (+1-4 mm), fine gravel (+4-16 mm) and coarse gravel (+16-64) are stated. The mean grading of groups of samples making up an identified mineral stratum are also given in detail and, to the left, in summary. Where more than one stratum is recognised the mean grading for the whole of the mineral in the borehole is given. Where necessary in calculating the mean grading, data for individual samples are weighted by the thickness represented.

Full representative sampling of sand and gravel is difficult to achieve, particularly where groundwater levels are high. Comparison between borehole and adjacent exposures suggests that in borehole samples the proportion of sand may be higher and the proportions of fine and coarse gravel may be lower.

12 Composition
Details of the composition of the gravel fraction may be given. Grouped samples are individually weighted according to their percentage of gravel and a mean composition calculated for the borehole.

**APPENDIX E**

**INDUSTRIAL MINERALS ASSESSMENT UNIT BOREHOLE RECORDS**

**TF 05 NE 18** **0943 5767** **Kirkby Green** **Block D**

Surface level +8.1 m (+27 ft)
Water not struck
November 1978

Waste 1.5 m
Bedrock 1.5 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.2 | 0.2 |
| Till | Clay, brownish grey, firm with pebbles of chalk and ferruginous sandstone | 0.7 | 0.9 |
| | Clay, grey with some yellowish mottling, firm with subangular chalk and some angular flint pebbles | 0.6 | 1.5 |
| Ancholme Clay Group | Clay, dark grey, slightly silty, friable with many bivalve fragments | 1.5+ | 3.0 |

**TF 05 NE 19** **0965 5624** **Rowston Cottage** **Block D**

Surface level +6.6 m (+22 ft)
Water struck at +5.5 m
April 1979

Waste 2.3 m
Bedrock 1.1 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Made ground | 0.4 | 0.4 |
| River Gravels | Clayey silt, greyish brown mottled with yellowish brown, firm with rootlets and carbonaceous patches | 0.5 | 0.9 |
| | Sandy clay, brownish yellow, soft to firm with some fine quartz sand | 0.2 | 1.1 |
| | 'Clayey' pebbly sand<br>Gravel: fine, subangular, oolitic and shelly limestone with angular flint<br>Sand: subangular, quartz with some limestone and flint | 0.4 | 1.5 |
| Till | Clay, dark greyish brown, stiff, with granules of limestone | 0.8 | 2.3 |
| Ancholme Clay Group | Clay, dark greenish grey, silty, stiff | 1.1+ | 3.4 |

**TF 05 SE 22** **0760 5776** **Ruskington** **Block D**

Surface level +15.1 m (+50 ft)
Water not struck
April 1979

Overburden 0.7 m
Mineral 0.8 m
Bedrock 2.1 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Made ground | 0.7 | 0.7 |
| River Gravels | Pebbly sand<br>Gravel: fine, subangular, shelly and oolitic limestone with trace sandstone and flint<br>Sand: medium, quartz with some limestone and lithic grains | 0.8 | 1.5 |
| Ancholme Clay Group | Sandy silt, dark greenish grey, very soft and friable with some bivalve fragments | 2.1+ | 3.6 |

**TF 05 SE 23** **0878 5040** **Ruskington** **Block D**

Surface level +9.5 m (+31 ft)
Water struck at +8.2 m
April 1979

Overburden 0.2 m
Mineral 2.9 m
Bedrock 1.2 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.2 | 0.2 |
| River Gravels | Sandy gravel<br>Gravel: fine with coarse, subangular, shelly and oolitic limestone with some ironstone, brown sandstone and flint<br>Sand: medium and coarse with fine, subrounded quartz with some flint and lithic grains | 2.9 | 3.1 |
| Ancholme Clay Group | Clayey silt, dark greenish grey, soft to firm | 1.2+ | 4.3 |

**GRADING**

| Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | +1 -4 | +4 -16 | +16 -64 | +64 mm |
| 2 | 52 | 46 | 0.2-1.3 | 4 | 8 | 29 | 23 | 32 | 4 | 0 |
| | | | 1.3-2.5 | 1 | 4 | 24 | 19 | 42 | 10 | 0 |
| | | | 2.5-3.1 | 2 | 7 | 25 | 16 | 48 | 2 | 0 |
| | | | **Mean** | **2** | **6** | **26** | **20** | **40** | **6** | **0** |

**TF 05 SE 24** **0751 5089** **Ruskington** **Block D**

Surface level +13.7 m (+45 ft)
Water level not recorded
Minuteman Auger 76 mm diameter
October 1979

Overburden 0.6 m
Mineral 1.2 m
Bedrock 3.1 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Topsoil and fill | 0.6 | 0.6 |
| River Gravels | 'Very clayey' sand, pebbly at top: mainly fine, subrounded, quartz | 1.2 | 1.8 |
| Ancholme Clay Group | Silt, grey, soft; sandy in part | 3.1+ | 4.9 |

**GRADING**

| Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | $+1-4$ | $+4-16$ | $+16-64$ | $+64$ mm |
| 21 | 76 | 3 | 0.6-1.8 | 21 | 66 | 7 | 3 | 3 | 0 | 0 |

**TF 15 NW 9** **1053 5991** **Martin** **Block A**

Surface level +18.0 m (+59 ft)
Water struck at +15.2 m
November 1978

Overburden 1.1 m
Mineral 2.1 m
Waste 15.3 m
Bedrock 0.5 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 1.1 | 1.1 |
| Fluvio-glacial and Older River Sand and Gravel | Sandy gravel, with clay nodules towards base<br>Gravel: fine with coarse, mainly subangular to subrounded, sandstone, quartzite and flint<br>Sand: mainly medium, subrounded quartz with quartzite and flint | 2.1 | 3.2 |
| Till | Clay, greyish brown becoming grey with depth, pebbles of subangular chalk and white flint with trace red marl | 15.3 | 18.5 |
| Ancholme Clay Group | Silty clay, dark greenish grey, hard, with some bivalve fragments | 0.5+ | 19.0 |

**GRADING**

| Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | $+1-4$ | $+4-16$ | $+16-64$ | $+64$ mm |
| 3 | 57 | 40 | 1.1-2.1 | 5 | 9 | 39 | 13 | 28 | 6 | 0 |
| | | | 2.1-3.2 | 3 | 5 | 34 | 14 | 27 | 17 | 0 |
| | | | **Mean** | **3** | **7** | **36** | **14** | **28** | **12** | **0** |

**TF 15 NW 10** **1098 5913** **Martin** **Block A**

Surface level +17.8 m (+58 ft)
Water not struck
November 1978

Overburden 0.5 m
Mineral 1.3 m
Waste 16.3 m
Bedrock 1.0 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.5 | 0.5 |
| Fluvio-glacial and Older River Sand and Gravel | 'Clayey' pebbly sand, sandy upper margin<br>Gravel: fine, subangular white flint with subrounded sandstone<br>Sand: medium with fine, quartz and dark minerals | 1.3 | 1.8 |
| Till | Clay, grey, firm to stiff, with pebbles of subangular chalk, angular white flint and trace brown ferruginous sandstone; becomes less chalky with depth | 16.3 | 18.1 |
| Ancholme Clay Group | Silty clay, dark greenish grey, hard | 1.0+ | 19.1 |

**GRADING**

| Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | $+1-4$ | $+4-16$ | $+16-64$ | $+64$ mm |
| 12 | 79 | 9 | 0.5-1.8 | 12 | 26 | 45 | 8 | 8 | 1 | 0 |

**TF 15 NW 11** **1264 5971** **Martin** **Block A**

Surface level +15.4 m (+50 ft)
Water not struck
November 1978

Overburden 0.6 m
Mineral 0.9 m
Waste 16.6 m
Bedrock 0.9 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.6 | 0.6 |
| Fluvio-glacial and Older River Sand and Gravel | 'Clayey' sand; medium, quartz with some flint and lithic grains | 0.9 | 1.5 |
| Till | Clay, dark grey, firm, with subangular chalk granules and some white flint and black mudstone | 16.6 | 18.1 |
| Ancholme Clay Group | Silty clay, dark greenish grey, hard, with trace bivalve fragments | 0.9+ | 19.0 |

**TF 15 NW 12** **1385 5894** **Timberland** **Block $B_1$**

Surface level +1.6 m (+5 ft)
Water struck at -3.9 m
November 1978

Overburden 5.9 m
Mineral 6.2 m
Bedrock 2.4 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.6 | 0.6 |
| Marine or Estuarine Alluvium | Silty clay, brown to reddish brown becoming grey with depth, firm and plastic | 4.3 | 4.9 |
| | Peat, black with wood fragments | 0.1 | 5.0 |
| | Silty clay, dark grey, soft and micaceous | 0.9 | 5.9 |
| River Gravels | **a** Sandy gravel<br>Gravel: fine and coarse, brown and grey angular flint with some limestone and quartzite<br>Sand: medium and fine, subrounded quartz with lithic grains | 1.0 | 6.9 |
| | **b** Gravel<br>Gravel: fine with coarse, mainly brown and purple subrounded quartzite with some flint and sandstone<br>Sand: mainly medium, quartz with some quartzite and trace jasper | 5.2 | 12.1 |
| Ancholme Clay Group | Silty clay, dark greenish grey, hard | 2.4+ | 14.5 |

**GRADING**

| | Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | +1 -4 | +4 -16 | +16 -64 | +64 mm |
| **a** | 2 | 72 | 26 | 5.9-6.9 | 2 | 20 | 45 | 7 | 14 | 12 | 0 |
| **b** | 3 | 45 | 52 | 6.9-7.9 | 1 | 11 | 39 | 11 | 27 | 11 | 0 |
| | | | | 7.9-8.9 | 2 | 10 | 30 | 8 | 39 | 11 | 0 |
| | | | | 8.9-9.9 | 1 | 6 | 24 | 7 | 38 | 24 | 0 |
| | | | | 9.9-10.9 | 2 | 6 | 17 | 10 | 37 | 28 | 0 |
| | | | | 10.9-12.1 | 4 | 9 | 25 | 12 | 31 | 19 | 0 |
| | | | | **Mean** | **3** | **8** | **27** | **10** | **34** | **18** | **0** |
| **a+b** | 2 | 49 | 49 | 5.9-12.1 | 2 | 10 | 30 | 9 | 31 | 18 | 0 |

**TF 15 NW 13** **1472 5921** **Timberland** **Block $B_1$**

Surface level +2.0 m (+7 ft)
Water struck at -10 m
November 1978

Overburden 6.5 m
Mineral 6.6 m
Bedrock 0.9 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.4 | 0.4 |
| Marine or Estuarine Alluvium | Clayey silt, yellowish brown becoming greyish brown, very soft; some fine sand | 6.1 | 6.5 |
| | **a** Sand: mainly fine with some medium, subrounded, quartz with some lithic grains and trace jasper | 2.6 | 9.1 |
| River Gravels | **b** Sandy gravel, shelly in upper part<br>Gravel: fine with coarse, angular to subangular, black flint with quartzite<br>Sand: medium with fine and coarse, subangular to subrounded quartz with flint | 2.4 | 11.5 |
| | **c** Gravel<br>Gravel: fine and coarse, subangular to subrounded grey and greyish brown quartzite with vein quartz, flint and some fine-grained igneous rock<br>Sand: medium, quartz and flint with some lithic grains | 1.6 | 13.1 |
| Ancholme Clay Group | Silty clay, dark greenish grey, stiff to hard | 0.9+ | 14.0 |

**GRADING**

| | Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | $+1-4$ | $+4-16$ | $+16-64$ | $+64$ mm |
| **a** | 8 | 92 | 0 | 6.5-7.5 | 10 | 88 | 2 | 0 | 0 | 0 | 0 |
| | | | | 7.5-9.1 | 6 | 84 | 9 | 1 | 0 | 0 | 0 |
| | | | | **Mean** | **8** | **85** | **6** | **1** | **0** | **0** | **0** |
| **b** | 2 | 51 | 47 | 9.1-10.1 | 2 | 16 | 20 | 15 | 40 | 7 | 0 |
| | | | | 10.1-11.5 | 1 | 5 | 35 | 11 | 30 | 18 | 0 |
| | | | | **Mean** | **2** | **10** | **29** | **12** | **34** | **13** | **0** |
| **c** | 2 | 44 | 54 | 11.5-12.5 | 2 | 4 | 38 | 12 | 27 | 17 | 0 |
| | | | | 12.5-13.1 | 1 | 2 | 17 | 8 | 30 | 42 | 0 |
| | | | | **Mean** | **2** | **3** | **31** | **10** | **28** | **26** | **0** |
| **a+b+c** | 4 | 65 | 31 | 6.5-13.1 | 4 | 38 | 20 | 7 | 20 | 11 | 0 |

**TF 15 NW 14** **1224 5817** **Timberland** **Block A**

Surface level +6.3 m (+21 ft)
Water not struck
November 1978

Waste 9.1 m
Bedrock 0.9 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil, with some flint pebbles | 0.9 | 0.9 |
| Till | Clay, grey, stiff, with pebbles of subangular chalk, some white and grey flint and black mudstone; percentage of chalk decreases with depth | 8.2 | 9.1 |
| Ancholme Clay Group | Silty clay, dark greenish grey, with some fragments of ammonite | 0.9+ | 10.0 |

**TF 15 NW 15** **1396 5805** **Timberland** **Block $B_1$**

Surface level +2.2 m (+7 ft)
Water struck at -4.5 m
November 1978

Overburden 8.5 m
Mineral 1.6 m
Bedrock 1.9 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.8 | 0.8 |
| Marine or Estuarine Alluvium | Silty clay, grey, firm, becoming softer with depth; patches of peat towards base | 3.1 | 3.9 |
| | Peat, black, with wood fragments | 0.9 | 4.8 |
| | Silt, grey, becomes reddish brown and sandy below 8.0 m, very soft | 3.7 | 8.5 |
| River Gravels | Gravel<br>Gravel: fine and coarse, grey and brown subangular to subrounded quartzite with vein quartz and some flint and limestone<br>Sand: medium, subangular to subrounded quartz with some quartzite and trace lithic grains | 1.6 | 10.1 |
| Ancholme Clay Group | Silty clay, dark greenish grey | 1.9+ | 12.0 |

**GRADING**

| Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | +1 -4 | +4 -16 | +16 -64 | +64 mm |
| 2 | 47 | 57 | 8.5-9.5 | 3 | 9 | 30 | 6 | 23 | 29 | 0 |
| | | | 9.5-10.1 | 1 | 5 | 28 | 16 | 37 | 13 | 0 |
| | | | **Mean** | **2** | **8** | **29** | **10** | **28** | **23** | **0** |

**TF 15 NW 16** **1129 5670** **Walcot** **Block D**

Surface level +3.6 m (+12 ft)
Water not struck
November 1978

Waste 7.8 m
Bedrock 1.2 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.5 | 0.5 |
| Marine or Estuarine Alluvium | Silty clay, light olive brown, firm, plastic; trace flint pebbles | 1.0 | 1.5 |
| Till | Clay, grey, stiff, with granules of subangular chalk and some quartzite and flint pebbles, becoming less chalky with depth | 6.3 | 7.8 |
| Ancholme Clay Group | Silty clay, dark greenish grey, hard, with some bivalve fragments | 1.2+ | 9.0 |

**TF 15 NW 17** **1224 5630** **Walcot** **Block D**

Surface level +4.6 m (+15 ft)
Water not struck
November 1978

Waste 6.8 m
Bedrock 0.3 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil, with some flint gravel | 0.5 | 0.5 |
| Marine or Estuarine Alluvium | 'Clayey' sand: medium with fine, subrounded, quartz with some lithic grains | 0.3 | 0.8 |
| Till | Pebbly clay, grey, firm, with some fine subangular chalk pebbles and trace flint and black mudstone | 6.0 | 6.8 |
| Ancholme Clay Group | Silty clay, dark greenish grey, hard, with some bivalve fragments | 0.3+ | 7.1 |

**TF 15 NW 18** **1444 5643** **Walcot** **Block $B_2$**

Surface level +3.6 m (+12 ft)
Water not struck
November 1978

Waste 8.1 m
Bedrock 0.9 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.4 | 0.4 |
| Till | Clay, grey, firm and plastic with some fine subangular chalk granules and pebbles of ferruginous sandstone; becomes less chalky with depth | 7.7 | 8.1 |
| Ancholme Clay Group | Silty clay, dark bluish grey, stiff and friable | 0.9+ | 9.0 |

**TF 15 NW 19** **1043 5524** **Digby** **Block D**

Surface level +6.0 m (+20 ft)
Water struck at +5.5 m
March 1979

Overburden 0.3 m
Mineral 0.9 m
Bedrock 1.2 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.3 | 0.3 |
| River Gravels | 'Clayey' sandy gravel<br>Gravel: fine, subangular, oolitic limestone<br>Sand: medium and fine, subrounded, quartz with some caurse limestone | 0.9 | 1.2 |
| Ancholme Clay Group | Silty clay, dark greenish grey, stiff | 1.2+ | 2.4 |

**GRADING**

| Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | +1 -4 | +4 -16 | +16 -64 | +64 mm |
| 12 | 56 | 32 | 0.3-1.2 | 12 | 18 | 25 | 13 | 28 | 4 | 0 |

**COMPOSITION**

| Depth below surface (m) | percentages by weight in gravel fraction | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Flint | Quartzite | Limestone | Quartz | Sandstone | Ironstone | Igneous | Others |
| | Percentage by weight in 8-16mm fraction | | | | | | | |
| 0.3-1.2 | trace | | 100 | - | - | - | - | - |
| | Percentage by weight in 4-8mm fraction | | | | | | | |
| 0.3-1.2 | trace | | 100 | - | - | - | - | - |
| **Mean** | **trace** | | **100** | - | - | - | - | - |

**TF 15 NW 20** **1160 5572** **Walcot Commons** **Block D**

Surface level +5.8 m (+19 ft)
Water not struck
November 1978

Waste 6.9 m
Bedrock 1.1 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.4 | 0.4 |
| Till | Clay, olive grey becoming grey with depth, stiff, with granules of chalk, some flint and black mudstone, trace ferruginous sandstone | 6.5 | 6.9 |
| Ancholme Clay Group | Silty clay, dark greenish grey, hard; some ammonite fragments | 1.1+ | 8.0 |

**TF 15 NW 21** **1438 5509** **Billinghay** **Block A**

Surface level +13.6 m (+45 ft)
Water struck at +11.9 m
December 1978

Overburden 0.6 m
Mineral 1.3 m
Waste 16.0 m
Bedrock 0.1 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil, with quartzite pebbles | 0.6 | 0.6 |
| Fluvio-glacial and Older River Sand and Gravel | 'Very clayey' pebbly sand<br>Gravel: fine, subrounded, brown and grey quartzite with sandstone<br>Sand: medium and fine, quartz with some lithic grains and coarse sandstone | 1.3 | 1.9 |
| Till | Pebbly clay, dark brown, firm to stiff with subangular chalk and some flint and mudstone pebbles | 6.6 | 8.5 |
| | Clay, brown, firm, laminated | 1.3 | 9.8 |
| | Clay, dark greyish brown with chalk granules and black mudstone pebbles | 8.1 | 17.9 |
| Ancholme Clay Group | Limestone, grey, hard and crystalline | 0.1+ | 18.0 |

**GRADING**

| Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | +1 -4 | +4 -16 | +16 -64 | +64 mm |
| 22 | 72 | 6 | 0.6-1.9 | 22 | 32 | 37 | 3 | 6 | 0 | 0 |

**TF 15 NW 22** **1167 5772** **Thorpe Tilney** **Block A**

Surface level +16.2 m (+53 ft)
Water not struck
November 1978

Waste 18.5 m
Bedrock 0.5 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 1.1 | 1.1 |
| Fluvio-glacial and Older River Sand and Gravel | 'Clayey' pebbly sand<br>Gravel: fine, subrounded, quartzite with angular flint and some sandstone<br>Sand: medium, subrounded, quartz | 0.3 | 1.4 |
| Till | Pebbly clay, grey, stiff; subangular chalk with some flint and black mudstone | 17.1 | 18.5 |
| Ancholme Clay Group | Silty clay, dark greenish grey, hard | 0.5+ | 19.0 |

**TF 15 NE 10** **1623 5977** **Timberland** **Block $B_1$**

Surface level +1.2 m (+4 ft)
Water struck at -2.1 m
December 1978

Overburden 4.9 m
Mineral 7.4 m
Bedrock 1.2 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 1.4 | 1.4 |
| Marine or Estuarine Alluvium | Silty clay, dark greyish brown becoming dark grey with depth, firm to soft | 1.8 | 3.2 |
| | Peat, dark brown with wood fragments | 0.5 | 3.7 |
| | Silt, grey, slightly sandy, firm to soft | 1.2 | 4.9 |
| | **a** Sand, with some flint gravel at base; medium and fine, subrounded quartz with some dark minerals and trace jasper | 2.9 | 7.8 |
| River Gravels | **b** Sandy gravel<br>Gravel: fine with coarse, grey and purple subrounded quartzite with some vein quartz and white flint<br>Sand: medium, subrounded, quartz with some quartzite and lithic grains | 4.5 | 12.3 |
| Ancholme Clay Group | Silty clay, dark greenish grey, hard | 1.2+ | 13.5 |

**GRADING**

| | Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | +1 -4 | +4 -16 | +16 -64 | +64 mm |
| **a** | 9 | 88 | 3 | 4.9-5.9 | 11 | 56 | 32 | 1 | 0 | 0 | 0 |
| | | | | 5.9-6.9 | 5 | 38 | 53 | 2 | 2 | 0 | 0 |
| | | | | 6.9-7.8 | 10 | 21 | 52 | 8 | 8 | 1 | 0 |
| | | | | **Mean** | **9** | **39** | **45** | **4** | **3** | **0** | **0** |
| **b** | 4 | 56 | 40 | 7.8-8.8 | 1 | 13 | 57 | 9 | 16 | 4 | 0 |
| | | | | 8.8-9.8 | 6 | 12 | 44 | 12 | 20 | 6 | 0 |
| | | | | 9.8-10.8 | 8 | 11 | 34 | 10 | 20 | 17 | 0 |
| | | | | 10.8-12.3 | 2 | 5 | 19 | 13 | 36 | 25 | 0 |
| | | | | **Mean** | **4** | **9** | **36** | **11** | **25** | **15** | **0** |
| **a+b** | 6 | 69 | 25 | 4.9-12.3 | 6 | 21 | 40 | 8 | 16 | 9 | 0 |

**TF 15 NE 11** **1704 5897** **Thorpe Tilney Fen** **Block $B_1$**

Surface level +1.1 m (+4 ft)
Water struck at -2.3 m
January 1979

Overburden 3.9 m
Mineral 12.7 m
Bedrock 1.0 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.4 | 0.4 |
| Marine or Estuarine Alluvium | Clayey silt, yellowish brown becoming bluish grey below 3.1 m, with some wood fragments; thin ? till raft at base | 3.5 | 3.9 |
| River Gravels | **a** Sandy gravel<br>Gravel: fine with coarse, angular black, grey and brown flint with subangular limestone<br>Sand: medium, subrounded, with some flint, quartzite and lithic grains | 8.5 | 12.4 |
| | **b** Gravel;<br>Gravel: fine and coarse, subangular to subrounded brown and dark grey quartzite with sandstone, vein quartz and some flint<br>Sand: medium, quartz with some flint and lithic grains | 4.2 | 16.6 |
| Ancholme Clay Group | Silty clay, dark greenish grey, firm to stiff | 1.0+ | 17.6 |

**GRADING**

| | Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | +1 -4 | +4 -16 | +16 -64 | +64 mm |
| **a** | 3 | 67 | 30 | 3.9-5.4 | 4 | 30 | 48 | 7 | 10 | 1 | 0 |
| | | | | 5.4-6.4 | 1 | 32 | 41 | 8 | 12 | 6 | 0 |
| | | | | 6.4-7.4 | 6 | 27 | 36 | 10 | 16 | 5 | 0 |
| | | | | 7.4-8.4 | 4 | 17 | 30 | 16 | 28 | 5 | 0 |
| | | | | 8.4-9.4 | 2 | 17 | 55 | 6 | 15 | 5 | 0 |
| | | | | 9.4-10.4 | 2 | 5 | 44 | 10 | 32 | 7 | 0 |
| | | | | 10.4-11.4 | 3 | 3 | 43 | 14 | 31 | 6 | 0 |
| | | | | 11.4-12.4 | 1 | 4 | 15 | 11 | 34 | 35 | 0 |
| | | | | **Mean** | **3** | **18** | **39** | **10** | **22** | **8** | **0** |
| **b** | 2 | 46 | 52 | 12.4-13.4 | 2 | 4 | 34 | 16 | 23 | 17 | 4 |
| | | | | 13.4-14.4 | 0 | 4 | 30 | 14 | 38 | 14 | 0 |
| | | | | 14.4-15.4 | 1 | 8 | 13 | 9 | 45 | 24 | 0 |
| | | | | 15.4-16.6 | 3 | 14 | 31 | 6 | 24 | 22 | 0 |
| | | | | **Mean** | **2** | **8** | **27** | **11** | **32** | **19** | **1** |
| **a+b** | 3 | 60 | 37 | 3.9-16.6 | 3 | 14 | 35 | 11 | 25 | 12 | 0 |

**TF 15 NE 12** **1788 5917** **Thorpe Tilney Dales** **Block $B_1$**

Surface level +0.7 m (+2 ft)
Water struck at -1.6 m
January 1979

Overburden 2.3 m
Mineral 4.6 m
Waste 3.6 m
Mineral 5.2 m
Bedrock 1.0 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.4 | 0.4 |
| Marine or Estuarine Alluvium | Clayey silt, dark grey with yellowish brown mottling, soft; sandy towards base | 1.3 | 1.7 |
| | Peat, very dark brown, friable | 0.6 | 2.3 |
| River Gravels | **a** 'Very clayey' sandy gravel<br>Gravel: fine angular grey and black flint with pale limestone<br>Sand: fine, and medium, subrounded, quartz with some limestone and flint | 1.0 | 3.3 |
| | **b** Sandy gravel<br>Gravel: fine and coarse, angular grey and brown flint with limestone and some sandstone<br>Sand: medium and fine, subrounded, quartz with some quartzite, limestone and flint | 3.6 | 6.9 |
| | Sandy silt, very dark brown, peaty; becoming dark grey with depth | 3.6 | 10.5 |
| | **c** Gravel<br>Gravel: fine, subrounded grey, brown and red quartzite with vein quartz and some limestone and flint<br>Sand: medium and coarse, subrounded, quartz with some flint and lithic grains | 5.2 | 15.7 |
| Ancholme Clay Group | Silty clay, dark greenish grey, stiff, friable, with some bivalve fragments | 1.0+ | 16.7 |

**GRADING**

| | Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | +1 -4 | +4 -16 | +16 -64 | +64 mm |
| **a** | 22 | 54 | 24 | 2.3-3.3 | 22 | 27 | 20 | 7 | 17 | 7 | 0 |
| **b** | 3 | 72 | 25 | 3.3-4.3 | 5 | 30 | 44 | 6 | 8 | 7 | 0 |
| | | | | 4.3-5.3 | 1 | 37 | 34 | 8 | 15 | 5 | 0 |
| | | | | 5.3-6.9 | 2 | 21 | 30 | 13 | 23 | 11 | 0 |
| | | | | **Mean** | **3** | **28** | **35** | **9** | **17** | **8** | **0** |
| **c** | 1 | 45 | 54 | 10.5-11.5 | 2 | 7 | 46 | 11 | 28 | 6 | 0 |
| | | | | 11.5-12.5 | 0 | 3 | 35 | 8 | 38 | 16 | 0 |
| | | | | 12.5-13.5 | 0 | 1 | 25 | 21 | 38 | 15 | 0 |
| | | | | 13.5-14.5 | 0 | 1 | 10 | 25 | 49 | 15 | 0 |
| | | | | 14.5-15.7 | 1 | 1 | 5 | 25 | 54 | 14 | 0 |
| | | | | **Mean** | **1** | **3** | **24** | **18** | **41** | **13** | **0** |
| **a+b+c** | **4** | **55** | **41** | **Mean** | **4** | **14** | **27** | **14** | **30** | **11** | **0** |

**TF 15 NE 13** **1926 5999** **Kirkstead** **Block C**

Surface level +5.7 m (+19 ft)
Water struck at +1.8 m
April 1979

Overburden 0.7 m
Mineral 3.2 m
Waste 4.9 m
Bedrock 1.1 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.7 | 0.7 |
| Fluvio-glacial and Older River Sand and Gravel | Sandy gravel<br>Gravel: fine with coarse, brown, white and black flint with quartzite, vein quartz and sandstone<br>Sand: medium with fine, subrounded, quartz with some quartzite and trace dark minerals | 3.2 | 3.9 |
| Till | Clay, dark grey, stiff, with chalk granules and trace sandstone pebbles | 4.9 | 8.8 |
| Ancholme Clay Group | Silty clay, very dark grey, hard, with some thin-shelled bivalve fragments | 1.1+ | 9.9 |

**GRADING**

| Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | +1 -4 | +4 -16 | +16 -64 | +64 mm |
| 9 | 59 | 32 | 0.7-1.7 | 17 | 26 | 40 | 5 | 9 | 3 | 0 |
| | | | 1.7-2.7 | 9 | 21 | 47 | 4 | 12 | 7 | 0 |
| | | | 2.7-3.9 | 3 | 7 | 21 | 10 | 37 | 22 | 0 |
| | | | **Mean** | **9** | **18** | **35** | **6** | **20** | **12** | **0** |

**COMPOSITION**

| Depth below surface (m) | percentages by weight in gravel fraction | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Flint | Quartzite | Limestone | Quartz | Sandstone | Ironstone | Igneous | Others |
| | Percentage by weight in 8-16mm fraction | | | | | | | |
| 0.7-3.9 | 57 | 23 | - | 11 | 9 | - | - | - |
| | Percentage by weight in 4-8mm fraction | | | | | | | |
| 0.7-3.9 | 54 | 26 | - | 12 | 8 | - | - | - |
| **Mean** | **56** | **25** | - | **11** | **8** | - | - | - |

**TF 15 NE 15** **1520 5802** **Thorpe Tilney** **Block $B_2$**

Surface level +1.8 m (+6 ft)
Water struck at -2.1 m
November 1978

Overburden 4.6 m
Mineral 7.9 m
Bedrock 1.5 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.6 | 0.6 |
| Marine or Estuarine Alluvium | Silt, reddish yellow becoming grey below 4.5 m; very soft and sandy | 4.0 | 4.6 |
| | **a** 'Clayey' sand: fine, subrounded, quartz with some lithic grains and white quartzite | 4.3 | 8.9 |
| River Gravels | **b** Sandy gravel<br>Gravel: fine and coarse, subrounded quartzite with vein quartz and flint with some limestone, sandstone and ironstone<br>Sand: medium, subrounded quartz | 3.6 | 12.5 |
| Ancholme Clay Group | Silty clay, dark greenish grey, hard | 1.5+ | 14.0 |

**GRADING**

| | Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | +1 -4 | +4 -16 | +16 -64 | +64 mm |
| **a** | 13 | 87 | 0 | 4.6-5.6 | 10 | 80 | 10 | 0 | 0 | 0 | 0 |
| | | | | 5.6-6.6 | 14 | 79 | 7 | 0 | 0 | 0 | 0 |
| | | | | 6.6-8.9 | 14 | 76 | 9 | 1 | 0 | 0 | 0 |
| | | | | **Mean** | **13** | **77** | **9** | **1** | **0** | **0** | **0** |
| **b** | 2 | 56 | 42 | 8.9-9.9 | 3 | 18 | 34 | 7 | 27 | 11 | 0 |
| | | | | 9.9-10.9 | 1 | 5 | 45 | 9 | 25 | 15 | 0 |
| | | | | 10.9-12.5 | 1 | 6 | 36 | 11 | 26 | 20 | 0 |
| | | | | **Mean** | **2** | **9** | **38** | **9** | **26** | **16** | **0** |
| **a+b** | 8 | 73 | 19 | 4.6-12.5 | 8 | 46 | 22 | 5 | 12 | 7 | 0 |

**COMPOSITION**

| Depth below surface (m) | percentages by weight in gravel fraction | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Flint | Quartzite | Limestone | Quartz | Sandstone | Ironstone | Igneous | Others |
| | Percentage by weight in 8-16mm fraction | | | | | | | |
| 8.9-12.5 | 16 | 62 | trace | 19 | 3 | - | - | - |
| | Percentage by weight in 4 - 8 mm fraction | | | | | | | |
| 8.9-12.5 | 16 | 57 | 4 | 19 | 2 | 2 | - | trace |
| **Mean** | **16** | **60** | **2** | **19** | **2** | **1** | - | - |

**TF 15 NE 16** **1587 5861** **Thorpe Tilney Fen** **Block $B_1$**

Surface level +1.4 m (+5 ft)
Water struck at -4.6 m
January 1979

Overburden 5.6 m
Mineral 8.0 m
Bedrock 1.0 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Made ground | 1.2 | 1.2 |
| Marine or Estuarine Alluvium | Clayey silt, grey, soft and micaceous | 3.4 | 4.6 |
| | Peat, dark brown, soft, sandy in part with some wood fragments | 0.7 | 5.3 |
| | Sandy silt, grey, very soft, clayey | 0.3 | 5.6 |
| | **a** 'Clayey' sand: fine with medium, subrounded, quartz with some lithic grains, jasper and quartzite | 1.1 | 6.7 |
| River Gravels | **b** Sandy gravel<br>Gravel: fine, subangular, limestone and subrounded quartzite with flint and vein quartz and some sandstone<br>Sand: medium and fine, subrounded, quartz with limestone, flint and quartzite | 2.0 | 8.7 |
| | **c** Sandy gravel<br>Gravel: fine with coarse, subrounded to subangular, quartzite with quartz, flint, limestone and some sandstone and ironstone<br>Sand: medium, quartz with quartzite and dark minerals | 4.9 | 13.6 |
| Ancholme Clay Group | Silty clay, dark greenish grey, stiff | 1.0+ | 14.6 |

**GRADING**

| | Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | $+1-4$ | $+4-16$ | $+16-64$ | $+64$ mm |
| **a** | 16 | 84 | 0 | 5.6-6.7 | 16 | 60 | 23 | 1 | 0 | 0 | 0 |
| **b** | 4 | 71 | 25 | 6.7-7.7 | 4 | 24 | 36 | 11 | 24 | 1 | 0 |
| | | | | 7.7-8.7 | 4 | 20 | 40 | 10 | 20 | 6 | 0 |
| | | | | **Mean** | **4** | **22** | **38** | **11** | **22** | **3** | **0** |
| **c** | 1 | 55 | 44 | 8.7-9.7 | 1 | 9 | 37 | 8 | 30 | 15 | 0 |
| | | | | 9.7-10.7 | 0 | 5 | 51 | 11 | 25 | 8 | 0 |
| | | | | 10.7-11.7 | 0 | 6 | 43 | 11 | 26 | 14 | 0 |
| | | | | 11.7-12.7 | 2 | 6 | 32 | 9 | 35 | 16 | 0 |
| | | | | 12.7-13.6 | 1 | 5 | 35 | 9 | 27 | 23 | 0 |
| | | | | **Mean** | **1** | **6** | **39** | **10** | **29** | **15** | **0** |
| **a+b+c** | 4 | 63 | 33 | 5.6-13.6 | 4 | 18 | 37 | 8 | 23 | 10 | 0 |

**COMPOSITION**

| Depth below surface (m) | Flint | Quartzite | Limestone | Quartz | Sandstone | Ironstone | Igneous | Others |
|---|---|---|---|---|---|---|---|---|
| | percentages by weight in gravel fraction | | | | | | | |
| | Percentage by weight in 8-16mm fraction | | | | | | | |
| 5.6-8.7 | 32 | 28 | 14 | 21 | 5 | - | - | - |
| | Percentage by weight in 4-8mm fraction | | | | | | | |
| 5.6-8.7 | 16 | 29 | 41 | 13 | trace | 1 | - | trace |
| | Percentage by weight in 8-16mm fraction | | | | | | | |
| 8.7-13.6 | 14 | 53 | 5 | 24 | 3 | - | - | 1 |
| | Percentage by weight in 4-8mm fraction | | | | | | | |
| 8.7-13.6 | 16 | 45 | 11 | 20 | 4 | 4 | - | trace |
| **Mean** | **16** | **46** | **11** | **21** | **4** | **2** | - | - |

**TF 15 NE 17** **1734 5782** **Walcot Hurn** **Block $B_2$**

Surface level +1.5 m (+5 ft)
Water level not recorded
April 1979

Overburden 2.6 m
Mineral 9.2 m
Bedrock 1.0 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.6 | 0.6 |
| Marine or Estuarine Alluvium | Silty clay, dark brown, becoming grey with depth; soft and glutinous | 1.7 | 2.3 |
| | Peat, very dark brown; sandy towards base | 0.3 | 2.6 |
| River Gravels | **a** Sandy gravel<br>Gravel: fine, subangular limestone with coarse, angular grey and black flint, and some sandstone and vein quartz<br>Sand: medium, subangular to subrounded, quartz with some flint and quartzite | 8.1 | 10.7 |
| | **b** Sandy gravel<br>Gravel: fine and coarse, subrounded, grey, greyish brown and brown quartzite, with flint and vein quartz<br>Sand: medium, quartz with some flint, lithic grains and jasper | 1.1 | 11.8 |
| Ancholme Clay Group | Silty clay, very dark grey, hard, with thin-shelled bivalves | 1.0+ | 12.8 |

**GRADING**

| | Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | +1 -4 | +4 -16 | +16 -64 | +64 mm |
| **a** | 3 | 79 | 18 | 2.6-4.0 | 4 | 29 | 42 | 8 | 13 | 4 | 0 |
| | | | | 4.0-5.0 | 2 | 11 | 36 | 13 | 28 | 10 | 0 |
| | | | | 5.0-6.0 | 0 | 16 | 39 | 11 | 18 | 16 | 0 |
| | | | | 6.0-7.0 | 4 | 22 | 45 | 7 | 15 | 7 | 0 |
| | | | | 7.0-8.5 | 4 | 12 | 63 | 11 | 8 | 2 | 0 |
| | | | | 8.5-9.5 | 3 | 10 | 75 | 9 | 3 | 0 | 0 |
| | | | | 9.5-10.7 | 1 | 9 | 68 | 10 | 7 | 5 | 0 |
| | | | | **Mean** | **3** | **16** | **53** | **10** | **12** | **6** | **0** |
| **b** | 4 | 61 | 35 | 10.7-11.8 | 4 | 7 | 40 | 14 | 20 | 15 | 0 |
| **a+b** | 3 | 76 | 21 | 2.6-11.8 | 3 | 15 | 51 | 10 | 14 | 7 | 0 |

**TF 15 NE 18** **1963 5836** **Tattershall** **Block C**

Surface level +3.2 m (+11 ft)
Water struck at +1.0 m
January 1979

Overburden 0.9 m
Mineral 2.2 m
Waste 0.8 m
Mineral 9.3 m
Bedrock 1.0 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.9 | 0.9 |
| River Gravels | **a** Sandy gravel<br>Gravel: fine and coarse, angular, brown flint with some limestone and sandstone<br>Sand: medium, quartz with limestone, flint and lithic grains | 2.2 | 3.1 |
| | Sandy silt, olive grey, soft, laminated | 0.8 | 3.9 |
| | **b** 'Very clayey' sand, with flint gravel to 4.9 m: fine with medium, quartz with some flint and quartzite | 4.2 | 8.1 |
| | **c** Sandy gravel<br>Gravel: fine with coarse, angular to subangular, black flint and dark grey and purple quartzite<br>Sand: medium, subrounded, quartz with coarse flint and some lithic grains | 5.1 | 13.2 |
| Ancholme Clay Group | Silty clay, dark greenish grey, hard, with fragments bivalve | 1.0+ | 14.2 |

**GRADING**

| | Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | $+1-4$ | $+4-16$ | $+16-64$ | $+64$ mm |
| **a** | 2 | 67 | 31 | 0.9-1.9 | 3 | 6 | 51 | 14 | 16 | 10 | 0 |
| | | | | 1.9-3.1 | 1 | 18 | 36 | 10 | 21 | 14 | 0 |
| | | | | **Mean** | **2** | **13** | **42** | **12** | **19** | **12** | **0** |
| **b** | 24 | 74 | 2 | 3.9-4.9 | 11 | 59 | 20 | 4 | 5 | 1 | 0 |
| | | | | 4.9-5.9 | 29 | 53 | 16 | 1 | 1 | 0 | 0 |
| | | | | 5.9-6.9 | 28 | 50 | 20 | 0 | 1 | 1 | 0 |
| | | | | 6.9-8.1 | 30 | 46 | 21 | 1 | 2 | 0 | 0 |
| | | | | **Mean** | **24** | **53** | **19** | **2** | **2** | **0** | **0** |
| **c** | 4 | 54 | 42 | 8.1-9.1 | 5 | 13 | 24 | 7 | 28 | 21 | 2 |
| | | | | 9.1-10.1 | 6 | 13 | 42 | 6 | 21 | 12 | 0 |
| | | | | 10.1-11.1 | 4 | 11 | 38 | 10 | 26 | 11 | 0 |
| | | | | 11.1-12.1 | 1 | 2 | 32 | 22 | 31 | 12 | 0 |
| | | | | 12.1-13.2 | 1 | 3 | 33 | 15 | 34 | 14 | 0 |
| | | | | **Mean** | **4** | **8** | **34** | **12** | **28** | **14** | **0** |
| **a+b+c** | **11** | **63** | **26** | **Mean** | **11** | **25** | **30** | **8** | **17** | **9** | **0** |

**TF 15 NE 19** **1614 5794** **Walcot** **Block $B_2$**

Surface level +1.6 m (+5 ft)
Water struck at -4.3 m
November 1978

Overburden 6.1 m
Mineral 10.0 m
Bedrock 0.9 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.8 | 0.8 |
| Marine or Estuarine Alluvium | Sandy silt, brownish yellow mottled with grey; soft and friable | 5.3 | 6.1 |
| River Gravels | **a** Sand, with some limestone and flint gravel in upper part; medium and fine, subrounded quartz with some angular flint and lithic grains | 1.9 | 8.0 |
| | **b** Sandy gravel<br>Gravel: fine and coarse, subrounded dark grey and greenish grey quartzite, some angular brown flint and dark, fine-grained igneous rock<br>Sand: medium, subrounded, quartz with some quartzite and jasper | 8.1 | 16.1 |
| Ancholme Clay Group | Silty clay, dark greenish grey, hard, with some bivalve fragments | 0.9+ | 17.0 |

**GRADING**

| | Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | +1 -4 | +4 -16 | +16 -64 | +64 mm |
| **a** | 6 | 90 | 4 | 6.1-7.0 | 9 | 39 | 37 | 8 | 7 | 0 | 0 |
| | | | | 7.0-8.0 | 3 | 33 | 57 | 5 | 2 | 0 | 0 |
| | | | | **Mean** | **6** | **36** | **48** | **6** | **4** | **0** | **0** |
| b | 3 | 53 | 44 | 8.0-9.0 | 7 | 32 | 47 | 6 | 7 | 1 | 0 |
| | | | | 9.0-9.4 | 6 | 24 | 66 | 2 | 2 | 0 | 0 |
| | | | | 9.4-10.4 | 1 | 8 | 45 | 10 | 26 | 10 | 0 |
| | | | | 10.4-11.4 | 0 | 9 | 58 | 8 | 17 | 8 | 0 |
| | | | | 11.4-12.4 | 1 | 5 | 23 | 7 | 18 | 46 | 0 |
| | | | | 12.4-13.4 | 6 | 4 | 21 | 10 | 30 | 29 | 0 |
| | | | | 13.4-14.4 | 1 | 4 | 22 | 12 | 41 | 20 | 0 |
| | | | | 14.4-16.1 | 3 | 3 | 18 | 15 | 44 | 17 | 0 |
| | | | | **Mean** | **3** | **9** | **34** | **10** | **26** | **18** | **0** |
| **a+b** | 4 | 60 | 36 | 6.1-16.1 | 4 | 15 | 36 | 9 | 22 | 14 | 0 |

**TF 15 NE 20** **1861 5767** **Walcot Dales** **Block $B_2$**

Surface level +1.8 m (+6 ft)
Water struck at +0.1 m
January 1979

Overburden 0.6 m
Mineral 7.9 m
Waste 3.4 m
Mineral 3.6 m
Bedrock 1.0 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.4 | 0.4 |
| Marine or Estuarine Alluvium | Silty clay, brownish yellow variegated with greyish brown, soft | 0.2 | 0.6 |
| River Gravels | **a** Sandy gravel<br>Gravel: fine and coarse, angular to subangular black and brown flint and subangular limestone with some quartzite and sandstone<br>Sand: medium, subrounded, quartz with some flint and limestone | 5.9 | 6.5 |
| | **b** Sandy gravel<br>Gravel: fine and coarse with some cobbles, mainly subangular to subrounded dark grey quartzite with vein quartz and flint<br>Sand: medium, quartz with some lithic grains and quartzite | 2.0 | 8.5 |
| | Silty clay, dark greenish grey with patches of peat | 3.4 | 11.9 |
| | **c** Sandy gravel<br>Gravel: fine with coarse, subrounded, mainly grey and brown quartzite with some purple varieties, with flint and vein quartz and some limestone and sandstone<br>Sand: medium, quartz with some flint and jasper | 3.6 | 15.5 |
| Ancholme Clay Group | Silty clay, dark greenish grey, firm | 1.0+ | 16.5 |

**GRADING**

| | Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | +1 -4 | +4 -16 | +16 -64 | +64 mm |
| **a** | 2 | 68 | 30 | 0.6-1.6 | 5 | 23 | 50 | 5 | 8 | 9 | 0 |
| | | | | 1.6-2.6 | 3 | 16 | 39 | 9 | 26 | 7 | 0 |
| | | | | 2.6-3.6 | 1 | 9 | 31 | 15 | 28 | 16 | 0 |
| | | | | 3.6-4.6 | 0 | 18 | 57 | 7 | 14 | 4 | 0 |
| | | | | 4.6-5.6 | 0 | 13 | 36 | 10 | 24 | 17 | 0 |
| | | | | 5.6-6.5 | 0 | 15 | 41 | 9 | 18 | 17 | 0 |
| | | | | **Mean** | **2** | **16** | **42** | **10** | **19** | **11** | **0** |
| **b** | 4 | 59 | 37 | 6.5-7.5 | 4 | 11 | 39 | 6 | 29 | 11 | 0 |
| | | | | 7.5-8.5 | 4 | 9 | 46 | 6 | 18 | 13 | 4 |
| | | | | **Mean** | **4** | **10** | **43** | **6** | **23** | **12** | **2** |
| **c** | 1 | 54 | 45 | 11.9-12.9 | 1 | 6 | 42 | 10 | 30 | 11 | 0 |
| | | | | 12.9-13.9 | 1 | 6 | 31 | 7 | 36 | 19 | 0 |
| | | | | 13.9-15.5 | 1 | 14 | 27 | 17 | 34 | 7 | 0 |
| | | | | **Mean** | **1** | **10** | **32** | **12** | **33** | **12** | **0** |
| **a+b+c** | **2** | **62** | **36** | **Mean** | **2** | **13** | **39** | **10** | **24** | **12** | **0** |

**COMPOSITION**

| Depth below surface (m) | Flint | Quartzite | Limestone | Quartz | Sandstone | Ironstone | Igneous | Others |
|---|---|---|---|---|---|---|---|---|
| | Percentage by weight in 8-16mm fraction | | | | | | | |
| 0.6-6.5 | 65 | 6 | 28 | trace | 1 | - | - | - |
| | Percentage by weight in 4-8mm fraction | | | | | | | |
| 0.6-6.5 | 31 | 3 | 59 | 4 | 1 | 1 | - | 1 |
| | Percentage by weight in 8-16mm fraction | | | | | | | |
| 6.5-15.5 | 16 | 60 | 3 | 17 | 3 | trace | 1 | - |
| | Percentage by weight in 4-8mm fraction | | | | | | | |
| 6.5-15.5 | 17 | 51 | 6 | 22 | 1 | 2 | - | 1 |
| **Mean** | **27** | **39** | **17** | **14** | **2** | **1** | - | - |

**TF 15 NE 21** **1970 5750** **Tattershall** **Block C**

Surface level +2.7 m (+9 ft)
Water struck at +0.9 m
January 1979

Overburden 0.6 m
Mineral 7.3 m
Bedrock 2.6 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.6 | 0.6 |
| River Gravels | Sandy gravel<br>Gravel: fine, angular, grey, brown and white flint with limestone and some quartzite<br>Sand: medium, subrounded quartz with coarse flint and limestone | 7.3 | 7.9 |
| Ancholme Clay Group | Silty clay, dark greenish grey, stiff, friable, with bivalves and ammonites | 2.6+ | 10.5 |

**GRADING**

| Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | +1 -4 | +4 -16 | +16 -64 | +64 mm |
| 1 | 72 | 27 | 0.6-1.6 | 1 | 25 | 35 | 10 | 17 | 12 | 0 |
| | | | 1.6-2.6 | 2 | 14 | 49 | 13 | 16 | 6 | 0 |
| | | | 2.6-3.6 | 1 | 7 | 36 | 13 | 26 | 17 | 0 |
| | | | 3.6-4.6 | 1 | 6 | 46 | 16 | 20 | 11 | 0 |
| | | | 4.6-5.6 | 1 | 13 | 61 | 8 | 12 | 5 | 0 |
| | | | 5.6-6.6 | 1 | 5 | 56 | 16 | 19 | 3 | 0 |
| | | | 6.6-7.9 | 3 | 4 | 56 | 13 | 15 | 9 | 0 |
| | | | **Mean** | **1** | **10** | **49** | **13** | **18** | **9** | **0** |

**TF 15 NE 22** **1559 5698** **Walcot** **Block $B_2$**

Surface level +1.9 m (+6 ft)
Water level not recorded
November 1978

Overburden 9.0 m
Mineral 4.6 m
Bedrock 1.4 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | | 0.4 |
| Marine or Estuarine Alluvium | Silty clay, grey, firm, micaceous, very soft and increasingly silty with depth | 8.6 | 9.0 |
| River Gravels | Gravel<br>Gravel: fine and coarse, trace cobbles, mainly subangular to subrounded, brown, grey and purple quartzite with some red sandstone, limestone and flint<br>Sand: medium, quartz with some limestone and lithic grains | | 4.6 |
| Ancholme Clay Group | Silty clay, dark greenish grey, hard | 1.4+ | 15.0 |

**GRADING**

| Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | +1 -4 | +4 -16 | +16 -64 | +64 mm |
| 1 | 36 | 63 | 9.0-10.0 | 1 | 5 | 26 | 15 | 33 | 20 | 0 |
| | | | 10.0-11.0 | 0 | 4 | 22 | 8 | 40 | 26 | 0 |
| | | | 11.0-12.0 | 1 | 3 | 20 | 10 | 40 | 24 | 2 |
| | | | 12.0-13.6 | 1 | 2 | 23 | 8 | 41 | 25 | 0 |
| | | | **Mean** | **1** | **3** | **23** | **10** | **39** | **24** | trace |

**TF 15 NE 23** **1618 5633** **Billinghay** **Block $B_2$**

Surface level +1.9 m (+6 ft)
Water struck at -0.3 m and -5.3 m
November 1978

Overburden 1.9 m
Mineral 4.2 m
Waste 1.0 m
Mineral 7.0 m
Bedrock 0.9 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.8 | 0.8 |
| Marine or Estuarine Alluvium | Silty clay, dark brown mottled with grey, firm | 1.1 | 1.9 |
| | **a** Sand, with some flint gravel at base: medium, subrounded, quartz with some lithic grains and trace jasper | 4.2 | 6.1 |
| | Pebbly clay, brown, soft to firm with flint and some chalk pebbles | 1.0 | 7.1 |

| | | | |
|---|---|---|---|
| River Gravels | **b** Pebbly sand, sand to 8.3 m<br>Gravel: fine, angular black and white flint with subangular limestone and some quartzite<br>Sand: medium, subrounded, quartz with lithic grains and some quartzite and flint | 2.2 | 9.3 |
| | **c** Gravel<br>Gravel: fine and coarse, subangular to subrounded dark grey, brown and purple quartzite with vein quartz and some sandstone and flint<br>Sand: medium with coarse, quartz with some lithic grains and trace jasper | 4.8 | 14.1 |
| Ancholme Clay Group | Silty clay, dark greenish grey | 0.9+ | 15.0 |

**GRADING**

| | Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | +1 -4 | +4 -16 | +16 -64 | +64 mm |
| **a** | 3 | 93 | 4 | 1.9-2.9 | 5 | 30 | 63 | 2 | 0 | 0 | 0 |
| | | | | 2.9-3.9 | 3 | 40 | 56 | 1 | 0 | 0 | 0 |
| | | | | 3.9-4.9 | 2 | 33 | 63 | 1 | 1 | 0 | 0 |
| | | | | 4.9-6.1 | 1 | 15 | 49 | 21 | 14 | 0 | 0 |
| | | | | **Mean** | **3** | **29** | **57** | **7** | **4** | **0** | **0** |
| **b** | 2 | 83 | 15 | 7.1-8.3 | 3 | 26 | 68 | 2 | 1 | 0 | 0 |
| | | | | 8.3-9.3 | 1 | 7 | 43 | 18 | 28 | 3 | 0 |
| | | | | **Mean** | **2** | **17** | **57** | **9** | **14** | **1** | **0** |
| **c** | 1 | 48 | 51 | 9.3-10.3 | 0 | 9 | 9 | 13 | 52 | 17 | 0 |
| | | | | 10.3-11.3 | 2 | 8 | 41 | 6 | 20 | 23 | 0 |
| | | | | 11.3-12.3 | 0 | 5 | 22 | 10 | 31 | 32 | 0 |
| | | | | 12.3-14.1 | 2 | 7 | 41 | 11 | 24 | 15 | 0 |
| | | | | **Mean** | **1** | **7** | **31** | **10** | **30** | **21** | **0** |
| **a+b+c** | **2** | **72** | **26** | **Mean** | **2** | **17** | **46** | **9** | **17** | **9** | **0** |

**TF 15 NE 24** **1718 5676** **Billinghay** **Block $B_2$**

Surface level +1.9 m (+6 ft)
Water struck at -2.7 m
January 1979

Overburden 4.4 m
Mineral 5.2 m
Waste 0.2 m
Mineral 6.8 m
Bedrock 1.0 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.7 | 0.7 |
| Marine or Estuarine Alluvium | Silty clay, strong brown becoming grey with depth, micaceous, with some plant remains | 3.2 | 3.9 |
| | Peat, very dark brown with large wood fragments | 0.5 | 4.4 |

| | | | |
|---|---|---|---|
| River Gravels | **a** Pebbly sand<br>Gravel: fine, subangular to subrounded limestone with grey and brown flint<br>Sand: medium and fine, subrounded, quartz with some limestone and lithic grains | 5.2 | 9.6 |
| | Sandy silt, very dark greyish brown, soft, with some carbonaceous patches | 0.2 | 9.8 |
| | **b** Sand medium and fine, subangular to subrounded quartz with some subangular lithic grains | 6.8 | 16.6 |
| Ancholme Clay Group | Silty clay, dark greenish grey, hard | 1.0+ | 17.6 |

**GRADING**

| | Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | +1 -4 | +4 -16 | +16 -64 | +64 mm |
| **a** | 6 | 71 | 23 | 4.4-5.4 | 28 | 26 | 23 | 6 | 14 | 3 | 0 |
| | | | | 5.4-6.4 | 1 | 19 | 28 | 12 | 33 | 7 | 0 |
| | | | | 6.4-7.4 | 1 | 19 | 47 | 11 | 19 | 3 | 0 |
| | | | | 7.4-8.4 | 1 | 13 | 47 | 13 | 22 | 4 | 0 |
| | | | | 8.4-9.6 | 2 | 27 | 43 | 17 | 9 | 2 | 0 |
| | | | | **Mean** | **6** | **21** | **38** | **12** | **19** | **4** | **0** |
| **b** | 8 | 92 | 0 | 9.8-10.8 | 6 | 56 | 36 | 1 | 1 | 0 | 0 |
| | | | | 10.8-11.8 | 3 | 56 | 41 | 0 | 0 | 0 | 0 |
| | | | | 11.8-12.8 | 4 | 30 | 66 | 0 | 0 | 0 | 0 |
| | | | | 12.8-13.8 | 3 | 40 | 57 | 0 | 0 | 0 | 0 |
| | | | | 13.8-14.8 | 4 | 36 | 59 | 0 | 1 | 0 | 0 |
| | | | | 14.8-15.8 | 5 | 41 | 53 | 1 | 0 | 0 | 0 |
| | | | | 15.8-16.6 | 37 | 28 | 34 | 1 | 0 | 0 | 0 |
| | | | | **Mean** | **8** | **42** | **50** | **0** | **0** | **0** | **0** |
| **a+b** | **7** | **83** | **10** | **Mean** | **7** | **33** | **45** | **5** | **8** | **2** | **0** |

**TF 15 NE 25** **1843 5644** **Tattershall Bridge** **Block $B_2$**

Surface level +1.9 m (+6 ft)
Water struck at 0.0 m
January 1979

Overburden 1.9 m
Mineral 14.4 m
Bedrock 1.0 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.9 | 0.9 |
| Marine or Estuarine Alluvium | Silt, dark brown, soft and clayey in part | 1.0 | 1.9 |
| River Gravels | **a** Sandy gravel<br>Gravel: fine, black and grey angular flint with limestone and some quartzite<br>Sand: medium, subrounded, quartz with some lithic and coarse limestone grains | 8.0 | 9.9 |
| | **b** Gravel<br>Gravel: fine and coarse, grey, brown and purple subrounded quartzite with sandstone and vein quartz<br>Sand: medium, subrounded, quartz with quartzite | 6.4 | 16.3 |
| Ancholme Clay Group | Silty clay, dark greenish grey, hard | 1.0+ | 17.3 |

**GRADING**

| | Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | +1 -4 | +4 -16 | +16 -64 | +64 mm |
| a | 3 | 72 | 25 | 1.9-2.9 | 12 | 11 | 26 | 10 | 23 | 18 | 0 |
| | | | | 2.9-3.9 | 2 | 25 | 34 | 12 | 21 | 6 | 0 |
| | | | | 3.9-4.9 | 3 | 17 | 42 | 16 | 15 | 7 | 0 |
| | | | | 4.9-5.9 | 0 | 24 | 55 | 8 | 11 | 2 | 0 |
| | | | | 5.9-6.9 | 2 | 10 | 42 | 12 | 21 | 13 | 0 |
| | | | | 6.9-7.9 | 1 | 18 | 63 | 7 | 8 | 3 | 0 |
| | | | | 7.9-8.9 | 5 | 17 | 52 | 8 | 12 | 6 | 0 |
| | | | | 8.9-9.9 | 1 | 8 | 55 | 8 | 16 | 12 | 0 |
| | | | | **Mean** | **3** | **16** | **46** | **10** | **16** | **9** | **0** |
| b | 2 | 49 | 49 | 9.9-10.9 | 1 | 5 | 33 | 9 | 28 | 21 | 3 |
| | | | | 10.9-11.9 | 5 | 3 | 63 | 10 | 16 | 3 | 0 |
| | | | | 11.9-12.9 | 0 | 3 | 34 | 11 | 29 | 23 | 0 |
| | | | | 12.9-13.9 | 1 | 4 | 29 | 13 | 29 | 21 | 3 |
| | | | | 13.9-14.9 | 0 | 2 | 21 | 14 | 31 | 32 | 0 |
| | | | | 14.9-16.3 | 3 | 3 | 27 | 14 | 42 | 11 | 0 |
| | | | | **Mean** | **2** | **3** | **34** | **12** | **30** | **18** | **1** |
| a+b | 3 | 62 | 35 | 1.9-16.3 | 3 | 10 | 41 | 11 | 22 | 13 | trace |

**TF 15 NE 26** **1963 5696** **Tattershall Bridge** **Block C**

Surface level +3.1 m (+10 ft)
Water struck at +1.0 m
January 1979

Overburden 0.5 m
Mineral 2.6 m
Waste 6.5 m
Bedrock 1.0 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.5 | 0.5 |
| River Gravels | Sandy gravel<br>Gravel: fine and coarse, angular grey, black and brown flint with subangular limestone and some sandstone, vein quartz and quartzite<br>Sand: medium, quartz with coarse flint and lithic grains | 2.6 | 3.1 |
| Till | Pebbly clay, dark grey, stiff, with subangular chalk and some mudstone and flint pebbles | 6.5 | 9.6 |
| Ancholme Clay Group | Silty clay, dark greenish grey, hard, with some bivalves and ammonites | 1.0+ | 10.6 |

**GRADING**

| | Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | +1 -4 | +4 -16 | +16 -64 | +64 mm |
| 1 | 59 | 40 | | 0.5-1.5 | 1 | 28 | 33 | 9 | 18 | 10 | 0 |
| | | | | 1.5-3.1 | 1 | 7 | 28 | 16 | 28 | 20 | 0 |
| | | | | **Mean** | **1** | **15** | **30** | **14** | **24** | **16** | **0** |

**COMPOSITION**

| Depth below surface (m) | percentages by weight in gravel fraction | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Flint | Quartzite | Limestone | Quartz | Sandstone | Ironstone | Igneous | Others |
| | Percentage by weight in 8-16mm fraction | | | | | | | |
| 0.5-3.1 | 84 | 5 | 7 | 1 | 3 | - | - | - |
| | Percentage by weight in 4-8mm fraction | | | | | | | |
| 0.5-3.1 | 50 | 8 | 34 | 4 | 4 | - | - | - |
| **Mean** | **67** | **7** | **21** | **2** | **3** | - | - | - |

**TF 15 NE 27 1535 5559** **Billinghay** **Block $B_2$**

Surface level +2.0 m +7 ft
Water not struck
December 1978

Waste 3.5 m
Bedrock 3.0 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 1.2 | 1.2 |
| Marine or Estuarine Alluvium | Sandy silt, reddish yellow, soft, with fine quartz grains and some mica flakes | 1.1 | 2.3 |
| | Peat, dark brown with large wood fragments | 0.5 | 2.8 |
| | Silt, dark grey, soft, micaceous | 0.7 | 3.5 |
| Ancholme Clay Group | Silty clay, grey mottled with light olive brown, becoming dark greenish grey with depth, stiff with some ?selenite crystals | 3.0+ | 6.5 |

**TF 15 NE 28 1633 5581** **Billinghay** **Block $B_2$**

Surface level +2.5 m (+8 ft)
Water struck at -0.4 m
December 1978

Overburden 8.5 m
Mineral 6.0 m
Bedrock 1.0 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.6 | 0.6 |
| Marine or Estuarine Alluvium | Sandy silt, yellowish brown becoming dark grey with depth; soft, micaceous | 5.7 | 6.3 |
| | Peat, very dark brown to black with clay nodules | 0.6 | 6.9 |
| | Pebbly clay, grey, firm with a sandy upper margin and some limestone pebbles | 1.6 | 8.5 |

| | | | | |
|---|---|---|---|---|
| River Gravels | **a** Sandy gravel<br>Gravel: fine, subangular, limestone and dark grey quartzite with brown and white flint and vein quartz<br>Sand: medium, subrounded, quartz with some quartzite, limestone and lithic grains | 3.0 | 11.5 |
| | **b** Gravel<br>Gravel: fine, subrounded, grey and brown quartzite with flint, vein quartz, limestone and sandstone<br>Sand: medium, quartz with some coarse flint and quartzite | 3.0 | 14.5 |
| Ancholme Clay Group | Silty clay, greenish grey, hard | 1.0+ | 15.5 |

**GRADING**

| | Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | +1 -4 | +4 -16 | +16 -64 | +64 mm |
| **a** | 1 | 70 | 29 | 8.5-9.5 | 1 | 6 | 51 | 14 | 24 | 4 | 0 |
| | | | | 9.5-10.5 | 2 | 6 | 47 | 16 | 24 | 5 | 0 |
| | | | | 10.5-11.5 | 1 | 5 | 51 | 14 | 23 | 6 | 0 |
| | | | | **Mean** | **1** | **6** | **50** | **14** | **24** | **5** | **0** |
| **b** | 1 | 49 | 50 | 11.5-12.5 | 1 | 6 | 23 | 12 | 42 | 16 | 0 |
| | | | | 12.5-13.5 | 3 | 14 | 34 | 11 | 26 | 12 | 0 |
| | | | | 13.5-14.5 | trace | 4 | 26 | 15 | 39 | 16 | 0 |
| | | | | **Mean** | **1** | **8** | **28** | **13** | **36** | **14** | **0** |
| **a+b** | 1 | 59 | 40 | 8.5-14.5 | 1 | 7 | 39 | 13 | 30 | 10 | 0 |

**COMPOSITION**

| Depth below surface (m) | percentages by weight in gravel fraction | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Flint | Quartzite | Limestone | Quartz | Sandstone | Ironstone | Igneous | Others |
| | Percentage by weight in 8-16mm fraction | | | | | | | |
| 8.5-11.5 | 14 | 41 | 26 | 16 | 1 | 1 | - | 1 |
| | Percentage by weight in 4-8mm fraction | | | | | | | |
| 8.5-11.5 | 14 | 22 | 49 | 12 | 1 | 2 | - | trace |
| | Percentage by weight in 8-16mm fraction | | | | | | | |
| 11.5-14.5 | 12 | 51 | 6 | 22 | 9 | trace | - | trace |
| | Percentage by weight in 4-8mm fraction | | | | | | | |
| 11.5-14.5 | 14 | 38 | 17 | 21 | 8 | 2 | - | trace |
| **Mean** | **13** | **40** | **21** | **19** | **6** | **1** | **-** | **-** |

**TF 15 NE 29** **1736 5521** **Billinghay** **Block $B_2$**

Surface level +2.2 m (+7 ft)
Water struck at -3.2 m
December 1978

Overburden 6.1 m
Mineral 8.5 m
Bedrock 1.0 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Made ground | 1.5 | 1.5 |
| Marine or Estuarine Alluvium | Silty clay, dark brown becoming grey with depth, soft; patches of peat and sand towards base | 4.6 | 6.1 |
| River Gravels | **a** Pebbly sand<br>Gravel: fine, subangular limestone and angular white and grey flint with some quartzite, vein quartz and sandstone<br>Sand: medium, subrounded, quartz with some lithic grains and jasper | 3.0 | 9.1 |
| | **b** Sandy gravel<br>Gravel: fine with coarse, subrounded to subangular quartzite with flint, limestone and vein quartz<br>Sand: medium, quartz with coarse flint, quartzite and limestone | 5.5 | 14.6 |
| Ancholme Clay Group | Silty clay, dark greenish grey, stiff with some bivalve fragments | 1.0+ | 15.6 |

**GRADING**

| | Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | +1 -4 | +4 -16 | +16 -64 | +64 mm |
| **a** | 3 | 80 | 17 | 6.1-7.1 | 4 | 22 | 60 | 6 | 6 | 2 | 0 |
| | | | | 7.1-8.1 | 3 | 15 | 49 | 8 | 20 | 5 | 0 |
| | | | | 8.1-9.1 | 2 | 11 | 61 | 8 | 17 | 1 | 0 |
| | | | | **Mean** | **3** | **16** | **57** | **7** | **14** | **3** | **0** |
| **b** | 2 | 53 | 45 | 9.1-10.1 | 1 | 3 | 36 | 15 | 32 | 13 | 0 |
| | | | | 10.1-11.1 | 1 | 4 | 19 | 16 | 49 | 11 | 0 |
| | | | | 11.1-12.1 | 3 | 11 | 48 | 8 | 19 | 11 | 0 |
| | | | | 12.1-13.1 | 1 | 2 | 42 | 12 | 29 | 14 | 0 |
| | | | | 13.1-14.6 | 2 | 2 | 42 | 8 | 23 | 23 | 0 |
| | | | | **Mean** | **2** | **4** | **38** | **11** | **30** | **15** | **0** |
| **a+b** | 2 | 63 | 35 | 6.1-14.6 | 2 | 8 | 45 | 10 | 24 | 11 | 0 |

**COMPOSITION**

| Depth below surface (m) | percentages by weight in gravel fraction | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Flint | Quartzite | Limestone | Quartz | Sandstone | Ironstone | Igneous | Others |
| | Percentage by weight in 8-16mm fraction | | | | | | | |
| 6.1-9.1 | 57 | 10 | 26 | 5 | 2 | - | trace | - |
| | Percentage by weight in 4-8mm fraction | | | | | | | |
| 6.1-9.1 | 25 | 12 | 57 | 4 | 1 | trace | 1 | trace |
| | Percentage by weight in 8-16mm fraction | | | | | | | |
| 9.1-14.6 | 21 | 42 | 11 | 22 | 2 | - | 1 | 1 |
| | Percentage by weight in 4-8mm fraction | | | | | | | |
| 9.1-14.6 | 14 | 40 | 21 | 21 | 2 | 1 | 1 | trace |
| **Mean** | **22** | **36** | **20** | **19** | **2** | **-** | **1** | **-** |

**TF 15 NE 30** **1996 5593** **Tattershall Bridge** **Block C**

Surface level +2.1 m (+7 ft)
Water struck at -0.6 m
January 1979

Overburden 0.9 m
Mineral 5.5 m
Waste 0.9 m
Bedrock 1.0 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.4 | 0.4 |
| Marine or Estuarine Alluvium | Clayey silt, grey mottled with brownish yellow, firm | 0.5 | 0.9 |
| River Gravels | Pebbly sand<br>Gravel: fine, angular, brown, grey and black flint with some greenish grey sandstone<br>Sand: medium, subrounded, quartz with some flint and lithic grains | 5.5 | 6.4 |
| Till | Pebbly clay, dark grey, firm to stiff, with chalk granules and some dark grey mudstone pebbles | 0.9 | 7.3 |
| Ancholme Clay Group | Silty clay, dark greenish grey, hard, with ammonites and bivalves | 1.0+ | 8.3 |

**GRADING**

| Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | +1 -4 | +4 -16 | +16 -64 | +64 mm |
| 4 | 81 | 15 | 0.9-1.9 | 2 | 15 | 41 | 9 | 26 | 7 | 0 |
| | | | 1.9-2.9 | 2 | 14 | 55 | 11 | 12 | 6 | 0 |
| | | | 2.9-3.9 | 2 | 16 | 59 | 9 | 9 | 5 | 0 |
| | | | 3.9-4.9 | 6 | 25 | 62 | 4 | 3 | 0 | 0 |
| | | | 4.9-6.4 | 5 | 19 | 62 | 5 | 5 | 4 | 0 |
| | | | **Mean** | **4** | **18** | **56** | **7** | **11** | **4** | **0** |

**TF 15 NE 31** **1832 5546** **Billinghay Dales** **Block $B_3$**

Surface level +1.9 m (+6 ft)
Water struck at -1.5 m
March 1979

Overburden 3.4 m
Mineral 12.2 m
Bedrock 1.1 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Made ground | 1.3 | 1.3 |
| Marine or Estuarine Alluvium | Silty clay, dark greyish brown, soft to firm | 2.0 | 3.3 |
| | Peat, very dark brown, with wood fragments | 0.1 | 3.4 |
| River Gravels | **a** Pebbly sand<br>Gravel: fine, subangular, limestone and angular grey, black and white flint with some quartzite, vein quartz and sandstone<br>Sand: medium, subrounded, quartz with some lithic grains and jasper | 5.4 | 8.8 |
| | **b** Sandy gravel<br>Gravel: fine, subangular to subrounded quartzite and angular flint with limestone, vein quartz and sandstone<br>Sand: medium quartz with some coarse flint | 6.8 | 15.6 |
| Ancholme Clay Group | Silty clay, dark greenish grey, hard | 1.1+ | 16.7 |

**GRADING**

| | Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | +1 -4 | +4 -16 | +16 -64 | +64 mm |
| **a** | 2 | 80 | 18 | 3.4-4.4 | 4 | 15 | 48 | 8 | 16 | 9 | 0 |
| | | | | 4.4-5.4 | 1 | 21 | 54 | 8 | 11 | 5 | 0 |
| | | | | 5.4-6.4 | 0 | 17 | 43 | 12 | 23 | 5 | 0 |
| | | | | 6.4-7.8 | 1 | 17 | 58 | 9 | 13 | 2 | 0 |
| | | | | 7.8-8.8 | 2 | 19 | 58 | 13 | 8 | 0 | 0 |
| | | | | **Mean** | **2** | **18** | **52** | **10** | **14** | **4** | **0** |
| **b** | 1 | 60 | 39 | 8.8-9.8 | 2 | 14 | 37 | 11 | 18 | 18 | 0 |
| | | | | 9.8-10.8 | 1 | 7 | 48 | 11 | 17 | 16 | 0 |
| | | | | 10.8-11.8 | 2 | 5 | 48 | 12 | 22 | 9 | 2 |
| | | | | 11.8-12.8 | 1 | 4 | 47 | 12 | 27 | 9 | 0 |
| | | | | 12.8-13.8 | 2 | 5 | 40 | 10 | 28 | 15 | 0 |
| | | | | 13.8-14.8 | 1 | 3 | 30 | 14 | 37 | 15 | 0 |
| | | | | 14.8-15.6 | 1 | 4 | 42 | 17 | 22 | 14 | 0 |
| | | | | **Mean** | **1** | **6** | **42** | **12** | **25** | **14** | **0** |
| **a+b** | 2 | 69 | 29 | 3.4-15.6 | 2 | 11 | 47 | 11 | 20 | 9 | trace |

**COMPOSITION**

| Depth below surface (m) | percentages by weight in gravel fraction | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Flint | Quartzite | Limestone | Quartz | Sandstone | Ironstone | Igneous | Others |
| | Percentage by weight in 8-16mm fraction | | | | | | | |
| 3.4-8.8 | 71 | 2 | 24 | 1 | 2 | - | - | trace |
| | Percentage by weight in 4-8mm fraction | | | | | | | |
| 3.4-8.8 | 30 | 6 | 56 | 5 | 3 | - | - | trace |
| | Percentage by weight in 8-16mm fraction | | | | | | | |
| 8.8-15.6 | 31 | 38 | 6 | 18 | 6 | trace | 1 | trace |
| | Percentage by weight in 4-8mm fraction | | | | | | | |
| 8.8-15.6 | 23 | 40 | 12 | 18 | 6 | 1 | trace | trace |
| **Mean** | **33** | **30** | **18** | **14** | **5** | - | - | - |

**TF 15 SW 8** **1254 5456** **Digby Fen** **Block D**

Surface level +1.4 m (+5 ft)
Water not struck
March 1979

Waste 2.7 m
Bedrock 1.0 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Made ground | 0.4 | 0.4 |
| Marine or Estuarine Alluvium | Silty clay, dark grey with yellowish brown mottling, soft and laminated | 0.5 | 0.9 |
| River Gravels | 'Clayey' pebbly sand<br>Gravel: fine, subangular, oolitic limestone<br>Sand: fine and medium, quartz with some jasper and lithic grains | 0.5 | 1.4 |
| Till | Clay, grey, with some olive brown mottling, firm with subangular ?chalk granules | 1.3 | 2.7 |
| Ancholme Clay Group | Silty clay, dark greenish grey, stiff | 1.0+ | 3.7 |

**TF 15 SW 9** **1157 5482** **Digby Fen** **Block D**

Surface level +3.1 m(+10 ft)
Water not struck
January 1979

Waste 3.8 m
Bedrock 1.0 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.6 | 0.6 |
| Marine or Estuarine Alluvium | Sandy clay, strong brown mottled with light grey, firm; trace flint pebbles towards base | 0.7 | 1.3 |
| Till | Clay, grey, firm, with subangular chalk granules and some flint and mudstone pebbles | 2.5 | 3.8 |
| Ancholme Clay Group | Silty clay, dark greenish grey, hard | 1.0+ | 4.8 |

**TF 15 SW 10** **1351 5456** **Digby Fen** **Block D**

Surface level +2.5 m (+8 ft)
Water not struck
March 1979

Waste 4.6 m
Bedrock 1.0 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.4 | 0.4 |
| Marine or Estuarine Alluvium | Sandy clay, light grey with some yellowish brown mottling | 0.3 | 0.7 |
| Till | Pebbly clay, grey, mottled with olive brown; some pebbles of flint and limestone | 3.9 | 4.6 |
| Ancholme Clay Group | Silty clay, dark greenish grey, hard | 1.0+ | 5.6 |

**TF 15 SW 11** **1162 5362** **Dorrington Fen** **Block D**

Surface level +2.2 m (+7 ft)
Water not struck
March 1979

Waste 3.9 m
Bedrock 1.1 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.5 | 0.5 |
| Marine or Estuarine Alluvium | Silty clay, grey, plastic and firm with rootlets and white ?calcareous patches | 1.4 | 1.9 |
| River Gravels | 'Very clayey' pebbly sand<br>Gravel: fine, angular, flint with some limestone<br>Sand: fine with medium, subrounded, quartz with some flint and lithic grains | 0.3 | 2.2 |
| Till | Clay, olive brown becoming grey, firm, with rootlets and subrounded ?chalk granules | 1.7 | 3.9 |
| Ancholme Clay Group | Silty clay, dark greenish grey, stiff | 1.1+ | 5.0 |

**TF 15 SW 12** **1266 5437** **Dorrington Fen** **Block D**

Surface level +1.7 m (+6 ft)
Water not struck
March 1979

Waste 3.4 m
Bedrock 0.6 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Made ground | 0.4 | 0.4 |
| Marine or Estuarine Alluvium | Silty clay, greyish brown, soft to firm | 0.9 | 1.3 |
| | Silt, very dark greyish brown, peaty | 0.4 | 1.7 |
| River Gravels | 'Very clayey' pebbly sand<br>Gravel: fine, subangular, oolitic limestone with some flint<br>Sand: fine with medium, subrounded, quartz with some lithic grains | 0.4 | 2.1 |
| Till | Pebbly clay, olive grey, firm, with fine pebbles of limestone, flint and green mudstone | 1.3 | 3.4 |
| Ancholme Clay Group | Silty clay, dark greenish grey, stiff | 0.6+ | 4.0 |

**TF 15 SW 13** **1348 5330** **Gale Fen** **Block D**

Surface level +1.4 m (+5 ft)
Water not struck
November 1978

Waste 5.5 m
Bedrock 1.0 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Made ground | 0.7 | 0.7 |
| Marine or Estuarine Alluvium | Silty clay, dark grey, firm, with black peaty patches | 0.4 | 1.1 |
| Till | Clay, light grey, stiff, with subangular granules of chalk and some flint pebbles, becoming less chalky with depth | 4.4 | 5.5 |
| Ancholme Clay Group | Silty clay, dark greenish grey, hard, with some bivalve fragments | 1.0+ | 6.5 |

**TF 15 SW 14** **1248 5275** **Ruskington Fen** **Block D**

Surface level +1.9 m (+6 ft)
Water not struck
March 1979

Waste 4.5 m
Bedrock 1.0 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.5 | 0.5 |
| Marine or Estuarine Alluvium | Silty clay, brown becoming grey with depth; firm, becoming soft and glutinous | 4.0 | 4.5 |
| Ancholme Clay Group | Silty clay, dark greenish grey, stiff | 1.0+ | 5.5 |

**TF 15 SW 15** **1328 5224** **Ruskington Dales** **Block D**

Surface level +1.7 m (+6 ft)
Water not struck
March 1979

Waste 3.9 m
Bedrock 1.0 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.7 | 0.7 |
| Marine or Estuarine Alluvium | Silty clay, olive grey, firm | 0.5 | 1.2 |
| | Peat, very dark brown, friable | 0.3 | 1.5 |
| | Silty clay, grey, firm with rootlets and thin seams of sand | 2.4 | 3.9 |
| Ancholme Clay Group | Silty clay, dark greenish grey, stiff | 1.0+ | 4.9 |

**TF 15 SW 16** **1455 5301** **North Kyme** **Block D**

Surface level +0.7 m (+3 ft)
Water not struck
November

Waste 5.9 m
Bedrock 1.1 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.7 | 0.7 |
| Marine or Estuarine Alluvium | Silty clay, medium bluish grey, firm, with patches of peat | 3.4 | 4.1 |
| Till | Clay, grey mottled with olive brown, firm with some granules of chalk and trace flint and black mudstone pebbles | 1.8 | 5.9 |
| Ancholme Clay Group | Silty clay, dark greenish grey, hard, with some bivalve fragments | 1.1+ | 7.0 |

**TF 15 SW 17** **1256 5180** **Anwick** **Block D**

Surface level +1.3 m (+4 ft)
Water not struck
March 1979

Waste 3.6 m
Bedrock 1.0 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Made ground | 0.6 | 0.6 |
| Marine or Estuarine Alluvium | Silty clay, dark brown mottled with yellowish brown, soft, laminated | 0.3 | 0.9 |
| River Gravels | 'Very clayey' pebbly sand<br>Gravel: fine, angular, grey flint<br>Sand: fine with medium, subrounded, quartz with some lithic grains | 0.4 | 1.3 |
| Till | Clay, medium bluish grey, firm, with chalk granules and some flint pebbles | 2.3 | 3.6 |
| Ancholme Clay Group | Silty clay, dark greenish grey, stiff | 1.0+ | 4.6 |

**TF 15 SW 18** **1381 5128** **Anwick Fen** **Block D**

Surface level +1.7 m (+6 ft)
Water struck at +0.4 m
March 1979

Overburden 1.3 m
Mineral 1.5 m
Waste 2.3 m
Bedrock 1.0 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Made ground | 1.1 | 1.1 |
| Marine or Estuarine Alluvium | Silty clay, dark greyish brown | 0.2 | 1.3 |
| River Gravels | Sandy gravel<br>Gravel: fine, angular grey and white flint with subangular oolitic and shelly limestone<br>Sand: medium, subrounded, quartz with some coarse flint | 1.5 | 2.8 |
| Till | Clay, dark grey, firm, with granules of chalk and trace black mudstone pebbles | 2.3 | 5.1 |
| Ancholme Clay Group | Silty clay, dark greenish grey, stiff to hard | 1.0+ | 6.1 |

**GRADING**

| Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | +1 -4 | +4 -16 | +16 -64 | +64 mm |
| 4 | 63 | 33 | 1.3-2.8 | 4 | 12 | 36 | 15 | 31 | 2 | 0 |

**TF 15 SW 19** **1463 5200** **North Kyme** **Block D**

Surface level +1.1 m (+4 ft)
Water not struck
January 1979

Waste 5.7 m
Bedrock 2.0 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 1.6 | 1.6 |
| Marine or Estuarine Alluvium | Silty clay, dark grey, soft, micaceous with pebbly lenses. | 4.1 | 5.7 |
| Ancholme Clay Group | Silty clay, dark greenish grey, hard | 2.0+ | 7.7 |

**TF 15 SW 20** **1153 5076** **Anwick** **Block D**

Surface level +10.3 m (+34 ft)
Water not struck
December 1978

Waste 6.3 m
Bedrock 1.0 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Made ground | 1.2 | 1.2 |
| Till | 'Very clayey' pebbly sand<br>Gravel: fine, subangular, chalk with flint<br>Sand: medium, quartz and lithic grains | 0.2 | 1.4 |
| | Pebbly clay, grey, stiff, with subangular chalk and some angular flint pebbles | 4.9 | 6.3 |
| Ancholme Clay Group | Silty clay, dark greenish grey, hard, with some bivalve fragments | 1.0+ | 7.3 |

**TF 15 SW 21** **1240 5073** **Anwick** **Block D**

Surface level +5.6 m (+18 ft)
Water not struck
March 1979

Waste 3.4 m
Bedrock 1.0 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.7 | 0.7 |
| Till | Clay, light brownish grey, firm, with pebbles of subangular chalk and trace flint and ferruginous sandstone | 2.7 | 3.4 |
| Ancholme Clay Group | Silty clay, dark greenish grey, hard, laminated, with trace bivalves | 1.0+ | 4.4 |

**TF 15 SW 22** **1395 5030** **Anwick Fen** **Block D**

Surface level +2.9 m (+10 ft)
Water not struck
March 1979

Waste 6.5 m
Bedrock 1.0 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.5 | 0.5 |
| River Gravels | 'Very clayey' pebbly sand<br>Gravel: fine, quartzite and flint<br>Sand: fine and medium, quartz with some lithic grains | 0.1 | 0.6 |
| Till | Clay, greyish brown, soft, with weathered chalk pebbles, becoming stiff and less chalky with depth | 5.9 | 6.5 |
| Ancholme Clay Group | Silty clay, dark greenish grey, hard | 1.0+ | 7.5 |

**TF 15 SE 4** **1911 5482** **Billinghay Dales** **Block $B_3$**

Surface level +2.2 m (+7 ft)
Water struck at -0.9 m
March 1979

Overburden 3.4 m
Mineral 10.8 m
Bedrock 1.0 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Fill | 0.7 | 0.7 |
| Marine or Estuarine Alluvium | Silty clay, dark greyish brown becoming grey with depth, soft | 2.2 | 2.9 |
| | Peat, dark brown | 0.1 | 3.0 |
| | Silt, dark grey, very soft and glutinous, sandy patches towards base | 0.4 | 3.4 |
| River Gravels | **a** Pebbly sand<br>Gravel: fine, subangular to angular white and grey flint with limestone and some vein quartz<br>Sand: medium and fine, quartz with some coarse flint and trace jasper and lithic grains | 6.9 | 10.3 |
| | **b** Sandy gravel<br>Gravel: fine and coarse, subangular to subrounded, dark grey, brown and purple quartzite with flint, vein quartz and trace igneous pebbles<br>Sand: medium, subrounded, quartz with coarse flint and some jasper and lithic grains | 3.9 | 14.2 |
| Ancholme Clay Group | Silty clay, dark greenish grey, stiff to hard | 1.0+ | 15.2 |

**GRADING**

| | Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | +1 -4 | +4 -16 | +16 -64 | +64 mm |
| a | 2 | 85 | 13 | 3.4-4.4 | 2 | 40 | 44 | 4 | 5 | 5 | 0 |
| | | | | 4.4-5.4 | 2 | 43 | 49 | 4 | 2 | 0 | 0 |
| | | | | 5.4-6.1 | 2 | 22 | 46 | 12 | 16 | 2 | 0 |
| | | | | 6.1-7.1 | 1 | 13 | 37 | 23 | 23 | 3 | 0 |
| | | | | 7.1-8.1 | 1 | 17 | 45 | 13 | 23 | 1 | 0 |
| | | | | 8.1-9.1 | 3 | 24 | 60 | 6 | 5 | 2 | 0 |
| | | | | 9.1-10.3 | 1 | 25 | 59 | 6 | 7 | 2 | 0 |
| | | | | **Mean** | **2** | **26** | **49** | **10** | **11** | **2** | **0** |
| b | 2 | 57 | 41 | 10.3-11.3 | 3 | 11 | 51 | 7 | 20 | 8 | 0 |
| | | | | 11.3-12.4 | 1 | 5 | 32 | 12 | 34 | 16 | 0 |
| | | | | 12.4-13.4 | 1 | 8 | 40 | 9 | 22 | 20 | 0 |
| | | | | 13.4-14.2 | 2 | 10 | 38 | 5 | 17 | 28 | 0 |
| | | | | **Mean** | **2** | **9** | **40** | **8** | **24** | **17** | **0** |
| a+b | 2 | 75 | 23 | 3.4-14.2 | 2 | 20 | 46 | 9 | 16 | 7 | 0 |

**TF 15 SE 5 1543 5419** **Billinghay** **Block A**

Surface level +2.8 m (+9 ft)
Water not struck
December 1978

Waste 7.7 m
Bedrock 1.0 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.6 | 0.6 |
| Marine or Estuarine Alluvium | Silty clay, dark brown, soft to firm | 0.8 | 1.4 |
| Till | Pebbly clay, dark grey, with some subangular chalk and trace flint pebbles, stiff | 6.3 | 7.7 |
| Ancholme Clay Group | Silty clay, dark greenish grey, hard | 1.0+ | 8.7 |

**TF 15 SE 6 1640 5496** **Billinghay** **Block $B_3$**

Surface level +2.0 m (+7 ft)
Water struck at -0.5 m
December 1978

Overburden 6.1 m
Mineral 7.1 m
Bedrock 1.0 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Made ground | 0.6 | 0.6 |
| Marine or Estuarine Alluvium | Sandy silt, yellowish brown becoming grey with depth; soft and micaceous | 5.5 | 6.1 |
| River Gravels | **a** Pebbly sand<br>Gravel: fine and coarse, angular, flint with some limestone<br>Sand: fine, subangular, quartz with some lithic grains and trace jasper | 1.8 | 7.9 |
| | **b** Sandy gravel<br>Gravel: fine and coarse, subangular to subrounded, quartzite with vein quartz, flint, sandstone and some limestone and shells<br>Sand: medium and fine, subrounded, quartz with some coarse quartzite, trace lithic grains | 5.3 | 13.2 |
| Ancholme Clay Group | Silty clay, dark greenish grey, stiff to hard | 1.0+ | 14.2 |

**GRADING**

| | Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | +1 -4 | +4 -16 | +16 -64 | +64 mm |
| **a** | 5 | 89 | 6 | 6.1-7.1 | 8 | 88 | 3 | 0 | 1 | 0 | 0 |
| | | | | 7.1-7.9 | 2 | 83 | 3 | 0 | 7 | 5 | 0 |
| | | | | **Mean** | **5** | **86** | **3** | **0** | **3** | **3** | **0** |
| **b** | 2 | 51 | 47 | 7.9-8.9 | 2 | 37 | 6 | 8 | 26 | 21 | 0 |
| | | | | 8.9-9.9 | 2 | 13 | 10 | 5 | 39 | 31 | 0 |
| | | | | 9.9-10.9 | 2 | 26 | 30 | 10 | 26 | 6 | 0 |
| | | | | 10.9-11.9 | 2 | 15 | 40 | 11 | 26 | 6 | 0 |
| | | | | 11.9-13.2 | 1 | 9 | 24 | 12 | 32 | 22 | 0 |
| | | | | **Mean** | **2** | **20** | **22** | **9** | **30** | **17** | **0** |
| **a+b** | 3 | 60 | 37 | 6.1-13.2 | 3 | 36 | 17 | 7 | 23 | 14 | 0 |

**COMPOSITION**

| Depth below surface (m) | percentages by weight in gravel fraction | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Flint | Quartzite | Limestone | Quartz | Sandstone | Ironstone | Igneous | Others |
| | Percentage by weight in 8-16 mm fraction | | | | | | | |
| 7.9-13.2 | 18 | 41 | 2 | 21 | 18 | - | trace | trace |
| | Percentage by weight in 4-8 mm fraction | | | | | | | |
| 7.9-13.2 | 17 | 40 | 8 | 21 | 11 | 3 | - | - |
| **Mean** | **18** | **41** | **5** | **21** | **14** | - | - | **1** |

**TF 15 SE 7** **1739 5473** **Billinghay** **Block $B_3$**

Surface level +2.5 m (+8 ft)
Water struck at +0.7 m
February 1979

Overburden 5.9 m
Mineral 10.3 m
Bedrock 1.0 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Made ground | 0.6 | 0.6 |
| Marine or Estuarine Alluvium | Sandy silt, brown becoming grey with depth, soft and micaceous | 5.3 | 5.9 |
| | **a** 'Clayey' sand: fine subangular to subrounded quartz with subangular lithic grains | 1.9 | 7.8 |
| River Gravels | **b** Sandy gravel<br>Gravel: fine, angular to subangular grey and white flint with limestone and some quartzite<br>Sand: medium, quartz with some coarse flint and limestone | 3.0 | 10.8 |
| | **c** Gravel<br>Gravel: fine and coarse, dark grey and brown subrounded quartzite with angular flint and some sandstone and vein quartz<br>Sand: medium, subrounded quartz | 5.4 | 16.2 |
| Ancholme Clay Group | Silty clay, dark greenish grey, stiff | 1.0+ | 17.2 |

**GRADING**

| | Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | +1 -4 | +4 -16 | +16 -64 | +64 mm |
| **a** | 17 | 83 | 0 | 5.9-6.9 | 22 | 78 | 0 | 0 | 0 | 0 | 0 |
| | | | | 6.9-7.8 | 12 | 87 | 1 | 0 | 0 | 0 | 0 |
| | | | | **Mean** | **17** | **82** | **1** | **0** | **0** | **0** | **0** |
| **b** | 3 | 71 | 26 | 7.8-8.8 | 5 | 34 | 26 | 17 | 17 | 1 | 0 |
| | | | | 8.8-9.8 | 3 | 5 | 36 | 15 | 31 | 10 | 0 |
| | | | | 9.8-10.8 | 1 | 8 | 52 | 18 | 18 | 2 | 1 |
| | | | | **Mean** | **3** | **16** | **38** | **17** | **22** | **4** | **0** |
| **c** | 1 | 47 | 52 | 10.8-11.8 | 1 | 7 | 51 | 16 | 17 | 8 | 0 |
| | | | | 11.8-12.8 | 1 | 3 | 30 | 10 | 29 | 26 | 1 |
| | | | | 12.8-13.8 | 2 | 2 | 41 | 13 | 26 | 16 | 0 |
| | | | | 13.8-14.8 | 1 | 1 | 24 | 9 | 33 | 27 | 5 |
| | | | | 14.8-16.2 | 0 | 2 | 25 | 8 | 30 | 33 | 2 |
| | | | | **Mean** | **1** | **3** | **33** | **11** | **27** | **23** | **2** |
| **a+b+c** | 4 | 61 | 35 | 5.9-16.2 | 4 | 21 | 29 | 11 | 21 | 13 | 1 |

**TF 15 SE 8** **1823 5470** **Billinghay Dales** **Block $B_3$**

Surface level +1.5 m (+5 ft)
Water struck at -3.2 m
January 1979

Overburden 5.5 m
Mineral 12.1 m
Bedrock 0.7 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.4 | 0.4 |
| Marine or Estuarine Alluvium | Silty clay, greyish brown becoming grey with depth; firm to soft, partly micaceous, some peat patches towards base | 5.1 | 5.5 |
| River Gravels | **a** Pebbly sand<br>Gravel: fine, angular, black and some white flint with some limestone<br>Sand: medium and fine, subrounded, quartz with some quartzite and lithic grains | 4.0 | 9.5 |
| | **b** Sandy gravel<br>Gravel: fine, subangular, grey and dark brown quartzite with white and brown flint and some red sandstone, limestone and conglomerate<br>Sand: medium, subrounded, quartz with some lithic grains and white flint | 8.1 | 17.6 |
| Ancholme Clay Group | Silty clay, dark greenish grey, hard | 0.7+ | 18.3 |

**GRADING**

| | Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | +1 -4 | +4 -16 | +16 -64 | +64 mm |
| **a** | 7 | 86 | 7 | 5.5-6.5 | 14 | 22 | 54 | 3 | 3 | 4 | 0 |
| | | | | 6.5-7.5 | 3 | 24 | 56 | 6 | 8 | 3 | 0 |
| | | | | 7.5-8.5 | 5 | 38 | 52 | 3 | 2 | 0 | 0 |
| | | | | 8.5-9.5 | No grading data available | | | | | | |
| | | | | **Mean** | **7** | **28** | **54** | **4** | **5** | **2** | **0** |
| **b** | 2 | 54 | 44 | 9.5-10.5 | 2 | 18 | 41 | 11 | 25 | 3 | 0 |
| | | | | 10.5-11.5 | 2 | 15 | 50 | 9 | 16 | 8 | 0 |
| | | | | 11.5-12.5 | 5 | 7 | 30 | 13 | 33 | 12 | 0 |
| | | | | 12.5-13.5 | 1 | 7 | 40 | 13 | 28 | 11 | 0 |
| | | | | 13.5-14.5 | 2 | 4 | 32 | 16 | 31 | 15 | 0 |
| | | | | 14.5-15.5 | 0 | 3 | 23 | 16 | 40 | 18 | 0 |
| | | | | 15.5-16.5 | 0 | 2 | 19 | 12 | 45 | 22 | 0 |
| | | | | 16.5-17.6 | 2 | 3 | 36 | 14 | 33 | 12 | 0 |
| | | | | **Mean** | **2** | **7** | **34** | **13** | **31** | **13** | **0** |
| **a+b** | 3 | 63 | 34 | 5.5-17.6 | 3 | 13 | 39 | 11 | 24 | 10 | 0 |

**TF 15 SE 9** **1516 5373** **North Kyme** **Block D**

Surface level +2.6 m (+9 ft)
Water not struck
April 1979

Waste 5.6 m
Bedrock 1.0 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Made ground | 0.3 | 0.3 |
| Till | Clay, dark grey, with some subangular chalk granules and trace soft red mudstone pebbles | 5.3 | 5.6 |
| Ancholme Clay Group | Silty clay, dark greenish grey, stiff to hard | 1.0+ | 6.6 |

**TF 15 SE 10** **1674 5414** **North Kyme Fen** **Block $B_3$**

Surface level +2.0 m (+7 ft)
Water struck at +0.3 m
February 1979

Overburden 5.9 m
Mineral 4.0 m
Bedrock 1.3 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.4 | 0.4 |
| Marine or Estuarine Alluvium | Silty clay, greyish brown mottled with grey | 0.1 | 0.5 |
| | Sandy silt, brown becoming grey with depth, soft and micaceous | 5.4 | 5.9 |
| River Gravels | Gravel<br>Gravel: fine and coarse, subangular to subrounded, dark greyish brown and brown quartzite with flint, vein quartz and some igneous rock<br>Sand: medium with coarse, subrounded, quartz with quartzite, flint and some fine lithic grains | 4.0 | 9.9 |
| Ancholme Clay Group | Silty clay, dark greenish grey, stiff, trace bivalve fragments | 1.3+ | 11.2 |

**GRADING**

| Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | +1 -4 | +4 -16 | +16 -64 | +64 mm |
| 1 | 48 | 51 | 5.9-6.9 | 3 | 4 | 17 | 14 | 39 | 23 | 0 |
| | | | 6.9-7.9 | 1 | 3 | 33 | 16 | 36 | 11 | 0 |
| | | | 7.9-8.9 | 1 | 2 | 43 | 18 | 29 | 7 | 0 |
| | | | 8.9-9.9 | 0 | 2 | 29 | 9 | 32 | 28 | 0 |
| | | | **Mean** | **1** | **3** | **31** | **14** | **34** | **17** | **0** |

**TF 15 SE 11** **1759 5343** **North Kyme Fen** **Block $B_3$**

Surface level +2.3 m (+8 ft)
Water struck at 0.0 m
February 1979

Overburden 5.2 m
Mineral 12.9 m
Bedrock 1.2 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Made ground | 0.4 | 0.4 |
| Marine or Estuarine Alluvium | Sandy silt, reddish grey becoming greyish brown with depth; soft and micaceous | 4.8 | 5.2 |
| | **a** 'Very clayey' sand: fine, subrounded, quartz with some lithic grains and angular mica | 2.1 | 7.3 |
| River Gravels | **b** Pebbly sand, sand from 10.3 m to 13.1 m<br>Gravel: fine and coarse, subangular white flint and quartzite with limestone, vein quartz and trace sandstone<br>Sand: fine, subangular to subrounded, quartz with some flint and lithic grains | 5.8 | 13.1 |
| | **c** Gravel<br>Gravel: fine and coarse, subrounded to subangular, purple, grey and brown quartzite with flint, vein quartz and some limestone<br>Sand: medium and coarse, quartz with some lithic grains | 5.0 | 18.1 |
| Ancholme Clay Group | Silty clay, dark greenish grey, stiff | 1.2+ | 19.3 |

**GRADING**

| | Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | $+1-4$ | $+4-16$ | $+16-64$ | $+64$ mm |
| **a** | 30 | 70 | 0 | 5.2-6.2 | 40 | 60 | 0 | 0 | 0 | 0 | 0 |
| | | | | 6.2-7.3 | 21 | 77 | 2 | 0 | 0 | 0 | 0 |
| | | | | **Mean** | **30** | **69** | **1** | **0** | **0** | **0** | **0** |
| **b** | 7 | 86 | 7 | 7.3-8.4 | 8 | 55 | 26 | 3 | 5 | 3 | 0 |
| | | | | 8.4-10.3 | 10 | 60 | 13 | 3 | 4 | 10 | 0 |
| | | | | 10.3-11.3 | 5 | 65 | 24 | 3 | 2 | 1 | 0 |
| | | | | 11.3-12.3 | 1 | 73 | 24 | 2 | 0 | 0 | 0 |
| | | | | 12.3-13.1 | 5 | 82 | 12 | 1 | 0 | 0 | 0 |
| | | | | **Mean** | **7** | **65** | **19** | **2** | **3** | **4** | **0** |
| **c** | 3 | 35 | 62 | 13.1-14.1 | 1 | 26 | 12 | 10 | 28 | 23 | 0 |
| | | | | 14.1-15.1 | 1 | 9 | 17 | 13 | 30 | 30 | 0 |
| | | | | 15.1-16.1 | 1 | 6 | 20 | 16 | 34 | 23 | 0 |
| | | | | 16.1-16.9 | 1 | 3 | 10 | 11 | 47 | 21 | 7 |
| | | | | 16.9-18.1 | 9 | 3 | 10 | 8 | 41 | 29 | 0 |
| | | | | **Mean** | **3** | **9** | **14** | **12** | **36** | **25** | **1** |
| **a+b+c** | 9 | 64 | 27 | 5.2-18.1 | 9 | 44 | 14 | 6 | 15 | 12 | 0 |

**COMPOSITION**

| Depth below surface (m) | percentages by weight in gravel fraction | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Flint | Quartzite | Limestone | Quartz | Sandstone | Ironstone | Igneous | Others |
| | Percentage by weight in 8-16 mm fraction | | | | | | | |
| 7.3-11.3 | 35 | 28 | 15 | 13 | 9 | trace | - | trace |
| | Percentage by weight in 4-8 mm fraction | | | | | | | |
| 7.3-11.3 | 29 | 28 | 26 | 13 | 2 | 1 | - | 1 |
| | Percentage by weight in 8-16 mm fraction | | | | | | | |
| 13.1-18.1 | 21 | 58 | 2 | 19 | - | trace | - | - |
| | Percentage by weight in 4-8 mm fraction | | | | | | | |
| 13.1-18.1 | 20 | 48 | 8 | 23 | 1 | trace | - | trace |
| **Mean** | **22** | **51** | **6** | **20** | **1** | - | - | - |

**TF 15 SE 12** **1800 5372** **Billinghay** **Block $B_3$**

Surface level +1.9 m (+6 ft)
Water level not recorded
February 1979

Overburden 7.0 m
Mineral 9.9 m
Bedrock 0.7 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.2 | 0.2 |
| Marine or Estuarine Alluvium | Sandy silt, yellowish brown becoming grey with depth; soft, micaceous | 6.8 | 7.0 |
| River Gravels | **a** Sandy gravel, 'clayey' to 8.0 m<br>Gravel: fine, angular to subangular, grey flint with vein quartz and quartzite<br>Sand: medium and coarse, subrounded, quartz with coarse flint and some lithic grains | 5.1 | 12.1 |
| | **b** Gravel;<br>Gravel: fine and coarse, white and brown flint with grey subrounded quartzite and some sandstone and vein quartz<br>Sand: medium, well-rounded, quartz with some flint and lithic grains | 4.8 | 16.9 |
| Ancholme Clay Group | Silty clay, dark greenish grey, stiff | 0.7+ | 17.6 |

**GRADING**

| | Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | +1 -4 | +4 -16 | +16 -64 | +64 mm |
| **a** | 4 | 55 | 41 | 7.0-8.0 | 15 | 31 | 5 | 9 | 28 | 12 | 0 |
| | | | | 8.0-9.0 | 3 | 7 | 25 | 17 | 37 | 11 | 0 |
| | | | | 9.0-10.0 | 1 | 5 | 29 | 26 | 34 | 5 | 0 |
| | | | | 10.0-11.0 | 3 | 7 | 28 | 23 | 34 | 5 | 0 |
| | | | | 11.0-12.1 | 0 | 5 | 39 | 15 | 28 | 13 | 0 |
| | | | | **Mean** | **4** | **11** | **26** | **18** | **32** | **9** | **0** |
| **b** | 4 | 41 | 55 | 12.1-13.0 | 0 | 4 | 29 | 11 | 26 | 30 | 0 |
| | | | | 13.0-14.0 | 0 | 7 | 27 | 13 | 31 | 22 | 0 |
| | | | | 14.0-15.0 | 18 | 2 | 11 | 5 | 37 | 27 | 0 |
| | | | | 15.0-16.0 | 1 | 3 | 26 | 8 | 32 | 30 | 0 |
| | | | | 16.0-16.9 | 2 | 4 | 40 | 16 | 21 | 17 | 0 |
| | | | | **Mean** | **4** | **4** | **26** | **11** | **30** | **25** | **0** |
| **a+b** | 4 | 48 | 48 | 7.0-16.9 | 4 | 8 | 26 | 14 | 31 | 17 | 0 |

**TF 15 SE 13** **1892 5356** **North Kyme Fen** **Block $B_3$**

Surface level +2.0 m (+7 ft)
Water struck at -0.8 m
February 1979

Overburden 9.3 m
Mineral 7.8 m
Bedrock 0.9 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.5 | 0.5 |
| Marine or Estuarine Alluvium | Sandy silt, yellowish brown becoming dark grey with depth; very soft and micaceous | 8.8 | 9.3 |
| River Gravels | **a** Pebbly sand<br>Gravel: coarse, angular to subangular, black and white flint with vein quartz<br>Sand: fine with medium, subrounded, quartz with some lithic grains | 1.0 | 10.3 |
| | **b** Gravel;<br>Gravel: fine and coarse, subangular to subrounded, greyish brown and grey quartzite with flint and some limestone<br>Sand: medium, subrounded, quartz, with lithic grains in the coarser grades | 6.8 | 17.1 |
| Ancholme Clay Group | Silty clay, dark greenish grey, stiff to hard | 0.9+ | 18.0 |

**GRADING**

| | Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | $+1-4$ | $+4-16$ | $+16-64$ | $+64$ mm |
| **a** | 3 | 84 | 13 | 9.3-10.3 | 3 | 56 | 27 | 1 | 3 | 10 | 0 |
| **b** | 1 | 49 | 50 | 10.3-11.3 | 0 | 6 | 23 | 15 | 29 | 25 | 2 |
| | | | | 11.3-12.3 | 0 | 5 | 23 | 10 | 30 | 32 | 0 |
| | | | | 12.3-13.3 | 2 | 5 | 27 | 13 | 29 | 24 | 0 |
| | | | | 13.3-14.9 | 2 | 5 | 36 | 11 | 27 | 19 | 0 |
| | | | | 14.9-15.5 | 1 | 6 | 55 | 6 | 16 | 16 | 0 |
| | | | | 15.5-17.1 | 0 | 5 | 38 | 11 | 25 | 21 | 0 |
| | | | | **Mean** | **1** | **5** | **33** | **11** | **27** | **23** | **0** |
| **a+b** | 1 | 54 | 45 | 9.3-17.1 | 1 | 12 | 32 | 10 | 24 | 21 | 0 |

**TF 15 SE 14** **1532 5220** **North Kyme** **Block C**

Surface level +6.1 m (+20 ft)
Water struck at +4.0 m
December 1978

Waste 12.3 m
Bedrock 1.0 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Made ground | 0.6 | 0.6 |
| River Gravels | Sandy silt, dark greyish brown, clayey and pebbly towards base | 1.5 | 2.1 |
| | 'Very clayey' pebbly sand<br>Gravel: fine, quartzite, sandstone and some flint<br>Sand: medium, quartz with some lithic grains | 0.2 | 2.3 |
| | Silty clay, brown, firm, pebbly at top | 2.9 | 5.2 |
| Till | Clay, grey to dark grey, stiff, with subangular chalk and some black mudstone and flint pebbles | 7.1 | 12.3 |
| Ancholme Clay Group | Silty clay, dark greenish grey, hard | 1.0+ | 13.3 |

**TF 15 SE 15** **1653 5284** **North Kyme** **Block $B_3$**

Surface level +1.8 m (+6 ft)
Water not struck
April 1979

Waste 6.5 m
Bedrock 1.0 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.7 | 0.7 |
| River Gravels | 'Clayey' sandy gravel<br>Gravel: fine, subrounded, quartzite with some predominantly brown flint<br>Sand: medium with fine, subrounded, quartz with some lithic grains and trace jasper | 0.3 | 1.0 |
| Till | Clay, grey to dark grey, stiff, with chalk granules and trace grey flint pebbles | 5.5 | 6.5 |
| Ancholme Clay Group | Silty clay, dark greenish grey, hard | 1.0+ | 7.5 |

**TF 15 SE 16** **1742 5215** **North Kyme** **Block $B_3$**

Surface level +1.6 m (+5 ft)
Water not struck
April 1979

Waste 6.5 m
Bedrock 1.0 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.6 | 0.6 |
| Marine or Estuarine Alluvium | Silty clay, greyish brown becoming grey with depth | 2.1 | 2.7 |
| | Peat, very dark brown, friable | 0.2 | 2.9 |
| Till | Clay, grey, stiff, with subangular chalk granules | 3.6 | 6.5 |
| Ancholme Clay Group | Silty clay, very dark grey, hard, with fragments brachiopod and ammonite | 1.0+ | 7.5 |

**TF 15 SE 17** **1849 5267** **North Kyme Fen** **Block $B_3$**

Surface level +2.7 m (+9 ft)
Water level not recorded
February 1979

Overburden 2.8 m
Mineral 13.1 m
Bedrock 1.2 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Made ground | 0.8 | 0.8 |
| Marine or Estuarine Alluvium | Sandy silt, dark brown with grey mottling, soft, micaceous; becoming more sandy with depth | 2.0 | 2.8 |
| | **a** 'Very clayey' sand: fine, subrounded to well-rounded, quartz with some lithic grains and mica | 4.5 | 7.3 |
| River Gravels | **b** Sand, pebbly towards base<br>Gravel: subangular to subrounded flint, limestone and quartzite with shell fragments and some vein quartz and sandstone<br>Sand: fine and medium, subrounded, quartz with some lithic grains and trace jasper | 4.0 | 11.3 |
| | **c** Sandy gravel<br>Gravel: fine and coarse, subangular to subrounded, quartzite, flint and vein quartz with some limestone and sandstone<br>Sand: medium quartz with coarse flint and quartzite | 4.6 | 15.9 |
| Ancholme Clay Group | Silty clay, dark greenish grey, stiff | 1.2+ | 17.1 |

**GRADING**

| | Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | +1 -4 | +4 -16 | +16 -64 | +64 mm |
| **a** | 20 | 80 | 0 | 3.8-4.8 | 36 | 64 | 0 | 0 | 0 | 0 | 0 |
| | | | | 4.8-5.8 | 14 | 85 | 1 | 0 | 0 | 0 | 0 |
| | | | | 5.8-7.3 | 14 | 84 | 2 | 0 | 0 | 0 | 0 |
| | | | | **Mean** | **20** | **79** | **1** | **0** | **0** | **0** | **0** |
| **b** | 4 | 91 | 5 | 7.3-8.3 | 6 | 57 | 34 | 3 | 0 | 0 | 0 |
| | | | | 8.3-9.3 | 5 | 66 | 27 | 2 | 0 | 0 | 0 |
| | | | | 9.3-10.3 | 3 | 54 | 32 | 6 | 5 | 0 | 0 |
| | | | | 10.3-11.3 | 3 | 27 | 45 | 13 | 10 | 2 | 0 |
| | | | | **Mean** | **4** | **51** | **34** | **6** | **4** | **1** | **0** |
| **c** | 2 | 51 | 47 | 11.3-12.3 | 2 | 11 | 31 | 14 | 32 | 10 | 0 |
| | | | | 12.3-13.3 | 2 | 5 | 32 | 10 | 30 | 21 | 0 |
| | | | | 13.3-14.3 | 3 | 9 | 42 | 9 | 24 | 13 | 0 |
| | | | | 14.3-15.9 | 1 | 5 | 29 | 11 | 35 | 19 | 0 |
| | | | | **Mean** | **2** | **7** | **33** | **11** | **31** | **16** | **0** |
| **a+b+c** | 8 | 73 | 19 | 3.8-15.9 | 8 | 43 | 24 | 6 | 13 | 6 | 0 |

**COMPOSITION**

| Depth below surface (m) | percentages by weight in gravel fraction | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Flint | Quartzite | Limestone | Quartz | Sandstone | Ironstone | Igneous | Shell Fragments |
| | Percentage by weight in 8-16 mm fraction | | | | | | | |
| 9.3-11.3 | 32 | 20 | 17 | 8 | 1 | - | - | 22 |
| | Percentage by weight in 4-8 mm fraction | | | | | | | |
| 9.3-11.3 | 23 | 17 | 27 | 8 | 2 | trace | - | 23 |
| | Percentage by weight in 8-16 mm fraction | | | | | | | |
| 11.3-15.9 | 23 | 42 | 3 | 27 | 4 | 1 | - | trace |
| | Percentage by weight in 4-8 mm fraction | | | | | | | |
| 11.3-15.9 | 26 | 33 | 10 | 25 | 5 | 1 | - | trace |
| **Mean** | **25** | **36** | **7** | **26** | **4** | **1** | - | **1** |

**TF 15 SE 18** **1955 5223** **Hart's Grounds** **Block $B_3$**

Surface level +2.3 m (+8 ft)
Water struck at +1.1 m
March 1979

Overburden 3.6 m
Mineral 16.1 m
Bedrock 0.6 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Made ground | 0.4 | 0.4 |
| Marine or Estuarine Alluvium | Sandy silt, dark greyish brown, very soft, micaceous | 3.2 | 3.6 |
| | **a** 'Clayey' sand: fine, subrounded to well-rounded quartz with some lithic grains and trace mica | 4.9 | 8.5 |
| River Gravels | **b** Pebbly sand<br>Gravel: fine with coarse, subrounded quartzite and subangular limestone with flint and vein quartz and some sandstone<br>Sand: medium and fine, subrounded, quartz with trace jasper and lithic grains | 2.9 | 11.4 |
| | **c** Sandy gravel, sand to 13.3 m and from 16.5 m to 17.6 m<br>Gravel: fine, subrounded, grey and brown quartzite with flint and vein quartz and some limestone and sandstone<br>Sand: medium, quartz with some lithic grains | 8.3 | 19.7 |
| Ancholme Clay Group | Silty clay, dark greenish grey, stiff to hard | 0.6+ | 20.3 |

**GRADING**

| | Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | +1 -4 | +4 -16 | +16 -64 | +64 mm |
| **a** | 16 | 84 | 0 | 3.6-4.6 | 30 | 69 | 1 | 0 | 0 | 0 | 0 |
| | | | | 4.6-5.6 | 18 | 81 | 1 | 0 | 0 | 0 | 0 |
| | | | | 5.6-6.6 | 8 | 91 | 1 | 0 | 0 | 0 | 0 |
| | | | | 6.6-7.6 | 11 | 88 | 1 | 0 | 0 | 0 | 0 |
| | | | | 7.6-8.5 | 11 | 84 | 5 | 0 | 0 | 0 | 0 |
| | | | | **Mean** | **16** | **82** | **2** | **0** | **0** | **0** | **0** |
| **b** | 4 | 75 | 21 | 8.5-9.5 | 1 | 26 | 30 | 10 | 27 | 6 | 0 |
| | | | | 9.5-10.3 | 8 | 37 | 35 | 7 | 9 | 4 | 0 |
| | | | | 10.3-11.4 | 3 | 24 | 51 | 7 | 10 | 5 | 0 |
| | | | | **Mean** | **4** | **28** | **39** | **8** | **16** | **5** | **0** |
| **c** | 2 | 72 | 26 | 11.4-12.3 | 3 | 20 | 72 | 2 | 3 | 0 | 0 |
| | | | | 12.3-13.3 | 4 | 21 | 75 | 0 | 0 | 0 | 0 |
| | | | | 13.3-14.3 | 1 | 8 | 38 | 14 | 27 | 12 | 0 |
| | | | | 14.3-15.3 | 0 | 4 | 20 | 17 | 42 | 17 | 0 |
| | | | | 15.3-16.5 | 0 | 6 | 59 | 13 | 21 | 1 | 0 |
| | | | | 16.5-17.6 | 3 | 10 | 81 | 5 | 1 | 0 | 0 |
| | | | | 17.6-18.6 | 2 | 4 | 40 | 17 | 33 | 4 | 0 |
| | | | | 18.6-19.7 | 2 | 7 | 34 | 13 | 36 | 8 | 0 |
| | | | | **Mean** | **2** | **10** | **52** | **10** | **21** | **5** | **0** |
| **a+b+c** | 7 | 76 | 17 | 3.6-19.7 | 7 | 35 | 34 | 7 | 13 | 4 | 0 |

**COMPOSITION**

| Depth below surface (m) | percentages by weight in gravel fraction | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Flint | Quartzite | Limestone | Quartz | Sandstone | Ironstone | Igneous | Shell Fragments |
| | Percentage by weight in 8-16 mm fraction | | | | | | | |
| 8.5-11.4 | 17 | 42 | 21 | 12 | 8 | - | - | - |
| | Percentage by weight in 4-8 mm fraction | | | | | | | |
| 8.5-11.4 | 15 | 21 | 44 | 12 | 8 | - | - | - |
| | Percentage by weight in 8-16 mm fraction | | | | | | | |
| 11.4-19.7 | 26 | 45 | 3 | 25 | 1 | trace | - | trace |
| | Percentage by weight in 4-8 mm fraction | | | | | | | |
| 11.4-19.7 | 22 | 39 | 8 | 22 | 7 | 1 | - | 1 |
| **Mean** | **22** | **40** | **11** | **21** | **5** | **-** | **-** | **1** |

**TF 15 SE 19** **1558 5146** **North Kyme** **Block C**

Surface level +3.5 m (+12 ft)
Water struck at +1.0 m
December 1978

Waste 11.1 m
Bedrock 0.4 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Made ground | 1.2 | 1.2 |
| Marine or Estuarine Alluvium | Silty clay, light yellowish brown becoming dark grey with depth, firm; seams of sand and pebbles | 2.7 | 3.9 |
| | Peat, very dark reddish brown, clayey, with fragments bivalve and gastropod | 1.5 | 5.4 |
| | Silt, dark grey, soft and sandy with bivalves and gastropods | 5.5 | 10.9 |

| | | | |
|---|---|---|---|
| Till | Clay, grey, very soft with some chalk granules and grey and black flint pebbles | 0.2 | 11.1 |
| Ancholme Clay Group | Silty clay, dark grey, stiff | 0.4+ | 11.5 |

**TF 15 SE 20** **1668 5186** **Damford Grounds** **Block C**

Surface level +2.8 m (+9 ft)
Water struck at +0.8 m
March 1979

Overburden 0.6 m
Mineral 1.1 m
Waste 1.6 m
Mineral 3.8 m
Bedrock 1.3 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.6 | 0.6 |
| River Gravels | **a** 'Clayey' pebbly sand<br>Gravel: fine and coarse, angular to subrounded grey and brown flint with some quartzite and vein quartz<br>Sand: fine, subangular to subrounded quartz with some coarse flint and lithic grains | 1.1 | 1.7 |
| | Sandy clay, brownish yellow, soft | 1.6 | 3.3 |
| | **b** Gravel<br>Gravel: fine, subangular to subrounded, brown, purple and grey quartzite with white and brown flint, vein quartz and trace shell fragments<br>Sand: coarse and medium, quartz with some lithic grains and trace jasper | 3.8 | 7.1 |
| Ancholme Clay Group | Silty clay, dark greenish grey, stiff to hard | 1.3+ | 8.4 |

**GRADING**

| | Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | +1 -4 | +4 -16 | +16 -64 | +64 mm |
| **a** | 13 | 69 | 18 | 0.6-1.7 | 13 | 47 | 18 | 4 | 11 | 7 | 0 |
| **b** | 1 | 33 | 66 | 3.3-4.4 | 2 | 5 | 12 | 11 | 53 | 17 | 0 |
| | | | | 4.4-5.4 | 1 | 2 | 13 | 17 | 50 | 17 | 0 |
| | | | | 5.4-6.4 | 1 | 3 | 12 | 20 | 54 | 10 | 0 |
| | | | | 6.4-7.1 | 0 | 1 | 18 | 21 | 50 | 10 | 0 |
| | | | | **Mean** | **1** | **3** | **13** | **17** | **52** | **14** | **0** |
| **a+b** | **4** | **41** | **55** | **Mean** | **4** | **13** | **14** | **14** | **43** | **12** | **0** |

**TF 15 SE 21** **1780 5118** **Damford Grounds** **Block C**

Surface level +1.5 m (+5 ft)
Water not struck
March 1979

Overburden 0.6 m
Mineral 1.3 m
Waste 6.4 m
Bedrock 1.0 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.6 | 0.6 |
| River Gravels | 'Clayey' pebbly sand<br>Gravel: fine, subrounded, grey and brown quartzite with some grey flint<br>Sand: fine and medium, quartz with trace flint and lithic grains | 1.3 | 1.9 |
| Till | Pebbly clay, dark grey mottled with olive grey, stiff, with subangular chalk, ferruginous sandstone and flint pebbles | 6.4 | 8.3 |
| Ancholme Clay Group | Silty clay, dark grey, stiff to hard with fragments ammonite | 1.0+ | 9.3 |

**GRADING**

| Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | +1 -4 | +4 -16 | +16 -64 | +64 mm |
| 13 | 77 | 10 | 0.6-1.9 | 13 | 44 | 32 | 1 | 7 | 3 | 0 |

**TF 15 SE 22** **1850 5186** **Damford Grounds** **Block $B_3$**

Surface level +3.0 m (+10 ft)
Water struck at +1.2 m
April 1979

Overburden 6.9 m
Mineral 12.0 m
Bedrock 1.1 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.6 | 0.6 |
| Marine or Estuarine Alluvium | Clayey silt, light brown becoming greyish brown with depth, soft and micaceous | 6.3 | 6.9 |
| River Gravels | **a** Pebbly sand<br>Gravel: fine, grey and brown angular flint with quartzite, vein quartz and limestone<br>Sand: fine, quartz with some lithic grains and trace shell fragments | 4.9 | 11.8 |
| | **b** Sandy gravel<br>Gravel: fine, subangular to subrounded, brown and grey quartzite with flint, vein quartz and some oolitic limestone<br>Sand: medium, quartz with flint, limestone and some lithic grains | 7.1 | 18.9 |
| Ancholme Clay Group | Silty clay, dark greenish grey, stiff | 1.1+ | 20.0 |

**GRADING**

| | Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | +1 -4 | +4 -16 | +16 -64 | +64 mm |
| a | 5 | 90 | 5 | 6.9-7.9 | 11 | 86 | 3 | 0 | 0 | 0 | 0 |
| | | | | 7.9-8.9 | 8 | 89 | 3 | 0 | 0 | 0 | 0 |
| | | | | 8.9-10.3 | 2 | 66 | 23 | 8 | 1 | 0 | 0 |
| | | | | 10.3-10.8 | 3 | 47 | 26 | 11 | 12 | 1 | 0 |
| | | | | 10.8-11.8 | 2 | 25 | 42 | 17 | 13 | 1 | 0 |
| | | | | **Mean** | **5** | **64** | **19** | **7** | **4** | **1** | **0** |
| b | 1 | 54 | 45 | 11.8-12.8 | 1 | 4 | 38 | 15 | 31 | 11 | 0 |
| | | | | 12.8-14.2 | 2 | 9 | 42 | 15 | 29 | 3 | 0 |
| | | | | 14.2-15.2 | 1 | 4 | 31 | 17 | 39 | 8 | 0 |
| | | | | 15.2-15.5 | 2 | 3 | 25 | 12 | 41 | 17 | 0 |
| | | | | 15.5-16.5 | 2 | 2 | 41 | 14 | 30 | 11 | 0 |
| | | | | 16.5-17.5 | 0 | 3 | 25 | 22 | 36 | 14 | 0 |
| | | | | 17.5-18.9 | 1 | 4 | 16 | 24 | 43 | 12 | 0 |
| | | | | **Mean** | **1** | **5** | **31** | **18** | **35** | **10** | **0** |
| a+b | 3 | 68 | 29 | 6.9-18.9 | 3 | 29 | 26 | 13 | 23 | 6 | 0 |

**TF 15 SE 23** **1972 5123** **Terry Booth** **Block B2**[2]

Surface level +2.7 m (+9 ft)
Water struck at +1.5 m
March 1979

Overburden 4.1 m
Mineral 11.9 m
Bedrock 1.0 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.3 | 0.3 |
| Marine or Estuarine Alluvium | Clayey silt, brown becoming grey with depth, soft and micaceous | 3.8 | 4.1 |
| | **a** Sand, 'clayey', to 5.5 m; fine, subrounded, quartz with some lithic grains | 6.5 | 10.6 |
| River Gravels | **b** Gravel<br>Gravel: fine and coarse, subangular to subrounded, brown, grey and purple quartzite with angular flint and some vein quartz and limestone<br>Sand: medium, quartz with some flint and lithic grains | 5.4 | 16.0 |
| Ancholme Clay Group | Silty clay, dark greenish grey, stiff to hard | 1.0+ | 17.0 |

**GRADING**

| | Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | +1 -4 | +4 -16 | +16 -64 | +64 mm |
| a | 7 | 93 | 0 | 4.1-5.5 | 12 | 86 | 2 | 0 | 0 | 0 | 0 |
| | | | | 5.5-6.5 | 9 | 88 | 3 | 0 | 0 | 0 | 0 |
| | | | | 6.5-7.5 | 5 | 88 | 6 | 1 | 0 | 0 | 0 |
| | | | | 7.5-8.5 | 5 | 93 | 2 | 0 | 0 | 0 | 0 |
| | | | | 8.5-9.6 | 4 | 74 | 21 | 1 | 0 | 0 | 0 |
| | | | | 9.6-10.6 | 3 | 41 | 37 | 16 | 3 | 0 | 0 |
| | | | | **Mean** | **7** | **79** | **11** | **3** | **0** | **0** | **0** |
| b | 1 | 46 | 53 | 10.6-11.6 | 2 | 27 | 27 | 20 | 23 | 1 | 0 |
| | | | | 11.6-12.7 | 1 | 15 | 15 | 20 | 42 | 7 | 0 |
| | | | | 12.7-13.7 | 0 | 5 | 21 | 7 | 41 | 26 | 0 |
| | | | | 13.7-15.1 | 1 | 3 | 38 | 15 | 28 | 15 | 0 |
| | | | | 15.1-16.0 | 0 | 2 | 6 | 3 | 15 | 74 | 0 |
| | | | | **Mean** | **1** | **10** | **23** | **13** | **30** | **23** | **0** |
| a+b | 4 | 72 | 24 | 4.1-16.0 | 4 | 47 | 17 | 8 | 14 | 10 | 0 |

**TF 15 SE 24** **1571 5028** **South Kyme** **Block C**

Surface level +7.0 m (+23 ft)
Water struck at +6.4 m
March 1979

Waste 6.4 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.6 | 0.6 |
| River Gravels | Sandy clay, strong brown, soft to firm | 0.1 | 0.7 |
| | Sandy gravel<br>Gravel: fine, flint with subrounded quartzite<br>Sand: medium, subrounded quartz | 0.4 | 1.1 |
| Till | Clay, dark greyish brown, stiff, with fine chalk granules and some flint pebbles | 5.3+ | 6.4 |
| | Borehole abandoned due to technical difficulties | | |

**TF 15 SE 25** **1670 5097** **Damford Grounds** **Block C**

Surface level +4.5 m (+15 ft)
Water not struck
March 1979

Overburden 0.7 m
Mineral 2.1 m
Waste 5.4 m
Bedrock 1.0 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.7 | 0.7 |
| River Gravels | Sandy gravel<br>Gravel: fine, subangular to subrounded brown and purple quartzite with angular to subangular flint, some vein quartz and trace igneous rock<br>Sand: medium, subrounded to subangular, quartz | 2.1 | 2.8 |
| Till | Pebbly clay, dark grey, stiff, with some subangular chalk and angular flint pebbles | 5.4 | 8.2 |
| Ancholme Clay Group | Silty clay, dark greenish grey, stiff to hard | 1.0+ | 9.2 |

**GRADING**

| Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | +1 -4 | +4 -16 | +16 -64 | +64 mm |
| 3 | 70 | 27 | 0.7-1.7 | 3 | 6 | 59 | 9 | 17 | 6 | 0 |
| | | | 1.7-2.8 | 3 | 10 | 48 | 9 | 19 | 11 | 0 |
| | | | **Mean** | **3** | **8** | **53** | **9** | **18** | **9** | **0** |

**TF 15 SE 26** **1765 5010** **South Kyme** **Block C**

Surface level +7.3 m (+24 ft)
Water not struck
March 1979

Overburden 0.1 m
Mineral 1.1 m
Waste 13.2 m
Bedrock 1.0 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.1 | 0.1 |
| River Gravels | 'Clayey' pebbly sand<br>Gravel: fine, angular grey and brown flint with subrounded quartzite and vein quartz<br>Sand: fine and medium, subrounded, quartz with some flint | 1.1 | 1.2 |
| Till | Pebbly clay, dark grey, firm to stiff, with some chalk and flint pebbles; seam of laminated clay between 8.0 m and 8.7 m | 13.2 | 14.4 |
| Ancholme Clay Group | Silty clay, dark greenish grey, hard, with some ammonites | 1.0+ | 15.4 |

**GRADING**

| Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | +1 -4 | +4 -16 | +16 -64 | +64 mm |
| 12 | 68 | 20 | 0.1-1.2 | 12 | 34 | 24 | 10 | 16 | 4 | 0 |

**TF 15 SE 27** **1867 5078** **Damford Grounds** **Block C**

Surface level +1.1 m (+4 ft)
Water struck at -0.5 m
March 1979

Overburden 0.4 m
Mineral 3.4 m
Waste 4.6 m
Bedrock 1.0 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Soil | 0.4 | 0.4 |
| River Gravels | Pebbly sand<br>Gravel: fine, subrounded quartzite with grey and brown angular flint<br>Sand: medium and fine, subrounded, quartz with some lithic grains | 3.4 | 3.8 |
| Till | Pebbly clay, dark grey, with subangular chalk and trace flint pebbles | 4.6 | 8.4 |
| Ancholme Clay Group | Silty clay, dark grey, hard, laminated; trace bivalve fragments | 1.0+ | 9.4 |

**GRADING**

| Mean for deposit percentages | | | Depth below surface (m) | percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Fines | Sand | Gravel | | Fines | Sand | | | Gravel | | |
| | | | | $-\frac{1}{16}$ | $+\frac{1}{16}-\frac{1}{4}$ | $+\frac{1}{4}-1$ | +1 -4 | +4 -16 | +16 -64 | +64 mm |
| 4 | 82 | 14 | 0.4-1.4 | 7 | 56 | 25 | 4 | 6 | 2 | 0 |
| | | | 1.4-2.4 | 3 | 32 | 58 | 5 | 2 | 0 | 0 |
| | | | 2.4-3.0 | 2 | 19 | 71 | 6 | 2 | 0 | 0 |
| | | | 3.0-3.8 | 1 | 6 | 34 | 13 | 33 | 13 | 0 |
| | | | **Mean** | **4** | **31** | **45** | **6** | **10** | **4** | **0** |

**TF 15 SE 28** **1946 5048** **Terry Booth** **Block $B_3$**

Surface level +2.5 m (+8 ft)
Water not struck
March 1979

Waste 10.4 m
Bedrock 1.0 m+

**LOG**

| Geological classification | Lithology | Thickness | Depth |
|---|---|---|---|
| | Made ground | 0.7 | 0.7 |
| Marine or Estuarine Alluvium | Silty clay, dark bluish grey, firm becoming soft | 2.0 | 2.7 |
| | Peat, very dark reddish brown | 0.8 | 3.5 |
| | Silty clay, as above | 0.2 | 3.7 |
| Till | Pebbly clay, dark grey, stiff, with some chalk granules and trace grey flint pebbles | 6.7 | 10.4 |
| Ancholme Clay Group | Silty clay, very dark grey, hard | 1.0+ | 11.4 |

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INSTITUTE OF GEOLOGICAL SCIENCES

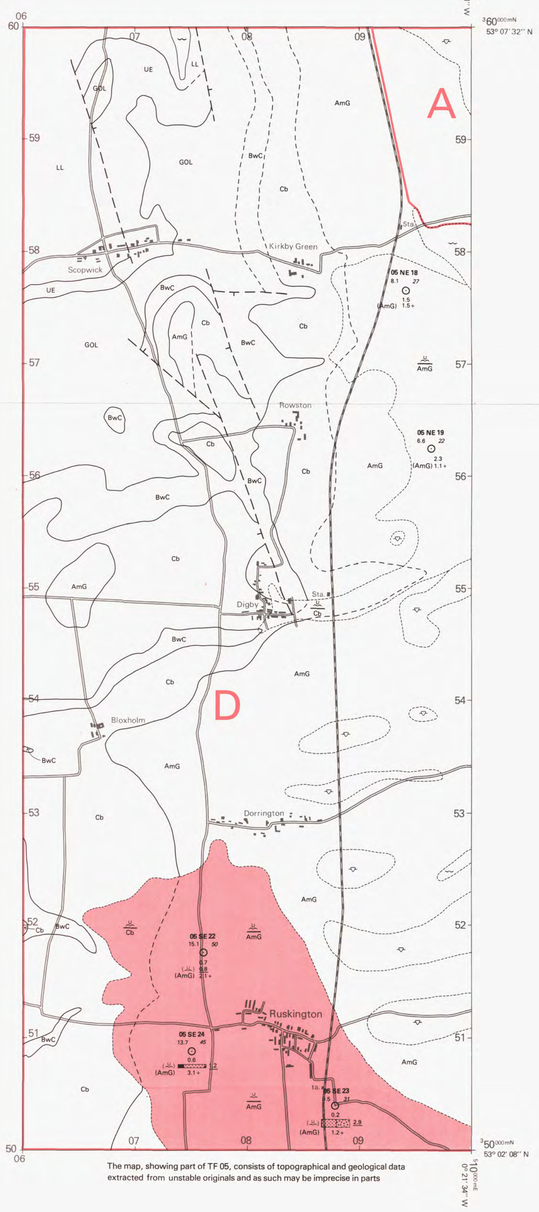
INDUSTRIAL MINERALS ASSESSMENT UNIT

# THE SAND AND GRAVEL RESOURCES OF THE COUNTRY AROUND BILLINGHAY, LINCOLNSHIRE

PART OF SHEET TF05

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

ORDNANCE SURVEY
SHEET TF 15
PROVISIONAL EDITION

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

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*Sand and Gravel Survey by J. B. L. Weir in 1978-9 under the supervision of I. Jackson and B. J. Taylor, R. G. Thurrell, Head, Industrial Minerals Assessment Unit.*

*1:25,000 Sand and Gravel Resource Sheet published 1982. © M. Brown, D.Sc., F.R.S., Director, Institute of Geological Sciences*

The GRID lines on this sheet are at 1 Kilometre interval.
*Heights are in feet above Mean Sea Level at Newlyn.*
*Contour values are in feet*
*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. However, estimates of the volume and mean grading of the mineral as a whole in each Resource Block are given in the Report.*

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Compiled from 6" sheets last fully revised 1903–04. Other partial systematic revision 1951–53 has been incorporated.

*Made and published by the Director General of the Ordnance Survey, Chessington, Surrey, 1959.*

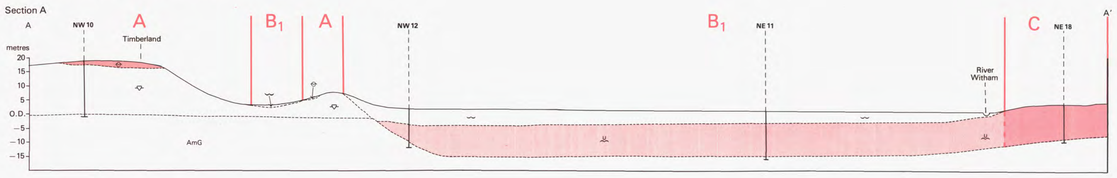
| | | | |
|---|---|---|---|
| SK 96 | TF 06 | TF 16 | TF 26 |
| SK 95 | 114 TF 05 127 | TF 15 | 115 TF 25 128 |
| SK 94 | TF 04 | TF 14 | TF 24 |

*Diagram showing the relationship of the National Grid 1:25 000 sheets with the 1:50 000 New Series Geological sheets 114 and 127 (published) and 115 and 128 (unpublished)*

## GENERALISED HORIZONTAL SECTIONS

Vertical exaggeration x25 Horizontal scale 1:25 000

Section A

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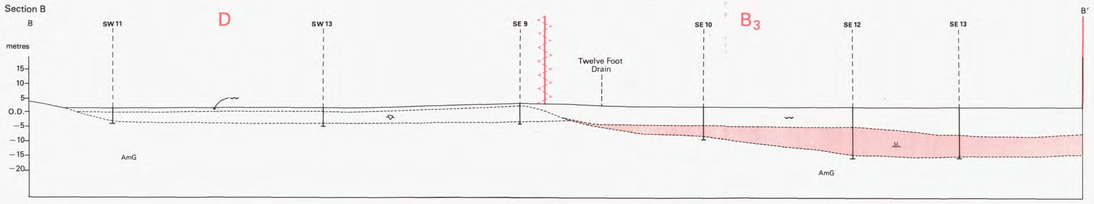



## THE SAND AND GRAVEL RESOURCES OF THE COUNTRY AROUND BILLINGHAY, LINCOLNSHIRE SHEET TF 15 AND PART OF TF 05.

100

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

### EXPLANATION OF SYMBOLS AND ABBREVIATIONS

**DRIFT**

| | | |
|---|---|---|
| | **Marine or Estuarine Alluvium** -silty clay with some peat | ME-12 |
| | **River Gravels, undifferentiated** — mainly sand and gravel | RG-5 |
| | **Fluvio-glacial and Older River Sand and Gravel** — thin pebbly sands | FL-18 |
| | **Till** — stony clay | TL-9 |

Holocene, Pleistocene — QUATERNARY

**SOLID**

| | |
|---|---|
| AmG | **Ancholme Clay Group** — mudstone with thin limestones |
| Cb | **Cornbrash** — limestone with marl |
| BwC | **Blisworth Clay** — dark blue mudstone weathering to clay |
| GOL | **Great Oolite Limestone** — limestone with clay intercalations |
| UE | **Upper Estuarine 'Beds'** — fine sandstones and mudstones |
| LL | **Lincolnshire Limestone, undivided** — oolitic and shelly limestones with intercalated clays |

Upper, Middle — JURASSIC

**Worked out areas of sand and gravel** WO-9

**BOUNDARY LINES**

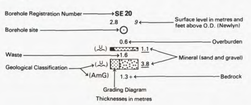
- Geological boundary, Drift
- Geological boundary, Solid
  (Broken lines denote uncertainty)
- Fault, crossmark indicates downthrow side
- Inferred boundary between recognised categories of deposits
- Resource Block boundary

**BOREHOLE DATA**

**SITE LOCATIONS**

Industrial Minerals Assessment Unit (I.M.A.U.) Boreholes

**I.M.A.U. BOREHOLES**



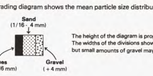

Note:
(i) Figures underlined denote thicknesses used in the assessment of resources
(ii) The + sign indicates that the base of the deposit was not reached
(iii) The figures in *italics* are the conversions to feet of the measurements recorded in metres.
(iv) The Geological Classification is given only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

**Borehole Registration Number**

Each I.M.A.U. borehole is identified by a Registration Number, for example SE 20. The letters refer to the quarter sheet and the figures to the I.G.S. serial numbers for that quarter. The unique designation for borehole SE 20 is TF 15 SE 20.

**Grading Diagrams**

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




The height of the diagram is proportional to the mineral thickness
The widths of the divisions show the proportions of **Fines**, **Sand** and **Gravel**
but small amounts of gravel may be omitted or exaggerated

**CATEGORIES OF DEPOSITS**

| | |
|---|---|
| **Exposed mineral** | CAT-E6 |
| **Continuous or almost continuous spreads of mineral beneath overburden, assessed** | CAT-C1 |
| **Sand and gravel either not potentially workable (see Report) or absent** | CAT-A2 |

**RESOURCE BLOCKS**

For the purpose of assessment, the mineral-bearing land is divided into Resource Blocks (see Report). Each is designated by a letter and, in the case of Block B, by a subscript number.

Detailed records may be consulted on application to the Head, Industrial Minerals Assessment Unit, Institute of Geological Sciences, Keyworth, Nottingham NG12 5GG

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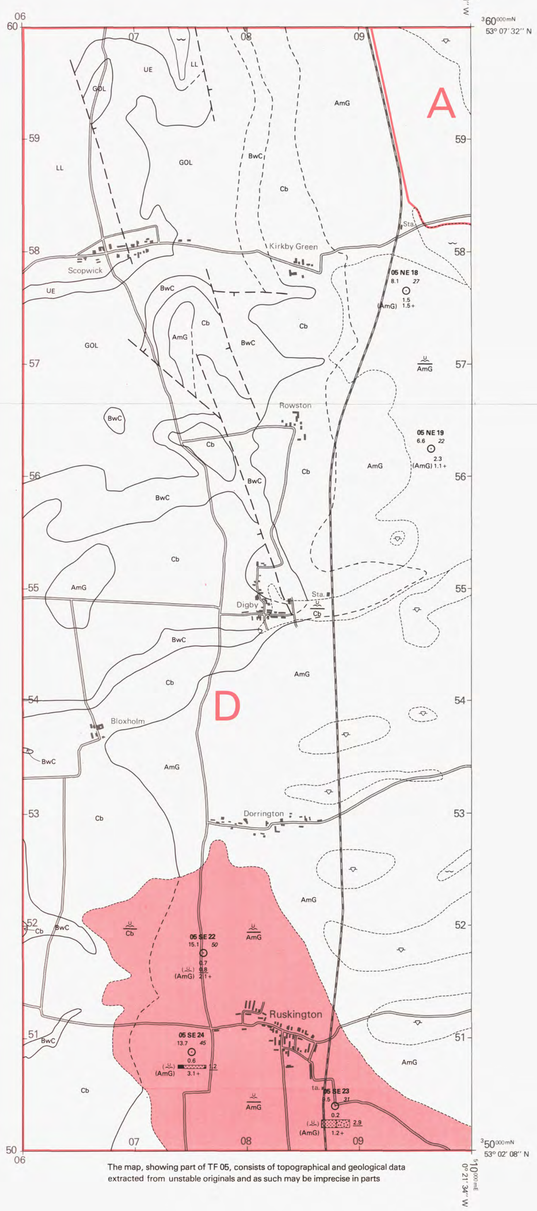


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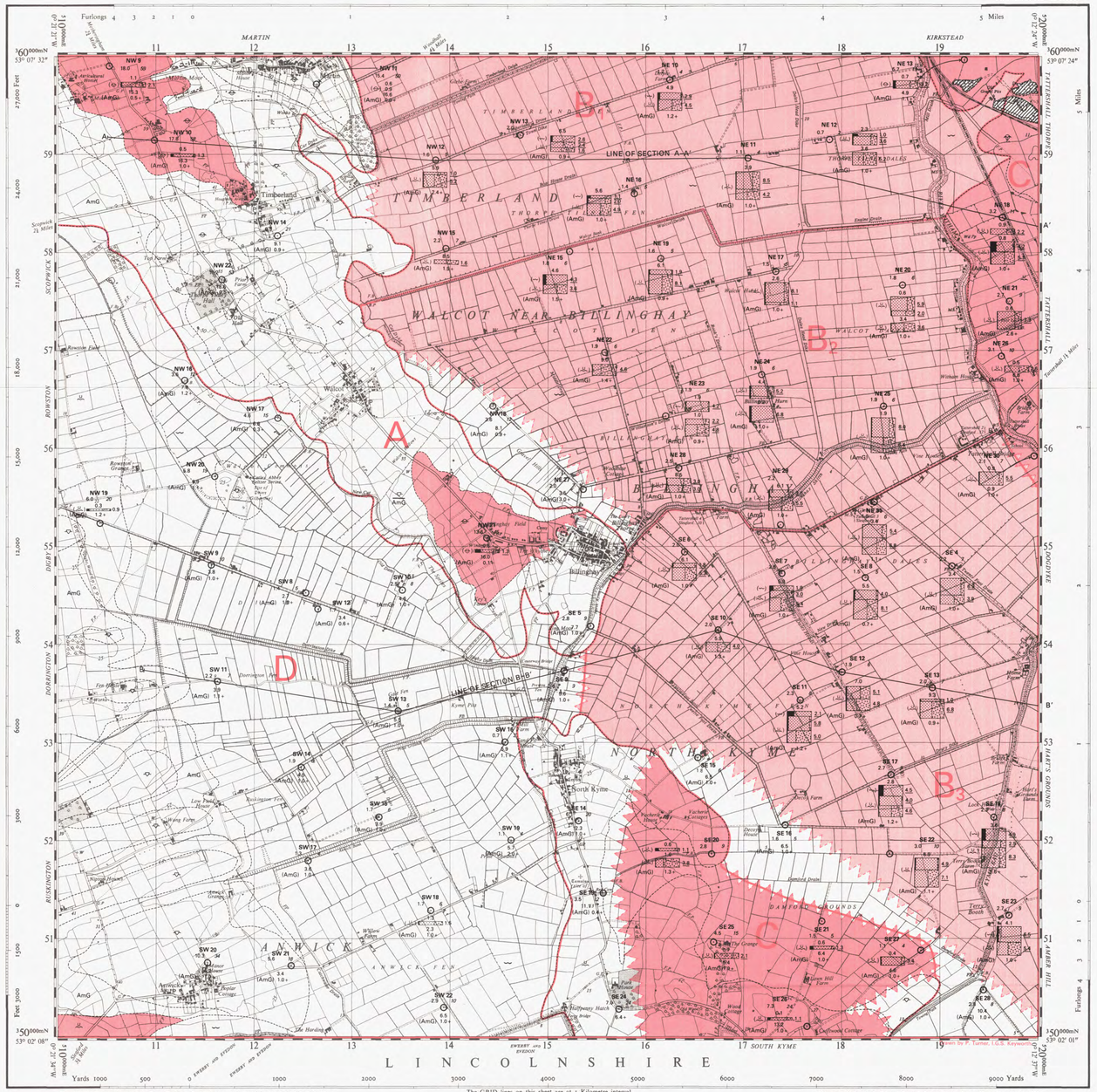


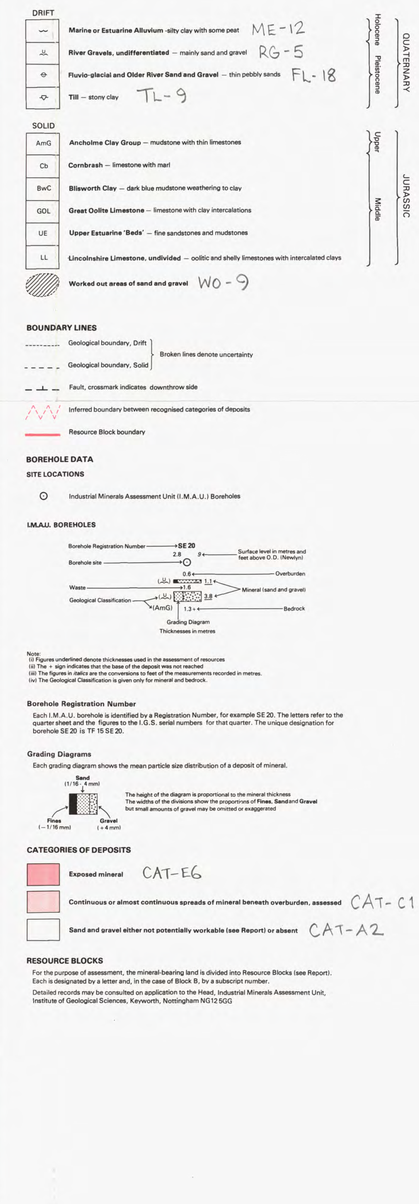

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*1:25,000 Sand and Gravel Resource Sheet published 1982.*
*G. M. Brown, D.Sc., F.R.S., Director, Institute of Geological Sciences.*

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|---|---|---|---|
| SK 96 | TF 06 | TF 16 | TF 26 |
| SK 95 | 114 TF 05 / 127 | TF 15 | 115 TF 25 / 128 |
| SK 94 | TF 04 | TF 14 | TF 24 |

*Diagram showing the relationship of the National Grid 1:25 000 sheets with the 1:50 000 New Series Geological sheets 114 and 127 (published) and 115 and 128 (unpublished)*

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Vertical exaggeration x25 Horizontal scale 1:25 000

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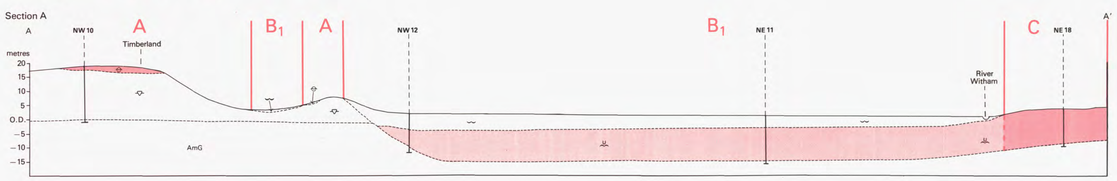


Section B