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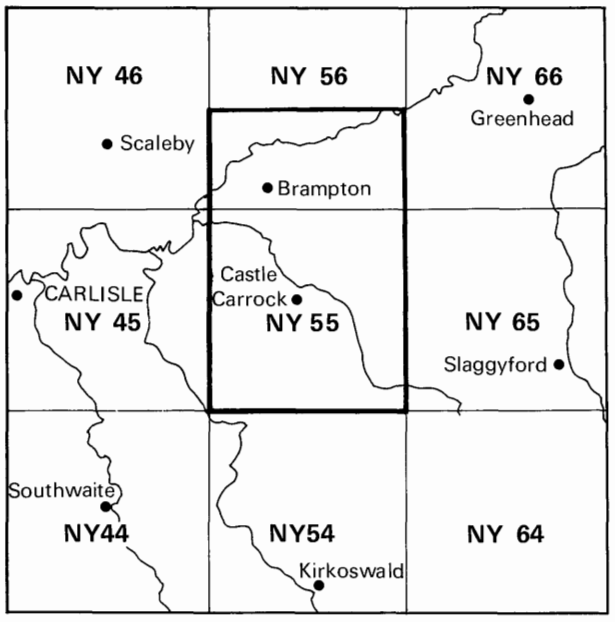

The sand and gravel resources of the country around Brampton, Cumbria

Description of 1:25 000 resource sheet NY 55 and part of NY 56

I. Jackson

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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 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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*The asterisk on the front cover indicates that part of a sheet adjacent to the one cited is described in this report.

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 been made 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 resources of sand and gravel of 150 km^2 of country around Brampton, Cumbria, shown on the accompanying resource map. The survey was conducted by Mr I. Jackson, assisted in the drilling and sampling programme by Mr R. G. Crofts. The work is based on a six-inch geological survey published on New Series one-inch Sheet 18 (Brampton) in 1931. The geological lines, now presented at the 1 : 25 000 scale, incorporate minor amendments resulting from the present survey.

Mr J. W. Gardner, C.B.E., and Mr C. Reeves (Land Agents) have been responsible for negotiating access to land for drilling, The ready cooperation of land owners and tenants in this work is gratefully acknowledged.

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MAP

The sand and gravel resources of sheet NY 55 and part of NY 56 *In pocket*

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The sand and gravel resources of the country around Brampton, Cumbria

Description of 1:25 000 resource sheet NY 55 and part of NY 56

I. JACKSON

SUMMARY

The geological maps of the Institute of Geological Sciences, pre-existing borehole information, and 84 boreholes drilled for the Industrial Minerals Assessment Unit form the basis of the assessment of sand and gravel resources in the area around Brampton, Cumbria.

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

The 1:25 000 map is divided into 7 resource blocks containing between 2.9 and 18.1 km² 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.

Bibliographical reference

JACKSON, I. 1979. The sand and gravel resources of the country around Brampton, Cumbria: description of 1:25 000 resource sheet NY 55 and part of NY 56. *Miner. Assess. Rep. Inst. Geol. Sci.*, No. 45.

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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, both the economic and the social factors used to decide whether a deposit may be workable in the future cannot 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; Harris and others, 1974).

The survey provides information at the 'indicated' level 'for which tonnage and grade are computed partly from specific measurements, samples or production data and partly from projection for a reasonable distance on geological evidence. The sites available for inspection, measurement, and sampling are too widely spaced to permit the mineral bodies to be outlined completely or the grade established throughout' (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 BS sieve, about $\frac{1}{16}$ mm) should not exceed 40 per cent.
d The deposit must 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 which broadly meets these criteria is regarded as 'potentially workable' and is described and assessed as 'mineral' in this report. As the assessment is at the indicated level, parts of such a deposit may not satisfy all the criteria.

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 has been adopted. The boundaries between fines (that is, the clay and silt fractions) and sand, and between sand and

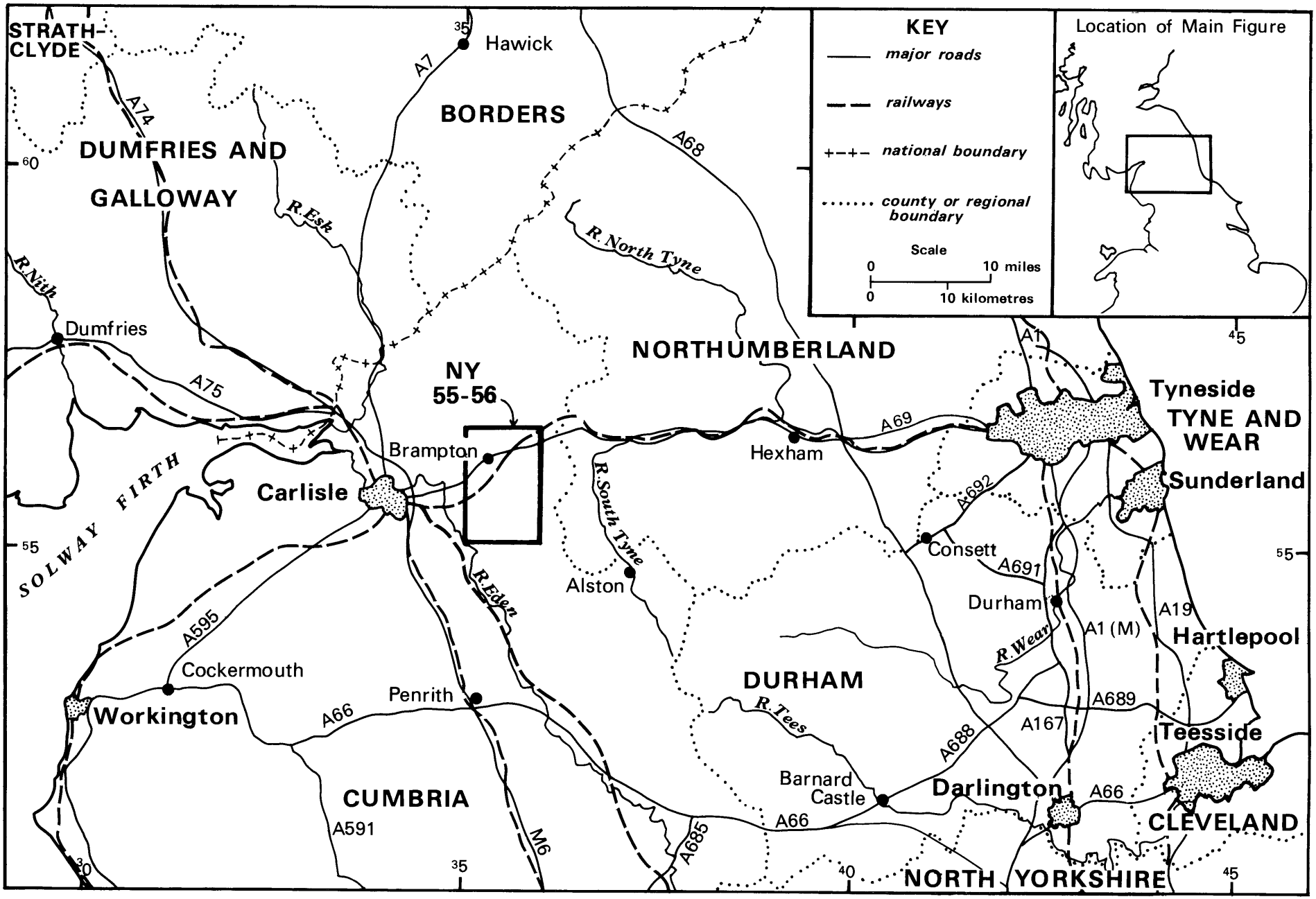


Figure 1 Map showing the location of NY 55 and part of NY 56

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 km² of sand and gravel. No account is taken of any factors, for example, roads, villages and 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 the mineral in parts of a block, except in the immediate vicinity of the actual sample points.

DESCRIPTION OF THE DISTRICT

GENERAL

The district here described lies approximately 10 km to the east of Carlisle (Figure 1) and is crossed by both road and rail routes to Tyneside. There is some light industry in the small market town of Brampton but the district is mainly devoted to dairy and sheep farming. On the higher ground coal mining and quarrying were formerly important, but the Pennine hills are now chiefly significant as a source of water. Hadrian's Wall and other sites of archaeological interest in the north of the district have become popular tourist attractions.

TOPOGRAPHY

The district includes parts of three major physiographic units – the Alston Block, the Tyne Gap and Edenside. The Alston Block, part of the northern Pennines, is bounded to the north and west by fault scarps. It is, in the main, a desolate, peat-covered highland where summit levels exceed 1600 ft (488 m). The Tyne Gap area to the north is comparatively low lying and includes the valley of the westerly flowing River Irthing. That part of Edenside within the district descends from a height of over 700 ft (213 m) in the region of the Pennine Escarpment to below 200 ft (61 m) in the west. It is intensely undulating country, a direct result of widespread glacial modification.

The River Gelt, which with its tributaries drains much of the higher ground, joins the River Irthing a kilometre to the west of the district.

GEOLOGY

The geological sequence is summarised in Table 1 where deposits are listed as far as possible in order of increasing age. A more detailed description of the geology of the area may be found in the descriptive memoir (Trotter and Hollingworth, 1932).

SOLID

Solid rocks are seen in the higher ground to the east and in the deeply incised valleys of the rivers Gelt and Irthing and their tributaries. Elsewhere they are covered by drift.

Quartz dolerite: This igneous rock forms the Whin Sill which is intruded at varying levels into Carboniferous strata. Its thickness is variable but at New Water [5920 5125] more than 24 m is exposed. The rock is uniform in composition, very tough and makes excellent roadstone.

Table 1 Geological sequence

DRIFT		
Recent and Pleistocene	Hill Peat	
	Peat	
	Alluvium	
	River Terraces (1 to 3)	
	Alluvial Fan	
	Moraine	
	Laminated Clay	
	Glacial Sand and Gravel	
	Boulder Clay	
SOLID		
Permo–Triassic	Kirklinton Sandstone	
	St Bees Sandstone	
	St Bees Shale (Eden Shales)	
	Penrith Sandstone	
	Basal Conglomerate (Brockram)	
Carboniferous		
Namurian	Upper Limestone Group	
Dinantian	Middle Limestone Group = Upper Alston Group	
	Lower Limestone Group = Lower Alston Group	
	Birdoswald Limestone Group	= Orton Group
	Craighill Sandstone Group	= Orton Group
	Basement Conglomerate	
Igneous (intrusive)	Quartz dolerite (Whin Sill)	

Carboniferous: Rocks of Carboniferous age crop out over the eastern half of the sheet and probably also incrop against the base of the drift in a small area in the north-west. Dinantian and Namurian strata are represented and these have been divided into a number of stratigraphical groups. Considerable facies variations are caused by the different depositional environments of the Northumberland Trough to the north and the Alston Block to the south. The main sediment types in both areas are limestone, sandstone, shale and coal arranged in various cyclic sequences, but in the north, i.e. the 'Trough' area, the deposits are of a much greater thickness. Table 1 gives the strata groups used by Trotter and Hollingworth (1932), with their approximate modern equivalents.

Permo-Triassic: Permo-Triassic rocks occupy the western half of the sheet and are largely concealed by drift. In this area approximately 425 m of a westerly dipping sequence unconformably overlie Carboniferous strata.

The oldest deposit, a breccia termed '*Basal Conglomerate*' or *Brockram*, is generally less than 1.5 m thick and crops out sporadically along the western edge of the Carboniferous. The *Penrith Sandstone*, a red, medium- to coarse-grained aeolian sandstone, crops out against faults in the extreme south-west of the district. In more complete sequences in the south of Edenside the deposit reaches about 460 m in thickness. The *St Bees* or *Eden Shales* rest on the Penrith Sandstone in the south-west but in the north they appear to overstep it and the Basal Conglomerate to rest directly on the Carboniferous. The beds are of variable thickness and consist of dull red mudstones and siltstones with subordinate sandstones. There is a gradual transition upwards into the *St Bees Sandstone*, which has the most extensive outcrop of the Triassic deposits in the district. It comprises compact, dull red sandstones and siltstones. Over 300 m of beds are exposed in

continuous sequence in the River Gelt. The *Kirklinton Sandstone* is thought to succeed the St Bees Sandstone conformably (Trotter and Hollingworth, 1932, p. 141). It comprises about 110 m of soft, red, fine-grained sandstone, which is exposed in the valleys of the rivers and streams in the north-west of the district.

DRIFT

Superficial deposits are present over large areas of Edenside and in the Tyne Gap, but the Pennines are largely drift free, except for spreads of hill peat and patches of boulder clay.

The glaciation of Edenside is a topic that has attracted several researchers, notably Trotter (1929) and Hollingworth (1931) who published papers dealing with the eastern and western parts of the region respectively, and cooperated to produce the descriptive memoir for the Brampton district (Trotter and Hollingworth, 1932). These two authors identified a tripartite sequence of Lower Boulder Clay, Middle Sands and Gravels with laminated clays and Upper Boulder Clay which they interpreted as being the result of the advance and retreat of the 'Main Glaciation' and a subsequent 'Scottish Readvance'. However, boreholes sunk in connection with the construction of the M6 motorway, information from this sand and gravel assessment and a geological resurvey of the Penrith district (R. S. Arthurton, *personal communication*) show that the sequence is more complex and that it may be the result of a single glaciation.

Boulder Clay: The most widespread boulder clay is a hard, compact deposit with pebbles and boulders set in a matrix that varies from a stiff clayey silt to a friable clayey sand (as for example at Whinnyhill, see p. 59). Its usual colour is reddish brown, though brown and greyish brown varieties may overlie Carboniferous rocks. Proved thicknesses of the clay range from 0.2 m to 18.5 m. The deposit generally rests on bedrock and is overlain by Glacial Sand and Gravel over much of the district. The sand and gravel is capped in the west by thin, discontinuous patches of a soft, mottled, silty clay with few pebbles and some sand lenses—the 'Upper Boulder Clay' of Trotter and Hollingworth.

Glacial Sand and Gravel: An extensive tract of Glacial Sand and Gravel known as the Brampton 'Kame' Belt occupies much of Edenside and the Tyne Gap within the district. Fluvio-glacial and glacio-lacustrine deposition in a series of different environments has resulted in considerable variation in the thickness and composition of these stratified deposits and produced a variety of landforms, the shapes of which are commonly indicative of their internal composition. Figure 2 illustrates the distribution of some of these landforms, but only those which could be recognised with some degree of confidence are depicted.

Large-scale linear ridges, for example north-east of Brampton [540 620], south of Faugh [510 548] and north of Morley Hill [509 532], are composed chiefly of sand with sporadic gravel lenses and thin silt and clay partings.

Flat-topped hills, for example the Crews [533 587] and Hall Bank (553 590), also consist predominantly of sand with some gravel and clay.

Eskers, smaller elongate mounds with sharp crests, are present in the eastern part of the deposit, for example south of Bowbank [563 591] and north of Hullerbank [555 581]. These comprise gravel with cobbles and boulders and subordinate amounts of sand, silt and clay. Areas of irregular hummocky terrain and terrace-like features appear to be more varied in composition and thickness, and while in the north and west they may consist of sand with silt and clay bands, to the south and east gravel becomes dominant.

Trotter and Hollingworth (1932, p. 148) considered many of these features to be the product of extraglacial deposition from a continuously retreating ice front. More recently however, Huddart (1970, p. 185) has interpreted the deposits in the context of a stagnating ice sheet, the sediments originating under conditions of ice control and support.

Laminated Clay: Laminated clay crops out in the north-west of the district (Figure 2), in the region of the Irthing Valley, and was encountered in many boreholes in that area. The deposit consists of reddish brown and brown laminated clayey silts ranging up to 19.3 m in thickness. These are often intercalated with fine sands and silts and together are interpreted as sediments deposited in a glacial lake in the valley of a proto-River Irthing.

Moraine: Sinuous ridges of ill-sorted gravel south and east of Longdyke [540 530] and north of Garth Head [550 558] have been mapped as 'Moraines'. However their composition suggests a fluvio-glacial derivation and as they are also closely aligned with nearby glacial drainage channels (Figure 2), they are more probably eskers.

Alluvial Fan: Alluvial fans are generally found at the outfall of small, steeply graded valleys and other areas of strong relief, for example near Wallholme in the upper Irthing valley [5817 6451] and north of Cumrew on the Pennine Escarpment [550 507]. Their lithology is influenced by surrounding deposits and therefore varies greatly.

River Terrace Deposits: Three terraces have been mapped in the Gelt and Irthing valleys; however, the number of a terrace indicates only the relative position above the alluvium at any one place, and IMAU boreholes found no corresponding changes in the composition, grade or thickness of the deposits. The terraces consist in the main of coarse gravels up to 5.1 m in thickness but in places they are represented by only thin silts and clays.

Alluvium: Alluvium crops out in the valleys of the Gelt and Irthing and other smaller streams and depressions throughout the district. It is not consistent in composition, and while in parts of the Irthing floodplain 2.8 m of gravel has been proved, many of the less extensive deposits consist of fine sands, silts and clays.

Peat: Two types of peat have been recognised – hill peat, which forms a widespread covering over the higher parts of the Pennine hills, and basin peat which occurs in ill-drained positions upon the glacial drift, often infilling kettleholes (Figure 2).

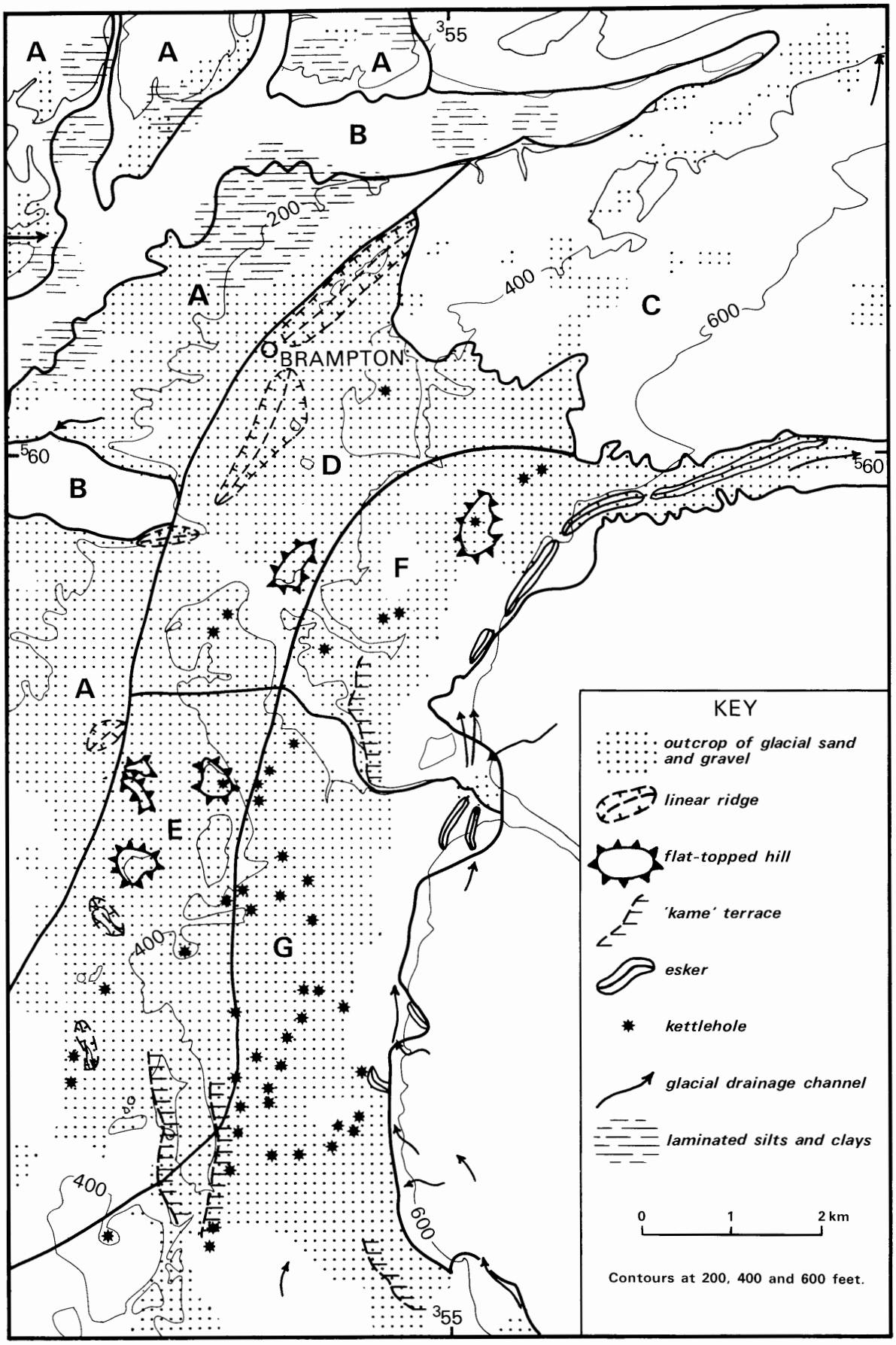


Figure 2 Selected glacial features and deposits in relation to resource block boundaries. (Blocks are outlined and designated by letters.)

Table 2 Pebble count analyses of selected samples (percentage by weight)

Deposit and Borehole number	Permo-Triassic sandstone	Carboniferous sandstone	Lower Palaeozoic grit and greywacke	Mudstone	Carboniferous limestone	Quartzite	Extrusive igneous	Granite	Quartz
GLACIAL SAND AND GRAVEL									
NY 55 NW 9	6	6	46	5	–	1	33	trace	trace
NY 55 NW 11	11	14	11	2	9	4	46	2	1
NY 55 NW 13	15	21	14	trace	–	2	46	1	1
NY 55 NW 16	48	2	13	1	–	5	30	trace	trace
NY 55 NE 32	6	39	30	1	–	3	19	1	1
NY 55 SW 5	15	27	18	2	3	3	30	trace	trace
NY 55 SW 7	13	10	10	1	–	6	34	23	2
NY 55 SW 11	22	7	6	1	1	3	58	1	1
NY 55 SW 18	10	23	28	4	trace	6	26	trace	2
NY 56 SW 17	12	12	53	1	–	1	19	1	1
RIVER TERRACE DEPOSITS AND ALLUVIUM									
NY 56 SW 7	2	42	40	trace	trace	2	10	1	2
NY 56 SW 8	1	46	35	–	–	2	14	1	1
NY 56 SE 6	trace	35	44	trace	trace	6	13	1	trace

COMPOSITION OF THE SAND AND GRAVEL

The potentially workable sand and gravel deposits of the area are Glacial Sand and Gravel, 'Moraines', River Terrace Deposits, Alluvium and small areas of Alluvial Fan. Locally, for example Whinnyhill (p. 59), boulder clay may grade as mineral (for definition see p. 1); the detailed distribution of this type of deposit is not known but it is probably limited and therefore it has not been included in the assessment.

St Bees Sandstone forms rockhead in many of the boreholes in the west of the sheet. The deposit is generally too compact and indurated to be regarded as potentially workable sand and is therefore not mineral within the terms of the definition on p. 1. However, certain bedrock samples were crushed and graded and showed the sandstone to be a 'very clayey' fine sand (Figure 13).

Glacial Sand and Gravel and Moraine: These deposits show considerable lateral and vertical variation in grade. In the east, adjacent to the Pennines (blocks F and G), gravel and sandy gravels predominate but north and westwards they pass into thick sequences of sand and pebbly sand, which in turn give way to 'clayey' sand with silt and clay bands. The mean grading of all the samples is fines 10 per cent, sand 75 per cent, and gravel 15 per cent.

The gravel fractions comprise subangular to subrounded coarse pebbles with generally subordinate amounts of fine and cobble grade material. However, several boreholes were drilled with a heavy chisel which produces fragmented clasts,the grading of which does not indicate the true *in situ* grading. Lithologically, extrusive igneous rocks, usually from the Borrowdale Volcanic Series, are most prevalent but Carboniferous and Permo-Triassic (mainly St Bees) sandstones and Lower Palaeozoic greywacke and grit are also common. In contrast, Carboniferous limestone, quartz, quartzite, granite and mudstone together usually account for less than 10 per cent of the total (Table 2).

The sand fraction consists predominantly of fine-grained quartz but some lithic fragments comparable to the rocks found in the gravels may be recognised, especially in the coarser grain sizes.

Alluvial Fan: Potentially workable sand and gravel was proved in only one of the two assessment boreholes drilled into these scattered deposits. It has a mean grading of fines 16 per cent, sand 66 per cent and gravel 18 per cent with a composition similar to that of Glacial Sand and Gravel.

River Terrace Deposits and Alluvium: Despite differences in age, the potentially workable sand and gravel within these deposits is fairly uniform in composition and has a mean grading of fines 5 per cent, sand 39 per cent, gravel 56 per cent. The gravel is predominantly coarse and commonly consists of subrounded Carboniferous sandstone and Lower Palaeozoic greywacke and grit with some extrusive igneous rocks and small amounts of quartz, Carboniferous limestone, granite, quartzite and sandstone. The sand fraction is medium-to fine-grained and comprises quartz with lithic fragments in the coarser grades.

THE MAP

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

Geological data: The geological boundaries shown are based on a six-inch scale geological survey of New Series sheet 18, first published in 1931, but the assessment map incorporates amendments resulting from the sand and gravel survey.

The geological boundaries are the best interpretation of the information available at the time of the survey. However, it is inevitable, particularly with glacial deposits, that local irregularities and discrepancies will be revealed as new evidence from boreholes and excavations becomes available.

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

Table 3 Sand and gravel resources of the area

Statistical assessment Block	Area		Mean thickness			Volume of mineral			Mean grading percentage			
	Block	Mineral	Overburden	Mineral	Waste		Limits at the 95 per cent confidence level		Fines $-\frac{1}{16}$ mm	Sand $+\frac{1}{16}-4$ mm	Gravel $+4-64$ mm	$+64$ mm
	km^2	km^2	m	m	m	$m^3\times10^6$	$\pm$%	$\pm m^3\times10^6$				
A	20.1	18.1	0.8	12.2	1.6	221	20	44	14	79	6	1
B	9.4	9.4	2.0	7.5	0.4	71	60	43	10	70	17	3
D	10.8	10.1	0.5	15.7	1.0	159	41	65	12	83	4	1
E	12.8	10.3	0.4	12.5	0.2	129	58	75	8	84	6	2
F	9.8	7.2	0.5	7.1	0.1	51	52	27	8	55	22	15
G	18.5	12.4	0.3	8.6	0.2	107	35	38	6	56	30	8
TOTAL	81.4	67.5	0.7	10.9	0.7	738	17	126	11	75	11	3
Inferred assessment, block C, not included above												
C	22.7	2.9	0.6	9.4	0.3	30 (speculative)			11	87	2	0

Mineral resource information: For assessment purposes the map is divided into areas of mineral and areas where sand and gravel are not potentially workable or absent (for definitions of 'mineral' and 'potentially workable' see p. 1). The mineral is further subdivided into areas where it crops out (except for thin soil) and areas where it is present in continuous spreads beneath overburden. However, within these areas there may be small patches where sand and gravel is absent or not potentially workable. Areas where bedrock crops out, where superficial deposits do not contain mineral and where sand and gravel is deemed not to be potentially workable are shown uncoloured.

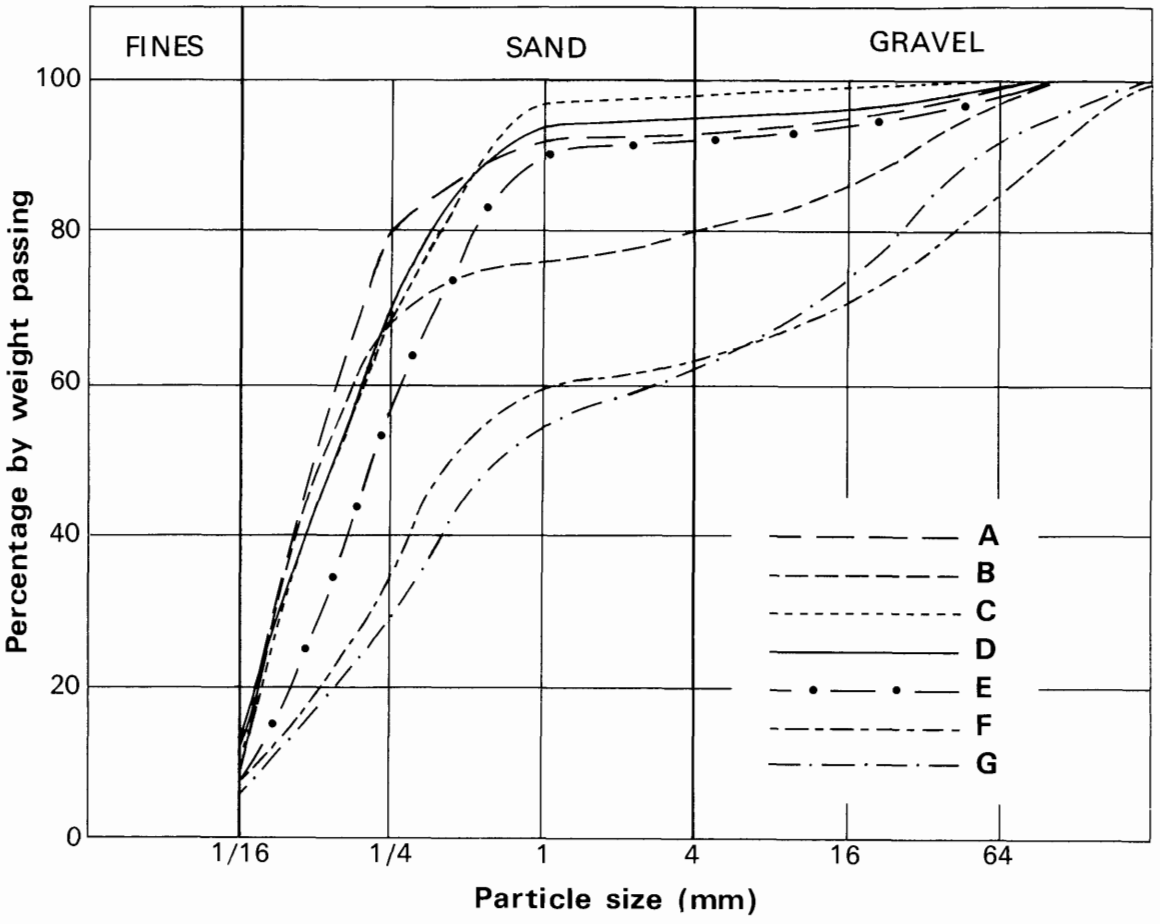
For the most part the depicted distribution of categories of deposits is based on the mapped geological boundaries. Where there is a transition from one category to another, which cannot be related to the geological map and which could not be accurately delineated during this survey, inferred boundaries have been inserted. Such boundaries are shown by a distinctive symbol which is intended to convey a likely zone of occurrence rather than to represent the breadth of the zone; its width is dictated by cartographic considerations. For the purpose of measuring areas the centre-line of the symbol is used.

RESULTS

The results are summarised in Table 3. Further grading particulars are shown in Figure 3 and the mean gradings and 'grading envelopes' for each resource block are given in Figures 4 to 10.

Some of the drift deposits of this district proved difficult to drill. A number of boreholes, especially in block A, had to be abandoned in mineral deposits without proving the base and others were stopped in boulder clay before reaching the prescribed depth. As a result the mineral thicknesses derived from these boreholes are minima and the estimates of mean thickness and volume are conservative.

For the six statistically assessed resource blocks on this resource sheet the confidence limits at the symmetrical 95 per cent probability level vary between 20 and 60 per cent. However, the true values are more likely to be nearer the figures estimated than the limits. Moreover, it is probable that in each block roughly the same percentage limits would apply for the estimate of volume of a very much smaller parcel of ground (say, 100 hectares) containing similar sand and gravel deposits if results from the same number of sample points (as provided by, say, 10 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 10 sample points will be needed, 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 A, B, D, E, F and G. The total (738 million m^3) volume can be estimated to limits of $\pm$17 per cent at the 95 per cent confidence level by a calculation based on the data from the 79 sample points spread across the six resource blocks. However, it must be emphasised that the quoted volume of sand and gravel has no simple relationship with the amount that could be extracted in practice, as no allowance has been made in the calculations for any restraints (such as existing buildings and roads etc.) on the use of land for mineral working.



Block	Percentage by weight passing					
	$\frac{1}{16}$ mm	$\frac{1}{4}$ mm	1 mm	4 mm	16 mm	64 mm
A	14	79	92	93	95	99
B	10	68	76	80	86	97
C	11	68	97	98	99	100
D	12	70	94	95	96	99
E	8	56	90	92	94	98
F	8	35	59	63	71	85
G	6	29	54	62	74	92

Figure 3 Mean particle-size distribution for the assessed thickness of sand and gravel in resource blocks A to G

Table 4 Data from assessment boreholes: block A

Borehole	Recorded thickness			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 $+16-64$ mm	Cobbles $+64$ mm
	m	m	m							
55 NW 6	14.1†	0.4	2.0	12	71	8	2	2	3	2
55 NW 7	17.9†	1.5	–	16	64	10	1	2	5	2
55 NW 9	12.7	0.4	1.0	11	58	10	2	5	11	3
55 NW 14	3.6	0.5	–	6	90	4	0	0	0	0
55 NW 19	11.9‡	0.6	3.0	22	73	4	0	0	1	0
56 SW 2	10.6	2.5	–	25	75	0	0	0	0	0
56 SW 6	11.1	1.0	1.0	18	67	14	1	0	0	0
56 SW 9	20.0‡	0.5	–	13	65	16	1	1	3	1
56 SW 12	8.7	0.3	0.3	8	70	22	0	0	0	0
56 SW 13	11.0‡	2.4	2.8	16	78	6	0	0	0	0
56 SW 17	15.9‡	0.3	–	6	43	29	4	5	10	3
56 SW 18	11.3†	0.3	8.4	14	76	9	0	1	0	0
56 SW 20	9.4‡	0.3	4.7	15	56	13	2	4	9	1
56 SW 21	8.7	0.3	–	16	48	23	3	4	5	1
Mean	12.2	0.8	1.6	14	65	13	1	2	4	1

* Within mineral

† The full thickness of mineral was not proved

‡ The borehole did not reach the prescribed depth

NOTES ON RESOURCE BLOCKS

The sand and gravel deposits of the sheet have been divided into seven resource blocks. Except for block B, which encompasses fluvial and underlying glacial deposits, and block C, which comprises scattered areas of Glacial Sand and Gravel, the resource block boundaries are somewhat arbitrary, being an attempt to reflect ill-defined variations of grade within the main outcrop of the Glacial Sand and Gravel.

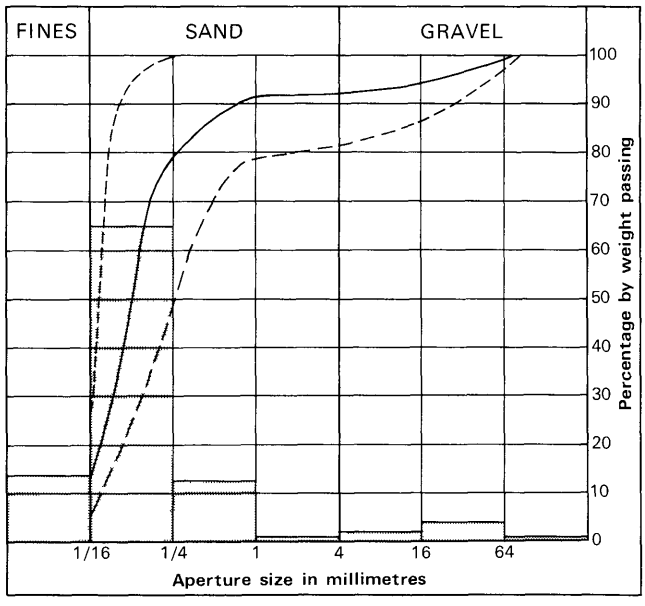


Figure 4 Grading characteristics of the mineral in block A. (The continuous line is the cumulative frequency curve of the mean grading of the block as a whole: the broken lines denote the envelope within which the mean grading curves for individual boreholes fall. The mean grading of the block is also shown as a histogram).

Block A (Table 4, Figure 4)

This block, which occupies 20.1 km^2 in the north-west is split into five parts by the valleys of the rivers Gelt, Irthing, King and Cam. Mineral consists mainly of Glacial Sand and Gravel which is sometimes over- or underlain by boulder clay and is commonly inter-bedded with laminated clay. Proved mineral thicknesses range from 3.6 m to 20.0 m but are generally closer to the mean of 12.2 m. The fines content of individual boreholes lies between 6 and 25 per cent but 'clayey' deposits predominate. Although several boreholes contain pebbly beds, in only three does gravel account for more than 10 per cent of the mineral: boreholes 55 NW 9, 56 SW 17 and 56 SW 20, which contained thicker pebbly sands or gravels, yield mean gravel contents of 19, 18 and 14 per cent respectively. The mean grading for the block is 14 per cent fines, 79 per cent sand and 7 per cent gravel and the estimated volume of mineral is 221 million m^3 $\pm$ 20 per cent.

In many places overburden consists only of thin soil, but where the mineral is overlain by boulder clay or laminated clay thicknesses of up to 2.5 m have been proved. Similarly, where laminated clays and silts occur within mineral, waste totalling up to 8.4 m is present.

Block B (Table 5, Figure 5)

This block encompasses the River Irthing and its tributaries and contains mineral which comprises alluvium, terrace, alluvial fan and underlying glacial material.

The alluvial and terrace deposits consist mainly of coarse gravel up to 5.1 m thick but at borehole 56 SW 5 are represented by 0.2 m of sandy gravel and in borehole 56 SW 11 comprise only silt and clay. The small alluvial fan near Wallholme yielded 6.4 m of pebbly sand in borehole 56 SE 3, whereas another small fan at Crookstown is composed of clay with sandy lenses (56 SE 7). The mean proved thickness of all the fluvial mineral deposits is 2.2 m and the estimated volume is 20 million m^3 $\pm$58 per cent.

Table 5 Data from assessment boreholes: block B

Borehole	Recorded thickness			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 $+16-64$ mm	Cobbles $+64$ mm
All deposits										
	m	m	m							
55 NW 1	1.5	1.1	–	2	8	12	16	21	14	27
55 NW 2	5.9	0.2	2.3	6	22	12	6	11	28	15
56 SW 5	11.3†	6.9	–	14	80	3	1	1	1	0
56 SW 7	2.8	0.4	–	3	6	11	11	29	38	2
56 SW 8	5.1†	0.6	–	5	9	18	12	27	28	1
56 SW 10	18.1†	1.1	–	16	75	2	1	2	3	1
56 SW 11	3.3	7.3	–	19	65	2	4	2	4	4
56 SW 16	5.7‡	1.7	0.3	5	18	16	7	19	31	4
56 SE 3	6.4	0.3	–	16	57	4	5	6	11	1
56 SE 5	2.9	1.8	–	6	10	10	8	19	42	5
56 SE 6	3.7	0.3	1.9	16	42	9	5	10	16	2
56 SE 7	23.4	2.3	–	6	79	12	0	1	2	0
Mean	7.5	2.0	0.4	10	58	8	4	6	11	3
River Terrace Deposits, Alluvium and Alluvial Fan										
	m	m	m							
55 NW 1	1.5	1.1	–	2	8	12	16	21	14	27
55 NW 2	3.0	0.2	0.4	7	30	11	4	8	23	17
56 SW 5	–	–	–	–	–	–	–	–	–	–
56 SW 7	2.8	0.4	–	3	6	11	11	29	38	2
56 SW 8	5.1	0.6	–	5	9	18	12	27	28	1
56 SW 10	1.3	1.1	–	6	13	23	13	25	20	0
56 SW 11	–	–	–	–	–	–	–	–	–	–
56 SW 16	1.1	1.7	–	6	14	20	6	10	36	8
56 SE 3	6.4	0.3	–	16	57	4	5	6	11	1
56 SE 5	2.9	1.8	–	6	10	10	8	19	42	5
56 SE 6	1.8	0.3	–	5	10	18	11	20	32	4
56 SE 7	–	–	–	–	–	–	–	–	–	–
Mean	2.2	0.6	–	8	24	12	9	17	25	5

* Within mineral

† The full thickness of mineral was not proved

‡ The borehole did not reach the prescribed depth

Glacial Sand and Gravel together with laminated clay, silt and underlying boulder clay have been proved beneath the river deposits. Mineral within Glacial Sand and Gravel is irregular in distribution, thickness and composition. A number of boreholes (56 SW 7, 56 SW 8 and 56 SE 5) found no sand and gravel within this glacial sequence. In contrast, borehole 56 SE 7 proved 3.4 m of 'clayey' sand on more than 20 m of partly pebbly sand. The mean proved thickness of glacial mineral is 5.4 m, giving an estimate of volume of 51 million m^3 but confidence limits are as high as 96 per cent! The mean grading is 16 per cent fines, 71 per cent sand and 13 per cent gravel.

Fluvial and glacial mineral combined has a mean grading of 10 per cent fines, 70 per cent sand and 20 per cent gravel. The mean thickness is 7.5 m and the estimated total volume is 71 million m^3 ± 60 per cent.

Where fluvial deposits are thin or absent and glacial silts and clays present, overburden thicknesses are high (for example 56 SW 11) but the mean for the block is only 2.0 m.

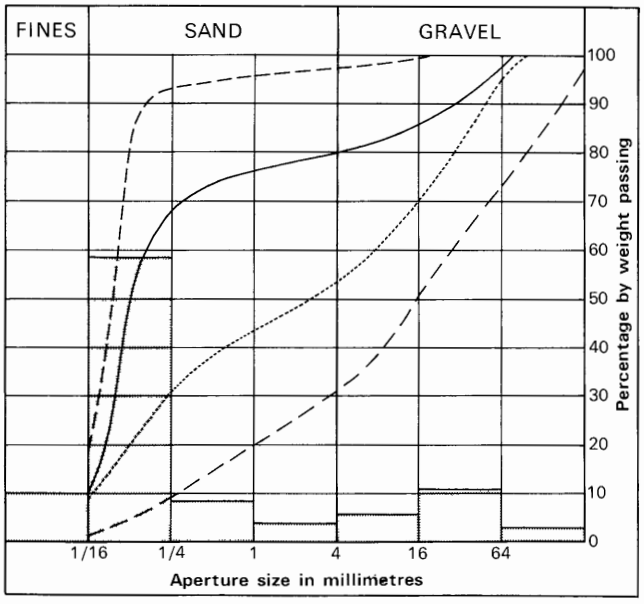


Figure 5 Grading characteristics of the mineral in block B. (For explanation see Figure 4. Note that the mean grading of River Terrace Deposits, Alluvium and Alluvial Fan is shown as a dotted line.)

Table 6 Data from assessment boreholes: block C

Borehole	Recorded thickness			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 +16–64 mm	Cobbles +64 mm
	m	m	m							
56 SE 4	23.4	0.5	1.1	10	54	33	1	1	1	0
56 SE 8	5.3	0.3	–	6	54	40	0	0	0	0
56 SE 12	3.7†	0.3	–	17	82	1	0	0	0	0
56 SE 13	5.3	1.1	–	16	55	17	5	3	4	0
Mean	9.4	0.6	0.3	11	57	29	1	1	1	0

* Within mineral

† The full thickness of mineral was not proved

Block C (Table 6, Figure 6)
This block has an area of 22.7 km² but only 2.9 km² are mineral-bearing, consisting mainly of scattered patches of Glacial Sand and Gravel.

Borehole 56 SE 9 drilled on ground mapped as 'Boulder Clay' proved 1.7 m of 'clayey' pebbly sand at surface; however, the area occupied by the deposit is too small to be delineated on the resource map. On the other hand, boreholes 56 SE 10, 11 and 15 sited to investigate areas mapped as sand and gravel proved only boulder clay and the geological lines have been revised accordingly. The four holes which proved sand and gravel found thicknesses between 3.7 m and 23.4 m. The presence of about 30 million m³ of mineral is inferred; but it is largely 'clayey' and contains little gravel.

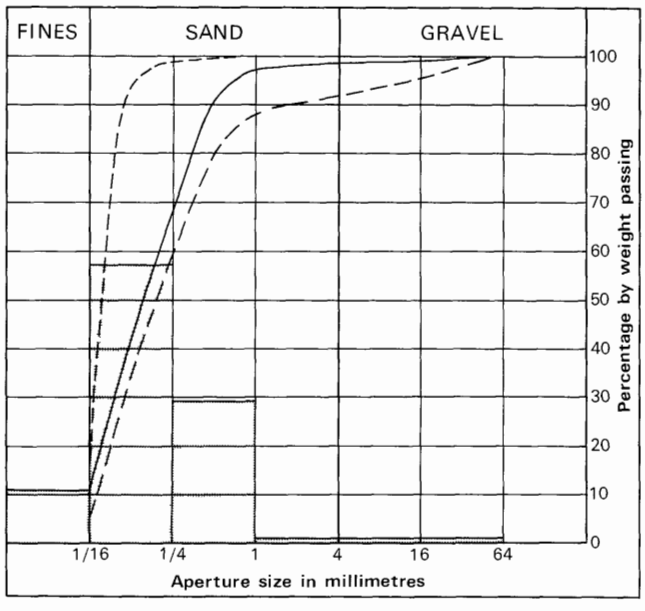


Figure 6 Grading characteristics of the mineral in block C. (For explanation see Figure 4.)

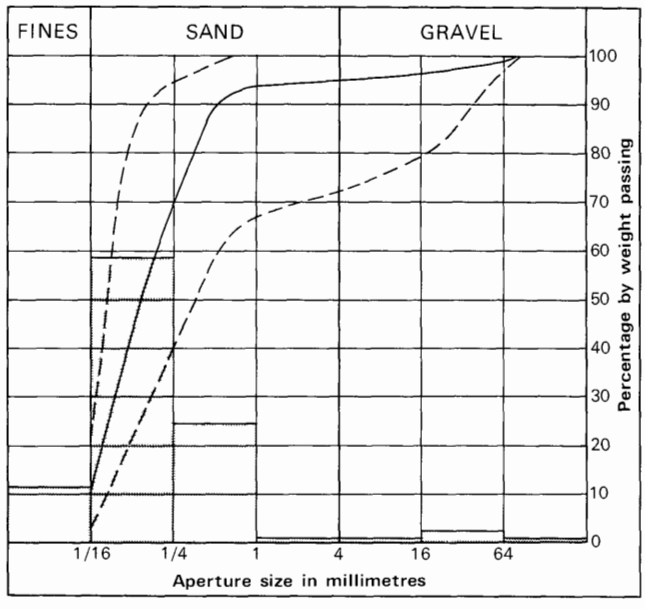


Figure 7 Grading characteristics of the mineral in block D. (For explanation see Figure 4.)

Block D (Table 7, Figure 7)
The mineral of this block consists for the most part of Glacial Sand and Gravel, which rests on boulder clay or bedrock.

The deposits may occur as linear ridges and flat-topped hills (see p. 4) with thicknesses which exceed 25 m and which therefore lie below the assumed maximum depth of working (p. 1). Surrounding these constructional forms are thinner amorphous spreads of sand and gravel. As a result of this topographic diversity the mineral thicknesses proved have a wide range: from 2.0 m in borehole 56 SE 14 to 24.7 m in boreholes 56 SW 14 and 56 SW 23. The mean thickness for the block is 15.7 m and the estimated volume is 159 million m³ ±41 per cent.

The mean grading for the block is fines 12 per cent, sand 83 per cent and gravel 5 per cent. However, borehole 56 SE 14 is exceptional in that it contained 28 per cent gravel, compared with a maximum of 12 per cent elsewhere. Fines, usually reddish brown silt, account for between 3 and 22 per cent of the deposit.

Overburden, mainly a sandy soil and subsoil, has a mean thickness of only 0.5 m. Waste partings reach a maximum total thickness of 5.0 m in borehole 55 NW 8, where they consist of sandy silt bands; the mean thickness, however, is only 1.0 m.

Table 7 Data from assessment boreholes: block D

Borehole	Recorded thickness			Mean grading percentage						
	Mineral	Overburden	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 +16–64 mm	Cobbles +64 mm
	m	m	m							
55 NW 3	23.9	0.5	–	22	74	4	0	0	0	0
55 NW 4	0.6	1.4	–	20	61	5	2	3	9	0
55 NW 8	19.1	0.3	5.0	20	75	3	0	1	1	0
55 NW 10	24.0	0.4	–	5	37	49	2	2	4	1
55 NW 11	20.0	0.4	3.4	7	31	45	5	5	6	1
56 SW 14	24.7	0.3	–	7	45	45	1	1	1	0
56 SW 19	11.1	0.4	2.2	15	65	6	2	4	5	3
56 SW 22	15.5	0.7	–	9	69	14	1	0	4	3
56 SW 23	24.7	0.3	–	13	78	8	0	0	1	0
56 SE 14	2.0	0.2	–	11	36	20	5	7	21	0
56 SE 16	6.9	0.4	–	3	63	34	0	0	0	0
Mean	15.7	0.5	1.0	12	58	24	1	1	3	1

* Within mineral

Block E (Table 8, Figure 8)
This block is a southwards extension of block D. The mineral is again subject to marked lateral variations in thickness and while in borehole 55 SW 4 only a thin veneer (0.5 m) of 'clayey' pebbly sand was present an exposure in a sand pit at the nearby village of Faugh recorded 29.5 m of sand. The mean mineral thickness for the block is 12.5 m and the estimated volume is 129 million m^3 ±58 per cent.

Lateral and vertical variations in composition also occur and the deposit ranges from a 'clayey' sand to a sandy gravel. Notable, however, are the thick sequences of sand which were proved at sites 55 NW 20, 55 SW 6, and 10 and E NY 55 SW1. The mean gravel content of individual boreholes ranges between 1 and 41 per cent but is commonly less than 26 per cent; fines range between 3 and 26 per cent. The mean grading for the block is fines 8 per cent, sand 84 per cent and gravel 8 per cent.

Overburden consists everywhere of thin soil and does not exceed 0.8 m in thickness.

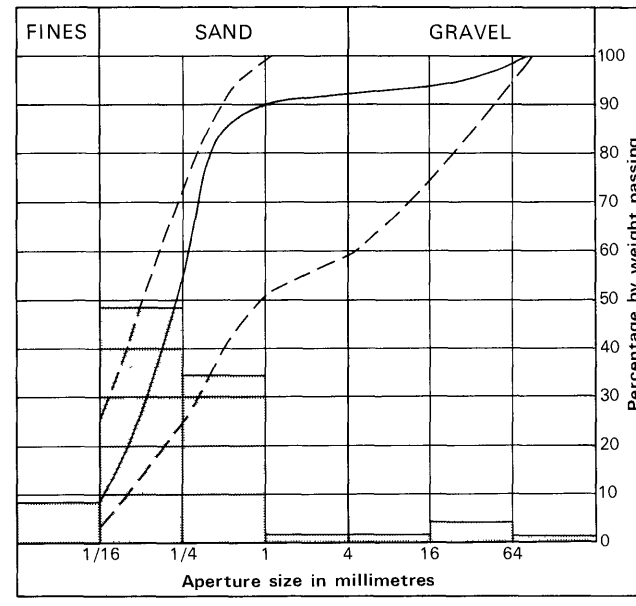


Figure 8 Grading characteristics of the mineral in block E. (For explanation see Figure 4.)

Table 8 Data from assessment boreholes and exposure records: block E

Borehole	Recorded thickness			Mean grading percentage						
	Mineral	Overburden	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 +16–64 mm	Cobbles +64 mm
	m	m	m							
55 NW 15	10.5	0.5	–	9	15	27	8	15	22	4
55 NW 16	9.4	0.8	–	12	69	2	1	3	10	3
55 NW 20	22.5	0.3	–	4	45	44	2	1	3	1
55 NW 21	3.4	0.3	–	26	47	17	3	3	4	0
E 55 NW 1	10.2	0.2	–	6	25	39	5	10	12	3
E 55 NW 2	15.6	–	–	13	53	31	1	0	1	1
55 SW 2	4.2	0.3	–	21	24	29	3	4	11	8
55 SW 4	0.5	0.3	–	10	34	24	10	11	11	0
55 SW 6	23.9	0.5	–	8	57	30	2	1	1	1
55 SW 7	0.9	0.3	–	10	32	20	8	9	19	2
55 SW 9	9.1	0.4	–	18	28	24	4	6	11	9
55 SW 10	21.8†	0.5	1.8	9	61	29	trace	trace	trace	trace
E 55 SW 1	29.5	–	–	3	40	51	3	1	1	1
Mean	12.5	0.4	0.2	8	48	34	2	2	4	2

* Within mineral

† The full thickness of mineral was not proved

Table 9 Data from assessment boreholes and exposure records: block F

Borehole	Recorded thickness			Mean grading percentage						
	Mineral	Overburden	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 +16–64 mm	Cobbles +64 mm
	m	m	m							
55 NW 5	3.8	0.2	–	3	16	29	5	13	29	5
55 NW 12	3.7	0.5	–	13	34	35	4	5	9	0
55 NW 13	13.2†	0.8	–	4	14	43	6	9	18	6
55 NW 18	21.0	0.3	–	8	41	39	3	4	4	1
55 NE 30	1.3	0.4	–	3	12	38	7	14	21	5
55 NE 31	4.8†	1.8	–	18	49	7	4	6	10	6
55 NE 32 A	8.3†	0.2	–	7	12	7	5	8	25	36
55 NE 33	4.8	0.4	–	12	19	7	5	14	24	19
55 NE 34	7.2	0.5	1.4	9	59	18	1	4	5	4
55 NE 35	3.1†	1.0	–	11	13	5	9	17	20	25
E 55 NE 1	9.8	0.2	–	4	3	2	5	10	20	56
Mean	7.1	0.5	0.1	8	27	24	4	8	14	15

* Within mineral

† The full thickness of mineral was not proved

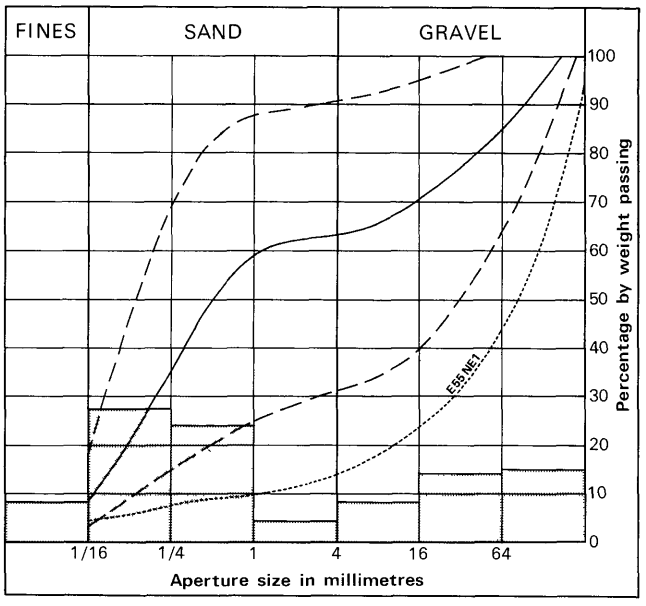


Figure 9 Grading characteristics of the mineral in block F. (For explanation see Figure 4.) Note that the mean grading of E 55 NE 1 is shown as a dotted line and is not included in the grading envelope.

Block F (Table 9, Figure 9)
The deposits of this block have a composition and form consistent with deposition in the high-energy environments which must have existed early in the stagnation and retreat phases of glaciation. The potentially workable sand and gravel is therefore characterised by large amounts of coarse and cobble gravel, which represents some 29 per cent of the total mean grading. An exposure of esker sediments, E NY 55 NE1, shows gravel containing many cobbles and boulders in an ill-sorted matrix—a composition typical of these landforms. Less gravelly deposits do occur however and boreholes 55 NW 13, 55 NW 18 and 55 NE 34 contain substantial sand sequences. The mean grading of the block as a whole is fines 8 per cent, sand 55 per cent and gravel 37 per cent.

The mineral attains a maximum proved thickness of 21.0 m in borehole 55 NW 18, although in all other boreholes it does not exceed 13.2 m. This is reflected in the mean thickness for the block of 7.1 m. The estimated volume of mineral is 51 million m^3 ±52 per cent.

Borehole 55 NE 31 proved boulder clay to a depth of 1.8 m from surface, but elsewhere overburden was found to consist only of soil 1.0 m thick or less.

Block G (Table 10, Figure 10)
The potentially workable sand and gravel of this block consists of Glacial Sand and Gravel and subordinate amounts of terrace and alluvial material. The latter have not been examined in detail but probably have a composition similar to that of the fluviatile deposits described above.

As with block F, Glacial Sand and Gravel here contains appreciable amounts of gravel and it is significant that this block lies directly to the north of low ground between the Pennine Escarpment and the St Bees Sandstone uplands west of Cumrew – a vale which may have functioned as an important glacial drainage route.

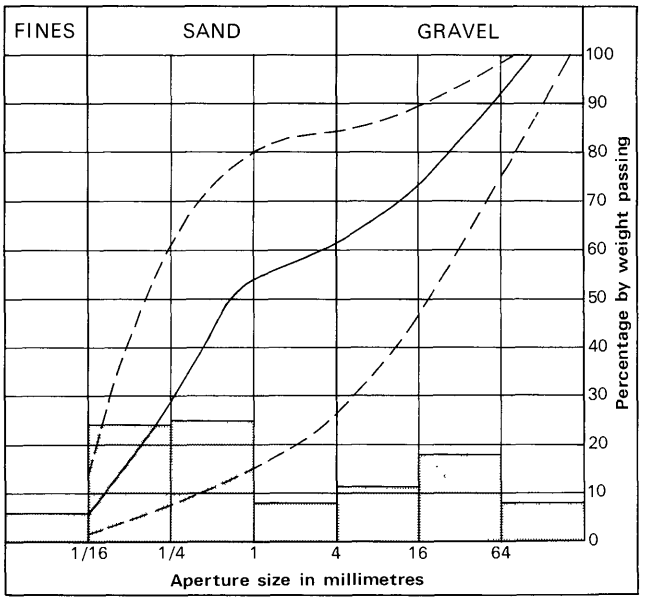


Figure 10 Grading characteristics of the mineral in block G. (For explanation see Figure 4.)

Table 10 Data from assessment boreholes and exposure records: block G

Borehole	Recorded thickness			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 +16–64 mm	Cobbles +64 mm
	m	m	m							
55 NW 17	16.8†	0.4	–	4	11	27	8	13	24	13
55 NW 22	4.0	0.3	–	14	43	21	4	3	11	4
55 NW 23	12.0	0.3	1.3	6	27	26	6	10	18	7
55 NE 36	10.2†	0.2	–	4	10	23	16	18	22	7
55 SW 3	1.4	0.2	–	3	7	37	25	12	11	5
55 SW 5	9.6†	0.4	–	9	29	16	8	10	23	5
55 SW 8	16.0	0.2	–	9	52	19	4	5	9	2
55 SW 11	6.0	0.4	–	5	11	21	16	19	24	4
55 SW 12 A	4.8	0.3	–	3	11	19	13	17	18	19
55 SW 13	5.5	0.3	–	2	11	23	9	26	20	9
55 SW 14 A	4.6‡	0.4	–	2	5	9	9	22	28	25
55 SW 15	6.6†	0.3	1.6	13	38	8	6	10	17	8
55 SW 17	16.1	0.3	–	4	17	54	4	7	11	3
55 SW 18	6.5	0.4	–	4	14	21	8	12	18	23
E 55 SW 2	1.7	0.3	–	3	7	11	15	15	27	22
Mean	8.6	0.3	0.2	6	23	25	8	12	18	8

* Within mineral

† The full thickness of mineral was not proved

‡ The borehole did not reach the prescribed depth

Mineral thicknesses again vary greatly over short distances; for example, borehole 55 NW 17 proved 16.8 m of gravel and adjacent boreholes 55 NW 22 and 55 SW 3 only 4.0 m and 1.4 m of sand and gravel respectively. The mean thickness for the block is 8.6 m and the estimated total volume is 107 million m^3 ± 35 per cent.

The mineral is generally gravel or sandy gravel with up to 25 per cent of cobble grade material; four boreholes, however, contain thick sand sequences. Fines are present in only small amounts, usually less than 6 per cent, although 14 per cent is recorded in 55 NW 22. The mean grading for the block is fines 6 per cent, sand 56 per cent and gravel 38 per cent.

Overburden consists only of soil and does not exceed 0.4 m. Boreholes 55 NW 23 and 55 SW 15 include waste partings of 1.3 m and 1.6 m respectively.

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, 10 km^2, 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. The blocks are drawn provisionally before drilling begins.

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 200 mm (8 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 depth. The samples, each weighing between 25 and 45 kg , are despatched in heavy duty polythene bags to a laboratory for grading. The grading procedure is based on British Standard 1377 (1967). Random checks on 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 F.

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

APPENDIX B

STATISTICAL PROCEDURE

Statistical assessment

1 A statistical assessment is made of an area of mineral greater than 2 km^2, if there is a minimum of 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. Conventional symmetrical confidence limits are calculated for the 95 per cent probability level, that is, there is a 5 per cent or one in twenty chance of a result falling outside the stated limits.

3 The volume estimate (V) for the mineral in a given block is the product of the 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

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

4 The above relationship may be transposed such that

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

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 mean 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 $S_{\bar{l}}$, expressed as a proportion of the mean thickness, is given by

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

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 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 $S_A/S_{\bar{l}_m} \leqslant \frac{1}{3}$ is assumed in all cases. It follows from equation [2] that

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

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).

Block calculation 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
123/45	½	2.0		4.6		Unit record
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		$w\bar{l}_o = 2.5$		$w\bar{l}_m = 6.5$		

Calculation of confidence limits

wl_m	$(wl_m - w\bar{l}_m)$	$(wl_m - w\bar{l}_m)^2$
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

$\Sigma(wl_m - w\bar{l}_m)^2 = 15.82$
$n = 8$
$t = 2.365$

L_V is calculated as
$1.05\,(t/w\bar{l}_m)\sqrt{[\Sigma(wl_m - w\bar{l}_m)^2/n(n-1)]} \times 100$
$= 1.05 \times (2.365/6.5)\sqrt{[15.82/(8 \times 7)]} \times 100$
$= 20.3$
$\simeq 20$ per cent.

Figure 11 Example of resource block assessment: calculation and results

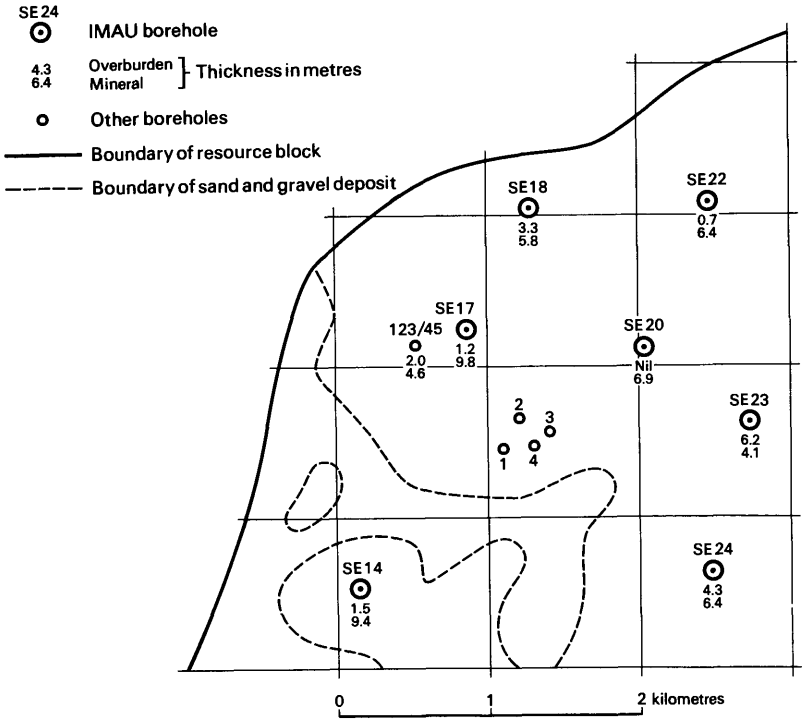


Figure 12 Example of resource block assessment: map of fictitious block

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, 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: $L_{\bar{l}_m} \leqslant L_V \leqslant 1.05 L_{\bar{l}_m}$

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 Figures 11 and 12.

Inferred assessment

12 If the sampled area of mineral in a resource block is between 0.25 km² and 2 km² an assessment is inferred, based on 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 km².

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 need 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 within the zone as the weighting factor.

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 (less than $\frac{1}{16}$ mm) and coarser than pebbles (more than 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 not considered to be 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 Figure 13). The procedure is as follows:

1 Classify according to ratio of sand to gravel.
2 Describe 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 Note 9, p. 20).

Many differing proposals exist for the classification of the grain size of sediments (Atterberg, 1905; Udden, 1914; Wentworth, 1922; Wentworth, 1935; Allen, 1936; Twenhofel, 1937; Lane and others, 1947). As Archer (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 (Table 11), which is used in this 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 (+1–4mm). The boundary at 16mm distinguishes fine gravel (+4–16mm) from coarse (+16–64mm). 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

Standard 1377: 1967). In this report the grading is tabulated on the borehole record sheets (Appendix F), 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, subjectively, by a geologist at the borehole site. Being based on visual examination, the description of the grading is inexact, the accuracy depending on the experience of the observer. The descriptions recorded are modified, as necessary, when the laboratory results become available.

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 very approximate equal proportions with neither constituent accounting for less than about 25 per cent of the whole; 'flint with quartz' indicates that flint is dominant and quartz, the 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 constituents are referred to as 'trace'.

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

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

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

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

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

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

Table 11 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

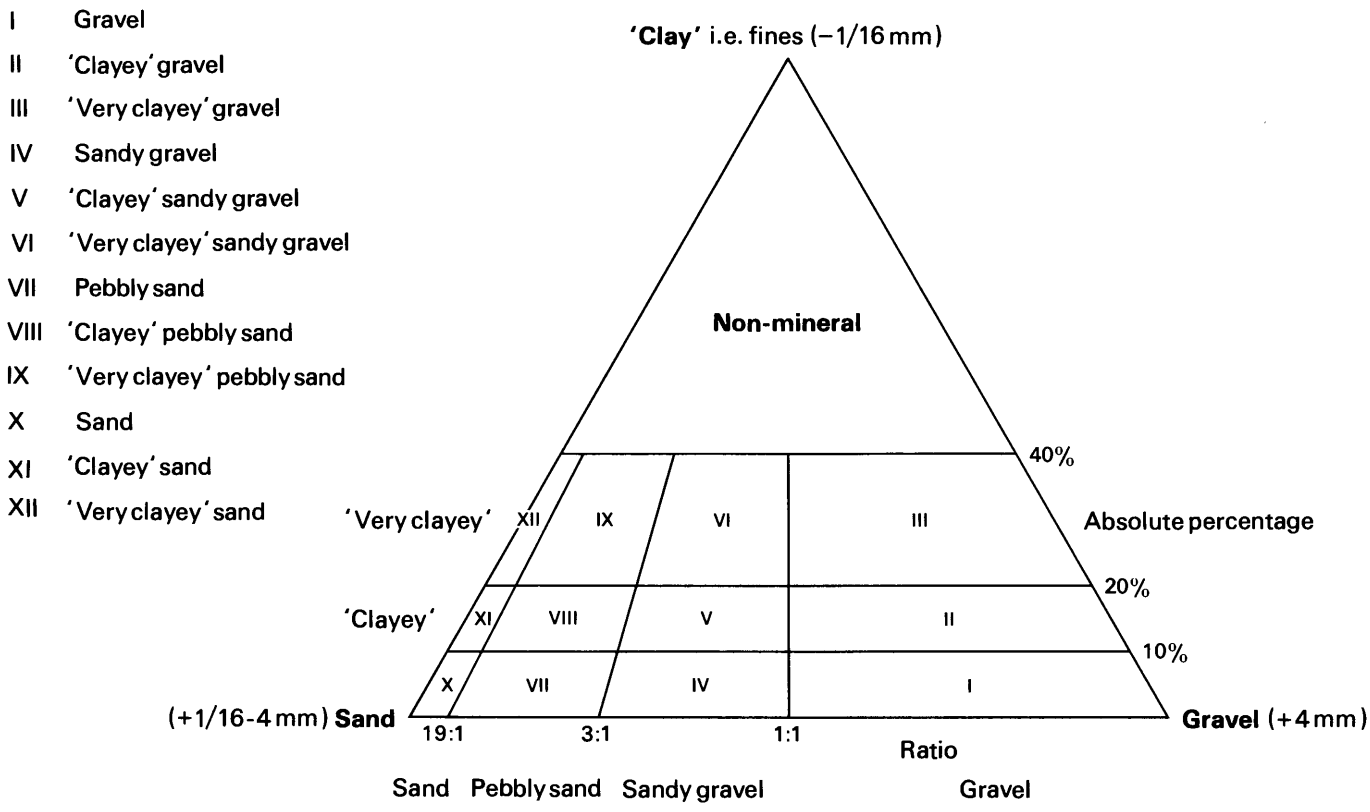


Figure 13 Diagram showing the descriptive categories used in the classification of sand and gravel

APPENDIX D

EXPLANATION OF THE BOREHOLE RECORDS

Annotated fictitious example

CK 66 NW 5[1] **6191 6962**[2] **Northfields**[3] **Block B**

Surface level (+ 49.7 m) + 163 ft[4]
Water struck at +45.9 m[5]
October 1977[6]

Overburden[7] 2.8 m
Mineral 5.4 m
Waste 1.1 m
Mineral 1.4 m
Bedrock 0.7 m+[8]

Log

Geological classification	*Lithology*[9]	*Thickness* m	*Depth* m
	Soil	0.2	0.2
Alluvium	Clay, silty, dark brown	2.6	2.8
River Terrace Deposits	**a** Gravel Gravel: fine to coarse, with cobbles towards base, angular to rounded, flint and limestone with ironstone and some quartz and chalk Sand: medium with coarse and some fine, quartz and limestone	5.4	8.2
Boulder Clay	Clay, sandy and pebbly, red-brown	1.1	9.3
Glacial Sand and Gravel	**b** Sand, 'clayey' in part: fine, subangular to rounded, quartz with some coal	1.4	10.7
Lias	Mudstone, blue-grey, fossiliferous	0.7+	11.4

Grading[10]

	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
a	5	46	49	2.8–3.8	20	14	62	2	2		
				3.8–4.8	2	2	12	18	42	24	
				4.8–5.8	1	3	24	13	35	24	
				5.8–6.8	0	4	21	20	26	29	
				6.8–8.2	4	3	23	10	23	30	7
				Mean	5	5	28	13	25	22	2
b	5	95	0	9.3–10.3	3	73	23	1			
				10.3–10.7	9	85	5	1			
				Mean	5	77	17	1			
a+b	5	56	39	Mean	5	20	26	10	20	17	2

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

1 Borehole Registration Number

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

1 The number of the 1:25 000 sheet on which the borehole lies, here CK 66.
2 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, here NW 5.

Thus the full Registration Number is CK 66 NW 5. Usually this is abbreviated to NW 5 in the text of the report.

2 National Grid reference

All National Grid references fall in the 100-km square identified by the first two letters of the Registration Number. Grid references are given to eight figures, accurate to within 10 m.

3 Location

The position of the borehole is generally referred to the nearest named locality on the 1:25 000 base map and the resource block in which the borehole lies is stated.

4 Surface level

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

5 Groundwater conditions

If groundwater was present the level at which it was encountered or the level at which it stood on completion of drilling is normally given (in metres relative to Ordnance Datum).

6 Type of drill and date of drilling

Unless otherwise stated the borehole was drilled by a Dando 150 shell and auger rig using 200 mm diameter casing and modified sampling equipment. The month and year of completion of drilling are stated.

7 Overburden, mineral, waste and bedrock

Mineral is sand and gravel which, as part of a deposit, falls within the arbitrary definition of potentially workable material (see p. 1). Bedrock is the 'formation', 'country rock' or 'rock head' 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 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. Where more than one mineral horizon is recognised each is designated by a letter, e.g. **a, b,** etc. The description of other deposits is based on visual examination in the field.

10 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 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), coarse gravel (+16–64 mm) and cobble gravel (+64 mm) are stated.

The mean grading of groups of samples making up an identified mineral horizon are also given in detail and in summary. Where more than one horizon is recognised the mean grading for the whole of the mineral in the borehole may be given. Where necessary, in calculating mean gradings, data for individual samples are weighted by the thickness represented. If, exceptionally, grading results are not available for a sample, an attempt may be made to estimate the grading by comparing the grading and field descriptions of adjacent samples with the sample in question. Such estimates are shown in square brackets.

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

APPENDIX E: LIST OF BOREHOLES AND EXPOSURE RECORDS USED IN THE ASSESSMENT OF RESOURCES

Borehole number*	Grid references	Page number
IMAU BOREHOLES		
NY 55 NW		
1	5060 5956	22
2	5167 5972	23
3	5348 5978	24
4	5278 5929	25
5	5420 5924	25
6	5048 5838	26
7	5110 5882	27
8	5334 5867	28
9	5041 5744	29
10	5192 5786	30
11	5242 5825	31
12	5361 5755	32
13	5436 5800	33
14	5025 5636	34
15	5131 5651	34
16	5202 5699	35
17	5308 5632	36
18	5418 5693	37
19	5059 5511	38
20	5143 5532	39
21	5224 5562	40
22	5285 5538	40
23	5392 5591	41
NY 55 NE		
30	5520 5984	43
31	5632 5942	44
32A	5762 5945	45
33	5880 5986	45
34	5514 5887	46
NY 55 NE		
35	5542 5786	47
36	5505 5584	47
NY 55 SW		
2	5179 5488	48
3	5386 5490	49
4	5101 5414	49
5	5310 5432	50
6	5090 5320	51
7	5200 5378	52
8	5319 5358	53
9	5080 5231	54
10	5172 5247	55
11	5284 5245	56
12A	5396 5228	56
13	5206 5158	57
14A	5305 5154	57
15	5416 5153	58
16	5092 5074	59
17	5209 5038	60
18	5461 5053	61
NY 56 SW		
2	5078 6454	62
3	5357 6457	63
4	5429 6492	63
5	5074 6347	63
6	5199 6391	64
7	5287 6344	65
8	5442 6380	66
9	5050 6248	67
10	5143 6293	68
NY 56 SW		
11	5232 6253	69
12	5324 6250	70
13	5386 6282	71
14	5422 6206	72
15	5490 6296	72
16	5016 6136	73
17	5145 6158	74
18	5270 6184	75
19	5379 6125	76
20	5070 6048	77
21	5194 6079	78
22	5291 6048	79
23	5438 6039	80
NY 56 SE		
2	5656 6494	80
3	5817 6451	81
4	5914 6456	82
5	5508 6373	83
6	5612 6373	84
7	5744 6388	85
8	5841 6367	86
9	5961 6388	86
10	5571 6215	87
11	5702 6264	87
12	5842 6273	87
13	5982 6214	88
14	5523 6122	89
15	5653 6127	90
16	5608 6058	90

Exposure number*	Grid reference	Page number
EXPOSURE RECORDS		
E NY 55 NW 1	5150 5674	42
E NY 55 NW 2	5153 5633	42
E NY 55 NE 1	5623 5901	48
E NY 55 SW 1	5104 5488	61
E NY 55 SW 2	5406 5488	62
OTHER BOREHOLE RECORDS		
NY 55 NW 27 and 30		
NY 56 SE 1		

* By sheet quadrant

APPENDIX F
INDUSTRIAL MINERALS ASSESSMENT UNIT
BOREHOLE AND EXPOSURE RECORDS

NY 55 NW 1 **5060 5956** **Park Barns** **Block B**

Surface level (+40.5 m) +133 ft
Water struck at +39.3 m
February 1976

Overburden 1.1 m
Mineral 1.5 m
Bedrock 2.4 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.5	0.5
Second Terrace	Silt, sandy, loamy, with some subrounded cobbles	0.6	1.1
	Gravel Gravel: mainly cobble and fine, subrounded, Carboniferous sandstone and extrusive igneous rocks with some St Bees Sandstone Sand: coarse and medium, quartz and angular lithic fragments	1.5	2.6
St Bees Sandstone	Siltstone, red-brown with orange-brown patches, soft, micaceous in parts	2.4+	5.0

Grading

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
2	36	62	1.1–2.6	2	8	12	16	21	14	27

NY 55 NW 2 **5167 5972** **New Gelt Bridge** **Block B**

Surface level (+57.3 m)+188 ft
Water level +56.8 m
November 1975

Overburden 0.2 m
Mineral 1.1 m
Waste 0.4 m
Mineral 1.9 m
Waste 1.9 m
Mineral 2.9 m
Waste 0.4 m
Bedrock 0.3 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.2	0.2
Third Terrace	**a** 'Clayey' sand: fine quartz with pale grey clay	1.1	1.3
	Peat, sandy, dark brown, fibrous	0.2	1.5
	Clay, sandy, grey-brown	0.2	1.7
	b Gravel Gravel: coarse and cobble, subangular to rounded, Carboniferous sandstone and quartzite, extrusive igneous rocks and grit with some Penrith and St Bees sandstones Sand: fine and medium quartz and coarse lithic fragments	1.9	3.6
Glacial Sand and Gravel	Silt, red-brown, sandy at base	1.9	5.5
	c Gravel, 'clayey' at base; with boulder of siltstone from 7.8 to 8.0 m Gravel: coarse, subangular to subrounded, extrusive igneous rocks and Carboniferous sandstone with greywacke, grit and some St Bees Sandstone Sand: medium and fine quartz with coarse lithic grains	2.9	8.4
Boulder Clay	Clay, red-brown, sandy, with angular pebbles of St Bees Sandstone and rounded extrusive igneous rocks	0.4	8.8
St Bees Sandstone	Sandstone and siltstone, micaceous, red-brown	0.3+	9.1

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
a	16	84	0	0.2–1.3	16	67	16	1			
b	2	23	75	1.7–2.7	2	7	8	5	9	30	39
				2.7–3.6	2	9	11	7	16	42	13
				Mean	2	8	9	6	12	36	27
c	4	34	62	5.5–6.5	3	10	9	6	11	40	21
				6.5–7.8	3	15	16	9	16	31	10
				7.8–8.0	boulder—no bulk sample						
				8.0–8.4	10	14	14	10	20	32	
				Mean	4	13	13	8	15	34	13
a+b+c	6	40	54	Mean	6	22	12	6	11	28	15

NY 55 NW 3 **5348 5978** **Woods Hill** **Block D**

Surface level (+123.4 m)+405 ft
Water not encountered
November 1975

Overburden 0.5 m
Mineral 23.9 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.5	0.5
Glacial Sand and Gravel	'Clayey' to 'very clayey' sand: fine quartz with red-brown silt	23.9+	24.4

Grading

Mean for deposit *percentages*			Depth below surface (m)	*percentages*		
Fines	Sand	Gravel		Fines	Sand	
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$
22	78	0	0.5–1.5	15	78	7
			1.5–2.5	31	68	1
			2.5–3.5	21	78	1
			3.5–4.5	24	76	
			4.5–5.5	29	70	1
			5.5–6.5	35	64	1
			6.5–7.5	8	88	4
			7.5–8.5	10	90	
			8.5–9.5	10	88	2
			9.5–10.5	6	89	5
			10.5–11.5	10	71	19
			11.5–12.3	10	89	1
			12.3–13.3	26	73	1
			13.3–14.0	12	69	19
			14.0–14.8	20	34	46
			14.8–15.8	49	46	5
			15.8–16.8	24	75	1
			16.8–17.8	23	77	
			17.8–18.8	39	61	
			18.8–19.8	31	69	
			19.8–20.6	30	70	
			20.6–21.8	21	79	
			21.8–22.8	13	87	
			22.8–24.4	17	83	
			Mean	22	74	4

NY 55 NW 4 5278 5929 Unity **Block D**

Surface level (+96.3 m) +316 ft
Water level +87.7 m
November 1975

Overburden 1.4 m
Mineral 0.6 m
Waste 7.8 m
Bedrock 0.5 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.2	0.2
Glacial Sand and Gravel	Sand, peaty: fine and medium quartz with dark brown fibrous material	0.2	0.4
	Clay, pale grey, sandy, with scattered pebbles	1.0	1.4
	'Very clayey' pebbly sand: coarse gravel and fine quartz sand with reddish brown and grey-brown silt	0.6	2.0
Boulder Clay	Clay, red-brown, sandy, with carbonaceous lenses and subangular to rounded pebbles of St Bees Sandstone—content increases with depth	7.8	9.8
St Bees Sandstone	Sandstone, red, fine	0.5+	10.3

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
20	68	12	1.4–2.0	20	61	5	2	3	9

NY 55 NW 5 5420 5924 Bramptonfell **Block F**

Surface level (+132.0 m) +433 ft
Water not encountered
January 1976

Overburden 0.2 m
Mineral 3.8 m
Waste 4.5 m
Bedrock 0.3 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.2	0.2
Glacial Sand and Gravel	Sandy gravel Gravel: coarse, subangular to well rounded, extrusive igneous rocks with St Bees and Carboniferous sandstones, and some granite, limestone, grit and quartz Sand: medium, subangular to well rounded, quartz and lithic grains	3.8	4.0
Boulder Clay	Clay, red-brown, sandy, with rounded to subrounded pebbles	4.5	8.5
St Bees Sandstone	Sandstone, red, fine and medium	0.3+	8.8

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
3	50	47	0.2–1.2	1	8	29	7	13	34	8
			1.2–2.2	5	11	24	5	12	32	11
			2.2–3.2	2	21	33	4	14	26	
			3.2–4.0	3	27	30	3	14	23	
			Mean	3	16	29	5	13	29	5

NY 55 NW 6 5048 5838 Hayton **Block A**

Surface level (+58.8 m) +193 ft
Water struck at +51.0 m
January 1976

Overburden 0.4 m
Mineral 5.7 m
Waste 2.0 m
Mineral 8.4 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.4	0.4
Glacial Sand and Gravel	**a** 'Clayey' sand: fine quartz	3.4	3.8
	b Sandy gravel Gravel: fine to cobble, angular to subrounded, extrusive igneous rocks and Carboniferous and St Bees sandstones, with some grit Sand: medium, subangular to rounded quartz with coarse angular lithic grains	2.3	6.1
	Silt, red-brown, unbedded, with some fine sand at base	2.0	8.1
	c 'Clayey' sand: fine quartz with red-brown silt	8.4+	16.5
	Hole abandoned owing to rising sand		

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
a	12	88	0	0.4–1.4	11	85	4				
				1.4–2.4	12	85	3				
				2.4–3.8	13	84	3				
				Mean	12	85	3				
b	5	50	45	3.8–4.8	5	26	14	6	13	28	8
				4.8–6.1	5	4	37	11	12	12	19
				Mean	5	14	27	9	12	19	14
c	13	87	0	8.1–12.0	18	77	5				
				12.0–15.0	6	86	8				
				15.0–16.5	13	84	3				
				Mean	13	82	5				
a+b+c	12	81	7	Mean	12	71	8	2	2	3	2

NY 55 NW 7 5110 5882 Hayton Lane End **Block A**

Surface level (+68.0 m) +223 ft
Water level +52.6 m
November 1975

Overburden 1.5 m
Mineral 17.9 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.2	0.2
Boulder Clay	Clay, pale red-brown, silty, poorly laminated, with carbonaceous lenses	1.3	1.5
Glacial Sand and Gravel	**a** 'Clayey' sand, pebbly at base Gravel: fine and coarse, subrounded to well rounded extrusive igneous rocks and St Bees Sandstone with some Carboniferous sandstone and grit Sand: fine quartz	14.9	16.4
	b 'Clayey' sandy gravel Gravel: coarse, subangular to rounded, extrusive igneous rocks and St Bees and Carboniferous sandstones with grit and quartz Sand: fine and medium quartz with some coarse lithic grains Fines: thin bands of red-brown laminated clay from 17.6 to 18.6 m	3.0+	19.4
	Hole abandoned owing to obstruction		

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
a	16	82	2	1.5–2.5	32	67	1				
				2.5–3.5	14	82	4				
				3.5–4.5	11	79	10				
				4.5–5.5	8	73	19				
				5.5–6.5	12	83	5				
				6.5–7.5	16	82	2				
				7.5–8.5	14	84	2				
				8.5–9.5	11	82	7				
				9.5–10.5	17	78	5				
				10.5–12.0	12	70	18				
				12.0–13.0	17	69	5	2	3	4	
				13.0–14.0	18	81	1				
				14.0–15.0	31	60	1			3	5
				15.0–15.4	17	72	6	1	1	3	
				15.4–16.4	15	41	22	4	8	6	4
				Mean	16	74	7	1	1	1	0
b	12	46	42	16.4–17.4	3	12	28	9	14	30	4
				17.4–18.6	24	17	12	4	7	21	15
				18.6–19.4	10	32	25	2	6	15	10
				Mean	12	19	22	5	9	23	10
a+b	16	75	9	Mean	16	64	10	1	2	5	2

NY 55 NW 8 5334 5867 The Crews **Block D**

Surface level (+136.6 m) +448 ft
Water not encountered
November 1975

Overburden 0.3 m
Mineral 6.7 m
Waste 3.0 m
Mineral 3.0 m
Waste 1.0 m
Mineral 3.0 m
Waste 1.0 m
Mineral 6.4 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.3	0.3
Glacial Sand and Gravel	**a** 'Very clayey' sand, pebbly in upper part Gravel: coarse and fine, subrounded, extrusive igneous rocks, grit and sandstone Sand: fine, subangular to well rounded quartz and lithic grains	6.7	7.0
	Sandy silt, red-brown	3.0	10.0
	b 'Clayey' sand: fine quartz	3.0	13.0
	Sandy silt, red-brown	1.0	14.0
	c 'Clayey' sand: fine quartz	3.0	17.0
	Sandy silt, red-brown	1.0	18.0
	d 'Clayey' sand: fine quartz	6.4+	24.4

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
a	28	68	4	0.3–2.0	30	53	9	2	3	3
				2.0–3.0	8	41	28	5	6	12
				3.0–4.0	23	70	5		2	
				4.0–5.0	37	61	1		1	
				5.0–6.0	34	63	2	1		
				6.0–7.0	32	67	1			
				Mean	28	59	8	1	2	2
b	11	89	0	10.0–11.0	16	81	3			
				11.0–12.0	8	91	1			
				12.0–13.0	8	90	2			
				Mean	11	87	2			
c	18	82	0	14.0–15.0	21	78	1			
				15.0–16.0	15	84	1			
				16.0–17.0	17	82	1			
				Mean	18	81	1			
d	17	83	0	18.0–19.0	25	73	2			
				19.0–20.0	11	87	2			
				20.0–21.0	17	82	1			
				21.0–22.0	22	78				
				22.0–23.0	15	85				
				23.0–24.4	15	85				
				Mean	17	82	1			
a+b+ c+d	20	78	2	Mean	20	75	3		1	1

NY 55 NW 9 **5041 5744** **Fenton Gate** **Block A**

Surface level (+60.7 m) +199 ft
Water struck at +56.7 m
October 1975

Overburden 0.4 m
Mineral 11.4 m
Waste 1.0 m
Mineral 1.3 m
Waste 0.2 m
Bedrock 0.5 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.4	0.4
Glacial Sand and Gravel	**a** Sand, 'clayey' at base: fine quartz	3.0	3.4
	b Gravel, 'clayey' at top and base Gravel: coarse, subangular to rounded, extrusive igneous rocks, grit and greywacke with St Bees, Penrith and Carboniferous sandstones, and mudstone Sand: medium, rounded quartz with subangular to rounded rock fragments	5.0	8.4
	c 'Clayey' sand, with some coarse gravel near top Sand: fine, rounded quartz Fines: red-brown silt bands	3.4	11.8
	Silt, red-brown, sandy, with some pebbles	1.0	12.8
	d 'Very clayey' sand: fine quartz	1.3	14.1
Boulder Clay	Clay, red-brown, with angular sandstone fragments	0.2	14.3
St Bees Sandstone	Sandstone, dull red, fine	0.5+	14.8

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
a	9	91	0	0.4–1.4	6	79	15				
				1.4–2.4	6	85	9				
				2.4–3.4	14	79	6		1		
				Mean	9	81	10		0		
b	9	44	47	3.4–4.4	19	64	4	2	3	8	
				4.4–5.4	8	57	4	4	8	13	6
				5.4–6.4	4	10	7	5	20	49	5
				6.4–7.4	2	7	19	8	14	29	21
				7.4–8.4	14	11	9	8	14	40	4
				Mean	9	30	9	5	12	28	7
c	10	89	1	8.4–9.4	6	74	14			6	
				9.4–10.4	7	85	8				
				10.4–11.8	15	73	12				
				Mean	10	77	12			1	
d	25	75	0	12.8–14.1	25	68	7				
a+b+ c+d	11	70	19	Mean	11	58	10	2	5	11	3

NY 55 NW 10 5192 5786 Townhead Wood **Block D**

Surface level (+127.7 m) +419 ft
Water not encountered
October 1975

Overburden 0.4 m
Mineral 24.0 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.4	0.4
Glacial Sand and Gravel	**a** Pebbly sand, 'clayey' at top Gravel: fine and coarse, subrounded, St Bees, Penrith and Carboniferous sandstones, extrusive igneous rocks and grit, with some quartz and granite Sand: medium, subrounded quartz with coarse subangular to angular lithic grains	7.0	7.4
	b Sand, with scattered pebbles: medium and fine quartz with some medium and coarse lithic grains	17.0+	24.4

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
a	5	76	19	0.4–1.4	11	53	24	5	7		
				1.4–2.4	8	50	25	2	3	3	9
				2.4–3.4	3	21	65	6	3	2	
				3.4–4.4	3	11	53	7	13	13	
				4.4–5.4	2	12	59	9	10	8	
				5.4–6.4	4	13	34	8	10	25	6
				6.4–7.4	3	17	57	4	5	11	3
				Mean	5	25	45	6	7	9	3
b	4	94	2	7.4–8.4	7	30	55	1	1	6	
				8.4–9.4	2	43	53	1	1		
				9.4–10.4	6	45	47			2	
				10.4–11.4	5	59	35			1	
				11.4–12.4	4	41	49	2	1	3	
				12.4–13.4	3	35	51	1	1	2	7
				13.4–14.4	4	33	54	3	2	4	
				14.4–15.4	3	30	66	1			
				15.4–16.4	4	26	69	1			
				16.4–17.4	4	26	68	1		1	
				17.4–18.4	5	52	42	1			
				18.4–19.4	4	41	55				
				19.4–20.4	4	41	55				
				20.4–21.4	4	42	54				
				21.4–22.4	4	75	21				
				22.4–23.4	3	45	49	1	1	1	
				23.4–24.4	8	58	24	1	4	5	
				Mean	4	43	50	1	1	1	
a+b	5	88	7	Mean	5	37	49	2	2	4	1

NY 55 NW 11 5242 5825 Priest's Wood **Block D**

Surface level (+134.7 m) +442 ft
Water not encountered
October 1975

Overburden 0.4 m
Mineral 16.0 m
Waste 3.4 m
Mineral 4.0 m
Waste 0.6 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.4	0.4
Glacial Sand and Gravel	**a** Pebbly sand, 'very clayey' at base Gravel: fine and coarse, subangular to rounded, extrusive igneous rocks with Carboniferous sandstone and some greywacke, limestone, and St Bees Sandstone Sand: medium subangular to rounded quartz with coarse lithic grains	16.0	16.4
	Sandy silt, red-brown	3.4	19.8
	b 'Clayey' sand: fine quartz	4.0	23.8
	Sandy silt, red-brown	0.6+	24.4

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
a	6	79	15	0.4–1.4	3	10	52	8	11	16	
				1.4–2.4	3	19	46	5	9	18	
				2.4–3.4	5	37	56	1		1	
				3.4–4.4	4	15	76	5			
				4.4–5.4	4	8	71	6	8	3	
				5.4–6.4	3	5	52	18	15	7	
				6.4–7.4	3	10	63	14	7	3	
				7.4–8.4	6	13	76	3	2		
				8.4–9.4	8	32	56	4			
				9.4–10.4	6	35	50	4	3	2	
				10.4–11.4	5	23	59	3	5	5	
				11.4–12.4	5	22	43	5	8	14	3
				12.4–13.4	3	20	40	5	15	16	1
				13.4–14.4	4	21	27	8	14	24	2
				14.4–15.4	8	33	26	5	8	18	2
				15.4–16.4	23	66	11				
				Mean	6	23	50	6	6	8	1
b	11	89	0	19.8–20.8	11	49	37	2	1		
				20.8–21.8	8	61	29	1	1		
				21.8–22.8	7	77	16				
				22.8–23.8	18	71	11				
				Mean	11	65	23	1	trace		
a+b	7	81	12	Mean	7	31	45	5	5	6	1

NY 55 NW 12 5361 5755 Hellbeck Bridge **Block F**

Surface level (+125.6 m) +412 ft
Water struck at +122.0 m
October 1975

Overburden 0.5 m
Mineral 3.7 m
Waste 0.3 m
Bedrock 1.2 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.5	0.5
Glacial Sand and Gravel	'Clayey' pebbly sand Gravel: mainly coarse, subrounded, extrusive igneous rocks with Carboniferous and St Bees sandstones and some grit and quartz Sand: fine and medium, subangular to rounded, quartz with some lithic grains	3.7	4.2
Boulder Clay	Clay, red-brown, silty, sandy and pebbly	0.3	4.5
St Bees Sandstone	Siltstone, dull red, soft, micaceous	1.2+	5.7

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
13	73	14	0.5–1.5	14	27	26	3	7	23
			1.5–2.5	18	40	30	3	4	5
			2.5–3.5	10	23	55	5	4	3
			3.5–4.2	7	52	30	5	3	3
			Mean	13	34	35	4	5	9

NY 55 NW 13 **5436 5800** **Tarn End** **Block F**

Surface level (+125.6 m) +412 ft
Water struck at +119.3 m
October 1975

Overburden 0.8 m
Mineral 13.2 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.8	0.8
Glacial Sand and Gravel	**a** Gravel, 'clayey' at top Gravel: coarse, subangular to subrounded, extrusive igneous rocks, with Carboniferous sandstone and some greywacke and Penrith sandstone Sand: medium, subrounded quartz with coarse angular lithic grains	6.7	7.5
	b Pebbly Sand Gravel: coarse, subangular to well rounded, extrusive igneous rocks with Carboniferous sandstone and some greywacke and Penrith sandstone	6.5+	14.0
	Hole abandoned owing to rising sand		

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
a	6	40	54	0.8–1.8	14	15	21	14	17	12	7
				1.8–2.8	5	8	24	7	20	33	3
				2.8–3.8	4	7	31	8	14	28	8
				3.8–4.8	4	8	15	6	15	34	18
				4.8–5.8	5	19	16	7	8	29	16
				5.8–6.8	1	4	26	10	15	27	17
				6.8–7.5	4	4	21	7	23	39	2
				Mean	6	10	22	8	16	28	10
b*	3	85	12	7.5–8.5	3	18	60	2	1	4	12
				8.5–9.5	3	19	71	2	2	3	
				9.5–10.5	2	23	71	3	1		
				10.5–11.5	2	29	66	1	1	1	
				11.5–12.5	1	13	36	2	10	38	
				12.5–13.5	5	13	79	2	1		
				13.5–14.0	2	10	78	5	5		
				Mean	3	18	65	2	3	7	2
a+b	4	63	33	Mean	4	14	43	6	9	18	6

* Rising sand may have resulted in samples being not truly representative of indicated depth.

NY 55 NW 14 5025 5636 How **Block A**

Surface level (+66.5 m) +218 ft
Water level +62.5 m
October 1975

Overburden 0.5 m
Mineral 3.6 m
Waste 5.6 m
Bedrock 0.3 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.5	0.5
Glacial Sand and Gravel	Sand: fine, quartz with scattered lithic grains	3.6	4.1
Boulder Clay	Clay, red-brown, sandy, with subrounded fine and coarse pebbles—St Bees Sandstone content increases with depth	5.6	9.7
St Bees Sandstone	Sandstone, fine-grained, dull red, with scattered light green lenses	0.3+	10.0

Grading

Mean for deposit *percentages*			Depth below surface (m)	*percentages*		
Fines	Sand	Gravel		Fines	Sand	
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$
6	94	0	0.5–1.5	5	92	3
			1.5–2.5	4	94	2
			2.5–3.5	8	87	5
			3.5–4.1	6	86	8
			Mean	6	90	4

NY 55 NW 15 5131 5651 How Mill Station **Block E**

Surface level (+110.3 m) +362 ft
Water not encountered
October 1975

Overburden 0.5 m
Mineral 10.5 m
Waste 10.2 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.5	0.5
Glacial Sand and Gravel	Sandy gravel, 'clayey' near top and base Gravel: coarse with fine, subrounded to rounded, extrusive igneous rocks, Carboniferous sandstone and grit with some St Bees Sandstone and limestone Sand: medium, subangular to well rounded, quartz with lithic grains	10.5	11.0
Boulder Clay	Clay, red-brown, sandy, with fine angular St Bees Sandstone and rounded Carboniferous sandstone and igneous pebbles	10.2+	21.2

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
9	50	41	0.5–1.5	6	18	47	7	10	11	1
			1.5–2.5	29	7	27	16	15	6	
			2.5–3.5	6	7	42	12	17	16	
			3.5–4.5	6	5	22	13	29	25	
			4.5–5.5	5	6	19	12	29	29	
			5.5–6.5	4	5	22	8	16	25	20
			6.5–7.5	4	6	15	5	22	41	7
			7.5–8.8	5	9	14	5	11	43	13
			8.8–10.0	11	42	41	3	1	2	
			10.0–11.0	12	39	19	4	8	15	3
			Mean	9	15	27	8	15	22	4

NY 55 NW 16 5202 5699 Skellion **Block E**

Surface level (+108.2 m) +355 ft
Water struck at +102.2 m
October 1975

Overburden 0.8 m
Mineral 9.4 m
Bedrock 0.4 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.8	0.8
Glacial Sand and Gravel	**a** 'Clayey' sand with some gravel at top Sand: fine quartz	6.8	7.6
	b Gravel, 'clayey' in part Gravel: coarse, angular St Bees Sandstone with subrounded to rounded extrusive igneous rocks and some greywacke and grit Sand: fine quartz	2.6	10.2
St Bees Sandstone	Sandstone and siltstone, soft, micaceous, red-brown	0.4+	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
a	13	86	1	0.8–1.8	14	65	7	4	4	6	
				1.8–2.8	7	92	1				
				2.8–3.8	6	94					
				3.8–4.8	11	89					
				4.8–5.8	11	89					
				5.8–6.8	27	73					
				6.8–7.6	16	84					
				Mean	13	84	1	1		1	
b	9	36	55	7.6–8.6	14	43	3	2	8	23	7
				8.6–10.2	6	24	3	2	10	43	12
				Mean	9	31	3	2	9	36	10
a+b	12	72	16	Mean	12	69	2	1	3	10	3

NY 55 NW 17 **5308 5632** **Ring Gate** **Block G**

Surface level (+141.7 m) +465 ft
Water not encountered
October 1975

Overburden 0.4 m
Mineral 16.8 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.4	0.4
Glacial Sand and Gravel	Gravel, with scattered boulders Gravel: coarse, subangular to rounded, extrusive igneous rocks with Carboniferous, St Bees and Penrith sandstones, grit and greywacke Sand: medium, angular to rounded, quartz and lithic grains	16.8+	17.2
	Hole abandoned owing to obstruction		

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
4	46	60	0.4–1.4	3	10	34	3	5	15	30
			1.4–2.4	3	12	21	5	12	26	21
			2.4–3.4	4	12	21	8	16	24	15
			3.4–4.4	3	8	20	6	11	24	28
			4.4–5.4	5	9	20	9	21	24	12
			5.4–6.4	4	9	23	9	18	30	7
			6.4–7.4	5	9	19	11	19	23	14
			7.4–8.5	5	11	17	7	16	36	8
			8.5–9.5	6	24	64	2	3	1	
			9.5–9.8	5	29	57	3	3	3	
			9.8–10.8	1	5	20	7	13	29	25
			10.8–11.8	4	16	35	7	11	23	4
			11.8–12.8	10	13	41	7	8	17	4
			12.8–13.8	2	9	31	6	12	29	11
			13.8–14.6	3	8	27	10	14	24	14
			14.6–14.9	boulder—no bulk sample						
			14.9–15.9	4	10	19	8	19	34	6
			15.9–17.2	3	8	18	18	18	21	14
			Mean	4	11	27	8	13	24	13

NY 55 NW 18 **5418 5693** **Netherton** **Block F**

Surface level (+138.7 m) +455 ft
Water not encountered
October 1975

Overburden 0.3 m
Mineral 21.0 m
Bedrock 2.1 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.3	0.3
Glacial Sand and Gravel	**a** Sandy gravel, 'clayey' at base Gravel: fine and coarse, subangular to rounded, extrusive igneous rocks, grit and sandstone with some granite, limestone and quartz Sand: medium, subangular to well rounded, quartz with some lithic grains	4.0	4.3
	b 'Clayey' sand Sand: fine with medium, subangular to rounded, quartz with some lithic grains Fines: red-brown silt with sporadic thin laminated clay bands	11.0	15.3
	c Pebbly sand and sandy gravel, 'clayey' in part Gravel: fine and coarse, subangular to rounded, extrusive igneous rocks, St Bees Sandstone and grit, with Carboniferous sandstone, limestone, quartz and granite Sand: medium and fine, subrounded to well rounded, quartz with some lithic grains	6.0	21.3
St Bees Sandstone	Sandstone and siltstone, soft, micaceous, dull red, with small light green lenses	2.1+	23.4

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
a	5	70	25	0.3–1.3	4	32	39	5	12	8	
				1.3–2.3	3	7	53	8	7	22	
				2.3–3.3	3	10	45	12	16	14	
				3.3–4.3	11	32	33	7	7	10	
				Mean	5	20	42	8	11	14	
b	10	90	0	4.3–5.3	13	41	45	1			
				5.3–6.3	14	59	27				
				6.3–7.3	9	45	46				
				7.3–8.3	20	53	27				
				8.3–9.3	6	52	42				
				9.3–10.3	7	42	48	2	1		
				10.3–11.3	8	37	53	2			
				11.3–12.3	18	65	17				
				12.3–13.3	7	45	48				
				13.3–14.3	6	55	39				
				14.3–15.3	6	63	31				
				Mean	10	51	38	1			
c	7	80	13	15.3–16.3	9	52	25	4	6	4	
				16.3–17.6	3	17	32	6	13	19	10
				17.6–18.6	12	63	15	2	3	5	
				18.6–19.6	4	35	53	6	2		
				19.6–20.6	6	25	61	6	2		
				20.6–21.3	9	45	46				
				Mean	7	38	38	4	5	6	2
a+b+c	8	83	9	Mean	8	41	39	3	4	4	1

NY 55 NW 19 **5059 5511** **Faugh Beeches** **Block A**

Surface level (+98.8 m) +324 ft
Water level +85.2 m
January 1976

Overburden 0.6 m
Mineral 4.0 m
Waste 3.0 m
Mineral 7.9 m
Waste 2.8 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.6	0.6
Glacial Sand and Gravel	**a** 'Very clayey' sand: fine quartz with red-brown silt	4.0	4.6
	Sandy silt, red-brown	3.0	7.6
	b 'Very clayey' sand: fine quartz	4.0	11.6
	c Pebbly sand Gravel: coarse Sand: fine quartz	3.9	15.5
Boulder Clay	Clay, compact, red-brown, sandy, with subrounded pebbles and cobbles	2.8+	18.3
	Hole abandoned owing to poor progress		

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
a	28	72	0	0.6–4.6	28	71	1			
b	28	72	0	7.6–10.6	30	70				
				10.6–11.6	23	68	9			
				Mean	28	69	3			
c	8	88	4	11.6–12.6	8	82	10			
				12.6–13.6	8	83	9			
				13.6–14.6	7	71	7	1	3	11
				14.6–15.5	9	75	9	1	3	3
				Mean	8	78	9	1	1	3
a+b+c	22	77	1	Mean	22	73	4			1

NY 55 NW 20 5143 5532 Whin Hill **Block E**

Surface level (+131.1 m) +430 ft
Water not encountered
September 1975

Overburden 0.3 m
Mineral 22.5 m
Waste 2.2 m

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.3	0.3
Glacial Sand and Gravel	Sand, pebbly in part, with sandy gravel at base Gravel: coarse, subrounded to rounded, extrusive igneous rocks, Carboniferous, St Bees and Penrith sandstones, greywacke and grit, with some limestone, quartz and granite Sand: medium and fine, subrounded to well rounded, quartz with some rock fragments	22.5	22.8
Boulder Clay	Clay, red-brown, sandy; fine and coarse subrounded pebbles in first metre, laminated below	1.3	24.1
Glacial Sand and Gravel	'Clayey' sand: fine quartz; red-brown silt partings	0.9+	25.0

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
4	91	5	0.3–1.3	1	24	74		1		
			1.3–2.3	2	45	52	1			
			2.3–3.3	2	46	52				
			3.3–4.3	2	58	40				
			4.3–5.3	3	39	54	3	1		
			5.3–6.3	4	30	60	5	1		
			6.3–7.3	4	31	43	3	3	16	
			7.3–8.3	3	27	59	2	1	3	5
			8.3–9.3	8	60	31			1	
			9.3–10.3	8	52	39		1		
			10.3–11.3	2	35	62	1			
			11.3–12.3	4	30	66				
			12.3–13.3	3	47	48	1	1		
			13.3–14.3	7	77	16				
			14.3–15.3	9	79	12				
			15.3–16.3	4	67	29				
			16.3–17.3	6	81	13				
			17.3–18.3	5	55	38	2			
			18.3–19.3	4	17	57	5	9	8	
			19.3–20.3	3	25	51	5	6	10	
			20.3–21.8	5	43	50	2			
			21.8–22.8	4	12	29	10	7	22	16
			Mean	4	45	44	2	1	3	1

NY 55 NW 21 5224 5562 Flatt **Block E**

Surface level (+126.2 m) +414 ft
Water not encountered
September 1975

Overburden 0.3 m
Mineral 3.4 m
Bedrock 3.1 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.3	0.3
Glacial Sand and Gravel	'Very clayey' pebbly sand Gravel: fine and coarse, rounded extrusive igneous rocks and angular St Bees Sandstone which becomes dominant towards base Sand: fine, quartz with scattered lithic grains	3.4	3.7
St Bees Sandstone	Sandstone, red-brown, soft, fine	3.1+	6.8

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
26	67	7	0.3–1.3	23	46	23	4	3	1
			1.3–2.3	26	42	20	3	4	5
			2.3–3.3	31	47	14	2	4	2
			3.3–3.7	21	63	5	1	1	9
			Mean	26	47	17	3	3	4

NY 55 NW 22 5285 5538 Hayton Moss **Block G**

Surface level (+122.5 m) +402 ft
Water not encountered
September 1975

Overburden 0.3 m
Mineral 4.0 m
Bedrock 1.0 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.3	0.3
Glacial Sand and Gravel	'Clayey' pebbly sand Gravel: coarse, angular St Bees Sandstone (which increases in amount with depth), subrounded extrusive igneous rocks, greywacke, grit and Carboniferous sandstone with some granite, quartz and quartzite Sand: fine, subrounded quartz with subangular to subrounded lithic grains Fines: nodules of red and orange silty clay	4.0	4.3
St Bees Sandstone	Sandstone, red-brown	1.0+	5.3

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
14	68	18	0.3–1.3	5	25	44	5	7	14	
			1.3–2.3	12	36	24	4	3	13	8
			2.3–3.3	19	56	11	4	3	7	
			3.3–4.3	19	56	6	1		10	8
			Mean	14	43	21	4	3	11	4

NY 55 NW 23 5392 5591 High Gelt Bridge **Block G**

Surface level (+137.2 m) +450 ft
Water struck at +126.0 m
December 1975

Overburden 0.3 m
Mineral 9.3 m
Waste 1.3 m
Mineral 2.7 m
Bedrock 0.4 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.3	0.3
Glacial Sand and Gravel	**a** Gravel, 'clayey' in part Gravel: coarse, subangular to subrounded, extrusive igneous rocks and Carboniferous and St Bees sandstones Sand: medium, quartz and lithic grains	5.0	5.3
	b Sand, 'clayey' in part, pebbly at top: Sand: fine with medium, rounded, quartz with some lithic grains	4.3	9.6
	'Clayey' silt, laminated, red-brown	1.3	10.9
	c Gravel Gravel: coarse, angular to well rounded, St Bees Sandstone (which increases in amount to base), extrusive igneous rocks and Carboniferous sandstone with some quartz, limestone and granite Sand: fine with medium, quartz with some lithic grains	2.7	13.6
St Bees Sandstone	Sandstone, dull red, fine, with micaceous partings	0.4+	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
a	4	47	49	0.3–1.3	2	8	36	16	16	19	3
				1.3–2.3	2	10	37	8	15	15	12
				2.3–3.3	2	7	10	8	23	40	10
				3.3–4.3	10	37	13	4	6	14	16
				4.3–5.3	2	12	21	7	14	35	9
				Mean	4	15	23	9	15	24	10
b	8	89	3	5.3–6.3	12	51	23	2	2	10	
				6.3–7.3	4	38	53	5			
				7.3–8.3	5	40	53	2			
				8.3–9.6	10	62	27	1			
				Mean	8	49	38	2	1	2	
c	7	34	59	10.9–11.9	9	10	12	8	17	25	19
				11.9–12.9	5	18	12	5	15	40	5
				12.9–13.6	4	19	11	10	22	28	6
				Mean	7	15	12	7	18	31	10
a+b+c	6	59	35	Mean	6	27	26	6	10	18	7

E NY 55 NW 1 5150 5674 How Mill Station **Block E**

Surface level (+113.4 m) +372 ft
Water not encountered
June 1976

Overburden 0.2 m
Mineral 10.2 m
Waste 3.6 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.2	0.2
Glacial Sand and Gravel	**a** Sandy gravel Gravel: coarse with fine, subrounded extrusive igneous rocks and St Bees and Carboniferous sandstones Sand: medium with fine, quartz and some lithic grains	8.4	8.6
	b Sand, medium with fine, quartz and some lithic grains	1.8	10.4
	Silt, red-brown, with sand bands	0.6	11.0
Boulder Clay	Clay, sandy, red-brown with many subangular St Bees Sandstone fragments	3.0+	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
a	6	64	30	0.2–2.4	2	20	28	10	18	19	3
				2.4–2.7	36	50	10	1	2	1	
				2.7–4.7	6	42	38	2	4	6	2
				4.7–5.4	3	17	43	5	11	8	13
				5.4–6.3	1	6	14	8	25	39	7
				6.3–8.6	8	19	45	5	8	15	
				Mean	6	24	34	6	12	15	3
b	6	94	0	8.6–10.4	6	28	64	2			
a+b	6	69	25	Mean	6	25	39	5	10	12	3

E NY 55 NW 2 5153 5633 Hardbanks **Block E**

Surface level (+127.4 m) +418 ft
Water not encountered
June 1976

Mineral 15.6 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
Glacial Sand and Gravel	'Clayey' sand, gravelly in top 0.8 m and with silt bands between 7.0 and 10.0 m and 13.0 and 15.6 m Sand: fine quartz	15.6+	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
13	85	2	0.0–0.8		13	44	6	7	11	19
			0.8–3.9	2	23	71	3	1		
			3.9–7.0	12	71	16	1			
			7.0–10.0	26	68	6				
			10.0–13.0	6	54	37	1			
			13.0–15.6	23	58	19			2	
			Mean	13	53	31	1	trace	1	1

NY 55 NE 30 5520 5984 Brampton Junction **Block F**

Surface level (+131.1 m) +430 ft
Water not encountered
January 1976

Overburden 0.4 m
Mineral 1.3 m
Waste 2.2 m
Bedrock 0.6 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.4	0.4
Glacial Sand and Gravel	Sandy gravel Gravel: coarse, subangular to subrounded, extrusive igneous rocks and Carboniferous and St Bees sandstones with some quartz Sand: medium, subangular to well rounded, quartz with some lithic grains	1.3	1.7
Boulder Clay	Clay, sandy, red-brown with pebbles and some cobbles and boulders; with grey and pale cream laminated clay lenses	2.2	3.9
Lower Limestone Group	Sandstone, purplish grey, fine, with micaceous partings	0.6+	4.5

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
3	57	40	0.4–1.7	3	12	38	7	14	21	5

NY 55 NE 31 5632 5942 Bowbank **Block F**

Surface level (+159.7 m) +524 ft
Water struck at +154.7 m
December 1975

Overburden 1.8 m
Mineral 4.8 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.4	0.4
Boulder Clay	Clay, brown, sandy, with subangular to subrounded pebbles and boulders to 1.7 m; red-brown, poorly laminated and with only sporadic pebbles below	1.4	1.8
Glacial Sand and Gravel	**a** 'Very clayey' sand: fine quartz with poorly laminated red-brown silt layers	3.0	4.8
	b 'Clayey' gravel Gravel: coarse with many cobbles at base, angular to subangular, Carboniferous limestone and sandstone; limestone becomes dominant at base Sand: medium, angular, rock fragments with some quartz	1.8+	6.6
	Hole abandoned owing to obstruction		

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
a	22	77	1	1.8–2.8	26	58	11	3	2		
				2.8–3.8	19	75	5	1			
				3.8–4.8	20	73	7				
				Mean	22	68	8	1	1		
b	12	28	60	4.8–5.8	17	20	7	7	15	28	6
				5.8–6.6	6	10	3	7	16	26	32
				Mean	12	16	5	7	15	27	18
a+b	18	60	22	Mean	18	49	7	4	6	10	6

NY 55 NE 32A 5762 5945 Hallbankgate **Block F**

Surface level (+214.6 m) +704 ft
Water not encountered
300 mm percussion
February 1976

Overburden 0.2 m
Mineral 8.3 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.2	0.2
Glacial Sand and Gravel	Gravel, with brown, red and grey clay Gravel: coarse to cobble with boulders, angular to rounded, Carboniferous sandstone with St Bees sandstone and extrusive igneous rocks Sand: medium, angular to subrounded, lithic grains and quartz	8.3+	8.5
	Hole abandoned owing to obstruction		

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
7	24	69	0.2–1.2*	8	12	6	5	10	29	30
			1.2–2.2*	6	11	8	5	7	21	42
			2.2–8.5	boulder gravel, chisel used—no bulk samples						
			Mean	7	12	7	5	8	25	36

* Use of a chiselling tool may have resulted in samples not being truly representative.

NY 55 NE 33 5880 5986 Beechwood Cottage **Block F**

Surface level (+204.2 m) +670 ft
Water not encountered
February 1976

Overburden 0.4 m
Mineral 4.8 m
Waste 7.4 m
Bedrock 0.1 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.4	0.4
Glacial Sand and Gravel	'Clayey' gravel Gravel: coarse, cobbles in lower part, subangular to rounded, Carboniferous and St Bees sandstones with some extrusive igneous rocks and limestone Sand: fine, quartz with some lithic grains Fines: brown silt and clay	4.8	5.2
Boulder Clay	Clay, brownish grey with subangular Carboniferous pebbles, cobbles and boulders	7.4	12.6
Upper Limestone Group	Limestone, grey-black, fossiliferous	0.1+	12.7

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
12	31	57	0.4–1.4	15	22	9	7	16	27	4
			1.4–2.4	14	26	11	10	19	20	
			2.4–3.4	12	25	7	3	8	26	19
			3.4–5.2	8	9	4	4	13	24	38
			Mean	12	19	7	5	14	24	19

NY 55 NE 34 5514 5887 Hall Bank **Block F**

Surface level (+137.8 m) +452 ft
Water struck at +130.2 m
January 1976

Overburden 0.5 m
Mineral 6.0 m
Waste 1.4 m
Mineral 1.2 m
Waste 2.1 m
Bedrock 1.0 m+

Log

Geological classification	*Lithology*	*Thickness*	*Depth*
		m	m
	Soil	0.5	0.5
Glacial Sand and Gravel	**a** Sand, 'clayey' in parts, with sporadic pebbles: fine quartz with some coarse lithic grains	6.0	6.5
	Sandy silt, red-brown, massive, with some gravel at base	1.4	7.9
	b Gravel, with some boulders Gravel: mainly coarse, angular to subrounded, Carboniferous sandstone and fine-grained igneous rocks with some quartz, limestone and coarse-grained igneous rocks Sand: fine quartz and some coarse angular lithic grains	1.2	9.1
Boulder Clay	Clay, red-brown and grey, with angular Carboniferous shale and sandstone and some boulders of extrusive igneous rocks and grit	2.1	11.2
Middle Limestone Group	Shale and mudstone with clay, dark grey, bituminous, micaceous; fissile and fractured at top, becoming harder towards base	1.0+	12.2

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
a	9	89	2	0.5–1.5	4	52	40	1	3		
				1.5–2.5	12	83	4	1			
				2.5–3.5	11	78	9		1	1	
				3.5–4.5	9	66	24		1		
				4.5–5.5	9	66	23	1	1		
				5.5–6.5	9	68	21	1		1	
				Mean	9	69	20		1	1	
b	6	23	71	7.9–9.1	6	12	5	6	17	30	24
a+b	9	78	13	Mean	9	59	18	1	4	5	4

NY 55 NE 35 5542 5786 Hullerbank **Block F**

Surface level (+173.4 m) +569 ft
Water struck at +171.4 m
November 1975

Overburden 1.0 m
Mineral 3.1 m+

Log

Geological classification	*Lithology*	*Thickness*	*Depth*
	Soil and fill	1.0	1.0
Glacial Sand and Gravel	'Clayey' gravel, with some boulders Gravel: mainly cobble, angular to subrounded, Carboniferous sandstone and quartzite, with extrusive igneous rocks Sand: fine to coarse, angular quartz and lithic grains Fines: red-brown clay	3.1+	4.1
	Hole abandoned owing to obstruction		

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
11	27	62	1.0–2.0	13	20	5	6	9	8	39
			2.0–3.0	17	16	9	11	16	20	11
			3.0–4.1	3	2	2	10	25	32	26
			Mean	11	13	5	9	17	20	25

NY 55 NE 36 5505 5584 Garth Marr **Block G**

Surface level (+167.6 m) +550 ft
Water not encountered
February 1976

Overburden 0.2 m
Mineral 10.2 m+

Log

Geological classification	*Lithology*	*Thickness*	*Depth*
		m	m
	Soil	0.2	0.2
Moraine	Sandy gravel, with some boulders Gravel: mainly coarse, subangular to subrounded, extrusive igneous rocks and Carboniferous and St Bees sandstones Sand: medium with coarse, angular to subrounded, lithic grains with quartz	10.2+	10.4
	Hole abandoned owing to obstruction		

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
4	49	47	0.2–1.2	10	12	31	20	15	12	
			1.2–2.2	6	6	21	22	19	19	7
			2.2–3.2	3	18	15	19	16	14	15
			3.2–4.2	2	8	20	19	18	22	11
			4.2–5.2	4	6	30	18	13	29	
			5.2–6.2	2	6	18	19	25	26	4
			6.2–7.2	2	11	34	19	13	18	3
			7.2–8.2	3	17	25	5	14	18	18
			8.2–9.0	2	10	14	8	24	38	4
			9.0–9.3	boulder—no bulk sample						
			9.3–10.0	3	10	9	11	29	34	4
			10.0–10.4	boulder—no bulk sample						
			Mean	4	10	23	16	18	22	7

E NY 55 NE 1 5623 5901 Farlam **Block F**

Surface level (+180.8 m) +593 ft
Water not encountered
June 1976

Overburden 0.2 m
Mineral 9.8 m+

Log

Geological classification	*Lithology*	*Thickness*	*Depth*
		m	m
	Soil	0.2	0.2
Glacial Sand and Gravel	Gravel	*c.* 9.8+	*c.* 10.0
	Gravel: cobbles and boulders, some coarse, angular to subrounded, Carboniferous sandstone with extrusive igneous rocks, greywacke, grit and St Bees Sandstone Sand: coarse, angular and subangular rock fragments		

Grading

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
4	10	86	0.2–2.9	4	3	2	5	10	20	56
			2.9–10.0	impractical to sample						

NY 55 SW 2 5179 5488 Whitefaugh Moss **Block E**

Surface level (+118.9 m) +390 ft
Water not encountered
September 1975

Overburden 0.3 m
Mineral 4.2 m
Waste 0.8 m
Bedrock 1.4 m+

Log

Geological classification	*Lithology*	*Thickness*	*Depth*
		m	m
	Soil	0.3	0.3
Glacial Sand and Gravel	'Very clayey' sandy gravel	4.2	4.5
	Gravel: coarse, cobbles at base, subrounded, extrusive igneous rocks, Carboniferous and St Bees sandstones and coarse grit Sand: medium to fine, subrounded, quartz with lithic grains Fines: nodules of orange-red, silty clay		
	Silty clay, red-brown, with coarse sand	0.8	5.3
St Bees Sandstone	Sandstone, red-brown, fine	1.4+	6.7

Grading

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
21	56	23	0.3–1.3	22	25	28	5	6	14	
			1.3–2.3	23	29	36	3	4	5	
			2.3–3.3	18	22	28	2	4	16	10
			3.3–4.5	21	22	25	3	3	9	17
			Mean	21	24	29	3	4	11	8

NY 55 SW 3 5386 5490 Oaktree Hall **Block G**

Surface level (+155.5 m) +510 ft
Water not encountered
December 1975

Overburden 0.2 m
Mineral 1.4 m
Bedrock 0.8 m+

Log

Geological classification	*Lithology*	*Thickness*	*Depth*
		m	m
	Soil	0.2	0.2
Glacial Sand and Gravel	Sandy gravel Gravel: fine and coarse, subrounded, extrusive igneous rocks with some sandstone Sand: medium with coarse, subangular lithic fragments and quartz	1.4	1.6
St Bees Sandstone	Sandstone, dull red, fine	0.8+	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
3	69	28	0.2–1.2	2	5	37	26	12	11	7
			1.2–1.6	4	11	40	22	13	10	
			Mean	3	7	37	25	12	11	5

NY 55 SW 4 5101 5414 Stonebridge Lees **Block E**

Surface level (+122.8 m) +403 ft
Water not encountered
September 1975

Overburden 0.3 m
Mineral 0.5 m
Waste 17.5 m

Log

Geological classification	*Lithology*	*Thickness*	*Depth*
		m	m
	Soil	0.3	0.3
Glacial Sand and Gravel	'Clayey' pebbly sand Gravel: fine and coarse, subrounded to rounded, Carboniferous and St Bees sandstones, extrusive igneous rocks, grit and some quartz, granite and limestone Sand: fine with medium, quartz and rock fragments	0.5	0.8
Boulder Clay	Clay, red-brown, sandy with much fine gravel and occasional coarse; some carbonaceous lenses with imperfect laminations	17.1	17.9
	Sandy silt, red-brown	0.4+	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
10	68	22	0.3–0.8	10	34	24	10	11	11

NY 55 SW 5 5310 5432 Moor House **Block G**

Surface level (+137.2 m) +450 ft
Water not encountered
September 1975

Overburden 0.4 m
Mineral 9.6 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.4	0.4
Glacial Sand and Gravel	**a** Gravel Gravel: coarse, subrounded, extrusive igneous rocks and Carboniferous sandstone, with greywacke and some St Bees Sandstone Sand: mainly medium, subangular to subrounded, quartz and some lithic grains	5.0	5.4
	b 'Clayey' pebbly sand Gravel: coarse, subangular to subrounded, St Bees Sandstone (increasing in amount to base), with some extrusive igneous rocks, greywacke and Carboniferous sandstone Sand: fine, quartz with some lithic grains	4.6+	10.0
	Hole abandoned owing to obstruction		

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
a	4	39	57	0.4–1.4	3	16	17	11	12	31	10
				1.4–2.4	5	17	16	9	12	22	19
				2.4–3.4	5	16	18	8	13	35	5
				3.4–4.4	3	7	11	14	22	41	2
				4.4–5.4	4	6	24	8	11	40	7
				Mean	4	12	17	10	14	34	9
b	14	67	19	5.4–6.4	4	10	38	15	14	19	
				6.4–7.4	13	51	10	4	3	16	3
				7.4–8.4	13	56	12	5	3	5	6
				8.4–9.4	20	68	3	2	3	4	
				9.4–10.0	27	47	10	1	4	11	
				Mean	14	46	15	6	6	11	2
a+b	9	53	38	Mean	9	29	16	8	10	23	5

NY 55 SW 6 **5090 5320** **Cairn Cottage** **Block E**

Surface level (+128.0 m) +420 ft
Water not encountered
January 1976

Overburden 0.5 m
Mineral 23.9 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.5	0.5
Glacial Sand and Gravel	Sand, 'clayey' and gravelly in parts: fine quartz with some lithic grains	23.9+	24.4

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
8	89	3	0.5–1.5	4	29	50	9	6	2	
			1.5–2.5	4	16	59	14	6	1	
			2.5–3.5	6	13	63	14	4		
			3.5–4.5	5	54	37	3	1		
			4.5–5.5	16	78	6				
			5.5–6.5	18	80	2				
			6.5–7.5	9	80	11				
			7.5–8.5	5	74	21				
			8.5–9.5	30	56	14				
			9.5–10.5	8	40	52				
			10.5–11.5	7	50	42	1			
			11.5–12.5	8	68	24				
			12.5–13.5	6	56	37	1			
			13.5–14.2	4	49	46	1			
			14.2–15.2	5	48	16		1	14	16
			15.2–16.2	6	73	21				
			16.2–17.2	4	38	58				
			17.2–18.2	6	74	20				
			18.2–19.2	7	74	18			1	
			19.2–20.2	9	78	13				
			20.2–21.2	7	71	22				
			21.2–22.2	6	63	31				
			22.2–23.2	5	58	37				
			23.2–24.4	5	53	36	1	1	4	
			Mean	8	57	30	2	1	1	1

NY 55 SW 7 5200 5378 Carlatton Middle **Block E**

Surface level (+126.2 m) +414 ft
Water not encountered
September 1975

Overburden 0.3 m
Mineral 0.9 m
Bedrock 1.3 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.3	0.3
Glacial Sand and Gravel	'Clayey' sandy gravel Gravel: coarse, subrounded to well rounded, extrusive igneous rocks with granite and some St Bees and Carboniferous sandstones and greywacke Sand: fine, rounded to well rounded quartz and some coarse lithic fragments	0.9	1.2
St Bees Sandstone	Sandstone, red, fine	1.3+	2.5

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
10	60	30	0.3–1.2	10	32	20	8	9	19	2

NY 55 SW 8 5319 5358 Woodcock Hill **Block G**

Surface level (+153.0 m) +502 ft
Water not encountered
September 1975

Overburden 0.2 m
Mineral 16.0 m
Bedrock 1.6 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.2	0.2
Glacial Sand and Gravel	**a** Pebbly sand, 'clayey' at base Gravel: coarse, subrounded, extrusive igneous rocks, greywacke and St Bees Sandstone with quartzite, quartz and granite Sand: fine, subangular to subrounded quartz with lithic grains	5.0	5.2
	b 'Clayey' sand: fine, subangular to subrounded, quartz with lithic grains	7.0	12.2
	c Gravel, 'clayey' at base Gravel: coarse, subangular to subrounded, extrusive igneous rocks, greywacke, quartzite, St Bees Sandstone (increases in amount with depth) and limestone Sand: fine and medium, quartz and lithic grains	4.0	16.2
St Bees Sandstone	Sandstone, finely laminated	1.6+	17.8

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
a	8	83	9	0.2–1.2	8	65	20	2	1	4	
				1.2–2.2	9	81	10				
				2.2–3.2	6	34	34	11	8	7	
				3.2–4.2	6	20	50	11	8	5	
				4.2–5.2	10	59	16	3	2	10	
				Mean	8	52	26	5	4	5	
b	12	88	0	5.2–6.2	14	80	6				
				6.2–7.2	12	85	3				
				7.2–8.2	9	81	10				
				8.2–9.2	8	48	39	4	1		
				9.2–10.2	13	69	17	1			
				10.2–11.2	16	68	16				
				11.2–12.2	9	70	21				
				Mean	12	71	16	1			
c	7	42	51	12.2–13.2	3	20	12	7	18	36	4
				13.2–14.2	5	8	11	11	14	41	10
				14.2–15.2	8	7	23	11	12	24	15
				15.2–16.2	12	35	11	11	8	18	5
				Mean	7	18	14	10	13	29	9
a+b+c	9	75	16	Mean	9	52	19	4	5	9	2

NY 55 SW 9 5080 5231 Cumwhitton **Block E**

Surface level (+117.4 m) +385 ft
Water struck at +108.7 m
January 1976

Overburden 0.4 m
Mineral 9.1 m
Waste 4.5 m
Bedrock 0.3 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.4	0.4
Glacial Sand and Gravel	**a** 'Very clayey' sandy gravel Gravel: mainly coarse, subrounded, extrusive igneous rocks with St Bees and Carboniferous sandstones Sand: fine with medium, subangular to rounded, quartz with some lithic grains Fines: orange and red-brown clay	7.2	7.6
	b Sandy gravel Gravel: coarse, subrounded to rounded, Carboniferous sandstone, quartzite and extrusive igneous rocks with granite, quartz and grit Sand: medium, subrounded to well rounded, quartz and some lithic grains	1.9	9.5
Boulder Clay	Clay, sandy, red-brown with angular, blocky St Bees Sandstone fragments (amount increases with depth), and some rounded igneous pebbles	4.5	14.0
St Bees Sandstone	Sandstone, dull red, fine micaceous	0.3+	14.3

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
a	21	57	22	0.4–1.4	16	31	28	4	5	7	9
				1.4–2.4	20	32	25	3	3	6	11
				2.4–3.4	25	32	31	4	3	5	
				3.4–4.4	23	33	21	3	5	11	4
				4.4–5.4	19	29	14	3	5	5	25
				5.4–6.4	21	32	22	3	4	8	10
				6.4–7.6	22	36	13	3	5	11	10
				Mean	21	32	22	3	4	8	10
b	4	51	45	7.6–8.6	6	9	20	6	18	37	4
				8.6–9.5	2	10	50	7	7	13	11
				Mean	4	10	35	6	13	25	7
a+b	18	56	26	Mean	18	28	24	4	6	11	9

NY 55 SW 10 **5172 5247** **Cumwhitton Moss** **Block E**

Surface level (+126.5 m) +415 ft
Water level +108.7 m
January 1976

Overburden 0.5 m
Mineral 0.8 m
Waste 1.8 m
Mineral 21.0 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.5	0.5
Glacial Sand and Gravel	**a** Sandy gravel Gravel: coarse, subrounded to rounded, extrusive igneous rocks and sandstone with some quartz and granite Sand: medium, quartz with some lithic grains	0.8	1.3
Boulder Clay	Sandy clay, orange-brown with subrounded pebbles	1.8	3.1
Glacial Sand and Gravel	**b** Sand, 'clayey' in parts: fine, quartz and some lithic grains	21.0+	24.1
	Hole abandoned owing to rising sand		

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
a	4	71	25	0.5–1.3	4	13	52	6	7	9	9
b	9	91	0	3.1–4.1	23	37	40				
				4.1–5.1	5	49	46				
				5.1–6.1	4	58	38				
				6.1–7.1	9	72	19				
				7.1–8.1	11	66	23				
				8.1–9.1	8	81	11				
				9.1–10.1	9	81	10				
				10.1–11.1	14	75	11				
				11.1–12.1	16	77	7				
				12.1–13.1	8	79	13				
				13.1–14.1	14	78	8				
				14.1–15.1	11	78	11				
				15.1–16.1	5	59	36				
				16.1–17.1	6	59	35				
				17.1–18.1	9	57	34				
				18.1–19.1	5	52	43				
				19.1–20.1	9	58	33				
				20.1–21.1	13	58	29				
				21.1–22.1	9	55	36				
				22.1–24.1	5	45	50				
				Mean	9	63	28				
a+b	9	90	1	Mean	9	61	29	trace	trace	trace	trace

NY 55 SW 11 5284 5245 Blackdub **Block G**

Surface level (+135.0 m) +443 ft
Water level not recorded
September 1975

Overburden 0.4 m
Mineral 6.0 m
Bedrock 4.0 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.4	0.4
Glacial Sand and Gravel	Sandy gravel Gravel: coarse with fine, subangular to subrounded, extrusive igneous rocks with St Bees Sandstone and some Carboniferous sandstone and greywacke Sand: medium, subangular to subrounded, lithic grains and quartz	6.0	6.4
St Bees Sandstone	Sandstone, red and cream, fine	4.0+	10.4

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
5	48	47	0.4–1.4	5	16	20	11	15	31	2
			1.4–2.4	6	12	27	12	13	26	4
			2.4–3.4	6	8	27	12	17	25	5
			3.4–4.4	4	8	19	23	20	24	2
			4.4–5.4	4	9	22	20	20	15	10
			5.4–6.4	7	11	14	19	28	21	0
			Mean	5	11	21	16	19	24	4

NY 55 SW 12A 5396 5228 Albyfield **Block G**

Surface level (+162.5 m) +533 ft
Water not encountered
300 mm percussion
February 1976

Overburden 0.3 m
Mineral 4.8 m
Waste 1.3 m
Bedrock 1.0 m+

Log

Geological classification	*Lithology*	*Thickness*	*Depth*
	Soil	0.3	0.3
Glacial Sand and Gravel	Gravel, with boulders and some clay lenses Gravel: fine to cobble, subrounded, extrusive igneous rocks, quartzite, grit and sandstone and occasional quartz, limestone and granite Sand: mainly medium, angular to subrounded, rock fragments with medium and fine, subrounded to rounded, quartz	4.8	5.1
Boulder Clay	Clay, red-brown, sandy with fine, subrounded to subangular pebbles and occasional cobbles	1.3	6.4
St Bees Sandstone	Sandstone, red, micaceous, fine	1.0+	7.4

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
3	43	54	0.3–1.3	3	11	22	15	18	21	10
			1.3–2.3	2	9	23	14	18	19	15
			2.3–3.3	4	17	22	10	13	17	17
			3.3–4.3	4	7	13	10	13	15	38
			4.3–5.1	3	10	15	15	24	20	13
			Mean	3	11	19	13	17	18	19

NY 55 SW 13 5206 5158 Carlatton Mill Bridge **Block G**

Surface level (+122.8 m) +403 ft
Water not encountered
300 mm percussion
February 1976

Overburden 0.3 m
Mineral 5.5 m
Bedrock 0.8 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.3	0.3
Glacial Sand and Gravel	Gravel, sandy in lower part Gravel: fine to coarse, subrounded, extrusive igneous rocks with St Bees and Carboniferous sandstones and some granite Sand: medium, rounded, quartz with some rock fragments	5.5	5.8
St Bees Sandstone	Sandstone, red, fine and medium, silty, micaceous, with light green argillaceous lenses	0.8+	6.6

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
2	43	55	0.3–1.3	2	5	13	13	26	27	14
			1.3–2.3	2	11	26	10	32	19	
			2.3–3.3	1	6	11	7	35	31	9
			3.3–4.3	2	9	17	5	24	21	22
			4.3–5.3	2	13	43	10	20	7	5
			5.3–5.8	6	32	37	9	12	4	
			Mean	2	11	23	9	26	20	9

NY 55 SW 14A 5305 5154 Carlatton Church **Block G**

Surface level (+139.0 m) +456 ft
Water struck at +135.0 m
300 mm percussion
February 1976

Overburden 0.4 m
Mineral 4.6 m
Waste 3.1 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.4	0.4
Glacial Sand and Gravel	Gravel, with boulders Gravel: mainly coarse, subangular to rounded, extrusive igneous rocks, Carboniferous and St Bees sandstones, grit and occasional granite Sand: fine and medium subrounded quartz, with coarse subangular to subrounded rock fragments	4.6	5.0
Boulder Clay	Clay, red-brown, sandy with fine subrounded pebbles and sporadic cobbles	3.1+	8.1
	Hole abandoned owing to obstruction		

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
2	23	75	0.4–2.1*	2	6	12	9	15	28	28
			2.1–4.1	compact gravel, chisel used—no bulk sample						
			4.1–5.0*	1	4	4	10	35	28	18
			Mean	2	5	9	9	22	28	25

* Use of a chiselling tool may have resulted in samples not being truly representative.

NY 55 SW 15 5416 5153 Saughtree Gate **Block G**

Surface level (+163.4 m) +536 ft
Water not encountered
February 1976

Overburden 0.3 m
Mineral 4.9 m
Waste 1.6 m
Mineral 1.7 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.3	0.3
Glacial Sand and Gravel	**a** Gravel Gravel: coarse, subrounded to well rounded, extrusive igneous rocks with St Bees and Carboniferous sandstones, grit and granite Sand: medium, lithic grains with quartz	2.1	2.4
	b 'Very clayey' sand: fine, quartz with red-brown silt, sometimes in lenses	2.8	5.2
	Silt, red-brown, 'clayey' and laminated in lower part	1.6	6.8
	c 'Clayey' gravel, with boulders Gravel: coarse, angular to rounded, extrusive igneous rocks and Carboniferous sandstone and limestone with St Bees Sandstone, granite and quartz Sand: coarse angular rock fragments, and fine and medium quartz	1.7+	8.5
	Hole abandoned owing to obstruction		

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
a	3	36	61	0.3–2.4	3	8	17	11	20	30	11
b	21	79	0	2.4–3.4	19	78	2	1			
				3.4–5.2	22	78					
				Mean	21	78	1				
c	11	27	62	6.8–8.5*	11	11	7	9	15	30	17
a+b+c	13	52	35	Mean	13	38	8	6	10	17	8

* Use of a chiselling tool may have resulted in samples not being truly representative.

NY 55 SW 16 **5092 5074** **Whinnyhill** **Block G**

Surface level (+126.8 m) +416 ft
Water struck at 119.8 m
January 1976

Overburden 0.2 m
Mineral 2.3 m
Bedrock 4.8 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.2	0.2
Boulder Clay	'Clayey' sandy gravel Gravel: coarse to cobble, extrusive igneous rocks with Carboniferous and St Bees sandstones Sand: fine to medium, subangular to well rounded, quartz with lithic grains	2.3	2.5
St Bees Sandstone	Sandstone, red-brown, fine, micaceous in parts	4.8+	7.3

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
13	61	26	0.2–1.2	10	29	30	6	4	12	9
			1.2–2.5	16	33	23	3	5	9	11
			Mean	13	31	26	4	5	11	10

NY 55 SW 17 **5209 5038** **Hornsbygate** **Block G**

Surface level (+130.5 m) +428 ft
Water level +120.5 m
December 1975

Overburden 0.3 m
Mineral 16.1 m
Bedrock 1.0 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.3	0.3
Glacial Sand and Gravel	**a** Sand, 'clayey' at top, pebbly in parts: medium, subangular to rounded quartz with some lithic grains	9.0	9.3
	b Sandy gravel, 'clayey' at base Gravel: coarse with fine, subrounded to well rounded, extrusive igneous rocks and St Bees and Carboniferous sandstones, with some Penrith Sandstone, quartz and granite Sand: medium, quartz with subangular lithic fragments	7.1	16.4
St Bees Shales	Mudstone, red-brown, poorly laminated, with micaceous partings and lenses of green siltstone	1.0+	17.4

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
a	5	93	2	0.3–1.3	14	39	45	1	1		
				1.3–2.3	11	32	56	1			
				2.3–3.3	3	17	77	2		1	
				3.3–4.3	3	11	82	4			
				4.3–5.3	3	17	68	2	1	1	8
				5.3–6.3	2	11	78	6	3		
				6.3–7.3	4	43	52	1			
				7.3–8.3	2	21	71	3	1	2	
				8.3–9.3	3	25	63	2	3	4	
				Mean	5	24	66	3	1	1	
b	4	53	43	9.3–10.3	3	14	54	7	14	8	
				10.3–11.3	1	7	44	3	9	32	4
				11.3–12.3	1	6	21	6	18	26	22
				12.3–13.3	2	6	41	8	19	24	
				13.3–14.3	2	8	50	5	16	16	3
				14.3–15.3	1	3	35	8	15	25	13
				15.3–16.4	15	12	25	7	14	25	2
				Mean	4	9	38	6	15	22	6
a+b	4	75	21	Mean	4	17	54	4	7	11	3

NY 55 SW 18 5461 5053 Cumrew **Block G**

Surface level (+167.3 m) +549 ft
Water not encountered
January 1976

Overburden 0.4 m
Mineral 6.5 m
Bedrock 1.0 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.4	0.4
Glacial Sand and Gravel	Gravel, sandy in part, with boulders Gravel: cobbles with coarse, subrounded, Carboniferous sandstone, greywacke, grit and extrusive igneous rocks with St Bees Sandstone and some quartzite, mudstone and quartz Sand: medium, subangular to rounded quartz with coarse subangular lithic grains	6.5	6.9
St Bees Sandstone	Sandstone, dull red, fine, with some micaceous partings	1.0+	7.9

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
4	43	53	0.4–1.4	5	10	28	12	17	20	8
			1.4–2.0	1	5	25	8	15	27	19
			2.0–2.8	4	29	43	8	10	6	
			2.8–3.8		4	16	10	16	31	23
			3.8–4.8	2	8	16	10	18	26	20
			4.8–6.9*	6	20	12	5	6	9	42
			Mean	4	14	21	8	12	18	23

* Use of a chiselling tool may have resulted in samples not being truly representative.

E NY 55 SW 1 5104 5488 Faugh **Block E**

Surface level (+129.9 m) +426 ft
Water not encountered
June 1976

Mineral 29.5 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
Glacial Sand and Gravel	Sand, pebbly in parts; mainly medium to 22.5 m then fine, quartz with some lithic grains	29.5+	29.5

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
3	94	3	0.0–2.3	2	26	69	1	1	1	
			2.3–5.3		14	86				
			5.3–7.1	1	10	78	2		9	
			7.1–9.1	7	75	18				
			9.1–10.2	2	17	57	22	2		
			10.2–12.1	2	29	65	4			
			12.1–12.6	3	29	56	2	5	5	
			12.6–15.2	7	32	58	1	1	1	
			15.2–18.2	2	27	71				
			18.2–22.5	1	12	68	7	4	1	7
			22.5–26.1	6	87	7				
			26.1–28.4	5	91	4				
			28.4–29.5	2	82	16				
			Mean	3	40	51	3	1	1	1

E NY 55 SW 2 5406 5488 Oaktree Hall **Block G**

Surface level (+157.9 m) +518 ft
Water not encountered
June 1976

Overburden 0.3 m
Mineral 1.7 m
Bedrock 0.6 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.3	0.3
Glacial Sand and Gravel	Gravel Gravel: coarse to cobbles, extrusive igneous rocks and Carboniferous and St Bees sandstones, with some greywacke and grit Sand: mainly medium, angular and subangular, rock fragments and quartz	1.7	2.0
St Bees Sandstone	Sandstone, red, fine, silty in lower part	0.6+	2.6

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
3	33	64	0.3–2.0	3	7	11	15	15	27	22

NY 56 SW 2 5078 6454 Blackhouse Plantation **Block A**

Surface level (+78.3 m) +257 ft
Water struck at +74.3 m
November 1976

Overburden 2.5 m
Mineral 10.6 m
Waste 9.4 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.2	0.2
Boulder Clay	Clay, red-brown and light green, sandy and pebbly; purple-brown, stoneless and well laminated below	2.0	2.2
	Silt, red-brown, massive, compact with sporadic pebbles	0.3	2.5
Glacial Sand and Gravel	'Very clayey' sand: fine quartz; thin, poorly laminated red-brown silt bands	10.6	13.1
	Silt, red-brown, pebbly, with sandy laminations	1.9	15.0
Boulder Clay	Clayey silt, red-brown to grey-brown, sandy in parts with fine and coarse subangular to subrounded pebbles	7.5+	22.5

Grading

Mean for deposit *percentages*			Depth below surface (m)	*percentages*		
Fines	Sand	Gravel		Fines	Sand	
				$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1
25	75	0	2.5–3.5	33	66	1
			3.5–4.5	24	76	
			4.5–7.5	22	78	
			7.5–10.5	24	76	
			10.5–13.1	28	71	1
			Mean	25	75	

NY 56 SW 3 5357 6457 Low Wall Farm **Block A**
Surface level (+73.2 m) +240 ft Waste 20.1 m+
Water not encountered
November 1976

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil and fill	0.8	0.8
Laminated Clay	Sandy clay, yellow, well laminated, much fine sand towards base	0.8	1.6
	Silty clay, brown, finely laminated	18.5+	20.1

NY 56 SW 4 5429 6492 Garthside **Block A**
Surface level (+81.1 m) +266 ft Waste 19.0 m+
Water not encountered
January 1977

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.3	0.3
Laminated Clay	Clay, mottled light blue-grey and brown with rootlets and sandy bands	2.7	3.0
	Silty clay, red-brown, occasional pebbles and sandy partings, some laminations	16.0+	19.0

NY 56 SW 5 5074 6347 Cambeckhill **Block B**
Surface level (+43.0 m) +141 ft Overburden 6.9 m
Water struck at +37.8 m Mineral 11.3 m+
November 1976

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.4	0.4
3rd Terrace	Sandy gravel, coarse with subrounded cobbles of Carboniferous sandstone and greywacke	0.2	0.6
Laminated Clay	Silty clay, red-brown, poorly laminated, with sandy bands and scattered cobbles	4.6	5.2
Glacial Sand and Gravel	'Very clayey' sand, fine quartz with red-brown silt	1.3	6.5
	Silt, red-brown, laminated, clayey	0.4	6.9
	'Clayey' to 'very clayey' sand, pebbly below 16.2 m: fine, with red-brown silt	11.3+	18.2
	Borehole abandoned – unable to case hole below 18.2 m		

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
19	80	1	6.9–9.9	32	67	1			
			9.9–12.9	11	85	4			
			12.9–16.2	11	87	2			
			16.2–17.2	23	63	4	6	2	2
			17.2–18.2	28	58	4	4	1	5
			Mean	14	80	3	1	1	1

NY 56 SW 6 5199 6391 Conqueror's Bank **Block A**

Surface level (+58.8 m) +193 ft
Water level not recorded
November 1976

Overburden 1.0 m
Mineral 2.8 m
Waste 1.0 m
Mineral 8.3 m
Waste 9.4 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.2	0.2
	Clayey silt, orange-brown, laminated; scattered pebbles	0.8	1.0
Glacial Sand and Gravel	**a** 'Very clayey' sand: fine quartz; thin silt bands	2.8	3.8
	Clayey silt, red-brown, with sandy partings	1.0	4.8
	b 'Clayey' sand: fine quartz with red-brown silt bands	8.3	13.1
	Silt, red-brown, sandy, massive, clayey near base; scattered pebbles	9.4+	22.5

Grading

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*			
	Fines	Sand	Gravel		Fines	Sand		
					$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4
a	28	72	0	1.0–2.0	20	76	4	
				2.0–3.0	36	63	1	
				3.0–3.8	27	73		
				Mean	28	70	2	
b	15	85	0	4.8–5.8	32	60	8	
				5.8–6.8	12	68	20	
				6.8–7.8	29	56	15	
				7.8–9.4	11	67	20	2
				9.4–10.4	13	71	15	1
				10.4–12.0	9	68	22	1
				12.0–13.1	7	65	27	1
				Mean	15	65	19	1
a+b	18	82	0	Mean	18	67	14	1

NY 56 SW 7 **5287 6344** **Kellwood** **Block B**

Surface level (+36.0 m) +118 ft
Water level not recorded
November 1976

Overburden 0.4 m
Mineral 2.8 m
Waste 14.0 m
Bedrock 1.3 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.4	0.4
Alluvium	Gravel, with a little grey-brown silt Gravel: coarse with fine, subrounded, Carboniferous sandstone and grit and greywacke with some extrusive igneous rocks Sand: medium and coarse, angular to subrounded, rock fragments and quartz	2.8	3.2
Laminated Clay	Silt, clayey in top metre, laminated in parts, with occasional sandy lenses	10.3	13.5
Boulder Clay	Sandy clay, red-brown, with angular and subangular blocks of St Bees Sandstone and some subrounded extrusive igneous rocks and mudstone fragments	3.7	17.2
St Bees Sandstone	Siltstone and mudstone, red-brown, soft; well-bedded in parts, otherwise massive	1.3+	18.5

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
3	28	69	0.4–1.4	5	10	16	10	26	33	
			1.4–2.4	1	3	7	10	34	45	
			2.4–3.2	3	4	11	15	25	35	7
			Mean	3	6	11	11	29	38	2

NY 56 SW 8 **5442 6380** **Burtholme** **Block B**

Surface level (+45.7 m) +150 ft
Water level +44.4 m
November 1976

Overburden 0.6 m
Mineral 5.1 m
Waste 15.3 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.3	0.3
2nd Terrace	Clayey silt, pale brown and rust coloured, some rootlets and sandy patches	0.3	0.6
	Gravel, 'clayey' and sandy at top Gravel: fine and coarse, subrounded, Carboniferous sandstone and grit, with some extrusive igneous rocks Sand: medium quartz with coarse angular rock fragments	5.1	5.7
Laminated Clay	Silty clay, brown, laminated	7.0	12.7
Boulder Clay	Clay, red-brown, sandy with subrounded pebbles of extrusive igneous rocks, grit and sandstone to *c.* 13.5 m and mainly Triassic sandstone below	8.3+	21.0

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
5	39	56	0.6–1.6	10	18	38	13	16	5	
			1.6–2.6	11	12	16	13	26	22	
			2.6–3.9	1	4	4	8	31	52	
			3.9–4.9	2	6	10	16	35	25	6
			4.9–5.7	2	6	26	14	25	27	
			Mean	5	9	18	12	27	28	1

NY 56 SW 9 **5050 6248** **Irthington Mill** **Block A**

Surface level (+50.0 m) +164 ft
Water level +35.5 m
December 1976

Overburden 0.5 m
Mineral 20.0 m
Waste 1.5 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.5	0.5
Glacial Sand and Gravel	**a** Sand, 'clayey' in parts, pebbly towards base: fine quartz with some medium lithic grains	17.1	17.6
	b 'Clayey' sandy gravel Gravel: coarse, subrounded, Carboniferous sandstone, grit, and extrusive igneous rocks with Triassic sandstone Sand: fine, subrounded to rounded, quartz with some lithic fragments Fines: red-brown silt and clay	2.9	20.5
Boulder Clay	Clay, red-brown, sandy with fine pebbles of extrusive igneous rocks and Carboniferous sandstone	1.5+	22.0
	Borehole abandoned – unable to case hole below 20.5 m		

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
a	12	86	2	0.5–1.5	31	62	7				
				1.5–2.3	9	87	4				
				2.3–3.3	7	52	41				
				3.3–4.3	7	61	32				
				4.3–5.3	5	79	16				
				5.3–6.5	8	72	20				
				6.5–7.5	13	67	20				
				7.5–8.7	8	83	9				
				8.7–9.7	9	79	12				
				9.7–11.4	9	86	5				
				11.4–12.4	9	47	28	1	1		14
				12.4–13.4	9	60	23	2		6	
				13.4–14.4	10	68	21	1			
				14.4–15.4	9	79	12				
				15.4–17.6	27	65	8				
				Mean	12	70	16			1	1
b	15	51	34	17.6–18.6	13	38	9	3	3	16	18
				18.6–19.9	15	29	11	5	9	24	7
				19.9–20.5	17	38	19	8	7	11	
				Mean	15	34	12	5	7	19	9
a+b	13	82	5	Mean	13	65	16	1	1	3	1

NY 56 SW 10 **5143 6293** **Castlesteads** **Block B**

Surface level (+36.9 m) +121 ft
Water level +32.8 m
November 1976

Overburden 1.1 m
Mineral 18.1 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil and subsoil	1.1	1.1
3rd Terrace	**a** Sandy gravel Gravel: fine with coarse, subrounded to rounded, extrusive igneous rocks, Carboniferous sandstone and grit with some Triassic sandstone and quartz Sand: medium quartz with some coarse lithic grains	1.3	2.4
Glacial Sand and Gravel	**b** 'Clayey' sand, with gravel between 3.1 m and 6.3 m: fine quartz with red-brown silt bands	16.8+	19.2
	Borehole abandoned – unable to case below 19.2 m		

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
a	6	49	45	1.1–2.1	6	14	25	13	26	16	
				2.1–2.4	6	12	15	12	23	32	
				Mean	6	13	23	13	25	20	
b	17	80	3	2.4–3.1	9	91					
				3.1–4.8	obstruction—no bulk sample						
				4.8–6.3	14	58	1	2	3	14	8
				6.3–9.3	29	71					
				9.3–12.3	11	88	1				
				12.3–15.3	10	90					
				15.3–18.3	21	79					
				18.3–19.2	12	88					
				Mean	17	80				2	1
a+b	16	78	6	Mean	16	75	2	1	2	3	1

NY 56 SW 11 5232 6253 Breconhill **Block B**

Surface level (+37.8 m) +124 ft
Water level +35.8 m
December 1976

Overburden 7.3 m
Mineral 3.3 m
Bedrock 1.2 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.3	0.3
2nd Terrace	Clay, mottled orange-yellow to grey-green, silty in lower part	0.9	1.2
	Silt, sandy at top, grey, with plant debris	1.6	2.8
	Silty clay, red-brown and grey, soft	1.3	4.1
Laminated Clay	Clay, laminated, red-brown, with sandy partings in last metre	3.2	7.3
Glacial Sand and Gravel	'Clayey' pebbly sand Gravel: coarse and cobble, extrusive igneous rocks and St Bees Sandstone Sand: fine, quartz Fines: red-brown silty clay	3.3	10.6
St Bees Sandstone	Sandstone, red, fine	1.2+	11.8

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
19	71	10	7.3–8.3	18	64	2	4	4	8	
			8.3–9.3	20	73	1	3	1	2	
			9.3–10.6	20	60	3	5	2	1	9
			Mean	19	65	2	4	2	4	4

NY 56 SW 12 5324 6250 Coathill Farm **Block A**

Surface level (+67.7 m) +222 ft
Water struck at +45.7 m
December 1976

Overburden 0.3 m
Mineral 4.5 m
Waste 0.3 m
Mineral 4.2 m
Waste 15.7 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.3	0.3
Glacial Sand and Gravel	**a** Sand: fine, subrounded to rounded quartz	4.5	4.8
	Clay, stiff, brown, laminated	0.3	5.1
	b Sand, 'clayey' in first metre; fine, subrounded to rounded quartz	4.2	9.3
Laminated Clay	Clay, brown, laminated, with silt bands and sandy partings	13.1	22.4
Glacial Sand and Gravel	'Clayey' sand: fine quartz with red-brown silt	2.6+	25.0

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
a	6	94	0	0.3–1.3	2	39	56	3	
				1.3–2.3	5	51	42	1	1
				2.3–4.8	8	73	18	1	
				Mean	6	61	32	1	
b	9	91	0	5.1–6.1	14	75	11		
				6.1–9.3	8	81	11		
				Mean	9	80	11		
a+b	8	92	0	Mean	8	70	22		

NY 56 SW 13 **5386 6282** **Great Easby** **Block A**

Surface level (+67.7 m) +222 ft
Water struck at +62.7 m
December 1976

Overburden 2.4 m
Mineral 8.0 m
Waste 2.8 m
Mineral 3.0 m
Waste 1.1 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.1	0.1
Laminated Clay	Clayey silt, red-brown, laminated, with sandy bands and pebbles of extrusive igneous rocks	2.3	2.4
Glacial Sand and Gravel	**a** Sand, 'very clayey' at top: fine quartz	8.0	10.4
Laminated Clay	Clayey silt, red-brown, laminated in parts, with sandy bands and pebbles of Carboniferous and extrusive igneous rocks	2.8	13.2
Glacial Sand and Gravel	**b** 'Very clayey' sand: fine quartz; red-brown silt	3.0	16.2
	Sandy silt, red-brown	1.1+	17.3
	Borehole abandoned – unable to case hole below 17.3 m		

Grading

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*		
	Fines	Sand	Gravel		Fines	Sand	
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$
a	12	88	0	2.4–4.8	24	75	1
				4.8–7.8	4	84	12
				7.8–10.4	9	81	10
				Mean	12	80	8
b	27	73	0	13.2–16.2	27	73	
a+b	16	84	0	Mean	16	78	6

NY 56 SW 14 5422 6206 Brampton Ridge **Block D**

Surface level (+127.7 m) +419 ft
Water not encountered
October 1976

Overburden 0.3 m
Mineral 24.7 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.3	0.3
Glacial Sand and Gravel	**a** Sand, pebbly at top and base: medium, quartz with some lithic fragments	18.5	18.8
	b 'Clayey' sand: fine, quartz; poorly laminated red-brown silt bands	6.2+	25.0

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
a	5	93	2	0.3–1.3	3	28	53	6	7	3
				1.3–2.3	4	34	57	4	1	
				2.3–3.3	3	42	49	1	1	4
				3.3–6.3	7	73	20			
				6.3–9.3	5	58	37			
				9.3–12.3	9	35	56			
				12.3–15.3	3	17	78	2		
				15.3–18.6	4	17	70	5	1	3
				18.6–18.8	5	21	45	8	7	14
				Mean	5	39	52	2	1	1
b	14	86	0	18.8–20.4	17	79	3	1		
				20.4–21.5	15	84	1			
				21.5–22.5	20	76	4			
				22.5–23.5	7	83	10			
				23.5–25.0	11	10	78	1		
				Mean	14	63	22	1		
a+b	7	91	2	Mean	7	45	45	1	1	1

NY 56 SW 15 5490 6296 Boothby **Block A**

Surface level (+79.9 m) +262 ft
Water not encountered
December 1976

Waste 18.8 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.3	0.3
Boulder Clay	Clay, red-brown, sandy, with sporadic pebbles	1.0	1.3
Laminated Clay	Clayey silt, red-brown, with sandy layers and lenses and some laminations	5.0	6.3
	Silt, red-brown, massive	3.2	9.5
	Sandy silt, red-brown with many fine sand bands	1.7	11.2
Boulder Clay	Sandy pebbly clay: angular blocks of St Bees Sandstone and some extrusive igneous rocks in a sandy clay matrix; St Bees Sandstone becomes dominant towards base	7.6+	18.8

NY 56 SW 16 **5016 6136** **Irthington** **Block B**

Surface level (+28.7 m) +94 ft
Water struck at +27.0 m
November 1976

Overburden 1.7 m
Mineral 1.1 m
Waste 0.3 m
Mineral 4.6 m
Waste 4.1 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.4	0.4
1st Terrace	Silt, grey-brown and grey with ochreous patches, sandy with root traces	1.0	1.4
	Peat, silty to sandy; wood, reeds and other organic matter	0.3	1.7
	a Gravel, sandy at top with grey silt band at 2.3 m Gravel: coarse, subangular to subrounded, grit, greywacke and extrusive igneous rocks with some Carboniferous and Permo-Triassic sandstones and trace of quartz Sand: medium with fine, subangular to subrounded quartz with green and grey lithic grains	1.1	2.8
Laminated Clay	Clayey silt, red-brown, poorly laminated	0.3	3.1
Glacial Sand and Gravel	**b** Gravel, with a red-brown silt Gravel: coarse with fine, subangular to subrounded, extrusive igneous rocks with grit, Carboniferous sandstone and some Triassic sandstone and quartz Sand: fine and medium, quartz with some lithic grains	4.6	7.7
Boulder Clay	Clay, red-brown, sandy with subangular to angular pebbles of Triassic sandstone and some subrounded igneous extrusive rocks	4.1+	11.8
	Borehole abandoned owing to obstruction		

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
a	6	40	54	1.7–2.8	6	14	20	6	10	36	8
b	5	41	54	3.1–4.4	5	29	22	5	12	27	
				4.4–5.4	2	6	4	2	31	55	
				5.4–6.7	5	20	22	13	19	13	8
				6.7–7.7	8	18	7	7	24	32	4
				Mean	5	19	15	7	21	30	3
a+b	5	41	54	Mean	5	18	16	7	19	31	4

NY 56 SW 17 **5145 6158** **Old Church** **Block A**

Surface level (+46.9 m) +154 ft
Water struck at +39.1 m
December 1976

Overburden 0.3 m
Mineral 15.9 m
Waste 0.8 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.3	0.3
Glacial Sand and Gravel	**a** 'Clayey' sand Sand: fine, subrounded to rounded, quartz with some lithic grains Fines: silt bands	7.1	7.4
	b Sandy gravel Gravel: coarse, subrounded to well rounded, greywacke and grit with some extrusive igneous rocks, Carboniferous sandstone and St Bees Sandstone Sand: medium with fine, subrounded to rounded, quartz with dark lithic grains	8.8	16.2
Boulder Clay	Clay, red-brown, sandy and pebbly	0.8+	17.0
	Borehole abandoned – unable to case below 17.0 m		

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
a	10	90	0	0.3–1.3	11	83	6				
				1.3–3.9	12	67	21				
				3.9–5.2	7	50	41	1	1		
				5.2–6.4	7	82	11				
				6.4–7.4	12	57	29	2			
				Mean	10	67	22	1			
b	4	66	30	7.4–8.6	7	54	30	2	4	3	
				8.6–9.6	4	21	38	15	5	9	8
				9.6–11.8	4	24	44	14	6	8	
				11.8–12.5	1	3	21	5	29	36	5
				12.5–13.5	2	13	48	3	7	27	
				13.5–14.2	2	12	30	2	4	31	19
				14.2–14.8	4	39	51	1	2	3	
				14.8–15.8	3	17	17	4	12	29	18
				15.8–16.2	4	16	14	7	16	43	
				Mean	4	24	35	7	8	17	5
a+b	6	77	17	Mean	6	43	29	4	5	10	3

NY 56 SW 18 **5270 6184** **Oakwood** **Block A**

Surface level (+70.4 m) +231 ft
Water struck at +50.6 m
December 1976

Overburden 0.3 m
Mineral 2.1 m
Waste 2.0 m
Mineral 1.9 m
Waste 6.4 m
Mineral 7.3 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.3	0.3
Glacial Sand and Gravel	**a** Sand, with pebbles at base; fine and medium, subangular to subrounded, quartz with some dark lithic grains	2.1	2.4
Laminated Clay	Clay, red-brown, laminated, with fine sand bands	1.0	3.4
	Silt	1.0	4.4
Glacial Sand and Gravel	**b** 'Clayey' sand: fine quartz with silty clay bands	1.9	6.3
Laminated Clay	Clay, red-brown, laminated, with silt bands below 11.5 m	6.4	12.7
Glacial Sand and Gravel	**c** 'Clayey sand': fine quartz; silt bands	7.3+	20.0
	Borehole abandoned – slow penetration through 'clayey' sand		

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
a	4	92	4	0.3–1.3	5	61	32	1	1	
				1.3–2.4	3	38	49	3	4	3
				Mean	4	49	41	2	3	1
b	10	90	0	4.4–6.3	10	84	6			
c	17	83	0	12.7–13.7	26	74				
				13.7–14.7	17	83				
				14.7–17.7	19	81				
				17.7–20.0	12	86	2			
				Mean	17	82	1			
a+b+c	14	85	1	Mean	14	76	9		1	

NY 56 SW 19 5379 6125 Warren House **Block D**

Surface level (+90.5 m) +297 ft
Water not encountered
October 1976

Overburden 0.4 m
Mineral 8.6 m
Waste 2.2 m
Mineral 2.5 m
Waste 3.5 m
Bedrock 0.8 m +

Log

Geological classification	*Lithology*	*Thickness*	*Depth*
		m	m
	Soil	0.4	0.4
Glacial Sand and Gravel	**a** 'Clayey' sand, with gravel in top 1.6 m Sand: fine, subrounded, quartz with some lithic grains Fines: red-brown silt and clay bands	8.6	9.0
	Sandy silt, red-brown	2.2	11.2
	b 'Clayey' sandy gravel Gravel: mainly coarse, subrounded, greywacke, Carboniferous and Permo-Triassic sandstones and extrusive igneous rocks Sand: fine, quartz with some green lithic grains Fines: red-brown silt and clay	2.5	13.7
Boulder Clay	Clay, sandy, red-brown with subangular to rounded pebbles of sandstone and extrusive igneous rocks	3.5	17.2
St Bees Sandstone	Sandstone, red-brown, soft, fine to medium	0.8+	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
a	14	81	5	0.4–0.9	20	59	10	4	4	3	
				0.9–2.0	11	39	16	6	17	11	
				2.0–3.0	9	80	9		1	1	
				3.0–4.0	16	80	4				
				4.0–5.0	9	87	3		1		
				5.0–6.0	12	86	2				
				6.0–9.0	17	78	5				
				Mean	14	74	6	1	3	2	
b	17	45	38	11.2–12.9	17	31	4	4	11	15	18
				12.9–13.7	16	39	10	9	9	17	
				Mean	17	34	6	5	10	16	12
a+b	15	73	12	Mean	15	65	6	2	4	5	3

NY 56 SW 20 5070 6048 Middle Farm **Block A**

Surface level (+54.0 m) +177 ft
Water struck at +52.4 m
October 1976

Overburden 0.3 m
Mineral 3.5 m
Waste 4.7 m
Mineral 5.9 m
Waste 2.5 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.3	0.3
Glacial Sand and Gravel	**a** Pebbly sand, 'clayey' in top 1.3 m and with much gravel between 1.6 and 2.6 m Gravel: coarse with fine, rounded, extrusive igneous rocks with some Carboniferous and Permo-Triassic sandstones and quartzite Sand: fine quartz	3.5	3.8
	Clay, soft, brown, with silt and fine sand bands	4.7	8.5
	b 'Clayey' sand with much gravel in bottom metre Sand: fine quartz, some green lithics Fines: red-brown laminated silt bands	5.9	14.4
Boulder Clay	Clay, brown, stony	2.5+	16.9
	Borehole abandoned – slow penetration through clay		

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
a	10	73	17	0.3–1.6	19	69	8	2	1	1	
				1.6–2.6	3	13	21	8	21	34	
				2.6–3.8	6	76	13	4	1		
				Mean	10	55	13	5	7	10	
b	18	70	12	8.5–9.5	38	61	1				
				9.5–10.5	22	77	1				
				10.5–11.5	8	87	5				
				11.5–12.5	9	74	13	2	2		
				12.5–13.4	16	15	60	2	2	5	
				13.4–14.4	13	18	4	3	8	47	7
				Mean	18	56	13	1	2	9	1
a+b	15	71	14	Mean	15	56	13	2	4	9	1

NY 56 SW 21 5194 6079 Townfoot Farm **Block A**

Surface level (+61.6 m) +202 ft
Water level +51.6 m
October 1976

Overburden 0.3 m
Mineral 8.7 m
Waste 8.7 m
Bedrock 0.3 m+

Log

Geological classification	*Lithology*	*Thickness*	*Depth*
		m	m
	Soil	0.3	0.3
Glacial Sand and Gravel	'Clayey' sand, pebbly in parts Gravel: fine and coarse, subangular to subrounded, extrusive igneous rocks with some Carboniferous sandstone, grit and greywacke and traces of quartz and granite Sand: fine, quartz with lithic fragments Fines: red-brown silt and clay bands	8.7	9.0
Boulder Clay	Clay, sandy, red-brown, with coarse pebbles and boulders	8.7	17.7
St Bees Sandstone	Sandstone, dull red, fine	0.3+	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
16	74	10	0.3–1.3	18	65	17				
			1.3–1.9	9	51	22	1	4	13	
			1.9–2.9	2	14	55	8	12	9	
			2.9–3.7	6	21	48	6	11	8	
			3.7–4.9	13	83	4				
			4.9–5.9	7	55	38				
			5.9–6.9	10	70	20				
			6.9–8.0	9	75	16				
			8.0–9.0	22	32	9	5	9	13	10
			Mean	16	48	23	3	4	5	1

NY 56 SW 22 5291 6048 Clay Dubs **Block D**

Surface level (+87.1 m) +286 ft
Water not encountered
December 1976

Overburden 0.7 m
Mineral 15.5 m
Bedrock 1.3 m+

Log

Geological classification	*Lithology*	*Thickness*	*Depth*
		m	m
	Soil	0.7	0.7
Glacial Sand and Gravel	Pebbly sand, with red-brown silt bands Gravel: coarse with cobbles at base, subrounded to rounded, extrusive igneous rocks and Carboniferous sandstone with much St Bees Sandstone towards base Sand: fine, quartz with some lithic grains	15.5	16.2
St Bees Sandstone	Sandstone, soft, dull red, massive	1.3+	17.5

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
9	84	7	0.7–1.9	19	52	19	2	3	5	
			1.9–2.9	8	63	8	1	4	16	
			2.9–3.9	9	87	1	1		2	
			3.9–6.9	8	81	11				
			6.9–9.9	9	75	16				
			9.9–12.9	8	56	25	1		10	
			12.9–16.2	7	67	10	3		1	12
			Mean	9	69	14	1		4	3

NY 56 SW 23 5438 6039 Milton Hall **Block D**

Surface level (+135.3 m) +444 ft
Water not encountered
December 1976

Overburden 0.3 m
Mineral 24.7 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.3	0.3
Glacial Sand and Gravel	'Clayey' sand with pebbly bands to 4.3 m Sand: fine, quartz with some lithic grains Fines: thin red-brown silt bands	24.7+	25.0

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
13	86	1	0.3–1.3	3	15	50	7	11	14
			1.3–2.3	5	54	37	1	1	2
			2.3–3.3	8	75	12	1	1	3
			3.3–4.3	12	76	9		2	1
			4.3–5.3	15	80	5			
			5.3–6.3	14	82	4			
			6.3–9.3	13	84	3			
			9.3–12.3	6	89	5			
			12.3–15.3	8	87	5			
			15.3–18.3	29	70	1			
			18.3–19.7	18	80	2			
			19.7–21.8	17	79	4			
			21.8–25.0	8	85	7			
			Mean	13	78	8			1

NY 56 SE 2 5656 6494 Barras Top **Block C**

Surface level (+126.2 m) +414 ft
Water not encountered
January 1977

Waste 6.6 m
Bedrock 0.5 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.2	0.2
Boulder Clay	Clay, orange-brown, with subangular to subrounded pebbles, with laminated structure and some sandy patches towards base	2.0	2.2
	Clay, sandy, red-brown, very compact with subrounded pebbles: at base shale fragments dominate	4.4	6.6
Birdoswald Limestone Group	Mudstone, grey, micaceous, fossiliferous	0.5+	7.1

NY 56 SE 3 5817 6451 Greenmouth Lane **Block B**

Surface level (+74.7 m) +245 ft
Water struck at +72.3 m
January 1977

Overburden 0.3 m
Mineral 6.4 m
Bedrock 0.8 m+

Log

Geological classification	*Lithology*	*Thickness*	*Depth*
		m	m
	Soil	0.3	0.3
Alluvial Fan	'Clayey' pebbly sand, less 'clayey' and with an increase in gravel content at base Gravel: coarse, subangular to subrounded, extrusive igneous rocks, Carboniferous sandstone and grit with some Permo-Triassic sandstone, granite and quartz Sand: fine, quartz with few lithic grains Fines: grey-brown and red-brown silt and clay	6.4	6.7
? Birdoswald Limestone Group	Sandstone, grey-brown, micaceous – ? boulder	0.8+	7.5

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
16	66	18	0.3–1.5	27	63	3	3	2	2	
			1.5–2.4	14	52	4	8	12	10	
			2.4–4.1	17	68	2	3	3	7	
			4.1–5.1	10	71	4	4	6	5	
			5.1–6.2	16	45	4	6	8	16	5
			6.2–6.7	6	13	7	8	13	46	7
			Mean	16	57	4	5	6	11	1

NY 56 SE 4 5914 6456 Church Hill **Block C**

Surface level (+100.9 m) +331 ft
Water not encountered
January 1977

Overburden 0.5 m
Mineral 9.0 m
Waste 1.1 m
Mineral 14.4 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.5	0.5
Glacial Sand and Gravel	**a** 'Clayey' sand, pebbly in top 2.6 m Sand: fine, quartz with lithic grains Fines: thin red-brown silt bands	9.0	9 5
	Silt, red-brown, banded	0.7	10.2
	Clay, grey-green	0.4	10.6
	b Sand, 'clayey' at top: medium to fine, quartz with some lithic grains	14.4+	25.0

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
a	18	77	5	0.5–2.6	24	44	12	1	3	16
				2.6–5.6	17	81	2			
				5.6–8.6	16	80	4			
				8.6–9.5	13	72	14	1		
				Mean	18	71	6		1	4
b	6	94		10.6–13.6	12	71	16	1		
				13.6–16.6	3	37	59	1		
				16.6–19.6	4	42	53		1	
				19.6–22.6	5	42	52	1		
				22.6–25.0	3	21	75	1		
				Mean	6	43	50	1		
a+b	10	88	2	Mean	10	54	33	1	1	1

NY 56 SE 5 5508 6373 Lanercost **Block B**

Surface level (+48.5 m) +159 ft
Water level +43.4 m
November 1976

Overburden 1.8 m
Mineral 2.9 m
Waste 7.8 m
Bedrock 1.0 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.3	0.3
2nd Terrace	Clay, silty and sandy in parts, pale grey with red-brown patches	1.5	1.8
	Gravel Gravel: coarse, subangular to subrounded, grit, with some Carboniferous sandstone and extrusive igneous rocks Sand: fine and medium quartz with coarse subangular lithic grains	2.9	4.7
Boulder Clay	Clay, red-brown, sandy, with angular, blocky St Bees Sandstone (dominant towards base) and subrounded extrusive igneous rocks	7.8	12.5
? St Bees Shale	Siltstone and sandstone, red-brown, micaceous, well-bedded	1.0+	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
6	28	66	1.8–2.8	8	13	12	9	21	37	
			2.8–3.8	4	7	9	7	15	48	10
			3.8–4.7	7	9	10	8	20	41	5
			Mean	6	10	10	8	19	42	5

NY 56 SE 6 5612 6373 Lanercost Priory **Block B**

Surface level (+49.4 m) +162 ft
Water struck at +47.9 m
November 1976

Overburden 0.3 m
Mineral 1.8 m
Waste 1.9 m
Mineral 1.9 m
Waste 19.1 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.3	0.3
1st Terrace	**a** Gravel, some grey-brown silt Gravel: coarse with fine, subangular to subrounded, grit and greywacke with Carboniferous sandstone and some extrusive igneous rocks Sand: medium, quartz with lithic grains	1.8	2.1
	Clay, light brown to brown with silty laminations and some pebbles	1.9	4.0
Glacial Sand and Gravel	**b** 'Very clayey' sand Sand: fine, quartz Fines: red-brown silt, sometimes in lenses	1.9	5.9
Laminated Clay	Silt and clay, brown, commonly well-laminated sometimes sandy	18.1	24.0
Glacial Sand and Gravel	'Very clayey' sand, fine quartz with red-brown silt	1.0+	25.0

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
a	5	39	56	0.3–1.3	6	12	17	10	19	32	4
				1.3–2.1	4	7	19	12	21	32	5
				Mean	5	10	18	11	20	32	4
b	26	74	0	4.0–5.0	27	72	1				
				5.0–5.9	25	74	1				
				Mean	26	73	1				
a+b	16	56	28	Mean	16	42	9	5	10	16	2

NY 56 SE 7 5744 6388 Crookstown **Block B**

Surface level (+62.5 m) +205 ft
Water level +51.5 m
January 1977

Overburden 2.3 m
Mineral 23.4 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.3	0.3
Alluvial Fan	Clay with sandy lenses, orange and red-brown	2.0	2.3
Glacial Sand and Gravel	**a** 'Clayey' sandy gravel with boulders between 4.1 and 5.7 m Gravel: fine and coarse, subangular to subrounded, Carboniferous sandstone and grit with some extrusive igneous rocks, quartz and granite Sand: fine quartz with medium and coarse angular lithic grains Fines: bands of red-brown silt and clay	3.4	5.7
	b Sand, pebbly in parts and with thin silt and clay bands between 9.0 and 12.0 m: fine, quartz with some medium lithic grains	20.0+	25.7

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
a	13	61	26	2.3–3.2	12	14	17	8	23	26
				3.2–4.1	13	79	2	2	3	1
				4.1–5.7	boulders—chisel used—no bulk sample					
				Mean	13	46	10	5	13	13
b	6	94	0	5.7—9.0	7	80	13			
				9.0–12.0	5	90	5			
				12.0–15.0	5	76	19			
				15.0–18.0	5	79	10	1		5
				18.0–21.0	5	80	15			
				21.0–25.7	6	83	11			
				Mean	6	82	12			
a+b	6	91	3	Mean	6	79	12		1	2

NY 56 SE 8 5841 6367 High Broom Hill **Block C**

Surface level (+116.7 m) +383 ft
Water not encountered
January 1977

Overburden 0.3 m
Mineral 5.3 m
Waste 1.0 m
Bedrock 0.9 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.3	0.3
Glacial Sand and Gravel	Sand: medium to 3.0 m, fine below, quartz with some lithic grains	5.3	5.6
Boulder Clay	Clay, sandy in parts, with fine subangular to subrounded Carboniferous sandstone and extrusive igneous rocks: red-brown at top becoming grey-brown towards base	1.0	6.6
Lower Limestone Group	Sandstone, with siltstone bands, grey and grey-brown, micaceous, with carbonaceous partings	0.9+	7.5

Grading

Mean for deposit *percentages*			Depth below surface (m)	*percentages*			
Fines	Sand	Gravel		Fines	Sand		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$
6	94	0	0.3–3.0	3	27	69	1
			3.0–5.6	8	82	10	
			Mean	6	54	40	

NY 56 SE 9 5961 6388 Chapelburn Rigg **Block C**

Surface level (+143.6 m) +471 ft
Water struck at +142.6 m
January 1977

Overburden 0.3 m
Mineral 1.7 m
Waste 1.4 m
Bedrock 1.6 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.3	0.3
Glacial Sand and Gravel	'Clayey' pebbly sand Gravel: coarse, subangular to subrounded, Carboniferous sandstone, grit and extrusive igneous rocks Sand: medium and fine, quartz with some lithic grains Fines: grey-brown silt and clay	1.7	2.0
Boulder Clay	Clay, red-brown with grey-green patches, sandy in parts, with subrounded, fine pebbles of extrusive igneous rocks and some coarse, angular Carboniferous material	1.4	3.4
Lower Limestone Group	Mudstone, grey, rubbly and clayey at top becoming more compact with hard calcareous bands	1.6+	5.0

Grading

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
12	69	19	0.3–2.0	12	30	33	6	4	11	4

NY 56 SE 10 5571 6215 Naworth Castle **Block C**

Surface level (+109.7 m) +360 ft
Water not encountered
October 1976

Waste 3.0 m
Bedrock 0.8 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.3	0.3
Boulder Clay	Clay, red-brown, sandy with fine subrounded to subangular pebbles and carbonaceous patches	2.7	3.0
Lower Limestone Group	Sandstone, yellow-brown, medium, quartzitic	0.8+	3.8

NY 56 SE 11 5702 6264 Naworth Park **Block C**

Surface level (+131.1 m) + 430 ft
Water struck at +123.6 m
January 1977

Waste 19.0 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.5	0.5
Boulder Clay	Clay, mottled, rust-brown and pale blue-grey, with some rough laminae, sandy partings and lenses and a few pebbles	1.5	2.0
	Clay, red-brown, with many subrounded to rounded pebbles; sandy to base; silt band at 3.0 m	17.0+	19.0

NY 56 SE 12 5842 6273 Middle Row **Block C**

Surface level (+145.1 m) +476 ft
Water level not recorded
115 mm Minuteman power auger
April 1975

Overburden 0.3 m
Mineral 3.7 m
Waste 0.6 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.3	0.3
Glacial Sand and Gravel	'Clayey' sand: fine quartz with red-brown silt	3.7	4.0
Boulder Clay	Clay, sandy, brown and blue, with some small pebbles	0.6+	4.6

Grading

Mean for deposit *percentages*			Depth below surface (m)	*percentages*		
Fines	Sand	Gravel		Fines	Sand	
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$
17	83	0	0.3–1.2	20	79	1
			1.2–2.1	18	81	1
			2.1–3.1	15	84	1
			3.1–4.0	15	84	1
			Mean	17	82	1

NY 56 SE 13 5982 6214 Cleugh Head **Block C**

Surface level (+219.2 m) +719 ft
Water struck at +206.9 m
January 1977

Overburden 1.1 m
Mineral 5.3 m
Waste 5.9 m
Bedrock 1.0 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.2	0.2
Glacial Sand and Gravel	'Clayey' sand: fine quartz	0.3	0.5
	Clay, mottled grey and orange-brown, sandy, with pebbles of Carboniferous rocks	0.4	0.9
	Silt, red-brown, poorly laminated	0.2	1.1
	'Clayey' pebbly sand Gravel: fine and coarse, subangular to subrounded, extrusive igneous rocks, and Carboniferous sandstone with some coal Sand: fine, quartz and some lithic grains Fines: red-brown silt, sometimes in bands	5.3	6.4
Boulder Clay	Clay, dark brown to 9.5 m, grey and light brown below, with pebbles and some cobbles and boulders	5.9	12.3
Middle Limestone Group	Sandstone and siltstone, grey and grey-brown, micaceous	1.0+	13.3

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
16	77	7	1.1–2.1	34	56	8	2		
			2.1–3.1	21	51	17	7	3	1
			3.1–4.8	10	28	35	8	8	11
			4.8–5.8	8	89	3			
			5.8–6.4	11	82	6	1		
			Mean	16	55	17	5	3	4

NY 56 SE 14 **5523 6122** **Cumcatch** **Block D**

Surface level (+120.1 m) +394 ft
Water level +119.1 m
October 1976

Overburden 0.2 m
Mineral 2.0 m
Waste 1.0 m
Bedrock 2.0 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.2	0.2
Glacial Sand and Gravel	**a** 'Clayey' pebbly sand Gravel: coarse, rounded, extrusive igneous rocks Sand: fine, quartz with some lithic grains	1.0	1.2
	b Gravel Gravel: coarse, subangular to well rounded, extrusive igneous rocks and Permo-Triassic and Carboniferous sandstones Sand: medium and fine, subangular to subrounded, quartz with some lithic grains	1.0	2.2
Boulder Clay	Clay, brown, with pebbles and cobbles of Carboniferous limestone and sandstone and extrusive igneous rocks	1.0	3.2
Lower Limestone Group	Shale, broken and clayey at top, brittle, purplish grey below	2.0+	5.2

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
a	18	75	7	0.2–1.2	18	53	19	3	2	5
b	4	46	50	1.2–2.2	4	19	20	7	12	38
a+b	11	61	28	Mean	11	36	20	5	7	21

NY 56 SE 15 5653 6127 Shaw Brow **Block C**

Surface level (+150.6 m) +494 ft
Water level +146.3 m
January 1977

Waste 10.8 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil and fill	0.6	0.6
Boulder Clay	Clay, orange-brown and grey becoming pale brown then red-brown to base, very sandy in parts, with subrounded pebbles of grit and extrusive igneous and Carboniferous rocks	10.2+	10.8
	Borehole abandoned – slow penetration through clay		

NY 56 SE 16 5608 6058 Black Hill **Block D**

Surface level (+149.7 m) +491 ft
Water not encountered
December 1976

Overburden 0.4 m
Mineral 6.9 m
Waste 1.3 m
Bedrock 0.4 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.4	0.4
Glacial Sand and Gravel	Sand: fine with medium, mainly quartz with some lithics	6.9	7.3
Boulder Clay	Clay, silty to sandy, pebbly, red-brown	1.3	8.6
Middle Limestone Group	Sandstone, yellow-brown and fawn, medium, quartzitic	0.4+	9.0

Grading

Mean for deposit *percentages*			Depth below surface (m)	*percentages*		
Fines	Sand	Gravel		Fines	Sand	
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$
3	97	0	0.4–1.4	1	62	37
			1.4–4.4	2	42	56
			4.4–7.3	4	84	12
			Mean	3	63	34

APPENDIX G
LIST OF WORKINGS

Site	*Grid reference*	*Operator*
ACTIVE		
Whin Hill, How Mill	511 568	Tilcon Limited
Hard Banks, How Mill	516 563	Harrison's Limeworks Limited
Faugh	510 549	Esk Manufacturing Company Limited
ABANDONED		
Capon Tree Hill	525 595	—
Whin Hill, Faugh	513 551	—
Moss Nook, Cairnbridge	506 542	—

All pits work Glacial Sand and Gravel and are dry.

APPENDIX H

CONVERSION TABLE, METRES TO FEET (to nearest 0.5 ft)

m	ft	m	ft	m	ft	m	ft	m	ft
0.1	0.5	6.1	20	12.1	39.5	18.1	59.5	24.1	79
0.2	0.5	6.2	20.5	12.2	40	18.2	59.5	24.2	79.5
0.3	1	6.3	20.5	12.3	40.5	18.3	60	24.3	79.5
0.4	1.5	6.4	21	12.4	40.5	18.4	60.5	24.4	80
0.5	1.5	6.5	21.5	12.5	41	18.5	60.5	24.5	80.5
0.6	2	6.6	21.5	12.6	41.5	18.6	61	24.6	80.5
0.7	2.5	6.7	22	12.7	41.5	18.7	61.5	24.7	81
0.8	2.5	6.8	22.5	12.8	42	18.8	61.5	24.8	81.5
0.9	3	6.9	22.5	12.9	42.5	18.9	62	24.9	81.5
1.0	3.5	7.0	23	13.0	42.5	19.0	62.5	25.0	82
1.1	3.5	7.1	23.5	13.1	43	19.1	62.5	25.1	82.5
1.2	4	7.2	23.5	13.2	43.5	19.2	63	25.2	82.5
1.3	4.5	7.3	24	13.3	43.5	19.3	63.5	25.3	83
1.4	4.5	7.4	24.5	13.4	44	19.4	63.5	25.4	83.5
1.5	5	7.5	24.5	13.5	44.5	19.5	64	25.5	83.5
1.6	5	7.6	25	13.6	44.5	19.6	64.5	25.6	84
1.7	5.5	7.7	25.5	13.7	45	19.7	64.5	25.7	84.5
1.8	6	7.8	25.5	13.8	45.5	19.8	65	25.8	84.5
1.9	6	7.9	26	13.9	45.5	19.9	65.5	25.9	85
2.0	6.5	8.0	26	14.0	46	20.0	65.5	26.0	85.5
2.1	7	8.1	26.5	14.1	46.5	20.1	66	26.1	85.5
2.2	7	8.2	27	14.2	46.5	20.2	66.5	26.2	86
2.3	7.5	8.3	27	14.3	47	20.3	66.5	26.3	86.5
2.4	8	8.4	27.5	14.4	47	20.4	67	26.4	86.5
2.5	8	8.5	28	14.5	47.5	20.5	67.5	26.5	87
2.6	8.5	8.6	28	14.6	48	20.6	67.5	26.6	87.5
2.7	9	8.7	28.5	14.7	48	20.7	68	26.7	87.5
2.8	9	8.8	29	14.8	48.5	20.8	68	26.8	88
2.9	9.5	8.9	29	14.9	49	20.9	68.5	26.9	88.5
3.0	10	9.0	29.5	15.0	49	21.0	69	27.0	88.5
3.1	10	9.1	30	15.1	49.5	21.1	69	27.1	89
3.2	10.5	9.2	30	15.2	50	21.2	69.5	27.2	89
3.3	11	9.3	30.5	15.3	50	21.3	70	27.3	89.5
3.4	11	9.4	31	15.4	50.5	21.4	70	27.4	90
3.5	11.5	9.5	31	15.5	51	21.5	70.5	27.5	90
3.6	12	9.6	31.5	15.6	51	21.6	71	27.6	90.5
3.7	12	9.7	32	15.7	51.5	21.7	71	27.7	91
3.8	12.5	9.8	32	15.8	52	21.8	71.5	27.8	91
3.9	13	9.9	32.5	15.9	52	21.9	72	27.9	91.5
4.0	13	10.0	33	16.0	52.5	22.0	72	28.0	92
4.1	13.5	10.1	33	16.1	53	22.1	72.5	28.1	92
4.2	14	10.2	33.5	16.2	53	22.2	73	28.2	92.5
4.3	14	10.3	34	16.3	53.5	22.3	73	28.3	93
4.4	14.5	10.4	34	16.4	54	22.4	73.5	28.4	93
4.5	15	10.5	34.5	16.5	54	22.5	74	28.5	93.5
4.6	15	10.6	35	16.6	54.5	22.6	74	28.6	94
4.7	15.5	10.7	35	16.7	55	22.7	74.5	28.7	94
4.8	15.5	10.8	35.5	16.8	55	22.8	75	28.8	94.5
4.9	16	10.9	36	16.9	55.5	22.9	75	28.9	95
5.0	16.5	11.0	36	17.0	56	23.0	75.5	29.0	95
5.1	17	11.1	36.5	17.1	56	23.1	76	29.1	95.5
5.2	17	11.2	36.5	17.2	56.5	23.2	76	29.2	96
5.3	17.5	11.3	37	17.3	57	23.3	76.5	29.3	96
5.4	17.5	11.4	37.5	17.4	57	23.4	77	29.4	96.5
5.5	18	11.5	37.5	17.5	57.5	23.5	77	29.5	97
5.6	18.5	11.6	38	17.6	57.5	23.6	77.5	29.6	97
5.7	18.5	11.7	38.5	17.7	58	23.7	78	29.7	97.5
5.8	19	11.8	38.5	17.8	58.5	23.8	78	29.8	98
5.9	19.5	11.9	39	17.9	58.5	23.9	78.5	29.9	98
6.0	19.5	12.0	39.5	18.0	59	24.0	78.5	30.0	98.5

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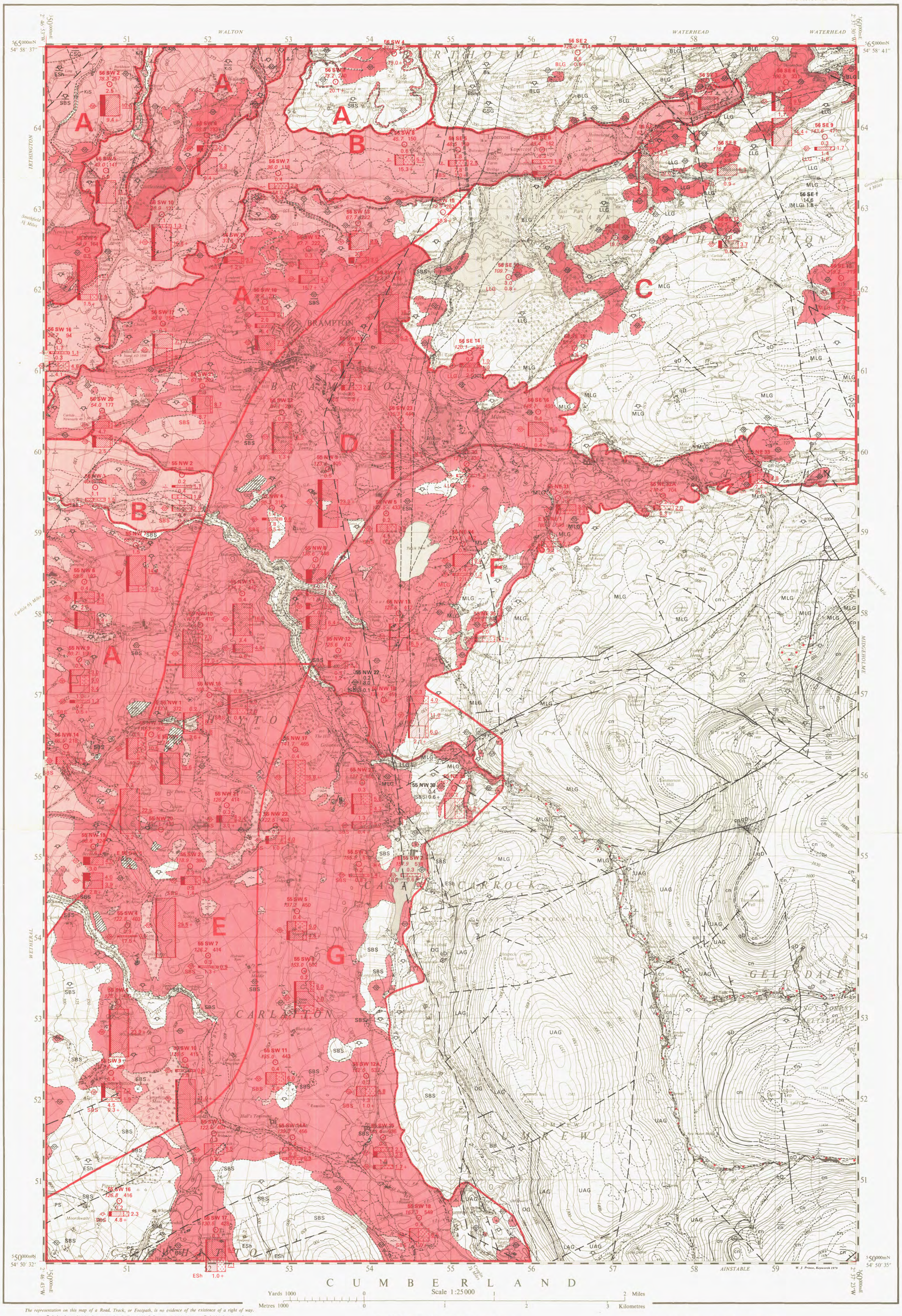
INSTITUTE OF GEOLOGICAL SCIENCES

INDUSTRIAL MINERALS ASSESSMENT UNIT

THE SAND AND GRAVEL RESOURCES OF SHEET NY 55 AND Pt. NY 56 (BRAMPTON, CUMBRIA)

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

ORDNANCE SURVEY
SHEET NY55 & Pt NY56
PROVISIONAL EDITION



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

Original geological survey by R.Russell, D.Burns, T.V.Holmes, E.J.Herbert and A.Colvin. Published on the one-inch scale in 1890.
Resurveyed in1923-7 by F.M.Trotter and S.E.Hollingworth. B.Smith, District Geologist.
Published on the one-inch scale in 1931. Sir John S. Flett, Director.
Solid edition reissued on the 1:50000 scale with minor amendments in 1976.
Drift lines amended on the six-inch scale by R.S.Arthurton in 1977.
W.B.Evans, District Geologist.

Sand and Gravel Survey by I.Jackson and R.G.Crofts in 1975-7.
R.G.Thurrell, Head, Industrial Minerals Assessment Unit.

1:25000 Sand and Gravel Resource Sheet published 1979.
Austin W. Woodland, C.B.E., *Director, Institute of Geological Sciences.*
1100/80

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.

Compiled from 6'' sheets last fully revised 1898-1924
Other partial systematic revision 1938-52 has been incorporated

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

Compiled and drawn in the Keyworth Office of the Institute of Geological Sciences.

THE SAND AND GRAVEL RESOURCES OF SHEET NY 55 AND Pt. NY 56 (BRAMPTON, CUMBRIA)

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

45

EXPLANATION OF SYMBOLS AND ABBREVIATIONS

DRIFT — RECENT AND PLEISTOCENE

Hill Peat	HP-1 ✓
Peat	P-1 ✓
Alluvium	A-30 ✓
First Terrace	1T-17 ✓
Second Terrace	2T-12 ✓
Third Terrace	3T-11 ✓
	-variable deposits of gravel and sand with silt, clay and some peat.
Alluvial Fan -sand with clay and gravel.	AF-3 ✓
Moraine -earthy, ill sorted gravel.	M-1 ✓
Laminated Clay -silty clay, laminated in parts, some silt and sand lenses.	LC-2 ✓
Glacial Sand and Gravel -sand with gravel, clayey in parts.	GS-28 ✓
Boulder Clay -stony, sandy clay.	BC-17 ✓

SOLID

KiS	**Kirklinton Sandstone** -bright red, soft, fine-grained sandstone.	PERMO-TRIASSIC
SBS	**St Bees Sandstone** -dull red, compact, micaceous sandstone with intercalated shale bands.	
ESh	**St Bees Shales (Eden Shales)** -dull red mudstones and siltstones with subordinate sandstones and gypsum bands.	
PS	**Penrith Sandstone** -brick red, medium-to coarse-grained, poorly cemented sandstone	
BK	**Basal Conglomerate (Brockram)** -fragments and pebbles of Carboniferous material in a sandy, calcareous matrix	
cn	**Upper Limestone Group**	CARBONIFEROUS
MLG	**Middle Limestone Group**	
UAG	**Upper Alston Group**	
LLG	**Lower Limestone Group**	
LAG	**Lower Alston Group**	
BLG	**Birdoswald Limestone Group**	
CSG	**Craighill Sandstone Group**	
OG	**Orton Group**	
	-variable sequence of limestones, sandstones and shales with coals.	
BB	**Basement Conglomerate** -conglomerates, grits, marls and mudstones.	IGNEOUS INTRUSIVE
qD	**Quartz Dolerite (Whin Sill)**	

Worked areas of sand and gravel WO-9

BOUNDARY LINES

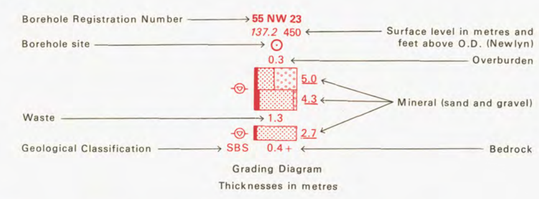
- Geological boundary, Drift
- Geological boundary, Solid
- Fault, crossmark indicates downthrow side
- Inferred boundary between recognised categories of deposits
- Resource Block boundary

Broken lines denote uncertainty

BOREHOLE DATA
SITE LOCATIONS

- Industrial Minerals Assessment Unit (I.M.A.U.) boreholes
- Other boreholes

I.M.A.U. BOREHOLES



Grading Diagram
Thicknesses in metres

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

Borehole Registration Number

Each I.M.A.U. borehole is identified by a Registration Number, e.g. 55NW23. The initial letters and numbers refer to the quarter sheet and the final figures to the I.G.S. serial number for that quarter. The unique designation for borehole 55NW23 is NY55 NW23.

Grading Diagrams

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

The height of the diagram is proportional to the mineral thickness.
The widths of the divisions show the proportions of **Fines**, **Sand** and **Gravel**.

OTHER BOREHOLES

The layout of information is the same as for I.M.A.U. boreholes, though the data available may not be as comprehensive. They are registered in the same series.

EXPOSURE RECORDS

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

CATEGORIES OF DEPOSITS

Exposed mineral	CAT-E6
Continous or almost continuous spreads of mineral beneath overburden	CAT-C1
Sand and gravel either not potentially workable (see Report) or absent	CAT-A2
Sand and gravel not assessed	CAT-N1

Where appropriate on other sheets a category 'Discontinuous spreads of mineral beneath overburden' is recognised.

RESOURCE BLOCKS

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

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

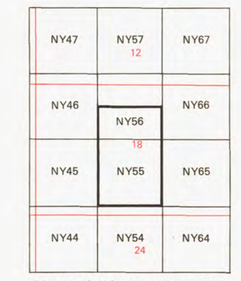


Diagram showing the relation of the National Grid 1:25000 sheets with One-Inch and 1:50000 Geological Sheets 12, 18 and 24.