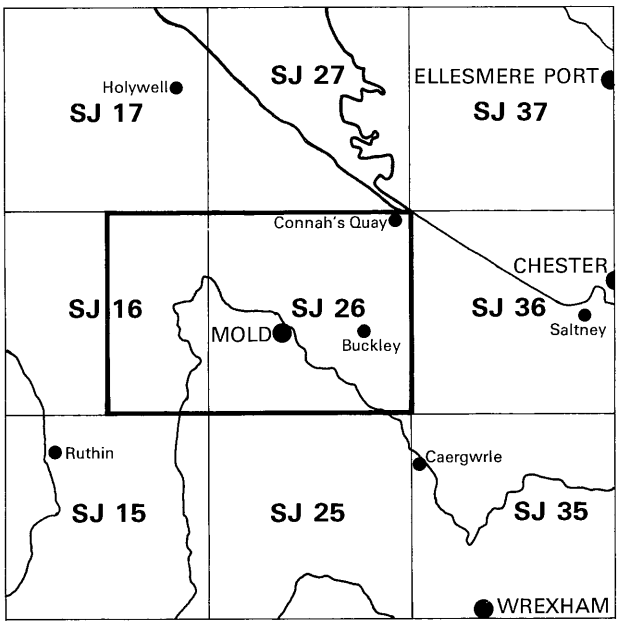
INSTITUTE OF GEOLOGICAL SCIENCES

Natural Environment Research Council

Mineral Assessment Report 113



The sand and gravel resources of the country around Mold, Clwyd

Description of 1:25 000 sheet SJ 26 and part of SJ 16

D. F. Ball and K. A. McL. Adlam

ISBN 0 11 884313 3*

London Her Majesty's Stationery Office 1982

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

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

Any enquiries concerning this report may be addressed to
Head, Industrial Minerals Assessment Unit,
Institute of Geological Sciences,
Keyworth, Nottingham NG12 5GG.

PREFACE

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

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

This report describes the sand and gravel resources of 150 km^2 of the country around Mold, Clwyd, shown on the accompanying resource map. The survey was carried out by Mr D. F. Ball and Mr K. A. McL. Adlam and the report has been written by them. The work is based on six-inch scale geological surveys carried out in 1879-81 and 1910-13 and published on one-inch geological sheet 108 (Flint).

Mr C. L. Reeves and Mr W. N. Pierce (Land Agents) were responsible for negotiating access to land for drilling. The ready co-operation of landowners and tenants, and of the local sand and gravel industry, is gratefully acknowledged.

G. M. Brown
Director

Institute of Geological Sciences
Exhibition Road
London SW7 2DE

27 November 1981

CONTENTS

FIGURES

MAP

TABLES

The sand and gravel resources of the country around Mold, Clwyd

Description of 1:25 000 sheet SJ 26 and part of SJ 16

D. F. BALL and K. A. McL. ADLAM

SUMMARY

The geological maps of the Institute of Geological Sciences, pre-existing borehole information, and 73 boreholes drilled for the Industrial Minerals Assessment Unit form the basis of the assessment of the sand and gravel resources of the country around Mold, Clwyd.

All the deposits in the district that 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 where appropriate.

The mineral bearing ground is divided amongst five resource blocks, containing between 2.2 and 14.2 km^2 of 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 gradings are stated. Detailed borehole data are also given. The geology, the position of the boreholes and the outlines of the resource blocks are shown on the accompanying map.

Notes

Each borehole registered with the Institute is identified by a four-element code (e.g. SJ 26 SE 23). The first two elements define the 10-km square (of the National Grid) in which the borehole is situated; the third element defines a quadrant of that square, and the fourth is the accession number of the borehole. In the text of the report the letters SJ are generally omitted.

All National Grid references in this publication lie within the 100-km square SJ unless otherwise stated. Grid references are given to eight figures, accurate to within 10 m, or to six figures for more extensive locations such as quarries.

Bibliographical reference

BALL, D. F. and ADLAM, K. A. McL. 1982. The sand and gravel resources of the country around Mold, Clwyd: description of 1:25 000 sheet SJ 26 and part of SJ 16. **Miner. Assess. Rep. Inst. Geol. Sci.** No. 113.

Authors

D. F. Ball, BSc
Institute of Geological Sciences
Murchison House, West Mains Road
Edinburgh EH9 3LA

K. A. McL. Adlam BSc
Institute of Geological Sciences
Keyworth
Nottingham NG12 5GG

INTRODUCTION

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

The survey provides information at the 'indicated' and 'inferred' levels. Indicated assessments "are computed partly from specific measurements, samples or production data and partly from projection for a reasonable distance on geologic evidence. The sites available for inspection, measurement, and sampling are too widely or otherwise inappropriately spaced to permit the mineral bodies to be outlined completely or the grade established throughout". 'Inferred' assessments are those "based largely on broad knowledge of the geologic character of the deposit and for which there are few, if any, samples or measurements." (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 a 0.625 mm B.S. sieve) should not exceed 40 per cent.
d The deposit should lie within 25 m of the surface, this being taken as the likely maximum working depth under most circumstances. It follows from the second criterion that boreholes are drilled no deeper than 18 m if no sand and gravel has been proved.

A deposit of sand and gravel that broadly meets these criteria is regarded as 'potentially workable' and is described and assessed as 'mineral' in this report. As the assessment is at the indicated level, parts of such a deposit may not satisfy all the criteria.

Pre-Pleistocene rocks, which are usually consolidated and devoid of potentially workable sand and gravel, are referred to as 'bedrock'; 'waste' is any material other than bedrock or mineral; 'overburden' is waste that occurs between the surface and an underlying body of mineral.

For the particular needs of assessing sand and gravel resources, a grain-size classification based on the geometric scale $\frac{1}{16}$ mm, $\frac{1}{4}$ mm, 1 mm, 4 mm, 16 mm, 64 mm has been adopted. The boundaries between fines (that is, the clay and silt fractions) and sand, and between sand and gravel 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 or land of high agricultural or landscape value, which might stand in the way of sand and gravel being exploited, although towns are excluded. The estimated total volume therefore bears no simple relationship to the amount that could be extracted in practice.

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

DESCRIPTION OF THE DISTRICT

General

The district comprises 150 km² of country around Mold, Clwyd (Figure 1). The ground rises, more or less progressively, from near sea level at Connah's Quay in the north-east to an elevation of 554 m above OD at Moel Fammau [1612 6268] in the south-west, the highest point on the north-south-trending Clwydian Range. The River Alun flows northwards from Llanferres before breaching the limestone escarpment and thence runs south-eastwards across the district. The higher ground, formed of hard Silurian and older Carboniferous rocks, is largely drift-free, whereas the lower ground, underlain by younger Carboniferous strata, carries an extensive drift cover.

The district has a mixed economy based on agriculture and light industry, together with some quarrying. Sand and gravel constitutes an important aggregate resource and is worked at Rhosesmor and near Hendre. Limestone is also extracted. Lead and coal were formerly mined and Coal Measures mudstones and seatearths have been extensively exploited north of Buckley.

Geology

The geological sequence is summarised in Table 1, in which the stratigraphic units are listed as far as possible in order of increasing age, and described briefly below.

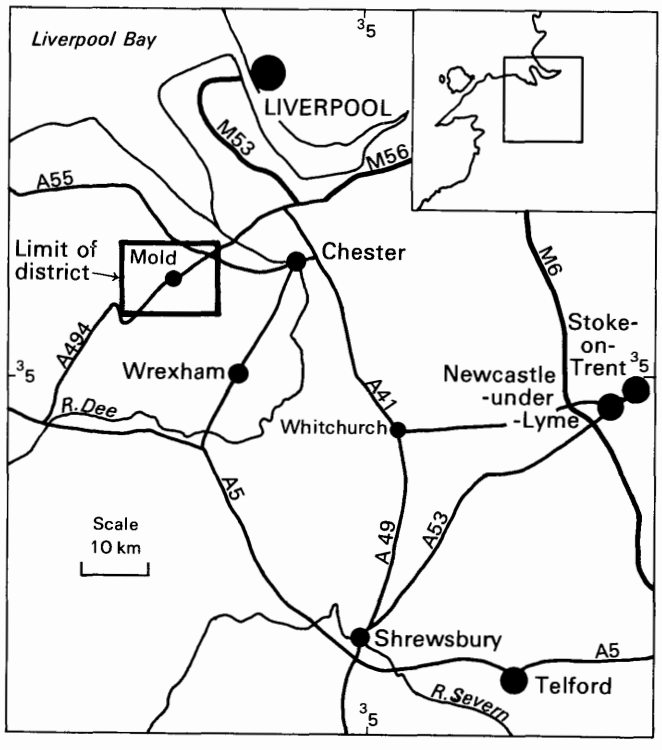


Figure 1 Regional map showing location of the district.

SOLID

Silurian The oldest rocks that crop out in the district are Silurian in age and consist of roughly cleaved grey mudstones with scattered, generally thin, fine-grained sandstones. They are found in the west, in the Clwydian Range.

Carboniferous Carboniferous strata rest unconformably on the Silurian. They have an easterly to north-easterly dip and higher beds appear successively eastwards. The lowest are Viséan in age and comprise the Carboniferous Limestone 'Series', the term 'Series' being used as recommended by Holland and others (1978, p. 3). They consist of a sequence of marine limestones and sandy limestones with intercalations of calcareous mudstone and siltstone and quartzose sandstone which passes upwards into the lower part of the Cefn-y-Fedw Sandstone. The latter includes pebbly sandstone, quartzite, mudstone and chert-like siltstone and, in the north, passes into the Chert Beds.

The Namurian Millstone Grit 'Series' comprises the upper part of the Cefn-y-Fedw Sandstone, its lateral equivalent the Holywell Shales and the Lower Gwespyr Sandstone. The Holywell Shales consist predominantly of dark mudstone and are found in the north of the district. Traced southwards they pass into the arenaceous Cefn-y-Fedw Sandstone. The overlying Gwespyr Sandstone is a feldspathic sandstone and is overlain by mudstone which includes the Gastrioceras subcrenatum Marine Band.

Table 1 Geological sequence.

DRIFT	
Recent and Pleistocene	Peat Alluvium River Terraces, undifferentiated Glacial Sand and Gravel Till (Boulder Clay)
SOLID	
Carboniferous	Coal Measures (Westphalian) Millstone Grit 'Series' (Namurian) Carboniferous Limestone 'Series' (Viséan)
Silurian	Undivided

The Coal Measures of the district may all be assigned to 'grey measures' (Calver and Smith, 1974). They are a largely cyclic sequence of coals, mudstones with siltstones, sandstones and seatearths but the highest beds, forming the Buckley Fireclay Group, are pinkish grey sandstones and grey, red and purple mudstones and seatearths.

DRIFT

The drift deposits of the district are largely glacial in origin and result from the last, Devensian, glaciation. During this episode north-east Wales came under the influence of ice from two sources. 'Welsh' ice, originating in the mountains of North Wales, flowed into the region across the Denbigh Moors and the Clwydian Range. Ice from the Lake District, Scotland and north-east Ireland coalesced in the Irish Sea basin and flowed southwards to cover the Cheshire Plain and impinge upon north and north-east Wales. Erosion and deposition during the advance and retreat of these ice sheets modified the pre-exisiting topography. Extensive spreads

of till (boulder clay) and outwash sand and gravel were left behind and, within this district, the River Alun was diverted, causing it to cut a gorge through the limestone outcrop.

The glaciation and de-glaciation of north-east Wales have attracted the attention of a number of workers and detailed accounts of the Pleistocene geology, as well as sometimes conflicting interpretations, may be found in papers by Derbyshire (1963), Embleton (1956, 1957, 1964, 1970) and Peake (1961).

Till (Boulder Clay) The tills of the district fall into two main types, the products of 'Welsh' and of 'Irish Sea' ice. The Welsh till is a dark grey clay with abundant clasts (stones) of Silurian greywacke (sandstone) and Carboniferous sandstone and limestone. It is found west of Rhydymwyn and Gwernymynydd, generally directly overlying bedrock. Although usually thin, it was at least 18 m thick in IMAU borehole 16 NE 17. A reddish brown sand component which is present in places was derived from Triassic rocks in the Vale of Clwyd.

Irish Sea till, found in the east of the district, usually consists of reddish brown clay containing, in addition to locally-derived stones, erratics of granite and volcanic rocks from the Lake district and Scotland. It is generally thicker than the Welsh till and may overlie or be interbedded with sand and gravel. Around Buckley, however, the Irish Sea till is commonly thin, rests directly on bedrock and becomes predominantly grey with depth.

A certain amount of interbedding of the two types of till may occur in the central parts of the district although some of the grey tills found there, and tentatively classified as 'Welsh', may well have been deposited by Irish Sea ice after it had passed over the Coal Measures outcrop.

Glacial Sand and Gravel The thickest deposits of sand and gravel are found between Nannerch [166 695] and Hendre [195 677], in the Alun valley to the south-east and in what appears to be a drift-filled trough extending northwards from Mold beneath Soughton and Northop. In places thicknesses exceed 25 m but in the Alun valley the deposits have limited lateral extent, thinning out rapidly against the hills.

Between Nannerch and Hendre the sand and gravel occurs in a complex series of landforms, including a well-developed set of kame terraces. The deposits comprise coarse ill-sorted gravel up to 7 m thick which in places is underlain by well-sorted red sand up to at least 16 m thick, in turn passing down into sandy silt. The pebble content suggests derivation from ice of Welsh origin. Hendre Quarry displays a chaotic assemblage of bouldery gravels which rest on bedrock and contain accumulations of limestone cobbles in the basal layers.

To the east of the above deposits, between Rhosesmor [214 685] and Gwynsaney Hall [228 665], the Glacial Sand and Gravel shows evidence of derivation from Irish Sea ice, yielding a high proportion of quartzite, quartz and igneous rocks. It is found over a wide range of heights and is dissected by an intricate series of glacial drainage channels. The deposits consist of gravel, in places overlying sand. They are finer and better sorted than those to the west although blocks of limestone up to 3 m across are locally seen within beds of sand. These deposits probably represent a pro-glacial delta. Across the valley, at Rhual [222 649], similar deltaic gravels (but nowhere underlain by sand) form a series of terraces.

Between Mold and Padeswood [276 621] gravels, partly overlain by alluvium, are up to 6.3 m thick. They thicken down-valley and, although partly covered by till, give rise to 'kame and kettle' terrain.

North of Mold, Glacial Sand and Gravel is again partly covered by till. Boreholes drilled for this assessment survey found gravel at surface, in places separated from underlying sand by till, but former temporary excavations (Wedd and King, 1924, p. 151) suggest a more diverse nature.

A belt of sand crosses the north-east corner of the district. It is more than 20 m thick near Wepre Wood [293 679] but appears to thin out south-westwards beneath till. Gravel and sandy gravel extend a short distance westward from Ewloe, largely beneath till.

In the southwestern part of the district, Glacial Sand and Gravel occupies much of the upper Alun valley south of Pont-newydd [191 651]. It consists mainly of clayey gravel of Welsh origin and appears to pass laterally into till. The geological map shows only its approximate distribution.

River Terraces Only two small areas of river terrace have been recognised in the district, in the Avon Conwy valley, but it is possible that some sand and gravel proved beneath alluvium in the Alun valley may be remnants of former terraces

Alluvium The alluvium of the River Alun consists predominantly of silty clay with sporadic seams of peat; it has been proved up to a thickness of 3.5 m. The alluvium of other, minor, streams reflects the nature of the ground through which they flow.

Peat Scattered small patches of peat probably mark the sites of formerly poorly-drained hollows within the drift deposits. Thin peat cover is found in places on the slopes of the Clwydian Range but is not shown on the geological map.

Composition of the sand and gravel deposits

All the potentially workable sand and gravel deposits within the district are here classified as Glacial Sand and Gravel although it is possible that there may be minor amounts of more recent fluvial material beneath the Alun alluvium. The deposits may be divided into two broad types on the basis of the composition of the gravel fraction. The first type contains only material of Welsh origin whereas the second may include rocks brought in by the Irish Sea ice.

The 'Welsh' deposits are in general confined to the area west of Rhydymwyn but have also been found in one borehole (26 NW 10) near Rhosesmor and two boreholes (26 NW 20 and SW 22) north-west of Mold. They generally consist of gravels and sandy gravels and subordinate pebbly sands and are commonly 'clayey'. Siltstone and greywacke (sandstone) usually account for more than 75 per cent of the gravel and coarse sand fractions, although concentrations of gravel rich in Carboniferous limestone are locally present - as in borehole 16 NE 14. Minor constituents include volcanic rock, quartz and chert. The finer sand fractions may also consist largely of siltstone but in places gravels are underlain by fine- to medium-grained red quartzose sands derived from the Triassic rocks of the Vale of Clwyd. The gravel-bearing deposits have a mean grading of 13 per cent fines, 41 per cent sand and 46 per cent gravel; when the red sands are included this becomes 14 per cent fines, 53 per cent sand and 33 per cent gravel. Testing of samples from boreholes 16 NE 8 and 26 NW 20 gave ten per cent fines values of 180 kN and 170 kN, respectively.

The 'Irish Sea' deposits are found in the remainder of the district. They generally consist of gravels but sands and pebbly sands are present in places; their mean grading is 13 per cent fines, 54 per cent sand and 33 per cent gravel. They have a more varied lithological composition but are characterised by significant amounts of quartzite (generally 10 to 63 per cent) and igneous rocks (averaging 14 per cent). The former was derived from local Coal Measures and Millstone Grit but the latter are mostly from the Lake District and the Southern Uplands and include granite and porphyritic volcanic rocks. Limestone may be absent or account for up to 47 per cent of the gravel fraction, the concentration commonly

increasing with depth. The coarse sand has a composition similar to that of the gravel but quartz predominates in the finer fractions.

The Map

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

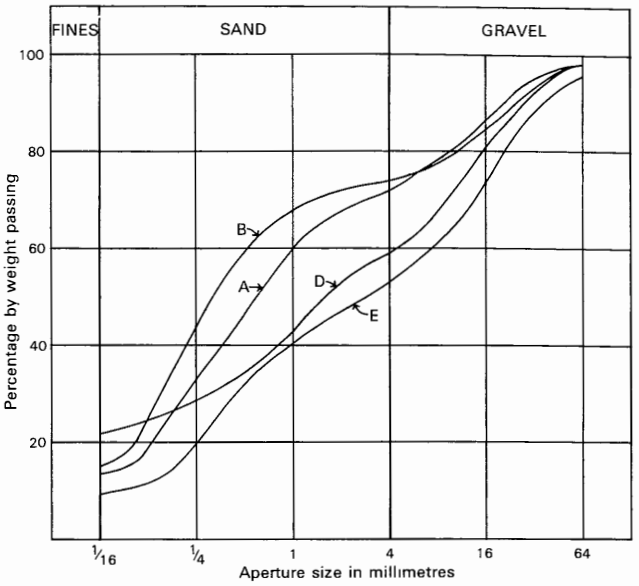
Geological data The Silurian, Carboniferous Limestone and Millstone Grit outcrops and the superficial deposits overlying them were surveyed on the six-inch scale by Strahan in 1879-81. The remainder of the district was re-surveyed by Wedd, King, Lamplugh and Thomas in 1910-13. The 'Drift' boundaries on the resource map are taken from the geological maps produced by these surveys but the 'Solid' boundaries result from a revision by Mr D. Lowe in 1980. No account has been taken of changes brought about by subsequent quarrying or the opencast extraction of coal, although areas from which sand and gravel have been removed are indicated.

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

Mineral resource information The mineral-bearing ground is divided into resource blocks (see Appendix A). Within a resource block the mineral is subdivided into areas where it is exposed and areas where it is present in continuous, or almost continuous spreads beneath overburden. The mineral is identified as 'exposed' where the overburden, commonly consisting only of soil and subsoil, averages less than 1.0 m in thickness.

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

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



Resource block	Cumulative percentage by weight passing					
	1/16 mm	1/4 mm	1 mm	4 mm	16 mm	64 mm
A	14	34	60	72	87	98
B	15	44	68	74	85	98
D	22	29	43	59	81	98
E	10	20	41	53	74	95

Figure 2 Mean particle-size distributions for the mineral in resource blocks A, B, D and E.

Results

The statistical results are summarised in Table 2. Fuller grading particulars are shown in Figures 2 to 6 and Tables 3 to 7.

Accuracy of results For the three resource blocks assessed at the indicated level, the accuracy of the results at the 95 per cent probability level (that is, on

Table 2 Summary of the sand and gravel resources of the district.

Block	Area		Mean thickness			Volume of sand and gravel			Mean grading percentage		
	Block	Mineral	Over-burden	Mineral	Waste		Limits at the 95% probability level		Fines -1/16 mm	Sand +1/16 -4 mm	Gravel +4 mm
	km²	km²	m	m	m	m³ × 10⁶	± %	± m³ × 10⁶			
A	12.3	6.9	0.7	9.3	0.7	64	47	30	14	58	28
B	24.3	14.2	1.5	9.5	1.6	135	41	55	15	59	26
C	38.1	3.0	4.1	4.5	-	14	Speculative		Data incomplete		
D	53.5	2.2	1.4	2.5	0	6	Speculative		22	37	41
E	16.6	10.2	2.6	7.3	0.8	74	36	27	10	43	47

average nineteen out of every twenty sets of limits constructed in this way contain the true value for the volume of mineral) lies between 36 per cent and 47 per cent (Appendix B). However, the true volumes are more likely to be nearer the figure estimated than either of the limits. Moreover, it is probable that roughly the same percentage limits would apply for the statistical estimate of mineral volume within a very much smaller parcel of ground (say 100 hectares) containing similar sand and gravel deposits, if the results from the same number of sample points (as provided by, say, ten boreholes) were used in the calculation. Thus, if closer limits are needed for quotation of reserves, data from more sample points would be required, even if the area were quite small. This point can be illustrated by considering the whole of the potentially workable sand and gravel in Blocks A, B and E. The total volume (273 million m^3) can be estimated to limits of $\pm$ 22 per cent at the 95 per cent probability level by a calculation based on the data from the 43 sample points spread across the three resource blocks. However, it must be emphasised that the quoted volume of mineral has no simple relationship with the amount that could be extracted in practice, as no allowance has been made in the calculations for any restraints (such as existing buildings and roads) on the use of the land for mineral working.

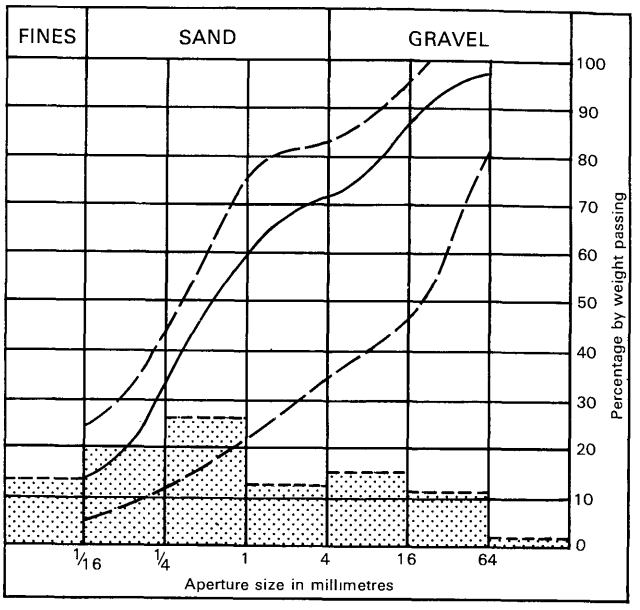


Figure 3 Grading characteristics of the mineral in Block A. The continuous line is the cumulative frequency curve of the mean grading of the block as a whole; the broken lines denote the envelope within which the mean grading curves for individual boreholes fall. The mean grading of the block is also shown as a histogram.

Notes on the resource blocks

Block A encompasses the sand and gravel of the valley between Nannerch and Hendre, block B the deposits of the valley downstream from the Alun gorge to Mold, as well as those between Mold and Northop, and block E the deposits in the valley south-east of Mold together with small patches of sand and gravel around Nercwys. The small area of sand and gravel south of Connah's Quay constitutes the mineral of block C and block D includes the deposits of the upper Alun valley between Llanferres and the gorge.

Block A (Table 3, Figure 3)

Within this block sand and gravel are best developed around Nannerch where they form a series of kame terraces. Two boreholes (16 NE 19 and 20) proved gravel overlying thick sand and pebbly sand. Three other boreholes (16 NE 7, 8 and 10) had to be abandoned before bottoming the gravel and it is not known whether underlying sand is present hereabouts.

In the remainder of the block mineral is somewhat thinner. Except in the south east corner, around borehole 16 NE 18, coarse gravel and sandy gravel prevail. In boreholes 16 NE 9, 11 and 14 they overlie bedrock and contain a high proportion of limestone, especially near the base. Borehole 16 NE 13, although sited in an area mapped as till, proved 'clayey' sandy gravel resting on 'clayey' sand; the extent of the mineral in this area is, therefore, uncertain.

The gravels and sandy gravels have a mean proved thickness of 5.7 m and an estimated mean grading of 14 per cent fines, 43 per cent sand and 43 per cent gravel. When the sands are included, the mean proved thickness rises to 9.3 m and the mean grading becomes 14 per cent fines, 58 per cent sand and 28 per cent gravel. The estimated volume of mineral in the block is 64 million m^3 $\pm$47 per cent.

Overburden nowhere exceeds 1.2 m in thickness and averages 0.7 m. It consists of clayey soil and, in places, partly stony clay. Significant waste partings were found in only three boreholes.

Table 3 Block A: data from IMAU boreholes.

Borehole	Recorded thickness (m)			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
16 NE 7	+10.1	0.1	1.8	9	4	15	22	27	20	3
16 NE 8	+11.1	0.6		8	20	20	9	22	19	2
16 NE 9	5.5	1.0	1.5	18	6	5	4	14	36	17
16 NE 10	+7.1	1.2		25	14	18	12	15	14	2
16 NE 11	7.0	0.3		13	11	24	14	23	14	1
16 NE 13	17.0	0.5		Data incomplete and unrepresentative						
16 NE 14	2.6	1.0		5	6	12	11	22	30	14
16 NE 15	+3.3	0.7		25	7	14	17	22	15	0
16 NE 16	4.5	0.5		No representative data available						
16 NE 18	3.7	1.2	0.1	Data incomplete						
16 NE 19	+22.5	0.5		15	26	33	9	13	4	0
16 NE 20	+17.6	0.9	4.5	12	32	34	6	8	7	1

* Between mineral deposits

Table 4 Block B: data from IMAU boreholes.

Borehole	Recorded thickness (m)			Mean grading percentage						
	Mineral	Over-burden	Waste*	Fines $-\frac{1}{16}$ mm	Fine sand $+\frac{1}{16}-\frac{1}{4}$ mm	Medium sand $+\frac{1}{4}-1$ mm	Coarse sand +1 -4 mm	Fine gravel +4 -16 mm	Coarse gravel +16 -64 mm	Cobbles +64 mm
26 NW 8	+1.1	3.0		No data available						
26 NW 9	Absent									
26 NW 10	8.7	1.3		12	12	18	11	19	23	5
26 NW 11	+22.9	1.0	1.6	8	41	37	3	5	5	1
26 NW 12	6.4	0.5	0.5	14	25	38	7	13	3	0
26 NW 13	9.0	0.3	1.1	21	8	10	7	17	28	9
26 NW 14	+8.6	0.4		No data available						
26 NW 15	Absent									
26 NW 16	Absent									
26 NW 17	2.3	1.0	1.2	19	16	14	8	18	18	7
26 NW 18	5.1	0.2	7.5	15	10	17	8	24	25	1
26 NW 19	19.6	0.8		22	43	29	2	2	2	0
26 NW 20	7.6	1.7		3	3	14	15	34	28	3
26 NW 21	14.5	4.0	3.0	19	51	16	3	5	6	0
26 NW 22	+20.5	2.0	3.5	14	32	28	7	6	10	3
26 NW 23	3.9	3.6		9	18	22	7	18	24	2
26 SW 21	7.0	2.1		26	16	12	5	16	22	3
26 SW 22	5.6	0.2	6.3	11	4	19	12	19	25	10

* Between mineral deposits

The thick sand and gravel deposits around Nannerch are generally above the water table although water was encountered in borehole 16 NE 8 at 4 m below the surface, within sandy gravel. In borehole 16 NE 13 the gravel was unsaturated but the water table was high in the underlying sand.

Block B (Table 4, Figure 4)
Of the 18 IMAU boreholes drilled within this block, 15 proved mineral. Most of these found partly 'clayey' gravel or sandy gravel. In four boreholes (26 NW 11, 19, 21 and 22) the gravel was underlain by thick partly 'clayey' to 'very clayey' sand or pebbly sand and in another (26 NW 12) it was overlain by 'very clayey' sand. The gravelly deposits are up to 9.5 m thick and have a mean grading of about 14 per cent fines, 40 per cent sand and 46 per cent gravel. Total mineral thicknesses range up to greater than 22.9 m and the mean grading of the mineral as a whole is estimated as 15 per cent fines, 59 per cent sand and 26 per cent gravel.

The relationship between sand and gravel and till in the block is not everywhere clear. Borehole 26 NW 21 proved mineral beneath till and a similar relationship elsewhere is inferred from the results of other boreholes. However, the distribution of mineral beneath overburden indicated on the resource map and, thus, the total area of mineral within the block, is somewhat speculative. With this reservation, the total volume of mineral is estimated as 135 million m^3 $\pm$ 41 per cent. A pit at Rhosesmor is actively exploiting sand and gravel and the deposits were formerly worked near Rhual on the south side of the Alun valley.

In the Rhosesmor-Gwynsaney area, groundwater was encountered near the base of the thick sand and gravel sequence, although in borehole 26 NW 14 about half the mineral was below water table. In the vicinity of Soughton and Northop the lower, sand, deposit (boreholes 26 NW 21 and 22) is mostly beneath water table but the gravel is unsaturated. The gravel in the bottom of the Alun valley appears to contain water confined by overlying alluvial silt. The sand and gravel around Rhual are mainly above the water table.

Block C (Table 5)
Glacial Sand and Gravel has been mapped along a prominent escarpment overlooking Connah's Quay. Two IMAU boreholes on the escarpment found no sand or gravel but several NCB boreholes have proved fine- to medium-grained, partly 'clayey' sand. The sand is very variable in thickness and more than 20 m have been encountered near Wepre Wood. It extends southwards below till for an uncertain distance. No grading data are available. To the south, IMAU boreholes indicate the presence of mineral west of Ewloe, largely under till; it consists of partly 'clayey' to 'very clayey', pebbly sand and gravel and has a mean grading of 17 per cent fines, 55 per cent sand and 28 per cent gravel. Another IMAU borehole (26 NE 27), west of Northop Hall, also proved gravel beneath till but, since the extent of potentially workable material hereabouts cannot be predicted, it is not taken into account in the assessment.

From the results of IMAU and NCB drilling, the presence within the block of about 14 million m^3 of mineral is inferred.

Hydrogeological data are sparse. To the west of Ewloe, mineral beneath till appears to contain confined

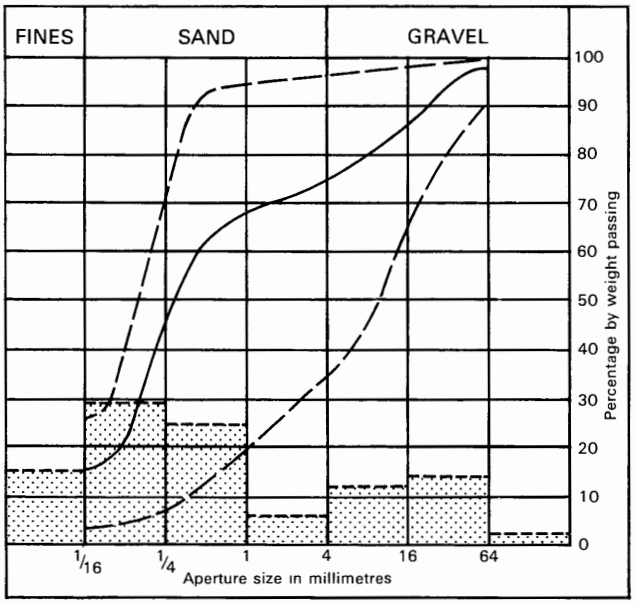


Figure 4 Grading characteristics of the mineral in Block B (for explanation see Figure 3).

Table 5 Block C: data from IMAU boreholes proving mineral.

Borehole	Recorded thickness (m)			Mean grading percentage						
	Mineral	Over-burden	Waste*	Fines $-\frac{1}{16}$ mm	Fine sand $+\frac{1}{16}-\frac{1}{4}$ mm	Medium sand $+\frac{1}{4}$ -1 mm	Coarse sand +1 -4 mm	Fine gravel +4 -16 mm	Coarse gravel +16 -64 mm	Cobbles +64 mm
26 NE 30	4.3	0.5		18	8	22	7	18	21	6
26 NE 31	5.0	8.8		25	47	15	3	5	4	1
26 NE 32	4.1	2.9	0.2	5	21	34	7	15	16	2

* Between mineral deposits

Table 6 Block D: data from IMAU boreholes proving mineral.

Borehole	Recorded thickness (m)		Mean grading percentage						
	Mineral	Over-burden	Fines $-\frac{1}{16}$ mm	Fine sand $+\frac{1}{16}-\frac{1}{4}$ mm	Medium sand $+\frac{1}{4}$ -1 mm	Coarse sand +1 -4 mm	Fine gravel +4 -16 mm	Coarse gravel +16 -64 mm	Cobbles +64 mm
16 SE 2	1.1	2.5	20	2	8	4	19	28	19
16 SE 3	4.1	2.4	17	8	21	16	20	18	0
16 SE 4	3.9	0.3	17	7	12	18	24	21	1
16 SE 5	3.8	0.3	32	6	12	17	24	8	1

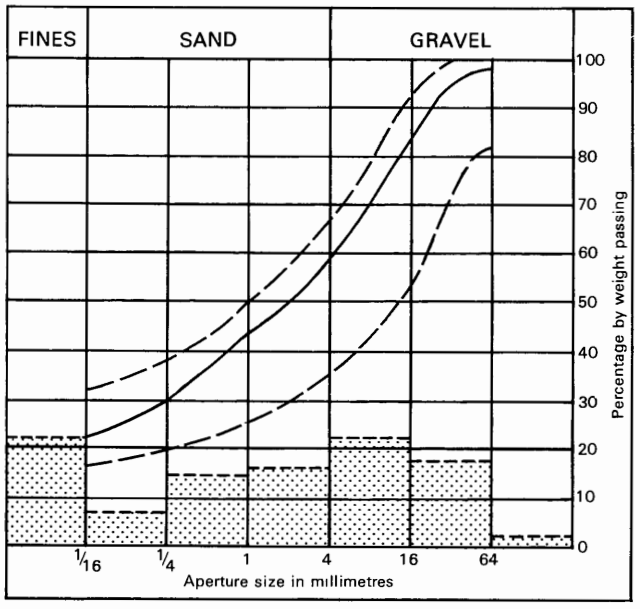


Figure 5 Grading characteristics of the mineral in Block D (for explanation see Figure 3).

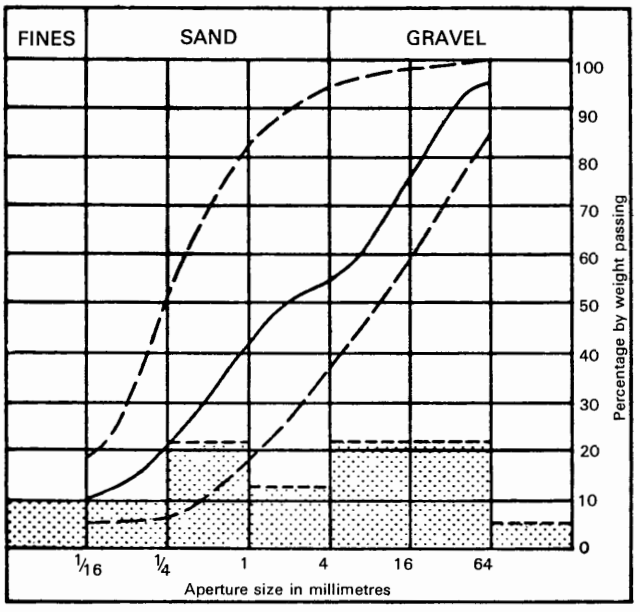


Figure 6 Grading characteristics of the mineral in Block E (for explanations see Figure 3).

groundwater. The sand of the escarpment was dry in its upper part at Wepre but it contains groundwater near its base, as evidenced by marshy ground on the lower slopes.

Block D (Table 6, Figure 5)
This block encompasses the Glacial Sand and Gravel of the upper Alun valley, deposits which are of somewhat uncertain extent. Borehole 16 SE 7 found no sand or gravel and the outcrop on which it was sited is assumed to be barren. Borehole 16 SE 6 was also devoid of mineral although other boreholes on the same outcrop found potentially workable material; the whole outcrop is shown as mineral bearing on the resource map but the 'nil' value is taken into account in arriving at the inferred assessment. A number of other patches of Glacial Sand and Gravel within the block have not been assessed.

Four boreholes proved 'clayey' to 'very clayey' gravel and sandy gravel up to 4.1 m thick and the presence within the block of about 6 million m^3 of mineral is inferred. The mean grading is 22 per cent fines, 37 per cent sand and 41 per cent gravel. The gravel fraction, in places, includes many subrounded siltstone cobbles. Overburden, consisting of soil and stony clay, ranges up to 2.5 m in thickness.

Block E (Table 7, Figure 6)
This block encompasses deposits south and south-east of Mold. The thickest mineral occurs between Padeswood and Hartsheath [286 602] where 'kame and kettle' terrain

Table 7 Block E: data from IMAU boreholes.

Borehole	Recorded thickness (m)			Mean grading percentage						
	Mineral	Over-burden	Waste*	Fines $-\frac{1}{16}$ mm	Fine sand $+\frac{1}{16}-\frac{1}{4}$ mm	Medium sand $+\frac{1}{4}$ -1 mm	Coarse sand +1 -4 mm	Fine gravel +4 -16 mm	Coarse gravel +16 -64 mm	Cobbles +64 mm
26 SW 24	3.8	2.0		7	4	15	13	24	33	4
26 SW 26	+5.1	1.4	6.3	9	2	15	13	20	25	16
26 SW 27	+13.1	0.2	0.5	4	1	13	30	23	22	7
26 SW 28	Absent									
26 SW 29	4.2		1.2	17	35	16	3	9	14	6
26 SW 30	2.5	1.5		11	19	52	14	4	0	0
26 SW 31	Absent									
26 SE 24	6.3	4.4	3.1	7	6	13	12	25	30	7
26 SE 25	Absent									
26 SE 26	6.3	3.5		8	13	25	10	18	21	5
26 SE 28	5.8	5.2		9	7	40	8	19	15	2
26 SE 29	3.4	2.6		7	5	15	14	38	21	0
26 SE 30	Absent									
26 SE 32	19.0	1.0		18	15	17	9	19	16	6
26 SE 34	+15.6	2.9		11	10	32	9	18	16	4
26 SE 35	+7.8	5.5	0.7	9	8	26	9	22	21	5
26 SE 37	13.0	0.3	2.2	8	6	16	6	26	31	7

* Between mineral deposits

yields up to 19.0 m of 'clayey' gravel or sandy gravel, in places beneath till. These deposits owe their preservation to the diversion of the River Alun through the Pontblyddyn gorge [276 607].

Between Padeswood and Mold, and south of the latter, mineral is generally thinner but has a lower fines content. It again consists largely of gravel and sandy gravel but 'clayey' sand was proved in borehole 26 SW 30 and at depth in 26 SW 29, and has been worked on a small scale near Bryn Coch Hall [232 631] to the west. The mineral deposits south of Mold may contain many cobbles (boreholes 26 SW 26 and 27).

The results from 17 IMAU boreholes and four others give a mean mineral thickness of 7.3 m and an estimated volume of 74 million m^3 $\pm$36 per cent. The mean grading is 10 per cent fines, 43 per cent sand and 47 per cent gravel.

Much of the mineral is concealed beneath alluvial or till overburden. The alluvium consists of silty clay and may be up to 3.5 m thick. The boulder clay is generally a stiff brown stony clay and has a maximum proved thickness of 5.3 m.

Confined groundwater was found in boreholes 26 SE 26 and 29 on the Alun floodplain but elsewhere in the block unconfined conditions appear to prevail. The thick sand and gravel around Padeswood and Hartsheath contains a water table between 4 m and 16 m below surface and is, for the most part, unsaturated. Sand and gravel near Nercwys is generally above the water table.

List of workings

The main workings are listed below but only the first two mentioned are presently active. All the pits are in Glacial Sand and Gravel.

Location	Grid reference
Hendre (Star Crossing)	180 680
Rhosesmor	215 670
Rhual	218 649
Wepre	292 681
Ewloe	297 674

REFERENCES

ALLEN, V. T. 1936. Terminology of medium-grained sediments. **Rep. Natl. Res. Counc., Washington, 1935–1936, App. 1, Rep. Comm. Sediment.**, 18-47.

ARCHER, A. A. 1969. Background and problems of an assessment of sand and gravel resources in the United Kingdom. **Proc. 9th Commonw. Min. & Metall. Congr., 1969**, Vol. 2: Mining and petroleum geology, 495-508.

— 1970a. Standardisation of the size classification of naturally occurring particles. **Geotechnique**, Vol. 20, 103-107.

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

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

BRITISH STANDARDS INSTITUTION. 1967. **B.S.1377: Methods of testing soils for civil engineering purposes.** (London: British Standards Institution.)

BUREAU OF MINES AND GEOLOGICAL SURVEY. 1948. **Pp. 14-17** in **Mineral resources of the United States.** (Washington, DC: Public Affairs Press.)

CALVER, M. A. and SMITH, E. G. 1974. The Westphalian of North Wales. Pp. 169-183 in **The Upper Palaeozoic and post-Palaeozoic rocks of Wales.** OWEN, T. R. (Editor). (Cardiff: Univerisity of Wales Press).

DERBYSHIRE, E. 1963. Late-Glacial drainage in part of north-east Wales: an alternative hypothesis. **Proc. Geol. Assoc.**, Vol. 73 (for 1962), 327-324.

EMBLETON, C. 1956. Late-Glacial drainage in part of north-east Wales: **Proc. Geol. Assoc.**, Vol. 67, 393-404.

— 1957 Some stages in the drainage evolution of part of north-east Wales. **Trans. Inst. Brit. Geol,** Vol. 23, 19-35.

— 1964. Sub-glacial drainage and supposed ice-dammed lakes in north-east Wales. **Proc. Geol. Assoc.**, Vol. 75, 31-38.

— 1970. North-eastern Wales. Pp. 59-82 in **The glaciations of Wales and adjoining regions.** LEWIS, C. A. (Editor). (London).

HARRIS, P. M., THURRELL, R. G., HEALING, R. A., and ARCHER, A. A. 1974. Aggregates in Britain. **Proc. R. Soc.**, Ser. A, Vol. 339, 329-353.

HOLLAND, C. H., and others. 1978. A guide to stratigraphical procedure. **Geol. Soc. Lond. Spec. Rep.** No. 11.

HULL, J. H. 1981. Methods of calculating the volume of resources of sand and gravel. **Appendix** (pp. 192-193) to **THURRELL, R. G.** 1981. Quarry resources and reserves: the identification of bulk mineral resources: the contribution of the Institute of Geological Sciences. **Quarry Management**, for March 1981, 181-193.

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

PEAKE, D. S. 1961. Glacial changes in the Alyn River system and their significance in the glaciology of the north Welsh border. **Q. J. Geol. Soc. London**, Vol. 117, 335-366.

PETTIJOHN, F. J. 1975. **Sedimentary rocks.** 3rd edition. (London: Harper and Row.)

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

— 1981. Quarry resources and reserves: the identification of bulk mineral resources: the contribution of the Institute of Geological Sciences. **Quarry Management**, for March 1981, 181-193.

TWENHOFEL, W. H. 1937. Terminology of the fine-grained mechanical sediments. **Rep. Natl. Res. Counc., Washington, 1936-37**, App. 1, Rep. Comm. Sediment., 81-104.

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

WEDD, C. B. and KING, W. B. R. 1924. The geology around Flint, Hawarden and Caergwrle. **Mem. Geol. Surv. G.B.** sheet 108.

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

— 1935. The terminology of coarse sediments. **Bull. Natl. Res. Counc. Washington**, No. 98, 225-246.

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

WP/KW/LKW

APPENDIX A

FIELD AND LABORATORY PROCEDURES

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

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

econnaissance of the ground is carried out to d any exposures and inquiries are made to ascertain at 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.

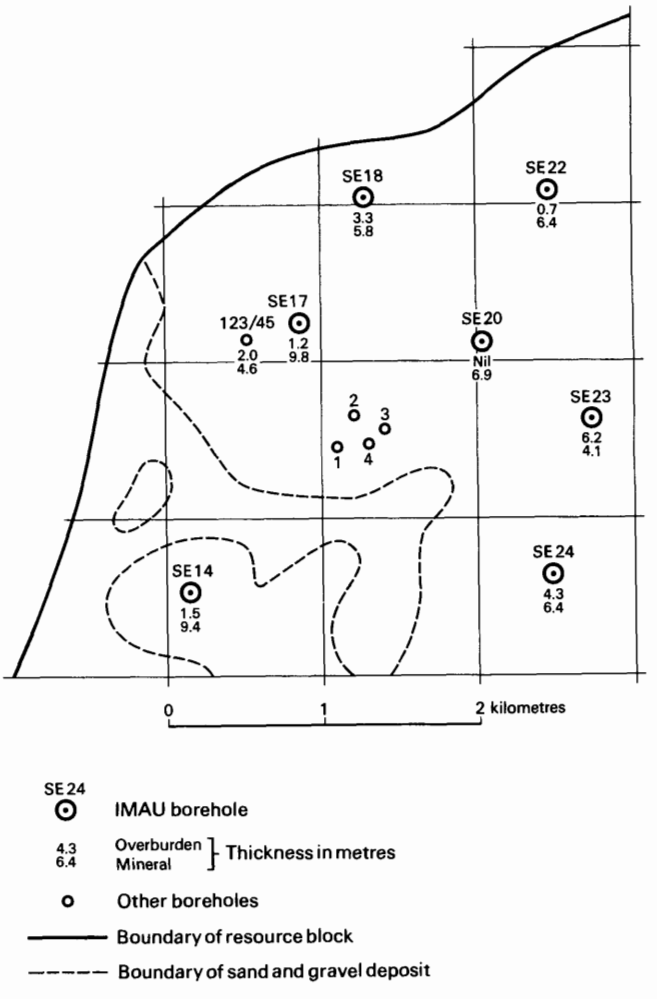
The drilling machine employed should be capable of providing a continuous sample representative of all unconsolidated deposits, so that the *in situ* grading can be determined, if necessary, to a depth of 30 m (100 ft) at a diameter of about 200 mm (8 in), beneath different types of overburden. It should be reliable, quiet, mobile and relatively small (so that it can be moved to sites of difficult access). In general, shell and auger rigs have proved to be almost ideal but they were not able to penetrate all the gravel deposits in the Mold district. At some sites they had to be replaced by a 'down the hole hammer' machine. The latter breaks up much of the gravel and samples obained may not be representative of the *in situ* grading.

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

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

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

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



Example of resource block assessment: map of a fictitious block

APPENDIX B

STATISTICAL PROCEDURE

Statistical assessment

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

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

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

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

4 The above relationship may be transposed such that

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

per cent,

and when n is greater than 20, as

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

per cent.

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

Inferred assessment

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

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

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

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

Block calculation

Scale: 1:25 000
Block: Fictitious

Area
Block: 11.08 km²
Mineral: 8.32 km²

Mean thickness
Overburden: 2.5 m
Mineral: 6.5 m

Volume
Overburden: 21 million m³
Mineral: 54 million m³

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

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

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

Calculation of confidence limits

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

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

$n = 8$

$t = 2.365$

L_V is calculated as

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

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

$= 20.3$

$\simeq 20$ per cent.

APPENDIX C

CLASSIFICATION AND DESCRIPTION OF SAND AND GRAVEL

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

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

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

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

The ratio of sand to gravel defines the boundaries between sand, pebbly sand, sandy gravel and gravel (at 19:1, 3:1 and 1:1).

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

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

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

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

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

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

Each bulk sample is described, 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 roughly equal proportions with neither constituent accounting for less than about 25 per cent of the whole; 'flint with quartz' indicates that flint is dominant and quartz, the principal accessory rock type, comprises 5 to 25 per cent of the whole. Where the accessory material accounts for less than 5 per cent of the whole, but is still readily apparent, the phrase 'with some' has been used. Rare constitutents are referred to as 'trace'.

The terms used in the field to describe the degree of rounding of particles, which is concerned with the sharpness of the edges and corners of a clastic fragment and not the shape (after Pettijohn, 1975), are as follows.

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

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

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

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

Well rounded: not original faces, edges or corners left. The entire surface consists of broad curves; flat areas are absent. The original shape is suggested by the present form of the grain.

Classification of gravel, sand and fines

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

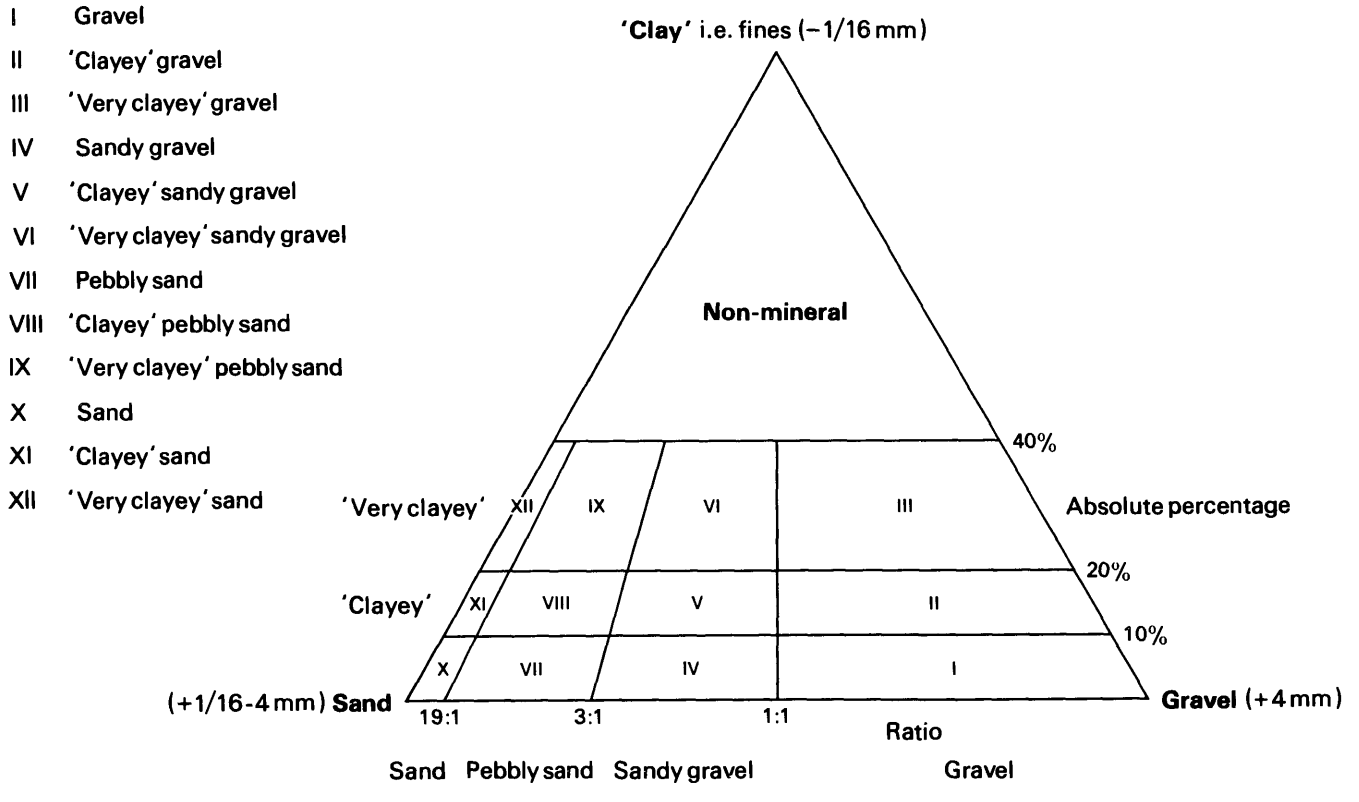


Diagram showing the descriptive categories used in the classification of sand and gravel

APPENDIX D

EXPLANATION OF THE BOREHOLE RECORDS

Annotated 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 1972[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 mm
a	5	46	49	2.8-3.9	20	14	62	2	2	0	0
				3.8-4.8	2	2	12	18	42	24	0
				4.8-5.8	1	3	24	13	35	24	0
				5.8-6.8	0	4	21	20	26	29	0
				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	0	0	0
				10.3-10.7	9	85	5	1	0	0	0
				Mean	**5**	**77**	**17**	**1**	**0**	**0**	**0**
a+b	**5**	**56**	**39**	**Mean**	**5**	**20**	**26**	**10**	**20**	**17**	**2**

COMPOSITION[11]

Depth below surface (m)	percentages by weight in the 8-16 mm fraction				
	Flint	Quartz	Limestone	Chalk	Ironstone
3.8-4.8	41	5	50	1	3
4.8-5.8	39	3	45	5	8
5.8-6.8	45	2	42	5	6
6.8-8.2	19	6	61	3	11
Mean	**35**	**4**	**51**	**3**	**7**

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

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

a The number of the 1:25 000 sheet on which the borehole lies, here CK 66.
b The quarter of the 1:25 000 sheet on which the borehole lies and the number of the borehole in a series for that quarter, here NW 5.

Thus the full Registration Number is CK 66 NW 5.

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 is normally given (in metres relative to Ordnance Datum).

6 Type of drill and date of drilling
The type of rig used, the diameter of the casing and 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 (+) indicated 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 fraction. Where more than one bed of mineral 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 an appreciable lithological change or at every 1 m of depth.

For each bulk sample the percentages of fines (-$\frac{1}{16}$ mm), fine sand (+$\frac{1}{16}$-$\frac{1}{4}$ mm), medium sand (+$\frac{1}{4}$-1 mm), coarse sand (+1-4 mm), fine gravel (+4-16 mm), coarse and (+16-64 mm) and cobble gravel (+64 mm) are stated.

The mean grading of groups of samples making up an identified bed of mineral are also given in detail and in summary. Where more than one bed 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. Alternatively, in claculating means, the sample may be allotted the mean grading of other samples in the deposit.

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.

11 Composition
Details of the composition of selected samples or groups of samples may be given.

APPENDIX E

INDUSTRIAL MINERALS ASSESSMENT BOREHOLE RECORDS

SJ 16 SE 1 **1720 6466** **Tyddyn-y-foel**

Surface level +215 m
Water not encountered
Shell and Auger, 203 mm diameter
September 1978

Waste 3.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown, clayey	0.3	0.3
Till	Clay, soft, brown, with stones of greywacke and siltstone	0.2	0.5
Glacial Sand and Gravel	'Very clayey' sandy gravel	0.5	1.0
Till	Clay, soft, pale grey with stones of greywacke and siltstone	2.5+	3.5
	Borehole abandoned because of slow progress		

SJ 16 SE 2 **1911 6222** **Cae'r Odyn** **Block D**

Surface level +209 m
Water not encountered
Shell and Auger, 203 mm diameter
September 1979

Overburden 2.5 m
Mineral 1.1 m
Waste 0.8 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown, clayey	0.3	0.3
Glacial Sand and Gravel	Clay, grey, with pebbles and cobbles of grey siltstone	2.2	2.5
	'Very clayey' gravel Gravel: mainly coarse with cobbles; angular siltstone Sand: mainly medium, subangular siltstone	1.1	3.6
Till	Clay, stiff, grey, with pebbles and cobbles of limestone and siltstone	0.8+	4.4
	Borehole abandoned due to obstruction (? bedrock)		

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages							
Fines	Sand	Gravel		Fines	Sand			Gravel			
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$ mm	
20	14	66	2.5-3.6	20	2	8	4	19	28	19	

SJ 16 SE 3 **1887 6302** **Maes-y-groes** **Block D**

Surface level +206 m
Water not encountered
Shell and Auger, 203 mm diameter
September 1978

Overburden 2.4 m
Mineral 4.1 m
Bedrock 0.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown, clayey and stony	0.3	0.3
Glacial Sand and Gravel	Clay, soft, red-brown, with stones of quartzite and siltstone	2.1	2.4
	'Clayey' sandy gravel Gravel: fine and coarse, subangular to subrounded siltstone Sand: mainly medium and coarse, subangular to subrounded siltstone	4.1	6.5
Silurian	Greywacke, dark grey	0.2+	6.7

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$ mm
17	45	38	2.4-4.0	10	12	30	19	19	10	0
			4.0-5.0	21	7	17	14	23	18	0
			5.0-6.0	26	3	11	12	18	30	0
			6.0-6.5	No grading data available						
			Mean	**17**	**8**	**21**	**16**	**20**	**18**	**0**

COMPOSITION

Depth below surface (m)	percentages by weight in +8 mm fraction								
	Quartz	Quartzite	Greywacke	Sandstone	Limestone	Siltstone	Mudstone	Igneous	Chert, Flint, etc.
4.0-6.0	0	0	8	0	0	92	0	0	0

SJ 16 SE 4 **1919 6200** **Cae'r Odyn** **Block D**

Surface level +208 m
Water not encountered
Shell and Auger, 203 mm diameter
September 1978

Overburden 0.3 m
Mineral 3.9 m
Bedrock 0.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown, stony	0.3	0.3
Glacial Sand and Gravel	'Clayey' to 'very clayey' gravel Gravel: fine and coarse, mainly subrounded siltstone Sand: mainly coarse and medium, subrounded siltstone	3.9	4.2
Carboniferous Limestone	Limestone, dark grey	0.1+	4.3

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
17	37	46	0.3-1.3	24	5	13	15	21	22	0
			1.3-3.0	13	8	12	20	24	21	2
			3.0-4.2	No grading data available						
			Mean	**17**	**7**	**12**	**18**	**24**	**21**	**1**

COMPOSITION

Depth below surface (m)	percentages by weight in +8 mm fraction								
	Quartz	Quartzite	Greywacke	Sandstone	Limestone	Siltstone	Mudstone	Igneous	Chert, Flint, etc.
1.3-3.0	1	0	15	0	10	74	0	0	0

SJ 16 SE 5 **1911 6113** **Nant** **Block D**

Surface level +202 m
Water not encountered
Shell and Auger, 203 mm diameter
September 1978

Overburden 0.3 m
Mineral 3.8 m
Waste 0.7 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown, clayey, stony	0.3	0.3
Glacial Sand and Gravel	'Very clayey' sandy gravel Gravel: mainly fine, subangular siltstone Sand: mainly coarse and medium, subrounded siltstone	3.8	4.1
Till	Clay, brown, with stones of siltstone	0.7+	4.8
	Borehole abandoned due 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 mm
32	35	33	0.3-1.3	22	5	13	14	35	11	0
			1.3-2.3	26	4	11	25	27	5	2
			2.3-3.3	43	4	16	21	16	0	0
			3.3-4.1	36	14	9	8	15	16	2
			Mean	**32**	**6**	**12**	**17**	**24**	**8**	**1**

SJ 16 SE 6 **1888 6048** **Pentre-cerrig-bach** **Block D**

Surface level +213 m
Water not encountered
Shell and Auger, 203 mm diameter
September 1979

Waste 3.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, grey, clayey	0.2	0.2
Glacial Sand and Gravel	Clay, grey, with pebbles and cobbles of siltstone	3.3+	3.5
	Borehole abandoned because of obstruction		

SJ 16 SE 7 **1956 6341** **Coed Pwll-y-blawd**

Surface level +228 m
Water not encountered
Shell and Auger, 203 mm diameter
August 1979

Waste 2.1 m
Bedrock 0.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown, sandy and clayey	0.2	0.2
Glacial Sand and Gravel	Clay, friable, yellow-brown, with stones of siltstone	1.9	2.1
Carboniferous Limestone	Limestone, pale grey	0.1+	2.2

SJ 16 NE 7 **1561 6975** **Pen-y-felin** **Block A**

Surface level +165 m
Water not encountered
Shell and Auger, 203 mm diameter
October 1978

Overburden 0.1 m
Mineral 6.4 m
Waste 1.3 m
Mineral 2.7 m
Waste 0.5 m
Mineral 1.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, grey-brown, clayey, stony	0.1	0.1
Glacial Sand and Gravel	a 'Clayey' gravel Gravel: coarse and fine, mainly angular to subrounded siltstone Sand: mainly coarse and medium, siltstone and quartz	6.4	6.5
Till	Clay, red-brown, with stones of siltstone and greywacke	1.3	7.8

Glacial Sand and Gravel	**b** Gravel, with clay parting from 10.5 m to 11.0 m Gravel: coarse and fine, mainly angular to subrounded siltstone Sand: mainly coarse and medium; siltstone and quartz	4.2+	12.0
	Borehole abandoned due to slow 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	+64 mm
a	11	41	48	0.1-1.1	19	5	12	21	23	20	0
				1.1-2.1	18	4	11	20	31	13	3
				2.1-3.1	6	4	12	15	39	22	2
				3.1-4.1	6	4	15	15	23	30	7
				4.1-5.1	5	2	18	29	27	19	0
				5.1-6.5	10	3	20	29	20	18	0
				Mean	**11**	**4**	**15**	**22**	**26**	**20**	**2**
b	5	41	54	7.8-8.1	No grading data available						
				8.1-9.1	5	2	15	27	25	23	3
				9.1-10.1	6	4	14	17	29	18	12
				10.1-10.5	5	7	22	18	24	17	7
				10.5-11.0	Clay parting						
				11.0-12.0	No grading data available						
				Mean	**5**	**4**	**16**	**21**	**27**	**20**	**7**
a+b	**9**	**41**	**50**	**Mean**	**9**	**4**	**15**	**22**	**27**	**20**	**3**

COMPOSITION

	Depth below surface (m)	percentages by weight in +8 mm fraction								
		Quartz	Quartzite	Greywacke	Sandstone	Limestone	Siltstone	Mudstone	Igneous	Chert, Flint, etc.
a	1.1-6.1	trace	trace	10	0	0	86	0	4	0
b	8.1-10.5	trace	trace	14	0	trace	85	0	1	trace

SJ 16 NE 8 **1703 6964** **Pant-y-ffuon** **Block A**

Surface level +145 m
Water struck at +141 m
Shell and Auger, 203 mm diameter
October 1978

Overburden 0.6 m
Mineral 11.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown	0.6	0.6
Glacial Sand and Gravel	Gravel, part sandy, with 'clayey' to 'very clayey' sand from 8.0 m to 10.0 m Gravel: fine and coarse with some cobbles, mainly subrounded to subangular; siltstone with greywacke and limestone Sand: fine and medium; quartz and siltstone	11.1+	11.7
	Borehole abandoned because of 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 mm
8	49	43	0.6-1.3	14	5	10	20	27	24	0
			1.3-1.6	No grading data available						
			1.6-2.6	5	15	31	13	21	15	0
			2.6-3.6	5	24	57	7	7	0	0
			3.6-4.6	13	13	20	8	22	13	11
			4.6-5.6	5	4	21	13	33	24	0
			5.6-6.6	3	2	10	13	40	30	2
			6.6-7.6	4	5	13	11	38	28	1
			7.6-8.0	3	8	16	13	24	33	3
			8.0-9.0	12	65	21	2	0	0	0
			9.0-10.0	23	61	16	0	0	0	0
			10.0-11.0	4	5	7	12	30	39	3
			11.0-11.7	4	16	12	6	26	34	2
			Mean	**8**	**20**	**20**	**9**	**22**	**19**	**2**

COMPOSITION

Depth below surface (m)	percentages by weight in +8 mm fraction								
	Quartz	Quartzite	Greywacke	Sandstone	Limestone	Siltstone	Mudstone	Igneous	Chert, Flint, etc.
0.6-8.0	trace	trace	15	0	17	67	0	1	trace
10.0-11.7	trace	1	4	0	10	80	0	5	0

SJ 16 NE 9 **1695 4836** **Penbedw** **Block A**

Surface level +152 m
Water struck at +147 m
Shell and Auger, 203 mm diameter
August 1979

Overburden 1.0 m
Mineral 1.0 m
Waste 1.5 m
Mineral 4.5 m
Bedrock 0.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Made ground, ashes and stones	0.3	0.3
	Clay, yellowish brown, sandy at base, with some subrounded siltstone fragments	0.7	1.0
Glacial Sand and Gravel	**a** 'Very clayey' sandy gravel Gravel: mainly fine, subrounded to subangular siltstone	1.0	2.0
Till	Clay, medium brown, with stones - mainly of subrounded to subangular siltstone	1.5	3.5
Glacial Sand and Gravel	**b** 'Clayey' gravel Gravel: mainly coarse, angular to subangular limestone and subrounded to subangular siltstone	4.5	8.0
Carboniferous Limestone	Limestone, cream	0.2+	8.2

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$ mm
a	36	40	24	1.0-2.0	36	14	16	10	18	6	0
b	14	10	76	3.5-4.5	No grading data available						
				4.5-5.0	16	2	4	8	26	38	6
				5.0-5.5	No grading data available						
				5.5-7.5	15	4	3	2	9	39	28
				7.5-8.0	6	6	4	3	17	54	10
				Mean	**14**	**4**	**3**	**3**	**13**	**42**	**21**
a+b	**18**	**15**	**67**	**Mean**	**18**	**6**	**5**	**4**	**14**	**36**	**17**

SJ 16 NE 10 **1732 6868** **Gelli** **Block A**

Surface level +182 m
Water not encountered
Shell and Auger, 203 mm diameter
October 1978

Overburden 1.2 m
Mineral 7.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown, clayey, with few stones	0.4	0.4
Glacial Sand and Gravel	Clay, soft, light orange-brown, silty	0.8	1.2
	'Very clayey' sandy gravel Gravel: coarse and fine, mainly angular to subrounded siltstones with angular limestone Sand: coarse to fine; mainly siltstone in coarse and medium fractions and quartz in fine	7.1	8.3
	Borehole abandoned because of obstruction		

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$ mm
25	44	31	1.2-2.2	26	14	20	14	13	13	0
			2.2-3.2	28	15	12	6	13	22	4
			3.2-4.4	23	15	19	10	16	15	2
			4.4-7.5	No grading data available						
			7.5-8.3	23	13	21	20	19	4	0
			Mean	**25**	**14**	**18**	**12**	**15**	**14**	**2**

COMPOSITION

Depth below surface (m)	percentages by weight in +8 mm fraction								
	Quartz	Quartzite	Greywacke	Sandstone	Limestone	Siltstone	Mudstone	Igneous	Chert, Flint, etc.
1.2-2.2	0	0	0	0	0	100	0	trace	0

SJ 16 NE 11 **1754 6780** **Star Crossing** **Block A**

Surface level +159 m
Water not encountered
Shell and auger, 203 mm diameter
September 1978

Overburden 0.3 m
Mineral 7.0 m
Bedrock 0.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, dark brown, stony	0.3	0.3
Glacial Sand and Gravel	'Clayey' sandy gravel Gravel: mainly fine and coarse, subrounded siltstone with angular limestone below 5.0 m Sand: coarse to fine; siltstone and quartz	7.0	7.3
Carboniferous Limestone	Limestone, cream	0.1+	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 mm
13	49	38	0.3-1.3	15	2	9	13	31	30	0
			1.3-2.3	20	2	13	17	25	19	4
			2.3-3.2	17	3	30	24	16	10	0
			3.2-4.2	6	41	47	5	1	0	0
			4.2-5.0	2	20	48	9	10	7	4
			5.0-5.2	No grading data available						
			5.2-7.1	15	6	12	14	38	15	0
			7.1-7.3	No grading data available						
			Mean	**13**	**11**	**24**	**14**	**23**	**14**	**1**

COMPOSITION

Depth below surface (m)	percentages by weight in +8 mm fraction								
	Quartz	Quartzite	Greywacke	Sandstone	Limestone	Siltstone	Mudstone	Igneous	Chert, Flint, etc.
1.3-7.3	1	1	8	0	23	65	0	2	trace

SJ 16 NE 13 **1750 6697** **Ty'n-y-caeau** **Block A**

Surface level +184 m
Water struck at +177 m
Down the hole hammer, 192 mm diameter
February 1979

Overburden 0.5 m
Mineral 17.0 m
Waste 0.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown, stony	0.5	0.5
Glacial Sand and Gravel	**a** 'Clayey' sandy gravel Gravel: fine, mainly siltstone with greywacke	5.5	6.0
	b 'Clayey' sand: fine to medium, brown	11.5	17.5
?Till	?Clay, no recovery	0.5+	18.0
	Borehole abandoned due to technical difficulties		
	Drilling caused crushing of much of the gravel: the description given above is, therefore, somewhat subjective and the data given below may not represent the in situ grading		

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
a	14	59	27	0.5-1.0	17	4	16	22	37	4	0
				1.0-2.0	11	5	23	25	36	0	0
				2.0-3.0	11	1	27	54	7	0	0
				3.0-4.0	17	1	18	32	31	1	0
				4.0-6.0	No grading data available						
				Mean	**14**	**3**	**22**	**34**	**26**	**1**	**0**
b	[15	85	0]	6.0-17.5	No grading data available for this deposit						

COMPOSITION

	Depth below surface (m)	percentages by weight in +8 mm fraction								
		Quartz	Quartzite	Greywacke	Sandstone	Limestone	Siltstone	Mudstone	Igneous	Chert, Flint, etc.
a	0.5-4.0	0	trace	3	0	0	97	0	0	trace

SJ 16 NE 14 **1836 6854** **Pen-y-gelli** **Block A**

Surface level +204 m
Water not encountered
Shell and Auger, 203 mm diameter
October 1978

Overburden 1.0 m
Mineral 2.6 m
Bedrock 0.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown with few stones	0.4	0.4
Glacial Sand and Gravel	Clay, soft, with stones - mainly angular to subangular siltstone	0.6	1.0
	Gravel Gravel: coarse and fine, with cobbles; mainly angular to subangular limestone Sand: mainly coarse and medium limestone	2.6	3.6
Carboniferous Limestone	Limestone, cream	0.2+	3.8

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages							
Fines	Sand	Gravel		Fines	Sand			Gravel			
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm	
5	29	66	1.0-2.0	10	5	8	8	19	40	10	
			2.0-3.0	1	7	10	10	23	26	23	
			3.0-3.6	4	5	21	19	27	19	5	
			Mean	**5**	**6**	**12**	**11**	**22**	**30**	**14**	

COMPOSITION

Depth below surface (m)	percentages by weight in +8 mm fraction								
	Quartz	Quartzite	Greywacke	Sandstone	Limestone	Siltstone	Mudstone	Igneous	Chert, Flint, etc.
2.0-3.6	0	0	1	0	92	6	0	1	trace

SJ 16 NE 15 **1832 6776** **Cilcain Hall Lodge** **Block A**

Surface level +153 m
Water not encountered
Shell and Auger, 203 mm diameter
September 1978

Overburden 0.7 m
Mineral 3.3 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, light brown, silty and clayey; few pebbles	0.4	0.4
Glacial Sand and Gravel	Clay, medium brown, sandy, with few pebbles	0.3	0.7
	'Very clayey' sandy gravel Gravel: fine and coarse, subangular to subrounded; siltstone and greywacke with limestone Sand: mainly coarse and medium; siltstone and quartz	3.3+	4.0
	Borehill abandoned because of 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 mm
25	38	37	0.7-1.7	21	10	15	14	23	17	0
			1.7-4.0	25	6	14	19	22	14	0
			Mean	**25**	**7**	**14**	**17**	**22**	**15**	**0**

COMPOSITION

Depth below surface (m)	percentages by weight in +8 mm fraction								
	Quartz	Quartzite	Greywacke	Sandstone	Limestone	Siltstone	Mudstone	Igneous	Chert, Flint, etc.
0.7-4.0	trace	trace	43	0	11	44	0	21	0

SJ 16 NE 16 **1796 6674** **Ty-uchaf** **Block A**

Surface level +187 m
Water not encountered
Down the hole hammer, 192 mm diameter
February 1979

Overburden 0.5 m
Mineral 4.5 m
Waste 5.5 m
Bedrock 3.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Glacial Sand and Gravel	'Clayey' sandy gravel Gravel: siltstone with greywacke and limestone, some igneous rock and trace of quartz Sand: quartz and ? siltstone	4.5	5.0
Till	Clay, grey-brown, stony	5.5	10.5
Carboniferous Limestone	Limestone, cream	3.5+	14.0
	Drilling caused crushing of much of the gravel: the description given above is, therefore, somewhat subjective and the data given below do not necessarily represent the in situ grading		

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
16	67	17	0.5-1.5	5	1	37	49	8	0	0
			1.5-3.5	16	2	37	39	6	0	0
			3.5-5.0	24	3	11	24	37	1	0
			Mean	**16**	**2**	**28**	**37**	**17**	**trace**	**0**

COMPOSITION

Depth below surface (m)	percentages by weight in +8 mm fraction								
	Quartz	Quartzite	Greywacke	Sandstone	Limestone	Siltstone	Mudstone	Igneous	Chert, Flint, etc.
0.5-5.0	trace	0	13	0	20	65	0	2	0

SJ 16 NE 17 **1847 6526** **Hesp Alyn** **Block D**

Surface level +179 m
Water not encountered
Shell and Auger, 203 mm diameter
August 1979

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, dark brown, clayey	0.2	0.2
Till	Clay, yellow-brown and grey-brown, with siltstone and sandstone fragments	17.8+	18.0

SJ 16 NE 18 **1953 6681** **Plas-Wilkin** **Block A**

Surface level +169 m
Water struck at 162 m
Shell and Auger, 203 mm diameter
September 1978

Overburden 1.2 m
Mineral 1.9 m
Waste 0.1 m
Mineral 1.8 m
Waste 2.5 m
Bedrock 6.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown, stony	0.3	0.3
Glacial Sand and Gravel	Clay, medium brown, stony	0.9	1.2
	a 'Very clayey' pebbly sand Gravel: coarse and fine, mainly subrounded siltstone Sand: fine to medium	1.9	3.1
	Silt, pale grey	0.1	3.2
	b 'Very clayey' sandy gravel Gravel: mainly subangular to subrounded siltstone Sand: siltstone with quartz	1.8	5.0
Till	Clay, red-brown and grey, stony	2.5	7.5
Carboniferous Limestone	Mudstone, dark grey, partly fossiliferous	6.2+	13.7

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
a	25	70	5	1.2-2.2	16	39	33	2	4	6	0
				2.2-3.1	36	53	11	0	0	0	0
				Mean	**25**	**46**	**23**	**1**	**2**	**3**	**0**
b	[25	55	20]	3.2-5.0	No grading data available for this deposit						

COMPOSITION

	Depth below surface (m)	percentages by weight in +8 mm fraction								
		Quartz	Quartzite	Greywacke	Sandstone	Limestone	Siltstone	Mudstone	Igneous	Chert, Flint, etc.
a	1.2-2.2	trace	10	11	0	0	79	0	0	0

SJ 16 NE 19 **1633 6919** **Wal-goch** **Block A**

Surface level +174 m
Water not encountered
Down the hole hammer, 254 mm diameter
March 1979

Overburden 0.5 m
Mineral 22.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown, stony	0.5	0.5
Glacial Sand and Gravel	**a** Gravel Gravel: siltstone and greywacke (partly cominuted by drilling method)	6.5	7.0
	b 'Clayey' sand, red: mainly fine and medium; quartz with some grey siltstone	16.0+	23.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
a	6	35	59	0.5-1.5	No grading data available						
				1.5-2.0	6	1	11	23	45	14	0
				2.0-7.0	No grading data available						
				Mean	**6**	**1**	**11**	**23**	**45**	**14**	**0**
b	18	82	0	7.0-9.0	5	11	71	31	0	0	0
				9.0-10.0	5	20	71	4	0	0	0
				10.0-11.0	31	23	40	6	0	0	0
				11.0-12.0	8	55	37	0	0	0	0
				12.0-13.0	13	35	42	10	0	0	0
				13.0-14.0	8	40	52	0	0	0	0
				14.0-15.0	17	50	33	0	0	0	0
				15.0-16.0	33	41	26	0	0	0	0
				16.0-17.0	37	35	26	2	0	0	0
				17.0-18.0	39	47	13	1	0	0	0
				18.0-19.0	29	36	35	0	0	0	0
				19.0-20.0	26	41	30	3	0	0	0
				20.0-21.0	18	52	25	5	0	0	0
				21.0-22.0	6	44	50	0	0	0	0
				22.0-23.0	7	39	52	2	0	0	0
				Mean	**18**	**36**	**42**	**4**	**0**	**0**	**0**
a+b	15	68	17	6.5-23.0	15	26	33	9	13	4	0

COMPOSITION

	Depth below surface (m)	percentages by weight in +8 mm fraction								
		Quartz	Quartzite	Greywacke	Sandstone	Limestone	Siltstone	Mudstone	Igneous	Chert, Flint, etc.
a	0.5-2.0	1	0	24	0	0	73	0	2	0

SJ 16 NE 20 **1634 6995** **Tyddyn-onn** **Block A**

Surface level +160 m
Water not encountered
Shell and Auger, 203 mm and 152 mm diameter
August 1979

Overburden 0.9 m
Mineral 4.1 m
Waste 4.5 m
Mineral 13.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Made ground and dark brown soil	0.9	0.9
Glacial Sand and Gravel	**a** 'Clayey' gravel Gravel: coarse and fine, mainly subrounded to subangular siltstone Sand: mainly coarse and medium siltstone	4.1	5.0
	Sandy silt, orange and buff, laminated	4.5	9.5
	b Sandy, 'clayey' to 'very clayey' in upper part, with bands of sandy gravel Gravel: coarse and fine; siltstone and limestone with traces of quartz and volcanic rock Sand: mainly fine and medium; quartz with trace of siltstone	13.5+	23.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
a	16	33	51	0.9-1.0	No grading data available						
				1.0-2.0	18	4	12	12	29	25	0
				2.0-3.0	15	5	17	10	23	30	0
				3.0-4.0	16	3	14	13	24	25	5
				4.0-5.0	14	9	14	19	26	18	0
				Mean	**16**	**5**	**14**	**14**	**25**	**25**	**1**
b	11	83	6	9.5-10.8	36	58	5	1	0	0	0
				10.8-12.0	10	61	27	2	0	0	0
				12.0-13.0	24	66	10	0	0	0	0
				13.0-14.0	16	57	26	1	0	0	0
				14.0-16.0	8	32	54	6	0	0	0
				16.0-17.0	8	48	42	2	0	0	0
				17.0-18.0	2	13	41	8	25	11	0
				18.0-20.0	7	45	44	4	0	0	0
				20.0-21.5	5	21	69	5	0	0	0
				21.5-22.5	2	14	35	7	16	17	9
				22.5-23.0	4	26	55	7	8	0	0
				Mean	**11**	**40**	**39**	**4**	**3**	**2**	**1**
a+b	**12**	**72**	**16**	**Mean**	**12**	**32**	**34**	**6**	**8**	**7**	**1**

SJ 26 NW 8 **2054 6710** **Rhydymwyn** **Block B**

Surface level +122 m
Water not encountered
Shell and Auger, 203 mm diameter
September 1979

Overburden 3.0 m
Mineral 1.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown, stony	0.3	0.3
Alluvium	Silt, soft, brown, stony	2.7	3.0
	'Very clayey' gravel Gravel: mainly coarse with cobbles, subrounded quartzite, siltstone and limestone Sand: mainly coarse and medium	1.1+	4.1
	Borehole abandoned due to obstruction		
	No grading data available		

SJ 26 NW 9 **2086 6848** **Nant-figillt Wood**

Surface level +231 m
Water struck at +229 m
Shell and Auger, 203 mm diameter
September 1979

Waste 7.2 m
Bedrock 0.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown, clayey	0.1	0.1
Till	Clay, slighty sandy, red-brown to grey, with stones of quartzite, siltstone and mudstone	7.1	7.2
Millstone Grit	Sandstone, buff	0.5+	7.7

SJ 26 NW 10 **2118 6760** **The Nant** **Block B**

Surface level +208 m
Water struck at +198 m
Shell and Auger, 203 mm and 152 mm diameter
September 1979

Overburden 1.3 m
Mineral 8.7 m
Waste 10.3 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy, brown	0.3	0.3
Glacial Sand and Gravel	Clay, light brown, with stones of quartzite and greywacke	1.0	1.3
	Gravel, largely 'clayey' to 'very clayey' Gravel: coarse and fine, subrounded; siltstone with limestone Sand: fine to coarse	8.7	10.0
Till	Clay, dark brown, with stones of siltstone and quartzite	10.3+	20.3

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
12	41	47	1.3-2.3	25	17	21	4	11	16	6
			2.3-2.8	23	59	16	2	0	0	0
			2.8-3.5	17	8	15	7	19	22	12
			3.5-4.5	13	33	42	3	4	5	0
			4.5-5.5	7	9	12	7	20	39	6
			5.5-6.5	3	2	9	10	26	39	11
			6.5-7.5	3	2	13	19	28	30	5
			7.5-8.5	4	3	19	19	28	21	6
			8.5-10.0	17	4	17	18	26	18	0
			Mean	**12**	**12**	**18**	**11**	**19**	**23**	**5**

COMPOSITION

Depth below surface (m)	percentages by weight in +8 mm fraction								
	Quartz	Quartzite	Greywacke	Sandstone	Limestone	Siltstone	Mudstone	Igneous	Chert, Flint, etc.
1.3-10.0	trace	trace	0	trace	26	65	8	1	0

SJ 26 NW 11 **2137 6704** **Tyddyn-y-gwynt** **Block B**

Surface level +174 m
Water struck at +151 m
Shell and Auger, 203 mm diameter
August 1979

Overburden 1.0 m
Mineral 10.5 m
Waste 0.7 m
Mineral 11.1 m
Waste 0.9 m
Mineral 1.3 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy, brown	0.2	0.2
Glacial Sand and Gravel	Clay, sandy, red-brown	0.8	1.0
	a 'Clayey' pebbly sand on gravel Gravel: coarse and fine with cobbles, mainly subrounded greywacke, quartzite and limestone	6.5	7.5
	b 'Clayey' sand: mainly fine; traces of coal	4.0	11.5
	Silty clay, buff and red-brown, laminated	0.7	12.2
	c Sand, 'very clayey' at top, 'clayey' at base: fine to medium; traces of coal	11.1	23.3
	Sandy clay, red-brown	0.9	24.2
	d 'Clayey' sand; fine; traces of coal	1.3+	25.5

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
a	6	56	38	1.0-2.0	15	34	37	6	8	0	0
				2.0-3.0	10	45	40	2	1	2	0
				3.0-4.0	6	35	45	4	6	4	0
				4.0-5.0	0	3	13	14	23	37	10
				5.0-6.0	[0	5	15	10	25	35	10]
				6.0-7.5	4	10	18	10	26	24	8
				Mean	**6**	**21**	**27**	**8**	**16**	**17**	**5**
b	10	90	0	7.5-8.5	9	52	38	1	0	0	0
				8.5-9.5	12	46	42	0	0	0	0
				9.5-11.5	10	69	21	0	0	0	0
				Mean	**10**	**59**	**31**	**trace**	**0**	**0**	**0**
c	8	92	0	12.2-13.0	23	37	40	0	0	0	0
				13.0-15.0	8	34	57	1	0	0	0
				15.0-17.0	3	45	52	0	0	0	0
				17.0-19.0	5	46	49	0	0	0	0
				19.0-21.0	3	44	52	1	0	0	0
				21.0-23.3	13	48	37	2	0	0	0
				Mean	**8**	**43**	**48**	**1**	**0**	**0**	**0**
d	14	86	0	24.2-25.5	14	64	22	0	0	0	0
a-d	**8**	**81**	**11**	**Mean**	**8**	**41**	**37**	**3**	**5**	**5**	**1**

SJ 26 NW 12 **2115 6623** **Bryn-Alyn** **Block B**

Surface level +145 m
Water not encountered
Shell and Auger, 203 mm diameter
August 1979

Overburden 0.5 m
Mineral 3.5 m
Waste 0.5 m
Mineral 2.9 m
Bedrock 0.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy, brown	0.5	0.5
Glacial Sand and Gravel	**a** 'Very clayey' sand: medium and fine	3.5	4.0
	Clay, silty, red-brown, laminated	0.5	4.5
	b Sandy gravel, 'clayey' at top Gravel: mainly fine, subrounded limestone with quartzite Sand: mainly medium, subrounded siltstone and quartz	2.9	7.4
Carboniferous Limestone	Limestone, grey	0.1+	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 mm
a	21	79	0	0.5-1.5	15	40	43	2	0	0	0
				1.5-2.5	18	27	53	2	0	0	0
				2.5-3.3	22	26	46	5	1	0	0
				3.3-4.0	34	56	9	1	0	0	0
				Mean	**21**	**36**	**41**	**2**	**trace**	**0**	**0**
b	6	58	36	4.5-5.0	14	14	26	14	27	5	0
				5.0-6.0	2	10	39	11	28	10	0
				6.0-7.4	No grading data available						
				Mean	**6**	**11**	**35**	**12**	**28**	**8**	**0**
a+b	**14**	**70**	**16**	**Mean**	**14**	**25**	**38**	**7**	**13**	**3**	**0**

COMPOSITION

	Depth below surface (m)	percentages by weight in +8 mm fraction								
		Quartz	Quartzite	Greywacke	Sandstone	Limestone	Siltstone	Mudstone	Igneous	Chert, Flint, etc.
b	6.0-7.4	3	22	10	7	37	6	3	9	3

SJ 26 NW 13 **2120 6505** **Bellan** **Block B**

Surface level +164 m
Water struck at +155 m
Shell and Auger, 203 mm diameter
September 1979

Overburden 0.3 m
Mineral 6.4 m
Waste 1.1 m
Mineral 2.6 m
Waste 3.4 m
Bedrock 0.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy, brown	0.3	0.3
Glacial Sand and Gravel	**a** 'Clayey' gravel Gravel: fine to cobble, subrounded; quartzite with sandstone Sand: mainly medium and coarse	6.4	6.7
	Silt, brown	1.1	7.8
	b 'Very clayey' gravel Gravel: mainly coarse, subangular to subrounded limestone Sand; fine and medium	2.6	10.4
Till	Clay, soft, grey	3.4	13.8
Millstone Grit	Mudstone, dark grey	0.2+	14.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
a	18	22	60	0.3-1.7	24	3	12	6	17	28	10
				1.7-2.7	16	6	11	7	23	36	1
				2.7-3.7	13	1	8	7	18	26	27
				3.7-4.7	12	1	3	17	20	31	16
				4.7-5.7	15	4	9	9	21	30	12
				5.7-6.7	23	15	10	6	14	23	9
				Mean	**18**	**5**	**9**	**8**	**19**	**29**	**12**
b	29	29	42	7.8-9.3	39	19	13	3	10	16	0
				9.3-10.4	15	8	8	5	20	41	3
				Mean	**29**	**14**	**11**	**4**	**14**	**27**	**1**
a+b	**21**	**25**	**54**	**Mean**	**21**	**8**	**10**	**7**	**17**	**28**	**9**

COMPOSITION

	Depth below surface (m)	percentages by weight in +8 mm fraction								
		Quartz	Quartzite	Greywacke	Sandstone	Limestone	Siltstone	Mudstone	Igneous	Chert, Flint, etc.
a	1.7-3.7	1	42	7	17	0	13	10	10	trace

SJ 26 NW 14 **2237 6782** **Ty-eurgain** **Block B**

Surface level +202 m
Water struck at +197 m
Shell and Auger, 203 m diameter
December 1978

Overburden 0.4 m
Mineral 8.6 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, clayey, brown	0.4	0.4
Glacial Sand and Gravel	'Clayey' sandy gravel: samples comminuted due to use of chisel in drilling	8.6+	9.0
	Borehole abandoned because of obstruction		

SJ 26 NW 15 **2215 6671** **Shifna-Hîr** **Block B**

Surface level +178 m
Water struck at +174 m
Shell and Auger, 203 mm diameter
September 1979

Waste 6.0 m
Bedrock 5.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, clayey, brown	0.3	0.3
Till	Clay, red-brown, with stones of greywacke, siltstone and sandstone	5.7	6.0
Millstone Grit	Mudstone, dark grey	5.0+	11.0

SJ 26 NW 16 **2365 6872** **Celyn Farm** **Block B**

Surface level +122 m
Water struck at +117 m
Shell and Auger, 203 mm diameter
December 1978

Waste 5.3 m
Bedrock 0.8 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, clayey, brown	0.3	0.3
Till	Clay, very sandy, brown	2.3	2.6
	Clay, silty at top, grey, with stones of quartzite and siltstone	2.6	5.2
Coal Measures	Sandstone, buff	0.8+	6.0

SJ 26 NW 17 **2350 6717** **Soughton Farm** **Block B**

Surface level +151 m
Water not encountered
Shell and Auger, 203 mm diameter
September 1979

Overburden 1.0 m+
Mineral 0.8 m
Waste 1.2 m
Mineral 1.5 m
Waste 3.4 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, clayey, brown	0.2	0.2
Glacial Sand and Gravel	Clay, sandy, dark brown, pebbly	0.8	1.0
	a Gravel Gravel: fine and coarse; mainly quartzite and limestone Sand: fine to coarse	0.8	1.8
	Clay, soft, very sandy, pebbly	1.2	3.0
	b 'Very clayey' sandy gravel, with few silty bands Gravel: coarse and fine, mainly quartzite Sand: mainly fine and medium	1.5	4.5
Till	Clay, grey, with stones of sandstone and mudstone	3.4+	7.9
	Borehole abandoned due to technical difficulties		

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$ mm
a	4	39	57	1.0-1.8	4	13	6	10	28	25	4
b	29	37	34	3.0-4.5	29	17	13	7	12	14	8
a+b	**19**	**38**	**43**	**Mean**	**19**	**16**	**14**	**8**	**18**	**18**	**7**

SJ 26 NW 18 **2329 6664** **Gwysaney Hall** **Block B**

Surface level +133 m
Water struck at +127 m
Shell and Auger, 203 mm diameter
September 1979

Overburden 0.2 m
Mineral 1.5 m
Waste 7.5 m
Mineral 3.6 m
Waste 1.4 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown	0.2	0.2
Glacial Sand and Gravel	**a** 'Very clayey' sandy gravel Gravel: fine and coarse; mainly quartzite and siltstone Sand: mainly fine	1.5	1.7
Till	Clay, grey to brown, with mudstone fragments	7.5	9.2

Glacial Sand and Gravel	**b** Gravel Gravel: coarse and fine, mainly subrounded; quartzite and siltstone Sand: mainly medium; similar composition to gravel	3.6	12.8
Till	Clay, stiff, dark grey, stony	1.4+	14.2
	Borehole abandoned due to obstruction		

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$ mm
a	30	38	32	0.2-1.0	21	24	14	4	18	19	0
				1.0-1.7	41	18	11	3	14	11	2
				Mean	**30**	**21**	**13**	**4**	**16**	**15**	**2**
b	9	34	57	9.2-10.5	10	4	20	8	23	33	2
				10.5-11.5	12	8	17	11	26	26	0
				11.5-12.3	5	4	18	12	32	29	0
				12.3-12.8	5	2	19	13	29	29	3
				Mean	**9**	**5**	**19**	**10**	**27**	**29**	**1**
a+b	**15**	**35**	**50**	**Mean**	**15**	**10**	**17**	**8**	**24**	**25**	**1**

COMPOSITION

	Depth below surface (m)	percentages by weight in +8 mm fraction								
		Quartz	Quartzite	Greywacke	Sandstone	Limestone	Siltstone	Mudstone	Igneous	Chert, Flint, etc.
b	11.5-12.8	4	35	7	5	6	23	1	18	1

SJ 26 NW 19 **2296 6565** **Tan-y-wal** **Block B**

Surface level +160 m
Water struck at +141 m
Shell and Auger, 203 mm diameter
September 1979

Overburden 0.8 m
Mineral 19.6 m
Waste 4.6 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown	0.1	0.1
Glacial Sand and Gravel	Clay, brown, stony	0.7	0.8
	a Pebbly sand and sandy gravel Gravel: mainly fine; quartzite with siltstone Sand: medium; mainly quartz	3.0	3.8
	b 'Very clayey' sand: mainly medium to 6.8 m, fine below	16.6	20.4
	Clay, silty, soft, grey	4.6+	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	+16 -64	+64 mm
a	8	69	23	0.8-1.9	9	4	49	9	17	12	0
				1.9-2.8	9	7	58	6	11	9	0
				2.8-3.8	6	13	54	7	13	7	0
				Mean	**8**	**8**	**54**	**7**	**14**	**9**	**0**
b	24	76	0	3.8-4.8	7	25	62	4	1	1	0
				4.8-5.8	10	26	59	2	2	1	0
				5.8-6.8	6	29	64	1	0	0	0
				6.8-7.8	14	49	36	1	0	0	0
				7.8-8.8	29	62	8	1	0	0	0
				8.8-10.0	27	48	25	0	0	0	0
				10.0-11.0	26	68	6	0	0	0	0
				11.0-12.1	29	50	21	0	0	0	0
				12.1-14.0	30	50	20	0	0	0	0
				14.0-16.0	16	63	21	0	0	0	0
				16.0-18.4	35	54	11	0	0	0	0
				18.4-20.4	37	56	6	1	0	0	0
				Mean	**24**	**51**	**24**	**1**	**trace**	**trace**	**0**
a+b	**22**	**74**	**4**	**Mean**	**22**	**43**	**29**	**2**	**2**	**2**	**0**

COMPOSITION

	Depth below surface (m)	percentages by weight in +8 mm fraction								
		Quartz	Quartzite	Greywacke	Sandstone	Limestone	Siltstone	Mudstone	Igneous	Chert, Flint, etc.
a	0.8-1.9	2	48	2	1	trace	26	trace	17	4

SJ 26 NW 20 **2290 6519** **Rhyd-y-goleu** **Block B**

Surface level +108 m
Water struck at +106 m
Shell and Auger, 203 mm diameter
September 1979

Overburden 1.7 m
Mineral 7.6 m
Waste 2.1 m
Bedrock 0.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown	0.2	0.2
Alluvium	Clay, silty, soft, pale grey	1.5	1.7
Glacial Sand and Gravel	Gravel, 'clayey' at base Gravel: fine and coarse, mainly subrounded; siltstone and limestone Sand: coarse and medium; mainly siltstone	7.6	9.3
Till	Clay, sandy, red-brown; few pebbles	2.1	11.4
Coal Measures	Siltstone, grey	0.1+	11.5

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
3	32	65	1.7-2.7	6	1	7	14	27	35	10
			2.7-3.7	1	1	9	17	39	33	0
			3.7-4.7	4	1	13	12	35	32	3
			4.7-5.7	1	4	23	18	37	17	0
			5.7-6.7	1	3	19	13	36	25	3
			6.7-7.7	1	3	20	17	23	28	8
			7.7-8.7	4	5	9	11	43	28	0
			8.7-9.3	10	3	11	22	28	24	2
			Mean	**3**	**3**	**14**	**15**	**34**	**28**	**3**

COMPOSITION

Depth below surface (m)	percentages by weight in +8 mm fraction								
	Quartz	Quartzite	Greywacke	Sandstone	Limestone	Siltstone	Mudstone	Igneous	Chert, Flint, etc.
1.7-9.3	0	7	1	2	35	55	0	trace	trace

SJ 26 NW 21 **2428 6936** **Tyddyn Starkey** **Block B**

Surface level +90 m
Water struck at +81 m
Shell and Auger, 203 mm
December 1978

Overburden 4.0 m
Mineral 2.0 m
Waste 3.0 m
Mineral 12.5 m
Waste 0.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown, pebbly	0.3	0.3
Till	Clay, red-brown, with few quartzite stones	3.7	4.0
Glacial Sand and Gravel	**a** Gravel Gravel: coarse and fine, mainly subrounded quartzite Sand: medium and coarse; mainly quartzite	2.0	6.0
Till	Clay, red-brown, with stones of quartzite and siltstone	3.0	9.0
Glacial Sand and Gravel	**b** 'Very clayey' sand, pebbly to 10.0 m and below 19.5 m Gravel: coarse and fine, mainly subrounded quartzite and sandstone Sand: fine, quartz	12.5	21.5
Till	Clay, grey, stony	0.1+	21.6

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
a	6	35	59	4.0-5.0	9	4	22	12	27	19	7
				5.0-6.0	2	1	14	15	23	45	0
				Mean	**6**	**3**	**18**	**14**	**25**	**30**	**4**
b	21	75	4	9.0-10.0	17	28	27	5	13	10	0
				10.0-12.0	14	67	19	0	0	0	0
				12.0-13.0	24	62	14	0	0	0	0
				13.0-14.0	21	65	14	0	0	0	0
				14.0-16.0	30	65	5	0	0	0	0
				16.0-18.0	27	54	12	3	1	3	0
				18.0-19.5	19	64	16	1	0	0	0
				19.5-20.5	18	27	29	6	6	14	0
				20.5-21.5	18	55	17	4	6	0	0
				Mean	**21**	**57**	**16**	**2**	**2**	**2**	**0**
a+b	**19**	**70**	**11**	**Mean**	**19**	**51**	**16**	**3**	**5**	**6**	**trace**

COMPOSITION

	Depth below surface (m)	percentages by weight in +8 mm fraction								
		Quartz	Quartzite	Greywacke	Sandstone	Limestone	Siltstone	Mudstone	Igneous	Chert, Flint, etc.
a	4.0-6.0	6	17	31	17	0	4	1	20	4
b	9.0-10.0	2	4	14	19	3	44	7	6	1
	16.0-21.5	1	34	3	25	16	1	1	18	1

SJ 26 NW 22 **2430 6744** **Clawdd-Offa** **Block B**

Surface level +123 m
Water struck at +106 m
Shell and Auger, 203 mm and 152 mm diameter
October 1979

Overburden 2.0 m
Mineral 9.5 m
Waste 3.5 m
Mineral 11.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy	0.3	0.3
Glacial Sand and Gravel	Clay, brown, very sandy and pebbly	1.7	2.0
	a 'Clayey' gravel with few silty clay bands Gravel: mainly coarse, subrounded; quartzite and siltstone Sand: fine to coarse	9.5	11.5
Till	Clay, dark grey, stony	3.5	15.0
Glacial Sand and Gravel	**b** 'Clayey' sand, fine and medium; quartz	11.0+	26.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
a	19	40	41	2.0-3.2	28	35	25	4	4	4	0
				3.2-5.0	10	7	8	7	10	49	9
				5.0-6.0	28	30	11	2	2	10	17
				6.0-7.4	34	23	5	4	12	22	0
				7.4-9.4	11	5	9	32	29	14	0
				9.4-10.5	8	10	13	17	18	20	14
				10.5-11.5	No grading data available						
b	10	90	0	15.0-17.5	18	52	27	1	1	1	0
				17.5-21.0	10	49	41	0	0	0	0
				21.0-26.0	6	40	53	1	0	0	0
				Mean	**10**	**46**	**43**	**1**	**trace**	**trace**	**0**
a+b	**14**	**67**	**19**	**Mean**	**14**	**32**	**28**	**7**	**6**	**10**	**3**

SJ 26 NW 23 **2404 6526** **Glasfryn** **Block B**

Surface level +146 m
Water not encountered
Shell and Auger, 203 mm diameter
September 1979

Overburden 3.6 m
Mineral 3.9 m
Waste 7.2 m
Bedrock 0.3 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Made ground	1.9	1.9
Glacial Sand and Gravel	Clay, sandy, soft; few pebbles	1.7	3.6
	Sandy gravel, 'clayey' to 4.6 m Gravel: coarse and fine, mainly subrounded quartzite and sandstone Sand: mainly medium to fine	3.9	7.5
Till	Clay, silty at top, grey, stony	7.2	14.7
Coal Measures	Sandstone, buff	0.3+	15.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
	9	47	44	3.6-4.6	13	27	15	6	16	23	0
				4.6-5.6	8	8	16	6	23	32	7
				5.6-7.5	7	19	28	9	16	21	0
				Mean	**9**	**18**	**22**	**7**	**18**	**24**	**2**

SJ 26 NE 26 **2559 6852** **Pont-Einon**

Surface level +102 m
Water struck at +90 m
Shell and Auger, 203 mm diameter
November 1979

Waste 17.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy	0.4	0.4
Till	Sand, 'clayey', pebbly	0.9	1.3
	Clay, red-brown, pebbly, silty at base	9.2	10.5
Glacial Sand and Gravel	Sand, 'clayey', red-brown	2.3	12.8
Till	Clay, red-brown, pebbly	1.7	14.5
Glacial Sand and Gravel	Gravel, coarse, mainly quartzite and sandstone	1.5	16.0
Till	Clay, silty, grey; pebbles and cobbles of siltstone and quartzite; especially at base	1.1+	17.1
	Borehole abandoned due to obstruction		

SJ 26 NE 27 **2631 6764** **Plas-Ifan** **Block B**

Surface level +89 m
Water struck at +83 m
Shell and Auger, 203 mm diameter
November 1979

Overburden 6.3 m
Mineral 6.8 m
Bedrock 0.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy and 'clayey'	0.2	0.2
Till	Clay, red-brown, with pebbles of sandstone, limestone and siltstone	6.1	6.3
Glacial Sand and Gravel	Gravel Gravel: fine to coarse with cobbles; subangular quartzite Sand: coarse and medium	6.8	13.1
Coal Measures	Mudstone, grey	0.5+	13.6

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
5	41	54	6.3-7.3	3	1	5	9	26	37	19
			7.3-8.3	8	2	19	31	25	10	5
			8.3-9.3	6	6	31	18	19	6	14
			9.3-10.3	2	4	26	23	12	15	18
			10.3-11.3	2	3	16	18	29	18	14
			11.3-12.3	9	3	13	14	23	28	10
			12.3-13.1	3	3	18	25	20	28	3
			Mean	**5**	**3**	**18**	**20**	**22**	**20**	**12**

COMPOSITION

Depth below surface (m)	percentages by weight in +8 mm fraction								
	Quartz	Quartzite	Greywacke	Sandstone	Limestone	Siltstone	Mudstone	Igneous	Chert, Flint, etc.
6.3-13.1	1	57	3	19	3	10	1	3	3

SJ 26 NE 28 **2706 6589** **Woodlands**

Surface level +115 m
Water not encountered
Shell and Auger, 203 mm diameter
October 1979

Waste 6.8 m
Bedrock 2.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Made ground	0.4	0.4
Till	Clay, red-brown to 5.9 m, grey below; stones of mudstone, siltstone and sandstone	6.4	6.8
Coal Measures	Siltstone, pale grey	2.2+	9.0

SJ 26 NE 29 **2823 6871** **Broad Oak Farm** **Block C**

Surface level +74 m
Water struck at +71 m
Shell and Auger, 203 mm diameter
October 1979

Waste 9.5 m
Bedrock 0.6 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy and clayey, brown	0.2	0.2
	Clay, mainly sandy and red-brown, laminated from 3.0 m to 8.0 m	9.3	9.5
Coal Measures	Siltstone, dark grey	0.6+	10.1

SJ 26 NE 30 **2795 6753** **Near Ewloe Wood** **Block C**

Surface level +84 m
Water not encountered
Shell and Auger, 203 mm diameter
October 1979

Overburden 0.5 m
Mineral 4.3 m
Waste 9.3 m
Bedrock 0.4 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, clayey, stony	0.5	0.5
Glacial Sand and Gravel	'Clayey' to 'very clayey' gravel Gravel: coarse and fine, mainly subrounded sandstone and quartzite Sand: medium	4.3	4.8
Till	Clay, grey, stony	9.3	14.1
Coal Measures	Sandstone, buff	0.4+	14.5

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
18	37	45	0.5-1.5	19	12	17	4	19	26	3
			1.5-2.5	13	4	28	7	19	23	6
			2.5-3.5	12	3	26	8	17	22	12
			3.5-4.5	27	11	22	9	16	13	2
			4.5-4.8	No grading data available						
			Mean	**18**	**8**	**22**	**7**	**18**	**21**	**6**

COMPOSITION

Depth below surface (m)	percentages by weight in +8 mm fraction								
	Quartz	Quartzite	Greywacke	Sandstone	Limestone	Siltstone	Mudstone	Igneous	Chert, Flint, etc.
2.5-4.5	1	27	trace	29	8	11	2	22	trace

SJ 26 NE 31 **2825 6646** **Homestead** **Block C**

Surface level +91 m
Water struck at +83 m
Shell and Auger, 203 mm diameter
November 1979

Overburden 8.8 m
Mineral 5.0
Waste 1.0
Bedrock 0.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, clayey	0.2	0.2
Till	Clay, red-brown to 8.0 m but grey below, stony	8.6	8.8
Glacial Sand and Gravel	'Clayey' gravel on 'very clayey' sand Gravel: mainly fine, subangular sandstone and mudstone Sand: mainly medium	5.0	13.8
Till	Clay, grey, stony	1.0	14.8
Coal Measures	Mudstone, grey	0.5+	15.3

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
25	65	10	8.8-9.8	10	3	27	13	26	18	3
			9.8-10.8	19	60	18	2	1	0	0
			10.8-13.8	32	58	10	0	0	0	0
			Mean	**25**	**47**	**15**	**3**	**5**	**4**	**1**

SJ 26 NE 32 **2915 6701** **New Inn Bridge Farm** **Block C**

Surface level +82 m
Water struck at +79 m
Shell and Auger, 203 mm and 152 mm diameter
November 1979

Overburden 2.9 m
Mineral 2.1 m
Waste 0.2 m
Mineral 2.0 m
Waste 4.7 m
Bedrock 0.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Made ground	1.2	1.2
Till	Clay, buff-brown, stony	1.7	2.9
Glacial Sand and Gravel	**a** Gravel, 'clayey' to 3.1 m Gravel: coarse and fine, subrounded siltstone and quartzite Sand: mainly medium	2.1	5.0
Till	Clay, red-brown, stony	0.2	5.2
Glacial Sand and Gravel	**b** Pebbly sand: medium and fine, subangular to subrounded	2.0	7.2
Till	Clay, red-brown, stony	4.7	11.9
Coal Measures	Sandstone, buff	0.2+	12.1

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
a	5	37	58	2.9-4.2	3	2	22	14	25	31	3
				4.2-5.0	7	2	24	9	25	28	5
				Mean	**5**	**2**	**23**	**12**	**25**	**29**	**4**
b	6	88	6	5.2-7.2	6	41	45	2	4	2	0
a+b	**5**	**62**	**33**	**Mean**	**5**	**21**	**34**	**7**	**15**	**16**	**2**

COMPOSITION

	Depth below surface (m)	percentages by weight in +8 mm fraction								
		Quartz	Quartzite	Greywacke	Sandstone	Limestone	Siltstone	Mudstone	Igneous	Chert, Flint, etc.
a	2.9-5.0	1	27	1	9	4	40	3	15	trace

SJ 26 NE 33 **2650 6865** **Northop Hall Farm**

Surface level +98 m
Water struck at +96 m
Shell and Auger, 203 mm diameter
November 1979

Waste 6.3 m
Bedrock 0.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, clayey	0.7	0.7
Till	Clay, red-brown, stony	5.6	6.3
Coal Measures	Sandstone, buff	0.1+	6.4

SJ 26 NE 34 **2751 6910** **Bryn Saer**

Surface level +79 m
Water struck at +75 m
Shell and Auger, 203 mm diameter
November 1979

Waste 4.3 m
Bedrock 0.9 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, clayey	0.3	0.3
Till	Clay, red-brown, stony; 0.6 m 'clayey' sand at 1.8 m	4.0	4.3
Coal Measures	Mudstone, grey	0.9+	5.2

SJ 26 NE 35 **2835 6771** **Llwyni Farm**

Surface level +89 m
Water struck at +72 m
Shell and Auger, 203 mm diameter
November 1979

Waste 19.4 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, clayey	0.3	0.3
Till	Clay, brown to red-brown, stony	8.2	8.5
Glacial Sand and Gravel	Sand, pebbly in upper part	1.5	10.0
Till	Clay, red-brown, stony	9.4+	19.4

SJ 26 SW 21 **2203 6476** **Rhual** **Block B**

Surface level +142 m
Water not encountered
Shell and Auger, 203 mm diameter
October 1979

Overburden 2.1 m
Mineral 7.0 m
Waste 9.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown	0.1	0.1
Glacial Sand and Gravel	Sand, brown; few pebbles	0.6	0.7
	Clay, sandy, red-brown; few pebbles	1.4	2.1
	'Very clayey' gravel Gravel: mainly coarse with cobbles to 5.0 m, subangular siltstone and quartzite Sand: fine and medium	7.0	9.1
Till	Clay, pale grey, stony	9.0+	18.1
	Borehole abandoned due to obstruction		

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$ mm
26	33	41	2.1-3.5	14	9	6	4	23	34	10
			3.5-5.0	47	8	9	6	12	13	5
			5.0-6.5	36	33	19	8	2	2	0
			6.5-9.1	14	15	14	3	23	31	0
			Mean	**26**	**16**	**12**	**5**	**16**	**22**	**3**

SJ 26 SW 22 **2262 6473** **Rhual-isa** **Block B**

Surface level +122 m
Water struck at +118 m
Shell and Auger, 203 mm and 152 mm diameter
October 1979

Overburden 0.2 m
Mineral 2.5 m
Waste 6.3 m
Mineral 3.1 m
Waste 5.7 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown	0.2	0.2
Glacial Sand and Gravel	**a** 'Very clayey' gravel Gravel: fine to coarse, subrounded siltstone and limestone Sand: mainly medium	2.5	2.7
Till	Clay, red-brown, stony in upper 0.8 m	6.3	9.0
Glacial Sand and Gravel	**b** Gravel Gravel: coarse and fine with cobbles, subrounded siltstone and limestone Sand: mainly medium	3.1	12.1
Till	Clay, dark brown; few pebbles	5.7+	17.8
	Borehole abandoned due 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 mm
a	20	34	46	0.2-1.2	32	6	14	9	22	17	0
				1.2-2.7	12	5	20	13	24	24	2
				Mean	**20**	**5**	**18**	**11**	**24**	**21**	**1**
b	4	35	61	9.0-10.0	5	1	13	12	23	32	14
				10.0-11.0	3	2	26	14	14	29	12
				11.0-12.1	3	5	20	11	11	24	26
				Mean	**4**	**3**	**20**	**12**	**16**	**27**	**18**
a+b	**11**	**35**	**54**	**Mean**	**11**	**4**	**19**	**12**	**19**	**25**	**10**

COMPOSITION

	Depth below surface (m)	percentages by weight in +8 mm fraction								
		Quartz	Quartzite	Greywacke	Sandstone	Limestone	Siltstone	Mudstone	Igneous	Chert, Flint, etc.
b	9.0-12.1	trace	2	trace	12	40	43	0	3	0

SJ 26 SW 23 **2260 6374** **Plas Aney**

Surface level +135 m
Water not encountered
Shell and Auger, 203 mm and 152 mm diameter
September

Waste 13.3 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
Till	Clay, mainly grey but red-brown in parts, stony	13.3+	13.3
	Borehole abandoned due to obstruction		

SJ 26 SW 24 **2299 6264** **Bryn Coch Hall** **Block E**

Surface level +145 m
Water struck at +134 m
Shell and Auger, 203 mm and 152 mm diameter
November 1978

Overburden 2.0 m
Mineral 3.8 m
Waste 7.2 m
Bedrock 1.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Made ground	1.7	1.7
Glacial Sand and Gravel	Clay, silty, soft, red-brown	0.3	2.0
	Gravel, 'clayey' to 3.0 m Gravel: mainly coarse, subrounded greywacke and igneous rocks Sand: medium and coarse	3.8	5.8
Till	Clay, red-brown, stony	7.2	13.0
Coal Measures	Marl, red	1.0+	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 mm
7	32	61	2.0-3.0	15	3	13	13	17	30	9
			3.0-4.0	4	7	19	14	22	32	2
			4.0-5.0	1	1	14	13	34	37	0
			5.0-5.8	No grading data available						
			Mean	**7**	**4**	**15**	**13**	**24**	**33**	**4**

COMPOSITION

Depth below surface (m)	percentages by weight in +8 mm fraction								
	Quartz	Quartzite	Greywacke	Sandstone	Limestone	Siltstone	Mudstone	Igneous	Chert, Flint, etc.
2.0-5.0	4	13	30	10	7	15	trace	21	trace

SJ 26 SW 25 **2333 6153** **Hendre Isa**

Surface level +155 m
Water not encountered
Shell and Auger, 203 mm diameter
October 1978

Waste 5.8 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, clayey, brown	0.3	0.3
Till	Clay, red-brown, stony	5.5+	5.8
	Borehole abandoned due to obstruction		

SJ 26 SW 26 **2355 6197** **The Tower** **Block E**

Surface level +149 m
Water struck at +146 m
Shell and Auger, 203 mm diameter
November 1978

Overburden 1.4 m
Mineral 2.3 m
Waste 6.3 m
Mineral 2.8 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy, clayey	0.4	0.4
Glacial Sand and Gravel	Clay, brown, very gravelly	1.0	1.4
	a Gravel, 'clayey' to 2.4 m Gravel: mainly fine, subrounded igneous rocks and quartzite Sand: mainly medium	2.3	3.7
Till	Clay, silty to 5.8 m, stony below	6.3	10.0
Glacial Sand and Gravel	**b** Gravel Gravel: mainly coarse with cobbles; limestone and siltstone with quartzite Sand: mainly coarse	2.8+	12.8
	Borehole abandoned due 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 mm
a	9	42	49	1.4-2.4	15	5	21	13	27	19	0
				2.4-3.7	4	4	29	12	30	19	2
				Mean	**9**	**4**	**26**	**12**	**29**	**19**	**1**
b	8	20	72	10.0-11.0	5	1	4	13	14	34	29
				11.0-12.0	No grading data available						
				12.0-12.4	17	1	9	16	11	20	26
				12.4-12.8	No grading data available						
				Mean	**8**	**1**	**5**	**14**	**13**	**31**	**28**
a+b	**9**	**30**	**61**	**Mean**	**9**	**2**	**15**	**13**	**20**	**25**	**16**

COMPOSITION

	Depth below surface (m)	percentages by weight in +8 mm fraction								
		Quartz	Quartzite	Greywacke	Sandstone	Limestone	Siltstone	Mudstone	Igneous	Chert, Flint, etc.
a	1.4-3.7	10	28	22	2	1	3	0	31	3
b	10.0-12.4	0	24	15	0	47	13	0	trace	1

SJ 26 SW 27 **2366 6019** **Nercwys Hall** **Block E**

Surface level +176 m
Water struck at +164 m
Shell and Auger, 203 mm diameter

Overburden 0.2 m
Mineral 7.3 m
Waste 0.5 m
Mineral 5.8 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, clayey	0.2	0.2
Glacial Sand and Gravel	**a** Gravel (mainly crushed due to use of chisel during drilling) to 7.5 m, many large cobbles Gravel: limestone and quartzite Sand: mainly coarse	7.3	7.5
Till	Clay, grey-brown, with cobbles	0.5	8.0
Glacial Sand and Gravel	**b** Gravel (mainly crushed due to use of chisel during drilling at 11.4 m and 13.0 to 13.1 m due to large cobbles) Gravel: limestone and quartzite Sand: coarse	5.8+	13.8
	Borehole abandoned due 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 mm
a	4	47	49	0.2-7.0	No grading data available						
				7.0-7.5	4	1	16	30	17	20	12
				Mean	**4**	**1**	**16**	**30**	**17**	**20**	**12**
b	5	40	55	8.0-11.2	No grading data available						
				11.2-11.4	6	2	10	23	28	29	2
				11.4-13.0	No grading data available						
				13.0-13.1	4	0	9	41	32	14	0
				13.1-13.8	No grading data available						
				Mean	**5**	**1**	**10**	**29**	**30**	**24**	**1**
a+b	**4**	**44**	**52**	**Mean**	**4**	**1**	**13**	**30**	**23**	**22**	**7**

COMPOSITION

	Depth below surface (m)	percentages by weight in +8 mm fraction								
		Quartz	Quartzite	Greywacke	Sandstone	Limestone	Siltstone	Mudstone	Igneous	Chert, Flint, etc.
b	8.0-13.8	1	36	14	2	38	3	0	4	2

SJ 26 SW 28 **2400 6080** **Pistyll** **Block E**

Surface level +148 m
Water struck at +137 m
Shell and Auger, 203 mm diameter
October 1978

Waste 12.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, clayey	0.3	0.3
Till	Clay, red-brown, sandy in parts; pebbles and cobbles of limestone and quartzite; 0.2 m sandy gravel at 10.9 m	11.9+	12.2
	Borehole abandoned due to obstruction		

SJ 26 SW 29 **2424 6162** **Waen Farm** **Block E**

Surface level +142 m
Water not encountered
Shell and Auger, 203 mm diameter
October 1979

Mineral 2.8 m
Waste 1.2 m
Mineral 1.4 m
Waste 3.4 m
Bedrock 1.9 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
Glacial Sand and Gravel	**a** Sandy gravel Gravel: mainly coarse with cobbles, subrounded sandstone, mudstone and igneous rocks Sand: mainly fine	2.8	2.8
Till	Clay, grey-brown, stony	1.2	4.0
Glacial Sand and Gravel	**b** 'Very clayey' fine sand with few silty bands	1.4	5.4
Till	Clay, sandy to 6.4 m, stony below	3.4	8.8
Coal Measures	Sandstone, buff	1.9+	10.7

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
a	7	51	42	0.0-1.0	4	40	36	3	7	10	0
				1.0-2.6	9	21	9	4	15	28	14
				2.6-2.8	No grading data available						
				Mean	**7**	**28**	**19**	**4**	**12**	**21**	**9**
b	38	59	3	4.0-5.4	38	49	9	1	2	1	0
a+b	**17**	**54**	**29**	**Mean**	**17**	**35**	**16**	**3**	**9**	**14**	**6**

SJ 26 SW 30 **2462 6271** **Lodge** **Block E**

Surface level +107 m
Water struck at +90 m
Shell and Auger, 203 mm diameter
September 1979

Overburden 1.5 m
Mineral 2.5 m
Waste 16.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, clayey and sandy	0.2	0.2
Glacial Sand and Gravel	Clay, brown, pebbly below 0.8 m	1.3	1.5
	'Clayey' sand; mainly medium, quartz	2.5	4.0
Till	Clay, red-brown in upper part becoming grey with depth, silty to 12.8 m, stony below; 0.5 m of gravel at 17.5 m	16.0+	20.0

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
11	85	4	1.5-2.5	13	35	49	3	0	0	0
			2.5-4.0	10	9	54	21	6	0	0
			Mean	**11**	**19**	**52**	**14**	**4**	**0**	**0**

SJ 26 SW 31 **2499 6344** **Pen-y-bont** **Block E**

Surface level +100 m
Water struck at +95 m
Shell and Auger, 203 mm diameter
September 1979

Waste 6.5 m
?Bedrock 1.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy	0.1	0.1
Alluvium	Clay, sandy, red-brown	4.9	5.0
Glacial Sand and Gravel	Sandy gravel	1.5	6.5
?Coal Measures	Marl, red-purple	1.5+	8.0

SJ 26 SE 23 **2555 6483** **Bryn Derw**

Surface level +155 m
Water struck at +151 m
Shell and Auger, 203 mm diameter
September 1979

Waste 4.5 m
Bedrock 1.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, clayey	0.1	0.1
Till	Clay, brown, stony	4.4	4.5
Coal Measures	Mudstone, dark grey	1.0+	5.5

SJ 26 SE 24 **2535 6304** **Tyddyn Cottages** **Block E**

Surface level +122 m
Water not encountered
Shell and Auger, 203 mm diameter
September 1979

Overburden 4.4 m
Mineral 2.1 m
Waste 3.1 m
Mineral 4.2 m
Bedrock 0.7 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy	0.2	0.2
Till	Clay, brown, stony	4.2	4.4
Glacial Sand and Gravel	**a** Gravel Gravel: coarse and fine, mainly subrounded to subangular quartzite Sand: mainly coarse, subrounded to subangular quartzite	2.1	6.5
Till	Clay, grey to brown, mainly stony but laminated and stoneless below 9.0 m	3.1	9.6
Glacial Sand and Gravel	**b** Gravel Gravel: mainly coarse, subrounded siltstone and quartzite Sand: mainly medium	4.2	13.8
Coal Measures	Mudstone, grey	0.7+	14.5

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
a	9	31	60	4.4-5.2	16	10	16	7	22	24	5
				5.2-6.5	4	0	5	25	26	34	6
				Mean	**9**	**4**	**9**	**18**	**24**	**30**	**6**
b	6	28	66	9.6-10.4	5	12	31	6	18	25	3
				10.4-11.0	5	10	18	11	29	25	2
				11.0-12.0	1	4	9	9	25	49	3
				12.0-13.8	9	4	9	8	27	30	13
				Mean	**6**	**6**	**14**	**8**	**25**	**34**	**7**
a+b	**7**	**31**	**62**	**Mean**	**7**	**6**	**13**	**12**	**25**	**30**	**7**

SJ 26 SE 25 **2518 6074** **Leeswood Farm** **Block E**

Surface level +148 m
Water struck at +144 m
Shell and Auger, 203 mm diameter
October 1979

Waste 13.0 m
Bedrock 0.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Till	Clay, red-brown to 7.0 m, grey below, stony below 4.0 m	12.8	13.0
Coal Measures	Mudstone, dark grey	0.1+	13.1

SJ 26 SE 26 **2561 6207** **Leeswood Old Hall** **Block E**

Surface level +95 m
Water struck at +92 m
Shell and Auger, 203 mm diameter
September 1979

Overburden 3.5 m
Mineral 6.3 m
Waste 9.7 m
Bedrock 0.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, silty	0.2	0.2
Alluvium	Clay, silty, soft; few pebbles	3.3	3.5
Glacial Sand and Gravel	Sandy gravel Gravel: coarse, subangular quartzite Sand: mainly medium	6.3	9.8
Till	Clay, silty, grey brown, laminated to 12.5 m, stony below	9.7	19.5
Coal Measures	Mudstone, dark grey	0.5+	20.0

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
8	48	44	3.5-4.5	9	4	6	6	17	47	11
			4.5-5.5	4	6	21	13	24	24	8
			5.5-6.5	5	3	12	13	26	33	8
			6.5-7.5	3	5	16	12	31	26	7
			7.5-9.8	14	29	41	8	6	2	0
			Mean	**8**	**13**	**25**	**10**	**18**	**21**	**5**

COMPOSITION

Depth below surface (m)	percentages by weight in +8 mm fraction								
	Quartz	Quartzite	Greywacke	Sandstone	Limestone	Siltstone	Mudstone	Igneous	Chert, Flint, etc.
3.5-4.5	trace	63	trace	12	20	4	0	1	trace

SJ 26 SE 27 **2644 6309** **Glenbrook Farm**

Surface level +144 m
Water not encountered
Shell and Auger, 203 mm diameter
October 1979

Waste 11.0 m
Bedrock 0.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, clayey and sandy	0.4	0.4
Till	Clay, red-brown, stony	10.6	11.0
Coal Measures	Mudstone, dark grey	0.5+	11.5

SJ 26 SE 28 **2675 6245** **Plas Major** **Block E**

Surface level +100 m
Water struck at +92 m
Shell and Auger, 203 mm diameter
October 1979

Overburden 5.2 m
Mineral 5.8 m
Waste 7.7 m
Bedrock 0.6 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy	0.2	0.2
Alluvium	Clay, brown, pebbly	5.0	5.2
Glacial Sand and Gravel	Sandy gravel, 'clayey' in upper part Gravel: fine and coarse, mainly subrounded siltstone and sandstone Sand: medium	5.8	11.0
Till	Clay, grey, stony	7.7	18.7
Coal Measures	Mudstone, dark grey	0.6+	19.3

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
9	55	36	5.2-6.8	10	5	19	10	33	19	4
			6.8-7.5	12	7	23	7	23	25	3
			7.5-8.5	11	6	41	8	17	17	0
			8.5-9.5	8	6	58	7	11	10	0
			9.5-10.5	5	12	59	5	7	10	2
			10.5-11.0	4	12	55	6	13	10	0
			Mean	**9**	**7**	**40**	**8**	**19**	**15**	**2**

COMPOSITION

Depth below surface (m)	percentages by weight in +8 mm fraction								
	Quartz	Quartzite	Greywacke	Sandstone	Limestone	Siltstone	Mudstone	Igneous	Chert, Flint, etc.
5.2-9.5	7	16	1	25	0	34	trace	16	1

SJ 26 SE 29 **2680 6212** **Tai Bowen** **Block E**

Surface level +97 m
Water struck at +95 m
Shell and Auger, 203 mm and 152 mm diameter
October 1979

Overburden 2.6 m
Mineral 3.4 m
Waste 16.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, silty	0.3	0.3
Alluvium	Clay, silty, grey-brown, pebbly below 2.0 m	2.3	2.6
Glacial Sand and Gravel	Gravel Gravel: mainly fine, subrounded siltstone, quartzite and limestone Sand: medium and coarse	3.4	6.0
	Clay, silty, soft, grey-brown, laminated	16.5+	22.5

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
7	34	59	2.6-3.6	14	7	18	10	34	17	0
			3.6-4.6	2	2	13	24	39	20	0
			4.6-5.6	4	5	13	7	44	27	0
			5.6-6.0	No grading data available						
			Mean	**7**	**5**	**15**	**14**	**38**	**21**	**0**

SJ 26 SE 30 **2658 6061** **Stryt-cae-rhedyn** **Block E**

Surface level +166 m
Water not encountered
Shell and Auger, 203 mm diameter
October 1979

Waste 16.0 m
Bedrock 0.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Till	Clay, grey-brown, stony	15.8	16.0
Coal Measures	Sandstone, grey	0.1+	16.1

SJ 26 SE 31 **2772 6277** **Bistre Farm**

Surface level +113 m
Water struck at +101 m
Shell and Auger, 203 mm diameter
October 1979

Waste 16.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy and clayey	0.2	0.2
Till	Clay, red-brown, stony	16.0+	16.2

SJ 26 SE 32 **2766 6160** **Coppa House** **Block E**

Surface level +96 m
Water struck at +84 m
Shell and Auger, 203 mm and 152 mm diameter
October 1979

Overburden 1.0 m
Mineral 19.0 m
Waste 3.3 m
Bedrock 0.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Made ground	1.0	1.0
Glacial Sand and Gravel	**a** 'Clayey' gravel Gravel: fine and coarse with abundant cobbles in upper part, mainly subrounded siltstone, sandstone, mudstone and quartz Sand: mainly medium	14.1	15.1
	b 'Clayey' to 'very clayey' sand, mainly fine, red-brown quartz Sand: pebbles and cobbles in upper part	4.9	20.0
	Clay, sandy, dark brown	2.5	22.5
Till	Clay, grey-brown, stony	0.8	23.3
Coal Measures	Sandstone, pale brown	0.5+	23.8

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
a	15	33	52	1.0-2.1	15	5	11	9	20	20	20
				2.1-3.1	9	3	8	9	18	20	33
				3.1-6.1	17	4	11	9	30	26	3
				6.1-7.1	17	2	10	10	27	32	2
				7.1-8.1	20	4	13	11	26	26	0
				8.1-9.4	27	3	14	7	23	22	4
				9.4-10.1	16	5	16	10	29	22	2
				10.1-11.1	17	5	16	11	32	19	0
				11.1-12.1	14	6	35	12	21	12	0
				12.1-13.1	7	5	42	18	22	6	0
				13.1-15.1	8	10	21	16	21	17	7
				Mean	**15**	**5**	**17**	**11**	**25**	**21**	**6**
b	29	65	6	15.1-17.0	9	41	33	3	2	2	10
				17.0-20.0	42	48	9	1	0	0	0
				Mean	**29**	**45**	**18**	**2**	**1**	**1**	**4**
a+b	18	41	41	1.0-20.0	18	15	17	9	19	16	6

SJ 26 SE 33 **2856 6250** **Padeswood Hall**

Surface level +114 m
Water not encountered
Shell and Auger, 203 mm diameter
October 1979

Waste 16.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, clayey	0.2	0.2
Till	Clay, red-brown, with stones of siltstone, mudstone and quartzite	15.8+	16.0
	Borehole abandoned due to technical difficulties		

SJ 26 SE 34 **2852 6108** **Plas Newydd** **Block E**

Surface level +98 m
Water struck at +82 m
Shell and Auger, 203 mm and 152 mm diameter
October 1979

Overburden 2.9 m
Mineral 15.6 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, stony	0.3	0.3
Till	Clay, red-brown, stony	2.6	2.9
Glacial Sand and Gravel	'Clayey' sandy gravel Gravel: fine and coarse, mainly subrounded quartzite and limestone Sand: mainly medium	15.6+	18.5
	Borehole abandoned due to technical difficulties		

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
				Fines	Sand			Gravel		
Fines	Sand	Gravel		$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
11	51	38	2.9-3.9	11	8	51	9	10	10	1
			3.9-4.9	9	3	23	7	17	24	17
			4.9-6.0	No grading data available						
			6.0-7.0	14	5	13	8	27	31	2
			7.0-8.0	5	7	12	16	35	25	0
			8.0-9.5	13	5	14	9	25	26	8
			9.5-10.0	15	4	19	15	30	17	0
			10.0-11.0	16	3	20	13	27	17	4
			11.0-12.0	16	11	25	6	21	19	2
			12.0-13.0	17	16	19	4	15	22	7
			13.0-14.0	17	12	21	8	22	14	6
			14.0-15.0	17	13	39	5	16	10	0
			15.0-16.0	5	15	72	8	0	0	0
			16.0-17.0	2	19	66	10	3	0	0
			17.0-18.5	3	19	51	6	6	13	2
			Mean	**11**	**10**	**32**	**9**	**18**	**16**	**4**

COMPOSITION

Depth below surface (m)	percentages by weight in +8 mm fraction								
	Quartz	Quartzite	Greywacke	Sandstone	Limestone	Siltstone	Mudstone	Igneous	Chert, Flint, etc.
2.9-9.5	2	31	4	3	29	8	trace	22	1
9.5-15.0	3	22	0	7	22	27	1	17	1

SJ 26 SE 35 **2871 6037** **Hartsheath** **Block E**

Surface level +100 m
Water struck at +90 m
Shell and Auger, 203 mm diameter
October 1979

Overburden 5.5 m
Mineral 3.3 m
Waste 0.7 m
Mineral 4.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Till	Clay, buff-brown; many coal fragments; 0.2 m sand at 3.3 m	5.3	5.5
Glacial Sand and Gravel	**a** 'Clayey' gravel Gravel: coarse and fine, mainly subrounded quartzite Sand: medium	3.3	8.8
Till	Clay, dark brown, stony	0.7	9.5
Glacial Sand and Gravel	**b** Sandy gravel, 'very clayey' near top Gravel: fine and coarse, mainly quartzite Sand: mainly medium	4.5+	14.0
	Borehole abandoned due 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 mm
a	10	36	54	5.5-6.5	17	7	24	5	19	25	3
				6.5-7.5	8	9	28	9	23	20	3
				7.5-8.8	7	5	15	8	28	28	9
				Mean	**10**	**7**	**22**	**7**	**24**	**25**	**5**
b	8	48	44	9.5-10.5	21	17	35	7	12	8	0
				10.5-11.6	4	3	26	11	30	24	2
				11.6-12.7	4	8	30	8	22	20	8
				12.7-13.7	5	7	21	16	19	21	11
				13.7-14.0	No grading data available						
				Mean	**8**	**9**	**29**	**10**	**21**	**18**	**5**
a+b	**9**	**43**	**48**	**Mean**	**9**	**8**	**26**	**9**	**22**	**21**	**5**

SJ 26 SE 36 **2958 6305** **Little Mountain**

Surface level +121 m
Water struck at +114 m
Shell and Auger, 203 mm diameter
October 1979

Waste 7.2 m
Bedrock 0.8 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Made ground	1.6	1.6
Till	Clay, sandy below 4.1 m; few stones above 4.1 m	5.6	7.2
Coal Measures	Sandstone, buff to grey	0.8+	8.0

SJ 26 SE 37 **2926 6089** **Rhyd Farm** **Block E**

Surface level +86 m
Water struck at +82 m
Shell and Auger, 203 mm and 152 mm diameter
October 1979

Overburden 0.3 m
Mineral 11.9 m
Waste 2.2 m
Mineral 1.1 m
Waste 2.8 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil,	0.3	0.3
Glacial Sand and Gravel	**a** Gravel, 'clayey' to 4.0 m Gravel: coarse and fine, mainly rounded and subrounded sandstone, quartzite and mudstone Sand: medium, quartz	11.9	12.2
Till	Clay, silty to 12.4 m, grey to brown, stony	2.2	14.4

Glacial Sand and Gravel	**b** 'Clayey' gravel Gravel: fine and coarse, mainly subrounded to subangular siltstone and quartzite with igneous rocks Sand: medium	1.1	15.5
Till	Clay, dark grey, stony	2.8+	18.3
	Borehole abandoned due to technical difficulties		

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$ mm
a	8	28	64	0.3-1.6	17	9	20	7	23	24	0
				1.6-2.8	13	8	34	7	21	12	5
				2.8-4.0	10	6	23	7	18	30	6
				4.0-5.5	9	4	9	4	20	38	16
				5.5-6.6	5	5	4	4	20	47	15
				6.6-8.0	3	5	8	6	41	33	4
				8.0-9.5	4	4	10	9	38	34	1
				9.5-11.0	4	7	17	3	22	33	14
				11.0-12.2	4	6	18	4	23	32	13
				Mean	**8**	**6**	**16**	**6**	**26**	**30**	**8**
b	12	38	50	14.4-15.5	12	6	17	15	29	21	0
a+b	**8**	**28**	**64**	**Mean**	**8**	**6**	**16**	**6**	**26**	**31**	**7**

SJ 26 SE 38 **2990 6233** **Oak Tree Farm**

Surface level +115 m
Water struck at +103 m
Shell and Auger, 203 mm diameter
October 1979

Waste 4.0 m
Bedrock 1.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, clayey	0.3	0.3
Till	Clay, mainly grey, with fragments of mudstone	3.7	4.0
Millstone Grit	Mudstone, dark grey	1.2+	5.2

The following reports of the Institute relate particularly to bulk mineral resources

Reports of the Institute of Geological Sciences

Assessment of British Sand and Gravel Resources

1 The sand and gravel resources of the country south-east of Norwich, Norfolk: Resource sheet TG 20.
E. F. P. Nickless.
Report 71/20 ISBN 0 11 880216 X £1.15

2 The sand and gravel resources of the country around Witham, Essex: Resource sheet TL 81. H. J. E. Haggard.
Report 72/6 ISBN 0 11 880588 6 £1.20

3 The sand and gravel resources of the area south and west of Woodbridge, Suffolk: Resource sheet TM 24.
R. Allender and S. E. Hollyer.
Report 72/9 ISBN 0 11 880596 7 £1.70

4 The sand and gravel resources of the country around Maldon, Essex: Resource sheet TL 80. J. D. Ambrose.
Report 73/1 ISBN 0 11 880600 9 £1.20

5 The sand and gravel resources of the country around Hethersett, Norfolk: Resource sheet TG 10.
E. F. P. Nickless.
Report 73/4 ISBN 0 11 880606 8 £1.60

6 The sand and gravel resources of the country around Terling, Essex: Resource sheet TL 71. C. H. Eaton.
Report 73/5 ISBN 0 11 880608 4 £1.20

7 The sand and gravel resources of the country around Layer Breton and Tolleshunt D'Arcy, Essex: Resource sheet TL 91 and part of TL 90. J. D. Ambrose.
Report 73/8 ISBN 0 11 880614 9 £1.30

8 The sand and gravel resources of the country around Shotley and Felixstowe, Suffolk: Resource sheet TM 23.
R. Allender and S. E. Hollyer.
Report 73/13 ISBN 0 11 880625 4 £1.60

9 The sand and gravel resources of the country around Attlebridge, Norfolk: Resource sheet TG 11.
E. F. P. Nickless.
Report 73/15 ISBN 0 11 880658 0 £1.85

10 The sand and gravel resources of the country west of Colchester, Essex: Resource sheet TL 92. J. D. Ambrose.
Report 74/6 ISBN 0 11 880671 8 £1.45

11 The sand and gravel resources of the country around Tattingstone, Suffolk: Resource sheet TM 13. S. E. Hollyer.
Report 74/9 ISBN 0 11 880675 0 £1.95

12 The sand and gravel resources of the country around Gerrards Cross, Buckinghamshire: Resource sheet SU 99, TQ 08 and TQ 09. H. C. Squirrell.
Report 74/14 ISBN 0 11 880710 2 £2.20

Mineral Assessment Reports

13 The sand and gravel resources of the country east of Chelmsford, Essex: Resource sheet TL 70. M. R. Clarke.
ISBN 0 11 880744 7 £3.50

14 The sand and gravel resources of the country east of Colchester, Essex: Resource sheet TM 02. J. D. Ambrose.
ISBN 0 11 880745 5 £3.25

15 The sand and gravel resources of the country around Newton on Trent, Lincolnshire: Resource sheet SK 87.
D. Price.
ISBN 0 11 880746 3 £3.00

16 The sand and gravel resources of the country around Braintree, Essex: Resource sheet TL 72. M. R. Clarke.
ISBN 0 11 880747 1 £3.50

17 The sand and gravel resources of the country around Besthorpe, Nottinghamshire: Resource sheet SK 86 and part of SK 76. J. R. Gozzard.
ISBN 0 11 880748 X £3.00

18 The sand and gravel resources of the Thames Valley, the country around Cricklade, Wiltshire: Resource sheet SU 09/19 and parts of SP 00/10. P. R. Robson.
ISBN 0 11 880749 8 £3.00

19 The sand and gravel resources of the country south of Gainsborough, Lincolnshire: Resource sheet SK 88 and part of SK 78. J. H. Lovell.
ISBN 0 11 880750 1 £2.50

20 The sand and gravel resources of the country east of Newark upon Trent, Nottinghamshire: Resource sheet SK 85.
J. R. Gozzard.
ISBN 0 11 880751 X £2.75

21 The sand and gravel resources of the Thames and Kennet Valleys, the country around Pangbourne, Berkshire: Resource sheet SU 67. H. C. Squirrell.
ISBN 0 11 880752 8 £3.25

22 The sand and gravel resources of the country north-west of Scunthorpe, Humberside: Resource sheet SE 81.
J. W. C. James.
ISBN 0 11 880753 6 £3.00

23 The sand and gravel resources of the Thames Valley, the country between Lechlade and Standlake: Resource sheet SP 30 and parts of SP 20, SU 29 and SU 39. P. Robson.
ISBN 0 11 881252 1 £7.25

24 The sand and gravel resources of the country around Aldermaston, Berkshire: Resource sheet SU 56 and SU 66. H. C. Squirrell.
ISBN 0 11 881253 X £5.00

25 The celestite resources of the area north-east of Bristol: Resource sheet ST 68 and parts of ST 59, 69, 79, 58, 78, 68 and 77. E. F. P. Nickless, S. J. Booth and P. N. Mosley.
ISBN 0 11 881262 9 £5.00

26 The limestone and dolomite resources of the country around Monyash, Derbyshire: Resource sheet SK 16.
F. C. Cox and D. McC. Bridge.
ISBN 0 11 881263 7 £7.00

27 The sand and gravel resources of the country west and south of Lincoln, Lincolnshire: Resource sheets SK 95, SK 96 and SK 97. I. Jackson.
ISBN 0 11 884003·7 £6.00

28 The sand and gravel resources of the country around Eynsham, Oxfordshire: Resource sheet SP 40 and part of SP 41. W. J. R. Harries.
ISBN 0 11 884012 6 £3.00

29 The sand and gravel resources of the country south-west of Scunthorpe, Humberside: Resource sheet SE 80.
J. H. Lovell.
ISBN 0 11 884013 4 £3.50

30 Procedure for the assessment of limestone resources.
F. C. Cox, D. McC. Bridge and J. H. Hull.
ISBN 0 11 884030 4 £1.25

31 The sand and gravel resources of the country west of Newark upon Trent, Nottinghamshire: Resource sheet SK 75.
D. Price and P. J. Rogers.
ISBN 0 11 884031 2 £3.50

32 The sand and gravel resources of the country around Sonning and Henley, Berkshire, Oxfordshire and Buckinghamshire: Resource sheet SU 77 and SU 78.
H. C. Squirrell.
ISBN 0 11 884032 0 £5.25

33 The sand and gravel resources of the country north of Gainsborough, Lincolnshire: Resource sheet SK 89.
J. R. Gozzard and D. Price
ISBN 0 11 884033 9 £4.50

34 The sand and gravel resources of the Dengie Peninsula, Essex: Resource sheet TL 90, etc. M. B. Simmons.
ISBN 0 11 884081 9 £5.00

35 The sand and gravel resources of the country around Darvel, Strathclyde: Resource sheet NS 53, 63, etc.
E. F. P. Nickless, A. M. Aitken and A. A. McMillan.
ISBN 0 11 884082 7 £7.00

36 The sand and gravel resources of the country around Southend-on-Sea, Essex: Resource sheets TQ 78, 79 etc. S. E. Hollyer and M. B. Simmons.
ISBN 0 11 884083 5 £7.50

37 The sand and gravel resources of the country around Bawtry, South Yorkshire: Resource sheet SK 69. A. R. Clayton
ISBN 0 11 884053 3 £5.75

38 The sand and gravel resources of the country around Abingdon, Oxfordshire: Resource sheet SU 49, 59, SP 40, 50. C. E. Corser.
ISBN 0 11 884084 5 £5.50

39 The sand and gravel resources of the Blackwater Valley (Aldershot) area: Resource sheet SU 85, 86, parts SU 84, 94, 95, 96. M. R. Clarke, A. J. Dixon and M. Kubala.
ISBN 0 11 884085 1 £7.00

40 The sand and gravel resources of the country west of Darlington, County Durham: Resource sheet NZ 11, 21. A. Smith.
ISBN 0 11 884086 X £5.00

41 The sand and gravel resources of the country around Garmouth, Grampian Region: Resource sheet NJ 36. A. M. Aitken, J. W. Merritt and A. J. Shaw.
ISBN 0 11 884090 8 £8.75

42 The sand and gravel resources of the country around Maidenhead and Marlow: Resource sheet SU 88, parts SU 87, 97, 98. P. N. Dunkley.
ISBN 0 11 884091 6 £5.00

43 The sand and gravel resources of the country around Misterton, Nottinghamshire: Resource sheet SK 79. D. Thomas and D. Price.
ISBN 0 11 884092 4 £5.25

44 The sand and gravel resources of the country around Sedgefield, Durham: Resource sheet NZ 32. M. D. A. Samuel.
ISBN 0 11 884093 2 £5.75

45 The sand and gravel resources of the country around Brampton, Cumbria: Resource sheet NY 55, part 56. I. Jackson.
ISBN 0 11 884094 0 £6.75

46 The sand and gravel resources of the country around Harlow, Essex: Resource sheet TL 41. P. M. Hopson.
ISBN 0 11 884107 6 £9.50

47 The limestone and dolomite resources of the country around Wirksworth, Derbyshire: Resource sheet SK 25, part 35. F. C. Cox and D. J. Harrison.
ISBN 0 11 884108 4 £15.00

48 The sand and gravel resources of the Loddon Valley area: Resource sheet SU 75, 76, parts 64, 65, 66 and 74. M. R. Clarke, E. J. Raynor and R. A. Sobey.
ISBN 0 11 884109 2 £8.75

49 The sand and gravel resources of the country around Lanark, Strathclyde Region: Resource sheet NS 94, part 84. J. L. Laxton and E. F. P. Nickless.
ISBN 0 11 884112 2 £11.00

50 The sand and gravel resources of the country around Fordingbridge, Hampshire: Resource sheet SU 11 and parts of SU 00, 01, 10, 20 and 21. M. Kubala.
ISBN 0 11 884111 4 £7.75

51 The sand and gravel resources of the country north of Bournemouth, Dorset: Resource sheet SU 00, 10, 20, SZ 09, 19 and 29. M. R. Clarke.
ISBN 0 11 884110 6 £9.75

52 The sand and gravel resources of the country between Hatfield Heath and Great Waltham, Essex: Resource sheet TL 51 and 61. R. J. Marks.
ISBN 0 11 884113 0 £8.00

53 The sand and gravel resources of the country around Cottenham, Cambridgeshire: Resource sheet TL 46 and 47. A. J. Dixon.
ISBN 0 11 884114 9 £9.25

54 The sand and gravel resources of the country around Huntingdon and St Ives. Cambridgeshire: Resource sheets TL 16, 17, 26, 27, 36 and 37. R. W. Gatliff.
ISBN 0 11 884115 7 £8.75

55 The sand and gravel resources of the country around Ipswich, Suffolk: Resource sheet TM 14. R. Allender and S. E. Hollyer.
ISBN 0 11 884116 5 £10.00

56 Procedure for the assessment of the conglomerate resources of the Sherwood Sandstone Group. D. P. Piper and P. J. Rogers.
ISBN 0 11 884143 2 £1.25

57 The conglomerate resources of the Sherwood Sandstone Group of the country around Cheadle, Staffordshire: Resource sheet SK 04. P. J. Rogers, D. P. Piper and T. J. Charsley.
ISBN 0 11 884144 0 £7.75

58 The sand and gravel resources of the country west of Peterhead, Grampian Region: Resource sheet NK 04 and parts of NJ 94 and 95, NK 05, 14 and 15. A. A. McMillan and A. M. Aitken.
ISBN 0 11 884145 9 £12.00

59 The sand and gravel resources of the country around Newbury, Berkshire: Resource sheet SU 46 and 57, parts of SU 36, 37 and 47. J. R. Gozzard.
ISBN 0 11 884146 7 £11.50

60 The sand and gravel resources of the country south-west of Peterborough, in Cambridgeshire and east Northamptonshire: Resource sheet TL 09 and 19 and SP 98 and TL 08. A. M. Harrisson.
ISBN 0 11 884147 5 £15.50

61 The sand and gravel resources of the country north of Wrexham, Clwyd: Resource sheet SJ 35 and part of SJ 25. P. N. Dunkley.
ISBN 0 11 884148 3 £11.75

62 The sand and gravel resources of the country around Dolphinton, Strathclyde Region, and West Linton, Borders Region: Resource sheet NT 04 and 14, parts of NT 05 and 15. A. A. McMillan, J. L. Laxton and A. J. Shaw.
ISBN 0 11 884149 1 £8.00

63 The sand and gravel resources of the valley of the Douglas Water, Strathclyde Region: Resource sheet NS 83 and parts of NS 82, 92 and 93. A. J. Shaw and E. F. P. Nickless.
ISBN 0 11 884150 5 £11.50

64 The sand and gravel resources of the country between Wallingford and Goring, Oxfordshire: Resource sheet SU 68 and part of SU 58. C. E. Corser.
ISBN 0 11 884151 3 £11.50

65 The sand and gravel resources of the country around Hexham, Northumberland: Resource sheet NY 86 and 96. J. H. Lovell.
ISBN 0 11 884152 1 £7.50

66 The sand and gravel resources of the country west of Chelmsford, Essex: Resource sheet TL 60. P. M. Hopson.
ISBN 0 11 884153 X £8.50

67 The sand and gravel resources of the country around Hatfield and Cheshunt, Hertfordshire: Resource sheet TL 20 and 30, and parts of TQ 29 and 39. J. R. Gozzard.
ISBN 0 11 884167 X £10.00

68 The sand and gravel resources of the country north-east of Halstead, Essex: Resource sheet TL 83. R. J. Marks and J. W. Merritt.
ISBN 0 11 884168 8 £13.25

69 The sand and gravel resources of the country around Welwyn Garden City. Hertfordshire: Resource sheet TL 11 and 21. J. R. Gozzard.
ISBN 0 11 884169 6 £10.50

70 The sand and gravel resources of the country east of Harrogate, North Yorkshire: Resource sheet SE 35. D. L. Dundas.
ISBN 0 11 884170 7 £15.50

71 The sand and gravel resources of the country around Hemel Hempstead, St Albans and Watford: Resource sheet TL 00, 10, and parts TQ 09, 19.
W. J. R. Harries, S. E. Hollyer and P. M. Hopson.
ISBN 0 11 884171 8 *not yet priced*

72 The sand and gravel resources of the country around Bury St Edmunds Suffolk: Resource sheet TL 86.
M. P. Hawkins.
ISBN 0 11 884172 6 £10.50

73 The sand and gravel resources of the country between Ely and Cambridge, Cambridgeshire: Resource sheet TL 56, 57. A. R. Clayton.
ISBN 0 11 884173 4 £9.50

74 The sand and gravel resources of the country around Blaydon, Tyne and Wear: Resource sheet NZ 06, 16.
J. R. A. Giles.
ISBN 0 11 884174 2 £10.50

75 The sand and gravel resources of the country around Stokesley, North Yorkshire: Resource sheet NZ 40, 50 and parts 41, 51. R. G. Crofts.
ISBN 0 11 884175 0 £11.50

76 The sand and gravel resources of the country around Ellon, Grampian Region: Resource sheets NJ 93 with parts 82, 83, 92, and NK 03 with parts 02, 13. J. W. Merrit.
ISBN 0 11 884176 9 £15.00

77 The limestone and dolomite resoures of the country around Buxton, Derbyshire: Resource sheet SK 07 and parts 06, 08. D. J. Harrison.
ISBN 0 11 884177 7 £13.50

78 The sand and gravel resources of the country west of Boroughbridge, North Yorkshire: Resource sheet SE 36.
D. A. Abraham.
ISBN 0 11 884178 5 £12.75

79 The limestone and dolomite resources of the country around Bakewell, Derbyshire: Resource sheet SK 26 and part 27. D. McC. Bridge and J. R. Gozzard.
ISBN 0 11 884179 3 £10.50

80 The sand and gravel resources of the country between Stamford, Lincolnshire, and Peterborough, Cambridgeshire: Resource sheet TF 00, 10. S. J. Booth.
ISBN 0 11 884180 7 £14.50

81 The sand and gravel resources of the country of the Thames and Thame valleys, the country around Dorchester and Watlington, Oxfordshire: Resource sheet SU 69 and part 59. C. E. Corser.
ISBN 0 11 884204 8 £14.25

82 The sand and gravel resources of the country around Sible Hedingham, Essex: Resource sheet TL 73.
R. J. Marks and D. W. Murray.
ISBN 0 11 884205 6 £10.75

83 The sand and gravel resources of the country around Hollesley, Suffolk: Resource sheet TM 34. S. E. Hollyer and R. Allender.
ISBN 0 11 884206 4 £13.25

84 The sand and gravel resources of the country around Kirk Hammerton, North Yorkshire: Resource sheet SE 45.
J. R. A. Giles.
ISBN 0 11 884207 2 £10.00

85 The sand and gravel resources of the country around Nayland, Suffolk: Resource sheet TL 93. P. M. Hopson.
ISBN 0 11 884208 0 £11.25

86 The sand and gravel resources of the country around Wem, Shropshire: Resource sheet SJ 42, 52. B. Cannell and W. J. R. Harries.
ISBN 0 11 884209 9 £15.50

87 The sand and gravel resources of the country around Ranskill and East Retford, Nottinghamshire: Resource sheet SK 68 and part 78. D. Thomas.
ISBN 0 11 884210 2 £8.50

88 The sand and gravel resources of the country around Tholthorpe, North Yorkshire: Resource sheet SE 46.
R. Stanczyszyn.
ISBN 0 11 884211 0 *not yet priced*

89 The sand and gravel resources of the country around Newport-on-Tay, Fife Region: Resource sheet NO 42 and parts 32, 52. J. L. Laxton and D. L. Ross.
ISBN 0 11 887413 6 £12.75

90 The sand and gravel resources of the country around Shrewsbury, Shropshire: Resource sheet SJ 41, 51.
B. Cannell.
ISBN 0 11 884213 7 £17.00

91 The conglomerate resources of the Sherwood Sandstone Group of the country east of Stoke-on-Trent, Staffordshire: Resource sheet SJ 94. D. Piper.
ISBN 0 11 884214 5 *not yet priced*

92 The sand and gravel resources of the country around Armthorpe, South Yorkshire: Resource sheet SE 60.
D. Price and D. P. Best.
ISBN 0 11 884215 3 £10.00

93 The sand and gravel resources of the country aound Whittlesey, Cambridgeshire: Resource sheet TF 20, TL 29.
S. J. Booth.
ISBN 0 11 884216 1 £12.50

94 The sand and gravel resources of the country north and west of Woodhall Spa, Lincolnshire: Resource sheet TF 16 and part 17. I. Jackson.
ISBN 0 11 884217 X £14.75

95 The sand and gravel resources of the country around Biggar, Strathclyde Region: Resource sheet NS 93, NT 03, and parts NS 92, NT 02. A. J. Shaw and J. W. Merritt.
ISBN 0 11 887414 4 £15.00

96 The sand and gravel resources of the country around Potter Hanworth and Reepham, Lincolnshire: Resource sheet TF 06, 07. R. G. Crofts.
ISBN 0 11 884216 6 £9.75

97 The sand and gravel resources of the country around Clare, Suffolk: Resource sheet TL 74. R. Marks.
ISBN 0 11 884297 8 £10.00

98 The limestone and dolomite resources of the country around Tideswell, Derbyshire: Resource sheet SK 17 and parts 18, 27. R. W. Gatliff.
ISBN 0 11 884298 6

99 The sand and gravel resources of the country north and west of Billingham, Cleveland: Resource sheet NZ 42 and part 52. J. W. C. James.
ISBN 0 11 884299 4 £10.50

100 The sand and gravel resources of the country around Billinghay, Lincolnshire: Resource sheet TF 15 and part 05.
J. B. L. Wild.
ISBN 0 11 884300 1 £13.75

101 The sand and gravel resources of the country around Glenrothes, Fife Region: Resource sheet NO 20 and parts 21, 30, 31. A. M. Aitken.
ISBN 0 11 8847415 2 £15.00

102 The sand and gravel resources of the country around Coggeshall, Essex: Resource sheet TL 82. S. J. Booth and J. W. Merritt.
ISBN 0 11 887416 0 £16.00

103 The sand and gravel resources of the country between Dorchester and Wareham, Dorset: Resource sheets comprising parts of SY 68, 69, 78, 79, 88, 89, 98, 99.
S. J. Mathers.
ISBN 0 11 884303 6 £17.00

104 The sand and gravel resources of the country around Stansted Mountfitchet, Essex: Resource sheet TL 52.
P. M. Hopson.
ISBN 0 11 884304 4 £11.75

105 The sand and gravel resources of the Welshampton area, Shropshire and Clwyd: Resource sheet SJ 43.
S. J. Mathers and A. C. Wilson.
ISBN 0 11 884305 2 *not yet priced*

106 The sand and gravel resources of the country south of Wrexham, Clwyd: Resource sheet SJ 34, and part 24.
D. F. Ball.
ISBN 0 11 884306 0 £11.00

107 The sand and gravel resources of the country between Rugby and Northampton, Warwickshire and Northamptonshire: Resource sheet SP 66 and parts 56, 57, 65, 67, 75 and 76.
M. R. Clarke and E. R. Moczarski.
ISBN 0 11 884307 9 £20.00

108 The sand and gravel resources of the country south of Horncastle, Lincolnshire: Resource sheet TF 26.
G. Power and J. B. L. Wild.
ISBN 0 11 884308 7 £9.75

109 The sand and gravel resources of the country around Great Dunmow, Essex: Resource sheet TL 62.
C. W. Thomas.
ISBN 0 11 884309 5 £12.75

110 The sand and gravel resources of the country north of Newmarket, Cambridgeshire and Suffolk: Resource sheet TL 67 and part 66. C. E. Corser.
ISBN 0 11 884310 9 £14.50

111 The sand and gravel resources of the country east and south-east of Darlington, Durham: Resource sheet NZ 30, 31. J. R. Gozzard and D. Price.
ISBN 0 11 884311 7 £14.25

112 The sand and gravel resources of the country around Hertford, Hertfordshire: Resource sheet TL 31.
P. M. Hopson and M. D. A. Samuel.
ISBN 0 11 884312 5 £11.75

113 The sand and gravel resources of the country around Mold, Clwyd: Resource sheet SJ 26 and part 16.
D. F. Ball and K. A. McL. Adlam.
ISBN 0 11 884313 3 £12.00

114 The sand and gravel resources of the country around Kettering and Wellingborough, Northamptonshire: Resource sheets SP 86, 96, and SP 97 and parts of SP 87, TF 07.
A. M. Harrison.
ISBN 0 11 884314 1 *not yet priced*

115 The sand and gravel resources of the country east of Solihull, Warwickshire: Resource sheet comprising parts of SP 17, 18, 27, 28.
B. Cannell.
ISBN 0 11 884315 X £10.75

Reports of the Institute of Geological Sciences

Other Reports

69/9 Sand and gravel resources of the Inner Moray Firth.
A. L. Harris and J. D. Peacock.
ISBN 0 11 880106 6 35p

70/4 Sands and gravels of the southern counties of Scotland.
G. A. Goodlet.
ISBN 0 11 880105 8 90p

72/8 The use and resources of moulding sand in Northern Ireland. R. A. Old.
ISBN 0 11 881594 0 30p

73/9 The superficial deposits of the Firth of Clyde and its sea lochs. C. E. Deegan, R. Kirby, I. Rae and R. Floyd.
ISBN 0 11 880617 3 95p

77/1 Sources of aggregate in Northern Ireland (2nd edition).
I. B. Cameron.
ISBN 0 11 881279 3 70p

77/2 Sand and gravel resources of the Grampian Region.
J. D. Peacock and others.
ISBN 0 11 881282 3 80p

77/5 Sand and gravel resources of the Fife Region.
M. A. E. Browne.
ISBN 0 11 884004 5 60p

77/6 Sand and gravel resources of the Tayside Region.
I. B. Paterson.
ISBN 0 11 884008 8 £1.40

77/8 Sand and gravel resources of the Strathclyde Region.
I. B. Cameron and others.
ISBN 0 11 884028 2 £2.50

77/9 Sand and gravel resources of the Central Region, Scotland. M. A. E. Browne.
ISBN 0 11 884016 9 £1.35

77/19 Sand and gravel resources of the Borders Region, Scotland. A. D. McAdam.
ISBN 0 11 884025 8 £1.00

77/22 Sand and gravel resources of the Dumfries and Galloway Region of Scotland. I. B. Cameron.
ISBN 0 11 884021 5 £1.20

78/1 Sand and gravels of the Lothian Region of Scotland.
A. D. McAdam.
ISBN 0 11 884042 8 £1.00

78/8 Sand and gravel resources of the Highland Region.
W. Mykura, D. L. Ross and F. May.
ISBN 0 11 884050 9 £3.00

Dd. 717413 K8

Printed in England for Her Majesty's Stationery Office
by Commercial Colour Press, London E7

INSTITUTE OF GEOLOGICAL SCIENCES

INDUSTRIAL MINERALS ASSESSMENT UNIT

THE SAND AND GRAVEL RESOURCES OF THE COUNTRY AROUND MOLD, CLWYD

ORDNANCE SURVEY

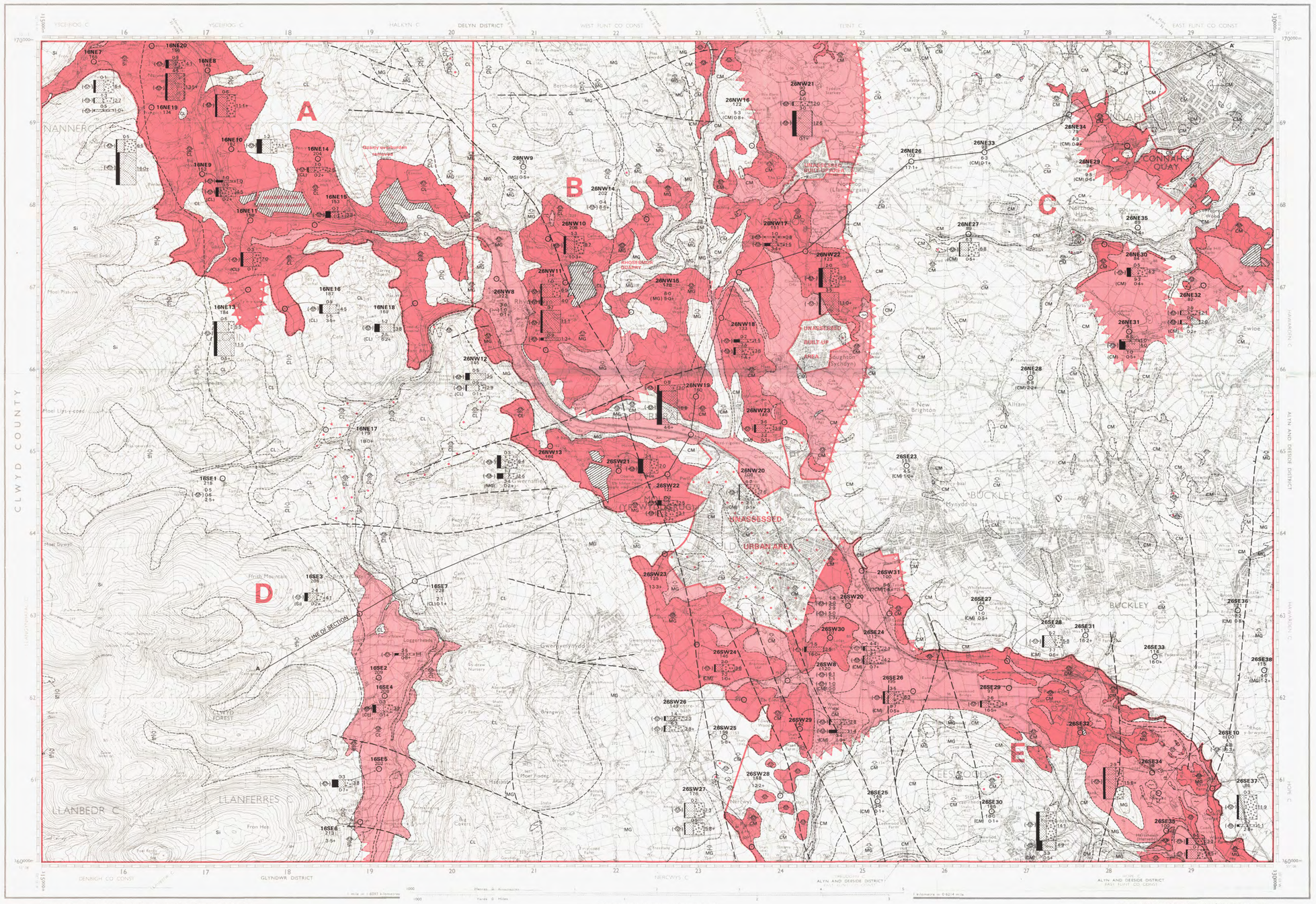
Scale 1:25 000 Second Series

SHEET SJ 26 & Part of SJ 16

THE SAND AND GRAVEL RESOURCES OF THE COUNTRY AROUND MOLD (SHEET SJ26 AND PART OF SJ16)

113

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



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

Surface heights are to the nearest metre above mean sea level.

Contour values are in metres

Compiled from 1:10 560 or 1:10 000 scale maps last revised 1964-71
Boundaries revised 1975
Major roads revised 1973-75

Made and published by the Director General of the Ordnance Survey, Southampton

© Crown Copyright **1982**

Geological survey on the six-inch scale by A. Strahan in 1879-81. Resurveyed in part by C.B. Wood, W.B.R. King, G.W. Lamplugh (District Geologist) and H.H. Thomas in 1910-13. Solid Boundaries revised by D. Lowe in 1980 (I.P. Stevenson, District Geologist).

Sand and Gravel Survey by K.A. McL. Adlam and D.F. Ball in 1978-9. R.G. Thurrell, Head, Industrial Minerals Assessment Unit.

1:25 000 Sand and Gravel Resource Sheet published 1982.
G.M. Brown F.R.S., Director, Institute of Geological Sciences, incorporating the Geological Survey of Great Britain, the Museum of Practical Geology and Overseas Geological Surveys.

EXPLANATION OF SYMBOLS AND ABBREVIATIONS

DRIFT

RECENT AND PLEISTOCENE

- **Peat** P-1
- **Alluvium** – sandy clay A-67
- **Terrace** – clayey sand and gravel T-5
- **Glacial Sand and Gravel** – sand and sandy gravel GS-23
- **Boulder Clay** – stony red and grey clays BC-42

SOLID

CARBONIFEROUS, SILURIAN

- CM **Coal Measures** – mudstones and sandstones with coal seams
- MG **Millstone Grit 'Series'** – sandstones and mudstones
- CL **Carboniferous Limestone 'Series'** – limestones, sandy limestones, calcareous mudstones and siltstones and sandstones
- Si **Undivided** – roughly cleaved mudstones with thin sandstones

Areas from which sand and gravel has been removed WO-18

Made ground MG-2

BOUNDARY LINES

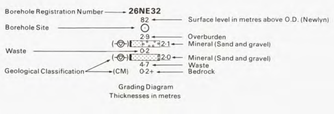
- Geological boundary, Drift
- Geological boundary, Solid
- Fault, crossmark indicates downthrow side
- Inferred boundary between recognised categories of deposits
- Resource Block boundary

Broken line denotes uncertainty

BOREHOLE DATA
SITE LOCATIONS

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

I.M.A.U. BOREHOLES



Note:
(i) Figures underlined denote thicknesses used in the assessment of resources.
(ii) The + sign indicates that the base of the deposit was not reached.
(iii) The 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. **26NE32**. The first figure and the letters refer to the quarter sheet and the second figure to the I.G.S. serial number for that quarter. The unique designation for borehole **26NE32** is **SJ 26NE32**.

Grading Diagrams

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

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

OTHER BOREHOLES

The layout of information is the same as for I.M.A.U. boreholes, although data available may not be as comprehensive. They are registered in either the same series or in an N.C.B. series.

CATEGORIES OF DEPOSITS

- **Exposed mineral, assessed** CAT-E2
- **Continuous 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

RESOURCE BLOCKS

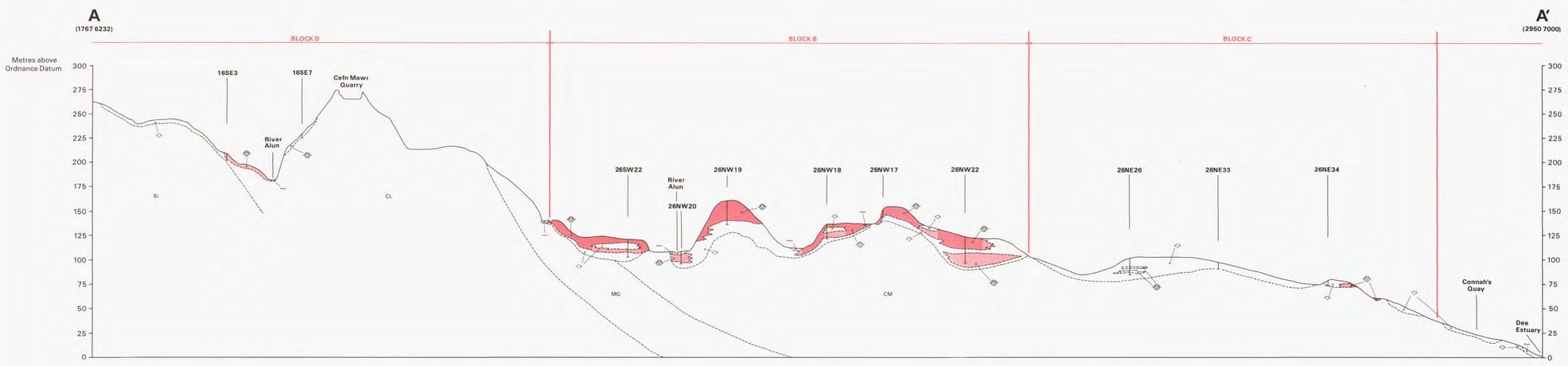
For the purpose of assessment, the mineral is divided into Resource Blocks (see Report). Each is designated by a letter.

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

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.

GENERALISED HORIZONTAL SECTION SHOWING RELATIONSHIPS OF THE DRIFT DEPOSITS

Horizontal scale 1:25 000 Vertical exaggeration x 10



SJ17	SJ27	SJ37
SJ16	SJ26	SJ36
		108 121
SJ15	SJ25	SJ35

Diagram showing the relation of this sheet with the National Grid 10-km squares and the One Inch New Series Geological Sheets 108 and 121

Produced for the Institute of Geological Sciences by Engineering Surveys Reproduction Ltd.
Printed by Impact Litho (Tolworth) 1981.