

## The sand and gravel resources of the country north of Wrexham, Clwyd

Description of 1:25 000 resource sheet SJ 35 and part of SJ 25

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The first twelve reports on the assessment of British sand and gravel resources appeared in the Report series of the Institute of Geological Sciences as a subseries. Report 13 and subsequent reports appear as Mineral Assessment Reports of the Institute.

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

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The asterisk on the cover indicates that parts of sheets adjacent to the one cited are described in this report.

## PREFACE

National resources of many industrial minerals may seem so large that stocktaking appears unnecessary, but the demand for minerals and for land for all purposes is intensifying and it has 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 co-operation of the Sand and Gravel Association of Great Britain.

This report describes the resources of sand and gravel of 130 km<sup>2</sup> of the country north of Wrexham, Clwyd, shown on the accompanying 1 : 25 000 resource map SJ35 and part of SJ25. The survey was carried out by D. F. Ball, A. R. Clayton, R. G. Crofts, P. N. Dunkley, W. J. R. Harries and R. Stanczyszyn. The work is based on a geological survey at 1 : 10 560 in 1881–82 by A. Strahan and 1910–13 by W. B. R. King, G. W. Lamplugh, H. H. Thomas and L. J. Wills. Drift lines were amended in 1978 by R. J. Tappin and D. J. Lowe; the latter also amended the solid geological lines and contributed the account of the solid geology. Access to land for drilling was negotiated by C. L. Reeves. The ready co-operation of landowners, tenants and sand and gravel operators is gratefully acknowledged.

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1 March 1981

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The sand and gravel resources of sheet SJ 35 and part of SJ 25, north of Wrexham, Clywd *in pocket*

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# The sand and gravel resources of the country north of Wrexham, Clwyd

Description of 1 : 25 000 resource sheet SJ 35 and part of SJ 25

P. N. DUNKLEY

## SUMMARY

The geological maps of the Institute of Geological Sciences and 96 boreholes drilled for the Industrial Minerals Assessment Unit (IMAU) form the basis of the assessment of sand and gravel resources in the district to the north of Wrexham, Clwyd.

The 1 : 25 000 map includes three resource blocks containing between 13.7 and 18.7 km<sup>2</sup> of potentially workable sand and gravel. The geology of the deposits is described and the mineral-bearing area, the mean thickness of overburden and mineral, and the mean grading of the mineral are stated. Detailed borehole data are given. The geology, the position of the boreholes and the outlines of the resource blocks are shown on the accompanying map.

## Note

National Grid references in this publication all lie within 100-km square SJ.

## Bibliographical reference

DUNKLEY, P. N. 1981. The sand and gravel resources of the country north of Wrexham, Clwyd: description of 1:25000 sheet SJ 35 and part of SJ 25. *Miner. Assess. Rep. Inst. Geol. Sci.*, No. 61.

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## INTRODUCTION

The survey is concerned with the estimation of resources, which include deposits that are not currently exploitable but have a foreseeable use, rather than reserves, which can only be assessed in the light of current, locally prevailing, economic considerations. Clearly, both the economic and social factors used to decide whether a deposit may be workable in the future cannot be precluded; they are likely to change with time. Deposits not currently economically workable may be exploited as demand increases, as higher grade or alternative materials become scarce, or as improved processing techniques are applied to them. The improved knowledge of the main physical properties of the resource and their variability which this survey seeks to provide, will add significantly to the factual background against which planning policies can be decided (Archer, 1969; Thurrell, 1971; Harris and others, 1974).

This survey provides information both at the *indicated* and the *inferred* level. In the former "tonnage and grade are computed partly from specific measurements, samples or production data and partly from projection for a reasonable distance of geologic evidence. The sites available for inspection, measurement, and sampling are too widely or otherwise inappropriately spaced to permit the mineral bodies to be outlined completely or the grade established throughout."

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

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

- a The deposit should average at least 1 m in thickness.
- b The ratio of overburden to sand and gravel should be no more than 3 : 1.
- c The proportion of fines (particles passing the No. 240 mesh BS sieve, about  $\frac{1}{16}$  mm) should not exceed 40 per cent.
- d The deposit is assessed to a depth of 25 m only, even though some of the deposit has been worked to greater depths. It follows from the second criterion that boreholes are drilled no deeper than 18 m if no sand and gravel is proved.

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

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

The volume and other characteristics are assessed within resource blocks. No account is taken of any factors, for example, roads, villages and 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 the mineral in parts of a block, except in the immediate vicinity of the actual sample points.

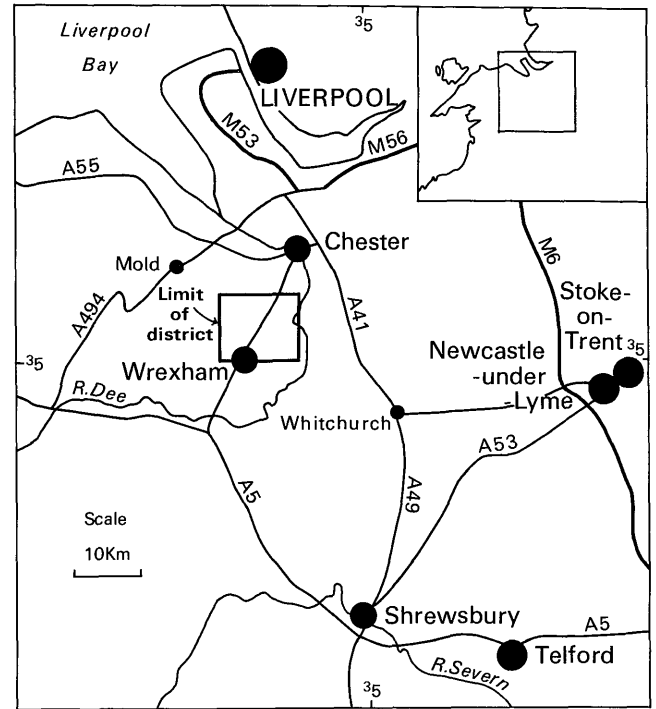


Figure 1 Regional map showing location of the district

### DESCRIPTION OF THE DISTRICT

The district occupies 130 km<sup>2</sup> of country to the north of Wrexham, Clwyd (Figures 1 and 2). It has a mixed economy of light industry, agriculture and brewing, and

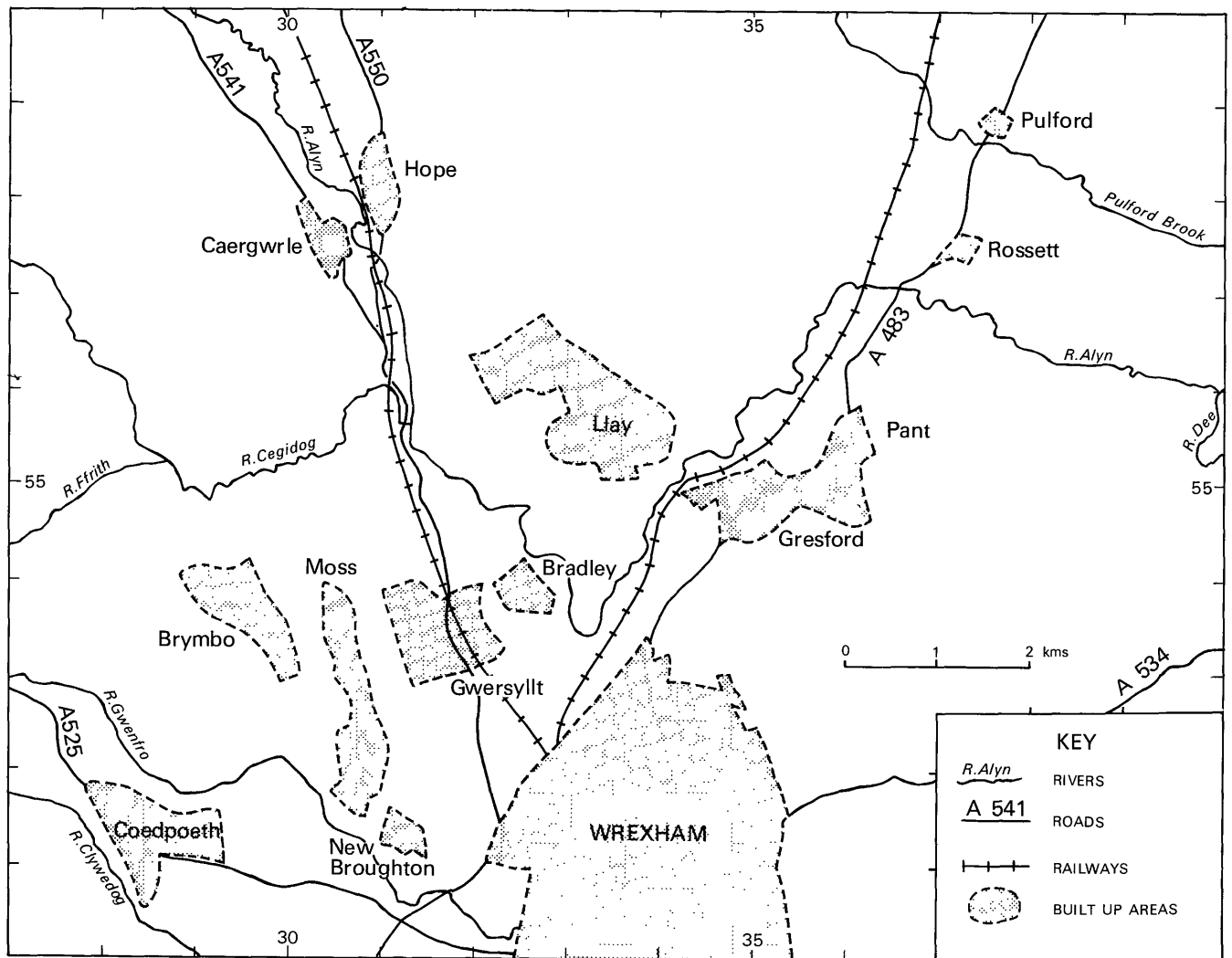


Figure 2 Locality map of the district

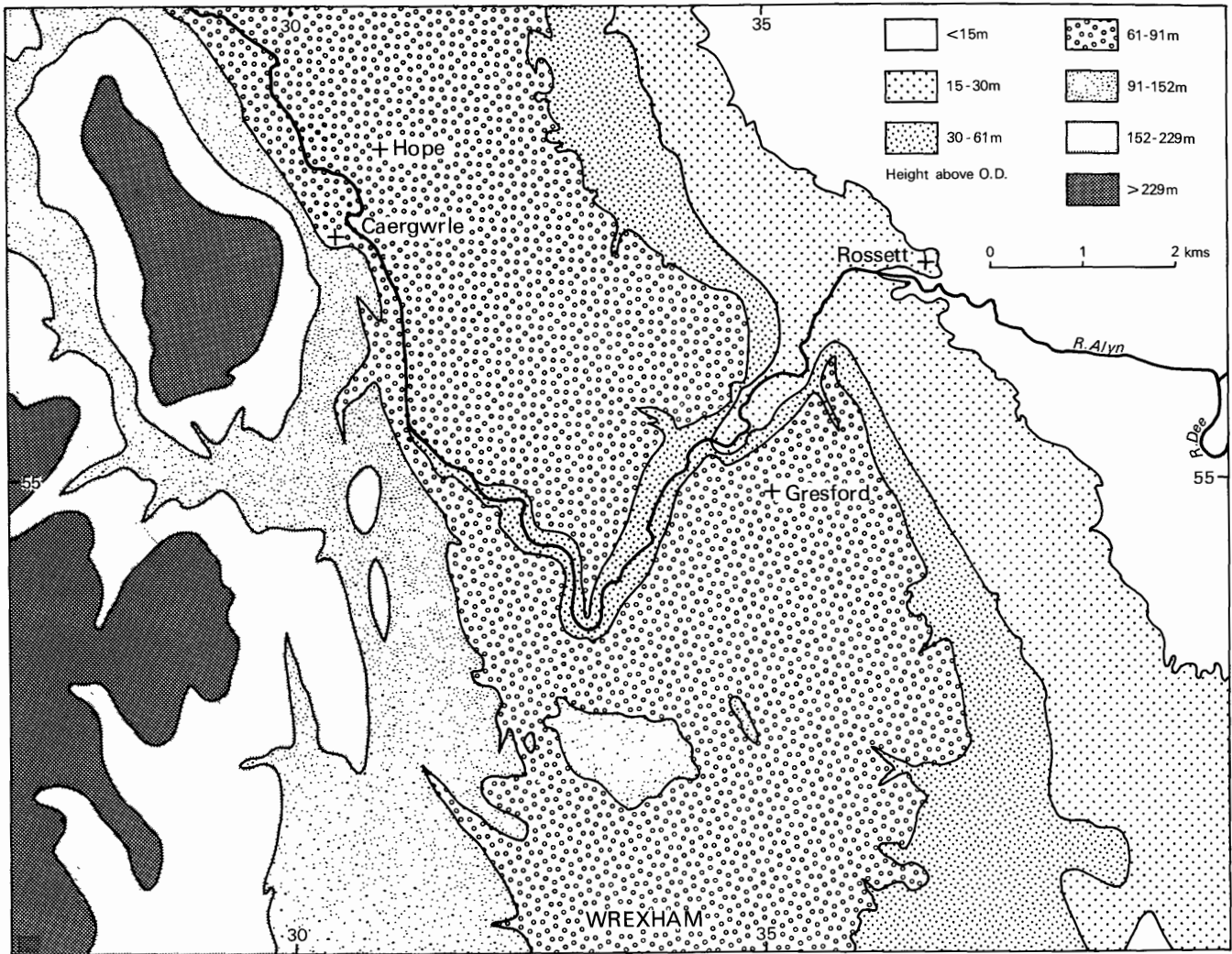


Figure 3 Topography of the district

was an important coal-mining area. Within the district there are extensive fluvio-glacial sand and gravel deposits which are an important source of aggregate, and it is estimated that in the past approximately 25 million m<sup>3</sup> has been extracted.

**TOPOGRAPHY**

The highest ground occurs in the west (Figure 3), reaching 350 m above OD on the flanks of Esclusham Mountain [270 505] and 330 m on Hope Mountain [295 569]. Eastwards there is a decrease in height, with the lowest ground occurring south-east of Rossett [365 571] on the floodplain of the rivers Alyn and Dee.

The topography can generally be divided into three broad belts, each trending north-north-west to south-south-east across the district. The highest ground in the west is hilly and dissected by steep-sided valleys of the easterly-flowing rivers Alyn, Cegidog, Ffrith and Gwenfro, and is characterised by exposure of solid rock, with superficial deposits generally confined to the valleys. The hilly country gives way in the central part of the district to a gently undulating terrace feature composed mainly of thick glacial sands and gravels. This terrace is dissected into two parts by the incised valley of the River Alyn, and it slopes gently eastwards from a height of about 90 m in the west to less than 70 m along its eastern edge where it terminates abruptly in an escarpment. This escarpment slopes eastwards down onto the Cheshire Plain, where the ground is low lying, poorly drained, and covered by thick boulder-clay deposits and alluvium.

**GEOLOGY**

The district was surveyed partly on the scale of six inches to one mile by A. Strahan in 1881 and 1882. The remainder was surveyed on the six-inch scale between 1910 and 1913 by W. B. R. King, G. W. Lamplugh, H. H. Thomas and L. J. Wills. The results of these surveys were published on the New Series one-inch geological sheet 108 (Flint) and its accompanying memoir (Wedd and King, 1924), sheet 109 (Chester), sheet 121 (Wrexham) and its memoir (Wedd and others, 1927, 1928) and sheet 122 (Nantwich) and its memoir (Poole and Whiteman, 1966). During the course of the present survey, drift lines were amended by D. J. Lowe and R. J. Tappin.

**SOLID**

For the purpose of this report and the accompanying map the solid rock succession is divided into four broad units (Table 1). In chronological order these are Carboniferous Limestone 'Series', Millstone Grit 'Series', Coal Measures and Lower Mottled Sandstone; the term 'Series' is used as recommended by Holland and others (1978, p. 3). The succession generally strikes north-south and dips to the east, the youngest rocks cropping out in the east of the area. The rocks are extensively faulted, the major fault trend varying between north-south and north-north-west to south-south-east. Less common fault trends are north-north-east to south-south-west, north-west to south-east and east-west. The major dislocation belt of the Llanellidan (Bala) Fault is exceptional in

**Table 1** Classification of the solid and drift deposits

DRIFT
<b>Recent and Pleistocene</b>
Peat
Alluvium
River Terrace Deposits (undifferentiated)
Boulder Clay
Glacial Sand and Gravel (including Glacial Silt)
Boulder Clay
SOLID
<b>Permo-Triassic</b>
Lower Mottled Sandstone
<b>Carboniferous</b>
Coal Measures (Westphalian)
Millstone Grit 'Series' (Namurian)
Carboniferous Limestone 'Series' (Viséan)

trending north-east to south-west and comprises a number of sub-parallel normal fractures and minor thrusts locally accompanied by severe overfolding.

*Carboniferous Limestone 'Series' (Viséan):* Rocks belonging to this 'Series' crop out north of the Llanelidan Fault towards the west of the district and in the south-west. A variable sequence of grey sparry limestones and sandy limestones, with intercalations of calcareous mudstone, calcareous siltstone and quartzitic sandstone, passes upwards into a more arenaceous facies, the lower part of the Cefn-y-Fedw Sandstone, which includes pebbly sandstone, secondary quartzite, variable mudstone and highly silicified chert-like siltstone.

*Millstone Grit 'Series' (Namurian):* This 'Series' is represented by two lithologically distinct but laterally equivalent facies, the Holywell Shale in the north and the upper part of the Cefn-y-Fedw Sandstone to the south. The Holywell Shale consists of dark marine mudstones with intercalations of felspathic sandstone and impure limestone, and is overlain by the fine-grained and well-bedded Gwespyr Sandstone. That part of the Cefn-y-Fedw Sandstone attributed to the Millstone Grit 'Series' consists of quartzitic sandstones with subordinate siltstone and mudstone. The highest sandstone within this sequence, the Aquaduct Grit, is correlated with the Gwespyr Sandstone, both of which are overlain by beds containing the *subcrenatum* Marine Band, marking the base of the Coal Measures.

*Coal Measures (Westphalian):* The Coal Measures of the district can be divided into three broad parts, Lower, Middle and Upper. The Lower Coal Measures, between the *subcrenatum* and *vanderbeckei* (Llay) marine bands, consists of predominantly dark mudstone, with quartzitic sandstone, coal seams and associated seatearths.

The Middle Coal Measures, above the *vanderbeckei* Marine Band and below the *aegiranum* (Warras) Marine Band, contains mainly dark mudstone and subordinate sandstone in its lower part, with a much greater proportion of thick siltstone and sandstone beds towards the top. Coal seams and seatearths occur throughout.

The Upper Coal Measures, above the *aegiranum* Marine Band, resemble the Middle Coal Measures, but with fewer coal seams. The typical grey measures of this area pass upwards into the Ruabon Marl, a red facies equivalent to grey beds developed at this horizon elsewhere, which consists of red, green and purple marl with

thin *Spirorbis* limestone bands. The base of the Ruabon Marl is diachronous. Above the Ruabon Marl is a series of greenish white calcareous sandstones, red marls and ostracod limestones which together comprise the Coedyr-allt Formation. These beds are followed, with apparent overstep, by the Erbistock Formation, composed of purple and red sandstones, marls, conglomerates and breccias, with thin impure limestones and coal seams.

*Lower Mottled Sandstone (Permo-Triassic):* The Lower Mottled Sandstone, consisting almost entirely of soft red-brown cross-bedded sandstone, crops out in the east of the district and lies unconformably upon the Carboniferous.

#### DRIFT

The superficial deposits consist of glacial deposits and post-glacial river terrace deposits, alluvium and peat (Figure 4). Relationships between these deposits are complex.

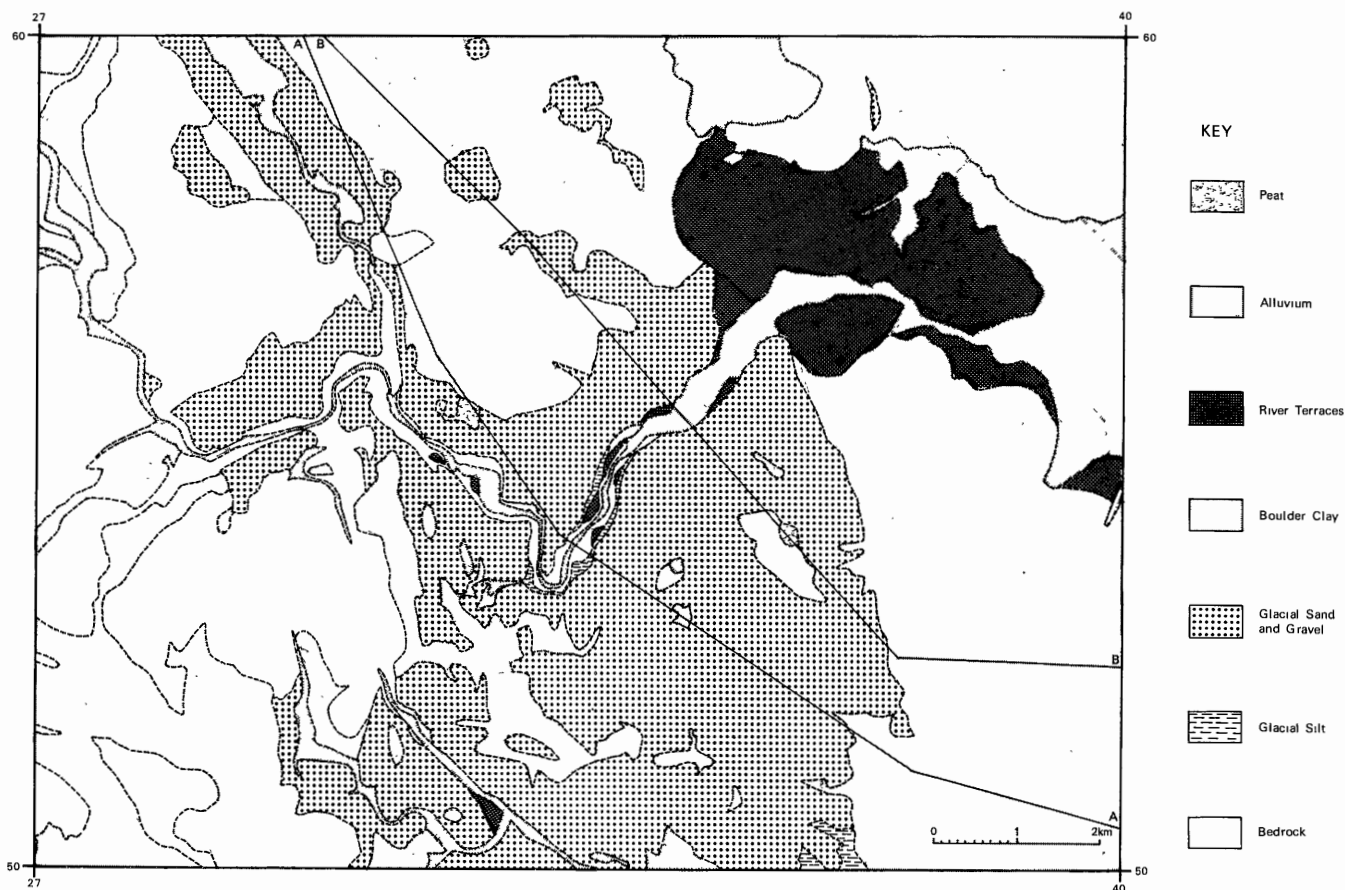
*Boulder Clay:* There are three distinctive boulder clays in the district, each having a different relationship with the glacial sand and gravel deposits.

In the east there is a broad expanse of boulder clay upon the Cheshire Plain. This boulder clay consists of reddish brown massive silty calcareous clays with gleyed streaks and in places is poorly laminated and contains intercalations of laminated silts and fine sands, as seen in borehole 35 NE 34. It contains few stones, but those that do occur are of quartzite, limestone, sandstone, igneous rocks (including granite) and coal, together with rare flint and comminuted shells. Although it is believed that this boulder clay represents a till deposited by Irish Sea Ice (Poole and Whiteman, 1961), its relatively stoneless nature led Wedd and Smith (1928) to suggest that in parts it might be lacustrine in origin. The relationship of the deposit to the Glacial Sand and Gravel has been a source of controversy (Poole, in discussion of Peake, 1961). The present survey suggests that the Glacial Sand and Gravel generally overlies this boulder clay, as indicated by borehole information and the mapped boundary between the two deposits. However there is some evidence for interdigitation of the two deposits in the south-east, in boreholes 35 SE 30 and 31 (Figure 5).

In the south-west there is a second area of boulder clay. This varies in colour from greyish green to ochreous brown. It is sandy and stony with the majority of clasts consisting of quartzose sandstones derived locally from Carboniferous rocks. The recorded thickness of this deposit varies from less than a metre to over 18 m and, although it is generally considered to be a till, the thinner deposits on the steeper slopes may be the product of solifluction. The relationship of this boulder clay to the Glacial Sand and Gravel is complex. Boreholes 35 SW 39 and 40 indicate that it overlies the sand and gravel, whereas boreholes 35 SW 36 and 37 show that it also occurs intercalated within, and beneath the latter deposit.

To the north of Llay [333 555] there is a lobate area of boulder clay that overlies the Glacial Sand and Gravel, as proved in boreholes 35 NW 33, 38 and 43. This boulder clay is reddish brown, very stony and sandy, with impersistent lenses of sand. The stones consist of quartzite, limestone and igneous rocks, and are similar to those found in the underlying gravels. This boulder clay is believed to represent a till deposited by a re-advance of the Irish Sea Ice (Peake, 1961).





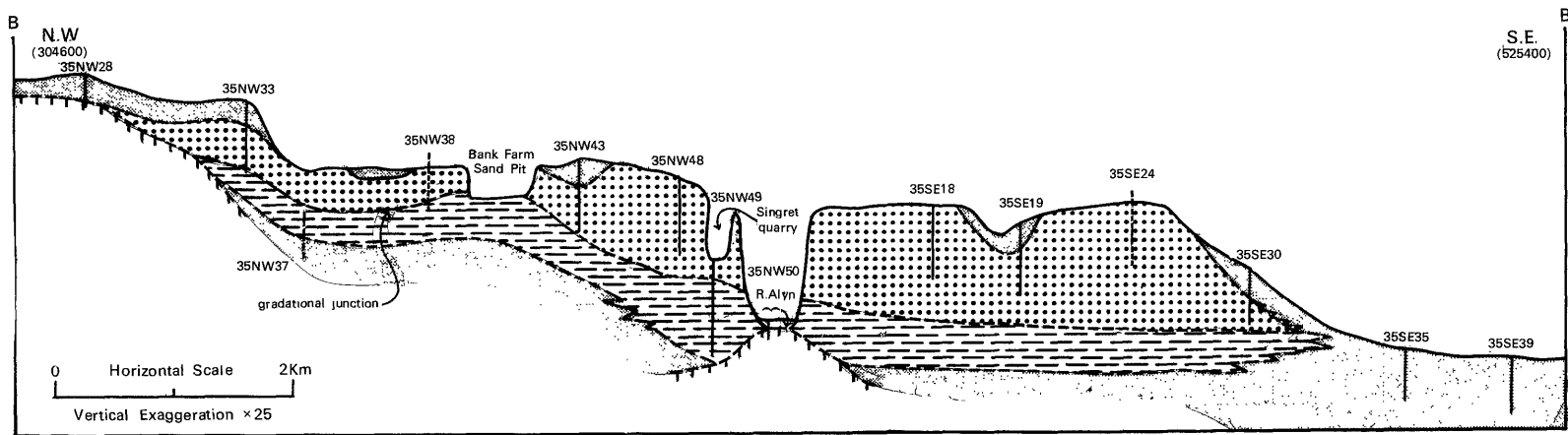
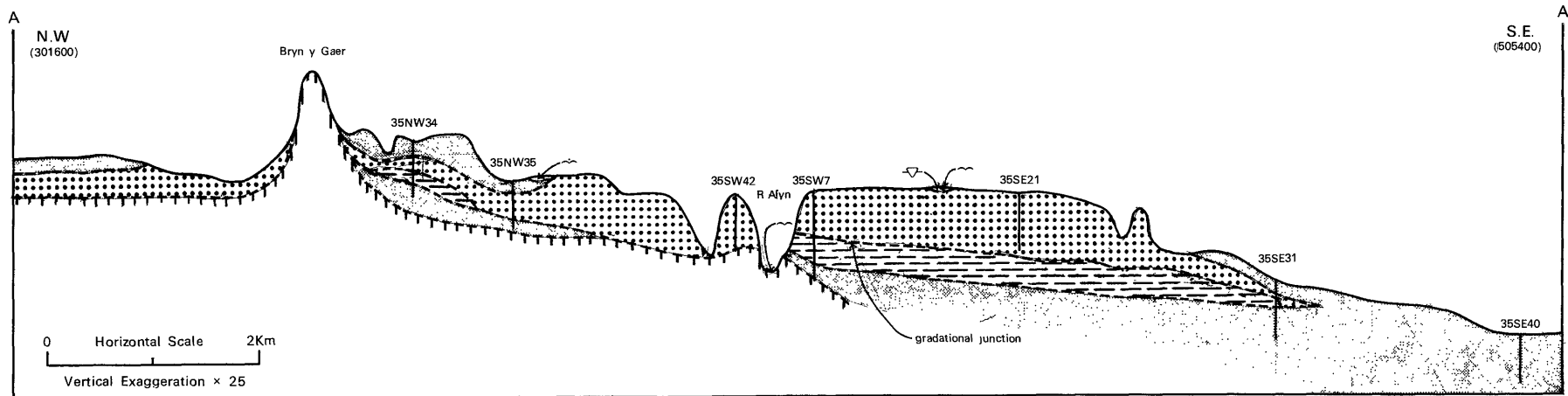
**Figure 4** Geological map of the superficial deposits

**Glacial Sand and Gravel:** The Glacial Sand and Gravel occurs in a broad belt trending south-south-east to north-north-west across the central part of the district. The deposits give rise to a terrace or platform, sloping gently eastwards. This is dissected by the River Alyn and terminated abruptly along its eastern margin by an escarpment which slopes eastwards down onto the Cheshire Plain. Upon the surface of this terrace there are kettle holes and at Gwersyllt Park [323 536] there is an esker (Worsley, 1970).

The Glacial Sand and Gravel deposits form part of a complex train which extends to the north and south of the district, although within the district they are approximately fan-like in form. The deposits are bedded and cross-bedded (Plate 1), and generally dip to the east, north-east and south-east at 5 to 15°, although locally dips may exceed 20°. The orientation of cross-bedding indicates that palaeocurrent directions were generally towards the east, north-east and south-east (Figure 6), fanning from a westerly source. In the northern part of the fan, palaeocurrent directions are mainly towards the north-east. In the central parts they are mainly towards the east and north-east, with minor directions towards the south-east. In the south, palaeocurrent directions are mainly towards the east, south-east and south. Grain-size and facies distribution also indicate a westerly source. The deposits fine from west to east, with the gravels generally occurring in the feeder valleys and in the central and western parts of the fan, whereas fine sands occur in more distal parts to the north-east and south-east (Figure 7). The deposits also exhibit an overall coarsening-upwards sequence, and they contain numerous small-scale post-depositional folds, faults and slump structures.

In the more proximal and central parts of the fan the deposits consist of complexly interbedded and laterally variable sands and gravels with subordinate silts and clays. These sands and gravels exhibit large- and small-scale trough and planar cross-bedding, with ripple drift cross-lamination in the finer sands. The gravels occur mainly as broadly planar sheets and lenses interbedded with sands. The sheets range from a few centimetres to several metres in thickness; they are cross-bedded internally and exhibit variable sorting, packing, clast fabrics and commonly pebble imbrication. Sheets of poorly sorted pebbly sand and sandy clays also occur, in which pebbles and mud clasts are supported in matrices of sand and sandy clay. Locally the bedded sands and gravels are cut by strongly discordant steep-sided channels filled with poorly sorted gravels; these are well developed at Singret Sand Pit [345 558] (Plate 2).

In the central and more proximal parts of the fan the deposits become finer with depth and the lower parts of the sequence are composed mainly of well-sorted sands. Several boreholes (Figure 5) indicate that these sands also become finer with depth, grading into silts and clays. In borehole 35NW 49 for example, the sand and gravel deposits grade downwards into a thick sequence of fine clayey sands, laminated silts and varved clays with thin interbedded boulder clays. Around Pont-y-Capel [336 542] and Big Wood [368 501] these finer deposits at the base of the glacial sands and gravels have been mapped separately as *Glacial Silt*. The lateral extent of these silts and clays is uncertain because many of the boreholes did not bottom the overlying sands and gravels. However, they are not continuous because borehole 35NW 35 proved sand and gravel resting directly upon boulder clay with no intervening silts.



**Figure 5** Schematic cross-sections through the superficial deposits of the district

The lines of section are shown in Figure 4. Boreholes lying on the line of section are represented by vertical solid lines; boreholes projected onto the line of section are represented by vertical dashed lines



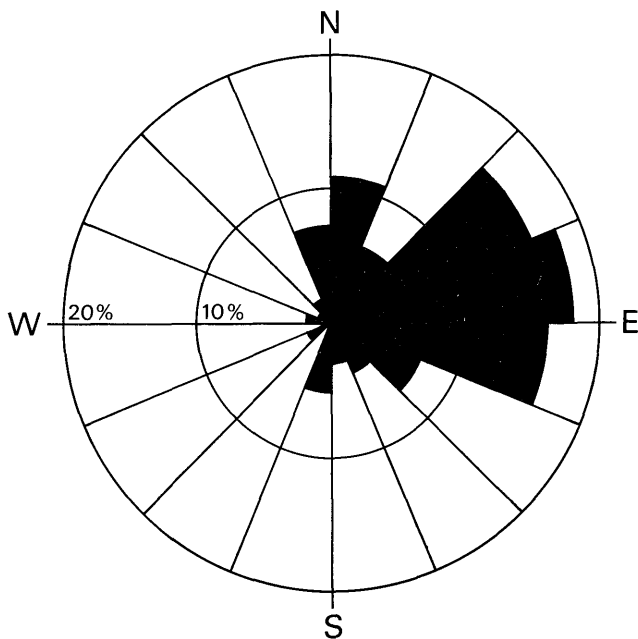
**Plate 1** Singret Sand Pit [345 558].  
Cross-bedded easterly-dipping sands  
and gravels unconformably overlain by  
poorly bedded horizontal gravels.  
L 1690



**Plate 2** Singret Sand Pit [345 558].  
Gravel-filled channels. L 1692



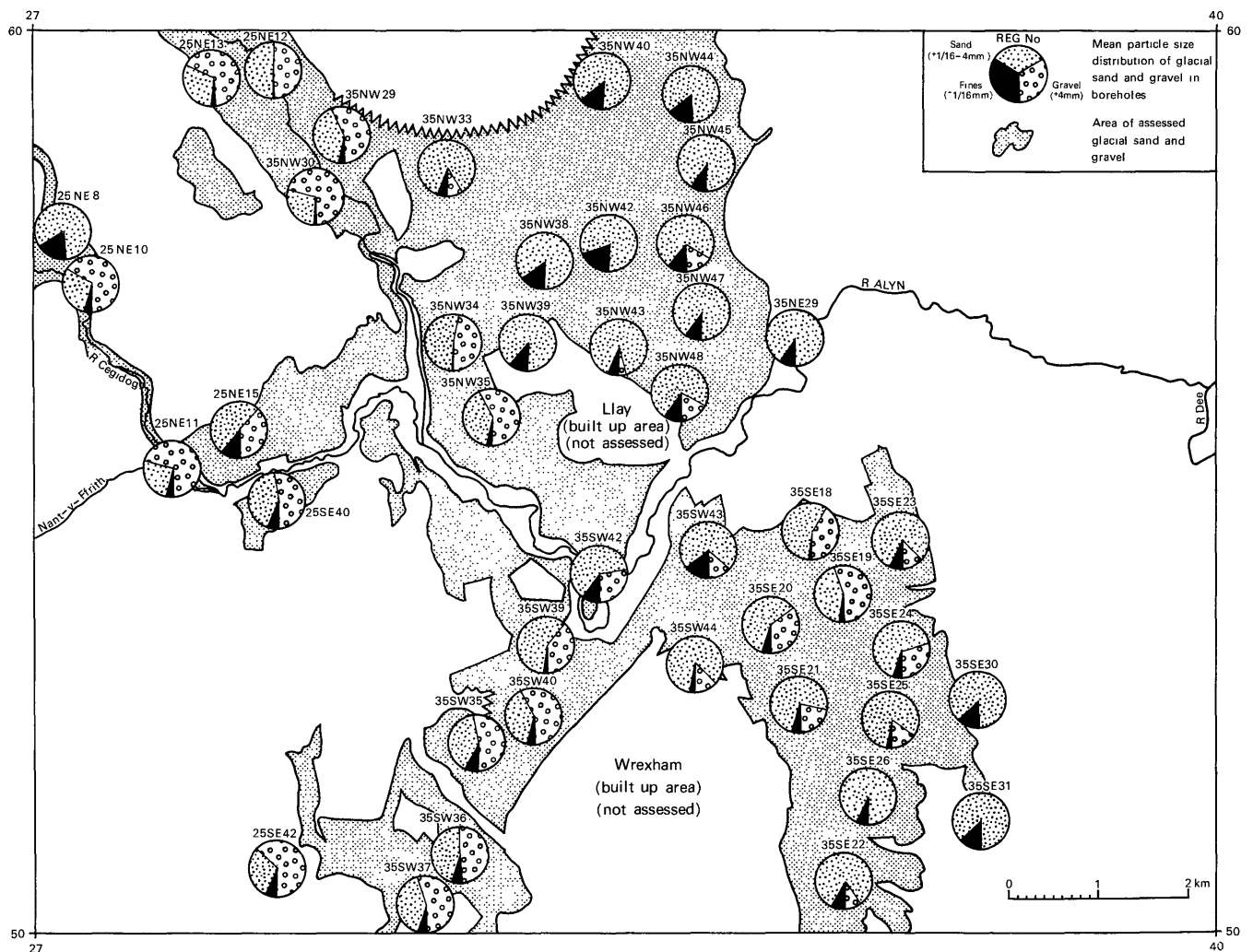
**Plate 3** Bank Farm Sand Pit [332 572].  
Gently inclined fine laminated distal  
sands, silts and clays. L 1699



**Figure 6** Diagram showing palaeocurrent directions within the Glacial Sand and Gravel

In the distal areas of the fan the deposits consist of well-sorted fine sands with interbedded silts and clays, as seen at Bank Farm Sand Pit [332 572] (Plate 3) in the north-east and at Llan-y-pwll Sand Pit [365 517] in the south-east. The deposits are well-bedded and, in contrast to the proximal areas, the beds are much more laterally extensive and dip at low angles. These finer deposits are cyclic in nature. They contain cycles of the order of a metre in thickness which, where fully developed, commence with a basal zone of planar-bedded sands passing up into low-angle planar cross-bedded sands, which in turn pass up into a zone of ripple drift cross-laminated sands with sinusoidal ripples; these are overlain by complexly trough cross-bedded sands with laminated silts and clays at the top of the cycle. Interbedded with these cycles, there are beds of the order of a metre in thickness, composed of high-angle planar cross-bedded and trough cross-bedded sands.

Two models have been proposed to explain the origin of the Glacial Sand and Gravel deposits. Peake (1961) believes they represent deltaic sediments deposited in a narrow ice-dammed lake between the hills in the west and a retreating Irish Sea ice sheet on the Cheshire Plain in the east. In contrast, Francis (1978) suggests that they are subaerial alluvial fan deposits. Interpretations from the present survey support the alluvial fan model. The gravels and sands of the central and western parts of the fan exhibit features consistent with deposition by



**Figure 7** Particle size distribution of the Glacial Sand and Gravel

proximal braided streams, whereas the cyclic sand and silt sequences in the eastern parts of the fan are interpreted as distal flood deposits (cf. McKee and others, 1967). However, the well-bedded fine sands, silts and clays occurring beneath the sands and gravels of the fan are interpreted as having been deposited in standing water. In view of the general fining from west to east and with depth in the deposits, it is concluded that as the alluvial fan developed it prograded eastwards over the finer silts and clays that were deposited in standing water.

In many places the bedded sands and gravels of the fan are unconformably overlain by a sub-horizontal sheet of variably sorted, poorly bedded and cross-bedded gravel (Plate 1). The unconformity is strongly disconformable and the top surface of the underlying bedded sands and gravels has been planed off. In the quarries at Singret [344 560] and Fagl Lane [300 586] there are lenses of lodgement till at the base of this upper gravel sheet, and where these occur, the immediately underlying bedded sands and gravels are deformed by low-angle shears. This upper gravel sheet is laterally extensive and ranges in thickness from about 3 to 10 m, thickening and coarsening towards the north where it gives rise to kame features, as seen in the Alyn Valley around the Fagl Lane quarry. It is exposed also in quarries at Borrás airfield [360 524], Marford [358 560], Pant [355 555], Balls Wood [347 565], Singret [344 560], in all the disused quarries to the south-west of Llay [335 555], and at Gwersyllt Park [318 543]. From its general characteristics and its association with a basal till, it is suggested that this upper gravel may represent outwash deposits associated with ice of the Llay re-advance, which overrode and eroded the bedded sands and gravels of the alluvial fan and deposited a till in the north of the district.

*River Terrace Deposits:* The most extensive terraces occur in the north-east of the area, associated with the River Alyn. They are cut in boulder clay and their deposits are thin and impersistent, consisting of gravels and gravelly clays.

*Alluvium:* Alluvium is found in all river valleys, although the most extensive areas occur on the floodplain of the rivers Alyn and Dee around Trefalun Meadows [398 566]. The deposits are variable and include gravels, clayey gravels, clayey sands and laminated sands and silts.

*Peat:* Small patches of peat occur on boulder clay at a locality to the south of Marford [360 540] and on glacial sand and gravel at a locality near Round Wood [321 555].

#### COMPOSITION OF THE SAND AND GRAVEL DEPOSITS

In the valleys to the west and in the western parts of the fan the Glacial Sand and Gravel consists mainly of gravel and sandy gravel. The gravel content decreases eastwards and in the more distal parts of the fan, in the north-east and south-east, the deposit consists mainly of sand (Figure 7). The proportion of fines averages 7%, with a highest recorded value of 18%.

The gravel is composed predominantly of pebbles and cobbles of quartzite, with limestone and igneous rocks, and some quartz, sandstone, siltstone, chert, ironstone and coal. Additionally there are traces of flint and metamorphic rocks. The quartzites consist mainly of white to

buff strongly cemented quartzose sandstones derived from the Millstone Grit and Coal Measures. Hard greyish green indurated greywacke sandstone is also an important constituent and is presumably derived from Silurian rocks to the west. The igneous material consists mainly of volcanics, of which a high proportion is rhyolitic, although basic volcanics and dolerite are also common. There is also a small but consistent fraction of porphyritic intermediate volcanics and coarse-grained granites, which sometimes occur as large cobbles. Most of the volcanic detritus was probably derived from the Ordovician rocks of North Wales. However, the porphyritic intermediate volcanic material is more akin to the Borrowdale Volcanic Group of the Lake District, and this, together with the occurrence of coarse-grained granite clasts, suggests that ice from a northerly source also played a role in the genesis of the deposit. Although the metamorphic material is only a trace constituent, it sometimes occurs as large cobbles and includes quartzofeldspathic gneisses and mica schists.

The composition of the sand fraction varies with grain size. There is an increase in quartz content with decreasing grain size, accompanied by a corresponding decrease in the lithic content. The coarse sand is composed of angular to subangular lithic grains with some subangular to subrounded quartz grains and a trace of coal. The medium sand consists of subrounded to rounded quartz grains with lithic and coal grains, whereas the fine sand is subangular to angular and is composed predominantly of quartz with some lithic grains and a trace of coal, white mica and magnetite. The lithic sand grains are mainly of quartzite and volcanics. Limestone is rare in the coarse sand and absent in the medium and fine sand. Although coal is generally a minor constituent of the sand, it often occurs locally in high concentrations. Most commonly it is concentrated in small lenses in the troughs of current ripples, although it also occurs concentrated in planar beds ranging up to about 20 cm in thickness.

#### 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 : 25000 Outline Edition in grey, on which the topography is shown by contours in green, the geological data in black and the mineral resource information in shades of red.

*Geological data:* The geological boundary lines and symbols shown are taken from geological maps of this area, which was surveyed at the scale 1 : 10 560. Borehole data, which include the stratigraphical relationships and mean particle size of the sand and gravel samples collected during the resource survey, are also shown.

The geological boundaries show the best interpretation of the information available at the time of the survey. However, it is inevitable, particularly with glacial deposits which change rapidly vertically and laterally, that local irregularities or discrepancies may occur.

*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 where it is present in continuous (or almost continuous) and discontinuous spreads beneath overburden. The mineral is identified as 'exposed' where the overburden, commonly consisting of soil and subsoil, averages less than 1.0 m in thickness.

Beneath overburden the mineral may be continuous (or almost continuous) or discontinuous. The mineral is described as 'almost continuous' if it is present in 75% or more of the boreholes in a resource block.

Areas where bedrock crops out, where boreholes indicate the 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. In such areas it is assumed that mineral is absent, except in infrequent and relatively minor patches which cannot be outlined or 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 exposed sand and gravel is measured from the mapped geological boundary lines. The whole of this area is considered as mineral, although it may include small areas where sand and gravel is not present or is not potentially workable. Inferred boundaries have been inserted where sand and gravel beneath cover is interpreted to be not potentially workable or absent. Such boundaries (for which a distinctive symbol is used) are drawn primarily for the purpose of volume estimation. The symbol is intended to convey an approximate location for the boundary, and for the purpose of measuring areas the centre-line of the symbol is used.

## RESULTS

The results of the assessment are summarised in Table 2. Fuller grading results are given in Figures 8 and 9.

A high proportion of the assessment boreholes did not 'bottom' the glacial sand and gravel deposits. Therefore the average thickness of mineral is likely to be greater than the mean thickness calculated from the borehole information. Consequently, estimates of the mineral volume (which are based on the mean thickness proved in the boreholes) are likely to be conservative.

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

## NOTES ON THE RESOURCE BLOCKS

The district's mineral consists of Glacial Sand and Gravel, River Terrace Deposits and Alluvium. The Glacial Sand and Gravel is assessed in Blocks A and B and the River Terrace Deposits and Alluvium in Block C.

The block boundaries are determined as far as possible by geological considerations.

### Block A

This block is situated in the northern half of the area and is bounded along its southern margin by the valleys of the rivers Alyn and Cegidog. It extends over an area of 19.1 km<sup>2</sup>, of which 18.7 km<sup>2</sup> is mineral bearing.

The assessment of resources is based on information from 24 IMAU boreholes (Table 3), three of which did not prove mineral; a further 7 did not 'bottom' the deposit. The proved thickness of mineral ranges from 1.4 m in borehole 35 NW 44 to over 21.5 m in borehole 25 NE 12, and the mean proved thickness is 10.6 m. From this mean proved thickness it is estimated that the volume of mineral is at least 187 million m<sup>3</sup> (after subtraction of 11 million m<sup>3</sup> estimated to have been removed from worked areas). The overburden, consisting of boulder clay and soil, ranges in thickness from 0.2 m in boreholes 35 SW 42 and 35 NW 42 to 11.5 m in borehole 35 NW 46, and has a mean thickness of 4.2 m.

The grading results (Table 3 and Figure 8) indicate a range from 'clayey' sand to gravel, with an overall coarsening from east to west across the block. The fines content ranges from 1% in boreholes 25 NE 12, 35 NW 30 and 35 NW 34, to 18% in borehole 35 NW 42. The sand content ranges from 27% in borehole 25 NE 11 to 85% in borehole 35 NW 38. The gravel content ranges from nil in boreholes 35 NW 38 and 35 NW 42, to 71% in borehole 35 NW 30. The mean grading for the block is fines 9%, sand 63% and gravel 28%.

### Block B

This block is confined to the south of the River Alyn around the built-up area of Wrexham; it covers an area of 17.6 km<sup>2</sup> of which 17.4 km<sup>2</sup> is mineral bearing.

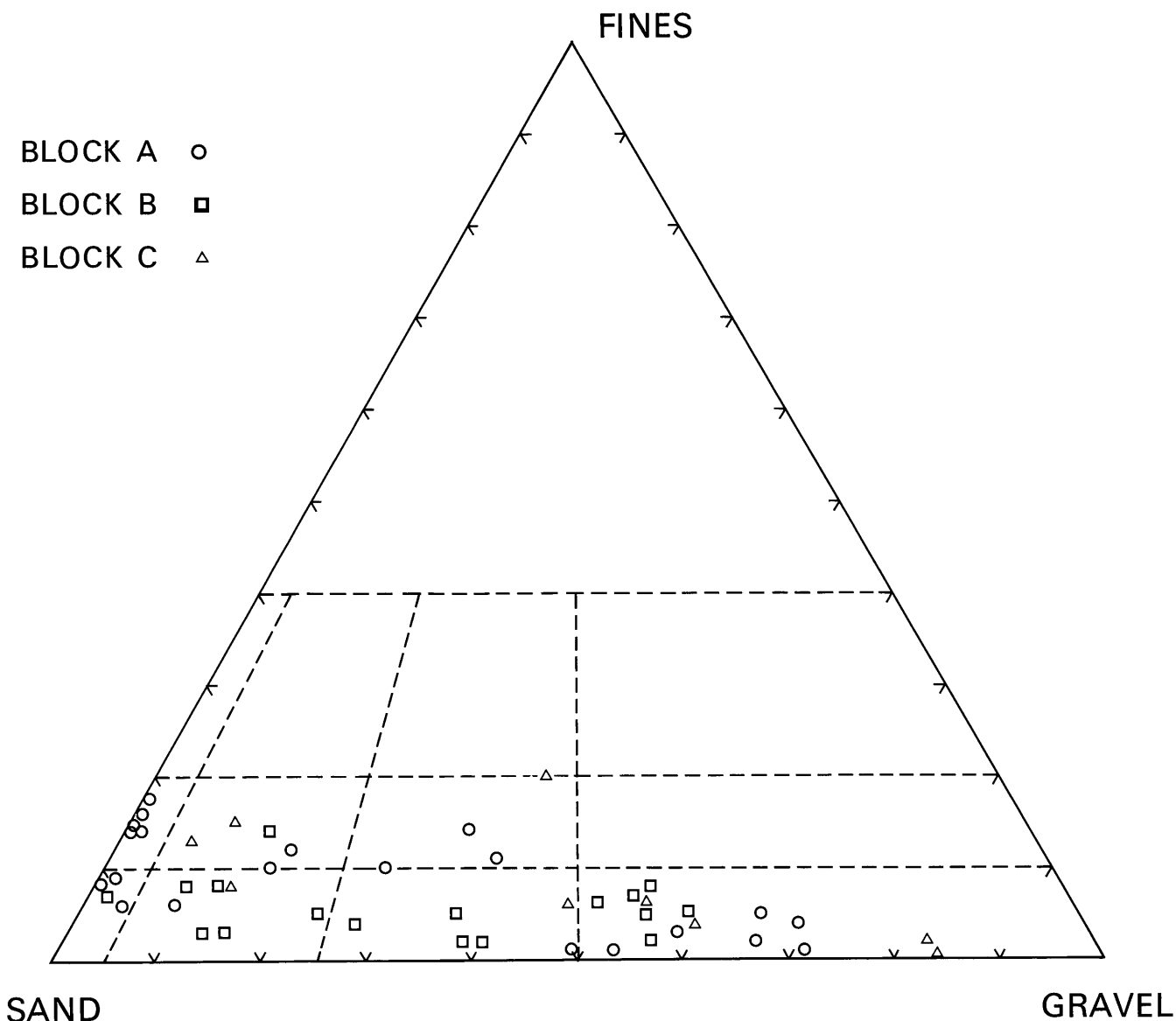
The assessment of resources is based upon 18 IMAU boreholes (Table 4). One borehole did not prove mineral and 12 others did not 'bottom' the mineral deposit. The thickness of mineral proved in the boreholes ranges from 9.9 m in borehole 35 SW 37 to over 24.8 m in borehole 35 SE 22, and the mean proved thickness is 18.5 m. However, because 12 of the boreholes did not 'bottom' the mineral, the actual mean thickness is likely to be greater. From the mean proved thickness it is estimated that the volume of mineral is at least 319 million m<sup>3</sup> (after subtraction of 3 million m<sup>3</sup> estimated to have been removed from worked areas). The overburden, consisting of soil and boulder clay, ranges in thickness from 0.2 m to 9.9 m and has a mean thickness of 1.8 m.

The grading results indicate a range in classification from sand through to gravel (Figure 8), with an overall coarsening from east to west. The fines content ranges from 2% in borehole 35 SE 18 to 15% in borehole 35 SW 43; the sand content ranges from 37% in borehole

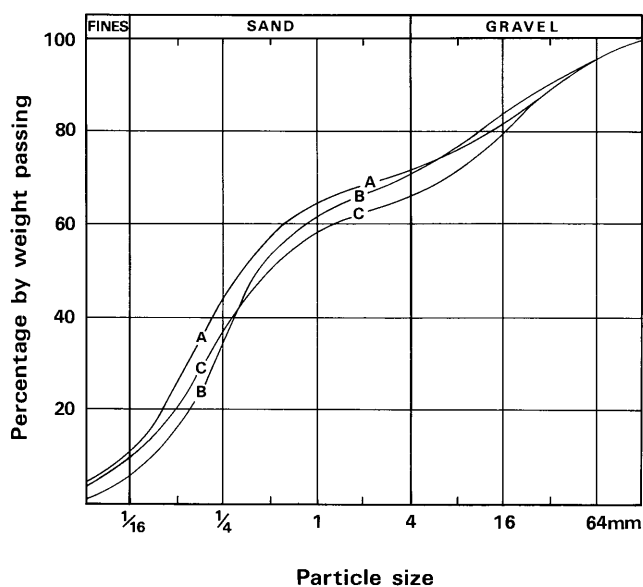
**Table 2** Summary of results

Block	Area		Mean thickness		Estimated minimum volume of mineral m <sup>3</sup> × 10 <sup>6</sup>	Mean grading percentage		
	Block km <sup>2</sup>	Mineral km <sup>2</sup>	Overburden m	Mineral m		Fines - 1/16 mm	Sand + 1/16-4 mm	Gravel + 4 mm
A	19.1	18.7	4.2	10.6	187*	9	63	28
B	17.6	17.4	1.8	18.5	319*	6	65	29
C	13.7	13.7	2.0	2.4	33	8	58	34

\* These figures exclude the volume of material already excavated from workings (see Appendix B)



**Figure 8** Grading characteristics of the sand and gravel in the resource blocks  
 Each point represents the mean grading of samples from an individual assessment borehole. The dotted lines represent boundaries of the fields of the descriptive categories used in the classification of sand and gravel, as shown in Figure 10



**Figure 9** Particle size distribution for the mineral in the resource blocks

35 SW 40 to 91% in borehole 35 SE 26, and the gravel content ranges from 2% in borehole 35 SE 26 to 58% in borehole 35 SW 40. The mean grading for the block is fines 6%, sand 65% and gravel 29%.

**Block C**

This block is confined to the north-east of the district. It covers an area of 13.7 km<sup>2</sup> consisting of river terrace and alluvial deposits of the rivers Alyn and Dee. Since the deposits are impersistent an inferred assessment is made. The assessment is based on 16 IMAU boreholes, 6 of which did not prove mineral (Table 5). The thickness of mineral where present ranges from 1.1 m in borehole 35 NE 36 to 8.5 m in borehole 35 NE 31. The mean thickness of mineral is 2.4 m. It is inferred that the volume of mineral is 33 million m<sup>3</sup>. The thickness of overburden ranges from 0.2 m in boreholes 35 NW 50, 35 NE 27 and 35 SE 37 to 4.0 m in borehole 35 NE 31, with a mean thickness of 2.0 m.

The grading results (Table 5 and Figure 8) indicate a range in classification from 'clayey' pebbly sand through to gravel. The fines content ranges from nil in borehole

**Table 3** Data from IMAU boreholes: Block A

Borehole	Recorded thickness		Mean grading percentage						
	Mineral	Overburden	Fines	Fine sand	Medium sand	Coarse sand	Fine gravel	Coarse gravel	Cobbles
			$-\frac{1}{16}$ mm	$+\frac{1}{16}-\frac{1}{4}$ mm	$+\frac{1}{4}-1$ mm	$+1-4$ mm	$+4-16$ mm	$+16-64$ mm	$+64$ mm
m	m								
<b>SJ 25</b>									
NE 8	19.8+	5.2	16	54	28	1	0	0	1
NE 9	17.0+	7.0	5	4	10	16	24	28	13
NE 11	14.4	3.4	4	3	7	17	24	37	8
NE 12	21.5+	2.5	1	8	29	13	19	23	7
NE 13	4.3	1.8	2	3	16	13	22	35	9
NE 15	15.2	3.6	11	32	13	7	9	21	7
<b>SJ 35</b>									
NW 29	8.3+	5.1	14	32	11	10	14	16	3
NW 30	10.0	5.1	1	2	13	13	28	35	8
NW 31	absent								
NW 33	16.0	7.5	9	50	34	1	2	4	0
NW 34	4.4	5.5	1	3	25	18	21	31	1
NW 35	9.8	4.2	3	11	18	10	18	24	16
NW 37	absent								
NW 38	11.3	4.9	15	81	4	0	0	0	0
NW 40	5.5	0.8	14	76	8	0	0	2	0
NW 41	absent								
NW 42	6.0	0.2	18	77	5	0	0	0	0
NW 43	16.2+	8.8	6	60	26	4	3	1	0
NW 44	1.4	0.7	14	37	46	2	1	0	0
NW 45	14.7+	5.3	9	60	31	0	0	0	0
NW 46	3.7	11.5	10	42	26	6	7	9	0
NW 47	13.1	2.1	9	44	44	1	1	1	0
NW 48	21.1+	2.8	12	37	28	6	6	10	1
SW 42	19.6	0.2	10	37	20	6	10	15	2

Plus sign indicates that the base of the mineral was not reached

**Table 4** Data from IMAU boreholes: Block B

Borehole	Recorded thickness		Mean grading percentage						
	Mineral	Overburden	Fines	Fine sand	Medium sand	Coarse sand	Fine gravel	Coarse gravel	Cobbles
			$-\frac{1}{16}$ mm	$+\frac{1}{16}-\frac{1}{4}$ mm	$+\frac{1}{4}-1$ mm	$+1-4$ mm	$+4-16$ mm	$+16-64$ mm	$+64$ mm
m	m								
<b>SJ 25</b>									
SE 40	17.9	0.8	7	23	7	11	20	25	7
<b>SJ 35</b>									
SW 32	absent								
SW 35	15.6	1.0	8	13	15	11	16	25	12
SW 36	14.7	1.5	6	15	20	10	13	22	14
SW 37	9.9	2.7	5	11	16	14	20	27	7
SW 39	21.1+	3.9	2	17	32	11	17	17	4
SW 40	16.0+	3.9	5	13	12	12	25	27	6
SW 43	24.0+	1.0	15	54	13	5	6	5	2
SW 44	18.5+	0.5	3	36	42	6	6	6	1
SE 18	24.0+	1.0	2	15	33	10	21	18	1
SE 19	15.1+	9.9	2	8	26	11	23	28	2
SE 20	18.5	0.5	5	13	31	15	20	14	2
SE 21	23.8+	0.2	5	32	35	5	9	11	3
SE 22	24.8+	0.2	8	45	35	3	4	5	0
SE 23	20.3+	0.2	8	35	41	4	6	6	0
SE 24	22.5+	0.2	4	19	43	7	13	13	0
SE 25	23.5+	1.5	3	24	52	6	8	7	1
SE 26	23.2+	1.8	7	43	47	1	1	1	0

Plus sign indicates that the base of the mineral was not reached



**Table 5** Data from IMAU boreholes: Block C

Borehole	Recorded thickness		Mean grading percentage						
	Mineral	Overburden	Fines - $\frac{1}{16}$ mm	Fine sand $+\frac{1}{16}$ - $\frac{1}{4}$ mm	Medium sand $+\frac{1}{4}$ -1 mm	Coarse sand +1-4 mm	Fine gravel +4-16 mm	Coarse gravel +16-64 mm	Cobbles +64 mm
	m	m							
<b>SJ 35</b>									
NW 50	3.3	0.2	13	68	7	3	7	2	0
NE 27	1.9	0.2	20	13	20	10	24	13	0
NE 28	2.2	0.3	missing data						
NE 29	8.0	1.0	8	43	34	2	3	6	4
NE 31	8.5	4.0	5	22	19	8	29	11	6
NE 32	3.2	0.3	4	8	15	14	17	42	0
NE 33	absent								
NE 36	1.1	1.0	2	1	5	10	22	48	12
NE 37	absent								
NE 39	2.3	3.9	0	1	6	9	33	40	11
NE 40	absent								
NE 41	absent								
NE 42	absent								
NE 44	absent								
NE 45	5.3	9.0	15	49	23	3	4	4	2
SE 37	2.7	0.2	6	8	21	12	30	23	0

35 NE 39 to 20% in borehole 35 NE 27. The sand content ranges from 16% in boreholes 35 NE 36 and 35 NE 39 to 79% in borehole 35 NE 29. The gravel content ranges

from 9% in borehole 35 NW 50 to 84% in borehole 35 NE 39. The mean grading for the block is fines 8%, sand 58% and gravel 34%.

## 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. As far as possible the block boundaries are determined by geological boundaries so that, for example, glacial and river terrace gravels are separated. Otherwise division is by arbitrary lines, which may bear no relationship to the geology.

A reconnaissance of the ground is carried out to record any exposures and inquiries are made to ascertain what borehole information is available. Borehole sites are then selected to provide an even pattern of sample points at a density of approximately one per square kilometre. However, because broad trends are independently overlain by small-scale characteristically random variations, it is unnecessary to adhere to a square grid pattern. Thus such factors as ease of access and the need to minimise disturbance to land and the public are taken into account in siting the holes; at the same time it is necessary to guard against the possibility that ease of access (that is, the positions of roads and farms) may reflect particular geological conditions, which may bias the drilling results.

The drilling machine employed should be capable of providing a continuous sample representative of all unconsolidated deposits, so that the in-situ grading can be determined, if necessary, to a depth of 30 m (100 ft) at a diameter of about 200 mm (8 in), beneath different types of overburden. It should be reliable, quiet, mobile and relatively small (so that it can be moved to sites of difficult access). Shell-and-auger rigs have proved to be almost ideal.

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

A continuous series of bulk samples is taken throughout the sand and gravel. Ideally samples are composed exclusively of the whole of the material encountered in the borehole between stated depths. However, care is taken to discard, as far as possible, material which has caved or has been pumped from the bottom of the hole. A new sample is commenced whenever there is an appreciable lithological change within the sand and gravel, or at every 1 m (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 British Standard 1377 (1967). Random checks on the accuracy of the grading are made in the Institute's laboratories.

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

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

## APPENDIX B

### ESTIMATION OF RESOURCES

The volume estimate for the mineral in each block has been made by multiplying the sampled area of the block by the mean of the thicknesses of mineral proved at individual sample points (including sample points where mineral was proved to be absent), and deducting from this product the volume estimated to have been removed from sand and gravel quarries. Since many of the assessment boreholes did not reach the base of the mineral, the volume quoted represents a conservative estimate.

The mineral-bearing 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 the 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 areas are small relative to those in thickness.

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; such an assessment is based on geological and topographical information supported usually by extrapolation from nearby boreholes or exposures.

No assessment is attempted for an isolated area of mineral less than 0.25 km<sup>2</sup>.

## APPENDIX C

### CLASSIFICATION AND DESCRIPTION OF SAND AND GRAVEL

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

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

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

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

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

Thus it is possible to classify the mineral into one of twelve descriptive categories (see Figure 10). The procedure is as follows:

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

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

Many differing proposals exist for the classification of the grain size of sediments (Atterberg, 1905; Udden, 1914;

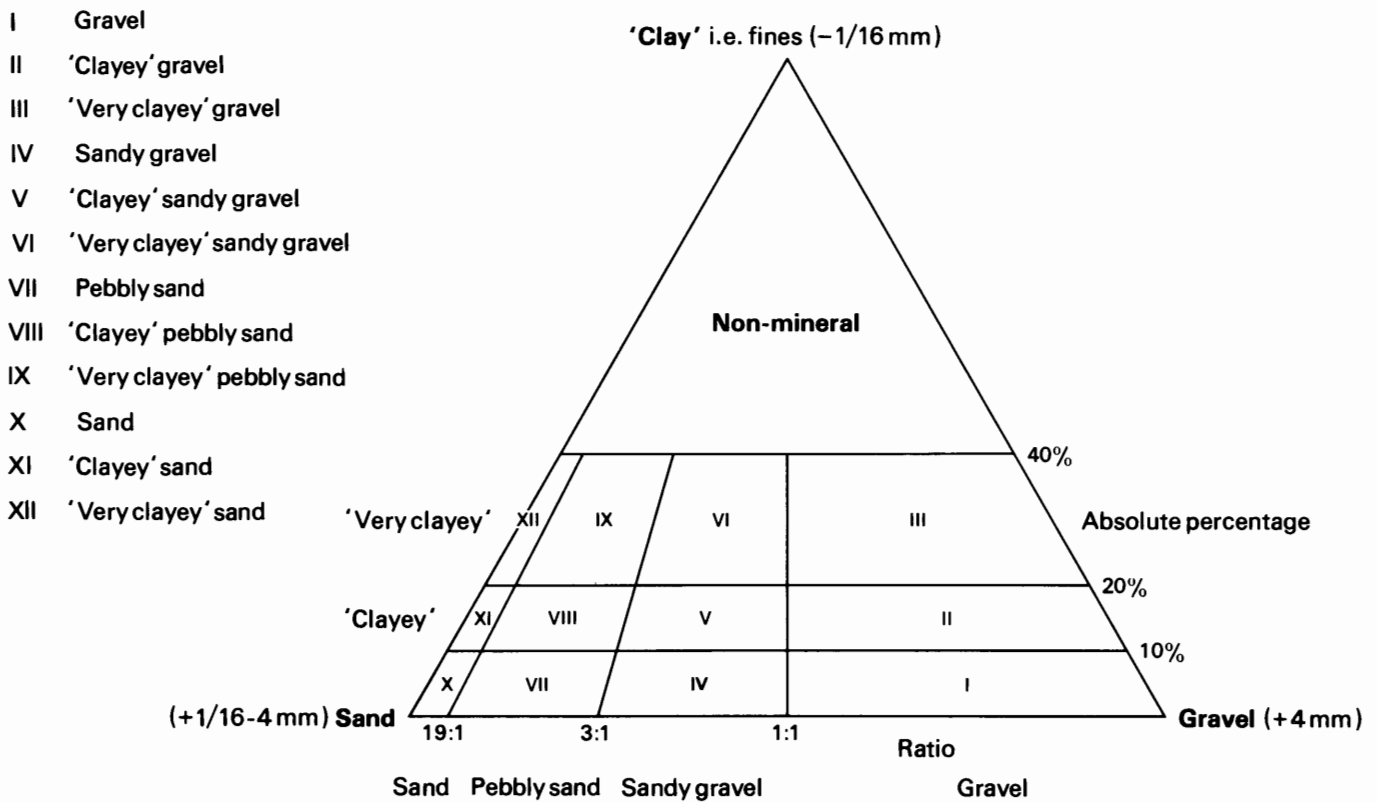


Figure 10 Diagram showing the descriptive categories used in the classification of sand and gravel

Wentworth, 1922; Wentworth, 1935; Allen, 1936; Twenhofel, 1937; Lane and others, 1947). As Archer (1970a, b) has emphasised, there is a pressing need for a simple metric scale acceptable to both scientific and engineering interests, for which the class limit sizes correspond closely with certain marked changes in the natural properties of mineral particles. For example, there is an important change in the degree of cohesion between particles at about the  $\frac{1}{16}$  mm size, which approximates to the generally accepted boundary between silt and sand. These and other requirements are met by a system based on Udden's geometric scale and a simplified form of Wentworth's terminology (Table 6), which is used in this Report.

The fairly wide intervals in the scale are consistent with the general level of accuracy of the qualitative assessments of the resource blocks. Three sizes of sand are recognised, fine ( $+\frac{1}{16} - \frac{1}{4}$  mm), medium ( $+\frac{1}{4} - 1$  mm) and coarse ( $+1 - 4$  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 Standard 1377: 1967). In this report the grading is tabulated on the borehole record sheets (Appendix F), the intercepts corresponding with the simple geometric scale  $\frac{1}{16}$  mm,  $\frac{1}{4}$  mm, 1 mm, 4 mm, 16 mm and so on as required. Original sample grading curves are available for reference at the appropriate office of the Institute.

Each bulk sample is described, subjectively, by a geologist at the borehole site. Being based on visual examination, the description of the grading is inexact, the accuracy depending on the experience of the observer. The descriptions recorded are modified, as necessary, when the laboratory results become available.

The relative proportions of the rock types present in the gravel fraction are indicated by the use of the words 'and' or 'with'. For example, 'flint and quartz' indicates very approximate equal proportions with neither constituent accounting for less than about 25 per cent of the whole; 'flint with quartz' indicates that flint is dominant and quartz, the principal accessory rock type, comprises 5 to 25 per cent of the whole. Where the accessory material accounts for less than 5 per cent of the whole, but is still readily apparent, the phrase 'with some' has been used. Rare constituents are referred to as 'trace'.

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

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

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

Table 6 Classification of gravel, sand and fines

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

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

**Rounded:** original faces almost completely destroyed, but some comparatively flat surfaces may still remain. All original

edges and corners have been smoothed off to rather broad curves. Original shape is still apparent.

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

**APPENDIX D**

**EXPLANATION OF THE BOREHOLE RECORDS**

Annotated example

SJ 35 NW 35<sup>1</sup> 3206 5575<sup>2</sup> West of Llay<sup>3</sup>

**Block A**

Surface level (+81.6 m) + 268 ft<sup>4</sup>

Water not struck<sup>5</sup>

Shell and auger 8-in (203 mm) diameter<sup>6</sup>

May 1977

Overburden<sup>7</sup> 4.2 m

Mineral<sup>7</sup> 9.8 m

Waste<sup>7</sup> 4.4 m +<sup>9</sup>

**LOG**

Geological classification	Lithology	Thickness <sup>8</sup> m	Depth <sup>8</sup> m
	Soil, dark brown, clayey	0.8	0.8
Boulder Clay <sup>10</sup>	Clay, grey-brown, sandy with subangular to subrounded clasts of quartzite and sandstone	3.4	4.2
Glacial Sand and Gravel	Gravel Gravel: fine and coarse with cobbles, subrounded quartzite with volcanics, limestone and some quartz, sandstone and chert. Sand: fine, medium and coarse, subrounded, clayey between 12.2 m and 13.6 m	9.8	13.6
Boulder Clay	Clay, silty and sandy, stiff, grey-brown, containing clasts of quartzite and limestone and also a large cobble of granite	4.4 +	18.0

**GRADING<sup>13</sup>**

Mean for deposit <sup>14</sup> percentages			Depth <sup>12</sup> below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				- $\frac{1}{16}$	+ $\frac{1}{16}$ - $\frac{1}{4}$	+ $\frac{1}{4}$ -1	+1-4	+4-16	+16-64	+64
3	39	58	4.2-5.0	1	5	20	9	14	32	19
			5.0-6.0	1	4	26	15	19	29	6
			6.0-7.0	4	8	28	7	17	23	13
			7.0-8.0	2	6	34	22	27	9	
			8.0-9.0	1	4	11	8	21	28	27
			9.0-10.0	1	2	5	16	31	35	10
			10.0-11.0	2	4	9	12	29	39	5
			11.0-13.0	7	33	13	2	2	9	34
			Mean	3	11	18	10	18	24	16

**COMPOSITION<sup>15</sup>**

Depth below surface (m)	Percentages by weight in +8 mm fraction						
	Quartz	Quartzite	Sandstone	Limestone	Other sediments	Igneous	Chert, flint
4.2-7.0	1	47	1	27	Trace	23	1
7.0-10.0	3	40	1	21	2	31	2
10.0-13.0	1	68	Trace	15	3	13	Trace

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

#### 1 Borehole Registration Number

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

1 The number of the 1 : 25 000 sheet on which the borehole lies, for example SJ 35.

2 The quarter of the 1 : 25 000 sheet on which the borehole lies and its number in a series for that quarter, for example NW 35.

Thus the full Registration Number is SJ 35 NW 35. Usually this is abbreviated to 35 NW 35 in the text.

#### 2 The National Grid Reference

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 for borehole locations. (In the text, six-figure grid references are used for more approximate locations, for example, for farms).

#### 3 Location

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

#### 4 Surface level

The surface level 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 and feet above Ordnance Datum).

#### 6 Type of drill and date of drilling

Modified shell-and-auger rigs were used in this survey. The type of machine, the external diameter of the casing used, and the month and year of the completion of the borehole are stated.

#### 7 Overburden, mineral, waste and bedrock

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

All measurements were made in metres.

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

#### 10 Geological classification

The geological classification is given whenever possible.

#### 11 Lithological description

When sand and gravel is recorded a general description based on the mean grading characteristics (for details see Appendix C) is followed by more detailed particulars. The description of other rocks is based on visual examination in the field.

#### 12 Sampling

A continuous series of bulk samples is taken throughout the thickness of sand and gravel. A new sample is commenced whenever there is an appreciable lithological change within the sand and gravel.

#### 13 Grading results

The limits are as follows: gravel, + 4 mm; sand,  $-4 + \frac{1}{16}$  mm; fines,  $-\frac{1}{16}$  mm.

#### 14 Mean grading

The grading of the full thickness of the mineral deposit identified in the log is the mean of the individual sample gradings weighted by the thicknesses represented, if these vary. The classification used is shown in Table 6.

Fully representative sampling of sand and gravel is difficult to achieve, particularly where groundwater levels are high. Comparison between boreholes and adjacent exposures suggests that in borehole samples the proportion of sand may be higher and the proportions of fines and coarse gravel (+ 16 mm) may be lower.

#### 15 Composition

Where gravel is present, detailed lithological composition is given for material coarser than 8 mm.

APPENDIX E

LIST OF BOREHOLES USED IN THE ASSESSMENT OF RESOURCES

INDUSTRIAL MINERALS ASSESSMENT UNIT BOREHOLES

Borehole number*	Grid reference†	Borehole number*	Grid reference†
<b>1 IMAU BOREHOLES</b>			
25 NE 7	2727 5919	35 NE 35	3754 5915
25 NE 8	2727 5750	35 NE 36	3765 5825
25 NE 9	2763 5726	35 NE 37	3782 5739
25 NE 10	2785 5697	35 NE 38	3880 5962
25 NE 11	2853 5515	35 NE 39	3852 5791
25 NE 12	2966 5958	35 NE 40	3825 5708
25 NE 13	2899 5947	35 NE 41	3858 5640
25 NE 14	2929 5870	35 NE 42	3830 5591
25 NE 15	2929 5560	35 NE 43	3965 5899
25 SE 35	2794 5451	35 NE 44	3932 5702
25 SE 36	2780 5399	35 NE 45	3961 5585
25 SE 37	2718 5378	35 SW 32	3045 5104
25 SE 38	2759 5201	35 SW 33	3126 5455
25 SE 39	2793 5040	35 SW 34	3170 5263
25 SE 40	2971 5483	35 SW 35	3191 5214
25 SE 41	2925 5168	35 SW 36	3171 5090
25 SE 42	2971 5077	35 SW 37	3137 5028
35 NW 28	3074 5957	35 SW 38	3248 5446
35 NW 29	3042 5884	35 SW 39	3263 5322
35 NW 30	3010 5817	35 SW 40	3252 5244
35 NW 31	3030 5612	35 SW 41	3370 5431
35 NW 32	3159 5965	35 SW 42	3328 5399
35 NW 33	3154 5850	35 SW 43	3447 5426
35 NW 34	3162 5657	35 SW 44	3430 5303
35 NW 35	3206 5573	35 SE 18	3558 5450
35 NW 36	3247 5953	35 SE 19	3589 5379
35 NW 37	3228 5857	35 SE 20	3513 5346
35 NW 38	3264 5743	35 SE 21	3548 5257
35 NW 39	3245 5655	35 SE 22	3596 5059
35 NW 40	3328 5944	35 SE 23	3651 5451
35 NW 41	3364 5848	35 SE 24	3659 5317
35 NW 42	3336 5765	35 SE 25	3648 5238
35 NW 43	3342 5652	35 SE 26	3622 5156
35 NW 44	3424 5929	35 SE 27	3683 5019
35 NW 45	3441 5852	35 SE 28	3726 5485
35 NW 46	3418 5764	35 SE 29	3750 5357
35 NW 47	3436 5689	35 SE 30	3742 5260
35 NW 48	3413 5599	35 SE 31	3750 5127
35 NW 49	3438 5586	35 SE 32	3735 5061
35 NW 50	3454 5549	35 SE 33	3839 5500
35 NE 26	3532 5961	35 SE 34	3842 5351
35 NE 27	3541 5819	35 SE 35	3872 5254
35 NE 28	3561 5744	35 SE 36	3849 5137
35 NE 29	3538 5661	35 SE 37	3978 5476
35 NE 30	3683 5976	35 SE 38	3931 5361
35 NE 31	3603 5781	35 SE 39	3957 5231
35 NE 32	3687 5695	35 SE 40	3962 5058
35 NE 33	3669 5651		
35 NE 34	3668 5566		
		<b>2 OTHER IGS-REGISTERED BOREHOLE</b>	
		35 SW 7	

\* By sheet quadrant.  
 † All fall in 100-km grid square SJ.

APPENDIX F

INDUSTRIAL MINERALS ASSESSMENT UNIT BOREHOLE RECORDS

SJ 25 NE 7 2727 5919 Pontybodkin

Block

Surface level (+ 153.0 m) + 501 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 April 1977

Waste 9.5 m  
 Bedrock 0.5 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
Boulder Clay	Soil, dark brown clayey	0.3	0.3
	Clay, pale brown, stiff with small angular clasts of quartzite, quartz and subrounded siltstone	5.5	5.8
	Gravel, coarse angular quartzite and siltstone, with coarse angular sand	0.8	6.6
Coal Measures	Clay, dark green, soft with some stones	2.9	9.5
	Siltstone, pale grey with interbedded dark mudstone	0.5+	10.0

SJ 25 NE 8 2727 5750 North-west of Llanfynydd

Block A

Surface level (+ 175.1 m) + 575 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 March 1977

Overburden 5.2 m  
 Mineral 19.8 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
Boulder Clay	Soil, dark brown clayey	0.4	0.4
	Clay, dark brown slightly sandy with angular to subangular clasts of quartzite and volcanics	4.8	5.2
Glacial Sand and Gravel	'Clayey' sand: brown-grey with thin silt and clay laminae. The sand is fine with medium and contains some coal	19.8+	25.0

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				- 1/16	+ 1/16-1/4	+ 1/4-1	+ 1-4	+ 4-16	+ 16-64	+ 64
16	83	1	5.2-6.2	15	54	28	0	0	0	0
			6.2-7.2	11	41	48	0	0	0	0
			7.2-8.2	11	30	57	2	0	0	0
			8.2-9.2	14	52	26	1	0	0	7
			9.2-10.2	21	52	26	1	0	0	0
			10.2-11.2	17	53	30	0	0	0	0
			11.2-12.2	10	55	35	0	0	0	0
			12.2-13.2	16	60	24	0	0	0	0
			13.2-14.2	11	68	21	0	0	0	0
			14.2-15.5	14	64	22	0	0	0	0
			15.5-16.5	19	56	25	0	0	0	0
			16.5-17.5	13	39	34	4	5	5	0
			17.5-18.5	19	51	30	0	0	0	0
			18.5-19.5	20	63	17	0	0	0	0
19.5-21.5	17	57	26	0	0	0	0			
21.5-23.5	23	61	14	2	0	0	0			
23.5-25.0	20	47	33	0	0	0	0			
			Mean	16	54	28	1	0	0	1



Surface level (+138.5 m) +453 ft  
 Water struck at +131.5 m  
 Shell and auger 8-in (203 mm) diameter  
 March 1973

Overburden 7.0 m  
 Mineral 17.0 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
Alluvium	Soil, dark brown, clayey	0.5	0.5
	Clay, brown to dark grey with laminations of silt and sandy clay. Contains scattered clasts of angular to rounded quartz, coal, limestone, siltstone and fragments of wood. Gravel content increases at the base	6.5	7.0
Glacial Sand and Gravel	Gravel Gravel: coarse and fine with cobbles, subrounded quartzite with limestone and some siltstone, volcanics, sandstone, chert and traces of quartz Sand: coarse and medium with fine, angular to subangular	17.0+	24.0

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				- $\frac{1}{16}$	+ $\frac{1}{16}$ - $\frac{1}{4}$	+ $\frac{1}{4}$ -1	+1-4	+4-16	+16-64	+64
5	30	65	7.0-8.0	4	5	8	15	29	39	0
			8.0-9.0	8	8	9	13	33	29	0
			9.0-10.0	6	7	12	19	29	22	5
			10.0-11.0	4	4	14	31	36	11	0
			11.0-12.0	3	5	12	13	25	37	5
			12.0-13.0	2	2	3	7	20	48	18
			13.0-14.0	5	4	6	12	22	26	25
			14.0-15.0	2	3	11	13	29	31	11
			15.0-16.0	3	4	16	21	23	29	4
			16.0-17.0	10	4	19	24	19	16	8
			17.0-18.0	8	4	15	21	20	13	19
			18.0-20.0	8	2	7	19	32	32	0
			20.0-22.0	5	3	11	13	18	32	18
			22.0-24.0	4	2	6	6	9	27	46
Mean			5	4	10	16	24	28	13	

COMPOSITION

Depth below surface (m)	Percentages by weight in +8 mm fraction						
	Quartz	Quartzite	Sandstone	Limestone	Other sediments	Igneous	Chert, flint
7.0-10.0	Trace	57	4	29	5	3	2
10.0-13.0	—	68	1	26	3	—	2
13.0-16.0	Trace	68	2	17	6	1	6
16.0-20.0	—	62	4	11	21	Trace	2
20.0-24.0	Trace	67	9	11	11	Trace	2

SJ 25 NE 10 2785 5697 Llanfynydd

Surface level (+150.8 m) +495 ft  
Water not struck  
Shell and auger 8-in (203 mm) diameter  
March 1977

Waste 11.3 m  
Bedrock 1.7 m+

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil, dark brown, clayey	0.3	0.3
Boulder Clay	Clay, dark grey-green, rusty brown at the top; coarse angular to subangular clasts of quartzite, limestone and volcanics	11.0	11.3
Coal Measures	Mudstone, dark grey	1.7+	13.0

Surface level (+ 120.0 m) + 394 ft  
 Water struck at + 111.5 m  
 Shell and auger 8-in (203 mm) diameter  
 March 1977

Overburden 3.4 m  
 Mineral 14.4 m  
 Bedrock 1.2 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
Alluvium	Soil, dark brown, clayey and stony	0.3	0.3
	Clay, stiff, dark brown with angular quartzite clasts, sandy at the base	3.1	3.4
Glacial Sand and Gravel	Gravel	14.4	17.8
	Gravel: coarse with fine and cobbles, angular to subangular quartzite with some limestone, sandstone, siltstone and traces of quartz, chert and volcanics Sand: subangular, coarse with medium and fine		
Coal Measures	Sandstone, yellow-brown	1.2+	19.0

**GRADING**

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				- $\frac{1}{16}$	+ $\frac{1}{16}$ - $\frac{1}{4}$	+ $\frac{1}{4}$ -1	+1-4	+4-16	+16-64	+64
4	27	69	3.4-4.4	3	3	5	7	12	49	21
			4.4-5.5	2	1	5	15	28	30	19
			5.5-6.4	1	1	1	4	17	72	4
			6.4-7.4	3	2	3	12	30	33	17
			7.4-8.4	2	4	4	7	24	46	13
			8.4-9.4	4	2	4	9	19	47	15
			9.4-10.4	4	2	7	25	32	30	0
			10.4-11.4	5	5	17	41	25	7	0
			11.4-12.4	5	3	8	26	28	25	5
			12.4-13.4	4	2	6	22	33	33	0
			13.4-14.4	5	3	7	25	33	27	0
			14.4-15.4	6	4	9	19	20	37	5
			15.4-16.4	3	7	9	11	14	43	13
			16.4-17.8	6	6	8	14	20	39	7
			Mean	4	3	7	17	24	37	8

**COMPOSITION**

Depth below surface (m)	Percentages by weight in + 8 mm fraction						
	Quartz	Quartzite	Sandstone	Limestone	Other sediments	Igneous	Chert, flint
3.4-4.4	Trace	94	2	1	2	1	—
4.4-7.4	Trace	91	6	1	1	—	1
8.4-9.4	—	76	3	15	6	—	—
9.4-11.4	—	89	4	—	7	—	—
11.4-14.4	—	70	6	16	7	—	1
14.4-15.4	—	18	65	9	7	1	—
15.4-17.8	1	64	27	1	7	Trace	—

Surface level (+80.4 m) +264 ft  
 Water struck at +77.9 m  
 Shell and auger 8-in (203 mm) diameter  
 April 1977

Overburden 2.5 m  
 Mineral 21.5 m+

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown, sandy	0.3	0.3
Alluvium	Clay, sandy and silty, stiff, dark brown	2.2	2.5
Glacial Sand and Gravel	Sandy gravel Gravel: fine and coarse with cobbles, subangular to rounded quartzite with limestone and some siltstone, volcanics, sandstone, quartz and chert Sand: fine and medium with coarse, subangular to subrounded	21.5+	24.0

**GRADING**

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines				Gravel		
				- $\frac{1}{16}$	+ $\frac{1}{16}$ - $\frac{1}{4}$	+ $\frac{1}{4}$ -1	1-4	+4-16	+16-64	+64
1	50	49	2.5-3.5	3	3	13	18	37	26	0
			3.5-5.0	1	1	5	12	41	40	0
			5.0-6.0	1	1	6	16	19	27	30
			6.0-7.0	1	1	10	18	34	36	0
			7.0-8.0	1	1	9	25	28	31	5
			8.0-9.0	1	1	9	35	24	30	0
			9.0-10.0	0	1	8	23	32	32	4
			10.0-11.0	0	1	13	12	20	43	11
			11.0-12.0	1	1	16	13	13	48	8
			12.0-13.0	3	22	45	13	10	7	0
			13.0-14.0	1	9	20	7	12	26	25
			14.0-15.0	2	12	28	10	13	19	16
			15.0-16.0	1	14	65	8	7	5	0
			16.0-17.0	2	16	67	7	2	6	0
			17.0-18.0	2	20	70	6	1	1	0
			18.0-20.0	2	13	40	10	13	11	11
			20.0-22.0	1	13	39	11	15	21	0
			22.0-24.0	1	13	37	9	16	13	11
			Mean	1	8	29	13	19	23	7

**COMPOSITION**

Depth below surface (m)	Percentages by weight in +8 mm fraction						
	Quartz	Quartzite	Sandstone	Limestone	Other sediments	Igneous	Chert, flint
2.5-8.0	2	53	4	23	12	5	1
8.0-12.0	1	38	3	41	11	6	Trace
12.0-16.0	2	60	Trace	9	14	14	1
16.0-24.0	2	73	3	4	11	7	Trace

Surface level (+98.5 m) +323 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 April 1977

Overburden 1.8 m  
 Mineral 4.3 m  
 Waste 0.4 m  
 Bedrock 0.5 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
Glacial Sand and Gravel	Soil, dark brown, stony	0.3	0.3
	Clay, light brown, sandy and silty with subangular clasts of quartzite and volcanics	1.5	1.8
	Gravel Gravel: fine and coarse with cobbles, subangular to subrounded quartzite with some volcanics, siltstone, sandstone, chert and flint Sand: medium and coarse with some fine	4.3	6.1
Millstone Grit "Series"	Clay, stiff, dark grey, stony	0.4	6.5
	Siltstone, pale grey with dark laminae	0.5+	7.0

**GRADING**

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				-1/16	+1/16-1/4	+1/4-1	+1-4	+4-16	+16-64	+64
2	32	66	1.8-2.8	2	3	8	12	23	47	5
			2.8-3.8	1	2	17	11	18	47	4
			3.8-4.8	1	3	26	14	15	28	13
			4.8-6.1	5	2	12	16	28	23	4
			Mean	2	3	16	13	22	35	9

**COMPOSITION**

Depth below surface (m)	Percentages by weight in +8 mm fraction						
	Quartz	Quartzite	Sandstone	Limestone	Other sediments	Igneous	Chert, flint
1.8-6.1	2	79	2	—	3	13	1

**SJ 25 NE 14 2929 5870 Pentre, near Caergwrle**

Surface level (+114.4 m) +375 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 May 1977

Waste 5.2 m  
 Bedrock 0.1 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
Boulder Clay	Soil, dark brown, clayey	0.3	0.3
	Clay, dark to light brown stiff sandy clay, containing clasts of quartzite, limestone, igneous material and coal	4.9	5.2
Millstone Grit "Series"	Limestone, dark blue-grey	0.1+	5.3

Surface level (+165.7 m) +343.7 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 March 1977

Overburden 3.6 m  
 Mineral 15.2 m  
 Waste 0.5 m  
 Bedrock 0.1 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil, dark brown, clayey	0.5	0.5
Glacial Sand and Gravel	Clay, rusty brown with angular clasts of quartzite and siltstone	3.1	3.6
	'Clayey' sandy gravel Gravel: coarse with fine and cobbles, angular quartzite with limestone and subangular volcanics, sandstone, siltstone and a trace of quartz and chert Sand: fine with medium and coarse, subangular to subrounded	15.2	18.8
Coal Measures	Clay, dark grey-brown with poorly sorted angular stones	0.5	19.3
	Limestone, dark blue-grey, fossiliferous	0.1 +	19.4

**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
11	52	37	3.6-5.1	27	66	6	1	0	0	0
			5.1-6.1	18	64	17	1	0	0	0
			6.1-7.1	18	59	23	0	0	0	0
			7.1-9.1	20	70	10	0	0	0	0
			9.1-10.1	10	42	28	6	5	9	0
			10.1-11.1	5	10	7	6	11	29	32
			11.1-12.1	9	16	16	12	16	23	8
			12.1-13.1	4	8	11	10	15	47	5
			13.1-14.1	4	22	12	9	16	37	0
			14.1-15.1	3	12	12	9	20	39	5
			15.1-16.1	2	6	13	11	14	37	17
16.1-17.1	1	1	7	10	12	46	23			
17.1-18.1	5	3	13	17	15	32	15			
Mean			11	32	13	7	9	21	7	

**COMPOSITION**

Depth below surface (m)	Percentages by weight in +8 mm fraction						
	Quartz	Quartzite	Sandstone	Limestone	Other sediments	Igneous	Chert, flint
9.1-12.1	Trace	46	1	36	1	15	1
12.1-15.1	Trace	78	9	11	Trace	2	Trace
15.1-18.1	Trace	75	Trace	10	3	11	1

**SJ 25 SE 35 2794 5451 South of Glascoed Hall, Glascoed**

Surface level (+ 223.4 m) + 733 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 March 1977

Waste 11.0 m  
 Bedrock 0.1 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil, clayey	0.2	0.2
Boulder Clay	Clay, stiff dark brown, ochreous at the top. Slightly sandy containing small subangular to subrounded clasts of quartzite, sandstone, limestone and igneous material. Becomes gravelly with cobbles at the base	10.8	11.0
Coal Measures	Sandstone, yellow	0.1+	11.1

**SJ 25 SE 36 2780 5399 East of Cefn, Brymbo**

Surface level (+ 243.1 m) + 798 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 March 1977

Waste 2.8 m  
 Bedrock 0.2 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil, clayey	0.3	0.3
Boulder Clay	Clay, yellow-brown containing angular sandstone fragments	2.5	2.8
Coal Measures	Sandstone, yellow, flaggy, medium grained	0.2+	3.0

**SJ 25 SE 37 2718 5378 South of Cefn, Brymbo**

Surface level (+ 294.7 m) + 965 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 March 1977

Waste 1.5 m  
 Bedrock 0.5 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil, clayey	0.2	0.2
Boulder Clay	Clay, yellow, slightly sandy	1.3	1.5
Millstone Grit "Series"	Sandstone, ochreous, flaggy, medium grained	0.5+	2.0

**SJ 25 SE 38 2759 5201 North-west of Coedpoeth**

Surface level (+ 245.5 m) + 805 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 April 1977

Waste 16.5 m

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil, clayey with occasional stones	0.2	0.2
Boulder Clay	Clay, dark grey, ochreous brown at the top. Stony, containing coarse angular to subangular clasts of sandstone, siltstone, mudstone and limestone	16.3	16.5

**SJ 25 SE 39 2793 5040 The Wern, south of Coedpoeth**

Surface level (+ 219.4 m) + 718.4 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 April 1977

Waste 2.7 m  
 Bedrock 0.5 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.6	0.6
Boulder Clay	Clay, sandy with subangular stones, orange at the top becoming grey	2.1	2.7
Millstone Grit "Series"	Limestone	0.5+	3.2

**SJ 25 SE 40 2971 5483 North of Brymbo**

**Block B**

Surface level (+ 148.9 m) + 489 ft  
 Water level not recorded  
 Shell and auger 8-in (203 mm) diameter  
 March 1977

Overburden 0.8 m  
 Mineral 6.2 m  
 Waste 4.1 m  
 Mineral 4.3 m  
 Waste 0.6 m  
 Mineral 7.4 m  
 Waste 1.6 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.8	0.8
Glacial Sand and Gravel	<b>a</b> Gravel Gravel: fine and coarse with cobbles, subrounded quartzite with limestone, some sandstone, siltstone and a trace of volcanics Sand: angular, coarse with medium becoming fine at the base	6.2	7.0
	Silt, green-brown laminated silts, clays and fine sand	4.1	11.1
	<b>b</b> Pebbly sand Gravel: fine and coarse, subangular quartzite with limestone and some sandstone, siltstone, volcanics and quartz Sand: fine with coarse and medium, subangular with traces of coal	4.3	15.4
	Silt, brown, soft with sandy and pebbly bands	0.6	16.0
	<b>c</b> Gravel Gravel: fine and coarse with cobbles, subrounded quartzite with limestone and some sandstone, volcanics, siltstone and quartz Sand: coarse with fine and medium subangular to subrounded	7.4	23.4
	Clay, dark brown, slightly sandy with some fine pebbles	1.4	24.8
	Gravel, fine and coarse with cobbles, subangular quartzite with volcanics and quartz	0.2+	25.0



**GRADING**

	Mean for deposit percentages			Depth below surface (m)	percentages								
	Fines	Sand	Gravel		Fines			Sand			Gravel		
					- $\frac{1}{16}$	+ $\frac{1}{16}$ - $\frac{1}{4}$	+ $\frac{1}{4}$ -1	+1-4	+4-16	+16-64	+64		
<b>a</b>	9	42	49	0.8-1.8	15	3	4	15	37	26	0		
				1.8-2.8	1	3	7	16	19	39	15		
				2.8-3.8	1	1	7	15	20	44	12		
				3.8-5.0	6	9	2	7	21	47	8		
				5.0-7.0	17	72	10	1	0	0	0		
				Mean	9	26	7	9	16	27	6		
<b>b</b>	10	68	22	11.1-12.1	5	3	5	23	31	33	0		
				12.1-13.1	5	43	16	13	15	8	0		
				13.1-14.1	10	73	8	4	4	1	0		
				14.1-15.4	17	75	5	2	1	0	0		
				Mean	10	50	8	10	12	10	0		
<b>c</b>	3	25	72	16.0-17.0	10	14	6	11	32	27	0		
				17.0-18.0	0	1	0	1	22	39	37		
				18.0-19.0	3	7	14	25	23	28	0		
				19.0-20.0	3	6	8	12	15	11	45		
				20.0-21.0	2	1	3	14	27	43	10		
				21.0-22.0	5	5	8	22	32	28	0		
				22.0-23.0	2	1	1	12	31	53	0		
				23.0-23.4	4	2	3	16	35	25	15		
				Mean	3	5	6	14	26	33	13		
<b>a + b + c</b>	7	41	52	Mean	7	23	7	11	20	25	7		

**SJ 25 SE 41 2925 5168 Lidiart Fanny, Coedpoeth**

Surface level (+ 183.5 m) + 602 ft

Waste 18.0 m +

Water not struck

Shell and auger 8-in (203 mm) diameter

April 1977

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Boulder Clay	Clay, greyish orange, slightly sandy with subrounded pebbles and cobbles of quartzite, limestone and sandstone	17.8 +	18.0

**SJ 25 SE 42 2971 5077 East of Coedpoeth**

Surface level (+157.2 m) + 516 ft  
 Water struck at +151.2 m  
 Shell and auger 8-in (203 mm) diameter  
 April 1977

Overburden 6.0 m  
 Mineral 2.5 m  
 Bedrock 0.5 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.1	0.1
Boulder Clay	Clay, brown to dark brown, stony, plastic becoming hard at the base	5.9	6.0
Glacial Sand and Gravel	Gravel Gravel: fine and coarse with cobbles, subangular sandstone with quartzite and some chert, siltstone, volcanics and a trace of quartz Sand: fine, medium and coarse	2.5	8.5
Coal Measures	Sandstone, yellow-brown	0.5+	9.0

**GRADING**

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines		Sand			Gravel	
				-1/16	+1/16-1/4	+1/4-1	+1-4	+4-16	+16-64	+64
6	30	64	6.0-7.0	3	5	9	13	15	25	30
			7.0-8.0	9	6	11	13	26	17	18
			8.0-8.5	5	6	12	17	17	38	5
			Mean	6	6	10	14	20	24	20

**COMPOSITION**

Depth below surface (m)	Percentages by weight in +8 mm fraction						
	Quartz	Quartzite	Sandstone	Limestone	Other sediments	Igneous	Chert, flint
6.0-8.5	Trace	18	75	—	3	1	3

**SJ 35 NW 28 3074 5957 North of Pigeon House Farm, Hope**

Surface level (+115.9 m) + 380 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 April 1977

Waste 9.1 m  
 Bedrock 0.4 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil, dark brown, loamy	0.3	0.3
Boulder Clay	Clay, stiff, brown-grey becoming red at the base. Contains subrounded stones (some of cobble size) with angular red sandstone fragments at the base	8.8	9.1
Millstone Grit "Series"	Sandstone, red-purple, quartzitic	0.4+	9.5

Surface level (+82.3 m) +270 ft  
 Water struck at 77.2 m  
 Shell and auger 8-in (203 mm) diameter  
 April 1977

Overburden 5.1 m  
 Mineral 4.1 m  
 Waste 3.7 m  
 Mineral 4.2 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy clay with quartzite fragments	0.5	0.5
	Clay, dark brown, stiff and stony, sandy at the top with subangular to subrounded clasts of quartzite, volcanics and quartz	4.6	5.1
Glacial Sand and Gravel	<b>a</b> Gravel Gravel: fine and coarse with some cobbles, subrounded to rounded quartzite with limestone, volcanics, and some quartz, sandstone, chert and siltstone Sand: medium and coarse with some fine, angular	4.0	9.1
	Clay, dark grey, stiff, with rare subrounded pebbles, and a sand intercalation between 10.9 m and 11.2 m	3.7	12.8
	<b>b</b> 'Very clayey' sand: dark grey, fine with traces of medium and coarse, occasional pebbles of quartzite, limestone, volcanics, quartz and sandstone	4.2	17.0

**GRADING**

	Mean for deposit percentages			Depth below surface (m)	percentages								
	Fines	Sand	Gravel		Fines			Sand			Gravel		
					- $\frac{1}{16}$	+ $\frac{1}{16}$ - $\frac{1}{4}$	+ $\frac{1}{4}$ -1	+1-4	+4-16	+16-64	+64		
<b>a</b>	3	41	56	5.1-6.1	1	1	9	11	19	45	14		
				6.1-7.1	2	2	23	34	31	8	0		
				7.1-8.1	7	20	24	10	16	17	6		
				8.1-9.1	1	1	19	14	28	38	0		
				Mean	3	5	19	17	24	27	5		
<b>b</b>	28	71	1	12.8-14.3	24	76	0	0	0	0	0		
				14.3-15.8	33	60	3	2	0	2	0		
				15.8-17.0	38	55	1	1	2	3	0		
				Mean	28	68	2	1	0	1	0		
<b>a + b</b>	14	53	33	Mean	14	32	11	10	14	16	3		

**COMPOSITION**

	Depth below surface (m)	Percentages by weight in +8 mm fraction						
		Quartz	Quartzite	Sandstone	Limestone	Other sediments	Igneous	Chert, flint
<b>a</b>	5.1-7.1	2	59	1	16	5	13	4
	7.1-9.1	1	70	3	13	1	13	Trace

Surface level (+85.0 m) +279 ft  
 Water level not recorded  
 Shell and auger 8-in (203 mm) diameter  
 April 1977

Overburden 5.1 m  
 Mineral 10.0 m  
 Waste 2.9 m+

**LOG**

Geological classification	Lithology	Thickness m	Depth m
Glacial Sand and Gravel	Soil, dark brown, loamy with pebbles	0.5	0.5
	Clay, red brown pebbly sandy clay with pebbles of quartzite, volcanics, quartz and coal	4.6	5.1
	Gravel	10.0	15.1
	Gravel: fine and coarse with cobbles, rounded quartzite with some limestone, volcanics, quartz, siltstone, sandstone and traces of chert. Limestone increases with depth Sand: medium and coarse with some fine, buff in colour, subangular Silt, stiff red-brown laminated sandy clays and silts	2.9+	18.0

**GRADING**

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				- 1/16	+ 1/16-1/4	+ 1/4-1	+ 1-4	+ 4-16	+ 16-64	+ 64
1	28	71	5.1-6.1	1	1	7	13	37	37	4
			6.1-7.1	2	3	10	12	22	37	14
			7.1-8.1	1	1	7	9	38	44	0
			8.1-9.1	1	1	9	11	28	50	0
			9.1-10.1	2	2	25	14	15	24	18
			10.1-11.1	1	2	7	5	18	55	12
			11.1-12.1	2	6	14	11	19	28	20
			12.1-13.1	1	2	13	24	37	15	8
			13.1-14.1	1	1	9	21	43	25	0
			14.1-15.1	1	2	22	13	21	41	0
			Mean	1	2	13	13	28	35	8

**COMPOSITION**

Depth below surface (m)	Percentages by weight in +8 mm fraction						
	Quartz	Quartzite	Sandstone	Limestone	Other sediments	Igneous	Chert, flint
5.1-6.1	3	80	2	Trace	1	14	—
6.1-8.1	4	69	4	4	2	16	1
8.1-11.1	3	66	5	12	6	7	1
11.1-13.1	9	50	4	14	2	20	1
13.1-15.1	3	23	15	30	7	22	—

Surface level (+140.8 m) +462 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 March 1977

Waste 15.0 m+

**LOG**

Geological classification	Lithology	Thickness m	Depth m
Boulder Clay	Soil, dark brown, very stony	0.2	0.2
	Clay, pale to dark brown, stiff, silty and stony with many angular clasts of quartzite, limestone, siltstone and sandstone ranging in size from coarse sand to cobbles	14.8+	15.0

SJ 35 NW 32 3159 5965 Lower Mountain, Hope

Surface level (+92.5 m) +303 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 April 1977

Waste 6.7 m  
 Bedrock 0.3 m+

**LOG**

Geological classification	Lithology	Thickness m	Depth m
Boulder Clay	Soil, dark brown, sandy and clayey	0.4	0.4
	Clay, buff with blue-grey gleyed streaks, sandy at the top. Contains angular to subangular fragments of coal and shale, and subrounded quartzite and sandstone. At the base becomes more stony with angular to subangular black shale and dark grey quartzite	6.3	6.7
Millstone Grit "Series"	Bedrock, laminated, dark grey-black silty shales and fine dark grey quartzite	0.3+	7.0

SJ 35 NW 33 3154 5850 Hope Hall Farm, Hope

Surface level (106.7 m) +350 ft  
 Water struck at +90.7 m  
 Shell and auger 8-in (203 mm) diameter  
 May 1977

Overburden 7.5 m  
 Mineral 16.0 m  
 Waste 1.5 m+

**LOG**

Geological classification	Lithology	Thickness m	Depth m
Boulder Clay	Soil, dark brown, clayey	0.4	0.4
	Clay, dark brown stiff and stony, poorly sorted with angular clasts of quartzite, igneous material, quartz sandstone and coal	7.1	7.5
Glacial Sand and Gravel	Pebbly sand	16.0	23.5
	Sand: buff, fine and medium, well sorted, subangular with traces of coal		
	Gravel: only occurs at the base of the deposit. Fine to coarse subangular quartzite, with some siltstone, limestone, volcanics and quartz		
	Clay, sandy and pebbly with laminated silts	1.5+	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
9	85	6	7.5-8.5	7	50	42	1	0	0	0
			8.5-9.5	6	32	60	1	1	0	0
			9.5-10.5	5	33	61	1	0	0	0
			10.5-11.5	5	41	53	1	0	0	0
			11.5-12.5	6	53	40	1	0	0	0
			12.5-13.5	8	60	31	1	0	0	0
			13.5-14.5	10	70	20	0	0	0	0
			14.5-16.5	15	76	9	0	0	0	0
			16.5-18.5	15	76	9	0	0	0	0
			18.5-20.5	6	34	57	3	0	0	0
			20.5-21.5	10	47	39	4	0	0	0
			21.5-22.5	7	19	27	7	11	29	0
			22.5-23.5	8	18	15	5	19	35	0
			Mean	9	50	34	1	2	4	0

## COMPOSITION

Depth below surface (m)	Percentages by weight in +8 mm fraction						
	Quartz	Quartzite	Sandstone	Limestone	Other sediments	Igneous	Chert, flint
21.5-23.5	2	60	4	10	17	7	—

Surface level (+92.3 m) +303 ft  
 Water level not recorded  
 Shell and auger 8-in (203 mm) diameter  
 May 1977

Overburden 5.5 m  
 Mineral 3.4 m  
 Waste 1.0 m  
 Mineral 1.0 m  
 Waste 10.1 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil, dark brown, clayey	0.3	0.3
Boulder Clay	Clay, dark grey, stiff and stony, containing poorly sorted subangular clasts of sandstone, limestone and volcanics	5.2	5.5
Glacial Sand and Gravel	<b>a</b> Gravel Gravel: fine and coarse, subrounded quartzite with volcanics and some limestone, quartz, sandstone, siltstone and a trace of chert. Sand: medium and coarse subangular to angular	3.4	8.9
	Clay, dark grey-brown, sandy and soft, containing coarse sand and subrounded to rounded pebbles of limestone, sandstone, quartzite and coal	1.0	9.9
	<b>b</b> Gravel Gravel: fine and coarse with cobbles, subrounded quartzite with volcanics and some limestone, quartz, chert and sandstone Sand: medium and coarse, angular	1.0	10.9
	Clay, dark grey, stiff and sandy with subangular clasts of quartzite and sandstone	0.6	11.5
	Clay, dark grey, sandy with occasional pebbles	4.4	15.9
Boulder Clay	Clay, red-brown, very stiff with subangular clasts of quartzite and sandstone	5.1	21.0

**GRADING**

	Mean for deposit <i>percentages</i>			Depth below surface (m)	<i>percentages</i>						
	Fines	Sand	Gravel		Fines			Gravel			
					- $\frac{1}{16}$	+ $\frac{1}{16}$ - $\frac{1}{4}$	+ $\frac{1}{4}$ -1	+1-4	+4-16	+16-64	+64
<b>a</b>	1	52	47	5.5-6.5	1	3	17	18	21	40	0
				6.5-7.5	2	3	19	29	24	23	0
				7.5-8.9	1	2	47	13	13	24	0
				Mean	1	3	30	19	19	28	0
<b>b</b>	1	25	74	9.9-10.9	1	2	10	13	30	40	4
<b>a + b</b>	1	46	53	Mean	1	3	25	18	21	31	1

**COMPOSITION**

	Depth below surface (m)	Percentages by weight in +8 mm fraction						
		Quartz	Quartzite	Sandstone	Limestone	Other sediments	Igneous	Chert, flint
<b>a</b>	5.5-8.9	5	64	1	7	5	18	Trace
<b>b</b>	9.9-10.9	4	66	1	8	Trace	19	2

Surface level (+81.6 m) +268 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 May 1977

Overburden 4.2 m  
 Mineral 9.8 m  
 Waste 4.4 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil, dark brown, clayey	0.8	0.8
Boulder Clay	Clay, grey-brown, sandy with subangular to subrounded clasts of quartzite and sandstone	3.4	4.2
Glacial Sand and Gravel	Gravel Gravel: fine and coarse with cobbles, subrounded quartzite with volcanics, limestone and some quartz sandstone and chert Sand: fine, medium and coarse, subrounded, clayey between 12.2 m and 13.6 m	9.8	13.6
Boulder Clay	Clay, silty and sandy, stiff, grey-brown, containing clasts of quartzite and limestone and also a large cobble of granite	4.4 +	18.0

**GRADING**

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines			Sand		Gravel	
				- 1/16	+ 1/16 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64
3	39	58	4.2-5.0	1	5	20	9	14	32	19
			5.0-6.0	1	4	26	15	19	29	6
			6.0-7.0	4	8	28	7	17	23	13
			7.0-8.0	2	6	34	22	27	9	0
			8.0-9.0	1	4	11	8	21	28	27
			9.0-10.0	1	2	5	16	31	35	10
			10.0-11.0	2	4	9	12	29	39	5
			11.0-13.0	7	33	13	2	2	9	34
			Mean	3	11	18	10	18	24	16

**COMPOSITION**

Depth below surface (m)	Percentages by weight in + 8 mm fraction						
	Quartz	Quartzite	Sandstone	Limestone	Other sediments	Igneous	Chert, flint
4.2-7.0	1	47	1	27	Trace	23	1
7.0-10.0	3	40	1	21	2	31	2
10.0-13.0	1	68	Trace	15	3	13	Trace

**SJ 35 NW 36 3247 5953 Wood Farm, near Hope**

Surface level (+62.8 m) +206 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 May 1972

Waste 3.4 m  
 Bedrock 0.1 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil, dark brown, stony	0.3	0.3
Boulder Clay	Clay, stiff, rusty brown, sandy at the top, stony throughout with small angular fragments of quartzite, limestone, igneous material, coal and sandstone, and occasional cobbles	3.1	3.4
Millstone Grit "Series"	Quartzite	0.1 +	3.5



Surface level (+69.8 m) + 229 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 May 1977

Waste 15.5 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil, clayey, dark brown	0.3	0.3
Glacial Sand and Gravel	Silt, soft, dark grey with no sand. Black with organic material in the top 2.5 m	7.9	8.2
	Sand, very clayey, grey-black	1.4	9.6
Boulder Clay	Clay, stiff, grey-brown with angular to subangular stones, including quartzite, limestone, igneous material and sandstone	5.9+	15.5

SJ 35 NW 38 3264 5743 Burton Farm, east of Caergwrle

Surface level (+88.7 m) + 291 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 April 1977

Overburden 4.9 m  
 Mineral 11.3 m  
 Waste 3.8 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil, dark brown, clayey	0.3	0.3
Boulder Clay	Clay, stiff, grey-brown with poorly sorted angular to rounded stones. Sandy and friable at the top with an horizon of fine to medium sand between 1.1 and 1.4 m	4.6	4.9
Glacial Sand and Gravel	'Clayey' sand	11.3	16.2
	Sand: light brown, fine with a trace of medium, becoming more clayey with depth. From 8.0 m there are thin clay laminae intercalated within the 'Clayey' sand		
	Clay, silty and sandy, light brown becoming clayier with depth	3.8	20.0

**GRADING**

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				-1/16	+1/16-1/4	+1/4-1	+1-4	+4-16	+16-64	+64
15	85	0	4.9-7.5	10	85	5	0	0	0	0
			7.5-9.5	11	85	4	0	0	0	0
			9.5-11.5	11	87	2	0	0	0	0
			11.5-13.5	30	68	2	0	0	0	0
			13.5-16.2	13	78	9	0	0	0	0
			Mean	15	81	4	0	0	0	0

Surface level (+96.8 m) +318 ft  
 Water struck at +91.8 m  
 Shell and auger 8-in (203 mm) diameter  
 May 1977

Overburden 5.2 m  
 Mineral 14.7 m  
 Waste 4.1 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil, dark brown, clayey	0.3	0.3
Boulder Clay	Clay, reddish brown, stiff, sandy and stony with poorly sorted angular to rounded clasts of quartzite, limestone, igneous material and quartz	4.9	5.2
Glacial Sand and Gravel	'Clayey' sand Sand: light brown, fine with medium containing coal grains. Some coarse sand and pebbles at the top becoming finer and more clayey with depth	14.7	19.9
	Silt, dark grey, sandy and clayey with occasional pebbles	4.1 +	24.0

**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
11	88	1	5.2-6.2	4	34	46	5	8	3	0
			6.2-7.2	3	37	59	1	0	0	0
			7.2-8.2	4	24	67	4	0	1	0
			8.2-9.2	7	34	56	2	1	0	0
			9.2-10.2	11	62	27	0	0	0	0
			10.2-11.2	14	76	10	0	0	0	0
			11.2-12.2	14	76	10	0	0	0	0
			12.2-13.2	10	81	9	0	0	0	0
			13.2-14.2	10	81	9	0	0	0	0
			14.2-15.2	17	78	5	0	0	0	0
			15.2-16.2	14	81	5	0	0	0	0
			16.2-18.2	15	82	3	0	0	0	0
			18.2-19.9	16	81	3	0	0	0	0
			Mean	11	66	21	1	1	0	0

Surface level (+39.8 m) +131 ft  
 Water struck at +81.0 m  
 Shell and auger 8-in (203 mm) diameter  
 June 1977

Overburden 0.8 m  
 Mineral 5.5 m  
 Waste 15.7 m+

**LOG**

Geological classification	Lithology	Thickness m	Depth m
Glacial Sand and Gravel	Soil, yellow-orange, loamy	0.8	0.8
	'Clayey' sand Sand: fine with some medium and a trace of coarse. Subangular to subrounded quartz with a trace of coal. Contains thin silt and clay laminae	5.5	6.3
Boulder Clay	Clay, soft chocolate brown with sand and silt laminae less than 20 cm thick	1.7	8.0
	Clay, hard, red-brown, sandy with subangular to subrounded clasts of quartzite, siltstone, sandstone and coal	7.8	15.8
Glacial Silt	Clay, soft, chocolate brown, laminated with thin silt and sand laminae	6.2+	22.0

**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
14	84	2	0.8-1.8	16	61	19	2	1	1	0
			1.8-2.8	14	70	9	1	1	5	0
			2.8-3.8	10	84	5	0	0	1	0
			3.8-4.8	15	80	4	0	0	1	0
			4.8-5.8	12	83	5	0	0	0	0
			5.8-6.3	17	79	4	0	0	0	0
			Mean	14	76	8	0	0	2	0

Surface level (+43.5 m) +143 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 May 1977

Waste 16.0 m+

**LOG**

Geological classification	Lithology	Thickness m	Depth m
Boulder Clay	Soil, loamy	0.4	0.4
	Clay, chocolate-brown, silty and stony with subangular to rounded quartzite, sandstone, siltstone, black shale and quartz. Between 0.4 m and 1.0 m thin sandy bands	7.4	7.8
	Clay, grey-green, hard, silty and stony with angular to rounded quartzite, sandstone, siltstone, black shale and quartz. Becomes very stony at the base.	3.7	11.5
	Clay, red-brown, sandy and silty with angular to rounded stones and thin sand, silt and gravel bands	4.5+	16.0

Surface level (+67.8 m) +222 ft  
 Water struck at +64.6 m  
 Shell and auger 8-in (203 mm) diameter  
 May 1977

Overburden 0.2 m  
 Mineral 1.2 m  
 Waste 1.3 m  
 Mineral 4.8 m  
 Waste 12.5 m+

**LOG**

Geological classification	Lithology	Thickness m	Depth m
Glacial Sand and Gravel	Soil, sandy	0.2	0.2
	'Clayey' sand Sand: fine with some medium and a trace of coarse, subangular to subrounded quartz, contains thin laminae of yellow clay	1.2	1.4
	Clay, chocolate-brown with well rounded pebbles	1.3	2.7
	'Clayey' sand Sand: fine with a trace of medium, subangular to subrounded quartz, contains brown-grey silt and clay laminae between 6.0 m and 6.7 m	4.8	7.5
Boulder Clay	Clay, brown, laminated with thin silt and fine sand laminae	1.3	8.8
	Clay, grey-brown, stiff, sandy and stony with subangular to subrounded clasts of quartzite, sandstone, black shale and coal	3.9	12.7
Glacial Silt	Silt, soft, brown with stony clay bands	7.3+	20.0

**GRADING**

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines			Gravel			
					- $\frac{1}{16}$	+ $\frac{1}{16}$ - $\frac{1}{4}$	+ $\frac{1}{4}$ -1	+1-4	+4-16	+16-64	+64
<b>a</b>	14	86	0	0.2-1.4	14	73	10	3	0	0	0
<b>b</b>	19	81	0	2.7-3.7	22	77	1	0	0	0	0
				3.7-4.7	23	76	1	0	0	0	0
				4.7-5.7	14	85	1	0	0	0	0
				5.7-6.7	16	81	3	0	0	0	0
				6.7-7.5	18	72	10	0	0	0	0
			Mean	19	78	3	0	0	0	0	
<b>a + b</b>	18	82	0	Mean	18	77	5	0	0	0	

Surface level (+ 86.4 m) + 284 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 March 1977

Overburden 8.8 m  
 Mineral 16.2 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
Boulder Clay	Soil, dark brown and clayey	0.3	0.3
	Clay, red-brown to grey, stiff and stony with sand lenses. Contains subangular to rounded clasts of quartzite, sandstone, igneous material, siltstone, quartz and coal. Sand horizons between 2.8 m and 3.4 m, and between 7.4 m and 7.9 m	8.5	8.8
Glacial Sand and Gravel	<b>a</b> Pebbly sand Gravel: fine with some coarse, quartzite with some volcanics, limestone, quartz, siltstone, chert and sandstone Sand: medium with fine and coarse, subangular	4.0	12.8
	<b>b</b> Sand: fine with medium, well sorted, subangular with coal. Fines with depth	12.2+	25.0

**GRADING**

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines		Sand			Gravel	
					-1/16	+1/16-1/4	+1/4-1	+1-4	+4-16	+16-64	+64
<b>a</b>	3	83	14	8.8-9.8	3	12	48	20	13	4	0
				9.8-10.8	4	9	56	23	6	2	0
				10.8-12.8	3	18	48	15	14	2	0
				Mean	3	14	50	19	11	3	0
<b>b</b>	7	93	0	12.8-13.8	3	59	38	0	0	0	0
				13.8-14.8	3	59	38	0	0	0	0
				14.8-15.8	5	63	32	0	0	0	0
				15.8-17.8	9	81	10	0	0	0	0
				17.8-21.0	7	83	10	0	0	0	0
				21.0-25.0	8	76	16	0	0	0	0
Mean	7	75	18	0	0	0	0				
<b>a+b</b>	<b>6</b>	<b>90</b>	<b>4</b>	Mean	<b>6</b>	<b>60</b>	<b>26</b>	<b>4</b>	<b>3</b>	<b>1</b>	<b>0</b>

**COMPOSITION**

	Depth below surface (m)	Percentages by weight in + 8 mm fraction						
		Quartz	Quartzite	Sandstone	Limestone	Other sediments	Igneous	Chert, flint
<b>a</b>	8.8-12.8	4	64	1	11	2	14	4

Surface level (+ 19.5 m) + 64 ft  
 Water struck at + 19.0 m  
 Shell and auger 8-in (203 mm) diameter  
 June 1977

Overburden 0.7 m  
 Mineral 1.4 m  
 Waste 15.9 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil, clayey	0.2	0.2
	Clay, soft with gleyed streaks	0.5	0.7
Glacial Sand and Gravel	'Clayey' sand: medium and fine, subangular to subrounded quartz, occasional pebbles and coal fragments	1.4	2.1
Boulder Clay	Clay, alternations of hard stony clay, soft brown clay and grey-brown silt and sand. From 5.5 m laminated in parts with occasional pebbles	9.4	11.5
Glacial Sand and Gravel	'Clayey' sand: fine with medium, subangular to subrounded quartz with traces of coal and occasional pebbles	3.0	14.5
Boulder Clay	Clay, alternating stony clay and laminated clay, silt and sand	3.0	17.5
Glacial Sand and Gravel	Sand, borehole abandoned in rising sand	0.5+	18.0

**GRADING**

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines		Sand		Gravel		
				- $\frac{1}{16}$	+ $\frac{1}{16}$ - $\frac{1}{4}$	+ $\frac{1}{4}$ -1	+1-4	+4-16	+16-64	+64
14	85	1	0.7-2.1	14	37	46	2	1	0	0

Surface level (+ 24.0 m) + 79 ft  
 Water struck at + 14.7 m  
 Shell and auger 8-in (203 mm) diameter  
 June 1977

Overburden 5.3 m  
 Mineral 14.7 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.1	0.1
Boulder Clay	Clay, reddish brown, firm, silty with rare subrounded clasts of igneous material and quartzite	5.2	5.3
Glacial Sand and Gravel	Sand: reddish brown, fine with medium subangular quartz and quartzite	14.7	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
9	91	0	5.3-7.3	9	59	32	0	0	0	0
			7.3-9.3	9	63	28	0	0	0	0
			9.3-11.3	8	59	32	1	0	0	0
			11.3-17.0	5	61	34	0	0	0	0
			17.0-20.0	19	58	23	0	0	0	0
			Mean	9	60	31	0	0	0	0

SJ 35 NW 46 3418 5764 Llyn tro Farm, Burton

Block A

Surface level (+38.3 m) +126 ft  
 Water struck at +26.8 m (Artesian)  
 Shell and auger 8-in (203 mm) diameter  
 May 1977

Overburden 11.5 m  
 Mineral 3.7 m  
 Waste 4.8 m +

## LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Boulder Clay	Clay, brown, stony containing subangular to well rounded clasts of sandstone, shale, coal and igneous material	11.3	11.5
Glacial Sand and Gravel	Pebbly sand Sand: fine with medium and some coarse, subangular to subrounded quartz with some coal and lithic fragments Gravel: fine and coarse, subangular to rounded sandstone and quartzite with some volcanics and a trace of siltstone and quartz	3.7	15.2
Boulder Clay	Clay, hard, grey-brown sandy, and stony; clasts of subangular to rounded sandstone, shale and volcanics	4.8+	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
10	74	16	11.5-12.5	10	40	27	5	7	11	0
			12.5-13.5	11	45	26	5	7	6	0
			13.5-14.5	10	35	30	9	8	8	0
			14.5-15.2	9	46	22	3	7	13	0
			Mean	10	42	26	6	7	9	0

## COMPOSITION

Depth below surface (m)	Percentages by weight in +8 mm fraction						
	Quartz	Quartzite	Sandstone	Limestone	Other sediments	Igneous	Chert, flint
11.5-15.2	Trace	44	50	—	1	5	—

Surface level (+ 66.5 m) + 218 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 February 1977

Overburden 2.1 m  
 Mineral 13.7 m  
 Waste 8.2 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
Glacial Sand and Gravel	Soil, dark brown and pebbly	0.4	0.4
	Clay, rusty brown with laminations of coal rich sand	1.7	2.1
	Sand: fine and medium, subangular to subrounded, fines content decreases with depth. Between 11.1 m and 13.1 m pebbles of quartzite, limestone, volcanics and quartz. From 2.1 m to 7.9 m light brown, below 7.9 m becomes dark grey with coal	13.7	15.8
	Clay, red-brown, sandy and silty, laminated with subrounded pebbles down to 18.5 m. Below 18.5 m soft, dark grey without pebbles	8.2+	24.0

**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
9	89	2	2.1-3.1	8	48	44	0	0	0	0
			3.1-4.1	8	48	44	0	0	0	0
			4.1-5.1	18	53	29	0	0	0	0
			5.1-6.1	18	57	25	0	0	0	0
			6.1-7.1	29	58	13	0	0	0	0
			7.1-8.1	17	44	32	7	0	0	0
			8.1-10.1	6	30	63	1	0	0	0
			10.1-11.1	3	27	56	4	5	5	0
			11.1-12.1	5	30	53	3	4	5	0
			12.1-13.1	5	46	47	1	0	0	0
			13.1-15.8	3	48	49	0	0	0	0
			Mean	9	44	44	1	1	1	0



Surface level (+79.2 m) +260 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 February 1977

Overburden 2.8 m  
 Mineral 6.3 m  
 Waste 1.1 m  
 Mineral 14.8 m+

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil, dark brown and clayey	0.5	0.5
	Clay, dark brown and sandy, very stiff at the top becoming softer and laminated in the lower half	2.3	2.8
Glacial Sand and Gravel	<b>a</b> Gravel Gravel: coarse and fine with some cobbles, subangular to subrounded quartzite with volcanics, limestone, and some quartz sandstone, chert and other sediments Sand: medium with coarse and some fine, subangular to subrounded, contains coal	6.3	9.1
	Clay, red-brown, stony	1.1	10.2
	<b>b</b> 'Clayey' sand, gravelly at the top fining downwards becoming clayey at the base Gravel: fine and coarse, subrounded pebbles of quartzite and limestone with some volcanics, quartz, sandstone, other sediments and chert Sand: fine with medium and some coarse, subrounded, light brown, becomes finer with depth	14.8+	25.0

**GRADING**

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines				Gravel		
					-1/16	+1/16-1/4	+1/4-1	+1-4	+4-16	+16-64	+64
<b>a</b>	1	50	49	2.8-4.0	2	5	20	11	17	35	10
				4.0-5.0	0	2	4	8	30	49	7
				5.0-7.0	1	5	31	15	19	29	0
				7.0-8.0	1	6	39	15	14	25	0
				8.0-9.1	2	7	61	17	8	5	0
				Mean	1	5	31	14	17	29	3
<b>b</b>	17	80	3	10.2-11.2	21	47	27	2	2	1	0
				11.2-12.2	25	32	17	4	3	19	0
				12.2-13.2	5	23	64	3	4	1	0
				13.2-14.2	5	19	71	3	2	0	0
				14.2-15.2	2	18	71	3	3	3	0
				15.2-16.2	8	32	53	4	2	1	0
				16.2-17.2	9	51	38	2	0	0	0
				17.2-18.2	8	76	15	1	0	0	0
				18.2-19.2	10	71	19	0	0	0	0
				19.2-21.5	22	71	4	1	0	2	0
				21.5-25.0	29	67	4	0	0	0	0
				Mean	17	51	27	2	1	2	0
<b>a+b</b>	12	71	17	Mean	12	37	28	6	6	10	1

**COMPOSITION**

	Depth below surface (m)	Percentages by weight in + 8 mm fraction						
		Quartz	Quartzite	Sandstone	Limestone	Other sediments	Igneous	Chert, flint
a	2.8-4.0	2	48	3	14	12	21	Trace
	4.0-5.0	3	51	3	23	3	16	1
	5.0-7.0	4	61	3	22	3	7	Trace
	7.0-8.0	10	71	3	9	4	2	1
	8.0-9.0	1	43	24	5	3	19	5
b	11.2-12.2	1	19	15	58	3	4	—
	12.2-16.2	3	56	9	20	2	9	1

**SJ 35 NW 49 3438 5586 Singrett Sand Pit, near Llay**

Surface level (+ 52.7 m) + 173 ft  
 Water level not recorded  
 Shell and auger 8-in (203 mm) diameter  
 May 1977

Mineral 5.0 m  
 Waste 25.8 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
Glacial Sand and Gravel	Sandy gravel Gravel: fine and coarse with some cobbles, rounded quartzite with volcanics, limestone, and some sandstone, quartz, siltstone and chert Sand: medium with coarse and fine, subangular to subrounded	5.0	5.0
Glacial Silt	Clay, stiff red-brown stony, passing down into laminated sands, silts and clays	2.0	7.0
	Clay, dark grey-green, very hard and stony with angular to rounded clasts of quartzite, limestone, volcanics, shale and sandstone	2.5	9.5
	Silts, laminated red-brown clays, silts and sands with pebbly horizons	12.5	22.0
	Clay, hard, stiff, brown massive stony clay, poorly sorted with subangular to subrounded quartzite and coal	3.0	25.0
	Silts, brown-buff and brown-green laminated clays, silts and sands	1.5	26.5
	Silts, green-brown clayey silts and sands with rare pebbles	4.3 +	30.8

**GRADING**

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines		Sand		Gravel		
				- 1/16	+ 1/16 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64
4	62	34	0-5.0	4	15	35	12	16	12	6

**COMPOSITION**

Depth below surface (m)	Percentages by weight in + 8 mm fraction						
	Quartz	Quartzite	Sandstone	Limestone	Other sediments	Igneous	Chert, flint
0-5.0	3	49	7	18	2	19	2

Surface level (+32.9 m) + 108 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 May 1977

Overburden 0.2 m  
 Mineral 3.3 m  
 Bedrock 0.5 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
Alluvium	Soil, sandy	0.2	0.2
	'Clayey' pebbly sand, clayey throughout with thin stony clay bands	3.3	3.5
	Gravel: fine with coarse, subangular to rounded quartzite with volcanics and some quartz, chert, sandstone, limestone and siltstone Sand: fine with some medium, subangular to subrounded quartz, clayey throughout		
Coal Measures	Sandstone	0.5+	4.0

**GRADING**

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				- 1/16	+ 1/16 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64
13	80	7	0.2-1.5	18	82	0	0	0	0	0
			1.5-2.7	9	80	4	3	3	1	0
			2.7-3.5	13	32	23	10	14	8	0
			Mean	13	68	7	3	7	2	0

**COMPOSITION**

Depth below surface (m)	Percentages by weight in +8 mm fraction						
	Quartz	Quartzite	Sandstone	Limestone	Other sediments	Igneous	Chert, flint
0.2-2.7	6	67	4	—	3	18	2
2.7-3.5	2	64	2	10	6	15	1

**SJ 35 NE 26 3532 5961 Burton Meadows**

Surface level (+8.9 m) + 29 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 June 1977

Waste 18.0 m

**LOG**

Geological classification	Lithology	Thickness m	Depth m
Alluvium	Soil, peaty, overlying peaty clay	0.6	0.6
Boulder Clay	Clay, red-brown, firm, silty and sandy with small subrounded pebble-sized clasts of quartz, quartzite and igneous material	17.4+	18.0

Surface level (+15.4 m) + 51 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 June 1977

Overburden 0.2 m  
 Mineral 1.9 m  
 Waste 15.9 m+

**LOG**

Geological classification	Lithology	Thickness m	Depth m
River Terrace Deposits	Soil, sandy	0.2	0.2
	'Clayey' sandy gravel Gravel: fine and coarse, subrounded quartzite with volcanics and some quartz, chert and sandstone Sand: medium and coarse with fine	1.9	2.1
Boulder Clay	Clay, dark brown, firm, silty and slightly sandy, poorly laminated in parts, containing occasional pebble size clasts of quartzite and igneous material	15.9+	18.0

**GRADING**

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				- 1/16	+ 1/16 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64
20	43	37	0.2-2.1	20	13	20	10	24	13	0

**COMPOSITION**

Depth below surface (m)	Percentages by weight in +8 mm fraction						
	Quartz	Quartzite	Sandstone	Limestone	Other sediments	Igneous	Chert, flint
0.2-2.1	5	60	3	—	1	27	4

Surface level (+20.1 m) + 66 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 June 1977

Overburden 0.3 m  
 Mineral 2.2 m  
 Waste 17.5 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil, clayey	0.3	0.3
River Terrace Deposits	Sandy gravel Gravel: fine and coarse, subrounded quartzite, volcanics, sandstone, limestone and quartz Sand: medium with coarse and some fine, subrounded	2.2	2.5
Boulder Clay	Clay, reddish brown, firm, slightly silty and sandy with small clasts of quartzite and igneous material	17.5 +	20.0

**GRADING**

Mean for deposit <i>percentages</i>	Depth below surface (m)	<i>percentages</i>									
		Fines	Sand	Gravel	Fines	Sand	Gravel				
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
	0.3-2.5	missing data									

Surface level (+21.5 m) + 70 ft  
 Artesian water struck at +15.0 m  
 Shell and auger 8-in (203 mm) diameter  
 February 1977

Overburden 1.0 m  
 Mineral 1.5 m  
 Waste 1.0 m  
 Mineral 2.0 m  
 Waste 1.0 m  
 Mineral 4.5 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil, dark brown and clayey	0.6	0.6
River Terrace Deposits	Clay, grey-blue, sandy with rounded quartzite pebbles	0.4	1.0
	Gravel Gravel: coarse and fine with cobbles, subrounded to rounded quartzite and limestone with volcanics, some siltstone, and traces of quartz, chert and sandstone Sand: medium with coarse and fine	1.5	2.5
Boulder Clay	Clay, red-brown, very hard with occasional stones	1.0	3.5
Glacial Sand and Gravel	'Clayey' sand: grey silty, fine with medium, subangular to subrounded with some pebbles	2.0	5.5
	Clay, dark brown with occasional pebbles, stiff	1.0	6.5
	Sand: fine and medium with a trace of coarse, subangular to subrounded, light brown with some coal	4.5 +	11.0

## GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines			Gravel			
					-1/16	+1/16-1/4	+1/4-1	+1-4	+4-16	+16-64	+64
<b>a</b>	4	30	66	1.0-2.5	4	6	15	9	15	30	21
<b>b</b>	19	81	0	3.5-5.5	19	61	20	0	0	0	0
<b>c</b>	5	95	0	6.5-7.5	5	43	52	0	0	0	0
				7.5-8.5	5	52	43	0	0	0	0
				8.5-9.5	7	51	40	0	0	2	0
				9.5-11.0	3	42	55	0	0	0	0
				Mean	5	46	49	0	0	0	0
<b>a + b + c</b>	8	79	13	Mean	8	43	34	2	3	6	4

## COMPOSITION

	Depth below surface (m)	Percentages by weight in +8 mm fraction						
		Quartz	Quartzite	Sandstone	Limestone	Other sediments	Igneous	Chert, flint
<b>a</b>	1.0-2.5	Trace	44	Trace	40	2	14	Trace

### SJ 35 NE 30 3683 5976 Moorfield, Pulford

Surface level (+15.8 m) + 52 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 June 1977

Waste 18.0 m +

## LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial Sand and Gravel	Sand, medium, clayey with subrounded pebbles of quartzite, sandstone, igneous material, limestone and traces of quartz	0.2	0.5
Boulder Clay	Clay, reddish brown, slightly silty, sandy and stony	17.5+	18.0

Surface level (+16.7 m) + 58 ft  
 Water struck at +7.8 m  
 Shell and auger 8-in (203 mm) diameter  
 July 1977

Overburden 4.0 m  
 Mineral 8.5 m  
 Waste 9.5 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Made ground	1.3	1.3
River Terrace Deposits	Gravel, coarse and fine with cobbles, mainly subrounded quartzite	0.4	1.7
	Clay, dark brown, sandy and silty with thin grey silt laminae	2.3	4.0
	Gravel, containing an horizon of laminated red-brown sandy silty clay between 8.5 m and 8.9 m	8.5	12.5
	Gravel: coarse and fine with cobbles, subrounded quartzite with volcanics, limestone and some quartz, sandstone and chert Sand: medium with coarse and fine, subangular to subrounded, becoming finer beneath the clay band at 8.9 m		
Boulder Clay	Clay, firm, red-brown, silty with small pebble size clasts of quartzite, limestone, sandstone and coal	9.5+	22.0

**GRADING**

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				-1/16	+1/16-1/4	+1/4-1	+1-4	+4-16	+16-64	+64
6	48	46	4.0-5.0	1	4	21	10	26	38	0
			5.0-6.0	1	4	18	12	23	25	17
			6.0-7.0	1	5	19	15	30	25	5
			7.0-8.5	1	4	17	20	15	28	15
			8.9-10.0	4	33	59	1	2	1	0
			10.0-12.5	1	15	39	8	17	20	0
			Mean	5	22	19	8	29	11	6

**COMPOSITION**

Depth below surface (m)	Percentages by weight in +8 mm fraction						
	Quartz	Quartzite	Sandstone	Limestone	Other sediments	Igneous	Chert, flint
4.0-5.0	3	71	—	—	1	24	1
5.0-9.0	2	56	1	17	2	20	2
9.0-12.5	5	59	2	16	—	16	2

Surface level (+14.6 m) +38 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 April 1977

Overburden 0.3 m  
 Mineral 3.2 m  
 Waste 14.5 m+

**LOG**

Geological classification	Lithology	Thickness m	Depth m
Alluvium	Soil, brown, loamy	0.3	0.3
	Gravel Gravel: coarse with fine, subangular to rounded quartzite with limestone, volcanics and some quartz sandstone and chert Sand: medium and coarse with fine	3.2	3.5
Boulder Clay	Clay, stiff, red-brown, stony, silty, with angular to subangular clasts of quartzite and sandstone, and traces of coal	14.5+	18.0

**GRADING**

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines		Sand			Gravel	
				-1/16	+1/16-1/4	+1/4-1	+1-4	+4-16	+16-64	+64
4	37	59	0.3-3.5	4	8	15	14	17	42	0

**COMPOSITION**

Depth below surface (m)	Percentages by weight in +8 mm fraction							
	Quartz	Quartzite	Sandstone	Limestone	Other sediments	Igneous	Chert, flint	
0.3-3.5	6	55	2	23	—	23	1	

SJ 35 NE 33 3669 5651 Trevalyn House, Rossett

Surface level (+16.7 m) +55 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 February 1977

Waste 18.0 m+

**LOG**

Geological classification	Lithology	Thickness m	Depth m
River Terrace Deposits	Soil, dark brown, silty and clayey	0.2	0.2
	Clay, yellow-green and grey, sandy and gravelly. The gravel consists of angular to subrounded pebbles of quartzite with quartz, limestone and volcanics, and rounded cobbles of quartzite	1.8	2.0
Boulder Clay	Clay, red-brown with small subangular to subrounded clasts of quartzite and traces of red sandstone and coal	16.0+	18.0



**SJ 35 NE 34 3668 5566 Allington Cottage, Allington**

Surface level (+ 20.9 m) + 69 ft  
 Water struck at + 12.4 m  
 Shell and auger 8 in (203 mm) diameter  
 January 1977

Waste 18.0+

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil, dark brown, clayey and stony	0.9	0.9
Boulder Clay	Clay, red-brown with gleyed streaks, very stiff, containing fine clasts of quartzite, quartz and coal, and occasional large striated clasts of quartzite. At the base becomes silty and sandy	7.6	8.5
Glacial Silt	Silts, red-brown, laminated with sand and clay	3.0	11.5
Boulder Clay	Clay, very stiff red clay, with rare small angular to subangular stones	6.5+	18.0

**SJ 35 NE 35 3754 5915 Pulford Hall, Pulford**

Surface level (+ 17.3 m) + 57 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 May 1977

Waste 18.0 m+

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil, dark brown, clayey	0.5	0.5
Boulder Clay	Clay, stiff, red-brown with gleyed streaks, sandy in parts. Contains numerous subangular to rounded clasts of quartzite, quartz, shale and coal, and traces of flint and shell fragments. With depth the clay becomes more plastic and the stones become finer	15.5	16.0
	Clay, dark red-brown, laminated, stoneless	2.0+	18.0

Surface level (+8.4 m) +28 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 June 1977

Overburden 1.0 m  
 Mineral 1.1 m  
 Waste 15.9 m+

**LOG**

Geological classification	Lithology	Thickness m	Depth m
Alluvium	Soil, clayey	0.4	0.4
	Clay, with rootlets	0.6	1.0
	Gravel Gravel: coarse and fine with cobbles, subrounded quartzite with volcanics and some quartz Sand: coarse with medium and some fine	1.1	2.1
Boulder Clay	Clay, reddish brown, firm and silty with occasional pebble size clasts of quartzite and sandstone, traces of coal	15.9+	18.0

**GRADING**

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand		Gravel			
				-1/16	+1/16-1/4	+1/4-1	+1-4	+4-16	+16-64	+64
2	16	82	1.0-2.1	2	1	5	10	22	48	12

**COMPOSITION**

Depth below surface (m)	Percentages by weight in +8 mm fraction						
	Quartz	Quartzite	Sandstone	Limestone	Other sediments	Igneous	Chert, flint
1.0-2.1	6	58	Trace	—	Trace	34	2

Surface level (+12.5 m) +41 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 May 1977

Waste 18.0 m+

**LOG**

Geological classification	Lithology	Thickness m	Depth m
Boulder Clay	Soil	0.2	0.2
	Clay, reddish brown, massive, sandy at the top, contains subrounded clasts of quartzite, quartz and volcanics	17.8+	18.0

Surface level (+ 12.9 m) + 42 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 June 1977

Waste 18.0 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
Boulder Clay	Soil	0.4	0.4
	Clay, dark brown, slightly silty with occasional coarse clasts of limestone and quartzite below 9 m	17.6+	18.0

**Block C**

Surface level (+ 6.5 m) + 21 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 June 1977

Overburden 3.9 m  
 Mineral 2.3 m  
 Waste 11.8 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
Alluvium	Soil	0.3	0.3
	Clay, dark grey, silty and sandy with occasional subrounded pebbles of quartzite and volcanics	3.6	3.9
	Gravel Gravel: coarse and fine with cobbles at the top, subrounded quartzite with volcanics and some quartz, sandstone, limestone and chert Sand: coarse and medium with fine	2.3	6.2
Boulder Clay	Clay, reddish brown, silty, with occasional stones	11.8 +	18.0

**GRADING**

Mean for deposit <i>percentages</i>			Depth below surface (m)	<i>percentages</i>						
Fines	Sand	Gravel		Fines		Sand		Gravel		
				-1/16	+1/16-1/4	+1/4-1	+1-4	+4-16	+16-64	+64
0	16	84	3.9-4.9	1	1	6	10	21	35	26
			4.9-6.2	0	1	6	8	41	44	0
			Mean	0	1	6	9	33	40	11

**COMPOSITION**

Depth below surface (m)	Percentages by weight in + 8 mm fraction						
	Quartz	Quartzite	Sandstone	Limestone	Other sediments	Igneous	Chert, flint
3.9-6.2	4	66	4	7	Trace	18	1

**SJ 35 NE 40 3825 5708 East of Trevalyn**

**Block C**

Surface level (+ 11.0 m) + 36 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 May 1977

Waste 18.0 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
Boulder Clay	Clay, reddish brown, gleyed, silty with traces of medium and coarse sand, stoneless	18.0+	18.0

**SJ 35 NE 41 3858 5640 East of Cooks Bridge, Allington**

**Block C**

Surface level (+ 7.8 m) + 26 ft  
 Water not struck  
 Shell and auger 8 in (203 mm) diameter  
 May 1977

Waste 18.0 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy	0.2	0.2
Alluvium	Sand, brown, fine to medium, very clayey	0.6	0.8
Boulder Clay	Clay, red-brown, stiff with occasional subrounded clasts of quartzite	17.2+	18.0

**SJ 35 NE 42 3830 5591 West of Daisylane Farm, Allington**

**Block C**

Surface level (+ 11.6 m) + 38 ft  
 Water not struck  
 Shell and auger 8 in (203 mm) diameter  
 May 1977

Waste 18.0 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Boulder Clay	Clay, red-brown, slightly silty and stony with poorly developed silty partings	17.8+	18.0

**SJ 35 NE 43 3965 5899 Green Farm, Poulton**

Waste 18.0 m +

Surface level (+ 17.6 m) + 58 ft  
 Water not struck  
 Shell and auger 8 in (203 mm) diameter  
 June 1977

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Boulder Clay	Clay, reddish brown, stiff, silty with some subrounded stones and poorly developed silty partings	17.8+	18.0

Surface level (+5.9 m) + 19 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 June 1977

Waste 18.0 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
Alluvium	Clay, grey, very silty and slightly sandy with clayey gravel between 1.5 and 2.2 m	2.2	2.2
Boulder Clay	Clay, reddish brown, grey at the top, firm with silty partings and occasional fine subrounded stones	15.8+	18.0

**SJ 35 NE 45 3961 5585 East of Hem House, Allington**

Surface level (+6.8 m) + 22 ft  
 Water struck at -2.2 m  
 Shell and auger 8-in (203 mm) diameter  
 May 1977

Overburden 9.0 m  
 Mineral 5.3 m  
 Waste 5.7 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
Alluvium	Clay, very sandy and silty with occasional fine subrounded pebbles of quartzite and sandstone, wood fragments at 8 m	9.0	9.0
	Clayey pebbly sand, sandy at the top coarsening downwards into pebbly sand and gravel	5.3	14.3
	Gravel: fine and coarse with cobbles, subrounded quartzite and volcanics with some quartz, chert and sandstone Sand: fine with medium and some coarse, clayey throughout, brown		
Boulder Clay	Clay, reddish brown, slightly silty, massive and stoneless	5.7+	20.0

**GRADING**

Mean for deposit percentages			Depth below surface (m)	Depth below surface (m) percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				-1/16	+1/16-1/4	+1/4-1	+1-4	+4-16	+16-64	+64
15	75	10	9.0-13.0	18	56	25	1	0	0	0
			13.0-13.7	14	45	16	9	14	2	0
			13.7-14.3	1	6	11	11	20	37	14
			Mean	15	49	23	3	4	4	2

**COMPOSITION**

Depth below surface (m)	Percentages by weight in + 8 mm fraction						
	Quartz	Quartzite	Sandstone	Limestone	Other sediments	Igneous	Chert, flint
9.0-14.3	3	45	1	—	—	50	1

Surface level (+128.7 m) +422 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 March 1977

Waste 18.0 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Boulder Clay	Clay, grey-brown, ochreous at the top, sandy, silty and stony becoming less sandy with depth. Contains numerous angular to subangular quartzite clasts	17.7 +	18.0

**SJ 35 SW 33 3126 5455 Old Hall Farm, Gwersyllt**

Surface level (+114.6 m) +376 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 March 1977

Waste 3.7 m  
 Bedrock 1.1 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Made ground, bricks and slag	0.7	0.7
Boulder Clay	Clay, greyish brown to yellow brown, sandy and stony	2.1	2.8
	Gravel, coarse and fine with well rounded medium sand	0.9	3.7
Coal Measures	Sandstone, dark grey, medium to fine grained, micaceous	1.1 +	4.8

**SJ 35 SW 34 3170 5263 North of Stanstay Park, Gwersyllt**

Surface level (+104.0 m) +340.6 ft  
 Water struck at +100.1 m  
 Shell and auger 8 in (203 mm) diameter  
 March 1977

Waste 9.3 m  
 Bedrock 0.1 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Boulder Clay	Clay, orange-brown, firm, sandy and stony	3.7	3.9
	Gravel, fine and coarse with coarse and medium sand	0.9	4.8
	Clay, greyish brown sandy and silty, massive with subrounded clasts of quartzite	3.1	7.9
	Gravel, coarse with some fine and cobbles	1.4	9.3
Coal Measures	Sandstone, buff, medium to coarse grained	0.1 +	9.4

Surface level (+98.4 m) + 323 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 March 1977

Overburden 1.0 m  
 Mineral 2.0 m  
 Waste 0.9 m  
 Mineral 13.6 m  
 Bedrock 0.4 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Made ground	0.3	0.3
	Clay, sandy with coarse subrounded pebbles and cobbles of quartzite, limestone, sandstone and igneous material	0.7	1.0
Glacial Sand and Gravel	<b>a</b> 'Clayey' sandy gravel Gravel: coarse with fine and cobbles. Composed of subrounded to rounded quartzite with limestone and some quartz, sandstone, chert and igneous material Sand: medium with coarse and fine, subangular to subrounded, reddish brown	2.0	3.0
	Clay, red-brown, slightly sandy with pebbles and cobbles at the top. Becomes less sandy and pebbly with depth passing into laminated clay with silt and sand partings	0.9	3.9
	<b>b</b> Gravel, contains a thin pebbly clay between 13.5 m and 13.7 m Gravel: fine and coarse with cobbles, subangular to rounded quartzite and limestone with sandstone, igneous material and traces of quartz, chert and other sediments Sand: buff, fine, medium and coarse, subrounded quartz and quartzite with traces of coal	13.6	17.5
Coal Measures	Mudstone, pale grey, silty	0.4+	17.9

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines		Sand			Gravel	
					-1/16	+1/16-1/4	+1/4-1	+1-4	+4-16	+16-64	+64
<b>a</b>	13	39	48	1.0-2.0	18	11	29	10	12	20	0
				2.0-3.0	8	7	16	6	17	36	10
				Mean	13	9	22	8	15	28	5
<b>b</b>	7	40	53	3.9-4.9	15	46	19	5	4	11	0
				4.9-5.9	3	6	7	6	9	26	43
				5.9-6.9	2	2	6	18	23	22	27
				6.9-7.9	2	6	11	14	25	32	10
				7.9-8.9	2	5	8	17	38	30	0
				8.9-9.9	3	14	16	7	13	24	23
				9.9-10.9	2	9	11	10	19	32	17
				10.9-11.9	3	6	14	16	21	17	23
				11.9-13.5	6	4	6	10	14	48	12
				13.7-15.5	11	20	23	12	15	19	0
				15.5-16.5	13	31	22	11	12	11	0
				16.5-17.5	6	22	21	21	11	11	8
			Mean	7	14	14	12	16	24	13	
<b>a + b</b>	8	39	53	Mean	8	13	15	11	16	25	12

**COMPOSITION**

	Depth below surface (m)	Percentages by weight in + 8 mm fraction						
		Quartz	Quartzite	Sandstone	Limestone	Other sediments	Igneous	Chert, flint
<b>a</b>	1.0-3.0	2	72	2	17	3	3	1
<b>b</b>	3.9-6.9	Trace	50	2	45	3	1	Trace
	6.9-9.9	Trace	63	17	12	2	6	Trace
	9.9-13.5	Trace	43	6	39	1	12	Trace
	13.7-17.5	1	53	1	28	1	16	1

**SJ 35 SW 36 3171 5090 Berse Drelincourt, New Broughton**

**Block B**

Surface level (+ 103.0 m) + 337 ft  
 Water not struck  
 Shell and auger 8 in (203 mm) diameter  
 March 1977

Overburden 1.5 m  
 Mineral 5.2 m  
 Waste 2.8 m  
 Mineral 9.5 m  
 Waste 1.8 m  
 Bedrock 0.2 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Made ground	1.3	1.3
	Clay, firm, brown, sandy in parts with subrounded pebbles of sandstone and quartzite	0.2	1.5
Glacial Sand and Gravel	<b>a</b> Gravel Gravel: coarse with fine and cobbles, subangular to subrounded quartzite, limestone and some igneous material, other sediments and a trace of quartz Sand: coarse with medium and fine, subangular to subrounded, reddish brown	5.2	6.7
	Clay, red-brown, firm, very silty and slightly sandy with traces of coal and occasional cobbles	2.8	9.5
	<b>b</b> Sandy gravel, clay band between 10.7 m and 10.9 m Gravel: coarse and fine with cobbles, subangular to subrounded quartzite, sandstone and limestone with some igneous, other sediments and a trace of quartz Sand: medium and fine with coarse, subangular to subrounded	9.5	19.0
Boulder Clay	Clay, dark brown, stony with subrounded quartzite, sandstone, limestone and volcanics, becomes gravelly at the base	1.8	20.8
Coal Measures	Sandstone, pale grey, medium grained	0.2+	21.0



## GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines		Sand		Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
<b>a</b>	3	16	81	1.5-2.0	3	2	5	5	9	22	54
				2.0-3.0	9	13	4	5	12	19	38
				3.0-4.0	0	1	3	16	30	27	23
				4.0-5.0	0	1	3	9	22	55	10
				5.0-6.0	1	1	3	5	16	38	36
				6.0-6.7	6	3	5	7	16	31	32
				Mean	3	4	4	8	18	33	30
<b>b</b>	8	61	31	9.5-10.5	11	19	19	20	9	19	3
				10.5-11.5	9	20	20	23	14	9	5
				11.5-12.5	9	24	27	17	11	9	3
				12.5-16.0	5	27	28	9	9	17	5
				16.0-19.0	9	13	38	5	13	17	5
				Mean	8	21	29	11	11	15	5
<b>a+b</b>	6	45	49	Mean	6	15	20	10	13	22	14

## COMPOSITION

	Depth below surface (m)	Percentages by weight in +8 mm fraction						
		Quartz	Quartzite	Sandstone	Limestone	Other sediments	Igneous	Chert, flint
<b>a</b>	1.5-2.0	Trace	17	4	78	1	1	—
	2.0-3.0	Trace	22	3	72	3	Trace	—
	3.0-4.0	Trace	38	2	56	1	2	—
	4.0-5.0	Trace	69	2	25	3	1	—
	5.0-6.0	1	42	1	52	3	2	—
	6.0-6.7	Trace	30	1	56	11	1	—
<b>b</b>	9.5-10.5	—	24	20	54	1	1	1
	10.5-11.5	1	37	10	40	12	Trace	—
	11.5-12.5	1	39	10	42	5	3	—
	12.5-16.0	Trace	25	58	8	8	1	—
	16.0-19.0	1	45	21	21	9	4	—

Surface level (+104.3 m) +342 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 March 1977

Overburden 2.7 m  
 Mineral 3.3 m  
 Waste 2.8 m  
 Mineral 6.6 m  
 Waste 3.6 m  
 Bedrock 1.0 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
Boulder Clay	Clay, dark brown with pebbles and cobbles of sandstone, quartzite, igneous material and limestone	2.7	2.7
Glacial Sand and Gravel	<b>a</b> Gravel Gravel: coarse and fine with cobbles, subrounded quartzite with limestone and some volcanics, chert, sandstone, siltstone and traces of quartz Sand: coarse and medium with a trace of fine, subrounded	3.3	6.0
Boulder Clay	Clay, reddish brown, slightly sandy with pebbles of sandstone and igneous material	2.8	8.8
Glacial Sand and Gravel	<b>b</b> Gravel, with a band of clay between 11.2 m and 12.0 m and thin bands between 12.0 m and 15.4 m Gravel: coarse and fine with some cobbles, subrounded quartzite with limestone and some sandstone and volcanics Sand: fine, medium and coarse, angular to subangular	6.6	15.4
Boulder Clay	Clay, grey-brown, stiff, poorly sorted, stony with clasts of quartzite, sandstone, limestone and traces of coal	3.6	19.0
Coal Measures	Shale, grey-black	1.0 +	20.0

**GRADING**

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines			Gravel			
					-1/16	+1/16-1/4	+1/4-1	+1-4	+4-16	+16-64	+64
<b>a</b>	2	26	72	2.7-3.2	4	1	13	14	12	25	31
				3.2-4.2	3	3	10	12	25	42	5
				4.2-5.2	1	0	5	13	25	33	23
				5.2-6.0	0	2	15	17	27	29	10
				Mean	2	2	10	14	23	33	16
<b>b</b>	7	50	43	8.8-10.0	3	7	28	24	25	13	0
				10.0-11.2	2	4	10	9	22	49	4
				12.0-13.0	15	16	17	12	13	23	4
				13.0-15.4	9	27	22	12	13	17	0
				Mean	7	16	20	14	17	24	2
<b>a + b</b>	5	41	54	Mean	5	11	16	14	20	27	7

**COMPOSITION**

	Depth below surface (m)	Percentages by weight in + 8 mm fraction						
		Quartz	Quartzite	Sandstone	Limestone	Other sediments	Igneous	Chert, flint
<b>a</b>	2.7-5.2	Trace	65	1	28	2	1	3
<b>b</b>	8.8-15.4	Trace	70	5	16	1	6	1

Surface level (+ 51.8 m) + 170 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 March 1977

Overburden 0.5 m  
 Mineral 2.6 m  
 Bedrock 0.3 m+

**LOG**

Geological classification	Lithology	Thickness m	Depth m
Alluvium	Soil	0.3	0.3
	Clay with pebbles	0.2	0.5
	Gravel	2.6	3.1
	Gravel: fine and coarse with some cobbles, subangular to subrounded quartzite with some sandstone, volcanics, chert, other sedimentary material and a trace of quartz and limestone Sand: coarse and medium with some fine, subangular		
	Sandstone, fine grained, grey, fissile	0.3+	3.4

**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
2	33	65	0.5-1.5	2	5	21	21	23	28	0
			1.5-3.1	1	3	6	16	29	34	11
			Mean	2	3	12	18	27	31	7

**COMPOSITION**

Depth below surface (m)	Percentages by weight in +8 mm fraction						
	Quartz	Quartzite	Sandstone	Limestone	Other sediments	Igneous	Chert, flint
0.5-1.5	Trace	87	Trace	Trace	4	5	3
1.5-3.1	1	68	18	—	4	2	7

Surface level (+89.7 m) +294 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 February 1977

Overburden 3.9 m  
 Mineral 21.1 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil, clayey	0.3	0.3
	Clay, reddish brown, crumbly, sandy with lenses of sand and abundant pebbles of quartzite, sandstone and igneous material	3.6	3.9
Glacial Sand and Gravel	Sandy gravel, thin pebbly clay horizon between 6.2 m and 6.5 m Gravel: fine and coarse with some cobbles, subrounded quartzite with volcanics, limestone, sandstone, quartz and some chert and other sedimentary material Sand: medium with fine and coarse, subangular to subrounded	21.1 +	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
2	60	38	3.9-4.9	9	16	29	7	16	15	8
			4.9-6.2	4	16	31	15	11	23	0
			6.5-7.5	4	11	44	8	10	23	0
			7.5-8.5	1	5	42	7	15	30	0
			8.5-9.5	0	3	12	7	18	36	24
			9.5-10.5	1	2	21	10	25	32	9
			10.5-11.5	1	1	7	8	24	35	24
			11.5-12.5	2	4	30	15	22	22	5
			12.5-13.5	1	12	45	8	5	10	19
			13.5-14.5	2	44	52	2	0	0	0
			14.5-15.5	3	51	45	1	0	0	0
			15.5-16.5	3	20	31	19	27	0	0
			16.5-17.5	1	4	15	20	43	17	0
			17.5-18.5	1	6	16	18	42	12	5
			18.5-19.5	1	7	17	20	35	20	0
			19.5-20.5	2	10	20	12	36	20	0
			20.5-21.5	2	15	30	13	23	17	0
			21.5-22.5	3	36	47	9	4	1	0
			22.5-23.5	3	33	44	7	5	8	0
			23.5-25.0	5	38	48	5	3	1	0
			Mean	2	17	32	11	17	17	4

**COMPOSITION**

Depth below surface (m)	Percentages by weight in +8 mm fraction						
	Quartz	Quartzite	Sandstone	Limestone	Other sediments	Igneous	Chert, flint
3.9-4.9	3	51	17	3	2	23	1
6.5-10.5	4	56	Trace	28	1	10	1
11.5-12.5	1	52	6	20	1	19	2
15.5-18.5	5	68	2	2	2	17	4
18.5-21.5	4	71	3	6	1	14	2
21.5-23.5	41	36	11	1	Trace	10	2
23.5-25.0	1	71	—	9	3	12	5

Surface level (+85.8 m) +282ft  
 Groundwater conditions not recorded  
 Shell and auger 8-in (203 mm) diameter  
 March 1977

Overburden 3.9 m  
 Mineral 8.3 m  
 Waste 4.1 m  
 Mineral 7.7 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Made ground, ashes and slag	3.0	3.0
Boulder Clay	Clay, orange-brown to grey with occasional thin sandy laminae and coarse sandstone clasts	0.9	3.9
Glacial Sand and Gravel	Gravel, becomes sandy and clayey at the base Gravel: fine and coarse, with cobbles between 6.9 m and 7.9 m. Subrounded quartzite with sandstone, limestone, volcanics and some quartz Sand: brown, fine, medium and coarse, subangular to subrounded	8.3	12.2
Glacial Silt	Clay, alternating with silt and clayey sand	4.1	16.3
Glacial Sand and Gravel	Gravel Gravel: coarse and fine with cobbles, subrounded quartzite with volcanics, sandstone, limestone and some quartz, chert and other sediments Sand: coarse, medium and fine, subrounded	7.7+	24.0

**GRADING**

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines		Sand		Gravel		
					-1/16	+1/16-1/4	+1/4-1	+1-4	+4-16	+16-64	+64
<b>a</b>	6	42	52	3.9-4.9	2	3	15	18	33	29	0
				4.9-5.9	1	5	7	12	33	42	0
				5.9-6.9	2	12	17	15	27	27	0
				6.9-7.9	2	4	6	12	28	25	23
				7.9-8.9	3	10	13	18	32	24	0
				8.9-9.9	2	4	6	18	27	43	0
				9.9-12.2	15	53	10	6	11	5	0
				Mean	6	18	11	13	25	24	3
<b>b</b>	4	31	65	16.3-16.8	4	2	2	6	21	48	17
				16.8-17.5	3	6	28	37	24	2	0
				17.5-19.0	2	7	11	8	27	34	11
				19.0-20.0	3	4	12	6	10	46	19
				20.0-21.5	8	12	9	6	17	29	19
				21.5-24.0	4	7	12	14	35	28	0
				Mean	4	7	12	12	25	31	9
<b>a + b</b>	5	37	58	Mean	5	13	12	12	25	27	6

**COMPOSITION**

	Depth below surface (m)	Percentages by weight in +8 mm fraction						
		Quartz	Quartzite	Sandstone	Limestone	Other sediments	Igneous	Chert, flint
<b>a</b>	3.9-6.9	3	66	9	6	2	14	Trace
	6.9-12.2	2	76	4	7	4	5	1
<b>b</b>	16.3-19.0	1	46	20	22	5	5	1
	19.0-24.0	2	64	4	20	1	8	1

**SJ 35 SW 41 3370 5431 Pont y Capel, Llay**

Surface level (+46.6 m) + 153 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 April 1977

Waste 1.0 m  
 Bedrock 1.0 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown with cobbles of sandstone	0.3	0.3
River Terrace Deposits	Clay, yellow-brown with blocks of sandstone	0.7	1.0
Coal Measures	Sandstone, reddish brown	1.0+	2.0

**SJ 35 SW 42 3328 5399 South-east of Bryn Alyn, Llay**

**Block A**

Surface level (+76.3 m) + 250 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 February 1977

Overburden 0.2 m  
 Mineral 12.3 m  
 Waste 2.0 m  
 Mineral 7.3 m  
 Bedrock 0.2 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil, pebbly	0.2	0.2
Glacial Sand and Gravel	<b>a</b> Gravel Gravel: coarse with fine, subangular to subrounded quartzite and limestone with volcanics, sandstone, some quartz, chert, other sediments and a trace of coal Sand: coarse with some medium and fine, subangular	3.8	4.0
	<b>b</b> 'Clayey' sand: buff, fine with some medium and a trace of coarse and gravel. Subangular with traces of coal, becoming finer and clayier with depth	8.5	12.5
	Clay, red-brown, laminated with thin buff coloured sand and silt laminae	2.0	14.5
	<b>c</b> Sandy gravel, coarsens with depth Gravel: coarse and fine with cobbles, subrounded quartzite, volcanics and limestone with quartz, sandstone and some chert and other sediments Sand: buff, medium and fine with some coarse, subangular to subrounded	7.3	21.8
Coal Measures	Sandstone, medium grained, ochreous	0.2+	22.0

## GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines		Sand			Gravel	
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
<b>a</b>	3	26	71	0.2-1.2	7	4	17	16	30	26	0
				1.2-2.2	1	1	7	14	26	51	0
				2.2-4.0	1	1	7	14	27	50	0
				Mean	3	2	10	14	27	44	0
<b>b</b>	20	80	0	4.0-5.0	3	49	41	2	2	3	0
				5.0-6.0	5	61	31	1	2	0	0
				6.0-7.0	8	73	18	1	0	0	0
				7.0-9.0	16	72	12	0	0	0	0
				9.0-12.5	34	61	4	1	0	0	0
				Mean	20	64	15	1	0	0	0
<b>c</b>	2	65	33	14.5-15.0	10	33	56	1	0	0	0
				15.0-16.0	3	39	53	4	1	0	0
				16.0-17.0	3	42	51	3	1	0	0
				17.0-18.0	2	28	31	3	5	15	16
				18.0-19.0	2	39	38	5	6	10	0
				19.0-20.0	1	8	18	18	24	31	0
				20.0-21.8	1	5	10	13	24	33	14
				Mean	2	25	32	8	11	16	6
<b>a + b + c</b>	10	63	27	Mean	10	37	20	6	10	15	2

## COMPOSITION

	Depth below surface (m)	Percentages by weight in +8 mm fraction						
		Quartz	Quartzite	Sandstone	Limestone	Other sediments	Igneous	Chert, flint
<b>a</b>	0.2-4.0	2	47	5	35	3	8	1
<b>b</b>	4.0-12.5	5	74	—	5	1	11	4
<b>c</b>	15.0-17.0	5	46	7	5	—	37	—
	17.0-18.0	Trace	10	3	25	1	61	—
	18.0-19.0	1	55	2	38	Trace	3	1
	19.0-20.0	2	67	3	14	2	12	Trace
	20.0-21.8	2	52	10	22	2	11	1

Surface level (+ 75.6 m) + 248 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 February 1977

Overburden 1.0 m  
 Mineral 24.0 m+

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil, leafmould (0.4 m) on clayey soil with pebbles	1.0	1.0
Glacial Sand and Gravel	<b>a</b> Gravel Gravel: coarse and fine with cobbles, subangular to subrounded quartzite with volcanics and some sandstone, quartz, limestone and other sediments Sand: coarse with medium and fine, subangular to subrounded	5.5	6.5
	<b>b</b> 'Clayey' sand Sand: fine with some medium and a trace of coarse, subangular to subrounded, mainly quartz, with fines throughout	18.5+	25.0

**GRADING**

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines			Gravel			
					- $\frac{1}{16}$	+ $\frac{1}{16}$ - $\frac{1}{4}$	+ $\frac{1}{4}$ -1	+1-4	+4-16	+16-64	+64
<b>a</b>	3	41	56	1.0-2.0	2	6	11	14	28	33	6
				2.0-3.0	2	16	22	10	12	11	27
				3.0-4.0	2	4	12	26	27	11	18
				4.0-5.0	3	5	13	24	39	16	0
				5.0-6.5	4	9	13	20	27	27	0
				Mean	3	8	14	19	27	20	9
<b>b</b>	18	82	0	6.5-7.5	6	56	33	3	1	1	0
				7.5-8.5	14	73	10	1	1	1	0
				8.5-10.5	39	56	4	1	0	0	0
				10.5-12.5	25	73	2	0	0	0	0
				12.5-14.5	20	74	3	1	1	1	0
				14.5-16.5	27	71	2	0	0	0	0
				16.5-18.5	31	65	3	0	1	0	0
				18.5-20.5	3	59	37	1	0	0	0
				20.5-22.5	5	62	33	0	0	0	0
				22.5-25.0	9	84	7	0	0	0	0
				Mean	18	69	12	1	0	0	0
<b>a + b</b>	15	72	13	Mean	15	54	13	5	6	5	2

**COMPOSITION**

	Depth below surface (m)	Percentages by weight in + 8 mm fraction						
		Quartz	Quartzite	Sandstone	Limestone	Other sediments	Igneous	Chert, flint
		<b>a</b>	1.0-2.0	3	68	3	Trace	5
	2.0-3.0	2	83	1	—	1	9	—
	3.0-4.0	3	75	5	2	2	11	—
	4.0-5.0	6	64	4	1	2	17	—
	5.0-6.5	2	77	2	4	1	12	—
<b>b</b>	6.5-7.5	1	66	7	—	4	20	—
	12.5-14.5	—	54	—	—	—	46	—
	16.5-18.5	—	—	29	—	—	71	—
	18.5-20.5	—	100	—	—	—	—	—



Surface level (+ 80.1 m) + 263 ft  
 Groundwater conditions not recorded  
 Shell and auger 8-in (203 mm) diameter  
 January 1977

Overburden 0.5 m  
 Mineral 18.5 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil, dark brown, sand and pebbly	0.5	0.5
Glacial Sand and Gravel	Pebbly sand, gravely at the top grading down into sand Gravel: fine and coarse with cobbles between 3.0 m and 4.0 m. Subrounded quartzite with some volcanics, chert, limestone, quartz and sandstone. Traces of coal and flint Sand: medium and fine with coarse, brown, subrounded grains of quartz and quartzite with some coal	18.5+	19.0

**GRADING**

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines			Gravel			
				-1/16	+1/16-1/4	+1/4-1	+1-4	+4-16	+16-64	+64
3	84	13	0.5-1.0	6	21	56	7	5	5	0
			1.0-2.0	4	14	56	10	10	6	0
			2.0-3.0	2	7	60	14	11	6	0
			3.0-4.0	1	2	17	13	18	33	16
			4.0-5.0	1	3	18	20	25	26	7
			5.0-6.0	2	12	33	11	18	24	0
			6.0-7.0	2	19	68	8	3	0	0
			7.0-8.0	2	15	54	11	10	8	0
			8.0-9.0	2	15	50	11	10	12	0
			9.0-10.0	2	29	65	3	1	0	0
			10.0-11.0	4	36	57	2	1	0	0
			11.0-12.0	4	51	43	2	0	0	0
			12.0-13.0	5	58	36	1	0	0	0
			13.0-14.0	9	63	27	1	0	0	0
			14.0-15.0	5	69	26	0	0	0	0
			15.0-16.0	4	72	24	0	0	0	0
			16.0-17.0	4	72	24	0	0	0	0
			17.0-18.0	3	68	29	0	0	0	0
			18.0-19.0	2	43	55	0	0	0	0
			Mean	3	36	42	6	6	6	1

**COMPOSITION**

Depth below surface (m)	Percentages by weight in + 8 mm fraction						
	Quartz	Quartzite	Sandstone	Limestone	Other sediments	Igneous	Chert, flint
0.5-2.0	3	75	1	—	1	11	9
2.0-19.0	2	65	2	8	3	18	2

Surface level (+71.0 m) + 233 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 February 1977

Overburden 1.0 m  
 Mineral 24.0 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, dark brown, loamy	0.3	0.3
Glacial Sand and Gravel	Clay, pale brown, sandy with rounded pebbles, becomes sandier with depth	0.7	1.0
	Sandy gravel, alternating gravel and sandy gravel with coal rich bands Gravel: coarse and fine with some cobbles, subrounded to rounded quartzite with volcanics, limestone, quartz and some chert, sandstone and other sedimentary material Sand: medium with fine and coarse, subangular to subrounded. Coarse sand is subangular and is composed of lithic clasts, medium and fine sand is composed of subrounded quartz	24.0+	25.0

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				-1/16	+1/16-1/4	+1/4-1	+1-4	+4-16	+16-64	+64
2	58	40	1.0-2.0	10	21	59	3	5	2	0
			2.0-3.0	4	3	23	14	13	32	11
			3.0-4.0	7	4	23	12	22	32	0
			4.0-5.0	2	2	15	10	26	45	0
			5.0-6.0	1	2	12	7	28	37	13
			6.0-7.0	9	10	28	9	17	24	3
			7.0-8.0	1	18	50	6	13	12	0
			8.0-9.0	1	18	42	9	24	6	0
			9.0-10.0	8	61	27	2	2	0	0
			10.0-11.0	2	19	50	10	12	7	0
			11.0-12.0	1	7	21	18	37	16	0
			12.0-13.0	1	8	26	16	37	12	0
			13.0-14.0	1	5	32	12	32	18	0
			14.0-15.0	1	9	48	12	17	13	0
			15.0-16.0	1	13	22	8	19	37	0
			16.0-17.0	1	26	52	2	8	11	0
			17.0-18.0	1	14	33	15	31	6	0
			18.0-19.0	1	6	23	10	33	24	3
			19.0-20.0	2	10	35	8	14	27	4
			20.0-21.0	4	40	46	3	3	4	0
			21.0-22.0	2	21	40	5	22	10	0
			22.0-23.0	3	13	28	15	31	10	0
			23.0-24.0	1	11	27	21	27	13	0
			24.0-25.0	2	9	22	17	25	25	0
			Mean	2	15	33	10	21	18	1

COMPOSITION

Depth below surface (m)	Percentages by weight in +8 mm fraction						
	Quartz	Quartzite	Sandstone	Limestone	Other sediments	Igneous	Chert, flint
1.0-5.0	4	71	Trace	11	2	11	1
6.0-9.0	8	63	Trace	10	5	9	5
9.0-13.0	5	51	—	12	4	23	5
13.0-17.0	3	43	1	15	—	33	5
17.0-21.0	4	63	3	15	4	11	Trace
22.0-25.0	9	51	3	21	1	15	Trace

Surface level (+64.5 m) + 212 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 July 1977

Overburden 9.9 m  
 Mineral 15.1 m+

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil, clayey	0.1	0.1
Boulder Clay	Clay, red-brown, grey at the top, silty and sandy with subrounded pebbles and cobbles of quartzite, limestone and igneous material	9.8	9.9
Glacial Sand and Gravel	Gravel Gravel: fine and coarse with some cobbles, subrounded quartzite, volcanics and limestone with sandstone and some quartz, chert and other sedimentary material Sand: brown, medium with fine and coarse, subrounded	15.1+	25.0

**GRADING**

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines		Sand		Gravel		
				- 1/16	+ 1/16-1/4	+ 1/4-1	+ 1-4	+ 4-16	+ 16-64	+ 64
2	45	53	9.9-11.0	1	5	19	10	22	26	17
			11.0-12.0	2	9	33	10	19	27	0
			12.0-13.0	1	9	24	9	24	33	0
			13.0-14.0	2	9	30	10	21	28	0
			14.0-15.0	2	6	22	10	21	29	10
			15.0-16.0	2	14	29	7	24	24	0
			16.0-17.0	2	8	32	12	24	22	0
			17.0-18.0	3	8	19	14	27	29	0
			18.0-19.0	1	5	16	11	26	41	0
			19.0-20.0	1	7	27	8	18	39	0
			20.0-21.0	2	12	26	8	22	30	0
			21.0-22.0	2	10	34	13	25	16	0
			22.0-23.0	1	5	18	13	28	35	0
			23.0-24.0	1	11	40	14	21	13	0
			24.0-25.0	2	6	20	14	26	32	0
			Mean	2	8	26	11	23	28	2

**COMPOSITION**

Depth below surface (m)	Percentages by weight in + 8 mm fraction						
	Quartz	Quartzite	Sandstone	Limestone	Other sediments	Igneous	Chert, flint
11.0-15.0	1	52	2	23	1	20	1
15.0-20.0	1	35	7	12	3	41	1
20.0-25.0	3	62	4	16	1	11	3

Surface level (+ 78.3 m) + 257 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 January 1977

Overburden 0.5 m  
 Mineral 18.5 m  
 Waste 6.0 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
Glacial Sand and Gravel	Soil, clayey with pebbles, brown	0.5	0.5
	Sandy gravel	18.5	19.0
	Gravel: fine and coarse with cobbles between 2.0 m and 4.0 m and between 9.0 m and 10.0 m. Subrounded to subangular quartzite with volcanics and some limestone, quartz, chert, coal and sandstone		
	Sand: medium with coarse and fine, subangular to subrounded. Coarse sand is subangular and composed of lithic grains, finer sand is subrounded and composed of quartz. Traces of coal		
	Clay, brown, soft, silty with some fine sand	2.5	21.5
	Clay, silty and sandy, firm with angular to subrounded clasts of quartzite, sandstone and occasional coal. Silty laminae and fine sand partings up to 0.3 m in thickness	3.5+	25.0

**GRADING**

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				- 1/16	+ 1/16-1/4	+ 1/4-1	+ 1-4	+ 4-16	+ 16-64	+ 64
5	59	36	0.5-1.5	26	8	14	8	20	22	2
			1.5-2.0	8	6	15	11	27	33	0
			2.0-3.0	1	4	13	12	33	23	14
			3.0-4.0	1	3	16	13	35	23	9
			4.0-5.0	1	2	20	15	35	27	0
			5.0-6.0	1	4	16	11	29	39	0
			6.0-7.0	2	27	39	11	15	6	0
			7.0-8.0	5	55	29	3	5	3	0
			8.0-9.0	4	15	17	16	28	20	0
			9.0-10.0	1	5	13	23	36	17	5
			10.0-11.0	1	5	37	29	21	7	0
			11.0-12.0	1	4	27	20	36	12	0
			12.0-13.0	1	6	30	20	31	12	0
			13.0-14.0	2	4	20	23	39	12	0
			14.0-15.0	3	7	62	14	13	1	0
			15.0-16.0	2	9	81	5	2	1	0
16.0-17.0	2	11	67	16	4	0	0			
17.0-18.0	11	23	44	19	3	0	0			
18.0-19.0	26	51	17	3	2	1	0			
			Mean	5	13	31	15	20	14	2

**COMPOSITION**

Depth below surface (m)	Percentages by weight in + 8 mm fraction						
	Quartz	Quartzite	Sandstone	Limestone	Other sediments	Igneous	Chert, flint
0.5-2.0	3	72	1	2	2	19	1
2.0-19.0	2	59	4	9	6	18	2

Surface level (+76.7 m) +252 ft  
 Groundwater conditions not recorded  
 Shell and auger 8-in (203 mm) diameter  
 January 1977

Overburden 0.2 m  
 Mineral 23.8 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, dark brown and sandy	0.2	0.2
Glacial Sand and Gravel	Pebbly sand, gravel at the top, fining downwards into fine sand Gravel: coarse and fine with some cobbles, subrounded quartzite with limestone, volcanics, sandstone, other sediments and some quartz, chert and coal Sand: medium and fine with a trace of coarse, fines with depth. Subangular to subrounded with small amounts of coal	23.8+	24.0

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				- <sup>1</sup> / <sub>16</sub>	+ <sup>1</sup> / <sub>16</sub> - <sup>1</sup> / <sub>4</sub>	+ <sup>1</sup> / <sub>4</sub> -1	+1-4	+4-16	+16-64	+64
5	72	23	0.2-1.0	25	7	16	19	19	14	0
			1.0-2.0	4	4	11	13	29	31	8
			2.0-3.0	2	13	28	8	10	11	28
			3.0-4.0	3	24	66	3	3	1	0
			4.0-5.3	6	27	63	2	2	0	0
			5.3-6.0	2	13	31	8	28	18	0
			6.0-7.0	1	5	23	10	26	35	0
			7.0-8.0	0	2	7	16	25	27	23
			8.0-9.0	1	3	8	14	43	31	0
			9.0-10.0	4	3	8	10	26	28	21
			10.0-11.0	2	16	9	4	27	42	0
			11.0-12.0	2	36	60	1	1	0	0
			12.0-13.0	1	18	78	2	1	0	0
			13.0-14.0	1	18	73	4	2	2	0
			14.0-15.0	3	31	60	2	0	4	0
			15.0-16.0	3	31	63	1	1	1	0
			16.0-17.0	2	49	49	0	0	0	0
			17.0-18.0	2	56	42	0	0	0	0
			18.0-19.0	2	60	38	0	0	0	0
			19.0-20.0	2	69	28	1	0	0	0
			20.0-21.0	5	73	21	1	0	0	0
			21.0-22.0	8	68	23	1	0	0	0
			22.0-23.0	22	68	9	1	0	0	0
			23.0-24.0	26	62	10	1	0	1	0
			Mean	5	32	35	5	9	11	3

COMPOSITION

Depth below surface (m)	Percentages by weight in +8 mm fraction						
	Quartz	Quartzite	Sandstone	Limestone	Other sediments	Igneous	Chert, flint
0.2-3.0	8	66	11	1	5	8	1
3.0-24.0	2	49	5	26	6	11	1

Surface level (+68.3 m) +224 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 March 1977

Overburden 0.2 m  
 Mineral 24.8 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy	0.2	0.2
Glacial Sand and Gravel	Pebbly sand, fine and clayey at the top becoming gravelly at 11.0 m Gravel: fine and coarse, subangular to subrounded quartzite and volcanics with quartz, sandstone, some chert, limestone, other sediments and coal Sand: fine and medium with a trace of coarse, coarsens with depth	24.8 +	25.0

**GRADING**

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				-1/16	+1/16-1/4	+1/4-1	+1-4	+4-16	+16-64	+64
8	83	9	0.2-1.0	16	72	10	2	0	0	0
			1.0-3.0	18	74	8	0	0	0	0
			3.0-5.0	20	76	4	0	0	0	0
			5.0-7.0	10	64	26	0	0	0	0
			7.0-9.0	5	62	33	0	0	0	0
			9.0-11.0	3	56	41	0	0	0	0
			11.0-13.0	6	9	35	8	17	25	0
			13.0-15.0	3	54	43	0	0	0	0
			15.0-17.0	2	37	58	3	0	0	0
			17.0-19.0	4	26	66	3	1	0	0
			19.0-21.0	5	21	30	7	21	16	0
			21.0-22.0	4	19	51	8	12	6	0
			22.0-23.0	3	14	40	8	18	17	0
			23.0-25.0	8	30	50	3	2	7	0
			Mean	8	45	35	3	4	5	0

**COMPOSITION**

Depth below surface (m)	Percentages by weight in +8 mm fraction						
	Quartz	Quartzite	Sandstone	Limestone	Other sediments	Igneous	Chert, flint
11.0-13.0	20	34	14	3	2	26	1
17.0-25.0	6	49	14	—	2	24	5

Surface level (+64.2 m) +211 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 February 1977

Overburden 0.2 m  
 Mineral 5.7 m  
 Waste 3.6 m  
 Mineral 2.0 m  
 Waste 0.9 m  
 Mineral 12.6 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Made ground, rubble	0.2	0.2
Glacial Sand and Gravel	<b>a</b> Sandy gravel Gravel: medium and coarse, subrounded quartzite and volcanics with limestone, quartz, chert, and some sandstone and other sediments Sand: medium with some fine and coarse, subangular to subrounded	5.7	5.9
Glacial Silt	Clay, red-brown, stiff, with sand and silt laminations	3.6	9.5
Glacial Sand and Gravel	<b>b</b> Pebbly sand Gravel: fine and coarse, subrounded quartzite with volcanics, limestone, chert, quartz and sandstone, and some other sedimentary material Sand: medium with fine and some coarse, subangular to subrounded	2.0	11.5
	Clay, reddish brown with fine pebbles of quartzite and sandstone	0.9	12.4
	<b>c</b> 'Clayey' sand, with some pebbles Sand: medium and fine with a trace of coarse, subangular to subrounded, mainly quartz	12.6 +	25.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines			Gravel			
					-1/16	+1/16-1/4	+1/4-1	+1-4	+4-16	+16-64	+64
<b>a</b>	4	63	33	0.2-2.2	2	12	24	11	28	23	0
				2.2-3.2	2	15	27	12	27	17	0
				3.2-4.2	4	19	62	5	6	4	0
				4.2-5.2	10	21	58	5	3	3	0
				5.2-5.9	6	9	34	14	20	17	0
				Mean	4	15	38	10	19	14	0
<b>b</b>	7	79	14	9.5-10.5	5	27	49	7	7	5	0
				10.5-11.5	9	22	47	6	8	8	0
				Mean	7	25	48	6	8	6	0
<b>c</b>	10	87	3	12.4-14.0	10	40	47	2	1	0	0
				14.0-15.0	6	29	59	2	1	3	0
				15.0-16.0	9	50	40	1	0	0	0
				16.0-18.0	16	44	39	1	0	0	0
				18.0-20.0	14	57	27	1	1	0	0
				20.0-22.0	11	54	34	1	0	0	0
				22.0-24.0	7	40	52	0	0	1	0
				24.0-25.0	6	30	44	2	3	15	0
				Mean	10	46	40	1	1	2	0
<b>a + b + c</b>	<b>8</b>	<b>80</b>	<b>12</b>	<b>Mean</b>	<b>8</b>	<b>35</b>	<b>41</b>	<b>4</b>	<b>6</b>	<b>6</b>	<b>0</b>

**COMPOSITION**

	Depth below surface (m)	Percentages by weight in +8 mm fraction						
		Quartz	Quartzite	Sandstone	Limestone	Other sediments	Igneous	Chert, flint
<b>a</b>	0.2-2.2	4	55	4	8	1	24	4
	3.2-5.9	1	69	1	7	2	16	4
<b>b</b>	9.5-11.5	9	42	6	13	1	18	11
<b>c</b>	14.0-25.0	4	31	2	51	2	8	2

**SJ 35 SE 24 3659 5317 Borras Head Farm, Borras**

**Block B**

Surface level (+75.3 m) +247 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 February 1977

Overburden 0.2 m  
 Mineral 9.3 m  
 Waste 2.3 m  
 Mineral 13.2 m+

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy	0.2	0.2
Glacial Sand and Gravel	<b>a</b> Gravel Gravel: fine and coarse with some cobbles, subrounded quartzite with limestone, volcanics, sandstone, some quartz and coal Sand: medium with coarse and some fine, subangular to subrounded. Mainly quartz with traces of coal	9.3	9.5
Glacial Silt	Clay, red-brown, sandy and silty with angular to rounded pebbles and laminations of fine sand, silt and clay	2.3	11.8
Glacial Sand and Gravel	<b>b</b> Pebbly sand, gravelly at the top and base, sandy in the middle Gravel: fine and coarse, subangular to subrounded quartzite and limestone with volcanics, sandstone and some quartz and coal Sand: buff, medium with fine and a trace of coarse, subangular to subrounded	13.2+	25.0



## GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines				Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
<b>a</b>	2	46	52	0.2-1.0	6	9	47	12	15	11	0
				1.0-2.3	4	7	37	12	22	18	0
				2.3-3.3	1	1	21	11	24	36	6
				3.3-4.3	1	2	17	18	35	27	0
				4.3-5.3	1	1	10	14	37	37	0
				5.3-7.3	1	4	43	12	26	14	0
				7.3-8.3	1	3	20	14	27	32	3
				8.3-9.5	0	4	20	17	25	22	12
				Mean	2	4	30	12	27	23	2
<b>b</b>	5	85	10	11.8-12.8	20	60	16	1	1	2	0
				12.8-13.8	4	22	25	5	19	25	0
				13.8-14.8	3	26	59	4	2	6	0
				14.8-15.8	3	26	62	2	3	4	0
				15.8-16.8	5	32	60	2	1	0	0
				16.8-17.8	4	33	61	1	0	1	0
				17.8-18.8	5	40	53	1	0	1	0
				18.8-19.8	4	43	52	1	0	0	0
				19.8-20.8	4	35	58	1	1	1	0
				20.8-21.8	4	25	46	6	11	8	0
				21.8-22.8	3	19	50	7	12	9	0
				22.8-23.8	3	19	61	6	6	5	0
				23.8-25.0	3	19	61	6	6	5	0
				Mean	5	30	52	3	5	5	0
<b>a + b</b>	4	69	27	Mean	4	19	43	7	13	13	1

## COMPOSITION

	Depth below surface (m)	Percentages by weight in +8 mm fraction						
		Quartz	Quartzite	Sandstone	Limestone	Other sediments	Igneous	Chert, flint
		<b>a</b>	0.2-1.0	7	54	4	—	28
	1.0-2.3	5	51	3	20	7	13	1
	3.3-4.3	2	50	8	19	9	10	2
	5.3-7.3	2	52	8	28	3	7	Trace
	7.3-8.3	2	51	2	32	7	6	—
	8.3-9.5	3	60	5	18	10	4	Trace
<b>b</b>	11.8-25.0	6	47	7	22	11	7	—

Surface level (+75.0 m) +246 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 January 1977

Overburden 1.5 m  
 Mineral 23.5 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil, clayey	0.1	0.1
	Clay, pale brown, firm, slightly sandy	1.4	1.5
Glacial Sand and Gravel	Pebbly sand Gravel: coarse and fine, subrounded quartzite with limestone, volcanics and some quartz, sandstone and other sediments Sand: red-buff, medium with fine and some coarse. The coarse sand is angular to subrounded, composed of subangular to subrounded quartz with angular to subangular quartzite and some coal. The medium sand is mainly subrounded to rounded quartz with some subangular quartzite. The fine sand is angular to subrounded quartz with small amounts of quartzite and coal. Some beds are rich in coal	23.5 +	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
3	82	15	1.5-3.0	4	34	46	2	2	12	0
			3.0-4.0	9	47	43	1	0	0	0
			4.0-5.0	5	48	46	1	0	0	0
			5.0-6.0	3	28	67	1	1	0	0
			6.0-8.0	2	13	65	4	8	8	0
			8.0-10.0	1	10	70	8	6	5	0
			10.0-12.0	5	36	54	2	2	1	0
			12.0-17.0	2	25	58	6	7	2	0
			17.0-18.0	1	4	27	21	33	14	0
			18.0-19.0	2	16	34	9	23	16	0
			19.0-20.0	2	12	34	13	27	12	0
			20.0-21.0	2	8	43	6	14	27	0
			21.0-22.0	2	9	50	5	6	21	7
			22.0-23.0	3	16	49	8	8	16	0
			23.0-24.0	4	45	47	2	2	0	0
			24.0-25.0	4	44	50	2	0	0	0
			Mean	3	24	52	6	8	7	0

**COMPOSITION**

Percentages by weight in +8 mm fraction

Depth below surface (m)	Percentages by weight in +8 mm fraction						Chert, flint
	Quartz	Quartzite	Sandstone	Limestone	Other sediments	Igneous	
1.5-25.0	2	67	1	16	1	13	Trace

Surface level (+ 73.2 m) + 240 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 February 1977

Overburden 1.8 m  
 Mineral 23.2 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil, slightly sandy with pebbles	0.3	0.3
	Clay, reddish brown, silty and sandy with occasional fine quartzite pebbles	1.5	1.8
Glacial Sand and Gravel	Sand, pebbly in parts Sand: buff-brown, medium and fine with a trace of coarse, subangular to subrounded. Fines with depth, with pebbles of quartzite, sandstone, volcanics, quartz, coal and limestone at the top	23.2+	25.0

**GRADING**

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				- $\frac{1}{16}$	+ $\frac{1}{16}$ - $\frac{1}{4}$	+ $\frac{1}{4}$ -1	+1-4	+4-16	+16-64	+64
7	91	2	1.8-2.8	8	27	57	3	3	2	0
			2.8-3.8	2	19	62	6	6	5	0
			3.8-4.8	5	15	63	5	6	6	0
			4.8-5.8	3	15	79	2	1	0	0
			5.8-6.8	2	11	79	7	1	0	0
			6.8-7.8	1	18	75	5	1	0	0
			7.8-8.8	2	36	53	1	1	0	7
			8.8-9.8	2	28	70	0	0	0	0
			9.8-10.8	2	36	61	1	0	0	0
			10.8-11.8	24	48	28	0	0	0	0
			11.8-12.8	4	40	56	0	0	0	0
			12.8-13.8	4	47	49	0	0	0	0
			13.8-14.8	2	36	62	0	0	0	0
			14.8-16.8	6	35	58	0	1	0	0
			16.8-18.8	6	53	41	0	0	0	0
			18.8-21.8	15	74	11	0	0	0	0
			21.8-25.0	13	69	18	0	0	0	0
			Mean	7	43	47	1	1	1	0

**COMPOSITION**

Depth below surface (m)	Percentages by weight in + 8 mm fraction						
	Quartz	Quartzite	Sandstone	Limestone	Other sediments	Igneous	Chert, flint
1.8-3.8	3	60	17	5	2	9	4
3.8-5.8	2	71	1	Trace	6	18	1
5.8-7.8	6	36	13		2	33	10
8.8-16.8	1	92	Trace	1	Trace	3	3

**SJ 35 SE 27 3683 5019 Big Wood, Abenbury, Wrexham**

Surface level (+46.3 m) +152 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 May 1977

Waste 18.0 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
Glacial Silt	Clay, reddish brown, firm, slightly silty becoming sandy at the base, occasional small stones	14.0	14.0
	Silts, sandy and clayey with thin clay partings. Sand is mainly fine with some medium	4.0+	18.0

**SJ 35 SE 28 3726 5485 West of Parkside, Allington**

Surface level (+22.9 m) +75 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 February 1977

Waste 18.0 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
Boulder Clay	Soil, clayey	0.3	0.3
	Clay, reddish brown, slightly silty and in parts sandy, poorly laminated, containing clasts of quartzite, sandstone and igneous material	17.7+	18.0

**SJ 35 SE 29 3750 5357 West of Commonwood, Holt**

Surface level (+31.2 m) +102 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 January 1977

Waste 18.0 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
Boulder Clay	Soil, clayey and stony	0.4	0.4
	Clay, stiff, reddish brown with gleyed streaks, containing some small subangular clasts of quartzite, coal, igneous material and rare shell fragments. Poorly laminated in parts, with thin silt and sand partings at 5 m	17.6+	18.0

**SJ 35 SE 30 3742 5260 West of Borrass Woods, Bieston**

Surface level (+48.8 m) + 160 ft  
 Water struck at +39.8 m  
 Shell and auger 8-in (203 mm) diameter  
 April 1977

Overburden 9.0 m  
 Mineral 10.0 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Boulder Clay	Clay, reddish brown with gleying, firm, sandy at the top, containing occasional fine subrounded clasts of sandstone, quartzite and traces of coal	8.8	9.0
Glacial Sand and Gravel	'Clayey' sand: fine with medium, subangular to subrounded, pale brown, silty with clay laminations up to 0.3 m thick	10.0+	19.0

**GRADING**

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
13	87	0	9.0-12.0	12	71	17	0	0	0	0
			12.0-15.0	15	54	31	0	0	0	0
			15.0-19.0	No grading data available						
			Mean	13	63	24	0	0	0	0

**SJ 35 SE 31 3750 5127 East of Clays Cottage, Brynestyn, Bieston**

Surface level (+42.1 m) + 138 ft  
 Groundwater conditions not recorded  
 Shell and auger 8-in (203 mm) diameter  
 April 1977

Overburden 4.1 m  
 Mineral 3.7 m  
 Waste 13.7 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Boulder Clay	Clay, reddish brown, gleyed, stiff, slightly silty with occasional coarse subrounded clasts of quartzite and igneous material	3.8	4.1
Glacial Sand and Gravel	'Clayey' sand, fine with some medium, subangular, traces of coal	3.7	7.8
Boulder Clay	Clay, reddish brown, sandy and silty with occasional coarse striated clasts of quartzite, limestone and igneous material, and traces of coal	13.7+	21.5

**GRADING**

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
13	87	0	4.1-6.1	12	79	9	0	0	0	0
			6.1-7.8	14	81	5	0	0	0	0
			Mean	13	80	7	0	0	0	0

**SJ 35 SE 32 3735 5061 South of Erlas Hall, Abenbury, Wrexham**

Surface level (+41.7 m) +137 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 April 1977

Waste 18.0 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Boulder Clay	Clay, reddish brown, firm, silty with occasional striated subrounded clasts of igneous material, quartzite and traces of coal	17.7+	18.0

**SJ 35 SE 33 3839 5500 Lower Parks Farm, Allington**

Surface level (+16.3 m) +54 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 May 1977

Waste 18.0 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Boulder Clay	Clay, reddish brown, gleyed, stiff, slightly silty and sandy with fine and coarse subrounded to rounded clasts of quartzite, limestone and igneous material with striations	17.8+	18.0

**SJ 35 SE 34 3842 5351 Commonwood, Holt**

Surface level (+21.8 m) +71 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 April 1977

Waste 18.0 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil, clayey	0.2	0.2
Boulder Clay	Clay, reddish brown with gleying, stiff, slightly silty with fine and coarse subrounded clasts of quartzite and igneous material	17.8+	18.0

**SJ 35 SE 35 3872 5254 Cornish Hall, Holt**

Surface level (+22.4 m) +74 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 April 1977

Waste 18.0 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Boulder Clay	Clay, reddish brown with gleyed streaks, occasional fine to coarse subrounded and striated clasts of quartzite, limestone and igneous material. Some sand size shell fragments	17.8+	18.0

**SJ 35 SE 36 3849 5137 East of Holt Lodge Farm, Holt**

Surface level (+29.7 m) +97 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 April 1977

Waste 18.0 m+

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Boulder Clay	Clay, red-brown with gleyed streaks, contains fine and coarse angular to subrounded striated clasts of quartzite, sandstone and igneous material, and sand size coal grains	17.8+	18.0

**SJ 35 SE 37 3978 5476 East of Plas Devon, Holt**

**Block C**

Surface level (+8.1 m) +27 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 May 1977

Overburden 0.2 m  
 Mineral 2.7 m  
 Waste 17.1 m+

**LOG**

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
River Terrace Deposits	Gravel Gravel: fine with coarse, subrounded quartzite with sandstone, igneous material and quartz Sand: medium with coarse and fine	2.7	2.9
Boulder Clay	Clay, reddish brown with gleyed patches, stiff, slightly silty with some fine angular to subrounded clasts of quartzite, igneous material, sandstone and quartz	17.1+	21.0

**GRADING**

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines		Sand		Gravel		
				-1/16	+1/16-1/4	+1/4-1	+1-4	+4-16	+16-64	+64
6	41	53	0.2-1.0	12	14	21	14	23	16	0
			1.0-2.0	3	4	15	10	35	33	0
			2.0-2.9	3	8	28	13	29	19	0
			Mean	6	8	21	12	30	23	0

**SJ 35 SE 38 3931 5361 East of Commonwood, Holt**

Surface level (+ 13.7 m) +45 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 February 1977

Waste 18.0 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
Boulder Clay	Soil, clayey	0.4	0.4
	Clay, reddish brown, gleyed, stiff, with fine clasts of sandstone and grains of coal	17.6+	18.0

**SJ 35 SE 39 3957 5231 North-east of Cornish Farm, Holt**

Surface level (+ 19.0 m) +62.5 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 April 1977

Waste 18.0 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
Boulder Clay	Soil, clayey	0.3	0.3
	Clay, reddish brown, gleyed, stiff, with some fine and coarse subrounded clasts of quartzite and igneous material	17.7+	18.0

**SJ 35 SE 40 3962 5058 North-west of Barn Farm, Isycoed**

Surface level (+ 22.3 m) +73 ft  
 Water not struck  
 Shell and auger 8-in (203 mm) diameter  
 May 1977

Waste 18.0 m +

**LOG**

Geological classification	Lithology	Thickness m	Depth m
Boulder Clay	Soil	0.1	0.1
	Clay, reddish brown, gleyed, stiff, slightly silty with occasional small subrounded clasts of quartzite, sandstone and igneous material	17.9+	18.0



## APPENDIX G

### LIST OF WORKINGS

In June 1977, the following sand and gravel workings were known to be operational in the area.

<i>Location</i>	<i>Grid reference</i>
Fagl	299 587
Bank Farm	332 572
Singret	345 558
West of Ffrwd	300 554
Borras Airfield	359 524
Llan y pwll	366 516

**APPENDIX H**

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

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

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Typeset for the Institute of Geological Sciences  
by Santype International Limited, Salisbury, Wilts.

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

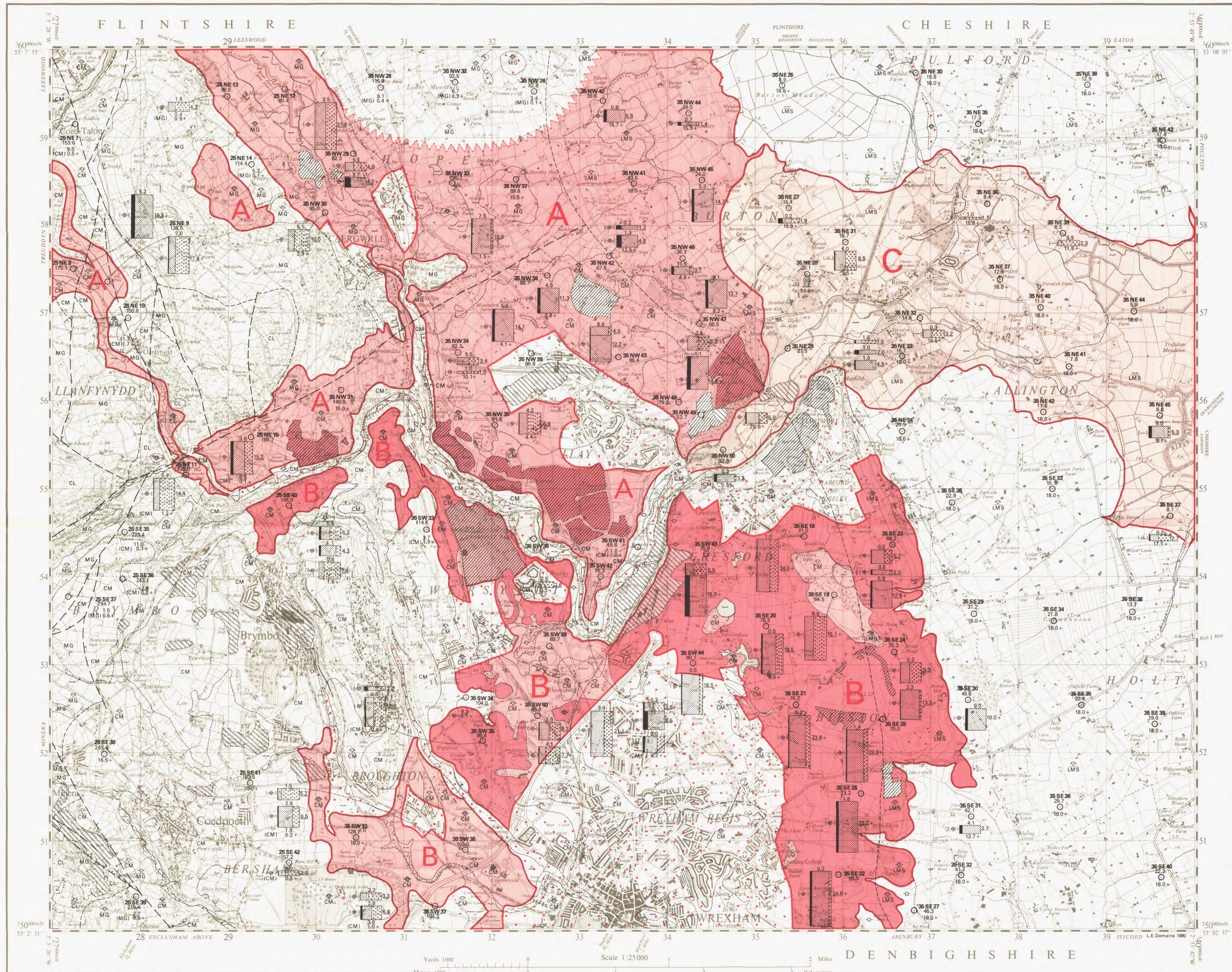
THE SAND & GRAVEL RESOURCES OF THE AREA NORTH OF WREXHAM

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

ORDNANCE SURVEY  
SHEET SJ35 & Pt SJ25  
PROVISIONAL EDITION

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

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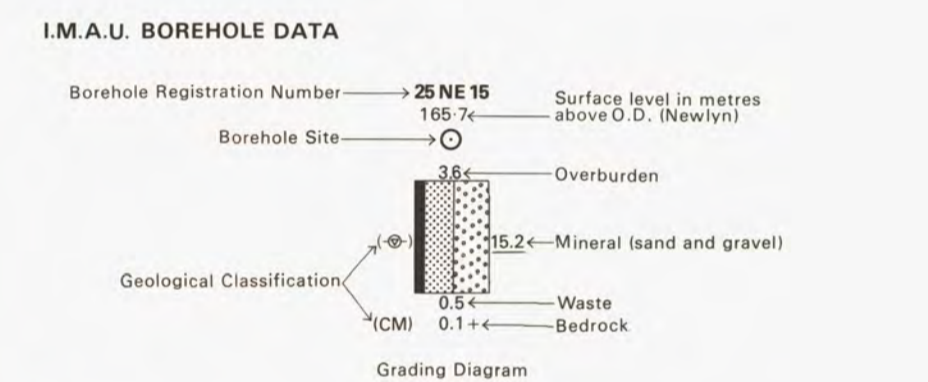
EXPLANATION OF SYMBOLS AND ABBREVIATIONS

- DRIFT**
- Peat P-1
  - Alluvium A-2
  - River Terrace Deposits, undifferentiated RT-6
  - Glacial Sand and Gravel GS-17
  - Glacial Silt GSI-1
  - Boulder Clay BC-11

- SOLID**
- LMS Lower Mottled Sandstone - red-brown, cross-bedded sandstones.
  - CM Coal Measures - mudstones, sandstones and coal seams with marls, thin limestones, conglomerates and breccias in the upper parts.
  - MG Millstone Grit 'Series' - sandstones and shales.
  - CL Carboniferous Limestone 'Series' - sparry and sandy limestones with calcareous mudstones, siltstones and sandstones.

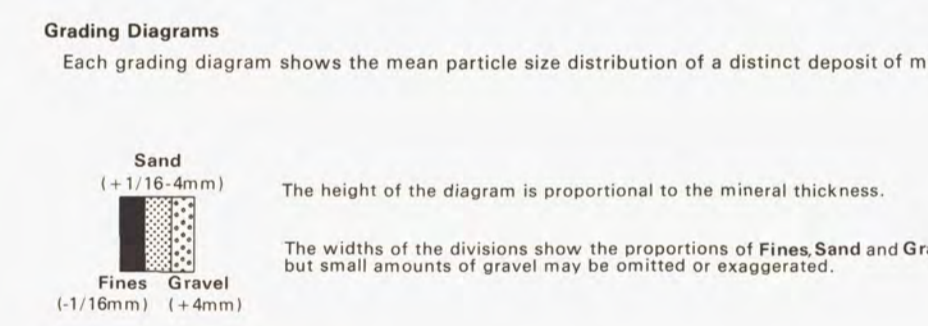
- Worked opencast sand and gravel WO-2
- Made Ground MG-2

- BOUNDARY LINES**
- Geological boundary, Drift.
  - Geological boundary, Solid.
  - Fault, crossmark indicates downthrow side.
  - Resource Block boundary.
  - Inferred boundary between recognised categories of deposits.
  - Broken line denotes uncertainty.



Note:  
(i) Measurements are in metres.  
(ii) Figures underlined denote thicknesses used in the assessment of resources.  
(iii) The = sign indicates that the base of the deposit was not reached.  
(iv) The Geological Classification is given only for mineral and bedrock.

**Borehole Registration Number**  
Each I.M.A.U. borehole is identified by a Registration Number, e.g. 25 NE 15. The first numbers and letters refer to the quarter sheet and the final numbers to the I.G.S. serial numbers for that quarter. The unique designation for borehole 25 NE 15 is SJ 25 NE 15.



- CATEGORIES OF DEPOSITS**
- Exposed mineral. CAT-E6
  - Continuous or almost continuous spreads of mineral beneath overburden. CAT-C2
  - Discontinuous mineral beneath overburden. CAT-D1
  - Sand and gravel absent. CAT-A3
  - 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 5G5

The representation on this map of a Road, Track, or Footpath, is no evidence of the existence of a right of way.  
Geological lines from six-inch surveys by A. Strahan in 1861-1862, and W.B.R. King, G.W. Lamplugh, H.H. Thomas and L.J. Willis in 1910-1913. Amended by D.J. Lowe and R.J. Tappin in 1978. I.P. Stevenson, District Geologist.  
Sand and Gravel Survey by D.F. Bell, A.R. Clayton, R.G. Crofts, P.N. Dunkley and R. Stanczyzyn in 1977.  
R.G. Thurrell, Head, Industrial Minerals Assessment Unit.  
1:25,000 Sand and Gravel Resource Sheet, published 1980.  
G.M. Brown, D.Sc. F.R.S., Director, Institute of Geological Sciences.  
110080

The GRID lines on this sheet are at 1 kilometre intervals. Heights are in feet above Mean Sea Level at Newlyn.  
1 square inch on this map represents 69,639 acres on the ground.

Compiled from 6" sheets last fully revised 1909-10. Other partial systematic revision 1938-53 has been incorporated. Major roads revised 1966-74.

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 as 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.

SJ 26	SJ 36	SJ 46
	108	109
SJ 25	SJ 35	SJ 45
	121	122
SJ 24	SJ 34	SJ 44

Diagram showing the relation of the National Grid 1:25,000 sheets with the One-Inch Geological Sheets 108, 109, 121 and 122.