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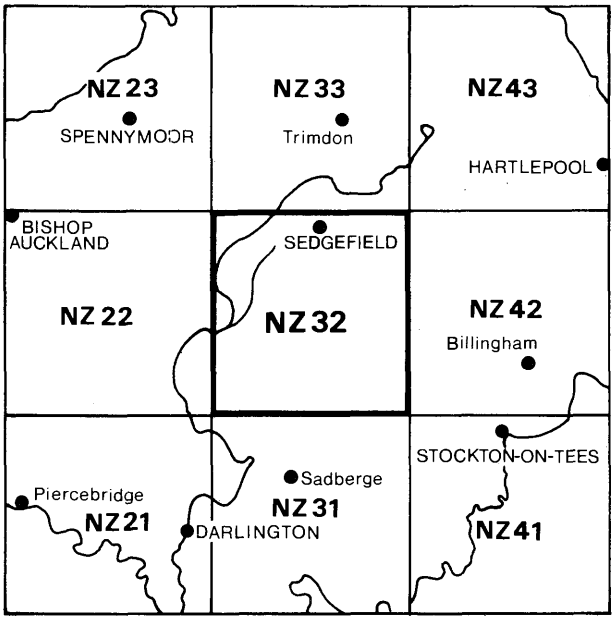

The sand and gravel resources of the country around Sedgefield, Durham

Description of 1:25 000 resource sheet NZ 32

M. D. A. Samuel

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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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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 Mineral Assessment Unit began systematic surveys in 1968. The work is now being financed by the Department of the Environment and is being undertaken with the cooperation of the Sand and Gravel Association of Great Britain.

This Report describes the resources of sand and gravel of 100 km^2 of country around Sedgefield, Durham, shown on the accompanying 1 : 25 000 resource sheet NZ 32. The survey was conducted by Mrs M. D. A. Samuel, under the supervision of Mr D. Price, assisted in the drilling and sampling programme by Messrs J. W. C. James and K. Chell. The work, which was controlled from the sub-unit in Leeds (J. H. Hull, Officer-in-Charge) is based on six-inch scale geological surveys carried out in 1953–61 and 1968–73 and published in part on one-inch new-series geological Sheet 27 (Durham).

Mr T. D. Hillyard of the Property Services Agency, Catterick, has been responsible for negotiating access to land for drilling. The ready cooperation of land owners and tenants in this work is gratefully acknowledged.

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SUMMARY

The geological maps of the Institute of Geological Sciences, pre-existing borehole information, and 80 boreholes drilled for the Industrial Minerals Assessment Unit, form the basis of the assessment of sand and gravel resources in the Sedgefield area of Durham.

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

The 1 : 25 000 map is divided into four resource blocks, containing between 3.4 and 17.1 km^2 of sand and gravel. For each block the geology of the deposits is described and the mineral-bearing area, the mean thicknesses of overburden and mineral and the mean gradings are stated. Detailed borehole data are also given. The geology, the position of the boreholes and the outlines of the resource blocks are shown on the accompanying map.

Bibliographical reference

SAMUEL, M. D. A. 1979. The sand and gravel resources of the country around Sedgefield, Durham: description of 1 : 25 000 resource sheet NZ 32. *Miner. Assess. Rep. Inst. Geol. Sci.*, No. 44.

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INTRODUCTION

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

The survey provides information at the 'indicated' level 'for which tonnage and grade are computed partly from specific measurements, samples or production data and partly from projection for a reasonable distance on geological evidence. The sites available for inspection, measurement, and sampling are too widely spaced to permit the mineral bodies to be outlined completely or the grade established throughout' (Bureau of Mines and Geological Survey, 1948, p. 15).

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

The following arbitrary physical criteria have been adopted:

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

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

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

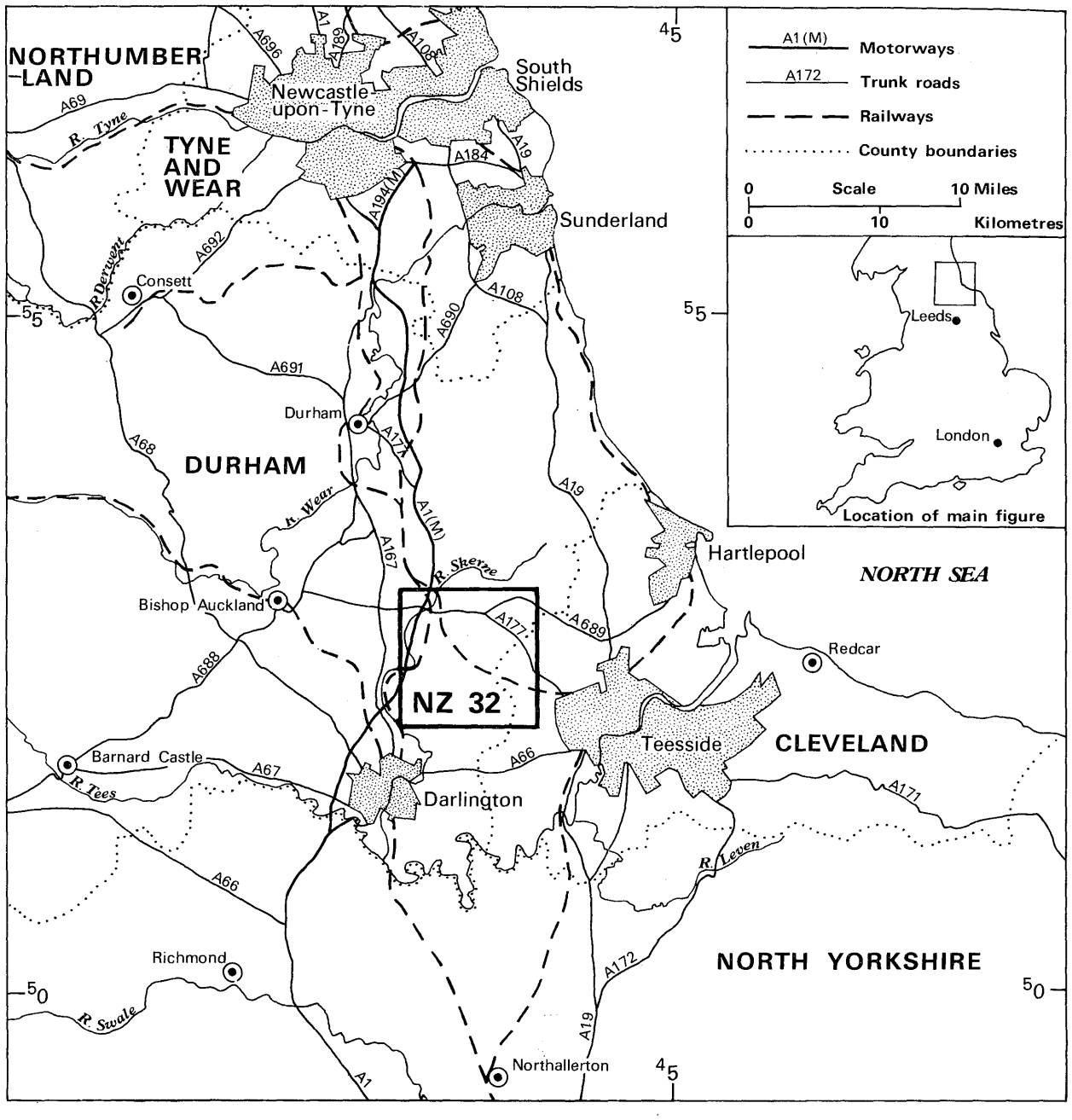


Figure 1 Sketch map showing the location of sheet NZ 32

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

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

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

DESCRIPTION OF THE AREA

GENERAL

The regional setting of the district is shown in Figure 1. Around Sedgefield, in the northern part of the resource sheet, is a plateau lying mostly above 90 m OD, but with its highest point at 122 m OD in the extreme north-west near Chilton Grange [303 299]. In the west and north-north-west are the Carrs, which are areas of relatively level marshy ground at about 75 m OD. Elsewhere, the topography is gently undulating, with elevations between 34 and 105 m OD. The River Skerne, fed by artificial drains, flows south-south-westward across the Carrs and drains the western part of the area; it eventually joins the River Tees south of Darlington. The remainder of the district is drained by numerous small streams, which eventually form Billingham Beck. The low ground frequently becomes waterlogged unless provided with an efficient system of land drains.

The area is mostly agricultural with much arable land, but there are chemical and engineering works at Stillington. In the south-east there are a few, mainly small, disused sand and gravel workings; some of these have been reclaimed, but others are in use for waste disposal.

GEOLOGY

The geological sequence is summarised in Table 1 and described briefly below. Further details may be found in the regional guide to the area (Taylor and others, 1971) and, for the most northern part, in the Durham and Hartlepool memoir (Smith and Francis, 1967).

Table 1 Geological sequence

DRIFT	
Quaternary (Recent and Pleistocene)	Peat
	Lacustrine Alluvium
	Alluvium and alluvial fan
	Head
	Glacial Sand and Gravel, including laminated clay and silt
	Boulder Clay and Glacial Drift undifferentiated
SOLID	
Permian and Triassic	Sherwood Sandstone Group ('Bunter' Sandstone)
	Permian Upper Marls, including interbedded evaporites
	Upper Magnesian Limestone
	Permian Middle Marls
	Middle Magnesian Limestone
	Lower Magnesian Limestone
	Marl Slate (not represented on the resource sheet)
	Basal Permian Sands and Breccias (not represented on the resource sheet)
Carboniferous	Namurian: Yoredale-type sequences

SOLID

There are no exposures of solid rock in the district. The nature and distribution of the solid formations are deduced from boreholes which penetrated the thick drift cover. The limits of the solid formations shown on the resource map are provisional and are being revised.

Carboniferous

Carboniferous rocks underlie the district, but incrop on the base of the drift only in the south-eastern and central parts of the area, where they form inliers surrounded by Permian strata. They comprise a Yoredale-type sequence of mudstones, shales, sandstones and limestones, with thin coals.

Permian and Triassic

Permian strata rest unconformably on Carboniferous rocks, and the lower members of the sequence, namely the Basal Sands and Breccias and the Marl Slate, are missing from the area.

The *Lower Magnesian Limestone* is found beneath drift at one locality on the northern margin of the district, and consists mainly of fine-grained dolomite in beds of varying thicknesses. The succeeding *Middle Magnesian Limestone* is found throughout most of the western part of the area and in the north-east, but is overstepped in the south-east by younger strata. It comprises thinly-bedded to massive, mainly oolitic dolomite and attains a recorded thickness of 47 m.

The *Permian Middle Marls*, consisting of reddish brown mudstones and siltstones with beds of massive and nodular anhydrite and some dolomite, range in recorded thickness from 5 m to 42 m, and occur in a narrow sinuous subcrop across the area. They are overlain by the *Upper Magnesian Limestone* which comprises grey, finely crystalline, cross-laminated dolomitic limestone and dolomite, with scattered calcitic concretions and, locally, collapse breccias. Proved thicknesses range from 18 m to 32 m.

The *Permian Upper Marls*, with the Billingham Main Anhydrite or its residue at the base, crop out beneath drift in the east. They are up to 50 m thick and consist of reddish brown silty mudstone with many red sandstone beds in the upper part.

The *Sherwood Sandstone Group* ('Bunter' Sandstone) comprises soft red sandstones with numerous reddish brown mudstone bands, which are found only in the south-eastern extremity of the district.

DRIFT

The sequence of deposits is complex and each drift deposit is lithologically variable. Thus, for example, Boulder Clay includes sand and gravel and laminated clay members which grade into each other; Glacial Sand and Gravel is similarly variable.

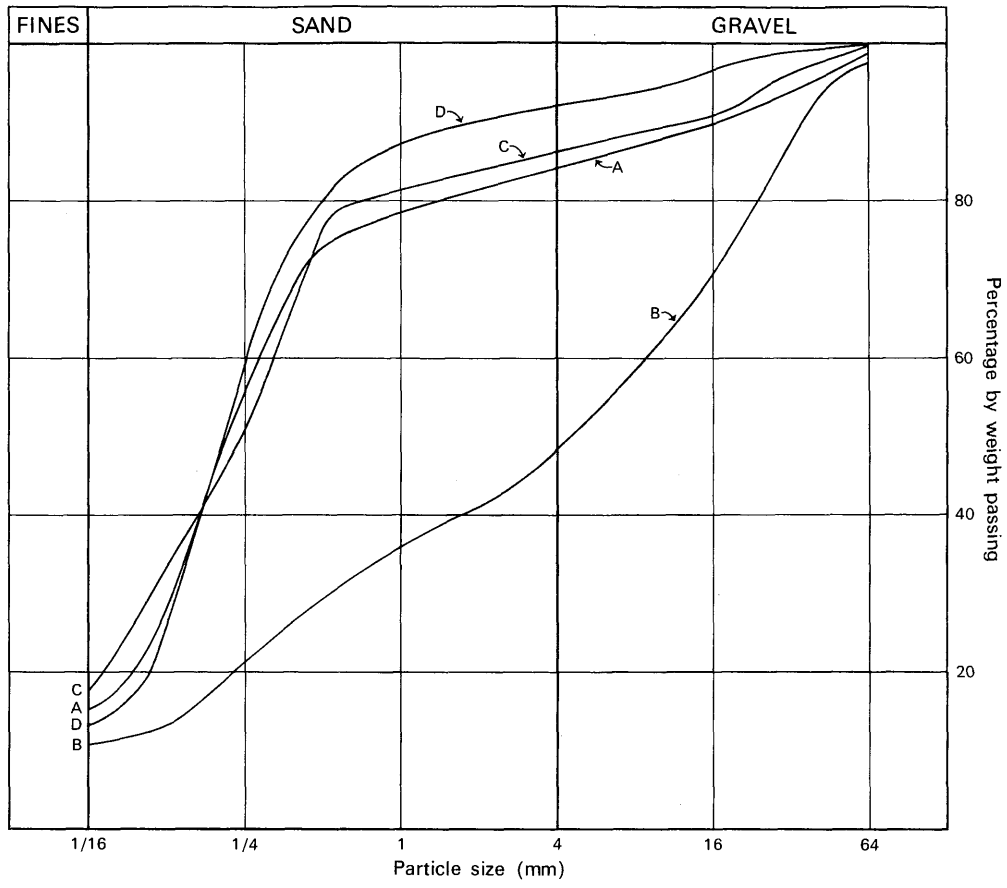
Boulder Clay (or Till)

Boulder Clay, which is probably ubiquitous, commonly exceeds 18 m in thickness, and may be subdivided in places into upper and lower tills. It consists of dark grey to reddish brown, partly sandy, pebbly clay, with scattered veins of fine sand. Erratics are mainly of coarse sand and fine gravel grades with subordinate coarse gravel and, more rarely, cobbles; however, in the lower till in the north-west many cobbles and boulders (up to 50 cm across) are found, especially near the base, and mainly comprise Magnesian Limestone and Carboniferous sandstone. Less common types include coal, siltstone and Carboniferous limestones together with, in the north, dolerite, other igneous rock (e.g. microgranite), red mudstone and soft pink sandstone. The proportion of Magnesian Limestone pebbles in the lower till decreases towards the south-east. It is in the south-eastern part of the area that the upper till is well developed, but in contrast the proportion of Magnesian Limestone pebbles declines towards the south west. Within the lower till finely laminated clays up to about 0.5 m thick are developed locally.

Glacial Sand and Gravel

Deposits of sand and gravel are found at the surface in many places, notably around Sedgefield, Bishopton and Whitton, and have been proved at depth in numerous boreholes. They are variable in composition, thickness and distribution.

Many boreholes proved 'clayey' sand, others sand with lenses of gravel or more rarely high proportions of gravel (for definitions of terms, see Appendix C). Composition is more fully discussed below. In places, particularly in the north and around Bishopton, the deposits exceed 11 m in thickness, but elsewhere they are thinner and may take the form of thin lenses within the boulder clay.



Block	Percentages by weight						
	$-\frac{1}{16}$ mm	$+\frac{1}{16}$ mm $-\frac{1}{4}$ mm	$+\frac{1}{4}$ mm -1 mm	$+1$ mm -4 mm	$+4$ mm -16 mm	$+16$ mm -64 mm	$+64$ mm
A	15	39	25	5	6	9	1
B	10	11	15	13	23	26	2
C	18	32	31	5	5	9	trace
D	13	45	29	5	5	3	trace

Figure 2 Mean particle-size distributions for the mineral in resource blocks A to D, based on data from IMAU boreholes

Locally, laminated clays occur within the deposits. In the south-west, for example, laminated pebble-free clays and silts up to 10 m in thickness have been proved.

Head
This deposit, colluvium on and at the foot of slopes and in minor valleys, mainly consists of stony clay, similar to weathered boulder clay; it occurs in small patches throughout the district, except on the Carrs and in the extreme north-west.

Alluvium and alluvial fans
Ribbons of alluvium are found along many of the streams. They comprise mainly silt and sand with lenses of gravel and, locally, beds of peat. Gravels proved below Bradbury Carrs are tentatively classified as fluvial in origin, although they may be partly glacial. In places small fans of sand and gravel extend on to alluvial flats from minor tributary valleys.

Lacustrine Alluvium
These deposits, of late-Glacial to Recent age, are found in small patches throughout the area and in the more extensive Carrs. They consist of generally stoneless, pale grey to greyish brown, laminated, micaceous clays and silts, with some fine quartz and coal sand partings.

Peat
In places, soft humic peat partly fills hollows in the lacustrine deposits. The main development is on the lacustrine alluvium of Mordon and Preston Carrs, where borehole NW 34 proved 1.5 m of peaty soil, but peat up to 0.6 m thick is also found in the alluvium of Thorpe Beck [397 234] in the south-east.

COMPOSITION OF THE SAND AND GRAVEL
Within the district only Glacial Sand and Gravel and possibly some alluvial deposits contain potentially workable sand and gravel.

Glacial Sand and Gravel
These deposits have a mean grading of 15 per cent fines, 73 per cent sand and 12 per cent gravel, but they exhibit marked variation. The mean gravel content of individual boreholes ranges from 0 to 62 per cent and the fines content from 5 to 39 per cent. 'Clayey' to 'very clayey'

sands are thicker and more widespread than the more gravelly deposits which tend to occur in irregularly distributed pockets.

The gravel fraction is generally fine to coarse, and mainly subangular to subrounded. The main constituents are Carboniferous sandstone, often coarse and micaceous and sometimes quartzitic, and soft cream to harder greyish brown Magnesian Limestone (embracing dolomites, calcitic dolomites and dolomitic limestones). Subordinate rock types include angular to subangular Carboniferous limestones, mudstone and siltstone, dark fine-grained igneous rock and, rarely, coal and chert. Additionally, traces of white quartzite, rounded vein-quartz, and bluish green and red igneous and metamorphic rocks are seen in both the gravel and coarse sand grades in some boreholes.

On average, the sand fraction comprises 57 per cent fine sand, 36 per cent medium sand and 7 per cent coarse sand. It is composed mainly of subangular to subrounded quartz with small amounts of coal, which is disseminated or concentrated into thin beds. Commonly a little Magnesian Limestone and white quartzite are also present.

Alluvium

The mineral in IMAU boreholes NW 19, 22 and 32, tentatively classified as alluvial, has a weighted mean grading of 10 per cent fines, 39 per cent sand and 51 per cent gravel. The fines content is low in two of the holes, but averages 19 per cent in samples from the other owing to the presence of thin clay seams, particularly near the top.

The gravel fraction is angular to rounded and generally fine to coarse grained but includes some cobbles. It is composed of Carboniferous sandstone, with Magnesian Limestone, which increases towards the base, and some dark grey Carboniferous limestone. There are also traces of coal, dolerite, and, more rarely, bluish grey and green igneous and metamorphic rocks. The sand fraction is fine to coarse and angular to subrounded; it is composed mainly of quartz, with some quartzite, Magnesian Limestone, Carboniferous limestones, a little chert, and traces of other rocks found in the gravel fraction.

THE MAP

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

Geological data

The geological boundary lines are taken from provisional geological maps of the area which was surveyed on the six-inch scale by D. B. Smith and G. D. Gaunt of the Institute's field staff. The 'solid' lines show an early interpretation of the sub-drift geology which is in process of revision. The drift boundaries are the best interpretation of the information available at the time of the survey. However, it is inevitable, particularly with respect to the glacial deposits which change rapidly vertically and laterally, that local irregularities and discrepancies will be revealed as new evidence from boreholes and excavations becomes available.

Borehole data, which include the stratigraphical relations and mean particle size analyses of the sand and gravel samples collected during the assessment, are summarised on the map.

Mineral resource information

For assessment purposes, the area is divided into resource blocks (see Appendix A) which are subdivided into areas where mineral is 'exposed', areas where mineral is present beneath overburden, and areas where sand and gravel is absent or not potentially workable. The mineral is identified as 'exposed', where the overburden, commonly consisting only of soil and subsoil, averages less than 1.0 m in thickness. Areas where bedrock outcrops, where boreholes indicate absence of sand and gravel beneath cover, and where sand and gravel beneath cover is interpreted to be not potentially workable are uncoloured on the Map. In such areas it has been assumed that mineral is absent except in infrequent and relatively minor patches which can neither be outlined nor assessed quantitatively in the context of this survey.

Where possible, the limits of the different categories of deposits are based on the mapped geological boundaries. Where there is a transition from one category to another which is independent of the geological lines and which could not be accurately delineated during this survey, inferred boundaries have been inserted. Such boundaries are shown by a distinctive symbol. The symbol is intended to convey an approximate location within a likely zone of occurrence, rather than to represent the breadth of the zone, its size being limited only by cartographic considerations. For the purpose of measuring area the centre-line of the symbol is used.

RESULTS

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

Table 2 The sand and gravel resources of sheet NZ 32—statistical assessment

Block	Area		Mean thickness			Volume of sand and gravel			Mean grading percentage		
	Block	Mineral	Over-burden	Mineral	Waste		Limits at the 95% confidence level		Fines	Sand	Gravel
	km²	km²	m	m	m	$m^3 \times 10^6$	± %	± $m^3 \times 10^6$	$-\frac{1}{16}$ mm	$+\frac{1}{16}$ –4 mm	+4 mm
A	28.3	14.4	3.0	7.4	1.2	107	33	36	15	69	16
B	8.9	3.4	3.7	4.4	0.6	15	38	6	10	39	51
C	48.5	17.1	6.2	7.1	1.5	121	39	47	18	68	14
D	14.3	13.6	8.7	7.0	1.3	95	25	24	13	79	8
Resource sheet	100.0	48.5	5.3	6.8	1.2	338	17	57	15	70	15

Tables 3 to 6; the cumulative grading curves are based on up to 15 data points.

Accuracy of results

For the four resource blocks the accuracy of the results at the symmetrical 95 per cent probability level varies between 25 per cent and 39 per cent (that is, it is probable that 19 times out of 20 the true volumes present lie within these limits). However, the true values are more likely to be nearer the figures estimated than either of the limits. Moreover, it is probable that approximately the same percentage limits would apply for the estimate of volume of a very much smaller parcel of ground (say, 1 km^2) containing similar sand and gravel deposits if the results from the same number of sample points (as provided by, say, ten boreholes) were used in the calculation. Thus, if closer limits are needed for the quotation of reserves of part of a block, it can be expected that data from more than 10 sample points will be required, even if the area is quite small. This point can be illustrated by considering the whole of the potentially workable sand and gravel on this sheet. The volume (338 million m^3) can be estimated to limits of ± 17 per cent at the 95 per cent probability level, by a calculation based on the data from 54 sample points spread across the four resource blocks.

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

NOTES ON RESOURCE BLOCKS

The resource block boundaries are drawn to take account of geological and geographical factors. The mineral in block A consists of Glacial Sand and Gravel which is exposed in the north around Sedgefield. Blocks C and D also contain potentially workable Glacial Sand and Gravel, but in block C it occurs discontinuously beneath overburden, whereas in block D it is more extensive and crops out in the valley sides. In contrast, the mineral in block B consists of potentially workable gravel believed to be of alluvial origin, occupying the valley of the River Skerne.

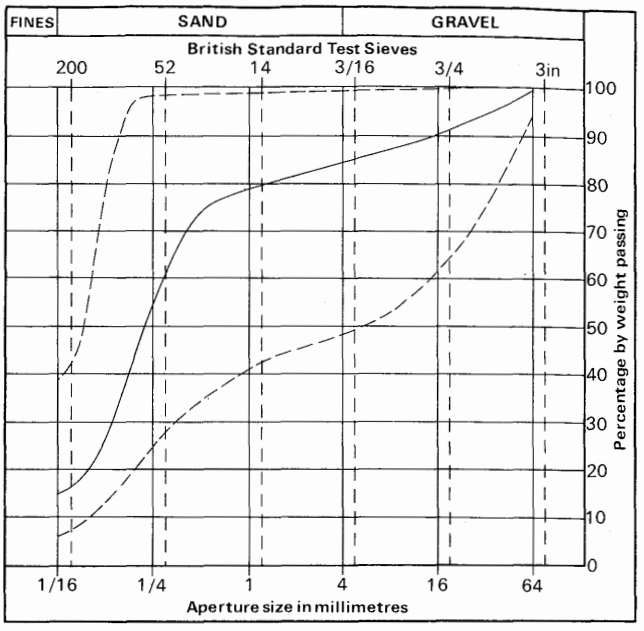


Figure 3 Grading characteristics of the mineral in block A: the continuous line represents the mean grading of the block; the broken lines denote the envelope within which the mean grading curves for individual gradings fall

Block A (Figure 3, Table 3)

The proved thicknesses of mineral range from 2.0 m to 18.0 m, with a mean of 7.4 m. Exceptionally, borehole NE 32 [3576 2984] found no sand and gravel, but the area of barren ground hereabouts cannot be delimited, and consequently the 'nil' value from this borehole has been taken into account in assessing the resources. The mineral varies in composition from 'very clayey' fine sand to 'clayey' gravel. In individual boreholes the mean fines content lies between 6 and 39 per cent, and the gravel content varies from a trace to as high as 53 per cent. Some boreholes encountered both gravelly beds and beds of almost pebble-free sand, but no simple pattern of variation is discernible.

The estimated volume of mineral in the block is 107 million m$^3 \pm 36$ million m^3, and its mean grading, based on analyses from 11 sample points, is 15 per cent fines, 69 per cent sand and 16 per cent gravel.

Overburden in areas where mineral is exposed consists

Table 3 Block A: data from assessment boreholes proving sand and gravel

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 mm
	m	m						
NW 16	18.0	5.0	6	45	30	4	6	9
NW 17	15.9	0.6	14	51	25	2	2	6
NW 20	2.0	2.5	39	59	2	trace	trace	–
NW 23	2.5	2.0	24	45	5	5	8	13
NW 24	10.0	1.0	12	37	22	8	13	8
NW 25	5.0	1.0	12	28	57	2	1	trace
NW 26	4.6	0.2	12	13	15	7	14	39
NW 27	2.0	5.6	32	24	20	5	13	6
NE 33	9.1	0.9	26	38	18	4	3	11
NE 39	16.1	1.4	18	49	31	1	trace	1
NE 44	10.6	13.0	11	15	18	12	19	25

generally of thin sandy soil, but where there is a cover of boulder clay it may range upwards in thickness probably to the maximum 18 m allowed by definition (see p. 1). Waste partings are not common, but they totalled 13.1 m in borehole NW 1, a non-IMAU borehole which penetrated a succession of interbedded sands and finely laminated clays. Additionally, borehole NE 39 proved 7.5 m of clay between 'clayey' and 'very clayey' sands.

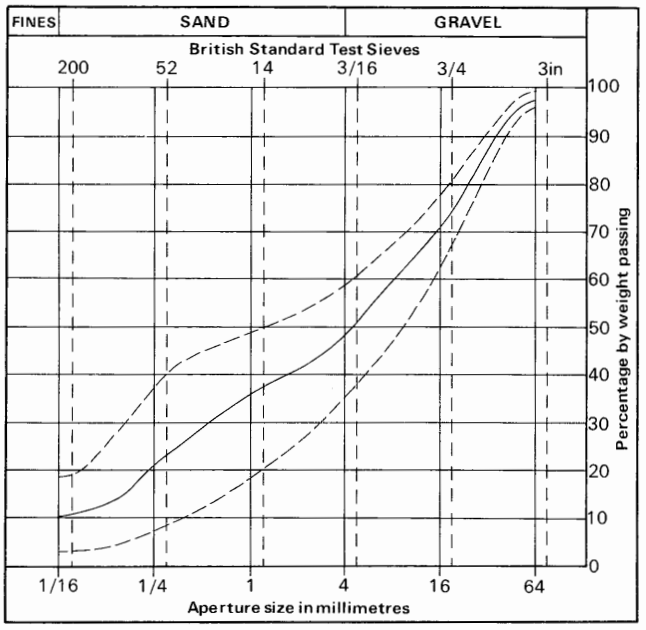


Figure 4 Grading characteristics of the mineral in block B: the continuous line represents the mean grading of the block; the broken lines denote the envelope within which the mean grading curves for individual gradings fall

Block B (Figure 4, Table 4)
This block encompasses the Carrs, much of which is covered by lacustrine alluvium and across which the River Skerne flows. Mineral is restricted to the northern part of the block, where it consists of sand and gravel, possibly of fluvial origin, which was deposited in late-Glacial or Recent times. Glacial Sand and Gravel may also be present within the block but none is known with certainty. The assessment is based on three IMAU boreholes and five site investigation records. The fluvial mineral deposits range in recorded thickness from 1.7 m (in NW 6/73, a non-IMAU borehole) to 6.7 m, giving a mean of 4.4 m. Their mean grading, based on IMAU borehole samples, is 10 per cent fines, 39 per cent sand and 51 per cent gravel and the estimated volume of mineral present is 15 million $m^3 \pm 6$ million m^3.

The alluvial clay and silt overburden ranges from 0.5 m to 7.8 m in recorded thickness, with a mean of 3.7 m, using the data from all eight mineral-bearing boreholes, appropriately weighted (see Appendix B, paragraph 15).

Block C (Figure 5, Table 5)
This block occupies a large tract in the centre of the sheet, but the area of mineral is 17.1 km^2. Only eight IMAU and five other boreholes proved mineral. The remaining 31 IMAU holes found sand and gravel to be absent, thin or too deeply buried beneath overburden to be potentially workable. Although the limiting ratio of thickness of overburden to mineral is slightly exceeded, the data from borehole SE 47 are included in the assessment calculations, because other evidence indicates that the closely surrounding area is mineral-bearing. The extent of the mineral, as shown on the resource map, is inferred from consideration of borehole data and topography and assumes some lateral continuity of deposits proved in boreholes; it is nevertheless largely hypothetical.

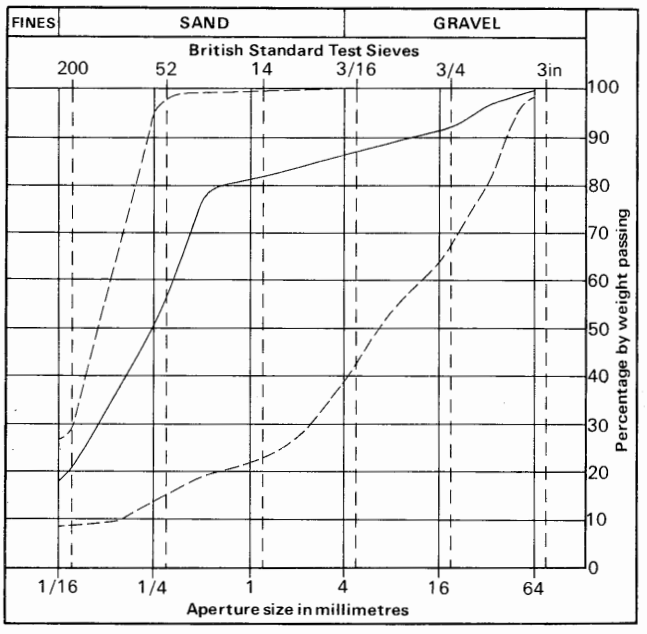


Figure 5 Grading characteristics of the mineral in block C: the continuous line represents the mean grading of the block; the broken lines denote the envelope within which the mean grading curves for individual gradings fall

Table 4 Block B: data from assessment boreholes proving sand and gravel

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 mm
	m	m						
NW 19	5.7	7.8	3	4	12	16	28	37
NW 22	6.7	7.7	19	18	12	10	18	23
NW 31	*1.1**	*14.8*	1	3	16	14	25	41
NW 32	3.4	0.5	3	9	27	12	24	25

* Italics in this table indicate that the sand and gravel encountered does not satisfy the requirements for mineral as defined on p. 1.

Table 5 Block C: data from assessment boreholes proving sand and gravel

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 mm
	m	m						
NE 45	*1.8*	*13.5*	25	15	15	15	21	9
SW 24	*1.0**	*7.0*	18	7	6	4	18	47
SW 26	*4.0*	2.9	11	19	69	1	trace	trace
SW 29	6.0	6.0	14	81	5	trace	–	–
SW 30	3.7	9.0	13	24	9	7	12	35
SW 31	6.3	7.9	11	22	54	9	3	1
SW 32	18.2	3.3	27	58	14	1	trace	–
SW 33	2.5	6.0	8	6	8	16	34	28
SW 40	*1.7*	*13.2*	28	60	2	trace	–	10
SW 43	9.0	5.0	19	48	24	2	4	3
SE 43	*4.4*	*13.7*	24	40	6	4	8	18
SE 47	*3.8*	*12.2*	15	15	39	18	5	8
SE 49	*2.9*	*12.8*	6	31	11	7	11	34
SE 52	7.0	2.4	16	11	11	9	16	37

* Italics in this table indicate that the sand and gravel encountered does not satisfy the requirements for mineral as defined on p. 1.

The hilly terrain, together with the irregularity of the beds, result in wide ranges of thickness of mineral and overburden. The proved thickness of potentially workable sand and gravel ranges from 1.8 m at NE 13 [3575 2652] and 2.1 m at NW 14 [3395 2541] (both non-IMAU boreholes, not shown on Table 5) to 18.2 m at SW 32. The overall mean thickness of mineral is 7.1 m and the estimated volume is 121 million $m^3 \pm 47$ million m^3.

In the south-west quarter of the block several boreholes encountered a few metres of 'clayey' sand, in places pebbly, beneath the boulder clay, and the higher ground west of Great Stainton [337 220] may conceal more below 18 m depth. Gravelly beds also occur, as around Preston-le-Skerne, and elsewhere in the block both sands and gravels were found. The mean grading for the block is 18 per cent fines, 68 per cent sand and 14 per cent gravel.

Overburden ranges from 1.5 m of clay at NW 14 [3396 2541] to 17.7 m of sandy clay and boulder clay, with very thin seams of gravel, at NE 7 near Shotton [369 253], both non-IMAU boreholes. Waste partings, found in four of the 14 mineral-bearing boreholes, are mostly thin, except at SW 43, East Ketton [3090 2037], where 10.1 m of laminated clay lies between 'very clayey' and 'clayey' pebbly sands.

Block D (Figure 6, Table 6)

The mineral of this block lies largely beneath overburden but is at the surface near Bishopton, in the side of the valley occupied by Bishopton, Whitton and Thorpe becks and in other scattered, mainly small exposures.

Proved thicknesses of mineral range from 2.9 m in borehole SE 58 to 13.5 m in SE 63 (where it is split by a minor parting), giving a mean of 7.0 m and an estimated volume of 95 million $m^3 \pm 24$ million m^3. Generally, the mineral consists of 'clayey' to 'very clayey' sand, but thin, more pebbly beds are recorded in several boreholes, with a maximum of 56 per cent for the gravel fraction of the basal mineral bed in borehole SE 54. Although the thicknesses of sand and gravel in borehole SE 50 are insufficient for the beds to be potentially workable, they are included in the calculations because the site is within a general area thought to be mineral-bearing.

Where overburden is present it ranges in recorded thickness up to 14.5 m and consists of clay with small pebbles. A parting, mainly of laminated clay, 10.8 m thick, is present at borehole SE 56; at borehole SE 50 there is a waste parting 5.3 m thick; and at borehole SE 57 three waste partings total 3.8 m. Minor partings were encountered in two other boreholes. The weighted mean thickness of overburden is 8.7 m and that of waste 1.3 m, including data from non-IMAU boreholes.

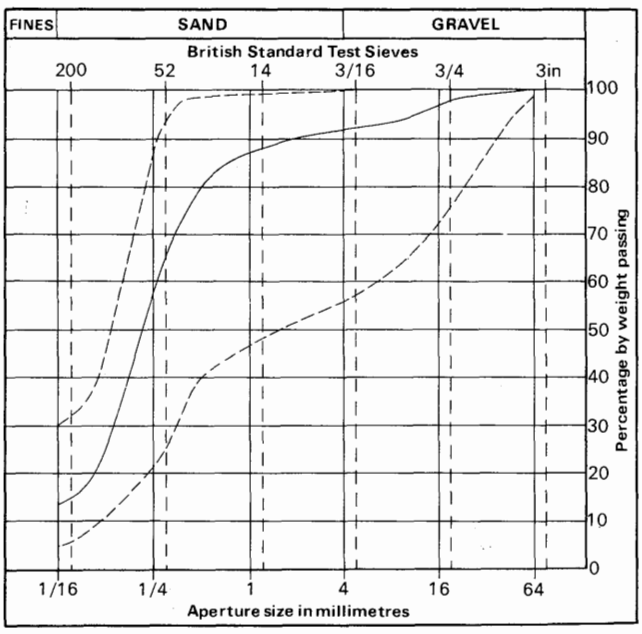


Figure 6 Grading characteristics of the mineral in block D: the continuous line represents the mean grading of the block; the broken lines denote the envelope within which the mean grading curves for individual gradings fall. The grading for the sand and gravel in borehole SE 50 has been included in the envelope, as the thicknesses have been used in the calculations (see description for block D)

Table 6 Block D: data from assessment boreholes proving sand and gravel

Borehole	Recorded thickness		Mean grading percentage					
	Mineral	Over-burden	Fines $-\frac{1}{16}$ mm	Fine sand $+\frac{1}{16}$–$\frac{1}{4}$ mm	Medium sand $+\frac{1}{4}$–1 mm	Coarse sand +1–4 mm	Fine gravel +4–16 mm	Coarse gravel +16 mm
	m	m						
SW 44	4.2	5.8	30	45	23	1	1	–
SE 50	*4.2**	*6.4*	10	11	26	8	16	29
SE 51	7.0	10.2	14	35	30	8	7	6
SE 53	5.9	12.9	8	20	40	12	12	8
SE 54	8.2	12.9	5	36	32	9	12	6
SE 56	10.7	1.0	11	56	31	trace	trace	2
SE 57	10.9	5.1	10	33	50	6	1	trace
SE 58	2.9	1.6	9	14	32	17	18	10
SE 59	3.6	10.9	13	33	44	7	3	trace
SE 60	8.5	11.5	19	58	20	2	1	–
SE 61	5.7	14.5	13	40	40	4	2	1
SE 62	6.5	10.0	9	70	12	7	2	trace
SE 63	13.5	11.2	19	68	12	trace	trace	trace

* Italics in this table indicate that the sand and gravel encountered does not satisfy the requirements for mineral as defined on p. 1.

APPENDIX A

FIELD AND LABORATORY PROCEDURES

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

The mineral shown on each 1: 25 000 sheet is divided into resource blocks. The ideal arbitrary size selected, 10 km², is a compromise to meet the aims of the survey by providing sufficient sample points in each block. As far as possible the block boundaries are determined by geological boundaries so that, for example, glacial and river terrace gravels are separated. Otherwise division is by arbitrary lines, which may bear no relationship to the geology. The blocks are drawn provisionally before drilling begins.

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

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

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

A continuous series of bulk samples is taken throughout the sand and gravel. Ideally samples are composed exclusively of the whole of the material encountered in the borehole between stated depths. However, care is taken to discard, as far as possible, material which has caved or has been pumped from the bottom of the hole. A new sample is commenced whenever there is an appreciable lithological change within the sand and gravel, or at every 1 m (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

STATISTICAL PROCEDURE

Statistical assessment

1 A statistical assessment is made of an area of mineral greater than 2 km², if there is a minimum of five evenly spaced boreholes in the resource block (for smaller areas see paragraph 12 below).

2 The simple methods used in the calculations are consistent with the amount of data provided by the survey. Conventional symmetrical confidence limits are calculated for the 95 per cent probability level, that is, there is a 5 per cent or one in twenty chance of a result falling outside the stated limits.

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

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

4 The above relationship may be transposed such that

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

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

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

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

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

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

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

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

6 The sampled area in each resource block is coloured pink on the map. Wherever possible, calculations relate to the mineral within mapped geological boundaries (which may not necessarily correspond to the limits of deposit). Where the area is not defined by a mapped boundary, that is, where the boundary is inferred, a distinctive symbol is used. Experience suggests that the errors in determining area are small relative to those in thickness. The relationship $S_A/S_{\bar{l}_m} \leqslant \frac{1}{3}$ is assumed in all cases. It follows from equation [2] that

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

7 The limits on the estimate of mean thickness of mineral, $L_{\bar{l}_m}$, may be expressed in absolute units $\pm (t/\sqrt{n}) \times S_{\bar{l}_m}$ or as a percentage $\pm (t/\sqrt{n}) \times S_{\bar{l}_m} \times (100/\bar{l}_m)$ per cent, where t is Student's t at the 95 per cent probability level for $(n-1)$ degrees of freedom, evaluated by reference to statistical tables. (In

Block calculation 1 : 25 000 Block } Fictitious

Area
Block: 11.08 km²
Mineral: 8.32 km²

Mean thickness
Overburden: 2.5 m
Mineral: 6.5 m

Volume
Overburden: 21 million m³
Mineral: 54 million m³

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

Thickness estimate: measurements in metres
l_o = overburden thickness l_m = mineral thickness

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

Calculation of confidence limits

l_m	$(l_m - \bar{l}_m)$	$(l_m - \bar{l}_m)^2$
9.4	2.9	8.41
5.8	0.7	0.49
6.9	0.4	0.16
6.4	0.1	0.01
4.1	2.4	5.76
6.4	0.1	0.01
7.2	0.7	0.49
5.8	0.7	0.49

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

L_p is calculated as

$$1.05\,(t/\bar{l}_m)\sqrt{[\Sigma(l_m - \bar{l}_m)^2/n(n-1)]} \times 100$$
$$= 1.05 \times (2.365/6.5)\sqrt{[15.82/(8 \times 7)]} \times 100$$
$$= 20.3$$
$$\doteq 20 \text{ per cent.}$$

Figure 7 Example of recource block assessment: calculation and results

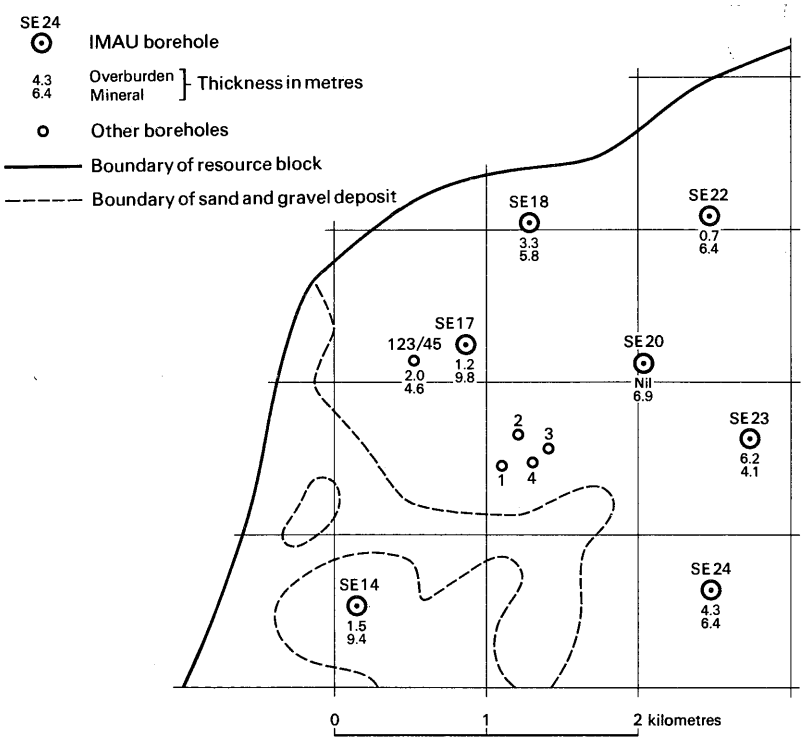


Figure 8 Example of resource block assessment: map of fictitious block

applying Student's t it is assumed that the measurements are distributed normally).

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

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

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

9 In calculating confidence limits for volume, L_V, the following inequality corresponding to equation [3] is applied: $L_{\bar{l}_m} \leqslant L_V \leqslant 1.05\, L_{\bar{l}_m}$

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

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

per cent, and when n is greater than 20, as

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

per cent.

11 . The application of this procedure to a fictitious area is illustrated in Figures 7 and 8.

Inferred assessment

12 If the sampled area of mineral in a resource block is between 0.25 km² and 2 km² an assessment is inferred, based on geological and topographical information usually supported by the data from one or two boreholes. The volume of mineral is calculated as the product of the area, measured from field data, and the estimated thickness. Confidence limits are not calculated.

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

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

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

APPENDIX C

CLASSIFICATION AND DESCRIPTION OF SAND AND GRAVEL

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

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

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

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

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

Thus it is possible to classify the mineral into one of twelve descriptive categories (see Figure 9). The procedure is as follows:

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

For example, a deposit grading 11 per cent gravel, 70 per cent sand and 19 per cent fines is classified as 'clayey' pebbly sand. This short description is included in the borehole log (see Note 9, Appendix D).

Many differing proposals exist for the classification of the grain size of sediments (Atterberg, 1905; Udden, 1914; Wentworth, 1922; Wentworth, 1935; Allen, 1936; Twenhofel, 1937; Lane and others, 1947). As Archer (1970a, b) has emphasised, there is a pressing need for a simple metric scale acceptable to both scientific and engineering interests, for which the class limit sizes correspond closely with certain marked changes in the natural properties of mineral particles. For example, there is an important change in the degree of cohesion between particles at about the $\frac{1}{16}$ -mm size, which approximates to the generally accepted boundary between silt and sand. These and other requirements are met by a system based on Udden's geometric scale and a simplified form of Wentworth's terminology (Table 7). 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 data are available for reference at the appropriate office of the Institute.

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

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

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

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

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

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

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

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

Table 7 Classification of gravel, sand and fines

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

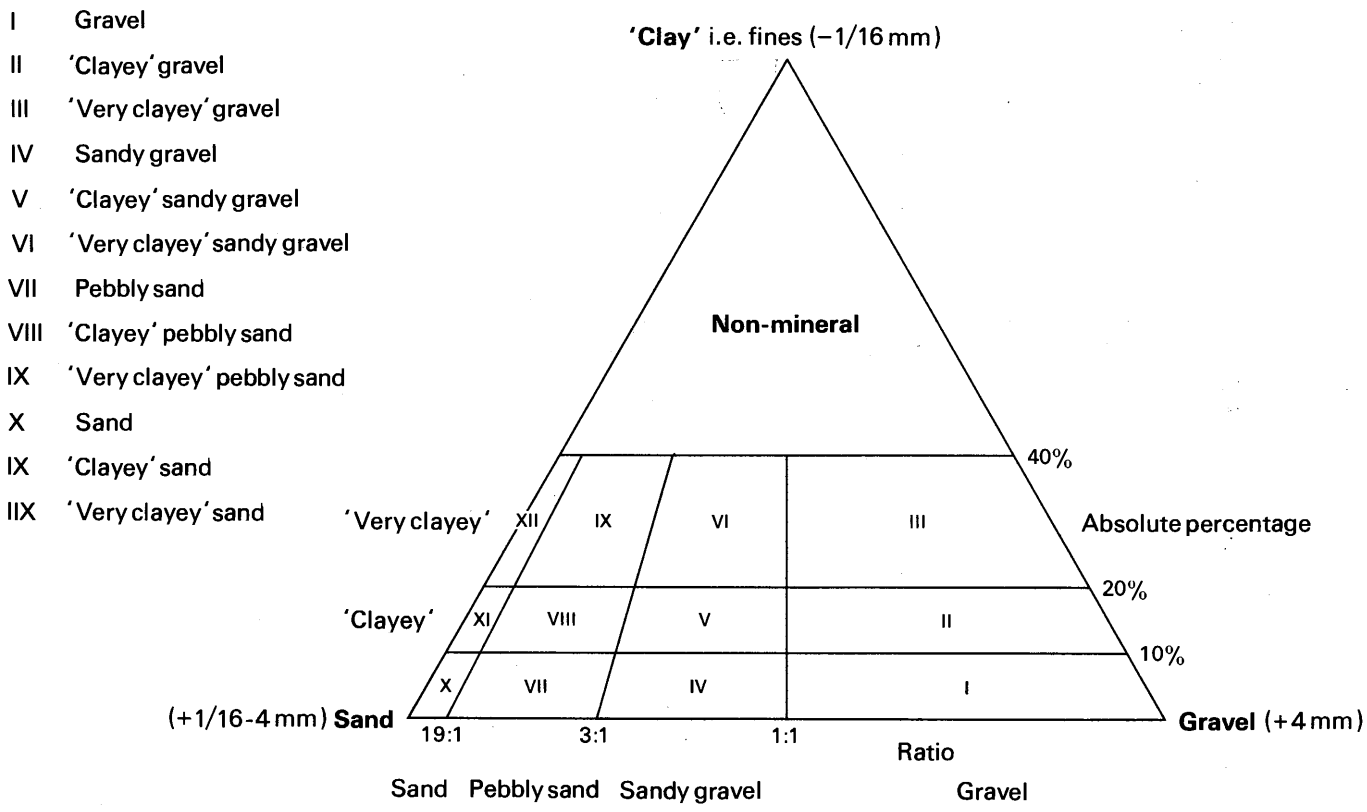


Figure 9 Diagram showing the descriptive categories used in the classification of sand and gravel

APPENDIX D

EXPLANATION OF THE BOREHOLE RECORDS

Annotated fictitious example

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

Surface level (+ 49.7 m) + 163 ft[4]
Water struck at + 45.9 m[5]
October 1972[6]

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

Log

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

Grading[10]

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
a	5	46	49	2.8–3.8	20	14	62	2	2	–	–
				3.8–4.8	2	2	12	18	42	24	–
				4.8–5.8	1	3	24	13	35	24	–
				5.8–6.8	0	4	21	20	26	29	–
				6.8–8.2	4	3	23	10	23	30	7
				Mean	5	5	28	13	25	22	2
b	5	95	0	9.3–10.3	3	73	23	1	–	–	–
				10.3–10.7	9	85	5	1	–	–	–
				Mean	5	77	17	1	–	–	–
a+b	5	56	39	Mean	5	20	26	10	20	17	2

Composition of gravel fraction[11]

Depth below surface (m)	Percentages by weight				
	Flint	Quartz	Limestone	Chalk	Ironstone
3.8–4.8	41	5	50	1	3
4.8–5.8	39	3	45	5	8
5.8–6.8	45	2	42	5	6
6.8–8.2	19	6	61	3	11
Mean	35	4	51	3	7

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

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

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

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

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

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

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

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

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

6 Type of drill and date of drilling
Unless otherwise stated the borehole was drilled by a shell and auger rig using 152 mm diameter casing. The month and year of completion of drilling are stated.

7 Overburden, mineral, waste and bedrock
Mineral is sand and gravel which, as part of a deposit, falls within the arbitrary definition of potentially workable material (see p. 1). Bedrock is the 'formation', 'country rock' or 'rock head' below which potentially workable sand and gravel will not be found. Waste is any material other than bedrock or mineral. Where waste occurs between the surface and mineral it is classified as overburden.

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

9 Lithological description
When sand and gravel is recorded a general description based on the grading characteristics (for details see Appendix C) is followed by more detailed particulars of the gravel and/or sand fractions. Where more than one bed of mineral is recognised each is designated by a letter, e.g. **a**, **b**, etc. The description of other deposits is based on visual examination in the field.

10 Grading data
A continuous series of bulk samples is taken throughout the thickness of sand and gravel. A new sample is commenced whenever there is appreciable lithological change or at every 1m of depth.

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

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

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

11 Composition
Details of the composition of selected samples or groups of samples may be given. Where appropriate the calculated weighted mean composition of groups of samples may be quoted.

APPENDIX E

LIST OF BOREHOLES USED IN THE ASSESSMENT OF RESOURCES

Industrial Minerals Assessment Unit boreholes

Borehole number*	Grid reference†
NZ 32 NW (pp. 17–29)	
16	3035 2992
17	3147 2983
18	3380 2975
19	3327 2945
20	3405 2879
21	3010 2858
22	3216 2849
23	3313 2821
24	3491 2828
25	3120 2811
26	3415 2793
27	3218 2766
28	3050 2724
29	3122 2712
30	3325 2704
31	3038 2679
32	3230 2674
33	3427 2656
34	3235 2555
35	3039 2531
36	3476 2537

Borehole number*	Grid reference†
NZ 32 NE (pp. 29–35)	
32	3576 2984
33	3512 2921
34	3828 2911
35	3974 2884
36	3642 2876
37	3867 2831
38	3573 2761
39	3785 2742
40	3675 2738
41	3524 2712
42	3899 2706
43	3595 2662
44	3843 2645
45	3964 2620
46	3880 2597
47	3987 2543
48	3584 2533

Borehole number*	Grid reference†
NZ 32 SW (pp. 35–44)	
24	3132 2468
25	3309 2478
26	3047 2443
27	3095 2386
28	3337 2374
29	3242 2338
30	3022 2324
31	3392 2324
32	3465 2274
33	3130 2244
34	3343 2240
35	3024 2224
36	3220 2212
37	3423 2220
38	3147 2177
39	3335 2140
40	3053 2108
41	3428 2107
42	3294 2057
43	3090 2037
44	3439 2028

Borehole number*	Grid reference†
NZ 32 SE (pp. 45–61)	
43	3877 2485
44	3778 2432
45	3960 2425
46	3702 2401
47	3886 2372
48	3783 2329
49	3631 2315
50	3978 2301
51	3917 2267
52	3578 2253
53	3796 2185
54	3962 2189
55	3541 2156
56	3663 2158
57	3903 2150
58	3674 2114
59	3824 2111
60	3924 2071
61	3555 2044
62	3626 2045
63	3748 2033

* By sheet quadrant.

† All fall in 100 km square NZ.

Other boreholes

NZ 32 NW	1, 5, 6/70, 6/73, 6/82, 6/85, 6/100, 6/105, 8, 11, 12, 14 and 15
NZ 32 NE	2, 3/10, 3/16, 3/20, 5, 6, 7, 11 to 14, 23, 30 and 31
NZ 32 SW	5 to 9 and 11
NZ 32 SE	1, 6, 11B and 12

Information from boreholes generously supplied by Steetley (Mfg) Ltd, Denniff Division, has also been used. This information is held in confidence by the Institute.

APPENDIX F

INDUSTRIAL MINERALS ASSESSMENT UNIT BOREHOLE RECORDS

NZ 32 NW 16 3035 2992 Chilton Grange, Chilton **Block A**

Surface level (+116.4 m)+382 ft
Groundwater conditions not recorded
March 1975

Overburden 5.0 m
Mineral 16.0 m
Waste 1.0 m
Mineral 2.0 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.2	0.2
Glacial Sand and Gravel	Loam, dark brown, with lenses of sand and occasional gritstone cobbles; stiff orange and grey laminated clay from 2.0 to 2.5 m	2.8	3.0
	Sand, fine, well-sorted	0.3	3.3
	Sandy gravelly silt, brown, with pebbles of sandstone, Magnesian Limestone and coal	1.7	5.0
	a Pebbly sand Gravel: fine to coarse, subrounded sandstone with angular coal Sand: mainly fine, subangular to subrounded quartz with some Magnesian Limestone and dark volcanic rock	11.0	16.0
	b Sandy gravel Gravel: coarse and fine, subrounded sandstone, with quartzite and igneous rock Sand: mainly medium, angular to subrounded, quartz with Magnesian Limestone and dark volcanic rock	5.0	21.0
	Silt, very sandy, dark brown, with fine coal fragments	1.0	22.0
	c 'Clayey' sand: mainly fine, well-sorted subangular to subrounded quartz with some coal fragments	2.0+	24.0

Grading

	Mean for deposit *percentages*			Bulk samples 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
a	6	83	11	5.0– 6.5	11	43	32	5	5	4
				6.5–16.0	6	57	25	1	4	7
				Mean	6	55	26	2	4	7
b	2	68	30	16.0–21.0	2	18	39	11	13	17
a+b	5	78	17	Mean	5	43	30	5	7	10
c	10	90	0	22.0–24.0	10	61	29	trace	0	0
a+b+c	6	79	15	Mean	6	45	30	4	6	9

Composition of gravel fraction

Depth below surface (m)	Percentages by weight							
	Sandstone	Quartzite	Igneous	Mudstone/ siltstone	Quartz	Coal	Ironstone	Chert
16.0–21.0	73	13	11	1	1	trace	1	trace

NZ 32 NW 17 3147 2983 Thrundle Farm, Chilton **Block A**

Surface level (+104.2 m)+342 ft
Groundwater standing at c. +99.3 m
October 1975

Overburden 0.6 m
Mineral 4.4 m
Waste 4.0 m
Mineral 11.5 m
Waste 3.0 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil, loamy	0.6	0.6
Glacial Sand and Gravel	**a** 'Very clayey' sandy gravel Gravel: mainly coarse with some cobbles, angular to subrounded, Carboniferous sandstone with some limestone Sand: mainly fine, subangular to subrounded quartz, with some coal	4.4	5.0
Boulder Clay	Clay, grey-brown, firm, with pebbles of Magnesian Limestone, sandstone and siltstone	1.6	6.6
Glacial Sand and Gravel	Silt, brownish-grey, micaceous; sand laminae in lower part	2.4	9.0
	b 'Very clayey' sand: mainly fine, subrounded quartz, with fine to coarse coal and some white lithic grains; sporadic light brown clay bands; a little gravel	5.0	14.0
	c Sand with a little gravel Gravel: coarse, subangular to subrounded, coal, Magnesian Limestone, Carboniferous sandstone and limestone Sand: fine to medium, subangular to rounded quartz with some coal	6.5	20.5
Boulder Clay	Clay, grey-brown, firm, with abundant pebbles of Magnesian Limestone and some coal, siltstone, Carboniferous sandstone and rare Carboniferous limestone	3.0+	23.5

Grading

	Mean for deposit *percentages*			Bulk samples 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
a	21	52	27	0.6–2.0	20	30	16	5	8	21
				2.0–4.0	23	31	18	5	7	16
				4.0–5.0	19	29	19	5	8	20
				Mean	21	30	17	5	8	19
b	20	79	1	9.0–10.0	25	61	13	trace	trace	0
				10.0–11.0	16	65	18	trace	trace	0
				11.0–12.0	26	59	14	1	trace	0
				12.0–13.0	17	72	10	1	trace	0
				13.0–14.0	16	63	18	1	trace	2
				Mean	20	64	15	trace	trace	trace
c	5	94	1	14.0–15.0	8	62	29	trace	1	0
				15.0–16.0	6	60	32	trace	trace	1
				16.0–17.0	5	49	45	trace	trace	0
				17.0–18.0	4	55	41	trace	trace	0
				18.0–19.0	3	55	41	1	0	0
				19.0–20.0	4	46	49	trace	trace	0
				20.0–20.5	7	52	34	1	trace	6
				Mean	5	55	39	trace	trace	1
b+c	12	87	1	Mean	12	59	28	trace	trace	1
a+b+c	14	78	8	Mean	14	51	25	2	2	6

NZ 32 NW 18 3380 2975 Low Hardwick, Sedgefield **Block A**

Surface level (+84.7 m)+278 ft
Groundwater conditions not recorded
April 1975

Waste 17.3 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil, brown, clayey	0.3	0.3
Alluvium	Silt, bluish-grey, with rootlets, fine quartz sand and mica	1.0	1.3
Boulder Clay	Clay, blue-grey to red-brown, with silt and sand pockets and pebbles and cobbles including quartzite, limestone, sandstone and grey-black fine-grained igneous rock	14.1	15.4
	Boulders of sandstone and limestone *Borehole abandoned owing to obstruction*	1.9+	17.3

NZ 32 NW 19 3327 2945 Near Tile Shed Plantation, Sedgefield **Block B**

Surface level (+75.9 m)+249 ft
Water encountered at c. +68.0 m
August 1975

Overburden 7.8 m
Mineral 5.7 m
Waste 3.0 m
Bedrock 0.5 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.3	0.3
Lacustrine Alluvium	Clay, generally stoneless and laminated: light grey and plastic in upper part, grey-brown and firm below; some sand partings	7.5	7.8
? Alluvium	Gravel Gravel: fine and coarse, with some cobbles, Carboniferous sandstone with Magnesian Limestone and some Carboniferous limestone, red siltstone, coal and dolerite Sand: medium and coarse, subangular to subrounded quartz, with angular quartzite and Magnesian Limestone and traces of red shale and other lithic grains	5.7	13.5
Boulder Clay	Clay, mainly grey-brown, with Magnesian Limestone sand throughout; single boulder of Carboniferous Limestone	3.0	16.5
Magnesian Limestone	Limestone, weathered: creamy-grey marl with pale cream fragments	0.5+	17.0

Grading

Mean for deposit *percentages*			Bulk samples 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
3	32	65	7.8–9.0	4	3	9	13	33	38
			9.0–10.0	2	3	14	15	38	28
			10.0–11.0	3	6	13	16	24	38
			11.0–12.0	3	6	12	13	22	44
			12.0–13.0	3	3	8	22	27	37
			13.0–13.5	5	7	13	18	19	38
			Mean	3	4	12	16	28	37

NZ 32 NW 20 3405 2879 Brakes, Sedgefield **Block A**

Surface level (+97.5 m)+320 ft
Groundwater conditions not recorded
March 1975

Overburden 2.5 m
Mineral 2.0 m
Waste 13.5 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.6	0.6
Boulder Clay	Clay, orange-brown, stiff, sandy, with coal fragments	1.9	2.5
Glacial Sand and Gravel	'Very clayey' sand: fine, well-sorted, subangular to subrounded quartz with trace of coal	2.0	4.5
	Clay, orange, with brown sandy silt laminae and some pebbles of Magnesian Limestone and volcanic rock	1.0	5.5
	Silt, micaceous, with fine quartz, Magnesian Limestone and coal sand	7.1	12.6
Boulder Clay	Clay, greenish-black, stiff, with pebbles of sandstone, Magnesian Limestone and dark rock	5.4+	18.0

Grading

Mean for deposit *percentages*			Bulk samples 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
39	61	trace	2.5–4.5	39	59	2	trace	trace	0

NZ 32 NW 21 3010 2858 W of Nunstainton Grange **Block A**

Surface level (+84.4 m)+277 ft
Groundwater not encountered
September 1975

Waste 11.2 m
Bedrock 0.8 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.6	0.6
Boulder Clay	Clay, brownish-grey, with fine to coarse sand and pebbles of Carboniferous sandstone, limestone, mudstone, coal and Magnesian Limestone	6.8	7.4
Glacial Sand and Gravel	'Clayey' gravel Gravel: fine to coarse subangular Magnesian Limestone with some Carboniferous sandstone and limestone Sand: fine to coarse, subangular Magnesian Limestone with quartz and other lithic grains	0.5	7.9
Boulder Clay	Clay, pebbly, as above	3.3	11.2
Magnesian Limestone	Clay, cream, with fragments of limestone or dolomite	0.8+	12.0

NZ 32 NW 22 3216 2849 Nunstainton Carrs **Block B**

Surface level (+74.1 m)+243 ft
Groundwater conditions not recorded
September 1975

Overburden 7.7 m
Mineral 6.7 m
Waste 10.6 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil, peaty	1.5	1.5
Lacustrine Alluvium	Silt, sandy, light grey	0.5	2.0
	Clay, brown, with laminae of light brown micaceous sandy silt and very fine coal fragments	5.7	7.7
? Alluvium	Gravel, mainly 'very clayey', sandy at top Gravel: fine and coarse, rounded to subangular, Carboniferous quartzite, sandstone and limestone, with trace of igneous rock Sand: fine to coarse, subrounded to subangular quartz, Magnesian and Carboniferous limestone with some chert Fines: red-brown, disseminated, and as thin clay bands in top metre	6.7	14.4
Boulder Clay	Clay, dark brown, with sand and pebbles of quartz, Carboniferous sandstone, limestone and mudstone, Magnesian Limestone and coal	10.6+	25.0

Grading

Mean for deposit *percentages*			Bulk samples 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
19	40	41	7.7–8.7	33	28	12	4	9	14
			8.7–9.7	23	24	13	7	16	17
			9.7–10.7	20	14	10	12	26	18
			10.7–11.7	21	21	12	6	19	21
			11.7–12.7	20	22	9	7	14	28
			12.7–13.7	9	9	16	17	22	27
			13.7–14.4	5	6	11	16	21	41
			Mean	19	18	12	10	18	23

Composition of gravel fraction

Depth below surface (m)	Percentages by weight									
	Sandstone	Magnesian Limestone	Carboniferous limestone	Quartzite	Igneous	Mudstone/ siltstone	Quartz	Coal	Ironstone	Chert
10.7–11.7	26	30	15	21	5	trace	1	trace	1	trace

NZ 32 NW 23 3313 2821 W of Firtree Hill **Block A**

Surface level (+81.7 m)+268 ft
Groundwater encountered at +78.3 m
August 1975

Overburden 2.0 m
Mineral 2.5 m
Waste 15.0 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil, clayey	0.3	0.3
Boulder Clay	Clay, orange-brown, firm, with coal fragments; sandy towards base	1.7	2.0
Glacial Sand and Gravel	**a** 'Very clayey' sand, cream to grey-brown; fine, subangular to subrounded quartz, with some medium, angular to subangular coal	1.5	3.5
	b 'Clayey' gravel Gravel: coarse and fine, Magnesian Limestone and Carboniferous sandstone, with rare subangular dark rock Sand: fine to coarse; lithic fragments as in gravel, with quartz	1.0	4.5
Boulder Clay	Clay, grey-brown, massive, with sand and pebbles of sandstone, Magnesian Limestone, Carboniferous Limestone, siltstone and coal	15.0+	19.5

Grading

	Mean for deposit *percentages*			Bulk samples 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
a	32	67	1	2.0–3.0	35	60	3	trace	1	1
				3.0–3.5	26	68	5	1	trace	0
				Mean	32	63	4	trace	1	trace
b	11	37	52	3.5–4.5	11	18	8	11	19	33
a+b	24	55	21	Mean	24	45	5	5	8	13

NZ 32 NW 24 3491 2828 SW of Sedgefield **Block A**

Surface level (+100.3 m)+329 ft
Groundwater conditions not recorded
March 1975

Overburden 1.0 m
Mineral 10.0 m
Waste 7.0 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	1.0	1.0
Glacial Sand and Gravel	**a** 'Clayey' pebbly sand Gravel: fine to coarse, subrounded, Magnesian Limestone and sandstone with quartzite and igneous rock and some mudstone, siltstone and ironstone Sand: fine to medium, subangular to subrounded quartz Fines: dark brown clay nodules	3.7	4.7
	b Gravel Gravel: fine to coarse, angular to subrounded, Magnesian Limestone with sandstone and dark volcanic rock Sand: fine quartz and coarse lithic grains	1.7	6.4
	c Pebbly sand Gravel: mainly fine, subangular to subrounded Magnesian Limestone and sandstone with some coal Sand: mainly fine, subangular to subrounded quartz, with some coal	4.6	11.0
Boulder Clay	Clay, dark brown with pebbles of sandstone, Magnesian Limestone, coal and dark volcanic rock	7.0+	18.0

Grading

	Mean for deposit *percentages*			Bulk samples depth below surface (m)	*percentages*					
	Fine	Sand	Gravel		Fines	Sand			Gravel	
					$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16
a	17	64	19	1.0–4.7	17	28	29	7	11	8
b	5	42	53	4.7–6.4	5	22	6	14	26	27
a+b	13	57	30	Mean	13	26	22	9	16	14
c	10	79	11	6.4–11.0	10	50	23	6	11	trace
b+c	8	69	23	Mean	8	42	19	8	15	8
a+b+c	12	67	21	Mean	12	37	22	8	13	8

Composition of gravel fraction

Depth below surface (m)	Percentages by weight							
	Sandstone	Magnesian Limestone	Quartzite	Igneous	Mudstone/ siltstone	Quartz	Ironstone	Chert
4.7–6.4	26	43	12	12	5	trace	2	trace

NZ 32 NW 25 3120 2811 Bradbury Carrs **Block A**

Surface level (+76.2 m)+250 ft
Groundwater encountered at c. +70.5 m
September 1975

Overburden 1.0 m
Mineral 5.0 m
Waste 14.0 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil, sandy	1.0	1.0
Glacial Sand and Gravel	'Clayey' sand: mainly medium, subangular to subrounded quartz, with medium to coarse coal (abundant between 2.8 and 3.5 m)	5.0	6.0
Boulder Clay	Clay, red-brown, firm, partly laminated, with disseminated fine quartz, mica and Magnesian Limestone sand; and a 0.1-m band of quartz and coarse coal sand at about 7.0 m	2.7	8.7
	Clay, grey-brown, with pebbles of Magnesian Limestone and Carboniferous sandstone and limestone	11.3+	20.0

Grading

Mean for deposit *percentages*			Bulk samples 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
12	87	1	1.0–2.0	12	25	61	1	1	trace
			2.0–2.8	14	22	63	1	trace	trace
			2.8–4.0	12	22	61	4	1	0
			4.0–5.0	10	32	55	2	1	0
			5.0–6.0	14	38	47	1	trace	0
			Mean	12	28	57	2	1	trace

NZ 32 NW 26 3415 2793 Sedgefield Race Course **Block A**

Surface level (+102.4 m)+336 ft
Groundwater conditions not recorded
March 1975

Overburden 0.2 m
Mineral 4.6 m
Waste 13.2 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.2	0.2
Glacial Sand and Gravel	'Clayey' gravel Gravel: coarse with some fine and cobbles; subangular to well-rounded sandstone with some Magnesian Limestone, quartzite and dark volcanic rock Sand: poorly sorted, fine to coarse, quartz with lithic grains as in gravel	4.6	4.8
Boulder Clay and Glacial Drift, undifferentiated	Silt, sandy, dark brown, with some pebbles of quartzite, Magnesian Limestone, coal and dolerite	6.2	11.0
	Clay, dark brown, with pebbles of Magnesian Limestone, sandstone, quartzite and dark volcanic rock	7.0+	18.0

Grading

Mean for deposit *percentages*			Bulk samples 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
12	35	53	0.2–4.8	12	13	15	7	14	39

Composition of gravel fraction

Depth below surface (m)	Percentages by weight							
	Sandstone	Magnesian Limestone	Quartzite	Igneous	Mudstone/ siltstone	Quartz	Ironstone	Chert
0.2–4.8	75	5	7	9	trace	2	1	1

NZ 32 NW 27 3218 2766 Near School, SE of Bradbury **Block A**

Surface level (+80.8 m)+265 ft
Groundwater conditions not recorded
March 1975

Overburden 5.6 m
Mineral 2.0 m
Waste 10.4 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.5	0.5
Boulder Clay	Clay, stiff, red-brown and grey	5.1	5.6
Glacial Sand and Gravel	'Very clayey' sandy gravel Gravel: fine to coarse sandstone Sand: fine to medium, quartz with some coal	2.0	7.6
Boulder Clay	Clay, dark brown, silty, with irregular bands of fine micaceous quartz sand	10.4+	18.0

Grading

Mean for deposit *percentages*			Bulk samples 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
32	49	19	5.6–7.6	32	24	20	5	13	6

NZ 32 NW 28 3050 2724 Great Isle, Bradbury **Block B**

Surface level (+74.7 m)+245 ft
Groundwater not encountered
April 1975

Waste 18.0 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.5	0.5
Lacustrine Alluvium	Clay, silty, grey with ochreous patches, laminated	1.5	2.0
Boulder Clay	Clay, dark brown and grey, slightly sandy, with pebbles of sandstone, quartzite, limestone, coal and igneous rock; partly laminated, with micaceous sand lenses, below 14.0 m	16.0+	18.0

NZ 32 NW 29 3122 2712 Swan Carr, Bradbury **Block B**

Surface level (+78.0 m)+256 ft
Groundwater conditions not recorded
September 1975

Waste 18.0 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	1.0	1.0
Boulder Clay	Clay, red-brown with pale grey mottling; poor laminae of grey micaceous silt and lenses of fine coaly sand	1.6	2.6
	Clay, grey-brown, with disseminated sand and pebbles of Magnesian Limestone, Carboniferous sandstone and limestone	15.4+	18.0

NZ 32 NW 30 3325 2704 Near Mordon East Farm, Mordon **Block C**

Surface level (+87.2 m)+286 ft
Groundwater not encountered
April 1975

Waste 18.0 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.7	0.7
Boulder Clay	Clay, red-brown and grey; pockets of red and yellow sand and blue-grey silt; pebbles of limestone, quartzite, sandstone and dark fine-grained igneous rock, and fragments of coal	17.3+	18.0

NZ 32 NW 31 3038 2679 Little Isle, Bradbury **Block B**

Surface level (+72.8 m)+239 ft
Water level not recorded
April 1975

Waste 18.0 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.7	0.7
Lacustrine Alluvium	Silt, clayey and micaceous, brown, reddish-brown and grey, with layers of coaly sand	14.1	14.8
? Alluvium	Gravel Gravel: coarse with fine, subangular to subrounded, dark grey and cream limestones, pale quartzite, yellow sandstone, some porphyritic igneous rock and trace of coal Sand: medium to coarse, well-rounded quartz with some angular lithic grains including coal	1.1	15.9
Boulder Clay	Clay, dark grey, laminated; some sand grade lithic fragments	2.1+	18.0

Grading

Mean for deposit *percentages*			Bulk samples 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
1	33	66	14.8–15.9	1	3	16	14	25	41

NZ 32 NW 32 3230 2674 Mordon North Farm **Block B**

Surface level (+71.9 m)+236 ft
Groundwater conditions not recorded
April 1975

Overburden 0.5 m
Mineral 3.4 m
Waste 15.7 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.5	0.5
? Alluvium	Gravel Gravel: fine to coarse, with some cobbles, well-rounded, limestone and sandstone, with quartzite and fine-grained igneous rock, some mudstone and siltstone and traces of quartz, coal, ironstone and chert Sand: mainly medium, well-rounded to subrounded quartz and lithic grains	3.4	3.9
	Silt, brown, laminated	0.6	4.5
Boulder Clay	Clay, silty, dark grey, micaceous, with pebbles of pale limestone, quartzite and dark igneous rock	15.1 +	19.6

Grading

Mean for deposit *percentages*			Bulk samples 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
3	48	49	0.5–1.5	4	7	29	13	28	19
			1.5–2.5	3	9	27	12	22	27
			2.5–3.9	1	9	27	12	23	28
			Mean	3	9	27	12	24	25

Composition of gravel fraction

Depth below surface (m)	Percentages by weight								
	Sandstone	Limestone	Quartzite	Igneous	Mudstone/ siltstone	Quartz	Coal	Ironstone	Chert
0.5–1.5	46	34	6	12	1	1	trace	trace	trace
1.5–2.5	49	35	8	3	2	1	trace	trace	1

NZ 32 NW 33 3427 2656 Hopper House, Mordon **Block C**

Surface level (+93.6 m)+307 ft
Groundwater conditions not recorded
March 1975

Waste 18.0 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.5	0.5
Boulder Clay	Clay, orange-red with irregular grey partings at top, dark brown below; pebbles of Magnesian Limestone, sandstone and dark volcanic rock, and coal fragments	17.5+	18.0

NZ 32 NW 34 3235 2555 SE of Mordon Carrs, Mordon **Block B**

Surface level (+70.4 m)+231 ft
Groundwater not encountered
August 1975

Waste 18.3 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil, peaty	1.5	1.5
Lacustrine Alluvium	Silt, clayey, light grey; few sandstone pebbles	2.0	3.5
	'Clayey' sand, grey-brown, with coal fragments	0.1	3.6
Boulder Clay	Clay, silty, brown-grey to brown; with pebbles of Magnesian Limestone (dominant above 7.5 m), Carboniferous sandstone, limestone and siltstone	14.7+	18.3

NZ 32 NW 35 3039 2531 Ricknall Carrs **Block C**

Surface level (+75.3 m)+247 ft
Groundwater encountered from +64.2 m to +63.8 m
October 1975

Waste 18.3 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil and fill	1.0	1.0
Boulder Clay and Glacial Drift, undifferentiated	Clay, grey-brown, with pebbles of Magnesian Limestone, coal, siltstone and Carboniferous sandstone and limestone; part-laminated metre-thick bands of stoneless clay at 6 m and 10 m	10.1	11.1
	Silt, clayey, grey, with traces of fine sand	0.4	11.5
	Clay, part silty, brown to grey-brown, and dark grey; pebbles of Magnesian Limestone, Carboniferous sandstone and limestone, siltstone and coal	6.8+	18.3

NZ 32 NW 36 3476 2537 Bog Hall, Foxton **Block C**

Surface level (+77.7 m)+255 ft
Groundwater encountered at c. +73.2 m
April 1975

Waste 18.8 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.3	0.3
Boulder Clay and Glacial Drift, undifferentiated	Clay, firm, red-grey; scattered, mainly small pebbles of quartzite, Carboniferous sandstone and Magnesian Limestone, and some coal fragments	2.7	3.0
	Silt, orange-grey, with very thin clay bands and a trace of fine quartz, coal and mica sand	1.5	4.5
	Clay, silty, brown with grey patches; pebbles of Carboniferous sandstone and quartzite with some mudstone and igneous rock and a little coal	7.7	12.2
	Silt, clayey and sandy, grey-brown, containing fine quartz and some lithic grains	1.8	14.0
	Clay, brown, partly laminated; pebbles of subrounded Magnesian Limestone, quartzite and sandstone and angular coal fragments	4.8+	18.8

NZ 32 NE 32 3576 2984 N of Sedgefield **Block A**

Surface level (+107.6 m)+353 ft
Groundwater not encountered
March 1975

Waste 18.6 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.1	0.1
Boulder Clay	Clay, grey-brown, hard, with pebbles of quartzite, sandstone and Magnesian Limestone, and, less commonly, coal, Carboniferous Limestone, shale, siltstone and dolerite	18.5+	18.6

NZ 32 NE 33 3512 2921 **Hardwick Park, Sedgefield** **Block A**

Surface level (+105.5 m)+346 ft
Water encountered at c. +98.9 m
March 1975

Overburden 0.9 m
Mineral 4.6 m
Waste 1.0 m
Mineral 4.5 m
Waste 4.0 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.9	0.9
Glacial Sand and Gravel	**a** 'Clayey' gravel, sandy at base Gravel: coarse, with fine and some cobbles, Carboniferous sandstone and Magnesian Limestone with quartzite, Carboniferous limestone, dolerite and other igneous rocks Sand: fine to coarse, subangular to subrounded quartz, with angular to subrounded Magnesian Limestone and other lithic grains, including coal	3.0	3.9
	b 'Very clayey' sand: mainly fine subangular quartz with some fine to medium coal and a trace of other lithic fragments and mica	1.6	5.5
	Clay, sandy, red-brown with coaly streaks in upper part, grey-brown and laminated below	1.0	6.5
	c 'Very clayey' sand Sand: as **b** Fines: pale brown, disseminated; some thin purple-brown laminated clay bands	4.5	11.0
	Silt, pale brown, with some fine to medium coal sand; a few thin clay bands in lower part *Hole abandoned owing to 'rising silt'*	4.0+	15.0

Grading

	Mean for deposit *percentages*			Bulk samples 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
a	11	45	44	0.9–1.5	19	16	17	10	16	22
				1.5–2.5	10	7	12	14	17	40
				2.5–3.0	12	7	12	10	14	45
				3.0–3.9	7	23	36	9	4	21
				Mean	11	14	20	11	12	32
b	28	72	trace	3.9–4.9	28	58	13	1	trace	0
				4.9–5.5	30	63	6	1	0	0
				Mean	28	60	11	1	trace	0
a+b	17	55	28	Mean	17	30	17	8	8	20
c	34	66	trace	6.5–7.5	28	55	16	1	0	0
				7.5–9.0	36	43	20	1	trace	0
				9.0–11.0	36	43	20	1	trace	0
				Mean	34	46	19	1	trace	0
a+b+c	26	60	14	Mean	26	38	18	4	3	11

Composition of gravel fraction

Depth below surface (m)	Percentages by weight								
	Sandstone	Magnesian Limestone	Carboniferous limestone	Quartzite	Igneous	Mudstone/ siltstone	Quartz	Ironstone	Chert
1.5–2.5	33	24	10	15	17	1	trace	trace	trace

NZ 32 NE 34 3828 2911 Beacon Hill Cottage, Sedgefield **Block A**

Surface level (+98.5 m)+323 ft
Water encountered from +93.6 m to +93.2 m
February 1975

Waste 18.3 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil, clayey	1.2	1.2
Boulder Clay and Glacial Drift, undifferentiated	Clay, grey-brown to grey, with some small pebbles of sandstone and quartzite, and coal fragments	1.6	2.8
	Silt, sandy, grey, with some thin clay partings	2.4	5.2
	Clay, sandy, tough, grey to grey-brown, with pebbles of sandstone, quartzite, and Magnesian Limestone, and less commonly Carboniferous limestone, siltstone and coal	13.1+	18.3

NZ 32 NE 35 3974 2884 Newlands **Block A**

Surface level (+85.6 m)+281 ft
Groundwater conditions not recorded
March 1975

Waste 18.4 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil, clayey	0.3	0.3
Boulder Clay	Clay, grey to grey-brown, with pebbles and cobbles of quartzite, sandstone and some shale	7.4	7.7
	Clay, creamy-brown, with soft Magnesian Limestone fragments	0.9	8.6
	Clay, red-brown near top, grey-brown below, with pebbles of sandstone, limestone and quartzite and coal fragments	9.8+	18.4

NZ 32 NE 36 3642 2876 c. 600 m E of Sedgefield Church, Sedgefield **Block A**

Surface level (+101.8 m)+334 ft
Groundwater not encountered
March 1975

Waste 18.3 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.3	0.3
Boulder Clay	Clay, mainly dark grey-brown, with, especially in top 3 m, pebbles of Magnesian Limestone, sandstone and quartzite and some coal and siltstone fragments; laminated in parts	18.0+	18.3

NZ 32 NE 37 3867 2831 East Close House, Sedgefield **Block A**

Surface level (+89.0 m)+292 ft
Groundwater encountered from +77 m to +76 m
February 1975

Waste 18.3 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.2	0.2
Boulder Clay and Glacial Drift, undifferentiated	Clay, part sandy, yellowish-brown to reddish orange, with pebbles of quartzite, sandstone and Carboniferous limestone, and fragments of coal	2.8	3.0
	Silt, grey to grey-brown, micaceous, with coal fragments	0.6	3.6
	Clay, grey, with pebbles of quartzite, sandstone, Magnesian Limestone and Carboniferous Limestone, and, less commonly, pink sandstone, siltstone and coal	8.4	12.0
	Silt, sandy, grey, with a trace of mica, coal and other lithic fragments	1.0	13.0
	Clay, firm, grey, as above	5.3+	18.3

NZ 32 NE 38 3573 2761 Diamond Hall, Sedgefield **Block C**

Surface level (+90.8 m)+298 ft
Groundwater not encountered
September 1975

Waste 18.0 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.9	0.9
Boulder Clay	Clay, brown and red-brown, with many Magnesian Limestone pebbles and some coal and other Carboniferous lithic fragments; at 11 m, thin band of cream silt and clay with Magnesian Limestone fragments	17.1+	18.0

NZ 32 NE 39 3785 2742 Layton House, Sedgefield **Block A**

Surface level (+93.6 m)+307 ft
Groundwater conditions not recorded
September 1975

Overburden 1.4 m
Mineral 6.1 m
Waste 7.5 m
Mineral 10.0 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil, clayey and sandy	1.4	1.4
Glacial Sand and Gravel	**a** 'Very clayey' sand Sand: mainly fine quartz, with traces of fine to coarse subangular coal Fines: yellow-brown to dark brown, disseminated; thin grey silt partings in top 0.5 m	6.1	7.5
Boulder Clay	Clay, silty, brown and grey, with pebbles of limestone, sandstone and dark grey siltstone	7.5	15.0
Glacial Sand and Gravel	**b** 'Clayey' sand, pebbly in upper part Gravel: mainly coarse, angular limestone and sandstone Sand: fine to medium, subrounded to subangular quartz, with some pale lithic grains	10.0+	25.0

Grading

	Mean for deposit *percentages*			Bulk samples 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
a	23	76	1	1.4–2.0	24	60	16	trace	trace	0
				2.0–3.0	29	57	12	1	1	0
				3.0–4.0	30	60	9	1	trace	0
				4.0–5.0	16	60	22	1	1	0
				5.0–6.0	17	59	23	1	trace	0
				6.0–7.0	21	53	22	2	1	1
				7.0–7.5	24	51	21	3	1	0
				Mean	23	57	18	1	1	trace
b	15	83	2	15.0–16.0	27	57	11	2	1	2
				16.0–17.0	21	56	15	1	1	6
				17.0–18.0	24	60	14	1	1	trace
				18.0–19.0	23	52	14	2	1	8
				19.0–20.0	5	26	68	1	0	0
				20.0–21.0	5	26	68	1	0	0
				21.0–22.0	6	30	63	1	trace	0
				22.0–23.0	7	31	61	1	trace	0
				23.0–25.0	17	47	36	trace	trace	0
				Mean	15	43	39	1	trace	2
a+b	18	81	1	Mean	18	49	31	1	trace	1

NZ 32 NE 40 3675 2738 Neasless, Sedgefield **Block A**

Surface level (+95.1 m)+312 ft
Groundwater encountered from +90.6 m to +90.2 m
February 1975

Waste 19.0 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.2	0.2
Boulder Clay	Clay, yellow to red-brown, slightly sandy at top; pebbles of sandstone, quartzite, Magnesian Limestone and coal, and, less commonly, quartz, dolerite and red siltstone	4.3	4.5
Glacial Sand and Gravel	'Clayey' gravel: coarse gravel and cobbles of angular to subangular quartzite, Magnesian Limestone and Carboniferous limestone, with fine to coarse sand	0.4	4.9
Boulder Clay and Glacial Drift, undifferentiated	Clay, dark grey, with pebbles and cobbles of Carboniferous sandstone, Magnesian Limestone, Carboniferous limestone and quartzite, and coal and mudstone fragments	3.9	8.8
	Silt, sandy, grey, with coal fragments	2.7	11.5
	Clay, grey to brownish-grey, silty, with pebbles of quartzite, sandstone, Magnesian Limestone, Carboniferous limestone, grey siltstone, coal and other dark rocks	7.5+	19.0

NZ 32 NE 41 3524 2712 Southfield House, Sedgefield **Block C**

Surface level (+91.1 m)+299 ft
Groundwater not encountered
March 1975

Waste 18.3 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil, clayey	0.2	0.2
Boulder Clay	Clay, grey to grey-brown with, especially above 5 m and below 10 m, pebbles of Magnesian Limestone, sandstone, siltstone, Carboniferous limestone and coal; thin partings of fine sand from 10 m to 14 m	18.1+	18.3

NZ 32 NE 42 3899 2706 SE of Cowley House **Block A**

Surface level (+89.9 m)+295 ft
Groundwater not encountered
September 1975

Waste 18.0 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.6	0.6
Boulder Clay	Clay, red-brown, with coal fragments and some micaceous silt laminae	1.0	1.6
Glacial Sand and Gravel	'Clayey' sandy gravel: Carboniferous limestone and Magnesian Limestone gravel with quartz sand	0.6	2.2
Boulder Clay	Clay, mainly brown, with pebbles of Magnesian Limestone, Carboniferous Limestone and sandstone, and some coal fragments; thin laminated clay and silt partings from 14.2 m to 16.0 m	15.8+	18.0

NZ 32 NE 43 3595 2662 E of Heley House **Block C**

Surface level (+79.6 m)+261 ft
Groundwater conditions not recorded
September 1975

Waste 18.0 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	1.0	1.0
Boulder Clay	Clay, red-brown and grey, with silty lenses; small coal pebbles and sand grade fragments of Magnesian Limestone and Carboniferous limestone and sandstone	17.0+	18.0

NZ 32 NE 44 3843 2645 East Layton **Block A**

Surface level (+82.0 m)+269 ft
Water level not recorded
March 1975

Overburden 13.0 m
Mineral 10.6 m
Waste 0.8 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.2	0.2
Boulder Clay	Clay, reddish-brown, with pebbles of Magnesian Limestone, quartzite, siltstone and Carboniferous limestone	12.8	13.0
Glacial Sand and Gravel	**a** 'Very clayey' pebbly sand Gravel: fine to coarse, subangular Magnesian Limestone with sandstone and some quartzite and igneous rock Sand: fine to medium, subangular to subrounded quartz, with some angular to subangular coal, quartzite and other lithic grains Fines: grey-brown to light brown, disseminated and as thin partings	4.0	17.0
	b Gravel Gravel: fine to coarse, Magnesian Limestone, Carboniferous limestone and sandstone, with quartzite and some dolerite, microgranite and other igneous rocks and a trace of quartz, chert and coal Sand: medium to coarse, subangular to subrounded, quartz with coarse coal, and some other lithic grains	6.6	23.6
Boulder Clay	Clay, hard, reddish-brown; rare coarse sand size fragments of quartzite, sandstone and coal	0.8+	24.4

Grading

	Mean for deposit *percentages*			Bulk samples 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
a	28	61	11	13.0–14.4	27	19	26	8	12	8
				14.4–15.5	grading not available					
				15.5–16.5	30	53	16	1	trace	0
				16.5–17.0	27	54	10	1	3	5
				Mean	28	37	20	4	6	5
b	3	38	59	17.0–17.8	11	14	12	11	18	34
				17.8–18.8	2	4	23	29	17	25
				18.8–19.8	1	4	27	16	27	25
				19.8–20.8	1	3	14	16	31	35
				20.8–21.3	1	2	14	24	27	32
				21.3–21.4	2	5	15	35	40	3
				21.4–21.6	4	16	29	21	27	3
				21.6–22.6	trace	1	3	6	33	57
				22.6–23.6	7	11	19	7	15	41
				Mean	3	5	17	16	24	35
a+b	11	45	44	Mean	11	15	18	12	19	25

Composition of gravel fraction

Depth below surface (m)	Percentages by weight							
	Sandstone	Limestone	Quartzite	Igneous	Mudstone/ siltstone	Quartz	Coal	Chert
17.8–18.8	21	58	7	13	trace	1	trace	0
18.8–19.8	27	57	12	3	trace	1	0	trace
19.8–20.8	26	59	11	3	trace	1	0	0

NZ 32 NE 45 3964 2620 Grindon Grange, Grindon **Block C**

Surface level (+81.4 m)+267 ft
Groundwater not encountered
September 1975

Waste 25.0 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.5	0.5
Boulder Clay and Glacial Drift, undifferentiated	Clay, reddish to dark brown, silty; pebbles of Magnesian Limestone, Carboniferous sandstone, limestone and coal; less stony and poorly laminated from 5 m to 6 m	11.3	11.8
	Silt, red-brown, with some thin clay bands	1.7	13.5
Glacial Sand and Gravel	'Very clayey' sandy gravel with thin coaly partings near top Gravel: fine to coarse, subrounded Carboniferous sandstone and limestone with some Magnesian Limestone Sand: fine to medium, subangular to subrounded quartz, and fine to coarse Carboniferous rocks including coal, and some Magnesian Limestone	1.8	15.3
Boulder Clay	Clay, dark brown, with pebbles of Magnesian Limestone, Carboniferous sandstone, limestone and coal; 0.2-m band of Carboniferous sandstone and limestone gravel in clayey matrix at 20.2 m; 0.2-m+ band of red-brown 'clayey' sand at 24.8 m	9.7+	25.0

Grading

Mean for deposit *percentages*			Bulk samples 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
25	45	30	13.5–14.5	22	15	15	16	21	11
			14.5–15.3	30	14	15	14	21	6
			Mean	25	15	15	15	21	9

NZ 32 NE 46 3880 2597 Thorpe Larches **Block C**

Surface level (+75.9 m)+249 ft
Groundwater not encountered
September 1975

Waste 18.0 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.5	0.5
Boulder Clay and Glacial Drift, undifferentiated	Clay, red-brown to grey-brown, with pebbles of Magnesian Limestone, and Carboniferous sandstone and limestone, and some coal fragments; relatively stoneless from 6.5 to 11.0 m, with poor laminae of micaceous sandy silt	17.5+	18.0

NZ 32 NE 47 3987 2543 Near ruined church, Grindon **Block C**

Surface level (+70.1 m)+230 ft
Groundwater not encountered
February 1975

Waste 18.3 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.5	0.5
Boulder Clay	Clay, red-brown to grey-brown, with pebbles of quartzite, sandstone, Magnesian Limestone, coal, dolerite and, rarely, metamorphic and igneous rocks; poorly laminated in part below 11.5 m	17.8+	18.3

NZ 32 NE 48 3584 2533 NW of Foxton **Block C**

Surface level (+78.3 m)+257 ft
Groundwater encountered from +65.3 m to +65.1 m and from +62.6 m to +62.3 m
March 1975

Waste 18.3 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.1	0.1
Boulder Clay	Clay, grey with iron staining; pebbles of sandstone, siltstone and dark rocks, and some coal fragments	2.6	2.7
	Clay, red-brown above 10.5 m, grey-brown below; pebbles of Magnesian Limestone (predominant), quartzite, sandstone, siltstone, and, rarely, Carboniferous limestone, dolerite and coal; scattered pebble-free bands with micaceous coaly sand partings	15.6+	18.3

NZ 32 SW 24 3132 2468 Carr Lane, Preston-le-Skerne **Block C**

Surface level (+71.9 m)+236 ft
Groundwater encountered at +66.8 m
February 1975

Waste 18.0 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.7	0.7
Boulder Clay	Clay, red-brown, with pebbles of sandstone and Magnesian Limestone, and coal fragments	6.3	7.0
Glacial Sand and Gravel	'Clayey' gravel: coarse with fine gravel of Magnesian Limestone, sandstone and dark volcanic rock, with fine to coarse red-brown 'clayey' sand	1.0	8.0
Boulder Clay	Clay, silty, dark brown, with pebbles of Magnesian Limestone, sandstone, and dark volcanic rock; thin cobble band at 11.7 m	10.0+	18.0

Grading

Mean for deposit *percentages*			Bulk samples 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
18	17	65	7.0–8.0	18	7	6	4	18	47

NZ 32 SW 25 3309 2478 Howe Hills Plantation **Block C**

Surface level (+81.1 m)+266 ft
Groundwater conditions not recorded
March 1975

Waste 18.0 m+

Log

Geological classification	*Lithology*	*Thickness* mm	*Depth* m
	Soil	0.8	0.8
Boulder Clay	Clay, red-brown with irregular grey partings; pebbles of Magnesian Limestone, sandstone and dark volcanic rock, and fragments of coal	17.2+	18.0

NZ 32 SW 26 3047 2443 Ricknall Grange, Preston-le-Skerne **Block C**

Surface level (+82.9 m)+272 ft
Groundwater conditions not recorded
April 1975

Overburden 2.9 m
Mineral 4.0 m
Waste 15.6 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	2.9	2.9
Glacial Sand and Gravel	'Clayey' sand: medium, subangular to subrounded quartz with fine to medium coal and a trace of quartzite and limestone; a little quartzite and coal gravel near top	4.0	6.9
	Clay with silt laminae, pale brown to purple-grey	9.6	16.5
Boulder Clay	Clay, hard, part sandy, grey-brown to grey, with pebbles of Carboniferous sandstone, quartzite, limestone, coal, siltstone, Magnesian Limestone and igneous rock	6.0+	22.5

Grading

Mean for deposit *percentages*			Bulk samples 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
11	89	trace	2.9–4.0	15	17	64	1	1	2
			4.0–5.0	14	18	68	trace	trace	0
			5.0–6.0	9	18	72	1	0	0
			6.0–6.9	5	24	71	trace	0	0
			Mean	11	19	69	1	trace	trace

NZ 32 SW 27 3095 2386 Lee Hall Lane, Preston-le-Skerne **Block C**

Surface level (+76.8 m)+252 ft
Groundwater not encountered
March 1975

Waste 18.0 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.6	0.6
Boulder Clay	Clay, orange with grey partings to 7.0 m, dark grey and silty below; pebbles of sandstone, limestone, coal, and ? volcanic rock	17.4+	18.0

NZ 32 SW 28 3337 2374 Elstob Lane, Elstob **Block C**

Surface level (+88.7 m)+291 ft
Groundwater conditions not recorded
February 1975

Waste 18.0 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.5	0.5
Boulder Clay	Clay, grey to brown with irregular grey and orange partings at top; pebbles of Magnesian Limestone, sandstone and quartzite, and, less commonly, coal and volcanic rocks	17.5+	18.0

NZ 32 SW 29 3242 2338 Grindon Lane **Block C**

Surface level (+88.7 m)+291 ft
Water level not recorded
August 1975

Overburden 6.0 m
Mineral 6.0 m
Waste 8.0 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.4	0.4
Boulder Clay	Clay, sandy, brown, with pebbles of sandstone, quartzite, siltstone, and, less commonly, Magnesian Limestone	4.1	4.5
Glacial Sand and Gravel	Clay, brown, laminated with fine sand	1.5	6.0
	'Clayey' sand: fine quartz with fine to medium coal and some quartzite and Magnesian Limestone	6.0	12.0
	Clay, brown, generally with silty and sandy laminae; scattered pebbles below 15m	8.0+	20.0

Grading

Mean for deposit *percentages*			Bulk samples 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
14	86	trace	6.0–7.0	17	78	5	trace	trace	0
			7.0–8.0	15	80	5	trace	0	0
			8.0–9.0	11	85	4	trace	trace	0
			9.0–10.0	11	82	7	trace	0	0
			10.0–11.0	13	83	4	trace	0	0
			11.0–12.0	18	79	3	trace	0	0
			Mean	14	81	5	trace	trace	0

NZ 32 SW 30 3022 2324 Ricknall Lane, Preston-le-Skerne **Block C**

Surface level (+83.2 m)+273 ft
Groundwater conditions not recorded
February 1975

Overburden 9.0 m
Mineral 3.7 m
Waste 5.3 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.6	0.6
Boulder Clay	Clay, red-brown with grey lenses; pebbles of sandstone and, below 4 m, Magnesian Limestone and igneous rocks; coal fragments above 4 m	8.4	9.0
Glacial Sand and Gravel	'Clayey' gravel on 'very clayey' sand Gravel: mainly coarse, subangular to subrounded sandstone and Magnesian Limestone, with dark volcanic rock and red felspathic igneous pebbles Sand: fine quartz, with occasional coarser Magnesian Limestone, sandstone and dark volcanic rock	3.7	12.7
Boulder Clay	Clay, sandy, dark brown; scattered pebbles of Magnesian Limestone and dark volcanic rock, and coal fragments	5.3+	18.0

Grading

Mean for deposit *percentages*			Bulk samples 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
13	40	47	9.0–11.7	10	9	8	8	16	49
			11.7–12.7	20	65	13	2	trace	0
			Mean	13	24	9	7	12	35

NZ 32 SW 31 3392 2324 E of Elstob Cottage, Elstob **Block C**

Surface level (+79.6 m)+261 ft
Groundwater encountered at +71.6 m
October 1975

Overburden 7.9 m
Mineral 6.3 m
Waste 10.6 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.3	0.3
Boulder Clay	Clay, sandy, orange-brown to grey-brown, with pebbles including Magnesian Limestone, sandstone and rare Carboniferous limestone and dolerite, and coal fragments	5.0	5.3
Glacial Sand and Gravel	Clay, grey-brown, with thin sand laminae	2.0	7.3
	Silt, sandy, grey-brown, soft, micaceous, with thin clay partings	0.6	7.9
	'Clayey' sand, part pebbly Gravel: mainly fine, Magnesian Limestone, with dark rocks and Carboniferous limestone, and trace of coal Sand: mainly medium, subangular quartz, with subangular to subrounded Magnesian Limestone and some coal and other lithic fragments	6.3	14.2
	Clay, brown, with silt laminae	10.6+	24.8

Grading

Mean for deposit *percentages*			Bulk samples 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
11	85	4	7.9–8.9	12	25	53	5	5	0
			8.9–9.8	15	28	50	4	2	1
			9.8–10.8	6	17	48	22	6	1
			10.8–11.8	11	21	58	8	2	trace
			11.8–12.8	8	20	58	7	4	3
			12.8–14.0	12	24	55	6	3	trace
			14.0–14.2	10	22	54	10	3	1
			Mean	11	22	54	9	3	1

NZ 32 SW 32 3465 2274 Lea Close, Great Stainton **Block C**

Surface level (+81.1 m)+266 ft
Groundwater conditions not recorded
March 1975

Overburden 3.3 m
Mineral 18.2 m
Waste 2.5 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.5	0.5
Boulder Clay	Clay, red-brown with grey partings; pebbles of sandstone, Magnesian Limestone and dark volcanic rock, and coal fragments	2.8	3.3
Glacial Sand and Gravel	'Very clayey' sand: fine, quartz with some Magnesian Limestone, coal and dark volcanic rock	18.2	21.5
Boulder Clay	Clay, dark brown; pebbles of Magnesian Limestone, quartzite, sandstone and dark volcanic rock	2.5+	24.0

Grading

Mean for deposit *percentages*			Bulk samples 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
27	73	trace	3.3–16.0	25	55	19	1	trace	0
			16.0–21.5	31	66	3	trace	0	0
			Mean	27	58	14	1	trace	0

NZ 32 SW 33 3130 2244 Lodge Lane **Block C**

Surface level (+98.8 m)+324 ft
Groundwater conditions not recorded
February 1975

Overburden 6.0 m
Mineral 2.5 m
Waste 9.5 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	1.2	1.2
Boulder Clay	Clay, sandy, red-brown with thin grey partings; pebbles of Magnesian Limestone, sandstone and coal	4.8	6.0
Glacial Sand and Gravel	Gravel Gravel: fine and coarse, Magnesian Limestone, sandstone and dark volcanic rock Sand: coarse with fine and medium, quartz and lithic grains	2.5	8.5
Boulder Clay	Clay, sandy, red to grey, with Magnesian Limestone, coal and dark volcanic pebbles	9.5+	18.0

Grading

Mean for deposit *percentages*			Bulk samples 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
8	30	62	6.0–8.5	8	6	8	16	34	28

NZ 32 SW 34 3343 2240 NW of Great Stainton **Block C**

Surface level (+97.8 m)+321 ft
Groundwater encountered at +83.2 m
April 1975

Waste 18.3 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.1	0.1
Boulder Clay and Glacial Drift, undifferentiated	Clay, orange-brown to grey-brown, with pebbles of sandstone, quartzite, Magnesian Limestone and dark rock, and coal fragments; thin sand partings near top	14.6	14.7
	Silt, grey-brown, with some coaly sand and thin clay partings	2.3	17.0
	Clay, brown, silty in part	1.3+	18.3

NZ 32 SW 35 3024 2224 E of High House, Brafferton **Block C**

Surface level (+94.2 m)+309 ft
Groundwater conditions not recorded
October 1975

Waste 18.3 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.3	0.3
Boulder Clay	Clay, orange-brown to brown, with dark coaly streaks; stoneless at top and from 7.3 m to 8.3 m; elsewhere, pebbles of Magnesian Limestone, Carboniferous limestone, sandstone, siltstone and coal	14.3	14.6
Glacial Sand and Gravel	'Very clayey' sand: fine, subangular to subrounded quartz, with some subangular Magnesian Limestone and coal	0.7	15.3
Boulder Clay	Clay, pinkish brown, with some sand and silt laminae; occasional small Magnesian Limestone and sandstone pebbles	3.0+	18.3

NZ 32 SW 36 3220 2212 NW of Hauxley, Great Stainton **Block C**

Surface level (+108.5 m)+356 ft
Groundwater not encountered
August 1975

Waste 18.0 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.2	0.2
Boulder Clay	Clay, orange-brown to mid-brown, grey-streaked,with pebbles of Magnesian Limestone, Carboniferous limestone, sandstone, quartzite, grey siltstone, dark mudstone and coal	17.8+	18.0

NZ 32 SW 37 3423 2220 Great Stainton **Block C**

Surface level (+77.1 m)+253 ft
Groundwater standing at +65.2 m
February 1975

Waste 18.0 m+

Log

Geological classification	*Lithology*	*Thichness* m	*Depth* m
	Soil	1.1	1.1
Boulder Clay and Glacial Drift, undifferentiated	Clay, orange-brown to light brown, micaceous and sandy, with sandstone, limestone and dark volcanic pebbles, and coal fragments	5.6	6.7
	Silt, sandy, with coal fragments	3.3	10.0
	Clay, red-brown, with Magnesian Limestone and sandstone pebbles	8.0+	18.0

NZ 32 SW 38 3147 2177 NW of Firtree House, Brafferton **Block C**

Surface level (+98.1 m)+322 ft
Groundwater conditions not recorded
October 1975

Waste 185 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.4	0.4
Lacustrine Alluvium	Silt, clayey and sandy, grey-brown with ochreous patches	3.1	3.5
Peat	Peat, black	0.3	3.8
Boulder Clay	Clay, silty, brown to grey-brown, with mainly small pebbles of Magnesian Limestone, sandstone, siltstone and dark rock, and coal fragments; thin bands of fine to coarse 'clayey' gravel at 5.8 m and 11.3 m; poorly laminated from 10.8 m to 11.3 m	14.7+	18.5

NZ 32 SW 39 3335 2140 Stainton Viewley, Great Stainton **Block C**

Surface level (+81.4 m)+267 ft
Groundwater (very little) encountered at +73.6 m
April 1975

Waste 18.3 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.1	0.1
Boulder Clay and Glacial Drift, undifferentiated	Clay, sandy, reddish-brown to grey-brown, partly laminated; few pebbles of sandstone, Magnesian Limestone, Carboniferous limestone, coal, and, rarely, microgranite; band of clayey and sandy silt from 7.0 to 7.7 m	18.2+	18.3

NZ 32 SW 40 3053 2108 SE of Lovesome Hill, Brafferton **Block C**

Surface level (+82.3 m)+270 ft
Groundwater encountered at +78.4 m
September 1975

Waste 18.3 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.4	0.4
Boulder Clay and Glacial Drift, undifferentiated	Clay, silty to sandy, orange-brown to brown, with pebbles of Magnesian Limestone and, less commonly, quartzite, siltstone, Carboniferous limestone and fine-grained igneous rock; 0.1-m sandy silt on 0.1-m 'clayey' gravel at 4.1 m	5.6	6.0
	Silt, light brown, with thin bands of clay laminated with fine sand	7.2	13.2
Glacial Sand and Gravel	'Very clayey' pebbly sand Gravel: coarse to cobble, subrounded Magnesian Limestone and subangular Carboniferous sandstone Sand: fine quartz and rock fragments	1.7	14.9
Boulder Clay	Clay, purple-brown, silty, with small fragments of Magnesian Limestone, sandstone and Carboniferous limestone	3.4+	18.3

Grading

Mean for deposit *percentages*			Bulk samples 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
28	62	10	13.2–14.9	28	60	2	trace	0	10

NZ 32 SW 41 3428 2107 NNW of Little Stainton **Block C**

Surface level (+56.1 m)+184 ft
Groundwater encountered from +50.6 to +50.5 m
September 1975

Waste 18.3 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.5	0.5
Boulder Clay and Glacial Drift, undifferentiated	Clay, greyish to reddish-brown, partly laminated; some lenses of fine quartz sand and scattered thin sandy silt bands; pebbles of Magnesian Limestone, sandstone, coal and dolerite; and, rarely, siltstone and vein quartz	17.8+	18.3

NZ 32 SW 42 3294 2057 Near Mount Pleasant, Little Stainton **Block C**

Surface level (+76.2 m)+250 ft
Groundwater conditions not recorded
March 1975

Waste 18.0 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.6	0.6
Boulder Clay and Glacial Drift, undifferentiated	Clay, sandy, red-brown to dark brown, with pebbles of Magnesian sandstone and volcanic rock, and coal fragments	7.2	7.8
	Silt, sandy, yellow-brown, with fine coal and Magnesian Limestone fragments	1.2	9.0
	Clay, red-brown, as above	9.0+	18.0

NZ 32 SW 43 3090 2037 East Ketton, Brafferton **Block C**

Surface level (+82.9 m) +272 ft
Water level not recorded
April 1975

Overburden 5.0 m
Mineral 3.0 m
Waste 0.3 m
Mineral 2.1 m
Waste 10. 1 m
Mineral 3.9 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.2	0.2
Boulder Clay	Clay, silty, greyish-brown; pebbles of Magnesian Limestone, sandstone, quartzite and, less commonly, coal and Carboniferous limestone	4.8	5.0
Glacial Sand and Gravel	**a** Sand on 'very clayey' sandy gravel Gravel: fine and coarse, quartzite and Magnesian Limestone with fine dark rock and coal Sand: mainly fine quartz, with some fine to coarse coal	3.0	8.0
	Clay, brown, laminated	0.3	8.3
	b 'Very clayey' pebbly sand Gravel and sand: as above	2.1	10.4
	Clay, light brown to grey-brown, laminated	10.1	20.5
	c 'Clayey' sand, pebbly at top Gravel: fine subangular and coarse subrounded Magnesian Limestone, Carboniferous limestone, quartzite and sandstone Sand: subangular to subrounded, fine to medium quartz, with coal abundant in upper part but decreasing downwards Fines: include thin clay partings	3.9+	24.4

Grading

	Mean for deposit *percentages*			Bulk samples 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
a	16	69	15	5.0–6.0	7	48	37	5	3	0
				6.0–6.5	6	61	32	1	trace	0
				6.5–7.5	26	34	10	4	14	12
				7.5–8.0	24	31	10	3	13	19
				Mean	16	42	23	4	8	7
b	32	62	6	8.3–9.3	38	46	7	3	3	3
				9.3–10.4	25	55	11	2	5	2
				Mean	32	50	9	3	4	2
a+b	23	66	11	Mean	23	46	17	3	6	5
c	15	83	2	20.5–20.9	10	48	26	1	2	13
				20.9–22.1	28	40	30	1	1	0
				22.1–23.1	11	57	31	1	0	0
				23.1–24.4	7	53	39	1	trace	0
				Mean	15	49	33	1	1	1
a+b+c	19	74	7	Mean	19	48	24	2	4	3

NZ 32 SW 44 3439 2028 Little Stainton **Block D**

Surface level (+66.4 m)+218 ft
Groundwater encountered at +60.6 m
February 1975

Overburden 5.8 m
Mineral 4.2 m
Waste 11.0 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.3	0.3
Boulder Clay	Clay, sandy, brick-red to dark brown, with small rock fragments	5.5	5.8
Glacial Sand and Gravel	'Very clayey' sand: fine with medium, subangular to subrounded quartz; few small coal and limestone pebbles	4.2	10.0
Glacial Drift, undifferentiated	Silt, dark brown, finely laminated, sandy in lower part; some coal fragments	11.0+	21.0

Grading

Mean for deposit *percentages*			Bulk samples 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
30	69	1	5.8–10.0	30	45	23	1	1	0

NZ 32 SE 43 3877 2485 Thorpe Leazes **Block C**

Surface level (+67.7 m)+222 ft
Groundwater encountered at +55.1 m
January 1975

Waste 24.4 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.4	0.4
Boulder Clay	Clay, reddish-grey to red-brown, with pebbles of Magnesian Limestone, quartzite, sandstone, dark siltstone and coal, and, less commonly, Carboniferous limestone	13.3	13.7
Glacial Sand and Gravel	**a** Gravel Gravel: coarse to cobble, Magnesian Limestone, Carboniferous limestone, sandstone and quartzite, with traces of igneous rock, quartz and siltstone Sand: mainly coarse, quartz and lithic grains	1.5	15.2
	Clay, reddish-orange, silty	0.9	16.1
	b 'Very clayey' sand: subangular to subrounded, fine quartz with fine to medium coal and some quartzite and Magnesian Limestone	1.2	17.3
Boulder Clay	Clay, brown, with silt and sand laminae to 19.0 m; reddish-brown, silty and micaceous below, with few pebbles	4.0	21.3
Glacial Sand and Gravel	**c** 'Very clayey' sand: fine quartz	1.7	23.0
Boulder Clay	Clay, brown, laminated, with scattered quartzite and Magnesian Limestone pebbles	1.4+	24.4

Grading

	Mean for deposit *percentages*			Bulk samples 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
a	8	16	76	13.7–14.7	7	3	4	14	26	46
				14.7–15.2	9	2	1	5	20	63
				Mean	8	3	3	10	24	52
b	25	75	0	16.1–17.1	24	57	18	1	0	0
				17.1–17.3	26	57	17	trace	0	0
				Mean	25	56	18	1	0	0
c	37	63	0	21.3–23.0	37	63	trace	trace	0	0
a+b+c	24	50	26	Mean	24	40	6	4	8	18

NZ 32 SE 44 3778 2432 Whitton Three Gates **Block C**

Surface level (+71.6 m)+235 ft
Groundwater not encountered
October 1975

Waste 18.0 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.3	0.3
Boulder Clay and Glacial Drift, undifferentiated	Clay, red-brown with grey mottling; scattered sandstone and limestone pebbles	11.4	11.7
	Clay, sandy, red, soft	1.0	12.7
	Clay, dark brown with red sand partings and scattered pebbles	5.3+	18.0

NZ 32 SE 45 3960 2425 NNE of Hell Hole **Block C**

Surface level (+63.7 m)+209 ft
Groundwater encountered from +55.4 m to +55.2 m
February 1975

Waste 18.9 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.2	0.2
Boulder Clay and Glacial Drift, undifferentiated	Clay, orange-brown to dark brown, with pebbles of Magnesian Limestone, quartzite, Carboniferous sandstone, coal, mudstone, and, rarely, Carboniferous limestone	17.3	17.5
	Silt, grey-brown, with some coal fragments	1.2	18.7
Glacial Sand and Gravel	'Very clayey' sand: fine quartz, with fine to coarse angular coal	0.2+	18.9

NZ 32 SE 46 3702 2401 NW of Engineering Works, Stillington **Block C**

Surface level (+64.9 m)+213 ft
Groundwater conditions not recorded
February 1975

Waste 18.0 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.6	0.6
Boulder Clay	Clay, sandy, dark reddish-brown, with pebbles of Magnesian Limestone and dark volcanic rock	17.4+	18.0

NZ 32 SE 47 3886 2372 Maudlin Gutter, Whitton **Block C**

Surface level (+37.5 m)+123 ft
Groundwater not encountered
September 1975

Waste 25.0 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.4	0.4
Boulder Clay and Glacial Drift, undifferentiated	Clay, red-brown, with pebbles of Carboniferous sandstone and limestone, and coal fragments; poorly laminated from 4.6 to 6.0 m	7.2	7.6
	Silt, sandy, light brown with coal fragments and scattered clay bands; poorly laminated at base	4.6	12.2
Glacial Sand and Gravel	'Clayey' pebbly sand Gravel: fine to coarse, subangular to subrounded Carboniferous limestone, sandstone and Magnesian Limestone Sand: fine to coarse, subangular to subrounded quartz and lithic grains including coal	3.8	16.0
Boulder Clay	Clay, grey-brown, with small pebbles of Magnesian Limestone, Carboniferous sandstone and coal; poorly laminated and less stony from 22.0 to 23.0 m	9.0+	25.0

Grading

Mean for deposit *percentages*			Bulk samples 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
15	72	13	12.2–13.2	18	24	24	20	4	10
			13.2–14.2	13	12	45	19	2	9
			14.2–15.2	14	12	52	19	2	1
			15.2–16.0	15	14	30	13	16	12
			Mean	15	15	39	18	5	8

NZ 32 SE 48 3783 2329 E of Mount Pleasant, Stillington **Block C**

Surface level (+60.4 m)+198 ft
Water level not recorded
February 1975

Waste 19.0 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.2	0.2
Boulder Clay	Clay, brown to reddish-grey, with fragments of Magnesian Limestone, sandstone, siltstone and coal; quartz sand partings below 9 m	11.7	11.9
Glacial Sand and Gravel	'Very clayey' sand; fine quartz, with trace of medium to coarse quartzite, limestone and coal in micaceous silt matrix	0.4	12.3
Boulder Clay	Clay, grey-brown, with pebbles of sandstone, quartzite, Magnesian Limestone and siltstone, and coal fragments	6.7+	19.0

NZ 32 SE 49 3631 2315 N of Stillington **Block C**

Surface level (+50.9 m)+167 ft Waste 18.3 m+
Water level not recorded
February 1975

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.2	0.2
Boulder Clay	Clay, brown, with grey sandy lenses: pebbles of sandstone, Magnesian Limestone and, less commonly, coal, quartzite, siltstone and Carboniferous limestone	12.6	12.8
Glacial Sand and Gravel	Gravel, with sand from 13.8 m to 14.5 m Gravel: coarse with some fine and cobbles; sandstone and Magnesian Limestone with some Carboniferous limestone, quartz and igneous rock Sand: fine quartz, with fine to coarse coal and some Magnesian Limestone	2.9	15.7
Boulder Clay	Clay, silty, grey-brown, with thin parting of micaceous coaly silt near top	2.6+	18.3

Grading

Mean for deposit *percentages*			Bulk samples 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
6	49	45	12.8–13.8	7	27	3	5	10	48
			13.8–14.5	7	71	15	3	2	2
			14.5–15.5	2	12	17	11	20	38
			15.5–15.7	14	11	12	7	8	48
			Mean	6	31	11	7	11	34

NZ 32 SE 50 3978 2301 N of Carlton Grange **Block D**

Surface level (+34.4 m)+113 ft Waste 24.4 m+
Groundwater encountered at +29.1 m
February 1975

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.2	0.2
Boulder Clay	Clay, purple to brown, generally with pebbles of Carboniferous sandstone, Magnesian Limestone, coal and siltstone	6.2	6.4
Glacial Sand and Gravel	**a** 'Clayey' gravel: fine to coarse, Magnesian Limestone with Carboniferous limestone, quartzitic sandstone and dark igneous rock; 'very clayey' quartz and lithic sand matrix	1.1	7.5
Boulder Clay	Clay, as above	5.3	12.8
Glacial Sand and Gravel	**b** 'Clayey' sand, grey-brown; medium quartz with fine to coarse coal and other lithic grains; a little fine gravel of Magnesian Limestone and quartzitic sandstone with traces of other rocks and quartz	1.2	14.0
	c Gravel Gravel: fine to coarse, quartzitic sandstone, Magnesian Limestone and Carboniferous limestone, with quartzite, some igneous rock, and traces of quartz and chert Sand: medium, quartz with some coal and other lithic grains	1.9	15.9
Boulder Clay	Clay, brown to grey-brown; laminated with pale sand partings below 21.0 m; scattered small pebbles of Magnesian Limestone, siltstone and sandstone, and coal fragments near base	8.5+	24.4

Grading

	Mean for deposit *percentages*			Bulk samples 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
a	10	19	71	6.4– 7.5	10	6	4	9	15	56
b	18	82	trace	12.8–14.0	18	21	58	3	trace	0
c	5	39	56	14.0–15.0	4	10	22	17	36	11
				15.0–15.9	6	7	15	5	14	53
				Mean	5	9	19	11	25	31
b+c	10	55	35	Mean	10	13	34	8	16	19
a+b+c	10	45	45	Mean	10	11	26	8	16	29

Composition of gravel fraction

Depth below surface (m)	Percentages by weight							
	Sandstone	Limestone	Quartzite	Igneous	Mudstone/ siltstone	Quartz	Ironstone	Chert
6.4– 7.5	11	77	3	7	2	trace	trace	trace
14.0–15.0	37	38	19	4	trace	1	trace	1

NZ 32 SE 51 3917 2267 Greystones, Carlton **Block D**

Surface level (+46.3 m)+152 ft
Groundwater encountered at +32.3 m
January 1975

Overburden 10.2 m
Mineral 7.0 m
Waste 7.2 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.2	0.2
Boulder Clay	Clay, grey-brown, with small pebbles of sandstone, Magnesian Limestone, siltstone and quartzite	10.0	10.2
Glacial Sand and Gravel	**a** 'Clayey' sand, pebbly at base Gravel: fine, Magnesian Limestone, Carboniferous limestone, quartzite and dark rocks including coal, with traces of igneous rock Sand: fine to medium, subangular to subrounded, quartz with some coal, Magnesian Limestone and quartzite	4.8	15.0
	b Sandy gravel Gravel: fine to coarse with some cobbles, Magnesian Limestone, quartzite and sandstone, with some coal, other dark rocks and grey igneous rock Sand: fine to coarse, quartz and rock fragments	2.2	17.2
	Silt, light red-brown, with mica and fine coal	2.9	20.1
Boulder Clay	Clay, red-brown, silty, laminated, with scattered pebbles including Magnesian Limestone, coal and quartzite	4.3+	24.4

Grading

	Mean for deposit *percentages*			Bulk samples 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
a	19	79	2	10.2–11.2	31	61	8	trace	trace	0
				11.2–12.2	24	53	23	trace	0	0
				12.2–13.1	17	45	37	1	trace	0
				13.1–14.0	15	24	50	8	3	0
				14.0–15.0	7	35	44	7	5	2
				Mean	19	44	32	3	2	trace
b	4	60	36	15.0–16.0	4	22	33	21	15	5
				16.0–17.0	2	9	19	17	26	27
				17.0–17.2	12	15	24	20	10	19
				Mean	4	15	26	19	19	17
a+b	14	73	13	Mean	14	35	30	8	7	6

NZ 32 SE 52 3578 2253 Near West Farm, Old Stillington **Block C**

Surface level (+49.7 m)+163 ft
Water level not recorded
April 1975

Overburden 2.4 m
Mineral 3.7 m
Waste 1.7 m
Mineral 2.3 m
Waste 2.7 m
Mineral 1.0 m
Waste 9.3 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.2	0.2
Boulder Clay	Clay, red-brown, with some coal flakes and scattered quartzite pebbles	2.2	2.4
Glacial Sand and Gravel	**a** 'Clayey' gravel Gravel: mainly coarse, quartzite, sandstone and limestone, with siltstone, coal, and a trace of dolerite Sand: fine to coarse, quartz with some Magnesian Limestone	3.7	6.1
Boulder Clay	Clay, light brown, with scattered pebbles, mainly of quartzite	1.7	7.8
Glacial Sand and Gravel	**b** 'Very clayey' gravel Gravel: coarse with fine, quartzite with Magnesian Limestone Sand: mainly fine, quartz with some coal Fines: disseminated, red-brown, micaceous, and grey-brown clay partings	2.3	10.1
Boulder Clay	Clay, grey-brown, with small quartzite, sandstone, Magnesian Limestone and siltstone fragments	2.7	12.8
Glacial Sand and Gravel	**c** 'Clayey' sandy gravel Gravel: fine to coarse, quartzite with limestone, coal and blue-green igneous rock Sand: medium, quartz with rock fragments	1.0	13.8
Boulder Clay	Clay, reddish-orange to grey-brown, with micaceous laminae; some partings of fine coaly quartz sand; scattered rock fragments	8.6	22.4
Glacial Sand and Gravel	'Clayey' gravel Gravel: as 12.8 to 13.8 m with some Carboniferous limestone Sand: fine quartz, with medium to coarse rock fragments *Borehole abandoned owing to obstruction*	0.7+	23.1

Grading

	Mean for deposit *percentages*			Bulk samples 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
a	11	24	65	2.4–3.4	9	6	11	13	19	42
				3.4–4.4	17	4	5	6	14	54
				4.4–4.7	12	6	7	9	22	44
				4.7–5.7	10	8	9	11	20	42
				5.7–6.1	7	7	8	7	18	53
				Mean	11	6	8	10	18	47
b	26	31	43	7.8–8.7	28	31	6	5	11	19
				8.7–10.1	25	13	5	5	17	35
				Mean	26	20	6	5	15	28
c	14	57	29	12.8–13.8	14	16	30	11	11	18
a+b+c	16	31	53	Mean	16	11	11	9	16	37

NZ 32 SE 53 3796 2185 W of Glebe Farm **Block D**

Surface level (+49.7 m)+163 ft
Groundwater conditions not recorded
September 1975

Overburden 12.9 m
Mineral 5.9 m
Waste 6.2 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.6	0.6
Boulder Clay	Clay, red-brown, with grey lenses; pockets of red sand; Magnesian Limestone and Carboniferous rock fragments; relatively stoneless and with silt laminae from 7.0 m to 12.9 m	12.3	12.9
Glacial Sand and Gravel	**a** 'Clayey' sandy gravel Gravel: fine to coarse, subrounded to subangular Carboniferous sandstone, limestone and Magnesian Limestone Sand: fine to medium quartz with medium to coarse lithic grains, including coal at top	2.0	14.9
	b Pebbly sand Gravel: fine, Magnesian Limestone, Carboniferous sandstone, limestone, and coal Sand: mainly medium, subangular to subrounded, quartz with lithic grains	3.9	18.8
	Silt, sandy, micaceous, brownish-grey to red, with fine coal laminae	3.5	22.3
Boulder Clay	Clay, dark brown, pebbly	2.7+	25.0

Grading

	Mean for deposit *percentages*			Bulk samples 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
a	10	46	44	12.9–13.9	12	13	18	15	19	23
				13.9–14.9	9	13	19	14	24	21
				Mean	10	13	19	14	17	27
b	7	85	8	14.9–15.9	10	32	32	13	10	3
				15.9–16.9	7	24	40	19	8	2
				16.9–17.9	3	20	69	5	3	0
				17.9–18.8	7	17	62	9	5	trace
				Mean	7	23	51	11	7	1
a+b	8	72	20	Mean	8	20	40	12	12	8

NZ 32 SE 54 3962 2189 Market Gardens, Carlton **Block D**

Surface level (+48.5 m)+159 ft
Groundwater encountered at +35.2 m
February 1975

Overburden 12.9 m
Mineral 1.6 m
Waste 0.5 m
Mineral 6.6 m
Waste 2.8 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.3	0.3
Boulder Clay	Clay, greyish-purple to brown, with pebbles of Magnesian Limestone, quartzite, sandstone, coal, Carboniferous limestone, siltstone and, less commonly, of chert and dolerite; scattered pockets of coaly sand	12.6	12.9
Glacial Sand and Gravel	**a** Sand, clayey at top Sand: mainly fine, quartz with coal and some quartzite and limestone Fines: disseminated and, in upper part, as scattered small pellets of grey-brown clay	1.6	14.5
Boulder Clay	Clay, grey, with rock fragments	0.5	15.0
Glacial Sand and Gravel	**b** Sand: fine to medium, quartz, with coal and some quartzite and Magnesian Limestone; a little gravel	4.0	19.0
	c Gravel Gravel: fine to coarse, sandstone, Magnesian Limestone, and Carboniferous limestone with quartzite and some fine-grained igneous rock and a trace of quartz, chert, siltstone, ironstone and coal Sand: fine to coarse, quartz with lithic grains	2.6	21.6
Boulder Clay	Clay, mid-brown, silty, laminated and micaceous, with rare coal and Magnesian Limestone fragments	2.8+	24.4

Grading

	Mean for deposit *percentages*			Bulk samples 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
a	10	90	trace	12.9–14.0	10	70	19	1	trace	0
				14.0–14.5	10	80	9	1	trace	0
				Mean	10	73	16	1	trace	0
b	6	92	2	15.0–16.0	9	45	39	4	2	1
				16.0–17.0	7	37	50	3	3	0
				17.0–18.0	5	30	62	3	trace	0
				18.0–19.0	4	48	44	3	1	0
				Mean	6	40	49	3	2	trace
a+b	7	92	1	Mean	7	49	40	3	1	trace
c	1	43	56	19.0–20.0	1	5	10	15	41	28
				20.0–20.4	2	12	27	24	24	11
				20.4–21.4	1	3	15	30	38	13
				21.4–21.6	1	5	16	24	39	15
				Mean	1	5	15	23	37	19
b+c	4	73	23	Mean	4	26	36	11	15	8
a+b+c	5	77	18	Mean	5	36	32	9	12	6

Composition of gravel fraction

Depth below surface (m)	Percentages by weight								
	Sandstone	Limestone	Quartzite	Igneous	Mudstone/ siltstone	Quartz	Coal	Ironstone	Chert
20.0–20.4	43	38	10	6	trace	1	1	trace	trace
20.4–21.4	34	49	7	9	1	trace	trace	0	0

NZ 32 SE 55 3541 2156 WNW of Bishopton **Block C**

Surface level (+57.0 m)+187 ft
Groundwater conditions not recorded
September 1975

Waste 17.4 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.4	0.4
Boulder Clay	Clay, sandy at top, orange-brown to mid-brown, with pebbles of sandstone and Magnesian Limestone; 0.2 m of 'clayey' gravel at 16.4 m *Borehole abandoned owing to obstruction*	17.0+	17.4

NZ 32 SE 56 3663 2158 Cobby Castle Lane, Bishopton **Block D**

Surface level (+50.9 m)+167 ft
Groundwater encountered at +36.4 m
September 1975

Overburden 1.0 m
Mineral 2.2 m
Waste 10.8 m
Mineral 8.5 m
Waste 2.0 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.3	0.3
Boulder Clay	Clay, grey-brown	0.7	1.0
Glacial Sand and Gravel	**a** 'Clayey' sand, grey-brown: mainly fine subangular quartz with some medium angular coal; fine to cobble, mainly sandstone gravel at base	2.2	3.2
Boulder Clay	Clay, reddish-brown, laminated; thin sand veins and fragments of coal, Magnesian Limestone and sandstone	9.8	13.0
	Silt, micaceous, grey to pale brown; with some fine coal and quartz sand	1.0	14.0
Glacial Sand and Gravel	**b** 'Clayey' sand, with gravel at base Gravel: coarse Magnesian Limestone and quartzitic sandstone, with some fine coal, Carboniferous limestone and igneous rock Sand: mainly fine, subangular quartz and coal, with some Magnesian Limestone and other rock fragments	8.5	22.5
Boulder Clay	Clay, silty, red-brown; scattered pebbles including Magnesian Limestone, sandstone, siltstone, coal and Carboniferous limestone	2.0+	24.5

Grading

	Mean for deposit *percentages*			Bulk samples 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
a	13	86	1	1.0–2.0	18	58	24	trace	trace	0
				2.0–3.1	9	64	27	trace	0	0
				3.1–3.2	9	41	23	2	2	23
				Mean	13	61	25	trace	trace	trace
b	11	87	2	14.0–15.0	14	58	28	trace	trace	0
				15.0–16.0	15	62	23	trace	0	0
				16.0–17.0	16	57	27	trace	0	0
				17.0–18.0	8	60	32	trace	0	0
				18.0–19.0	8	52	39	1	0	0
				19.0–20.0	10	56	34	trace	0	0
				20.0–21.0	10	53	37	trace	0	0
				21.0–22.0	8	50	42	trace	0	0
				22.0–22.2	7	50	42	1	trace	0
				22.2–22.5	3	17	13	5	12	50
				Mean	11	54	32	1	trace	2
a+b	11	87	2	Mean	11	56	31	trace	trace	2

NZ 32 SE 57 3903 2150 SW of Carlton **Block D**

Surface level (+46.4 m)+152 ft
Groundwater encountered at +35.1 m and +31.2 m
January 1975

Overburden 5.1 m
Mineral 3.2 m
Waste 1.4 m
Mineral 2.6 m
Waste 0.4 m
Mineral 4.0 m
Waste 2.0 m
Mineral 1.1 m
Waste 4.6 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.2	0.2
Boulder Clay and Glacial Drift, undifferentiated	Clay, silty, orange-brown, with small pebbles of coal, sandstone, quartzite, Magnesian Limestone and siltstone	2.9	3.1
	Silt, brownish-grey, with some coal streaks	0.6	3.7
	Clay, silty, grey-brown, with some quartz and coal sand	1.4	5.1
Glacial Sand and Gravel	**a** Sand, pebbly at base Gravel: fine, coal, Carboniferous sandstone, quartzite and Magnesian Limestone Sand: mainly medium, quartz with Magnesian Limestone and some quartzite	3.2	8.3
Boulder Clay	Clay, brown	1.4	9.7
Glacial Sand and Gravel	**b** 'Clayey' sand: fine to medium quartz, with medium to coarse coal and Magnesian Limestone; disseminated silt, and clay nodules; a little gravel	2.6	12.3
Boulder Clay	Clay, silty, grey and brown, partly laminated	0.4	12.7
Glacial Sand and Gravel	**c** Sand: mainly medium, quartz wtih some coal, quartzite, Magnesian Limestone and Carboniferous limestone; a little gravel	4.0	16.7
	Silt, sandy, with coal fragments	2.0	18.7
	d 'Very clayey' sand: fine quartz	1.1	19.8
Boulder Clay	Clay, red-brown to reddish grey, part silty, part laminated; 0.4-m silt parting at 22.8 m	4.6+	24.4

Grading

	Mean for deposit *percentages*			Bulk samples 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
a	8	90	2	5.1–6.1	12	40	46	2	trace	0
				6.1–7.1	9	32	55	3	1	0
				7.1–8.1	4	19	66	10	1	0
				8.1–8.3	6	10	51	17	12	4
				Mean	8	29	55	6	2	trace
b	16	82	2	9.7–10.7	14	22	53	8	3	0
				10.7–11.7	18	45	35	2	trace	0
				11.7–12.3	18	42	34	4	2	0
				Mean	16	36	42	4	2	0
c	4	94	2	12.7–13.7	3	12	72	10	3	0
				13.7–14.7	3	15	63	17	2	0
				14.7–15.7	5	33	57	4	1	0
				15.7–16.7	5	37	57	1	trace	0
				Mean	4	24	62	8	2	0
d	20	80	0	18.7–19.8	20	70	9	1	0	0
a+b+ c+d	10	89	1	Mean	10	33	50	6	1	trace

NZ 32 SE 58 3674 2114 **Grange Farm, Bishopton** **Block D**

Surface level (+47.9)+157 ft
Groundwater encountered at +43.4 m
April 1975

Overburden 1.6 m
Mineral 2.9 m
Waste 19.9 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.4	0.4
Boulder Clay	Clay, orange-brown, sandy	1.2	1.6
Glacial Sand and Gravel	Sandy gravel, 'clayey' towards base Gravel: fine to coarse, Magnesian Limestone and quartzite with some Carboniferous limestone, coal and other dark rocks Sand: fine to coarse, quartz with coal and some quartzite and limestone Fines: disseminated and in few thin partings	2.9	4.5
Boulder Clay and Glacial Drift, undifferentiated	Clay, red-brown, part laminated, part sandy, with pebbles of quartzite, Magnesian Limestone and dark siltstone	6.9	11.4
	Silt, clayey, grey-brown to red-brown; some fine quartz and coal sand; a trace of gravel near base	6.1	17.5
Glacial Sand and Gravel	'Very clayey' sand: fine quartz with rock fragments; trace of gravel	2.4	19.9
Glacial Drift undifferentiated	Silt, grey-brown, sandy at top, clayey below; a trace of fine gravel	4.5+	24.4

Grading

Mean for deposit *percentages*			Bulk samples 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
9	63	28	1.6–2.6	7	24	50	10	8	1
			2.6–3.6	5	12	34	21	18	10
			3.6–4.5	16	5	11	20	28	20
			Mean	9	14	32	17	18	10

NZ 32 SE 59 3824 2111 High Farm, E of Redmarshall **Block D**

Surface level (+50.9 m)+167 ft
Water level not recorded
January 1975

Overburden 10.9 m
Mineral 3.6 m
Waste 9.9 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.2	0.2
Boulder Clay	Clay, grey to red-brown, with pebbles of quartzite, Magnesian Limestone, dark siltstone and coal	10.7	10.9
Glacial Sand and Gravel	'Clayey' sand, pebbly in part Gravel: mainly fine, Magnesian Limestone and sandstone with some Carboniferous limestone, quartzite, siltstone, coal and igneous rock Sand: fine to medium quartz with some medium to coarse rock fragments	3.6	14.5
Glacial Drift, undifferentiated	Clay and silt, grey-brown to red, scattered pebbles near top	9.9+	24.4

Grading

Mean for deposit *percentages*			Bulk samples 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
13	84	3	10.9–11.7	21	24	44	7	4	0
			11.7–12.7	12	31	44	11	2	0
			12.7–13.7	10	37	52	1	trace	0
			13.7–13.9	5	41	39	6	9	0
			13.9–14.5	14	40	35	5	4	2
			Mean	13	33	44	7	3	trace

Composition of gravel fraction

Depth below surface (m)	Percentages by weight								
	Sandstone	Magnesian Limestone	Carboniferous limestone	Quartzite	Igneous	Mudstone/ siltstone	Quartz	Coal	Ironstone
13.9–14.5	41	31	10	4	3	9	1	1	trace

NZ 32 SE 60 3924 2071 S of Hill House, Redmarshall **Block D**

Surface level (+54.3 m)+178 ft
Groundwater encountered at c. +35.6 m
January 1975

Overburden 11.5 m
Mineral 8.5 m
Waste 3.5 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.3	0.3
Boulder Clay	Clay, red-brown, with pebbles of sandstone, quartzite and, rarely, Magnesian Limestone, coal and siltstone	11.2	11.5
Glacial Sand and Gravel	'Clayey' sand: fine to medium, angular to subrounded quartz, with fine to coarse angular coal and some quartzite and Magnesian Limestone; a little gravel in upper part; fines include lumps of clay	8.5	20.0
Glacial Drift, undifferentiated	Silt, grey-brown, with some clay nodules and coal fragments	3.5+	23.5
	Hole abandoned owing to 'rising silt'		

Grading

Mean for deposit *percentages*			Bulk samples 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
19	80	1	11.5–12.5	19	55	24	1	1	0
			12.5–13.5	5	46	45	3	1	0
			13.5–14.5	13	48	33	4	2	0
			14.5–15.5	14	56	26	3	1	0
			15.5–16.5	13	67	20	trace	0	0
			16.5–17.5	20	66	13	1	0	0
			17.5–18.5	34	62	4	trace	0	0
			18.5–19.5	30	66	3	1	trace	0
			19.5–20.0	35	61	3	1	trace	0
			Mean	19	58	20	2	1	0

NZ 32 SE 61 3555 2044 Hambleton View **Block D**

Surface level (+59.1 m)+194 ft
Groundwater encountered at c. +42.1 m
January 1975

Overburden 14.5 m
Mineral 5.7 m
Waste 4.2 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.5	0.5
Boulder Clay	Clay, grey-brown to red-brown, with pebbles of Magnesian Limestone and Carboniferous sandstone; 0.1-m band of medium quartz sand with some coarse coal at 11.1 m	14.0	14.5
Glacial Sand and Gravel	'Clayey' to 'very clayey' sand, pebbly in part Gravel: fine to coarse, Magnesian Limestone with coal, Carboniferous sandstone and some quartzite and igneous rock Sand: fine to medium, quartz with coal and Magnesian Limestone Fines: disseminated and in small nodules	5.7	20.2
Glacial Drift, undifferentiated	Clay, grey-brown, laminated	3.3	23.5
	Silt, orange-brown	0.9+	24.4

Grading

Mean for deposit *percentages*			Bulk samples 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
13	84	3	14.5–15.5	22	25	39	8	5	1
			15.5–15.8	16	17	43	11	9	4
			15.8–16.8	9	18	68	4	1	0
			16.8–17.8	7	25	62	3	trace	3
			17.8–18.8	11	53	34	2	trace	0
			18.8–19.8	12	78	9	1	trace	0
			19.8–20.2	27	68	5	0	0	0
			Mean	13	40	40	4	2	1

NZ 32 SE 62 3626 2045 Near Gilly Flats, Bishopton **Block D**

Surface level (+54.9 m)+180 ft
Groundwater encountered at +38.4 m
January 1975

Overburden 10.0 m
Mineral 6.5 m
Waste 8.5 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.2	0.2
Boulder Clay	Clay, grey-brown, laminated to 6.0 m, with pebbles of Carboniferous sandstone, Magnesian Limestone and some fine siltstone, coal and, rarely, Carboniferous limestone	9.8	10.0
Glacial Sand and Gravel	Sand, pebbly near top Gravel: fine, Carboniferous sandstone with some Magnesian Limestone Sand: mainly fine quartz, with medium to coarse coal and other lithic grains	6.5	16.5
Glacial Drift, undifferentiated	Silt, brown, with clay nodules	4.2	20.7
	Clay, purple-brown, laminated, with coal fragments	1.0	21.7
	Silt, light brown, clayey	3.3+	25.0

Grading

Mean for deposit *percentages*			Bulk samples 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
9	89	2	10.0–10.2	30	32	24	7	6	1
			10.2–11.2	17	48	26	4	5	0
			11.2–12.2	6	69	20	5	trace	0
			12.2–13.2	7	74	10	7	2	0
			13.2–14.2	3	62	11	21	3	0
			14.2–15.2	4	87	6	3	trace	0
			15.2–16.2	12	83	3	2	trace	0
			16.2–16.5	16	75	4	4	1	0
			Mean	9	70	12	7	2	trace

NZ 32 SE 63 3748 2033 Stone Riggs, Bishopton **Block D**

Surface level (+53.9 m)+177 ft
Groundwater standing at +35.8 m
September 1975

Overburden 11.2 m
Mineral 11.5 m
Waste 0.3 m
Mineral 2.0 m+

Log

Geological classification	*Lithology*	*Thickness* m	*Depth* m
	Soil	0.5	0.5
Boulder Clay	Clay, red-brown, with pebbles of Carboniferous sandstone and limestone and Magnesian Limestone; relatively stoneless, with fine silty laminae, from 5.0 m to 7.0 m	10.7	11.2
Glacial Sand and Gravel	**a** 'Clayey' to 'very clayey' sand: fine, subrounded quartz, with Carboniferous rocks, including coal; fines disseminated and in silt and clay partings	11.5	22.7
	Clay, red-brown, with micaceous silt laminae and coal fragments	0.3	23.0
	b 'Very clayey' sand: as at **a**	2.0+	25.0

Grading

	Mean for deposit *percentages*			Bulk samples 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
a	17	82	1	11.2–12.2	28	48	16	2	2	4
				12.2–13.2	18	68	13	1	trace	0
				13.2–14.2	16	69	15	trace	0	trace
				14.2–15.2	7	54	39	trace	0	0
				15.2–16.2	7	68	24	1	0	0
				16.2–17.2	8	68	24	trace	trace	0
				17.2–18.2	13	79	8	trace	0	0
				18.2–19.2	26	70	4	trace	0	0
				19.2–20.2	15	78	7	trace	0	0
				20.2–21.2	21	75	4	trace	0	0
				21.2–22.7	23	73	4	trace	0	0
				Mean	17	68	14	trace	trace	trace
b	30	70	0	23.0–24.0	27	72	1	0	0	0
				24.0–25.0	33	66	1	0	0	0
				Mean	30	69	1	0	0	0
a+b	19	80	1	Mean	19	68	12	trace	trace	trace

APPENDIX G

LIST OF WORKINGS

Although sand and gravel have been worked at many localities, there are no active pits at present. The most recently abandoned working is at Stony Flat, south of Bishopton. All of the former workings listed are in the south-east of the district; the sites of numerous minor diggings throughout the area are noted on the resource map.

Location	Grid reference
Whitton	374 238
West of Stillington	360 224
Stillington	367 226
Near West House, Bishopton	374 229
Seaton Hills	392 233
Thorpe Thewles	397 237
Whitton	384 225
Morrington Bridge	371 206
South of Bishopton	364 202

APPENDIX H

CONVERSION TABLE METRES TO FEET (to nearest 0.5 ft)

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

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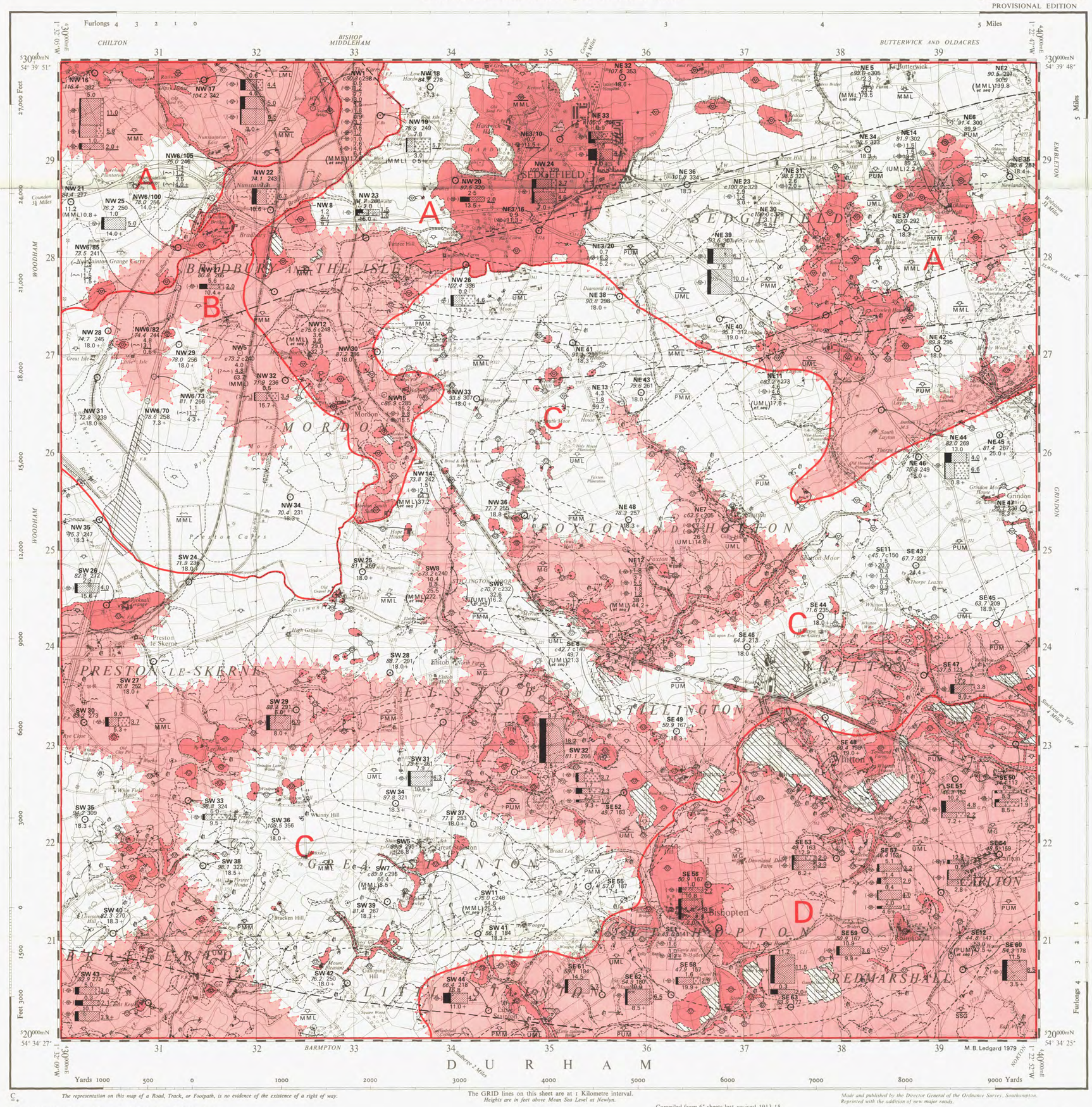
INSTITUTE OF GEOLOGICAL SCIENCES

INDUSTRIAL MINERALS ASSESSMENT UNIT

THE SAND & GRAVEL RESOURCES OF SHEET NZ 32 (SEDGEFIELD, DURHAM)

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

ORDNANCE SURVEY
SHEET NZ32
PROVISIONAL EDITION



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 D.B. Smith, E.A. Francis and G.D. Gaunt in 1953-61 (northern part), and by D.B. Smith in 1968-73. (The interpretation of sub-drift geology shown here is an early one; it is in process of revision). W. Anderson, A. W. Woodland and B.J. Taylor District Geologists. Included on one-inch geological sheets 27 and 33.

Sand and gravel survey by M.D.A. Samuel and J.W.C. James in 1975, under the supervision of D. Price. R.G. Thurrell, Head, Industrial Minerals Assessment Unit.

1:25,000 Sand and Gravel Resource Sheet published 1979.
Austin W. Woodland, C.B.E., *Director, Institute of Geological Sciences incorporating the Geological Survey of Great Britain, the Museum of Practical Geology, and Overseas Geological Surveys*
1100/79

The GRID lines on this sheet are at 1 Kilometre interval.
Heights are in feet above Mean Sea Level at Newlyn.
Contour values are in feet
1 square inch on this map represents 99·639 acres on the ground.

Data quoted for an individual borehole refer strictly to that site; reliable conclusions cannot be drawn about the thickness and grading elsewhere in the deposit, particularly in material as variable as sand and gravel. However, estimates of the volume and mean grading of the mineral as a whole in each Resource Block are given in the Report.

Compiled from 6" sheets last revised 1913-15.
Other partial systematic revision 1938-50 has been incorporated.
Major roads revised 1971.

Made and published by the Director General of the Ordnance Survey, Southampton. Reprinted with the addition of new major roads.

NZ 23	27 NZ 33	NZ 43
NZ 22	NZ 32	NZ 42
NZ 21	33 NZ 31	NZ 41

Diagram showing the relation of the National Grid 1:25,000 sheets with the New series One-Inch Geological sheets 27 and 33.

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

44

EXPLANATION OF SYMBOLS AND ABBREVIATIONS

DRIFT

	Peat P-1 ✓	RECENT AND PLEISTOCENE
	Lacustrine Alluvium -clay, silt and sand. LA-2 ✓	
	Alluvium -mainly silt and sand with lenses of gravel and locally peat. A-29 ✓	
	Alluvial Fan -mainly gravel and sand. AF-2 ✓	
	Head -mainly of stony clay; includes alluvium of minor valleys. H-20 ✓	
	Glacial Sand and Gravel -mainly sand, with lenses of gravel and with beds of laminated clay and silt locally. GS-27 ✓	
	Boulder Clay and Glacial Drift, undifferentiated -mainly grey-brown and red-brown stiff stony clay with scattered lenses of sand and/or gravel and of laminated clay. BC-16 ✓	

SOLID

SSG	**Sherwood Sandstone Group ('Bunter' Sandstone)** -soft red sandstone with mudstone beds.	TRIASSIC
PUM	**Permian Upper Marls** -red-brown mudstone and siltstone with thin red sandstones and with Billingham Main Anhydrite or its residue at base.	PERMIAN AND CARBONIFEROUS
UML	**Upper Magnesian Limestone** -grey thin-bedded fine-grained dolomite.	
PMM	**Permian Middle Marls** -red and grey mudstones and siltstones with nodular and bedded anhydrite or their residues at many levels. Passes locally into breccia.	
MML	**Middle Magnesian Limestone** -white to pale grey, thin-bedded to massive, mainly oolitic dolomite.	
LML	**Lower Magnesian Limestone** -grey to buff finely granular dolomite and limestone.	
MG	**Carboniferous (Millstone Grit)** -Yoredale sequence of interbedded mudstones, shales, sandstones and limestones with thin coals.	

Made Ground MG-2

BOUNDARY LINES

- Geological boundary, Drift.
- Geological boundary, Solid.
- Line of fault, crossmark indicates downthrow side. } Provisional, 1977.
- Inferred boundary between recognised categories of deposits.
- Resource Block boundary.

Broken lines denote uncertainty.

BOREHOLE DATA

SITE LOCATIONS

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

I.M.A.U. BOREHOLES

Borehole Registration Number → NW 19 ← Surface level in metres and feet above O.D. (Newlyn)
Borehole Site → 75.9 249
7.8 ← Overburden
Geological Classification → (? ~) 5.7 ← Mineral (sand and gravel)
Waste → 3.0
(M M L) 0.5+ ← Bedrock
Grading Diagram

Thicknesses in metres

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

Borehole Registration Number

Each I.M.A.U. borehole is identified by a Registration Number, e.g. NW 19. The letters refer to the quarter sheet and the figures to the I.G.S. serial numbers for that quarter. The unique designation for borehole NW 19 is NZ 32 NW 19.

Grading Diagrams

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

Sand (+1/16-4mm)
Fines (-1/16mm) Gravel (+4mm)

The height of the diagram is proportional to the mineral thickness.

The widths of the divisions show the proportions of **Fines**, **Sand** and **Gravel** but small amounts of gravel may be omitted or exaggerated.

OTHER BOREHOLES

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

CATEGORIES OF DEPOSITS

Exposed mineral, assessed. CAT-E2

Continuous or almost continuous spreads of mineral beneath overburden. CAT-C1

Sand and gravel either not potentially workable (see Report) or absent. CAT-A2

Where appropriate on other sheets the categories 'sand and gravel not assessed', and 'Discontinous spreads of mineral beneath overburden' are recognised.

RESOURCE BLOCKS

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

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

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