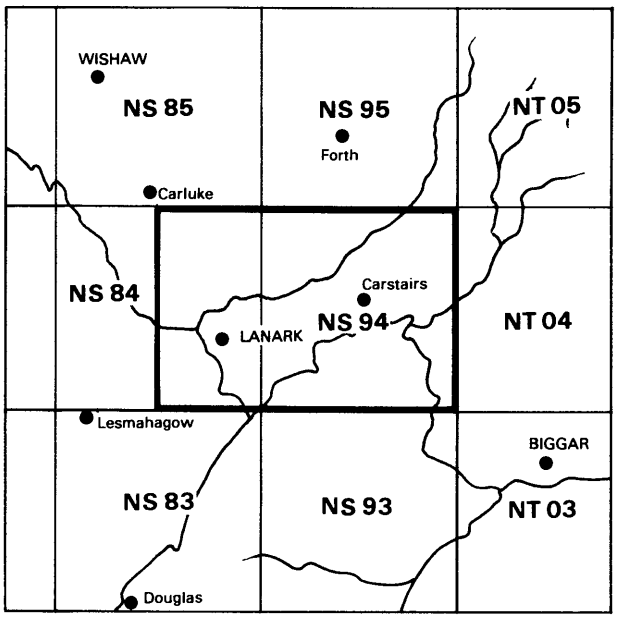
INSTITUTE OF GEOLOGICAL SCIENCES
Natural Environment Research Council

Mineral Assessment Report 49



The sand and gravel resources of the country around Lanark, Strathclyde Region

Description of 1:25 000 sheet NS 94 and part of NS 84

J. L. Laxton and E. F. P. Nickless

Contributor
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ISBN 0 11 884110 6*

London Her Majesty's Stationery Office 1980

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

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

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

PREFACE

National resources of many industrial minerals may seem so large that stock-taking 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 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. In 1968, following a short feasibility study initiated in 1966 by the Ministry of Land and Natural Resources, the Industrial Minerals Assessment Unit (formerly the Mineral Assessment Unit) began systematic surveys which have been extended progressively through central and northern England. Work in Scotland, which began in 1975 in the Darvel area of Strathclyde Region, is being financed by the Department of the Environment, acting through the Scottish Development Department and is being undertaken with the co-operation of the Sand and Gravel Association of Great Britain.

This report describes the resources of sand and gravel of 150 km^2 of country around Lanark, Strathclyde Region, shown on the accompanying resource map. The survey was conducted by J. L. Laxton assisted in the drilling and sampling programme by A. A. McMillan and others. The work, which was supervised by E. F. P. Nickless, Officer-in-Charge of the sub-unit in Edinburgh, is based on the six-inch to one-mile geological survey of sheets 23 and 24 undertaken between 1869 and 1871 and revision surveys conducted between 1909 and 1926. The geological lines, now presented at the 1:25 000 scale, include partial remapping of the drift geology by M. A. E. Browne based on field surveys during 1976.

The section of the report on the geology of the area was prepared by M. A. E. Browne and J. L. Laxton. The tests to determine the mechanical and physical properties were undertaken by M. Finlay.

J. D. Burnell, ISO, ARICS (Land Agent), has been responsible for negotiating access to land for drilling. The assistance of officials of Lanark District and the ready cooperation of land owners, tenants and sand and gravel operators is gratefully acknowledged.

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12 July 1979

CONTENTS

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J. L. LAXTON and E. F. P. NICKLESS

SUMMARY

The geological maps of the Institute of Geological Sciences, eighty-six boreholes sunk for the Industrial Minerals Assessment Unit, and twenty-one shallow pits, together with data from the inspection of ten sand and gravel workings, form the basis of the assessment of sand and gravel resources in the Lanark area, Strathclyde Region.

All deposits in the area which might be potentially workable for sand and gravel have been investigated and a simple statistical method 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 seven resource blocks, six of which are assessed statistically and contain between 2.3 and 10.8 km^2 of potentially workable sand and gravel. For the seventh resource block inferred assessments are offered for 0.28 km^2 of mineral. The geology of the deposits is described and the mineral-bearing area, the mean thickness of overburden and mineral, and the mean grading are stated. Detailed borehole data are given. The geology, the outlines of the resource blocks and the position of boreholes used in the assessment are shown on the accompanying map.

Bibliographic reference

LAXTON, J. L. and NICKLESS, E. F. P. 1980 The sand and gravel resources of the country around Lanark, Strathclyde Region. Description of 1:25 000 sheet NS 94 and part of NS 84. *Miner. Assess. Rep. Inst. Geol. Sci.*, No. 49.

Note

National Grid references are given in square brackets. In this publication all lie within the 100-km square NS.

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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 geologic evidence. The sites available for inspection, measurement, and sampling are too widely or otherwise inappropriately spaced to permit the mineral bodies to be outlined completely or the grade established throughout" (Bureau of Mines and Geological Survey, 1948, p. 15).

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

The following arbitrary physical criteria have been adopted:

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

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

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

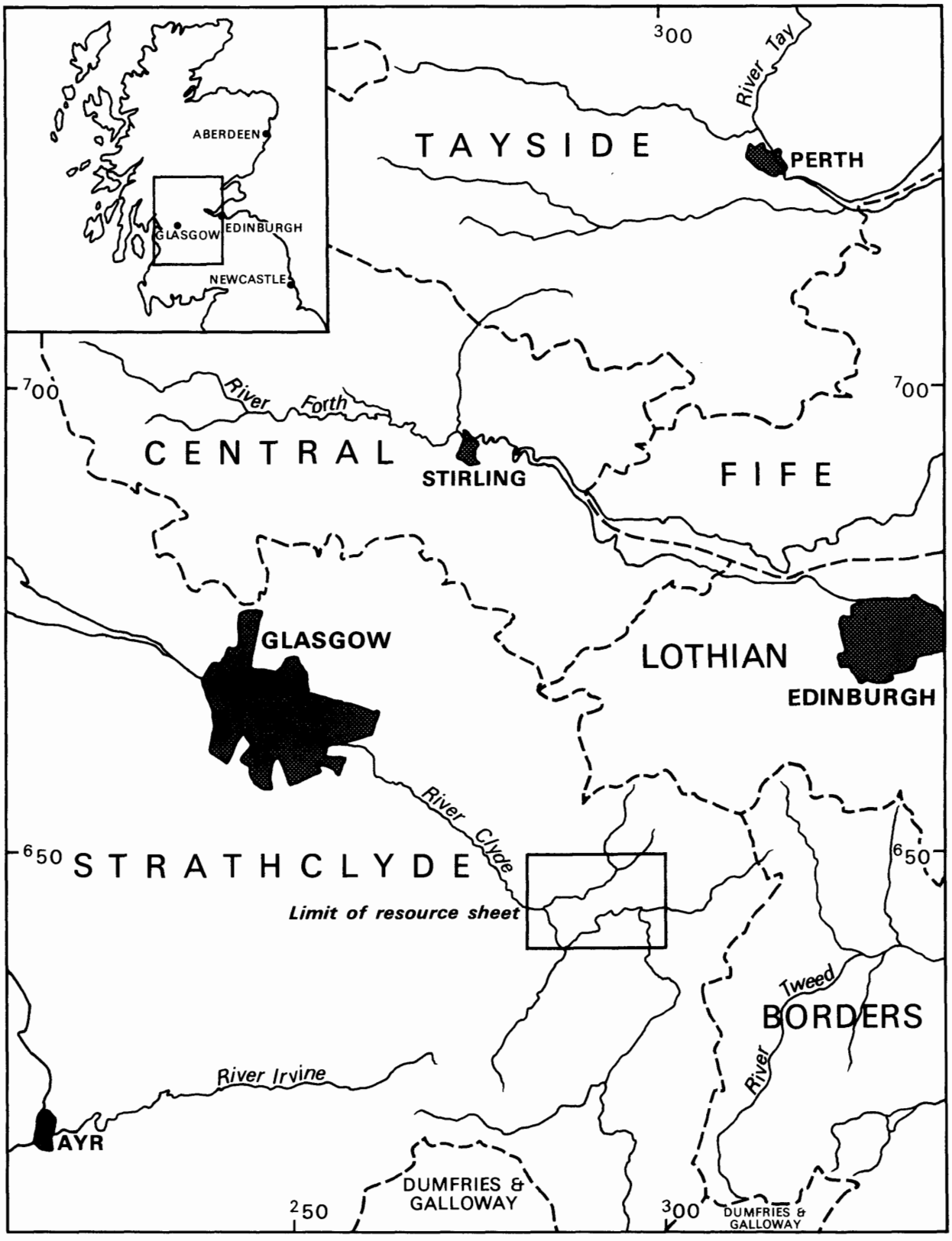

Figure 1 Sketch-map showing the location of the Lanark area

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 actual sample points.

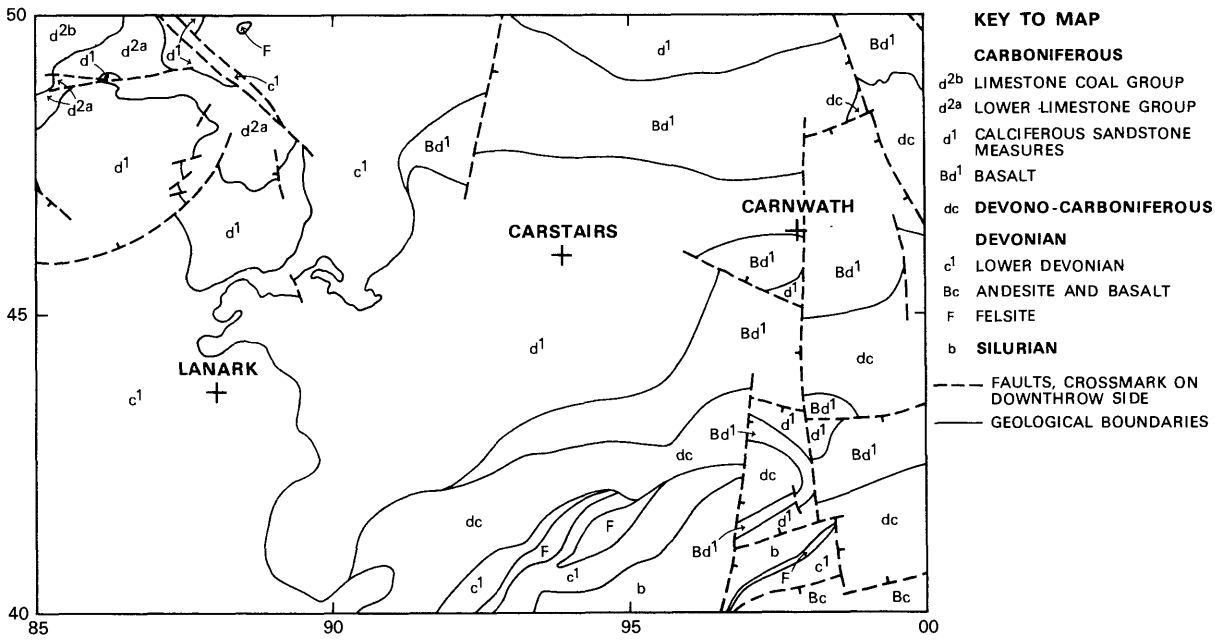

Figure 2 Sketch-map showing the solid geology

DESCRIPTION OF THE RESOURCE SHEET

GENERAL

Predominantly agricultural, the survey area lies around the small market town of Lanark, Strathclyde Region, about 50 km south-west of Edinburgh and 40 km south-east of Glasgow (Figure 1). Gently hilly, the area is cut by the valley of the Clyde, which is broadly followed by the Glasgow to London railway line; the river flows in a circuitous course generally north-westwards, in the east meandering across a floodplain up to 1 km in width, but downstream of Cobblehaugh Farm [9250 4265] it occupies a narrow valley which in places cuts down to bedrock.

The higher ground occurs towards the periphery of the resource sheet where bedrock is at or near surface (Figure I): in the centre of the area glacial sediments (the principal aggregate resource) show a more subdued terrace-like or moundy landform. The Carstairs esker system (often previously referred to as kames) forms a series of north-east trending, steep-sided, anastomosing ridges and constitutes a most distinctive topographic feature. In the north, certain glacial deposits are locally overlain by flat spreads of peat (the Mosses) which are generally low-lying, and extremely boggy for much of the year: being of limited agricultural use they have been partially afforested. Ryeflat Moss [953 481] is exploited for peat.

The glacial deposits are extensively worked for aggregate and, in addition, felsite is quarried on Cairngryffe Hill [9427 4127].

GEOLOGY

The area, which is mainly included in one-inch Geological Sheet 23 (Hamilton) and partly in Sheet 24 (Peebles), was originally surveyed at a scale of six inches to one mile by A. Geikie, J. Geikie and B. N. Peach and the maps published in 1872 and 1868 respectively. A resurvey was undertaken between 1909 and 1926 by L. W. Hinxman, M. MacGregor, J. Phemister, H. H. Read and G. Ross, and revised maps published in 1929 and 1932. To provide an up-to-date interpretation of the glacial geology against which to assess resources the drift was partly remapped by M. A. E. Browne during 1976.

SOLID

Generally the rocks are not well-exposed and the structure is poorly known: no systematic fault pattern has been recognised.

The distribution and classification of solid rock are summarised on Figure 2, which includes new data from assessment boreholes: bedrock is undifferentiated on the resource map.

The oldest rocks in the area are of Upper Silurian age. They crop out in the south-east near Heatheryhall [9711 4090] and comprise red, purple and green, quartzose or feldspathic sandstones interbedded with siltstone and mudstone: at least one bed of quartzose conglomerate is present. The strata dip at about five degrees to the north-west and are succeeded by Lower Devonian feldspathic sandstones with no obvious discordance, although there is a basal conglomerate. The sandstones crop out in the bed of the River Clyde near Corra Linn [8830 4140]. Lower Devonian basaltic andesites, thought to be younger than the sandstones, occur near Burnfoot [9911 4031].

Pink, reddish brown and cream quartzose sandstones with beds of concretionary limestone, described as Devono-Carboniferous as their age is uncertain, rest with marked unconformity on Lower Devonian strata. Over the eastern part of the resource sheet Devono-Carboniferous sediments are succeeded by fine-grained olivine basalt lavas, in places feldsparphyric. These extrusives, a thin local representative of the Lower Carboniferous Clyde Plateau Lavas, are overlain by calcareous, carbonaceous, greenish grey and purple sandstones with thin beds of siltstone. The lavas and sediments are assigned to the Calciferous Sandstone Measures (Lower Carboniferous). In the west the lavas are absent and sediments of the Calciferous Sandstone Measures rest directly on the Devono-Carboniferous or Lower Devonian strata. The sequence passes up conformably into the youngest rocks of the area, the Lower Limestone Group (Lower Carboniferous) and Limestone Coal Group (Upper Carboniferous), which comprise sandstone, siltstone and shale with subordinate beds of limestone, ironstone and coal.

Near Cairngryffe Hill there are two major felsite sills of Lower Devonian age. Small porphyrite dykes of the same

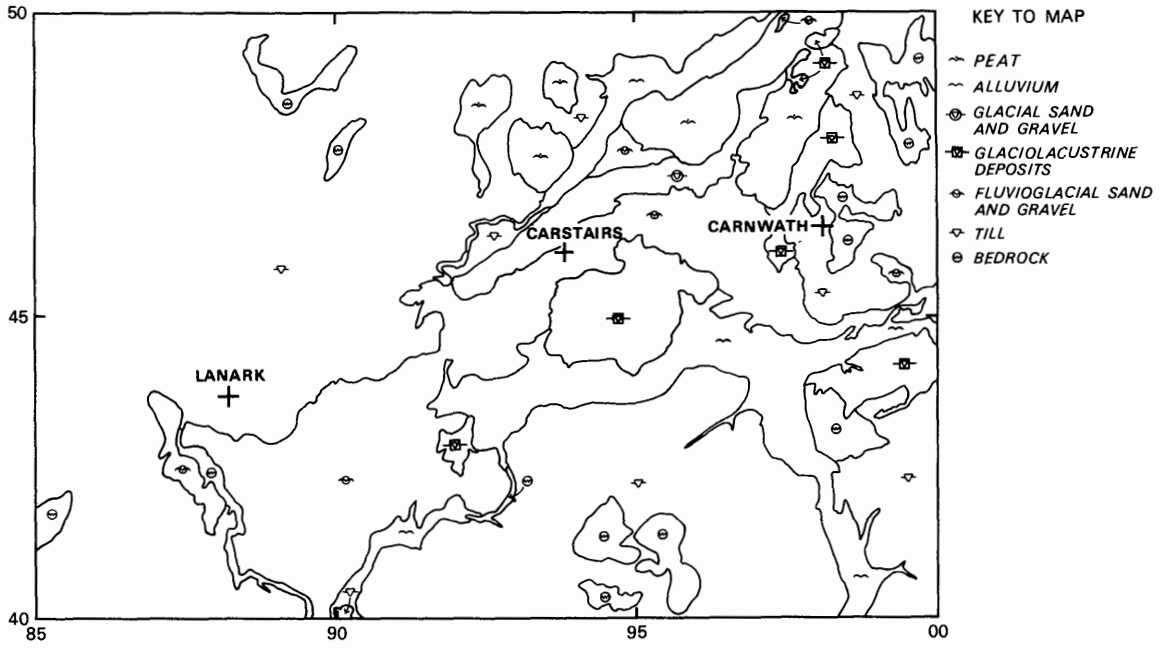

Figure 3 Sketch-map showing the drift geology

age occur in the Lanark area but are too small to be shown on Figure 2.

DRIFT

The distribution of the Quaternary deposits in the assessment area is shown on the simplified drift map (Figure 3). The bulk of the sand and gravel deposits occupy a belt approximately 3 km in width, which extends from the hummocky ground around Hyndford [9065 4170] to Woodend Moss [975 495], north of Carnwath: less extensive deposits occur along the valleys of the Clyde and Medwin. Till, which is generally thin, mantles bedrock over much of the area and was only investigated by drilling where it underlies or borders the main sand and gravel deposits. Alluvium occupies the valley bottoms.

An elongate depression in bedrock trending north-east from Hyndford to Woodend Moss strongly influences the distribution of the drift. Contours drawn on the bedrock surface (Figure I) show this to be a shallow basin modified along its southern margin by an overdeepened channel. The basin itself is divided by a buried ridge (A–A on Figure I) as noted by McLellan (1969) and reflected by the narrowing of the mapped outcrop of the supra-till glacial deposits (Figure 3). Assessment boreholes 94 NW 9, 94 SW 19 and 21 and 94 SE 1, which prove from 5.6 to 15.8 m show that the glacial deposits thin across the ridge, compared with thicknesses typically in excess of 20 m to the north and south. The feature is shown by the drift isopachytes in Figure I. There is a marked over-deepening of the valley of the Clyde upstream of Cobblehaugh Farm, where bedrock was not proved in boreholes drilled to depths of 20.7 to 25.9 m.

Till

Till, generally thin or absent on high ground, occurs over much of the area as a mantle lying directly on bedrock. It averages 4 m in thickness in the assessment boreholes. Thicknesses greater than 6 m are unusual, but the maximum thickness encountered was 14.1 m in borehole 94 SW 15.

McLellan's (1969) account of the last glaciation of central Lanarkshire distinguishes a southerly derived, red-brown till from a grey till of northerly origin. The present survey, however, does not confirm these findings. In the boreholes the deposit is highly variable in texture and it exhibits all shades of colour from red to grey and green. Likewise, the clast content is diverse, local bedrock being dominant. In places, for example in borehole 94 NE 22, clayey till rests on Devono-Carboniferous sandstone and becomes increasingly sandy with depth, the lower part of the deposit grading as mineral (Appendix C), but such occurrences are thin and patchy.

In boreholes 84 SE 19, 94 NE 12, 94 SE 5, 12 and 13, till overlies other drift deposits, which in boreholes 94 NE 12 and 94 SE 5 in turn rest on till, the intervening drift being 6.2 m and 5.5 m thick respectively. McLellan (1969) records a similar repeated sequence at [801 445] in the Nethan Valley, a little to the west of the assessment area, where 30 ft (9.1 m) of sand and gravel occur between grey tills.

In the valley of the small stream at Spittal [9880 4500] a solifluction deposit of ill-sorted clasts up to 1.0 m in diameter in a clayey sand matrix rests on till, and is overlain by a highly folded sandy silt bed, the folds indicating slippage.

Glacial sand and gravel

In this report, the term glacial sand and gravel (the Boulder Drift of Goodlet, 1964) is used to describe a distinctive, ill-sorted cobble and boulder gravel with a clayey, sandy matrix. The gravel component is dominantly of locally derived sandstones (Table 4) and much of the sand-grade material is derived from break-up of these clasts. Glacial sand and gravel is found principally in the series of steep-sided, anastomosing, undulating ridges aligned north-eastwards from north of Newhouse [9280 4570] to Woodend Moss, a distance of 5 km (Plate 1). A similar deposit has also been proved in a small ridge [9975 4332] to the north-east of Libberton and in the sinuous esker extending westwards from Drummonds Hill [8875 4041]. Boreholes and sections along the length of the Carstairs esker system show the deposit is generally poorly bedded and homogeneous in both grading and clast composition (Table 4): where the base of the deposit was proved, for example in boreholes 94 NW 8, 12 and NE 3, it is underlain by 5.6 to 13.1 m+ of fluvioglacial sand and gravel, distinguished principally by a lower

cobble content. Grading analyses of bulk samples collected during this survey did not detect, along the ridge as a whole, fining of material in a north-easterly direction as noted by McLellan (1969).

The ridge-complex reaches a maximum elevation of 237 m above Ordnance Datum close to borehole 94 NE 8, where it stands about 23 m above the general level of the surrounding countryside. For a short distance to the north of White Loch [962 472] the ridges become lower, and narrow to about 40 m from a usual width of approximately 500 m. The distribution of glacial sand and gravel is closely related to morphology, as indicated by boreholes 94 NW 6 and 13 and 94 NE 9, which although sited near the ridge-complex do not prove glacial sand and gravel, demonstrating the restricted extent of the deposit. In a longitudinal sense the ridges become less pronounced (Gregory, 1915) to the north-east, merging into a moundy area, the principal part of which runs along the south-east margin of Woodend Moss, where glacial sand and gravel was proved beneath fluvioglacial and glaciolacustrine deposits in boreholes 94 NE 14 and 16. These mounds are composed dominantly of glaciolacustrine deposits as illustrated by borehole 94 NE 15 and the upper part of the sequence proved in borehole 94 NE 16. Because of their topographic continuity Gregory and other authors considered the ridges and mounds to be part of the same feature but lithology shows them to be distinct. Glacial sand and gravel may occur at depth beneath Woodend Moss.

Moundy deposits are also found between Corbiehall [9265 4440] and Carnwath Station [9700 4694], and in a section [9275 4605] north of Newhouse fluvioglacial deposits are seen to grade laterally into glacial sand and gravel in the space of a few metres (Plate 2).

All workers except Goodlet (1964) have concluded that the ridge deposits are waterlain (Gregory, 1915; Charlesworth, 1926; MacGregor, 1927; Sissons, 1961; McLellan, 1969; Boulton, 1972) but have disagreed as to sedimentary environment. Early workers described them as kame deposits of either Southern Upland ice, for example, Gregory (1915), or of Highland ice (the Lammermuir–Stranraer moraine of Charlesworth, 1926). Goodlet (1964) considered them to be morainic deposits associated with southern ice, largely on the basis of collapse structures, interpreted as due to melt of buried ice. MacGregor (1927) first attributed the steep-sided and linear nature of the ridges to deposition bounded by ice. Sissons (1961), inferring that the Southern Upland ice trended north-north-east in this area, concluded that they are eskers, although Boulton (1972) considered them to be subaerial deposits formed between ice-cored ridges. A sedimentological study carried out by McLellan (1969) supports a south-western fluvial origin of the material and deposition as an esker. More recent work has thrown new light on the origin of the Carstairs ridges, which show considerable morphological and lithological similarities to the Guelph and associated eskers in Ontario (Saunderson, 1977). Both features include a ridge-complex of ill-sorted and poorly bedded material, which fines into bedded and better-sorted material both downstream, in which direction the ridge topography is maintained for a short distance, and laterally. Saunderson suggests deposition of a sliding bed induced by high velocity flow in a sub-ice tunnel, ridge gaps being caused by non-deposition due to increased current velocities in local constrictions of the tunnel. Possibly the fluvioglacial deposits proved by boreholes to underlie the ridge-complex represent early sub-ice deposition in less restricted tunnels under lower velocity conditions.

Glaciolacustrine deposits

Sequences composed primarily of grey laminated clays, silt and fine sand are described as glaciolacustrine. The deposits occupy the depression in the bedrock surface in the Hyndford–Carstairs area and usually occur as the stratigraphically lowest waterlain drift: they also infill the over-deepened parts of the valley of the Clyde (Section 2) and were not bottomed in boreholes which proved from 15.4 (borehole 94 SE 14) to 22.0 m (borehole 94 SW 22) before being abandoned. Over the high ground to the north of Libberton [9911 4285] a thin cover of lacustrine deposits rests on till.

The proved deposits span a range of levels from 151.0 m above Ordnance Datum in borehole 94 SW 6 in the valley of the Clyde to 255.9 m above Ordnance Datum in borehole 94 NE 16, within the outwash mounds associated with glacial sand and gravel.

The glaciolacustrine sediments are considered by Gregory (1915) and Ross (1926) to have been deposited in lakes formed when ice dammed pre-glacial drainage channels. The position and size of these lakes, possibly equivalent in part to the Lake Clyde of Charlesworth (1926), changed with time as a result of movements of the ice-front and changes in the height and position of overflow levels.

Fluvioglacial sand and gravel

Fluvioglacial deposits comprise a series of well-bedded sands and gravels. They are found in two distinct areas (McLellan, 1969); firstly in the moundy area to the east of Carstairs and to the north of the Carstairs esker system, in part underlying Ryeflat Moss (for example, boreholes 94 NE 1 and 2), and secondly forming the extensive hummocky ground around Hyndford. Thin sequences of fluvioglacial material also occur in association with lake deposits between Carstairs and the Clyde, and to the north of Libberton. Sediments in the two principal areas have distinctive clast compositions (Table 4), the esker-associated deposits having a composition closer to the glacial sand and gravel than to that of the south-western fluvioglacial material. In both areas the deposits show lateral and vertical gradation into lake sediments, which generally underlie the fluvioglacial deposits (Section 1). In the Hyndford area glaciolacustrine sediments generally occur at a lower altitudinal level in the west than the east and both these and fluvioglacial deposits exhibit a general coarsening upwards. This evidence suggests that the deposits were laid down by north-easterly flowing meltwater streams which formed prograding deltas into ice-dammed lakes. The presence of kettle-holes indicates that masses of dead ice were frequently incorporated within the sediment. In the valley of the Medwin similar fluvioglacial material was proved in borehole 94 SE 16. The fluvioglacial deposits of the Carstairs area are thought to have formed when the englacial streams which gave rise to the esker deposits discharged from beneath the ice.

Thus, the fluvioglacial and glaciolacustrine deposits are considered to be products of the same, or same group of depositional environments, explaining the rapid vertical and lateral variation of deposits frequently observed in the Lanark area. The distinction of deposits in the borehole logs and on the map is, of necessity, arbitrary, being decided principally on the basis of grading. Goodlet (1964) on the basis of sections in pits at

Table 1 Mean grading of deposits (based on borehole samples)

Deposit	Mean grading percentages						
	Fines $-\frac{1}{16}$ mm	Fine sand $+\frac{1}{16}-\frac{1}{4}$ mm	Medium sand $+\frac{1}{4}-1$ mm	Coarse sand +1–4 mm	Fine gravel +4–16 mm	Coarse gravel +16–64 mm	Cobbles and boulders +64 mm
Glacial sand and gravel	11.6	12.9	16.4	12.4	16.7	20.3	9.7
Fluvioglacial sand and gravel	9.8	28.1	32.1	9.1	10.6	8.9	1.4
Glaciolacustrine deposits	15.7	62.0	19.8	1.2	0.7	0.5	0.1
Till	18.7	24.3	16.6	8.3	13.6	14.8	3.7
Alluvium	10.0	20.0	17.4	11.6	22.0	17.8	1.2

Table 2 Mean grading of deposits (based on photographic interpretation and sieve-grading)

Deposit	Mean grading percentages						
	Fines $-\frac{1}{16}$ mm	Fine sand $+\frac{1}{16}-\frac{1}{4}$ mm	Medium sand $+\frac{1}{4}-1$ mm	Coarse sand +1–4 mm	Fine gravel +4–16 mm	Coarse gravel +16–64 mm	Cobbles and boulders +64 mm
Glacial sand and gravel (Newhouse)	9.3	5.5	10.6	10.7	19.8	35.9	8.2
Fluvioglacial sand and gravel (Hyndford)	3.6	15.1	16.4	7.1	15.7	31.1	11.0
Fluvioglacial sand and gravel (Newhouse)	12.0	31.0	12.0	5.4	12.8	20.0	6.8
Fluvioglacial sand and gravel (Total)	6.8	21.2	14.8	6.4	14.6	26.8	9.4

[945 459] Carstairs Junction, [937 465] Eastend and [960 468] Westendwood proposed a stratigraphic framework for the north-eastern fluvioglacial deposits. His interpretation, however, conflicts with the results of boreholes sunk for this survey which suggest a complex variation of deposits with time and facies rather than a simple, laterally extensive stratigraphy. Goodlet's interpretation, therefore, must be considered valid only within the pits in which the original observations were made.

Alluvium

Alluvium covers the extensive floodplain of the Clyde from south of Burnfoot to north of Cobblehaugh Farm and from Charleston [9223 4174] to Prett's Mill [9018 4012]. Elsewhere the Clyde occupies a narrow valley cut in bedrock. Alluvium is also found in the valleys of the Medwin, and the Mouse Water upstream of Cowford Bridge [9345 4677].

The valley of the Clyde south of the confluence with the Medwin, and the valley of the Medwin, are floored by silt or clay which overlies clean, moderately sorted, river gravel. (The base of this deposit has been taken to define the bottom of the alluvium on borehole logs). Downstream, and in the valley of the Mouse Water, alluvium comprises mainly sand, silt and clay and usually rests on similar glaciolacustrine deposits, thus making distinction between them difficult. In these situations the base of the less consolidated sediments has been used to distinguish the deposits.

Peat

Hollows floored with peat occur in between hummocks of fluvioglacial deposits around Hyndford and between the esker ridges. Many of these depressions are kettleholes (Plate 3). More extensive areas of peat are found north of the ridges in the Mosses of Woodend, Carnwath [973 480], Blackgate [962 483], Ryeflat, Cranley [934 477] and Blacklaw [927 485]. A thickness of 4.3 m was proved at borehole 94 NE 9.

Plate 1 Oblique aerial photograph looking north-east from near Eastend Pit [937 465] showing the steep-sided, sub-parallel ridges which comprise the Carstairs esker system. Between the ridges are areas of poorly drained peat-covered ground. Behind the farm in the middle distance are the rounded mounds of fluvioglacial sand and gravel which occur in association with the eskers. In the background is the flat peat-covered ground of Ryeflat Moss.
(Cambridge University Collection: copyright reserved)

Plate 2 Quarry to the north of Newhouse [9280 4570], Carstairs (D 2609)

Plate 3 Kettle-holes to the north-east of Bonnington Mains [8918 4196], Lanark (D 2608)

Plate 4 Valley of the Clyde looking north from Quothquan Law [9882 3842], Libberton (D 2613)

Plate 5 Working face at Hyndford Quarry [896 416], Lanark (D 2610)

COMPOSITION OF THE MINERAL DEPOSITS

Particle-size distribution and petrography

Glacial sand and gravel, fluvioglacial sand and gravel and glaciolacustrine deposits, components of a glacial outwash environment, grade imperceptibly one into another and any division between them, therefore, is arbitrary. In constructing the geological map deposits are distinguished on the basis of morphology, grain size and composition. Comparison of these data with the dominant grading for sequences of samples from boreholes suggests that grain size can be used as a basis on which to identify and classify material at depth. Thin bands with 'atypical' grading do not affect the overall deposit classification, as local rapid variation, both vertical and horizontal, is to be expected in glacial sediments.

The following grading parameters have usually been found to apply: that glaciolacustrine deposits have a sand to gravel ratio in excess of 19:1 with more than 60 per cent by weight passing 0.25 mm; that glacial sand and gravel is ill-sorted with more than 40 per cent by weight coarser than 4 mm and in excess of 15 per cent by weight of the remainder passing $\frac{1}{16}$ mm. Outwash deposits falling outside these limits are described as fluvioglacial.

The mean grading data for each drift deposit is given in Table 1 and shown graphically in Figures 4 to 8, which also illustrate the envelope containing the mean grading by borehole for each deposit. Only samples grading as mineral (Appendix C) have been considered, although there are significant waste sequences in the glaciolacustrine deposits and till. Although the mean grading curves for the three outwash deposits are distinct (Figures 5 to 7), and naturally reflect the criteria used to distinguish them, there is substantial overlap between the envelope defined by each deposit. Glacial sand and gravel has the least variable composition.

Observations at borehole sites suggest that samples recovered from cobble and boulder-rich deposits are not fully representative, as the drilling method causes selectively higher comminution of coarse-grained material, there is a tendency for the shell to push coarse material to one side, and the borehole diameter limits the maximum particle size recovered. To provide an indication of the differences in grading between drilled samples and material in-situ, samples from temporary sections in the vicinity of boreholes have been analysed.

Two sand and gravel pits were chosen, one [9275 4605] to the north of Newhouse exposes glacial sand and gravel and fluvioglacial material (Plate 2), the other [896 416], at Hyndford, shows fluvioglacial deposits (Plate 4). In both pits extremely coarse sediment up to 1 m in diameter occurs, making conventional sampling and grading impractical. A photographic technique has been developed by Church (1967), and modified by Ballantyne (1978), for the estimation of the mean grading of alluvial gravel deposits in northern Canada. A metre quadrant is placed on the gravel surface and photographed from the normal. The number of clasts within the quadrant is counted from the photograph and related to mean grading by use of a pre-determined control curve, which takes account of packing and shape. The method is based on the direct relationship that must exist between the number of clasts in a given area and their size: it assumes a wholly clast-covered surface, so that where there is a significant extent of the quadrant formed of fine-grained material this area is subtracted and the reduced value used in the calculation. A similar procedure has been used in the present investigation, a metre quadrant being placed on representative parts of vertical faces and photographed using a polaroid camera. Due to the limited size of sections and the large area occupied by fine material at most sample points, it was considered impractical to develop control curves for different deposits and the area of +64 mm material within each quadrant was calculated from the photographs using a superimposed transparent plastic graph sheet. In view of the general lithological homogeneity of different grain-size fractions, a one-to-one relationship between areal per cent and weight per cent was assumed. The grading of material less than 64 mm was determined by sieving a bulk sample collected from within the area of each photographed quadrant, and the results combined with the photographically derived value of the +64 mm fraction to give an overall grading.

Representative samples of fine-grained beds within the sequence were also taken and sieve-graded, the results being incorporated in the derived mean gradings given in Table 2 and shown in Figures 5 and 6. In comparing these results with those for samples from boreholes it should be remembered that the deposits vary laterally and any differences may reflect this. Nevertheless, it is perhaps significant that grading analyses from boreholes 94 NW 8, 94 SW 4 and 5, sited close to sampled pit faces, show less +4 mm material than the face samples: not only have the pit samples a higher weight per cent in the coarser fractions than the mean of borehole data but, more significantly, for certain size fractions they fall outside the grading envelope of borehole samples. The increase in coarse material is matched by a reduction in sand, suggesting that comminution of sandstone clasts, the dominant rock type in the deposits (Table 4), by the drilling method employed, has had a significant effect on the borehole samples collected from coarse-grained deposits.

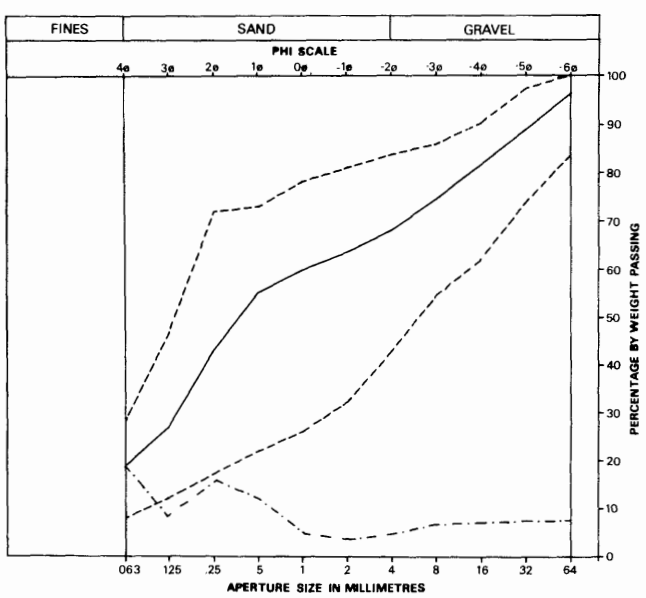

Figure 4 Grading characteristics of resources in the till: the continuous line is the cumulative weighted mean; the broken lines denote the envelope containing the cumulative mean grading for each separately identified deposit proved by boreholes to contain less than 40 per cent fines: the frequency distribution of the mean grading for the resource as a whole is shown by a dashed and dotted line

Table 3 Source and classification of composite samples

Composite sample	Geological classification	Boreholes from which samples taken	Depth range (m)	No. of samples †
A	Alluvium	94 SW 6	1.8–4.8	3
		94 SW 7	0.3–1.3	1
		94 SW 17	2.3–3.3	1
		94 SE 3	0.3–2.3	2
		94 SE 6	1.0–6.4	4*
		94 SE 7	1.3–4.8	4
		94 SE 10	3.0–4.0	1
		94 SE 14	2.3–5.3	3
		94 SE 15	0.4–5.4	5
				(24)
B	Fluvioglacial sand and gravel	84 SE 18	0.6–13.6	13
		84 SE 22	3.6–11.6	7*
		84 SE 24	1.4–7.4	6
		84 SE 28	0.6–25.5	23
		84 SE 29	0.5–3.5	3
				(52)
C	Fluvioglacial sand and gravel	94 NW 4	0.4–2.6	2
		94 NW 6	2.5–6.0	2*
		94 NW 9	4.0–7.0	3
		94 NW 11	7.0–8.7	2
		94 NE 23	8.7–10.0	1
		94 SW 2	1.6–3.6	2
		94 SW 4	(1.4–3.5). (8.7–12.5)	6
		94 SW 5	0.2–5.5	5
		94 SW 9	2.0–6.0	3*
		94 SW 13	(2.8–3.8) (5.8–6.8)	2
		94 SW 14	(4.5–7.0) (19.0–24.5)	8
		94 SW 15	(4.4–6.3) (10.5–11.5)	3
		94 SW 16	0.2–3.4	3
		94 SW 18	7.3–8.8	2
		94 SW 19	6.7–9.7	3
		94 SW 21	3.0–5.6	3
		94 SE 5	10.2–11.7	2
		94 SE 12	6.0–7.0	1
		94 SE 13	(0.4–1.4) (14.2–15.2) (18.2–20.2)	4
		94 SE 16	5.5–9.5	4
				(61)
D	Fluvioglacial sand and gravel	94 NE 1	(18.0–19.0) (21.0–21.6)	2
		94 NE 2	1.0–14.0	11*
		94 NE 10	0.5–2.5	2
				(15)
E	Glacial sand and gravel	94 NW 7	0.5–14.1	13*
		94 NW 8	2.5–12.5	9*
				(22)
F	Glacial sand and gravel	94 NW 12	0.2–23.7	20*
				(20)
G	Glacial sand and gravel	94 NE 3	0.3–22.8	21*
				(21)
H	Glacial sand and gravel	94 NE 8	0.1–24.0	21*
		94 NE 14	6.3–16.0	9*
		94 NE 16	8.0–19.0	11
				(41)

* The number of samples tested is less than the total for the depth range due to the paucity of 10–14 mm material in some samples.

†For each composite, the number of component samples is given in parenthesis.

Table 4 Pebble count analyses of composite samples A to H
(Results are given in frequency per cent with the corresponding weight per cent in brackets. For location of samples see Table 3. Sample A is alluvium, samples B to D are fluvioglacial sand and gravel, samples E to H are glacial sand and gravel)

British Standard Trade Groups	Rock type (modified after BS 812)	A		B		C		D		E	
		10–14 mm	14–32 mm	10–14 mm	14–32 mm	10–14 mm	14–32 mm	10–14 mm	14–32 mm	10–14 mm	14–32 mm
Number of pebbles counted:-		452	511	299	364	290	429	295	420	302	343
Basalt	Basalt (inc. dolerite)	2.2 (1.5)	5.5 (6.9)	22.4 (25.2)	12.1 (9.7)	22.4 (23.5)	13.0 (14.2)	9.8 (11.6)	1.9 (2.2)	12.3 (12.8)	2.9 (8.1)
	Andesite (inc. porphyrite)	5.8 (5.0)	7.6 (9.4)	2.7 (2.9)	8.8 (8.7)	3.8 (4.2)	9.6 (9.5)	6.4 (6.3)	3.3 (3.3)	3.6 (3.0)	3.8 (7.6)
Flint	Chert	15.5 (15.1)	11.7 (10.5)	4.0 (4.4)	2.2 (2.8)	4.1 (4.2)	3.0 (2.6)	4.7 (4.9)	2.6 (3.3)	1.3 (1.4)	0.9 (0.9)
Gabbro	Undivided	0.2 (0.2)	0.2 (0.1)	–	0.2 (0.4)	–	–	–	–	–	0.8 (1.1)
Granite (inc. microgranite)	Undivided	–	0.4 (0.4)	1.3 (1.4)	0.8 (1.5)	–	2.1 (1.9)	0.7 (0.5)	1.7 (2.2)	0.7 (0.4)	0.9 (0.5)
Gritstone	Grit and greywacke (indurated)	52.9 (57.8)	52.4 (49.9)	10.7 (11.5)	12.1 (10.3)	9.7 (11.5)	10.7 (11.3)	9.5 (11.7)	11.4 (9.5)	3.6 (4.4)	7.0 (5.1)
	Sandstone (inc. quartzitic sandstone)	6.0 (4.8)	8.6 (8.6)	37.8 (34.7)	40.1 (41.0)	35.5 (32.8)	40.3 (36.9)	44.8 (40.7)	57.2 (59.2)	52.7 (50.6)	58.9 (51.8)
Limestone	Undivided	–	–	–	–	1.0 (1.0)	1.9 (2.7)	0.7 (0.7)	0.5 (0.5)	1.0 (0.8)	0.6 (0.7)
Porphyry	Felsite	4.4 (4.1)	3.7 (4.4)	5.7. (5.7)	8.5 (8.3)	9.7 (8.1)	5.6 (5.4)	7.8 (8.7)	8.8 (8.9)	10.9 (11.5)	15.7 (15.5)
	Others (inc. volcanic glass)	0.9 (0.5)	–	0.7 (0.8)	0.5 (0.5)	2.1 (2.1)	1.2 (0.5)	4.1 (4.0)	6.4 (6.3)	2.0 (2.2)	0.9 (0.6)
Quartzite	Quartzite (inc. psammite)	6.4 (5.7)	2.4 (2.7)	2.7 (3.0)	4.9 (7.0)	4.8 (5.3)	4.9 (7.1)	3.7 (4.4)	3.3 (2.6)	3.0 (3.2)	3.8 (4.2)
Schist	Undivided	0.4 (0.5)	0.8 (1.0)	–	1.1 (0.9)	–	0.7 (0.6)	–	0.5 (0.3)	–	0.3 (0.3)
Others	Vein quartz	3.5 (3.4)	4.9 (4.9)	11.0 (10.0)	8.5 (8.7)	6.2 (6.8)	5.6 (6.4)	6.4 (6.1)	1.9 (1.4)	7.9 (9.0)	3.2 (3.5)
	Shale, siltstone, mudstone	1.8 (1.4)	1.8 (1.2)	1.0 (0.4)	0.2 (0.2)	0.7 (0.5)	1.4 (0.9)	1.4 (0.4)	0.5 (0.3)	1.0 (0.7)	0.3 (0.1)
	Vein calcite	–	–	–	–	–	–	–	–	–	–
	Coal	–	–	–	–	–	–	–	–	–	–

Till: Till generally comprises stony clay but locally, particularly where it overlies sandstone bedrock, it contains sufficient, dominantly quartz, sand to classify as mineral. Potentially workable till is extremely ill-sorted (Table 1 and Figure 4) and varies laterally in composition, influenced largely by the local bedrock which generally forms the dominant clast component. The angularity of clasts varies from well rounded to angular. As the bulk of the material is locally derived no pebble count is given for the till as a whole.

Potentially workable till frequently passes vertically into waste, and it is often this gradation which enables the sandier parts of the deposit to be recognised as till in boreholes and to be distinguished from the more clayey parts of the fluvial deposits which are similar in composition.

Glacial sand and gravel: Lack of sorting and the large amounts of pebble, cobble and boulder material (Table 1 and Figure 5), including clasts up to a metre in diameter, make the glacial sand and gravel a distinctive deposit. The grading of samples from boreholes shows a poorly developed bimodality with peaks in the fine to medium sand, and coarse gravel fractions. The former peak is not evident in the derived grading of samples from pit faces and may therefore be partially due to the drilling process. In spite of the lack of sorting, the material exhibits little variation from the mean, laterally or vertically, and this homogeneity is also seen in the clast composition, which is dominated by well-rounded to subangular sandstones with felsite, basalt, greywacke and andesite (Table 4 and Gregory, 1915). Usually the matrix is composed of angular to subangular quartz, with rock fragments and disseminated clay and silt.

F		G		H	
10–14 mm	14–32 mm	10–14 mm	14–32 mm	10–14 mm	14–32 mm
294	456	297	433	290	321
10.9 (11.9)	4.6 (4.8)	12.1 (12.3)	8.3 (9.5)	11.4 (11.6)	8.7 (8.2)
5.8 (5.8)	7.2 (6.8)	4.7 (4.5)	5.6 (6.6)	8.9 (9.3)	4.1 (3.8)
2.7 (2.3)	1.3 (1.1)	2.0 (1.9)	2.1 (1.5)	3.8 (3.7)	2.2 (1.0)
1.0 (1.0)	0.4 (0.3)	–	0.2 (0.5)	–	–
0.7 (0.7)	0.5 (0.3)	0.7 (0.7)	–	0.7 (0.6)	–
7.1 (8.1)	8.6 (7.8)	10.1 (12.2)	8.8 (9.6)	9.0 (9.8)	10.9 (11.8)
43.5 (42.4)	52.4 (53.9)	50.5 (48.5)	62.6 (58.2)	45.2 (41.7)	56.4 (57.9)
1.7 (2.0)	0.2 (0.1)	0.7 (0.6)	--	1.0 (1.2)	3.4 (2.6)
19.0 (18.6)	16.2 (17.1)	7.1 (7.5)	3.7 (2.8)	6.9 (7.2)	8.1 (8.5)
1.4 (1.0)	0.9 (1.5)	2.7 (2.5)	1.6 (2.7)	1.0 (1.5)	0.9 (1.1)
3.1 (3.2)	3.3 (2.9)	3.7 (3.8)	3.9 (4.8)	3.8 (4.7)	2.8 (2.3)
–	0.2 (0.3)	–	0.5 (1.4)	–	0.3 (0.2)
2.4 (2.5)	3.3 (2.8)	3.4 (3.8)	1.6 (0.9)	7.2 (7.6)	1.9 (2.1)
0.7 (0.5)	0.9 (0.3)	2.3 (1.7)	0.9 (0.3)	–	0.3 (0.5)
–	–	–	0.2 (1.2)	0.4 (0.5)	–
–	–	–	–	0.7 (0.6)	–

Fluvioglacial sand and gravel: The extreme compositional variability of potentially workable fluvioglacial sand and gravel, which ranges from boulder gravels in the Hyndford area to 'very clayey' sand in boreholes 94 NW 6 and 94 NE 4, is illustrated graphically (Figure 6) by the width of the grading envelopes about the mean. The deposit contains intercalated thin bands of clay or silt, which are classified as fluvioglacial owing to their relationship with the coarser, more typical material. Compositional variation is rapid, both laterally and vertically, and precludes any statement of the likely mean grading or succession at locations between sample points. However, there is a general fining both eastwards from the Hyndford area, the material merging into glaciolacustrine sediments to the south of Carstairs, and also with depth within the fluvioglacial deposits as in boreholes 84 SE 29, 94 NW 4 and 14, and 94 SW 2, and from fluvioglacial to glaciolacustrine deposits as in boreholes 94 SW 4, 5, 12 and 16.

The mean grading of the deposit based on borehole data (Table 1 and Figure 6) shows a unimodal distribution peaking in the fine to medium sand grades; face samples show an additional maximum in the coarse gravel grade and a corresponding reduction in the coarse and medium sand, again suggesting comminution of coarse material by drilling. This conclusion should, however, be treated cautiously as the face samples are representative of a smaller thickness and area of the deposit than are the boreholes.

Clast shape ranges across the whole scale of angularity but dominantly it is subangular to subrounded. Sandstone with basalt and lesser amounts of greywacke, felsite, vein-quartz, andesite and chert are present (Table 4). However, the pebble count for fluvioglacial deposits occurring in association with the glacial sand and gravel ridges shows a markedly reduced basalt content and concomitant increase in sandstone (Sample D in Table 4). Throughout the deposit the sand fraction is composed principally of subrounded to subangular quartz with some rock fragments, and coal usually in laminae. Fines are of silt or clay, normally disseminated, but are also present in beds up to 1.9 m thick, as in boreholes 94 NW 4 and 94 SE 16.

Glaciolacustrine deposits: The mineral component of the deposit is, by definition, formed of waterlain sequences grading predominantly as fine sand (Table 1 and Figure 7), the great width of the grading envelope over the coarse sand and gravel grades being caused by thin beds of coarse material (boreholes 94 NW 13, 94 NE 23, 94 SE 1 and 17). The sands are generally of subangular quartz: coal-rich laminae occur sporadically throughout, although in the main they are associated with fines-rich bands. Rapid variation of fines content gives many waste partings, for example, in boreholes 84 SE 19, 94 NE 9 and 23. Downward fining within the fluvioglacial material is

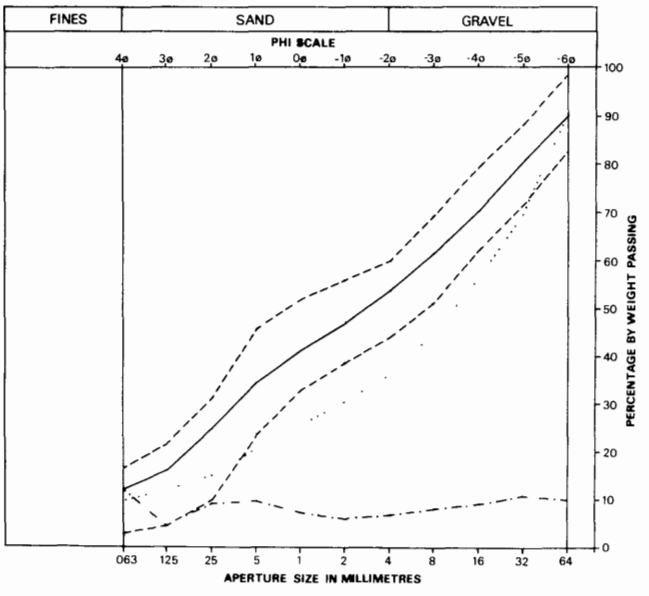

Figure 5 Grading characteristics of resources in the glacial sand and gravel: the continuous line is the cumulative weighted mean; the broken lines denote the envelope containing the cumulative mean grading for each separately identified deposit proved by boreholes to contain less than 40 per cent fines; the frequency distribution of the mean grading for the resource as a whole is shown by a dashed and dotted line; the dotted line is the cumulative mean grading based on the interpretation of photographs and samples from sections

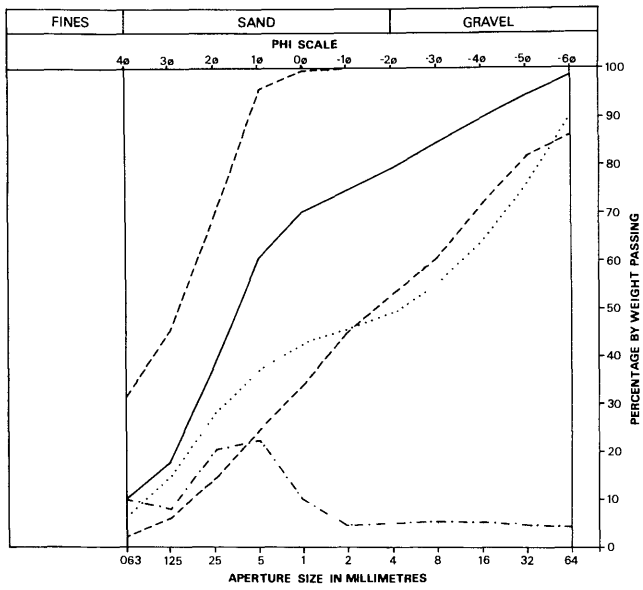

Figure 6 Grading characteristics of resources in the fluvioglacial sand and gravel (for explanation see Figure 5)

usually also shown by the glaciolacustrine sediments and the number of waste bands increases with depth. Rarely a complete sequence from fine sand through silt to clay is displayed (boreholes 94 SW 11, 94 SE 10 and 11). Overall nearly 60 per cent of the total thickness of glaciolacustrine sediments penetrated in assessment boreholes comprises often well-laminated clays and silts, which in the past have been worked for brick making.

Alluvium: The bulk of the alluvial deposits of the area lie in the valley of the Clyde and on the basis of composition can be divided into those south and west of the confluence [9726 4441] of the river with the Medwin Water. The southern deposits constitute the greater part of the resource and typically comprise a layer of silt or clay, up to 2.5 m thick in borehole 94 SE 10, overlying moderately well-sorted, dominantly fine gravel-grade material. The gravel becomes coarser upstream and is composed principally of greywacke with chert, andesite, quartzite, sandstone and basalt (Table 4), set in a quartz-sand matrix, both gravel and sand fractions being dominantly angular to subangular. The grading data generally show a low fines content but these results may have been exaggerated by 'washing', which occurs when drilling beneath the water table.

Alluvium covers the valley floor downstream of the confluence of the Clyde and Medwin Water as far as Prett's Mill [9018 4012] and over this area that part of the deposit which is potentially workable contains more fines and less, but more rounded, gravel. Boreholes other than 94 SW 14 indicate that in the detached area of alluvium downstream of Charleston [9223 4174] the overlying silt or clay is absent.

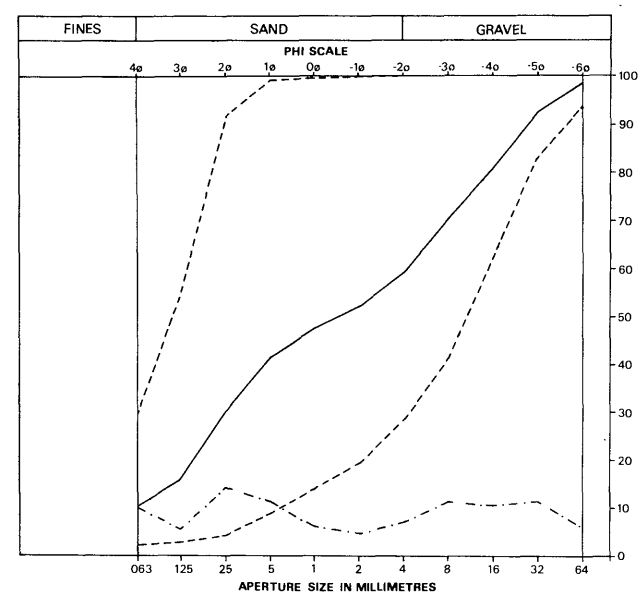

Figure 8 Grading characteristics of resources in the alluvium (for explanation see Figure 4)

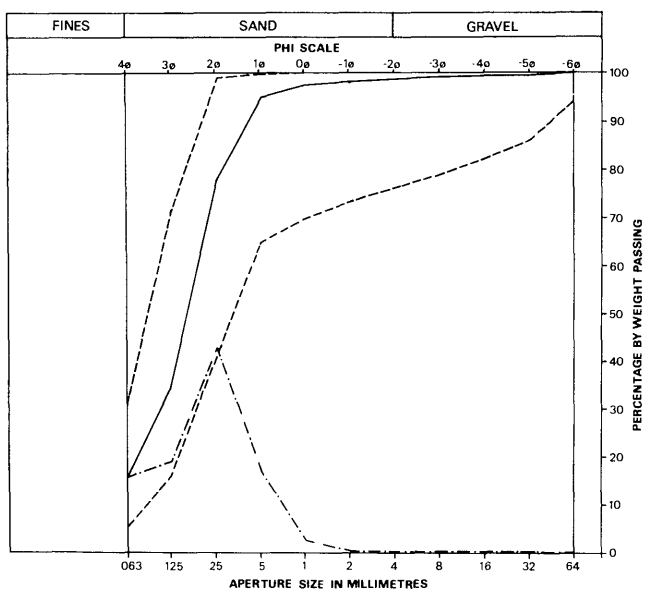

Figure 7 Grading characteristics of resources in the glaciolacustrine deposits (for explanation see Figure 4)

The alluvium of the Mouse Water was nowhere proved to be mineral but in the valley of the South Medwin river gravel similar to that in the valley of the Clyde, apart from the dominance of sandstone clasts, was found beneath silt in borehole 94 SE 16.

The grading of the deposit (Table 1 and Figure 8) is characterised by the wide envelope, reflecting both the downstream fining of material and the classification of the deposit solely on generic grounds.

Mechanical and physical properties of the aggregate

Aggregate impact value (AIV), 10 per cent fines, relative density (calculated using both surface and oven drying), apparent relative density and water absorption were determined in accordance with BS 812.3: 1975 for eight samples representative of deposits in the survey area: additionally the aggregate crushing value (ACV) was measured on three of the samples.

The mechanical and physical tests were conducted on 10 to 14 mm sized material (BS 812.3: 1975). About 15 kg

Table 5 Results of mechanical and physical tests (BS 812: 1975)

Composite Sample	Deposit type	AIV	ACV	10% fines	Relative density (oven dried)	Relative density (surface dried)	Apparent relative density	Water absorption (%)
A	Alluvium	21	21	180	2.52	2.59	2.69	2.5
B	Fluvioglacial sand and gravel	21	22	170	2.48	2.56	2.70	3.2
C	Fluvioglacial sand and gravel	21	22	170	2.48	2.56	2.69	3.2
D	Fluvioglacial sand and gravel	26	–	140	2.44	2.52	2.65	3.2
E	Glacial sand and gravel	23	–	130	2.47	2.56	2.57	3.3
F	Glacial sand and gravel	24	–	150	2.42	2.52	2.68	4.0
G	Glacial sand and gravel	25	–	–	2.47	2.56	2.70	3.5
H	Glacial sand and gravel	22	–	170	2.49	2.56	2.68	3.0

is required for a complete series of tests and the amount of this fraction available is the principal factor limiting the number of determinations which can be made for any one sample. All +4 mm material was retained from the sieve-grading of bulk samples and resieved to give 10 to 14 mm and 14 to 32 mm fractions, the larger size only being used for comparative pebble counts. To obtain enough test material, composite samples were prepared by grouping, both within and between boreholes, as listed in Table 3. In only two cases was a single borehole able to provide a test sample. As the compaction tests, ACV and 10 per cent fines, require the most material, both tests were possible for only three samples, and for another, neither could be undertaken.

In addition to aggregate testing, pebble counts were carried out on the composite samples in an attempt to see if any differences in the test results could be attributed to a particular lithology. The categories recognised are the trade group classification given in BS 812.1: 1975, with minor amendments: microgranite is included in the granite group and quartzitic sandstone in the gritstone group. Both these rock-types are minor constituents of the samples and form part of gradational sequences with granite and sandstone respectively, making separate classification difficult. Four rock-types not recognised in the Standard are listed under 'others'. Pebble counts of both the 10 to 14 mm and 14 to 32 mm size fractions were made to check that the samples used for testing represent the lithologies present in the aggregate as a whole. A comparison of pebble counts on the two fractions generally bears this out except for a predictable slight increase in the smaller size fraction of the hard, fine-grained rock types, particularly, basalt, chert, felsite, quartzite and vein-quartz, at the expense of gritstone. Andesite is anomalous being more abundant in the coarser size fraction. The results are given in Table 4 as per cent weight and per cent number of clasts.

Results of the mechanical testing

AIV, ACV and 10 per cent fines are tests of the strength of an aggregate. ACV and 10 per cent fines measure resistance to applied compressive load. In the former test, load is increased up to a fixed magnitude in a standard time: in the latter, the load is gradually increased up to that required to produce a given degree of compaction in a standard time. The 10 per cent fines test, therefore, in some cases measures the resistance of aggregate at higher loads than the ACV. The results (Table 5) show the expected general correlation between ACV and 10 per cent fines, whereas a comparison of the crushing values with the average ACV of 17 for Scottish and English gravels given by Edwards (1970) shows material from the Lanark area to be weaker. There is a general inverse relationship between compressive strength and sandstone content (Tables 4 and 5) but this weakness does not of itself adversely affect the use of the aggregate in concrete manufacture, as the strength of a mix is largely dependent on water absorption, surface texture, specific surface area, organic impurities and chemistry (Edwards, 1970).

AIV is a measure of the resistance of rock to sudden load and is a function of petrography and aggregate shape: in gravels this latter characteristic is in turn related to petrography and to conditions of deposition. In clastic sedimentary rocks failure is primarily a function of the strength of the intergranular cement. In igneous rocks it depends on the degree of crystal interlocking, which decreases with increase in the surface area of crystals, and is, therefore, inversely proportional to grain size. Additionally, in coarse-grained igneous rocks the strength of individual crystals, a function of twinning, cleavage and microfracture planes, becomes important (Ramsay, 1965). Generally, therefore, fine-grained igneous rocks are the strongest, followed by coarse-grained igneous and sedimentary rocks of decreasing induration, although weathering will reduce the strength of any rock.

Work by Ramsay (1965) has shown that AIV rises with increasing flakiness index (a measure of the shortest axis of clasts, see BS 812.1: 1975), but flakiness of gravels, as opposed to crushed rock, is principally a function of petrography and has not been determined in the present study.

The AIV results presented in Table 5 are higher than the average of 19 for worked gravels given by Edwards (1970), and although showing no simple relationship with petrography (Table 4), they generally rise with increasing sandstone and decreasing basalt content.

Water absorption by aggregate is an important measure because of its broad linear relationship with drying shrinkage, both of the aggregate itself and of any concrete manufactured from it. Limestone aggregates, however, give concrete of low shrinkage independent of absorption level (Edwards 1966, 1970). The drying shrinkage in turn is a key factor affecting the stress-carrying and weathering ability of concrete, and Building Research Station Digest 35 (1968) encodes values acceptable for concrete in particular situations. Measurements have been made of the water absorption of crushed rock aggregates (Edwards, 1966, 1970) and attempts made to relate these values to petrography. In very general terms quartz and flint give the lowest absorption, gritstones, mudstone and shale, the highest, and the acid igneous rocks have a lower absorption than their more basic counterparts, although weathering is likely to increase the absorption of any rock.

The water absorption of the aggregates tested in this survey (Table 5) is high compared with the average of 1.48 per cent for other gravels, and the range of values (0.27 to 1.36 per cent) for various types of crushed rock aggregates, listed by Edwards (1966, 1970). The results generally reflect the high gritstone content (Table 4): alluvium (Sample A) gives a slightly lower value, the gritstone group, atypically, being dominantly composed of greywacke rather than sandstone. Using the graph drawn by Edwards (1970) linking water absorption with concrete drying shrinkage, glacial drift aggregates in the Lanark area have inferred shrinkage values between 0.09 and 0.11 per cent, and alluvium a value of 0.08 per cent: aggregates with values greater than 0.085 per cent lie in the category, defined by the Building Research Station (Digest 35, 1968), that requires the greatest care to be exercised when such material is used in concrete manufacture. It must be emphasised that inferred shrinkage values should be interpreted cautiously; for definitive values laboratory tests of concrete blocks made from the various aggregates should be undertaken.

The relative densities of samples tested in this survey are a little lower than the mean of 2.58 for worked gravels given by Edwards (1970), probably due to the high gritstone content, the variation between composite samples being small and not directly relatable to petrography (Tables 4 and 5).

THE MAP

The sand and gravel resource map is folded into the pocket at the end of the report. The base is the Ordnance Survey 1:25000 Outline Edition in grey, on which the topography is shown by contours in green, the geological data in black and the mineral resource information in shades of red.

Geological data: The geological boundary lines are taken from geological maps surveyed at the scale of 1:10560; these offer the best interpretation of the available data but, due to the highly variable nature of the deposits, the accuracy of the map will be improved as new evidence from boreholes and excavations becomes available.

Mineral resource information: The mineral-bearing ground is divided into resource blocks (see Appendix A), within which the extent of mineral is shown in red, a dark shade being used to identify areas where it is exposed (that is, overburden averages less than 1 m), and a lighter tone areas where it is present in relatively continuous spreads beneath overburden averaging more than 1 m in thickness. The map is left uncoloured where sand and gravel is considered to be generally either absent or not potentially workable, except where this category occurs in small undefinable patches within an area of mineral, for example, in the vicinity of borehole 94 NW 11. Small patches of sand and gravel that have not been assessed, although they may be potentially workable, are indicated by red stipple.

In the main, the boundaries between categories of deposits coincide with geological boundary lines: where a transition between categories occurs that cannot be located in this way an inferred boundary has been drawn. Such boundaries are shown as zig-zag lines, which are pecked where they indicate an inferred boundary of a buried deposit. The symbol is intended to signify 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.

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

RESULTS

The results of the assessment of resources are summarised in Tables 6 and 7. More detailed grading and thickness data by block are given in Tables 8 to 14 and presented graphically in Figures 9 to 14, which show mean grading plotted both cumulatively and as a frequency distribution, with grading envelopes for the former. No statistical assessment is given for block G where the distribution of mineral is limited and uneven.

As most of the drift deposits of the assessment area, both mineral and non-mineral, show great lateral variability, correlation with any certainty between boreholes is not possible. However, areas in which sediments are the product of the same depositional environment, or related group of depositional environments, can be recognised and used as the basis for defining blocks. Within any block the same sedimentary sequences are likely to recur and a good estimate of mean thickness and grading may be derived by averaging data from the randomly distributed boreholes. For this reason all material proved to be potentially workable in assessment boreholes has been treated with equal weight in the volumetric calculation, as no deposit or sequence of deposits can be considered to be anomalous, even if only proved in a single borehole.

Where possible separate assessments are provided for individual deposits within each block (Tables 8b to 13b), usually for the most abundant potentially workable material, but in the case of block D for the deposit comprising the major part of the total drift thickness proved. For block E, only an overall assessment is provided as, owing to the large amount of peat cover, no determination of the areal extent of the component deposits can be made.

In calculating the mean thickness of total mineral in each block all boreholes other than those defining an area of barren ground have been taken into account. A nil thickness is taken for those boreholes which although not proving potentially workable material lie within an

Table 6 Summary of statistical assessments

Resource block (principal deposit)	No. of sample points	Area (km²)		Mean thickness (m)		Volume of mineral			Mean grading percentage		
		Block	Mineral	Over-burden	Mineral	million m³	Limits at the 95% probability level ± %	± million m³	Fines $-\frac{1}{16}$ mm	Sand $+\frac{1}{16}$–4 mm	Gravel +4 mm
A (Fluvioglacial sand and gravel)	13 (10)	9.0	8.4 (7.9)	0.9 (0.9)	15.5 (13.1)	130 (103)	33 (44)	43 (46)	11 (9)	70 (65)	19 (26)
B (Fluvioglacial sand and gravel)	9 (8)	8.0	8.0 (7.7)	0.6 (0.9)	6.5 (4.5)	52 (34)	51 (27)	26 (9)	16 (13)	71 (66)	13 (21)
A+B (Fluvioglacial sand and gravel)	22 (18)	17.0	16.3 (15.5)	0.8 (0.9)	11.1 (8.8)	181 (137)			12 (10)	70 (65)	18 (25)
C (Alluvium)	9 (9)	7.7	7.7 (7.7)	1.2 (1.2)	5.0 (3.0)	39 (23)	40 (40)	15 (9)	9 (8)	63 (46)	28 (46)
D (Glaciolacustrine deposits)	18 (14)	10.9	10.8 (8.3)	1.0 (0.7)	4.9 (2.7)	53 (22)	62 (71)	32 (16)	15 (22)	72 (77)	13 (1)
E (Fluvioglacial sand and gravel)	11 (6)	9.3	8.9	2.0 (3.6)	15.6 (15.9)	140	36	50	11 (10)	78 (77)	11 (13)
F (Glacial sand and gravel)	6 (6)	2.7	2.3 (2.3)	0.3 (1.4)	19.7 (14.1)	44 (32)	23 (43)	10 (14)	12 (12)	47 (41)	41 (47)
Totals	66	47.6	46.1	1.1	9.9	458			12	68	20

Notes

a Limits at the 95 per cent probability level are a measure of the range of thicknesses about the mean. Because of differences in borehole density between blocks it is not justifiable to give limits when volumes of mineral for individual blocks are added.

b For each block data on the principal deposit are given in parentheses.

c Figures may not add to totals shown owing to independent rounding.

area where mineral generally occurs: for assessment of individual deposits only boreholes proving mineral have been considered, a nil value being given to those boreholes where the deposits occur but are judged not potentially workable.

Accuracy of results: For the six resource blocks assessed statistically, the accuracy of the results at the symmetrical 95 per cent probability level ranges from 23 to 62 per cent (that is, it is probable that nineteen times out of twenty the true volumes present lie within these limits). However, the real values are more likely to be nearer the median than the limits. Moreover, it is probable that roughly the same percentage limits would apply for the estimate of mineral volume within a very much smaller parcel of ground (for example, 100 hectares) containing similar sand and gravel deposits, if the results from the same number of sample points (as provided by, say, ten boreholes) were used in the calculation. Thus, if closer limits are needed for the quotation of reserves, data from more sample points would be required, even if the area is quite small. However, it must be emphasised that the quoted volume of sand and gravel has no simple relationship with the amount that could be extracted in practice, as no allowance has been made in the calculations for any restraints (such as existing buildings and roads) on the use of land for mineral working.

NOTES ON RESOURCE BLOCKS

Glacial, fluvioglacial and glaciolacustrine deposits, which form the bulk of the potentially workable sand and gravel, lie in a broad belt extending from south of Lanark to Woodend Moss. Potentially workable alluvium, comprising mainly river gravel in the upper part of the valley of the Clyde, forms a lesser resource.

Most of the periphery of the survey area, which comprises high ground with, at most, a thin drift cover probably only locally potentially workable, is considered in block G. Otherwise the deposits are included in blocks A to F, the boundaries of which have been drawn primarily for geological reasons.

Block A

The block has been drawn to encompass the fluvioglacial sand and gravel to the south and south-east of Lanark. The boundaries generally follow the mapped outcrop of the deposit except to the north-east, where an arbitrary line has been taken both roughly to delimit these thicker, coarser deposits from the finer grained material of block B, and to divide the outcrop of fluvioglacial sand and gravel lying between the Clyde south of Lanark and Carstairs approximately equally between the two blocks: the isolated patch of fluvioglacial sand and gravel around Howford Farm [9130 4076] is also included.

The greater part of the block, east of Bonnington [8875 4143] and Kingson's Knowe [885 429], and to the

Table 7 Summary of inferred assessments

Deposit	Locality	Resource block	Area (km^2)	Thickness (m)	Inferred volume (million m^3)
Glacial sand and gravel	West from Drummonds Hill [872 403]	G_1	0.17	4.7	0.8
Glacial sand and gravel	North-east of Libberton [997 433]	G_3	0.10	2.0	0.2
Fluvioglacial sand and gravel	South-west of Yetts farm [983 422]	G_3	0.01	18.8	0.2
Totals			0.28		1.2

north of the Clyde, exhibits hummocky kettle-hole topography, the base of the hollows being peat covered. The area is cut by the valley of the Clyde and, in the west, by two steep-sided, dry valleys, the larger of which trends north then west from a group of kettle-holes near Bonnington Mains [8918 4196] (Plate 3) to join the Clyde at New Lanark [880 426], the smaller running westwards, north of Bonnington. The Clyde upstream of Boathaugh [8986 4014] flows to the south-west across an alluvial flat averaging 250 m in width and lying about 30 m below the general level of the surrounding country: to the south, just outside the assessment area, the river is joined by the northward-flowing Douglas Water and makes a major change in course to the north-west, the river profile steepening, losing about 85 m in height in the 5 km between Tulliford [8918 4057] and Kirkfieldbank [866 439], over which distance the valley is floored by bedrock and its steep sides are composed of till or fluvioglacial sand and gravel.

The principal deposit of the area is fluvioglacial sand and gravel, which occurs at the surface in all but the extreme south-eastern part of the block, where it is proved beneath 4.5 m of soil and alluvium in borehole 94 SW 14, but is absent in boreholes 84 SE 30, 94 SW 6 and 7. Fluvioglacial sand and gravel is compositionally extremely variable, having an overall mean grading of 9 per cent fines, 65 per cent sand, 26 per cent gravel (sandy gravel), but the mean grading by borehole ranges from 2 per cent fines, 96 per cent sand, 2 per cent gravel (sand) at borehole 84 SE 19 to 5 per cent fines, 49 per cent sand, 46 per cent gravel (sandy gravel) at borehole 94 SW 5 (Tables 6 and 8b). Within boreholes beds of material ranging in composition from clay to fines-free gravel are found. Variation in grading is rapid both horizontally and vertically, and it is impossible to trace units laterally for any distance with certainty. The deposit ranges in thickness from 3.6 m at borehole 94 SW 15 to 24.9 m+ at borehole 84 SE 28, but no regional trends are readily apparent.

Glaciolacustrine deposits underlie fluvioglacial sand and gravel in four boreholes (84 SE 19, 24, 94 SW 4 and 5) of the six which proved the base of the latter, the exceptions being borehole 84 SE 18, where fluvioglacial sand and gravel lies on bedrock, and borehole 94 SW 15, where it rests on till. In addition, glaciolacustrine sediments were found at the surface in borehole 84 SE 30 and beneath alluvium in boreholes 94 SW 6 and 7; although only proved in seven boreholes, it is likely that glaciolacustrine deposits underlie fluvioglacial sand and gravel over the greater part of the block (Section 1).

A little under 40 per cent by thickness of the total glaciolacustrine deposits penetrated in assessment boreholes is mineral, this figure being mainly accounted for by boreholes 94 SW 4, 5 and 7 which prove 11.0 m, 18.4 m+ and 19.9 m respectively of 'clayey' sand and sand. When the fluvioglacial sand and gravel and the glaciolacustrine deposits are considered together a general upward coarsening is discernible in about half the boreholes, the trend being best displayed in borehole 84 SE 24, where silt passes up through 'very clayey' sand to 'very clayey' sandy gravel. Treated as a single unit, the two deposits show a marked eastward thickening, boreholes 84 SE 28, 29, 94 SW 4, 5, 6, 7 and 14 all penetrating in excess of 20 m, although at 94 SW 6 the basal 16.4 m is silt. In the west of the block bedrock is proved at around 15 m depth in boreholes 84 SE 18 and 24 and, just outside the block, boreholes 84 SE 23 and 25 prove bedrock about 1 m below the surface. Borehole 84 SE 19 is exceptional, proving drift to 25.0 m+, but this is probably due to its location on the side of the overdeepened valley of the Clyde. Borehole 94 SW 15 sited on an outlier of fluvioglacial sand and gravel south-east of the Clyde proves the deposit to overlie till on bedrock.

Borehole 84 SE 30 is anomalous, reaching bedrock at a depth of 5.0 m, whereas 600 m to the north borehole 84 SE 29 failed to prove bedrock at 25.2 m, the present topography not reflecting this variation in bedrock surface level.

Two boreholes encountered till: at 84 SE 19 the glaciolacustrine deposits include 3.0 m of stiff clay and at 94 SW 15, 14.1 m of generally clayey till includes, near the top of the deposit, 1.9 m grading as gravel. In the four boreholes other than 94 SW 15 in which bedrock was reached (84 SE 18, 24, 30 and 94 SW 7) till was not found, suggesting that it is less extensive over block A than the remainder of the resource sheet.

Alluvium, which underlies the floodplain of the Clyde between Hyndford Bridge [9150 4145] and Prett's Mill [9018 4012], was investigated by three boreholes which show the deposit to range in thickness from 2.0 m at borehole 94 SW 7 to 4.5 m at borehole 94 SW 6. Potentially workable material comprises about 45 per cent of the total thickness proved: 'clayey' to 'very clayey' sand or pebbly sand occurs in all three boreholes together with 3.0 m of fines-free gravel in borehole 94 SW 6 and 3.0 m of silt and clay in borehole 94 SW 14.

The assessment of resources, which comprise fluvioglacial sand and gravel, glaciolacustrine deposits, and minor amounts of till and alluvium, is based on thirteen IMAU boreholes. Thickness and grading data are

Table 8 Block A: data from assessment boreholes

Borehole	Recorded thickness			Mean grading percentage						
	Total mineral (m)	Depth of burial (m)	Intervening waste (m)	Fines $-\frac{1}{16}$ mm	Fine sand $+\frac{1}{16}$–$\frac{1}{4}$ mm	Medium sand $+\frac{1}{4}$–1 mm	Coarse sand +1–4 mm	Fine gravel +4–16 mm	Coarse gravel +16–64 mm	Cobbles and boulders +64 mm
a ALL DEPOSITS										
84 SE 18	13.0	0.6	0.0	16	17	14	11	19	21	2
84 SE 19	8.4	0.3	5.8	8	52	37	2	1	1	0
84 SE 22	11.6+	1.6	0.0	21	22	12	10	14	15	6
84 SE 24	11.0	0.1	0.3	24	36	14	5	8	12	1
84 SE 28	24.9+	0.6	0.0	8	13	22	14	24	18	1
84 SE 29	24.7+	0.5	0.0	5	49	39	2	2	2	1
84 SE 30	2.5	2.5	0.0	19	72	7	1	1	0	0
94 SW 4	23.1	0.4	1.0	12	42	26	6	7	7	0
94 SW 5	24.8+	0.2	0.0	11	43	29	4	6	6	1
94 SW 6	8.7	0.3	0.0	16	40	16	6	9	11	2
94 SW 7	21.9	0.3	0.0	8	63	25	2	1	1	0
94 SW 14	21.0+	3.5	0.0	7	32	33	9	9	9	1
94 SW 15	5.5	0.5	0.3	10	28	33	7	7	12	3
Mean	15.5	0.9	0.6	11	38	26	6	9	9	1
b FLUVIOGLACIAL SAND AND GRAVEL										
84 SE 18	13.0	0.6	0.0	16	17	14	11	19	21	2
84 SE 19	6.4	0.3	0.0	2	49	45	2	1	1	0
84 SE 22	11.6+	1.6	0.0	21	22	12	10	14	15	6
84 SE 24	8.0	0.1	0.3	21	25	19	7	11	16	1
84 SE 28	24.9+	0.6	0.0	8	13	22	14	24	18	1
84 SE 29	24.7+	0.5	0.0	5	49	39	2	2	2	1
94 SW 4	12.1	0.4	0.0	8	26	29	11	13	13	0
94 SW 5	6.4	0.2	0.0	5	13	26	10	22	22	2
94 SW 14	20.0+	4.5	0.0	6	31	34	9	10	9	1
94 SW 15	3.6	0.5	0.0	10	33	44	7	4	2	0
Mean	13.1	0.9	0.0	9	28	28	9	13	12	1

summarised in Tables 8a, 8b and Figure 9.

Two statistical assessments are offered: one considers fluvioglacial sand and gravel alone, the other all potentially workable deposits.

On the basis of ten data points, the volume of fluvioglacial sand and gravel is estimated to be 103 million m³ ±44 per cent (Table 6). In defining the extent of the deposit note has been taken both of ground worked to the west of Hyndford [9065 4170] and the area in the south-east of the block where boreholes 84 SE 30, 94 SW 6 and 7 indicate that fluvioglacial sand and gravel (though not other potentially workable deposits) is absent. The area within which fluvioglacial deposits do not occur cannot be shown on the resource map because potentially workable alluvium overlies it but it is limited to the south and west by the block boundary, to the north-west by the geological boundary separating glaciolacustrine deposits and alluvium from fluvioglacial sand and gravel, and to the north-east by the inferred boundary (zig-zag line) drawn between boreholes 94 SW 6, in which fluvioglacial deposits are absent, and 94 SW 14, where 20 m+ were proved.

There is insufficient data on which to base separate statistical assessments of the potentially workable alluvium and glaciolacustrine deposits. These deposits have been considered, however, in assessing the resources as a whole, the total volume of which is estimated at 130 million m³ ±33 per cent (Table 6). The overall mean grading is 11 per cent fines, 70 per cent sand, 19 per cent gravel ('clayey' pebbly sand).

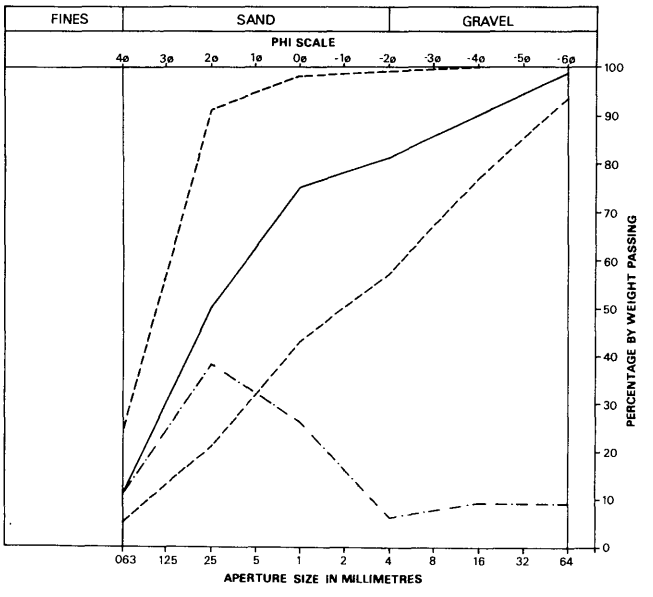

Figure 9 Grading characteristics of resources in block A: the continuous line is the cumulative weighted mean; the broken lines denote the envelope containing the cumulative mean grading of mineral proved in individual boreholes; the frequency distribution of the mean grading is shown by a dashed and dotted line

Table 9 Block B: data from assessment boreholes

Borehole	Recorded thickness			Mean grading percentage						
	Total mineral (m)	Depth of burial (m)	Intervening waste (m)	Fines $-\frac{1}{16}$ mm	Fine sand $+\frac{1}{16}$–$\frac{1}{4}$ mm	Medium sand $+\frac{1}{4}$–1 mm	Coarse sand +1–4 mm	Fine gravel +4–16 mm	Coarse gravel +16–64 mm	Cobbles and boulders +64
a ALL DEPOSITS										
94 NW 4	3.2	0.4	0.0	17	26	21	6	12	14	4
94 NW 6	5.6	0.4	0.0	25	37	16	5	9	7	1
94 SW 2	2.9	1.6	0.0	12	19	23	12	18	16	0
94 SW 3	8.8	0.3	0.0	10	39	29	7	9	6	0
94 SW 9	5.0	1.0	0.0	14	29	23	8	10	8	8
94 SW 11	1.3	0.8	0.0	27	56	15	1	1	0	0
94 SW 12	10.3	0.4	2.6	18	58	21	2	1	0	0
94 SW 13	7.6+	0.6	0.0	11	36	33	9	9	2	0
94 SW 16	14.2	0.2	0.0	18	51	17	4	4	5	1
Mean	6.5	0.6	0.3	16	43	22	6	7	5	1
b FLUVIOGLACIAL SAND AND GRAVEL										
94 NW 4	3.2	0.4	0.0	17	26	21	6	12	14	4
94 NW 6	5.6	0.4	0.0	25	37	16	5	9	7	1
94 SW 2	2.9	1.6	0.0	12	19	23	12	18	16	0
94 SW 3	6.7	0.3	0.0	10	44	30	6	8	2	0
94 SW 9	5.0	1.0	0.0	14	29	23	8	10	8	8
94 SW 12	4.0	0.4	0.0	10	36	46	4	3	1	0
94 SW 13	5.4+	2.8	0.0	6	27	39	12	13	3	0
94 SW 16	3.2	0.2	0.0	6	8	24	15	19	23	5
Mean	4.5	0.9	0.0	13	30	28	8	11	8	2

Block B

The block includes the north-eastern part of the mapped area of fluvioglacial sand and gravel that occupies the ground north of the Clyde between Lanark and Carstairs; the south-western deposits lie in block A. Over most of the block fluvioglacial sand and gravel forms the surface deposit. The principal exceptions, two areas of glaciolacustrine deposits to the north-west and south-east respectively of Cobblehaugh Farm [9250 4265], may be more extensive than shown on the map, the smaller only being identified at the surface as a result of the drilling programme carried out during the present survey. Additionally, in the east of the block, small patches of alluvium cover the valley floor of the Flush Burn and its principal tributary and form an alluvial cone where the stream joins the valley of the Clyde: although not investigated by assessment boreholes these deposits are considered to be thin and to contain in excess of 40 per cent fines. Small areas of peat cover low ground, principally to the west of Huntlyhill [9158 4402] and around Oldmill Wood [936 454]. Two small patches of till occur south of Huntlyhill.

Topographically the block comprises a generally flat, terrace-like feature, lying, in the main, between 205 m and 214 m above Ordnance Datum. Three wide valleys graded to the Clyde dissect the area: two have small streams, the Sandy Burn and Flush Burn, the valley of the former containing Lanark Moor [905 432]; the third, running south-east from Huntlybank [9165 4474], is dry. To the west of Charleston [9223 4174] the block includes a small section of the valley of the Clyde with an alluvial flat up to 450 m in width.

Fluvioglacial sand and gravel commonly crops out at the surface but was overlain by 2.8 m of soil and alluvium in borehole 94 SW 13. It was found in eight of the ten assessment boreholes drilled in block B, the exceptions being 94 SW 11 and 18. The deposit is continuous with the fluvioglacial sand and gravel of block A, but thinner, the potentially workable part of the sequence ranging from 6.7 m at borehole 94 SW 3 to 2.9 m at borehole 94 SW 2; the mean thickness is 4.5 m compared with the mean of 13.1 m for block A. The difference is principally due to the generally higher bedrock surface level, which in block B rises towards the north, boreholes 94 SW 12, 3 and 2 showing an increase in height from less than 181.4 m through 186.1 m to 203.3 m above Ordnance Datum. In the north-east the high ground comprises a drift-covered ridge of bedrock, which extends from west of Huntlybank towards Carstairs Junction (Section 1 and Figure I). Fluvioglacial sand and gravel was bottomed in all boreholes, and, with the exceptions of 94 SW 12 and 16, which prove an underlying sequence of glaciolacustrine deposits, overlies till on bedrock. Glaciolacustrine deposits were encountered in boreholes 94 SW 11, 12, 16 and 18 and, as in block A, generally underlie and form a continuous sequence with fluvioglacial sand and gravel. Fluvioglacial material, in boreholes 94 NW 4 and 94 SW 2, and glaciolacustrine deposits, in boreholes 94 SW 11, 12 and 16, show upward coarsening: the same trend is apparent in boreholes 94 SW 12 and 16 when the two deposits are considered together. Besides vertical coarsening the deposits show lateral fining and compared with block A glaciolacustrine deposits comprise a greater proportion of the drift, partially accounting for the lower mean thickness of fluvioglacial sand and gravel in block B relative to block A. Boreholes 94 SW 11 and 12 (and 94 SW 10 and 17 in block C) penetrated from 18.5 m to 25.0 m of drift without reaching bedrock, indicating a marked lowering in the bedrock surface relative to neighbouring boreholes to the north-west and south-east. The boreholes lie on a line trending north-east linking the overdeepened part of the valley of the Clyde to the east with

the bedrock depression south-west of Hyndford [9065 4170], and are thought to indicate a buried valley of the Clyde (Figure I). The view that an earlier valley was filled with glacial sediments is further supported by the abrupt change in the course of the Clyde which occurs hereabouts, the river turning through 90° to flow south out of its wide floodplain and into a narrow valley cut down to bedrock.

The potentially workable fluvioglacial sand and gravel has a mean grading of 13 per cent fines, 66 per cent sand, 21 per cent gravel ('clayey' pebbly sand)—a little more fines and sand but less gravel than that in block A. The mean grading by borehole ranges from 6 per cent fines, 47 per cent sand, 47 per cent gravel (gravel) in borehole 94 SW 16 to 10 per cent fines, 86 per cent sand, 4 per cent gravel ('clayey' sand) in borehole 94 SW 12 (Tables 6 and 9b). Within boreholes, recognisable units in the deposit range from sandy silt to gravel. Because of its widespread distribution within the block a volumetric estimate, 34 million $m^3 \pm 27$ per cent (Table 6), has been made for the fluvioglacial sand and gravel alone: the area of the block less the surface extent of glaciolacustrine deposits has been taken for calculation.

A little under 30 per cent of the total thickness of glaciolacustrine deposits penetrated in the assessment boreholes 94 SW 11, 12, 16 and 18 grades as 'very clayey' sand, over 60 per cent of which is accounted for by the 11.0 m proved in borehole 94 SW 16; the remainder of the deposit comprises clays and silts bottomed only in borehole 94 SW 18 where the sediments overlie 6.1 m of till on basalt. The glaciolacustrine deposits are restricted to the southern part of the block, the greatest thickness proved occurring in the lower parts of the north-east-trending buried valley. Because of this limited extent and the small amount of borehole evidence no separate volumetric assessment is given.

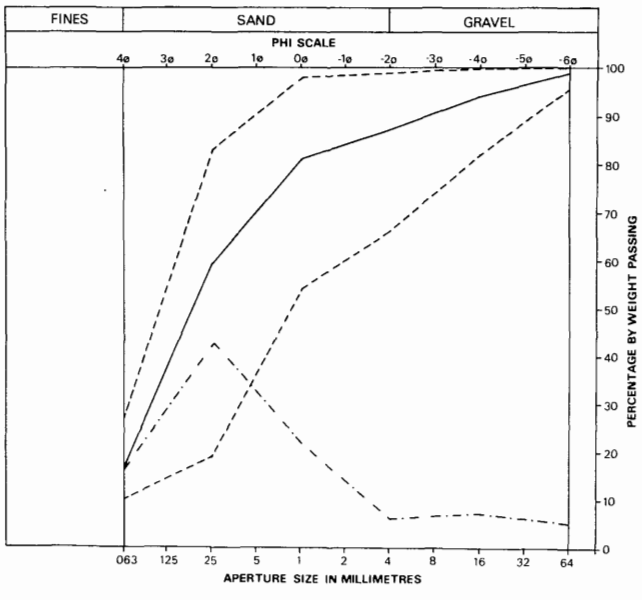

Figure 10 Grading characteristics of resources in block B (for explanation see Figure 9)

Till rests on bedrock in all boreholes in which the latter was proved except 94 NW 6 and 94 SW 13 where bedrock is overlain by fluvioglacial sand and gravel. Till, typically a reddish silty or sandy stony clay, averages 2.6 m in thickness and ranges from 0.1 m in borehole 94 SW 9 to 6.1 m in borehole 94 SW 18. The 2.1 m proven in borehole 94 SW 3, and the upper 1.5 m of borehole 94 SW 18, grade as sandy gravel and 'very clayey' sandy gravel respectively but, although locally classifying as potentially workable, the mineral till is too patchy to allow separate statistical assessment.

Alluvium was only penetrated by borehole 94 SW 13, which proved 2.2 m of 'very clayey' sand overlying fluvioglacial sand and gravel. The floodplain of the Clyde in the vicinity of this borehole is the only area where the deposit is likely to be of any significant thickness but, owing to the paucity of data, no separate assessment is offered.

On the basis of nine sample points the volume of all potentially workable material is estimated at 52 million m^3 ± 51 per cent (Table 6). The overall mean grading is 16 per cent fines, 71 per cent sand, 13 per cent gravel ('clayey' pebbly sand) (Table 9a and Figure 10).

Block C

The block has been drawn to define an area where alluvium of the Clyde overlies glaciolacustrine deposits, which usually are not potentially workable. The block boundaries, in the main, coincide with the mapped extent of alluvium upstream of Cobblehaugh Farm [9250 4265]. The valley of the Medwin Water, where alluvium is thought generally to overlie fluvioglacial sand and gravel in excess of 21 m in thickness, is included in block D. The alluvium of other smaller tributaries of the Clyde is not assessed as the deposits are considered not potentially workable.

The Clyde enters the block from the south near Burnfoot [9911 4031], flows north for 4·5 km to its confluence with the Medwin Water, where it turns westwards for 5 km before taking a southerly course. Downstream of Cobblehaugh Farm the river flows through a valley never more than 450 m wide, and usually cut down into bedrock: upstream, the Clyde floodplain averages 800 m in width as far as Yett Farm [9874 4271] whereafter it narrows to about 500 m. The river has a gentle gradient, dropping 8 m over the block and meandering across its floodplain, in places forming river cliffs in the glacial deposits of the valley sides (Plate 5); a good example [9710 4485] is to be seen to the west of Bank. Locally the valley floor is cut by the channels of abandoned meanders, some of which, such as the Crook [939 441], form ox-bow lakes.

Alluvium occurs at the surface throughout the block, except for a small outlier of fluvioglacial sand and gravel [922 436] to the north-east of Sandyford Bridge, and ranges in thickness from 2.0 m at boreholes 94 SW 10 and 94 SE 3 (both sites are near the edge of the alluvial flat) to 6.4 m at borehole 94 SE 6: thickness variation shows no discernible trend. Typically the alluvium, which was penetrated in all of the nine boreholes in the block, comprises an upper bed of silt or clay, averaging 1.5 m in thickness but ranging up to 2.5 m in borehole 94 SE 10. This overlies potentially workable sand and gravel averaging 3.0 m in thickness, although in boreholes 94 SE 3 and 15 the mineral occurs at surface. Potentially workable alluvium has a mean grading of 8 per cent fines, 46 per cent sand, 46 per cent gravel (gravel) (Tables 6 and 10b) and exhibits downstream fining: in boreholes 94 SE 6, 7, 10, 14 and 15, upstream of the Clyde-Medwin Water confluence, the deposit grades as gravel with a mean fines content of only 3 per cent, whereas downstream it becomes increasingly rich in sand and fines, grading as 'clayey' sandy gravel in borehole 94 SE 3, 'clayey' pebbly sand in borehole 94 SW 22, 'very clayey' pebbly sand in borehole 94 SW 17 and 'clayey' sand in borehole 94 SW 10, although the absence of any gravel

Table 10 Block C: data from assessment boreholes

Borehole	Recorded thickness			Mean grading percentage						
	Total mineral (m)	Depth of burial (m)	Intervening waste (m)	Fines $-\frac{1}{16}$ mm	Fine sand $+\frac{1}{16}-\frac{1}{4}$ mm	Medium sand $+\frac{1}{4}-1$ mm	Coarse sand +1–4 mm	Fine gravel +4–16 mm	Coarse gravel +16–64 mm	Cobbles and boulders +64 mm
a ALL DEPOSITS										
94 SW 10	8.8	0.2	10.3	6	59	35	0	0	0	0
94 SW 17	3.4	1.3	0.0	22	17	36	12	12	1	0
94 SW 22	9.0+	1.0	15.0	17	58	21	3	1	0	0
94 SE 3	2.0	0.3	0.0	16	16	24	9	23	12	0
94 SE 6	5.4	1.0	0.0	6	6	16	16	44	12	0
94 SE 7	3.5	1.3	0.0	2	2	10	16	45	25	0
94 SE 10	5.0	3.0	0.0	8	50	22	6	11	3	0
94 SE 14	3.0	2.3	0.0	3	3	11	12	34	37	0
94 SE 15	5.0	0.4	0.0	2	4	13	19	34	22	6
Mean	5.0	1.2	2.8	9	32	22	9	18	9	1
b ALLUVIUM										
94 SW 10	2.0	0.2	0.0	12	80	8	0	0	0	0
94 SW 17	3.4	1.3	0.0	22	17	36	12	12	1	0
94 SW 22	2.0	1.0	0.0	12	41	32	10	5	0	0
94 SE 3	2.0	0.3	0.0	16	16	24	9	23	12	0
94 SE 6	5.4	1.0	0.0	6	6	16	16	44	12	0
94 SE 7	3.5	1.3	0.0	2	2	10	16	45	25	0
94 SE 10	1.0	3.0	0.0	3	3	15	17	49	13	0
94 SE 14	3.0	2.3	0.0	3	3	11	12	34	37	0
94 SE 15	5.0	0.4	0.0	2	4	13	19	34	22	6
Mean	3.0	1.2	0.0	8	15	18	13	30	15	1

fraction at the last-named site is partly due to its position on the edge of the floodplain.

The glaciolacustrine sediments underlying the alluvium fill an overdeepened valley in the bedrock surface (Figure I): only borehole 94 SW 10 proved a base to these deposits, the other eight boreholes in the block being terminated at depths ranging from 20.7 m to 25.0 m. The glaciolacustrine deposits are principally non-mineral and, in contrast with the sedimentary sequence elsewhere in the assessment area, usually become coarser with depth, grading from clay into silt in boreholes 94 SE 3, 14, 15 and 94 SW 17; in borehole 94 SW 22, 'clayey' sand underlies clay and silty clay. These sequences, at the lowest observed altitudinal level within the glacial sediments, probably represent an increase in water depth prior to later infill by fluvial material seen at higher levels, or a retreating source. The more usual upwards coarsening sequence of clay through silt to sand is found in borehole 94 SE 10, near the confluence of the Medwin Water and Clyde.

Only 8 per cent of the total thickness of glaciolacustrine deposits penetrated classified as mineral and, of this, half is made up of the 7.0 m+ of 'clayey' sand found in borehole 94 SW 22, the remainder comprising 4.0 and 2.5 m of sand, in boreholes 94 SE 10 and 94 SW 10 respectively. Although no lateral correlation is possible, as the sedimentary sequences reflect local depositional conditions, the grading and percentage of total thickness of the potentially workable glaciolacustrine material proved in boreholes is likely to be representative of the block as a whole. On this basis the deposit has been included in the volumetric assessment of total mineral (Table 10a). At borehole 94 SW 10 the glaciolacustrine deposits are underlain by 4.3 m of fluvioglacial sand and gravel on 1.7 m+ of till: the fluvioglacial deposit grades as sand and has been included in the mean grading calculation. The high altitudinal level of the base of the lake deposits here is due to the position of the borehole on the margin of the overdeepened valley, transitional between the sedimentary sequences of blocks C and B.

Two volumetric statements are provided (Table 6): the estimate of all potentially workable material is 39 million m³ ± 40 per cent; potentially workable alluvium, the most significant component of the resource in block C, is estimated at 23 million m³ ± 40 per cent. The mean grading of the resource as a whole is 9 per cent fines, 63 per cent sand, 28 per cent gravel (sandy gravel) (Tables 6, 10a and Figure 11.)

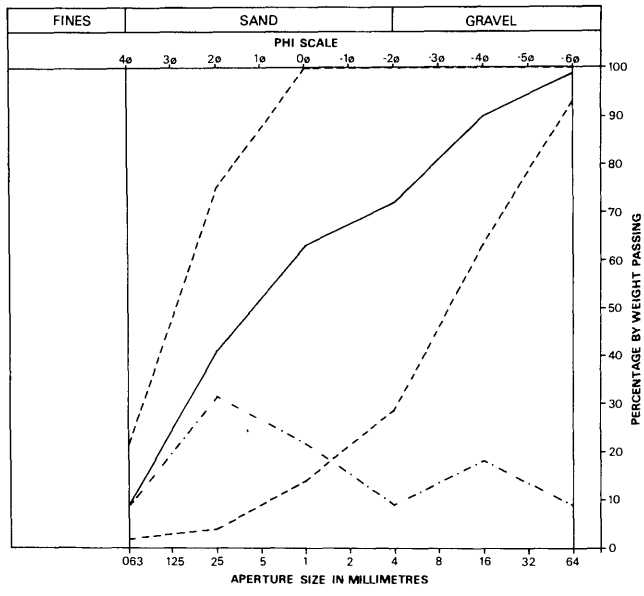

Figure 11 Grading characteristics of resources in block C (for explanation see Figure 9)

Block D

The block lies to the east of the valley of the Flush Burn and south-east of the moundy fluvioglacial sand and gravel associated with the Carstairs eskers (block E). The surface deposit is dominantly glaciolacustrine, the block boundary generally following the mapped extent of this deposit and being limited to the south by alluvium of the Clyde, to the north-west by fluvioglacial sand and gravel, and to the north-east and south-east by till or bedrock. The isolated patch of glaciolacustrine deposits [957 438] on the southern side of the Clyde to the north-east of Bagmoors is also included. From south of Carnwath Station to Carnwath Mill [9974 4544] the surface deposit is fluvioglacial sand and gravel, continuous with the moundy deposit to the south-east of the Carstairs eskers, but thinner, averaging 1.9 m in boreholes 94 NE 19 and 94 SE 5, where it overlies till, although at the latter site fluvioglacial sand and gravel was encountered again at depth. To separate these fluvioglacial sediments from the moundy deposits of block E, the block boundary has been drawn across the outcrop of fluvioglacial sand and gravel to the south of Carnwath Station on the basis of topography, and continued north-east over the peat of Carnwath Moss [973 480], which obscures the contact between the esker-associated deposits around Woodend Farm [9684 4866] and the thinner finer-grained sediments to the north of Carnwath.

The block comprises a generally flat terrace-like feature at about 210 m above Ordnance Datum that has been highly dissected by drainage channels, the most important being the valley of the Medwin Water. The river meanders across an alluvial flat, with old river channels and ox-bow lakes, that widens downstream from about 200 m to 400 m. There are two lesser valleys: that of Lampits Burn (renamed Carnwath Burn north of Carnwath), which flows south-west from west of Craigs Wood [985 478] towards Dean Wood [973 453], where it has cut down to bedrock; and the generally peat-filled depression between Oldmill Wood [936 454] and Carstairs Junction, through which the railway line runs. The ground is more hummocky south-west of Carnwath, the mote-capped hill [9747 4663] and Gallow Hill [971 463] probably being outliers of the moundy fluvioglacial deposits further to the west, whereas the hummocks west of Winterlaw Wood [969 458] are more likely to be due to the presence of bedrock near the surface.

Glaciolacustrine sediments have only been proved within the outcrop shown on the map, although in addition to the surface deposit they occur beneath till in borehole 94 NE 12, and beneath fluvioglacial sand and gravel in borehole 94 SW 19: glaciolacustrine sediments may also underlie fluvioglacial sand and gravel in borehole 94 SE 16, which was terminated at 25 m depth. The glaciolacustrine sediments, penetrated in fifteen boreholes, have a mean thickness of 8.7 m and range up to 21.5 m+ in borehole 94 SE 11. Only 29 per cent of the sequence drilled is potentially workable. Mineral, proved at eight of the sites, has a mean thickness of 4.8 m and the maximum value recorded is 10.0 m of 'clayey' sand proved in borehole 94 SE 2. The mineral normally grades as 'clayey' or 'very clayey' sand, although gravelly beds up to 1.3 m thick, usually resting on bedrock, are found in boreholes 94 NE 23, 94 SE 1 and 17. Between Oldmill Wood and Carnwath the glaciolacustrine deposits are dominantly clays and silts (boreholes 94 NW 9, 94 NE 5, 12, 13, 18 and 94 SW 21), and the only potentially workable sequence in this area is 3.2 m of 'very clayey' sand proved in borehole 94 NE 11. The upward coarsening, which generally characterises the glaciolacustrine and fluvioglacial deposits, is seen in boreholes 94 NE 17, 94 SE 11 and 12: at other sites the deposits are generally vertically homogeneous.

In contrast to the deposits of blocks A and B the glaciolacustrine sediments overlie fluvioglacial sand and gravel in all boreholes in which both deposits occur (94 NW 9, 94 SW 19, 21, and 94 SE 12) although in borehole 94 SE 12 they are separated by 1.4 m of till and in borehole 94 SW 19 the glaciolacustrine sediments recur at a lower level. The fluvioglacial deposits in boreholes 94 NW 9, 94 SW 19 and 21, all of which are situated in the south-west of the block, range from 3.0 m to 4.9 m in thickness and are closely similar to the sediments of block B.

Fluvioglacial sand and gravel was proved at the surface in boreholes 94 NE 19, 94 SE 5 and in six of a line of eight pits between Bank and Spittal (94 SE P2, P3, P5, P6, P7 and P9). Three pits in this traverse (94 SE P4, P6 and P8) proved bedrock within a metre of the surface and, considered with the outcrop of bedrock in Dean Wood and the sequence proved in borehole 94 NE 19, where 1.1 m of fluvioglacial sand and gravel overlies 3.4 m of till on bedrock, suggest that the fluvioglacial deposits form only a thin mantle on rock or till (Figure 1). Borehole 94 SE 5 is anomalous in that the normal sequence of fluvioglacial sand and gravel on till is repeated, a lower bed of 5.5 m of fluvioglacial sediments on 1.8 m of till occurring above bedrock. The greatest thickness of fluvioglacial deposits is found in borehole 94 SE 16 where 21.4 m+ (19.5 m+ is mineral) underlie alluvium. The nearest borehole downstream (94 SE 10) did not prove fluvioglacial material and although removal by subsequent erosion is possible, it is thought more likely that the deposit was derived from the east and is restricted to the valley of the Medwin. The depth of drift found at borehole 94 SE 16 shows the valley of the Medwin Water to be overdeepened like that of the Clyde. The drift thickness of 22.0 m+ proved in borehole 94 SE 11, on the high ground just to the south of the valley, contrasts with neighbouring boreholes 94 SE 12 and 17, where bedrock was reached at 7.0 m and 9.5 m respectively, suggesting that prior to emplacement of the glacial deposits the valley was a little wider than it is now (Figure 1). In all, six boreholes failed to reach bedrock

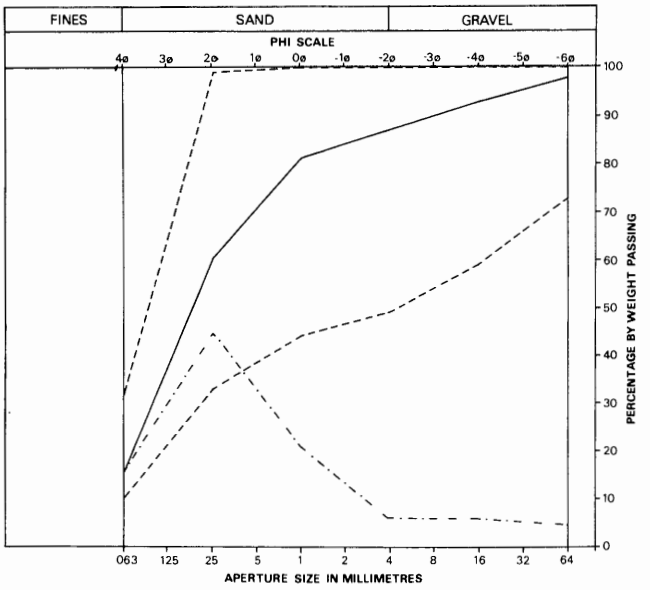

Figure 12 Grading characteristics of resources in block D (for explanation see Figure 9)

Table 11 Block D: data from assessment boreholes

Borehole	Recorded thickness			Mean grading percentage						
	Total mineral (m)	Depth of burial (m)	Intervening waste (m)	Fines $-\frac{1}{16}$ mm	Fine sand $+\frac{1}{16}$–$\frac{1}{4}$ mm	Medium sand $+\frac{1}{4}$–1 mm	Coarse sand +1–4 mm	Fine gravel +4–16 mm	Coarse gravel +16–64 mm	Cobbles and boulders +64 mm
a ALL DEPOSITS										
94 NW 9	3.0	4.0	0.0	13	30	21	7	8	7	14
94 NE 5	0.0	–	–	–	–	–	–	–	–	–
94 NE 11	3.2	0.3	1.0	31	34	34	1	0	0	0
94 NE 13	0.0	–	–	–	–	–	–	–	–	–
94 NE 17	7.6	0.4	0.0	29	62	9	0	0	0	0
94 NE 18	0.0	–	–	–	–	–	–	–	–	–
94 NE 19	1.1	0.5	0.0	31	39	19	4	5	2	0
94 NE 23	2.0	0.7	0.0	31	68	1	0	0	0	0
94 SW 19	10.0	2.7	1.0	17	45	14	6	9	9	0
94 SW 21	4.9	1.0	0.0	16	20	20	18	15	9	2
94 SE 1	4.2	0.4	1.0	22	47	26	2	1	1	1
94 SE 2	11.5	0.5	0.0	17	74	4	1	1	3	0
94 SE 5	10.2	0.5	2.0	10	45	14	7	9	11	4
94 SE 9	2.1	0.9	0.0	15	18	11	5	10	14	27
94 SE 11	3.0	0.5	1.0	18	74	7	1	0	0	0
94 SE 12	2.3	0.4	0.0	11	69	17	2	1	0	0
94 SE 16	22.5+	0.6	1.9	5	27	42	10	9	6	1
94 SE 17	0.0	–	–	–	–	–	–	–	–	–
Mean	4.9	1.0	0.6	15	45	21	6	6	5	2
b GLACIOLACUSTRINE DEPOSITS										
94 NW 9	0.0	–	–	–	–	–	–	–	–	–
94 NE 5	0.0	–	–	–	–	–	–	–	–	–
94 NE 11	3.2	0.3	1.0	31	34	34	1	0	0	0
94 NE 13	0.0	–	–	–	–	–	–	–	–	–
94 NE 17	7.6	0.4	0.0	29	62	9	0	0	0	0
94 NE 18	0.0	–	–	–	–	–	–	–	–	–
94 NE 23	2.0	0.7	0.0	31	68	1	0	0	0	0
94 SW 19	6.0	2.7	4.0†	23	60	13	2	2	0	0
94 SW 21	0.0	–	–	–	–	–	–	–	–	–
94 SE 1	4.2	0.4	1.0	22	47	26	2	1	1	1
94 SE 2	10.0	0.5	0.0	15	79	4	1	1	0	0
94 SE 11	3.0	0.5	1.0	18	74	7	1	0	0	0
94 SE 12	2.3	0.4	0.0	11	69	17	2	1	0	0
94 SE 17	0.0	–	–	–	–	–	–	–	–	–
Mean	2.7	0.7	0.5	22	64	12	1	1	0	0

† Includes 3.0 m of potentially workable fluvioglacial sand and gravel.

and, except for boreholes 94 SE 11 and 16, these were terminated in till and therefore probably close to the bedrock surface. Drift thickness decreases west of Carstairs Junction and towards the north-eastern and south-eastern margins of the block, beyond which till on bedrock occurs at the surface. In the first-mentioned area boreholes 94 NW 9 and 94 SE 1 proved solid at 7.8 m and 5.6 m depth respectively, and borehole 94 SW 21 was terminated in till at 6.5 m; farther south-west the drift thickens, 15.8 m being found at borehole 94 SW 19. Except for boreholes 94 NE 23 and 94 SE 1, at all sites where the full drift thickness was determined, till, averaging 3.2 m, rests on bedrock: in borehole 94 SE 12, 1.0 m of fluvioglacial sand and gravel intervenes between till and rock but the occurrence is thought to be localised. In boreholes 94 NE 12 and 94 SE 5, till, in addition to its usual basal position, was proved to occur at a higher level in the sequence. Generally till has in excess of 40 per cent fines but in boreholes 94 SE 2, 5 and 94 SW 19 the upper 1.5 m, 2.0 m and 1.0 m respectively grade as mineral, as does the basal 1.6 m in borehole 94 NE 5.

A terrace to the east of Carstairs Junction and the valley floor of the Medwin Water constitute two areas of alluvium within the block. The edge of the former deposit was investigated by borehole 94 NE 13, which showed alluvium to comprise 0.5 m of 'clayey' sand; in the latter area borehole 94 SE 16 demonstrates 0.3 m of silt on 3.0 m of gravel.

The bottom of the valley of the How Burn at Spittal is filled by an extremely ill-sorted 'clayey' boulder gravel (94 SE 9, P7) overlain, where seen in section [9871 4496], by a contorted band of sandy silt. Although mapped as fluvioglacial sand and gravel, the deposit is thought to have been formed by solifluction of till from the hill to the north. This contention is supported by the valley-fill nature of the deposit (it is absent in pit 94 SE P6 a little up the valley side); the contortions in the silt band which suggest slippage; a poorly defined scar

feature to the north, possibly representing the source of the slipped material; and the lobe, shown on the map as fluvioglacial sand and gravel, which extends from the How Burn valley into the Medwin Water valley.

Based on eighteen boreholes the volume of all potentially workable deposits in the block is 53 million m^3 ± 62 per cent (Table 6) with an overall mean grading of 15 per cent fines, 72 per cent sand, 13 per cent gravel ('clayey' pebbly sand) (Table 11a and Figure 12). Data from fourteen boreholes indicate that, although the most extensive deposit in the block, the potentially workable component of the glaciolacustrine sediments may be estimated at only 22 million m^3 ± 71 per cent (Table 6), the limits reflecting the extreme thickness variation shown by the deposit. The mean grading is 22 per cent fines, 77 per cent sand, 1 per cent gravel ('very clayey' sand) (Table 11b).

Block E

To the south-west of Carstairs the esker system, included in block F, is bounded to the north by till and to the south by generally flat-lying spreads of fluvioglacial sand and gravel. In contrast, farther north-east, the ridges are margined by moundy deposits interrupted by extensive peat bogs. The mounds, which comprise both fluvioglacial and glaciolacustrine deposits, rise to about 230 m above Ordnance Datum and are found in three principal areas: between Carstairs and Carnwath Station [9700 4694], in the neighbourhood of Ryeflat [9472 4753], and to the north-east of Woodend [9683 4868]. The mounds to the east of Carstairs are distinct from those of the other areas in that they are detached from the esker ridges, being separated by an area of low ground (Section 2). Peat forms the large Mosses of Carnwath, Woodend, Blackgate and Ryeflat and is underlain by sediments of similar composition to those of the moundy areas. In summary, block E includes all deposits occurring in close association with the ridges north-east of Carstairs, whether at surface or buried beneath peat.

To the north-west of the esker system, moundy deposits are only seen at the surface in the neighbourhood of Ryeflat and at the solitary mound on which borehole 94 NE 14 was sunk, the remainder of the area being covered by peat under which glaciolacustrine deposits were proved in boreholes 94 NE 1 and 7. Both the mounds and peat are bounded to the north-west by the alluvial plain of the Mouse Water, the recent river deposits overlying glaciolacustrine sediments in borehole 94 NW 11 and till in borehole 94 NW 10. On the basis of the presence of fluvioglacial or glaciolacustrine deposits in boreholes 94 NW 11, 94 NE 7 and 14, and their absence in boreholes 94 NW 10 and 94 NE 6, the north-western boundary of the block has been drawn generally along the Mouse Water, coinciding with the inferred limit of the extent of generally potentially workable deposits.

Although no boreholes were drilled on Carnwath Moss, as mounds of fluvioglacial or glaciolacustrine deposits occur immediately to the north and south-west of the Moss and similar sediments were proved beneath peat on the northern side of the ridges, it is considered likely that deposits of this type underlie its western part. The eastern margin of the moundy deposits is defined to the north of Carnwath Moss by the mapped geological line between glaciolacustrine deposits and till and to the south on the basis of topography, these boundaries being joined to form the block boundary which has been drawn arbitrarily across the Moss to delimit and separate the esker-associated sediments from the flat-lying glaciolacustrine deposits and till, which abut the peat to the east.

The block boundary in the south divides a generally moundy area from a terrace-like feature and coincides in part with the mapped contact of fluvioglacial and glaciolacustrine deposits: elsewhere it has been drawn across the outcrop of fluvioglacial sediments solely on topographical grounds.

Of the total drift thickness penetrated in the eleven assessment boreholes sunk in the block, 44 per cent is fluvioglacial sand and gravel, almost all of which is potentially workable. In contrast, 39 per cent of the total drift thickness proved by drilling is glaciolacustrine of which 80 per cent is mineral. Both types of deposit occur at the surface, the mounds east of Carstairs and those around Ryeflat being of fluvioglacial sand and gravel, those north-east of Woodend of glaciolacustrine sediments; similarly both deposits occur at depth with fluvial sediments in boreholes 94 NE 1 and 2 and lake material in boreholes 94 NW 11, 94 NE 1, 7 and 9. The deposits are the product of a single depositional environment. Fluvioglacial sand and gravel, of mean grading 10 per cent fines, 77 per cent sand, 13 per cent gravel ('clayey' pebbly sand) (Tables 6 and 12b), comprises the coarser-grained part of the sequence; the glaciolacustrine deposits grade principally as sands and 'clayey' sands and in borehole 94 NW 11 include clay or silt bands up to 4.0 m in thickness. Surface and borehole evidence shows grading to vary rapidly laterally and to exhibit a general fining towards the north-east, with glaciolacustrine deposits occurring at boreholes 94 NW 11, 13, 94 NE 1, 7, 9 and 15 and fluvioglacial sand and gravel at boreholes 94 NW 14, 94 NE 1, 2, 4, 10 and 14. The rapid compositional variation is further demonstrated by borehole 94 NW 11 which, although not proving mineral, has been included as a nil value in the volume calculation, as there is insufficient data to estimate the areal extent of the non-mineral component of the deposits.

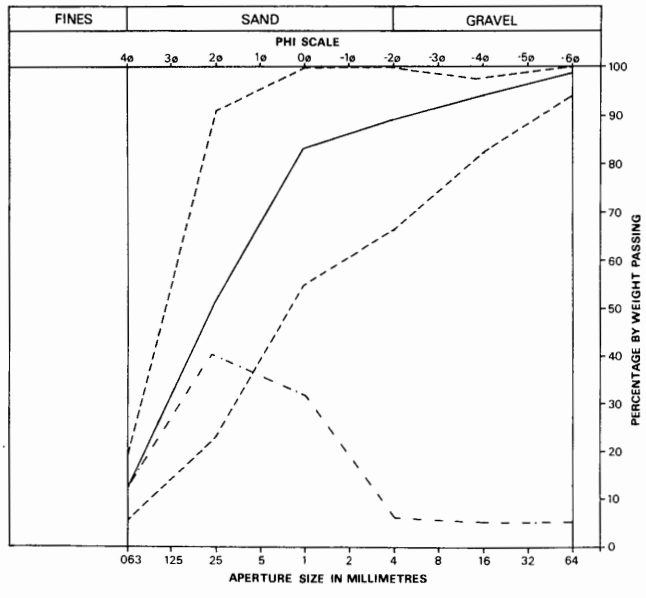

Figure 13 Grading characteristics of resources in block E (for explanation see Figure 9)

Table 12 Block E: data from assessment boreholes

Borehole	Recorded thickness			Mean grading percentage						
	Total mineral (m)	Depth of burial (m)	Intervening waste (m)	Fines $-\frac{1}{16}$ mm	Fine sand $+\frac{1}{16}$–$\frac{1}{4}$ mm	Medium sand $+\frac{1}{4}$–1 mm	Coarse sand +1–4 mm	Fine gravel +4–16 mm	Coarse gravel +16–64 mm	Cobbles and boulders +64
a ALL DEPOSITS										
94 NW 11	0.0	–	–	–	–	–	–	–	–	–
94 NW 13	4.4	0.4	2.4	15	27	28	6	6	13	5
94 NW 14	12.0	2.0	0.0	9	41	41	4	3	2	0
94 NE 1	20.5+	2.1	0.0	7	45	35	4	5	4	0
94 NE 2	15.0	1.0	0.0	5	18	32	11	18	15	1
94 NE 4	23.0	1.0	0.0	18	30	36	4	5	7	0
94 NE 7	16.0+	2.5	0.0	14	77	9	0	0	0	0
94 NE 9	14.0+	11.5	0.0	10	79	11	0	0	0	0
94 NE 10	24.5+	0.5	0.0	9	25	50	8	5	3	0
94 NE 14	24.9+	0.4	0.0	8	20	34	14	8	10	6
94 NE 15	17.4	1.0	2.3	14	51	34	1	0	0	0
Mean	15.6	2.0	0.4	11	40	32	6	5	5	1
b FLUVIOGLACIAL SAND AND GRAVEL										
94 NW 14	12.0	2.0	0.0	9	41	41	4	3	2	0
94 NE 1	5.6	17.0	0.0	5	26	29	10	18	12	0
94 NE 2	15.0	1.0	0.0	5	18	32	11	18	15	1
94 NE 4	23.0	1.0	0.0	18	30	36	4	5	7	0
94 NE 10	24.5	0.5	0.0	9	25	50	8	5	3	0
94 NE 14	15.2	0.4	9.7†	10	29	43	12	3	2	1
Mean	15.9	3.6	1.6	10	28	41	8	7	6	0

† Potentially workable glacial sand and gravel.

In spite of the lateral variability, the deposits are more vertically homogenous than fluvioglacial or glaciolacustrine sediments elsewhere in the resource sheet area; there is no evidence of a general upward coarsening nor, except in borehole 94 NE 1, do the two deposits occur in the same borehole.

Glacial sand and gravel was found at depth in boreholes 94 NW 11 and 94 NE 14. At the latter site 9.7 m (grading as gravel) occur within a fluvioglacial sequence; at the former 1.7 m of sandy gravel and 0.3 m of clay lie beneath alluvium and glaciolacustrine sediments, but are judged to be non-mineral owing to the overburden ratio. Borehole 94 NE 14 is approximately aligned with the northern part of the esker ridges and it is likely that glacial sand and gravel, thickening to the south, is present at depth between boreholes 94 NE 14 and 16, 12.0 m+ of the deposit being proved at the latter site.

Alluvium underlies the floodplain of the Mouse Water and boreholes 94 NW 10 and 11 show it to comprise clay and silt. On the basis of this evidence, the deposit is considered generally to be not potentially workable. In addition, in borehole 94 NE 7, 1.1 m of older alluvial silt were found beneath peat, being distinguished from the underlying glaciolacustrine sediments by a high content of plant detritus.

Boreholes 94 NW 14 and 94 NE 2 and 4 encountered till in the basal part of the drift sequence, bedrock being proved only at the second site. In boreholes 94 NE 2 and 4 till is clayey or silty with angular clasts, whereas borehole 94 NW 14 proved 0.8 m+ grading as 'clayey' sandy gravel, but the deposit probably becomes more clayey or silty at greater depth. Apart from borehole 94 NE 2, bedrock was encountered in boreholes 94 NW 11, 13 and 94 NE 15 and at none of these sites is it overlain by till.

The total volume of potentially workable sand and gravel is estimated at 140 million $m^3 \pm 36$ per cent (Table 6): the mean grading is 11 per cent fines, 78 per cent sand, 11 per cent gravel ('clayey' pebbly sand) (Tables 6, 12a and Figure 13). The estimate takes account of the worked ground of the Eastend and Carstairs Junction pits. Separate assessments are not provided for the potentially workable glaciolacustrine or fluvioglacial sediments, as the available information does not allow the areal extent of either deposit to be satisfactorily defined.

Block F

The block boundary corresponds with the mapped outcrop of glacial sand and gravel in all but the extreme north-east, where the boundary has been extended to include borehole 94 NE 16, in which 12.0 m+ of glacial sand and gravel were proved beneath 7.0 m of glaciolacustrine deposits. Mineral occurs at the surface throughout the block, with the exception of peat-filled hollows lying between the esker ridges of glacial sand and gravel which characterise the topography. Although no assessment boreholes were sited on peat the deposit is thought to be thin.

Glacial sand and gravel generally comprises an ill-sorted cobble gravel set in a 'clayey' sandy matrix: the mean grading for the block is 12 per cent fines, 41 per cent sand and 47 per cent gravel ('clayey'gravel) (Tables 6 and 13b). There is little variation from this mean over the block, the deposit by borehole being classified as 'clayey' gravel except in boreholes 94 NW 8 and 94 NE 16, where it grades as sandy gravel and 'clayey' sandy gravel respectively. These two boreholes are the nearest to the south-western and north-eastern ends respectively of the block, possibly indicating slight

Table 13 Block F: data from assessment boreholes

Borehole	Recorded thickness			Mean grading percentage						
	Total mineral (m)	Depth of burial (m)	Intervening waste (m)	Fines $-\frac{1}{16}$ mm	Fine sand $+\frac{1}{16}$–$\frac{1}{4}$ mm	Medium sand $+\frac{1}{4}$–1 mm	Coarse sand +1–4 mm	Fine gravel +4–16 mm	Coarse gravel +16–64 mm	Cobbles and boulders +64
a ALL DEPOSITS										
94 NW 7	13.6+	0.5	0.0	16	14	11	9	13	20	17
94 NW 8	16.4	0.4	0.0	11	25	26	7	12	14	5
94 NW 12	23.5	0.2	0.0	9	13	20	12	16	19	11
94 NE 3	22.5+	0.3	0.0	8	11	16	18	20	17	10
94 NE 8	23.0+	0.1	0.9	14	12	16	14	19	20	5
94 NE 16	19.0+	0.0	0.0	15	30	17	11	14	12	1
Mean	19.7	0.3	0.1	12	17	18	12	16	17	8
b GLACIAL SAND AND GRAVEL										
94 NW 7	13.6+	0.5	0.0	16	14	11	9	13	20	17
94 NW 8	8.4	0.4	0.0	7	24	21	8	14	18	8
94 SW 12	17.9	0.2	0.0	10	12	17	11	16	20	14
94 NE 3	9.4	0.3	0.0	11	11	13	11	15	22	17
94 NE 8	23.0+	0.1	0.9	14	12	16	14	19	20	5
94 NE 16	12.0+	7.0	0.0	12	10	18	18	22	19	1
Mean	14.1	1.4	0.1	12	13	16	12	17	20	10

fining of the deposit near the ridge termini. As this conclusion is based on only two sample points it should be treated cautiously, however, particularly as there is no apparent trend of lateral fining in the central part of the block. The thickness of the deposit is more variable, ranging from in excess of 23.9 m at borehole 94 NE 8, close to the highest point of the ridges, to 8.4 m at borehole 94 NW 8 near the south-western end of the block. No corresponding thinning was found at the north-eastern end, borehole 94 NE 16 proving a buried deposit in excess of 12.0 m.

The glacial sand and gravel exhibits a general vertical homogeneity in both boreholes and temporary sections; minor variations within the normal cobble gravel sequence only occur in boreholes 94 NE 8, which includes 0.9 m of sandy clay over 1.2 m of 'very clayey' pebbly sand, and 94 NW 8 and 12, which show 2.1 m of pebbly sand and 2.5 m of 'clayey' pebbly sand respectively. Such variations are local and in the absence of additional data cannot be traced laterally.

In the three boreholes, 94 NW 8, 12 and 94 NE 3, that prove the base of the glacial sand and gravel the immediately underlying deposit is fluvioglacial. The latter is thickest at borehole 94 NE 3 with 1.7 m of pebbly sand overlying 11.4 m+ of sandy gravel, similar in composition to the overlying glacial sand and gravel, but with a lower cobble and fines content. Boreholes 94 NW 8 and 12 proved 5.7 m of 'clayey' pebbly sand and 5.6 m of sandy gravel respectively, distinguished in both cases from the overlying glacial sand and gravel by the lower gravel content, particularly in the cobble size fraction: the fluvioglacial deposits in turn overlie till, the uppermost 2.3 m of which grades as 'clayey' sandy gravel in borehole 94 NW 8. It is likely that throughout the block glacial sand and gravel overlies fluvioglacial deposits on till. Lack of borehole evidence prevents the separate volumetric calculation of resources in the fluvioglacial deposits and till which, along with 7.0 m of glaciolacustrine sands overlying glacial sand and gravel in borehole 94 NE 16, are included in an overall assessment of potentially workable material (Table 6). The mean grading for the block as a whole is 12 per cent fines, 47 per cent sand, 41 per cent gravel ('clayey' sandy gravel) (Table 13a and Figure 14).

Quarrying continues at various places within a complex of pits between Newhouse and Gallow Hill [943 468], to the north of Carstairs (Plate 1): the extent of worked ground has been accounted for in the volumetric assessments of 44 million $m^3 \pm 23$ per cent for all potentially workable deposits in the block, and 32 million $m^3 \pm 43$ per cent for the glacial sand and gravel. The area of the ridge system designated a 'Site of Special Scientific Interest' (SSSI) by the Nature Conservancy has not been excluded from the assessment.

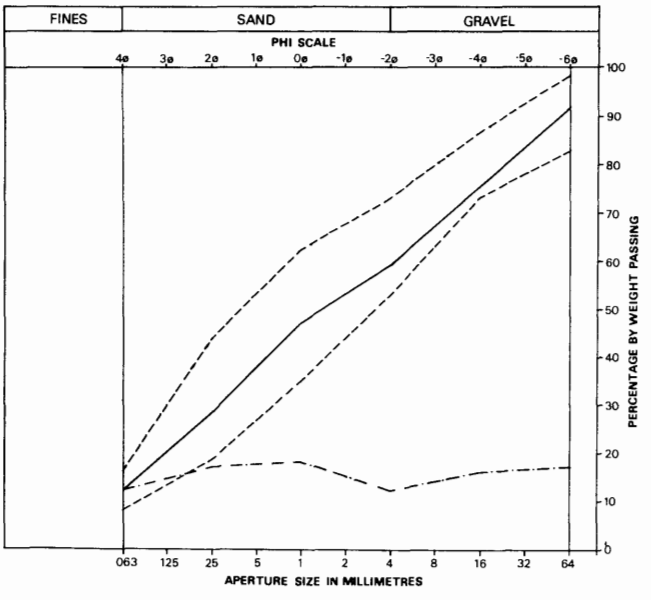

Figure 14 Grading characteristics of resources in block F (for explanation see Figure 9)

Table 14 Block G: data from assessment boreholes—all deposits

Borehole	Recorded thickness			Mean grading percentage						
	Total mineral (m)	Depth of burial (m)	Intervening waste (m)	Fines $-\frac{1}{16}$ mm	Fine sand $+\frac{1}{16}$–$\frac{1}{4}$ mm	Medium sand $+\frac{1}{4}$–1 mm	Coarse sand +1–4 mm	Fine gravel +4–16 mm	Coarse gravel +16–64 mm	Cobbles and boulders +64
Sub-block G_1										
84 SE 20	2.6	1.4	0.0	22	13	19	14	22	10	0
84 SE 21	0.0	–	–	–	–	–	–	–	–	–
84 SE 23	0.0	–	–	–	–	–	–	–	–	–
84 SE 25	0.0	–	–	–	–	–	–	–	–	–
84 SE 26	7.7	0.3	0.8	16	21	17	7	15	20	4
84 SE 27	2.0	1.0	0.0	20	19	13	7	16	25	0
94 NW 5	0.0	–	–	–	–	–	–	–	–	–
94 NW 10	0.0	–	–	–	–	–	–	–	–	–
94 NE 6	0.0	–	–	–	–	–	–	–	–	–
94 SW 8	0.0	–	–	–	–	–	–	–	–	–
Sub-block G_2										
94 NE 20	0.0	–	–	–	–	–	–	–	–	–
94 NE 21	0.0	–	–	–	–	–	–	–	–	–
94 NE 22	1.4	1.3	0.0	18	25	35	5	4	9	4
Sub-block G_3										
94 SE 13	18.8+	0.4	6.0	10	32	34	9	8	6	1
94 SE 18	4.0	0.4	0.0	21	16	11	10	18	19	5
Sub-block G_4										
94 SW 20	3.2	0.4	0.0	23	31	20	4	8	12	2
94 SE 4	3.7	2.3	0.0	20	19	21	11	15	14	0
94 SE 8	2.3	0.3	0.0	15	28	15	8	11	8	15

Block G

That part of the assessment area not included in blocks A to F has been designated block G, and divided into sub-blocks 1 to 4 on geographical grounds. The block comprises the higher ground surrounding the main areas of potentially workable material; till or bedrock is commonly found at the surface, the former locally grading as mineral, and, in addition, isolated patches of glacial or fluvioglacial sand and gravel occur. Geological mapping shows the sand and gravel deposits to be more limited in extent and much thinner than in other blocks. These findings were confirmed by boreholes (Table 14) drilled at scattered sites with a view both to providing data for inferred assessments and to locate any buried deposits. The patchy distribution of mineral, particularly potentially workable till, indicates that a level of sampling at least as detailed as in other blocks would be necessary to determine a representative mean thickness, grading and areal extent for statistical volumetric assessment. As the number of sample points is small these values have not been calculated but inferred assessments are presented where possible, though these should be treated with caution owing to the limited data on which they are based.

Sub-block G_1: The sub-block, lying west of block A and north-west of blocks B, E and F, comprises generally high ground dissected by the valleys of the Clyde, Mouse Water and the deep dry valley to the north of Nemphlar [8560 4477]. It includes the urban area of Lanark. Most of the ground is covered by till, through which bedrock frequently crops out: in the north-east, till, in turn, is overlain by peat of the Cranley [935 476], Shodshill [938 488] and Blacklaw Mosses [927 485]. Boreholes and pits have only been sunk in the eastern part of the sub-block, but general uniformity of topography and drift geology argues that the available data are representative of the whole.

Ten of the twelve boreholes and pits in the sub-block, the exceptions being boreholes 84 SE 26 and 94 NW 10, were sited on ground mapped as till; of these, boreholes 84 SE 21, 23, 25 and 94 SW 8, and pits 94 NW P1 and 94 SW P1, reached bedrock at depths ranging from 0.2 m to 1.2 m, resulting in modification of the geological lines on the map accompanying this report. Considered in conjunction with the numerous other outcrops of bedrock, this evidence suggests that much of the till cover is thin and patchy. Boreholes 94 NW 5, 10 and 94 NE 6, show till to be thickest in the north-east, where the least area of exposed bedrock has been recognised, but not to be potentially workable. The deposit is dominantly stiff and clayey with angular clasts, occurs beneath alluvium in borehole 94 NW 10 and ranges up to 9.6 m in borehole 94 NW 5.

Farther south, till thicknesses of 3.5 m, 3.0 m and 7.5 m were proved in boreholes 84 SE 20, 26 and 27 respectively, that in borehole 84 SE 26 occurring beneath glacial sand and gravel. Of the total till thickness proved by these three boreholes 62 per cent grades as potentially workable, grading principally as 'very clayey' sandy gravel; the remainder comprises sandy silty clays. In summary, the borehole evidence shows the potentially workable till to have a limited and uneven distribution but to be restricted to the southern part of the sub-block; a volumetric assessment is not given, as the area over which the deposit is potentially workable cannot be determined, but it is considered to be small.

A sinuous esker composed of glacial sand and gravel stretches from Drummonds Hill [8875 4041] to south-west of Corramore [8649 4043], a distance of about 3 km; near Linnhead Farm [8824 4040] 4.7 m of 'clayey' sandy gravel with cobbles, overlying 0.8 m of silt, was proved in borehole 84 SE 26. The material is similar to that found in the larger Carstairs esker ridges and is

likely to be representative of the Linnhead esker as a whole, although some lateral and longitudinal variation in both grade and thickness is to be expected. On the basis of the thickness of potentially workable glacial sand and gravel proved in borehole 84 SE 26 a volume of 0.8 million m^3 may be inferred for the deposit (Table 7). Patches of glacial sand and gravel occur to the south of Linnhead Farm and to the east of Overhall [8694 4207], and small areas of fluvioglacial sand and gravel are present to the south and west of Lanark. There is no borehole evidence of the thickness of these deposits, which is likely to be variable but generally thin; no assessment has been attempted.

Alluvium underlies the wide floodplain of the Mouse Water to the north-east of Cowford Bridge [9345 4677]; in the more narrow valley downstream it occurs only as isolated patches, as it does in the valleys of the Clyde and the numerous minor streams throughout the sub-block. Only in the floodplain of the Mouse Water, where up to 3.6 m of clay and silt were proved in boreholes 94 NW 10 and 11, is alluvium considered to be other than a thin cover, and nowhere is it regarded as potentially workable.

Sub-block G_2: The high ground to the north-east of block D, over which till or bedrock usually occurs at the surface, constitutes sub-block G_2. It contains the north-eastern part of Carnwath Moss [973 480], where peat is considered to overlie till, and the village of Carnwath. Till occupies the lower slopes of the hills, ranging up to 3.9 m in thickness at borehole 94 NE 20; bedrock crops out on the higher ground. At boreholes 94 NE 20 and 21, where bedrock is basalt, the till is clayey with angular clasts; in borehole 94 NE 22, where the deposit overlies Devono-Carboniferous red sandstone, the basal 1.4 m grades as 'clayey' pebbly sand and has a distinct red colour. Potentially workable till is thought to be mainly restricted to that area underlain by Devono-Carboniferous sandstone. It likely to be variable in thickness and patchily distributed, as evidenced by boreholes 94 NE 23, 94 SW 15, 94 SE 4, 8 and 17 outside the sub-block, which prove till on Devono-Carboniferous sandstone; for this reason no volumetric assessment of till is given. A small patch of sand and gravel of unknown thickness occurs at Kame-end [9970 4595].

Sub-block G_3: That part of the high ground in the south-eastern corner of the survey area, to the south of block D and east of the floodplain of the Clyde, is designated sub-block G_3. North-west of Libberton bedrock occurs at surface: most of the remaining area is covered by till, which was penetrated in boreholes 94 SE 13 and 18; the former proved 6.0 m of clayey till within a fluvioglacial sequence. The latter, sited on a small ridge of glacial sand and gravel, showed the underlying till to comprise 2.0 m of 'very clayey' sandy gravel over 3.1 m of clayey till with angular clasts. This evidence suggests the till is variable in grade and thickness, as in the other sub-blocks, and no assessment of it has been made.

The glacial sand and gravel forming the low ridge [9975 4332] to the north-east of Libberton was proved in borehole 94 SE 18 to comprise 2.0 m of 'clayey' gravel with cobbles. As the topography of the ridge varies along its length and as the borehole was sited at a point below the average height, the inferred volume of 0.2 million m^3 (Table 7) based on the proved thickness is likely to be an underestimate. Three small patches of glacial sand and gravel to the south have not been assessed.

Borehole 94 SE 13, sited on a mound bounded to the west by the valley of the Clyde, proved 4.0 m of fluvioglacial sand and gravel at surface and a further 14.8 m+ beneath 6.0 m of till; to the north and east of the borehole, pits 94 SE P14, P15, and P16 proved glaciolacustrine clays, suggesting fluvioglacial deposits only occupy the central part of the mound. Assuming a buried extent equivalent to that seen at surface, probably a slight underestimate, the fluvioglacial deposits have an inferred volume of 0.2 million m^3 (Table 7).

The alluvial deposits of the Craigie Burn and Quothquan Burn, although not investigated by boreholes, are considered to be thin and to have in excess of 40 per cent fines.

Sub-block G_4: The sub-block includes all the ground to the south of the valley of the Clyde from Prett's Mill [9018 4012] to Hillhead [9790 4048], except for the detached portions of blocks A and D, at Howford Farm [9130 4076] and to the north-east of Bagmoors [957 438] respectively. The ground rises steeply away from the valley to about 335 m above Ordnance Datum at Cairngryffe Hill [9427 4127], bedrock occurring at surface on the upper part of the hills and till covering most of the lower slopes.

Boreholes 94 SW 20, 94 SE 4 and 8 and pit 94 SE P1 prove till at the surface, ranging up to 5.7 m in thickness at borehole 94 SE 4. Of the total thickness penetrated in boreholes, 71 per cent is potentially workable, grading as 'clayey' or 'very clayey' sandy gravel: the maximum proved mineral thickness is 3.7 m at borehole 94 SE 4. Although pit 94 SE P1 showed till to be a stiff clay with clasts, the borehole evidence suggests that the greater part of the sub-block is underlain by mineral. Such a conclusion is considered erroneous, however, as the sample points are not uniformly distributed, being restricted to the topographically lower fringes of the area. Bedrock crops out extensively on the hilltops and patchily on the lower slopes where till thickness, although variable, is considered to be greatest. The till is generally of local provenance, the high sand content in the deposits investigated being derived from underlying Devono-Carboniferous sandstone, proved, for example, in boreholes 94 SE 4 and 8. Parts of the low ground in the north and south-east of the sub-block are underlain by basalt and Silurian sediments respectively, and the till thereabout is likely to have a much lower sand content. In summary, potentially workable till is considered to be generally restricted to that part of the periphery of the sub-block underlain by Devono-Carboniferous sandstone and, within this area, to be of patchy distribution and variable thickness. No volumetric assessment has been attempted, but the amount of potentially workable till is likely to be substantially less than that suggested by the borehole sequences. Alluvium occupies the floors of minor valleys but is considered too thin and 'clayey' to be potentially workable.

APPENDIX A

FIELD AND LABORATORY PROCEDURES

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

The mineral shown on each 1 : 25 000 sheet is divided into resource blocks. The arbitrary size selected, 10 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 laboratories of the Industrial Minerals Assessment Unit.

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.

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 $l_{m_1}, l_{m_2}, \ldots, l_{m_n}$, then the best estimate of mean thickness, $\bar{l}_m$, is given by

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

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

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

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

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

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

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

Block calculation 1:25 000 Block } Fictitious

Area
Block: 11.08 km²
Mineral: 8.32 km²

Mean thickness
Overburden: 2.5 m
Mineral: 6.5 m

Volume
Overburden: 21 million m³
Mineral: 54 million m³

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

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

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

Calculation of confidence limits

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

$\Sigma(wl_m - \overline{wl_m})^2 = 15.82$
$n = 8$
t = 2.365

L_V is calculated as

$$1.05(t/\overline{wl_m})\sqrt{[\Sigma(wl_m - \overline{wl_m})^2/n(n-1)]} \times 100$$
$$= 1.05 \times (2.365/6.5)\sqrt{[15.82/(8 \times 7)]} \times 100$$
$$= 20.3$$
$$\simeq 20 \text{ per cent}$$

Figure 15 Example of resource block assessment: calculation and results

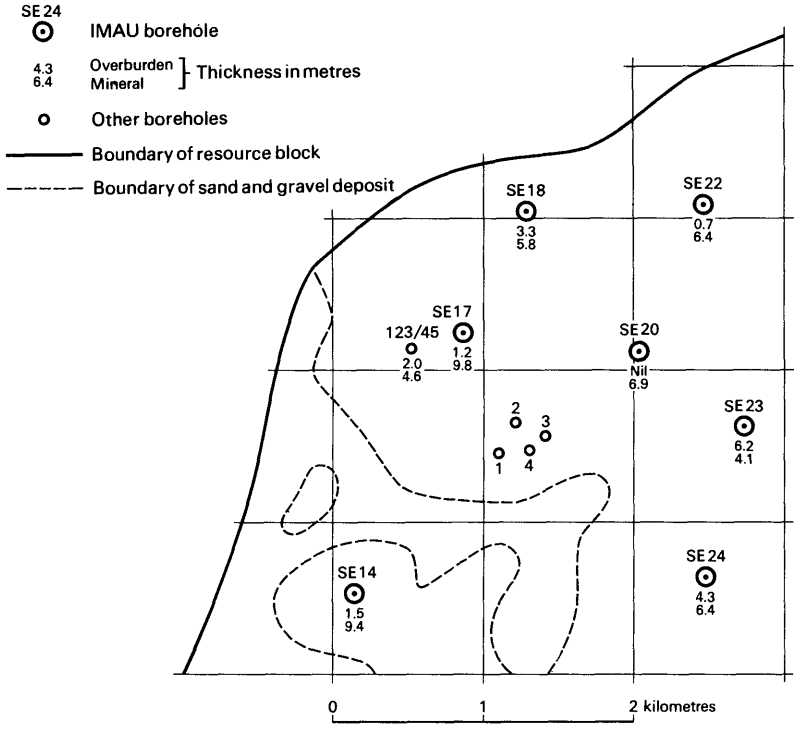

Figure 16 Example of resource block assessment: map of fictitious block

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

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

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

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

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

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

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

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

per cent.

11 The application of this procedure to a fictitious area is illustrated in Figures 15 and 16.

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 17). 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 11, 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 15), 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 D), the intercepts corresponding with the simple geometric scale $\frac{1}{16}$ mm, $\frac{1}{4}$ mm, 1 mm, 4 mm, 16 mm and so on as required. Original sample grading curves are available for reference at the appropriate office of the Institute.

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

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

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

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

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

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

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

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

Table 15 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

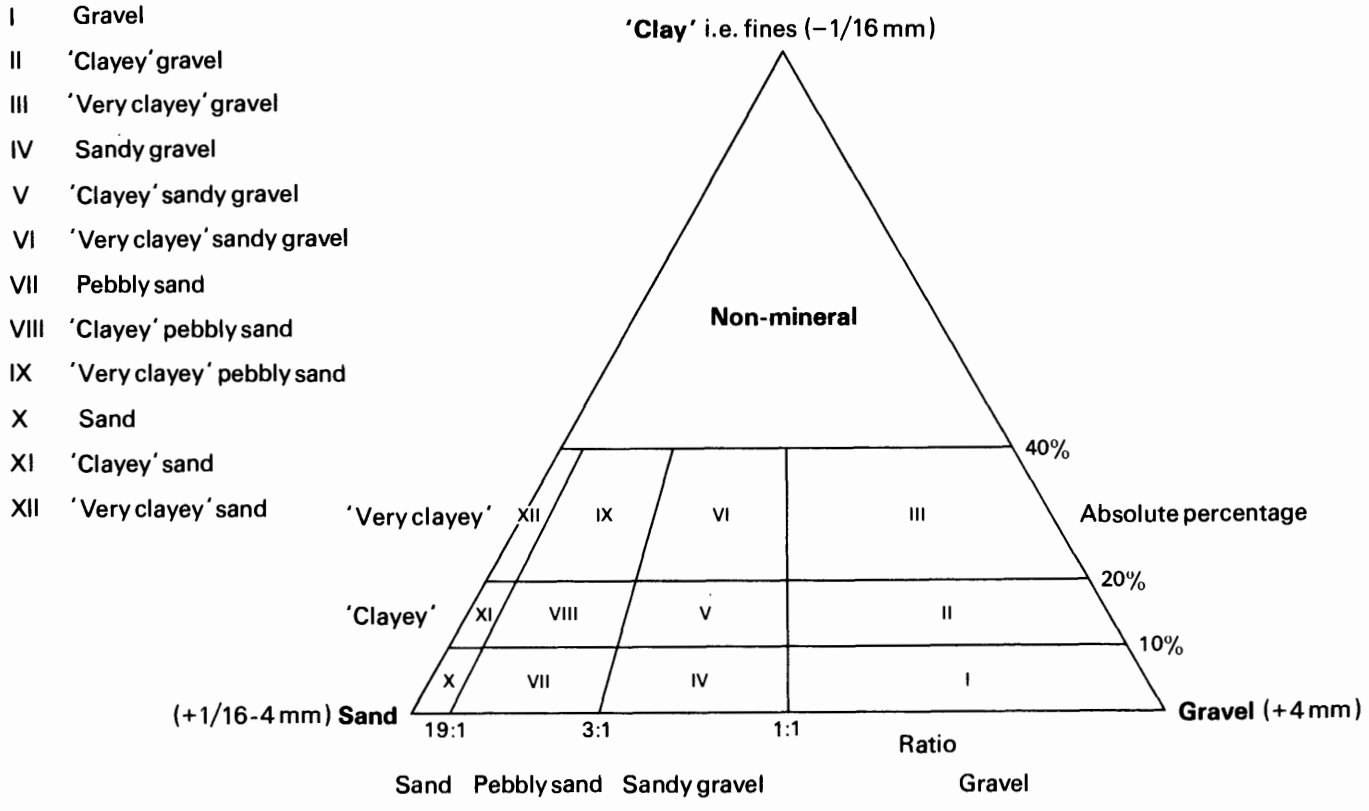

Figure 17 Diagram to show the descriptive categories used in the classification of sand and gravel

APPENDIX D

EXPLANATION OF THE BOREHOLE RECORDS

ANNOTATED EXAMPLE

NS 94 SW 15[1] **9121 4079**[2] **Howford Farm, Carmichael**[3] **Block A**

Surface level (+203.8 m)+669 ft[4]
Water struck at +201.7 m[5]
250 mm and 200 mm percussion[6]
June 1977

Overburden[7] 0.5 m
Mineral 5.8 m
Waste 11.9 m
Bedrock 1.2 m+[9]

LOG

Geological classification	Lithology	Thickness[8] m	Depth m
	Soil	0.5	0.5
Fluvioglacial sand and gravel[10]	**a** Pebbly sand[11] Gravel: fine and coarse, rare below 2.7 m, well rounded, felsite, quartz and sandstone Sand: medium with fine and a little coarse, subangular, quartz with rock fragments, coal-rich bands Fines: silt	3.6	4.1
Till	Clay, sandy, red-brown, with clasts up to boulder size of purple sandstone	0.3	4.4
	b Gravel, clay bound Gravel: coarse with fine and cobbles, subangular to well rounded, purple sandstone, dolerite, basalt, felsite and quartz Sand: fine with medium and coarse, subangular, quartz and rock fragments Fines: clay, red-brown, stiff, binding the sand and gravel fractions	1.9	6.3
	Clay, silty, stiff, red-brown with angular clasts, principally of red sandstone and felsite with (c) 'clayey' sandy gravel from 10.5 m to 11.5 m	11.9	18.2
Devono-Carboniferous	Sandstone, medium-grained, soft, buff	1.2+	19.4

GRADING

	Mean for deposit[15] *percentages*			Depth below surface (m)[12]	*percentages*[13]							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64	
a	10	84	6	0.5–1.5	14	24	43	7	6	6	0	
				1.5–2.7	10	18	50	12	7	3	0	†[14]
				2.7–4.1	6	52	39	3	0	0	0	†
				Mean	10	33	44	7	4	2	0	
b	10	38	53	4.4–5.2	14	27	14	7	14	13	11	†
				5.2–6.3	6	14	10	6	16	40	8	†
				Mean	10	19	11	7	15	29	9	
c	16	60	24	10.5–11.5	16	30	20	10	18	6	0	†*
a+b	10	68	22		10	28	33	7	7	12	3	

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

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

1 The number of the 1:25 000 sheet on which the borehole lies, for example NS 94.

2 The quarter of the 1:25 000 sheet on which the borehole lies and its number in a series for that quarter, for example SW 15.

Thus the full registration number is NS 94 SW 15. Usually this is abbreviated to 94 SW 15 in the text.

Shallow pits used in the assessment are numbered in a similar way but form part of a separate series: they are distinguished by the letter P placed before the serial number.

2 The National Grid reference
All National Grid references in this publication lie within the 100-km square NS. Grid references are given to eight figures, accurate to within 10 m for borehole locations. (In the text, six-figure grid references are used for more approximate locations, for example, for quarries.)

3 Location
The position of the borehole is referred to the nearest named locality on the 1:25 000 base map, usually followed by the name of the parish. The resource block in which it lies is also stated.

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

5 Groundwater conditions
If groundwater was present the level at which it was either encountered or statically measured is normally given (in metres above Ordnance Datum).

6 Type of drill and date of drilling
Modified shell and auger rigs were used in this survey. The drilling method, the external diameter of the casing used, and the month and year of completion of the borehole are stated.

7 Overburden, mineral, waste and bedrock
Mineral is sand and gravel which, as part of a deposit, falls within the arbitrary definition of potentially workable material (see p. 1). The summary of mineral thicknesses may include waste partings: the aggregated waste thickness is given in brackets and has been excluded in the assessment of resources. Consequently mineral thicknesses given in Tables 6 to 14 may not correspond precisely with the logs. Bedrock is the 'formation', 'country rock' or 'rock head' below which potentially workable sand and gravel will not be found. Waste is any material other than bedrock or mineral. Where waste occurs between the surface and mineral it is classified as overburden.

8 Thickness and depth
All measurements were made in metres.

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

10 Geological classification
The geological classification is given whenever possible.

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

12 Sampling
A continuous series of bulk samples is taken through the thickness of sand and gravel. A new sample is commenced whenever there is an appreciable lithological change within the sand and gravel or at every 1 m of depth.

13 Grading results
The results are expressed as per cent by weight retained on British Standard sieves whose aperture sizes are given in millimetres or fractions thereof.

14 Bailed samples
Fully representative sampling of sand and gravel is difficult to achieve, particularly where groundwater levels are high. Comparison between boreholes and adjacent exposures suggests that in borehole samples the proportion of sand may be higher and the proportions of fines and coarse gravel (+16 mm) may be lower. Samples obtained by the bailing technique (that is, from deposits below the water table) are indicated thus:†

15 Mean grading
The grading of the full thickness of the mineral deposit identified in the log is the mean of the individual sample gradings weighted by the thicknesses represented. The classification used is shown in Table 15. Where two or more distinct mineral units form continuous sequences, the mean gradings of these are also given under each unit.

Samples with less than 40 per cent by weight passing $\frac{1}{16}$ mm, but not considered in the calculation of mean grading, are indicated thus: *. These samples either are considered non-mineral owing to the amount of overburden or form small parts of sequences regarded as generally unworkable.

APPENDIX E

LIST OF BOREHOLES AND SHALLOW PITS USED IN THE ASSESSMENT OF RESOURCES

Borehole*	Grid reference
1 INDUSTRIAL MINERALS ASSESSMENT UNIT BOREHOLES	
NS 84 SE	
18	8722 4332
19	8749 4239
20	8753 4079
21	8707 4026
22	8878 4213
23	8804 4143
24	8877 4121
25	8892 4053
26	8823 4042
27	8918 4298
28	8923 4127
29	8947 4063
30	8970 4011
NS 94 NW	
4	9167 4521
5	9255 4631
6	9268 4558
7	9343 4665
8	9302 4588
9	9390 4546
10	9491 4895
11	9412 4765
12	9436 4693
13	9465 4677
14	9439 4587
NS 94 NE	
1	9577 4787
2	9527 4774
3	9559 4746
4	9531 4644
5	9535 4574
6	9615 4954
7	9650 4893
8	9662 4777
9	9652 4736
10	9617 4664
11	9661 4607
12	9669 4521
13	9609 4520
14	9744 4979
15	9796 4951
16	9723 4871
17	9785 4741
18	9725 4671

Borehole*	Grid reference
NS 94 NE	
19	9758 4572
20	9842 4866
21	9898 4617
22	9976 4584
23	9989 4508
NS 94 SW	
2	9007 4371
3	9068 4309
4	9062 4211
5	9024 4140
6	9063 4116
7	9021 4025
8	9133 4471
9	9113 4400
10	9197 4367
11	9197 4293
12	9108 4262
13	9181 4178
14	9105 4132
15	9121 4079
16	9276 4433
17	9285 4320
18	9255 4237
19	9373 4447
20	9363 4271
21	9461 4492
22	9452 4409
NS 94 SE	
1	9520 4467
2	9590 4403
3	9672 4473
4	9628 4352
5	9764 4490
6	9705 4411
7	9744 4337
8	9755 4198
9	9875 4492
10	9807 4432
11	9896 4429
12	9855 4349
13	9833 4221
14	9843 4153
15	9883 4055
16	9986 4487
17	9996 4435
18	9975 4332

Pit*	Grid reference
2 INDUSTRIAL MINERALS ASSESSMENT UNIT PITS (SHALLOW PITS DUG BY EXCAVATOR)	
NS 94 NW	
P1	9261 4767
P2	9343 4665
NS 94 SW	
P1	9042 4439
NS 94 SE	
P1	9599 4397
P2	9764 4490
P3	9791 4489
P4	9852 4499
P5	9843 4498
P6	9862 4497
P7	9871 4496
P8	9825 4495
P9	9805 4489
P10	9893 4392
P11	9886 4377
P12	9880 4354
P13	9866 4348
P14	9834 4229
P15	9847 4227
P16	9840 4223
P17	9908 4417
P18	9904 4406

*By sheet quadrant.

APPENDIX F

INDUSTRIAL MINERALS ASSESSMENT UNIT
BOREHOLE AND SHALLOW PIT RECORDS

NS 84 SE 18 **8722 4332** **Kirkfieldbank, Lesmahagow** **Block A**

Surface level (+127.7 m)+419 ft
Water struck at +114.7 m
250 mm percussion
July 1977

Overburden 0.6 m
Mineral 13.0 m
Waste 1.1 m
Bedrock 0.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.6	0.6
Fluvioglacial sand and gravel	'Clayey' sandy gravel Gravel: coarse and fine with some cobbles up to 17 cm diameter, angular to rounded, white sandstone with red sandstone, felsite and basalt Sand: fine to coarse, some coal Fines: clay	13.0	13.6
	Clay, mid-brown, sandy, a few pebble size clasts	1.1	14.7
Lower Old Red Sandstone	Sandstone, medium-grained, moderately well sorted, very indurated, purplish red	0.1+	14.8

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
Fines	Sand	Gravel		Fines	Sand			Gravel			
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$	
16	42	42	0.6–1.5	29	25	11	6	12	17	0	
			1.5–2.5	15	13	12	11	16	33	0	
			2.5–3.5	11	13	12	11	21	23	9	
			3.5–4.5	13	15	10	11	24	27	0	
			4.5–5.5	18	20	10	13	24	15	0	
			5.5–6.5	17	10	22	16	19	16	0	
			6.5–7.5	15	15	15	14	21	20	0	
			7.5–8.5	13	13	15	13	18	28	0	
			8.5–10.0	17	20	14	11	19	19	0	
			10.0–11.0	18	20	22	10	15	15	0	
			11.0–12.0	17	28	15	7	15	18	0	
			12.0–13.0	12	13	11	10	21	33	0	
			13.0–13.6	21	22	16	6	13	5	17	†
			Mean	16	17	14	11	19	21	2	

NS 84 SE 19 8749 4239 Byretown Farm, Lesmahagow **Block A**

Surface level (+185.6 m)+609 ft
Water struck at 183.5 m
250 mm and 200 mm percussion
July 1977

Overburden 0.3 m
Mineral 6.4 m
Waste 5.8 m
Mineral 2.0 m
Waste 10.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Fluvioglacial sand and gravel	**a** Sand Gravel: rare fine and coarse, felsite and red sandstone, angular to subangular Sand: fine and medium, quartz with feldspar, coal and basalt Fines: clay, grey, occurring in bands from 4.3 m to 5.3 m and near the base	6.4	6.7
Glaciolacustrine deposit	Clay, laminated, stiff, grey, rare brown sandy partings	2.3	9.0
Till	Clay, stiff, dark grey becoming brownish near base, ill-sorted angular clasts up to 28 cm diameter of red, green and white sandstones, quartz, basalt, felsite and andesite. Fewer clasts with depth	3.0	12.0
Glaciolacustrine deposit	Clay, silty, poorly laminated, mid-brown	0.5	12.5
	b 'Very clayey' sand Sand: fine with medium Fines: silt, brown, disseminated and in bands	2.0	14.5
	Silt, poorly laminated, brown, with more sandy or clayey horizons. Sand from 21.5 m to 22.0 m	8.5	23.0
	c 'Very clayey' sand Sand: fine with medium Fines: silt	1.5	24.5
	Silt, brown with reddish brown bands containing clasts	0.5+	25.0

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
a	2	96	2	0.3–1.3	2	50	45	2	1	0	0	
				1.3–2.1	3	51	45	1	0	0	0	
				2.1–3.3	2	47	51	0	0	0	0	†
				3.3–4.3	2	44	52	1	1	0	0	†
				4.3–5.3	1	39	47	5	2	6	0	†
				5.3–6.3	2	64	32	2	0	0	0	†
				6.3–6.7	2	61	34	2	1	0	0	†
				Mean	2	49	45	2	1	1	0	
b	27	72	1	12.5–13.5	37	55	6	1	1	0	0	†
				13.5–14.5	18	61	21	0	0	0	0	†
				Mean	27	58	14	0	1	0	0	
c	35	65	0	23.0–24.5	35	52	13	0	0	0	0	†*
a+b	8	91	1	Mean	8	52	37	2	1	0	0	

NS 84 SE 20 8753 4079 Parkhead, Lesmahagow **Block G_1**

Surface level (+199.2 m) +654 ft
Water not struck
250 mm percussion
June 1977

Overburden 1.4 m
Mineral 2.6 m
Bedrock 0.3 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Till	Silty clay, mottled, rare pebbles, sandy in parts	0.9	1.4
	'Very clayey' sandy gravel Gravel: fine to coarse, and cobbles up to 18 cm diameter, subrounded to rounded, reddish brown and yellowish white sandstones and coal Sand: coarse to fine, angular Fines: clay	2.6	4.0
Lower Old Red Sandstone	Sandstone, medium-grained, micaceous, reddish brown, indurated	0.3+	4.3

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64
22	46	32	1.4–2.4	21	15	20	9	19	16	0 *
			2.4–4.0	23	11	19	16	25	6	0 *
			Mean	22	13	19	14	22	10	0

NS 84 SE 21 8707 4026 Corramore, Lesmahagow **Block G_1**

Surface level (+206.8 m) +678 ft
Water not struck
250 mm percussion
June 1977

Waste 0.3 m
Bedrock 1.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Lower Old Red Sandstone	Sandstone, medium-grained, micaceous, bluish grey to reddish brown	1.0+	1.3

NS 84 SE 22 8878 4213 Robiesland Farm, Lanark **Block A**

Surface level (+195.3 m)+641 ft
Water not struck
250 mm and 200 mm percussion
June 1977

Overburden 1.6 m
Mineral 11.6 m+

LOG

Geological classification	Lithology	Thickness m	Depths m
	Soil, containing boulders up to 1.0 m diameter in the neighbourhood of the borehole site	0.6	0.6
Fluvioglacial sand and gravel	Clay, orange, faintly laminated, with disseminated fine quartz sand	1.0	1.6
	a 'Very clayey' pebbly sand Gravel: fine, coarse and cobbles with boulders, subrounded to well rounded, red sandstone with quartzite, basalt, felsite and conglomerate Sand: fine with medium, subangular, quartz with rock fragments Fines: clay, silty, orange-brown	4.0	5.6
	b 'Clayey' gravel Gravel: fine, coarse and cobbles, with boulders below 9.6 m, red sandstone with white sandstone, basalt, quartz, chert and coal Sand: fine to coarse, subangular, quartz with rock fragments Fines: clay, silty, orange-brown	7.6+	13.2
	Borehole terminated due to boulder obstruction		

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64
a	30	53	17	1.6–2.6	37	41	11	4	4	3	0
				2.6–3.6	36	43	15	2	2	2	0
				3.6–4.6	23	36	11	2	3	7	18
				4.6–5.6	26	28	6	12	14	14	0
				Mean	30	37	13	3	5	7	5
b	15	40	45	5.6–6.6	11	14	10	10	13	24	18
				6.6–7.6	13	15	11	8	12	31	10
				7.6–8.6	12	14	12	12	19	16	15
				8.6–9.6	21	19	12	11	20	17	0
				10.6–11.6	18	13	12	21	22	14	0
				11.6–13.2	18	13	11	17	25	16	0
				Mean	15	15	12	13	18	20	7
a+b	21	44	35	Mean	21	22	12	10	14	15	6

Surface level (+171.7 m)+563 ft
Water not struck
250 mm percussion
June 1977

Waste 0.7 m
Bedrock 0.8 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Fluvioglacial sand and gravel	'Clayey' pebbly sand Gravel: fine to coarse, rounded, red and white sandstones and felsite Sand: medium with coarse and fine Fines: silt	0.2	0.7
Lower Old Red Sandstone	Sandstone, medium-grained, micaceous, reddish brown	0.8+	1.5

NS 84 SE 24 8877 4121 Robiesland Farm, Lanark **Block A**

Surface level (+177.1 m)+581 ft
Water struck at +174.4 m
250 mm and 200 mm percussion
July 1977

Overburden 0.1 m
Mineral 11.3 m
(inc. 0.3 m waste)
Waste 3.6 m
Bedrock 0.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.1	0.1
Fluvioglacial sand and gravel	**a** 'Very clayey' gravel, sandy with silty clay band from 1.1 m to 1.4 m Gravel: coarse and fine with rare cobbles up to 10 cm, subangular to well rounded, red and yellow sandstones, basalt, quartz and felsite Sand: fine and medium with coarse, coal from 6.4 m Fines: silt, clayey to 1.1 m, mid-brown	8.3	8.4
Glaciolacustrine deposit	**b** 'Very clayey' sand Sand: fine, with coal Fines: silt, micaceous, grey, laminated bands from 10.4 m	3.0	11.4
	Silt, laminated, grey, with laminae of dark brown clay or fine sand. Basal angular gravel layer of red sandstone, felsite and quartzite	3.6	15.0
Lower Old Red Sandstone	Sandstone, purple-red	0.2+	15.2

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
a	21	51	28	0.1–1.1	23	27	25	8	11	6	0	
				1.1–1.4	Silty clay							
				1.4–2.4	31	34	11	5	8	11	0	
				2.4–3.4	23	24	15	5	10	23	0	†
				3.4–4.4	23	26	14	4	8	25	0	†
				4.4–5.4	23	18	16	6	15	12	10	†
				5.4–6.4	20	21	20	6	9	23	0	†
				6.4–7.4	22	23	17	8	16	14	0	†
				7.4–8.4	7	27	35	9	9	13	0	†
				Mean	21	25	19	7	11	16	1	
b	30	69	1	8.4–9.4	22	70	4	1	1	2	0	†
				9.4–10.4	31	65	3	1	0	0	0	†
				10.4–11.4	37	62	1	0	0	0	0	†
				Mean	30	65	3	1	0	1	0	
a+b	24	55	21	Mean	24	36	14	5	8	12	1	

NS 84 SE 25 8892 4053 Drummond's Hill, Lesmahagow **Block G_1**

Surface level (+175.6 m)+576 ft
Water not struck
250 mm percussion
June 1977

Waste 1.2 m
Bedrock 0.6 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Alluvium	Pebbly sand Gravel: coarse with fine, rare cobbles, rounded, red and white sandstones, basalt, andesite, felsite, quartzite and coal Sand: medium and fine with coarse, brown Fines: silt	0.7	1.2
Carboniferous (Calciferous Sandstone Measures)	Sandstone, medium-grained, micaceous, bluish grey	0.6+	1.8

NS 84 SE 26 8823 4042 **Linnhead Farm, Lesmahagow** **Block G_1**

Surface level (+199.7 m) + 655 ft
Water struck at +191.9 m
250 mm and 200 mm percussion
June 1977

Overburden 0.3 m
Mineral 4.7 m
Waste 0.8 m
Mineral 3.0 m
Bedrock 0.3 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Made ground	0.3	0.3
Glacial sand and gravel	**a** 'Clayey' sandy gravel Gravel: coarse to fine with cobbles up to 19 cm diameter, sub-rounded to well rounded, red and white sandstones with felsite, basalt, granite and coal Sand: medium and fine with coarse Fines: silt, clay with depth	4.7	5.0
	Silt, laminated, rare sand laminae, dark to mid-brown	0.8	5.8
Till	**b** 'Very clayey' sandy gravel Gravel: coarse to fine with cobbles up to 18 cm diameter, subrounded to well rounded, red sandstone with yellow sandstone, felsite and coal Sand: fine and medium with coarse Fines: silty clay	3.0	8.8
Lower Old Red Sandstone	Sandstone, medium-grained, micaceous, indurated, reddish brown	0.3+	9.1

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
a	11	46	43	0.3–1.3	7	23	28	9	12	21	0	
				1.3–2.3	7	20	21	7	14	31	0	
				2.3–3.3	10	20	19	7	20	24	0	
				3.3–4.5	16	22	15	6	13	28	0	
				4.5–5.0	15	11	9	7	12	23	23	
				Mean	11	20	19	7	15	26	2	
b	24	45	31	5.8–6.8	25	24	9	9	17	16	0	*
				6.8–7.8	23	22	20	5	12	5	13	*
				7.8–8.8	No data available							†*
				Mean	24	23	15	7	14	10	7	
a+b	16	45	39	Mean	16	21	17	7	15	20	4	

NS 84 SE 27 8918 4298 Kingson's Knowe, Lanark **Block G_1**

Surface level (+207.9 m)+682 ft
Water not struck
250 mm percussion
July 1977

Overburden 1.0 m
Mineral 2.0 m
Waste 5.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Made ground	0.5	0.5
Till	Clay, sandy, grey-brown, rare clasts	0.5	1.0
	a 'Clayey' gravel Gravel: coarse with fine and rare cobbles up to 20 cm diameter, subrounded to subangular, red and white sandstones, felsite and psammite Sand: fine and medium with coarse, subrounded to angular, quartz with feldspar and red sandstone Fines: clay	2.0	3.0
	Clay, sandy, red to 4.0 m, grey to 6.0 m and brown near base. Very stiff from 4.0 m. Rare clasts up to 14 cm diameter of green, white and red sandstones and felsite occur below 4.0 m	3.9	6.9
	b 'Very clayey' sandy gravel. Driving red sandstone boulder from 7.5 m to 8.0 m Gravel: fine and coarse with rare cobbles, red, white and green sandstones and felsite Sand: fine and medium with coarse, subrounded to angular, quartz Fines: clay	1.1+	8.0
	Borehole terminated due to boulder obstruction		

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
a	20	39	41	1.0–2.0	27	26	15	6	10	16	0	
				2.0–3.0	13	13	11	7	21	35	0	
				Mean	20	19	13	7	16	25	0	
b	28	46	26	6.9–7.5	28	23	17	6	14	12	0	*

Surface level (+183.5 m) +602 ft
Water struck at +164.1 m
250 mm and 200 mm percussion
July 1977

Overburden 0.6 m
Mineral 24.9 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.6	0.6
Fluvioglacial sand and gravel	**a** Gravel Gravel: fine and coarse with rare cobbles, subrounded to well rounded, purple and white sandstones, quartzite and felsite with basalt, quartz and coal Sand: fine to coarse, subangular, quartz and rock fragments Fines: clay, orange	5.0	5.6
	b 'Very clayey' sandy gravel Gravel: fine and coarse with rare cobbles, well rounded, sandstone, felsite and basalt Sand: fine with medium and coarse, quartz with rock fragments Fines: clay, yellow	1.0	6.6
	c Sandy gravel Gravel: fine and coarse with rare cobbles up to 18 cm diameter, well rounded, sandstone, basalt, felsite, and quartz, with coal Sand: medium with fine and coarse, subrounded Fines: silt, brown	6.0	12.6
	d 'Clayey' pebbly sand Gravel: fine with coarse, rounded to well rounded, sandstone, basalt, felsite and coal Sand: fine and medium with coarse Fines: silt, brown, disseminated and, above 13.6 m, in bands with coal fragments	2.0	14.6
	e Gravel Gravel: fine with coarse and rare cobbles up to 17 cm diameter, well rounded, red and yellow sandstones, basalt, quartz and felsite with gneiss. Coal above 19.6 m Sand: medium and coarse with fine, subrounded, grey-brown Fines: silt	10.9+	25.5

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
a	7	45	48	0.6–1.6	5	12	18	13	23	20	9	
				1.6–2.6	8	9	21	20	30	12	0	
				2.6–3.6	7	12	17	14	26	24	0	
				3.6–4.6	7	9	16	15	27	26	0	
				4.6–5.6	9	15	19	14	29	14	0	
				Mean	7	11	18	16	27	19	2	
b	23	51	26	5.6–6.6	23	29	13	9	14	12	0	
c	10	49	41	6.6–7.6	14	14	14	10	14	34	0	
				7.6–8.6	10	10	17	15	24	24	0	
				8.6–9.6	8	19	38	8	15	12	0	
				9.6–10.6	9	9	34	16	24	8	0	
				10.6–11.6	9	10	22	10	25	24	0	
				11.6–12.6	8	11	19	20	27	15	0	
				Mean	10	12	24	13	22	19	0	
d	11	70	19	12.6–13.6	10	38	23	9	13	7	0	
				13.6–14.6	11	28	32	9	12	8	0	
				Mean	11	33	28	9	12	7	0	
e	5	46	49	14.6–15.6	7	11	28	11	29	14	0	
				15.6–16.6	8	13	25	11	24	19	0	
				16.6–17.6	12	11	18	12	22	25	0	
				17.6–18.6	8	8	28	8	26	22	0	
				18.6–19.6	8	10	19	12	20	31	0	†
				19.6–20.6	3	10	22	17	33	15	0	†
				20.6–21.6	3	7	24	18	34	14	0	†
				21.6–22.6	4	5	24	28	30	9	0	†
				22.6–23.6	2	5	24	19	27	23	0	†
				23.6–24.6	2	3	16	16	29	18	16	†
				24.6–25.5	1	4	21	21	28	25	0	†
				Mean	5	8	22	16	27	20	2	
a–e	8	49	43	Mean	8	13	22	14	24	18	1	

NS 84 SE 29 8947 4063 Tulliford, Lanark **Block A**

Surface level (+204.2 m) +670 ft
Water not struck
250 mm and 200 mm percussion
July 1977

Overburden 0.5 m
Mineral 24.7 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Fluvioglacial sand and gravel	**a** Sandy gravel Gravel: coarse and fine with cobbles up to 10 cm diameter, angular to subangular becoming more rounded below 1.5 m, red sandstone, quartz, basalt and felsite Sand: medium with fine and coarse, angular, quartz, becomes coarser with red sandstone, felsite and basalt below 1.5 m Fines: silt, brown, disseminated, laminated bands near 3.5 m	3.0	3.5
	b Sand Sand: fine and medium, angular to subangular, quartz with felsite, basalt, red sandstone and some coal Fines: silt, medium brown, as bands from 18.0 to 18.5 m	17.7	21.2
	c 'Clayey' sand Gravel: concentrated near the base, coarse, subrounded to angular, red sandstone, with quartz and green sandstone Sand: fine with medium Fines: silt	4.0+	25.2

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64
a	7	59	34	0.5–1.5	5	20	36	8	10	21	0
				1.5–2.5	3	8	35	12	16	13	13
				2.5–3.5	14	16	30	10	17	13	0
				Mean	7	15	34	10	14	16	4
b	3	97	0	3.5–4.5	3	48	46	3	0	0	0
				4.5–5.5	2	40	57	1	0	0	0
				5.5–6.5	2	40	55	2	1	0	0
				6.5–7.5	2	41	52	4	1	0	0
				7.5–8.5	2	51	46	1	0	0	0
				8.5–9.5	1	40	58	1	0	0	0
				9.5–10.5	2	50	46	2	0	0	0
				10.5–11.5	4	68	28	0	0	0	0
				11.5–12.4	3	60	37	0	0	0	0
				12.4–13.7	3	61	33	2	1	0	0
				13.7–14.5	3	57	37	2	1	0	0
				14.5–15.5	2	50	46	2	0	0	0
				15.5–16.5	3	48	49	0	0	0	0
				16.5–17.5	3	38	58	1	0	0	0
				17.5–18.5	4	52	44	0	0	0	0
				18.5–19.4	4	54	41	1	0	0	0
				19.4–20.6	3	56	40	1	0	0	0
				20.6–21.2	3	67	29	1	0	0	0
				Mean	3	51	45	1	0	0	0
c	14	83	3	21.2–23.0	12	70	18	0	0	0	0
				23.0–23.9	18	67	15	0	0	0	0
				23.9–25.2	13	61	17	1	1	7	0
				Mean	14	66	17	0	1	2	0
a–c	5	90	5	Mean	5	49	39	2	2	2	1

NS 84 SE 30 8970 4011 Boathaugh, Lanark **Block A**

Surface level (+191.5 m) +628 ft
Water not struck
250 mm percussion
March 1978

Overburden 2.5 m
Mineral 2.5 m
Bedrock 1.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Glaciolacustrine deposit	Silt, light brown, sandy, with subrounded clasts up to 5 cm diameter of yellow sandstone and weathered basalt	2.2	2.5
	'Clayey' sand Gravel: fine, only from 4.5 m Sand: fine, with a little medium principally from 4.5 m, subrounded, quartz Fines: silt, yellow-brown, disseminated and in bands	2.5	5.0
Lower Old Red Sandstone	Sandstone, fine, micaceous, indurated, red-brown	1.0+	6.0

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
19	80	1	2.5–3.5	17	80	3	0	0	0	0
			3.5–4.5	19	76	5	0	0	0	0
			4.5–5.0	23	44	22	4	7	0	0
			Mean	19	72	7	1	1	0	0

NS 94 NW 4 9167 4521 Silvermuir Farm, Carstairs **Block B**

Surface level (+211.2 m) +693 ft
Water not struck
250 mm and 200 mm percussion
May 1977

Overburden 0.4 m
Mineral 3.2 m
Waste 2.9 m
Bedrock 1.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Fluvioglacial sand and gravel	**a** 'Clayey' sandy gravel Gravel: fine and coarse with cobbles, angular to well rounded, purple sandstone with undifferentiated igneous rocks Sand: fine with medium and coarse, quartz and rock fragments Fines: silt with clay, brown	2.2	2.6
	b 'Clayey' pebbly sand Gravel: fine and coarse, subrounded to rounded, purple sandstone Sand: fine and medium with coarse, quartz and rock fragments Fines: silt	1.0	3.6
	Silt, sandy in upper part, laminated, carbonaceous laminae, brown to 4.7 m and grey below	1.9	5.5
Till	Clay, reddish grey, clasts, fine to medium, greenish grey and reddish sandstones	1.0	6.5
Carboniferous (Calciferous Sandstone Measures)	Sandstone, indurated, fine-grained, silty in part, variegated	1.5+	8.0

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64
a	17	45	38	0.4–1.4	19	23	14	7	13	18	6
				1.4–2.6	16	20	17	8	17	17	5
				Mean	17	21	16	8	15	17	6
b	16	74	10	2.6–3.6	16	38	32	4	5	5	0
a+b	17	54	29	Mean	17	26	21	6	12	14	4

NS 94 NW 5 9255 4631 Windyshields, Carstairs **Block G_1**

Surface level (+228.7 m) +750 ft
Water struck at +223.0 m
250 mm and 200 mm percussion
May 1977

Waste 10.0 m
Bedrock 1.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Till	Sandy silt, light brown with clasts of ill-sorted green sandstone	1.1	1.5
	Clay, very stiff, reddish brown becoming greenish grey below 7.0 m, with clasts up to 27 cm diameter of green sandstone with red sandstone and felsite, and mudstone below 7.0 m	8.5	10.0
Carboniferous (Calciferous Sandstone Measures)	Mudstone, silty, sandy in part, laminated, mid-grey with plant fragments	1.0+	11.0

NS 94 NW 6 9268 4558 Newhouse Farm, Carstairs **Block B**

Surface level (+202.5 m) +664 ft
Water not struck
250 mm and 200 mm percussion
May 1977

Overburden 0.4 m
Mineral 5.6 m
Bedrock 2.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Fluvioglacial sand and gravel	**a** 'Very clayey' sand Sand: fine with medium, quartz Fines: silt, reddish brown	1.1	1.5
	b 'Very clayey' sandy gravel Gravel: fine with coarse, rounded to well rounded, purple sandstone, quartz, felsite, undifferentiated igneous rocks Sand: fine with medium and coarse, angular to well rounded, mineral and rock fragments Fines: silt, brown, increasing with lenses below 4.5 m	4.5	6.0
Carboniferous (Calciferous Sandstone Measures)	Alternating grey-green sandstone and greenish grey siltstone	2.1+	8.1

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64
a	36	64	0	0.4–1.5	36	56	7	1	0	0	0
b	22	57	21	1.5–2.5	17	42	21	8	6	6	0
				2.5–3.5	14	30	17	7	16	12	4
				3.5–4.5	30	32	23	5	6	4	0
				4.5–6.0	26	27	13	7	15	12	0
				Mean	22	32	18	7	11	9	1
a+b	25	58	17	Mean	25	37	16	5	9	7	1

NS 94 NW 7 9343 4665 **Cowford Bridge, Carstairs** **Block F**

Surface level (+216.9 m) +712 ft
Water struck at +205.5 m
250 mm and 200 mm percussion
May 1977

Overburden 0.5 m
Mineral 13.6 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Glacial sand and gravel	'Clayey' gravel Gravel: fine, coarse, and cobbles with boulders up to 30 cm diameter, subangular to well rounded, red, green and grey sandstones with felsite and undifferentiated igneous rocks, shale, conglomerate and quartz Sand: fine with medium and coarse, subangular, quartz and rock fragments Fines: clay, red	13.6+	14.1
	Borehole terminated due to boulder obstruction		

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
Fines	Sand	Gravel		Fines	Sand			Gravel			
				$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
16	34	50	0.5–1.5	18	11	10	14	18	10	19	
			1.5–2.4	19	15	14	10	14	28	0	
			2.4–3.4	11	8	9	13	28	20	11	
			3.4–4.5	24	8	10	10	18	30	0	
			4.5–5.5	10	12	10	8	16	20	24	
			5.5–6.5	10	8	10	9	11	20	32	
			6.5–7.5	12	8	8	6	10	17	39	
			7.5–8.4	13	11	15	11	21	29	0	
			8.4–9.4	16	24	7	5	9	18	21	
			9.4–10.7	18	25	9	5	8	12	23	
			10.7–11.6	14	14	11	6	9	16	30	†
			11.6–12.6	19	18	15	9	8	15	16	†
			12.6–13.6	26	21	14	9	8	15	7	†
			13.6–14.1	12	10	11	10	4	38	15	†
			Mean	16	14	11	9	13	20	17	

NS 94 NW 8 9302 4588 White Loch, Carstairs **Block F**

Surface level (+218.2 m) +716 ft
Water struck at +203.7 m
250 mm and 200 mm percussion
May 1977

Overburden 0.4 m
Mineral 16.4 m
Waste 4.2 m
Bedrock 0.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Glacial sand and gravel	**a** Pebbly sand Gravel: fine with coarse, subrounded, basalt, felsite, quartzite and red sandstone Sand: fine with medium, angular to subangular, quartz with mica and coal Fines: clay and silt	2.1	2.5
	b Gravel Gravel: coarse with fine, cobbles, and boulders up to 26 cm diameter, angular to subrounded, basalt, felsite, quartzite, quartz, schist, red and green sandstones Sand: medium with fine and coarse, angular to subangular, quartz with rock fragments Fines: clay and silt, locally in bands, brown, orange in places	6.3	8.8
Fluvioglacial sand and gravel	**c** 'Clayey' pebbly sand Gravel: fine with coarse, rare cobbles and boulders, subrounded to subangular, red and green sandstones, felsite and basalt Sand: medium and fine with coarse, angular to subangular, quartz, felsite and basalt. Below 13.5 m some derived from break up of green sandstone boulder Fines: clay and silt	5.7	14.5
Till	**d** 'Clayey' sandy gravel Gravel: coarse and fine, with cobbles up to 14 cm diameter, angular to subangular, green sandstone Sand: fine with medium and coarse Fines: clay, brown	2.3	16.8
	Clay, grey becoming brown and softer with depth, clasts up to cobble size of green and grey sandstones with felsite, trachyte, basalt, slate and limestone, with much green and brown mottled mudstone below 19.5 m	4.2	21.0
Carboniferous (Calciferous Sandstone Measures)	Sandstone, fine-grained, indurated, light grey	0.2+	21.2

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
a	4	90	6	0.4–1.5	4	57	28	2	6	3	0	
				1.5–2.5	5	54	40	0	1	0	0	
				Mean	4	55	34	1	4	2	0	
b	7	41	52	2.5–3.5	6	24	17	10	16	27	0	
				3.5–4.5	6	13	12	10	21	29	9	
				4.5–5.5	6	13	27	13	16	21	4	
				5.5–6.5	7	12	17	9	18	26	11	
				6.5–7.6	10	11	14	7	16	24	18	
				7.6–8.8	8	10	14	13	15	18	22	
				Mean	7	14	17	10	17	24	11	
c	14	69	17	8.8–9.5	15	13	27	11	17	17	0	
				9.5–10.6	15	15	52	7	7	4	0	
				10.6–11.7	14	22	35	7	10	7	5	
				11.7–12.5	11	15	26	14	19	15	0	
				12.5–13.5	15	26	49	4	4	2	0	
				13.5–14.5	15	44	37	2	2	0	0	
				Mean	14	23	39	7	9	7	1	
d	20	55	25	14.5–15.5	18	35	13	7	11	16	0	†
				15.5–16.8	21	36	12	7	11	13	0	†
				Mean	20	36	12	7	11	14	0	
a–d	11	58	31	Mean	11	25	26	7	12	14	5	
a+b	7	53	40	Mean	7	24	21	8	14	18	8	

NS 94 NW 9 9390 4546 Oldmill, Carstairs **Block D**

Surface level (+198.7 m) +652 ft
Water struck at +196.2 m
250 mm percussion
May 1977

Overburden 4.9 m
Mineral 3.0 m
Waste 0.8 m
Bedrock 0.3 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	1.0	1.0
Glaciolacustrine deposit	Silt, sandy, grey-brown, angular to subrounded yellow sandstone clasts up to 17 cm diameter with, below 2.5 m, thin bands of clean sand and grey clay	3.0	4.0
Fluvioglacial sand and gravel	'Clayey' sandy gravel Gravel: fine, coarse and cobbles up to 28 cm diameter, subrounded to angular, green, yellow, red and white sandstones, basalt, felsite and volcanic glass Sand: fine and medium with coarse, subrounded to subangular, quartz with felsite and shale Fines: silt and grey clay	3.0	7.0
Till	Clay, stiff, reddish brown, becomes sandy near base, angular to subrounded clasts up to 11 cm of green and red sandstones and quartzite	0.8	7.8
Carboniferous (Calciferous Sandstone Measures)	Sandstone, coarse-grained, ill-sorted, green, friable	0.3+	8.1

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
Fines	Sand	Gravel		Fines	Sand			Gravel			
				$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
13	58	29	4.0–5.5	20	31	18	5	6	7	13	†
			5.5–6.5	6	30	27	9	13	7	8	†
			6.5–7.0	6	29	20	6	6	5	28	†
			Mean	13	30	21	7	8	7	14	

NS 94 NW 10 9491 4895 Boghall Farm, Carnwath **Block G_1**

Surface level (+209.1 m) +686 ft
Water struck at +206.6 m
250 mm percussion
February 1977

Waste 11.4 m
Bedrock 0.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Alluvium	Clay, very stiff, laminated, grey, brown mottling in upper part	3.6	3.8
Till	Clay, very stiff, grey-brown with, above 8.5 m, clasts of basalt and green sandstone with quartzite and felsite	7.6	11.4
Carboniferous (Calciferous Sandstone Measures)	Siltstone, micaceous, poor laminations, light green	0.1+	11.5

NS 94 NW 11 9412 4765 Ryeflat Farm, Carstairs **Block E**

Surface level (+206.4 m) +677 ft
Water struck at +204.4 m
250 mm percussion
February 1977

Waste 9.0 m
Bedrock 0.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.1	0.1
Alluvium	Clay, silty, mid-brown, becomes sandy with depth	2.3	2.4
	Silt, mid-brown, with sand of medium to coarse-grained, rounded to subrounded, quartz with felsite. A thin band of peat including large wood fragments at the base	0.6	3.0
Glaciolacustrine deposit	Clay, grey, stiff, laminated in part. Micaceous silt bands beneath 4.5 m	4.0	7.0
Glacial sand and gravel	Sandy gravel Gravel: fine, coarse and cobbles up to 18 cm diameter near the base, subrounded with subangular and angular, green sandstone with felsite and basalt Sand: medium and coarse with fine, angular to subangular, quartz with felsite, basalt and sandstone Fines: silt	1.7	8.7
	Clay, silty, laminated, brown	0.3	9.0
Carboniferous (Calciferous Sandstone Measures)	Basalt, fine-grained and amygdaloidal, containing a contact with indurated mudstone breccia. The nature of this contact indicates that it is either that between an included basalt boulder and a mudstone breccia matrix, or, more probably, the erosional surface of a lava flow (Number S63516 in the specimen and thin section collection of the Geological Survey (Edinburgh))	0.2+	9.2

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
Fines	Sand	Gravel		Fines	Sand			Gravel			
				$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
3	50	47	7.0–8.0	3	9	34	21	22	11	0	†*
			8.0–8.7	2	4	15	13	14	26	26	†*
			Mean	3	7	26	17	19	17	11	

NS 94 NW 12 9436 4693 Gallow Hill, Carstairs **Block F**

Surface level (+224.5 m) +737 ft
Water struck at +207.5 m
250 mm and 200 mm percussion
February 1977

Overburden 0.2 m
Mineral 23.5 m
Waste 1.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Glacial sand and gravel	**a** Gravel Gravel: fine, coarse, cobbles and boulders up to 50 cm diameter, subrounded, green sandstone and felsite with red sandstone, basalt and quartzite Sand: medium and coarse with fine, much from the break up of sandstone boulders Fines: clay and silt with coal occurring as bands. Less with depth	13.3	13.5
	b 'Clayey' pebbly sand Gravel: fine and coarse, subrounded Sand: medium with fine and coarse, coaly horizons Fines: silt	2.5	16.0
	c 'Clayey' gravel Gravel: coarse with fine, cobbles and boulders up to 30 cm diameter, green sandstone Sand: fine and medium with coarse Fines: clay	2.1	18.1
Fluvioglacial sand and gravel	**d** Sandy gravel Gravel: fine and coarse with cobbles, subrounded with subangular, green sandstone with felsite, basalt, and rare volcanic glass and coal Sand: medium with coarse and fine, quartz and felsite with basalt Fines: clay. Laminated clay band from 19.5 m to 19.8 m	5.6	23.7
Till	Clay, very stiff, dark brown, angular clasts up to cobble size of green sandstone with basalt	1.1+	24.8

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
a	9	35	56	0.2–1.1	5	18	12	7	10	22	26	
				1.1–2.2	19	7	16	13	13	21	11	
				2.2–3.3	19	8	21	13	9	14	16	
				3.3–4.3	8	11	23	18	18	11	11	
				4.3–5.7	8	11	19	17	20	17	8	
				5.7–6.8	6	7	10	6	11	26	34	
				6.8–7.5	8	8	10	7	22	35	10	
				7.5–8.6	6	8	10	9	24	29	14	
				8.6–9.5	6	7	8	10	23	25	21	
				9.5–10.6	8	8	10	16	33	19	6	
				10.6–11.6	7	7	9	15	27	24	11	
				11.6–12.6	8	10	9	8	13	18	34	
				12.6–13.5	9	12	20	16	22	19	2	
				Mean	9	9	14	12	19	21	16	
b	12	68	20	13.5–14.6	12	23	36	11	8	10	0	
				14.6–15.5	10	17	34	14	12	10	3	
				15.6–16.0	15	29	33	8	7	8	0	
				Mean	12	22	35	11	9	10	1	
c	11	35	54	16.0–17.0	14	16	13	6	7	19	25	
				17.0–18.1	8	14	16	5	15	33	9	†
				Mean	11	15	15	5	11	26	17	
d	6	60	34	18.1–19.0	12	22	33	8	9	11	5	†
				19.0–19.5	13	22	26	8	8	23	0	†
				19.5–20.5	7	14	26	15	17	14	7	†
				20.5–21.5	4	14	29	22	15	13	3	†
				21.5–22.5	4	10	33	18	17	14	4	†
				22.5–23.7	4	16	24	17	20	13	6	†
				Mean	6	16	28	16	15	14	5	
a–d	9	45	46	Mean	9	13	20	12	16	19	11	
a–c	10	40	50	Mean	10	12	17	11	16	20	14	

NS 94 NW 13 9465 4677 Columbie Farm, Carstairs **Block E**

Surface level (+206.5 m) +677 ft
Water struck at +203.9 m
250 mm and 200 mm percussion
January 1977

Overburden 0.4 m
Mineral 2.2 m
Waste 2.4 m
Mineral 2.2 m
Waste 1.7 m
Bedrock 0.3 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Glaciolacustrine deposit	**a** 'Very clayey' sand Sand: medium and fine Fines: clay, grey	2.2	2.6
	Clay, silty, poorly laminated, grey becoming brown with depth. Small amounts of plant matter	2.4	5.0
	b Gravel Gravel: coarse with fine and cobbles, subangular, green and red sandstones, felsite, basalt, quartzite and andesite Sand: fine to coarse. Sand content increases with depth Fines: clay, grey, in laminated bands which also contain gravel size material	2.2	7.2
	Clay, becoming silty with depth, laminated, grey, with rare clasts up to cobble size, and a little coal	1.7	8.9
Carboniferous (Calciferous Sandstone Measures)	Sandstone, moderately weathered, medium to coarse grained, greenish	0.3+	9.2

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64	
a	21	79	0	0.4–1.5	21	44	33	2	0	0	0	
				1.5–2.6	21	31	46	2	0	0	0	
				Mean	21	38	39	2	0	0	0	
b	10	43	47	5.0–6.0	14	13	12	7	13	18	23	†
				6.0–7.2	7	18	19	14	11	31	0	†
				Mean	10	16	16	11	12	25	10	
a+b	15	61	24	Mean	15	27	28	6	6	13	5	

NS 94 NW 14 9439 4587 Eastend, Carstairs **Block E**

Surface level (+204.6 m)+671 ft
Water struck at +199.6 m
250 mm percussion
January 1977

Overburden 2.0 m
Mineral 12.0 m
Waste 2.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Made ground	2.0	2.0
Fluvioglacial sand and gravel	**a** 'Clayey' pebbly sand Gravel: fine and coarse, subrounded to well rounded, felsite and microgranite with greenish grey sandstone, quartz and weathered basalt Sand: medium and fine with coarse, orange-grey Fines: disseminated silt with sandy clay bands, particularly between 3.0 m and 4.0 m	4.0	6.0
	b Sand Gravel: rare fine, well rounded Sand: fine and medium with a little coarse, subrounded to well rounded. Coal in the coarse size fraction Fines: silt, disseminated and in bands	8.0	14.0
	Silt, varying sand content, including coarse coal sand	1.7	15.7
Till	**c** 'Clayey' sandy gravel Gravel: fine and coarse with rare cobbles, angular to subangular, grey sandstone, felsite and basalt Sand: medium and fine with a little coarse, dark grey, coal in coarse fraction Fines: disseminated silt becoming clayey with depth	0.8+	16.5
	Borehole terminated due to technical reasons		

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64	
a	12	77	11	2.0–3.0	20	37	24	5	8	6	0	
				3.0–4.0	6	23	46	15	8	2	0	
				4.0–5.0	11	37	32	10	5	5	0	
				5.0–6.0	8	36	41	5	5	5	0	†
				Mean	12	33	36	8	7	4	0	
b	8	91	1	6.0–7.0	7	34	51	4	3	1	0	†
				7.0–8.0	2	46	48	2	1	1	0	†
				8.0–9.0	6	44	47	2	0	1	0	†
				9.0–10.0	6	47	45	1	1	0	0	†
				10.0–11.0	9	52	38	1	0	0	0	†
				11.0–12.0	6	31	59	2	2	0	0	†
				12.0–13.0	6	47	42	2	2	1	0	†
				13.0–14.0	18	60	19	2	1	0	0	†
				Mean	8	45	44	2	1	0	0	
c	12	59	29	15.7–16.5	12	23	27	9	17	12	0	†*
a+b	9	86	5	Mean	9	41	41	4	3	2	0	

NS 94 NE 1 9577 4787 Clydesdale Forest, Carnwath **Block E**

Surface level (+211.1 m)+693 ft
Water struck at +208.1 m
250 mm and 200 mm percussion
February 1977

Overburden 2.1 m
Mineral 20.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
Peat	Peat	2.1	2.1
Glaciolacustrine deposit	**a** 'Clayey' sand Sand: fine with medium, subrounded, quartz with felsite and basalt. Rare coal Fines: silt, laminated bands between 3.0 m and 4.0 m	2.9	5.0
	b Pebbly sand Gravel: coarse with fine, subangular, green sandstone, basalt, felsite, quartzite and andesite. Less gravel with depth Sand: medium with fine, subrounded, quartz with felsite and basalt Fines: silt	2.0	7.0
	c Sand Gravel: rare coal up to cobble size Sand: fine with medium, quartz, felsite and basalt with coal Fines: silt, brown	10.0	17.0
Fluvioglacial sand and gravel	**d** Sandy gravel Gravel: fine with coarse, angular to subrounded, sandstone, quartz, felsite and basalt Sand: medium and fine with coarse Fines: silt	5.6+	22.6
	Borehole terminated due to technical reasons		

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
a	11	89	0	2.1–3.0	12	52	34	1	1	0	0	
				3.0–4.0	15	54	30	1	0	0	0	†
				4.0–5.0	5	44	49	2	0	0	0	†
				Mean	11	50	38	1	0	0	0	
b	3	85	12	5.0–6.0	3	37	44	3	5	8	0	†
				6.0–7.0	3	35	48	3	2	9	0	†
				Mean	3	36	46	3	4	8	0	
c	8	91	1	7.0–8.0	5	38	54	1	1	1	0	†
				8.0–9.0	5	50	44	1	0	0	0	†
				9.0–10.0	6	61	32	1	0	0	0	†
				10.0–11.0	2	67	30	1	0	0	0	†
				11.0–12.0	9	63	27	1	0	0	0	†
				12.0–13.0	9	64	27	0	0	0	0	†
				13.0–14.0	12	59	29	0	0	0	0	†
				14.0–15.0	10	53	34	2	1	0	0	†
				15.0–16.0	10	47	38	3	2	0	0	†
				16.0–17.0	8	51	36	3	2	0	0	†
				Mean	8	55	35	1	1	0	0	
d	5	65	30	17.0–18.0	6	33	35	7	14	5	0	†
				18.0–19.0	6	27	24	11	19	13	0	†
				19.0–20.0	6	29	37	12	14	2	0	†
				20.0–21.0	3	24	37	13	16	7	0	†
				21.0–21.6	3	18	24	7	20	25	3	†
				21.6–22.6	6	22	15	7	26	24	0	†
				Mean	5	26	29	10	18	12	0	
a–d	7	84	9	Mean	7	45	35	4	5	4	0	
a–c	8	90	2	Mean	8	52	37	1	1	1	0	

NS 94 NE 2 9527 4774 Ryeflat Moss, Carstairs **Block E**

Surface level (+214.1 m)+702 ft
Water struck at +209.6 m
250 mm and 200 mm percussion
February 1977

Overburden 1.0 m
Mineral 15.0 m
Waste 2.6 m
Bedrock 0.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
Peat	Peat	1.0	1.0
Fluvioglacial sand and gravel	**a** Sandy gravel Gravel: fine with coarse, rare cobbles below 5.0 m, subangular, sandstone, quartzite, felsite and quartz Sand: medium with fine and coarse, subrounded to subangular, quartz with felsite, basalt and sandstone Fines: silt	8.0	9.0
	b Pebbly sand Gravel: fine with coarse, subangular, sandstone, quartzite, felsite and quartz Sand: medium with fine and coarse, subrounded to subangular, quartz with felsite, basalt and sandstone Fines: silt	2.0	11.0
	c Sandy gravel Gravel: fine and coarse with cobbles, subangular, sandstone with felsite and basalt Sand: medium with fine and coarse, subrounded to subangular, quartz, felsite and basalt Fines: silt	3.0	14.0
	d Pebbly sand Gravel: coarse and fine, rare cobbles, angular Sand: medium with fine and coarse, rare coal Fines: silt, laminated in part	2.0	16.0
Till	Clay, silty, stiff, dark brown, with angular clasts up to 13 cm diameter of sandstone, felsite and basalt	2.6	18.6
Carboniferous (Calciferous Sandstone Measures)	Basalt, microcrystalline, rare small pyroxene phenocrysts and pyritisation, black, chips of rock recovered, no progress	0.1+	18.7

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
a	5	52	43	1.0–2.0	7	17	27	11	24	14	0	
				2.0–3.0	8	14	21	10	25	22	0	
				3.0–4.0	9	16	24	11	23	17	0	
				4.0–5.0	7	13	27	13	24	16	0	†
				5.0–6.0	2	7	26	17	27	21	0	†
				6.0–7.0	1	10	32	11	22	24	0	†
				7.0–8.0	2	13	25	11	24	25	0	†
				8.0–9.0	3	17	32	12	21	15	0	†
				Mean	5	13	27	12	24	19	0	
b	7	82	11	9.0–10.0	4	15	49	11	12	9	0	†
				10.0–11.0	9	38	44	7	2	0	0	†
				Mean	7	27	46	9	7	4	0	
c	4	63	33	11.0–12.0	4	16	35	13	15	17	0	†
				12.0–13.0	4	15	32	16	17	16	0	†
				13.0–14.0	4	20	29	12	12	17	6	†
				Mean	4	17	32	14	15	16	2	
d	7	75	18	14.0–15.0	4	30	43	10	7	6	0	†
				15.0–16.0	10	28	33	7	9	13	0	†
				Mean	7	29	38	8	8	10	0	
a–d	5	61	34	Mean	5	18	32	11	18	15	1	

NS 94 NE 3 9559 4746 Red Loch, Carstairs **Block F**

Surface level (+222.8 m)+731 ft
Water struck at +209.6 m
250 mm and 200 mm percussion
January 1977

Overburden 0.3 m
Mineral 22.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial sand and gravel	**a** 'Clayey' gravel Gravel: coarse with fine, cobbles and boulders, subangular to subrounded, green sandstone with felsite, basalt, limestone and rare schist Sand: fine to coarse, much is formed from the breakdown of the sandstone cobbles and boulders Fines: silt	9.4	9.7
Fluvioglacial sand and gravel	**b** Pebbly sand Gravel: fine with coarse, subrounded Sand: medium with fine and coarse Fines: clay, silty, restricted to coaly partings	1.7	11.4
	c Sandy gravel Gravel: fine with coarse and cobbles, the latter less numerous below 14.5 m, subrounded to subangular, pink sandstone with green sandstone, felsite and basalt Sand: coarse with medium and fine, much coal to 12.3 m Fines: clay, silty	11.4+	22.8
	Borehole terminated due to technical reasons		

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
a	12	35	53	0.3–1.3	12	13	25	16	13	16	5	
				1.3–2.3	13	12	17	13	15	23	7	
				2.3–3.3	12	13	12	9	17	17	20	
				3.3–4.3	12	13	14	9	18	27	7	
				4.3–5.3	13	11	9	12	18	26	11	
				5.3–6.3	13	10	13	12	15	15	22	
				6.3–7.3	12	10	9	10	16	24	19	
				7.3–8.3	9	8	8	10	13	23	29	
				8.3–9.3	8	12	10	7	12	21	30	
				9.3–9.7	8	10	10	12	20	31	9	
				Mean	11	11	13	11	15	22	17	
b	8	71	21	9.7–10.7	8	17	39	12	14	10	0	
				10.7–11.4	9	16	42	16	12	5	0	
				Mean	8	17	40	14	13	8	0	
c	6	48	46	11.4–12.3	10	11	22	12	12	20	13	
				12.3–13.2	6	6	11	5	9	24	39	
				13.2–14.5	7	6	14	21	23	19	10	†
				14.5–15.8	4	12	21	38	23	2	0	†
				15.8–16.8	3	7	13	24	35	18	0	†
				16.8–17.8	6	14	14	26	27	9	4	†
				17.8–18.8	3	9	11	25	36	16	0	†
				18.8–19.8	5	12	18	32	25	5	3	†
				19.8–20.8	12	12	14	23	18	15	6	†
				20.8–21.8	3	4	7	17	36	33	0	†
				21.8–22.8	4	8	18	29	21	11	9	†
				Mean	6	9	15	24	24	15	7	
a–c	8	45	47	Mean	8	11	16	18	20	17	10	
b+c	6	50	44	Mean	6	10	18	22	23	15	6	

NS 94 NE 4 9531 4644 White Hill, Carstairs **Block E**

Surface level (+226.6 m)+743 ft
Water struck at +207.0 m
250 mm and 200 mm percussion
January 1977

Overburden 1.0 m
Mineral 23.0 m
Waste 1.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Fluvioglacial sand and gravel	Clay, silty with sand, clasts up to 6 m diameter of sandstone, felsite and basalt	0.5	1.0
	a 'Clayey' pebbly sand Gravel: coarse with fine and cobbles, subrounded, green sandstone, felsite and basalt. Gravel rare beneath 4.0 m Sand: medium with fine and a little coarse Fines: silt in bands, some laminated, with grains of coal	6.3	7.3
	b Sandy gravel Gravel: coarse and fine with rare cobbles, subangular, red and green sandstones, conglomerate, felsite, basalt and quartzite Sand: medium with fine and coarse Fines: silt	4.6	11.9
	c 'Very clayey' sand Gravel: a little coarse and fine to 12.9 m Sand: fine with medium Fines: clay in bands with coal grains	12.1	24.0
Till	Silt, brown-grey, clasts up to 6 cm diameter of green sandstone and conglomerate	1.0+	25.0

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64
a	16	74	10	1.0–1.5	8	9	73	4	2	4	0
				1.5–2.4	13	9	35	7	8	18	10
				2.4–4.0	17	23	46	4	4	6	0
				4.0–5.0	19	18	55	4	2	2	0
				5.0–6.1	18	24	56	1	1	0	0
				6.1–7.0	20	8	67	4	1	0	0
				7.0–7.3	10	23	54	10	3	0	0
				Mean	16	17	53	4	3	5	2
b	8	46	46	7.3–8.3	5	6	20	9	23	37	0
				8.3–9.3	7	11	28	10	11	33	0
				9.3–10.3	7	11	28	14	22	18	0
				10.3–11.3	9	11	25	13	25	17	0
				11.3–11.9	11	15	26	10	24	14	0
				Mean	8	10	25	11	21	25	0
c	22	76	2	11.9–12.9	14	8	50	14	6	8	0
				12.9–14.0	19	41	38	2	0	0	0
				14.0–14.9	23	19	57	1	0	0	0
				14.9–16.0	22	50	26	2	0	0	0
				16.0–17.0	19	54	26	1	0	0	0
				17.0–18.0	20	32	48	0	0	0	0
				18.0–19.0	22	19	59	0	0	0	0
				19.0–20.0	29	15	56	0	0	0	0 †
				20.0–20.7	16	79	5	0	0	0	0 †
				20.7–22.0	13	79	8	0	0	0	0 †
				22.0–23.0	37	61	2	0	0	0	0 †
				23.0–24.0	28	71	1	0	0	0	0 †
				Mean	22	44	31	1	1	1	0
a–c	18	70	12	Mean	18	30	36	4	5	7	0

NS 94 NE 5 9535 4574 Carstairs Junction **Block D**

Surface level (+198.5 m)+651 ft
Water struck at +196.0 m
250 mm and 200 mm percussion
January 1977

Waste 13.0 m
Bedrock 0.7 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Glaciolacustrine deposit	Sandy silt, soft, poorly laminated, micaceous, mottled, grey becoming brownish grey with depth. Sandier below 0.7 m	8.5	9.0
Till	Clay, stiff, grey, with clasts of green, grey and brown sandstones, basalt, quartz and felsite	2.4	11.4
	Gravel Gravel: fine and coarse with cobbles, angular to subrounded, green, grey and brown sandstones, basalt, quartz and felsite. Sandstone cobble gravel below 12.4 m Sand: coarse with medium and fine, quartz, basalt and felsite Fines: clay, grey	1.6	13.0
Carboniferous (Calciferous Sandstone Measures)	Sandstone, indurated, grey	0.7+	13.7

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
Fines	Sand	Gravel		Fines	Sand			Gravel			
				$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
8	34	58	11.4–12.4	8	10	8	16	24	26	8	†*

NS 94 NE 6 9615 4954 Eastshield, Carnwath **Block G_1**

Surface level (+212.6 m)+697 ft
Water struck at +206.8 m
250 mm percussion
December 1976

Waste 5.3 m
Bedrock 0.7 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	1.0	1.0
Till	Clay, stiff, grey to reddish brown with angular to rounded clasts of greenish grey sandstone and basalt	4.3	5.3
Carboniferous (Calciferous Sandstone Measures)	Clay, light grey with greenish grey siltstone	0.7+	6.0

NS 94 NE 7 9650 4893 **Woodend Farm, Carnwath** **Block E**

Surface level (+209.6 m)+688 ft
Water struck at +206.9 m
250 mm and 200 mm percussion
November 1976

Overburden 2.5 m
Mineral 16.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
Peat	Peat, with birch fragments	1.4	1.4
Older alluvium	Silt, micaceous, dark grey, plant fragments	1.1	2.5
Glaciolacustrine deposit	'Clayey' sand Gravel: fine, rounded to subrounded, sandstone, basalt and quartz, mainly from 18.0 m to 18.5 m Sand: fine with medium, quartz with coal below 5.8 m Fines: silt, micaceous	16.0+	18.5
	Borehole terminated due to technical reasons		

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
Fines	Sand	Gravel		Fines	Sand			Gravel			
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64	
14	86	0	2.5–3.6	14	85	1	0	0	0	0	†
			3.6–4.8	19	79	2	0	0	0	0	†
			4.8–5.8	25	73	2	0	0	0	0	†
			5.8–6.8	19	80	1	0	0	0	0	†
			6.8–7.8	17	81	2	0	0	0	0	†
			7.8–8.8	14	85	1	0	0	0	0	†
			8.8–10.0	16	83	1	0	0	0	0	†
			10.0–11.0	15	84	1	0	0	0	0	†
			11.0–12.0	14	85	1	0	0	0	0	†
			12.0–13.0	15	82	3	0	0	0	0	†
			13.0–14.0	16	75	8	1	0	0	0	†
			14.0–15.0	14	78	8	0	0	0	0	†
			15.0–16.0	10	73	17	0	0	0	0	†
			16.0–17.0	5	55	40	0	0	0	0	†
			17.0–18.0	6	61	32	1	0	0	0	†
			18.0–18.6	5	64	26	3	2	0	0	†
			Mean	14	77	9	0	0	0	0	

NS 94 NE 8 9662 4777 Woodend Farm, Carnwath Block F

Surface level (+235.0 m)+771 ft
Water not struck
250 mm and 200 mm percussion
November 1976

Overburden 0.1 m
Mineral 23.9 m+
(inc. 0.9 m waste)

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.1	0.1
Glacial sand and gravel	'Clayey' gravel, sandy from 12.2 m to 13.4 m, with clay band from 11.3 m to 12.2 m Gravel: fine and coarse with cobbles, subrounded to well rounded, grey, yellow and red sandstones, felsite, quartz, and basalt Sand: fine to coarse, quartz and rock fragments Fines: clay and silt, reddish	23.9+	24.0
	Borehole terminated due to technical reasons		

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64
14	42	44	0.1–1.0	6	10	37	16	10	7	14
			1.0–2.1	10	9	25	17	14	8	17
			2.1–3.0	10	9	31	14	17	19	0
			3.0–3.9	13	8	23	20	16	20	0
			3 9–5.0	5	6	18	19	16	22	14
			5.0–6.0	7	7	8	11	20	47	0
			6.0–7.0	6	5	8	7	18	45	11
			7.0–8.0	1	8	10	9	17	34	21
			8.0–9.1	2	8	29	18	14	18	11
			9.1–10.0	10	7	8	10	29	31	5
			10.0–11.3	20	13	18	13	22	14	0
			11.3–12.2	Clay						
			12.2–13.4	28	35	16	6	9	6	0
			13.4–14.4	14	16	29	20	18	3	0
			14.4–15.5	15	13	13	11	18	24	6
			15.5–16.7	15	11	11	16	24	23	0
			16.7–17.8	21	20	13	17	21	8	0
			17.8–18.7	14	14	15	15	20	22	0
			18.7–19.8	18	13	11	14	23	15	6
			19.8–20.9	18	11	9	17	26	19	0
			20.9–21.9	20	11	8	13	24	24	0
			21.9–22.9	22	11	8	10	23	26	0
			22.9–24.0	17	18	8	11	23	23	0
			Mean	14	12	16	14	19	20	5

NS 94 NE 9 9652 4736 **White Loch, Carnwath** **Block E**

Surface level (+218.5 m)+717 ft
Water struck at +215.5 m
250 mm and 200 mm percussion
February 1977

Overburden 11.5 m
Mineral 14.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Made ground	4.0	4.0
Peat	Peat, becomes increasingly compact with depth	4.3	8.3
Glaciolacustrine deposit	**a** 'Very clayey' sand Sand: fine with medium Fines: silt, disseminated and in thin laminated bands	1.0	9.3
	Silt, sandy, rare subangular basalt clasts up to 2 cm diameter	2.2	11.5
	b 'Clayey' sand Sand: fine with a little medium, becomes finer with depth, rare coaly laminae Fines: silt, medium brown, disseminated	14.0+	25.5

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64	
a	25	75	0	8.3–9.3	25	56	18	1	0	0	0	†*
b	10	89	0	11.5–12.5	12	64	21	2	1	0	0	†
				12.5–13.5	13	68	18	1	0	0	0	†
				13.5–14.5	12	71	17	0	0	0	0	†
				14.5–15.5	9	76	15	0	0	0	0	†
				15.5–16.5	12	81	7	0	0	0	0	†
				16.5–17.5	8	83	9	0	0	0	0	†
				17.5–18.5	7	81	12	0	0	0	0	†
				18.5–19.5	6	82	12	0	0	0	0	†
				19.5–20.5	8	83	9	0	0	0	0	†
				20.5–21.5	17	79	4	0	0	0	0	†
				21.5–22.5	12	81	7	0	0	0	0	†
				22.5–23.5	11	83	6	0	0	0	0	†
				23.5–24.5	11	83	6	0	0	0	0	†
				24.5–25.5	9	86	5	0	0	0	0	†
				Mean	10	79	11	0	0	0	0	

NS 94 NE 10 9617 4664 West End, Carnwath **Block E**

Surface level (+223.8 m)+734 ft
Water struck at +209.0 m
250 mm and 200 mm percussion
December 1976

Overburden 0.5 m
Mineral 24.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Fluvioglacial sand and gravel	**a** Sandy gravel Gravel: coarse and fine with cobbles, subrounded, basalt and felsite Sand: medium and coarse with fine, bands of finer sand, rare coal Fines: silt	2.0	2.5
	b 'Clayey' sand Gravel: fine with coarse, subrounded, sandstone, felsite and basalt, principally from 2.5 m to 3.5 m and from 7.5 m to 9.0 m Sand: medium with fine and coarse, quartz, felsite and mafic minerals Fines: clay	9.5	12.0
	c Sandy gravel Gravel: fine with coarse, finer towards base, subrounded, sandstone, basalt, felsite and quartz Sand: medium with fine and coarse, quartz, felsite and mafic minerals Fines: clay	2.0	14.0
	d 'Clayey' sand Gravel: fine with coarse Sand: medium with fine and coarse Fines: clay	1.9	15.9
	e 'Clayey' pebbly sand Gravel: fine, sandstone, felsite and basalt Sand: fine to coarse, rare coal Fines: clay	2.2	18.1
	f Sand Sand: fine and medium wtih coarse, rare coal Fines: clay	6.9+	25.0

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
a	5	50	45	0.5–1.4	6	7	26	13	18	30	0	
				1.4–2.5	5	8	23	22	17	18	7	
				Mean	5	8	24	18	18	23	4	
b	12	84	4	2.5–3.5	20	10	47	11	7	5	0	
				3.5–4.5	14	13	69	3	1	0	0	
				4.5–5.5	8	16	74	2	0	0	0	
				5.5–6.5	12	18	65	4	1	0	0	
				6.5–7.5	5	23	64	6	1	1	0	
				7.5–8.0	8	25	52	9	5	1	0	
				8.0–9.0	10	16	49	15	6	4	0	
				9.0–9.7	10	19	65	3	2	1	0	
				9.7–11.0	11	22	57	5	3	1	0	
				11.0–12.0	16	18	63	3	0	0	0	
				Mean	12	18	60	6	3	1	0	
c	9	68	23	12.0–12.5	4	13	52	12	13	6	0	
				12.5–13.0	11	8	33	15	22	11	0	
				13.0–14.0	11	18	40	11	15	5	0	
				Mean	9	14	42	12	16	7	0	
d	11	87	2	14.0–14.8	12	14	53	19	2	0	0	
				14.8–15.9	10	16	65	6	2	1	0	†
				Mean	11	15	60	12	2	0	0	
e	12	77	11	15.9–17.1	13	19	37	18	13	0	0	†
				17.1–18.1	12	34	30	15	9	0	0	†
				Mean	12	26	34	17	11	0	0	
f	6	93	1	18.1–18.9	10	42	44	3	1	0	0	†
				18.9–19.8	8	35	53	3	1	0	0	†
				19.8–20.5	7	52	40	1	0	0	0	†
				20.5–21.0	11	56	32	1	0	0	0	†
				21.0–22.0	3	51	39	5	2	0	0	†
				22.0–23.0	7	44	44	4	1	0	0	†
				23.0–24.0	2	40	51	6	1	0	0	†
				24.0–25.0	3	42	54	1	0	0	0	†
				Mean	6	44	46	3	1	0	0	
a–f	9	83	8	Mean	9	25	50	8	5	3	0	

NS 94 NE 11 9661 4607 State Hospital, Carnwath **Block D**

Surface level (+204.4 m)+671 ft
Water struck at +202.4 m
250 mm percussion
November 1976

Overburden 0.3 m
Mineral 4.2 m
(inc. 1.0 m waste)
Waste 3.0 m
Bedrock 1.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glaciolacustrine deposit	'Very clayey' sand with sandy silt band from 2.3 m to 3.3 m Sand: fine and medium, quartz, micaceous Fines: silt, mid-brown	4.2	4.5
Till	Clay, with silt and sand, angular basalt clasts up to 25 cm diameter, dark brown, grey with depth, rare silty sand lenses	3.0	7.5
Carboniferous (Calciferous Sandstone Measures)	Basalt, vesicles with chert infilling, porphyroblastic, dark green	1.5+	9.0

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
Fines	Sand	Gravel		Fines	Sand			Gravel			
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64	
31	69	0	0.3–1.3	36	47	17	0	0	0	0	
			1.3–2.3	36	48	16	0	0	0	0	†
			2.3–3.3	Sandy silt							
			3.3–4.5	24	12	63	1	0	0	0	†
			Mean	31	34	34	1	0	0	0	

NS 94 NE 12 9669 4521 Lampits Farm, Carnwath **Block D**

Surface level (+196.9 m)+646 ft
Water struck at +185.6 m
250 mm and 200 mm percussion
November 1976

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	1.5	1.5
Glaciolacustrine deposit	Clay, laminated, silty, brown, micaceous in upper part	4.8	6.3
Till	Clay, dark, becoming stiffer with depth. Iron staining near the base. Subangular clasts of weathered sandstone and basalt becoming more numerous with depth	4.5	10.8
Glaciolacustrine deposit	Clay, laminated, stiff, brown	6.2	17.0
Till	Clay, silty, black, with basalt clasts up to 15 cm diameter	1.0+	18.0

NS 94 NE 13 9609 4520 Sewage Farm, Carnwath **Block D**

Surface level (+190.7 m)+626 ft
Water struck at +183.2 m
250 mm and 200 mm percussion
January 1977

Waste 18.7 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.8	0.8
Alluvium	'Clayey' sand Sand: medium and fine, light brown Fines: clay, grey	0.5	1.3
Glaciolacustrine deposit	Clay, laminated in places, stiff, black	4.7	6.0
	Silt, soft, grey-brown	1.5	7.5
	Clay, laminated in places, stiff, black	8.3	15.8
Till	Clay, silty, becomes stiffer with depth, dark brown. Subrounded to subangular clasts of felsite, basalt, sandstone and quartzite up to 15 cm diameter	2.9+	18.7

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
Fines	Sand	Gravel		Fines	Sand			Gravel			
				$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
15	84	1	0.8–1.3	15	41	41	2	1	0	0	*

NS 94 NE 14 9744 4979 Woodend Moss, Carnwath **Block E**

Surface level (+222.1 m)+729 ft
Water struck at +214.3 m
250 mm and 200 mm percussion
November 1976

Overburden 0.4 m
Mineral 24.9 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
Peat	Peat, sandy	0.4	0.4
Fluvioglacial sand and gravel	**a** 'Clayey' pebbly sand Gravel: coarse and fine with rare cobbles, subrounded, green sandstone, felsite and basalt Sand: medium with fine and coarse, subrounded to well rounded, quartz with rock fragments and coal Fines: silt, laminated clay bands below 5.3 m	5.9	6.3
Glacial sand and gravel	**b** Gravel Gravel: coarse with fine and cobbles up to 25 cm diameter, subangular to well rounded, becomes better rounded with depth, green and grey sandstones, conglomerate, siltstone, felsite, basalt and quartz Sand: medium and coarse with fine, subangular to subrounded, quartz and rock fragments with coal, grey Fines: silt and clay	9.7	16.0
Fluvioglacial sand and gravel	**c** Pebbly sand Gravel: fine with coarse and cobbles, well rounded to subrounded, sandstone, conglomerate, quartzite, quartz and basalt. Gravel rare beneath 20.0 m Sand: medium and fine with coarse, subangular to subrounded, quartz, rock fragments and coal, grey Fines: silt, micaceous, disseminated with occasional bands	9.3+	25.3

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
a	11	83	6	0.4–1.4	9	26	45	16	2	2	0	
				1.4–2.3	8	58	26	4	1	3	0	
				2.3–3.5	10	7	54	22	5	2	0	
				3.5–4.3	11	6	55	24	4	0	0	
				4.3–5.3	10	46	43	1	0	0	0	
				5.3–6.3	19	18	46	4	4	9	0	
				Mean	11	26	45	12	3	3	0	
b	7	42	51	6.3–7.3	8	7	18	10	7	34	16	
				7.3–8.2	8	5	18	10	11	39	9	†
				8.2–9.0	4	6	21	12	9	23	25	†
				9.0–10.0	7	6	20	21	18	17	11	†
				10.0–11.0	5	7	31	14	18	25	0	†
				11.0–12.0	4	8	21	19	15	17	16	†
				12.0–13.0	7	4	18	18	21	32	0	†
				13.0–14.0	6	4	18	17	17	17	21	†
				14.0–15.0	2	2	17	21	10	9	39	†
				15.0–16.0	14	8	20	19	14	20	5	†
				Mean	7	6	20	16	14	23	14	
c	8	85	7	16.0–17.0	6	26	39	20	9	0	0	†
				17.0–18.0	7	11	52	30	0	0	0	†
				18.0–19.0	5	9	29	21	14	14	8	†
				19.0–20.0	0	12	48	27	11	2	0	†
				20.0–21.0	10	28	52	8	2	0	0	†
				21.0–22.0	6	39	52	3	0	0	0	†
				22.0–23.0	8	48	43	1	0	0	0	†
				23.0–24.0	15	51	34	0	0	0	0	†
				24.0–25.3	16	52	32	0	0	0	0	†
				Mean	8	31	42	12	4	2	1	
a–c	8	68	24	Mean	8	20	34	14	8	10	6	
a+c	10	84	6	Mean	10	29	43	12	3	2	1	

NS 94 NE 15 9796 4951 Woodend Moss, Carnwath **Block E**

Surface level (+225.2 m)+739 ft
Water struck at +212.9 m
250 mm and 200 mm percussion
December 1976

Overburden 1.0 m
Mineral 19.7 m
(inc. 2.3 m waste)
Waste 3.6 m
Bedrock 0.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	1.0	1.0
Glaciolacustrine deposit	'Clayey' sand with clay band from 7.0 m to 9.3 m Gravel: a little coarse and fine between 10.4 m and 11.3 m, subrounded, felsite and sandstone Sand: medium with fine, subrounded to subangular, quartz with coal Fines: silt and red-brown clay	19.7	20.7
	Silt, stiff in part, dark grey	3.6	24.3
Carboniferous (Calciferous Sandstone Measures)	Basalt, trachytic texture, hematite, dark grey, with quartz veinlets	0.2+	24.5

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
Fines	Sand	Gravel		Fines	Sand			Gravel			
				$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
14	86	0	1.0–2.0	13	55	32	0	0	0	0	
			2.0–3.0	7	52	41	0	0	0	0	
			3.0–4.0	26	57	17	0	0	0	0	
			4.0–5.0	26	60	14	0	0	0	0	
			5.0–6.0	10	59	31	0	0	0	0	
			6.0–7.0	33	54	13	0	0	0	0	
			7.0–9.3	Clay							
			9.3–10.4	23	43	34	0	0	0	0	
			10.4–11.3	16	25	49	2	2	6	0	
			11.3–12.3	14	28	53	2	0	3	0	
			12.3–13.7	14	37	47	2	0	0	0	†
			13.7–14.7	16	68	15	1	0	0	0	†
			14.7–15.7	10	59	30	1	0	0	0	†
			15.7–16.7	8	55	37	0	0	0	0	†
			16.7–17.7	7	55	38	0	0	0	0	†
			17.7–18.7	6	57	37	0	0	0	0	†
			18.7–19.7	4	54	42	0	0	0	0	†
			19.7–20.7	7	44	49	0	0	0	0	†
			Mean	14	51	34	1	0	0	0	

NS 94 NE 16 9723 4871 Woodend Farm, Carnwath **Block F**

Surface level (+225.9 m)+741 ft
Water struck at +210.2 m
250 mm and 200 mm percussion
November 1976

Mineral 19.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
Glaciolacustrine deposit	**a** 'Clayey' sand Gravel: trace, fine with coarse, well rounded, basalt, felsite and sandstone Sand: fine with medium, rounded, quartz Fines: silt, micaceous, red	4.0	4.0
	b 'Very clayey' sand Sand: fine with medium, well rounded, quartz with rock fragments and mica, rare coal Fines: clay, red-brown	3.0	7.0
Glacial sand and gravel	**c** 'Clayey' sandy gravel Gravel: fine and coarse with cobbles and boulders up to 25 cm diameter, subangular to well rounded, red, yellow and buff sandstones, quartz, quartzite, basalt, felsite, with rare jasper Sand: medium with fine and coarse, subangular to well rounded, quartz and rock fragments, rare coal Fines: clay, brown	12.0+	19.0
	Borehole terminated due to boulder obstruction		

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
a	12	88	0	0.0–1.0	8	77	13	1	1	0	0	
				1.0–2.0	12	62	24	1	1	0	0	
				2.0–3.0	12	47	41	0	0	0	0	
				3.0–4.0	15	70	15	0	0	0	0	
				Mean	12	64	23	1	0	0	0	
b	30	70	0	4.0–4.9	30	68	2	0	0	0	0	
				4.9–6.0	36	63	1	0	0	0	0	
				6.0–7.0	24	61	15	0	0	0	0	
				Mean	30	64	6	0	0	0	0	
c	12	46	42	7.0–8.0	10	27	37	8	10	8	0	
				8.0–9.0	9	14	35	15	14	13	0	
				9.0–10.0	23	4	16	13	21	23	0	
				10.0–11.0	12	9	18	23	24	15	0	
				11.0–12.0	14	11	11	10	17	21	16	
				12.0–13.0	14	9	13	17	23	24	0	
				13.0–14.0	22	8	10	13	23	24	0	
				14.0–15.0	15	9	9	14	29	24	0	
				15.0–15.7	12	7	7	12	23	39	0	
				15.7–16.7	14	10	10	15	19	32	0	†
				16.7–17.7	1	11	28	32	22	6	0	†
				17.7–19.0	3	5	14	35	33	10	0	†
				Mean	12	10	18	18	22	19	1	
a–c	15	58	27	Mean	15	30	17	11	14	12	1	
a+b	20	80	0	Mean	20	64	16	0	0	0	0	

NS 94 NE 17 9785 4741 Head Inns Farm, Carnwath **Block D**

Surface level (+209.7 m)+688 ft
Water struck at +209.3 m
250 mm and 200 mm percussion
December 1976

Overburden 0.4 m
Mineral 7.6 m
Waste 6.4 m
Bedrock 0.3 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
Peat	Peat	0.4	0.4
Glaciolacustrine deposit	'Very clayey' sand Sand: fine with medium, quartz with coal Fines: silt with clay bands, grey	7.6	8.0
	Silt, clayey, stiff, grey with rare igneous clasts	1.0	9.0
Till	Clay, silty, stiff, fine sand partings, grey becoming brown with depth, angular clasts up to 30 cm diameter of basalt with felsite and sandstone	5.4	14.4
Carboniferous (Calciferous Sandstone Measures)	Sandstone, fine- to medium-grained quartz with feldspar and mafics, light grey	0.3+	14.7

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
Fines	Sand	Gravel		Fines	Sand			Gravel			
				$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
29	71	0	0.4–3.0	32	59	9	0	0	0	0	†
			3.0–4.0	31	56	13	0	0	0	0	†
			4.0–5.0	26	64	10	0	0	0	0	†
			5.0–6.1	28	64	8	0	0	0	0	†
			6.1–7.0	28	64	7	1	0	0	0	†
			7.0–8.0	28	66	6	0	0	0	0	†
			Mean	29	62	9	0	0	0	0	

NS 94 NE 18 9725 4671 Golf Course, Carnwath **Block D**

Surface level (+212.3 m)+697 ft
Water struck at +195.8 m
250 mm and 200 mm percussion
November 1976

Waste 16.8 m
Bedrock 0.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	1.4	1.4
Glaciolacustrine deposit	Silt, clayey, stiff in parts, micaceous, faintly laminated, red-brown becoming grey with depth. Rare sand laminae	15.1	16.5
Till	Clay, red-brown with basalt boulder	0.3	16.8
Carboniferous (Calciferous Sandstone Measures)	Sandstone, fine-grained, reddish purple	0.5+	17.3

NS 94 NE 19 9758 4572 Burnhouse Farm, Carnwath **Block D**

Surface level (+205.1 m)+673 ft
Water struck at +202.6 m
250 mm percussion
March 1977

Overburden 0.5 m
Mineral 1.1 m
Waste 3.4 m
Bedrock 0.3 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Fluvioglacial sand and gravel	'Very clayey' pebbly sand Gravel: fine with coarse, rare cobbles up to 10 cm diameter, red sandstone, felsite and quartzite Sand: fine with medium Fines: clay	1.1	1.6
Till	Silt, sandy to 4.0 m, laminated clay band from 1.6 m to 1.7 m. Clasts, angular and subangular with rounded, of green sandstone with basalt, felsite and andesite	3.4	5.0
Carboniferous (Calciferous Sandstone Measures)	Basalt, microcrystalline, black, small pyroxene phenocrysts showing reaction rims	0.3+	5.3

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
31	62	7	0.5–1.6	31	39	19	4	5	2	0

NS 94 NE 20 9842 4866 Calla, Carnwath **Block G_2**

Surface level (+219.1 m)+719 ft
Water not struck
250 mm percussion
December 1976

Waste 4.2 m
Bedrock 0.6 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
Peat	Peat	0.3	0.3
Till	Clay, red-brown, sandy in parts, angular clasts of basalt with sandstone	3.9	4.2
Carboniferous (Calciferous Sandstone Measures)	Basalt, trachytic, dark grey	0.2+	4.4

NS 94 NE 21 9898 4617 Howburn Bridge, Carnwath **Block G_2**

Surface level (+222.8 m)+731 ft
Water struck at +219.9 m
250 mm percussion
March 1977

Waste 2.9 m
Bedrock 0.6 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, subsoil from 0.2 m of weathered till with partly decayed plant material	2.0	2.0
Till	Clay, stiff, reddish brown with subangular clasts of green sandstone	0.9	2.9
Carboniferous (Calciferous Sandstone Measures)	Basalt, fine-grained, vesicular, greenish grey, weathered	0.6+	3.5

NS 94 NE 22 9976 4584 Kame-end, Carnwath **Block G_2**

Surface level (+216.6 m)+711 ft
Water struck at +213.9 m
250 mm percussion
March 1977

Overburden 1.3 m
Mineral 1.4 m
Bedrock 0.8 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Till	Silt, sandy, stiff below 0.8 m	0.9	1.3
	'Clayey' pebbly sand Gravel: coarse with fine and cobbles, subrounded, green sandstone Sand: coarse with medium and fine, subangular to subrounded with rounded and angular, quartz	1.4	2.7
Devono-Carboniferous	Sandstone, medium-grained, pinkish grey	0.8+	3.5

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64
18	65	17	1.3–2.3	19	24	33	5	4	10	5 *
			2.3–2.7	17	28	41	6	4	4	0 *
			Mean	18	25	35	5	4	9	4

NS 94 NE 23 9989 4508 Carnwath Mill **Block D**

Surface level (+216.2 m)+709 ft
Water not struck
250 mm and 200 mm percussion
March 1977

Overburden 0.7 m
Mineral 2.0 m
Waste 7.3 m
Bedrock 0.3 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.7	0.7
Glaciolacustrine deposit	**a** 'Very clayey' sand Sand: fine, angular, quartz Fines: silt, brown, both disseminated and in poorly laminated bands up to 0.3 m thick	2.0	2.7
	Silt, sandy, poorly laminated, brown. Becomes stiffer, better laminated, and with less sand below 7.0 m	6.0	8.7
	b 'Clayey' sandy gravel Gravel: coarse and fine with rare cobbles up to 14 cm diameter, angular to subrounded, green sandstone with red sandstone, basalt and shale Sand: fine to coarse, angular to subangular, quartz with basalt Fines: silt	1.3	10.0
Devono-Carboniferous	Sandstone, medium- to coarse-grained, indurated, red	0.3+	10.3

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64	
a	31	69	0	0.7–1.7	27	72	1	0	0	0	0	
				1.7–2.7	35	64	1	0	0	0	0	
				Mean	31	68	1	0	0	0	0	
b	14	45	42	8.7–10.0	14	18	14	13	19	22	0	*

NS 94 SW 2 9007 4371 Clifford's Sawmill, Lanark **Block B**

Surface level (+212.8 m) + 698 ft
Water not struck
250 mm and 200 mm percussion
May 1977

Overburden 1.6 m
Mineral 2.9 m
Waste 5.0 m
Bedrock 1.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Made ground	1.6	1.6
Fluvioglacial sand and gravel	**a** 'Clayey' sandy gravel Gravel: fine and coarse, rare cobbles, rounded to well rounded, basalt with porphyry and sandstone Sand: fine to coarse Fines: silt and clay	2.0	3.6
	b 'Clayey' pebbly sand Gravel: fine with coarse, subrounded to well rounded Sand: medium and fine with coarse, quartz and rock fragments Fines: silt and clay	0.9	4.5
	Silt, sandy, mid-brown, laminated below 5.1 m	1.2	5.7
Till	Clay, sandy, reddish brown, becoming stiffer with depth, angular clasts of purple and yellow sandstones, mudstone	3.8	9.5
Carboniferous (Calciferous Sandstone Measures)	Sandstone, loosely cemented, subangular to subrounded grains of quartz with feldspar, blue-grey to greenish grey	1.0+	10.5

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
a	13	45	42	1.6–2.6	12	15	15	11	22	25	0
				2.6–3.6	13	13	22	14	21	17	0
				Mean	13	14	19	12	21	21	0
b	11	73	16	3.6–4.5	11	28	34	11	10	6	0
a+b	12	54	34	Mean	12	19	23	12	18	16	0

NS 94 SW 3 9068 4309 Lanark Moor **Block B**

Surface level (+195.2 m) +640 ft
Water struck at +193.9 m
250 mm and 200 mm percussion
June 1977

Overburden 0.3 m
Mineral 8.8 m
Bedrock 0.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Fluvioglacial sand and gravel	**a** 'Clayey' sand Gravel: a little fine and coarse below 1.3 m, angular to subangular, basalt, white sandstone and quartz Sand: fine with medium, quartz with feldspar and shale, grey-brown becoming grey below 1.3 m Fines: silt	2.0	2.3
	b Pebbly sand Gravel: fine with coarse, angular to subangular, white, black and red sandstones, quartz, basalt, andesite and volcanic glass. Gravel content decreases with depth Sand: medium and fine with coarse, quartz with feldspar, shale and coal Fine: silt, grey, disseminated, with a thin band at 6.0 m	4.7	7.0
Till	**c** Sandy gravel, clay-bound Gravel: coarse and fine with rare cobbles up to 17 cm diameter, angular to subangular, red sandstone with green sandstone, basalt, felsite and quartz. Less gravel with depth Sand: medium and fine with coarse, subangular, quartz with feldspar, mica and shale Fines: clay, disseminated, gives an overall cohesive texture to the deposit. Thin grey silt band at 7.0 m	2.1	9.1
Carboniferous (Calciferous Sandstone Measures)	Sandstone, medium- to coarse-grained well-sorted, indurated, olive-green	0.2+	9.3

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
a	16	82	2	0.3–1.3	21	60	18	1	0	0	0	
				1.3–2.3	12	46	32	5	5	0	0	†
				Mean	16	54	25	3	2	0	0	
b	7	79	14	2.3–3.3	8	38	26	7	17	4	0	†
				3.3–4.3	6	49	26	5	11	3	0	†
				4.3–5.3	4	46	30	6	9	5	0	†
				5.3–6.0	7	30	44	9	8	2	0	†
				6.0–7.0	11	35	38	9	7	0	0	†
				Mean	7	40	32	7	11	3	0	
c	10	61	29	7.0–8.0	5	18	21	12	17	27	0	†
				8.0–9.1	14	25	34	11	9	7	0	†
				Mean	10	22	27	12	13	16	0	
a–c	10	75	15	Mean	10	39	29	7	9	6	0	
a+b	10	80	10	Mean	10	44	30	6	8	2	0	

NS 94 SW 4 9062 4211 Langloch, Lanark **Block A**

Surface level (+210.6 m) +691 ft
Water struck at +193.1 m
250 mm and 200 mm percussion
June 1977

Overburden 0.4 m
Mineral 24.1 m
(inc. 1.0 m waste)
Waste 1.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Fluvioglacial sand and gravel	**a** 'Very clayey' pebbly sand Gravel: coarse and fine with rare cobbles up to 7 cm diameter, angular to subangular Sand: fine with medium, angular quartz Fines: silt	1.0	1.4
	b Gravel Gravel: coarse and fine with rare cobbles up to 17 cm diameter, angular to rounded, white and red sandstones, basalt and volcanic glass Sand: fine to coarse, angular, quartz Fines: silt	3.1	4.5
	c Pebbly sand Gravel: fine with a little coarse, angular to subangular, felsite, andesite, basalt and shale Sand: fine and medium, angular to subangular, quartz with basalt, feldspar, green sandstone, shale, and coal from 5.5 m to 6.5 m Fines: silt	4.2	8.7
	d Sandy gravel Gravel: fine and coarse, with rare cobbles up to 11 cm diameter principally in the top metre, subangular to subrounded, red, white and green sandstones, felsite, andesite, basalt, shale, volcanic glass, quartz and schist Sand: medium with fine and coarse, quartz with basalt, feldspar, green sandstone, shale and coal. The coal is most concentrated from 10.6 m to 11.5 m Fines: clay, dark grey, disseminated, increases near base	3.8	12.5
Glaciolacustrine deposit	**e** 'Clayey' sand with silt band from 17.5 m to 18.5 m Gravel: a little fine with coarse to 13.5 m Sand: fine with medium, angular to subangular, quartz with feldspar, basalt, a little mica, and varying amounts of coal Fines: silt, occurs in sandy silt bands of varying thickness, rarely poorly laminated	12.0	24.5
	Clay, silty, micaceous, laminated, stiff, grey	1.0+	25.5

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
a	20	72	8	0.4–1.4	20	49	20	3	3	5	0	
b	9	40	51	1.4–2.6	14	11	15	8	20	32	0	
				2.6–3.5	6	8	19	14	21	32	0	
				3.5–4.5	5	11	22	14	21	27	0	
				Mean	9	10	19	12	20	30	0	
c	7	88	5	4.5–5.5	7	39	48	2	2	2	0	
				5.5–6.5	7	49	37	5	2	0	0	
				6.5–7.7	9	52	34	3	2	0	0	
				7.7–8.7	7	24	45	12	10	2	0	
				Mean	7	41	41	6	4	1	0	
d	7	61	32	8.7–9.6	4	20	31	13	14	18	0	
				9.6–10.6	7	15	39	15	17	7	0	
				10.6–11.5	7	12	24	28	21	8	0	
				11.5–12.5	8	11	19	17	25	20	0	
				Mean	7	15	28	18	19	13	0	
e	15	83	2	12.5–13.5	10	29	43	7	9	2	0	
				13.5–14.5	7	32	57	3	1	0	0	
				14.5–15.5	12	55	28	3	2	0	0	
				15.5–16.5	8	70	22	0	0	0	0	
				16.5–17.5	24	62	14	0	0	0	0	
				17.5–18.5	Silt							
				18.5–19.5	18	59	23	0	0	0	0	†
				19.5–20.5	24	59	17	0	0	0	0	†
				20.5–21.5	13	75	12	0	0	0	0	†
				21.5–22.5	15	78	7	0	0	0	0	†
				22.5–23.5	18	74	8	0	0	0	0	†
				23.5–24.5	15	81	4	0	0	0	0	†
				Mean	15	61	21	1	2	0	0	
a–e	12	74	14	Mean	12	42	26	6	7	7	0	
a–d	8	66	26	Mean	8	26	29	11	13	13	0	

NS 94 SW 5 9024 4140 Hyndford, Lanark **Block A**

Surface level (+211.6 m) + 694 ft
Water struck at +193.4 m
250 mm and 200 mm percussion
June 1977

Overburden 0.2 m
Mineral 24.8 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Fluvioglacial sand and gravel	**a** Sandy gravel Gravel: fine and coarse with rare cobbles, subrounded to subangular, white and red sandstones, felsite, basalt, quartz, andesite, gneiss, and volcanic glass. Less gravel below 4.1 m Sand: medium with fine and coarse, subangular, quartz Fines: clay	6.4	6.6
Glaciolacustrine deposit	**b** 'Clayey' sand Gravel: a little fine, principally from 6.6 m to 7.5 m. Near 25.0 m rare angular up to 11 cm diameter of red sandstone and coal Sand: fine with medium, angular to subangular, quartz with feldspar and, beneath 12.6 m, shale and coal Fines: silt, occurring in sandy silt and silty sand bands, often with coal grains. Brown clay bands from 16.5 m to 17.2 m	18.4+	25.0

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
a	5	49	46	0.2–1.0	5	9	16	10	26	34	0	
				1.0–2.2	6	13	27	9	23	22	0	
				2.2–3.1	5	10	18	12	28	27	0	
				3.1–4.1	5	11	21	10	25	23	5	
				4.1–5.5	7	12	30	13	21	17	0	
				5.5–6.6	4	19	40	5	12	13	7	
				Mean	5	13	26	10	22	22	2	
b	13	86	1	6.6–7.5	5	22	62	5	5	1	0	
				7.5–8.5	5	40	49	4	2	0	0	
				8.5–9.5	4	41	50	2	2	1	0	
				9.5–10.5	15	56	28	1	0	0	0	
				10.5–11.5	10	70	20	0	0	0	0	
				11.5–12.6	4	78	18	0	0	0	0	
				12.6–13.5	2	53	45	0	0	0	0	
				13.5–14.7	1	49	47	3	0	0	0	
				14.7–15.5	12	70	18	0	0	0	0	
				15.5–17.0	21	69	9	1	0	0	0	
				17.0–18.2	19	60	15	4	2	0	0	
				18.2–19.3	20	51	23	4	2	0	0	†
				19.3–20.5	6	57	28	7	2	0	0	†
				20.5–22.2	34	48	15	2	1	0	0	†
				22.2–23.0	19	56	24	1	0	0	0	†
				23.0–24.0	14	44	41	1	0	0	0	†
				24.0–25.0	6	45	48	1	0	0	0	†
				Mean	13	54	30	2	1	0	0	
a+b	11	76	13	Mean	11	43	29	4	6	6	1	

NS 94 SW 6 9063 4116 River Clyde, Howford, Carmichael **Block A**

Surface level (+176.4 m)+579 ft
Water struck at +173.6 m
250 mm and 200 mm percussion
June 1977

Overburden 0.3 m
Mineral 8.7 m
Waste 16.4 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Alluvium	**a** 'Very clayey' sand Sand: fine with medium, subangular, quartz, yellow Fines: silt	1.5 3.0	1.8 4.8
	b Gravel Gravel: coarse and fine with cobbles, well rounded to subrounded quartz, quartzite, greywacke, felsite, white and grey sandstones Sand: fine to coarse, subangular, quartz and rock fragments Fines: clay		
Glaciolacustrine deposit	**c** 'Clayey' pebbly sand Gravel: fine with coarse, decreasing with depth Sand: fine with medium, subangular quartz with coal Fines: silt, grey, laminated in part	4.2	9.0
	Silt, grey, micaceous, sandy to 15.5 m, becoming poorly laminated, stiff in part, with sand partings below this	16.4+	25.4

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
a	29	71	0	0.3–1.8	29	57	13	1	0	0	0	
b	5	38	57	1.8–2.8	10	13	33	12	17	15	0	
				2.8–3.8	2	6	13	13	25	29	12	†
				3.8–4.8	2	5	11	11	25	41	5	†
				Mean	5	8	19	12	22	28	6	
c	18	78	4	4.8–6.8	18	54	13	8	6	1	0	†
				6.8–8.0	19	61	13	3	1	3	0	†
				8.0–9.0	18	62	19	1	0	0	0	†
				Mean	18	58	15	5	3	1	0	
a–c	16	63	22	Mean	16	40	16	6	9	11	2	
a+b	13	49	38	Mean	13	24	17	8	15	19	4	

NS 94 SW 7 9021 4025 Prett's Mill, Carmichael **Block A**

Surface level (+178.3 m) + 585 ft
Water struck at +174.0 m
250 mm and 200 mm percussion
June 1977

Overburden 0.3 m
Mineral 21.9 m
Bedrock 0.3 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Alluvium	**a** 'Clayey' pebbly sand Gravel: fine and coarse with rare cobbles, subrounded to well rounded, cobbles bladed, reddish purple and yellowish white sandstones with coal Sand: fine with medium Fines: silt, brown, increasing with depth	2.0	2.3
Glaciolacustrine deposit	**b** Sand Gravel: trace, fine, coal Sand: fine with medium, quartz with coal Fines: silt	19.9	22.2
Lower Old Red Sandstone	Sandstone, medium-grained, micaceous, reddish brown	0.3+	22.5

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
a	18	63	18	0.3–1.3	14	28	23	7	13	15	0	
				1.3–2.3	22	53	12	4	7	2	0	
				Mean	18	41	17	6	10	8	0	
	7	93	0	2.3–3.3	29	69	1	1	0	0	0	
				3.3–4.3	23	70	7	0	0	0	0	
				4.3–5.3	14	74	12	0	0	0	0	†
				5.3–6.3	4	87	9	0	0	0	0	†
				6.3–7.3	4	82	14	0	0	0	0	†
				7.3–8.3	6	72	20	2	0	0	0	†
				8.3–9.3	5	68	23	3	1	0	0	†
				9.3–10.3	4	71	24	1	0	0	0	†
				10.3–11.3	5	70	24	1	0	0	0	†
				11.3–12.3	6	62	31	1	0	0	0	†
				12.3–13.3	5	64	30	1	0	0	0	†
				13.3–14.3	4	62	33	1	0	0	0	†
				14.3–15.3	4	58	35	3	0	0	0	†
				15.3–16.3	4	57	37	2	0	0	0	†
				16.3–17.3	4	64	30	2	0	0	0	†
				17.3–18.3	3	55	38	3	1	0	0	†
				18.3–19.3	4	60	35	1	0	0	0	†
				19.3–20.3	3	53	43	1	0	0	0	†
				20.3–21.3	2	54	43	1	0	0	0	†
				21.3–22.2	6	52	38	2	2	0	0	†
				Mean	7	65	27	1	0	0	0	
a+b	8	90	2	Mean	8	63	25	2	1	1	0	

NS 94 SW 8 9133 4471 Stickhill, Lanark **Block G_1**

Surface level (+223.4 m)+733 ft
Water not struck
250 mm percussion
May 1977

Waste 0.6 m
Bedrock 2.4 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, sandy, yellow-brown with sandstone clasts	0.3	0.6
Carboniferous (Calciferous Sandstone Measures)	Sandstone, medium- to coarse-grained with fine-grained, buff to pale yellow, carbonaceous fragments, conglomeratic bands with chert pebbles	2.4+	3.0

NS 94 SW 9 9113 4400 Huntlyhill Farm, Lanark **Block B**

Surface level (+204.3 m)+670 ft
Water struck at +202.5 m
250 mm percussion
June 1977

Overburden 1.0 m
Mineral 5.0 m
Waste 0.1 m
Bedrock 0.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, silty subsoil from 0.3 m	1.0	1.0
Fluvioglacial sand and gravel	'Clayey' sandy gravel Gravel: fine to coarse and cobbles, becoming coarser with depth, well rounded with more angular below 3.8 m, undifferentiated weathered igneous rocks, sandstones, quartz and felsite Sand: fine and medium with coarse, subangular to well rounded, quartz and rock fragments with coal Fines: silt with clay, micaceous, orange-grey	5.0	6.0
Till	Clay, silty, grey, clasts of weathered rock	0.1	6.1
Carboniferous (Calciferous Sandstone Measures)	Conglomerate, dark green, quartz fragments	0.2+	6.3

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
Fines	Sand	Gravel		Fines	Sand			Gravel			
				$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
14	60	26	1.0–2.0	11	11	18	14	26	20	0	
			2.0–3.0	21	37	15	10	12	5	0	†
			3.0–3.8	15	44	36	4	1	0	0	†
			3.8–5.0	14	32	20	4	3	4	23	†
			5.0–6.0	9	21	27	11	7	10	15	†
			Mean	14	29	23	8	10	8	8	

NS 94 SW 10 9197 4367 Sandyford Bridge, Lanark **Block C**

Surface level (+188.3 m)+618 ft
Water struck at +185.0 m
250 mm and 200 mm percussion
May 1977

Overburden 0.2 m
Mineral 2.0 m
Waste 6.8 m
Mineral 2.5 m
Waste 3.5 m
Mineral 4.3 m
Waste 1.7 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Alluvium	**a** 'Clayey' sand Sand: fine with a little medium Fines: silt, yellow-brown	2.0	2.2
Glaciolacustrine deposit	Silt, sandy, with silty clay to 4.0 m, faintly laminated, brownish grey. Becomes increasingly sandy below 4.0 m	6.8	9.0
	b Sand Sand: fine with medium, quartz with mica and coal, yellow Fines: silt	2.5	11.5
	Silt, clayey, laminated in part, grey-brown, sand partings, fine coal clasts, with rare, coarser, well-rounded felsite	3.5	15.0
Fluvioglacial sand and gravel	**c** Sand Sand: medium and fine, subangular, quartz and rock fragments, yellow Fines: silt	4.3	19.3
Till	Clay, silty in upper part, stiff, grey, with angular to well-rounded clasts of felsite and other igneous rocks, quartz	1.7+	21.0
	Borehole terminated due to slow progress		

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
a	12	88	0	0.2–1.2	14	77	9	0	0	0	0	
				1.2–2.2	11	82	7	0	0	0	0	
				Mean	12	80	8	0	0	0	0	
b	6	94	0	9.0–10.5	5	66	29	0	0	0	0	†
				10.5–11.5	7	62	31	0	0	0	0	†
				Mean	6	64	30	0	0	0	0	
c	4	96	0	15.0–16.0	4	45	50	1	0	0	0	†
				16.0–17.0	5	45	50	0	0	0	0	†
				17.0–18.0	6	51	43	0	0	0	0	†
				18.0–19.3	2	42	56	0	0	0	0	†
				Mean	4	45	50	1	0	0	0	
a–c	6	94	0	Mean	6	59	35	0	0	0	0	

NS 94 SW 11 9197 4293 Cobblehaugh Farm, Lanark **Block B**

Surface level (+189.1 m)+620 ft
Water struck at +183.8 m
250 mm and 200 mm percussion
June 1977

Overburden 0.8 m
Mineral 1.3 m
Waste 16.4 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.8	0.8
Glaciolacustrine deposit	'Very clayey' sand Sand: fine with medium, quartz Fines: clay, yellow, disseminated, with bands of grey laminated micaceous silt	1.3	2.1
	Silt, faintly laminated, dark grey, with thin stringers of fine yellow sand	1.0	3.1
	Clay, silty, laminated in part, dark to medium grey, with fine micaceous angular quartz sand between 17.5 m and 18.2 m. Very silty below 18.2 m	15.4+	18.5

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64
27	72	1	0.8–2.1	27	56	15	1	1	0	0

NS 94 SW 12 9108 4262 Winston Barracks, Lanark **Block B**

Surface level (+206.4 m) +677 ft
Water struck at +199.0 m
250 mm and 200 mm percussion
May 1977

Overburden 0.4 m
Mineral 12.9 m
(inc. 2.6 m waste)
Waste 11.7 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Fluvioglacial sand and gravel	**a** 'Clayey' sand Gravel: a little fine with coarse, rounded to well rounded Sand: medium and fine, subangular to subrounded, quartz Fines: silt, brown	4.0	4.4
Glaciolacustrine deposit	**b** 'Very clayey' sand with silt bands from 7.4 m to 8.5 m and from 9.8 m to 11.3 m Gravel: rare coal up to 5 cm diameter Sand: fine with a little medium, subangular, quartz with felsite, shale and coal Fines: silt, brown, occurs in bands of varying thickness	8.9	13.3
	Clay, grey, silty and sandy near the top, increasingly well laminated with depth. From 18.5 m to 20.5 m clasts up to 14 cm diameter of green, red and white sandstones and felsite	11.7+	25.0

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64	
a	10	86	4	0.4–1.4	23	42	28	4	3	0	0	
				1.4–2.4	7	28	54	5	5	1	0	
				2.4–3.4	5	27	60	4	3	1	0	
				3.4–4.4	6	48	41	2	1	2	0	
				Mean	10	36	46	4	3	1	0	
b	23	77	0	4.4–5.4	12	76	12	0	0	0	0	
				5.4–6.4	20	73	7	0	0	0	0	
				6.4–7.4	21	76	3	0	0	0	0	
				7.4–8.5	Silt							
				8.5–9.8	37	61	2	0	0	0	0	†
				9.8–11.3	Silt							
				11.3–12.3	25	71	4	0	0	0	0	†
				12.3–13.3	21	76	3	0	0	0	0	†
				Mean	23	72	5	0	0	0	0	
a+b	18	81	1	Mean	18	58	21	2	1	0	0	

NS 94 SW 13 9181 4178 Charleston Farm, Lanark **Block B**

Surface level (+177.3 m) + 582 ft
Water struck at +174.5 m
250 mm percussion
July 1977

Overburden 0.6 m
Mineral 7.6 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.6	0.6
Alluvium	**a** 'Very clayey' sand Sand: fine with medium, quartz with feldspar, mica and basalt Fines: silt	2.2	2.8
Fluvioglacial sand and gravel	**b** Pebbly sand Gravel: fine with coarse and rare cobbles up to 16 cm diameter, angular, green and red sandstones, quartz, felsite and volcanic glass Sand: medium with fine and a little coarse, quartz with feldspar, mica and basalt Fines: silt	5.4+	8.2
	Borehole terminated on ? bedrock		

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64	
a	24	76	0	0.6–1.6	26	57	17	0	0	0	0	
				1.6–2.8	22	57	20	0	1	0	0	
				Mean	24	57	18	1	0	0	0	
b	6	78	16	2.8–3.8	16	43	16	4	13	8	0	†
				3.8–4.8	4	24	42	15	14	1	0	†
				4.8–5.8	1	30	58	8	3	0	0	†
				5.8–6.8	3	27	35	9	22	4	0	†
				6.8–8.2	5	16	44	19	14	2	0	†
				Mean	6	27	39	12	13	3	0	
a+b	11	78	11	Mean	11	36	33	9	9	2	0	

NS 94 SW 14 9105 4132 Hyndford Bridge, Lanark **Block A**

Surface level (+176.9 m) + 580 ft
Water struck at +172.4 m
250 mm and 200 mm percussion
June 1977

Overburden 3.5 m
Mineral 21.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Alluvium	Silt with fine sand, light brown	2.0	2.5
	Clay, sandy, banded, light grey	1.0	3.5
	a 'Very clayey' pebbly sand Gravel: coarse Sand: fine with a little medium, angular, quartz with feldspar and mica. Becomes sandier with depth Fines: silt, grey	1.0	4.5
Fluvioglacial sand and gravel	**b** Sandy gravel Gravel: coarse and fine with sporadic cobbles up to 15 cm diameter, subangular, red sandstone, basalt, quartz and felsite Sand: medium with fine and coarse, angular, quartz and green sandstone with basalt and felsite. More sand below 5.5 m Fines: silt	2.5	7.0
	c 'Clayey' sand Gravel: a little fine with coarse, principally from 11.0 m to 12.0 m. Angular, red sandstone with quartz, basalt, felsite and coal Sand: fine with medium, angular to subangular, quartz with feldspar, mica and coal Fines: silt	8.0	15.0
	d Pebbly sand Gravel: fine and coarse, with rare cobbles up to 14 cm diameter above 17.0 m, subrounded to subangular, white and red sandstones, felsite, basalt, gneiss and schist Sand: medium and fine with coarse, quartz with felsite, basalt, red sandstone and, beneath 17.0 m, coal Fines: silt	4.0	19.0
	e Sandy gravel Gravel: fine and coarse, with rare cobbles up to 16 cm diameter, subrounded to subangular, red, white and green sandstones, felsite, basalt and tuff Sand: medium with coarse and fine, quartz with felsite, basalt, red sandstone and coal Fines: silt	5.5+	24.5

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
a	29	65	6	3.5–4.5	29	58	7	0	0	6	0	
b	4	49	47	4.5–5.5	3	9	20	10	18	28	12	†
				5.5–7.0	5	17	28	10	20	20	0	†
				Mean	4	14	25	10	19	23	5	
c	10	88	2	7.0–8.0	20	63	14	2	1	0	0	†
				8.0–9.0	15	67	17	1	0	0	0	†
				9.0–10.0	15	45	37	2	1	0	0	†
				10.0–11.0	6	41	51	2	0	0	0	†
				11.0–12.0	10	36	38	5	8	3	0	†
				12.0–13.0	6	45	43	4	2	0	0	†
				13.0–14.0	4	43	49	2	2	0	0	†
				14.0–15.0	4	55	39	2	0	0	0	†
				Mean	10	49	36	2	2	1	0	
d	4	84	12	15.0–16.0	5	34	39	11	8	3	0	†
				16.0–17.0	3	24	41	17	4	11	0	†
				17.0–18.0	5	34	35	14	8	4	0	†
				18.0–19.0	3	33	43	11	5	5	0	†
				Mean	4	31	40	13	6	6	0	
e	3	60	37	19.0–20.0	3	16	29	12	16	24	0	†
				20.0–21.0	3	11	22	12	25	27	0	†
				21.0–22.0	2	8	31	25	24	10	0	†
				22.0–23.0	2	8	36	18	16	20	0	†
				23.0–24.0	4	8	36	19	24	9	0	†
				24.0–24.5	3	13	49	9	16	10	0	†
				Mean	3	11	32	17	20	17	0	
a–e	7	74	19	Mean	7	32	33	9	9	9	1	
b–e	6	74	20	Mean	6	31	34	9	10	9	1	

NS 94 SW 15 9121 4079 Howford Farm, Carmichael **Block A**

Surface level (+203.8 m) +669 ft
Water struck at +201.7 m
250 mm and 200 mm percussion
June 1977

Overburden 0.5 m
Mineral 5.8 m
(inc. 0.3 m waste)
Waste 11.9 m
Bedrock 1.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Fluvioglacial sand and gravel	**a** Pebbly sand Gravel: fine and coarse, rare below 2.7 m, well rounded, felsite, quartz and sandstone Sand: medium with fine and a little coarse, subangular, quartz with rock fragments, coal rich bands Fines: silt	3.6	4.1
Till	Clay, sandy, red-brown, with clasts up to boulder size of purple sandstone	0.3	4.4
	b Gravel, clay bound Gravel: coarse with fine and cobbles, subangular to well rounded, purple sandstone, dolerite, basalt, felsite and quartz Sand: fine with medium and coarse, subangular, quartz and rock fragments Fines: clay, red-brown, stiff, binding the sand and gravel fractions	1.9	6.3
	Clay, silty, stiff, red-brown with angular clasts, principally of red sandstone and felsite with (**c**) 'clayey' sandy gravel from 10.5 m to 11.5 m	11.9	18.2
Devono-Carboniferous	Sandstone, medium-grained, soft, buff	1.2+	19.4

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
a	10	84	6	0.5–1.5	14	24	43	7	6	6	0	
				1.5–2.7	10	18	50	12	7	3	0	†
				2.7–4.1	6	52	39	3	0	0	0	†
				Mean	10	33	44	7	4	2	0	
b	10	38	53	4.4–5.2	14	27	14	7	14	13	11	†
				5.2–6.3	6	14	10	6	16	40	8	†
				Mean	10	19	11	7	15	29	9	
c	16	60	24	10.5–11.5	16	30	20	10	18	6	0	†*
a+b	10	68	22	Mean	10	28	33	7	7	12	3	

NS 94 SW 16 9276 4433 **Corbiehall Farm, Carstairs** **Block B**

Surface level (+210.8 m) + 692 ft
Water struck at +197.1 m
250 mm and 200 mm percussion
May 1977

Overburden 0.2 m
Mineral 14.2 m
Waste 8.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Fluvioglacial sand and gravel	**a** Gravel Gravel: coarse and fine with rare cobbles, subangular to well rounded, the coarser being more rounded, greenish grey and yellow, medium-grained sandstones, with felsite, quartz, purple sandstone and porphyry Sand: medium with coarse and fine, subangular, quartz with rock fragments Fines: silt, thin bands of orange sandy clay	3.2	3.4
Glaciolacustrine deposit	**b** 'Very clayey' sand Gravel: rare fine and coarse above 5.1 m Sand: fine with medium, more medium above 6.1 m Fines: silt, orange-brown, disseminated and as thin bands, often with coal. Becomes clayey below 13.4 m	11.0	14.4
	Silt, sandy, clay bands, faintly laminated, soft, bluish grey	8.1+	22.5

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
a	6	47	47	0.2–1.2	5	7	21	14	22	25	6	
				1.2–2.2	4	9	28	17	20	22	0	
				2.2–3.4	9	9	22	13	15	22	10	
				Mean	6	8	24	15	19	23	5	
b	21	79	0	3.4–4.4	12	33	46	3	3	3	0	
				4.4–5.1	9	41	48	1	1	0	0	
				5.1–6.1	14	55	30	1	0	0	0	
				6.1–7.3	27	65	8	0	0	0	0	
				7.3–8.3	22	72	6	0	0	0	0	
				8.3–9.3	18	76	5	1	0	0	0	
				9.3–10.3	15	79	6	0	0	0	0	
				10.3–11.0	30	68	2	0	0	0	0	
				11.0–12.0	23	67	10	0	0	0	0	
				12.0–13.4	20	73	7	0	0	0	0	
				13.4–14.0	38	59	3	0	0	0	0	†
				Mean	21	63	15	1	0	0	0	
a+b	18	72	10	Mean	18	51	17	4	4	5	1	

NS 94 SW 17 9285 4320 Easter Sills Farm, Pettinain **Block C**

Surface level (+187.2 m)+614 ft
Water struck at +184.9 m
250 mm and 200 mm percussion
June 1977

Overburden 1.3 m
Mineral 3.4 m
Waste 20.3 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
Alluvium	Clay, silty, cohesive, orange-brown	1.3	1.3
	a 'Very clayey' pebbly sand Gravel: mainly below 2.3 m, fine, rare cobbles, subangular to well rounded, the coarser material being more rounded, reddish brown and yellowish white sandstones, greywacke, quartz and coal Sand: medium with fine and coarse, rounded to subangular Fines: silt, less with depth, band at 1.9 m	3.4	4.7
Glaciolacustrine deposit	Clay, silty, laminated, cohesive, grey, silt partings, stringer of gravel and coarse sand from 4.7 m to 5.0 m, sandy below 10.0 m	10.3	15.0
	b 'Very clayey' sand Sand: fine, medium brown, coaly Fines: silt	1.0	16.0
	Silt, sandy with **c** 'very clayey' sand band from 21.5 m to 22.5 m, less sandy bands are laminated, brown	9.0+	25.0

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
a	22	65	13	1.3–2.3	38	29	26	4	3	0	0	
				2.3–3.3	19	12	32	13	22	2	0	†
				3.3–4.7	14	13	45	16	12	0	0	†
				Mean	22	17	36	12	12	1	0	
b	33	67	0	15.0–16.0	33	66	1	0	0	0	0	†*
c	26	74	0	21.5–22.5	26	70	4	0	0	0	0	†*

NS 94 SW 18 9255 4237 Cobblehaugh Farm, Lanark **Block B**

Surface level (+194.0 m)+636 ft
Water struck at +186.7 m
250 mm and 200 mm percussion
June 1977

Waste 13.4 m
Bedrock 0.3 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Glaciolacustrine deposit	Clay, laminated, stiff in parts, light brown becoming dark brown to grey at depth with fine sand laminae	3.8	4.3
	Silt, sandy, micaceous, yellow-brown	3.0	7.3
Till	'Very clayey' sandy gravel Gravel: fine, coarse and cobbles, subrounded to well rounded, felsite and dark igneous clasts Sand: fine with coarse and medium, quartz Fines: clay	1.5	8.8
	Clay, stiff, sandy, dark red-brown, clasts of felsite, purple sandstone and basalt up to 30 cm diameter	4.6	13.4
Carboniferous (Calciferous Sandstone Measures)	Basalt, fine-grained, dark grey	0.3+	13.7

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
Fines	Sand	Gravel		Fines	Sand			Gravel			
				$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
18	46	36	7.3–8.3	16	23	13	6	9	23	10	†*
			8.3–8.8	22	29	17	10	15	7	0	†*
			Mean	18	25	14	7	11	18	7	

NS 94 SW 19 9373 4447 Carstairs House **Block D**

Surface level (+208.2 m) +683 ft
Water struck at +201.5 m
250 mm and 200 mm percussion
May 1977

Overburden 2.7 m
Mineral 11.0 m
(inc. 1.0 m waste)
Waste 2.1 m
Bedrock 0.9 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glaciolacustrine deposit	Silt, light brown, angular clasts up to 10 cm diameter of predominantly green sandstone with some quartz	2.4	2.7
	a 'Very clayey' sand with silt band from 4.7 m to 5.7 m Sand: fine, subangular, quartz with felsite. A little coarse sand and rare fine gravel of felsite, quartz, coal and shale below 5.7 m Fines: silt and clay, brown, micaceous	4.0	6.7
Fluvioglacial sand and gravel	**b** Sandy gravel Gravel: coarse and fine with rare cobbles up to 10 cm diameter, subangular to subrounded, green and red sandstones, basalt, felsite and quartz Sand: fine to coarse, angular to subangular, quartz, felsite, green sandstone, basalt and shale Fines: silt	3.0	9.7
Glaciolacustrine deposit	**c** 'Clayey' sand Gravel: fine, felsite, red and green sandstones, shale Sand: fine with medium, subangular, quartz with felsite and shale Fines: silt	3.0	12.7
Till	**d** 'Very clayey' sandy gravel Gravel: fine with coarse and rare cobbles up to 10 cm diameter, subangular, green, with some red, sandstone Sand: fine with medium and coarse Fines: clay, red	1.0	13.7
	Clay, sandy, red, very stiff, clasts of predominantly red and green mottled mudstone becoming more dominant with depth, with some green sandstone	2.1	15.8
Carboniferous (Calciferous Sandstone Measures)	Mudstone, green and red mottled, soft, becomes brittle, reddish brown and laminated below 16.5 m. Fine-grained green sandstone band from 16.3 m to 16.5 m	0.9+	16.7

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
a	36	64	0	2.7–3.7	35	63	1	1	0	0	0	
				3.7–4.7	38	61	1	0	0	0	0	
				4.7–5.7	Silt							
				5.7–6.7	33	63	4	0	0	0	0	
				Mean	36	62	2	0	0	0	0	
b	5	49	46	6.7–7.7	6	24	14	10	15	31	0	†
				7.7–8.7	6	14	11	13	29	27	0	†
				8.7–9.7	4	19	23	18	20	16	0	†
				Mean	5	19	16	14	21	25	0	
c	12	85	3	9.7–10.7	12	51	29	5	3	0	0	†
				10.7–11.7	10	56	25	5	4	0	0	†
				11.7–12.7	13	67	15	2	2	1	0	†
				Mean	12	58	23	4	3	0	0	
d	11	60	29	12.7–13.7	11	37	14	9	18	11	0	†
a–d	17	65	18	Mean	17	45	14	6	9	9	0	
a+c	23	75	2	Mean	23	60	13	2	2	0	0	

NS 94 SW 20 9363 4271 Westown Farm, Pettinain **Block G_4**

Surface level (+211.7 m) +695 ft
Water not struck
250 mm percussion
June 1977

Overburden 0.4 m
Mineral 3.2 m
Waste 1.8 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Till	'Very clayey' sandy gravel Gravel: coarse and fine with rare cobbles, subrounded, red-purple sandstone Sand: fine with medium Fines: clay, red	3.2	3.6
	Clay, very compact, with subangular to well-rounded clasts up to boulder size of purple sandstone and dark grey igneous rock	1.8+	5.4
	Borehole terminated due to boulder obstruction		

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64
23	55	22	0.4–1.4	26	30	19	4	8	13	0 *
			1.4–2.4	23	29	21	4	7	10	6 *
			2.4–3.6	21	32	20	4	9	14	0 *
			Mean	23	31	20	4	8	12	2

NS 94 SW 21 9461 4492 Carstairs Mains **Block D**

Surface level (+209.9 m) +689 ft
Water struck at +206.9 m
250 mm percussion
May 1977

Overburden 1.0 m
Mineral 4.9 m
Waste 0.6 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Glaciolacustrine deposit	Clay, sandy, moderately stiff, light brown, with subangular to angular clasts up to 8 cm diameter of green and red sandstones and felsite	0.5	1.0
Fluvioglacial sand and gravel	**a** 'Very clayey' pebbly sand Gravel: fine with coarse, principally below 2.0 m depth, and rare cobbles up to 8 cm diameter near the base, subangular, green sandstone and felsite Sand: fine with medium and coarse, subangular to subrounded, quartz Fines: silt, light brown	2.0	3.0
	b 'Clayey' sandy gravel Gravel: fine and coarse with cobbles up to 15 cm diameter, subrounded to angular, green sandstone with red sandstone, felsite, shale, quartz, yellow mudstone and volcanic glass Sand: fine to coarse Fines: silt	2.9	5.9
Till	Clay, olive-green, many angular clasts of green mudstone with fragments of shale, black sandstone and felsite	0.6+	6.5
	Borehole terminated due to technical reasons		

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
a	24	69	7	1.0–2.0	27	43	22	7	1	0	0	
				2.0–3.0	20	23	27	17	9	4	0	
				Mean	24	33	24	12	5	2	0	
b	10	49	41	3.0–4.0	14	15	17	19	20	12	3	†
				4.0–5.0	8	9	15	21	23	20	4	†
				5.0–5.6	7	9	19	26	23	10	6	†
				5.6–5.9	No data available							†
				Mean	10	11	17	21	22	15	4	
a+b	16	58	26	Mean	16	20	20	18	15	9	2	

NS 94 SW 22 9452 4409 Carstairs House **Block C**

Surface level (+187.6 m)+615 ft
Water struck at +185.6 m
250 mm and 200 mm percussion
May 1977

Overburden 1.0 m
Mineral 2.0 m
Waste 15.0 m
Mineral 7.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
Alluvium	Silt, grey-brown, with much fine sand which increases with depth	1.0	1.0
	a 'Clayey' pebbly sand Gravel: fine Sand: fine and medium with coarse, subangular, quartz with felsite, basalt and shale Fines: silt	2.0	3.0
Glaciolacustrine deposit	Clay, silty from 9.0 m to 11.0 m and below 15.0 m, sandy below 16.5 m, laminated, stiff, grey	15.0	18.0
	b 'Clayey' sand Sand: fine with medium, subrounded to subangular, quartz with feldspar, shale and coal Fines: silt, grey	7.0+	25.0

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
a	12	84	4	1.0–2.0	13	33	40	10	4	0	0	
				2.0–3.0	11	49	25	10	5	0	0	†
				Mean	12	41	32	10	5	0	0	
b	19	81	0	18.0–19.0	25	66	8	1	0	0	0	†
				19.0–20.0	30	63	7	0	0	0	0	†
				20.0–21.0	23	63	13	1	0	0	0	†
				21.0–22.0	15	68	16	1	0	0	0	†
				22.0–23.0	18	64	18	0	0	0	0	†
				23.0–24.0	10	57	32	1	0	0	0	†
				24.0–25.0	11	57	31	1	0	0	0	†
				Mean	19	62	18	1	0	0	0	
a+b	17	82	1	Mean	17	58	21	3	1	0	0	

NS 94 SE 1 9520 4467 **Strawfrank, Carstairs** **Block D**

Surface level (+203.3 m) + 667 ft
Water struck at +202.9 m
250 m percussion
May 1977

Overburden 0.4 m
Mineral 5.2 m
(inc. 1.0 m waste)
Bedrock 3.4 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Glaciolacustrine deposit	'Very clayey' sand with silt band from 3.4 m to 4.4 m Gravel: restricted to top 0.5 m, fine, coarse and cobbles up to 9 cm diameter Sand: fine with medium, angular to subangular, quartz with felsite Fines: silt, brown, in sandy silt bands of varying thickness	5.0	5.4
	Gravel, sandy, an ill-sorted basal deposit, including cobbles up to 15 cm diameter of green and red sandstones, conglomerate, felsite, quartzite, andesite, basalt and volcanic glass	0.2	5.6
Carboniferous (Calciferous Sandstone Measures)	Mudstone, soft, highly weathered, with red and green mottling	2.6	8.2
	Sandstone, green, to 8.5 m fine-grained and interbedded with mudstone, below this coarser grained with no mudstone	0.8+	9.0

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
Fines	Sand	Gravel		Fines	Sand			Gravel			
				$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
22	75	3	0.4–1.4	15	34	35	4	5	3	4	†
			1.4–2.4	25	46	27	1	1	0	0	†
			2.4–3.4	22	51	26	1	0	0	0	†
			3.4–4.4	Silt							
			4.4–5.6	28	56	16	0	0	0	0	†
			Mean	22	47	26	2	1	1	1	

NS 94 SE 2 9590 4403 Bagmoors Farm, Pettinain **Block D**

Surface level (+201.5 m)+661 ft
Water struck at +196.0 m
250 mm and 200 mm percussion
May 1977

Overburden 0.5 m
Mineral 11.5 m
Waste 3.0 m
Bedrock 0.3 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Glaciolacustrine deposit	**a** 'Clayey' sand Gravel: fine with coarse, rare cobbles up to 15 cm diameter, angular, basalt with felsite, principally from 1.5 m to 2.5 m and 7.5 m to 10.5 m Sand: fine with a little medium and coarse, subangular, quartz Fines: silt, with carbonaceous bands between 3.5 m and 4.5 m	10.0	10.5
Till	**b** 'Very clayey' sandy gravel Gravel: coarse with fine, rare cobbles up to 8 cm diameter, angular to subrounded, basalt, red, yellow and green sandstones Sand: fine with a little medium and coarse Fines: silt	1.5	12.0
	Clay, sandy, reddish brown, clasts up to 13.5 cm diameter of basalt with sandstone	3.0	15.0
Carboniferous (Calciferous Sandstone Measures)	Basalt, microcrystalline, black, amygdaloidal	0.3+	15.3

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
a	15	84	1	0.5–1.5	11	76	11	1	1	0	0	
				1.5–2.5	17	68	8	2	2	3	0	
				2.5–3.5	12	86	2	0	0	0	0	
				3.5–4.5	15	82	3	0	0	0	0	
				4.5–5.5	15	83	2	0	0	0	0	
				5.5–6.5	14	85	1	0	0	0	0	†
				6.5–7.5	11	89	0	0	0	0	0	†
				7.5–8.5	15	71	5	6	3	0	0	†
				8.5–9.5	9	85	3	2	1	0	0	†
				9.5–10.5	36	62	1	1	0	0	0	†
				Mean	15	79	4	1	1	0	0	
b	26	50	24	10.5–12.0	26	46	2	2	5	19	0	†
a+b	17	79	4	Mean	17	74	4	1	1	3	0	

NS 94 SE 3 9672 4473 Lampits Farm, Carnwath **Block C**

Surface level (+189.9 m) +623 ft
Water struck at +187.8 m
250 mm and 200 mm percussion
November 1976

Overburden 0.3 m
Mineral 2.0 m
Waste 18.7 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Alluvium	'Clayey' sandy gravel Gravel: fine with coarse, rare cobbles up to 5 cm diameter, subangular, greywacke with felsite Sand: medium with fine and coarse, quartz and rock fragments Fines: clay and silt, light brown	2.0	2.3
Glaciolacustrine deposit	Clay with silt increasing with depth, poorly laminated, very stiff, black	18.7+	21.0

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
Fines	Sand	Gravel		Fines	Sand			Gravel			
				$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
16	49	35	0.3–1.3	13	11	22	9	21	24	0	
			1.3–2.3	19	21	27	9	24	0	0	†
			Mean	16	16	24	9	23	12	0	

NS 94 SE 4 9628 4352 Eastfield Farm, Pettinain **Block G_4**

Surface level (+216.0 m)+709 ft
Water struck at +210.0 m
250 mm percussion
April 1977

Overburden 2.3 m
Mineral 3.7 m
Bedrock 0.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	'Clayey' sandy gravel Gravel: fine to coarse with cobbles up to 14 cm diameter, angular to subrounded, black sandstone Sand: medium, subangular, quartz Fines: silt	0.5	0.8
	Clay, moderately stiff, red, angular to subangular clasts up to cobble size, red sandstone with basalt and yellow sandstone	1.5	2.3
	'Very clayey' sandy gravel Gravel: fine and coarse, rare cobbles up to 20 cm diameter, angular, red sandstone with rare basalt, volcanic glass and felsite below 5.3 m Sand: fine and medium with coarse Fines: silt and clay	3.7	6.0
Devono-Carboniferous	Sandstone with a little conglomerate, purplish red with green reduction spots, indurated	0.2+	6.2

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64
20	51	29	2.3–3.2	23	29	12	4	10	22	0 *
			3.2–4.3	21	19	22	11	15	12	0 *
			4.3–5.3	20	14	26	16	15	9	0 *
			5.3–6.0	16	13	21	13	19	18	0 *
			Mean	20	19	21	11	15	14	0

NS 94 SE 5 9764 4490 **Bankhead Farm, Carnwath** **Block D**

Surface level (+207.2 m) + 680 ft
Water struck at +205.7 m
250 mm and 200 mm percussion
March 1977

Overburden 0.5 m
Mineral 4.7 m
Waste 2.0 m
Mineral 5.5 m
Waste 1.8 m
Bedrock 0.3 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Fluvioglacial sand and gravel	**a** 'Clayey' pebbly sand Gravel: fine with coarse and rare cobbles up to 14 cm, angular to subangular felsite, and basalt. No gravel above 1.5 m Sand: fine with medium, subrounded, quartz with basalt and rare felsite Fines: silt, increasing near the base	2.7	3.2
Till	**b** Gravel, grading into the underlying cohesive till Gravel: fine, coarse and cobbles up to 24 cm diameter, angular to subangular, weathered basalt and felsite with green and yellow sandstones. The largest clasts are all basalt Sand: fine with medium and coarse, subrounded with subangular, quartz with basalt and felsite Fines: silt, reddish brown	2.0	5.2
	Clay, brownish grey, clasts of vesicular basalt with quartz and felsite	2.0	7.2
Fluvioglacial sand and gravel	**c** 'Clayey' sand Sand: fine, angular to subangular, quartz with felsite and basalt Fines: silt	1.8	9.0
	d Sandy gravel Gravel: coarse and fine with cobbles up to 20 cm diameter, subrounded to angular, vesicular basalt and green sandstone with felsite and trace crinoidal limestone Sand: fine with medium and coarse, subrounded to subangular Fines: silt, disseminated, increasing near base, thin clayey band at 10.7 m	3.7	12.7
Till	Clay, very stiff, brownish grey, with subrounded to angular clasts of green sandstone and shale with felsite	1.8	14.5
Carboniferous (Calciferous Sandstone Measures)	Basalt, fine-grained, tuffaceous including angular clasts of basalt with rare sandstone. Locally weathered green	0.3+	14.8

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
a	11	82	7	0.5–1.5	7	52	33	6	1	1	0	
				1.5–2.8	10	57	19	6	6	2	0	†
				2.8–3.2	23	49	9	3	6	10	0	†
				Mean	11	54	23	5	4	3	0	
b	10	42	48	3.2–4.2	11	33	14	11	16	15	0	†
				4.2–5.2	9	15	6	5	11	22	32	†
				Mean	10	24	10	8	14	18	16	
c	10	90	0	7.2–8.2	10	90	0	0	0	0	0	†
				8.2–9.0	11	88	1	0	0	0	0	†
				Mean	10	89	1	0	0	0	0	
d	8	57	35	9.0–10.2	9	38	19	9	10	15	0	†
				10.2–10.7	7	26	17	7	12	31	0	†
				10.7–11.7	5	23	18	15	20	14	5	†
				11.7–12.7	12	26	13	11	12	17	9	†
				Mean	8	29	17	11	14	17	4	
a–d	10	66	24	Mean	10	45	14	7	9	11	4	
a, c+d	9	72	19	Mean	9	50	15	7	8	9	2	

NS 94 SE 6 9705 4411 **River Clyde, Eastfield, Pettinain** **Block C**

Surface level (+188.2 m) + 617 ft
Water struck at +186.7 m
250 mm and 200 mm percussion
April 1977

Overburden 1.0 m
Mineral 5.4 m
Waste 16.1 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
Alluvium	Silt, grey-brown	1.0	1.0
	Gravel Gravel: fine with coarse, rare cobbles up to 7.5 cm diameter, angular with subangular, greywacke with quartz, felsite, green sandstone, shale, andesite and volcanic glass Sand: medium and coarse with fine, angular to subangular, quartz with basalt Fines: silt, grey-brown, with grey clay bands at 4.0 m depth. Peat from 5.5 m to 5.6 m	5.4	6.4
Glaciolacustrine deposit	Clay, stiff, laminated, grey, thin silt bands	16.1+	22.5

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64
6	38	56	1.0–2.0	17	12	22	14	34	1	0
			2.0–3.0	1	3	21	16	47	12	0
			3.0–4.0	2	4	16	16	48	14	0
			4.0–5.0	7	8	15	16	35	19	0
			5.0–6.4	2	4	11	17	53	13	0
			Mean	6	6	16	16	44	12	0

NS 94 SE 7 9744 4337 **River Clyde, Muirhouse, Libberton** **Block C**

Surface level (+188.8 m)+619 ft
Water struck at +187.5 m
250 mm and 200 mm percussion
March 1977

Overburden 1.3 m
Mineral 3.5 m
Waste 17.9 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Alluvium	Clay, moderately stiff, grey-brown	0.8	1.3
	Gravel Gravel: fine with coarse and rare cobbles up to 8.0 cm diameter, subrounded with subangular to angular, greywacke with felsite, quartz, conglomerate, yellow and red sandstones Sand: coarse and medium with fine, angular to subangular, quartz with basalt and felsite Fines: silt, disseminated and in band from 4.3 m to 4.4 m with plant matter	3.5	4.8
Glaciolacustrine deposit	Clay, stiff, laminated, grey	17.9+	22.7

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
Fines	Sand	Gravel		Fines	Sand			Gravel			
				$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
2	28	70	1.3–2.3	2	3	10	16	42	27	0	†
			2.3–3.3	2	4	18	24	37	15	0	†
			3.3–4.3	1	0	1	7	58	33	0	†
			4.3–4.8	4	3	10	16	44	23	0	†
			Mean	2	2	10	16	45	25	0	

NS 94 SE 8 9755 4198 Southholm, Pettinain **Block G_4**

Surface level (+204.9 m)+672 ft
Water struck at +202.3 m
250 mm percussion
April 1977

Overburden 0.3 m
Mineral 2.3 m
Bedrock 0.6 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	'Clayey' sandy gravel Gravel: fine to coarse, and cobbles up to 20 cm diameter, angular, red sandstone with basalt and conglomerate. Most coarse material concentrated at base of the deposit Sand: fine with medium and coarse, subangular, quartz Fines: silt, red	2.3	2.6
Devono-Carboniferous	Sandstone, well-sorted, indurated	0.6+	3.2

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64
15	51	34	0.3–1.3	14	27	19	10	17	13	0 *
			1.3–2.6	17	29	12	6	5	4	27 *
			Mean	15	28	15	8	11	8	15

NS 94 SE 9 9875 4492 Spittal Farm, Carnwath **Block D**

Surface level (+196.8 m)+646 ft
Water struck at +194.9 m
250 mm and 200 mm percussion
March 1977

Overburden 0.9 m
Mineral 2.1 m
Waste 2.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.7	0.7
Solifluction deposit	Clay, silty, brown-black	0.2	0.9
	'Clayey' gravel Gravel: cobbles, with coarse and fine, up to 20 cm diameter, angular to subangular with the smaller pebbles subrounded, red and green sandstones with felsite and basalt Sand: fine and medium with coarse, angular to subangular, quartz Fines: clay	2.1	3.0
Till	Clay, increasingly stiff with depth, red, clasts up to 70 cm diameter of red sandstone	2.0+	5.0
	Borehole terminated due to boulder obstruction		

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
Fines	Sand	Gravel		Fines	Sand			Gravel			
				$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
15	34	51	0.9–1.9	12	15	16	6	12	14	25	
			1.9–3.0	17	21	7	4	9	14	28	†
			Mean	15	18	11	5	10	14	27	

NS 94 SE 10 9807 4432 Roseburgh Bridge, Carnwath **Block C**

Surface level (+187.9 m) +616 ft
Water struck at +186.9 m
250 mm and 200 mm percussion
March 1977

Overburden 3.0 m
Mineral 5.0 m
Waste 15.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Alluvium	Clay, grey with brown mottling becoming uniformly grey with depth. Plant matter	2.5	3.0
	a Gravel Gravel: fine with coarse and rare cobbles up to 7 cm diameter, angular, greywacke with red sandstone, felsite and quartz Sand: coarse and medium with fine Fines: silt	1.0	4.0
Glaciolacustrine deposit	**b** Sand Gravel: fine with coarse, rare cobbles up to 12 cm diameter, subrounded to angular, basalt with felsite, red sandstone and quartz. No gravel below 6.0 m Sand: fine with medium, angular to subangular, quartz with basalt and felsite Fines: silt, in bands below 6.0 m	4.0	8.0
	Silt, grey with black bands between 9.0 m and 9.5 m, with micaceous sand concentrated near 8.0 m and between 10.5 m and 11.5 m	4.0	12.0
	Clay, laminated in part, grey	11.0+	23.0

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
a	3	35	62	3.0–4.0	3	3	15	17	49	13	0	†
b	10	88	2	4.0–5.0	3	40	43	6	6	2	0	†
				5.0–6.0	7	54	35	3	1	0	0	†
				6.0–7.0	12	85	3	0	0	0	0	†
				7.0–8.0	19	65	15	1	0	0	0	†
				Mean	10	61	24	3	2	0	0	
a+b	8	77	14	Mean	8	50	22	6	11	3	0	

NS 94 SE 11 9896 4429 Brownhill Farm, Libberton **Block D**

Surface level (+200.4 m) + 657 ft
Water struck at +197.9 m
250 mm and 200 mm percussion
April 1977

Overburden 0.5 m
Mineral 4.0 m
(inc. 1.0 m waste)
Waste 17.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Glaciolacustrine deposit	'Clayey' sand with sandy silt from 2.5 m to 3.5 m Sand: fine with a little medium, subrounded, quartz with basalt Fines: silt, grey, occurs in bands between 2.5 m and 3.5 m	4.0	4.5
	Silt, grey, sandy bands	1.0	5.5
	Clay, laminated, grey, some brown silt laminae	16.5+	22.0

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
Fines	Sand	Gravel		Fines	Sand			Gravel			
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64	
18	82	0	0.5–1.5	7	86	6	1	0	0	0	
			1.5–2.5	17	66	16	1	0	0	0	
			2.5–3.5	Sandy silt							
			3.5–4.5	29	70	1	0	0	0	0	†
			Mean	18	74	7	1	0	0	0	

NS 94 SE 12 9855 4349 **Muirhouse Farm, Libberton** **Block D**

Surface level (+203.7 m)+668 ft
Water struck at +202.2 m
250 mm percussion
March 1977

Overburden 0.4 m
Mineral 2.3 m
Waste 4.3 m
Bedrock 0.3 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Glaciolacustrine deposit	**a** 'Clayey' sand Gravel: fine with coarse, subangular Sand: fine with medium, subrounded to subangular, quartz with felsite and basalt Fines: clay	2.3	2.7
	Clay, stiff, laminated, grey, rare brown silt bands	1.9	4.6
Till	Clay, stiff, grey, angular to subangular clasts of basalt, grey and red sandstones, quartz, schist and felsite	1.4	6.0
Fluvioglacial sand and gravel	**b** Sandy gravel Gravel: fine with coarse and rare cobbles up to 14 cm diameter, angular to subangular, basalt, red and green sandstones, felsite Sand: coarse with medium and fine Fines: a little clay	1.0	7.0
Carboniferous (Calciferous Sandstone Measures)	Basalt, microcrystalline, amygdaloidal, black	0.3+	7.3

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
a	11	88	2	0.4–1.4	10	67	19	2	2	0	0	
				1.4–2.7	12	71	14	2	1	0	0	†
				Mean	11	69	17	2	1	0	0	
b	3	56	41	6.0–7.0	3	11	20	25	25	16	0	†*

NS 94 SE 13 9833 4221 Yett Farm, Libberton **Block G_3**

Surface level (+199.9 m)+656 ft
Water struck at +189.5 m
250 mm and 200 mm percussion
April 1977

Overburden 0.4 m
Mineral 4.0 m
Waste 6.0 m
Mineral 14.8 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Fluvioglacial sand and gravel	**a** 'Very clayey' pebbly sand Gravel: fine and coarse with cobbles up to 14 cm diameter, subangular to subrounded, basalt with red sandstone and felsite Sand: fine with medium and coarse, angular to subrounded, quartz with basalt and felsite Fines: clay	4.0	4.4
Till	Clay, moderately stiff, red, angular to subrounded clasts up to 16 cm diameter of basalt, tuff, red sandstone, felsite and quartzite	6.0	10.4
Fluvioglacial sand and gravel	**b** Pebbly sand Gravel: fine with coarse and rare cobbles up to 16 cm diameter, rounded to angular, red and yellow sandstones, felsite, quartz, volcanic glass, andesite and basalt Sand: medium and fine with coarse, angular to subangular, quartz with felsite, slate, basalt and coal Fines: silt	5.8	16.2
	c Sand Gravel: a little fine with coarse Sand: fine with medium, angular to subangular, quartz with felsite, slate, basalt and coal Fines: silt	1.0	17.2
	d Sandy gravel Gravel: coarse with fine and cobbles up to 13 cm diameter, yellow and red sandstones, basalt, schist, andesite, quartzite and granite Sand: medium and fine, angular to subangular, quartz with felsite, slate, basalt and coal Fines: silt, in bands between 19.5 m and 19.7 m	4.0	21.2
	e Sand Gravel: a little fine with coarse and rare cobbles, from 21.2 m to 22.2 m and 24.2 m to 25.2 m, subrounded, green and red sandstones, felsite Sand: medium with fine, quartz Fines: silt, between 23.2 m and 24.2 m cobble size pieces of laminated clay with gravel stuck to their sides	4.0+	25.2

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
a	26	56	18	0.4–1.4	26	22	13	9	14	12	4	
				1.4–2.4	27	33	16	8	9	7	0	
				2.4–3.4	27	43	19	3	6	2	0	
				3.4–4.4	22	32	19	8	12	7	0	
				Mean	26	32	17	7	10	7	1	
b	6	74	20	10.4–11.4	14	29	30	11	10	6	0	†
				11.4–13.2	5	30	29	11	19	6	0	†
				13.2–14.2	4	28	39	12	9	8	0	†
				14.2–15.2	3	15	40	16	16	10	0	†
				15.2–16.2	4	37	34	13	9	3	0	†
				Mean	6	28	34	12	13	7	0	
c	5	92	3	16.2–17.2	5	53	32	7	2	1	0	†
d	6	68	26	17.2–18.2	3	30	35	9	5	18	0	†
				18.2–19.2	5	26	22	9	13	25	0	†
				19.2–20.2	9	27	29	8	8	1	18	†
				20.2–21.2	5	32	39	7	7	10	0	†
				Mean	6	29	31	8	8	13	5	
e	5	93	2	21.2–22.2	4	36	54	6	0	0	0	†
				22.2–23.2	6	37	50	5	2	0	0	†
				23.2–24.2	5	32	55	6	2	0	0	†
				24.2–25.2	3	28	58	7	3	1	0	†
				Mean	5	33	54	6	2	0	0	
a–e	10	75	15	Mean	10	32	34	9	8	6	1	

NS 94 SE 14 9843 4153 Townhead Farm, Libberton **Block C**

Surface level (+190.4 m)+625 ft
Water struck at +188.1 m
250 mm and 200 mm percussion
April 1977

Overburden 2.3 m
Mineral 3.0 m
Waste 15.4 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
Alluvium	Silt, moderately stiff, becoming sandy with depth, grey-brown	2.3	2.3
	Gravel Gravel: coarse and fine, rare cobbles up to 11 cm, subrounded to subangular, green and red sandstones, felsite, greywacke, andesite, volcanic glass, quartz, slate Sand: coarse and medium with fine, angular to subrounded Fines: clay, grey, in bands between 3.3 m and 4.3 m	3.0	5.3
Glaciolacustrine deposit	Clay, poorly laminated, moderately stiff, grey	1.7	7.0
	Silt, sandy, poorly laminated, rare subrounded to angular clasts up to 12 cm diameter of andesite, green sandstone, basalt and felsite	13.7+	20.7

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
Fines	Sand	Gravel		Fines	Sand			Gravel			
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64	
3	26	71	2.3–3.3	1	4	18	13	31	33	0	†
			3.3–4.3	4	3	8	12	36	37	0	†
			4.3–5.3	2	2	8	11	35	42	0	†
			Mean	3	3	11	12	34	37	0	

NS 94 SE 15 9883 4055 Hillhead Farm, Libberton **Block C**

Surface level (+190.7 m) +626 ft
Water struck at +189.3 m
250 mm and 200 mm percussion
April 1977

Overburden 0.4 m
Mineral 5.0 m
Waste 19.6 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Alluvium	Gravel Gravel: fine with coarse and rare cobbles up to 14 cm diameter, angular to subrounded, greywacke with felsite, andesite, quartz, volcanic glass, red sandstone and microgranite Sand: coarse with medium, angular, quartz, basalt and felsite Fines: silt	5.0	5.4
Peat	Peat, unconsolidated, brown	0.1	5.5
Glaciolacustrine deposit	Clay, laminated, grey, becomes stiff and siltier with depth	8.0	13.5
	Gradational boundary, passing into silt, poorly laminated, sandy, principally from 19.5 m to 20.5 m, brownish grey, with grey clay bands	11.5+	25.0

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
Fines	Sand	Gravel		Fines	Sand			Gravel			
				$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
2	36	62	0.4–1.4	6	9	22	14	23	26	0	
			1.4–2.4	1	1	7	11	21	41	18	†
			2.4–3.4	2	3	13	30	36	8	8	†
			3.4–4.4	1	3	8	19	44	22	3	†
			4.4–5.4	2	4	14	20	45	15	0	†
			Mean	2	4	13	19	34	22	6	

NS 94 SE 16 9986 4487 South Medwin River, Carnwath Mill **Block D**

Surface level (+198.7 m) +652 ft
Water struck at +198.1 m
250 mm and 200 mm percussion
March 1977

Overburden 0.6 m
Mineral 3.0 m
Waste 1.9 m
Mineral 19.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Alluvium	Silt, sandy, black, subrounded to subangular clasts of green sandstone, quartzite, basalt and felsite	0.3	0.6
	a Gravel Gravel: fine with coarse and rare cobbles up to 11 cm diameter, angular to subangular, red and green sandstones, quartzite, basalt, felsite and marble Sand: coarse and medium with fine, angular to subangular, quartz, basalt and felsite Fines: silt	3.0	3.6
Fluvioglacial sand and gravel	Silt, sandy, micaceous, brown, occasional bands of clean sand or silt	1.9	5.5
	b Sandy gravel Gravel: fine with coarse and cobbles up to 17 cm diameter, subrounded to angular, yellow and green sandstones, basalt and felsite Sand: fine with coarse and medium, subrounded to angular, quartz with basalt and felsite Fines: silt	4.0	9.5
	c Sand Gravel: fine with coarse, principally in the upper two metres Sand: medium with fine, angular, disseminated coal Fines: silt	15.5+	25.0

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
a	2	42	56	0.6–1.6	3	8	17	18	32	22	0	†
				1.6–2.6	1	8	21	17	27	26	0	†
				2.6–3.6	1	5	12	19	34	29	0	†
				Mean	2	7	17	18	31	25	0	
b	4	59	37	5.5–6.5	7	31	19	18	18	7	0	†
				6.5–7.5	4	27	16	21	21	11	0	†
				7.5–8.5	3	15	12	19	23	19	9	†
				8.5–9.5	4	18	24	15	13	7	19	†
				Mean	4	23	18	18	19	11	7	
c	6	92	2	9.5–10.5	5	21	48	13	6	7	0	†
				10.5–11.5	4	17	58	12	7	2	0	†
				11.5–12.5	4	17	66	9	4	0	0	†
				12.5–13.5	9	28	52	9	2	0	0	†
				13.5–14.5	6	29	55	9	1	0	0	†
				14.5–15.5	6	35	52	6	1	0	0	†
				15.5–16.5	5	34	55	6	0	0	0	†
				16.5–17.5	7	27	57	9	0	0	0	†
				17.5–18.5	8	30	56	6	0	0	0	†
				18.5–19.5	4	34	58	4	0	0	0	†
				19.5–20.5	7	32	56	4	1	0	0	†
				20.5–21.5	5	35	56	4	0	0	0	†
				21.5–22.5	7	40	51	2	0	0	0	†
				22.5–23.5	7	39	51	3	0	0	0	†
				23.5–25.0	6	46	42	6	0	0	0	†
				Mean	6	31	54	7	1	1	0	
a–c	5	79	16	Mean	5	27	42	10	9	6	1	
b+c	6	85	9	Mean	6	30	46	9	5	3	1	

NS 94 SE 17 9996 4435 Millridge, Libberton **Block D**

Surface level (+196.0 m)+643 ft
Water struck at +194.5 m
250 mm percussion
April 1977

Waste 9.5 m
Bedrock 0.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.7	0.7
Glaciolacustrine deposit	Clay, grey-brown with darker brown mottling, sandy partings	1.8	2.5
	'Very clayey' sandy gravel Gravel: fine, coarse and cobbles, subangular quartz, quartzite, green and red sandstones, basalt and felsite Sand: fine to coarse Fines: silt	0.7	3.2
	Silt, with laminations becoming more pronounced with depth, sandy in upper part, brownish grey	1.6	4.8
	'Clayey' pebbly sand Gravel: fine with coarse, felsite, red and green sandstones, basalt and quartz Sand: medium with fine and coarse Fines: silt	1.2	6.0
Till	Clay, sandy, red, soft becoming stiffer with depth, sandier from 8.1 m to 8.8 m. Angular clasts up to 23 cm diameter of red sandstone with andesite, basalt, quartz, quartzite, felsite and volcanic glass	3.5	9.5
Devono-Carboniferous	Sandstone, indurated, red with green reduction spots	0.2+	9.7

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
Fines	Sand	Gravel		Fines	Sand			Gravel			
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$	
10	73	17	4.8–6.0	10	22	35	16	13	4	0	†*

NS 94 SE 18 9975 4332 Larch Knowe Wood, Libberton **Block G_3**

Surface level (+222.3 m) + 729 ft
Water struck at +217.5 m
250 mm percussion
April 1977

Overburden 0.4 m
Mineral 4.0 m
Waste 3.1 m
Bedrock 0.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Glacial sand and gravel	**a** 'Clayey' gravel Gravel: coarse with fine and cobbles up to 10 cm diameter, subangular to subrounded, red and green sandstones, andesite, felsite and basalt Sand: fine to coarse, angular, quartz with felsite Fines: clay	2.0	2.4
Till	**b** 'Very clayey' sandy gravel Gravel: fine with coarse, rare cobbles up to 20 cm diameter, subrounded to subangular, basalt with red sandstone and felsite Sand: fine with medium and coarse Fines: clay, red	2.0	4.4
	Clay, red, becoming grey and stiffer below 5.5 m, subrounded to subangular clasts of basalt, with red sandstone and felsite, becoming less numerous below 5.5 m	3.1	7.5
Carboniferous (Calciferous Sandstone Measures)	Basalt, microcrystalline, black, amygdaloidal, quartz veining	0.2+	7.7

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
a	14	30	56	0.4–1.4	17	13	9	8	16	23	14	
				1.4–2.4	10	11	10	10	20	32	7	
				Mean	14	12	9	9	18	27	11	
b	28	45	27	2.4–3.4	28	23	13	9	17	10	0	*
				3.4–4.4	28	18	13	13	16	12	0	*
				Mean	28	21	13	11	16	11	0	
a+b	21	37	42	Mean	21	16	11	10	18	19	5	

NS 94 NW P1 9261 4767 Sheaffyknowe, Carstairs **Block G_1**

Surface level (+224.0 m) + 735 ft
Water not struck
Pit
August 1977

Waste 0.2 m
Bedrock 0.8 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Carboniferous (Calciferous Sandstone Measures)	Sandstone, medium-grained with rare pebbles, green, horizontally bedded, weathered to 0.8 m	0.8+	1.0

NS 94 NW P2 9343 4665 Cowford Bridge, Carstairs **Block F**

Surface level (+216.9 m) + 712 ft
Water not struck
Pit
August 1977

Overburden 0.3 m
Mineral 1.6 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial sand and gravel	'Clayey' gravel ill-sorted Gravel: fine, coarse and cobbles with boulders, angular to subangular, green with red sandstones Sand: coarse and medium with fine, angular, quartz and rock fragments Fines: clay	1.6+	1.9

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
Fines	Sand	Gravel		Fines	Sand			Gravel			
				$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
12	39	49	0.3–1.3	11	7	15	21	17	8	21	*
			1.3–1.9	12	8	14	13	15	30	8	*
			Mean	12	7	14	18	17	16	16	

NS 94 SW P1 9042 4439 Caldwellside Farm, Lanark **Block G_1**

Surface level (+171.7 m) +563 ft
Water not struck
Pit
August 1977

Waste 0.6 m
Bedrock 0.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
Till	Clay, sandy, reddish brown, angular clasts of flaggy sandstone	0.6	0.6
Carboniferous (Calciferous Sandstone Measures)	Sandstone, bedded, coaly, buff to yellow-brown, weathered at top	0.2+	0.8

NS 94 SE P1 9599 4397 Bagmoors Farm, Pettinain **Block G_4**

Surface level (+201.7 m) +662 ft
Water not struck
Pit
August 1977

Waste 1.7 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Till	Clay, stiff, red, with clasts up to boulder size	1.2+	1.7

NS 94 SE P2 9764 4490 Bank, Carnwath **Block D**

Surface level (+208.1 m) +683 ft
Water not struck
Pit
August 1977

Mineral 1.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
Fluvioglacial sand and gravel	'Clayey' sandy gravel Gravel: coarse with fine and cobbles, angular, ill-sorted, basalt, felsite, green and red sandstones Sand: fine with medium and coarse Fines: clay	1.2 +	1.2

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64
17	42	41	0.0–1.2	17	21	13	8	12	20	9 *

NS 94 SE P3 9791 4489 Bankhead, Carnwath **Block D**

Surface level (+208.6 m)+684 ft
Water not struck
Pit
August 1977

Overburden 0.8 m
Mineral 1.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.8	0.8
Fluvioglacial sand and gravel	'Very clayey' gravel Gravel: coarse with fine and rare cobbles and boulders up to 32 cm diameter, red and green sandstones, felsite, andesite and quartzite Sand: fine with medium and coarse Fines: clay	1.1+	1.9

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
Fines	Sand	Gravel		Fines	Sand			Gravel			
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64	
23	32	45	0.8–1.9	23	18	8	6	13	32	0	*

NS 94 SE P4 9852 4499 Gallow Hill, Carnwath **Block G_2**

Surface level (+210.4 m)+690 ft
Water not struck
Pit
August 1977

Waste 0.3 m
Bedrock 1.6 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Carboniferous (Calciferous Sandstone Measures)	Sandstone, medium-grained, well-sorted, white	0.1	0.4
	Mudstone, red with green mottling, soft, shows poorly developed bedding	1.5+	1.9

NS 94 SE P5 9843 4498 Gallow Hill, Carnwath **Block D**

Surface level (+214.7 m)+704 ft
Water not struck
Pit
August 1977

Overburden 0.3 m
Mineral 1.8 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Fluvioglacial sand and gravel	'Clayey' sandy gravel Gravel: mainly below 0.9 m, fine, coarse, cobbles and boulders, angular, basalt and red sandstone Sand: fine- to medium-grained, becoming coarser and less well sorted below 0.9 m Fines: clay increasing below 0.9 m and including a grey more clayey till-like layer at 1.4 m	1.8+	2.1

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
Fines	Sand	Gravel		Fines	Sand			Gravel			
				$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
13	44	43	0.9–1.8	13	24	12	8	13	12	18	*

NS 94 SE P6 9862 4497 Spittal, Carnwath **Block G_2**

Surface level (+201.2 m)+660 ft
Water not struck
Pit
August 1977

Waste 0.9 m
Bedrock 1.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Fluvioglacial sand and gravel	Sand, fine- to medium-grained, moderately well-sorted, quartz grains. Red sandstone clasts	0.6	0.9
Carboniferous (Calciferous Sandstone Measures)	Mudstone, red with green mottling	1.0+	1.9

NS 94 SE P7 9871 4496 Spittal, Carnwath **Block D**

Surface level (+199.0 m) +653 ft
Water struck at +196.3 m
Pit and Section
August 1977

Overburden 0.6 m
Mineral 2.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Fluvioglacial sand and gravel	Silt, sandy; highly contorted	0.3	0.6
	'Clayey' gravel Gravel: cobbles and boulders up to 1.0 m diameter with fine and coarse gravel, subangular to angular, red sandstone Sand: fine with medium and coarse quartz Fines: clay, red	2.1+	2.7

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
Fines	Sand	Gravel		Fines	Sand			Gravel			
				$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
16	27	57	0.3–2.7	16	17	6	4	8	19	30	*

NS 94 SE P8 9825 4495 Bankhead, Carnwath **Block D**

Surface level (+217.3 m) +713 ft
Water not struck
Pit
August 1977

Waste 0.2 m
Bedrock 0.7 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Carboniferous (Calciferous Sandstone Measures)	Basalt, fine-grained, black, weathering to brown sand	0.7+	0.9

NS 94 SE P9 9805 4489 Bankhead, Carnwath **Block D**

Surface level (+211.5 m) +694 ft
Water not struck
Pit
August 1977

Overburden 0.2 m
Mineral 1.8 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Fluvioglacial sand and gravel	'Clayey' sandy gravel Gravel: fine and coarse with cobbles up to 15 cm diameter, angular basalt with red sandstone; above 1.2 m the gravel occurs in clay-rich bands, below it is disseminated Sand: fine with medium and coarse, angular to subangular, quartz Fines: clay, red, in bands above 1.2 m	1.8+	2.0

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
Fines	Sand	Gravel		Fines	Sand			Gravel			
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$	
19	42	39	0.2–1.2	23	26	9	5	19	18	0	*
			1.2–2.0	15	17	11	15	18	16	8	*
			Mean	19	22	10	10	18	17	4	

NS 94 SE P10 9893 4392 Mains Wood, Libberton **Block D**

Surface level (+195.6 m)+642 ft
Water struck at +193.7 m
Pit
August 1977

Overburden 0.4 m
Mineral 1.9 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Glaciolacustrine deposit	Sand Sand: fine with medium, bands of fine-grained sand below 1.6 m, subangular, quartz with feldspar, mica and basalt Fines: clay	1.9+	2.3

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
Fines	Sand	Gravel		Fines	Sand			Gravel			
				$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
5	94	1	0.4–1.6	6	66	27	1	0	0	0	*
			1.6–2.3	4	69	24	1	1	1	0	*
			Mean	5	67	26	1	1	0	0	

NS 94 SE P11 9886 4377 **Mains Wood, Libberton** **Block D**

Surface level (+199.7 m) +655 ft
Water not struck
Pit
August 1977

Overburden 0.3 m
Mineral 2.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, peaty	0.3	0.3
Glaciolacustrine deposit	Sand Sand: fine with medium, angular, quartz Fines: silt	2.0+	2.3

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
Fines	Sand	Gravel		Fines	Sand			Gravel			
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
1	99	0	0.3–1.3	1	81	17	1	0	0	0	*
			1.3–2.3	1	87	12	0	0	0	0	*
			Mean	1	84	14	1	0	0	0	

NS 94 SE P12 9880 4354 Mains Wood, Libberton **Block D**

Surface level (+205.9 m)+676 ft
Water not struck
Pit
August 1977

Overburden 0.4 m
Mineral 1.6 m
Waste 0.4 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Fluvioglacial sand and gravel	'Clayey' sandy gravel Gravel: fine and coarse with cobbles, angular to subangular, basalt with felsite Sand: fine with medium, quartz with feldspar and rock fragments Fines: silt, disseminated and in band at 1.5 m	1.6	2.0
Till	Clay, soft, red with angular clasts of basalt	0.4+	2.4

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
Fines	Sand	Gravel		Fines	Sand			Gravel			
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64	
14	61	25	0.4–1.0	9	37	17	5	11	15	6	*
			1.0–2.0	17	41	17	4	5	4	12	*
			Mean	14	39	17	5	7	8	10	

NS 94 SE P13 9866 4348 Muirhouse Strip, Libberton **Block D**

Surface level (+204.7 m)+672 ft
Water not struck
Pit
August 1977

Waste 2.4 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Glaciolacustrine deposit	Sand, fine to medium, angular to subangular, quartz	0.7	1.2
	Silt, micaceous, grey	0.6	1.8
Till	Clay, grey, soft, angular clasts up to boulder size of basalt	0.6+	2.4

NS 94 SE P14 9834 4229 Yett Farm, Libberton **Block G_3**

Surface level (+199.5 m)+655 ft
Water not struck
Pit
August 1977

Waste 1.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glaciolacustrine deposit	Sand, medium, well-sorted	0.3	0.6
	Clay, silty, red and brown mottling	0.6+	1.2

NS 94 SE P15 9847 4227 Yett Farm, Libberton **Block G_3**

Surface level (+196.5 m) +645 ft
Water not struck
Pit
August 1977

Waste 1.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.6	0.6
Glaciolacustrine deposit	Clay, silty, grey and red mottling, becomes increasingly laminated with depth	0.9+	1.5

NS 94 SE P16 9840 4223 Yett Farm, Libberton **Block G_3**

Surface level (+199.0 m) +653 ft
Water not struck
Pit
August 1977

Waste 1.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Glaciolacustrine deposit	Clay, silty, moderately stiff, red and brown mottling	1.0+	1.5

NS 94 SE P17 9908 4417 Brownhill, Libberton **Block D**

Surface level (+201.2 m)+660 ft
Water not struck
Pit
August 1977

Waste 2.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Glaciolacustrine deposit	Sand, fine, with silt both disseminated and in bands near the base	0.9	1.3
	Silt, moderately stiff, grey, poorly laminated, clayey bands	0.8+	2.1

NS 94 SE P18 9904 4406 Brownhill, Libberton **Block D**

Surface level (+197.0 m)+646 ft
Water not struck
Pit
August 1977

Overburden 0.4 m
Mineral 1.9 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Glaciolacustrine deposit	Sand Sand: fine with medium, subangular, quartz, laminated above 0.7 m Fines: silt	1.9+	2.3

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
Fines	Sand	Gravel		Fines	Sand			Gravel			
				$-\frac{1}{16}$	$+\frac{1}{16}$–$\frac{1}{4}$	$+\frac{1}{4}$–1	+1–4	+4–16	+16–64	+64	
2	98	0	0.4–1.4	1	80	18	1	0	0	0	*
			1.4–2.3	2	81	17	0	0	0	0	*
			Mean	2	80	17	1	0	0	0	

APPENDIX G

LIST OF WORKINGS

In October 1978 six sand and gravel pits were being worked and a further seven had been abandoned. Each distinct area of worked ground shown on the resource map is considered as a separate pit: within those that are operational usually only a small part of the total area is active and it is to this that the grid reference refers. This resource map shows the extent of workings at August 1976 and this appendix includes additions and extensions to October 1978.

Location	*Grid reference*	*Deposit worked*
ACTIVE		
Hyndford (West)	895 416	Fluvioglacial sand and gravel
Newhouse (North)	927 460	Glacial sand and gravel
East End (South)	938 464	Glacial sand and gravel
Hills of Columbie	949 470	Glacial sand and gravel
Ryeflat	949 478	Fluvioglacial sand and gravel
Westend Wood	964 468	Fluvioglacial sand and gravel
DISUSED		
Hyndford (East)	904 417	Fluvioglacial sand and gravel
Newhouse (South)	929 459	Glacial sand and gravel
Kilnmuir	930 455	Fluvioglacial sand and gravel
Eastend (North)	936 465	Glacial sand and gravel
Columbie	940 467	Glacial sand and gravel
Gallow Hill	943 468	Glacial sand and gravel
Carstairs Junction	946 458	Fluvioglacial sand and gravel

APPENDIX H

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

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

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Typeset for the Institute of Geological Sciences by John Wright and Sons Ltd, Bristol

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

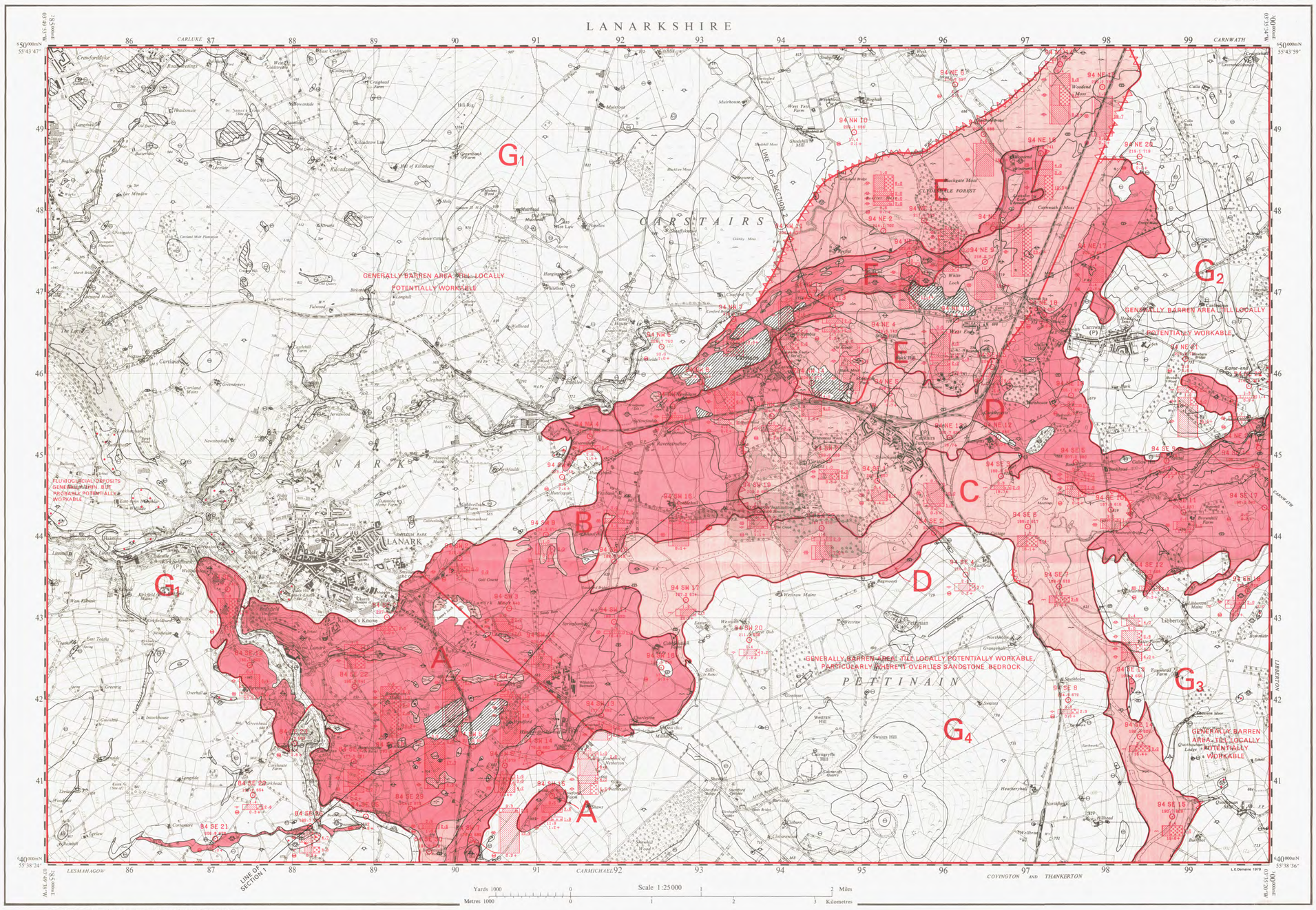
INSTITUTE OF GEOLOGICAL SCIENCES

INDUSTRIAL MINERALS ASSESSMENT UNIT

THE SAND AND GRAVEL RESOURCES OF THE LANARK AREA, STRATHCLYDE REGION

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

ORDNANCE SURVEY
SHEET NS 94 & Pt NS 84
PROVISIONAL EDITION



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

Original geological survey on the six-inch scale by A. Geikie, J.Geikie and B.N. Peach, in 1872.
Revised by L.W. Hinxman, M. MacGregor, J. Phemister, H.H. Read and G.Ross between 1909 and 1926.
Partial re-survey by M.A.E. Browne in 1976.
E.G. Poole, District Geologist.

Sand and gravel Survey by J.L. Laxton and A.A. McMillan in 1976-77, under the supervision of E.F.P. Nicklass 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.

1:00:80

Borehole graphics drawn by computer programs written by J. L. McInnes, Computer Unit, I.G.S. Edinburgh.

The GRID Lines on this sheet are at 1 Kilometre interval.
Heights are in feet above Mean Sea Level at Newlyn.
1 square inch on this map represents 99.639 acres on the ground

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

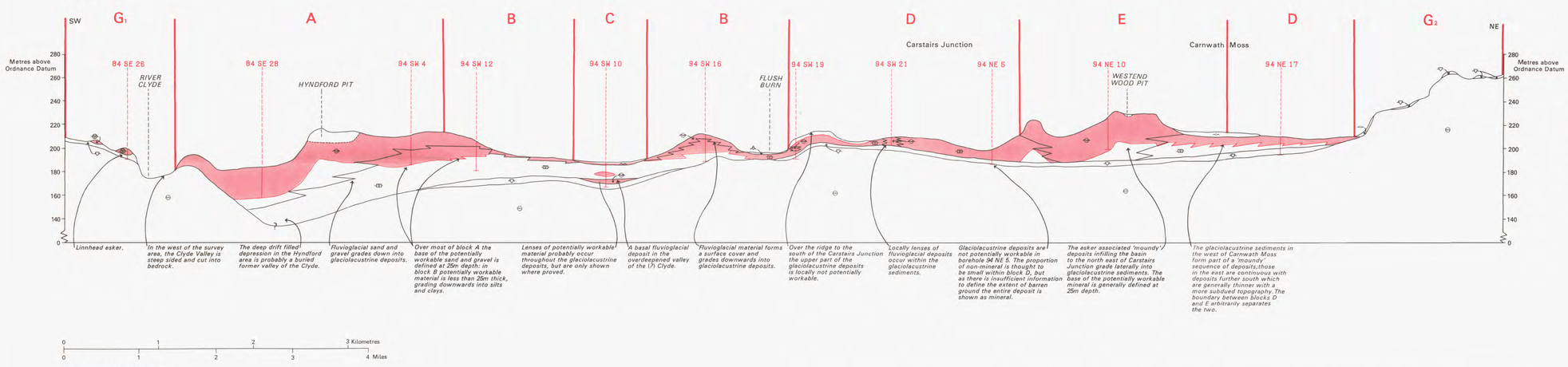
Compiled from 6" sheets last fully revised 1909-41.
Other partial systematic revision 1938-54 has been incorporated
Some major roads revised 1968.

NS 75	NS 85	NS 95	31 32 23 24 NT 05
NS 74	NS 84	NS 94	NT 04
NS 73	NS 83	NS 93	NT 03

Diagram showing the relation of this sheet with the National Grid 1:25 000 and the One-inch Geological Sheets 23, 24, 31 and 32

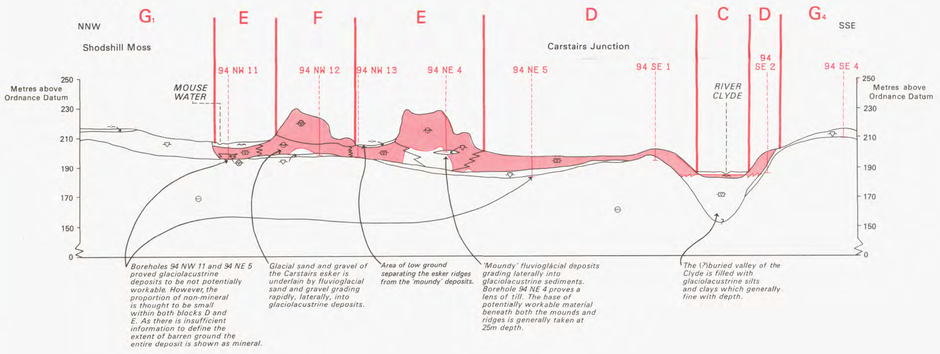
GENERALISED HORIZONTAL SECTIONS SHOWING RELATIONSHIPS OF DRIFT DEPOSITS

Section 1



HORIZONTAL SCALE 1:25,000
VERTICAL EXAGGERATION 12.5×

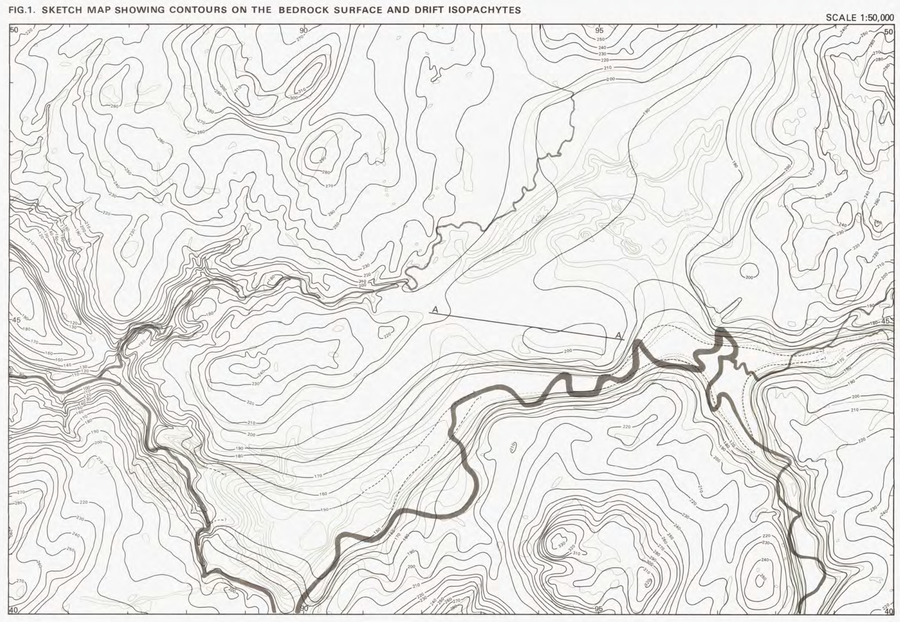
Section 2



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

FIG.1. SKETCH MAP SHOWING CONTOURS ON THE BEDROCK SURFACE AND DRIFT ISOPACHYTES

SCALE 1:50,000



KEY TO FIG.1

Drift thickness in metres. The vertical interval is 5m. The 0m line is unnumbered.

240 Height in metres, of bedrock surface above Ordnance Datum. The vertical interval is 10m.

Major rivers.

A A Inferred alignment of buried bedrock ridge (see Report).

Broken lines denote uncertainty.

Detailed records may be consulted on application to the Officer-in-charge, Industrial Minerals Assessment Unit, Institute of Geological Sciences, Murchison House, West Mains Road, Edinburgh EH9 3LA.

THE SAND AND GRAVEL RESOURCES OF THE LANARK AREA, STRATHCLYDE REGION

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

49

EXPLANATION OF SYMBOLS AND ABBREVIATIONS

DRIFT

RECENT AND PLEISTOCENE

- **Peat** P-1
- **Alluvium**-clay, silt, sand and gravel. A-17
- **Alluvial cone**-fan composed of alluvium. AC-2
- **First terrace of the River Clyde** 1T-19
- **Head**-ill sorted 'clayey' boulder gravel (proved only in borehole 94 SE 9). H-22
- **Glaciolacustrine deposits**-mainly clay, silt and fine-grained sand. G-1
- **Fluvioglacial sand and gravel**-moderately well sorted and bedded sand and gravel. FL-2
- **Glacial sand and gravel**-mainly ill-sorted 'clayey' cobble and boulder gravel deposited in eskers. GS-30
- **Till**-stony clay of variable stiffness, locally silty or sandy. Th-1

SOLID

- **Bedrock, at or near surface (undifferentiated)** In the central and northern part of the resource sheet, bedrock mainly comprises sediments and basaltic lavas of Lower Carboniferous age. Most of the remainder of the area comprises Devonian or Devono-Carboniferous sandstones.

- **Made ground** Waste and/or natural earth materials deposited on original ground surface or in former quarries. MG-3
- **Worked ground** (Sand and gravel) as at August 1976. WG-2

BOUNDARY LINES

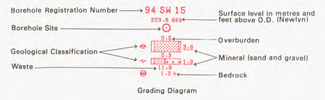
- Geological boundary.
- Back feature of river terrace.
- Inferred boundary between categories of deposits at surface.
- Inferred boundary between categories of deposits at depth.
- Resource block boundary.

BOREHOLE DATA

SITE LOCATIONS

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

I.M.A.U. BOREHOLES



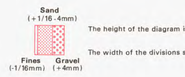
Note:
(i) Figures underlined denote thicknesses used in the assessment of resources.
(ii) The + sign indicates that the base of the deposit was not reached.
(iii) The Geological Classification is given only for mineral and bedrock.

Borehole Registration Number

Each I.M.A.U. borehole is identified by a Registration Number eg. 94 SW 15. The first number and letters refer to the quarter sheet and the final figures to the I.G.S. serial number for that quarter. The unique designation for borehole 94 SW 15 is NS 94 SW 15.

Grading Diagrams

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



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

The width of the divisions show the proportions of Fines, Sand and Gravel.

CATEGORIES OF DEPOSITS

- **Exposed mineral.** CAT-E6
- **Continuous or almost continuous spreads of mineral beneath overburden.** CAT-C1
- **Sand and gravel absent or not potentially workable.** CAT-A2
- **Sand and gravel not assessed (exposed or beneath cover).** CAT-N3

RESOURCE BLOCKS

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

KEY TO SECTIONS

- Potentially workable sand and gravel, (mineral) exposed or beneath cover.

Bedrock and waste, including overburden, are uncoloured.

- Geological boundary.
- Boundary limiting the extent of potentially workable sand and gravel.

Otherwise symbols and abbreviations as map legend.