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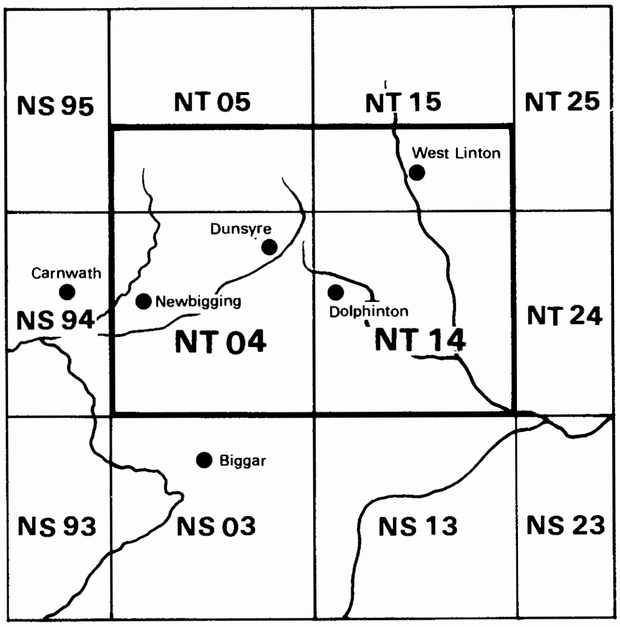

The sand and gravel resources of the country around Dolphinton, Strathclyde Region, and West Linton, Borders Region

Description of 1 : 25 000 resource sheets NT 04 and 14, and parts of NT 05 and 15

A. A. McMillan, J. L. Laxton and A. J. Shaw

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

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

Any enquiries concerning this report may be addressed to the Officer-in-Charge, Industrial Minerals Assessment Unit, Murchison House, West Mains Road, Edinburgh EH9 3LA.

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

PREFACE

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

Sand and gravel, considered together as naturally occurring aggregate, was selected as the bulk mineral demanding the most urgent attention, initially in the south-east of England, where about half the national output is won and very few sources of alternative aggregates are available. Following a short feasibility project, initiated in 1966 by the Ministry of Land and Natural Resources, the Industrial Minerals Assessment Unit (formerly the Mineral Assessment Unit) began systematic surveys in 1968, which have been extended progressively through central and northern England. Work in Scotland, which began in 1975, is being financed by the Department of the Environment, acting through the Scottish Development Department, and is being undertaken with the cooperation of the Sand and Gravel Association of Great Britain.

This report describes the resources of sand and gravel of 280 km^2 of country around Dolphinton, Strathclyde Region, and West Linton, Borders Region, shown on the accompanying resource sheet. The survey was conducted by A. A. McMillan, J. L. Laxton and A. J. Shaw under the supervision of E. F. P. Nickless (Officer-in-Charge of the Sub-unit in Edinburgh). The work is based on Sheet 24 of the one-inch Geological Map of Scotland first published in 1868, and re-published in a revised edition in 1932. The geological lines, now presented at the 1 : 25 000 scale, include a re-appraisal of the drift geology of the valley floors and sides by A. M. Bell and P. Stone based on field surveys during 1977–78.

The section of the report on the geology of the area was prepared by A. M. Bell and A. A. McMillan. J. D. Burnell, ISO, ARICS (Land Agent) has been responsible for negotiating access to land for drilling and pitting. The ready cooperation of land owners, tenants and gravel companies and the assistance of officials of Lanark District and Tweeddale District is gratefully acknowledged.

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SUMMARY

The geological maps of the Institute of Geological Sciences, pre-existing borehole information, sixty-three boreholes drilled for the Industrial Minerals Assessment Unit, together with data from seven shallow trenches, form the basis of the assessment of sand and gravel resources in the area, which includes Dolphinton and West Linton and straddles the boundary between the Strathclyde and Borders regions.

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

The 1 : 25 000 map is divided into four resource blocks. Statistical assessments are offered for the alluvium and glacial meltwater deposits of Blocks A, B and C which contain 11.4, 9.6 and 12.9 km^2 respectively of potentially workable sand and gravel. Inferred assessments are offered for a total of 10.1 km^2 of scattered sand and gravel deposits in Block D. For all blocks, the geology of the deposits is described and the mineral-bearing area, the mean thickness of overburden and mineral and the mean grading (where available) of the various types of deposit are stated. Detailed borehole and shallow-trench data are given. The geology, the outlines of the resource blocks and the position of sample points considered in the assessment are shown on the accompanying 1 : 25 000-scale resource map.

Bibliographical reference

McMillan, A. A., Laxton, J. L. and Shaw, A. J. 1981. The sand and gravel resources of the country around Dolphinton, Strathclyde Region, and West Linton, Borders Region: Description of 1 : 25 000 resource sheets NT 04 and 14 and parts of NT 05 and 15. *Miner. Assess. Rep. Inst. Geol. Sci.*, No. 62.

Note

National Grid References are given in square brackets. In this publication all lie within the 100-kilometre square NT unless otherwise stated.

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

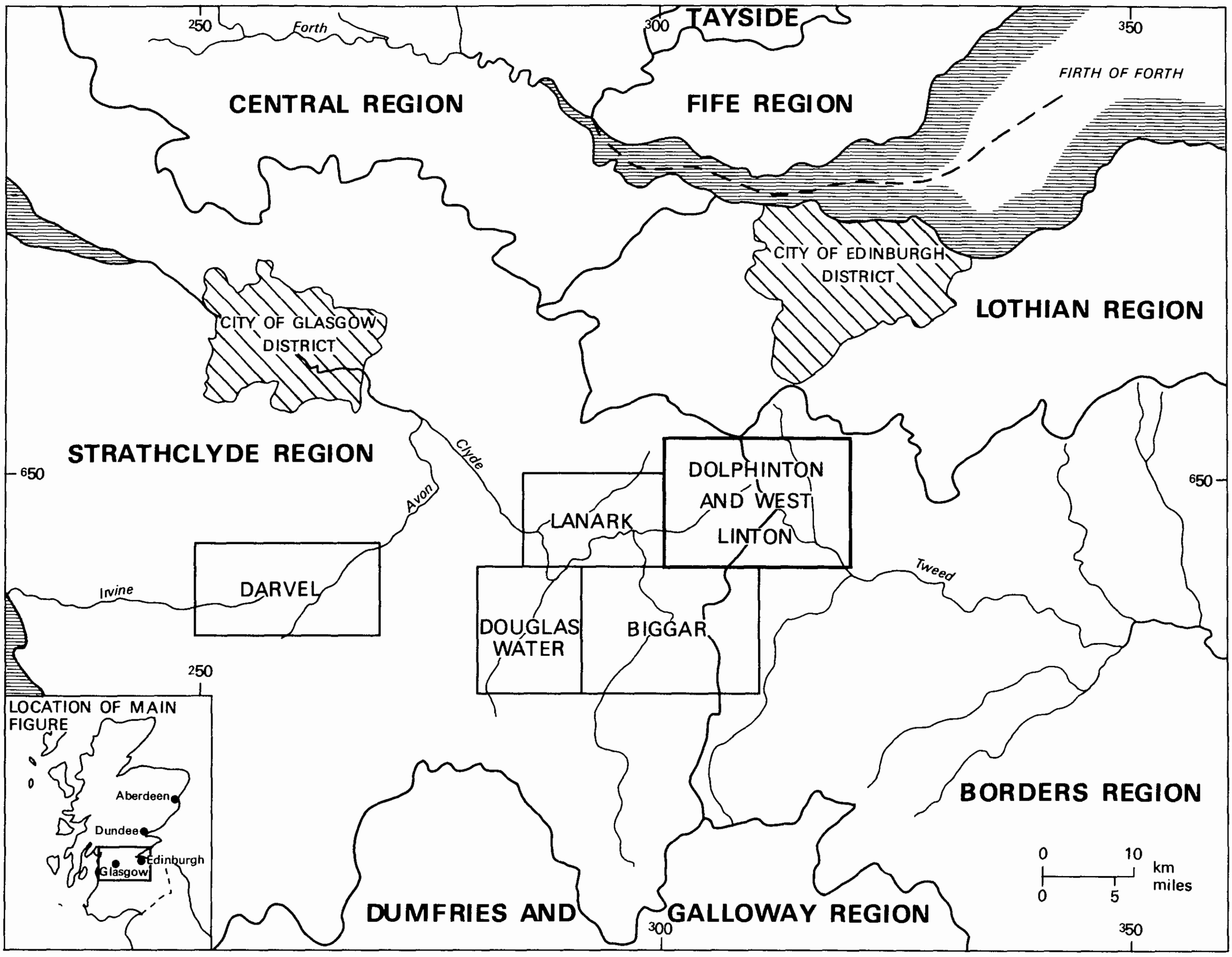


Figure 1 Sketch-map showing the location and limits of the published resource sheets in the south of Scotland

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

The volume and other characteristics are assessed within resource blocks, 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.

DESCRIPTION OF THE RESOURCE SHEET

GENERAL

The sand and gravel resources of south-east Scotland were described briefly by Haldane (1948) and Goodlet (1970). More recently, McAdam (1977) and Cameron and others (1977) have summarised published and unpublished data for the Borders and Strathclyde regions respectively. Assessments of resources in the Lanark and Douglas areas are published in Mineral Assessment Reports 49 and 63 respectively (Laxton and Nickless, 1980; Shaw and Nickless, 1981): the results of a similar investigation in the Biggar area are being processed (Shaw and Merritt, *in preparation*).

The area assessed covers 280 km^2 of country around Dolphinton (Figure 1) of which 44.0 km^2 (16 per cent) is mineral-bearing. Dolphinton is situated 34 km by road south-west of Edinburgh and 69 km south-east of Glasgow.

Workings for sand and gravel, to supply both local needs and the markets of Edinburgh and Glasgow, are operated in glacial meltwater deposits at Dolphinton, Newbigging, and at Candybank near Biggar. Much of the land is devoted to sheep- and cattle-farming, though grain crops are more common around West Linton, Dolphinton, Elsrickle, and in the valley of the Medwin.

TOPOGRAPHY

Although the influence of the geological structure on the form of the ground in the assessment area is marked, the rivers in the south-eastern half of the resource sheet flow in a generally south-easterly direction, normal to the regional north-easterly strike; this pattern probably bears a strong relationship to erosion surfaces developed during the Tertiary. Glacial action caused overdeepening of pre-existing valleys, many of which are now partially filled with meltwater deposits. The entire area was covered by ice during glaciation, resulting in a general rounding of the topography: glacial striae have been observed in a few hill-tops.

The dominating geological structure, the Southern Upland Fault, extends north-eastwards through Muirburn [096 413] and Halmyre Mains [176 494] across the south-eastern part of the resource sheet. South of the fault the rounded tops of the Broughton Heights (attaining a maximum height of 571 m above Ordnance Datum), Ladyurd Hill (525 m), Drochil Hill (376 m) and Wide Hope Shank (462 m) form the highest ground in the area and are composed of Lower Palaeozoic sediments. Lying north of the fault are the hills of The Mount (422 m above OD) and Broomy Law (426 m) and lower tops of Shaw Hill (342 m) and Blyth Muir (310 m), all composed of Lower Devonian lavas and sediments. The misfit Tarth Water flows south-eastwards in a steep-sided glaciated valley through the high ground across the Southern Upland Fault. The Tarth Water, which is fed by the Garvald Burn near Dolphinton [105 467], joins the Lyne Water, another misfit river flowing across the regional strike, at Drochil Castle [163 435] and the combined waters flow south-eastwards to join the River Tweed west of Peebles [250 405]. The Lyne Water, which rises in the Pentland Hills to the north of the resource sheet flows southwards through West Linton [150 520], where it is flanked by extensive mounds of meltwater sand and gravel, and Romannobridge [160 480] before crossing the Southern Upland Fault and flowing through a deep U-shaped valley.

A line of hills of Lower Devonian volcanic rocks, which includes Black Mount (516 m above OD) and Mendick Hill (451 m), runs parallel to the regional strike and forms a south-westerly-trending spur to the Pentland Hills that constitutes an effective barrier between the south-eastward drainage of the Tarth and Lyne waters and the south-westward-flowing South Medwin. The last-named river rises to the north of the reource sheet and flows southwards past Medwinbank [098 498] before turning southwestwards through a wide, relatively flat, over-deepened and partly drift-filled valley (Plate 2), flanked by moundy meltwater deposits which attain their maximum extent and thickness south and west of Newbigging [015 458]. To the west of the resource sheet the river is joined by the North Medwin before reaching its confluence with the Clyde south of Carnwath, [NS 982 465]. An impressive col in the hills formed of Devonian volcanic rocks occurs south of Garvald House [099 490]. This low-lying ground, named the Dolphinton Gap by Eckford (1952) is thought to have been breached and modified by ice and subsequently to have acted as a channel for meltwaters flowing from the valley of the South Medwin to the valley of the Tarth Water. The Gap contains moundy meltwater deposits (Plate 1) that are considered to have blocked drainage to the south-east following the retreat of the ice and the initiation of westerly drainage to the Clyde. The Garvald Burn, the small stream that now runs through the Dolphinton Gap, has been artificially diverted to flow into the Tarth Water.

GEOLOGY

The resource sheet falls within the Biggar (24 W) Sheet of the 1 : 50 000 Geological Map of Scotland, published in 1976. The area was originally geologically surveyed at a scale of six inches to one mile by Sir Archibald Geikie, J. Geikie, H. H. Howell and J. Young and published at the one-inch scale in 1868 together with an explanation of the geology (Geikie, 1869). Drift lines for the upland areas of the resource sheet have been taken from surveys between 1872 and 1932 at a scale of six inches to one mile by B. N. Peach, J. Horne, W. Q. Kennedy, J. Phemister, H. H. Read and J. E. Richey, whose work was incorporated in the revision of Sheet 24 published in 1932. In connection with the present investigation A. M. Bell and P. Stone re-surveyed the drift deposits of the lower ground during 1977–78.

Over much of the assessment area, Recent and Pleistocene sediments, comprising till, glacial meltwater deposits, alluvium and peat, overlie a variety of rock types which range from Ordovician to ?Permo-Carboniferous in age. The geological sequence is summarised in Table 1, where deposits are listed, as far as possible, in order of increasing age.

SOLID

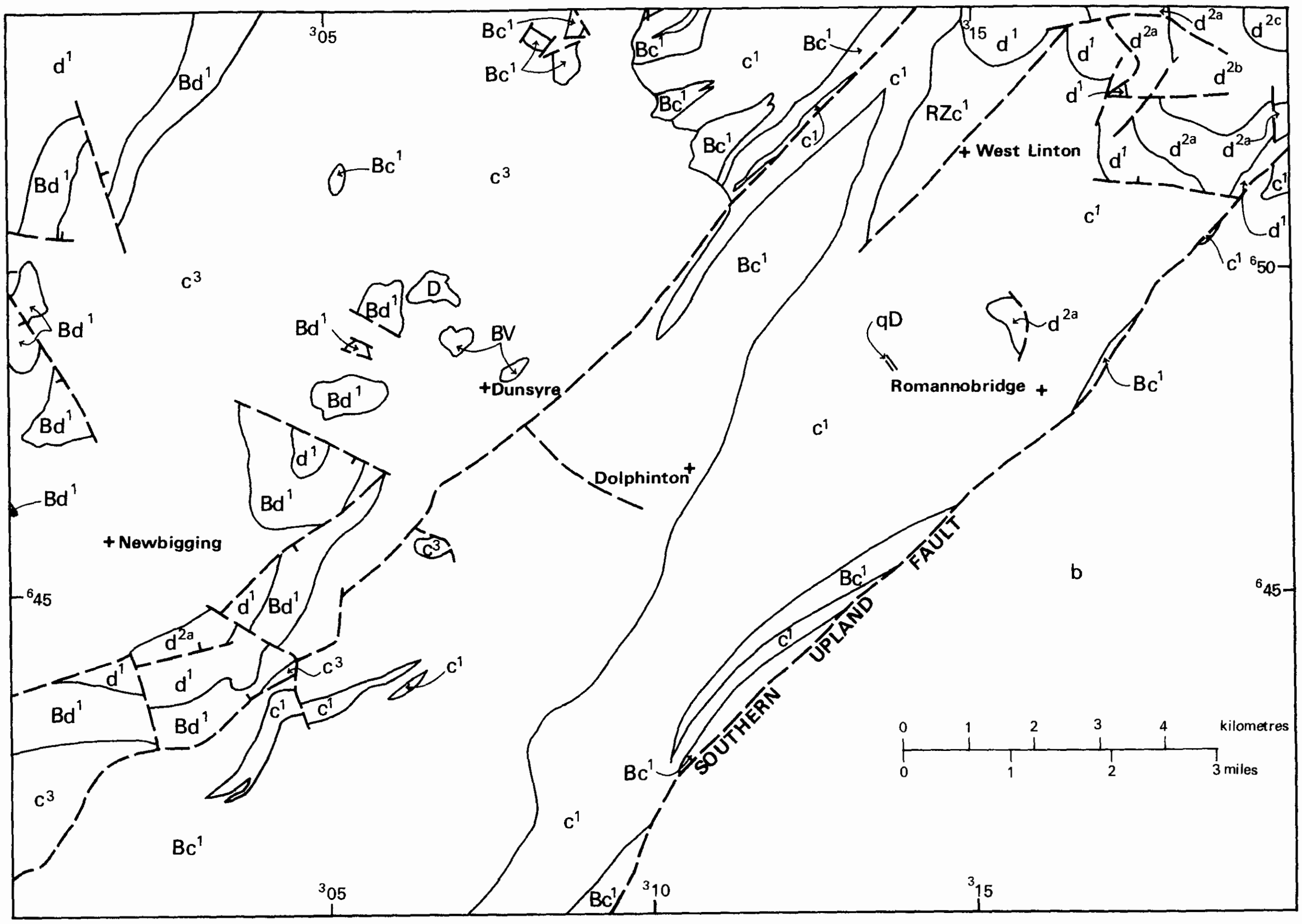
A sketch-map of the solid geology is shown in Figure 2. The oldest rocks crop out to the south-east of the Southern Upland Fault. They are of Lower Palaeozoic age, ranging from Lower to Middle Ordovician, and include shales, red and black cherts, spilitic lavas, greywackes and conglomerates. Many of the conglomerates have a distinctive composition: 'haggis rock' is a particularly striking example. They were deposited on the margins of a deep, elongate basin, the axis of which lay well to the south. Rocks of Upper Ordovician and Silurian age have not been recognised in the area.

During the Caledonian orogeny, which was most intense in late Silurian and early Devonian times, these rocks suffered deformation and cleavage, and were folded and faulted along north-easterly trends. Subsequent uplift produced a high mountainous massif in the Southern Uplands. Rapid erosion of these mountains led to the formation of Lower Devonian conglomerates and

Table 1 Geological classification of deposits

DRIFT
Recent and **Pleistocene**
Peat
Alluvium(undifferentiated); mainly sand and gravel, with silt and clay
Glacial meltwater deposits (undifferentiated); gravel, sand, and laminated silt and clay
Till; stiff stony clay, locally sandy

SOLID
?Permo-Carboniferous
Quartz-dolerite dyke
Carboniferous
Sandstones, limestones and basaltic lavas
Devonian
Sandstones, cornstones, conglomerates, tuffs, and andesitic, trachytic and rhyolitic lavas
Ordovician
Greywackes, conglomerates, shales, cherts and spilitic lavas



?**Permo-Carboniferous**
qD Quartz-dolerite

d **Carboniferous**
d^{2c} Upper Limestone Group
d^{2b} Limestone Coal Group
d^{2a} Lower Limestone Group
d^{1} Calciferous Sandstone Measures

Bd^{1} Basalt
BV Basaltic Agglomerate
D Tholeiite

c **Devonian**
c^{3} Upper Devonian
c^{1} Lower Devonian

Bc^{1} Andesite-basalt and trachyte
RZc^{1} Rhyolite-breccia of West Linton

b **Ordovician**

Fault, crossmark on downthrow side

Geological boundary

Figure 2 Sketch-map showing the solid geology

sandstones. The conglomerates are composed chiefly of reddened greywacke pebbles, and are overlain by red sandstones. Contemporaneous volcanic activity led to the extrusion of andesitic, trachytic and rhyolitic lavas which now form the upland belt, including Black Mount and Mendick Hill, that trends north-eastwards from Libberton [NS 990 430], west of the resource sheet, to West Linton. In many places tuffs and sandstones are interbedded with the lavas.

A period of uplift, gentle folding and erosion occurred prior to the deposition of rocks assigned to the Upper Devonian. Red sandstones and occasional thin concretionary limestones (cornstones) of this age underlie much of the north-west part of the survey area. In most places a major, north-easterly-trending fault separates the sediments from the volcanics, but in the north, Upper Devonian sandstones lie with marked unconformity on Lower Devonian sandstones and lavas.

Soon after the beginning of the Carboniferous Period a volcanic outburst produced basaltic lavas which conformably overlie Upper Devonian sediments in the west of the area. Agglomerate vents and doleritic plugs near Dunsyre [073 482] may indicate sources of these lavas. The basalts are themselves overlain by red sandstones, followed by sandstones and limestones of Lower Carboniferous age.

Folding and faulting with a north-westerly trend, and reactivation of existing Caledonian fault lines, occurred during the Hercynian orogeny in late Carboniferous and early Permian times.

Younger rocks are represented solely by a quartz-dolerite dyke west of Romannobridge, which may be Permo-Carboniferous in age.

DRIFT

A sketch-map of the drift geology is shown in Figure 3. The area, which was completely covered by ice during the Devensian glaciation, probably became ice-free some 12 500 years BP (Sissons, 1974). Most of the superficial deposits in the area are thought to have been laid down during times of ice wastage and stagnation. Streamlined landforms, rare glacial striae and abundant glacial

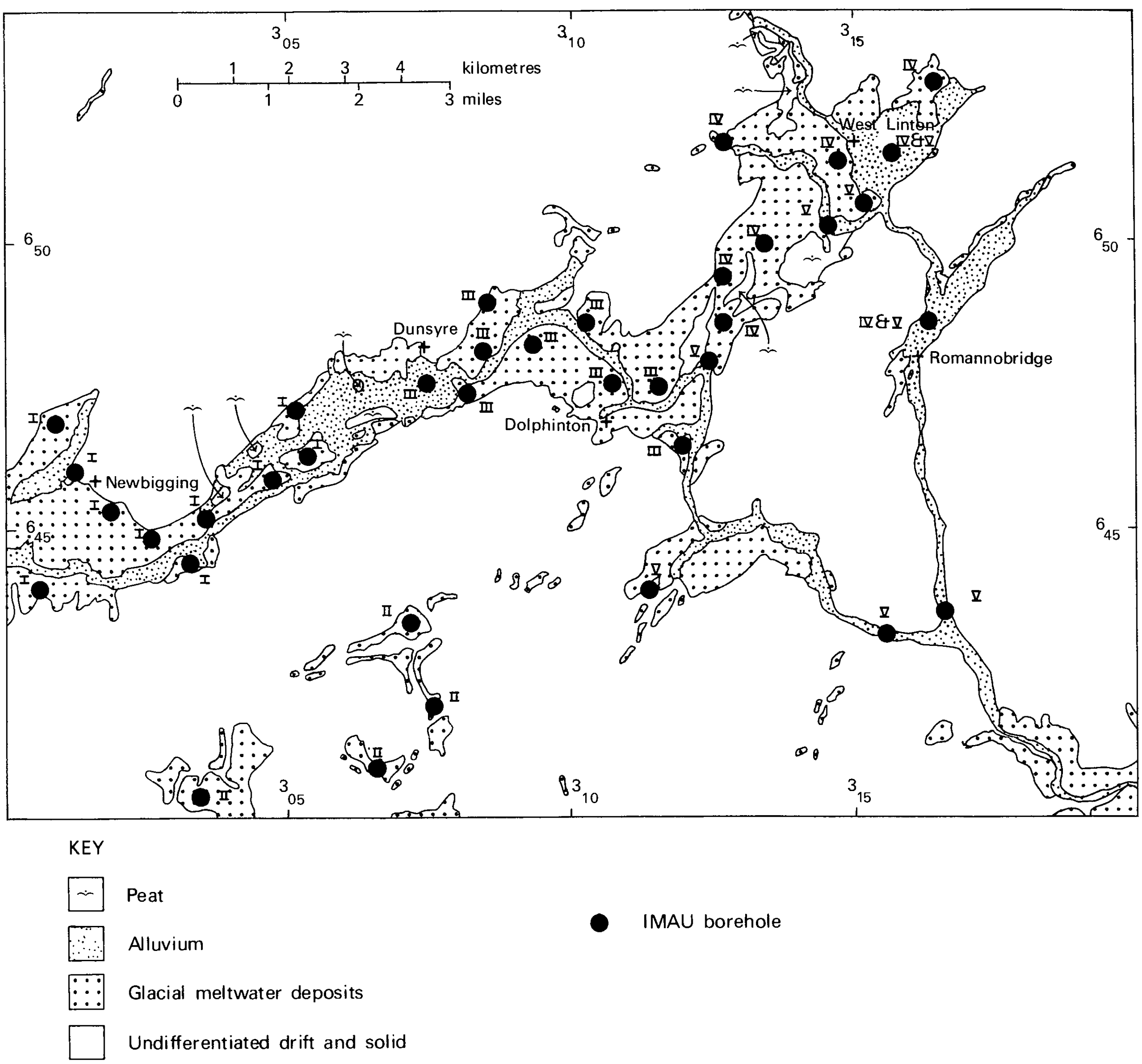


Figure 3 Sketch-map showing the drift geology of the principal valleys and the locations of the boreholes from which Composite Samples I to V were taken

drainage features (cf. Sissons, 1963) indicate that ice generally advanced from the south-west along the south-eastern margin of the Pentland Hills.

Examination of the lithologies of clasts present in the drift indicates that ice was predominantly of Southern Uplands origin and that the effects of ice originating from the southern Grampians were minimal in this area. Comparative petrological analysis by McCall and Goodlet (1952) on indicator stones shows that constituent felsite pebbles were derived from nearby Tinto Hill [NS 953 344] and Cairngryffe Hill [NS 943 413], lying west of the resource sheet. Compositional analysis in connection with the present survey indicates that the crest of the north-easterly-trending line of volcanic hills including Black Mount may have divided the ice into two main streams. The line of hills is breached by the Dolphinton Gap and the presence of meltwater deposits here indicates that at times ice occupied the col. To the north, in the valley of the South Medwin, glacial meltwater deposits contain a high proportion of locally-derived basalt and sandstone, whereas to the south around Elsrickle [060 433] pebbles of greywacke and grit of Southern Uplands origin predominate.

At the time of the maximum extent of the ice, probably only the highest hills stood out as nunataks. With climatic amelioration, however, ice-advance was halted and the ice-sheet began to melt *in situ*. Melting was slow at first, leading to exposure of hill tops in excess of 300 m above OD. Increasing volumes of meltwater caused the development of drainage-channel systems carrying meltwater in streams running beneath the ice towards the valleys. On the floor of many of the valleys are large sinuous eskers—ridges of sand and gravel deposited by sub-glacial streams. Several of the eskers, for example near Medwyn Cottage [126 489], and Romannobridge, run sub-parallel to late-Glacial drainage channels, which in turn are tributaries of the re-excavated pre-Glacial drainage system. Sub-glacial drainage during the later stages of glaciation probably followed the existing valley pattern.

Further melting of the ice left the valleys choked with masses of stagnant ice, around which sand and gravel accumulated to form extensive kame spreads, as seen west of West Linton, in the Dolphinton Gap and at Newbigging. The upper limit of these kames is about 300 m above OD in the north-east, dropping to below 230 m above OD in the valley of the South Medwin. This drop in elevation, coupled with the generally accepted thesis that the ice retreated south-westwards (Eckford, 1952; Sissons, 1963), suggests that glacial meltwater deposits around West Linton and Dolphinton formed at an early stage, when the ice level was higher, and are therefore older than comparable deposits around Newbigging in the west.

Locally, ponding of glacial meltwaters may have occurred, as, for example, at Ingraston Moss [120 482] and in the valley of the South Medwin where assessment boreholes proved fine sands, and laminated silts and clays, overlain either by peat or alluvium.

In the valley of the South Medwin, where the alluvial flat is just below 213 m above OD, the upper limit of ponded water may be defined by drainage channels: the termini of the highest end abruptly about 235 m above OD. It is probable that water to this level was dammed in the region of Walstonmill [037 451] since the pattern of drainage channels and the nature of the valley bottom change abruptly there. The extent of this lake is unknown, and its relationship to the Lake Clyde of Charlesworth (1926) and the development of modern drainage (Sissons, 1961) is problematical.

Glacially-dammed lakes are also thought by Charlesworth (1926) and Eckford (1952) to have occupied rock-floored basins south of West Linton and north of Romannobridge. At West Linton degraded back features of terraces at about 244 m above OD, notably south-east of Broomlee Mains [158 510], may represent former lake levels when meltwaters possibly drained north-east towards Carlops [160 560]. However, assessment boreholes sited both on the northern flanks and in the centre of the supposed lake basin failed to prove fine-grained lithologies normally indicating lacustrine sedimentation. Available data show that the alluvial flat lying at about 229 m above OD is underlain by thin peats and silts which cap coarse meltwater sands and gravels, the latter possibly having been transported and deposited by waters draining off the Pentland Hills. Consequently, it is thought that any ponding of meltwaters was short-lived, and that the basin was probably occupied by bodies of stagnant ice for a considerable period of time. A similar history may be suggested for the lake at Romannobridge (Eckford, 1952) where again borehole data indicate that coarse meltwater sediments underlie river alluvium.

With the westward retreat of the ice-margin, drainage was effected to the south via the re-opened valley of the Lyne Water. West of the river near West Linton an extensive area is formed of high mounds of sand and gravel locally with interbedded till. These kamiform deposits are thought to represent deposition from meltwaters on and around masses of stagnant ice abandoned by an ice mass gradually retreating south-westwards.

Progressive westward retreat of the ice-margin opened another drainage route to the south via the valley of the Tarth Water, but elsewhere outwash deposits and masses of dead ice blocked potential channels. The pre-glacial valley from Dunsyre to Dolphinton via Garvald (the Dolphinton Gap) was blocked by a mass of kamiform sand and gravel, in which the cross-bedding has an overall dip towards the south-east. At the south-eastern end of the Gap, near Nick's Plantation [114 482], a section in sand and fine gravel shows the deposit to contain coal, fragments some of which measure up to 12 cm in diameter. It is probable that the coal, being light, was either floated or washed into deposits of sand transported from either the Hamilton–Motherwell area or from the valley of the Douglas Water, some 40 km distant.

At Newbigging an extensive spread of kamiform pebbly sand and sand infills a wide channel cut in bedrock, now occupied by the South Medwin, and may represent a further period of ice stagnation and slow wastage.

Alluvial spreads which occupy the present valleys and comprise silts, sands and gravels are locally overlain by peat, for example, in the valley of the South Medwin. Peat is also extensively developed on high ground over much of the northern part of the resource sheet.

COMPOSITION OF THE MINERAL DEPOSITS

Particle size distribution and petrography

The greater part of the mineral resources of the assessment area occurs within the glacial meltwater deposits, which comprise all waterlaid sediments of the sub- and pro-glacial environments. Because of the great diversity of sedimentary conditions that co-existed in close proximity, the deposits of such environments vary rapidly in composition both laterally and vertically. Generally, distinctive landforms resulting from compositional differences can be used to facilitate mapping of subdivisions within the glacial meltwater deposits; in the Dolphinton area, however, such a relationship is not seen and no division has been attempted on the resource map.

Because the meltwater deposits exhibit great lithological variation, ranging from clays and silts up to 8.9 m thick (borehole 04 NE 4) to deposits with 47 per cent coarse gravel and cobbles (borehole 04 NW 7), they have been classified in the borehole logs into three lithologies solely on the basis of grading characteristics. Lithology 1 comprises those deposits with more than 60 per cent fines and fine sand and less than 5 per cent gravel, and includes all non-mineral clay and silt bands; Lithology 3 is defined as having more than 50 per cent gravel of which more than half is of coarse-gravel, cobble or boulder grade. Lithology 2 contains all the remaining, intermediate-grade, sediments, that is, those containing more than 50 per cent gravel of which more than half is fine grade, those with less than 50 per cent gravel and less than 60 per cent fines and fine sand, and those with more than 60 per cent fines and fine sand and more than 5 per cent gravel. To the west, in the neighbouring Lanark assessment area (Laxton and Nickless, 1980), similar criteria based on grading were used to subdivide the glacial meltwater deposits and, because both the greater correlation between topography and sediment type allowed these subdivisions to be mapped and the greater number of working sand and gravel pits enables the sediments to be examined in more detail, it was possible to relate the lithologies to specific depositional environments. A similar correlation was made in the Douglas Water assessment area (Shaw and Nickless, 1981).

The criteria defining the potentially workable deposits of Lithology 1 are closely similar to those defining glaciolacustrine deposits in the Lanark and Douglas Water areas. A comparison of the grading data (Table 2; Figure 4) with those from these neighbouring areas shows a much closer correlation than would be expected merely as a result of the similar limiting criteria, and for this reason it is considered likely that the majority of Lithology 1 deposits were laid down in glacial lakes.

The deposits of Lithology 3 (Table 2; Figure 6) are defined by criteria generally similar to the glacial sand and gravel of the Lanark area which is thought to be the product of eskerine sedimentation. However, boreholes 14 NW 10 and 14 NE 1, sunk on eskers in the Dolphinton area proved sandier deposits with less coarse gravel, the material classifying as Lithology 2. The bounding grading parameters of Lithology 2 relate closely to those of the

Table 2 Mean grading of deposits

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
Meltwater Lithology I	15	62	21	1	1	0	0
Meltwater Lithology II	8	28	34	9	11	9	1
Meltwater Lithology III	8	11	12	12	22	30	5
Till	13	14	13	14	23	20	3
Alluvium	8	18	16	13	22	22	1

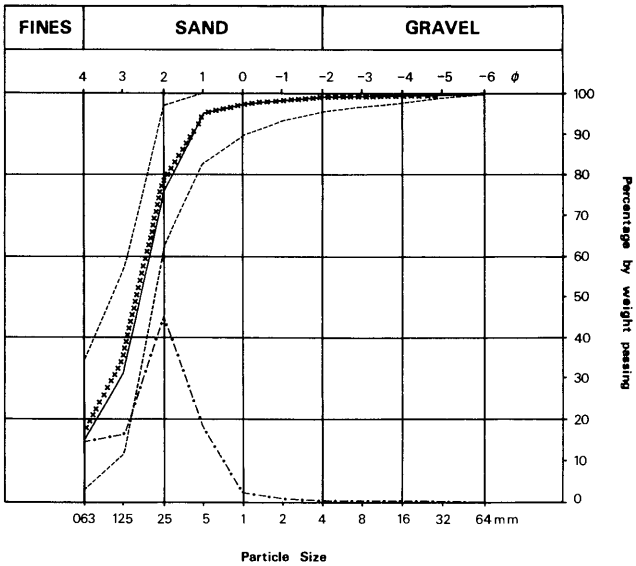


Figure 4 Grading characteristics of resources in glacial meltwater deposits (Lithology 1)
The continuous line shows the cumulative weighted mean; the broken lines define the envelope within which the cumulative mean gradings of individual mineral deposits fall; the frequency distribution of the mean grading is shown by a dashed and dotted line; the mean grading of the equivalent deposit in the Lanark area (see text) is shown by a crossed line

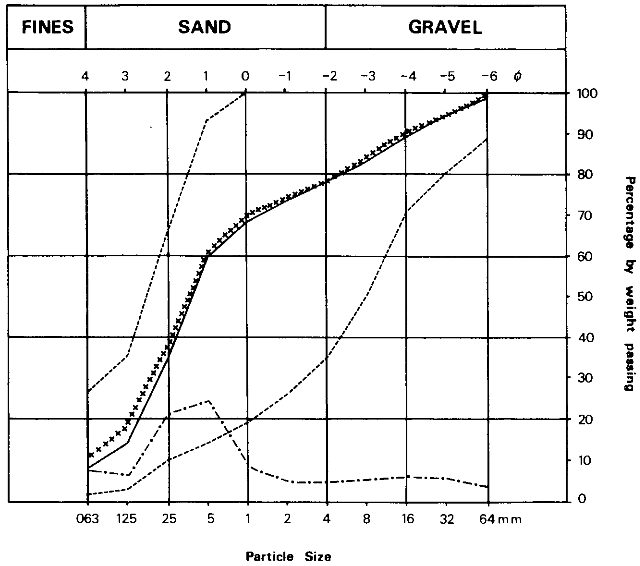


Figure 5 Grading characteristics of resources in glacial meltwater deposits (Lithology 2); for explanation, see Figure 4

fluvioglacial sand and gravel of the Lanark and Douglas Water areas which is considered to be a product of fluvial ice-front deposition, probably in braided stream or outwash delta complexes prograding into glacial lakes. Again, the degree to which grading correlates (Table 2; Figure 5) with these neighbouring areas is greater than would be expected as a result of the bounding grading criteria alone and suggests that Lithology 2 was deposited in an environment similar to that of the fluvioglacial deposits although including eskerine sedimentation. Lithology 3 is thought to have been deposited under closely related conditions, possibly nearer to the ice front.

Because all three lithologies are the product of a single depositionary system their compositions range one into another as shown by the grading diagrams (Figures 4 to 6) in which, although the mean grading for the lithologies is distinct, there is considerable overlap of the envelopes, in particular between lithologies 2 and 3 where, over the finer part of the curve, the entire envelope of Lithology 3 is contained within that of Lithology 2. The greater

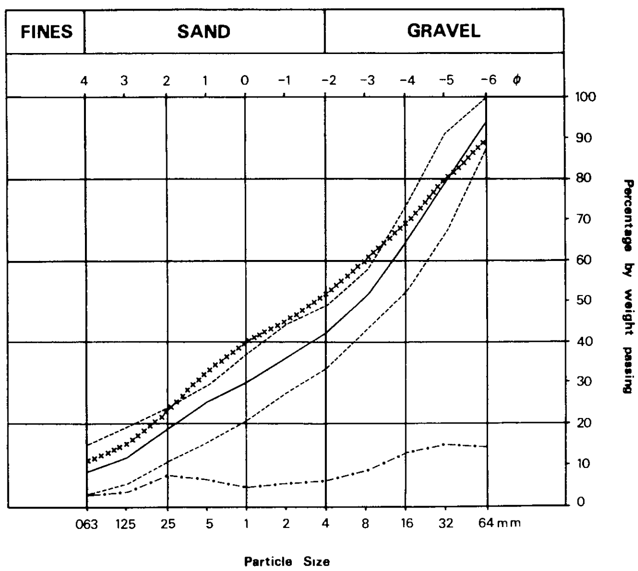


Figure 6 Grading characteristics of resources in glacial meltwater deposits (Lithology 3); for explanation, see Figure 4

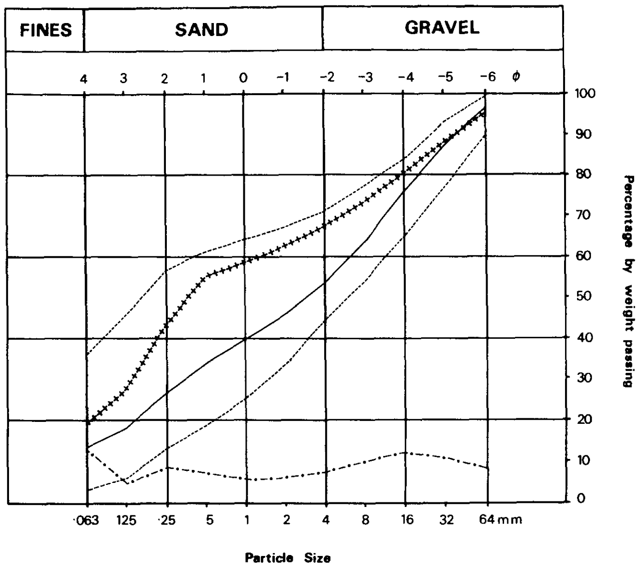


Figure 7 Grading characteristics of resources in till; for explanation, see Figure 4

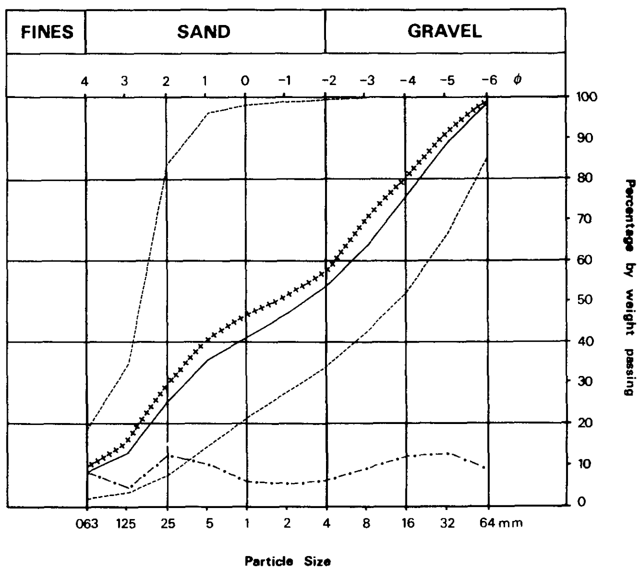


Figure 8 Grading characteristics of resources in alluvium; for explanation, see Figure 4

breadth of envelope for Lithology 2 compared with lithologies 1 and 3 is mainly due to the more embracing criteria used to define the lithology. Of the total thicknesses penetrated in boreholes, 38 and 79 per cent respectively of till and alluvium proved to be potentially workable. Both these deposits are defined genetically without regard to their composition; their mean gradings are shown in Table 2 and, respectively, in Figures 7 and 8.

Lithological analyses were made of five samples of 10–14 mm material derived by combining samples from boreholes as listed in Table 3; their approximate locations are shown in Figure 3. The samples correspond to those used in the mechanical and physical testing, described below; grouping of material from several boreholes was necessary to obtain sufficient 10–14 mm material for the full range of tests. Samples I to IV were taken from the glacial meltwater deposits: I, III and IV were from the south-west, centre and north-east respectively of the South Medwin–Dolphinton Gap–West Linton sediments, which comprise the principal resource of the area,

Table 3 Sources and geological classification of composite samples

Boreholes from which the composite sample was taken	Depth range (m)	Number of samples
Composite sample I (Glacial meltwater deposits)		
04 NW 1	0.2–4.7	4
04 NW 4	0.3–3.4	3
04 NW 5	0.3–2.9	3
04 NW 6	0.4–2.4 13.4–14.4 15.8–25.0	12
04 NW 7	3.0–7.1	4
04 NW 9	11.7–22.8	10
04 NE 2	1.3–5.3 8.3–11.4 12.8–15.9	10
04 SW 1	0.3–2.0 3.0–4.6	3
04 SW 3	3.2–15.1	12
04 SW 5	6.6–9.6 14.6–16.0	5
	Total	66
Composite sample II (Glacial meltwater deposits)		
04 SW 6	0.3–5.0	5
04 SE 1	0.2–19.8	19
04 SE 2	0.5–3.6 6.8–17.8	12
04 SE 4	0.3–8.0	8
	Total	44
Composite sample III (Glacial meltwater deposits)		
04 NE 5	2.5–4.5 9.0–10.0 11.0–12.0 13.0–15.0	6
04 NE 6	0.4–4.7	4
04 NE 7	0.2–4.2 11.2–12.2 14.2–16.0	7
04 NE 8	1.5–4.5	3
04 NE 10	0.3–24.2	24
14 NW 2	0.4–1.9	2
14 NW 3	0.3–4.0	4
14 NW 8	0.5–5.8	5
14 NW 9	0.3–3.5	3
	Total	58
Composite sample IV (Glacial meltwater deposits)		
14 NW 10	0.3–6.3	6
14 NW 11	0.3–2.1	2
14 NE 3	1.7–9.3	7
15 SW 13	1.8–4.6	3
15 SW 15	0.3–13.0	13
15 SW 16	0.4–9.5	9
15 SE 116	3.0–8.0 9.5–13.1	8
15 SE 117	0.7–2.8 7.3–13.5	8
15 SE 118	0.3–3.6	4
	Total	60
Composite sample V (Alluvium)		
14 NW 12	0.4–4.4	4
14 NE 3	0.7–1.7	1
14 SW 1	1.6–3.2	1
14 SE 1	1.8–3.0	1
14 SE 2	0.4–4.7	3
15 SW 17	0.2–4.2	4
15 SE 116	1.0–3.0	2
	Total	16

Table 4 Lithological analyses of composite samples
Results are given in frequency per cent and weight per cent; for location of samples, see Table 3 and Figure 3

	Composite sample number	I		II		III		IV		V	
	Number of pebbles counted	240		245		256		261		224	
British Standard Trade Group	Rock type (modified after BS 812)	fr %	wt %	fr %	wt %	fr %	wt %	fr %	wt %	fr %	wt %
Basalt	Undivided	41.2	41.2	18.4	16.7	36.7	37.2	29.9	32.3	34.4	34.0
Flint	Chert	6.3	6.3	3.7	4.0	5.1	4.6	4.2	4.6	3.6	2.9
Granite including diorite and microgranite)	Undivided	–	–	2.0	1.6	2.7	2.4	8.8	8.8	1.8	2.1
Gritstone	Grit and greywacke (indurated)	13.8	12.7	54.7	58.2	12.9	11.8	6.1	6.2	33.9	38.1
	Sandstone (including quartzitic sandstone)	16.7	17.8	9.0	7.6	23.8	24.2	33.0	31.2	11.6	9.3
	Tuff	0.8	0.9	0.8	0.8	0.4	0.5	3.1	2.5	–	–
Limestone	Undivided	0.8	1.1	–	–	–	–	–	–	–	–
Porphyry	Undivided (mainly felsite)	6.6	5.5	5.7	5.9	6.7	7.6	6.9	6.5	4.4	3.1
Quartzite	Quartzite (including psammite)	9.2	9.5	5.7	5.2	5.1	4.9	4.2	4.5	4.5	5.0
Schist	Undivided	–	–	–	–	–	–	–	–	2.2	1.4
Others	Vein-quartz	4.6	5.0	–	–	6.6	6.8	3.8	3.4	3.6	4.1

and Sample II from the more patchy sand and gravel in the south-west around the Candy Burn and the Biggar Burn. Sample V is from the alluvium of the Lyne and Tarth waters. No lithological analysis was undertaken of the till, due to the limited proportion of that deposit that is potentially workable, or of the individual lithologies, defined above, within the glacial meltwater deposits.

The results of the analyses are presented in Table 4. The lithological classification is based on the trade groups given in BS 812.1: 1975 with minor modifications: diorite and microgranite are included in the granite group, with which they form a continuous series, psammite is consigned to the quartzite group, which therefore comprises all unfoliated metamorphic rocks; and vein-quartz is listed separately. The gritstone group is subdivided into grit and greywacke, highly indurated sediments derived predominantly from the Lower Palaeozoic rocks of the Southern Uplands; sandstone, including quartzitic sandstone, comprising much less indurated rocks derived principally from the Devonian and Carboniferous to the north of the Southern Upland Fault; and tuff. Lower and Upper Palaeozoic sediments have been distinguished because of differences in their areas of provenance and in their mechanical and physical properties, the much greater induration of the former resulting from tectonism during the Caledonian orogeny. Pebbles of the grit and greywacke sub-group form a petrographically continuous series with those of the quartzite group, but in most cases a clear distinction between the two groups can be made.

The dominant lithologies present in the Newbigging–West Linton meltwater deposits (Samples I, III, IV) are the basalt group and sandstone (Table 4): there is a decrease in the former and concomitant increase in the latter from south-west to north-east. Consideration of the lithological analyses in relation to the solid geology supports the view of McCall and Goodlet (1952) and Eckford (1952) that the last ice advance was from the south-west up the Medwin Valley, through the Dolphinton Gap and then north-east to West Linton. The abundant basalt in Sample I is likely to be derived from the extensive outcrops of the Clyde Plateau lavas around Carnwath and in the valley of the Clyde near Pettinain [954 430], to the west and south-west of Newbigging. North-east of Newbigging, ice crossed Upper Devonian sandstones as far as the Dolphinton Gap, and Lower Devonian sandstones beyond it, traversing volcanics for only 2.5 km through the Gap. The ice therefore became increasingly depleted in basalt at the expense of sandstone to the north-east. The relative depletion in basalt of sample IV suggests that there was little ice movement up the valley of the Candy Burn and Back Burn to Dolphinton, since this course would have traversed mainly andesite and basalt. Other rock types occur only as minor constituents in the deposit and show no significant variation between the samples. Tuff is the exception, the much higher relative amount in Sample IV probably being derived from the large outcrop of volcanic breccia just to the north of West Linton. The presence of minor amounts of the quartzite group in all the samples lends support to the views of McCall and Goodlet (1952) and Eckford (1952) that the area was glaciated by Highland ice prior to that from the Southern Uplands, although some such material may be derived from conglomeratic bands within the Ordovician sediments.

Sample II, from the meltwater deposits in the south-west, has a much higher grit and greywacke content than is found elsewhere due to the proximity of Lower Palaeozoic rocks, although, surprisingly, it does not contain a correspondingly greater amount of chert. Sample V from the alluvial deposits in the north-east of the area is also compositionally distinct, the principal constituents being almost equal proportions of basalt, and grit and greywacke, with a lesser amount of sandstone. The boreholes from which the material of Sample V was taken (Table 3) extend over a considerable length of the valleys of the Tarth and Lyne waters from West Linton and Felton [125 478] to the junction of the valleys near Drochil Castle [163 435], and over this distance the bedrock is principally Lower Devonian sandstone in the north, and Lower Palaeozoic rocks in the south. The latter probably account for the high grit and greywacke content of Sample V; the basalt is more difficult to explain, but is most likely to have been derived by reworking of the Dolphinton–West Linton meltwater deposits. The low sandstone content is also surprising and shows the readiness with which the Upper Palaeozoic sandstones break down during transport, lending further support to the view that the meltwater deposits, some of which have high sandstone contents, must have been deposited close to the ice front, after having been carried for only a short distance.

Meltwater deposits

Due to the rapid lateral compositional variation of the meltwater deposits, no correlation of individual beds is possible between boreholes; there is similar vertical variation, as in boreholes 04 SW 5 and 15 SW 15. However, in many of the thicker meltwater sequences, particularly in the valley of the South Medwin and around West Linton, there is upward fining either from Lithology 2 or 3 deposits into Lithology 1, as for example in boreholes 04 NW 7 and 04 SW 3, or from coarser to finer deposits within Lithology 2, as in boreholes 04 NW 9 and 04 NE 2. These trends do not occur in all boreholes, but overall the sediments suggest the development of ephemeral glacial lakes subsequent to the formation of ice-marginal fluvial deposits. This view is supported by the occurrence of areas of flat ground indicative of lacustrine sedimentation near West Linton and in the valley of the South Medwin.

Lithology 1 sediments constitute 31 per cent of the total thickness of meltwater deposits penetrated in boreholes, of which 37 per cent, that is, about 11 per cent of the whole, is non-mineral, comprising brown to grey, usually laminated, silts and clays which were proved in fifteen boreholes. The potentially workable component of the lithology consists of well sorted sands having a mean grading in the 'clayey' sand category and a unimodal distribution peaking in the 0.125–0.25 mm size range (Table 2; Figure 4). The grains are generally of subrounded quartz.

The greater part, 61 per cent of the total thickness, of the meltwater deposits are of Lithology 2 and by definition contain no waste; they range in composition from fines-free sand to gravel and their mean grading falls in the sandy gravel category. The lithology is relatively well sorted and shows unimodal distribution, the peak occurring in the fine to medium sand grades (Table 2; Figure 5). The pebbles range from angular to well rounded but are principally subrounded to well rounded, whereas the sand, predominantly quartz, is generally subrounded.

The remaining 8 per cent of the glacial meltwater deposits comprise Lithology 3 which has a composition restricted to either 'clayey' gravel or gravel with a mean grading in the 'clayey' gravel category (Table 2; Figure 6). The compositional uniformity is reflected in the narrow grading envelope and is partly a function of the grading criteria defining the lithology. The deposit is slightly bimodal, with maxima in the fine to medium sand and coarse gravel to cobble grades, but normally is poorly sorted. The gravel shows the same range of angularity as Lithology 2, but the sand fraction is distinct, grains being generally subangular. This greater angularity supports the view that sediments of Lithology 3 were laid down closer to the ice-front than those of Lithology 2.

Till

The till is generally a stiff reddish brown to brown clay with ill-sorted angular to well-rounded clasts up to cobble size. In eleven boreholes, however, at least part of the till sequence is potentially workable: it ranges in composition from gravel to 'very clayey' sandy gravel and has a mean grading classifying as 'clayey gravel' (Table 2; Figure 7). The more fines-rich deposits are often clay-bound, the remainder frequently showing evidence of washing during drilling. The deposit is characterised by being extremely ill-sorted; the grading curve shows only poorly developed modes in the fine- to medium-sand and coarse-gravel grades.

Alluvium

The main alluvial deposits of the area are in the valleys of the South Medwin in the west, and the Tarth and Lyne waters in the east, with small deposits in the south associated with Biggar Burn, Candy Burn and Lochurd Burn. The potentially workable alluvial deposits of the South Medwin range from 'clayey' sand in borehole 04 NE 1 to gravel in borehole 04 SW 4, whereas those of the Tarth and Lyne waters are principally gravel and sandy gravel, although an upper deposit of 'clayey' pebbly sand occurs in borehole 15 SW 17. The Biggar Burn deposit was proved in borehole 04 SE 3 to comprise 0.5 m of 'very clayey' sand on 0.1 m of silt; probably the deposit is nowhere thick enough to be potentially workable.

Considered as a whole the potentially workable alluvium has a mean grading in the sandy gravel category and is bimodal with peaks in the fine- to medium-sand and coarse-gravel grades (Table 2; Figure 8). This curve is similar to that for till from which much of the deposit may be derived by reworking. Both the sand and gravel grades have been rounded during transport, the former being generally subrounded, the latter subrounded to well rounded; the gravel of the Tarth Water appears a little more angular.

Mechanical and physical properties of the aggregate

A programme of mechanical and physical testing, in accordance with BS 812: 1975, was carried out on material from the five composite samples listed in Table 3 and comprised measurements of aggregate impact value (AIV), aggregate crushing value (ACV), 10 per cent fines, flakiness index, relative density (on both an oven-dried and surface-dried basis), apparent relative density, and water absorption. In addition values of aggregate impact value residue (AIVR) and aggregate crushing value residue (ACVR), as defined by Ramsay (1965) and Ramsay, Dhir and Spence (1974) were determined. Pebble counts (Table 4) were carried out on material from the samples to see if any correlation between petrography and the test results existed. It has been shown by Ramsay (1965) and Ramsay, Dhir and Spence (1974) that the principal petrographic factors affecting aggregate strength are, in igneous rocks, the degree of crystal interlocking, and cleavage, microfracture and twinning planes, and, in sedimentary rocks, the strength of the intergranular cement. These are factors not directly considered in the trade groups of BS 812: 1975 which have therefore been slightly modified (Table 4) so as to reflect better any petrographic factors affecting the test results (Table 5).

Results of the mechanical and physical testing

The resistance of an aggregate to both sudden load and slowly-applied compressive load affects its potential use particularly as a roadstone; AIV is a measure of the former property, ACV and 10 per cent fines the latter. The AIV test measures the amount of cataclastic material

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

Composite sample number	Flakiness index	AIV	AIVR	ACV	ACVR	10% fines value	Relative density: Oven-dried basis	Relative density: Surface-dried basis	Apparent relative density	Water absorption %
I	10	19	47	19	36	210	2.52	2.59	2.71	2.7
II	13	20	39	19	32	200	2.45	2.54	2.69	3.7
III	11	18	46	20	35	210	2.47	2.54	2.67	3.1
IV	12	25	46	23	32	140	2.38	2.49	2.67	4.5
V	14	23	38	21	31	170	2.49	2.56	2.69	2.9

passing a 2.36 mm sieve relative to the original weight of a 10–14 mm size fraction sample after it has been subjected to fifteen blows of standard magnitude. In considering the economic potential of an aggregate, however, it is usually the ability of clasts to withstand impact relatively intact, rather than to withstand a high level of comminution, that is most important. For this reason Ramsay (1965) introduced the AIVR which measures the weight of +10 mm material remaining after the AIV test.

In a study of the AIV values of rock aggregates Ramsay (1965) found an inverse relationship to exist between strength and the flakiness index. Further work (Dhir, Ramsay and Balfour, 1971) has shown there to be an even closer correlation between flakiness index and AIVR. Natural aggregates, not having undergone a crushing process, will generally have a much lower flakiness index than rock aggregates, as can be seen by comparing the mean value of 17 given by Edwards (1970) for gravels, with those of rock aggregates, which range from 22 to 35. The AIV, AIVR and flakiness index results of the present study (Table 5) confirm the low flakiness values of natural aggregates and show little variation between samples. For this reason there is no correlation between flakiness index and either AIV or AIVR, the values of which indicate different relative strengths for the samples, reflecting differing degrees of comminution. Although these results appear not to be related to petrography (Table 4) there is a good correlation between the AIVR values and location; Samples I, III and IV from the Newbigging–West Linton meltwater deposits all have similar, and markedly higher values than those for the southern meltwater deposits (Sample II), or alluvium (Sample V), probably relating to differences in sedimentary history, such as distance of transport or length of subaerial exposure, which affected the degree of weathering of pebbles.

Dhir, Ramsay and Balfour (1971) have shown there to be a linear relationship between both AIV and ACV and between AIVR and ACVR, the last named being defined in a similar way to the AIVR and this is generally supported by the results of the present study (Table 5). The relationship of ACV to ACVR and AIV to AIVR diverge from linearity in a similar way. The 10 per cent fines value differs from the ACV in that it measures the load required to produce 10 per cent fines in ten minutes as against measuring the compaction produced by applying a gradually increasing load attaining 400 kN after ten minutes. For the samples in the present study the force applied in the 10 per cent fines test ranges from 140 to 210 kN, about half that used in the ACV test. There is a direct correlation between the results of the two tests with the samples therefore having the same relative strengths at different levels of applied load. Comparison of the AIV and ACV results in Table 5 with average values of 19 and 17 respectively for Scottish and English gravels (Edwards, 1970) shows the aggregates of the present study area to be generally weaker, although the AIV results for Samples I, II and III are close to the mean. The low strengths are probably due to the large amount of the gritstone group present.

A prime factor determining the stress carrying and weathering resistance of concrete is its drying shrinkage (Building Research Establishment, 1968) which in turn is related to the shrinkage of the component aggregate, a function of the amount of water than can be absorbed by the rock matrix. Edwards (1970) has determined a very general linear relationship between water absorption of aggregate and the drying shrinkage of concrete. The water absorptions measured in the present study (Table 5) are substantially higher than the mean of 1.48 per cent given by Edwards (1970) for Scottish and English gravels, but compare well with the values determined for aggregates in neighbouring areas (Laxton and Nickless, 1980; Shaw and Nickless, 1981). These high values appear to be related to the number of sandstone pebbles in the samples which, being poorly indurated, have large intergranular pore spaces. Generally gritstones have higher water absorption than igneous rocks which, in turn, are higher than flint and quartz. Using the linear relationship given by Edwards (1970) the aggregates of the study area give shrinkage values between about 0.083 and 0.12, all but Samples I and V lying above the 0.085 value set by the Building Research Establishment (1968) as requiring the greatest care to be exercised in the uses to which concrete made of such material is put. Such inferred shrinkage values however should be treated cautiously as true values can be obtained only by the testing of concrete blocks.

The relative densities (Table 5) show only a little variation between samples and this cannot be related to petrography, although the slightly higher values for Sample I may be due to the greater basalt content.

THE MAP

The sand and gravel resource map is folded into the pocket at the end of this report. The base map is the Ordnance Survey 1 : 25 000 Outline Edition which together with the contours is printed in grey: the geological lines and symbols are in black. Mineral assessment information, including areas of potentially workable sand and gravel, resource notes and block boundaries, is presented in shades of red.

Geological data

The geological boundary lines and symbols are taken from the geological maps of the area, parts of which were last surveyed on the scale of 1 : 10 560 by staff of the Institute's South Lowlands Unit during 1977–78. The boundaries are the best interpretation of information available at the time of the survey. However it is inevitable, particularly with variable superficial deposits, that locally the accuracy of the map will be improved as new evidence from boreholes and excavations becomes available.

Mineral assessment information
The map is divided into resource blocks (see Appendix A), within which the extent of mineral is shown in red. A further subdivision of the mineral into areas where it is exposed (where the overburden averages less than 1.0 m in thickness) and areas where it is present in relatively continuous spreads beneath overburden averaging more than 1.0 m in thickness are represented by progressively lighter shading. Within these areas, however, there may be small patches where sand and gravel is absent or not potentially workable, as for example, around borehole 04 SW 2. Areas where sand and gravel is considered to be generally not potentially workable, where the superficial deposits do not contain mineral or where bedrock crops out are uncoloured. Small patches of sand and gravel that were not assessed, although they may be potentially workable, are indicated by red stipple.

For the most part the distribution of resource categories is based on mapped geological boundaries. Where transitions between categories cannot be related to the geological map, inferred boundaries have been inserted. Such boundaries, drawn primarily for the purpose of volume estimation, are shown by a distinctive zigzag symbol, which is intended to convey an approximate location with a likely zone of occurrence rather than to represent the breadth of the zone; its width is dictated by cartographic considerations. For the purpose of measuring areas the centre-line of the symbol is used.

RESULTS
The results are summarised in Tables 6 and 7. Detailed mineral grading and thickness data from assessment sample points used in the calculation of resources are given in Tables 8 to 11. The cumulative frequency, grading 'envelope' and frequency distribution for all deposits grading as mineral (including glacial meltwater deposits, alluvium and till) are given in Figures 4 to 8. Particle size distribution curves for the statistically assessed potentially workable deposits in each resource block are presented in Figures 9 to 11.

Accuracy of results
For deposits assessed statistically in Blocks A, B and C the accuracy of the results at the symmetrical 95 per cent probability level ranges from 34 to 63 per cent. However, the true values are more likely to be nearer the figure estimated than the limits. Moreover, it is probable that in each block roughly the same percentage limits would apply for the estimate of volume of a very much smaller parcel of ground (say, one hundred hectares) containing similar sand and gravel deposits if results from the same number of sample points (as provided by, say, ten boreholes) were used in the calculation. Thus, if closer limits are needed for the quotation of reserves of part of a block it can be expected that data from more than ten sample points will be required, even if the area is quite small.

However, it must again be emphasised that the quoted volume of sand and gravel has no simple relationship with the amount that could be extracted in practice, since 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.

RESOURCE BLOCK DESCRIPTIONS
The area assessed is divided into four resource blocks. Statistical assessments are offered in Table 6 for Blocks A, B and C which encompass the principal potentially workable glacial meltwater deposits and alluvium occupying the land around West Linton, Dolphinton and the valleys of the South and North Medwin. Inferred assessments are presented in Table 7 for scattered spreads of glacial meltwater deposits of Block D which is divided into three sub-blocks, D_1, D_2 and D_3. Inferred assessments are also given for glacial meltwater deposits and alluvium of the Lyne and Tarth waters lying within Sub-block D_3. Elsewhere in Block D, pockets of alluvium flanking the higher reaches of or lying outwith the valleys of the major rivers are generally considered to be not potentially workable and are not assessed. Although till occurs in all blocks and may be locally potentially workable, the deposit is only considered in the calculation of resources when it forms part of a continuous sequence of mineral, or is proved at a sample point lying within an area generally thought to contain mineral.

Table 6 The sand and gravel resources: summary of statistical assessments

Resource block and mineral-bearing deposits	Area (km^2)		Mean thickness (m)		Volume* of sand and gravel			Mean grading percentage		
	Block	Mineral	Overburden	Mineral	$m^3 \times 10^6$	Limits at the 95% probability level $\pm$%	Limits at the 95% probability level $\pm m^3 \times 10^6$	Fines $-\frac{1}{16}$mm	Sand $+\frac{1}{16}$–4 mm	Gravel +4 mm
A (Alluvium, glacial meltwater deposits and till)	12.4	11.4	0.9	8.5	96.8	46	45.0	10	62	28
B (Alluvium, glacial meltwater deposits and till)	11.5	9.6	0.3	8.3	79.7	63	50.2	10	66	24
C (Alluvium and glacial meltwater deposits)	13.3	12.9	0.6	12.4	159.8	34	54.3	8	78	14
D	242.8	No statistical assessment offered—for inferred assessments, see Table 7								
Total	280.0	33.9			336.3					

* Figures for volume may not exactly equal the products of area and mean thickness because of independent rounding.

Table 7 The sand and gravel resources: summary of inferred assessments

Resource block and mineral-bearing deposits	Area (km²) Block	Area (km²) Mineral	Mean thickness (m) Over-burden	Mean thickness (m) Mineral	Volume* of sand and gravel $m^3 \times 10^6$	Limits at the 95% probability level ±%	Limits at the 95% probability level $\pm m^3 \times 10^6$	Mean grading percentage Fines $-\frac{1}{16}$ mm	Sand $+\frac{1}{16}$–4 mm	Gravel +4 mm
A	12.4	Statistical assessment—see Table 6								
B	11.5	Statistical assessment—see Table 6								
C	13.3	Statistical assessment—see Table 6								
D_1 Scattered glacial meltwater deposits:										
The Kames	79.0	0.1	At or near surface	5.0‡	0.3	Speculative		No data available		
South Tarbrax	79.0	0.1		4.6‡	0.2	Speculative		No data available		
D_2 Scattered glacial meltwater deposits:										
Carwood	59.8	1.5	0.3†	3.0§	4.5	Speculative		(16	59	25)†
Elsrickle to Candyburn	59.8	1.1	0.4	7.3§	8.0	Speculative		8	42	50
Candybank and Cambwell	59.8	0.4	0.2†	19.6†	8.4	Speculative		(11	59	30)†
D_3 Scattered glacial meltwater deposits of the valley sides:										
Blyth Bridge	104.0	2.0	0.2†	3.5§	7.0	Speculative		(14	50	36)†
Romannobridge	104.0	0.7	1.5	3.0	2.0	Speculative		18	50	32
Alluvium, glacial meltwater deposits and till of the valley floor of the Tarth Water	104.0	1.6	1.3	6.3	9.8	Speculative		4	67	29
Alluvium and glacial meltwater deposits of the valley floor of the Lyne Water	104.0	2.6	0.3	3.0	7.9	Speculative		7	48	45
Total	280.0	10.1			48.1					

* Figures for volume may not exactly equal the products of area and mean thickness because of independent rounding.
† Based on data from one sample point.
‡ Based on field survey only.
§ Estimate based on available data

Block A

The block contains the valleys of the Lyne and West waters and includes alluvium and glacial deposits around West Linton. Glacial meltwater deposits, which constitute the greatest volume of potentially workable material, occupy extensive areas of ground south-west of West Linton where they form kame-and-kettle topography, and also flank and underlie a low-lying alluvial flat to the south-east of the village.

At an early stage of deglaciation meltwater from a mass of south-westward-retreating ice, being unable to drain southwards via the ice-filled valley of the Lyne Water, may have flowed north-eastwards via Carlops [160 559] (Sissons, 1963). Immediately south-east of West Linton stagnant ice is considered to have occupied a basin which is now filled with meltwater and alluvial silts, sands and gravels. These deposits are shown by IGS records to thin towards the north and north-east. Borehole 15 SE 107, near Whitfield [168 530], proves 9.1 m of undifferentiated alluvium and glacial meltwater deposits on sandstone and, to the north of the alluvial flat, borehole 15 SE 118, near Deanfoot Farm [158 525], sited on a higher terrace, shows 3.3 m of meltwater deposits on 2.3 m of till which rests on sandstone. At Robinsland [155 519], borehole 15 SE 116, in the centre of the valley floor, shows 3.0 m of peat and alluvium overlying 10.1 m of meltwater deposits (mainly Lithology 2), which rest on a thin basal till on bedrock. These meltwater deposits are thought to have been laid down when dead ice had melted sufficiently to allow drainage into the centre of the West Linton basin from the Pentland Hills. Southward drainage is thought to have continued via the reopened valley of the Lyne Water.

To the west of the Lyne Water, widespread deposits of moundy (kamiform) sands and gravels occupy ground up to about 300 m above OD. These deposits probably formed initially against dead ice occupying ground near West Linton as the main ice mass retreated south-

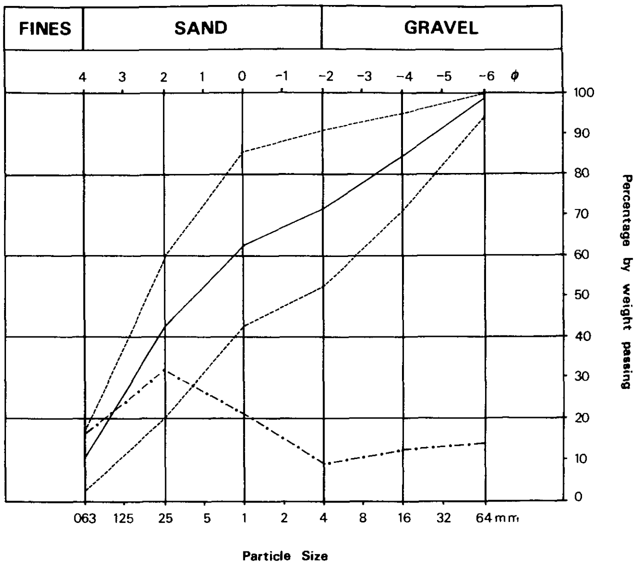


Figure 9 Grading characteristics of resources in alluvium, glacial meltwater deposits and till (Block A)
The continuous line shows the cumulative weighted mean; the broken lines define the envelope within which the cumulative mean gradings of individual deposits fall; the frequency distribution of the mean grading is shown by a dashed and dotted line

westwards. Boreholes 15 SW 13, 14, 15 and 16 and 15 SE 117 show complex sequences of meltwater deposits interbedded with or overlying till—locally the latter grades as mineral—indicating that these sediments were probably deposited over and around bodies of stagnant ice. The mineral thickness ranges from 5.4 m in borehole 15 SW 13, at North Slipperfield [128 518] near the northern margin of the deposits, to 20.1 m in borehole 15 SW 16, near Castlelaw [145 510].

North-west of Lynedale [142 525] on the west side of the Lyne Water where peat forms an extensive cover, an inferred boundary is drawn between concealed mineral and barren ground. Farther north, between Crooked Jock [140 528] and Wakefield [129 540], borehole records from IGS Site Exploration File SE 549 (see Appendix E) have been used to infer the western limit of buried mineral deposits filling a deep former channel of the Lyne Water. Borehole 15 SW X3 proves the greatest thickness of drift, 61.3 m (of which 11.6 m is considered potentially workable), resting on andesite bedrock. This record, together with three others (not shown on the resource sheet) proving buried mineral, indicates a mean thickness of 5.7 m of sand and gravel overlain by 5.0 m of overburden. Boreholes 15 SW X1 and X2, sited to the west of the buried channel, show thin drift, mainly till, on bedrock.

South and west of Lynedale, although a continuous spread of mineral is shown on the resource sheet extending over the south-western part of the block, individual, locally peat-filled, hollows (or kettles) may be barren of potentially workable material. South of the A702, at White Moss [140 495] a more extensive peat spread is thought to overlie thin mineral, which is delimited to the south-east by an inferred boundary. To the south-west of the Moss, ground near Hyndfordwell [140 488] is gently undulating. Here, although generally there may be a thin cover of sand and gravel, borehole 14 NW 13 proves sandstone at the surface, indicating a rapid south-westward thinning of the West Linton kame deposits. North-west of the A702 and south-west of Slipperfield Loch [136 505], sand and gravel also thins towards the south-west, merging into a series of north-easterly-trending sub-parallel esker ridges. Borehole 14 NW 10, sited on one such ridge, proves 6.0 m of 'clayey' sandy gravel resting on sandstone.

The valley of the West Water cuts through the kame deposits near West Linton. On the valley floor at Tarfhaugh [145 504], borehole 15 SW 17 shows 4.0 m of alluvium on 2.9 m of meltwater deposits (Lithology 1) overlying sandstone. Alluvium is considered to be potentially workable as far upstream as North Slipperfield, where an inferred boundary is drawn to divide exposed mineral from barren ground. The deep valley of the Lyne Water north of West Linton exposes bedrock locally, but upstream of Lynedale patches of alluvium are considered to be potentially workable: Site Exploration File SE 549, which includes borehole 15 SW X4 (shown on the resource sheet), contains data that indicate a mean thick-

Table 8 Block A: data from assessment boreholes—all deposits in the alluvium, glacial meltwater deposits and till

Borehole number	Recorded thickness			Mean grading percentage						
	Mineral (m)	Over-burden (m)	Waste partings (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
14 NW 10	6.0	0.3	0.0	16	23	15	11	15	16	4
14 NW 13	0.0	–	–	–	–	–	–	–	–	–
15 SW 13	5.4	1.8	0.0	9	20	17	11	21	22	0
15 SW 14	14.9	0.3	0.0	8	21	15	11	17	23	5
15 SW 15	20.0	0.3	4.7	10	44	32	5	4	5	0
15 SW 16	20.1	0.4	4.5	15	44	21	7	7	6	trace
15 SW 17	6.9	0.2	0.0	14	42	10	7	14	13	0
15 SE 116	10.6	1.0	1.5	8	19	21	12	23	17	0
15 SE 117	12.3	0.7	0.5	6	24	16	10	18	24	2
15 SE 118	3.3	0.3	0.0	10	20	26	12	18	14	0
15 SE 120	1.1	0.7	0.0	2	18	24	9	28	19	0
Mean*	9.1	0.6	–	10	32	21	9	13	14	1

* The mean thicknesses of mineral and overburden are based on unweighted assessment data only and may not necessarily correspond with figures given in Table 6.

ness of mineral (alluvium and thin till) of 3.4 m near Tocher Knowe [138 538].

Assessment of resources: On the basis of eleven assessment boreholes, the mean grading of potentially workable alluvium, glacial meltwater deposits and till is fines 10 per cent, sand 62 per cent and gravel 28 per cent ('clayey' sandy gravel) (Table 8; Figure 9). The mineral, with the exception of concealed deposits of the buried channel of the Lyne Water, is generally at or near surface. Based on available data for both concealed and exposed potentially workable sand and gravel, the mean overburden and mineral thicknesses are calculated at 0.9 m and 8.5 m respectively. The volume of potentially workable material is estimated at 97 million $m^3 \pm 46$ per cent (Table 6).

Block B

The block, which encompasses potentially workable deposits of the Dolphinton Gap (Eckford, 1952), Dolphinton village and Ingraston [116 489], is bordered to the north-east by Block A and to the west by Block C. To the north lie the south-western foothills of the Pentlands, to the south-west the volcanic hills culminating in Black Mount (516 m above OD) and to the east, Blyth Muir. Most of the potentially workable deposits occur in the moundy meltwater deposits that occupy the Dolphinton Gap. Cutting through the drift are the south-westward-flowing South Medwin and the south-eastward-flowing Garvald Burn; the streams have been artificially divided south of Medwinbank [098 498].

As ice occupying the low lying ground of Ingraston and the valley of the South Medwin continued to retreat south-westwards, rapid sedimentation took place in the Dolphinton Gap, some drainage occurring via the valley of the Tarth Water which probably still contained ice at this time. Meltwater sand and gravel was probably transported eastwards from a body of ice occupying the valley of the South Medwin and deposited on and against patches of dead ice. Consequently a wide variation in mineral thickness may be encountered. Sited on top of a mound just north of the South Medwin in the centre of the valley, borehole 04 NE 7 proves 16.8 m+ of mineral. To

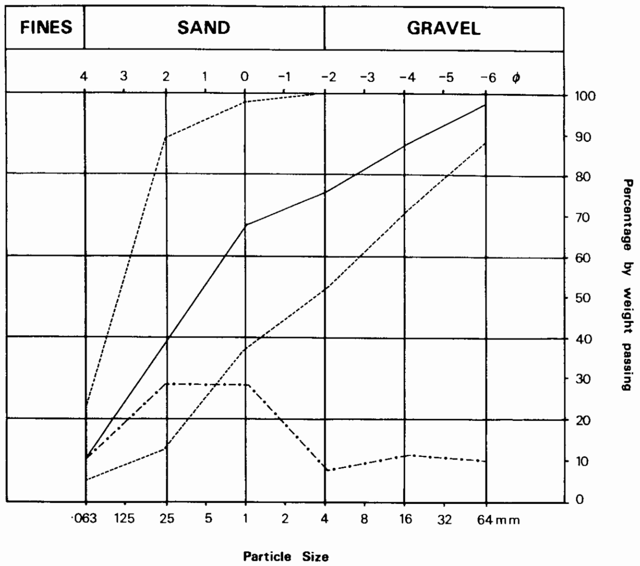


Figure 10 Grading characteristics of resources in alluvium, glacial meltwater deposits and till (Block B); for explanation, see Figure 9

the north, borehole 04 NE 6, at Easton [084 492] near the edge of the meltwater deposits, proves 4.3 m of 'very clayey' sandy gravel resting on sandstone. Upstream, borehole 04 NE 9, located on ground thought to be composed mainly of till, proves 3.0 m of 'clayey' pebbly sand (meltwater deposits) resting on thin till on sandstone. As the sample point lies outwith the area mapped as meltwater deposits, it has not been used in the assessment of resources. No data are available for isolated deposits north of Medwinbank. South of the South Medwin, borehole 04 NE 10, in the valley centre, proves 23.9 m of potentially workable sand and gravel and borehole 04 NE 8 and 11 illustrate the thinning or absence of meltwater deposits towards the southern margin of the Dolphinton Gap.

South-east of Garvald House meltwater deposits lie either side of the Garvald Burn. South of the burn a working gravel pit [101 483] shows 10 m+ of sand and

Table 9 Block B: data from assessment boreholes—all deposits in the alluvium, glacial meltwater deposits and till

Borehole number	Recorded thickness			Mean grading percentage						
	Mineral (m)	Over-burden (m)	Waste partings (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
04 NE 6	4.3	0.4	0.0	21	33	17	6	10	13	0
04 NE 7	16.8	0.2	0.0	5	23	45	7	7	9	4
04 NE 8	9.5	0.5	0.0	14	27	13	10	19	15	2
04 NE 10	23.9	0.3	0.0	13	21	22	10	16	16	2
04 NE 11	1.7	0.4	0.0	13	14	14	15	24	20	0
14 NW 2	1.5	0.4	0.0	8	20	10	15	32	15	0
14 NW 3	3.7	0.3	0.0	5	11	28	17	21	18	0
14 NW 6	5.6	0.2	1.2	22	67	9	2	0	0	0
14 NW 7	25.3	0.2	0.0	6	46	45	2	1	0	0
14 NW 8	5.3	0.5	0.0	5	8	25	23	22	15	2
14 NW 9	3.2	0.3	0.0	9	16	17	13	17	20	8
14 NW 11	1.8	0.3	0.0	8	24	20	10	13	14	11
14 NW 12	5.6	0.4	0.0	9	18	20	13	23	16	1
Mean	8.3	0.3	–	10	29	29	8	12	10	2

Plate 1 Kames of the Dolphinton Gap, near Dunsyre [082 486], looking south. Part of the series of mounds of meltwater sands and gravels which accumulated amidst bodies of stagnant ice in the valley of the South Medwin. To the south is Black Mount (516 m above OD) composed of andesitic and trachytic lavas of Lower Devonian age (D 2986).

Plate 2 Valley of the South Medwin, west of Dunsyre at [053 476], looking east-south-east. In contrast to the topography of the Dolphinton Gap, downstream the valley floor of the South Medwin is flat and locally poorly drained. Alluvium or peat or both overlie fine-grained meltwater deposits thought to be of glaciolacustrine origin. Black Mount (516 m above OD) forms the background (D 2987).

fine gravel and borehole 14 NW 3, drilled on a low terrace at Haughead [106 479], proves 3.7 m of mineral on tuff. North of the burn, borehole 14 NW 2, near Garvald House, proves only 1.5 m of gravel on rock but south of Cockup [109 487] a more extensive and thicker spread of meltwater deposits forms the prominent mounds of Nick's Plantation where a section in a working pit, and borehole 14 NW 7 sited close by, show fine to medium sand 10.0 m+ and 25.3 m+ thick respectively. The land slopes sharply eastwards towards the relatively flat plain of Ingraston Moss. Southwards the drop in surface level is not as abrupt and mounds of sand and gravel occur south of the A702 at Kippit Hill [111 477] and Carmaben Hill [109 469]. On a lower mound near Kippet Farm [111 474] borehole 14 NW 8 proves 5.3 m of sandy gravel resting on 1.9 m of laminated silt and clay on sandstone.

The drift around Dolphinton village is considered to be thin and mainly barren of mineral: borehole 14 NW 4 proves rock at surface and borehole 14 NW 5, at Ash Hill [105 460], outside the block proves 8.3 m of laminated clay and silt (Lithology 1) to rest on a thin basal till. East of Dolphinton, however, near Newmill [120 464] borehole 14 NW 9, located on a low terrace, proves 3.2 m of sandy gravel interbedded with thin till on 4.8 m of red-brown till resting on tuff.

At Ingraston Moss the poorly drained flat land, floored by peat, conceals fine-grained (Lithology 1) meltwater deposits, probably deposited in a small water-filled basin following the formation of the Dolphinton Gap deposits, when drainage via the valley of the Tarth Water was still at least partially blocked by dead ice. Borehole 14 NW 6 proves 6.8 m of 'very clayey' sand on 8.8 m of silt and laminated clay which lie on 0.5 m+ of gravel. However, the basin is of limited extent, since borehole 14 NW 12, near Felton proves 4.0 m of alluvial sandy gravel resting on 1.6 m of mineral till on sandstone; to the north-east near Medwin Cottage, borehole 14 NW 11, drilled on a remnant patch of the West Linton moundy deposits, shows only 1.8 m of glacial meltwater deposits (Lithology 2) on tuff.

With the exception of borehole 14 NW 12, no assessment data are available for the alluvium of the valley floors of the Garvald Burn and South Medwin. However, field survey shows several small sections of sand and gravel in the river banks and, although the alluvial flat of the principal valley floors is locally poorly drained, the underlying deposit of the area as a whole is considered to be potentially workable. Inferred boundaries between mineral-bearing and barren ground are drawn across the valley floors of the South Medwin and Back Burn at [0980 4982] and [1106 4656] respectively. Upstream of the boundaries, alluvium is considered to be too thin to be potentially workable.

Assessment of resources: Based on thirteen assessment boreholes, the mean grading of potentially workable alluvium, glacial meltwater deposits and till is fines 10 per cent, sand 66 per cent and gravel 24 per cent ('clayey' sandy gravel) (Table 9; Figure 10). Eight of eleven boreholes penetrating glacial meltwater deposits remained dry, suggesting that much of the resource in the block occurs above the water table. Taken as a whole, the mineral, which is generally at or near surface (mean overburden is 0.3 m) has a mean thickness of 8.3 m and, on the basis of exposed alluvium and glacial meltwater deposits, is estimated to have a volume of 80 million $m^3 \pm 63$ per cent (Table 6).

Block C
The block, which contains parts of the valleys of the North and South Medwin, runs from Newholm Bridge [078 478] in the east to the western margin of the resource sheet. Alluvial and glacial meltwater deposits form the major resource of the block.

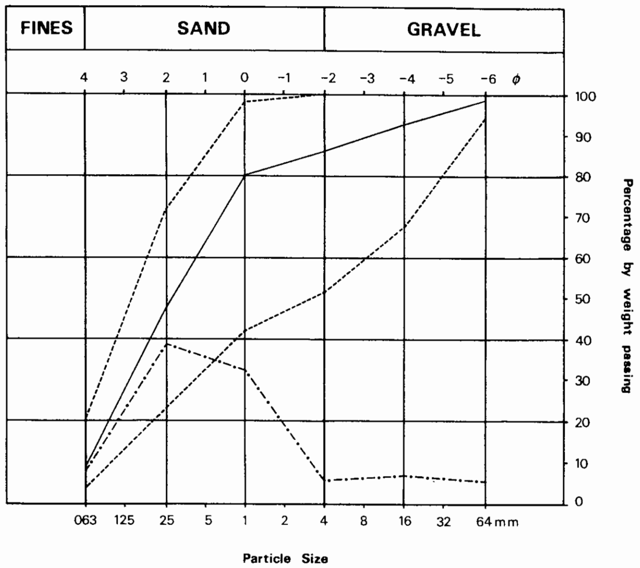


Figure 11 Grading characteristics of resources in alluvium and glacial meltwater deposits (Block C); for explanation, see Figure 9

As ice retreated rapidly south-westwards along the valley of the South Medwin, an over-deepened basin cut in bedrock was filled with mainly fine sediments (Lithology 1) which probably formed in standing water, ponded by mounds of sand and gravel occupying the Dolphinton Gap. Boreholes sited on the flat valley floor south and south-west of Dunsyre show thin alluvium and peat resting on thick meltwater deposits. Sited in the valley centre at Westhall Strip [053 473], borehole 04 NE 1 proves 2.0 m of potentially workable alluvium on 21 m+ of meltwater (Lithology 1) sand and 'very clayey' sand interbedded with silt, and to the north-east, borehole 04 NE 5 shows a similar thickness of sand and silt overlain by 3.0 m of alluvium and peat. On the northern side of the flat ground, borehole 04 NW 8, near Cableburn Wood [040 467], shows peat covering 11.3 m of meltwater deposits which in turn rest on 6.1 m of till on sandstone, illustrating a shallowing of the basin.

The valley floor is flanked by moundy meltwater deposits and alluvial cones, the latter having fanned out from numerous glacial drainage channels running off hillsides to the north and south of the valley. Deposits on the northern side of the valley are penetrated by boreholes 04 NW 7 and 04 NE 4: the former proves 6.1 m of meltwater deposits (of which the lower 4.1 m grades as Lithology 3) resting on a thin basal till; the latter, sited near Kirkland [066 483], proves 12.0 m of meltwater deposits of which only the uppermost metre is mineral. On the southern side of the valley of South Medwin at Borland [062 462], borehole 04 NE 3 proves 13.0 m of meltwater deposits, of which 11.0 m is mineral.

South-west of a line between Todholes [038 460] and Glebe Burn [054 461] glacial meltwater deposits occupying the valley of the South Medwin exhibit a distinctive morphology. In an area apparently corresponding to a

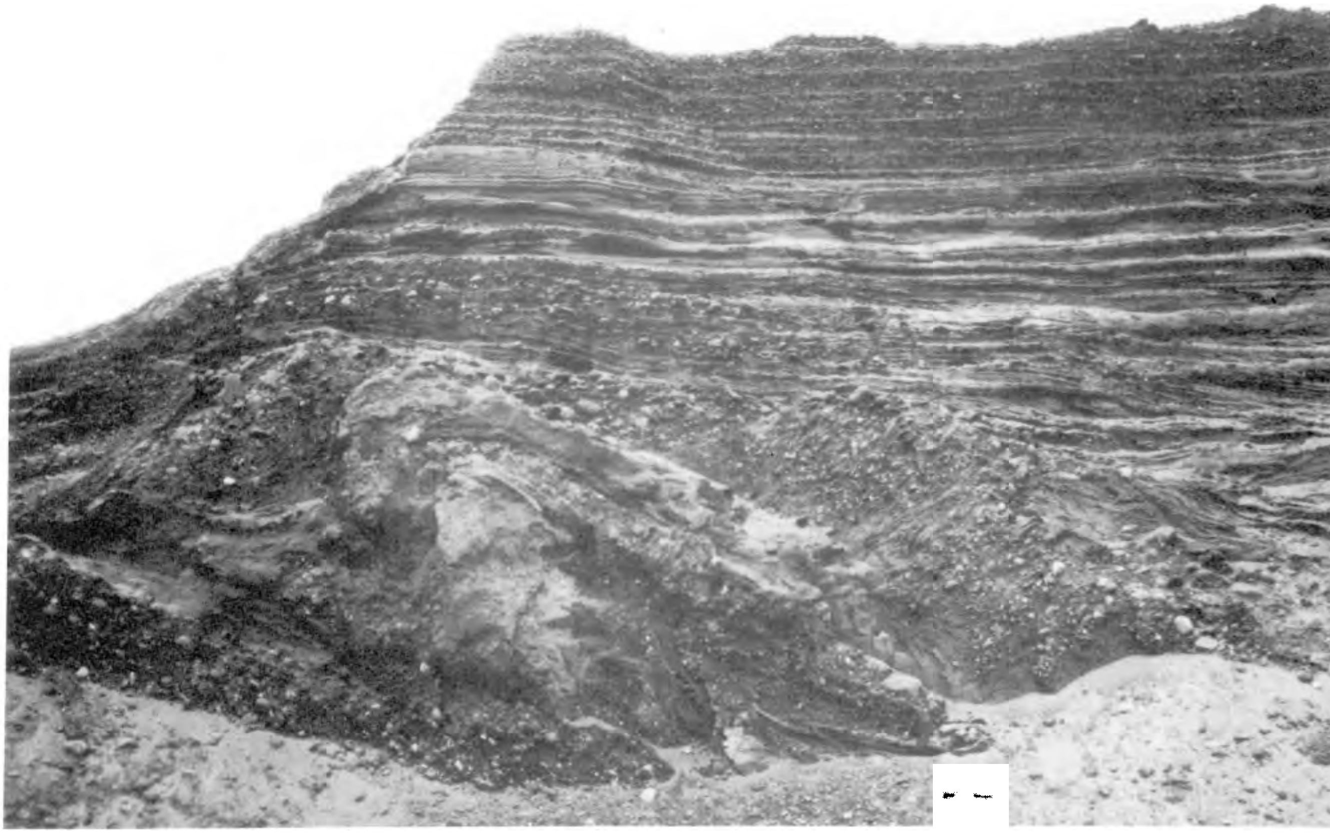


Plate 3 Glacial meltwater deposits, Newbiggingmill gravel pit near Newbigging [037 455], looking east. Evenly bedded outwash fine sand and fine gravel locally with small scale cross lamination overlie poorly sorted coarse gravels, the bedding of which is contorted. The disrupted bedding of the lower gravels may be the result of collapse on melting of ice incorporated in the sediment at the time of deposition (TS 1690).

Plate 4 Glacial meltwater deposits, Newbiggingmill gravel pit near Newbigging [037 455], looking east. Part of the poorly sorted coarse gravel 'core' of buried esker. Bands of fine to coarse sand and fine gravel are disrupted by small scale normal and reverse faults (TS 1691).

Table 10 Block C: data from assessment boreholes—all deposits in the alluvium, glacial meltwater deposits

Borehole number	Recorded thickness			Mean grading percentage						
	Mineral (m)	Over-burden (m)	Waste partings (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
04 NW 1	4.5	0.2	0.0	5	38	34	11	9	3	0
04 NW 2	1.2	0.4	0.0	6	36	21	15	18	4	0
04 NW 3	23.6	0.2	1.2	12	43	44	1	0	0	0
04 NW 5	2.6	0.3	0.0	4	32	33	7	13	11	0
04 NW 6	24.6	0.4	0.0	5	51	23	11	7	3	0
04 NW 7	6.1	1.0	0.0	9	30	14	5	10	31	1
04 NW 8	8.3	1.0	3.0	8	45	42	3	1	1	0
04 NW 9	22.5	0.3	0.0	6	17	40	10	11	11	5
04 NE 1	19.4	0.3	1.6	14	57	27	2	0	0	0
04 NE 2	15.6	0.3	0.0	3	28	56	5	3	4	1
04 NE 3	11.0	0.5	2.0	8	21	13	10	26	22	0
04 NE 4	1.0	0.4	0.0	12	54	26	1	2	5	0
04 NE 5	21.7	2.5	0.8	8	58	29	2	2	1	0
04 SW 1	4.3	0.3	0.0	19	40	19	5	9	8	0
04 SW 2	0.0	–	–	–	–	–	–	–	–	–
04 SW 3	13.9	1.2	0.0	8	20	26	12	16	17	1
04 SW 4	14.5	0.4	1.0	4	31	41	9	7	8	0
04 SW 5	14.4	0.6	1.0	17	47	30	3	2	1	0
Mean*	12.4	0.6	–	8	39	33	6	7	6	1

* The mean thicknesses of mineral and overburden are based on unweighted assessment data only and may not necessarily correspond with figures given in Table 6.

constriction of the bedrock surface in the valley hereabout, the drift deposits assume a varied topography comprising prominent kamiform mounds and esker ridges which have been incised by the South Medwin. Near Walstonmill [037 451] to the north of the river, boreholes 04 NW 6 and 04 NW 9, sited on north-east-trending ridges, prove 24.6 m+ and 22.5 m+ of mineral respectively which coarsens downwards from fine and medium sand to sandy gravel. A section in the working gravel pit [033 451] near Newbiggingmill shows sand and fine gravel capping poorly sorted boulder gravel and it appears likely that the coarse deposits were laid down subglacially, at a time when lacustrine sedimentation was occurring to the north-east (Plates 3 and 4).

West of Newbiggingmill [027 448] an extensive area is covered by moundy ice-contact meltwater deposits similar in form to the kames of West Linton and the Dolphinton Gap. Boreholes 04 NW 3 and 5 and 04 SW 3, located on mounds to the north of the South Medwin, show the mineral to vary in thickness from 2.6 m to 23.6 m+, but borehole 04 SW 2, sited on ground also mapped as sand and gravel, proves bedrock at surface. Data from these sample points illustrate that the base of the drift deposits around Newbigging is irregular. South of these meltwater deposits, the valley flat of the South Medwin is covered by alluvium overlying thick water-saturated meltwater deposits, as shown by borehole 04 SW 4 which proves a total of 14.5 m of mineral. Flanking the south side of the valley, moundy deposits, less extensive than those at Newbigging, are penetrated by boreholes 04 SW 1 and 5 which prove 4.3 m and 14.4 m of meltwater sands and pebbly sands, some of which are 'clayey' and 'very clayey'.

North of Newbigging, till flanks the eastern side of the valley of the North Medwin. Borehole 04 NW 4, sited at West Mains Farm [012 460] on ground mapped as till, proves 3.1 m of meltwater deposits at surface and is probably a detached remnant of moundy deposits lying to the south. As the areal extent of sand and gravel deposits in the vicinity of the borehole is not known, data from this sample point are not used in the assessment of resources. No borehole data are available for the deposits of the valley floor of the North Medwin, although field inspection indicates that near the surface the deposits are composed of fine sand. Consequently the alluvium is judged to be potentially workable. North-west of the valley flat, meltwater deposits form mounds between Sandhill Wood [001 460] and north of Kerswell College [008 472]. Boreholes 04 NW 1 and 2, sited near the College, prove 4.5 m and 1.2 m respectively of pebbly sand resting on till and sandstone.

Assessment of resources: On the basis of seventeen assessment boreholes, the mean grading of potentially workable alluvium and glacial meltwater deposits is fines 8 per cent, sand 78 per cent and gravel 14 per cent (pebbly sand) (Table 10; Figure 11). Based on assessment data and unpublished commercial records, the mineral, which occurs at or near surface (the overburden is 0.6 m thick on average), has a mean thickness of 12.4 m and is estimated to have a volume of about 160 million $m^3 \pm 34$ per cent (Table 6).

Block D

Block D encompasses all ground lying outside the main Newbigging–West Linton mineral-bearing tract: for ease of description it is divided into three sub-blocks.

Sub-block D_1: The sub-block covers the north-western part of the resource sheet and lies north of Blocks B and C. The area, which includes the south-western extension of the Pentland Hills, is almost totally devoid of mineral,

Table 11 Block D: data from assessment boreholes—all deposits in the alluvium, glacial meltwater deposits and till

Sub-block, deposit and borehole number	Recorded thickness: Mineral (m)	Overburden (m)	Waste partings (m)	Mean grading percentage: 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
D_2 Glacial meltwater deposits, Carwood										
04 SW 6	4.7	0.3	0.0	16	31	22	6	11	12	2
04 SW 7	0.0	–	–	–	–	–	–	–	–	–
D_2 Glacial meltwater deposits, between Elsrickle and Candyburn										
04 SE 2	14.1	0.5	3.2	7	14	12	16	29	19	3
04 SE 4	7.7	0.3	0.0	9	9	19	17	20	24	2
Mean*	10.9	0.4	–	8	12	14	16	26	21	3
D_2 Glacial meltwater deposits, Candybank and Cambwell										
04 SE 1	19.6	0.2	0.0	11	20	25	14	16	12	2
D_3 Glacial meltwater deposits of the valley sides, Blyth Bridge										
14 SW 2	3.6	0.2	0.0	14	17	16	17	22	13	1
D_3 Glacial meltwater deposits of the valley sides, Romannobridge										
14 NE 1	2.0	0.3	0.0	15	9	11	13	26	14	12
14 NE 2	2.0	2.6	0.0	22	31	32	4	3	8	0
Mean*	2.0	1.5	–	18	20	22	8	15	11	6
D_3 Alluvium, glacial meltwater deposits and till of the valley floor of the Tarth Water										
14 SW 1	1.6	1.6	0.0	5	4	19	40	29	3	0
14 SW 4	9.2	1.8	0.0	3	36	30	7	10	12	2
14 SE 1	8.0	0.4	0.0	6	36	17	7	17	17	0
Mean*	6.3	1.3	–	4	33	24	10	15	13	1
D_3 Alluvium and glacial meltwater deposits of the valley floor of the Lyne Water										
14 NE 3	8.6	0.7	0.0	9	24	19	14	21	12	1
14 NE 4	1.3	0.2	0.0	4	10	13	8	18	32	15
14 SE 2	3.3	0.4	0.0	4	7	11	14	27	34	3
Mean*	4.4	0.4	–	7	18	17	13	22	20	3

* The mean thicknesses of mineral and overburden are based on unweighted assessment data and may not necessarily correspond with figures given in Table 7.

the upland terrain being composed of large areas of peat, till and bedrock. Bedrock crops out over much of the higher ground, for example, on Darlees Rig. (448 m above OD), Bleak Law (445 m), Catstone (448 m), Fadden Hill (465 m), Mendick Hill (451 m) and King Seat (463 m). Drainage off these hills feeds the North Medwin, South Medwin, West Water and Lyne Water, the last two named having been dammed to form the West Water [117 524] and Baddinsgill [130 560] Reservoirs for the public water supply.

Potentially workable deposits are thought to occur only in the north-western corner of the sub-block in proximity to the upper reaches of the North Medwin. The largest deposit, a north-easterly-trending 1.3-km-long esker ridge known locally as The Kames [015 526], is cut by the Greenfield Burn, a tributary of the North Medwin. Although no borehole data are available, field survey shows the ridge to be gravelly and to stand about 5 m above the surrounding peat-covered flat of Stallashaw Moss. A volume of potentially workable material of 0.3 million m^3 may be inferred (Table 7). Less extensive spreads of meltwater deposits are mapped near South Tarbrax [033 535], where an exposure south of the North Medwin showed 4.6 m of bright red sand, becoming brown with depth and interbedded with brown plastic clay, resting on 1.0 m+ of bright red till. If this section is representative of the deposits, then a volume of about 0.2 million m^3 may be inferred (Table 7). No assessment is offered for a smaller patch of meltwater deposits east of Eastyardhouse Hill [014 516].

The alluvium of the North Medwin and its tributaries as far south as Block C is considered either too thin or too silty to be potentially workable. Similarly, alluvium of the upper reaches of the South Medwin and West Water is thought not to be potentially workable.

Sub-block D_2: The sub-block includes land lying south of Blocks B and C and contains potentially workable deposits flanking the valley sides of the southward-draining Biggar and Candy burns. Black Mount and White Hill (438 m above OD), composed of volcanic rocks, form the high ground in the north of the sub-block and Broomy Law (426 m) and The Mount (422 m) occupy ground on the eastern margin.

Three major spreads of mineral occur over the lower ground to the south and west. The most extensive is a belt of meltwater deposits forming ground either side of the Biggar Burn north of Carwood [039 401]. Sited on moundy deposits at Muirwood [035 404], borehole 04 SW 6 proves 9.4 m of meltwater deposits, of which the upper 4.7 m is mineral (Table 11), to rest on till and rock: a disused gravel pit [0405 4033] some 300 m north-northeast of Carwood shows 4.0 m of fine gravel, the base of which was not visible in 1978. South of these sample points the deposits are considered to thicken: sand and gravel forms mounds the tops of which are up to 12 m above the valley floor of the Biggar Burn north-east of Carwood and continues to the south of this resource sheet into the Biggar assessment area (Shaw and Merritt, *in preparation*) where mineral is locally in excess of 18 m thick. North of Muir Wood and around Whauphead Knowe [041 412] and Strawlaw [044 410], meltwater deposits are thought to be thin. At Blackwell Tryst [029 409], a small pit located near the northern edge of the deposits exposes coarse gravel with irregular sandy lenses. East of the Biggar Burn, around Whauphead Knowe, although a continuous spread of mineral is shown on the resource map, locally it is absent, as shown by borehole 04 SW 7, which proves basalt at surface. Assuming a mean mineral thickness of 3.0 m, based on available data over the area of exposed potentially workable meltwater deposits, a volume of 4.5 million m^3 may be inferred (Table 7). However this figure is probably an under-estimate, if, as is suggested, the deposits thicken southwards. The silt-rich alluvium of the Biggar Burn is considered not to be potentially workable.

The second most extensive spread of meltwater deposits in the sub-block occurs south of Elsrickle flanking the valley sides of the Candy Burn. South-west of Howburn [074 439], borehole 04 SE 2, sited on moundy deposits, did not reach the base of the meltwater deposits: of 17.3 m penetrated, 14.1 m is mineral. South-west of this sample point, the moundy deposits peter out into strings of esker ridges, the crests of which at Cocklaw Moss Plantation [045 422] lie only 2 m above the surrounding ground level. West of the Candy Burn at Kame Wood [069 426] there is an esker ridge up to 8 m above the level of the surrounding till-covered ground: although no borehole data are available, field survey shows the soil to be gravelly. East of the stream, meltwater deposits in the vicinity of Candyburn Farm [075 417] are shown by borehole 04 SE 4 to be 7.7 m thick. Based on available assessment, commercial and field data, the mean thickness of potentially workable meltwater deposits lying between Elsrickle and Candyburn Farm is estimated at 7.3 m and a volume of 8 million m^3 may be inferred (Table 7). Assessment grading data for meltwater deposits in this area are shown in Table 11. Alluvium of the Candy Burn is considered not potentially workable as it is thought to be dominantly composed of silt. Borehole 04 SE 3 sited on the valley floor east of Strathbogie [065 429] proves 0.6 m of 'very clayey' sand and silt on 4.7 m of till. Samples recovered during drilling from below the water table were washed free of fines and the latter deposit grades as gravel. Although the in-situ grading of the deposit is unknown, it is considered to be mineral. However, with the exception of this sample point and borehole 04 SE 5, which proves 3.1 m of mineral till, the till in this sub-block is thought to be generally not potentially workable.

A third spread of meltwater deposits lies south and south-west of Candybank [070 414] and around Cambwell [070 401]. Near Candybank, on the south-west side of Castle Hill [065 412], a gravel deposit was being exploited in 1980. Borehole 04 SE 1, sited to the south of the working, proves in downward sequence 6.0 m of gravel (Lithology 3), 13.6 m of 'clayey' pebbly sand and 1.4 m of till on rock. Nearby, to the east of the Candy Burn, dissected mounds of thin gravel on bedrock are mapped. On the southern margin of the resource sheet, around Cambwell, flat-topped kamiform deposits occur and, although no borehole data are available, sand and gravel hereabout is thought to be thin and to rest on thin till or bedrock. However, the deposits are thought to thicken towards the south (Shaw and Merritt, *in preparation*) and locally to attain 13 m or more in thickness. The paucity of data does not permit the volume of meltwater deposits around Castle Hill and Cambwell to be estimated with any precision, and the inferred assessment of 8.4 million m^3 given in Table 7 should be regarded only as an upper limit.

No quantitative data are available for patches of meltwater deposits (not assessed) north of East Whitecastle [018 417], west of Stirkfield [102 406] or around Melbourne [087 442], adjacent to the A721 trunk road. At the last-named locality field survey indicates subdued mounds with gravelly soil. To the north-east, moundy deposits forming Kiln Hill near Townfoot [099 456] also have a gravelly soil. Again, no borehole data are available and the deposit is not assessed. At Ash Hill, immediately south of Block B, borehole 14 NW 5 proves laminated silt and clay resting on till and basalt; although the area around the site is mapped as glacial meltwater deposits, the sediments hereabout are considered to be mainly clay and, as such, are not potentially workable.

Sub-block D_3: The largest sub-block (D_3) covers ground lying east of Blocks A and B and Sub-block D_2. The upland including Broughton Heights (571 m above OD), Ladyurd Hill (525 m), Drum Maw (433 m) and Wide Hope Shank (465 m) is composed of till or rock at surface. Potentially workable deposits are confined to the valley floors and sides of the Tarth and Lyne waters which meet at Drochil Castle.

South of Blyth Bridge [132 453] on the *valley sides of the Tarth Water,* field survey shows a patchwork of till, bedrock and meltwater deposits forming a moundy topography. Mounds of drift are often gravelly or sandy at surface and probably comprise both meltwater deposits and till. The deposits of mineral are therefore thought to be highly variable in quantity and quality. The point is demonstrated by the till, which locally is gravelly, possibly owing to its reworking by water (much of the material may have originated as ablation till) and to the nature and proximity of the easily-fragmented greywacke bedrock. To summarise, both till and meltwater deposits hereabout may be potentially workable, as evidenced by borehole 14 SW 2, sited near Kirkdean [121 444] on a flat-topped mound, which proves 3.6 m (Table 11) of 'clayey' sandy gravel (meltwater deposits) resting on rock, and borehole 14 SW 3, sited north of Castle Hill [138 443] on ground of moundy morphology mapped as till, where 5.0 m of 'clayey' gravel (till) on non-mineral (till) were encountered. Castle Hill itself is a high gravelly mound extending eastwards across the A721 to form part of the western side of the valley of the Tarth Water. Westwards, lower mounds mapped as meltwater deposits occupy ground around Kirkdean, Netherurd [119 447] and Netherurd Mains [108 440], the tops of mounds and ridges ranging from 2 to 5 m in height above the surrounding ground. On the basis of limited field and assessment data for exposed potentially workable meltwater deposits lying on the valley sides south of Blyth Bridge between Mount [105 425] and Castle Hill, a mean mineral thickness of 3.5 m is estimated and a volume of about 7 million m^3 may be inferred (Table 7). In the absence of sufficient data, borehole 14 SW 3 being the only sample point, it is not possible to estimate the volume of potentially workable till, although it should be noted that a proportion of the ground mapped as meltwater deposits may in fact be potentially workable ablation till and that this area has been included in the above calculation.

Downstream, exposed meltwater deposits also occur at [145 440] south of Scotston Bank, at Woolshears Wood [148 432] and as small patches adjacent to the Ladyurd Burn. All of these deposits are considered to be thin and to rest directly on bedrock or till. Absence of quantitative data precludes a volumetric assessment of these deposits. At Kirkstead Knowe [149 428], old workings reveal little sign of meltwater sand and gravel and it is possible that the deposit worked here is gravelly ablation till.

The floor of the valley of the Tarth Water is filled with alluvium, shown by two boreholes to overlie meltwater deposits and till. Boreholes 14 SW 4 and 14 SE 1 prove 9.2 m and 8.0 m of mineral respectively, with 0.7 m of basal till at the latter sample point. Outside the main valley, alluvium floors the small tributaries including the Bryland Burn. To the west, near Netherurd Mains, a small pocket of alluvium was shown by borehole 14 SW 1 to comprise clay, gravel and silt, of which only 1.6 m is mineral. Based on the area of alluvium of the Tarth Water and its tributaries as far east as Drochil Castle, the volume of potentially workable deposits beneath the valley floor is inferred to be 9.8 million m^3. The mean mineral thickness is estimated at 6.3 m (Tables 7 and 11).

In this sub-block, meltwater deposits that occur on the valley sides are confined to two areas in the *valley of the Lyne Water*, namely, around Romannobridge and south of Wester Happrew [171 418].

In the northern area, patches of sand and gravel occur on either side of the river north of Romannobridge near Paulswell [159 493] and extend north-eastwards as far as Macbiehill [184 515] as a discontinuous ridge which is shown by disused pits to be sandy and gravelly at surface. Borehole 14 NE 2, sited at the south-western end of the ridge at Boghouse [167 496], proves finer-grained meltwater deposits, comprising 2.3 m of laminated silt and clay on 2.0 m of 'very clayey' pebbly sand which rests on sandstone. To the north-east of Macbiehill, small spreads of sand and gravel around Lamancha [200 522] were not assessed. West of Romannobridge, moundy deposits at Kaims [157 478], shown by borehole 14 NE 1 to comprise only 2.0 m of 'clayey' gravel (Lithology 3) resting on bedrock, develop southwards into a fine esker ridge, the crest of which is locally 5.0 m above the surrounding ground level. Based on field survey and limited assessment data, a mean thickness of potentially workable meltwater deposits of the valley sides around Romannobridge is estimated at 3.0 m, from which a volume of about 2 million m^3 may be inferred (Table 7). Assessment grading data are given in Table 11.

No assessment data are available for spreads of glacial meltwater deposits flanking the valley sides of the Lyne Water south of Wester Happrew. Field survey indicates that these deposits, which occupy ground up to over 240 m above OD, are composed dominantly of gravel and near the valley bottom rest mainly on till but directly on bedrock at higher levels. An exposure [1844 4066] near Torbank revealed 3 m of coarse gravel, the base of which was not seen, composed dominantly of greywacke. In the valley of the tributary Wester Happrew Burn mounds of sand and gravel between 2 and 12 m high are recorded: scrapes indicate greywacke gravel. In the absence of any borehole data, no volumetric assessment is offered but the area of potentially workable meltwater deposits exposed on the valley sides is estimated at 2 km^2.

Downstream of West Linton, a thin cover of alluvium of the Lyne Water probably rests on bedrock as far south-east as Paulswell. Locally exposures in the river bank reveal silt overlying gravel. Elsewhere, for example south-west of Broomlee Hill [1582 5026] and near Waterside [164 493], bedrock crops out. At the latter locality the outcrop is too small to be shown on the resource map. South-east of Paulswell, the valley widens into an extensive flat which extends south-westwards from Plewlands [181 507] to Bordlands [156 467]. Borehole 14 NE 3, sited near Paulswell, proves 1.0 m of alluvial 'clayey' sandy gravel resting on 7.6 m+ of meltwater deposits, indicating that the alluvial flat hereabout conceals an over-deepened basin. Locally the surface is poorly drained and peaty. On the west side of the alluvial flat inferred boundaries have been drawn at Drake Knowe Wood [162 491] and east of Hamiltonhall [152 481], separating the potentially workable deposits of the Lyne Water from small alluvium-filled valley floors of tributary burns, in which the alluvium is considered too thin to be potentially workable; similarly alluvium immediately south of Macbiehill is thought to be barren. South of Bordlands, the valley floor is of restricted width and is flanked by steep slopes on which the bedrock crops out or is mantled by till. Alluvium of the valley floor is thin and rests directly on bedrock, as shown by trench 14 NE 4 at Flemington Farm [167 452], and borehole 14 SE 2 at Drochil Castle, which prove respectively 1.3 m and 3.3 m of gravel. No assessment is offered for the deposits south of the confluence of the Lyne and Tarth waters because no borehole data are available. An inferred boundary is drawn at Stevenson [170 431] between assessed and unassessed sand and gravel. Downstream of Stevenson the alluvium may be thin as bedrock crops out in places on the valley floor, as, for example, south-west of Hamildean [1824 4124] and Five Mile Bridge [186 408]. Based on field survey and data from three assessment sample points, the mean thickness of potentially workable alluvium and glacial meltwater deposits of the valley floor of the Lyne Water is estimated at 3.0 m, on which basis a volume of 8 million m^3 may be inferred (Table 7). Assessment grading data are offered in Table 11.

Although borehole 15 SE 119, near Kaimhouse [165 499], proved 1.0 m of till grading as 'clayey' sandy gravel, the till that occupies the ground on either side of the valley of the Lyne Water is considered generally to be not 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, $10\,km^2$, is a compromise to meet the aims of the survey by providing sufficient sample points in each block. As far as possible the block boundaries are determined by geological boundaries so that, for example, glacial and river terrace gravels are separated. Otherwise division is by arbitrary lines, which may bear no relationship to the geology. The blocks are drawn provisionally before drilling begins.

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

The drilling machine employed should be capable of providing a continuous sample representative of all unconsolidated deposits, so that the in-situ grading can be determined, if necessary, to a depth of 30 m (100 ft) at a diameter of about 250 mm (10 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 botton.

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 deposit or, ideally, 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 (1975). Random checks on the accuracy of the grading are made in the IMAU soils laboratory.

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 Institute's Edinburgh Office, upon application to the Officer-in-Charge, Industrial Minerals Assessment Unit.

APPENDIX B

STATISTICAL PROCEDURE

Statistical assessment

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

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

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

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

4 The above relationship may be transposed such that

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

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

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

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

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

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

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

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

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

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

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

Block calculation 1 : 25 000 Block } Fictitious

Area
Block: 11.08 km^2
Mineral: 8.32 km^2

Mean thickness
Overburden: 2.5 m
Mineral: 6.5 m

Volume
Overburden: 21 million m^3
Mineral: 54 million m^3

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 m^3

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

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

Calculation of confidence limits

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

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

L_V is calculated as

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

Figure 12 Example of resource block assessment: calculation and results

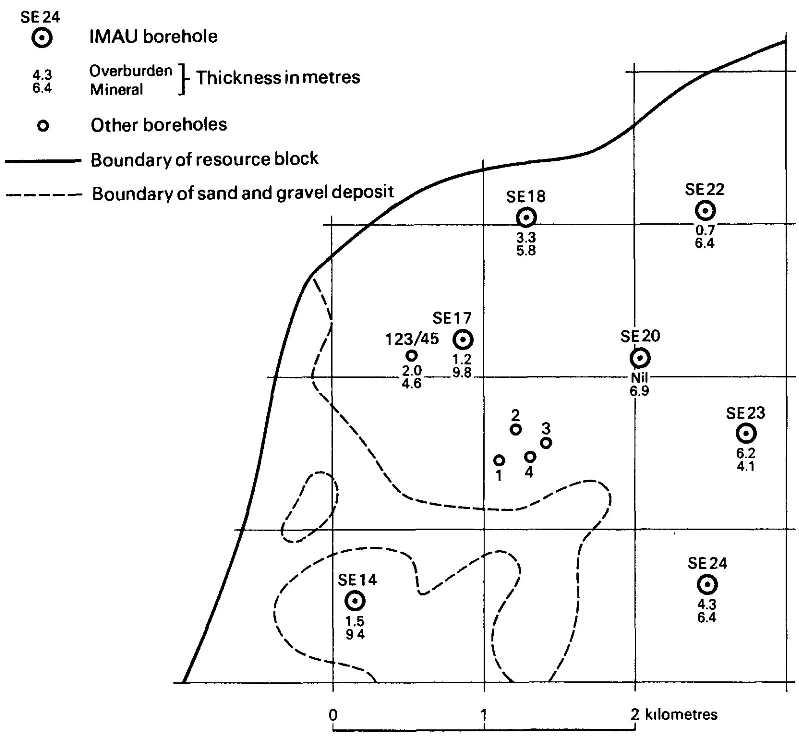


Figure 13 Example of resource block assessment: map of fictitious block

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 12 and 13.

Inferred assessment

12 If the sampled area of mineral in a resource block is between $0.25\,km^2$ and $2\ km^2$ an assessment is inferred, 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 $0.25\,km^2$.

15 *Note on weighting* The thickness of a deposit at any point may be governed solely by the position of the point in relation to a broad trend. However, most sand and gravel deposits also exhibit a random pattern of local, and sometimes considerable, variation in thickness. Thus the distribution of sample points 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 14). 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 12), 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: 1975). In this report the grading is tabulated on the borehole record sheets (Appendix F), the intercepts corresponding with the simple geometric scale $\frac{1}{16}$ mm, $\frac{1}{4}$ mm, 1 mm, 4 mm, 16 mm and so on as required. Original sample grading curves are available for reference at the appropriate office of the Institute.

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

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

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

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

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

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

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

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

Table 12 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

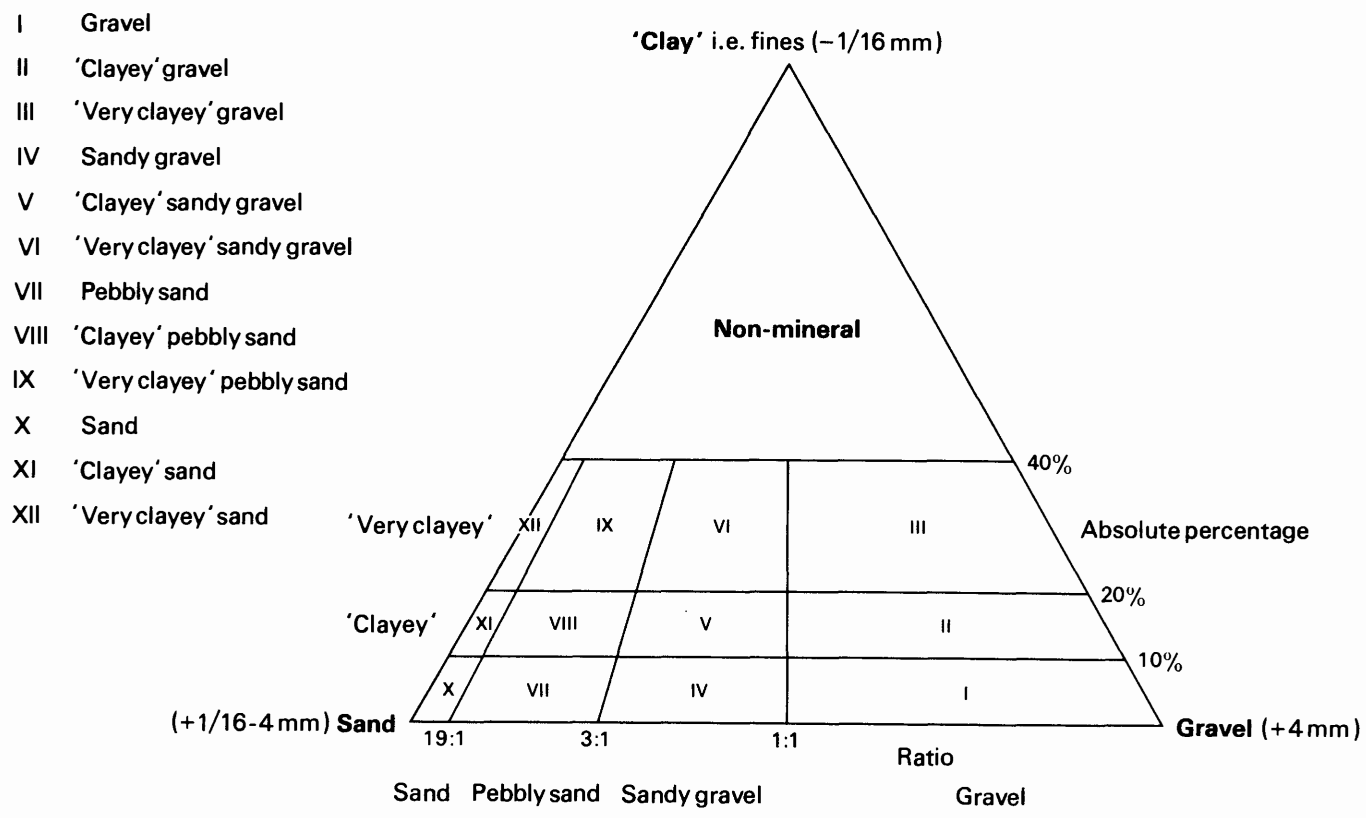


Figure 14 Diagram to show the descriptive categories used in the classification of sand and gravel

APPENDIX D

EXPLANATION OF THE ASSESSMENT RECORD

Annotated example
NT 04 NW 7 [1] **0496 4712** [2] **Westhall, Dunsyre** [3] **Block C**

Surface level +219.8 m [4]
Water struck at +216.8 m [5]
250 mm percussion [6]
October 1978

Overburden 1.0 m [7]
Mineral 6.1 m
Waste 0.7 m
Bedrock 0.4 m+

LOG

Geological classification[10]	Lithology[11]	Thickness m	Depth[8] m
	Soil	1.0	1.0
Glacial meltwater deposits	**a** Sand (L1) Gravel: rare fine and coarse above 2.0 m, subangular to subrounded, red sandstone, basalt and felsite Sand: fine with medium, subrounded to rounded, quartz, orange-brown Fines: silt disseminated and in laminae	2.0	3.0
	b 'Clayey' gravel (L3) Gravel: coarse with fine and rare cobbles, coarser below 5.0 m with a higher cobble content from 5.0 m to 6.0 m, subangular to rounded, basalt, greywacke, sandstone, felsite, andesite and quartz Sand: fine with medium and coarse, quartz with rock fragments, subangular to subrounded, medium brown Fines: silt, disseminated	4.1	7.1
Till	Clay, stiff, reddish brown with subangular to subrounded clasts of basalt, greywacke, chert, quartz, andesite and red sandstone	0.7	7.8
Upper Devonian	Sandstone, medium-grained, quartzose, reddish maroon, with rounded clasts	0.4+[9]	8.2

GRADING

	Mean for deposit[15] *percentages*			Depth below surface[12] (m)	*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	4	95	1	1.0–2.0	5	70	21	1	2	1	0	
				2.0–3.0	3	61	35	1	0	0	0	
				Mean	4	66	28	1	1	0	0	
b	11	27	62	3.0–4.0	19	12	9	9	17	34	0	†[14]
				4.0–5.0	20	28	11	2	5	34	0	†
				5.0–6.0	3	6	4	4	12	64	7	†
				6.0–7.1	4	6	6	10	25	49	0	†
				Mean	11	13	8	6	15	45	2	
a+b	9	49	42	Mean	9	30	14	5	10	31	1	

LOG

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

1 Registration number
Each Industrial Minerals Assessment Unit (IMAU) borehole and shallow trench is identified by a Registration Number. This consists of two statements:

1 The number of the 1 : 25 000 sheet on which the record lies, for example NT 04;

2 The quarter of the 1 : 25 000 sheet on which the record lies and its number in a series for that quarter, for example NW 7.

Thus the full Registration Number is NT 04 NW 7. Usually this is abbreviated to 04 NW 7 in the text.

2 The National Grid reference
All National Grid references in this publication lie within the 100 km square NT unless otherwise stated. Grid references are given to eight figures, accurate to within 10 m for sample point locations. (In the text, six-figure grid references are used for more extensive locations, for example, for farms.)

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

4 Surface level
The surface level at the sample point is given in metres above Ordnance Datum. Measurements were made in metres.

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 Method and date of sampling
Modified shell-and-auger rigs were used for the drilling of the boreholes 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. Where appropriate other methods of sampling are stated (for example, trench sampling).

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). Mineral thicknesses may include individual waste partings up to 1.0 m thick, which are excluded in the assessment of resources. Consequently mineral thicknesses given in Tables 8 to 11 may not correspond precisely with the logs. Bedrock is the 'formation', 'country rock' or 'rockhead' 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. Glacial meltwater deposits are divided into three lithologies (abbreviated to L1, L2 and L3) which are considered to correlate broadly with depositional environments. The description of other deposits and bedrock 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 where possible, at every 1 m of depth.

13 Grading results
The results are expressed as per cent 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 ($-\frac{1}{16}$ mm) and coarse gravel (+16 mm) may be lower. Samples obtained by the bailing technique (that is, from deposits below the water table) are indicated with a dagger, 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, if these vary. The classification used is shown in Table 12. Where two or more units of mineral are distinguished, the mean grading for each unit is given in addition to the combined calculation for the log. For multiple mineral units, each is designated by a letter, for example, **a**, **b**, etc.

Samples of till with less than 40 per cent by weight passing $\frac{1}{16}$ mm, which form part of a sequence of potentially workable material are considered in the assessment of resources. These samples form a small proportion of a deposit which in the Dolphinton and West Linton areas is regarded as generally unworkable. Grading data for other samples of sand and gravel with less than 40 per cent by weight passing $\frac{1}{16}$ mm, but regarded as not potentially workable owing to excessive overburden are marked with an asterisk, thus: *. Mineral proved in boreholes and trenches lying outside areas considered to contain potentially workable sand and gravel and not included in the assessment of resources is similarly annotated, *.

APPENDIX E

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

Borehole number by sheet quadrant	Grid references (all lie in 100 km square NT)	Page number
1. INDUSTRIAL MINERALS ASSESSMENT UNIT BOREHOLES		
NT 04 NW		
1	0087 4690	31
2	0074 4670	32
3	0091 4516	33
4	0121 4605	34
5	0189 4547	35
6	0354 4541	36
7	0496 4712	37
8	0422 4658	38
9	0463 4589	39
NT 04 NE		
1	0550 4700	40
2	05335 46435	41
3	05990 46335	42
4	0667 4800	43
5	0721 4760	44
6	08535 49025	45
7	0834 4810	46
8	0809 4751	47
9	0963 4944	48
10	0919 4830	49
11	0970 4782	50
NT 04 SW		
1	0059 4410	51
2	0195 4460	51
3	0255 4499	52
4	0213 4436	53
5	0318 4461	54
6	0327 4040	55
7	0424 4124	55
NT 04 SE		
1	0644 4081	56
2	0712 4341	57
3	0723 4301	58
4	0745 4185	59
5	0837 4428	60
NT 14 NW		
2	1006 4871	61
3	1062 4763	62
4	1090 4660	62
5	1060 4605	63
6	1196 4840	63
7	1122 4840	64
8	1164 4763	65
9	1191 4665	66
10	1264 4945	67
11	1269 4868	68
12	1237 4811	69
13	13745 49150	69
14	1467 4949	70

Borehole number by sheet quadrant	Grid references (all lie in 100 km square NT)	Page number
NT 14 NE		
1	1567 4774	70
2	1666 4959	71
3	1631 4865	72
NT 14 SW		
1	1125 4406	73
2	1252 4439	74
3	1397 4458	75
4	1431 4381	76
NT 14 SE		
1	1548 4319	77
2	1646 4349	78
NT 15 SW		
13	1283 5175	79
14	1359 5129	80
15	1338 5006	81
16	1459 5152	82
17	1454 5041	84
NT 15 SE		
116	1564 5162	85
117	1514 5073	87
118	1636 5281	88
119	1645 5014	89
2 INDUSTRIAL MINERALS ASSESSMENT UNIT SHALLOW TRENCHES (dug by excavator)		
NT 04 SE		
6	0545 4308	89
7	0780 4046	89
8	0906 4479	90
9	0966 4469	90
NT 14 NW		
15	1255 4731	90
NT 14 NE		
4	0637 4506	91
NT 15 SE		
120	1540 5213	91

3 OTHER BOREHOLE RECORDS (held by IGS)

IGS registered number	Reference used on this resource sheet	Grid reference	Thickness in metres			
			Over-burden	Mineral	Waste	Bedrock
Block A						
SE 549/3		1367 5374	0.2	1.0	–	12.8+
SE 549/4	15 SW X4	1370 5378	0	2.9	–	13.9+
SE 549/5		13645 53795	0.2	3.8	–	3.6+
SE 549/6		1370 5375	0.1	3.1	–	5.0+
SE 549/7		1368 5376	0.2	7.1	–	4.0+
SE 549/8		1369 5380	0	2.4	–	3.0+
SE 549/12		1357 5360	2.1	3.5	48.0	14.6+
SE 549/13		13615 53650	1.2	1.2	51.9	4.2+
SE 549/15	15 SW X3	1359 5362	10.7	11.6	39.0	4.8+
SE 549/16		1325 5346	5.9	6.6	3.3	8.6+
SE 549/19*	15 SW X1	13135 53515	–	–	1.8	1.9+
SE 549/20*	15 SW X2	1338 5336	–	–	3.5	5.3+
NT 15 SE 107	15 SE 107	1691 5258	0.5	9.1	–	3.2+

* Borehole not used in the calculations but referred to in the text.

In addition, unpublished commercial data have been taken into account in the calculation of resources in Blocks C and D_2.

APPENDIX F

INDUSTRIAL MINERALS ASSESSMENT UNIT
BOREHOLE AND SHALLOW TRENCH RECORDS

NT 04 NW 1 0087 4690 Kerswell College, Newbigging **Block C**

Surface level +215.6 m
Water not struck
250 mm percussion
November 1978

Overburden 0.2 m
Mineral 4.5 m
Waste 0.5 m
Bedrock 0.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Glacial meltwater deposits	**a** Pebbly sand (L2) Gravel: fine with coarse up to 4 cm diameter, subangular to well rounded, quartz, greywacke, basalt, chert, felsite and sandstone with coal Sand: fine and medium with coarse, subrounded, quartz with rock fragments, yellow-brown Fines: silt, disseminated	4.5	4.7
Till	Clay, stiff, red, angular to rounded clasts up to cobble size of andesite, basalt, coal, quartzite and mudstone	0.5	5.2
Upper Devonian	Sandstone, medium to coarse grained, micaceous	0.2+	5.4

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
a	5	83	13	0.2–1.2	6	61	25	3	1	4	0
				1.2–2.2	6	31	38	16	9	0	0
				2.2–3.2	4	42	33	10	9	2	0
				3.2–4.7	3	25	38	13	15	6	0
				Mean	5	38	34	11	9	3	0

NT 04 NW 2   0074 4670   Kerswell College, Newbigging   Block C

Surface level +213.7 m
Water not struck
250 mm percussion
November 1978

Overburden 0.4 m
Mineral 1.2 m
Bedrock 0.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Glacial meltwater deposits	**a** Pebbly sand (L2) Gravel: fine with coarse, rounded to well rounded, basalt, quartzite, chert, greywacke, felsite and quartz Sand: fine with medium and coarse, subrounded, quartz, orange-brown Fines: silt, disseminated	1.2	1.6
? Upper Devonian	*Borehole terminated on bedrock, sample not retrieved*	0.5+	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
a	6	72	22	0.4–1.6	6	36	21	15	18	4	0

Surface level +220.7 m
Water struck at +200.7 m
250 mm percussion
October 1978

Overburden 0.2 m
Mineral 12.8 m
Waste 1.2 m
Mineral 10.8 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Glacial meltwater deposits	**a** Sand (L2) Gravel: trace, fine, coarse and cobbles to 3.3 m, subrounded, quartzite, felsite and basalt Sand: medium and fine becoming finer below 11.0 m, subrounded, quartz with rock fragments. Coal-rich laminae Fines: silt, in laminae often associated with coal	12.8	13.0
	Silt (L1), moderately stiff, poorly laminated, brown	1.2	14.2
	b 'Very clayey' sand (L1) Sand: fine with medium, subrounded, quartz with feldspar, rock fragments and a little coal Fines: silt, disseminated and in laminae	6.8	21.0
	c Sand (L2) Sand: medium with fine Fines: silt	4.0+	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	8	91	1	0.2–1.3	5	37	56	2	0	0	0	
				1.3–2.3	4	23	62	6	5	0	0	
				2.3–3.3	6	27	59	4	3	1	0	
				3.3–4.3	5	28	65	2	0	0	0	
				4.3–5.3	5	40	55	0	0	0	0	
				5.3–6.3	8	40	52	0	0	0	0	
				6.3–7.2	13	36	50	1	0	0	0	
				7.2–8.2	8	56	36	0	0	0	0	
				8.2–9.2	11	33	56	0	0	0	0	
				9.2–10.2	13	57	30	0	0	0	0	
				10.2–11.0	7	39	54	0	0	0	0	
				11.0–12.0	9	73	18	0	0	0	0	
				12.0–13.0	11	86	3	0	0	0	0	
				Mean	8	44	46	1	1	0	0	
b	21	79	0	14.2–15.2	20	32	44	4	0	0	0	
				15.2–16.0	24	28	41	7	0	0	0	
				16.0–17.0	13	63	24	0	0	0	0	†
				17.0–18.0	16	76	8	0	0	0	0	†
				18.0–19.0	36	55	9	0	0	0	0	†
				19.0–20.0	13	37	50	0	0	0	0	†
				20.0–21.0	23	36	41	0	0	0	0	†
				Mean	21	47	31	1	0	0	0	
c	6	94	0	21.0–22.0	7	31	62	0	0	0	0	†
				22.0–23.0	6	31	63	0	0	0	0	†
				23.0–24.0	6	38	56	0	0	0	0	†
				24.0–25.0	6	34	60	0	0	0	0	†
				Mean	6	34	60	0	0	0	0	
a to c	12	88	trace	Mean	12	43	44	1	0	0	0	

NT 04 NW 4 0121 4605 West Mains, Newbigging **Block C**

Surface level +209.6 m
Water not struck
250 mm percussion
November 1978

Overburden 0.3 m
Mineral 3.1 m
Bedrock 0.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial meltwater deposits	**a** Pebbly sand (L2) Gravel: coarse with fine, subrounded to well rounded, greywacke, quartzite, felsite, basalt, quartz, red sandstone. Increase in gravel content below 2.3 m Sand: medium with fine, subrounded, brown Fines: silt, disseminated and in laminae below 2.3 m	3.1	3.4
Upper Devonian	Sandstone, medium grained, micaceous, red	0.2+	3.6

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64	
a	6	74	20	0.3–1.3	6	24	57	3	3	7	0	*
				1.3–2.3	4	29	51	1	2	13	0	*
				2.3–3.4	7	26	26	7	16	18	0	*
				Mean	6	26	44	4	7	13	0	

NT 04 NW 5 0189 4547 East Mains, Newbigging **Block C**

Surface level +218.7 m
Water not struck
250 mm percussion
November 1978

Overburden 0.3 m
Mineral 2.6 m
Bedrock 0.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial meltwater deposits	**a** Pebbly sand (L2) Gravel: fine and coarse, subrounded to subangular, basalt with red sandstone, felsite and quartzite Sand: medium and fine with coarse, becomes finer with depth, subangular to subrounded, quartz with rock fragments, the latter generally coarser Fines: silt, brown	2.6	2.9
Upper Devonian	Sandstone, medium grained, red. Black (?)carbonaceous band	0.2+	3.1

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	4	72	24	0.3–1.3	3	19	27	10	23	18	0
				1.3–2.3	6	38	42	5	5	4	0
				2.3–2.9	4	45	26	5	8	12	0
				Mean	4	32	33	7	13	11	0

NT 04 NW 6 0354 4541 Walstonmill, Newbigging **Block C**

Surface level +217.9 m
Water struck at +206.5 m
250 mm and 200 mm percussion
December 1978

Overburden 0.4 m
Mineral 24.6 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Glacial meltwater deposits	**a** Sand (L1) Gravel: trace, mainly above 2.4 m, fine and coarse, subangular to well rounded, felsite with quartz and sandstone Sand: fine with medium, subangular to subrounded, quartz, with feldspar, rock fragments and coal Fines: silt, orange-brown, disseminated, and in poorly laminated bands containing coal fragments, up to 4 mm in thickness	15.4	15.8
	b Sandy gravel (L2) Gravel: fine, with coarse and cobbles, principally from 17.0 m to 19.0 m, angular to rounded, greywacke, basalt, felsite, quartzite, vein-quartz, andesite, porphyry, red sandstone and chert Sand: fine with medium and coarse, angular to subrounded, quartz with rock fragments the latter coarser grained and more angular Fines: silt, disseminated, medium brown, with thin grey silt bands near 17.0 m	9.2+	25.0

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64	
a	7	92	1	0.4–1.4	9	40	39	4	5	3	0	
				1.4–2.4	6	63	28	1	2	0	0	
				2.4–3.5	5	82	12	1	0	0	0	
				3.5–4.8	1	66	32	1	0	0	0	
				4.8–5.4	5	81	14	0	0	0	0	
				5.4–6.4	3	78	19	0	0	0	0	
				6.4–7.4	4	76	20	0	0	0	0	
				7.4–8.4	11	81	8	0	0	0	0	
				8.4–9.4	7	82	10	1	0	0	0	
				9.4–10.4	7	85	8	0	0	0	0	
				10.4–11.4	5	83	12	0	0	0	0	
				11.4–12.4	12	68	20	0	0	0	0	†
				12.4–13.4	12	73	15	0	0	0	0	†
				13.4–14.4	14	73	11	1	1	0	0	†
				14.4–15.8	10	76	11	1	0	2	0	†
				Mean	7	74	17	1	1	trace	0	
b	2	72	26	15.8–17.0	4	44	19	11	18	4	0	†
				17.0–18.0	2	11	19	17	25	26	0	†
				18.0–19.0	1	5	15	18	27	25	9	†
				19.0–20.0	2	15	40	31	10	2	0	†
				20.0–21.0	1	14	31	33	18	3	0	†
				21.0–22.0	1	6	44	38	9	2	0	†
				22.0–23.0	4	7	39	33	15	2	0	†
				23.0–24.0	1	8	36	30	16	9	0	†
				24.0–25.0	2	7	46	32	10	3	0	†
				Mean	2	14	32	26	17	8	1	
a+b	5	85	10	Mean	5	51	23	11	7	3	0	

NT 04 NW 7 0496 4712 Westhall, Dunsyre **Block C**

Surface level +219.8 m
Water struck at +216.8 m
250 mm percussion
October 1978

Overburden 1.0 m
Mineral 6.1 m
Waste 0.7 m
Bedrock 0.4 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	1.0	1.0
Glacial meltwater deposits	**a** Sand (L1) Gravel: rare fine and coarse above 2.0 m, subangular to subrounded, red sandstone, basalt and felsite Sand: fine with medium, subrounded to rounded, quartz, orange-brown Fines: silt, disseminated and in laminae	2.0	3.0
	b 'Clayey' gravel (L3) Gravel: coarse with fine and rare cobbles, coarser below 5.0 m with a higher cobble content from 5.0 m to 6.0 m, subangular to rounded, basalt, greywacke, sandstone, felsite, andesite and quartz Sand: fine with medium and course, subangular to subrounded, quartz with rock fragments, medium brown Fines: silt, disseminated	4.1	7.1
Till	Clay, stiff, reddish brown with subangular to subrounded clasts of basalt, greywacke, chert, quartz, andesite and red sandstone	0.7	7.8
Upper Devonian	Sandstone, medium grained, reddish maroon	0.4+	8.2

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64	
a	4	95	1	1.0–2.0	5	70	21	1	2	1	0	
				2.0–3.0	3	61	35	1	0	0	0	
				Mean	4	66	28	1	1	0	0	
b	11	27	62	3.0–4.0	19	12	9	9	17	34	0	†
				4.0–5.0	20	28	11	2	5	34	0	†
				5.0–6.0	3	6	4	4	12	64	7	†
				6.0–7.1	4	6	6	10	25	49	0	†
				Mean	11	13	8	6	15	45	2	
a+b	9	49	42	Mean	9	30	14	5	10	31	1	

NT 04 NW 8 0422 4658 Cableburn Wood, Dunsyre **Block C**

Surface level +211.8 m
Water struck at +210.0 m
200 mm and 150 mm percussion
November 1978

Overburden 1.0 m
Mineral (including 3.0 m waste) 11.3 m
Waste 6.1 m
Bedrock 0.2 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Peat	Peat	0.7	1.0
Glacial meltwater deposits	**a** Sand (L2), including silt bands (L1) from 6.0 m to 7.0 m, 8.0 m to 9.0 m and 10.0 m to 11.0 m Gravel: trace, fine and coarse principally above 3.0 m and below 11.0 m, rounded to well rounded, sandstone, basalt, felsite, greywacke and quartz Sand: fine and medium, subrounded, quartz with rock fragments and coal, medium to dark brown Fines: silt, disseminated and in laminated seams, the latter increase in thickness and number below 6.0 m to give three 1.0 m waste partings	11.3	12.3
Till	Clay, stiff, mottled reddish brown to blue-grey, sandy near top, clasts of coarse and fine gravel size with rare cobbles and boulders, chert, vein-quartz, quartzite, felsite, greywacke, red and yellow-brown sandstones	6.1	18.4
Carboniferous (Calciferous Sandstone Measures)	Sandstone, fine grained, blue-grey, highly weathered to 18.5 m	0.2+	18.6

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64	
a	8	90	2	1.0–2.0	3	48	41	4	3	1	0	
				2.0–3.0	2	49	41	5	3	0	0	†
				3.0–4.0	1	51	45	3	0	0	0	†
				4.0–5.0	1	54	43	2	0	0	0	†
				5.0–6.0	4	44	50	2	0	0	0	†
				6.0–7.0	Silt							
				7.0–8.0	15	47	36	2	0	0	0	†
				8.0–9.0	Silt							
				9.0–10.0	33	45	21	1	0	0	0	†
				10.0–11.0	Silt							
				11.0–12.3	7	29	55	5	3	1	0	†
				Mean	8	45	42	3	1	1	0	

NT 04 NW 9 0463 4589 Todholes, Dunsyre **Block C**

Surface level +226.6 m
Water struck at +209.8 m
250 mm and 200 mm percussion
November 1978

Overburden 0.3 m
Mineral 22.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial meltwater deposits	**a** Sand (L2) Gravel: trace, fine above 4.3 m and from 6.3 m to 9.2 m, felsite and chert Sand: medium with fine, subrounded with subangular, quartz with feldspar and rock fragments Fines: silt, disseminated, brown	8.9	9.2
	b Sandy gravel (L2) Gravel: fine and coarse with cobbles up to 20 cm diameter, subrounded to well rounded, red, yellow, white and green sandstones, indurated gritstone, basalt, quartz, quartzite, felsite, conglomerate, andesite and coal Sand: medium with fine and coarse, angular to subrounded, quartz with feldspar, rock fragments and coal Fines: disseminated silt and clay, brown	13.6+	22.8

Borehole terminated owing 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	7	92	1	0.3–1.3	4	48	44	3	1	0	0	
				1.3–2.3	3	24	69	3	1	0	0	
				2.3–3.3	9	27	60	3	1	0	0	
				3.3–4.3	10	43	47	0	0	0	0	
				4.3–5.2	6	38	55	1	0	0	0	
				5.2–6.3	6	20	73	1	0	0	0	
				6.3–7.2	7	22	69	2	0	0	0	
				7.2–8.2	7	15	68	7	3	0	0	
				8.2–9.2	7	16	61	13	3	0	0	
				Mean	7	28	61	3	1	0	0	
b	6	50	44	9.2–9.7	5	9	39	24	20	3	0	
				9.7–10.7	3	5	19	12	13	20	28	
				10.7–11.7	9	21	39	12	9	10	0	
				11.7–13.2	7	9	10	11	15	24	24	
				13.2–14.0	8	8	10	10	15	30	19	
				14.0–15.3	17	7	12	10	15	23	16	
				15.3–16.6	7	12	18	17	23	18	5	
				16.6–17.5	4	7	14	13	18	37	7	†
				17.5–19.5	3	8	52	15	10	12	0	†
				19.5–20.5	1	6	34	21	18	13	7	†
				20.5–21.4	2	4	36	15	19	24	0	†
				21.4–22.3	2	7	41	21	20	9	0	†
				22.3–22.8	2	14	7	17	39	21	0	†
				Mean	6	9	27	14	16	19	9	
a+b	6	67	27	Mean	6	17	40	10	11	11	5	

NT 04 NE 1 0550 4700 Westhall Strip, Dunsyre **Block C**

Surface level +212.5 m
Water struck at +210.7 m
200 mm and 150 mm percussion
October 1978

Overburden 0.3 m
Mineral 11.4 m
Waste 1.6 m
Mineral 8.0 m
Waste 2.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Alluvium	**a** 'Clayey' sand Gravel: trace, fine Sand: fine with medium, subrounded, quartz, orange-brown Fines: silt, brown	2.0	2.3
Glacial meltwater deposits	**b** Sand (L1) Gravel: trace, fine, principally above 5.3 m Sand: fine with medium, becoming finer with depth, subrounded, quartz with rock fragments, yellow-brown Fines: silt, brown	9.4	11.7
	Silt (L1), grey-brown, sandy in parts, locally laminated, with grey clay seams	1.6	13.3
	c 'Very clayey' sand (L1) Sand: fine with medium, subrounded, quartz with rock fragments and coal, grey-brown Fines: silt, brown, disseminated and in seams	8.0	21.3
	Silt (L1), grey-brown, with fine sand and coal	2.2+	23.5

Borehole terminated owing to technical reasons

GRADING

	Mean for deposit *percentages* Fines	Sand	Gravel	Depth below surface (m)	*percentages* Fines $-\frac{1}{16}$	Sand $+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	Gravel $+4-16$	$+16-64$	$+64$	
a	17	83	0	0.3–1.3	18	72	10	0	0	0	0	
				1.3–2.3	16	62	19	2	1	0	0	†
				Mean	17	67	14	2	0	0	0	
b	6	93	1	2.3–3.3	6	35	47	9	3	0	0	†
				3.3–4.3	6	27	47	18	2	0	0	†
				4.3–5.3	6	55	34	3	2	0	0	†
				5.3–6.3	5	55	38	2	0	0	0	†
				6.3–7.3	12	69	18	1	0	0	0	†
				7.3–8.3	8	72	20	0	0	0	0	†
				8.3–9.3	4	72	24	0	0	0	0	†
				9.3–10.3	6	71	23	0	0	0	0	†
				10.3–11.7	5	70	25	0	0	0	0	†
				Mean	6	59	30	4	1	0	0	
c	21	79	0	13.3–14.3	14	59	27	0	0	0	0	†
				14.3–15.3	23	33	43	1	0	0	0	†
				15.3–16.3	15	35	49	1	0	0	0	†
				16.3–17.3	29	38	32	1	0	0	0	†
				17.3–18.3	23	65	12	0	0	0	0	†
				18.3–19.3	18	61	21	0	0	0	0	†
				19.3–20.3	21	60	19	0	0	0	0	†
				20.3–21.3	26	59	15	0	0	0	0	†
				Mean	21	52	27	0	0	0	0	
b+c	13	87	trace	Mean	13	56	29	2	0	0	0	
a to c	14	86	trace	Mean	14	57	27	2	0	0	0	

NT 04 NE 2 05335 46435 Walston Mansion, Walston **Block C**

Surface level +212.8 m
Water struck at +211.2 m
200 mm and 150 mm percussion
October 1978

Overburden 0.3 m
Mineral 15.6 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial meltwater deposits	**a** Sand (L2) Gravel: fine, coarse and cobbles, rounded to well rounded, greywacke, quartz, basalt, andesite, sandstone and coal. Gravel concentrated between 9.4 m and 11.4 m Sand: medium with fine, subrounded to rounded, quartz with disseminated coal Fines: salt, disseminated	12.5	12.8
	b Sandy gravel (L2) Gravel: fine and coarse with cobbles, rounded to well rounded, red and yellow sandstones, chert, greywacke, quartz, basalt, felsite, andesite and coal Sand: medium with coarse and fine, subrounded, quartz with rock fragments Fines: silt, disseminated	3.1+	15.9

Borehole terminated owing 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	4	93	3	0.3–1.3	11	52	37	0	0	0	0	
				1.3–2.3	4	40	54	1	1	0	0	†
				2.3–3.3	2	35	59	2	1	1	0	†
				3.3–4.3	2	34	59	2	1	2	0	†
				4.3–5.3	3	34	61	1	1	0	0	†
				5.3–6.3	4	63	32	1	0	0	0	†
				6.3–7.3	4	50	46	0	0	0	0	†
				7.3–8.3	3	4	89	4	0	0	0	†
				8.3–9.4	3	14	76	5	1	1	0	†
				9.4–10.4	2	20	57	3	4	14	0	†
				10.4–11.4	3	19	58	3	1	0	16	†
				11.4–12.8	3	22	74	1	0	0	0	†
				Mean	4	32	59	2	1	1	1	
b	2	70	28	12.8–13.8	2	7	33	29	17	12	0	†
				13.8–14.8	2	16	36	20	16	10	0	†
				14.8–15.9	1	11	49	9	10	16	4	†
				Mean	2	11	40	19	14	13	1	
a+b	3	88	9	Mean	3	28	56	5	3	4	1	

NT 04 NE 3 **05990 46335** **Borland, Walston** **Block C**

Surface level +222.1 m
Water struck at +220.6 m
250 mm and 200 mm percussion
October 1978

Overburden 0.5 m
Mineral (including 0.8 m waste) 6.5 m
Waste 1.2 m
Mineral 5.3 m
Waste 6.0 m
Bedrock 0.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Glacial meltwater deposits	**a** 'Clayey' gravel (L3) including a silt band (L1) from 5.0 m to 5.8 m Gravel: coarse and fine with rare cobbles, angular to rounded, basalt, andesite, greywacke, quartzite, quartz, chert, felsite and red sandstone Sand: fine to coarse, subangular, quartz with rock fragments, reddish brown, grey below 5.8 m Fines: silt and clay, disseminated	6.5	7.0
	Silt (L1) laminated, brown, sand partings becoming thicker and more numerous with depth, rare fine pebbles and coal fragments	1.2	8.2
	b 'Clayey' sand (L1) Gravel: trace Sand: fine with medium, rounded, quartz with rock fragments, brown Fines: silt	2.1	10.3
	c Gravel (L2) Gravel: fine with coarse, angular to well rounded, greywacke, chert, quartz, basalt, andesite, felsite and red sandstone Sand: fine to coarse, subangular to subrounded, quartz with rock fragments, brown Fines: silt, disseminated	3.2	13.5
Till	Clay, very stiff, reddish brown with coarse to fine grained, angular to subrounded clasts of basalt, andesite, greywacke, chert, felsite and sandstone	6.0	19.5
Lower Devonian	Tuff, mottled reddish brown with green banding, highly weathered	0.5+	20.0

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64	
a	10	33	57	0.5–1.5	15	17	14	12	23	19	0	
				1.5–2.0	7	8	10	16	29	30	0	†
				2.0–3.0	5	6	9	13	32	35	0	†
				3.0–4.0	12	7	12	18	27	24	0	†
				4.0–5.0	5	6	9	16	33	31	0	†
				5.0–5.8	Silt							
				5.8–7.0	16	14	4	7	23	36	0	†
				Mean	10	10	10	13	28	29	0	
b	12	87	1	8.2–9.2	19	53	26	1	1	0	0	†
				9.2–10.3	6	68	25	1	0	0	0	†
				Mean	12	61	26	1	0	0	0	
c	2	34	64	10.3–11.3	2	20	10	6	38	24	0	†
				11.3–12.3	3	10	9	11	51	16	0	†
				12.3–13.5	2	14	13	8	35	28	0	†
				Mean	2	15	11	8	41	23	0	
a to c	8	44	48	Mean	8	21	13	10	26	22	0	

NT 04 NE 4 0667 4800 Kirkland, Dunsyre **Block C**

Surface level +228.4 m
Water struck at +222.4 m
250 mm percussion
October 1978

Overburden 0.4 m
Mineral 1.0 m
Waste 11.0 m
Bedrock 0.4 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Glacial meltwater deposits	**a** 'Clayey' pebbly sand (L2) Gravel: coarse with fine, subrounded to well rounded, greywacke and basalt Sand: fine with medium, rounded quartz, yellow-brown Fines: silt, disseminated and in laminae	1.0	1.4
	b Silt (L1), laminated, micaceous, medium-brown, includes much fine quartz sand particularly from 5.4 m to 6.4 m where material grades 'very clayey' sand	8.9	10.3
	c 'Very clayey' gravel (L2) Gravel: fine with coarse, subrounded to well rounded, red sandstone, greywacke, basalt, andesite, quartz and felsite Sand: fine to coarse, rounded, quartz, medium brown Fines: silt, disseminated and in laminae	2.1	12.4
Upper Devonian	Sandstone, medium to coarse grained, red	0.4+	12.8

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	12	81	7	0.4–1.4	12	54	26	1	2	5	0	
b	34	66	0	5.4–6.4	34	64	2	0	0	0	0	*
c	27	28	45	10.3–11.3	35	11	4	7	31	12	0	*†
				11.3–12.4	19	9	10	15	25	22	0	*†
				Mean	27	10	7	11	28	17	0	

Surface level +212.8 m
Water struck at +210.8 m
250 mm and 200 mm percussion
October 1978

Overburden 2.5 m
Mineral (including 0.8 m waste) 22.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Alluvium	Silt, sandy, medium grey, with sandy laminae	1.0	1.5
Peat	Peat	1.0	2.5
Alluvium	**a** Sandy gravel Gravel: fine with coarse up to 4 cm diameter, rounded to well rounded, greywacke, quartz, chert, andesite, basalt and red sandstone Sand: medium and fine with coarse, subangular to subrounded, the coarser grains being more angular, quartz and rock fragments, brown Fines: silt, disseminated	1.0	3.5
Glacial meltwater deposits	**b** Sand (L2), including silt band (L1) from 6.3 m to 7.1 m Gravel: trace, fine and medium, mainly between 9.0 m and 10.0 m. Subangular to subrounded, felsite, basalt and quartz Sand: fine and medium, subrounded, quartz and rock fragments with coal Fines: silt, disseminated and in laminae beneath 12.0 m	11.5	15.0
	c 'Clayey' sand (L1) Sand: fine with medium, quartz with coal up to 3 cm diameter Fines: silt	10.0+	25.0

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$	
a	5	52	43	2.5–3.5	5	19	24	9	26	17	0	†
b	6	93	1	3.5–4.5	3	30	58	7	1	1	0	†
				4.5–6.3	4	51	41	4	0	0	0	†
				6.3–7.1	Silt							
				7.1–8.0	3	43	52	2	0	0	0	†
				8.0–9.0	4	45	50	1	0	0	0	†
				9.0–10.0	7	59	28	1	1	4	0	†
				10.0–11.0	5	56	38	1	0	0	0	†
				11.0–12.0	5	44	44	6	1	0	0	†
				12.0–13.0	16	66	17	1	0	0	0	†
				13.0–14.0	6	50	40	3	1	0	0	†
				14.0–15.0	7	45	44	3	1	0	0	†
				Mean	6	49	41	3	1	trace	0	
c	10	90	0	15.0–16.0	7	81	11	1	0	0	0	†
				16.0–17.0	7	56	36	1	0	0	0	†
				17.0–18.0	8	74	17	1	0	0	0	†
				18.0–19.0	7	71	21	1	0	0	0	†
				19.0–20.0	10	64	25	1	0	0	0	†
				20.0–21.0	12	71	16	1	0	0	0	†
				21.0–22.0	13	76	10	1	0	0	0	†
				22.0–23.0	13	75	12	0	0	0	0	†
				23.0–24.0	12	75	12	1	0	0	0	†
				24.0–25.0	13	75	11	1	0	0	0	†
				Mean	10	72	17	1	0	0	0	
b+c	8	92	trace	Mean	8	60	30	2	trace	trace	0	
a to c	8	90	2	Mean	8	58	29	2	2	1	0	

NT 04 NE 6 **08535 49025** **Easton, Dunsyre** **Block B**

Surface level +244.2 m
Water struck at +240.5 m
250 mm percussion
October 1978

Overburden 0.4 m
Mineral 4.3 m
Bedrock 0.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Glacial meltwater deposits	**a** 'Very clayey' sandy gravel (L2) Gravel: coarse and fine, becomes coarser with depth including rare cobbles, subrounded to well rounded, greywacke, quartz, basalt, felsite, chert, andesite and red sandstone Sand: fine with medium and coarse, subrounded to rounded, quartz, reddish brown Fines: silt and clay, disseminated	4.3	4.7
Upper Devonian	Sandstone, medium to coarse grained, red. Weathered to 4.8 m	0.5+	5.2

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
a	21	56	23	0.4–1.5	17	36	19	9	14	5	0
				1.5–2.5	25	34	16	7	12	6	0
				2.5–3.5	21	38	16	5	4	16	0
				3.5–4.7	21	26	16	5	9	23	0
				Mean	21	33	17	6	10	13	0

NT 04 NE 7 **0834 4810** **Newholm, Dunsyre** **Block B**

Surface level +238.0 m
Water not struck
250 mm percussion
September 1978

Overburden 0.2 m
Mineral 16.8+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Glacial meltwater deposits	**a** Gravel (L3) Gravel: coarse with fine and cobbles, subrounded to well rounded, red sandstone, felsite, fine grained acid igneous rocks, basalt, quartzite and quartz Sand: medium with fine and coarse, subrounded, quartz with rock fragments red-brown Fines: clay, red	4.0	4.2
	b Sand (L2) Gravel: trace, fine below 11.2 m, well rounded, felsite and buff sandstone Sand: medium with fine, subrounded, quartz with rock fragments Fines: silt	10.0	14.2
	c 'Clayey' sandy gravel (L2) Gravel: coarse and fine with cobbles, very coarse with boulders below 16.5 m, well rounded, buff, red and grey sandstones, felsite, quartz and greywacke, with trace shelly limestones Sand: fine to coarse, subrounded, quartz and rock fragments, yellow-brown Fines: clay, brown	2.8+	17.0

Borehole terminated owing 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	4	45	51	0.2–1.2	3	11	13	8	14	27	24
				1.2–2.2	4	9	13	8	19	42	5
				2.2–3.2	5	12	19	13	21	27	3
				3.2–4.2	5	20	36	18	13	8	0
				Mean	4	13	20	12	17	26	8
b	4	96	0	4.2–5.2	5	25	69	1	0	0	0
				5.2–6.2	6	52	42	0	0	0	0
				6.2–7.2	No grading data available						
				7.2–8.2	5	40	51	4	0	0	0
				8.2–9.2	8	42	48	2	0	0	0
				9.2–10.2	2	23	71	4	0	0	0
				10.2–11.2	2	17	72	9	0	0	0
				11.2–12.2	3	14	73	9	1	0	0
				12.2–13.2	3	28	69	0	0	0	0
				13.2–14.2	3	26	68	3	0	0	0
				Mean	4	30	62	4	0	0	0
c	10	45	45	14.2–15.2	9	16	23	12	14	19	7
				15.2–16.0	12	15	14	9	17	20	13
				16.0–17.0	No grading data available						
				Mean	10	16	19	11	15	19	10
a to c	5	75	20	Mean	5	23	45	7	7	9	4

NT 04 NE 8 0809 4751 Newholm, Dunsyre **Block B**

Surface level +222.7 m
Water struck at +216.7 m
250 mm percussion
September 1978

Overburden 0.5 m
Mineral 9.5 m
Bedrock 0.3 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Glacial meltwater deposits	**a** Sand (L1) Sand: fine, subrounded to rounded, quartz, yellow Fines: silt	1.0	1.5
	b 'Very clayey' sandy gravel (L2) Gravel: fine and coarse with cobbles, red sandstone and basalt with felsite, greywacke, quartz and coal Sand: fine with medium, subrounded, quartz and rock fragments, brown Fines: clay and silt, brown	3.0	4.5
Till	**c** Gravel Gravel: fine and coarse with cobbles, angular with subangular to well rounded, basalt and andesite with felsite Sand: fine to coarse, subangular, rock fragments and quartz Fines: clay, silty, red-brown much washed out during drilling; some lumps of clay-bound till recovered	5.5	10.0
Lower Devonian	Basalt, dark grey, weathered near surface	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	9	91	0	0.5–1.5	9	83	8	0	0	0	0	
b	24	50	26	1.5–2.5	17	14	12	9	19	20	9	
				2.5–3.5	29	26	14	5	12	14	0	
				3.5–4.5	25	50	17	3	5	0	0	
				Mean	24	30	14	6	12	11	3	
c	9	42	49	4.5–5.5	26	24	13	6	16	15	0	
				5.5–6.5	11	18	10	12	27	22	0	†
				6.5–7.5	3	14	20	22	27	14	0	†
				7.5–8.5	3	11	19	18	28	16	5	†
				8.5–9.5	5	6	7	11	37	34	0	†
				9.5–10.5	4	12	15	14	25	19	11	†
				Mean	9	14	14	14	27	20	2	
a+b	20	60	20	Mean	20	43	13	4	9	9	2	
a to c	14	50	36	Mean	14	27	13	10	19	15	2	

NT 04 NE 9 **0963 4944** **Medwinbank, Dolphinton** **Block B**

Surface level +248.6 m
Water not struck
250 mm percussion
October 1978

Overburden 0.3 m
Mineral 3.0 m
Waste 0.2 m
Bedrock 0.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial meltwater deposits	**a** 'Clayey' pebbly sand (L2) Gravel: coarse with fine, rare cobbles, subrounded to well rounded, red sandstone with basalt and quartz. Gravel content increases below 2.3 m Sand: fine with medium and a little coarse, rounded, quartz with coal, reddish brown Fines: silt, disseminated and in laminated seams which become more common with depth	3.0	3.3
Till	Clay, stiff, subangular to well rounded, pebble-sized clasts of red and yellow-white sandstones, andesite, basalt and chert	0.2	3.5
Upper Devonian	Sandstone, fine to medium grained, quartz with mica, red	0.5+	4.0

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	20	61	19	0.3–1.3	13	50	18	6	7	6	0	*
				1.3–2.3	27	45	18	2	3	5	0	*
				2.3–3.3	19	26	13	5	11	26	0	*
				Mean	20	41	16	4	7	12	0	

NT 04 NE 10 0919 4830 Croft-an-Righ, Dolphinton **Block B**

Surface level +240.6 m
Water struck at +222.3 m
250 mm percussion
September 1978

Overburden 0.3 m
Mineral 23.9 m
Bedrock 0.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial meltwater deposits	**a** 'Very clayey' pebbly sand (L1) Gravel: concentrated from 3.3 m to 4.3 m, fine with coarse, well rounded, felsite, white and grey quartzites, buff and red sandstones, fine-grained igneous rocks, quartz Sand: fine with medium, rounded to subrounded, quartz, with rock fragments from 3.3 m to 4.3 m, yellow-brown Fines: silt, disseminated and in coal-rich seams	5.0	5.3
	b Gravel (L2) Gravel: coarse and fine with cobbles, subrounded to well rounded, felsite, red and buff sandstones, quartzite, acid and intermediate fine-grained igneous rocks, greywacke and quartz Sand: medium with fine and coarse, subrounded, quartz with some coal near base, yellow-brown Fines: silt, disseminated and in laminae near the base	15.0	20.3
	c 'Very clayey' sandy gravel (L2) Gravel: fine and coarse, with cobbles below 23.3 m, composition as above Sand: fine and medium with coarse, subrounded, quartz Fines: silt, brown	3.9	24.2
Lower Devonian	Basalt, amygdaloidal, grey	0.1+	24.3

GRADING

	Mean for deposit *percentages* Fines	Sand	Gravel	Depth below surface (m)	*percentages* Fines $-\frac{1}{16}$	Sand $+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	Gravel $+4-16$	$+16-64$	$+64$	
a	23	73	4	0.3–1.3	38	44	12	4	2	0	0	
				1.3–2.3	15	44	37	3	1	0	0	
				2.3–3.3	22	43	30	4	1	0	0	
				3.3–4.3	6	25	38	15	11	5	0	
				4.3–5.3	32	44	20	3	1	0	0	
				Mean	23	40	27	6	3	1	0	
b	5	47	48	5.3–6.3	5	12	20	9	21	22	11	
				6.3–7.3	3	12	32	11	14	20	8	
				7.3–8.3	4	6	24	21	23	22	0	
				8.3–9.3	5	7	21	12	21	28	6	
				9.3–10.3	5	11	28	14	22	20	0	
				10.3–11.3	5	14	16	18	28	19	0	
				11.3–12.3	8	15	20	12	22	23	0	
				12.3–13.3	4	17	23	15	27	14	0	
				13.3–14.3	5	14	21	13	29	18	0	
				14.3–15.3	3	13	18	10	24	32	0	
				15.3–16.3	5	9	15	13	28	30	0	
				16.3–17.3	5	9	18	13	19	25	11	
				17.3–18.3	5	17	31	11	17	19	0	
				18.3–19.3	10	22	23	8	15	22	0	†
				19.3–20.3	10	13	14	8	15	36	4	†
				Mean	5	13	22	12	22	23	3	
c	26	51	23	20.3–21.3	34	33	20	0	10	3	0	†
				21.3–22.3	28	23	19	7	9	14	0	†
				22.3–23.3	32	30	20	5	8	5	0	†
				23.3–24.2	10	22	15	9	16	9	19	†
				Mean	26	27	19	5	11	8	4	
a to c	13	53	34	Mean	13	21	22	10	16	16	2	

NT 04 NE 11 0970 4782 Roberton Mains, Dolphinton **Block B**

Surface level +269.9 m
Water struck at +267.8 m
250 mm percussion
September 1978

Overburden 0.4 m
Mineral 1.7 m
Bedrock 0.3 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Till	**a** 'Clayey' gravel Gravel: fine and coarse, angular to subrounded, basalt Sand: fine to coarse, ill-sorted, subangular to subrounded, rock fragments with quartz, brown Fines: clay, brown	1.7	2.1
Lower Devonian	Basalt, fine grained, dark grey	0.3+	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
a	13	43	44	0.4–1.4	11	17	14	13	22	23	0
				1.4–2.1	15	10	14	18	27	16	0
				Mean	13	14	14	15	24	20	0

NT 04 SW 1 0059 4410 Millridge, Carnwath **Block C**

Surface level +206.9 m
Water not struck
200 mm percussion
November 1978

Overburden 0.3 m
Mineral 4.3 m
Bedrock 1.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial meltwater deposits	**a** 'Clayey' pebbly sand (L2), becomes less gravelly and more clayey below 2.0 m Gravel: fine and coarse, rounded to well rounded, greywacke, sandstone, felsite, vein-quartz and basalt Sand: fine with medium, subrounded, quartz, medium to dark brown Fines: silt and clay, disseminated	4.3	4.6
Upper Devonian	Sandstone, medium grained, red. Highly weathered above 5.6 m, indurated below	1.2+	5.8

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	19	64	17	0.3–1.3	10	25	23	7	25	10	0	
				1.3–2.0	8	32	32	11	13	4	0	
				2.0–3.0	16	71	11	2	0	0	0	
				3.0–4.6	30	34	16	3	4	13	0	†
				Mean	19	40	19	5	9	8	0	

NT 04 SW 2 0195 4460 Newbigging **Block C**

Surface level +220.0 m
Water not struck
250 mm percussion
November 1978

Waste 0.85 m
Bedrock 0.15 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Glacial meltwater deposits	Pebbly sand (L2) Gravel: fine and coarse up to 3 cm diameter, subrounded to rounded, red sandstone, greywacke, felsite, basalt, quartz Sand: fine, subrounded, quartz, medium-brown Fines: silt, disseminated	0.65	0.85
Upper Devonian	Sandstone, medium grained, red	0.15+	1.0

NT 04 SW 3 **0255 4499** **Newbiggingmill, Newbigging** **Block C**

Surface level +220.0 m
Water not struck
250 mm percussion
November 1978

Overburden 1.2 m
Mineral 13.9 m
Bedrock 0.7 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Glacial meltwater deposits	Clay (L1), silty, mottled reddish brown to pale grey	1.0	1.2
	a Sand (L2) Gravel: trace, below 3.2 m, fine, rounded, felsite and vein-quartz Sand: medium and fine, subrounded to subangular, with felsite, yellow-brown Fines: silt, disseminated and in thin laminae, medium brown	4.1	5.3
	b Gravel (L2), 'very clayey' beneath 14.3 m Gravel: coarse and fine with cobbles up to 18 cm diameter, rounded to well rounded, red sandstone becoming dominant below 12.3 m, greywacke, basalt, felsite, vein-quartz, yellow sandstone and rare coal Sand: fine to coarse, subrounded, quartz with rock fragments, medium to dark brown Fines: silt, disseminated and in thin seams	9.8	15.1
Upper Devonian	Sandstone, medium grained, indurated, red, weathered near surface	0.4	15.5
	Mudstone, red, soft, slickensided fratures running oblique to bedding planes	0.3+	15.8

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	90	1	1.2–2.2	6	40	52	2	0	0	0
				2.2–3.2	12	54	33	1	0	0	0
				3.2–4.2	10	25	46	16	3	0	0
				4.2–5.3	8	37	46	8	1	0	0
				Mean	9	39	44	7	1	0	0
b	8	45	47	5.3–6.3	5	10	17	9	18	34	7
				6.3–7.3	4	5	19	22	25	25	0
				7.3–8.3	8	17	28	13	25	9	0
				8.3–9.3	8	16	17	13	23	23	0
				9.3–10.3	4	9	27	20	26	14	0
				10.3–11.3	6	6	10	15	28	30	5
				11.3–12.3	7	11	11	12	29	30	0
				12.3–13.3	8	10	13	14	22	33	0
				13.3–14.3	8	12	15	16	19	30	0
				14.3–15.1	21	35	18	11	9	6	0
				Mean	8	13	17	15	22	24	1
a+b	8	58	34	Mean	8	20	26	12	16	17	1

NT 04 SW 4 0213 4436 Newbigging **Block C**

Surface level +201.2 m
Water struck at +198.8 m
200 mm and 150 mm percussion
November 1978

Overburden 0.4 m
Mineral 12.6 m
Waste 1.0 m
Mineral 1.9 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Alluvium	**a** Gravel Gravel: coarse with fine and rare cobbles, subangular to well rounded, greywacke, chert, vein-quartz, felsite, basalt, sandstone, quartzite and coal Sand: medium and coarse with fine, subangular to subrounded, quartz with rock fragments, orange-brown Fines: silt, disseminated	3.2	3.6
Glacial meltwater deposits	**b** Sand (L2) Gravel: trace fine from 10.1 m to 11.0 m and below 12.0 m, subangular to well rounded, felsite and vein-quartz Sand: medium and fine, subangular to subrounded, quartz with coal and other rock fragments, orange-brown Fines: silt, disseminated	9.4	13.0
	Clay (L1), silty, stiff, dark grey-brown	1.0	14.0
	c Pebbly sand (L2) Gravel: fine with coarse, subangular to rounded, felsite, vein-quartz, chert, quartzite, greywacke, basalt and coal Sand: medium with fine and coarse, subrounded to subangular, the coarse-grained generally more angular, quartz with rock fragments Fines: silt, disseminated	1.9+	15.9

Borehole terminated owing 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	2	41	57	0.4–1.4	3	6	14	8	23	42	4	
				1.4–2.4	2	8	24	15	25	26	0	
				2.4–3.6	1	4	26	18	20	31	0	†
				Mean	2	6	21	14	23	33	1	
b	4	95	1	3.6–4.6	4	31	62	3	0	0	0	†
				4.6–5.6	3	24	73	0	0	0	0	†
				5.6–6.6	3	26	70	1	0	0	0	†
				6.6–7.6	5	67	28	0	0	0	0	†
				7.6–9.0	6	67	27	0	0	0	0	†
				9.0–10.1	4	50	46	0	0	0	0	†
				10.1–11.0	4	19	45	28	4	0	0	†
				11.0–12.0	6	47	42	5	0	0	0	†
				12.0–13.0	5	42	37	14	2	0	0	†
				Mean	4	43	47	5	1	0	0	
c	2	77	21	14.0–15.0	3	13	40	22	16	6	0	†
				15.0–15.9	2	18	44	17	16	3	0	†
				Mean	2	15	42	20	16	5	0	
b+c	4	92	4	Mean	4	38	46	8	3	1	0	
a to c	4	81	15	Mean	4	31	41	9	7	8	0	

NT 04 SW 5 0318 4461 Ogscastle, Newbigging **Block C**

Surface level +215.0 m
Water struck at +207.0 m
250 mm percussion
November 1978

Overburden 0.6 m
Mineral 12.0 m
Waste 1.0 m
Mineral 2.4 m
Bedrock 0.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.6	0.6
Glacial meltwater deposits	**a** Sand (L2) Gravel: trace, fine and coarse, principally from 1.6 m to 3.6 m, rounded, greywacke Sand: fine and medium, subrounded, quartz, orange-brown Fines: silt, disseminated, less below 2.6 m	5.0	5.6
	b Pebbly sand (L2) Gravel: fine and coarse, subangular to rounded, greywacke, basalt, felsite, quartz and sandstone Sand: fine and medium with coarse, subangular to subrounded, quartz with rock fragments, medium brown Fines: silt, disseminated and in laminae	2.0	7.6
	c 'Very clayey' sand (L1) Gravel: trace, fine and coarse Sand: fine with medium, subrounded, quartz, medium brown Fines: silt, disseminated and in laminae	5.0	12.6
	Silt, sandy, grading from overlying sand	1.0	13.6
	d Sand (L2) Gravel: fine with coarse Sand: medium and fine, subrounded, quartz with coal, orange-brown Fines: silt, disseminated	2.4	16.0
Upper Devonian	Sandstone, medium to coarse grained, mottled red with black, weathered	0.5+	16.5

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	8	91	1	0.6–1.6	14	51	32	3	0	0	0	
				1.6–2.6	11	50	29	6	3	1	0	
				2.6–3.6	6	28	62	3	1	0	0	
				3.6–4.6	3	65	30	2	0	0	0	
				4.6–5.6	6	52	39	3	0	0	0	†
				Mean	8	49	39	3	1	0	0	
b	4	82	14	5.6–6.6	1	35	43	8	6	7	0	†
				6.6–7.6	7	40	31	7	10	5	0	†
				Mean	4	38	37	7	8	6	0	
c	34	64	2	7.6–8.6	35	51	9	1	1	3	0	†
				8.6–9.6	31	57	10	1	1	0	0	†
				9.6–10.6	35	52	12	1	0	0	0	†
				10.6–11.6	34	48	18	0	0	0	0	†
				11.6–12.6	38	50	10	1	1	0	0	†
				Mean	34	51	12	1	1	1	0	
d	7	88	5	13.6–14.6	8	42	49	1	0	0	0	†
				14.6–15.6	6	43	36	5	8	2	0	†
				15.6–16.0	9	34	54	1	1	1	0	†
				Mean	7	41	44	3	4	1	0	
a to d	17	80	3	Mean	17	47	30	3	2	1	0	

NT 04 SW 6 **0327 4040** **Muir Wood, Libberton** **Block D_2**

Surface level +253.5 m
Water struck at +248.7 m
250 mm percussion
November 1978

Overburden 0.3 m
Mineral 4.7 m
Waste 5.0 m
Bedrock 0.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial meltwater deposits	**a** Gravel (L3) Gravel: coarse and fine with rare cobbles, subrounded to well rounded, basalt with greywacke, chert and felsite Sand: fine to coarse, subangular, quartz and rock fragments, medium to dark brown Fines: silt and clay, disseminated	1.7	2.0
	b 'Very clayey' sand (L1) Gravel: rare, fine and coarse, principally above 3.0 m, basalt Sand: fine with medium, subrounded, quartz, medium brown Fines: silt, disseminated and in thin seams which increase in number with depth	3.0	5.0
	Silt (L1), laminated, medium grey-brown, some thin sand partings	4.7	9.7
Till	Clay, stiff, medium to dark brown, with angular to subangular clasts of andesite, basalt, felsite and vein-quartz	0.3	10.0
Lower Devonian	Andesite, fine grained, equigranular, purple	0.1+	10.1

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	4	31	65	0.3–1.3	4	8	10	12	27	29	10
				1.3–2.0	3	6	11	17	26	37	0
				Mean	4	7	10	14	27	32	6
b	23	75	2	2.0–3.0	18	37	39	1	3	2	0
				3.0–4.0	16	48	34	1	1	0	0
				4.0–5.0	36	49	14	0	1	0	0
				Mean	23	45	29	1	1	1	0
a+b	16	59	25	Mean	16	31	22	6	11	12	2

NT 04 SW7 **0424 4124** **Strawlaw, Biggar** **Block D_2**

Surface level +246.2 m
Water not struck
250 mm percussion
November 1978

Waste 0.8 m
Bedrock 0.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, sandy with angular to rounded pebble-sized clasts of basalt	0.5	0.8
Lower Devonian	Basalt, fine grained with olivine phenocrysts, dark grey	0.1+	0.9

NT 04 SE 1 0644 4081 The Dean, Biggar **Block D_2**

Surface level +249.1 m
Water struck at +234.2 m
250 mm and 200 mm percussion
November 1978

Overburden 0.2 m
Mineral 19.6 m
Waste 1.4 m
Bedrock 0.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Glacial meltwater deposits	**a** Gravel (L3) Gravel: fine and coarse with cobbles up to 14 cm diameter, subangular to rounded, basalt with grey grit, quartzite, chert, red and white sandstones and andesite Sand: fine to coarse, angular to subrounded, quartz, rock fragments and feldspar Fines: silt and clay, disseminated and in seams, brown	6.0	6.2
	b 'Clayey' pebbly sand (L2), poorly bedded with gravel most abundant from 6.2 m to 9.1 m and 13.2 m to 15.0 m Gravel: fine with coarse, subrounded to well rounded, composition as above with rare felsite Sand: medium and fine with coarse, angular to subangular, quartz, rock fragments and feldspar Fines: silt, disseminated and in laminated seams, brown	13.6	19.8
Till	Clay, very stiff, medium to dark brown, coarse and fine, angular to rounded clasts of greywacke, basalt, felsite, sandstone and vein-quartz	1.4	21.2
Lower Devonian	Basalt, fine grained, blue-grey	0.1+	21.3

GRADING

	Mean for deposit *percentages* Fines	Sand	Gravel	Depth below surface (m)	*percentages* Fines $-\frac{1}{16}$	Sand $+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	Gravel $+4-16$	$+16-64$	$+64$	
a	10	30	60	0.2–1.2	22	16	11	9	16	10	16	
				1.2–2.2	7	5	8	17	29	25	9	
				2.2–3.2	7	12	11	15	30	25	0	
				3.2–4.2	9	10	12	12	24	33	0	
				4.2–5.2	6	4	7	9	21	31	22	
				5.2–6.2	8	6	8	11	38	29	0	
				Mean	10	9	9	12	26	26	8	
b	11	71	18	6.2–7.3	26	19	8	9	22	16	0	
				7.3–8.2	12	20	25	14	20	9	0	
				8.2–9.1	13	24	24	11	14	14	0	
				9.1–9.9	17	36	27	7	8	5	0	
				9.9–11.0	14	30	36	8	7	5	0	
				11.0–12.0	9	46	36	5	3	1	0	
				12.0–13.2	9	28	30	16	14	3	0	
				13.2–14.0	4	7	32	30	22	5	0	
				14.0–15.0	9	9	37	21	15	9	0	
				15.0–16.0	11	19	37	16	11	6	0	†
				16.0–17.0	8	31	49	9	3	0	0	†
				17.0–18.0	9	23	30	23	13	2	0	†
				18.0–19.8	7	27	31	25	10	0	0	†
				Mean	11	25	31	15	12	6	0	
a+b	11	59	30	Mean	11	20	25	14	16	12	2	

NT 04 SE 2 0712 4341 Howburn Farm, Elsrickle **Block D_2**

Surface level +248.3 m
Water struck at +239.6 m
250 mm and 200 mm percussion
October 1978

Overburden 0.5 m
Mineral 3.1 m
Waste 3.2 m
Mineral 11.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Glacial meltwater deposits	**a** 'Clayey' pebbly sand (L2) Gravel: fine with coarse Sand: fine with medium and coarse, subrounded to rounded, quartz and rock fragments Fines: silt, brown	3.1	3.6
	Silt (L1), laminated, brown, with rare clasts, sandy below 6.0 m	3.2	6.8
	b Gravel (L2) Gravel: fine and coarse with cobbles, angular to well rounded, basalt with buff and red sandstones, felsite, quartzite, intermediate lavas, greywacke, grit and rare quartz Sand: coarse with medium and fine, subrounded to subangular, quartz Fines: silt, brown	11.0+	17.8

Borehole terminated owing 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	13	78	9	0.5–2.0	17	68	11	1	1	2	0	
				2.0–3.6	9	21	35	21	13	1	0	
				Mean	13	44	23	11	7	2	0	
b	5	32	63	6.8–7.8	16	24	20	13	14	13	0	
				7.8–8.8	5	9	13	9	26	26	12	
				8.8–9.8	1	2	6	15	46	24	6	†
				9.8–10.8	1	4	9	17	41	28	0	†
				10.8–11.8	1	6	17	21	34	21	0	†
				11.8–12.8	3	2	10	19	37	22	7	†
				12.8–13.8	13	2	3	12	36	34	0	†
				13.8–14.8	1	2	10	29	41	17	0	†
				14.8–16.8	6	2	4	19	34	23	12	†
				16.8–17.8	1	2	6	16	42	33	0	†
				Mean	5	5	10	17	35	24	4	
a+b	7	42	51	Mean	7	14	12	16	29	19	3	

NT 04 SE 3 0723 4301 Strathbogie, Biggar **Block D_2**

Surface level +239.2 m
Water struck at +237.9 m
200 m percussion
December 1978

Overburden 0.8 m
Mineral 4.7 m
Bedrock 0.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Alluvium	'Very clayey' sand Sand: fine to medium, subrounded, quartz Fines: silt, brown	0.5	0.7
	Silt, brown-grey, mottled	0.1	0.8
Till	**a** Gravel Gravel: fine and coarse with some cobbles up to 8 cm diameter, angular to rounded, grit and basalt with andesite, felsite, red sandstone, quartzite and shale. Basalt more abundant with depth, amygdaloidal, generally more angular than other clasts. Sand: coarse and medium with fine, angular to rounded, becoming more angular with depth, rock fragments Fines: clay and silt, brown, original clay-bound texture generally broken down by washing	4.7	5.5
Lower Devonian	Basalt, porphyritic with euhedral phenocrysts of pyroxene with olivine in groundmass of feldspar with quartz; vesicles infilled with chalcedony	0.1+	5.6

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64	
a	7	37	56	0.8–1.8	11	9	13	18	29	20	0	
				1.8–2.8	3	5	12	17	38	25	0	†
				2.8–3.6	3	6	11	15	38	27	0	†
				3.6–4.5	14	2	7	15	31	31	0	†
				4.5–5.5	6	7	20	24	18	25	0	†
				Mean	7	6	13	18	31	25	0	

NT 04 SE 4 **0745 4185** **Candyburn, Biggar** **Block D_2**

Surface level +254.6 m
Water not struck
250 mm percussion
November 1978

Overburden 0.3 m
Mineral 7.7 m
Bedrock 0.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial meltwater deposits	**a** Gravel (L2), poorly bedded, sandier from 2.3 m to 4.0 m and below 6.0 m. Above 3.3 m clay-bound and very compact Gravel: coarse and fine with, principally above 1.3 m, cobbles up to 25 cm diameter, subangular to rounded, basalt, red and white sandstones, grit, greywacke, slate with quartz Sand: medium and coarse with fine, subrounded to rounded, quartz and rock fragments, brown Fines: clay, red-brown, and comminuted rock	7.7	8.0
? Lower Devonian	*Borehole terminated on bedrock, sample not retrieved*	0.1+	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	9	45	46	0.3–1.3	7	5	7	11	26	32	12
				1.3–2.3	9	4	7	10	27	43	0
				2.3–3.3	9	10	31	17	18	15	0
				3.3–4.0	12	23	30	8	15	12	0
				4.0–5.0	9	12	18	11	12	38	0
				5.0–6.0	9	6	15	16	23	31	0
				6.0–7.0	13	7	21	30	17	12	0
				7.0–8.0	7	11	27	24	25	6	0
				Mean	9	9	19	17	20	24	2

NT 04 SE 5 0837 4428 Melbourne, Dolphinton **Block D_2**

Surface level +259.0 m
Water not struck
250 mm percussion
November 1978

Overburden 0.4 m
Mineral 3.1 m
Bedrock 1.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Till	**a** 'Clayey' gravel Gravel: coarse and fine with cobbles, subangular to subrounded, basic and intermediate lavas, dolerite and purple sandstone Sand: fine to coarse, subrounded to subangular, rock fragments, grey-brown Fines: clay, brown	3.1	3.5
Lower Devonian	Basalt, highly weathered to fine and coarse angular sand, dark grey	1.0+	4.5

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
a	17	33	50	0.4–2.0	21	7	10	13	18	17	14
				2.0–3.5	12	8	11	17	20	28	4
				Mean	17	7	11	15	19	22	9
Weathered rock	16	65	19	3.5–4.4	16	12	16	37	18	1	0

NT 14 NW 2 **1006 4871** **Garvald House, Dolphinton** **Block B**

Surface level +232.8 m
Water not struck
250 mm percussion
September 1978

Overburden 0.4 m
Mineral 1.5 m
Bedrock 0.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Glacial meltwater deposits	**a** Gravel (L2) Gravel: fine with coarse, subangular to subrounded, red sandstone and amygdaloidal basalt Sand: fine to coarse, subrounded, quartz and rock fragments, red-brown Fines: clay, brown	1.5	1.9
Lower Devonian	Andesite, amygdaloidal, fine grained with euhedral feldspar phenocrysts, grey	0.1+	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
a	8	45	47	0.4–1.4	8	21	10	15	32	14	0
				1.4–1.9	9	17	10	16	30	18	0
				Mean	8	20	10	15	32	15	0

NT 14 NW 3 **1062 4763** **Haughhead Farm, Dolphinton** **Block B**

Surface level +220.2 m
Water not struck
250 mm percussion
September 1978

Overburden 0.3 m
Mineral 3.7 m
Bedrock 0.6 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial meltwater deposits	**a** Sandy gravel (L2), more gravelly below 2.3 m Gravel: fine and coarse, subrounded to well rounded, red, purple and buff sandstones, basalt and felsite with greywacke and quartz Sand: medium with fine and coarse, subrounded, quartz and rock fragments, yellow-brown Fines: silt, disseminated	3.7	4.0
Lower Devonian	Tuff, banded, grey-brown to purplish brown, very weathered near the top	0.6+	4.6

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
a	5	56	39	0.3–1.3	7	14	34	20	15	10	0
				1.3–2.3	5	13	35	22	14	11	0
				2.3–3.3	4	7	22	10	34	23	0
				3.3–4.0	5	7	20	13	21	34	0
				Mean	5	11	28	17	21	18	0

NT 14 NW 4 **1090 4660** **Westmill Farm, Dolphinton** **Block B**

Surface level +224.3 m
Water not struck
250 mm percussion
September 1978

Waste 0.4 m
Bedrock 1.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, becoming orange-brown clay with basalt clasts below 0.3 m	0.4	0.4
Lower Devonian	Basalt, weathered	1.0+	1.4

NT 14 NW 5 1060 4605 Ash Hill, Dolphinton **Block D_2**

Surface level +238.4 m
Water struck at +229.9 m
250 mm percussion
September 1978

Waste 8.8 m
Bedrock 0.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Glacial meltwater deposits	Clay (L1), silty, laminated in part, red-brown	2.8	3.0
	Silt (L1), laminated, grey	5.5	8.5
Till	Clay, dark brown, fine to coarse gravel-sized clasts of subangular basalt and red lava with sandstone	0.3	8.8
Lower Devonian	Basalt, amygdaloidal, dark grey, highly weathered to grey clay	0.5+	9.3

NT 14 NW 6 1196 4840 Ingraston Farm, Dolphinton **Block B**

Surface level +215.2 m
Water struck at +213.2 m
250 mm and 200 mm percussion
August 1978

Overburden 0.2 m
Mineral (including 1.2 m waste) 6.8 m
Waste 9.3 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Glacial meltwater deposits	**a** 'Very clayey' sand (L1) including a silt band (L1) from 4.8 m to 6.0 m Sand: fine with some medium, mostly medium above 1.2 m, subrounded to well rounded, quartz with rock fragments, feldspar and coal, brown Fines: silt, micaceous, grey-brown, disseminated and in a seam from 4.8 m to 6.0 m	6.8	7 0
	Silt (L1), sandy to 7.8 m, brown to grey-brown, red-brown laminae of clay, rare well rounded clasts of shale and greywacke	8.8	15.8
	Gravel (L2) Gravel: fine to coarse, angular to subrounded, vesicular basalt with red sandstone, greywacke and a little quartz, chert and shale Sand: fine to coarse, subangular, quartz and rock fragments, yellow Fines: clay, silty, red-brown, in thin laminae	0.5+	16.3

Borehole terminated owing 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	22	78	0	0.2–1.2	9	52	35	4	0	0	0	
				1.2–2.2	25	70	4	1	0	0	0	†
				2.2–3.2	17	78	4	1	0	0	0	†
				3.2–4.8	31	65	3	1	0	0	0	†
				4.8–6.0	Silt							
				6.0–7.0	23	71	5	1	0	0	0	†
				Mean	22	67	9	2	0	0	0	

NT 14 NW 7 1122 4840 Nick's Plantation, Dolphinton **Block B**

Surface level +251.9 m
Water not struck
250 mm and 200 mm percussion
September 1978

Overburden 0.2 m
Mineral 25.3 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Glacial meltwater deposits	**a** Sand (L2), pebbly from 1.2 m to 2.2 m and from 6.5 m to 7.5 m Gravel: rare, fine with coarse and trace cobbles up to 7.5 cm diameter, rounded to well rounded, felsite, andesite, red sandstone, basalt, greywacke, chert, quartzite and vein-quartz Sand: fine and medium, rounded to subrounded, quartz with feldspar and rock fragments and, beneath 8.5 m, coal Fines: silt, disseminated, brown 10 cm band of red-brown clay between 5.5 m and 6.5 m	25.3+	25.5

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
a	6	93	1	0.2–1.2	3	50	47	0	0	0	0
				1.2–2.2	4	21	43	11	13	8	0
				2.2–3.2	4	34	56	5	1	0	0
				3.2–4.5	7	39	49	4	1	0	0
				4.5–5.5	8	59	32	1	0	0	0
				5.5–6.5	13	47	39	1	0	0	0
				6.5–7.5	10	50	30	5	5	0	0
				7.5–8.5	1	58	41	0	0	0	0
				8.5–9.5	14	71	15	0	0	0	0
				9.5–10.5	8	81	10	1	0	0	0
				10.5–11.5	5	80	15	0	0	0	0
				11.5–12.5	1	51	48	0	0	0	0
				12.5–13.5	6	42	52	0	0	0	0
				13.5–14.5	1	32	67	0	0	0	0
				14.5–15.5	3	29	68	0	0	0	0
				15.5–16.5	2	31	67	0	0	0	0
				16.5–17.5	4	28	66	2	0	0	0
				17.5–18.5	4	38	55	3	0	0	0
				18.5–19.5	6	29	62	3	0	0	0
				19.5–20.5	4	35	57	4	0	0	0
				20.5–21.5	7	28	53	8	3	1	0
				21.5–22.5	4	30	56	7	2	1	0
				22.5–23.5	12	53	33	1	1	0	0
				23.5–24.5	6	74	19	1	0	0	0
				24.5–25.5	3	59	38	0	0	0	0
				Mean	6	46	45	2	1	0	0

NT 14 NW 8 **1164 4763** **Kippit, Dolphinton** **Block B**

Surface level +219.1 m
Water struck at +212.8 m
250 mm and 200 mm percussion
August 1978

Overburden 0.5 m
Mineral 5.3 m
Waste 1.9 m
Bedrock 0.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Glacial meltwater deposits	**a** Sandy gravel (L2) Gravel: fine with coarse and rare cobbles and boulders up to 18 cm diameter, well rounded, felsite, quartz, andesite, greywacke, basalt, red and yellow sandstones, quartzite, chert, porphyry and trace coal Sand: medium and coarse with fine, subrounded to rounded, brown Fines: silt, disseminated	5.3	5.8
	Silts and clays (L1), laminated, medium brown to grey, thin sandy partings, rare sandstone clasts to 6.2 m	1.9	7.7
Lower Devonian	Sandstone, medium grained, indurated, bluish green	0.2+	7.9

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
a	5	56	39	0.5–1.4	8	8	21	24	22	17	0
				1.4–2.4	4	6	18	27	26	19	0
				2.4–3.4	3	9	30	20	21	17	0
				3.4–4.4	4	12	32	17	16	16	3
				4.4–5.8	4	8	24	25	25	10	4
				Mean	5	8	25	23	22	15	2

NT 14 NW 9 1191 4665 Newmill Farm, Dolphinton **Block B**

Surface level +209.2 m
Water struck at +207.9 m
250 mm percussion
September 1978

Overburden 0.3 m
Mineral 3.2 m
Waste 4.8 m
Bedrock 0.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial meltwater deposits	**a** Sandy gravel (L2), including red-brown till band from 2.2 m to 2.5 m Gravel: coarse and fine with cobbles, subangular to subrounded with rounded, basalt, pink, red and buff sandstones, quartzite, greywacke, breccia and quartz Sand: fine to coarse, subrounded, quartz and rock fragments Fines: clay, red-brown to brown	3.2	3.5
Till	Clay, stiff, red-brown, with subangular to subrounded clasts of basalt and red and buff sandstones	4.8	8.3
Lower Devonian	Tuff, granular, highly weathered	0.1+	8.4

GRADING

	Mean for deposit *percentages* Fines	Sand	Gravel	Depth below surface (m)	*percentages* Fines $-\frac{1}{16}$	Sand $+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	Gravel $+4-16$	$+16-64$	$+64$	
a	9	46	45	0.3–1.3	11	26	13	10	18	22	0	
				1.3–2.2	16	20	24	11	13	16	0	†
				2.2–3.5	2	6	14	18	19	20	21	†
				Mean	9	16	17	13	17	20	8	

NT 14 NW 10 1264 4945 Medwyn Mains, Dolphinton **Block A**

Surface level +229.9 m
Water struck at +223.6 m
250 mm percussion
September 1978

Overburden 0.3 m
Mineral 6.0 m
Bedrock 0.3 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial meltwater deposits	**a** 'Clayey' sandy gravel (L2) Gravel: fine and coarse with cobbles, the latter principally below 5.3 m, subrounded to well rounded, basalt, andesite, felsite and red, buff and purple sandstones Sand: fine with medium and coarse, subrounded, quartz with rock fragments. Gravel-free bands of sand occur above 2.3 m Fines: clay, red, the highest fines content occurs above 2.3 m where gravel is clay-bound	6.0	6.3
Lower Devonian	Sandstone, indurated, purplish grey	0.3+	6.6

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
a	16	49	35	0.3–1.3	20	32	14	13	14	7	0
				1.3–2.3	21	31	17	11	11	9	0
				2.3–3.3	12	23	17	9	15	18	6
				3.3–4.3	15	19	16	14	21	15	0
				4.3–5.3	15	21	16	10	17	21	0
				5.3–6.3	12	16	10	8	14	24	16
				Mean	16	23	15	11	15	16	4

NT 14 NW 11 **1269 4868** **Medwyn Cottage, Dolphinton** **Block B**

Surface level +217.8 m
Water struck at +215.3 m
250 mm percussion
September 1978

Overburden 0.3 m
Mineral 1.8 m
Bedrock 1.3 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial meltwater deposits	**a** Sandy gravel (L2) Gravel: fine, coarse and cobbles, subrounded, red and buff sandstones, basalt, felsite, quartzite and phyllite Sand: fine and medium with coarse, subrounded, quartz, orange-brown Fines: clay	1.8	2.1
Lower Devonian	Tuff, rhyolitic, welded grains principally of quartz and feldspar, rarely euhedral, highly weathered	1.3+	3.4

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
a	8	54	38	0.3–1.3	6	26	22	10	11	13	12
				1.3–2.1	10	20	18	10	16	16	10
				Mean	8	24	20	10	13	14	11

NT 14 NW 12 1237 4811 Felton Farm, Dolphinton **Block B**

Surface level +212.5 m
Water struck at +209.9 m
250 mm percussion
September 1978

Overburden 0.4 m
Mineral 5.6 m
Bedrock 0.2 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Alluvium	**a** Sandy gravel Gravel: fine with coarse, subrounded to well rounded, felsite, quartz, greywacke, basalt, quartzite, acid extrusives, red and buff sandstones Sand: medium with fine and coarse, subrounded, quartz with rock fragments, brown Fines: clay	4.0	4.4
Till	**b** 'Clayey' sandy gravel Gravel: fine and coarse with cobbles up to 25 cm diameter, subangular to subrounded, red sandstone with felsite, basalt, andesite, quartz and greywacke Sand: fine with medium and coarse Fines: clay, red-brown, generally washed out but rare clay bound till lumps retrieved	1.6	6.0
Lower Devonian	Sandstone, red with white reduction mottling	0.2+	6.2

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$	
a	7	49	44	0.4–1.4	5	17	35	12	21	10	0	
				1.4–2.4	6	11	25	19	25	14	0	
				2.4–3.4	12	14	17	13	27	17	0	†
				3.4–4.4	4	17	9	8	32	30	0	†
				Mean	7	15	21	13	26	18	0	
b	13	55	32	4.4–5.4	16	32	20	10	11	11	0	†
				5.4–6.0	8	16	14	14	24	13	11	†
				Mean	13	26	18	11	16	12	4	
a+b	9	51	40	Mean	9	18	20	13	23	16	1	

NT 14 NW 13 13745 49150 Hyndfordwell, West Linton **Block A**

Surface level +232.2 m
Water not struck
250 mm percussion
August 1978

Waste 0.7 m
Bedrock 1.6 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.7	0.7
Lower Devonian	Sandstone, medium grained, micaceous, indurated, red; above 2.1 m highly weathered, soft, green	1.6+	2.3

NT 14 NW 14 1467 4949 White Moss, West Linton **Block D_3**

Surface level +238.8 m
Water not struck
250 mm percussion
September 1978

Waste 1.8 m
Bedrock 0.6 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Till	Clay, stiff, sandy, reddish brown, with angular to rounded clasts up to 18 cm diameter of red sandstone with basalt, andesite and felsite	1.6	1.8
Lower Devonian	Sandstone, fine to medium grained, red; above 2.1 m soft, yellowish green, weathered	0.6+	2.4

NT 14 NE 1 1567 4774 Kaims, Romannobridge **Block D_3**

Surface level +222.3 m
Water not struck
250 mm percussion
October 1978

Overburden 0.3 m
Mineral 2.0 m
Bedrock 0.7 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial meltwater deposits	**a** 'Clayey' gravel (L3) Gravel: fine with coarse and cobbles up to 25 cm diameter, sandstone and amygdaloidal basalt Sand: fine to coarse, subangular, rock fragments Fines: clay, brown	2.0	2.3
Lower Devonian	Conglomerate, rounded clasts of fine-grained basic lavas set in an ill sorted matrix of lava fragments	0.7+	3.0

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	15	33	52	0.3–1.3	12	8	11	13	31	13	12
				1.3–2.3	18	10	12	12	21	14	13
				Mean	15	9	11	13	26	14	12

NT 14 NE 2 **1666 4959** **Spittalhaugh, West Linton** **Block D_3**

Surface level +220.3 m
Water not struck
250 mm percussion
October 1978

Overburden 2.6 m
Mineral 2.0 m
Bedrock 0.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial meltwater deposits	Silt (L1), faintly laminated, red-brown, with disseminated sand and red clay seams up to 1 cm thick	1.9	2.2
	Clay (L1), laminated, silty, red	0.4	2.6
	a 'Very clayey' pebbly sand (L2) Gravel: coarse and fine, principally below 3.6 m, subangular to well rounded, red sandstone and basalt Sand: medium and fine with a little coarse, becoming finer with depth, subangular to subrounded, rock fragments with quartz, greenish grey Fines: clay, silty, red-brown, occurring in thin laminated seams	2.0	4.6
Lower Devonian	Sandstone, fine grained, micaceous, red with white reduction mottling	0.5+	5.1

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	22	67	11	2.6–3.6	17	29	49	4	1	0	0
				3.6–4.6	26	32	15	5	6	16	0
				Mean	22	31	32	4	3	8	0

NT 14 NE 3 1631 4865 Paulswell Farm, West Linton **Block D_3**

Surface level +211.9 m
Water struck at +211.2 m
250 mm percussion
October 1978

Overburden 0.7 m
Mineral 8.6 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.7	0.7
Alluvium	**a** 'Clayey' sandy gravel Gravel: fine and coarse, well rounded, felsite, greywacke and quartz Sand: fine with medium and coarse, subrounded quartz, brown Fines: clay, silty, grey-brown	1.0	1.7
Glacial meltwater deposits	**b** Gravel (L2) Gravel: fine with coarse, subrounded to well rounded with subangular, greywacke, felsite, quartz, red and buff sandstones, acid and intermediate extrusives Sand: fine to coarse, subrounded, quartz Fines: trace	2.0	3.7
	c 'Clayey' pebbly sand (L2) Gravel: fine with coarse, subrounded to well rounded, composition as above Sand: fine with medium and coarse, finer below 5.7 m, subrounded, quartz with rock fragments and coal, brown Fines: silt with coal, concentrated from 5.7 m to 6.7 m, grey-brown	4.0	7.7
	d Gravel (L2) Gravel: fine with coarse and cobbles, composition as above Sand: fine to coarse Fines: silt	1.6+	9.3

Borehole terminated owing 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	19	58	23	0.7–1.7	19	36	15	7	13	10	0	†
b	3	32	65	1.7–2.7	3	8	11	15	39	24	0	†
				2.7–3.7	3	9	12	10	37	29	0	†
				Mean	3	8	11	13	38	27	0	
c	12	73	15	3.7–4.7	3	21	38	21	15	2	0	†
				4.7–5.7	9	28	29	17	14	3	0	†
				5.7–6.7	23	46	16	9	5	1	0	†
				6.7–7.7	12	43	16	9	11	9	0	†
				Mean	12	34	25	14	11	4	0	
d	3	47	50	7.7–9.3	3	12	17	18	27	18	5	†
b to d	8	57	35	Mean	8	23	20	14	21	13	1	
a to d	9	57	34	Mean	9	24	19	14	21	12	1	

NT 14 SW 1 **1125 4406** **Netherurd Mains, Blyth Bridge** **Block D_3**

Surface level +231.3 m
Water struck at +229.7 m
250 mm percussion
November 1978

Overburden 1.6 m
Mineral 1.6 m
Waste 3.8 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Alluvium	Clay, stiff, orange-brown, mottled	1.2	1.6
	a Sandy gravel Gravel: fine with rare coarse, subrounded to rounded, greywacke and lavas Sand: coarse with medium and some fine, subangular, rock fragments Fines: silt and clay, grey-brown	1.6	3.2
	Silt, laminated, brown becoming grey below 4.9 m, some fine sand laminae above 4.9 m: grey, clay seams and plant remains below this depth	2.5	5.7
Till	Clay, very stiff, red-brown, sandy with clasts of angular to rounded greywacke and lavas	1.3+	7.0
	Borehole terminated owing to lack of 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	5	63	32	1.6–3.2	5	4	19	40	29	3	0	†

NT 14 SW 2 1252 4439 West Mains Farm, Blyth Bridge **Block D_3**

Surface level +257.6m
Water not struck
250mm percussion
November 1978

Overburden 0.2m
Mineral 3.6m
Bedrock 0.6m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Glacial meltwater deposits	**a** 'Clayey' sandy gravel (L2) Gravel: fine with coarse and rare cobbles, subrounded to rounded, quartzite and basalt Sand: fine to coarse, subrounded, quartz with rock fragments, brown Fines: silt and clay, brown	3.6	3.8
Lower Devonian	Basalt, fine grained, grey, highly weathered	0.6+	4.4

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	14	50	36	0.2–1.2	12	9	13	21	26	19	0
				1.2–2.2	18	22	20	17	17	6	0
				2.2–3.2	12	20	16	15	23	14	0
				3.2–3.8	16	14	14	16	22	11	7
				Mean	14	17	16	17	22	13	1

NT 14 SW 3 **1397 4458** **Castlecraig, Blyth Bridge** **Block D_3**

Surface level +216.7 m
Water struck at +212.3 m
250 mm and 200 mm percussion
October 1978

Overburden 1.0 m
Mineral 5.0 m
Waste 3.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	1.0	1.0
Till	**a** 'Clayey' gravel, clay-bound, becoming stiff below 5.2 m Gravel: fine with coarse and some cobbles, subangular to rounded, basalt, often weathered, with sandstone, greywacke and chert Sand: fine to coarse, subangular, rock fragments with quartz, brown Fines: clay, orange-brown to red	5.0	6.0
	Clay, stiff, grey, cobble-sized clasts of dolerite and greywacke	3.5+	9.5
	Borehole terminated owing to lack of 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	15	40	45	1.0–2.0	17	17	17	17	22	10	0	
				2.0–3.0	21	17	16	18	21	7	0	
				3.0–4.0	9	7	17	23	33	11	0	
				4.0–5.2	8	5	8	13	22	23	21	†
				5.2–6.0	23	6	7	11	20	24	9	†
				Mean	15	10	13	17	24	15	6	

NT 14 SW 4 1431 4381 Grantshill, Blyth Bridge **Block D_3**

Surface level +198.1 m
Water struck at +196.9 m
250 mm and 200 mm percussion
October 1978

Overburden 1.8 m
Mineral 9.2 m
Waste 4.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Alluvium	Clay, blue-grey with orange mottling, silty, clasts of greywacke and weathered rock fragments	1.4	1.8
	a Sandy gravel Gravel: coarse with fine, subangular to subrounded, greywacke Sand: medium and coarse with fine, quartz Fines: silt and clay, light grey	1.2	3.0
Glacial meltwater deposits	**b** Pebbly sand (L2), more gravelly from 4.0 m to 5.0 m and below 9.0 m Gravel: coarse and fine with cobbles near base, subrounded, greywacke, buff, cream and red sandstones, quartz and chert with felsite and basalt Sand: fine with medium and a little coarse, subrounded, quartz with rock fragments, yellow-brown to orange-brown Fines: silt	8.0	11.0
Till	Silt at the top, grey, sandy, becoming very stiff grey clay with depth, numerous angular to subrounded clasts up to cobble size of greywacke, quartz, chert, mudstone and sandstone	4.0+	15.0
	Borehole terminated owing 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	9	51	40	1.8–3.0	9	10	21	20	13	27	0	†
b	2	77	21	3.0–4.0	4	43	45	4	3	1	0	†
				4.0–5.0	1	31	23	5	19	21	0	†
				5.0–6.0	1	46	34	5	8	6	0	†
				6.0–7.0	1	58	35	3	3	0	0	†
				7.0–8.0	2	44	39	4	7	4	0	†
				8.0–9.0	2	52	32	5	7	2	0	†
				9.0–10.0	1	28	22	7	18	24	0	†
				10.0–11.0	2	23	20	7	16	15	17	†
				Mean	2	41	31	5	11	9	1	
a+b	3	73	24	Mean	3	36	30	7	10	12	2	

NT 14 SE 1 1548 4319 Ladyurd Farm, Blyth Bridge **Block D_3**

Surface level +194.3 m
Water struck at +193.9 m
250 mm and 200 mm percussion
October 1978

Overburden 0.4 m
Mineral 8.0 m
Bedrock 0.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Alluvium	**a** Gravel Gravel: fine and coarse with rare cobbles, subangular to rounded, greywacke with buff and cream sandstones, quartz, chert and acid lavas Sand: fine to coarse, subrounded, quartz and rock fragments with feldspar Fines: silt, grey, with brown clay above 1.7 m	4.3	4.7
Glacial meltwater deposits	**b** Sand (L1) Gravel: a little fine and coarse, subangular to subrounded, greywacke and felsite Sand: fine with medium, quartz with coal, yellow-brown Fines: silt	3.0	7.7
Till	**c** Sandy gravel Gravel: fine and coarse with cobbles, greywacke with cream sandstone and felsite Sand: fine and medium with coarse, quartz Fines: silt, grey-brown	0.7	8.4
?Ordovician	*Borehole terminated on bedrock, sample not retrieved*	0.1+	8.5

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	8	37	55	0.4–1.7	15	15	12	11	27	20	0	†
				1.7–2.7	6	8	15	11	24	36	0	†
				2.7–3.7	3	16	14	4	38	25	0	†
				3.7–4.7	6	15	17	11	22	29	0	†
				Mean	8	14	14	9	28	27	0	-
b	3	94	3	4.7–5.7	2	63	23	2	4	6	0	†
				5.7–6.7	3	76	19	2	0	0	0	†
				6.7–7.7	3	76	19	2	0	0	0	†
				Mean	3	72	20	2	1	2	0	
c	3	60	37	7.7–8.4	3	23	22	15	17	15	5	†
a to c	6	60	34	Mean	6	36	17	7	17	17	0	

NT 14 SE 2 1646 4349 Drochil Castle Farm, Blyth Bridge **Block D_3**

Surface level +194.6 m
Water struck at +193.4 m
250 mm percussion
October 1978

Overburden 0.4 m
Mineral 3.3 m
Bedrock 0.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Alluvium	**a** Gravel Gravel: coarse and fine with a few cobbles, angular to subrounded, greywacke and black shale with grit, basalt, chert and a little rounded quartz and quartzite Sand: fine to coarse, subangular to subrounded, rock fragments and quartz, brown Fines: clay, brown	3.3	3.7
Ordovician	Mudstone, black, with disseminated pyrite	0.2+	3.9

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	
a	4	33	63	0.4–1.4	5	10	9	12	24	37	3	
				1.4–2.4	5	4	12	16	24	39	0	†
				2.4–3.7	3	7	12	15	30	28	5	†
				Mean	4	7	11	15	26	34	3	

NT 15 SW 13 **1283 5175** **North Slipperfield, West Linton** **Block A**

Surface level +278.0 m
Water struck at +275.2 m
250 mm and 200 mm percussion
September 1978

Overburden 1.8 m
Mineral 5.4 m
Waste 7.6 m
Bedrock 0.7 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Peat	Peat, with clay	0.8	1.2
Glacial meltwater deposits	Silt (L1), becoming sandy with depth with pebbles near the base, greenish grey, with plant fragments	0.6	1.8
	a 'Clayey' sandy gravel (L2) Gravel: coarse with fine and rare cobbles, rounded to well rounded, red sandstone, greywacke, basalt, andesite and quartz Sand: fine with medium and coarse, subrounded, greenish grey to red, much is probably derived from decomposition of sandstone clasts Fines: silt, disseminated, increasing below 2.8 m	2.8	4.6
Till	**b** Gravel Gravel: fine and coarse with rare cobbles, subrounded to well rounded, red and white sandstones, basalt, andesite, felsite, quartzite, quartz and greywacke Sand: fine to coarse, subangular to subrounded, with coarse grade material angular to subangular, quartz with rock fragments, reddish brown Fines: silt, disseminated	2.6	7.2
	Clay, stiff, sandy, reddish brown, with angular to rounded clasts up to boulder size of basalt, andesite, felsite, greywacke and red sandstone	7.6	14.8
Lower Devonian	Trachyte, fine grained, grey, weathered in upper part	0.7+	15.5

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	11	54	35	1.8–2.8	9	31	25	6	14	15	0	
				2.8–3.8	13	26	13	8	15	25	0	†
				3.8–4.6	12	29	14	8	16	21	0	†
				Mean	11	29	18	7	15	20	0	
b	5	44	51	4.6–5.5	No grading data available							
				5.5–6.5	5	9	18	16	28	24	0	†
				6.5–7.2	6	15	13	15	28	23	0	†
				Mean	5	12	16	16	28	23	0	
a+b	9	48	43	Mean	9	20	17	11	21	22	0	

NT 15 SW 14 **1359 5129** **Slipperfield Cottages, West Linton** **Block A**

Surface level +260.1 m
Water struck at +249.1 m
250 mm percussion
September 1978

Overburden 0.3 m
Mineral 14.9 m
Bedrock 0.3 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial meltwater deposits	**a** 'Clayey' sand (L1) Gravel: trace, fine and coarse, well rounded, red sandstone and basalt Sand: fine with medium, rounded, quartz Fines: silt, disseminated, laminated clayey, silt from 1.4 m to 1.5 m and thinner seams below this depth	2.2	2.5
	b Gravel (L3), becoming clay-bound with depth Gravel: coarse and fine with cobbles and boulders, angular to well rounded, red and green sandstones, basalt, andesite, quartz, quartzite, greywacke, porphyry, conglomerates, brecciated tuff, felsite and trace coal, many of the pebbles are weathered Sand: fine to coarse, angular to rounded, coarse grained generally more angular, quartz, medium brown to red Fines: clay and silt, disseminated	12.7	15.2
Lower Devonian	Sandstone, medium grained, indurated, yellowish green, containing rare fine, rounded pebbles, weathered near surface	0.3+	15.5

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	11	86	3	0.3–1.3	11	61	25	2	1	0	0	
				1.3–2.5	11	55	28	2	2	2	0	
				Mean	11	58	26	2	2	1	0	
b	8	40	52	2.5–3.5	5	23	22	9	15	26	0	
				3.5–4.9	8	29	16	13	18	16	0	
				4.9–5.9	9	19	15	16	17	14	10	
				5.9–6.9	7	9	18	21	16	29	0	
				6.9–7.9	9	12	12	18	17	27	5	†
				7.9–8.9	11	11	10	13	19	36	0	†
				8.9–9.9	18	15	11	9	15	14	18	†
				9.9–10.9	15	17	13	13	18	18	6	†
				10.9–11.9	4	6	6	8	20	36	20	†
				11.9–12.9	3	8	9	11	25	40	4	†
				12.9–13.9	4	9	11	15	27	34	0	†
				13.9–15.2	4	7	8	11	26	40	4	†
				Mean	8	14	13	13	20	27	5	
a+b	8	47	45	Mean	8	21	15	11	17	23	5	

NT 15 SW 15 1338 5006 Slipperfield Loch, West Linton Block A

Surface level +266.8 m
Water not struck
250 mm percussion
November 1978

Overburden 0.3 m
Mineral (including 1.7 m waste) 18.7 m
Waste 3.0 m
Mineral 3.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial meltwater deposits	**a** Pebbly sand (L2), more gravelly from 1.0 m to 3.0 m and from 5.0 m to 6.0 m Gravel: coarse and fine with rare cobbles, subangular to well rounded, red and yellow-white sandstones, quartzite, quartz, basalt, greywacke, felsite, andesite and coal Sand: medium with fine and a little coarse, angular to subrounded, coarser grained generally more angular, quartz with rock fragments Fines: silt, disseminated, thin reddish brown seams from 0.3 m to 1.0 m and from 3.0 m to 4.0 m	11.7	12.0
	b 'Clayey' sand (L1), becoming more clayey with depth Gravel: trace, fine above 13.0 m, rounded, felsite Sand: fine with medium, subrounded, quartz with coal, reddish brown Fines: Silt, disseminated and in reddish brown seams	7.0	19.0
	Silt (L1), laminated, reddish brown, fine sandy partings	3.0	22.0
	c Clayey' sand (L1) Sand: fine with medium, subrounded, quartz, reddish brown Fines: silt, disseminated and in reddish brown laminated seams	3.0+	25.0

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$	
a	5	79	16	0.3–1.0	2	44	46	7	1	0	0	
				1.0–2.0	3	12	36	12	12	25	0	
				2.0–3.0	3	17	49	5	8	18	0	
				3.0–4.0	5	28	53	5	5	4	0	
				4.0–5.0	4	12	68	8	7	1	0	†
				5.0–6.0	5	7	22	21	26	19	0	†
				6.0–7.0	7	37	39	6	5	6	0	†
				7.0–8.0	4	21	52	11	6	6	0	†
				8.0–9.0	8	51	28	5	4	4	0	†
				9.0–10.0	7	42	38	6	5	2	0	†
				10.0–11.0	6	34	45	4	5	6	0	†
				11.0–12.0	8	36	41	7	4	4	0	†
				Mean	5	28	43	8	8	8	0	
b	15	85	0	12.0–13.0	3	55	38	3	1	0	0	†
				13.0–14.0	9	70	20	1	0	0	0	†
				14.0–15.0	10	74	16	0	0	0	0	†
				15.0–16.0	15	70	15	0	0	0	0	†
				16.0–17.0	19	69	12	0	0	0	0	†
				17.0–18.0	14	80	6	0	0	0	0	†
				18.0–19.0	35	58	7	0	0	0	0	†
				Mean	15	68	16	1	0	0	0	
c	19	81	0	22.0–23.0	14	64	22	0	0	0	0	†
				23.0–24.0	25	36	38	1	0	0	0	†
				24.0–25.0	17	53	30	0	0	0	0	†
				Mean	19	51	30	0	0	0	0	
a to c	10	81	9	Mean	10	44	32	5	4	5	0	

NT 15 SW 16 **1459 5152** **Castle Law, West Linton** **Block A**

Surface level +257.5 m
Water struck at +238.5 m
250 mm percussion
September 1978

Overburden 0.4 m
Mineral 17.1 m
Waste 4.5 m
Mineral 3.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Glacial meltwater deposits	**a** Sandy gravel (L2) Gravel: fine with coarse and rare cobbles up to 13 cm diameter, rounded to well rounded, red and white sandstones, felsite, quartz, basalt and greywacke with coal below 5.5 m. Gravel content is reduced below 4.5 m Sand: medium with fine and coarse, generally subangular to subrounded, quartz, with some coal below 5.5 m Fines: silt, disseminated and in seams, the latter often clayey	7.1	7.5
	b 'Clayey' sand (L1) Gravel: rare, fine and coarse above 10.5 m, rounded to well rounded, red sandstone, basalt, felsite and coal Sand: fine with medium, rounded, quartz Fines: silt, disseminated and in laminated seams	8.0	15.5
	c 'Very clayey' sand (L1) Sand: fine, rounded, quartz with coal Fines: silt, disseminated and in seams	2.0	17.5
	Silt (L1), laminated, reddish brown to pale grey, sand disseminated in thin partings	4.5	22.0
Till	**d** 'Very clayey' sandy gravel Gravel: coarse and fine, angular to well rounded, red sandstone with basalt and felsite Sand: fine with coarse and medium, angular to subrounded, reddish brown Fines: clay, stiff	3.0+	25.0

GRADING

	Mean for deposit *percentages* Fines	Sand	Gravel	Depth below surface (m)	*percentages* 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	67	26	0.4–1.5	7	29	35	10	14	5	0
				1.5–2.5	3	13	34	14	19	17	0
				2.5–3.5	6	11	24	13	24	22	0
				3.5–4.5	5	9	19	23	22	18	4
				4.5–5.5	8	21	40	14	11	6	0
				5.5–6.5	6	23	47	15	6	3	0
				6.5–7.5	11	23	29	18	13	6	0
				Mean	7	19	33	15	15	11	0
b	10	89	1	7.5–8.5	11	53	32	3	1	0	0
				8.5–9.5	7	56	28	5	3	1	0
				9.5–10.5	9	62	27	1	0	1	0
				10.5–11.5	12	78	9	1	0	0	0
				11.5–12.5	9	69	21	1	0	0	0
				12.5–13.5	8	77	14	1	0	0	0
				13.5–14.5	16	70	13	1	0	0	0
				14.5–15.5	11	65	24	0	0	0	0
				Mean	10	66	21	2	1	0	0
c	32	68	0	15.5–16.5	31	67	2	0	0	0	0
				16.5–17.5	33	63	4	0	0	0	0
				Mean	32	65	3	0	0	0	0
d	36	36	28	22.0–25.0	36	21	8	7	11	17	0 †
a to c	11	77	12	Mean	11	46	24	7	7	5	trace
a to d	15	72	13	Mean	15	44	21	7	7	6	trace

NT 15 SW 17 1454 5041 Tarfhaugh, West Linton **Block A**

Surface level +230.9 m
Water struck at +227.8 m
250 mm percussion
August 1978

Overburden 0.2 m
Mineral 6.9 m
Bedrock 0.9 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Alluvium	**a** 'Clayey' pebbly sand Gravel: fine with coarse, subrounded to rounded, yellow-white sandstone, basalt and quartz Sand: fine with medium, rounded, brown Fines: silt, disseminated	1.0	1.2
	b Gravel Gravel: fine and coarse, subrounded to well rounded, red and yellow sandstones, basalt, andesite, quartz, quartzite and felsite Sand: fine to coarse, rounded, brown Fines: silt, disseminated	3.0	4.2
Glacial meltwater deposits	**c** 'Very clayey' sand (L1) Gravel: a little fine and coarse Sand: fine, rounded, quartz with ?coal and feldspar Fines: silt	2.9	7.1
Lower Devonian	Sandstone, medium grained, yellow-brown, weathered near surface	0.9+	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	16	72	12	0.2–1.2	16	48	20	4	8	4	0	
b	7	38	55	1.2–2.2	5	15	13	8	28	31	0	
				2.2–3.2	11	11	11	12	24	31	0	
				3.2–4.2	6	11	15	20	30	18	0	†
				Mean	7	12	13	13	27	28	0	
c	22	74	4	4.2–5.2	22	76	2	0	0	0	0	†
				5.2–6.2	24	71	2	1	1	1	0	†
				6.2–7.1	18	63	6	3	5	5	0	†
				Mean	22	70	3	1	2	2	0	
a+b	9	47	44	Mean	9	21	15	11	23	21	0	
a to c	14	59	27	Mean	14	42	10	7	14	13	0	

NT 15 SE 116 1564 5162 Robinsland, West Linton **Block A**

Surface level +226.7 m
Water struck at +225.9 m
250 mm and 200 mm percussion
September 1978

Overburden 1.0 m
Mineral 7.0 m
Waste 1.5 m
Mineral 3.6 m
Waste 0.4 m
Bedrock 1.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
Peat	Peat	0.4	0.4
Alluvium	Clay, silty, sandy below 0.7 m, rare clasts near base, grey becoming orange-brown with depth	0.6	1.0
	a 'Clayey' gravel Gravel: coarse and fine, subrounded to well rounded, red and yellow sandstones, greywacke, basalt, andesite and quartz Sand: fine with medium and coarse, subrounded, quartz, brown Fines: silt and clay, disseminated and in seams	2.0	3.0
Glacial meltwater deposits	**b** Gravel (L2) Gravel: fine with coarse and rare cobbles, angular to subrounded with rounded in the coarser grade material, red and yellow sandstones, greywacke, basalt, quartz and andesite Sand: medium and coarse with fine, subangular to subrounded, rock fragments and quartz, medium brown Fines: silt, disseminated	3.1	6.1
	c 'Clayey' pebbly sand (L2) Gravel: fine and coarse, up to 3 cm diameter, composition as above Sand: medium and fine, subrounded, quartz with coal, medium brown Fines: silt, disseminated	1.9	8.0
	Silt (L1), laminated, sandy partings, grey becoming brown below 8.9 m	1.5	9.5
	d Sandy gravel (L2) Gravel: fine with coarse, angular to well rounded, yellow and red sandstones, basalt, andesite, felsite, quartz, greywacke and coal Sand: fine to coarse, subrounded, with coarse fraction containing angular to subangular, quartz with rock fragments and coal Fines: silt, disseminated	3.6	13.1
Till	Clay, soft, sandy, clasts of red sandstone with basalt, quartz and felsite	0.4	13.5
Lower Devonian	Sandstone, medium grained, reddish maroon	1.0+	14.5

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$	
a	18	38	44	1.0–2.0	20	21	13	9	17	20	0	
				2.0–3.0	15	15	11	8	25	26	0	†
				Mean	18	18	12	8	21	23	0	
b	5	39	56	3.0–4.0	5	3	13	20	35	24	0	†
				4.0–5.1	4	7	9	14	35	31	0	†
				5.1–6.1	7	20	22	11	21	19	0	†
				Mean	5	10	14	15	31	25	0	
c	11	83	6	6.1–7.1	12	33	42	6	4	3	0	†
				7.1–8.0	10	42	39	4	3	2	0	†
				Mean	11	37	41	5	4	2	0	
d	3	55	42	9.5–10.5	9	28	17	12	22	12	0	†
				10.5–11.5	1	15	18	18	34	14	0	†
				11.5–13.1	1	13	26	18	29	13	0	†
				Mean	3	18	21	16	29	13	0	
b to d	6	56	38	Mean	6	19	23	13	24	15	0	
a to d	8	52	40	Mean	8	19	21	12	23	17	0	

NT 15 SE 117 **1514 5073** **West Linton Cemetery** **Block A**

Surface level +230.2 m
Water struck at +224.4 m
250 mm percussion
September 1978

Overburden 0.7 m
Mineral 2.1 m
Waste 0.5 m
Mineral 10.2 m
Bedrock 0.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.7	0.7
Glacial meltwater deposits	**a** Sandy gravel (L2) Gravel: fine with coarse and very rare cobbles, well rounded, red, green and white sandstones, andesite, basalt, greywacke, quartz, quartzite, felsite and coal Sand: fine with medium and coarse, rounded, reddish brown Fines: silt, disseminated, clayey towards base	2.1	2.8
Till	Clay, stiff, reddish brown, subangular to well rounded clasts up to 13 cm diameter of the same composition as above, many of which are weathered	0.5	3.3
	b 'Clayey' gravel Gravel: coarse with fine, composition as above Sand: fine to coarse, subangular to subrounded, reddish brown Fines: silt and clay, disseminated	1.3	4.6
Glacial meltwater deposits	**c** 'Clayey' sand (L1) Gravel: very rare, fine and coarse, felsite Sand: fine with medium, subrounded, quartz, reddish brown Fines: silt, disseminated	2.7	7.3
	d Gravel (L3) Gravel: coarse and fine with cobbles up to 16 cm diameter, angular to well rounded the fine grained being generally more angular, red and yellow sandstones, basalt, andesite, felsite, greywacke, quartz and quartzite Sand: fine to coarse, subangular, quartz, reddish brown Fines: silt and clay, disseminated	6.2	13.5
Lower Devonian	Sandstone: fine to medium grained, indurated, micaceous, reddish maroon	0.2+	13.7

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*							
	Fines	Sand	Gravel		Fines	Sand			Gravel			
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64	
a	7	61	32	0.7–1.7	10	35	17	10	19	9	0	
				1.7–2.8	5	28	21	11	22	13	0	
				Mean	7	31	19	11	21	11	0	
b	10	36	54	3.3–4.6	10	16	10	10	20	34	0	
c	11	88	1	4.6–5.6	18	56	22	2	1	1	0	
				5.6–7.3	7	57	30	5	1	0	0	†
				Mean	11	57	27	4	1	0	0	
d	3	31	66	7.3–8.3	4	8	13	14	24	33	4	†
				8.3–9.3	3	10	10	10	26	41	0	†
				9.3–10.3	3	5	10	14	26	34	8	†
				10.3–11.3	3	8	10	10	21	41	7	†
				11.3–12.3	2	11	12	11	27	29	8	†
				12.3–13.5	2	10	12	10	24	42	0	†
				Mean	3	9	11	11	25	37	4	
a+c+d	6	51	43	Mean	6	25	17	9	18	23	2	
a to d	6	49	45	Mean	6	24	16	10	18	24	2	

NT 15 SE 118 1636 5281 Deanfoot Farm, West Linton **Block A**

Surface level +233.1 m
Water not struck
250 mm and 200 mm percussion
October 1978

Overburden 0.3 m
Mineral 3.3 m
Waste 2.3 m
Bedrock 0.6 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial meltwater deposits	**a** 'Clayey' sandy gravel (L2) Gravel: fine and coarse, subrounded with rounded, green and white volcanics, with felsite and buff and cream sandstones Sand: fine and medium with coarse, subrounded to subangular, quartz and rock fragments, brown Fines: clay with coal, brown	3.3	3.6
Till	Clay, silty, red-brown, becoming sandy at depth, with subangular to subrounded clasts up to cobble-size of red and yellow sandstones and volcanics	2.3	5.9
Lower Devonian	Sandstone, fine grained, pale yellow, weathered near surface	0.6+	6.5

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	10	58	32	0.3–1.3	12	23	23	11	20	11	0
				1.3–2.3	8	14	26	14	20	18	0
				2.3–3.3	10	24	27	10	15	14	0
				3.3–3.6	10	22	27	12	17	12	0
				Mean	10	20	26	12	18	14	0

NT 15 SE 119 **1645 5014** **Kaimhouse, West Linton** **Block D_3**

Surface level +224.8 m
Water not struck
250 mm percussion
October 1978

Overburden 0.4 m
Mineral 1.0 m
Bedrock 1.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Till	a 'Clayey' sandy gravel Gravel: coarse and fine, subangular to rounded, red sandstone with quartzite Sand: fine with medium and coarse, rounded, quartz, red-brown Fines: clay, red-brown	1.0	1.4
Lower Devonian	Sandstone, fine grained, micaceous, soft, red	1.1+	2.5

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
a	16	56	28	0.4–1.4	16	34	13	9	13	15	0

INDUSTRIAL MINERALS ASSESSMENT UNIT SHALLOW TRENCH RECORDS

NT 04 SE 6 **0545 4308** **Hyndshillend Farm, Elsrickle** **Block D_2**

Surface level c+268 m
Water not struck
Trench
November 1978

Waste 0.2 m
Bedrock 0.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, dark brown, slightly peaty	0.2	0.2
Lower Devonian	Sandstone, medium grained, weathered, brownish grey	0.2+	0.4

NT 04 SE 7 **0780 4046** **Cambwell Farm, Skirling** **Block D_2**

Surface level c+268 m
Water not struck
Trench
November 1978

Waste 1.6 m
Bedrock 0.4 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy	0.3	0.3
Till	Clay, orange-brown, sandy, with numerous angular to subrounded clasts up to boulder size, mainly indurated green sandstones; much weathered material at top	1.3	1.6
Lower Devonian	Sandstone, medium grained, indurated, greenish grey	0.4+	2.0

NT 04 SE 8 0906 4479 Townhead Farm, Dolphinton **Block D_2**

Surface level c + 261 m
Water not struck
Trench
November 1978

Waste 2.4 m
Bedrock 0.1 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, dark brown, with orange-brown subsoil	0.6	0.6
Till	Clay, silty, sandy in parts, light brown, with clasts of tuff, red sandstone and vesicular basalt	1.8	2.4
Lower Devonian	Tuffaceous sandstone, medium grained	0.1 +	2.5

NT 04 SE 9 0966 4469 Townhead Farm, Dolphinton **Block D_2**

Surface level c + 262 m
Water struck at c + 260 m
Trench
November 1978

Waste 2.2 m
Bedrock 0.2 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, dark brown, silty	0.5	0.5
Till	Clay, silty, orange-brown becoming grey, sandy below 2.0 m, with rounded to subangular clasts of vesicular basalt and buff sandstone	1.7	2.2
Lower Devonian	Basalt, vesicular, porphyritic, purple, finely crystalline matrix	0.2 +	2.4

NT 14 NW 15 1255 4731 Felton Farm, Dolphinton **Block D_3**

Surface level c + 225 m
Water not struck
Trench
September 1978

Waste 0.3 m
Bedrock 0.7 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy, dark brown	0.3	0.3
Lower Devonian	Sandstone, red, fine grained, with irony patches	0.7 +	1.0

NT 14 NE 4 **1637 4506** **Flemington Farm, Romannobridge** **Block D_3**

Surface level c+201 m
Water struck at c+200 m
Trench
November 1978

Overburden 0.2 m
Mineral 1.3 m
Bedrock 0.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy, yellow	0.2	0.2
Alluvium	**a** Gravel, sandy at top Gravel: fine to coarse with cobbles, mainly subrounded, red, white and buff sandstones, greywacke, lavas, felsite, chert and quartz Sand: fine to coarse, subrounded, quartz with rock fragments, yellow-brown Fines: silt, disseminated	1.3	1.5
Ordovician	Greywacke, hard, grey, medium grained, angular quartz, micaceous	0.2+	1.7

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	4	31	65	0.2–1.5	4	10	13	8	18	32	15	†

NT 15 SE 120 **1540 5213** **Dryburn Cottage, West Linton** **Block A**

Surface level c+236 m
Water not struck
Trench
October 1978

Overburden 0.7 m
Mineral 1.1 m
Waste 0.4 m
Bedrock 0.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.7	0.7
Alluvium	**a** Sandy gravel, bedded, with rafts of sandy till near base Gravel: fine with coarse, subrounded to well rounded, red and yellow sandstones, basalt, quartz, felsite and coal Sand: medium and fine with coarse, subrounded to rounded, quartz, medium brown Fines: silt, disseminated	1.1	1.8
Till	Clay, sandy, soft, red-brown with small clasts of the same composition as above	0.4	2.2
Lower Devonian	Sandstone, fine to medium grained, yellow-buff	0.5+	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
a	2	51	47	0.7–1.8	2	18	24	9	28	19	0

APPENDIX G

LIST OF WORKINGS

In 1978 four sand and gravel pits, listed below, were known to be operational. All areas which are known to have been worked are shown on the map accompanying this report. To date, all sand and gravel extraction has been confined to deposits lying above the water table.

Grid reference	Site	Operator	Deposit worked
033 451	Newbiggingmill, Newbigging	Tilling Construction Services Ltd	Glacial meltwater deposits
063 410	Candybank Biggar	Murdoch Mackenzie (Foundations) Ltd	Glacial meltwater deposits
101 483	Garvald, Dolphinton	Wm Stokes and Sons	Glacial meltwater deposits
114 483	Nick's Plantation, Dolphinton	Wm Stokes and Sons	Glacial meltwater deposits

APPENDIX H

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

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

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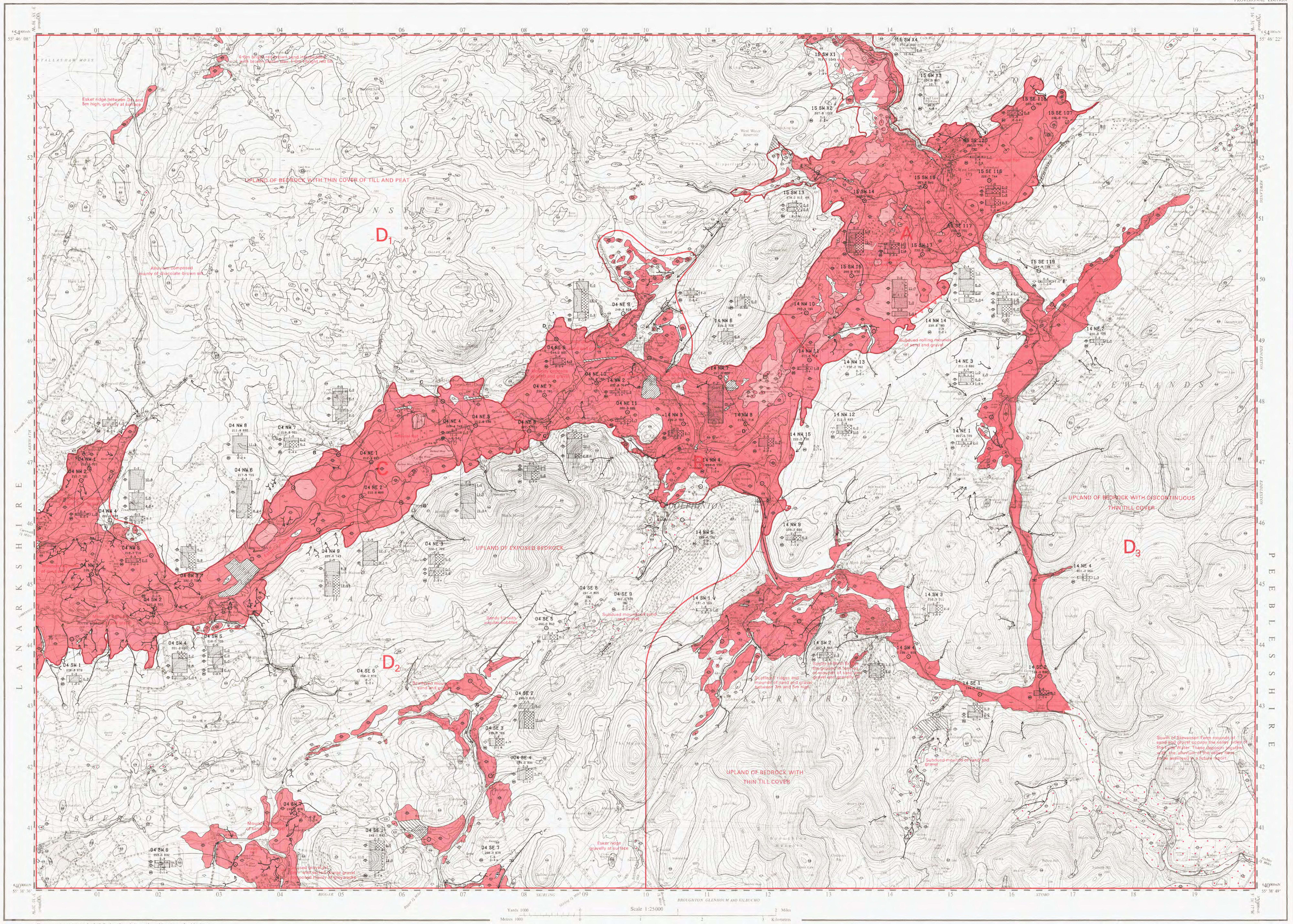
INSTITUTE OF GEOLOGICAL SCIENCES

INDUSTRIAL MINERALS ASSESSMENT UNIT

THE SAND AND GRAVEL RESOURCES OF DOLPHINTON, STRATHCLYDE REGION, AND WEST LINTON, BORDERS REGION

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

ORDNANCE SURVEY
SHEETS NT 04, 14 & PARTS OF SHEETS NT 05, 15
PROVISIONAL EDITION



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

Scale 1:25000

Yards 1000 — 0 — 1 — 2 Miles

Metres 1000 — 0 — 1 — 2 — 3 Kilometres

THE SAND AND GRAVEL RESOURCES OF DOLPHINTON, STRATHCLYDE REGION, AND WEST LINTON, BORDERS REGION.

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

EXPLANATION OF SYMBOLS AND ABBREVIATIONS

DRIFT

Recent and Pleistocene

- **Peat** P-1
- **Alluvium (undifferentiated)** -mainly sand and gravel, with silt and clay A-41
- **Alluvial cone** AC-1
- **Glacial meltwater deposits (undifferentiated)** -including lacustrine fine sand, silt and clay (Lithology 1), outwash and sub-glacial sand and gravel (Lithologies 2 and 3) GM-1
- **Till** -stiff stony clay (lodgement) of variable colour, locally silty or sandy (ablation) TL-3

SOLID

- **Bedrock (undifferentiated)**
South of the north-easterly aligned Southern Upland Fault running through Muirburn and Halmyre Mains the bedrock comprises greywackes, conglomerates, shales, cherts and spilitic lavas of Ordovician age. North of the Fault, sediments and volcanic rocks of Lower Devonian age predominate. The sediments are mainly conglomerates overlain by red sandstones. Andesitic, trachytic and rhyolitic lavas form the high ground between the parishes of Libberton and Linton. To the north, the south-western extension of the Pentland Hills is composed mainly of Upper Devonian and Lower Carboniferous sandstones and basaltic lavas.

- **Made ground,** waste and/or natural earth materials deposited either on original ground surface or in man-made working MG-3
- **Worked ground,** boundaries as at August 1978 WG-1

BOUNDARY LINES

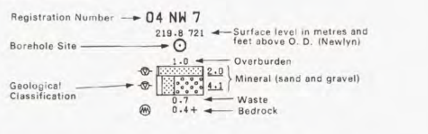
- Geological boundary
- Glacial drainage channel, arrow shows direction of water flow
- Inferred boundary between recognised categories of deposits
- Resource Block boundary

BOREHOLE AND OTHER DATA

SITE LOCATIONS

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

I.M.A.U. BOREHOLES



Note

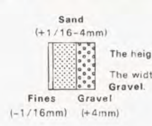
(i) Figures underlined denote thicknesses used in the assessment of resources.
(ii) The + sign indicates that the base of the deposit was not reached.
(iii) The Geological Classification is given only for mineral and bedrock.

Registration Number

Each I. M. A. U. borehole is identified by a Registration Number e.g. **04NW7**. The first numbers and letters refer to the quarter sheet and the final figures to the I. G. S. serial numbers for that quarter. The unique designation for borehole **04NW7** is **NT04NW7**.

Grading Diagrams

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



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

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

OTHER BOREHOLES

The registration of other boreholes is the same as for I. M. A. U. sample points except that, on this Resource Sheet, the serial number of Site Exploration records held by I. G. S. is prefixed by the letter **X**, for example **15SWX2**. The layout of information is the same as for I. M. A. U. sample points although data may not be as comprehensive. For example, mineral for which no grading data are avalable, is portrayed by an empty grading box whose height is proportional to the mineral thickness.

SHALLOW TRENCHES

The location of shallow trenches providing ancillary assessment data are shown by a distinctive symbol, thus ═. Otherwise information is shown in the same way as for boreholes.

CATEGORIES OF DEPOSITS

- **Exposed mineral** CAT-E6
- **Continuous or almost continuous spreads of mineral beneath overburden** CAT-C2
- **Sand and gravel not assessed** CAT-N1
- **Sand and gravel absent or not potentially workable** CAT-A2

RESOURCE BLOCKS

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

Original geological survey on the six-inch scale by Sir A. Geikie, J. Geikie, H. H. Howell and J. Young in 1868

Revised by B. N. Peach, J. Horne, W. Q. Kennedy, J. Phemister, H. H. Read and J. E. Richey between 1872 and 1932

Partial re-survey by A. M. Bell and P. Stone in 1977-78. G. I. Lumsden, District Geologist

Sand and Gravel Survey by A. A. McMillan, J. L. Laxton and A. J. Shaw in 1978 under the supervision of E. F. P. Nickless.
R. G. Thurrell, Head, Industrial Minerals Assessment Unit

1:25,000 Sand and Gravel Resource Sheet published 1981
G. M Brown D. Sc., F. R. S., Director, Institute of Geological Sciences, incorporating the Geological Survey of Great Britain, the Museum of Practical Geology and Overseas Geological Surveys

Produced for the Institute of Geological Sciences by Clyde Surveys Scotland Ltd., Livingston, West Lothian.

Printed by John Bartholomew & Son Ltd., Edinburgh 1981

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

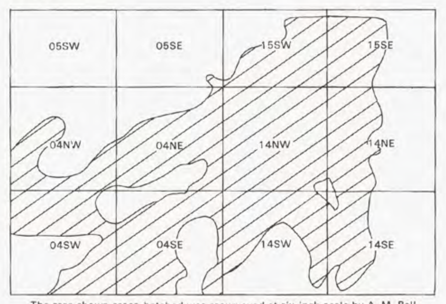
Data quoted for an individual sample point refer strictly to that site; reliable conclusions cannot be drawn about the thickness and grading elsewhere in the deposit, particularly in material as variable as sand and gravel. However, estimates of volume and mean grading of the mineral as a whole in each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

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

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.

Compiled from 6" sheets last fully revised 1893-1912.
Other partial systematic revision 1953-54 has been incorporated.
West Water Reservoir revised 1966
Some major roads revised 1967

SURVEY DIAGRAM



The area shown cross-hatched was resurveyed at six-inch scale by A. M. Bell and P. Stone in 1978. The remainder of the sheet is compiled from older geological surveys.

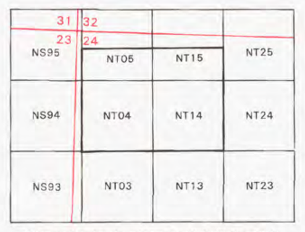
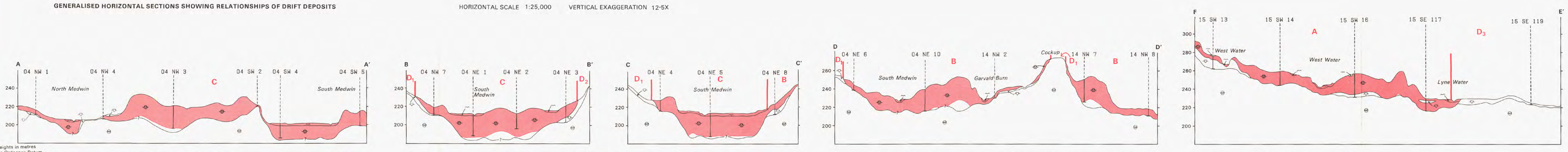


Diagram showing the relationship of the National Grid 1:25,000 sheets with the One-inch Geological Sheets 23, 24, 31 and 32

GENERALISED HORIZONTAL SECTIONS SHOWING RELATIONSHIPS OF DRIFT DEPOSITS

HORIZONTAL SCALE 1:25,000   VERTICAL EXAGGERATION 12·5X



Alluvial sand and silt covers the floor of the North Medwin. The thickness of the valley floor deposits is not known.

At Newbigging, kamiform glacial meltwater deposits occupy ground lying between the North and South Medwin. Boreholes show the deposits to be dominantly fine and medium sand, sometimes pebbly and 'clayey'.

Thick mineral lying below the water table, underlies the valley floor of the South Medwin.

Sections B-B', C-C', illustrate the overdeepened valley basin of the South Medwin, partly filled by glacial meltwater deposits. The deposits which range in lithology from fine sands, silts and clays (lithology 1) to coarser sand and gravel (lithologies 2 and 3) are probably mainly of pro-glacial lacustrine and fluvial origin. The deposits thin towards the valley sides where they usually rest on reddish brown basal tills.

North of the Dolphinton Gap drift deposits form the watershed between the south-westward flowing South Medwin and the south-eastward flowing Garvald Burn. The kamiform glacial meltwater deposits which occupy the Gap are thought to have been laid down on and around stagnant ice.

North of the Garvald Burn, near the watershed, sand and gravel deposits are thin. The deposits thicken south-eastwards, culminating in the mounds of Nicks Plantation where borehole 14 NW 7 proves at least 25m of sand.

A complex sequence of kamiform glacial meltwater deposits occurs near West Linton, west of the Lyne Water, sands and gravels locally interbedded with and overlying till are considered to have formed on and around stagnant ice.

KEY TO SECTIONS

- Potentially workable sand and gravel (excluding till)
- Geological boundary
- Boundary limiting the extent of potentially workable sand and gravel
- Other symbols and abbreviations as map legend

0 — 1 — 2 km
0 — 1 mile