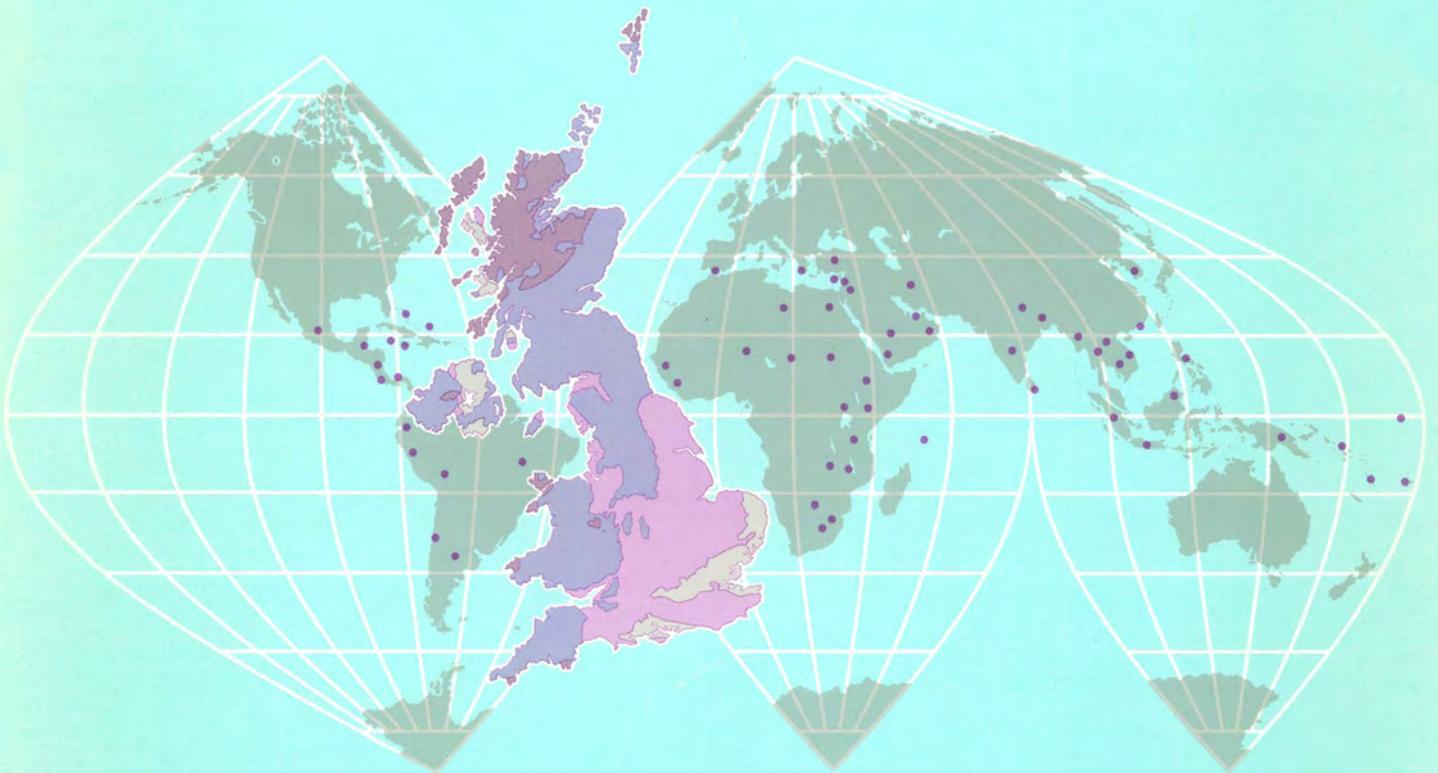




Sand and gravel resources of the Borders Region of Scotland



NATURAL ENVIRONMENT RESEARCH COUNCIL

INSTITUTE OF GEOLOGICAL SCIENCES

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Sand and gravel resources of the Borders Region of Scotland

A. D. McAdam

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Preface

This report is based upon published information, unpublished records in the Institute's files and a limited amount of recent observation in the field. It relates to resources and not to reserves. In the quantitative calculations little account has been taken of restraints to working the deposits, except that built-up areas have been indicated and mentioned in the text. Conservation and amenity considerations have been given only passing mention in the knowledge that detailed advice on these aspects can be had from the Nature Conservancy Council, 12 Hope Terrace, Edinburgh EH9 2AS.

The report has been assembled on the basis of information available at 31 October 1975. It is inevitably incomplete because of the uneven data cover and for some deposits no quantitative assessment has been attempted because of the dearth of relevant fact. All quantities are approximate and, without doubt, silt, clay and other unsuitable materials have been included in places in the gross calculations. No account has been taken of deposits less than 2 m thick.

For each District the resources have been divided wherever possible into those above and those below the water table, so that the comparison can be made between the resources available to methods of extraction traditional in Scotland and resources available in some places by dredging. A list of working sand and gravel pits in each District, all of which were visited between August and October 1975, is given.

For many areas detailed records are available for consultation at the Institute of Geological Sciences, Murchison House, West Mains Road, Edinburgh EH9 3LA.

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London SW7 2DE
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Director

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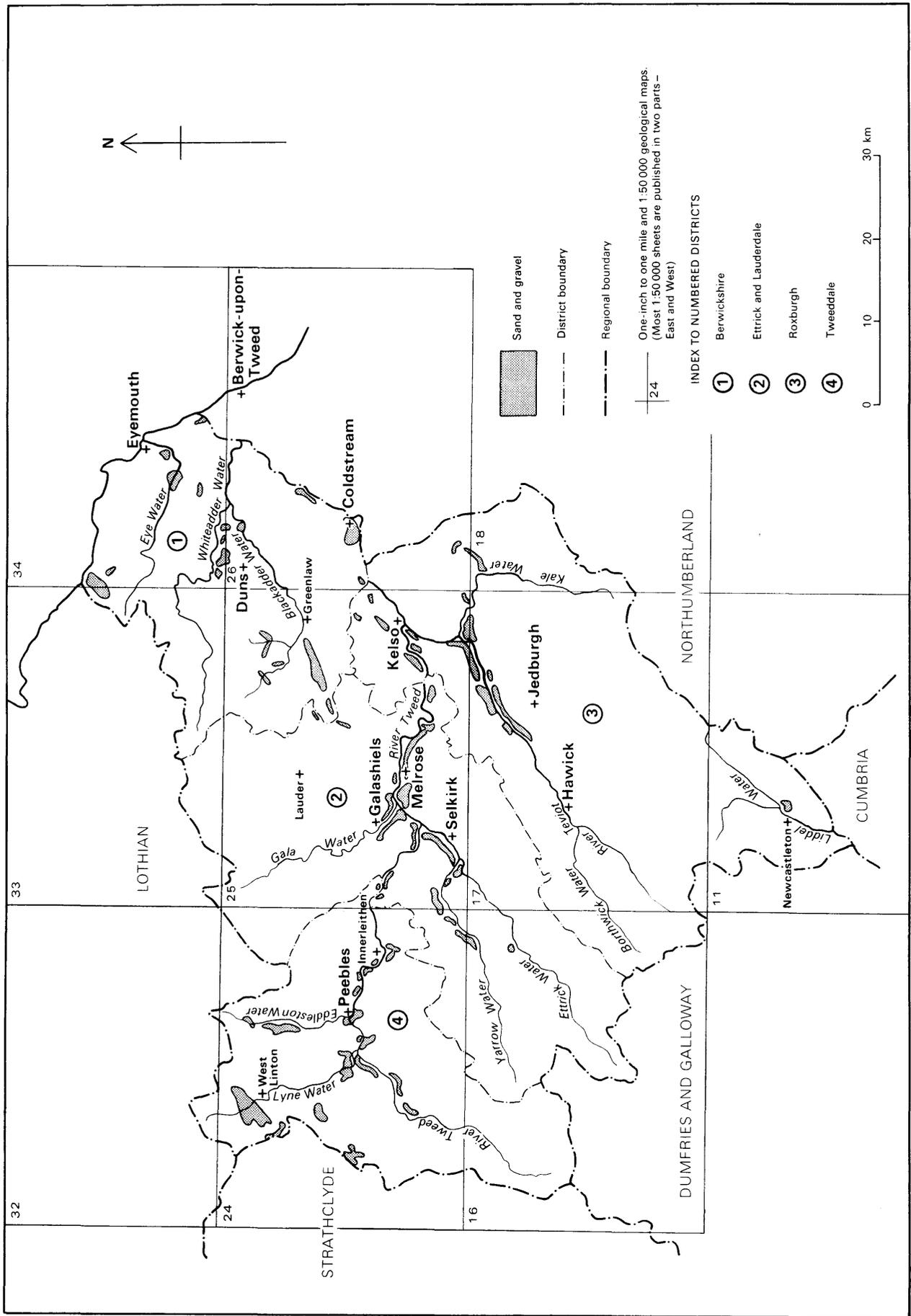
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- ④ Tweeddale



Fig. 1. Sands and gravels of the Borders Region

Sand and gravel resources of the Borders Region of Scotland

A. D. MCADAM

Introduction

PHYSIOGRAPHY

The area of the Borders Region coincides almost exactly with the drainage basin of the River Tweed, and the regional boundary follows the high ground that forms the major watersheds between it and adjacent drainage basins. The main exceptions are where the boundary is formed by the River Tweed from Coldstream to the coast and where it includes part of Liddesdale at Newcastleton.

SOLID GEOLOGY

Most of the Borders Region lies in the part of Scotland known geologically as the Southern Uplands, which is bounded to the north-west by a major structure called the Southern Upland Fault. A small area around West Linton lies across the fault in the Midland Valley.

The oldest rocks are greywackes and shales belonging to the Ordovician and Silurian systems which form the high western half and some northern parts of the region. Greywackes are dark, hard, fissile, compact type of sandstone, siltstone and grit, generally dark grey in colour, but in places stained purple. Being very hard and extensively distributed rocks greywackes form a major component of the gravel deposits. Because the rock is fissile greywacke pebbles tend to be flattish in shape. The shales form only a small proportion of these strata, and being relatively soft rarely occur in the gravels. Later rocks belong to the Old Red Sandstone and Carboniferous systems. They underlie the generally lower ground in the east of the region and around Newcastleton and West Linton. Old Red Sandstone sediments consist of red and pink sandstones and conglomerates, with red and green siltstones and mudstones. It is the sandstones and pebbles from the conglomerates which are hard and are found in the gravels. Carboniferous sediments are mainly interbedded grey mudstones and siltstones and white and brown sandstones with thin bands of coal, limestone and ironstone. Generally it is the sandstones with rare limestones and ironstones that survive in the gravels. Extrusive igneous rocks, such as basalt and trachyte lavas, agglomerates and tuffs of Old Red Sandstone age occur in the Cheviot and West Linton areas, while similar rocks of Carboniferous age are found around Kelso. Only pebbles of the lavas are usually hard enough to be found in the gravels. The most important of the intrusive igneous rocks, which being hard are common in some gravels, are dolerite sills, plugs and dykes which mainly occur in the Old Red Sandstone areas, and felsite dykes which cut the Ordovician and Silurian greywackes.

SUPERFICIAL DEPOSITS

During the Ice Age, which ended less than 10 000 years ago, an ice sheet flowed generally eastwards or north-eastwards across the Borders Region. Detritus from this was deposited on the lower ground as boulder clay. During decay of the ice sheet glacial meltwater sorted and redeposited this material mainly in valleys in the form of

mounds, ridges, terraces and flat spreads of sand and gravel. They are usually well bedded and sorted with high proportions of gravel in the upper valleys and both sand and gravel in the lower areas. Silt and clay are present in the gravel matrix and as discrete beds in the sands. Almost all the pebbles in gravels in the west of the region consist of greywacke. In the east, eastward transport of greywacke pebbles by ice and river action has mixed them with local pebbles of sandstone, basalt and dolerite. It is these deposits that are potentially the main sand and gravel resources of the region.

Some valleys of the preglacial river system have been recognised as buried channels infilled with debris which may include large volumes of sand and gravel. These may constitute large resources entirely below the water table and usually under a thick overburden. An example is the buried channel of the River Tweed near Melrose.

Along most of the modern rivers are wide terraces of alluvium. The constituent material of gravel, sand, silt and clay locally may offer important resources, but they have not been considered in detail.

Berwickshire District

The north-eastern part of Berwickshire is drained by the Eye Water, and its tributary the Ale Water. The rest of the district is part of the drainage area of the River Tweed, which forms the south-eastern boundary of the district. The main tributaries of the Tweed which flow generally south-eastwards are the Eden, Leet, Blackadder and Whiteadder Waters.

The rocks underlying the district are the source of the material which forms the sand and gravel resources. Their distribution is a major factor in the lithological content of the pebbles in each gravel deposit. Five main rock groups occur in Berwickshire, and it is the hardest, most durable rocks which constitute the bulk of the gravel deposits.

Greywackes of Ordovician and Silurian age underlie that part of the district north-west of a line through Westruther and Coldingham, and also in areas along the coast from Coldingham to Lamberton. Greywackes are a dark compact type of sandstone, siltstone and grit.

Red and pink sandstones of Old Red Sandstone age occur in a belt from Gordon and Westruther through Duns to Chirnside, Eyemouth and Coldingham. Other areas of Old Red Sandstone rocks are present north to Longformacus where the rocks are mainly conglomerates and at Cockburnspath where they are mainly red sandstones.

White and brown sandstones with a few limestones and ironstones are the hardest of the Carboniferous sedimentary rocks which lie in an extensive basin south and east of Duns and also in two small coastal areas at Lamberton and Cockburnspath.

Basalt lavas and dolerite intrusions of Carboniferous age occur in the Greenlaw-Gordon-Hume area and at Duns.

Of the minor constituents of the gravel pebbles, vein quartz occurs in most rock groups, quartzite originates from Old Red Sandstone conglomerates, and pink felsite comes from minor intrusions in the Ordovician and Silurian greywackes.

During the Ice Age an ice sheet flowed generally eastwards across Berwickshire, eroding the underlying rocks and depositing the debris as boulder clay on low ground and in valleys. The boulder clay contains boulders and pebbles which generally correspond in composition to the underlying rocks. As the ice decayed glacial meltwater eroded both boulder clay and the underlying rocks, washed out most of the clay and silt, and deposited the sand and gravel fractions. It is these that form the main sand and gravel resources of the Berwickshire District.

In the south-east the glacial meltwater flowed along the Tweed valley where the main sand and gravel deposits are around Coldstream. In the central part of the district the glacial drainage was generally east-north-easterly along several valleys from Gordon to the coast at Eyemouth. The meltwater left a series of deposits in the dry valley between Gordon and Greenlaw, in the upland area north from Hexpath, along the Whiteadder valley from Duns to Edrom, along the dry valley north of Chirnside, and in the Eye valley. In the north meltwater draining along the edge of an ice sheet banked up against the Lammermuir Hills led to extensive deposits of sand and gravel, the eastern part of which lies in the district around Cockburnspath. In the south-east similar deposits were laid down between an ice sheet and the coastal slopes at Lamerton.

Glacial sand and gravel was laid down in the form of flat spreads, mounds and eskers – narrow, sinuous, sharp-topped ridges. Where later river erosion has taken place, the deposits remain as terraces along valley sides. Although sand and gravel deposits are quite widespread only certain parts are sufficiently thick and extensive to be considered resources. These are shown on Fig. 2, numbers in circles referring to the numbered localities described below.

More recent river action along the main valleys caused erosion of the glacial sand and gravel deposits, the boulder clay, and the underlying rock. This material was redeposited as alluvial deposits containing gravel, sand, silt and clay in varying proportions, which take the form of river terraces and flood plains generally known in the district as haugh lands. Because the proportion of sand and gravel in the deposit as against silt and clay is not known, it is uncertain which deposits if any, constitute resources of sand and gravel.

GLACIAL SAND AND GRAVEL DEPOSITS ABOVE THE WATER TABLE

Locality 1: Birgham

South-east of Birgham on the north bank of the Tweed, irregular dissected terraces lie 5 to 10 m above the present alluvial flats. Sparse natural sections indicate that the deposits are mainly coarse boulder gravel with some bands of sand. The pebbles range mainly from 1 to 15 cm with some boulders up to 30 cm, they are predominantly greywacke with minor proportions of basalt, dolerite, vein quartz and felsite, and set in a medium sand matrix. The deposits underlie 35 hectares of arable land. They are estimated to average 4 to 5 m in thickness, and contain resources estimated at 3·2 million tonnes.

Locality 2: Coldstream

Both east and west of Coldstream on the north bank of the Tweed, flat-topped terraces lie some 10 m above the allu-

vial flats. These extend north-west up the Leet valley where there are also mounds up to 8 m high. One good section in an old gravel pit, 1 km south-west of Coldstream [NT 832 391], showed 5 m of fine to medium, bedded gravel with a few thin bands of sand. This would indicate that the deposits are mainly gravel with smaller proportions of sand. The pebbles range mainly from 0·5 to 5 cm with some up to 20 cm; they consist two-thirds of greywacke, a quarter basalt and dolerite, with minor proportions of vein quartz, quartzite and felsite; and they are set in a sandy grit matrix. Some 70 hectares of the deposits have been sterilised by Coldstream. The remaining deposits occupy 260 hectares of arable and estate land. They are estimated to average 3 to 5 m in thickness, and contain resources estimated at 23 million tonnes. This is the most promising of the deposits in the valley of the Tweed.

Locality 3: Ladykirk

South-west of Ladykirk on the north bank of the Tweed flat-topped terraces lie some 8 to 10 m above the alluvial flats. In the absence of pits or natural sections in the deposit little is known of its content. It is likely to be similar to the deposits at Coldstream, being mainly gravel with some sand, but probably containing a slightly smaller proportion of greywacke pebbles. The deposits cover 80 hectares, are estimated to average 3 to 5 m in thickness, and contain resources estimated at 6·2 million tonnes.

Locality 4: Huntleywood

Along the north side of the valley which extends south-west from Gordon, a mounded terrace lies some 12 m above the valley bottom. Although there are no pits or natural sections, evidence from adjacent areas indicates that the deposit is probably coarse boulder gravel with a small proportion of sand. The pebbles probably range from 1 to 15 cm with boulders up to 30 cm, consist three-quarters of greywacke, a sixth of red sandstone, with minor proportions of vein quartz, quartzite and felsite, and set in a matrix of fine gravel, grit and sand. The deposits underlie 40 hectares of arable land. They are estimated to average 5 m in thickness, and contain resources estimated at 4 million tonnes.

Locality 5: Gordon

North and north-east of Gordon is an area of mounded deposits, with mounds some 6 to 8 m high. To the north-west of Gordon the deposit tends to thin out leaving only isolated high mounds. The few natural sections indicate that the deposit contains medium to coarse sand as well as coarse gravel. The pebbles are predominantly greywacke with some red sandstone and locally derived dolerite. The deposits occupy 120 hectares of arable land. They are estimated to average 3 to 4 m in thickness, and contain resources estimated at 7·2 million tonnes.

Locality 6: Hexpath

Along the valley of the Eden Water south-west from Hexpath are three small mounded areas with mounds up to 8 m high. Evidence from the most northerly area indicates that the deposits contain both fine to coarse gravel and red silty sand. The pebbles range mainly from 0·5 to 10 cm with a few up to 25 cm. They consist two-thirds of greywacke, about a third of red sandstone with minor proportions of basalt and vein quartz, and they are set in a silty clay or silty sand matrix. The deposits cover 30 hectares, are estimated to average 3 to 5 m in thickness, and contain resources estimated at 2·2 million tonnes.

Locality 7: Hallyburton

A wide esker, located in the moorland area north of the farm, forms a ridge 6 to 12 m high, which is a continuation of the esker at Bedshiel. The deposit contains red medium sand and possibly a smaller proportion of gravel. Sections in adjacent areas suggest that constituent pebbles range from 1 to 20 cm with a few boulders up to 40 cm, consist of two-thirds to three-quarters of greywacke with the rest red sandstone, and are set in a matrix of sandy grit and fine gravel. The deposits lie in a very inaccessible area, and the north-east part has been designated a site of Special Scientific Interest by the Nature Conservancy Council. They cover 40 hectares, are estimated to average 6 m in thickness and contain resources estimated at 4·8 million tonnes.

Locality 8: Cammerlaws

Near the farm are four small isolated mounds up to 8 m high, consisting of fine to coarse boulder gravel. The pebbles range mainly from 0·5 to 10 cm with a few boulders up to 30 cm, are two-thirds greywacke, and one-third sandstone, and are set in a silty, sandy grit matrix. The deposits cover 10 hectares, are estimated to average 4 m in thickness, and contain resources estimated at 0·8 million tonnes.

Locality 9: Bedshiel

In the moorland area between Westruther and Polwarth lies the geologically spectacular esker known as The Kaimes or Bedshiel Kaimes. It is an interrupted, sinuous, sharp-topped ridge some 3 km long and 2 to 10 m high. The esker lies on boulder clay and has the thick peat of Dogden Moss banked up against it to the south-west. Surface evidence indicates that it consists mainly of coarse boulder gravel, probably with a smaller proportion of fine coarse sand. The pebbles range mainly from 1 to 20 cm with some boulders up to 40 cm, and they consist of almost three-fifths greywacke, two-fifths of red sandstone, with minor basalt and felsite. The Kaimes have been scheduled by the Nature Conservancy Council as a site of Special Scientific Interest as the finest example of an esker in the South of Scotland. The deposits cover some 15 hectares, are estimated to average 3 or 4 m in thickness and contain resources estimated at 1·1 million tonnes.

Locality 10: Duns to Edrom

Extensive deposits occur in this area along the south slopes of the valley of the Whiteadder Water. They start 2 km north-west of Duns as eskers and mounds up to 6 m high, and continue east as dissected terraces and mounds up to 10 m high. The deposits lie on boulder clay which is present in the hollows between the mounds. Rare natural sections indicate that they are mainly coarse gravel with a sandy grit matrix; the proportion of sand is uncertain but is probably small in the west increasing eastwards. The pebbles range mainly from 1 to 15 cm, in places up to 25 cm. They consist in the west four-fifths of greywacke and in the east two-thirds of greywacke, the rest being red sandstone with minor proportions of dolerite. In the west the deposits are inaccessible and on poor land, while in the east they occupy arable land. The deposits cover 325 hectares, are estimated to average 3 or 4 m in thickness, and contain resources estimated at 20 million tonnes. While these are possibly good deposits a lack of knowledge, particularly about their thickness, makes the quantitative estimate particularly uncertain.

Locality 11: Edrom to Chirnside

Around Edrom deposits are located on the south side of the valley of the Whiteadder Water and near Chirnside-bridge further deposits occupy part of the tributary valley of the Billiemire Burn. They are thinner than to the west and are reduced to isolated mounds up to 6 m high, lying on a boulder clay surface. Natural sections and former pits indicate that the deposits contain much fine sand. There is little information about the associated gravels, but they probably form a small proportion of the deposit, and are most likely of coarse gravel with the pebbles mainly consisting of two-thirds greywacke and one-third red sandstone. Also in the south of this area is a gravel terrace some 10 m above the alluvial flats of the Blackadder Water at Kelloe, but little detailed information is available. The deposits underlie 100 hectares of mostly arable land. They are estimated to average about 3 m in thickness, and contain resources estimated at 6·5 million tonnes.

Locality 12: Broomdykes

South of the Whiteadder Water at Broomdykes is an area of mounds of sand and gravel up to 10 m high lying on boulder clay ridges. Little is known of the quality of the deposit, but it is probably similar to adjacent areas. The deposits cover 30 hectares, are estimated to average about 3 m in thickness, and contain resources estimated at 1·8 million tonnes.

Locality 13: Causewaybank

Along the dry valley, now occupied only by the Billiemire Burn, which once linked the valleys of the Whiteadder Water and Eye Water, are moundy terrace deposits of sand and gravel. These are more extensive on the south side of the valley where they occur up to 25 m above the valley floor with mounds up to 10 m high. Excellent sections of the deposit are given by the active pit at Piper's Knowe [NT 880 592], where a thickness of 20 m has been worked down almost to the water table. Thick bands of fine to coarse, bedded gravel with a grit matrix generally 5 m thick alternate with 2 m bands of fine to coarse, cross-bedded sand. Where observed gravel makes up about 60 per cent of the deposit, sand about 30 per cent, silt and clay about 10 per cent. The pebbles range from 0·5 to 10 cm with some up to 30 cm and a few boulders 1 m across. About half consist of greywacke, two-fifths of red and white sandstone, and the remainder of basalt, dolerite, vein quartz, quartzite and felsite. The deposits underlie 65 hectares of arable land. They are estimated to average 5 to 10 m in thickness and contain resources estimated at 10 million tonnes.

Locality 14: Reston to Ayton

On both sides of this part of the valley of the Eye Water extensive flat-topped terraces lie about 6 m above the alluvial flat. Small disused pits indicate that the deposits contain both fine to medium gravel with a sandy grit matrix and fine to medium sand, possibly with a greater proportion of gravel. The pebbles range from about 0·5 to 20 cm and consist predominantly of greywacke with minor proportions of basalt, dolerite, sandstone and vein quartz. South-east of Reston, moundy deposits occur on the slopes above the terrace, and these contain coarse gravel with boulders up to 30 cm in size. Some 25 hectares of the deposits have been sterilised by Reston village. The remaining deposits underlie 160 hectares of mostly arable land. They are estimated to average 3 to 4 m in thickness and contain resources estimated at 16 million tonnes.

Locality 15: Ayton to Eyemouth

High above the west bank of this part of the Eye Valley are terrace deposits with mounds up to 6 m high. There is very little evidence of the content of these deposits, but they may contain more sand than gravel. The pebbles are probably similar in size and composition to the deposits upstream from Ayton. The deposits occupy over 100 hectares of arable land. They are estimated to average about 4 m in thickness and contain reserves estimated at 8.4 million tonnes.

Locality 16: Lamberton

On the steep coastal slope is an area of steep sharp-topped mounds and ridges, the main part of which is across the border in Berwick-upon-Tweed. Road cuttings indicate that the mounds consist mainly of fine to medium sand with clay bands and small proportions of fine gravel. The pebbles range mainly from 0.5 to 2 cm with some up to 10 cm, and they consist two-thirds of greywacke, a quarter of sandstone with minor basalt and vein quartz. The deposits underlie 130 hectares of mostly arable land close to the A1 road. They are estimated to average 3 to 5 m in thickness, and contain resources estimated at 2.6 million tonnes.

Locality 17: Cockburnspath

On the coastal slope from Dunbar to Cockburnspath are extensive mounded terrace deposits, only the south-east part of which are in Berwickshire. These deposits form mounds generally up to 10 m high, dissected by glacial channels. They lie on a boulder clay surface and generally thin towards the east and south. Along the valley south-east to Grantshouse a flattish topped terrace lies some 5 m above the valley floor. The nature of the deposits is best seen in the active pit, Kinegar No. 2 [NT 772 705], 0.5 km south-west of Cockburnspath. Here up to 4 m of coarse, bedded gravel with a matrix of coarse sand and greywacke grit lies on at least 5 m of fine to medium, cross-bedded sand with isolated lenses of gravel. Sand probably forms a greater proportion of the deposit than gravel. Bands of tough clay up to 1 m thick occur in places within the deposit. The pebbles range mainly from 0.5 to 5 cm with some up to 20 cm. Greywacke makes up about three-quarters of them, sandstone about a sixth and there are minor proportions of basalt, dolerite, felsite, vein quartz and ironstone. The deposits underlie over 500 hectares of arable land, and parts are sterilised by the main road and railway line. They are estimated to average in different parts 3 to 6 m in thickness, and contain resources estimated at 50 million tonnes. It is probably the largest deposit in the district.

GLACIAL SAND AND GRAVEL DEPOSITS BELOW THE WATER TABLE

Locality 18: Gordon to Greenlaw

The extensive boggy flattish area with isolated mounds and ridges up to 3 m high in the valley running west-east between these villages is thought to be formed by a deposit of sand and gravel infilling a deep preglacial valley. Most of the deposit is covered by an overburden of bog peat and the deposit is probably mainly below the water table. Little is known of the quality of the deposit, but evidence from adjacent areas indicates that it may contain both gravel and sand, and the pebbles are likely to be predominantly greywacke with a small proportion of red sandstone. The deposit underlies about 300 hectares, and, as the thickness is unknown, a quantitative assessment cannot be made. Even if the deposit was proved to be thick

and of good quality, the presence of peat overburden and the waterlogged condition of the deposit would pose problems of extraction.

ALLUVIAL DEPOSITS BELOW THE WATER TABLE

River terraces and flood plains occur along all the main river valleys – the River Tweed and the Blackadder, Whiteadder, Eye and Ale Waters. Composition of these alluvial deposits ranges from coarse gravel and sand to silt, clay and in places peat. The proportion made up of sand and gravel is not known, but it is thought that in general deposits upstream and higher terraces have more sand and gravel, whereas the more extensive downstream deposits have more of the finer grades. Alluvial deposits have large potential as a resource, but, because of the lack of information of thickness and quality, a quantitative assessment cannot be made. Furthermore the quality may not be adequate anywhere to support a large working.

Ettrick and Lauderdale District

The River Tweed flows through the middle of Ettrick and Lauderdale District from Elibank to Rutherford. The south part of the district comprises the valleys of the Ettrick Water and its major tributary the Yarrow Water which flow north-eastwards into the Tweed. The valleys of the south-flowing Caddon Water, Gala Water, Allan Water and Leader Water tributaries of the River Tweed make up the north part of the District. In the south-east a small area around Ashkirk is drained by the Ale Water, a tributary of the River Teviot.

The rocks underlying the district are the source of most of the material which forms the sand and gravel resources. Their distribution controls to a great extent the lithological content of the pebbles in each gravel deposit. Only three main rock groups occur in Ettrick and Lauderdale, and it is the hardest, most durable rocks which constitute the bulk of the gravel deposits.

Greywackes of Ordovician and Silurian age underlie almost nine-tenths of the district. Greywackes are a dark compact type of sandstone, siltstone and grit.

Red and pink sandstones and conglomerates of Old Red Sandstone age underlie the rest of the district, namely Lauderdale north of Lauder and the area east of a line through Lauder and Melrose.

Dolerite intrusions form isolated hills in the area of Old Red Sandstone rocks.

Of the minor constituents of the gravel pebbles, vein quartz occurs in most rock groups, quartzite originates from the Old Red Sandstone conglomerates, and felsite comes from minor intrusions in the Ordovician and Silurian greywackes.

During the Ice Age an ice sheet flowed generally eastwards across Ettrick and Lauderdale, though in its later stages, glaciers flowed down the major valleys. The ice eroded the underlying rocks and deposited the debris as boulder clay on low-lying ground and in the valleys. The boulder clay contains boulders and pebbles which generally correspond in composition to the underlying rocks. As the ice decayed glacial meltwater eroded both the boulder clay and the underlying rock, washed out most of the clay and silt and laid down the sand and gravel fractions as glacial deposits. It is these that form the main sand and gravel resources of the Ettrick and Lauderdale District.

Glacial meltwater flowing along the valley of the River Tweed laid down extensive sand and gravel deposits. In the valleys of the Ettrick Water below Gilmanscleuch and

the Yarrow Water below St Mary's Loch meltwater laid down mainly gravel deposits, but it is only in the lower part of these valleys that the deposits become well developed. In the northern valleys, the only deposits are at the mouths of the Gala and Allan Waters and along two small valleys on the east side of Lauderdale. Glacial sand and gravel was laid down in the form of flat spreads, mounds and eskers – narrow, sinuous, sharp-topped ridges. Where later river erosion has taken place, the deposits remain as terraces along valley sides. Although sand and gravel deposits are quite widespread only parts are sufficiently thick and extensive to be considered as resources. These are shown on Fig. 3, numbers in circles referring to the numbered localities described below.

More recent river action along the main valleys caused erosion of the glacial sand and gravel deposits, the boulder clay, and the underlying rock. This material was redeposited as alluvial deposits containing gravel, sand, silt and clay in varying proportions, which take the form of river terraces and floodplains generally known in the district as haugh lands. Because the proportion of sand and gravel in the deposits as against silt and clay is not known, it is uncertain what, if any, is their value as resources of sand and gravel.

GLACIAL SAND AND GRAVEL DEPOSITS ABOVE THE WATER TABLE

Locality 1: Ladhope to Yarrow

At Ladhope in the valley of the Yarrow Water the glacial sand and gravel deposits are well developed. On the north-west bank mounded terraces lie up to 10 m above the valley floor, and opposite Ladhope isolated mounds are up to 15 m high. Mounds and eskers up to 6 m high lie on a boulder clay slope on the south-east side of the valley. Sections indicate the deposit is mainly coarse boulder gravel with a matrix of fine gravel, grit and silty clay. The pebbles mainly range from 0.5 to 10 cm with boulders up to 50 cm, and they consist almost entirely of greywacke. The deposits underlie 80 hectares of mainly arable land in an area of high amenity. They are estimated to average 3 to 6 m in thickness in different parts and contain resources estimated at 7.1 million tonnes.

Locality 2: Yarrow to Bowhill

On the north bank mounded terraces lie up to 10 m above the valley floor, with mounds and eskers some 3 to 5 m high on a boulder clay slope. Towards Bowhill is a similar deposit lying some 20 m above the valley floor. Rare natural sections indicate that the deposits are mainly coarse boulder gravel, very similar in composition to those upstream. The deposits occupy 125 hectares of arable and wooded land. They are estimated to average 4 to 5 m in thickness, and contain resources estimated at 11 million tonnes.

Locality 3: Gilmanscleuch

The largest of several small deposits in this part of the Etrick valley is a terrace with mounds 3 to 5 m high on the north bank around Gilmanscleuch Farm. Sections indicate that the deposit is mainly a coarse boulder gravel with a matrix of fine gravel and grit. The pebbles range mainly from 1 to 15 cm, with boulders up to 50 cm, and they consist almost entirely of greywacke. The deposits occupy 10 hectares of arable land. They are estimated to average 3 m in thickness, and contain resources estimated at 0.6 million tonnes.

Locality 4: Bowhill

In the Bowhill area all the large deposits are on the north-west bank of the Etrick Water. At Fauldshope a mounded terrace lying on boulder clay is up to 30 m above the valley floor with mounds from 3 to 10 m high. At Bowhill there is an extensive flat-topped terrace 5 m above the alluvial flats at the confluence of the Etrick and Yarrow Waters, while the higher ground has mounds and ridges up to 8 m high. All these deposits lie on boulder clay and in the absence of sections it is uncertain how much good deposit there is. The deposits are probably coarse boulder gravel, similar to those in adjacent areas. They underlie 140 hectares of arable and estate land, are estimated to average 4 to 5 m in thickness, and contain resources estimated at 13 million tonnes.

Locality 5: Philiphaugh to Sunderland

Mounded terrace deposits extend along the north bank of this section of the valley of the Etrick Water. Mounds generally 4 to 10 m high lying on a boulder clay slope are particularly well developed in the middle of the area. At Sunderland, because of lack of information, it is not certain whether there is much deposit. Sections indicate that the deposit is mainly coarse boulder gravel with a matrix of fine gravel, grit and silty clay. The pebbles range mainly from 1 to 20 cm with boulders up to 50 cm and they consist almost entirely of greywacke. The deposits occupy 95 hectares of a generally steep valley side. They are estimated to average 3 or 4 m in thickness and contain resources estimated at 7 million tonnes.

Locality 6: Elibank to Peel

Where it first enters the district the River Tweed runs in a deep, steep-sided valley. Two areas of deposits occur on the south bank. In the north at Elibank mounded terraces lie some 10 or 12 m above the alluvium, while at Peel are two flat-topped terraces each 10 m high. Natural sections indicate that the deposits are mainly coarse boulder gravel with a matrix of fine gravel and silty clay. The pebbles range mainly from 0.5 to 20 cm with boulders up to 50 cm, and they consist almost entirely of greywacke with a few of felsite and vein quartz. The deposits underlie 45 hectares of steep wooded slopes. They are estimated to average 5 m in thickness and contain resources estimated at 4.5 million tonnes.

Locality 7: Fairnilee to Galashiels

Along most of the north side of this section of the Tweed mounded and flat-topped terraces lie up to 15 m above the valley floor. Mounds up to 8 m high lie on a boulder clay slope. Sections indicate that the deposits consist mainly of coarse boulder gravel similar in composition to those upstream. They occupy 160 hectares of both arable land and steep wooded slopes. The deposits are estimated to average 4 m in thickness, and contain resources estimated at 13 million tonnes.

Locality 8: Galashiels to Melrose

Narrow gravel terraces some 10 to 12 m above the valley floor line both sides of the Gala Water at Galashiels before it enters the River Tweed. Further downstream at Tweedbank and Melrose extensive dissected terraces lie about 15 m above the river, and on these are isolated mounds up to 6 m high. Rare natural sections indicate that the deposits consist mainly of coarse greywacke gravel, similar in composition to those deposits upstream, but generally without the boulders. Some 155 hectares of the deposit have been sterilised by the built-up areas of

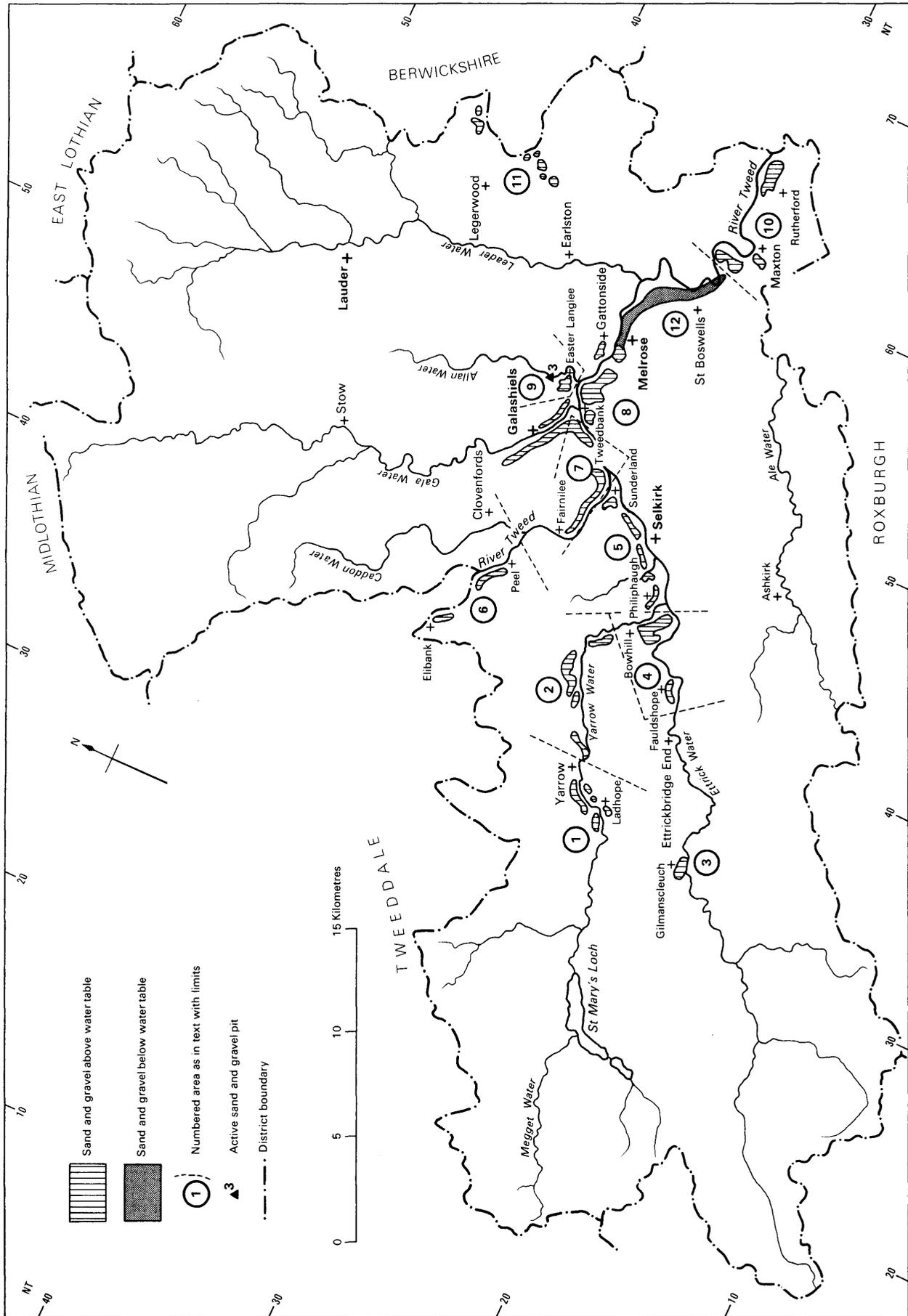


Fig. 3. Distribution of sands and gravels in Etrick and Lauderdale

Galashiels and Melrose and their environs, while the remaining 105 hectares is being sterilised by the Tweed-bank development, leaving nothing at present workable of a sand and gravel deposit of 19 million tonnes.

Locality 9: Easter Langlee

The south part of the deposit is a high flat-topped terrace, similar to other terraces along the River Tweed; little is known about this deposit, but it could be up to 5 m thick. An esker some 8 to 12 m high extends east-west across the middle of this area. North of the esker an area of mounds has been almost completely removed down to the boulder clay base by workings in the abandoned Easter Langlee Pit [NT 521 361] and the active Easter Langlee No. 2 Pit [NT 519 365]. Sections in the latter pit show the mounds to be up to 12 m thick, and to consist of mainly coarse gravel and boulder gravel with a matrix of fine gravel, grit and sand. Bands of medium bedded sand occur, the sand forming up to a third of the deposit. The pebbles range mainly from 1 to 20 cm with boulders in some bands up to 1 m across. They consist about 95 per cent of greywacke, with minor proportions of sandstone, felsite, dolerite and vein quartz. The remaining mounds cover 5 hectares and the terrace 35 hectares of mainly arable land. They are estimated to average 4 m in thickness and contain resources estimated at 3.2 million tonnes.

Locality 10: St Boswells and Rutherford

Flat-topped terraces, some 6 to 8 m above the valley floor, with a few low mounds, are present at these localities on the south bank of the River Tweed. In the absence of natural sections little is known of their thickness or composition, but they probably consist mainly of coarse gravel, with small proportions of sand, and contain pebbles of which over a half are greywacke, about a quarter dolerite and about a sixth sandstone. The deposits underlie 155 hectares of arable land. They are estimated to average 3 m in thickness, and contain resources estimated at 9.3 million tonnes.

Locality 11: Legerwood

About 3 km south-east of the village along the north-west side of a dry valley between the valleys of the Leader Water and Eden Water is an area of mounds and eskers some 6 to 12 m high lying on a boulder clay slope. A small disused sand pit [NT 603 410], where 3 m is exposed, and other sections indicate that the deposits consist mainly of fine to coarse bedded boulder gravel with a sandy matrix, and with a smaller proportion of fine to coarse sand. The pebbles range mainly from 0.5 to 15 cm with a few boulders up to 50 cm, and they consist four-fifths of greywacke, a sixth of red sandstone, and with minor proportions of felsite, vein quartz and quartzite. A similar deposit occurs 3 km north-east of Legerwood, on the north-west side of an adjacent valley, but it has a composition four-fifths of greywacke and a fifth of red sandstone. The deposits cover 35 and 10 hectares respectively, are estimated to average 4 to 8 m in thickness, and together contain resources estimated at 4.1 million tonnes.

BURIED CHANNEL DEPOSITS BELOW THE WATER TABLE

Locality 12: Melrose to St Boswells

There is some evidence that the River Tweed formerly flowed from Melrose to St Boswells along a valley somewhat south of the present river. In a few places over 10 m of greywacke gravel infilling the former valley is overlain

by 10 m or more of boulder clay. Little is known in detail of this deposit, which could extend to over 300 hectares, and no quantitative assessment has been attempted.

ALLUVIAL DEPOSITS BELOW THE WATER TABLE

River terraces and floodplains occur along all the main river valleys – the River Tweed and the Ettrick, Yarrow, Gala and Leader Waters. Composition of these alluvial deposits ranges from coarse gravel and sand to silt, clay and in places peat. The proportion made up of sand and gravel is not known, but it is thought that in general the deposits may be mainly sand and gravel, particularly in the upstream parts of the valleys and in the higher terraces. The only detailed evidence comes from water wells in the Ettrick alluvium at Selkirk which proved 5 to 7 m of river gravel and sand, and 5 to 10 m were proved in wells in the Gala alluvium at Galashiels. Extraction of river gravel at one time provided a small local supply from the Leader alluvial deposits at Lauder. Alluvial deposits have large potential as a resource, but, because of the lack of information about thickness and quality, a quantitative assessment cannot be made. Furthermore the quality may not be adequate anywhere to supply a large working.

Roxburgh District

The major part of Roxburgh consists of the drainage basin of the River Teviot which runs north into the River Tweed at Kelso. North of the Tweed lies a small part of the district drained by its tributary the Eden Water. In the south, across the major watershed between Tweed and Solway, is an area drained by the Liddel Water.

The rocks underlying the district are the source of almost all the material which forms the sand and gravel resources. Their distribution controls to a large extent the lithological content of the pebbles in each gravel deposit. Five main rock groups occur in Roxburgh, and it is the hardest, most durable rocks which constitute the bulk of the gravel deposits.

Greywackes of Ordovician and Silurian age underlie the third of the district west of Hawick. Greywackes are a dark compact type of sandstone, siltstone and grit.

Red and pink sandstones and conglomerates of Old Red Sandstone age occur in a central belt running north-south through Jedburgh.

White and brown sandstones with a few limestones and ironstones are the hardest of the Carboniferous sedimentary rocks which lie in separate basins around Kelso and Newcastleton.

Basalt lavas of both Old Red Sandstone and Carboniferous age are present, the former in the Cheviot area south of Kirk Yetholm, and the latter in an area around Kelso.

Dolerite intrusions of Carboniferous age occur as isolated hills such as Rubers Law and Minto Hills, mainly within the central belt of Old Red Sandstone rocks.

Of the minor constituents of the gravel pebbles, vein quartz occurs in most of the rock groups, quartzite originates from Old Red Sandstone conglomerates, and pink felsite comes from minor intrusions in the Ordovician and Silurian greywackes.

During the Ice Age an ice sheet flowed north-eastwards across Roxburgh, eroding the underlying rocks and depositing the debris as boulder clay on low ground and in valleys. The boulder clay contains boulders and pebbles which generally reflect the lithology of the underlying rocks. As the ice decayed glacial meltwater eroded both

boulder clay and the underlying rock, washed out most of the clay and silt, and laid down the sand and gravel fractions as glacial deposits. It is these that form the main sand and gravel resources of the Roxburgh District.

The main glacial meltwater in the District flowed down the Teviot valley, along the Kale valley from Eckford to Morebattle and by the dry valley into the Bowmont valley at Kirk Yetholm. Sand and gravel was deposited along these valleys north-east from Hawick, but the deposits are well developed only below Denholm. In the north glacial meltwater flowed down the Tweed valley entering the district at Makerstoun, but south-west of Kelso it diverged from the present Tweed valley and flowed north-east to Ednam where it followed the Eden valley back to the Tweed. Sand and gravel deposits occur all along this route. In Liddesdale to the south glacial drainage ran south, but the meltwater was mainly erosive and there are very limited sand and gravel deposits.

Glacial sand and gravel was laid down in the form of flat spreads, mounds and eskers – narrow, sinuous, sharp-topped ridges. Where later river erosion has taken place, the deposits remain as terraces along the valley sides. Although sand and gravel deposits are quite widespread only certain parts are sufficiently thick and extensive to be considered resources. These are shown on Fig. 4, numbers in circles referring to the numbered localities described below.

More recent river action along the main valleys caused erosion of the glacial sand and gravel deposits, the boulder clay, and the underlying rock. This material was redeposited as alluvial deposits containing gravel, sand, silt and clay in varying proportions, which take the form of river terraces and floodplains, generally known in the district as haugh lands. Because the proportion of sand and gravel in the deposits as against silt and clay is not known it is uncertain what if any is their value as resources of sand and gravel.

GLACIAL SAND AND GRAVEL DEPOSITS ABOVE THE WATER TABLE

Locality 1: Denholm to Ancrum

On both banks of the Teviot, terrace features are raised some 5 to 10 m above the present alluvial flats. In places the terraces are flat-topped, but in other places mounds and ridges generally 5 to 8 m high lie on the terraces. Because of a scarcity of evidence it is uncertain whether the mounds and ridges are isolated deposits lying on a boulder clay base or whether they lie on more widespread terraced sand and gravel deposits. Sparse natural sections indicate that the deposits consist mainly of fine to coarse gravel, with possibly a quarter to a third of sand and finer grades. The pebbles range mainly from 0.5 to 10 cm with some up to 20 cm, consist two-thirds of greywacke, a sixth sandstone, a sixth dolerite, with minor vein quartz, and they are set in a matrix of fine gravel and sandy grit. Some 20 hectares of the deposits have been sterilised by Denholm and Ancrum villages. The remaining deposits underlie over 500 hectares of mostly arable land. They are estimated to average 3 or 4 m in thickness, and contain resources estimated at 40 million tonnes. Because of lack of information on this area these estimates are particularly uncertain.

Locality 2: Ancrum to Roxburgh

Downstream from Ancrum the mounded terrace deposits continue, but mainly on the north and west side of the valley. From evidence in natural sections, the deposits are similar to those just described, except in that the propor-

tion of sand and finer grades is probably somewhat greater at a third or more, and that the pebbles contain only about half greywacke with a fifth sandstone and a fifth dolerite. The deposits underlie 250 hectares mostly of arable land. They are estimated to average some 3 or 4 m in thickness, and contain resources estimated at 17 million tonnes. This estimate is only approximate because of the lack of detailed evidence.

Locality 3: Eckford

Mounded deposits around Eckford vary from 3 to 12 m in height but a thickness of 22 m has been proved in one working. The deposits lie on boulder clay as is shown by the wet boggy low-lying areas between some of the mounds. Good indications of the nature of the deposits have been given by two sand pits, one at Eckford now abandoned and restored, one at Easter Wooden, the only active pit in Roxburgh District. At Eckford Pit [NT 711 270] a ridge up to 22 m thick consisting predominantly of fine sand, with bands of fine to coarse gravel, was removed by the working. At Easter Wooden Pit [NT 731 262] the main face has proved 6 m of fine to medium bedded sand with silty and clayey bands, suitable as building sand, lying on at least 3 m of medium to coarse bedded gravel. These sections suggest that the deposit contains at least as much sand as gravel. The pebbles range mainly from 1 to 10 cm with a few up to 25 cm, consist about half of greywacke, a third of sandstone with minor proportions of dolerite, basalt, quartzite and vein quartz, and are set in a matrix of medium to coarse sand and fine gravel. Most of the deposits underlie arable land and have been sterilised in part by Eckford village. Just over 1 km south-east of Easter Wooden Pit is an isolated mound some 12 m high which appears to be mainly sand. North of the Kale Water is an area of gravel mounds and eskers 5 to 10 m high, which contain a larger proportion of dolerite and basalt pebbles and less greywacke and sandstone than at Easter Wooden. The deposits cover some 250 hectares, are estimated to average 4 to 10 m in thickness in different parts, and contain resources estimated at 28 million tonnes. This is probably the best deposit in the Roxburgh District.

Locality 4: Morebattle to Kirk Yetholm

Here the best deposits are developed along the south side of the sinuous dry valley between the Kale valley at Morebattle and the Bowmont valley at Kirk Yetholm. At the west end mounds and eskers some 5 to 10 m high lie on boulder clay slopes extending from the valley floor to over 50 m above it. Towards Kirk Yetholm flat-topped gravel terraces are raised from 3 to 10 m above the alluvial flats. Several natural sections indicate that the deposits are possibly at least half medium to coarse gravel with less than half consisting of sand and finer grades. The pebbles mainly range from 0.5 to 10 cm with in places boulders up to 40 cm. In the west the pebble content is about two-fifths of basalt, a third of greywacke and a fifth of sandstone with minor vein quartz and felsite in a sandy grit matrix, whereas in the Kirk Yetholm area it is entirely of rotten basalt set in a matrix of basaltic grit. Almost 20 hectares of the deposit have been sterilised by Town Yetholm and Kirk Yetholm. The remaining deposits underlie some 100 hectares of pasture and arable land. They are estimated to average some 3 to 5 m in thickness, and contain resources estimated at 11 million tonnes.

Locality 5: Makerstoun to Roxburgh

Isolated mounds and esker ridges, generally 3 to 10 m

high, lie on an irregular boulder clay surface high above the north bank of the River Tweed. The main deposit south of the Tweed forms three terraces stepping down to the alluvial flat. Also included are isolated mounds up to 10 m high near the confluence of Tweed and Teviot, and a ridge of gravel some 5 m high in the moorland area to the south-west. Several natural sections indicate that the deposit consists mainly of medium to coarse gravel in a sandy grit matrix; evidence is lacking for any sand or finer grade material, but this could form a small proportion of the deposit. The pebbles range mainly from 0.5 to 15 cm probably with larger boulders in places, and consist mainly of greywacke with smaller proportions of basalt and dolerite. The deposits underlie 125 hectares of mostly arable and estate land. They are estimated to average 4 m in thickness, and contain resources estimated at 10 million tonnes.

Locality 6: Ednam

From the south-west to the north of this area several esker ridges 3 to 6 m high lie on boulder clay along a flattish valley. Down the Eden Water are several isolated flat or mounded topped terraces, generally 5 m above the alluvial flats. The few natural sections indicate that the deposits are mainly medium to coarse gravel with a fine sandy gravel matrix; although there is no evidence for beds of sand or finer material, these could form a small proportion of the deposit. The pebbles range mainly from 0.5 to 15 cm with boulders up to 40 cm in places, and about half are greywacke with dolerite (which forms the large boulders), basalt and sandstone. A few hectares of the deposit have been sterilised by Ednam village. The remaining deposits underlie some 65 hectares of arable land. They are estimated to average 3 or 4 m in thickness, and contain resources estimated at 4.2 million tonnes.

Locality 7: Newcastleton

This area was not examined in present survey. The largest of several isolated mounded sand and gravel deposits is at Priest Hill, 2 km north-east of Newcastleton, and the only other significant deposit lies 5 km south of there. Little evidence is available of the composition of these deposits, but indications are that they contain both sand and gravel, and that the pebbles consist mainly of sandstone, greywacke, basalt and dolerite. The deposits cover 60 hectares, are estimated to average 3 m in thickness, and contain resources estimated at 3.6 million tonnes.

ALLUVIAL DEPOSITS BELOW THE WATER TABLE

River terraces and floodplains occur along all the main river valleys – the River Tweed and its tributary the Eden Water, the River Teviot and its many tributaries, and the Bowmont and Liddel Waters. Composition of these alluvial deposits ranges from coarse gravel and sand to silt, clay and in places peat. The proportion of the deposits made up of sand and gravel is not known but it is thought that in general deposits upstream and higher terraces have more gravel and sand and the more extensive downstream deposits have more of the finer grades. In the Teviot valley at Hawick up to 6 m of coarse gravel has been proved in numerous water wells, and similar deposits have been proved in the Tweed valley at Kelso. In places such as the Liddel Water at Newcastleton, workings in alluvial deposits have provided small local supplies. Alluvial deposits have large potential as a resource, but, because of the lack of information about thickness and quality, a quantitative assessment cannot be made. Furthermore the quality may not be adequate anywhere to support a large working.

Tweeddale District

Tweeddale, as the new district name indicates, is the upper part of the drainage basin of the River Tweed. The Tweed rises in the extreme south of the district, flows north-north-east to Lyne, and then east to the district border at Thornylee. The main tributaries are those from the west and north, namely the Biggar, Tarth, Lyne, Eddleston and Leithen Waters, whereas only two small tributaries the Manor and Quair Waters flow from the south.

The rocks underlying the district are the source of most of the material which forms the sand and gravel resources. Their distribution controls to a great extent the lithological content of the pebbles in each gravel deposit. It is the hardest most durable rocks which constitute the bulk of the gravel deposits. Geologically the district has two distinct parts, separated by the Southern Upland Fault which extends north-eastwards from Skirling to Leadburn. To the south-east there are Ordovician and Silurian strata whereas to the north-west are Old Red Sandstone and Carboniferous rocks.

Greywackes of Ordovician and Silurian age underlie all the district south-east of the Southern Upland Fault. They also occur in a small area north-west of Carllops. Greywackes are a dark compact type of sandstone, siltstone and grit.

Red and pink sandstones, and conglomerates of Old Red Sandstone age underlie much of the area north-west of the Southern Upland Fault and south-west of Carllops and West Linton.

Basalt lavas are present in the same area interbedded with the Old Red Sandstone sediments.

Brown and white sandstones and a few limestones are the hardest of the Carboniferous rocks which lie in a basin to the north-east of Carllops and West Linton.

Of the minor constituents of the gravel pebbles, vein quartz occurs in most rock groups, quartzite originates from the Old Red Sandstone conglomerates, dolerite occurs as minor intrusions in the Old Red Sandstone and Carboniferous rocks, and felsite comes from minor intrusions in the Ordovician and Silurian greywackes.

During the Ice Age, an ice sheet flowed generally eastwards across Tweeddale, though in its later stages glaciers flowed along the major valleys. The ice eroded the underlying rocks and deposited the debris as boulder clay on low-lying ground and in valleys. The boulder clay contains boulders and pebbles which generally correspond in composition to the underlying rocks. As the ice decayed glacial meltwater eroded both the boulder clay and the underlying rock, washed out most of the clay and silt and laid down the sand and gravel fractions as glacial deposits. It is these that form the main sand and gravel resources of the Tweeddale District.

Glacial meltwater flowed along the valley of the River Tweed and laid down extensive sand and gravel terrace deposits at intervals all along its course from Tweedhopefoot to Thornylee, but it is below Drumelzier that the deposits are well developed. The only associated deposits in the tributary valleys are in the lower parts of the closely adjacent valleys of the Lyne Water and Meldon Burn. In the upper part of the valley of the Eddleston Water meltwater laid down an extensive, thick pile of sand and gravel which blocked the whole valley, causing the Eddleston Water to excavate a new route between the deposit and the east side of the valley. In the north-west part of the district, that part north-west of the Southern Upland Fault, ice blocked the broad valley linking the Clyde basin with the headwaters of the River Esk. The

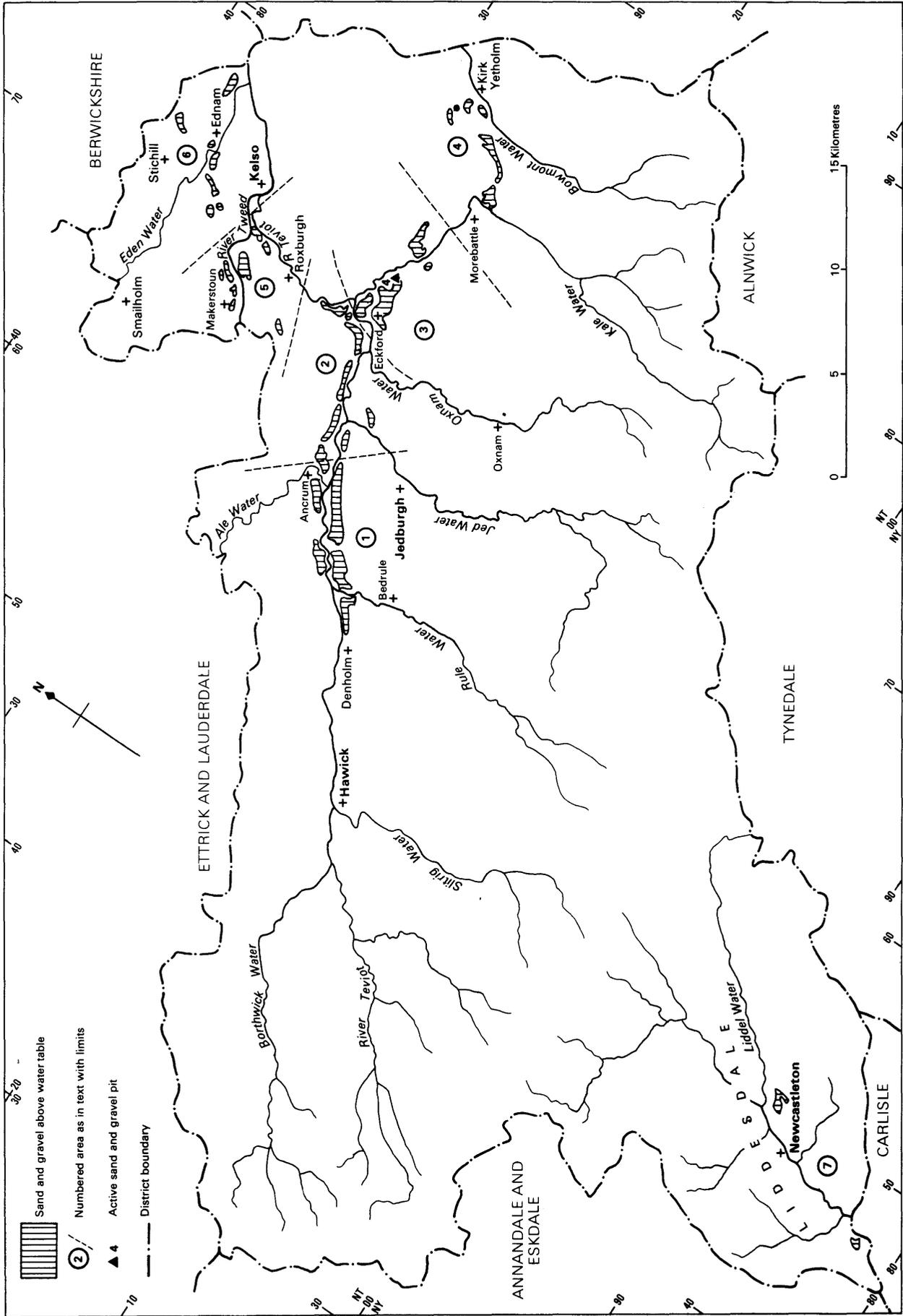


Fig. 4. Distribution of sands and gravels in Roxburgh

resultant deposits of sand and gravel laid down by the melting ice extend from north of West Linton south-west to Dolphinton, Blyth Bridge and Skirling, and are in fact part of a much larger deposit which lies mainly in the Lanark District.

Glacial sand and gravel was laid down in the form of flat spreads, mounds and eskers – narrow, sinuous, sharp-topped ridges. Where later river erosion has taken place, the deposits remain as terraces along the valley sides. Although sand and gravel deposits are quite widespread only parts are sufficiently thick and extensive to be considered as resources. These are shown on Fig. 5, numbers in circles referring to the numbered localities described below.

More recent river action along the main valleys caused erosion of the glacial sand and gravel deposits, the boulder clay and the underlying rock. This material was redeposited as alluvial deposits containing gravel, sand, silt and clay which take the form of river terraces and floodplains generally known in the district as haugh lands. Because the proportion of sand and gravel as against silt and clay is not known, it is uncertain what if any is the value of these deposits as resources.

GLACIAL SAND AND GRAVEL DEPOSITS ABOVE THE WATER TABLE

Locality 1: Kingledoors

Terraces flank the valley of the River Tweed from Tweedhopefoot to Drumelzier, but generally these are cut in boulder clay with in places a thin cover of 1 to 2 m of coarse boulder gravel. The gravel is only well developed in the terrace lying between the River Tweed and a small tributary at Kingledoors, where there is at least 7 m of coarse boulder gravel with gritty sand bands. The pebbles range mainly from 2 to 20 cm with boulders up to 60 cm, and they consist almost entirely of greywacke. The deposits underlie 13 hectares of mainly arable land, are estimated to average 3 m in thickness, and contain resources estimated at 0·8 million tonnes.

Locality 2: Drumelzier to Stobo

Moundy and terrace gravel deposits are present on the boulder clay slopes all along the south bank of this stretch of the River Tweed and also on the north bank near Stobo. The terraces generally lie about 6 or 8 m above the alluvial flats, and the mounds are about 5 m high with some near Dawyck up to 15 m high. An area of mounds generally 4 to 8 m high lies in the ground between the Biggar Water and the River Tweed. Sections indicate that the deposits are mainly coarse boulder gravel with a silty clay matrix. There is probably little sand in the deposit. The pebbles range mainly from 1 to 10 cm with boulders up to 40 cm, and they consist almost entirely of greywacke. The deposits underlie 215 hectares of partly arable land and partly steep wooded slopes. They are estimated to average 3 or 4 m in thickness and contain resources estimated at 16 million tonnes.

Locality 3: Stobo to Lyne

Moundy and terrace gravel deposits are well developed on both sides of the River Tweed. The terraces lie generally at 6 to 10 m above the alluvial flats and are extensive at Lyne. Mounds and esker ridges 3 to 10 m high extend up the boulder clay slopes to 30 m above the river. Sections indicate that the deposits are mainly coarse boulder gravel with a sandy grit matrix. Sand probably forms a small proportion of the deposit. The pebbles range mainly from 0·5 to 10 cm with boulders, particularly upstream,

up to 40 cm. They consist about three-quarters of greywacke, with the remainder of sandstone, basalt, felsite and vein quartz. The deposits underlie 330 hectares of mainly arable land. They are estimated to average 3 to 6 m in thickness in different parts and contain resources estimated at 30 million tonnes.

Locality 4: Ladyurd to Lyne

At Ladyurd former workings have removed much of an isolated area of sand and gravel mounds. A conical mound 20 m high and a lower rounded mound remain, extending to only 10 hectares. Further downstream moundy terrace deposits lie generally from about 15 to 60 m above the river, with mounds in places up to 20 m high. Sections indicate that the deposits consist mainly of coarse gravel with a sandy grit matrix. Bands of fine to coarse sand form a small proportion of the deposit. The pebbles range mainly from 1 to 10 cm with boulders up to 40 cm. About four-fifths of them consist of greywacke with minor proportions of sandstone, basalt, felsite and vein quartz. The deposits cover 110 hectares, are estimated to average 5 m in thickness, and contain resources estimated at 11 million tonnes.

Locality 5: Meldon Burn

Moundy terrace deposits of gravel lie up to 15 m above the valley floor, mainly on the west side of the lower part of this valley. Sections indicate the deposit is mainly coarse boulder gravel with a sandy grit matrix. The pebbles range from 0·5 to 10 cm with boulders up to 40 cm. In the north they consist almost entirely of greywacke, but there are small proportions of sandstone, basalt, felsite and vein quartz. The deposits cover 35 hectares, are estimated to average 5 m in thickness, and contain resources estimated at 3·5 million tonnes.

Locality 6: Barns

Flat-topped terraces lie 4 to 10 m above the alluvial flats on either side of the Tweed. Few sections indicate that the deposits consist mainly of coarse boulder gravel with a matrix of clay, sand and grit. The pebbles range mainly from 0·5 to 10 cm with boulders up to 50 cm, and consist mainly of greywacke, with a tenth of sandstone, felsite and vein quartz. The deposits underlie 70 hectares of mainly arable land. They are estimated to average 3 or 4 m in thickness, and contain resources estimated at 5·3 million tonnes.

Locality 7: Peebles

On the north bank of the River Tweed at the mouth of the Eddleston Water, the old part of Peebles is built on gravel terraces which lie 5 to 8 m above the alluvial flats. South of the river is an extensive dissected gravel terrace which is the site of most of the development in Peebles. There is little evidence of its composition, but the deposit is probably coarse greywacke gravel similar to adjacent areas. The deposits underlie 180 hectares, are estimated to average 4 m in thickness, and contain resources estimated at 14 million tonnes. These have been almost completely sterilised by development in and around Peebles.

Locality 8: Peebles to Traquair

On alternating sides of the valley there are flat-topped or moundy terraces generally lying about 6 m above the alluvial flats. At Traquair there are three terraces lying up to 25 m above the alluvial flats. Sections indicate that the deposits are mainly coarse boulder gravel with a matrix of sandy grit and fine gravel. There is probably in places a

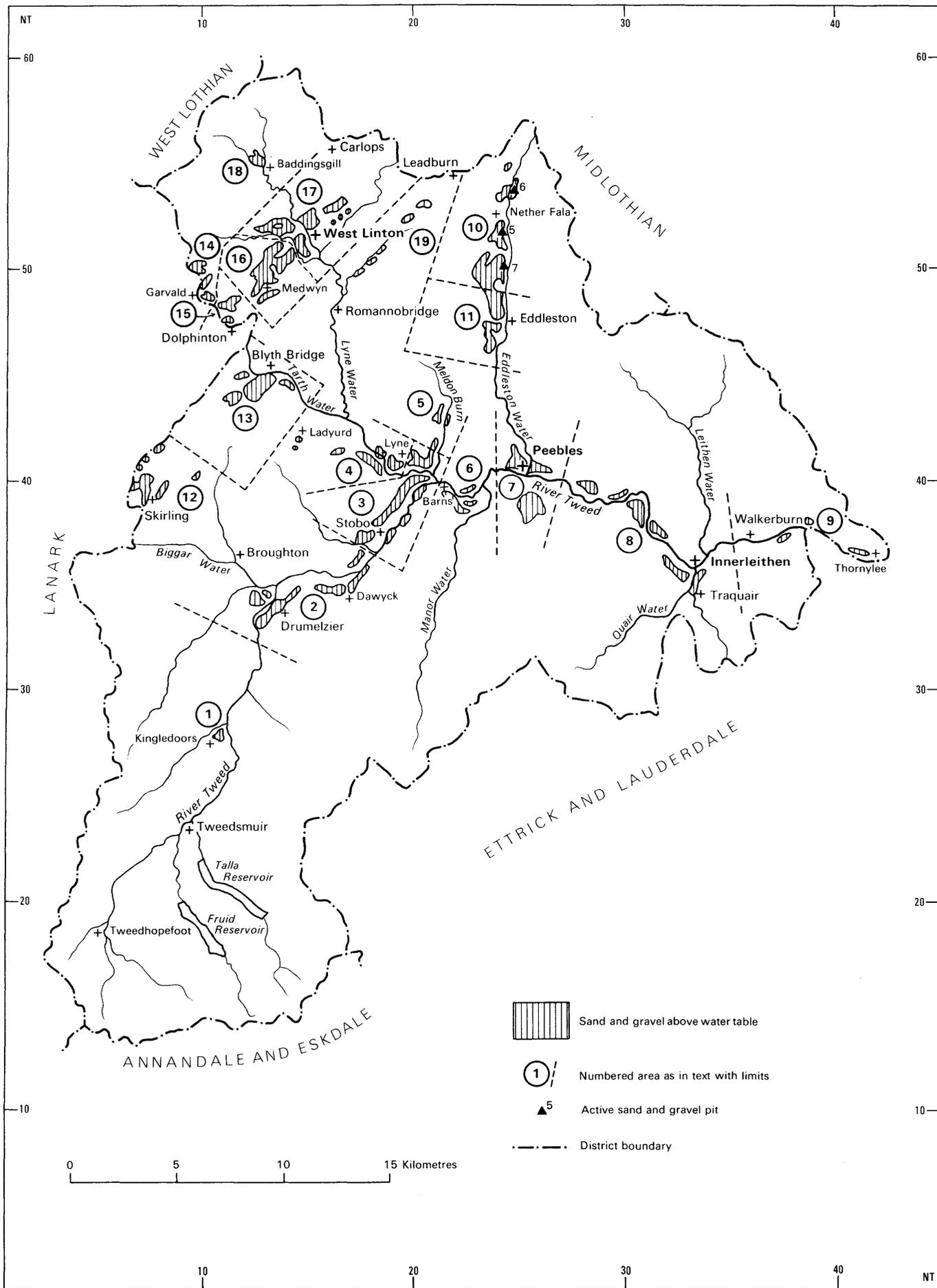


Fig. 5. Distribution of sands and gravels in Tweeddale

small proportion of sand. The pebbles range mainly from 0.5 to 20 cm with boulders up to 60 cm, and consist almost entirely of greywacke, with a few of sandstone, felsite and vein quartz. The deposits underlie 190 hectares of partly arable land and partly estate land. They are estimated to average 4 to 5 m in thickness, and contain resources estimated at 14 million tonnes.

Locality 9: Walkerburn to Thornylee

Gravel deposits occur in three isolated areas. The central area has mounds and ridges on a boulder clay slope, lying up to 60 m above the river. In the other two areas mounded terraces lie about 8 to 10 m above the alluvial flats. Sections indicate that the deposits consist of coarse boulder gravel with a matrix of fine gravel, grit and silty clay. There is probably a small proportion of sand. The pebbles range mainly from 0.5 to 15 cm with boulders up to 50 cm, and consist almost entirely of greywacke. The deposits underlie 42 hectares, are estimated to average 4 to 5 m in thickness, and contain resources estimated at 3.8 million tonnes.

Locality 10: Nether Fala

Extensive mounds and terraces of sand and gravel fill the upper part of the valley of the Eddleston Water. These deposits are well known from sections in three working pits and other abandoned pits. At least 25 m of sand and gravel occur in a deep preglacial channel some 200 to 300 m wide which lies west of the present course of the Eddleston Water. West of this channel the sand and gravel deposits are much thinner, occurring as isolated mounds up to 10 m high lying on a generally boggy boulder clay surface. Only very small deposits are present on the east side of the Eddleston Water. Sections in the deep channel deposit are exposed in the Cowieslinn Pit [NT 239 516], where up to 8 m of bedded coarse boulder gravel lies between thick bands of fine, bedded and ripple-bedded sand with silty clay beds, and at Shiphorns Pit [NT 242 502], where coarse boulder gravel and fine to coarse, bedded gravel with beds of sand and silt constitute most of the deposit, at least 25 m thick. The nature of the thinner deposits is seen in the west part of the Cowieslinn Pit where the coarse, bedded gravel is less than 2 m thick, and in the north in the Nether Fala No. 2 Pit [NT 242 535] where 6 m of deposit consists mainly of coarse boulder gravel with beds of fine gravel and sand. An overburden of silty clay with stones is generally only 1 m thick but in places is over 8 m thick. Although it varies considerably the deposit generally contains about 60 per cent gravel, 30 per cent sand and 10 per cent of finer grades. The pebbles range mainly from 0.5 to 20 cm with boulders up to 60 cm. About four-fifths of them are greywacke, and the rest are sandstone, basalt, dolerite, felsite and vein quartz. They are set in a matrix which is silty clay, sandy greywacke grit, or fine gravel. Over 50 hectares of the best deposits have already been worked down to boulder clay or to about 3 m above the water table. About 50 hectares of the channel deposits remain with an estimated average thickness of about 10 m and resources estimated at 10 million tonnes. The other deposits cover 150 hectares, are estimated to average 3 to 5 m in thickness and contain resources estimated at 15 million tonnes.

Locality 11: Eddleston

Although there is very little information from the south part of the valley of the Eddleston Water it is probable that the deposits are similar in form to those proved in the north. Channel deposits up to 20 m thick may extend to

about 0.5 km south of Eddleston village, but south of that the deposits are less than 5 m thick resting on rock. On the slope to the west mounds up to 10 m high and a sinuous esker 3 to 7 m high rest on boulder clay. The deposits are probably similar to those to the north containing coarse boulder gravel, coarse gravel and sand with a little silt and clay. The only evidence comes from the esker which is composed of coarse boulder gravel with a matrix of fine gravel, grit and silty clay. The pebbles range mainly from 1 to 10 cm with some up to 40 cm, and consist almost entirely of greywacke. The channel deposits underlie 55 hectares of mainly arable land, are estimated to average about 10 m in thickness and contain resources estimated at 11 million tonnes. The slope deposits cover 160 hectares, are estimated to average 5 m in thickness and contain 16 million tonnes.

Locality 12: Skirling

Gravel mounds and eskers are present in the valley at Skirling, over the high col to the north-west, and along the south-east side of the valley beyond. The mounds are generally 5 to 8 m high, the eskers 2 to 6 m high, and they lie on boulder clay. Sections indicate that the deposits are mainly fine to coarse gravel with a grit matrix. The pebbles range mainly from 0.5 to 20 cm, and consist 90 per cent of greywacke with small proportions of sandstone, basalt, felsite and vein quartz. The deposits underlie 135 hectares of partly arable land. They are estimated to average 3 to 5 m in thickness in different parts and contain resources estimated at 10 million tonnes.

Locality 13: Blyth Bridge

On the south slopes of the valley of the Tarth Water near Blyth Bridge there are numerous gravel mounds and eskers. The mounds are generally 5 to 15 m high, the eskers up to 6 m high, and they lie on boulder clay. Due to lack of sections, little is known in detail of the deposits. They are probably mainly coarse gravel, with a composition of about three-quarters greywacke with sandstone, basalt, felsite and vein quartz. The deposits underlie 150 hectares of mainly arable land, are estimated to average 3 to 5 m in thickness and contain resources estimated at 13 million tonnes. This estimate is only approximate because of the lack of information.

Locality 14: Garvald

In the moorland area north of Garvald School are mounded terrace deposits lying up to 12 m above the valleys. A 10 m high ridge between two valleys lies just south of this. On the steep slopes rising east from Garvald mounds up to 30 m high lie on boulder clay and bedrock. The only evidence of their composition comes from the first area where sections show coarse boulder gravel with a matrix of sand, grit and fine gravel. The pebbles range mainly from 1 to 20 cm with boulders up to 50 cm. They consist three-fifths of red sandstone, a fifth of basalt, with minor proportions of dolerite, quartzite, felsite and vein quartz. Evidence from the adjacent Dolphinton area suggests that the sand content of the deposits increases rapidly eastwards. The deposits cover 65 hectares, are estimated to average 5 to 10 m in thickness, and contain resources estimated at 9 million tonnes.

Locality 15: Dolphinton

North of Dolphinton an extensive area of sand mounds 25 to 30 m high lies along the bottom and the north side of the wide valley. Sections in the abandoned Nick Sand Pit [NT 112 482] show that bedded and cross-bedded fine

sand is at least 12 m thick and probably forms over four-fifths of the deposit. Fine to coarse gravel occurs as thin bands particularly near the top, and there is an overburden of 1 to 2 m of dark earthy fine sand with scattered pebbles. The pebbles consist mainly of red sandstone, basalt and greywacke. Only 4 hectares has been worked, and 55 hectares of the deposits remain. They are estimated to average 10 to 15 m in thickness and contain resources estimated at 15 million tonnes.

Locality 16: Medwyn

Within the broad open valley extending north-eastwards from Dolphinton is an extensive area of mounds and eskers. In the south these are generally 6 to 8 m high, probably lying on boulder clay as shown by the intervening boggy flats. In the north the mounds are 15 to 20 m high and are dissected by deep glacial channels. The few sections indicate that the deposit is in part fine to coarse gravel with a sandy grit matrix. Comparison with adjacent areas, however, suggests that over half of these deposits also consist of sand. The pebbles range mainly from 0.5 to 20 cm. They consist about half of red sandstone and quarter each of basalt and greywacke, though some bands consist almost entirely of basalt pebbles in a basaltic grit. The deposits cover over 200 hectares, much of it wooded. They are estimated to average 4 to 10 m in thickness and contain resources estimated at 21 million tonnes.

Locality 17: West Linton

On the slopes which lie west and north-east of the village there are gravel mounds generally 6 to 10 m high resting on boulder clay. South from West Linton is an extensive area of sand and gravel mounds standing 15 to 25 m above the surrounding alluvial flats, which was formerly exploited by the Castlelaw Pit. Similar small isolated mounds lie 1.5 km east of the village. There is little information about the mounds on the slopes but they probably contain both coarse gravel and sand. Sections recorded in the Castlelaw Pit [NT 148 511], which is now restored, showed up to 15 m of deposit which was mainly sand, with thin gravel bands particularly near the top forming less than a quarter of the deposit. An overburden of 1 m of red silty clay with stones is usually present. The pebbles range mainly from 1 to 25 cm. Half of them consist of red and white sandstone, a quarter of greywacke and the rest of basalt, dolerite, quartzite, felsite and vein quartz. Only 5 hectares was worked at Castlelaw, leaving 50 hectares which are estimated to average 15 m in thickness and contain resources mainly of sand estimated at 15 million tonnes. West Linton village sterilises 20 hectares of the other deposits, leaving 125 hectares which is partly arable land, partly golf course; they are estimated to average 4 to 5 m in thickness and contain resources estimated at 11 million tonnes.

Locality 18: Baddingsgill

In this remote area north-west of West Linton is a deposit of gravel mounds up to 6 m high. Little is known of the deposits but they are probably mainly coarse gravel containing a mixture of greywacke, sandstone, basalt, and other pebbles. The deposits cover 30 hectares, are estimated to average 4 m in thickness and contain resources estimated at 2.4 million tonnes.

Locality 19: Romanno to Leadburn

Along the minor valley between these villages is a discontinuous series of mound and esker deposits. Generally

these are only 2 to 3 m high, but in two areas they are well developed. In the northerly one are flat-topped mounds up to 8 m high, and to the south an esker ridge is generally 5 to 12 m high. The deposits are mainly coarse gravel with a matrix of sandy grit. The pebbles consist at least three-quarters of greywacke with minor proportions of sandstone, basalt, dolerite, felsite and vein quartz. The deposits cover some 20 hectares, are estimated to average 3 to 5 m in thickness and contain resources estimated at 1.5 million tonnes.

ALLUVIAL DEPOSITS BELOW THE WATER TABLE

River terraces and floodplains occur along all the River Tweed and in the tributary valleys, particularly those of the Lyne Water, Eddleston Water and Manor Water. Composition of these alluvial deposits ranges from coarse gravel and sand to silt, clay and in places peat. The proportion of the deposits made up of sand and gravel is not known but it is thought that in general deposits upstream and higher terraces have more gravel and sand and the more extensive downstream deposits have more of the finer grades. Boreholes at Peebles proved alluvial deposits over 30 m thick but much of that was silt and clay. Alluvial deposits have large potential as a resource, but, because of the lack of information about thickness and quality, a quantitative assessment cannot be made. Furthermore the quality may not be adequate anywhere to support a large working.

List of working pits, autumn 1975

Berwickshire District

Kinegar No. 2 [NT 772 705], Cockburnspath
1-inch Sheet 64; 1:50 000 Geological Sheet 33; 1:10 000
Sheet NT 77 SE

Owner: Alex Robertson & Co. Ltd, Craiguscar Road,
Dunfermline

Preparation: screening, washing, grading

Uses: sand for building, concrete and asphalt; gravel for
concrete

Markets: Berwickshire and East Lothian districts

Piper's Knowe [NT 880 592], Chirnside

1-inch Sheet 64; 1:50 000 Geological Sheet 34; 1:10 000
Sheet NT 85 NE

Owner: Amalgamated Quarries (Scotland) Ltd, 15
Melville Terrace, Stirling

Preparation: crushing, screening, washing, grading

Uses: sand for concrete, gravel for concrete

Markets: eastern Borders Region

Ettrick and Lauderdale District

Easter Langlee No. 2 [NT 519 365], Galashiels

1-inch Sheet 69; 1:50 000 Geological Sheet 25; 1:10 000
Sheet NT 53 NW

Owner: Diamond Gravel Ltd, Easter Langlee, Galashiels

Preparation: crushing, screening, washing, grading

Uses: sand and gravel for concrete

Markets: Borders Region

Roxburgh District

Easter Wooden [NT 731 262], Eckford

1-inch Sheet 70; 1:50 000 Geological Sheet 25; 1:10 000
Sheet NT 72 NW

Owner: D. C. Souter, Ardath, Maxwellheugh, Kelso

Preparation: screening

Uses: sand for building

Markets: Borders Region

Tweeddale District

Cowieslinn [NT 239 516], Eddleston
 1-inch Sheet 62; 1:50 000 Geological Sheet 24; 1:10 000
 Sheet NT 25 SW
 Owner: W. & J. R. Watson, 43 Station Road,
 Edinburgh 12
 Preparation: crushing, washing, screening, grading
 Uses: sand and gravel for concrete
 Markets: Lothian Region

Shiphorns [NT 242 502], Eddleston
 1-inch Sheet 62; 1:50 000 Geological Sheet 24; 1:10 000
 Sheet NT 25 SW
 Owners: Shiphorn Estates Ltd and Alexander Russell
 Ltd, Shiphorns, Eddleston
 Preparation: crushing, washing, screening, grading
 Uses: sand for concrete; gravel for concrete and asphalt
 Markets: Lothian and Borders regions

Nether Fala No. 2 [NT 242 535], Eddleston
 1-inch Sheet 62; 1:50 000 Geological Sheet 24; 1:10 000
 Sheet NT 25 SW
 Owner: Shiphorn Estates Ltd, Eddleston
 Preparation: none
 Uses: fill
 Markets: Edinburgh

Table 1. Estimated resources

	Estimated area (ha)	Estimated* thickness (m)		Estimated† quantity (m.t.)	Remarks
		Av.	Max.		
<i>Berwickshire District</i>					
1. Birgham	35	4-5	8	3.2	Information poor
2. Coldstream	330	3-5	8	23	70 ha, 4.2 m.t. sterilised
3. Ladykirk	80	3-5	8	6.2	Information poor
4. Huntleywood	40	5	12	4.0	
5. Gordon	120	3-5	8	7.2	
6. Hexpath	30	3-5	8	2.2	
7. Hallyburton	40	6	10	4.8	Remote
8. Cammerlaws	10	4	8	0.8	
9. Bedshiel	15	3-4	10	1.1	S.S.S.I.‡
10. Duns to Edrom	325	3-4	10	20	
11. Edrom to Chirnside	100	3-4	8	6.5	
12. Broomdykes	30	3	6	1.8	
13. Causewaybank	65	5-10	20	10	Relatively good deposit
14. Reston to Ayton	220	3-4	6	16	25 ha, 2 m.t. sterilised
15. Ayton to Eyemouth	105	4	6	8.4	Information poor
16. Lamberton	30	3-5	10	2.6	
17. Cockburnspath	520	3-6	10	50	Relatively good deposit
18. Gordon-Greenlaw	300	-	-	-	Below water table
<i>Ettrick and Lauderdale District</i>					
1. Ladhope to Yarrow	80	3-6	15	7.1	
2. Yarrow to Bowhill	125	4-5	10	11	Information poor
3. Gilmanscleuch	10	3	5	0.6	
4. Bowhill	140	4-5	10	13	Information poor
5. Philiphaugh to Sunderland	95	3-4	10	7.0	Information poor
6. Elibank to Peel	45	5	12	4.5	Steep wooded slopes
7. Fairnilee to Galashiels	160	4	10	13	
8. Galashiels to Melrose	260	3-5	10	19	All sterilised
9. Easter Langlee	40	4	12	3.2	Mainly worked out
10. St Boswells and Rutherford	155	3	5	9.3	Information poor
11. Legerwood	45	4-8	12	4.1	
12. Melrose to St Boswells	300	-	-	-	Buried channel deposit
<i>Roxburgh District</i>					
1. Denholm to Ancrum	530	3-4	8	40	20 ha, 2 m.t. sterilised
2. Ancrum to Roxburgh	260	3-4	10	17	Information poor
3. Eckford	250	4-10	22	28	Very good deposit
4. Morebattle to Kirk Yetholm	120	3-5	10	11	20 ha, 2 m.t. sterilised
5. Makerstoun to Roxburgh	125	4	10	10	
6. Ednam	65	3-4	10	4.2	
7. Newcastleton	60	3	-	3.6	Not re-examined

	Estimated area (ha)	Estimated* thickness (m)		Estimated† quantity (m.t.)	Remarks
		Av.	Max.		
<i>Tweeddale District</i>					
1. Kingledoors	13	3	8	0·8	
2. Drumelzier to Stobo	215	3-4	15	16	Information poor
3. Stobo to Lyne	330	3-6	15	30	
4. Ladyurd to Lyne	110	5	20	11	
5. Meldon Burn	35	5	15	3·5	
6. Barns	70	3-4	10	5·3	
7. Peebles	180	4	10	14	110 ha, 8·8 m.t. sterilised
8. Peebles to Traquair	190	3-5	10	14	
9. Walkerburn to Thornylee	42	4-5	10	3·8	
10. Nether Fala	200	3-10	25	25	Very good deposit
11. Eddleston	215	5-10	20	27	
12. Skirling	135	3-5	15	10	
13. Blyth Bridge	150	3-5	15	13	Information poor
14. Garvald	65	5-10	25	9·0	
15. Dolphinton	55	10-15	25	15	Very good sand deposit
16. Medwyn	205	4-10	20	21	
17. West Linton	195	4-15	25	26	20 ha, 1·6 m.t. sterilised Very good sand deposit
18. Baddingsgill	30	4	6	2·4	Remote
19. Romanno to Leadburn	20	3-5	12	1·5	

*Where a range of values is given, two or more smaller areas with different average thicknesses have been grouped together.

†Calculated to two significant figures.

‡Site of Special Scientific Interest.

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