British Geological Survey
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Geology of the Accrington area

Integrated Geoscience Surveys (Southern Britain)

Internal Report IR04/128

BRITISH GEOLOGICAL SURVEY

INTERNAL REPORT IR/04/128

Geology of the Accrington area (SD72NE and SD73SE)

E Hough

Key words

Geology, Millstone Grit, Lower Coal Measures, Quaternary, Accrington, Padiham, Rossendale, Lancashire

Bibliographical reference

HOUGH, E. 2004. Geology of the Accrington area (SD72NE and SD73SE). *British Geological Survey Internal Report*, IR/04/128

Keyworth, Nottingham British Geological Survey 2004

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1 Introduction

This report describes the geology of 1:10 000 sheets SD72NE (Accrington) and SD73SE (Padiham) (figures 1 and 2). The area (hereafter referred to as 'the district') was first geologically surveyed on the 'old' county series by E Hull and published in 1875. R L Sherlock and L H Tonks subsequently remapped the district on the 'new' county series sheets Lancashire 55, 56, 63, 64, 71 and 72 in 1921-23. The one-inch Geological Sheet 76 (Rochdale) and accompanying sheet memoir (Wright *et al.* 1927) were published in 1927. The area was resurveyed on the 1:10 560 and 1:10 000-scales by J R Earp in 1947 (Clitheroe Sheet) and E Hough in 2000 (Rochdale Sheet).

Topographic variation within the district varies from 60 m in the Calder Valley [7500 3412] to 409 m at Great Hameldon [7940 28795]. The district comprises upland moorland in the south and east, which falls northwards to the Calder; to the north of the Calder the land is gently undulating pasture. Accrington is situated in the central part of the district. The district is drained by the northward flowing Woodnook Water and Sure Clough-Cocker Lumb in the south-west of the district. The Clader is the main river in the district; in this area it is fed by the minor tributaries of Castle Clough Brook, Shorten Brook, Clough Brook and Dean Brook. Coal, sandstone and mudstone (for brickclay) have been heavily exploited in the area. The Accrington area remains one of the main sources of brickclay in north-west England. The district is underlain by rocks of Millstone Grit to Pennine Lower Coal Measures Group.

All National Grid references in this report lie within 100 km grid square SD, and are given as eight figure numbers. Grid references for the borehole and shaft sections referred to in the text are given in Appendix 1.

The area to the east is described in Hough (2004c), 'Geology of the Burnley district'.

The area to the west is described in Hough (in prep), 'Geology of the Oswaldtwistle district'.

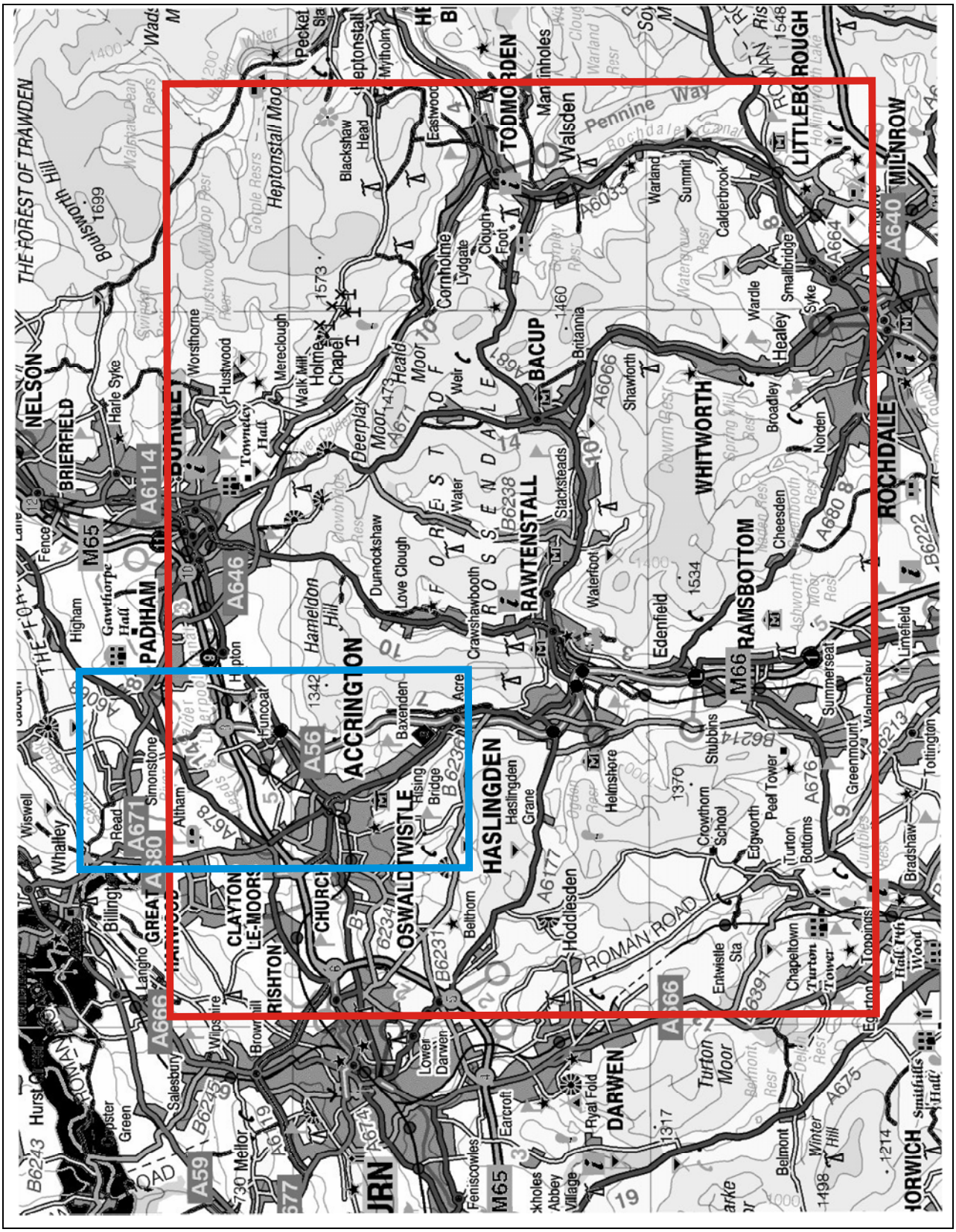

Figure 1: limit of the Rochdale Geological Sheet outlined in red showing the Accrington district outlined in blue explained in this report

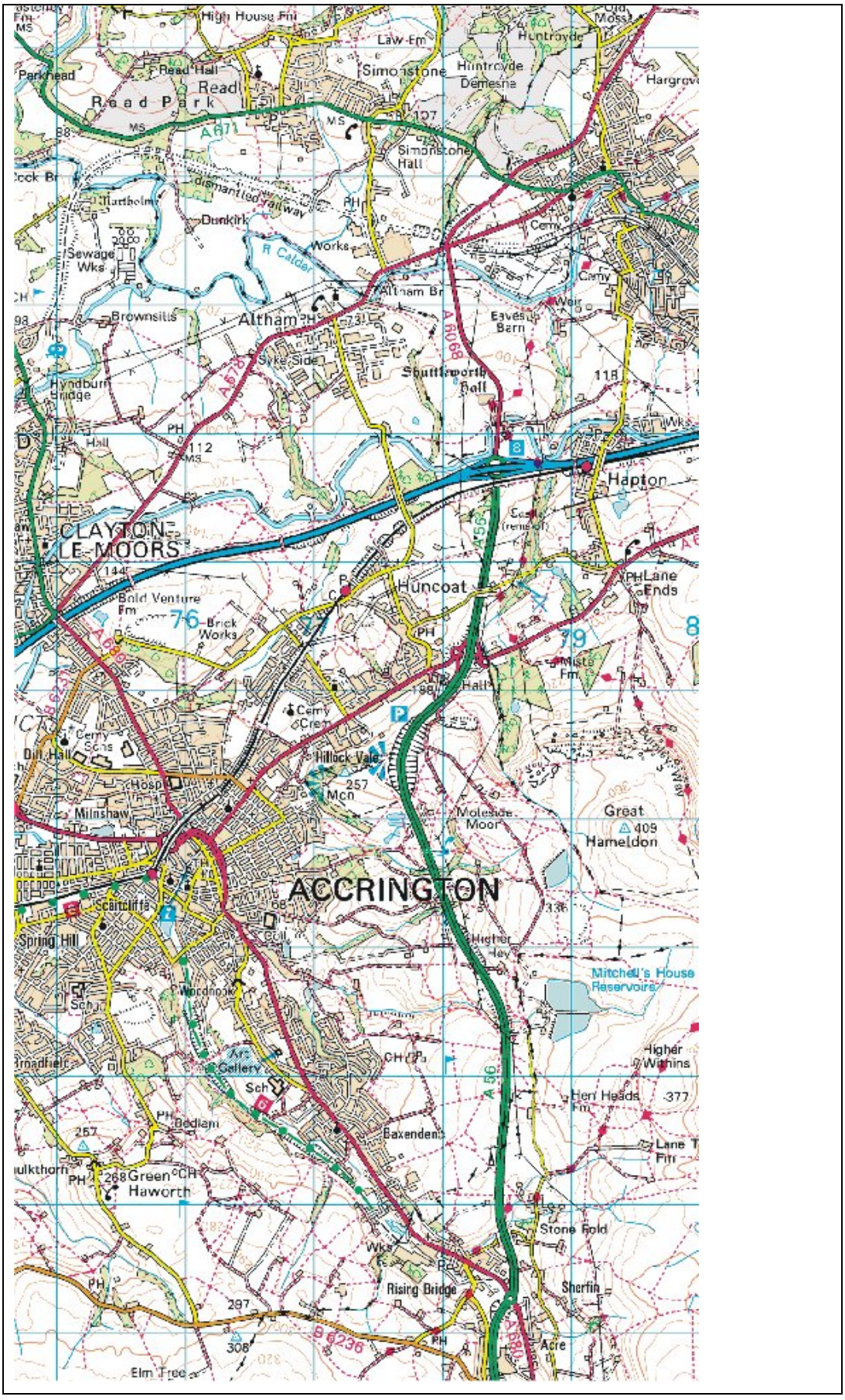

Figure 2: Map of the Accrington district. Graticule at 1 km intervals.

Geological sequence

The Carboniferous rocks proved beneath the area are from upper part of the Millstone Grit, and the lower part of the Pennine Lower Coal Measures Group, both of which are Langsettian (Westphalian A) in age.

The Quaternary deposits are grouped genetically on the accompanying 1:10 000 map in terms of process operating during their deposition. The sequence below gives a broad indication of their relative ages.

DRIFT

Flandrian	River Terrace Deposits, Alluvium, Peat, Head, Debris Cone
Pre-Flandrian	Till, Glaciofluvial Deposits

SOLID

Silesian (Upper Carboniferous)

Pennine Lower Coal Measures Group

Millstone Grit Group

2 Silesian (Upper Carboniferous)

Carboniferous rocks are known form outcrop studies, boreholes and from records of former collieries and opencast workings in the area. Borehole logs are held in the National Geosciences Record Centre (NGRC) at BGS. Definitive details of coal workings are held by the Coal Authority, 200 Lichfield Lane, Mansfield, Nottinghamshire NG18 4RG.

2.1 MILLSTONE GRIT GROUP

Strata from the Millstone Grit Group are present at outcrop in the extreme north-western (Read Park, [7545 3470]) and extreme southern (Rising Bridge, [7805 2535]) parts of the district. Namurian Millstone Grit strata proved within the district are shown in Figure 3.

The **Kinderscout Grit** is present in the Sagar Heys [7515 3495] area, and is not currently exposed in the district. At least 125 m of the unit is estimated to be present beneath the district. Elsewhere, the Kinderscout Grit comprises grey-brown fine- to coarse-grained sandstone with subordinate beds of micaceous mudstone (e.g., Hough, 2004 b). The Kinderscout Grit is overlain by the **Reticuloceras corecticulatum Marine Band (R_1c^4)**, which is not exposed in the district.

The **Gorpley (Fletcher Bank; Revidge) Grit** is thought to be 35 m thick in the north-western part of the district. No lithological details are available from within the district; in the Cliviger area, the Gorpley Grit comprises grey and brown sandstone and pebbly sandstone which is poorly-sorted (Hough, 2004b).

The **Hazel Greave Grit** has been proved in the Paragon Chemical Works Borehole (SD72NE/101), where it comprises 19.2 m of fine-grained, light grey micaceous sandstone with carbonaceous plant fragments. Elsewhere in the district, the Hazel Greave Grit is thought to attain a thickness of 30 m.

The **Bilinguites superbilinguis Marine Band (R_2c^1)** rests on the Hazel Greave Grit. The marine band comprises black mudstone with the following fossils (as identified by WHC Ramsbottom in 1951, from the Paragon Chemical Works Borehole SD72NE/101): *Lingula mytiloides, Posidonella sp., Orbiculoidea cf. nitida, Naticopsis cf. plicistria*, ostrocod and fish debris.

The **Brooksbottoms Sandstone** overlies 12.4 - 13.1 m of mudstone, ironstone and sandstone that rests on the Reticuloceras reticulatum Marine Band. The sandstone has been proven in the Paragon Chemical Works Borehole (SD72NE/101), where it comprises 2.5 m of grey-brown, fine-grained, micaceous, cross-bedded sandstone with plant remains.

The **Lower Holcombe Brook Coal** is present in the Paragon Chemical Works Borehole (SD72NE/101), where it overlies 15 - 24 m of mudstone on the Brooks Bottom Sandstone. The coal is present as 5 cm of coaly sandstone, resting on 18 cm fine grained micaceous sandstone on 2 cm of coal.

The **Holcombe Brook Grit**, which is 13.5 m above the Lower Holcombe Brook Coal, comprises 4.3 m of sandstone that is fine-grained, micaceous, thinly-laminated, cross-bedded with plant debris and mudstone interbeds in the Paragon Chemical Works Borehole (SD72NE/101). The sandstone is 3.05 m thick in the Wood Nook Mills (SD72NE/96) borehole.

The **Holcombe Brook Coal** overlies the Holcombe Brook Grit. The coal is 28 cm thick in the Paragon Chemical Works Borehole (SD72NE/101), although has not been identified in the Wood Nook Mills (SD72NE/96) borehole.

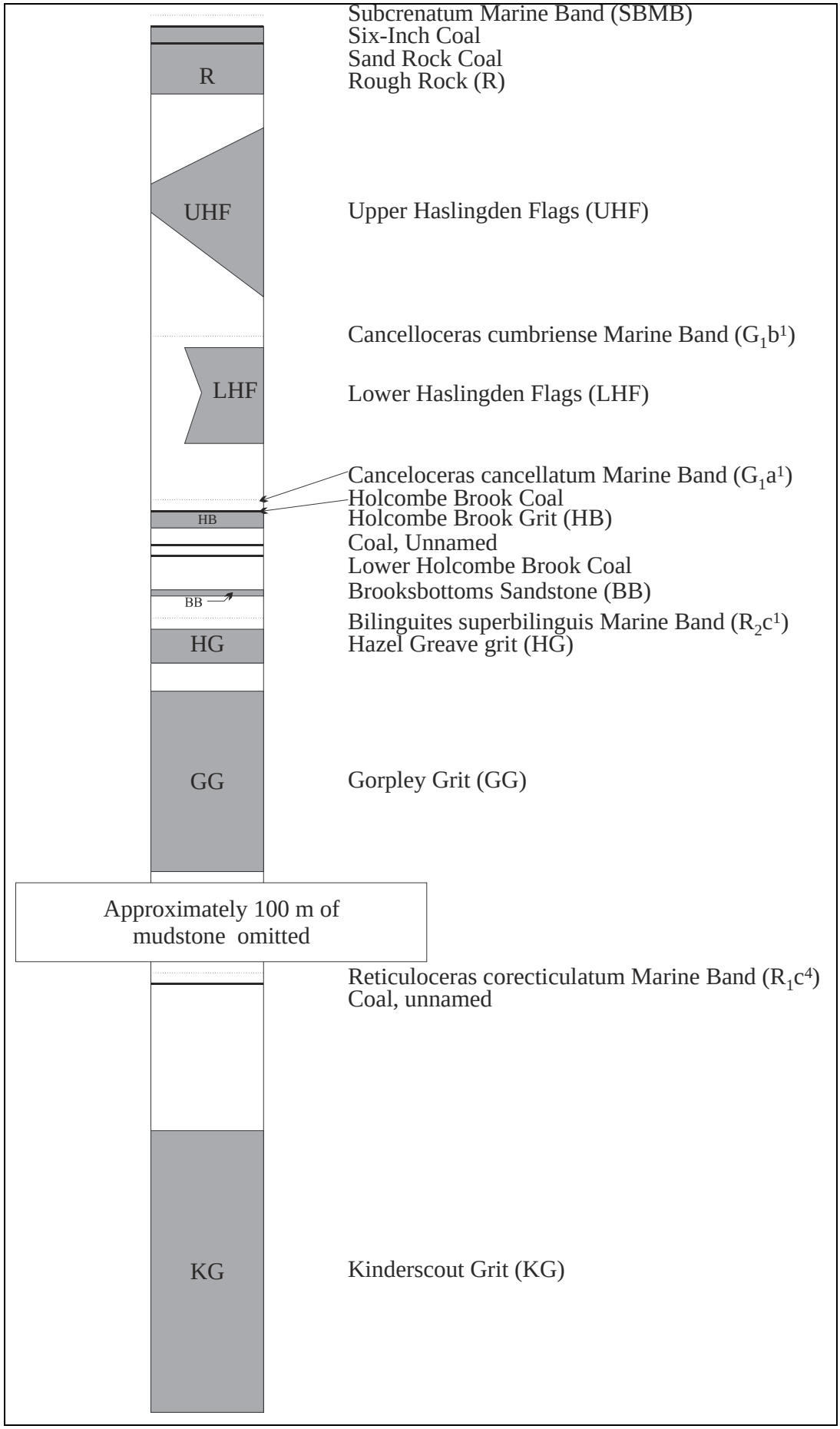

Figure 3: Generalized vertical section of the Namurian Millstone Grit proved within the district. Scale approx. 1: 2500 (1 cm to 25 m).

The Cancelloceras cancellatum Marine Band (G_1a^1) has been proven in the Paragon Chemical Works (SD72NE/101) and the Wood Nook Mills (SD72NE/96) boreholes. The marine band is 18-19 m above the Holcombe Brook Coal based on provings from these boreholes. The following fossils have been recovered from the marine band (fossils identified by WHC Ramsbottom in 1951, from the Paragon Chemical Works Borehole SD72NE/101):

Lingula mytiloides, Dunbarella elegans, Posidonella miltirugata, Agastrioceras carinatum, Anthracoceras sp., Gastrioceras cencellatum, Gastrioceras crenulatum, Gastrioceras rurae, Cycloceras sp, fish debris.

The **Lower Haslingden Flags** attain a maximum thickness of approximately 48 m in the southern part of the district. The Lower Haslingden Flags apparently fail northwards, due to facies changes. In the Paragon Chemical Works (SD72NE/101) Borehole, the unit comprises 31 m of dark grey, fine-grained, ripple-laminated sandstone that rests on 25.2 m of mudstone.

The **Cancelloceras cumbriense Marine Band (G_1b^1)** rests on the Lower Haslingden Flags in the Paragon Chemical Works (SD72NE/101) Borehole; in the Wood Nook Mills (SD72NE/96) Borehole the marine band is sepatared from the Lower Haslingden Flags by 26 m of mudstone. The following fossils were identified from the marine band by WHC Ramsbottom in 1951, from the Paragon Chemical Works Borehole SD72NE/101: *Lingula mytiloides, Auiculopecten cf. losseni, Gastriceras crenulatum, Gastrioceras cumbriense, Orthocone* nautiloid, *Dunbarella elegans, Posidonia gibsoni, Bucanopsis, Pleurotornarian* gastropod.

The **Upper Haslingden Flags** have been proven in the Wood Nook Mills (SD72NE/96) Borehole 30.9 m above the Gastrioceras cumbriense Marine Band, where they are 0.91 m of very well-cemented siltstone.

The **Rough Rock** is 29.2 m thick in the Wood Nook Mills (SD72NE/96) Borehole. The Rough Rock overlies approximately 15 m of mudstone on the Upper Haslingden Flags. The Rough Rock is exposed in the Rising Bridge area [7810 2540], around which it has been quarried in numerous small quarries. A disused quarry 250 m to the west of Needless [7875 2568] exposed a pale grey, coarse-grained sandstone with rare quartz pebbles. At Sherfin Nook [7882 2543], approximately 4 m of pale pink, cross-bedded sandstone with planar bounding surfaces is exposed. The sedimentology of the Rough Rock is discussed in Hough (2004a). In the northern part of the Rochdale Sheet area, the Rough Rock typically contains many lithified stems of *Calamites, Cordaites, Sigillaria, Lepidodendron* and *Stigmaria* (Learoyd, 1988), which probably occurred as log-jams in the depositional fluvial system (Wignall and Kabrna, 1994).

The **Sand Rock Coal** has been proven to be 0.4 m thick in the Wood Nook Mills (SD72NE/96) Borehole; it rests on a 0.15 m fireclay seam 21 m above the base of the Rough Rock. The Rough Rock is overlain by up to 8.5 m of well-cemented siltstone and mudstone.

2.2 PENNINE LOWER COAL MEASURES GROUP

The Pennine Lower Coal Measures Group are known from exposures, boreholes and from workings for coal (both deep-mined and opencast), and sandstone and mudstone quarries within the district. Strata generally young towards the axis of a the Blackburn-Burnley Syncline that passes under Clayton Hall Farm in the west [7520 3200] and Jack Hill in the east [7965 3465]. Strata on the southern limb of the syncline have, in general, shallow north or north-westerly dips, while strata on the northern limb of the syncline dip steeply to the south-east. Generalized vertical sections of Pennine Lower Coal Measures Group strata within the Accrington district are shown in figures 4 and 7.

The **Subcrenatum Marine Band**, proved in the Wood Nook Mills (SD72NE/96) Borehole, is represented by 1.75 m of dark mudstone with rare goinatites and abundant lingula towards the base.

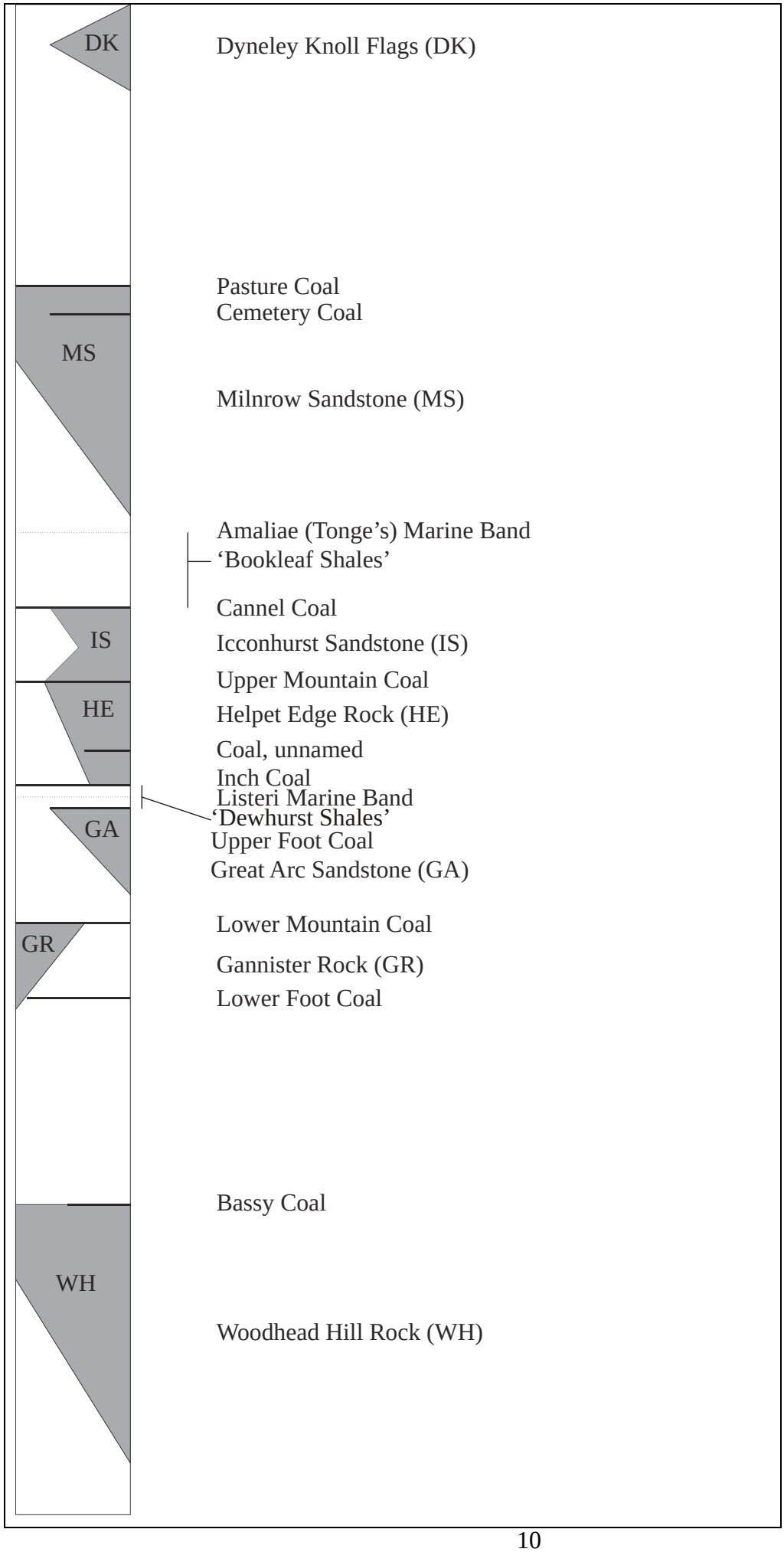
DK
Dyneley Knoll Flags (DK)
Pasture Coal
Cemetery Coal
MS
Milnrow Sandstone (MS)
Amaliae (Tonge's) Marine Band
'Bookleaf Shales'
Cannel Coal
IS
Icconhurst Sandstone (IS)
Upper Mountain Coal
HE
Helpet Edge Rock (HE)
Coal, unnamed
Inch Coal
Listeri Marine Band
'Dewhurst Shales'
GA
Upper Foot Coal
Great Arc Sandstone (GA)
Lower Mountain Coal
GR
Gannister Rock (GR)
Lower Foot Coal
Bassy Coal
WH
Woodhead Hill Rock (WH)

Figure 4: Generalized vertical section of the Westphalian A strata proved in the district, from the base of the Westphalian to the Dyneley Knoll Flags. Uncoloured parts of the section are mudstone-dominated Pennine Lower Coal Measures Group. Scale approximately 1:1000 (1 cm to 10 m).

The **Woodhead Hill Rock** overlies 25 m of mudstone on the Subcrenatum Marine Band. The unit is 14 m thick in the Wood Nook Mills (SD72NE/96) Borehole, where it is composed of well-bedded sandstone and siltstone. The thickness of the unit is estimated to thicken to approximately 45 m in the northern part of the district.

The **Bassy (Shale Bed) Coal** overlies the Woodhead Hill Rock; the maximum proven thickness in the district is 1.22 m at Victoria Pit, Accrington (SD72NE/107).

The **Lower Foot Coal** is 41 cm thick at Calder Pit, Simonstone (SD73SE/5). The Lower Foot Coal typically overlies 10-30 m of mudstone overlying the Woodhead Hill Rock.The **Gannister Rock** has been proved at Calder Pit, Simonstone (SD73SE/5), where it is 5.4 m thick; no further lithological details are available from within the district; elsewhere the lithology is of a medium-grained, orange-brown, micaceous, ripple-laminated sandstone (Hough, 2004b).

The **Lower Mountain Coal** overlies the Gannister Rock, or where this is absent, overlies approximately 9 m of mudstone on the Lower Foot Coal. The coal is 0.1-1.0 m thick within the district.

The **Great Arc Sandstone (Bullion Rock)** is present to the south of Accrington, along Laund Clough [7696 2743] and Warmden Brook [7780 2749 – 7801 2753], the latter being the type section for the unit. The lithology at Laund Clough (Location 7) is a buff-grey sandstone that is fine- to medium-grained and quartz and mica-rich. The sandstone is poorly-bedded and moderately-sorted, with angular, non-rounded to rounded grains. Boreholes prove the sandstone is up to 14.6 m thick (e.g., Borehole No. 5, Huncoat, SD73SE/35) in the northern part of the area, and overlies a variable thickness of mudstone on the Lower Mountain/Union Coal, up to 13 m thick.

The **Upper Foot Coal** has a maximum proved thickness of 1.0 m in Borehole No. 5 at Huncoat (SD73SE/35). The coal rests on the Great Arc Sandstone, and is not thought to be present beneath the northern part of the district.

Strata between the Upper Foot and Inch coals have traditionally been grouped together as the informal ‘Dewhurst Shales’. The ‘Dewhurst Shales’ are approximately 5-15 m thick, and comprise dark grey and black mudstone. The **Listeri Marine Band** rests on the Upper Foot Coal; the Marine Band has been identified in core in the Huntroyde Demense NCB BA/23/6 Borehole (SD73SE/40), where it was represented by dark grey, matt mudstone with Lingula, Gastrioceras, ?Posidonia and Dunbarella.

The **Inch Coal** is 0-0.15 m thick in the district; the coal rests approximately 15-22 m above the Lower Mountain Coal.

The **Helpet Edge Rock (Warmden Sandstone; Shoe Mill Rock)** is up to 33 m thick in the district. The sandstone overlies up to 30 m of mudstone on the Inch Coal. The sandstone is exposed in numerous quarries throughout the south-western and south-eastern parts of the district. A disused quarry to the north of Goodshaw Hill (Location 4) [7974 2718] exposed 2.54 m of buff, fine- to medium-grained micaceous sandstone that was massive or ripple-laminated and trough cross-bedded. To the south of Goodshaw Hill, 3.5 m of the sandstone was exposed in upwards-fining trough-sets with ripple-laminated tops (Figure 5).

The **Upper Mountain (Old Robin) Coal** overlies the Helpet Edge Rock; where this is absent, the Upper Mountain Coal rests on approximately 7 m of mudstone overlying the Inch Coal. The Upper Mountain Coal is up to 1.1 m thick. Boreholes indicate that the Upper Mountain Coal has been washed out in the central parts of the district, within fault blocks centred at [7700 2820], [7730 2790] and [7800 2800].

The **Icconhurst Sandstone** is a laterally impersistent sandstone unit that is up to 13 m thick. The type area of the sandstone is at Icconhurst [7625 2650], to the south of Accrington. The sandstone overlies up to 6 m of mudstone on the Upper Mountain Coal. No lithological details for the sandstone were available at the time of resurvey; no lithological details were given by Wright *et al.* (1927).

Figure 5: Helpet Edge Rock exposed in a disused quarry to the south of Goodshaw Hill [7982 2681]. Exposure of 3.5 m sandstone in upwards-fining trough-sets with ripple-laminated tops. Photograph taken to taken to 005; mapcase for scale is 30 cm high.

The **Cannel Coal** is up to 0.7 m thick. The coal overlies the Icconhurst Sandstone, or where this is absent, 5-13 m of mudstone overlying the Upper Mountain Coal.

The 'Bookleaf Shales' are an informal, mudstone-dominated unit between the Cannel Coal and Amaliae (Tonge's) Marine Band. The unit is up to approximately 21.4m thick, and comprises black mudstone with ironstone nodules. **Amaliae (Tonge's) Marine Band** has been identified in core in the Whalley Road NCB Borehole (SD73SE/39), where it was described as black shale with Dunbarella

The **Milnrow (Crutchman) Sandstone** is 13-40 m thick in the Accrington district. The sandstone is up to 30 m above the Cannel Coal. The sandstone has formerly been widely exploited in the district as a building and paving stone from numerous quarries; consequentially, the sandstone is well exposed. Sections within the Milnrow Sandstone are exposed in unnamed disused quarries approximately 500 m to the north of Mitchells House Reservoirs [7900 2820] (Location 2). The following section was exposed in the eastern face of the quarry:

> Upper 1 m: fine- to medium-grained sandstone, medium-bedded, planar bedded, with PCL (Planar Current Lineation) on the lowermost bedding plane, indicating palaeoflow to $101^{o}/281^{o}$.
>
> Lower 2 m: Sandstone, fine-grained, buff-brown, moderately well-sorted, with micaceous bedding planes. The sandstone is thinly-bedded and low-angle cross-bedded, with wavy

sub-horizontal bounding surfaces. Some bedding sets exhibit climbing ripples with black laminae that possibly have a high organics content. Ripple crest azimuths indicate a depositional palaeoflow to 267°.

Numerous exposures of the sandstone are located to the west of Mitchell's House Reservoirs, in Crutchman's Quarry (now disused) (Location 5) [7869 2745-7856 2760]. The lithology in this area is of a buff-grey, fine- to medium-grained, moderately to moderately-well sorted sandstone with coarse mica flakes on the main bedding planes. The sandstone is planar-bedded and ripple-laminated with straight crested ripples. Trough sets indicate a depositional palaeoflow to 330°. The sandstone sequence is interbedded with mudstone on an approximate 7:3 ratio. Dips of the sandstone in this area are steepened up to 59 degrees by faulting, as shown in Figure 6.

Figure 6: Milnrow Sandstone exposed at Crutchman's Quarry, to the east of Acctington [7862 2755]; bedding is steppened due to fault drag. Section is approximately 7 m high.

The **Cemetery Coal** is thought to occur within the Milnrow Sandstone under at least part of the district, although the coal has not been proved with any certainty from borehole or outcrop evidence.

The **Pasture Coal** is up to 0.8m thick (proved from Calder Pit, Simonstone, SD73SE/5) in three leaves). The coal rests directly on the Milnrow Sandstone.

The **Dyneley Knoll Flags** vary in thickness, from 0-15m thick. The Dyneley Knoll Flags are typically composed of well-bedded, micaceous sandstone that is rarely cross-bedded, with subordinate beds of mudstone.

The 'Accrington Mudstones' is an informal term for the mud-prone strata between the Dyneley Koll Flags and the Old Lawrence Rock. The units is up to 39.7 m thick (Calder Pit, Simonstone, SD73SE/5). The unit constitutes the most important brick-clay resource in the Accrington district and is still worked today (see 6.3, below), producing bricks commonly known as 'Accrington Stock'. Sections of up to 6 m of the 'Accrington Mudstones' are exposed in the disused Enfield Quarries [7540 3062]. Strata in the section dip gently to 290°, and comprise mudstone with subordinate sandstone.

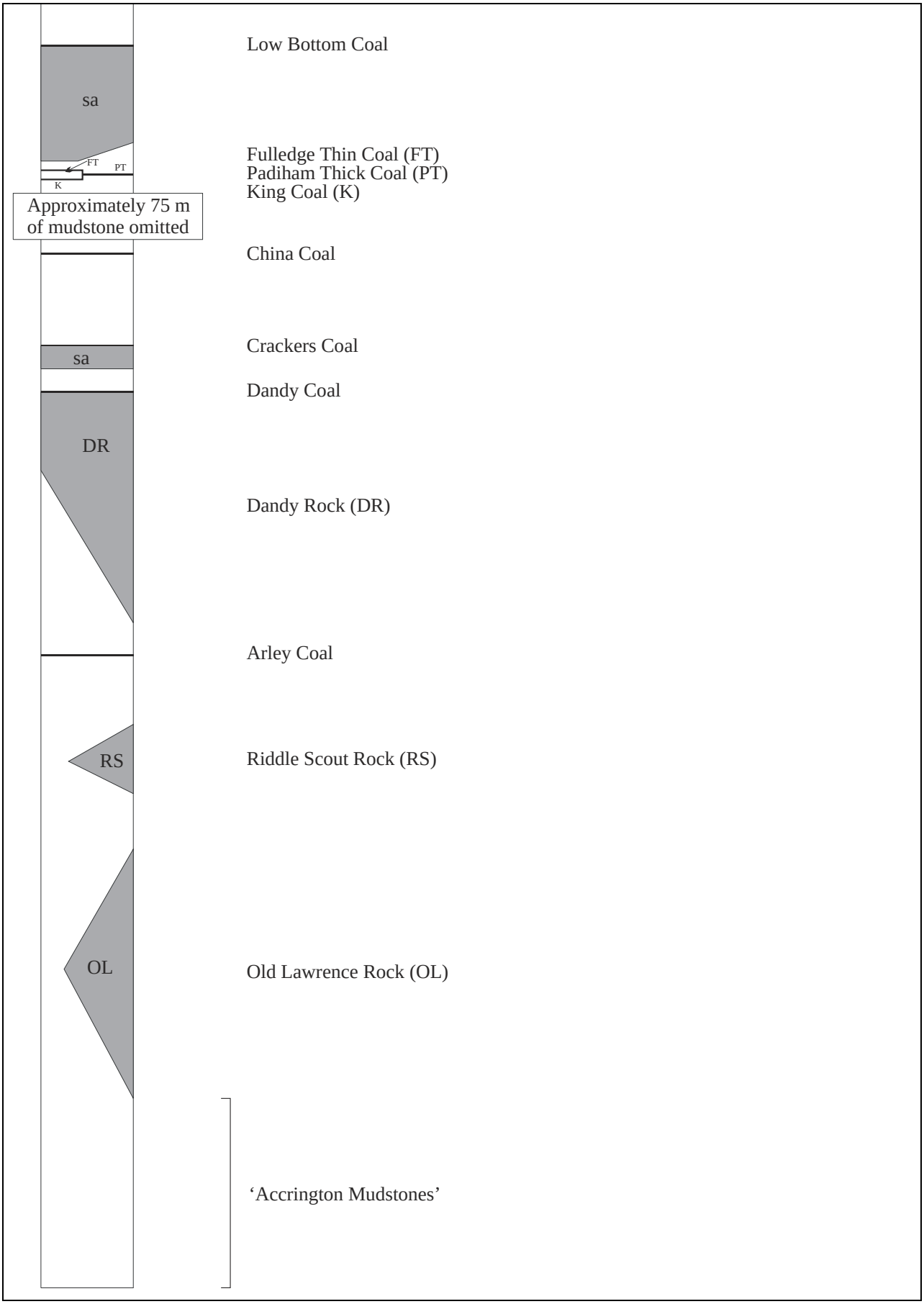

Figure 7: Generalized vertical section of the Westphalian A strata proved in the district, from the 'Accrington Mudstones' to the Low Bottom Coal. Sandstones named, or 'sa' when unnamed. Uncoloured parts of the section are mudstone-dominated Pennine Lower Coal Measures Group. Scale approximately 1:1000 (1 cm to 10 m).

The **Old Lawrence Rock** is up to 54.6 m thick in the district, and forms the major scarp between The Coppice [7720 2920] and Little Hameldon [8000 2890], to the east of Accrington, and Whinney Hill [7625 3075] to the north of the town. Approximately 4.5 m of the sandstone is exposed in the A56 road cutting [7762 2942] (Location 3). The lithology exposed at the A56 road cutting [7762 2942] is a fine- to medium-grained, moderately sorted, green-brown sandstone. The sandstone is poorly-bounded by very gently undulating surfaces that downcut slightly into the lower units; current ripples are preserved on the bounding surfaces, which indicate a depositional flow to 169. The sandstone is for the most part structureless between the bounding surfaces. The sandstone is well jointed by two major joint sets, striking 023^{o} and 284^{o}.

The sandstone has been exploited on a large scale at Hameldon Quarries [7878 2954] – [7987 2924] and Snipe Rake [7875 2935], to the north of Great Hameldon. At Hameldon Quarries (Location 6; Figure 5), up to 6 m of grey-buff, fine- to medium-grained, micaceous sandstone is exposed. The sandstone is well-bedded, with major bounding surfaces c. 2 m apart and minor bedding planes typically 5 cm apart. The sandstone is trough cross-bedded throughout, and rarely current ripple-laminated. The sandstone is interbedded with subordinate mudstone.

The **Riddle Scout Rock** is 0-15 m thick, attaining a maximum proven thickness in Calder Pit, Simonstone (SD73SE/5). The lithology is typically a grey-green, micaceous, cross-bedded sandstone with interbeds of silty sandstone and siltstone. The base Riddle Scout Rock is approximately 35m above the top of the Old Lawrence Rock, with the intervening strata being mudstone-dominated.

The **Arley Coal** overlies approximately 12-17m of mudstone on the Riddle Scout Rock. The coal is up to approximately 2 m thick. The coal was formerly taken as the boundary between the Lower and Middle Coal Measures within the Burnley Coalfield (Wright *et al.* 1927). It was also one of the main coals historically worked in the area; consequently, it is identified on most of the shaft sections and borehole logs that prove this interval of strata. The Arley Coal has been worked by intense bell-pitting at Moleside Moor [7835 2890].

The **Dandy Rock** overlies 25-35m of mudstone on the Riddle Scout Rock. The Dandy Rock is up to 49.7m thick, with the maximum thickness proved in Borehole No. 4 at Syke Side, Altham(SD73SE/28), where the Dandy Rock is interbedded by mudstone units up to 4.5 m thick. The Dandy Rock is not well-exposed in the district; elsewhere it typically comprises pale grey, medium-grained sandstone that is well-jointed and cross-bedded (Hough, 2004c). The Dandy Rock forms the high ground of Great Hameldon [7940 2895], to the east of Accrington.

The **Dandy Coal** overlies 0-6m of mudstone on the Dandy Rock. The coal is up to 0.9 m thick, and has been widely worked in the northern part of the district.

The **Crackers Coal** is not present at surface within the district, due to faulting. It is not proven by boreholes, but is thought to be present beneath the north-eastern part of the district. Based on provings from adjacent districts, the Crackers Coal is likely to be in the region of 0.5 m thick.

The **China Coal** is present beneath superficial deposits north of Higher Slade [7895 3500]. The coal is estimated to be 0.5 m thick.

The **King Coal** is up to 3.2 m thick (with partings). The following sequence was proven in Bancroft Engine Pit (SD73SE/3):

Roof Coal…….0.86

Mudstone…….1.73

Coal……..0.15

‘Parting’……...0.15

King Coal…….2.09

The **Fulledge Thick Coal (Habergham Blindstone)** is thought to be present beneath at least part of the north-eastern part of the district. Based on provings from adjacent areas, the Fulledge Thick Coal is likely to be 0.4-1.0m thick.

The amalgamation of the King and Fulledge Thin coals forms the **Padiham Thick Coal**, the thickest coal in the South Lancashire Coalfield. The Padiham Thick Coal is present at surface in the north-eastern part of the district, around Hargrove [7985 2485]. The Padiham Thick Coal has been worked in the Gawthorpe Hall Opencast Site [8040 3470] and the Hargrove Opencast Site [7970 3490]; the coal is 3.2 m thick in this area.

The **Low Bottom Coal (Clifton Blindstone)** comes to crop in the Jack Hill area [7970 3460]. Based on provings from the Burnley district (Hough, 2004c), the coal is likely to be approximately 0.9 m thick.

3 QUATERNARY

3.1 DEBRIS CONE

A limited area of Debris Cone has developed in the head of Bank Clough [8000 2898]. The deposit is composed of matrix-supported sandstone blocks, predominantly of Old Lawrence Rock. The deposit was actively moving downslope at the time of resurvey.

3.2 HEAD

Head is typically composed of unconsolidated, poorly-sorted and stratified sand, silt and clay, although it may contain bedrock clasts. Head in the district is formed by solifluction and soil-creep processes. Consequently, Head deposits are generally restricted to topographic hollows and lows.

Head is commonly associated with glacial meltwater channels. These channels (e.g., at Gaulkthorn [7518 2632]), cut by meltwater during the last glaciation, are up to 5m deep, and 50m wide. The channels are commonly dry, with Head deposits at their base. Head deposits are not likely to exceed 5 m thickness within the district. Thin spreads of blanket Head have been mapped at Hameldon Common [7900 2920], and around New Field Farm e.g., [7630 2510].

3.3 PEAT

Spreads of Peat have been identified on Hameldon Hill [7940 2855], Snipe Hole [7970 2780] and Cribden Moor [7980 2560]. Peat is typically composed of wet, dark brown, partially decomposed vegetation with interbeds of silt and sand. Peat in the district is estimated to be no more than 4 m thick; at Hameldon Hill [7490 2855], the deposit is not likely to exceed 2 m in thickness.

3.4 ALLUVIUM

Thin tracts of Alluvium have developed in the southern part of the district, associated with Woodnook Water, from Rising Bridge [7810 2555] in the south to Woodnook [7600 2735], to the south of Accrington. Alluvium typically comprises sand, gravel and clay, and may be well-bedded. The thickness of Alluvium along Woodnook Clough is unlikely to exceed 3m. In the northern part of the district, Alluvium is well-developed associated with the River Calder, where it is 8-11 m thick, comprising 1m of ‘loamy sand resting on [0.3m] banded pebbly sandstone underlain by coarse gravel’ (Earp *et al.* 1961).

3.5 FIRST RIVER TERRACE

First River Terraces associated with the River Calder have been mapped in the northern part of the district. Further details are given in Earp *et al.* (1961), p. 253-4.

3.6 GLACIOFLUVIAL SAND AND GRAVEL

Small areas of Glaciofluvial Sand and Gravel occur in the south-west of the district, around Red Walls [7572 2566], and at Rising Bridge [7848 2560]. Glaciofluvial Sand and Gravel at these locations are well-featured mounds resting on Glacial Till and Bedrock. The deposits are estimated to be up to 5 m thick, and are typically shallow-sided.

3.7 TILL

Much of the district is mantled by a patchy cover of Glacial Till; the cover becomes generally thicker and more extensive towards the central and western parts of the district. Till is exposed approximately 500 m to the east of Wooley Lane Farm [7845 2685], where it comprises a matrix-supported sandy clay with limestone pebbles. The morphology of the Glacial Till in the south and eastern parts of the district is generally subdued. The area around Lower Gate, Huncoat [7790 3040] is characterised by well-featured Till that forms mounds up to approximately 20 m in height, perhaps indicating deposition in contact with a body of ice.

4 STRUCTURE

The district is situated on the northern fringe of the Rossendale anticline (Williamson, 1956). The Accrington district lies within the central and northern parts of the Burnley Coalfield, which is part of the South Lancashire Coalfield. The Blackburn-Burnley Syncline is present in the northern part of the district, plunging south-westwards. To the south of this, strata dip gently, or are pseudo-horizontal. To the north of the Blackburn-Burnley Syncline, strata dip steeply to the south-east, as they come off the Pendle Monocline.

Strata within the district are affected by numerous faults. In the southern part of the district, where duperficial deposits are thin or absent, faults have been proved by field mapping. On the southern margin of the Calder Valley the thickness of the superficial deposits increases, and the presence of faults has been inferred mainly from deep mine workings and drilling for opencast coal prospects. Only the major faults within the area are described in this report, from south to north.

An unnamed fault trending westwards to south-westwards has been mapped from Cattle Plantation Higher [7500 2500] to Goodshaw Hill [7995 2750]. The fault has a throw in the region of 120 m to the north/north-west, throwing the Milnrow Sandstone to the north down against the Woodhead Hill Rock to the south in the Withins Grove [7930 2660] area.

An unnamed fault has been mapped trending north-eastwards from New Houses [7683 2520] to [7885 2840], where it terminates against an unnamed fault. The fault throws up to 36 m to the south-east, throwing the Milnrow Sandstone to the south-east down against the Icconhurst Sandstone to the north-west in the Warmden Clough [7845 2740] area.

The Dog and Partridge Fault has been mapped from Lower Baxenden [7795 2600] to Accrington [7585 2850]. The fault is itself offset in places by minor faulting, but broadly trends north-westwards. The fault throws up to 13 m to the south-west, throwing the Inch Coal to the south-west down against the Great Arc Sandstone to the north-east in the Oak Hill Park [7625 2770] area. The fault is named after ‘The Dog and Partridge’, a pub on Back Lane at Lower Baxenden.

An unnamed fault has been mapped trending broadly westwards from Scaitcliffe [7500 2745] to [7875 2827], where it terminates against an unnamed fault. The fault throws up to approximately 40 m down to the north, throwing the Helpet Edge Rock to the north down against the Lower Foot Coal to the south.

A major unnamed fault has been mapped trending broadly westwards from Accrington [7610 2840] to [8000 2830]. The fault throws up to approximately 250 m to the north, throwing the Dandy Rock to the north down against the Milnrow Sandstone to the south.

An unnamed fault has been mapped trending broadly westwards from Accrington Cemetery [7700 3000] to [8000 2980]. The fault throws approximately 60 m down to the south, throwing the Dyneley Knoll Flags to the south down against the Milnrow Sandstone to the north.

Although many faults in the northern part of the district can be traced over many kilometres (e.g., the unnamed fault mapped from Huncoat Quarry [7812 2977] to Read Hall [7588 3500]), they are generally characterised by throws that do not exceed 40 m.

5 ECONOMIC GEOLOGY

5.1 COAL

Coal is one of the main resources of the area, and although not presently worked, it has been extensively worked in the past. Extraction was by crop working, bell pitting, shaft and adit working prior to the 1950s, after which opencasting became the favoured method (Table 1). Practically all the seams in the district have been mined at one time or another, with workings concentrated in the thicker seams. An extensive area of bell-pitting is present at Moleside Moor [7835 2890], where the Arley Coal was formerly worked.

BGS Ref. No.	Site name and approximate Grid reference of site centre	Coal worked	Year ceased	Restoration
SD83SW/125	Hargrove/Gawthorpe Hall	Padiham Thick	1961	Full

Table 1: Details of the opencast coal site within the Accrington district.

5.2 SANDSTONE

Former workings for sandstone are widespread within the district. Many of the disused sandstone quarries within the district have been wholly or partially backfilled. The main areas of sandstone quarrying within the district are shown in Table 2.

Site location and approximate grid reference of quarry	**Sandstone worked**
Luddington Clough [7755 2555]	Rough Rock
Hill Top [7810 2580]	Rough Rock
250 m to the west of Needless [7875 2568]	Rough Rock
Sherfin Nook [7882 2543]	Rough Rock
South of Goodshaw Hill [7982 2681]	Helpet Edge Rock
North of Goodshaw Hill [7974 4218]	Helpet Edge Rock
500 m to the north of Mitchell's House Reservoirs [7900 2820]	Milnrow Sandstone
Crutchman's Quarry [7862 2755]	Milnrow Sandstone
Hameldon Quarries [7878 2954] – [7987 2924]	Old Lawrence Rock
Snipe Rake [7875 2935]	Old Lawrence Rock

Table 2: Main sandstone quarries within the Accrington district.

5.3 MUDSTONE-BRICKCLAY

The Accrington district is synonymous with the brick manufacturing and brickclay extraction industries. The industry has been active since 1875 (Wright *et al.* 1927), aided by the abolition of

the brick tax in 1851. A disused brick-clay quarry is present at Huncoat [7730 3056]. Two large quarries are presently active to the north and north-east of Accrington. Park Royal Whinney Hill Quarry [7590 3050], an extension of Enfield Quarry [7530 3050], is currently operated by Marshalls/NORI, and has been operational since the late 1800s. Huncoat (Rakehead) Quarry [781 297] is currently operated by Ibstock. Both quarries work the Accrington Mudstones, which underlie the Old Lawrence Rock. A log of the worked strata at Whinney Hill [c.7590 3050], given in Wright *et al.* is repeated below:

Old Lawrence Rock: siltstone and sandstone	
Brown mudstone of variable thickness	c. 6.09 m
Ironstone band	0.69 m
Brown mudstone	15.2 m
Ironstone band	0.12 m
Brown mudstone passing down into	
greenish (‘blue’) silty mudstone	c. 12.2 m

5.4 FIRECLAY

Fireclay was previously worked from Hardy Brick and Tile Works (formerly Higher Antley Quarry) at Fern Gore [7557 2731] (Wright *et al.* 1927). Fireclay was extracted from the Cannel Coal fireclay, which is approximately 1.2 m thick. The clay was used in the manufacture of coke-oven bricks (Wright *et al.* 1927).

6 MAN MADE DEPOSITS and WORKED GROUND

6.1 MADE GROUND

The main areas of Made ground within the district occur at:

SD72NE

Quarry spoil at Hameldon Scouts (Figure 8) [7895 2960] to [7990 2930].

Figure 8: Hameldon Quarry and Hameldon Scouts: spoil (Pendle Hill at skyline). Image taken to the north-east, from [7895 2960].

Quarry spoil at Warmden Clough [7850 2745].

Accrington town centre [7590 2880].

Infilling of Priestly Clough at Woodnook-Scaitcliffe [7575 2825].

Road embankments associated with the A56/A680 [2500 7865] to [2990 7790].

Industrial land, Rising Bridge [7780 2562].

Mitchell's House Reservoir embankments [7878 2750].

SD73SE

Embankments associated with the M65 [7618 3103] to [7960 3183].

Embankments associated with the A56 [7820 3027].

Embankments associated with power station site [7810 3135].

Former landfill, Pollard Moss [7975 3210].

Embankments associated with disused railway, Martholme [7500 3300] to Padiham [7938 3368].

Quarry spoil at Huncoat [7715 3046].

Embankments associated with Leeds and Liverpool Canal [7500 3111] to [8000 3200].

6.2 WORKED GROUND

The main areas of worked ground occur at:

SD72NE

Cuttings associated with disused railway, Baxenden [7710 2634] to Scaitcliffe [7600 2790].

Cuttings associated with railway at Laneside [7645 2943].

Huncoat (Ravenhead) Quarry [7810 2970].

Road cuttings associated with the A56 [7840 2500] to [7770 2960].

SD73SE

Park Royal-Whinney Hill Quarry and Enfield Quarry [7590 3050].

Disused quarry at Huncoat [7730 3056].

Cuttings associated with the M65 [7500 3050] to [7925 3180].

Cutting associated with the A56 [7830 3075].

6.3 INFILLED GROUND

Infilled ground includes excavations fully or partially backfilled. BGS does not hold definitive records of the nature or type of backfill for the majority of sites. The main areas of Infilled Ground occur at:

SD72NE

Infilled quarry, Rising Bridge [7795 2580].

Partially backfilled quarry, 500 m north of Mitchell's House Reservoirs [7900 2820].

Backfilled quarry, Snipe Rake [7870 2936].

Hameldon Quarries, Hameldon Scouts [7880 2955] to [7975 2940].

Former Hardy Brick and Tile Works (formerly Higher Antley Quarry) at Fern Gore [7557 2731]

SD73SE

Park Royal-Whinney Hill Quarry, and land to the south of Whinney Hill Road [7580 3028].

Enfield Quarry [7545 3045].

Infilled quarry at Quarryfield Farm [7980 2995].

Hargreave Opencast Site (Restored) [8000 3500].

6.4 LANDSCAPED GROUND

SD72NE

Dill Hall schools complex [7530 2960].

Bullough Park, Fern Gore [7557 2750].

Green Haworth Golf Course [7600 2600].

Milnshaw Park, Milnshaw [7540 2910].

Oak Hill Park, Woodnook [7655 2765].

School site, Fern Gore [7515 2750].

School site, Baxenden [7660 2700].

Haworth Park, Baxenden [7670 2720].

Accrington Stanley football ground [7575 3000].

SD73SE

Industrial estate, Altham [7750 3275].

Power station, south-west of Padiham [7850 3325].

6.5 DISTURBED GROUND

SD72NE

Land 500 m north of Mitchell’s House Reservoir [7880 2820].

7 GEOLOGICAL HAZARDS

7.1 UNCONSOLIDATED DEPOSITS

Unconsolidated deposits in the Accrington area include **Debris Cone, Head, Peat, Alluvium, First River Terrace Deposits, Glaciofluvial Sand and Gravel and Glacial Till.** Unconsolidated deposits are internally heterogeneous, and can be highly compressible compared with other drift deposits or bedrock, and may give rise to excessive or differential settlement of superposed structures. For this reason particular care should be taken in the siting of any construction on such deposits. The presence of relatively impermeable till beneath sand may cause the presence of a perched water table. Running conditions may be encountered in such unconsolidated deposits if encountered below the water table.

7.2 LANDSLIP

Steep slopes consisting of interbedded sandstone and mudstone (such as those formed by parts of the Pennine Lower Coal Measures Group and Millstone Grit Group) may be susceptible to slope instability and failure. Additionally, in certain circumstances, slopes composed of Glacial Till may also be susceptible to slope instability and failure. Two main areas of landslip have been identified during the resurvey. Slopes at Herst [788 298] (Figure 9) are comprised of mudstone underlying the Old Lawrence Rock and apparently Glacial Till.

Figure 9: Slips lobes at Herst [788 298]; mounds in the extreme right hand side of the image are quarry spoil.

Slopes in the upper part of Cocker Lumb [7535 2555] have a moundy, lobate form, indicating ground movement. The slips at Cocker Lumb [7535 2555] are within mudstone that underlies the Milnrow Sandstone.

Small areas of landslip have been identified at Warmden Clough [7780 2745], Priestly Clough/Woodnook Water e.g., [7625 2682] and Rothwell Heights [7590 2700].

7.3 MAN MADE DEPOSITS

Man Made Deposits represent a hazard in three main ways:

1. Areas of backfill (see 'Infilled Ground', above) may have been poorly compacted when emplaced or may contain materials likely to rot or corrode. The composition of the fill material can vary from site to site, and within short distances on a single site. This may lead to unpredictable bearing capacity and uneaven settlement. Additionally, the backfill material may be partly water-soluble and the slow dissolution by water over time may result in the formation of voids and unpredictable ground conditions. If the spoil is dumped on a slope, any buried soil/organic layer may form a plane of weakness and therefore might form a potential failure surface. Poorly managed groundwater flow in embankments and spoil heaps may allow pore pressures to build up in these deposits, resulting in slope failure.
2. Toxic residues, either as a primary component of a Man Made Deposit or generated secondarily by chemical or biological reactions, can migrate both within a deposit itself, and into adjacent permeable strata. The presence of partially backfilled quarries in this area may provide a source of such a hazard.
3. Toxic or explosive gases, particularly methane, can be generated within waste tips and landfill sites. Such gases migrate (sometimes through adjacent permeable strata) and accumulate within buildings or excavations either nearby or some distance away (Aitkenhead and Williams, 1991; Hooker and Bannon, 1993). As with toxic residues, the presence of backfilled quarries may provide a potential hazard.

The possible problems presented by Man Made Deposits in various geological contexts should be addressed by appropriate geotechnical investigations. It must always be borne in mind that, in an area of past and active opencast mining and quarrying, Man Made Deposits are common. Those shown on 1:10 000 Geological Sheet SD72NE/SE (Accrington and Padiham) were delineated principally by recognition in the field and the examination of documentary sources. As such, only the more obvious Man Made Deposits can be mapped by this method, and the boundaries shown may contain inaccuracies

7.4 COAL MINING SUBSIDENCE

Much of the area has been undermined, often at many levels under any one site, and from surface to potentially considerable depths. Deep mining ceased in the 1950s and any subsidence affects are likely to have long ceased. A detailed account of the mining history and possible effects that may be related to mining can be obtained from the Coal Authority, Mining Reports, 200 Lichfield Lane, Mansfield, Nottinghamshire NG18 4RG.

7.5 MINEWATER POLLUTION

Minewater pollution has been a problem since the cessation of deep mining in the region. Polluted minewater (locally termed 'race') has escaped into the local waterways from numerous collieries in the region. After the mine-pumps are turned off, rising groundwater can exit the mine void through shafts and adits. The Coal Authority has undertaken remediation at numerous sites in recent years (for example, at the site of the former Old Meadows Colliery [8680 2400]) in order to alleviate the problem.

Appendix 1

Grid references of borehole and shaft sections, and opencast sites referred to in text.

BGS Ref. No.	Borehole/Shaft/Opencast Name	Grid Reference
SD72NE/96	Wood Nook Mills	7592 2783
SD72NE/101	Paragon Chemical Works	7760 2561
SD72NE/107	Victoria Pit, Accrington	?7644 2635
SD73SE/3	Bancroft Engine Pit, Padiham	7922 3492
SD73SE/5	Calder Pit, Simonstone	7744 3322
SD73SE/28	Borehole No. 4, Syke Side, Altham	
SD73SE/35	Borehole No. 5, Huncoat	7707 3068
SD73SE/39	Whalley Road, Padiham NCB Borehole BA/23/2	7848 3393
SD73SE/40	Huntroyde Demesne NCB BA/23/6	7873 3454

Appendix 2

Location Number	Grid Reference	Stratigraphy exposed; location
Location 2	[7913 2809]	Milnrow Sandstone; unnamed quarry, 500 m north of Mitchell's House Reservoirs
Location 3	[7762 2942]	Old Lawrence Rock; A56 road cutting
Location 4	[7974 2718]	Helpet Edge Rock; North of Goodshaw Hill
Location 5	[7869 2745]	Milnrow Sandstone; Crutchman's Quarry, west of Mitchell's House Reservoirs
Location 6	[7987 2928]	Old Lawrence Rock; Hameldon Quarries
Location 7	[7696 2743]	Great Arc Sandstone; Laund Clough

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Most of the references listed below are held in the Library of the British Geological Survey at Keyworth, Nottingham. Copies of the references may be purchased from the Library subject to the current copyright legislation.

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