British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Doncaster Geodiversity Assessment

Volumes 1& 2

Geology and Landscape South Programme
Commissioned Report CR/07/025N

Doncaster
Metropolitan Borough Council

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Volume 1 – Report

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BRITISH GEOLOGICAL SURVEY
GEOLOGY AND LANDSCAPE SOUTH PROGRAMME
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Doncaster Geodiversity Assessment

Volume 1 – Report

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Foreword

Increasing pressure on land and the environment demands a greater awareness and understanding of the dynamics of our natural world in order to deliver a sustainable environment for the future. Biodiversity and the need for the Government to recognise, audit and plan for habitat and ecology is widely accepted and enshrined in UK legislation. However, the importance of the complementary concept of Geodiversity is only now gaining recognition, despite providing the foundations for habitats and species.

Geodiversity has a vital role in all aspects of the natural heritage and impacts on many sectors in economic development and historical and cultural heritage. For example, in the development of sustainable eco or geo-tourism (UNESCO Global Geoparks), Strategic Environmental Assessment, local authority structure and mineral plans, building stone resources, education and art.

Nationally important geological sites have been assessed and are protected by statutory measures, but other than Regionally Important Geological and Geomorphological Sites (RIGS) in some areas, there is little systematic inventory and evaluation of local sites or development of management measures for these sites. The introduction of Planning Policy Statement 9 (PPS9): *Biodiversity and Geological Conservation* has elevated the importance of geodiversity to a new level in England and Wales.

This report produced by the British Geological Survey seeks to address the aims of PPS9 and provides a foundation for developing a Doncaster Geodiversity Action Plan.

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Contents

Summary

This report describes a resurvey of Doncaster's RIGS (Regionally Important Geological and Geomorphological Sites) commissioned by Doncaster Metropolitan Borough Council (DMBC). It updates and expands the 1997 South Yorkshire RIGS Group survey of geologically important areas in Doncaster Barnsley and Rotherham.

Since 1997 the concept of geodiversity has moved up the planning agenda. The recent Planning Policy Statement 9: Biodiversity and Geological Conservation (PPS9), which places equal weight on biodiversity and geodiversity is a key driver in this process. The report will allow DMBC to develop a Doncaster Geodiversity Action Plan and incorporate this within the Local Development Framework.

RIGS resurvey work took place between January and March 2007. Site assessment data was collected using the UKRIG Site Assessment Form and entered into the UKRIGS GeoConservation database. Problems were encountered in using this database, especially importing and exporting data and the translation into a user-friendly report format. The database entries have been exported and appended to ESRI shape files for use in Geographic Information Systems (GIS).

Of the 28 sites listed in 1997, 23 are recommended for continued designation as RIGS, while five sites are proposed for removal from the list. Six new sites were surveyed and are recommended for designation as RIGS, bringing the total RIGS in Doncaster to 29. The new sites are:

- DR1-Denaby Woods –Mexborough Oxbow Lake
- DR2-Harlington Railway Cutting
- DR3-Cadeby Waste Water Works
- DR4-Nearcliff Wood Quarries
- DR5-Levitt Hagg Wood
- DR6-Barnburgh Cliff

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1 Introduction

1.1 PROJECT BACKGROUND

Doncaster Metropolitan Borough Council (DMBC) is currently progressing the production of the Local Development Framework (LDF), the new style development plan. An important aspect of the LDF system is the requirement for policy formulation to be underpinned by a robust and credible evidence base.

Geodiversity can be defined as, "the variety of rocks, fossils, minerals, landforms and soils, along with the natural processes that shape the landscape" (Stace and Larwood, 2006). Development can harm it both directly (e.g. mineral extraction, road building) and indirectly (e.g. air pollution), but may also offer opportunities to create more rock exposures, or planning permission may insist on mitigation, such as future monitoring and maintenance work.

In 1997 Doncaster, with Barnsley and Rotherham, undertook a survey to identify the geologically important areas of the Borough (see Figure 1 for authority boundaries). However, since the 1997 survey the concept of geodiversity has moved up the planning agenda as authorities start to move beyond surveys and develop Geodiversity Action Plans. A key driver for this is Planning Policy Statement 9: Biodiversity and Geological Conservation (PPS9), which places equal (and considerable) weight on biodiversity and geodiversity (see section 1.3).

BGS was contracted to undertake a desk and field resurvey of these existing Regionally Important Geological/Geomorphological Sites (RIGS), suggest up to five further sites for designation as RIGS and to report the results of this work.

1.2 PROJECT OBJECTIVES

The objectives of this project are to:

- Compile a desk summary of the geology of Doncaster, a stratigraphic column highlighting the strata that can be seen within Doncaster, and accompanying summary maps in A3 format.
- Present the above to a workshop in February 2007 to seek views on the content of the background document and whether any sites of importance were omitted from the 1997 survey.
- Re-survey the 27 existing RIGS within Doncaster, plus any additional sites identified as a result of the workshop, using the UKRIGS Field Record and Site Assessment form
- Present the results of the survey work as a final report and database linked to GIS layers in ESRI shapefile format.

1.3 LEGISLATIVE AND POLICY CONTEXT

The introduction of PPS9 by the Office of the Deputy Prime Minister (ODPM, now DCLG, Department for Communities and Local Government) has elevated the importance of geodiversity to a new level in England and Wales. In PPS9, the Government's objectives for planning include:

- **to promote sustainable development** by ensuring that biological and geological diversity are conserved and enhanced as an integral part of social, environmental and economic development, so that policies and decisions about the development and use of land integrate biodiversity and geological diversity with other considerations.

- **to conserve, enhance and restore the diversity of England's wildlife and geology** by sustaining, and where possible improving, the quality and extent of natural habitat and geological and geomorphological sites; the natural physical processes on which they depend; and the populations of naturally occurring species which they support.

The first of six key principles in the document states:

- Development plan policies and planning decisions should be based upon up-to-date information about the environmental characteristics of their areas. These characteristics should include the relevant biodiversity and geological resources of the area. In reviewing environmental characteristics local authorities should assess the potential to sustain and enhance those resources.

2 Geodiversity and its importance

International recognition of the need to conserve biological diversity led to the UN Convention on Biodiversity agreed at the Rio Earth Summit in 1992 and the subsequent signing by over 160 countries. Since the UK government published 'Meeting the Rio Challenge' in 1995, most local authorities or regions in the UK have prepared and implemented Biodiversity Action Plans (BAPs) for their areas, and biodiversity is now accepted as an essential element in sustainable development planning and management strategies.

Until relatively recently the parallel concept of geodiversity had attracted little interest, despite its fundamental importance in underpinning biodiversity by providing the substrates.

Geological and landscape features, other than those already afforded some measure of protection such as SSSIs, are often seen as sufficiently robust not to require active management or action planning. All geological features are potentially vulnerable. In addition to threats posed by inappropriate site development and the infilling of quarries, the encroachment of vegetation, natural weathering and general deterioration with time may threaten to damage or obliterate important geological features. This situation would not be tolerated in wildlife or archaeological sites of comparable scientific or educational value.

The geodiversity of an area may be considered as one of its chief natural resources. A key starting point is an appreciation of the most up to date available understanding of the area's geology, landforms and soils, together with the processes and phenomena which have formed them and continue to influence them. An area's geodiversity thus encompasses:

- sites or natural features which are deemed worthy of some form of designation or protection for the quality of Earth heritage features displayed
- sites or natural features where representative examples of the area's Earth heritage may be seen
- sites and natural features currently employed in interpreting Earth science
- resource potential for geotourism and education
- the whereabouts and nature of past and present working of mineral products
- the influence of earth science in shaping the man-made environment, urban landscapes and architectural heritage
- natural hazard management
- the inter-relationship and inter-dependence between Earth heritage and other interests, for example biodiversity, arcaheology, history
-

Documentation of an areas' geodiversity may include:

- sites with geological exposures
- materials collections and sites and other records such as borehole logs
- published literature and maps
- the historical legacy of research within the area

2.1 GEODIVERSITY – WHY IS IT IMPORTANT?

Geodiversity is fundamental to almost every aspect of life – all raw materials that cannot be grown and all energy that cannot be generated by renewables have to be found using geological science.

A clear understanding of geology is also vital to the design and location of buildings, roads, railways and airports as well as to the safe control of waste disposal, and the management of a wide range of natural and man-made natural hazards. All are aspects of geodiversity.

An awareness of geodiversity helps us to understand our environment and predict environmental change in the future. Geological research demonstrates that surface environments are continually evolving through natural self-regulating systems involving the Earth's crust and mantle, oceans, atmospheric processes and life forms. Human activity imposes further pressures and changes to these natural cycles, which pose great challenges to modern society. Exhaustion of finite resources such as fossil fuel and global climate change are two of the most pressing. Only by studying the geological record can we hope to predict the earth's response to these changing conditions.

The recognition of natural and cultural heritage features and their sustainable management are today accepted as important functions within a civilised society. The importance of the range and diversity of Earth heritage features – the 'geodiversity' - of any area is as important a facet of its natural heritage as its wildlife interests. Conservation, sustainable management, educational use and interpretation of geodiversity are thus as important as that of biodiversity or archaeology.

However, geodiversity is not, or should not be regarded merely as concerned with conservation of Earth heritage sites or features – it has a vital place in all aspects of natural heritage and impacts in fields as varied as economic development (for example, supporting the development of geotourism in the new UNESCO European Geopark Network), building stone resource development, education and lifelong learning, archaeology, art and wildlife. Geodiversity may be one of the most significant areas of heritage interest in areas of high landscape value, or areas previously or currently affected by significant mineral extraction.

Geodiversity interests need to be integrated into other policies and processess relating to sustainable development including:

- Strategic Environmental Assessment
- Local Development Framework and mineral plans
- The Water Framework Directive
- EU Soil Protection Directive
- Local Biodiversity Action Plans

An appreciation of geodiversity is important for a comprehensive understanding of many aspects of biodiversity. It also offers substantial opportunities to enhance the conservation, management, educational use and interpretation of such related features. Because it has hitherto received little serious consideration, geodiversity needs to be addressed and evaluated by expert earth scientists.

3 The Geology of Doncaster

3.1 INTRODUCTION – BEDROCK

The oldest rocks that are found at the surface in Doncaster belong to the Pennine Middle Coal Measures Group of the Carboniferous System (Figures 2 – 4) and whilst older rocks have been proven by colliery shafts and boreholes and were once highly significant to the coal mining industry, these are underground and not considered relevant to this report.

The configuration of landmasses across the earth during Carboniferous times was very different from today. By the beginning of the Carboniferous Period, roughly 360 million years ago (Ma), the area destined to become South Yorkshire was part of a continent known as Laurasia that had moved to a position almost astride the equator. At this time much of what is today northern England began to be progressively submerged beneath a wide, shallow tropical sea, in the clear, warm waters in which beds of limestone accumulated. Periodic influxes of sand and mud, deposited by deltas building from a landmass to the north or north east, periodically established swamp or delta top environments, occasionally with the development of lush tropical forests. The evidence for these conditions is preserved today as the layers of sandstone and mudstone of the Carboniferous rocks. As Carboniferous times progressed, tropical forest cover became much more frequent, the remains of which are preserved today as the coal seams of the Coal Measures.

Towards the end of Carboniferous times, about 290 million years ago, that part of the earth's crust on which the Carboniferous sediments had been deposited continued to drift northwards. Major Variscan earth movements associated with the formation of the supercontinent, Pangaea, once more created mountains across what became northern England. By about 280 million years ago, during the early Permian Period, northern Europe was one of the world's great deserts and the area that is today the Pennines probably consisted of mountains, with valleys choked with rock debris broken from these rapidly eroding barren uplands. Up to 500 m of Carboniferous rocks were eroded by this desert erosion, forming huge wind-blown sand dunes that covered much of a comparatively low gently rolling plain that sloped gently eastwards into the subsiding North Sea Basin. These are the 'Yellow Sands Formation' that is very occasionally seen at the base of the limestone escarpment in the western part of Doncaster today.

This Permian desert was soon inundated by the rapidly advancing waters of a sea, known to geologists as the Zechstein Sea. This occupied an area within a subsiding basin, flanked by uplands to the south and west, which included that of the modern North Sea and stretched into Eastern Europe. Sediments deposited in the Zechstein Sea record five major and numerous minor cycles of sea level change, with periods of high salinity, in part due to periods of evaporation of substantial parts of the sea, resulting in the deposition of repeated sequences of carbonate, evaporite and clastic sediments.

The earliest Zechstein sediments in Doncaster, associated with the first phase of inundation by the sea, comprise a muddy dolostone (formerly termed limestone) sequence (formerly called the Lower Permian Marl, but now included as the lower part of the Cadeby Formation), which was deposited at the south-western edge of the North Sea Basin in a large river estuary or a lagoon. With the sea level continuing to rise, a succession of dolostones was deposited, which, from the common occurrence of the magnesium carbonate mineral dolomite, was previous known as the Lower Magnesian Limestone (now Cadeby formation). A well-known feature of the Cadeby Formation is the presence of very well preserved fossilized reefs composed of bryozoans, algae, bivalves and brachiopods. These were formed in shallow water, very near to an ancient shoreline to the west.

With the next major change in sea level and the regression of the Zechstein Sea into the centre of the marine basin to the north-west, the land reverted to a low lying, wide coastal plain containing transient lagoons and playa lakes into which sediments derived from an arid hinterland to the west and south were deposited. This Edlington Formation (formerly The Middle Permian Marl) comprises calcareous mudstones, with occasional layers of gypsum that indicates the periodic incursion and evaporation of an increasingly saline Zechstein Sea.

Another substantial rise in sea level during the middle of the Permian Period saw the land once again inundated, with a return to shallow shelf conditions and the deposition of the dolomitic limestones of the Brotherton Formation (formerly the Upper Magnesian Limestone) near to the ancient sea shore.

Once again, the Zechstein sea level dropped with a return to a palaeoenvironment dominated by lagoons and playa lakes, where layers of anhydrite and rock salt were formed; especially to the north and east of the region and extending into north-east England, where thick deposits were laid down in the centre of the still subsiding basin. At the end of the Permian, 250 million years ago, when this Roxby Formation was formed, the Zechstein Sea finally dried up and the region remained arid and was covered in thick spreads of sandy fluvial deposits, commonly with pebbles and laid down as flash floods, that were derived from the erosion of upland areas to the south. Although in England there are no obvious boundaries visible in the rocks, the deposition of the Sherwood Sandstone Group (formerly Bunter and Lower Mottled Sandstones) marks the transition from the Permian to the Triassic Period, which ended 205 million years ago.

Successively younger rocks to the east of the region record geological events up to modern times, in Doncaster these are absent and there is no tangible evidence of the geological history until the deposits left by ice sheets during the glacial period of the Quaternary which began here about two million years ago. However, based on the geological record found in the surrounding regions, some general assumptions can be made. The latest Triassic saw the continuation of desert conditions, dominated by dust storms.

For much of the Jurassic Period the district was covered by shallow open seas, with mudstone and at times limestone deposition, but it is possible that in the middle part of the period, northern and western areas experienced brackish and freshwater depositional conditions, with transient emergence and erosion. Similar mainly nonmarine and periodically emergent conditions probably continued during much of the early Cretaceous. In the late Cretaceous, however, the sea in which the Chalk was deposited covered the entire district. During the Tertiary, differential uplift and the imposition of an overall easterly dip resulted in prolonged erosion, which removed all the post-Triassic rocks from the district and exposed Permian rocks in the extreme west. The westerly and northerly flowing drainage pattern evolved during this time.

3.2 INTRODUCTION – QUATERNARY

At the start of the Quaternary, which commenced approximately 2.5 Ma and is commonly referred to as the ‘Ice Age’, an episode of global cooling caused polar ice sheets to extend southwards to cover much of Great Britain and Northern Europe. During the Quaternary the climate oscillated between colder (glacial) and warmer (interglacial) stages. Study of sediments, landforms and fauna onshore and offshore have identified 14 to 17 stages of alternating cold glacial and warm interglacial conditions in Great Britain. The extensive ice sheets, which in places were over 1 km thick, resulted in erosion and modification of the existing landscape. The effects of persistent freeze-thaw action in ground, which was often very deeply frozen, and the deposition of a variety of glacial sediments further modified this pre-existing landscape.

The most recent glaciation, the Devensian, ended around 11,500 years ago, marking the beginning of the Holocene or recent period and deposits reflect erosion and deposition in a varied succession of environments during much milder climatic conditions. Fluvial deposits occur in almost all valleys or river courses and are still forming. These include a wide range of

deposits including clays, silts, sands and gravels. Landslides occur in many areas and are not necessarily limited to steep slopes or hillsides. Peat deposits also developed during the Holocene after the glaciers retreated and occur both in local topographic lows in the deglaciated landscape and as extensive expanses of blanket bog over areas of high ground.

In Doncaster, Quaternary deposits cover 60 per cent of the land (Figures 5 and 6), generally being most extensive and thickest in the low-lying areas. Much of the form of the present day physical landscape derives from the effects of this prolonged period of ice cover and its subsequent melting. This has strongly influenced settlement patterns agriculture and, in historical times, man has diverted some of the rivers during high tides to produce extensive spreads of artificially induced alluvium, or warp to raise and fertilise the land.

The interpretation of the Quaternary deposits provides a wealth of information on the environments of the recent geological past. Information from glacial landforms and the nature and morphology of glacial deposits is essential to the understanding of these climatic conditions and may provide valuable insights into likely future environmental changes related to global warming. The study of Holocene fluvial sediments allows interpretation of the evolution of rivers or streams, including extreme events such as flooding.

BGS has subdivided Britain into a number of Quaternary domains, based on the occurrence of distinctive Quaternary landform-sediment associations and structural characteristics. Doncaster is covered by three Quaternary domains (Figure 7):

1. Plateau and Valley Domain
2. Dissected Till Domain
3. Lowland Basin Domain

Within the district there are deposits attributable to the last three British Quaternary stages (the Ipswichian, Devensian and Flandrian), and also to an older, pre-Ipswichian, glacial stage. Consequently, the long, early part of the Quaternary appears to represent a continuation of the denudational regime that had persisted during Tertiary times. The oldest deposits, of pre-Ipswichian glacial origin, indicate the existence of a thick cover of ice derived from the north and north-west, beneath which deep subglacial incision and deposition took place; fluvioglacial meltwater deposits entered the district from the south and west during deglaciation. Subsequent fluvial incision occurred just prior to the temperate Ipswichian Stage as a result of the sea level being at or more than 13 m below OD, which suggests retarded glacioeustatic effects. As sea level rose to about, or just above, OD during this interglacial, estuarine deposits formed in the incised drainage courses.

Somewhat later, the rivers Don and Idle deposited extensive spreads of river terrace deposits (Older River Gravel on some maps). In the cold Devensian Stage, which apparently began about 120 000 years ago, sea level fell to more than 20 m below OD, again reflecting glacioeustatic effects, and rivers crossing the district incised wide valleys directed towards the Humber Gap to the east. Periglacial conditions, indicated mainly by cryoturbation structures and ventifacts, prevailed during at least part of this long incision phase. However, except possibly for some fluvial sand and gravel now deeply concealed beneath the Hemingbrough Formation, and also possibly some head, there is no evidence of deposition until late in the Devensian.

Then, probably about 18 000 years ago, glacial blockage of the Humber Gap impounded a large lake (Lake Humber) across much of the district and adjacent areas. The lake rose initially to about 30 m above OD, sand and gravel being deposited around its margins. During this high-level lacustrine phase a tongue of ice surged southwards down the Vale of York and into northern and eastern parts of the district, depositing sand and gravel into the lake. The ice soon melted and the lake level fell, apparently transiently to as low as 4 m below OD, before establishing a longer lasting level at about 9 m above OD. Lake Humber finally disappeared, apparently by filling up with sediments, which are known as the Hemingbrough Formation.

Rivers then deposited sandy levees as they initiated courses across the emergent lacustrine plain. In the last millennium of the Devensian (which by definition terminated 10 000 radiocarbon years ago), blown sand accumulated in places, and some ventifacts and cryoturbation structures at the top of the Devensian glacial and lacustrine deposits may have formed at this time.

At the beginning of the Flandrian or slightly earlier, breaching of the glacial deposits in the Humber Gap allowed the rivers crossing the district to incise their courses down almost to 20 m below OD, again in response to the continuing eustatically low sea level. As the sea rose to its present level later in the Flandrian, alluvium eventually filled these incised courses and spread thinly but widely beyond them, locally covering peat that had developed in the prevailing wetter climate and more waterlogged conditions.

3.3 GEOLOGY AND LANDSCAPE – NATURAL AREAS

There is a fundamental relationship between the bedrock geology and the topography and landscape of the Doncaster area. Natural England has subdivided England into areas each with a unique identity resulting from the interaction of wildlife, landforms, geology, land use and human impact. Doncaster is covered by three Natural Areas (Figure 8) which closely match the bedrock geology (Figure 3):

1. Coal Measures
2. Southern Magnesian Limestone
3. Humberhead Levels

The Coal Measures Natural Area, in the west of the borough, coincides with distinctive scarp and dip slope topography resulting from the folding of the Carboniferous rocks, the differential erosion of the sandstones and intervening shales and the drainage patterns of the rivers Don and Dearne.

The Southern Magnesian Limestone Natural Area coincides with the Permian rocks that occupy the west-central part of the region. It is generally characterised by well drained rolling countryside, with minor landforms controlled by local faulting and folding, and a western boundary sharply defined by the very distinctive limestone escarpment.

The Humberhead Levels Natural Area concides with the Triassic rocks and unconsolidated Quaternary sediments that are found in the central and eastern part of the region. East of a line that runs approximately from Arksey, Doncaster to Tickhill, the Sherwood Sandstone that comprises the Doncaster and Rossington Ridges passes into the relatively flat, lowland areas of eastern Doncaster, where the solid bedrock is covered by sand and gravel, silt, clay and peat.

These Natural Areas are also readily distinguishable on the NEXTMap Britain Digital Surface Model (Figure 9).

3.4 CARBONIFEROUS

The bulk of the Carboniferous rocks in Doncaster lie deeply buried beneath a thick sequence of younger rocks to the east of the limestone escarpment, which essentially defines its western geographical boundary. Historically, their position was marked by numerous pit heads and collieries that, until recently, contributed greatly to the economic wealth and growth of settlements in the borough. Details of the geology, as seen in numerous colliery shafts and boreholes, are available in BGS Memoir 88; The Geology of the country around Goole, Doncaster and the Isle of Axholme and other mine records but other than to note that landscaped coal waste tips now add to the natural topography of the area, these are considered beyond the scope of this report.

The upper part of the Pennine Coal Measures Group of Carboniferous age exposed at the surface in Doncaster form an insignificant part of the geology of the borough and occur west of the limestone escarpment around Denaby, Mexborough, Barnburgh and the areas west of Hickleton, Hooton Pagnell and Clifton.

The Coal Measures rocks comprise a succession of largely mudstones and siltstones with subsidiary sandstones, seatearths (fireclays) and coals, which occur in a cyclical sequence throughout and reflect changes in sea level and repeated transitions between a marine and freshwater environment. Sedimentological characteristics of the Coal Measures indicate mainly lacustrine, fluvial and swamp deposition on an extensive and flat coastal plain, with sediments being derived from the ancient and long eroded Caledonian mountains to the north.

Medium grained sandstones form the most distinctive topographic features and in places stand out as bold escarpments but, in the district, these vary considerably in thickness and quickly die away laterally. The mudstones and siltstones occupy the intervening, lower lying areas.

Although the exposed carboniferous rocks in Doncaster are of limited geographical extent, they coincide with important structural and topographic features in the region. The Don Monocline and the North and South Don faults have controlled the river courses of the Dearne and the Don and have strongly influenced the distribution of younger strata and the development of distinctive landforms that can be seen around Mexborough, Conisbrough, along the Don Gorge to Doncaster and at Cusworth Hall. Significant Carboniferous formations are as follows (representative geodiversity sites are listed in square brackets):

3.4.1 Pennine Middle Coal Measures Formation

3.4.1.1 Mexborough Rock [D6-Denaby Lane; D166-doncaster Road]

A medium grained sandstone that forms a north-west trending ridge from Mexborough to Adwick-upon-Dearne and a north-east trending escarpment at Denaby Wood, plus a small but very distinctive feature to the immediate west of Old Denaby. Together, these provide good evidence of the position and influence of the Don Monocline. Mexborough Rock has been locally exploited as a building stone and contributes to the character of the local historic built environment and has been a good source of water supply.

3.4.1.2 Shafton Coal

With a maximum thickness of 1.5 m, this was once the highest of the important productive coal seams. Whilst once important underground, it was also once mined extensively at outcrop and in shallow workings at Denaby Wood (Figure 4).

3.4.2 Pennine Upper Coal Measures Formation

3.4.2.1 Ackworth Rock [DR2-Harlington Railway Cutting]

A medium grained buff coloured sandstone that forms a topographic feature to the west of Barnburgh but rapidly thins out at Harlington and appears again south of the Don at Denaby Wood (Figure 4).

3.4.2.2 Dalton Rock [DR3-Cadeby Waste Water Works; DR6-Barnburgh Cliff]

A medium grained buff coloured sandstone that appears between High Melton and Cadeby and also forms small topographic features in the area to the west of the limestone ridge to Hickleton .

3.4.2.3 WICKERSLEY ROCK

A medium grained buff coloured sandstone that forms a prominent feature at Stotfold and at the edge of the borough at Howell Wood, north-west of Clayton.

3.4.2.4 RAVENFIELD ROCK

A medium grained buff coloured sandstone that forms small features to the south-west and north-west of Hooton Pagnell.

The highest Coal Measures in the area are mudstones and subordinate sandstones with thin coals, the topmost beds of which are usually stained red, the result of weathering of the Upper Carboniferous strata during the period of uplift and erosion in an arid climate that was a feature of the Permian period. Exposures are very rare and are usually only evident from boreholes, colliery shafts, clay and brick pits, cuttings, trenches and miscellaneous excavations.

3.5 PERMIAN

3.5.1 Yellow Sands Formation (formerly Basal Permian Sands) [D4- Watchley Crags; D15-Melton Park]

In much of South Yorkshire the denuded and weathered top of the Carboniferous sequence is covered unconformably by a friable and locally incohesive sandstone which varies from 0 – 30 m in thickness. Evidence from boreholes within the district indicates that the Yellow Sands Formation form a nearly continuous spread, but some boreholes failed to prove the deposit and it is uncertain whether the thickness variations mainly reflect irregularities in the surface on which the sandstone was deposited or an undulating top to the sandstone. The isolation of some of the thicker sequences suggests that deposition may have been in localised dune fields.

In boreholes, the sandstone is predominantly pale to medium grey and, more commonly in its upper part, bluish grey. It is mainly fine to medium grained, fairly well sorted and dominantly composed of quartz. The constituent sand grains are rounded or sub-angular and their surface is frosted in a manner suggestive of wind-abrasion and implies an aeolian origin. However, current bedding appears to be due to water action, so that it seems likely that the products of wind erosion were finally deposited under water, further evidenced by the occasional presence of argillaceous layers.

At outcrop, the Yellow Sands Formation is found only occasionally in the west of Doncaster, immediately beneath the limestone that forms the escarpment that essentially defines the western boundary of the borough. Where the sandstone is weathered the ferruginous component of it weathers from the bluish grey seen in boreholes to a yellow or orange-yellow colour.

Near Hampole, between Hooton Pagnell and Hickleton, at High Melton and at Conisbrough there are exposures of yellow, current-bedded sand that were formerly worked as building and moulding sand but, in no exposure are these beds more than 20 ft. thick. Elsewhere, the Yellow Sands Formation is not exposed.

3.5.2 Cadeby Formation (formerly Lower Magnesian Limestone) [DR4-Nearcliff Wood Quarries; D300-Conisbrough Caves East; D302-Conisbrough Caves South]

The Cadeby Formation comprises a white to grey, calcitic and dolomitic carbonate sequence, generally up to 80 m, and locally more than 100 m thick. It forms the main topographical feature, a major escarpment, along the west of the Permian outcrop that extends the length of its 300 km outcrop. Locally there is also a fault bounded outlier at Conisbrough and the escarpment is transected by the Don Gorge.

It comprises a thick sequence of limestones laid down in a shallow shelf marine environment at the edge of the Zechstein Sea and generally thickens to the east. During its formation, the calcium carbonate sediments of the Cadeby Formation were dolomitised, the result of chemical reaction with the increasingly hypersaline sea.

The lower calcareous mudstone (marl) facies of the Cadeby Formation (formerly Lower Permian Marl) appears to be absent from Permian strata that outcrop in the west of the borough and is known only from its occurrence in boreholes, in thicknesses of up to 4 m. It consists of pale or, more rarely, dark grey, flaggy to massive, calcareous and/or dolomitic mudstone and siltstone, with thin beds and lenses of argillaceous dolomitic limestone in places. It contains a restricted fossil assemblage consisting mainly of carbonaceous plant debris, fish debris, foraminifera and a locally abundant calcareous macrofauna, notably of bryozoans and brachiopods.

The Lower Marl Facies was deposited in shallow coastal lagoons, which passed laterally into a shallow marine shelf, on which were deposited the limestones of the Cadeby Formation.

The Cadeby Formation may be divided into two major stratigraphical subdivisions, the lower being the Wetherby Member and the upper the Sprotbrough Member separated by the Hampole Beds. These in turn are divided into several rock-types.

3.5.2.1 WETHERBY MEMBER [DR6-BARNBURGH CLIFF; D11-HAZEL LANE QUARRY; D4-WATCHLEY CRAGS; D15-MELTON PARK; D133- HOOTON PAGNELL; D13-NORTH CLIFF QUARRY; D5- HOOTON PAGNELL VILLAGE POUND; D20–22-CADEBY CLIFF - CONSTITUTION HILL; D112-PARKNOOK QUARRY; D28-POT RIDINGS WOOD RAILWAY CUTTING]

The Wetherby Member consists mainly of well-bedded fine grained to coarsely granular limestone and ooid-limestone, appreciably dolomitised and generally forming thick parallel beds, although small-scale cross-bedding and ripple-bedding are present locally. In places the beds are fossiliferous, but the fauna is rich in individuals rather than in species. Associated with these beds are masses of unbedded limestones, commonly referred to as reef-limestone, which are frequently crowded with fossils. Brachiopods occur in the reefs, though they are rarely found in the bedded limestones.

At the base a few feet of sandy limestone have been observed in places. Above this, ooidal limestones are the most important constituent, forming thick beds that are frequently fossiliferous. The ooids are small, well-formed and comparatively little altered. Many of the beds clearly show that they originally contained normal ooidal grains plus shell fragments and that both these constituents became completely crystalline during dolomitisation. With the ooid-limestones are pisoid-limestones (pisolites), a rock-type that is more common in the southern portion of the area. Some beds contain rhombs of dolomite that are clearly visible.

Near the base there are lenticular or irregular masses of hard, fine-grained, unbedded reef-limestone, which is white or cream in colour and locally brecciated. They consist largely of unbroken shells and fragments of lamellibranchs, brachiopods and bryozoa, accompanied in places by gastropods and foraminifera. Later alteration appears in some cases to have resulted in the obliteration of the fossils and the production of hard, compact, fine-grained limestone.

3.5.2.2 SPROTBROUGH MEMBER [D28-POT RIDINGS WOOD RAILWAY CUTTING; DR5 LEVITT HAGG WOOD; D94- WARMSWORTH QUARRY; D78- WARMSWORTH PARK]

The Sprotbrough Member consists mainly of finely or, less commonly, coarsely crystalline dolostone, some of it minutely cellular due to the recrystallisation of ooids; locally there is also some less altered ooid-limestone. The subdivision is practically unfossiliferous.

It commonly exhibits large-scale cross-bedding and wedge bedding that is one of the most striking features of the Sprotbrough Formation. Individual beds thicken and thin rapidly; thus in a few metres beds may thicken to as much as one metre and just as rapidly thin out.

Two main types of dolostone are found. The more abundant is a grey, white, cream or buff, crystalline, often saccharoidal dolostone that is largely composed of dolomite rhombs. Differences in cementation account for the variation in hardness between hard, compact, crystalline varieties and others, which are so friable as to break down readily to 'dolostone sand.' Stylolites are common. Small black specks, possibly consisting of a salt of manganese, are sometimes present.

The second type of dolostone is light in weight, cellular and therefore very porous. The rock is seen to be composed of numerous minute cells occasionally accompanied by larger examples. These minute cells make up a high proportion of the volume of the rock, the remainder of which is composed of finely granular crystalline material. Microscopical examination demonstrates that these rocks were originally ooidal. The ooids appear to have been dissolved away thus giving a cellular structure, modified by recrystallisation of the matrix during dolomitisation.

The Wetherby and Sprotbrough Members are separated by the Hampole Discontinuity, recognised locally at outcrop as a minor erosional surface with alteration of the dolostone below it. It is particularly seen around Hampole, Cadeby and Sprotborough where it is well exposed in quarries and railway cuttings. The **Hampole Beds** lie mainly above the discontinuity and comprise a sequence up to 1.5 m thick, composed of three thin, greenish, fissile mudstones separated by two cream, finely ooidal and partly laminated calcitic dolostones.

3.5.3 The Edlington Formation (formerly the Middle Permian Marl) [D61-New Edlington Brick Pit; D31- Leys Hill Bridge]

The Edlington Formation is infrequently exposed to the east of the outcrop of the Cadeby Formation. It usually occupies a belt of low lying, wet ground rising up to the escarpment of the Brotherton Formation and, as seen at Skelbrooke, Skellow, Edlington, Wadworth and Tickhill, it yields heavy, typically reddened soils.

It comprises a sequence of red and subordinate greyish green, locally dolomitic, calcareous and gypsiferous mudstones and siltstones. Where it is exposed in railway cuttings, drainage ditches and water logged and overgrown brick pits (D61), fibrous gypsum layers can occasionally be seen. This and the interbedded gypsum was once used to make plaster of Paris.

The Edlington Formation shows thickness variations of up to 6 m, with the most marked thinning frequently corresponding with a thickening of the Cadeby Formation below and vice versa, thus suggesting that the Edlington Formation fills hollows in the surface of the Cadeby Formation, where it was deposited in transient lagoons on a wide coastal plain.

From the evidence of boreholes and colliery shafts, the formation is seen to contain increasing amounts of nodular and layered anhydrite to the north and east of its outcrop, where these are concentrated at certain stratigraphical levels and are considered to be distinct formations in their own right. Although they make no contribution to the landscape, they provide good evidence of the geological history of the region, especially the changes in sea level, increasing salinity, aridity and evaporation that took place in the ancient Zechstein Sea. These are briefly summarised below:

'Marl' between Cadeby Formation and ?Hayton Anhydrite

Comprises an argillaceous reddish, marl, with some gypsum or anhydrite as seen in Thorne Colliery No.1 Shaft.

?Hayton Anhydrite

This formation is recorded as being 13 m thick in the Thorne Colliery Centre Borehole and comprises reddish to grey anhydrite with various amounts of gypsum, dolostone, calcareous mudstones, siltstone and mudstone.

Kirkham Abbey Formation

A thin limestone, the feather edge of which may occur in the district, based on evidence from the east of Doncaster but has not been fully proven in recent boreholes.

'Marl' Between ?Hayton Anhydrite and ?Fordon Evaporites

Grey and blueish mudstones and siltstones containing lenses of anhydrite have been proven in Thorne Colliery No. 1 Shaft.

3.5.4 Brotherton Formation (formerly Upper Magnesian Limestone) [D51- Hexthorpe Flatts – The Dell]

The Brotherton Formation is a relatively uniform sequence of white to grey, mainly dolomitic limestones 13 – 16 m thick, producing a minor feature along much of the outcrop which stretches from Burghwallis in the north to Tickhill in the south and coincides approximately with the line of the A1.

The limestone is always thin-bedded and flaggy, with individual beds varying somewhat in thickness but seldom exceeding 100 mm. Such thicker beds as are present never approach the size of those in the Cadeby Formation and this is a distinguishing feature. Much of the sequence is finely crystalline and small-scale cross-bedding, ripple-bedding and channel cut and fill structures testify to shallow water deposition. Ooid-limestones are present in some western locations and are considered to be near-shore sediments. In more eastern areas the highest strata are locally algal-laminated, suggesting an epitidal environment.

Especially in the upper beds, the bedding-planes may be coated with thin films of red or grey calcareous mudstone or form distinct red mudstone partings. A local development at the base of the Brotherton Formation is a sandy dolostone resembling that found in a similar position beneath the Cadeby Formation.

Fossils are rare and are concentrated in certain beds and include algae, bivalves and some gastropods that are tolerant to saline conditions, however, the formation does contain abundant filaments of the alga *Calcinema permiana*, which allow it to be easily identified. These filaments look like thin matchsticks and are commonly present as concentrations in the cross-bedded units.

3.5.5 The Roxby Formation (formerly Upper Permian Marl)

Despite being 28 m thick at outcrop near Askern, 18 – 20 m at Bentley and 14 m in Doncaster, the Roxby Formation is very poorly exposed and thins considerably to the south, where it eventually passes laterally into the Lenton Formation, in Nottinghamshire. It is seen in sections exposed by limestone quarrying or old brick pits, at Skelbrooke and Balby respectively, where the sequence comprises reddish and greenish grey mudstone and siltstone, containing thin lenses of anhydrite and/or gypsum in places. Like the Edlington Formation it is evidenced by heavy, reddened soils.

Also like the Edlington Formation it originated mainly as fluvial and lagoonal sediment, deposited on a wide coastal plain and possesses very similar characteristics, including the development of distinct deposits, indicating hypersaline conditions and intense evaporation; these are proven in boreholes and colliery shafts showing that the units thickens away from the district to the north east. Like those of the Edlington Formation, the deposits seen deeper in the basin provide good evidence of the geological history of the area and are summarised below:

'Marl' between Brotherton Formation and Billingham Main Anhydrite

Comprises grey-green and red-brown silty marls as proved in the Thorne Colliery Centre Borehole, with gypsum veins and layers up to 30mm thick in places.

Billingham Main Anhydrite

This formation is laterally impersistent and in many places is not recorded in boreholes and has a maximum thickness of 4.6 m where found near Askern. It comprises grey anhydrite, with grey and white gypsum and is commonly associated with grey and red marl, particularly in the west.

Carnallitic Marl

The Carnallitic Marl is a sequence of red and subsidiary greyish green mudstones and siltstones, less than 5 m thick where recorded in the Austerfield area and at Rossington Colliery it may be less than 2.5 m thick.

Upper or Sherburn Anhydrite

Where found in the Hatfield Moors No.1 and No.2 boreholes, it is described as white, clear, translucent and finely crystalline in the Thorne Colliery Centre Borehole, it is 5.4 m thick and pearly white with red marl layers up to 80mm thick.

3.6 TRIASSIC

3.6.1 Sherwood Sandstone Group (formerly Lower Mottled and Bunter Sandstone) [D101- Dunsville Quarry; D102- Common Lane Quarry; S190-92- Blaxton Common]

The Sherwood Sandstone Group occurs at or very near to the surface to the east of the A1 where landforms such as the Rossington and Doncaster ridges provide the largest outcrops. Here the sandstone weathers to form pale brown, light, sandy soil. Except for these and small areas north and east of Tickhill (Lenton Formation), where there is a pronounced scarp slope, the Sherwood Sandstone is overlain by loosely consolidated Quaternary sediments but is frequently exposed in sand and gravel pits, notably around Balby, Dunsville and Austerfield.

The Sherwood Sandstone Group in the south of the Doncaster area is subdivided into two formations, the lower unit is the Lenton Formation of probable Permian age and it is overlain by the Nottingham Castle Sandstone Formation of Triassic age. In the north of the area the Sherwood Sandstone Group is mainly covered by thick Quaternary deposits and is undivided. A borehole at Bentley towards the west of the outcrop proves 35 m of sandstone, but at Hatfield Moors and Misson, this increases to 260- 280 m. In the east where the Sherwood Sandstone is overlain by younger Triassic sediments, just east of the borough at Misterton, it has a full thickness of over 400 m.

The Sherwood Sandstone consists mainly of red, brown, fine to medium grained cross-bedded sandstone. Green-grey varieties are occasionally found and thin layers and lenses of brownish red and greenish grey mudstone and siltstone are common. It is moderately hard to friable, well to poorly sorted, and contains scattered, but locally numerous, rolled fragments of reddish and greyish mudstone and siltstone rip-up clasts. Although subangular to subrounded grain shapes predominate in the sandstone, the localised occurrences of rounded grains, and also of ventifacts and desiccation cracks, testify to some degree of aridity, with some wind blown deposits formed on dry land.

The Sherwood Sandstone is unfossiliferous. The Lenton Sandstone is interpreted as aeolian with minor fluvial interludes. The Nottingham Castle Sandstone represents a fluvial sequence deposited along the western margin of the Southern North Sea Basin as a major braided river

system sourced from northern France The deposits suggest continuing, but spasmodic, uplift of the London - Brabant Massif, a large landmass that lay to the south in Permo-Triassic times.

3.6.1.1 LENTON SANDSTONE FORMATION

The Lenton Sandstone Formation crops out to the north and south of Tickhill. It consists mainly of red-brown and buff mottled, very fine- to medium-grained, argillaceous, cross-stratified sandstone with subordinate beds of red-brown mudstone and conglomerate.

3.6.1.2 NOTTINGHAM CASTLE SANDSTONE FORMATION [D44-CEDAR ROAD ADVENTURE PLAYGROUND]

The Nottingham Castle Sandstone Formation Sandstone overlies the Lenton formation and consists of, pinkish red or buff-grey, medium- to coarse-grained, pebbly, cross-bedded, friable sandstone with subordinate lenticular beds of reddish brown mudstone. The pebbles die out north of Doncaster and hence the formation is not recognised.

3.6.2 Mercia Mudstone Group (formerly Keuper Marl)

This thick sequence of mainly reddish mudstones and siltstones, with occasional gypsum dolostone, succeeds the Sherwood Sandstone Group. The earliest deposits represent deposituion on abroad alluvial plain, with a complex association of channel sandstones, overbank deposits, lacustine and lagoonal environments. Later, the Mercia Mudstone became a desert-sabkha association, dominated by wind blown dust deposition with periodic flash floods deposited on a coastal plain around the western margin of the Southern North Sea Basin.

In Doncaster, they occupy a very small area on the eastern boundary and, being covered in Quaternary sediments, are exposed only in excavations.

3.7 NEOGENE (QUATERNARY)

The superficial deposits in the area mainly represent the deposits from at least the last two ice-ages and the intervening interglacial deposits (Figure 6). The landscape has been subjected to several episodes of erosion and several episodes of deposition. The lateral extent and thickness of the Quaternary is extremely variable and many of the sedimentary deposits possess very similar lithologies that are not easily distinguished.

The soft and unconsolidated nature of the sediments mean that they do not form easily recognisable outcrops and details of much of the geology is known from boreholes, excavations, cuttings and particularly from the temporary exposures seen in the numerous sand and gravel pits found in the area. Much of the natural landscape and topography is obscured by sand and gravel workings, but detailed field surveys reveal a wide variety of low lying landforms and structures associated with these recent geological events. The superficial geological sequence is shown in Table 1.

Series	Stage	Group	Generic Name	Thickness	Details
Holocene	Recent		Warp (1)	Up to 1m	Made ground formed by flooding land and the artificial deposition of laminated silt and clay.
	Flandrian	Yorkshire Catchment Subgroup	Peat (2)	0-4.5m	Peat
			Alluvium (3)	3-8m	River flood plain deposits
			Blown Sand (4)	0- 4m, 8 in places	Fine-grained wind-blown sand that commonly underlies peat in the east of the area
Late Pleistocene	Probably late Devensian	Caledonia Glacigenic Group	River Terrace Deposits (5)	0-8m, 15 in places	Sand and gravel with some clay
	Devensian (glacial and pro-glacial deposits)		Head (6)	0-3m	Generally sandy and gravelly clay, dependent on the surrounding deposits, caused by solifluction during and at the end of the last glacial interval.
			Glaciolacustrine Deposits (sand) (7)	0-1m	Sand with silt and clay deposited in the Pro-glacial Lake Humber or when the lake had just drained.
			Glaciolacustrine deposits (silt and clay) (8)	0-8m	Also called the Hemingbrough Formation or 25ft Drift (silt and clay) Pro-glacial lake deposits formed in Lake Humber when the present estuary was blocked with ice.
			Glaciolacustrine deposits (basal sand) (9)	0-3m	Sand with clay and silt
			Glaciofluvial deposits (10)	0-5m	Sand and gravel, with silt and clay interdigitating with Glaciolacustrine deposits in places.
	Ipswichian	Albion Glacigenic Group	Older River Gravel (11)	5-15m	Sand and gravel
Middle Pleistocene	Pre-Ipswichian possibly Anglian		Glaciofluvial deposits (12)	0-16m generally 0-10m	Well-sorted sand and gravel with abundant pebbles derived from the Sherwood Sandstone Group bedrock.
	Possibly Anglian		Older Till (13)	0- 9m	Sandy clay, with boulders, cobbles and gravel deposited from ice.
	Pre-Anglian or Anglian		Buried Channel Deposits (14)	Up to 58m	Deposits filling deep incised buried valleys; mainly sand and gravel at base overlain by thick laminated silt and clay.

Table 1 The sequence of superficial deposits in the Doncaster area. Numbers in the name column are used in the sections below and on Figure 2.

3.7.1 Pre-Anglian or Anglian Glacial Deposits

3.7.1.1 CHANNEL DEPOSITS (14)

The bedrock of the area is traversed by eleven deeply buried channels that are only proved in boreholes and which are mainly orientated approximately north-west to south-east, with the only exception being the most southerly, with an orientation of west to east. These are named as the

Moss, Barnby Dun Station, Arksey, Armthorpe, Wheatley Park, Bessacar, Rossington, Blackwood, Loversall, Hunster Grange and Lim Pool Channels.

The deposits filling the channels consist largely of virtually stoneless and commonly laminated greyish clay. Sand, with or without gravel and commonly containing coal particles, occurs in several channels, mainly in their lower parts and towards their eastern ends. Where pebbles are present they are mainly of Carboniferous sandstone, limestone and associated rocks, and of Permian limestone; they are commonly grooved and scratched.

The channels are unrelated to the present or any known pre-existing valleys and are believed to have been cut by powerful subglacial drainage, produced from the action of meltwater beneath advancing glaciers. The easterly or south-easterly trend of the channels, and the obviously Pennine derivation of some of the contained deposits, suggest that they probably flowed from sources high in the Pennines. Most of the channels in the district are aligned with gaps through the Permian scarp to the west and also point eastwards to the Haxey Gap south of the Isle of Axholme, so that a genetic relationship between the channels and these gaps is possible.

These are all interpreted as being pre-Ipswichian and most probably related to the Anglian glacial event.

3.7.1.2 TILL (13) [D61- NEW EDLINGTON BRICK PIT; D51- HEXTHORPE FLATTS – THE DELL; D44-CEDAR ROAD ADVENTURE PLAYGROUND]

Patchy glacial till has been mapped throughout the western part of the area where it mainly forms relics sitting on slightly elevated bedrock so that it caps hills and ridges. These include isolated occurrences at Adwick upon Dearne, Skelbrooke, Braithwell and on the Rossington ridge. Around Balby and Warmsworth, much thicker and more extensive deposits are preserved in an ancient valley. On the flanks of the hills they are commonly much thinner and in the low ground they have not been recognised having presumably been eroded away.

Till (shown as boulder clay on older geological maps) consists of bluish grey to reddish brown silty and locally sandy diamicton with scattered erratics up to boulder size; it is more reddish or yellowish where weathered. The erratics are mainly of Carboniferous sandstone, siltstone and coal, and Permian limestone, with smaller numbers of Carboniferous limestone and chert, derived from the Pennines. A few erratics of igneous rocks, some recognisably from the Lake District, are also present.

On the evidence of these erratics, the ice which deposited the clay till in the district had traversed the eastern Pennine slopes, and some of it had originated or passed close to the Lake District. The stone orientations and analysis of coal erratics at Balby, and distribution of Permian erratics west of the Permian outcrops beyond the district show that most of the ice which entered the district from the north and north-west had flowed south down the Vale of York after crossing the Pennines. The sparsity of clay till, its isolation either on elevated locations or in sheltered low-lying areas, and the absence of associated glacial landforms, suggests a glaciation of considerable antiquity. The presence, locally above the clay till, of older river gravel, for which there is fossil evidence of an Ipswichian interglacial age, confirms the glaciation as Anglian.

3.7.1.3 PRE-IPSWICHIAN, POSSIBLY ANGLIAN FLUVIOGLACIAL DEPOSITS (12) [D44-CEDAR ROAD ADVENTURE PLAYGROUND; D102 COMMON LANE QUARRY; D109-HURST PLANTATION QUARRY]

The fluvioglacial deposits occur in two main concentrations within the area, capping the Doncaster and Rossington ridges where they rest on bedrock and, occasionally, the underlying till. The deposits comprise beds, lenses and layers of both pebble-free sand, and gravel with a sand matrix. They are well bedded, with cross-bedding and cut-and-fill channel structures in places, and fairly well sorted, although cobbles and a few small boulders are also present.

However, the deposits vary considerably in composition across the district and imply an origin from different source rocks.

The sediments on the Rossington Ridge contain abundant 'Bunter 'quartzite pebbles whose only possible source is the Sherwood Sandstone of Nottinghamshire and the northern Midlands. In the absence of accompanying durable Jurassic rocks, flint pebbles are unlikely to have come directly from the east, and the only other source is the 'chalky' glacial deposits in the middle Trent Valley to the south.

Although the sand and gravel on the Doncaster ridge is superficially similar in composition to the clay till and glacial deposits, Carboniferous limestone, chert, Permian limestone and igneous rocks are virtually absent. Instead their constituents imply derivation from Coal Measures to the west instead of the glacial trans-Pennine origin to the north-west,.

The sedimentary features and compositions of these deposits, together with their ridge top location, which implies transport over a watershed, indicates a fluvioglacial origin with meltwater flowing from ice sheets in the south and west.

3.7.2 Ipswichian Deposits

3.7.2.1 OLDER RIVER GRAVEL (11) [D101- DUNSVILLE QUARRY]

Large spreads of Older River Gravel are present in the north and east of the district where they form a terrace-like area with an elevation of up to 12 m above OD. They contain sedimentary structures indicative of deposition from a fluvial environment.

These deposits consist of beds, lenses and layers of well sorted fine to medium gravel with a sand matrix, without pebbles, which include level bedding and gentle cross-bedding, and also shallow cut-and-fill channel structures. They rest mainly on Sherwood Sandstone but transgress locally over clay till and glacial channel deposits. Their top, whether at outcrop or concealed beneath younger deposits, is commonly severely cryoturbated and strewn with ventifacts.

There is a wide variation in the composition of the sand and gravel and this, in addition to variations in palaeocurrent directions, indicates different geographical origins. To the north–west of Doncaster at Edenthorpe, Armthorpe and Dunsville and along the Don Valley, the pebbles mainly comprise Carboniferous sandstone and suggest deposition by fluvial activity of the river Don.

To the south-east of Doncaster at Blaxton, Finningley and Austerfield, the pebbles mainly comprise 'Bunter' quartzite, deposited by the rivers Idle and Thorne which flowed from the south.

Fossiliferous deposits within the Older River Gravel near Austerfield and Armthorpe have provided good evidence of the palaeoenvironment. Wood fragments, fruits, pollen and seeds indicate oak, pine, hazel, birch and alder in a temperate environment. Other non-tree pollen suggest freshwater and saltmarsh habitats, with dinoflagellate cysts and forams also implying an estuarine tidal reach.

3.7.3 Devensian Deposits

The Devensian cold Stage started approximately 120 000 years ago and, using modern radiocarbon dating techniques, is considered to have ended about 10 000 years ago.

During this time, the region was subjected to severe periglacial conditions when the land was generally deeply frozen. At the start and end of the Devensian Stage, there are distinctive sedimentary and topographical structures that are termed the **Lower and Upper Periglacial Surfaces**.

Four types of non depositional evidence reflect these conditions. They are cryoturbation structures, alases, ventifacts and desert pavements and all are important features that have enabled geologists to interpret climatic conditions throughout the northern hemisphere.

Cryoturbation structures are subsurface disruptions resulting from freezing and thawing of groundwater in what is called the active layer. Alases are wide, shallow, steep-sided, flat-bottomed depressions, commonly circular or oval in shape, as seen in the West Moor depression. Ventifacts are stones, generally of large pebble size or bigger, that have been shaped by prolonged impact of wind-blown sand grains and possess flat facets with sharp edges. Desert pavements are the remnants of rock debris after lighter particles have been blown away by wind.

Position of Lower Periglacial Surface

3.7.3.1 GLACIAL SAND AND GRAVEL (10)

Small outcrops of glacial sand and gravel run in a line from Thorne to Wroot. The deposits contain pebbles consisting mainly of Carboniferous sandstone and Permian limestone, with a few of other Carboniferous rocks including limestone and chert, and rare Lake District rocks, indicating a provenance from the north-west.

The deposits share their stratigraphical position between the two periglacial surfaces with the lacustrine sand and gravel which, as described below, were formed in and around Lake Humber when at its maximum level of about 30 m above OD in the late Devensian. It is highly probable that the ice surged transiently into the lake and deposited sand and gravel, mainly along its western and southern edges, as it melted.

3.7.3.2 LACUSTRINE SAND AND GRAVEL DEPOSITS (9)

Sand and gravel deposits with compositions similar to older sediments described above occur throughout the area, but are not detailed on the current geological map.

Around Burghwallis, Cusworth and Askern, these comprise angular to subrounded pebbles of Permian limestone in a grey silt matrix and at Bentley, there are also Carboniferous rocks. Further south, at Rossington, Bawtry and Austerfield, as seen in sand and gravel pits, there is a predominance of ‘Bunter’ quartzite pebbles.

These deposits indicate an origin by reworking of pre-existing deposits in situ, with no input of sediment from outside the immediate locality and imply deposition as beach deposits at the edge of Lake Humber. Throughout the district, these deposits occur at 27 m OD and it is a striking fact that dry valleys, which are frequent in the Permian limestone, all terminate at about this level.

3.7.3.3 GLACIOLACUSTRINE DEPOSITS (SILT AND CLAY) (8)

Known previously as the 25 Foot Drift but now termed the Hemingbrough Formation, this vast expanse of loose, unconsolidated sediment forms most of the flat plain of the southern part of the Vale of York that, in Doncaster, covers most of the low lying areas or flat land east of the A1.

It essentially comprises a sequence of silt and clay with some fine grained sand deposited in and at the edges of Lake Humber, which was formed as the result of a blockage of the established river drainage system by an ice sheet that had encroached from the north-east. The details of this important period in Doncaster’s recent geological history need to be the subject of extensive field survey work and research but a brief summary of knowledge acquired to date is as follows:

Silt and Clay: These beds comprise fine grained grey to red sediment with low-angle cross-bedding and ripple structures that contain virtually no stones. The sporadic stones that do occur are 'drop stones' that have been deposited from melting ice.

Marginal Sand: The sand is fine and rarely medium grained, often with silt, clay, abundant coal particles and, in some areas, a few small pebbles.

It is often not easy to distinguish either of these, as they pass laterally into one another but they were both formed in a relatively placid environment, undisturbed by the influx of high energy, rapidly flowing rivers.

3.7.3.4 GLACIOLACUSTRINE DEPOSITS (SAND) (7)

Resting on the deposits described above, sand forms discontinuous, low ridges and mounds around Hampole Beck, Braithwaite and Fishlake, with silt, clay and coal particles at their margins. Many of these landforms are adjacent to present rivers and suggest that these are levees which indicate that Lake Humber had partly filled with sediments and drained so that rivers, now recognisable in modern times, had begun to make their mark on a flood plain. An increasing abundance of sand dunes indicates the action of wind upon an increasingly dry land surface and many of the deposits can be interpreted as fluvio-aeolian.

3.7.3.5 HEAD (6) [D20–22- CADEBY CLIFF/CONSTITUTION HILL; DR4-NEARCLIFF WOOD QUARRIES]

Head deposits are mainly associated with the older Quaternary deposits or with exposed bedrock within the area. They are generally unsorted gravels and clays that are the product of reworked local glacial and fluvioglacial sediments. They are found in valley bottoms and generally represent re-deposition of material, by freeze and thaw conditions (solifluction) and hillwash in a periglacial environment.

3.7.3.6 RIVER TERRACE DEPOSITS (5)

River terrace deposits are present in the north-west of the area near Bentley and around the river Don, where the clast component is predominantly of Carboniferous rocks. Further to the south-east, especially at Austerfield, quartzites derived from the Sherwood Sandstone Group are the main constituent. Together, these sediments are intimately linked with events that were taking place in the Vale of York and terrace river valleys.

Position of Upper Periglacial Surface

3.7.4 Flandrian Post-Glacial Deposits

3.7.4.1 BLOWN SAND (4)

Blown sand is extensive in the north-east of the district, where it forms thin spreads of fine-grained silty sand, but much is largely concealed beneath and alluvium. It is characterised by its fine-grained, well-sorted nature and forms linear and crescentic dunes, often with horns that provide evidence of the wind direction. The sand is often associated with the formation of river levees and these are seen along the River Torne from Auckey Common to Wroot.

The sand overlies both Sherwood Sandstone and glaciofluvial sediments and was formed after Lake Humber drained and dried up.

3.7.4.2 ALLUVIUM (3)

Extensive areas of alluvial deposits are present in the area associated with all the main drainage courses. In the Doncaster area it is associated with the River Don, but also spreads out into low-lying area of Potter Carr to the south of Doncaster. Along the River Don, the alluvium is up to around 6 m thick. By comparison, the large ponded areas of alluvium are only 3 or 4 m thick and are mainly concentrated in a belt along the junction of the Sherwood Sandstone Group and the Roxby Formation. In the north-east of the area the alluvium associated with the east of Hatfield Moors is much thicker than the other rivers of the area and reaches around 6-8 m.

In the deeper parts of the former alluvial channels much of the deposit consists of sand and silt, commonly with a gravelly base. The alluvium becomes increasingly clayey upwards; the surface deposits of the major rivers consist of silt, but this grades away from the rivers into stiff, heavy and commonly peaty clay. The upward-decreasing coarseness of the alluvium reflects decreasingly energetic fluvial deposition in the incised river courses as sea level rose rapidly in the Humber region during the Flandrian. After the incised courses were filled with alluvium, deposition culminated in thin but extensive spreads of appreciably peaty clay and peat on adjacent low-lying areas.

3.7.4.3 INCISION AND DENUDATION

Contours at and below OD on the base of the Flandrian deposits reveal a landscape in which rivers crossing the district, including minor ones, have deeply incised their courses, reaching depths of nearly 20 m below OD as they approach the Humber Gap. This vigorous fluvial incision was accompanied by little or no interfluvial erosion. It resulted from a rapid drop of regional drainage base level, when the ‘nickpoint’ of the ‘River Humber’ finally eroded through the glacial deposits in the Humber Gap to reach the soft, waterlogged sediments of the Hemingbrough Formation to the west.

3.7.4.4 PEAT (2)

Peat is extensive in the east of the area, where it forms spreads resting on the flat Glaciolacustrine deposits. The peat is rarely more than a few metres thick, but on Hatfield Moors and Thorne Moors, where it has been extensively worked, it is in excess of 3 m thick. It is also commonly associated with present and past drainage courses in the centre and west of the area, notably along the length of the River Torne. A significant deposit also occurs in the West Moor depression.

The peat growth may be attributed mainly to two factors. One is the wetter climate which ensued from Atlantic times onwards, and which, particularly from the onset of Sub-Atlantic times, was conducive to raised bog development in suitable areas. The other is the waterlogged ground and poor drainage in low-lying areas produced in late Flandrian times in the Humber region by the change of sea level, which rose sharply from about 9 m below OD to between 3 m and 5 m below OD between 7000 and 6000 radiocarbon years ago, but which has oscillated within a metre or two of OD within the last 3500 radiocarbon years.

3.7.4.5 WARP (1)

Warp or “floodwarp” develops by building flood banks around field areas and artificially flooding the ground so that layers of clay and silt are built up. Over time the land can be raised by a metre or so. This can be seen around Thorne Moors. In several places on Hatfield Moors “cartwarp” has been deposited. This term refers to the process of raising the level of the land manually by transporting material into the fields and spreading it out.

3.7.4.6 RIVER DIVERSIONS

Several man-made river diversions are recognisable in the district, partly by comparing the early Flandrian courses with the present courses.

A side branch of the River Don, formerly known as Turnbrigg Dike, was constructed northwards from Thorne to the River Aire near East Cowick, at some time before 1410 beheading the lower course of the River Went at a locality which is now their confluence, south of New Bridge. The drainage alterations accomplished by Cornelius Vermuyden in 1625-27 consisted essentially of diverting two rivers. The River Torne, having previously joined the Idle near Tunnel Pits Farm, was channelled into an artificial course, the New River Torne, which joins the Trent outside the district at Althorpe.

3.8 STRUCTURE

Towards the end of the Carboniferous period, during the hiatus between Coal Measures deposition and the renewal of sedimentation in the late Permian Zechstein Sea, the Hercynian Orogeny produced gentle folding, extensive faulting, uplift and consequent erosion in the region.

In general, the pattern of folding is aligned north-west to south-east with Carboniferous strata dipping gently to the north-east, reflected in the dip and scarp topography that can be seen in exposed Coal Measures in western Doncaster to the north of the River Don. Geophysical evidence and detailed mapping of the concealed Carboniferous strata during exploration of the coal fields reveals similar trends, with the major structures being principally the Finningley syncline, the Askern-Spital anticline, with smaller similarly aligned structures to the north.

The exception is a narrow belt that extends from Rotherham to Mexborough and Cadeby, associated with the Don Monocline, which runs from the south-west to north-east and where, locally, the strata dip as much as 30 degrees to the south-east. At Denaby, this is evidenced by small but very distinctive landforms with steep dip and scarp topography.

The pattern of faulting follows the general plan common in the coalfield, in which two sets of faults at right angles and trending respectively north-west and north-east may be recognized. In the area as a whole there is nothing to choose in importance between the two groups.

However, a belt of parallel faults trending north-eastwards, associated with the Don Monocline, have had a considerable influence on the geology and topography of the region. The most persistent of these is the South Don fault (Figure 4) which is evident at Conisbrough, Cadeby and Cusworth and has been located at several places in Thorne Colliery; it can also be traced on the NEXTMap image (Figure 9). South-east trending faults are notable along the Askern-Spital structure but whilst once important to the collieries do not greatly affect the topography of the area.

Along the limestone escarpment, particularly at Hampole, Bilham and Conisbrough, overlying Permian strata have been displaced by these faults. These along with rift, or graben, structures around Warmsworth, Balby and Loversall, in which Triassic sediments were laid down, show that movement often continued into Permian and Triassic times. The rift structures around Loversall are also associated with movement along south-east trending faults along the axis of the Finningley Syncline, where there is evidence that this area was also subjected to crustal tension and subsidence.

The Permian rocks rest with marked unconformity on the underlying Coal Measures and although local variations relate to earth movements that affected Carboniferous rocks, they generally have a very shallow dip to the east or north-east. Along with the overlying Triassic rocks that possess a similar dip this may partly be attributable to the continuing tilting and subsidence of the Southern North Sea Basin in which the Zechstein Sea was formed. However, evidence from younger strata to the east of the district shows that there were unrelated earth

movements during the Jurassic period and post-Cretaceous times and that the dip of the Permo-Triassic rocks is probably best considered as a composite structural feature.

4 Mineral Resources

4.1 INTRODUCTION

The earliest records of exploitation of a geological resource in Doncaster, other than water supply, refer to peat cutting, which has continued from mediaeval times and was until recently carried out on a large scale by mechanised means. In contrast, the sand and gravel industry has expanded enormously since the Second World War. However, the most important industry based on a geological resource is coal mining. This began in the first decade of the 20th century with the sinking of several deep shafts, forming part of the extension of the Yorkshire Coalfield eastward into its 'concealed' region. This industry, more than any other, has been responsible for the large increase in population in the district, mainly concentrated in Doncaster and adjacent areas, during the present century, and it has enabled other industries to develop in these areas. More recently there has been some exploration for deep hydrocarbon sources in the district, and although the results are extremely modest by comparison with other regions in and around Britain, the gas find which produced a spectacular 'blow out' on Hatfield Moors late in 1981 has now been tapped for industrial use.

4.2 RESOURCES AND RESERVES

Mineral resources are natural concentrations of minerals or bodies of rock that are, or may become, of potential interest for the economic extraction of a mineral product. They exhibit physical and/or chemical properties that make them suitable for specific uses and are present in sufficient quantity to be of economic interest. Areas that are of potential economic interest as sources of minerals change with time as markets expand or contract, product specifications change, recovery technology improves or more cost-effective sources become available.

That part of a mineral resource, which has been fully evaluated and is commercially viable to extract is called a mineral reserve. In the context of land-use planning, the term mineral reserve should strictly be further limited to those minerals for which valid planning permission for extraction has been granted (i.e. permitted reserves). Without a valid planning consent no mineral working can take place and consequently the economic value of the mineral resource cannot be released.

Currently active, ceased and recently disused mines and quarries from the BGS BritPits Database are shown on Figure 10.

4.3 SAND AND GRAVEL

Sand and gravel resources occur in a variety of geological environments. In the Doncaster area these resources occur mainly within superficial deposits, resulting from glaciofluvial, glaciolacustrine, fluvial and aeolian processes. Additional sand and gravel resources occur within the bedrock.

Sand and gravel are defined on the basis of particle size rather than composition. In current commercial practice, following the introduction of new European standards from 1 January 2004, the term 'gravel' (or more correctly coarse aggregate) is used for general and concrete applications to define particles between 4 and 80 mm, and the term 'sand' for material that is finer than 4 mm, but coarser than 0.063 mm. For use in asphalt 2 mm is now the break point

between coarse and fine aggregate. Most commercial sand and gravel is composed of particles that are rich in silica (quartz, quartzite and flint).

4.3.1 River sand and gravel (Terrace and sub-alluvial deposits)

Resources occur in both raised river terrace sequences flanking the modern floodplains and in floodplain terrace deposits underlying present day alluvium. This sequence of deposits is best developed along the River Don with a succession of deposits formed, representing accumulations of sand and gravel in response to falling sea level in Pleistocene times.

Extensive terrace deposits occur around Bentley at up to 12 m above OD. These deposits consist of sand, thin beds of fine gravel in which most of the pebbles are of Carboniferous rocks, and thin clay beds. Coal particles are present in the sand fraction. The deposits pass laterally into glaciolacustrine silt and clay deposits. East of Doncaster, fluvial deposits of sand and gravel form extensive flattish spreads, commonly referred to as Older River Gravels. These deposits consist of beds, lenses and layers of both pebble-free sand and well-sorted fine to medium gravel with a sand matrix. Variations in composition of the gravel fraction show that the more northerly deposits around Dunsville were derived from the west, presumably via the Don, with the predominant composition of the pebbles being Carboniferous sandstone. In areas rich in Carboniferous-derived materials, coal detritus, usually in the form of coarse sand-sized particles can comprise up to 1 per cent of the deposit.

The Older River Gravels are worked for sand and gravel at several sites in the Doncaster district, primarily in the Finningley area and to the northeast of Doncaster for example, at Dunsville Quarry. At both Finningley and Austerfield Quarries, Older River Gravels, the original focus of extraction, have now been depleted. Current extraction at Finningley is from adjacent glaciofluvial deposits while extraction at Austerfield is now from the underlying Sherwood Sandstone Group.

Sub-alluvial gravels are encountered beneath the alluvium of the major valleys throughout the area. The extent of alluvium has been modified in places by land management practices, including the construction of drainage channels and the deposition of Warp (silt and clay) during periods of artificially controlled flooding. The deposits are compositionally similar to the river terrace deposits. They were mainly laid down during periods of deep downcutting during the late Devensian cold phase when sea-levels fell to at least -100 m OD. The subsequent rise in sea level enabled silting up of these river channels producing thick overlying alluvial deposits. The deposits rest on an irregular channelled surface and are thus of very variable thickness. These deposits are always saturated and require wet working.

4.3.2 Glaciofluvial deposits

The sequence of glaciofluvial deposits is complex with units commonly exhibiting intricate relationships. Bodies of sand and gravel may occur as sheet-like layers or ridges on top of the sheet of till (boulder clay) or as elongate, irregular lenses within the till sequence. Areas of wholly concealed, and thus unknown, bodies of sand and gravel may occur under spreads of till and other drift deposits.

Glaciofluvial deposits occur in the east of the county, where they form elongate ridges and mounds capping the Doncaster and Rossington ridges and adjacent hills. These deposits have been described in detail in BGS Mineral Assessment Reports Nos. 37 and 92. The deposits comprise beds, lenses and layers of both pebble-free sand, and gravel with a sand matrix. They are fairly well sorted, though a few cobbles and small boulders are present. The deposits rest mainly on Sherwood Sandstone and transgress locally over clay, till and glacial channel deposits.

4.3.3 Glaciolacustrine deposits

During the Devensian glaciation, ice occupying the present coastal zone farther east blocked the eastward-draining valleys including the Humber Gap between Brough and Winterton and thus impounded ‘Lake Humber’ in the southern part of the Vale of York. Glaciolacustrine deposits associated with this glacial lake occupy a wide irregular channel incised into Older River Gravels (see River sand and gravel) and Sherwood Sandstone, running from Doncaster Racecourse northeastwards towards Hatfield Woodhouse. They are present in the West Moor depression, in other low-lying localities towards the east (where they pass under the peat on Hatfield Moors) and under the alluvium of the River Don in the northwest. These deposits are predominantly bedded fine-grained sands and laminated clays up to 5 m in thickness. The sand fraction is predominantly fine-grained quartz; up to 35 per cent of medium-grained sand has been recorded but coarse-grained sand nowhere accounts for more than 1 per cent of these deposits.

4.3.4 Blown sand

Blown sand deposits occur in the east of the area and are largely concealed beneath peat and alluvium. The most extensive blown sand deposits crop out on the flanks of Thorne Moor, Hatfield Moor and south of Finningley. Extensive deposits of sand, that rest in turn on glaciolacustrine silt and clay, also extend under the peat and alluvium of Thorne Moor and adjacent areas. This concealed sand varies from 0 to 3 m in thickness, with appreciable variations across short distances due to its undulating top. Blown sand is not worked in the area. These deposits are believed to be largely of late Quaternary age resulting from aeolian reworking of fluvial and glaciofluvial sands, particularly those associated with the Vale of York superficial deposits.

4.3.5 Bedrock Sand and Gravel

The sandstones and conglomerates of the Sherwood Sandstone Group, in particular the Nottingham Castle Sandstone Formation, have been worked mainly as a minor component in the floor of sites working overlying superficial sand and gravel deposits. This material is mainly friable, loosely consolidated and easily worked. It is largely composed of a fine "clayey" sand with generally <2 per cent gravel and is generally more suitable for building sand and asphalting than the 'sharper' alluvial sands which are used for concreting. Where more gravel is present or conglomeratic horizons occur, the clasts are mainly rounded and sub-rounded quartz and quartzite pebbles with subordinate Carboniferous sandstone fragments. The Sherwood Sandstone Group is currently worked at Austerfield Quarry. The sand, which is dry screened, is predominantly used for mortar sand and asphalt sand and to a lesser extent for fill and pipe bedding sand.

4.4 CRUSHED ROCK AGGREGATES

A variety of hard rocks are suitable for use as aggregates when crushed. Their suitability for different applications depends on their physical characteristics, such as resistance to impact and abrasion and crushing strength. Higher quality aggregates are required for coating with bitumen for road surfacing, or for mixing with cement to produce concrete. For applications with less demanding specifications, such as constructional fill and drainage media, lower quality materials are acceptable. The only significant source of crushed rock aggregate in Doncaster is dolostone.

4.4.1 Dolostones

Dolostones and subordinate limestones of the Zechstein Group occupy a broad outcrop of easterly dipping strata to the west of Doncaster (Figure 3). These strata, commonly referred to as the Magnesian Limestone, have highly variable lithological and rock properties. They are frequently too weak and friable to make high quality aggregate. Nevertheless, they are extensively quarried for low-grade applications, such as sub-base roadstone and fill, but some of the rocks are sufficiently strong and durable to be used as concreting aggregate or coated roadstone.

4.4.2 Sandstone

Most sandstone is too weak and porous to make good quality aggregate for roadstone and concrete, but may be suitable for fill or for the production of sand for reconstituted stone products.

Sandstones form substantial parts of the Upper Carboniferous sequence in Doncaster where they are interbedded with mudstones and coals. Where thick beds of sandstone are developed they have been widely extracted for building stone, although there is little current quarrying activity. There is no production of aggregate materials due, in part, to more readily available local supplies of crushed dolostone and natural sand and gravel.

4.5 INDUSTRIAL DOLOSTONE

Dolostone is an important economic mineral because of its physical and chemical properties. It has a wide variety of applications but its primary use is in the construction industry. Dolostone is also important in certain industrial applications where its chemical properties are important. The principal uses of industrial dolostone are as a flux in steelmaking, for refractory use and in glassmaking. For these applications, dolostone is required to be of high chemical purity. Dolostone for industrial purposes accounts for a relatively small and decreasing proportion of total dolostone output in Britain.

Dolostones with sufficiently low levels of impurities to be used in steelmaking and glassmaking are relatively scarce in Britain. The Permian, Cadeby Formation in the Cadeby, Sprotborough and Warmsworth area is, however, of higher purity and is extracted for glassmaking at Warmsworth and Cadeby quarries. The quality of the stone is variable and selective quarrying of specific horizons and subsequent blending is required to ensure that the stone meets the low iron requirements for glassmaking. Ground dolostone is also used for filler applications.

4.6 BRICK CLAY, INCLUDING FIRECLAY

‘Brick clay’ is used in the manufacture of bricks, roof tiles, clay pipes and decorative pottery. These clays may sometimes be used in cement manufacture, as a source of constructional fill and for lining and sealing landfill sites. The suitability of a clay for the manufacture of bricks depends largely on its behaviour during shaping, drying and firing. This determines the properties of the fired brick, such as strength and frost resistance and, importantly, its architectural appearance.

Most facing bricks, engineering bricks and related clay-based building products are manufactured in large automated factories. These represent a high capital investment and are increasingly dependent, therefore, on raw materials with predictable and consistent firing characteristics in order to achieve high yields of saleable products. Blending different clays to achieve improved durability and to provide a range of fired colours and textures is an increasingly common feature of the brick industry. Continuity of supply of consistent raw materials is of paramount importance.

The major brick clay resources in Doncaster occur within the mudstones of the Pennine Coal Measures Group which are interbedded with siltstones, sandstones, coal seams and seatearths. The mudstones are dark grey, with variable carbon content. They are typically up to 5 m thick, but much thicker (20 to 30 m) in places.

Fireclays typically occur beneath coal seams and resources are confined to coal-bearing strata. Although originally valued as a refractory raw material, fireclay is now used by the brick industry for its combination of good technical properties allied to its cream-buff-firing characteristics. Not all fireclays are suitable for buff brick production because of the presence of impurities. The close association of fireclay and coal means that opencast coal sites are one of the few viable sources. Resources of fireclay are thus coincident with opencast coal resources and consequently the future supply of fireclay is largely dependent on the future of the opencast coal industry.

4.7 BUILDING STONES

The Pennine Coal Measures Group has been a prolific source of building sandstones, and the many sandstones that occur in the succession have all been used for local building purposes, mostly to the west of Doncaster around Barnsley, Mexborough, Sheffield and Rotherham.

The pale coloured dolostones of the Cadeby Formation have been extensively quarried for local building along much of their outcrop, most notably around Brodsworth, Doncaster and Conisborough. Building stone is largely produced as a by-product of aggregates and dolostone production but good quality stone extracted by traditional quarry methods is intermittently available.

4.8 COAL

Doncaster lies predominantly within the East Pennine Coalfield. The coal-bearing strata of the Pennine Coal Measures Group (Upper Carboniferous) generally dip to the east or south. Coal seams crop out at the surface in the west and become concealed to the east beneath younger rocks, down to depths of 1200 m below OD (Figure 10). Coal seams are numerous and many are developed at a regional scale. They vary laterally in both thickness and composition, chiefly by variation in the number of dirt partings present within the seams. Nine major coal seams are recognised in the Pennine Coal Measures Group of the Doncaster area. The seams are mainly bituminous and the calorific value and rank of the coals broadly increases eastwards. Sulphur is an impurity associated with all Yorkshire coals, with the most easterly parts of the coalfield recorded as moderately high in sulphur.

Although UK domestic production of coal has declined in recent years, South Yorkshire remains an important coal-mining region in the UK with five opencast coal sites and two deep coal mines in recent operation. In the last five years, from 1999 to 2004, total coal production in South Yorkshire decreased from 3.5 Mt to 2.8 Mt. There is no current opencast coal production in Doncaster. Production from the last underground coal mine in Doncaster, Rossington ceased in 2006.

4.9 PEAT

Peat is an unconsolidated deposit of compressed plant remains formed in a water-saturated environment such as a bog or fen. Bogs occur in areas where inputs of water (almost exclusively from precipitation) have a low nutrient content and where rainfall is sufficient and drainage low enough to maintain the ground surface in a waterlogged condition. The vegetation is characterised by acid-tolerant plant communities of which the moss genus *Sphagnum* is dominant. The two main types of bog are **raised bogs**, characteristic of flat underlying

topography and found on plains and broad valley floors; and **blanket bogs**, which occur mainly in upland areas where conditions are suitably cool and wet, both of which occur in Doncaster.

Many lowland raised bogs have been designated as sites of international and national conservation importance. Peat in England is dug almost entirely (98 per cent) for horticultural purposes, either as a growing medium, or as a soil improver.

In Doncaster, extensive peat deposits occur in the east of the county on Hatfield Moors and Thorne Moors. These deposits have been exploited for many years and the industry based on these resources is currently one of the largest in Great Britain. The peat is extracted by both a mechanised block cutting method and a surface milling technique, the latter accounting for an increasing proportion of the output. The peat is used for a variety of horticultural applications. The upper part of the deposit produces a light brown, open-textured peat which is of premium quality. A darker, more compact material from lower levels is of less value. These deposits occur within designated conservation areas (SSSI, SPA and SAC). Natural England now own both Thorne and Hatfield moors and Peat extraction has now largely ceased with extraction only occurring as part of the restoration process. Natural England managed restoration programmes are now in place to return the land to its original raised bog status.

4.10 HYDROCARBONS

4.10.1 Conventional Oil and Gas

Doncaster lies towards the northwestern end of two major Carboniferous basins: the Gainsborough Trough and Edale Gulf. Within these areas source rocks were deposited which have since produced significant quantities of oil and gas, forming a series of important oil and gas fields to the southeast that make up the East Midlands Oil Province. Permian and Triassic strata crop out over the eastern half of the county providing, in addition to Carboniferous sequences, potential reservoir rocks for hydrocarbons generated from the Carboniferous rocks.

Several exploration wells were drilled in the county between 1940 and 1983 (Figure 11). All were dry, plugged and abandoned with the exception of two wells. Trumfleet 1 proved a major gas discovery but was only developed in 1998. To the southeast, Hatfield 1 followed as a gas discovery in 1981 and proved to be the discovery well for the series of wells that confirmed the two related Hatfield West and Hatfield Moors gas fields, which were developed in the mid 1980s. Trumfleet was still producing in late 2005, whilst the role of the Hatfield gasfields had changed to that of gas storage facilities, gas being injected into the reservoir during periods of low demand and then pumped out during peak demand.

The pattern of exploration to date thus indicates that the hydrocarbon potential of the county is perhaps relatively poor, due to the previous exploration and the level of coal mining activity. As seen in the Hatfield fields, depleted oil and gas fields could be increasingly used for gas storage. The majority of the exploration licences held in the county relate to the extraction of methane (see below).

4.10.2 Abandoned Mine Methane (AMM), Coal Mine Methane (CMM) and Coal Bed Methane (CBM) Potential

Pennine Coal Measures forming crop out or are below the Permian cover in much of the area. These Coal Measures have a generally simple eastward dip with local folding. They continue eastwards beneath the Permian cover rocks in the east of the county, being continuous with the concealed Eastern England Coalfield.

The Pennine Coal Measures in the county have been very heavily worked, with thicker seams almost totally worked out. The coal across the county is a high volatile bituminous coal with a seam gas content of between 4.1 and 6.1 cubic metres methane per tonne. In the USA, most CBM

production is from coals containing 7 or more cubic metres methane per tonne. The lower gas content of the coal in the county, combined with the fact that the coalfield has been heavily worked suggests that CBM development from virgin coal seams in South Yorkshire is probably not economic at present. However, the gas seam content in the South Yorkshire region is 6.1 cubic metres methane per tonne and is therefore perhaps only just marginal. Future CBM potential and prospectivity will be dependent on areas of undisturbed coal, which in the county will probably be limited to the east.

Initially AMM and CMM potential in the county appears good, given the intense coal mining in the area. During 2005 Alkane Energy held one licence (PEDL 37), Stratagas one (PEDL92) and Octagon three (PEDLs 60, 11, 43) that covered some part of the area. These permit the extraction of gas from abandoned coal mines with schemes at Wheldale (near Castleford) and at Monk Bretton (near Barnsley) and at Shirebrook and Markham in the North Derbyshire, although all are outside Doncaster. Investigations for CMM are currently taking place at Cadeby; results of this are not yet available. The gas produced is commonly used on site for power generation or supplied direct to local consumers. However, the potential for water entering and flooding areas of the mines, that are often interconnected, could impact greatly on any prospects identified in the county. Water is currently pumped from the Barnsley area to protect Maltby Colliery.

Prospects for AMM in the county are thus thought to be good if the mines are not flooded. The schemes operated by Alkane Energy have, however, seen rapid declines in the volumes of gas extracted and concerns in 2003 over the classification and tax regimes of the resource have led to doubts over the economic viability of this resource. Coal Mine Methane is recovered from existing operating mines.

A potential future area for development in coalfield areas is Underground Coal Gasification. This is very much an unproven, new technology, which is under review and test in a number of countries. Again, the level of mining across the county and the depth of the coals might rule against this being a realistic potential resource in Doncaster.

4.10.3 Licensing

The Department of Trade and Industry grants licences for exclusive rights to explore and exploit oil and gas onshore within Great Britain. The rights granted by landward licences do not include rights of access, and the licensees must obtain any consent under current legislation, including planning permission. Licensees wishing to enter or drill through coal seams for coalbed methane and abandoned mine methane must also seek the permission of the Coal Authority.

5 Groundwater Resources

5.1 OVERVIEW

The Environment Agency licence groundwater abstraction in Doncaster for a number of purposes including:

- Agricultural use, including irrigation (50 abstraction points)
- Industrial processes, including cooling (31 abstraction points)
- Public water supply (11 abstraction points)
- Mineral washing (4 abstraction points)
- Lake and pond level maintenance (1 abstraction point)

In addition, there are a number of unlicenced abstraction boreholes, mainly for domestic supplies. An extract from the BGS Wellmaster database of water wells and boreholes is shown on Figure 12; these include licenced and unlicenced wells and boreholes, and not all sources may currently be in use.

Groundwater is abstracted from a various subsurface strata within the Doncaster region, including:

- Carboniferous Limestone Supergroup (not present at surface)
- Pennine Coal Measures Group (mainly in the the Mexborough Rock)
- Permian Yellow Sands, Cadeby and Brotherton formations
- Triassic Sherwood Sandstone Group
- Quaternary superficial deposits

The most important of these aquifers are considered below. More detail is given in Allen et al. 1997 and Jones et al. 2000.

5.2 PERMIAN YELLOW SANDS, CADEBY AND BROTHERTON FORMATIONS

The hydrogeology of the Permian strata is controlled by lithology and structure. Variations in lithology result in changes in hydraulic conductivity and hence transmissivity and yield. However, the greatest control on the aquifer properties is the extent of the fracturing. As a consequence aquifer properties are unpredictable. The Yellow Sands Formation has been an important aquifer throughout the area and its presence in colliery shafts often posed considerable flooding problems for the coal mining industry. The Cadeby Formation is also a significant aquifer.

5.3 TRIASSIC SHERWOOD SANDSTONE GROUP

The Triassic Sherwood Sandstone Group is the most important aquifer in the Doncaster area. Groundwater flow is predominantly within fractures, although intergranular flow and storage is siginificant. The fluvial sequences which form most of the Sherwood Sandstone Group aquifer fine upwards from pebbly sandstone to sandstone and siltstone. Extensive mudstone horizons, resulting from the settling of flood overbank deposits, also occur. Channel deposits may be continuous for distances of up to tens of kilometres. The result of this deposition is that hydraulic

conductivity in the aquifer may be directional: values are likely to be higher along and down the channels. Fine-grained layers within the sandstones have lower permeabilities, and can act as confining layers. There is a general northerly decrease in grain size due to the fact that much of the sedimentation occurred from braided rivers flowing northwards from the Armorican massif. The lateral persistence of individual fine-grained bands can be highly variable. Lateral facies changes can cause deposits to change from being aquifers to aquitards.

The water table beneath Doncaster is typically 5 to 15 m below ground level. As the aquifer is generally unconfined, the vulnerability is regarded as moderate to high. The Environment Agency considers current abstraction status to the east of the city as being unsustainable.

Doncaster's public water supply is drawn from 11 sites operated by Yorkshire Water located mainly to the east of the city. At each site there are two, or more commonly three, large diameter boreholes. These typically penetrate either close to the base or into the lowest third of the Sherwood Sandstone aquifer (with depths of 120 to 241 m). Private abstraction, mainly for industrial uses, is also from boreholes across the city and its fringes.

Following the wet autumn and winter of 2000 – 2001 water levels in many aquifers rose to exceptionally high levels and remained high for extended periods of time. Associated with this rise, concentrations of nitrate in abstracted groundwater have increased considerably. Against this background, Yorkshire Water has detected a possible upturn in trace pesticide concentrations in blended water from the Triassic Sandstone aquifer for supply in the Doncaster area. A recent programme of analysis of groundwater from individual boreholes has shown that a number have been affected by pesticides, possibly from both agricultural and amenity use.

5.4 QUATERNARY SUPERFICIAL DEPOSITS

The cover of Quaternary deposits in the Doncaster area is complex and contains a wide range of lithologies with differing hydraulic conductivities. Some provide hydraulic connectivity with the Sherwood Sandstone aquifer and others act as an aquitard. These deposits include river terraces, silts and clays, peat and alluvium. In some locations multiple lithologies are found superimposed, resulting in inter-bedded layers of varying transmissivity.

6 Geodiversity of Doncaster

6.1 SITE OF SPECIAL SCIENTIFIC IMPORTANCE (SSSI)

Four sites in Doncaster are listed as SSSIs (Figure 13):

- Ashfield Brick Pit, Conisbrough (CadebyFormation)
- Bilham Quarry (CadebyFormation)
- Cadeby Quarry (CadebyFormation)
- New Edlington Brick-clay Pit (Edlington Formation)

All four sites were cited under the Geological Conservation Review (GCR) process and the details are published in the Marine Permian of England GCR volume (Smith, 1995)

6.2 REGIONALLY IMPORTANT GEOLOGICAL/GEOMORPHOLOGICAL SITES (RIGS)

In 1997 the survey of geological sites in Doncaster by the South Yorkshire RIGS Group was essentially based on information gleaned from BGS Geological Memoirs and Maps, old Ordnance Survey maps and other relevant publications, largely provided by Doncaster Museum. The desktop research was undertaken by a small team of volunteers and enthusiastic amateurs, with the field work undertaken by a freelance geologist contracted on a fixed sum.

Based on criteria used to assess potential RIGS in Barnsley and Rotherham, RIGS in Doncaster were selected on the strength of:

- Representing a full cross-section of geological formations in the area
- Scientific value
- Education value
- Accessibility and aesthetic, recreation and amenity value
- Links with other biological, archaeological and architectural interests

Although several active hard rock and sand and gravel quarries were assessed as part of the 1997 field survey work, with some considered to merit RIGS status, the existing planning conditions and legislation, together with commercial interests of quarry operators deemed it necessary to omit certain sites from the RIGS selection process, even though on strict merit these would have been included in the final short list.

The increased protection now afforded to geological sites by PPS9 and the Local Development Framework and the realistic prospect of Geodiversity Action Plans, produced in conjunction with the private sector, has emphasised the need to devote professional expertise to the current project. With more time to assess each of the RIGS and related geological features, the 2007 Survey highlights the opportunity to reinforce geological links with current management plans, especially along the Don Gorge, where there is great potential to link to funding opportunities with English Heritage and Natural England, and along the Permian limestone escarpment.

The resurvey of sites was conducted during mid January to early March 2007. Site assessment data was collected using the UKRIG Site Assessment Form and entered into the UKRIGS GeoConservation Microsoft Access database. In practice, this database has proved very difficult to use, especially importing and exporting data and the translation into a user friendly report

format. These database problems only came to light once the project was well underway, leaving no opportunity to introduce an alternative system.

It is therefore recommended that when undertaking future surveys of Sites of Scientific Interest within the borough, the compatibility of using this database alongside others used in Doncaster for Ecology, Archaeology and Architecture should be taken fully into account.

A summary of the 2007 survey is presented in Table 2 with sites plotted on Figure 13. Of the 28 sites listed in 1997, 23 are recommended for continued designation as RIGS, while five sites are proposed for removal from the list. Six new sites were surveyed and are recommended for designation as RIGS, bringing the total RIGS in Doncaster to 29. For full details of the individual sites see individual site assessment reports in Appendix 1.

With respect to geological formations that are not well represented, difficulties still remain in that both the Permian marls and associated minerals, together with the soft Quaternary sediments, are extremely susceptible to natural weathering, quarrying operations and development and these are probably best recorded in addition to an archaeological or ecological survey that may be required as part of future works.

Site No	Site Name	Site type	NGR	Stratigraphy	Current site condition	Geodiversity value	Score	Add, Remove or Keep
D6	Denaby Lane	Road cutting	SK 489 995	Mexborough Rock Pennine Middle Coal Measures Formation	Much of the section is overgrown and would be improved by selective clearance	Excellent geodiversity site (to be extended) for geology and a wide variety of landforms and fluvial geomorphology	9	Keep
D166	Doncaster Road	Disused quarry	SK 492 998	Mexborough Rock, Pennine Middle Coal Measures Formation	Partially overgrown	Moderately high, just because it is still the best exposure of Mexborough Rock recorded	7	Keep
D177	Wath Road Railway Cutting	Railway cutting	SE 461 002	Mexborough Rock, Pennine Middle Coal Measures Formation	completely infilled	No geodiversity value as site now completely infilled	0	Remove
DR2	Harlington Railway Cutting	Railway cutting	SE 477 033	Ackworth Rock, Pennine Middle Coal Measures Formation	Most of the eastern end is embankment. Western end more rocky but heavily vegetated	Limited. Very limited exposure of value to research and field mapping only	5	Add
DR3	Cadeby Waste Water Works	Disused quarry	SE 512 004	Dalton Rock, Pennine Upper Coal Measures Formation	Clean, clear rock faces. Shrubs and vegetation to lower rock face	Very good, on strength of rarity of Dalton Rock and possible associations with unconformable Permian rocks	8	Add
DR1	Denaby Woods – Mexborough Oxbow Lake	Geomor. interest site	SK 478 995	Pennine Coal Measures Group	Areas of interest are in good condition but lie in and around areas that are rapidly developing	Very good. Faulting and folding, alluvial processes and geomorphology	9	Add
DR6	Barnburgh Cliff	Exposure	SE 501 037	Dalton Rock, Pennine Upper Coal Measures Formation Wetherby Member, Cadeby Formation	Very good. Plenty of good exposure	A good site to show reef formation and associated beds, fissures and related deposits, an unconformity and geomorphology	9	Add
D11	Hazel Lane Quarry	Active quarry	SE 500 110	Pennine Upper Coal Measures Formation Wetherby Member, Cadeby Formation	Plenty of exposed faces but quarry is being progressively landfilled	Good example of lithological variation in the Cadeby Formation but limited by planning permission and landfill	5	Keep
D4	Watchley Crags	Disused quarry	SE 476 068	Yellow Sands Formation Wetherby Member, Cadeby Formation	The exposures furthest away from Watchley Lane are very good but the nearest are being increasingly littered	A very good site, for the rarity value, lithological variety and historic/industrial archaeological interests	8	Keep
D15	Melton Park	Disused quarry	SE 509 014	Yellow Sands Formation Wetherby Member, Cadeby Formation	The limestone is in excellent condition. The Yellow Sands would benefit considerably from vegetation clearance	A good range of geological processes can be demonstrated. Very high aesthetic/landscape value	8	Keep

Site No	Site Name	Site type	NGR	Stratigraphy	Current site condition	Geodiversity value	Score	Add, Remove or Keep
D133	Hooton Pagnell	Disused quarry	SE 483 074	Wetherby Member, Cadeby Formation	Vegetation and rubbish etc make access awakward but rock faces are largely free of vegetation and well exposed	A very good site, for the rarity value, lithological variety and historic/industrial archaeological interests	8	Keep
D13	North Cliff Quarry	Disused quarry	SK 507 992	Wetherby Member, Cadeby Formation	Requires extensive clearance to improve access to best exposures.	A very good site with variable lithology, excellent landscape value and proximity to several very notable historic buildings	9	Keep
D5	Hooton Pagnell Village Pound	Natural exposure	SE 486 081	Wetherby Member, Cadeby Formation	Very good, but some cutting back of vegetation around the reef exposure is required on a regular basis	Outstanding example of the creation of an estate village using local building materials with a particularly good reef	9	Keep
D20 – D22	Cadeby Cliff – Constitution Hill	Natural exposure	SK 511 999	Wetherby Member, Cadeby Formation Glaciofluvial Deposits	Several natural rock features well exposed. Old quarry requires clearance to facilitate access	A very good geodiversity site with a variety of lithological, geomorphological and historical interests	9	Keep
D112	Parknook Quarry	Active quarry	SE 513 128	Wetherby Member, Cadeby Formation	Commercial use of site and rock waste, rubbish and vegetation etc limit ease of access	Moderate geodiversity value. Some interesting geological features but mainly valuable as a potential source of building stone	7	Keep
D28	Pot Ridings Wood Railway Cutting	Railway cutting	SE 526 003	Wetherby and Sprotbrough Members, Hampole Beds, Cadeby Formation	Good exposures but access along the cutting was difficult at the time of the survey due to deep mud	A very good insight into the importance of geology in determining the route of railway networks	9	Keep
DR5	Levitt Hagg Wood	Disused quarry	SE 538 011	Sprotbrough Member, Cadeby Formation	Overgrown but there are reasonable rock exposures to be seen	Possesses group value with other sites along the Don Gorge	7	Add
D94	Warmsworth Quarry	Active quarry	SE 535 004	Sprotbrough Member, Cadeby Formation	Very good	Unusual occurrence of brecciated dolostone	8	Keep
D78	Warmsworth Park	Disused quarry	SE 544 030	Sprotbrough Member, Cadeby Formation	Very good but needs to be cleaned regularly	A wide range of geological processes can be demonstrated, especially in conjunction with other nearby sites	9	Keep
DR4	Nearcliff Wood Quarries	Disused quarry	SK 527 995	Cadeby Formation	Some rubbish, fires and other debris associated with redundant quarries but acceptable for scientific visits	Extremely important in at least both a regional and national context for the use and exploitation of a natural resource	10	Add
D300	Conisbrough Caves East	Caves	SK 523 992	Cadeby Formation	Some of cave entrances have been covered by landfill	Caves are of specialist speleological interest but associated breccias, rifts and slump structures are very interesting	8	Keep

Site No	Site Name	Site type	NGR	Stratigraphy	Current site condition	Geodiversity value	Score	Add, Remove or Keep
D301	Conisbrough Caves West	Caves	SK 515 996	Cadeby Formation	D/K	Entrances to both caves were not found and no geodiversity value could therefore be assigned	0	Remove
D302	Conisbrough Caves South	Caves	SK 511 985	Cadeby Formation	Full of rubbish and damaged by fire. Well is maintained	Speoleogical research potential. Spring line associated with fault. Historic associations	8	Keep
D303	Levitt Hagg Hole	Caves	SE 538 009	Cadeby Formation	Not found	The grid reference for the cave entrance appears to coincide with the restored Levitt Hagg Landfill Site and was not found	0	Remove
D61	New Edlington Brick Pit	Disused pit	SK 534 986	Edlington Formation Till	Gypsum and marl not visible at time of survey. Till has limited exposures that are susceptible to vegetation growth	Main value relates to rare occurrence of gypsum in a landscape dominated by human activity, waste tips and industry	5	Keep
D31	Leys Hill Bridge	Railway cutting	SE 523 067	Edlington Formation	Largely overgrown and obscured by grass, hawthorns and osiers	Limited value except use as a marker for the position of the Edlington Formation	5	Keep
D51	Hexthorpe Flatts – The Dell	Disused quarry	SE 558 020	Brotherton Formation Till	Very good. Only periodic removal of plant growth from rock faces required	A good introduction to magnesian limestone in situ and various man made features using stone. Landscape/rockery stone for ornamemtal garden features	7	Keep
D87	Brodsworth Quarry	Disused quarry	SE 530 070	Brotherton Formation	Misidentified site	None	0	Remove
D99	Skelbrooke Quarry	Disused quarry	SE 505 114	Brotherton Formation	Landfilled	None	0	Remove
D44	Cedar Road Adventure Playground	Disused quarry	SE 558 010	Nottingham Castle Formation Till and Glaciofluvial deposits	Some clearance of faces and rubbish required. Boundary fences need attention due to undermining /erosion of gravels	Good accessible introduction to a variety of lithologies and associations with quarrying and construction	6	Keep
D101	Dunsville Quarry	Active quarry	SE 655 075	Sherwood Sandstone Group Older River Gravel (River Terrace Deposits)	Exposures noted in the 1997 survey are obliterated but there is potential for further exposure with good management	A good site to demonstrate a wide variety of sedimentary processes	7	Keep
D102	Common Lane Quarry	Disused quarry	SE 567 962	Sherwood Sandstone Group Glaciofluvial deposits	Good condition. Clean and clear quarry faces. Sand and gravel also well exposed.	Remote location but one of few exposures of Sherwood Sandstone not under threat, with Glaciofluvial deposits	7	Keep

Site No	Site Name	Site type	NGR	Stratigraphy	Current site condition	Geodiversity value	Score	Add, Remove or Keep
D190–192	Blaxton Common	Disused quarry	E 685 015	Sherwood Sandstone Group Older River Gravel (River Terrace Deposits)	Sandstone exposures clear and visible but Older River Gravels are increasingly becoming overgrown	Links well with biodiversity interests, but lithologies not easily studied due to access difficulties	7	Keep
D109	Hurst Plantation Quarry	Disused quarry	SK 640 990	Glaciofluvial deposits	Plenty of exposure, but needs improvement of pathways and access to exposures if land is to be properly managed	Limited lithologies and interest, other than sedimentology but a good expossure of Anglian sand and gravel	7	Keep

Table 2 Summary of Doncaster RIGS and potential RIG site (D and DR in site number column respectively)

7 Sources of Information

The following sources of information were used in this project:

7.1 BGS MAPS

1:50 000 scale

E78 Wakefield (S&D) 1998, E78 Wakefield (SwD) 1978
E79 Goole (S&D) 1971, E79 Goole (SwD) 1972
E87 Barnsley (S&D) 1976
E88 Doncaster (S&D) 1969, E88 Doncaster (SwD) 1969
E100Sheffield (S&D) 1974
E101 East Retford (S&D) 1967

7.2 SOUTH YORKSHIRE RIGS GROUP

Inventory of Regionally Important Geological Sites Doncaster 1997

7.3 DONCASTER COUNCIL

Doncaster Museum Geological Site Inventory (Geosite1.xls)
Doncaster Museum Geological Sites featured in BGS memoir (Geosite2.xls)

7.4 PROJECT GIS

The following files were used in the project GIS:

Dataset	Figure No.	Format	Supplier	Licence req. for BGS use	Licence fee
Earth science					
Digital Geology (DiGMapGB-50 & 10)	3, 4, 6	ESRI shape files	BGS	No	No
Quaternart domains and lithostratigraphy	5, 7	ESRI shape files	BGS	No	No
BritPits database of mines and quarries	10	ESRI shape file	BGS	No	No
Index of onshore petroleum wells	11	ESRI shape file	BGS	No	No
Wellmaster database of water wells	12	ESRI shape file	BGS	No	No
Geological Conservation Review sites (GCR)	13	Web table	JNCC	No	No
Sites of Special Scientific Interest (SSSI)	8	ESRI shape files	NE	Yes	No
Regionally Important Geological and Geomorphological Sites (RIGS)	13	Excel table	DMBC	No	No
Topography and landscape					
NEXTMap Britain DSM from radar altimetry	9	Raster images	Intermap, but processed	Yes	Yes

			by BGS		
1:250k, 1:50k, 1:25k, 1:10k topography, National Grid, Admin Meridian		Raster and vector	OS	Yes, PGA	Yes
Natural Areas	8	ESRI shape files	NE	Yes	No

Table 3 Digital datasets used in the project GIS.

8 Glossary

Alluvial Environments, actions and products of rivers or streams

Anhydrite Anhydrous calcium sulphate, $CaSO_4$. A white, sometimes greyish, bluish or purple mineral. When exposed to water, anhydrite readily transforms to the more commonly occurring gypsum, ($CaSO_4 \cdot 2H_2O$) by the absorption of water. Anhydrite is commonly associated with calcite, halite, and sulphides such as galena, chalcopyrite, molybdenite, and pyrite in vein deposits.

Armorican The Gaulish name for the area that includes the Brittany peninsula and the territory between the Seine and Loire rivers, extending inland to an indeterminate point and down the Atlantic coast

Anticline An arch-shaped fold in rock in which the rock layers are upwardly convex. The oldest rock layers form the core of the fold, and outward from the core progressively younger rocks occur.

Argillaceous Detrital sedimentary rocks composed of very fine grain silt or clay-sized particles (<0.0625 mm), usually with a high content of clay minerals

Bedding A feature of sedimentary rocks, in which planar or near-planar surfaces known as bedding planes indicate successive depositional surfaces formed as the sediments were laid down.

Bedrock A term used to describe unweathered rock below soil or superficial deposits. Can also be exposed at the surface.

Bivalve class of molluscs with paired oval or elongated shell valves joined by a hinge.

Brachiopod A phylum of solitary marine shelled invertebrates

Breccia Coarse-grained clastic sedimentary rock consisting of angular fragments of pre-existing rocks

Brickclay Mudstone used in the manufacture of structural clay products such as bricks, pavers, roofing tiles and clay pipes.

Calcite Calcium Carbonate [$CaCO_3$] a widely distributed mineral and a common constituent of sedimentary rocks, limestone in particular. Also occurs as stalactites and stalagmites and is often the primary constituent of marine shells.

Carboniferous A geological period [359–299 Ma] preceded by the Devonian and followed by the **Permian**.

Conglomerate A sedimentary rock, a significant proportion of which is composed of rounded pebbles and boulders, greater than 2mm in diameter, set in a finer-grained groundmass.

Clast Particle of broken down rock, eroded and deposited in a new setting.

Clastic Applies to the texture of rocks which are comprised of fragments of pre-existing rocks which have been weathered or eroded.

Cross-bedding Cross-stratification formed by the migration of dunes and sand waves on a sediment surface.

Cross-lamination Cross-stratification formed by the migration of ripples on a sediment surface. **Foresets** less than 10 mm thick.

Cross-stratification A general term for the internal bedding structure produced in sand by moving wind or water. If the individual inclined layers (**foresets**) are thicker than 10 mm the cross-stratification may be referred to as **cross-bedding**. Thinner inclined layering is called **cross-lamination**. Cross-stratification forms beneath ripples

	and dunes. The layering is inclined at an angle to the horizontal, dipping downward in the downcurrent direction.
Cuesta	Asymmetric landform with one face (dip slope) long and gentle and conforming with the dip of the resistant bed or beds that form it, and the opposite face (scarp slope) steep or even cliff like and formed by the outcrop of the resistant rocks. Formed by the differential erosion of gently inclined strata.
Desiccation breccia	A layer of mudstone completely broken by subaerial cracking as it dries out in a terrestrial environment.
Devensian	The last glacial stage in Britain, lasting from around 70 000 BP (Before Present) to about 10,000 BP.
Dinoflagellate	The dinoflagella are a large group of flagellate organisms. Most are marine plankton, but they are also common in fresh water habitats. Their populations are distributed depending on temperature, salinity, or depth. Dinoflagellate cysts are commonly preserved in the fossil record and are useful for stratigraphic correlation and palaeoenvironmental analysis.
Discontinuity	A break in sedimentation.
Dolomite	Calcium magnesium carbonate, A sedimentary rock-forming mineral [$CaMg(CO_3)_2$].
Dolostone	A sedimentary rock usually formed by the dolomitization of limestones.
Dolomitization	Diagenetic conversion of calcium carbonate (limestone) to calcium magnesium carbonate (dolomite)
Eustatic	World-wide changes in sea-level caused either by tectonic movement or growth or melting of glacial ice-sheets (glacioeustatic)
Evaporite	Sedimentary rock formed by the precipitation of salts from natural brines.
Facies	The characteristic features of a rock unit, including rock type, mineralogy, texture and structure, which together reflect a particular sedimentary, igneous or metamorphic environment and/or process.
Fault	A fracture in the Earth's crust across which the rocks have been displaced relative to each other.
Fireclay	Sedimentary mudstones that occur as seatearths underlying almost all coal seams. They represent fossil soils on which the coal-forming vegetation grew. The term was originally derived from their ability to resist heat. They are mainly used in the manfacture of high-quality facing bricks.
Fluvial	Referring to a river environment.
Foraminifera	The Foraminifera, or forams for short, are a large group of amoeboid organisms. They typically produce a shell, or test, which can have either one or multiple chambers. About 275,000 species are recognized, both living and fossil. They are usually less than 1 mm in size and are commonly preserved in the fossil record. Useful for stratigraphic correlation and palaeoenvironmental analysis.
Foreset	The inclined surface within a cross set produced by the forward movement of the slip-face of a ripple or dune.
Glaciofluvial	Refers to sediments deposited by flowing glacial **meltwater**
Graben	A graben is a structural feature consisting of a depressed block of land bordered by parallel normal faults.
Holocene	The youngest epoch of the Quaternary Period. Covers the last 10 000 years.
Lacustrine	Refers to a lake environment.
Lamellibranchs	Any of the bivalve mollusks of the class Lamellibranchia, including the clams,

	scallops, and oysters. Also called pelecypod
Lithology	The character of a rock expressed in terms of its mineral composition, structure, grain size and arrangement of its constituents.
Meltwater	Water produced by melting of snow or ice.
Monocline	A linear of fold in which strata dip in one direction between horizontal or uniformally dipping layers on each side
Ooid	Sub-spherical, sans-sized carbonate particle that has concentric rings of calcium carbonate surrounded a nucleus of another particle. Ooids usually form on the sea floor, most commonly in shallow tropical seas
Periglacial	Conditions, processes and landforms associated with cold, nonglacial environments.
Permian	A geological period [299–251 Ma] preceded by the **Carboniferous** and followed by the **Triassic**.
Pisoids	A variety of calcite consisting of aggregated globular concretions about the size of a pea. Pisolites form by the precipitation of calcium carbonate around nuclei trapped in sediment within the vadose zone of soils or marine tidal flats
Pyrolusite	Pyrolusite is a mineral consisting essentially of manganese dioxide (MnO2) and is important as an ore of manganese. It is a soft, black, amorphous appearing mineral, often with a granular, fibrous or columnar structure, sometimes forming reniform crusts.
Reef	A rigid, wave-resistant organosedimentary build-up constructed by carbonate organisms. Reefs are held up by a macroscopic skeletal framework.
Rhomb	Equilateral oblique-angled parallelogram shaped mineral grains.
Rip-up clasts	In a fluvial setting, semi-lithified mudstone or siltstone overbank deposits ripped up during times of flooding and re-deposited in the channel.
Saccharoidal	A mineral Composed of tiny, equidimensional crystals that resemble grains of sugar.
Seatearth	A bed of rock underlying a coal seam, representing a fossil soil that supported the vegetation from which the coal was formed.
Sedimentology	The study of sedimentary rocks and of the processes by which they were formed; the description, classification, origin, and interpretation of sediments.
Sedimentary rock	A rock formed in one of three main ways: by the deposition of the weathered remains of other rocks (clastic sedimentary rock); by the deposition of the results of biogenic activity; and by precipitation from solution. Four basic processes are involved in the formation of a clastic sedimentary rock: weathering (erosion), transportation, deposition and compaction.
Solifluction	Solifluction is a slow downslope flow of water-saturated fragmental material or soil. It is promoted by the existence of permafrost which traps snow and ice melt within the surface layer making it more fluid.
Stylolites	Stylolites are irregular surfaces that commonly appear as dark, jagged lines on exposed surfaces of carbonate rock (and rarely on other sedimentary rock types). Their origin is usually attributed to solution that occurs after the host rock was formed. The dark layers are insoluble residues.
Strata	Rocks that form layers or beds.
Stratigraphy	The definition and description of the stratified rocks of the Earth's crust.
Subaerial	Located or occurring on or near the surface of the earth.

Syncline A basin- or trough-shaped fold in rock in which rock layers are downwardly concave. The youngest rock layers form the core of the fold and outward from the core progressively older rocks occur.

Triassic A geological period [251–200 Ma] preceded by the **Permian** and followed by the Jurassic.

Unconformable A term generally applied to applied to younger strata that do not conform in position or that do not have the same dip and strike as those of the immediately underlying rocks. Also applies to the contact between unconformable rocks.

Unconformity A surface of contact between two groups of **unconformable** strata. Represents a break in the geological record where a combination of erosion and lack of deposition was taking place.

Vug Vugs are small cavities inside rock that are formed when crystals form inside a rock matrix and are later removed through erosive processes, leaving behind voids. A common cause of vugs is minerals precipitating from solution in water, and then later being dissolved again by less saturated water. The inner surfaces of vugs are often coated with some of the mineral matter that formed them. Fine crystals are often found in vugs where the open space allows the free development of external crystal form.

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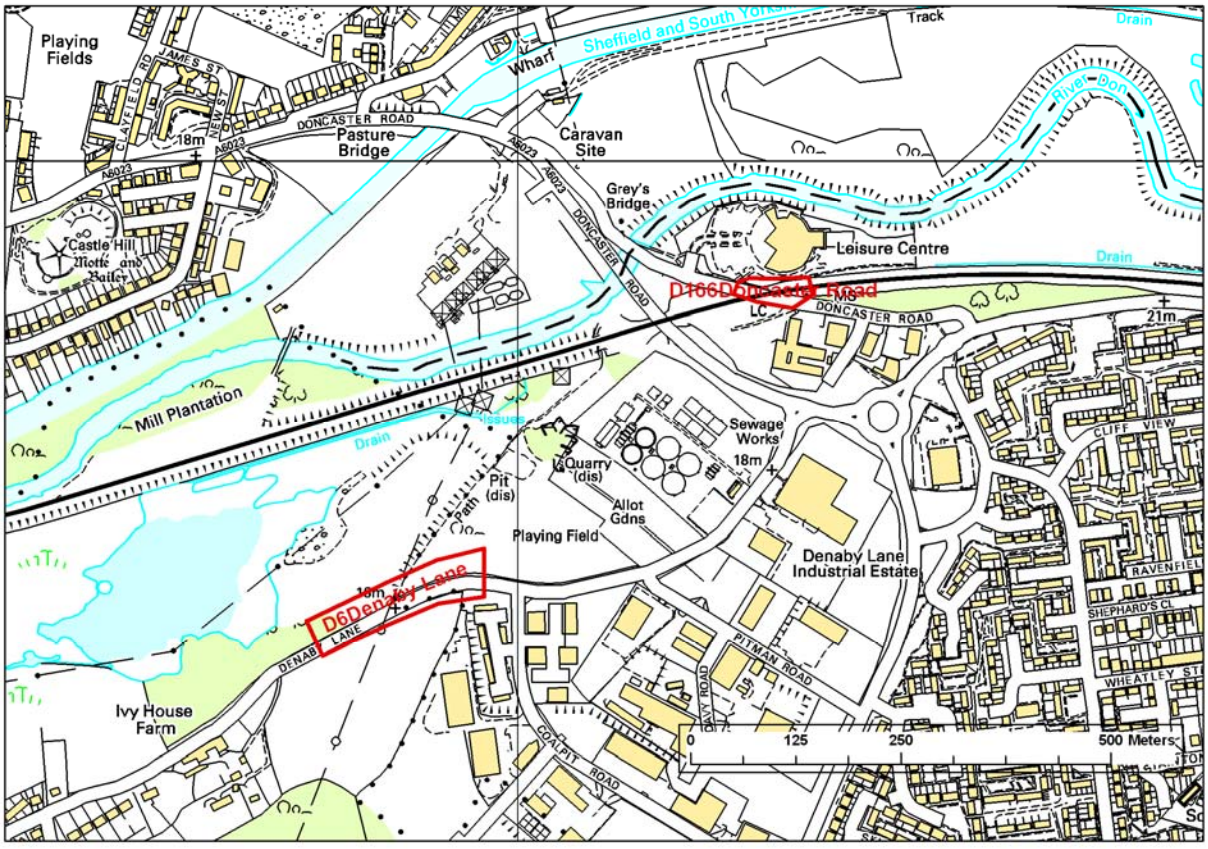
Appendix UKRIGS Field Record and Site Assessment

A1 D6 DENABY LANE

Site Name: **Denaby Lane**		Site Key: **D6**
Grid Reference: **SK 489 995 (centred on)**		Site Type: **cutting, road**
Local Authority: **Doncaster Metropolitan Borough Council, South Yorkshire**		
Site Dimensions: 30 m x 3 m	Site Owner: Highways Agency	
Conservation Status: **Regionally Important Geological Site**		Date: 14/9/97
Field surveyor: Scott Engering		Date: 16/2/07

Stratigraphy and Rock Types	
Time Unit: Carboniferous, Westphalian	Rock Unit: Mexborough Rock, Pennine Middle Coal Measures Formation, Pennine Coal Measures Group
Rock Type: Sandstone	Details: Cross bedded fine to medium grained, buff and iron stained flaggy sandstone

Site Map	**Figure 14 - D6 Denaby Lane**



Site Description	D6 Denaby Lane

Limited outcrop of Mexborough Rock in roadside cutting (SK 48974 99510), with maximum section of 3 m. Exposure is sporadic along the length and is often largely overgrown. Where exposed, it comprises cross bedded, fine to medium grained flaggy sandstone with iron staining, especially to the surfaces of the joints. The highest levels of the exposed sections show advanced disruption by roots and the processes of soil formation.

The position of the roadside exposure coincides with a steep drop in the road down an escarpment that is formed by a south-west trending fault line, with a down throw to the north. The fault is part of the South and North Don Fault system and contributes to the topography of the Mexborough Rock, which forms a prominent ridge alongside the Hooton Roberts road. Where the rock mainly outcrops opposite Coalpit Road, there are good views of this topography and further down the hill at SK 48894 99501 and SK 48848 99473, the wetlands associated with a former meander of the River Don is seen. From this site, at SK 4855 9865 to the north of the River Don and SK 47859 99511 (Ferryboat Farm Fisheries), where there is part of an oxbow lake, a good appreciation of the geological structure and geomorphology of the area may be obtained.

The wetlands, river terraces etc associated with the meandering and floodplain of the Don and Dearne in this area merit further investigation and it is considered that a large area should possess geodiversity value and not just single, isolated sites. There are strong links to biodiversity in this area.

RIGS Assessment of Site Value	D6 Denaby Lane

Ratings: 1-2 very poor; 3-4 poor; 5-6 acceptable/useful; 7-8 quite good; 9-10 very good/excellent; N/A not applicable; D/K don't know

Access and Safety

Aspect	Description	Rating
road access & parking	Wide access road to industrial estate is located opposite the exposure with small parking area at SK 48848 99473	**7**
safety of access	Accessible from public path on roadside	**7**
safety of exposure	Some flaggy beds are slightly loose but there is no danger from rock overhangs	**7**
permission to visit	Not applicable	**N/A**
current condition	Much of the section is overgrown and would be improved by selective clearance and removal of large shrubs/small trees	**5**
current conflicting activities	None envisaged	
restricting conditions	No collecting at the site	
nature of exposure	Roadside cutting but displacement of escarpment is evidence of faulting	
multiple exposures / prospect for trail	Consider trail relating to exposures/dip and scarp topography of Mexborough Rock and geomorphology of river terraces, oxbow lakes, meanders, braiding	
Notes		

Culture, Heritage & Economic

Aspect	Description	Rating
historic, archaeological & literary associations	None known	**0**
aesthetic landscape	Excellent. Very distinctive dip and scarp topography and fluvial morphology of the River Don with meanders and floodplains.	**9**
history of Earth Sciences	Type locality for Mexborough Rock	**8**
economic geology	Not applicable	**0**

Notes		
Education and Science		
surface processes	Modern and recent fluvial processes and landforms	**7**
geomorphology	Folding and faulting, dip and scarp topography, meanders, oxbow lakes, braiding, river terraces	**9**
sedimentary	Cross bedding and lithology in Mexborough Rock. Patterns of fluvial deposition.	**8**
fossils	Not seen although certain horizons within the formation are rich in fossil trees	**0**
igneous	Not applicable	**0**
metamorphic	Not applicable	**0**
tectonic: structural	Folding, faulting and topographic evidence of the Don Monocline	**8**
minerals	Not applicable	**0**
stratigraphy	Good opportunity to correlate Mexborough Rock with the same formation in Rotherham and Barnsley. Type locality	**7**
Notes	Potentially an excellent area to study structures, dip and scarp topography and fluvial geomorphology at A level upwards	
Geodiversity value		
Excellent geodiversity site (to be extended) for geology and a wide variety of landforms and fluvial geomorphology		**9**

Site Photographs	**D6 Denaby Lane**

Figure 15 Road cutting exposure of Mexborough Rock with vegetation overgrowth.SK 48974 99510.

Figure 16 Wetlands associated with the former course of the River Don. SK 48894 99473.

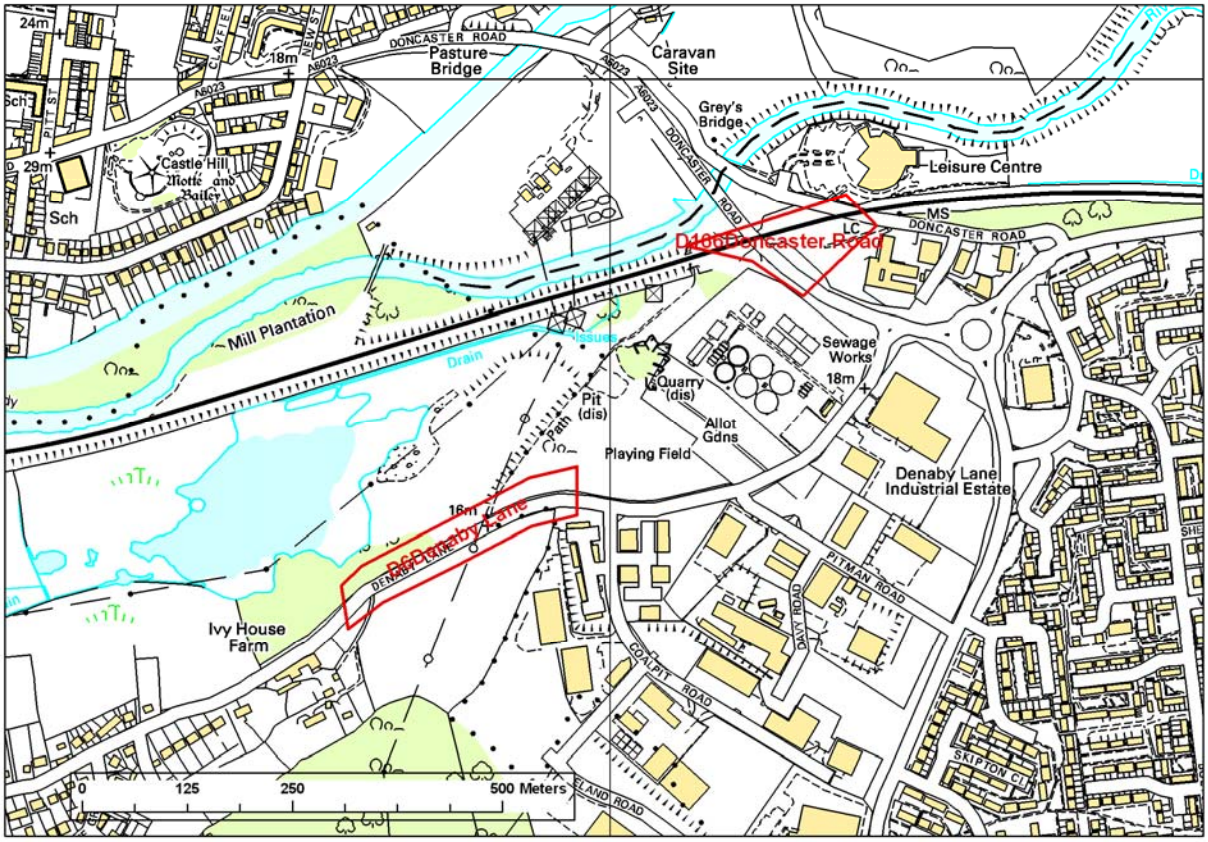
Figure 17 View to the Don Valley over a fault and down the escarpment. SK 48870 99500.

A2 D166 DONCASTER ROAD

Site Name: **Doncaster Road**	Site Key: **D166**
Grid Reference: **SK 492 998 (centred on)**	Site Type: **disused quarries, pits and cuttings**
Local Authority: **Doncaster Metropolitan Borough Council, South Yorkshire**	
Site Dimensions: 8 m x 3 m	Site Owner: Not known
Conservation Status: **Regionally Important Geological Site**	Date: 19/8/97
Field surveyor: Scott Engering	Date: 21/2/07

Stratigraphy and Rock Types	
Time Unit: Carboniferous, Westphalian	Rock Unit: Mexborough Rock, Pennine Middle Coal Measures Formation, Pennine Coal Measures Group
Rock Type: Sandstone	Details: Massive cross-bedded medium grained buff sandstone

Site Map	**Figure 18 - D166 Doncaster Road**



Site Description	D166 Doncaster Road

The old quarry which once had an extensive of exposure of Mexborough is now virtually entirely developed and incorporated into the road scheme. A very small exposure now exists adjacent to the railway line with maximum dimensions of 8 m x 3 m. It is visible from the northern side of the railway, accessible over made ground that is not likely to remain undeveloped. The exposure itself is fenced off and for most practical purposes is inaccessible; although in the absence of other good exposures of Mexborough Rock it still retains geodiversity value. The Mexborough Rock forms some important geomorphological features in the area and it is important to have an exposure of this formation visible.

The exposure comprises massive, cross bedded, medium grained buff coloured sandstone.

RIGS Assessment of Site Value	D166 Doncaster Road

Ratings: 1-2 very poor; 3-4 poor; 5-6 acceptable/useful; 7-8 quite good; 9-10 very good/excellent; N/A not applicable; D/K don't know

Access and Safety

Aspect	Description	Rating
road access & parking	Good parking in nearby leisure centre	**8**
safety of access	Best view is obtained by walking onto mound of made ground. Grassed and uneven. Moderate care required	**5**
safety of exposure	Safe. Viewed only from other side of railway line	**5**
permission to visit	Not required at present	**5**
current condition	Partially overgrown	**5**
current conflicting activities	Development of area	
restricting conditions	Inaccessible	
nature of exposure	Remains of old quarry face	
multiple exposures / prospect for trail	Limited due to lack of access	
Notes		

Culture, Heritage & Economic

Aspect	Description	Rating
historic, archaeological & literary associations	Not applicable	**0**
aesthetic landscape	Negligible	**1**
history of Earth Sciences	One of only two recorded exposures of Mexborough Rock	**1**
economic geology	Formerly a building stone quarry for local use	
Notes	Limited cultural value	

Education and Science

surface processes	Weathering of rock face	**5**
geomorphology	Not applicable	**0**
sedimentary	Large scale cross bedding and massive beds indicative of fluvial conditions	**5**
fossils	Not applicable	**0**
igneous	Not applicable	**0**
metamorphic	Not applicable	**0**

tectonic: structural	Not applicable	**0**
minerals	Not applicable	**0**
stratigraphy	An example of Mexborough Rock near to type locality	**5**
Notes	Limited value due to inaccessibility and position but it is one of only 2 recorded exposures of Mexborough Rock	
Geodiversity value		
Moderately high, just because it is still the best exposure of Mexborough Rock recorded		**7**

Site Photographs	**D166 Doncaster Road**

Figure 19 Flyover obscuring outcrop of Mexborough Rock. SK 49300 99840.

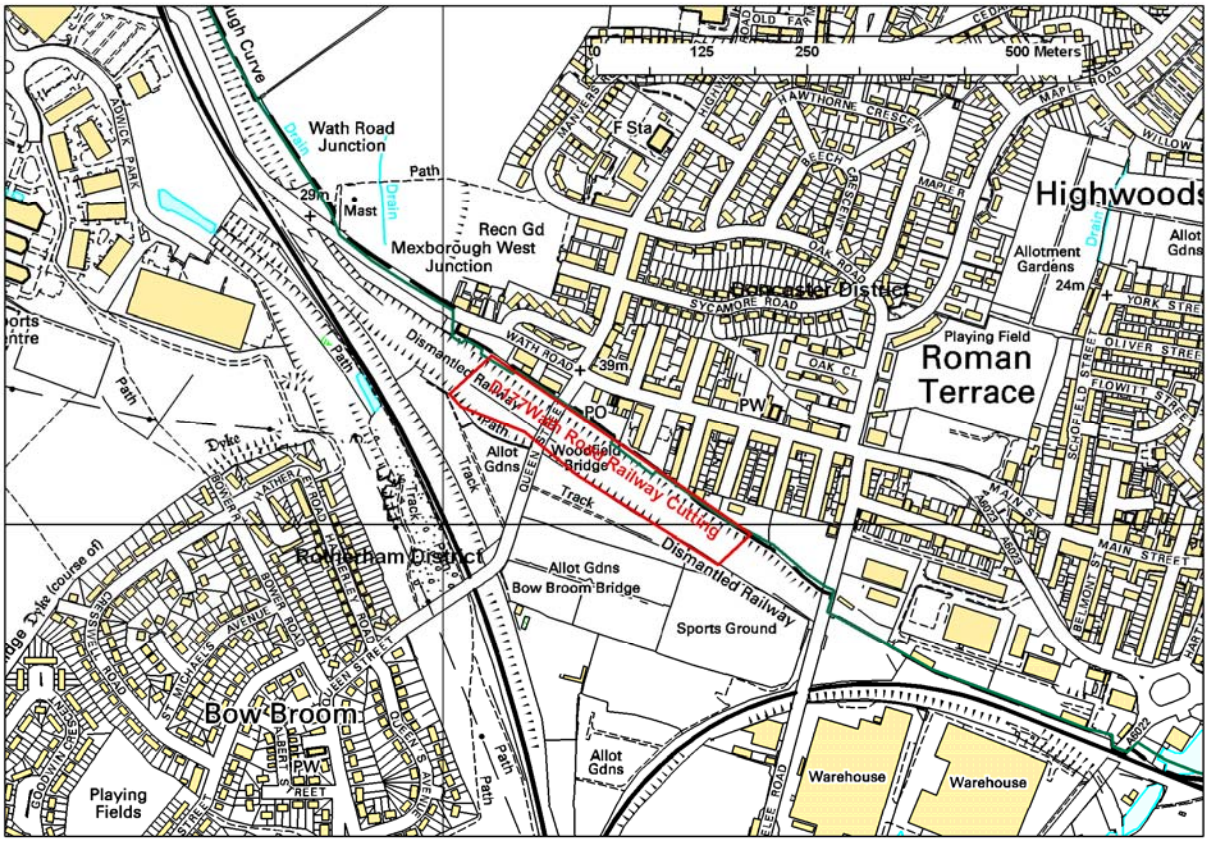
Figure 20 Remaining outcrop of Mexborough Rock. SK 49300 99840.

A3 D177 WATH ROAD RAILWAY CUTTING

Site Name: **Wath Road Railway Cutting**	Site Key: **D177**
Grid Reference: SE 461 002 **(centred on)**	Site Type: **cutting, railway**
Local Authority: **Doncaster/Rotherham Metropolitan Borough Councils, South Yorkshire**	
Site Dimensions: 350 m x 60	Site Owner: Not known
Conservation Status: **Regionally Important Geological Site**	Date: 1/9/07
Field surveyor: Scott Engering	Date: 16/2/07

Stratigraphy and Rock Types	
Time Unit: Carboniferous, Westphalian	Rock Unit: Mexborough Rock, Pennine Middle Coal Measures Formation, Pennine Coal Measures Group
Rock Type: Sandstone	Details:

Site Map	**Figure 21 - D177 Wath Road Railway Cutting**



Site Description	**D177 Wath Road Railway Cutting**
Former site of old railway cutting with good exposures of Mexborough Rock but now completely infilled. Most of former site is situated in Rotherham MBC.	

Geodiversity value	
No geodiversity value as site now completely infilled	**0**

Site Photographs	D177 Wath Road Railway Cutting

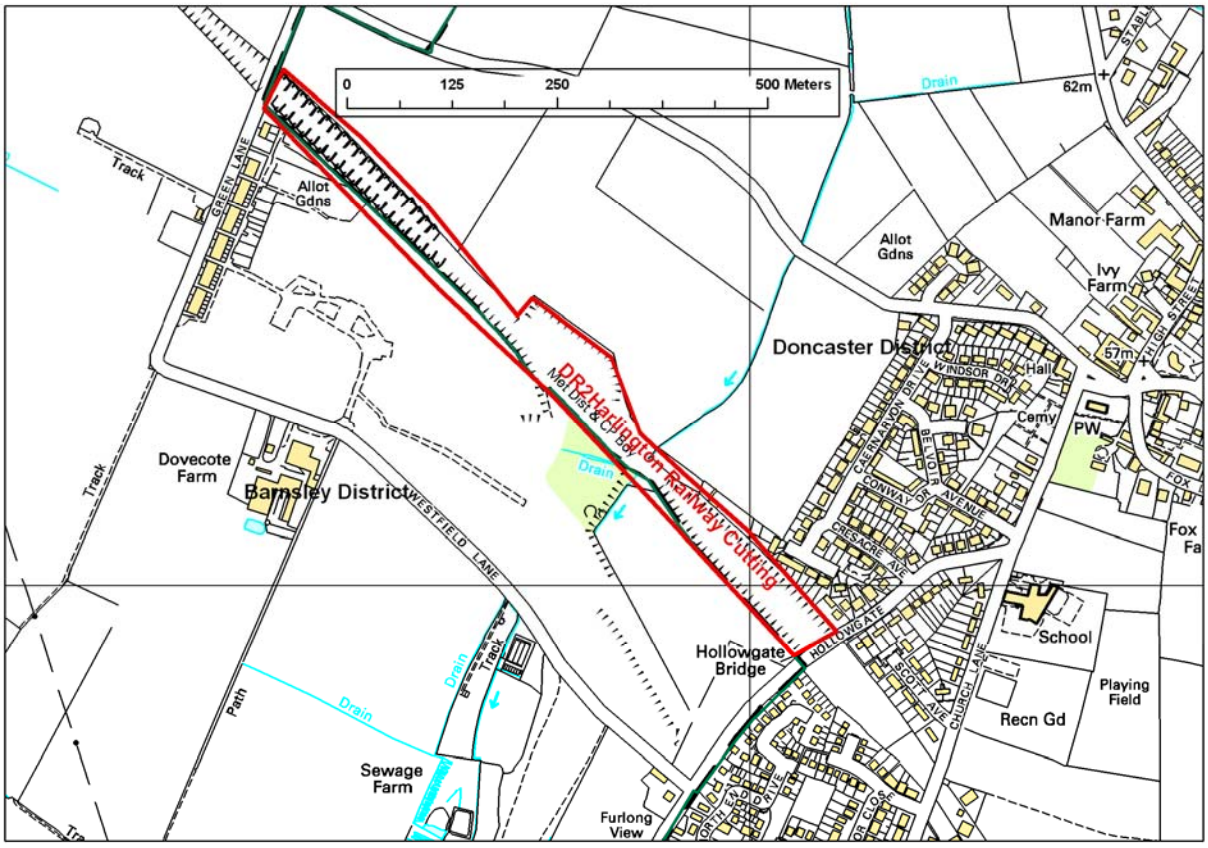
Figure 22 General view to the east. SE 46116 00093.

A4 DR2 HARLINGTON RAILWAY CUTTING

Site Name: **Harlington Railway Cutting**	Site Key: **DR2**
Grid Reference: **SE 4772 0331 (centred on)**	Site Type: **disused quarries, pits and cuttings**
Local Authority: **Doncaster Metropolitan Borough Council, South Yorkshire**	
Site Dimensions: 1500 m x 7 m	Site Owner: Not known
Conservation Status: **Possible Regionally Important Geological Site**	Date: No Date
Field surveyor: Scott Engering	Date: 13/3/07

Stratigraphy and Rock Types	
Time Unit: Carboniferous, Westphalian	Rock Unit: Ackworth Rock, Pennine Middle Coal Measures Formation, Pennine Coal Measure Group
Rock Type: Sandstone	Details: Massive cross-bedded sandstone with some flaggy beds

Site Map	**Figure 23 - DR2 Harlington Railway Cutting**



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Site Description	DR2 Harlington Railway Cutting

The site surveyed comprises the section of old railway cutting to the east of Harlington. Occasional and very isolated exposures of Ackworth Rock appear in the cutting east of Hollowgate, comprising blocks of massive and cross-bedded sandstone no larger than 2 m by 2 m, with occasional flaggy beds. At no point is there any good section of rock that displays the characteristics of the strata and there is little of educational or scientific value except to note the presence of strata that have not been identified as RIGS. Beween Hollowgate and Green Lane Bridge, the path was covered in deep mud and not safely accessible.

From Green Lane Bridge, exposure of rock in the cutting was slightly better but again these were very small and isolated, with no good full sections. Based on criteria for the original RIGS survey and for the purposes of the current survey, this site would not be considered as as a RIGS, with its only real value being for geological field mapping work.

RIGS Assessment of Site Value	DR2 Harlington Railway Cutting

Ratings: 1-2 very poor; 3-4 poor; 5-6 acceptable/useful; 7-8 quite good; 9-10 very good/excellent; N/A not applicable; D/K don't know

Access and Safety

Aspect	Description	Rating
road access & parking	On street at Green Lane. Very restricted at Hollowgate	**5**
safety of access	From Hollowgate, along specially built path. Muddy bank at Green Lane off agricultural land. Fieldwork precautions needed	**5**
safety of exposure	Exposures visible from cutting floor, but very muddy in places	**5**
permission to visit		**N/A**
current condition	Most of the eastern end is embankment. Western end more rocky but heavily vegetated	**5**
current conflicting activities	None envisaged	
restricting conditions	Limited exposures available	
nature of exposure	Old railway cutting	
multiple exposures / prospect for trail	Limited value	
Notes		

Culture, Heritage & Economic

Aspect	Description	Rating
historic, archaeological & literary associations	Industrial archaeology and railway history of area	**5**
aesthetic landscape	Very limited due to sunken position. Adjacent to restored site of Barnburgh Colliery	**4**
history of Earth Sciences	Research field mapping value only	**7**
economic geology	Industrial archaeology associated with former Barnburgh Colliery	**5**
Notes	Limited value except for associations with Barnburgh Colliery	

Education and Science

surface processes	vegetation growth on rocky outcrops	**5**
geomorphology	Not applicable	**0**
sedimentary	Limited opportunities to study lithology due to lack of exposure	**5**
fossils	Not applicable	**0**

igneous	Not applicable	**0**
metamorphic	Not applicable	**0**
tectonic: structural	Not applicable	**0**
minerals	Not applicable.	**0**
stratigraphy	Research and mapping potential as a very rare exposure of Ackworth Rock	**5**
Notes		
Geodiversity value		
Limited. Very limited exposure of value to research and field mapping only		**5**

Site Photographs	**DR2 Harlington Railway Cutting**

Figure 24 Exposure A. Massive Ackworth Rock overlain by flaggy rock and soil in embankment. SE 47721 03309.

Figure 25 Exposure B. Cross bedded sandstone. SE 47934 03075.

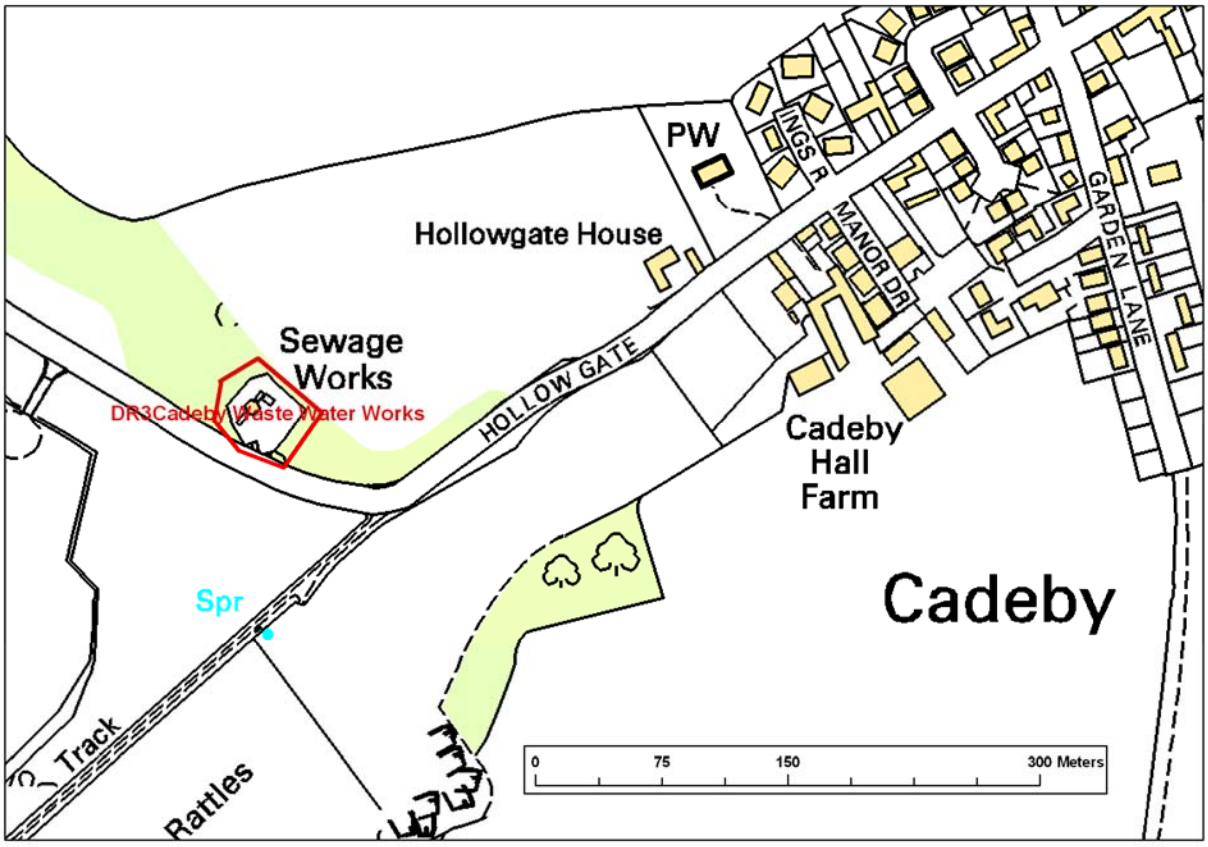
Figure 26 General view of cutting from Green Lane. SE 47474 03597.

A5 DR3 CADEBY WASTE WATER WORKS

Site Name: **Cadeby Waste Water Works**	Site Key: **DR3**
Grid Reference: **SE 5121 0036 (centred on)**	Site Type: **disused quarries, pits and cuttings**
Local Authority: **Doncaster Metropolitan Borough Council, South Yorkshire**	
Site Dimensions: 10 m x 6 m	Site Owner: Yorkshire Water
Conservation Status: **Proposed Regionally Important Geological Site**	Date: No Date
Field surveyor: Scott Engering	Date: 13/3/07

Stratigraphy and Rock Types	
Time Unit: Carboniferous, Westphalian	Rock Unit: Dalton Rock, Pennine Upper Coal Measures Formation, Pennine Coal Measure Group
Rock Type: Sandstone	Details: Massive medium grained reddened sandstone and fine grained, cross bedded, pale yellow sandstone

Site Map	**Figure 27 - DR3 Cadeby Waste Water Works**



Site Description	DR3 Cadeby Waste Water Works

An old quarry exposure of a section through the Upper Coal Measures strata beneath the limestone escarpment immediately to the west of the South Don Fault. The gates were locked and a close inspection not possible but the lower half of the section appeared to comprise massive reddened sandstone, overlain by cross-bedded pale yellow friable sandstone which does not have the typical darkened and weathered appearance of Carboniferous sandstone. They also contain occasional large vugs/nodules, which appear as discontinuous lenses.

At SE 513004, 100 m down the limestone escarpment from Cadeby, small exposures of reddened massive sandstone identified as Dalton Rock are seen in the road cutting.

In view of the rarity of good exposures in the Upper Coal Measures in Doncaster, further investigation of this site is recommended with the permission of the owners, Yorkshire Water.

RIGS Assessment of Site Value	DR3 Cadeby Waste Water Works

Ratings: 1-2 very poor; 3-4 poor; 5-6 acceptable/useful; 7-8 quite good; 9-10 very good/excellent; N/A not applicable; D/K don't know

Access and Safety

Aspect	Description	Rating
road access & parking	Limited outside gates to old quarry site. Care needs to be taken when pulling out into a busy back lane	**5**
safety of access	No access beyong gates but visible from safe area away from road	**5**
safety of exposure	Not assessed. View from outside fence to site. Appears reasonably safe	**5**
permission to visit	Yorkshire Water	**D/K**
current condition	Clean, clear rock faces. Shrubs and vegetation to lower rock face	**7**
current conflicting activities	Site used as waste water treatment works	
restricting conditions	Gated and fenced	
nature of exposure	Old quarry face	
multiple exposures / prospect for trail	Good potential for stop off with small party/minibus in association with a variety of other sites in the area	
Notes	A locked site in private ownership	

Culture, Heritage & Economic

Aspect	Description	Rating
historic, archaeological & literary associations	Local industrial archaeology	**5**
aesthetic landscape	Limited quarry exposure but good views at top of escarpment near Cadeby	**5**
history of Earth Sciences	Locally important as an outcrop of Dalton Rock	**6**
economic geology	Source of local building stone	**6**
Notes		

Education and Science

surface processes	General weathering of rock surfaces	**6**
geomorphology	Base of limestone escarpment	**5**
sedimentary	Varied lithology of Coal Measure sandstone, vugs, nodules and possible Permian sandstone	**7**

fossils	Not applicable	**0**
igneous	Not applicable	**0**
metamorphic	Not applicable	**0**
tectonic: structural	Close proximity to position of the South Don Fault, an important feature of regional structural geology	**7**
minerals	Not applicable	**0**
stratigraphy	rare exposure of Dalton Rock in Doncaster	**7**
Notes	Limited general education value for close study due to inaccessibility but a very good fieldwork and research site, with permission	
Geodiversity value		
Very good, on strength of rarity of Dalton Rock and possible associations with unconformable Permian rocks		**8**

Site Photographs	**DR3 Cadeby Waste Water Works**

Figure 28 General view of old quarry face. SE 51205 00361.

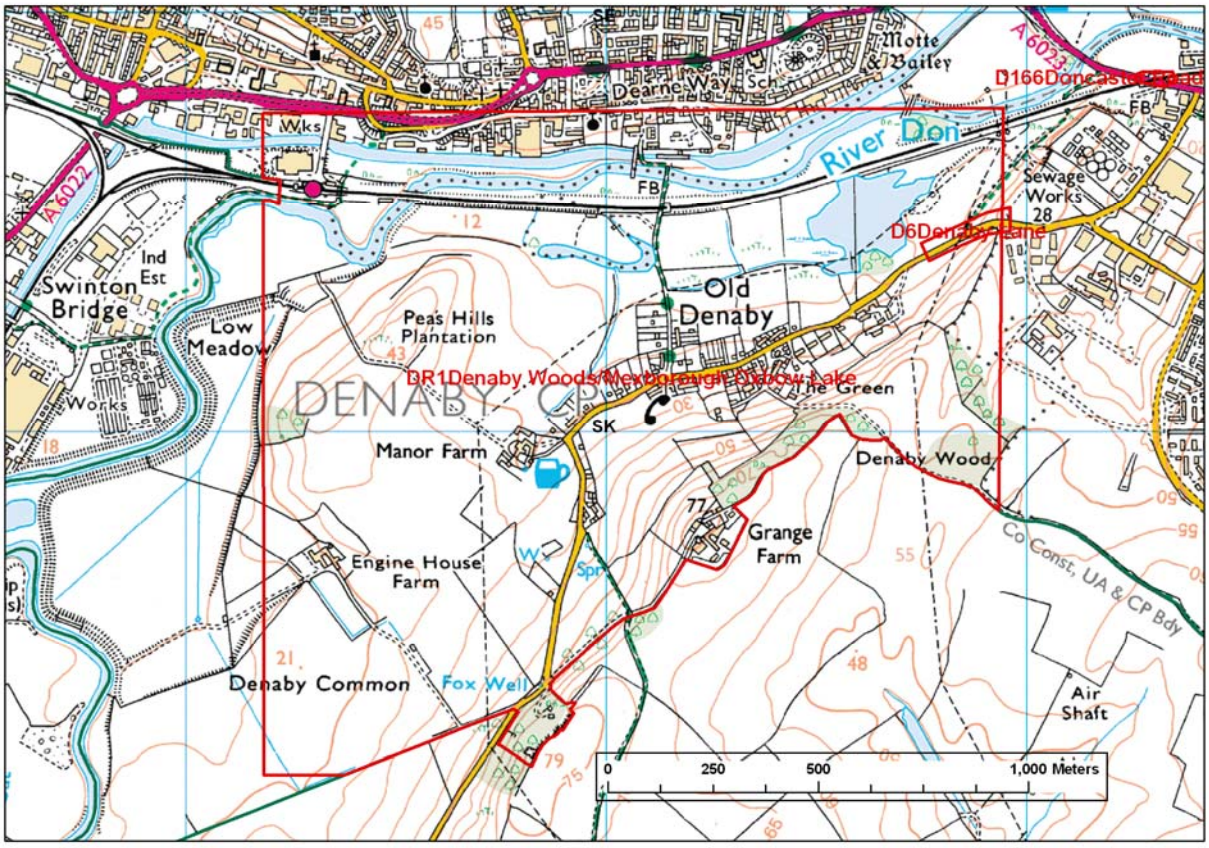
Figure 29 Detail of old quarry face showing yellow and red cross bedded sandstone. SE 51205 00361.

A6 DR1 DENABY WOODS/MEXBOROUGH OXBOW LAKE

Site Name: **Denaby Woods/Mexborough Oxbow Lake**	Site Key: **DR1**
Grid Reference: **SK 4782 9946 (centred on)**	Site Type: **geomorphological interest site**
Local Authority: **Doncaster Metropolitan Borough Council, South Yorkshire**	
Site Dimensions: several km^2	Site Owner: Various
Conservation Status: **Proposed Regionally Important Geological Site**	Date: No Date
Field surveyor: Scott Engering	Date: 13/3/07

Stratigraphy and Rock Types	
Time Unit: Carboniferous, Westphalian	Rock Unit: Pennine Coal Measure Group
Rock Type:	Details:

Site Map	**Figure 30 - DR1 Denaby Woods/Mexborough Oxbow Lake**



Site Description	DR1 Denaby Woods/Mexborough Oxbow Lake

The area around Mexborough and Old Denaby is of particular interest in a regional context for landforms and topography that provide evidence of two major structural geology features: the Don Monocline and the South Don fault. These have also influenced the drainage patterns of the River Don and the River Dearne and in the low lying areas adjacent to these two rivers, there are river terraces, braided channels, oxbow lakes and wetlands that record the development of river systems during the Quaternary Period.

In general, the Coal Measures rocks that form the distinctive scarp and topography to the west of the Permian limestone escarpment posses a north-north-west–south-south-east alignment, with strata generally dipping to the north-east with progressively younger rocks outcropping in that direction. In the Doncaster region, this is seen at Barnburgh and from viewpoints at Conisbrough, Cadeby, High Melton and Hooton Pagnell, this pattern is clearly seen in the landscape and by following the course of the River Dearne. However, from Sheffield, Rotherham and into the region between Hooton Roberts and Old Denaby, the strata immediately to the south of the course of the River Don are aligned south-south-west–north-north-east, with strata dipping steeply to the south-east and form distinct escarpments of Mexborough Rock and Ackworth Rock at Denaby Wood and a much smaller, but very distinctive, escarpment, also Mexborough rock, south of the Don at Mexbrorough (centred on SK 474992). These are best seen from SK 47440 99750.

The alignment and form of these escarpments is closely associated with the south-south-west–north-north-east Don Fault System and the outcrop of these strata has controlled the course of the River Don and the position of associated alluvial terraces. At SK 48013 99521, at Ferryboat Farm Fisheries there is part of an oxbow lake which, although partly remodelled for fishing and flood protection purposes, links to wetland areas west and north of the Denaby Lane RIGS (D6) and to Denaby Ings at the confluence of the Don and Dearne. Here, it is quite possible that the position of alluvial terraces and other related features are obscured by landscaping, restoration and subsidence associated with the former Denaby main Colliery.

In a regional context, linking with biodiversity initiatives and existing Nature Reserves, the area merits further protection for its geological and geomorphological significance.

RIGS Assessment of Site Value	DR1 Denaby Woods/Mexborough Oxbow Lake

Ratings: 1-2 very poor; 3-4 poor; 5-6 acceptable/useful; 7-8 quite good; 9-10 very good/excellent; N/A not applicable; D/K don't know

Access and Safety

Aspect	Description	Rating
road access & parking	On street, roadside parking. The proposed site covers a large area and walking is required	**6**
safety of access	Good access. Involves walking around wetland areas and associated paths	**7**
safety of exposure	Reasonable precautions required around wetland areas ie good footwear etc.	**7**
permission to visit	Ferryboat Farm Fisheries is private. Points of interest viewed from public rights of way	**5**
current condition	Areas of interest are in good condition but lie in and around areas that are rapidly developing	**7**
current conflicting activities	Development	
restricting conditions	Private access to some parts. Possibility of opening new pathways etc	
nature of exposure	Escarpments and geomorphological and topographic features	
multiple exposures / prospect for trail	With proper management and access, there are good prospects for education at a variety of levels and trails. Links to hard rock geology on Permian limestone	
Notes	Most features viewed from public rights of way	

Culture, Heritage & Economic		
Aspect	**Description**	**Rating**
historic, archaeological & literary associations	Settlement patterns associated with the confluence of the River Don and Dearne e.g. Mexborough castle	**7**
aesthetic landscape	Excellent site, with scarp topography and other rural features within an are dominated by industrial development	**9**
history of Earth Sciences	Regionally significant for demonstrating the Don Monocline and Don faults	**9**
economic geology	Not applicable	**0**
Notes	Settlement patterns associated with confluence of the Don and Dearne	
Education and Science		
surface processes	Meandering, alluvial terraces, oxbow lakes, river drainage patterns, fluvial processes	**7**
geomorphology	Fault bound escarpments and fluvial landforms	**8**
sedimentary	Fluvial processes	**8**
fossils	Not applicable	**0**
igneous	Not applicable	**0**
metamorphic	Not applicable	**0**
tectonic: structural	Evidence of the Don Monocline and Don Fault System	**9**
minerals	Not applicable.	**0**
stratigraphy	None known	**0**
Notes	Excellent site to demonstrate Don Monocline and associated faulting and river channel processes	
Geodiversity value		
Very good. Faulting and folding, alluvial processes and geomorphology		**9**

Site Photographs	DR1 Denaby Woods/Mexborough Oxbow Lake

Figure 31 View to the south of escarpments in Mexborough Rock. SK 47440 99750.

Figure 32 View to the east along the oxbow lake. SK 48013 99521.

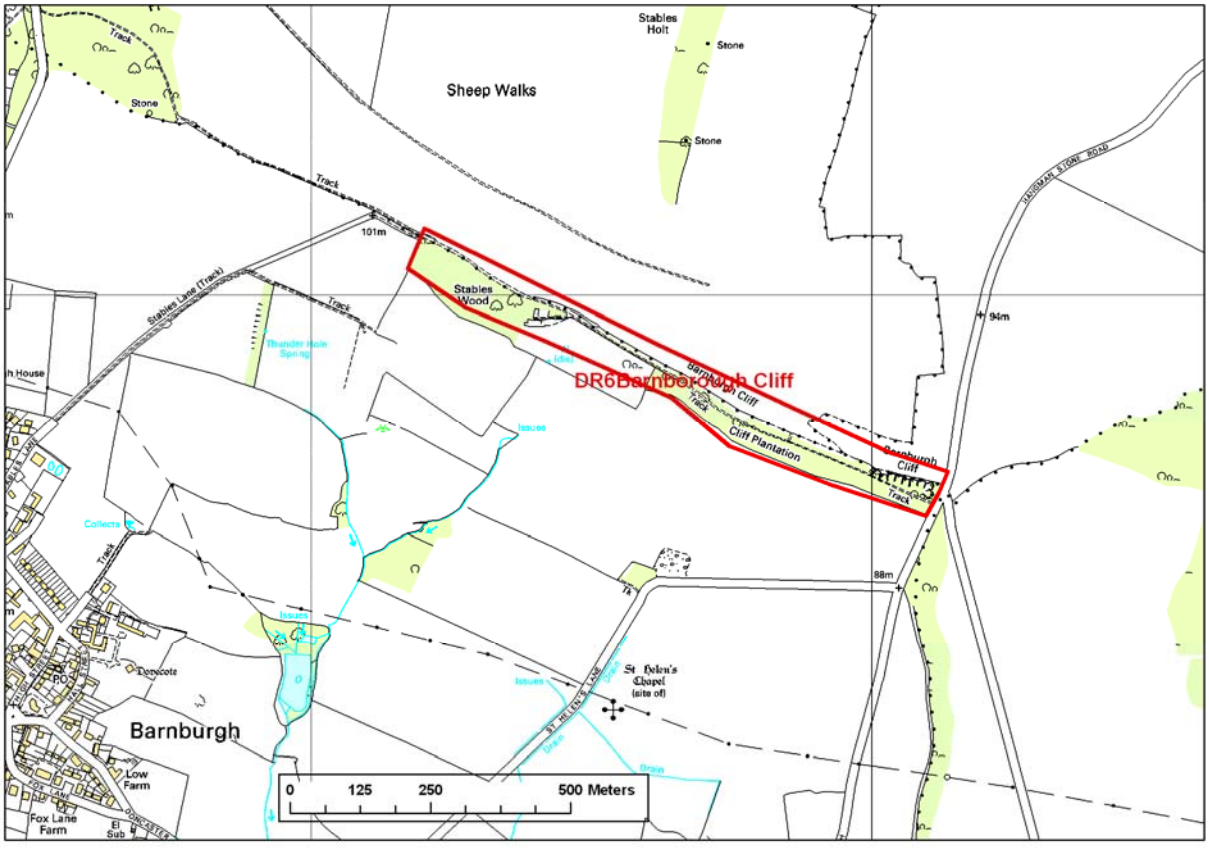
Figure 33 View to the south from the north-west end of oxbow lake. SK 47859 99511.

A7 DR6 BARNBURGH CLIFF

Site Name: **Barnburgh Cliff**	Site Key: **DR6**
Grid Reference: **SE 5006 0366 (east end)**	Site Type: **exposure**
Local Authority: **Doncaster Metropolitan Borough Council, South Yorkshire**	
Site Dimensions: 1000 m x 100 x 15 m	Site Owner: Not known
Conservation Status: **Proposed Regionally Important Geological Site**	Date:
Field surveyor: Scott Engering	Date: 13/3/07

Stratigraphy and Rock Types	
Time Unit: Carboniferous, Westphalian	Rock Unit: Dalton Rock, Pennine Upper Coal Measures Formation, Pennine Coal Measures Group
Rock Type: Sandstone	Details: Massive, cross-bedded yellow-red medium grained sandstone with ironstone pebbles
Time Unit: Permian	Rock Unit: Wetherby Member, Cadeby Formation, Zechstein Group
Rock Type: Dolostone	Details: Horizontally bedded shelly ooid-limestones

Site Map	**Figure 34 - DR6 Barnburgh Cliff**



Site Description

An outcrop of the Wetherby Member of the Cadeby Formation is exposed along nearly the whole length of the escarpment, from SE 50063 03661 to SE 49405 03964 and provides the best opportunity to observe and research the Carboniferous-Permian boundary in Doncaster. From east to west, there is a near horizontal exposure of beds that record an ancient reef and inter reef environment.

From SE 50063 03361 to SE 50029 03689, there is the largest exposure of Bryozoan/Stromatolite reefs in the region. At SE 49595 03980, the increasingly yellow colour of the limestone coincides with the appearance of large rifts in the exposure, filled with orange sands and limestone breccia and at SE 49546 03918, another rift is exposed parallel to the rock face. Here, there is good evidence of slumping and cambering, with the development of large cavities that along the Don Gorge have been previously investigated as caves.

At SE 49488 03953, the geomorphology of the region associated with the Don Monocline and North and South Don faults is clearly seen. The increasingly sandy, yellow limestone of the Wetherby Member dies out at SE 49405 03964 but within less than 1 metre of the lowest exposed beds, there is a large 10 metre x 4.5 metre quarried exposure of yellow to red , massive and cross-bedded sandstone with ironstone pebbles. This is the Dalton Rock.The junction between these two distinctive rocks is marked by the growth of well established trees, with associated and distinctive vegetation and, at this point, this should be considered as the best example of the Carboniferous – Permian unconformity, although the precise boundary is inferred by field evidence but not fully exposed.

RIGS Assessment of Site Value	DR6 Barnburgh Cliff

Ratings: 1-2 very poor; 3-4 poor; 5-6 acceptable/useful; 7-8 quite good; 9-10 very good/excellent; N/A not applicable; D/K don't know

Access and Safety

Aspect	Description	Rating
Road access & parking	Limited parking at east end of escarpment. Park in Barnburgh and walk up Stables Lane for best access	**6**
safety of access	Access along bridleway and well trodden paths	**6**
safety of exposure	Where quarried, care must be taken on loose debris and where the foot of the face is overgrown	**7**
permission to visit	Access along established rights of way	**N/A**
current condition	Very good. Plenty of good exposure	**8**
current conflicting activities	None envisaged, although fly tipping at the east end of the escarpment makes access to bridleway less than ideal.	
restricting conditions	Relatively remote from parking area, so a degree of physical mobility is required to undertake the necessary walk	
nature of exposure	Natural and quarried exposures in the limestone escarpment	
multiple exposures / prospect for trail	There is scope for an extended visit to study the variations between reef and inter reef environment and the Carboniferous rocks along the length of the crags	
Notes	A good walk is needed to access the crags but the pathways are well established and safe	

Culture, Heritage & Economic

Aspect	Description	Rating
historic, archaeological & literary associations	None known	**0**
aesthetic landscape	A good site with excellent views of the topography to the west and an extended rocky exposure	**8**
history of Earth Sciences	One of the very few opportunities to study the geology at the Carboniferous-Permian boundary	**9**
economic geology	Local interest. Probably one source of building stone used for	**7**

	historic buildings in nearby Barnburgh	
Notes		
Education and Science		
surface processes	Weathering of reef and bedded limestones. Rifting and cambering	**7**
geomorphology	Excellent views of Carboniferous escarpments and the structural effects of the Don Monocline	**9**
sedimentary	A wide variety of lithologies, including well developed reefs, ooid-limestones, massive, cross bedded strata and fissure deposits	**8**
fossils	Permian reef fossils. Specialist interest in Permian marine fauna	**6**
igneous	Not applicable	**0**
metamorphic	Not applicable	**0**
tectonic: structural	Evidence of unconformity, rifts and cambering	**8**
minerals	Not applicable	**0**
stratigraphy	A very good site to study the Permian and Carboniferous strata at the position of the unconformity	**8**
Notes	A very good site to demonstrate the lateral variation of strata within the reef facies. An important location at which to see Carboniferous and Permian rocks	
Geodiversity value		
A good site to show reef formation and associated beds, fissures and related deposits, an unconformity and geomorphology		**9**

Site Photographs	**DR6 Barnburgh Cliff**

Figure 35 Quarry exposure of Carboniferous Dalton Rock. Trees and vegetation mark the position of the Carboniferous-Permian unconformity. SE 49400 03960

Figure 36 Detail of uppermost exposure of Dalton Rock SE 49400 03960.

Figure 37 Detail of ironstone pebbles in Dalton Rock SE 49400 03960.

Figure 38 General view of massive shelly ooid-limestones with overlying reef. SE 50063 03661

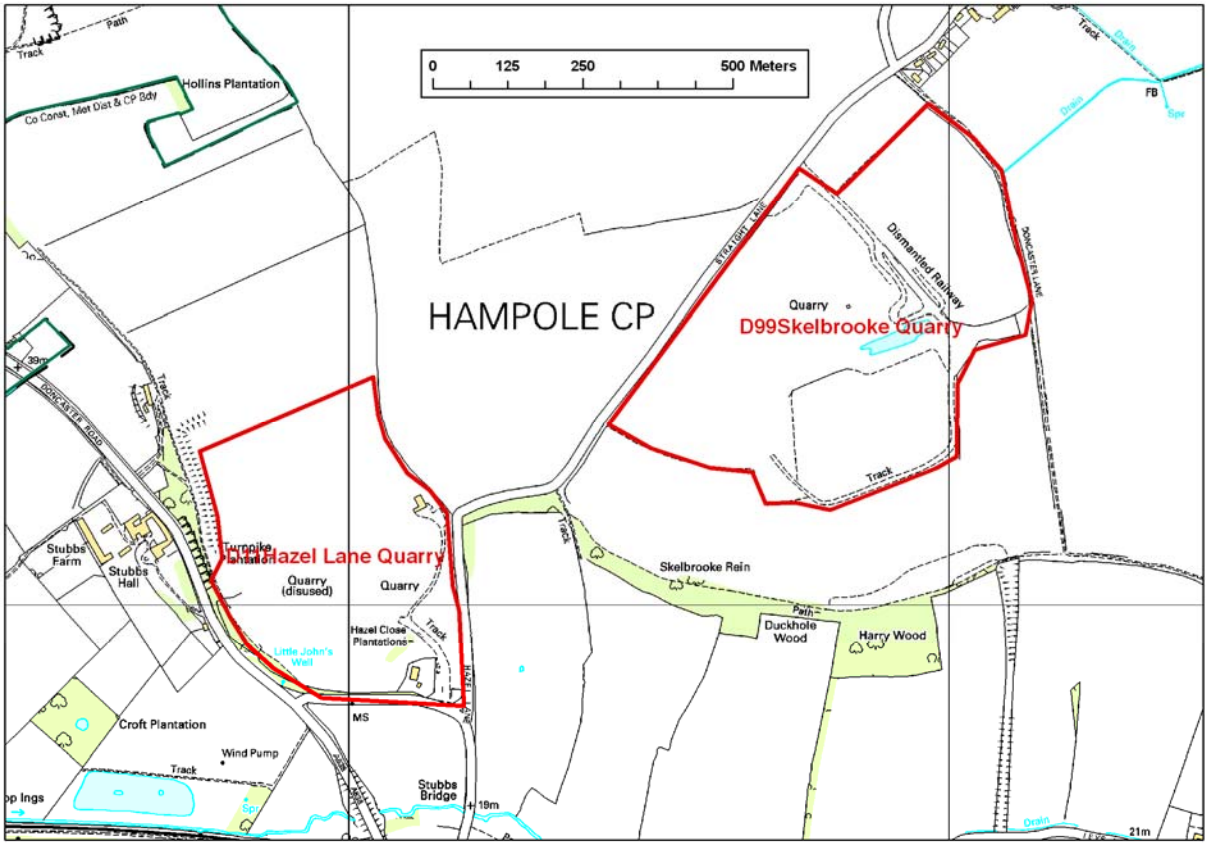
Figure 39 Massive horizontally bedded shelly ooid-limestones with iron staining. SE 49488 03953

A8 D11 HAZEL LANE QUARRY

Site Name: **Hazel Lane Quarry**	Site Key: **D11**
Grid Reference: **SE 500 110 (centred on)**	Site Type: **active quarries and pits**
Local Authority: **Doncaster Metropolitan Borough Council, South Yorkshire**	
Site Dimensions: 500 m x 400 m x 15 m	Site Owner: Catplant Ltd
Conservation Status: **Regionally Important Geological Site**	Date: 1/9/97
Field surveyor: Scott Engering	Date: 16/2/07

Stratigraphy and Rock Types	
Time Unit: Carboniferous, Westphalian	Rock Unit: Pennine Upper Coal Measures Formation, Pennine Coal Measures Group
Rock Type: Shale and siltstone	Details: Reddened laminated beds
Time Unit: Permian	Rock Unit: Wetherby Member, Cadeby Formation, Zechstein Group
Rock Type: Dolostone	Details: Haematite stained cross bedded ooid-limestone with marls and micrites

Site Map	**Figure 40 - D11 Hazel Lane Quarry**



Site Description

A medium sized working quarry extracting limestone and now being used as a landfill site.

At the time of the RIGS survey in 1997, the site was notable for the excavation through the base of the Permian strata into the underlying Upper Coal Measures to produce an interesting exposure of reddened sandstone, siltstone and shale. Such exposures of Carboniferous strata are not often seen in the region. There are good examples of reddened shelly ooid-limestones (approximately 4 m) in the lower sections of many of the quarry faces, with well developed thin marls in places.

Good examples of strata in the Wetherby Member that are described in the Barnsley Memoir from small quarries and temporary exposures.

The quarry has extended considerably in the last 10 years. Landfill preparation is well under way and the exposure of Coal Measures strata will soon be covered.

RIGS Assessment of Site Value	D11 Hazel Lane Quarry

Ratings: 1-2 very poor; 3-4 poor; 5-6 acceptable/useful; 7-8 quite good; 9-10 very good/excellent; N/A not applicable; D/K don't know

Access and Safety

Aspect	Description	Rating
Road access & parking	In quarry car park	**5**
safety of access	Working quarry. All current health and safety regulations apply	**N/A**
safety of exposure	Working quarry. All current health and safety regulations apply	**N/A**
permission to visit	privately owned working quarry	**N/A**
current condition	Plenty of exposed faces but quarry is being progressively landfilled	**N/A**
current conflicting activities	Working quarry and landfill	
restricting conditions	Working quarry and landfill	
nature of exposure	Quarry	
multiple exposures / prospect for trail	Not applicable	
Notes	Private owned quarry and landfill site	

Culture, Heritage & Economic

Aspect	Description	Rating
historic, archaeological & literary associations	Not applicable	**0**
aesthetic landscape	Not applicable	**0**
history of Earth Sciences	Not applicable	**0**
economic geology	Working quarry producing aggregates and some building stone	**6**
Notes		

Education and Science

surface processes	Not applicable	**0**
geomorphology	Not applicable	**0**
sedimentary	Good range of lithologies present. Exposure of reddened Pennine Upper Coal Measures Formation	**8**
fossils	Not applicable	**0**

igneous	Not applicable	**0**
metamorphic	Not applicable	**0**
tectonic: structural	Not applicable	**0**
minerals	Not applicable	**0**
stratigraphy	Not applicable	**0**
Notes	Limited value due to current and planned landfill activities	
Geodiversity value		
Good example of lithological variation in the Cadeby Formation but limited by planning permission and landfill		**5**

Site Photographs	**D11 Hazel Lane Quarry**

Figure 41 General view to the south-west of landfill preparatory works. SE 50063 11272.

Figure 42 Tyres from Hampole Lime Works Quarry used as drainage layer. SE 49950 11050.

Figure 43 Exposure of sandstones and shales of Upper Coal Measures in quarry floor. SE 50174 11154.

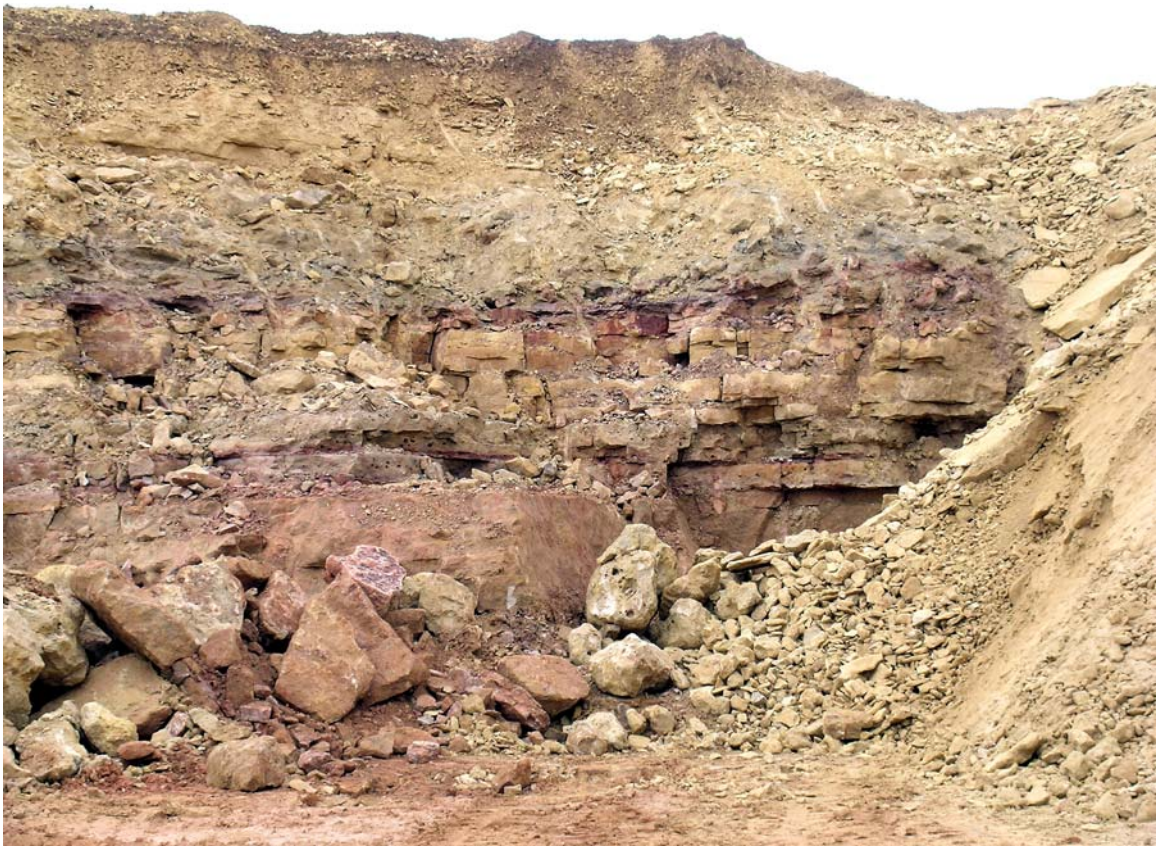


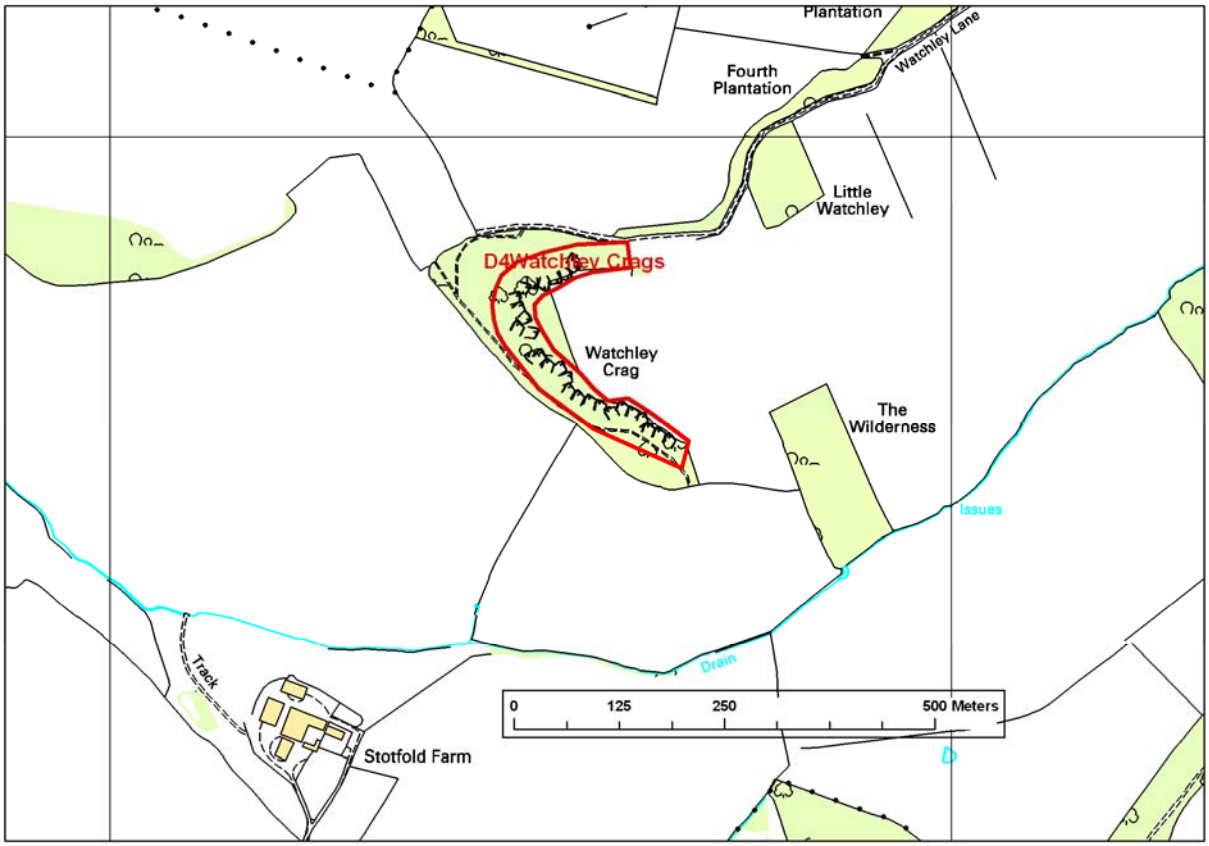
Figure 44 Exposure of reddened limestones and red marl bands to north-east corner. SE 49701 11567.

A9 D4 WATCHLEY CRAGS

Site Name: **Watchley Crags**	Site Key: **D4**
Grid Reference: **SE 476 068 (centred on)**	Site Type: **disused quarries, pits and cuttings**
Local Authority: **Doncaster Metropolitan Borough Council, South Yorkshire**	
Site Dimensions: 350 m x 5 m	Site Owner: Trustees of MWA Warde – Norbury
Conservation Status: **Regionally Important Geological Site**	Date: 14/9/97
Field surveyor: Scott Engering	Date: 16/2/07

Stratigraphy and Rock Types	
Time Unit: Permian	Rock Unit: Wetherby Member, Cadeby Formation, Zechstein Group
Rock Type: Dolostone	Details: Thin bedded, fine grained flaggy limestones with fine cross-laminations and vugs
Time Unit: Permian	Rock Unit: Yellow Sands Formation, Rotliegendes Group
Rock Type: Sandstone	Details: Laminated and cross bedded, fine grained yellow, grey and orange friable sandstone

Site Map	**Figure 45 - D4 Watchley Crags**



Site Description	D4 Watchley Crags

Extensive outcrop of well bedded limestone unconformably resting on excellent exposures of yellow/grey and orange Yellow Sands Formation. Several exposures occur around the southwest extremeties of a finger like outcrop of the Cadeby Formation. Starting from SE 47924 07118, the survey follows the escarpment in a clockwise direction until it disappears at the fault bound junction with Upper Coal Measures shales at SK 47674 06642. Access is along Watchley Lane and paths through the woods which can be very muddy.

From SE 47924 07118 to SE 47761 07012, there is very little exposure, with the occasional outcrop of well bedded flaggy buff limestone. Various mounds, excavations and rock debris indicate the site of quarrying but no exposures of Yellow Sands Formation visible. The only evidence is in the very sandy soil at the edge of ploughed fields, where unseeded soils are yellow grey and very sandy in appearance.

Exposure A at SE 47562 06856, beneath undermined tree roots measures 4.5 m x 2.25 m of pale yellow-grey fine grained sandstone with steep cross bedding picked out by orange iron rich laminations. Very similar in appearance to Melton Park (D15) but the upper section is more yellow/orange in colour. Exposure B (SE 47555 06871) comprises 1 m of yellow sands, overlain by 2 m of fine grained well bedded and flaggy fine grained sandy limestone, with individual beds generally 50 – 75 mm and with a maximum 150 mm in thickness. The discontinuity between the limestone and yellow sands is marked by a rippled bedding plane. The Yellow Sands are yellow/orange with horizontal laminations but no steep cross bedding.

Exposure C (SE 47545 06860) comprises 3 – 4 m of well bedded flaggy fine grained, yellow limestone. A variety of sedimentary structures are displayed, including fine cross laminations and occasional thicker, ooidal beds which are sometimes vuggy. The Yellow Sands Formation is seen only as a small exposure at the base of the outcrop. The large section of the exposed face has been blackened by fires. Access to these exposures for a detailed view is up a vegetated mound of scree which can be muddy and slippery. The area is also accumulating rubbish, including car wheels, bottles and cans etc.

Exposure D (SE 47515 06863) and E (SE 47486 06794) comprise 3.5 – 4 m sections through well bedded and flaggy sandy limestone, with yellow beds at the base.

Exposure F (SE 47482 06676) is 6 m exposure of yellow/orange sands, up to 400 mm thick, overlain by largely overgrown flaggy limestone. Concentrations of iron mark the position of horizontal beds. The sands are friable and, where weathering, have fine encrustations of white salts.

Exposure G (SE 47559 06699) is 16 m x 1.3 m and provides a section of orange sandstone overlain by metres of well bedded flaggy limestone. Although defaced and partially reddened through fire, it is the most complete exposure of the Yellow Sands Formation and displays the lithological variation between orange and yellow horizontally bedded sands.

Exposure H (SE 47594 06671) comprises 4 m of well bedded flaggy limestone overlying 300 mm of horizontally bedded orange sand.

RIGS Assessment of Site Value	D4 Watchley Crags

Ratings: 1-2 very poor; 3-4 poor; 5-6 acceptable/useful; 7-8 quite good; 9-10 very good/excellent; N/A not applicable; D/K don't know

Access and Safety

Aspect	Description	Rating
road access & parking	Limited parking at end of Watchley Lane for 2-3 vehicles	**6**
safety of access	Access to exposure along unmade track and patchs. Vegetated slope to exposure very slippery when muddy.	**8**
safety of exposure	Very good. No dangerous overhangs. The best exposures are safely accessible from a well worn path.	**8**
permission to visit	The Trustees of MWA Warde – Norbury, The East Office Hooton Pagnell, Doncaster DN5 7BW	**D/K**

current condition	The exposures furthest away from Watchley Lane are very good but the nearest are being increasingly littered	**8**
current conflicting activities	Rubbish disposal and large fires obscuring rock face. Some vandalism at the remote sites	
restricting conditions	No collecting	
nature of exposure	Exposed sand pit beneath natural limestone escarpment	
multiple exposures / prospect for trail	If permission obtained, combine with visit to sites at Hooton Pagnell	
Notes	Overall good access, with correct footwear etc, although a moderately long walk from the parking area	

Culture, Heritage & Economic

Aspect	Description	Rating
historic, archaeological & literary associations	Industrial archaeological interests associated with foundry industry and building of estate properties/boundary walls	**7**
aesthetic landscape	Very limited due to position in woodland but it is located on the limestone escarpment	**8**
history of Earth Sciences	Locally very important as a rare occcurence of the Yellow Sands Formation	**8**
economic geology	Once a significant local industry, extracting sand for building and the foundry industry as a moulding sand	**8**
Notes	Once had local significance as a source of local building sands and the foundry industry	

Education and Science

surface processes	Differential weathering of hard limestone and friable sandstone	**6**
geomorphology	Located on limestone escarpment with Carboniferous dip and scarp topography to the west	**7**
sedimentary	A variety of lithologies and sedimentary structures	**8**
fossils	Not applicable	**0**
igneous	Not applicable	**0**
metamorphic	Not applicable	**0**
tectonic: structural	The south-western part of the escarpment is terminated by a fault	**5**
minerals	Not applicable	**0**
stratigraphy	One of very limited number of localities to study Yellow Sands Formation and relationship to Wetherby Member	**8**
Notes	Has rarity value and interests for graduates and research students studying Permian. With permission, it is also potentially a good field visit site	

Geodiversity value

A very good site, for the rarity value, lithological variety and historic/industrial archaeological interests	**8**

Site Photographs	D4 Watchley Crags

Figure 46 Exposure C - extensive fire damage to exposure of flaggy limestone. SE 47545 06860.

Figure 47 Exposure C - detail of fine grained, cross-laminated limestone. SE 47545 06860.

Figure 48 Exposure F - detail of the Yellow Sands Formation and overlying limestone of the Cadeby Formation. SE 47482 06776.

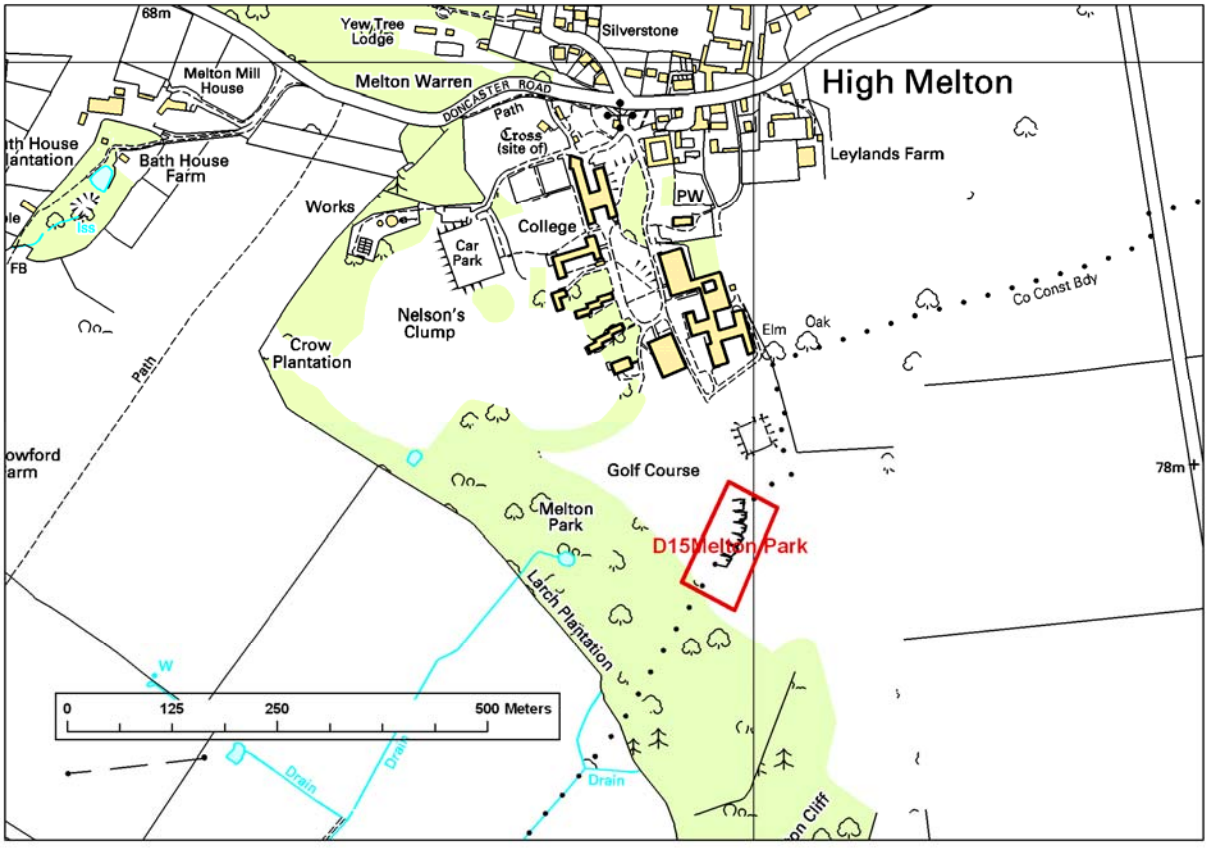
Figure 49 Exposure G - general view of the junction between the Yellow Sands Formation and the Cadeby Formation. SE 47482 06776.

A10 D15 MELTON PARK

Site Name: **Melton Park**	Site Key: **D15**
Grid Reference: **SE 509 014 (centred on)**	Site Type: **disused quarries, pits and cuttings**
Local Authority: **Doncaster Metropolitan Borough Council, South Yorkshire**	
Site Dimensions: 35 m x 3 m and 160 m x 3 m	Site Owner: Doncaster College
Conservation Status: **Regionally Important Geological Site**	Date: 14/9/97
Field surveyor: Scott Engering	Date: 16/2/07

Stratigraphy and Rock Types	
Time Unit: Permian	Rock Unit: Yellow Sands Formation, Rotliegendes Group
Rock Type: Sandstone	Details: Yellow to blue-grey cross bedded medium grained sandstones
Time Unit: Permian	Rock Unit: Wetherby Member, Cadeby Formation, Zechstein Group
Rock Type: Dolostone	Details: Massive cross bedded ooid-limestones with dense shelly beds varying from buff to yellow in colour. Compact fine grained flaggy beds, breccias and pisolite lenses.

Site Map	**Figure 50 - D15 Melton Park**



Site Description	D15 Melton Park

Two separate exposures of limestone are recorded at this site in former quarry workings, a section (east) of the lowest beds of the Wetherby Member of the Cadeby Formation with transitional beds and underlying Yellow Sands Formation and a section (west) of shelly ooid-limestones in the Wetherby Member.

The east section (SE 50967 01400 to SE 50967 01432) forms an exposure comprising approximately 1 metre of horizontally bedded yellow sandy limestone with very fine grained flaggy beds up to 40 mm thick. Vughs are common. This unconformably overlies 700 mm and more of yellow and blue/grey friable cross bedded sandstone, with the individual beds up to 400 mm thick. The junction beween the limestone and sandstone is a horizontal erosional surface with no undulations. In places the sandstone has eroded considerably compared to the limestone and at one location there is an overhang of 700 mm.

Beneath the level of the exposure and up to 5 m away from the rock face, the ground forms a depression along the length of the escarpment, approximately 100 m, and loose shapeless mounds rise up to the exposure. The limestone is well weathered and does not appear to have been a working quarry face and it is therefore likely that the escarpment was exploited for building sand. To the south of the exposure, the escarpment is wooded and there is only the occasional exposure of limestone but beneath this cap, the presence of the Yellow Sands is confirmed by very sandy soil, rabbit warrens and molehills.

The west section comprises two quarry faces. The east of the two extends from SE 50885 01735 to SE 50856 01778 and exposes sections up to 2.5 m. The upper part comprises massive, cross bedded buff coloured ooid-limestone with shells in beds up to 800 mm, with undulating surfaces. The individual ooids are still clearly visible. The surface occasionally reveals crusts of red-brown iron mineralisation that has taken place along the joints and at one location (SE 50668 01762) there is a breccia, with angular fragments up to 50 mm. Vughs and cavities are frequent and water seepage from these is commonplace. The lower 900 mm comprises a yellowish ooid-limestone densely packed with shells. In places where beds are exposed beneath the shelly beds, there are lenses of pisolite within fine grained compact limestones containing occasional pebbles (SE 50858 01776).

The east section (centred on SE 50861 01839) comprises an old quarry with at least two working benches that has been planted and landscaped. The limestone is ooidal with beds of variable thickness and undulating surfaces.

The limestone quarries, along with those at Melton Warren, are probably associated with the building of the church, local historic stone buildings and the retaining walls that line the approach road up the escarpment into the village. High Melton Hall (1750) is built out of Ackworth Rock sandstone. The escarpment provides commanding views of the south and west, including escarpments at Conisbrough and Clifton, Sheffield Manor Top, Tinsley Viaduct, Hoober Stand and across the Dearne Valley to Barnsley and beyond to the Pennines.

RIGS Assessment of Site Value	D15 Melton Park

Ratings: 1-2 very poor; 3-4 poor; 5-6 acceptable/useful; 7-8 quite good; 9-10 very good/excellent; N/A not applicable; D/K don't know

Access and Safety

Aspect	Description	Rating
road access & parking	Large car park in college grounds but very limited in village	**8**
safety of access	Located in the middle of a golf course	**6**
safety of exposure	Exposure to limestone very safe. Access to Yellow Sands has a muddy slope. Good footwear required. Rock overhangs	**7**
permission to visit	Through Doncaster College	**N/A**
current condition	The limestone is in excellent condition. The Yellow Sands would benefit considerably from vegetation clearance	**7**
current conflicting activities	Golf	
restricting conditions	No collecting	

nature of exposure	Quarried escarpment	
multiple exposures / prospect for trail	Limited due to isolation from other clusters of safe and freely accessible sites	
Notes		

Culture, Heritage & Economic

Aspect	Description	Rating
historic, archaeological & literary associations	Probable historic associations with building of the church and the vernacular architecture in the village	**8**
aesthetic landscape	Set in landscaped groundson limestone escarpment. Good views and location in attractive stone village.	**9**
history of Earth Sciences	This site possesses local rarity value for its exposure of the Yellow Sands Formation	**9**
economic geology	Not believed to have possessed any economic value except for local use as building material	**6**
Notes		

Education and Science

surface processes	Differential weathering of sandy limestone	**6**
geomorphology	Limestone escarpment and extensive views of Carboniferous topography to the west	**8**
sedimentary	Wide range of lithologies, erosional surfaces, reworked aeolian deposits and transitional beds	**7**
fossils	Specialist interests in Permian fossils. Bivalves and brachipods	**6**
igneous	Not applicable	**0**
metamorphic	Not applicable	**0**
tectonic: structural	Not applicable	**0**
minerals	Not applicable	**0**
stratigraphy	One of very few sites to study and research the Yellow Sands Formation	**8**
Notes	A very good research location for study at advanced and graduate level	

Geodiversity value

A good range of geological processes can be demonstrated. Very high aesthetic/landscape value	**8**

Site Photographs	D15 Melton Park

Figure 51 Old dolostone quarry face in the Wetherby Member, Cadeby Formation. SE 50885 01735.

Figure 52 View to the along the escarpment in Pennine Upper Coal Measures. SE 50940 01370.

Figure 53 General view of main exposure of the Yellow Sands Formation. SE 50882 01404.

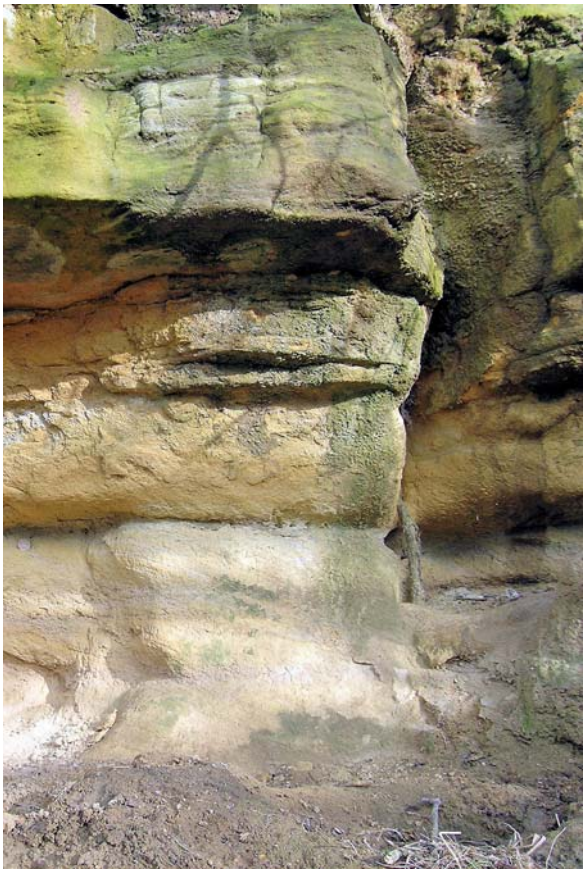


Figure 54 Boundary between the Yellow Sands Formation and the overlying Wetherby Member of the Cadeby Formation. SE 50882 01404.

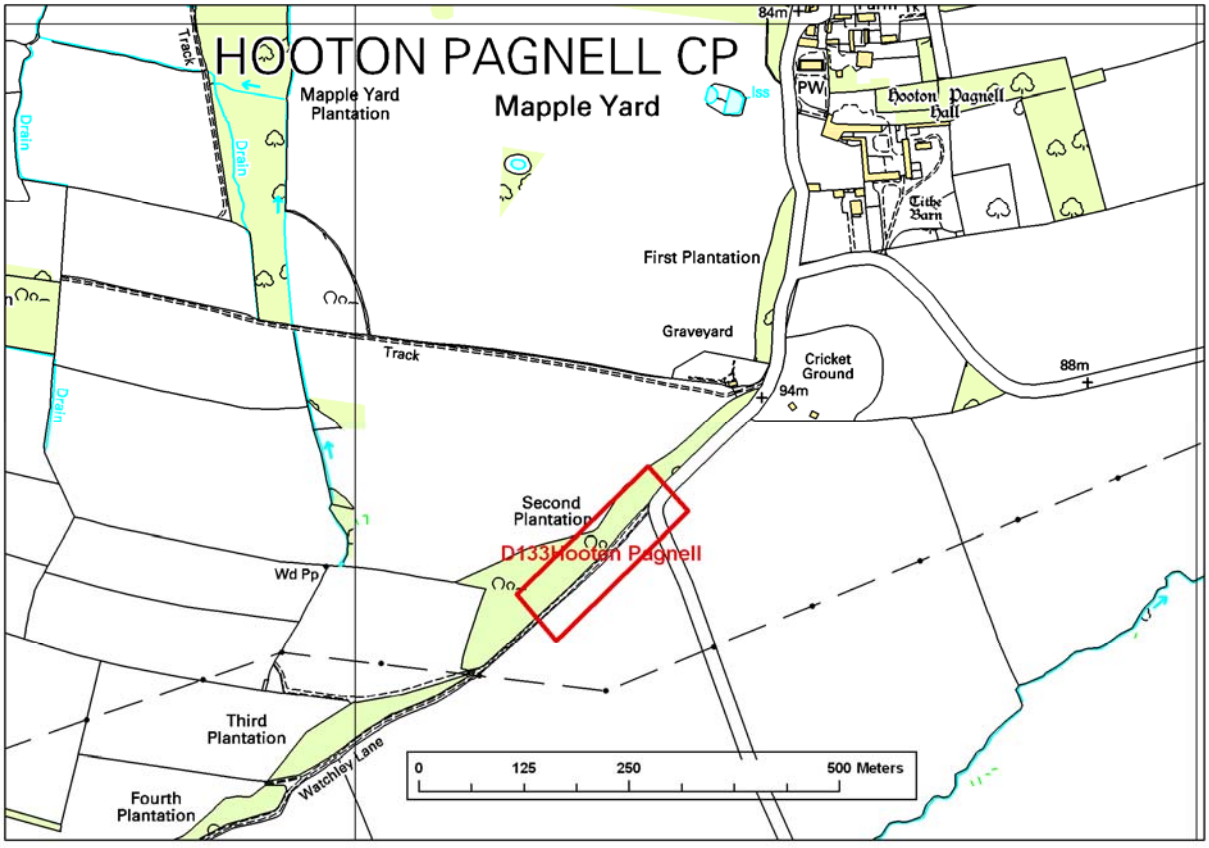
Figure 55 Detail of limestone breccia along a joint running parallel to the quarry face. SE 50868 01762.

A11 D133 HOOTON PAGNELL

Site Name: **Hooton Pagnell**	Site Key: **D133**
Grid Reference: **SE 483 074 (centred on)**	Site Type: **disused quarries, pits and cuttings**
Local Authority: **Doncaster Metropolitan Borough Council, South Yorkshire**	
Site Dimensions: 20 m x 3 m	Site Owner: Trustees of MWA Warde – Norbury
Conservation Status: **Regionally Important Geological Site**	Date: 14/9/97
Field surveyor: Scott Engering	Date: 19/2/07

Stratigraphy and Rock Types	
Time Unit: Permian	Rock Unit: Wetherby Member, Cadeby Formation, Zechstein Group
Rock Type: Dolostone	Details: Orange sandy cross-bedded ooid-limestones. Reworked Yellow Sands Formation

Site Map	**Figure 56 - D133 Hooton Pagnell**



Site Description	D133 Hooton Pagnell

Exposure of lowest beds of Wetherby Member of the Cadeby Formation comprising up to 2 m of well bedded flaggy, sandy, yellow limestone with coarser pisolitic beds overlying up to 2 m of massive, sandy, yellow shelly ooid-limestones. Exposed from SE 48337 07434 to SE 48352 07448.

The upper flaggy beds have similarities to those exposed at Hooton Pagnell Village Pound with successions of fine grained and coarse beds with erosional surfaces but are less well cemented and friable (SE 48341 07433) and where obviously sandy, especially to the northeast of the section, differential weathering is a prominent feature of these upper beds, with the occasional development of deeply weathered sandy pockets (SE 48350 407420). The weathering of these upper beds clearly distinguishes them from the lower ooid-limestone (SE 48352 07448).

There is no unfenced access to the exposure and the foot of the quarry face has brambles etc and like many similar sites suffers from rubbish, including a tyre and chairs.

The lower shelly ooid-limestones are uniform throughout their length and at SE 48352 07448 there are remanants of a breccia on the rock face.

RIGS Assessment of Site Value	D133 Hooton Pagnell

Ratings: 1-2 very poor; 3-4 poor; 5-6 acceptable/useful; 7-8 quite good; 9-10 very good/excellent; N/A not applicable; D/K don't know

Access and Safety

Aspect	Description	Rating
road access & parking	Parking on roadside for 3-4 cars next to field gate and public footpath	**5**
safety of access	Access over fence and down moderately steep slope over relatively rough ground. Usual fieldwork conduct applies	**5**
safety of exposure	Brambles and rubbish on vegetated rock spoil. Some undermining of small trees in soil horizon. Fieldwork conditions apply	**5**
permission to visit	The Trustees of MWA Warde – Norbury, The East Office Hooton Pagnell, Doncaster DN5 7BW	**5**
current condition	Vegetation and rubbish etc make access awakward but rock faces are largely free of vegetation and well exposed	**6**
current conflicting activities	Rubbish disposal	
restricting conditions	Private ownership. No collecting	
nature of exposure	Quarried natural limestone escarpment	
multiple exposures / prospect for trail	With permission, some potential with Watchley Crags, Hooton Pagnell Village Pound and possibly Brodsworth Hall	
Notes	Not suitable for general public but experienced field geologists will be used to the conditions	

Culture, Heritage & Economic

Aspect	Description	Rating
historic, archaeological & literary associations	Associations with local vernacular architecture	**6**
aesthetic landscape	Limestone escarpment overlooking undulating Carboniferous topography. Quite good.	**6**
history of Earth Sciences	Local interest only in study of base of Cadeby Formation and transitional sandy beds	**6**
economic geology	Local economic significance only	**5**
Notes	Although not a large or significant quarry, its exploitation would have contributed to the development of Hooton Pagnell, an outstanding example of an estate village	

Education and Science		
surface processes	Weathering of sandy dolostone	**5**
geomorphology	Limestone escarpment and Carboniferous dip and scarp topography to the west	**6**
sedimentary	Cross bedded ooid-limestones and high content of sand provides evidence of transitional facies and reworking of sand dunes	**7**
fossils	Not applicable	**0**
igneous	Not applicable	**0**
metamorphic	Not applicable	**0**
tectonic: structural	Not applicable	**0**
minerals	Not applicable	**0**
stratigraphy	Good site for studying the transitional beds beneath the Cadeby Formation	**6**
Notes	A good research or field mapping site but not really suitable for the general public	
Geodiversity value		
A very good site, for the rarity value, lithological variety and historic/industrial archaeological interests		**8**

Site Photographs	D133 Hooton Pagnell

Figure 57 General view of old quarry face in the Wetherby Member along the limestone escarpment. SE 48352 07448.

Figure 58 Differential weathering between shelly ooid-limestones and overlying flaggy limestones in the Wetherby Member. SE 48349 07443.

Figure 59 Erosional surface between coarse pisolites and the underlying shelly ooid-limestones in the Wetherby Member. SE 48341 07433.

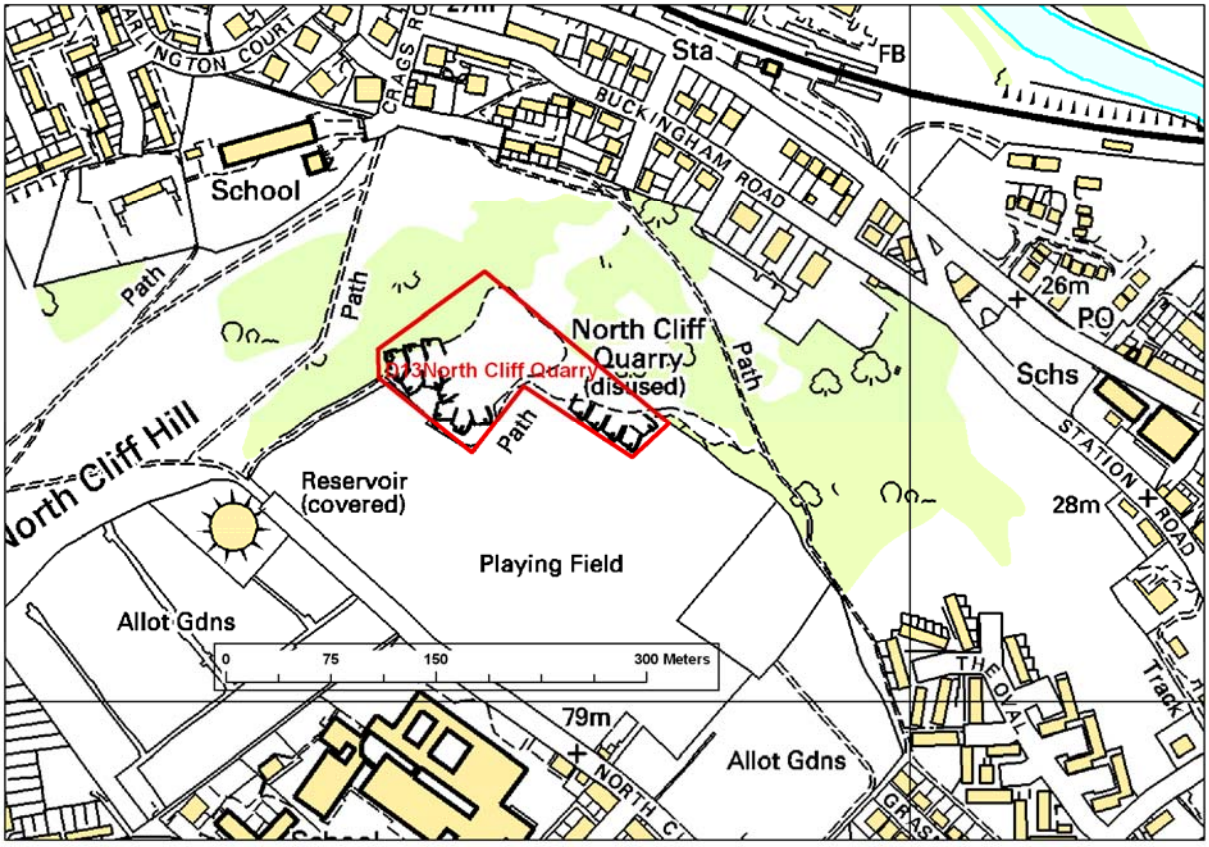
Figure 60 Sandy pockets within the flaggy limestones of the Wetherby Member. SE 48345 07440.

A12 D13 NORTH CLIFF QUARRY

Site Name: **North Cliff Quarry**	Site Key: **D13**
Grid Reference: **SK 507 992 (centred on)**	Site Type: **disused quarries, pits and cuttings**
Local Authority: **Doncaster Metropolitan Borough Council, South Yorkshire**	
Site Dimensions: 80 m x 70 m	Site Owner: DMBC
Conservation Status: **Regionally Important Geological Site**	Date: 16/9/97
Field surveyor: Scott Engering	Date: 7/2/07

Stratigraphy and Rock Types	
Time Unit: Permian	Rock Unit: Wetherby Member, Cadeby Formation, Zechstein Group
Rock Type: Dolostones	Details: Bryozoan reef, associated with massive granular beds, cross-bedded shelly ooid-limestones and flaggy beds

Site Map	**Figure 61 - D13 North Cliff Quarry**



Site Description	D13 North Cliff Quarry

Discontinuous sections through the Wetherby Member of the Cadeby Formation in old quarry faces up to 10 m high that illustrate a wide variety of lithologies. The best and most accessible exposure is in the north-east corner (SK 5064899256) and comprises a 5.5 m section through an unbedded pillow like bryozoan reef, overlying a succession of massive, buff coloured fine grained granular limestone and cross bedded shelly ooid-limestones, up to 400 mm thick, with concentrations of small bivalves. The bivalves are preserved as moulds or casts which gives the shelly beds a very open and porous texture that easily distinguish them from granular beds that lie above and beneath them. Crystal lined vughs are common.

From west to east, there is some thinning of the beds which are flaggy, although these are best seen in the generally poorly exposed south-west quarry face. The reef mass also overlies progressively younger beds from west to east and the lower section is partly brecciated, often with a distinct reddening of the fine grained matrix, providing evidence of the influx of muddy sediments similar to those found in the Permian marls.

Outcrops are exposed sporadically in the quarry but access is difficult and there are overhangs and loose blocks.

From the path at the top of the northern quarry faces there are excellent views of the dip and scarp topography of the Coal Measures strata to the west in Rotherham and Barnsley, the limestone escarpment at Cadeby, High Melton and Hickleton to the north and the topography associated with the confluence of the Don and the Dearne.

The quarry presents considerable management problems. Three burnt out cars were in the quarry at the time of the survey but a local dog walker recounted that 28 cars were recently removed by crane. There is rubbish, sections of metal fencing, beer cans etc everywhere and signs of recent fires in several places. The reef exposure is marred by graffiti. Also the quarry appears to be frequented by trail bikes.

RIGS Assessment of Site Value	D13 North Cliff Quarry

Ratings: 1-2 very poor; 3-4 poor; 5-6 acceptable/useful; 7-8 quite good; 9-10 very good/excellent; N/A not applicable; D/K don't know

Access and Safety

Aspect	Description	Rating
road access & parking	On street parking on North Cliff Road and residential areas off Doncaster Road	**7**
safety of access	Path runs along unfenced quarry top. Moderately steep access into quarry down rough, poorly defined paths.	**6**
safety of exposure	The limestone reef is accessible. Most quarry exposures are not easily accessible and there are overhangs and loose rock	**5**
permission to visit		**N/A**
current condition	Requires extensive clearance of cars, general rubbish and clearance of thick scrub to improve access to best exposures.	**2**
current conflicting activities	Dumping of cars and rubbish, vandalism, grafitti and use by trail bikes	
restricting conditions	General condition of the site makes visits by larger parties difficult.	
nature of exposure	Old quarry faces with discontinuous sections.	
multiple exposures / prospect for trail	Good field trip locality in conjunction with Warmsworth Park, Cedar Road Quarry and Hexthorpe Flatts.	
Notes	Access and safety measures could be considerably improved by extensive clearance and better defined paths	

Culture, Heritage & Economic		
Aspect	**Description**	**Rating**
historic, archaeological & literary associations	A good source of building stone with probable links to the historic architecture of Conisbrough	**7**
aesthetic landscape	Excellent views across Rotherham, Barnsley, the Don and Dearne valleys and the limestone escarpment	**9**
history of Earth Sciences	Correlation of reefs in district	**6**
economic geology	Former building stone quarry	**6**
Notes		

Education and Science		
surface processes	Limited opportunities to observe differential weathering of reef and bedded limestones	**4**
geomorphology	Excellent opportunity to observe regional scarp and dip topography and breach of the limestone escarpment by the River Don	**8**
sedimentary	Very good example of reef formation and associated sedimentary facies, bedding structures and lithological variation.	**7**
fossils	Mainly specialist interests. Restricted fauna of bryozoans, bivalves, brachiopods and foraminifera. Not good for collecting	**6**
igneous	Not applicable	**0**
metamorphic	Not applicable	**0**
tectonic: structural	Not applicable	**0**
minerals	Not applicable	**0**
stratigraphy	Reefs provide opportunity to correlate with other similar exposures in the district.	**5**

Geodiversity value	
A very good site with variable lithology, excellent landscape value and proximity to several very notable historic buildings	**9**

Site Photographs	D13 North Cliff Quarry

Figure 62 View of Carboniferous scarp and dip topography across the Don Valley to the west. SK 50500 99180.

Figure 63 General view across the quarry towards Conisbrough Viaduct to the east. SK 50620 99250.

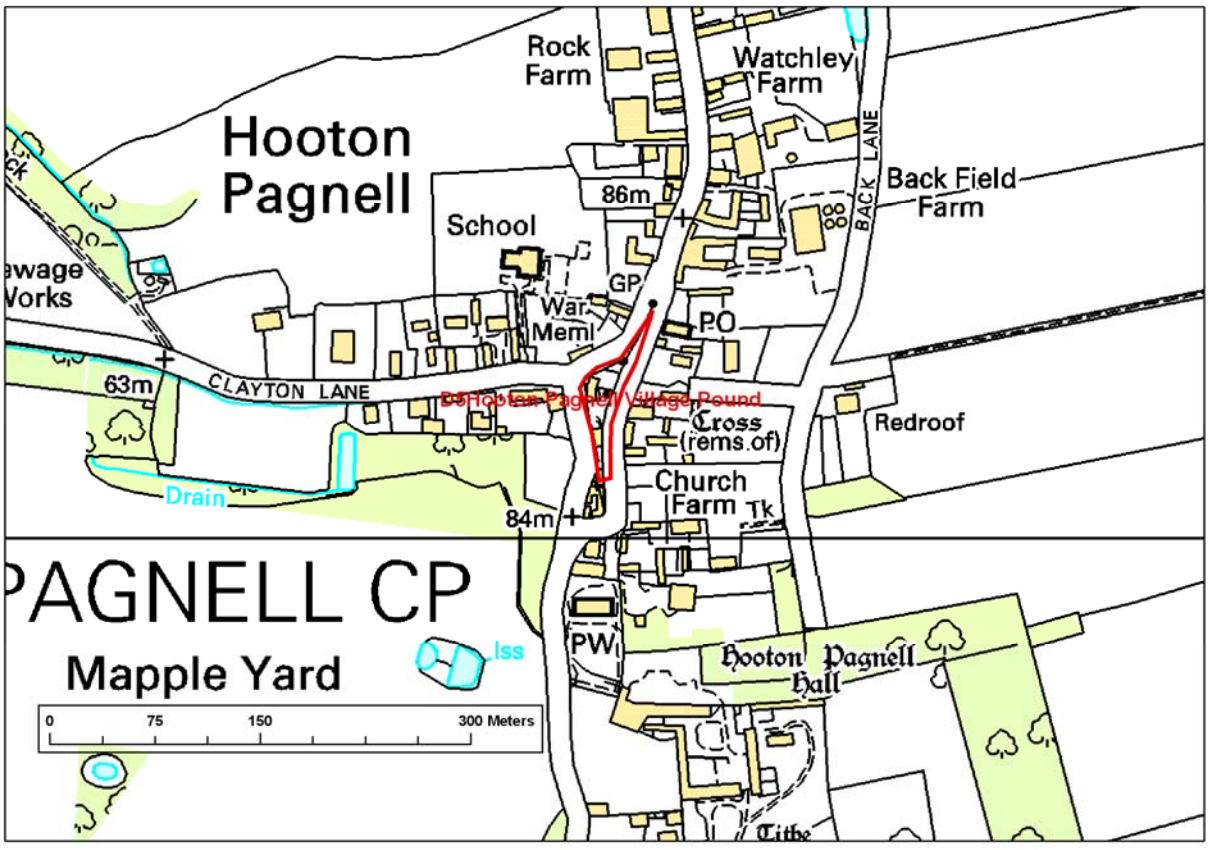
Figure 64 Section through Bryozoan reef overlying well bedded shelly limestones in the Wetherby Member. SK 50648 99256.

A13 D5 HOOTON PAGNELL VILLAGE POUND

Site Name: **Hooton Pagnell Village Pound**		Site Key: **D5**
Grid Reference: **SE 486 081 (centred on)**		Site Type: **exposure, natural**
Local Authority: **Doncaster Metropolitan Borough Council, South Yorkshire**		
Site Dimensions: 6 m x 4 m and 7 m x 3 m	Site Owner: Hooton Pagnell Parish Council	
Conservation Status: **Regionally Important Geological Site**		Date: 14/9/97
Field surveyor: Scott Engering		Date: 14/2/07

Stratigraphy and Rock Types	
Time Unit: Permian	Rock Unit: Wetherby Member, Cadeby Formation, Zechstein Group
Rock Type: Dolostone	Details: Unbedded bryozoan reef mass with associated thick bedded shelly ooid-limestones. Sequence of thin bedded, upward coarsening dolostone sand beds and pisoids

Site Map	**Figure 65 - D5 Hooton Pagnell Village Pound**



Site Description	D5 Hooton Pagnell Village Pound

Two separate exposures in close proximity displaying a bryozoan patch reef with associated thick bedded shelly ooid-limestones and a 3 metre section comprising a series of thin grey laminated muddy beds, coarsening upwards into buff sub angular pisolite.

The reef (SE 4856308127) comprises an irregular buff/orange pillow-like mass, pitted with numerous tiny hollows representing external moulds of bryozoans with some surfaces showing net like patterns which suggest a well preserved skeletal structure of these colonial organisms. The irregular mass passes both laterally and downwards into thickly bedded, breccia and shelly ooid-limestones which appear depressed and distorted by the overlying reef. The reef forms part of a retaining wall and landscaped and planted area, where large limestone slabs are used for rockery stones.

The laminated beds are located approximately 60 m to the south at a similar level (SE 48551 08048). The upward coarsening beds are generally less than 150 mm thick and are mostly separated by a sharp erosional surface. The fine grained sediments appear to comprise small broken shell fragments and have an open cellular texture. Cross laminations and undulating (ripple marked) bedding planes are common. The exposure is incorporated into a retaining wall. A slab of rock that is detached from the outcrop but is in a stratigraphically lower position is weathered to a deep red/purple colour, with a very fine grained muddy patina and 400 m to the south, the lowest exposed limestone is yellow/orange and contains a high proportion of reworked sediments from the Yellow Sands Formation. Overall, there is a very different character to the reefs exposed in North Cliff Quarry.

Hooton Pagnell itself is and outstanding example of a 16th century estate village, all built out of the local stone. Traditional farm buildings and cottages are numerous and together with the Norman church and old Hall, where the gatehouse is spectacular, possesses a very high geodiversity value.

RIGS Assessment of Site Value	D5 Hooton Pagnell Village Pound

Ratings: 1-2 very poor; 3-4 poor; 5-6 acceptable/useful; 7-8 quite good; 9-10 very good/excellent; N/A not applicable; D/K don't know

Access and Safety

Aspect	Description	Rating
road access & parking	Parking in the village is extremely restricted but up to six vehicles could park in the layby in front of the church	**7**
safety of access	Access to exposures is good but a lack of roadside paths and blind bends requires a cautious approach via the churchyard	**6**
safety of exposure	Very good	**8**
permission to visit	Exposures publicly accessible but the quiet exclusive character of the village needs to be considered for larger parties	**7**
current condition	Very good, but some cutting back of vegetation around the reef exposure is required on a regular basis	**8**
current conflicting activities	None envisaged, except limitations on parking when there is a church service	
restricting conditions	No collecting or hammering	
nature of exposure	Natural rock exposures incorporated into retaining walls and landscaped War Memorial gardens	
multiple exposures / prospect for trail	Link with Watchley Crags and provides an interesting contrast to the quarry exposures seen in the gardens of English Heritage owned Brodsworth Hall	
Notes		

Culture, Heritage & Economic

Aspect	Description	Rating
historic, archaeological & literary associations	The village provides an outstanding example of the use of local building materials for vernacular architecture.	**9**

aesthetic landscape	The village has previously been given awards as the best kept village in South Yorkshire	**10**
history of Earth Sciences	This site has been highlighted in several publications as an important location to view an excellent Permian reef	**9**
economic geology	Several local quarries are located within the area but none are of economic significance	**2**
Notes		
Education and Science		
surface processes	General weathering of limestone	**6**
geomorphology	From the escarpment, there are good views of the topography formed by the Carboniferous rocks to the west	**6**
sedimentary	A good range of lithologies and sedimentary structures associated with reef development and related facies	**8**
fossils	Specialist interests. Bryozoans, brachiopods, bivalves and foraminifera typical of the margins of hypersaline seas	**7**
igneous	Not applicable	**0**
metamorphic	Not applicable	**0**
tectonic: structural	Not applicable	**0**
minerals	Not applicable	**0**
stratigraphy	Provides a good comparison and contrast with reefs present in the Wetherby member around Conisbrough	**8**
Notes	Considered to be an outstanding example of a patch reef, for study and research at advanced levels	
Geodiversity value		
Outstanding example of the creation of an estate village using local building materials with a particularly good reef		**9**

Site Photographs	**D5 Hooton Pagnell Village Pound**

Figure 66 Detail of well bedded and sorted pisolite beds. SE 48551 08048.

Figure 67 General view of well bedded and sorted pisolite beds in the Wetherby Member. SE 48551 08048.

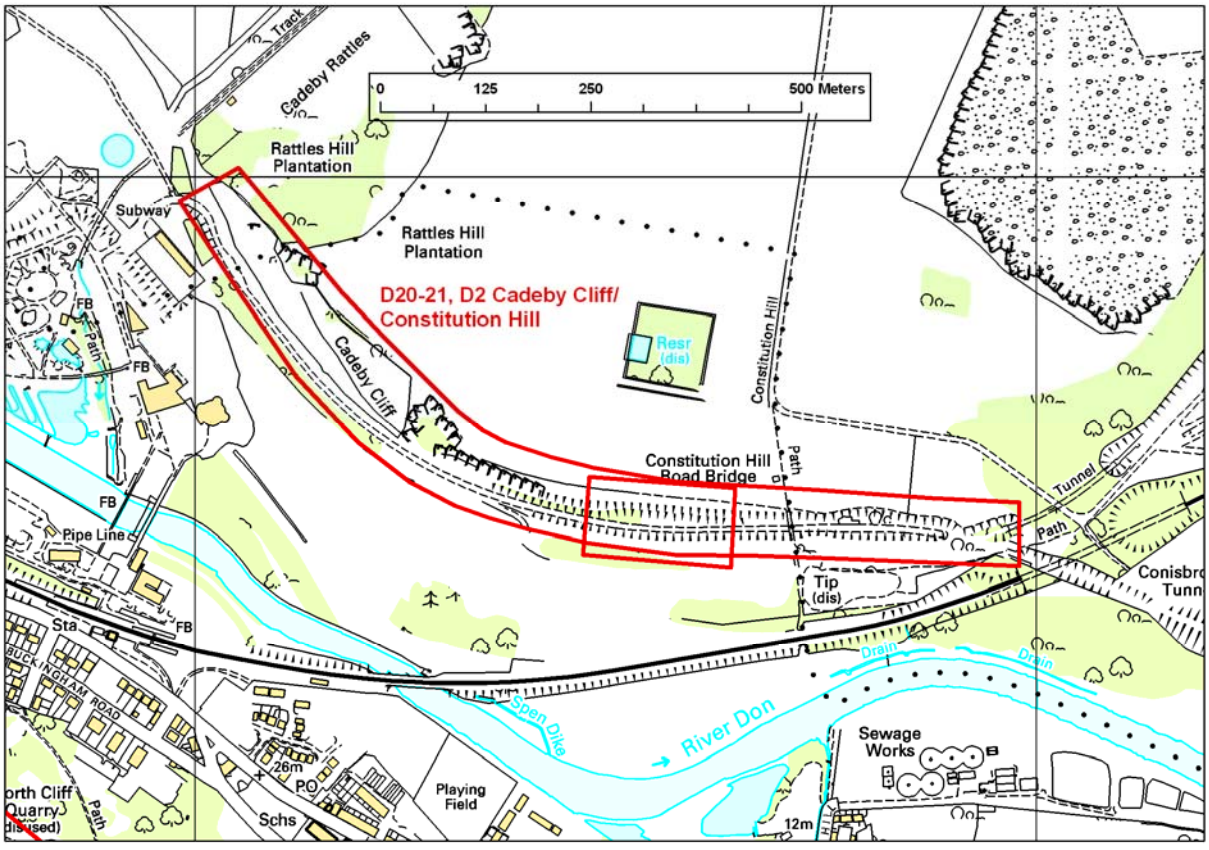
Figure 68 General view of bryozoan reef in the Wetherby Member incorporated into War Memorial Garden. SE 48563 08127.

A14 D20 – D22 CADEBY CLIFF/CONSTITUTION HILL

Site Name: **Cadeby Cliff/Constitution Hill**	Site Key: **D20 – D22**
Grid Reference: **SK 511 999 (centred on)**	Site Type: **exposure, natural**
Local Authority: **Doncaster Metropolitan Borough Council, South Yorkshire**	
Site Dimensions: 1000 m x 25 m	Site Owner: DMBC
Conservation Status: **Regionally Important Geological Site**	Date: 16/9/97
Field surveyor: Scott Engering	Date: 16/2/07

Stratigraphy and Rock Types	
Time Unit: Permian	Rock Unit: Wetherby Member, Cadeby Formation, Zechstein Group
Rock Type: Dolostone	Details: Massive bedded ooid-limestones, stromatolite reefs, and inter reef sediments
Time Unit: Devensian, Late Pleistocene	Rock Unit: Head
Rock Type: Sand and Gravel	Details:
Time Unit: Devensian, Late Pleistocene	Rock Unit: Glaciofluvial Deposits
Rock Type: Sand and Gravel	Details:

Site Map	**Figure 69 - D20 – D22 Cadeby Cliff/Constitution Hill**



Site Description	D20 – D22 Cadeby Cliff/Constitution Hill

Extensive site with several exposures of interest along a natural limestone escarpment from SK 510000 400000 to SK 51954 99568.

The survey was started at the eastern end, proceeded westwards along the top of the escarpment and returned eastwards following the line of the old railway. The exposures are as follows:

From SK 51934 99567, the escarpment is seen to be covered in thick gorse, evidence of sandy soil associated with the position of fluvioglacial sands, with occasional outcrops of massive, cream coloured fine grained limestone. The soil is brown/black and full of limestone fragments. At the roadside at SK 51857 99584 there is a small exposure (A) of coarse grey sandstone with large angular limestone fragments.

SK 51846 99590. Exposure B. 6 – 7 m of bedded fine grained limestone with individual beds up to 400mm with fine cross laminations. Throughout this outcrop, the surfaces of the joints provide excellent examples of calcite mineralisation, often iron stained and with well defined crystal growth, thick amorphous encrustations and in, places, stalactitic growth. These are often associated with fine limestone breccias.

Approximately 3 – 4 m above these limestones, exposures C and D reveal well cemented, coarse grained, pink gritty sandstone with rounded pebbles up to 10 mm with occasional concentrations of red and orange rounded sandstone pebbles, quartzite and ironstone. Together with large angular limestone fragments, these coarse sandstones appear as fissure deposits within exposed joints in the underlying limestone (B).

At SK 51713 99601, above an angled stone retaining wall, exposure E comprises a massive block (6 m x 2.5 m) of grey/brown, well cemented shingle, with large angular and sub-rounded limestones and flattened pebbles which are imbricated to the east. This overlies a pink/orange gritty sandstone (as described at C and D). The difference in colour is in the fresh and weathered surface. Some surfaces are encrusted with calcite (flow stone) and beneath the exposure and the retaining wall, there is an accumulation of angular and iron stained limestone blocks.

At SK 51670 98616 two large weathered slabs of limestone lie isolated at the edge of a ploughed field on top of the escarpment, the largest being approximately 2 m x 2 m x 700 mm. This has deeply weathered surfaces. Both are probably glacial erratics. From SK 51540 99616, there are excellent views of the topography of the Conisbrough outlier, Conisbrough Castle, North Cliff Quarry, the limestone escarpment at Clifton and the Don Valley to the west.

In the old quarry in Cadeby Cliff (exposure F SK 51271 99715), 6-7 m of massive shelly ooid-limestones with beds up to I metre thick are exposed. Beneath the soil horizon, 2 m of reddened sandy head are exposed with angular blocks of limestone which, in places, appear to have filled fissures and joints in the limestone.

At SK 51271 99715, at the top of the quarry face, there is an elongate, flattened dome like irregular mass that is probably a stromatolite reef. A bed of overlying ooid-limestone defines the shape of the upper surface of the reef. At SK 51281 99240, the underside of a slab preserves a mould of a Karst like erosional surface. The quarry is accessible from the road that runs along the bottom of the escarpment but moderately thick hawthorns and overgrown rock debris prevents very easy access to the exposed rock faces. The strata in the quarry dip moderately steeply to the south-west.

The old quarry at the west end of Cadeby Cliff is fenced off and not readily accessible but from the road at SK 51116 99791, exposures G and H reveal thick, massive bedded ooid-limestones in the escarpment. In the railway cutting at SK 451311 99601 an irregular reef mass is exposed (Exposures I and J). To the east of this, 2 m of head with a well defined soil horizon is exposed, which contains blocks with a black speckled appearance, fine black laminations and a fine grained granular texture similar to the limestones of the Sprotbrough formation.

From SK 51340 99641 to SK 51498 99585, massive bedded ooid-limestones are exposed along the length of the escarpment and at SK 51340 99641 a thick section is seen to dip at approximately 35 degrees to the south-west (Exposure L). The hillside exposures commonly contain irregular reef masses and at SK 51446 99595 (Exposure N), this is distinguishable from the surrounding exposures by a white weathered appearance. Also, along this section of the escarpment, there are odd exposures of coarse rubbly brecciated rock which at SK 51498 99585 (Exposure O) is found below a thick bed of massive ooid-limestone and appears to be associated with the weathering of an adjacent irregular reef like mass.

RIGS Assessment of Site Value	D20 – D22 Cadeby Cliff/Constitution Hill

Ratings: 1-2 very poor; 3-4 poor; 5-6 acceptable/useful; 7-8 quite good; 9-10 very good/excellent; N/A not applicable; D/K don't know

Access and Safety

Aspect	Description	Rating
road access & parking	Former Earth Centre Car park but DMBC owned land. Limited space at east end of Constitution Hill	**7**
safety of access	Exposure on moderately steep scarp slope requires usual fieldwork precautions. Some access off tracks	**6**
safety of exposure	Exposure on moderately steep scarp slope requires usual fieldwork precautions. No loose or dangerous outcrops	**7**
permission to visit	Owned by Doncaster MBC but paths pass through the site	**7**
current condition	Several natural rock features well exposed. Old quarry requires clearance to facilitate access	**8**
current conflicting activities	None envisaged, except further development on the site	
restricting conditions	No collecting	
nature of exposure	Natural exposure on scarp slope at head of Don Gorge, with quarry exposures	
multiple exposures / prospect for trail	Good site to study varied lithology in conjunction with North Cliff Quarry, Warmsworth Park, Cedar Road Quarry and Hexthorpe Flatts	
Notes	Moderately safe and accessible taking usual fieldwork precautions	

Culture, Heritage & Economic

Aspect	Description	Rating
historic, archaeological & literary associations	None known except a connection between Conisbrough and Ivanhoe	**4**
aesthetic landscape	Good views of the Conisbrough outlier, the escarpment, Carboniferous topography and Conisbrough Castle	**9**
history of Earth Sciences	None known	**0**
economic geology	Small quarry exposed	**5**
Notes	Conisbrough possesses a variety of interesting geological feature, a historic townscape and outstanding architectural monuments	

Education and Science

surface processes	Weathering of hard rock, calcite mineralisation and glacial deposition.	**8**
geomorphology	Cuesta, breached escarpment related to faultlines. Views of fault bound Conisbrough outlier	**8**
sedimentary	Good range of lithologies and sedimentary structures in limestone, glaciofluvial sands and head	**8**
fossils	Special interests in Permian marine fossils	**7**
igneous	Not applicable	**0**
metamorphic	Not applicable	**0**
tectonic: structural	Evidence of South Don and associated faults from Conisbrough outlier and Cadeby Cliff	**7**
minerals	Calcite mineralisation	**8**

stratigraphy	Good site for stratigraphic correlation, especially reefs, and rae occurrence of cemented Quaternary sand and gravels	**8**
Notes	A very good site for education purposes, with some unusual geological features not seen elsewhere in the region	
Geodiversity value		
A very good geodiversity site with a variety of lithological, geomorphological and historical interests		**9**

Site Photographs	**D20 – D22 Cadeby Cliff/Constitution Hill**

Figure 70 General view of escarpment to west, with gorse marking the approximate location of glacial sand and gravel. SK 51954 99568.

Figure 71 Exposure B - stalactitic calcite growth along joint. SK 51846 99590.

Figure 72 Exposure B - growth of calcite crystals along joint. SK 51846 99590.

Figure 73 Exposure E - outcrop of cemented coarse glacial sand and gravel. SK 51713 99601.

Figure 74 Exposure E - detail of cemented coarse glacial sand and gravel, showing imbricated pebbles. SK 51713 99601.

Figure 75 Exposure F - underside of limestone slab, showing cast of a Karst surface. SK 51281 99240.

Figure 76 Exposure J - detail of fine pyrolusite laminations in limestone fragment within head deposit. SK 51350 99600.

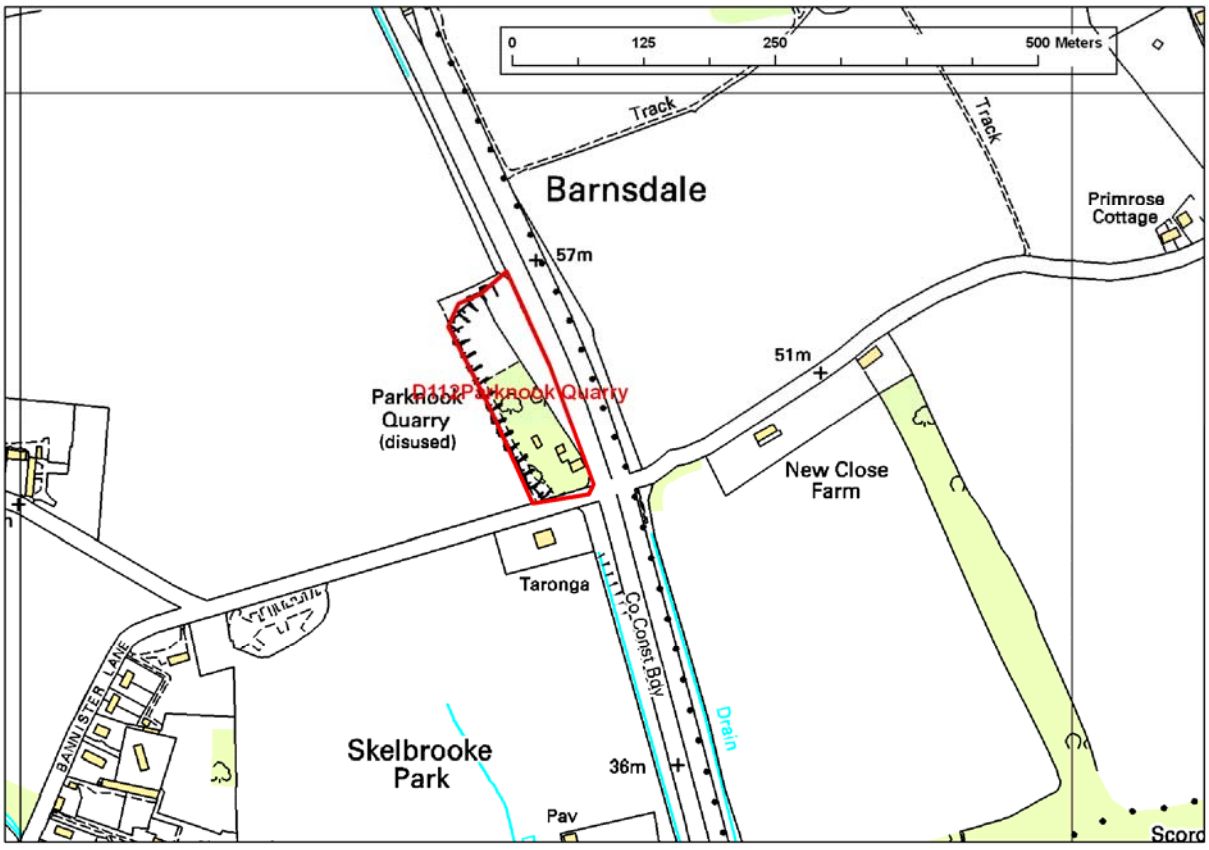
Figure 77 Exposure N - reef exposure in middle foreground, distinguished by white weathered appearance and irregular shape. SK 51446 99595.

A15 D112 PARKNOOK QUARRY

Site Name: **Parknook Quarry**	Site Key: **D112**
Grid Reference: **SE 513 128 (centred on)**	Site Type: **active quarries and pits**
Local Authority: **Doncaster Metropolitan Borough Council, South Yorkshire**	
Site Dimensions: 200 m x 70 m	Site Owner: Highways Agency
Conservation Status: **Regionally Important Geological Site**	Date: 14/9/97
Field surveyor: Scott Engering	Date: 16/2/07

Stratigraphy and Rock Types	
Time Unit: Permian	Rock Unit: Wetherby Member, Cadeby Formation, Zechstein Group
Rock Type: Dolostone	Details: Reefs, breccias and massive bedded limestones

Site Map	**Figure 78 - D112 Parknook Quarry**



Site Description	D112 Parknook Quarry

Large quarried exposure in the Wetherby Member of the Cadeby Formation with maximum section of approximately 13 m on the north face. Comprises a succession of massive buff, granular limestone with thick, even beds up to 600 mm thick with no obvious wedge bedding. The lowest 2 m of the north face are distinctly laminated (SE 45145 41270). A notable feature of the lowest 4-5 m of the north face is the appearance of vertical fracture zones approximately 1 metre wide in at least five locations. Here, the individual fractures are approximately 30 – 50 mm apart and the zones appear to be aligned in both a north-east and north-west direction. These fracture zones are not apparent in the upper parts of the quarry face. In places, the plane of the quarry face is brecciated and probably coincides with the formation of jointing. In one place (SE 45143 41268) there is an irregular depression in the rock face, that has a brecciated appearance but is not accessible. This may be a partially formed reef. It is notable that the disordered rock faces have a distinctly buff colour that stands out from the massive, well bedded rock.

The north-west corner is not accessible but comprises similar lithologies to the above. Here, there are quarry benches and it appears that the building stone was last quarried from here, although the quarry does not appear to have been operational for several years. A recent enquiry by York Minster to the Highways Agency has been made but the outcome of this is not known.

To the west, 6 m of massive limestone similar to the above is exposed. The rock is well weathered and the jointing and internal fracture pattern associated with this rock formation are well displayed (SE 51487 12659). Stylolites are also visible.

The quarry is now owned by the Highways Agency and appears to be earmarked for the widening of the A1 although this is not expected for some years. Part of the quarry is occupied by cottages and the southern end now forms a garden area. The foot of the quarry faces are not easily accessible due to the presence of rock debris and thick brambles. There are numerous old vehicles and miscellaneous rubbish in the northern part of the quarry that appears to relate to business carried out by the occupants of the land. Apparently these are removed on a regular basis.

The quarry has past historic associations with the building of most parish churches in the area and Selby Abbey.

RIGS Assessment of Site Value	D112 Parknook Quarry

Ratings: 1-2 very poor; 3-4 poor; 5-6 acceptable/useful; 7-8 quite good; 9-10 very good/excellent; N/A not applicable; D/K don't know

Access and Safety

Aspect	Description	Rating
road access & parking	Parking for three vehicles outside private entrance. Immediately adjacent to A1	**5**
safety of access	Uneven ground, rock debris, brambles, cars and rubbish prevent easy access to rock faces	**5**
safety of exposure	Uneven ground, rock debris, brambles, cars and rubbish prevent easy access to rock faces	**5**
permission to visit	Privately owned and partially occupied by residential and business uses	**5**
current condition	Commercial use of site and rock waste, rubbish and vegetation etc limit ease of access	**5**
current conflicting activities	Commercial and residential use of site. Possibility of extension of the A1	
restricting conditions	Accessibility and potential redevelopment	
nature of exposure	Old quarry faces	
multiple exposures / prospect for trail	Limited due to its isolated position and private ownership. Other clusters of sites have greater potential	

Culture, Heritage & Economic		
Aspect	**Description**	**Rating**
historic, archaeological & literary associations	History of use as building stone quarry and associations with local churches and Selby Abbey.	**6**
aesthetic landscape	Potential for managed nature reserve, if road widening plans go ahead	**6**
history of Earth Sciences	Local stratigraphic interest	**5**
economic geology	Once used for good quality building stone. Some potential reserves of stone for restoration work	**7**
Notes	Potentially of importance for restoration of historic buildings due to lack of good sources nationwide. Needs to be kept available with scope for expansion	
Education and Science		
surface processes	General weathering of rock faces	**5**
geomorphology	Not applicable	**0**
sedimentary	A range of lithologies and bedding structures	**6**
fossils	Specialist interests in Permian fossils	**5**
igneous	Not applicable	**0**
metamorphic	Not applicable	**0**
tectonic: structural	Evidence of shearing and fracturing	**6**
minerals	Not applicable	**0**
stratigraphy	Local example of stratigraphic correlation	**7**
Notes	Examples of geological features that are not obvious in other exposures in the region	
Geodiversity value		
Moderate geodiversity value. Some interesting geological features but mainly valuable as a potential source of building stone		**7**

Site Photographs	D112 Park Nook Quarry

Figure 79 General view of bedded limestone and former quarry benches to the north-west corner. SE 51400 12835.

Figure 80 Horizontal bedded limestones showing typical fracture patterns in the west quarry face. SE 51487 12659.

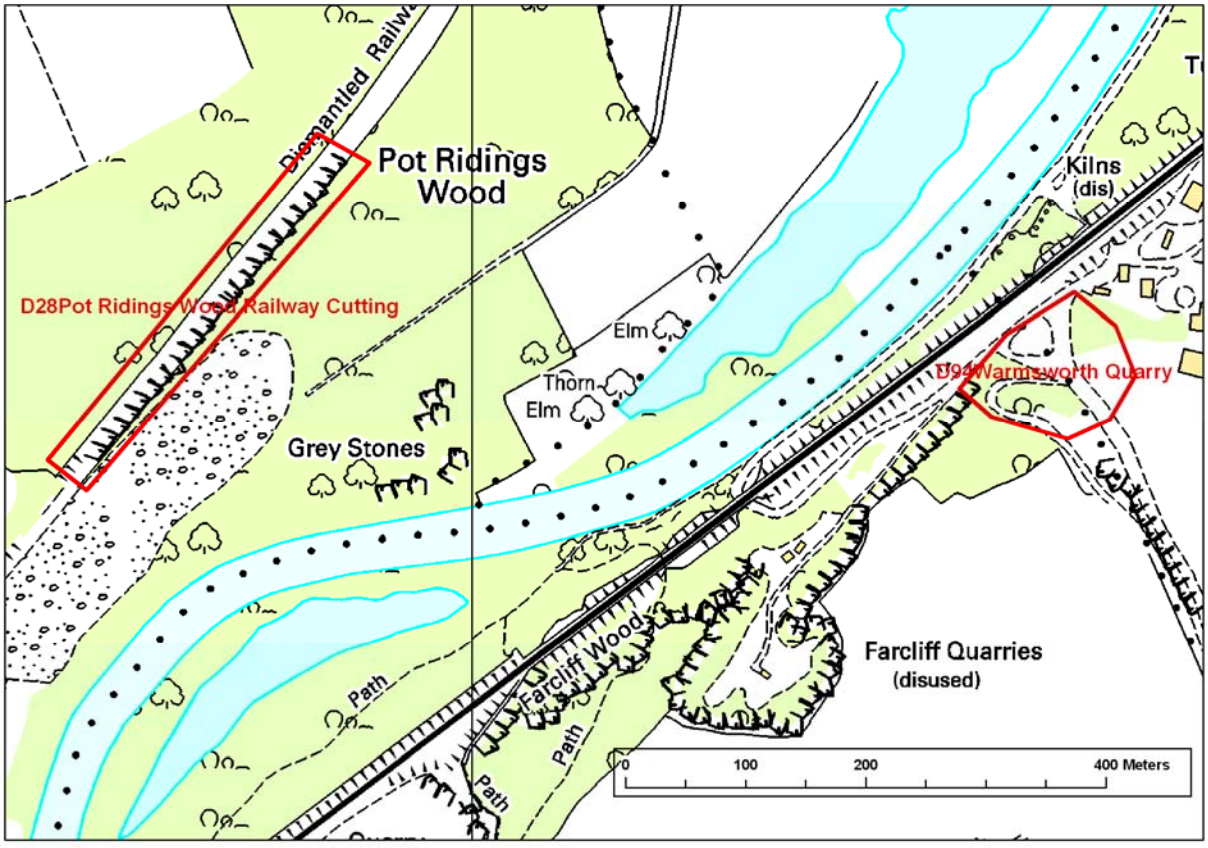
Figure 81 Well bedded limestone exposed in the lower section of the north quarry face within the Wetherby member. SE 51440 12850.

A16 D28 POT RIDINGS WOOD RAILWAY CUTTING

Site Name: **Pot Ridings Wood Railway Cutting**	Site Key: **D28**
Grid Reference: **SE 526 003 (west end)**	Site Type: **cutting, railway, disused**
Local Authority: **Doncaster Metropolitan Borough Council, South Yorkshire**	
Site Dimensions: 100 m x 8 m	Site Owner: Lafarge
Conservation Status: **Regionally Important Geological Site**	Date: 16/9/97
Field surveyor: Scott Engering	Date: 16/2/07

Stratigraphy and Rock Types	
Time Unit: Permian	Rock Unit: Wetherby and Sprotbrough Members, Hampole Beds, Cadeby Formation, Zechstein Group
Rock Type: Dolostone	Details: Massive bedded ooid-limestones, stromatolite reefs, and inter reef sediments

Site Map	**Figure 82 - D28 Pot Ridings Wood Railway Cutting**



Site Description	D28 Pot Ridings Wood Railway Cutting

An extensive and continuous section through the Cadeby Formation (SE 52729 00422 to SE 52988 07568), comprising a wide variety of lithologies and structures, including: reefs, large scale wedge bedding, desiccation breccias, marls, fracture zones, fissure deposits, erosional surfaces, flexures and steeply dipping beds.

The survey of the cutting was undertaken from south-west to north-east and the features highlighted are as follows:

(SE 52727 00444) 4 metre section of massive, buff, granular limestone with brecciated upper beds dipping steeply to south and incorporating an irregular reef mass 2 m high x 5 m long at the base of the section, with overlying coarsely bedded breccia.

(SE 52755 00451) Irregular reef mass 3 m high x 5 m long on south side and steeply dipping starta to south. To the north-east, the beds vary considerably in thickness with pronounced wedge bedding and brecciation being common. Massive beds of limestone reach a maximum thickness of about 1 m.

(East of SE 52757 00457) Occassional fissure deposit to north side of quarry. Angular fragments of limestone up to 50mm in brown clay/sand matrix. Upper sections of limestone are massively bedded and there are occasional vertical fractures appearing as narrow zones. Further east at approximately (SE 52770 00500), two rubbly brecciated beds are seen in the north face at approximately 1 m and 2 m above the floor of the cutting. These are irregular and with a distinctive knobbled appearance, with the lower bed being much more peristent laterally. These coincide approximately with the 50 – 55 m contour.

At SE 52839 00549, the cutting widens and the lower breccia passes laterally into a very distinctive red marl which is exposed half way up the cutting and beneath which there is a loose mound of red soil that obscures the lower section. The band of marl is differentially weathered and is easily distinguished from the massive limestone above. One metre above the red marl, the upper breccia is also seen. The widening of the cutting appears to coincide with a fault, with the down throw to the south-west, as the relative position of the breccias in the exposed rock face is now higher and there is a change in the dip of the strata from a southerly direction to the east. At SE 52833 00560 and SE 52805 00591, the red beds pass laterally and thicken from a compact reddened brecciated limestone into a true red marl. Here the overlying beds are flaggy and partially brecciated and the junction with the marl/breccia is a distinct undulating surface. Further to the east at SE 52870 00594 the flaggy and brecciated beds persist at lower levels but the red colouration completely disappears. At SE52897 00623 the breccia has the irregular rounded appearance of a reef and is overlain by thin bedded, but not flaggy limestones, that follow the contours of this brecciated mass. Towards SE 52937 00713, there is further change in the lithology from flaggy and brecciated beds to sections, 3-4 m thick, of massive wedge bedded limestones.

The marl sections were previously considered to correlate with the Hampole Beds in the 1997 survey. Although not conforming to typical descriptions in the Geological Memoirs for Barnsley and Doncaster and the Geological Conservation Review, their position in the stratigraphic column coupled with evidence of desiccation and erosion that has not been seen or recorded elsewhere in the Cadeby Formation within Doncaster indicates that this assertion still remains the same and deserves further detailed research.

The exposure itself is relatively remote and not easily accessible but merits further detailed scientific investigation with other sites on the River Don.

RIGS Assessment of Site Value	D28 Pot Ridings Wood Railway Cutting

Ratings: 1-2 very poor; 3-4 poor; 5-6 acceptable/useful; 7-8 quite good; 9-10 very good/excellent; N/A not applicable; D/K don't know

Access and Safety

Aspect	Description	Rating
road access & parking	Remote. Nearest parking is adjacent to gypsy camp	**3**
safety of access	Safe for experienced country walkers but extremely muddy and full of recent wind blown hazards (trees) at time of survey	**5**
safety of exposure	No obvious hazards, apart from blown down trees, slippery surfaces and an occasional rock fall	**8**
permission to visit	Owned by Lafarge but access appears to be unrestricted from the east	**5**

current condition	Good exposures but access along the cutting was difficult at the time of the survey due to deep mud	**8**
current conflicting activities	Weather	
restricting conditions	None envisaged, but ease of access needs to be considered	
nature of exposure	Railway cutting	
multiple exposures / prospect for trail	Limited, except for a long days field trip in conjunction with Cadeby Cliff/Constitution Hill	
Notes	This site was difficult to visit, with a long walk, but well worth the time spent	

Culture, Heritage & Economic

Aspect	Description	Rating
historic, archaeological & literary associations	Historic associations with the South Yorkshire Junction Railway	**8**
aesthetic landscape	Access to the site from the Don Gorge coincides with a wide variety of Nature Reserves	**8**
history of Earth Sciences	This site provides a good opportunity to add to and advance the knowledge as described in existing geological publications	**8**
economic geology	This site records the development of the railway network at a time when the economy of Great Britain was at its very best	**7**
Notes		

Education and Science

surface processes	General weathering of limestone and marl	**7**
geomorphology	Access from the River Don provides a good insight into the geomorphology of the Don Gorge	**7**
sedimentary	An extremely diverse variety of lithologies and sedimentary structures are exposed	**9**
fossils	Specialist interests in Permian species	**7**
igneous	Not applicable	**0**
metamorphic	Not applicable	**0**
tectonic: structural	Good field evidence of folding and faulting	**7**
minerals	Not applicable	**0**
stratigraphy	Considerable potential to establish the stratigraphic relationship with the Hampole Beds	**8**
Notes	This is a very good site to demonstrate a wide range of sedimentary and structural processes	

Geodiversity value

A very good insight into the importance of geology in determining the route of railway networks	**9**

Site Photographs	D28 Pot Ridings Wood Railway Cutting

Figure 83 General view east from centre of cutting. SE 52785 00492.

Figure 84 Brecciated mound with overlying well bedded limestones following the topography of an erosional surface. SE 52897 00623.

Figure 85 Exposure of irregular shaped reef mound with steeply dipping well bedded limestones of the Wetherby Member. SE 52727 00444.

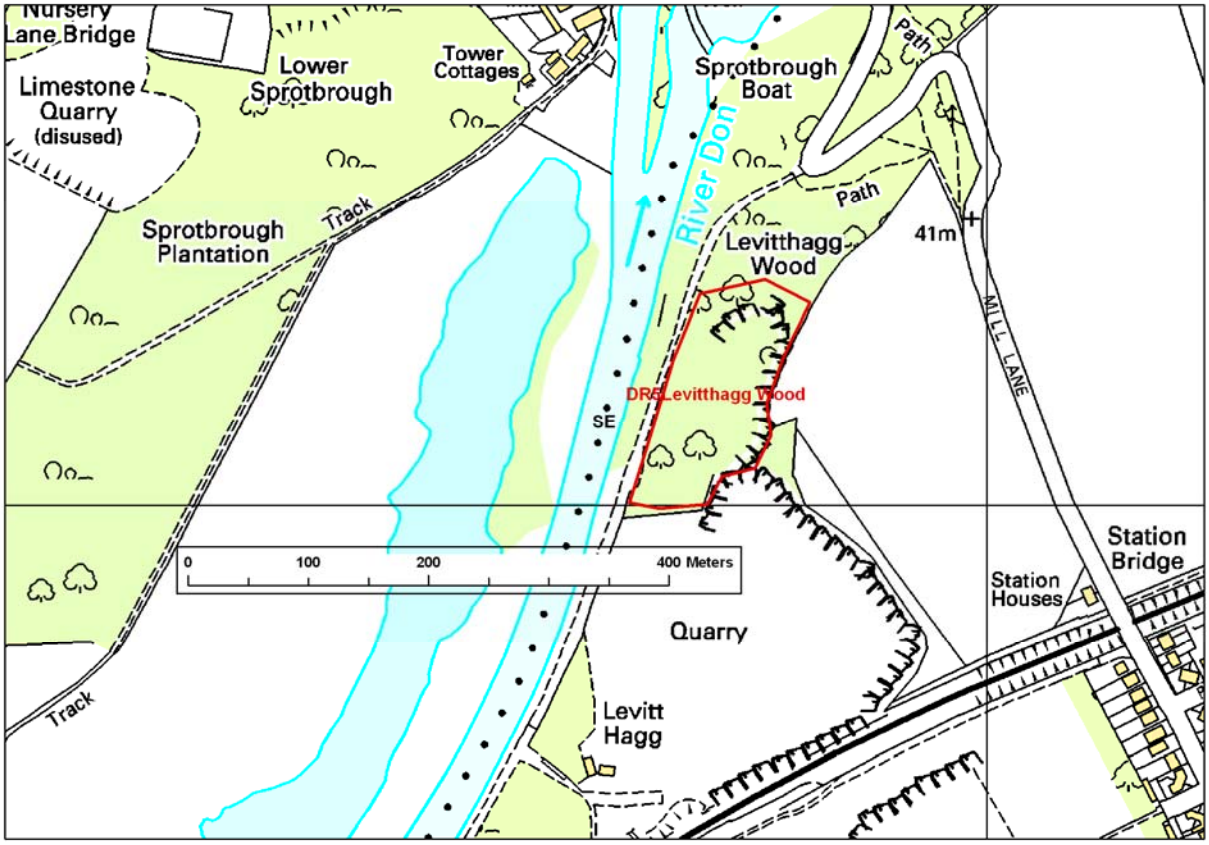
Figure 86 A joint infilled with brecciated limestone fragments and unconsolidated Quaternary sandy clay. SE 52750 00450.

A17 DR5 LEVITTHAGG WOOD

Site Name: **Levitthagg Wood**	Site Key: **DR5**
Grid Reference: **SE 538 011 (centred on)**	Site Type: **disused quarries, pits and cuttings**
Local Authority: **Doncaster Metropolitan Borough Council, South Yorkshire**	
Site Dimensions: 150 m x 60 m	Site Owner: DMBC
Conservation Status: **Proposed Regionally Important Geological Site**	Date: No Date
Field surveyor: Scott Engering	Date: 13/3/07

Stratigraphy and Rock Types	
Time Unit: Permian	Rock Unit: Sprotbrough Member, Cadeby Formation, Zechstein Group
Rock Type: Dolostone	Details: Massive wedge bedded limestones, reefs and marls

Site Map	**Figure 87 - DR5 Levitthagg Wood**



Site Description	**DR5 Levitthagg Wood**

The site was surveyed principally to investigate the location of Levitt Hagg Hole (D303). However, this area was not investigated during the 1997 RIGS Survey and along with Nearcliff Woods and Nearcliff Quarries, there are features of interest, although the site was not assessed in detail.

From SE 53791 01137 , a bed of red and green marl approxiamately 500 mm thick can be seen at about 4 m from the top of the exposed quarry face, which exceeds 25 m in height in places. From SE 53780 01803, the red marls are seen to continue at a similar level. The quarry face is largely overgrown with well

established trees and thick vegetation, so details cannot be clearly seen. Also, the floor of the quarry is covered by large boulders of rock waste, covered in moss and ferns and is not easily accessible.

At SE 53769 01050, at the back of the Levitt Hagg Landfill site, there is approximately 17 m of good exposure, with massive, wedge bedded ooid-limestones in the lower section and a reef in the upper section. To the right hand side of the exposure, the limestone is very pale and fallen debris show this to possess a fine granular texture and a flow stone texture.

This site, although possessing points of interest, should mainly be recorded as having interest for any future geological work on the Don Gorge. There are still sites in the gorge that warrant further investigation but hese are considered to be beyond the scope of this report.

RIGS Assessment of Site Value	DR5 Levitthagg Wood

Ratings: 1-2 very poor; 3-4 poor; 5-6 acceptable/useful; 7-8 quite good; 9-10 very good/excellent; N/A not applicable; D/K don't know

Access and Safety

Aspect	Description	Rating
road access & parking	Limited at the hairpin bend on the Warmsworth-Sprotbrough road	**6**
safety of access	Access along banks of Don is an established path. Off the path, there is some very uneven and potentially hazardous ground	**5**
safety of exposure	Rock debris, moss and other vegetation prevent safe access to rock faces, which are not considered to be very stable	**4**
permission to visit		**N/A**
current condition	Overgrown but there are reasonable rock exposures to be seen	**5**
current conflicting activities	Some rubbish and littering. Increasingly vegetated condition is limiting exposures	
restricting conditions	Vegetation and safe access	
nature of exposure	Old quarry faces	
multiple exposures / prospect for trail	Has potential as one of several sites of interest along the south side of the Don Gorge	
Notes	Accessible with care, taking usual fieldwork precautions	

Culture, Heritage & Economic

Aspect	Description	Rating
historic, archaeological & literary associations	Industrial archaeology associated with quarrying in the Don Gorge	**6**
aesthetic landscape	Adjacent to popular walking routes along the Don Gorge	**6**
history of Earth Sciences	Potentially a good site to study the formation of the Don Gorge along with other nearby sites	**6**
economic geology	Quarrying history of dolostone in a regional context	**6**
Notes	One of several sites along the Don Gorge that has potential historical and archaeological value	

Education and Science

surface processes	Solution processes, formation of head and soil horizons	**6**
geomorphology	Part of Don Gorge	**7**
sedimentary	Various lithologies and sedimentary structures, including reefs and red marls	**7**
fossils	Specialist interests in Permian fossils	**0**
igneous	Not applicable	**0**

metamorphic	Not applicable	**0**
tectonic: structural	In conjunction with other sites, an opportunity to study processes that have formed the Don Gorge	**7**
minerals	Not applicable	**0**
stratigraphy	Possible occurrence of stratigraphic equivalent to Hampole Beds	
Notes	One of several sites along the Don Gorge that potentially have scope for further investigation	
Geodiversity value		
Possesses group value with other sites along the Don Gorge		**7**

Site Photographs	**DR5 Levitthagg Wood**

Figure 88 General view of reef/breccia and white flow stone to right hand side. SE 53769 01050.

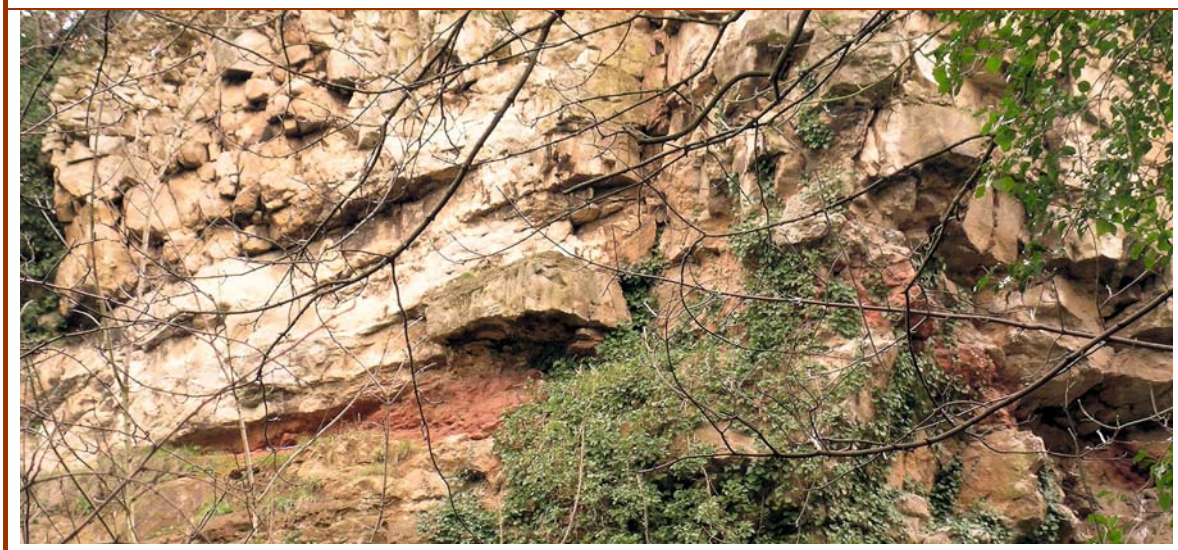


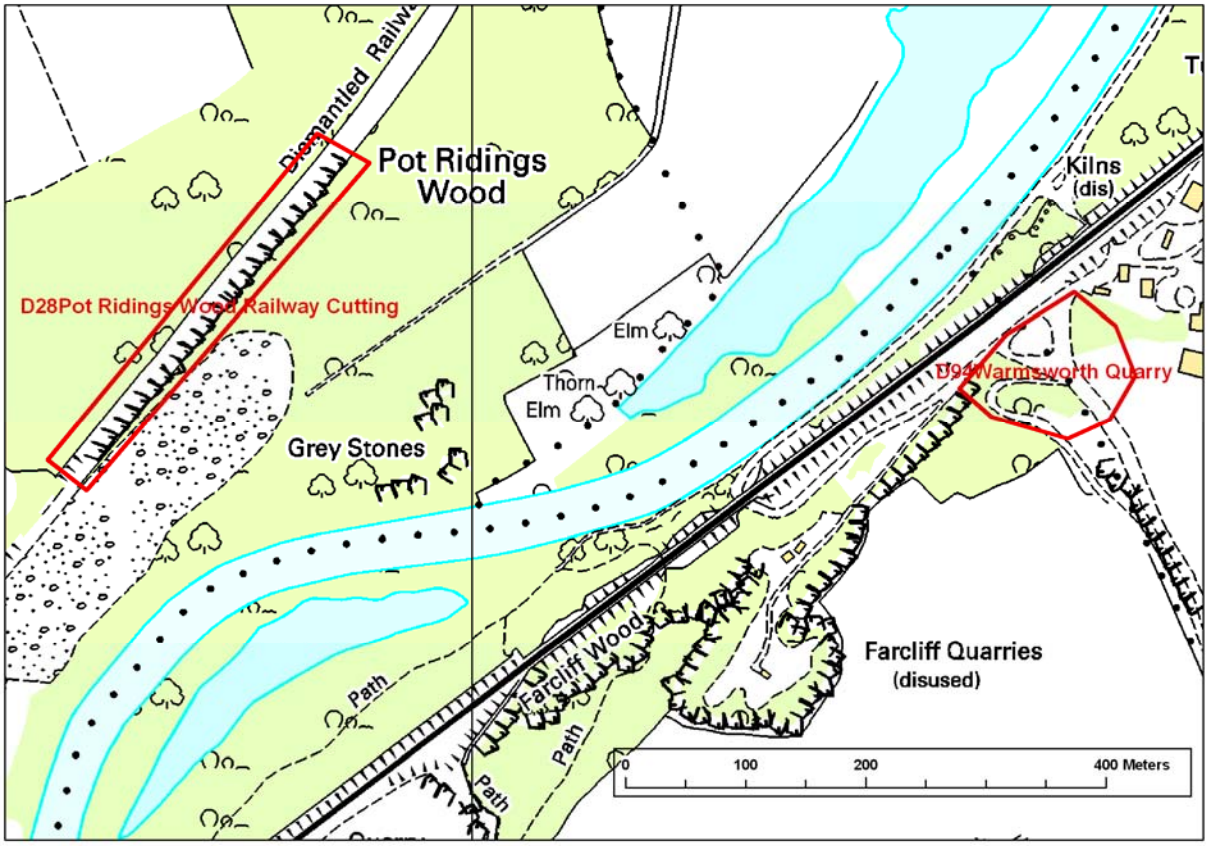
Figure 89 Detail of red marl and associated breccia. SE 53780 01083.

A18 D94 WARMSWORTH QUARRY

Site Name: **Warmsworth Quarry**	Site Key: **D94**
Grid Reference: **SE 535 004 (accurate)**	Site Type: **active quarries and pits**
Local Authority: **Doncaster Metropolitan Borough Council, South Yorkshire**	
Site Dimensions: 15 m x 6 x 10 m	Site Owner: WBB Minerals
Conservation Status: **Regionally Important Geological Site**	Date: 16/9/97
Field surveyor: Scott Engering	Date: 16/2/07

Stratigraphy and Rock Types	
Time Unit: Permian	Rock Unit: Sprotbrough Member, Cadeby Formation, Zechstein Group
Rock Type: Dolostone	Details: Dolostone breccia

Site Map	**Figure 90 - D94 Warmsworth Quarry**



Site Description	D94 Warmsworth Quarry

An isolated stump comprising a breccia of angular and in places sub-rounded limestone generally less than 100 mm in size with an orange-brown sandy matrix. The south side contains lenses where there is a large proportion of sandy material and to the north side, there are two beds 300-400 mm thick that are essentially composed of cemented sand and form a sharp boundary with the underlying breccia but coarsen upwards into the overlying breccia.

According to the quarry manager the exposure is located in a position that was previously the site of a large mound of quarry waste and adjacent to the exposure, there is a remnant which is obviously man made. However, this exposure is very well cemented and has sheer vertical faces and has a well developed upper soil horizon. To the south, the access road to the quarry is flanked to the west by a rock face that is extremely fissured and further along the Don Gorge to the west at Nearcliff Woods, the limestone has been subjected to massive slumping and brecciation with very large fissures that are filled with similar material.

RIGS Assessment of Site Value	D94 Warmsworth Quarry

Ratings: 1-2 very poor; 3-4 poor; 5-6 acceptable/useful; 7-8 quite good; 9-10 very good/excellent; N/A not applicable; D/K don't know

Access and Safety

Aspect	Description	Rating
road access & parking	Accessible along road to working limestone quarry. Limited parking at site offices	**4**
safety of access	Very busy working quarry so considered potentially hazardous	**4**
safety of exposure	Adjacent to busy access road to quarry without pathways	**4**
permission to visit	Private Ownership WBB Minerals	**5**
current condition	Very good	**8**
current conflicting activities	traffic to quarry and landfill site	
restricting conditions	No collecting	
nature of exposure	Large stubby pillar of dolostone breccia left as a remnant of past quarrying activities	
multiple exposures / prospect for trail	With specific permission, potential to link with Warmsworth Park, Cadeby Cliff, Cedar Road Quarry and Hexthorpe Flatts as part of organised group visit	
Notes	This is a busy quarry and landfill site and particular care needs to be taken when visiting, over and above usual fieldwork precautions	

Culture, Heritage & Economic

Aspect	Description	Rating
historic, archaeological & literary associations	None known	**0**
aesthetic landscape	Working quarry environment	**3**
history of Earth Sciences	None known	**0**
economic geology	Production of pure dolostone suitable for the glass making industry. Aggregates and some building stone produced	**8**
Notes	Economically significant source of materials for glass industry	

Education and Science

surface processes	Deposit associated with gorge formation, rifting, slumping and cambering	**8**

geomorphology	Not applicable	**0**
sedimentary	Good example of brecciated dolomitic limestone with sandy beds	**8**
fossils	Not applicable	**0**
igneous	Not applicable	**0**
metamorphic	Not applicable	**0**
tectonic: structural	Associations with rifting, slumping and cambering in the Don Gorgeand its relationship to the South Don fault	**8**
minerals	.	**0**
stratigraphy	Rare occurrence of brecciated dolostone	**7**
Notes	Good field work site at advanced, graduate or adult level, for rarity value	
Geodiversity value		
Unusual occurrence of brecciated dolostone		**8**

Site Photographs	**D94 Warmsworth Quarry**

Figure 91 General view of north face of breccia stump. SE 53458 00455.

Figure 92 General view of south face of breccia stump. SE 53457 00488.

Figure 93 Detail of sandstone and limestone layers in south face of breccia stump. SE 53457 00488.

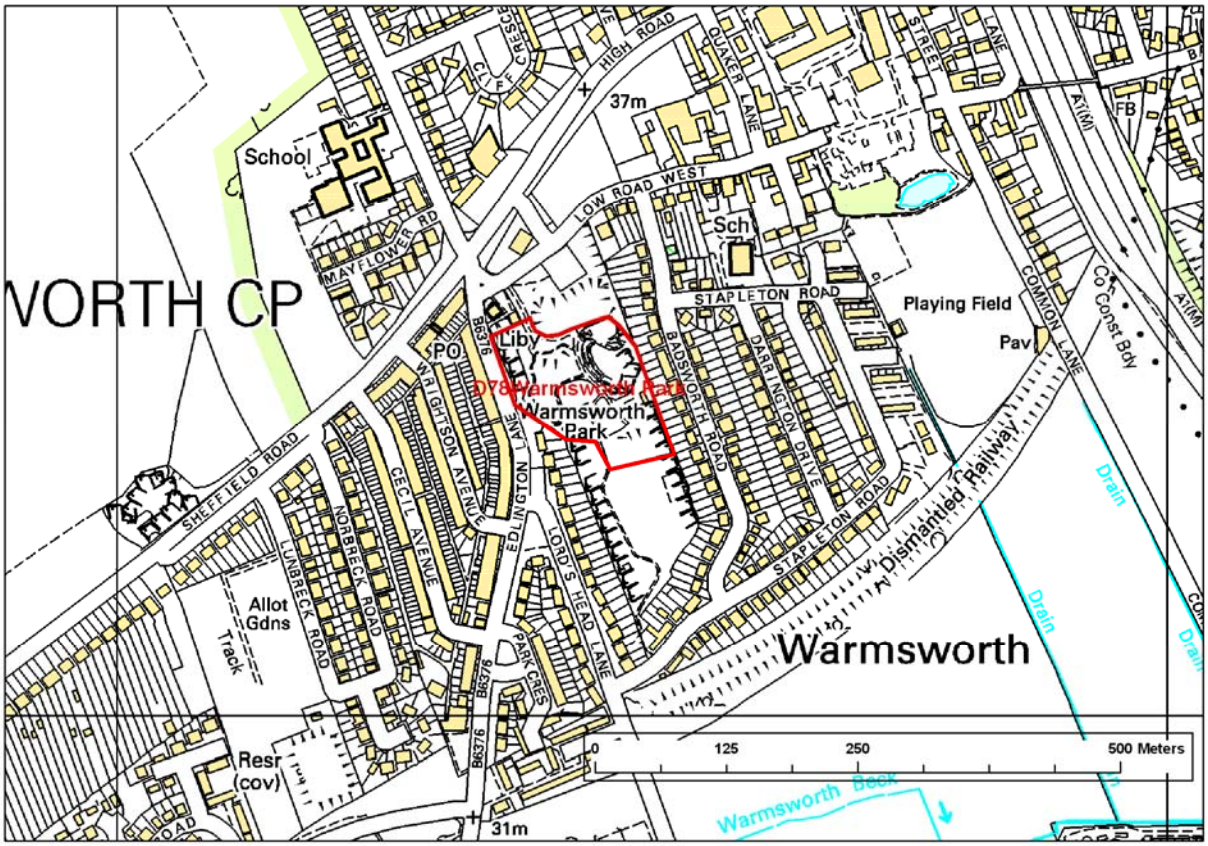
Figure 94 General view of quarry looking to the west. SE 53900 00400.

A19 D78 WARMSWORTH PARK

Site Name: **Warmsworth Park**	Site Key: **D78**
Grid Reference: **SE 544 030 (accurate)**	Site Type: **disused quarries, pits and cuttings**
Local Authority: **Doncaster Metropolitan Borough Council, South Yorkshire**	
Site Dimensions: 100 m x 80 m	Site Owner: DMBC
Conservation Status: **Regionally Important Geological Site**	Date: 14/9/97
Field surveyor: Scott Engering	Date: 19/1/07

Stratigraphy and Rock Types	
Time Unit: Permian	Rock Unit: Sprotbrough Member, Cadeby Formation, Zechstein Group
Rock Type: Dolostone	Details: Massive and wedge bedded compact limestone with dentritic pyrolusite and stylolites
Time Unit: Anglian, Middle Pleistocene	Rock Unit: Till
Rock Type: Diamicton, sandy	Details: Red sandy boulder clay with angular fragments and subrounded pebbles

Site Map	**Figure 95 –Warmswoth Park**



Site Description	D78 Warmsworth Park

A medium sized quarry in the Sprotbrough Formation (former upper subdivision of Lower Magnesian Limestone) with exposures of massive, wedge bedded, fine grained and compact limestone up to 10 m. Several safe and accessible quarry faces demonstrate the vertical and lateral changes in thickness of beds, typical of this formation. Individual beds of limestone are up to 600 mm thick, making it suited to use as a building stone.

Unlike the Cadeby Formation, crystal lined cavities and calcite veins are not abundant, although many of the beds demonstrate jointing and fractures, often at oblique angles. Stylolites are common and fresh surfaces of the stone show a black speckled appearance which, when viewed through a hand lens, are seen to be dendritic crystal growths of the manganese bearing mineral pyrolusite.

Many of the quarry faces are obscured with vegetation but where exposed in the high quarry benches, the uppermost beds are flaggy in nature, a feature that is highlighted by weathering and the formation of soil horizons.

At one location on the eastern side of the quarry, there is a mass of poorly consolidated red/brown sandy material up to 6.5 m thick with angular and sub-rounded fragments which is probably till similar to that seen at Hexthorpe Flatts, Cedar Road Quarry and New Edlington Brick Pit. However, here it occurs at the same level as an 8 m high limestone quarry face. Junctions with the limestone are not exposed and it is not clear if this is a natural deposit in a fault bound rift within the limestone or relates to the former quarrying activities.

One particularly interesting feature is a vertical joint in a quarry face that shows widening and solution of the limestone by percolating groundwater and is possibly associated with the formation of Karst topography on a once exposed and weathered surface.

RIGS Assessment of Site Value	D78 Warmsworth Park

Ratings: 1-2 very poor; 3-4 poor; 5-6 acceptable/useful; 7-8 quite good; 9-10 very good/excellent; N/A not applicable; D/K don't know

Access and Safety

Aspect	Description	Rating
road access & parking	Very poor but with the landlords permission, there is plenty of parking space available in the adjacent public house	**2**
safety of access	Very good at three separate locations	**9**
safety of exposure	Very good. No loose material obvious on quarry faces and bases are clear of vegetation	**9**
permission to visit		**D/K**
current condition	Very good but needs to be cleaned regularly	**7**
current conflicting activities	Potential nuisance of youths and associated littering and abuse of a public park	
restricting conditions	Parking is not ideal (see above)	
nature of exposure	Clean and safe extensive old quarry faces up to 10 m	
multiple exposures / prospect for trail	Very good potential in conjunction with Hexthorpe Flatts and Cedar Road Quarry	
Notes		

Culture, Heritage & Economic

Aspect	Description	Rating
historic, archaeological & literary associations	Local building stone used for construction of several historic buildings in Warmsworth	**8**
aesthetic landscape	Good landscaped public park but limited botanical interest	**6**
history of Earth Sciences	Not applicable	**0**

economic geology	Former local building stone quarry. Good illustration of the fractures etc that limit the applications as a building material	**7**
Notes		
Education and Science		
surface processes	Solution features associated with percolation of groundwater and formation of Karst topography. Glacial deposition	**7**
geomorphology	Not applicable	**0**
sedimentary	Good example of wedge bedding, variation in bed thickness, Stylolites	**8**
fossils	Not applicable	**0**
igneous	Not applicable	**0**
metamorphic	Not applicable	**0**
tectonic: structural	Evidence of rifting and formation of grabens relating to earth movements of the South Don and associated faults	**7**
minerals	Occurrence of pyrolusite is one characteristic feature of the Sprotbrough Formation.	**7**
stratigraphy	Not applicable	**0**
Notes	Possesses very good educational and interpretation value. Has the advantage of being next to a branch library where leaflets etc. could be displayed or distributed	
Geodiversity value		
A wide range of geological processes can be demonstrated, especially in conjunction with other nearby sites		**9**

Site Photographs	**D78 Warmsworth Park**

Figure 96 General view of landscaping of the old quarry benches looking to the north. SE 54460 00300.

Figure 97 General view of till (left) and limestones of the Sprotbrough Member (right). SE 54470 00305.

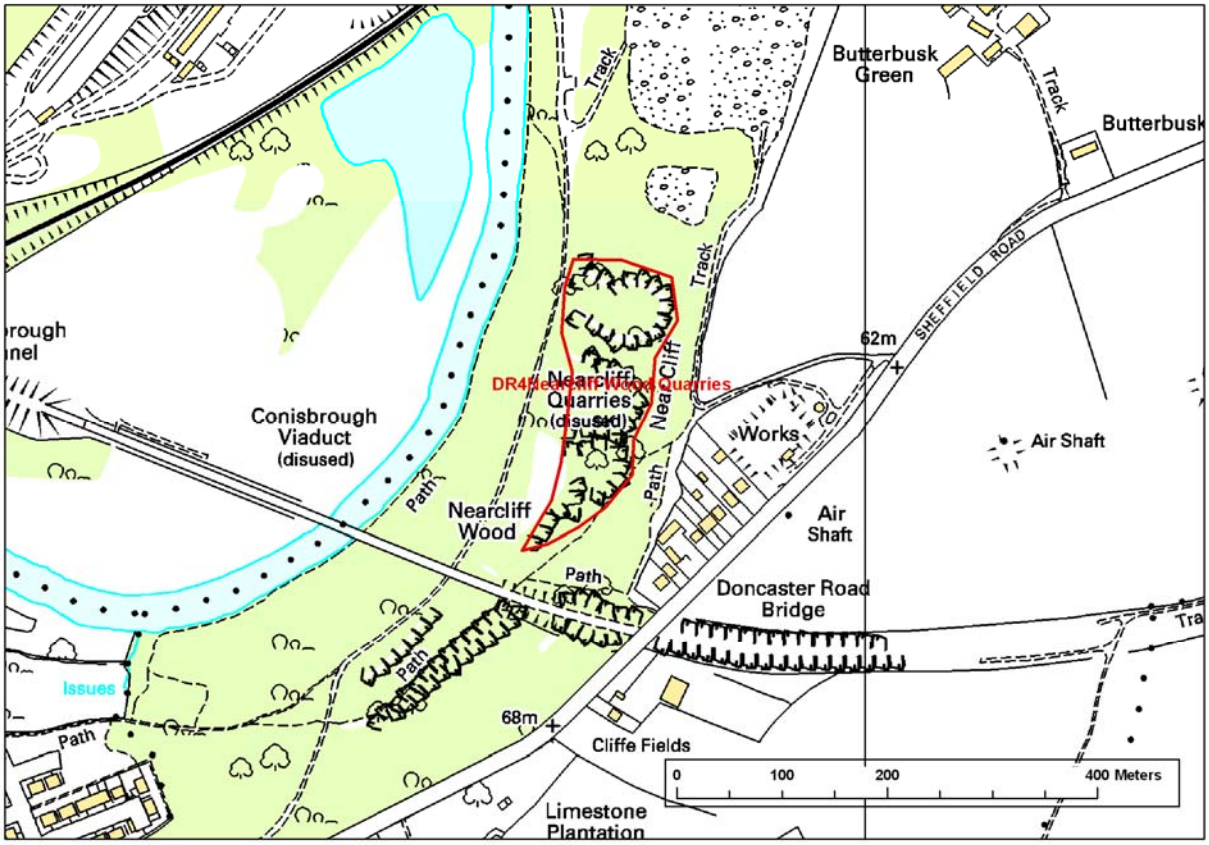
Figure 98 Development of a sink hole and solution features along a joint in the eastern face of the quarry. SE 54470 00370.

A20 DR4 NEARCLIFF WOOD QUARRIES

Site Name: **Nearcliff Wood Quarries**		Site Key: **DR4**
Grid Reference: **SK 527 995 (centred on)**	Site Type: **disused quarries, pits and cuttings**	
Local Authority: **Doncaster Metropolitan Borough Council, South Yorkshire**		
Site Dimensions: 300m x 100 m	Site Owner: Taylor Woolhouse Holdings	
Conservation Status: **Proposed Regionally Important Geological Site**		Date: No Date
Field surveyor: Scott Engering		Date: 13/3/07

Stratigraphy and Rock Types	
Time Unit: Permian	Rock Unit: Cadeby Formation, Zechstein Group
Rock Type: Dolostone	Details: Slumped and rifted massive bedded limestones and reefs
Time Unit: Devensian, Late Pleistocene	Rock Unit:
Rock Type: Sand and Gravel	Details: Fissure deposits in rifts associated with slumping and cambering

Site Map	**Figure 99 - DR4 Nearcliff Wood Quarries**



Site Description	DR4 Nearcliff Wood Quarries

As part of the inspection of the entrances to Conisbrough Caves East (D300), a brief survey of the old quarry faces, which exceed 20 m in places, reveal numerous examples of brecciation, rifting, slumping on a massive scale, with associated deposits of head and breccia with an orange sandy matrix. These are similar in colour and composition to exposures seen in smaller excavations at Grey Stones (SE 52971 00367) on the north bank of the River Don and have similarities to the component rocks at the breccia stump at Warmsworth Quarry (D94).

The bedded appearance normally associated with limestones of the Cadeby Formation are largely absent but when seen in large slumped blocks massive beds dip steeply with no obvious relationship to the structural dip of bedded limestones in the region and often at oblique angles to neighbouring blocks. Large pillow shaped masses with no obvious bedding planes appear to be reefs. Examples of these structures can be seen from SE 52737 99519 (near to Nearcliff Wood Rift Cave entrances), SE 52763 99485, SE 52763 99843 and from SE52761 99540, where the entrance of Windy Cave is also seen at the bottom of the quarry face. Here there is a very good example of a sand and breccia filled rift, 3 m wide at the base.

From Constitution Hill to Levitt Hagg Wood, there are several slip rift cave systems that appear to be associated with this pattern of large scale slumping and which have been listed as RIGS. The rift structures and associated sandy deposits found along the Don Gorge have been considered to be worth detailed investigation for fossil remains. In Victorian times, the Don Gorge was considered to possess similar potential to Cresswell Crags, which is now an internationally recognised heritage site.

Along with sites at Levitt Hagg Wood, Grey Stones and other sites along the Don Gorge that have not yet been surveyed for their potential value, there is further scope to bring the geology into line with other historic, archaeological, architectural and biological interests that already feature in the Don Gorge Management Plan.

RIGS Assessment of Site Value	DR4 Nearcliff Wood Quarries

Ratings: 1-2 very poor; 3-4 poor; 5-6 acceptable/useful; 7-8 quite good; 9-10 very good/excellent; N/A not applicable; D/K don't know

Access and Safety

Aspect	Description	Rating
road access & parking	Very poor and visit to the site requires a good walk along country paths	**5**
safety of access	Off country paths along River Don, access is over vegetated quarry waste	**5**
safety of exposure	The quarry faces, by their disrupted and brecciated nature, requires due care and attention when visiting	**5**
permission to visit	Site privately owned, but adjacent to PROW	**D/K**
current condition	Some rubbish, fires and other debris associated with redundant quarries but acceptable for scientific visits	**5**
current conflicting activities	Fires, rubbish etc and misuse of redundant quarries	
restricting conditions	No hammering of quarry faces	
nature of exposure	Old quarry faces	
multiple exposures / prospect for trail	Excellent prospects for an extended or short field trip along the Don Gorge	
Notes		

Culture, Heritage & Economic

Aspect	Description	Rating
historic, archaeological & literary associations	None known but further investigation is merited	**7**

aesthetic landscape	Extremely good, with a walk from Conisbrough to the A1 beyond Sprotbrough unrivalled in Yorks	**9**
history of Earth Sciences	The region is a largely untapped site for geological/anthropological/archaeological research	**9**
economic geology	The Don Gorge has been continually exploited for its limestone resources at least as far back as Norman times	**9**
Notes	A first class site	
Education and Science		
surface processes	Large scale structures associated with cambering, slumping and rifting during the Quaternary period	**7**
geomorphology	Excellent opportunity to study and observe large scale structures associated with the formation of a major gorge	**9**
sedimentary	A good variety of large scale sedimentary structures associated with glacial and interglacial conditions	**9**
fossils	Potential for investigation of sandy fissure deposits	
igneous	Not applicable	**0**
metamorphic	Not applicable	**0**
tectonic: structural	Slumping, cambering and rifting along the Don Gorge associated with the Don Monocline and Don Fault System	**9**
minerals	Not applicable	**0**
stratigraphy	Extremely good potential to research the hard rock geology and stratigraphy of a nationally important limestone gorge	**8**
Notes	As a part of the entire Don Gorge, this site possesses first class research and education potential	
Geodiversity value		
Extremely important in at least both a regional and national context for the use and exploitation of a natural resource		**10**

Site Photographs	**DR4 Nearcliff Woods/Quarries**

Figure 100 General view of large scale slumping, breccias, rifts and associated head and fissure deposits. SK 52763 99485.

Figure 101 General view of large scale slumping, breccias, rifts and associated head and fissure deposits. SK 52763 99485.

Figure 102 Slump structures. SK 52763 99548.

Figure 103 General view of large scale slumping, breccias, rifts and associated head and fissure deposits. SK 52763 99485.

Figure 104 Slump structures. SK 52763 99548.

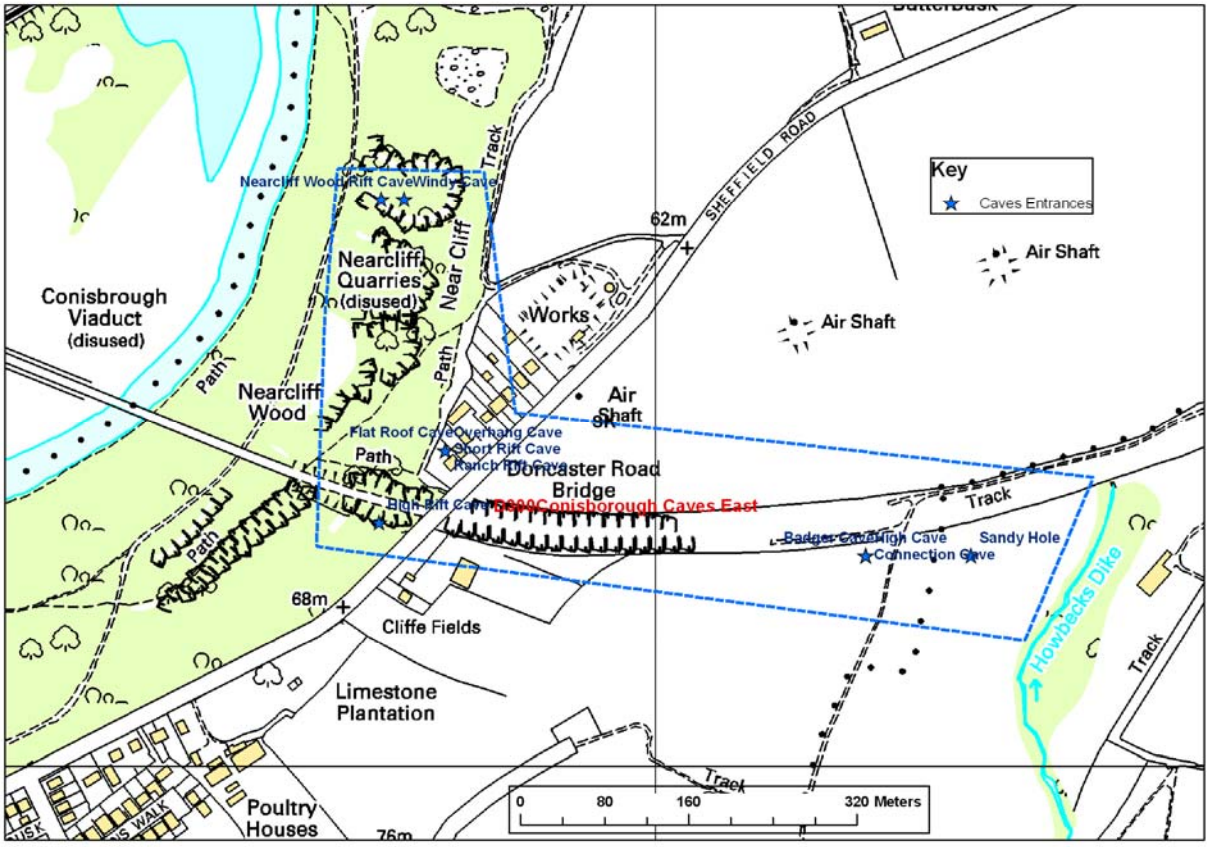
Figure 105 . Breccia and sandy deposits in rift SK 52761 99540.

A21 D300 CONISBROUGH CAVES EAST

Site Name: **Conisbrough Caves East**	Site Key: **D300**
Grid Reference: **SK 523 992 (west end)**	Site Type: **cave**
Local Authority: **Doncaster Metropolitan Borough Council, South Yorkshire**	
Site Dimensions:	Site Owner: Various
Conservation Status: **Regionally Important Geological Site**	Date: 17/5/97
Field surveyor: Tony Gibbs, Derbyshire Caving Association	Date: 1997

Stratigraphy and Rock Types	
Time Unit: Permian	Rock Unit: Cadeby Formation, Zechstein Group
Rock Type: Dolostone	Details:

Site Map	**Figure 106 - D300 Conisbrough Caves East**



Site Description	**D300 Conisbrough Caves East**

The 1997 RIGS Survey included an assessment of cave systems along the Don Gorge by Tony Gibbs of the Derbyshire Caving Association. The notes from this survey are included below. On 4th March 1997, accompanying Tony Gibbs, the following notes were made:

The entrances to **Nearcliff Wood Rift** were located at SK 52739 99519, halfway up a steep slope in the quarry face. These comprise small openings and do not appear to be easily accessible. At SK 52761 99540, the entry to **Windy Cave** is at the base of the quarried face

and again comprises a small hole. Access to the caves is along the towpath to the south of the River Don (nearest points of access unknown). **High Rift Cave** is at SK 52737 99231 and is approximately 13 m up a steep sided railway cutting. Accessible by climbing or abseiling with ropes only. **Ranch Rift Cave** occupies a similar position down the face of the cutting and access is equally as difficult. **Flat Roof Cave** is apparently used as a Den and access is considered to be difficult, especially in wet weather.

BADGER CAVE [SK 532 992] See also High Cave. Entry No. 54.
Altitude: 60 m Length: 12 m
Description: Entrance now covered by tipping. Possibility of re-opening needs investigating. Tight entrance about 14 m west of High Cave was a drop of 1.2 m into a passage and low bedding chamber. Higher passage with avens and draughting tubes ended at a choke. Entrances now covered by tipping (1994).
Main Points of Interest: Slip rift development, bedding plane enlargement, an unusual combination of development types and palaeontology.

WINDY CAVE [SK 527 996]
Altitude: 30 m Length: 10 m
Description: No known restrictions. Quarry location. Entrance is in same quarry as Nearcliff Wood Rift Cave. It lies in an area of Limestone debris under a large overhang. A crawl into a 2 metre high rift which lowers to a crawl and choke. Checked by T.Gibbs, 10/01/93.
Main Points of Interest: Slip rift development, bedding plane enlargement, unusual combination of development types and palaeontology.

NEARCLIFF WOOD RIFT CAVE [SK 527 995]
Altitude: 40 m Length: 88 m Depth: 12 m
Description: Possible threat from quarry tipping. About 400 m North of East end of disused railway viaduct in old quarry, are two entrances, difficult to locate. Follow path under railway to path slanting up on right over old tips. Follow this path back towards the railway, to branch path on left into thick woodland. With luck the entrances will be found nearby, near foot of scarp. Lower entrance is 10 m down bank from upper entrance. The crawl into the upper series enlarges to 4.5 m climbable drop into chamber (rope useful) with three routes leading off. First is high level link to upper entrance passage. Second is lower and leads to other entrance. Third is the lowest, reached by a further 4.5 m decent, and ending in a choke after a further link to the lower entrance. Bolts were in place for handlines in 1994.
Main Points of Interest: Major slip rift development, extensive and complex underground system and palaeontology.

RANCH RIFT [SK 528 993]
Altitude: 60 m Length: 26 m
Description: See Ranch Rift. Suspected wrong spelling of Ranch Rift as described in YSS 1, and therefore described in full under Ranch Rift Cave.
Main Points of Interest: See Ranch Rift Cave.

RANCH RIFT CAVE (SK 528 993]
Altitude: 60 m Length: 26 m
Description: Care is needed on the approach. The entrance is on the north side of a disused railway cutting about 25 m east of the main A630 Doncaster to Sheffield Road. It can be approached from above, but it is better located from below first. It can be approached with more difficulty from below. Either approach requires care and/or a rope. Slope down from entrance into 6 metres high rift which closes to squeeze to narrow rift, widening and ending at loose boulders.
Main Points of Interest: Slip rift development and palaeontology.

OVERHANG CAVE [SK 528 993]
Altitude: 60 m Length: 8 m
Description: A steep approach, which is awkward in wet weather. At top of fault above Short Rift Cave, left of overhang at top of slope. Approach as for Short Rift Cave. Roomy entrance lowers and enters small chamber with two choked passages in right wall.
Main Points of Interest: Slip rift development and palaeontology.

FLAT ROOF CAVE [SK 528 993]
Altitude: 60 m Length: 6 m

Description: Used as Den by local youngsters. Much altered from original description. A steep approach, which is awkward in wet weather. Not listed in Northern Caves Volume 1, 1988. Approach as for Short Rift Cave. Description had changed in 1994. Situated to the left of Short Rift Cave on the far side of a short exposed ledge. Twin entrances are now one (left) which had been enlarged when visited in 1994. The second entrance has been virtually obliterated in by the excavations. The entrance opens out into a small chamber 4 m long by 3 m wide and 1.2 m high and choked at the far end. The roof still contains some small, inactive formations.
Main Points of Interest: Unusual bedding development, spaeleothems and palaeontology.

SHORT RIFT CAVE [SK 528 993]
Altitude: 60 m Length: 15 m Depth: 2 m
Description: A steep approach, which is awkward in wet weather. On the south side of the disused railwaycutting diagonally opposite High Rift Cave is an exposed fault. The cave entrance is high up this fault and the climb requires care if wet. Small entrance near top of fault is followed by a 2 metre drop into a 2.5 metre high rift with a boulder roof and ending in a choke. At the lowest point and in the floor a strong draught was noticed on 20/08/94 by T.Gibbs and party.
Main Points of Interest: Slip rift development, palaeontology and fault.

HIGH RIFT CAVE [SK 527 992] ALSO KNOWN AS CONISBROUGH CAVE NO. 1
Altitude: 60 m Length: 27 m
Description: Steep approach needs care, especially in wet weather. On the north side of cutting near large viaduct on north west side of A630 road. Entrance just west of the road bridge and is reached by scramble up cutting side. Just inside is a short climb down to a floor of higher fissure with a boulder roof. Fissure closes down to a small chamber and ends at a choke. Tight squeeze on left enters bedding chamber with no way on.
Main Points of Interest: Slip rift development, interesting bedding development at end and palaeontology.

HIGH CAVE [SK 532 992] Also Known As CONISBROUGH CAVE NO. 2.
Altitude: 60 m Length: 30 m
Description: Lost to tipping. Possibility of re-opening needs investigating. See also Badger Cave (Entry No.36.) and Connection Cave, lost to same tipping. The entrance is high up on the south side of railway cutting 400 m east of the bridge on the A630 Doncaster to Sheffield Road. Roomy entrance with large slab led to chamber with low choked chamber off to the Right. Ahead is a further chamber with various digs and small aven and crawl to flowstone choke at far side. Left is the excessively low bedding plane link with Connection Cave. About 3 m east of main entrance is tight entrance and tortuous passage linking with first chamber in main cave. Now covered by tipping.
Main Points of Interest: Slip rift development and bedding development/enlargement.

CONNECTION CAVE [SK 532 992] Connects with High Cave.
Altitude: 60 m Length: 7.5 m
Description:
Lost to tipping. Possibility of re-opening needs investigating. See also Badger Cave and High Cave, lost to same tipping. Connection Cave is 10 m east of High Cave and led to low bedding passage as described under High Cave.
Main Points of Interest: Bedding development/enlargement and part of larger system.

SANDY HOLE [SK 533 992]
Altitude: 60 m Length: 9 m
Description: Lost to tipping. Possibility of re- opening needs investigating. Entrance obliterated by tipping by council. Located on the south side of a disused railway cutting about 500 m east of the main road bridge and east of High Cave. There is small tube which became too tight.
Main Points of Interest: Bedding development/enlargement and phreatic development.

As a geologist, apart from providing evidence of rifting, cambering and slumping during the formation of the Don Gorge, there appears to be no great merit and the entrances viewed seem more fit for animals than for men. For full details relating to the RIGS Site Assessment, it is recommended that Derbyshire Caving Association are approached for this very specialist information.

RIGS Assessment of Site Value	D300 Conisbrough Caves East

Ratings: 1-2 very poor; 3-4 poor; 5-6 acceptable/useful; 7-8 quite good; 9-10 very good/excellent; N/A not applicable; D/K don't know

Access and Safety

Aspect	Description	Rating
road access & parking	Parking near water tower east of Conisbrough on Doncaster Road. 2-3 vehicles with care	**4**
safety of access	Along very muddy pathways frequented by BMX and trail bikes	**4**
safety of exposure	Rock faces are highly brecciated and have inherent structural instability,	**3**
permission to visit	Not applicable	**N/A**
current condition	Some of cave entrances have been covered by landfill	**5**
current conflicting activities	Landfill	
restricting conditions	Considered to be moderately hazardous locations, with poor access and potentially unstable rock faces	
nature of exposure	Cave entrances in old quarries and railway cutting	
multiple exposures / prospect for trail	For specialist cavers only	
Notes		

Culture, Heritage & Economic

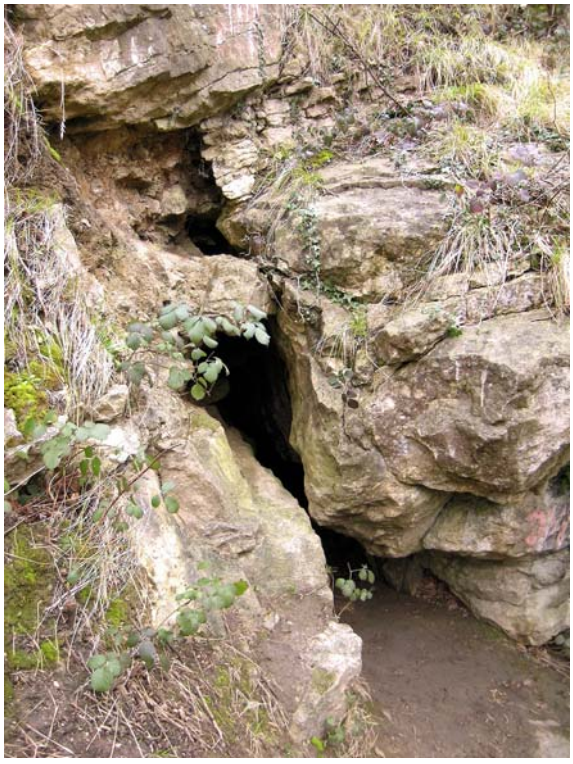
Aspect	Description	Rating
historic, archaeological & literary associations	None known	**0**
aesthetic landscape	Old quarried side of gorge now heavily overgrown with biological interests	**6**
history of Earth Sciences	Good location for studying rifting, brecciation etc associated with formation of Don Gorge	**6**
economic geology	One of numerous old quarries along the Don Gorge but no details known	**5**
Notes		

Education and Science

surface processes	Rifting, slumping and cambering	**8**
geomorphology	Gorge and rift cave formation	**7**
sedimentary	Large scale sedimentary structures associated with slumping	**7**
fossils	Possibility of fossil remains in fissure deposits associated with cave formation	**0**
igneous	Not applicable	**0**
metamorphic	Not applicable	**0**
tectonic: structural	Cave formation associated with slumping and rifting	**8**
minerals	Not applicable	**0**
stratigraphy	Not applicable	**0**
Notes	Caves have limited specialist interest but important for demonstrating rifting and slumping	

Geodiversity value

Caves are of specialist speleological interest but associated breccias, rifts and slump structures are very interesting	**8**

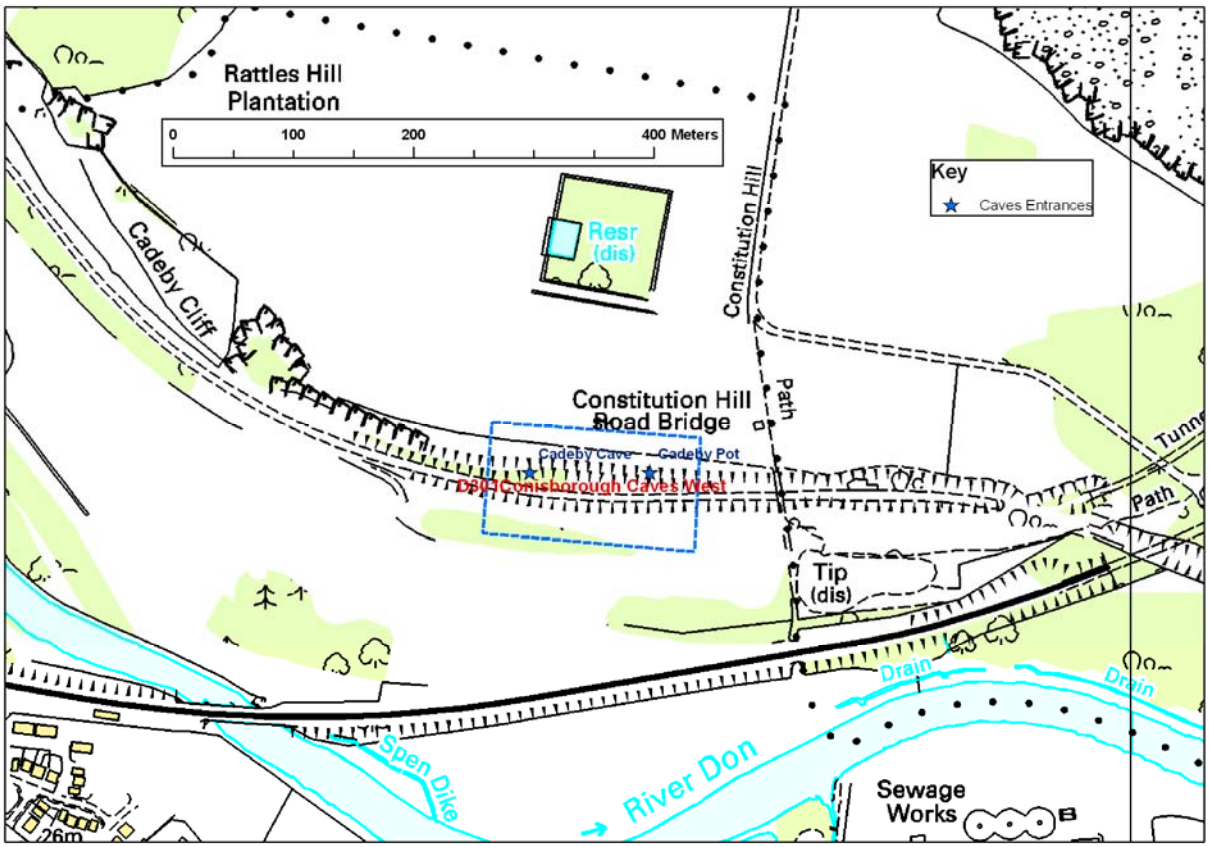
Site Photographs	D300 Conisbrough Caves East
	
Figure 107 General view of entrances to Nearcliff Wood Cave. SK 52734 99519.	**Figure 108** Entrances to Nearcliff Wood Cave. SK 52734 99519.
	
Figure 109 Entrance to Windy Cave. SK 52761 99540.	**Figure 110** Entrance to High Rift Cave. SK 52737 99231.

A22 D301 CONISBROUGH CAVES WEST

Site Name: **Conisbrough Caves West**	Site Key: **D301**
Grid Reference: **SK 515 996 (west end)**	Site Type: **cave**
Local Authority: **Doncaster Metropolitan Borough Council, South Yorkshire**	
Site Dimensions:	Site Owner: Various
Conservation Status: **Regionally Important Geological Site**	Date: 17/5/97
Field surveyor: Tony Gibbs, Derbyshire Caving Association	Date: 1997

Stratigraphy and Rock Types	
Time Unit: Permian	Rock Unit: Cadeby Formation, Zechstein Group
Rock Type: Dolostone	Details: Massive bedded dolostone

Site Map	**Figure 111 - D301 Conisbrough Caves West**



Site Description	**D301 Conisbrough Caves West**

The information detailed below is taken from the 1997 RIGS Survey by Tony Gibbs of the Derbyshire Caving Association. However, the following notes relate to the survey undertaken on 16 March 2007.

The quarry in which Cadeby Cave is recorded was inspected on 2nd March 2007 as part of an assessment of Cadeby Cliff and no obvious cave entrances were seen.

Following a visit to Conisbrough Caves East with Tony Gibbs a second visit was made but again there was nothing visible that I would consider to be the cave entrance. Similarly, Cadeby Pot has been

considered as difficult to find and access. Although apparently the entrance is visible from the north side of the old railway cutting, this area is covered in thick gorse.

Access to the east and west ends of the cutting are essentially blocked by dense growth of trees, shrubs, hawthorns and brambles etc and the southern side of the cutting is similarly blocked and when attempting to access the cutting from the further hazard of ditches, obscured barbed wire and stumps of fence posts were encountered, making this hazardous. For further details of the site and a full assessment contact the Derbyshire Caving Association.

CADEBY CAVE ([SK 515 996]
Altitude: 52 m Length: 12 m
Description: the boundary of the old Earth Centre development. About 800 m west-north-west of the west end of the disused viaduct is a small quarry on the north side of old railway cutting. In the east side of the quarry is an entrance 3 m high and 1.5 m wide leading to chamber. In the left wall behind a slab is a squeeze into low boulder chamber 6 m long. A small rift leading off becomes too tight. Unable to locate in 1994? Main **Points of Interest**: Slip rift development. Needs further speleological investigation.

CADEBY POT [SK 516 996]
Altitude: 55 m Length: 45 m Depth: 14 m
Description: No Known Access Restrictions. Close to old Earth Centre. No immediate threats. Approaches are difficult in wet weather. Explored in 1974 as part of the Yorkshire Speleological Society survey. Located about 500 m west of the railway viaduct along disused a railway line, and 200 m beyond the small footbridge. The Pot is three quarters off the way up the side of the cutting, and is difficult to find. The west entrance needs 9 m of rope and descends in steps to boulder-floored rift. To the west it ascends and ends at an earth choke after 8 m. To the east is a passage up to 2 m wide and 6 m high, ending at a boulder fall after 20 m. A roof passage near the fall can be reached by chimneying, and crawls at two levels separated by climbs end in chokes. Further ascent reaches the east entrance which is tight. The 9 metre pitch in the west entrance is best laddered.

RIGS Assessment of Site Value	**D301 Conisbrough Caves West**

Ratings: 1-2 very poor; 3-4 poor; 5-6 acceptable/useful; 7-8 quite good; 9-10 very good/excellent; N/A not applicable; D/K don't know

Access and Safety

Aspect	Description	Rating
road access & parking		
safety of access		
safety of exposure		**D/K**
permission to visit		**D/K**
current condition		**D/K**
current conflicting activities		
restricting conditions		
nature of exposure		
multiple exposures / prospect for trail		
Notes		

Culture, Heritage & Economic

Aspect	Description	Rating
historic, archaeological & literary associations		**0**
aesthetic landscape		**0**

history of Earth Sciences		**0**
economic geology		**0**
Notes		
Education and Science		
surface processes		**0**
geomorphology		**0**
sedimentary		**0**
fossils		**0**
igneous		**0**
metamorphic		**0**
tectonic: structural		**0**
minerals		**0**
stratigraphy		**0**
Notes		
Geodiversity value		
Entrances to both caves were not found and no geodiversity value could therefore be assigned		**0**

Site Photographs	**D301 Conisbrough Caves West**

Figure 112 Eastern access to Cadeby Pot. SK 51800 99060.

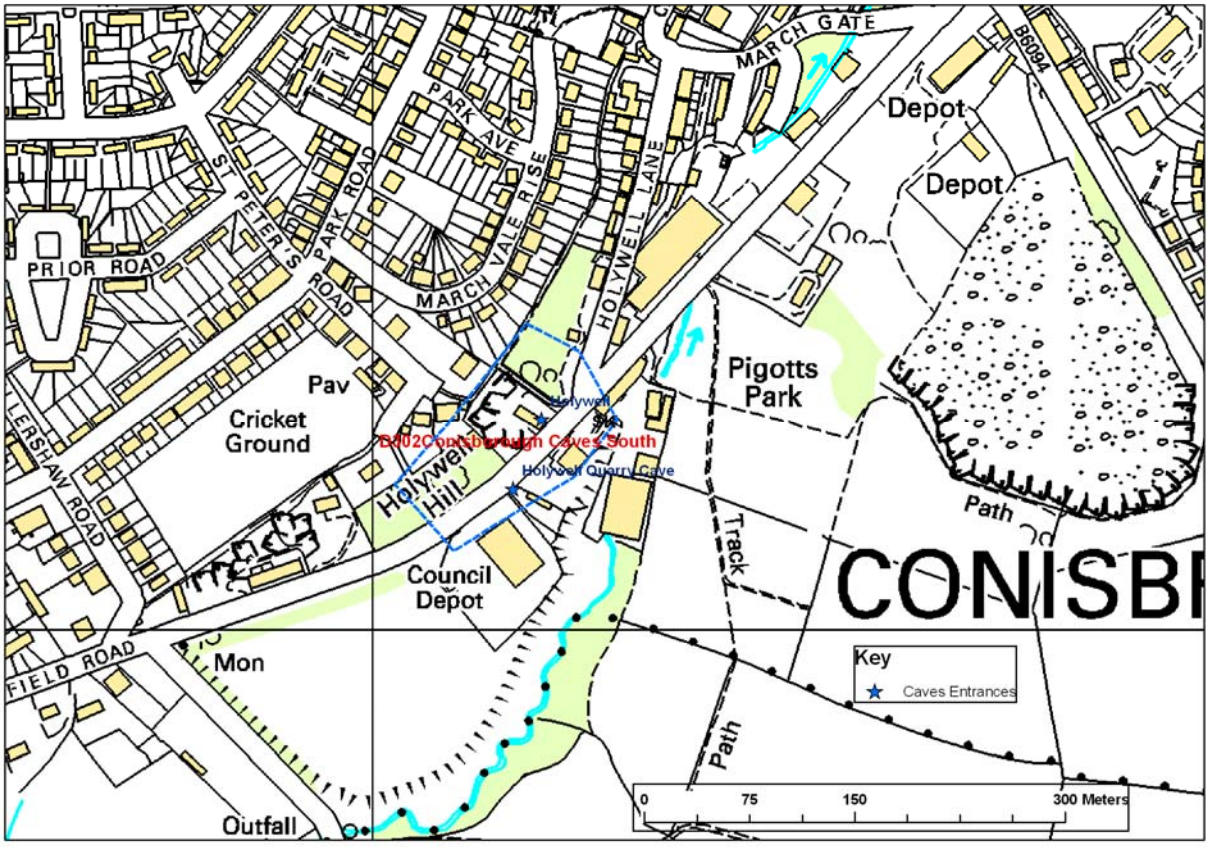
Figure 112 Western access to Cadeby Pot. SK 51400 99070.

A23 D302 CONISBROUGH CAVES SOUTH

Site Name: **Conisbrough Caves South**	Site Key: **D302**
Grid Reference: **SK 511 985 (west end)**	Site Type: **cave**
Local Authority: **Doncaster Metropolitan Borough Council, South Yorkshire**	
Site Dimensions:	Site Owner: DMBC?
Conservation Status: **Regionally Important Geological Site**	Date: 17/5/97
Field surveyor: Tony Gibbs, Derbyshire Caving Association	Date: 1997

Stratigraphy and Rock Types	
Time Unit: Permian	Rock Unit: Cadeby Formation, Zechstein Group
Rock Type: Dolostone	Details: Massive bedded dolostone

Site Map	**Figure 113 - D302 Conisbrough Caves South**



Site Description	**D302 Conisbrough Caves South**

The 1997 RIGS Survey included an assessment of cave systems along the Don Gorge by Tony Gibbs of the Derbyshire Caving Association. The notes from this survey are included below. On 4th March 1997, accompanying Tony Gibbs, the following notes were made:

The site entrance to the cave is located at SE 51077 98199. It is accessible only over a barbed wire fence and by negotiating a very steep rocky face using tree branches and rope. Considered to be very risky and

hazardous. Otherwise, access is by climbing or abseiling with ropes. Nonetheless the cave, which has an enlarged shelter at the entrance, is very heavily littered and very blackened from fires so is obviously used. The steps running up from the Doncaster Road are also very heavily littered. The speleological interest relates to the position of the cave in relation to an active spring line, with the possibility of associated flow stones and related sedimentary deposits. This is apparently extremely rare. The position of the spring may relate to the presence of a faultline and juxtaposition of the Permian limestone with Carboniferous shales.

HOLYWELL [SK 5112 9815] Altitude: 40 m Length; 1 metre
Description: Cannot be entered. Open access beside main road. Permission required from Highways Dept. for digging or detailed study. The whole site needs tidying up. It is an historic site, and an important rising. There is a capped well at a spring line on the west side of the A630 road. The Well water used to flow beneath the road into ponds which used to provide water for the brewery (Holywell) across the road, which is sadly no longer there. The well was also used at one stage for watering horses. There is still a strong flow of water from the well. Sometimes this is sufficient to rise above the capping and flow onto the road. It was in 1995 found to be sadly neglected. The above information was given to me by Tony Greathead during a visit to the site in Feb. 1995.
Main Points of Interest: Natural spring and hydrologically important. Requires further speleological investigation.

HOLYWELL QUARRY CAVE [SK 511 981] Altitude: 50 m Length; 5 m
Description; Access is strictly by permission from the owner of the old quarry on the Doncaster Road. There are two entrances high in the back of the quarry. The entrance on the left is larger. The site might benefit from archaeological digging. There is one large chamber with evidence of solution development. A rift just inside the left entrance can be seen to continue. Digging in the floor might gain entry. This rift is directly above Holywell at the roadside below. If it could be forced, it would be the first Magnesian Limestone Cave to reach the present water table and any accompanying development.
Main Points of Interest: Rift development, with potential archaeological interests. Solution evidence needs further investigation. Further details of the site available from the Derbyshire Caving Association

RIGS Assessment of Site Value	**D302 Conisbrough Caves South**

Ratings: 1-2 very poor; 3-4 poor; 5-6 acceptable/useful; 7-8 quite good; 9-10 very good/excellent; N/A not applicable; D/K don't know

Access and Safety

Aspect	Description	Rating
road access & parking	Limited on street parking in residential area. Site located on very busy main road	**4**
safety of access	Hazardous. Requires access with ropes	**1**
safety of exposure	Located on ledge in old quarry face. Hazardous	**1**
permission to visit	By permission of owner of old quarry. Spring is accessible off public footpath	**5**
current condition	Full of rubbish and damaged by fire. Well is maintained	**5**
current conflicting activities	Misuse of site and vandalism	
restricting conditions	Very poor access to cave	
nature of exposure	Cave in old quarry face. Natural spring line	
multiple exposures / prospect for trail	Potential for quick stop on a day field trip	
Notes	The cave is basically inaccessible, except with climbing equipment	

Culture, Heritage & Economic

Aspect	Description	Rating
historic, archaeological & literary associations	Local historical vaule as a water supply	**6**

aesthetic landscape	Not applicable	**0**
history of Earth Sciences	Potential speleological significance if research and excavation of cave undertaken	**5**
economic geology	Local association as water supply to an old brewery	**0**
Notes	Local interest value	
Education and Science		
surface processes	Potential solution processes associated with spring line	**6**
geomorphology	Cave. Evidence of rifting and slumping	**6**
sedimentary	Cave. Evidence of rifting and slumping	**5**
fossils	Not applicable	**0**
igneous	Not applicable	**0**
metamorphic	Not applicable	**0**
tectonic: structural	Evidence of rifting. Spring potentially associated with the fault	**0**
minerals	Not applicable	**0**
stratigraphy	Not applicable	**0**
Notes	Main interests relate to the spring and its potential association with a fault	
Geodiversity value		
Speleological research potential. Spring line associated with fault. Historic associations		**8**

Site Photographs	**D302 Conisbrough Caves South**

Figure 114 Holy Well Spring. SK 51077 98199.

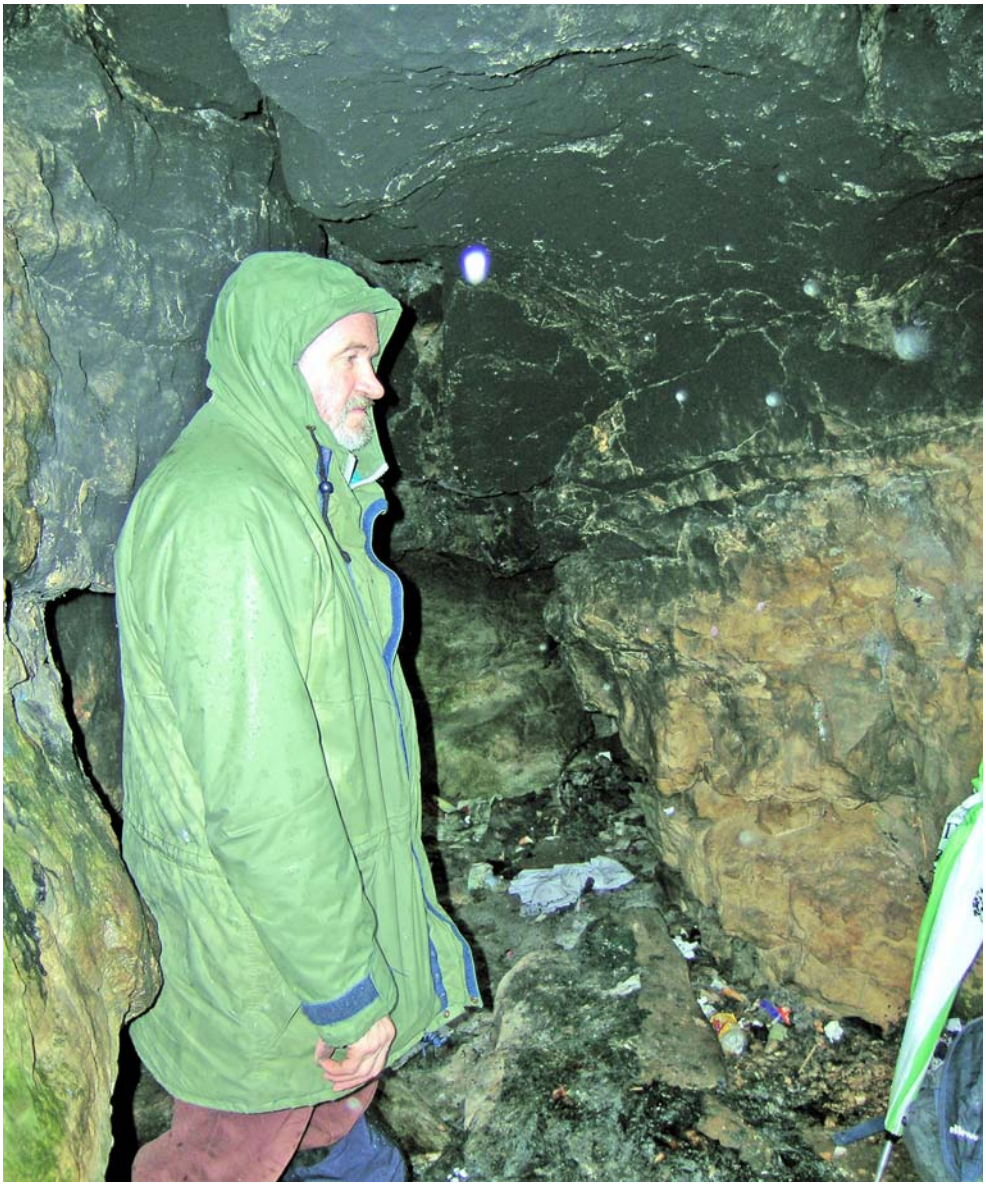


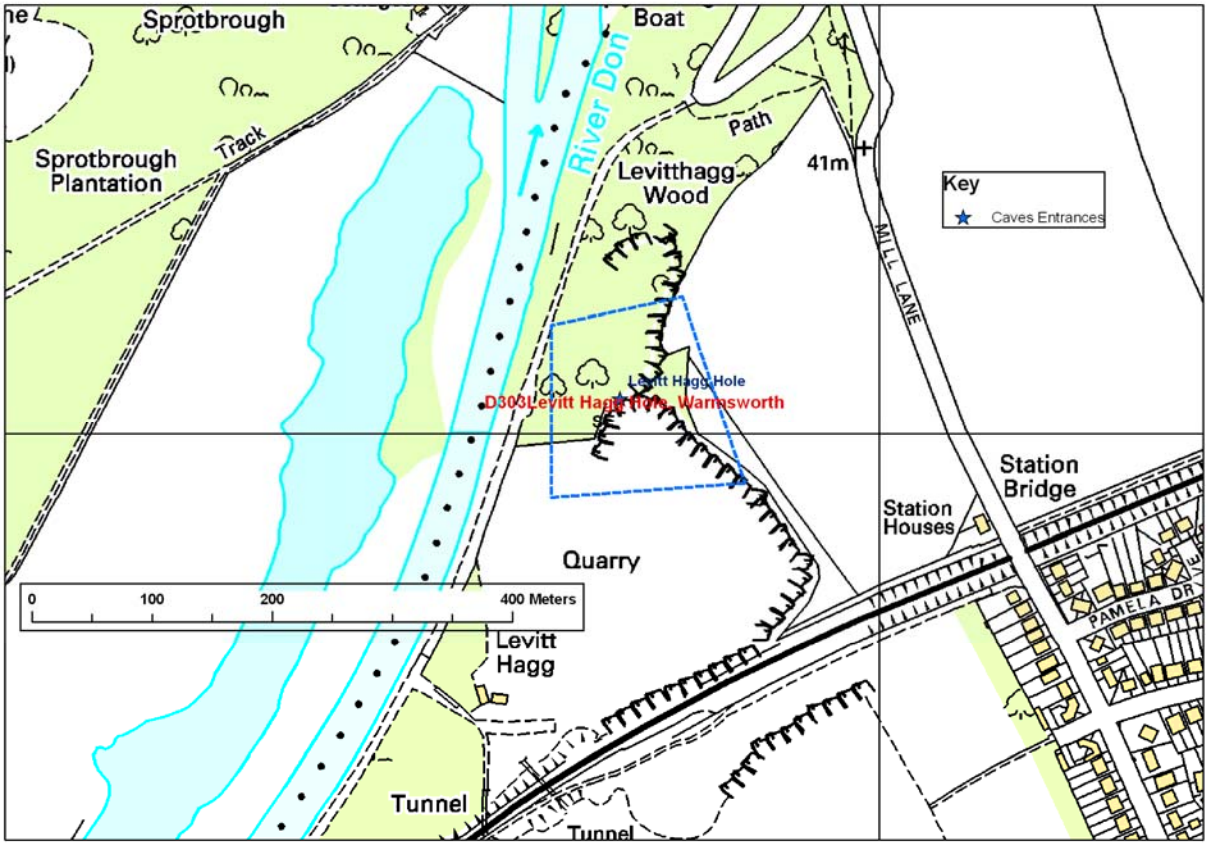
Figure 115 Entrance to Holy Well Cave. SK 51077 98199.

A24 D303 LEVITT HAGG HOLE

Site Name: **Levitt Hagg Hole**	Site Key: **D303**
Grid Reference: **SE 538 009 (centred on)**	Site Type: **cave**
Local Authority: **Doncaster Metropolitan Borough Council, South Yorkshire**	
Site Dimensions: Altitude 60 m Length 27 m	Site Owner: DMBC?
Conservation Status: **Regionally Important Geological Site**	Date: 17/5/97
Field surveyor: Tony Gibbs, Derbyshire Caving Association	Date: 1997

Stratigraphy and Rock Types	
Time Unit: Permian	Rock Unit: Cadeby Formation, Zechstein Group
Rock Type: Dolostone	Details:

Site Map	**Figure 116 - D303 Levitt Hagg Hole**



Site Description	**D303 Levitt Hagg Hole**

Levitt Hagg Hole was included in the 1997 RIGS Survey by Tony Gibbs of the Derbyshire Caving Association.

The area around Levitt Hagg Wood was inspected twice, on the 7th and 16th of March 2007. The grid reference provided appeared to locate this cave in the fenced and landscaped Levitt Hagg landfill site, which is not readily accessible However, many of the caves listed have proved to have been extremely difficult to locate, access or identify and on at least one occasion the information sources relating to the caves have had inaccurate grid references. Following instructions by Tony Gibbs, the remaining quarries

of Levitt Hagg were inspected. Photographs from SE 53791 01137 showed two holes in the rock face, at an elevated position and at SE 53784 01029, there is an entrance into the rock face which has been enlarged with a man made arched entrance and has been walled up.

Further information on this site should be obtained from Derbyshire Caving Association.

Geodiversity value	
The grid reference for the cave entrance appears to coincide with the restored Levitt Hagg Landfill Site and was not found	**0**

Site Photographs	D303 Levitt Hagg Hole

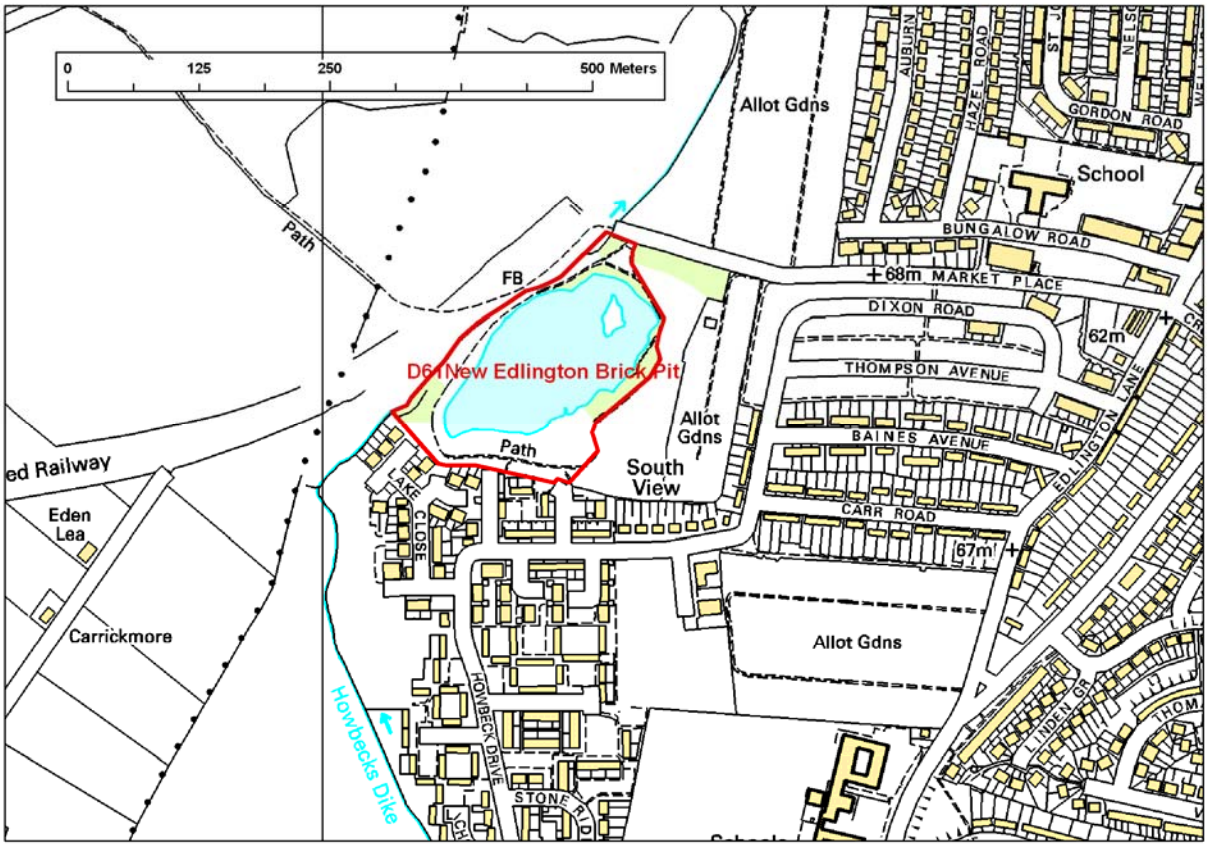
Figure 117 General view of cave entrance from 1997 survey. SE 53784 01029.

A25 D61 NEW EDLINGTON BRICK PIT

Site Name: **New Edlington Brick Pit**	Site Key: **D61**
Grid Reference: **SK 534 986 (accurate)**	Site Type: **disused quarries, pits and cuttings**
Local Authority: **Doncaster Metropolitan Borough Council, South Yorkshire**	
Site Dimensions: 250 m x 100 m	Site Owner: DMBC?
Conservation Status: **Regionally Important Geological Site**	Date: 16/9/97
Field surveyor: Scott Engering	Date: 19/1/07

Stratigraphy and Rock Types	
Time Unit: Permian	Rock Unit: Edlington Formation, Zechstein Group
Rock Type: Mudstone, Calcareous	Details: Green and red marl with gypsum layers
Time Unit: Anglian, Middle Pleistocene	Rock Unit: Till
Rock Type: Diamicton, sandy	Details: Red sandy till

Site Map **Figure 118 - D61 New Edlington Brick Pit**



Site Description	D61 New Edlington Brick Pit

Disused brick pit, now filled with water and used for angling and nesting site for birds. Located behind allotments to rear of Dixon Road.

Green and red marls with gypsum bands exposed at water level around the edge of the pit. To the northern edge of the pond, occasional exposures of red, sandy boulder clay can be seen, similar to that seen at Warmsworth Park, Hexthorpe Flatts and Cedar Road Quarry. At the date of survey, there were no exposures of marl and gypsum visible due to rise in water level of approximately 4 feet after recent heavy rains. Current water level approximately 4.3 m, with minimum of about 2.5 m feet in summer. The pond is normally drained at regular intervals with a sluice but this had not been done for some time.

Parking on roughly surfaced ground is limited due to anglers and allotment users

RIGS Assessment of Site Value	D61 New Edlington Brick Pit

Ratings: 1-2 very poor; 3-4 poor; 5-6 acceptable/useful; 7-8 quite good; 9-10 very good/excellent; N/A not applicable; D/K don't know

Access and Safety

Aspect	Description	Rating
road access & parking	Limited to 4/5 spaces. Potential conflict with anglers and allotment holders	**3**
safety of access	Unmade track accessed by 4x4 vehicles. Muddy when wet. Well maintained path around the pond. Angling platforms can provide viewing points	**4**
safety of exposure	Due to exposure at water's edge, there is a potential hazard of falling into the pond. No life saving equipment at the site	**3**
permission to visit	Not applicable	**N/A**
current condition	Gypsum and marl not visible at time of survey. Till has limited exposures that are susceptible to vegetation growth	**4**
current conflicting activities	Angling, but not a serious conflict as, when exposed, gypsum can be seen from the waters edge	
restricting conditions	Water levels in pond may obscure exposures, which are already limited	
nature of exposure	Small outcrops at waters edge	
multiple exposures / prospect for trail	Possible stop on trail, together with nearby Warmsworth Park, Cedar Road Quarry and Hexthorpe Flatts	
Notes	Care must be taken due to muddy access track and exposures at waters edge	

Culture, Heritage & Economic

Aspect	Description	Rating
historic, archaeological & literary associations	None known	**0**
aesthetic landscape	Not applicable	**0**
history of Earth Sciences	Not applicable	**0**
economic geology	Local example of former brick making industry	**5**
Notes	Possesses rarity value	

Education and Science

surface processes	Glacial deposition	**4**
geomorphology	Till outcrop largely disturbed by man made landscaping relating to extraction of marl	**4**

sedimentary	Rare exposure of gypsum in Edlington Formation. Till provides evidence of distribution of this deposit in the district	**6**
fossils	Not applicable	**0**
igneous	Not applicable	**0**
metamorphic	Not applicable	**0**
tectonic: structural	Not applicable	**0**
minerals	Rare occurrence of gypsum	**6**
stratigraphy	Not applicable	**0**
Notes	A useful educational site as part of a wider field trip, principally for the rarity of gypsum	
Geodiversity value		
Main value relates to rare occurrence of gypsum in a landscape dominated by human activity, waste tips and industry		**5**

Site Photographs	**D61 New Edlington Brick Pit**

Figure 119 General view across the old flooded brick pit to the south-west. SK 53320 98610.

Figure 120 Exposure of weathered till to the north side of the flooded brick pit. SK 53140 98550

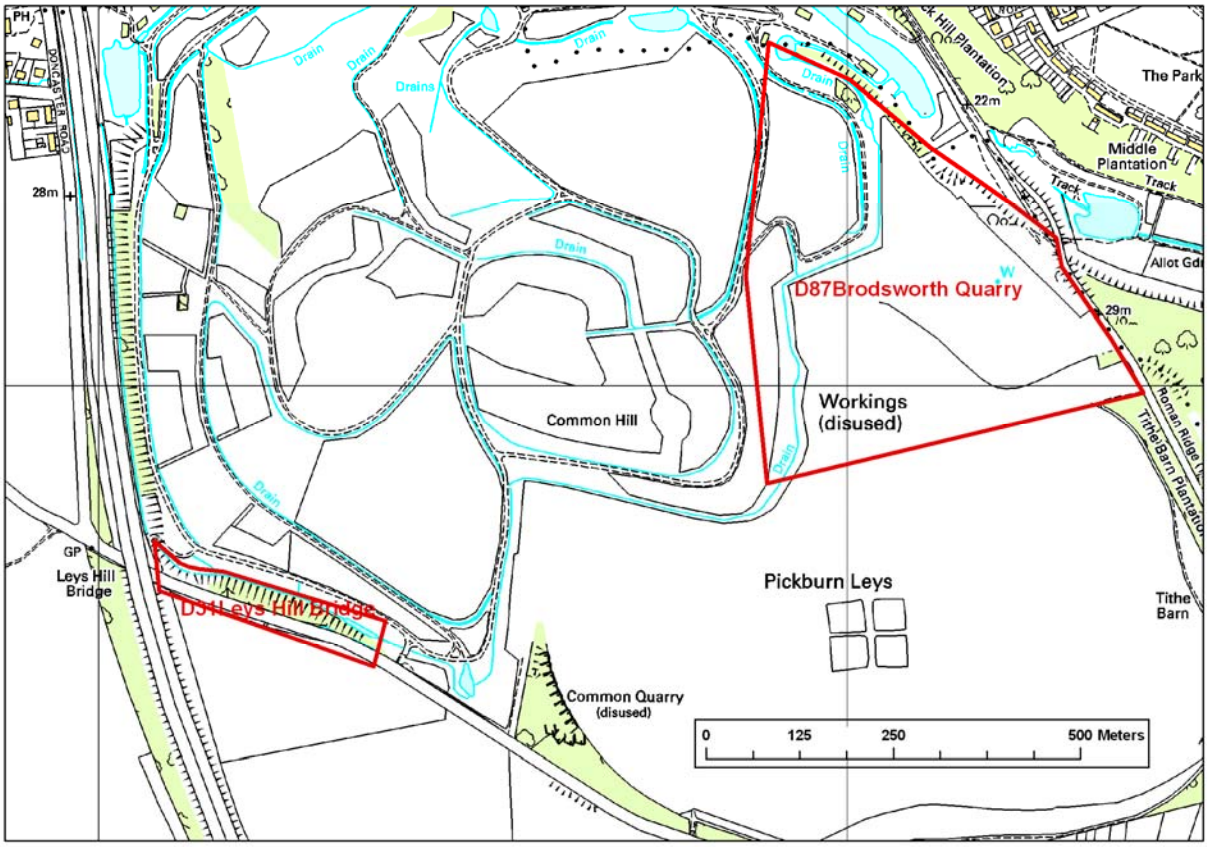
Figure 121 Detail of gypsum outcrop within the Edlington Formation, as seen during the 1997 RIGS survey. SK 53250 98500.

A26 D31 LEYS HILL BRIDGE

Site Name: **Leys Hill Bridge**	Site Key: **D31**
Grid Reference: **SE 523 067 (centred on)**	Site Type: **cutting, railway, disused**
Local Authority: **Doncaster Metropolitan Borough Council, South Yorkshire**	
Site Dimensions: 100 m x 2 m	Site Owner: DMBC
Conservation Status: **Regionally Important Geological Site**	Date: 14/9/97
Field surveyor: Scott Engering	Date: 16/2/07

Stratigraphy and Rock Types	
Time Unit: Permian	Rock Unit: Edlington Formation, Zechstein Group
Rock Type: Calcareous mudstone	Details: Marl

Site Map	**Figure 122 - D31 Leys Hill Bridge**



Site Description	D31 Leys Hill Bridge
Exposure of Edlington Formation in roadside drainage ditch at the edge of landscaped Brodsworth Colliery waste tip. At date of previous survey in 1997, calcareous precipitation associated with weathering of marls visible. The ditch has been fenced off and planted with hawthorn and gabions have been erected to stabilise the slope. The ditch is now largely overgrown and obscured by osiers with only the occasional exposure of red weathered marl soil now visible. Along the bottom of the ditch and on man made waterfalls, there is a white/grey precipitate but this bears no obvious relationship with the marl exposures.	

RIGS Assessment of Site Value	D31 Leys Hill Bridge
Ratings: 1-2 very poor; 3-4 poor; 5-6 acceptable/useful; 7-8 quite good; 9-10 very good/excellent; N/A not applicable; D/K don't know	

Access and Safety

Aspect	Description	Rating
road access & parking	Parking in nearby country park	**8**
safety of access	Grassy bank at edge of shallow ditch and now fenced off s	**5**
safety of exposure	Exposure is safe but precautions are required because of the presence of a shallow water filled ditch	**5**
permission to visit	Not applicable. Accessible from public highway	**5**
current condition	Largely overgrown and obscured by grass, hawthorns and osiers	**D/K**
current conflicting activities	None envisaged	
restricting conditions	No collecting	
nature of exposure	Exposure in roadside drainage ditch	
multiple exposures / prospect for trail	Very limited	
Notes		

Culture, Heritage & Economic

Aspect	Description	Rating
historic, archaeological & literary associations	Not applicable	**0**
aesthetic landscape	Not applicable	**0**
history of Earth Sciences	No formal associations, but good local marker horizon	**5**
economic geology	Not applicable	**0**
Notes	Not applicable	

Education and Science

surface processes	Weathering and calcite precipitation from marls	**7**
geomorphology	Not applicable	**0**
sedimentary	Modern sedimentary processes	**4**
fossils	Not applicable	**0**
igneous	Not applicable	**0**
metamorphic	Not applicable	**0**
tectonic: structural	Not applicable	**0**
minerals	Calcite precipitation	**5**

stratigraphy	Useful marker horizon and correlation of Edlington Formation. Research/fieldwork interest for field mapping. Rarity value	**5**
Notes	Limited exposure is useful for advanced studies, especially for field mapping work	
Geodiversity value		
Limited value except use as a marker for the position of the Edlington Formation		**5**

Site Photographs	**D31 Leys Hill Bridge**

Figure 123 General view along drainage ditch to the east. SE 52150 06720.

Figure 124 General view along drainage ditch to the west. SE 52340 06650.

Figure 125 Exposure of weathered red marl of the Edlington Formation. SE 52280 06679.

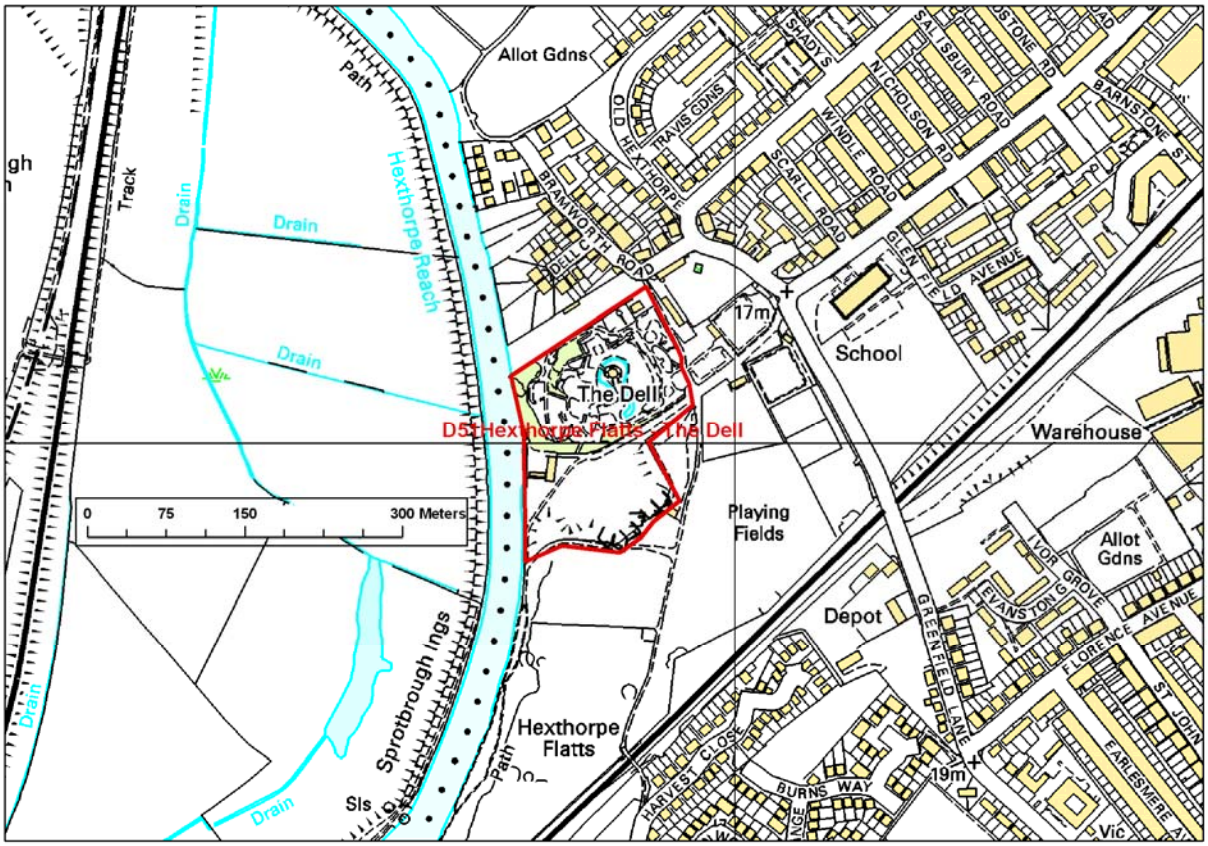
Figure 126 View of osiers that largely obscure the exposures of marl in the drainage ditch. SE 52280 06679.

A27 D51 HEXTHORPE FLATTS – THE DELL

Site Name: **Hexthorpe Flatts – The Dell**	Site Key: **D51**
Grid Reference: **SE 558 020 (accurate)**	Site Type: **quarry, disused**
Local Authority: **Doncaster Metropolitan Borough Council, South Yorkshire**	
Site Dimensions: 250 m x 150 m	Site Owner: DMBC
Conservation Status: **Regionally Important Geological Site**	Date: 16/9/97
Field surveyor: Scott Engering	Date: 13/2/07

Stratigraphy and Rock Types	
Time Unit: Permian	Rock Unit: Brotherton Formation, Zechstein Group
Rock Type: Dolostone	Details: Thin bedded flaggy cross laminated limestones with occasional thicker ooid-limestones
Time Unit: Anglian, Middle Pleistocene	Rock Unit: Till
Rock Type: Diamicton, sandy	Details: Red sandy till with angular limestone fragments and subrounded pebbles

Site Map	**Figure 127 - D51 Hexthorpe Flatts – The Dell**



Site Description	D51 Hexthorpe Flatts – The Dell

Several sections (maximum 6 m) through the Brotherton Formation (previously Upper Magnesian Limestone) showing typical exposures of very fine grained thinly bedded flaggy limestones (typically less than 100 mm) with fine cross laminations and ripples, indicating deposition in shallow, fast flowing water. Interspersed with occasional thicker beds (up to 200 m), comprising massive medium grained ooidal limestone with a porous cellular texture. There is a distinct contrast between the two lithologies, marked by a sharp boundaries, undulating bedding planes and cut and fill structures.

Above the limestone, although a contact is not seen, there are hummocks of ground where reddened sandy till can be occasionally be seen.

The site is well maintained and only requires regular trimming of Ivy etc from exposed rock faces. Several exposures of limestone visible to the north and east sides of The Dell. The western quarry is not landscaped but the quarry faces are generally clean and vegetation free.

Regular clearance of vegetation from the till required but care must be taken to minimise damage to this friable deposit.

RIGS Assessment of Site Value	D51 Hexthorpe Flatts – The Dell

Ratings: 1-2 very poor; 3-4 poor; 5-6 acceptable/useful; 7-8 quite good; 9-10 very good/excellent; N/A not applicable; D/K don't know

Access and Safety

Aspect	Description	Rating
road access & parking	Layby at main entrance on Greenfield Lane has room for 5/6 cars. Limited on street parking	**7**
safety of access	Excellent. A further point of access is available from a footpath along the River Don but this has not been investigated	**8**
safety of exposure	Quarry faces very safe. Numerous water features must be taken into consideration if used by school groups	**9**
permission to visit	Not applicable	**N/A**
current condition	Very good. Only periodic removal of plant growth from rock faces required	**9**
current conflicting activities	None envisaged	
restricting conditions	None envisaged	
nature of exposure	Low quarry faces with no loose rock or dangerous overhangs	
multiple exposures / prospect for trail	Good field visit site with Warmsworth Park and Cedar Road Quarry	
Notes		

Culture, Heritage & Economic

Aspect	Description	Rating
historic, archaeological & literary associations	Good example of landscaped public gardens (opened 1902) inredundant quarry space. ‘Dick Turpin’s cave’	**8**
aesthetic landscape	Excellent. Adds another dimension to the wide range of recreational facilities within the park	**9**
history of Earth Sciences	Not applicable	**0**
economic geology	Example of quarrying (probably for lime) recoreded in local book “From Quarry to Park”	**7**
Notes		

Education and Science		
surface processes	Numerous rockery stones demonstrate surface weathering and solution features. Glacial deposition	**5**
geomorphology	The quarry is adjacent to the River Don and the northern bank shows use of levees on flood plain	**4**
sedimentary	Good range of bedding, ripples, cut and fill structures typical of shallow water environment. Accessible deposit of till	**7**
fossils	Not applicable	**0**
igneous	Not applicable	**0**
metamorphic	Not applicable	**0**
tectonic: structural	Not applicable	**0**
minerals	Not applicable	**0**
stratigraphy	Not applicable	**8**
Notes	Potentially excellent educational site for field trips and very near to local schools	
Geodiversity value		
A good introduction to magnesian limestone in situ and various man made features using stone. Landscape/rockery stone for ornamemtal garden features		**7**

Site Photographs	D51 Hexthorpe Flatts

Figure 128 General views looking north of rocky landscaping in The Dell, the water feature and quarry faces in the background. SE 55900 02100.

Figure 129 Thin bedded limestones with a thicker ooidal bed, typical of the limestones of the Brotherton Formation. SE 55930 02050.

Figure 130 Detail of fine grained flaggy limestones and a bed of massive ooid-limestone within the Brotherton Formation. SE 55930 02050.

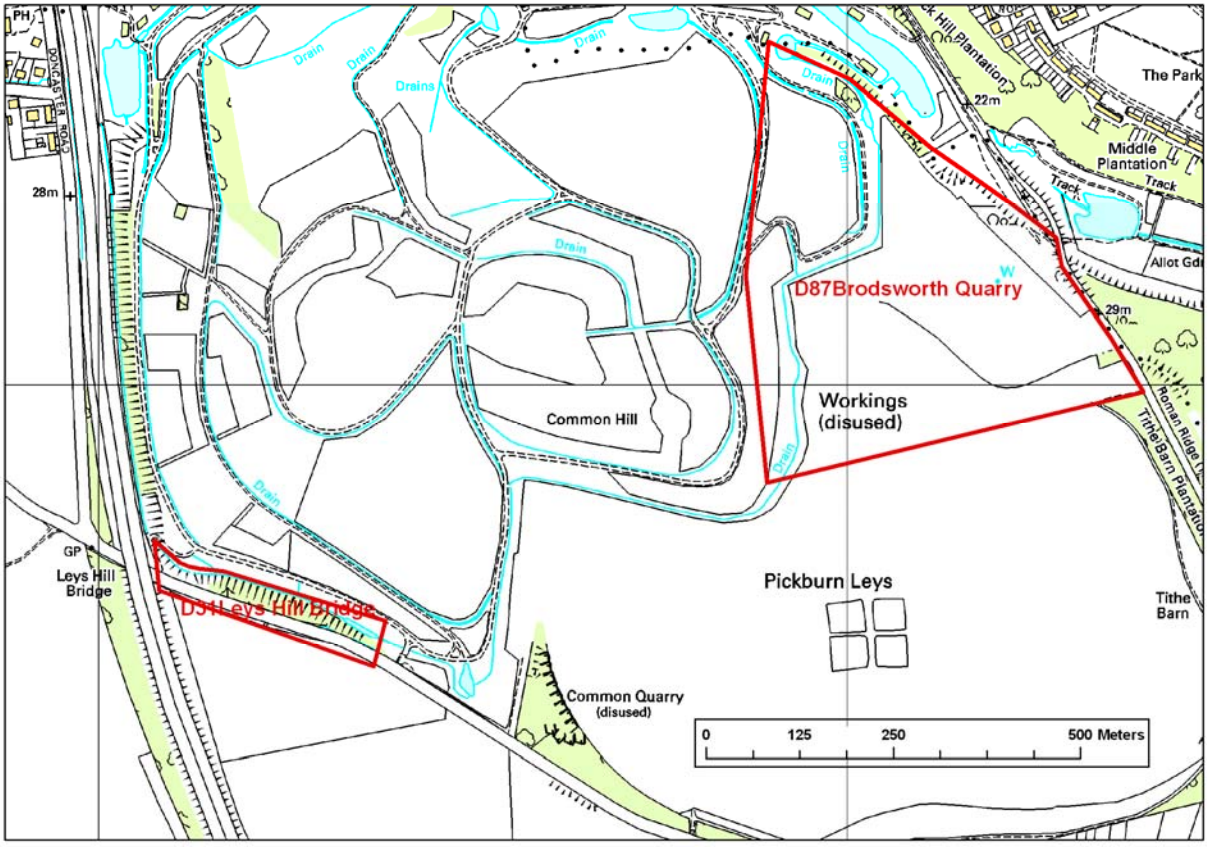
Figure 131 Exposure of Pleistocene till. SE 50800 02000.

A28 D87 BRODSWORTH QUARRY

Site Name: **Brodsworth Quarry**	Site Key: **D87**
Grid Reference: **SE 530 070 (accurate)**	Site Type: **Disused quarry**
Local Authority: **Doncaster Metropolitan Borough Council, South Yorkshire**	
Site Dimensions: 200 x 200 x 3 m	Site Owner: Mineral Investments
Conservation Status: **Regionally Important Geological Site**	Date: 16/9/97
Field surveyor: Scott Engering	Date: 16/2/07

Stratigraphy and Rock Types	
Time Unit: Permian	Rock Unit: Brotherton Formation, Zechstein Group
Rock Type: Dolostone	Details:

Site Map	**Figure 132 - D87 Brodsworth Quarry**



Site Description	**D87 Brodsworth Quarry**
Site misidentified from the 1997 RIGS Survey. The area forms part of the large scale restoration of the area around Brodsworth Quarry and was not identified as a RIGS in 1997. The area was investigated but there was no ready access to the site. From a distance, old quarried faces were visible but these appeared to be landscaped and were not considered worthy of further investigation.	

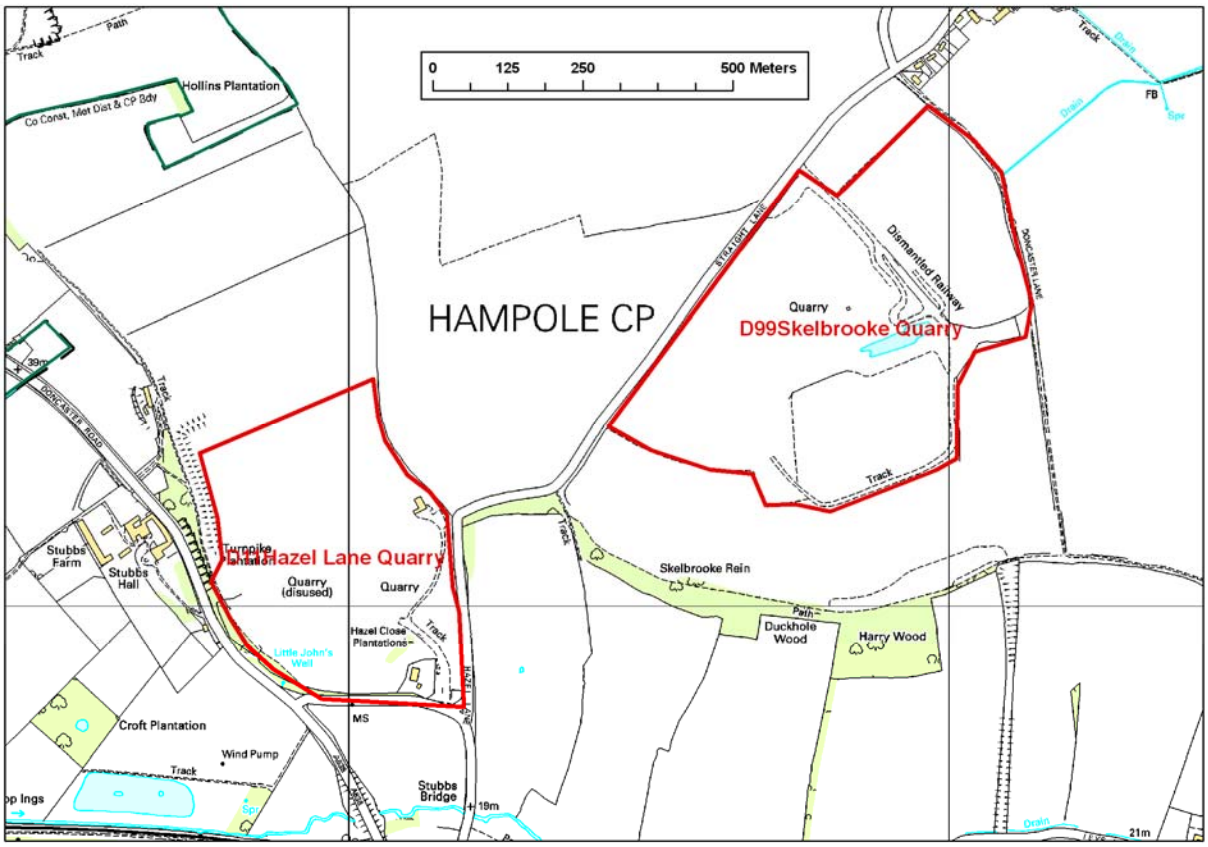
Geodiversity value	
None	**0**

A29 D99 SKELBROOKE QUARRY

Site Name: **Skelbrooke Quarry**	Site Key: **D99**
Grid Reference: **SE 505 114 (centred on)**	Site Type: **disused quarries, pits and cuttings**
Local Authority: **Doncaster Metropolitan Borough Council, South Yorkshire**	
Site Dimensions: 50 x 7 m	Site Owner: Darrington Quarries Ltd
Conservation Status: **Regionally Important Geological Site**	Date: 16/9/97
Field surveyor: Scott Engering	Date: 16/2/07

Stratigraphy and Rock Types	
Time Unit: Permian	Rock Unit: Brotherton Formation, Zechstein Group
Rock Type: Dolostone	Details: Well bedded dolostone

Site Map	**Figure 133 - D99 Skelbrooke Quarry**



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Site Description	**D99 Skelbrooke Quarry**

The site has ceased quarrying activities and is now full with water and is being progressively landfilled. The section of marl described in the 1997 survey has now been landscaped and at the date of the resurvey, a maximum section of 2-3 m of dolostone was still seen in the north-west face. No features of geological interest will remain.

RIGS Assessment of Site Value	D99 Skelbrooke Quarry

Ratings: 1-2 very poor; 3-4 poor; 5-6 acceptable/useful; 7-8 quite good; 9-10 very good/excellent; N/A not applicable; D/K don't know

Access and Safety

Aspect	Description	Rating
road access & parking	Not applicable	**0**
safety of access	Not applicable	**0**
safety of exposure	Not applicable	**0**
permission to visit	Not applicable	**0**
current condition	Not applicable	**0**
current conflicting activities	Landfill	
restricting conditions	Landfill	
nature of exposure	Old quarry exposure	
multiple exposures / prospect for trail	None	
Notes		

Culture, Heritage & Economic

Aspect	Description	Rating
historic, archaeological & literary associations	Former dolostone quarry	**5**
aesthetic landscape	Not applicable	**0**
history of Earth Sciences	Not applicable	**0**
economic geology	Formerly a dolostone quarry	**0**
Notes		

Education and Science

surface processes	Not applicable	**0**
geomorphology	Not applicable	**0**
sedimentary	Not applicable	**0**
fossils	Not applicable	**0**
igneous	Not applicable	**0**
metamorphic	Not applicable	**0**
tectonic: structural	Not applicable	**0**
minerals	Not applicable.	**0**
stratigraphy	Not applicable	**0**
Notes	Not applicable	

Geodiversity value

None	**0**

Site Photographs	D99 Skelbrooke Quarry

Figure 134 General view of restoration and tree planting works. SE 51116 11573.

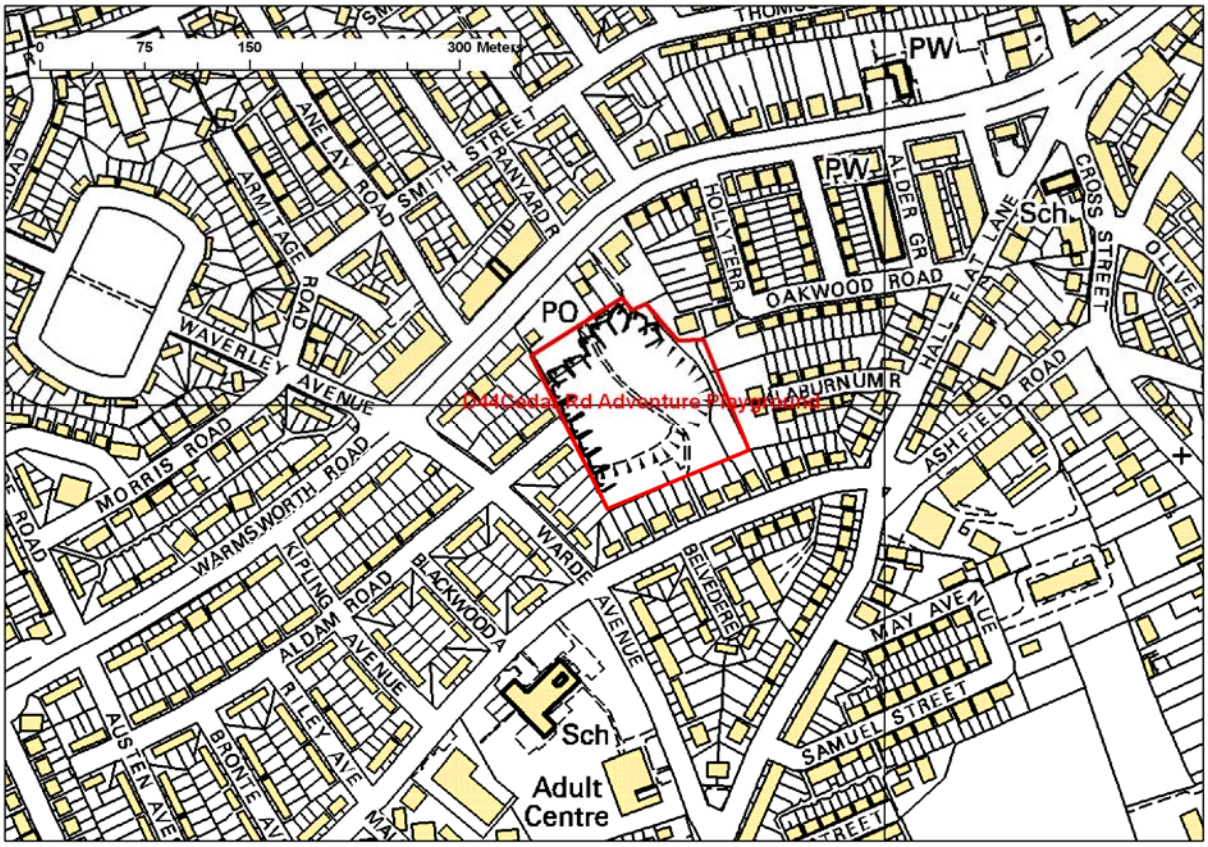
Figure 135 Last remaining exposure of limestones of the Brotherton Formation and overlying Roxby Formation. SE 51116 11573.

A30 D44 CEDAR ROAD ADVENTURE PLAYGROUND

Site Name: **Cedar Road Adventure Playground**		Site Key: **D44**
Grid Reference: **SE 558 010 (centred on)**		Site Type: **quarry, disused**
Local Authority: **Doncaster Metropolitan Borough Council, South Yorkshire**		
Site Dimensions: 75 x 75 m	Site Owner: DMBC	
Conservation Status: **Regionally Important Geological Site**		Date: 16/9/97
Field surveyor: Scott Engering		Date: 19/1/07

Stratigraphy and Rock Types	
Time Unit: Triassic	Rock Unit: Nottingham Castle Formation, Sherwood Sandstone Group
Rock Type: Sandstone	Details: 4 – 7 m section of cross bedded red/brown sandstone with occasional red/green marl beds and pebbles
Time Unit: Anglian, Middle Pleistocene	Rock Unit: Glaciofluvial deposits
Rock Type: Sand and Gravel	Details: 1.5 m of well bedded, sorted and cross laminated glaciofluvial sand and gravel. White quartzite and purple pebbles up to 150 mm, with predominantly 40–50 mm. Some angular fragments of Carboniferous flaggy sandstone. Exposed in east/south-east of quarry
Time Unit: Anglian, Middle Pleistocene	Rock Unit: Till
Rock Type: Diamicton, sandy	Details: 1.5 m of Pre-Ipswichian reddened and sandy till with pale limestone rock fragments and rounded pebbles overlying sandstone in north-east corner

Site Map	**Figure 136 - D44 Cedar Road Adventure Playground**



Site Description	D44 Cedar Road Adventure Playground

Old quarry measuring 75 m x 75 m dug into the Sherwood sandstone with extensive quarry faces up to 6.5 m, with most being 4–5 m. Thick sections of medium grained red/brown sandstone with large cross bedded structures with occasional thin red and green mudstone beds with small pebbles which have now weathered out. The most conspicuous mudstone appears as a distinctly undulating bed, possibly demonstrating deposition on sand banks or shingle bars in the river channel.

To the eastern part, 1.5 m of Quaternary river gravel is exposed along a length of 30 m at the top of the quarry face. The deposit is well bedded and contains the occasional cobble up to 150 mm long, but with coarse material being generally no larger than 50 mm in diameter and comprising purple quartzite and white quartz pebbles with the occasional angular fragment of flaggy Carboniferous sandstone. The Sherwood Sandstone is not visible here, being obscured by vegetated scree composed of eroded sand and gravel.

To the north-east corner, above the Sherwood Sandstone, there is an outcrop of red/brown sandy Boulder Clay containing numerous randomly orientated fragments of pale coloured well flaggy rock, but the contact with the underlying sandstone is obscured. This deposit is not accessible for close inspection but corresponds in appearance to deposits at Hexthorpe Flatts, New Edlington Brick Pit and Warmsworth Park.

Likely conservation measures required (first impression):

There is an abundance of miscellaneous rubbish, apparently thrown over the fences of adjoining housing on the western and eastern boundaries and this needs to be cleared. The base of the quarry faces is overgrown with scrub and needs to be removed to allow close, safe inspection of the quarry faces.

To the eastern boundary, sand and gravels are eroded to within 400 mm of the rear face of garden fences and the roots of trees have been severely undermined. Inevitably, the fences will be undermined in the near future and remedial works will obscure any exposure of the Quaternary river gravels.

RIGS Assessment of Site Value	D44 Cedar Road Adventure Playground

Ratings: 1-2 very poor; 3-4 poor; 5-6 acceptable/useful; 7-8 quite good; 9-10 very good/excellent; N/A not applicable; D/K don't know

Access and Safety

Aspect	Description	Rating
road access & parking	On street parking on Cedar Road. Adequate for limited vehicles on weekdays. Near to bus routes	**5**
safety of access	Moderately steep grassy bank into quarry. Access to sand and gravel is a moderately steep grassed over scree slope	**6**
safety of exposure	Sandstone faces in good condition. Rubbish and vegetation needs to be cleared to access faces for close inspection	**6**
permission to visit	Not applicable	**N/A**
current condition	Some clearance of faces and rubbish required. Boundary fences need attention due to undermining/erosion of gravels	**6**
current conflicting activities	Tipping. Syringes, beer cans and general rubbish indicate abuse of site but empty during visit apart from a dog walker	
restricting conditions	Not applicable, except clearance of faces and rubbish removal	
nature of exposure	Vertical quarry faces with no dangerous overhangs or loose material	
multiple exposures / prospect for trail	Good potential to link with Warmsworth Park and Hexthorpe Flatts	
Notes	With good management of site and abiding by field work codes of practice, this is a good accessible site	

Culture, Heritage & Economic		
Aspect	**Description**	**Rating**
historic, archaeological & literary associations	Local quarrying history	**6**
aesthetic landscape	Limited value due to sunken position	**1**
history of Earth Sciences	Not applicable	**0**
economic geology	Local example of exploitation of Sherwood Sandstone for building sand	**5**
Notes		
Education and Science		
surface processes	Fluvial, glaciofluvial and ice sheet deposition	**7**
geomorphology	Not applicable	**0**
sedimentary	Large scale cross bedding. Grading and sorting. Cut and fill structures. Lithological variation	**7**
fossils	Not applicable	**0**
igneous	Not applicable	**0**
metamorphic	Not applicable	**0**
tectonic: structural	Stratigraphic position provides evidence of graben in the region	**7**
minerals	Not applicable	**0**
stratigraphy	Not applicable	**0**
Notes	Near to Cedar Junior school. Good field trip location for sedimentary processes in conjunction with other nearby sites	
Geodiversity value		
Good accessible introduction to a variety of lithologies and associations with quarrying and construction		**6**

Site Photographs	D44 Cedar Road Adventure Playground

Figure 137 General view of the quarry and Sherwood Sandstone faces to the north. SE 55840 01000.

Figure 138 Section through cross-bedded Sherwood Sandstone showing thin beds of marl pebbles. SE 55770 01030.

Figure 139 Exposure of Pleistocene glaciofluvial sand and gravel overlying Sherwood Sandstone along the eastern boundary. SE 55870 01020.

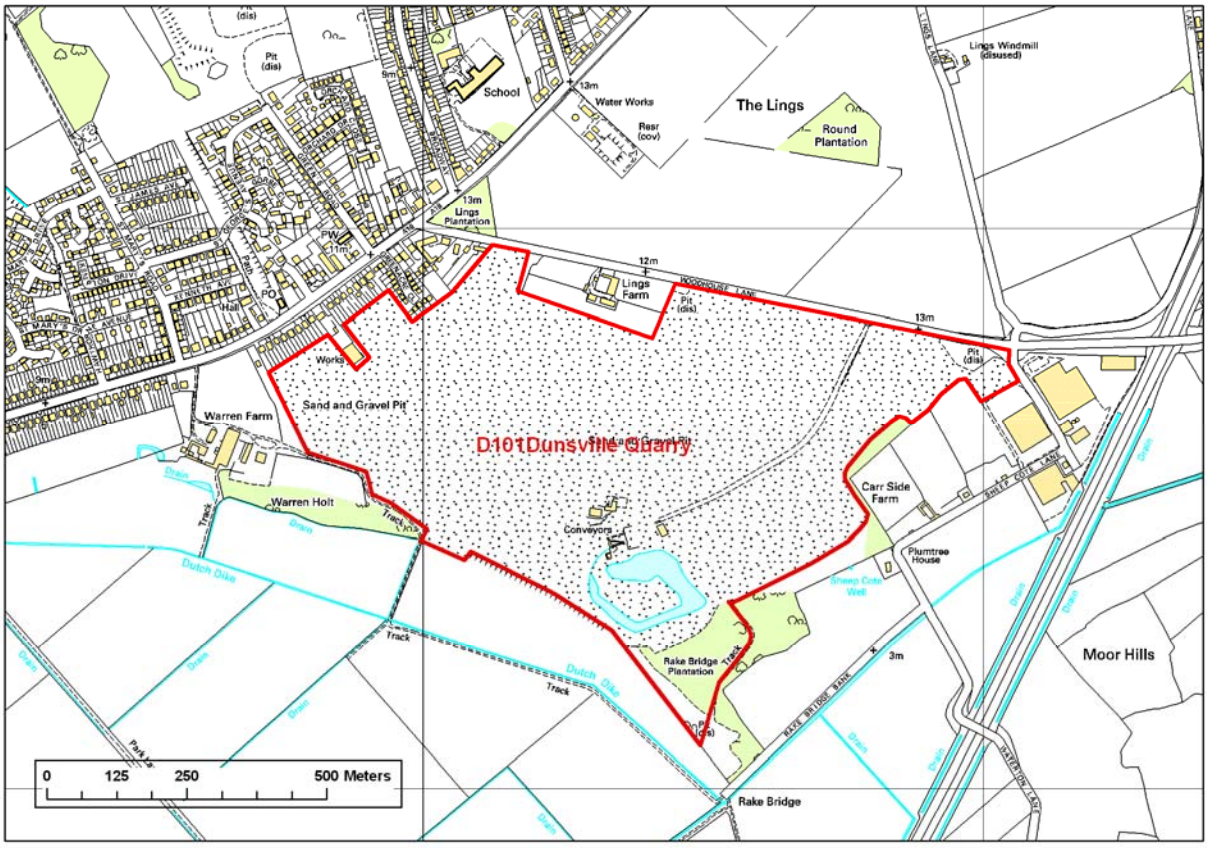
Figure 140 Detail of Pleistocene boulder clay overlying Sherwood Sandstone in the north-eastern corner of the quarry. SE 55810 01060.

A31 D101 DUNSVILLE QUARRY

Site Name: **Dunsville Quarry**	Site Key: **D101**
Grid Reference: **SE 655 075 (centred on)**	Site Type: **active quarries and pits**
Local Authority: **Doncaster Metropolitan Borough Council, South Yorkshire**	
Site Dimensions: 800 m x 600 m	Site Owner: Marshall Natural Stone
Conservation Status: **Regionally Important Geological Site**	Date: no date
Field surveyor: Scott Engering	Date: 19/2/07

Stratigraphy and Rock Types	
Time Unit: Triassic	Rock Unit: Sherwood Sandstone Group
Rock Type: Sandstone (undifferentiated)	Details: Fluvial sandstone with large scale cross bedding
Time Unit: Anglian, Middle Pleistocene	Rock Unit: Older River Gravel (River Terrace Deposits)
Rock Type: Sand And Gravel	Details: Sequence of sorted and cross bedded sand and gravels

Site Map	**Figure 141 - D101 Dunsville Quarry**



Site Description	D101 Dunsville Quarry

Large active sand and gravel pit that has altered substantially since the 1997 RIGS survey. The main changes are the extension of workings up to the boundary to the north at Woodhouse Lane and up to Lings Farm, where upwards of 10 m of Sherwood Sandstone are exposed with a cap of river gravel. Also, to the east of the access road of Woodhouse lane, the quarry has been worked up to the boundary, with similar exposure of Sherwood Sandstone. The northern face is part of the active area of the quarry and not effectively accessible and the eastern part is full of water filled pits, with quicksands and was not visited during this survey.

The quarry has been extended past its 1997 boundaries to the west of Lings Farm and the area centred on SE 651 078, as shown on the existing site boundary map has been extended to the eastern boundary, adjacent to the gardens of the houses on High Street. The exposures in this part of the quarry as noted in the 1997 survey and comprising good clean sections of Sherwood Sandstone with overlying orange fluvioglacials sands and cryoturbated Older River Gravel no longer exist. There are now only gorse covered embankments, capped with largely overgrown sections of Older River Gravels. Also, to the eastern part of the quarry, there are now large mounds of topsoil obscuring the sand and gravel.

In 1997, sediments comprising thin layers of pebbles alternating with cross bedded orange sand were being extensively quarried but exposures of sand and gravel are now rare. These deposits were apparently identified as belonging to the Barnby Dun Station Channel, one of several subglacial channels that cross the Doncaster region. These have now been worked out and the quarry has been deepened considerably and now works the Sherwood Sandstone which is by and large free of pebbles and uniform and comprises massive, cross-bedded friable sandstone. However, the following were observed: At SE 65775 07817, cryoturbated sand and gravel is seen to overly the Sherwood Sandstone to the immediate north of the quarry entrance.

At SE 65175 07905, in the north-west corner adjacent to Lings Farm paddock, there are poorly exposed sections of Older River gravel with ventifacts. Of particular interest is the occurrence of 1.25 – 1.5 m of thin bedded red and green marl in the lower section of a quarry face. It extends to a length of approximately 100 m from SE 65197 07870 to SE 65175 07776 with an apparent dip of about 10 degrees to the west. Where it outcrops continually along the northern part of the exposure towards the base of the quarry face, it froms a very distinct spring line, a few metres above the general level of the water table in the quarry. It was dripping heavily along its length and this has been exploited by a lush growth of mosses and liverworts and other species, forming a very distinctive feature in otherwise very barren quarried Sherwood sandstone faces.

Discontinuous beds of marl have been exposed in various parts of the quarry, according to Geoff Nutt, the quarry manager since 1972 and in places thin flaggy beds may be seen, At SE 65665 07697, an exposure of these is 2 m thick.

Occasionally, along exposed oblique joint planes, there are fluted solution features that appear to have been formed over a length of time, as the recently quarried faces do not have this characteristic.

At the eastern end at SE 64958 07724, 1 metre of very cryoturbated yellow sand is overlain by 2 m of Older River Gravel. The beds of cryoturbated sand have been differentially weathered and this brings these structures into strong relief.

The manager has indicated that Marshalls are receptive to the idea of sensitive restoration and management of quarries in their possession and at Stainton, they are implementing a biodiversity action plan. This could be advantageous, if similar management plans are adopted at this quarry. The exposures that were considered to be the best seen at the gravel pits seen during the 1997 survey are no longer available and so there is good potential to reexpose some quarry faces. There is good evidence, in the cryoturbation and ventifacts, of the lower periglacial surface and typical exposures of Older River Gravel and clearly seen unconformable relationships with the Sherwood Sandstone.

The geology of the Quaternary in the region is very complex and the quarry manager has indicated that he has encountered extreme variation within the sediments in a limited geographical area, both from his experience of excavating deposits within the site boundaries and from boreholes on adjoining land, which includes the West Moor depression and is interpreted as an alas. There is therefore considerable research and educational potential at this site.

RIGS Assessment of Site Value	D101 Dunsville Quarry

Ratings: 1-2 very poor; 3-4 poor; 5-6 acceptable/useful; 7-8 quite good; 9-10 very good/excellent; N/A not applicable; D/K don't know

Access and Safety		
Aspect	**Description**	**Rating**
road access & parking	Limited parking at site offices	**5**
safety of access	Safety varies in relation to the water table and there are dry areas, ponds and quicksands. Fieldwork precautions required	**5**
safety of exposure	Care needed to avoid working plant and precautions needed to negotiate variations in the water table described above	**5**
permission to visit	Private ownership by Marshalls. The longstanding quarry manager is very co-operative	**7**
current condition	Exposures noted in the 1997 survey are obliterated but there is potential for further exposure with good management	**5**
current conflicting activities	Active quarryin	
restricting conditions	Active quarryin	
nature of exposure	Quarried faces in friable sandstone and sand and gravel	
multiple exposures / prospect for trail	Limited due to isolation from other RIGS sites	
Notes		

Culture, Heritage & Economic		
Aspect	**Description**	**Rating**
historic, archaeological & literary associations	Associations with the regional minerals industry and local economic history	**6**
aesthetic landscape	Typical appearance of sand and gravel pit. Good potential for restoration and conservation as a nature reserve	**7**
history of Earth Sciences	An extremely good opportunity to add further to the Quaternary history of South Yorkshire and adjoining counties	**8**
economic geology	Good example of sand and gravel extraction industry with potential to demonstrate restoration techniques	**8**
Notes	Potentially a good site to retain geodiversity interests when the sand pit is finally restored	

Education and Science		
surface processes	Glaciofluvial deposition and erosion of sandstone bedrock. Erosional surfaces, especially along oblique joint planes	**7**
geomorphology	Periglacial structures are well developed on adjacent land	**6**
sedimentary	Wide range of bedding relationships, sedimentary structures and lithologies	**6**
fossils	Not applicable	**0**
igneous	Not applicable	**0**
metamorphic	Not applicable	**0**
tectonic: structural	Unconformity. Seen in current exposures	**6**
minerals	Not applicable	**0**
stratigraphy	Good site for stratigraphic correlation of Quaternary deposits in Doncaster	**8**
Notes	Very good site to demonstrate sedimentary processes and structures in Mesozoic, Quaternary and modern sediments. Other natural history interests	

Geodiversity value	
A good site to demonstrate a wide variety of sedimentary processes	**7**

Site Photographs	D101 Dunsville Quarry

Figure 142 General view to the west. SE 65175 07905.

Figure 143 General view to south west from quarry entrance. SE 65775 07817.

Figure 144 General view of Sherwood Sandstone to north quarry face. SE65775 07817.

Figure 145 Development of spring line along a bed of marl in Sherwood Sandstone. SE 65237 07846.

Figure 146 Exposed joint plane in Sherwood Sandstone, showing ersoional surface. SE 65230 07820.

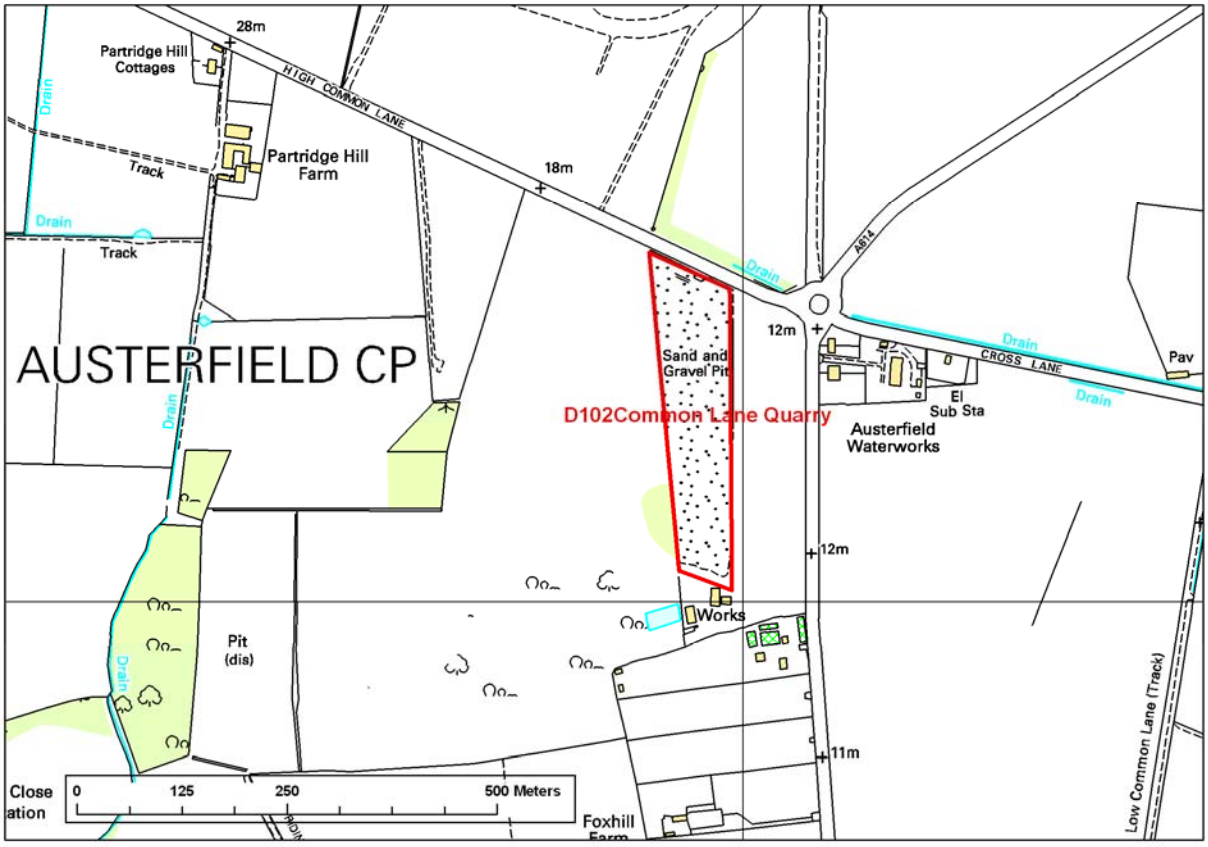
Figure 147 Cryoturbated Older River Gravel. SE 65775 07817.

A32 D102 COMMON LANE QUARRY

Site Name: **Common Lane Quarry**	Site Key: **D102**
Grid Reference: **SE 567 962 (centred on)**	Site Type: **disused quarries, pits and cuttings**
Local Authority: **Doncaster Metropolitan Borough Council, South Yorkshire**	
Site Dimensions:	Site Owner: RMC Aggregates (Eastern) Ltd
Conservation Status: **Regionally Important Geological Site**	Date: 4/10/97
Field surveyor: Scott Engering	Date: 16/2/07

Stratigraphy and Rock Types	
Time Unit: Triassic	Rock Unit: Sherwood Sandstone Group
Rock Type: Sandstone (undifferentiated)	Details: Fluvial sandstone with large scale cross bedding
Time Unit: Anglian, Middle Pleistocene	Rock Unit: Glaciofluvial deposits
Rock Type: Sand and Gravel	Details: Sequence of sorted and cross-bedded sand and gravels

Site Map **Figure 148 - D102 Common Lane Quarry**



Site Description	D102 Common Lane Quarry

Large rectangular disused sand pit in Sherwood Sandstone with overlying Older River Gravel.

This exposure comprises an extensive section, up to 10 m thick, of medium grained, cross-bedded pink to red sandstone. Generally, there are only occasional pebbles but as at SE 65926 96179, there are a few lenses of red, pebbly material, including white quartzite and marl. Thin beds of marl occasionally separate thick beds of sandstone and at SE 65914 96211 there are two isolated boulders of deep red weathered marl. Throughout the length of the exposure, the sandstone is very consistent in appearance, colour and texture.

Overlying the sandstone, in places there are up to 2 m of orange/red sand that appears to be reworked Sherwood Sandstone which is in turn overlain by coarse sandy gravel, dirty red-brown in colour which has a well developed horizon. In most places around the quarry, this is seen to be generally less than one metre thick but at SE 65960 96256, it increases to a thickness of over 3 m, where the gravel fills a depression in the underlying sandstone and appears to be a channel deposit. Here the coarse gravel is interbedded with brownish sands.

The sand and gravel beds are inaccessible in most places but theses can be observed at close quarters along the access ramps into the quarry along the north and west sides. A brief examination of the pebbles found at the base of the quarry faces shows white and liver coloured quartzite, carboniferous sandstone, dolerite and chert.

In the sands above the Sherwood Sandstone, there are numerous burrows and rabbits are common. However, many of these could be Sand Martins nests and there are signs of possible mining bee activity.

Access is down a gently sloping ramp and the quarry floor is vegetated but slightly uneven. To the far south of the quarry, there is a pond. Although potentially a hazard, there is no need to access this part of the quarry to observe geological features.

RIGS Assessment of Site Value	D102 Common Lane Quarry

Ratings: 1-2 very poor; 3-4 poor; 5-6 acceptable/useful; 7-8 quite good; 9-10 very good/excellent; N/A not applicable; D/K don't know

Access and Safety

Aspect	Description	Rating
road access & parking	Parking for 2-3 vehicles outside entrance gate	**6**
safety of access	Down gently sloping ramp to quarry floor. Some care required when wet.	**6**
safety of exposure	Clean quarry faces with no rock overhangs. Access to sand and gravel requires care on loose sloping material	**7**
permission to visit	Owned by CEMEX.. Gate is locked to prevent possibility of fly tipping. Land let out for shooting rights	**N/A**
current condition	Good condition. Clean and clear quarry faces. Sand and gravel also well exposed. Some Biffa bins in quarry floor	**8**
current conflicting activities	Shooting	
restricting conditions	Private ownership and locked gate	
nature of exposure	Quarried rock faces	
multiple exposures / prospect for trail	Limited opportunity due to remote position. Link with biodiversity interests	
Notes	Private ownership and locked gate may prevent access. Keys held by person who owns shooting rights and works at Doncaster Airport	

Culture, Heritage & Economic

historic, archaeological & literary associations	Local industrial archaeology	**5**
aesthetic landscape	Sunken pit so minimal aethetic value	**4**

history of Earth Sciences	Not known	
economic geology	Extraction of building sand	**6**
Notes	Limited value for culture and heritage apart from local industrial archaeology	
Education and Science		
surface processes	Weathering and erosion of sand and grave	**6**
geomorphology	Not applicable	**0**
sedimentary	Varied lithology in Sherwood Sandstone and Quaternary sands and gravels	**8**
fossils	Not applicable	**0**
igneous	Not applicable	**0**
metamorphic	Not applicable	**0**
tectonic: structural	Not applicable	**0**
minerals	Not applicable	**0**
stratigraphy	An accessible location to see permanent outcrop of Older River Gravels	**6**
Notes	A good succession of Sherwood Sandstone and Older River Gravel for research purposes but a bit remote and limited appeal to general public	
Geodiversity value		
Remote location but one of few exposures of Sherwood Sandstone not under threat, with Glaciofluvial deposits		**7**

Site Photographs	**D102 Common Lane Quarry**

Figure 149 General view of Sherwood Sandstone along east quarry face. SK 65933 96386.

Figure 150 General view of Sherwood Sandstone in the west quarry face, with large scale cross bedding. SK 65944 96127.

Figure 151 Burrow/nest and mining bee holes in Sherwood Sandstone. SK 65970 96268.

Figure 152 Weathered boulder of red marl in Sherwood Sandstone. SK 65914 96211.

Figure 153 Boundary between Older River Gravel and Sherwood Sandstone. SK 65912 96305.

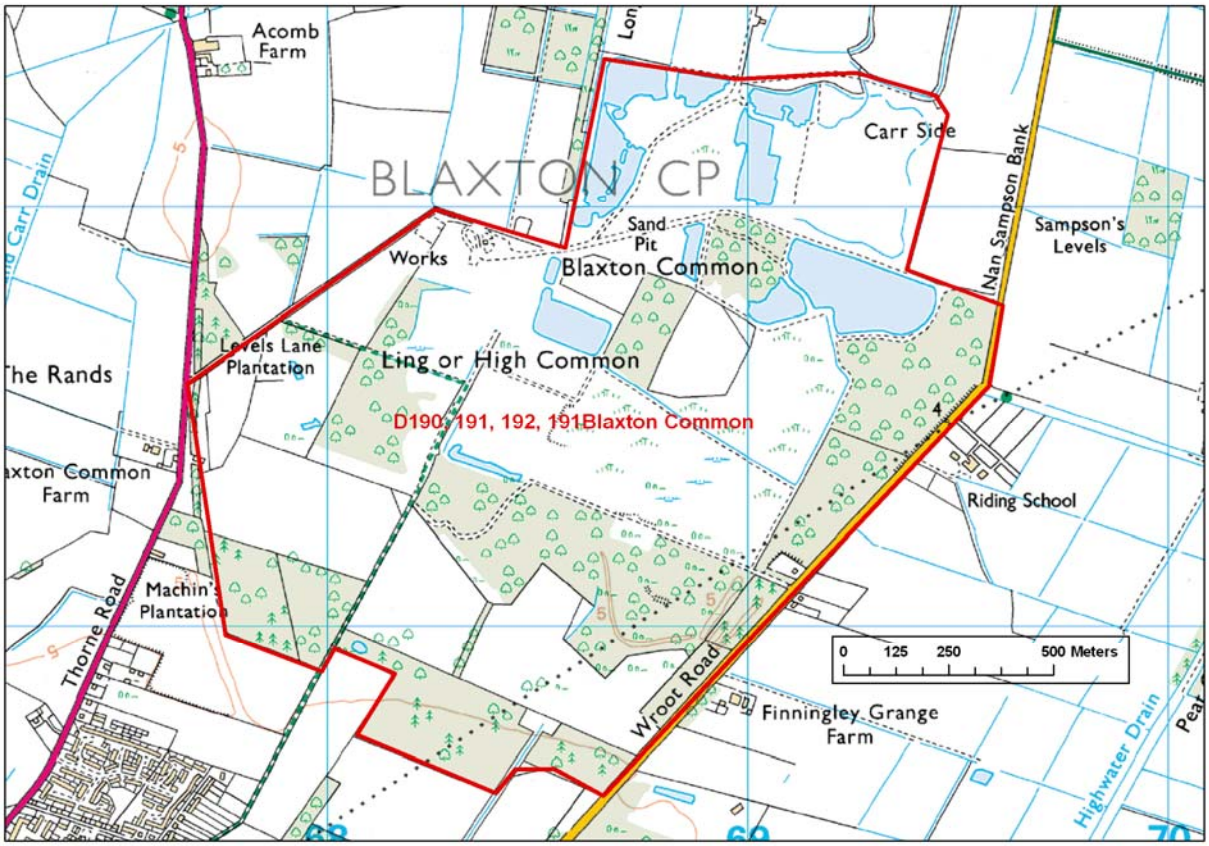
Figure 154 Channel of Older River Gravel on Sherwood Sandstone in east quarry face. SK 65960 96325.

A33 D190–192 BLAXTON COMMON

Site Name: **Blaxton Common**	Site Key: **D190, D191, D192**
Grid Reference: **SE 685 015 (centred on)**	Site Type: **disused quarries, pits and cuttings**
Local Authority: **Doncaster Metropolitan Borough Council, South Yorkshire**	
Site Dimensions: 1800 x 1500 m	Site Owner: Tarmac Quarry Products
Conservation Status: **Regionally Important Geological Site**	Date: 16/9/97
Field surveyor: Scott Engering	Date: 16/2/07

Stratigraphy and Rock Types	
Time Unit: Triassic	Rock Unit: Sherwood Sandstone Group
Rock Type: Sandstone (undifferentiated)	Details: Massive cross-bedded sandstone with marl pebbles
Time Unit: Anglian, Middle Pleistocene	Rock Unit: Older River Gravel (River Terrace Deposits)
Rock Type: Sand and Gravel	Details: Cross-bedded sands and gravels

Site Map	**Figure 155 - D190–192 Blaxton Common**



Site Description	D190–192 Blaxton Common

Large area of old sand and gravel pits that have long since been disused. The site is understood to be in multiple ownership but the only known owner is Tarmac, whose representative accompanied me on the visit to the Levels Lane Quarry. The principal feature of interest here is a large flooded pit with an exposure of up to 6 m of Sherwood Sandstone along the entire length of its western side. Photos taken from SE 68716 02029. The pit has been fenced off since the date of the last survey in 1997 and old bits of plant and machinery etc have been cleared away.

The exposure is in effect now inaccessible. The entrance to the quarry is gated and is used by a farmer on adjoining land. Waterside exposure limits safe access to study rock.

The site is now much more overgrown than in the 1997 survey and exposures of the Older River Gravel are not easy to find. Many exposures are adjacent to flooded parts of the site and are thickly vegetated and are not generally safely accessible. Occasional exposures can be seen beneath tree roots as at SE 66879 01714 or larger expanses as seen at SE 68491 01742 but detailed assessments of the potential value of these exposures was not ascertained due to access problems.

RIGS Assessment of Site Value	D190–192 Blaxton Common

Ratings: 1-2 very poor; 3-4 poor; 5-6 acceptable/useful; 7-8 quite good; 9-10 very good/excellent; N/A not applicable; D/K don't know

Access and Safety

Aspect	Description	Rating
road access & parking	Very limited at gated entrance. 2-3 vehicles	**5**
safety of access	Access along established footpaths pass close to flooded pits. Other access across uneven ground and embankments	**5**
safety of exposure	Sandstone inaccessible. Water hazards of flooded pits	**4**
permission to visit	From Tarmac, although public footpaths cross the land	**5**
current condition	Sandstone exposures clear and visible but Older River Gravels are increasingly becoming overgrown	**6**
current conflicting activities	Vegetation growth	
restricting conditions	Private ownership.heath and safety hazards associated with water and steep, overgrown embankments	
nature of exposure	Quarried faces	
multiple exposures / prospect for trail	has potential for interpretation as a nature reserve	
Notes	Overgrown and potentially hazardous site	

Culture, Heritage & Economic

Aspect	Description	Rating
historic, archaeological & literary associations	None known. Local industrial archaeology interest only	**5**
aesthetic landscape	The area has been recolonised by plants and would make a good nature reserve	**6**
history of Earth Sciences	No associations known	**0**
economic geology	Former sand and gravel extraction site. Potentially a good example of restoration and landscape	**7**
Notes	Limited value as part of industrial archaeology of the area	

Education and Science		
surface processes	Erosional surfaces, fluvioglacial deposition and modern weathering and erosional processes	**6**
geomorphology	Ancient erosional surface on Sherwood Sandstone	**7**
sedimentary	A range of lithologies and sedimentary structures	**8**
fossils	Not applicable	**0**
igneous	Not applicable	**0**
metamorphic	Not applicable	**0**
tectonic: structural	Unconformity between Triassic and Quaternary	**0**
minerals	Not applicable	**7**
stratigraphy	Good site for correlating Quaternary stratigraphy	**7**
Notes	Good exposures suitable for research, advanced students and group visits under supervision of experienced leader. Regeneration of vegetation at advanced stage	
Geodiversity value		
Links well with biodiversity interests, but lithologies not easily studied due to access difficulties		**7**

Site Photographs	D190–192 Blaxton Common

Figure 156 General view of old sand and gravel workings. SE 68716 02029.

Figure 157 Detail of Sherwood Sandstone in old sand and gravel workings. SE 68716 02029.

Figure 158 Residual exposure of sand and gravel. SE 68491 01742.

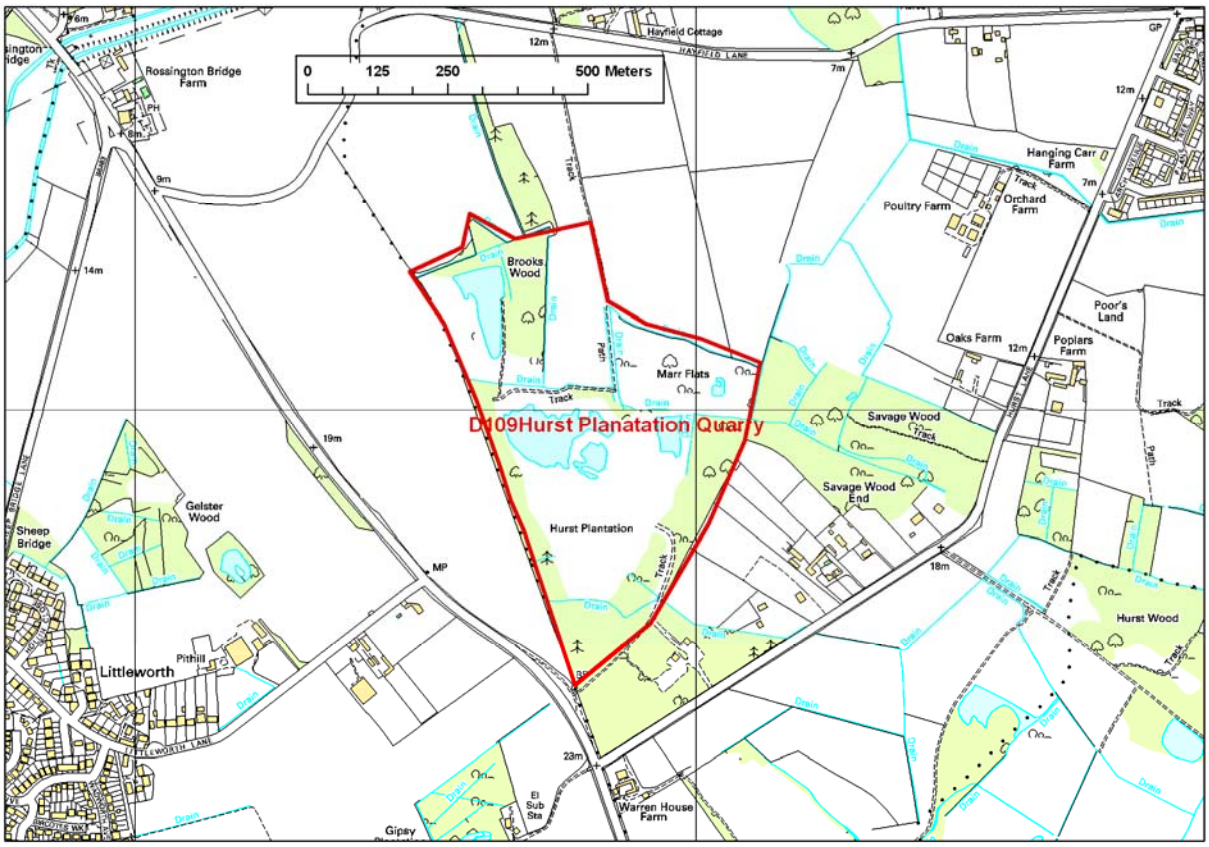
Figure 159 Detail of sand and gravel beneath tree roots . SE 66879 01704.

A34 D109 HURST PLANTATION QUARRY

Site Name: **Hurst Plantation Quarry**	Site Key: **D109**
Grid Reference: **SK 640 990 (centred on)**	Site Type: **disused quarries, pits and cuttings**
Local Authority: **Doncaster Metropolitan Borough Council, South Yorkshire**	
Site Dimensions: 400 m x 300 m	Site Owner: Doncaster Minerals
Conservation Status: **Regionally Important Geological Site**	Date: 16/9/97
Field surveyor: Scott Engering	Date: 16/2/07

Stratigraphy and Rock Types	
Time Unit: Anglian, Middle Pleistocene	Rock Unit: Glaciofluvial deposits
Rock Type: Sand and Gravel	Details: Cross bedded yellow and orange sands with gravel

Site Map	**Figure 160 - D109 Hurst Plantation Quarry**



Site Description	**D109 Hurst Plantation Quarry**

Extensive site with planning permissions still in force, used for extraction of clay and sand and gravel. Planning conditions stated that the land should be landscaped and restored as wetland areas. However, the development of Robin Hood Airport means that the restoration of the land will not proceed in accordance with the existing conditions due to the potential hazard of flocking birds in the flight paths.

At present, two main areas exist. The former clay pits have no exposure and is geologically insignificant. The area worked for sand and gravel consists of flooded pits with a series of islands, comprising banks of

excavated material and natural exposures of up to 5 m of yellow and orange Pre-Ipswichian sands with gravel beds. The site is considerably overgrown in relation to its condition in the 1997 RIGS survey.

Many exposures of sand and gravel are at the edge of the flooded pits and there are no well defined points of access, so the education value for anything other than detailed research is limited.

One of the company directors, Keith Lewis, informs me that the company has many other mineral interests and that they do not have any plans to quarry this site further, despite planning permission existed. They want the land to be restored, landscaped and managed as a natural resource for the benefit of the area. As part of any such plans, it was suggested that exposures of sand and gravel on the site could be improved and retained as part of future plans.

The site possesses very good biodiversity interest. Bridleways run alongside the site but apparently there are increasing problems of vandalism, littering etc.

RIGS Assessment of Site Value	**D109 Hurst Plantation Quarry**	
Ratings: 1-2 very poor; 3-4 poor; 5-6 acceptable/useful; 7-8 quite good; 9-10 very good/excellent; N/A not applicable; D/K don't know		
Access and Safety		
Aspect	**Description**	**Rating**
road access & parking	Parking for numerous vehicles on large layby	**5**
safety of access	Access along well defined paths and bridleways on edge of site, but no paths within the site itself	**9**
safety of exposure	At present, all geological features are seen at the edge of flooded pits and constitute a potential hazard	**4**
permission to visit	Privately owned by Doncaster Minerals	**D/K**
current condition	Plenty of exposure, but needs improvement of pathways and access to exposures if land is to be properly managed	**7**
current conflicting activities	None envisaged	
restricting conditions	Safety of access to exposures	
nature of exposure	Quarried faces in sand and gravel	
multiple exposures / prospect for trail	Potential with other sites near Austerfield, subject to access and exposure of these sand and gravel sites	
Notes	Currently unlandscaped but with potential for developing safe, accessible sites with proper management	
Culture, Heritage & Economic		
Aspect	**Description**	**Rating**
historic, archaeological & literary associations	Local industrial archaeology	**D/K**
aesthetic landscape	Site is secluded within a plantation and there has been no attempt at landscaping. Considerable potential as a reserve	**7**
history of Earth Sciences	One of limited exposures of Anglian fluvioglacial sand and gravel in the region	**8**
economic geology	Local example of sand and gravel extraction	**5**
Notes	Limited interest except on a very local scale one	
Education and Science		
surface processes	Fluvioglacial deposition and modern sedimentary processes	**7**
geomorphology	Not applicable	
sedimentary	Range of sedimentary structures and lithologies. Orange/ yellow sands and carbonaceous deposits	**7**
fossils	Not applicable	**0**

igneous	Not applicable	**0**
metamorphic	Not applicable	**0**
tectonic: structural	Not applicable	**0**
minerals	Not applicable	**0**
stratigraphy	Useful for correlating Anglian fluvioglacial sand and gravel	**7**
Notes	Useful site for studying sediments with a suitably experienced group leader	
Geodiversity value		
Limited lithologies and interest, other than sedimentology but a good exposure of Anglian sand and gravel		**7**

Site Photographs	**D109 Hurst Plantation Quarry**

Figure 161 General view of dormant sand and gravel quarry. SK 63883 98977.

Figure 162 General view of dormant sand and gravel quarry. SK 63883 98977.

Figure 163 General view of old clay workings. SK 63639 99078.

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Doncaster Geodiversity Assessment

Volume 2 – Maps

Geology and Landscape South Programme
Commissioned Report CR/07/025N

Doncaster
Metropolitan Borough Council

BRITISH GEOLOGICAL SURVEY
GEOLOGY AND LANDSCAPE SOUTH PROGRAMME
COMMISSIONED REPORT CR/07/025N

Doncaster Geodiversity Assessment

Volume 2 – Maps

S Engering and H F Barron

Contributors

Editor
A H Cooper

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Permian Bryozoan reef, North Cliff Quarry, Doncaster

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Maps and diagrams in this report use topography based on Ordnance Survey mapping.

Keyworth, Nottingham British Geological Survey 2007

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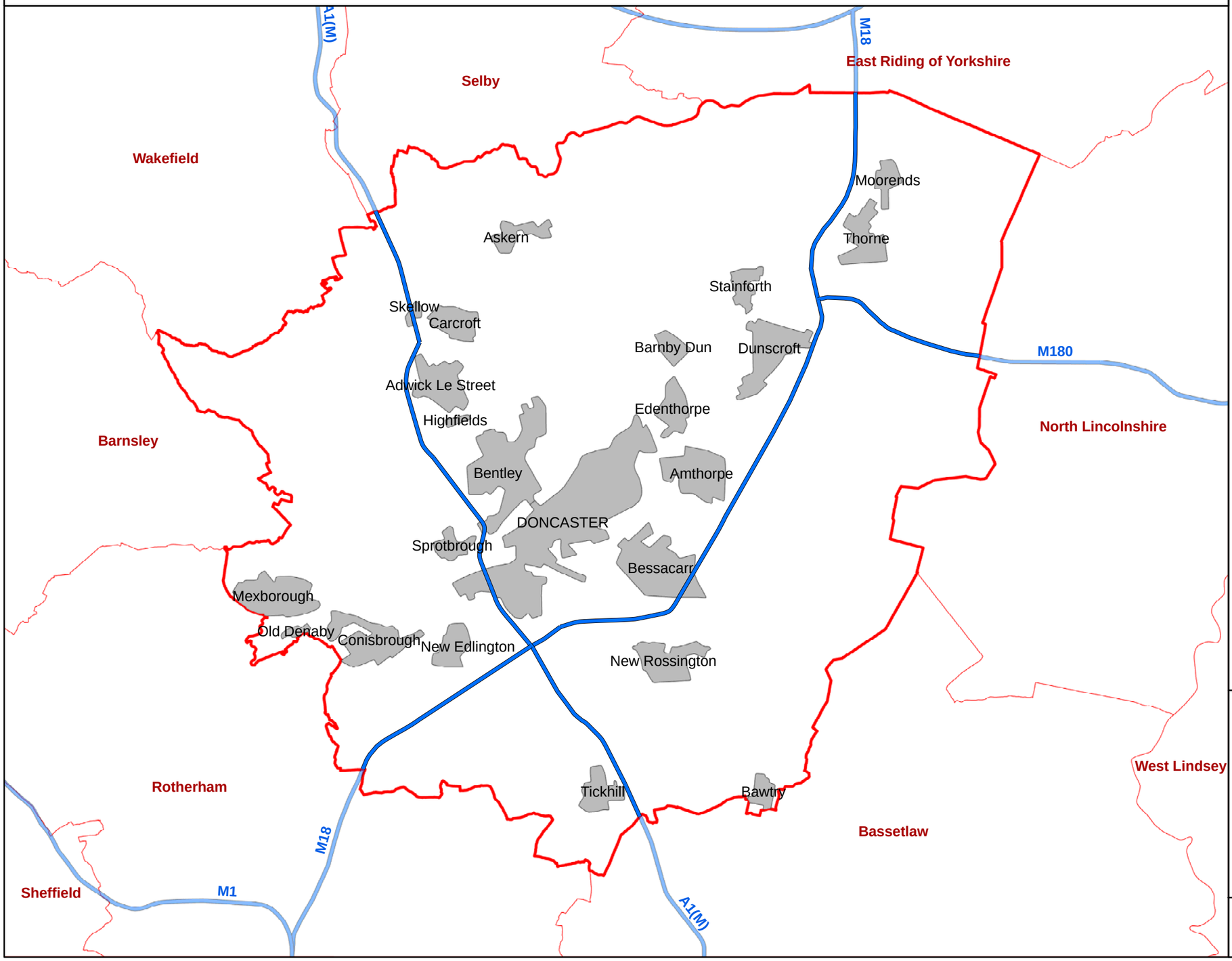
Contents

Figure 1 - Location Map



Key

- DMBC boundary
- Other Local Authorities
- Urban areas
- Motorways

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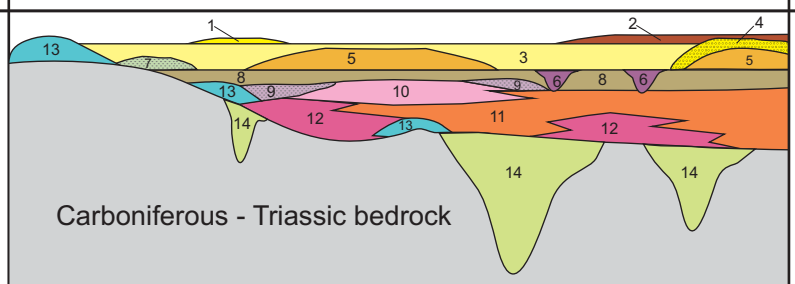
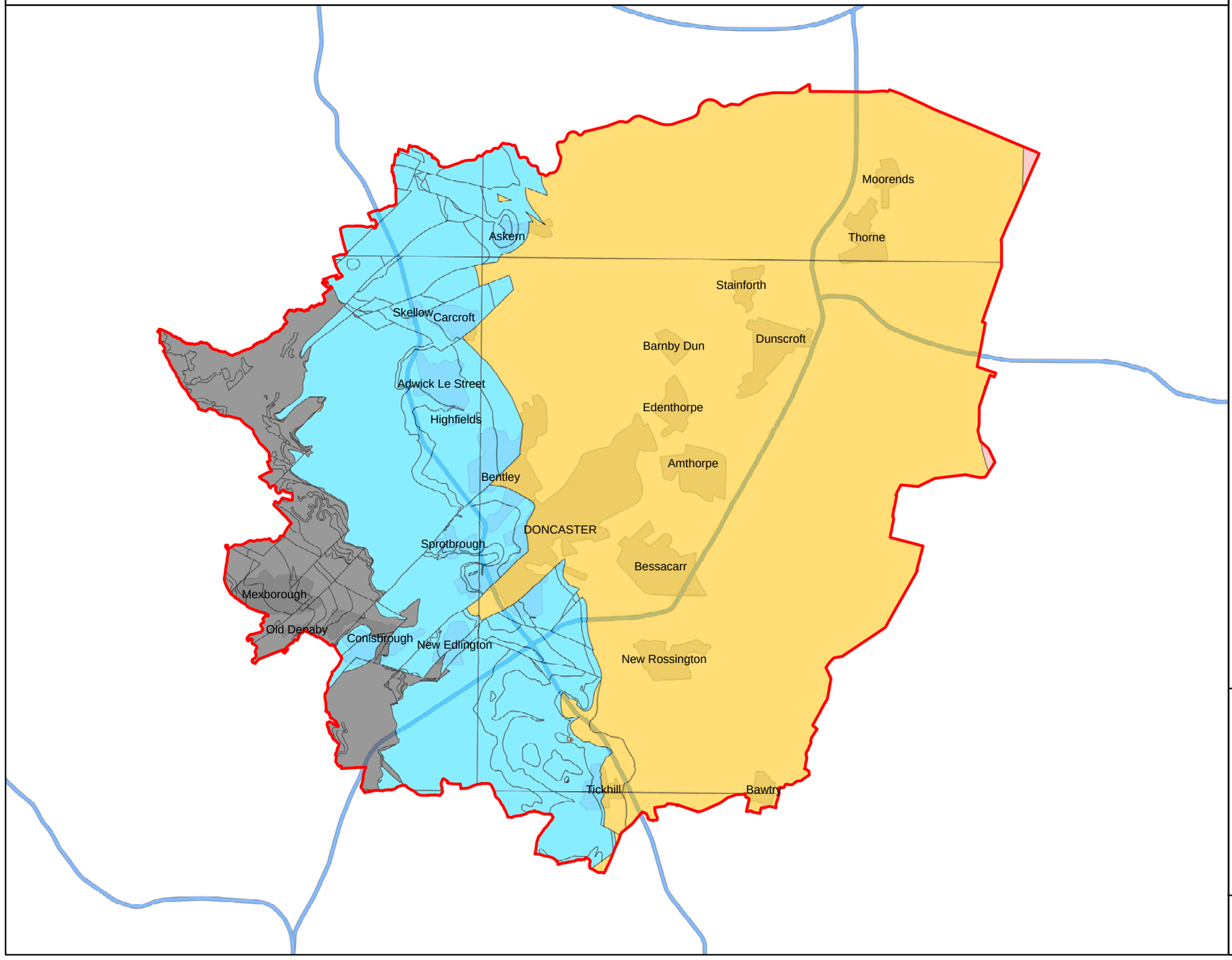
System	Stage/ Subseries	Group	Formation (former names)	Generalised Schematic Vertical Section	Doncaster Geodiversity Sites
NEOGENE	Middle - Upper Pleistocene	Yorkshire Catchment Subgroup / Albion & Caledonia Glacigenic			D109 D78 D190-2 D44 D101 D20-21, D2 D102
JURASSIC - NEOGENE				Deposition of Jurassic and Cretaceous rocks and subsequent erosion during Palaeogene & Neogene Top not exposed in Doncaster	
TRIASSIC		MMG	**Mercia Mudstone Group** (Keuper Marl)	**Mercia Mudstone Group MMG-MDST** up to 15m thick	
	Scythian	Sherwood Sandstone Gp	**Nottingham Castle Formation** (Bunter Sandstone and Bunter Pebble Beds) **Lenton Formation** (Lower Mottled Sandstone at base)	**Nottingham Castle Formation NTC-SDST** Sandstone and pebbly sandstone brown, grey and red **Sherwood Sandstone Group SSG-SDST** Sandstone and pebbly sandstone up to 350m thick, thinning southwards **Lenton Fm LNS-SDST** fine-grained sandstone 0-70m	D102 D101 D44
251 Ma					
PERMIAN	Kazanian - Tatarian	Zechstein Group	**Roxby Formation** (Upper Permian Marl, Upper Marl, including gypsum/anhydrite and salt)	**Roxby Formation ROX-CAMDST** Up to 60m thick, thinning southwards	
			Brotherton Formation (Upper Magnesian Limestone)	**Brotherton Formation - Dolomitic Limestone BTH-DOLM** 17 - 35m - a good marker horizon	D99 D87 D51
			Edlington Formation (Middle Permian Marl or Middle Marl including gypsum/anhydrite and salt plus sandstone in south; also called Lower Lenton Sandstone on some logs)	**Edlington Formation EDT-CAMDST** up to 15m thick at outcrop where gypsum is missing or dissolved, thickens to east and north-east to around 60m max	D31 D61
			Cadeby Formation (Lower Magnesian Limestone and Lower Permian Marl or Lower Marl)	**Cadeby Formation CDF-DOLO** wedges out to south and thickens to the north-east. Generally around 0-45m at outcrop thickening to around 110m in NE Sprotbrough Member Hampole Beds Wetherby Member	D78 D94 DR5 DR4 D28 D300-303 D112 D5 D20-22 D15 D133 D13 DR6 D11 D4
	Asselian - Kungurian?	Rotliegendes Gp	**Yellow Sands Formation** (Basal Permian Sands, Basal Permian Sandstone)	Unconformable contact between base of Cadeby and underlying sequence **Yellow Sands Formation YWS-SDST** yellow sst at outcrop or blue-grey sst at depth patchy 0-10 or 20m max as dunes	D15 D4
299 Ma					
CARBONIFEROUS	Westphalian	Pennine Coal Measures Gp	**Pennine Upper Coal Measures Fm** (Middle Coal Measures Formation)	Unconformable contact between Permian strata and underlying Carboniferous strata PUCM-SDST Ravenfield Rock RVR-SDST **Pennine Upper Coal Measures Fm PUCM-MDSS** Up to 300m Wickersley Rock WYR-SDST Dalton Rock DLT-SDST Ackworth Rock AR-SDST	DR1 D11 DR6 DR3 DR2
			Pennine Middle Coal Measures Fm (Middle Coal Measures Formation)	Mexborough Rock MXR-SDST **Pennine Middle Coal Measures Fm PMCM-MDSS** Up to 250m PMCM-SDST	D177 D166 D6

Figure 2 Generalised vertical section of the strata exposed in Doncaster. Superficial deposit numbers refer to the numbered units in Table 1

Figure 3 - Bedrock geology by lithostratigraphical group



Key

- Mercia Mudstone Group
- Sherwood Sandstone Group
- Zechstein Group
- Rotliegendes Group
- Pennine Coal Measures Group
- DMBC boundary
- Uraban areas
- Motorways

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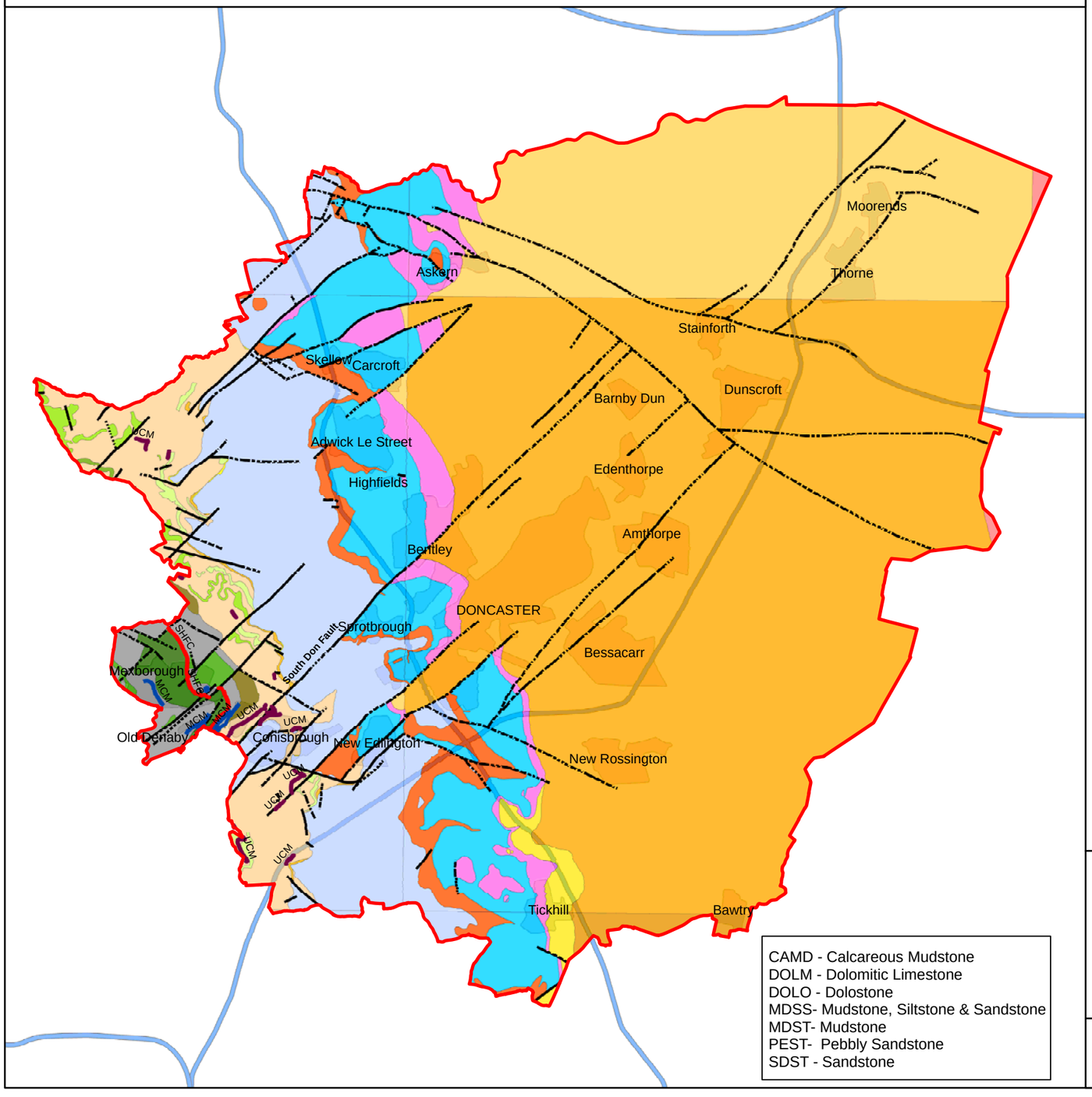
Figure 4 - Bedrock geology by lithostratigraphical formation



Key

- Mercia Mudstone Group-MDST
- Sherwood Sandstone Group-SDST
- Nottingham Castle Formation-SDST
- Nottingham Castle Formation-PEST
- Lenton Formation-SDST
- Roxby Formation-CAMD
- Brotherton Formation-DOLM
- Edlington Formation-CAMD
- Cadeby Formation-DOLO
- Yellow Sands Formation-SDST
- Pennine Upper Coal Measures Fm-SDST
- Pennine Upper Coal Measures Fm, Ravenfield Rock-SDST
- Pennine Upper Coal Measures Fm, Wickersley Rock-SDST
- Pennine Upper Coal Measures Fm, Dalton Rock-SDST
- Pennine Upper Coal Measures Fm-MDSS
- Pennine Coal Measures Fm, Ackworth Rock-SDST
- Pennine Coal Measures Fm-SDST
- Pennine Coal Measures Fm, Mexborough Rock-SDST
- Pennine Coal Measures Fm-MDSS
- Normal Fault, inferred
- Normal Fault, observed
- Pennine Upper Coal Measures Fm-COAL
- Pennine Middle Coal Measures Fm, Shafton Coal-COAL
- Pennine Middle Coal Measures Fm-COAL
- DMBC boundary
- Urban areas
- Motorways

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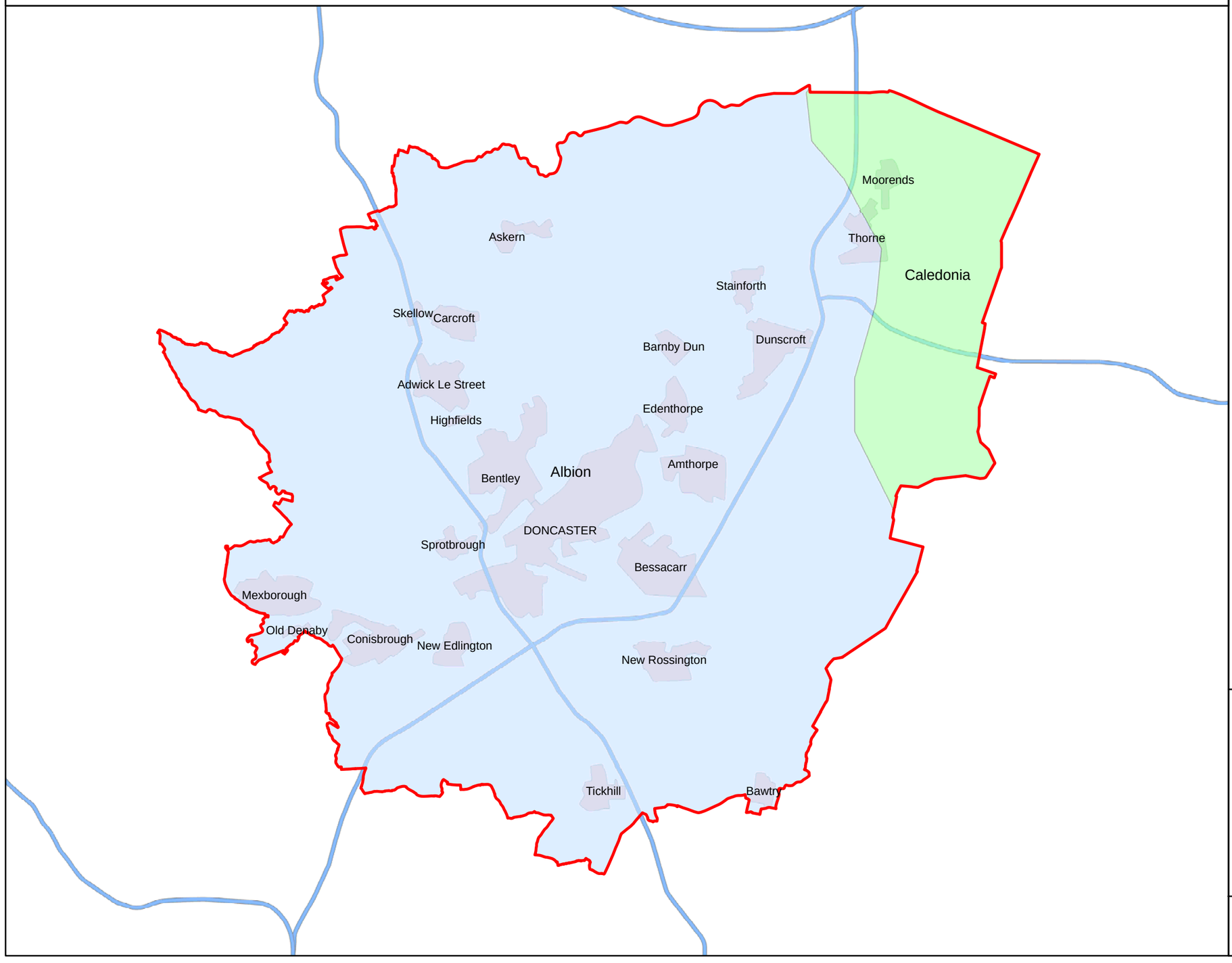
Figure 5 - Superficial geology by lithostratigraphical group



Key

- Albion Glacigenic Group
- Caledonia Glacigenic Group
- Urban areas
- DMBC boundary
- Motorways

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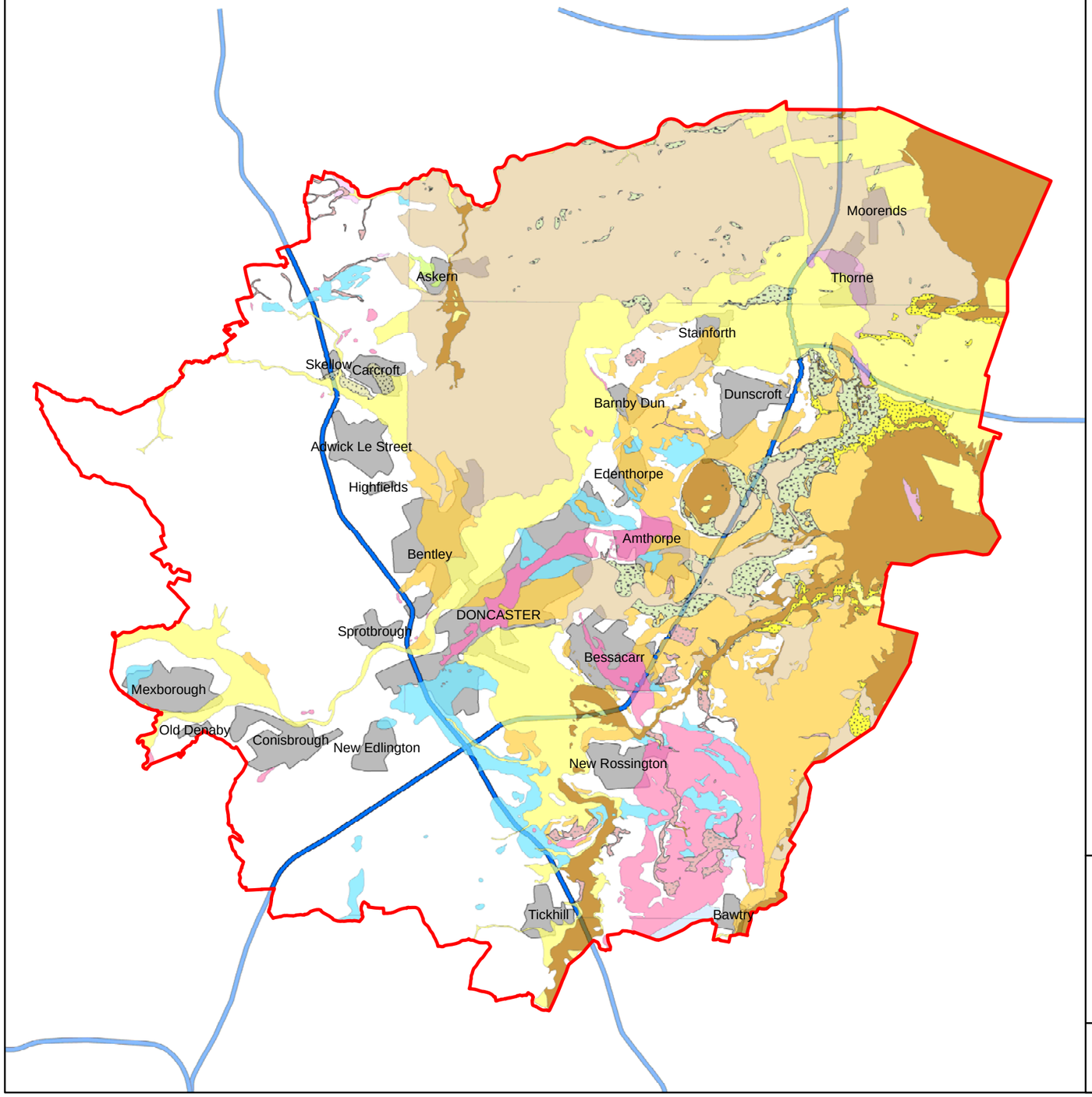
Figure 6 - Superficial deposits by lithogenetic class



Key

- Peat-PEAT
- Alluvium-CSSG
- Lacustrine Beach Deposits-SAGR
- River Terrace Deposits, Undifferentiated-SAGR
- Blown Sand-SAND
- Head-CSSG
- Glaciofluvial Deposits, Undifferentiated, Devensian-SAGR
- Glaciofluvial Deposits, Middle Pleistocene-SAGR
- Glaciofluvial Deposits, Undifferentiated-SAGR
- Glaciolacustrine Deposits, Devensian-CLSI
- Glaciolacustrine Deposits, Devensian-SAGR
- Glaciolacustrine Deposits, Devensian-SAND
- Till, Middle Pleistocene-DMSG
- Till, Middle Pleistocene-DMTN
- DMBC boundary
- Urban areas
- Motorways

CLSI - Clay & Silt
CSSG - Clay, Sand & Gravel
DMSG - Diamicton, Sand & gravel
DMTN - Diamicton
SAGR - Sand & Gravel

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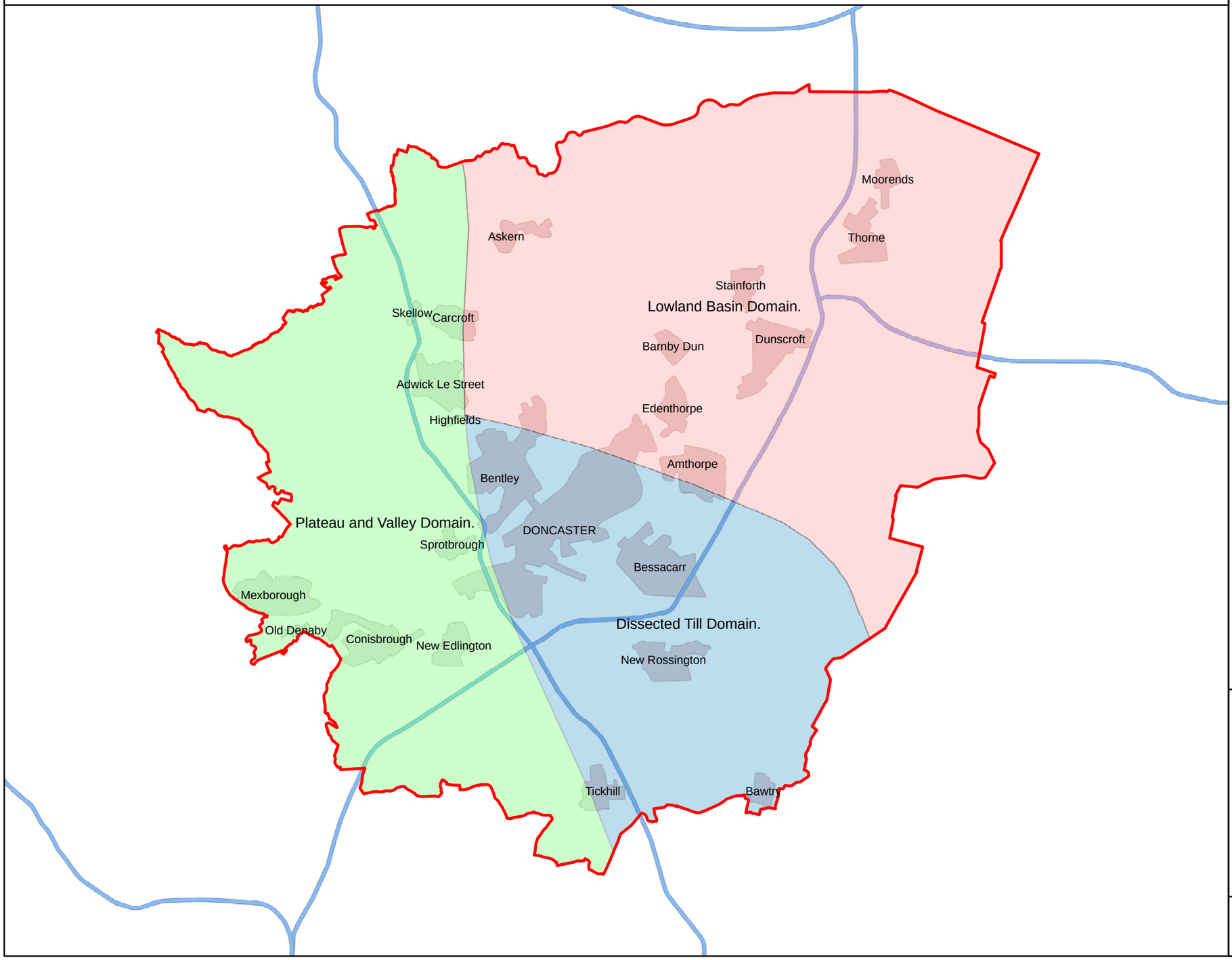
Figure 7 - Superficial geology by Quaternary domain



Key

- Dissected Till Domain.
- Lowland Basin Domain.
- Plateau and Valley Domain.
- DMBC boundary
- Urban areas
- Motorways

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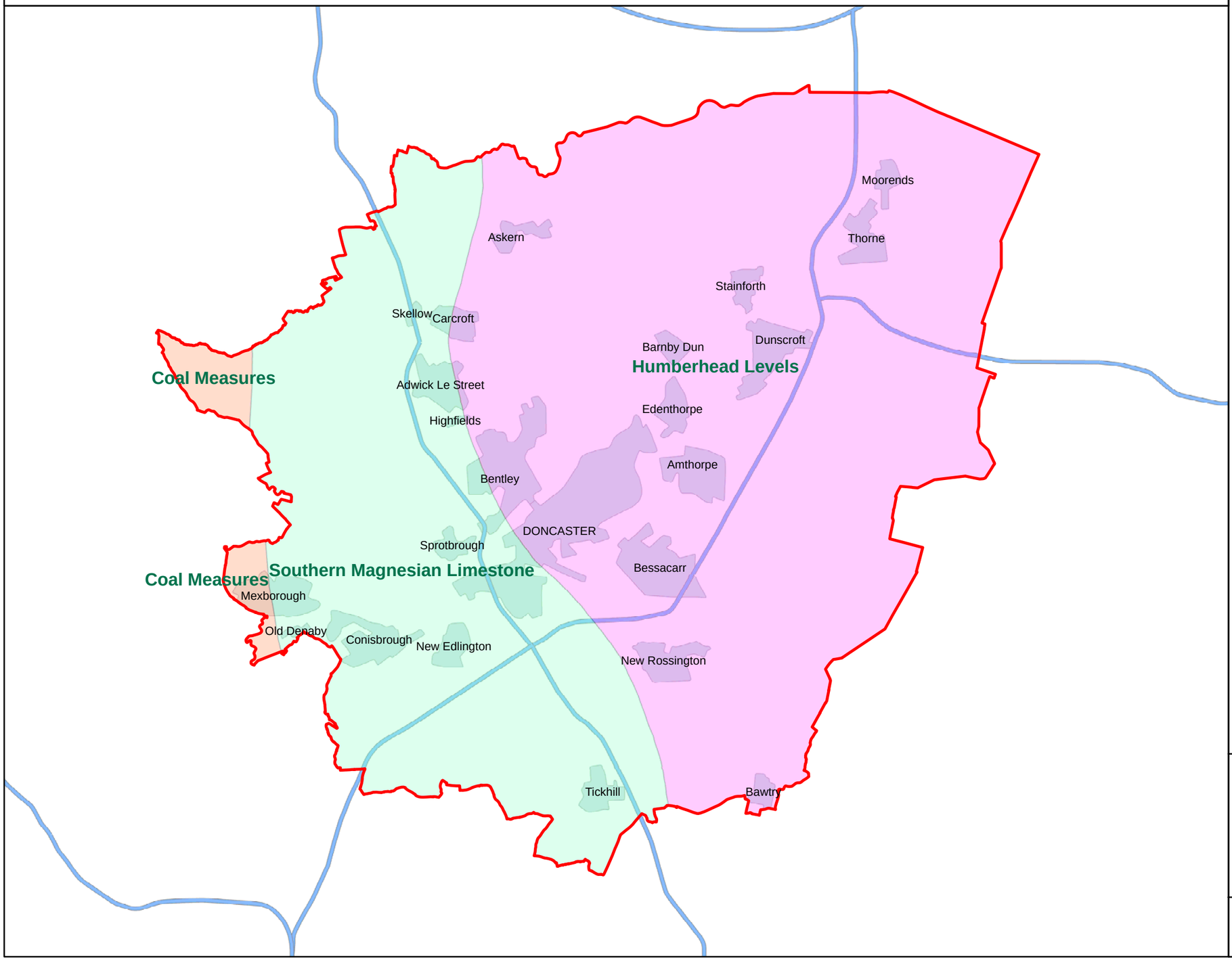
Figure 8 - Natural England Natural Areas



Key

- Coal Measures
- Humberhead Levels
- Southern Magnesian Limestone
- DMBC boundary
- Urban areas
- Motorways

1:150,000

0 1.25 2.5 5 Kilometers

N

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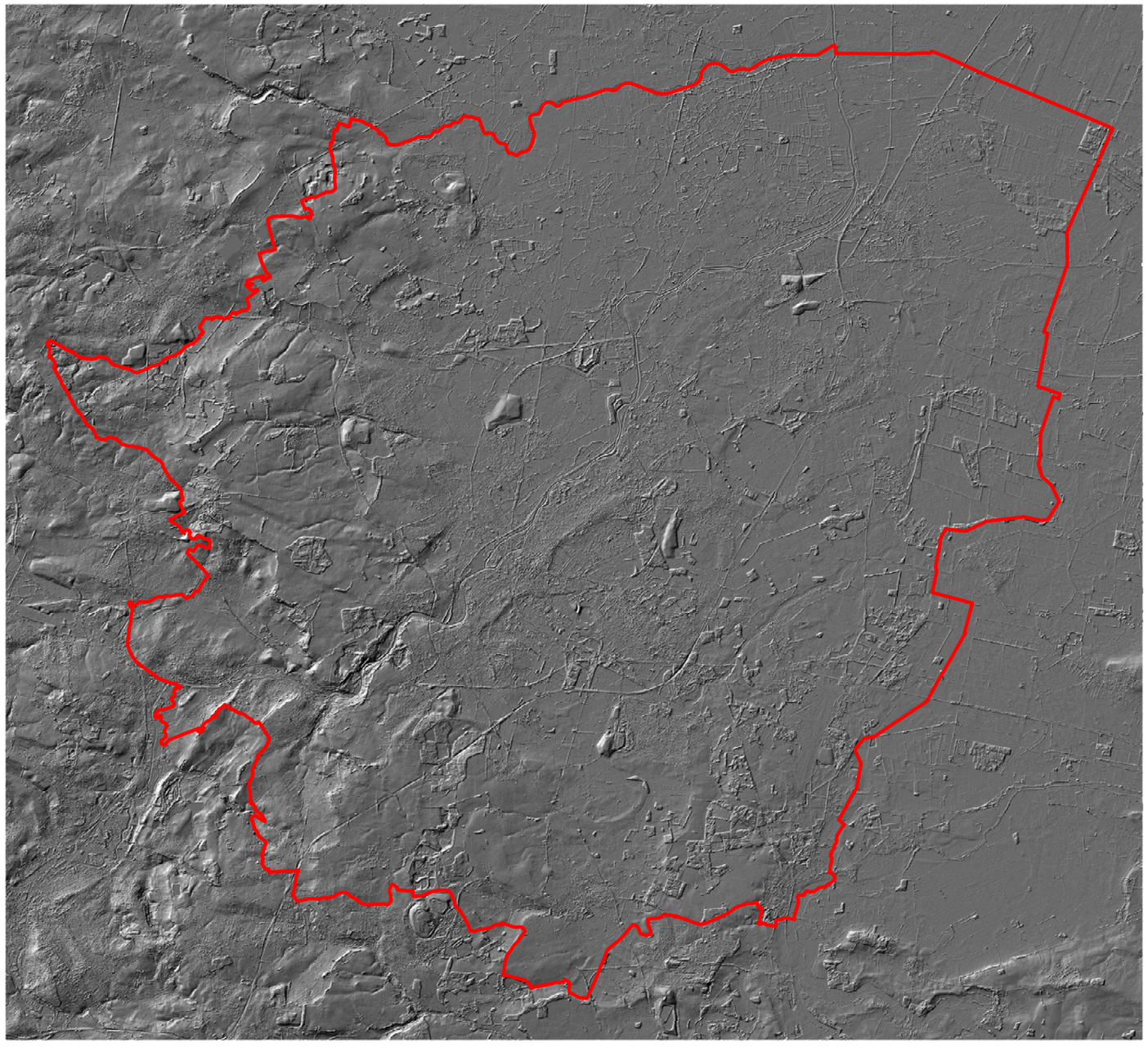
Figure 9 - Hillshade Digital Surface Model



Othorectified radar altimetry Digital Surface Model (DSM) derived from Intermap Technologies NEXTMap Britain data processed by BGS

Key

DMBC boundary

1:150,000

0 1.25 2.5 5 Kilometers

N

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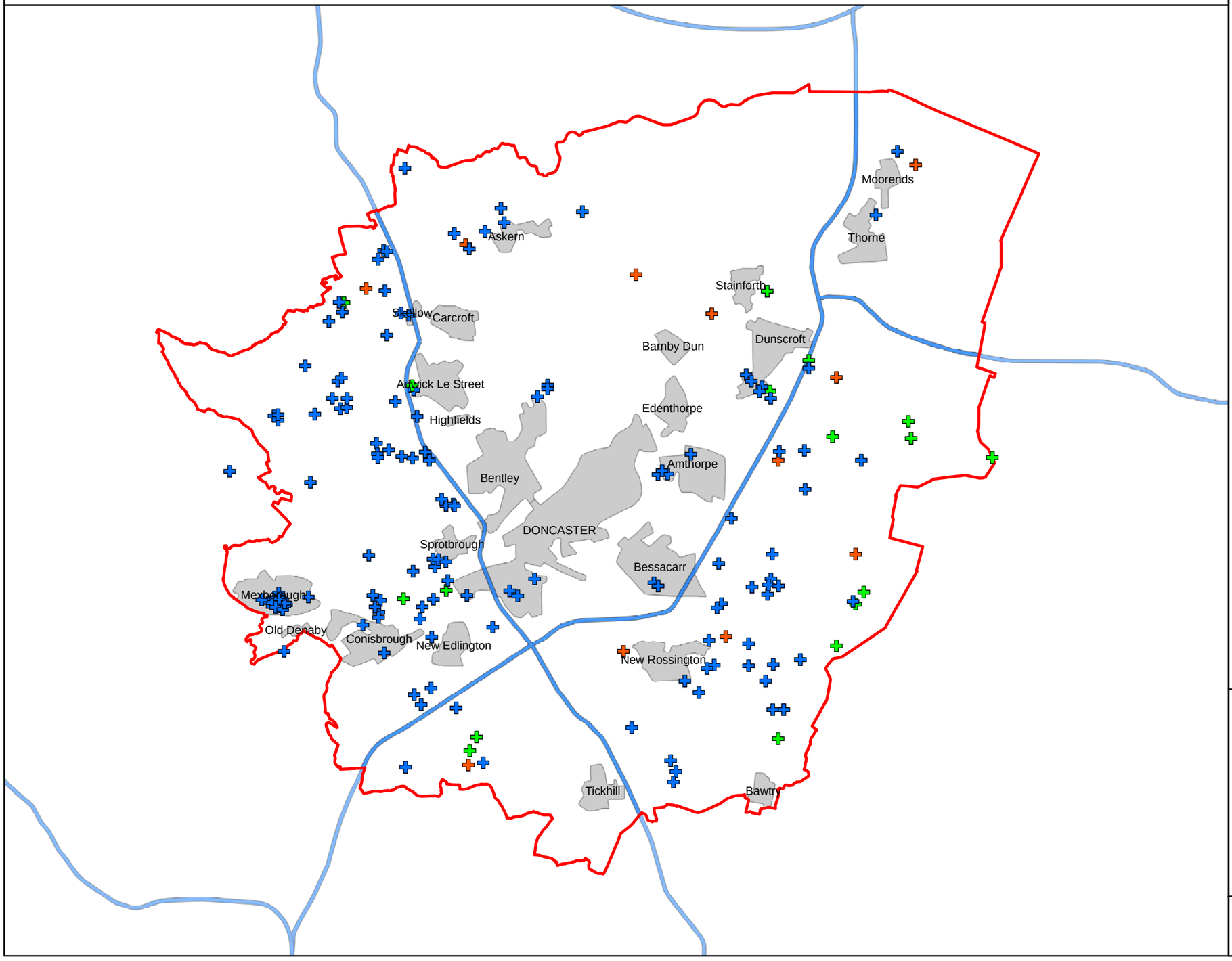
Figure 10 - BGS Mines & Quarries Database (25 January 2007)



Key

- Active
- Ceased
- Inactive
- DMBC boundary
- Urban areas
- Motorways

1:150,000

0 1.25 2.5 5 Kilometers

N

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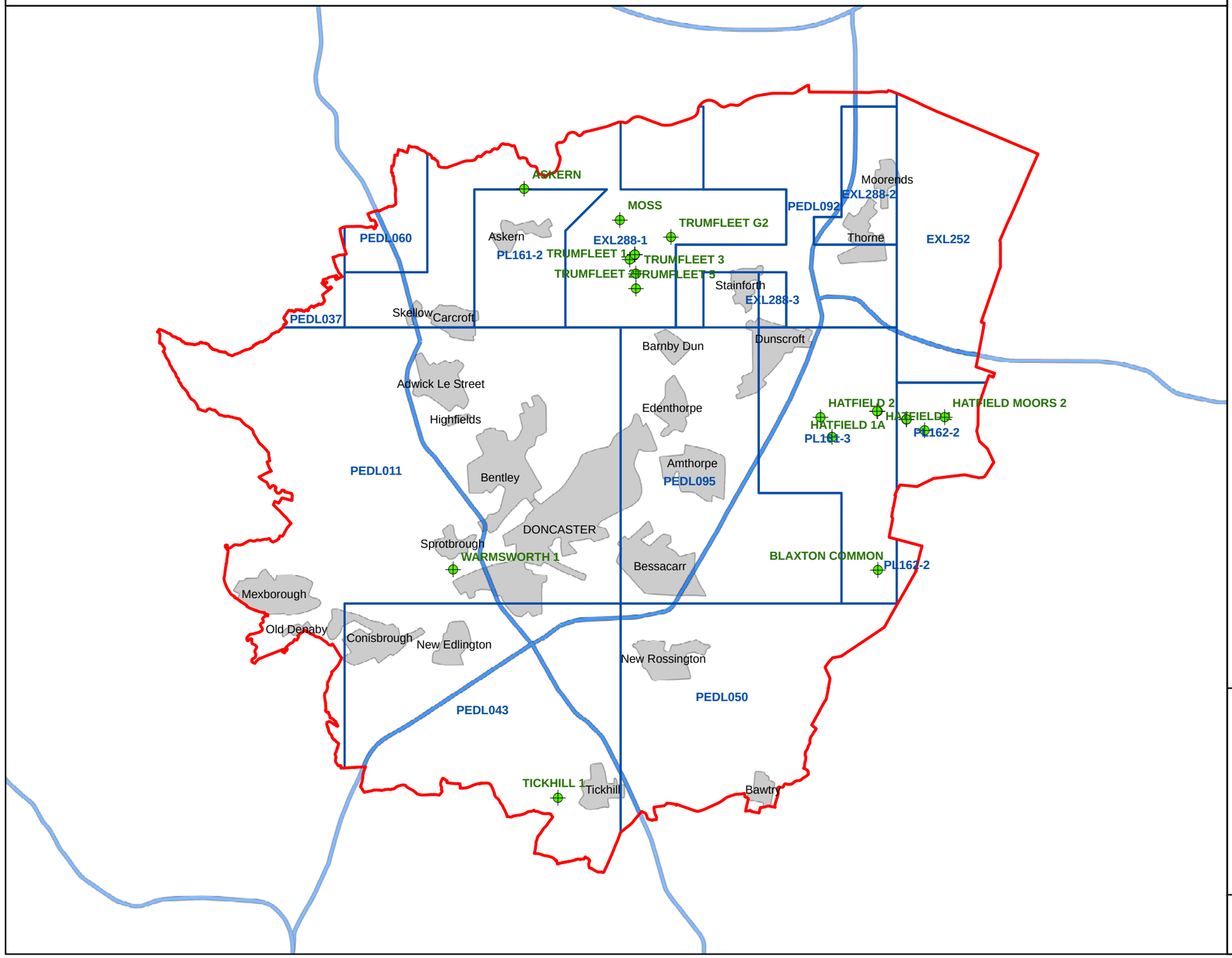
Figure 11 - Hydrocarbon wells and licence areas



Key

- DMBC boundary
- Urban areas
- Motorways
- Hydrocarbon Wells
- Hydrocarbon Licence Areas

1:150,000

0 1.25 2.5 5 Kilometers

N

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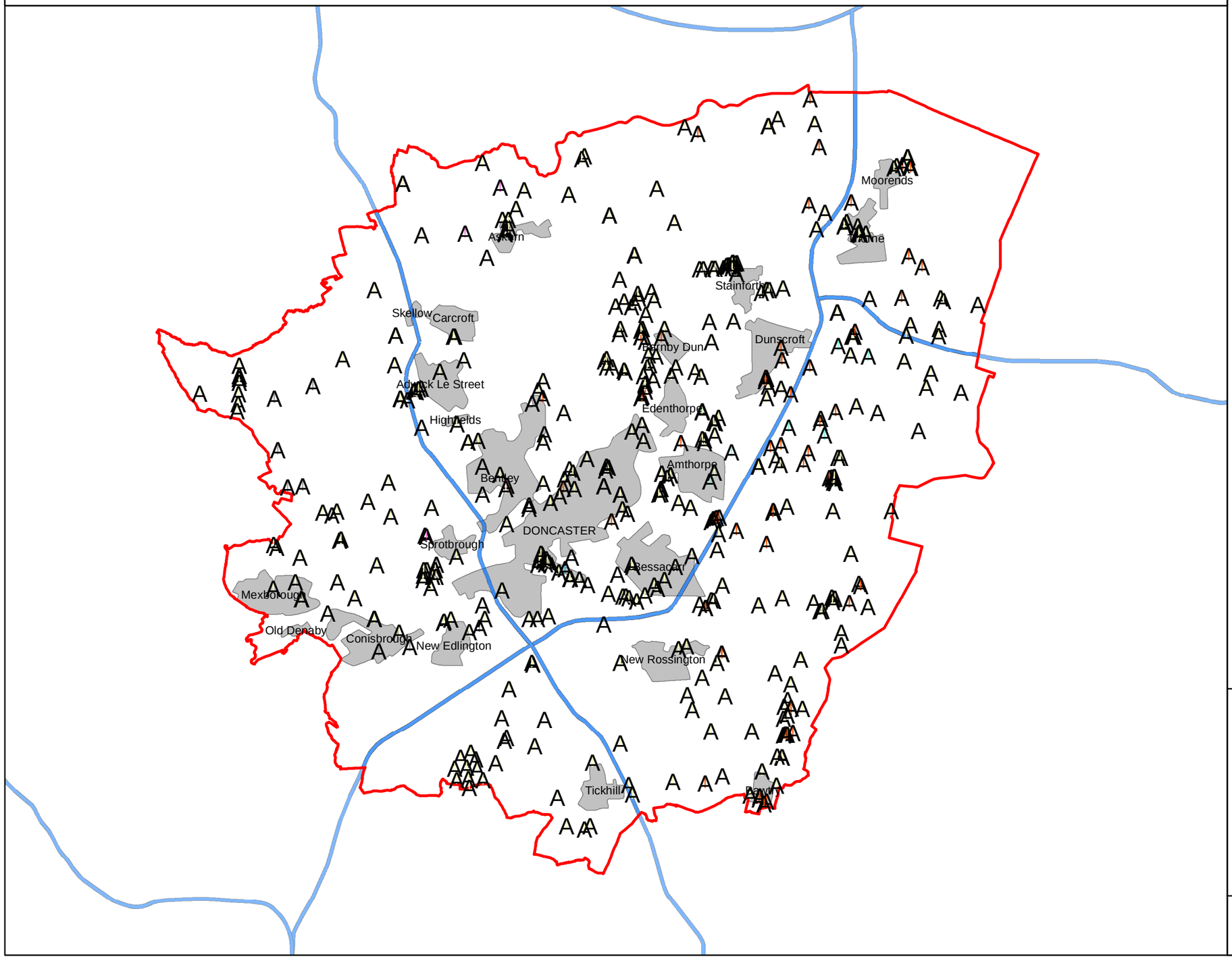
Figure 12 - Water Wells from BGS Wellmaster - January 2007



Key

- DMBC boundary
- Urban areas
- Motorways

AQUIFER

- Not Entered
- Unknown
- Superficial Deposits
- Sherwood Sandstone Group
- Brotherton Formation
- Cadeby Formation
- Pennine Coal Measures Group
- Carboniferous Limestone Supergroup

1:150,000

0 1.25 2.5 5 Kilometers

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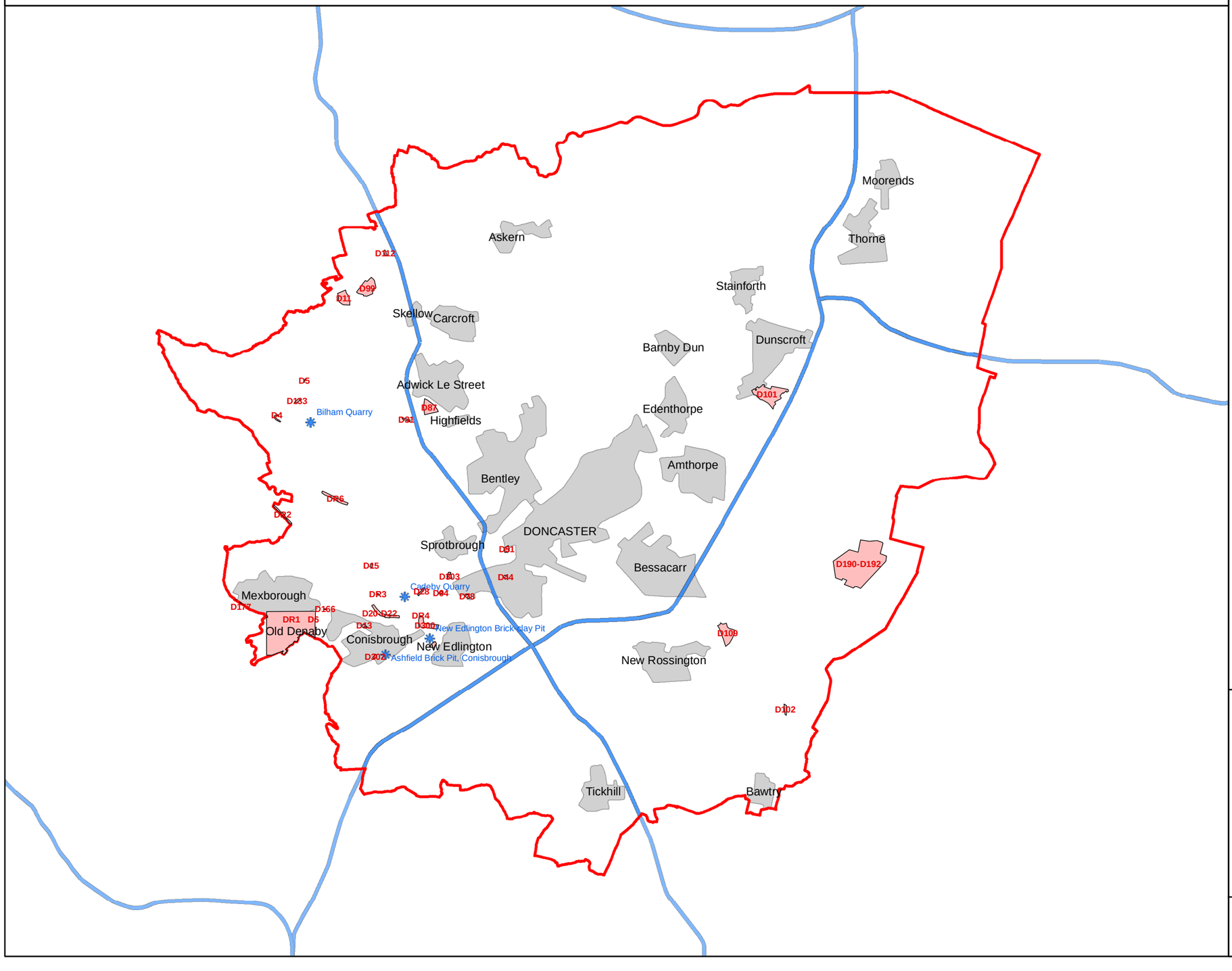
Figure 13 - Doncaster RIGS - March 2007



Key

- RIGS March07
- GCR Sites
- DMBC boundary
- Urban areas
- Motorways

1:150,000

0 1.25 2.5 5 Kilometers

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