# 3. The Aggregates Industry

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Aggregates are the most commonly used construction minerals in the UK and are either naturally occurring (sand and gravel) or produced from rock deposits by crushing (crushed rock). Aggregates produced from naturally occurring mineral deposits, and used for the first time, are classed as primary aggregates; the most important sources in the study area being sand and gravel and crushed limestone and sandstone. Secondary aggregates are by-products and mineral waste from other quarrying and mining operations, for example, quarries supplying limestone primarily for industrial and agricultural uses regularly produce crushed rock aggregate from unsuitable 'waste' material (Highley *et al*. 2005) and some stone quarries supply modest quantities of aggregate as a by-product of extracting and processing building stone (Lott *et al*, 2005). Secondary aggregates, together with small quantities of recycled aggregates, form a small proportion of the total aggregate provision of which, for the foreseeable future, an estimated 73% will derive from primary sources, (ODPM 2004).

The commercial extraction of sand, gravel and crushed rock is subject to the Aggregates Levy. Introduced in April 2002 at the rate of £1.60/tonne the levy is intended to address the environmental costs associated with quarrying operations. Its objective is to reduce demand for primary aggregate and encourage the use of secondary aggregates, which are exempt from the levy, and recycled materials. The levy is not a revenue raising tax and about 90% is returned to employers, generally through a small reduction in National Insurance contributions (Steadman *et al*. 2004). The remaining 10% is transferred to a Sustainability Fund to support work to reduce the negative environmental impacts - including those on the archaeological resource - of the aggregate industry.

In England, two levels of development plan affect aggregate extraction: Structure Plans set out general principles and policies in line with national policies for all forms of development and Local Plans cover detailed policies for control of development in the local area (Steadman *et al*. 2004). Local Plans relevant to aggregates include Minerals Local Plans (MLP) or Minerals and Waste Local Plans, which are prepared

by local authorities and set out detailed policies governing extraction. (For a comprehensive description of historical and current planning legislation relating to mineral extraction see Planning4Minerals: A Guide on Aggregates (NERC 2006)).
Minerals Local Plans usually indicate areas in which mineral extraction might be acceptable and where proposals will normally be resisted or considered inappropriate. Of the local authorities within the study area only Selby District (via North Yorkshire CC) and Nottinghamshire CC have Minerals Local Plans. Doncaster MBC, Leeds City Council, Wakefield MDC, Rotherham MBC and Barnsley MBC presently have no specific MLP, but do have detailed policies and proposals in their Unitary Development Plans (UDPs) that are used for site-specific considerations in the Planning Process. In Wakefield District there is a relative scarcity of most minerals, other than coal, and therefore the adoption of individual policies to control the working of crushed rock and sand and gravel was not considered appropriate. Consequently, Policy OL8 of the Wakefield UDP provides a basic development control policy for all mineral extraction other than coal (WMDC 2003, 10.5.49). The Minerals Local Plans for North Yorkshire were adopted in 1997 and the Nottinghamshire MLP was adopted in 2005, however, following the introduction of the Planning and Compulsory Act 2004, local authorities are required to prepare a Local Development Framework (LDF), which will ultimately replace Structure Plans, Minerals Local Plans and Unitary Development Plans (NERC 2006). North Yorkshire CC has recently issued proposals for consultation and anticipates having their Minerals and Waste Site Allocations Development Plan adopted around December 2008 (Gresty 2006a). Both Doncaster MBC and Barnsley MBC are due to produce pre-submission LDFs after 2007.

Within the MLP/UDP structure three methods are employed to assist Mineral Planning Authorities in deciding where future mineral extraction might be appropriate, namely Specific Sites, Preferred Areas and Areas of Search (Steadman *et al.* 2004). Specific sites are where the Mineral Planning Authority is aware that certain sites have viable mineral resources, that the landowners are willing to allow mineral development and 'that any planning applications which come forward are likely to be acceptable in planning terms' (MPG1 1996). These are often planned extensions to existing quarry sites and offer a degree of certainty to the planning applicant, the landowner and the general public that mineral extraction will take place.

Preferred areas are locations of *known* mineral resources 'where planning permission might reasonably be anticipated by industry' (MPG1 1996), as long as any detailed issues at each site are properly addressed in a planning application. They are generally much larger than specific sites and less well defined, although viable reserves are known to exist. Occasionally there may be little difference between specific sites and preferred areas. The ability of a Mineral Planning Authority to identify preferred areas requires comprehensive information on the nature and distribution of mineral resources and the likely environmental implications of working the resources in addition to an understanding of the likely levels of demand for the mineral (Highley *et al*. 2005). The identification of preferred areas therefore depends largely on subjective decisions about where extraction is likely to be more successful and acceptable.

Areas of search can contain both sites that meet the requirements for minerals extraction as well as sites that are unlikely to be granted planning permission for economic or environmental reasons. They exist primarily as a cushion, in the event of a shortfall in the supply of minerals because applications for extraction in specific sites or in preferred areas did not come forward. Planning permissions can be granted in an area of search in order to meet additional requirements that cannot be met through the MLP/UDPs specific sites or preferred areas. The western edge of North Yorkshire bordering Leeds district is designated an area of search covering almost 59 sq km (Fig. 7.1.1).

In addition to the above some local authorities use buffer zones and Safeguarding Areas. A buffer zone is a designated area bordering an extraction site designed to protect residential development and other sensitive areas, including those of archaeological and historical significance, from the effects of surface mineral development (Skinner 1998). Additional development within a buffer zone is denied where it would constrain existing mineral development or possible future mineral development. Buffer zones are particularly important where crushed rock is blasted and processed on-site and are required within Doncaster's UDP and employed around existing and potential limestone quarries in the west of the Doncaster area. Conversely, in the east of the district, sand and gravel workings are protected by large Safeguarding Areas that prevent development, beyond the preferred areas and areas of

search, that may result in the 'sterilisation' of the mineral deposit (Skinner 1998, 222). Because it is considered likely that good sand and gravel deposits will be in increasingly short supply in parts of the study area, Safeguarding Areas are employed by Doncaster MBC, and occur on a much smaller scale, in parts of Wakefield and Leeds districts (Fig. 7.1.1).

Areas that hold valid planning permissions for extraction are referred to as 'reserves' or 'mineral reserves'. Normally a 'landbank' is quoted for aggregate minerals, which is the total of all permitted reserves for a given area at a specified time. This includes active and inactive quarries, sites that have been worked in the past and also those where extraction is yet to begin (Brown and Highley 2006). The landbank is usually expressed in terms of years supply at an average rate of output and is the key indicator in assessing when new permissions should be considered. The minimum length of a landbank reflects the time needed to obtain planning permission and to bring a site into full production. In England, current guidance indicates that this should be for a minimum of seven years for sand and/or gravel and a longer period for crushed rock (Highley *et al.* 2005).

A variety of rocks are, when crushed, suitable for use as aggregates, the most important resources in the study area being Permian limestone and dolomite. These materials are highly variable and much softer than higher quality Carboniferous limestone; hence, they are quarried for mostly low-grade applications. Some beds are, however, sufficiently strong to be used as concreting aggregate and several quarries near Maltby in South Yorkshire produce high quality aggregate materials (Highley *et al*. 2005).

Sandstones have traditionally been valued as sources of building stone but today only about 3% of total production is for this purpose and sandstone is now used mainly as crushed rock aggregate. The most extensively worked sandstones are those of Upper Carboniferous Millstone Grits and Coal Measures in the Pennines. Aggregates produced from these sandstones are mostly of low or moderate strength and are, therefore, generally considered to be low-quality. There is, however, a considerable demand for these aggregates in West Yorkshire due to the lack of other suitable materials that can be locally supplied (Highley *et al*. 2005).

Sand and gravel (more correctly 'fine aggregate' and 'coarse aggregate') resources can be classified into two major categories depending on their age and geology: superficial or ‘drift’ deposits and bedrock or ‘solid’ deposits. Superficial deposits mainly comprise river sands and gravels which take the form of extensive spreads that occur along the floors of major river valleys, generally beneath alluvium, and as river terraces flanking the valley sides. Resources in some river valleys are being rapidly depleted because they have been extensively worked in the past. Deposits are often worked below the water table and thus give rise to lakes on completion. In general, the composition of the sand and gravel of a river basin reflects that of the rocks in the uplands drained by the river and its tributaries.

The other major group of resources is glaciofluvial sands and gravels. The deposits are commonly associated with till occurring as sheet layers above or as irregular lenses within the till. Bodies of wholly concealed, and thus unknown, sand and gravel may occur under spreads of till. As a result, the distribution of glaciofluvial deposits is less predictable in geographical extent than river sand and gravel deposits. The essential feature of these deposits, critical in terms of their economic value, is their variation in both thickness and composition. Thicknesses of over 30m have been reported but overburden thicknesses can also be high.

Bedrock deposits of sand and/or gravel are important sources of supply in Yorkshire and Humberside. Some deposits such as the Permian Yellow Sands consist entirely of sand. The sandy pebble beds (conglomerates) of the Sherwood Sandstones in North Nottinghamshire are important sources of coarse concrete aggregate. Where devoid of pebbles, the deposits are of lesser value as an aggregate resource but may be worked locally for fine aggregate. Bedrock deposits are generally much thicker than most superficial deposits and thus yields per hectare are much greater.

Quarries in the study area have exploited the mineral and aggregate resources since at least the Roman period. Quarry pits associated with the construction of the Roman road between Micklefield and Aberford have been identified at Roman Ridge (O'Neill 2001). A number of long established quarries are located close to Roman roads, including Smaws, Highmoor, Jackdaw Crag, Barnsdale Bar, Skelbrooke, Brodsworth,

Hurst Plantation, and Austerfield, and as the Roman road system is intrinsically linked to the exploitation of raw materials (Parsons 1990, 3) their location may hint at earlier aggregate workings. The Romans are reported to have used gritstone from Thorner, near Leeds for building in York (Pevsner and Neave 1972). The Roman town of *Calcaria* (Tadcaster) takes its name from 'limestone' and may make reference to lime kilns or lime quarrying (Smith 1961, 76) and the extraction of local clay supported a Roman pottery industry at Potteric Carr, Cantley and Rossington Bridge (Buckland *et al.* 1980).

Several Permian limestone quarries on the Cadeby and Brotherton formations were worked for building stone during the medieval period, as evidenced by documentary sources, namely, Smaws, Jackdaw Crag, Sherburn, Newthorpe, Foxcliffe, Darrington, and the Hampole area incorporating the quarries at Hazel Lane and Skelbrooke (Page 1974, 376; NY SMR; Yarwood 1981b; LUAU 1999). The earliest known building constructed using Magnesian Limestone that still survives is the Anglo-Saxon church at Ledsham, north of Pontefract (Yarwood 1981b). Tadcaster Stone was extracted from Smaws Quarry and Jackdaw Crag Quarry near Tadcaster; the latter is thought to have supplied the original stone for York Minster (Hart 1988, 12) and many of the principal buildings in medieval York (Pevsner and Neave 1972). In South Yorkshire, the Roche Abbey quarries in the parish of Maltby supplied limestone for the groined roof of King's College chapel, Cambridge (Lewis 1848).

Many of the industrial towns that expanded during the 18th and 19th centuries on the success of the textile trade and the steel and coal industries, particularly in South and West Yorkshire, used local material for civic building. Several sandstone horizons in the Coal Measures were worked for both building stone and grindstone, and a larger number for walling and roadstone. Notable building stone includes Thornhill Rock, Wooley Edge Rock and Ackworth Rock (Lake 1999). Examination of the first edition Ordnance Survey mapping demonstrates the extent of quarrying for building stone, minerals and aggregates during the 19th century. Some quarries active today date from this time, or earlier (Section 7), and some have adapted to target different resources. A small quarry at Cadeby near Doncaster produced building stone in the early 19th century. At the end of the century it had expanded and was engaged in the extraction of dolomite for the glass industry. Today, Cadeby Quarry (Cat. 21)

continues to extract dolomite for this purpose, along with the nearby Warmsworth Quarry (Bloodworth *et al.* 2004) but it is now also a major source of crushed limestone aggregates (Hart 1988). Further north the Basal Permian Sand were mined in a band from Garforth to south of Kippax and to the east of Castleford and Pontefract. This was used for glass making in the Glass Houghton area from the early 1700s and was extracted for a moulding sand for the iron and steel industry until recently (Lake 1999).

Both the Cadeby and Brotherton formations have been quarried for burning to produce lime for use in mortar and as fertiliser (Yarwood 1981b), the latter has been extensively worked in the Brotherton and Knottingley areas (Lake 1999). The Cadeby limestone is also documented for its quality, as in the parish of Stainton to the west of Tickhill where, 'the substratum abounds with limestone of good quality, which is extensively burnt into lime' (Lewis 1848). The Permian mudstone of the Edlington and Roxby Marls contain abundant gypsum, which was exploited in surface workings, 'plaster pits', up to 10m deep (Lake 1999). Roman gypsum burials are known from Glass Houghton and extraction continued during the medieval and later periods particularly in the Ferrybridge and Ledsham areas (Yarwood 1981); the latter producing gypsum of 'alibastrine quality' used for sculpted monuments in the later medieval period (Gaunt and Buckland 2003, 21).

Clay and shale are extracted at five quarries in the west of the study area, which are mainly involved with brick manufacture utilising Coal Measures mudstones and clay overburden on stone quarries. Clay is extracted from brickworks at Altofts, Newlands Lane, Nostell, and Swillington in West Yorkshire and Maltby in South Yorkshire. The production and use of bricks date back to the 16th century when they were used for the construction of Temple Newsam (Linstrum 1978, 21). The house was rebuilt and enlarged in the first half of the 17th century using locally produced bricks. Earthworks associated with brick-making are visible within Brickiln Field at nearby Colton (Yarwood 1981) close to the extant brickworks at Swillington.

Mudstone strata within coal seams were worked for fireclay, as a refractory material used for the production of tiles and pipes, and for the manufacture of fine pottery and stoneware up to the 19th century at potteries around Leeds, Castleford and

Ferrybridge (Lake 1999). Fireclay is currently extracted at Newlands Lane Quarry (Cameron *et al*. 2005).

For this ALSF report, quarry data were obtained from the online British Geological Survey GeoIndex (www.bgs.ac.uk/geoindex) in conjunction with data from the Directory of Mines and Quarries (Cameron *et al*. 2005). A total of 56 sites were identified within the bounds of the study area, of which 41 were active at the time of writing. The individual sites are described in detail in the quarry catalogue (Section 7) and are split between 25 sand and gravel, 23 Magnesian Limestone, 5 clay and shale, and 3 sandstone (Fig. 7.1).

The majority of sand and gravel quarries work river terrace deposits located on the Sherwood Sandstones, with the exception of Firgreen Quarry (Cat. 1) located on glaciofluvial deposits overlying Permian marls and Moss Carr Wood (Cat. 4) that previously operated on 'Older' till deposits overlying Middle Coal Measures. Magnesian Limestone extraction is divided between the Cadeby and Brotherton formations, the former being the largest fraction forming 49% of the Permian outcrop. The five quarries located on the clay and shales of the Middle and Upper Coal Measures are all extracting clay as the primary resource and are related to on-site or nearby brickworks; Hazel Lane Quarry (Cat. 44) extracts clay and underlying limestone. Only three quarries are listed for the production of building sandstone, although Styrrup Quarry (Cat. 37) has ceased extraction of stone and now only removes unprocessed sand (NCC 2005).

Nationally, most sand and gravel quarries have outputs in the range 100–300,000 tonnes per year, with very few producing annual amounts in excess of 0.5 million (Highley *et al*. 2005). At Methley, river Calder terrace deposits produce approximately 180,000 tonnes of aggregates per year (McEvoy *et al*. 2004). The extensive deposits of the Sherwood Sandstones can normally produce 60-80,000 tonnes from each hectare annually in the Idle Valley but a more modest return of 20-30,000 tonnes per hectare is produced around Misson (Cat. 33/34) (NCC AMLP).

The extraction of solid rock to be crushed for aggregates requires quarries that are much larger and deeper than sand and gravel operations. Crushed rock quarries

typically can have outputs in the range 100,000 tonnes per year up to *c*. 5 million tonnes per year (Highley *et al*. 2005). A recent planning application for an extension at Jackdaw Crags Quarry (Cat. 10) predicts annual production of 200,000 tonnes of limestone over a fourteen-year period, which equates to *c*. 41,000 tonnes per hectare. At Barnsdale Bar Northern Extension an annual extraction of 350,000 tonnes over 5-6 years is estimated (Gresty 2006b).

Despite an increased requirement for the use of alternative materials, such as recycled demolition waste, crushed rock aggregate and sand and gravel remain the most important sources of construction aggregates. In 2004 the Yorkshire and Humber Region produced a total of 4.52 million tonnes (m/t) of sand and gravel and over 12 m/t of crushed rock (Brown and Highley 2006). Technical advice on the demand for, and supply of, construction aggregates is given to the Regional Planning Body and to the Office of the Deputy Prime Minister (ODPM) by the Yorkshire and the Humber Regional Aggregate Working Party (RSS 2004/5). In 2003 the ODPM published revised national and regional guidelines for the provision of aggregates in England for the period 2001 to 2016. These guidelines replaced those published in Mineral Planning Guideline 6 (Brown and Highley 2006).

The figures for land-won sand and gravel and crushed rock aggregate have been apportioned for each region based on the average reserves for the five-year period 1997 to 2001 (ODPM 2004). For Yorkshire and the Humber Region the following estimates for production from 2001 to 2016 are: Land-won crushed rock 220 m/t (52%), land-won sand and gravel 73 m/t (17.2%), marine sand and gravel 3 m/t (0.7%) and alternative materials 128 m/t (30.1%). Current reserves of crushed rock, as estimated in 2001, should exceed anticipated demand by 187 m/t (Table 1). Conversely, sand and gravel reserves are below expected demand (Table 2), with a possible deficit of 11.55 m/t in North Yorkshire and 4.74 m/t from the combined output of the East Riding and North Lincolnshire, with South Yorkshire showing a surplus of 2.96 m/t. The total sand and gravel reserve in West Yorkshire is confidential but estimated to be low (ODPM 2004). Mineral resources in Wakefield are relatively scarce and so there is a dependency on imports from other areas for the majority of aggregate minerals used in the District (WMDC 2003, 10.5.45).

**Table 1. Crushed Rock**

| | 5-year average 1997 – 2001 % | Guideline 2001 – 2016 (m/t) | Reserves at beginning of 2001 (m/t) | Surplus/deficit (m/t) |
|---|---|---|---|---|
| North Yorkshire | 64.02% | 140.85 | 269.08 * | + 132.81 * |
| South Yorkshire | 24.30% | 53.46 | 99.79 | + 46.33 |
| West Yorkshire | 8.09% | 17.80 | 25.77 | + 7.97 |
| East Riding | 2.39% | 5.26 | 89.63 | Mostly non-aggregate use |
| North Lincolnshire | 1.20% | 2.64 | | |
| | 100% | 220 | | 187 |

Source: RSS, 2004/5. * Excludes North York Moors NP, data withheld

The most recently published figures on primary aggregate reserves for the Yorkshire and the Humber region give totals at the end of 2004 of 353 m/t of crushed rock, an estimated surplus of 133 m/t, and 49 m/t of sand and gravel, and a forecast combined deficit of 24 m/t by 2016 (Brown and Highley 2006, table 18).

**Table 2. Land-won Sand and Gravel**

| | 5-year average 1997 – 2001 % | Guideline 2001 – 2016 (m/t) | Reserves at beginning of 2001 (m/t) | Surplus/deficit (m/t) |
|---|---|---|---|---|
| North Yorkshire | 57.6% | 42.08 | 30.53 | - 11.55 |
| South Yorkshire | 17.8% | 13.03 | 15.99 | + 2.96 |
| West Yorkshire | 7.6% | 5.51 | Confidential (low) | - |
| East Riding | 11.3% | 8.26 | 7.63 | - 4.74 |
| North Lincolnshire | 5.6% | 4.11 | | |
| | 100% | 73 | | -13.33 |

Source: RSS 2004/5

The Yorkshire and the Humber region is one of the major producers of aggregate in the UK. In terms of tonnage, aggregate minerals are likely to continue as the major surface mineral worked in the study area. Minerals Policy Guidance 6 (MPG6 1994) states the need for an adequate and steady supply of aggregate, whilst at the same time recognising that such extraction has a significant environmental impact; one aspect of which is the archaeological resource (e.g. North Yorkshire Minerals Local Plan (NYCC) 1997, policies 4/7, 4/8 and 4/9; Doncaster Unitary Development Plan 1998, policies ENV35-38), a resource that includes ancient river channels (palaeochannels) and alluvial (river borne) or colluvial (surface wash) deposits in the Nottinghamshire MLP (NCC 2005, Section 3.96).

At present, existing aggregate extraction operations receive archaeological investigation as a consequence of Section 106 agreements, entered into by Mineral Operators largely as a consequence of the long-standing *Archaeological Investigations. The Code of Practice for Mineral Operators* produced by the Confederation of British Industry (last revised in 1991). Alternatively, archaeological investigations have taken place as a consequence of post-determination planning conditions. Increasingly, however, the planning process has required pre-determination archaeological assessment and evaluation of proposed aggregates sites and is a key issue in the review of Planning Policy Guidance Note 16 (PPG 16). This trend has frustrated minerals operators who are concerned by potential delays imposed by 'over-the-top' pre-determination investigations, particularly in Yorkshire (Roberts *et al*. 2004).

The existence of a Minerals Local Plan gives some predictability regarding locations liable to be subject to aggregate extraction over the short term. Even in these areas there is not yet anything decided regarding the location or extent of preferred areas for extraction in the new MLP/LDF. In the Selby District of North Yorkshire all the preferred areas are almost worked and the new MLP is overdue. In Doncaster there are better reserves in the landbanks, but more areas for sand and gravel will need to be designated to compensate for the shortfall if guideline figures are to be met. In all areas there could also be additional aggregate working through short-term permissions via the planning process, or the reactivation of old quarries or for the purpose of borrow pits associated with specific developments, such as new highways projects, or

the excavation of agricultural lagoons for water supply. The Regional Aggregates Working Party advice is that:

> *'There is insufficient evidence to assess the likely environmental impacts of additional sand and gravel extraction and the ability of the aggregate producing areas concerned to absorb such impacts. Comprehensive studies of these factors are required and additional work is needed to investigate the composition of sand and gravel reserves in the region, particularly in Doncaster.'*
> (RSS 2004/5, para.10).

Under such circumstances, and in the absence of MLPs in Leeds and Wakefield districts, there is a degree of unpredictability about where future aggregate extraction may occur. Therefore, it is not wholly possible to localise the potential impact of aggregate extraction on the archaeological resource (Roberts *et al*. 2004).

All quarries have restoration conditions attached to them at the time planning permission is granted and mineral developments are seen as temporary uses of land which 'can be restored to the original or an alternative use' (Gresty 2006a, 4). Extraction sites can be reinstated as agricultural land, landscaped to create recreation and amenity sites, left open as 'type' sites to expose geological strata or commonly developed as wildlife habitats; over one third of the Sites of Special Scientific Interest nationally are old quarry sites (BAA 2005). Only one aspect of the original quarry site cannot be restored or recreated *in situ* - the buried archaeological heritage resource.