

Minerals Local Plan Background Document

Clay in Worcestershire

Worcestershire County Council

September 2018

Document Details:

Document Location: www.worcestershire.gov.uk/minerals

Contact: *Minerals and Waste Planning Policy*
Worcestershire County Council, Business, Environment and Communities, Minerals Planning, County Hall, Worcester, WR5 2NP

Email: minerals@worcestershire.gov.uk

Tel: 01905 766374

1. Executive Summary

- 1.1 Worcestershire contains extensive clay deposits which have been worked for brick production for centuries. Clay is currently worked at two sites in the county, each of which has an associated brickworks. Together, the sites are capable of producing over two million bricks per week. These sites contribute to the local and national supply of construction materials and are essential to the continued smooth functioning of the construction industry. The county's stock of permitted reserves is either 63 years (using averages of known past sales estimates), or 24 years (based on operator's data).¹
- 1.2 Clay is considered an 'industrial mineral' in national policy, and mineral planning authorities are required to plan for a steady and adequate supply, including by providing a stock of permitted reserves of at least 25 years for brick clay.
- 1.3 Because the clay currently worked in Worcestershire is used for brick production, this paper focuses primarily on brick clay, and other types of clay will be addressed in brief.

¹ Based on the figure for the remaining stock of permitted reserves in December 2016 (as provided in confidential discussions with the operator of the clay sites in Worcestershire, Weinerberger, April 2017), the permitted reserves would last approximately 63 years based on the 10 year average of known annual sales. Based on the sites' maximum potential output this could be less than 25 years.

Contents

1. Executive Summary	2
Contents.....	3
2. Introduction to clay	5
Geology	5
Types of clay.....	7
Clay resources in Worcestershire.....	8
Economics: Brick Clay	12
Recycled bricks and alternatives to primary extraction	14
3. Winning and working clay.....	15
Extraction.....	15
Preparation and processing	16
Production.....	16
Forming.....	16
Drying	18
Firing.....	18
4. Clay extraction and brick works in Worcestershire.....	19
Clay and brick sales	19
Historical workings in Worcestershire.....	21
Future of the clay industry in Worcestershire.....	22
Safeguarding.....	22
5. Policy context for clay extraction	23
National Planning Policy Framework.....	23
National Planning Practice Guidance	24
Local Planning Policies	25
6. Planning issues arising from clay extraction	28
Traffic.....	28
Dust	29
Noise.....	31
Waste.....	32

Water and hydrogeological impacts.....	32
Visual Impacts.....	33
Protected sites and designated landscapes	34
Green Belt.....	35
Restoration potential	35
Historic conservation.....	36
Geological conservation	37
Climate change	37
Resilience	38
Mitigation	39
7. Conclusion	40
Appendix 1: Glossary	42
Appendix 2: Case Studies	44

2. Introduction to clay

- 2.1. Durable and convenient clay bricks are one of the oldest building materials. Burnt and fired bricks are known to have been used in ancient cities, and have been dated to over 6,000 years old.
- 2.2. Clay is an incredibly versatile material. In addition to being essential as a raw material for the construction industry through its use in bricks, tiles, pavers and pipes, clay is also used in cement production, as a construction fill, and for lining and sealing landfill sites. Beyond the building industry, clay is used to manufacture ceramics, bathroom fixtures and fittings, cooking pots, art objects and musical instruments as well as in industrial processes such as paper making, chemical filtering, and in the production of some medicines. Other clay deposits such as diatomite (fossilised algae) and bentonite (formed from the alteration of volcanic ash) are used in the food industry to clarify drinks, such as beer, fruit juices and wine.

Geology

- 2.3. Clay bricks are produced in all parts of the UK, but England accounts for about 90% of brick production². There are significant clay resources in the West Midlands, but not all clays are suitable for brickmaking as only certain geological formations have the physical and chemical properties suitable for use in the manufacture of bricks, pipes and tiles, or for environmental and engineering uses. Factors including the presence of other rock types, large amounts of overburden, and impurities in the clay can preclude working in areas that may otherwise appear suitable.
- 2.4. Historically, a wide variety of clays have been used in the manufacture of clay products, including waste from other mineral extraction operations³, and the term 'clay' has been used relatively loosely as the clay mineral content of the raw material may vary from 20% to 80%⁴. The term "brick clay" can

² British Geological Survey (2007) Mineral Planning Fact sheet: Brick Clay [online] Available at <http://www.bgs.ac.uk/mineralsuk/planning/mineralPlanningFactsheets.html> [Accessed 13.09.2018] p.7

³ British Geological Survey (2007) Mineral Planning Fact sheet: Brick Clay [online] Available at <http://www.bgs.ac.uk/mineralsuk/planning/mineralPlanningFactsheets.html> [Accessed 13.09.2018] p.6

⁴ British Geological Survey (2007) Mineral Planning Fact sheet: Brick Clay [online] Available at <http://www.bgs.ac.uk/mineralsuk/planning/mineralPlanningFactsheets.html> [Accessed 13.09.2018] p.9

encompass sedimentary mudstones of a variety of geological ages and compositions ranging from relatively soft, plastic clays to hard mudstones.

- 2.5. Brick production in the Midlands is mainly from the Mercia Mudstone Group (sometimes called the 'Keuper Marl'). The mineralogy of these clays produces distinctive pale-coloured bricks.
- 2.6. Some particularly valuable clays are nationally scarce, but these are mainly found outside of the Midlands (see below under 'types of clay').
- 2.7. The chemical and physical properties of a deposit are critical to determining how suitable the material is for the manufacture of structural clay products. These properties affect the "forming behaviour" of the clay (that is, how the material behaves before it is fired), the behaviour during drying and firing, and the final properties of the finished product⁵.
- 2.8. Sedimentary clays are mainly composed of clay minerals and quartz, though many other minerals may be present in trace amounts. These trace minerals can also affect the suitability of a deposit for brickmaking. Ideally, a brick clay must have enough clay mineral to allow it to be moulded but also retain its shape prior to and during firing. It must also have enough 'fluxing materials'⁶ to allow the clay to vitrify (partially fuse) during firing. However, the clay must also have enough 'non-plastic' components to ensure that the bricks do not shrink and deform during firing⁷.
- 2.9. These additional minerals can include carbon, sulphur, iron and calcite, all of which can impart different properties to the bricks including colour, firing performance, and surface finish. The variety of compositions of clays (and therefore the bricks made from them) gives rise to distinctive regional variations in the appearance of the built environment.
- 2.10. As brick production has fallen and the size of production units increased, production has concentrated on a more limited range of resources which has contributed to the supply of raw materials with more predictable and consistent firing characteristics.

⁵ British Geological Survey (2007) Mineral Planning Fact sheet: Brick Clay [online] Available at <http://www.bgs.ac.uk/mineralsuk/planning/mineralPlanningFactsheets.html> [Accessed 13.09.2018] p.1

⁶ Specific mineral or chemical components of clays that promote the limited and controlled formation of glass in clay bodies during firing in order to cement crystalline components together. These essentially lower the overall melting point of the clay body which allows for more efficient firing.

⁷ British Geological Survey (2007) Mineral Planning Fact sheet: Brick Clay [online] Available at <http://www.bgs.ac.uk/mineralsuk/planning/mineralPlanningFactsheets.html> [Accessed 13.09.2018] p.7

Types of clay

- 2.11. Clays are mainly composed of mudstones of varying hardness, but there are a number of recognised variations and uses for different specifications of clay. These are covered in brief below, though the remainder of this paper will focus on brick clay as that is what is produced in Worcestershire. Other types of clay are occasionally blended with brick clay in order to obtain particular sought-after characteristics.

Fireclay

- 2.12. Fireclay is generally associated with coal seams. The term was derived from the fact that these clays are unusually heat-resistant. In the past, these clays were used to line furnaces and were very valuable for the manufacture of firebricks and heat resistant ceramics. Today the term is used for any fireclay that is of economic interest regardless of its heat resistant properties, and the major use of fireclay is now brickmaking.
- 2.13. Fireclays are valued in brickmaking due to their relatively low iron content which gives them a desirable buff colour when fired. They also have important frost-resistant qualities. In the mid-2000s, the Caugley Quarry in Shropshire was the most important source of buff-firing fireclays in Britain⁸. Fireclay is not produced in Worcestershire.

Ball Clay

- 2.14. Ball clays are very fine grained, highly plastic clays, which fire to a light or near white colour. They are mainly used in the manufacture of ceramics, including sanitary-ware, tiles and tableware. Ball clay is quarried in Devon, but is often blended with clays produced elsewhere (including Kaolin) to improve its performance⁹. Ball clay is not found in Worcestershire.

Kaolin

- 2.15. Kaolin, sometimes referred to as China Clay, is composed mainly of the mineral Kaolinite. It is valued for its whiteness, its fine but controllable particle size, and its flat molecular shape, which lends it greater opacity than other

⁸ British Geological Survey (2006) Mineral Planning Fact sheet: Fireclay [online] Available at <http://www.bgs.ac.uk/mineralsuk/planning/mineralPlanningFactsheets.html> [Accessed 13.09.2018] p.6.

⁹ British Geological Survey (2011) Mineral Planning Fact sheet: Ball Clay [online] Available at <http://www.bgs.ac.uk/mineralsuk/planning/mineralPlanningFactsheets.html> [Accessed 13.09.2018] p.1.

clays. It is also non-abrasive and inert. Kaolin has a variety of industrial applications, including ceramics and paper making, and the resources of South-West England are an important economic asset. Kaolin is not found in Worcestershire.

Brick Clay

2.16. Brick clays are used in the production of structural clay products including bricks, pavers, tiles and pipes. There are three basic types of construction bricks:

- Common bricks, for general building work;
- Facing bricks, with aesthetic properties for fine work including colour and texture variations (these account for over 90% of demand¹⁰); and
- Engineering bricks, made for specific load-bearing or difficult conditions (including high strength or frost-resistance)¹¹.

Brick clay is found in Worcestershire.

Clay resources in Worcestershire

2.17. There are 24 geological formations in Worcestershire that possess some clay properties, however many of these are not extensive in their spread and do not contain high-quality clays that are currently useful. The following are the most important clay formations in Worcestershire:

- **Mercia Mudstone Group:** This group accounts for over 45% of the clay groups in Worcestershire¹² and includes:
 - Blue Anchor Formation: Typically comprising pale green-grey, dolomitic silty mudstones and siltstones¹³. Small deposits are found around Worcester, Droitwich, and Redditch.
 - Branscombe Formation: This mudstone and siltstone formation is typically red-brown with common grey-green reduction patches and spots. The mudstones are mostly structureless, with a blocky weathering habit and Gypsum/anhydrite is

¹⁰ British Geological Survey (2007) Mineral Planning Fact sheet: Brick Clay [online] Available at <http://www.bgs.ac.uk/mineralsuk/planning/mineralPlanningFactsheets.html> [Accessed 13.09.2018] p.1.

¹¹ Surrey County Council (2011) Minerals Local Plan – Chapter 6

¹² By coverage (ha)

¹³ The BGS Lexicon of Named Rock Units: Blue Anchor Formation [online] Available at <http://www.bgs.ac.uk/Lexicon/lexicon.cfm?pub=BAN> [Accessed 13.09.2018]

common throughout¹⁴. A small deposit runs south from Worcester down into Gloucestershire through Upton-upon-Severn.

- Arden Sandstone Formation: The Arden Sandstone Formation is a predominantly greenish grey colour with the presence of a significant proportion of sandstone. It's found in small dispersed deposits near Malvern, Upton-upon-Severn and south of Worcester. Grey with slightly sandy clay soils.
- Sidmouth Mudstone Formation: The formation consists of red-brown mudstone and siltstone, with common grey-green reduction patches and spots. A small formation is found in the Malvern Hills area where there are reddish-brown clayey soils.

This group is currently worked at three sites in the county and contains 80% of Worcestershire's historic clay pits, brickworks and kilns.

- **Sherwood Sandstone Group:** This group covers large areas of the north of the county forming an arc north of Worcester and Redditch. It accounts for 15% of clay groups in Worcestershire¹⁵ and includes:
 - Bromsgrove Sandstone Formation: The formation consists of sandstones, red, brown and grey, commonly pebbly or conglomeratic at the bases of beds, interbedded with red and brown siltstones and mudstones.¹⁶
 - Wildmoor Sandstone Formation: The formation consists of sandstones, generally silty or argillaceous, fine- to medium-grained, bright orange-red to dark brick-red, with subordinate siltstone and mudstone; pebbles rare.¹⁷
 - Kidderminster Sandstone Formation: The formation consists of pebble conglomerates and reddish brown sandstones. The sandstones are cross-bedded and pebbly. The conglomerates have a reddish brown sandy matrix and consist mainly of pebbles of brown or purple quartzite, with quartz conglomerate and vein quartz. (Mitchell and others, 1962).¹⁸

This group is not currently worked in Worcestershire but contains 5% of Worcestershire's historic clay pits, brickworks and kilns.

¹⁴ The BGS Lexicon of Named Rock Units: Blue Anchor Formation [online] Available at <http://www.bgs.ac.uk/Lexicon/lexicon.cfm?pub=BCMU> [Accessed 13.09.2018]

¹⁵ By coverage (ha)

¹⁶ The BGS Lexicon of Named Rock Units: Bromsgrove Sandstone Formation [online] Available at <http://www.bgs.ac.uk/Lexicon/lexicon.cfm?pub=BMS> [Accessed 13.09.2018]

¹⁷ The BGS Lexicon of Named Rock Units: Wildmoor Sandstone Member [online] Available at <http://www.bgs.ac.uk/lexicon/lexicon.cfm?pub=WRS> [Accessed 13.09.2018]

¹⁸ The BGS Lexicon of Named Rock Units: Kidderminster Formation [online] Available at <http://www.bgs.ac.uk/Lexicon/lexicon.cfm?pub=KDM> [Accessed 13.09.2018]

- **Lias Group:** This group covers large areas of the south-east of the county and accounts for 18% of clay groups in Worcestershire.¹⁹ It includes:
 - Charmouth Mudstone Formation: abundant argillaceous limestone, phosphatic or ironstone (sideritic mudstone) nodules in some areas; organic-rich paper shales at some levels; finely sandy beds in lower part in some areas.
 - Blue Lias Formation: The formation consists of thinly interbedded limestone (laminated, nodular, or massive and persistent) and calcareous mudstone or siltstone (locally laminated). Individual limestones are typically 0.10-0.30m thick. In some areas, intervening mudstone units with relatively few limestone beds. Also includes littoral limestone facies of the Radstock Shelf - Mendip area and South Wales.

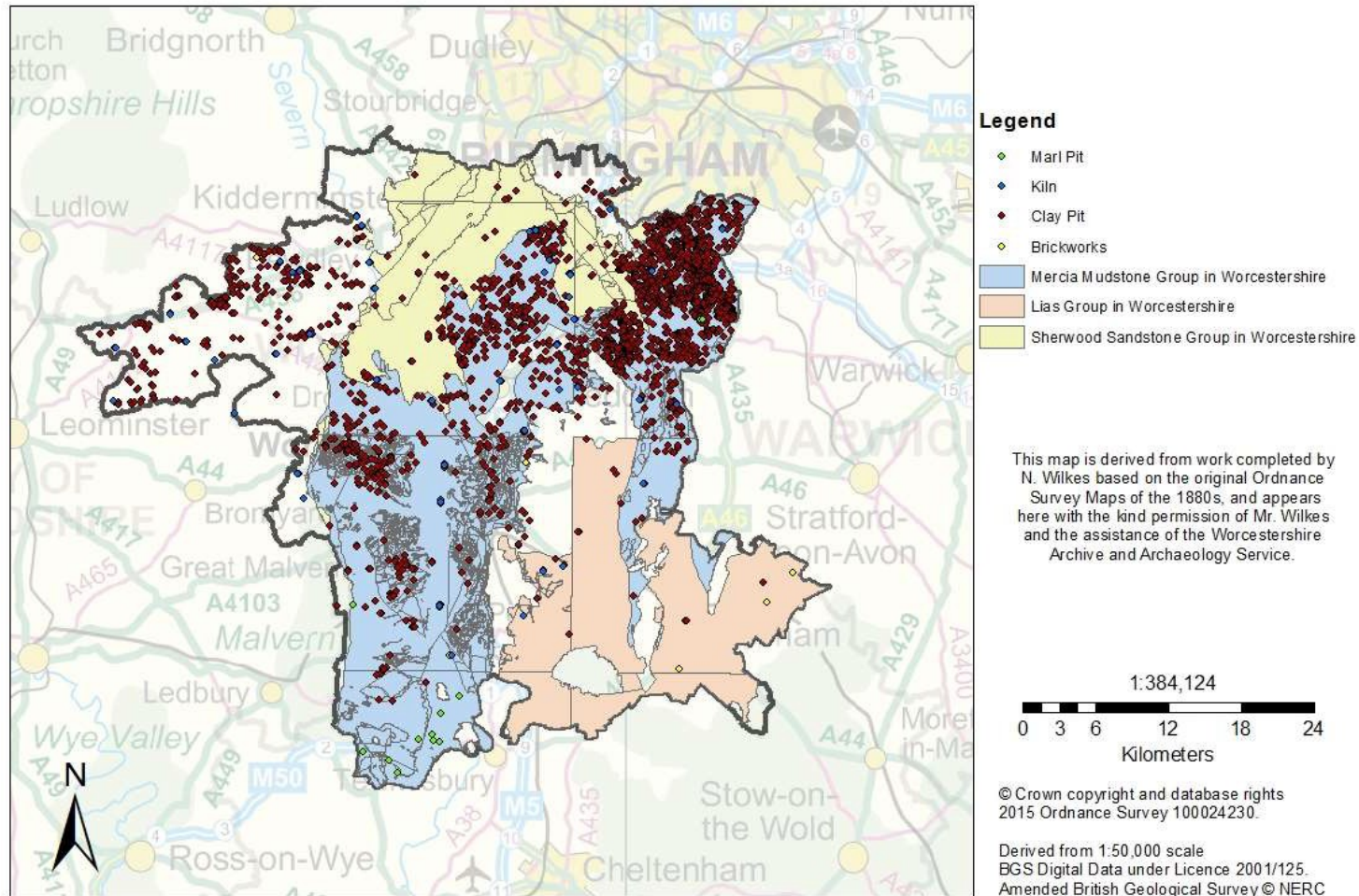
This group is not currently worked in Worcestershire and contains less than 1% of Worcestershire's historic clay pits, brickworks and kilns.

2.18. The other geological formations in Worcestershire that possess some clay properties collectively account for less than 20% of the clay-bearing formations found in the county. These are Downton Group (8%), Warwickshire Group (5%), Lower Old Red Sandstone Group (4%), Penarth Group (less than 1%), Bridgnorth Group (less than 1%) and Wenlock Group (less than 1%).

2.19. The County Council has only limited information about the specific geological conditions that might make any particular part of any of these deposits more suitable for extraction or commercially viable than another.

¹⁹ By coverage (ha)

Figure 1. Mercia Mudstone Group, Sherwood Sandstone Group and Lias Group in Worcestershire, with historic clay sites shown.



Economics: Brick Clay

2.20. Bricks, pipes and tiles are important to the construction industry, which is a major sector of the UK economy. Brick clay is mainly produced by brick manufacturers, and the location of the industry reflects the distribution of clay resources.

2.21. The industry contracted significantly from the mid-1970s to the mid-1990s (refer to figure 2 below). In 2007 there were about 100 brickworks operating in the country, however production was dominated by five major companies who had over 90% of the market share. The remaining 10% was made up of about 30 smaller independent companies, normally with a single site.²⁰ The large companies operate plants which can produce between 30 and 55 million bricks per year in the UK, while the smaller operators normally produce fewer than 5 million bricks per year.²¹

Figure 2: Seasonally adjusted deliveries of bricks, GB, 2013-2017²²

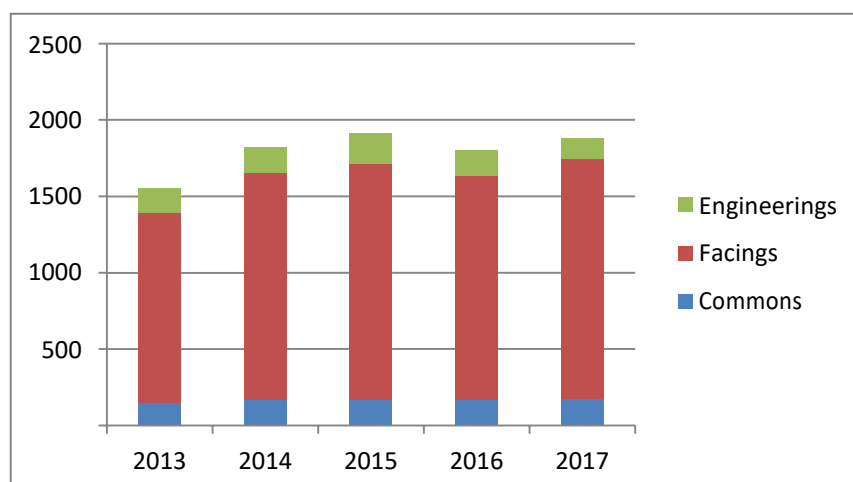


²⁰ British Geological Survey (2007) Mineral Planning Fact sheet: Brick Clay [online] Available at <http://www.bgs.ac.uk/mineralsuk/planning/mineralPlanningFactsheets.html> [Accessed 13.09.2018] p.5

²¹ British Geological Survey (2007) Mineral Planning Fact sheet: Brick Clay [online] Available at <http://www.bgs.ac.uk/mineralsuk/planning/mineralPlanningFactsheets.html> [Accessed on 13.09.2018] p.5

²² Department for Business, Energy and Industrial Strategy (April 2018) Monthly Statistics of Building Materials and Components – February 2018

Figure 3: Brick production Great Britain by type, 2013-2017 (millions)²³



2.22. During the recession, from around 2007, brick production declined. At the start of 2009, 90% of UK brick factories were temporarily closed, or on short-time working. The suppliers of support services to the ceramics industry in the West Midlands were seriously affected by the downturn, notably the Stoke-on-Trent based kiln-maker Drayton Beaumont, which ceased trading in February 2009²⁴.

2.23. As indicated in **Error! Reference source not found.** the market is recovering and production rates are generally increasing. In July 2014, brick company Wienerberger announced the creation of 120 new jobs nationally, and 35 in Worcestershire, increasing UK production by 200 million bricks per year²⁵. This is linked to the upturn in the building industry. New housing accounts for about 60% of the brick clay market and historically there has been a positive correlation between brick production and house building.

2.24. As illustrated in **Error! Reference source not found.**, there has been relatively limited production of 'common bricks' in recent years, as these have been replaced by other building materials in cavity walls and internal walls. The overall use of bricks is also dependent on changing building methods

²³ National Statistics (2018) Building materials and components statistics: August 2018 [online] available at <https://www.gov.uk/government/statistics/building-materials-and-components-statistics-august-2018> [Accessed 13.09.2018]

²⁴ Memorandum from the British Ceramic Confederation (WM 04) regarding the impact of the current economic and financial situation on businesses in the West Midlands Region - West Midlands Regional Committee 31st July 2009, Available at <https://publications.parliament.uk/pa/cm200809/cmselect/cmwestmid/409/409we05.htm> [Accessed 19.09.2018]

²⁵ Hanney, R., Wienerberger (2014) *Wienerberger to create 120 new jobs with 200m annual brick capacity rise* [online] Available at <http://www.wienerberger.co.uk/wienerberger-to-create-120-jobs-with-200m-annual-brick-capacity-rise.html> [Accessed 19.09.2018]

(including timber frame)²⁶. Other construction methods which involve increased use of wood or concrete could further reduce the demand for bricks, and therefore brick clay.

Recycled bricks and alternatives to primary extraction

- 2.25. There is limited scope to use substitutes for primary brick clay materials in brick manufacture. In the past, colliery waste was used extensively in brickmaking, but this is now limited, partially because the variability of colliery waste is not compatible with mechanised manufacturing methods which require high consistency of raw material. These materials can also be highly polluting when fired²⁷.
- 2.26. Other materials that can be substituted for clay in brick manufacturing include Pulverised Fuel Ash (PVA) or Incinerator Bottom Ash (IBA), granular blast furnace slag, ground recycled glass, polystyrene, and even some waste organic materials including sawdust, straw, and water treatment sludge.
- 2.27. The use of local clays in brick production has led to distinctive colours and styles of bricks that contribute to the local character of the built environment across the country. Re-use of bricks to ensure matching styles is a common practice in building conservation, although this is generally limited to those buildings constructed over 60 ago, as the lower-strength lime mortars used before that time make the bricks relatively easy to separate and clean. Newer Portland cement-based mortars are much stronger and impractical to remove²⁸, and bricks from newer buildings (with the mortar attached) are more often crushed and re-used as low-quality aggregate.
- 2.28. Reclaimed bricks have the potential to play an important role in reducing the demand for primary products in certain applications, although re-using bricks is often more costly than purchasing new bricks, because the reclamation process is so labour-intensive. Re-used bricks have high heritage value, and can be essential for specialised conservation works, and the importance of matching styles can offset the increased cost in these types of projects.

²⁶ UK Minerals Forum (2014) Trends in UK Production of Minerals [online] Available at https://www.ukmineralsforum.org.uk/downloads/Trends%20in%20UK%20Production%20of%20Minerals_08012014.pdf [Accessed 13.09.2018] p.17

²⁷ British Geological Survey (2007) Mineral Planning Fact sheet: Brick Clay [online] Available at <http://www.bgs.ac.uk/mineralsuk/planning/mineralPlanningFactsheets.html> [Accessed 13.09.2018] p.11

²⁸ British Geological Survey (2007) Mineral Planning Fact sheet: Brick Clay [online] Available at <http://www.bgs.ac.uk/mineralsuk/planning/mineralPlanningFactsheets.html> [Accessed 13.09.2018] p.11

3. Winning and working clay

3.1. This section primarily focuses on brickmaking, which is the main use of clay in Worcestershire. There are four basic stages in the brickmaking process:

- Clay extraction
- Clay preparation (getting the raw material into a workable consistency for forming or shaping)
- Drying (to remove moisture and add strength)
- Firing

Extraction

3.2. Brick clay is normally worked in open pits, though these may be deep or shallow, with uniform or heterogeneous deposits, and involve soft clays or hard shales²⁹. Approximately three tonnes of clay or shale are required to manufacture 1,000 bricks³⁰. The scale of clay extraction is much smaller than aggregates extraction in terms of total tonnage.

3.3. The precise method of extraction depends on the depth, thickness, hardness and geological characteristics of the clay deposit. Clay is often worked periodically using heavy plant machinery – this allows operators to stockpile large amounts of mineral, and excavate during periods of good weather³¹. This type of bulk winning also allows operators greater control over their production schedule.

²⁹ British Geological Survey (2007) Mineral Planning Fact sheet: Brick Clay [online] Available at <http://www.bgs.ac.uk/mineralsuk/planning/mineralPlanningFactsheets.html> [Accessed 13.09.2018] p.9

³⁰ British Geological Survey (2007) Mineral Planning Fact sheet: Brick Clay [online] Available at <http://www.bgs.ac.uk/mineralsuk/planning/mineralPlanningFactsheets.html> [Accessed 13.09.2018]

³¹ IBSTOCK (2005) Technical Information Sheet 16: How Clay Bricks are Made [online] Available at <http://www.ibstock.com/wp-content/uploads/2015/08/ibstock-TIS-A1-HOW-BRICKS-ARE-MADE.pdf> [Accessed 13.09.2018]

- 3.4. It is important to ensure that the material that goes into the plant is consistent. This means that excavation sometimes takes place by scraping the vertical face of a deposit to ensure a consistent mix. Layering stockpiles can also allow operators to eliminate localised variations in the clay reserve. Blending different clays to obtain increased durability or a range of colours and textures is increasingly common.

Preparation and processing

- 3.5. Clay brick and tile plants are often located near the clay deposit or pit which increases the efficiency of the process. The BGS explains that:
- "the impracticality and cost of removing impurities is such that brick clays undergo little processing other than grinding and screening to remove any hard or coarse components. It is, therefore, important to extract the clay selectively, avoiding any contaminating material³²".
- 3.6. Depending on geological conditions, clay processing may also require crushing, which transforms the clay rock into a mouldable material by grinding it and mixing it with water.

Production

Forming

- 3.7. Most bricks are made using the "extrusion" method, which accounts for about 65% of brick production. "*Extrusion involves forming a column of clay by pushing the material through a die at high pressure. The rectangular section column is then cut into bricks (known as 'wirecut'). Most drainage pipes and clay roof tiles are also made by extrusion*³³". This method requires fairly stiffly-textured clay.
- 3.8. Another method of brickmaking is the "soft mud" process, which involves forming individual bricks in a sand-lined mould (other lining materials are

³² British Geological Survey (2007) Mineral Planning Fact sheet: Brick Clay [online] Available at <http://www.bgs.ac.uk/mineralsuk/planning/mineralPlanningFactsheets.html> [Accessed 13.09.2018] p.9

³³ British Geological Survey (2007) Mineral Planning Fact sheet: Brick Clay [online] Available at <http://www.bgs.ac.uk/mineralsuk/planning/mineralPlanningFactsheets.html> [Accessed 13.09.2018] p.10

sometimes used). The lining is to prevent the clay sticking to the moulding box. As the name indicates, this method can be employed with a more 'watery' clay mix. This process results in bricks with a somewhat irregular outline, a popular aesthetic feature.

- 3.9. Bricks are also still handmade, albeit on a much smaller scale, especially in producing premium facing bricks and special shapes.

Drying

- 3.10. After forming, the bricks are dried. Drying is essential to lower the moisture content of the bricks, as bricks with a high moisture content can explode during firing. The bricks will shrink somewhat during drying – this is expected, and the moulding or extrusion processes described above account for this.

Firing

- 3.11. Once drying is complete, the bricks are fired. Firing temperatures can vary considerably (normally between 900 and 1200 degrees centigrade) depending on the mineralogy of the clay involved, but the end result is always a hard, durable, weather-resistant end product. The clay undergoes a chemical physical change during firing called 'vitrification', which usually also involves a colour change and further shrinkage.
- 3.12. Subjecting bricks to these high temperatures too quickly will result in cracking and damage, so firing normally takes place in three stages: pre-heating, firing, and cooling, and the type of kiln used can determine how these stages relate to each other.
- 3.13. There are two types of kiln: intermittent and continuous. Continuous kilns are normally more efficient for large-scale production – these can be of a 'tunnel' or 'chamber' type, but both allow for near-continuous production.

3. Clay extraction and brick works in Worcestershire

- 4.1. The only group that is currently worked for clay production in Worcestershire is the Mercia Mudstone Group. There are no further details about the formations within this group in Worcestershire. Firing this clay produces a relatively pale-coloured brick, and the mineralogy is well-suited to taking a variety of sanded and textured finishes in extruded wire-cut bricks, allowing the production of a wide range of colours and textures demanded by the house-building sector³⁴. Small quantities of clays from outside the area may be blended in to improve the physical and aesthetic character of some bricks.

Clay and brick sales

- 4.2. Worcestershire plays a significant role in the supply of brick clay and clay products both locally and nationally. This role has been maintained with some market fluctuations since at least the 1980s. Annual sales of brick clay from Worcestershire are approximately 126,250 tpa.³⁵
- 4.3. There are currently only two active sites for the winning of clay in Worcestershire, with associated brick works at both sites:
- **Waresley Quarry** (Waresley Brickworks):
 - **New House Farm Quarry** (Hartlebury Brickworks):

Both of these sites primarily produce facing bricks from the Triassic Mercia Mudstone Group.

- 4.4. The clay which is exploited at these sites was formerly known as 'Keuper Marl' strata that is now included in the Mercia Mudstone classification. These are typically reddish in colour, though some strata tend toward green or grey, and all are equally suitable for brick-making. Small amounts of clay and shale - mostly China Clay waste - are also used as aggregates nationally but there is no evidence of any significant such use in this county³⁶.

³⁴ British Geological Survey (2007) Mineral Planning Fact sheet: Brick Clay [online] Available at <http://www.bgs.ac.uk/mineralsuk/planning/mineralPlanningFactsheets.html> [Accessed 13.09.2018] p.9

³⁵ 10 year average based on Mineral Extract: Great Britain Reports 2005 – 2014, Data for Worcestershire only published for 2006, 2010, 2011 and 2012.

³⁶ Collation of the results of the 2009 aggregate minerals survey for England and Wales
J M Mankelaw, M A Sen, C E Wrighton, and N. Idoine
British Geological Survey Department for Communities 2012

- 4.5. The two sites in Worcestershire are capable of producing over two million bricks per week. Production of bricks, pipes and tiles in Worcestershire, presumably solely from these plants, was 111,000 tonnes in 2012³⁷, the latest date for which figures are published.
- 4.6. The Waresley site is one of Weinberger's largest manufacturing sites in the UK. The factory was built in 1989 to extend the range of products already being manufactured at the nearby Hartlebury site.
- 4.7. The Waresley factory is unusual in several ways: first, it is based at the edge of an industrial estate with the quarry on adjacent farmland. Secondly, the facility is able to produce both extruded bricks (for use in modern high-volume house building) and soft mud moulded bricks (which provides an effect similar to older bricks for use in conservation)³⁸.
- 4.8. Brick production at the Hartlebury site can be traced to the 1840s. The modern operation has two production lines: the older part of the factory makes traditional solid stock bricks ideal for refurbishment and restoration, while the modern factory (built in 1985) produces extruded products mainly for new housing³⁹.
- 4.9. The New House Farm quarry, around 750m from the factory, opened in 2005. An extensive programme of landscaping and site preparation was undertaken in order to manage noise and visual impacts of the new site. Extraction activities at the quarry are restricted to between April and September (inclusive), with extraction generally lasting between 6 to 8 weeks per year.

³⁷ Mineral extraction in Great Britain 2012, Business Monitor PA1007 (February 2014) table 8

³⁸ Wienerberger (2014) *Sustainability at Waresley Works* [Accessed 24.07.2014 but no longer available online]

³⁹ Wienerberger (2014) *Sustainability at Hartlebury Works* [Accessed 24.07.2014 but no longer available online]

Historical workings in Worcestershire

- 4.10. Clay working within the county was once quite extensive. The Worcestershire Historic Environment Record includes 341 known clay pits or brickworks, some of which date to the medieval period, although the dates of most of them are unknown. In many cases, the records are created from fieldnames rather than from physical evidence in the landscape⁴⁰.
- 4.11. Ordnance Survey maps from the 1880s show 2,276 clay pit sites and 152 brick works or kilns in Worcestershire. Some of these would have been pits for marl (which was historically added to soil as an improver) or fertilisers for agricultural purposes, as opposed to pits associated with brick kilns.
- 4.12. Historic workings were not just limited to the Mercia mudstone group, as indicated in Figure 3.

Figure 3. Historic clay sites by geological group

Group	Proportion of Worcestershire's clay deposit	Proportion of historic sites	Number of historic sites
Mercia Mudstone Group	47%	82%	1,910
Lias Group	19%	Less than 1%	21
Sherwood Sandstone Group	16%	5%	119
Downton Group	8%	5%	110
Warwickshire Group	5%	4%	98
Lower Old Red Sandstone Group	4%	3%	63
Penarth Group	Less than 1%	Less than 1%	4
Bridgnorth Group	Less than 1%	Less than 1%	5
Wenlock Group	Less than 1%	Less than 1%	2

- 4.13. There is a clear correlation of workings with the Mercia Mudstone formation, but the presence of substantial numbers of historical workings may indicate the presence of potential clay resources in the county beyond the Mercia Mudstone.

⁴⁰ Hancox, E. (2014) Personal communication; Email re: *Query about historical brickworks or clay extraction in Worcestershire* 28.07.2014

Future of the clay industry in Worcestershire

- 4.15. Weinerberger Ltd has confirmed that it has sufficient permitted reserves of clay in Worcestershire to meet its needs and, as such, a planning application is not expected within the lifetime of the Plan. No other parties have expressed any interest in winning and working clay or other aspects of the industry in Worcestershire.
- 4.16. Based on the figure for the remaining stock of permitted reserves in December 2016 (as provided in confidential discussions with the operator of the clay sites in Worcestershire, Weinerberger, April 2017), the permitted reserves would last approximately 63 years based on the 10 year average of known annual sales, but based on the sites' maximum potential output this could be less than 25 years.

Safeguarding

- 4.17. Weinerberger have also informed the council that it would always support the safeguarding of minerals close to the brickworks themselves because they want to avoid travelling on public roads where possible. The company has identified two possible extensions to their current quarries for safeguarding, which are shown below. It should be noted that the Waresley land was not within the company's ownership at this time⁴¹.
- 4.18. Given the very large areas of clay resource in the county, the range of clay strata that have been used in the county in the past and the limited interest expressed in the need to develop new areas of clay extraction, there does not appear to be any need to identify further areas of clay to be safeguarded within the Minerals Local Plan.

⁴¹ 2nd December 2014

5. Policy context for clay extraction

National Planning Policy Framework

- 5.1. The National Planning Policy Framework (NPPF) sets out policies on the development of mineral resources including clay. It states that "It is essential that there is a sufficient supply of minerals to provide the infrastructure, buildings, energy and goods that the country needs"⁴², and "great weight should be given to the benefits of mineral extraction, including to the economy"⁴³. Clay and clay products make an essential contribution to the construction industry for infrastructure and buildings. Authorities must also ensure that there are no unacceptable adverse effects from mineral development on the natural or historic environment, or on human health.
- 5.2. The NPPF also requires that planning policies "ensure that worked land is reclaimed at the earliest opportunity [...] and that high quality restoration and aftercare of mineral sites takes place"⁴⁴.
- 5.3. In addition, the NPPF requires planning policies to "provide for the extraction of mineral resources of local and national importance"⁴⁵. Minerals of local and national importance are defined as "Minerals which are necessary to meet society's needs, including [...] brickclay (especially Etruria Marl fireclay), [...] kaolin, ball clay, potash, polyhalite and local minerals of importance to heritage assets and local distinctiveness"⁴⁶. As previously described, bricks can play a major role in establishing local character. English Heritage (now Historic England) states that "if the erosion of local and regional identity is to be arrested, measures need to be taken to ensure that local materials are both made available for use in the present and safeguarded for use in the future"⁴⁷.

⁴² Ministry of Housing, Communities and Local Government (2018) *National Planning Policy Framework*, paragraph 203

⁴³ Ministry of Housing, Communities and Local Government (2018) *National Planning Policy Framework*, paragraph 205

⁴⁴ Ministry of Housing, Communities and Local Government (2018) *National Planning Policy Framework*, paragraph 204(h)

⁴⁵ Ministry of Housing, Communities and Local Government (2018) *National Planning Policy Framework*, paragraph 204(a)

⁴⁶ Ministry of Housing, Communities and Local Government (2018) *National Planning Policy Framework*, Annex 2: Glossary

⁴⁷ English Heritage (2008) *Mineral Extraction and the Historic Environment* English Heritage Publications, p.13

- 5.4. The NPPF considers clay to be an "industrial mineral". Paragraph 208 states that "minerals planning authorities should plan for a steady and adequate supply of industrial minerals" and with respect to clay, MPAs should maintain "a stock of permitted reserves to support the level of actual and proposed investment required for new or existing plant, and the maintenance and improvement of existing plant and equipment". It states that "These reserves should be at least 10 years for individual silica sand sites; at least 15 years for cement primary (chalk and limestone) and secondary (clay and shale) materials to maintain an existing plant, and for silica sand sites where significant new capital is required; and at least 25 years for brick clay, and for cement primary and secondary materials to support a new kiln". It also states that MPAs should take account of "the need for provision of brick clay from a number of different sources to enable appropriate blends to be made".
- 5.5. In line with the presumption in favour of sustainable development, the NPPF also requires mineral planning authorities to "so far as practicable, take account of the contribution that substitute or secondary and recycled materials and minerals waste would make to the supply of materials, before considering extraction of primary materials, whilst aiming to source minerals supplies indigenously"⁴⁸. This is relevant to clay extraction and brick production, as it is possible to reuse bricks from old structures, provided they are appropriately reclaimed. This is covered in more detail above.
- 5.6. The NPPF also stipulates that planning policies must "safeguard mineral resources [...] and adopt appropriate policies so that known locations of specific minerals resources of local and national importance are not sterilised by non-mineral development where this should be avoided"⁴⁹.

National Planning Practice Guidance

- 5.7. In March 2014, the Department for Communities and Local Government (now the Ministry of Housing, Communities and Local Government) launched a national Planning Practice Guidance (PPG) web-based resource.
- 5.8. The PPG contains further detail on the policies in the NPPF, including an extensive section on minerals which includes a "planning for industrial minerals" chapter. Clay is not mentioned specifically in this section, though the PPG states that "mineral planning authorities should recognise that there are marked differences in geology, physical and chemical properties, markets and supply and demand between different industrial minerals, which can have different implications for their extraction"⁵⁰.

⁴⁸ Ministry of Housing, Communities and Local Government (2018) *National Planning Policy Framework*, paragraph 204(b)

⁴⁹ Ministry of Housing, Communities and Local Government (2018) *National Planning Policy Framework*, paragraph 204(c)

⁵⁰ Ministry of Housing, Communities and Local Government (2014) *National Planning Practice Guidance: Minerals*, Paragraph: 086 Reference ID: 27-086-20140306, Revision date: 06 03

- 5.9. The PPG for industrial minerals also covers stocks of permitted reserves and how to calculate them.

Local Planning Policies

- 5.10. The adopted County of Hereford and Worcester Minerals Local Plan 1997 forms part of the existing Development Plan. Only policies 1,2,5,6 and 7 have been "saved" by the Secretary of State. There are no policies dealing specifically with clay extraction in the Adopted Plan. Saved policy 6 states that applications for extraction of minerals other than aggregates will be assessed against the same criteria as aggregates extraction in order to ensure consistency of approach.
- 5.11. There are no "preferred areas" established for clay working in this document, which concludes that "given the dispersed nature of suitable clay deposits and their limited size, further clay extraction in the county is likely to be limited⁵¹".
- 5.12. The saved policies in the Adopted Minerals Local Plan (1997) will be superseded by the emerging Minerals Local Plan.

City, District and Borough Council Plans

- 5.13. Policies contained in District, Borough and City local plans set out the amount of development for each area. These plans indicate that there is likely to be continued demand for brick clay and clay products for the foreseeable future.
- 5.14. Other policies in these plans address protecting green open space, green infrastructure and amenity, all of which may be impacted by applications for clay extraction. Restoration plans for clay extraction sites may also contribute to achieving these types of objectives.

Borough of Redditch Local Plan No. 4

- 5.15. The Borough of Redditch Local Plan No.4 includes policies that seek to conserve and enhance designated and non-designated heritage assets. Of specific relevance to the need for brick clay are policies 37 and 38.
- 5.16. Policy 37 seeks the conservation and enhancement of all historic buildings and structures and the reasoned justification accompanying the policies states, at paragraph 37.12, that "The alteration or extension of a historic building will be expected to reflect the special characteristics of the existing building and be designed either to merge unobtrusively with it or appear as a

2014 [online] Available at <http://planningguidance.planningportal.gov.uk/blog/guidance/> [Accessed 13.09.2018]

⁵¹ Worcestershire County Council (1997) Adopted Minerals Local Plan [online] Available at http://www.worcestershire.gov.uk/downloads/file/3850/minerals_local_plan [Accessed 13.09.2018] p.6.

separate entity. Materials used in the construction of extensions or alterations must strive to achieve as close a match as possible with the original in their selection and application".

- 5.17. Policy 38 on Conservation Areas includes part A(iv), which requires development within conservation areas to "demonstrate attention to the quality, sourcing and application of materials, finishes and detail, reflecting but not necessarily copying the elements of existing buildings within the area".
- 5.18. The Local Plan also seeks to ensure appropriate materials are used in modern development. Policy 40, on high quality design and safer communities, states that all development will be expected to, among other things, "be of a high quality design that reflects or complements the local surroundings and materials".

Wyre Forest Core Strategy

- 5.19. The Wyre Forest Core Strategy includes policy CP11 on quality design and local distinctiveness. This policy requires new buildings to be well-designed and take account of appropriate scale, massing, proportions and materials in keeping with the site context.

Bromsgrove District Plan

- 5.20. The Bromsgrove District Plan includes policy BDP17.5 on urban design and conservation. Part (a) of the policy states that all development should "include high standards of architecture and design, using high quality sustainable materials and building methods". Part (b) states that new buildings in the town centre should "add to the evolution of the area whilst respecting the scale, height, massing, alignment and materials of adjacent historic buildings".

South Worcestershire Development Plan

- 5.21. The South Worcestershire Development Plan includes policy SWDP6 on the historic environment. Part (vii) of this policy states that development proposals "will be supported where they conserve and enhance the significance of heritage assets, including [...] the civic, religious and market cores of south Worcestershire's city, town and village fabric with their wide variety of building styles, materials and street and plot patterns".
- 5.22. Elsewhere in the plan, the reasoned justification states that "Contemporary design can either involve new materials and technology used in a traditional format or the use of traditional materials in a new and innovative design, or a combination of both.
- 5.23. Policy SWDP21 concerns design. Part B(x) of the policy states that "The detailing and materials of development should be of high quality and appropriate to its context".

- 5.24. Policy SWDP 24 concerns management of the historic environment. The reasoned justification for this policy states, at part (3), that "Proposals involving new build, repair, alteration or extension of heritage assets can conserve the significance of the existing asset and its setting. This may be achieved by means of appropriate siting, massing, form, height, scale, design and use of local materials".
- 5.25. Policy SWDP 32 concerns minerals. Part (A) concerns safeguarding, ensuring that non-minerals development will not sterilise minerals development. Part (B) states that "Developers will be encouraged to recycle and reuse construction waste on-site".

6. Planning issues arising from clay extraction

- 6.1. The Minerals Local Plan is required to provide a policy framework that will ensure that the environmental, amenity and other impacts from any clay extraction in the county are acceptable. Potential impacts and other planning issues are detailed below.
- 6.2. It is important to recognise that there are differences in scale and methods of working between different types of mineral extraction, and that the impacts of a clay extraction site may be different from a large crushed stone aggregate quarry or a sand and gravel pit. Please refer to the section on working methods above for more detail.

Traffic

- 6.3. The extraction of clay and its transport off-site can cause an increase in traffic in the local areas around the site, including the movement of large lorries along access roads. Movements of material over longer distances will likely be dispersed through the wider road network. Employee commuting will also likely generate some additional traffic, though this will be determined by the size of the operation and the number of employees.
- 6.4. Clay is often only won for short periods of time each year, so traffic impacts will also be partly determined by whether clay is stockpiled and/or processed on site or transported elsewhere shortly after winning (in which case lorry movements are likely to be concentrated over short periods of time).
- 6.5. Where brickworks (processing) are located on site, the movement of raw material on the road network is likely to be minimised. However, lorry movements associated with brick production will also occur, including the transport of materials such as additives and colourings to the site, and movement of finished product off site to clients.
- 6.6. Traffic impacts, including dust and noise, can be minimised by appropriate transport policies and assessments, and consideration should be given to other transport measures such as private haul roads, rail, and waterways. The consideration of conveyors may also be appropriate on larger sites.

Dust

- 6.7. Dust is an almost "inevitable consequence of all mineral extraction due to the processes of breaking and handling rock and soils"⁵². It can also be generated during the transportation of material within and off the site, by soil stripping operations and from exposed strata. Because brickworks are often co-located with clay pits, dust can also be generated during the processing and production stages. Though dust levels associated with clay extraction tend to be fairly low, the NPPF requires that "any unavoidable [...] dust and particle emissions [...] are controlled, mitigated or removed at source"⁵³. The Planning Practice Guidance provides detailed information on dust assessments that will be needed where dust emissions are likely to arise⁵⁴.
- 6.8. Modelling the possible effects of dust is a complex task because of the large number of factors that affect dust levels, and so predicting the level of dust emissions from a new clay pit is very difficult.
- 6.9. The amount of dust emitted from a clay working is affected by:
- Weather (temperature, wind speed and direction, precipitation and humidity – clay workings can be particularly sensitive to these conditions where extraction occurs only sporadically);
 - Working methods;
 - The size of the working;
 - Type of soils or overburden;
 - The extent of exposed soil and other strata – this may be a relatively large area at clay workings because of the need to blend clays from different parts of the site;
 - Local topography, hydrogeology and vegetation cover; and
 - The dust control measures employed by the site operator⁵⁵.
- 6.10. Concerns about dust generally fall into two categories: nuisance effects and health effects. There is also the possibility of negative impacts on the wider environment, including heritage, ecology, agriculture and designated nature conservation sites.
- 6.11. "Nuisance" dust is dust that collects on windows, cars and surfaces. This is the most frequently mentioned cause of public concern. The rate of deposition can vary enormously depending on weather conditions, and qualitative measurement of the rate and severity of dust accumulation can be difficult due to variation in public perception. There are a number of measurement methods available, but the "wide range of values and subjective descriptions used to define 'acceptable' nuisance dust deposition or spoiling, together with

⁵² Sustainable Aggregates (2011) *Information Gateway: Operational considerations: Dust* [Accessed 5.12.2013 but no longer available online]

⁵³ Ministry of Housing, Communities and Local Government (2018) *National Planning Policy Framework*, paragraph 205(b)

⁵⁴ Ministry of Housing, Communities and Local Government (2014) *National Planning Practice Guidance: Minerals, Paragraphs 023-032, Revision date: 06 03 2014* [online] Available at <http://planningguidance.planningportal.gov.uk/blog/guidance/> [Accessed 13.09.2018]

⁵⁵ Sustainable Aggregates (2011) *Information Gateway: Operational considerations: Dust* [Accessed 5.12.2013 but no longer available online]

the fact that complaints received are often received well below these levels⁵⁶ indicates that there is no broadly accepted useful standard.

- 6.12. The health effects of dust are linked to airborne particulate matter. Although any particles smaller than 2mm are sometimes called dust, the industry standard defines dust as particulate matter between 1 and 75µm in diameter. Particles smaller than 10µm are considered "inhalable", while particles smaller than 2.5µm are "respirable" which means they are small enough to be taken down into the lungs. Generally, particles larger than 10µm are associated with nuisance and particles smaller than that cause health concerns⁵⁷. Industry body Sustainable Aggregates states that "it is not thought that there are any substantiated claims that health has been affected around working quarries", but if any evidence to the contrary is brought to our attention, we will revise our guidance as appropriate.
- 6.13. Good site management can help reduce the impacts of dust at the source, and best practice applies to all mineral extraction sites. The PPG's approach to dust assessment identifies the following key stages:
- establish baseline conditions of the existing dust climate around the site of the proposed operations;
 - identify site activities that could lead to dust emission without mitigation;
 - identify site parameters which may increase potential impacts from dust;
 - recommend mitigation measures, including modification of site design; and
 - make proposals to monitor and report dust emissions to ensure compliance with appropriate environmental standards and to enable an effective response to complaints.
- 6.14. The severity of dust impacts can also depend on the types and sensitivities of nearby receptors. Special care must be taken to ensure that facilities that are sensitive to dust are not unduly impacted by clay workings. Dust impacts arising from extraction can be mitigated through the following means⁵⁸:
- Using dust filters on equipment where possible;
 - Restricting dust-creating activities to certain times or locations;
 - Using water sprays and wheel-washes; and
 - Protecting materials (including stockpiles) and active work areas from wind.
- 6.15. As brickworks are often located with or close to extraction sites, dust impacts may also arise from mineral processing and production. These impacts can be mitigated by:

⁵⁶ Sustainable Aggregates (2011) *Information Gateway: Operational considerations: Dust* [Accessed 5.12.2013 but no longer available online]

⁵⁷ Sustainable Aggregates (2011) *Information Gateway: Operational considerations: Dust* [Accessed 5.12.2013 but no longer available online]

⁵⁸ Arup Environmental/Ove Arup & Partners (1995) *The Environmental Effects of Dust from Surface Mineral Workings*. Report on behalf of the Department of the Environment.

- Maximising the enclosed area of the processing plant;
- Using water sprays; and
- Using conveyors to transport material.

Noise

- 6.16. Noise is likely to arise from extraction and the operation of the brick works. It is an important health and safety consideration for employees in the sector, and becomes an issue for the surrounding area when it disrupts or disturbs people outside the site boundary⁵⁹.
- 6.17. Noise can be created during clay extraction, processing, and during the transportation of material around and off the site. The PPG requires that a noise emissions assessment be carried out, and that the mineral planning authority establish appropriate noise limits for any extraction occurring in proximity to noise sensitive properties⁶⁰.
- 6.18. In addition to setting noise limits, there are a number of other ways to mitigate the noise impacts caused by minerals extraction:
- Limiting working hours, or only permitting noisy operations at certain times;
 - Taking care with reversing alarms;
 - Minimising drop heights from lorries or plant;
 - Using rubber linings in chutes or transfer points where appropriate; and
 - Switching off machinery when not in use.
- 6.19. Site design is also an important factor in managing noise impacts, and planted screens and bunds may assist with noise management in addition to reducing dust and visual impacts (though in some cases the bunds themselves may cause a nuisance, as discussed in the Visual Impacts section below). Because most clay excavation happens in the open in shallow workings, there may be limits to the amount of noise attenuation that is possible⁶¹.
- 6.20. Clay is typically extracted directly with an excavating shovel or wheeled loader. Blasting and high explosives are not used in clay extraction. Some mudstone deposits may require blasting depending on the hardness of the deposit, but the deposits found in Worcestershire are able to be worked directly using similar methods to unconsolidated sand and gravel.

⁵⁹ Sustainable Aggregates (2011) *Information Gateway: Operational considerations: Noise* [Accessed 5.12.2013 but no longer available online]

⁶⁰ Ministry of Housing, Communities and Local Government (2014) *National Planning Practice Guidance, Minerals section, Paragraphs 019-022, Revision date: 06 03 2014* [online] Available at <http://planningguidance.planningportal.gov.uk/blog/guidance/minerals/assessing-environmental-impacts-from-minerals-extraction/noise-emissions/> [Accessed on 14.09.2018]

⁶¹ Sustainable Aggregates (2011) *Information Gateway: Operational considerations: Noise* [Accessed 5.12.2013 but no longer available online]

Waste

- 6.21. Clay operations generate fairly low levels of waste, as extraction is only economical where the ratio of usable to unusable material is high. The volume required can be accurately assessed on an ongoing basis because clay is usually processed in close proximity to the extraction site, and prudent use of resources is easier to manage⁶².
- 6.22. The brick production process also generates very little waste, as clay can be recycled back into the process at any stage, and the industry already uses various secondary materials as a partial substitute for primary material. Modern plant and production facilities, and consistent clay blends (which reduce cracking and other faults) can also help reduce waste throughout the extraction and production chain⁶³. Waste bricks can also be recycled as secondary aggregate⁶⁴.

Water and hydrogeological impacts

- 6.23. The Mercia Mudstone Group is a "non-aquifer", which means that it effectively forms an impermeable layer between the surface and the aquifer below. A Hydrogeological risk assessment will need to be carried out to ensure that any clay quarry sites will have no impact on the groundwater system. Policies need to be implemented to ensure that groundwater is not contaminated by any clay or landfill operations on site and should have the consent of the Environment Agency.
- 6.24. Potential hydrological effects are regulated by the Environment Agency. Methods to protect groundwater resources may include:
- Ensuring oils, chemicals or fuels and any wet-process plant are sited on impervious bases and surrounded by impervious bund walls;
 - Ensuring filter layers are maintained between aquifers;
 - Providing bunds or hard infrastructure (i.e. drains) to keep surface water out of workings and manage water on site; and
 - When creating lagoons, ensuring they are of a sufficient size to cope with storm events.

⁶² Tiles and Bricks of Europe (2011) The Clay Lifecycle, available at <https://static1.squarespace.com/static/5629fd2ce4b065f044bf8e5a/t/56378cabe4b0f0f9e6eb3d50/1446481067745/Full+-+ClayLifeCycle.pdf> [Accessed 14.09.2018]

⁶³ British Geological Society (2001) Brick Clay: Issues for Planning [online] Available at <http://www.bgs.ac.uk/downloads/start.cfm?id=1522> [Accessed on 14.09.2018]

⁶⁴ British Geological Society (2001) Brick Clay: Issues for Planning [online] Available at <http://www.bgs.ac.uk/downloads/start.cfm?id=1522> [Accessed on 14.09.2018]

Visual Impacts

- 6.25. Any large minerals extraction operation has potential visual impacts on the landscape, as will any associated large buildings or machinery. Any mineral working must consider the effect it could have on surrounding areas, both during working phases and in the final restoration scheme. As clay processing is often co-located with extraction, the visual impact of the processing facility must also be considered.
- 6.26. The clay deposits in Worcestershire tend to be near the surface and shallow, and workings tend to reflect this, as they are often broad and fairly shallow. Historically these workings were restored by being landfilled but this is increasingly unlikely to be acceptable for new sites and is discouraged in the Waste Core Strategy.
- 6.27. Several elements can contribute to the visual intrusion of a clay site, including:
- the development of the site prior to clay extraction;
 - creation of soil and overburden mounds;
 - stockpiling of raw material and finished products such as bricks;
 - landfill used for restoration;
 - the presence of heavy machinery during extraction; and
 - the processing facility itself.
- 6.28. Planting of tree screens, hedgerows or other vegetation may help mitigate the visual effects of clay excavation, although planting can take a long time to mature. Topsoil, subsoil, and other overburden that must be removed prior to extraction may be used to construct bunds or mounds around the site that could help reduce the visual impact (as well as contribute to noise and dust mitigation) of the site and ensure that the materials are retained on site for use in site restoration.
- 6.29. However, any features used to mitigate visual impacts must also be handled sensitively to ensure that they do not become intrusive features in their own right. For example, tree and hedge planting can be a permanent feature in the landscape and may remain long after the extraction activity has ceased. This type of landscape change may not be acceptable. In a very flat landscape, bunds may be out of keeping with the surrounding area and be more intrusive than simply leaving the working site unscreened. These are important considerations for these types of mitigation.

Protected sites and designated landscapes

- 6.30. National policy gives protection to designated sites and areas, including Sites of Special Scientific Interest (SSSIs) and Areas of Outstanding National Beauty (AONB). Clay deposits in Worcestershire often overlap with these sites.
- 6.31. The Malvern Hills AONB is located on the Herefordshire and Worcestershire boundary. Though mainly composed of hard rock, the Malvern Hills AONB does encompass part of the Sidmouth Mudstone Formation in the east and Raglan Mudstone Formation in the north. Parts of the Cotswolds AONB are also partially in Worcestershire. These areas comprise formations from the lias group that include clay.
- 6.32. There are also SSSIs and Local Wildlife Sites located all over the county which overlap clay deposits in and around Bromsgrove, Redditch, Worcester, Malvern and Upton-upon-Severn. It is possible that proposals for future clay extraction could affect these sites if they are in or near to SSSIs. Appropriate policies would be needed to balance these impacts against the need for the mineral.
- 6.33. Historic monuments and their settings can also be affected by mineral development. Safeguarding the natural environment as well as sites of historic importance can give rise to occasional conflict; the Green Infrastructure approach adopted by the council is founded on the idea that it is possible to successfully address both priorities through comprehensive restoration plans.
- 6.34. Competing priorities can be especially acute in designated areas "where geological diversity has contributed [both] to the attractiveness of the landscape and to distinctive styles of traditional architecture"⁶⁵. This may be more widely recognised in hard rock and building stone resources, but it can also apply to the distinctive colours of locally produced clay bricks.
- 6.35. National and international designations for protected areas afford a high degree of protection from development, including mineral development. Local sites can also be designated for a variety of purposes including nature and geological conservation, and the County Council regards these sites as material considerations.

⁶⁵ English Heritage (2008) *Mineral Extraction and the Historic Environment* English Heritage Publications, p.13

Green Belt

- 6.36. The National Planning Policy Framework states that "Mineral extraction" is among certain forms of development that are "not inappropriate in the Green Belt provided they preserve its openness and do not conflict with the purposes of including land within it"⁶⁶. The north-eastern part of Worcestershire lies within the Green Belt surrounding Birmingham. Kidderminster, Bromsgrove and Redditch are completely surrounded by Green Belt land. National policy on mineral working in Green Belt land will apply here.
- 6.37. Both current clay workings in Worcestershire are located in the Green Belt. The restoration of sites in the Green Belt will need careful consideration to ensure that they do not harm openness.

Restoration potential

- 6.38. Minerals extraction is ultimately a temporary land use, and extraction sites present excellent opportunities for restoration and for biological, geological and cultural conservation. Restored clay sites can make an important contribution toward green infrastructure goals, including recreation opportunities. The NPPF requires that planning policies "ensure that worked land is reclaimed at the earliest opportunity [...] and that high quality restoration and aftercare of mineral sites takes place"⁶⁷.
- 6.39. The nature of clay sites is such that large sections of a site can remain open for working for a long period of time, which can make best-practice 'progressive' or 'rolling' restoration difficult. Restoration will depend on many factors including the type of landscape the quarry is located on, local hydrology and the landowner's aspirations. Although it might not be possible to restore clay workings to their former land use, there is often potential to restore sites for environmental gain and about 700 SSSIs nationally are former mineral workings. This includes one site within Worcestershire - Grimley Brick Pits SSSI – which is a series of old brick clay pits dug along the bank of the River Severn.
- 6.40. The involvement of Natural England and the RSPB in the restoration of aggregate quarries has led to a focus on biological and ecological conservation opportunities. Much of the best practice guidance for quarry restoration applies to large-scale sand and gravel sites that are able to progressively return large areas of former workings to productive use and

⁶⁶ Ministry of Housing, Communities and Local Government (2018) *National Planning Policy Framework*, paragraph 146

⁶⁷ Ministry of Housing, Communities and Local Government (2018) *National Planning Policy Framework*, paragraph 204

contribute to biodiversity or habitat creation targets. There is less information available that specifically deals with clay extraction sites.

- 6.41. There are, however, many examples of clay pits that have been successfully restored. Appendix 2 provides several case studies that demonstrate what is possible in clay pit restoration.
- 6.42. Clay sites in Worcestershire are currently being restored using inert waste. The Waste Core Strategy envisages only limited future arisings of inert waste, which could be a factor in the restoration of existing and future mineral workings in the county.

Historic conservation

- 6.43. The historic environment interests that can arise from minerals extraction may fit into one of several categories: archaeological remains on the site, including the remains of other historical workings in the same location which require preservation; the impact of the development on the settings of listed buildings, monuments or other sites; and changes to historic landscape character.
- 6.44. As with minerals, archaeological remains can only be extracted from where they occur. As these remains are irreplaceable, once they have been removed it is critical to take proper care with their handling. Archaeological remains on clay sites may be found in the topsoil, subsoil, overburden, or within the deposit itself (including evidence of historical extraction).
- 6.45. Each of these categories presents unique circumstances for site restoration. In the case of archaeological remains, discoveries may ultimately be removed from the site altogether after excavation and therefore not have any implications for the site's restoration plan. However, if remains are deemed nationally significant, best practice might demand that they be preserved in situ. A restoration plan for a site that impacts the setting of a listed building might be dedicated to improving that setting and enhancing the historic landscape character, leaving it in better condition than it was found, or in a state that better reflects the historical context in which the building was originally found.
- 6.46. If the preliminary work for a project identifies archaeological issues, a full archaeological assessment (which would normally form part of the Environmental Impact Assessment) may be required. This may be sufficient, but in some cases, further work might be required or there may be a requirement to preserve any new finds in-situ during the work.
- 6.47. The Worcestershire Archive and Archaeology Service has identified a number of historic ponds associated with clay extraction, and notes that "The development of the brick industry from the 16th century created a new class

of pond which was created as a by-product of the excavation of clay. Earlier clay pits were connected with the pottery making industry around Malvern⁶⁸. Though new sites may not be located on or near historical sites, it is worth noting that clay deposits may be associated with historical industrial remains.

- 6.48. Restoration plans for clay sites will also need to consider potential impacts on the settings of listed buildings or monuments or other sites, as well as potential changes to landscape character.

Geological conservation

- 6.49. The National Planning Policy Framework aims to protect and enhance sites of geological value⁶⁹. Because mineral deposits are finite, mineral extraction can permanently destroy geological features that may merit conservation. Ensuring that geo-conservationists are allowed to record the structures within a deposit as they are exposed is important, and this requires good working relationships with site operators.
- 6.50. Geological conservation can also involve maintaining an exposure of interesting strata after an extraction site has been abandoned, as part of the restoration plan. Depending on their mineralogy, exposures of clay deposits may be difficult to preserve. Material may erode through wind or water action, slopes may re-vegetate naturally, and any protection installed may obscure the feature that it is trying to protect⁷⁰.
- 6.51. There are three Local Geological Sites in Worcestershire on former clay deposits:
- Crowle Quarry LGS – which has an old clay working within the boundary.
 - Huntinghouse Wood LGS - had a clay pit just at the edge of the boundary
 - Top Barn Farm North LGS - was a series of gravel pits but some seem to have had clay working originally, probably a covering layer which was exhausted.

Climate change

⁶⁸ Worcestershire Archive Archaeological Service (publication date unknown) Fact Sheet no. 8: Ponds and Archaeology [online] Available at http://www.adlib.ac.uk/resources/000/091/004/cs-archo-fact_sheet_8.pdf [Accessed 14.09.2018]

⁶⁹ Ministry of Housing, Communities and Local Government (2018) *National Planning Policy Framework*, paragraph 170(a)

⁷⁰ British Geological Survey (2013) *Explore Quarry Restoration: Sand and Gravel Quarries* [online] Available at <https://www.bgs.ac.uk/downloads/start.cfm?id=1451> [Accessed 14.09.2018]

- 6.52. The Council's 'Minerals and Climate Change' background paper outlines some of the key climate change sustainability issues for the minerals sector and areas in which the minerals industry can contribute to sustainability targets. These include energy efficiency and renewable energy, transportation and other emissions, flood mitigation, habitat creation and biodiversity⁷¹.

Resilience

- 6.53. There are several climate change issues in Worcestershire which can impact on clay workings. It is anticipated that the annual mean temperature will increase by between 2.5 °C and 4.1°C by the 2080s⁷². Warmer summer temperatures could cause overheating of buildings with an associated increase in demand for mechanical air conditioning, as well affecting working conditions for staff and customers, especially those working outside. This could also impact those working in brickworks which already experience high temperatures. Transport infrastructure could also be affected as road and rail structures could be prone to contract, move, split or melt.
- 6.54. Predictions of summer precipitation in Worcestershire show some severe changes. By the 2020s, an 11%-12% decrease in rainfall over the whole county is predicted⁷³. Lower summer rainfall and higher temperatures are likely to cause the incidence of fires to increase in Worcestershire; the most vulnerable locations include Hartlebury Common.⁷⁴ This could, in theory, cause an increased fire risk to the existing brickworks and quarry at Hartlebury.
- 6.55. Because of projected lower summer precipitation, soil moisture is predicted to decrease by between 12%-23% annually, and by the 2080s dramatic changes of 22% to 42% are projected, due to a drier and warmer Worcestershire. Lower soil moisture and higher temperatures could increase the risk of subsidence on clay workings and on roads and railways which are used to transport goods off site⁷⁵.

⁷¹ Worcestershire County Council (2018) *Minerals and Climate Change Background Paper* [online] available at <http://www.worcestershire.gov.uk/mineralsbackground> [Accessed 14.09.2018]

⁷² Worcestershire County Council (2008) Planning for Climate Change in Worcestershire [online] Available at http://www.worcestershire.gov.uk/downloads/file/6749/planning_for_climate_change_research_paper [Accessed 14.09.2018]

⁷³ Worcestershire County Council (2008) Planning for Climate Change in Worcestershire [online] Available at http://www.worcestershire.gov.uk/downloads/file/6749/planning_for_climate_change_research_paper [Accessed 14.09.2018]

⁷⁴ Worcestershire County Council (2008) Planning for Climate Change in Worcestershire [online] Available at http://www.worcestershire.gov.uk/downloads/file/6749/planning_for_climate_change_research_paper [Accessed 14.09.2018]

⁷⁵ Worcestershire County Council (2008) Planning for Climate Change in Worcestershire [online] Available at

- 6.56. These changes may also impact the way clays are processed, as brick clays must be dried before they are fired. At one site in Worcestershire this is often done using excess heat from the brick kilns, but if the materials are more moist, additional heat may be required, potentially impacting on resource demand and viability.
- 6.57. Climate change projections forecast a winter rainfall increase of 12%-23% in Worcestershire, and an increased risk of winter flood events⁷⁶. This could cause surface water flood risks for brickwork sites. Wider flooding events could interrupt clay operations in quarries due to equipment damage.

Mitigation

- 6.58. The minerals industry as a whole has agreed to reduce its emissions. One site in Worcestershire is using gas captured from an adjacent landfill site (part of the restoration scheme) to power their kiln. They also use excess heat from the kilns to dry the bricks before firing. Other strategies for mitigation address the energy used during extraction and processing, and emissions caused by transporting minerals.
- 6.59. Brick making is an energy-intensive process, and the Worcestershire Waste Core Strategy has policies which aim to maximise the use of recycled and recyclable materials on construction sites and ensure sustainable waste management and mineral extraction.
- 6.60. Mineral site restoration presents opportunities to help plan for climate change. Exhausted workings may provide space for floodwater storage or contribute towards broader green infrastructure goals including habitat creation and recreation. Clay operators elsewhere are also restoring mineral sites to act as carbon sinks and/or to link semi-natural habitats⁷⁷.

http://www.worcestershire.gov.uk/downloads/file/6749/planning_for_climate_change_research_paper [Accessed 14.09.2018]

⁷⁶ Worcestershire County Council (2008) Planning for Climate Change in Worcestershire [online] Available at http://www.worcestershire.gov.uk/downloads/file/6749/planning_for_climate_change_research_paper [Accessed 14.09.2018]

⁷⁷ Worcestershire County Council (2008) Planning for Climate Change in Worcestershire [online] Available at http://www.worcestershire.gov.uk/downloads/file/6749/planning_for_climate_change_research_paper [Accessed 14.09.2018]

Conclusion

- 1.1. Clay is economically important for the construction industry and various industrial processes. We know that the clay resources in Worcestershire are suitable for brickmaking in some areas, but we do not think we have any resources that are suitable for industrial uses. Worcestershire has a long history of clay extraction, and there are two current workings in the county, both operated by Wienerberger.
- 1.2. Mercia Mudstone is currently used for the production of bricks in the Hartlebury and Waresley area. This type of clay is present across a large part of Worcestershire, and there are many variations within the deposit. There are also several other types of clay present in the county that may be suitable for clay extraction, though none of these are specialised types of national importance (i.e. ball clay or china clay). We do not have enough information about what might make a particular clay deposit economically viable to be able to identify specific areas of search for clay.
- 1.3. Clay extraction for brick production normally takes place in close proximity to the brickworks or factory, and this is the case in Worcestershire. Extraction normally only takes place for a few weeks per year, and the raw material is stockpiled until required for brick production. This pattern of working means that clay sites are often worked as open pits, and may remain open for a long time in order to ensure a consistent supply of material.
- 1.4. There is no national requirement to maintain a certain landbank of clay at county level, but the NPPF does require minerals planning authorities to plan for a steady and adequate supply of industrial minerals, including by "maintaining a stock of permitted reserves to support the level of actual and proposed investment required for new or existing plant, and the maintenance and improvement of existing plant and equipment"⁷⁸. It specifies that these reserves "should be at least [...] 25 years for brick clay, and for cement primary and secondary materials to support a new kiln"⁷⁹. Based on the figure for the remaining stock of permitted reserves in December 2016 (as provided in confidential discussions with the operator of the clay sites in Worcestershire, Wienerberger, April 2017), the permitted reserves would last approximately 63 years based on the 10 year average of known annual sales, but based on the sites' maximum potential output this could be less than 25 years. The Council is not aware of any actual or proposed investment, or

⁷⁸ Ministry of Housing, Communities and Local Government (2018) National Planning Policy Framework, paragraph 208(c).

⁷⁹ Ministry of Housing, Communities and Local Government (2018) National Planning Policy Framework, paragraph 208(c), footnote 68.

maintenance and improvement of plant and equipment, that would require additional reserves to be permitted.

- 1.5. The minerals local plan will need to take into account the following planning issues when considering any new applications for clay extraction: traffic, environmental impacts, visual impacts, protected sites and designated areas, as well as considering the particular restoration potential of the site in question given the particularities of clay extraction methods.

Appendix 1: Glossary

Clay: A stiff, sticky fine-grained natural material that can be moulded when wet and is dried. It is a sediment with particles smaller than silt, generally smaller than 0.002mm.

Designated areas: A collective term that includes a number of statutory designations including European designated sites (Special Areas of Conservation, SACs, and Special Protection Areas, SPAs), National Nature Reserves, Sites of Special Scientific Interest, Scheduled Ancient Monuments, Areas of Outstanding Natural Beauty, Conservation Areas, Listed Buildings, Registered Battlefields, Local Geological Sites, Registered Parks and Gardens, and Local Wildlife Sites.

Firing: The process of heating clay in a kiln.

Fluxing materials: Specific mineral or chemical components of clays that promote the limited and controlled formation of glass in clay bodies during firing in order to cement crystalline components together. These essentially lower the overall melting point of the clay body which allows for more efficient firing.

Hydrogeology: The area of geology that deals with the distribution and movement of groundwater through soil and rock in the earth's crust.

Keuper Marl: An obsolete name for Triassic-age layers of mudstone and siltstone. Typically reddish in colour, but sometimes tending to grey or green, these strata generally contain few fossils. These layers are now included in the Mercia Mudstone Group.

Overburden: Material that lies above a geological area of economic or scientific interest.

Plastic: With reference to clay, a material that can be easily shaped or moulded.

Reserves: The part of a mineral resource which has been fully evaluated and appraised and is deemed commercially viable to work. The extent of reserves

can only be determined after a detailed appraisal process, and the capital involved in taking a site to this point can be substantial. In the context of planning, the term "reserves" should be further restricted to minerals with legal access and for which valid planning permission for extraction also exists (i.e. "permitted reserves"). Therefore reserves must also meet geological and economic criteria, but also accessibility based on legal permission to extract the mineral. Permitted reserves form a small part of total mineral resources⁸⁰.

Resources: Natural concentrations of minerals of a sufficient size that are or may become of potential economic interest due to their inherent properties. The status of a resource in economic terms may change over time as markets decline or expand, transport links and distribution networks change and as extraction and processing technology improves. "Resources that might previously have remained unworked, because of their poor quality [...] are increasingly being considered as potential sources of supply⁸¹".

Vitrification: the transformation of a substance into glass. See above under "Fluxing materials".

⁸⁰ British Geological Society (2013) *Resources: what is the difference between resources and reserves?* [online] Available at <https://www.bgs.ac.uk/mineralsUK/mineralsYou/resourcesReserves.html> [Accessed on 14.09.2018]

⁸¹ British Geological Society (2013) *Resources: what is the difference between resources and reserves?* [online] Available at <https://www.bgs.ac.uk/mineralsUK/mineralsYou/resourcesReserves.html> [Accessed on 14.09.2018]

Appendix 2: Case Studies

There are several examples of creative restoration of former clay workings.

Park Pit, Cornwall

Park Pit was a china clay site on Bodmin Moor in Cornwall. South West Water purchased the site from the mining company Imerys in 2007 for use as a reservoir. At the time, ecologists described the site as a "moonscape". South West Water embarked on a carefully managed restoration programme, re-landscaping and re-seeding 125 hectares of land that surround the reservoir⁸². By late 2012, the site had regenerated to such a degree that it was designated a County Wildlife Site by a panel of experts from Cornwall Wildlife Trust, the Environment Agency, Natural England, Cornwall Council and the Farming and Wildlife Advisory Group. Two rare species are found there – the Marsh Clubmoss and the Stag's Horn Clubmoss, and the site is now one of the best heathland sites on Bodmin Moor⁸³.

Rixton Claypits, Cheshire

Boulder clay extraction began at Rixton Claypits in the 1920s and ceased in 1965 when the site was left to regenerate naturally. While a laissez-faire approach is not considered modern best practice, the 80-acre site has become a haven for wildlife including ponds, scrubland, woodlands, and wet grassland. By 1979, 37 acres of calcareous grassland meadow were designated a SSSI because of their rich biodiversity. 14 hectares of the site have also been designated as an SAC because the ponds are a nesting site for Great Crested Newts, and in 1996 the entire site was designated a local nature reserve. The site is maintained and managed by Warrington Borough Council, and includes publically accessible paths and viewing platforms, information panels and a visitor's centre.

The Eden Project, Cornwall

Perhaps the best-known clay pit restoration, the Eden Project is a major visitor attraction and educational facility built in a 160-year old exhausted China Clay quarry near St. Austell in Cornwall. In the mid-1990s the concept of the Eden project evolved, with the architecture of the buildings inspired by the ability of soap bubbles to settle on an uneven surface. Construction began in 1998. The space opened to

⁸² BBC News (12 November 2012) Wildlife site status for restored Cornish clay pit [online] Available at <https://www.bbc.co.uk/news/uk-england-cornwall-20299332> [accessed 14.09.2018]

⁸³ BBC News (12 November 2012) Wildlife site status for restored Cornish clay pit [online] Available at <https://www.bbc.co.uk/news/uk-england-cornwall-20299332> [accessed 14.09.2018]

the public in 2001, and it now houses the largest "captive" rainforest in the world, as well as an extensive programme of educational, entertainment, and outreach events focused on community engagement and sustainability.