

The Caves of Nottingham

Desk-Based Assessment and Laser Surveys



The Caves of Nottingham Regeneration Project

Historic England Project 5866

March 2020



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*The illustration on the cover is part of the laser survey of cave number **0144**,
with a figure of Hercules in the foreground and another figure beyond*

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Summary

Introduction (1)

This report sets out the results of a desk-based assessment ('DBA') of recorded caves in Nottingham, and the laser surveys of a selection of them ('Laser Surveys'), which together are known in this document as 'The Survey'. The Survey forms a component of the Historic England Project 5866, the Caves of Nottingham Regeneration Project ('CNRP'). The Survey was funded by English Heritage (now Historic England), Nottingham City Council, Nottingham Civic Society, the University of Nottingham and the now disbanded East Midlands Development Agency and the Greater Nottingham Partnership. It was conducted by Trent & Peak Archaeology between 2010 and 2020, in association with SLR Consulting Limited since 2017.

The caves of Nottingham lie chiefly in the centre of the City, including parts of New Lenton, Radford, St Ann's and Sneinton (National Grid references 455250E–458600E and 339000N–341500N). There are small numbers of isolated outlying caves beyond this area, at Wollaton Hall to the west and New Basford, Bestwood, Bulwell, Arnold and Daybrook in the northern part of the City.

Terminology (1.1)

Key abbreviations used in this report are:

BDZ	Built Development Zone
CNRP	Caves of Nottingham Regeneration Project
DBA	desk-based assessment
DSW	David Walker, later Strange-Walker
GIS	geographical information system (computer-based integrated maps and database)
NCHER	Nottingham City Historic Environment Record
TPA	Trent & Peak Archaeology

The numbering of cave systems in this report follows that of the NCHER.

The following terms used in this document are defined as follows:

- **Cave:** a void in the bedrock formed by human excavation, which has, or originally had, a floor, walls and roof formed of *in situ* rock; and
- **Cave system:** a collection of physically linked caves (comprising passages, chambers and/or subterranean shafts or wells).

The caves (1.2)

The DBA addresses references to 697 locations where caves are known in Nottingham. These caves 'constitute a feature of the City that is unique in the national context' (City of Nottingham 2005, 79).

Most are in private ownership, with the most notable exceptions being the caves at Nottingham Castle, the National Justice Museum (including the Broadmarsh caves) and the Park Tunnel.

The abundance of caves in Nottingham contrasts with the scarcity of medieval structures still standing above ground. The caves thus represent a unique and major component of Nottingham's historic built environment.

Cave studies (1.3)

Archaeological studies of individual cave systems have been carried out since the 18th century. Discoveries during development have been recorded, notably in the Victorian period and between the wars, by groups and individual workers and latterly by archaeological units and other commercially-based organisations.

From 2010 to the present the most comprehensive catalogue and documentary archive of the caves has been, and remains, the NCHER. The CNRP project GIS was derived from that dataset in 2010.

There is however currently no detailed and comprehensive synthesis available, no up-to-date data on loss, preservation and access, and no cave system has a fully adequate record.

The Caves of Nottingham Regeneration Project (1.4, 1.5)

The CNRP commenced in early 2010 with the aims and objectives of advancing understanding of the caves through investigation and selective recording utilising high-definition laser scanners, providing a publicly-accessible archive to assist with their management in the planning process and in other ways, and promoting them to the public through visualisation.

Project scope and authorship (1.6)

The project as a whole was managed initially by DSW of TPA, assisted principally by Julia Walker, and from May 2015 by Dr Paul Johnson of TPA, assisted by Dr Emily Stammitti-Campbell. From January 2017 it was managed through to completion by Dr David Knight of TPA.

The Survey was carried out initially by DSW of TPA, assisted principally by Julia Walker. DSW initiated the GIS and provided survey methodology sections used in the report. A documentary archive was compiled by Scott Lomax (then of TPA); the laser surveys and most of the processing were carried out by DSW, with further processing by Norma Oldfield of TPA. The GIS was enhanced, and the analysis and report written by Gavin Kinsley of SLR Consulting, with final review by Dr David Knight.

Desk-based Assessment (2)

Methodology (2.1)

The DBA addresses a very wide range of existing records and earlier assessments and provides analyses of selected themes. All are presented within the framework of identified stages of Nottingham's urban development, termed Built Development Zones (BDZs). The DBA is very far from being exhaustive (see Section 4).

Sources used comprised artistic illustrations, historic maps, antiquarian and historical narratives, historic documentation, individual cave records from a wide variety of sources, and archaeological surveys and analyses.

The DBA analysis used the GIS (compiled in 2010) which contained the most up-to-date and comprehensive record of known caves in Nottingham. It includes an outline plan or other location information for each cave system and cross-references to the laser surveys, the Nottingham City Historic Environment Record ('NCHER'), the earlier British Geological Survey Register of Caves, the CNRP project archive and key published specialist studies.

The analytical framework of the DBA is the historic mapping of the expanding built-up area of Nottingham and neighbouring settlements, identified in a series of stages termed Built Development Zones (BDZs; Figures 15-17). The BDZs are:

- 1609 (derived from the Bankes map);
- 1744 (derived from the Badder and Peat, and Chapman maps); and
- 1844 (derived from Dearden's and Sanderson's maps).

Despite the large numbers of caves recorded, the pre-CNRP record of each one is almost always very limited in archaeological value in comparison with a thorough and informed archaeological survey. Few have been subject to the whole-site multidisciplinary studies which are required to provide a satisfactory level of understanding.

General distribution and types of cave system and cave (2.2)

The great majority of the caves lie in the centre of the City of Nottingham, including parts of New Lenton, Radford, St Ann's and Sneinton (National Grid references 455E–459E and 339N–342N), with outliers at New Lenton, Radford, St Ann's and Sneinton.

The caves lie almost entirely within the geological Chester Formation. To the south the distribution is limited by the alluvium of the Leen/Trent floodplain.

The access to cave systems is either *down-entry* (a cave or cave system entered down a passage from the surface or from a basement or cellar), or *level-entry* (a cave or cave system entered on the level through a vertical or steeply-sloping cliff-face or terrace-edge). The topographical location is the governing factor in the form of access, though there may be functional reasons for the choice of that location.

Several main forms of cave system are noticeable. The simplest cave systems are those comprising only passages, or else a single access passage leading to one chamber. Clustered systems are the most common type but occasionally, where there is only one route through the system, they may consist of a string of caves.

Multiple levels occur in systems containing both clustered and string forms. The presence of multiple levels may indicate a sequence of development, with the oldest caves lying at the top where they were easiest to both dig and use.

The individual components of a cave system are chiefly *passages* and *chambers*, the former usually leading to and linking the latter, though there are some passage-only systems. Passages are usually between 1–2m in width though in some passage-only systems they are wider: up to 7m wide in the case of the Victorian Park Tunnel, which was built to accommodate two carriages abreast.

Significant types identified in the analysis are:

- Malt kiln conforming to MacCormick's definition (MKI) (MacCormick 2001);
- Small D-shaped and small rounded (SDS; SRO); and

- Rectangular with rounded end (RRE).

Further research may identify other significant cave types.

There is a wide range of related smaller features such as stairs, shafts and wells.

Architectural detailing is sometimes preserved and in certain cases may provide evidence of date.

Dates and uses of caves (2.3)

An isolated documentary reference suggests that there were cave-dwellings at Nottingham prior to the Norman Conquest, but physical remains of these have not been certainly identified. There is frequent documentation and some archaeological evidence of caves in the medieval period. Cave-maltings and tanneries have been identified which were used from the medieval period through to the mid-17th century. Distributions compared with the BDZs suggest that other small, rounded and often clustered caves are also likely to be of medieval or early post-medieval date. Early documentary evidence suggests that uses included access passages, storage, dwellings, mines, maltings and tanneries, churches, and prisons.

Post-medieval cave systems are considered under the following topics:

- mines;
- beer cellars;
- industrial;
- residential; and
- purpose built air-raid shelters.

Laser Surveys (3)

Selection and Methodology (3.1–3.3)

Laser surveys of 66 cave systems were completed. These are distributed from Lenton Hermitage in the west to Sneinton Hermitage in the east, and from the north edge of the Leen/Trent floodplain in the south to the Forest Road West Rock Cemetery in the north.

Within this distribution the focus lies within the footprint of the historic urban centre, with outliers on the principal extra-urban routeways of Mansfield Road to the north, Alfreton Road to the north-west, Derby Road and Castle Boulevard to the west and Sneinton to the east.

The cave systems were scanned using a tripod-mounted laser scanner, with a camera to capture colours. The results were processed to form point clouds (a very large collection of coordinates defining surfaces with attached colour information). These permitted interactive analysis and public presentation as video ‘fly-throughs’.

Illustration and description of ten selected cave systems (3.4)

A selection of ten caves with description and analysis illustrating key themes and types is presented in Section 3.4.

Potential for further research (4)

There are abundant opportunities for further productive research into the caves of Nottingham. Themes include:

- accurate, detailed and complete integrated recording and interpretation of individual cave systems and their overlying buildings;
- further work to correct and complete the archive of existing data;
- study of detailed contemporary accounts of specific cave construction or use;
- further research into medieval and Post-medieval urban development;
- construction and destruction of caves; and
- agenda topics and research objectives that have been identified in the East Midlands Historic Environment Research Framework for the Early and High Medieval, Post-Medieval and Modern periods.

Archive location and contents (5)

The archive is entirely digital. Components are held by BGS, NCHER and ADS as follows:

Table A1
Archive component locations

Component	BGS	NCHER	ADS
Introduction	x	x	x
Laser Survey report (this document)	x	x	x
Project GIS	x	x	
Laser Survey Archive			
Illustrations and descriptions of 58 laser-surveyed cave systems	x	x	
Point clouds	x	x	
Selected reduced-size point clouds	x	x	
Video fly-throughs	x	x	
Documentary Archive	x	x	

Reduced size versions of the largest point clouds are provided in order to make the whole archive suitable for download and use with standard computer equipment.

References (6)

References comprise a list of historic maps in chronological order and references to published sources.

Acknowledgements (7)

Key contributors to the project are acknowledged.

1 Introduction

This report is the product of Historic England Project 5866 (Caves of Nottingham Regeneration Project, 'CNRP') Stages 1, 2 and 7. It has been completed in accordance with approved project designs drawn up by Trent & Peak Archaeology ('TPA') and funded by English Heritage (now Historic England), Nottingham City Council, Nottingham Civic Society, the East Midlands Development Agency, the Greater Nottingham Partnership and the University of Nottingham. It was prepared by TPA between 2010 and 2020, in association with SLR Consulting Limited since 2017. Historic England provided monitoring during the project delivery.

The caves of Nottingham lie chiefly in the centre of the City, including parts of New Lenton, Radford, St Ann's and Sneinton. There are small numbers of isolated outlying caves beyond this area, at Wollaton Hall to the west and New Basford, Bestwood, Bulwell, Arnold and Daybrook in the northern part of the City.

The report sets out the results of a desk-based assessment ('DBA') of recorded caves and laser surveys of selected caves ('Laser Surveys'). They are together referred to in this document as 'the Survey', where there is a need to make a distinction from the whole CNRP.

Other CNRP project stages have produced a website, online visualisations and other public promotional material, and a supplementary planning document; all of these lie outside the scope of this report.

1.1 Terminology

Key abbreviations used in this report are:

CNRP	Caves of Nottingham Regeneration Project
DBA	desk-based assessment
DSW	David Walker, later Strange-Walker
GIS	geographical information system (computer-based integrated maps and database)
NCHER	Nottingham City Historic Environment Record
TPA	Trent & Peak Archaeology

The numbering of cave systems in this report follows that of the NCHER, modified for brevity by omitting the universal prefix 'MNU' and padding to four digits with leading zeros. An a, b, c etc suffix has been added where necessary to distinguish multiple systems recorded under one HER number.

The following terms used in this document are defined as follows:

- **Cave:** a void in the bedrock formed by human excavation, which has, or originally had, a floor, walls and roof formed of *in situ* rock; and
- **Cave system:** a collection of physically linked caves (comprising passages, chambers and/or subterranean shafts or wells). On occasion, groups of numerous and associated small caves have also been described as systems.

Where the context requires it, interpretative terms used to distinguish between types of cave and assumed function are:

- **Passage:** a relatively narrow cave providing access to a cave system, linking chambers within a system, or linking two external points. Passages are generally no wider than 2m in passage and chamber systems but up to 3m wide in passage-only systems (at 7m wide the Park Tunnel is unique);
- **Chamber:** a relatively wide cave providing the primary space within a cave system;
- **Shaft and well:** these are not caves according to the above definition as they have no rock roofs, but they are included within the descriptions of cave systems because they are often very largely rock-cut and formed an integral subterranean part of the system; and
- **Mine:** a particular type of cave system comprising passages and chambers created for the purpose of extracting the natural sandstone.

Terms used for historical periods are:

- Early Medieval: 410 to 1066;
- High Medieval 1066 to c1550;
- Early Post-medieval: c1550 to 1744;
- Later Post-medieval: c1744 to 1900; and
- Modern: after 1900.

1.2 The caves

The DBA contains references to 697 locations where caves are known in Nottingham. These caves 'constitute a feature of the City that is unique in the national context' (City of Nottingham 2005, 79).

Most are in private ownership, with the most notable exceptions being the caves at Nottingham Castle, those at the National Justice Museum and the Park Tunnel. Some of these caves are currently utilised for commercial purposes or form visitor attractions, including the City of Caves attraction in the Broadmarsh Centre, Mortimer's Hole beneath the Castle, Brewhouse Yard Museum, the Malt Cross, the cave-restaurant at the Hand and Heart public house and the Trip to Jerusalem public house. Most of the other caves are neither publicly accessible nor widely known.

The abundance of caves in Nottingham contrasts with the scarcity of medieval structures still standing above ground. The caves thus represent a unique and major component of Nottingham's historic built environment.

1.3 Cave studies

Archaeological studies of individual cave systems have been carried out since the 18th century. The caves at Lenton Hermitage were recorded and discussed by Stukeley in 1722 (Stukeley 1776, 53) and illustrated by him and numerous later artists. Caves and other underground excavations discovered during development have been recorded, notably in the Victorian period and between the wars. Since its foundation in 1968 the Nottingham Historical Arts Society (later the Nottingham Historical and Archaeological Society) has carried out extensive investigations of cave systems and promoted scheduling, while further extensive recording and analytical work has been conducted by Tony Waltham and Alan MacCormick. Since the 1990s further caves have been investigated and surveyed by professional organisations in connection with redevelopment.

Until the early 2000s the most extensive catalogue of caves which existed was the British Geological Survey's *Register of Nottingham's Caves*, published in 1989 and reprinted in 2006 with new additions and some minor revisions (Walsby 2006). It listed 460 cave locations; of the 181 whose status was known 41 had been filled and 84 were physically accessible, the remainder had been sealed or were otherwise inaccessible. Information was derived predominantly from archival sources, with numerous visits to caves but comparatively little formal survey work (Owen and Walsby 1989, 6).

Since the BGS *Register* was compiled there have been many further discoveries, and from 2010 to the present the most comprehensive catalogue and documentary archive of caves has been, and remains, the NCHER. The CNRP project GIS was derived from that dataset in 2010.

There is however currently no detailed and comprehensive synthesis available, no up-to-date data on loss, preservation and access, and no cave systems have a fully adequate record.

1.4 The Caves of Nottingham Regeneration Project (CNRP)

The potential for further investigation, survey and public promotion of Nottingham's caves has long been recognised within the City, including in the Nottingham City Council's discussion paper *Nottingham Caves 2001 – A Review* (Young revised 2004). This document considered the state of knowledge and understanding of the caves. The focus of the document was primarily on the caves as historic and archaeological resources, but it highlighted the problems associated with any structured attempt to understand the caves. Without a full assessment of what has been recorded and what remains of the caves, it was not possible to construct a rational plan for their future management.

The need was recognised for better understanding of the caves through investigation and selective recording and archiving for research purposes, assisting with their management in the planning process and in other ways, and visualising them to support their promotion to the general public. The advent of 360° high-definition laser scanners provided the opportunity to carry out cave surveys more quickly, more accurately and more completely than had been possible with earlier technology.

With the aim of addressing these issues, the CNRP project commenced in early 2010.

1.5 Survey aims and objectives

The Survey's aims were to achieve a greater understanding of Nottingham's caves and to make the survey results publicly accessible.

The Survey's objectives were to create the following key products:

- a full and accurate GIS database of all known caves in the study area;
- a desk-based synthesis of sources and previous research;
- archive records of the 3D laser surveys in digital format;
- synthesis of results (presented in this report) addressing the following aspects of caves:
 - overall distribution;
 - forms and typology;
 - associations with buildings and other features;
 - functions;
 - relationship of form and function;

- chronological developments; and
- spatial patterning of the above attributes.

1.6 The scope and authorship of the Survey

The project as a whole was managed initially by DSW of TPA, assisted principally by Julia Walker, and from May 2015 by Dr Paul Johnson of TPA, assisted by Dr Emily Stammitti-Campbell. From January 2017 it was managed through to completion by Dr David Knight of TPA. The Survey was completed in 3 stages.

Stage 1 comprised the compilation by DSW of a GIS cross-referenced to the BGS Register and NCHER (this document, Section 5.2). This GIS was also linked to a Documentary Archive (prepared by Scott Lomax) of over 4000 digitised documents and images related to the caves, using the BGS referencing system.

Stage 2 comprised visiting and surveying cave systems at 66 locations. DSW led the fieldwork, assisted by Julia Walker. DSW also carried out most of the processing up to the point of completion of the point clouds and provided early drafts of this report prior to his departure from the project in 2016. The surveys were recorded in three dimensions using a laser scanner, as noted above, and processed into full-colour point cloud models. The models were animated and rendered to video, and most have been uploaded to the online YouTube collection at

<https://www.youtube.com/user/NottinghamCaves>

Subsequent processing (including georeferencing and illustration) has been carried out by Norma Oldfield.

Stage 3 was largely the modification of the GIS, analysis of the data and the preparation of this report.

The GIS was reconfigured by Gavin Kinsley to reference the NCHER numbering system (while retaining cross-references to the earlier numbering systems) and to link to the NCHER documentary archive (the project Documentary Archive compiled in 2010 having been superseded). Many further notes and corrections were made during this process but the GIS remains a work in progress due to the very large quantity of data it contains.

The DBA process examined and analysed the source data, addressing the project aims and objectives (Section 1.5), and recorded key analytical attributes in the GIS.

The Laser Survey Archive was finalised, principally by adding chamber reference numbers and descriptions of each system.

An early short draft of the report was provided by Dr Emily Stammitti. The analysis and further editing of the factual content of the report were provided in 2017–18 by Gavin Kinsley of SLR Consulting, with final review and project management by Dr David Knight of Trent & Peak Archaeology. Comments on a draft of the final report by Historic England (Tim Allen) and Nottingham City Council (Scott Lomax) have been addressed and Scott Lomax provided information on specific caves during the reporting drafting process.

The quantity and complexity of the source material have hindered objective analysis and resulted in the synthesis provided in this report being highly selective. There are some basic questions which could be addressed but have not been due to the pressure of the reporting programme; some of these are suggested in Section 4.

The key products of the project are:

- this report;
- the GIS;
- the Laser Survey Archive; and
- the Documentary Archive (now incorporated within the NCHER).

2 Desk-based assessment of all recorded caves

2.1 Methodology

2.1.1 Scope

The study dataset was compiled in 2010 and comprised the fullest possible collection of records relating to Nottingham's caves. The documentation relating to specific caves was stored in the project Documentary Archive, now superseded by the NCHER (see Section 5.4).

The DBA involved firstly the compilation of a GIS (Section 5.2) which stores the key available data in a structured, readily-accessible and extendable format, with cross-references to the NCHER and other key studies. The GIS and its linked material were then used to provide a provisional analysis of key aspects of the data. The DBA is very far from being exhaustive (see Section 4).

The DBA provides the following key analyses:

- identification of a series of spatial Built Development Zones ('BDZs') from historic mapping;
- brief consideration of evidence for very early caves;
- evidence for medieval caves identified from documentary evidence, including form, architectural styling or archaeological evidence and a summary of a key previous study;
- identification of further probable medieval or early post-medieval plan-form types from their spatial relationship with BDZs; and
- identification of certain post-medieval types and their probable functions from their spatial relationship with BDZs and specific documentation, including historic mapping.

2.1.2 Sources used

The project identified the following potential sources of relevant material, much of which has been considered to varying levels of detail in the analysis.

Unpublished archives and indexes:

- Post-medieval illustrations made for purely artistic reasons;
- Nottinghamshire Archives;
- Nottingham City Council Brewhouse Yard Museum:
 - NCHER;
 - Air-Raid Shelter Survey (a survey of sites potentially to be used as air-raid shelters in World War II);
 - Nottingham Cellar Survey;
 - Nottingham Deeds Survey (unpublished, but see Mastoris 1985, 37 and Cameron and Henstock 1983, 11);
 - Tony Wass archive;
 - G F Campion archive including copies of the Thoroton Society Excavation Section Reports and Nottingham Archaeological Society Annual Reports annotated by Campion;
 - Peverel Archaeological Research Group reports (unpublished);
 - other plans, antiquarian records, photographs and slides and miscellaneous documents;
 - unpublished fieldwork ('grey') reports;
- British Geological Survey:
 - *Register of Nottingham's Caves*;
 - archive: plans, photographs and miscellaneous documentary material;
- Nottingham Local Studies Library:
 - photographs, newspaper reports, cave drawings by S Clements and entries in the Doubleday indices;
- Nottingham University Museum and University of Nottingham East Midlands Collection, King's Meadow Campus:
 - excavation reports, photographs and slides;
- Dr Tony Waltham:
 - photographs and slides, cave plans and miscellaneous documentary material; and

- Material collected by CNRP project staff from newspaper advertisements and owners' and architects' information and miscellaneous private oral histories and photographs.

Historic maps consulted through digital copies (see Section 6.1 for details):

- 1609 Bankes;
- 1610 Speed;
- 1677 Thoroton;
- 1710 Overton;
- 1744 Badder and Peat;
- 1774 Chapman;
- 1820 Smith and Wild;
- 1831 Staveley and Wood;
- 1835 Sanderson;
- 1835 Creighton;
- 1844 Anonymous;
- 1844 Dearden;
- 1854 Enclosure Map;
- 1861 Salmon;
- 1882 Ordnance Survey Town Plan at 1:500 scale; and
- 1885–1972: later Ordnance Survey maps at smaller scales through to 1972 (see 6.1 for a full list).

Key published studies (see Section 6.2 for details):

- Antiquarian studies:
 - Leland (c 1540; Toulmin-Smith 1907);
 - Camden (1575, published 1610);
 - Speed (1614);
 - William Stukeley (1776);
 - Deering (1751; almost complete by 1743);
 - Thoroton (1677);
 - Throsby (1790–7);
 - Stretton (Robertson 1910);
 - Blackner (1815);
 - Orange (1840);
 - Shipman (1899);
 - Corporation of Nottingham (1882–1906);
- Beckett (1997), 59–60;
- *East Midlands Archaeological Bulletin*;
- Hamilton 2004;
- Nottingham Historic Arts Society publications;
- *Transactions of the Thoroton Society of Nottinghamshire* (especially the analysis of recorded caves and summary of medieval documentation in MacCormick 2001);
- Waltham 2008; and
- an important study of Nottingham's early urban topography by Stephanos Mastoris (1985).

Archaeological excavation reports including caves (see Section 6.2 for details):

- Town Hall (Shipman 1899);
- Excavations directed by Charles Young in and adjacent to the pre-Conquest Borough, in particular Halifax Place (Young 1982; Knight *et al* 2012);
- Nottingham Castle (Drage 1989);
- Broad Marsh Pillar Cave (MacCormick 2001, 83–4);
- 8 Castle Gate (MacCormick 2001, 83);
- Drury Hill IIIB (MacCormick 2001, 83);
- Pepper Street (MacCormick 2001, 83–4);
- Bridlesmith Gate (Kinsley 2005);
- Garner’s Hill (Kinsley in prep);
- Lenton Hermitage (Kinsley 2003); and
- Convent Street (Groarke and Elliott 2017).

Brief notes of excavated evidence relating to some caves are provided by MacCormick (2001). A detailed review of the results of these investigations is required but lies beyond the scope of this project. However the results of excavation derived from authors’ summaries are noted where available and relevant to the interpretation of the caves.

No field inspection was carried out in the preparation of the synthesis.

2.1.3 Limitations of pre-CNRP evidence for caves

Despite the large numbers of caves recorded, the existing available record of each one is almost always very limited in archaeological value in comparison with a thorough and informed archaeological survey. Few have been subject to the whole-site multidisciplinary studies which are required to provide a satisfactory level of understanding.

Of course, the level of information recorded generally reflects the purpose of forming the record. For example, surveys were often made only to support the design of a new development, and a cave was omitted from an air-raid shelter survey, presumably because it would not be used (see Section 3.4.3). Very few have been recorded for the purpose of archaeological research.

Many of the known caves have no recorded plan and/or cannot even be approximately located within the site. Of those that do have a plan, many make no distinction between rock and built structures, and very few have recorded profiles, roof heights or details of the character of brickwork in built structures. Absolute elevation values are generally lacking and the position of the cave in relation to the overlying buildings is uncertain in many cases.

The plans may in many cases be summaries, with straight lines drawn between a limited number of measured points; such plans will exaggerate the apparent regularity of the cave forms. Most have no photographic record, written description or analysis.

It is easy to mistake neat presentation for accuracy. New inspection of caves to verify the records was beyond the scope of this project, so there is currently no basis for assessing the accuracy of existing surveys except where laser survey has been carried out.

Subjectively it appears that for many cave systems the following aspects may be deduced from the records (in declining order of frequency):

- distribution within the historic town;
- location within the site;
- complexity of the system; and
- plan-forms of chambers and passages.

Particularly with regard to the last category, it may be expected that the high number of caves recorded will to some degree help to balance false conclusions due to unknown errors. Where clear trends in data can be observed on this basis the conclusion may be regarded as a working hypothesis, though not applicable with confidence to any given system. It seems likely that there will be an unreal bias towards rectilinear forms as such forms are easier to record. Further fieldwork is clearly required in all cases.

2.1.4 Analytical framework

Cave distributions and Built Development Zones

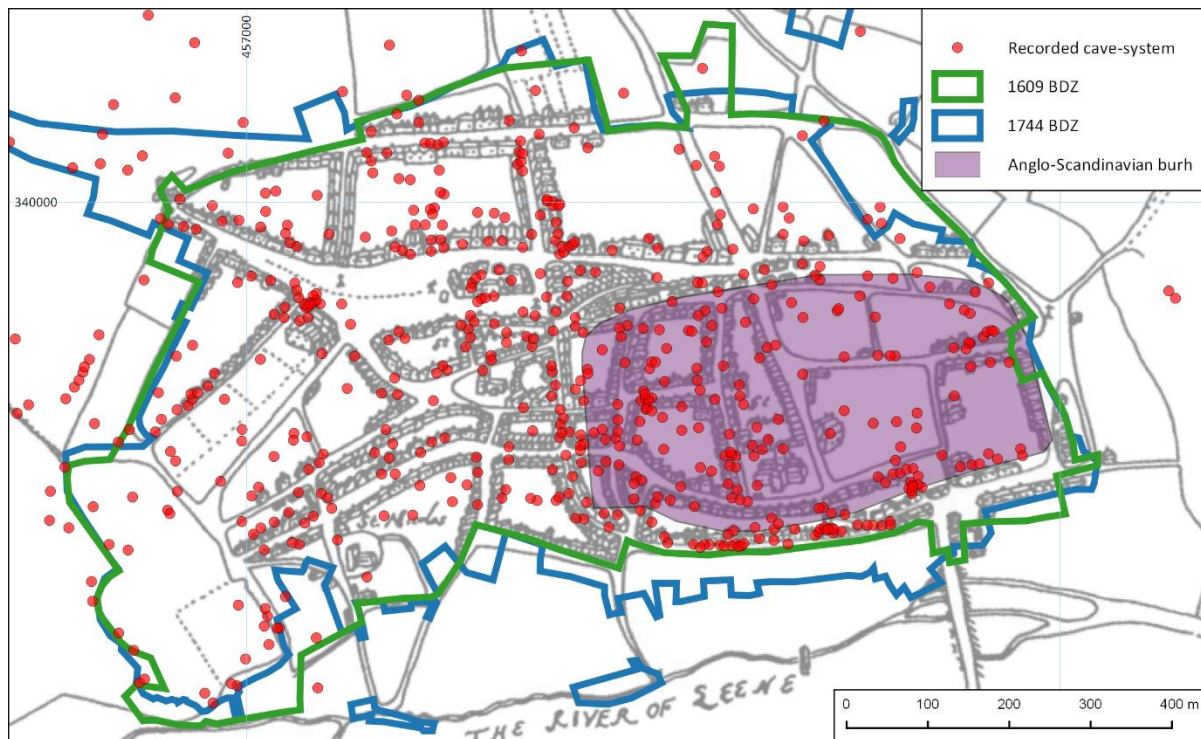
The known distribution of caves is a product of both continued use and re-discovery, and it must be questioned whether these processes have resulted in systematic bias in the distributions. There are grounds for optimism that this is not the case. The early post-medieval town contained several areas characterised by large blocks and few houses on the west and

north sides and in the Lace Market area. This pattern, which documents suggest existed in at the least the early 16th century (Mastoris 1985, 39), and mapping suggests persisted until the late 18th or early 19th century, corresponds to a significant degree with the general distribution of recorded cave systems (Figure 1). The correspondence indirectly supports the view that the distribution of known caves reflects their original distribution as a whole, although due to the length of the period no significant chronological implications for caves can be deduced. For example, it might be thought that the construction of numerous large basements in the Lace Market area might have reduced the number of survivals there, or enhanced the number of discoveries. However the relative scarcity of caves in that area mirrors the sparse numbers of dwellings and in general terms seems most likely to be a true distribution pattern.

Figure 1

Recorded cave-systems in relation to the Anglo-Scandinavian burh, the 1609 map and the 1609 and 1744 BDZs

Map based with permission on redrawn Crown Survey map of Nottingham printed in Mastoris, S. and Groves, S. (eds), *Sherwood Forest in 1609: a Crown survey by Richard Bankes*. Thoroton Society Record Series, 40, 1997.



Following the hypothesis that cave construction will be related to mapped surface urban development, a series of 'Built Development Zones' ('BDZ's) has been identified with the aim of summarising the spatial expansion of the built-up area of Nottingham (Figures 15-17). The BDZs attempt to identify occupied areas where, it is assumed, caves may have been constructed. For the purposes of analysis it is assumed that any cave located in the land beyond the boundary of a given BDZ is likely to post-date the formation of that BDZ. While the BDZ indicates development within its boundary, it also has a chronological implication for the land beyond its boundary.

The BDZs have been identified from historic maps. The historic maps used have been selected with reference to their value for illustrating key stages in urban development, their dimensional accuracy, and the degree to which they provide both sufficient detail and spatial coverage to best illustrate the development stages.

The BDZs are:

- 1609 (derived from the Bankes map);
- 1744 (derived from the Badder and Peat map supplemented by the Chapman map of 1774 for outlying areas); and
- 1844 (derived from Dearden's map supplemented by Sanderson's map of 1835 for outlying areas).

It is recognised that the area of the medieval and Early Post-medieval town may have contracted as well as expanded, but there has currently been insufficient analysis of urban development to map any such processes.

Where appropriate other maps have been used selectively to refine dating evidence for groups of caves within individual BDZs.

Each source map has been georeferenced as accurately as possible and the outline of the built-up area has been traced. Each BDZ includes buildings and their immediate plots and adjacent detached gardens where these are known to have been used. Where possible, the boundary has then been subjectively adjusted where the same boundary appears to be more accurately recorded on modern mapping; where that boundary has been removed the most accurate available mapping of has been used. The BDZs are shown superimposed on the source maps in Figures 15-17.

Subjective visual appraisal of chamber plan-forms

A routine was added to the GIS software to permit rapid scanning by cycling through the plans of all cave systems in the order the records were compiled, showing one plan at a time with no background. This permitted subjective identification of certain recurring plan-forms of chambers within cave systems. As the order of recording of the cave systems is unrelated to their location, this process also excluded unconscious bias derived from the operator's knowledge of the location. A duplicate version of the master layer was created, which then permitted the splitting of each cave system plan into components and identifying the relevant part as an example of the given type. This in turn permitted the drawing-up of distribution maps of selected types. An analysis of these types is provided in Section 0 and mapping of their distribution in Figure 5.

Subjective decisions were made to identify chambers whose form has been partly altered through having been cut by other elements in the system, while excluding chambers where the form is an integral part of a larger form. For example, a subjective distinctions have been made between a rectangular chamber with a rounded end compared with a small rounded chamber cut by a rectangular chamber. Such judgements are dependent upon the accuracy and detail of the recorded plans, something which can rarely be assessed, but which is often poor. The identifications are therefore necessarily provisional.

Cave systems

The BDZs provide provisional dating based on the assumption that, apart from mines or other caves with functions unrelated to the overlying context, caves outside a BDZ will post-date the development of the BDZ area. Forms located in areas which have been continuously occupied from the pre-Conquest period to the present day could contain elements of any date, but where they are found only in earlier BDZs there is a suspicion of early dating.

Caves

During the visual scanning described above a number of distinctive cave plan-types were noticed; further examples were then sought by re-scanning. The significance of these types is described and their distributions analysed in Sections 2.2–2.3). The low quality of the records prevents any kind of metric analysis. It is likely that further types could be identified if a body of better quality records were to become available over time.

The plan-types were coded as follows:

- MKI: small circular plan identified as a malt kiln;
- SDS: small D-shaped;
- SRO: small rounded; and
- RRE: rectangular with rounded end.

2.2 General distribution and typology

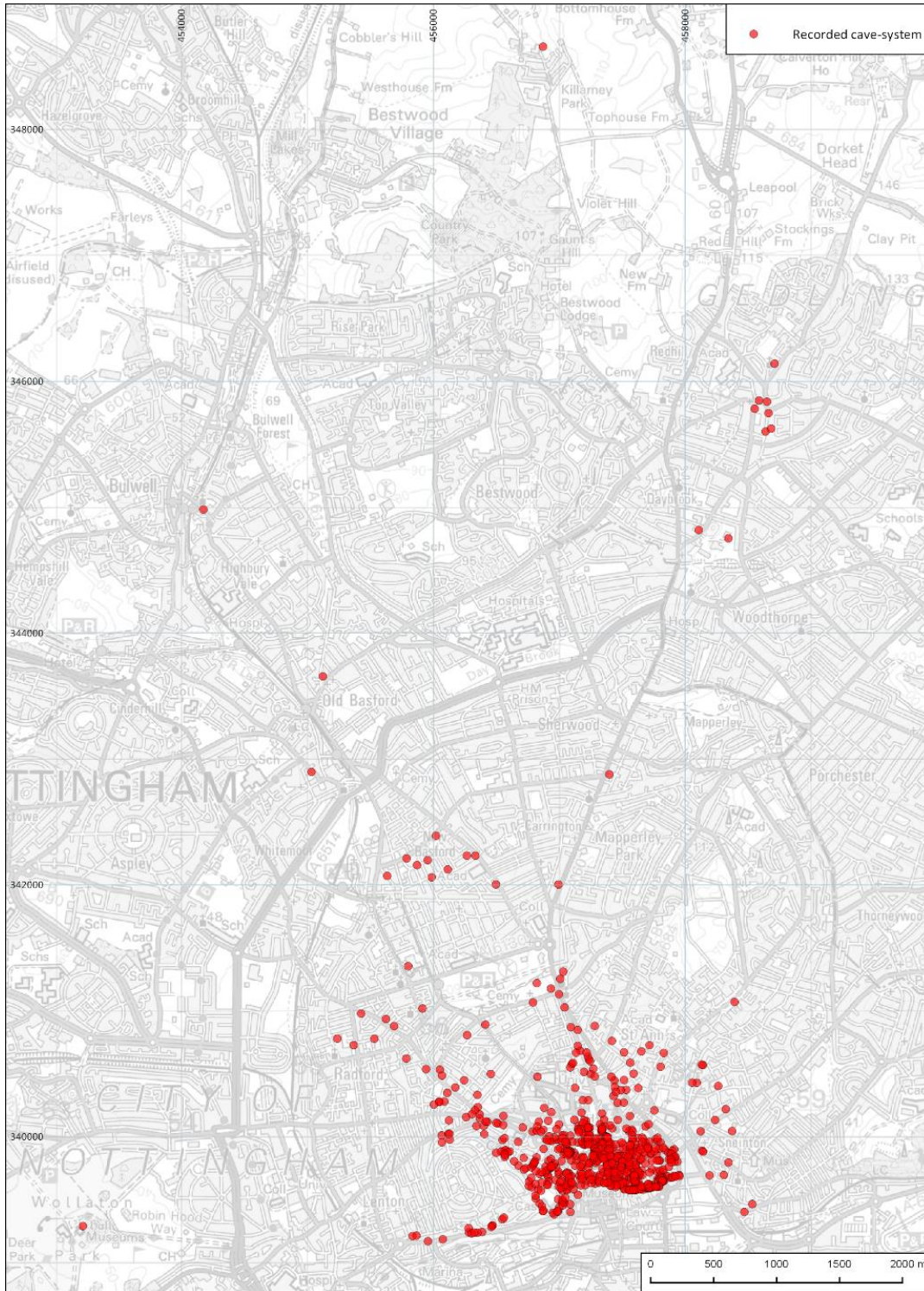
2.2.1 Spatial distribution of known caves

The geographical survey area was initially set as the area occupied by the caves recorded in the BGS Register of Caves, recognising that it might require adjustment in the light of new information acquired by the project. In the event no such adjustment was required.

The great majority of these caves lie in the centre of the City of Nottingham, including parts of New Lenton, Radford, St Ann's and Sneinton (National Grid references 455E–459E and 339N–342N).

There are small numbers of isolated outlying caves beyond this area: at Wollaton Hall to the west, in New Basford, Old Basford and Bulwell in the northern part of the City and in Arnold and Daybrook beyond the City boundary. For the purposes of synthesis these northern outliers have been omitted from distribution maps except in relation to geology (Figures 2 and 3).

Figure 2
Distribution of caves considered in the desk-based assessment
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2.2.2 Geology and topography

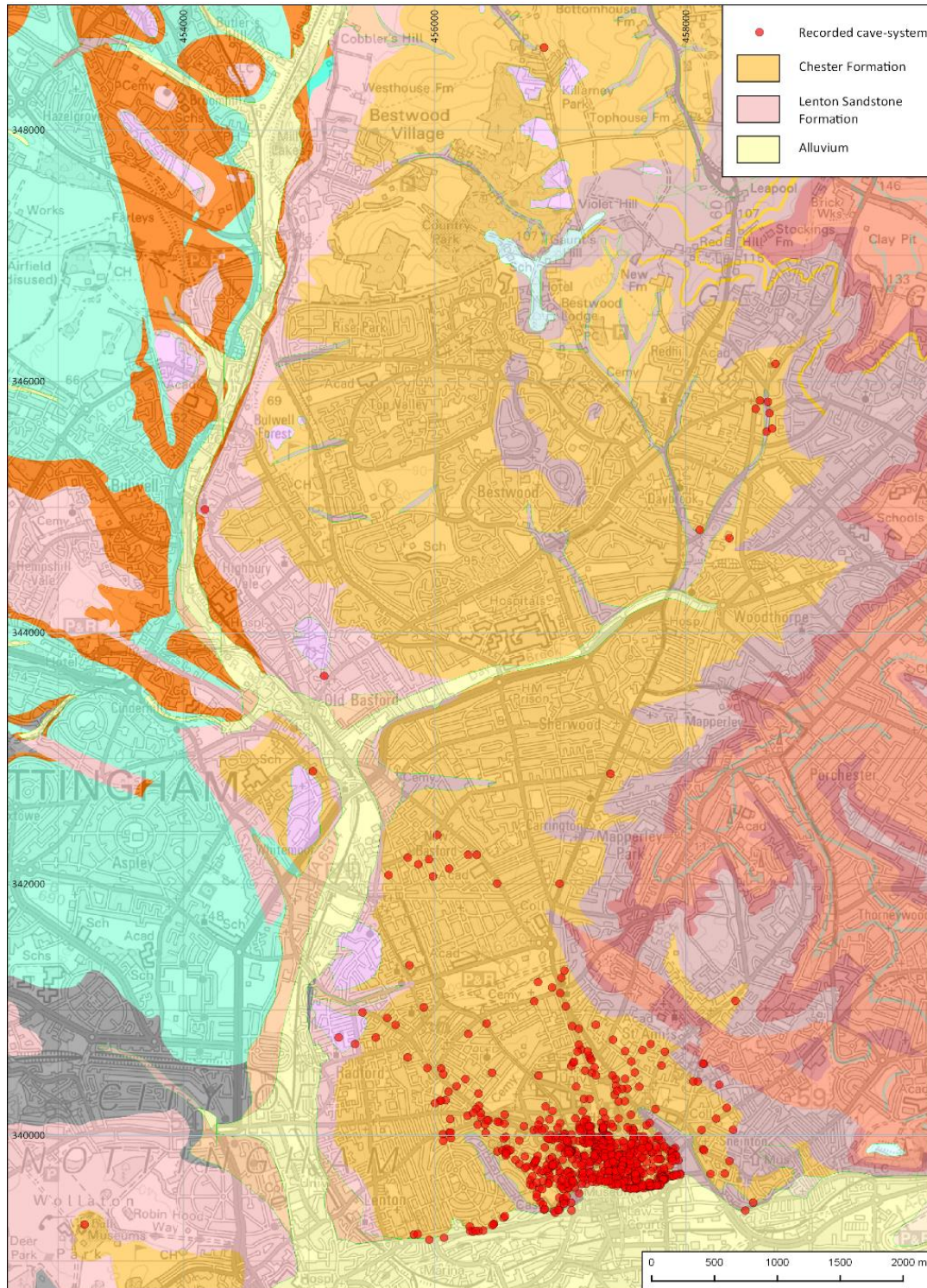
The distribution of caves falls almost entirely within that of the geological Chester Formation and to a much lesser extent the narrow outcrops of the Lenton Sandstone Formation which flank the Chester Formation on its west and east sides (Figure 3).

To the south the distribution is limited by the alluvium of the Leen/Trent floodplain. Apparent outliers in the alluvium reflect inaccuracies in mapping.

There is no clear indication that topography has determined the distribution of caves, although it has influenced cave system forms (Section 2.3).

Figure 3
Distribution of recorded caves and geological formations

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2.2.3 Typology

This section provides a non-exhaustive categorisation of the common forms of caves systems and caves, with reference to ten examples of cave systems as illustrated and described in Section 3.4. An explanation of the terminology used is provided in Section 1.1.

Systems

Types of access

The types of access fall into two categories:

- *down-entry*: a cave or cave system entered down a passage from the surface or from a basement or cellar (generally located in a relatively level surface topography); and
- *level-entry*: a cave or cave system entered on the level (generally through a vertical or steeply-sloping cliff-face or terrace-edge).

Topographical location is the governing factor in the form of access, though there may be functional reasons for the choice of that location. The principal cliff in the historic town runs east/west along the south side of the Castle, through the Broadmarsh Shopping Centre, along Cliff Road to Sneinton Hermitage. Parts of this cliff have now been obscured by modern development. Lesser north/south-aligned cliffs occur south of St Nicholas' Church and to either side of the east end of Hollowstone. Some parts of these cliffs appear to be of natural origin, for example at the castle. Others have been created or enhanced by human agency, cutting back an existing steep slope to gain additional level building land and to provide a vertical face to permit construction of a level-entry system.

System forms

Several main forms of cave system are noticeable. Among the simpler systems are those consisting only of a passage, or a single access passage leading to one or two chambers (**0959**). Clustered systems are the most common type (**0367**, **0318**, **0268**, **0088**). There may be more than one access passage and there are many examples where the access has been changed. Occasionally cave systems may consist of a string of caves, where there is only one route through the system; it seems likely that this form has resulted from development of a long, narrow site (**0228b** of which there is no laser survey).

Multiple levels occur in some systems; this may indicate a sequence of development, with the oldest caves lying at the highest level where they were easiest to form and use.

Caves

Cave typology is based on physical shape and dimensions. At present analysis is largely based on the plan as that is often the only information available. Caves are chiefly categorised as passages, chambers or vertical or sloping shafts including wells, and there is inevitably an element of interpretation in these categories.

Passages

Passages are generally narrow relative to their length and/or relative to any chambers which they may link. There is an unavoidable element of interpretation in this definition. Widths vary greatly: the Park Tunnel allowed two carriages to pass abreast, and both Mortimer's Hole and the Western Passage at the Castle would allow several people to walk abreast. The steepness of the castle passages makes it clear that they were intended only for foot traffic or possibly pack-horses.

A small number of systems comprise long passages: Mortimer's Hole (0070) and the Western Passage (0071 and 0074) at the Castle, a passage for a water system on St James's Street (0372a), the Park Tunnel (0385) and Willoughby House and Gawthorne House (nos. 20 and 24 on Low Pavement: 0180b and 0046). Not all passages were for access: 0010c at 9 Angel Row was a wine store, and the purpose-built World War II air-raid shelters also took this form (0088; see Section 2.3.4).

Chamber plan-forms

The abbreviations noted below have been incorporated in the GIS.

Small circular malt kilns (MKI)

These chambers are generally 3–4m in diameter and their distinctive oval vertical profiles and identification as malt kilns have led to a greater than usual number of sections being recorded (Figure 4). The plan-form is not distinguishable from other circular plan-forms without a record of the vertical profile, and no attempt has been made in this study to identify further caves of this type from the available records.

Small D-shaped and small rounded chambers (SDS; SRO)

These chambers are less than 5m across. The clearest D-shaped chambers have restricted entrances, but some have been identified from partial plans when they have been apparently been cut through by later chambers (**0318**). Rounded caves are often irregular. Many occur in clusters within a system.

Rectangular chambers with one rounded end (RRE)

These plans take the form of elongated, straight-sided rectangles with one rounded end (0006).

2.2.4 Internal features

Systematic study of internal features is beyond the limit of this study. However the following types of internal feature are commonly present:

- roofs:
 - shaft (circular/square/rectangular);
 - goods collection/delivery;
 - ventilation/smoke hole/chimney;
 - probe hole;
- walls/floors:
 - shaft;
 - well;
 - door;
 - window;
 - built structure;
 - pillar;
 - niche;
 - thrall (brick or stone bench at the base of a wall);
 - bin;
 - pit;
 - avoidance feature (eg buttress to avoid well);
 - stairs/steps; and
- decorative:
 - architectural detailing (eg capital, blind arcading).

Shafts passing through roofs but not floors were probably used for loading and unloading where they are vertical. Provision of daylight to caves has also been suggested as the purpose of some shafts. Many shafts were wells; where cut from the surface wells pass through the roof and the floor.

2.3 Types, distributions and dates

Caves have been put to a very wide range of uses, and in many cases these have this has no doubt changed over time. Evidence of earlier usage mainly comes from historical documentation. Perhaps the most varied change of use over time has occurred in the caves at Lenton Hermitage: supposed Druidical site; monastic cell; hunting lodge; secret place of worship for Catholic recusants; dining and leisure activities; public park; and storage areas for private residences.

Documented uses of caves in general include:

- hermitage;
- church;
- dwelling;
- maltings;
- tannery;
- storage of goods;
- mine;
- cold cellar (including use as beer and wine cellars, cold stores for food and other beverages);
- prison;
- museum;
- laboratory;
- herbarium
- passage for foot or vehicular traffic;
- catacomb;
- leisure (including grottos, summer houses and garden follies);
- rifle range; and
- air raid shelter.

2.3.1 Potential pre-medieval cave usage

Archaeological evidence has been obtained for human activity in the area currently occupied by the City of Nottingham from at least the Mesolithic period (Dixon *et al* 1997), including for example a regionally important Late Bronze Age metalwork hoard at Great Freeman Street and redeposited Middle to Late Iron Age pottery from sites on the Castle Rock and in the Lace Market area (including Fisher Gate and Halifax Place). This implies that the sandstone bluffs were occupied or used in prehistory, at least a thousand years before the Middle Ages, while discoveries of Roman pottery at sites such as Fisher Gate attest continued activity into the Romano-British period (*ibid*). There is currently no evidence for the construction of caves in these early periods, but, given the frequency of their formation in the medieval period, it is possible that people made and used caves on a temporary or permanent basis in the Roman period, Iron Age or earlier.

2.3.2 Potential pre-Conquest caves

The monk Asser, writing in 893 and referring to the overwintering at Nottingham of the Danish army in the year 868, gives the Welsh and Latin names for the place. One modern source (Gover *et al* 1979, 14) gives these as *Tigguocobauc/Speluncarum Domos*, in Latin, translating them as 'cavy house', while another (Keynes and Lapidge 1983, 77) gives *Tig Guocobauc/Speluncarum Domus*, translated as 'house of caves'. Both translations indicate the singular, hinting at a single habitation rather than a settlement. Keynes and Lapidge (*ibid*, 241, note 59) suggest that the name may have been Asser's invention based on personal knowledge of the place, without saying why he would concoct a name. Asser 'had a Welsh audience uppermost in his mind' (*ibid*, 56) and for various places in addition to Nottingham he provides Welsh language equivalents to English names. As a Welshman installed as Bishop of Sherburn by King Alfred it therefore seems possible that he knew of *Tig Guocobauc* from a Welsh source rather than direct experience.

A hermitage is recorded at Sneinton in 1544 (MacCormick 2001, 98) and this may be the cave system located at Sneinton Hermitage (0367). An ecclesiastical origin is securely documented for the cave system at 'Lenton Hermitage' (0119), though the term 'hermitage' could be a 19th-century creation. In the Middle Ages it was known as the monastery of St Mary de la Roche (Drage 1989, 65–6). While there is no direct evidence for a pre-conquest date it cannot be ruled out.

There is no particular correspondence between known caves and the area of the pre-Conquest *borough*; indeed they are less common there than elsewhere. This could indicate at least that urban caves were not particularly common in the pre-Conquest period, though the extent of surface occupation in this period is also very uncertain.

2.3.3 High Medieval and Early Post-medieval caves

This section includes High Medieval and early Post-medieval sources through to the mid-17th century.

Documentation

General references to caves

The following observations regarding documentary references have been collated from an article by MacCormick (2001), a short description by Foulds (1997a, 59–60) and the project archive's *Table of Historical References* (see Section 5.4).

Stevenson (1904, 21) relates that Higden's *Polychronicon* of 1270 calls Nottingham '*a woning of dennes*' (dwelling of caves), a phrase noticeably similar to that of Asser.

The term appears to have been used to commonly indicate a cave in the medieval documentation of Nottingham is *cellarium* (cellar). Recorded meanings in Latin from British sources generally include a store room (especially subterranean) or cellar; recorded uses are the storage of wine, coal or firewood and food (DMLBS 2017 under *cellarium*). This could of course mean basements as well as caves. From 1300 there are numerous medieval documents referring to individual cellars (eg '*celaria subteranea*') or using phrases such as 'buildings thereupon constructed above and below ground', all suggesting use of caves but with no clear indication of use for habitation. Writing around 1540, Leland refers to great caves at the foot of the southern cliff where stone had been dug for buildings in the town; the caves were partly used for dwellings and partly for cellars and storehouses (Toulmin-Smith 1907, 94–5).

It is difficult to know whether referenced features were on or below the surface. A 13th-century surface-cut cellar was excavated at Boots Garage (Young 1982, fig 3) but archaeological evidence for medieval open-cut cellars in Nottingham is rare. Two cellars could lie below one property and more than one house could be over one cellar. In Little (Narrow) Marsh a number of properties had the messuage on the south side of the road and a cellar below the rock on the north side (ie cut into the base of the cliff). In Stoney Street one toft was divided into two; one of the parts which had a separate entrance contained a cellar and a kiln with no constraint on enlarging the cellar.

Amongst the earliest probable references to specific caves in Nottingham is probably one of 1168: a land grant which refers to 'digging the rock for making a cellar without injury to the house above' (MacCormick 2001, 97).

Vault Lane (generally thought to indicate a cave) is referenced from 1323.

During the reign of King John, from January 1212 to February 1213 ten miners were at the castle, possibly to dig caves (Drage 1989, 43). A document of 1460 refers to what is probably now known as Mortimer's Hole lying west of the rock brewhouses and other offices. Leland (c 1540) identified Mortimer's Hole, quoting 'the keepers' (of the castle?) (ibid, 96).

There were 'common caves' belonging to the town in 1411 at the ends of St James' Street and Bearward Lane and outside the town walls.

In 1544 reference is made to a house under the ground in a 'roche of stone' sometime called the Hermitage (Sneinton).

In 1603 a petition was made that too many malt mills were being established in Nottingham and adversely affecting prices, and in 1604 another from the malt millers of the town referring to the malt mill under the castle which was solely for the use of the castle.

From 1600 onwards there are many references to people living in caves but cave dwelling seems likely to have begun earlier: in 1606 and 1607 it was decided that the holes at Hollowstone were to be walled up to prevent further habitation.

It appears that English terms for caves included 'holes': medieval documents refer to the *Bugholes* (associated with a dyke in medieval documentation and mapped by Badder and Peat in 1744 adjacent to the south-east corner of Brewhouse Yard), a lane called *Milne Holes*, and *Toadholes* (possibly *t'owd holes – the old holes*);

A contemporary account of Nottingham dated 1641 (Anonymous 1641, 40–1) states that the town had a 'great store of cellarage', and the townsmen believed that they had as much storage below ground as above. The goods stored included beer and ale (which were kept as cold in summer as in winter) and wood, coal and 'brakes' (fuel of fern, bracken, bushes, brushwood or briers) for the maltings. Wheat and barley were extensively imported from the Vale of Belvoir and adjacent areas. The account also provides some detail of the maltings, which is set out below.

Property types

Mastoris' (1985, 37) conclusion that 'few attempts have been made to assess the topography of Nottingham at any one time in the medieval period' remains valid today, as illustrated by the relatively few references to such works in the most recent syntheses of Nottingham's history (Foulds 1997a, 1997b; Marcombe 1997).

Mastoris has, however, analysed a tax assessment of 1504 (Mastoris 1985). This describes the property of each taxpayer, excepting those of the Corporation of Nottingham, urban parishes, friaries and monasteries, and any valued under £1. The analysis identifies medieval street names and the distribution of various types of property within the town.

The types of property listed in 1504 are: barn, close, croft, garden, house, land, orchard, place, shop, stable, tenement and tentryard. The distribution of property types suggests that the medieval town can be divided into three character zones:

- **Central core** (Chapel Bar / Market Place south-east to Cliff Road / Fisher Gate): tenements with few or no gardens or associated properties;
- **Second (intermediate) Zone**: mixture of tenements and gardens; and
- **Peripheral Zone** (Broadmarsh, Castle Road, St James' Street, Broad Street, Goose Gate, Woolpack Lane): few tenements but many closes, barns and gardens.

Other zoning is discussed and Mastoris notes in conclusion that the picture is similar to the distribution of tenements in the 1609 survey (Figure 1). The zoning also correlates with caves in the historic core (see Section 2.1.4).

Dating of medieval caves

Dating caves in general, and medieval caves in particular, is greatly hindered by the frequent lack of *in situ* deposits, architectural detailing and site-specific documentation. However, a number can be identified from the sporadic surviving evidence, and wider generalisations may be made with reference to the distributions of specific types.

Caves are likely to have often been small. The anonymous author of 1641 (Anonymous 1641, 41) refers to maltings caves with 'large' and level floors; surviving examples suggests that 'large' therefore referred to a size range of 3.5-5m x 5-7m. Deering, writing in the 1740s (1751, 15), observed of the Willoughby House caves (constructed in the 1730s) that there was no crack in the rock despite the size of the caves. The largest cave in the system is 7.8m in diameter with a 1m diameter central pillar, and his comment suggests that in the mid-18th century spans of this size were rare.

Cave maltings

The anonymous author noted above states that some caves had large and level floors used for making malt, and cisterns and wells to steep the barley in, though there is no explicit reference to kilns. The malt could be made there 'as kindly' in the heat of the summer as at the 'best of time of the winter'. Because of this there was an abundance of malt in the town, permitting its export to Lancashire, Cheshire, Shropshire, Staffordshire and the Derbyshire Peak District by 'badgers,

carriers and hucksters'. The Cheshire carriers returned to Nottingham with salt from the Wiches¹. The account provides the number of tradesmen of each sort in the town, the most numerous being 61 butchers, 60 maltsters and 36 tanners.

These earlier subterranean maltings were said by Deering (1751, 15), to be 'much less' than the 'malt offices' of his day: the context suggests a meaning of smaller rather than fewer. In 1641 they were described as a contemporary phenomenon (Anonymous 1641, 41) while Deering states that in his day maltings were "almost all" above ground. 'Office' can mean an ancillary utility or storage building (for example in an inventory of 1717: 'The Brewhouse – The office & utensils...'; OED 2018 under 'office (n.)', meaning number 7). In the 1740s the number of maltsters in Nottingham had reduced to 40.

Deering (ibid, 175) refers to 'the remains of a staircase' leading up into the rock from a kitchen garden west of Mortimer's Hole in Brewhouse Yard. This description can only refer to the lower part of the Western Passage at the castle (Section 3.4.2). It led to a malt kiln and several even-floored rooms visible in his day. He took the kiln to indicate the location of the former 'malt-office' of the castle. The nature of his description implies that the kiln and caves had fallen into disuse by the 1740s. Blackner (1815, 50–51) records a former kiln at Brewhouse Yard that had become by his day 'lost in an ice house belonging to Mr Topott, confectioner, in Bridlesmith-gate'. Deering's account seems to indicate that only one kiln was present in Brewhouse Yard, and the combined evidence of the two authors suggests that the existing ice house in the lower Western Passage is the one converted from a malt kiln. The system as it exists now is described in Section 3.4.2. Deering's note is the only known documentation which can be attributed with reasonable certainty to a specific malt kiln in Nottingham and it is unfortunate that its form has been 'lost in the ice house'.

MacCormick (2001, 74-5) provided a systematic study of the physical remains of cave-maltings, which he considered to be largely medieval on the basis of the documentary evidence noted above. The twenty-eight cave-maltings identified by MacCormick (numbered M1 to M21) are summarised using his descriptions in Table 1 (ibid 94-95) and mapped in Figure 5.

Table 1
MacCormick's 2001 analysis of cave-maltings, with probable cross-references

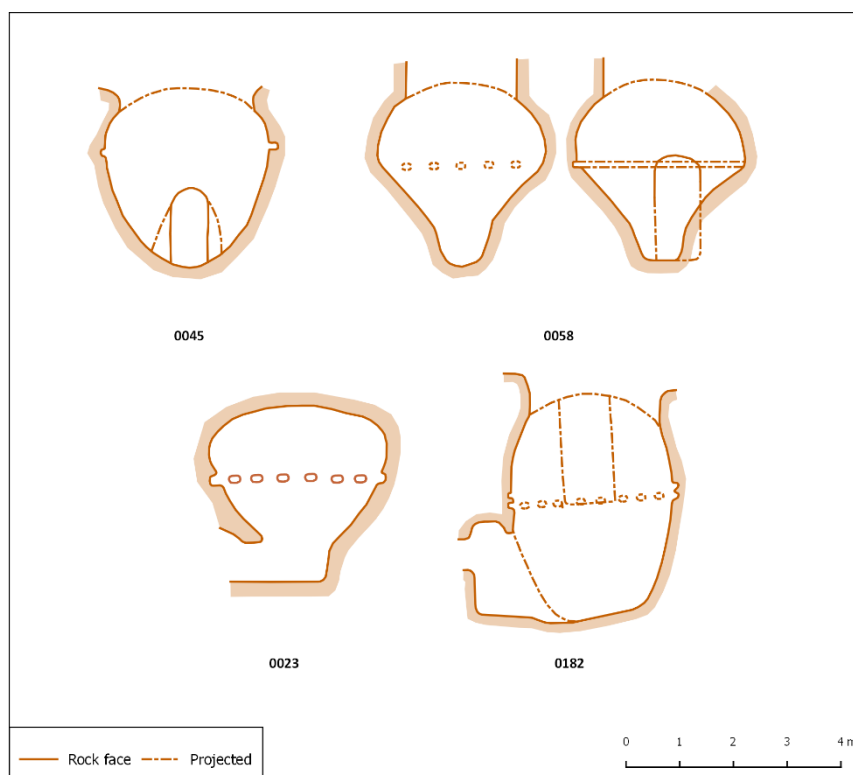
MacCormick ref	NCHER reference	BGS reference	Name	Kiln	Well	Cistern	Germination chamber	Laser survey
M01	0023	Be01	Lloyds Bank	x				
M02	0080	Ce03	8 Castle Gate	x	x	x	x	x
M03	unlocated		Drury Hill	x				
M04	0044	Bi01	Drury Hill IIIB	x			x	
M05	0358	Sf01	Farmer's Drapery	x			x	
M06	0033	Bh13	54–56 Bridlesmith Gate		x		x	
M07	0281	Mf02	3–7 Middle Pavement	x	x	x	x	
M08	0281	Mf02	3–7 Middle Pavement	x				
M09	0310	Pj02	Pilcher Gate	x	x	x	x	
M10	0170	Gf03	Goose Gate / Brightmoor St	x	x		x	x
M11	0142	Fa03	2-4 Fletcher Gate (M22 on MacCormick's plan)	x				
M12	0011	Ab04	Bromley House, Angel Row	x	x	x	x	
M13	0055	Bk02	Broadway (Plumtree House / Birkin's Warehouse 1)	not stated				x
M14	0058	Bk06	Broadway (Plumtree House / Birkin's Warehouse 2)	not stated				
M15	0071	Cd02	Nottingham Castle, Western Passage	x				
M16	0223	Hj02	240 Huntingdon Street	x	?		x	
M17	0182	Le05	14 Low Pavement	x				
M18	0054	Bj05	Broad Street, Broadway Cinema	x				
M19	0508	Lf10	Barker Gate, Ice Stadium	x				
M20	0047	Bi04	Middle Pavement, Severn's Building		x	x	x	
M21	unlocated		Fletcher Gate	x	x	x	x	
M22	unlocated		Fletcher Gate	x	x		x	
M23	0399	Wa03	Warser Gate, midway north side	?		x		
M24	0434		Barker Gate, 'cave farmstead'	x	x		x	
M25	unlocated		Cranbrook Street	x				
M26	0041	Bh07	Byard Lane					
M27	0220	Hh03	57 Hounds Gate	?	x			
M28	0646	Ce12	Castle Gate	x				

¹Presumably the Cheshire salt-making centres of Middlewich, Nantwich, Northwich and Leftwich, and Droitwich in Worcestershire

The kiln chambers are generally circular in plan, with diameters between 3 and 3.75m. The rooves are always domed, but the forms of the sections vary considerably; the height is within a similar range to that of the diameters. Sections of the best-preserved and recorded malt kilns are shown in Figure 4 and plans of the laser-surveyed systems in Figure 18. The form is very similar to a very well-preserved surface malt kiln of 13th-century date excavated at Boots Garage and a corn-drying kiln excavated at Fisher Gate (Young 1982, Sections D and C respectively, photo and fig 2).

The kilns generally occur in association with various combinations of well, cistern and rectangular cave for germination. A corn drying function is ruled out due to the regular presence of the cistern and well, neither of which would be necessary for this function. Together, these caves are interpreted as the distinctive components of a cave-maltings complex and, following Deering's comment, are likely to be of medieval or early post-medieval date (continuing as late perhaps as the mid-17th century: MacCormick 2001, 75).

Figure 4
Malt kiln sections
After MacCormick 2001, fig 3



Having identified kiln-chambers, MacCormick then noted several other cave forms which are regularly associated with malt kilns. Including documentary material, MacCormick identified a total of 28 cave-maltings, some of which are fairly speculative (2001, 94–95); he presented them as a gazetteer, numbered M1–M28. The caves and their recorded features are listed in Table 1, together with cross-references to the NCHER and the BGS referencing system.

Laser surveys were completed of **0080** (M2), **0170** (M10) and **0055** (M13). Plans from various sources of the seven best-preserved and recorded cave-maltings are provided by MacCormick:

- 8 Castle Gate (**0080**; M2);
- Goose Gate (**0170**; M10);
- Goose Gate (**0358**; M5);
- 3–7 Middle Pavement (**0281**; M7);
- Pilcher Gate (**0310**; M9);
- 2–4 Fletcher Gate (**0142**; M11); and
- Birkin's Warehouse (**0055**; M13).

These plans display a considerable degree of uniformity. They all show the kilns and wells (labelled on the drawings) and germination chambers (not labelled but clear enough from their size). The cisterns are less clear: none of MacCormick's

plans indicate the location of the cistern, though several have a pit marked on the plan. No explanation of the evidence for any feature being a cistern is provided; signs of waterproofing or lining would be expected, given the porous nature of the sandstone.

Kilns and wells are generally located to either side of the access steps (to which may be added the **0011/M12** Bromley House system, not illustrated by MacCormick). Other plans not illustrated by MacCormick indicate more variation, notably in the entrance arrangements. At **0142/M11** Fletcher Gate, **0223/M16** Fletcher Gate and **0434/M24** Barker Gate the kiln was not close to the entrance steps. Several of the identified cave-maltings do not have all the diagnostic features. The malt kiln at the Castle (**0071**; M15) is the only one to be identified as such in historical documents; while its form has been obscured by later conversion into an ice house, a kiln of the form and dimensions noted above would fit inside the current ice house form.

The cave-maltings systems generally have roofs about 3m below surface level, with about 1m of rockhead. The germination caves are generally about 2.5–3m high to the roof apex, 3.5–5m wide and generally 5m long, with an exception of 7m at **0170/M10** (later extended to 11m). Pillars are round or square in plan. The roasting floor is marked by a ledge or joist holes at the widest point, above a narrow 2m-deep fire pit and a 1m-high stoke hole set at right-angles to the loading door. Wells are circular in plan and about 0.9–1.2m in diameter, with foot or hand holes in the sides. Most extend to the surface. Cisterns are round (2m diameter) or rectangular (1.5–2m x 1m wide) in plan.

One notable feature detectable in three of the six more complete plans is the tendency for the germination cave to have a plan in the form of a slightly irregular tapering rectangle with pillar (**0310/M09**/Pilcher Gate; **0055/M13**/Birkin Warehouse 1; **0142/M11/2-4** Fletcher Gate). The dimensions are approximately 3–4m minimum width and 6–7m in length. There are caves of this form to either side of the Western Passage cave system at the Castle though the kiln itself is now obscured by later modification. Identification of this form requires good preservation and an accurate survey, which prevents more extensive identifications.

Other medieval caves identified by MacCormick

Study of excavated material from caves is beyond the scope of this report, but MacCormick identified five caves dated to the medieval period from archaeological evidence; they are listed below with his catalogue numbers:

- 8 Castle Gate maltings (**0080**; M2): a cess pit forming part of the system contained a pottery sequence from 1230–50 to c 1600;
- Drury Hill IIIB (**0044**; M4): the stokehole of a maltkiln was modified by inserted masonry sealing late 13th-century potsherds, and was filled with material including 14th/15th-century pottery, a coin of 1351 and a mail fragment of no later than 1400; the in-filled material was overlain by a brick floor placed on a layer of coal containing pottery and clay pipes of the late 17th century;
- Broad Marsh Pillar Cave (**0045**; C24): two rock cut pits (one outside the cave) contained large sherds of 1270–1300 pottery and no later material; the cave floor was then raised by c 1m by a layer incorporating 14th and 15th-century material; evidence suggests that this constructional modification took place after a rock fall at the cave mouth. Tanning vats were then cut into the raised floor and were also dug in an adjacent cave. Tanning on the site is documented in 1639;
- Pepper Street (**0035**; C25): excavated fills indicated a sequence of infilling from the 13th to the mid-15th century; the upper fills were dated to the late 17th to early 18th centuries; and
- The Flying Horse Hotel (**0317a**, C27): the roof of the main cave is cut by a chimney of 2–2.25in. bricks; this type of brick is thought to pre-date bricks of 2.25–2.5in thickness used at Wollaton Hall (1580–8).

MacCormick (ibid 84–6) concluded with a discussion of the forms and features which he identified as characteristic of a medieval date. These include the following:

- rectangular form up to 4 x 5m;
- regard for symmetry about the long axis;
- doorways central with rounded, segmental or pointed arches, sometimes with a recessed tympanum;
- central pillar with carved capital and vaulted roof; some capitals are comparable to those in medieval buildings;
- carved or incised crosses above the entrance door to the system;
- precise and regular roof tooling, with a shallow broad groove along the length of the vault;
- string course, sometimes cabled, at the base of the springing of the vault; and
- blind arcading (33 Long Row cited, but also preserved at Lenton Hermitage).

No detailing in the perpendicular style is known. Other features are noted in the same section but there is no clear statement that these are diagnostic of the medieval period.

He also identified four medieval tunnel caves at the Castle, and the Cokwatergang conduit running from the Athilwelle in Lenton to the Friary in Broadmarsh (known only from documentation but presumably at least partly underground).

MacCormick's analysis of 27 non-maltings cave systems is summarised with additional notes in Table 2.

Table 2
MacCormick's 2001 analysis of proposed medieval non-maltings caves

Catalogue	NCHER reference	BGS ref	Name	Pillar/pilaster	(Pointed?) vault	String course	Incised cross	Archaeological evidence	Notes	Laser survey	Other plan
C01	0119	Cp1	Lenton Hermitage			x			A variety of dates is likely; 'chapel cave' had Romanesque detailing; others are post-1722	x	
C02	0070	Cd1	Castle - Mortimer's Hole						First recorded 1540; MacCormick suggests an earlier record	x	
C03	0071	Cd2	Castle - Western Passage						Upper part of passage post-medieval; lower part contains former malt kiln of possible medieval date	x	
C04	0072	Cd3	Castle - 'Davy Scot's Hole'						Evidence for name and date not stated; pre-dates late C19 carriageway	x	
C05	0687	-	Castle - northern passage						A passage found under Lenton Road; evidence for date not stated		x
C06	0247	Ld08	58 Long Row	x							x
C07	Multi	Ld05	33 Long Row		x	x			Vault to corbelled blind arcade		x
C08	0238	Ld10	67 Long Row							x	x
C09	0228	Ka1	Queen Street Old GPO	x							x
C10	0043	Bh09	47 Bridlesmith Gate	x							
C11	0037	Bh3	6-8 Bridlesmith Gate	x			x				x
C12	0200	Hc13	Shire Hall		x		x			x	
C13	0632?	Bk1?	5 [=3?] Broadway	x					Probably Bk1; colour photos show it to be rubble-filled		x
C14	0230	Kc1	King's Place off Stoney Street	x	x	x					x
C15	unlocated		Plumtre Street	x	x	x			Not located; see Stretton MSS		
C16	0079	Ce2	6 Castle Gate	x	x	x					x
C17	unlocated		Castle Gate-Black Lion Yard	x					Pillar similar to Queen St; added to GIS from location of Black Lion Yard in late C19		
C18	0384	St1	Stanford Street		x	x			Interrupted spine wall rather than pillar; V-shape plan; resembles medieval vault in Southampton (C14/15)		x
C19	0151	Fg1	Friar Lane - Collins Almshouses	x	x	x					x
C20	0151	Fg1	Friar Lane - Collins Almshouses	x	x	x					x
C21	unlocated	-	c51 Hounds Gate	x	x				Cave not identified		
C22	0359	Sf2	c31 Wheeler Gate	x					2-arched door		x
C23	unlocated		Wheeler Gate - west side	x					2-centred arched door; cave unlocated		
C24	0045	Bi2	Broad Marsh - Pillar Cave	x				x		x	
C25	0035	Bh15	Pepper Street/Bridlesmith Gate					x	Excavation		x
C26	0744		Lister Gate C&A Store	x	x	x			Now possibly H&M, 11-17 Lister Gate		
C27	0317a	Pm1	Flying Horse Inn								x

A visual scan of the plans of the above non-maltings caves does not reveal any repeated cave forms, but the location of the medieval elements within the cave systems is often not indicated by MacCormick.

Potential medieval or Early Post-medieval chambers dated by plan-form and distribution

Malt kilns (MKI) have been described above.

Small, rounded (SRO)

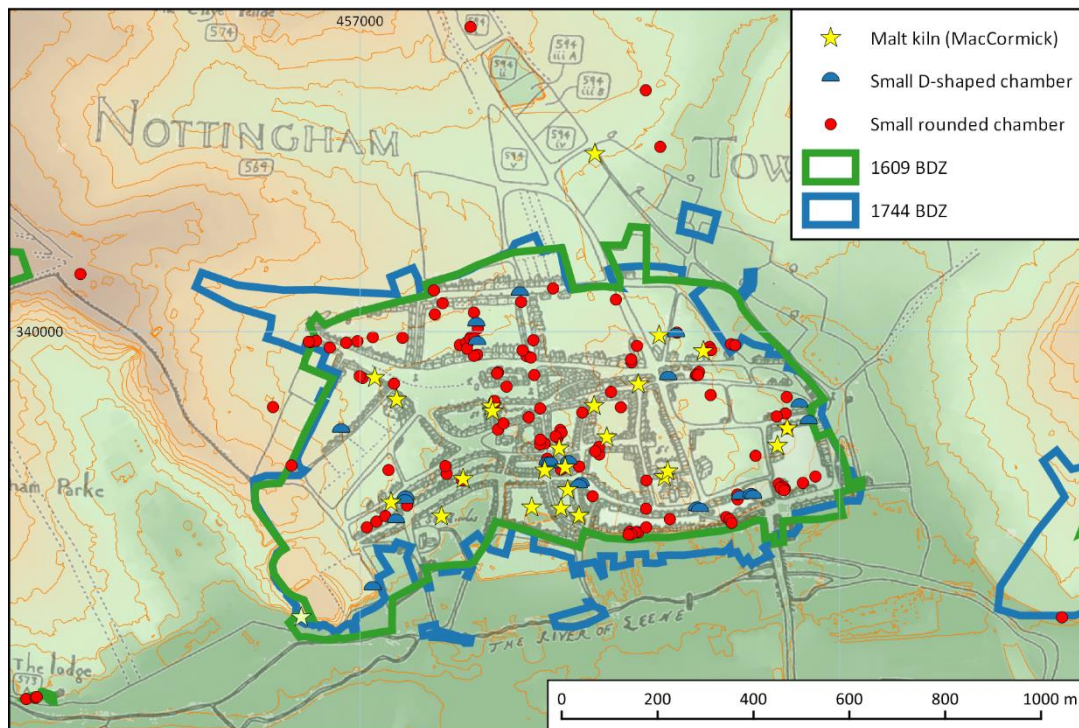
Chambers of this type are mainly between 1.5m and 4m across, with continuously curved sides, without any significant indication of angularity such as rounded corners or flattened edges. They are often joined to larger caves, where there needs to be a constriction between the SRO and the larger chamber for the former to be included in the type. Those closest to a circular form can be similar in plan and dimensions to malt kilns (MKI). These chambers are sometimes clustered, when they form multi-lobed curvilinear plan-forms (see for example Section 3.4.1).

Small D-shaped (SDS)

Chambers of this type are between 3m and 5m across. They have one curved side with little or no suggestion of rectilinearity, and one straight. Some are connected to a passage on the straight side, others are joined to a larger chamber of different shape.

The distribution of SRO and SDS chambers is provided in Figure 5.

Figure 5
Distribution of SRO and SDS chambers and malt kilns in relation to BDZs
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The distribution of both types correlates very strongly with the 1609 and 1744 BDZs, and a medieval or Early Post-medieval date for the form may be suggested. The 1744 BDZ has a very similar footprint to that of 1609 with only very small extensions to the north. This provides little to distinguish caves of potential 1609–1744 date from those dating before 1609.

Distribution of other medieval caves

Cave-maltings are generally set back from the property frontage (MacCormick 2001, 92). This may have been to minimise the risk of fire to surface buildings, but ventilation and light may also have been factors. At the Farmers site, a wide sandstone foundation over the cave could have supported an open-sided building protecting the cave entrance while retaining lighting and ventilation (ibid, 92). The distribution of medieval caves lies entirely within the medieval borough, except for Lenton Hermitage and M16 on Huntingdon Street (which may be within the outlying settlement of Whiston).

The distribution of medieval caves identified by MacCormick has the following characteristics:

- concentrated around the two marketplaces, the adjacent wealthy streets, and the axis of High-Middle-Low Pavement-Castle Gate;
- none between St James' Street and the Town Wall and few in the north-east corner of the town;

- documented common caves at western ends of St James' Street and Bearward Street;
- no distinction in date or style between the English and French Boroughs;
- the distribution of known examples suggests that there may have been well over 100 medieval caves;
- several large central sites have been developed without record (eg Debenham's, Littlewoods), though caves are still accessible under Debenham's; and
- investigated sites on Long Row show that every old property had at least one cave.

Although cave-maltings are widely distributed throughout the medieval town, there is a distinct concentration west of Weekday Cross, even when the general distribution of caves is taken into account.

2.3.4 Late Post-medieval and Modern caves

General documentary evidence

Expansion of the town between 1609 and the later 18th century was very limited (Figure 16).

The Enclosure of Basford took place in 1792–7 and of Radford, Lenton and Sneinton in 1796. This permitted the expansion of both housing and industrial works such as cotton mills and bleaching works (Beckett 1997, 212).

The map chosen to define the limit of mid-19th-century urban development is Dearden's map of 1844 (Figure 17), supplemented by that of Sanderson (1835) for outlying areas. The extent, relative accuracy and detail of Dearden's map, and its near-coincidence in date with the passing of the Nottingham Enclosure Act in 1845 (which made possible the subsequent major expansion of the urban area) make it an ideal datum against which to compare cave types and urban development. Within this area, the late Georgian to early Victorian expansion may be identified by comparison with the 1744 BDZ. The 86 caves located outside the built-up area indicated by this map are likely to have been constructed after the map was drawn up.

A scan of the DBA Archive *Table of Historic References* (see Section 5.4) indicates the following points of general relevance to cave development in the Post-medieval period:

- in 1740 rockholes in the sandhills 'beyond Chapel Bar' were to be levelled (there is topographical evidence of a hollow way on Derby Road south-east of Canning Circus at the hill crest, which may be the site of these demolished caves);
- before 1815 caves had been used as cess pits²;
- in 1847 some of the poorer classes were still living in caves; and
- by 1852, thanks to the acts (including eviction) of the Sanitary Committee, The Board of Guardians and the Board of Highways the number of 'cellar dwellings' in Nottingham was not large.

Deering (1751, 6) refers to 'caves and rock holes &c'; the term 'rockholes' is suspected to refer particularly to rock houses and occurs into the mid-19th century. He uses the terms 'cellar' and 'rock cellar' interchangeably to refer to a cave. In the 19th century 'cellar' meant open cut cellar, while 'rock cellar' meant 'cave' as defined in this document (information from Mr Scott Lomax). Deering (*ibid*, 15) provides a summary of cave usage in his time: he noted that the inhabitants of Nottingham (which was famed in the 18th century for its malt and ale) had, in addition to good barley, 'also the best, coolest and deepest rock cellars, to stow their liquor in, many being 20, 24 to 36 steps deep, nay in some places there are cellars within cellars, deeper and deeper into the rock'. Deering used the present tense when saying that the shallowest cellars were used by tradesmen for storage of goods, and the past tense when referring to the use of caves for maltings in the latter years of the reign of Charles I.

Historic mapping permits the identification of the 'context' of the cave site (the broadly contemporary documented function of the overlying site) in the late 19th century. This categorisation has been used as the basis for analysis of caves outside the 1844 BDZ. 'Sand mines and quarries' form a special category which is also considered, as they have their own distinctive form and documentation and are unrelated to the overlying properties. The other contexts which have been identified (using the Ordnance Survey Town Plan of 1880 at 1:500 scale and the First Edition map at 1:2 500 scale) are 'beer cellars', 'industrial' and 'residential'. Beer cellars are those which lie beneath or directly adjacent to public houses, inns, taverns, breweries and hotels. They may also or alternatively have held wine, but on a commercial and not a domestic scale. Industrial caves are those which lie under sites labelled 'factory' or 'works'. Residential contexts are nearly all other

²Blackner (1815, 26) noted that a pump opposite the south end of Sheep Lane (now Market Street) had been removed because 'the ordure, which accumulated year after year in the vaults on the Long-Row had so far penetrated the rock as to ooze into the well, which rendered the water, at times, quite nauseous to the taste, and altogether unfit for culinary purposes'.

locations (almost always unlabelled on the maps), recognising that this may include other uses such as shops, and combined functions such as workshops and houses. A small number of caves are purpose-built air-raid shelters from World War II.

Caves are discussed under these categories in the remainder of this section.

Sand mines and quarries

The sand mines and quarries are located at the margins of the 1844 built-up area, and generally date from the 18th and early 19th centuries (Figure 6; Waltham 1994). They lie in two pairs located to either side of Mansfield Road and apparently exploiting the necessary presence of open ground, the slope for ease of access and, in the case of Rouse's mine at least, the high-quality sand accessible at their location. The following account is based largely on that in Waltham (1994).

The most extensive surviving mine (**0277**; see Section 3.4.5) lies south of the hill crest on the west side of Mansfield Road, and is now accessed from Peel Street. The mine is very probably that referred to by Blackner (1815, 10), located beneath 'Dog-kennel-hill' and operated for over thirty years until retirement by James Rouse or Ross. Its operation must have been from c 1780 to its closure in 1810, though the mining could have been begun earlier. The method of working was 'pillar-and-stall', to no systematic plan. Galleries range between 2m and 5m wide and 1.6–2m high, with cross-sections in the form of flattened ellipses. Roof failure has never been a problem in the mine. It was reopened in the later 19th century as an attraction during Goose Fair, and was used as an air-raid shelter in World War II.

On the opposite side of the road to Rouse's mine is another mine (**0745**), known as the 'Whiston Mine'. This is similar in form to Rouse's Mine, but it is much less extensive and its form is known only from sketches.

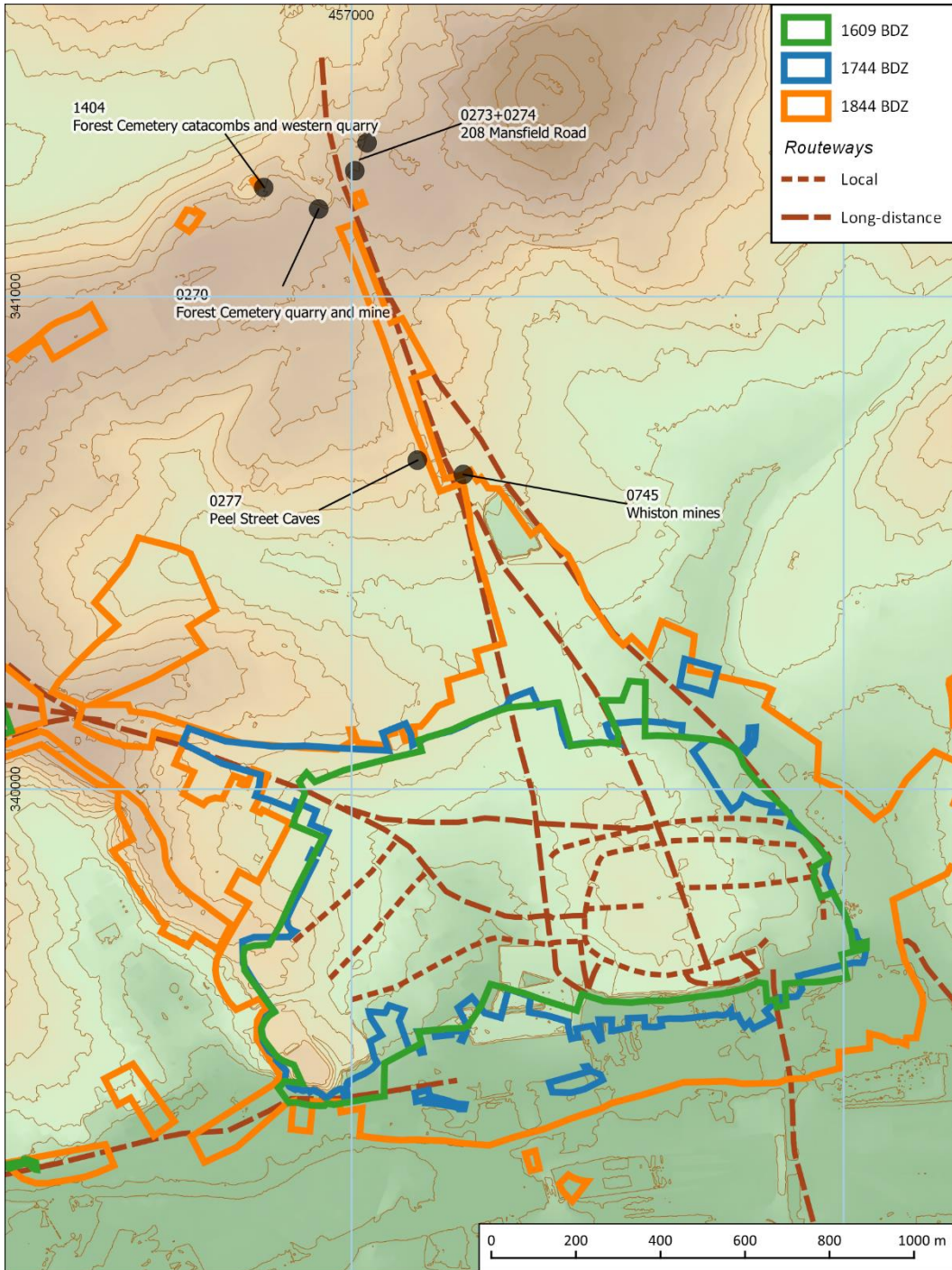
Two further mines lie north of the Rouse and Whiston mines, just north of the crest of Mansfield Road where it drops towards Sherwood. The Cemetery Mine lies on the west side of the road and comprises a quarry and a mine, now occupied by the Forest Road Cemetery (**1404**, **0270**). Following a fatal accident in 1806 the mine was blown-up and the entrances blocked, the miners being obliged in future to work open-cast. The mine/quarry was abandoned in 1811 (Blackner 1815), possibly used as a ropewalk c 1850 and subsequently developed as a cemetery. Catacombs (**1404**) wrap around the wall of the disused western quarry and are probably dated to 1859–63. The main surviving mines (**0270**) lie to the south within the cemetery, further up the hill. The quarries and mine are still visible in the cemetery, including stumps of pillars between graves and ends of galleries in the cliff. There are three gated caves.

On the opposite side of Mansfield Road to the Cemetery Mine lies the Gallows Hill Mine (**0273**, **0274**). In addition to the underground workings, the mine site included an adjacent quarry that is represented today by a significant north- and west-facing working face. The site also contained the town gallows and now St Andrew's Church. Blackner (1815, 10) refers to sand mines around Gallows Hill, filled up in 1811 by poor labourers employed by the overseers of St Mary's parish, as an alternative to sending them to the workhouse.

These mines and quarries could have served a nearby glassworks located on Mansfield Road of the same period. Another possible use for the sand could have included the documented spreading of sand on domestic floors, use for building and as raw material for the manufacture of bricks, tiles and pottery.

Figure 6
Mines, relief and routeways

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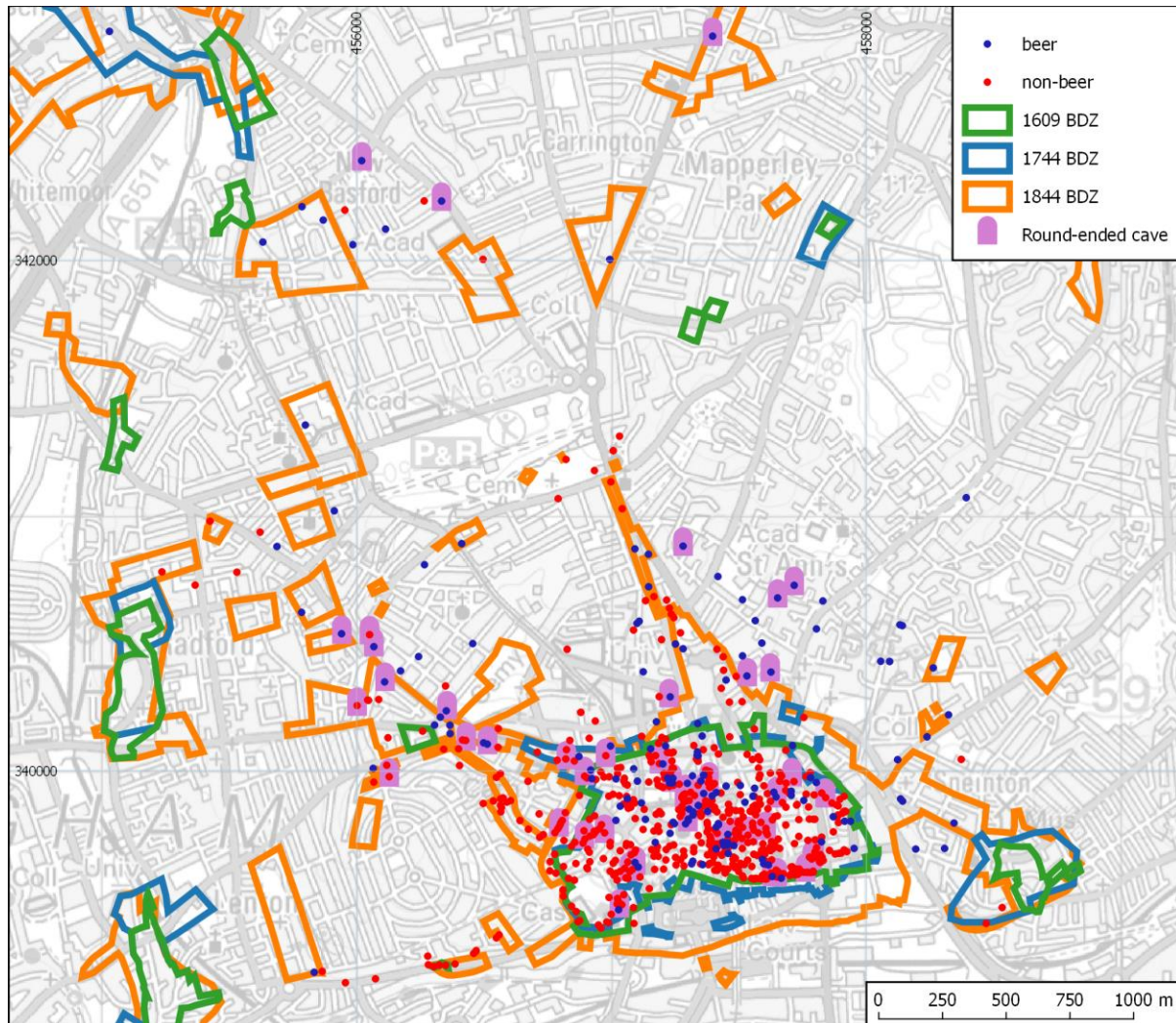
Beer cellars

The distribution of caves with a mapped 'beer' context, or with other evidence for this function is shown in Figure 7.

Figure 7

Beer cellars

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A basic numerical analysis of located cave systems in beer contexts and BDZs is provided in Table 3.

Table 3
Cave systems in relation to beer-related contexts and BDZs

BDZ	Cave-systems in beer context	Total caves in BDZ	%
1744	85	516	17
Outside 1744 and inside 1844	27	81	33
Outside 1844	41	86	48

As may be expected the correlation is strongest in the last group (>1844) where the documentation is probably broadly contemporary with the caves. The number of beer locations with or without known caves in the >1844 group has not been calculated but it must be a very small proportion of the total number of properties within the area at this time. The evidence clearly indicates that the creation of beer cellars was a significant purpose of cave-construction between 1744 and 1844, and a major one after then.

The much lower proportion in the 1744 BDZ may reflect nothing more than a poor level of documentation or a change in the location of beer contexts over time.

The perceived advantages of storing beer in caves have been discussed above, and this would have remained the case after their usage for underground maltings was abandoned in the mid-17th century.

A description of the Flying Horse beer cellars (0317a) was written by a visitor in 1746 (project archive, source not stated): they were of surprising depth, consisting of more 'stories' than one, each with several 'vaults' and all rock-cut; each of the 'cells' contained 'large butts of racy beer', some of which had a volume of 20 hogsheads (c 1080 gallons/5000 litres/5m³).

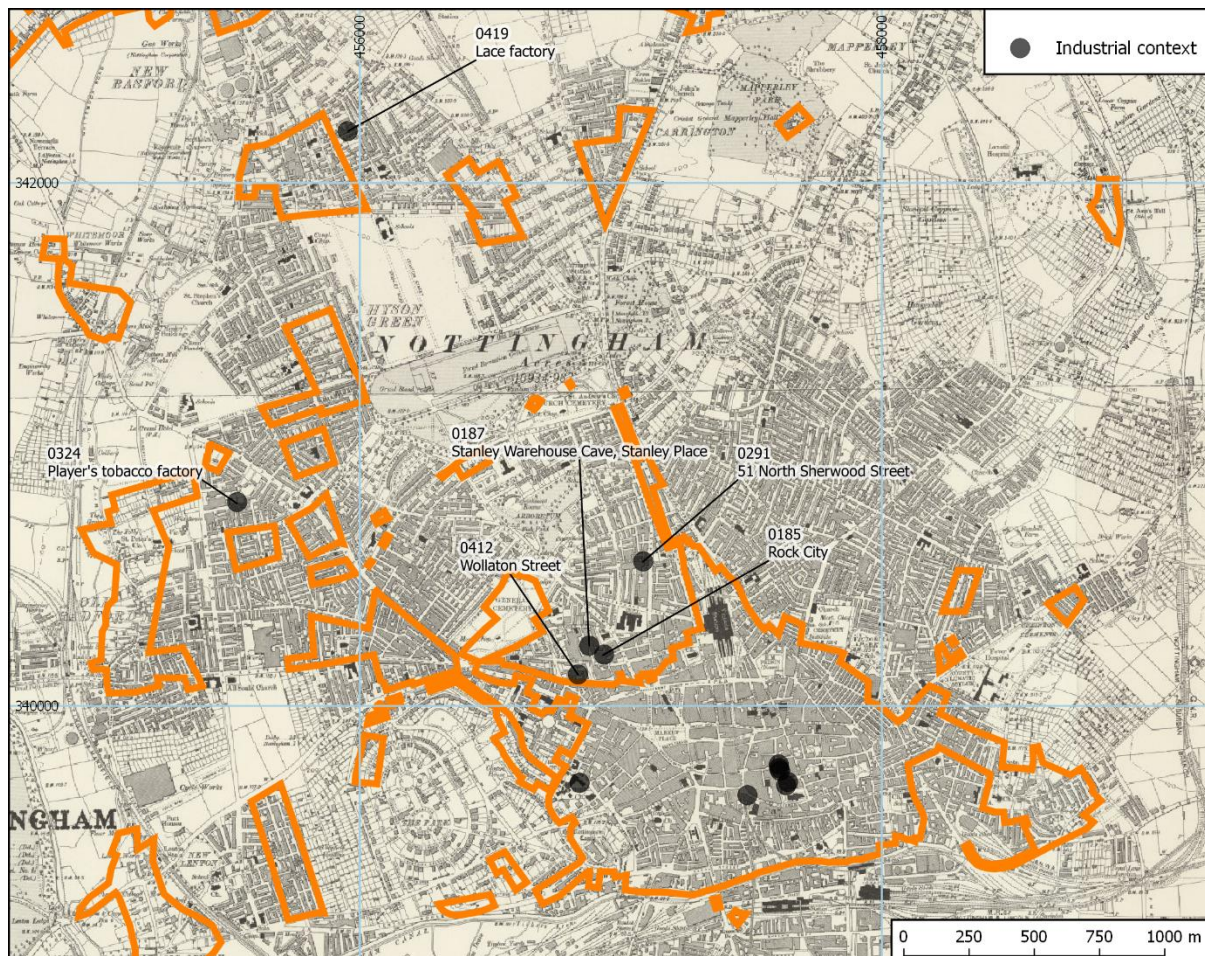
Waltham (2008, 16) notes that inn cellars are characteristically 3–4m wide and perhaps twice as long, often with one rounded end especially where there is a post-1600 date; there is usually c 2m of rock cover; thralls are present particularly after c 1700; and there is often a shaft for a barrel-hoist (though this would apply to any storage function). An analysis of forms supports Waltham's observation: there is a strong correlation between rectangular caves with rounded ends and caves in beer contexts, especially outside the 1844 BDZ (Figure 7).

Industrial

Surprisingly few of the caves are located in an industrial context (Figure 8). Caves are recorded under a lace factory in Basford (0419) and below a lace dressing works (0291) just off North Sherwood Street. A cave system under Rock City (0185) performed a specialist function as an ice manufactory, while a nearby cave (0187) is located under the Stanley Warehouse, the function of which has not been identified in this study.

Very extensive passages (0324) lie beneath the John Player & Sons factory site, some of which were cut in the late-19th century, and others of similar form cut possibly in the 20th century to form air-raid shelters (information Scott Lomax, NCHER). The passages are marked on a plan with a green wash which is coded 'shelters' on the plan, but some apparent ground-floor rooms are similarly designated. In one place the passages are marked 'plan of subways' (rather than shelters), suggesting that a pre-war plan had been marked up with air-raid arrangements. It is not certain that they are true caves and an inspection would be required to verify this point.

Figure 8
Later BDZs and caves in an industrial context



Residential

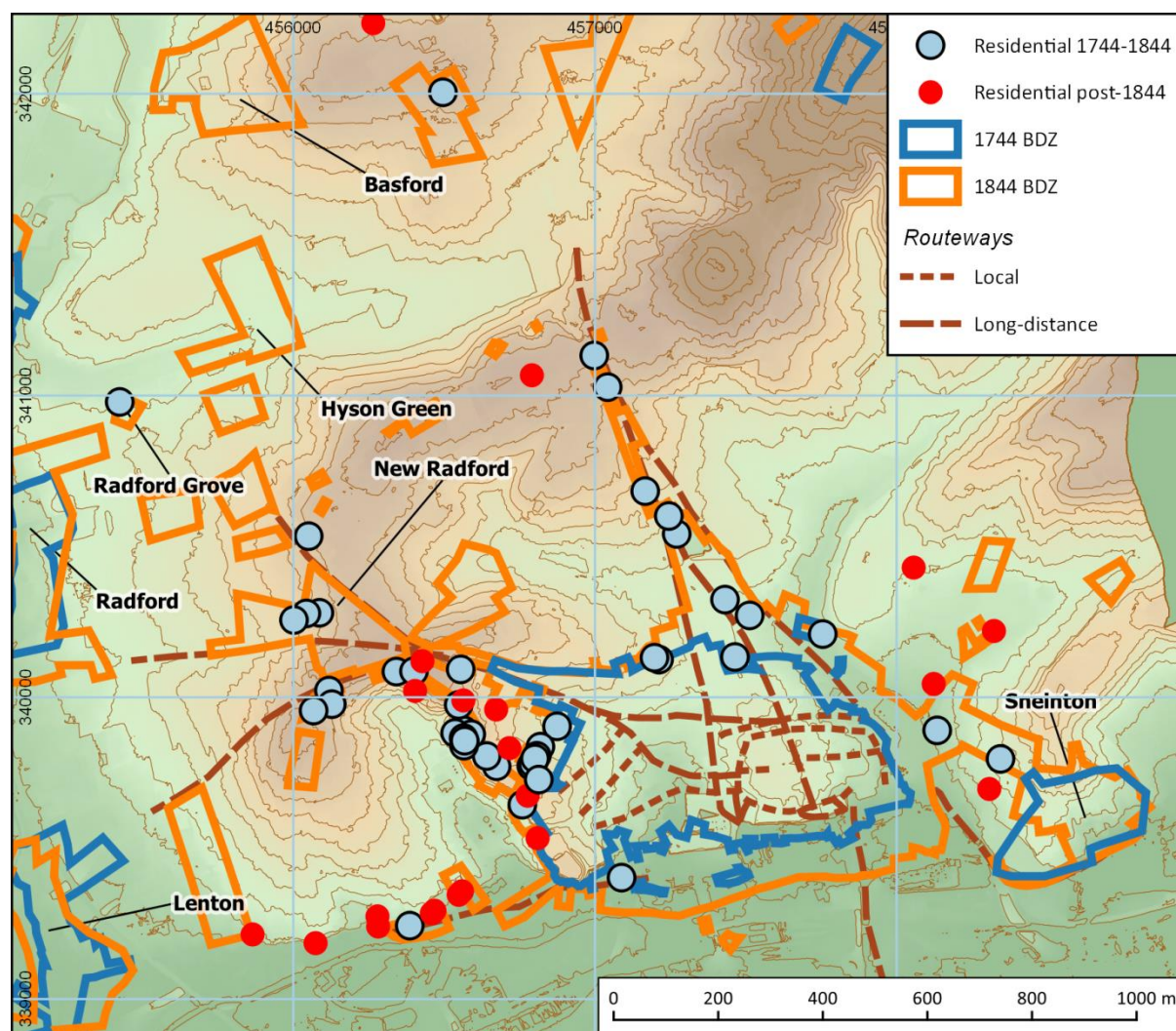
Correlating caves and context in the historic core has generally been beyond the scope of this study, but the Willoughby House caves are too important to pass without reference. The cave system lies beneath Willoughby House, 22 Low Pavement (0180; described in more detail in Section 3.4.6). The very fine house was built in the 1730s (Holland Walker 1929) and Deering, a contemporary witness (1751, 15), considered them to be 'without comparison in the whole kingdom'. The uniqueness and regularity of form is still striking and suggests that they were created partly for impressing guests. At the time that the house was built the view from the roof was regarded as a great asset, and visiting the caves may have also been an important part of any visit. The presence of bins and thralls suggests that they were used for the storage of wine and beer.

Caves outside the 1744 BDZ

A map of residential caves outside the 1744 BDZ is presented as Figure 9.

Figure 9
Map of caves in residential contexts outside the 1744 BDZ

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Of the 167 located caves lying outside the 1744 BDZ, 63 (38 per cent) lie in a residential context. It is not possible to distinguish shops from houses on this map and a number will no doubt fall into the former category. Within this group, 68 per cent of the caves lie outside the 1744 BDZ and within 1844 BDZ, while the remainder lie outside the 1844 BDZ. The proportion of caves beneath houses in the last-mentioned group is very small.

The caves in a residential context are concentrated along and around the main routeways of Castle Boulevard, Derby Road, Alfreton Road and Mansfield Road.

1744–1844

The western Post-medieval urban margin

These caves include a number of caves located along Park Row and Chapel Bar. These properties appear to represent medium-sized urban housing. These developments generally form small enclaves, though one at Forest Road West (**0149**) is an isolated example. The prospect from these houses, which were built in what was then open land, appears to have been a significant factor in the choice of site. All of the houses are large, three-storeyed buildings, and most of them survive. Further west, along the Ropewalk, Park Terrace and Derby Road (**0959**, **0976**, **0975**), lie large houses of this era with substantial gardens and fine prospects south and west over The Park. Caves are relatively common in these areas, reflecting establishments of sufficient size to have the resources and need for caves.

Cave-systems in this group are also known in more isolated but distinctive locations within the western post-medieval urban margin. One at 449 Alfreton Road (**0968**) lies in a former miniature ‘estate’ comprising house, formal gardens and lower-grade terraced housing (three of which still stand). The large house was named ‘Prospect House’, inviting comparison with the buildings discussed above, although in this case the site was relatively low-lying and it is unclear what prospect the name referred to.

Along Mansfield Road and along the northern Post-medieval urban margin, caves are associated with small properties. In the northern part of this area, they are closely associated with the road frontage and may be linked to shops.

The southern Post-medieval urban margin

Three caves on the southern post-medieval urban margin (**0700**, **0695**, **0227**) are also located in an area of small houses developed after 1744 and probably by 1874.

Cave types 1744-1844

While the houses are relatively substantial, the restricted size of their plots due to the urban context renders it unsurprising that cave systems in this group are generally simple: they frequently consist of one or two rounded rectilinear chambers of limited size. Elongated caves are sometimes present (eg **0973**). The caves are normally located beneath the houses rather than the gardens and therefore appear to be utilitarian in function (Figure 10). On Park Row caves were constructed outside the frontages, possibly due to the soft ground occupied by the in-filled medieval town ditch which lay immediately west of the town wall (Figure 11).

Figure 10
Cave-systems on Western Terrace (c. 1744–1844)

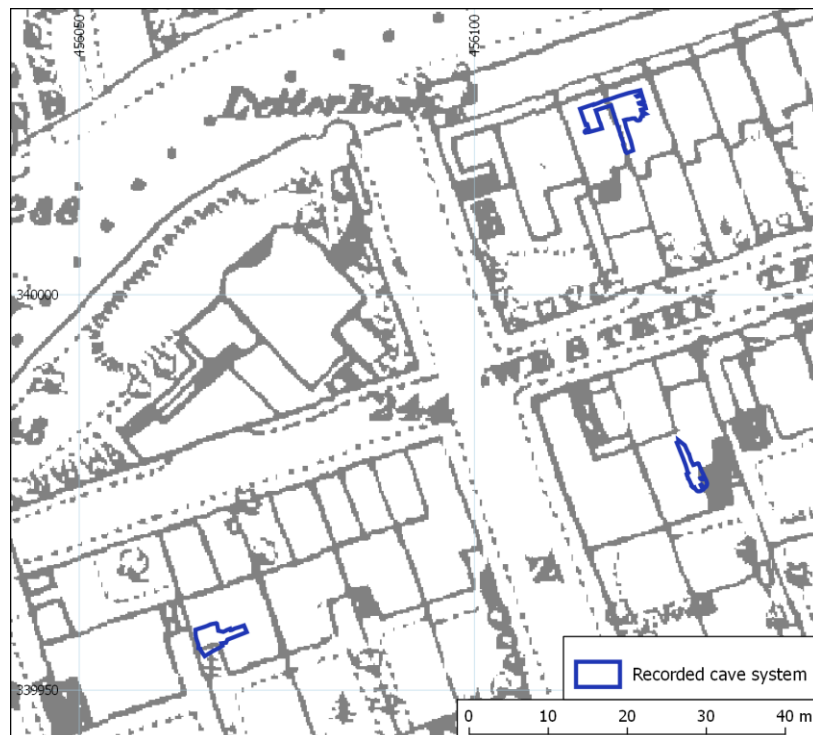


Figure 11
Cave-systems on Park Row (c. 1774–1844)



Later Victorian

Caves lie below substantial houses in comparable locations to those discussed above on the south edge of The Forest (2015) and around the high point of Derby Road and Alfreton Road (0213, 0177, 0014, 0130, 0974). Some are small caves similar in concept to the 1744–1844 category, though others are also seen beneath smaller domestic properties.

A distinct group of later-Victorian garden caves is found on the southern and eastern edges of The Park. This area is on lower ground and was developed after 1844. Caves are notably generally absent from most of The Park despite the presence of large houses and substantial gardens.

The garden caves are associated with large Victorian houses with large, often detached, gardens and located at some distance from the house. These locations all lie in steep topography: either the cliff or steep slopes on the north side of the Leen or the steep slopes flanking the west side of the Castle. The impression is that the construction of these caves was prompted by the opportunity presented by the built context and topography. One at Maria Court contains a relief statue of Hercules and another figure, not identified at present (0144); others are plain caves which may have functioned as summer houses. The construction of these caves may have been inspired by the proximity of this area to Lenton Hermitage (0119): a group of caves of medieval monastic origin which were in the 19th century incorporated within a park, ‘enhanced’ by rusticated styling and used for leisure pursuits, including dining. The combination of plainer summer houses and an ornamental cave links this group very closely with another on the Ropewalk and Park Terrace, which consists of a similar combination of summer houses and ornamental designs such as a rock-cut staircase and statuary (1274, 0328, 0973, 1132, 1275 and 0321).

A distinct cluster of four caves is associated with small houses in the industrial settlement of New Radford (0307, 0213, 0177, 0014). These may form a group related to a specific function that has yet to be determined.

Purpose-built air-raid shelters

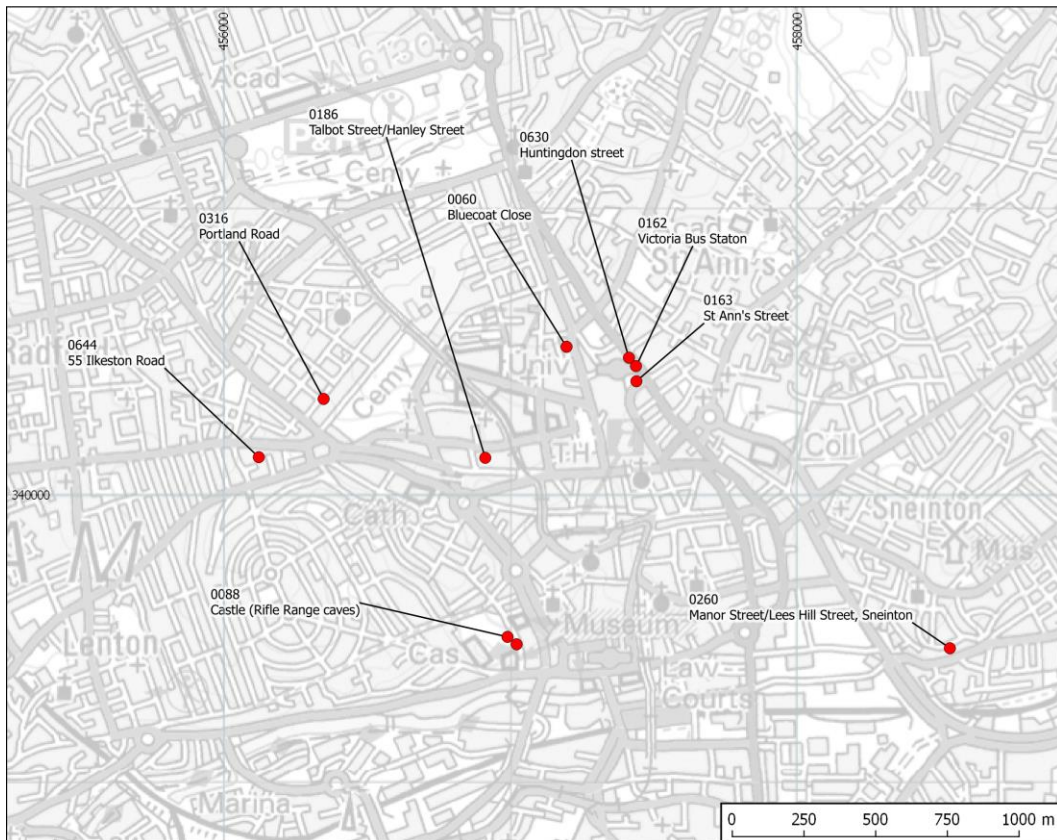
Many caves were used as air-raid shelters, generally during World War II but in one case in World War I (Lomax 2013, 140–1); most were existing caves which were adapted for this purpose, but a number appear to have been purpose-built (Figure 12).

Nine apparently purpose-built air-raid shelter cave systems are formed of very distinctive form extended narrow passages, sometimes occurring in interconnected groups (Figure 12). Some of these systems are linear in plan, while others form an irregular but orthogonal grid. Many have one end within a street, suggesting that they were designed with public access in mind. As a whole the systems items are located in or accessed from residential areas, and they are distributed in a ring around the city centre. All are recorded as having been used for air-raid shelters in World War II. The regularity of the caves form suggests a fairly recent origin for all, and their distinctive and consistent character suggests that they may have been purpose-built air-raid shelters. Documentation for one of these caves, **0260** in Sneinton (Lees Hill Street), demonstrates that it was purpose-built as an air-raid shelter, though formed by extending an earlier cave. The location and outline of the earlier cave is not apparent in the plan.

Figure 12

Possible purpose-built air-raid shelters

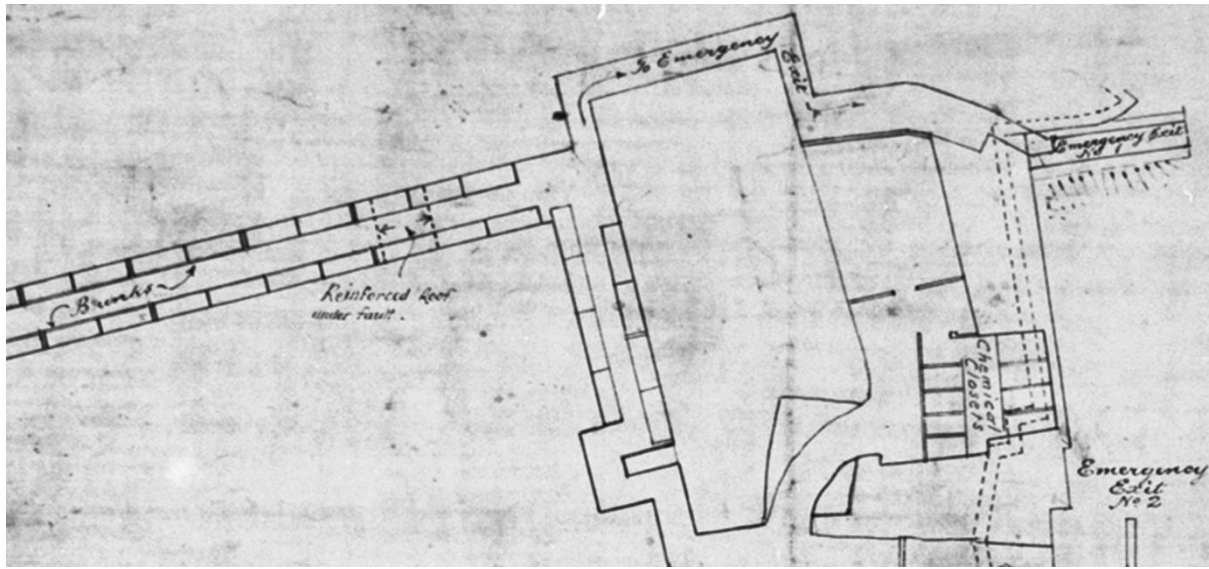
Ordnance Survey © Crown copyright 2020. All rights reserved. Licence number 100018343.



The 'Rifle Range' caves (**0088**; see **3.4.9**), entered from Castle Road and running under the outer bailey of the Castle, were added as 'tunnel shelters' to an existing system in the late 1930s. A war-time plan shows that, despite the narrowness of the tunnels, bunks were positioned along both walls of most tunnels, and chemical toilets were placed in the larger earlier caves. The entrance and two emergency exits connected with Castle Road (Figure 13). A length of tunnel marked 'fault over' had been walled off, presumably due to being considered unsafe. The tunnel design was presumably thought to be the strongest though many pre-war caves of larger spans were used as shelters.

The possible cave systems of late 19th-century date beneath the John Player & Sons factory are of similar character to the purpose-built air-raid shelters but, as described above, they appear to have been built for an industrial purpose and pressed into service as air-raid shelters.

Figure 13
Detail from air-raid shelter plan of the 'Rifle Range' caves, dated 1942



3 CNRP laser surveys

3.1 Criteria for selection for survey

Cave-systems were selected for survey on the grounds of accessibility and in order to provide a sample of the following urban development contexts:

- Anglo-Saxon *burh*;
- High Medieval borough;
- pre-Victorian urban area;
- later-Victorian urban area; and
- outliers on principal approaches.

3.2 Spatial distribution of surveyed cave systems

The 66 cave systems subjected to laser survey are listed in **Table 4** (including National Grid references) and mapped in Figure 14.

They are distributed from Lenton Hermitage in the west to Sneinton Hermitage in the east, and from the north edge of the Leen/Trent floodplain in the south to the Rock Cemetery in the north.

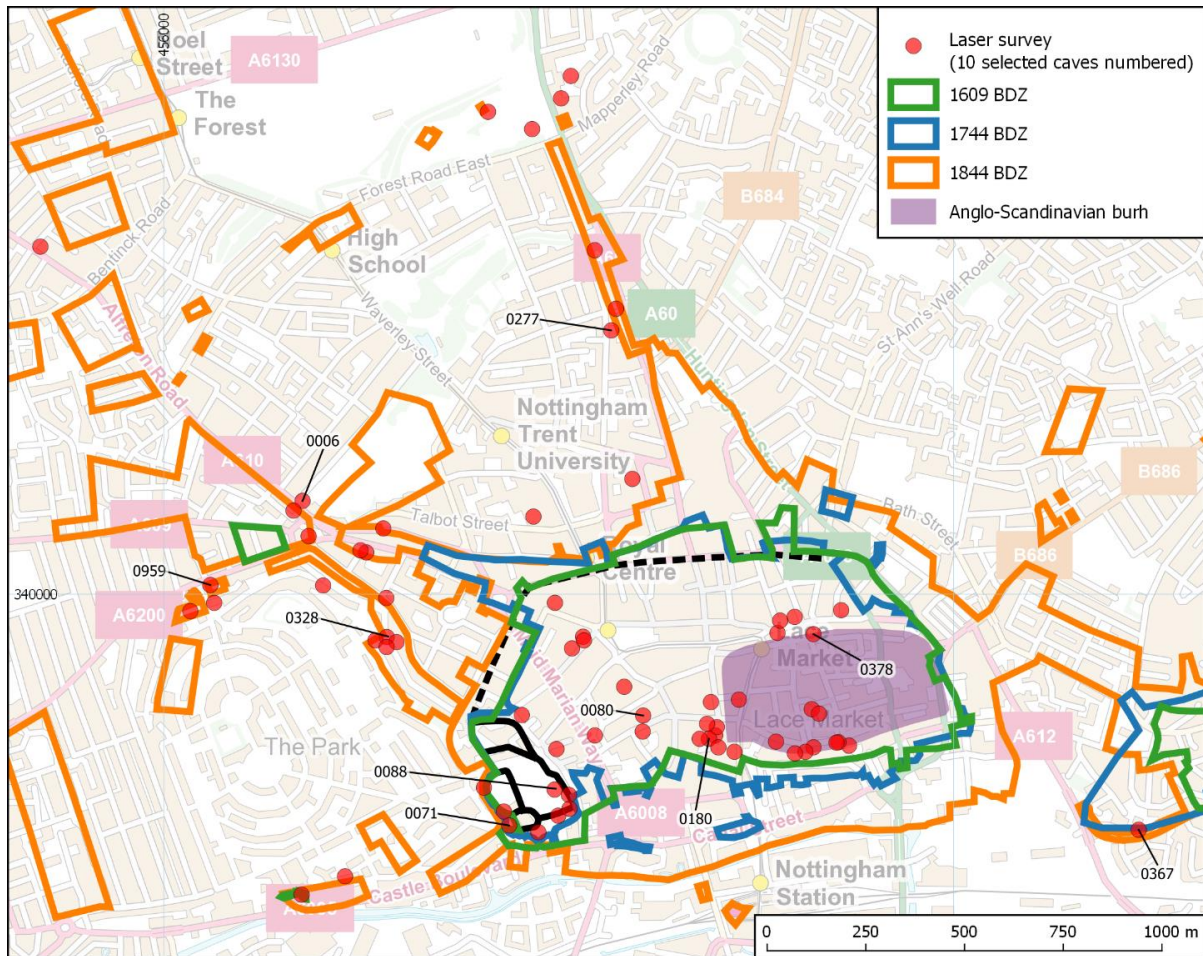
Within this distribution the focus is on the footprint of the historic urban centre with outliers on the principal extra-urban routeways of Mansfield Road to the north, Alfreton Road to the north-west, Derby Road and Castle Boulevard to the west and Sneinton to the east.

Table 4
Laser-surveyed cave systems

NCHER	Name	Property numbers	Street	NGRE	NGRN	BGS_ref
0002	Clarence Hotel	284	Alfreton Road	455687	340880	Aa1
0006	Running Horse public house	16	Alfreton Road	456352	340236	Aa5
0007	Red Lion public house	21	Alfreton Road	456328	340211	Aa6
0009	The Bell Inn	18	Angel Row	457062	339892	Ab2
0010	–	19	Angel Row	457064	339883	Ab3
0027	The Trip To Jerusalem public house	–	Brewhouse Yard	457028	339456	Bg1
0028	Brewhouse Yard Museum	–	Brewhouse Yard	456999	339439	Bg2
0030	–	48–52	Bridlesmith Gate	457386	339727	Bh10
0045+0048	Pillar Cave Complex	–	Broadmarsh Shopping Centre (Drury Hill)	457435	339609	Bi2, Bi5
0046	Passage Caves, Gawthorne House	24	Low Pavement	457396	339642	Bi3
0055	Birkin's Warehouse No 1	8	Broadway	457641	339709	Bk2
0057	Site of Plumptre House	2	Kayes Walk	457660	339697	Bk4+Bk5
0068	The Lord Nelson public house	16–18	Carlton Street	457554	339901	Cc2
0070	Mortimer's Hole	–	Castle	456949	339397	Cd1
0071+0074	King David's Dungeon, Romylowe's Cave, Upper Western Passage, Wine Cellar	–	Castle	456875	339414	Cd2+Cd5
0072	Middle Bailey Passage or 'North-western Passage' (Davy Scots' tunnel)]	–	Castle	456811	339510	Cd3
0078	–	17	Castle Gate/Stamford Street	457213	339652	Ce11
0080	–	8	Castle Gate	457214	339692	Ce3
0087	Castle Road Caves	–	Castle Road	457031	339486	Cf1
0088	Rifle Range	–	Castle Road	456993	339507	Cf2
0089	-	1	Castle Road	456995	339608	Cf3
0119	The Hermitage	–	Castle Boulevard	456335	339238	Cp1
0133	Site of Halls Hardware store	159–163	Wollaton Street	456556	340166	Dd3
0134	Sir John Borlase Warren public	132–136	Derby Road	456367	340147	Dd4

	house					
0136	Hand and Heart public house	65	Derby Road	456513	340105	Dd6
0144	Maria Court	1–8	Fishpond Drive	456459	339285	Fb2
0160	George Hotel	7–9	Carlton Street	457563	339936	Gc1
0170	29–35 Goose Gate	29–35	Goose Gate	457716	339959	Gf3
0180	Willoughby House (back)	20	Low Pavement	457381	339633	Le3
0181	Gawthorne House	26	Low Pavement	457401	339663	Le4
0182	Black's Head / Royal Oak public houses	14	Low Pavement	457357	339633	Le5
0185	Rock City	–	Talbot Street	456936	340196	Ta1
0197	–	50	High Pavement	457704	339624	Hc10
0198	–	52	High Pavement	457709	339625	Hc11
0199	–	56	High Pavement	457736	339616	Hc12
0200	Shire Hall	20–24	High Pavement	457597	339596	Hc13
0203	–	14	High Pavement	457551	339626	Hc2
0206	Court Houses	26–28	High Pavement	457625	339600	Hc5
0208	–	30–32	High Pavement	457646	339612	Hc7
0238	The Dragon public house	67	Long Row	456991	339978	Ld10
0268	Golden Fleece public house	105	Mansfield Road	457145	340722	Mc10
0270	Forest Cemetery quarry and mine	–	Mansfield Road	456933	341177	Mc2
0273+0274	208 Mansfield Road	208, 216	Mansfield Road	457022	341284	Mc5+Mc6
0277	Peel Street Caves (sand mine)	–	Peel Street	457133	340668	Mc9
0286	Police/Fire Station (formerly Guildhall)	–	North Church Street	457186	340290	Nc1
0328	'Columns Cave'	30	Ropewalk	456568	339893	Rc2
0346	Former The Old Malt Cross public house	16	St James Street	457034	339863	Sc8
0356	Salutation Inn	75	St Nicholas Street	457093	339641	Se1
0362	Clark & Wright, Architects	4	St James Terrace	456907	339694	Sh1
0367	'Sneinton Hermitage'	–	Sneinton Hermitage	458469	339403	Sl1
0378	The Old Angel Inn	7	Stoney Street	457646	339898	Sq2
0385	Park Tunnel	–	College Street	456564	339990	Tc2
0418	–	16	Weekday Cross	457457	339733	Wc4
0958	The Hawkesley public house	69–73	Derby Road	456498	340111	–
0959	3 Derby Terrace	3	Derby Terrace	456118	340023	–
0973	–	32A	Ropewalk	456589	339878	–
0974	–	13	Newcastle Drive	456404	340022	–
0975	–	10	Western Terrace	456067	339957	–
0976	–	5	Western Terrace	456128	339978	–
0977	Lincolnshire Poacher public house	161–163	Mansfield Road	457092	340871	–
0978	–	17–19	Carlton Street	457598	339942	–
1132	'Steps Cave'	14A	Park Terrace	456564	339866	–
1274	'Herbarium Cave'	14A	Park Terrace	456536	339882	Rc2
1351	Willoughby House (front)	20	Low Pavement	457376	339671	Le3
1404	Forest Cemetery catacombs and western quarry	–	Mansfield Road	456821	341221	Mc2
1405	Eldon Chambers	–	Wheeler Gate	457166	339765	–

Figure 14
Distribution of laser-surveyed caves and historic urban areas
 Contains OS data © Crown copyright and database right (2020)



3.3 Field survey methodology

3.3.1 Laser survey and integrated photography

Surveys were carried out by DSW, assisted principally by Julia Walker (TPA) and sometimes by volunteers. Once location, access and ownership details had been established and permission obtained, the team conducted a metric survey and a photographic survey in accordance with Historic England Guidelines (English Heritage 2000; English Heritage 2006).

The survey equipment was transported to the survey site on two bicycles with trailers. This saved cost, avoided parking issues and lowered the project's potential carbon footprint.

The following key equipment was utilised in the laser scanning process:

- Leica HDS6000 scanner;
- Camera mount;
- Canon EOS EOS500D camera;
- 8mm fisheye lens;
- Small tripod;
- Dell workstation;
- Software- Pukj;
- Software- Pointools;
- 2 bicycles (for transportation);
- 2 trailers (for equipment transportation); and
- 2 aluminium boxes (for equipment containment).

The chosen scanner had 360° horizontal by 310° vertical coverage and a practical operational range of around 50m. The interior of a single, simple, empty cave generally required only one or two scan positions. Full scanning of chambers with

numerous small compartments was not possible due to the large number of stations that would have been required. The surveys were controlled by locating four intervisible targets in each scan position and then registered using Leica Cyclone Register software.

Scans of caves and exposed bedrock were taken at 'Highest' setting (a point spacing of 3.1mm x 3.1mm at 10m, the scan taking around seven minutes to complete). Scans of external and access areas such as cellars and internal rooms were taken at 'High' setting (a point spacing of 6.2 x 6.2mm at 10m).

Scans of external features were included to permit subsequent relation to the National Grid.

Rectifiable photographs were taken after scanning using a Canon EOS500D digital SLR with a 15.2MP sensor and a Sigma 8mm fisheye lens. The camera was mounted on the scanner tripod with a bracket such that the focal centre of the lens matched the optical centre of the scanner. Six photographs taken at 60° horizontal angles gave full 360° x 360° coverage.

These photographs were converted using PTGui and Panotools software into a spherical image and then an equirectangular cubemap. The cubemap was imported into Leica Cyclone using Pointools View Pro and used to colour the scanned point cloud.

3.3.2 Post-fieldwork recording and processing

A list of all surveyed caves was included in the GIS.

The registered and georeferenced point cloud was viewed and explored as an intensity-based image, a false-colour elevation map and as a full-colour photorealistic image to facilitate interpretation of the surveyed cave system.

Other components of the CNRP project utilised the point clouds to generate fly-through and fly-around videos to be posted on YouTube, the project website and a smartphone app for public viewing.

3.3.3 Editing of point clouds (November 2017 onwards)

The largest point cloud was approximately 64GB in size, and it is suspected that overlapping survey data contributed substantially to this volume. This made processing and viewing files impractical due to the slow response of computers, and they were all sub-sampled using CloudCompare software to remove all points closer than 10mm to a neighbour.

Each point cloud was then edited to merge the points recorded from individual survey stations into a single cloud. This was then re-sub-divided into the following component clouds:

- **noise** (detached points resulting from erroneous readings);
- **externals** (external details to be retained for reference but not used in the project);
- **georeferencing** (selection of externals to provide a basis for georeferencing of xy values in relation to Mastermap);
- **built internals** (built internal features connecting the cave system to the externals)
- **cut internals** (any rock-cut lower parts of chambers and passages not roofed in rock, which connect the cave system to the externals); and
- **caves** (all features cut into and roofed with bedrock including any floors present of any material).

The point cloud was then georeferenced using CloudCompare software by first importing an excerpt from the OS Mastermap data into the cloud file, and then using Transformation function to move and rotate all points to find the best fit in relation to the Mastermap mapping. Elevation values were not recorded in the surveys and the values in the resulting final point clouds are random.

The outline of the surveyed caves was then digitised from the point cloud data and transferred to the project GIS, and the cloud further manipulated to provide isometric illustration and interpretation (see Section 3.4).

The point clouds have been stored in the project archive (Section 5)

3.4 Illustration and description of ten selected cave systems

Ten cave systems have been selected for detailed illustration and discussion in this report as they illustrate various key aspects of the conclusions of this study. Full-size illustrations are provided in Figures 19-29, while some small figures which illustrate details are embedded in the text. The illustrations show the caves with the roofs hidden to include a partial view of the interior. Selected high-level features such as stairs and shafts have been shown in grey and white rather than natural colouring to make them easier to distinguish.

The cave systems and the reasons for their selection are as follows:

- **0367:** Sneinton Hermitage (potentially amongst the oldest surviving cave systems);
- **0071+0074:** Nottingham Castle Western Passage (a passage cave, documented and physical evidence of development sequence);
- **0378:** The Old Angel public house (physical evidence of development sequence and a variety of cave types);
- **0080:** No 8 Castle Gate (maltings with a kiln);
- **0277:** Rouse sand mine Peel Street (a mine);
- **0180b:** Willoughby House (early example of an ornamental cave; well documented);
- **0959:** 2–3 Derby Terrace (early 19th-century residential);
- **0006:** Running Horse public house, Derby Road (19th-century pub cellar);
- **0088:** Rifle Range Caves, Castle Road (purpose-built air raid shelter); and
- **0328:** 30 The Ropewalk (later 19th-century ornamental cave).

A number of the surveys have wedge-shaped gaps in the recorded features; this is due to small areas lying out of sight from all survey stations and the large number of stations which would have been required to record the cave fully.

3.4.1 0367: Sneinton Hermitage

Description

The cave system (Figures 19 and 20) comprises two clusters of small rounded caves cut back horizontally into the cliff face. A further opening to the east has not been surveyed. Over the eastern surveyed cluster (right in the illustration) the original cliff face above the cave system is preserved, while to the west it is not, the cliff having been cut back and faced by a stone wall in the 19th century.

The cave system is a level-entry system, now entered in the eastern half. The cliff face above contains two vertical and one horizontal slot, and two main recesses, along with a number of small round and rectangular recesses.

The system originally comprised three groups of chambers, all of which may have all been aligned along a common frontage. Each main frontage chamber had one or more smaller chambers to the rear.

Western Group

Chamber **01** at the front has been largely vertically truncated; a doorway **02** at the back leads to a short cross-passage **03** with a small chamber at its eastern end **04**. **01–04** are all on the same level. Opposite doorway **02** on the far side of cross-passage **03**, passage **05** with steps leads down to a cluster of intersecting rounded chambers. A high-level chamber **06** has a floor level close to that of **01–04**. Three lower rounded chambers **07–09** have ceilings which intersect with the floor of **06**. **08** contains a well or circular pit, accessed down three steps.

Central group

Chamber **10** is an incomplete D-shape in plan with a smaller tapering chamber **11** to the rear. On the west side of chamber **11** there is a ledge which continues west around the north side of chamber **10**. It is possible that this ledge represents an incomplete process of cave enlargement, though it appears very eroded. **10** has a slight change in floor level which also hints at incomplete enlargement.

Eastern group

Chamber **12** at the front is, or was, originally an irregular D-shape in plan. A small chamber **13** lies to the west and intersects slightly with chambers **10** and **11**. The small size of the resulting holes suggests that the intersection was accidental. A larger chamber **14** (incompletely surveyed) lies beyond chamber **12**. There are two main levels in the floor of chamber **12**, to either side of a marked step.

Interpretation

The cliff face is undercut suggesting that it was formed by erosion from the River Leen which flowed immediately to the south in 1609. A record of 1544 relating to Sneinton refers to a house under the ground in a 'roche of stone' sometime called the Hermitage and it is very tempting to suppose that this cave system forms part of that site. The site is now known as Sneinton Hermitage and has been since at least the 19th century, but further research is required to establish whether this is an ancient attribution or more recent antiquarian speculation.

The Ordnance Survey Town Plan (1880) shows 'Rock Houses' abutting the cliff and extending over a distance of 350m, with this cave system located towards the centre. The houses were built after 1609 but probably mapped by 1774 and demolished in the late 19th century to make way for a railway.

The high-level recesses in the cliff face indicate that buildings of at least two storeys used to abut the cliff face. A similar arrangement survives complete at the Trip To Jerusalem public house in Brewhouse Yard. The vertical grooves are likely to have housed the ends of first-floor walls or internal partitions abutting the cliff face at right-angles. Recesses to the left appear to be a niche with D-shaped elevation and a small chamber with a horizontal slot beneath which could have housed a sill beam for a first floor. Several small, often rectangular, holes in the rock probably housed the ends of smaller timbers. Collectively the recesses indicate a two-storeyed building.

The system is notable for its important collection of small rounded and small D-shaped caves: such types occur only infrequently outside the 1744 BDZ and are likely to be of early origin, quite possibly medieval.

3.4.2 0071+0074: Nottingham Castle Western Passage

Description

The upper part of the Western Passage (Figure 21) comprises an access stair **01** from the boiler house through King David's Dungeon **02** to Romylowe's Cave **03**. Early on a passage ran south-east from Romylowe's Cave to the foot of the rock **12-18** without connecting to the Wine Cellar **04-11**. This passage has been either narrowed or blocked by sandstone masonry within Romylowe's Cave, part of which has been removed (part is inaccessible for inspection), this has itself been partly covered by a curved wall of pre-Victorian brick. Writing in 1904, Stevenson (1904, 38) noted that the higher part of the Western Passage had an outlet into private grounds and approached Romylowe's Cave on a landing with intact roof, but that the access to the cave was blocked at its outlet by the 'modern castle'. This must be the extant blocking. In the early 20th century the upper parts of the passage were said to be in perfect condition with broad rock-cut steps (ibid). This part is marked on a 1950s plan as 'open', the roof presumably having collapsed; the date of collapse is unknown, but Stevenson's account hints that it may have occurred prior to providing his description.

A second route ran from Romylowe's Cave in a series of climbing stairs and landings **04-09** to the Ducal Palace Wine Cellar **10**. It seems likely that this part of the system was formed when the Wine Cellar was built in the 17th century.

In 1955 a link **11** was made between the eastern corner of the Wine Cellar to the northernmost surviving part of the early Western Passage **12**. This restored a full route from Romylowe's Cave to the foot of the rock. The access to the collapsed stretch was blocked with brick at this time.

The Western Passage then leads south and downwards **12** to a point where there is an abrupt change in floor and roof level, then **13** past a small cave **14** which is open to the cliff face to the west, and then into a large cave incorporating brick structures **15**.

The abrupt change in floor and roof level (between **12** and **13**) is now accommodated by a wooden stair with metal rails, and revetted with mortared sandstone masonry. The higher passage floor is very worn at this point and the masonry may be patching of the wear—or a level platform on which to found the stair, or another structure. The abrupt change in level seems likely to reflect different stages of construction of the passages.

The small cave on the west side of the passage is accessed through a doorway with a metal barred gate; it is rock cut and roughly rectangular in plan, opening out and providing a view over the properties beneath. Before the 19th century when this area was developed there would have been an extensive view over the Trent Valley. It lies above the Peveril Drive Rock House (**0647**).

The large chamber **15** contains a large niche on its north-western wall and two on its north-eastern wall. A small cave **16** lies to the west. The south side of the cave is formed by a cross wall built in 19th-century or later brick. It contains a high-level arched subterranean window at the west end and a doorway at its east end, through which the passage passes.

South of the cross-wall is a chamber **19** with rock walls and roof, largely lined with a skin of pre-Victorian brick. This chamber is polygonal in plan and contains a circular depression in the floor which may be a well or drain. Otherwise the floor was originally of brick, much of which is now removed or covered in sand, but round the edges the brick floor incorporated an open shallow gully to provide drainage. The interior is currently accessed from the north-west but there is a blocked doorway at interior floor level on the south-east side and a high-level arched opening on the same side.

The passage continues **17** from the doorway at the south-east corner of **15**, followed by a further descent with concrete walls and ceiling **18** to a door, beyond which the passage is unroofed and fragmentary, leading to 'ground' level.

Interpretation

A description of the 1740s by Deering (1751, 175) refers to a group of caves containing a malt-kiln accessed by stairs leading from a kitchen garden in the west side of Brewhouse Yard. Deering's description suggests that the feature was disused in his day, and the presence of an underground malt kiln points towards a medieval or Early Post-medieval origin for this group of caves.

Before 1799–1800 a malt kiln in this vicinity was converted to an ice house (Blackner 1815, 50–1)³, and there is little doubt that the kiln was that described by Deering. The current form of feature **19** is consistent with that of an ice house and while there is no obvious extant physical indication of an earlier malt kiln, its dimensions would allow a 3.2m diameter kiln (of the form surviving in other cave systems in the City) to have existed within its form. Deering does not refer to any continuation of the passage further up beyond the maltings caves, strongly indicating that it did not exist when he was writing in the 1740s. Blackner’s 1815 account also omits any mention of the higher passage, but his reference is an aside to his account of Brewhouse Yard and the omission cannot be taken as firm evidence of its absence in 1815.

The higher part of the Western Passage therefore appears likely to have been formed after c 1751 and the construction of the ice house between c.1750 and 1800 seems a likely context. This new passage provided a link between part of the service area of the castle (Romylowe’s Cave, King David’s Dungeon, the Service Courtyard and possibly other locations in their vicinity) and both the ice house and the kitchen garden in Brewhouse Yard. By the early 20th century (and possibly much earlier) the link with the castle had been blocked and eventually collapsed.

The abrupt change in level between **12** and **13** makes it probable that the upper passage was dug from the higher level to the lower. This sheds significant light on the ability of Post-medieval cave diggers to navigate below ground, though the methodology is unknown.

3.4.3 0378: The Old Angel public house

There are two almost-separate cave systems under The Old Angel (Figure 22). A smaller upper system (termed in this report ‘System A’) lies on the south side of, and oversails the lower ‘System B’.

Description

System A

A short passage with steps **01** leads to a row of three similarly-sized linked chambers (**04**, **02** and **06**). The central chamber, **02** has a shaft **03** in the roof. The east end of the third chamber **04** links to a small niche on the north-west side of a vertical shaft **05**. It is unclear whether or not the shaft originally extended deeper than its current base and has been filled in, so it may be a well or a goods shaft. There is a very small angled shaft **07** connecting the current foot of shaft **05** to the roof of chamber **19** in the lower system. This connection seems too small and awkward to have carried goods or people and it seems more likely to have been for ventilation of the lower level, or even a pilot hole for navigation during construction.

System B

This system itself lies on two main levels. This system is entered from the east through a short passage **08**, leading to the round-ended chamber **09** which has been blocked to the north by a wall of brick with a small opening. The west end of this chamber has a shaft **10** in the roof. Chamber **09** is linked by a short flight of steps **11** to a small D-shaped chamber **12**, but the steps have subsequently been extended down through the floor of **12** where they widen and continue down **13** to a larger rectangular chamber **14** with thralls and two shafts, one circular **15** and one rectangular **16**. The plan of **14** is slightly irregular and there are brick blockings across the east end and in the south-west corner. Two regular, round-ended chambers with thralls, **17** and **19**, extend from this chamber to the north and south respectively. Chamber **19** is connected to **14** by a short passage **18**.

Interpretation

There is a clear sequence of at least two phases in System B. The upper part of passage **08** and chambers **09** and **12** form a coherent group on one level. Chamber **12** was subsequently cut through by the extended stairs **13**. General spatial analysis of chamber-forms (see Section 2.3.3) suggests that small D-shaped chambers such as chamber **12** appear to be medieval or Early Post-medieval. Chamber **14** is slightly irregular in shape and sealed at one end in brick, while chambers **17** and **19** are more regular and could be a later phase. Round-ended rectangular chambers such as these are regularly associated with a beer context. However, chamber **19** undersails chamber **04** in the upper system, suggesting that the lower part of System B (**14**, **17** and **19** plus associated stairs passages and shafts) may have been dug deeper to avoid intersection with chamber **04**. This would mean that the lower part of System B may be all of one date.

System A and the upper level of System B represent an early stage of development and suggest that there may have been two overlying properties at that time. The lower part of System B was formed later, following the amalgamation of any separate overlying properties.

³ Blackner mentions in passing that the kiln was ‘lost in an ice house’ in the ownership of Mr Topott, a confectioner of Bridlesmith Gate; further documentation indicates that Topott was the new tenant for the ice house in the castle rock in 1799–1800.

The World War II air-raid shelter plan of the systems is provided in Figure 13 for comparison with the laser survey. Although the air-raid shelter plans have proved more accurate than many, the relative position of the two cave systems is incorrect, the shape of the character of the large central cave is significantly incorrect and caves in the top left corner have been omitted (perhaps because they were not part of the identified shelter provision). It also shows that the shaft over the central cave was identified as an escape route.

3.4.4 0080: No. 8 Castle Gate

Description

The cave system (Figure 23) was originally entered by passage **01** with steps, though there is now a metal spiral stair of recent origin leading to a landing halfway down the passage.

To the left as the stairs descend is a small chamber **02** with privy pit, then a short passage **03** leading to a small rounded chamber **04** with a well **05** to the side.

On the right of the steps is firstly a malt kiln **06**, with domed roof and inverted-conical fire-pit. At a lower level there is a small chamber **07** which leads to the fire pit of **06**. The steps of passage **01** continue down into chamber **08** which is a slightly elongated square with a central pillar. Off to the right of this chamber is a long rectangular chamber **09** which is linked by two openings, one to **08** and one to **07**.

Four recent structural piles are visible, two in **08** and two in **09**.

Interpretation

This cave system is a well-preserved example of the cave-maltings type identified by MacCormick (see Section 2.3.3). Such systems are thought to be of medieval to mid-17th-century date based on documentary evidence.

The key components of an underground maltings were the kiln (circular in plan; **06**), a well (**05**), a cistern (not identified in this case) and a germination floor in a larger chamber (**08**, and possibly **09**).

3.4.5 0277: Rouse sand mine, Peel Street

Description

The cave system (Figure 24) is now entered down passages from Peel Street **01** and North Sherwood Street **02**, but the original entrance is believed to be that at 65 Mansfield Road, in an area which was not accessible at the time of the laser survey.

The system comprises a mass of intersecting chambers and passages too numerous to label. The system contains one area where the levels overlap and intersect and there is one hole **04** between an overlying floor and an underlying ceiling. One shaft **03** is recorded in the laser survey but there were more to the south where basements of houses on Mansfield Road breached the caves and they appear to have been used for storage (Waltham 1994, 3). Some of the chambers are too low for an adult to work in comfortably, suggesting that they were worked by children (inset). Many of the exposed surfaces exhibit large flattish facets resulting from extraction with none of the subsequent finishing using small tools which is normal in caves intended for habitation or storage. Such finer tooling is found to the east in the system where some chambers were linked to overlying properties and were probably used for storage. There are some modifications believed to date to the use of the system as an air-raid shelter.

Interpretation

This cave system is generally identified as a mine operated by William Rouse or Ross at a location beneath 'Dog Kennel Hill' (Blackner 1815, 10). Rouse worked the mine from about 1780 until his retirement c 1810 when it was closed, though the mining could have been begun earlier. The method of working was 'pillar-and-stall', to no systematic plan. Galleries range between 2m and 5m in width and 1.6–2m high, with cross-sections in the form of flattened ellipses. Roof failure has never been a problem in the mine. It was reopened in the later 19th century as an attraction during Goose Fair and was used as an air-raid shelter in World War II.

Waltham (2008, 1) has noted the purity of the sand which the mine exploits and it could well have glassworks in the town. Another possible use for the sand could have included the documented spreading of sand on domestic floors and use for building and as raw material for the manufacture of bricks, tiles and pottery.

The northern part of the system was used as an air-raid shelter in World War II and contains several blast-walls, metal roof-reinforcements and signage.

3.4.6 0180: Willoughby House

Description

The cave system (Figure 25) is entered down passage **01** which leads to an intersection of passages: passage **02** with niches to north and south leads east to circular chamber **03**, with a mirror arrangement to the west (**04–05**). A large circular chamber **06** is reached at the end of **01**, just past the intersection. Each of the three chambers is supported by a central pillar. In the two smaller chambers the pillar has a narrow circular ledge around it at waist height which would have served as a table for a standing person. In **06** there is a thrall round the outer edge and a square ledge at similar height around the foot of the pillar. All these features are formed of *in situ* rock. **03** and **05** are nearly identical in diameter but **05** has a crescent-shaped extension to the north. Chambers **03** and the south side of **05** have curved brick-built bins round the outer edge, while the north side of **05** has a thrall with integral, open-faced low partitions. Radial recessed channels cut into the roof of chamber **06** suggest that it has been propped at some point.

Passage **07** leads south in a gentle downward slope without steps from the south-east sector of **06** into chamber **08**, only part of which has been surveyed. This chamber reaches as far south as the abutting property to the south.

Interpretation

The caves lie beneath Willoughby house, 22 Low Pavement. The house was built by the Honourable Rothwell Willoughby, brother of Lord Middleton, between the years 1730 and 1740 (Holland Walker 1929). Deering (1751, 15), describing Nottingham caves in general, observed that the caves beneath the garden ‘deserve the principal notice’, being ‘without comparison in the whole kingdom’. According to him (writing in the early 1740s) they had been constructed ‘not many years ago’ and so are contemporary with Willoughby’s house, or nearly so. It was remarkable to Deering that there was no crack in the rock despite the size of the caves (the largest cave has a diameter of approximately 7.8m). The uniqueness and regularity of form remains striking today, and while the bins in **03** and **05** and the thrall in **06** suggest storage of wine and beer respectively, their elaborate form suggests that they were also designed to host and impress guests. At the time that the house was built the view from the roof was regarded as a great asset and visiting the caves must have also been an important part of any visit.

The central axis of the large circular chamber **06** is aligned slightly differently to the axis of the access passage **01**. Passage **07** is also aligned off-centre from the other two axes and links to the side of chamber **06** rather than down its central axis. It also has slight irregularities in its side-walls which contrast with the extreme regularity of the circular chambers. These observations suggest that it is a secondary feature constructed to provide a link with the cliff at the south end of the garden. The large chamber **08** may already have been in existence at this time.

The propping of the roof of **06** seems likely to have been carried out in World War II as a precaution against bomb blast shocks and there is no indication of roof failure.

3.4.7 0959: 2–3 Derby Terrace

Description

This system (Figure 26) lies beneath the houses of 2–3 Derby Terrace. It is entered from no. 3 Derby Terrace down steps in passage **01**, leading into a rectangular chamber **02** which has a series of partitions in the eastern wall. A further passage **03** leads to a smaller chamber **04**, also with partitions.

Interpretation

The plan is typical of many later cave systems in residential contexts: the system lies beneath substantial houses, is small and exhibits geometric accuracy. It lies beneath the houses and is entered from no. 3, rather than the gardens, suggesting a functional purpose in contrast to domestic cave systems located in gardens. The listed building description dates the houses above to c 1830 and it seems likely that the caves are contemporary with their construction.

The linking of caves beneath properties which would be expected to have always been under separate ownership requires explanation, and further research has potential to resolve the issue. It could also shed light on later domestic cave occupation generally.

3.4.8 0006: Running Horse public house, Alfreton Road

Description

This cave system (Figure 27) is entered through passage **01** which leads down to three main chambers. Chamber **02** lies to the right and **03** to the left of the passage, together forming an L-shape. The passage continues a little further down to reach chamber **05** which is parallel to **02** but at a lower level. Their footprints overlap slightly. **02** is fitted with small partitions and **03** and **05** with long thralls. **03** and **05** both have shafts: **04** and **06** respectively.

Interpretation

Long narrow chambers such as **03** and **05** are often found in beer contexts; in this case neither chamber has the rounded end which is particularly characteristic of beer cellars, though the west end of **05** is blocked. The thralls and shafts suggest beer storage while the smaller size and partitioning of **02** shows that it had a different function.

3.4.9 0088: Rifle Range Caves, Castle Road

This system (Figure 28) is entered from Castle Road and lies to the west. In 2012 it was used by the Nottingham Castle Rifle and Pistol Club.

The system comprises three main sub-rectangular chambers and a passage at the Castle Road frontage, with five long straight passages beyond, leading west some distance beneath the Outer Bailey of the Castle.

Description

Chambers and passages 01–07

Chambers **01**, **03** and **05** are oriented perpendicular to Castle Road, while chamber **07** is parallel to it. All are rock-cut with substantial blue-brick buttresses and arches, constructed in the early 20th century to resist the weight of the overlying castle curtain wall at the Castle Road frontage. Chambers **05** and **07** have rock-cut thralls.

Chamber **05** has a pre-Victorian brick partition, though the door in it is of more recent blue brick (19th/20th-century). The partition runs over the stone thrall to the south-east.

Passages 09–15

The remaining caves are all passages with pointed roofs. Three long passages (**10**, **12**, **14**) are oriented approximately south-west/north-east and are linked at the west ends by a further passage (**11**). A short passage cuts off the south corner (**13**). All are of similar character and wide cutting marks can be observed at many places in the rock, possibly indicating machine-excavation. In passage **15** the lower rock face has such marks, while higher up finer marks probably indicate hand-finishing. Passages **09**, **12** and **15** contain dog-legged lengths of passage skirting brick pillars. These form baffles to protect against blast or noise.

Interpretation

From before 1820 (as indicated by the Smith and Wild map), three small buildings fronting Castle Gate abutted the rock face, in front of chambers **01–07**. No buildings are shown on the Badder and Peat map at this location, suggesting a date of c 1744–1820 for the buildings. These chambers are all shown on a plan of 1904 by Lewis, indicating a construction date in or before 1904. The blue brick strengthening arches are similar to those in the caves further down Castle Road, probably c 1908. Passages **08–14** are all absent from the 1904 plan and from a description which accompanied it.

The cave system was recorded in detail in a plan dated 1942 entitled ‘Castle Road Caves – Civil Defence’. This depicted two phases of caves, apparently marked in contrasting colours as ‘new excavations’ and ‘existing caves’. The available copy of the plan is monochrome and the two colours used cannot now be distinguished. However, comparison of the 1904 and 1942 plan makes it plain that the chambers **01–07** are the ‘existing caves’ and the passages **08–14** are the ‘new excavations’. The passages are described on the plan as ‘tunnel shelters’ and a 1938 newspaper article refers to them being prepared as an air-raid shelter.

The plan shows that despite the narrowness of the passages bunks were positioned along both walls of most tunnels, and chemical toilets were placed in the larger earlier caves (Figure 12). The entrance and two emergency exits connected with Castle Road. A length of passage marked ‘fault over’ had been walled off, presumably due to being thought unsafe. The tunnel design was presumably thought to be the strongest, though many pre-war caves of larger spans were used as shelters.

3.4.10 0328: 30 The Ropewalk (‘Columns Cave’)

This system consists of a single large chamber (Figure 29).

Description

This chamber **01** originally measured approximately 20 x 7m and lay beneath both the garden of No. 30 and the roadway Park Row, which abuts the garden at its south-west end. The north-eastern 8m has been in-filled to allow building above. The roof is flattish, supported by a 6 x 3 grid of pillars. The long walls contain half-round pseudo-pillars and there are six half-round statues of human figures in the north wall.

Interpretation

The property was that of William Herbert and dates from the 1830s. The gardens originally extended beyond Park Row to the south-west. It is difficult to imagine this cave as anything other than an ornamental garden structure built for display and entertainment. The cave system was described in 1840 (Orange 1840, II, 956–7). The statues represent John Wesley,

Lord Brougham (a slavery abolitionist), Nelson, Napoleon Bonaparte, the Duke of Wellington and finally William Herbert himself.

The gardens contain other less elaborate caves and there is another cave system with an elaborate carved stairway and sculpture of Daniel in the Lions' Den in the neighbouring property to the south (**0321a**), occupied by his cousin, Alderman Thomas Herbert. The listing description (National Heritage List for England No. 1254802) states that the cave was made for Alderman Thomas Herbert c 1870, but the cave system is described by Orange (1840, volume II, 956-7) and its construction appears likely to have been broadly contemporary with that of the house.

4 Potential for further research

There are abundant opportunities for further productive research into the caves of Nottingham.

In the current state of knowledge, the greatest progress is likely to be made through integrated recording and interpretation of individual cave systems and their overlying buildings. Accurate, detailed and complete measured and photographic surveys are required, supported by detailed documentary research.

Further work is required to correct and complete the archive of existing data. For systems which have been destroyed this may be all that can now be achieved. It is likely that further information is held by societies and members of the public but has not been copied in the archive.

This study discovered no detailed contemporary accounts of specific cave construction or use. It is hard to believe that no such accounts exist, and this appears to be a potentially productive area of research.

Further research into particularly medieval, but also post-medieval, urban development would contribute to understanding the context of cave systems.

Specific themes which could be addressed are as follows:

- discovery and destruction of caves:
 - influence on existing data set;
 - means of detection;
 - conservation;
- construction methods, including:
 - dimensional traits eg perceived structural limitations;
 - underground surveying/navigation;
 - comparison with other forms of mining and quarrying;
 - toolmarks, especially where there is evidence for phased development;
 - cave distribution in relation to rock character;
- geological context:
 - historic exploitation of excavated rock material; and
 - water table and wells.

Further study of the caves also has potential for addressing a number of the key Agenda Topics and Research Objectives that have been identified in the East Midlands Historic Environment Research Framework for the Early and High Medieval, Post-Medieval and Modern periods (<http://archaeologydataservice.ac.uk/researchframeworks/eastmidlands/wiki/Main>). The most significant of these include the following:

- Early Medieval:
 - Agenda Topic 6.5.4: how did Nottingham develop during the Anglo-Saxon and Viking periods?
 - Research Objective 6E: undertake further research on Anglo-Saxon and Viking urban development;
- High Medieval:
 - Agenda Topic 7.1.3: how may we enhance our understanding of the chronology, functions and morphology of caves, and in particular the outstanding subterranean resource of medieval Nottingham?
 - Research Objective 7A: undertake syntheses of urban and suburban excavation, survey and documentary data;
 - Research Objective 7B: enhance record of urban and suburban secular standing buildings and subterranean structures;
 - Research Objective 7C: investigate provisioning of the medieval town;
- Post-medieval:
 - Agenda Topic 8.1.2: how were towns organised and planned, and how did population growth impact upon their internal spatial organisation?
 - Agenda Topic 8.1.6: how can we advance studies of building plans and standing remains, especially where hidden inside later buildings, and of caves and cellars?
 - Agenda Topic 8.5.1: can we elucidate the organisation of the workplace, gender differences at work and the development of industrial processes (especially the nationally important lead, coal and tanning industries)?
 - Research Objective 8B: further research the morphology and use of caves;
- Modern:
 - Agenda Topic 9.7.2: how have agricultural processing industries such as brewing, malting and milling developed, and what structural traces have survived?
 - Agenda Topic 9.7.3: how can we enhance our records of mines and surface features associated with extractive industry and their relationship to markets, settlements and transport? and
 - Research Objective 9I: explore the evidence for non-factory trades and industries.

5 Archive location and contents

5.1 Contents

A copy of this report has been deposited with the Archaeology Data Service.

The full project archive has been deposited with the British Geological Survey. It is entirely digital and comprises:

- introduction to the archive;
- this report;
- the Project GIS;
- the Laser Survey Archive; and
- the Documentary Archive.

The contents of the last three components are set out in sub-sections 5.2-5.4.

5.2 Project GIS

The GIS is stored as a shapefile in ESRI format and as two comma-separated ascii files (one containing the textual data, the other containing the geometry of the records). The fields comprise:

- **HER:** NCHER reference number, with the 'MNU' prefix removed and padded with leading zeros;
- **Name:** name of any overlying property;
- **Street:** street in which overlying property lies;
- **Prop_nos:** number within street of overlying property;
- **Locator:** type of location (LS = laser survey; P = plan; S = sketch; L = location only, with no plan; U = not precisely located);
- **Las_survey:** laser survey number;
- **Notes:** comments on data sources;
- **BGS_ref:** cave(s)/cave system(s) reference number in the BGS dataset;
- **BGS:** up to three components in the field, each separated by a '+' symbol:
 - '89P' or '89L': recorded in BGS 1989 with plan (89P) or with location only (89L);
 - '06': recorded in BGS 2006;
 - 'Db' recorded in BGS database;
- **MacC_C:** MacCormick 2001 catalogue of medieval caves reference number (C1-C27);
- **MacC_M:** MacCormick 2001 catalogue of medieval cave-maltings reference number (M1-M28);
- **Group:** function of overlying property recorded on historic mapping; and
- **BDZ:** Built Development Zone in which the cave system lies.

The GIS contains 697 records of caves/systems/groups of caves or systems. Of these, 617 records were identified by the BGS, while the remainder have been added subsequently to the NCHER. Not all of the additions represent recent discoveries. Caves catalogued by MacCormick and CNRP laser-surveyed caves are dispersed across both datasets.

A total of 13 caves are located only to grid square. These are recorded with null geometry in the shapefile; they cannot be mapped, therefore, but can be considered in text-based analyses and quantifications.

Where available (including all laser-surveyed caves), outline cave-plans have been provided in the GIS geometries. Others are known only as an estimated general location. A few are of unknown or very general location. The outline plans are of very variable reliability and should not be taken to be in any way definitive.

5.3 Laser survey archive

The Laser Survey Archive deposited with BGS and NCHER comprises:

- a document describing and illustrating the 56 surveyed cave systems not described in detail in this report;
- full-sized point clouds stored in E57 format;
- reduced-size point clouds in E57 format of the larger surveys intended to be usable on standard hardware; and
- video files showing fly-throughs / fly-arounds of the cave systems derived from the point clouds.

5.4 Documentary archive

The project Documentary Archive was created in 2010 to facilitate the preparation of this report. It has been superseded by further work since then, and the full archive of records relating to cave systems is now stored as part of the NCHER.

For each cave, the compiled dataset has been stored in a single folder identified by NCHER number and comprises some or all of the following elements:

- a drawn plan or plans where available (generally air-raid shelter surveys drawn up in World War II, uninterpreted surveys by developers or archaeological surveys by Waltham and others);
- photographs;
- written descriptions (chiefly from newspaper articles and letters but also extracts from archaeological reports and surveys where occasionally available);
- a short document providing the following details:
 - cave reference number;
 - BGS reference number;
 - a brief description of the cave; and
 - references to sources, particularly those outside the CNRP archive.

The Documentary Archive also includes a *Table of Historical References*, comprising the source, date and a summary of the content.

5.5 Archive location

The archive is very large when the full-size point clouds are included. Reduced size versions of the largest point clouds are provided in order to make the whole archive suitable for download and use with standard computer equipment.

Locations for the archive components are set out in Table 5.

Table 5
Archive component locations

Component	BGS	NCHER	ADS
Introduction	x	x	x
Laser Survey Report (this document)	x	x	x
Project GIS	x	x	
Laser Survey Archive			
Illustrations and descriptions of 58 laser-surveyed cave systems	x	x	
Point clouds	x	x	
Selected reduced-size point clouds	x	x	
Video fly-throughs	x	x	
Documentary Archive	x	x	

6 References

6.1 Historic maps in chronological order

1609 Bankes	Richard Bankes 1609, reproduced in <i>Sherwood Forest in 1609: a Crown Survey by Richard Bankes, transcribed and edited by Stephanos Mastoris and Sue Groves</i> (Thoroton Society Record Series XL)
1610 Speed	John Speed 1614 <i>Theatre of the Empire of Great Britaine</i>
1677 Thoroton	Facsimile from an unidentified source
1710 Overton	Henry Overton <i>A New Mapp of Nottingham and A New Mapp of Nottinghamshire</i> (Nottinghamshire Archives N 11 S)
1744 Badder and Peat	Inigo Badder and Thomas Peat, <i>Map of Nottingham</i> , published in Deering 1751
1774 Chapman	John Chapman <i>Map of Nottinghamshire</i> . Surveyed 1774
1820 Smith and Wild	H Wild and T H Smith <i>A New Plan of the Town of Nottingham</i>
1831 Staveley and Wood	<i>Plan of the Town and County of the Town of Nottingham</i> . Surveyed 1827–9
1835 Sanderson	George Sanderson 1835 <i>Map of the Country Twenty Miles Round Mansfield</i> . Surveyed 1830–1834
1835 Creighton	Robert Creighton, engr. J & C Walker in Samuel Lewis's <i>Topographical Dictionary</i>
1844 Anonymous	<i>Plan of the Borough of Nottingham, shewing the Commons and Commonable Lands, by which the Enlargement and Improvement of the Town are prevented</i> (Nottinghamshire Archives reference NO 8 S)
1844 Dearden	William Dearden <i>Plan of the Town of Nottingham</i> published in Dearden's <i>History and Directory of Nottingham</i> . Compiled 'from the best authorities' and 'containing all the new streets and every recent alteration'
1854 Enclosure Map	(source unknown)
1861 Salmon	Edward W Salmon <i>Plan of the Town of Nottingham and its Environs</i> .
1882 Ordnance Survey	Town Plan at 1:500 scale
1885 Ordnance Survey	Maps at 1:10 560 scale
1901 Ordnance Survey	Maps at 1:10 560 scale
1920 Ordnance Survey	Maps at 1:10 560 scale
1938 Ordnance Survey	Maps at 1:10 560 scale
1955-6 Ordnance Survey	Maps at 1:10 560 scale
1900-1901 Ordnance Survey	Maps at 1:2 500 scale
1938 Ordnance Survey	Maps at 1:10 560 scale
1954 Ordnance Survey	Maps at 1:1 250 scale
1965 Ordnance Survey	Map at 1:2 500 scale
1969 Ordnance Survey	Maps at 1:1 250 scale
1972 Ordnance Survey	Maps at 1:2 500 scale (marked with caves by BGS)

6.2 Written sources

TTSN: Transactions of the Thoroton Society of Nottinghamshire

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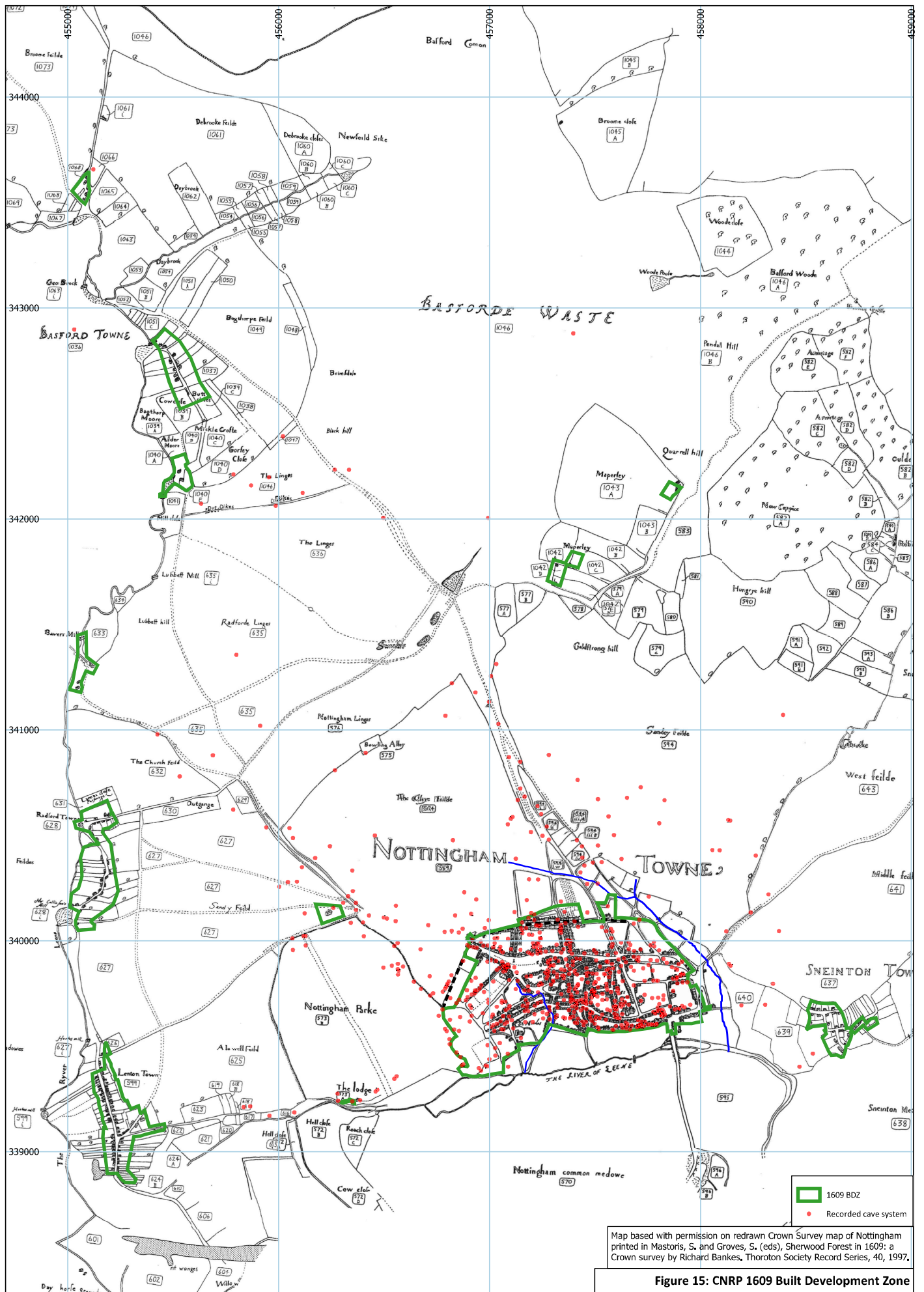
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7 Acknowledgements

Nottingham City Council (Nottingham City Museums and Galleries) supplied a substantial proportion of the unpublished archive material described in Section 2.1.2. Extensive source materials were also provided by the British Geological Survey, the originator and current holder of the *Register of Caves*, and from Dr Tony Waltham.

Scott Lomax of Nottingham City Council provided general review of this report, assistance on points of fact and several references to documentation.

Tim Allen of Historic England provided a general review of this report.



Map based with permission on redrawn Crown Survey map of Nottingham printed in Mastons, S. and Groves, S. (eds), *Sherwood Forest in 1609: a Crown survey* by Richard Bankes, Thoroton Society Record Series, 40, 1997.

Figure 15: CNRP 1609 Built Development Zone

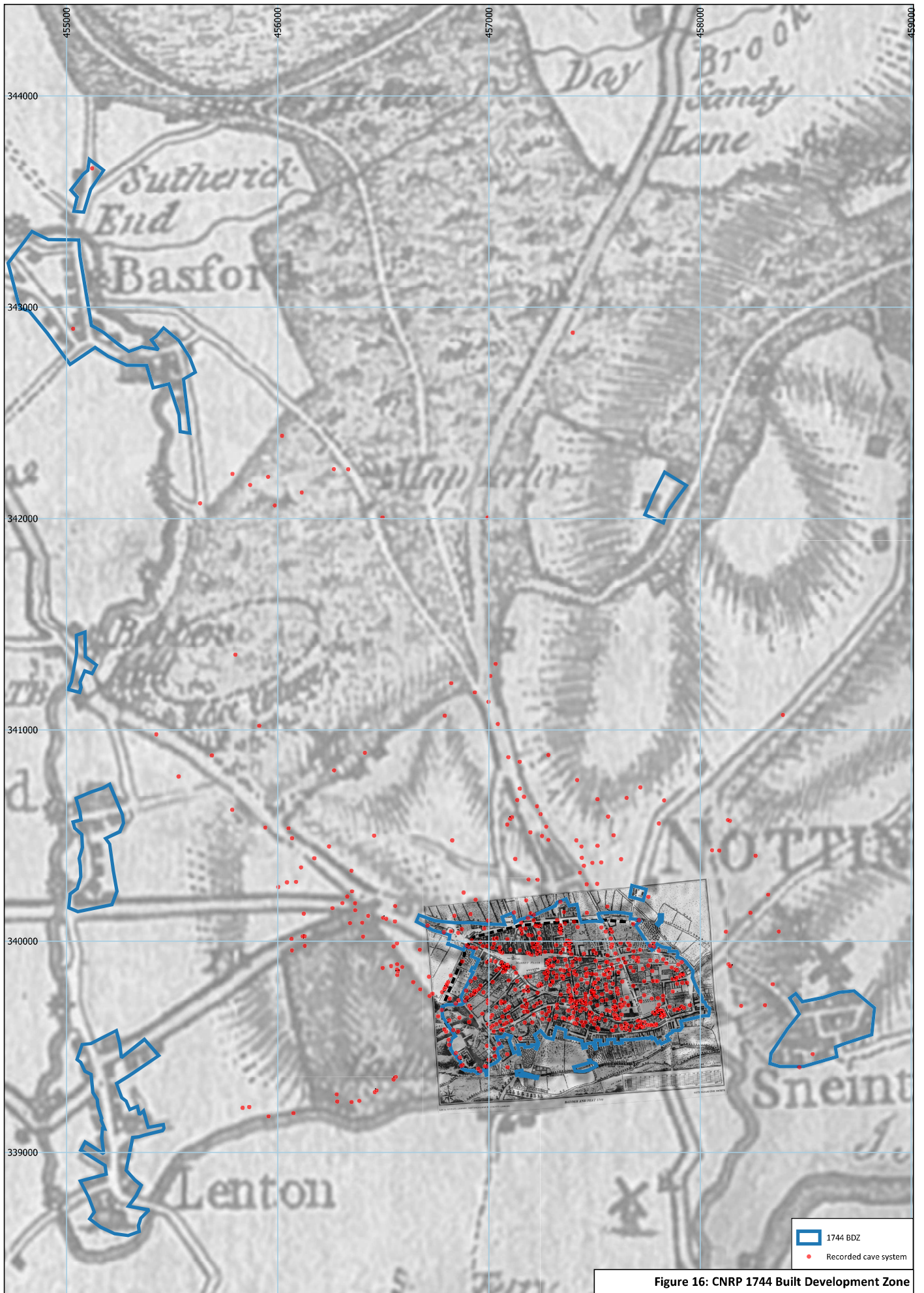


Figure 16: CNRP 1744 Built Development Zone

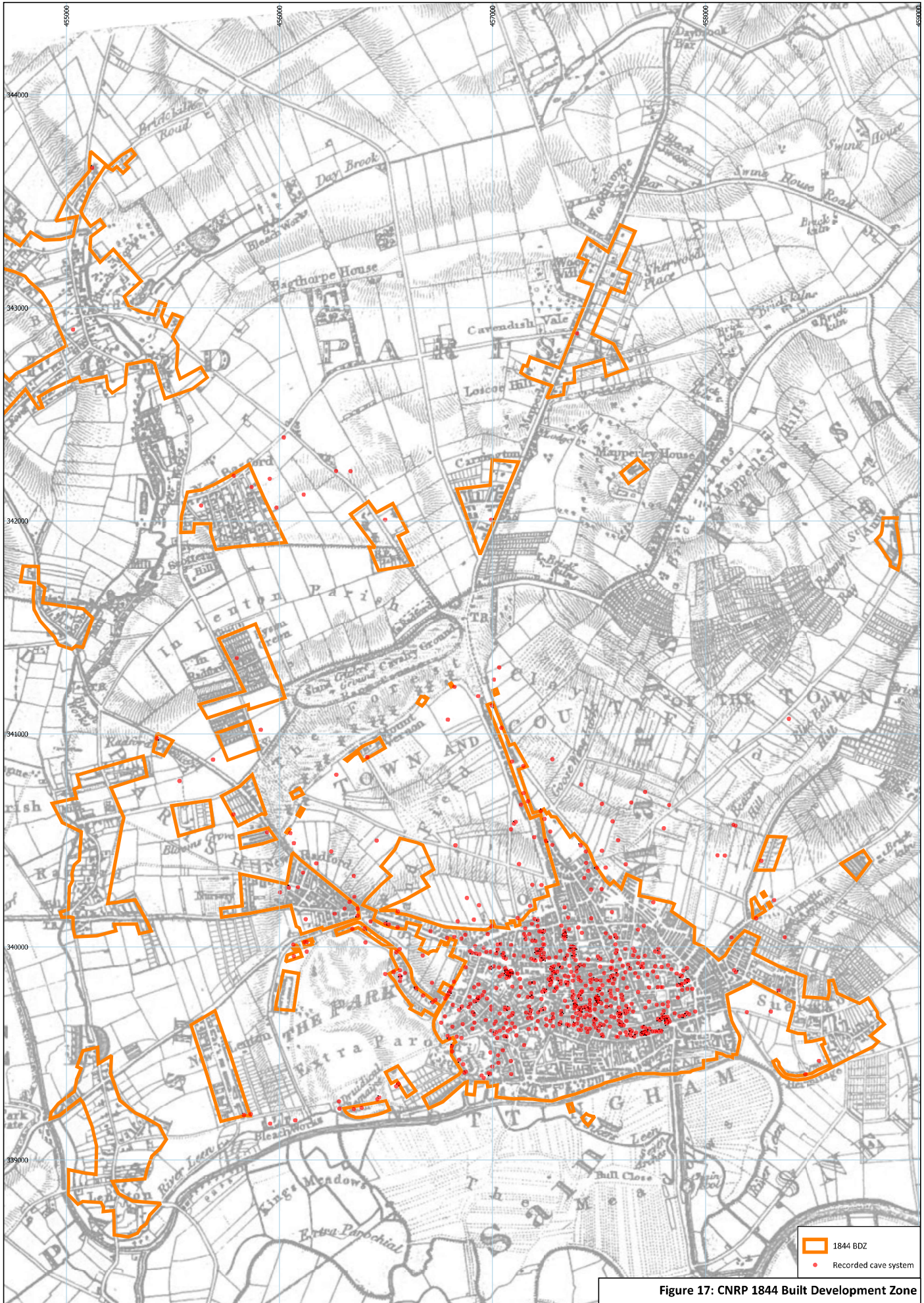
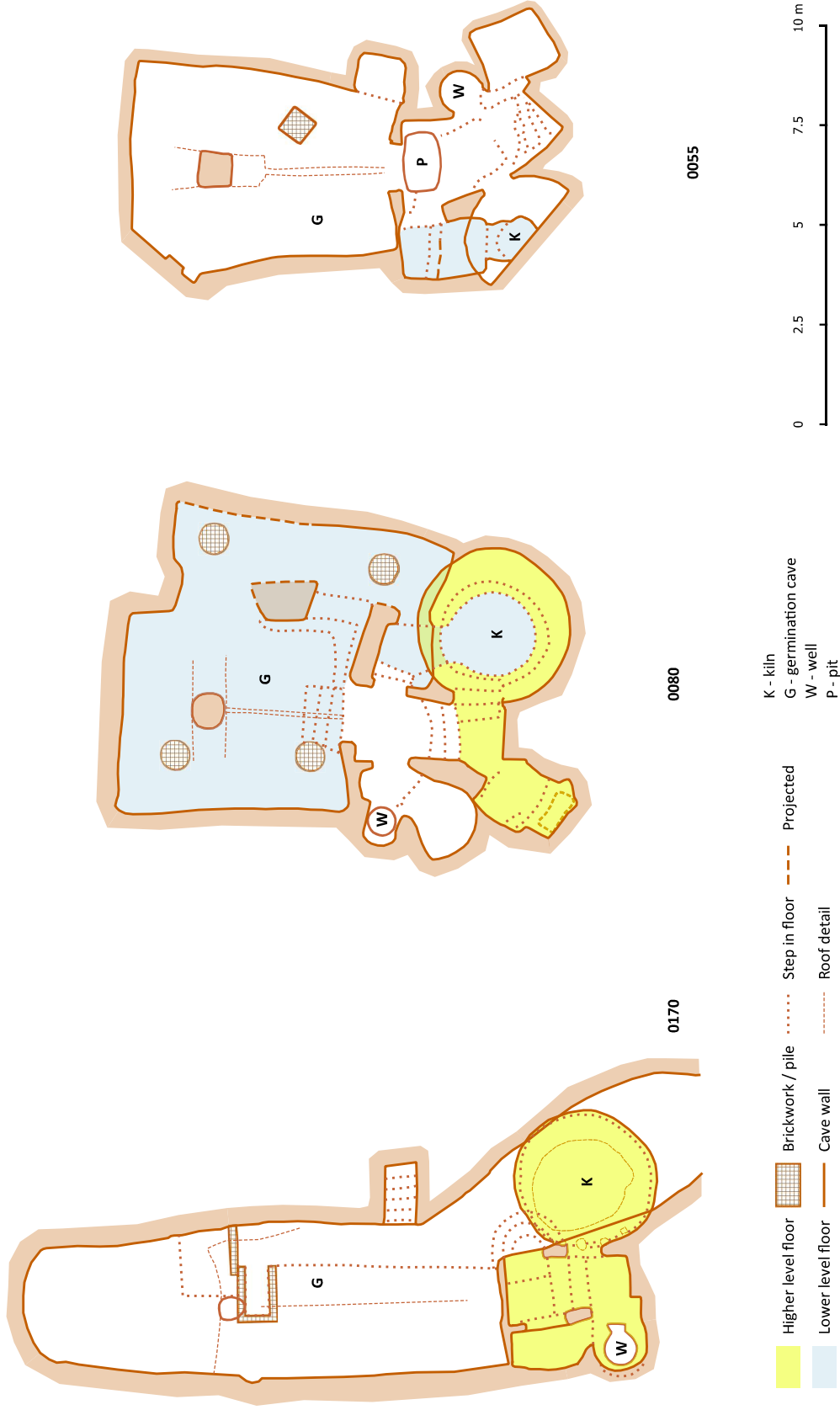


Figure 17: CNRP 1844 Built Development Zone

Figure 18: Plans of laser-surveyed cave-maltings



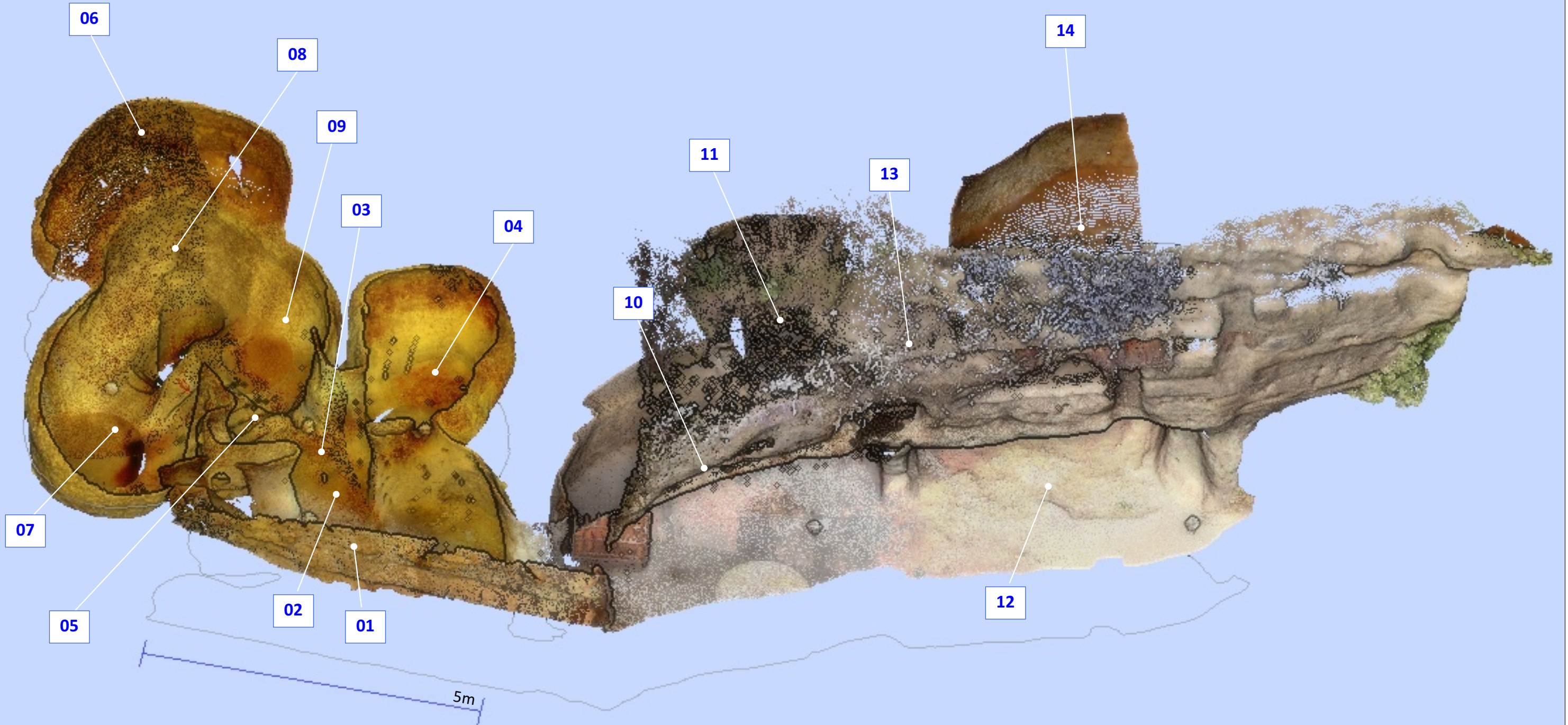
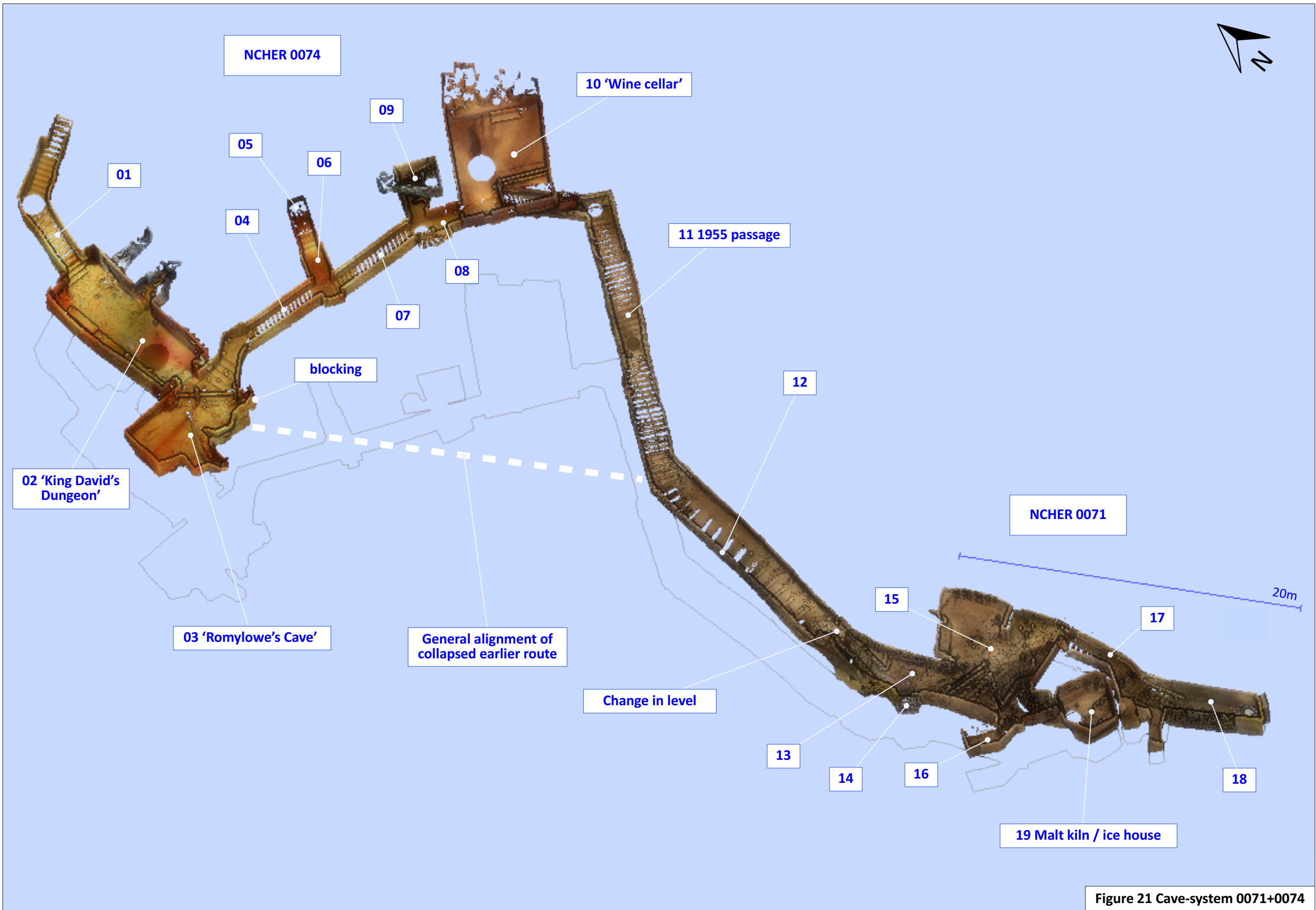


Figure 19 Cave-system 0367 showing cliff face



Figure 20 Cave-system 0367



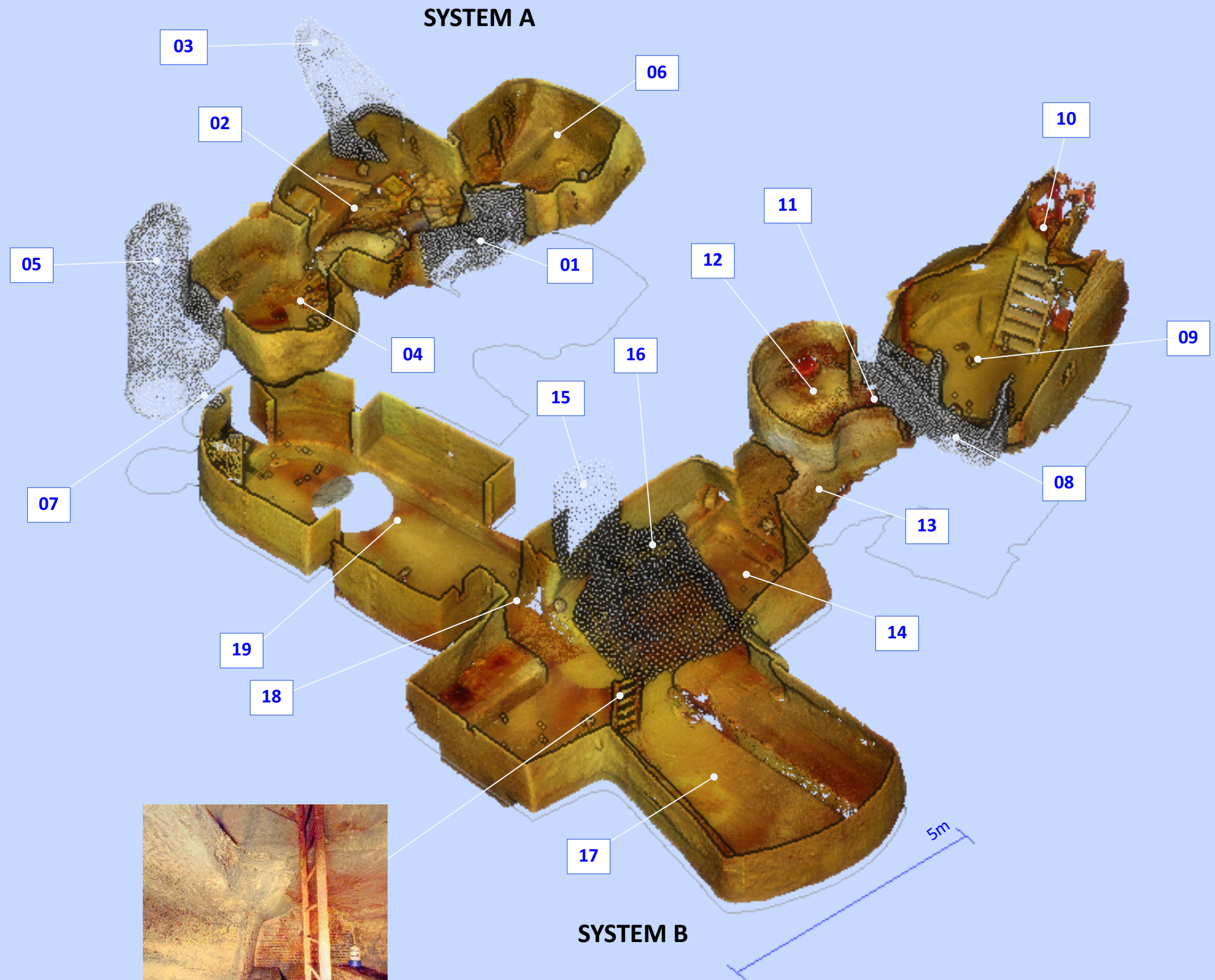


Figure 22 Cave-system 0378

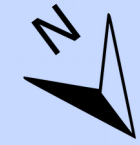


Figure 23 Cave-system 0080

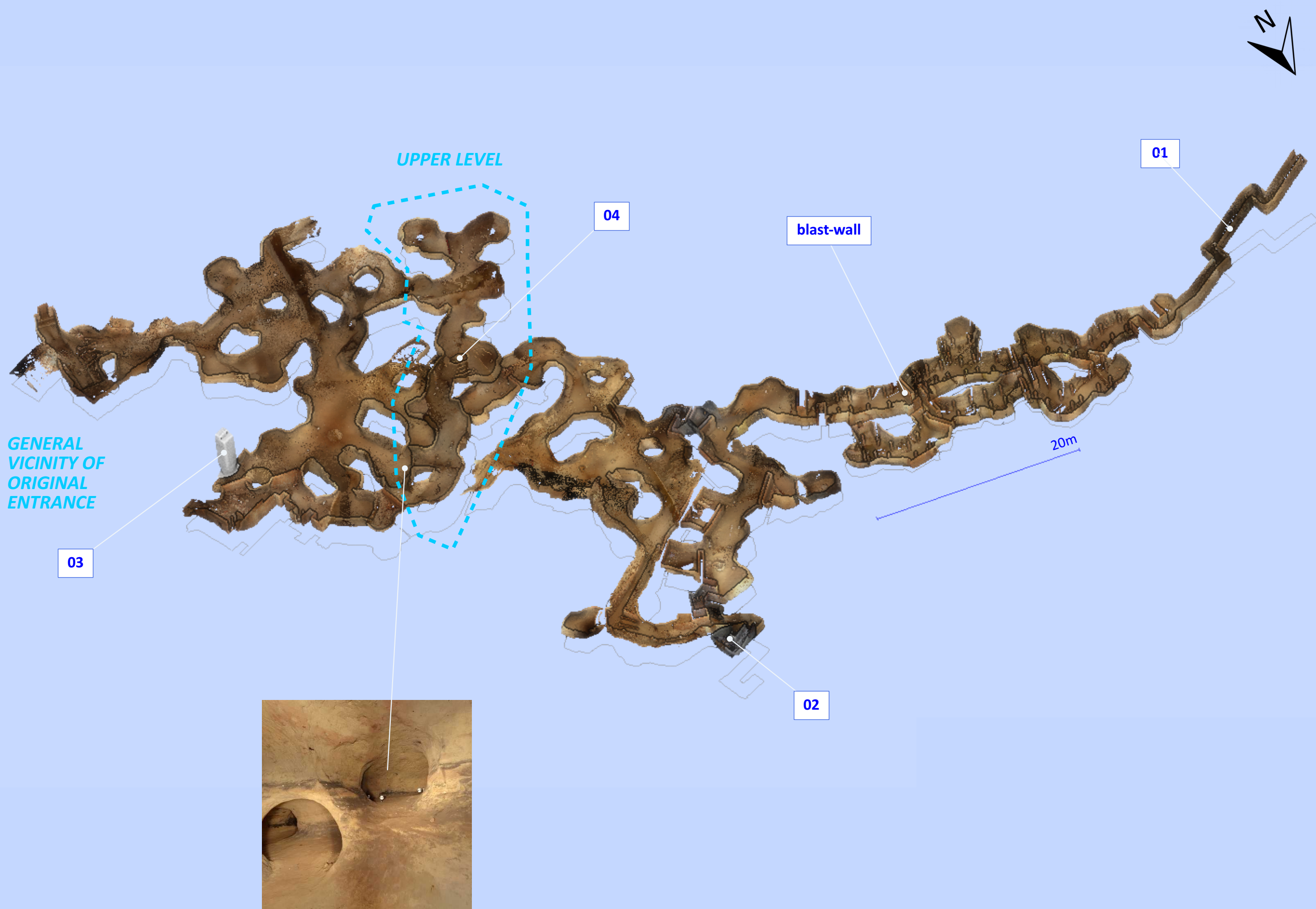


Figure 24 Cave-system 0277



Figure 25 Cave-system 0180

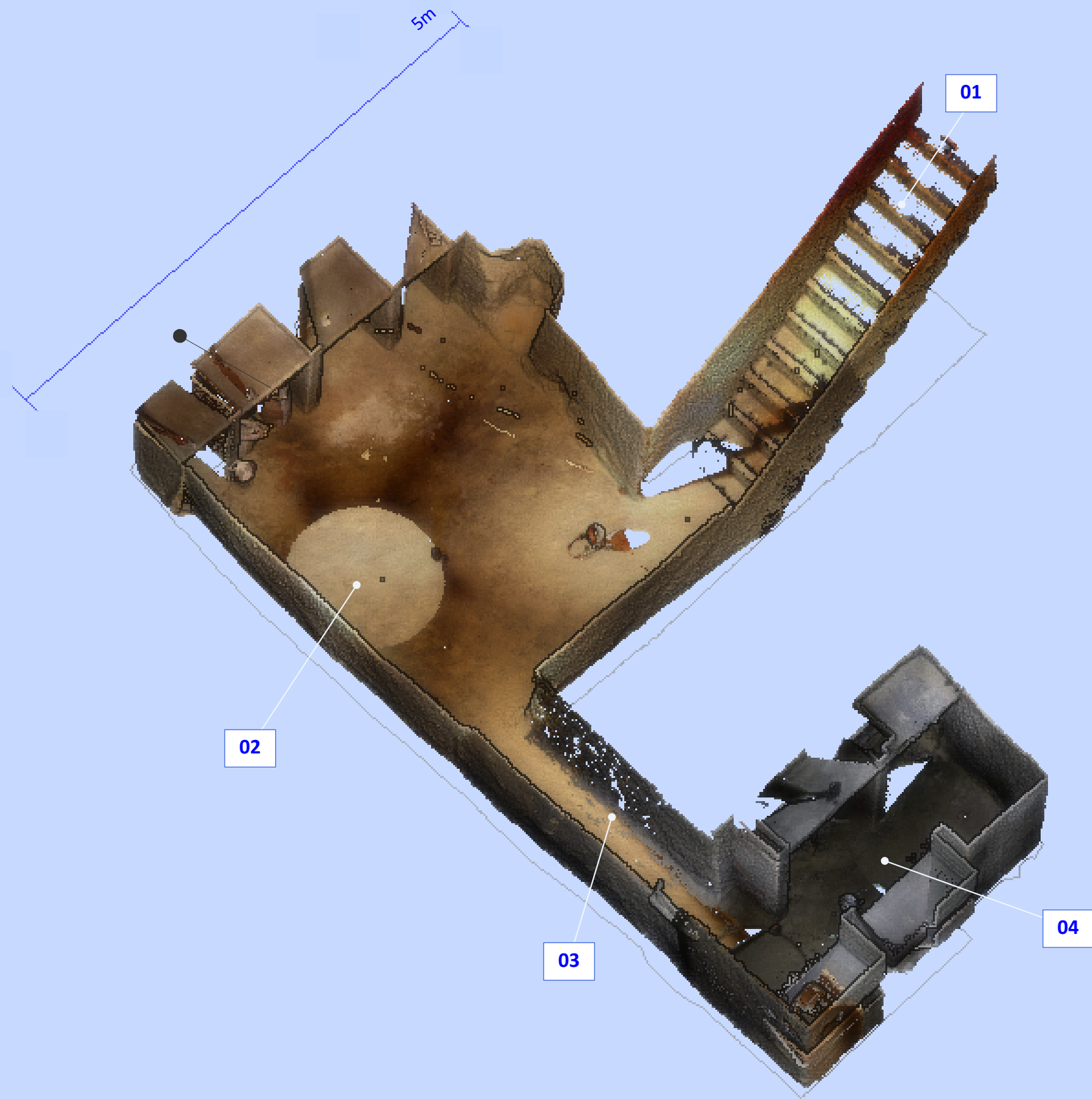


Figure 26 Cave-system 0959

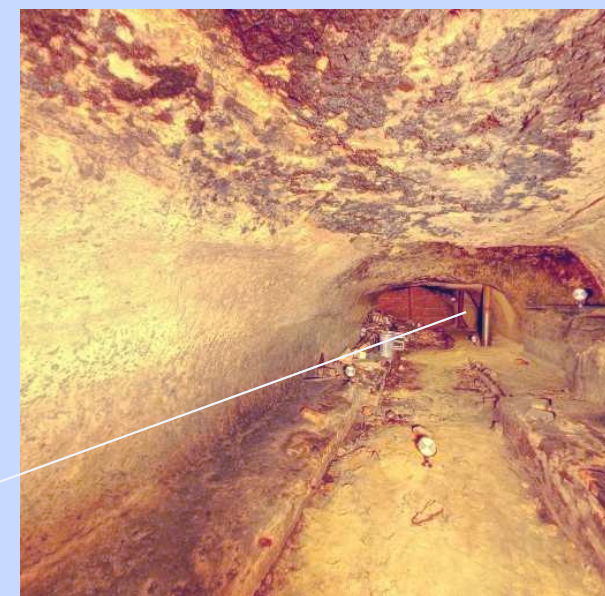


Figure 27 Cave-system 0006

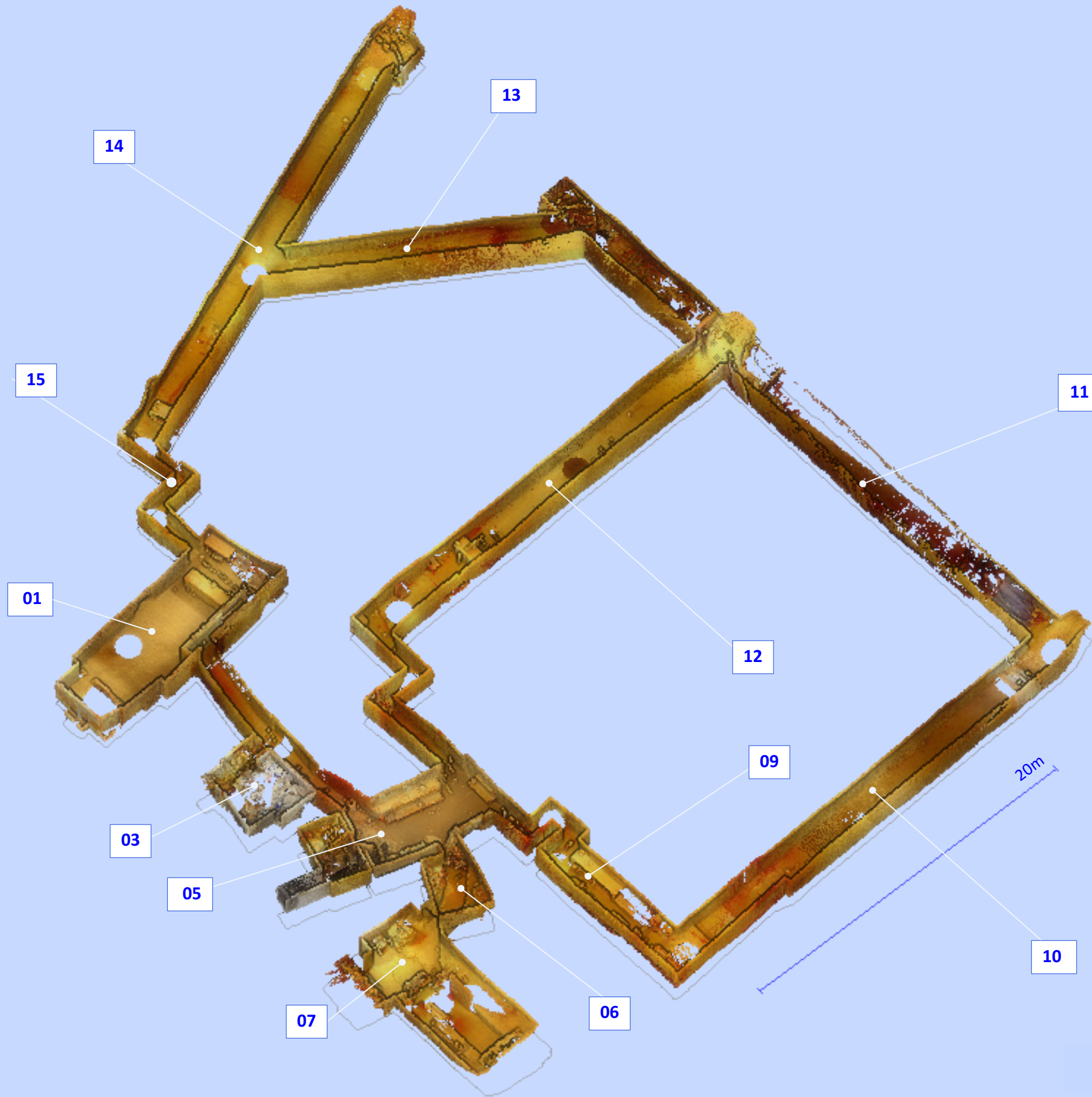


Figure 28 Cave-system 0088

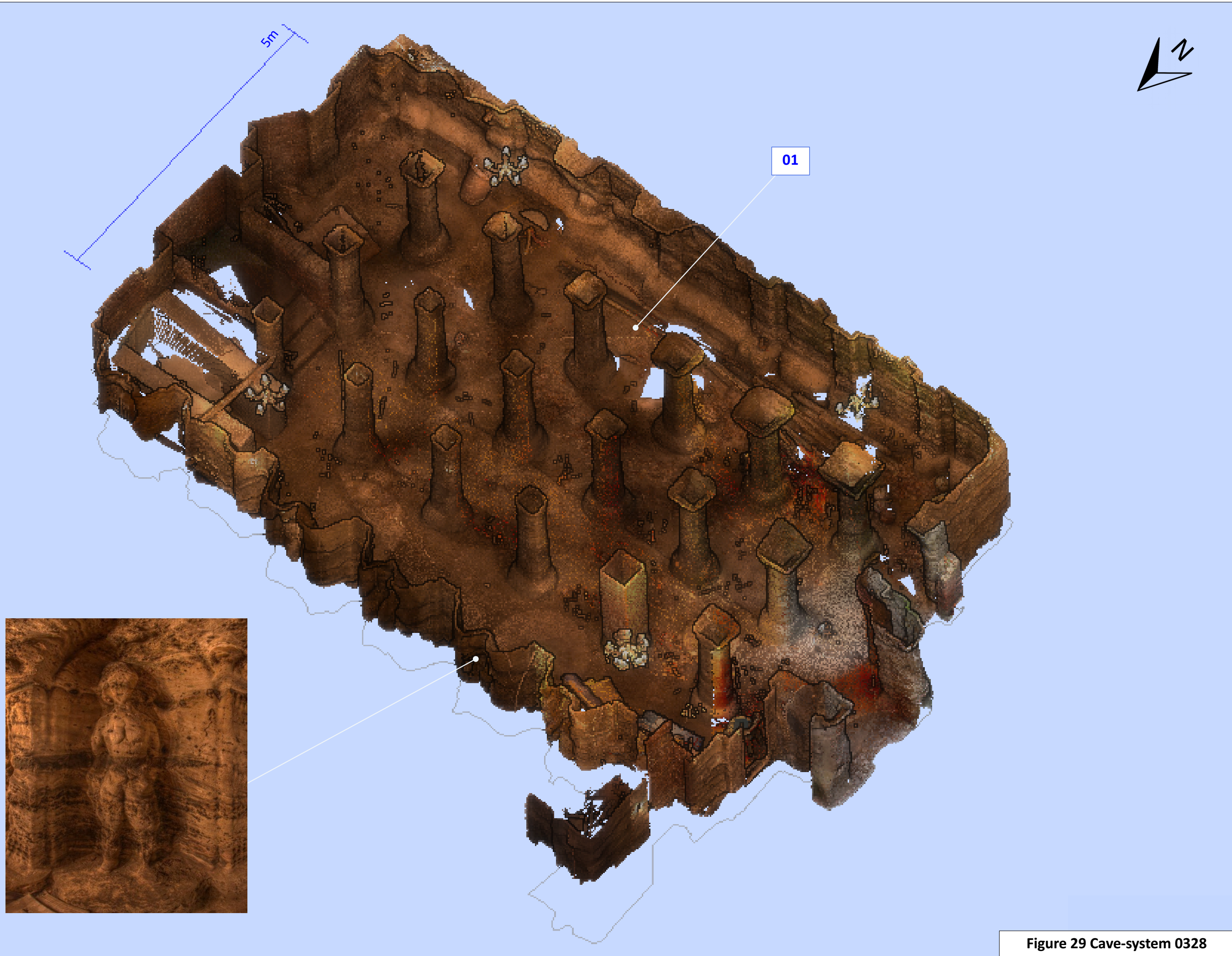


Figure 29 Cave-system 0328