A BUILDING STONE AND SLATE SURVEY OF THE CALLANDER CONSERVATION AREA

recording, matching and sourcing for the built heritage

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A building stone and slate survey of the Callander Conservation Area: recording, matching and sourcing for the built heritage

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Main image: looking towards Bridge Street, Callander.

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Foreword

The survey of stone buildings in the Callander Conservation Area described in this report was carried out by the British Geological Survey (BGS) on behalf of Loch Lomond & The Trossachs National Park Authority (LLTNPA). The work was facilitated by a partnership arrangement between LLTNPA, BGS and the Scottish Stone Liaison Group (SSLG), as part of the Callander Conservation Area Regeneration Scheme (CARS; funded by Historic Scotland). This report is one of a series of building stone and slate assessments supported by SSLG.

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Contents

FIGURES

TABLES

Summary

The town of Callander is the eastern gateway to Loch Lomond & The Trossachs National Park. This report describes the background to, and outcomes of, a survey of buildings and other structures comprised of natural stone and slate in the Callander Conservation Area (CCA). The survey was conducted by the Building Stones Team of the British Geological Survey (BGS), for the Scottish Stone Liaison Group. The survey data and other project outcomes will be used by Loch Lomond & The Trossachs National Park Authority to inform planning decisions, with a view to safeguarding the built heritage of the CCA. A total of 382 structures were surveyed between February and May 2010. With the exception of one bridge and two monuments, the surveyed structures consisted of residential, commercial, ecclesiastical and civic buildings.

Survey data were recorded on hand-held PC tablets running the BGS 'SIGMA' system for digital field data capture. A 'Building Stone Data Capture' module was designed specifically for the project. Data describing the character and condition of stone and slate were gathered for separate architectural elements (walling, dressings, and roofing) in each surveyed structure. A set of pre-determined data fields guided and restricted the range of properties that could be recorded, and a set of supporting dictionaries (with definitions, where appropriate) restricted the range of terms that could be used to describe each property. The recorded data have been transferred to a set of data files that can be interrogated independently or used within a GIS application.

The survey methodology is described, and details of the database hierarchy and supporting dictionaries are presented. The main outcomes of the survey, in terms of the range of stone and slate types used in surveyed structures, their distribution in the CCA and current condition, are described.

Four masonry styles (i.e. particular combinations of stone type, block size/shape/tooling and coursing used in the main architectural elements of a building) are recognised in the CCA, each reflecting the available building materials, architectural tastes and masonry skills of the time. The main changes in masonry style can be linked to events affecting the availability of materials, in particular the opening of quarries in the local area (providing a reliable but restricted source of local building stone), the arrival of the railway (bringing a variety of stone and slate types from other parts of the UK), and the impact of the First World War (associated with a rapid decline in the number of operational building stone quarries in the UK, and a shift to 'modern', manmade building materials).

Three of the most important stone types used in Callander buildings - conglomerate (*Callander puddingstone*), and two types of flagstone - were sourced locally, from three long-disused quarries in wooded slopes north of the town centre. These quarries are overgrown and neglected, but they are not filled or flooded. They represent the most obvious sources of matching stone for these stone types, to be used in future repairs to existing buildings and new-build constructions. If re-opening these quarries proves impractical, sites for potential new quarries could be identified by examining ground along strike of the bedrock strata exploited by the original quarries.

Three types of blonde to buff sandstone and four types of red sandstone are also recognised in Callander buildings. One of the red sandstone variants was probably sourced from one of the three local building stone quarries, but the other types of sandstone were imported from quarries in the Central Belt of Scotland, Dumfries & Galloway, and Northumberland. Potential matching stones are listed for each stone type, but this information is intended only to be a general guide; a formal stone matching exercise should be carried out whenever replacement stone is required.

Scottish Highland Border slate and Welsh purple slate are by far the most commonly used roofing materials in the CCA, and have been used on approximately equal numbers of buildings.

English (Cumbrian) slate and Spanish slate have been used on approximately equal numbers of buildings, but are much less common than Scottish and Welsh slate.

The most serious causes of stone decay in the CCA are cement pointing and patchwork, face bedding, and failing rainwater goods. These are described, and best practice guidance for conservation and repair of affected buildings is provided. Slates that have moved out of correct position constitute the most important roofing condition issue in the CCA.

A survey of stone condition in the 'Desirables' building, at 1-3 Main Street, is presented as a short, stand-alone report (in Appendix 3). The report is intended to be a template for future surveys of stone condition and maintenance issues in individual buildings.

1 Introduction

This report describes a survey of the natural stone and slate used in buildings within the Conservation Area of the town of Callander, in Stirlingshire. The survey was commissioned by the Scottish Stone Liaison Group, acting on behalf of Loch Lomond & The Trossachs National Park Authority (LLTNPA), and was undertaken by the Building Stones Team of the British Geological Survey (BGS).

The project objectives were as follows.

- Provide an inventory of the stone and slate types used in the Callander Conservation Area (CCA).
- Generate maps illustrating the distribution of the identified stone and slate types.
- Describe the historical development of Callander and chart the evolution of masonry and roofing styles through the changing uses of stone and slate.
- Provide guidance for the repair and conservation of stone and slate in Callander.
- Identify (where possible) the original sources of the recorded stone and slate types, and describe potential new sources of matching stone and slate that could be used in repairs and new-build construction.
- Conduct a stone and slate condition survey of 1 Cross Street/ 29-33 Main Street, Callander (which currently hosts the 'Desirables' shop), and provide an exemplar case study of best-practise guidance for stone and slate repairs to buildings in the CCA.

The first two of these objectives have been tackled by conducting a detailed survey of the stone-built structures within the CCA. The other objectives have been met by drawing on a range of information sources, including the survey data, field work in the local area, BGS maps, reports and databases, and historical maps and accounts. The information gathered by the project is intended to inform planning decisions regarding repairs to, and construction of, stone-built structures within the CCA, and can be used to raise public awareness of the history, character and value of the local built heritage.

Summaries of the geographical setting, the geological setting, and the historical development of Callander are presented in Section 2. The scope, methodology and limitations of the survey are described in Section 3. The 'raw' data gathered in the course of the survey have been delivered independently of this report, in a series of database files. Some of the main outcomes of the survey, including descriptions of the stone and slate types and maps to illustrate their distribution, are summarised in Section 4. The historical development of the CCA, as revealed by the evolution of masonry and roofing styles, is described in Section 5. Past and possible future sources of locally sourced stone used in Callander buildings are reviewed in Section 6. Sources of currently available stone and slate, which broadly match the original materials used in Callander, are described in Section 7.

Details of the fields and dictionary terms used in the survey database are presented in Appendix 1. Some guidance for the conservation of stone and slate in Callander buildings is provided in Appendix 2. Appendix 3 contains a stand-alone report describing the stone and slate condition survey of 1 Cross Street/ 29-33 Main Street, Callander (which currently hosts the 'Desirables' shop). The 'Desirables' report provides a template for conducting and presenting future surveys of stone and slate condition in individual buildings.

2 The geographical, geological and historical context

The character of stone-built settlements typically reflects a range of geographical, geological and historical factors. The following sections describe the location, geological setting and historical development of Callander.

2.1 LOCATION

Callander lies close to, and just within, the eastern boundary of Loch Lomond & The Trossachs National Park (Figure 1). It is one of the largest settlements (pop. c. 3,000) in the park and serves as its eastern gateway. The town occupies a strategically important location: it developed at the point where the Garbh Uisge and Eas Gobhain rivers combine to form River Teith, and is close to Strathyre (historically an important transit point between the Highlands and Lowlands), the Trossachs (a popular tourist destination), and Stirling (a major trade and administrative centre).

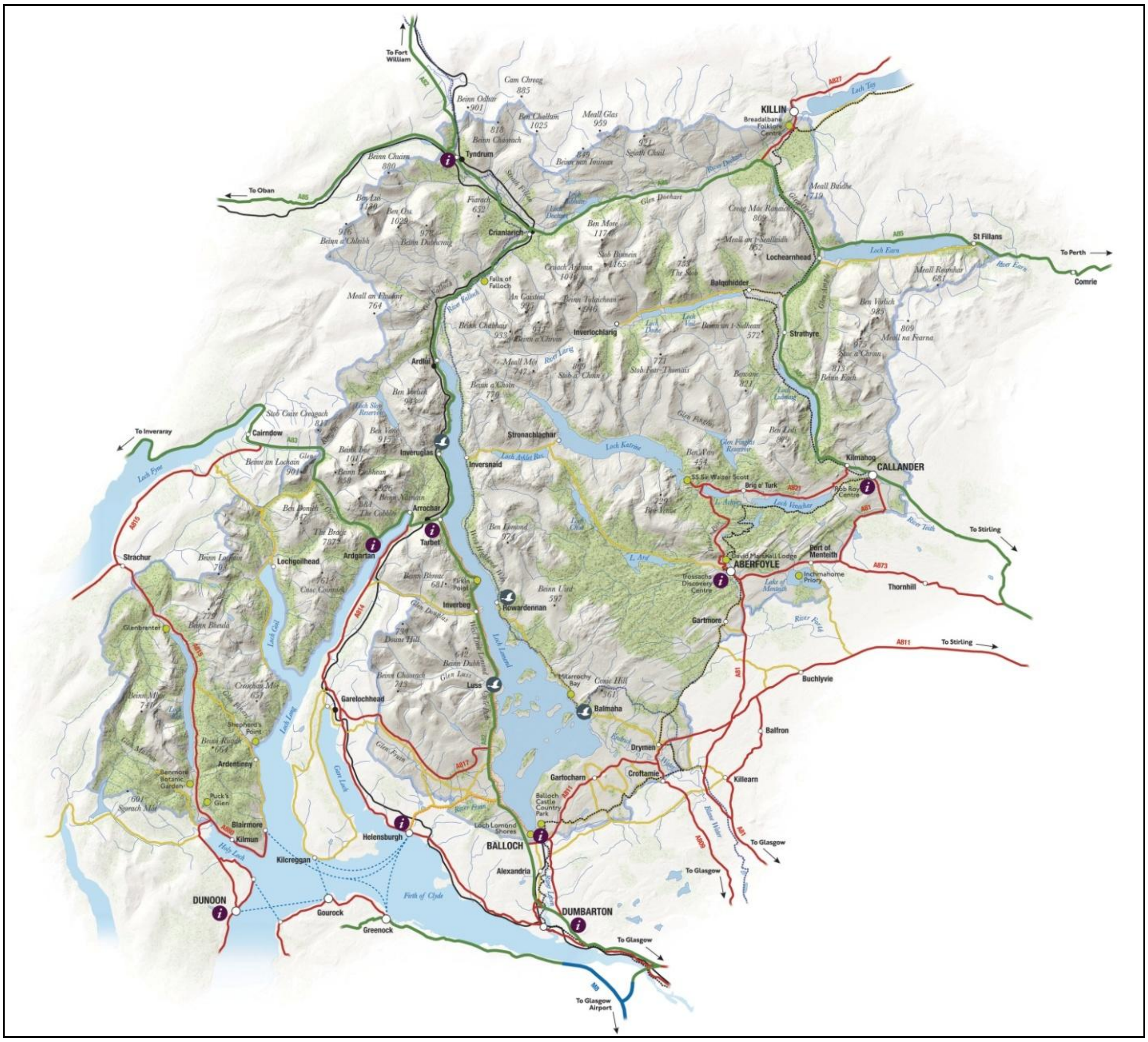

Figure 1 Shaded topographic map of Loch Lomond and The Trossachs National Park.

Callander is close to the eastern boundary of the park. A distinct northeast-trending 'grain' in the topography extends in a straight line from just to the north of Callander, through Aberfoyle, Balmaha and the southern-most islands in Loch Lomond. This is the surface trace of the Highland Boundary Fault, a major geological boundary separating older, folded and metamorphosed strata of the Grampian terrane on its northwest side (the 'Highlands') from younger, non-metamorphosed strata of the Midland Valley terrane on its southeast side (the 'Lowlands'). Callander is situated a short distance to the southeast of the Highland Boundary Fault.

The town is centred on a single main street (Main Street), the principal (oldest) part of which is around 0.75 kilometres long. Near its central point the street opens out on both sides into Ancaster Square, but is otherwise lined by buildings fronting directly onto it. A regular, grid-like street pattern is developed in the area immediately around Main Street, beyond which are areas of grand Victorian villas (notably Leny Feus) and modern housing. The Callander Conservation Area is broadly centred on Main Street and encompasses several hundred stone structures (buildings, bridges and monuments) (Figure 2). The main part of the town lies on the north side of River Teith, at an elevation of c. 70 metres OD. The town is hemmed in on its north side by a craggy, wooded hillside (Callander Craig), and to the northeast it is overlooked by Ben Ledi (879 metres), one of the most prominent and best known peaks in the Southern Highlands.

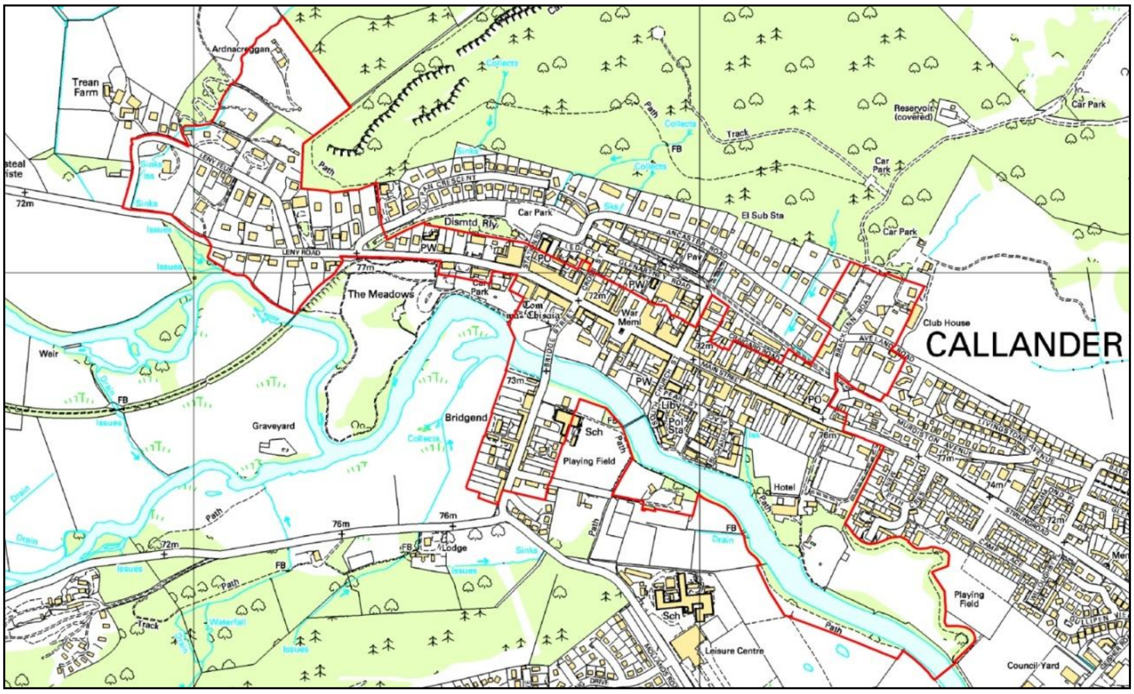

Figure 2 Map of the town of Callander and outline of the CCA.

2.2 GEOLOGICAL SETTING

Callander lies a little over 2 km southeast of the *Highland Boundary Fault* (HBF), a major geological boundary that crosses Scotland from Arran in the southwest to Stonehaven in the northeast. The trace of the HBF transects Loch Lomond & The Trossachs National Park, trending roughly parallel to, and generally a few kilometres to the north of, its south-eastern boundary (Figure 3). The fault separates two of the main blocks of Earth's crust that underlie Scotland – the Grampian terrane and the Midland Valley terrane.

On the northwest side of the HBF, the *Grampian terrane* consists of a thick sequence of sedimentary rocks (mainly sandstone, mudstone and limestone) known collectively as the *Dalradian Supergroup*. These strata were deposited in a shallow sea between approximately 800 and 470 million years ago. Between 500 and 400 million years ago the Dalradian strata were folded and metamorphosed by the *Caledonian Orogeny*, a major geological event caused by a closing ocean and colliding tectonic plates. The heat and pressure associated with metamorphism caused the granular, soft sedimentary rocks to become crystalline and hard. Layers of porous sandstone became compacted and impermeable, and layers of mudstone developed a schistosity (a preferred orientation of mineral grains along which the rock will split). In some places the metamorphism caused mudstone layers to develop into the hard, easily split rock called *slate*.

Units of dark bluish-grey to greyish-green and purple slate (which has been quarried in places like Luss, Aberfoyle and Dunkeld) crop out in many areas just to the north of the HBF. Erosion of the Dalradian strata over many millions of years has formed the rugged mountains and valleys of the Scottish Highlands.

On the southeast side of the HBF, the *Midland Valley terrane* consists of a thick sequence of sedimentary rocks and volcanic rocks that were deposited after the Caledonian Orogeny, during the Devonian (416-359 million years old) and Carboniferous (359-299 million years old) periods. By the end of the orogeny, the Dalradian strata had been uplifted to form a mountain belt. Rivers then carried enormous volumes of sediment from the eroding mountains and deposited it on floodplains on what is now the Midland Valley terrane. During the Devonian Period, the sediments were deposited in a generally arid (desert) environment, forming a thick pile of typically reddish brown strata known collectively as the *Old Red Sandstone Supergroup*. Coarser sediment (cobbles and boulders with a sandy matrix) was typically deposited closest to the eroding source and finer sediment (sand and mud) was deposited further away. As more and more sediment accumulated, the thickening pile became deeply buried and converted to solid rock: the layers of cobbles and boulders became *conglomerate*, layers of sand became *sandstone*, and layers of mud became *siltstone*. *Puddingstone* and *flagstone* are vernacular terms for conglomerate and flaggy siltstone (or fine sandstone), respectively. The Old Red Sandstone and younger (Carboniferous) strata within the Midland Valley terrane are only weakly folded, and they are not metamorphosed. Erosion of these relatively soft rocks has yielded the low-lying, gently undulating landscape of the Midland Valley.

Later movements on the Highland Boundary Fault caused the younger rocks of the Midland Valley terrane to be uplifted relative to the older rocks of the Grampian terrane; the hard, metamorphosed sedimentary rocks of the Dalradian Supergroup and the soft, red-brown conglomerates, sandstones and siltstones of the Old Red Sandstone Supergroup are now juxtaposed at ground level across the fault.

Close proximity to the Highland Boundary Fault means the town of Callander has developed in an area of considerable geological diversity and contrasting geological character: it sits on relatively soft, steeply dipping bedrock strata of conglomerate, sandstone and siltstone, and is overlooked by Ben Ledi and other rugged hills composed of hard, folded Dalradian strata.

More details of the bedrock geology in the Callander area are provided in Section 6.

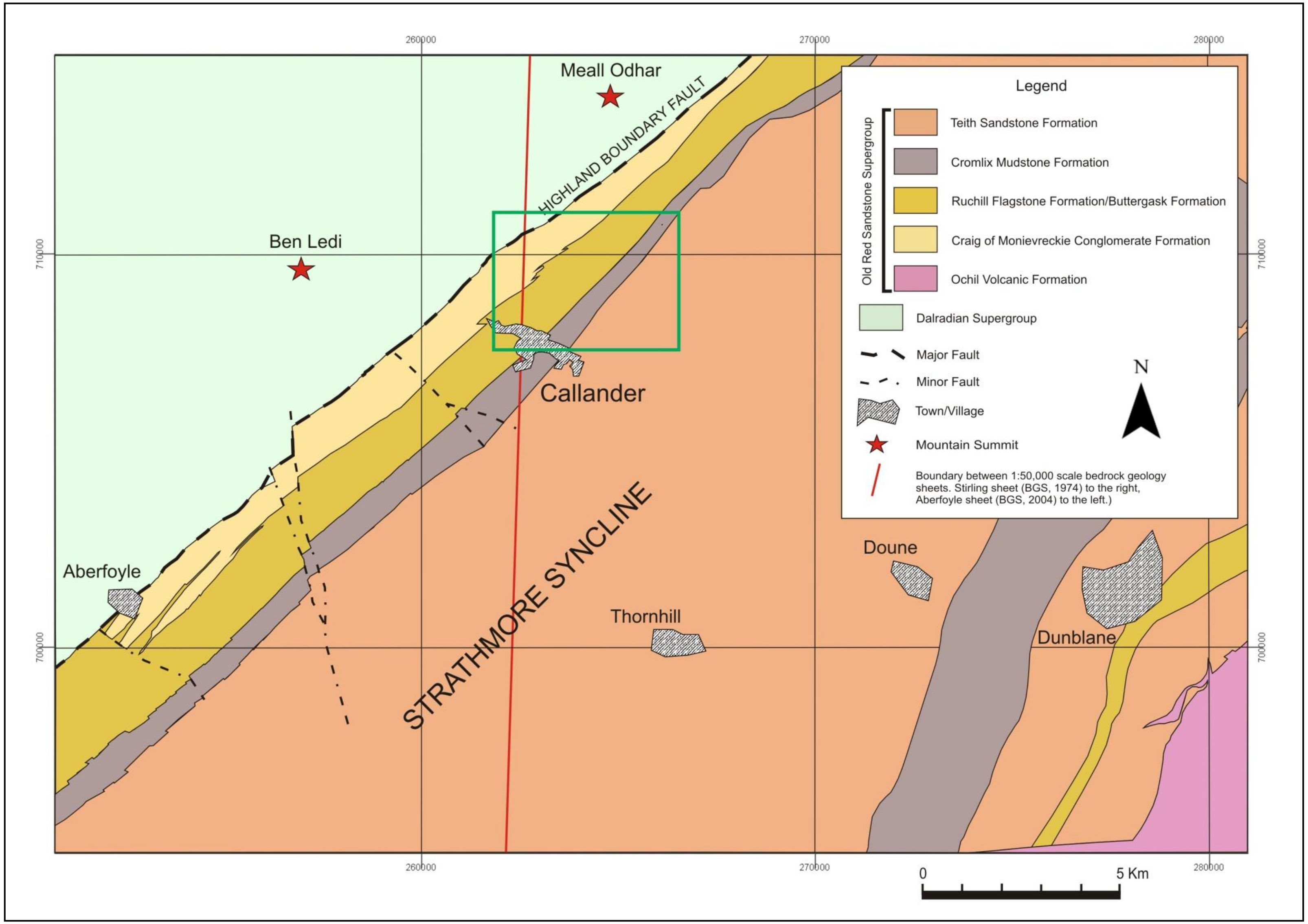

Figure 3 Map of simplified bedrock geology in the Callander district.

The Highland Boundary Fault separates older, folded and metamorphosed strata of the Dalradian Supergroup (mapped strata not shown) from younger, non-metamorphosed strata of the Old Red Sandstone Supergroup. Callander straddles the outcrop of several major mapped strata of conglomerate, sandstone and flagstone on the northwest limb of the Strathmore Syncline. Some of the same strata re-appear on the south-east limb of the syncline, around Doune and Dunblane. The green box shows the position of Figure 17.

2.3 HISTORICAL DEVELOPMENT OF CALLANDER

St. Kessog, a disciple of Columba of Iona, preached in what is now Callander as early as the sixth century AD. The Saint is believed to have preached on the mound known as 'Tom na Chessaig', on the banks of River Teith at Callander. A pre-reformation kirk was later sited nearby; all that remains today is the old Parish graveyard.

The Duke of Perth acquired the lands of Callander in 1618 (Maclean, no publication date; p5) and administered the lands from Drummond Castle, near Crieff. A hunting lodge was built for the Drummond Estate shortly thereafter (c.1625) on the north bank of River Teith. Remnants of the lodge survive today as the 'Roman Camp'[1], which has been a fully operational hotel since 1939. The building was purchased by Reginald Balliol Brett, 2nd Viscount Esher, in 1896, and it was restored and altered at that time; many of the alterations survive in the building today.

Early village development was focused around Bridgend, on the south side of River Teith (Figure 2). This area retains its historical feu patterns and remnants of 17th century building foundations (e.g. Bridgend House Hotel; C(s) listed).

Callander is located on an important transit route between the Highlands and Lowlands of Scotland. Town expansion was thus greatly influenced by the trade and manufacture of agricultural goods from as early as the 17th century. The earliest known 'marcat' (market) in Callander was in 1696 (Maclean, *op cit*; p8), and such events continued into the 19th century. Fairs based around the trade of cattle, sheep and horses were held in March and May. Beginning in 1723, Callander hosted an annual market every tenth day of March (Mitchell, 1906; p133), and there were also smaller trade fairs for lambs and farm servants. The success of these fairs soon led to plans for town development.

In the 1730s, James Drummond (the 4th Duke of Perth) commissioned a town plan entitled *'the New Towne of Callender in Monteith belonging to his grace the Duke of Perth drawn at five falls to an inch of scale at Drummond Castle the 29th of July 1739 by [no name]'*. The plan visualised one long, wide street with feus flanking either side, a large central square with a church, and a bridge over River Teith to Bridgend. The "new towne" falls entirely within the CCA. By 1745, twenty-nine feus had been granted for housing by the Duke of Perth (Maclean, *op cit*; p14). However, the Duke's lands were forfeited after the 1745 Jacobite rebellion, and there was little building on these plots until the 1770s. Many Jacobite-owned estates were surrendered to the Crown; however, the Drummond Estate was one of fourteen to be later annexed by the Government in 1752. It was shortly thereafter that significant construction began in Callander.

By 1763 the Commissioners for the Annexed Estates (often referred to as the Forfeited Estate Commissioners) had granted thirty-seven feus in Callander (information from the Scran website; see Section 9 for website address), and development along Main Street and Ancaster Square had begun (Byrom, 2005; p3). The stone bridge over River Teith was completed in 1764 (Mitchell, 1906; p13) and the old Parish kirk (previously along the banks of River Teith) was relocated to the square in 1773; the kirk still carried the name of St. Kessog at this time. The square was named after the Earl of Ancaster, successor to the Duke of Perth.

Callander experienced a period of rapid expansion in the latter part of the 18th century, probably due largely to the impact of the Highland Clearances. People and their livestock moved into the district, areas of grazing were placed to the north of the planned town, and the number of sheep increased from 2,000 to 18,000. Several mills for lint, meal and grain were constructed (none of

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[1] It was formerly believed that the remains of a Roman camp survived to the south of the house, hence its name; however, it is known today that what appears to be the remnant of a foundation is more likely to be a naturally raised feature caused by the changing course of River Teith (RCAHMS).

which are known to have survived), and by 1798 one hundred looms were weaving muslin between Callander and the neighbouring village of Kilmahog (Byrom, 2005; p3).

By the end of the 18th century, the population of Callander exceeded 1,000 for the first time. A daily coach to Stirling carrying passengers and delivering post began in 1835, and great quantities of wool were transported to Bannockburn, Glasgow, and Liverpool for the carpet industry (Byrom, 2005; p3).

Tourists began visiting the town in significant numbers at the turn of the 19th century, and the Dreadnought Hotel (one of Callander's biggest hotels) was constructed to meet the demand for tourist accommodation. Additional daily coaches from Callander to the Trossachs, Aberfeldy and Dunkeld operated during the summer season.

The first railway station in Callander was opened on 1st July 1858 on the Dunblane, Doune and Callander Railway. The line was absorbed by the Caledonian Railway Company from 1st August 1865. The station closed on 1st June 1870, and was replaced by the Callander (Dreadnought) Station on the newly extended line towards Killin and Oban. The line was further extended in 1870 and became part of the Callander & Oban Railway, eventually reaching Oban in 1880. Dreadnought Station was refurbished in 1883, and closed to regular passenger traffic on 1st November 1965 (Byrom, 2005; p14).

The railway had a significant impact on the development of Callander, bringing people, trade, and new building materials to the town (see Figure 4 for maps demonstrating town expansion from 1866 to 1901). The dependence on agricultural trade was lessened as public transportation improved and tourism became increasingly popular. Many important commercial, religious and civic buildings, including hotels, banks, churches and schools, were built during the latter half of the 19th century, as were the impressive residential villas of Lenny Feus. Bracklinn Road, Aveland Road, Tulipan Crescent and Ancaster Road (see Figure 2) were laid out subsequently, although some were not fully developed until the 20th century.

The First World War brought an end to villa developments. 'Bed & breakfast' tourism caught on in the 1930s, and many historic buildings in Callander were converted to guest houses at this time. A number of 'modern' developments were constructed in the 20th and 21st centuries, most of them concentrated along Glenartney Road, Ledi Court and the south side of Craigard Road; these all lie outwith the CCA (Figure 2). Modern housing developments at Pearl Street and Buchanan Place lie within the CCA. Many of the modern developments break the historical feu pattern, and the buildings are typically constructed using man-made materials with little or no natural stone.

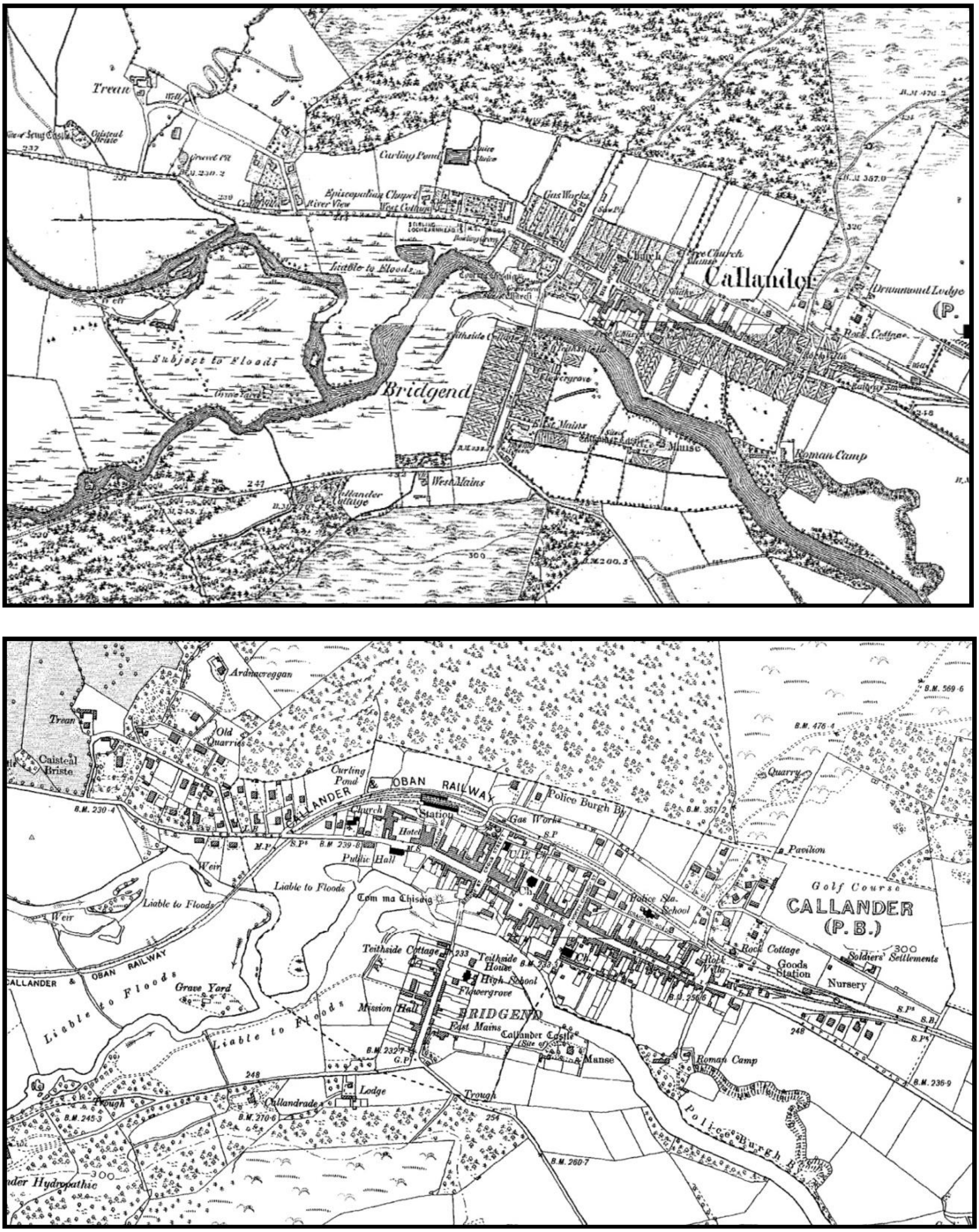


Figure 4 1866 Ordnance Survey map (top) and 1901 Ordnance Survey map (bottom), demonstrating pre and post rail development in Callander.

3 Scope, methodology and limitations of the survey

3.1 SCOPE

The survey was limited to buildings and other stone structures within the boundary of the Callander Conservation Area (Figure 2). Outbuildings and areas of modern development (such as Pearl Street and Buchanan Place) were excluded. A total of 382 buildings and other structures were surveyed.

In general, the attributes recorded for each building relate to the principle (street facing) facade and the roof above the principle facade. Where a different elevation was visible and consisted of a different stone or slate type, or masonry style, a separate record was made for that elevation.

The field survey was carried out by Paul Everett and Luis Albornoz-Parra between February and May 2010.

3.2 METHODOLOGY

3.2.1 Data capture and presentation

The BGS System for Integrated GeoScience Mapping (SIGMA) was used to record the survey data. SIGMA is an open-source database system built under the BGS Spatial GeoScience Technology Programme, and is the BGS preferred tool for field data capture. Data are captured on Xplore iX104 tablet PCs running Microsoft XP.

SIGMA is designed to allow a wide range of geological and other information to be captured quickly and consistently in the field, in digital form, within a geospatial frame, and in a relational database format. The system contains a number of discrete modules, each of which is designed to suit the needs of a different type of survey. A 'Building Stone Data Capture' module was developed specifically for this survey of stone-built structures in Callander. The module consists of a database of hierarchically arranged attribute fields, many of which are supported by dictionaries of defined terms that guide and restrict the way they can be populated. The range of attribute fields and the range of terms held in the supporting dictionaries have been designed to allow a comprehensive description of the stone and slate types that exist within the CCA, and their condition.

The 'raw' data arising from the survey have been delivered independently of this report, as one GIS *shape file* ("Surveyed building stone and slate types summary for Callander Conservation Area") and one database (*dbf*) file ("Surveyed maintenance issues for Callander Conservation Area"). Appendix 1 contains details of the attribute fields, the supporting dictionaries associated with the attribute fields and, where appropriate, definitions for dictionary terms.

The combined SIGMA-GIS approach provides a convenient means of systematically recording, storing, updating, interrogating and displaying a wide range of spatially referenced data. In its GIS form the dataset can be used by planners to quickly select, organise and view data, and to easily compare and contrast aspects of the dataset. The digital, hierarchical method of data capture and storage represents a radical departure from previous building surveys of this type (e.g. Hyslop et al., 2006; 2009; 2010; in which data typically have been recorded in analogue form), and has a number of advantages. These include:

- the pre-determined hierarchy of fields and the supporting dictionaries ensure a high degree of consistency in the dataset
- the data recorded for single attributes or combinations of attributes can be selected and manipulated easily, allowing statistical or geospatial patterns to be drawn from the data.

Some of the main outcomes of the survey are described in Section 4, Section 5 and Appendix 2.

3.3 LIMITATIONS OF THE DATASET

Every effort has been made to ensure that recorded data are accurate and consistent. However, the following factors should be borne in mind when using the data.

- Data were recorded in the course of a rapid visual examination made from ground level only.
- The distance between surveyor and surveyed building varied considerably, from less than one metre to more than twenty metres.
- Some facades and roofs were viewed at a distinctly oblique angle (rather than ‘head-on’, which was the norm). It is more difficult to see details clearly on obliquely viewed surfaces, and protruding parts of such surfaces sometimes concealed other parts from view.
- Stone and slate surfaces were commonly concealed to varying degrees by applied coatings or coverings (i.e. paint, plastic repairs, cement, harling), soiling or biogenic matter.
- The survey was conducted over several months in widely varying weather and lighting conditions. Slate type recognition is particularly difficult in wet conditions.
- The attributes of natural stone and slate (including colour, grain-size and fabric) can vary considerably, even in stone and slate sourced from a single quarry. The various stone and slate types identified in the course of this survey were, generally, reasonably easy to distinguish when they could be observed clearly. However, there are some instances where two or more ‘types’ of stone or slate have characteristics that overlap to some degree, meaning it was not always possible to distinguish them easily and unambiguously.

4 Building stone and roofing slate in the Callander Conservation Area

4.1 BUILDING STONE

Stone-built structures within the Callander Conservation Area are constructed of stone with a broad range of characteristics. During the survey, a set of descriptive details about the stone (including its geological type, colour, grain-size and fabric) was recorded for every architectural element (walling and dressings) in every building/structure. In the course of conducting the survey it became clear how this broad range could be divided most usefully into a number of discrete stone 'types', based on their character and inferred source. Once the survey was completed, each stone type was assigned a 'stone code' and the appropriate code was assigned to each architectural element recorded in the database, to identify it as one of these types.

4.1.1 Stone types

Nearly all of the stone is of clastic sedimentary origin – that is, it consists of eroded rock fragments (clasts) that were transported and then deposited to form sediment. The sedimentary stone is of three main types:

- *flagstone*, in which the deposited clasts are generally in the size range 0.016 to 0.25 mm diameter, and the stone parts readily along parallel bedding surfaces (giving it a 'flaggy' character)
- *sandstone*, in which the deposited clasts are in the size range 0.06 to 2 mm diameter and the stone typically lacks a flaggy character
- *conglomerate*, in which relatively large clasts - pebbles (4-64 mm) and cobbles (64-256 mm) - are set in a 'matrix' of smaller clasts.

The sandstone occurs in two broad, easily distinguishable categories – red sandstone and blonde to buff sandstone.

In order to assign a stone type to each stone element recorded in the database, the four main categories of sedimentary stone were assigned the following codes: R (red sandstone), B (blonde to buff sandstone), F (flagstone) and P (conglomerate, for which the vernacular term is puddingstone). Walling or dressings consisting of a mixture of stone types (Dalradian rocks and/or igneous rocks and/or sedimentary rocks) were assigned to a 'mixed' [M] category. The 'M' category was used occasionally for walling or dressings consisting only of Dalradian rock (to avoid the need for an additional rarely used category).

The stone in three of these categories has been subdivided into two or more discrete 'types', each characterised by one or more distinctive features. Four types of red sandstone are recognised [R1 to R4], three types of blonde to buff sandstone [B1 to B3], and two types of flagstone [F1 and F2]. Some of the sandstone types are characterised by a restricted and distinctive set of features suggesting they have a common source (perhaps one quarry, or several closely spaced quarries exploiting the same geological formation). Some other sandstone types encompass stone with a range of features suggesting it comes from a number of sources (perhaps several quarries exploiting different geological formations and spread across a wide geographical area).

The eleven stone codes assigned to walling and dressings are listed in Table 1, with a brief description of their key characteristics.

A photograph showing the typical characteristics of each stone type is presented in Figure 5.

4.1.2 Distribution of stone types

A stone code (representing one of the stone types listed in Table 1) has been assigned to each *walling* and *dressings* element in every surveyed structure. The geographical distribution of the stone types represented in walling and dressings in the Callander Conservation Area is illustrated in figures 6 and 7, respectively. Note that in many buildings the stone type was recorded as 'unknown'; this was usually because of restricted visibility (e.g. due to harling), but in rare cases it was because the stone type could not be identified unambiguously. The following points summarise some of the more obvious features revealed by the maps and illustrate the utility of the GIS approach.

Walling (Figure 6)

- Conglomerate [P] is by far the most commonly used walling stone type and occurs in buildings predominantly to the east of the Dreadnought Hotel.
- Flagstone [F1 and F2] is the most common walling stone type in the Leny Feus area.
- Blonde to buff sandstone [B1, B2 and B3] is typically used in the walling of relatively large buildings in all parts of the CCA; B1 sandstone is the most commonly used.
- Red sandstone [R1-R4] has been used less commonly in walling than blonde to buff sandstone, and its use has been restricted almost exclusively to buildings along and near to Main Street.

Dressings (Figure 7)

- Conglomerate [P] has been used for dressings in only a handful of buildings; in every case the walling also consists of conglomerate.
- F2 flagstone has been used for dressings in buildings along or near to Main Street.
- The survey identified no occurrences of F1 flagstone dressings; however, the possibility that some F1 dressings exist but have been concealed beneath mortar and paint cannot be excluded.
- Blonde to buff sandstone [B1, B2, B3] is by far the most commonly used stone type in dressings, and B1 sandstone is by far the most commonly used of the three types; blonde to buff sandstone has been used as dressings in all parts of the CCA.
- Red sandstone [R1-R4] has rarely been used as dressings, almost exclusively in buildings along Main Street; commonly it has been used as dressings in the same buildings in which it is used as walling.
- The stone type for many dressings has been recorded as 'unknown' because they have been concealed beneath mortar or paint. However, the evidence indicates that such coatings have commonly been applied to F2 flagstone, probably due to its propensity to suffer significant decay (see Table 1 and Appendix 2).

More details of stone type distribution within the CCA are presented in Section 5.

4.1.3 Stone condition

General observations regarding the current condition of the various stone types are presented in Table 1. Some guidance for conservation and repair of stone buildings is presented in Appendix 2. Some of the more notable observations are listed below.

- Conglomerate, which is by far the most commonly used walling material, is generally in good condition.
- Flagstone [F1 and F2], which is an important component of walling in Leny Feus and of dressings throughout the CCA, is prone to splitting along bedding (see Appendix 1), especially where it has been placed face-bedded (i.e. with the flaggy bedding surfaces orientated vertically and parallel to ['facing'] the facade, rather than horizontally).

- Of the four types of red sandstone, R1 and some R2 stone is generally in good condition, whereas R3, R4 and some R2 stone is commonly in poor condition, being susceptible to water penetration and granular disintegration.
- The three types of blonde to buff sandstone are generally in good condition but can be prone to scaling and granular disintegration.

4.1.4 Sources of stone

Table 1 includes details of the inferred source (mainly quarries) of the various types of stone used in Callander buildings. The sources have been identified using BGS expert knowledge of UK building stones, and information gathered from historical records, visits to local quarries and the BGS Collection of UK Building Stones.

Mixed stone [M] would certainly have been collected locally, from fields and river beds. The conglomerate [P] and both types of flagstone [F1, F2] were sourced from local quarries, on the north side of Callander. Most of the red sandstone [R1, R2, R4] and all the blonde to buff sandstone [B1, B2, B3] has been imported from outside the Callander area. All of the red sandstone is Scottish; most of it almost certainly comes from quarries in Dumfries and Galloway (stone of Permo-Triassic age), but a proportion probably comes from elsewhere, possibly including quarries near Kippen (stone of Carboniferous age). The blonde to buff sandstone comes from Carboniferous age strata, but whereas B1 and B3 are believed to come from quarries in the Central Belt of Scotland, B2 is from quarries in northern England.

More details of the past and possible future sources of local Callander stones are presented in Section 6.

4.2 ROOFING SLATE

Roofing slate from a range of sources has been used on building roofs in the Callander Conservation Area. Unlike stone, slate from each source can generally be distinguished (when visibility is good) by a set of features that include colour, lustre, surface texture, shape and size. Different ‘types’ of slate were therefore named on the basis of their provenance (source) and assigned a code prior to the survey. Roofing slate in the CCA is generally in good condition, and slate condition is not discussed further here. Some guidance for the conservation and repair of roofing slate is presented in Appendix 2.

4.2.1 Slate types

Eight types of slate were distinguished and assigned a code (Table 2). Two are from Scotland, two are from Wales, one is from England and one from Spain. Two other slate ‘types’ - ‘undifferentiated Scottish slate’ and ‘slate of mixed provenance’ - have been identified to allow all records of slate type to be coded accurately. Table 2 includes a description of each slate type and its man-made characteristics.

A photograph showing the typical characteristics of each slate type is presented in Figure 8.

4.2.2 Distribution of slate types

A slate code (representing one of the slate types listed in Table 2) has been assigned to each *roofing* element in every surveyed building. The geographical distribution of the slate types in the Callander Conservation Area is illustrated in Figure 9. The following points summarise some of the more obvious features revealed by the map.

- Scottish slate and Welsh slate dominate, and have been used on approximately equal numbers of buildings.

- Scottish Highland Border slate (SHB) is the most commonly used Scottish roofing slate; it has been used most commonly on buildings along and near to Main Street.
- Scottish West Highland slate (SWH) is relatively rare, but has been used on buildings in most parts of the CCA.
- Welsh purple slate (WPP) is the most commonly used Welsh roofing slate and appears on buildings throughout the CCA.
- Welsh grey slate (WGP) is significantly less common than Welsh purple slate, but also appears on buildings throughout the CCA.
- English slate (ECB) and Spanish slate (FSP) have been used on approximately equal numbers of buildings, but are much less common than Scottish and Welsh slate.

Stone code	Stone type	Stone description	Source(s) of stone	Stone condition observations	Typical mode of use	Representative buildings
P	conglomerate	Purple to reddish-brown, dense and well indurated conglomerate, occasionally with intercalated purplish-red to reddish-brown beds of sandstone. The conglomerate is typically very pebble rich with a red sandstone matrix, but it displays considerable variation in character due to differences in clast grain-size (granule-, pebble- and cobble-grade), in the relative proportions of clast and matrix, and in the relative proportions of quartz and lithic clasts. The vernacular name for this conglomerate is *Callander Puddingstone* .	Almost certainly sourced mainly from the East Callander Puddingstone Quarry, with a smaller proportion from the Central Callander Puddingstone Quarry.	Prone to minor scaling and occasional loss of pebbles, but generally in good condition.	Rubble, random and squared.	121 Main Street; walling 14 Ancaster Square; walling 49 Main Street; walling
F1	flagstone	Purplish-red, mica-rich, fine sandstone and siltstone with a finely laminated, flaggy character. Similar in character to the more strongly laminated examples of R3 stone.	Almost certainly from the Leny Feus Flagstone Quarry in Callander (Ruchill Flagstone Formation).	Prone to splitting along bedding (delamination), especially when placed face-bedded ('on cant').	Rubble	Carrigart Villa, Leny Road; walling
F2	flagstone	Greyish-brown, mica-rich, fine sandstone and siltstone with a finely laminated, flaggy character. The flaggy character is generally less well developed than in the F1 (purplish-red) flagstone.	Almost certainly from the Leny Feus Flagstone Quarry in Callander (Ruchill Flagstone Formation).	Prone to splitting along bedding (delamination), especially when placed face-bedded ('on cant'); many dressings that have been covered in mortar (and are therefore concealed from view) may consist of this stone, especially where it has been placed face-bedded and has suffered decay.	Mainly dressings in the oldest buildings. Also used as rubble in many mansion houses in Leny Feus.	4 Bridge Street; dressings 17 Main Street; dressings
R1	sandstone	Orangeish-red to dull red sandstone, occasionally with a purplish tinge. Typically fine- to medium-grained. Occasionally uniform but more usually with planar bedding or large scale cross bedding. Texturally uniform blocks are typically finer grained than bedded blocks.	Almost certainly from quarries exploiting the Permo-Triassic basins of southwest Scotland. The most likely candidates are Ballochmyle and other quarries at Mauchline in Ayrshire, Locharbriggs, Newton/Gatelawbridge, Knowehead, and Corsehill quarries in Dumfries & Galloway.	Generally in good condition.	Walling and dressings.	100-102 Main Street; walling & dressings 95-97 Main Street; dressings
R2	sandstone	Vivid orange-red or brick-red sandstone, sometimes with a purplish tinge. Typically fine- to medium-grained and mostly with a uniform texture, but stone assigned to this category displays a range of characteristics and is not defined unambiguously by a set of features. A carbonate mineral cement is a feature of R2 stone in some buildings.	Probably from quarries such as Bloodymires, Bloodymoss and others in the Kippen area, south of Callander, which exploited the Kinneswood Formation and Stockiemuir Sandstone Formation.	In good condition in some buildings, in poor condition in others (probably reflecting a combination of varying stone character and quality of maintenance).	Walling and dressings.	1 Cross Street ('Desirables' building); walling & dressings Ancaster Square (Pringle Weavers); 4-6 Cross Street; rubble & dressings
R3	sandstone	Purplish-pink sandstone, generally fine- to medium-grained and typically strongly laminated but not to the extent that it is flaggy. This stone has similarities to the F1 type, but lacks a true flaggy character.	Probably sourced locally, from sandstone beds in the Central Callander Puddingstone Quarry and/or East Callander Puddingstone Quarry.	The stone is commonly in poor condition (very friable) due mainly to water penetration, which has caused scaling, granular disintegration and salt efflorescence (the latter related to ingress of de-icing salt); condition is particularly poor in face-bedded blocks.	Always as rubble walling. Mostly placed in correct (horizontal) bedding orientation, but occasionally placed face bedded to increase the vertical dimension of blocks.	101 Main Street (Crags Hotel); rubble walling 8 Main Street ('Mohr Bread'); rubble walling 8-10 Leny Road ('Riverside Inn'); rubble walling
R4	sandstone	Greyish-pink to purplish-pink sandstone. Generally medium- to coarse-grained, but characterised by a rough, gritty character. Ranges from uniform to cross bedded.	Not obvious. Possibly from quarries exploiting the Stockiemuir Sandstone Formation and/or the Kinnesswood Formation.	Prone to water penetration and granular disintegration.	Walling and dressings.	7-9 North Church Street ('Nature's Corner'); rubble 10 South Church Street; walling & dressings

Table 1 Details of stone types used in Callander buildings.

Stone code	Stone type	Stone description	Source(s) of stone	Stone condition observations	Typical mode of use	Representative buildings
B1	sandstone	Off-white to buff, fine- to medium-grained, generally uniform sandstone.	Probably from various quarries exploiting Carboniferous age sandstone in the Central Belt. Some examples are similar to Glasgow 'blonde' and buff sandstones (such as Giffnock and Bishopbriggs).	Prone to scaling and granular disintegration along base courses where de-icing salt has entered the stone, but otherwise generally in good condition; whiter examples of the stone commonly weather to ochre or orangeish-buff on exposed surfaces.	Rubble and ashlar.	131 Main Street; walling and dressings
						4 Leny Feus ('Inverleny House'); walling & dressings
						2 Leny Road (wings of Dreadnought Hotel); walling & dressings
						Ancaster Square North (Rob Roy Centre); walling & dressings
B2	sandstone	Buff, fine- to coarse-grained sandstone, generally uniform in terms of both colour and texture.	Almost certainly from quarries exploiting Carboniferous age sandstones in northern England, such as Darney, Stanton Moor, Peakmoor, Blaxter, Dunhouse Buff and Black Pasture.	Generally in good condition.	Ashlar and dressings.	5 Main Street ('Old Bank'); repairs to walling
B3	sandstone	Light grey to light greyish-buff, medium- to coarse- (and occasionally very coarse-) grained sandstone, commonly with large, visible quartz grains that give it a gritty character. Uniform to cross bedded.	Not obvious but perhaps from quarries in the Stirling and/or Falkirk areas, and possibly other parts of the Central Belt.	Condition varies from good to poor, probably reflecting a range of factors including the effect of salt used for de-icing and the degree to which a mineral cement is present.	Used mainly in dressings (quoins and in window and door surrounds). Rarely, entire facades (walling and dressings) have been built using this stone.	151 Main Street ('Gartlands'); dressings
						8 Main Street ('Mohr Bread'); dressings
						101 Main Street (Crags Hotel); dressings
						87 Main Street ('Highland Arts'); walling
M	mixed	Various lithologies including conglomerate (*puddingstone*), siltstone (*flagstone,* mostly of the red [F1] type), dolerite and other basic intrusive igneous rocks (*whin*), metavolcanic rocks (*greenstone*), metasandstone/quartzite, schist and gneiss.	Virtually all examples were probably sourced locally as loose cobbles and boulders in fields and river beds. Blocks of metamorphic stone have been used as lintels and quoins in a small number of properties (and in one case an entire house has been built of such material), and these may have been quarried.	Generally in good condition.	Rubble	4 Bridge Street ('Craigroyston')
						6 Bridge Street ('St. Kessog House')
						3 Ancaster Square

Table 1 (continued) Details of stone types used in Callander buildings.

See Section 6 for more details of the local Callander quarries mentioned in the 'Source(s) of stone' column.
See Appendix 1 for definitions of some of the terms used in the 'Stone condition observations' column.

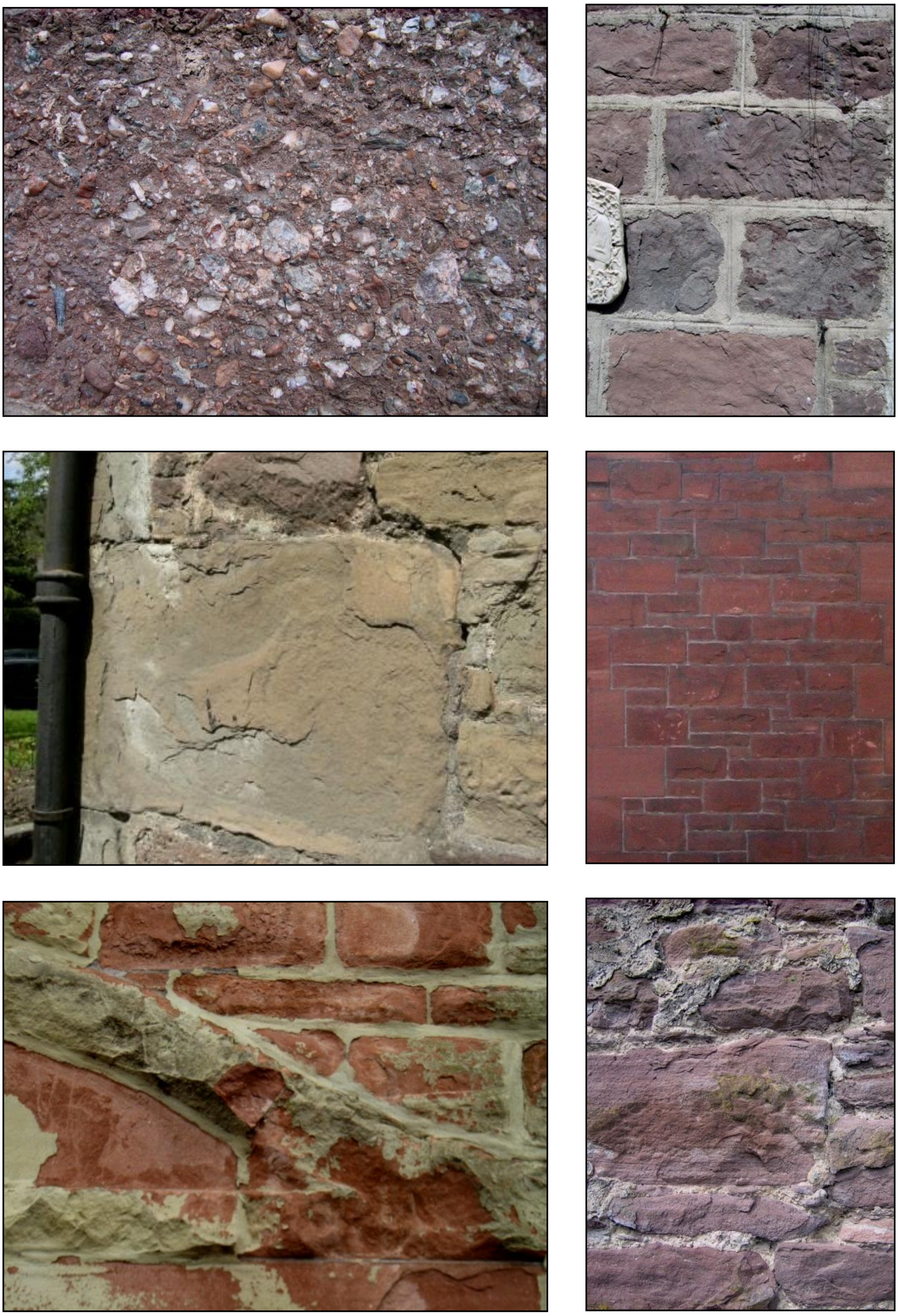


Figure 5 Typical examples of the stone types described in Table 1

Top left: conglomerate [P]; top right: F1 flagstone
Middle left: F2 flagstone; middle right: R1 sandstone
Bottom left: R2 sandstone; bottom right: R3 sandstone

Figure 5 (continued) Typical examples of the stone types described in Table 1

Top left: R4 sandstone; top right: B1 sandstone
Middle left: B2 sandstone (paler stone indents on window surrounds); middle right: B3 sandstone
Bottom: mixed stone [M]

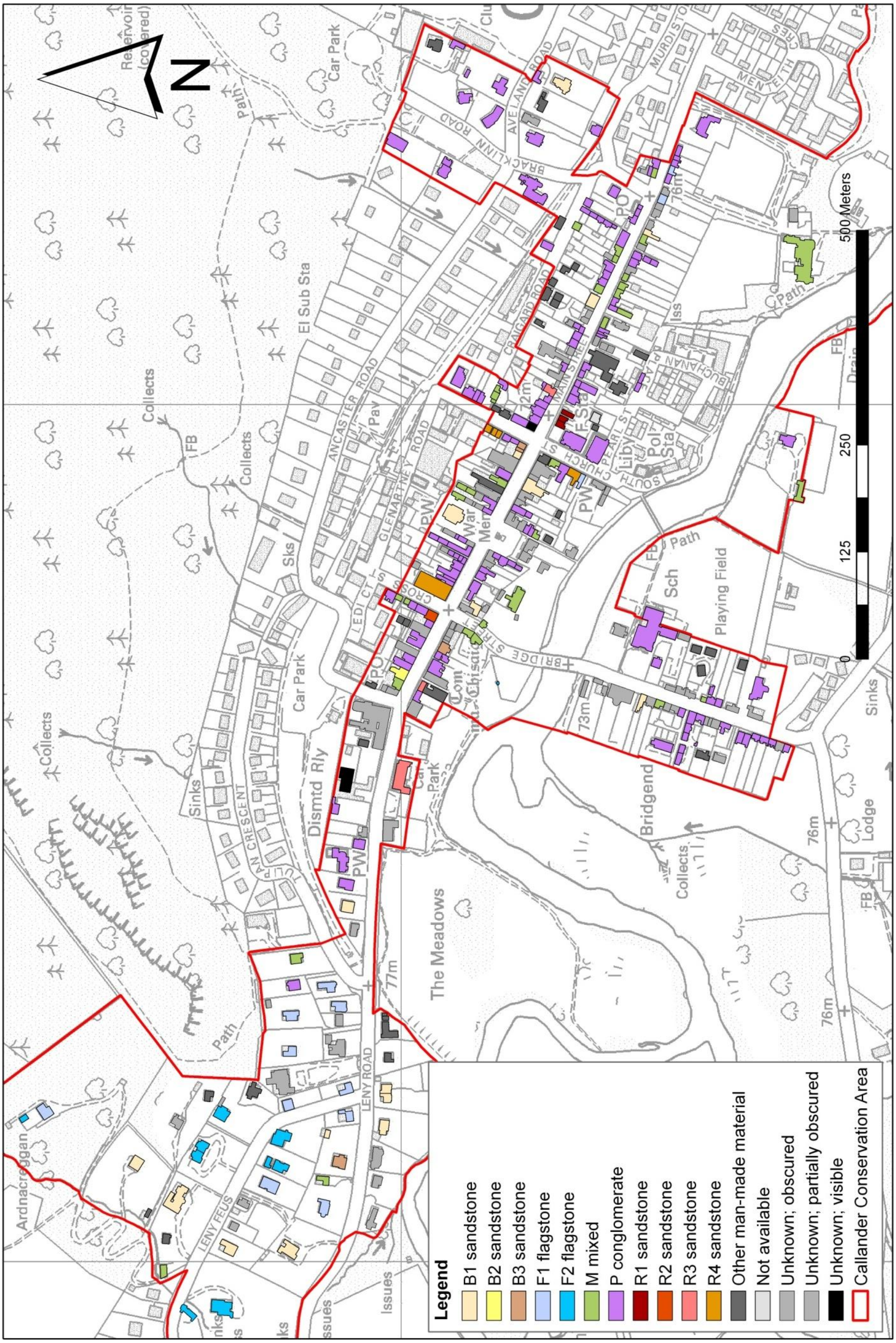


Figure 6 The distribution of stone types used in WALLING in the Callander Conservation Area.

See Table 1 for more details of the stone types listed in the Legend.

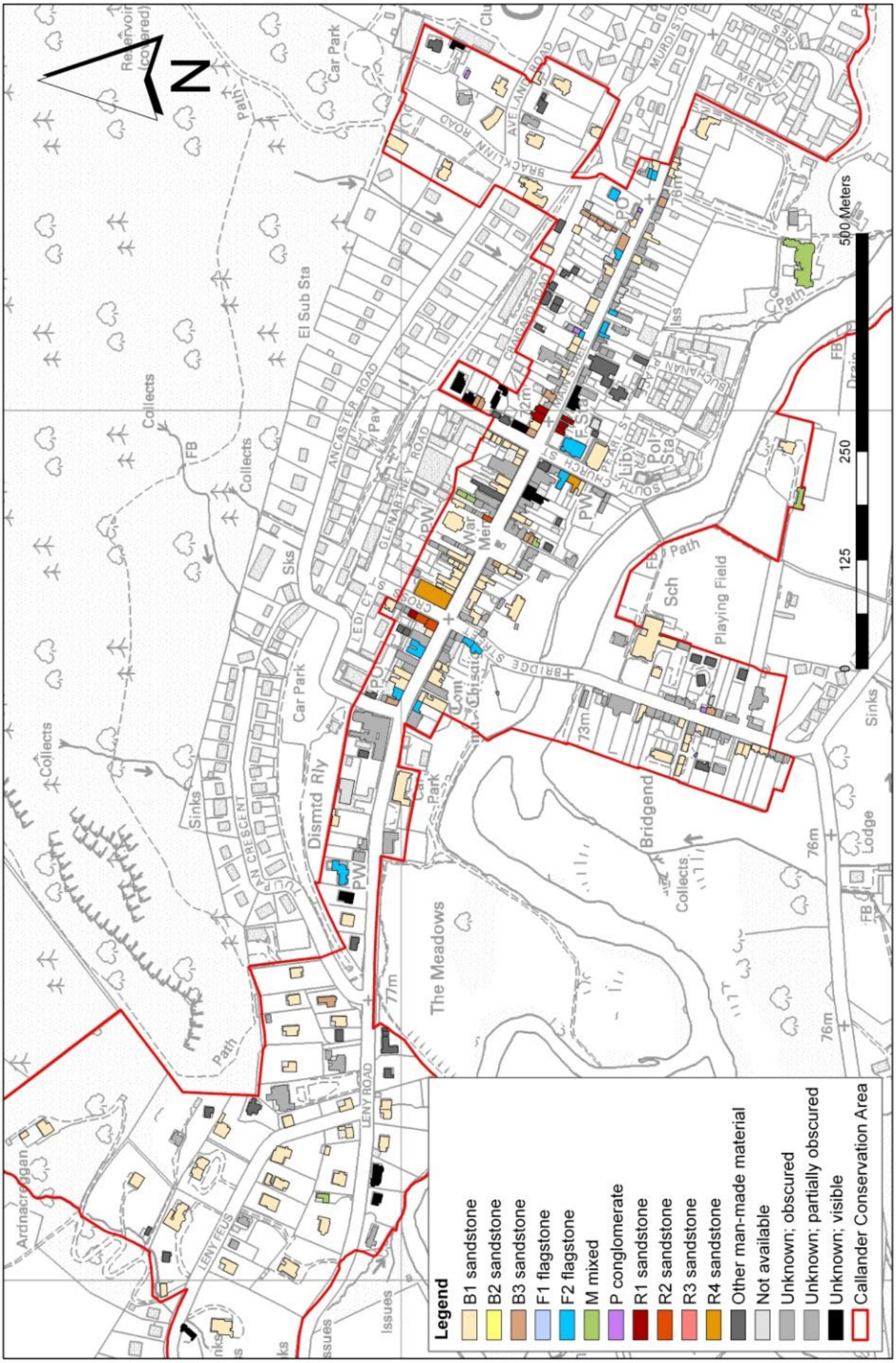


Figure 7 The distribution of stone types used in DRESSINGS in the Callander Conservation Area.

See Table 1 for more details of the stone types listed in the Legend.

Slate code	Slate type	Slate description	Typical man-made characteristics
SHB	Scottish Highland Border slate	Grey, purplish grey and greenish grey, occasionally variegated, with a characteristic lustre and moderately smooth surfaces. Often contains ribboning (banding on the slate surface which usually results from the intersection of sedimentary bedding with the metamorphic cleavage plane on which the stone has parted). Can weather to whitish colours ('bleached').	Prepared in a range of sizes and moderately thick. Reclaimed slates tend to be relatively small because they are redressed. Shouldered and with one hole. Always laid in diminishing courses and random widths. All three colour variants commonly appear on single roofs. Occasionally, just one colour of slate is used, but either way the overall effect is greyish, sometimes with a slight variation depending on the extent of soot and biogenic growth.
SWH	Scottish West Highland slate	Black to grey slate with rough, variably crenulated surfaces and commonly with scattered cubes of pyrite. Slate from the Easdale quarries is typically more strongly crenulated than slate from the Ballachullish quarries.	Larger than Scottish Highland Border slates, and relatively thick. Shouldered, with one hole. Laid in diminishing courses and random widths.
SUD	Undifferentiated Scottish slate	Slate which is laid in the typical Scottish style (and is therefore likely to be of Scottish origin), but for which there is insufficient information (due to poor visibility or lack of diagnostic characteristics) to assign them unambiguously to a particular Scottish source.	Moderately thick to thick. Shouldered, with one hole. Laid in diminishing courses and random widths.
WGP	Welsh grey slate	Grey, uniform slate typically with smooth, matt surfaces.	Relatively thin, with smooth edges and right angled corners, often supplied in one standard size and commonly with two holes.
WPP	Welsh purple slate	Purple, uniform slate typically with smooth, matt surfaces.	Relatively thin, with smooth edges and right angled corners, often supplied in one standard size and commonly with two holes.
ECB	English Cumbrian Burlington slate	Bluish grey to greenish grey slate with typically rough, matt surfaces. The distinctive colour and texture of the slate reflects the volcanic origin of the original sedimentary material.	Moderately thick and with right-angled corners. Currently available in a range of sizes. The slates have uniform width but tend to be laid in diminishing courses.
FSP	Spanish slate	Black to blue-black and dark grey slate, commonly with a slight 'oily' lustre, particularly when new. Scattered crystals of pyrite are common. Surfaces can be crenulated, but not as much as Scottish West Highland slate.	Uniform size, thin to moderately thick, and with right-angled corners.
MIX	Slate of mixed provenance	Slate of mixed character, from a range of sources.	Variable.

Table 2 Details of slate types used in Callander buildings.

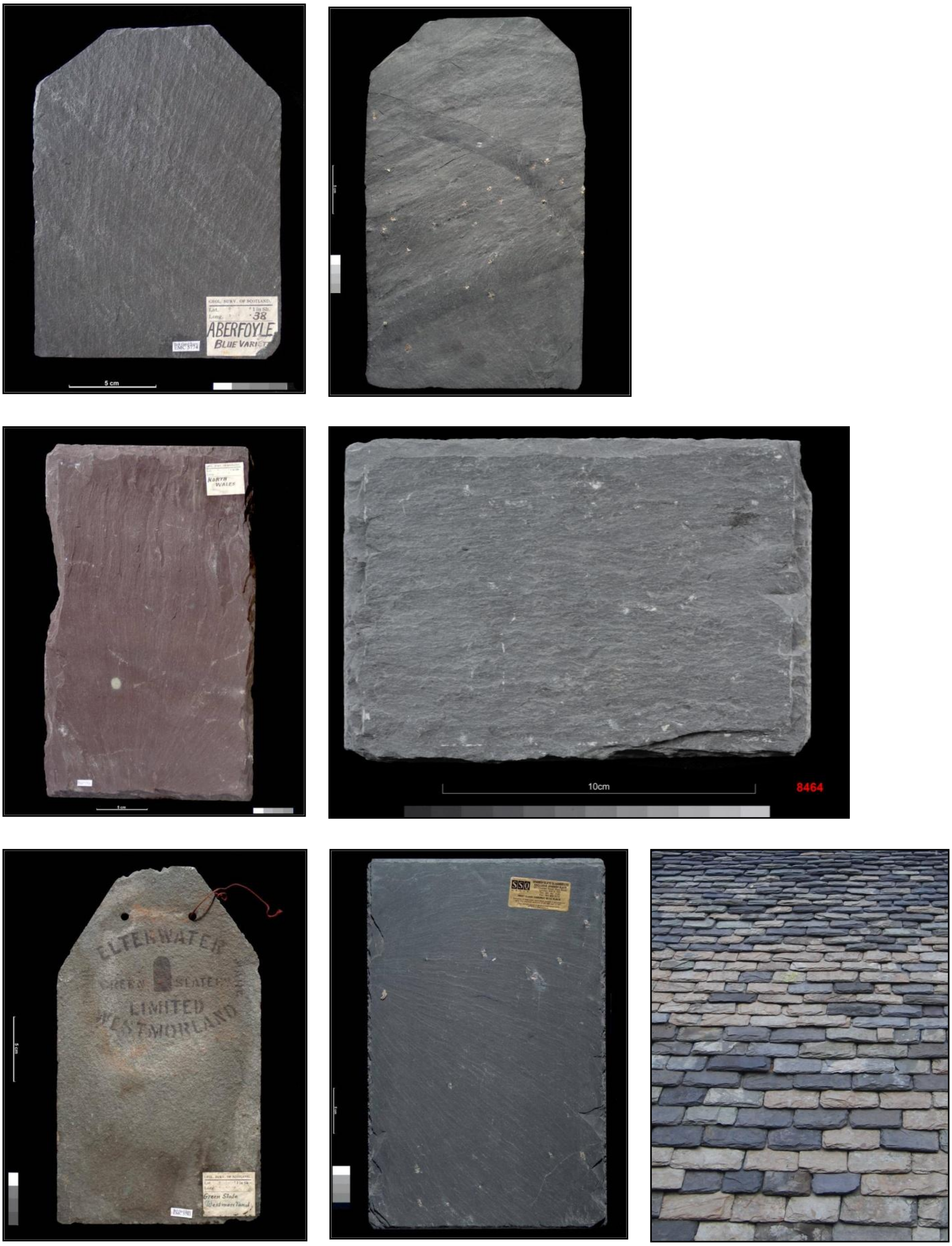


Figure 8 Typical examples of the slate types described in Table 2.

Top left: Scottish Highland Border slate [SHB]; top right: Scottish West Highland slate [SWH]
Middle left: Welsh purple slate [WPP]; middle right: Welsh grey slate [WGP]
Bottom left: English Cumbrian slate [ECB]; bottom middle: Spanish slate [FSP]; bottom right: a mixed provenance [MIX] slate roof in the CCA.

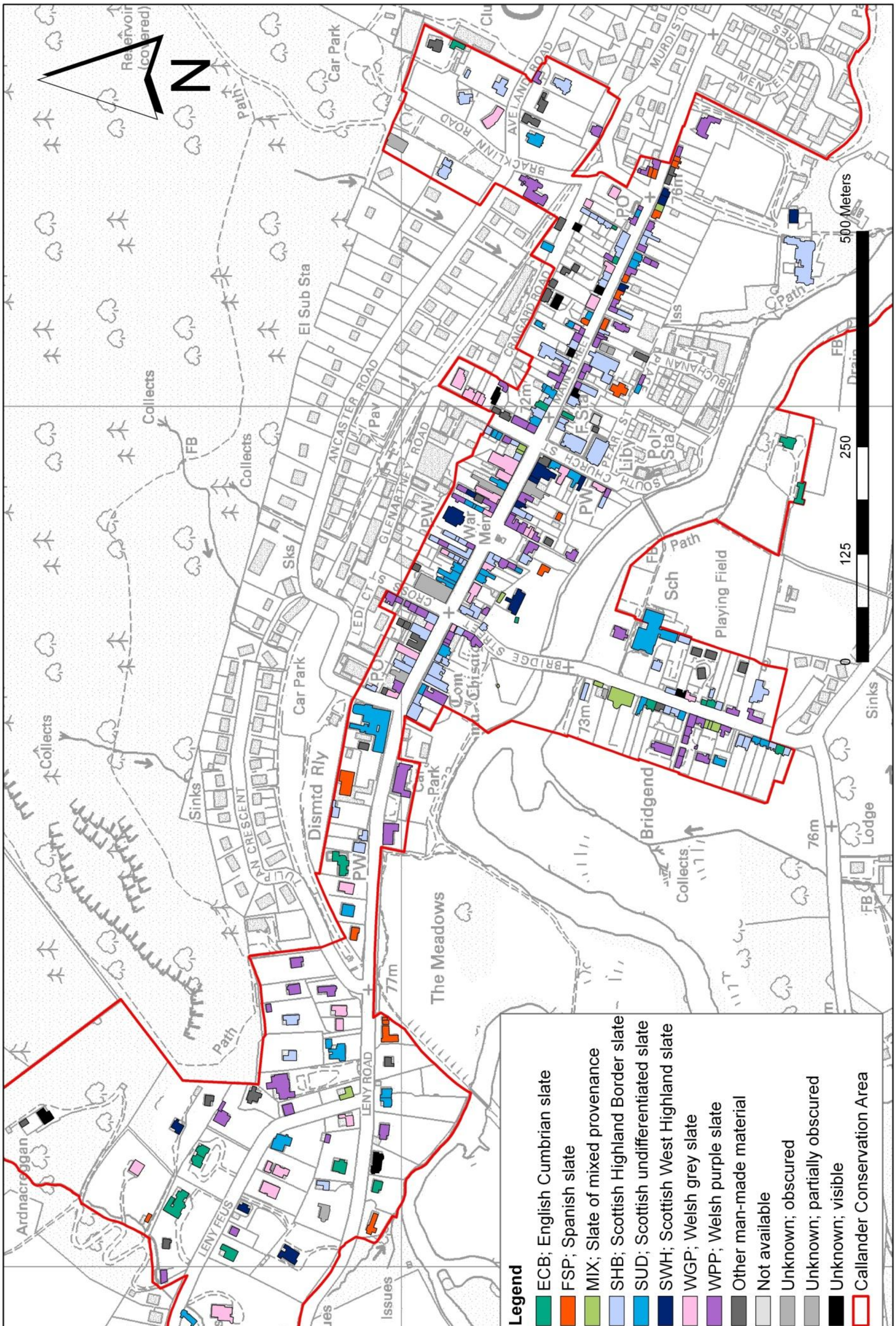


Figure 9 The distribution of slate types used in ROOFING in the Callander Conservation Area.

See Table 2 for more details of the slate types listed in the Legend.

5 Masonry and roofing styles in the Callander Conservation Area

5.1 INTRODUCTION

'Masonry style' refers to the combination of stone type, block size/shape/tooling and coursing used in the main architectural elements (walling and dressings) of a building. 'Roofing style' refers to the combination of slate type, size and laying pattern used on building roofs.

Block shape, which refers to the shape of individual stone blocks, ranges from 'rubble' (variable shape and size, not squared), through 'squared rubble' (variable shape and size, roughly squared) to 'ashlar' (regular shape and size, squared and rectilinear). Tooling, which refers to how the block was finished, ranges from non-tooled (i.e. 'rough natural') to highly skilled finishes (e.g. smooth, droved). Coursing denotes how the building stone is laid to form a wall. This is dependent to a large degree on block shape; for example, rubble is typically left 'uncoursed', squared rubble is typically 'irregularly coursed', and ashlar is always 'coursed' (laid on a regular horizontal bed).

In any settlement, the masonry style and roofing style typically evolve over time due mainly to changes in available materials, architectural fashion, and levels of craftsmanship.

5.2 MASONRY STYLES

Four masonry styles are recognised in Callander, each characterised mainly by a particular combination of stone types used in walling and dressings. Each is described below with a selection of typical examples.

5.2.1 Masonry Style 1

Description

In Callander, as in many other parts of Scotland, the earliest buildings are constructed from locally sourced stone and therefore closely reflect aspects of the local geology. Buildings of Masonry Style 1 are long, low structures with walling and dressings composed of mixed stone [M] rubble sourced from fields and river beds. The rubble walling comprises cobbles and boulders of local conglomerate (*puddingstone*) and siltstone (*flagstone*, mostly of the red [F1] type), dolerite and other basic intrusive igneous rocks (*whin*), metavolcanic rocks (*greenstone*) metasandstone, schist and gneiss.

The buildings are located in the oldest parts of the town, notably in Bridgend and Ancaster Square. They are generally very simple constructions of mixed rubble [M] walling and dressings formed of variably shaped blocks, with relatively small fenestration and little architectural detailing. Dressings are often large spans of stone, some of which retain the original extraction tooling marks. Large boulder footings were characteristically used along the base course of the buildings. This feature, which is common in early buildings, was designed to provide protection against rising damp and to provide a strong foundation. Large blocks of stone were often used in combination with small flaggy pieces of stone. For this reason, uncoursed or irregularly coursed rubble with rough natural finishes is characteristic of this masonry style.

Example buildings (most of the buildings described below are shown in Figure 10)

Construction of Ancaster Square began in the late 18th century, with single storey buildings. Some of these remain in an almost unaltered state; for example, the rear feu plots of Ancaster

Square North (4A and 8A; C(s) listed) maintain original mixed rubble walling and dressings of very large spans of stone, some of which still retain extraction tooling marks.

25 Ancaster Square South, also known as Creel Cottage, further illustrates the early architecture of Ancaster Square. The walling and dressings of this building are slightly more typical of the Callander mixed [M] rubble, in that there is a high concentration of blocks of the local conglomerate [P] and flagstone [F1].

The earliest surviving buildings in Callander are on the south side of River Teith, in Bridgend, where fragments of 17th century buildings still exist. Bridgend House Hotel (C(s) listed) and Teithside Cottage (C(s) listed) (17th and 18th century builds respectively) are examples of this early architecture. The masonry in these buildings is currently concealed by harling, paint or timber cladding, but it is likely to be similar to the Ancaster Square examples described above. The relatively small windows and close spacing of bays is indicative of early construction. The listed building description for Bridgend House Hotel indicates that the original building was a row of single storey cottages that were raised in the 19th century.

The buildings along Bridge Street, built during the mid- to late- 18th century, also display mixed rubble [M] walling. The building at 4 Bridge Street (C(s) listed), on the north side of River Teith, is unlike any other in Callander, being constructed mainly from round river boulders of varying size and shape, often split in half. It is also unusual in having relatively sophisticated dressings and being two storeys high—this building may represent a transition between two masonry styles.

5.2.2 Masonry Style 2

Description

This masonry style is characterised by the first use of local grey-brown flagstone [F2] dressings in combination with mixed rubble [M] walling, and by the appearance and eventual dominance of walling consisting entirely of conglomerate [P]. It is a feature of late 18th to mid- 19th century buildings. These changes may partly reflect a reduction of the mixed stone resource, and partly the need for reliable, sustainable local stone resources as town development became more organised. Local quarries would have opened to provide the building stone needed for new construction (see Section 6 for a description of the local quarries).

The markedly heterogeneous texture of the conglomerate makes it very difficult to work, and in the earliest examples conglomerate walling consists of uncoursed random rubble with a rough natural finish. The F2 flagstone dressings were commonly stugged or droved.

This masonry style occurs throughout the Callander Conservation Area, most commonly in Ancaster Square and along Main Street. The buildings were constructed as part of a major development undertaken by the Commissioners for Forfeited Estates, who administered the lands forfeited by landlords that supported the 1745 Jacobite rebellion (Scran website). The plans for Callander at this time were very much the same as visualised in the 1739 drawings prepared for James Drummond, the 17th Earl, 4th Duke of Perth. A total of twenty-nine feus were planned in the 1739 drawings: one block of feus to the east and two blocks to the west of Main Street, and the remainder centred on Ancaster Square. Thirty-seven additional feus were granted by the Commissioners for Forfeited Estates; these extended further east along Main Street.

The buildings are generally very simple constructions, similar architecturally to those of Masonry Style 1. They are attached builds with gable end chimneys and widely spaced windows flanking a central door; however, unlike Masonry Style 1, most of the buildings have two storeys (though in some cases the second storey is a later addition). The walling is typically irregularly coursed, random rubble conglomerate with a rough natural finish. Commonly, the rubble walling is 'lined out' to imitate ashlar masonry. The dressings are of local grey-brown flagstone [F2], commonly stugged.

Example buildings (most of the buildings described below are shown in Figure 11)

In Ancaster Square, the earliest known building (1 Ancaster Square North) maintains a 1773 marriage lintel. This building is painted and the stone walling and dressings are obscured; however, 3 Ancaster Square North remains unpainted and was probably built at the same time. This building was originally a single storey construction that was later raised, as indicated by the larger block sizes of the upper level (visible in Figure 11). This is possibly one of the earliest examples of a mixed [M] rubble construction with grey-brown flagstone [F2] dressings. The F2 dressings may have been installed when the additional storey was added.

Buildings along Bridge Street illustrate the early masonry styles of Callander. 4 Bridge Street (Masonry Style 1) has been described previously. The dominance of conglomerate in the mixed [M] rubble walling suggests 6 Bridge Street (C(s) listed) is a slightly later (late 18th century) construction. The walling used in this construction contains much larger blocks than those described above in 3 Ancaster Square. Although it is lined out to give the impression of ashlar blocks, the walling remains very roughly coursed. The dressings are obscured by mortar and paint, but are likely to be F2 flagstone.

169 Main Street is an early example of roughly coursed and roughly squared mixed [M] rubble walling. The base course of the building is flaggy random rubble. The predominant stone type is the local conglomerate and the dressings are of mortared and painted local grey-brown flagstone [F2]. The dressings are slightly more formalised, with roughly squared quoins (or cornerstones) and window and door surrounds laid in an alternate pattern. This is likely to be a late 18th century construction.

125 Main Street (late 18th century) is one of the first buildings in which the walling consists entirely of conglomerate [P]. The building is constructed from small, roughly squared, roughly coursed blocks with a rough natural finish, and dressings of squared grey-brown flagstone [F2]. Quoins and window and door surrounds are laid in clear alternate patterns.

Other examples of the mixed [M] rubble walling and early conglomerate [P] walling, both with F2 dressings, occur further east along Main Street. These are late 18th / early 19th century constructions, some of which may be associated with the Roman Camp.

By the early 19th century the use of conglomerate had become even more refined, as illustrated by the C(s) listed buildings at 15, 17 and 19 Main Street. The masonry walling is squared conglomerate block with a rough natural finish, evenly coursed and cut for arched entrances and shopfront windows. The dressings are grey-brown flagstone [F2] laid in clear alternate patterns.

Conglomerate was used for the walling of two impressive ecclesiastical buildings in the mid 19th century. The Callander Kirk Hall (c.1849) is constructed from evenly coursed, squared block conglomerate walling with a rough natural finish. St. Andrew’s Church, Leny Road (c.1857) (B listed), is constructed from uncoursed, perfectly jointed, shaped blocks. Both buildings have grey-brown flagstone [F2] dressings.

The squared and snecked conglomerate walling of 6A Main Street, in which the original droved tooling of the grey-brown flagstone [F2] dressings still survives, provides another example of this masonry style.

5.2.3 Masonry Style 3

Description

This masonry style is characterised by walling of local Callander stone (conglomerate [P] and flagstone [F1]) and dressings of imported Scottish sandstone. The appearance of imported sandstone dressings coincides with the opening of the Dunblane, Doune and Callander Railway in 1858, which stimulated a rapid expansion of the town and a rise in tourism. Large, regular-sized blocks of buff sandstone [B1, B3] and red sandstone [R1, R2] began to replace the dressings of locally sourced grey-brown flagstone [F2]. The sandstone dressings were commonly droved, high quality ashlar blocks. Compared to the F2 flagstone, the imported sandstone would have been attractive because it was available in larger blocks (making it more suitable for dressings), and easy to carve.

Corner sites were redeveloped and new residences and shops were constructed along Main Street. For these buildings, the typical masonry style consists of ‘formalised’ (squared and coursed) conglomerate [P] rubble walling with a rough natural finish and imported sandstone dressings. The rear elevations and gable ends retain the random rubble conglomerate walling.

Villas were constructed by the wealthy for summer homes and, in some cases, as permanent residences away from the city. A new development of villas expanded rapidly at Leny Feus. For these buildings, the typical masonry style is purplish-red flagstone [F1] walling and imported Scottish sandstone dressings. The use of F1 flagstone walling is a characteristic feature of the Leny Feus area, reflecting the fact that the development is adjacent to the Leny Feus Flagstone Quarry (see Section 6); it is the only part of the CCA in which F1 flagstone is the dominant stone type.

In Leny Feus buildings the walling typically consists of variable sized tabular blocks, commonly squared and roughly coursed with riven, smooth, or rock-faced tooling. The sandstone dressings are droved ashlar blocks.

Masonry Style 3 is most common in buildings constructed in the period following the arrival of the railway (mid to late 19th century), but it continued to be used until the early 20th century. It is the most common masonry style in the Callander Conservation Area, and occurs in all parts of it.

Example buildings (most of the buildings described below are shown in Figure 12)

St. Bride’s Church, South Church Street was built in 1840 with alterations made in 1861, shortly after the railway opened in Callander. The dressings are B1 sandstone, ornately carved in a distinctive vermiculated style. The south facing elevation is part of the original 1840 structure and retains its earlier construction style of roughly coursed conglomerate. This elevation was originally hidden (not meant to be seen) behind old buildings developed on a row of feus; the buildings were demolished in the 20th century. The much altered front facade with Italianate bell tower is constructed from squared and coursed conglomerate [P]. The Royal Bank of Scotland building at 55A Main Street presents another example of high quality conglomerate [P] masonry walling with imported buff sandstone [B1] dressings. Both of these significant public buildings have conglomerate as the walling material, despite being built at a time when imported sandstone was available.

Examples of early post-rail residential buildings with imported buff sandstone [B1] dressings include: St. Kessog’s, Manse Lane (1868); 188-190 Main Street; and 11 Bridgend (Robertson House; mid 19th century; C(s) listed). St. Kessog’s and 188-190 Main Street have roughly squared, irregularly coursed conglomerate with B1 dressings, while 11 Bridgend has squared and coursed conglomerate, with B1 dressings. The contrasting styles of conglomerate walling may reflect differences in the skill of the mason or the wealth of the patron.

Dressings of imported [B3] buff sandstone were first used in slightly older, possibly pre-rail, buildings than those described above for other buildings constructed using Masonry Style 3. This stone type was imported from the late 18th century (presumably by cart) and throughout the 19th century. Examples of the earliest use of B3 dressings are found in Ancaster Square. The conglomerate walling of 14 and 21-23 Ancaster Square South indicates a late 18th (possibly early 19th) century construction. The building is lined-out to give the impression of ashlar block, but close inspection shows the walling to be the roughly coursed random rubble typical of earlier Callander buildings. Increasing wealth from the successful manufacture and trade of agricultural goods in Callander through the 18th century may have allowed building materials to be transported by cart from nearby towns and cities, such as Stirling.

Most of the buildings in Leny Feus were constructed in the mid to late 19th century. 1 Tulipan Crescent presents a good example of this masonry style in Leny Feus. This building exemplifies the typical use of F1 flagstone walling, with coursed, tabular blocks and rock-faced tooling. The dressings are smooth ashlar blocks of B1 sandstone.

Dressings of B1 and B3 sandstone dominate in buildings constructed in the post-rail period, however R1 and less commonly R2 sandstone was also used for dressings. 95 Main Street and 5 Cross Street present examples of the typical R1 smooth ashlar dressings found in Callander. 3 Cross Street is an example of the R2 smooth ashlar dressings. Squared and often irregularly coursed conglomerate walling was used with the imported red sandstone dressings.

Callander Primary School, in Bridgend (former McLaren High School; C(s) listed), was constructed in 1907 and is an example of Masonry Style 3 being used in a 20th century building. Squared and snecked conglomerate [P] was used on the front elevation, random rubble conglomerate on the side elevations, and B1 dressings (including quoins) were used on all elevations. The school demonstrates that the locally sourced conglomerate continued to be used in Callander buildings long after imported, more easily worked and popular building stones were available.

5.2.4 Masonry Style 4

Description

This masonry style is characterised by the use of imported sandstone for both walling and dressings. It first appears after the arrival of the Dunblane, Doune and Callander Railway in 1858 and was used in buildings until the First World War. Large, regular-sized, smooth ashlar blocks of regularly coursed B1, B2 and B3 sandstone and R2, R3 and R4 sandstone were used in the construction of many of the larger, more important Callander buildings of this period, such as banks, hotels and churches.

Many buildings displaying this masonry style are located on Main Street. In most cases, older buildings would have been demolished to redevelop corner sites at cross streets and other prominent locations.

Masonry Style 4 is also characterised by ornate carving and detailing. The relatively soft, homogeneous, imported sandstone allowed masons to produce a level of detail that was not possible with the hard, pebbly conglomerate. As a result (and in line with a widespread, general improvement in masonry skills), facades became more detailed with architectural elements such as string courses, cornicing, large bay windows, parapets and towers.

Example buildings (most of the buildings described below are shown in Figure 13)

The mid to late 19th century Kinnell House, at 24 Main Street (C(s) listed), is an early example of a building in which the walling and dressings consist entirely of the same imported sandstone. The 3-bay, 2-storey front elevation with wallhead dormers is constructed from smooth coursed ashlar B3 sandstone walling with elaborate ornamentation, large tripartite windows, pedimented door surrounds, and prominent corniced string coursing. The coursed sandstone with decorative moulded dressings is only present on the front elevation; the remaining elevations consist of rubble conglomerate with dressings of stugged B3 sandstone.

Two significant public buildings were constructed in 1883 in Callander, and both used imported sandstone for the walling and dressings: the Old Bank at 5 Main Street (former National Commerce Bank; C(s) listed), and the Rob Roy and The Trossachs Visitor Centre, Ancaster Square (former St. Kessog’s Church; B listed). The Old Bank is constructed from B2 sandstone walling (with possible repairs) and B1 sandstone dressings. The Visitor Centre is constructed from B1 sandstone walling and dressings. The building was constructed as an early Gothic church, with a tall steepled entrance, belfry with pointed tracery windows, and spire. The bank is detailed with a round arched door, large windows and decorative brackets supporting sills and string course.

2 Cross Street/35 Main Street (former Ancaster Arms Hotel; 1893) has a 4-storey Baronial corner tower and is constructed of smooth, coursed R4 sandstone. The 'Desirables' building, at 1 Cross Street/29-33 Main Street (late 19th century), has a bay window corner tower and original Victorian shopfront, and is constructed of irregularly coursed, squared R2 sandstone walling with rock-faced finish. Both buildings are examples of redeveloped corner sites.

The Crags Hotel, at 101 Main Street (late 19th century), was constructed using R3 sandstone walling and B1 sandstone dressings.

In the early 20th century, Red Bridge (1908) over River Teith was constructed entirely from red sandstone [R1].

5.2.5 Post World War One development

Following the First World War, the stone industry in Scotland went into rapid decline and most of the building stone quarries closed. Post-war development in Callander reflects these events, with 20th century buildings such as those along Pearl Street and Buchanan Place being constructed of manmade materials [OMM].

5.2.6 Other significant buildings

Description

Several significant Callander buildings display a range of features that don't fit the typical pattern of evolving masonry style in the town. The two examples described below are relatively early constructions. Their distinctive appearance makes an important contribution to the local character.

Example buildings (most of the buildings described below are shown in Figure 14)

The Roman Camp is a large low house that reputedly was built as the hunting lodge for the Drummond family when they first bought the Drummond Estate in the 17th century. The building is located close to River Teith and set within 20 acres of grounds. In 1896 the house underwent major alterations, and the main block currently consists of a gabled 2-storey, 5-bay house. Today, the building has predominantly rendered walls painted pink with some exposed string courses and sills of B3 sandstone. The original (now concealed) walling is likely to be mixed [M] random rubble, similar to Masonry Style 1 (Section 5.2.1).

In its original form, the Dreadnought Hotel (c.1802) was a three storey, eight bay attached corner build with a hexagonal-roofed turret at the easternmost corner. The east elevation is four bays with a cross roof. The majority of the building facade is painted; however, some of the walling and dressings are exposed, revealing the stone masonry to be buff [B1] sandstone. The date of construction is very early for this type of sandstone to be imported into Callander. However, it may have been transported by horse and carriage for such a significant building.

5.3 EVOLUTION OF ROOFING STYLE

The development of Callander is less easily traced through evolving roofing style than through evolving masonry style, as roofing materials are more likely to have been changed or replaced than walling.

The earliest buildings in Callander would have been thatched. In Scotland, thatch was the only roofing material available to most of the rural population, and in many towns and villages, until the 1800s. Several buildings in the Callander Conservation Area retain thackstanes—small stone projections at the base of chimneystacks used to hold thatch in place and prevent water leakage at the chimney wallhead. The rear feu plots of Ancaster Square North (4A and 8A) retain their original thackstanes along the base of the chimneys (Figure 15); these buildings currently have Welsh slate or corrugated iron roofing, both of which were common post-rail replacements of thatch roofs. There are no thatched roofs in Callander today.

The slate quarries at Aberfoyle are the closest source of roofing slate, and almost certainly supplied the earliest roofing slate used in the town. Scottish Highland Border slate [SHB] is found on early to mid 19th century (pre-rail) buildings throughout the Callander Conservation Area. However, slate production at the Aberfoyle quarries began before the 1750s (and continued until the mid 20th century), so roofs of Scottish Highland Border slate may have existed in Callander at an earlier date. Scottish Highland Border slates are typically relatively small and thick. They were traditionally produced in a variety of lengths and widths, and laid with the largest slates at the base of the roof and the smallest at the top ('diminishing courses'). This method was introduced for purely economic reasons, as it made best use of all the material produced. It also resulted in a distinctive roofscape character (Figure 15).

The arrival of the railways in the late 19th century probably introduced supplies of West Highland slate [SWH] and subsequently Welsh slate to the town. Some of the later 19th century and early 20th century buildings have Welsh slate roofing, although Scottish Highland Border slate and Scottish West Highland slate were still available and widely used at that time. The Callander Conservation Area contains one example of an early Welsh (purple) slate roof laid in diminishing courses (Figure 15). Welsh slate typically splits along more closely spaced cleavage surfaces than Scottish slate and therefore provides roofing slates that are lighter and of more uniform size. For this reason it is commonly perceived to be of a higher quality than typical Scottish slate. Repairs to roofs of Scottish slate have commonly been carried out using Welsh slate (both Penrhyn (purple) [WPP] and Porthmadog (grey) [WPG]) and, in some circumstances, English Cumbrian slate [ECB] and imported Spanish slate [FSP]. All of these non-Scottish slates were produced in uniform sizes, and their use in repairs to Scottish slate roofs has acted to diminish the traditional character. Some man-made roofing materials (concrete tiles, clay tiles etc) have been used in the conservation area, but they are mainly associated with 20th century developments.

Figure 10 Examples of Masonry Style 1.

Early mixed stone [M] rubble constructions built between the 17th and late 18th centuries. See Section 5.2.1 for more information regarding the masonry style and the illustrated structures.

Top left and right: 4A and 8A Ancaster Square North (rear feu plots), late 18th century. Early constructions contain very large spans of stone for dressings, some of which still retain extraction tooling marks.

Middle left: 25 Ancaster Square South, also known as 'Creel Cottage', late 18th century. Middle right: 4 Bridge Street (C(s) listed), mid to late 18th century.

Bottom left: Bridgend House Hotel (C(s) listed) with remnants of 17th century foundations. Bottom right: Teithside Cottage (C(s) listed), 18th century. Both buildings are currently covered by timber cladding and harling, concealing the stone masonry.

Figure 11 Examples of Masonry Style 2.

Mixed stone [M] rubble and conglomerate [P] walling with grey-brown flagstone [F2] dressings, built between the late 18th and mid 19th centuries. See Section 5.2.2 for more information regarding the masonry style and the illustrated structures.

Top left: 3 Ancaster Square North, late 18th century. Top right: 6 Bridge Street (C(s) listed), late 18th century.

Middle left: 169 Main Street, late 18th century. Middle right: 125 Main Street, late 18th century.

Bottom left: 15, 17, 19 Main Street, early 19th century. Bottom right: Callander Kirk Hall (B listed), c.1849.

Figure 12 Examples of Masonry Style 3.

Locally sourced walling stone (conglomerate and flagstone) with imported sandstone dressings. This masonry style is the most commonly used throughout the CCA. These images are presented in chronological order. See Section 5.2.3 for more information regarding the masonry style and the illustrated structures.

Top left: 21-24 Ancaster Square South, late 18th or early 19th century. Top right: St. Kessog's, Manse Lane (1868).

Middle left: 188-90 Main Street, mid 19th century. Middle right: 11 Bridgend (Robertson House), mid 19th century.

Bottom left: St. Bride's Church, 1840 with 1861 alterations (B listed). Bottom right: 1 Tulipan Crescent, Leny Feus, mid to late 19th century.

Figure 12 (continued) Examples of Masonry Style 3.

Top left: 3 Cross Street, late 19th century. Top right: 95 Main Street, late 19th century.

Middle left: Callander Primary School, Bridgend (former McLaren High School; C(s) listed), 1907.

Figure 13 Examples of Masonry Style 4.

Imported sandstone walling and dressings, in structures built from the late 19th century onwards. See Section 5.2.4 for more information regarding the masonry style and the illustrated structures.

Top left: 24 Main Street (Kinnell House: C(s) listed), mid to late 19th century. Top right: 6 Bridge Street (C(s) listed), late 18th century.

Middle left: 5 Main Street (Old Bank, former National Commerce Bank; C(s) listed), 1883. Middle right: Rob Roy & The Trossachs Visitor Centre (former St. Kessog's Church; B listed), 1883.

Bottom left: 2 Cross Street/35 Main Street (former Ancaster Arms Hotel), 1893. Bottom right: 1 Cross Street/29-33 Main Street ('Desirables' building), late 19th century.

Figure 14 Examples of significant buildings in the CCA with characteristics not consistent with masonry styles 1-4.

Top row: Roman Camp Hotel (B listed), 17th century with major 1896 alterations.

Bottom row: Dreadnought Hotel, c.1802.

Figure 15 Examples of roofing styles in the Callander Conservation Area.

See Section 5.3 for more information regarding roofing style and the illustrated structures.

Top: 4A and 8A Ancaster Square North (rear feu plots). The roof, currently with Welsh [WPP] slate, has thackstanes (not visible in the image) which point to the historical use of thatch roofing.

Middle: Roof with Scottish Highland Border [SHB] slate, displaying random widths and diminishing courses.

Bottom: Roof with Scottish West Highland [SWH] slate, displaying random widths and diminishing courses.

Figure 15 (continued) Examples of roofing styles in the Callander Conservation Area.

Top: Roof with Welsh grey slate [WGP] displaying a uniform shape and coursing.

Top middle: Roof with English Cumbrian slate [ECB], displaying a uniform shape and coursing.

Bottom middle: Roof with Spanish slate [FSP], displaying a uniform shape and coursing.

Bottom: Roof with other manmade material [OMM], displaying a uniform shape and coursing.

6 Past and future supply of locally sourced stone and slate

Several of the stone types recorded in the survey of Callander buildings have characteristics that are typical of the Old Red Sandstone strata that crop out around Callander, indicating that one or more quarries near to Callander supplied building stone to the town. The BGS Britpits database, which holds information for more than 100,000 currently and formerly active quarries and pits in the UK, contains location details for three quarries situated in wooded slopes on the north side of Callander (Figure 16). All are long-disused and overgrown. Four of the main stone types identified in the building survey (P, F1, F2 and R3) can be matched to stone exposed in these three quarries, and it is inferred that they were the main suppliers of locally sourced building stone. There is no record of formal names being used for these quarries, so a simple descriptive name has been assigned here to each one.

In this section of the report the bedrock geology in which the quarries are sited is reviewed, the quarries are described, and potential new sources of the same stone types from the same Old Red Sandstone strata are assessed. Sources of currently available stone and slate that broadly match the stone and slate used in Callander buildings (and could substitute for them in repairs and new-build construction) are presented in Section 7.

6.1 LOCAL BEDROCK GEOLOGY

Callander lies on the boundary between two adjacent 1:50,000 scale bedrock geology sheets (see Figure 3). The current version of the Stirling sheet, which covers the area east of the boundary, was published in 1974 (BGS, 1974). The current version of the Aberfoyle sheet, which covers the area west of the boundary, was published much more recently, in 2004 (BGS, 2004). As is often the case with geological map sheets published many years apart, the geographical limits of mapped geological units and the names given to those units do not agree perfectly on both sides of the boundary. The mismatch in this case is relatively minor, and has been 'smoothed out' in Figure 3.

Figure 16 shows the mapped bedrock geology in ground to the north of Callander, as presented on a BGS field slip of 1962 (the most recent BGS bedrock mapping survey in this area). The locations of the three Callander building stone quarries are superimposed. The field slip was used as the basis for this part of the Stirling sheet (BGS, 1974). The bedrock in this area consists of Old Red Sandstone Supergroup strata dipping moderately steeply to steeply (60-80˚) towards the southeast. The map (Figure 16) identifies major units that are dominated by either conglomerate ±pebbly sandstone or sandstone ±mudstone. However, in practice these rock types are commonly interbedded on a range of scales smaller than the map scale; in other words, the mapped units of conglomerate locally contain beds of sandstone and mudstone, and the mapped units of sandstone and mudstone locally contain beds of pebbly sandstone and conglomerate.

The Old Red Sandstone Supergroup here and elsewhere in Scotland is subdivided into smaller named units according to mapped variations in rock type. The lithostratigraphy (i.e. the arrangement of sedimentary units according to rock type and relative age) for the Old Red Sandstone Supergroup in the Callander district is shown in Figure 17. The names assigned to bedrock units on the Aberfoyle sheet (BGS, 2004) have been assigned (by extrapolation) to the mapped units on Figure 16, and are used in the descriptions below.

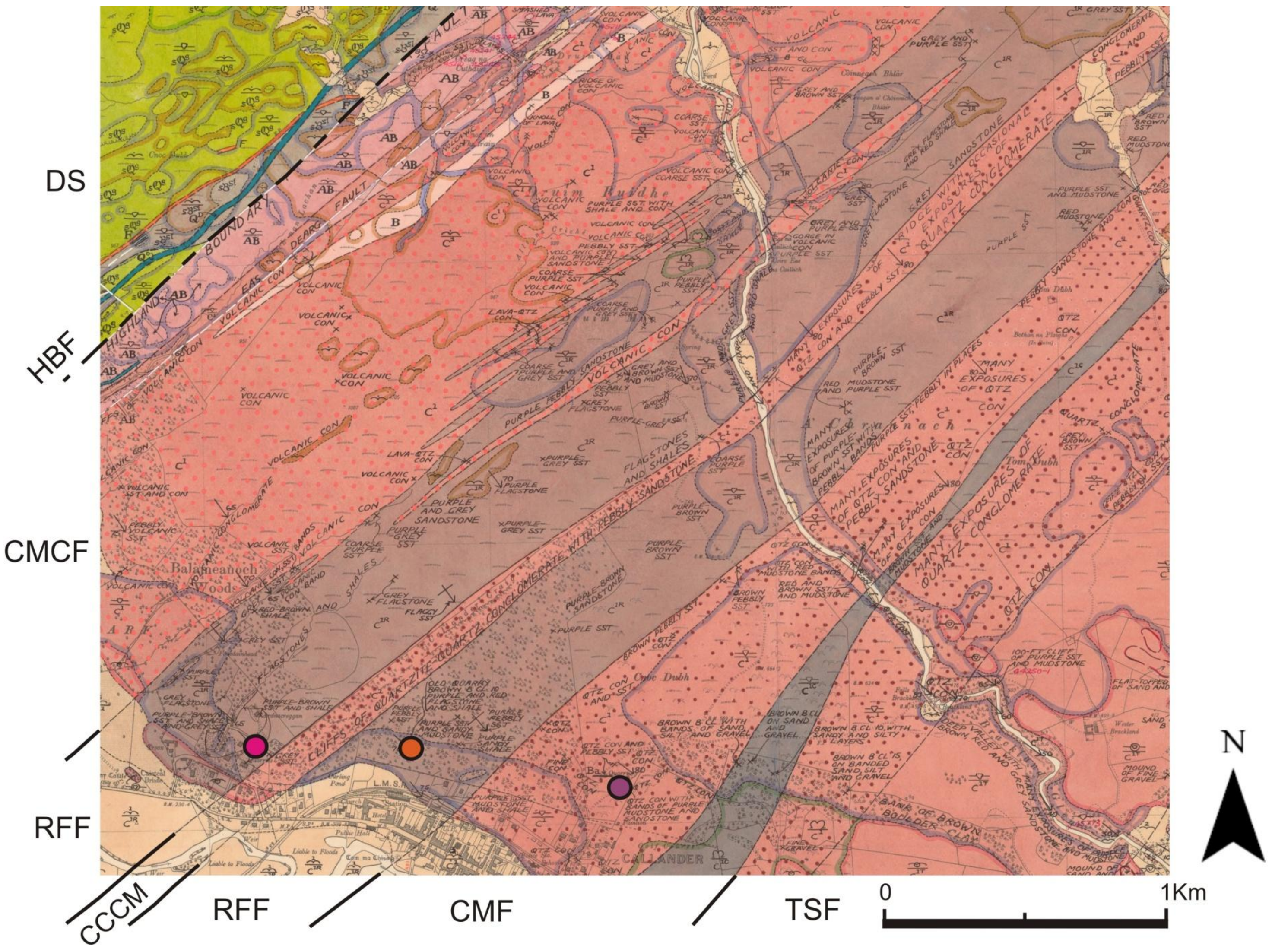


Figure 16 Bedrock geology and building stone quarries on the north side of Callander.

BGS 'clean copy' geological field slip for ground on the north side of Callander, mapped at 1:10,000 scale in 1962 using an Ordnance Survey topographic base map of 1901. Coloured bands southeast of the Highland Boundary Fault are mapped strata of the Old Red Sandstone Supergroup. TSF = Teith Sandstone Formation; CMF = Cromlix Mudstone Formation; RFF = Ruchill Flagstone Formation; CCCM = Callander Craig Conglomerate Member; CMCF = Craig of Monievreckie Conglomerate Formation; HBF = Highland Boundary Fault; DS = Dalradian Supergroup. See Figure 17 for the lithostratigraphy of the Old Red Sandstone units. Pink dot (left) = Leny Feus Flagstone Quarry; orange dot (central) = Central Callander Puddingstone Quarry; purple dot (right) = East Callander Puddingstone Quarry.

<table>
<tr><th>Supergroup level</th><th>Group level</th><th>Formation level</th><th>Member level</th></tr>
<tr><td rowspan="8">Old Red Sandstone Supergroup</td><td rowspan="5">Strathmore Group</td><td rowspan="2">Teith Sandstone Formation</td><td>Dalmary Sandstone Member</td></tr>
<tr><td>Bracklinn Falls Conglomerate Member</td></tr>
<tr><td rowspan="3">Cromlix Mudstone Formation</td><td>Undivided units of mudstone</td></tr>
<tr><td>Tom Dubh Conglomerate Member</td></tr>
<tr><td>Malling Conglomerate Member</td></tr>
<tr><td rowspan="3">Arbuthnot-Garvock Group</td><td rowspan="2">Ruchill Flagstone Formation</td><td>Undivided units of sandstone and pebbly sandstone</td></tr>
<tr><td>Callander Craig Conglomerate Member</td></tr>
<tr><td>Craig of Monievreckie Conglomerate Formation</td><td>Undivided units of conglomerate</td></tr>
</table>

Figure 17 Lithostratigraphy of the Old Red Sandstone Supergroup in the Callander area.

Based on BGS (2004). The named sedimentary units are arranged according to rock type and relative age.

6.2 BUILDING STONE QUARRIES IN THE CALLANDER AREA

6.2.1 East Callander Puddingstone Quarry

This quarry, the easternmost of the three Callander building stone quarries, lies northeast of the historical town centre in the Bracklinn area, in wooded ground beside the golf course [NGR 26343 70813]. The quarry is approximately oval and is the largest of the three, being roughly 100 x 50 metres and up to 5 metres deep.

The quarry is sited within a thick unit of conglomerate; the quarry location suggests this unit is part of the Cromlix Mudstone Formation (Figure 16). Despite its name, in the Callander area this formation is dominated by two adjacent conglomerate units, the Tom Dubh Conglomerate Member and the Malling Conglomerate Member (Figure 17). The Tom Dubh unit lies stratigraphically above (i.e. it is younger than) the Malling unit, and hence would crop out parallel to, and southeast of, the Malling unit. Both units vary in thickness but are typically in the order of 100 metres thick. The two units were not identified at the time the field slip shown in Figure 16 was produced, and it is not certain which of them the East Callander Puddingstone Quarry has exploited. A note on the BGS field slip (not legible in Figure 16) describes the quarry as consisting of “quartz conglomerate with bands of purple mudstone and sandstone”. The beds of conglomerate exposed in the quarry dip very steeply (at 80 degrees) towards southeast.

The quartz pebble-rich conglomerate exposed in the East Callander Puddingstone Quarry is essentially identical to the typical ‘Callander puddingstone’ (stone code [P] and possibly some of [R3]). The relatively large size of the quarry and the distinctive lithology indicate that it was the main source of the conglomerate used in Callander buildings. Tool marks and drill holes still visible on some faces indicate the quarried blocks were extracted using tools (as opposed to blasting).

Conglomerate from this quarry has been recorded in many of the surveyed buildings in the Callander Conservation Area (see, for example, Figure 6). The stone has most commonly been used as rubble walling, with both random and squared finishes. The stone blocks contain relatively few beds of sandstone and/or siltstone, and the character of the stone has remained broadly consistent through different building periods.

6.2.2 Central Callander Puddingstone Quarry

This quarry lies in a wooded area immediately to the north of the central part of Callander (NGR 26271 70828]. It is relatively small, being approximately ten by five metres in area and up to around six metres deep. The quarry is sited within a thick unit of sandstone which typically occurs in shades of purple-brown and red. The quarry location suggests the unit is part of the Ruchill Flagstone Formation (Figure 16).

In the Callander area the Ruchill Flagstone Formation consists of two parallel units of lithic, fine- to coarse-grained, locally pebbly sandstone with beds of red siltstone in places. The units crop out as parallel bands trending approximately NE-SW and each is around 0.5 km wide on the ground. These two units are separated by a unit of conglomerate, which is inferred to be the Callander Craig Conglomerate Member. The Central Callander Puddingstone Quarry is roughly in the centre of the outcrop of the southeast-most unit of sandstone (Figure 16). The beds dip steeply (at 70 degrees) towards southeast.

The rock exposed in the quarry is lithologically variable on a range of scales, consisting of interbedded conglomerate/pebbly sandstone, sandstone and siltstone. The conglomerate is distinguished from that in the East Callander Puddingstone Quarry by a larger proportion of lithic pebbles (i.e. pebbles composed of discrete rock fragments) relative to pebbles of pure quartz, and by the presence of sandstone bands. Single blocks extracted from the quarry and used in Callander buildings sometimes consist of conglomerate with bands of sandstone and/or siltstone.

This quarry appears to have supplied blocks of stone type [P], but in much smaller quantity than the East Callander Puddingstone Quarry.

6.2.3 Leny Feus Flagstone Quarry

This quarry, the western-most of the three Callander building stone quarries, is near Ardnacreggan in the Leny Feus area of the town [NGR 26220 70840]. It is approximately 60 by 30 metres in area and up to around 5 metres deep. The disused quarry is overgrown and has residential properties nearby, one of which is immediately adjacent.

The Ordnance Survey topographic base map to the BGS field slip (Figure 16) records ‘Old Quarries’ at this location, and a note written by the geologist on the field slip records “purple-brown sandstone and shale”. Beds near to the quarry dip at 65˚ towards southeast.

Leny Feus Flagstone Quarry is sited close to the eastern boundary of the older (northwest-most) unit of the Ruchill Sandstone Formation (Figure 16). Beds of purplish-red and greyish-brown flagstone exposed in the quarry are essentially identical to the [F1] and [F2] flagstone (respectively) recorded in Callander buildings. The quarry is therefore believed to have supplied most of the flagstone that traditionally was used in Callander as dressings, and much of the rubble that is not conglomerate.

6.3 OTHER LOCALLY SOURCED STONE

Some of the earliest surviving buildings in Callander have rubble walling composed of variably rounded cobbles and boulders that were probably gathered from where they lay in nearby fields and river beds (stone type [M]; see Section 5.2.1). The cobbles and boulders consist of a wide range of rock types, including conglomerate, siltstone (*flagstone*, mostly of the purplish-red F1 type), dolerite and other basic intrusive igneous rocks (*whin*), metavolcanic rocks (*greenstone*), metasandstone/quartzite, schist and gneiss. The conglomerate and F1 flagstone are typical of local Old Red Sandstone strata. All the other stone types are derived from Dalradian strata and associated igneous rocks on the north side of the Highland Boundary Fault.

6.4 FUTURE SUPPLY OF LOCALLY SOURCED STONE

6.4.1 Re-opening existing quarries

The quarries that originally supplied locally sourced stone to Callander – the East Callander, Central Callander and Leny Feus quarries described above – present the most obvious places to source future supplies of the same stone types. All three quarries have been disused for a considerable time and are in an overgrown and neglected condition. However, they have not been 'sterilised' by flooding or filling, and there is no evidence that the stone resource has been exhausted. Re-opening old quarries can be complicated by problems associated with access, ownership and negative public perception, and it can be difficult to obtain planning permission. Nevertheless, given that these quarries already exist and could almost certainly provide stone to match that which was extracted previously, the feasibility of re-opening one or more of them should first be established.

Building stone is typically recovered in relatively small quantity compared to, for example, rock used for aggregate. Modern quarrying techniques allow the stone to be detached without the need for blasting and with minimal damage to the stone. Modern building stone quarries can therefore extract and transport stone without the problems of noise, dust, waste and aesthetic impact that are commonly associated with other quarrying operations. There is unlikely to be a substantial and/or consistent demand for locally sourced building stone in the Callander area, so any re-opened quarry may only need to be active intermittently, on an as-needed basis. That said, the Old Red Sandstone Supergroup crops out in many parts of Scotland, and other settlements will include buildings constructed using stone of similar character to that extracted from the Callander quarries. Re-opened quarries in Callander might therefore find a market for the stone in other parts of Scotland.

6.4.2 Other existing quarries in the Callander area

Three quarries within twenty kilometres of Callander were visited to assess whether they expose stone that would provide a suitable match for the stone sourced from the three Callander building stone quarries. All three quarries were created by the Forestry Commission to provide aggregate for forest track construction.

A quarry at Bochastle [NGR 2603 7081], a little over two kilometres west of Callander, is sited on the outcrop of the Craig of Monievreckie Conglomerate Formation. Stone referred to by the operator (Forestry Commission) as 'puddingrock' has been extracted from the quarry, but the colour (generally grey), grain-size (clasts up to decimetre scale) and clast composition (various lithologies, not dominated by quartz) of the conglomerate would not be a good match for the 'Callander puddingstone'.

A quarry at [NGR 2506 6981], around three kilometres southwest of Aberfoyle, is sited on the outcrop of the Ruchill Flagstone Formation. The exposed rock is pebble- to cobble-grade conglomerate with a purplish-grey coarse sandstone matrix. In terms of appearance it is not a good match for 'Callander puddingstone'.

A quarry at [NGR 2476 6964], around six kilometres southwest of Aberfoyle, is sited on the outcrop of the Craig of Monievreckie Conglomerate Formation. The exposed rock is conglomerate consisting of mainly cobble-grade clasts set in a weakly purplish-grey, coarse sandstone matrix. In terms of appearance it is not a good match for 'Callander puddingstone'.

6.4.3 Opening new quarries in the Callander area

If re-opening the disused Callander quarries proves impractical, it may be possible to obtain matching stone from other parts of the same geological units by opening one or more new quarries. The three Callander quarries have extracted stone from different layers of sedimentary strata in the Old Red Sandstone Supergroup. The strata crop out in bands aligned parallel to the Highland Boundary Fault, and each band extends for many kilometres to the northeast and southwest of Callander (Figure 3). Stone of similar character to that extracted from the quarries is likely to crop out elsewhere within these strata in the vicinity of Callander, but the closeness of the match is in general likely to diminish with increasing distance from the original quarry source. Predicting where stone of a particular character might crop out in sedimentary rock strata is commonly not straightforward because they are prone to change character in all vectors, at all scales. This heterogeneity reflects changes in the source of sedimentary material and/or changes to the environment in which the sediment was deposited. Conglomerate is particularly prone to vary in character from place to place, in terms of the type and/or size and/or shape and/or colour of the clasts, in terms of the relative proportions of clasts and matrix, and in terms of the grain-size and colour of the matrix. This variability reflects the fact that conglomerate is typically deposited during times of rapid uplift and erosion of the land (hence the character of the eroding source rock can change frequently) and is deposited from fast-flowing rivers (e.g. flash floods) that are prone to rapid changes in flow rate and rapid migration of the river channel back and forth across the floodplain.

Identifying potential sites for establishing new building stone quarries in the Callander area would require a programme of detailed geological mapping and, ideally, some carefully targeted borehole drilling.

6.4.4 Possible sources further afield

Old Red Sandstone strata of the same age and lithology as those that crop out around Callander are found in many parts of Scotland. The largest continuous area of outcrop is in the northern part of the Midland Valley, in a swathe of ground bounded by the HBF to the north and extending from the Clyde estuary in the southwest to Stonehaven in the northeast. Smaller pockets crop out in the southern part of the Midland Valley, around Lauder and Longformacus in the Southern Uplands, and around Muir of Ord and Berriedale in the northern Highlands. The likelihood of finding a good match for the locally sourced Callander building stones (especially the conglomerate) in general diminishes with increasing distance from Callander and the HBF. Nevertheless, a review of existing (generally disused) quarries in these areas may identify reserves of stone that could provide a sufficiently good match for one or more of the Callander stones. The best prospects may lie in the two areas described below.

The southeast-dipping Old Red Sandstone strata of the Callander area form one limb of the Strathmore Syncline, a large, gentle, concave-upwards fold in the Old Red Sandstone bedrock. The strata hosting the three Callander building stone quarries are concealed deep below the ground surface between Callander and Doune, but they reappear at the ground surface to the east of Doune, on the opposite limb of the Strathmore Syncline (Figure 3). Existing (generally disused) quarries in this part of Strathmore may expose stone that is a reasonable match for one or more of the locally sourced Callander building stones.

Units of Old Red Sandstone conglomerate, sandstone and siltstone crop out on the southeast side of the Highland Boundary Fault along much of its length. Towns like Edzell (Angus) and Stonehaven (Aberdeenshire), which occupy a similar position with respect to the HBF as Callander, contain many buildings constructed of stone sourced from local Old Red Sandstone strata. A review of existing (generally disused) quarries sited in suitable lithologies along the length of the Highland Boundary Fault may identify other reserves of stone that is a reasonable match for one or more of the locally sourced Callander building stones.

7 Sources of currently available matching stone and slate

New-build construction and repairs to existing buildings need to be 'in keeping' with existing buildings to ensure that the character and quality of the built heritage in the Callander Conservation Area is maintained or enhanced. To be 'in-keeping', the stone and slate used in future projects needs to match as closely as possible the original materials. Buildings undergoing repair or demolition within the town might provide a valuable source of stone and slate that matches some of the original types, but this resource is likely to be small, intermittent and unreliable. Other larger and more reliable sources will need to be identified.

The indigenous stone and slate industry was at its peak in Scotland in the 19th Century, when many hundreds of quarries produced building stone and roofing slate. That industry suffered a dramatic decline in the 20th Century, when the great majority of building stone and slate quarries ceased operation. Currently, very few quarries in Scotland produce building stone and none produce roofing slate. Consequently, it is commonly not possible to obtain new supplies of stone and slate from the quarries where they were originally sourced.

7.1 STONE MATCHING

Stone matching is the process of identifying one or more suitable, currently available stones to replace an original stone used in some component of the built environment (e.g. a building, bridge, monument, pavement or carriageway). It may be possible to identify the source quarry of a building stone through historical records or a set of distinctive geological characteristics, in which case more of the same stone may be available if the quarry is still operational or can be re-opened. More commonly, it is either not possible to link the stone to its source quarry (typically because there are too many possible sources, or there is too little information about the stone from those sources, or the stone lacks sufficiently distinctive characteristics), or the source quarry is known but is no longer operational. In such instances, stone matching is used to compare the geological characteristics of the original stone with the characteristics of currently available stones, to identify one or more currently available stones that could be a suitable replacement.

Too often, a replacement stone is selected mainly, or entirely, on the basis of appearance – in other words because it looks similar (in terms of colour and fabric) to the original. Although appearance is important, the degree to which one stone is a good match for another can depend critically on other attributes of stone and on the function of the original stone (e.g. water-shedding element, load-bearing element). The most important attributes to be considered in a stone match are as follows.

- *Appearance* – i.e. how closely does the replacement stone match the original stone in terms of colour and fabric? A replacement stone can be selected to match the fresh part, the weathered part, or the external surface of an original stone, each of which can look very different.
- *Weathering performance* – is the replacement stone likely to respond in similar ways to the physical and chemical changes associated with weathering? A replacement stone that is a good match in terms of weathering performance should suffer decay and discolouration in a similar way and at a similar rate to the original stone.
- *Permeability* – the permeability of the replacement stone (i.e. the ease with which water and air can pass through it, via its pore spaces) should be similar to that of the original stone against which it is placed in a repair. If the replacement stone has significantly lower permeability than the original stone it will inhibit the migration of air and water between stone blocks, which could lead to accelerated decay in the original stone. If the

replacement stone has significantly higher permeability than the original stone, water could become trapped in the replacement stone leading to accelerated decay there.

- *Strength* – if the original stone performed a load-bearing role, the replacement stone must be at least as strong.
- *Ease of shaping and tooling* – if the original stone was carved, tooled or sawn, it should be possible to achieve the same quality of detail and finish in the replacement stone.

A stone matching recommendation is normally based on a detailed examination of the original stone in hand specimen and in thin section (a slice of the stone cut thin enough to be transparent so that it can be examined using a petrological microscope). The stone is then compared to a range of possible replacement stones on the basis of the various attributes described above, and matched to the most appropriate one(s). Typically, more than one replacement stone is recommended as it is unusual for a single stone type to provide the best match in terms of all of the relevant attributes and for all stone functions.

The importance of good stone matching (particularly in areas where a distinctive stone-built character exists) is increasingly being recognised by heritage and construction communities. However, the great diversity of character displayed by natural stones and the large number of building stone types currently available in the UK present significant challenges in matching a good replacement stone with an original stone.

An assessment of the original sources of stone used in Callander buildings, and of potential sources of currently available matching stone, is presented in Table 3. The original source (quarry and geological unit) of each stone type has been assessed by expert judgement and by comparison with samples held in the BGS Collection of UK Building Stones. The stone matching assessment is based largely on the appearance of each stone; no detailed microscope (thin section) examination of the stones has been performed. As such, the stone matching recommendations should be taken as indicative only. A formal stone matching exercise should be carried out whenever a replacement stone is required, so that the best matching stone(s) can be selected to suit both the character and function of the stone being replaced.

7.2 SLATE MATCHING

Slate matching is generally more straight-forward than stone matching because most of the traditionally used slate in the UK has come from relatively few major sources, and slate from each source typically has a set of distinctive characteristics by which it can be recognised. Unfortunately, none of the original Scottish slate quarries are in operation today, but several quarries remain operational in England and Wales, and slate can also be sourced from continental Europe.

Details of the original sources of slate used in Callander buildings, and of potential sources of currently available matching slate, are presented in Table 4.

Currently available slate is typically supplied in a uniform size. This may cause problems when replacing slate on the roof of a traditional Scottish building, because Scottish slate has traditionally been laid in diminishing courses with random widths. If slate that is not traditionally used in Scotland is selected for roofing repairs in Callander, assurances should be obtained from the supplier that it is capable of withstanding the climate and complies with the British Standards Institute (BSI) specifications for roofing slates (BS 680:-2:1971).

Stone code	Stone type	Source(s) of stone	Currently available stones that could provide a suitable match *
P	conglomerate	Almost certainly sourced mainly from the East Callander Puddingstone Quarry, with a smaller proportion from the Central Callander Puddingstone Quarry.	None. It may be possible to recycle some stone of this type from existing Callander buildings.
F1	flagstone	Almost certainly from the Leny Feus Flagstone Quarry in Callander (Ruchill Flagstone Formation).	Golspie (quarry currently closed but supplies of Golspie stone may still be available); possibly also Cove Red.
F2	flagstone	Almost certainly from the Leny Feus Flagstone Quarry in Callander (Ruchill Flagstone Formation).	Pitairlie, Dunaverig.
R1	sandstone	Almost certainly from quarries exploiting the Permo-Triassic basins of southwest Scotland. The most likely candidates are Ballochmyle and other quarries at Mauchline in Ayrshire, Locharbriggs, Newton/Gatelawbridge, Knowehead, and Corsehill quarries in Dumfries & Galloway.	Stone from the Corncockle, Locharbriggs, and Corsehill quarries (Dumfries & Galloway). St Bees sandstone (Cumbria) could also be considered.
R2	sandstone	Probably from quarries such as Bloodymires, Bloodymoss and others in the Kippen area, south of Callander, which exploited the Kinneswood Formation and Stockiemuir Sandstone Formation.	No good matches. The best options are likely to be St Bees/Beestone, Corsehill (bedded variety) and Cove Red. Other red sandstones, such as Corncockle and Locharbriggs, could be considered.
R3	sandstone	Probably sourced locally, from sandstone beds in the Central Callander Puddingstone Quarry and/or East Callander Puddingstone Quarry.	King's Grit, Brownieside, Sunwick, Wattscliffe Lilac and Golspie.
R4	sandstone	Not obvious. Possibly from quarries exploiting the Stockiemuir Sandstone Formation and/or the Kinnesswood Formation.	King's Grit, Cloudside Gritstone, Duke's Sandstone, Birchover 'Wild Pink'.
B1	sandstone	Probably from various quarries exploiting Carboniferous age sandstone in the Central Belt. Some examples are similar to Glasgow 'blonde' and buff sandstones (such as Giffnock and Bishopbriggs).	Drumhead White/Buff (near Falkirk). English stones such as High Nick, Blaxter, Dunhouse Buff, Stainton, Birchover Buff, Scotch Buff and Hazeldene are likely to be petrologically compatible but most are a stronger buff colour.
B2	sandstone	Almost certainly from quarries exploiting Carboniferous age sandstones in northern England, such as Darney, Stanton Moor, Peakmoor, Blaxter, Dunhouse Buff and Black Pasture.	Darney, Stanton Moor, Peakmoor, Blaxter, Dunhouse Buff and many others.
B3	sandstone	Not obvious but perhaps from quarries in the Stirling and/or Falkirk areas, and possibly other parts of the Central Belt.	Fletcher Bank (White and Buff varieties), Bearl, Lingberry, Catcastle.
M	mixed	Virtually all examples were probably sourced locally as loose cobbles and boulders in fields and river beds. Blocks of metamorphic stone have been used as lintels and quoins in a small number of properties (and in one case an entire house has been built of such material), and these may have been quarried.	The original river and field sources, and other similar sources in the surrounding area, should yield a similar range of stone types.

Table 3 Sources of stone used in Callander buildings, and possible sources of replacement stone.

Note: buildings undergoing repair or demolition may provide a valuable source of replacement stone.

*A stone matching recommendation is normally based on a detailed petrographical (microscope) examination of the original stone, on which basis it can be compared to possible replacement stones. One or more replacement stones are typically recommended by taking into consideration a number of important stone matching criteria (including appearance, likely weathering performance, permeability and strength of the original). It is strongly recommended that a formal stone matching exercise be carried out whenever a replacement stone is required, so that the best matching stone(s) can be selected to suit both the character and function of the stone being replaced.

Slate code	Slate type	Source(s) of slate	Currently available slate that could provide a suitable match
SHB	Scottish Highland Border slate	Quarries exploiting Dalradian Supergroup strata, a short distance from the Highland Boundary Fault. Quarries at Aberfoyle and Luss are the closest to Callander.	Slate is not currently available from any of the original quarries. SHB slate is characterised by variable colour, and therefore no single currently available slate is a good match. Depending on the colour, English Cumbrian, Welsh grey or Welsh purple slate (and in some cases a combination of these) should provide a reasonable match. The typical Scottish roofing style (diminishing courses, random widths) should be used.
SWH	Scottish West Highland slate	Several large quarrying operations in the West Highlands, the best known being at Easdale and Ballachulish.	Slate is not currently available from any of the original quarries. Currently available slate from the northwest of Spain should provide a good match. One variety of Spanish slate described as 'Scottish style' may still be available.
SUD	undifferentiated Scottish slate	Almost certainly from quarries exploiting Dalradian Supergroup strata a short distance from the Highland Boundary Fault, or from several large quarrying operations in the West Highlands, the best known being at Easdale and Ballachulish..	Scottish slate is not currently available from any of the original quarries. Depending on the colour and texture of the slate, English Cumbrian, Welsh grey, Welsh purple or Spanish slate (and in some cases a combination of these) are likely to provide the closest match. The typical Scottish roofing style (diminishing courses, random widths) should be used.
WGP	Welsh grey slate	Probably from quarries at Porthmadog and Ffestiniog, in north Wales. These quarries have produced mainly grey slate but greenish and purple varieties have also been produced.	Welsh grey slate is currently available.
WPP	Welsh purple slate	Probably from Penrhyn quarry in north Wales. The slate produced here is mostly purple but grey and greenish slate has also been produced.	Welsh purple slate is currently available.
ECB	English Cumbrian slate	Several quarries in Cumbria. The slate is sold under various names including Burlington, Kirkby, Elterwater and Broughton Moor.	Blueish grey and greenish grey varieties of English Cumbrian slate are currently available.
FSP	Spanish slate	Probably from quarries in a slate belt in the northwest of Spain.	Spanish slate is currently available.
MIX	slate of mixed provenance	Recycled from different sources and buildings.	N/A

Table 4 Sources of slate used in Callander buildings, and possible sources of replacement slate.

Note: buildings undergoing repair or demolition may provide a valuable source of replacement slate.

8 Conclusions

8.1 METHODOLOGY

A survey methodology has been developed (based on the BGS System for Integrated GeoScience Mapping [SIGMA]) that allows a wide range of attributes describing stone/slate type and stone/slate condition to be linked to architectural elements within single geospatially referenced structures, rapidly and consistently, in a digital, hierarchical form, in the field.

The survey data are presented as attribute tables linked to polygons (one polygon per surveyed structure). The polygons are defined in the GIS shape file deliverable. This format allows subsets of the data to be sorted, selected and combined quickly and easily, and presented in either statistical form or map form, thereby providing a powerful and versatile planning tool.

A survey of stone condition in the 'Desirables' building at 1-3 Main Street, Callander (presented in Appendix 3), can be used as a template for conducting and presenting future surveys of stone condition in individual buildings.

These new methodologies can be applied generically, and they should be used in future similar studies in Callander and elsewhere in LLTNP to ensure a consistency of approach and terminology.

8.2 CALLANDER BUILDING STONE AND ROOFING SLATE

The great majority of the stone used in surveyed buildings is of three types of sedimentary rock: conglomerate, sandstone and flagstone. The sandstone falls into two broad categories distinguished by colour: red sandstone and blonde to buff sandstone. Four 'types' of red sandstone and three 'types' of blonde to buff sandstone have been distinguished by colour and other attributes. The flagstone falls into two categories distinguished by colour: purplish-red and greyish-brown.

Conglomerate (*Callander puddingstone*) is the stone most commonly used for walling, but has virtually never been used for dressings. The stone is generally in good condition.

Flagstone has been used for walling in many buildings in the Leny Feus area, but only very rarely elsewhere. It has been used for dressings on many buildings throughout the Conservation Area. The stone is prone to splitting along bedding (delamination), especially where it has been placed face-bedded (which it commonly has).

Blonde to buff sandstone is typically used in the walling of relatively large buildings in all parts of the CCA, and is by far the most commonly used stone in dressings throughout the CCA. The stone is generally in good condition but can be prone to scaling and granular disintegration.

Red sandstone has been used less commonly in walling than blonde to buff sandstone, and its use has been restricted almost exclusively to buildings along and near to Main Street. In the rare cases where it has been used for dressings, it is usually in the same buildings in which it has been used for walling. Some red sandstone is in good condition, but some can be in poor condition mainly through a susceptibility to water penetration and granular disintegration.

Stone of mixed type (including conglomerate, flagstone and igneous rocks and metamorphosed sedimentary rocks originally from bedrock to the north of the Highland Boundary Fault) is used for rubble walling in a small proportion of (usually older) buildings. Rarely, metamorphosed stone has been used for dressings and, in one case, for an entire house. The stone is generally in good condition.

The main causes of stone decay in the CCA are: cement pointing and patchwork (which prevents the stone from 'breathing' naturally, and leads to accelerated decay); face bedding (which accelerates the rate at which the stone suffers splitting along bedding [delamination], and can lead to crumbling and granular disintegration); and failing rainwater goods (which locally focuses rainwater onto stone surfaces, leading to problems associated with water penetration/saturation).

Scottish and Welsh slate is by far the most commonly used in the CCA, and has been used on approximately equal numbers of buildings. Scottish Highland Border slate is the most commonly used Scottish roofing slate; it has been used most commonly on buildings along and near to the Main Street. Welsh purple slate is the most commonly used Welsh roofing slate and appears on buildings throughout the CCA. English slate and Spanish slate have been used on approximately equal numbers of buildings, but are much less common than Scottish and Welsh slate.

8.3 EVOLUTION OF NATURAL STONE AND SLATE USE IN CALLANDER

Four distinct masonry styles are recognised in Callander buildings, each characterised mainly by the combination of stone types used for walling and dressings. The first appearance of each masonry style typically reflects a change in the availability of stone building materials as the town developed. The main events affecting the availability of materials were: the opening of local quarries (c.18th century); the arrival of the railway in the second half of the 19th century; and the First World War (which coincided with the rapid demise of the building stone quarry industry in Scotland). With just a few exceptions, natural stone has not been used in buildings constructed since the First World War, leading to a gradual dilution of the traditional character of the built heritage in Callander.

Locally sourced conglomerate (‘Callander puddingstone’) is the most widely used natural stone building material in the Callander Conservation Area. The conglomerate is an unusual building stone in terms of its appearance and the fact that it is not easy to work (compared to sandstone and flagstone, for example). Nevertheless, it was used at all stages of town development up to the First World War. For much of this time, other widely available, easy to use and popular building stones were available, raising the question of why the conglomerate remained popular in Callander for so long. The locals may have been aware of its importance to the character of their town and its sense of identity. Alternatively, the importance of maintaining the local quarrying industry (and the associated jobs) may have over-ridden the aesthetic and economic reasons for using imported stone. Today, the conglomerate plays an important role in defining the ‘sense of place’ within the CCA.

Thatch roofing on the earliest buildings was gradually superseded by slate, which was sourced initially from quarries supplying Scottish Highland Border slate (probably mainly at Aberfoyle) and laid in the traditional Scottish style (random widths, diminishing courses). Later, slate from the West Highlands of Scotland, Wales, England and Spain was made available by improving transport links (especially rail). Today, no one slate type dominates in the CCA; Scottish and Welsh slate have been used on approximately equal numbers of buildings, and are much more common than slate from other sources. The character of roofing in the CCA depends at least as much on the style in which the slate is laid as on the slate type.

Although imported stone and slate have been used extensively, and man-made materials are used almost exclusively in modern buildings, the widespread and long-term use of locally sourced conglomerate, flagstone and slate has ensured that the built heritage within the Callander Conservation Area continues to reflect the local bedrock geology, and the proximity of the town to the Highland Boundary Fault.

8.4 PAST AND FUTURE SOURCES OF BUILDING STONE AND SLATE

To be ‘in-keeping’ with the built heritage in the Callander Conservation Area, the stone and slate used in future projects needs to match as closely as possible to the original materials. Buildings undergoing repair or demolition within the town might provide a valuable source of stone and slate that matches some of the original types, but this resource is likely to be small, intermittent and unreliable. Other larger and more reliable sources will need to be identified.

The ‘stone of mixed type’ has also been sourced locally, probably mainly as loose cobbles and boulders in fields and river beds. It should be possible to obtain small quantities of similar materials from superficial materials (river and glacier deposits) in the local area or further afield.

The conglomerate and flagstone used in Callander buildings was sourced locally from three disused quarries situated on the north side of the town. Each quarry exploited a separate stratum of the Old Red Sandstone Supergroup. The quarries are in an overgrown and neglected condition, however they have not been ‘sterilised’ by flooding or filling, and there is no evidence that the stone resource has been exhausted. They present the most obvious places to source future supplies of these stone types, and the feasibility of re-opening one or more of them should be established as a first step in securing future supplies of these important stone types.

If re-opening the disused Callander quarries proves impractical, it may be possible to obtain matching stone from other parts of the same geological units by opening one or more new quarries. The Old Red Sandstone strata that have been exploited by the Callander building stone quarries crop out in parallel, northeast-trending bands that extend for many kilometres to the northeast and southwest of Callander. Identifying potential sites for quarrying would require a programme of detailed geological mapping and, ideally, some carefully targeted borehole drilling.

A small proportion of the red sandstone was probably sourced locally, from one of the Callander building stone quarries, but most of the red sandstone and all of the blonde to buff sandstone has been imported from outside the Callander area. Most of the imported red sandstone almost certainly comes from quarries in Dumfries and Galloway, but a proportion probably comes from elsewhere, possibly including quarries near Kippen. The blonde to buff sandstone comes from quarries exploiting Carboniferous age sandstone in the Central Belt of Scotland and possibly also in northern England.

A selection of currently available sandstones that broadly match these red and blonde to buff varieties has been identified. However, this exercise has been based only on a field examination of the Callander building stones, which lacks the important petrographical information usually supplied by thin section (microscope) examination. A formal, more rigorous, stone matching exercise should be carried out whenever a replacement stone is required, so that the best currently available matching stone(s) can be selected to suit both the character and function of the stone being replaced.

9 References

British Geological Survey holds most of the references listed below, and copies may be obtained via the library service subject to copyright legislation (contact libuser@bgs.ac.uk for details). The library catalogue is available at: http://geolib.bgs.ac.uk.

BRITISH GEOLOGICAL SURVEY. 1974. Stirling. Scotland Sheet 39W. Solid Edition. 1:50 000 Geology Series. (Keyworth, Nottingham: British Geological Survey).

BRITISH GEOLOGICAL SURVEY. 2004. Aberfoyle. Scotland Sheet 38E. Bedrock. 1:50 000 Geology Series. (Keyworth, Nottingham: British Geological Survey).

BUTT, R V J. 1995. *The directory of railway stations.* (Sparkford, Somerset: Patrick Stephens Ltd.)

BYROM, B. 2005. *Old Callander and the Trossachs*. (Glasgow: Stenlake Publishing.)

HYSLOP, E K, ALBORNOZ-PARRA, L J, FISHER, L C and HAMILTON S L. 2006. Safeguarding Glasgow's Stone Built Heritage Skills and Materials Requirements: Façade Surveys and Building Stone Analysis. *British Geological Survey Commissioned Report*, CR/06077.

HYSLOP, E K, ALBORNOZ-PARRA, L J and TRACEY, E A. 2009. A Building Stone Audit for Kilmarnock: Surveying, Matching and Sourcing Stone for the Built Heritage. *British Geological Survey Open Report*, OR/09/0002.

HYSLOP, E K, TRACEY, E A, ALBORNOZ-PARRA, L J, EVERETT, P A, PARRY, S F and CUSTANCE-BAKER, A B. 2010. The Building Stones and Slates of Killin: an investigation of stone for the built heritage. *British Geological Survey GeoReport*, GR_140191_1.

MACLEAN, R. No publication date. *Callander—rise of the new town: its growth from 1689 to 1889.* (Callander and District Heritage Society.)

MITCHELL, A (ed.). 1906. *Geographical collections relating to Scotland by Walter Macfarlane.* Vol. 1. (Edinburgh: T and A Constable for the Scottish History Society.)

ROYAL COMMISSION ON THE ANCIENT AND HISTORICAL MONUMENTS OF SCOTLAND (RCAHMS). [2011]. RCAHMS website [online]. [Cited 13 August 2010]. Available from http://www.rcahms.gov.uk/

SCRAN. [2011]. Scran website [online]. [Cited 13 August 2010]. Available from http://www.scran.ac.uk/

Appendix 1 Data fields and dictionaries for the GIS deliverable

The data arising from the survey of stone structures in the Callander Conservation Area described in Section 3 have been delivered independently of the report, as one GIS *shape file* ("Surveyed building stone and slate types summary for Callander Conservation Area") and one database (*dbf*) file ("Surveyed maintenance issues for Callander Conservation Area"). Details of the data fields and their supporting dictionaries are provided below.

1 Data fields and dictionaries for the GIS shape file "Surveyed building stone and slate types summary for Callander Conservation Area"

1.1 Data fields

Field title	Field definition
FID	A sequential ID number provided by LLTNPA.
TOID	TOpographic IDentifier, assigned by the Ordnance Survey to every topographical feature in Great Britain.
UPRN	Unique Property Reference Number, assigned by the National Land & Property Gazetteer.
BID	Building ID, provided by LLTNPA.
FOP	Field Observation Point consisting of surveyor initials and sequential number. Used to identify each surveyed structure uniquely.
ADDRESS	The address of the surveyed property.
SUM_LABEL	Alternative name or address for a property.
BD_EVENT*	Building status at the time of survey (complete, demolished etc).
BD_CLASS*	Building class at the time of survey (commercial, residential etc).
BD_USE*	Building use at the time of survey (vacant, occupied etc).
COMMENTS	An architectural description of the surveyed structure.
SL_VIS*	The visibility of roofing slate at the time of survey (obscured, partial, visible).
SL_CODE	Assigned roofing slate code based on slate characteristics recorded at the time of survey.
SL_DESC	Brief description of roofing slate type.
SL_MATCH	Proposed currently available matching slate.
SL_ORIG*	Inferred origin (source) of roofing slate, based on characteristics observed at the time of survey.
ST_VIS_W*	The visibility of walling stone at the time of survey (obscured, partial, visible).
ST_CODE_W	Assigned walling stone code based on stone characteristics recorded at the time of survey.
ST_DESC_W	Brief description of walling stone type.
ST_MATCH_W	Proposed currently available matching stone for walling.
ST_ORIG_W*	Inferred origin (source) of walling stone, based on characteristics observed at the time of survey.
ST_VIS_D*	The visibility of stone used for dressings at the time of survey (obscured, partial, visible).
ST_CODE_D	Assigned code for the stone used in dressings, based on stone characteristics recorded at the time of survey.
ST_DESC_D	Brief description of the type of stone used for dressings.
ST_MATCH_D	Proposed currently available matching stone for dressings.
ST_ORIG_D*	Inferred origin (source) of the stone used for dressings, based on characteristics observed at the time of survey.
SL_COND*	A simple, generalised assessment of roofing slate condition at the time of survey. The assessment is based on visual observation from ground level.
REC_MAINT	Total number of maintenance issues for all surveyed architectural elements in the surveyed structure.

*Denotes a field with an associated Dictionary. Dictionary terms are defined in Appendix 1.3.

1.2 Dictionary terms and definitions

BD_EVENT field

Dictionary term	Definition
ADDITION	An addition to an existing structure
BUILD	A structure under construction
COMPLETE	A completed structure
DESTRUCT	A structure undergoing demolition
N/A	Not applicable
NULL	Not entered
RECON	A reconstructed structure
UNK	Unknown

BD_CLASS field

Dictionary term	Definition
AGRIC	A structure used for agricultural purposes (e.g. barn, cowsheds)
COMM	A structure used for commercial purposes (e.g. shop, garage)
COMM&RES	A structure used for both commercial and residential purposes
INDUST	A structure used for industrial purposes (e.g. warehouse, factory)
INFRA	A structure forming part of the transport or building infrastructure (e.g. bridge)
N/A	Not applicable
NULL	Not entered
OTHER	A type of structure not encompassed by other terms in this dictionary
PUBLIC	A structure used for public purposes (e.g. church, school, library)
RESID	A structure used for residential purposes (e.g. house, flat)
UNK	Unknown

BD_USE field

Dictionary term	Definition
DEMOLISH	A demolished structure
DERELICT	A derelict or abandoned structure
INUSE	A structure in use and serving original function
N/A	Not applicable
NULL	Not entered
OCCUPIED	An occupied structure not serving its original function
UNK	Unknown
VACANT	A vacant or empty structure

SL_VIS, ST_VIS_W and ST_VIS_D fields

Dictionary term	Definition
N/A	Not applicable
NULL	Not entered
OBSCURED	Architectural element obscured (e.g. covered by mortar) at the time of survey
PARTIAL	Architectural element partially visible at the time of survey
UNK	Unknown
VISIBLE	Architectural element visible at the time of survey

SL_ORIG, ST_ORIG_W and ST_ORIG_D fields

Dictionary term	Definition
CALLANDER	Callander district
CUMBRIA	Cumbria
ENGLAND	England (undifferentiated)
MIXED	Mixed (more than one) source
N/A	Not applicable
NULL	Not entered
OTHER	A source not encompassed by other terms in this dictionary
SCB	Scottish Central Belt
SCOTBORD	Scottish Borders
SCOTHB	Scottish Highland Border
SCOTHIGH	Scottish Highlands
SCOTUND	Scotland (undifferentiated)
SCOTWH	Scottish West Highlands
SPANISH	Spain
UNK	Unknown
WALES	Wales

SL_COND field

Dictionary term	Definition
GOOD	Good condition, repairs not required
MOD	Moderate condition, may benefit from some repairs
N/A	Not applicable
NULL	Not entered
REPAIR	Repairs required
UNK	Unknown
URGENT	Urgent attention required

2 Data fields and dictionaries for the GIS database file "Surveyed maintenance issues for Callander Conservation Area"

2.1 Data fields

Field title	Field definition
TOID	TOpographic IDentifier, assigned by the Ordnance Survey to every topographical feature in Great Britain
FOP	Field Observation Point consisting of surveyor initials and sequential number. Used to identify each surveyed structure uniquely.
ELEMENT	The architectural element to which the recorded maintenance issue refers (e.g. roofing, walling, dressings)
MAINT_CODE	The maintenance code for the maintenance issue recorded at the time of survey
MAINT_DESC	Translation of maintenance code
MAINT_COMM	Comment relating to maintenance issue

2.2 Dictionaries for data fields contained within the GIS shape file "Surveyed maintenance issues for Callander Conservation Area"

MAINT_DESC field

Dictionary Term	Description
BIOGENIC GROWTH	Algae, moss, or lichen has grown over stone masonry or slate. Typically associated with stone affected by dysfunctional rainwater goods, slate on north-facing roofs, and other areas that remain moist over a long period of time.
CEMENT POINTING/PATCHING	Impermeable cement has been applied to narrow (POINTING) and/or broad (PATCHING) masonry joints, adversely affecting the adjacent stone or with the potential to adversely affect the adjacent stone. Cement pointing/patching has commonly been applied to open masonry joints where the original lime mortar has eroded (in many cases washed out due to water penetration). Lime mortar is relatively permeable and dissolves in preference to the adjacent stone masonry, thus protecting the stone; however, where masonry has been repointed using an impermeable cement mortar, water is forced to evaporate through the stone rather than the mortar. The stone is weakened and becomes friable leading to granular disintegration.
CRACKS TO MASONRY	Masonry shows one or more cracks. Typically a feature of load-bearing blocks, areas that have undergone structural subsidence and/or sagging (differential tension/compression forces), and areas that have been expanded by metallic inserts.
DAMAGE TO WATER-SHEDDING MASONRY	Protruding masonry features (sills, cornices, string courses) designed to protect masonry beneath by deflecting rainwater off the face of the building are damaged in some way. Some of these features are intended to be sacrificial and to decay faster than other architectural elements due to increased exposure to water penetration.
DISPLACED SLATES	Slates are still fixed but one or more are displaced (moved out of correct position). Compare with the definition for LOOSE SLATES.
FACE BEDDING	Bedding planes in stone masonry are orientated parallel to the face of the building. Bedding planes can be particularly prone to weathering and parting (the latter is also known as 'delamination' and 'splitting along bedding'), so face bedded blocks can suffer decay more quickly than blocks of the same stone placed in other orientations. Stone masonry should, wherever possible, be placed with the bedding planes orientated horizontally.

FAILING FLASHING/EDGE DETAILS	Flashing and/or edge details designed to protect vulnerable masonry from excess water penetration and over-exposure to wind and rain are damaged.
FAILING RAINWATER GOODS	Gutters and/or downpipes and/or internal drainage systems are blocked or broken. Typically due to lack of maintenance, such problems can concentrate water into localised areas of masonry which is then likely to develop biogenic growth and soiling with white salts (efflorescence).
HIGHER PLANTS	Plants more sophisticated than algae, moss, or lichen have grown on a facade or roofing. The plant roots can exploit open joints and saturated mortar, and their growth can lead to further opening of the joints and increased water penetration, potentially leading to internal dampness in the building.
LOOSE SLATES	One or more slates are no longer fixed and have slipped out of position; they are, however, still present (usually in the gutter). Compare with the definitions for DISPLACED SLATES and MISSING PART. Loose slates may point to 'nail sickness' (corrosion of the nails and subsequent slipping of slate). Roof damage is often related to deterioration of the fixings and supporting timbers rather than the slate itself. Loose slates can present a danger to pedestrians.
LOSS OF LINED-OUT MARGINS	Formerly lined-out margins are no longer visible. The conglomerate walling in many Callander buildings, which was typically random rubble or irregularly coursed rubble, was commonly 'lined out' or framed by lime putty to accentuate the masonry blocks and to imitate the appearance of regularly coursed ashlar walling.
MINOR GRANULAR DISINTEGRATION	Granular disintegration has caused stone decay. Loss of cohesion between the constituent grains in a stone causes it to become friable and to disintegrate. Granular disintegration has several causes, including the growth of ice, salt or clay minerals in the pore spaces of a stone acting to force the constituent grains apart.
MISSING PART	A part of the stone masonry is missing. OR One or more slates are missing or broken such that a significant part is missing. Compare with the definition for LOOSE SLATES.
PLASTIC REPAIR/COATINGS	A plastic repair or coating (i.e. cement or other mortar used to replace part of, or an entire, stone block) has adversely affected the adjacent stone or has the potential to adversely affect the adjacent stone. When an impermeable surface is applied to stone, decay is often enhanced due to trapped water behind the coating. The underlying stone is weakened and becomes friable leading to granular disintegration.
PREVIOUS REPAIR	Enhanced stone decay is associated with a previous stone or mortar repair. This typically occurs if the material used for repair and the adjacent original stone do not have similar permeability. OR One or more slates have been replaced with slate that is not a good visual match.
REPOINTING REQUIRED	New pointing using a permeable lime mortar is recommended, because the original mortar is eroded (in many cases washed out due to water penetration).

SALTS PRESENT	An efflorescence of salt crystals has formed on the surface of the stone. A mineral salt like gypsum (calcium sulphate) can be a product of natural weathering alteration or the corrosive action of chemical cleaning agents in the stone. Other calcium sulphate and related mineral salts can form through chemical reactions in cement mortar and guano. De-icing salt (sodium chloride) laid on roads and pavements dissolves in water and can then enter permeable stone through capillary action or by 'salt splash' (typically seen in basal masonry courses and around entranceways). Salt efflorescence is an indication that salt crystals may be growing in the pore spaces of a stone, which can cause granular disintegration.
SCALING (MAJOR & MINOR)	The stone shows signs of scaling (detachment of flakes of stone on surfaces approximately parallel to the masonry surface). Scaling typically occurs when water evaporation from the masonry surface causes minerals to dissolve from or grow in the near-surface part of the stone, causing part of the stone to weaken and become prone to failure.
SIGNIFICANT CRUMBLING	Part of the stone has disintegrated into fragments. Crumbling may have a number of causes, including granular disintegration and splitting along bedding. Stone suffering from significant crumbling may threaten the structural integrity of a wall.
SOFT BED EROSION	Layers of weak or soluble material in the stone (commonly beds rich in clay or carbonate minerals) have suffered erosion. Such erosion typically develops parallel to bedding in the stone.
SOILING (MAJOR & MINOR)	The stone surface is significantly discoloured (usually greenish) by a veneer of introduced matter. Sources of soiling include algae (typically green initially, over time becoming dark/black), moss, lichen, bird droppings (guano), dust and charcoal particles.
SPLITTING ALONG BEDDING	The stone is suffering from delamination along bedding planes. The presence of excess moisture in sandstone greatly increases the likelihood of the stone splitting along bedding. Often associated with prominent horizontal masonry elements (i.e. sills, cornices, string courses).
STONE CLEANED	An aggressive cleaning method has caused discolouration and/or loss of carved detail and/or rounding of previously sharp edges and/or reduction in stone cohesion.
STRUCTURAL SUBSIDENCE/SAGGING	The masonry has moved due to ground subsidence and/or sagging within the structure. Such movements often cause masonry to crack and can lead to serious structural damage.
WATER PENETRATION TO STONE	The stone is saturated by water. This is typically due to poor maintenance (e.g. failure of rainwater goods) or heightened exposure. Parapet wallheads, projecting hood mouldings, cornices, sills and other water shedding elements are particularly prone to water penetration.

Appendix 2 Guidance for the conservation of stone and slate in Callander buildings

Introduction

Natural processes of stone decay and poor building maintenance pose a considerable threat to the long-term health and appearance of stone buildings. A carefully designed conservation plan for the stone and slate in the Callander Conservation Area will help to mitigate the causes and effects of stone decay, maintain the visual aesthetic qualities of the built environment, and reduce the risk to the public of falling slate and masonry.

The purpose of this Appendix is to identify the most serious conservation issues – in terms of damage to masonry and roofing, and loss of character – within the Callander Conservation Area, and to describe maintenance solutions that represent best practice. The data files described in Section 3 and Appendix 1 of this report contain an inventory of stone and slate conditions recorded in the course of the survey. The full list of terms used to record aspects of stone and slate condition in the Callander building survey is presented in Table 2.2 (MAINT_DESC field) of Appendix 1, with a description for each term. In the remainder of this Appendix, terms that appear in Table 2.2 are underlined (e.g. <u>granular disintegration</u>), and the reader should refer to Table 2.2 for a description of the term.

A case study of stone and slate condition in the 'Desirables' building at 1-3 Main Street, Callander, with best practice guidance for conservation and repair, is presented in Appendix 3.

Maintenance solutions for damaged stone and slate

Stone and slate undergo decay through a range of naturally occurring physical (e.g. delamination, disintegration) and chemical (e.g. mineral precipitation, mineral dissolution) processes. However, the most significant causes of damage to stone masonry in the Callander Conservation Area are <u>cement pointing and patchwork</u>, <u>face bedding</u>, and <u>failing rainwater goods</u>, all of which are associated with locally accelerated decay as a result of human intervention or bad practice. Slates no longer in correct position (<u>displaced slates</u>, <u>loose slates, missing slates)</u> and <u>biogenic growth</u> are the most significant maintenance issues for roofing in the Callander Conservation Area. Figure 18 shows examples of the most serious conservation issues affecting buildings in the CCA.

Cement pointing and patchwork

Traditional lime mortar is permeable, and does not significantly restrict the flow of moisture and air through adjacent permeable stone. Moisture is therefore able to evaporate freely from lime-mortared stone buildings, keeping condensation levels low. Cement, on the other hand, is essentially impermeable, and where applied to the surface of a permeable stone it can prevent moisture escaping; the stone therefore retains the moisture and commonly decays significantly faster than it otherwise would. Masonry adjacent to joints filled with cement mortar is much more likely to suffer exacerbated decay and internal condensation.

The localised dampness that typically occurs around cement pointing and patchwork means that biogenic growth can occur in association, which exacerbates the problem. The processes of stone decay associated with cement pointing and patchwork include <u>granular disintegration</u>, <u>scaling</u>, and growth of salt crystals (<u>salts present</u>).

Cement pointing and patchwork is very common in Callander buildings. The degree of visible decay in adjacent masonry varies, but is generally greater in sandstone and flagstone than it is in conglomerate. The grey cement is highly visible and it can conceal significant areas of the natural stone masonry, having a substantial negative impact on the visual aesthetic of the built heritage.

In some situations, cement pointing and patchwork can be removed with minimal damage to the underlying walling. However, in most cases an attempt to remove the cement is likely to cause significant damage to the underlying stone.

For future mortar repairs, a detailed analysis of the original mortar and adjacent stone should be undertaken to ensure the chosen replacement mortar is compatible with the walling. Pinning stones, which provide additional structural strength to a rubble wall and prolong the life expectancy of mortar, were used in the early mixed [M] and conglomerate [P] rubble walling in Callander. In repairs to such walls, the pinning stones should be re-used or replaced; if they are not, the appearance of the wall can be substantially altered.

Face bedding

When a block of building stone is placed ‘on cant’, with the plane of geological bedding orientated parallel to vertical stone surfaces rather than horizontally, it is said to be ‘face bedded’. Face bedding is common in vertical architectural elements, such as window and door surrounds, because the longest dimension of such elements is typically greater than the thickness of individual beds of sandstone and flagstone. Stone blocks used for such elements are commonly placed with the bedding planes aligned vertically, to achieve the required long dimension. The anisotropic character of stone with well developed bedding means it is generally significantly less strong when placed with the bedding orientated vertically than if the bedding is horizontal. Weathering and the downward pressure of overlying masonry lead to a range of decay processes, including granular disintegration, scaling, soft bed erosion, and splitting along bedding.

Splitting along bedding in face-bedded stone blocks is a significant problem in Callander buildings. Most of the problems associated with face bedding occur in flagstone: F2 flagstone has commonly been placed face bedded in dressings and walling, and F1 flagstone has commonly been placed face bedded in walling (see Table 1 and Section 4 for a description of these stone types). Face-bedded stone that has suffered significant splitting along bedding has commonly been repaired with cement mortar and painted. As discussed above, it is generally bad practice to apply an impermeable coating to building stone.

Face-bedded stone that has suffered decay should be brushed back to a healthy surface in order to prevent water from saturating the delaminating surfaces. It is generally considered good practice to retain as much original stonework as possible and to minimise physical disturbance of the stone. Stone should only be indented or replaced when structural stability is compromised. If indenting is required, a compatible, currently available stone type should be identified through a stone matching procedure (see Section 7).

Failing rainwater goods

Failing rainwater goods is not a common maintenance issue in Callander, but where it does occur it can cause significant problems to stone masonry. Localised water saturation, which accelerates decay of walling, and in some cases roofs, is often caused by failing rainwater goods. This can be prevented with regular maintenance; however rainwater goods are commonly left unmaintained and overlooked due to their relative inaccessibility. Gutters and down pipes are prone to blockage by leaves and other vegetation; freeze-thaw cycles can cause fractures to form; and leaking, badly sealed joints and exposed metal can lead to corrosion. In some cases, the capacity of rainwater goods may be insufficient to deal effectively with the volume of rainwater.

Stone affected by failing rainwater goods commonly suffers from biogenic growth, granular disintegration, scaling, and salts present (efflorescence). Slate affected by failing rainwater goods commonly suffers from biogenic growth.

Rainwater goods should be cleaned regularly, repaired or replaced with like for like materials where parts are missing or malfunctioning, and painted periodically to prevent corrosion. Rust should be removed by wire brush and/or sandpaper prior to repainting with compatible paint. With appropriate care of rainwater goods, water saturation of walling stone will be prevented and water will be removed effectively and efficiently from the roof line.

Slates no longer in correct position

Slates that are no longer in correct position have been recorded in three separate categories: displaced slates, loose slates, and missing slates. The roof is the most exposed element of a building, and slates that are no longer in correct position can lead to serious problems associated with water penetration. Loose slates in particular have the potential to fall, and so represent a risk to the public. Pitched roofs are also generally highly visible, and make an important contribution to the visual quality of the built heritage in Callander. Collectively, the three categories of 'slates no longer in correct position' were recorded in more than half of the surveyed buildings in the Callander Conservation Area. Slate roofing should be maintained on a regular basis to ensure buildings remain wind- and water-tight and safe. Inspection and repair should be carried out by trained professionals.

Natural roofing slate is generally a very durable material, and slate movement is often caused by problems associated with the fixings (nails) and supporting timbers rather than the slate itself. Corrosion of nails, known as 'nail sickness', can affect many of the slates on a roof at a similar time. Occasionally, deterioration of the slate around the nail hole can lead to slate movement. In such cases it may be possible to re-dress the slate, punch a new nail hole and re-use it, rather than replace it.

If several slates on one roof are not in correct position, the fixings should be inspected to check for nail sickness and the underlying timber sarking should be checked for rot. If the nails and sarking are in good condition, the likeliest cause of loose or displaced slates is high wind. Slates moved by high wind can simply be re-aligned or re-fixed.

If new slate is required for repair works, the selected replacement slate should match the original as closely as possible in terms of colour, texture, size and thickness. No slate quarries are currently active in Scotland, so re-using Scottish slate (from the same building, or salvaged/recycled from other buildings) is recommended wherever possible. The coursing style of a slate roof is an important component of the visual aesthetic. Diminishing courses and varied size (width and length) of slate is the typical pattern of a traditional Scottish slate roof, and this pattern should be reproduced wherever possible and appropriate.

Biogenic growth

Biogenic growth was recorded as a feature of more than one third of surveyed buildings in the Callander Conservation Area. It occurs mainly on slate roofing, but is also a feature of stone masonry. Biogenic material grows wherever conditions of moisture, light, and temperature are suitable, and its presence is an indication of persistently damp conditions.

Biogenic growth is not generally a cause of significant damage to slate; however, the increased dampness on roofs suffering biogenic growth may accelerate the decay of nail fixings and timber sarking.

The growth of biogenic material can be controlled by removing it, by repairing or improving rainwater goods, by reducing the sheltering effects of nearby vegetation, and by removing or replacing cement pointing/patchwork that may be hindering water evaporation.

Maintenance solutions for loss of character

Loss of lined-out margins

In the late Georgian and early Victorian periods, random rubble walls were commonly rendered and ‘lined-out’ to imitate coursed ashlar block. A similar practice developed in Callander, however it is not clear when the practice was introduced and to what extent it has been applied after buildings were constructed rather than at the time of construction.

The mixed [M] and conglomerate [P] rubble walls were not necessarily rendered (although some exist in the conservation area), but rubble walling was lined out. Lined-out margins are now one of the most distinctive aspects of the Callander built heritage, however more than one-third of the buildings surveyed in Callander currently suffer from loss of lined-out margins.

In all future stone walling repointing works, lined-out margins should be retained or re-instated where they currently exist or previously existed.

Figure 18 Examples of the most serious conservation issues affecting buildings in the CCA.

Top left: cement pointing/patching to stone masonry walling. Top right: face-bedded F1 and F2 flagstone blocks in window surrounds showing the effects of splitting along bedding. The vertical window surrounds have been mortared and painted, probably concealing damage caused by splitting along bedding.

Middle left: Failing rainwater goods (corroded, leaking down pipes) causing soiling (dark grey to black) to red sandstone walling, and both biogenic growth (pale green) and salt efflorescence (white; salts present) to blonde to buff sandstone dressings. These various conservation issues point to stone suffering water penetration and saturation. Middle right: slate roof suffering from many displaced slates, loose slates, and missing slates.

Bottom left: slate roof displaying extensive biogenic growth (greenish to orangeish discolouration). Bottom right: conglomerate walling suffering from partial loss of lined-out margins.

Appendix 3 A facade condition survey of the Desirables building, Callander

Building stone assessment: 'Desirables Building'

1 Cross Street & 29-33 Main Street, Callander

Emily A. Tracey and Luis J. Albornoz-Parra

Name: 'Desirables' Building	**Address:** 1 Cross Street /29 33 Main Street, Callander FK17 8EA	**Unique Property Reference No:** 000122001060
Building type: Commercial/residential	**Status:** In use	**Façade orientation:** South and East
Date built: Late 19th century	**Date of previous repairs:** Unknown	**Date surveyed:** 10 February 2010

Contents

1 Introduction

The ‘Desirables’ building at 1 Cross Street and 29-33 Main Street, Callander, was selected by Loch Lomond & The Trossachs National Park Authority for a facade stone condition survey in order to provide an exemplar ‘case study’ of best-practise guidance for stone and slate repairs to buildings in the Callander Conservation Area. The survey is intended to highlight areas of stone decay and specific issues concerning the causes of decay and associated maintenance needs in order to bring these to attention at an early stage in the process of assessment and planning for repairs.

1.1 SITE LOCATION

1 Cross Street & 29-33 Main Street, Callander

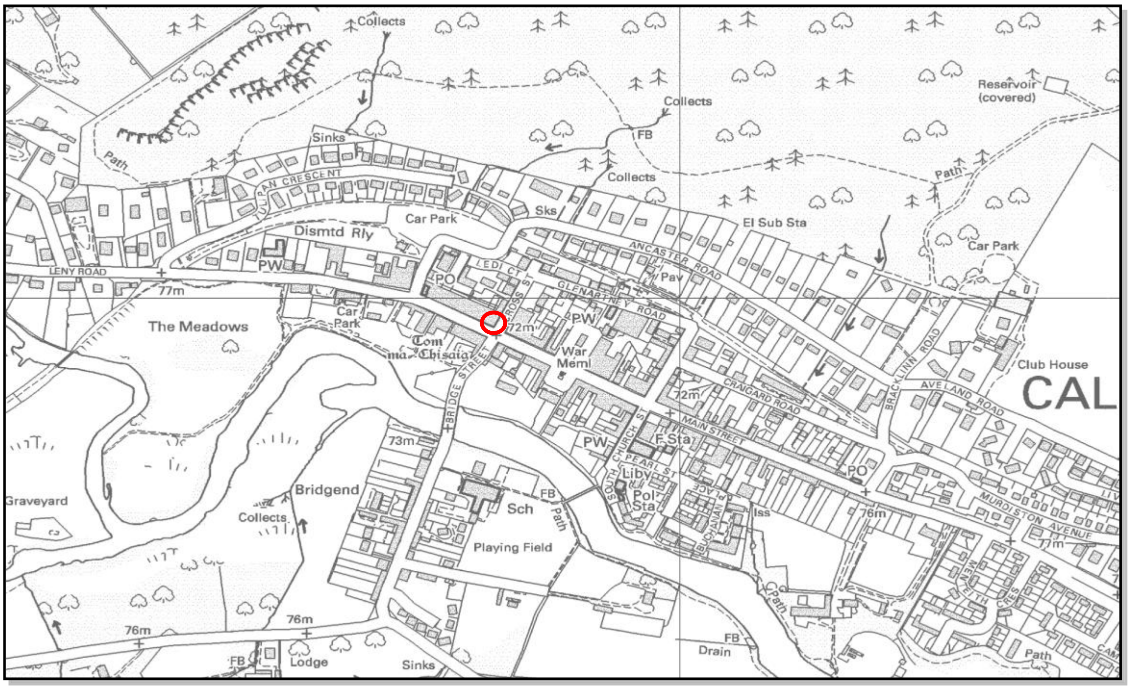


Figure 1: Location of ‘Desirables’ building (red circle) in Callander.

This building was identified by the Loch Lomond and The Trossachs National Park Authority (LLTNPA) as a good case study due to its prominent position along the central cross road of the Conservation Area, its original Victorian features (including the shop front and architectural ornamentation) and the currently poor condition of the stone work.

1.2 AIMS OF THE STUDY

The primary aim of this study is to provide information to assist the local authority, building owners and building professionals (e.g. architects, surveyors, and masonry contractors) in making decisions concerning repairs to the stone masonry and slate roofing as part of the grant-aided heritage Conservation Area Regeneration Scheme. During this study, a stone condition assessment of the street facing facades of the building was undertaken to identify masonry which shows damage or decay, and to highlight where stone and slate replacement, repair and maintenance is required. Further aims were to establish the provenance of stone and slate used in the ‘Desirables’ building, and to identify materials suited to replacement and repair that can be sourced from currently active quarries.

1.3 FACADE SURVEYS

The facade surveys are presented as rectified photographic images with digital overlays to highlight areas of stone masonry requiring repair or maintenance. The type of maintenance required, or the source of decay, is indicated by colour symbols superimposed on the digital facade images. The facade surveys of the Main Street elevation, Cross Street elevation, and corner elevation are presented at the end of this appendix as Sheets 1, 2, and 3 respectively.

1.4 SAMPLE ANALYSIS AND STONE AND SLATE MATCHING

A representative sample of stone taken from the 'Desirables' building is described in detail in order to:

1. characterise the original stone
2. establish its source/provenance (if possible)
3. identify the most appropriate currently available stone suitable for repairs

The description and sample analysis follows the procedure outlined in BS EN 12407:2000 'Natural Stone Test Methods—Petrographic Examination'.

The slate roofing was visually examined *in situ*, from ground level, under good weather conditions in order to:

1. characterise the slate type
2. identify its source/provenance (if possible)
3. identify the most appropriate currently available slate suitable for repairs

1.5 LAYOUT OF THE REPORT

This report presents the results of the facade surveys and stone and slate matching for the 'Desirables' building in Callander. The survey methodology is presented in Section 2 with a brief description of each category of damage associated with the surveyed building. Analysis of the building materials and stone/slate matching are presented in Section 3. Section 4 contains recommendations for repair and maintenance.

2 Facade survey

The facade survey constitutes a visual assessment of the stone condition based on surface appearance. The survey is not intended to be a detailed itemisation of specific stone blocks which require repair, nor a substitute for detailed structural or architectural surveys. Closer inspection may identify additional issues.

In this report the survey results are divided into two material types: stone masonry and roofing materials. Each material type is described in Section 3. The visual assessments of the stone condition of the 'Desirables' building are presented as A3 size digital images for each elevation (Sheets 1-3). Colour overlays show the areas of stone which require repair. Related issues, such as maintenance requirements, are also highlighted. The results are accompanied by defined 'categories of damage' with example locations of each (Table 1).

2.1 SURVEY METHODOLOGY AND CATEGORIES OF DAMAGE

The 'Desirables' building was surveyed from street level. The building's facades were photographed using a digital camera. The photographs were converted to 'line drawing' images, which were printed out at A3 size and marked up by hand in the field during the surveys.

For each facade a coloured digital photographic image has been marked with areas of pattern and colour to highlight localities of stone decay and damage. The resulting Facade Stone Condition Survey sheets (Sheets 3-5) should be read alongside the definitions for the various categories of damage, which are presented below. Table 1 (located at the end of this section) summarises each category and identifies specific examples from the surveyed elevations.

- *Repointing required*—This is generally highlighted where the original mortar is eroded (in many cases washed out due to water penetration), or where damage is being caused to the stone by the presence of relatively impermeable replacement mortar.
- *Fractured or cracked stonework*—Areas of masonry which are fractured or cracked are highlighted on the Survey sheets in order to draw attention to these features, whether or not the stonework is considered to require replacement. Detailed inspection of these areas should be undertaken prior to stone replacement.
- *Water penetration*—This has been recorded where the stone is saturated by water, typically due to poor maintenance (e.g. failure of rainwater goods) or in exposed elements which are prone to water saturation (e.g. parapet wallheads, projecting hood mouldings, cornices, sills).
- *Splitting and breakage (including human intervention)*—Some prominent horizontal masonry elements (i.e. sills, cornices, string courses) show splitting along natural bedding planes. This occurs where such features have been exposed to water penetration over a long period of time. The presence of excess moisture in sandstone greatly increases the likelihood of the stone splitting along the bedding. In the case of 'Desirables' many of these horizontal masonry elements appear to have been removed through human intervention. Perhaps, as splitting and major spalling were enhanced over time, these elements were removed and simply never replaced.
- *Soiling (black dots)*—This category refers to organic matter ranging from algae (typically green, forming a dark/black soiling over a long time period) to moss and lichen, and higher plants. It also includes soiling from bird droppings (guano), dust and/or charcoal particles deposited on the surface of the stone.
- *Salt or carbonate efflorescence*—Two sources of salt contamination have been observed in the 'Desirables' building:

i. As a result of water saturation and washing out of salts from the mortar (also possible from sources such as chemical cleaning or guano—both unlikely in this case). This is apparent as white efflorescence at the edge of water saturated stone, and is most common in the upper parts of buildings due to rainwater penetration.

ii. Salt splash due to contamination of stone from de-icing salts on roads and pavements, typically seen in basal masonry courses and around entranceways. Salts are dissolved in rainwater and drawn into the porous sandstone, where they precipitate within the pore spaces causing granular disintegration.

- *Scaling*—Scaling occurs due to water evaporation from the masonry surface, which draws out soluble and easy to mobilize minerals (i.e. iron oxides, carbonates, clays etc) from inside the stone, leaving a weakened subsurface layer which is prone to failure.

- *Granular disintegration*—Granular disintegration occurs when the bonds between individual grains in the sandstone are broken, usually due to the forceful expansion of growing salt crystals or swelling clay crystals (both of which can occur as a consequence of water penetration).

- *Cement mortar patches and other applied coatings or coverings*—This condition is highlighted where cement mortar patches and other applied coverings have been used to cover or patch a damaged stone surface, and where masonry has been detrimentally re-pointed (overpointed) using an inappropriate or impermeable cement mortar which is likely to result in damage to the stone.

Figure 2 Cross Street elevation. Examples of scaling, crumbling and areas where repointing is required. Paintwork is flaking off.

  Cement has been applied to many parts of the surveyed building, for example in the construction of the walled dormers, first storey bay window, the Shell Centre entrance, and alongside the side and base course of the 'Desirables' shopfront—mainly on the Main Street elevation. Although it is likely that the applied coatings were a 'cosmetic' solution to already damaged masonry, it is apparent that these products have a relatively short life and may result in further decay to any remaining stonework underlying the current construction.

- *Damaged or missing slates*—Slates which are missing or appear loose are sometimes associated with 'nail sickness' (corrosion of the nails and subsequent slipping of slate work). Slate is a long lasting natural material; roof damage is often related to deterioration of the fixings and supporting timbers rather than the slate itself. Loose slates present a danger to pedestrians.

Category of Damage	Details	Main Occurrences
REPOINTING REQUIRED	Mortar missing, dissolved/mobilised by water.	Various locations, e.g. RHS of window above Desirables shop front at Cross Street.
FRACTURED AND CRACKED STONEWORK	Due to settling of the building (differential tension/compression forces), or to expansion of metallic inserts.	Present at ground level windows and door at Cross Street elevation.
WATER PENETRATION	From defective rainwater goods and lack of water shedding elements.	Particularly at Cross Street elevation, northernmost bay.
SPLITTING ALONG BEDDING	Splitting occurs along weaker bedding planes within the stone.	Often seen in cornices and string courses.
SOILING (MINOR)	Due mainly to water penetration to the stone and algae growth. Soiling also present in area of previous signage.	A minor feature of all facades.
GRANULAR DISINTEGRATION (MAJOR/MINOR)	Stone crumbling/disaggregating due to the combined effects of poor quality stone, water penetration and salt/carbonate efflorescence.	At different locations all over the building, extending to various depths.
SCALING (MAJOR/MINOR)	Weakened subsurface prone to failure due to water penetration and later evaporation, with mineral (clay/carbonate) mobilization or expansion, creating a weakened subsurface. Occasionally related to face bedding.	All facades, mostly minor scaling that may eventually coalesce into major scaling. Present in mullions, ashlar, rubble, etc.
SALT OR CARBONATE EFFLORESCENCE	Appears pink in contrast to the redder, fresher sandstone. Efflorescence disaggregates the grains, making the stone softer and producing blistering and scaling.	All facades in multiple locations, e.g. windows and door at Cross Street elevation.
CEMENT MORTAR AND OTHER APPLIED COATINGS	Paint and occasional cement mortar.	All facades are painted. Cement mortar on upper levels and around westernmost door on Main Street and ground level.
DAMAGE TO WATER-SHEDDING ELEMENTS	Natural: splitting along bedding. Human intervention: removal of sills, string courses, cornices, and hood moulds - presumably to avoid them splitting/breaking and causing damage.	All facades and at all levels.
FAILING RAINWATER GOODS	Some have vegetation growing, others appear slightly loose and others are not fulfilling their function properly (water is pouring out of them and into the stone).	All facades, with worst condition at Cross Street elevation.
MISSING/DISPLACED/LOOSE SLATES	Minor, some slates displaced. A few missing. At least one loose slate lying on the rainwater goods.	Mainly at Cross Street elevation.

3 Analysis of materials and stone/slate matching

3.1 STONE AND SLATE DESCRIPTIONS

<table>
<tr><td colspan="2">STONE MASONRY</td></tr>
<tr><td rowspan="2">Building Description: Two-and-a-half storey corner build with wallhead dormers and cross roof. Three-storey canted bay window at southeast corner with hexagonal roof and timber eaves with flanking wallhead parapets. Stone transoms and mullions to first floor canted bay windows. Original Victorian shopfront with cast iron mouldings.

Complex rainwater good system with no original water shedding elements remaining (all sill courses, cornicing, hood moulds, etc. have been removed). No original windows. Large chimney along Cross Street elevation with heavy cement patchwork.</td><td>Visibility: Moderate (all façades have been over-painted)</td></tr>
<tr><td>Material: sandstone, the same type in both the walling and the dressings. Vivid red colour with a purple tinge, fine- to medium-grained, mostly uniform texture, moderate permeability. Appears soft and pink where altered. Strong reaction to 10% solution of HCl indicates the presence of carbonate minerals. Its carbonate content may make the stone particularly vulnerable to weathering.</td></tr>
<tr><td>Masonry Style - Walling: Irregularly coursed squared rubble. Rock-faced finish.</td><td>Masonry Style - Dressings: Smooth ashlar, large block size.</td></tr>
<tr><td>Stone origin (walling & dressings): Although the original quarry is still unidentified, moderately similar red sandstones with a carbonate mineral cement appear in both the Kinneswood and Teith formations. The origin is likely to be south of Callander and reasonably local; probably in Stirlingshire.</td><td>Sample: ED10684, obtained from the remains of a previously hacked off hood over doorway on Cross Street which later was painted over. Sample is representative of all the stone present in the building (see Figure 5).</td></tr>
<tr><td colspan="2">Masonry condition: The sandstone is relatively poor quality with significant areas of minor scaling and granular disintegration; however it is likely that this decay is superficial. All water shedding elements should be reinstated to prevent further water damage to the masonry. The current condition of all rainwater goods should be assessed, and maintenance carried out as appropriate. Both these actions will reduce the level of water penetration to the masonry. The poor condition of the sandstone has been exacerbated by the paint coating.</td></tr>
</table>

NOTE: The analysis of the stonework has been undertaken from ground level, with no access to upper levels. Stone is partially covered in paint and occasional cement mortar, significantly reducing the visible area of natural stone and thereby limiting the surveyor's ability to identify the extent of decay/damage to the stonework.

<table>
<tr><td colspan="2">SLATE</td></tr>
<tr><td rowspan="2">Roof Description: Complex roof with multiple steep pitches, with dormers and turret.</td><td>Visibility: Good</td></tr>
<tr><td>Material: Slate</td></tr>
<tr><td colspan="2">Slate description: Small size slates, irregular widths, diminishing courses, occasional 'ribboning' observed. Overall grey colour, but different tinges can be seen, chiefly greenish grey and purplish grey. Probably local slate (maybe original?), but likely redressed, as sizes are rather small.</td></tr>
<tr><td>Slate origin: the mix of colours and other characteristics mentioned in the slate description point to a source near the Highland Boundary Fault (Aberfoyle, Luss quarries).</td><td>Sample: No</td></tr>
<tr><td colspan="2">Roof condition: Some urgent repairs required; however, overall good material condition. Two slates on the Cross Street elevation (between the dormers) are about to fall (probable nail sickness)—needs urgent attention. Other displaced slates are located on the main roof as well as the corner hexagonal roof. Loose slates have fallen into the rainwater goods (recent fall, as per September 2009). See the Facade Stone Condition Survey Sheets 1-3 for exact location of all displaced slates. Close inspection of entire roof is highly recommended.</td></tr>
</table>

NOTE: The analysis of the roof was undertaken from ground level. No samples were obtained.

3.2 PETROLOGICAL DESCRIPTION OF STONE SAMPLE

A sample of the stone masonry was obtained from the surveyed 'Desirables' building for petrological analysis, with the aim of identifying a replacement stone type of similar performance to ensure long term compatibility with the original stone.

The sample was gently washed with water and examined using a binocular microscope (Bausch & Lomb). Colour was determined using a standard Munsell® Colour Rock Chart (Geological Society of America). The sample underwent thin sectioning at the University of Edinburgh thin section laboratory, impregnated with blue dye resin in order to highlight porosity. The section is supplied on a glass slide measuring 75mm by 25mm. The thin section was chosen to be as representative of the stone sample as possible, cut perpendicular to fabric and contains, where appropriate, the external surface. It was examined using a petrological microscope (Zeiss Standard WL polarizing microscope) following the procedures given in BS EN 12407:2000 'Natural Stone Test Methods – Petrographic Examination'.

Hand specimen description

A well sorted, fine-grained, red sandstone. The Munsell colour code (when dry) is close to 2.5YR 5/3-5/4; *dull reddish brown*. The stone is mostly uniform, with occasional minor banding. A strong reaction to 10% HCl indicates the presence of carbonate minerals, and a water bead test indicates moderate to high permeability. The sample appears competent in the freshest part, but is soft and crumbly up to a depth of 5-7mm from the surface. Areas suffering blistering, scaling or granular disintegration are pink rather than red. The stone is over painted, and this appears to have contributed to the stone's deterioration.

Thin section description

Moderately well sorted, mostly fine-grained sandstone, with occasional 'very fine' and 'medium' grains, and a uniform texture in the thin section.

The detrital (framework) grains are angular to sub-rounded, and dominated by quartz (c.52%). Quartz grains range up to 0.55mm across, and are generally monocrystalline, with occasional polycrystalline grains. Feldspar grains (c.7%; generally plagioclase, microcline and occasional untwinned varieties) appear mostly well preserved, though occasional relict (skeletal) grains have been replaced by clay minerals. Lithic grains (rock fragments), (c.6%) are of a mixture of metamorphic and volcanic origin. Discrete iron oxide grains (c.2%) are scattered throughout.

The intergranular component of the stone consists of authigenic (post-detrital) minerals and pore space. The authigenic minerals are sparry calcite (c.14%), clay (c.6%) and iron oxide/oxyhydroxide (c.3%). The latter mineral, which is present as thin grain coatings, gives the red colour to the stone.

The sample has a moderate open porosity (c.9%), moderately communicated with a range of pore sizes and conduits. The sandstone is moderately compacted, with punctual and long contacts binding the grains, and weakly cemented by clay, iron oxide and calcite.

Based on the relative proportions of the main types of detrital grain, the rock classifies as **subfeldspathic-arenite**.

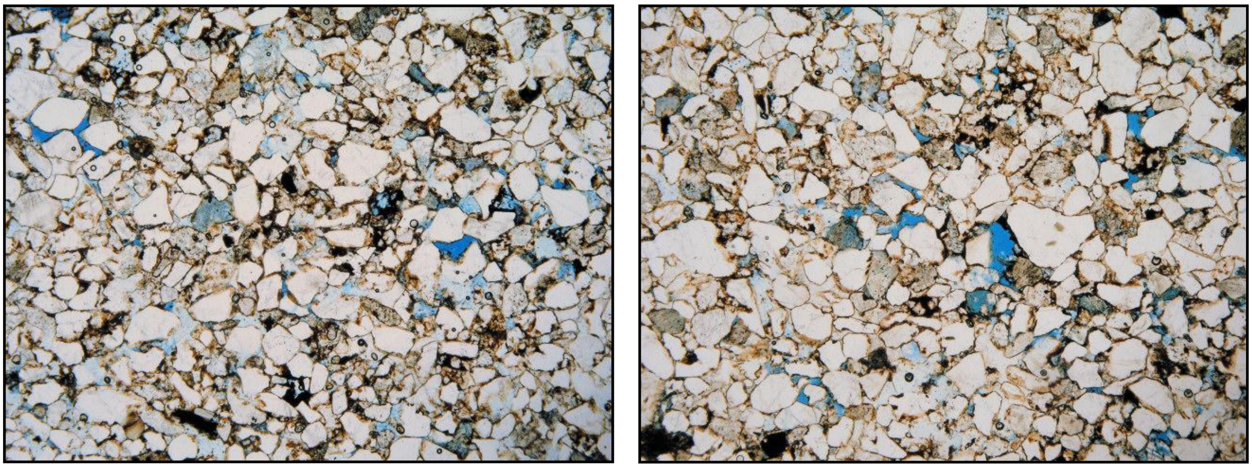


Figure 3: Microphotographs from the sample from 1 Cross Street (‘Desirables’). Images taken with plane polarised light. Pore space is highlighted in blue dye resin. The field of view is c.3.3mm wide.

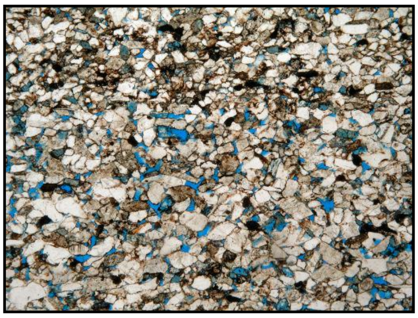
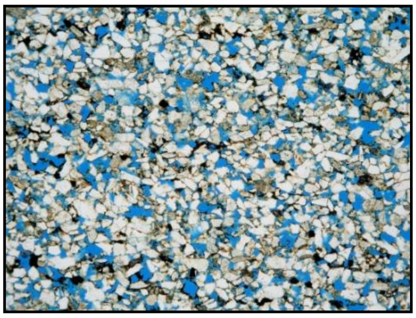
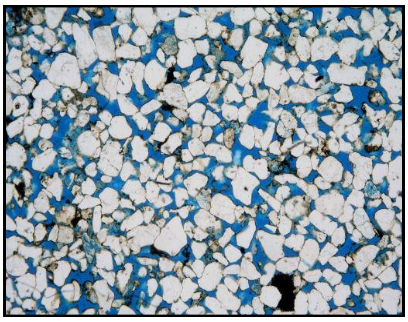
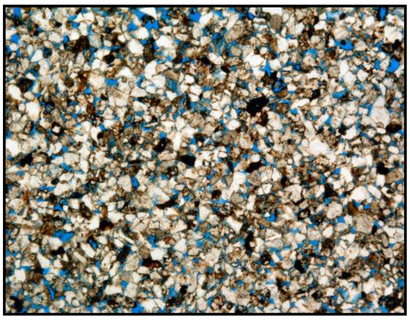
3.3 IDENTIFICATION OF CURRENTLY AVAILABLE MATCHING STONE FOR REPAIRS

None of the original quarries in Scotland producing sandstone of this type are active today. The sample from ‘Desirables’ was compared to specimens of currently-available sandstone held in the BGS collection of UK building stones.

The sandstone types with closest visual (i.e. colour, general appearance and macroscopic texture) and petrographic (i.e. composition, microscopic texture, porosity etc.) characteristics are listed below, in order of decreasing similarity to the original. These should provide compatible matching stone for repairs. Samples of these stone types should be obtained for on-site visual comparison prior to stone specification. Contact details for suppliers of these stone types are given at the end of this report (see Section 5). Microphotographs were taken in plane polarised light and have a field of view c.3.3mm across. Porosity is highlighted in blue dye resin.

Figure 4 Example of visual stone matching. The sample most to the right is the original stone from the building. Samples to the left are currently available red sandstones.

Currently available matching stones, in order of decreasing similarity:

1. **St. Bees, Beestone, bedded/laminated variety** Porosity and permeability are broadly similar to the Desirables sample, but the grain-size is finer, there is a larger proportion of iron oxides, and no carbonate minerals. • Colour is red with a faint purplish tinge, making it broadly similar to the Desirables stone. • The stone has a faint bedding lamination. This needs to be considered both for visual matching and for any masonry work (to avoid face-bedding/splitting). • There is a more uniform variety of the St Bees stone, which has a more open texture and a different colour. The bedded variety would provide a closer match to the Desirables stone, and should be specified.	
2. **Corsehill, bedded variety** This stone is somewhat finer-grained than the Desirables sample. There is a slightly larger proportion of iron oxide, a smaller proportion of clay minerals, and no carbonate minerals. Porosity and permeability are higher than in the Desirables sample, but lower than in the other available variety of Corsehill stone, which has a uniform (not bedded) character. • Colour, although slightly more orange than the Desirables stone, tends to have a faint purplish tinge, making it broadly similar. • This stone has a faint bedding lamination, which needs to be considered both for visual matching and for any masonry work (to avoid face-bedding/splitting).	
3. **Corsehill, uniform variety** This stone has a similar grain-size to the Desirables sample, but it has a more open texture, and higher porosity and permeability. The mineral composition is moderately similar, with a smaller proportion of clay and no carbonate. It is reasonably well cemented. • Overall colour is more orange than the Desirables stone. • The permeability may be too high for the stone to be suitable for water shedding elements, but it may be a good stone for walling.	
4. **Cove Red** This stone has a finer grain-size than the Desirables stone, with a moderately tight texture. Clay is relatively abundant, as are mica and feldspar grains, but there is no carbonate. The stone is moderately cemented. • Colour is more orange than the Desirables stone. The clay minerals and micas can be more evident than in other red sandstones. • Despite the small pore sizes, the stone may be rather permeable due to capillarity, which is favoured by smaller pore sizes.	

3.4 IDENTIFICATION OF CURRENTLY AVAILABLE MATCHING SLATE FOR REPAIRS

The slate has been identified as ‘Highland Boundary’ type, possibly from the Aberfoyle or Luss quarries. There are no active slate quarries in Scotland today. If new slate is required for repairs, reclaimed local Highland Boundary slate is recommended as a ‘like for like’ replacement. Given that this may not be possible, grey Welsh slate (such as Ffestiniog or Greaves Porthmadog) supplied in small sizes, variable widths, and diminishing courses is recommended. A mixture of colours (grey, greenish grey and purplish grey – Penrhyn Welsh slate) would best replicate the typical variety of Highland Boundary slates (e.g. Aberfoyle).

4 Recommendations and conclusions

4.1 RECOMMENDATIONS

The sandstone from the ‘Desirables’ building (29-33 Main Street & 1 Cross Street, Callander) is of relatively poor quality due mainly to the high content of matrix minerals and poor cementing agents (clay, carbonate, iron oxides/hydroxides), which are easily mobilized and dissolved. Such intrinsic internal characteristics make the stone soft and prone to decay, particularly if there is excess water penetration. The facade stone condition surveys found that damage to water shedding elements and defective rainwater goods were the main cause of water penetration to the existing masonry, along with the use of an impermeable paint coating over the facade surfaces.

This section will describe in detail each of the specific categories of damage and supply recommendations for repair.

4.1.1 Defective rainwater goods

A significant problem observed in the ‘Desirables’ building is excessive water penetration due to failing rainwater goods, normally resulting from lack of maintenance (e.g. blocked or broken gutters and downpipes, or problems with parapet gutters and internal drainage). Such problems typically concentrate large volumes of water into localised areas of the masonry, which is unable to cope. Where saturated, the masonry is likely to show biological growth and soiling with white salts, typically in areas of masonry subjected to continual wetting and drying. Scaling of the stone takes place where the level of water evaporation is enhanced, and granular disintegration occurs where accelerated wetting and drying results in the formation of salt crystals within the rock.

A complex guttering system was designed for the original building and is still in place today. Due to the soft nature of this sandstone (associated with the amount of carbonates), enhanced decay is more likely to occur with excess water penetration; it is therefore particularly important that the water goods are in working order and well maintained, and that the capacity of the water goods is closely examined and possibly increased.

4.1.2 Damage to water shedding elements

Excess rainwater penetration from failed rainwater goods is a common cause of masonry decay; however, a contributing factor to stone decay in the case of ‘Desirables’ is also the failure of, or damage to, water shedding elements such as sills, cornices, and string courses. The function of protruding masonry features is to protect the underlying stonework by deflecting rainwater off the face of the building. Some of these features are in effect sacrificial and will decay faster than other architectural elements (i.e. walling and dressings) due to increased exposure to water penetration. This may have been the case with ‘Desirables’—decay to water shedding masonry had accelerated to the point where complete removal or ‘breakage’ by human intervention was thought to be the best solution rather than replacement and restoration. It is strongly recommended that these water shedding elements are replaced in order to reduce the amount of rainwater penetrating the existing masonry.

Red sandstones are typically relatively permeable, making the stone prone to water ingress and saturation, and leading to the common problems of soiling and consequent decay such as is observed in this surveyed building. The permeable nature of the Desirables sandstone makes it particularly important that the building is maintained in such a way that water is deflected off the face of the masonry in order to avoid stone decay. Due to the high porosity and permeability of this sandstone, it is also important to note that lead flashing may be required to further protect masonry from excess water penetration, where appropriate.

Figure 5 Damage to a hood mould on Cross Street elevation. It is possible that the complete removal of this water shedding element was thought to be a better solution than repairing and restoring the protruding masonry; however, this has only led to the enhanced decay of the stone facade below.

4.1.3 Use of impermeable paint and other coatings

When an impermeable surface is applied to stone, decay is often enhanced due to trapped water behind the coating. The underlying stone is weakened and becomes friable. All surveyed elevations of the Desirables building are over-painted. Where the paint is already flaking the stone appears weakened and is friable.

The building was not painted until the late 1950s, as is illustrated in Figures 9 and 10 (Old Callander and the Trossachs, Bernard Byrom, 2005). Due to the soft nature of this sandstone, the paint has proven detrimental to the underlying masonry, and should be removed if this can be done without significant damage. The recommended removal method is first with wire brush and water cleaning systems (e.g. DOFF Systems) to remove the existing paint layer; and then to dress back any damaged stone to a healthy surface. <u>Further analysis should be undertaken prior to paint removal, and test trials completed before work begins</u>.

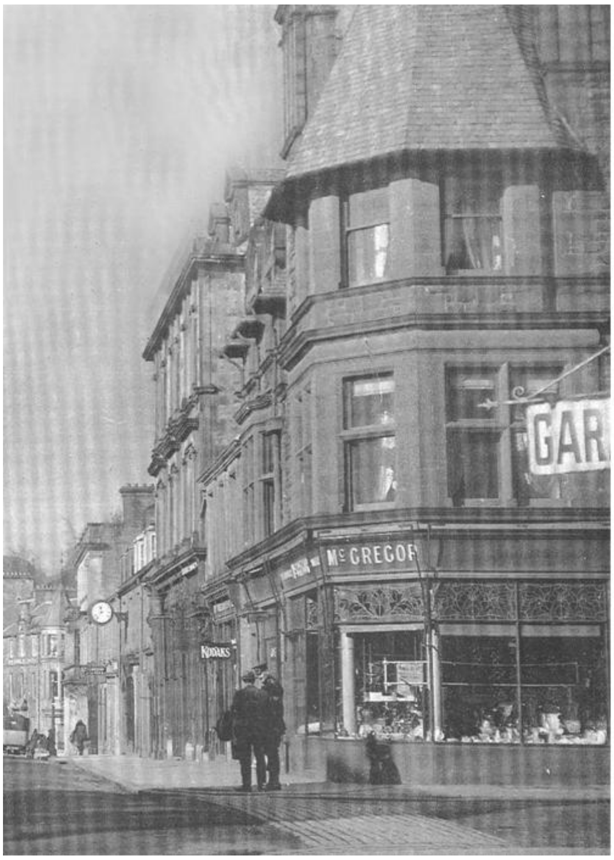


Figure 6 1920s photograph of the intersection of Main Street and Cross Street showing McGregor's as the present day 'Desirables' shop. The walling is irregularly coursed squared rubble with rock-face finish and the dressings are smooth ashlar. No over painting is present at the time of this photograph (Byrom, 8).

Figure 7 1950s photograph of Main Street showing the edge of the present day 'Shell Centre'. The original stonework of the first floor canted bay window is present; however, possible salts or carbonate efflorescence are visible in the stonework just above the bay window near the rainwater goods. This indicates excess water penetration beneath the wallhead dormers, most likely due to early stages of failing rainwater goods. No over painting is present at the time of this photograph (Byrom, 9).

4.2 ADDITIONAL INTERVENTION NEEDS

Main Street elevation:

Parapet at wallhead of hexagonal roof: Major water penetration and scaling, which has affected the walling directly below the parapet; the most affected areas have suffered from major paint loss due to scaling and granular disintegration of underlying stonework.

Fractured and cracked stonework: First storey sill course has a major crack. This is not a structural element; however, the crack will prohibit the water shedding element from diverting water off the facade, which could lead to further water penetration to the ground floor masonry.

Chimney: Major scaling and splitting. This element needs further assessment to verify its structural competency.

Removal of cement mortar (dormers and bay window): Optional.

Bay window transoms and mullions: Scaling, blistering, and granular disintegration. These elements may need further assessment to verify their structural competency.

Corner elevation:

Missing/displaced/loose slates: Loose slates present a hazard and should be removed. The roof should be inspected to determine the extent and cause of failure (possible nail sickness).

Cross Street elevation:

Fractured and cracked stonework: Minor cracking to stone masonry. The damage does not appear to pose a structural problem; however, further assessment should be undertaken. These blocks may need re-instating.

4.3 ALTERNATIVE REPAIR OPTIONS

The client has requested alternative repair options, specifically involving the use of KEIM paint. KEIM Silicate Mineral Paint is defined as:

> A waterglass and inorganic natural mineral pigment that penetrates substrate creating a covalent bond, forming a microporous breathable coating, highly vapour permeable, yet water resistant. (http://www.keim.com)

BGS has no knowledge or evidence of how this mineral pigment might perform on a sandstone substrate. Application of a new applied layer would require the existing paint to be removed (see Section 4.1.3) and any damaged stonework brushed and dressed back to a healthy surface in order to have a durable substrate for the applied coating to bind to; therefore, painting would be an additional step to the already recommended repair works.

All water shedding elements should be reinstated prior to any surface application. This will prevent the applied coating from flaking and further decay to the underlying masonry if water does get trapped beneath the surface through excess water saturation. It is also crucial that maintenance of all rainwater goods takes place along with a thorough investigation of their capacity.

The building was not originally painted and it is highly likely that the poor condition of the sandstone was enhanced by the current applied coating; therefore, it is not recommended that a new coating is applied to this building. If it this option is chosen, test trials should be performed prior to application.

4.4 CONCLUSIONS

The moderately permeable character of the Desirables sandstone makes it prone to water ingress and saturation, leading to problems of soiling and decay. This vulnerability makes the maintenance of rainwater goods and the reinstatement of water shedding elements particularly important in order to protect the masonry from excess water penetration, soiling, and further stone decay.

It is also highly likely that the poor condition of the sandstone has been exacerbated by the present day applied paint coating. The paint has proven detrimental to the underlying masonry, and should be removed—if this can be done without significant further damage to the stone. Upon removal of this coating, any damaged stone should be dressed back to a healthy surface. Indents should be made only where necessary, and with one of the matching stones recommended in this report. All functional architectural elements (e.g. string courses, cornicing, hoodmoulds, etc.) should be reinstated.

Although significant areas of minor scaling and granular disintegration were recorded in the façade stone condition surveys, such decay is likely to be superficial. The examined sample of 'Desirables' stone shows minor decay that does not penetrate far below the weathered surface (further investigation should be undertaken to establish if this applies to all elevations of the building). If the sample is representative of all elevations then the weathered masonry will probably brush back to a healthy fresh surface and the underlying sandstone should thereafter display good durability if water penetration is reduced.

4.5 FURTHER INVESTIGATION

This report looked in detail at the condition of stone masonry and the repair and maintenance requirements of a single stone building within the Callander Conservation Area. A stone sample was collected to establish the stone type and identify currently available sandstones suitable for repairs.

The type of information presented in this report will be relevant to other buildings in the local area (see, for example, Figure 8) and more widely within the Loch Lomond and The Trossachs National Park.

Figure 8 Main Street and Trossachs Road, Aberfoyle. C(s) listed building (c.1886) with squared and snecked whinstone rubble and red sandstone dressings. The red sandstone dressings are similar to the 'Desirables' stone type and display some of the similar features of stone decay.

5 Contact details for suppliers of currently available sandstones

Cove Red

Beestone

Realstone Head Office, Derbyshire
Tel: 01246 270244
Email: sales@realstone.co.uk

Realstone Scotland, Glasgow
Tel: 0141 954 1161
Email: glasgow@realstone.co.uk

Block Stone Ltd.

Derbyshire

Tel: 01246-554450

blockstone@realstone.co.uk

Red St Bees

Stancliffe Stone

Matlock, Derbyshire
Tel: 01629 653000
Email: info@stancliffe.com

Corsehill

Dunhouse Quarry Ltd.
Darlington
County Durham
General Enquiries, Tel: 01833 660 208

Contract Sales Office, Tel: 01833 660 999

Webpage: www.dunhouse.co.uk

'Desirables' Building, Callander
Facade Stone Condition Survey
Main Street Elevation

Legend

- Missing/displaced/loose slates
- Repointing required
- Fractured and cracked stonework
- Water Penetration
- Failing rainwater goods
- Major scaling & splitting/breakage - including human intervention
- Soiling
- Minor scaling & granular disintegration + possible salts or carbonate efflorescence
- Cement mortar and other applied coatings or coverings

'Desirables' Building, Callander
Facade Stone Condition Survey
Cross Street Elevation

Legend

- Missing/displaced/loose slates
- Repointing required
- Fractured and cracked stonework
- Water Penetration
- Failing rainwater goods
- Major scaling & splitting/breakage - including human intervention
- Soiling
- Minor scaling & granular disintegration + possible salts or carbonate efflorescence
- Cement mortar and other applied coatings or coverings

'Desirables' Building, Callander
Facade Stone Condition Survey
Corner Elevation

Legend

- Missing/displaced/loose slates
- Repointing required
- Fractured and cracked stonework
- Water Penetration
- Failing rainwater goods
- Major scaling & splitting/breakage - including human intervention
- Soiling
- Minor scaling & granular disintegration + possible salts or carbonate efflorescence
- Cement mortar and other applied coatings or coverings