



A Building Stone Survey for Cupar Conservation Area, Cupar, Fife

Carried out by the Scottish Lime Centre Trust

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1.0 Introduction

The Scottish Lime Centre Trust (SLCT) was commissioned by the Fife Historic Buildings Trust, operating the Cupar Conservation Area Regeneration Scheme (CARS) and the Townscape Heritage Initiative (THI), to undertake a survey of the building stone and slate in Cupar. This was in response to the general condition of the building stone in Cupar being quite poor; having been quarried around the same time and of the same or similar stone type, the stone is now deteriorating. The aim of the survey is to 'help property owners and occupiers to repair and conserve the external fabric and traditional appearance of their buildings' and to get a better understanding of the stone condition in Cupar.

Along with the stone and slate survey, the research undertaken by the SLCT also incorporated a detailed look into historic sandstone, limestone, aggregate and slate quarries in the area. This included visual condition surveys of all street-facing properties in the Priority Area as well as exemplary buildings within the Conservation Area but out with the Priority Area. As part of the visual surveys and analysis work, mortar samples were taken and analysed based on the SLCT's vast experience of historic mortars. Parallel to this and similar to the historic quarries, an aggregate analysis enables the better understanding of possible sources of mortar aggregates.

The findings will benefit the building owners, building professionals and contractors by assessing the general condition of Cupar's buildings, by identifying areas of urgent works and repairs required and by recommending maintenance routines that should be enacted.

This report should be read in conjunction with the Cupar Conservation Plan.

1.1 Geography and History of Cupar

Cupar is situated in the centre of Fife on the River Eden between St. Andrews and the M90. As such, it is the biggest settlement (population around 9,000) on the A91 and is surrounded by agricultural land. Cupar retains medieval street patterns and is important as a thoroughfare both for the railway line and for the local road network. The latter results in an amount of traffic passing through leading to a congested town centre. Around the outskirts of the old town are newer developments. The Conservation Area centres on the three main historic streets as well as the 19th Century developments surrounding the old town.

The earliest settlement in Cupar was of Pictish origin between the two rivers Eden and Ladyburn. In medieval times, Cupar held the seat of the sheriff by 1213 and was mentioned as a royal burgh by 1328. It was an important market town and the country city of Fife for a long time, with an early bridge over the river Eden. The medieval period of Cupar is still visible in the distinct street pattern of

Bonnygate, Kirkwynd and the market area in Crossgate. Entry into the city could only be gained through one of six gates located around the city. The garden walls of the individual properties made up barriers between the gates. After a number of fires in the 17th Century which destroyed much of the wooden buildings, the city was rebuilt in stone, relevant for this study.

The 18th Century represented a high time for the town of Cupar. Most of the houses remaining in the town centre now were built during this century, as an increase in wealth meant the inhabitants wanted bigger stone-built houses and better living conditions. In the town centre, most windows were said to be glazed, another indicator of the wealth of the town. Nevertheless, most buildings had thatched roofs, which can still be seen by the frequent thack stanes on the roofs in the older parts of town. Next to the important trading centre, industry started coming into Cupar with tile and brick works set up in the middle of the century. Additionally, a number of expansions on the outskirts of the town also stretched into the beginning of the 19th Century.

Industrial development became more important in the 19th Century, with industrial output including linen factories, corn mills, breweries, rope works, tanneries and more. Next to this, trading was still of great importance with many regular markets and fairs throughout the year. There was also a significant social change with an increase in finance and management jobs, the building of the County Building and establishment of a public hall in the Corn Exchange. The railway came to Cupar in 1847 and with it a change of professions with more people being employed in service and transport. Nevertheless, the railway did not bring the desired growth in trade, as being able to transport finished products from Cupar also enabled the transport of these kinds of goods in from other cities. The growth of the town halted in the middle of the 19th century with fewer developments evident compared to the 1820s.

A greater decline of Cupar could be seen after 1915 with the removal of the county administration to Kirkcaldy and Glenrothes and the closure of the remaining markets. Despite this, Cupar is still a centre for legal services and banking, and the railway continues to pass through the town on the direct north-south line.

1.2 Project Brief (Aims & Objectives)

The project brief was to complete a stone and slate survey of Cupar fulfilling certain objectives as mentioned below. This was to be focused on the Buildings Repair Grant Scheme area as identified by the Fife Historic Buildings Trust. This was to be presented in a report including the methodology and results as well as recommendations.

The aims of the project were to gain a better understanding of the condition of stone buildings within the town centre and recommendations on necessary repair and maintenance work within the area.

The objectives were:

- An analysis of the stone of the street-facing frontages and slate roofs of historic buildings within the Building Repair Grant Scheme area;
- The identification of the stone and slate types used;
- The identification of original quarries in the Cupar area that may originally have supplied the stone;
- Recommendations of matching stone and slate from currently active quarries for use in repair/conservation work;
- A survey of the condition of the stone masonry of buildings within the Building Repair Grant Scheme area and recommendations for repair/maintenance;
- Recommendations on how to deal with paintwork, particularly where this is causing damage to the stonework.

1.3 Staffing and Project Management

The project team included members of the SLCT 'in house' team as well as external consultants for their specialist knowledge. The project was managed by Stacey Rowntree and Anne Schmidt with direct input from Rosamond Artis and others from the 'in house' team.

'In house'

Rosamond Artis – Director of the SLCT and Building Surveyor

Dr Callum Graham – Building Materials Analyst

Stacey Rowntree – Building Surveyor

Scott MacAskill – Stonemason and Principal Trainer

Mitchell Fotheringham – Building Surveying Graduate/Intern, Glasgow Caledonian University

Anne Schmidt – HES sponsored Intern (currently working on our Mortars Archive to produce a joint publication characterizing Scottish historic mortars)

Neil Grieve, SLCT Trustee

External Consultants

Scott Gillies, Gillies and Farrell Masonry Ltd

Tony Carter, Technical Representative, Keim Paint

Phil Poels, Strippers Paint Removers Company

2.0 Visual Surveys

2.1 Survey Methodology

Building stone and slate visual survey

To carry out the building stone and slate visual surveys in Cupar, a visual survey form was produced to collect the raw data on each building. This form had to be flexible enough to suit the needs of each building, and also structured to create consistency throughout each survey carried out. The information collected from the visual survey forms was then condensed into a visual summary report, which outlines the defects and the repairs required for each individual building. This format makes it easier for property owners to identify the priority repairs required, and further investigation required for their building. 87 buildings within the Priority Area and 50 out with were surveyed using the visual survey forms.

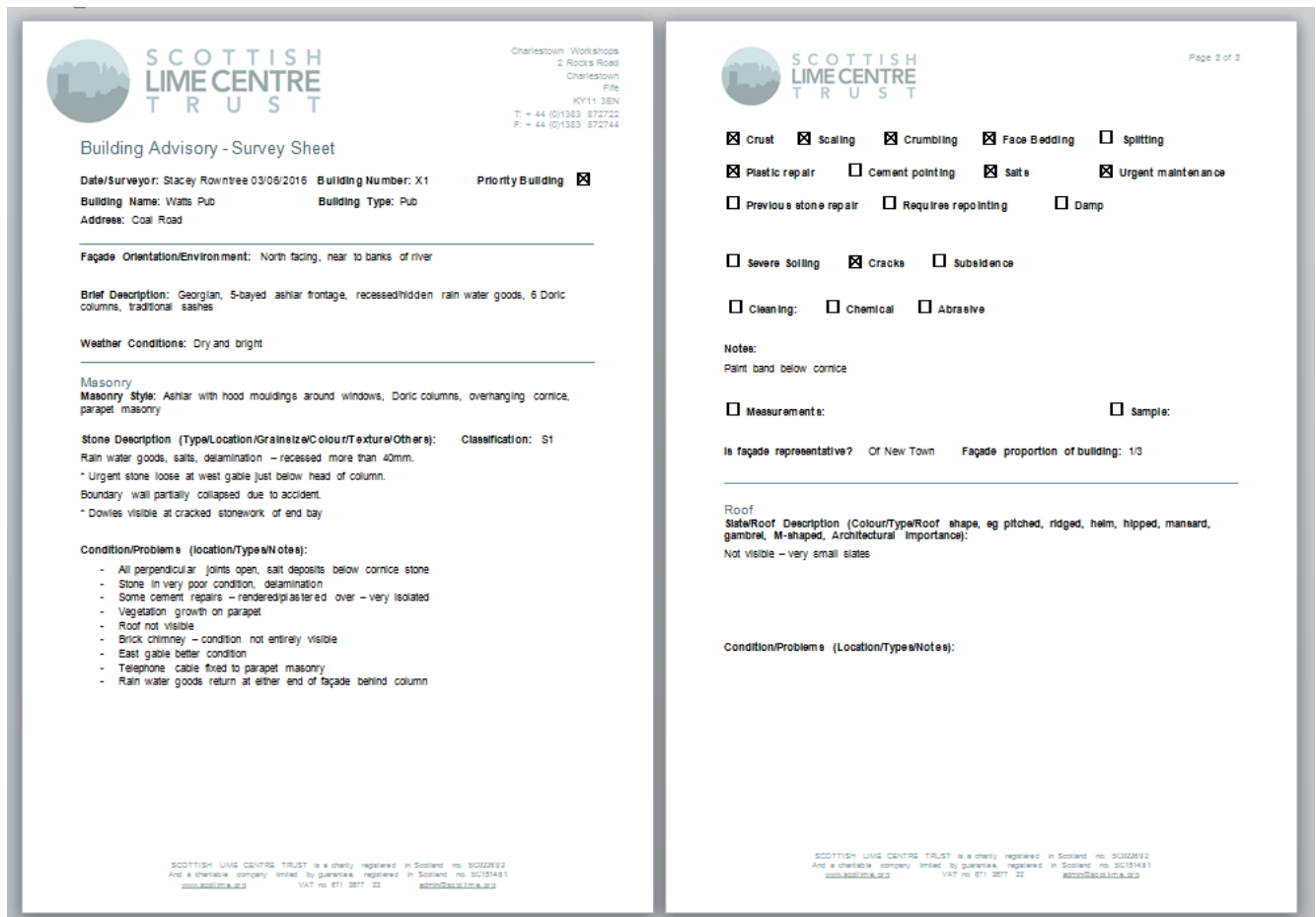
The following was included in each survey form;

- Building type
- Stone type of principal façade and its condition;
- Type of masonry, eg ashlar, coursed formal rubble, squared snecked rubble etc;
- Type and condition of jointing mortars;
- Presence of paint finishes, type and their condition;
- Presence of 'plastic repairs' and their condition;
- Presence of render finishes, material types and condition;
- Presence of 'cleaned' exposed stone, likely method of cleaning and resultant effects;
- Condition of the masonry including 'above eaves level' masonry where possible, eg chimneys, skews, stone ridges, presence of thack stanes, rebuilt chimneys, chimney pots - mismatched or missing, aerials and satellite dishes, cables and lightening conductors; further inspection recommended where condition was not possible to ascertain;
- External roof shape, eg pitched, ridged, helm, hipped, mansard, gambrel, M-shaped etc;
- Slate type and condition on front facing façade – to include presence of slipped, broken or missing slates;
- Coursing of the slates, eg laid to random diminishing courses, tally slating or decorative slating;
- Roof detailing and condition, eg abutments, fillets, flashings, ventilation, rainwater goods, decorative features including patterned slating, finials, brattishing and balustrading, dormers and roof lights;

- Summary of recommended sensitive and conservative repairs in order of priority.

The condition of each building was then categorized as follows;

- Extremely Poor and requiring emergency repair works to keep the building wind and water tight;
- Poor requiring urgent work to be undertaken within the next 12 months in order to prevent further deterioration;
- Fair but requiring necessary but less urgent work to be carried within the next 2 -5 years in order to prevent more serious problems;
- Good requiring only desirable works that will enhance or improve the buildings appearance while safe guarding original features.



The image shows two pages of a 'Building Advisory - Survey Sheet' from the Scottish Lime Centre Trust. The left page is the main survey form, and the right page is a continuation of the form, labeled 'Page 2 of 2'.

Page 1 (Left):

- Header:** Scottish Lime Centre Trust logo and contact information (Charlestown Workshops, 2 Rocks Road, Charlestown, Fife, KY11 3EN, T: +44 (0)1383 872722, F: +44 (0)1383 872744).
- Title:** Building Advisory - Survey Sheet
- Survey Details:** Date/Surveyor: Stacey Rowtree 03/06/2016, Building Number: X1, Priority Building: ☒, Building Name: Watts Pub, Building Type: Pub, Address: Coal Road.
- Facade Orientation/Environment:** North facing, near to banks of river.
- Brief Description:** Georgian, 5-bayed ashlar frontage, recessed/hidden rain water goods, 6 Doric columns, traditional sashes.
- Weather Conditions:** Dry and bright.
- Masonry:** Masonry Style: Ashlar with hood mouldings around windows, Doric columns, overhanging cornice, parapet masonry.
- Stone Description (Type/Location/Grain/size/Colour/Texture/Other):** Classification: S1. Rain water goods, salts, delamination - recessed more than 40mm. * Urgent stone loose at west gable just below head of column. Boundary wall partially collapsed due to accident. * Dowels visible at cracked stonework of end bay.
- Condition/Problems (Location/Type/Notes):**
 - All perpendicular joints open, salt deposits below cornice stone
 - Stone in very poor condition, delamination
 - Some cement repairs - rendered/plastered over - very isolated
 - Vegetation growth on parapet
 - Roof not visible
 - Brick chimney - condition not entirely visible
 - East gable better condition
 - Telephone cable fixed to parapet masonry
 - Rain water goods return at either end of facade behind column

Page 2 (Right):

- Header:** Scottish Lime Centre Trust logo and contact information.
- Page:** Page 2 of 2
- Checkboxes:**
 - ☒ Crust, ☒ Scaling, ☒ Crumbling, ☒ Face Bedding, ☐ Spitting
 - ☒ Plastic repair, ☐ Cement pointing, ☒ Salts, ☒ Urgent maintenance
 - ☐ Previous stone repair, ☐ Requires repointing, ☐ Damp
 - ☐ Severe soiling, ☒ Cracks, ☐ Subsidence
 - ☐ Cleaning: ☐ Chemical, ☐ Abrasive
- Notes:** Paint band below cornice.
- Measurements:** ☐ Measurements, ☐ Sample.
- Is facade representative?** Of New Town, Facade proportion of building: 1/3
- Roof:** State/Roof Description (Colour/Type/Roof shape, eg pitched, ridged, helm, hipped, mansard, gambrel, M-shaped, Architectural importance): Not visible - very small slates.
- Condition/Problems (Location/Type/Notes):**

Footer: SCOTTISH LIME CENTRE TRUST is a charity registered in Scotland no. SC022892. And a charitable company limited by guarantee, registered in Scotland no. SC151481. VAT no 871 2077 22.

Figure 1: Example of Visual Survey Form.

Disclaimer: All surveys have been carried out from ground level only, and being a general surface inspection of parts that are accessible and visible. These recommendations interpret external examinations only and should not be taken as an indication of internal condition.

Building stone and slate analysis work

Prior to this work being carried out, each building owner and occupier was contacted for written permission to remove both stone cores and construction / jointing mortar with an explanation of why this was deemed necessary and what the process involves.

Stone analysis work

Representative stone cores were taken from locations that minimise disruption of the façade masonry.

All voids created by stone coring were filled with a weak hydraulic lime mortar with a 20mm 'disc' taken from the core inserted flush to the wall face to minimise the visual impact. Stone cores were extracted using a specified drill with attached 45mm diamond tipped core. Coring was undertaken by our trained Stone Mason, Scott MacAskill. Cores were taken in areas where it was deemed possible to collect the minimum representative sample for physical testing and petrographic thin section analysis and where the stone was representative of the original fresh stone that is unweathered.

Four stone core samples were taken for analysis by petrographic methods following the BS EN 12407:2000 'Natural Stone Test Methods' (requiring a thin section to be prepared) and subject to physical testing to include density and porosity (BS EN 1936:1999), capillarity coefficient (BS EN 1925:1999) and water absorption (BS EN 13755:2008) following the stated BS EN methods from a selection of buildings (painted and unpainted) from within the Building Repair Grant Scheme area and subject to the owner's permission. This work was carried out in-house, in our Building Materials Laboratory (except for thin section preparation which is out-sourced). Thin section preparation was undertaken by Mr Mike Hall of the Department of Geographical Sciences at The University of Edinburgh.

Upon receipt of stone samples in the laboratory, they were washed with distilled water to remove any dust or clay and dried to a constant mass. Each sample was then analysed in hand specimen by means of binocular microscope. Stone samples were tested using a systematic approach in order to examine their: (i) grain size; (ii) texture; (iii) colour, using the Munsell Soil Colour Chart system; (iv) degree of cohesion/friability; (v) basic water absorption using the water droplet test, and (vi) carbonate content using the 10% HCL acid droplet test.

Petrographic thin section analysis was undertaken on blue-stained thin sections of each sample using an Olympus polarised light microscope fitted with a digital camera to permit recording of photomicrographs. The thin section analysis was undertaken to describe the stone texture, mineralogy, grain size and shape, pore structure (porosity, permeability) and approximate

proportions of primary and secondary minerals and clays by point counting analysis with the aid of the image processing software 'ImageJ'. The results from physical tests, macroscopic (hand specimen) and microscopic (thin section) analyses then aided in the identification of potential sources of matching (technically and aesthetically) stone where replacement dimensional stone is required and as identified by our visual survey. These results were also used to compare against those samples taken from historic quarry sites to try to identify the original quarry sources.

Mortar analysis work

The vast majority of buildings in the Priority Area and out with, are built with fine ashlar facades, which makes mortar difficult to sample due to the fine joint sizes. Very little mortar can be retrieved from these joints making it difficult to get a representative sample size. Another difficulty with ashlar mortar is that often linseed oil was used when mixing, and this reacts with acid during our standard mortar analysis, the principal service offered by our Laboratory since 1994. It forms a 'spongey' substance that cannot be analysed and therefore renders our analysis techniques for lime mortars useless. Historic lime mortars from accessible areas of rubble walling were instead used as a representation of construction or building mortars for Cupar, as these would have been used with ashlar and less formal stonework.

The samples are first dried to a constant mass to calculate their initial moisture content and then subjected to visual analysis under binocular microscope. Visual analysis revealed information relating to the physical characteristics of the mortar, including any features that may explain their weathering behaviour/failure within the building, the hydraulicity / strength and binder type (dry hydrate / lime putty / quicklime) employed in its original production and its water absorption rate.

To determine the binder : aggregate ratio, the sample is first gently disrupted and ground in a mortar and pestle and then subjected to 10% HCL acid immersion for a period of 1 to 4 days (depending on reaction). The addition of HCL acid to the sample will dissolve any carbonated lime. The sample is then filtered and dried, with the remaining aggregate subjected to dry sieve and microscopic analysis to reveal the aggregate grading, texture and mineralogy.

The results reveal the method of mortar manufacture, binder type, binder to sand ratio, source of matching sand/ aggregate, original mix proportions and matching mortar mix(es) for replacement work.

Report on findings and recommendations to include

An overall list of the recommendations for building repair work will be prepared which has been developed from the building summary sheets. These building summaries can be made available to

the building owners if FHBT see fit. Visual surveys of the roof scapes will include recommendations for further investigation work where required to reveal the nature of the defects identified.

2.2 Examples of Visual Summaries



Charlestown Workshops
2 Rocks Road
Charlestown
Fife
KY11 3EN
T: +44 (0)1383 872722
F: +44 (0)1383 872744

Address: Watts Pub, Coal Road
Condition: Poor
☒ Target Building

Summary of Repairs Required:

- Extensive stone repairs required to loose, cracked and damaged masonry – stone replacement required urgently
- Surface repairs and repointing required to less decayed stone
- Salts require brushing off at parapet level
- Investigate concealed gutter as clearly there is a problem with water at the parapet
- Full condition survey required for remedial works

☒ Urgent Repairs Needed *please see notes

Description of Building:
Georgian, 5-bayed ashlar frontage, recessed/hidden rain water goods, 6 Doric columns, traditional sashes

Stone Description: ☐ Stone Sampled

Ashlar with hood mouldings around windows. Doric columns, overhanging cornice, parapet masonry. Salts, delamination under hidden rainwater goods. Stone in very poor condition, delamination. Some cement repairs, rendered/plaster over. Vegetation growth on parapet. Urgent: stone loose at west gable just below head of column; dowels visible at cracked stonework of end bay.

☐ Stone/Painted ☐ Render/Painted ☒ Exposed Stone
☐ Presence of DPC ☐ Cleaned ☒ Fixings: Telephone cable fixed to parapet masonry

☒ Solid Masonry Wall ☐ Cavity Wall

Mortar Description:
Ashlar stuff. Cement repairs throughout façade.
☐ Surface Repairs ☐ Needs Repointing

Slate/Roof Description:
Roof not visible. Brick chimney better, condition not entirely visible.
☐ Scots Slate ☐ Easing Course ☐ Pantiles
☐ Traditional Random Diminishing ☐ Diminishing Regular ☐ Regular Coursed

Rain Water Goods: Hidden behind parapet, return at either end of façade behind column.
☐ Blocked ☐ Vegetation ☐ Rusted/Needs replacing

Disclaimer: All surveys have been carried out from ground level only, and being a general surface inspection of parts that are accessible and visible. These results interpret external examinations only and should not be taken as an indication of internal condition.



Charlestown Workshops
2 Rocks Road
Charlestown
Fife
KY11 3EN
T: +44 (0)1383 872722
F: +44 (0)1383 872744

Address: ~~Semichan~~ 11-13 Crossgate
Condition: Fair-Poor
☐ Target Building

Summary of Repairs Required:

- Removing of vegetation from above shop front
- Repointing required at chimney
- Chimneys need further investigation due to leaning
- Cleaning of downpipe required

☐ Urgent Repairs Needed *please see notes

Description of Building:
Sandstone ashlar front, smooth. 3-storey, 4 bays with sash and case windows. Recessed gutters

Stone Description: ☐ Stone Sampled

Smooth ashlar buff/orange sandstone. Stone starting to delaminate. Vegetation growth above shop front. Soiling around downpipe on left. Cornice has been damaged.

☐ Stone/Painted ☐ Render/Painted ☒ Exposed Stone
☐ Presence of DPC ☒ Cleaned ☐ Fixings:
☒ Solid Masonry Wall ☐ Cavity Wall

Mortar Description:
Cement pointing in some areas.
☐ Surface Repairs ☒ Needs Repointing

Slate/Roof Description:
Gray slate (Scots) on pitched roof. Few slipped slates. Mortar skew fillets are in poor condition. Chimneys require further investigation, they are leaning and joints empty in areas.
☒ Scots Slate ☐ Easing Course ☐ Pantiles
☐ Traditional Random Diminishing ☐ Diminishing Regular ☒ Regular Coursed

Rain Water Goods: Downpipe on left blocked leaving soiling and vegetation growth
☒ Blocked ☒ Vegetation ☐ Rusted/Needs replacing

Disclaimer: All surveys have been carried out from ground level only, and being a general surface inspection of parts that are accessible and visible. These results interpret external examinations only and should not be taken as an indication of internal condition.

Figure 2: Examples of the survey summaries.

Figure 1 and 2 above outline examples of the visual summaries included in Appendix A and B, which can be given to building owners as a summary of works required to improve the condition of their building. From carrying out these visual surveys we have gained large quantities of data relating to trends on maintenance and defects in Cupar. These will be discussed later on this section.

To highlight the key trends, we will focus on a few properties in Cupar which will demonstrate the effects of a lack of maintenance, use of inappropriate materials and poor stone qualities.

Watts Pub, Coal Road (S1)

One of the target buildings as part of the Cupar THI is Watts Pub (Figure 3), which has a myriad of issues caused by a lack of maintenance and a poorer stone quality. As the visual survey summary highlights, there are several areas of cracked masonry which in some places have become partially detached and could fall below.

The managerial staff have informed us that fallen pieces of masonry have been found



Figure 3: Watt's Pub.

before following bad weather, and in response they have moved the outdoor dining areas away from these areas. It is therefore quite urgent that these high level areas of loose masonry be attended to immediately to avoid any risk of masonry falling onto the public below. The repairs required to the building are predominantly stone replacement and repointing empty joints as this is the most widespread problem. There are previous surface repairs that require removal as these are causing damage to the stone and have been carried out in dense, cement based mortars. This is due to the poorer stone quality having eroded away at exposed areas, requiring surface repairs and thus the cement mortar has not solved the problem but made it worse. Surface repairs are only a 'sticking plaster' method of repairing stone, particularly if carried out in cement with soft sandstone as this can lead to further decay. However, if the correct materials are used, with the right methods and a skilled worker then it can be a means to revive lost details in carved stone.

As the building has a grand design and is significant to the town of Cupar as the former jail, it would be a shame to lose the detail in the stonework. It would be recommended to carry out isolated surface repairs to restore the details lost around windows, column heads and any areas of carved stone using appropriate materials.

From the picture, the salt accumulation on the surface of the stonework is obvious, and it is widespread. This is most likely due to the concealed gutters and downpipes not working efficiently as rainwater is either being blocked by vegetation or not being drained fast enough and being allowed to penetrate the parapet masonry. If lead is used to line the watergate (possible detail, although not confirmed or inspected), then this may have failed and requires to be renewed. Further investigation is required at high level to ascertain the route for water, as it is clearly an issue here and action is required to stop further salts being produced. It is recommended these salts be brushed off with a wire brush, although this will not stop the salts from re-forming; the root cause of the water needs to be addressed before salts can be eradicated.

8 Bonnygate (possible S1)

This property (Figure 4) highlights the effects of the inappropriate use of dense materials on soft sandstone, and also the lack of maintenance that can cause damage. The stonework has been repaired so many times using various materials, it is almost impossible to make out the original fabric. As some of the render, cement wash or paint has fallen off in areas, this allowed us to identify the stone beneath. The external condition of this target



Figure 4: 8 Bonnygate.

building is extremely poor, as the stone is quite soft

and the dense cement surface repairs are causing the stone to work much harder and weather much faster. The masonry paint or cement wash is also trapping moisture and causing the stone to decay, which is much worse at the left hand side downpipe where water is obviously cascading down the wall regularly. The lack of maintenance and regular clearing of rainwater goods and vegetation is causing the stonework to work much harder as more water is retained on the surface, saturating the stone. It is recommended to remove all finishes from the surface of the stone and assess the condition of the stone underneath when exposed. Some further stone repairs may be required, possibly stone replacement if the condition is very poor. The poorer stone types in Bonnygate are usually treated in some way in a response to weathering, and therefore it would be best to protect the stonework once repairs have been carried out by means of a harl finish, or paint (lime paint or mineral based paint). Ongoing maintenance is also advised, and this should be coordinated with the neighbouring property.

44 Kirkgate (local sandstone, type unknown)

Urgent repairs are required at 44 & 46 Kirkgate (shared) where the chimney stack has an alarming amount of fabric loss due to various reasons (Figure 5). These are most likely cement mortars being used on a soft sandstone causing the stone to erode at a very exposed area, potentially sulphate attack could be causing stone decay, and the poor quality of stone being used with no protection from the weather. This chimney would require taking down and rebuilding, with some replacement stones bedded in robust lime mortars. It may also prove prudent to render the chimney in a weather proof lime render to prevent this extent of decay from happening again in the future.



Figure 5: Chimney of 44 Kirkgate.

2.3 Trends

The SLCT undertook visual surveys of all of the building facades within Cupar to gain an overall view of the building conditions. What was found was that there were definite trends that ran through all of Cupar with regards to problems that contributed to the deterioration of the building stock. This was then examined further and trends were drawn from these surveys. The findings were that a lack of maintenance was mostly to blame for the problems observed in the visual surveys. The survey areas were broken into two different areas: the first being the Priority Area as outlined by the Cupar Townscape Heritage Initiative. This encompassed Bonnygate, Crossgate and St Catherine Street where we undertook surveys of 87 buildings in this area. We then carried out a survey of 50 buildings out with the Priority Area, and these were broken into 5 sub sections with 10 buildings in each. These were:

- Area A - Crossgate,
- Area B - Kirk Wynd, Provost Wynd,
- Area C – Bonnygate, West Port,
- Area D - Newtown, Bishopgate, Burnside (western)
- Area E - Castlefield, Burnside (eastern)

The trends that were found throughout these areas are as below, the 50 buildings out with the Priority Area have been grouped together as it was felt that presenting them in one table gave a better representation of the problems within and out with the Priority Area (Table 1 and Table 2).

Priority Area	
Defect	Number of properties effected out of 87 buildings
Vegetation growth on building	52
Rainwater goods require cleaning/replacement	50
Repointing required	49
Stone replacement/surface repairs required	23
Requires new render	21
Slipped/missing slates & tiles	17
Chimney requires attention	47
Presence of salt crystallisation	2

Table 1: Defects within the Priority Area

50 Buildings out with Priority Area	
Defect	Number of properties effected out of 50 buildings
Repointing required	41
Vegetation growth on building	25
Rainwater goods require cleaning/replacement	24
Stone replacement/surface repairs required	17
Presence of salt crystallisation	14
Slipped/missing slates & tiles	2
Chimney requires attention	15
Requires new render	1

Table 2: Defects out with the Priority Area

The most prevalent problems that were evident in the findings were related to the maintenance of the rainwater goods and repointing of buildings. It was established that the vegetation growth has a direct correlation to the failure of the rainwater goods, as the vegetation was thriving on the water which was not draining away adequately and debris from blockages. An issue which affects most of the inner part of Cupar is a lack of space for accessing roofs and rainwater goods, due to the roads and pavements being quite narrow and busy. It is likely that this is a



Figure 6: Blocked rainwater goods causing vegetation growth on the façade of 20 St. Catherine Street.

contributing factor in the neglect of rainwater goods in the Priority Area. Another factor that was taken into consideration was that most of the properties affected have more than one property and therefore multiple owners, and it is a possibility that the residents may not be working together to clean and maintain the rainwater goods (Figure 6).

The repointing works which are required in both areas could also in part be attributed to the failure of the rainwater goods as the water is tracking down the face of the building, in turn washing out the mortar joints. However, many of the buildings requiring repointing is not a result of open joints, but rather the main reason for repointing work to be carried out in Cupar is due to the use of inappropriate materials. Most of the buildings in Cupar are pointed in cement which is causing substantial damage to the stone work of the buildings, and in these cases it is advised that the cement mortar be removed and replaced with a lime mortar.

The findings also showed that the buildings badly affected by salt crystallisation were predominately in the areas out with the Priority Area with 7% of the buildings showing the presence of salt crystallisation, where as in contrast only two of the buildings within the Priority Area with salt crystallisation (Figure 7). This is thought to be due to the fact that the majority of buildings in the Priority Area are painted at ground level or have a plinth course which stops salts from forming by excessive wetting and drying cycles or by road grit, therefore not showing on the façade.

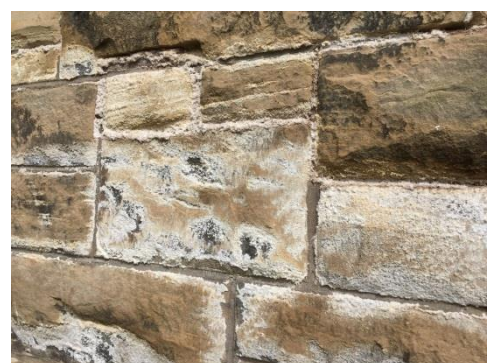


Figure 7: Efflorescence on the façade of West Port flats.

There are more chimneys within the Priority Area which require attention i.e. repointing work or vegetation removal. However, there is only 1% of the chimneys in the non-Priority Area which require attention, but these chimneys are in urgent need of repair as they are causing a safety risk.

Vegetation growth on chimneys in the Priority Area is thought to tie into the lack of access to the roof area due to the limited space on the pavements. It is harder to determine why the chimneys in the non-Priority Areas have fallen so far into disrepair; it may be down to an 'out of sight out of mind' mentality which is common where maintenance is not regularly carried out. This is not easily confirmed through surveys alone, and hopefully with on-going consultation through the CARS and THI schemes, more knowledge can be imparted to solve this issue.

It was found that a larger percentage of the buildings that were rendered were in Bonnygate compared to Crossgate and St. Catherine Street. This is thought to be the case as the stone used in Bonnygate is of a lesser quality than the other areas. Due to a faster deterioration these facades were rendered, painted or harled in a greater number than in the rest of the Priority Area.

The trends are consistent throughout the whole of Cupar, with select problems that are more prevalent in one area rather than another. The severity of the problems are not taken into consideration when looking at the trends, and this is outlined in the visual summaries for individual buildings.

3.0 Stone and Slate of Cupar

3.1 Geological Background

Cupar is located within the Midland Valley of Scotland; a major geological terrane of generally low-lying land which is separated from the Grampian Terrane in the North by the Highland Boundary Fault and from the Southern Uplands Terrane in the south by the Southern Uplands Fault (Figure 8). Terranes are major geological structures, or individual slabs of the Earth's crust that have separate and distinct geological histories from surrounding 'slabs' of land, and which are defined as a group of similar aged and type of rock. Scotland is comprised of three main terranes, or blocks, of different aged crustal rock; namely the Southern Uplands, Midland Valley and the Highlands and Islands.

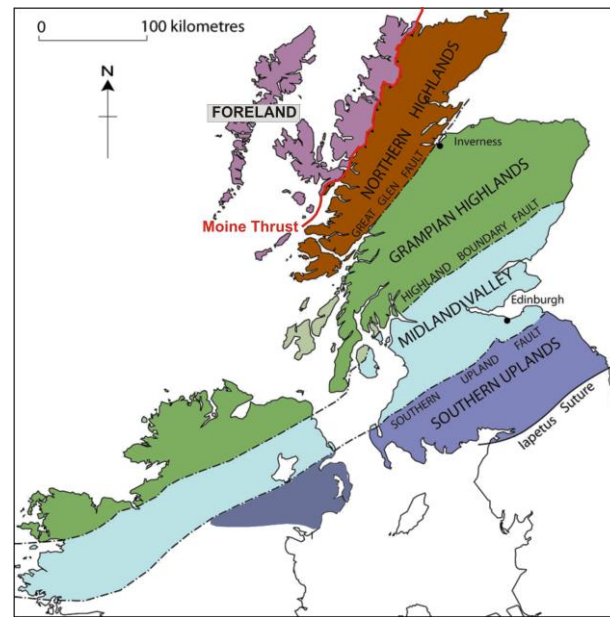


Figure 8: The five different terranes of Scotland (Mendum, 2012).

The Grampian Terrane (part of the Highlands and Islands) is comprised of a sequence of metamorphosed sedimentary rock that are known as the Dalradian Supergroup. After sediment had been previously deposited within shallow seas, the land was ‘uplifted’ during a major mountain-making process called an orogeny; known as the Caledonian Orogeny. During this period of ocean closure and tectonic collision, this sequence of sedimentary rock was folded and subjected to great temperatures and pressures (known as metamorphism), turning originally soft and granular sedimentary rock such as sandstone, siltstone and mudstone into hard crystalline rock, including psammite/quartzite, schist and slate, respectively. The height of the land (or ‘relief’ in relation to the surrounding rock) was significantly increased during this period, making this land especially susceptible to increased weathering and erosion, which was to influence the mineralogy and type of rock deposited in the Midland Valley.

The Midland Valley is an ancient ‘graben’, or valley structure that was formed between the two major areas of high land of the Southern Uplands and Grampian Terrane (Figure 9). It is comprised of both Devonian and Carboniferous strata, aged between 416 – 359 million years and 359 – 299 million years, respectively. In Scotland, this sequence of Devonian-aged rock is usually referred to as ‘Old Red Sandstone’ (ORS); applied to the rock due to its common red to brown colour. Devonian-aged rock is found in both the most northern and southern regions of the Midland Valley, with rocks at each location influenced by the eroded rock of the Grampian and Southern Uplands Terranes, respectively. By the end of the Caledonian Orogeny (~416 million years ago), large rivers had developed that transported and deposited sediment from the eroding Dalradian rocks into the now developing Midland Valley. Areas closest to the valley sides produced immature and poorly sorted

rock known as conglomerate, while areas further away formed sandstones and siltstones, with some ORS rocks containing important fish fossils. Scotland during this period experienced an arid climate which was dominated by alluvial fans, rivers and shallow lakes; which then developed into the conglomerates, sandstones, siltstones, mudstones and occasionally limestones that are present in the Devonian rocks of the current Midland Valley.

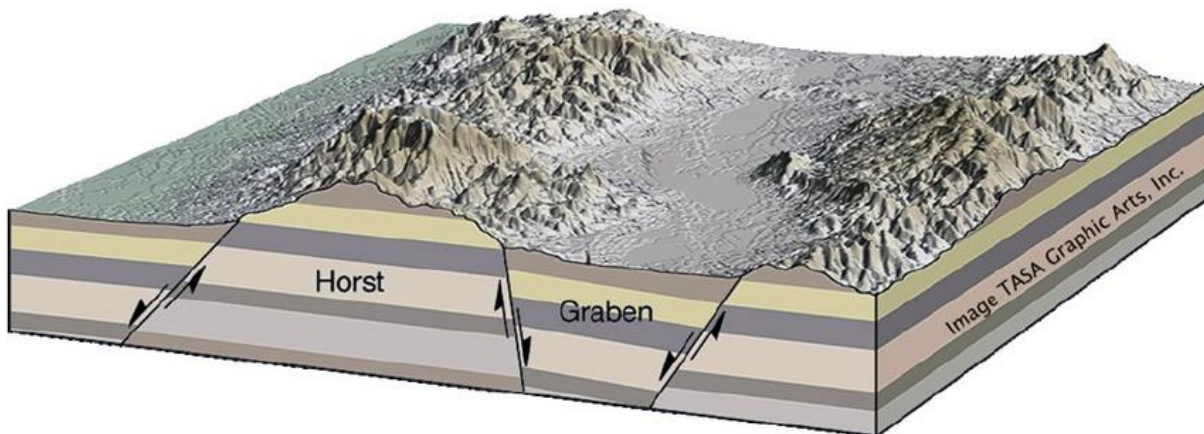


Figure 9: Schematic diagram depicting a typical horst and graben structure (Wood et al, 2015); similar to the Midland Valley of Scotland, which was located within a graben valley structure.

Sitting stratigraphically above the ORS is Carboniferous-aged rock, which dominates the main central belt of Scotland, incorporating much of the country's main settlements. The carboniferous strata is characterised by a range of different sedimentary and igneous rocks, most notably sandstone, limestone and coal, as Scotland was situated within the tropic region (near the equator) at this time.

Cupar is directly underlain by rocks of upper Old Red Sandstone, with the upper stratigraphic boundary between the ORS and Carboniferous present just south of Cupar (Figure 10). The rock directly underneath Cupar forms the Burnside Sandstone and Glenvale Sandstone Formations, which are part of the Stratheden Group of sandstone, siltstone and conglomerate (Figure 11), with the boundary between the Devonian and the overlying Carboniferous rock located at Dura Den, transecting the land between Blebo Craigs and Kemback. Located directly North of Cupar lie andesite and basalt rocks of the Ochil Volcanic Formation of Devonian age.

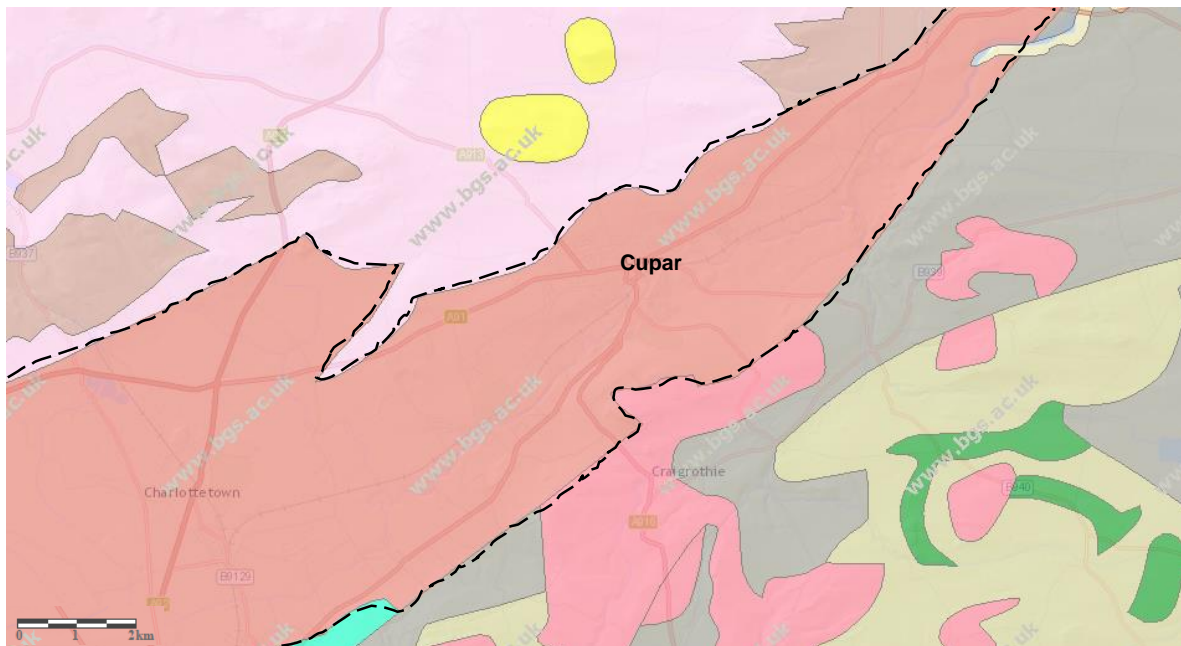


Figure 10: Geological map of Cupar. The area within the dashed lines represents upper ORS of Devonian age. North of this lies igneous rock of Devonian age, and South of it lies sedimentary rock of Carboniferous age and igneous rock of Carboniferous to Permian age. *Contains British Geological Survey materials © NERC (2016).*

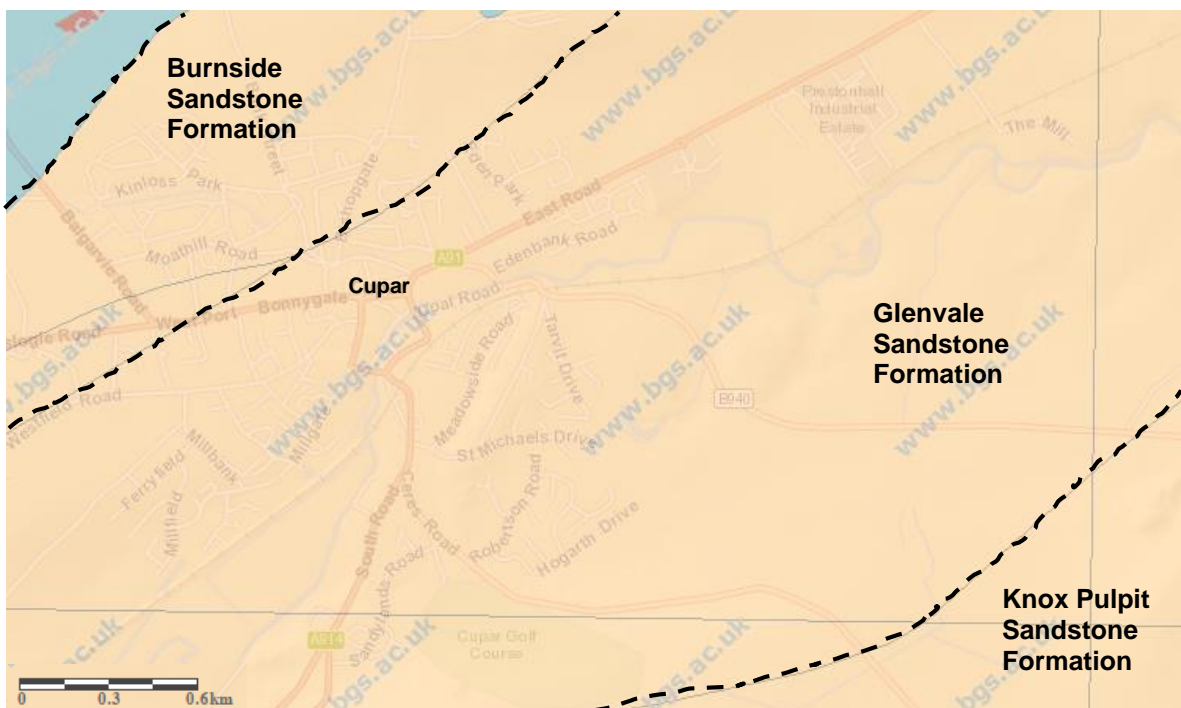


Figure 11: Underlying geology of Cupar. *Contains British Geological Survey materials © NERC (2016).*

The Stratheden Group (359 – 385 million years old) is comprised of a mixture of sandstone, siltstone and conglomerate, and stretches North East, past Guardbridge to the eastern Fife coastline and South West to Kinross. During this time, the area of land that would become Cupar was dominated by rivers and alluvial fans. Sandstone and siltstone was formed from rivers depositing sand and gravel type deposits in river terraces, while finer grained siltstone was formed in overbank floodplain deposits. Conglomerates would have formed closer to the source material, where fast-moving rivers in the higher land would have cascaded down into flat lying valley floors, depositing a mixture of large pebbles within a matrix of fine sand and clay.

The Carboniferous period marks the youngest bedrock strata within the Cupar and East Midland Valley district, at roughly 299 million years old. Since then, parts of the Midland Valley have undergone considerable erosion, with later mass structural movement uplifting the Midland Valley to a similar height of the Grampian Terrane. A final major period of change then took place during the Quaternary period, when parts of east Fife were enveloped by shallow seas, depositing raised marine deposits of sand, silt and mud, and in cold periods when glaciers dominated much of land, eroding and shaping the distinct U-shaped valleys that are present throughout Scotland, depositing sand and gravel moraine and till deposits.

The buildings of Cupar are influenced by this underlying geology, with most buildings built using the local brown to orange coloured sandstone and mortars utilising the plentiful Carboniferous limestone and quaternary sand deposits.

3.2 Economic Geology

Throughout history we have continually exploited our natural geologic resources for our economic benefit. The Midland Valley and Grampian regions of Scotland have supplied the country with some of its most important natural resources, especially in respect to the construction industry. Within Fife, sandstone, limestone, whinstone, coal, clay and sand have all been exploited to different extents. Sandstone and igneous rock (whinstone); which was quarried from the local volcanic measures and igneous intrusions, were used extensively as building stone within Cupar and the surrounding towns and villages, while coal, limestone and sand would have been quarried extensively for use in lime mortars, and clay for brick manufacture. Table 3 presents a list of all known current and historic quarry and pit works within the Cupar region. Similar resources would have been exploited elsewhere, with extensive coal seams and ironstone mined throughout the Carboniferous of the Midland Valley, and slate quarried extensively along the highland boundary fault and within Ballachulish and the inner Hebridean slate islands. A list of all known current and historic sandstone quarries within the Cupar region are presented in Table 7.

Material Resource	Number of known quarries
Sandstone	29
Limestone	8
Sand and Gravel	26
Igneous	101
Clay and Shale	4

Table 3: Number of known current and historic quarries within the Cupar region; which contain 'Cupar' as part of the quarry address.

3.3 Building materials

It is important to consider buildings as composite structures, comprising of stone, brick, mortar and slate, rather than just considering stone and mortar as separate entities in isolation. The combination of materials and their compatibility is of utmost importance in determining the performance characteristics of the walls in use, and especially when considering suitable repair materials and strategies. In the case of stone repair or replacement, mortar must be considered within this repair strategy. Built structures within Cupar are almost entirely constructed using local natural materials, consisting of local stone, lime and aggregate; influenced by the underlying and local geology of Fife, while slate was likely imported from elsewhere in Scotland and the United Kingdom.

Each different building stone type in Cupar was identified and described, with representative stone cores measured for their physical properties and analysed by petrographic microscope. Samples of mortar, representative of their different use within buildings (bedding, pointing, construction) were also analysed for their method of manufacture, original mix proportions, binder type, binder strength and source of aggregate/sand.

3.4 Building Stone

Buildings within the Cupar Conservation Area are constructed using a small range of different stone types, with each stone differentiated by its colour, mineralogy and texture. Each different stone type used throughout Cupar was originally identified during the initial walk-over survey, with field notes relating to colour, mineralogy, grain size, texture, stone type and condition made about each distinctive stone. It was initially very clear that one building stone type dominated the stone-built structures in Cupar. In order to present a more comprehensive report of the subtle and sometimes substantial differences within this stone type, each stone that displayed these specific characteristics was assigned a separate 'code'; namely S1, S2, S3, S3a, S4, S5, S6 and W1, with the prefix 'S' representing 'sandstone' and 'W' representing 'whinstone'.

Stone types classifications

The most prominent stone type used within Cupar is of local brown to buff and grey coloured sandstone, followed by the minor use of conglomerate, basalt, granite, larvikite and new brick. Sandstone was classified into seven different 'types' or 'codes' in an attempt to describe and highlight the different textures and conditions of the stone. However, upon further petrographic analysis of select sandstone cores, it is considered that only four distinct types and 'qualities' of sandstone, including conglomerate, exist within the main conservation area. Basalt was found exclusively in the Castlefield area of Cupar, while granite and larvikite were used solely in the base-courses of retail buildings.

Table 4 highlights the initial stone descriptions for each sandstone 'type'; with differences mainly associated with the quality of the stone, grain size and stone texture. Upon petrographic thin section analysis of representative samples of some of the sandstone types, it is concluded that only sandstone types: S1 (including S5 and S6), S2, S3 (including conglomerate) and S4 are representative of distinctly different sandstone types. A summary of the petrographic analysis results for each analysed sandstone type is given in the stone sample description summary.

Stone type	Description	Weathering features
S1	Blonde to yellow and buff coloured, with dark orange speckles/mottling and banding. Fine to medium grained, very heterogeneous sandstone, containing fine laminations, ripple beds, cross-beds and layers/bedding planes. Fe (iron) and clay-rich sandstone, with different sized (small – large) clay inclusions and Fe-nodules. Generally soft and friable, containing a striking orange mottle appearance and high-range of sedimentary features.	Bottom courses of buildings highly affected by: delamination, granular decay, bubbling, flaking, contour scaling, salt bursting, salt efflorescence, gypsum crusts, fracturing and cracking amongst others.
S2	Grey to white coloured, generally medium to fine grained and locally coarse grained sandstone. Some faint laminations present, with locally finely bedding (up-to 5-7cm between bedding planes), but generally homogeneous and uniform throughout. Quartz-rich and generally well-graded, texturally mature sandstone, with a small proportion of darker grains evident. Grains are predominantly rounded to sub-rounded and spherical, showing point and line-contacts; well compacted and cemented, strong, high quality sandstone.	Some pitted surfaces evident on fresh stone and some thin films of biological growth evident, but in generally very good condition.
S3	Grey to blonde and occasionally pale orange sandstone, with Fe-staining and mottling. Medium to coarse grained matrix, with coarse grained lenses. Matrix is similar in colour and texture to type S1, characterised by indiscernible beds/layers of coarse grains, comprising quartz and lithic fragments that are sometimes randomly dispersed throughout the full stone.	Granular decay evident on fine-grained areas, with some pitted areas else, with the loss of the largest grains/pebbles/clay inclusions and mud flakes.
S3a	Conglomerate. Variable yellow to brown coloured, medium to coarse grained matrix, with similar orange mottled appearance. Generally uniform stone, with faint bedding planes evident through the concentration of grains; often difficult to distinguish. Similar matrix to S1 and S3, characterised by Fe-mottling and staining, but significantly more coarse-grained. Very large clasts are evident throughout (up-to 15cm in length), with most measuring 3-5cm in diameter/length. Clasts and main detrital mineralogy is sub-rounded to well-rounded and elongate to spherical in shape. Clasts are comprised of a majority of quartz grains, but also include vein quartz, mixed igneous rock and sandstone.	In generally good condition and not affected by decay, which is occasionally in contrast to surrounding medium grained, uniform sandstone. Large clasts are occasionally displaced, but this is uncommon throughout.
S4	Predominantly grey coloured on the weathered surfaces and pale buff on fresh surfaces, with faint Fe-mottled matrix. Generally fine to medium grained, uniform and homogeneous sandstone, with no distinct sedimentary features present. The stone is cohesive and non-friable, with sub-angular to angular, tightly interlocking quartz grains. Moderately well-graded, mineralogically mature and texturally immature. Similar Fe-stained, and mottled matrix appearance to stone types S1 and S3, but less obvious and faint.	Minimal pitting and granular decay. Some powdery sodium sulphate salt efflorescence, but in very good overall condition.
S5	Blonde-buff and slightly pale yellow coloured, fine to medium grained sandstone that contains a similar matrix appearance to S1 and S3 sandstone types. Generally uniform sandstone, with	Very little decay and generally good condition.

	similar matrix composition to S3, but with only very occasional coarse-grained beds, with evidence of bedding planes, laminations and cross-beds also locally apparent. Hard and cohesive, highly compacted sandstone, with mainly sub-rounded to rounded and occasionally sub-angular quartz grains that show point and line contacts. Fe-mottled matrix is occasionally coarse grained, with large clay inclusions and Fe-nodules. More bedding features than S3 and less coarse-grained beds, but with similar underlying matrix.	
S6	Pale blonde to very light buff coloured, fine-grained sandstone, with small and faint orange-Fe-mottled matrix. Finely bedded, with occasional cross-beds evident, but overall uniform sandstone. Grains are mainly sub-angular to sub-rounded and rounded, comprised of quartz that are strong and highly compacted, with slightly friable silica cement, point and line contacts evident.	Very little decay, with only some granular decay at low level. Also weathering out of clay inclusions/ mud flakes, and some delamination and granular decay of bedding planes at the very bottom of the buildings.
W1	Fine to occasionally medium crystalline, dark blue to grey coloured basalt. Main groundmass cannot be identified in hand specimen, with occasional medium-sized crystals of plagioclase feldspar: too small and infrequent to describe as 'porphyritic'. Groundmass is dark and comprised of olivine and pyroxene. Very occasional and localised xenoliths of other lighter coloured, more acidic, medium-crystalline igneous rock evident. Highly fractured throughout different individual blocks, providing an unusual surface texture. Localised quartz veins evident in a small proportion of blocks, which measure 1-2cm aperture.	Semi-friable stone, with evidence of spalling and scaling taking place. Some areas of stone are 'boss' in places, with voids located behind the spalled/scaled areas. Scaling regions are easily removed. Some biological growth also present.

Table 4: Field descriptions of each separate stone type identified in Cupar.

Stone distribution

Sandstone type S1 is described as the generic local sandstone used in Cupar, displaying a range of sedimentary structures, textures and decay features. This stone type was present in the majority of the oldest buildings in Cupar, generally suffered from a greater range of decay processes and were in a poorer condition in relation to the other sandstone types. Sandstone types S5 and S6, as previously distinguished from type S1, are listed within Figure 12 and Figure 13, and are in generally better condition than those initially classified as type S1. This difference in stone quality between types S1, S5 and S6 is explained by the natural variation in stone properties, as a function of the subtle variation in the depositional environment and diagenetic processes, from within and between different beds within the same quarry or from the differences between different quarries working the same sandstone formation. Additionally, each block extracted from the same quarry has the potential to vary in its weathering behaviour over a period of years in accordance to the weather conditions, the stone extraction process, and it's functionally within a building.

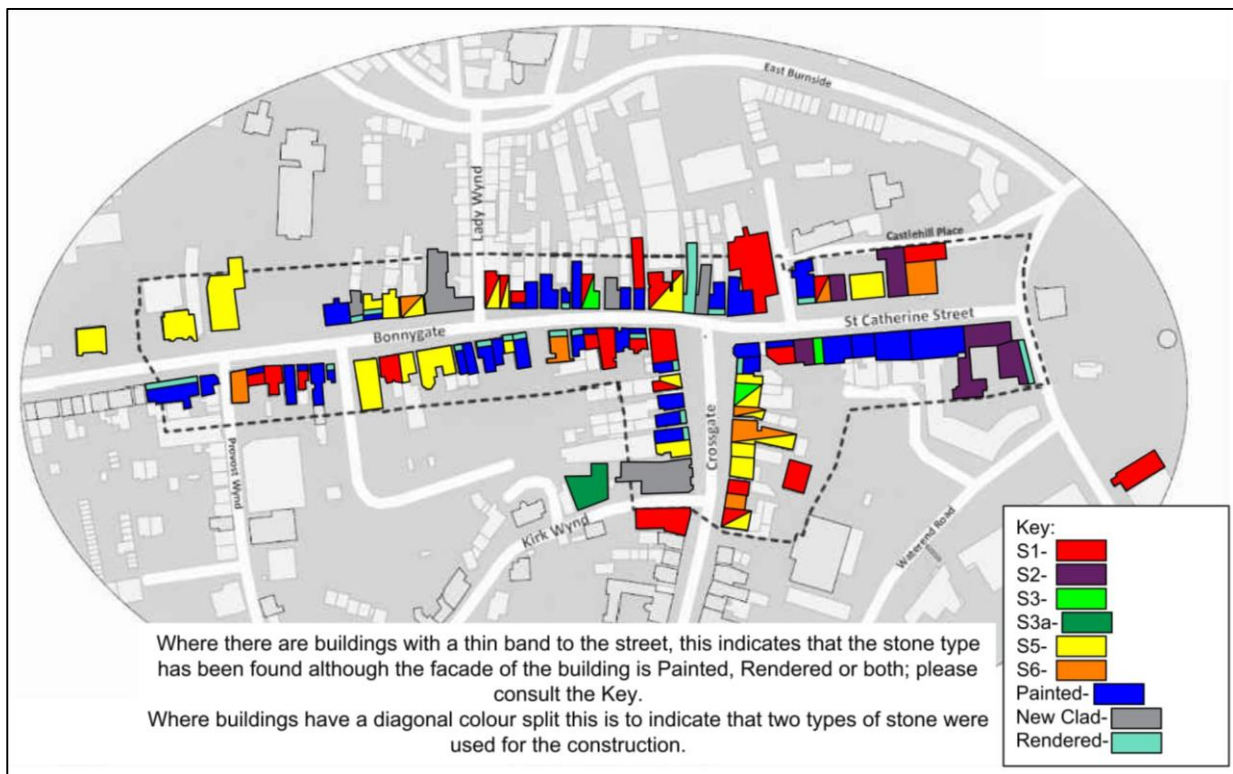


Figure 12: Distribution of stone types within the principle street elevations of the Cupar Priority Area. Map © Crown copyright and database rights 2015 Ordnance Survey 100023385.



Figure 13: Simplified distribution of stone types within the principle street elevations of the Cupar Priority Area. Sandstone type S1 includes types S1, S5 and S6, as determined by petrographic thin section analysis. Map © Crown copyright and database rights 2015 Ordnance Survey 100023385.

Sandstone type S2 represented high quality, grey to white coloured sandstone that was restricted in its use to later buildings, likely post-dating the arrival of the railway infrastructure. These were only identified as being used in the council buildings, Pagan Osbourne's offices and the former bank at number 11-13, Catherine Street. Additionally, these building are restricted in their spatial distribution to a small area east of Mercat Cross.

Sandstone type S3 (including S3a) is characterised as containing a higher proportion of coarse aggregate, including occasional coarse-grained, conglomeritic beds, as well as incorporating conglomerate as a distinct stone type (Figure 14 and 15). Conglomerate was found exclusively within boundary walls in the Castlefield area, while coarse-grained sandstone, and those characterised by conglomeritic beds were found within poorer quality and back-buildings throughout the conservation area, such as the garage opposite 17 Kirk Wynd, and as part of a door surround at 19-21 St. Catherine Street.



Figure 14: Block of conglomerate in-situ within the east boundary wall on Bishopgate. The block is surrounded by cement overpointing. Pencil used for scale measures ~15cm length.



Figure 15: Block of conglomerate in-situ within the east boundary wall on Bishopgate, surrounded by cement overpointing. The largest quartz clast (centre right) measures ~8 – 10cm in length.

Sandstone type S4 was identified as being used exclusively in the plinth of the Mercat Cross monument and was generally described as being better quality local stone, possibly extracted from higher quality beds or imported from slightly further away for its use in more prestigious structures.

Stone type W1 was also located exclusively in the Castlefield area of Cupar. It was used as building stone in Bishopgate House, surrounding properties and in the boundary walls. Granite and larvikite meanwhile were identified as being used in the base courses of several retail premises in the conservation area of Cupar, including The Royal Bank of Scotland on Crossgate.

The distribution of stone types within the priority area is given in Appendix G.

Stone condition

A general assessment on the condition of each stone type is made, based upon the inherent stone properties, its weathering potential, and by the prior maintenance and condition of the overall building. Sandstone type S1 suffered from a greater range of decay processes than other stone types. The type and extent of decay was significantly influenced, in some buildings, from the inherent fabric and texture of the stone, with decay features including delamination, granular decay, bursting, bubbling, flaking, scaling, salt efflorescence, cracking, fracturing and black crust development.

Stone type S2 was in generally very good condition, which can be partly associated with the overall good condition of the associated building; probably owing to their more important stature within Cupar. Sandstone type S2 experienced minor pitting on exposed surfaces, with thin films of biological growth also present. Sandstone type S3 and S4 were also found in generally good condition, with the occasional preferential loss of some of the largest clasts within coarse grained beds of sandstone and within the conglomerate.

Sandstone types S5 and S6, when presented separately from type S1, show very little weathering and alteration, with most decay (delamination and weathering out of clay inclusions) limited to areas on the tide line/splash zone on the lower courses of buildings.

Sandstone type S3 was in relatively good condition throughout, with evidence of granular decay mainly associated with the loss of coarse grained pebbles, clay inclusions and mud flakes.

Stone sample description summary

This section summarises the results from the petrographic analysis of four sandstone cores; representing stone types S1, S2 and S5. It was deemed unnecessary to analyse stone type S3 owing to the fact that: (i) conglomerate is not currently worked within the UK, and therefore no exact stone match can be obtained, and (ii) it would only be possible to analyse the stone matrix, with the largest

grains and pebbles neglected as they would not fit onto a thin section slide. Additionally, samples S4 and S6 were not analysed as these were in generally good condition throughout Cupar, with permission not granted for the coring of sandstone type 6 at one location. It was also deemed unnecessary to analyse the sample of basalt owing to its crystalline structure and lack of available replacement stone. Hand specimen descriptions of each sandstone type are given in Table 4 and are sometimes more representative of the differences between each sandstone type. For this reason, the summary descriptions for samples SS1, SS2 and SS3 are combined, as their petrographic descriptions are so similar. Figure 16 presents the stone and mortar sampling locations within the priority area.

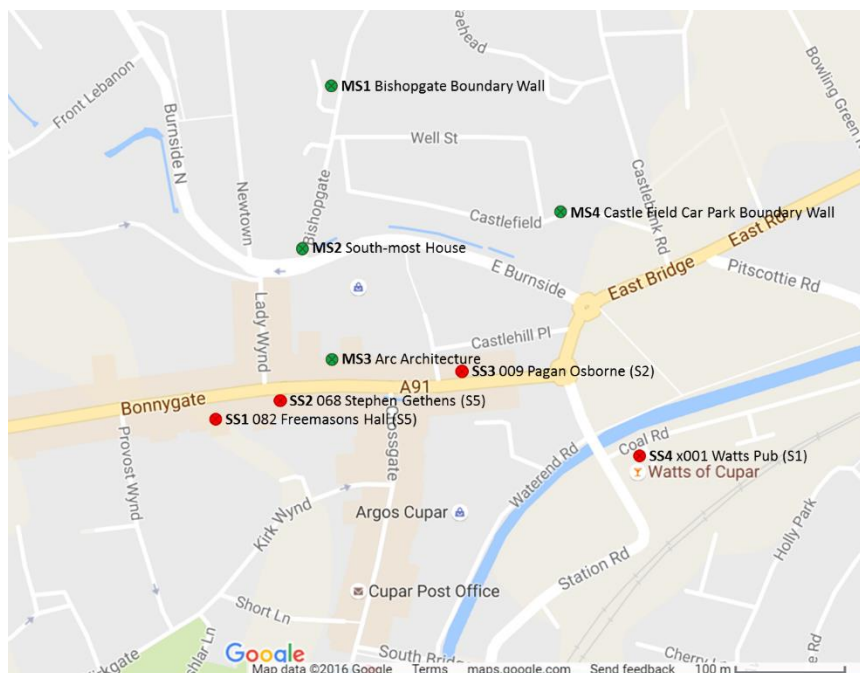


Figure 16: Map of Cupar showing the stone and mortar sampling locations, with attached sample numbers. *Contains Google Maps materials, © Google (2016).*

Sandstone Sample SS1 (type S5: Freemason’s Hall), SS2 (type S5: Stephen Gethins MP Office) and SS3 (type S1: Watt’s Restaurant)

Sandstone sample SS1, type S5, SS2, type S5 and sample SS3, type S1 are relatively uniform to slightly diffuse bedded, mineralogically mature to sub-mature, texturally immature, poorly graded calcareous quartz to sub-lithic arenite sandstones, comprised of a majority of fine, sub-angular to sub-rounded, sub-elongate to sub-spherical quartz grains and lower proportions of feldspar, lithic fragments and muscovite mica. The detrital mineralogy is bound by calcite cement, causing this stone to be reactive to dilute acidic solutions. The stone is relatively ‘dirty’ sandstone, containing a high proportion of authigenic minerals in the form of Fe-oxides and a mixture of clays. This high

content of leached Fe-oxides from elsewhere in the stone provides it with its distinct orange mottled appearance, while the overall proportion of authigenic minerals is likely to have lowered the permeability of the internal pore network of each stone. Each stone contained similar physical characteristics that are related to their internal pore network; these are highlighted in Table 5. Thin section and hand specimen images are provided in the relevant stone matching reports attached in the Appendix C.

Sandstone Sample SS4 (type S2: Pagan Osbourne)

Sandstone sample SS4, type S2 is a uniform, texturally and mineralogically mature, well graded, fine to medium grained quartz arenite sandstone. It contains a majority of sub-rounded, sub-spherical quartz grains, with trace proportions of feldspar and lithic fragments, and no evidence of mica. It is very 'clean' sandstone, containing a very low proportion of authigenic minerals, which has led to the preservation of an open and permeable pore network. Detrital grains show a stable and uniform compaction, with a majority of well-preserved point and line contacts and minor quartz overgrowths. It contains an interconnected and open pore network with moderate porosity and moderate to high permeability.

Property	SS1	SS2	SS3	SS4
Effective Porosity (%)	16.7	17.5	12.9	12.9
Total Porosity (%)	19.5	20.4	14.8	16.6
Water Absorption (%)	6.33	7.14	7.18	5.45
Saturation	0.84	0.85	0.87	0.75
Capillary Coefficient (g/m ² /s)	43.3	135	73.27	126

Table 5: Physical properties of analysed sandstone cores.

3.5 Mortar

A summary of the main findings from mortar analyses are presented in this section. Four separate bedding mortars were analysed from different locations around Cupar (Figure 16) and are thought to be representative of the range of mortar types, such as bedding, pointing and construction mortars used throughout Cupar.

Mortar description summary

All analysed mortars appear to consist of a mixture of moderately to eminently hydraulic ‘hot mixed’ lime mortars, which would have been prepared by slaking quicklime and sand together with water in one operation. Samples MS1, MS3 and MS4 are thought to be moderately hydraulic, while sample MS2 is thought to be eminently hydraulic; this assumption is based on their breaking strength and reaction with dilute hydraulic acid. All mortar samples had similar mix-ratios, ranging from 1 part quicklime to 0.42 – 0.62 parts aggregate (by volume); which are relatively common mix-ratio values for historic quicklime mortars in Scotland. All analysed mortars were of similar colour and contained very similar aggregate grain size distributions, textures and mineralogy. Every mortar contained a predominantly medium grained, moderately to well graded, negatively skewed, uni-modal to normal grain size distribution which was comprised of sub-angular to sub-rounded, sub-spherical, clear to light buff coloured quartz grains, weathered igneous rock, sandstone fragments and coal.

Each analysed mortar contains similarities in their mix ratios, colour and aggregate-type, which likely reveals a similar overall mix composition, with similar raw materials used throughout the Cupar conservation area. Table 6 highlights the similarities between the analysed mortar samples.

Sample	Location	Hydraulicity	Colour	Mix Ratio
MS1	Close on Bishopgate	moderately hydraulic	light grey – very pale brown	1 : 0.54
MS2	South-most house	eminently hydraulic	pale brown – very pale brown	1 : 0.42
MS3	Arc Architects	moderately hydraulic	pale brown – very pale brown	1 : 0.59
MS4	Boundary wall; Castlefield car park	moderately hydraulic	Very pale brown	1 : 0.62

Table 6: Mortar characteristics.

3.6 Historic material sources and future supply

Like the majority of towns and settlements throughout Scotland, the buildings of Cupar are influenced by the local underlying geology, which provide the town with its individual character. Three main phases of building material use can be identified throughout Cupar, with each phase influencing the character and appearance of buildings. The earliest buildings would have been constructed using the most locally sourced materials, which were constrained and determined by the local geology. At

this time, the aesthetic appearance and durability were not crucial considerations for the building stone; ease of extraction and accessibility were the most important factors. This philosophy also rings true of the use of lime mortars, with locally sourced lime, probably from Culter Limeworks and nearby river/quarried sand likely used in their manufacture. A second phase of material use in Cupar dates to the introduction of railway infrastructure and mass industrial development throughout the 19th century in Scotland. The development of industry during this period would have significantly influenced the cost and ease of building stone transportation and production, with a second phase of buildings in Cupar displaying a change in material use owing to the importation of stone. A third phase relates to the use of more 'modern' materials within Cupar, which were generally used exclusively as repair materials over the last 25 years. Unfortunately, many of these materials, such as cement pointing and cement renders, have been used inappropriately, which in many cases has led to the exacerbation of many issues within the buildings.

Historic Stone Resources

In the area surrounding present-day Cupar, there is no longer evidence of past quarry or mining works, with many historic quarries having been backfilled or landscaped into the surrounding land. This fact makes the sourcing of these quarries an extremely difficult task without the prior knowledge of historic maps or the historical development of the area. Information on possible matching historic quarries within the Cupar region was made using information from the British Geological Society's Britpits database, which is a comprehensive list of all known mining, quarry and pit sites throughout the UK; providing information on their location, status and geology. Table 7 lists all known sandstone quarries within the Cupar region; consisting of 20 individual quarry regions; with some quarries, including Kemback Quarries, containing over ten individual quarry workings within the same formation. The locations of the largest of these quarries are presented in Figure 17.

Sandstone

Cupar is built using a majority of similar lithologies, comprised of a mixture of mainly sandstone, with the minor use of conglomerate and whinstone. These rock types are representative of the local Old Red Sandstone and Carboniferous formations that outcrop throughout Fife and the Midland Valley of Scotland. Cupar is directly underlain and surrounded by the Burnside, Glenvale and Knox Pulpit Formations of upper Old Red Sandstone; described as containing a mixture of sandstone, siltstone and conglomerate, which formed under environments dominated by alluvial fans, rivers and wind-blown deposits. Each distinct geological formation is described as a mixture of layered rock, usually found as cycles of repeating lithologies, which are grouped together owing to their distinct cyclicity or similar depositional environment.

On this basis, it is considered that the conglomerate (stone types S3 & S3a) used in Cupar was probably produced from a local quarry within the Burnside Formation of sandstone, siltstone and conglomerate. Local brown to orange sandstone (stone types S1, S5 & S6), on the other hand, is likely to have been extracted from quarries in the Burnside and Glenvale Formations, having likely been deposited in river terrace deposits as opposed to wind deposits, as found in the Knox Pulpit Formation.

Sandstone type S2 is likely to have been obtained from elsewhere in Fife, with buildings constructed using this stone post-dating the arrival of railway infrastructure into Cupar. The stone shows remarkable similarities to stone quarried from Newbigging and especially Cullalo Quarry in Burntisland, Fife. Newbigging and Cullalo produced stone from the Sandy Craig Formation of the Strathclyde Group of rocks of Carboniferous age. Six quarries within the Cupar area also produced rock from the same stratigraphic group, however these are likely to have been extracted from different lithological members of the Sandy Craig Formation than Newbigging and Cullalo.

Quarry Name	Reference Number	Age	Formation
Peterhead Quarry	1	Devonian	Glenvale Formation
Cults Mill	2	Devonian	Glenvale Formation
Cupar Muir Quarry	3	Devonian	Glenvale Formation
Dron Mill	4	Devonian	Glenvale Formation
Kemback Wood	5	Devonian	Glenvale Formation
Springfield	6	Devonian	Glenvale Formation
Springfield Farm	7	Devonian	Glenvale Formation
Cupar Muir New Quarry	8	Devonian	Glenvale Formation
Owlet Wood	9	Devonian	Glenvale Formation
Hilltarvit	10	Devonian	Glenvale Formation
Drumdryan	11	Devonian	Glenvale Formation
Russel Mains	12	Devonian	Glenvale Formation
Edenwood	13	Devonian	Glenvale Formation
Bogle Wood	14	Devonian	Glenvale Formation
Eden Grove	15	Devonian	Glenvale Formation

Stratheden Park	16	Devonian	Burnside Formation
Bow of Fife	17	Devonian	Burnside Formation
Balbirnie	18	Devonian	Burnside Formation
Witch	19	Devonian	Burnside Formation
Cairngreen Quarry	20	Devonian	Knox Pulpit Formation
Hilltarvit Mains	21	Devonian	Knox Pulpit Formation
Hill of Tarvit Quarries	22	Devonian	Knox Pulpit Formation
Kemback Wood Quarries	1	Carboniferous	Sandy Craig Formation
Flisk Quarry	2	Carboniferous	Sandy Craig Formation
Blebocraigs Quarries	3	Carboniferous	Sandy Craig Formation
Clatto Hill	4	Carboniferous	Sandy Craig Formation
Blebo Skellies	5	Carboniferous	Sandy Craig Formation
Lady Mary's Wood	6	Carboniferous	Sandy Craig Formation
Denhead	7	Carboniferous	Pathhead Formation

Table 7: List of all known sandstone quarries within the Cupar region. All of these quarries have now ceased production. Taken from BGS Britpits database.

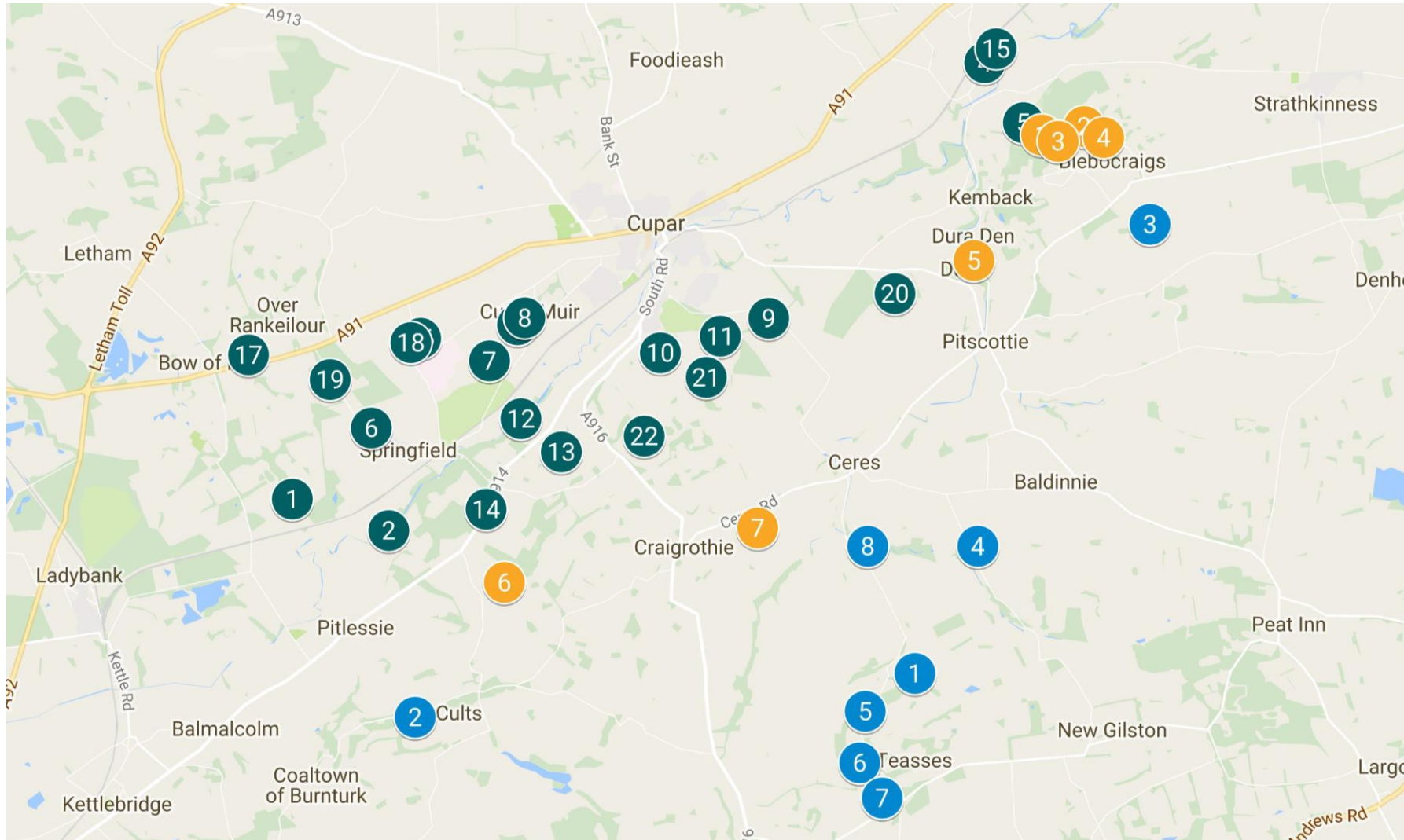


Figure 17: Map showing location of sandstone and limestone quarries near Cupar. Green is Devonian Sandstone, orange is Carboniferous Sandstone, blue is Limestone. Numbers correspond to reference numbers on Table 7 and Table 8. *Contains Google Maps materials, © Google (2016).*

Case Study 1: Kemback Quarry

One quarry that did produce stone from the Sandy Craig Formation is Kemback Quarry. This quarry is located within 5 miles of Cupar (NO4290, 1575) and is comprised of up-to 10 separate quarry workings within Kemback wood; the most prominent of these being Flisk, Blebocraigs and Kemback Wood quarries. These quarries were featured in the 1st and 2nd edition Fifeshire OS maps, whereby large open quarry workings and cranes were evident for all three quarries on the 1894 25 inch 2nd edition OS map for Kemback Wood. These quarries are listed as disused on the 1912 updated OS map for the same area, indicating the closure of all three at some point between 1894 and 1912. Additionally, Blebocraigs Quarry was the only one not listed on the 1854 1st edition OS map for the same area, indicating the establishment of this quarry between 1854 and 1894. Figure 18 highlights Flisk Quarry, where underground quarrying had been employed to continue stone excavation. Elsewhere, including Kemback and Blebocraigs, open cast quarrying was prevalent. At Flisk Quarry, cyclic beds of mudstone and sandstone were evident, with the quarried stone throughout most of the Kemback quarries being of a slightly friable, pale cream to white coloured quartz arenite. During this field trip to Kemback, a local resident mentioned that most of this stone had been used at the harbour at St Andrews. Figure 19 shows three hand specimens of stone from Cullalo Quarry, Flisk Quarry and the stone core SS4 from Pagan Osbourne in Cupar. Both Cullalo and stone type S2 (sample SS4) are more cohesive and compacted than the stone from Flisk. Without further petrographic analysis, Kemback might still provide a possible source quarry for stone type S2, however due to the similarities with Cullalo sandstone, this remains unlikely, and therefore didn't warrant further analysis.



Figure 18: Flisk Quarry, with beds of mudstone sitting directly above sandstone (left), with arrows indicating the strike of the mudstone layers. Tool marks on the quarried sandstone (right).



Figure 19: Hand specimens (left to right) of Kemback sandstone, Stone type S2 and Cullalo sandstone. Length of core is 55.5mm.

Case Study 2: Drumdryan Quarry

Drumdryan Quarry is located ~1mile South of Cupar, adjacent to Cupar golf course (NO3840, 1332). Drumdryan produced stone from the Glenvale Formation of Devonian aged sandstone and mudstone. Drumdryan Quarry appears prominently on the 1855-86 OS Country Indexes and 1843-82 six inch OS maps, with open quarry workings evident on the 1856 1st edition OS map for Cupar. The land here had been landscaped as a 'new cemetery' by 1895, with the addition of several new paths and with no reference to Drumdryan Quarry; suggesting the discontinuation of workings here at some point between 1856 and 1895. This is the closest historic quarry to Cupar and would therefore provide an ideal candidate as a source quarry for sandstone types S1 (incorporating S5 and S6) and S4. One large quarry face was evident at Drumdryan (Figure 20), characterised by interbeds of clay-rich medium to fine grained sandstone and flaggy siltstone; displaying the characteristic cyclic variation of changing depositional environments typical of Devonian and Carboniferous formations. Six representative samples of stone were collected from Drumdryan Quarry in order to show the variation across the face of the quarry. It is this natural variation within the geology, at the quarry scale, which produces the heterogeneous texture evident in type 1 sandstone from Cupar. Figure 21 highlights the differences in colour and texture between the lower, middle and upper beds of sandstone at Drumdryan Quarry.



Figure 20: Quarry face at Drumdryan.



Figure 21: Three samples representative of sandstone produced at Drumdryan Quarry. **(right):** the lowest accessible bed, characterised by dark colour, Fe-oxides and large swelling clay inclusions. **(middle):** the middle beds from the quarry show some variability, with characteristic orange-brown mottling. **(left):** top beds from the quarry are of better quality and lower spatial variation.

Petrographic analysis of the middle and top beds of sandstone from Drumdryan Quarry show some similarities to the sandstone from Cupar (Figure 21). Both beds are fine-grained, well graded, texturally sub-mature and mineralogically mature quartz arenite sandstones that contain a lower overall proportion of Fe-oxides and clay than Cupar samples, and show no evidence of calcite or

muscovite mica. They show similar grain compaction to the Cupar samples, with a majority of point and line contacts, limited quartz overgrowths and a substantial open pore network, with higher porosity, water absorption and capillary coefficient values than the analysed Cupar samples. They share a similar detrital grain framework, texture and grading with the analysed Cupar samples, with a lower proportion of authigenic minerals, no calcium carbonate content and a higher porosity and permeability. Figure 22 shows the comparison in petrographic properties between the analysed Cupar samples and those from Drumdryan.

Overall, Drumdryan may have provided some of the original stone used throughout Cupar, with the most notable differences lying within the physical properties of the stone, its authigenic mineral content and the absence of calcium carbonate cement.

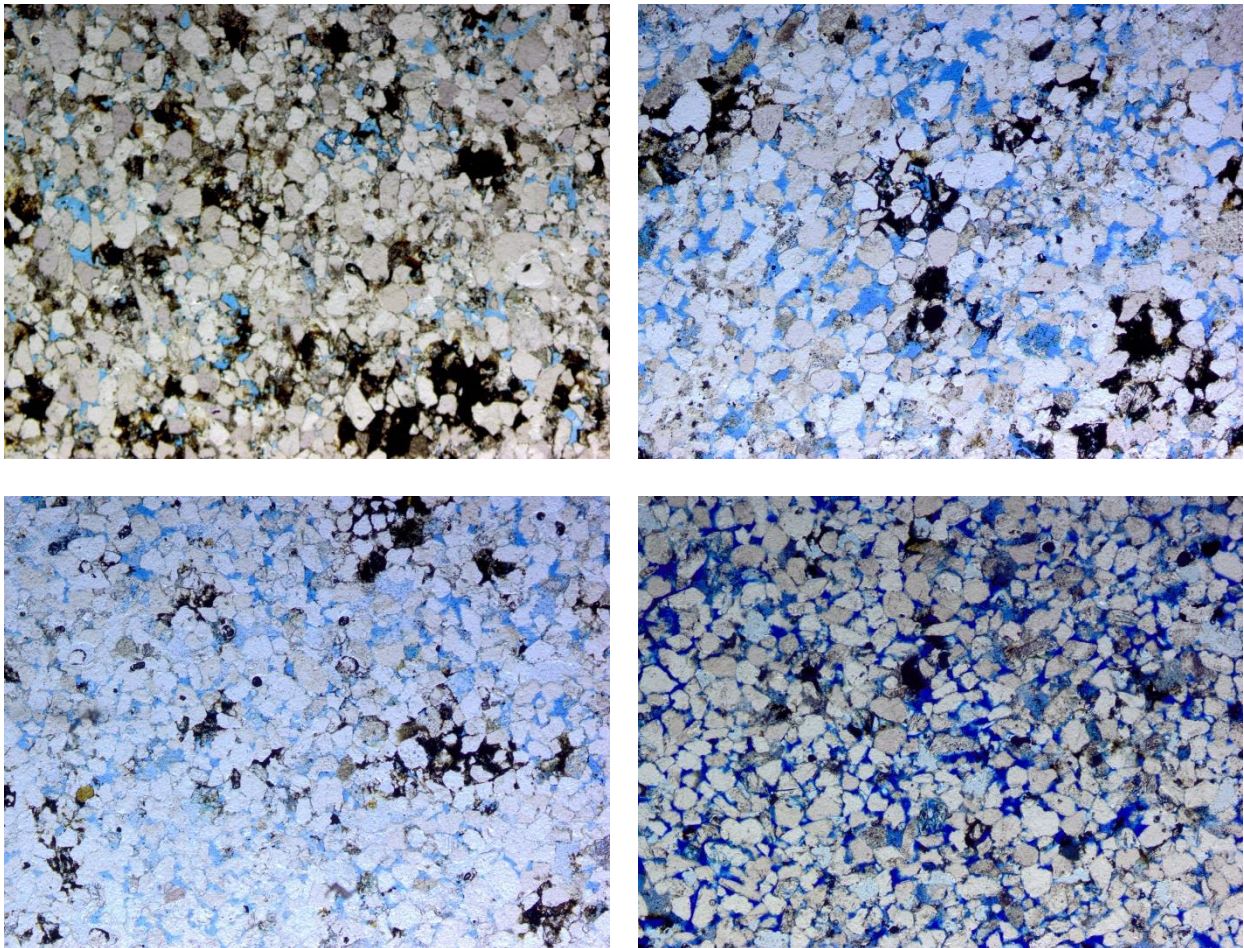


Figure 22: Thin section images of Cupar and Drumdryan sandstone samples. (**top left**): Cupar sample SS1 (type S5), (**top right**): Cupar sample SS2 (type S5), (**bottom left**): Cupar sample SS3 (type S1), (**bottom right**): Drumdryan middle bed sandstone. Field of view in each image is 3.3mm.

Mixed stone

Mixed stone within Cupar includes (i) basalt, found exclusively within the Castlefield area, (ii) granite, and (iii) larvikite; the latter of which are only used for base courses of retail premises. Within the Cupar area, 101 separate igneous quarries have been recognised and documented, ranging in age from Silurian – Devonian (359 – 444 Million years old) to Carboniferous-Permian (251 – 359 Million years old), and including volcanic rock of the Ochil Volcanic Formation, intrusive igneous rock from the Midland Valley Sill-Complex, late Carboniferous Plug and Vent suites, Midland Valley Sill-Complex and the North Britain Calc-alkaline Dyke Suites. Of the local igneous quarries, 37 of these are from the Ochil Volcanic Formation of Devonian age, which is thought to be most likely formation to provide basalt-type extrusive igneous rock. These quarries are generally found North of Cupar, with most of the other intrusive igneous rock quarries found South of Cupar.

Granite is likely to have been imported from elsewhere in Scotland, with notable granite quarries located throughout Aberdeenshire, Peterhead, Galloway and the Highlands, with the most notable differences between each granite related to its mineralogical content and therefore colour. Aberdeenshire and Peterhead granites are known for their grey-silver and red colour, while Ross of Mull granite from the Highlands has a distinctive pink to reddish-brown colour. Larvikite is feldspar-rich intrusive igneous rock, famed for its distinctive silver-blue sheen, known as Schiller or labradorescence. Larvikite is used around the world for base courses of retail premises, however is only quarried for a few select quarries in Finland and Canada.

In regards to stone replacement of granite and larvikite, a petrographic analysis is of less importance, as granite contains a tightly interlocking crystalline mineralogical framework and therefore replacement is generally made on an aesthetic visual match.

Mortar: lime and aggregate

Only eight historic limestone quarries have been identified within the Cupar region; with all eight belonging to Carboniferous aged rock of the Lower Limestone, Hurlet and Pathhead Formations (Table 8). Of the eight limestone quarries, Cults lime works is known to have operated two of them; namely the Teasses Mine and Backbraes quarries (Figure 17). Most of this quarried limestone was originally burned in open-ended kilns and laterally by large draw kilns (Figure 23) for quicklime purposes for the construction industry, agriculture and iron making. Lime burning at Cults ceased in 1968, and quarrying was ceased by 1970. The chemical composition of limestone from the Hurlet and Lower Limestone Formations would have produced hydraulic lime, similar to that analysed in the Cupar mortar samples.

Quarry Name	Ref No.	Age	Formation
Teasses Mine	1	Carboniferous	Lower Limestone Formation
Bunzion Lime Works Quarries	2	Carboniferous	Hurlet Limestone
St. Andrews Wells Lime Works	3	Carboniferous	Hurlet Limestone
Newbigging of Craighall Lime Works	4	Carboniferous	Hurlet Limestone
Backbraes	5	Carboniferous	Hurlet Limestone
Teasses Den	6	Carboniferous	Hurlet Limestone
Teuchats Mine	7	Carboniferous	Pathhead Formation
Craighall Lime Workings	8	Carboniferous	Hurlet Limestone

Table 8: List of all known limestone quarries within the Cupar region. All of these quarries have now ceased production. *Taken from BGS Britpits database.*



Figure 23: Disused draw kilns at Cults lime works (NO3505, 0883).

Aggregate was likely obtained from a mixture of locations around Cupar, including similar superficial deposits as those currently acquired from Melville Gates Quarry. Representative sand was obtained from the River Eden, East of Cupar in order to ascertain whether this might have been used as the original source material for mortar aggregate (Figure 24). When the largest aggregate fragments were subtracted from the sand, slight similarities in mineralogy and texture to the aggregate obtained from the mortar are evident, however the sand gradings did not match (Figure 24). This mismatch in aggregate grading might be explained by the location of where sand was dredged from the River

Eden; with the finest sediment likely to have been deposited on point bars and on the inside bends of rivers, while coarse aggregate is likely obtained from the river bed and outside bends. It is recommended that representative building sand from Melville Gates Quarry is used for mortar repair work throughout Cupar; providing similar grain size distributions, mineralogy, colour and texture. The use of alternative aggregates, as provided in the relevant mortar analysis reports (Appendix D) should only be sought in the event where building sand from Melville Gates Quarry is unavailable.

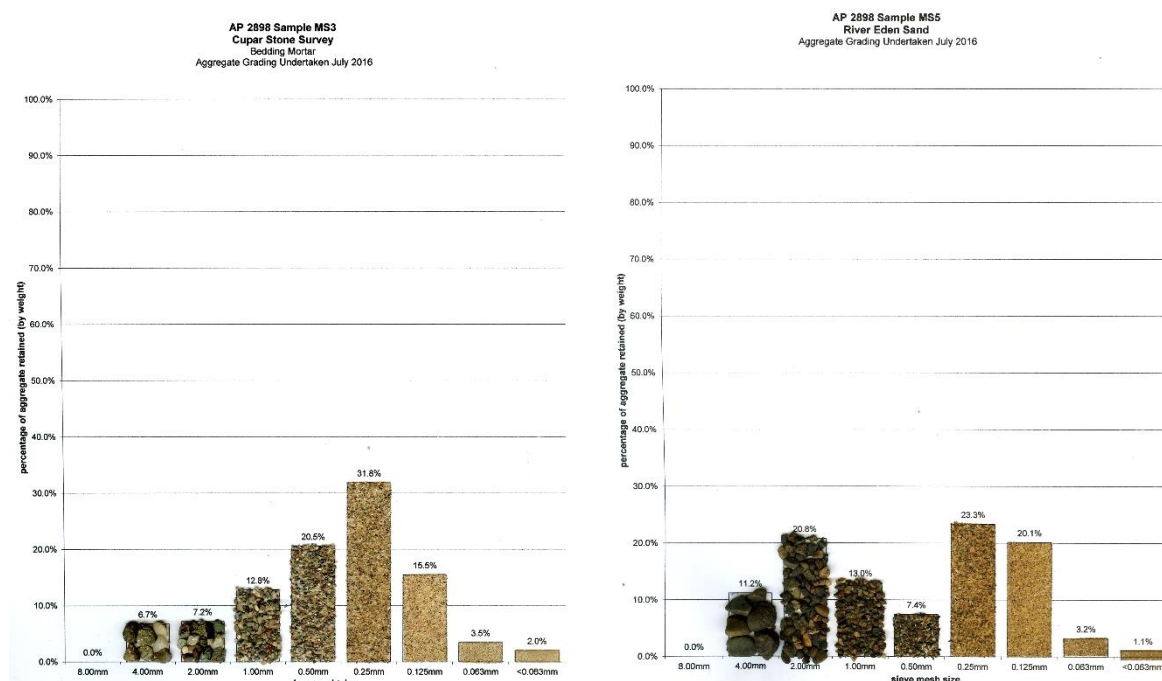


Figure 24: Aggregate grading profiles from bedding mortar, MS3 (left) and from the River Eden (right).

3.7 Future Stone Supply and matching replacement stone

Recommending suitable replacement stone is sometimes a more difficult task than the identification of the original source quarry of the stone. This difficulty lies in the limited supply of currently operating stone quarries throughout the UK, and especially those that might provide a suitable aesthetic and petrographic match. In regards to stone matching, a like-for-like stone replacement is always sought to ensure stone continuity and to protect the original aesthetic value of the building; the feasibility of re-opening original historic quarries in order to provide an exact replacement stone may therefore be considered and established on a case-by-case basis. The protection of the original stone must always be of principle importance however, in order to preserve the original building fabric. The use of a slightly less durable stone may therefore be justified in certain situations, ensuring that replacement sandstone experiences greater rates of decay, compensating for the continued life-

span of the original sandstone. By using significantly more durable and/or unsuitable stone, the original stone may experience differential decay, causing the new, replacement stone to sit proud of the surrounding, decayed stone.

Stone weathering is a complex and dynamic system comprising a suite of inter-related physical, chemical and biological processes that are almost always aided by the presence of water. Water, in the form of ice, liquid and gas, can only penetrate into stone through its pore network; which act as conduits for water migration. Water will facilitate stone decay by actively dissolving vulnerable minerals, such as calcite; by imposing high physical pressures through expansion as water freezes; and by acting as a pathway for other decay agents, including salt. It is therefore recognised that understanding the moisture transportation pathways in the stone in tandem with petrographic thin section analysis, is an essential process for recommending suitable replacement stone; these properties are measured using a suite of physical tests. The mineralogical and textural characteristics of the stone including grain shape, grain size, their spatial distribution and compaction (as measured with petrographic thin section analysis), will significantly influence the structural and pore network properties of the stone, and therefore the uptake and migration of moisture through it.

Stone matching is based primarily on the petrographic structure, mineralogy and physical properties of the analysed stone, taking into account grain size, grain shape, detrital mineralogy, cement and pore connectivity; the latter of which considers the porosity, saturation, water absorption, capillary coefficient and permeability of the stone. These properties are inherently related and significantly influence the weathering behaviour of the stone. It is therefore of extreme importance that we recognise and understand the past weathering behaviour of the historic stone so we can mitigate against these processes in the future by recommending replacement stone that will both weather in harmony with the original stone, but also be slightly more durable towards specific weathering agents.

Salt staining and salt crystallisation damage was identified as one of the most important factors affecting the lower courses of buildings in Cupar. The crystallisation of soluble salts within the pore spaces of sandstone is one of the most detrimental decay processes affecting sandstone buildings. Salt is introduced into the stone through a number of sources and pathways, including: (i) the dissolution of calcite (in the stone or mortar) by acidic rain that contains sulphate (this can also be released by high sulphate cement mortars), which leads to the development of black surface crusts; and (ii) de-icing salts which are washed into the lower courses of buildings. When salt crystallises (grows) within the stone, it exerts high pressures within the small confined pore spaces, which can considerably weaken it, leading to various different decay features. Salt that grows on the surface of

the stone is relatively harmless, but can cause nasty and unappealing surface staining, as well as blocking the surface of the stone, inhibiting it from drying efficiently.

Research has revealed that specific pore-structural properties of sandstone can significantly influence their durability/vulnerability to salt-crystallisation damage from sodium chloride (NaCl / rock salt); which is the most widely used de-icing salt in Scotland (Graham, 2016). By using the sandstone vulnerability estimator which is based on the pore size distribution and water absorption of sandstone (Graham, 2016), the most salt-resilient matching sandstones for Cupar can be identified (Figure 25). Table 9 shows the most appropriate matching sandstones for types S1 (incorporating S5 and S6), in order of resilience to salt crystallisation damage. These sandstone types should be used in regions vulnerable to salt crystallisation damage. Figure 25 highlights the overall vulnerability of matching sandstones to NaCl-crystallisation damage. Hazeldean and Cullalo are very resistant to NaCl-induced decay, and therefore both are suitable replacement sandstone matches for areas of high salt damage.

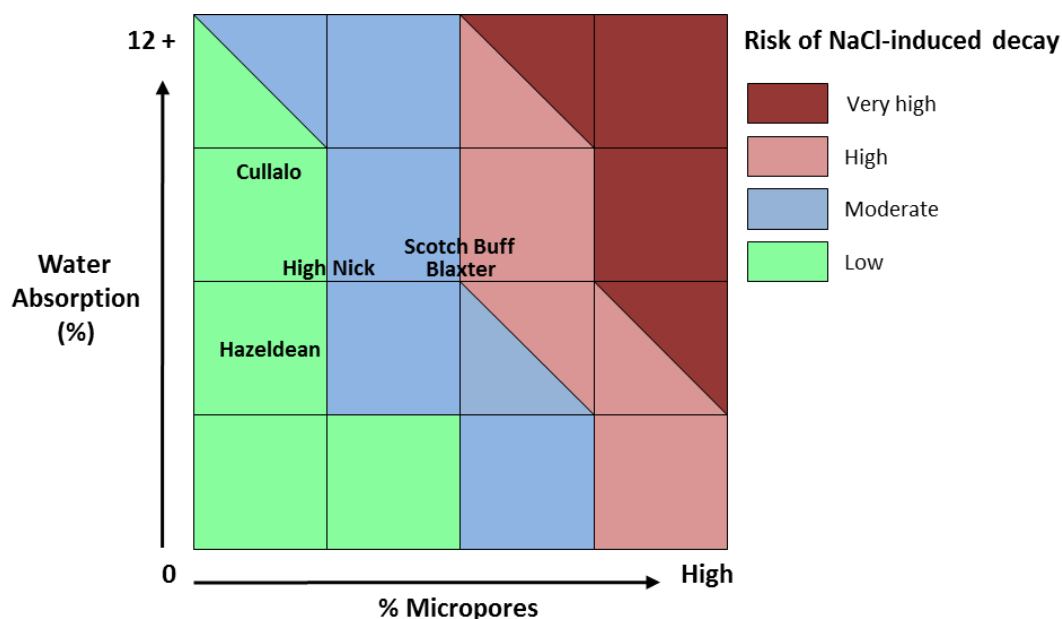


Figure 25: NaCl crystallisation damage matrix, overprinted with matching sandstones for Cupar.

Sandstone	Vulnerability to salt crystallisation
High Nick	Moderate to Low (lowest)
Blaxter	Moderate to High
Scotch Buff	Moderate to High (highest)
Drumhead Buff	No current data

Table 9: Vulnerability of matching sandstone types to salt crystallisation damage.

The matching sandstones for Cupar are listed in Table 10, with quarry operator information provided in the attached stone analysis reports.

Stone Type	Matching Stone
S1 (sample SS3), S3, S3a, S4, S5 (Samples SS1-2) and S6	Blaxter
	Drumhead Buff
	High Nick
	Scotch Buff
S2 (sample SS4)	Cullalo
	Hazeldean
W1	'Scottish Whinstone' from Tradstocks
Granite/Larvikite	Various stone merchants

Table 10: Matching stone types.

There are no quarries currently working conglomerate (type S3a) within the UK, and therefore, dependent on the quantity of replacement stone required it may be appropriate to search the local area for reclaimed stone from a demolition contractor, or alternatively obtain the stone from a local outcrop. It is recommended, that in the absence of obtaining suitable reclaimed stone, the matching stone types for S1 (incorporating types S3-6) are sought for replacement. These stone types should provide a suitable match for the similar conglomerate matrix (the main fabric of the stone controlling moisture transportation), ensuring compatibility with the original stone.

In relation to sample W1, only Tradstocks currently supplies dimensional 'whinstone', which might provide a suitable stone match. This stone is described as grey to dark grey to black coarse to medium crystalline Gabbro/Dolerite. Although this stone does not match petrographically with the basalt stone from Cupar, it does provide hard, dark crystalline rock that shares similar porosity and permeability characteristics.

A common suggestion when recommending suitable matching stone for crystalline rock (igneous/metamorphic) is to approach aggregate quarries that work similar hard rock. We do not recommend this approach on the basis of the unsuitable extraction process (blasting) at these quarries for dimensional stone. By blasting the stone for aggregate, this can produce both macro (large) and micro fractures within the rock which can have detrimental future consequences for both the stone and building. By creating fractures (even in low porosity and impervious rock), the water absorption rate and permeability of the rock can significantly increase, introducing moisture into the building, or wall which cannot be easily remediated, leading, in some cases, to severe future problems. It is with this in mind, that no other matching stone quarries are listed, as there are no others within the UK that currently produce matching dimensional stone. In the first instance, obtaining local reclaimed stone from a demolition contractor, or from local outcrops, would be recommended.

3.8 Slate

Roof coverings

The purpose of the roof can easily be summarised; it is to collect all rain and snow and shed from the building and increasingly important, offer a degree of insulation and prevent the spread of flame in the event of a fire. Rather less obviously and a surprise to many people is the fact that roofs can account for up to 40% of the total volume of a building and can be roughly equivalent to a storey and a half of the building's height. Therefore, the appearance is important. It might be argued that appearance in a place such as Cupar is not such an issue and it is true that streets are narrow in places particularly in sections of Bonnygate where it is difficult to see the direct relationship of a building's roof to its façade but, long oblique views are there as are more direct vistas such as looking up Crossgate to its junction with Bonnygate. Here, the roof type most common to the area, of a ridge contained by two chimney gables using mortar fillets is immediately obvious as is the fact that roofs tend to be steeply pitched, vary in height and frequently carry dormers.

Originally they would have been covered in the most readily available material which would have been thatch, a local stone slab or possibly pantiles. As transport improved and particularly with the

coming of the railways, from the late 1800s onwards the preferred choice up until comparatively recent times was slate until, due mainly to economic reasons, concrete tiles in a variety of profiles have started to appear. Initially, the slate would have been Scots which came in variety of sizes and would have been laid in diminishing courses. Later slate roofs (or where there has been an insistence on replacing a failed roof with new slate) have mostly used imported slate which comes in standard sizes which means there is little or no variety in the size of the courses.

A Scots slate roof with its diminishing courses is extremely attractive and can add real character to a building. Where they have survived, as at 5 The Cross (Remax) and 9 Bonnygate it is likely that the buildings will be listed. When repair or complete renewal is required consideration must be given to retaining the character and appearance by using Scots slate but this requires what is often, a difficult value judgement. There has been no new Scots slate since the 1950s only salvaged material is available and this is becoming increasingly scarce. In addition, there were a considerable number of Scottish slate quarries and broadly, each produced a different type of slate.

Analysis

It is possible with experience, by examining the appearance and the sound a slate will make when struck with a metallic object (a coin can be used) to say with some certainty where a slate would have originated from; but due to our survey being carried out in a busy public realm with very limited access to buildings, identifying individual types or sources of slate especially on a building-by-building basis has been impossible.

The only reasonably sure method for properly identifying the source of a particular slate is through X-Ray Diffraction which examines the mineral content of the rock. This can be used to identify the provenance of a slate or the quarry it was most likely to have been extracted from and a suitable match for renewal or repairs. A suitable match will probably mean using an imported slate which come in a limited range of standard sizes which means that a considerable amount of redressing might be required if the character and appearance is to be retained.

While it is difficult to confirm the provenance of a slate from sight only, at least two 'types' of slate were identified due to their characteristic colours and textures; these were namely blue and black slates. Blue slates are associated with the Highland Boundary quarries which range in colour from blue/grey, very dark grey to light 'lead' grey. These are quite noticeable in contrast to darker black slates in colour as well as texture due to the slatey cleavage that occurs in the seams close to the boundary fault. Black slates describe probably the most common slates in Scotland, which are slates of Lorn being from Ballachulish quarries, and island quarries namely Easdale Island. These slates are smoother in texture with pyrite inclusions which are mostly unreactive, which cleave smoother

giving slightly more precise edges. All these slates are part of the Dalradian Assemblage, like all slate quarries in Scotland, and therefore all have similar geological characteristics which make identifying the provenance more difficult. However, we have identified Highland Boundary slates due to the very light grey colour of slates (for example at East Burnside), and additionally Ballachulish slates or slates of Lorn being used throughout Cupar. Easdale slates being very similar in geology and appearance (as other slates of Lorn) can only be differentiated from Ballachulish by other means (X-Ray diffraction) and therefore have not been differentiated. Even when using X-Ray Diffraction it may be difficult to match a slate to a historic quarry due to the close geological characteristics, and also due to differences in the seams within the same quarries making these results even more difficult to interpret.

Condition of Roof coverings in Cupar

The data collected from our visual surveys of both the Priority Area and outside the Priority Area show that the roof coverings in Cupar are generally in a fair to good condition. This may be due to the good quality slates used to cover the roofs, as maintenance has been identified as a major flaw in the area. Repairs required range from a few slipped slates and moss on slates to failed mortar skews, and vegetation at coping with none requiring further investigation other than above eaves level masonry. Roof coverings and roof structures themselves appeared in the main to be in good condition, although many roofs have been replaced in a wholesale manner. Most of these roofs are now covered in concrete interlocking tiles, and while not traditional they are in good condition and serve the purpose of keeping the structure dry. Many slate roofs have also been replaced with less traditional, imported slate or Welsh slate usually in tally slating (regular sizes and coursing), which creates an irregular roof-scape such as at 52-54 Bonnygate (see Figure 26). The central roof of 48-50 Bonnygate is concrete tiles, with the neighbouring property to the left a more traditional diminishing courses, and 52-54 Bonnygate to the right with tally slating. While there are issues with moss and various cables from satellite dishes, the roof coverings are sound. However, the traditional roof is most pleasing when viewed down the street and alongside neighbouring properties.



Figure 26: 52-54 Bonnygate demonstrating concrete tile replacement, with traditional slating to the left and tally slating to the right

Some pantile roofs have been replaced with new pantiles, some still keeping the slate easing course such as 44 & 46 Kirkgate, still keeping a traditional roofing style in modern materials. However, these properties have been subject to a total lack of maintenance with regards to the chimneys and have now fallen into a serious state of disrepair. This highlights the correlation between repairs and maintenance as the two must go together.

Maintenance and Chimneys

Roofs are vulnerable and while generally, across Cupar there are no obvious defects evident, all roofs require regular inspection and maintenance. If this work is not carried out there is a serious risk of further erosion in the character and appearance of the area. In addition to the condition of the covering material, particular attention should be paid to the manner in which it is fixed, all points of maximum exposure or natural wear, inaccessible points and interruptions such as vent pipes and dormers particularly where they are later additions. It is particularly important to check rainwater goods and in the event of renewal, consideration should be given, at this time of increased rainfall to increasing their capacity. Probably the most vulnerable areas are at verges or abutments where

most typically the roof meets a chimney stack and protection is provided by the use of a mortar fillet which can be prone to failure.

Most if not all chimneys in Cupar are poorly maintained as highlighted in the above example, left with open joints and extensive vegetation growth which erodes stone to the point where many have been rebuilt in brick, either fully or partially. Many are rendered in cement, which to some degree has protected the fabric of the chimneys from weathering. But the use of Ordinary Portland Cement bound mortars in connection with any chimneys or flues is to be discouraged as there can be an adverse effect where flue gases in the masonry (even if the chimney is no longer used for solid fuel fires), the sulphate content in the cement (this is primarily from the addition of gypsum to cement at the production plant) and uncontrolled access to water (leading to saturation of the masonry – and chimneys are of course more susceptible to this) create the perfect environment for sulphate attack. This manifests itself as expanding mortar beds and joints which can blow apart masonry units, leaving chimney stalks in an unstable state. For this reason low sulphate cements or sulphate resisting cements, or more ideally hydraulic limes (particularly the case for stone built chimneys) should be used to repair, bed and repoint masonry connected with flue lines and chimneys. There are a few cases of dangerous chimney stacks in Cupar, with the masonry below on gables in extremely poor condition leading to partial collapse. This is endemic in Cupar, leading from the issues of maintenance or lack thereof creating serious structural problems. Along with the lack of maintenance, the use of inappropriate materials is rife as many roofs have been repaired in modern materials. Many roofs which may have been either slated, pantiled or thatched have been replaced with concrete tiles which does nothing to enhance the character of the building, but rather it takes away from it leaving a harsh contrast to neighbouring properties. Most mortar fillets have been carried out in cement, as has much of the above eaves level masonry. As cement is a dense mortar liable to cracking, this has led to extensive cracking which allows vegetation to grow within these openings and thus worsening problems. The most suitable mortar to use for mortar fillets is a robust lime mortar that has the flexibility to expand in its length without cracking, and ideally with a water repellent additive to promote water run-off (see Appendix J for specification).

Limitations of Surveying Slate

Due to the close mineralogy of the slates present in Cupar, as stated above further analysis would not necessarily identify historic sources of slate. Therefore visual surveys of slate can be just as telling as lab testing, if carried out in close proximity to the roof, i.e. within touching distance. The feel of a slate is one way in identifying the most likely source due to known characteristics of common

slate types, as well as the sound when tapped with a metallic object. In Cupar this was not possible due to the narrow paths, and busy road being a main thoroughfare to St Andrews. As we were limited to what we could identify from ground level, we have identified Scots slates and the colour/type where possible and distinguished this from possible imported/foreign slate and Welsh slates. However, with the repairs required in Cupar being so few, this does not impact on the replacement recommendations and sourcing, as individual slates are much easier to match than whole roofs.

Replacement Slates and Recommendations

As most roofs in Cupar (in and out with the Priority Area) require isolated repairs, it is best to match slates to existing to ensure repairs are not highlighted. These should match in texture, size, colour and thickness, and should harmonise with the surrounding slates. This may be more effectively carried out by eye, and when provenance can be assumed, should be replaced with reclaimed slate. If a good quality slate of the same texture and provenance can be sourced but is a different colour, always urge towards slightly lighter in colour as these can weather darker, whereas a darker slate can never weather a lighter colour. Sometimes the cost of carrying out X-Ray Diffraction analysis would outweigh the total cost of the repair, and would not necessarily achieve a good visual match. Therefore, if a good, skilled roofer is employed to match the slate from reclaimed Scots resources, this is a more effective method for replacements. 'The Pattern of Scottish Roofing' (Historic Scotland, 2000) gives great insight into the different types of slates and their origins, how they are used and repaired. It is recommended that this publication be referred to when repairs are being carried out to ensure a sympathetic repair is achieved.

As highlighted above, maintenance is key and this includes all areas above eaves level. This includes chimney stacks and pots, haunching, skews and coping stones, mortar skew fillets, ridge tiles, flashings, and also gable masonry. Note that in the visual surveys poor condition gable ends have been identified where possible, however not all were inspected and therefore further investigation may be required at a number of properties where damp issues are being experienced. Appendix J includes the specification for a mortar skew fillet which is flexible and durable enough to not crack over time, and also includes a water repellent to promote water run-off.

Chimneys, skews and associated masonry must be maintained with no open joints or vegetation as this promotes water shedding rather than ingress. Along with the maintenance and repair of the roof covering, maintaining and repairing the associated masonry will insure a durable roof which will last many years, keeping the structure dry. Think of servicing your car; it requires annual servicing, checks, repairs and fluid changes to keep it in good condition and road worthy. This is also required

for buildings, in particular at roof level. Always clear gutters, vegetation and check slates have not slipped or missing bi-annually.

4.0 Skills

It is apparent from our survey work that there is or has been in the past a considerable skills and knowledge gap amongst building owners, contractors and building professionals as to the repair and maintenance requirements of traditional buildings. It is vital that the knowledge is there to know what the correct thing to do is and the skills for how to undertake work successfully; with either of these missing or indeed both then the conservation, repair and maintenance of our traditional building stock is in danger. This is particularly apparent on the Bonnygate where a plethora of remedial works to stone facades which are non-traditional (ie not 'like for like') and in many cases positively damaging to historic building fabric, eg cement rendered and painted stone facades. There is also widespread neglect of rainwater goods and above eaves level masonry leading to widespread 'roof top gardens' and problems of water ingress into building fabric, and no doubt issues of internal dampness (though this is out with the scope of our remit). This is also compounded with issues of multi occupancy/ownership issues which present difficulties in organising common repairs. Many of these attempts at re-facing crumbling stone facades, no doubt with the best of intentions, has resulted in inappropriate materials being applied to an already weakened stone, or dressing back with inappropriate methods, eg 'scutching' leaving surface finishes that bear no relationship to the original tooling, eg droved, broached or polished and radically altering the overall appearance of buildings to their detriment. There appears to be no pride in the facades of buildings found in the prominent streets in Cupar, such apathy normally being reserved for the backs of buildings.

A quick appraisal of the knowledge and skills set in Fife amongst building professionals and masonry contractors reveals that there are only two conservation accredited architects, one accredited surveyor and a handful of stone masonry companies serving a county with the second largest number of listed buildings next to the City of Edinburgh. Larger conservation jobs are frequently won by central belt masonry contractors and are often in the hands of central belt architects. This highlights the requirement for traditional building skills training and upskilling of workforces to meet the demand of repair works and to avoid future deterioration by using the correct methods and materials. It would be ideal to engage local contractors to improve the local economy and retain local knowledge of specific materials and building types within a region. For example, having worked previously with building contractors whose background is not in stonemasonry or traditional building

repairs, and with the help of on-site training carried out by the SLCT, a successful harling job was delivered. This was a local contractor and with ongoing training and assistance could up-skill their workforce to widen their market while also serving the local area by having the ability to carry out the repairs required to traditional buildings successfully.

5.0 Summary and Conclusions

5.1 Summary

To summarise this report, the original objectives given in the introduction will be looked at. After a general introduction and basic outline of the project undertaken, an analysis of the stone of the street-facing frontages and slate was carried out. Stone coring and analysis were undertaken for four buildings, as it was deemed unnecessary to analyse all ten as proposed, due to generally only a few stone types present as mentioned above. The slate roof coverings were also identified, however due to limitations mentioned in the above section about slate, this was not always possible. In addition, a number of mortar samples were taken from around Cupar. These were found to be very similar throughout, making further sampling unnecessary. Furthermore, most of the visible stone facades on the main streets were comprised of ashlar, making mortar analysis for these properties difficult and irrelevant. Often, if there was mortar joints large enough to sample, this was modern cement mortar, which is not appropriate for testing.

It was found that for all painted buildings where stone was visible, this stone was of the S1 type. It is therefore assumed that most painted properties have this stone type. It should be noted that this is merely an assumption based on the evidence gathered and that for any future work the stone type should be analysed for the individual building. This is particularly true for those properties covered in either paint or render. It would be expedient and more cost effective for any potential requirement for stone analysis to come to the SLCT where the matching work has already been completed.

The report has also identified possible historic sources of the stones and mortar, all of which were relatively close to the town itself. Stone recommendations for the individual stone types were given. Again, it is important to confirm these for individual buildings in any future work.

Surveys were undertaken for all street-facing properties in the Priority Area and 50 buildings within the Conservation Area. It was decided to take a more general overview with a greater number of surveys including the ones outside the Priority Area. This will give a better indicating of the overall trends within the whole of Cupar and would be more beneficial for a wider audience. It was found

that most properties were ashlar, rendered and painted and there were a great number of maintenance issues outlined in the summary of trends above.

A recommendation for removing paintwork will follow the conclusion of the findings in the section of recommended repair works. This will also give further recommendations for the most important maintenance and repair works identified in this report.

5.2 Conclusions

From the map of Cupar with identified types of stone along with the data collected from the visual surveys, it is possible to draw the conclusion that the buildings with poorest stone type (S1) are also the most commonly rendered or painted buildings. Surface treatments are obviously in response to extensive weathering or premature surface loss, to improve the aesthetics and also give an extra layer of protection to buildings. This concept is prevalent through most of Scotland, as a lot of buildings would historically have been harled both to give a more formal appearance than rubble walling afforded, and to give an extra layer of protection to the stonework. However, the use of inappropriate materials such as dense, cement based renders, and film forming masonry paint only make the stone condition worse as these materials trap moisture, causing weakened fabric of the stone.

In terms of repairs going forward, while it may be necessary in some cases to replace stone where too much fabric has been lost, alternatives such as using traditional lime harls and renders would be a more conservative way to approach repairs. As many of the facades which are now treated have been for some time, the streetscape has already changed to incorporate rendered and painted facades. If all rendered or painted facades were taken back to their originally exposed ashlar facades, this would impact greatly on the look and feel of the streets in Cupar. To re-render a building which already is rendered is more of a minimal intervention approach as it retains more historic fabric. It is recommended that wholesale replacement of stone must be fully justified, practically and technically as this would remove more historic fabric and is not necessarily an 'improvement' as stone replacements are not the same quality as the existing fabric.

The decision-makers involved in these schemes of repair must also consider all the options, most importantly the use of the correct materials suited to each building and stone type. It is apparent that inappropriate materials and repairs have been allowed to go ahead, either by lack of control at planning stage or a lack of enforcement during works. Planning authorities should work closely with those who can specify practical solutions that do not impact negatively on the fabric of the building

or the aesthetics of the street as a whole. This does not necessarily mean taking a purist view on materials as there are alternatives available with workable mortars and techniques on offer.

As this report has pointed out numerous times already, the lack of maintenance is widespread throughout Cupar with overflowing, blocked, rusted, and failed rainwater goods with vegetation abundant above eaves and even on walling. This has partly been attributed to the difficulty in gaining access particularly at the Crossgate intersection with Bonnygate, with a busy road and narrow paths. Along with access difficulties, most properties are owned by several people of which not all are local and are difficult to contact. This makes agreeing and arranging repairs and maintenance time-consuming, and discourages tenants or landlords from taking things forward. It would be beneficial to create a solution for this problem, and along with informative guides and seminars, educate the wider public in Cupar of the advantages of regular maintenance. See further reading for a list of useful guides.

5.3 Recommendations for Repair

It was decided that condition surveys of individual buildings in Cupar would be counterproductive as when analysing the trends within Cupar it was noticed that the same building defects were reoccurring. It was therefore decided that a list of recommendations which outline the main problems within Cupar would be a better way to remedy the lack of repair and maintenance within the town.

Stone Cleaning

Within Cupar there is a large proportion of the buildings where masonry paint and cement wash has been used to cover the facades of the buildings. This paint covers an array of different substrates. Many of the buildings that are painted have the paint finishes applied to previously exposed stone work. However, there are many that have paint over cement wash and where paint covers cement render, be that smooth or roughcast. It is advised that all modern masonry paint (non-breathable) should be removed from stonework and where there is cement wash and cement renders, this should also be removed. This will be covered in a separate section of this report.

The methods of stone cleaning/paint removal that we would recommend are listed below with recommendations on the best practice when undertaking the work. Before undertaking any major works, trial cleaning areas should be undertaken to assess efficacy and time required. These should be located in discrete locations and should be small in case it is decided cleaning is not required. It must be taken into consideration when carrying out these trial areas that there is the potential the cleaning agent/methods could cause damage to the fabric of the building. This could be through material loss or colour change and it is worth bearing in mind that it can take several weeks for colour

changes to become apparent in some stones. Other things to consider before undertaking any form of stone cleaning is the effect that it will have on the appearance of the façade as cleaning is irreversible, as well as how likely it is that the façade will have to be cleaned again in the future

It is likely that cleaned stone buildings will develop issues with accelerated weathering, and will not fit in with the streetscape due to removing the patina from the stone. Patina is the weathered face of stone that gives buildings their character and setting and removing this can create a totally different image of the building and the street. We only recommend cleaning where it is absolutely necessary, such as large areas of algae/staining that could accelerate stone decay.

Within Cupar most of the building stone is calcareous. This therefore means that the use of any form of acid to clean stone work has been ruled out as it has an adverse effect on any stone it would come in contact with. Therefore the following cleaning methods have been chosen to protect and cause as little damage to the buildings of Cupar as possible.

Table 11 shows the different kinds of cleaning methods that we would recommend for the removal of any paint within Cupar;

Method	System	How it works	Possible Damage	Media	Comments
Low Water Pressure		Water at mains pressure used to wash the wall	Large amounts of water can soak the masonry and surrounding ground	Loose particles of media	This should be used after all other methods to remove dust and traces of the cleaning method
High Water Pressure		High pressure water is used to wash the wall utilizing water cutting action	As above. Additionally high pressure can erode the substrate surface	Loose particles of media and soiling	Very high pressure water should not be used on historic masonry
Steam	e.g. DOFF	Combination of pressure and hot steam to soften and loosen the media	Steam and water can quickly saturate porous stones		Softening the media with chemical agents can help the process

Brushing/Mechanical Cleaning		Manually taking off the layer of paint and outer layer of stone with brushes, needle guns or rotating discs	Erosion and loss of detail due to the stone surface being taken off	All soiling and paint	For sound surfaces with low intrinsic value and even surface
Dry Air Abrasive		Small particles of abrasive agent are shot at the substrate under pressure	Erosion and loss of detail due to the high pressure and abrasive nature of the method. This might also produce airborne silica, a hazardous material	All soiling and paint	
Wet Air Abrasive	e.g. TORC (JOS)	As above with added water binding the dust (including airborne silica)	As above. Further added risk of saturation of substrate	All soiling and paint	TORC is said to have a lower impact than other similar systems due to the rotating action
Dry Ice Cleaning		The transformation from solid to gas bounces off the particles, loosening them from the substrate	Possible damage due to thermal shock	Different media and substrate	No long term data available

Table 11: Different kinds of cleaning methods recommended for removal of paint, from least aggressive to most aggressive (not including dry ice cleaning due to lack of data).

Cement wash / Paint removal

As outlined above, trial panels are the best way to ascertain which technique is required to clean stone/remove paint. Therefore, it is not ideal to recommend individual cleaning regimes for individual properties as this might not be as effective as carrying out trials. As well as the difficulty in identifying

a method of cleaning, it has been difficult to determine (non-destructively) the type of paint/cement wash present. With these points in mind, it has been decided that individual paint surveys would not be possible or beneficial within the scope of this audit. Therefore, carrying out the recommended course of action below is best for all paint types including cement washes.

As identified through the visual surveys, buildings with poorer stone qualities tend to have some form of surface treatment in Cupar, usually using masonry paint, as a response to the poor stone quality. However, in many cases a cement wash was used as the base coat and obviously for some added weather protection. This, like the masonry paint, has caused underlying stone decay and in many cases is started to flake off of its own volition. In many buildings, though, the cement wash is still fully adhered to the surface of the stone and requires a specific scheme of cleaning to remove it. The stone cleaning section above covers the different techniques which can be used and we have identified that abrasive systems would work best for cement washes, as any type of acid cleaner is not suitable for the calcareous stone type in Cupar. Therefore, using the same methodology as cleaning by starting the least abrasive method and working up to larger, more abrasive sand blasting by means of sample panels is the best way forward. Starting with the Jos/Torc systems, very fine aggregate sizes can be trialled working up to larger grains with sand blasting. Where a system is most effective at less aggressive means, it may be better to use this on the whole façade and use a needle gun run off an air compressor to remove any small, stubborn areas. This method while not ideal, is the least aggressive and damaging to stone given the type of stone and the vast areas required to be cleaned. A few properties have had a cement wash (or render) removed using hand tools, such as 28 Provost Wynd, and this has resulted in a very fresh scutch finish which in no way resembles the original tooling or neighbouring properties. Most buildings in Cupar have either a droved/broached finish or stugged finish if any finish is used at all, as most ashlar work is smooth. Scutching removes more of the surface of the stone when compared to other methods, such as the Torc system; other systems of paint removal retain more of the historic fabric and also preserve the appearance of the stone to some degree. In Figure 27 the fresh face of stonework can be seen at 28 Provost Wynd where a previous cement wash (presumably) was removed by scutching the surface back. The property to the left while painted shows the tooling of the stone to be stugged ashlar, which is much more suitable for a residential property in Cupar. While the stonework may not be adversely affected in weathering characteristics, the finish of the stone is not traditional and does not resemble the original finishes.



Figure 27: 28 Provost Wynd, demonstrating scutch finish next to traditional stucco finish (on left)

Paint removal would follow the same process, starting with the least aggressive method and working through to more abrasive methods, as various types of paint will react differently with each removal technique. For masonry paint, the Doff system can also be trialled as the most gentle approach, working up to the Torc system and other methods. Where stubborn areas persist a plastic buffing disc (attached to a drill) could be used to remove isolated areas of paint.

The stone can then be re-dressed with original tooling if appropriate if evidence is found of original facades, or the stonework can be painted for protection using a mineral or lime paint.

These cleaning works can be carried out by specialist cleaning contractors who are well trained in the techniques and have a knowledge of which materials work best with particular methods. However, it is vital for any stone cleaning that it is carried out carefully with operatives who are fully trained to use the equipment required and who are sympathetic to the substrate. Any pressurised cleaning systems or other cleaning methods need to be allowed enough time to be carried out carefully and allowed to dry out fully before other works commence. For any stone cleaning it is advised that trial panels be cleaned in small areas and agreed prior to any commencement of works.

Salts

What is evident within Cupar is the extent to which salts are present on the stone work of the buildings. This was particularly around ground level and at eaves/parapet level where rain water goods are not shedding water properly, and also around areas of cement repointing indicating trapped moisture. Where salts are present on stone work it should be removed to avoid further decay. This should be done using a wire brush to remove the salt from the surface of the stone work. This form of maintenance should be carried out periodically to avoid a build-up of salts and long-term damage of stone.

Roofs maintenance

Chimneys

As most buildings in the UK are now heated using central heating systems chimneys have now become obsolete. This therefore means that the dynamics of a chimney have changed, as have the maintenance schedules of chimneys. In the past chimneys would have been ventilated due to them being in constant use. As this is no longer common and fireplaces have been blocked up, these chimneys now have a lack of ventilation and can become saturated because they are also no longer being heated. Due to this change in use, chimneys become vulnerable to water ingress which over time can erode the stone work and the mortar making the chimneys dangerous. This can be seen throughout Cupar with many of the chimneys having empty mortar joints and vegetation growth protruding from the masonry.

It is advised that any chimneys that are deemed to be dangerous/ leaning should be dismantled and rebuilt using appropriate materials. This is most commonly stone in Cupar, however some chimneys have been rebuilt in brick and rendered or left exposed. Brick could be argued to be a suitable material if the chimneys are rendered as it will not be visible or as an 'honest' repair making it obvious where a chimney has been rebuilt – something which could be advantageous for future building owners. These scenarios are most common on gable ends in Cupar where flue gases have weakened the masonry, compounded by the common presence of cement render, which in turn destabilises chimney stacks making them liable to collapse. Where a chimney requires repointing this should be carried out using appropriate materials avoiding cement. While carrying out any work to the chimney it is important to remove any vegetation that has taken root in the open joints or on the stone work. This should be carried out at least once a year. All chimneys should be sufficiently ventilated throughout the property. This will allow the stonework to go through a drying cycle while also allowing air to circulate around the property more freely. If modern lime mortars with additives are used, ensure low sulphate cement is used if included as an ingredient, as these can be used for mortar fillets around the base of the chimney or haunching around chimney pots. Where there are

slipped/ missing slates or tiles these should be replaced straight away as this can allow water ingress. All lead work and penetrations should be checked and corrected where it has failed as again this is an area which can allow water to enter the property.

Rainwater goods

It was evident within Cupar that rain water goods had been neglected over a long period of time which has resulted in staining to stone work and vegetation growth on the majority of the properties in Cupar.

We advise that rainwater goods should be cleaned every 6 months with an inspection and cleaning after winter at a minimum to avoid any problems. All leaking rain water goods should be cleaned, repaired and replaced where necessary. This should be carried out on a like-for-like basis where possible, although aluminium replicas may be used in some cases (will require listed building consent if using different materials). Aluminium replicas have certain advantages for areas such as Bonnygate, the Cross and Crossgate where access to building frontages can be difficult, therefore a relatively lightweight section can be easily installed compared to a heavy cast iron section. Cast iron rainwater goods do have better long term costing projections as there is very little maintenance required to keep them in good condition compared to uPVC or aluminium. However, aluminium comes quite close to cast iron long term, where uPVC fails quite considerably on replacement costs. Where there has been vegetation growth this should be removed and treated with a biocide to prevent any regrowth. The falls (direction of flow) of the guttering should be checked; this can be done by using a hose with running water to gauge the run off. If it is not adequate or where water is standing then the gutters should be adjusted to suit. In some cases it may be advised to upgrade the existing gutters for a wider diameter, deep flow gutter system particularly where there is a larger roof span or steep pitch as this will help deal with run off. During cleaning and general maintenance of rain water goods it would be advised that wire mesh balls be installed at gutter level over down pipes to prevent any debris blocking the down pipe as this stops free draining of water therefore causing the system to fail. Extra efforts should be made where shared rain water goods are causing damage to multiple properties. Agreements between all parties should be made and a maintenance schedule should be agreed. All concealed rainwater goods must be inspected and cleaned regularly, especially as they are not visible externally and can cause extensive damage when blocked (as can be seen throughout Cupar). These types of rainwater goods will require additional access means for inspection and cleaning due to their location, and efforts must be made to have this carried out regularly and not to delay it due to cost or other limitations. If left too long, salts can accumulate at parapet level which damages stone and along with vegetation growth can worsen the water ingress issues experienced at high level.

Walls

There are different approaches to the repair of loose, cracked or friable masonry. We would advise that all delaminated, loose and friable stone be dressed back to a sound substrate. If it is more than one third of the stone that is lost after dressing back then a replacement stone should be considered. Where detail is to be retained, stone indenting should be considered or where less of the surface area has been lost a surface repair mortar may be used to repair the stone work. If the stone is face bedded or friable then this form of repair may not be long lasting, therefore meaning that the condition of these repairs should be revisited regularly. All new work, be that dressed back stone, indents, replacements or surface repairs should be tooled as per the original dressing or the adjacent property.

Once the condition of the stone work has been addressed by creating a scheme of works to either replace or repair the stone, many areas of masonry will require repointing mortar joints. This may also be where cement mortars have been used to repair open joints and have started to become loose or cause damage to the stone and requires replacing. Generally all mortar that is failed in some way, be it cracked, loose, friable or causing damage to surrounding stone, should be removed. In the case of cement pointing, this should be carried out carefully as cement can adhere strongly to the face of stone and if not removed sympathetically, it can take the face of the stone with it. Where joints are to be repointed with lime mortar, these should be raked out to a sound backing with enough depth to provide the new mortar with a strong bond to the masonry. The open joints should be cleaned of debris and washed down and allowed to dry out fully before works can commence.

Specifications

As specifications are usually carried out in tandem with a site visit as these are individual to each building due to detailing, condition of stone, exposure and lots of other factors, specifications for repairs require a more bespoke approach. There are some mortars which are suitable for all buildings, such as the mortar skew fillet mortar which is included in Appendix J. Going forward, it should be considered to appoint a building professional to investigate further if required, arrange skilled contractors to carry out the work and oversee the repairs. SLCT can work with these building professionals and contractors through all facets of the repairs be it specifications, skills training or quality assurance. However, if this is not possible, where further investigation is required or the complete condition of the external fabric was not possible and problems are being experienced internally, it is recommended to get a building professional or SLCT to carry out a more thorough survey. Where works require various consents from Fife Council, SLCT can also aid with mortar and stone analysis based on the work that has been carried out for this report.

It is recommended to use Melville Gates quarry sands as far as possible as these match historic mortars and local geology, and are well graded sands. All new lime work should be protected and cured correctly, and good site practice is key in achieving successful work. See Appendix I for guidance in new lime works and general site practice.

5.4 Further Reading

Maintaining Your Home (2015), Short Guide 9, Historic Environment Scotland,

Appendix I: General Guidance for Lime Works

Inform Guides

- Masonry Decay

The Pattern of Scottish Roofing (2000), Research Report, Historic Scotland (now Historic Environment Scotland)

Traditional masonry building repair using lime mortars DVD, Scottish Lime Centre Trust (available online at www.scotlime.org)

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