Research Report

Soft Capping in Scotland

The context and potential of using plants to protect masonry

Volume 2 Case Studies

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with

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Some photographs included in this digital report may not be clear when printed but have been included for illustrative purposes due to their relevance.

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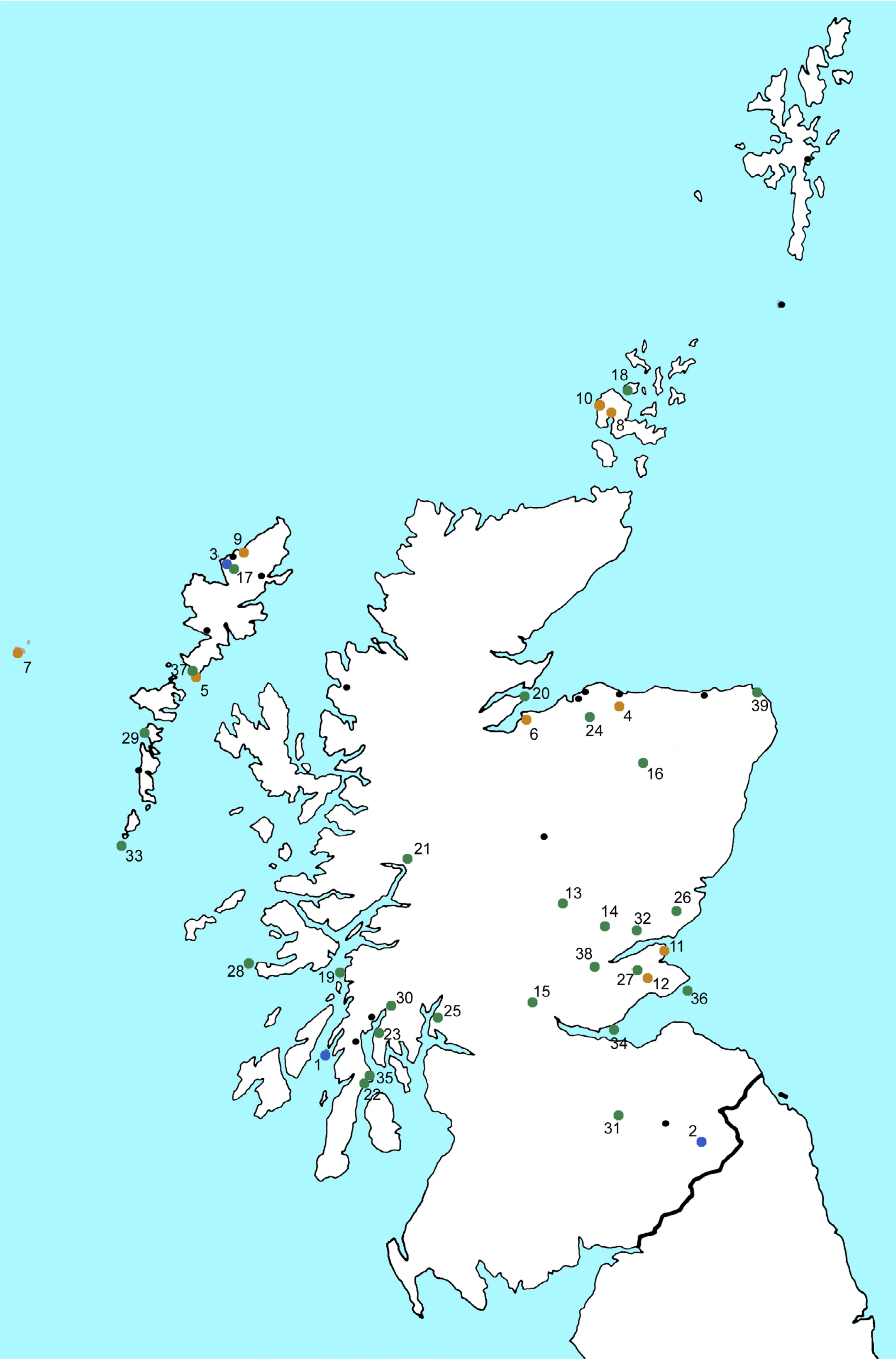
INTRODUCTION

This volume presents 39 case studies of soft cappings in Scotland, studied in a programme of field assessments, undertaken between 2004 and 2006.

Case studies 1-3 represent a range of soft cappings that have become naturally established on masonry. Case studies 4-12 present diverse examples of soft cappings that have been used as part of a structure's original construction. One is a reconstruction and four have had conservation work undertaken. Case studies 13-39 present soft cappings that have been applied as part of conservation work to masonry structures. Seven of these also have significant naturally established cappings, which were retained during the works.

In presenting these case studies our intention has been to highlight factors that could help to increase understanding of the issues that lead to successful conservation work. This means that less successful aspects of projects tend to be highlighted. In the developing field of soft capping, performance can be difficult to predict and any comments highlighting poor performance of cappings should not be taken as criticism of any individuals or organisations (involved in their design or installation), who are often leading practitioners in their fields, keen to develop new ideas and techniques to enhance the conservation of Scotland's built heritage. Our thanks go to them.

It is intended that the information on technique, climate and performance contained in these studies should act as a useful resource to people designing soft cappings in the future. The authors welcome feedback on this report, as well as information on any examples not shown here, or on future projects.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- **Other Sites Considered**

Ash Cottage, Monimail, Fife	Auchindrain Village, Argyll
Blackhouses, Bernaray	Blackhouses, Gearranan, Lewis
Enclosure Walls, Glen Lochy	Enclosure Walls, Luskentyre, Harris
Fort Charlotte, Shetland	Findhorn Icehouse, Moray
Highland Folk Museum, Newtonmore	Howmore Ruins, South Uist
Kirkyard, Gairloch	Moray Costal Defences
St. Mary's Kirkyard, Banff	Tugnet Icehouse
Walls, Lamancha, Midlothian	Walls, West Loch Fyne

Case Study 1: ST. CORMAC'S CHAPEL, Eilean Mor, Argyll

This case study documents an extraordinary example of the benign natural capping of masonry by vegetation.

Fig. 1.1: St. Cormac's Chapel from the north, with sheltering hill behind.

1.0	**Background**			
1.1	Location:	A small uninhabited island in the Sound of Jura, Argyll		
1.2	Grid Reference:	NR 6665 7528		
1.3	Date of Works:	N/A		
1.4	Client:	N/A		
1.5	Contractor:	N/A		
1.6	Architect:	N/A		
1.7	Access:	Unrestricted private access, boats can be chartered from Crinan		
1.8	Visit Record:	Date:	By:	
		29.07.05	TM, Martin Hadlington (MH)	
2.0	**Building**			
2.1	Type:	Chapel, ruinous		
2.2	Classification:	Scheduled Ancient Monument Category B Listed Building		
2.3	Chronology:	Built:	The original structure was probably built in the early 13thC. with the vault probably added in the mid 14thC. The building was adapted to a house after the Reformation, with the addition of first floor windows, a fireplace and internal masonry skin to the west gable.	
		Ruined:	pre 1875	
		Repairs:	Uncertain, there seems to have been a cementitious coating applied internally to the vault during the 20thC.	
2.4	Construction & Form:	The building is divided into two sections. The eastern half comprises a complete ground floor chamber, with doorway to the west and windows to the east, whose vaulted roof encloses a passage. The western half of the building has no roof, but walls practically complete to the flat wallheads on the north and south sides and a gable with central chimney to the west. The pitch of the vault and gable is approximately 45 degrees. The walls are built of local schist random rubble in lime mortar. Evidence from other buildings in the area would suggest that the core mortar could be clay (MH). Original lime render survives on the west and north elevations. On the south face the joints are fairly open and support spleenwort and traces of grass. The visible areas of external vault surface show a well-constructed stone and mortar face. There is some cementitious pointing, particularly to the west and on the internal west face of the cross wall. Internally, large areas of plaster remain, though they are quite damp. Some areas have spalled off and this might be linked to an apparent surface cementitious coating. Plaster remains on the vault soffit, though again areas have spalled off, particularly on the south side, with the south-east corner most affected, and some open jointed stonework visible (Fig. 1.4).		
3.0	**Site**			
3.1	Setting:	Description:	The chapel sits in the middle of a small island between the west coast of Argyll and Jura. The chapel ground is enclosed by a post and wire fence, though this does not fully exclude sheep. The island is rugged, with a small hill rising higher than the chapel to its south-west.	
		Altitude:	< 10 m	
		Distance inland:	~200 m	
3.2	Classifications:	None known		

<table>
<tr><td rowspan="5">3.3</td><td rowspan="5">Microclimate:

* Data source:

Met. Office, Annual Averages 1971 – 2000

‘Numbers in brackets give data as a % of national average’</td><td colspan="4">The island is exposed in all directions, especially to the prevailing south-west, though crucially the chapel is in the lee of a small hill.</td></tr>
<tr><td>Rainfall (mm) *</td><td>~1700mm (112%)</td><td>Days of Rain > = 1mm *</td><td>210 (112%)</td></tr>
<tr><td>Min Temp *</td><td>~6.2°C (155%)</td><td>Max Temp *</td><td>11.9°C (113%)</td></tr>
<tr><td>Days Ground Frost *</td><td>~15</td><td>Hours sunshine *</td><td>1380 (118%)</td></tr>
<tr><td colspan="2">Prevailing Wind Direction:</td><td colspan="2">South-west</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>**4.0**</td><td colspan="5">**Flora and Fauna**</td></tr>
<tr><td>4.1</td><td>Vegetation on building:</td><td colspan="4">The vegetation is divided into four sections; the vault, the two flat wallheads and the west gable:

a) The Vault Vegetation

The exterior surface of the vault is almost completely covered with dense and lush vegetation. The masonry is enclosed by a matrix of soil and densely matted fine roots, of about equal proportions and approx. 10-40mm deep, which was damp to the touch. It contained some sand and was very dark and ‘soily’, rather than seeming to be formed of desiccated plant material (Fig. 1.6).

Above this layer, a diverse mix of plants forms a natural living thatch of leaves about 300mm thick. Where the masonry became locally vertical near the eaves, the soil and roots did not cover the vertical face of stones, though the leaf layer did (Fig. 1.7). The roots did not seem to penetrate significantly into the masonry, which seemed tight and well bonded. There were not significant amounts of lime or decayed mortar apparent in the soil layer.

On the south side, vegetation generally overhung the south eaves by 50–100mm (Fig. 1.9), but there were triangular areas of exposed stone in both of the lower corners, the south-east corner being approx. 300mm wide x 750mm tall and the south-west approx. 300mm x 600mm, though some vegetation at the very eaves linked to the flat wallhead.

On the north side, vegetation overhung the north eaves by 0–50mm and the exposed areas of masonry at the corners were larger, approx. 1m x 1m in the north-east and 0.4m x 1m in the north-west (Fig. 1.8).

The vegetation at the ridges was less lush than that further down and there appeared to be a vertical grading of species, with more grasses higher up and more wildflowers lower down. Seen from the east, the vegetation clearly displayed a convex curve over the masonry, being thinner at the ridge and eaves and thickest in the middle (Fig. 1.10).

There appears to be some blue-green algae in the vault passage, but no significant vegetation.

b) South Wallhead.

The south wallhead has a similar cover of vegetation. There is a deeper layer of soil, up to 75mm and with a rounded profile, which contains some small stones. The roots do not seem to significantly penetrate the sound masonry (Fig. 1.12). The vegetation overhangs the south face by up to 100mm, but does not overhang the north.

At the east end, abutting the vault, there is a bald area of wallhead on the north side, approx. 450mm x 900mm (Fig. 1.11). Conversely, on the west end there is a large bushy overhang of vegetation.

c) North Wallhead.

The north wallhead has a similar layering of soil and vegetation. On the north side the vegetation overhangs by 0-25mm and on the south side the maximum overhang is 25mm, but there is dieback up to 100mm.

d) West Gable.

The south side of the gable has skew putts, but no skew stones in place. The exposed wall has grass in tufts up the wall core and between the original inner face and the later masonry lining. On the north side, the skew stones are mainly in place and there is only some dead vegetation adhering to the later inner lining (Fig. 1.13).

The first floor chimney hearth has one or two small shrubs, but the two window sills have no plants.</td></tr>
<tr><td>4.2</td><td>Surrounding Vegetation:</td><td colspan="4">The enclosed area is mown grass. Outside this the dominant grass mixes with wildflowers and other plants in damper areas.</td></tr>
</table>

4.3	Species Survey. *Assessment by HL from photographs* **D**=Dominant, **A**=Abundant, **F**=Frequent, **O**=Occasional, **R**=Rare, **VR**=Very Rare, *=Present						
	Common Name	Latin Name	Gable	Wall-heads	Vault roof	Surr Veg	Comment
	Grasses:						
	False Oat Grass	*Arrhenatherum elatius*			**R**	**F**	
	Red Fescue	*Festuca rubra agg.*	**F**	**A**	**A**	**O**	
	Sheep's Fescue	*Festuca ovina*		**R**			On edges
	Yorkshire Fog	*Holcus lanatus*			**R**	**A**	
	Ruderals/Herbs:						
	Bracken	*Pteridium aquilinum*				**O**	
	Brambles	*Rubus fruticosus agg.*				**O**	
	Broadleaved Dock	*Rumex obtusifolius*				**R**	
	Common Birdsfoot Trefoil	*Lotus corniculatus*	**F**	**A**	**F**		Large clumps overhang edges of gable. Mat forming clumps on edges of wallheads. Clumps on edge of vault.
	Dandelion	*Taraxacum stet agg.*		**R**			
	Hawkweed	*Hieracium agg.*			**O**		
	Knapweed	*Centaurea nigra*		**O**	**F**		
	Lady's Bedstraw	*Galium verum*			**O**		
	Marsh Cinquefoil	*Potentilla palustris*				**R**	
	Meadowsweet	*Filipendula ulmaria*				**O**	
	Nettles	*Urtica dioica*				**F**	
	Ragwort	*Senecio jacobaea*	**R**	**VR**	**R**		
	Reedmace	*Typha angustifolia*				**O**	
	Ribwort Plantain	*Plantago lanceolata*	**F**	**O**	**F**		
	Spear Thistle	*Cirsium vulgare*				**R**	
	Trees/Shrubs: None						
	Mosses/Ferns: None						
4.4	Fauna:	Woodlice were observed in the capping soil layer. A small bird's nest/burrow was observed in the lower leaf layer (Fig. 1.14). The island is grazed by Soay and Blackface sheep. Ground nesting gulls breed during May and June.					

5.0	**Technique**	
5.1	Source of Technique:	N/A
5.2	Season of Work:	N/A
5.3	Preliminary Repairs to Structure:	N/A
5.4	Treatment of Existing Vegetation:	N/A

5.5	Soft Capping Technique:	The gradual establishment of this remarkable natural soft capping can be charted in a series of photographs (Figs. 1.15-1.18). These images show that the establishment of the soft capping has been incremental over a significant period of time, with the process to date taking perhaps 200 years and no reason to suppose that the capping will not continue to mature. The island's shores are rocky and there is unlikely to have been significant deposits of wind-blown sand, though decaying lime mortar will have provided some aggregate to combine with humus deposited from the increasing plant cover. Although the masonry surface is not smooth, its incline and exposure will have presented significant impediments to the accumulation of organic matter. The source of seeds is likely to have been predominantly wind-blown, from the island itself and from Jura to the west, with seeds brought by birds probably a minor contribution. It is possible that the vegetation has reached its principal limits, with wind inhibiting further colonisation of the gable, vault corners and the south wall's east internal end. However, it remains possible that these areas will also be colonised gradually over perhaps another 100 years.
5.6	Vegetation: Source and Description:	N/A
5.7	Soil: Source and Description:	N/A
5.8	DPC:	N/A
5.9	Defining Membrane:	N/A
5.10	Fixing:	N/A
5.11	Aftercare:	N/A
5.12	Maintenance:	The grass within the enclosed area is mown regularly by Historic Scotland. The vegetation on the building is untouched.
6.0	**Performance Assessment**	
6.1	General Performance:	The vegetation on this building seems to be very mature and well established. It forms a natural thatch that significantly reduces the amount of precipitation entering the masonry, perhaps by 50-70%. The soil does not form a significant moisture barrier and instead the masonry itself will act, to some extent, as a moisture reservoir for the vegetation. Despite this, there does not seem to have been significant damage through root penetration. Although the masonry is evidently damp, with unenclosed window and door openings, strong winds and prevalent high relative humidity, the amount that is attributable to rain penetrating the vault is difficult to assess. The worst area of damp on the vault soffit relates to the thinnest part of the masonry. It is also clear that the cementitious internal coating exacerbates the effect of damp in the masonry. The vegetation will provide significant protection from thermal flux, both shading from peak solar radiation and frost damage. It will also protect the vault surface from erosion, through wind-driven rain, which might otherwise have been severe, given the vulnerable nature of the mortar joints. The vegetation is therefore generally beneficial to the conservation of the monument, with little likelihood of increased risk of causing damage through maturing further. In this assessment, the minimal risk of seeding of trees or rooty shrubs is significant.
6.2	Effect of Climate:	The mild climate is beneficial to the establishment of a natural capping. Wind clearly affected the pattern of natural establishment.
6.3	Effect of Birds:	None noted
6.4	Effect of Animals:	None noted
6.5	Aesthetic Performance:	The general visual effect of the capping is good, with the underlying form of the building generally able to be read. However, the outer masonry surface of the vault, though protected by the capping, is also concealed. When the vault is seasonally covered by a bright yellow flower (Bird's-foot Trefoil (Fig. 1.19), the visual balance is disturbed, with the capping perhaps dominating the visitor's impression of the monument.

6.6	Public Reaction:	The natural capping is perceived by HS as being attractive to visitors.
6.7	Team Reaction:	It is recognised by HS that the lack of intervention to remove vegetation on this monument has been beneficial.
6.8	Comments:	This site demonstrates the complexity of factors affecting the viability of soft capping vegetation. The ability of soil to accumulate on the vault is limited and the density of the root mat is clearly important in retaining what soil there is. More soil accumulates on the flat wallheads, with some mixing with the core stones and mortar, indicating a limited amount of root penetration. The plants have a rich bio-diversity, which creates a dense, intertwined variety of leaf forms, forming a significant barrier to wind and rain (Fig. 1.20). There is a subtle gradation of plants across the vault, indicating different microclimatic conditions, depth of soil and levels of moisture. While the building undoubtedly benefits from the shelter of a small hill to the south-west, the site remains very exposed to both wind and solar radiation. The extent and quality of natural colonisation is therefore impressive and an indication that mildness of climate is of considerable importance. There are several small areas where vegetation has been unable to colonise, on the corners on the vault and on the wallheads, which are attributable to local focusing of the wind. The lack of plants on the narrow west gable demonstrates the importance of the shape and size of the vault roof to the establishment of vegetation. The mass of vault masonry will retain moisture in a way that the narrow gable cannot, sustaining the plants through periods of drought. Towards the top of the vault, where the masonry is thinner and more exposed to wind, the vegetation is thinner. That the flat wallheads have a good cover while the gable does not, indicates that the exposure of a narrow wall is not enough in itself to prevent vegetation, but that the addition of slope is sufficient. This capping has survived intact in no small part because of its remoteness to both visitors and maintenance teams. As such, it forms a model for similar monuments, of which there are many in Argyll with similar ecological, constructional and climatic situations. Comparisons can be made with Skipness Castle (CS35), St. Adrian's Chapel (CS36) and the Nunnery, Iona (SC28), where visitor numbers are much greater and 'maintenance' more easily effected. It can also be contrasted with the character of the natural cappings at Cessford Castle (SC2), which developed under quite different conditions. It is always important to recognise the differences between sites. The benign performance of this natural capping is in no small part related to its benign botanical context. Similar structures in more urban sites have had natural cappings removed following colonisation by rooty shrubs, ivy and trees. While such intervention can prevent root damage, it increases the masonry's climatic exposure, requiring a greater commitment to maintenance expenditure. The maintenance of these natural soft cappings on Eilean Mor, then, at the very least, represent good value for money.
7.0	**References:**	
	Interviews: C. McGregor & M. Burgoyne, *HS Architects* Sources: MacGibbon & Ross, 1896-97, *The Ecclesiastical Architecture of Scotland from the Earliest Christian times to the Seventeenth Century*, Vol. 1, 89-91 RCAMHS Photographs: SC743225, SC743226, A46006, A46007, AG/1647, G/5231 Data: http://www.metoffice.gov.uk/climate/uk/averages/19712000/mapped.html	

Fig. 1.2: North-east view, shelter indicated by surviving render.

Fig. 1.3: South-west view, exposure indicated by loss of render.

Fig. 1.4: North-east view, showing rising ground to south-west.

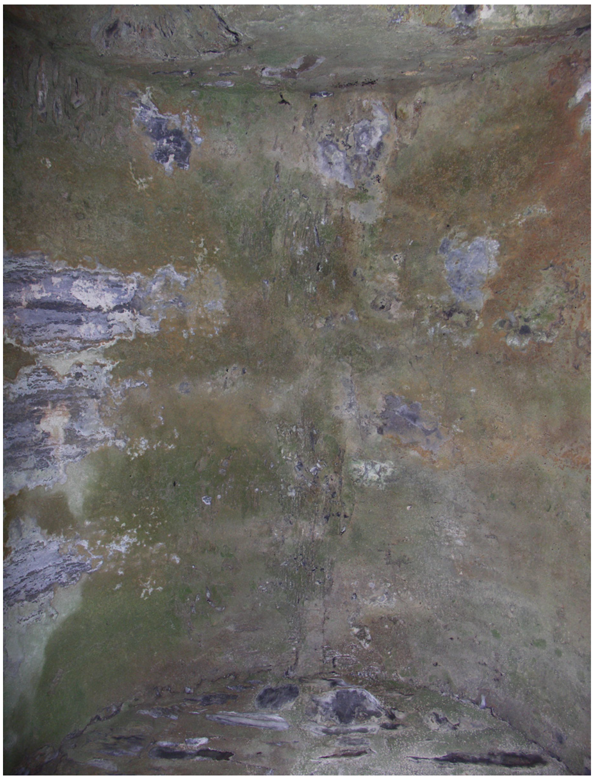


Fig. 1.5: The vault interior.

Fig. 1.6: Dense root mat and thin soil.

Fig. 1.7: Bare soil sheltered by the dense sward.

Fig. 1.9: Edge overhang and colonisation of the south wall.

Fig. 1.8: Colonisation pioneered along joints, but the corners remain bare.

Fig. 1.10: Concave profile of the sward

Fig. 1.11: Wind exposure on the 'sheltered' inside edge of the south wall.

Fig. 1.12: Thicker soil layer mixes with the wallhead masonry.

Fig. 1.13: The west gable.

Fig 1.14: Bird's nest or burrow.

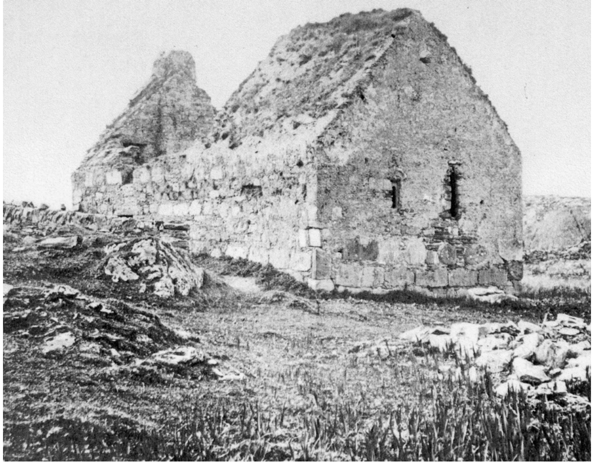


Fig. 1.15: South-east view, undated.

Fig 1.18: South view, 29 July 2005.

Fig 1.16: South-east view, 17 August 1898.

Fig 1.19: The dense diverse sward.

Fig 1.17: South view, 1984.

Fig. 1.20: Wind exposure on the corners inhibits colonisation.

Case Study 2: CESSFORD CASTLE, Roxburghshire

This case study is thought to be the oldest example of a naturally established soft capping and has been largely retained during conservation works to the masonry.

Fig. 2.1: A view of Cessford Castle ruin after the masonry repairs which kept most of the historic natural cappings.

1.0	**Background**				
1.1	Location:	10km south of Kelso, Borders			
1.2	Grid Reference:	NT 7380 2384			
1.3	Date of Works:	2004-2005. The site was visited during the second year of a two year programme of works to consolidate the castle masonry.			
1.4	Client:	Roxburghe Estate			
1.5	Contractor:	Graham Brown, Stonemason			
1.6	Architect:	Krystyna Pytasz, Waterman HDC			
1.7	Access:	Unrestricted access to ruin, but the wallheads are mainly inaccessible			
1.8	Visit Record:	Date:	By:		
		16.06.05	TM, Alun Tarr (Blackdown Horticultural Consultants)		
		12.09.05	HL		
2.0	**Building**				
2.1	Type:	Castle, ruinous			
2.2	Classification:	Scheduled Ancient Monument Category A Listed			
2.3	Chronology:	Built:	Probably mid 15th C.		
		Ruined:	c. 1640		
		Repairs:	None previous to wallheads		
2.4	Construction and Form:	The castle is an L-shaped tower with massive walls up to 3.5m thick, standing to ~14m above ground level. The ruinous masonry wallheads have a highly varied surface, roughly flat in some areas and sloping at up to 45 degrees in other places. Where the masonry is sloping, it tends to present a series of ledges, rather than a continuous plane. The wall faces are sandstone rubble and the core is a mix of sandstone and basalt rubble, all in lime mortar.			
3.0	**Site**				
3.1	Setting:	Description:	The castle is quite exposed, set high in a rolling, open landscape of hedged, arable land and small stands of trees. There is significant frost activity in this upland, inland location.		
		Altitude:	~130m		
		Distance inland:	~43km		
3.2	Classifications:	None known			
3.3	Microclimate: Data source: www.ecn.ac.uk Met. Office, *Annual Averages 1971 – 2000 *(Numbers in brackets give data as a % of national average)*	This area of the east Borders received relatively low rainfall, but over a large number of days. These are good conditions for soft cappings, with prolonged damp conditions and few long sunny periods. The wallheads are very exposed to wind, though there are some sheltered spots within the structure.			
		Rainfall (Ann. Aver)	~842mm (55%)		~130 (70%)
		Min Temp December	~0.5°C		~17.3°C
		Days Ground Frost	~50		~1250 (108%)
		Prevailing Wind Direction:		The contractor reported that the prevailing weather came from the north-west.	

4.0	**Flora and Fauna**	
4.1	Vegetation on Wall:	The natural vegetation seemed to generally be in a healthy condition. The flat wallheads support a dense sward, but the plant density and height reduces significantly on the more inclined surfaces, with sporadic growth between exposed masonry on slopes of 45 degrees (Fig 2.4). There are no naturally established cappings on the ~300mm thick masonry gable wall, which is severely exposed and pitched at approx. 45 degrees. The wallheads support a diverse range of species, including an unusual diversity of grasses and a rare recording of sedums, which occur in some quantity on vulnerable edges. Ribwort plantain similarly seems to be a stabilising influence. The capping has much greater diversity than is apparent in the surrounding countryside. In particular, there was no obvious natural habitat for sedums within sight. Where new cappings have been applied they were in good condition in exposed areas, but in sheltered locations, such as fireplace recesses, the turf had died and appeared quite dry. There were four semi-mature trees in the wallheads, which were being removed. There was no evidence of ivy. The only shrubby plants whose roots were reported to be causing damage were dandelions.
4.2	Surrounding Vegetation:	The castle stands in a field that is grazed by sheep during the summer to minimise erosion of the earthwork around the tower. It contains short grass and some nettles.

4.3 Species Survey. *Assessment on site by HL,12.9.05*

D=Dominant, **A**=Abundant, **F**=Frequent, **O**=Occasional, **R**=Rare, **VR**=Very Rare, *****=Present

A - NE wall ; B - SE wall to edge tower; C - S tower wall; D - SW wall; E - NW wall; F - Lower wall; S - Surrounding veg

Common Name	Latin Name	**A**	**B**	**C**	**D**	**E**	**F**	**S**	
Grasses:									
Cock's Foot	*Dactylis glomerata*	**R**		**O**	**F**	**R**	**F**	**F**	
Common Bent	*Agrostis capillaris*							**F**	
Common Couch	*Elytrigia repens*	**R**		**O**	**O**	**A**	**R**		
Perennial Rye Grass	*Lolium perenne*	**R**		**A**	**O**	**O**	**O**	**A**	
Red Fescue	*Festuca rubra agg.*	**R**			**A**	**O**	**R**		
Sheep's Fescue	*Festuca ovina*	**R**							
Smooth Meadow Grass	*Poa pratensis*	**F**		**R**	**R**	**F**	**O**		
Common Wild Oat	*Avena Fatua*	**F**			**R**	**R**	**R**		
Ruderals/Herbs:									
Biting Stonecrop	*Sedum acre*	**F**				**F**	**O**		
Common Chickweed	*Stellaria media*	**VR**						**R**	
Common Mouse Ear	*Cerastium fontanum*				**R**				
Dandelion	*Taraxacum officinale agg*	**R**		**R**			**O**		
Hedge Mustard	*Sisymbrium officinale*	**VR**		**R**		**R**			
Mugwort	*Artemisia vulgaris*								Inside wall of round turret
Nettles	*Urtica dioica*							**F**	
Ragwort	*Senecio jacobaea*	**O**		**F**	**F**	**F**	**F**		
Ribwort Plantain	*Plantago lanceolata*	**R**		**F**	**R**	**O**	**F**		
Spear Thistle	*Cirsium vulgare*							**R**	
Yarrow	*Achillea millefolium*	**O**		**R**	**O**	**O**	**R**		

	Trees/Shrubs:									
	Ash	*Fraxinus excelsior*				**VR**			*	D - Inside wall - Ash in wall for >50 years. Main trunk 10-30cm in diameter. Very well rooted into wall. Ditto Ash removed - corner C.
	Elder	*Sambucus nigra*				**VR**				1 x well established
	Hawthorn	*Crataegus monogyna*							*	Hedge
	Lime sp.	*Tilia sp*.							*	
	Sycamore	*Acer pseudoplatanus*							*	
	Wych Elm	*Ulmus glabra*							*	In hedge
	Mosses/Ferns:			**R**				**R**		
4.4	Fauna:	The castle is a habitat for owls, with many dead mice having been collected during the works. Though the owls use the castle to hunt from, they actually nest in nearby trees. Rooks have created burrows in the soft cappings and there are thought to be many diverse invertebrates in the cappings.								

5.0	**Technique**	
5.1	Source of Technique:	The old natural capping was preserved on the basis of conservation logic - there was no apparent need to remove it. For the new areas, the architect had previous experience of soft cappings in Poland.
5.2	Season of Work:	Autumn (new caps)
5.3	Preliminary Repairs to Structure:	A careful preliminary assessment of the wallhead masonry determined that the core was stable beneath the soft caps, but that the face stonework required consolidation with lime mortar. There was also extensive consolidation of masonry at lower levels.
5.4	Treatment of Existing Vegetation:	The vegetation was removed from the edges as required to effect the consolidation of the masonry, generally about 150-300mm. This vegetation was not reinstated after completion of the repairs.
5.5	Soft Capping Technique:	New soft cappings were applied to smaller ledges, such as fireplace and window recesses, as well as on some narrow wallheads where the natural vegetation was completely removed to effect masonry consolidation. Two methods were used. In some areas, a thin layer, ~ 25mm, of clay, followed by nom. 25mm soil were applied to the masonry and a single layer of turf applied on top. In other areas, 40mm of clay was followed by two layers of turf, root to root. The turf was rolled out on the scaffold the day before use and watered. The wallheads were covered with black, wide-meshed polypropylene netting, secured to stainless steel bolts into the edge masonry. This has no effect on the vegetation and was essentially a precautionary health and safety measure to prevent any loose core masonry subsequently falling from the wallhead.
5.6	Vegetation: Source and Description	Commercial turf, from Stewarts in East Lothian.

5.7	Soil: Source and Description	On the natural cappings, there has been a considerable build up of soil, forming a mound up to 450mm thick on the flatter wallheads. On slopes this is much thinner, becoming patchy by 45degrees. The soil appears to be largely desiccated plant material, mixed with some sand from decayed mortar. It is peat-like, but lacks any binding structure other than plant roots and is loose and dusty below the surface. This soil appears to be dry within inches of the surface, even on the exposed sides and after a consistently rainy period. Where it is exposed on the surface, the soil seems to form a skin when wet, which cracks as it subsequently dries out. This skin has a slightly oily feel, suggesting a hydrophobic content given by the decayed waxy or oily organic matter. The clay for the new cappings was from Errol Brickworks. The soil is assumed to be of local provenance.
5.8	DPC:	None
5.9	Defining Membrane:	None
5.10	Fixing:	None
5.11	Aftercare:	The new cappings were watered after installation.
5.12	Maintenance:	None
6.0	**Performance Assessment**	
6.1	General Performance:	The natural cappings seem to be mature and stable on the wide flatter wallheads, providing good protection to the masonry, except at the edges where mortar joints are exposed. It appears that organic matter has built up to a depth where, in many areas, it effectively prevents moisture penetrating the vulnerable wallhead core and gives a significant degree of protection from frost. The organic matter can be seen to have stabilised loose rubble where the lime binder leached out of the core mortar, with humus mixing with residual sand. Few roots penetrate to the core rubble (only trees and perhaps dandelions) and the core seems to have been effectively stabilised by the natural soft capping. The edges of the walls and steeply sloping areas are less fully stabilised by the capping and there seems to be continued ebb and flow in the accumulation and erosion of humus, growth and failure of plants. The less dense vegetation and soil cover on steep core areas allows more moisture ingress, wind erosion and animal activity, while the edge stones also have face exposure to contend with. The decision not to reinstate the edge vegetation reduces the protection of some of the most exposed masonry (Fig. 2.6). The new cappings were in good condition in most areas (Fig. 2.8). In sheltered locations, the turf had died after just a year, due either to general lack of moisture of the sheltering effects of the scaffolding (Fig. 2.9). Here, the dry turf may provide a suitable bedding medium for other plants to colonise.
6.2	Effect of Climate:	The damp, cloudy conditions prevalent on this site limit the stress caused by drought and solar radiation, despite the apparent low rainfall and amount of moisture retained in the soil at depth.
6.3	Effect of Birds:	The activities of birds may be affected by the polypropylene netting applied to the wallheads (Fig. 2.10), which has caused some bird deaths through entanglement in other cases, such as Black Castle (CS13).
6.4	Effect of Animals:	The works should not have affected animals significantly. The activities of invertebrates should continue to contribute to capping health.
6.5	Aesthetic Performance:	The aesthetic performance of the cappings is good, though the decision not to reinstate edge vegetation reduces the naturalistic effect.
6.6	Public Reaction:	The public is reported to be very enthusiastic. (KP)
6.7	Team Reaction:	The team regard the project as very successful.

6.8	Analysis:	The unusual range of species has a number of possible contributory factors. The range of grass species in particular indicates that conditions in many areas are not very stressful. Although very exposed, the wind does not seem to have a significant effect because of the short spells of drought and low solar radiation. The large physical size of the wallheads facilitates a more complex ecology, while the longevity of the process of natural capping gives it more maturity than any of the other sites, except perhaps the Iona Nunnery (CS28). Eilean Mor (CS1) has a similar large physical size, but is set at an incline that prevents significant accumulation of humus. The cappings have greater bio-diversity than is apparent in the surrounding countryside. In particular, there was no other obvious natural habitat for sedums in sight, ~10km (Fig. 2.4). The castle is thought to have been ruinous since around 1640, when the surrounding landscape would have been more bio-diverse and provided a wider variety of seed and the castle may since have acted as a refuge for such species. It is also possible that some of the species were established on the masonry prior to ruination. The qualities of the natural humus are interesting. Decayed waxy or oily organic matter apparently gives the soil a hydrophobic quality not dissimilar to peat, so that it forms a protective skin. However the soil also lacks any structure, making it very vulnerable to wind erosion when exposed. Such a soil has the opposite properties to the clay caps of vernacular structures such as the Arnol Blackhouse (CS9), though in this climate and circumstance it seems to provide an equally effective moisture barrier, where slopes allow.
7.0	References:	
	Interview: K. Pytasz, *Architect* Graham Brown, *Mason* R. Fawcett, *Historic Scotland Inspector* Sources: RCAHMS (1956) The Royal Commission on the Ancient and Historical Monuments of Scotland. An inventory of the ancient and historical monuments of Roxburghshire: with the fourteenth report of the Commission, 2v, Edinburgh, pp.128-31 MacGibbon and Ross, D and T (1887-92) The castellated and domestic architecture of Scotland from the twelfth to the eighteenth centuries, 5v, Edinburgh, pp.138-142 Data: http://www.metoffice.gov.uk/climate/uk/averages/19712000/mapped.html	

Fig. 2.2: South-west aerial view, 1978, showing the substantial size of the masonry wallheads.

Fig. 2.3: West view, 2005. The wallhead on the left had been repaired the previous year.

Fig. 2.4: Thicker soils accumulate on the flatter areas, but not on significant slopes where core rubble remains exposed.

Fig. 2.5: Sedums stabilise exposed edges with thin soil.

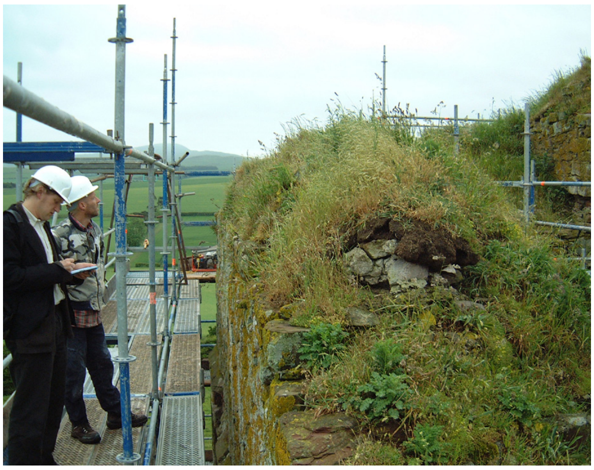


Fig. 2.6: Where soil accumulates, the natural capping achieves a rounded profile, perhaps documenting the historic vulnerability of the edge stones to decay.

Fig. 2.7: Edge repairs leave the central capping untouched, but did not reinstate soft cappings removed to repair the edge masonry.

Fig. 2.8 A new capping thrives in a sheltered location.

Fig. 2.9: New cappings initially died in sheltered, dry locations.

Fig. 2.10: Vegetation rapidly grew through the protective netting.

Fig. 2.11: The broad mass of a natural capping and, below right, a smaller section of new capping on a narrow wallhead, one year after works. The repaired edge masonry showing the stones natural red colour, without lichen and algae growth, indicates where natural soft cappings were removed to effect repairs.

Case Study 3: DUN CARLOWAY BLACKHOUSES, Lewis, Outer Hebrides

This case study presents an interesting example of naturally established cappings, which is a typical example of many ruined vernacular buildings in the Western Isles and Highlands.

Fig. 3.1: The east blackhouse ruin, Dun Carloway.

1.0	**Background**				
1.1	Location:	Dun Carloway, the west coast of the Isle of Lewis, Western Isles. There are two blackhouse ruins in fields below the broch described in CS17.			
1.2	Grid Reference:	NB 1900 4123			
1.3	Date of Works:	N/A			
1.4	Client:	N/A			
1.5	Contractor:	N/A			
1.6	Architect:	N/A			
1.7	Access:	Though on private property, the site can be viewed from public areas			
1.8	Visit Record:	Date:	By:		
		07.09.05	TM		
2.0	**Building**				
2.1	Type:	Blackhouses, two, ruined			
2.2	Classification:	None known			
2.3	Chronology:	Built:	18th C		
		Ruined:	Late 19th C		
		Repairs:	None known		
2.4	Construction and Form:	Both rectangular blackhouses have turf caps, assumed to be naturally established following the decay of the original building. It is possible to take the nearby Arnol Blackhouse (CS9) as a model of their original appearance, which would have therefore included flat turf and clay caps over external walls formed from two drystone skins with an earth core. The roof is likely to have been thatch with a turf underlayer.			
3.0	**Site**				
3.1	Setting:	Description:	The site sits on the west coast of Lewis, generally an open and exposed area of moorland rough grazing leading to a rocky Atlantic coast.		
		Altitude:	50m		
		Distance from Coast:	~1 km		
3.2	Classifications:	None known			
3.3	Microclimate:	Although situated in an exposed area, the blackhouses are slightly sheltered by a rocky outcrop.			
	Data source: Met. Office, *Annual Averages 1971- 2000	Rainfall (mm) *	1550?mm (101%)	Days of Rain >= 1mm *	220 (119%)
		Min Temp *	5.0ºC (125%)	Max Temp*	10.9ºC (103%)
	(Numbers in brackets give data as a % of national average)	Days Ground Frost *	80	Hours sunshine *	1050 (90%)
		Prevailing Wind Direction:		South-west	
4.0	**Flora and Fauna**				
4.1	Vegetation on Wall:	The west ruin has a cap predominantly of grasses, but with significant colonisation by bracken. The eastern ruin has a much tighter covering, mainly grasses.			
4.2	Surrounding Vegetation:	Both ruins stand in rough grassy ground. The west ruin is in an enclosed field, where sheep are excluded. The east ruin is in a field grazed by sheep.			

4.3	Species Survey. *Assessment by HL from photos* **D**=Dominant, **A**=Abundant, **F**=Frequent, **O**=Occasional, **R**=Rare, **VR**=Very Rare, *=Present						
	Common Name	Latin Name	B1 Top	B1 Surr	B2 Top	B2 Surr	Comment
	B1: East Blackhouse with grazed top. Both the topping and the surrounding vegetation have been browsed by sheep. Identification of species was difficult; some grasses may not have been identified.						
	B2: West Blackhouse with ungrazed top. It was difficult to determine any other species from photographs.						
	Grasses:						
	Red Fescue	*Festuca rubra agg.*		*	**D**	*	
	Yorkshire Fog	*Holcus lanatus*	**?**	*		*	
	Soft Rush	*Juncus effusus*	**?**	*			
	Ruderals/Herbs:						
	Creeping Buttercup	*Ranunculus repens*		*			
	Heather	*Calluna vulgaris*		*			
	Trees/Shrubs: none						
	Mosses/Ferns:						
	Bracken	*Pteridium aquilinum*			**O**	*	
	Male Fern	*Dryopteris filix-mas*		*			
4.4	Fauna:						

5.0	**Technique**	
5.1	Source of Technique:	N/A
5.2	Season of Work:	N/A
5.3	Preliminary Repairs to Structure:	N/A
5.4	Treatment of Existing Vegetation:	N/A
5.5	Soft Capping Technique:	It is reasonable to suppose that the original turf cap survived the ruination of the building and was augmented by organic material deposited by the decaying thatched roof, which typically would have undergone a slow process of collapse, with material slumping down to the eaves. This material would have been gradually colonised by species in the surrounding area over a period of perhaps 100 years.
5.6	Vegetation: Source and Description	See 5.5
5.7	Soil: Source and Description	See 5.5
5.8	DPC:	N/A
5.9	Defining Membrane:	N/A
5.10	Fixing:	N/A
5.11	Aftercare:	N/A
5.12	Maintenance:	N/A

6.0	**Performance Assessment**	
6.2	Effect of Climate:	The climate does not seem to have had a significant determining effect. The eastern ruin has some local loss of wallhead masonry, but overall the masonry is in much better condition and is more legible as a structure.
6.3	Effect of Birds:	None noted
6.4	Effect of Animals:	The grazing by sheep has a major effect on the condition of the ruins because of their desire to graze on the wall cappings. The cappings have good quality grass, being well drained in a boggy area, and may have fewer parasites, as occurs on the St. Kilda cleits (CS7). It seems reasonable to deduce that on the east ruin sheep provide effective suppression of non-grass plants, in particular rooty shrubs. The benefits of grazing on the east ruin may also be to create a denser root mat and subtly alter the grass species in favour of fescues. Shrubs with invasive tap roots easily damage the vulnerable unmortared walls on the west ruin, leading to greater collapse of the drystone wall faces. The minor loss of top stones on the east ruin can be attributed to damage by the sheep's feet in climbing onto the wallheads. Such damage is akin to the damage to the turf cap caused by sheep on St. Kilda. While there would appear to be a direct correlation between the presence of grazing sheep and the condition of the masonry, lack of detailed knowledge sounds a note of caution. It would be a mistake to assume that both buildings were built to the same standard, that they have been ruined for a similar length of time or that grazing by sheep has always been as described.
6.5	Aesthetic Performance:	The 'natural' ruination of the west blackhouse has apparently been a process uninterrupted by intervention from man or his animals. Thus the masonry ruin as it survives is a product of the natural decay of the original fabric back into the landscape. In this, the fact that this type of vernacular building utilised earth and plant materials in its original construction has contributed to the process of decay through colonisation and growth of plants. The building is seen to decay back into the landscape from which it came. In contrast, grazing by sheep of the east ruin has significantly retarded this 'natural' decay process, arresting colonisation by damaging local plants and strengthening the protection offered by the turf wall caps. The building form and construction is much more legible as a result of the close grazing of the caps. While the sheep clearly assist the preservation of the masonry, their preservation of the turf capping, which was an integral part of the original wall construction, is also of conservation significance. The image of sheep grazing on a ruined blackhouse also raises complex cultural issues. While the sheep could be seen as a much more natural means of maintaining the ruin in good condition than the strimmers used at the Arnol Blackhouse (CS9), it should be recognised that the supremacy of the grazing needs of sheep over the rights of the indigenous population was a significant factor in the abandonment of many blackhouses during the 18th and 19thC. The cultural landscape value of abandoned townships and individual buildings is arguably inadequately recognised in Scotland. The unplanned presentation of these two ruins therefore makes an interesting, complex and not entirely comfortable juxtaposition.
6.6	Public Reaction:	N/A
6.7	Team Reaction:	N/A
6.8	Comments:	This case study is interesting in documenting the processes of decay of a vernacular typology that used soft capping as part of the original construction, and is commonly found as ruins. It also adds to the varied evidence of the benefits and damage caused by grazing by sheep on substantive soft cappings. Perhaps surprisingly, it also presents one of the most aesthetically rewarding sites and raises some of the most complex conservation issues.

7.0	**References:**
	http://www.stonepages.com/scotland/duncarloway.html Gerald and Margaret Ponting, 1980 (reprinted 2002), *A Mini-Guide to Dun Carloway Broch: Isle of Lewis*, Hebridean Printers, Stornoway

Fig. 3.2: The east blackhouse ruin.

Fig. 3.3: The west blackhouse ruin.

Case Study 4: GORDON CASTLE ESTATE WALLS, Moray

This case study documents a substantial example of vernacular soft cappings to masonry walls, which has acquired great bio-diversity as a result of its age and variety of setting.

Fig. 4.1 Wall 2, typical view of the boundary wall between open fields and woodland.

1.0	**Background**		
1.1	Location:	Gordon Castle Estate perimeter, by Fochabers, Moray	
1.2	Grid Reference:	NJ 350 595 and thereabouts	
1.3	Date of Works:	Unknown	
1.4	Client:	Unknown, presumed to be Gordon Castle Estate	
1.5	Contractor:	Unknown	
1.6	Architect:	N/A	
1.7	Access:	The principal boundary walls are generally visible from public roads. Walls within the estate can be accessed by prior arrangement only with the Gordon-Lennox Estate (01343 820 244)	
1.8	Visit Record:	Date:	By:
		20/07/05	EP, TM
		28/09/05	HL
		24/04/06	TM
2.0	**Building**		
2.1	Type:	Long boundary walls around the Gordon Castle Estate, low garden walls set within it and freestanding boundary wall to Bellie Cemetery.	
2.2	Classification:	None known	
2.3	Chronology:	Built:	Unknown, thought to be mainly pre-1850. One small section of soft capped concrete block wall (Wall 4) was built c. 1970. Wall 5 is also probably post-1850.
		Ruined:	N/A
		Repairs:	Unknown, though no works carried out in last fifty years.
2.4	Construction and Form:	*a) Wall 1: South Boundary Wall, A98* The wall is made of random rubble in lime mortar and is ~1km long, 1m high and 3-400mm wide. It is possible that the wall has a clay core. The masonry has a flat head, capped with a semi-circular dome of clay mortar, originally turfed (Fig. 4.3). *b) Wall 2: West Boundary Wall, B9104* The wall is ~2km long, with about half being sheltered by woodland and half being in open ground (Fig. 4.9). Its northern end runs into the concrete wall, Wall 4. The stone rubble and lime wall is ~1.6m high by 450mm wide and complete. The masonry has a flat head, capped with a semi-circular dome of clay mortar, originally turfed. *c) Wall 3: Low Wall, inside estate.* The wall stands ~0.6m tall and 0.4m wide and is ~40m long. It is constructed of clay and bool stone masonry with lime mortar pointing (Fig. 4.15). The masonry has a thinner layer of clay earth and vegetation, though it may simply be degraded from the type on Walls 1 and 2. *d) Wall 4: Bellie Cottage* There are two contiguous walls, both ~0.7m high. The stone wall is ~20m long and 0.3m wide, built of stone rubble in lime mortar and perhaps dates from the 19thC. The concrete block wall is ~10m. long and 150mm wide. The walls have a turf topping on an earth layer, ~150mm thick, with a flattish profile (Fig. 4.17). *e) Wall 5: Cemetery Wall* The wall is ~40m long, 2m tall and 450mm wide at the head, constructed of random stone rubble in lime mortar. The wallheads are complete and horizontal with vertical steps, ~450mm every ~10m. The walls have a turf topping on an earth layer, ~150mm thick, with a flat profile and exposed cut edges (Fig. 4.19).	

<table>
<tr><th>3.0</th><th colspan="5">Site</th></tr>
<tr><td rowspan="3">3.1</td><td rowspan="3">Setting:</td><td>Description:</td><td colspan="3">The walls are situated in and around the Gordon Castle Estate, which stands to the north and east of Fochabers.

a) Wall 1 forms the enclosure to the estate bounding the A98 south of Fochabers. It is generally very sheltered, with dense coniferous woodland on both sides. The section entering the town is less sheltered and borders domestic gardens.

b) Wall 2 forms the enclosure to the estate bounding a minor road with coniferous woodland beyond. To the west the wall encloses arable fields and areas of mature woodland and its exposure correspondingly varies between moderately exposed and very sheltered.

c) Wall 3 is a partial retaining wall, enclosing a small area of coniferous woodland for part of its length, but otherwise borders grass fields beside an estate road. The wall is generally exposed, especially to the west, although it is partly sheltered to the east by the wood, and retained ground.

d) Wall 4 forms the roadside garden enclosure contiguous with the old estate wall. The garden has ornamental trees on a well-tended lawn and the other side of the wall is bounded by the road and coniferous woodland.

e) Wall 5 encloses a maintained cemetery to the north of the estate. There is a shelter band of trees to the southwest and some private housing to the north-west.</td></tr>
<tr><td>Altitude:</td><td colspan="3">~20-60m</td></tr>
<tr><td>Distance from Coast:</td><td colspan="3">~6-9km</td></tr>
<tr><td>3.2</td><td>Classifications:</td><td colspan="4">None known.</td></tr>
<tr><td rowspan="5">3.3</td><td>Microclimate:</td><td colspan="4">This is an area of low rainfall and long periods of drought, which have a significant effect on soft cappings. Woodland areas will give some rain shadowing. There is fairly high solar radiation generally, though some woodland sections are heavily shaded. While some areas are fairly exposed, the area does not have a high level of wind. The site does not have a high level of frost.</td></tr>
<tr><td rowspan="4">Data source:

Met. Office, *Annual Averages 1971 – 2000

(Numbers in brackets give data as a % of national average)</td><td>Rainfall*</td><td>~890mm (58%)</td><td>Days of Rain >= 1:*</td><td>~145 (78%)</td></tr>
<tr><td>Min Temp*</td><td>~4ºC (100%)</td><td>Max Temp *</td><td>~11.4ºC (109%)</td></tr>
<tr><td>Days Frost*</td><td>~130</td><td>Hours sunshine*</td><td>~1280 (110%)</td></tr>
<tr><td colspan="2">Prevailing Wind Direction:</td><td colspan="2">Southwest</td></tr>
</table>

4.0	**Flora and Fauna**	
4.1	Vegetation on Wall:	This case study recorded the greatest bio-diversity, with a huge variety of species growing on these walls. The length of the walls present a wide range of ecological and microclimatic conditions and this is reflected in the recorded plant species. a) Wall 1: Generally, with the wall very shaded and sheltered by trees, ivy, ferns, nettles and other woodland species dominate (Fig. 4.2). In more open sections, the species clearly change with lush grass predominant and occasionally other species, such as Dandelions or Ribwort Plantain. Grass species change from Cock's Foot and Common Bent to Red Fescue as the setting becomes more open. As the wall enters the town there is significant colonisation by sedums (Fig. 4.5). Generally the vegetation is well established, but there are some areas with no plants (Fig. 4.6 - 8). These are both in the most shaded areas and the most solar exposed areas, in the town, where there has also perhaps been damage through human wear. b) Wall 2: In exposed areas, a thick vegetation layer commonly sits over the crown of the mud mortar, with no vegetation growing on the steep sides of the mud. The plants are predominantly a dense mat of upland mosses and lichens, with fine grasses (commonly Sweet Vernal Grass and locally Common Bent and Red Fescue) and occasional other species, such as Gorse and Ribwort Plantain (Fig. 4.12). In sheltered areas, below trees the vegetation is lush, well established and extremely dense, with a well-matted fine root mass. The same grasses become more abundant, joined by Cock's Foot, False Oat Grass and Early Hair Grass, which becomes locally dominant, as do dense groupings of ferns, nettles, ivy and other woodland species (Fig.4.13). There are also a variety of tree saplings up to 1.5m tall, including Ash, Wych Elm and Scots Pine (Fig. 4.10). The vegetation forms a thick protective overhang. Apart from occasional Ribwort Plantain, small herbs are generally rare. The presence of Dog's Mercury is notable as this is an ancient woodland indicator and its presence on the wall turf suggests that the cappings are themselves old. c) Wall 3: Generally the turf provides a thick covering to the wall head of predominantly grass, but with frequent herbs, such as Ribwort Plantain, Lady's Bedstraw, Common Bird's Foot Trefoil, Thyme and Carnation Sedge. More invasive species were also present, such as Ivy, Bramble, Creeping Thistle and Nettle (Fig. 4.15). The vegetation was generally more verdant than the other walls examined, suggesting that the clay core of the wall and low height may supply more moisture and/or nutrients. d) Wall 4: The stone masonry wall capping has a reasonably well-established cap of predominantly grass, mainly Fescues, with a few other colonised species (Fig. 4.17). The concrete cap was dominated by ephemeral herbs and grasses. e) Wall 5: An open mix, dominated by Sweet Vernal Grass with abundant Ribwort Plantain and a few other species formed an even covering to the main crown of the cap, growing to a height of approximately 300mm over a dense mat of mosses and lichens (Fig. 4.20). No plants were found on the vertical sides, apart from mosses and lichens.
4.2	Surrounding Vegetation:	The surrounding vegetation is varied and diverse. In general all of the walls are in close proximity to mature coniferous woodland, which in places, overhangs the walls, (notably Walls 1 and 2). Additionally there is a mixture of arable fields and tended domestic garden areas.

4.3 Species Survey. *Site Assessment by HL, 28.09.05*

D=Dominant, **A**=Abundant, **F**=Frequent, **O**=Occasional, **R**=Rare, **VR**=Very Rare, *=Present

Common Name	Latin Name	W-5	W-4	S-4	W-2c	W-2a	W-2b	S-2	W-3	S-3	W-1	S-1	Comments
Grasses:													
Annual Meadow Grass	Poa annua	**R**	**O**										W2-Small plants on barer surfaces.
Carnation sedge	Carex panicea								**R**				
Cock's Foot	Dactylis glomerata		**O**			**R**	**F**		**F**	*	**F**		
Common Bent	Agrostis capillaris		**R**			**O**	**F**		**R**	*	**A**		
Common Couch	Elytrigia repens												
Creeping Soft Grass	Holcus mollis									*			
Perennial Rye Grass	Lolium perenne		**R**							*			
Early Hairgrass						**R**	**O**						
Red Fescue	Festuca rubra agg	**R**	**F**			**F**	**O**				**O**		
Sheep's Fescue	Festuca ovina	**O**	**O**						**R**		**R**		
Smooth Meadow Grass	Poa pratensis	**R**	**O**			**R**			**O**		**VR**		
Yorkshire Fog	Holcus lanatus									*			
Viviparous Fescue	Festuca vivipara										**R**		
Ruderals/Herbs:													
Angelica	Angelica sylvestris						**R**						
Autumn Hawkbit	Leontodon autumnalis						**VR**						
Bindweed	Calystegia sepium			*									
Bittercress sp.	Cardamine sp.						**VR**						
Bramble	Rubus fruticosus agg.			*			**VR**		**R**				
Broadleaved Dock	Rumex obtusifolius			*					**R**	*			
Broadleaved Willowherb	Epilobium montanum			*			**VR**						

Cleavers	Galium aparine		**VR**							*			
Common Birdsfoot Trefoil	Lotus corniculatus								**O**	*			
Common Cat's Ear	Hypochoeris radicata		**R**	*		**VR**			**R**				
Common Chickweed	Stellaria media												
Common Knapweed	Centaurea nigra												
Common Mouse Ear	Cerastium fontanum		**R**			**VR**							
Common Sorrel	Rumex acetosa												
Cow Parsley	Anthriscus sylvestris								**R**		**VR**		
Creeping Thistle	Cirsium arvense			*						*			
Curled Dock	Rumex crispus		**R**	*									
Daisy	Bellis perennis			*									
Dandelion	Taraxacum officinale agg		**R**	*		**VR**	**R**				**R**		
Dog's Mercury	Mercurialis perennis						**VR**						
Field Woundwort	Stachys arvensis												
Great Plantain	Plantago major		**R**										
Germander Speedwell	Veronica chamaedrys								**R**		**O**		
Great Woodrush	Luzula sylvatica										**R**		
Greater Stitchwort	Stellaria holostea					**VR**			**R**				
Ground Elder	Aegopodium podagraria								**R**	*			
Heath Speedwell	Veronica officinalis										**R**		
Hedge Parsley	Torilis japonica						**R**						
Hogweed	Heracleum sphondylium									*			
Ivy	Hedera helix	**R**					**R**				**F**		W1-Southern end. Beyond becomes dominant
Lady's Bedstraw	Galium verum								**A**				

Meadow Vetchling	Lathyrus pratensis								**O**				
Mugwort	Artemisia vulgaris												
Nettle	Urtica dioica			*			**O**		**R**	*			
Nipplewort	Lapsana communis						**O**		**R**				
Northern Dock	Rumex longifolius												
Ragwort	Senecio jacobaea			*		**VR**	**VR**		**VR**		**O**		
Raspberry	Rubus idaeus			*									
Ribwort Plantain	Plantago lanceolata	**A**				**A**	**O**		**A**	*	**F**		
Red Dead Nettle	Lamium purpureum												
Smooth Sow Thistle	Sonchus oleraceus		**R**	*					**R**				
Sheep’s Sorrel	Rumex acetosella					**VR**							
Shepherd’s Purse	Capsella bursa-pastoris		**R**										
Soft Rush	Juncus effusus									*			
Spear Thistle	Cirsium vulgare		**R**										
Tufted Vetch	Vicia cracca												
Thyme	Thymus praecox								**R**				
Valarian	Valariana officinalis						**R**						
Yarrow	Achillea millefolium	**R**							**R**				
White Clover	Trifolium repens			*					**R**	*			
Wood Avens	Geum urbanum						**VR**						
Trees/Shrubs:													
Alder	Alnus glutinosa												
Ash	Fraxinus excelsior											*	W3a- <5cm - <30cm
Beech	Fagus sylvatica			*								*	
Birch spp	Betula spp											*	
Broom	Cytisus scoparius												

Cotoneaster sp.	Cotoneaster sp.	**R**											W1-5 x <15cm + 1 x 1m at north end
Douglas Fir	Pseudotsuga menziesii											*	W3a-1 x 1.5m
Elder	Sambucus nigra			*					**R**				
Escallonia sp.	Escallonia sp.			*									
English Elm	Ulmus procera												
Gean/Wild Cherry	Prunus avium												
Goat Willow	Salix cinerea												
Gorse	Ulex europaeus	**O**				**O**							W1-11 x <30cm, 5 x >50cm + seedlings W3a-30-50cm; 2 x dead 50cm-1m
Grey Willow	Salix cinerea											*	
Hawthorn	Crataegus monogyna	**VR**											W1-1x75cm
Holly	Ilex aquifolium											*	
Lime sp	Tilia sp												
Norway Spruce	Picea abies			*									
Oak spp.	Quercus spp												
Poplar sp.	Populus sp.			*									
Rose sp.	Rosa canina agg											*	
Rowan	Sorbus aucuparia											*	
Scots Pine	Pinus sylvestris											*	W3a- 2x40-60cm; 2x<30cm
Silver Birch	Betula pendula												
Sitka	Picea sitchensis												
Wych Elm	Ulmus glabra												W3a- 1x60cm,
Western Hemlock	Tsuga heterophylla											*	
Mosses/Ferns:													
Mosses	Dicranum sp (et al)	**A**	**O**			**F**							W2- Edges
Moss	Hylocomium splendens					**R**							
Moss	Polytrichum juniperus (et al)												
Moss	Hypnum spp					**O**							

	Lichens	Cladonia spp	**F**										

4.4	Fauna:	None noted
5.0	**Technique**	
5.1	Source of Technique:	Walls 1, 2 and 3 are assumed to be a local vernacular technique related to other vernacular uses of clay and turf in building. Walls 4 and 5 are thought to be late versions of this, not fully replicating the traditional technique.
5.2	Season of Work:	Unknown
5.3	Preliminary Repairs to Structure:	N/A
5.4	Treatment of Existing Vegetation:	N/A
5.5	Soft Capping Technique:	The vernacular technique is of a substantial semi-circular dome of clay mortar, ~250-300mm high, finished ~ 50mm in from the wall edge and overlaid with turf so that the cut edge butts flush to the masonry edge, fixed into the earth with timber pegs. Walls 4 and 5 have much less substantial earth domes, with less clay content and often expose the cut sides of the turf.
5.6	Sketch Section:	
5.7	Vegetation: Source and Description	Assumed to be turf cut from the immediate area.
5.8	Soil: Source and Description	Walls 1, 2 and 3 use predominantly a grey clay subsoil, apparently tempered with sand. Occasionally the soil has a red colour and this proves much less durable (Fig. 4.3). These soils are assumed to be tempered local clay subsoils. The soils on Walls 4 and 5 are also grey, but have a crumbly texture, suggesting they are probably local top soils without significant clay content.
5.9	DPC:	None used
5.10	Defining Membrane:	None used
5.11	Fixing:	There was clear evidence of wooden pegs used as turf fastenings on Wall 2 (Fig. 4.11).
5.12	Aftercare:	Unknown
5.13	Maintenance:	On Walls 1, 2 and 3 there has been no maintenance in the past fifty years, and none apparent before that. On wall 5 some tree saplings were cut off at their base and poisoned in 2003 to prevent any damage being caused by their roots.

6.0	**Performance Assessment**	
6.1	General Performance:	*Walls 1, 2 and 3:* The cappings have proved to provide durable protection to the masonry walls beneath, with an estate worker commenting that you *'never see water running off these walls'*. It is likely that the original turf gave limited protection, dying off both where exposed to wind and solar radiation and where shaded and rain shadowed by trees. In almost all locations the earth cap has subsequently been colonised by species more suitable to the local climatic exposure. The great diversity of these species reflects both the age of the cappings and the age of their ecological and microclimates. The few bald areas are mainly located by the town and may indicate interference by people, competition from exotic garden plants, or removal of ivy. It is also clear that the clay mortar caps provide a strong barrier that is durable even when exposed, in a manner comparable to good quality traditional mud wall. The vegetation certainly provides benefits in reducing the effects of moisture, but the main protection is likely to be provided by the mud. The density of the mud may mean it provides a poor base to support plants, with roots unable to penetrate deeply to tap it as a moisture reservoir, but equally there is little apparent root damage to the earth cap, even by gorse and tree saplings. The cap on Wall 3 is better bonded, perhaps reflecting higher moisture content from a clay wall mortared masonry core and low height. The importance of the specific qualities of the soil used is demonstrated by the poorer performance of the patches of red soil and the caps to Walls 4 and 5. *Walls 4 and 5.* These caps perform less well and this can be linked to a failure to follow the vernacular tradition of careful soil selection, cap profile and detailing, specifically leaving cut turf edges exposed.
6.2	Effect of Climate:	The climate does not effect the protection afforded to the masonry or the viability of the cap, but it does have a strong effect on the species that dominate local areas. The low rainfall makes plant viability marginal, with moisture insufficient for the clay to act as a viable reservoir through drought. This is clear when compared to wet sites, such as those in Argyll, where the clay remains damp all year. The best conditions for plants, where lush growth is found, are the open areas within woodland that are not rain shadowed by trees, but do gain some solar shading and wind shelter (Fig. 4.13).
6.3	Effect of Birds:	None noted
6.4	Effect of Animals:	There are no known problems with animals, save minor damage to Wall 3.
6.5	Aesthetic Performance:	The walls make a distinctive contribution to the local landscape character. In having such mature vegetation, the cappings are significantly different from their original appearance, but do perhaps reflect the greater complexities of passing time and local bio-diversity. Nonetheless, it is probably true to say that these caps represent an example of a vernacular soft capping which has partially failed and subsequently been naturally colonised.
6.6	Public Reaction:	None noted
6.7	Team Reaction:	Moray Council (G Morrison, pers. comm.) is very positive about the technique, considering it to be aesthetically pleasing and technically effective.
6.8	Comments:	These cappings are fascinating in several respects. The long-term performance of clay soil caps is clearly demonstrated to be very effective in a relatively dry climate, though there may have been complete loss of the original turf and the subsequent natural establishment of an appropriate vegetation may take a long time. This sheds useful light on the apparent poor short-term performance of some recent clay caps, such as ST. Kattan's chapel, Aberuthven (CS38). The successful combination of clay cap with moss and lichen cover is intriguing. The soil remains undisturbed by root damage, which would struggle to penetrate its density in what are often dry situations, while the mosses can dry out without damage and still absorb large quantities of rain. Such mossy caps can develop to great thickness, providing edges that project beyond the wall line. This has been demonstrated at other sites, but nowhere as consistently as on Wall 2. The great bio-diversity of these caps clearly demonstrates that species are related to very local factors as well as regional ones. The recent caps on Walls 4 and 5 are significant in showing that locally there remains a desire to continue this practice and preserve an important aspect of local landscape character and built heritage. However, if these traditions are to be maintained and understood, this should be on the basis of a sound understanding of the tradition. This will require some re-learning of lost traditions, but holds out hope for the survival of regional identity in one area of traditional soft cappings technique.

7.0	**References:**
	Site Visit Report, B Walker, Historic Scotland Architect, 24.6.97 Interviews: Gary Morrison, *Moray Council, Maintenance* Ruth Taylor, *Gordon-Lennox Estate* *Met. Data:* http://www.metoffice.gov.uk/climate/uk/averages/19712000/mapped.html

Fig 4.2: Wall 1, there is a clear correlation between shading and vegetation growth.

Fig. 4.3: Wall 1, there is evidence of grass being killed by dense ivy growth, here resurgent after cutting back.

Fig. 4.4: Wall 1, where the clay soil type changes to red from grey, the soil is much more vulnerable to erosion.

Fig. 4.5: Wall 1, there is clear stabilisation, focused on edges, by sedums near the town, suggesting possible colonisation from gardens.

Fig. 4.6: Wall 1, there is some colonisation by mosses of dead areas, where no other species compete.

Fig. 4.7: Wall 1, where the wall borders gardens, the caps are vulnerable to colonisation by exotic species.

Fig. 4.8: Wall 1, High solar exposure and low rainfall seems linked to extensive grass dieback, though there is significant re-growth from seeds. Here the barest section may be associated with damage from the cut back clematis below.

Fig. 4.9: Wall 2, general view. Although there are areas of high exposure, there is generally good plant cover and no bare areas comparable to the urban areas of Wall 1.

Fig. 4.10: Wall 2, where trees are present to seed, but do not give dense cover, trees can colonise the capping.

Fig. 4.11: Wall 2, the holes for the timber pegs, which originally fixed the turf caps, are still clearly visible in areas, indicating a highly durable mud mortar mix.

Fig. 4.12: Wall 2, exposed areas typically have a complete loss of original turf, good subsequent colonisation by moss and lichen of the top, with thin grass distribution and occasional larger plants, such as gorse.

Fig. 4.13: Wall 2, in sheltered areas, there can be thick growth, though this is dramatically reduced by strong shading.

Fig. 4.14: Wall 2, dense top growth, here by ferns, often leaves the sides exposed.

Fig. 4.15: Wall 3, growth is strong despite exposure, perhaps indicating the benefit of low height.

Fig. 4.16: Wall 3, damage by animals establishing a regular path over the retaining section of wall.

Fig.4.17: Wall 4, the relative failure of the modern soft capping over concrete block work is evident.

Fig. 4.18: Wall 4, the modern capping clearly did not replicate the original turf capped mud mortar dome.

Fig. 4.19: Wall 5, although very exposed, these caps perform well, apart from the exposed edges.

Fig. 4.20: Wall 5, the domed profile follows the vernacular of Walls 1 and 2, and seems to be following the same pattern of progressive grass dieback and colonisation by other species.

Case Study 5: ENCLOSURE WALLS, Roghadal, Harris, Outer Hebrides

This case study presents another example of vernacular soft capping to masonry walls, in this case on drystone dykes in a Hebridean climate.

Fig 5.1. Field Enclosure Walls, Roghadal. View of wall running across wet ground. The amount of fallen wall may relate to weak foundation conditions.

1.0	**Background**		
1.1	Location:	Roghadal (alt. Rodel), Harris, Western Isles	
1.2	Grid Reference:	NG 0477 8318	
1.3	Date of Works:	N/A	
1.4	Client:	Unknown	
1.5	Contractor:	Unknown	
1.6	Architect:	N/A	
1.7	Access:	Unrestricted access	
1.8	Visit Record:	Date:	By:
		06.09.05	TM

2.0	**Building**		
2.1	Type:	Field enclosure walls	
2.2	Classification:	N/A	
2.3	Chronology:	Built:	Probably 19thC.
		Ruined:	N/A
		Repairs:	None known
2.4	Construction and Form:	There are three sections of rough drystone field enclosure walls, totalling over 800m in length, located east of the church and south of the road. The walls are about 1m tall and have battered faces rising to about 400mm wide (Fig. 5.7). There are other comparable examples elsewhere on Harris.	

3.0	**Site**				
3.1	Setting:	Description:	The walls enclose rough grazing land on the west side of the small township of Roghadal, which sits on the relatively sheltered south-eastern corner of the island of Harris. The ground includes wetland and steep hillsides (Figs. 5.1-3).		
		Altitude:	~10-50m		
		Distance from Coast:	~0.5km		
3.2	Classifications:	None known			
3.3	Microclimate: Data source: Met. Office, *Annual Averages 1971 – 2000	The island generally is exposed to strong south-westerly winds, but these walls have a sheltering hill to the south.			
		Rainfall	~2000mm	Days of Rain>= 1	~240
		Min Temp	~-6.5ºC	Max Temp	~3.5ºC
		Days Frost	~30	Hours sunshine	~1160
		Prevailing Wind Direction:		South-west	

4.0	**Ecology**	
4.1	Vegetation on Wall:	The cappings are fairly consistent in having a dense mat of mosses and lichen, though the grasses change in locally different levels of abundance (Fig. 5.4). There are few other species. The sides are generally covered by the mosses and lichens, though there are also some bare patches (Fig. 5.4).
4.2	Surrounding Vegetation:	Mainly rough improved pasture, some wetland, and moorland beyond. There are few trees.

4.3	Species Survey. *Assessment by HL from photographs* **D**=Dominant, **A**=Abundant, **F**=Frequent, **O**=Occasional, **R**=Rare, **VR**=Very Rare, *=Present			
	Common Name	Latin Name	Field Walls	Comment
	Grasses:			
	Velvet Bent	*Agrostis canina*	**A**	
	Ruderals/Herbs:			
	Heath Bedstraw	*Galium saxatile*	**R**	
	Trees/Shrubs: None Noted			
	Mosses/Ferns:			
	Lichens	*Cladonia spp*	**O**	
	Mosses		**O**	
4.3	Fauna:	None noted		

5.0	**Technique**	
5.1	Source of Technique:	Assumed to be a local vernacular technique.
5.2	Season of Work:	Unknown
5.3	Preliminary Repairs to Structure:	N/A
5.4	Treatment of Existing Vegetation:	N/A
5.5	Soft Capping Technique:	The cappings were apparently constructed with a soil dome covered by turf. There appeared to be no particular attempt to close holes in the top of the drystone walling.
5.6	Vegetation: Source and Description	Assumed to be turf cut from the immediate vicinity.
5.7	Soil: Source and Description	The soil layer is darker than the soil included in the turf cap, implying a different source, likely to be peaty or wet ground, rather than the valuable improved soil of the adjacent grazing land (Fig 5.6).
5.8	DPC:	None used
5.9	Defining Membrane:	None used
5.10	Fixing:	None apparent, but timber pegs may have been used.
5.11	Aftercare:	Unknown
5.12	Maintenance:	None apparent
6.0	**Performance Assessment**	
6.1	General Performance:	The walls' beneath surviving sections of soft cappings are in reasonably good condition and there is some evidence that the soft cappings assist the walls stability. While there are many areas where the wall has collapsed, there are relatively few areas where the wall is standing without cappings. The cappings may help by binding together the upper course of stones, reducing the likelihood of onset of collapse. The cappings are generally in good condition, with little sign of ongoing erosion or decay. However, it is evident that the original turf caps failed and that the soil beneath suffered some decay before they were stabilised through colonisation by mosses, which allowed grasses to form a secondary layer. The amount by which the caps decayed away from the wall edge in this process varies from nothing to half the wallhead width (Fig 5.5-6).

6.2	Effect of Climate:	The relatively sheltered location will have impeded the decay of exposed soil and, together with reasonable rainfall and short periods of drought, facilitate plant growth on the capping sides.
6.3	Effect of Birds:	None noted
6.4	Effect of Animals:	None noted
6.5	Aesthetic Performance:	The walls are an important aspect of local landscape character, contributing to cultural heritage.
6.6	Public Reaction:	None known
6.7	Team Reaction:	N/A
6.8	Comments:	These wall cappings fall into a tradition of soft capping documented across Scotland, with significant local variations. Comparison with the exposed sections of the Gordon Castle walls (CS4) is interesting. The fact that the Harris walls have plant growth down the sides gives them greater protection and this is attributable to the damper climate. This is fortuitous as the soil is much more vulnerable to decay, lacking the durability of the Gordon clay soil. The lack of any apparent attempt to close the wallhead before applying the caps is interesting. Given the open texture of the soil, this may imply that the soil core was bound by roots, as found in peaty turf. The difference in colour to the upper turf soil suggests that this was not two layers of turf laid root to root, but use of different types of turf within one wall could relate to other turf construction traditions in the area, which include walls fully built from turf.
7.0	**References:**	
	First edition OS Map	

Fig. 5.2. View of wall across rough pasture.

Fig. 5.3. View of wall running up hillside.

Fig. 5.4. Some areas show a similar exposed side as at Gordon Castle (CS3).

Fig. 5.5. The cap has a large stable mat of moss and lichen, with fine grasses rising through.

Fig. 5.6. The capping has a core of dark soil beneath a thick turf.

Fig. 5.7. The caps may give some stability to the crudely constructed drystone walls

Case Study 6: LEANACH ENCLOSURE WALLS, Culloden, Inverness-shire

This case study describes a reconstructed vernacular turf wall and compares its turf capping to another on an adjacent drystone wall.

Fig. 6.1: Leannach Enclosure, Culloden. A general view of the turf dyke cap.

1.0	**Background**		
1.1	Location:	Culloden, near Inverness	
1.2	Grid Reference:	NH 745 450	
1.3	Date of Works:	1994 -97, 1999	
1.4	Client:	The National Trust for Scotland	
1.5	Contractor:	National Trust Conservation Volunteers	
1.6	Architect:	N/A	
1.7	Access:	Restricted access managed by NTS. Open daily, but opening times vary throughout the year and admission is charged.	
1.8	Visit Record:	Date:	By:
		20.07.05	TM, EP, Jim McMurray (Grounds Manager, NTS)

2.0	**Building**		
2.1	Type:	Reconstructed field enclosure walls. There are two types, a turf wall on a stone base and a turf-capped drystone wall.	
2.2	Classification:	None known	
2.3	Chronology:	Built:	The turf walls were built in 1994-97 as a reconstruction of those that were used in the Battle of Culloden in 1746. The dry stone walls were turf capped in 1999.
		Ruined:	N/A
		Repairs:	N/A
2.4	Construction and Form:	*Wall 1: Turf Dyke* The turf dykes along the Leanach enclosure form a rough U-shape along the south, east and west sides of the battlefield, 153m long. They vary in height from ~0.7m to 1.2m high and rise with battered sides to a head ~0.8m thick. *Wall 2: Drystone Dyke* These walls define the boundary of the Leanach holding to the south of the Leanach Enclosure and are drystone with a turf capping. They are ~1.4m high and ~0.4m thick. The walls are constructed of large stone rubble without mortar.	

3.0	**Site**					
3.1	Setting:	Description:	The walls are built on a stretch of open moorland to the south of the enclosed park around Culloden House and north of the River Nairn. The ground is occasionally grazed.			
		Altitude:	~160m			
		Distance from Coast:	~ 4km			
3.2	Classifications:	None known				
3.3	Microclimate: Data source: Met. Office, *Annual Averages 1971 – 2000 *(Numbers in brackets give data as a % of national average)*	The open ground is very exposed to the prevailing winds. Rainfall is moderate.				
		Rainfall (mm) *	~710mm (47%)	Days of Rain >= 1mm *	150 (81%)	
		Min Temp *	~5.5ºC (138%)	Max Temp *	11.9ºC (113%)	
		Days Ground Frost *	~110	Hours sunshine *	1200 (103%)	
		Prevailing Wind Direction:		West		

4.0	**Flora and Fauna**	
4.1	Vegetation on Wall:	There is a large variety of grass and herb species growing on the turf dyke capping, with less diversity on the stone dyke capping. The turf dyke seems to support drought tolerant species not found in the surrounding fields. There also seems to be no growth of nettles or thistles on the walls, even though they grow in abundance beside the wall. There is no evidence of trees seeding into the wallheads.
4.2	Surrounding Vegetation:	The walls are surrounded by lightly managed rough pasture. There are a number of clusters of trees, the closest being 30m to the north.
4.3	Species Survey. *Assessment by HL from photographs* **D**=Dominant, **A**=Abundant, **F**=Frequent, **O**=Occasional, **R**=Rare, **VR**=Very Rare, *=Present	

Common Name	Latin Name	Fale Dyke	Stone Dyke	Main Surr. Veg.	Adjacent to Walls	Comment
Grasses:						
Cock's Foot	*Dactylis glomerata*	**O**	*			
Common Bent	*Agrostis capillaris*	**A**		**F**		Locally dominant in places
Crested Dog's Tail	*Cynosurus cristatus*	**O**				
Meadow Grass sp.	*Poa sp.*		*			
Perennial Rye Grass	*Lolium perenne*	**O**				
Red Fescue	*Festuca rubra agg.*		*			
Sheep's Fescue	*Festuca ovina*		*			
Sweet Vernal Grass	*Anthoxanthum odoratum*			**R**		
Timothy Grass	*Phleum pratense*	**R**				
Tufted Hair Grass	*Deschampsia cespitosa*				*	
Yorkshire Fog	*Holcus lanatus*	**A**	*	**A**	*	Locally dominant in places
Ruderals/Herbs:						
Broadleaved or Curled Dock	*Rumex obtusifolius/crispus*			**R**	*	
Cleavers	*Galium aparine*	**VR**				
Common Cat's Ear	*Hypoecharis radicata*	**O**	**R**	**O**		
Common Mouse Ear	*Cerastium fontanum*	**R**	**R**			
Common Sorrel	*Rumex acetosa*	**VR**				
Creeping Buttercup	*Ranunculus repens*	**R**				
Creeping Thistle	*Cirsium arvense*	**O(e)**		**R**	*	
Hogweed	*Heracleum sphondylium*			**R**		
Knotgrass	*Polygonum aviculare*	**R**				
Nettle	*Urtica dioica*				*	
Ragged Robin	*Lychnis flos-cuculi*			**VR**		
Ribwort Plantain	*Plantago lanceolata*	**O**				
Soft Rush	*Juncus effusus*			**O**		

	Spear Thistle	*Cirsium vulgare*	**R(e)**				
	White Clover	*Trifolium repens*	**R**		**O**	*	
	Yellow Rattle	*Rhinanthus minor*			**F**		
	Trees/Shrubs:						
	Birch	*Betula sp*.			**O**		Young
	Gorse	*Ulex europaeus*			**O**		Mature, on edges
	Mosses/Ferns: none noted						
4.4	Fauna:	Sheep and cows seasonally graze in and around the enclosure.					

5.0	**Technique**	
5.1	Source of Technique:	Traditional 18thC walling techniques were emulated, following studies of contemporary descriptions and comparable surviving fragments in the area and elsewhere (for a more detailed account see Walker, 2006).
5.2	Season of Work:	Spring and autumn (March – June and September – October). In summer the turf was too dry and friable to work.
5.3	Preliminary Repairs to Structure:	N/A
5.4	Treatment of Existing Vegetation:	N/A
5.5	Soft Capping Technique:	Turf dyke: The turf was applied over the rubble base in layers, to form two external faces, ~300mm deep, with a slight batter. The turves were laid root to root in a common bond pattern. The core was filled with packed earth, carried over the top of the turf leaves to form a domed section, which in turn was covered with turf, laid in strips, side to side. In one single layer. Drystone dyke: Turf was applied in a double layer, root to root, directly onto the wallhead.
5.6	Vegetation: Source and Description	The turf was cut from the adjacent fields in strips spaced to encourage regeneration (Fig. 6.3). The fields have not been fertilised, apart from the droppings of animals. Ten years later, there is little evidence of the turf having been cut, with only gentle furrows discernable in the ground. In one area where turf was sourced for repairs a year ago the vegetation had already grown back. The grass was first cut close, before strips were cut with a mechanical turf cutter, a Ryan Junior 6hp turf-cutter, which produced a continuous length of turf 300mm wide and 63mm deep.
5.7	Soil: Source and Description	The soil was local subsoil sourced from the area. It appears quite rich but also quite stony.
5.8	DPC:	None used
5.9	Defining Membrane:	N/A
5.10	Fixing:	None used
5.11	Aftercare:	None known
5.12	Maintenance:	The walls are occasionally strimmed.

6.0	Performance Assessment	
6.1	General Performance:	*a) Turf Dykes* The turf has compacted and compressed over the years to form a solid earth wall with a thick covering of grasses and other plants rooted into the top. The original rounded head profile has flattened over the years, principally due to pedestrian traffic along the wallhead, where visitors use the walls to get an overview of the battlefield (Fig.6.8). Where it is not eroded by heavy foot traffic, the turf head appears dense, well rooted and flourishing to a height of about 0.5m. There is a rich diversity of species growing on the wallheads, showing differences from the adjacent source area turf. There is some vertical growth on the side of the walls but it is quite sparse and limited to the more sheltered, east side of the enclosure. There is very little growth on the west side of the wall, exposed to the prevailing wind (Fig. 6.6). There is evidence of some erosion at the edges in some areas. The earth felt damp to touch and there is a small amount of moss growth. *b) Drystone Wall Dykes with Turf Top* These caps are much drier, with stress conditions contributing to much less species diversity. There is a great deal of soil exposed not only at the edges but also along the length of the wall (Fig. 6.11). The earth has eroded in many areas, although there is some moss growth, which has a stabilising effect.
6.2	Effect of Climate:	The climatic exposure of the location has only a minor influence on the turf dyke, mostly affecting the amount of growth on the side faces. The turf-capped stone dyke is much more affected, with drought conditions limiting the species that can survive on the capping and mosses in the process of stabilising wind erosion of the soil.
6.3	Effect of Birds:	None noted
6.4	Effect of Animals:	During construction a mole was inadvertently included in the earth core material, resulting in a series of molehills along the new wallhead. Care was thereafter taken to exclude moles from the mix, by manually rather than mechanically moving the earth. Grazing sheep do not seem to cause any major damage to the wall, though they are known to walk along the top of it, which could cause erosion in climbing up and contribute to path damage. Grazing cattle cause a great deal of damage, with several sections of wall having collapsed after being leaned on and climbed over. This initial damage is then exacerbated by wind and rain erosion (Fig. 6.7).
6.5	Aesthetic Performance:	The turf dykes accurately recreate the impression of the historic walls, assisting public interpretation of the site, though with a low level of grazing, it can seasonally be difficult to discern the walls among tall grass.
6.6	Public Reaction:	None noted
6.7	Team Reaction:	The wall reconstruction has proved a great success.
6.8	Comments:	The turf dyke demonstrates the effect of soil as a moisture reservoir, in sustaining vegetation in dry conditions. The wall seems stable and durable, requiring no maintenance as long as the attentions of cattle can be managed. The healthy capping vegetation will shed some rainwater off the wallhead and absorb and transpire more, dramatically reducing the quantity that will penetrate into the wall core, where it might reduce stability. The relative dryness of the core is indicated by the low level of face vegetation. An excellent balance of moisture within the wall is therefore maintained; wet enough on top to ensure a healthy cap vegetation and dry enough below to ensure wall stability. The drystone wall provides, by contrast, no moisture retention and there is a dramatic reduction in the soft capping performance as a result. The vegetation exists in much greater stress conditions in summer and it is likely to be in the early stages of a gradual transition to a stable capping of a dense moss/lichen mat with occasional grasses growing through, comparable to those at Roghadal (CS5) Gordon Castle (CS4). While different turf, soil and detailing might have made a marginal improvement, this assessment would argue against any intervention to try and 'repair' the turf, and for allowing nature to establish an appropriate mix of species over time. The level of maintenance, naturalistic appearance and legibility can be contrasted with that of Skara Brae (CS10), which has similar high number of visitors, though to a much more focused space.

7.0	**References:**
	Interviews: Jim McMurray *(Grounds Manager, NTS)* Sources: Walker, B (2006), Historic Scotland TAN 30, Turf Construction, pp 61-69 http://www.nts.org.uk/web/site/home/visit/places Data: http://www.metoffice.gov.uk/climate/uk/averages/19712000/mapped.html

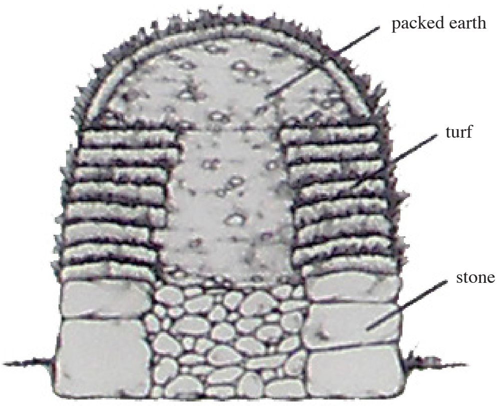


Fig. 6.2 Turf Dyke Section

Fig. 6.3: Turf was cut in spaced strips to encourage regeneration.

Fig. 6.4: The turf dyke in construction, with turf outer faces, domed earth core, covered by a turf cap.

Fig. 6.5: The completed wall, with the volunteer builders.

Fig. 6.6: In some places the sides show no vegetation, though there is more generally some grass growth.

Fig. 6.7: Decay to the sides of an opening forced through by cattle, showing how the turf sides have degraded to lose the binding strength of its root mat, while the living roots provide some resistance to damage.

Fig. 6.8: Grass eroded by pedestrian traffic on the wallhead. Thistles and nettles grow in the sheltered areas on either side of the wall, but not in the fields generally and not on the cap.

Fig. 6.9: The turf dyke cap shows more diversity than the surrounding fields.

Fig. 6.10: The turf capped drystone dyke in its exposed surroundings.

Fig. 6.11: The turf capped drystone dyke is more vulnerable to drought, which means it can support much fewer species than the turf dyke and experiences progressive edge decay.

Case Study 7: CLEITEAN, HIRTA, St. Kilda, Outer Hebrides

This case study documents an unusual and rare form of vernacular soft capping in a climatically severe location, and describes work to conserve them under very environmentally and archaeologically sensitive conditions.

Fig. 7.1: A general view near the village, showing one of the tallest turf cappings, with some edge decay.

1.0	**Background**		
1.1	Location:	Hirta is the main island of the remote St. Kilda archipelago, located approximately fifty miles west of the Western Isles. Cleitean exist on other islands, which are identical in typology, but are not being conserved and were not visited.	
1.2	Grid Reference:	NF 101 993 approx.	
1.3	Date of Works:	Repairs have been carried out with volunteers since the 1960s, and under archaeological supervision since 1996.	
1.4	Client:	The National Trust for Scotland (NTS)	
1.5	Contractor:	NTS Conservation Volunteers	
1.6	Architect:	N/A, works are directed by the island's archaeologist	
1.7	Access:	The cleitean are fully accessible to visitors, though access to the island is limited. A private boat regularly takes day visitors to the island during the summer from Harris and private visits to the island can be made at any time.	
1.8	Visit Record:	Date:	By:
		08.09.05	TM, Sam Dennis (NTS Archaeologist, St. Kilda)
2.0	**Building**		
2.1	Type:	Dry storage sheds, of a type unique to this location known as cleits.	
2.2	Classification:	Scheduled Ancient Monuments (1963, 1972, 2002) (not listed). World Heritage Site for cultural significance.	
2.3	Chronology:	Built:	Continuously ~ 1000 – 1930 AD
		Ruined:	The cleits stand in all states of preservation
		Repairs:	Seasonally since the 1960s

2.4	Construction and Form:	Cleitean are rounded rectilinear in plan, commonly pointing into the wind and lying across sloping ground, with an entrance at the uphill end. Their walls are constructed of two leaves of drystone masonry, with the inner leaf of better quality and larger stones and the outer leaf having a significant batter. The roof is formed from stone slabs laid across the wallheads, covered with small stones, then soil and turf (Fig 7.5-6). The size of the cleits varies significantly, ~ 1 – 1.5m wide x 2 – 4m long x 1.5 – 2.5m high. The cleitean were used for dry storage, mainly of dried seabirds, eggs, feathers, harvested crops, turf and peat. They were constructed in many different sites on the islands. The form and materials of the buildings correspond with that of other buildings on the islands, including souterrains, blackhouses and earlier dwellings, indicating a continuity of construction through perhaps 3000 years of human habitation. There are estimated to be 1260 cleits on Hirta and another 170 cleitean on outlying islands and stacks. They exist in all states of preservation. Many have lost all soil and vegetation, some stand as pristine stone shells, others are undergoing progressive decay and many lie as simple mounds of stone. Nevertheless, many, especially within the village head dyke, are in good condition with full or decaying turf caps. 300 of these have been identified for conservation. *The Soil and Turf Roofs* The soils and turf roofs vary considerably in shape, with some being relatively thin and flat and others being nearly as tall as the masonry beneath and having almost vertical sides. The soil layers thus vary in thickness, from about 200mm to as much as 1m. The reason for such large amounts of soil is unclear. Soil was a precious resource and there would have been considerable effort required to place large amounts of soil on the roofs. The thinner examples demonstrate that these are adequate for waterproofing and sustaining the vegetation and thermal insulation was not a requirement of these uninhabited structures. Further, thick soil layers produce steep sides, which are more vulnerable to erosion. One possible explanation is that height is an indication of numerous repetitive repairs, each laying another layer of turf on top, gradually building up height. This hypothesis is countered by the fact that many of the tallest roofs are in good condition and do not appear to be the ones that require repair due to decay. There is some evidence for stratification of the soil layers (Fig. 7.7). It seems more likely that this was simply a result of soil being sourced from different locations, rather than being the result of a deliberate design of layers of soils with different properties, or of re-turfing of failing caps. However, it is possible that layers of seaweed or other material were applied as fertiliser, or that cleits were re-capped. There is evidence of very deep grass root penetration into the soil (Fig. 7.8). In one example a dense matrix of fine roots could be seen to penetrate the full 600mm depth of the soil. This implies that a shallow root system did not provide the grass with sufficient nutrients or moisture. It is reported (S Bain, NTS) that the core soil is always bone dry when exposed during repairs. The effect of such a full root system is to stabilise the soil and, as a result, when the soil is exposed it erodes evenly. There was no evidence of the turf edge undermining often seen as a characteristic decay pattern in soft cappings. In such cases, unbound soil is vulnerable to wind erosion, but the upper rooted layer is more robust and decays at a slower rate by gradual drying of the roots, an effect of soil loss. There are many cleitean that have stones lying on top of the grass, suggesting they were placed onto the thin turf top to prevent initial wind uplift.	
3.0	**Site**		
3.1	Setting:	Description:	Hirta is a small mountainous island in the North Atlantic, with a sheltered bay and village on its east side. The cleitean are located all over Hirta, on the exposed high hillsides and within the relatively sheltered village, and elsewhere in the archipelago.
		Altitude:	10-350 m
		Distance from Coast:	0-1 km

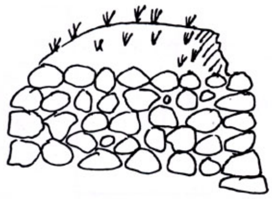
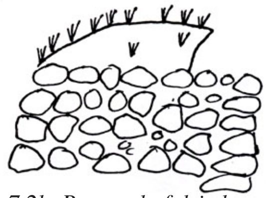
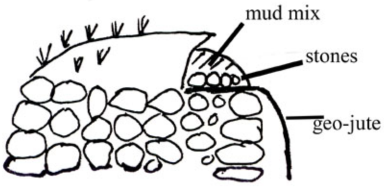
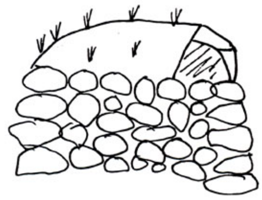
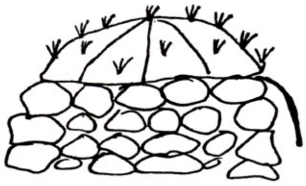
<table>
<tr><td>3.2</td><td>Classifications:</td><td colspan="4">SSSI (1984)
Dual World Heritage Site (2004) for its natural and cultural significance.
European Community Special Protection Area (1992)
National Nature Reserve (1957)
Geological Conservation Review Site (1984)
National Scenic Area (1981)
Biosphere Reserve (1976)</td></tr>
<tr><td rowspan="5">3.3</td><td rowspan="5">Microclimate:

Data estimated from: RGU climate record 2006 and Met office mapped annual averages 1971-2000</td><td colspan="4">Hirta is severely exposed to wind; with over fifty days of storm force winds each year and very few still days. There is also a very high level of airborne salts.</td></tr>
<tr><td>Rainfall (mm) *</td><td>~1400 (92%)</td><td>Days of Rain >= 1mm *</td><td></td></tr>
<tr><td>Ave. Min Temp *</td><td>4.4 ºC (110%)</td><td>Ave. Max Temp *</td><td></td></tr>
<tr><td>Days Ground Frost *</td><td>~100</td><td>Hours sunshine *</td><td></td></tr>
<tr><td colspan="2">Prevailing Wind Direction:</td><td colspan="2">Southwest</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>4.0</td><td colspan="5">Flora and Fauna</td></tr>
<tr><td>4.1</td><td>Vegetation on Wall:</td><td colspan="4">The roof vegetation on the Cleitean is predominantly Festuca Rubra (Red Fescue) grass, rather less lush than the general ground cover. There were some examples above the head dyke of more bio-diverse caps. These had mature short heather, edge mosses and lichens and some grass (Fig. 7.4). It seems that this is likely to have been as much the result of the original applied vegetation, as of subsequent natural colonisation. These caps were in fairly good condition, generally mature and stable, though there was some locally exposed soil, especially around the edges. This may suggest that greater bio-diversity means they are more robust against decay, for example because of a thicker root matrix.

The repairs have similar species to the original cappings, though often growth is more luxuriant because of the sheep fertiliser applied to the underlying soil. Festuca rubra and Agrostis capillaris are two of the most versatile British grasses (Grime et al, 1988), while Holcus mollis can also exploit widely different soil and climatic conditions.</td></tr>
<tr><td>4.2</td><td>Surrounding Vegetation:</td><td colspan="4">The surrounding vegetation is commonly rough grassland, grazed by sheep, though some upland areas contain heather and other species, and there are isolated small wetland areas.</td></tr>
</table>

4.3	Species Survey. *Assessment from photos by HL*					
	D=Dominant, **A**=Abundant, **F**=Frequent, **O**=Occasional, **R**=Rare, **VR**=Very Rare, *=Present					
	Common Name	Latin Name	Upland Capping	Upland Surr. Veg	Lowland Capping	Lowland Surr. Veg.
	Grasses:					
	Bent sp.	*Agrostis sp.*	**R**	*	**O**	*
	Creeping Soft Grass	*Holcus mollis*	**O**	*	**O**	*
	Early Hair Grass	*Aira praecox*			**R**	
	Matt Grass	*Nardus stricta*		*		*
	Perennial Rye Grass	*Lolium perenne*			**O**	*
	Reedmace	*Typha latifolia*				**?**
	Sheep's Fescue	*Festuca ovina*	**O**	*	**O**	*
	Sedge sp.	*Carex sp.*		*		
	# This species appears to overwhelmingly dominate the majority of cleits.					
	Ruderals/Herbs:					
	Buttercup sp	*Ranunculus sp.*				*
	Common Mouse Ear	*Cerastium fontanum*	**VR**			
	Daisy	*Bellis perennis*			**VR**	
	Heather	*Calluna vulgaris*	**O**	*		
	Procumbent Pearlwort	*Sagina procumbens*			**?**	
	Ribwort Plantain	*Plantago lanceolata*			**R**	
	Trees/Shrubs: None noted					
	Mosses/Ferns:					
	Mosses and Lichens		**R**		**R**	

4.4	Fauna:	Birds nest in the masonry structures, but do not seem to affect the cappings. However, their protected status can inhibit repairs. Sheep climb onto accessible cappings to graze, as the caps contain fewer parasites than the surroundings, which is because their droppings generally roll off the sides. Thick layers of sheep dung also tend to accumulate inside the cleitean, as sheep use them for shelter. The effect of this local fertilisation is to make the grass around the cleits more luxuriant. See also 6.4.
5.0	**Technique**	
5.1	Source of Technique:	The NTS have gradually developed a repair technique aimed at conserving the character of the original roofs.
5.2	Season of Work:	Summer months, generally mid May - August, as this is when the weather is easiest for access and work.
5.3	Preliminary Repairs to Structure:	There are sometimes associated repairs to the masonry structure.
5.4	Treatment of Existing Vegetation:	The existing vegetation is cut back to a line of healthy grass.
5.5	Soft Capping Technique:	The repairs have generally been to roofs with advanced decay, involving large repairs from the wallhead into the core of the capping. The decaying turf edge is cut back to an even line and all the solid beneath is removed down to the stone roof, cut back into the cap at an angle under the turf, in order to get a good key. The stiff mud repair mix is reapplied to reinstate the original shape, with occasional stone and jute mesh included. Turf is then reapplied, usually in horizontal strips, with jute mesh over, pinned in place. There was evidence of very steep turf edges being repaired in stacks of thin turf.

5.6	Sketch Section:	 *Fig. 7.2a. Cleit Pre-work*  *Fig. 7.2b Removal of dried roof*  *Fig. 7.2c. Re-build cleit*  *Fig. 7.2d Tapered turf applied*  *Fig. 7.2e. Completed repairs*
5.7	Vegetation: Source and Description	Because of the island's conservation controls, no plants can be imported onto the island and there should be minimal disturbance of the ground. Turf is cut from suitable areas near the cleits. The turf has been cut both as blocks and thin turfs, though generally thinner turf is used to minimise ground disturbance. Strips are cut as large as is practical to handle.
5.8	Soil: Source and Description	The soil previously removed from the cap is mixed with new soil, which is carefully set aside during excavations or other activities involving ground disturbance on the island, and sheep dung. Recently the proportion of sheep dung has been reduced. In 2005, the mix was 2 soil: 1 dung.
5.9	DPC:	None used
5.10	Defining Membrane:	None used
5.11	Fixing:	The new turf is stitched to the old capping with metal staples and timber pegs. Jute netting is used locally to hold the turf down, and seems to rot away within a few years.
5.12	Aftercare:	The repairs are watered; with ten full watering cans daily if there has been no rain for three days, until there is rain. This can be an onerous task, given the island conditions.
5.13	Maintenance:	There is no long-term maintenance of the repairs.

6.0	**Performance Assessment**	
6.1	General Performance:	The repairs have met with mixed success, with about 50% surviving in the long term. While the reasons for the failure of repairs can be identified it is less easy to understand why others have succeeded. The repairs initially appear healthy and lush in comparison with the remaining original cap, but there has been quite a lot of subsequent failure, with the grass dying, mainly within the first year. The repairs have also sometimes slumped and slipped away from the old material, with some large crevices opening up between the repair and original cap. There appear to be several factors contributing to these problems. The slumping and slippage suggest that the soil is poorly compacted or applied too wet and subsequently shrinks as it dries, or slips into voids between the underlying stones. This could be exacerbated by shrinkage cracks opening up between the repairs and the original material, allowing rainwater to penetrate deep into the caps and wash away the repair soil. This drying shrinkage may also inhibit good rooting in of the relatively thin turf. Installation during the summer months is not ideal, being most prone to drying out before the roots become established. Although the site has a good rainfall, it also has near constant wind and high solar radiation, creating strong drying conditions in summer. The post-repair watering regime alleviates this problem, though this may in some cases be counter-productive by encouraging shallow rooting rather than deep rooting which would both tie in the turf and give it a greater source area for water after watering has stopped. The use of fertiliser may also create artificially benign conditions for plant growth, encouraging shallow rooted thick leaved growth during the first year, which is less robust than the deep and dense fine roots and thin leaves of the original caps. These less hardy dominant plants subsequently progressively fail in the harsher naturally prevailing conditions of subsequent years. The use of turf sourced from immediately around the cleitean would have a similar effect, as this grass is similarly lush and broad leaved thanks to the local concentration of sheep dung (Fig 7.16). The visual difference between the grass sward of the repairs and some original caps supports this theory (Figs. 7.17, 7.19 and 7.20). When there is later new growth on the dead repairs this tends to be fine grasses, either growing from wind-blown seed or seed latent in the original turf repair material, and this might suggest that the seasonal need for watering is the main problem, rather than soil fertility. The metal staples do not seem to have been very effective in fixing the turves, as they rapidly corrode in the salt laden air. The timber pegs seem to have performed better, though these may provide routes channelling rainwater into the core.
6.2	Effect of Climate:	The climate creates strong seasonal drying conditions, leading to early dieback as described above. There has also been some damage caused by wind uplift.
6.3	Effect of Birds:	Fulmars are reported to nest in the turf, without causing problems, while wrens and petrels inhabit the walls.
6.4	Effect of Animals:	The Soay sheep are reported to often climb onto the cleitean and recent repairs would be especially vulnerable to mechanical damage from their feet, which could expose soil, especially at the edges, allowing progressive decay to become established. No sheep were observed on top of cleitean during the survey, though some of the grass cappings clearly had been recently grazed, however grazing itself does not directly cause decay. The cleitean in the best condition all had tall grass that had obviously not been grazed (Fig. 7.3) and these are thought to comprise about 10%. It is known that sheep were traditionally seasonally excluded from the area enclosed by the head dyke to protect crops. This is no longer done as the sheep are now wild animals and it would be impossible to exclude them. While grazing does not directly cause decay, it does have more subtle effects on the health of the turf capping. Grazing will encourage a dense root mat to develop, which is favourable, but reduce the benefits of wind shelter and rain dispersal given by a tall sward. Eilean Mor (CS1) is another good example of the benefits of tall sward in protecting vulnerable soil. Grazing can also affect species. In mainland conditions, lack of grazing leads to domination by *Arrhenantherum elatius* with *Dactylis glomerata* and a few tall herbs. When ungrazed, *Festuca rubra* can form a very dense sward and exclude most other species, though there are usually some other species present. Thus the ungrazed cleit roofs are very similar to ungrazed coastal grasslands on mineral soils in other parts of Scotland. However, on the grazed roofs species similar to those on the ungrazed roofs, as in the extreme maritime conditions of St Kilda, *Festuca rubra* completely out-competes *Arrhenatherum*.

6.5	Aesthetic Performance:	The most successful repairs effectively reinstate the appearance of the original cappings and conserve an important part of this site's cultural heritage. The verdant sward of some repairs is incongruous, but better than the appearance of the failed repairs.
6.6	Public Reaction:	None noted
6.7	Team Reaction:	The team are keenly aware of the need to achieve an effective conservation strategy, given the scale of vulnerable structures and their cultural importance. Many of the issues outlined above have been considered and practice has gradually developed in the years that repairs have been carried out. Currently the following modifications of technique are being considered: 1. The soil could be applied damp rather than as mud, to reduce shrinkage. 2. Coir netting, rather than jute, could be used to prevent wind uplift. This should have a life of seven years rather than two to three. 3. Timber pegs should be used, angled in at approx. 45 degrees. 4. Two layers of turf could be tried, root-to-root, to create a larger root mass, though there is always a reluctance to lift turf. 5. Sheep could be excluded from the head dyke area, though there may then be a problem of maintaining the grass. Alternatively, they could be locally excluded from repaired cleits to protect them during the vulnerable early years.
6.8	Comments:	Climatic conditions for soft cappings on St. Kilda are aggressive and severe. Nonetheless soft caps seem to be an effective defence against decay of the masonry fabric of these important structures, with the evidence suggesting the inexorable progressive collapse of uncapped masonry. The key factor in this decay of the masonry is probably wind, with the caps providing a binding effect on the whole structure, as well as providing a significant weight, holding down the stones. This has direct parallels with vernacular construction in Orkney (CS8, 10 and 18) and may be an answer to the puzzle of why so much soil was used in many cases. Lacking detailed documentary evidence of the date of construction, chronology of use, history of maintenance, quality of original construction, activity of sheep, microclimate, etc, it is difficult to make useful conclusions about the patterns of decay in individual cleits. Mechanical damage by sheep may be a critical factor in establishing a progressive decay pattern and a precautionary approach would be to exclude them. However, other sites (Eynhallow, Orkney, CS18) have shown that wind action can be sufficient in itself to render cappings non-viable, while others (Dun Carloway Blackhouses, CS3) have shown that sheep can be beneficial overall. It may be that many of the cleitean were not self-sustaining without the maintenance provided originally by the island community. Or they may have required little maintenance unless accessed by sheep. Evidence of a continuous process of constructing buildings from re-cycled materials suggests that there may have been an acceptance that cleitean had a limited life. However, it is possible that there is a great range in the age of the surviving cleitean, with some being very old structures dating back well over 1000 years and essentially unaltered from that time. In any case the context of the cleits has fundamentally changed from being working buildings within an adaptive living community to being historical artefacts that should be preserved in as near to their original conditions and appearance as possible. It seems inevitable that conservation of all the cleitean is not practically achievable because of the lack of resources to maintain them. What may be more pragmatic is a policy of effective management of their gradual decay, with good recording procedures to try and understand the decay patterns and selective intervention to preserve the most important examples. In this, it may be more beneficial to carry out smaller repairs to a larger number of cleitean where the process of decay has recently taken hold, rather than undertaking major repairs to a few of the most damaged roofs. Given the seasonal limitations on when repairs can be undertaken, which are also experienced at other sites such as Eynhallow (CS18), it might prove beneficial to undertake the first stages of repair on all cleits in one season, leaving the turfing of them all until last. This would allow some shrinkage of the soil to occur before the turf is applied and minimise the time the turf spends in summer conditions. *Festuca rubra* grows in the late autumn as well as the spring, flowers from May to July and sets seed from July to August. This means that turf cut in the late summer would contain fresh seed as well as experiencing autumn growth to root in. In doing this, it is important to develop the most effective repair techniques that maintain the original appearance of the cleitean selected for preservation, while minimising the wider effects of soil and turf removal. The commitment of the NTS staff and volunteers suggest that such best practice will be achieved over a period of years, despite the difficult conditions they face and this maybe of wider benefit in the understanding of these issues.

7.0	**References:**
	Interviews: Susan Bain, *National Trust for Scotland* Jane MacKintosh, *Scottish National Heritage* Sam Dennis, *National Trust for Scotland* Sources: http://www.kilda.org.uk/ *St Kilda Cliet Roofs:* Project 362.5, Lorna Johnstone, 2001, Glasgow University Archaeological Research Division *Buildings of St Kilda*, 1988, Stell, G P, and Harman M. Royal Commission on the Ancient and Historical Monuments of Scotland/HMSO, Edinburgh *World Heritage Site, St Kilda: A comparative analysis of the cultural landscape*, 2004, The National Trust for Scotland

Fig. 7.3: The common 'Mohican' profile of the grass cappings. The left turf edge has stabilised back from the stone edge, implying stronger wind on that side than the right. The front edge is eroding with some moss and lichen growth. This cleit would appear to steep-sided to allow sheep to graze on top.

Fig. 7.4: Though Red Fescue grass is the dominant cap species; upland situations are more bio-diverse, including, in this example, heather.

Fig. 7.5: The turf and soil was laid over small stones on top of large cross slabs.

Fig. 7.6: Typical interior view, with larger stones on the inner wall faces, cross-slabbed roof and build up of sheep dung on the floor.

Fig. 7.7: There is apparent stratification in the soil, which might simply reflect different sources of soil, but could imply periodic repair and re-turfing.

Fig. 7.8: In mature caps there is a deep penetration of fine hair roots. This binds the otherwise friable soil, retarding decay and creating an even erosion face, even when, as in this example, the turf has fully died on top. This case shows the opposite condition from a turf cap undermined by soil erosion.

Fig. 7.9: Cleitean facing the prevailing winds at 300m above the North Atlantic. Even in situations of extreme exposure caps can prove durable protection to the masonry structure beneath.

Fig. 7.10. A view looking west across the village from 1878, before the island was evacuated and while cleitean were still in use and being periodically constructed. The building in the right foreground has a straw thatch roof, with turf wallheads and netting over, held down by stones. This is comparable to the roof on the Arnol Blackhouse (CS9).

Fig. 7.11. A comparable view from 2005. Several cleitean can be identified that were constructed between 1878 and the evacuation of the island.

Fig. 7.12. Cleitean within the head dyke. The condition of individual cappings can dramatically differ from apparently comparable ones nearby.

Fig. 7.13. The cleitean in the background show the characteristic pattern of progressive decay from the windward edge. This may be a very slow, but inexorable, process. However, other comparable cleits, such as the one in the foreground, are able to resist the onset of decay.

Fig. 7.14. The process of decay leads to the complete loss of vegetation and soil and the ultimate collapse of the masonry structure.

Fig. 7.15. Cleit 23, the feet of sheep climbing onto the cleit roofs may, in some cases, instigate the decay process. Fig. 6.7 shows a detail of this roof.

Fig. 7.16. Though cleitean usually erode from the lower face, others do not. This may relate to the local prevailing wind direction or where sheep have climbed onto the roof. Note the verdant growth on the ground around the cleit, which probably relates to the deposition of dung by sheep sheltering inside.

Fig. 7.17: Repairs are often notable for their lush green colour.

Fig.7.18. Cleitean.

Fig. 7.19: Cleit 39, repaired one year previously.

Fig. 7.20: Cleit 39, repaired one year previously.

Fig. 7.21: General view showing two cleit roofs where repairs are failing.

Fig. 7.22: Cleit 15, repaired four years previously showing some re-growth on areas of slow, even die-back, contrasting with the rapid failure shown in Fig.6.24.

Fig. 7.23: Partial failure of roof repairs, showing the how the original roof was cut back to key in.

Fig. 7.24: Cleit 6, repaired one year previously, showing turfs which have shrunk, following a failure to root in.

Fig. 7.25: Stacked turf has been used to repair some steep sides, here with partial failure.

Case Study 8: DOUNBY CLICK MILL, Orkney

This case study documents the vernacular soft capping of low-pitched stone roofs in Orkney.

Fig. 8.1: Dounby Click Mill. North view of the mill with typical open moorland behind. The stonewall eaves are capped by the edges of the large sandstone roof slabs on which the turf cap sits.

1.0	**Background**		
1.1	Location:	3.7km North-east of Dounby, Orkney mainland	
1.2	Grid Reference:	HY 3253 2284	
1.3	Date of Works:	c. 1980	
1.4	Client:	Historic Scotland (HS)	
1.5	Contractor:	Historic Scotland	
1.6	Architect:	Historic Scotland	
1.7	Access:	Unrestricted access	
1.8	Visit Record:	Date:	By:
		11.08.05	TM, Adrian Stanger (HS Area Works Manager)
2.0	**Building**		
2.1	Type:	Agricultural Mill, a small horizontal water-mill, restored	
2.2	Classification:	Scheduled Ancient Monument	
2.3	Chronology:	Built:	c. 1825
		Ruined:	N/A
		Repairs:	1932, re-roofing c. 1980
2.4	Construction and Form:	The mill is a small, low building of mortared rubble wall construction with recessed pointing. The roof has two sides, ~2m x 6m, rising at ~20 degrees from eaves at ~1.5-2.5m. above external ground level. The ridge runs south-east/north-west. The roof is formed of large sandstone slabs laid on timber purlins. The slabs project ~50mm at the eaves, but the gable is flush, with the wall rubble forming the top masonry surface. On top of the slabs is a layer of earth, tapering from nothing at the eaves to ~150mm in the centre, with a single layer of ~100mm turf over the top (Fig. 8.4). There is one small pane of glass forming an in-line rooflight on the north side (Fig. 8.7).	

3.0	**Site**				
3.1	Setting:	Description:	The mill is located inland on an exposed, open stretch of land. It stands in a small fenced enclosure where the grass is regularly mown. Outside this is a mixture of rough grazing, including some boggy areas and a small burn, which runs through the site and previously powered the mill.		
		Altitude:	~50m		
		Distance inland:	~5.5 km		
3.2	Classifications:	None			
3.3	Microclimate: Data source: Met. Office, *Annual Averages 1971 – 2000 *(Numbers in brackets give data as a % of national average)*	Orkney has little frost and periods without rain are reported to rarely exceed a week. Although the site is very exposed to winds, it is relatively sheltered compared to costal sites on Orkney, such as Skara Brae or Eynhallow.			
		Rainfall*	~1000mm (66%)	Days of Rain>=1mm *	~186 (102%)
		Min Temp*	~5.4ºC (135%)	Max Temp*	~10.7ºC (105%)
		Days Frost*	~112	Hours sunshine*	~1100 (95%)
		Prevailing Wind Direction:		North-west	

4.0	**Flora and Fauna**				
4.1	Vegetation on Cap:	There is generally a thick dense mat of mixed species, dominated by grasses, but also including a small amount of buttercups and dock. There is a significant amount of locally dense moss, focused on the eaves edge and, to a lesser extent, the gable edges (Fig. 8.4).			
4.2	Surrounding Vegetation:	The surrounding rough grazing is predominantly grass, but also includes a range of wild flowers and ruderals.			
4.3	Species Survey. *Assessment by HL from photographs* **D**=Dominant, **A**=Abundant, **F**=Frequent, **O**=Occasional, **R**=Rare, **VR**=Very Rare, *=Present				
	Common Name	Latin Name	Capping	Surrounding Vegetation	Comment
	Grasses:	**Note: Mown grasses adjacent to mill were difficult to identify.**			
	Red Fescue	*Festuca rubra agg*.	**D**	*	
	Soft Rush	*Juncus effusus*			
	Sweet Vernal Grass	*Anthoxanthum odoratum*		*	
	Yorkshire Fog	*Holcus lanatus*		*	
	Smooth Meadow Grass	*Poa pratensis*	**R**		**Edges**
	Ruderals/Herbs:				
	Angelica	*Angelica sylvestris*		*	
	Autumn Hawkbit	*Leontodon autumnalis*	**R**	*	
	Broadleaved Dock	*Rumex obtusifolium*		*	
	Common Sorrel	*Rumex acetosa*	**F**	*	
	Daisy	*Bellis perennis*	**VR**	*	
	Dandelion	*Taraxacum officinale agg*	**O**	*	
	Yellow Flag Iris	*Iris pseudacorus*		*	
	Meadow Buttercup	*Ranunculus acris*		*	
	Meadowsweet	*Filipendula ulmaria*		*	
	White Clover	*Trifolium repens*		*	
	Trees/Shrubs: none noted				
	Mosses/Ferns:				
	Unidentified		**O**		
4.4	Fauna:	One bird's egg was seen on the grass roof, but without sign of a nest.			
5.0	**Technique**				
5.1	Source of Technique:	In the re-roofing, HS replicated the local vernacular technique of applying turf on soil on top of a low pitched stone slabbed roof. It is thought that the primary purpose of the turf was to protect the stone from delamination resulting from exposure to frost. The turf was initially held down with ropes and by the time these had rotted the turf was well-established. A similar technique is also recorded in Moray on steeper pantiled roofs, for isolative effect (B Walker, 2006).			
5.2	Season of Work:	Unknown			
5.3	Preliminary Repairs to Structure:	Unknown			
5.4	Treatment of Existing Vegetation:	It is uncertain what condition the roof was in prior to the reconstruction. However, it is known that all the roofing material was newly sourced.			

5.5	Soft Capping Technique:	A single layer of turf was applied on a thin layer of soil, over the large stone slabs.
5.6	Vegetation: Source and Description	Turf was cut from the nearby rough pasture.
5.7	Soil: Source and Description	Unknown, but assumed to be local.
5.8	DPC:	None used
5.9	Defining Membrane:	None used
5.10	Fixing:	Ropes are thought to have been used to prevent wind uplift. There is no evidence surviving of any timber pegs.
5.11	Aftercare:	None known
5.12	Maintenance:	None
6.0	**Performance Assessment**	
6.1	General Performance:	The capping seems to be performing very well, with the walls in good condition and the slabs dry on the inside. There was no evidence of delamination. There was some dieback, mainly on the south-east gable, where exposed earth is apparently slowly eroding, currently ~max. 50mm from the face of the masonry wall and in line with the recessed pointing. The north-west gable had been stabilised by grasses and moss to a large extent, but the south-east gable had only been stabilised by moss about 30% (Fig. 8.3).
6.2	Effect of Climate:	Though there is a little rounding of the corners, the severe winds of Orkney apparently have little effect and this can perhaps be attributed to the low pitch and overall shape of the roof. The north-west is more exposed to wind driven rain and yet is more stable than the south-east gable edge, suggesting that this may seasonally dry out from solar exposure.
6.3	Effect of Birds:	None noted
6.4	Effect of Animals:	None noted
6.5	Aesthetic Performance:	The effect of the soft-capped roof is very good, apparently effectively representing the vernacular technique. The natural appearance of the turf can be contrasted with the mown turf at other sites on Orkney, such as Skara Brae (CS10), where it is a conservation material, and at the Arnol Blackhouse (CS9), where it is a vernacular technique.
6.6	Public Reaction:	None noted
6.7	Team Reaction:	This is regarded as having been very successful.
6.8	Analysis:	This building was built to grind grain and did not require insulation or waterproofing to increase the comfort of inhabitants. This reinforces the view that the soft capping was used to thermally blanket the underlying stone and protect it from delamination by frost. It will also have moderated the flux of moisture in the stone slabs. The good performance of the turf capping is attributable to the quality of turf used, being suited to local conditions, and the shape of the roof. Other examples of this technique examined nearby and at Eynhallow (CS18) indicate that these soft cappings were often not durable in the long term and suggest that the severity of wind in Orkney is the primary factor in a slow, but inexorable process of decay. The mill at Dounby is interesting in that the condition of the two gables suggests that solar radiation can be more critical than wind. Orkney has relatively low solar radiation, being at high latitude and often has cloud cover, but this example suggests that summer peaks can still have a significant effect in drying out the capping edge, albeit in association with fairly continuous wind movement.
7.0	**References:**	
	Interview: Adrian Stanger, *Historic Scotland Area Works Manager* Data: http://www.metoffice.gov.uk/climate/uk/averages/19712000/mapped.html Sources: B. Walker, 2006, *Historic Scotland TAN23, 4.9*	

Fig. 8.2: West view. The setting is damp, but open. The north-west gable vegetation is stable against the prevailing wind.

Fig. 8.3: On the south-east gable, which is apparently more sheltered, vegetation is less stable with loss of ~ 50mm.

Fig. 8.4: Interior view. The turf capping sits on large sandstone slabs on a timber structure.

Fig. 8.5: The most exposed west corner shows a little local decay and stabilisation by mosses.

Fig. 8.6: The edges typically have a dense moss mat.

Fig. 8.7: The rooflight did not cause decay. The moss mat at the window head implies that moss growth is associated with accumulations of moisture before its drips away.

Case Study 9: THE BLACKHOUSE, 42 ARNOL, Lewis, Outer Hebrides

This case study describes an interesting vernacular soft capping technique, which has been conserved in a rare example.

Fig. 9.1: The Arnol Blackhouse. The broad, turf capped wallheads take the full rainwater runoff from the roof, with the eaves profile being designed to minimise wind damage rather than throw off water. Maintenance is by non-traditional means.

<table>
<tr><th>1.0</th><th colspan="4">Background</th></tr>
<tr><td>1.1</td><td>Location:</td><td colspan="3">42 Arnol, Lewis, Outer Hebrides</td></tr>
<tr><td>1.2</td><td>Grid Reference:</td><td colspan="3">NB 3104 4927</td></tr>
<tr><td>1.3</td><td>Date of Works:</td><td colspan="3">1990</td></tr>
<tr><td>1.4</td><td>Client:</td><td colspan="3">Historic Scotland</td></tr>
<tr><td>1.5</td><td>Contractor:</td><td colspan="3">Historic Scotland</td></tr>
<tr><td>1.6</td><td>Architect:</td><td colspan="3">Historic Scotland</td></tr>
<tr><td>1.7</td><td>Access:</td><td colspan="3">Open throughout the year, except Sundays. Opening times vary and there is an admission fee.</td></tr>
<tr><td rowspan="3">1.8</td><td rowspan="3">Visit Record:</td><td>Date:</td><td colspan="2">By:</td></tr>
<tr><td>26.8.03</td><td colspan="2">TM, BL</td></tr>
<tr><td>10.9.06</td><td colspan="2">TM</td></tr>
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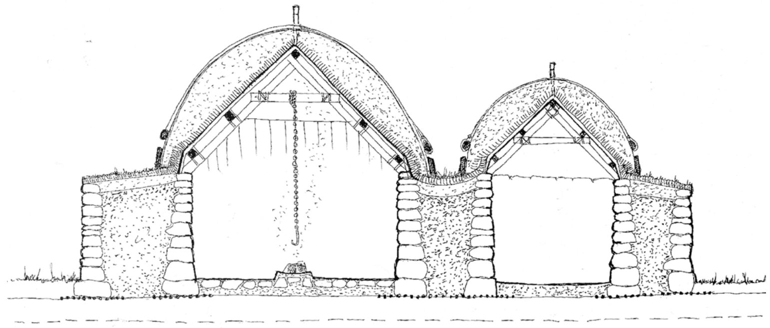
<table>
<tr><th>2.0</th><th colspan="3">Building</th></tr>
<tr><td>2.1</td><td>Type:</td><td colspan="2">Traditional Hebridean Blackhouse, a late example</td></tr>
<tr><td>2.2</td><td>Classification:</td><td colspan="2">Scheduled Ancient Monument
Property In Care, Historic Scotland (1965) (not listed)</td></tr>
<tr><td rowspan="3">2.3</td><td rowspan="3">Chronology:</td><td>Built:</td><td>1885</td></tr>
<tr><td>Ruined:</td><td>Occupied until 1965</td></tr>
<tr><td>Repairs:</td><td>1990</td></tr>
<tr><td>2.4</td><td>Construction and Form:</td><td colspan="2">The building comprises two linked parallel, long narrow structures, whose thatched roofs drain onto the top of their thick walls.
The walls vary in thickness from ~1.5m to 2.1m, and reach ~1.8m in height. They consist of two drystone masonry skins with a tempered earth core. The stones are primarily local gneiss and schist. The earth core consists of topsoil excavated from the site combined with blue clay, ash from the fire and peat dust.
The wallhead is finished with a layer of blue clay, ~130mm thick, on which is a layer of turf, with a very slight slope to the outer edge. The wallhead between the two ranges, effectively a valley gutter, does not have turf over the clay.
Near the building a comparable roofless blackhouse is maintained with a similar wallhead capping.</td></tr>
</table>

<table>
<tr><th>3.0</th><th colspan="5">Site</th></tr>
<tr><td rowspan="3">3.1</td><td rowspan="3">Setting:</td><td colspan="2">Description:</td><td colspan="2">The Blackhouse is set in a small crafting township on the exposed west coast of Lewis.</td></tr>
<tr><td colspan="2">Altitude:</td><td colspan="2">~30m</td></tr>
<tr><td colspan="2">Distance from Coast:</td><td colspan="2">~0.5km</td></tr>
<tr><td>3.2</td><td>Classifications:</td><td colspan="4">None known</td></tr>
<tr><td rowspan="5">3.3</td><td rowspan="5">Microclimate:
* Estimated from Met. Office, Ann. Averages 1971–2000
(Numbers in brackets are % of Scot. Ave.)</td><td colspan="4">The site is exposed to wind, rain and sun, with weather tending to blow in off the Atlantic and pass through.</td></tr>
<tr><td>Rainfall (mm)*</td><td>~ 1400mm (92%)</td><td>Days of Rain >= 1mm *</td><td>~240 (130%)</td></tr>
<tr><td>Min Temp*</td><td>5.5ºC (138%)</td><td>Max Temp *</td><td>~10ºC (95%)</td></tr>
<tr><td>Days Ground Frost *</td><td>20</td><td>Hours sunshine*</td><td>~1140 (98%)</td></tr>
<tr><td colspan="2">Prevailing Wind Direction:</td><td colspan="2">Assumed south-west</td></tr>
</table>

4.0	**Flora and Fauna**	
4.1	Vegetation on Wall:	None noted
4.2	Surrounding Vegetation:	The building is surrounded generally by rough pasture, grazed by sheep. There is more bio-diverse uncultivated ground within 1km, but the immediate vicinity is mown grass.

4.3	Species Survey. **D**=Dominant, **A**=Abundant, **F**=Frequent, **O**=Occasional, **R**=Rare, **VR**=Very Rare, *=Present				
	Common Name	Latin Name	Capping	Surrounding Vegetation	Comment
	Grasses:				
	Common Bent	*Agrostis capillaris*	**F**		
	Perennial Rye Grass	*Lolium perenne*	**O**		
	Red Fescue	*Festuca rubra*	**A**		
	Yorkshire Fog	*Holcus lanatus*	**O**		
	Ruderals/Herbs:				
	Broadleaved Dock	*Rumex obtusifolius*	**O**		Inc1. largish patch
	Silverweed	*Potentilla anserina*	**O**		
	Trees/Shrubs: none				
	Mosses/Ferns:				
	Male Fern Type	*Dryopteris sp*			In walls below. Not clearly identifiable
4.4	Fauna:	None noted			

5.0	**Technique**	
5.1	Source of Technique:	The reconstruction of the soft-capped wall and roof was undertaken after a detailed study of traditional blackhouse construction, specific to Arnol.
5.2	Season of Work:	Not known
5.3	Preliminary Repairs to Structure:	Not known
5.4	Treatment of Existing Vegetation:	Not known
5.5	Soft Capping Technique:	Turf was laid over the timber roof structure as an underlayer to the thatch, as well as on the wallhead. The turf was generally a single layer, where the two join, they overlap to form a double layer. The joints between the turves are mitred to encourage water to drain away from the wallhead rather than into it.

5.6	Sketch Section:	 *Fig. 9.2: Cross Section*
5.7	Vegetation: Source and Description	The wall turves were sourced specifically for their well-matted root system. They were dominated by grass species, and strimmed before the turves were cut. They were cut to a uniform thickness and as large as possible to allow for transportation. The turves were applied to the wallhead on the same day that they were cut. Heather turves, sourced elsewhere were used for the roof capping.
5.8	Soil: Source and Description	The walls are capped with a layer of blue clay, ~130mm thick. This material is oily, greasy clay, known to have waterproofing qualities and traditionally found locally in peat bogs. It contains kaolinite clay minerals, residual quartz crystals and mica flakes. The quartz and mica flakes act like an aggregate and as the material dries it tends to form small hairline cracks.
5.9	DPC:	None used
5.10	Defining Membrane:	None used
5.11	Fixing:	None known
5.12	Aftercare:	None known
5.13	Maintenance:	The wall capping has a high level of maintenance. The grass is regularly strimmed to keep a neat even appearance. The 'valley gutter' clay is periodically repaired in summer with clay to fill cracks. Animals are excluded.
6.0	**Performance Assessment**	
6.1	General Performance:	The cappings perform well. As intended, they effectively waterproof the wallhead against rain and roof runoff. The valley gutter suffers minor seasonal cracking, but enjoys fairly benign conditions, being reasonably well shaded from solar radiation, sheltered from the wind and enjoys the runoff from two roofs. The level of required maintenance is therefore acceptably low. There does not seem to be appreciable damage to the exposed clay from rainwater runoff, despite the high intensities that must periodically occur. The turf is very even and neat, given the high level of maintenance, but does not suffer from significant dieback.
6.2	Effect of Climate:	The capping seems eminently suited to its climate.
6.3	Effect of Birds:	None noted
6.4	Effect of Animals:	None noted
6.5	Aesthetic Performance:	The wallheads have a very tidy appearance, as does the lawn around the building, but arguably less well kept vegetation would be a more accurate representation of the vernacular. Specifically, in regularly strimming the caps, species diversity will be suppressed and the range of species commonly found on traditional wall caps are not represented.
6.6	Public Reaction:	None noted
6.7	Team Reaction:	None noted

6.8	Comments:	This form of construction is the classic traditional example of a clay capped wallhead, where the clay layer is intended to act as a waterproofing course and the role of the turf is to prevent the clay from cracking. It is part of a wider Scottish tradition of using clay on wallheads, which includes examples such as Gordon Castle Estate (CS4), and has informed contemporary practice in using clay in conservation soft cappings. Other vernacular cappings, such as Dounby Click Mill (CS8), do not specifically use clay soil and naturally occurring caps, such as Eilean Mor (CS1) and Cessford Castle (CS2) have very free draining soils. In these cases the sward and roots are the main waterproofing elements. The use of clay in conservation cappings has met with mixed success and this case study is interesting in that the clay performs well even when not protected by turf. It is perhaps not significant that a kaolin clay mineral is present in this soil, where most of the recent clay conservation caps have used illites, as they both have negligible expansive qualities. The source is perhaps more important, with waterproofing oils perhaps having been deposited below the peat in the source area. The climate may not be very significant when comparing this site to others where there is more dieback, such as Skara Brae (CS10), Eynhallow (CS18) and St. Kilda (CS7). Wind conditions here are marginally less, but still strong. Equally, it is tempting to suggest that the rainwater runoff from the thatched roof would be a significant benefit to grass viability. However, this does not correspond to the evidence of the healthy caps on the adjacent unroofed blackhouse ruin (Fig. 9.8) and the one at Dun Carloway (CS3). This leaves two aspects that might significantly contribute to the good performance of these caps compared to other examples. Firstly, the near horizontal profile minimises rainwater runoff, allowing moisture to penetrate the root system and be absorbed into the clay layer. Secondly, the clay could be sufficiently moist and open structured to act as a moisture reservoir for the plants through summer.
7.0	**References:**	
	Sources: The Hebridean Blackhouse: A Guide to materials, construction and maintenance, Historic Scotland Technical Advice Note 5 (1996) B Walker and C McGregor, Historic Scotland, Edinburgh Data: http://www.metoffice.gov.uk/climate/uk/averages/19712000/mapped.html	

Fig. 9.3: North view showing the two parallel ranges with valley gutter between. The slope of the wallhead is generally quite shallow.

Fig. 9.4: East view. Grass tends to infiltrate the thatch edge where it is difficult to strim. Note the projecting stone steps on the left to access the wallhead.

Fig. 9.5: Typical eaves condition in August, with thatched dressed over a turf upstand. The main turf remains verdant through summer with only minor edge dieback.

Fig. 9.6: The valley gutter during summer repairs to remove plant growth and repair cracks with clay.

Fig. 9.7: Detail of draining end of clay gutter, with hairline cracks and colonising grass.

Fig. 9.8: The nearby blackhouse ruin with repaired wallheads and roofed version behind.

Case Study 10: SKARA BRAE NEOLITHIC VILLAGE, Orkney

This case study is an unusual example of vernacular turf cappings that are part of a conserved Neolithic village, which presents difficult conditions for cappings.

Fig. 10.1: Skara Brae, Orkney. In summer the site attracts large number of visitors. Despite being maintained to a very high standard the failure of some turf edges detracts from the presentation of the monument.

1.0	**Background**		
1.1	Location:	Mainland, Orkney Islands	
1.2	Grid Reference:	HY 2313 1874	
1.3	Date of Works:	On going	
1.4	Client:	Historic Scotland	
1.5	Contractor:	Historic Scotland	
1.6	Architect:	Historic Scotland	
1.7	Access:	The site is open to the public, with an admission charge and visitor centre.	
1.8	Visit Record:	Date:	By:
		11.08.05	TM, Adrian Stanger, Historic Scotland Works Manager
2.0	**Building**		
2.1	Type:	Remains of a Neolithic/Early Bronze Age settlement, conserved	
2.2	Classification:	Scheduled Ancient Monument (not listed)	
2.3	Chronology:	Built:	3200-2200 BC
		Ruined:	It is uncertain when the village was abandoned
		Repairs:	The remarkably complete remains of this Neolithic village were revealed by a storm in 1850, which washed away its sand dune covering. An extensive archaeological investigation was followed by consolidation and presentation of the site to the public, including stabilisation of the shore and the construction of a replica dwelling. Repairs to the turf wall caps continues on an intermittent basis.
2.4	Construction and Form:	The village comprises a cluster of curvilinear dwellings, connected by passages, all set into the ground. The public currently access the grass areas, but are largely excluded from the lower stone levels. The original construction was drywall masonry using the locally abundant natural supply of sandstone slabs. The walls were lined with clay on the outside and detritus was bermed up against them, together with wind-blown sand, which eventually engulfed the dwellings into the growing dune system. It is thought that the current turf finishes replicate the approximate form and conditions of grass cappings to the walls, while avoiding reconstruction of higher levels. The replica dwelling gives an idea of how they may have originally appeared, with a full turf covering (Fig.10.4). Originally subterranean, the dwellings and passages have lost their roofs, though much survives to wallhead level. The wallheads are set into the ground, with undulating grass between, covering a mix of sand and midden material, reinstated after excavations to current levels.	
3.0	**Site**		
3.1	Setting:	Description:	The Neolithic village is located on an exposed grassy area on the edge of a sandy bay. The beach edge is protected by a concrete retaining wall.
		Altitude:	<10m
		Distance from Coast:	~1-40m
3.2	Classifications:	None known	

3.3	Microclimate: * Data source: Met. Office, Annual Averages 1971 – 2000 *(Numbers in brackets give data as a % of national average)*	Concrete walls have been erected to prevent waves directly entering the site, but it remains very exposed, particularly to the north-west. The headland provides some limited reduction of the prevailing south-west winds. Orkney has little reported frost and periods without rain rarely exceed a week.

Rainfall*	~1150mm(78%)	Days of Rain>= 1mm*	~185 (100%)
Min Temp*	~5.9ºC? (148%)	Max Temp*	~10.9ºC (103%)
Days Frost*	~80?	Hours sunshine*	~1200 (103%)
Prevailing Wind Direction:		South-west	

4.0	**Flora and Fauna**	
4.1	Vegetation on Wall:	The cappings are dominated by short cut grasses, principally Fetuca rubra, though there are a variety of other minor species, locally in abundance where not strimmed. Two were in flower during the visit and Birdsfoot Trefoil was also reported to flower on the site earlier in the year.
4.2	Surrounding Vegetation:	The surrounding vegetation is largely grassland, some grazed by cattle and some left wild. Unsurprisingly, there is greater diversity of species in these areas than on the site.

4.3 Species Survey. *Assessment by HL from Photos*

D=Dominant, **A**=Abundant, **F**=Frequent, **O**=Occasional, **R**=Rare, **VR**=Very Rare, *=Present

Common Name	Latin Name	Capping	Surrounding Vegetation	Comment
Grasses:				
Common Bent	*Agrostis capillaris*	**R**	**O**	
Creeping Soft Grass	*Holcus mollis*		**R**	
Red Fescue	*Festuca rubra*	**D**	**D**	
Ruderals/Herbs:				
Creeping Thistle	*Cirsium arvense*		**F**	
Daisy	*Bellis perennis*	**O**		
Dandelion	*Taraxacum officinale agg*	**R**		Small
Eyebright	*Euphrasia arctica agg.*		**O**	
Great Plantain	*Plantago major*		**O**	
Hogweed	*Heracleum sphondylium*		**O**	
Lady's Bedstraw	*Galium verum*	**O**		Edges
Nettle	*Urtica dioica*		**F**	
Ragwort	*Senecio jacobaea*	**R**	**F**	
Red Clover	*Trifolium pratense*		**O**	
Ribwort Plantain	*Plantago lanceolata*		**O**	
Spear Thistle	*Cirsium vulgare*	**R**	**R**	Cap - small
White Clover	*Trifolium repens*	**O**		Patch
Yarrow	*Achillea millefolium*	**R**	**O**	
Trees/Shrubs: None				
Mosses/Ferns: None				

4.4	Fauna:	None noted

5.0	**Technique**	
5.1	Source of Technique:	It is assumed the finishing of the turf caps was consistent with the evidence of the original construction. The repair technique has no known source.
5.2	Season of Work:	Early Spring
5.3	Preliminary Repairs to Structure:	There has been some consolidation of the masonry in recessed cement mortar.
5.4	Treatment of Existing Vegetation:	The existing dead caps are cut back to effect the repairs, with minimal disturbance of the ground, for archaeological reasons.
5.5	Soft Capping Technique:	Continuing repairs use small thick sections of turf, often pegged into place.
5.6	Vegetation: Source and Description	The original turf is thought to have been sourced from Caithness. The turf for the repairs is locally cut.
5.7	Soil: Source and Description	No soil is used. The site soil is very free draining, having a large sand content.
5.8	DPC:	None used
5.9	Defining Membrane:	None used
5.10	Fixing:	Timber pegs
5.11	Aftercare:	Fertilised and watered for the first couple of weeks after installation.
5.12	Maintenance:	The turf is closely strimmed monthly through the growing season.
6.0	**Performance Assessment**	
6.1	General Performance:	The turf seemed to be generally performing well, with the walls in good condition and the grass apparently protecting the soil from erosion and the masonry from mechanical damage from the feet of visitors. The close strimming allows visitors to appreciate the complex form of the site and does not impede view of the dwelling interiors. There is significant edge dieback, particularly to the exposed west sides. Soil is exposed for up to 250mm above the masonry wallheads, with repairs in turf largely failing to root into the soil and subsequently dying.
6.2	Effect of Climate:	The extreme winds and seasonal solar radiation contribute to locally severe drying conditions. The greatest amount of dieback is generally throughout the winter months due to the severe salt spray and wind. That is why, in general, repairs are carried out in early spring.
6.3	Effect of Birds:	None noted
6.4	Effect of Animals:	None noted
6.5	Aesthetic Performance:	The visual effect of the turf is minimal, being intended as a protective surface which should not distract from the visual focus on the interiors, though it does contribute by revealing the site's complex topography. A higher sward would arguably give a more naturalistic and historically accurate presentation of the site. While this might create a more romantic and alluring impression, recreating the feel of a village lost in the dunes, it could reduce the legibility of the site and encourage damage by animals. Nonetheless, in its current state, the severe edge dieback detracts from the site's appearance.
6.6	Public Reaction:	None noted
6.7	Team Reaction:	None noted

6.8	Comments:	The general wonder of this extraordinary monument is it can in part be attributed to the interplay of grass and masonry, which makes an important contribution to its aesthetic appreciation as noted above. However edge dieback is a severe problem that needs to be addressed without otherwise detrimentally affecting the site. The dieback is apparently due to a combination of strong climatic drying forces, as noted above, and the failure of the sand-rich soil to retain significant moisture. Although Orkney does not have a low rainfall, locally severe drought conditions are experienced by the edge turf in many locations. The fact that where there is some degree of shelter, the turf survives, indicates that a minor change in circumstance could have a significant beneficial effect. The close and frequent strimming is also a significant factor, creating conditions where *Festuca rubra* dominates, but is unable to flower and seed. If the strimming regime were to be subtly relaxed at the edges, a taller sward and greater species diversity might gradually naturally stabilise the edges through root growth, seeding and the micro-sheltering effects of the sward.
7.0	**References:**	
	Interview: Adrian Stanger, *Historic Scotland Works Manager* Data: http://www.metoffice.gov.uk/climate/uk/averages/19712000/mapped.html	

Fig. 10.2: Aerial view of the site, showing the wall protecting against costal erosion.

Fig. 10.3: The grass cappings have a complex 3-dimensional form, tightly maintained to both display and protect the monument.

Fig. 10.4: The replica dwelling gives an indication of the original form. The complete turf covering enjoys much more benign conditions than the original remains, with a greater mass, few exposed edges, no pedestrian traffic and no mowing.

Fig. 10.5: Edge dieback of the grass is fairly common, though other species seem more resilient.

Fig. 10.6: Where the stone edge is more complex, the grass fares better.

Fig. 10.7: On edges that are not strimmed, a more diverse vegetation creates a more stable edge.

Fig. 10.8: The unmown grassland around the site gives an indication of what the natural vegetation would be like.

Fig. 10.9: Both original turf (foreground) and subsequent repairs (background) fare worse on the exposed seaward faces.

Fig. 10.10: The complex shape of the grass surface makes cutting difficult to achieve without over-cutting in places.

Fig. 10.11: Some of the dead repairs experience re-growth.

Case Study 11: ICEHOUSE, Tentsmuir, Fife

This is an example of turf capping used for insulation as part of the original design of an icehouse. It is an example of the important heritage of 19th century industrial fishing buildings, which are distributed along the east coast of Scotland.

Fig. 11.1: Icehouse, Tentsmuir. The current ground levels, with the higher original ground, indicated by the line on the stone walls.

1.0	**Background**				
1.1	Location:	Tentsmuir, Fife, on a public walk about 3km north of the Kinshaldy car park			
1.2	Grid Reference:	NO 500 263			
1.3	Date of Works:	c. 1888 and earlier			
1.4	Client:	N/A, current owner: the Forestry Commission.			
1.5	Contractor:	N/A			
1.6	Architect:	N/A			
1.7	Access:	Unrestricted, however parking is only available during the hours of daylight (3km away). The interior can be viewed by prior arrangement.			
1.8	Visit Record:	Date:	By:		
		07.09.05	EP, KM, TM		

2.0	**Building**		
2.1	Type:	Icehouse, partially subterranean, used to store salmon. This example is fairly typical of a class of buildings of which there are many variations.	
2.2	Classification:	None.	
2.3	Chronology:	Built:	Thought to have been constructed in three stages, ending c.1888
		Ruined:	N/A
		Repairs:	The ground levels were recently lowered around the building in order to reduce damage by visitors, particularly from mountain bikers riding over the vault. This has separated the vault cap from the surrounding vegetation and perhaps reduced moisture levels in the structure.
2.4	Construction and Form:	The icehouse comprises three linked barrel vaulted chambers. The larger, older section has random rubble walls in lime mortar, internally finished with a lime/shell plaster. The barrel vault is of random stone rubble with some repairs in brick. The wallheads are ~5m above ground level, by ~7m long. The two later additions have a combined length of ~9m, and a height of 3m at the wallhead. The walls are of random rubble, with sandstone ashlars surrounding the door. The barrel vaults are of red brick in lime mortar. Both vaults are fairly shallow, with a max. pitch of approx. 40degrees, and surface areas of approx. 6 x 7m and 6 x 9m. It was not possible to determine the thickness of the vault construction	

3.0	**Site**				
3.1	Setting:	Description:	The icehouse lies on the edge of a forest adjacent to extensive dune grassland on the north-east coast of Fife. The conifer forest was planted in 1920s and is now well established, with mature trees and thick undergrowth. The forest extends ~30m to the east where it gives way to a wide, sandy beach.		
		Altitude:	~ 3m		
		Distance inland:	~ 0.5 - 1km, with tidal variation.		
3.2	Classifications:	National Nature Reserve (also adjacent to a SSSI Site)			
3.3	Microclimate: * Estimated from Met. Office, Annual Averages 1971 – 2000. *(Numbers in brackets are % of national average)*	The site is sheltered on all sides by mature trees and natural topography. The forest is less dense to the east. The building is partially shaded.			
		Rainfall*	~480mm (32%)	Days of Rain>= 1mm*	~115 (62%)
		Min Temp*	~5.7°C (142%)	Max Temp*	~11.7°C (111%)
		Days Ground Frost*	~100	Hours sunshine*	~1600 (138%)
		Prevailing Wind Direction:		South-west	

4.0	**Flora and Fauna**				
4.1	Vegetation on Vault:	Generally the vegetation is thick and well established, providing good protection to the barrel vault. There are isolated patches of failure and the vegetation on the ridge of the vault is shorter and slightly sparser than elsewhere. Several species that are evident on the forest floor have seeded into the capping, resulting in a diverse species mix with grasses dominating.			
4.2	Surrounding Vegetation:	The conifer forest is fairly dense, especially to the north and south. The Forestry Commission planted the trees in the 1920s and there are a variety of other species, including a number of marine plants.			
4.3	Species Survey. *Assessment by HL from photographs*				
	D=Dominant; **A**=Abundant; **F**=Frequent; **O**=Occasional; **R**=Rare; **VR**=Very Rare; *=Present				
	Common Name	Latin Name	Capping	Surrounding Vegetation	Comments
	Grasses:				
	Cock's Foot	*Dactylis glomerata*	**R**		
	Common Bent	*Agrostis capillaris*	**O**	**A**	
	Creeping Soft Grass	*Holcus mollis*	**F**		
	Perennial Rye Grass	*Lolium perenne*	**R**		
	Red Fescue	*Festuca rubra agg.*	**A**	*	
	Sweet Vernal Grass	*Anthoxanthum odoratum*		*	
	Ruderals/Herbs:				
	Bramble	*Rubus fruticosus agg.*	**VR**		small
	Common Birdsfoot Trefoil	*Lotus corniculatus*	**O**		at edges
	Common Cat's Ear	*Hypochoeris radicata*	**O**	*	at top of capping
	Creeping Thistle	*Cirsium arvense*	**R**		
	Daisy	*Bellis perennis*	**R**	*	at top of capping
	Nettle	*Urtica dioica*	**R**		
	Ragwort	*Senecio jacobaea*	**R**	*	at top of capping
	Raspberry	*Rubus idaeus*	**O**		
	Ribwort Plantain	*Plantago lanceolata*	**O**	*	
	Rosebay Willowherb	*Chamerion angustifolium*	**F (LA)**	*	well established on cap
	Trees/Shrubs:				
	Birch	*Betula sp.*	**VR?**		one multi-stemmed tree losing leaves
	Broom	*Cytisus scoparius*	**VR**		one dead plant
	Scot's Pine	*Pinus sylvestris*		*	surrounding Forestry
	Mosses/Ferns:				
	Broad Buckler Fern	*Dryopteris dilatata*	**R**		one very large plant
	Male Fern	*Dryopteris filix-mas*	**R**		small
4.4	Fauna:	There are a wide variety of insects inhabiting the roof. The icehouse is home to a colony of natterers bats and there are a number of small holes, particularly on the gable, that could be attributed to bats or birds.			

5.0	**Technique**	
5.1	Source of Technique:	The development of the design of cold, dry buildings to store ice became increasingly sophisticated during the cold spell in the 19thC before cheap, commercially produced ice became available. The use of earth sheltering and turf caps was a fairly simple aspect of these buildings, which were also sited for shade from the sun, especially of the entrance.
5.2	Season of Work:	Unknown
5.3	Preliminary Repairs to Structure:	N/A
5.4	Treatment of Existing Vegetation:	N/A
5.5	Soft Capping Technique:	Assumed to be a layer of turf laid over a layer of soil. There was no visible evidence of a base coat of clay damp-proofing over the masonry.
5.6	Vegetation: Source and Description	Assumed to be locally sourced turf, lifted from what was probably grassy moorland when the icehouse was constructed, before trees were planted thirty plus years later.
5.7	Soil: Source and Description	The soil has a very high sand content, little structure and is very free draining. It is local soil, dug from the colonised dune system.
5.8	DPC:	N/A
5.9	Defining Membrane:	N/A
5.10	Fixing:	N/A
5.11	Aftercare:	N/A
5.12	Maintenance:	None, other than to try and deter people from climbing and cycling on the cap.
6.0	**Performance Assessment**	
6.1	General Performance:	The interior felt cold, even in mid summer, indicating some insulative effect from the capping. The brick vault had suffered significant leaching of lime from the mortar, though it was dry and there was no sign of water staining on the concrete floor, indicating that the lime leaching may date from the initial post construction period (Fig. 11.6). The dryness could be seasonal. The capping appeared lush and healthy, with vegetation growing right up to all the edges, except the south gable edge, which has been capped with cement, and onto which no grass has spread. There were isolated areas of severe damage caused by people climbing onto the roof (Fig. 11.10). Where this had occurred, the soil was particularly vulnerable to erosion as it was exceptionally sandy, dry and friable (Fig.11.11). The vegetation on the ridge was noticeably thinner than on the sloping sides of the vault and this appeared to be caused by people walking along it (Fig. 11.5).
6.2	Effect of Climate:	Although the site is relatively dry and the soil unlikely to retain much moisture, shade and shelter provided by the trees will reduce the drying effects of the sun and wind.
6.3	Effect of Birds:	None recorded
6.4	Effect of Animals:	None recorded
6.5	Aesthetic Performance:	The cap performs well, retaining much of its original character and being a significant landmark in a forest that yearly has over 15,000 visitors. It is unfortunate that, in order to deter mountain bikers from using the roof, the ground level has been reduced, as this has lost the original appearance of the building, so closely tied to the insulative effect of soil and vegetation.
6.6	Public Reaction:	None noted
6.7	Team Reaction:	N/A

6.8	Analysis:	The change of environment from open moorland to enclosing forest is significant. The cap has many species that are not now found nearby and may indicate some of the botanical diversity of the area up until 1920. The health of the cap is impressive, given the dry climate and poor moisture retention in the soil. Dampness in the masonry, perhaps partly from condensation in the vault when ice was bring stored, may have helped in what must have been a dry, sunny and windy site. The shape and size of the caps is beneficial, as was the original proximity of ground level. The cap apparently survived well in open conditions until the shelter and shade of the trees came, and this can be favourably compared to the nearby Pillboxes (CS12). It could be surmised that the cap is more vulnerable to drought now that the ground level has been reduced and the building doesn't contain ice. If the original setting was restored, the capping might struggle to survive, especially if the wind was more able to attack the damage caused by visitors.
7.0	**References:**	
	Interview: Park Ranger, *Forestry Commission, 07.09.05* Data: http://www.metoffice.gov.uk/climate/uk/averages/19712000/mapped.html	

Fig. 11.2: The north side, showing good cover over the steep sides.

Fig. 11.3: The south side.

Fig. 11.4: An undated picture showing the original ground levels.

Fig. 11.5: Growth on top is suppressed by foot traffic.

Fig. 11.6: The interior surface of the vaults appeared dry, though the brick vault especially, showed significant leached lime.

Fig. 11.7: Woodland species include ferns.

Fig. 11.8: Typical edge, with local stabilisation by moss and lichen, indicating seasonal saturation.

Fig. 11.9: Dryness from solar exposure on the south edge.

Fig. 11.10: Damage by pedestrians

Fig. 11.11: The soil is very sandy

Case Study 12: PILLBOX, Ladybank, Fife

This case study is an unusual example of a soft capping used as camouflage as part of a buildings design. It represents a wider class of historic military structures, mainly, but not exclusively, dating from the two world wars.

Fig. 12.1: Pillbox, Ladybank. West view, the turf camouflage remains largely in place.

1.0	**Background**				
1.1	Location:	North Annsmuir Wood, by Ladybank, Fife, 50m from a public footpath			
1.2	Grid Reference:	NO 3045 1173			
1.3	Date of Works:	c. 1940			
1.4	Client:	The War Office, present owner: the Forestry Commission			
1.5	Contractor:	Unknown			
1.6	Architect:	Unknown			
1.7	Access:	Unrestricted access, situated on land owned and managed by the Forestry Commission, which is used for recreational activities.			
1.8	Visit Record:	Date:	By:		
		22.08.05	EP, TM		
		10.10.05	HL		
2.0	**Building**				
2.1	Type:	WWII Pillbox, Type 24 (Fig, 12.3). This building is taken as a good surviving example of a range of military structures where roofs camouflaged with turf were an important design feature, especially against aerial reconnaissance prior to invasion.			
2.2	Classification:	None, previously unrecorded. Report sent to Historic Scotland as part of a survey (Guy, 1994).			
2.3	Chronology:	Built:	c. 1940		
		Ruined:	N/A. Assumed abandoned after use during WWII		
		Repairs:	None known		
2.4	Construction and Form:	The pillbox is constructed of concrete, cast between interior and exterior brick permanent shuttering. The walls are approximately 0.7m thick and 2m tall. In plan the pillbox has six angled sides supporting an unequal hexagonal roof of approx. 24m2. The floor is approx. 450mm below ground level.			
3.0	**Site**				
3.1	Setting:	Description:	The pillbox was constructed on open ground, which was planted as a coniferous plantation in 1952-58. This now provides a very sheltered and shaded environment. A similar pillbox about one mile away has retained its open setting.		
		Altitude:	50m		
		Distance from Coast:	10 miles		
3.2	Classifications:	None known			
3.3	Microclimate: * Data source: Met. Office, Annual Averages 1971 – 2000 *(Numbers in brackets give data as a % of national average)*	The building is situated in a mature woodland that has been established since WWII. This shelters the site from wind but also gives some solar shading and rainshadowing.			
		Rainfall (mm)*	~870mm (57%)	Days of Rain >= 1mm*	~138 (75%)
		Min Temp*	~4.7°C (117%)	Max Temp*	~20.5°C (119%)
		Days Ground Frost*	~135	Hours sunshine*	~1350 (116%)
		Prevailing Wind Direction:		South-west	
4.0	**Flora and Fauna**				
4.1	Vegetation on Wall:	The vegetation is thick and lush, with some ferns and ruderals among the dominant grasses. Approximately 80% of the roof is covered in vegetation, with the remainder bare concrete, mainly in the south-west corner.			
4.2	Surrounding Vegetation:	The pillbox is surrounded by coniferous trees, with the closest ones overhanging it. The undergrowth is quite thick, consisting of brambles, nettles, grasses, small bushes and a variety of tree saplings.			

4.3	Species Survey. *Assessment on site by HL, 10.10.05* **D**=Dominant, **A**=Abundant, **F**=Frequent, **O**=Occasional, **R**=Rare, **VR**=Very Rare, *=Present				
	Common Name	Latin Name	Capping	Surrounding Vegetation	Comments
	Grasses:				
	Cock's Foot	Dactylis glomerata		**R**	
	Common Bent	Agrostis capillaris	**A**	**O**	
	False Oat Grass	Arrhenatherum elatius	**O**	**O**	
	Red Fescue	Festuca rubra agg.	**F**	**F**	
	Yorkshire Fog	Holcus lanatus	**A**	**A**	
	Ruderals/Herbs:				
	Bramble	Rubus fruticosus agg		**F**	
	Dandelion	Taraxacum officinale agg	**R**		in cracks
	Hogweed	Heracleum sphondylium		**R**	
	Nettles	Urtica dioica		**O**	
	Ragwort	Senecio jacobaea		**R**	
	Raspberry	Rubus idaeus		**O**	
	Rosebay Willowherb	Chamerion angustifolium	**R**	**A**	in edge cracks of cap
	Violet	Viola riviniana		**O**	
	Trees/Shrubs:				
	Beech	Fagus sylvatica		**VR**	Seedling
	Birch spp.	Betula spp.		**O**	saplings
	Broom	Cytisus scoparius	**VR**	**R**	1 x 30cm on cap
	Elder	Sambucus nigra		**O**	
	Japanese Larch	Larix Kaempferi		**O**	Mature
	Lime sp.	Tilia sp.		**R**	Mature
	Oak sp.	Quercus sp.		**VR**	Seedling
	Rowan	Sorbus aucuparia		**R**	saplings
	Scots Pine	Pinus sylvestris		**D**	Mature
	Mosses/Ferns:				
	Moss	Pseudoscleropodium purum		*	
	Moss	Rhytidiadelphus squarrosus		*	
	Broad Buckler Fern	Dryopteris dilatata		**O**	
	Male Fern	Dryopteris filix-mas	**VR**	**R**	
4.4	Fauna:	The cap does not appear to be a specific habitat for fauna within the wood.			

5.0	**Technique**	
5.1	Source of Technique:	No record. Turf was one of a variety of techniques widely used to camouflage defensive structures.
5.2	Season of Work:	Not known

5.3	Preliminary Repairs to Structure:	N/A
5.4	Treatment of Existing Vegetation:	N/A
5.5	Soft Capping Technique:	Not known. It is assumed a single layer of turf was laid over a shaped layer of soil. The thickness of the soil varies from 100mm thick on the south and west sides sloping upwards to approximately 600mm thick in the north-east corner. While there are no fixings for guns apparent on the roof, the shape of the soil suggests it may have been intended as a protective berm for soldiers on the roof (Fig. 12.6).
5.6	Vegetation: Source and Description	Assumed to be cut on site.
5.7	Soil: Source and Description	Assumed to be sourced from the ground excavated for the building.
5.8	DPC:	None used
5.9	Defining Membrane:	None used
5.10	Fixing:	N/A
5.11	Aftercare:	N/A
5.12	Maintenance:	N/A
6.0	**Performance Assessment**	
6.1	General Performance:	The capping continues to perform well as camouflage and is impeding decay of the building. The vegetation appeared dense and healthy, with surprisingly little colonisation by woodland species, given the good depth of soil. The grass was generally dense to the edge of the roof, often projecting over the face. This protected the vulnerable exposed joint between the brick facing and concrete roof. Where this joint was not protected by turf, the crack had been colonised by ruderals and progressive decay of the brick was established (Fig. 12.5). The areas where there is no vegetation seem to have been areas of shallow cover originally, that have been damaged by people climbing onto the roof (Fig. 12.6).
6.2	Effect of Climate:	The shade and shelter provided by the woodland setting has undoubtedly been the main factor behind the good condition of the cap. Evidence from other comparable structures shows that turf often struggles to survive on flat concrete surfaces, due to the exposure to sun and wind that their strategic locations required. This is illustrated by a similar pillbox, about 1km away, in an open setting, where only a few tufts of grass survive (Fig. 12.7).
6.3	Effect of Birds:	No recorded problems.
6.4	Effect of Animals:	The south-west corner has eroded severely and this is presumed to be due to mechanical damage caused by people accessing it.
6.5	Aesthetic Performance:	The cap successfully maintains the original appearance of the building, which is a pleasant feature within the woodland setting.
6.6	Public Reaction:	N/A
6.7	Team Reaction:	N/A

6.8	Analysis:	While the function of this soft capping is unusual, it does have a long and varied precedent and this is a rare example of a well-preserved capping on a type of building that is historically important, but rarely conserved. Urgency of construction and progress of the war means that these types of caps were unlikely to have been built under ideal conditions or subsequently maintained. Its good condition can be attributed to the woodland shelter and rounded shape of the cap. It is interesting to note that the moderate shade provided by this woodland has been benign, in comparison to the dense shade given by the woodland at parts of Doune Castle Mill, which allowed only very thin grass, ultimately causing sections of the cap to fail (CS15).
7.0	**References:**	
	Sources: John Guy, Fife: *World War One and Two Defences of Fife, 1994* Data: http://www.metoffice.gov.uk/climate/uk/averages/19712000/mapped.html	

Fig. 12.2: View from the south-east. The cap is much less bio-diverse than its woodland surroundings.

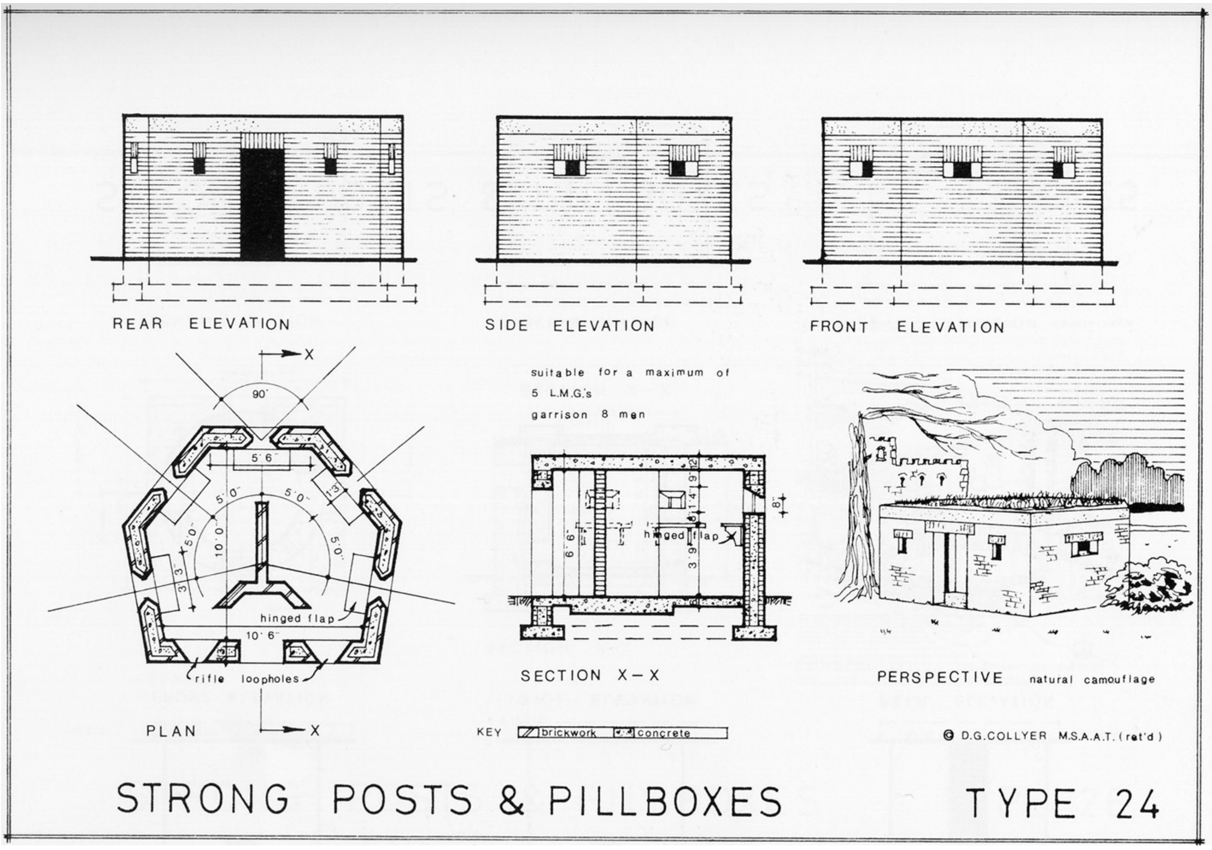


Fig. 12.3: Typical design indicating turf roof camouflage.

Fig. 12.4: Typical good edge protection does not extend to this corner.

Fig. 12.5: Decay of the brick where there is no grass.

Fig. 12.6: Decay of the brick facing head is associated with loss of the turf capping and to climbing by people.

Fig. 12.7: A nearby comparable pillbox, where the capping has not survived in the open exposure and dry climate.

Case Study 13: BLACK CASTLE OF MOULIN, Perthshire

This case study illustrates many aspects of good practice in sensitively consolidating masonry, which has existing naturally established soft cappings and highlights issues regarding associated landscape management.

Fig. 13.1: Black Castle. The south wall, which retained the central natural vegetation, while edges were replaced with new caps. The general effect of the soft cappings is very good, being very naturalistic and appropriate to the rural landscape context. However, colonisation by tall ruderals and tree saplings, associated with the tall plant growth within the site enclosure detracts from this impression and obscures the monument.

1.0	**Background**				
1.1	Location:	Near Pitlochry, Perthshire. Also known as Caisteal Dubh and Moulin Castle			
1.2	Grid Reference:	NN 9470 5892			
1.3	Date of Works:	Late September 2002			
1.4	Client:	Perth and Kinross Heritage Trust			
1.5	Contractor:	Rebecca Little Construction			
1.6	Architect:	Historic Scotland Architects advised			
1.7	Access:	Unrestricted access, on signed public walk.			
1.8	Visit Record:	Date:	By:		
		27/07/05	TM, EP, RL, HL		
2.0	**Building**				
2.1	Type:	Castle, ruined			
2.2	Classification:	Scheduled Ancient Monument			
2.3	Chronology:	Built:	c. 1326		
		Ruined:	c. 1500, when it was burned in fear of the plague.		
		Repairs:	No previous recorded repairs.		
2.4	Construction and Form:	There are five free-standing linear wall fragments, built of sandstone rubble in lime mortar and standing to 2-5m above ground level. The faces are generally in good condition, but the heads and ends are uneven. Three walls had new cappings applied. The south wall is ~12m. long x 1.4m wide, the two northwest walls are ~2.5m long x 600mm wide. These walls had natural cappings that were largely removed and reinstated after masonry repairs. The west wall, ~7m x 1m, had a naturally established cap that was left undisturbed. The north wall, approx. 8m x 600mm, had a very uneven head that did not support significant vegetation.			
3.0	**Site**				
3.1	Setting:	Description:	The castle is situated on the north-west outskirts of Pitlochry. It stands in a fenced enclosure within a field grazed by cattle. The fence was erected as part of the conservation works to exclude cattle and the vegetation within is wild and overgrown.		
		Altitude:	140m		
		Distance inland:	~70km		
3.2	Classifications:	None			
3.3	Microclimate: * Data source: Met. Office, Annual Averages 1971 – 2000 *(Numbers in brackets give data as a % of national average)*	Description:	The site is exposed to the prevailing wind, rain and sun. Being inland, it also has a significant frost exposure.		
		Rainfall*	1000mm (65%)	Days of Rain >= 1mm*	170 (91%)
		Min Temp*	4.5°C (1.1%)	Max Temp *	10.5°C (100%)
		Days Ground Frost*	135	Hours sunshine*	1160 (100%)
		Prevailing Wind Direction:		South-west	

4.0	**Flora and Fauna.**	
4.1	New Soft Cappings:	About 15% of the caps have diedback from the edges, with the smaller sections more damaged. Living vegetation is thick and well established. The new cappings support predominantly grass species. Two of the grass species found in the turf source area have survived, though Sweet Vernal Grass cannot be identified and two other types have colonised the failed edges. There is significant invasion by some tall ruderals, such as Ragwort, and occasional trees.
4.2	Naturally Established Cappings:	The natural toppings have a much thinner soil layer than the new caps, generally less than 20mm, though the depth of soil removed from the south wall, which is significantly wider, is thought to have been up to 200mm. The cover of the natural toppings is more open and there are large patches dominated by mosses, which sometimes form a thick blanket. There is also greater diversity of species than in the new cappings and less presence of undesirable ruderals. Ruderals and trees were removed from these natural caps during the works.
4.3	Surrounding Vegetation:	There is a wide range of species growing unrestrained within the enclosed area, including a number of mature trees.

4.4 Species Survey. *Assessment from ground level by HL, 27.7.05*

D=Dominant; **A**=Abundant; **F**=Frequent; **O**=Occasional; **R**=Rare; **VR**=Very Rare; *=Present

Common Name	Latin Name	Turf Source	New Capping	Natural Cappings		Surr. Veg.	Comment
				top	shelf		
Grasses:							
Red Fescue	*Festuca rubra agg*	**A**	**D**	**F**	**F**	**R**	
Sheep's Fescue	*Festuca ovina*		**O**	**A**			On edges of new
Cock's foot	*Dactylis glomerata*		**O**		**O**	**O**	Tussock forming grass
Common Bent	*Agrostis capillaris*	**F**	**R**				
Sweet Vernal Grass	*Anthoxanthum odoratum*	**F**			**R**		
Smooth Meadow Grass	*Poa pratensis*			**O**			
False Oat Grass	*Arrhenatherum elatius*					**O**	
Ruderals/Herbs:							
Yarrow	*Achillea millefolium*		**F**	**O**	**F**		
Ragwort	*Senecio jacobaea*		**O**			**O**	Taproot/ Invasive
Dandelion	*Taraxacum officinale agg*		**O**	**F**	**O**		Taproot
Bush Vetch	*Vicia sepium*		**O**				
Common Sorrel	*Rumex acetosa*		**R**				Only on small section of wall to north
Knapweed	*Centaurea nigra*			**R**	**O**	**O**	
Hawkweed sp.	*Hieracium agg.*			**O**	**R**		
Germander Speedwell	*Veronica chamaedrys*				**R**		

	Herb Robert	*Geranium robertianum*				**R**		
	Field Forget-me-not	*Myosotis arvensis*				**R**		
	White Clover	*Trifolium arvense*				**R**		
	Common Mouse-ear	*Cerastium fontanum*			**R**	**R**		
	Greater Plantain	*Plantago major*				**R**		
	Creeping Thistle	*Cirsium arvense*					**F**	Taproot/ Invasive
	Nettles	*Urtica dioica*					**F**	Invasive root system
	Broadleaved Dock	*Rumex obtusifolia*					**O**	Taproot/ Invasive
	Hogweed	*Heracleum sphondylium*					**O**	Taproot
	Creeping Buttercup	*Ranunculus repens*					**O**	
	Cleavers	*Galium aparine*					**R**	
	Meadow Vetchling	*Lathyrus pratensis*					**R**	
	Broadleaved Willowherb	*Epilobium montanum*					**R**	Generally small but invasive
	Trees/Shrubs:							
	Hawthorn	*Crataegus monogyna*		**1<20cm**	**1<20cm**	**3< 10cm; 1<50cm**	**2>3m**	
	Rowan	*Sorbus aucuparia*		**1<40cm**	**1<40cm**	**1<30cm**		Browsed in past by deer
	Elm	*Ulmus glabra*				**2<20cm**		
	Wild Rose	*Rosa canina agg*				**1<10cm**		
	Elder	*Sambucus nigra*					**O**	Potential seed source
	Other:							
	Moss	*Rhytidiadelphus squarrosus*					**F**	
	Moss	unidentified					**O**	
4.5	Fauna:	Two dead birds were found ensnared in the plastic netting. Live ones were seen on other high wallheads.						

5.0	Technique	
5.1	Source of Technique:	Rebecca Little Construction, a development of earlier techniques. It had initially been intended that two layers of commercial turf would be used, root to root. However, when a source of good quality local turf was established, it was decided to use a thick single layer of this superior material instead. The contractor was not confident that the soft capping would survive the exposed climatic conditions. The consolidated masonry wallheads were therefore intended to be sufficiently robust in their own right, although it was recognised that the caps would provide important frost protection during the first winter. The role of the clay layer was seen as being mainly to establish an even, sticky surface that the turf could bond well to, as well as having a water-proofing or moisture retaining function.
5.2	Season of Work:	Autumn
5.3	Preliminary Repairs to Structure:	Moderately and eminently hydraulic hot lime mortars were used to consolidate the repaired walls, mainly focusing on underpinning vulnerable face work, consolidating wall cores and rough racking wallheads. Great effort was put into achieving a tight, rough racked, water-shedding wallhead because of the known climatic exposure and anticipated lack of future maintenance.
5.4	Treatment of Existing Vegetation:	One wall was assessed as having sound masonry and was not repaired, leaving undisturbed its naturally established plant cover, apart from removal of trees and tall ruderals. On the three wall sections that had major repairs, a number of trees were removed, with some deeply embedded roots left in situ. A layer, ~200mm deep, of loose masonry, soil and vegetation was generally removed in order to allow consolidation of the wallheads. A large section of vegetation (about 30% of the head area), consisting of grasses and wild flowers, was left in the centre of the largest wall core to encourage colonisation of introduced turf by existing species (Fig. 13.6).
5.5	Soft Capping Technique:	A moulded clay layer was applied to level off the unevenness of the consolidated wall head masonry, creating a gradient to drain water away to the edges. A single layer of turf was applied on top, root down.
5.6	Vegetation: Source and Description	The turf was sourced locally from a moorland/forest habitat about a mile north of the site, but ~200m higher. It was cut from the central strip of a forest access track, which ensured easy access and that the species were predominantly grasses, with heather and bracken excluded. It had an extensive root mat, was lifted in approx. 600mm wide strips and applied soon after. The source site was visited during the site assessment and regeneration was good, with no long-term damage apparent (Fig. 13.17).
5.7	Soil: Source and Description	The mix was 1:2, Errol Clay : coarse sharp sand. It was applied to a thickness of ~125mm.
5.8	DPC:	None used
5.9	Defining Membrane:	Historic Scotland requested the use of a defining geo-textile membrane.
5.10	Fixing:	Large areas of capping (~75%) were fixed with twine, while smaller sections were fixed with green plastic garden netting, fastened with twine. The twine was tied to timber dooks in the wall at low level. This method of fixing was designed to prevent wind damage during the first few months of turf growth but to allow it to be removed later without the need for scaffolding (Fig. 13.16). The netting was still in place and had not deteriorated after three years, though the twine had gone. The netting had become loose in places and was clearly visible on the lower walls (Fig. 13.17). Two dead birds were found, which had become trapped in the netting (Fig. 13.19).
5.11	Aftercare:	The caps were watered immediately after application. Further regular watering of the turfs was prevented by the lack of an easily accessible water supply.
5.12	Maintenance:	None, as anticipated.

6.0	Performance Assessment	
6.1	General Performance:	In the months following the work, the turf appeared healthy and green (RT). Three years later, the principal newly capped (south) wall appeared in good condition, with no deterioration of the masonry consolidation evident. The vegetation seemed to have established well, though there was significant edge dieback, mainly on steeply sloping areas and more on the south than north sides (Figs. 13.9 and 10). Some small sections of the clay underlayer were exposed and had caused some superficial surface staining of the masonry. Though the central area could not be seen, it was evident that there had been colonisation of the new cappings by species that are found on the naturally established areas, both desirable and undesirable, and that some species in the surroundings had failed to colonise. One species of grass and two of herbs were recorded that were not found elsewhere on the site and would seem to have been introduced with the turf. The smaller capped walls were in a similar condition, though edge dieback was more significant because of their thinner geometry. The worst conditions were found at the ends of these walls, where the turf had died completely, there was no colonisation and the clay underlayer was dry and hard (Fig. 13.15). The natural cappings appeared dry in places, but dieback was much less and limited to the west edge.
6.2	Effect of Climate:	The weeks immediately following the soft toppings work were exceptionally damp, and this may have contributed to good early rooting in. The subsequent damp winter conditions would also have prepared the vegetation for drier summer conditions. Photographs from the first winter (RT) indicate that the caps were less affected by frost than the surrounding ground, presumably because of their high level, and there was no indication of damage by frost (Fig. 13.11). Edge dieback seemed to be associated with drought conditions intensified by wind and solar exposure.
6.3	Effect of Birds:	Birds appeared to be nesting in the natural cappings. The use of the smaller newly capped wallheads for nesting or overseeing the surrounding area was inhibited by the plastic netting.
6.4	Effect of Animals:	There was evidence of some of the lower mural vegetation being grazed by deer. Prior to the work being carried out the site was grazed by cattle, which helped to control the vegetation around the ruins but risked damaging the structure of the monument. After the work, the monument was fenced in without alternative maintenance provision being established and vegetation grew unchecked. This created a seed bank of undesirable species around the walls, with seasonal growth of over 1m significantly obscuring them (Fig. 13.1).
6.5	Aesthetic Performance:	The general effect of the soft cappings is very good, being very naturalistic and appropriate to the rural landscape context. However, the colonisation by tall ruderals and tree saplings detracts from this. The tall plant growth within the site enclosure adds to the unkempt appearance and obscures the monument. The enduring green plastic netting is increasingly unsightly as it comes loose from its original fixings.
6.6	Public Reaction:	None recorded
6.7	Team Reaction:	The project is seen as very successful, with the cappings performing well, as a low maintenance solution.

6.8	Analysis:	This is one of the colder, more inland sites and it is interesting to compare the new caps with the natural vegetation as well as with those on other sites. The thinness of the natural soil layer is surprising compared to that on Cessford Castle (CS2), which was ruined at a comparable date and has greater exposure. However, it seems likely that there was progressive collapse of the walls associated with ground drainage and tree root growth, which would have disturbed the natural accumulation of humus. Nonetheless the cappings were evidently providing a degree of protection to the masonry and the lack of soil depth seems to have deterred colonisation by damaging species. The thinness of the natural capping soil indicates that the thicker clay caps were not necessary as a moisture reservoir, however, the clay affords the masonry more protection from moisture, even when the vegetation has died. Death of the turf seems to precede the drying out of the clay layer. The steepness of the edges created by the thick clay layer may have, in places, contributed to excessively dry conditions and subsequent dieback. The species list demonstrates how bio-diversity in turf can vary significantly within a relatively short distance. Nonetheless the turf seems to have generally performed well, in line with the contractor's expectations in selecting it in preference to a commercial turf. The failure to remove the plastic netting is unfortunate, but the lack of maintenance to the enclosed area is more significant as it creates an aggressive seed pool around the caps, and visually obscures the monument. Selective grazing by sheep, as used in natural grassland management, may be a possible solution, as indicated on the Dun Carloway Blackhouse (CS3). However, occasional removal of tree saplings would also seem necessary over the long term. This site demonstrates the greater viability of larger geometry wallheads in exposed conditions. In similar circumstances, given the same high quality of the masonry consolidation, it may be more successful to have a thinner clay layer, avoiding steeply sloping sides. Re-use of soil and plants removed during consolidation, as an underlayer to new turf, may also have been successful in transferring the natural seed bank of the old cappings to the less bio-diverse new caps.
7.0	**References**	
	Interviews: Rebecca Little Rachel Tilling, PKHT Sources: Tilling, R (2004), 'Curtains of Stone: Conservation of the Black Castle of Moulin', SSCR Journal, Vol. 15, p 10-12 Data: http://www.metoffice.gov.uk/climate/uk/averages/19712000/mapped.html	

Fig. 13.2: West view in 1875. More masonry was intact, the natural caps are thin and the grass was well grazed

Fig. 13.3: Aerial view. The castle was similar in original form to Inverlochy Castle (CS21), though much less remains.

Fig. 13.4: View from the west, with public on footpath.

Fig. 13.5: The natural capping is thin, with few ruderals.

Fig. 13.6: One side of the wall-head has been cleared of natural vegetation, in preperation for masonry consolidation.

Fig. 13.7: The turf was lifted from the centre of the track, between occasional heather clumps. This shows three years regeneration.

Fig. 13.8: The new caps with a single layer of moorland turf, sourced as shown in 13.7

Fig. 13.9: South wall, south side, three years after completion.

Fig. 13.10: South wall, north side, three years after completion. Dieback on the north edges is less significant than on the south.

Fig. 13.11: Photographs from the first winter indicate that the caps were less affected by frost than the surrounding ground, presumably because of their high level, and there has been no indication of damage by frost to the lime repairs.

Fig. 13.12: The same section prior to repairs.

Fig. 13.13: The core of the natural cappings were retained in situ to act as botanical reservoirs for recolonisation of the edges, in areas where these failed.

Fig. 13.14: One of the small northwest caps. Small areas of capping, such as this, are always vulnerable to drought damage.

Fig. 13.15: Dry clay under dead turf on one of the small sections of new capping.

Fig. 13.16: Plastic netting was fixed with twine to timber pegs, which were located at low level so as to be easier to remove.

Fig. 13.17: Once the twine had rotted, the plastic netting loosened, trapping birds.

The use of the newly capped wallheads for nesting or overseeing the surrounding area was terminally inhibited by the plastic netting

Fig. 13.18: Birds use the walls to over look the surrounding area and appear to be nesting in the natural cappings.

Case Study 14: COUPAR ANGUS ABBEY, Angus

This case study is an interesting example of a successful summer installation in a relatively dry site using high quality turf.

Fig. 14.1: Coupar Angus Abbey. The capping from the north, eight years after the works application.

1.0	**Background**				
1.1	Location:	Coupar Angus, Perthshire, in the south-west corner of the Coupar Angus parish churchyard, adjacent to the A923, Dundee Road.			
1.2	Grid Reference:	NO 223 397			
1.3	Date of Works:	July 1997			
1.4	Client:	Perth and Kinross Heritage Trust			
1.5	Contractor:	Rebecca Little Construction			
1.6	Architect:	None			
1.7	Access:	Unrestricted access, in public graveyard.			
1.8	Visit Record:	Date:	By:		
		06.09.05	TM, EP, HL		
2.0	**Building**				
2.1	Type:	Abbey, ruined, gatehouse, wall and vault fragment			
2.2	Classification:	Scheduled Ancient Monument			
2.3	Chronology:	Built:	1164-1233		
		Ruined:	1559		
		Repairs:	None known		
2.4	Construction and Form:	The ruin comprises a single storey barrel vault, open at two ends and varying in thickness from approximately 300-600mm. The top surface of the vault is approximately 4m by 5m and falls in height to the west, from 5m to 4m, to flat to a max. pitch of 45degrees. A narrow stub rises a further 6m in the south-east corner. The ruin is constructed of soft red sandstone rubble in lime mortar, although a section of the arch is formed from a less durable stone and this has eroded quite severely.			
3.0	**Site**				
3.1	Setting:	Description:	The Abbey gatehouse remains are situated in the corner of a well-maintained graveyard, with a private garden 2m to the south and a road 2m. to the west.		
		Altitude:	~50m		
		Distance inland:	~37 km		
3.2	Classifications:	None known			
3.3	Microclimate: * Data source: Met. Office, Annual Averages 1971 – 2000 *(Numbers in brackets give data as a % of national average)*	The site is exposed to the prevailing south-west wind, though nearby buildings provide some shelter. Mature coniferous trees to the west and south give good shelter and partial shade.			
		Rainfall*	~ 870mm (57%)	Days of Rain >= 1mm*	~210 (112%)
		Min Temp*	~4.2°C (105%)	Max Temp *	~11.9°C (113%)
		Days Ground Frost*	~140	Hours sunshine*	~1380 (118%)
		Prevailing Wind Direction:		South-west	

4.0	**Flora and Fauna**	
4.1	Vegetation on Wall:	The turf, although seasonally dry, was healthy and dense. There was a thick covering to the vault, but evidence of dieback at the edges, especially on the roadside, the direction of the prevailing wind. Grasses dominate the capping, but a variety of other moorland species have survived, though the heather has died.
4.2	Surrounding Vegetation:	The graveyard has a regularly mown lawn. The nearby gardens contain a wide variety of exotic and native plants and trees. There was no evidence of colonisation by undesirable species.

4.3 Species Survey. *Assessment on site by HL*

D= Dominant, **A**=Abundant, **F**= Frequent, **O**= Occasional, **R**=Rare, **VR**= Very Rare, *= Present

Common Name	Latin Name	Capping	Surrounding Vegetation	Comments
Grasses:				
Cock's Foot	*Dacytilis glomerata*		*	
Common Bent	*Agrostis capillaris*		*	mown grass
Perennial Rye Grass	*Lolium perenne*		*	mown grass
Red Fescue	*Festuca rubra agg*	**A**	*	
Smooth Meadow Grass	*Poa pratensis*		*	
Sheep's Fescue	*Festuca ovina*	**F**		mainly on edges
Ruderals/Herbs:				
Bitter Vetch	*Lathyrus montanus*	**VR**		
Broadleaved Willowherb	*Epilobium montanum*		*	
Cleavers	*Galium aparine*	**VR**		
Dandelion	*Taraxacum officinale agg*		*	mown grass
Foxglove	*Digitalis purpurea*		*	
Groundsel	*Senecio vulgare*		*	
Heather	*Calluna vulgaris*	**F**		appears to be dying, roots remain
Ivy	*Hedera helix*		*	
Ribwort Plantain	*Plantago lanceolata*		*	mown grass
Rosebay Willowherb	*Chamerion angustifolium*		*	
Selfheal	*Prunella vulgaris*		*	
Smooth Sow Thistle	*Sonchus oleraceus*		*	
Spear Thistle	*Cirsium vulgare*		*	mown grass
Stonecrop	*Sedum spurium*		*	on grave
Tormentil	*Potentilla erecta*	**R**		
Trees/Shrubs:				
Sycamore	*Acer pseudoplatanus*		*	mature, adjacent to site
Yew	*Taxus baccata*		*	sapling
Wild Cherry	*Prunus avium*		*	mature
Rowan	*Sorbus aucuparia*		*	mature

	Purple Plum			*	
	Lime sp.	*Tilia sp*.		*	mature
	Beech	*Fagus sylvatica*		*	mature, adjacent to site
	Elm	*Ulmus glabra*		*	mature
	Silver Birch	*Betula pendula*		*	mature, adjacent to site
	Ash	*Fraxinus excelsior*		*	mature, adjacent to site
	Elder	*Sambucus nigra*		*	
	Mosses/Ferns:				
	Moss	*Rhytidiadelphus squarrosus*		*	Mown grass
	Moss	*Pleurozium schreberi*	**O**		
	Moss	*Hylocomium splendens*	**F**		
4.4	Fauna:	There was evidence of spiders in the capping.			
5.0	**Technique**				
5.1	Source of Technique:	Rebecca Little Construction, a development of earlier techniques.			
5.2	Season of Work:	Summer			
5.3	Preliminary Repairs to Structure:	The masonry was consolidated with lime mortar.			
5.4	Treatment of Existing Vegetation:	The ruin was engulfed in a heavy cloak of ivy, which was well established in the earliest images, dated 1920 (Fig. 14.2). Root damage had apparently caused cracking of the base masonry, but when it was removed the ivy was found to have not significantly rooted into the masonry above ground. In the contractor's opinion it had given significant weather protection, especially to the higher masonry stub.			
5.5	Soft Capping Technique:	A 'mushroom-shaped' dome, ~200mm thick, of tempered clay was applied over the vault masonry. The turf was applied on top in a single layer of wide strips.			
5.6	Vegetation: Source and Description	Heather turf, approximately 100mm thick, was cut from a local hillside.			
5.7	Soil: Source and Description	The mix was 1 : 2, Errol clay : coarse sharp sand.			
5.8	DPC:	None			
5.9	Defining Membrane:	None			
5.10	Fixing:	Timber pegs			
5.11	Aftercare:	None			
5.12	Maintenance:	None known			
6.0	**Performance Assessment**				
6.1	General Performance:	RCAHMS photographs from September 2002, five years after the work, show the capping well established on both the vault and stub, but not having spread beyond the application areas (Fig. 14.3). Three years later, the heather had died, apparently from drought, but formed a tough matrix of stems and roots, through which grass formed a continuous blanket. The turf/soil layer was ~100mm thick, with a dense root mass and the 150-200mm thick clay layer beneath was damp, but quite firm (Fig. 14.5). There was no significant root penetration into the clay layer. Grass had begun to colonise the masonry outside of the application area, establishing in small clumps on the flatter areas.			

6.2	Effect of Climate:	The main body of turf seemed to have benefited from the shade and shelter to the east and south. In contrast, the west edge, which is exposed to the wind, has thin soil and lies at an increasing slope, was somewhat unstable, with loose clumps of grass (Fig. 14.6). Conditions on the stack top are more exposed, but still partly sheltered by the masonry.
6.3	Effect of Birds:	None recorded
6.4	Effect of Animals:	None recorded
6.5	Aesthetic Performance:	The aesthetic effect of the capping is very good, appearing very naturalistic and not concealing the masonry detail.
6.6	Public Reaction:	None recorded
6.7	Team Reaction:	None recorded
6.8	Analysis:	It is striking that the species on the cap remain quite different from those in the surrounding vegetation after eight years. Hillside species have survived on the capping and urban species have failed to colonise. The density of the original turf, even as a single layer, would appear to be the main factor. The use of a single thick layer of good quality turf is often comparable to the performance of two thinner layers of poorer quality material elsewhere. Although the heather has died, it still acts as a dense stabilising matrix and it is reasonable to suppose that as this gradually disintegrates, the grasses will become thicker and failure will not result. This performance can be contrasted with that at Aberuthven (CS38), where a poor quality single layer of turf was used on a narrow wallhead. Even in this dry location, the clay layer was still damp after a dry summer. This, as well as the general good performance, can be attributed to the shade and shelter provided by the trees and masonry, and the size and geometry of the main cap. While the cap is attempting to colonise other masonry surfaces, these may never become stable and the edge line may vary back and forth with weather cycles.
7.0	**References:**	
	Interviews: Rebecca Little Information: www.pkht.org.uk/historic_buildings/Coupar_Angus.html RCAHMS photographs: E30015, E30014, 04/09/02 Data: http://www.metoffice.gov.uk/climate/uk/averages/19712000/mapped.html	

Fig. 14.2: West view, c.1920.

Fig. 14.3: Fiveyears after capping.

Fig.14.4:Eight years after capping.

Fig. 14.5: The clay below the turf soil was damp but firm, after a dry summer.

Fig.14.6: Eight years after capping, the turf joints were visible in dieback on the exposed, sloping west side, with colonisation by grasses of the masonry below.

Fig. 14.7: Eight years after capping, the grasses were still surviving on the more severe conditions of the stack top.

Fig. 14.8: The edge over the vault is well established, with a pleasant grassy fringe.

Case Study 15: DOUNE CASTLE MILL, Perthshire

This case study documents an experiment in recent conservation capping by Historic Scotland. This site showed the greatest long-term effects of high moisture levels.

Fig. 15.1: View of Doune Castle Mill from the west.

1.0	**Background**		
1.1	Location:	Adjacent to Historic Scotland's depot, 300m east of Doune Castle, Doune, Stirlingshire	
1.2	Grid Reference:	NN 725 014	
1.3	Date of Works:	Probably 1997-98	
1.4	Client:	Historic Scotland	
1.5	Contractor:	Historic Scotland	
1.6	Architect:	Historic Scotland	
1.7	Access:	By arrangement with Historic Scotland	
1.8	Visit Record:	Date:	By:
		06.10.2005	TM, EP, HL

2.0	**Building**		
2.1	Type:	Mill, ruinous	
2.2	Classification:	Scheduled Ancient Monument. Category A listed.	
2.3	Chronology:	Built:	Early 19thC
		Ruined:	1930s The East Wing was still roofed in 1976.
		Repairs:	1997-98
2.4	Construction and Form:	The mill is a two-storey, L-shaped building, with walls largely intact to wallhead level and constructed of the hard local sandstone in lime mortar. The wallheads in all areas were soft capped. The South Wing walls are ~7-8m high and 0.6m wide at the level head. The walls are in reasonably good condition. The East Wing walls are ~ 4-5m high. The inner faces of these walls have largely collapsed leaving the outer face complete to wall head level. This had an experiment in soft walling, in an attempt to stabilise the broken face. East Low Walls are ~3m long and 1m high, varying in thickness ~0.6-0.8m wide. The consolidated masonry slopes at ~45degrees. This corner of the mill is extremely sheltered and damp. It is completely overhung by trees and receives very low levels of light.	

3.0	**Site**				
3.1	Setting:	Description:	Doune Castle Mill is situated adjacent to a small stream. The surrounding wooded area is very damp and sheltered. The structure is fenced off for safety reasons and the interior is very overgrown. The South Wing is sheltered, the East Wing more sheltered and the Low East Walls are extremely sheltered, in a damp shady area beneath mature trees.		
		Altitude:	~20m		
		Distance inland:	48 km		
3.2	Classifications:	None.			
3.3	Microclimate:				
	* Data source: Met. Office, Annual Averages 1971 – 2000 *(Numbers in brackets give data as a % of national average)*	Rainfall *	~1150mm (75%)	Days of Rain >= 1mm*	~175 (95%)
		Min Temp*	~4°C (100%)	Max Temp *	~10.5°C (100%)
		Days Ground Frost*	~112	Hours sunshine*	~1270 (109%)
		Prevailing Wind Direction:		West	

4.0	**Flora and Fauna**	
4.1	Vegetation on Wall:	The South Wing walls have a complete covering of mainly grasses, but with significant numbers of tree saplings and other plants, and considerable lichen on the sides. The grass cover is rather thin. The East Wing has a narrower strip of vegetation, complete except over lintels. The Low East Wall has a very thin cover of grass.
4.2	Surrounding Vegetation:	Mixed, mature woodland overhangs the building to the west and south, with dense growth of saplings and other plants in the ruin's interior. To the east and north are open lawns.

4.3 Species Survey. *Assessment on Site by HL, 06.10.2005*

D=Dominant, **A**=Abundant, **F**=Frequent, **O**=Occasional, **R**=Rare, **VR**=Very Rare, *=Present

Common Name	Latin Name	South Wing	East Wing	Low E. Wall	Surr. Veg.	Comment
Grasses:						
Cock's Foot	*Dactylis glomerata*		**O**		**R**	
Common Bent	*Agrostis capillaris*	**R**	**O**	**VR**	**A**	H-Edge Su-Mown grass
Creeping Soft Grass	*Holcus mollis*				**O**	
Fescue spp.	*Festuca spp.*				**O**	Mown grass
Red Fescue	*Festuca rubra agg*	**A**	**O**			
Sheep's Fescue	*Festuca ovina*	**F**				
Yorkshire Fog	*Holcus lanatus*				**O**	Inc. mown grass
Ruderals/Herbs:						
Black Medick	*Medicago lupulina*	**R**				
Bramble	*Rubus fruticosus agg.*		**R**		**O**	
Broadleaved Dock	*Rumex obtusifolius*				**R**	
Broadleaved Willowherb	*Epilobium montanum*	**R**	**R**	**O**	**R**	
Cleavers	*Galium aparine*				**R**	
Creeping Buttercup	*Ranunculus repens*				**F**	Mown grass +
Daisy	*Bellis perennis*				**O**	
Dandelion	*Taraxacum offiicinale agg*	**R**	**R**			
Field Forget-me-not	*Myosotis arvensis*				**VR**	
Germander Speedwell	*Veronica chamaedrys*				**VR**	
Great Plantain	*Plantago major*				**R**	
Greater Woodrush	*Luzula sylvatica*				**R**	
Ground Elder	*Aegopodium podograria*				**O**	
Hawkweed sp.	*Hieracium agg*	**F**	**F**			H-Mature plus seedlings L- in bare areas
Herb Robert	*Geranium robertianum*	**VR**			**R**	H-Window
Hogweed	*Heracleum sphondylium*		**R**		**R**	
Lesser Burdock	*Arctium minus agg*				**R**	

Nettle	*Urtica dioica*				**F**	
Opposite Leaved Golden Saxifrage	*Chrysoplenium oppositifolium*			**O**	**F**	
Ragwort	*Senecio jacobaea*	**O**	**O**		**R**	H-Mature plus seedlings
Rosebay Willowherb	*Chamerion angustifolium*		**R**		**O**	
Selfheal	*Prunella vulgaris*				**R**	Mown grass
Soft Rush	*Juncus effusus*				**R**	
Spear Thistle	*Cirsium vulgare*				**R**	
White Clover	*Trifolium arvense*		**R**			
Wood Avens	*Geum urbanum*			**VR**	**R**	
Trees/Shrubs:						
Alder	*Alnus glutinosa*				**R**	
Ash	*Fraxinus excelsior*	**VR**			**O**	H-Seedling
Beech	*Fagus sylvatica*				**R**	
Bird Cherry	*Prunus padus*	**O**				6 x 1.5m, 2 x 1m, 2 seedlings
Elder	*Sambucus nigra*				**F**	
Elm	*Ulmus glabra*				**O**	
Goat Willow	*Salix cinerea*				**O**	
Grey Alder*	*Alnus incana*				**R**	
Holly	*Ilex aquifolium*				**R**	
Rowan	*Sorbus aucuparia*				**O**	
Silver Birch	*Betula pendula*				**R**	
Sycamore	*Acer pseudoplatanus*				**F**	
Ferns:						
Hart's Tongue	*Phyllitis scolopendrium*				**R**	
Maidenhair Spleenwort	*Asplenium trichomanes*		**VR**		**R**	
Male Fern	*Dryopteris filix-mas*				**O**	
Lady Fern	*Athyrium filix-femina*				**R**	
Broad Buckler Fern	*Dryopteris dilatata*				**R**	
Mosses & Liverworts:						
Liverwort	*Plagiochila asplenioides*				*	
Moss	*Plagiomnium undulatum*				*	
Moss	*Brachythecium sp*		**O**	**D**	*	Sh-Under dense shade of Elm canopy
Moss	*Thuidium tamariscinum*				*	
Moss	*Dicranum scoparium*				*	
Moss	*Calliergon cuspidatum*		**O**		*	
Moss	*Rhytidiadelphus squarrosus*		**F (LD)**			

	Other Mosses		**O**	**A**			
4.4	Fauna:	None recorded					
5.0	**Technique**						
5.1	Source of Technique:	Guidance was given by Bruce Walker, following repairs to the Cottown Schoolhouse, which included a clay and turf thatch ridge (see CS32).					
5.2	Season of Work:	Late autumn (?)					
5.3	Preliminary Repairs to Structure:	Minimal consolidation of the wallheads was required.					
5.4	Treatment of Existing Vegetation:	Photographs indicate that there was an extensive cover of vegetation to the wallheads, which was removed and discarded (Fig. 15.4). This appears to have been a continuous low mat out of which rose thin tall grass and generally an appearance similar to the current vegetation.					
5.5	Soft Capping Technique:	A dome of clay was applied to the head of the wall, 100-150mm thick, with a single layer of turf applied over (Fig.15.4).					
5.6	Soft Walling Technique:	Clay mortar was applied to the broken inner face of sections of the East Wing, to ~200-400mm thick. Shuttering may have been used.					
5.7	Vegetation: Source and Description	It is thought that thin, commercial turf was used.					
5.8	Soil: Source and Description	It is thought that the mix was Errol Clay: coarse sharp sand, with a flax fibre additive. The flax fibre was obtained from the Historic Scotland. ESRP test site at Battleby and was like a long coarse hair.					
5.9	DPC:	None used					
5.10	Defining Membrane:	None used					
5.11	Fixing:	A green, 10mm square plastic mesh was laid over the turf and fastened with twine to timber pegs and metal pins fitted into mortar joints (Fig.15.11).					
5.12	Aftercare:	None known					
5.13	Maintenance:	None					
6.0	**Performance Assessment**						
6.1	General Performance:	On the South Wing: the grass has survived as a rather thin layer, extensively colonised by tree saplings and ruderals (Fig.15.6). There is some dieback on the north edge, with colonisation by moss and lichen (Fig.15.7). What was apparently a timber internal lintel has rotted and partially collapsed, with the capping restrained from full collapse by the plastic mesh (Fig 15.8). The clay layer was wet and greasy on top, but the core was less wet, dense but still malleable (Fig. 15.10). The East Wing has a thinner strip of vegetation, which seems to have benefited from a lower height, in that the edges are less steep and have more grasses (Fig. 15.12). The Low East Walls have a very thin spread of grass and some moss (Fig. 15.13). The clay here is very wet and there has been some loss of the face through mudslides, although the plastic mesh acts to restrain this. While the twine has rotted, the plastic mesh, metal pins and timber pegs remain in position. There was no evidence of the flax fibres when the clay was dug into, suggesting that they too have completely rotted. The collapse of timber lintels and the staining on the masonry face (Fig. 15.14) indicate that the turf and clay layers had limited benefit as a moisture barrier to protect the wallhead masonry. The soft walling has completely failed, with remnants of clay remaining, on the broken inner face of the masonry walls.					
6.2	Effect of Climate:	The dominant features of this site are dampness and shade. The site has lower than average rainfall, but this moisture is retained by the seasonal shade of the deciduous trees and the wind shelter provided by trees and topography.					
6.3	Effect of Birds:	None noted					

6.4	Effect of Animals:	None noted
6.5	Aesthetic Performance:	The turf capping appears appropriate to the building in its current condition. Although the building is externally complete to wallhead level and could therefore be classed as roofless rather than ruinous, the soft capping mimics the natural process that would apply to such a structure, as evidenced by the images of the vegetation removed prior to the works.
6.6	Public Reaction:	None recorded
6.7	Team Reaction:	The soft capping is viewed as being successful. Historic Scotland's sustainability publication, *Passed to the Future*, uses it as an illustration of 'sympathetic management to enhance bio-diversity while their *Conservation of Architectural Ancient Monuments in Scotland*, states that 'this technique is probably more appropriate for less complete structures'.
6.8	Analysis:	The microclimate of this site is of major importance, and it bears comparison with the other damp, sheltered mill site at Ardkinglass (CS30) as well as with nearer sites with a different climate, such as Aberuthven (CS38). All three sites have similar soil, capping profile and building base. The performance is similar to that at Ardkinglass, with a significant danger of destructive colonisation. Although rainfall is greater at Ardkinglass, the fact that this site is more sheltered and shaded is more significant for long-term performance. The degree of shade provided by the trees to the Low East Walls, though only seasonal, is sufficient to take vegetation to the limit of viability. This is one of only two sites where lack of solar radiation could be established to be a cause of failure, the other being sections of Gordon Castle Estate walls (CS4), which run through dense woodland. The wall at Aberuthven is sheltered by surrounding walls and trees, experiences slightly less rainfall and has suffered considerable failure due to drought. The difference in performance of the two sites is stark, given their proximity. The critical difference would seem to be the drying action of solar radiation, with air movement secondary. Orientation and the surrounding landscape are also contributory factors. Apart from the difference in precipitation, moisture will be affected by a significant difference in air relative humidity between the two sites, with Doune near a burn and dense woodland on a hilly topography, while Aberuthven is surrounded by open, flat arable farmland. The relative performance of the clay layer is also interesting. At Doune the clay reaches the limit of being able to store moisture, maintain coherence, protect the wallhead from moisture ingress and deter invasive root systems through its density, with some sections failing on each of these counts. The cap at Aberuthven reaches the limit of being able to retain useful moisture and allow roots to penetrate to tap nutrients and moisture. The cap at Ardkinglas is in the middle and generally successful. This demonstrates the importance that relatively minor changes in microclimate can have. The use of flax did not appear to be of discernable benefit. The soft walling was a complete failure, though this was, in reality, an attempt at consolidation with mudwall, designed to dry out, rather than a vertical version of a soft capping. While surviving mudwall ruins and the clay caps at Gordon Castle, suggest the material can be remarkably durable, the ESRP research suggests that decay of clay materials accelerates when they are adjacent to harder ones. The soft walling test would have lasted longer in a drier location and such tests would be interesting, but on the basis of this site's results its usefulness as a conservation technique remains to be demonstrated. While information on many sites is sparse, these cappings were viewed as tests and as such it is unfortunate that better records of the work and monitoring of its subsequent performance were not available.
7.0	**References:**	
	Interviews: John Fell, *Historic Scotland, charge hand mason* Chris McGregor, *Historic Scotland Architect* Rebecca Little, *Historic Scotland intern at time of works* Data: http://www.metoffice.gov.uk/climate/uk/averages/19712000/mapped.html	

Fig. 15.2: View from the west.

Fig.15.3: View from the North, with the South Wing to the right and the East Wing to the left.

Fig.15.4: During application, with a section of naturally established capping within the capped walls.

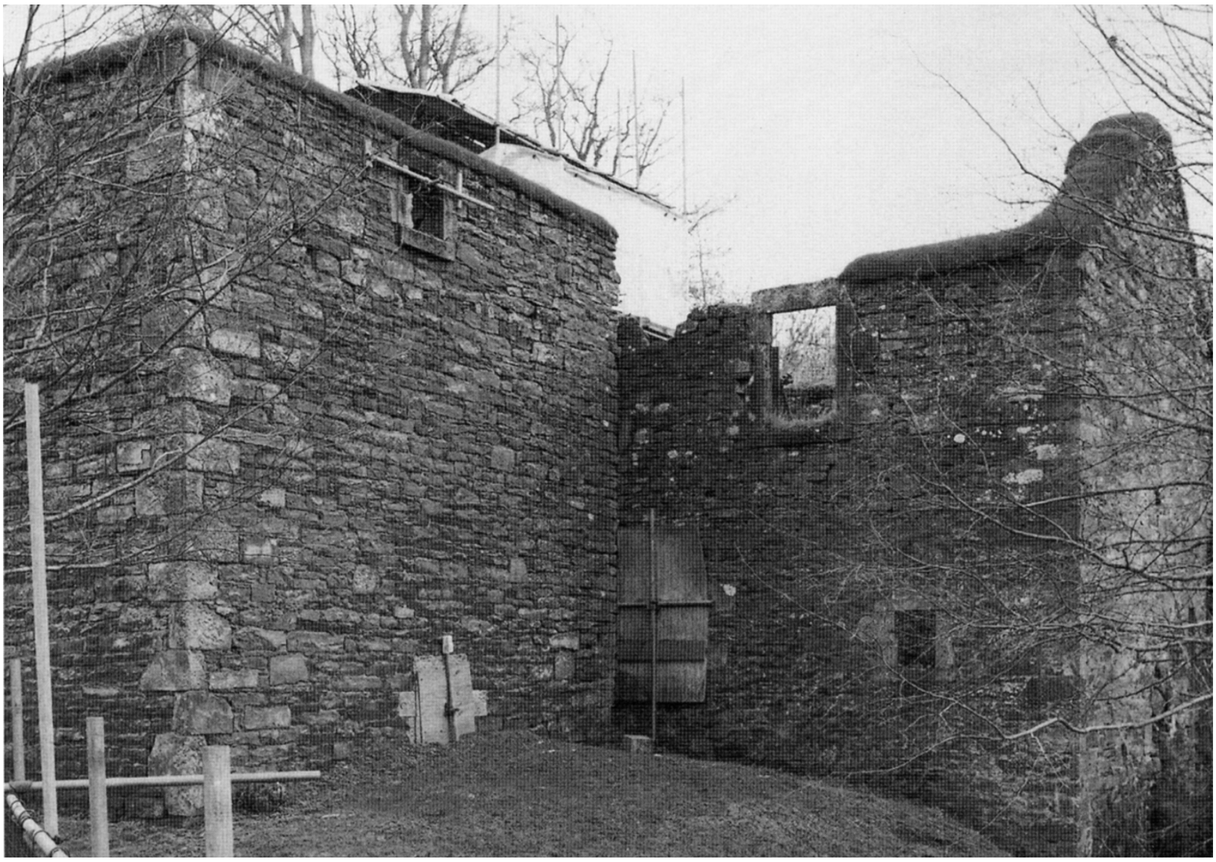


Fig.15.5: The caps soon after completion.

Fig.15.6 : The driest section of capping.

Fig.15.7 : The side has moss and lichen.

Fig.15.8: Collapsed timber lintel.

Fig.15.9: The gable capping.

Fig.15.10: The clay soil was much drier inside than on the surface.

Fig.15.11: Timber pegs and fine plastic mesh.

Fig.15.12: The East Wing cpping is less thick

Fig.15.13: The Low East Wall.

Fig.15.14: The masonry for about 0.6m below the cappings is damp, with some surface staining.

Fig. 15.15: Clay from the soft walling test remains as a thin coating on the broken face of the outer masonry leaf.

Case Study 16: DRUMIN CASTLE, Glenlivet Estate, Banffshire

This case study is interesting in being the most inland and subject to fairly severe frosts.

Fig. 16.1: Drumin Castle from the east.

1.0	**Background**				
1.1	Location:	Beside the garden of Drumin Farmhouse, Glenlivet, Banffshire			
1.2	Grid Reference:	NJ 182 303			
1.3	Date of Works:	2004, the last stage of consolidation works begun in 1999			
1.4	Client:	The Crown Estate			
1.5	Contractor:	Cummings & Co			
1.6	Architect:	Law & Dunbar Nasmith			
1.7	Access:	There is unrestricted access from a nearby-signed car park. The adjacent garden is private ground.			
1.8	Visit Record:	Date:	By:		
		6.10.06	TM		
2.0	**Building**				
2.1	Type:	Ruinous tower house			
2.2	Classification:	Scheduled Ancient Monument			
2.3	Chronology:	Built:	14thC		
		Ruined:	Ruination began in the late 1500s. It was last occupied in the 18thC, with three walls substantially robbed of stone in 1818.		
		Repairs:	The ruin was consolidated, 1948-57, after coming into guardianship. Excavations and consolidation work was undertaken 1999-2003.		
2.4	Construction and Form:	The structure is roughly rectangular in plan, with walls originally 11.3m by 16.2m. Now only the north-west wall remains largely intact, to parapet level, though the parapet stones are gone, leaving wide, flat rubble on most of the wallheads. There is almost no evidence of the south-east wall whilst the other two have substantial remnants standing. The walls vary in height up to 11m and at the base reach a thickness of almost 3m, perhaps 2m at the head. The walls are of whin and freestone rubble in lime mortar.			
3.0	**Site**				
3.1	Setting:	Description:	The ruin stands on high ground overlooking the meeting of two glens, which have mainly rough pasture. There is a group of mature trees close by the ruin and the garden of a farmhouse to the south.		
		Altitude:	200m		
		Distance from Coast:	40km		
3.2	Classifications:	None known			
3.3	Microclimate: * Estimated from Annual Averages 1971 – 2000 *(Numbers in brackets give data as a % of national average)*	The wallheads are exposed to wind and rain. The site has a high level of frost.			
		Rainfall*	980mm (64%)	Days of Rain >= 1mm*	170 (92%)
		Min Temp*	-15°C (80%)	Max Temp *	20°C (103%)
		Days Ground Frost*	150	Hours sunshine*	1190 (103%)
		Prevailing Wind Direction:		Assumed south-west	
4.0	**Flora and Fauna**				
4.1	Vegetation on Wall:	The dominant grass has been colonised by a range of plants, including a number of undesirable species and a significant number of tree saplings.			
4.2	Surrounding Vegetation:	On the south the ruin abuts the orchard and garden of a farmhouse, which contains many exotic species, as well as ivy. The other sides are open rough grazing, with a mixture of mature pine and deciduous trees close by.			

4.3	Species Survey. *Assessment by HL from Photos* The site was difficult to assess because of access and the season of visit **D**=Dominant, **A**=Abundant, **F**=Frequent, **O**=Occasional, **R**=Rare, **VR**=Very Rare, *=Present				
	Common Name	Latin Name	Capping	Surrounding Vegetation	Comment
	Grasses:				
	Cock's Foot	*Dactylis glomerata*	?		
	Common Bent	*Agrostis capillaris*	?		
	Perennial Rye Grass	*Lolium perenne*	?	?	
	Red Fescue	*Festuca rubra*	?	?	
	Yorkshire Fog	*Holcus lanatus*	?	?	
	Bent spp	*Agrostis spp*		?	
	Ruderals/Herbs:				
	Common Sorrel	*Rumex acetosa*	*		
	Dandelion	*Taraxacum officinale*	*		
	Mouse-eared Hawkweed	*Pilosella officinarum*	*		On edges below
	Ragwort	*Senecio jacobaea*	*		
	Yarrow	*Achillea millefolium*	*		
	Bramble	*Rubus fruticosus agg*		?	
	Creeping Thistle	*Cirsium arvense*		?	
	Trees/Shrubs:				
	Apple spp	*Malus sp*		*	
	Ash	*Fraxinus excelsior*		*	
	Beech	*Fagus sylvatica*		*	
	Cedar sp	*Cederus sp*		*	
	Common Alder	*Alnus glutinosa*		*	
	Rowan	*Sorbus aucuparia*		*	
	Sycamore	*Acer pseudoplatanus*		*	
	Shrub Veronica	*Hebe sp*		*	
4.4	Fauna:	Barn owls roost in the lower cavities of the masonry.			

5.0	**Technique**	
5.1	Source of Technique:	'The usual kind of spec' was advised by Historic Scotland (AR)
5.2	Season of Work:	Unknown
5.3	Preliminary Repairs to Structure:	There was extensive consolidation of the masonry with lime mortar.
5.4	Treatment of Existing Vegetation:	The ruin had a considerable cover of vegetation including ivy and tree saplings. Photographs show considerable growth having occurred between 1890 and 1910, though it seems likely that much of this would have been removed during the early repairs, 1948-57.
5.5	Soft Capping Technique:	Turf was laid over a clay cap.

5.6	Vegetation: Source and Description	Not known
5.7	Soil: Source and Description	Thought to be Errol clay.
5.8	DPC:	None used
5.9	Defining Membrane:	None used
5.10	Fixing:	Netting was used to tie down the turf.
5.11	Aftercare:	Not known
5.12	Maintenance:	There is no maintenance plan. The (difficult to access) high walls and potential for seeding onto them by trees in the vicinity are identified as issues. Saplings have already started to establish (AR), but it is unclear whether these will thrive.
6.0	**Performance Assessment**	
6.1	General Performance:	The cappings have performed well in protecting the masonry from frost damage and reducing moisture ingress. The significance of the frost protection is demonstrated by the extensive damage to the lime mortar repairs that have not been soft capped (Fig. 16.6). There is significant edge dieback, which has resulted in extensive clay staining of the masonry face (Fig. 16.2).
6.2	Effect of Climate:	Notwithstanding the netting, sections of turf are reported to have blown off (AR).
6.3	Effect of Birds:	None noted
6.4	Effect of Animals:	None noted
6.5	Aesthetic Performance:	The cappings are successful in giving the impression of a naturalistic ruin. Given the height of the tower, the cappings make a subtle impact overall (Fig. 16.3), though they can conceal detail locally (Fig. 16.5). The concrete floor, frost damaged lime mortar and clay staining detract from this impression.
6.6	Public Reaction:	The repairs were warmly welcomed by the public, with a plaque being unveiled by HRH Duke of York.
6.7	Team Reaction:	The cappings are regarded as 'reasonably successful' (AR).
6.8	Comments:	The wide wallheads give the cappings a sizeable base and reduce the impact of edge dieback. This contributes to what is a healthy sward in a relatively dry and exposed location, reminiscent to Kinloss Abbey (CS24). Given the previous natural cappings, it would seem likely that the decaying edges will stabilise and this should arrest the unsightly clay staining. It seems probable that a better technique, including possible re-use of the removed natural capping vegetation would have suffered less edge decay. Certainly the lack of a bitumen membrane contributes to less severe edge stress, and therefore decay, than Kinloss. In the long term, seeding from nearby trees may require intervention to remove them. However, they may fail to survive, if the clay dries sufficiently in summer.
7.0	**References:**	
	Interviews: Andrew Wells, *The Crown Estates (client)* Rachel Bromby, *Smith Gore (managing agents)* Alan Rutherford, *Historic Scotland* Mike Penderey, *Historic Scotland*	

Fig. 16.2 Detail of the head of the west wall.

Fig. 16.3: West view. The visual impact of the cappings is subtle, though brown clay staining is quite apparent.

Fig. 16.4: An isolated capping.

Fig. 16.5: The capping protects but conceals the layered wall construction.

Fig. 16.6: Typical frost damage. This type of rough racking, consolidated with lime mortar but uncapped, is then open to uncontrolled colonisation by plants.

Fig. 16.7 : View from the north-east, c. 1910.

Fig. 16.8 : View from the north-east, 2006.

Fig. 16.9 : View from the south, c. 1890.

Fig. 16.10 : View from the south, c.1910, showing substantial ivy growth and tree colonisation over 20 years.

Case Study 17: DUN CARLOWAY BROCH, Lewis, Outer Hebrides

This case study presents an interesting early use of soft capping to conserve the drystone walls of a broch in an exposed situation, with interesting natural lichen growth on other walls.

Fig 17.1: View from the north

<table>
<tr><th>1.0</th><th colspan="5">Background</th></tr>
<tr><td>1.1</td><td>Location:</td><td colspan="4">Dun Carloway, on the west coast of the Isle of Lewis, Western Isles</td></tr>
<tr><td>1.2</td><td>Grid Reference:</td><td colspan="4">NB 1900 4123</td></tr>
<tr><td>1.3</td><td>Date of Works:</td><td colspan="4">~1930?</td></tr>
<tr><td>1.4</td><td>Client:</td><td colspan="4">Uncertain, possibly Ministry of Works</td></tr>
<tr><td>1.5</td><td>Contractor:</td><td colspan="4">Uncertain, possibly Ministry of Works</td></tr>
<tr><td>1.6</td><td>Architect:</td><td colspan="4">Uncertain, possibly Ministry of Works</td></tr>
<tr><td>1.7</td><td>Access:</td><td colspan="4">Unrestricted access.</td></tr>
<tr><td rowspan="2">1.8</td><td rowspan="2">Visit Record:</td><td>Date:</td><td colspan="3">By:</td></tr>
<tr><td>07.09.05</td><td colspan="3">TM</td></tr>
<tr><td colspan="6"></td></tr>
<tr><th>2.0</th><th colspan="5">Building</th></tr>
<tr><td>2.1</td><td>Type:</td><td colspan="4">Ruined broch</td></tr>
<tr><td>2.2</td><td>Classification:</td><td colspan="4">Category A Listed, 27/02/1978. Scheduled Ancient Monument</td></tr>
<tr><td rowspan="3">2.3</td><td rowspan="3">Chronology:</td><td>Built:</td><td colspan="3">300-100 BC</td></tr>
<tr><td>Ruined:</td><td colspan="3">After 1500</td></tr>
<tr><td>Repairs:</td><td colspan="3">After 1887?</td></tr>
<tr><td>2.4</td><td>Construction and Form:</td><td colspan="4">Dun Carloway is one of the best-preserved brochs, drystone towers with inhabited walls. The tallest part still standing some 6.7m high. The external diameter is 14.3m and the inner courtyard, which has two side cells leading off, is 7.5m across. Originally, the walls might have been about 13m high. The broch’s typical double wall is well preserved, showing how tiers of galleries were linked by a stone staircase within the hollow wall.

The north quarter of the broch seems to have been reconstructed in drystone rubble to a flat wallhead about 1m above ground level, to complete the form of the circular building, and this has a turf cap. The masonry of the apparently reconstructed areas does not match that of the original construction. A sketch dated 1846 (Fig 17.2) shows this area in roughly its current state, but without turf, and it is thought this section may have been reconstructed to convert the broch into a residence and this was subsequently given a soft cap sometime after it came into guardianship in 1887. The cap is ~7m long by 3m wide.</td></tr>
<tr><td colspan="6"></td></tr>
<tr><th>3.0</th><th colspan="5">Site</th></tr>
<tr><td rowspan="3">3.1</td><td rowspan="3">Setting:</td><td>Description:</td><td colspan="3">The site is located on the west coast of Lewis. The broch sits on a rocky outcrop and is very exposed on all sides.</td></tr>
<tr><td>Altitude:</td><td colspan="3">~50m</td></tr>
<tr><td>Distance from Coast:</td><td colspan="3">~1km</td></tr>
<tr><td>3.2</td><td>Classifications:</td><td colspan="4">None known</td></tr>
<tr><td rowspan="5">3.3</td><td rowspan="5">Microclimate:

* Data source:
Met. Office, Annual Averages 1971 – 2000

(Numbers in brackets give data as a % of national average)</td><td colspan="4">The site is very exposed to strong prevailing winds, sun and rain.</td></tr>
<tr><td>Rainfall*</td><td>~1550mm (101%)</td><td>Days of Rain >= 1mm *</td><td>~220 (119%)</td></tr>
<tr><td>Min Temp*</td><td>~5.0°C (125%)</td><td>Max Temp *</td><td>~10.9°C (103%)</td></tr>
<tr><td>Days Ground Frost*</td><td>~80</td><td>Hours sunshine*</td><td>~1050 (90%)</td></tr>
<tr><td colspan="2">Prevailing Wind Direction:</td><td colspan="2">South-west</td></tr>
</table>

4.0	**Flora and Fauna**	
4.1	Vegetation on Wall:	The turf of the cap is about 75mm thick, of fine grasses with a few wildflowers. The turf is generally set back from the edge and provides good stabilisation of the edge stones. The turf is apparently regularly, closely and carefully mown, with no damage to the stones apparent.
4.2	Surrounding Vegetation:	The broch is surrounded by lightly grazed rough moorland, with rocky outcrops. The immediate enclosed area is well-mown grass.

4.3 Species Survey. *Assessment by HL from photos*
Close mowing made identification of species difficult.

D=Dominant, **A**=Abundant, **F**=Frequent, **O**=Occasional, **R**=Rare, **VR**=Very Rare, *****=Present

Common Name	Latin Name	Broch Top	Broch Surroundings	Comment
Grasses:				
Crested Dogstail	Cynosurus cristatus	**R**		
Perennial Rye Grass	Lolium perenne	**D**	*	
Ruderals/Herbs:				
Creeping Buttercup	Ranunculus repens			
Daisy	Belllis perennis	**R**	*	
White Clover	Trifolium repens	**O**		
Trees/Shrubs:				
None				
Mosses/Ferns:				
None				

4.4	Fauna:	The cap and surroundings are possible grazed by rabbits.

5.0	**Technique**	
5.1	Source of Technique:	Uncertain. Early uses by the Ministry of Works may have been influenced by SPAB guidance as well as vernacular techniques.
5.2	Season of Work:	Unknown
5.3	Preliminary Repairs to Structure:	Unknown. It is thought that the section of wall below was rebuilt as drystone walling to imitate the original, sometime prior to 1846.
5.4	Treatment of Existing Vegetation:	Assumed none
5.5	Soft Capping Technique:	The capping seems to have been a single layer of turf, laid flat onto a wallhead, where voids had been filled with small stones.
5.6	Vegetation: Source and Description	Assumed good quality local turf was selected.
5.7	Soil: Source and Description	It is uncertain whether a soil layer was applied, it seems likely that the wallhead was filled with stones and a layer of soil would follow the local vernacular, as described in the Roghadal Walls (CS5).
5.8	DPC:	None used
5.9	Defining Membrane:	None used
5.10	Fixing:	None apparent
5.11	Aftercare:	Not known
5.12	Maintenance:	The capping is closely and regularly mown.

6.0	Performance Assessment	
6.1	General Performance:	The turf capping performs well in binding the unmortared masonry and protecting it from mechanical damage by visitors climbing on the wallheads; this is a significant problem. Several of the drystones have been mortared in place (Fig. 17.7), but one at high level had still been dislodged by a visitor climbing in the higher levels and was lying on the ground. The external south face of the broch has been heavily colonised by lichen (Fig. 17.9). This is likely to have been a continuous process since the construction of the broch, with much less growing on the inner face. Growth is also less on other orientations of external wall, suggesting solar exposure encourages growth. That the south wall is also the best preserved and tallest might suggest that the lichen is adding to the stability of the masonry.
6.2	Effect of Climate:	The climate does not seem to have had a significant effect. Given the apparent longevity of the capping, the species will have adjusted to suit the conditions. The edges also present a low profile to the wind (Fig. 17.5).
6.3	Effect of Birds:	None noted
6.4	Effect of Animals:	Grazing by rabbits may have contributed to the close cropping of the cap.
6.5	Aesthetic Performance:	The very tidy and flat cap minimises visual intrusion on the surviving masonry, which is of primary importance. However, it does not give the appearance of a natural vegetation capping. The turf cap also contrasted with the grit floor to the passage south of the entry, which was the same finish as the internal floor (Fig. 17.6). This differentiates between original floor levels and the consolidated masonry. The visual effect of the natural lichen 'green walling' is completely different, being very natural, indicating the longevity of the monument, but obscuring the detail. This contrasts with the treatment of the nearby Callanish Stones, which have been scrubbed clean of lichen.
6.6	Public Reaction:	None known
6.7	Team Reaction:	None known
6.8	Comments:	The broch shows an effective use of turf to prevent visitor damage to an unmanned site that invites inappropriate climbing. However it is not entirely visually satisfactory. The close maintenance, exposure and visitors can be compared to Skara Brae (CS10), but minor differences and the lack of exposed sides is significant. Performance is more similar to that on the nearby Blackhouse (CS9), where the caps are also flat. Comparison to Eynhallow (CS18) is also interesting. This was a site with similar wind exposure, where early conservation capping were also applied. These have not fared as well and one contributing factor may be the domes profile. At Dun Carloway, there are no exposed edges to catch the wind and start a progressive decay pattern.

7.0	References:
	Data: http://www.metoffice.gov.uk/climate/uk/averages/19712000/mapped.html http://www.stonepages.com/scotland/duncarloway.html Sources: A Mini-Guide to Dun Carloway Broch: Isle of Lewis, Gerald and Margaret Ponting, 1980, Hebridean Printers, Stornoway (reprinted 2002)

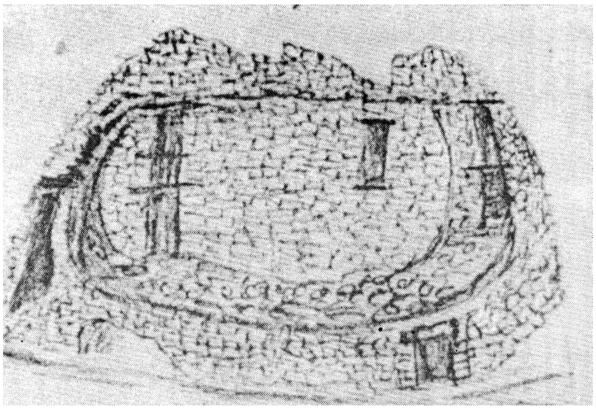


Fig.17.2: A sketch dated 1846. The wallhead has exposed rubble.

Fig.17.3: View of the capping from above.

Fig.17.5: Typical how profile edge, minimises wind exposure.

Fig.17.4: Moss growth at the edge.

Fig.17.7: Stones are occasionally mortared in place where not bound by the turf.

Fig.17.6: The turf capping contrasts with the gravel floored passage ways.

Fig.17.8: There are only rare isolated examples of colonisation of the inside drystone.

Fig.17.9: South side, with extensive colonisation by lichen.

Fig.17.10: Lichen growth may help bind the masonry.

Case Study 18: EYNHALLOW MONASTERY, Orkney

This case study documents the oldest recorded conservation cappings, which have in turn been recently partially replaced. The site is also interesting climatically and in its difficult working conditions.

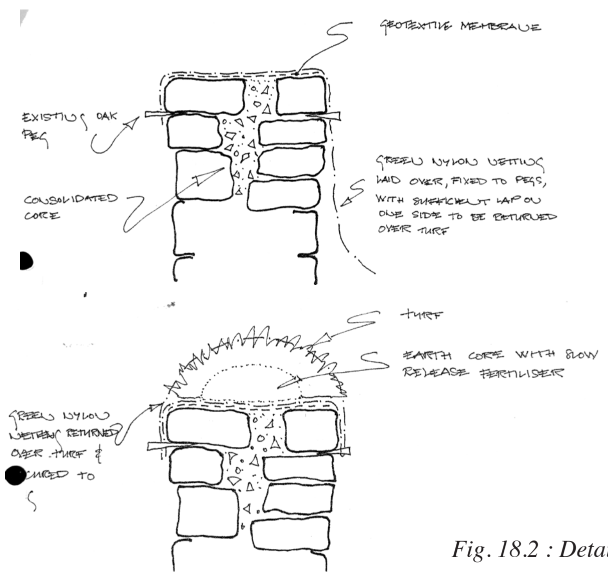
Fig. 18.1: Eynhallow Monastery, view from the north.

1.0	**Background**		
1.1	Location:	The Orkney island of Eynhallow, between the mainland and Rousay	
1.2	Grid Reference:	HY 3590 2882	
1.3	Date of Works:	2003, 2004	
1.4	Client:	Historic Scotland	
1.5	Contractor:	Historic Scotland	
1.6	Architect:	Stephen Watt, Historic Scotland	
1.7	Access:	The site is on an island without established means of public access. The importance of the island as a SSSI habitat for ground-nesting birds restricts access during the nesting season, even for maintenance, meaning that works cannot begin until late August or September. The local archaeological society organises one pubic visit each year.	
1.8	Visit Record:	Date:	By:
		11.08.05	TM, Adrian Stanger (Historic Scotland), Steve Cowsill (Historic Scotland)
2.0	**Building**		
2.1	Type:	Monastery and Church, ruined	
2.2	Classification:	Category B listed, 08.12.1971, Scheduled Ancient Monument	
2.3	Chronology:	Built:	Prob. second quarter of 12thC.
		Ruined:	Not known, but revealed during demolition of cottages in 1851
		Repairs:	1897, 1911-24, 2003, 2004, see 2.4 for details
2.4	Construction and Form:	The remains of this 12thC. chapel, last mentioned as a religious house in 1588, was revealed in 1851 during the demolition of a group of cottages, which had been constructed around it. The remains are all single storey, with walls of local coursed rubble stone laid in clay mortar, with traces of lime plaster internally and presumably originally lime render externally. The principal building is a rectangular chapel, surviving to wallhead level, with two gables and a similar internal crosswall. The west end has external buttresses. To the east of this is an array of lower walled structures. A drystone dyke encloses the whole site. In 1865-66 the buildings were surveyed by Sir Henry Dryden and T S Muir. In 1896-97 MacGibbon & Ross published a description and sketches of the buildings, including Dryden's elevations, which do not show the external buttresses, the enclosure wall or any significant vegetation. In 1897, T Lethaby, the arts and crafts architect, cleared the site, examined the buildings and undertook repairs, the exact extent of which is unclear, but are known to have included the external buttresses. The enclosure wall was also constructed around this time. In 1911 the site passed into state care. Between 1911 and 1924 there were some works which included opening up of the chancel arch. After 1924 there was only minor maintenance and rebuild carried out. An undated and unreferenced photograph shows the chapel with buttresses and enclosure wall but without any soft caps on the chapel or other low walls. By 1924, all the walls of the chapel had soft caps showing dieback and joint shrinkage at the edges, especially on the sloping wallheads. There are no caps on the lower walls in these photographs (RCAHMS photo. ref. A499.8, A499.12). By 1938 (A499.19) the capping has retreated ~100mm from the edge on the gables, but the flat wallheads seem in good condition. By 1956 the cappings on the end gables had completely disappeared, though reasonably full cover remained on the internal sloping cross-wall (A122.4) and caps were apparent on at least some of the low walls (though these are not the ones that can be seen to be uncapped in earlier photographs). Photographs by Lamb in 1972, show some capping remaining on the internal cross-wall and caps in good condition on all the flat wallsheads.	

3.0	**Site**				
3.1	Setting:	Description:	The ruins are located on a small grassy island in the Orkney archipelago, on gently rising ground about 200m from the shore to the south, and is exposed on all sides, though some of the lower walls provide a degree of mutual shelter.		
		Altitude:	10 m		
		Distance inland:	200 m		
3.2	Classifications:	The island is a SSSI for ground nesting birds, being researched by the University of Aberdeen. It is also Local Authority Rural Conservation Area.			
3.3	Microclimate:	Though the buildings are not tall, exposure to the prevailing south-west winds is severe.			
	* Estimated from Met. Office, Annual Averages 1971 – 2000	Rainfall*	~1090mm (71%)	Days of Rain >= 1mm*	~185 (100%)
	(Numbers in brackets give data as a % of national average)	Min Temp*	~5.0°C (125%)	Max Temp *	~10.8°C (103%)
		Days Ground Frost*	~100	Hours sunshine*	~1180 (102%)
		Prevailing Wind Direction:		South-west	

4.0	**Flora and Fauna**	
4.1	Vegetation on Wall:	Fine grasses, and a sparse range of other species, dominate the cappings. Based on the severe wind exposure, the limited time since the ruins were exposed and the early photographs, it seems unlikely that any of the chapel cappings at Eynhallow are naturally established. On the low walls, the lack of naturally colonised vegetation in the 1924 photographs, the mortar profiling and fullness of the caps in 1956 all indicate that these are applied caps rather than naturally established vegetation.
4.2	Surrounding Vegetation:	The island is dominated by grasses, and is ungrazed.

4.3	Species Survey. *Assessment from photographs by HL* **D**=Dominant, **A**=Abundant, **F**=Frequent, O=Occasional, **R**=Rare, **VR**=Very Rare, *****=Present					
	Common Name	Latin Name	Capping	Cottage by shore	Surr. Veg.	Comment
	Grasses:					
	Cock's Foot	*Dactylis glomerata*		**R**		
	Common Bent	*Agrostis capillaris*	**R**		**F**	
	Creeping Soft Grass	*Holcus mollis*	**O**		**F**	
	Early Hair Grass	*Aira praecox*	**R**			
	Perennial Rye Grass	*Lolium perenne*	**R**	**F**		
	Red Fescue	*Festuca rubra agg*	**D**	**O**	**O**	
	Smooth Meadow Grass	*Poa pratensis*	**F**	**F**		
	Sweet Vernal Grass	*Anthoxanthum odoratum*	**R**			
	Ruderals/Herbs:					
	Cleavers	*Galium aparine*	**R**			On lower ledges
	Common Mouse Ear	*Cerastium fontanum*	**R**			
	Common Sorrel	*Rumex acetosa*			**R**	
	Creeping Buttercup	*Ranunculus repens*	**R**		**F**	
	Creeping Thistle	*Cirsium arvense*			**VR**	
	Curled Dock	*Rumex crispus*		**R**		
	Daisy	*Bellis perennis*	**R**			
	Dandelion	*Taraxacum officinale agg*	**VR**			
	Meadow Buttercup	*Ranunculus acris*	**R**			
	Mountain Sorrel	*Oxyria digyna*	**R**	**O**		
	Nettles	*Urtica dioica*	**R**		**A**	
	Ribwort Plantain	*Plantago lanceolata*	**R**			
	White Clover	*Trifolium repens*	**F**			
	Trees/Shrubs: None noted					
	Mosses/Ferns: None noted					
4.4	Fauna:	None noted on the walls. Birds nest on the sheltered ground within the ruins.				
5.0	**Technique**					
5.1	Source of Technique:	The technique of the early repairs seems to have been a domed earth layer topped by turf. It is reasonable to suppose that this was applied sometime between 1911 and 1924 as part of early Ministry of Works conservation works. However it remains possible that the caps were made by Lethaby and the undated photographs were taken between phases of repairs in 1896-97. In any case, the technique was probably related to vernacular soft capping techniques in the north of Scotland and Orkneys, as illustrated at Dounby (CS8), while also being influenced by SPAB recommendations of the time. The recent capping technique aims to replicate the earlier method, with minor improvements. These cappings replaced areas of the earlier cappings that were failing.				
5.2	Season of Work:	Early cappings, unknown. Recent cappings: Autumn 2003 and September 2004.				

5.3	Preliminary Repairs to Structure:	On the chapel, there is no indication of mortar consolidation of the masonry below the caps as part of previous repairs and the original clay mortar is visible below the remnants of caps in places on the internal cross-wall. On the lower walls, the wallheads are generally consolidated with lime mortar prior to soft capping, with mortar formed into raised lines over joints on the head of the masonry, apparently in an effort to provide and enhance mechanical key for the soft capping. The cappings on the east end of the south wall of the chapel were replaced by Historic Scotland in 2003. The west section of the south chapel wall was re-capped with the same method in September 2004. The existing cap was fully removed and the wallhead consolidated to a water shedding surface. Over this, a geotextile membrane was laid and plastic netting. In 2004 a wider spacing of plastic net was used (~ 100mm) as the edge dieback of the 2003 repairs were attributed in part to the close weave of the mesh inhibiting grass growth.
5.4	Treatment of Existing Vegetation:	Any vegetation from the earlier cappings was discarded.
5.5	Soft Capping Technique:	In the early chapel cappings, the caps were made with an arched section of earth, turfed over and restrained by chicken wire fixed to timber pegs. The timber pegs can still be seen fixed into masonry courses about 300mm below the wallhead. There are indications that the turf may have been laid in two layers. Photographs indicate that the lower walls were capped later than the chapel walls, between 1924 and 1956, and the technique shows some differences, with a shallower profile and no discernable fixings, but better mechanical bond to the wallhead masonry. The caps vary in thickness up to 600mm and there is no indication of the thickness or size of the turves. In the recant cappings, soil was applied in a dome shape, and turf laid over in a single layer, with the plastic mesh wrapped over the top and secured to existing and new timber pegs (Fig's 18.13-15).
5.6	Sketch Section:	 *Fig. 18.2 : Detail of repairs.*
5.7	Vegetation: Source and Description	Turf sourced locally to SNH approval.
5.8	Soil: Source and Description	The removed earlier capping soil was mixed with 20% commercial compost.
5.9	DPC:	None used
5.10	Defining Membrane:	For the cappings applied in 2003, a geotextile membrane was used.
5.11	Fixing:	Timber pegs and plastic mesh
5.12	Aftercare:	None
5.13	Maintenance:	None

6.0	Performance Assessment	
6.1	General Performance	*Early Cappings: The Chapel.* On the chapel, there is progressive decay of the cappings, varying in degree. The severity of decay of the cappings has a direct correlation to wind exposure and wallhead incline (Fig. 18.6). The caps to the end gables have completely disappeared. Those to the west gables and internal cross-wall are in an advanced state of deterioration and the caps on the flat north and south wallheads have significant and progressive decay. There is some evidence of accelerated decay above cap stone joints. Much of the, presumably galvanised, chicken wire remains, which is surprising given the salt laden air (Fig. 18.8). The caps rise to a height of ~ 300-450mm, with the upper 50-100mm well stabilised with the grass root system. Below this there are few or no roots and there is severe undermining of the edge faces by wind erosion. The soil appears to be clay rich and must be reasonably robust to have survived such severe exposure, assuming that the edges have not been covered by vegetation for a significant period. These cappings can be considered to have been effective. They have not prevented severe decay of the clay mortar in the body of the walls, as this is eroded from the face by wind-blown rain, rather than through the penetration of moisture through the wallhead. Indeed the soil seemed pretty dry generally. There is little evidence of colonisation by other plants. It was interesting to note that the plant roots did not grow into clay mortar on internal gables and the survival of the original mortar in these locations is attributable to the effectiveness of the capping. The principal benefit of these cappings is probably protection of damage to the masonry by wind. The monolithic nature of the cappings will have a binding effect on the wallhead, stabilising increasingly unbound rubblework. The dead weight of the cappings must also provide protection from wind uplift to the wallhead stones, which tend to be thin and flat, following the vernacular detail for eaves on stone slabbed roofs. *Early Repairs: The Low Walls* These cappings have suffered less severe decay from exposure to wind. The westernmost walls have lost their caps entirely and the height of caps rises progressively to the east. Corners and wall ends generally have grass held well back from the edge, while there are less predictable small areas of severe decay associated with focused wind patterns. There is evidence of decay associated with joints in wallhead masonry, however joints can also be seen to provide shelter and a mechanical key. There is locally an inability to form a stable edge with progressive undermining of the turf. There is some colonisation by wildflowers and other plants, though potentially damaging plants, such as the abundant nettles, have failed to colonise. Mosses colonise decayed edges. These caps are generally effective and in good condition. However, the westernmost wallhead, which has no cap, is also in good condition and it can be surmised that the mortar consolidation is providing important stabilisation of the masonry head. The weight and hugging root mass of the soft caps can be seen to stabilise some particularly vulnerable thin, flat stones, that would be vulnerable to wind uplift, even with mortar. *Recent Cappings.* Both sections of repair seem to be suffering the onset of the same decay mechanisms that affected the old caps, though this had progressed more in the earlier section. The edges have failed to prosper. The older section is worse than that from 2004, with dead turf on the edges, especially the south side, and much shrinkage of joints. However, examination of the 2005 edges showed that the turf had failed to root in and the soil beneath was dry and hard (Fig. 18.19). The difference in plastic mesh size does not appear to be a significant factor in the success or failure of these repairs. The poorer condition of the older test may be more attributable to drier weather conditions immediately after the repairs, on a site where aftercare is not possible due to access restrictions. Both caps are providing the same protection that the original caps gave and this will inhibit the decay of the masonry below.

6.2	General Performance of Neighbouring Ruin	There is a nearby ruined shore-side cottage, which has a vernacular roof construction of turf on low pitched stone slabs, as described in CS8. It is assumed that this was also abandoned in the mid 19thC. The turf cap showed progressive decay from the ridge, with about 70% loss of cover on the south side and 40% on the north. This indicates that the climatic conditions are too severe for the survival of relatively large areas of exposed capping. However this represents 150 years of decay and some occasional maintenance was presumably carried out to habited buildings. Some other ruined walls to the north show only occasional colonisation by grasses and other species, indicating that the severity of the climate inhibits natural colonisation of masonry (Figs. 18.25 and 18.26). Though birds were nesting in the turf, there was no sign of direct damage.
6.2	Effect of Climate:	As detailed in 6.1-6.2
6.3	Effect of Birds:	None noted
6.4	Effect of Animals:	None noted
6.5	Aesthetic Performance:	The cappings are generally successful in giving a naturalistic impression. However the severe decay on the chapel is unsightly. The bare masonry of the chapel gables is stark and looks very unprotected, while the lower walls, where lost turf reveals mortar caps, seem more robust and thus less concerning. There is a question over the presentational appropriateness of soft cappings on Orkney sites, as they may inadvertently suggest an original turfed roof covering for which there is no direct evidence. They certainly suggest natural colonisation of a ruin, though they are not and this may not be possible under the climatic conditions on site. On the whole though, they should be assessed as visually appropriate.
6.6	Public Reaction:	None recorded
6.7	Team Reaction:	None recorded

6.8	Comments:	It seems likely that the climatic conditions at this site are too severe to sustain soft cappings in all locations in the long term, with the durability of the cappings directly related to wind exposure. Nonetheless the early cappings have been very successful in providing low maintenance, reversible and visually appropriate protection to the wallheads. The soil appears to be clay rich and must be reasonably robust to have survived such severe exposure, assuming that the edges have not been covered by vegetation for a significant period. On the other hand, the clay content may inhibit good root penetration. Gordon Castle (CS4) and St. Kilda (CS7) exhibit interesting parallels. The chapel cappings have not prevented decay of the wall mortar, except immediately below the cappings. Generally decay of the wall mortar is severe and there have been no repairs or consolidation of the clay mortar core or lime finish. This means that the building is slowly changing from having a mortared masonry construction to having a drywall construction, which is resulting in a significant loss of strength of the walls. The caps provide some binding strength to the wallheads, but the loss of core mortar will be a factor accelerating decay of the caps. There remain visible areas of original clay mortar that could be matched for consolidation of the masonry, which, together with an ongoing programme of soft capping renewal, would be effective steps in conserving this important monument. It seems possible to reinstate the soft cappings on the chapel gables, and this could provide effective protection to vulnerable masonry. Although they would need to be renewed more often, the archive photographs would suggest they could provide effective protection for perhaps fifty years. It may also be possible to improve the durability of the cappings, by varying the technique in a number of ways, responding to experience in other exposed sites, especially in the Western Isles, such as Pabbaigh (CS33), where working restrictions were also similar. On the low walls, the mortar repairs seem to provide adequate protection, where the soft cappings have decayed. It should be noted that the mortar consolidation is an invasive and irreversible repair technique, not compatible with the original materials, but can be visually intrusive where exposed. The soft caps, in contrast, are fully reversible and do not damage the original fabric. The profile of the caps vary. Generally the chapel caps have a consistent semi-circular profile, with the steeps sides commonly decaying to a vertical or undermined profile. The lower walls generally have a lower, flatter but less regular profile, with less steep sides and few areas where progressive decay of unstabilised sides is in progress. The recent repairs attempted to replicate the original technique, while improving the fertility of the soil. There are no signs that fertility of soil is in itself, a problem with the failed caps, though the structure of the soil, which is related, may be. Indeed, as has been noted on other sites, increasing the fertility of the soil can create artificially benign conditions in the initial stages, encouraging dominance by grass species that are less robust in the longterm at the expense of more drought tolerant and root dense species. Evidence from other sites, such as Pabbaigh, would suggest that levels of moisture should not be a problem, as the caps were fitted in the autumn, solar radiation is low and precipitation is reasonably frequent. However, the lower walls seem to retain more moisture and this may be related to the mortar consolidation. This also seems to inhibit accelerated decay above stone joints. It is possible that the use of a defining membrane below the repairs will inhibit accelerated decay above the joints, by breaking the wind and preventing dry soil from falling below. Airborne salts will inhibit growth, but this should not be a significant factor between the relative success and failure in different areas. Both new caps are providing the same protection that the original caps gave and this will inhibit the decay of the masonry below. While it might appear that the caps could fail fairly quickly and not provide the roughly eighty years of protection afforded by the old caps, this should not be assumed. The turf edges of the new caps may well die off in the first couple of years, but provide a growing medium for new growth of suitable species thereafter. These could grow from seeds in the existing soil and turf, or from seeds blown in from the surrounding area. The old caps may have followed this process, only to slowly decay over the long-term. However, it is also possible that the recent repairs prove less durable than the original caps, for a variety of reasons. The old caps may have had more aftercare watering, been installed at a different time of year, had two layers of turf or the increased fertility of the soil may be detrimental. Continued recording of the cap condition will therefore be useful.

7.0	**References:**
	Interviews: Stephen Watt, *Historic Scotland Architect* Adrian Stanger, *Historic Scotland, Foreman* Stevie Cowsill, *Historic Scotland mason* Data : Eynhallow Church Monument Condition Survey, February 2004, SA Watt, Historic Scotland MacGibbon & Ross, Vol. 1, 1896-7, p.116-121 http://www.metoffice.gov.uk/climate/uk/averages/19712000/mapped.html

Fig. 18.3: Aerial view from the south.

Fig. 18.4: View west from the chapel, 1970.

Fig. 18.5: Comparable view, 2006. The 2003 repairs in the foreground dying back to a central strip.

Fig. 18.6: The chapel from the north-west. The prevailing wind is from the right.

Fig. 18.7: Original clay mortar beneath the old soft cappings.

Fig. 18.8: Chicken wire survives in the old cappings.

Fig. 18.9: Chapel, west end.

Fig. 18.10: The weight of the failing old cappings still protects the stones from wind uplift.

Fig. 18.11: Chapel west gable, with 2004 repairs in front.

Fig. 18.12: South wallhead before the 2004 repairs, with old cappings in front and 2003 repairs to right.

Fig. 18.13: 2004, preliminary consolidation with lime mortar.

Fig. 18.14: 2004, the soil underlayer.

Fig. 18.15: Completed works, 2004.

Fig. 18.16: Chapel from the north-east, with 2003 and 2004 repairs in front.

Fig. 18.17: View along the wallhead re-capped in 2004.

Fig. 18.18: The re-capped wallhead contrasts with the decayed older cappings.

Fig. 18.19: One year after application, the edge of the 2004 repairs had failed to root in and was dying back.

Fig. 18.20: The 2004 cappings in front of the eighty year old cappings.

Fig. 18.21: The lower walls show dieback relating to wind exposure.

Fig. 18.22: Thin stones at the wallhead are protected from wind uplift by the cappings.

Fig. 18.23: Dieback on the exposed west edge reveals the textured mortar.

Fig. 18.24: Local wind eddies create unpredictable patterns of decay.

Fig. 18.25: The nearby ruin, sheltered side.

Fig. 18.26: Nearby ruin, exposed side..

Case Study 19: GYLEN CASTLE, Kerrera, Argyll

This case study documents an interesting project where natural capping turf was carefully re-used in conservation cappings on an exposed and remote maritime ruin.

Fig.19.1: Gylen Castle, looking south, prior to conservation

1.0	**Background**		
1.1	Location:	The south end of Kerrera, Argyll, West Scotland.	
1.2	Grid Reference:	NM 8053 2649	
1.3	Date of Works:	1993-2002 The main soft capping work was carried out in 1995	
1.4	Client:	Unknown	
1.5	Contractor:	Duncan Strachan (DS)	
1.6	Architect:	Martin Hadlington	
1.7	Access:	Unrestricted public access. There is a footpath from the ferry landing	
1.8	Visit Record:	Date:	By:
		Summer 2001	TM, BL

2.0	**Building**		
2.1	Type:	Tower House, ruined	
2.2	Classification:	Category A Listed Building Scheduled Ancient Monument: Secular	
2.3	Chronology:	Built:	c. 1580
		Ruined:	1647
		Repairs:	HM Office of Works carried out some consolidation work in 1913.
2.4	Construction and Materials:	The walls consist of local whinstone rubble and sandstone dressings in lime mortar. Originally the building was lime harled, but most of this has eroded.	

3.0	**Site**				
3.1	Setting:	Description:	The tower stands in a prominent position, high over cliffs at the south end of the island. The south wall is very exposed and this shields the lower lying north and west facing walls.		
		Altitude:	~50m		
		Distance from Coast:	~30m		
3.2	Classifications:	None known			
3.3	Microclimate: * Data source: Met. Office, Annual Averages 1971 – 2000 *(Numbers in brackets give data as a % of national average)*	Description: The costal climate is mild and almost frost-free. Wind exposure is severe and airborne salts from the sea spray are prevalent.			
		Rainfall*	~1690mm (111%)	Days of Rain >= 1mm *	~250 (135%)
		Min Temp*	~6.4°C (160%)	Max Temp *	~12.3°C (117%)
		Days Ground Frost*	~15	Hours sunshine*	~1280 (110%)
		Prevailing Wind Direction:		Assumed south-west	

4.0	**Flora and Fauna**					
4.1	Vegetation on Building:	The wallheads had been naturally colonised with a number of plants and grasses. In the more sheltered areas there was evidence of natural seeding of trees.				
4.2	Surrounding Vegetation:	The site is surrounded by rough grazing leading to a rocky coastline.				
4.3	Species Survey. **D**=Dominant, **A**=Abundant, **F**=Frequent, **O**=Occasional, **R**=Rare, **VR**=Very Rare, *=Present					
	Common Name	Latin Name	N facing wall	S facing wall	Surrounding	Comment
	Grasses:					
	Mixed Grasses-Fescues		abundancy uncertain	abundancy uncertain		
	Ruderals:					
	Sea Plantain	*Plantago Maritima*	abundancy uncertain	abundancy uncertain		
	Tormentil	*Potentilla Erecta*		abundancy uncertain		
	Polypody	*Polypodium Vulgare*	abundancy uncertain	abundancy uncertain		
	Hairy Tare	*Vicia Hirsuta*	abundancy uncertain	abundancy uncertain		
	Black Knapweed	*Centaura Nigra*	abundancy uncertain	abundancy uncertain		
	Smooth Hawksbeard	*Crepis Capillaris*	abundancy uncertain	abundancy uncertain		
	Hawkbit	*Leontodon Pyrenaicus*		abundancy uncertain		
	Winter Heath	*Erica Carnea*		abundancy uncertain		
	Maidenhair Spleenwort	*Asplenium Trichomanes*		abundancy uncertain		
	Dog Rose	*Rosa Canina*		abundancy uncertain		
	Catchfly	*Silene Maritima*	abundancy uncertain			
	Yarrow	*Achillea Ordata*	abundancy uncertain			
	Sea Mouse-ear	*Cerastium Diffusum*	abundancy uncertain			
	Sow Thistle	*Sonchus Oleraceus*	abundancy uncertain			
	Dandelion	*Taraxacum Officinale*	abundancy uncertain			
	Trees:					
						In the more sheltered areas there was evidence of natural seeding of trees.

5.0	**Technique**	
5.1	Source of Technique:	The contractor contacted Becky Little, Rebecca Little Construction, who suggested some of the techniques used.
5.2	Season of Work:	Summer
5.3	Preliminary Repairs to Structure:	The wallheads were consolidated with hydraulic lime mortar and the joints re-pointed.
5.4	Treatment of Existing Vegetation:	The existing naturally established capping vegetation was fully removed, carefully stored and watered, so that it could be re-applied later. Ivy, which covered the eastern wall exterior and was patchy elsewhere, was completely removed (Fig. 19.1).
5.5	Soft Capping Technique:	A rounded clay capping was applied directly to the wallhead, the turf was then laid in a single layer and pinned.
5.6	Vegetation: Source and Description	The original vegetation, which had been removed and maintained, was reused. Additional turf was sourced from exposed areas of the island. This was high quality, well-established turf with a good root system and included heather, thyme and wild grasses.
5.7	Soil: Source and Description	The clay capping mix was 1:3, Errol clay:sharp sand.
5.8	DPC:	None used
5.9	Defining Membrane:	None used
5.10	Fixing:	The turf was pinned into place using hazel pegs.
5.11	Aftercare:	Unknown
5.12	Maintenance:	None
6.0	**Performance Assessment**	
6.1	General Performance:	The cappings have mostly been very successful, though there has been some variation in performance. Most failure was almost instantaneous, with the plants failing to root in and dying, primarily because of too much exposure or shelter. The failures were in specific areas, such as the sloping gables, pitch ~50degrees, which were extremely exposed to the elements.
6.2	Effect of Climate:	The wind proved to be the major factor in determining whether the turf survived or not. In one instance, on an exposed wall, a board fixed to protect the lime repairs also sheltered the turf from the wind. This turf survived considerably better than comparable exposed turf. There was also minor damage to the masonry caused by the salt crystallisation as the masonry dried out, though this is thought to have been primarily due to the protection of the lime work, rather than due to reductions in masonry moisture as a result of the soft cappings.
6.3	Effect of Birds:	The rock doves that inhabited the island were a problem. As they stood on the turf, their feet trampled the grass and their faeces also damaged the plants by toxic run off.
6.4	Effect of Animals:	None noted
6.5	Aesthetic Performance:	The works carefully preserved the appearance of a natural ruin.
6.6	Public Reaction:	None noted
6.7	Team Reaction:	The works are regarded as having been very successful. On future work DS would not remove non-damaging vegetation as it greatly increased the risk of failure. He would not try a different technique in harsh environments; on areas that failed he would allow the vegetation to reseed naturally.

6.8	Comments:	In retrospect, some of the natural cappings did not need to be removed to repair the masonry and their retention insitu would have reduced the problems of re-establishment in such an aggressive environment. This can be compared with the approach at Black Castle (CS13), where some areas were left undisturbed. The effect of salt crystallisation may be a common problem in coastal situations and a reminder that reducing the moisture in masonry through soft capping is not always beneficial and that each masonry element should be considered individually. While removal of the ivy will have increased the climatic exposure of the masonry, it will have reduced other possible decay forces and renders the ruin more readable. On the whole, the project is a good example of very careful site practice in respecting the character of the ruin.
7.0	**References:**	
	Interviews: Martin Hadlington. *Architect* Duncan Strachan, *Mason* Data: http://www.metoffice.gov.uk/climate/uk/averages/19712000/mapped.html	

Fig. 19.2: Aerial view from the south.

Fig.19.3: The north-west corner prior to repairs, with ivy threatening to conceal the architectural detail.

Fig. 19.4: A view of frozen conditions, unusual this close to the see in Argyll.

Fig. 19.5: Photo of upper west wall in 1971.

Fig.19.6: The natural turf capping gave good protection to the wallheads in exposed conditions, but left more slender masonry unprotected.

Fig.19.7: The window opening shown above, after the repairs and reinstatement of the original capping turf. This side is more sheltered than the seaward side.

Case Study 20: HUGH MILLER'S COTTAGE, Cromarty, Ross & Cromarty

This case study is an interesting example in two respects: it sits on a clay mortared wall and it is in an urban environment, surrounded by domestic gardens with potentially invasive species.

Fig. 20.1: Garden Wall, Hugh Miller's Cottage. South-east view, five years after capping. The turf has surprisingly little colonisation by garden species and much less than the adjacent stone coped wall.

1.0	**Background**		
1.1	Location:	Church Street, Cromarty, Black Isle, Ross-shire	
1.2	Grid Reference:	NH 7899 6738	
1.3	Date of Works:	September 2000	
1.4	Client:	National Trust for Scotland	
1.5	Contractor:	Rebecca Little Construction	
1.6	Architect:	N/A	
1.7	Access:	By arrangement	
1.8	Visit Record:	Date:	By:
		20.06.05	TM, EP, Martin Gorthwick, NTS Property Manager

2.0	**Building**		
2.1	Type:	Garden wall, originally a cottage gable wall built by Hugh Miller	
2.2	Classification:	Unclear, the cottage is Category A listed.	
2.3	Chronology:	Built:	19thC
		Ruined:	Not known
		Repairs:	Turf capped c. 1996, collapsed wall repaired 2002-04
2.4	Construction and Form:	The wall is constructed of clay and bool masonry, a local tradition of round rubble stones laid in clay mortar between temporary shutters. The wall is approximately 2.5m long, 2m tall and 400mm thick and is complete to wallhead level. There has been a variety of repairs, in cement in the lower section, latterly in lime and clay, in the upper section.	

3.0	**Site**				
3.1	Setting:	Description:	The wall is in at the bottom of a garden in a small town, with close shelter provided by gardens and buildings on all sides.		
		Altitude:	<10 m		
		Distance inland:	~100 m		
3.2	Classifications:	None			
3.3	Microclimate: * Data source: Met. Office, Annual Averages 1971 – 2000 *(Numbers in brackets give data as a % of national average)*	There are occasionally gales from the east, but little frost due to the proximity to the sea, which moderates the temperature. The worst weather occurs in February and March.			
		Rainfall*	~800mm (53%)	Days of Rain >= 1mm*	~150 (81%)
		Min Temp*	~4.9°C (122%)	Max Temp*	~10.6°C (100%)
		Days Ground Frost*	~80	Hours sunshine*	~1290 (111%)
		Prevailing Wind Direction:		Assumed south-west	

4.0	**Flora and Fauna**				
4.1	Vegetation on Wall:	A range of the normal grasses, mosses and wild flowers are joined on the wallhead by ornamental flowers, which have probably colonised from neighbouring gardens. There is no evidence of invasive seeding by trees although there are a large number of trees nearby. There are a number of dandelions growing in the wallhead, which are felt by the staff to be a problem.			
4.2	Surrounding Vegetation:	The surrounding gardens contain a wide variety of trees, flowers, shrubs and other plants.			
4.3	Species Survey. *Assessment by HL from photographs* **D**=Dominant, **A**=Abundant, **F**=Frequent, **O**=Occasional, **R**=Rare, **VR**=Very Rare, *=Present				
	Common Name	Latin Name	Capping	Surrounding Vegetation	Comment
	Grasses:				
	Red Fescue	*Festuca rubra agg.*	**D**		
	Cock's Foot	*Dactylis glomerata*	**O**		
	Ruderals/Herbs:				
	Dandelion	*Taraxacum officinale agg.*	**R**		
	Bush Vetch	*Vicia sepium*		*	
	Cabbage family sp.	*Cruciferae family sp.*	**R**	*	Purple flowered garden plant
	Broadleaved Willowherb	*Epilobium montanum*	**O**		
	Forget-me-not sp.	*Myosotis sp.*		*	Garden plant
	Foxglove	*Digitalis purpurea*		*	
	Greater Woodrush	*Luzula sylvatica*		*	
	Hedge Bindweed	*Calystegia sepium*		*	
	Herb Robert	*Geranium robertianum*		*	
	Iris sp.	*Iris sp.*		*	
	Sweet Cicely	*Myrrhis odorata*		*	
	Tutsan	*Hypericum androsaemum*		*	
	Yellow Archangel	*Galeobdolon luteum*		*	
	Trees/Shrubs:				
	Guelder Rose	*Vibernum opulus*		*	
	Hazel	*Corylus avellana*		*	
	Holly	*Ilex aquifolium*		*	
	Rose	*Rosa sp.*		*	Garden plant
	Rowan	*Sorbus aucuparia*	**R**	*	
	Mosses/Ferns:				
	Broad Buckler Fern	*Dryopteris dilatata*	**A**	*	
	Male Fern	*Dryopteris filix-mas*	**A**	*	
4.4	Fauna:	None noted			

5.0	Technique	
5.1	Source of Technique:	Rebecca Little Construction, a development of earlier techniques.
5.2	Season of Work:	Early autumn
5.3	Preliminary Repairs to Structure:	The walls suffered from instability and partial collapse as a result of leaching of the clay binder. Repairs and rebuilding of small areas were carried out, mainly to the lower areas.
5.4	Treatment of Existing Vegetation:	None known
5.5	Soft Capping Technique:	A shallow dome of tempered clay was applied to max. 100mm thick, with turf applied over in a single layer.
5.6	Vegetation: Source and Description	'Rough grass' cut locally.
5.7	Soil: Source and Description	The mix was 1:1, Errol clay:coarse sharp sand. This is richer than other mixes by the same contractor.
5.8	DPC:	None used
5.9	Defining Membrane:	None used
5.10	Fixing:	Timber pegs
5.11	Aftercare:	There was some watering while work continued on site.
5.12	Maintenance:	None recorded. The site has a gardener, who could carry out low-level maintenance.
6.0	Performance Assessment	
6.1	General Performance:	The capping has survived well, and would appear to have dramatically reduced the amount of precipitation penetrating the wallhead. The vegetation forms a thick root mat in sandy soil, ~50mm thick, covering the layer of clay beneath, which remains quite distinct, with little root penetration. The vegetation felt damp, but the clay layer was quite dry and formed a solid cap on top of the wall, with no root penetration through into the masonry. The vegetation forms a significant lip, overhanging the edge by 25-30mm. However the species vary between the two sides, with the south side dominated by mosses and the shadier north side having more grasses, growing to 600mm tall (Figs 20.5 and 20.6).
6.2	Effect of Climate:	The sheltered location has encouraged edge growth. While the climate is mild and coastal, the dominance of moss on the south side indicates that the rainfall is not high, at least through the summer.
6.3	Effect of Birds:	None noted
6.4	Effect of Animals:	None noted
6.5	Aesthetic Performance:	The visual appearance of the wall is in keeping with the rather rambling, intimate character of the garden.
6.6	Public Reaction:	None noted
6.7	Team Reaction:	None noted

6.8	Comments:	Although potentially damaging species have seeded in from the bio-diverse surroundings, the clay capping seems to have deterred root penetration, and combined with the turf it has prevented significant moisture penetration, fulfilling the principal intention of preventing further leaching of the clay wall mortar. The fine and dense Errol clay mix seems to have performed well here compared to other sites and to other walls on the same site (Fig. 20.1). Its density prevents root penetration and it absorbs excess precipitation, while the climate is sufficiently mild and sheltered to support a full cover of plants projecting over the edges, rather than dying back. This site shows that, under the right conditions, moss can come to dominate in a relatively short time and create very stable conditions. In this respect, this site bears comparison with Gordon Castle Estate (CS4), where climatic conditions are slightly less mild and sheltered, and there is more variation in edge cover. Although the rich seed bank of the neighbouring gardens seems to have had limited effect to date, it would be wise if species such as dandelions were occasional removed. The permanent staffing of this property would make this a simple task.
7.0	**References:**	
	Interviews: Rebecca Little, *contractor* Glyn Young, *NTS surveyor, client* Martin Gorthwick, *NTS site manager* Data: http://www.metoffice.gov.uk/climate/uk/averages/19712000/mapped.html	

Fig. 20.2: The south side has an open sunny aspect.

Fig. 20.3 The north side view, in contrast, has a damp, shady situation.

Fig. 20.4: South side. A variety of grasses and wild flowers grow out of a thick, mossy quilt.

Fig. 20.5: The south edge has a thick mossy overhang protecting the clay mortared masonry below.

Fig. 20.6: The north edge has a similar overhang, but containing much more grass.

Case Study 21: INVERLOCHY CASTLE (OLD), Inverness-shire

This case study is an interesting example of soft capping where cappings onto masonry can be compared with cappings onto bitumen-capped masonry.

Fig. 21.1: Inverlochy Castle. Naturalistic cappings viewed from the north.

1.0	**Background**		
1.1	Location:	Inverlochy, near Fort William, Inverness-shire	
1.2	Grid Reference:	NN 1203 7544	
1.3	Date of Works:	1997	
1.4	Client:	Historic Scotland	
1.5	Contractor:	Historic Scotland, Oban works squad	
1.6	Architect:	Historic Scotland, Michael Burgoyne	
1.7	Access:	Unrestricted public access to ground level	
1.8	Visit Record:	Date:	By:
		06.12.06	TM

2.0	**Building**		
2.1	Type:	Ruined Castle	
2.2	Classification:	Scheduled Ancient Monument, Secular	
2.3	Chronology:	Built:	c.1280-1306
		Ruined:	c. 1500
		Repairs:	There was romantic consolidation of some parapets during the Victorian era. Natural colonisation of the wallheads is recorded in a sketch from 1849 and this seems undisturbed in photographs from 1938, 1962 and 1976. Around 1996 a programme of repairs cleared the wallheads and consolidated them with lime mortar hard cappings, which were mostly covered in bitumen asphalt. These were subsequently considered unattractive and soft cappings were placed on top to conceal the bitumen caps.
2.4	Construction and Form:	The castle is roughly 30m square in plan, with a round tower in each corner. The wallheads are evenly ruined at walkway level, with varying remnants of parapets, and stand about 8m high and 2-3m thick. The walls are lime mortared rubble stone, repaired to a good condition. The castle was comparable in form to Black Castle (CS13), though it survives to a much greater extent.	

3.0	**Site**				
3.1	Setting:	Description:	The ruin is located on flat low ground close to a river. It is surrounded by maintained grass amid an industrial estate.		
		Altitude:	40m		
		Distance from Coast:	30km		
3.2	Classifications:	None known			
3.3	Microclimate: * Data source: Met. Office, Annual Averages 1971 – 2000 *(Numbers in brackets give data as a % of national average)*	The site is relatively sheltered with high mountains to the south-west, though the walls stand above neighbouring features and winds blow up the glen from the coast to the west. This site probably has the highest rainfall of all the case studies. Hard frosts are reported.			
		Rainfall*	~350mm (230%)	Days of Rain >= 1mm*	~260 (140%)
		Min Temp*	~3.7°C (93%)	Max Temp *	~11°C (104%)
		Days Ground Frost*	~110	Hours sunshine*	~1000 (86%)
		Prevailing Wind Direction:		Assumed south-west	

4.0	**Flora and Fauna**	
4.1	Vegetation on Wall:	The wall cappings are generally mature with a dense sward dominated by grasses. However there is some significant colonisation by other species, mainly at edges.
4.2	Surrounding Vegetation:	Mown grasses, species unidentifiable, together with rosette species - possibly Daisy, dominate the immediate surrounding area. Beyond this is a range of habitats. There are deciduous trees reasonably close to the ruin.

4.3 Species Survey. *Assessment by HL from photographs*

D=Dominant, **A**=Abundant, **F**=Frequent, **O**=Occasional, **R**=Rare, **VR**=Very Rare, *=Present

Common Name	Latin Name	Capping	Surrounding Vegetation	Comment
Grasses:				
Gorse	*Ulex europaeus*	**VR**		<30cm high
Hawthorn sapling	*Crataegus monogyna*	**VR**		1 x approx 50cm high
Willow sp. Sapling	*Salix sp*	**VR**		1 x approx 50cm high
Ruderals/Herbs:				
Common Bent	*Agrostis capillaris*	**A**		
Crested Dog's Tail	*Cynosurus cristatus*	**R**		
Red Fescue	*Festuca rubra agg*	**A**		
Trees/Shrubs:				
Dandelion	*Taraxacum officinale agg*	**R**		
Mouse-ear Hawkweed	*Pilosella officinarum*	**R**		
Ragwort	*Senecio jacobaea*	**O**		
Red Clover	*Trifolium pratense*	**O**		
Ribwort Plantain	*Plantago lanceolata*	**O**		
White Clover	*Trifolium arvense*	**O**		
Mosses/Ferns:				
Maidenhair Spleenwort	*Asplenium trichomanes*	**R**		
Moss sp	*Pleurozium schreberi*	**O**		

4.4	Fauna:	None known
5.0	**Technique**	
5.1	Source of Technique:	The technique followed the experimental work by Historic Scotland at Doune Castle Mill (CS15), but with modifications.
5.2	Season of Work:	Summer
5.3	Preliminary Repairs to Structure:	The wallheads were consolidated with lime hard cappings. All except the east wallheads were coated with bitumen asphalt.
5.4	Treatment of Existing Vegetation:	Naturally established cappings were extensive and will have been mature and bio-diverse, as they were around 500 years old. These were completely removed prior to the repairs.
5.5	Soft Capping Technique:	A layer of local topsoil was laid over the hard cappings, about 10mm thick and roughly level. This was covered with a single layer of turf.
5.6	Vegetation: Source and Description	The east wallhead used turf cut from a damp grassy area to the east of the ruin. The other wallheads used commercial turf from a local garden centre.
5.7	Soil: Source and Description	The soil was local topsoil.

5.8	DPC:	There is a bitumen layer under all except the east wallhead.
5.9	Defining Membrane:	None used
5.10	Fixing:	None used
5.11	Aftercare:	There was some watering of the turf through the summer.
5.12	Maintenance:	The turf was strimmed regularly for a period, though this has now ceased.
6.0	**Performance Assessment**	
6.1	General Performance:	The soft cappings have performed well in protecting the masonry beneath. Frost damage is evident to the lime hard caps and rough racking where they have not been protected by soft cappings. Though the bitumen caps must be more protective than the limecrete caps, there is no discernable difference in moisture in the masonry between these areas. This is surprising given the high rainfall, flatness of profile and lack of clay soil layer. The turf on the bitumen caps seems to get more saturated, though this may relate more to the greater degree of enclosure by parapet sides. The density of the grass sward, where it has not been worn away, has restrained invasive seeding, with uncapped areas attracting more shrubby plants. The soft caps have effectively concealed the bitumen caps, except where they have been worn away. The local turf has produced more bio-diverse caps, which seem more durable and have spread to adjacent areas.
6.2	Effect of Climate:	The soft caps do not seem to have suffered from the climate, though the high rainfall may make them more vulnerable to erosion by foot traffic. The flat profile and enclosing parapets will retain a greater proportion of rainfall on the caps, with minimal runoff onto the wall face.
6.3	Effect of Birds:	None noted
6.4	Effect of Animals:	None noted
6.5	Aesthetic Performance:	The caps are generally successful. The lack of caps on rough racked areas reduces the naturalistic impression, though this highlights the walkways and gives most protection to the most vulnerable masonry.
6.6	Public Reaction:	There is a lot of unauthorised public access to the wallheads, which has created paths where the grass has worn completely away. There has also been some vandalism, involving throwing turf off the wallheads, but this is reported to regenerate quickly. Though the masonry is robust, this is a roughly used site, with three suicides, including one by hanging from the works scaffolding.
6.7	Team Reaction:	The project is regarded as very successful.
6.8	Comments:	This monument is interesting in comparison to Skipness Castle (CS35), which has comparable, though more complex, wallhead conditions, greater wind exposure and a clay layer. At Inverlochy, the caps have only been applied to the walkway areas, which give a consistent presentation, though this leaves the other masonry vulnerable to frost damage and invasive seeding. The damage to the caps by unauthorised foot traffic is severe and there is no obvious physical solution to prevent this. This is the only new capping which has not used a clay underlayer and this does not seem to have affected the caps' performance. A clay layer may have reduced water penetrating the non-bitumen caps, though there is not evidence that this is currently significant. It should be noted that this site has high rainfall and flat profiles, so it is in need of a clay layer to act as a moisture reservoir during dry spells.
7.0	**References:**	
	Sources: RCAHMS Image, M Bouquet, 1849 (Ref PO 498286) Inverlochy Old Castle http://www.metoffice.gov.uk/climate/uk/averages/19712000/mapped.html Interviews: Michael Burgoyne, *Historic Scotland Architect* Lawrence Begg, *Historic Scotland works manager* Ginger Beaton, *Historic Scotland foreman*	

Fig. 21.2: Historic view, dated 1849.

Fig. 21.3: View from the north, 2006.

Fig. 21.4: Frost damage to lime mortared wallheads.

Fig. 21.5: Colonisation of edges of the west wall.

Fig. 21.6: The inner east face of the west wall.

Fig. 21.7: Colonisation of an uncapped section.

Fig. 21.8: The west wall.

Fig. 21.9: The south wall, isolated walkway capping.

Fig. 21.10: The west wall walkway leading to the south wall.

Fig. 21.11: The east wall walkway.

Fig. 21.12: The west wall walkway.

Fig. 21.13: East wall, bitumen exposed by foot traffic.

Fig 21.14: West wall, masonry exposed by foot traffic.

Case Study 22: KILBRANNAN CHAPEL, Kintyre, Argyll

This case study presents an interesting example where conservation cappings can be compared to natural cappings and uncapped wallheads.

Fig. 22.1: The chapel from the north-west.

1.0	**Background**				
1.1	Location:	Near Skipness Castle, Kintyre			
1.2	Grid Reference:	NR 905 575			
1.3	Date of Works:	Not Known			
1.4	Client:	Historic Scotland			
1.5	Contractor:	Historic Scotland, Lochgilphead works squad			
1.6	Architect:	Michael Burgoyne, Historic Scotland			
1.7	Access:	Un-restricted 24 hour access			
1.8	Visit Record:	Date:	By:		
		06.12.04	TM		
2.0	**Building**				
2.1	Type:	Chapel, ruinous			
2.2	Classification:	Scheduled Ancient Monument Category A Listed building			
2.3	Chronology:	Founded:	Circa 1400		
		Ruined:	1800s		
		Repairs:			
2.4	Construction and Form:	The chapel is a rectilinear building, measuring 25m from east to west and 8.2m transversely. The walls vary in thickness from 1.14 to 1.37m. The masonry is grey schistose rubble with red sandstone dressings and lime mortar. (Inventories of Ancient Monuments)			
3.0	**Site**				
3.1	Setting:	Description:	The chapel is situated on the west side of Loch Fyne, in a small walled graveyard, set amid pasture close by the shore. It is very exposed to the prevailing south-west winds.		
		Altitude:	2m		
		Distance from Coast:	100m		
3.2	Classifications:	None Known			
3.3	Microclimate: * Data source: Met. Office, Annual Averages 1971 – 2000 *(Numbers in brackets give data as a % of national average)*	The site enjoys the mild but wet Argyll climate. Although there is higher ground to the west, giving a little shelter from the Atlantic, the building is very exposed generally and especially to weather coming up the sea loch from the south.			
		Rainfall*	~1700mm (111%)	Days of Rain >= 1mm*	~185 (100%)
		Min Temp*	~6.2°C (155%)	Max Temp *	~11.8°C (112%)
		Days Ground Frost*	~40	Hours sunshine *	~1340 (115%)
		Prevailing Wind Direction:		South-west	

4.0	**Flora and Fauna**	
4.1	Vegetation on Wall:	There are four zones of wallheads. The two gables have been stripped of all vegetation. The north wallhead seems to have naturally colonised vegetation on rubble, comprising a range of plants among the dominant grass, with traces of the ivy that has generally been removed. The south-west wallhead has apparently been re-capped in recent years with clay and turf over a rubble wallhead. The south-east wallhead has also been re-capped, but this has a shallower profile and the outer section sits on flat sandstone copes. Both the new cappings are much less species diverse than the natural capping.
4.2	Surrounding Vegetation:	The graveyard enclosure is well tended, with close mown grass. The surrounding field is well grazed grass, while the beach edge becomes a little more diverse.
4.3	Species Survey. *Assessment by HL from Photographs* **D**=Dominant, **A**=Abundant, **F**=Frequent, **O**=Occasional, **R**=Rare, **VR**=Very Rare, *=Present	

Common Name	Latin Name	Capping	Surrounding Vegetation	Comment
Grasses:				
Common Bent	*Agrostis capillaris*	**R**		
Red Fescue	*Festuca rubra agg.*	**D**		
Ruderals/Herbs:				
Common Cat's Ear	*Hypocharis radicata*	**R**		Difficult to identify with certainty
Ivy	*Hedera helix*	**O**		Edge
Ragwort	*Senecio jacobaea*	**VR**		
Ribwort Plantain	*Plantago lanceolata*	**R**		
Trees/Shrubs: None noted				
Mosses/Ferns:				
Moss sp	*Polytrichum type*	**O**		Edge

4.4	Fauna:	None noted

5.0	**Technique**	
5.1	Source of Technique:	The technique was carried forward from the experimental work by Historic Scotland at Doune Castle Mill (CS15), but with some modifications and improvements. It is essentially the same as for Skipness Castle (CS35).
5.2	Season of Work:	Winter (September – March)
5.3	Preliminary Repairs to Structure:	There seems to have been minor lime mortar repairs associated with re-capping.
5.4	Treatment of Existing Vegetation:	Photographs indicate that significant ivy growth has been removed from on and around the west gable. These also record natural grass caps, which have been stripped. The natural cappings on the re-capped walls were removed as preparation.
5.5	Soft Capping Technique:	Clay, stiff from storage under cover, is worked up on boards by foot into blocks. This requires great effort and considerable time. These are laid over the bare masonry to achieve a roughly uniform section, to a min. 75mm thick. Hessian is used as a temporary cover to prevent drying out. Over this, a nominal 75mm topsoil is laid, sufficiently damp to be homogenous, followed by one layer of turf, with staggered joints, as one process in day sections. The turf is pegged against wind uplift.
5.6	Vegetation: Source and Description	The turf is assumed to be fresh and cut from a nearby field, grazed by sheep.
5.7	Soil: Source and Description	Topsoil is thought to have been sourced from the local Kilmartin Quarry, riddled to remove stones. The clay was excess Errol clay from Doune Castle Mill mixed with sand (1:4, Gallowflat red clay:sharp sand).

5.8	DPC:	Clay cap, see above
5.9	Defining Membrane:	None
5.10	Fixing:	Turf pegged at edges: twigs or metal hoops.
5.11	Aftercare:	None
5.12	Maintenance:	None
6.0	**Performance Assessment**	
6.1	General Performance:	The natural north wallhead capping is mature, with a dense sward (Fig. 22.8). There are remnants of the ivy, but these do not seem to be prospering in the dense mass of vegetation. The cap is in good condition and seems to be protecting the underlying masonry well. The south-west capping has taken well, forming a similar dense sward, but much less species diverse and dominated by grass, giving a very uniform appearance, reminiscent of the west wall of Skipness Castle. On the outside south edge, it sits ~50mm back from the stone edge. The capping edge is stable and mature, which suggests it may either have originally been finished to this line, or it stabilised several years ago, following initial dieback. The inner north edge is stable and finishes to the masonry edge. The south-east capping is generally sound and comparable to the south-west capping, but has an unstable outer south edge (Fig. 22.11). Here, the edge sits ~25mm back from the stone edge and is actively decaying, with exposed roots and soil ~ 50mm high. The inner north edge is stable (Fig. 22.12).
6.2	Effect of Climate:	The southern edges experience most exposure to wind and, combined with the fact that these are finished to an even line, this creates considerable stress on the capping edge, leading to decay away from the stone edge.
6.3	Effect of Birds:	None noted
6.4	Effect of Animals:	None noted
6.5	Aesthetic Performance:	The cappings generally appear as modest, naturalistic crowns to the masonry. The greater diversity on the natural cappings is more attractive than the rather monotonous appearance of the recent re-cappings. The modest wildness of the cappings seems more appropriate than the bare masonry of the gables, which stand out in some contrast, as do the close mown lawns in which the ruin is set.
6.6	Public Reaction:	None noted
6.7	Team Reaction:	The cappings are regarded as very successful.
6.8	Comments:	The wallheads are generously wide, comparable to Skipness Castle and this, together with the mild climate, contributed to the viability of the cappings. The severity of wind exposure is indicated by the decay of the south edge, but evidence suggests this should stabilise back from the edge. The smooth dressed stone copes clearly provide less microshelter than the less even rubble wallhead. This decay is comparable to the most exposed bare areas on Eilean Mor (CS1). The gables must be under considerable exposure to wind-driven rain, especially their south sides and soft capping would provide considerable protection, while also giving a more unified presentation to the monument. There seems no need to disturb the northern capping.
7.0	**References:**	
	Interviews: Lawrence Begg, *Historic Sscotland works manager* Robbie Wilson, *Historic Scotland foreman* Sources: Inventories of Ancient Monuments, Vol. 23 (1971): Argyll, Vol. 1, Kintyre, RCAHMS, The University Press, Glasgow http://www.metoffice.gov.uk/climate/uk/averages/19712000/mapped.html	

Fig. 22.2: A view of the chapel from the south-east.

Fig. 22.3: A view of the chapel from the south-west, 2006. The bare gable contrasts with the capped south wall.

Fig. 22.4: A view of the chapel from the south-west. The natural vegetation included considerable ivy on the west gable.

Fig. 22.5: Interior view, 2006.

Fig. 22.6: Interior view, date unknown.

Fig. 22.7: The natural cappings on the right and re-cappings on the left.

Fig. 22.8: The natural cappings have good benign species diversity.

Fig. 22.9: The junction between the south-west and south-east cappings.

Fig. 22.10: The junction between the south-west and south-east cappings.

Fig. 22.11: The decaying south edge on the south-east capping.

Fig. 22.12: The inner edge of the south-east capping.

Case Study 23: KILMORIE CHAPEL, Argyll

This case study illustrates the successful summer application of soft cappings onto steep, narrow masonry, thanks to benign climatic conditions.

Fig. 23.1: South-east view. The front gable and ledge, capped the year before, show some clay staining. The rear gable is natural vegetation and the side wallhead is three months old and already rooted in.

1.0	**Background**				
1.1	Location:	On the east side of Loch Fyne, Argyll			
1.2	Grid Reference:	NS 0108 9517			
1.3	Date of Works:	2003-06			
1.4	Client:				
1.5	Contractor:	Laing Traditional Masonry			
1.6	Architect:	Martin Hadlington			
1.7	Access:	Access to the graveyard is unrestricted			
1.8	Visit Record:	Date:	By:		
		28.07.05	TM, Jordan Peden (Laing Traditional Masonry)		
2.0	**Building**				
2.1	Type:	Chapel, ruined			
2.2	Classification:	Scheduled Ancient Monument (not listed)			
2.3	Chronology:	Built:	after 1543		
		Ruined:	abandoned in 1782		
		Repairs:	The walls are being consolidated during the current works. No previous repairs known.		
2.4	Construction and Form:	The chapel is a rectangular structure, ~6m. x 8m. with roughly flat wallheads on the east and west sides, ~750mm thick and 4m. high. Some dressed cap stones remain in place. The east and west gables rise at a pitch that varies between 45 and 60 degrees and the wallheads here are 600mm wide. These are very roughly racked. The south gable has a ~150mm deep ledge at ~4m above ground level on the outside face, formed by a thickening of the wall. The north gable has a similar ledge on the inner face. The walls are constructed from mainly schist and basalt rubble, with sandstone dressings, in lime mortar. The ruin was in an advanced state of deterioration when conservation work began in 2003. Work to the south gable, carried out in 2004, involved removal of mature trees and significant structural repair and consolidation. The work to the other walls, being carried out in 2005 when the site was visited, involved extensive masonry repair and consolidation.			
3.0	**Site**				
3.1	Setting:	Description:	The chapel ruin sits within a small historic graveyard, which has well mown grass and surrounded by mature trees, mainly sycamore, but also including beech and fir. Beyond the trees lies rough grazing and woodland.		
		Altitude:	~10 m		
		Distance from Coast:	<500 m		
3.2	Classifications:	None known			
3.3	Microclimate: * Data source: Met. Office, Annual Averages 1971 – 2000 *(Numbers in brackets give data as a % of national average)*	The site is on the east side of a sea loch in Argyll and therefore generally has a very mild and wet climate. However, locally the site is sheltered by trees and the topography, which reduce the power of westerly winds.			
		Rainfall*	~300mm (197%)	Days of Rain >= 1mm*	~250 (135%)
		Min Temp *	~5°C (125%)	Max Temp*	~11°C (104%)
		Days Ground Frost *	~200	Hours sunshine*	~1260 (109%)
		Prevailing Wind Direction:		South-west	

4.0	**Flora and Fauna**	
4.1	Vegetation on Wall:	*The South Gable* This wall was repaired in early spring 2004. Considerable vegetation was removed, including mature trees as well as grasses, shrubs and ruderals. The species mix would have been similar to those on the un-repaired north gable. *The East Wall Head* This wall was repaired around April 2005. The masonry was consolidated with lime prior to a capping, with a similar make-up to the previous gables. The profile was fairly flat. *The West Wall Head* This wall repair was just being completed in July 2005. The clay was soft and malleable, with a fine texture. *The North Gable* This wall was planned for repair later in 2005. There was vegetation over most of the wallhead, mainly grasses, but also nettles and mosses. The plants appeared well rooted in, with soil in the upper masonry joints and penetrating especially into the small material in the wall core.
4.2	Surrounding Vegetation:	The areas of turf sourcing were examined. The area lifted in spring 2004 had regenerated 60%. The area lifted in spring 2005 had regenerated 20%.

4.3	Species Survey. *Assessment by HL from photos* **D**=Dominant, **A**=Abundant, **F**=Frequent, **O**=Occasional, **R**=Rare, **VR**=Very Rare, *=Present										
	1=North Gable; 2=Ledge Capping at South Gable; 3=New Capping July 2005; 4=New Capping April 2005; 5=Surrounding Vegetation; 6=Area Where Turf Sourced April 2005; 7=Area Where Turf Sourced 2004; 8=Surrounding Turf Source Area. Note: Majority of the surrounding area is dominated by mown grasses - species unidentified										
	Common Name	Latin Name	1	2	3	4	5	6	7	8	Comment
	Grasses:										
	Common Bent	*Agrostis capillaris*	**R**		**A**	**A**	**F**	**D**	**A**	*	
	Red Fescue	*Festuca rubra agg.*	**F**				**F**				1 - Also on shelf at back
	Sweet Vernal Grass	*Anthoxanthum odoratum*	**O**	**R**	**F**	**F**			**O**	*	
	Yorkshire Fog	*Holcus lanatus*	**F**	**O**	**O**	**O**	**A**	**F**	**O**	*	
	Ruderals/Herbs:										
	Broadleaved Willowherb	*Epilobium montanum*	**R**	**R**							
	Common Birdsfoot Trefoil	*Lotus corniculatus*					**R**	**R**			
	Creeping Buttercup	*Ranunculus repens*	**O**		**R**	**F**	**O**				3+4 - Likely to die in dry conditions.
	Creeping Thistle	*Cirsium arvense*					**R**				
	Figwort	*Scrophularia nodosa*	**O**								
	Foxglove	*Digitalis purpurea*		**F**							
	Meadowsweet	*Filipendula ulmaria*					**A**			**A**	5 - Field in distance 8 – Large area nearby
	Nettles	*Urtica dioica*	**R**	**O**			**O**				
	Sheep's Sorrel	*Rumex acetosella*	**O**								
	Soft Rush	*Juncus effusus*					**O**			**A**	8 - Common
	Spear Thistle	*Cirsium vulgare*							**VR**		7 - Seeding to open area
	Trees/Shrubs:										
	Beech	*Fagus sylvatica*					**R**				
	Grey Willow	*Salix cinerea*					**R**			*	8 – 1 x 5m
	Larch sp	*Larix sp*					**R**				
	Oak sp	*Quercus sp.*					**R**				
	Sitka Spruce	*Picea sitchensis*					**A**				5 -Plantation in distance
	Sycamore	*Acer pseudoplatanus*					**F**				
	Mosses/Ferns:										
	Male Fern	*Dryopteris filix-mas*					**O**				
4.4	Fauna:	None noted									

5.0	**Technique**	
5.1	Source of Technique:	This work followed previous soft capping projects by the Architect, such as Gylen Castle (CS19)
5.2	Season of Work:	Spring and summer (Spring 2004, April – July 2005 and ongoing)
5.3	Preliminary Repairs to Structure:	The masonry was extensively consolidated with lime mortar.
5.4	Treatment of Existing Vegetation:	All existing vegetation was removed.
5.5	Soft Capping Technique:	1 layer of turf, ~100mm thick, pressed and pegged into 125-150mm tempered clay, which was finished 50mm from the edge (Fig. 23.5).
5.6	Vegetation: Source and Description	The turf was cut manually in a neighbouring field, selected to be close grazed and without nettles, rushes, etc. Some wildflowers were evident (Fig.23.6).
5.7	Soil: Source and Description	The clay mortar was mixed by a tractor in a local farmer's yard. The mix was 3:1, sharp sand:Errol clay.
5.8	DPC:	None used
5.9	Defining Membrane:	None used
5.10	Fixing:	Timber pegs
5.11	Aftercare:	The cappings were given a good watering after installation, but there was no other aftercare.
5.12	Maintenance:	None known
6.0	**Performance Assessment**	
6.1	General Performance:	*The South Gable* The capping had survived pretty well. The grass looked dry but alive, with growth to 300mm or so. There had been some edge dieback, mainly on the north side. There seemed to be some terracing on the steeper sections, but generally the survival on slopes up to 65 or 70 degrees was impressive (Fig. 23.4). *Edge Capping at South Gable* The edge capping was narrower than the wallhead capping and seemed to be in a similar condition. It had caused some clay staining to the lower masonry. *The East Wall Head* The capping seemed to be doing well, with lush green growth (Fig. 23.7).
6.2	Effect of Climate:	The climate was benign in available moisture and sheltered from the wind.
6.3	Effect of Birds:	None noted
6.4	Effect of Animals:	None noted
6.5	Aesthetic Performance:	The work has been successful in preserving the appearance of a well-conserved natural ruin, despite some minor clay staining on the south wall.
6.6	Public Reaction:	None noted
6.7	Team Reaction:	None noted
6.8	Comments:	The survival of plants on the steep gables was impressive, with climatic conditions more similar to Ardkinglas (CS30) than Eilean Mor (CS1).
7.0	**References:**	
	Interviews: Martin Hadlington, *Architect* Jordan Peden, *Mason* Data: http://www.metoffice.gov.uk/climate/uk/averages/19712000/mapped.html	

Fig. 23.2: North-east view. The repairs retain the appearance of a natural ruin.

Fig. 23.3: The foreground turf has recently been applied. The background turf is three months old, while the gable shows the natural vegetation in the process of removal.

Fig. 23.4: South gable at about 60 degrees, in good condition for midsummer.

Fig. 23.5: Typical locally cut quality turf dressed around a surviving copestone, set onto a clay cap that is held back from the edge to avoid an exposed cut turf edge.

Fig. 23.6: The source turf area nearby. The rear section was cut one year previously, the near section only four months before. Cutting turf in spaced rows would have further assisted regeneration.

Fig. 23.7: This turf capping was cut and fitted in April, four months before this image and has already rooted in and experienced good lush growth.

Case Study 24: KINLOSS ABBEY, Moray

This case study documents an interesting use of soft capping over asphalt membranes, and showed the only instance of vandalism of a soft capping.

Fig. 24.1: The vaulted aisle ruin from the south-west.

<table>
<tr><th>1.0</th><th colspan="5">Background</th></tr>
<tr><td>1.1</td><td>Location:</td><td colspan="4">Kinloss, Moray, within a public graveyard</td></tr>
<tr><td>1.2</td><td>Grid Reference:</td><td colspan="4">NJ 066 615</td></tr>
<tr><td>1.3</td><td>Date of Works:</td><td colspan="4">c. 1995</td></tr>
<tr><td>1.4</td><td>Client:</td><td colspan="4">Moray District Council</td></tr>
<tr><td>1.5</td><td>Contractor:</td><td colspan="4">Unknown</td></tr>
<tr><td>1.6</td><td>Architect:</td><td colspan="4">Uncertain, possibly Robin Kent</td></tr>
<tr><td>1.7</td><td>Access:</td><td colspan="4">Un-restricted 24 hour access</td></tr>
<tr><td rowspan="2">1.8</td><td rowspan="2">Visit Record:</td><td>Date:</td><td colspan="3">By:</td></tr>
<tr><td>19.10.06</td><td colspan="3">TM, Mike Penderey (Historic Scotland)</td></tr>
<tr><th>2.0</th><th colspan="5">Building</th></tr>
<tr><td>2.1</td><td>Type:</td><td colspan="4">Abbey, fragment, ruined.</td></tr>
<tr><td>2.2</td><td>Classification:</td><td colspan="4">Scheduled Ancient Monument
Category A Listed building</td></tr>
<tr><td rowspan="3">2.3</td><td rowspan="3">Chronology:</td><td>Founded:</td><td colspan="3">1150</td></tr>
<tr><td>Ruined:</td><td colspan="3">1650, the stones were used in the construction of another building.</td></tr>
<tr><td>Repairs:</td><td colspan="3">Work was carried out in 1995 to remove ivy and consolidate masonry. Further minor work was undertaken c. 2003.</td></tr>
<tr><td>2.4</td><td>Construction and Form:</td><td colspan="4">There are several standing fragments of the abbey. The most substantial fragment is engulfed by ivy and stands, inaccessible, on the edge of a public graveyard. Two smaller, but still substantial fragments, stand within the graveyard. One of these, a vaulted aisle fairly complete, with some appended structure, has been partly soft capped.</td></tr>
<tr><th>3.0</th><th colspan="5">Site</th></tr>
<tr><td rowspan="3">3.1</td><td rowspan="3">Setting:</td><td>Description:</td><td colspan="3">The aisle ruin stands centrally in a well-tended graveyard and, together with the other abbey remnants, lends the place considerable character.
‘The ground has always been fertile, and is well watered by a stream which passes close to the ruins’ McGibbon and Ross (1896).</td></tr>
<tr><td>Altitude:</td><td colspan="3">10m</td></tr>
<tr><td>Distance from Coast:</td><td colspan="3">~30km</td></tr>
<tr><td>3.2</td><td>Classifications:</td><td colspan="4">None known</td></tr>
<tr><td rowspan="5">3.3</td><td rowspan="5">Microclimate:
* Estimated from Met. Office, Annual Averages 1971 – 2000
(Numbers in brackets are % of national average)</td><td colspan="4">The graveyard is fairly open to the wind and very exposed to sun and rain. It also has a fairly high level of frost.</td></tr>
<tr><td>Rainfall*</td><td>~1060mm (70%)</td><td>Days of Rain >= 1mm*</td><td>~140 (76%)</td></tr>
<tr><td>Min Temp*</td><td>~3.8°C (95%)</td><td>Max Temp*</td><td>~11.4°C (109%)</td></tr>
<tr><td>Days Ground Frost*</td><td>~150</td><td>Hours sunshine*</td><td>~1240 (107%)</td></tr>
<tr><td colspan="2">Prevailing Wind Direction:</td><td colspan="2">Assumed south-west</td></tr>
<tr><th>4.0</th><th colspan="5">Flora and Fauna</th></tr>
<tr><td>4.1</td><td>Vegetation on Wall:</td><td colspan="4">The cappings are generally a dense sward of predominantly grasses, though with some other benign species, including sedum.</td></tr>
<tr><td>4.2</td><td>Surrounding Vegetation:</td><td colspan="4">The ruin is surrounded by well-maintained graveyard lawns, with woodland, arable fields and the overgrown other ruins beyond.</td></tr>
</table>

4.3	Species Survey. *Assessment by HL from Photos* **D**=Dominant, **A**=Abundant, **F**=Frequent, **O**=Occasional, **R**=Rare, **VR**=Very Rare, *=Present				
	Common Name	Latin Name	Capping	Surrounding Vegetation	Comment
	Grasses:				
	Common Bent	*Agrostis capillaris*	?		
	Perennial Rye Grass	*Lolium perenne*	?	*	Mown churchyard
	Red Fescue	*Lolium perenne*	?	*	Mown churchyard
	Ruderals/Herbs:				
	Bramble	*Rubus fruticosus agg*		?	
	Ivy	*Hedera helix*		*	Wall edge of building
	Ribwort Plantain	*Plantago lanceolata*	?	?	
	Cleavers	*Galium aparine*	?		
	Clover sp	*Trifolium sp*	?		
	Ragwort	*Senecio jacobaea*	?		
	Stonecrop sp	*Sedum sp*	?		
	Trees/Shrubs:				
	Ash	*Fraxinus excelsior*		*	
	Sycamore	*Acer pseudoplatanus*		*	
	Yew	*Taxus baccata*		*	
	Mosses/Ferns:				
	Moss	*Rhytidiadelphus squarrosus*	?		
	Male Fern type	*Dryopteris sp*		?	
4.4	Fauna:	None noted			
5.0	**Technique**				
5.1	Source of Technique:	Not known			
5.2	Season of Work:	Not known			
5.3	Preliminary Repairs to Structure:	There appears to have been some removal of earlier cement pointing and re-pointing in lime mortar.			
5.4	Treatment of Existing Vegetation:	Not known			
5.5	Soft Capping Technique:	Turf was laid over a layer of soil, in a generally flat profile.			
5.6	Vegetation: Source and Description	Not known			
5.7	Soil: Source and Description	Not known			
5.8	DPC:	The cappings are mainly laid over a geotextile layer, sitting on a bitumen asphalt membrane, which gently falls to lead lined drainage points.			
5.9	Defining Membrane:	None used			
5.10	Fixing:	Not known			
5.11	Aftercare:	Not Known			
5.12	Maintenance:				

6.0	**Performance Assessment**	
6.1	General Performance:	Generally the cappings have proved durable and attractive finishes to the bitumen roofing, while significantly reducing environmental stresses on the masonry. The cappings will dramatically reduce the rainwater runoff from the roof areas, given their flat profile and the relatively low rainfall on the site. This runoff reduction is very significant as the bitumen roofing drains to fixed points, where runoff would be concentrated, increasing surface erosion and risk of damage from freeze/thaw in a site with a high level of frost. These problems of focused runoff still exist, especially on the main vault, where runoff drains onto carved sandstone, which must be vulnerable to such decay mechanisms. It would be reasonable to assume that the soft cappings reduce rainwater runoff onto these stones by around 50%. The cappings will also significantly reduce the thermal flux of the bitumen membrane and vault masonry below. With higher than average maximum temperatures and a high level of frost, the dark bitumen would suffer considerable thermal stress if exposed, which would transfer to the masonry below. The capping should reduce this thermal flux by over 50%, significantly increasing the life of the membrane and reducing movement and frost damage to the masonry. The capping is generally lush and healthy, with little evidence of colonisation by damaging plants (Fig. 24.3). This is doubtless related to the significant exclusion zone created by the mown lawns of the graveyard. The dense sward must also inhibit colonisation, as there is some evident on other exposed masonry (Fig. 24.7). There is, however, severe local dieback to exposed edges. This affects the south edge of the main vault roof, where moisture is focused because of its fall, and there is considerable drying exposure from solar radiation and wind (Fig. 24.2). The edge here will suffer considerable variation between being very wet and very dry, with heat intensified by the adjacent black exposed bitumen. There has been some limited stabilisation by mosses, but the edge appears to be progressively decaying. On the same roof, under the tower, there is similar edge dieback on the south, and this has been exacerbated by the attentions of the local youth who have apparently pulled away the edge vegetation and geotextile (Fig. 24.6). It should be noted that the ruin generally has suffered severe acts of vandalism. The soft capping behind this area, within the tower, has died completely, due to lack of moisture and light. The capping to the top of the tower has suffered severe dieback to all sides, with every sign that this is progressive and caused by climatic exposure (Fig. 24.8). The greatest decay has been on the south-west side, which receives most wind, rain and sunshine.
6.2	Effect of Climate:	See 6.1
6.3	Effect of Birds:	None noted
6.4	Effect of Animals:	None noted
6.5	Aesthetic Performance:	The capping generally is very successful, though where it fails to conceal the bitumen the result is unsightly.
6.6	Public Reaction:	None noted
6.7	Team Reaction:	None known
6.8	Comments:	The general success of these cappings is severely impaired by the local edge failure and this is in part related to the membrane below. In milder climates, such as Inverlochy (CS21) or even Fraserburgh (CS39), such climatically caused failure has not occurred over membranes. Nonetheless the capping has performed better in protecting the masonry than clay/turf cappings on similar flat roofed vaults at Fraserburgh (CS39) and Monimail (CS26).
7.0	**References:**	
	http://www.kinlossabbey.co.uk/ McGibbon & Ross, The Ecclesiastical Architecture of Scotland, Vol. 1, p.416-421, 1896-7	

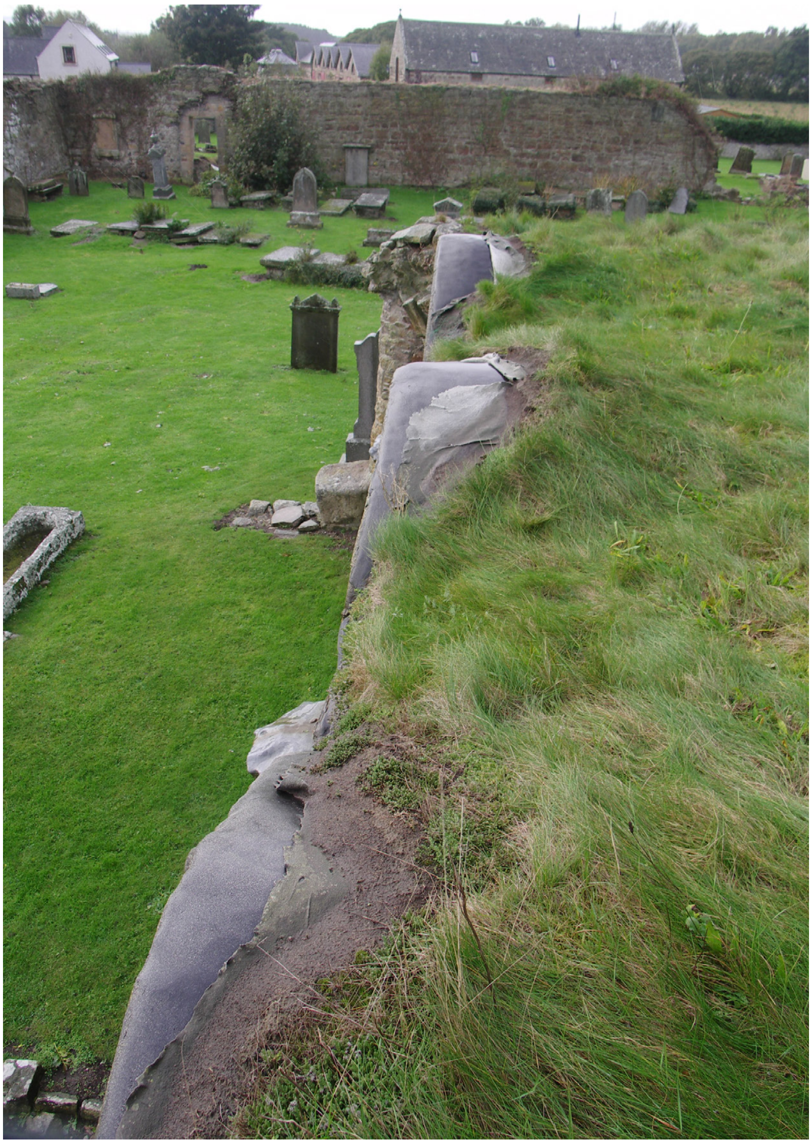


Fig. 24.2: The south edge of the main roof capping. There is some local stabilisation, especially by sedum.

Fig. 24.3: The main roof is generally in very good condition.

Fig. 24.4: The decay of the south edge of the main roof capping is unsightly from ground level.

Fig. 24.5: The main roof focuses drainage onto vulnerable dressed stones.

Fig. 24.6: The grass under the tower has died due to lack of rain, while the south edge has also been subjected by vandalism.

Fig. 24.7: The east side of the tower capping, with some colonisation of exposed rubble.

Fig. 24.8: The tower capping shows most severe decay to the south-west edge.

Fig. 24.9: One section where a bitumen roof is set in and has not been turf capped.

Case Study 25: LUSS KIRKYARD, Dunbartonshire

This case study documents some unusual conservation cappings on walls in a village graveyard.

Fig. 25.1: View from the north. The un-maintained soft cappings contrast with the mown lawns.

1.0	**Background**				
1.1	Location:	Kirkyard, St. MacKessog's Church, Luss, Argyll			
1.2	Grid Reference:	NS 3610 9286			
1.3	Date of Works:	Late November 2002			
1.4	Client:	Congregational Board of Luss Church, Church of Scotland			
1.5	Contractor:	Rebecca Little Construction			
1.6	Architect:	Thomson McCrea Architects, Historic Scotland advised			
1.7	Access:	Un-restricted access, in public graveyard.			
1.8	Visit Record:	Date:	By:		
		28.07.05	RL, TM		
2.0	**Building**				
2.1	Type:	Two low enclosure walls and two monument walls.			
2.2	Classification:	Category B listed : 14/05/1971(assumed)			
2.3	Chronology:	Built:	Probably 1778-1875		
		Ruined:	N/A		
		Repairs:	None known		
2.4	Construction and Form:	The two principal linear sections of wall run south-east to north-west and are ~5m and 18m long, 0.6m thick and 1.2m high. The walls are built of coursed schist rubble in lime mortar to a level head. Another two small, isolated sections of walls enclose memorial monuments, dated 1778 and 1789. These walls are ~3m long, 0.6m thick with rough racked sides that rise from the ground at 45 degrees to a flat central section about 1.2m above ground level. These walls are built of basalt and sandstone random rubble in lime mortar. The central memorial stones are sandstone.			
3.0	**Site**				
3.1	Setting:	Description:	The kirkyard is located on the south-west shore of Loch Lomond, in a small village with well-tended gardens. The graveyard has well-mown grass and is surrounded by mature mixed woodland.		
		Altitude:	~10m		
		Distance inland:	2km from the Clyde estuary, 50m from Loch Lomond		
3.2	Classifications:	None known.			
3.3	Microclimate: * Data source: Met. Office, Annual Averages 1971 – 2000 *(Numbers in brackets give data as a % of national average)*	The walls are fairly exposed to the sun, though they are sheltered from the wind by mature trees to the east, north and west and the church to the south. *'The climate is mild and temperate. Snow seldom lies many days on the low grounds. In severe winters, the degree of cold has been found to be considerably greater near Glasgow and Edinburgh than in this county. Hollies, and other plants in hedges and gardens, have there been killed by the frost, where here they remain unhurt. The mountains and woods break the force of the wind in every direction, and the exhalations from that part of the lake which never freezes, may perhaps likewise serve to temper the atmosphere.' (Statistical Account).*			
		Rainfall*	~1690mm (111%)	Days of Rain >= 1mm*	~190 (104%)
		Min Temp*	~5.6°C (140%)	Max Temp *	~10°C ? (95%)
		Days Ground Frost*	~120	Hours sunshine*	~1140 (98%)
		Prevailing Wind Direction:		South-west	

4.0	**Flora and Fauna**	
4.1	Vegetation on Wall:	Diverse grasses have been joined by occasional mosses, ivy and other woodland plants. There is one exotic sedum, perhaps seeded from a nearby garden.
4.2	Surrounding Vegetation:	The regular mowing of the graveyard grass inhibits colonisation by plants from the surrounding woodland.
4.3	Species Survey. *Assessment by HL from photographs*	

D=Dominant, **A**=Abundant, **F**=Frequent, **O**=Occasional, **R**=Rare, **VR**=Very Rare, *=Present

Common Name	Latin Name	Walls	Monuments	Surrounding Vegetation	Comments
Grasses:					
Common Bent	*Agrostis capillaris*	**R**	**O**	*	Surrounding vegetation is predominately mown grass
Perennial Rye Grass	*Lolium perenne*	**A**	**F**	*	
Red Fescue	*Festuca rubra agg*	**F**	**A**	*	
Sheep's Fescue	*Festuca ovina*		**R**	*	
Yorkshire Fog	*Holcus lanatus*	**O**	**R**	*	
Ruderals/Herbs:					
Bramble	*Rubus fruticosus agg*.	**O**		**R**	on edges and adjacent to walls
Broadleaved Willowherb	*Epilobium montanum*		**R**		
Cleavers	*Galium aparine*	**R**			on edges
Common Sorrel	*Rumex acetosa*		**R**		
Colorado Stonecrop	*Sedum spathulifolium*	**R**			not native
Creeping Buttercup	*Ranunculus repens*	**R**	**R**	**R**	at monument bases & in mown grass
Herb Robert	*Geranium robertianum*		**R**		at bases
Ivy	*Hedera helix*	**R**	**R**		
Nettle	*Urtica dioica*	**R**			at edges
Raspberry	*Rubus idaeus*			**R**	adjacent to wall
Wood Sorrel	*Oxalis acetosella*	**R**			at edge - dying
Trees/Shrubs:					
Lime sp.	*Tilia sp*.			**A**	
Maple - ornamental	*Acer sp*.			**R**	exotic
Sycamore sapling	*Acer pseudoplatanus*			**VR**	adjacent to wall
Whitebeam	*Sorbus aria agg*			**R**	
Mosses/Ferns:					
Lady Fern	*Athyrium filix-femina*		**R**		at base
Polypody	*Polypodium vulgare agg*.		**R**		

4.3	Fauna:	None recorded

5.0	**Technique**	
5.1	Source of Technique:	Rebecca Little Construction, a development of earlier techniques.
5.2	Season of Work:	Autumn
5.3	Preliminary Repairs to Structure:	Prior to the application of the capping the wall was consolidated and re-pointed with hydraulic lime mortar.
5.4	Treatment of Existing Vegetation:	None
5.5	Soft Capping Technique:	A layer of clay, ~ 50mm thick, was applied to the consolidated wallhead, giving the cap a flat profile. Two layers of turf were applied, root-to-root, with the clay acting as glue for fixing the turf, not as a waterproofing layer.
5.6	Vegetation: Source and Description	Mature lawn turf was lifted from the garden of the local minister. The grass was well-established, non-cultivated garden grass with a dense root system.
5.7	Soil: Source and Description	The clay mix was 1:2, Errol clay:coarse sharp sand.
5.8	DPC:	None used
5.9	Defining Membrane:	None used
5.10	Fixing:	Bamboo fixings were used
5.11	Aftercare:	None
5.12	Maintenance:	None known

6.0	**Performance Assessment**	
6.1	General Performance:	On the south-east wall, which is partly shaded, the grass forms an overhang of 10-25mm. The grass is well bonded, with no edge dieback. Brambles have invaded from the adjacent woodland, rooting into the cap (Fig. 25.3). The north-west wall cap displays some edge dieback, especially on the south side, with associated decay worst above joints in the head masonry, which has left some clay staining. Where gravestones stand in front of the wall, they have protected it, allowing greater edge overhang of grass (Figs. 25.4, 5 and 6). The south monument wall has some dieback at the edges, though the turf is generally well rooted into the clay layer (Figs. 25.8 and 9). The north monument wall is similar, but has some grass and one dock on the south side. It also shows some clay staining. Although well rooted in, the turf at the edge has died back and the clay here is dry, hard and cracked. There is some failure of the lime pointing on the west face (Figs. 25.10 and 11).
6.2	Effect of Climate:	The mild, sheltered climate has allowed the turf to become well established, with only mild dieback on south edges and no evidence of clay drying out.
6.3	Effect of Birds:	No recorded problems
6.4	Effect of Animals:	No recorded problems
6.5	Aesthetic Performance:	The caps are generally successful in maintaining a healthy sward in a site regularly visited by local people and visitors. The unkempt appearance of the cappings contrasts uneasily with the graveyards tidy mown lawns.
6.6	Public Reaction:	None recorded
6.7	Team Reaction:	The contractor was pleased with the success, which was attributed to the mild climate, good turf and season of application. Long-term maintenance was identified as an issue.

6.8	Analysis:	Although these cappings were applied late in the year, the proximity of the loch meant there was unlikely to be frost damage because of the mild climate and quality of turf used, in a way similar to Skipness Castle (CS35). The use of a flat profile and prioritisation of the performance of the turf over that of the clay was a significant development from the contractor's previous experience and has been successful. The flat profile retains more precipitation than a domed profile, reducing face runoff and sustaining vegetation, both of which may have contributed to a low rate of edge dieback. The thin layer of clay seems to have been adequate to prevent damage to the wallhead from moisture penetration, while being damp enough to allow the grass to root in well, without becoming too wet. The caps might benefit from light maintenance, with strimming after the grass has seeded, to bring their appearance more in tune with the tidy graveyard aesthetic. Control of the vegetation at the woodland edge and behind gravestones would remove the danger of invasive seeding.
7.0	**References:**	
	Interviews: Rebecca Little, *contractor* Sources: The statistical account of Scotland, drawn up from the communications of the ministers of the different parishes, (1791-9) Sinclair, J (Sir), Edinburgh, 17, 264	

Fig. 25.2: View of the wall with monuments behind.

Fig. 25.3: The south wall becomes engulfed by the surrounding woodland vegetation.

Fig. 25.4: North wall, 2002

Fig. 25.5: North wall, 2005.

Fig. 25.6: Edge decay seemed to be accelerated above masonry joints.

Fig. 25.7: The turf benefited from the shelter of gravestones, but this made invasive plants difficult to control.

Fig. 25.8: North monument, 2002.

Fig. 25.9: North monument, 2005.

Fig. 25.10: South monument, 2002.

Fig. 25.11: South monument, 2005.

Case Study 26: MELGUND CASTLE, Angus

This case study documents an interesting project site where natural soft cappings were reinstated through conservation works for intentional aesthetic effect, as well as to protect the masonry.

Fig. 26.1: Melgund Catle: the soft cappings contrast pleasantly with restored masonry.

1.0	**Background**		
1.1	Location:	~10km north-east of Forfar, Angus	
1.2	Grid Reference:	NO 5461 5633	
1.3	Date of Works:	1996	
1.4	Client:	Private client	
1.5	Contractor:	Ian Cumming	
1.6	Architect:	Benjamin Tindall Architects	
1.7	Access:	No public access	
1.8	Visit Record:	Date:	By:
		06.10.05	HL, EP, TM

2.0	**Building**		
2.1	Type:	Castle, part restored residence, part consolidated ruin.	
2.2	Classification:	Category A listed Scheduled Ancient Monument	
2.3	Chronology:	Built:	1534
		Ruined:	Before 1830. It was partly dismantled for building materials rather than being 'naturally' ruined.
		Repairs:	The castle was partly restored in the late 1990's. The soft toppings are located in areas that were consolidated in a picturesque ruinous condition.
2.4	Construction and Form:	The capped walls are on the rectangular wing, with a round corner stair tower. The walls, constructed of course pink sandstone rubble in lime mortar, vary between 0.7m to 1.4m thick and the caps' heights vary from 6m to approximately 12m. The soft cappings are mainly on consolidated rough racked rubble, but also, in places, onto wide sandstone parapet dressings.	

3.0	**Site**				
3.1	Setting:	Description:	Melgund Castle is set in well-maintained grounds amid arable farmland. There are woods to the east and a steep gorge immediately to the south.		
		Altitude:	~100m		
		Distance inland:	~16 km		
3.2	Classifications:	None known			
3.3	Microclimate: * Data source: Met. Office, Annual Averages 1971 – 2000 *(Numbers in brackets give data as a % of national average)*	The area has a dry climate, with the castle sheltered to the east by a band of small trees. Though the site is open to the south-west, the restored tower provides significant shelter to most cappings.			
		Rainfall*	~900mm (60%)	Days of Rain >= 1mm*	~130 (70%)
		Min Temp*	~4.1°C (101%)	Max Temp*	~11.0°C (105%)
		Days Ground Frost*	~140	Hours sunshine*	~1370 (118%)
		Prevailing Wind Direction:		South-west	

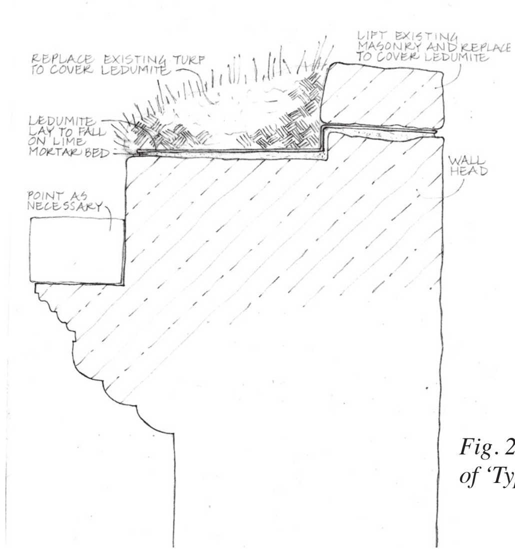
4.0	**Flora and Fauna.**	
4.1	Vegetation on Wall:	There is a variety of vegetation cappings in varying situations and conditions, some well established and others in decay. Grass species dominate and there is a clear difference between the areas with original topping turf and those that used ground-sourced turf.
4.2	Surrounding Vegetation:	The park grassland is regularly mown, with a number of ornamental trees scattered around the grounds. The surrounding fields predominately contained wheat.
4.3	Species Survey. *Assessment on site by HL, 06.10.05*	

D=Dominant, **A**=Abundant, **F**=Frequent, **O**=Occasional, **R**=Rare, **VR**=Very Rare, *= Present

Common Name	Latin Name	High Walls	By Entrance	Surr Veg.	Comment for surrounding veg
Grasses:					
Annual Meadow Grass	*Poa annua*			*	
Cock’s Foot	*Dactylis glomerata*	**F**	**A**	*	
Common Bent	*Agrostis capillaris*			*	Mown grass
Couch Grass	*Elytriga repens*		**R**		
Fescue spp.	*Festuca spp.*		**O**	*	Dominant in mown grass
Perennial Rye Grass	*Lolium perenne*		**R**		
Red Fescue	*Festuca rubra agg.*	**A**			
Sheep’s Fescue	*Festuca ovina*	**O**			
Smooth Meadow Grass	*Poa pratensis*	**O**	**R**		
Ruderals/Herbs:					
Azorella	*Azorella trifucata*			*	Garden sp by door
Broadleaved Dock	*Rumex obtusifolius*			*	
Cinquefoil sp.	*Potentilla sp.*			*	Garden sp by door
Common Mouse Ear	*Cerastium fontanum*			*	
Cow Parsley	*Anthriscus sylvestris*	**R**		*	Woodland below, to south
Cranesbill spp	*Geranium spp.*			*	Garden sp by door
Creeping Buttercup	*Ranunculus repens*			*	
Dandelion	*Taraxacum officinale agg*	**R**		*	
Field Forget-me-not	*Myosotis arvensis*			*	
Gooseberry	*Rubus uva-crispa*			*	
Green Alkanet	*Pentaglottis sempervirens*			*	Woodland below, to south
Groundsel	*Senecio jacobaea*			*	
Hedge Woundwort	*Stachys sylvatica*			*	
Herb Robert	*Geranium robertianum*			*	
Hogweed	*Heracleum sphondylium*			*	Woodland below, to south
Lady’s Mantle	*Alchemilla glaba*			*	
Lesser Burdock	*Arctium minusagg.*			*	

	Lithodora	*Lithodora diffusa*			*	Garden sp by door
	Nettle	*Urtica dioica*			*	
	Nipplewort	*Lapsana communis*	**R**	**VR**		
	Pineapple Weed	*Matricaria matricarioides*			*	
	Ribwort Plantain	*Plantago lanceolata*	**F**	**O**		
	Rosebay Willowherb	*Chamerion angustifolium*			*	
	Shepherd's Purse	*Capsella bursa-pastoris*			*	
	Smooth Sow Thistle	*Sonchus oleraceus*			*	
	Spear Thistle	*Cirsium vulgare*			*	
	Thyme	*Thymus praecox*			*	
	Wavy Bittercress	*Cardamine flexuosa*			*	
	White Clover	*Trifolium repens*			*	
	Wood Cranesbill	*Geranium sylvaticum*			*	
	Yarrow	*Achillea millefolium*	**O**			
	Trees/Shrubs:					
	Ash	*Fraxinus excelsior*			*	Woodland below, to south
	Beech	*Fagus sylvatica*			*	Woodland below, to south
	Broom	*Cytisus scoparius*			*	Woodland below, to south
	Elm	*Ulmus glabra*			*	Woodland below, to south
	Guelder Rose	*Viburnum opulus*			*	Woodland below, to south
	Hawthorn	*Crataegus monogyna*			*	Woodland below, to south
	Sycamore	*Acer pseudoplatanus*			*	Woodland below, to south
	Mosses/Ferns:					
	Brittle Bladder Fern	*Cystopteris fragilis*			*	
	Mosses		**R**			
4.4	Fauna:	None noted				

5.0	**Technique**	
5.1	Source of Technique:	The architects had not used soft toppings in this manner before, but their technique was based on a very long interest and some previous practical experience. There was a conscious intention to retain the picturesque aesthetic.
5.2	Season of Work:	Summer
5.3	Preliminary Repairs to Structure:	Intervention to consolidate the masonry with lime mortar varied in degree. In places, the top course of the wall was removed and a 'Ledumite' dpc applied, the masonry rebuilt and a planting bed formed in the middle.

5.4	Treatment of Existing Vegetation:	A natural build up of vegetation over more than 170 years, had created lush, well-established grass cappings on all wallheads, with occasional juvenile trees. The vegetation in photographs from 1990 was much as shown in etchings of c. 1887-92 and rather more than suggested by an etching of 1830. On most wallheads, the existing vegetation was stripped, stored on the scaffolding and watered. Before it was reapplied, undesirable and invasive species such as tree saplings were removed. Ledges with grass and minor shrubs growing on them remained untouched.
5.5	Soft Capping Technique:	Earth was used to fill in the centre of the capping and one layer of turf applied directly on top.
5.6	Sketch Section:	 *Fig. 26.2: Architects drawing of 'Typical Wallhead Section'.*
5.7	Vegetation: Source and Description	The high wallheads all apparently re-used the retained turf that had previously been removed. The lower gablet apparently used turf cut from the ground nearby.
5.8	Soil: Source and Description	The soil was sourced from the site and would have included sand, lime, rubbish, pigeon droppings and earth. The depth of the soil varies up to ~100mm on the wallheads and is ~300mm deep on the corner tower.
5.9	DPC:	A 'Ledumite' dpc was used in some areas. This proprietary bitumen coated lead is impermeable and highly malleable.
5.10	Defining Membrane:	None used
5.11	Fixing:	None thought to have been used.
5.12	Aftercare:	The turf was watered after application.
5.13	Maintenance:	No known maintenance. As a domestic residence, periodic removal of obvious tree saplings could be expected.

6.0	**Performance Assessment**	
6.1	General Performance:	There are five distinct areas of capping each of which merits separate analysis. However, we were often unable to be certain about the degree of intervention, the materials used and whether the contractor followed the architect's intentions. None of the conditions directly equate to the architect's typical detail. The low *North Gablet* has a rough racked head at ~45degree slope, ~ 5m long by 0.6m wide (Fig. 26.9). Species suggest that this was capped with ground cut turf. There does not appear to be a dpc. This wall is sheltered and shaded by the main body of the castle. Edge dieback is severe, with grass stabilised as a central strip 200-400mm wide. The *North Wallhead* has about 8m of roughly level masonry, with some steep broken sections (Fig. 26.7-8). It is ~0.8m thick and 6-8m high. A dpc has been applied and is covered with mortared stones presenting a broken profile. The caps are ~100mm thick. None of the caps are as lush or thick as the natural caps, though the best sections have no edge dieback. Dieback is worst on the higher and steeper sections, where the turf has completely failed and in places the mortar has fallen away, exposing the dpc (Fig. 26.10). There are some clumps of secondary growth of apparent re-colonisation of sheltered clefts. The *Internal Cross-wall* has a broken profile and is about 600mm thick. Fig. 26.14 from the west shows good coverage, but now the grass had retreated to the flat sheltered areas. That the photograph shows white clover flowers indicates that this capping was with ground turf. The *South Wall* has a consistent level profile, with a rubble inner edge, about 200mm thick, a little higher than the stepped sandstone copes that cap the outer 600mm (Figs. 26.12 and 13). The inner section has a dpc and occasional patches of turf surviving from apparently once full cover. The dressed copes have grass clumps in the more sheltered spaces. The 1990 pictures show a full lush covering, suggesting a significant depth of accumulated humus was removed during the works (Fig. 26.11). This section is the most exposed to the prevailing winds and is also reasonably exposed to the sun. It is seems likely that a narrow soft cap was applied to the inner face only, which has progressively failed and that the patches on the outer scopes have naturally re-colonised. The *Round Tower* in the north-east corner has a good full covering, consistent with all previous illustrations, though perhaps not as thick, suggesting some net removal of soil (Figs 26.15, 16 and 17). The turf forms a thick mat with roots penetrating 100-150mm into the soil (Fig. 26.18). The undisturbed turf on isolated ledges appeared healthy. Where visible, the soil was quite dry to touch and has a sandy texture.
6.2	Effect of Climate:	The greater exposure of the tall south wall seems to be reflected in a more advanced state of decay. However, the shelter of the north gablet has not prevented strong edge dieback. It is reported that gales in the first winter swept way some of the caps and this seems most likely to have affected these walls.
6.3	Effect of Birds:	No recorded problems
6.4	Effect of Animals:	No recorded problems
6.5	Aesthetic Performance:	The overall effect of the cappings is good in retaining the ruinous character through a programme of repairs. However, where the turf has failed and the mortar and dpc have become exposed, the result is unsightly.
6.6	Public Reaction:	None recorded
6.7	Team Reaction:	The application was felt to be successful by the client and architect. However, in retrospect it is thought that the sections where the turf has failed to establish should not have been attempted.

6.8	Comments:	This case study is generally successful in applying soft cappings to deliberately retain the naturally ruinous impression of colonisation of masonry by vegetation. The lack of significant aggressive colonisation in ten years, when the surrounding vegetation is very bio-diverse and there are mature trees adjacent to the cappings, is impressive. This suggests that the turf was well maintained on the scaffold and re-applied with a healthy dense root system. However it was significant that the caps did not achieve as good cover as the natural ones they replaced and there are several factors that may contribute to this. The use of ground turf, even from nearby, has clearly introduced species less well adapted to the stressed conditions on the wallheads. The apparent net removal of soil mass would have reduced the moisture reservoir on this relatively dry site and may have contributed to local soil staining (Fig. 26.16). The apparent use of a poor, sandy soil, containing alkaline lime construction debris may have retarded growth. The lack of any fixings also left the caps exposed to wind uplift. This is the only site where a proprietary dpc has been used. Where this is below a substantial course of masonry, it does not seem to have affected the performance of the capping. Where the covering of mortar and stone is thin, or where the vegetation may have been laid directly onto the dpc, the cappings have tended to fail. This may be linked to an intensification of both peak dryness and wetness at the edge. It seems unlikely that any toxicity of lead or bitumen would have had an effect in the ten years since application. There has been some failure of mortar on the wallheads and there are a number of possible contributory factors. The failure seems to have occurred subsequent to the loss of turf cover and to be focused on areas of shallow mortar and stone cover over the dpc. This suggests that the mortar here is more prone to saturation and frost damage, comparable to that at Drumin Castle (CS16). The turf is likely to have given some initial protection from moisture and cold, but it was difficult to directly compare a turf/dpc capping with a pure turf capping in respect of protection of the underlying masonry.
7.0	**References:**	
	Interviews: Ben Tindall, *Architect*. Martin Gregory, *Client* Sources: MacGibbon and Ross, D and T (1887-92) The Castellated and Domestic Architecture of Scotland from the Twelfth to the Eighteenth Centuries, 5v, Edinburgh, Vol. 4, 311-6, Tranter, N (1962-70) The Fortified House in Scotland, Edinburgh, Vol. 4, 139, RCAHMS photos; B456726N, B345674, B45684, B45673CN, B45677. Data: http://www.metoffice.gov.uk/climate/uk/averages/19712000/mapped.html	

Fig. 26.3: North view, June 1990.

Fig. 26.4: North view, October 2005, ten years after works.

Fig. 26.5: East view, June 1990.

Fig. 26.6: East view, October 2005. After ten years, there was little evidence of invasive re-colonisation.

Fig. 26.7: North wall, June 1990, the natural capping gives good edge cover.

Fig. 26.8: The best areas of the reinstated cappings give less protection than the original natural ones.

Fig. 26.9: The north gablet, edge dieback suggests there may be a central trough formed in the reconstructed masonry.

Fig. 26.10: North wall detail. There is extensive failure of lime mortar and soft cappings where these are thin over the ledumite dpc. Some re-colonisation of sheltered niches was evident.

Fig. 26.11: South wall, June 1990, with a thick natural capping.

Fig. 26.12: October 2005, a much sparser cap.

Fig. 26.13: The turf has retreated to the more sheltered areas.

Fig. 26.14: Internal cross-wall. The caps have largely failed, leaving isolated clumps in sheltered places.

Fig. 26.15: The north-east corner tower.

Fig. 26.16: There is some sign of soil staining about 1m below the cap.

Fig. 26.17: North-east tower. The turf dies away towards the narrow wallheads.

Fig. 26.18: North-east tower. The turf has a good root system.

Case Study 27: MONIMAIL TOWER, Fife

This case study is an interesting example where soft cappings can be compared on different types of structures, in different exposures on the same site and with the same technique.

Fig. 27.1: The gabled ruin, five years after soft capping.

<table>
<tr><td>1.0</td><td colspan="3">Background</td></tr>
<tr><td>1.1</td><td>Location:</td><td colspan="2">Monimail, by Letham, Fife</td></tr>
<tr><td>1.2</td><td>Grid Reference:</td><td colspan="2">NO 2983 1409</td></tr>
<tr><td>1.3</td><td>Date of Works:</td><td colspan="2">Gabled Ruin and Domed Vault: Spring 2000
Retaining Wall A: June 2000
Retaining Wall B: October 2000</td></tr>
<tr><td>1.4</td><td>Client:</td><td colspan="2">Monimail Tower Preservation Trust</td></tr>
<tr><td>1.5</td><td>Contractor:</td><td colspan="2">Rebecca Little Construction</td></tr>
<tr><td>1.6</td><td>Architect:</td><td colspan="2">Tom Morton</td></tr>
<tr><td>1.7</td><td>Access:</td><td colspan="2">Generally open to the public, though access is restricted at times.</td></tr>
<tr><td rowspan="2">1.8</td><td rowspan="2">Visit Record:</td><td>Date:</td><td>By:</td></tr>
<tr><td>18/03/05</td><td>TM, HL, EP</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>2.0</td><td colspan="3">Building</td></tr>
<tr><td>2.1</td><td>Type:</td><td colspan="2">Ruinous structures in the grounds of Monimail. Consisting of ruined gable walls forming, a semi-subterranean vaulted dome and a number of retaining walls.</td></tr>
<tr><td>2.2</td><td>Classification:</td><td colspan="2">Scheduled Ancient Monument
Category A listed</td></tr>
<tr><td rowspan="3">2.3</td><td rowspan="3">Chronology:</td><td>Built:</td><td>The Vault ~1520
Gabled Ruin 17thC
Retaining Walls: 18thC</td></tr>
<tr><td>Ruined:</td><td>The Vault ~1560
Gabled Ruin: 19thC
Retaining Walls: not ruined, but became roofless 20thC</td></tr>
<tr><td>Repairs:</td><td>2000</td></tr>
<tr><td>2.4</td><td>Construction and Form:</td><td colspan="2">The vaulted masonry chamber forms the base of a truncated tower, with traces of first floor walls, though the floor has been robbed out. It has a diameter of ~2.5m and walls with a thickness of 450mm. The walls are whinstone rubble with sandstone dressings in lime mortar. The ground level rises on the east side to the top of the structure. There is an opening on the west side that gives access to the interior.

The gabled ruin consists of two steeply sloping (~ 60degrees) ruinous gables with central chimneys rising to about 6m and two flat, low-level walls. The walls are mainly whinstone random rubble in lime mortar. The walls are ~500mm wide and have a number of window openings.

The retaining walls run in an L-shape with Wall A running to a higher enclosure wall and Wall B adjacent to the tower.</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>3.0</td><td colspan="3">Site</td></tr>
<tr><td rowspan="3">3.1</td><td rowspan="3">Setting:</td><td>Description:</td><td>The walls are situated in former estate grounds, surrounded by farmland. The gabled ruin and the vault are sheltered and shaded by a number of large trees that overhang the structures and a 4m high boundary wall running to the south of the site. The site is damp.

The retaining walls are slightly more exposed and in a drier environment, but are still sheltered by neighbouring buildings and vegetation</td></tr>
<tr><td>Altitude:</td><td>60m</td></tr>
<tr><td>Distance inland:</td><td>10km</td></tr>
<tr><td>3.2</td><td>Classifications:</td><td colspan="2">None</td></tr>
</table>

<table>
<tr><td rowspan="5">3.3</td><td rowspan="5">Microclimate:

* Estimated from Met. Office, Annual Averages 1971 – 2000

(Numbers in brackets give data as a % of national average)</td><td colspan="4">The site has low rainfall and is sunny, though the walls themselves are often shaded.</td></tr>
<tr><td>Rainfall *</td><td>~750mm (49%)</td><td>Days of Rain >= 1mm *</td><td>~132 (71%)</td></tr>
<tr><td>Min Temp*</td><td>~4.8°C (120%)</td><td>Max Temp *</td><td>~11.4°C (109%)</td></tr>
<tr><td>Days Ground Frost*</td><td>~130</td><td>Hours sunshine*</td><td>~1350 (116%)</td></tr>
<tr><td colspan="2">Prevailing Wind Direction:</td><td colspan="2">Assumed south-west</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>4.0</td><td colspan="5">Flora and Fauna</td></tr>
<tr><td>4.1</td><td>Vegetation on Wall:</td><td colspan="4">Vault: There is a continuous mass of turf with little or no dieback at the edges. The sempervivum are also well established and appear healthy, but have not contributed significantly to the success of the soft cappings.

Gabled Ruin: The vegetation on the gables is patchy with considerable dieback at the edges. On the window sills there has been complete failure of the turf and the clay is exposed and eroding.

On the low walls the vegetation is well established and lush. A number of other species of plants have colonised these areas. The wallheads are damp and blend in with the surrounding woodland.

Retaining Walls: Wall A demonstrates significant failure of the vegetation, with exposure of the underlying clay.

Wall B is quite well established, with only minor areas of failure. In general the capping appears to be retaining little moisture.</td></tr>
<tr><td>4.2</td><td>Surrounding Vegetation:</td><td colspan="4">The gabled ruin and vault are situated in an area that has low maintenance and is wooded. The area is quite damp and shaded, with lush vegetation.

The retaining walls are adjacent to an occupied building and are in an orchard area of grass and shrubs.</td></tr>
</table>

<table>
<tr><td rowspan="13">4.3</td><td colspan="5">Species Survey. Site Assessment by HL, 18/03/06
D=Dominant, A=Abundant, F=Frequent, O=Occasional, R=Rare, VR=Very Rare, *=Present</td></tr>
<tr><td>Common Name</td><td>Latin Name</td><td>Capping</td><td>Surrounding Vegetation</td><td>Comment</td></tr>
<tr><td colspan="5">Grasses:</td></tr>
<tr><td>Fescue spp</td><td>Festuca spp</td><td>D</td><td></td><td>Commercial turf</td></tr>
<tr><td colspan="5">Ruderals/Herbs:</td></tr>
<tr><td>Ragwort</td><td>Senecio jacobaea</td><td>*</td><td></td><td></td></tr>
<tr><td>Wild Strawberry</td><td>Fragaria vesca</td><td>*</td><td></td><td></td></tr>
<tr><td>Broadleaved Dock</td><td>Rumex obtusifolius</td><td>*</td><td></td><td>Well established</td></tr>
<tr><td>Rosebay Willowherb</td><td>Chamerion angustifolium</td><td>*</td><td></td><td>Well established</td></tr>
<tr><td>Teasel</td><td>Dipsacus fullonum</td><td>*</td><td></td><td>Well established</td></tr>
<tr><td colspan="5">Trees/Shrubs: None noted</td></tr>
<tr><td colspan="5">Mosses/Ferns: None noted</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td>4.4</td><td>Fauna:</td><td colspan="4">None recorded</td></tr>
</table>

5.0	**Technique**	
5.1	Source of Technique:	Rebecca Little Construction, development of earlier techniques.
5.2	Season of Work:	Vault and gabled ruin: spring Retaining wall A: summer Retaining wall B: autumn
5.3	Preliminary Repairs to Structure:	Gabled ruin: The walls were consolidated with mildly hydraulic lime mortar and any loose stones made stable. Vault: Minor mortar repairs were made to the soffit of the vault and the walls using a mildly hydraulic lime mortar and the top of the vault was covered with gravel to form a water-shedding slope. The retaining walls were consolidated with mildly hydraulic lime mortar.
5.4	Treatment of Existing Vegetation:	Gabled ruin: There was a large amount of ivy growing on the walls prior to the work being carried out. Although extensive, it was not significantly rooted in the wall. There were also some tree saplings and a variety of grasses. These were all removed prior to any works being carried out. Vault: Prior to work being carried out there was a great deal of naturally seeded grasses, moss and brambles that were growing on and over the structure. All of this was cleared, as well as ~400mm of soil that had built up on the soffit of the vault.
5.5	Soft Capping Technique:	Gabled ruin: A slightly domed capping of clay was put on the wallhead, on to which a single layer of turf was laid, with lapped joints to counteract shrinkage. Vaulted dome: An earth mortar (100-150mm thick) was applied to the top of the vault. Then the turf was applied in a single slightly overlapping layer. Retaining walls: The turf was placed on top of a thin, rounded layer of earth mix on the wallhead.
5.6	Vegetation: Source and Description	Gabled ruin: The turf used was commercially bought turf. It had a poorly established root system and contained a few potato-like roots. In the window pockets sempervivum was planted to see if it would establish over the longterm in dry locations. Vault: The turf was the same as that used for the gables. A few sempervivums were also planted as an experiment at the edges where dieback was expected. Retaining walls: Turf as above. No sempervivum were planted.
5.7	Soil: Source and Description	Gabled ruin: The soil mix was 1:2, Errol clay:coarse sharp sand. It was used both to create a more even base for the turf and as a waterproofing layer. Where there were large gaps and hollows in the wall, gravel was also used as filler. Vault: The earth mix was tempered with a proportion of grit: 1:2:1, grit (5-10mm) : coarse sharp sand : Errol clay. This mix was relatively lean in clay content and this reduced its waterproofing qualities. Retaining walls : A 1 Errol clay : 2 sand earth mix was applied.
5.8	DPC:	None used. The clay was intended to reduce the water penetrating through to the vault masonry, though complete waterproofing was not expected.
5.9	Defining Membrane:	None used
5.10	Fixing:	All structures: The turf was fixed at the outer edge with hazel pegs set in at a horizontal angle to minimise water ingress.
5.11	Aftercare:	Gabled ruin: Turf was watered whilst RLC was on site, for approximately two weeks. Vault: The turf was watered once a day for approximately a week immediately after it had been laid. Retaining walls: None
5.12	Maintenance:	None

6.0	**Performance Assessment**	
6.1	General Performance:	*Gabled ruin*: The work has been fairly successful, with the majority of the turf surviving. On the gable walls, the dieback is related to the steepness of pitch. The remaining turf is patchy and sparse but the clay layer remains, though this is now vulnerable to erosion. The flat surfaces have been very successful, especially the very sheltered ones, with a healthy layer of turf that is gradually being colonised by local plants. The lower wall is now overgrown with brambles and other species. *Vault*: This has generally been successful, with the turf looking healthy and becoming well established. The sempervivums grew very slowly and took a relatively long time to establish. After five years they could not yet be said to form a stable edge. The waterproofing effect of the clay seems to have reduced over time. Initially the vault dried out, but after two years some moisture began to penetrate through, though this was much less than before the capping. *Retaining walls*: The work on the wall was carried out in two stages in a moderately hot June and later in the following October. The earlier work was not very successful, with visible shrinkage and the turf failing to establish well, eventually becoming patchy with considerable dieback and erosion of soil. In contrast, the wall that was capped in October thrived.
6.2	Effect of Climate:	Moisture is a significant factor. The gabled ruin and vault are in areas that are very sheltered and shaded. Although they are rain-shadowed by trees, the lack of wind and sun means there is much less drying and their cappings have become better established than those of the open retaining walls. It is thought that the poor performance of retaining wall A relates to the summer application and that the comparative success of retaining wall B can be attributed to the wetter seasonal conditions at the time of application, in comparison.
6.3	Effect of Birds:	On the gabled ruin, the birds appeared to take the grit out of the mortar for nesting but they did not detrimentally affect the cappings.
6.4	Effect of Animals:	None noted
6.5	Aesthetic Performance:	The cappings to the gabled ruins perform well as naturalistic caps, with dieback gradually eroding the areas that are not viable in the long term and the healthy areas seeming stable. The nearby dead turf on the window sills is a little incongruous in comparison. The vault capping works well in revealing the form of the ruin more clearly than the natural vegetation did, albeit in a less romantic manner. This is an important fragment of the monument and the revealed form and first floor room walls increase its legibility. The retaining walls are a different type of structure, being really a roofless building, rather than a ruined wall. While the cappings perform reasonably well in the varied landscape of the former estate gardens, which are dotted with ruin fragments, there is an argument that a different technique should have been used to signal the difference. A sedum or moss capping may have presented a tighter finish to these complete walls, while performing better in the dry situation.
6.6	Public Reaction:	None noted
6.7	Team Reaction:	BL thought that the gable walls, although not totally successful, performed better than she had originally expected.
6.8	Comments:	The survival of turf on the gables is impressive, given the low rainfall and this can be directly attributed to the sheltered and shaded situation. Comparison can be made to the largely bare, exposed gable on Eilean Mor (CS1). It is interesting that there is little sign of colonisation of dead turf in the window sills. The penetration of some water through vault capping can be attributed to the lack of slope on the clay cap and its low clay content. The clay may suffer seasonal shrinkage, opening up cracks, which water can then penetrate, though this seems unlikely, given the shelter and shade. A layer of more pure clay may be all that is needed to give a better seal. Comparison can be made to The Wine Tower (CS39), which has a much more exposed situation. The retaining walls underline the difficulty of summer applications in low rainfall areas, especially where low quality turf is used. They also suggest the potential for using different types of capping on the same site, for presentational as well as microclimatic reasons. Overall, it is interesting to ponder the effects of climate on the different areas at Monimail, with Aberuthven, where a capping has survived less well, though it has conditions similar to the sheltered ones at Monimail and rainfall is somewhat higher. This cautions against simplistic analysis.

7.0	**References:**
	Interviews: Rebecca Little, *Contractor* Tom Morton, *Architect* Data: http://www.metoffice.gov.uk/climate/uk/averages/19712000/mapped.html

Fig. 27.2: Gabled ruin before the repairs.

Fig. 27.3: Gable ruin after capping, note early edge dieback.

Fig. 27.4: Gabled ruin, five years after application.

Fig. 27.5: Window sill detail, five years after application.

Fig. 27.6: Gable ruin, the low level walls after five years.

Fig. 27.7: Vault cleared of vegetation.

Fig. 27.8: Capping in progress.

Fig. 27.9: Capping five years after installation.

Fig. 27.10: Sempervivum fail to achieve a dense cover.

Fig. 27.11: Retaining wall A, application in June.

Fig. 27.12: Retaining wall B, application in October.

Case Study 28: THE NUNNERY, Iona, Argyll

This case study documents an aesthetically complex ruin, which had an intriguing experiment in soft capping, involving artificial soil improvement and grass seeding.

Fig. 28.1: The Nunnery from the east. The church is on the left, the Refectory on the right, with test areas hidden by its east gable.

1.0	**Background**		
1.1	Location:	Isle of Iona, Argyll	
1.2	Grid Reference:	NM28482409	
1.3	Date of Works:	1994	
1.4	Client:	Historic Scotland	
1.5	Contractor:	Historic Scotland	
1.6	Architect:	John Renshaw	
1.7	Access:	Un-restricted public access.	
1.8	Visit Record:	Date:	By:
		01.08.05	TM, Gordon Rutherford (Historic Scotland)
		20.08.05	HL
2.0	**Building**		
2.1	Type:	Nunnery, ruined	
2.2	Classification:	Category A listed 20/07/1971,	
2.3	Chronology:	Built:	Before 1200, rebuilding c. 1390
		Ruined:	Probably late 16thC. In 1688 there was a great bush of Deadly Nightshade growing in the cloisters, and travellers used to take pieces of it away with them as a charm. Burials of island women continued until around 1780. It was used as a quarry for local construction. In 1773 Doctor Johnson and Boswell found the nun's church used as a cow-house, with the sculptured stones buried a foot deep in dung and mire. In 1833 the splendid stone vaulted roof of the chancel collapsed and later the arches of the north aisle were built up to keep cattle out. By the mid 19thC 'no islander, alone after dark, would pass the ruins, which were believed to be haunted'.
		Repairs:	Partly restored, 1923, when a memorial garden was created within the ruin. The ruins are lightly maintained by Historic Scotland. GR reported that occasionally stones will fall off and that they will selectively remove plants if the occasion arises. Dandelions which grow on the high level walls in profusion are seen as a particular problem.
2.4	Construction & Form:	The Nunnery is the most elegant and one of the oldest buildings on Iona. The remains are substantial, though only one original small vaulted room remains fully enclosed, with another small room restored with a slated roof above. About half of the walls are evenly consolidated at low level with various amounts of vegetation established. About a third are at high level and fairly complete. The rest of the walls are rough racked at various heights. The Nunnery walls are constructed from pink granite blocks, with slate and schist pinnings and sandstone dressings, all in lime mortar. There have been a variety of repairs in cementitious mortar.	
3.0	**Site**		
3.1	Setting:	Description:	The Nunnery sits in the middle of Baile Mor, a small and dispersed island village. The beaches 200m away will supply some wind-blown sand. The local soil is reported to be very fertile.
		Altitude:	< 10 m
		Distance inland:	< 100 m
3.2	Classifications:	None known	

<table>
<tr><td rowspan="5">3.3</td><td rowspan="5">Microclimate:
* Estimated from Met. Office, Annual Averages 1971 – 2000
(Numbers in brackets give data as a % of national average)</td><td colspan="4">To the south and north are open fields, which afford little shelter. To the west of the village, rough hilly pasture rises higher than the ruin walls, affording some protection. To the east the village drops down to the shore, with the Ross of Mull a mile beyond. The island is not prone to frosts.</td></tr>
<tr><td>Rainfall*</td><td>~1550mm
(101%)</td><td>Days of Rain >= 1mm*</td><td>~210
(113%)</td></tr>
<tr><td>Min Temp*</td><td>~6.4°C
(160%)</td><td>Max Temp*</td><td>~11.9°C
(113%)</td></tr>
<tr><td>Days Ground Frost*</td><td>~30</td><td>Hours sunshine*</td><td>~1350
(116%)</td></tr>
<tr><td colspan="2">Prevailing Wind Direction:</td><td colspan="2">Assumed south-west</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>4.0</td><td colspan="5">Flora and Fauna Assessment by HL & TM</td></tr>
<tr><td>4.1</td><td>Vegetation on Wall</td><td colspan="4">The earliest known image of the Nunnery, a view from the north-east dated 1775 (Fig.28.4) (RCAMHS ref. AGD/24/104) shows it as a picturesque ‘natural’ ruin, a romantic object of interest, with shrubby vegetation consistently along the flat wallheads and as occasional clumps on sloping wallheads.

The ruins currently contain a complex variety of vegetation on some areas of naturally established cappings and some cleared wallheads, which have been re-colonised to different degrees. The focus of this case study is four test sections of soft capping which were applied to one of the high flat wallheads, at the west end of the south Refectory wall.

Dandelion, which occurs frequently throughout, appears to be well established and likely to be deep rooting into the wall.</td></tr>
<tr><td>4.1.1</td><td>Area 1: The High Level Walls around the Church, excluding the North Isle West Gable.</td><td colspan="4">These walls are ~ 600mm thick and the flat wallheads stand at ~4m. with the east and west gables rising at ~50degrees to ~ 7m.

A photograph from the north-west dated 1888 (RCAHMS Ref: AG/7103) shows apparent consolidation of the church and adjacent wallheads, with mortar stains over the upper ~600mm and no vegetation whatsoever. It must be assumed that a layer of naturally established vegetation had recently been removed, though no written record remains of this work. By 1900 (AG/6069) some vegetation can seen to have re-established on the flat wallheads, isolated tall shrubs and clumps of grasses, presumably seeded into cracks in the mortar repairs. join here

By 1973 (Fig. 28.6) (RCAHMS Ref: AG/512) this has grown into a thin, apparently complete covering of the flat wallhead, with occasional clumps of tall shrubs (possibly nettles). Such clumps also appear on the west gable. By 1981, however, no vegetation can be seen on any of these wallheads. As the same photographs apparently show a progressive growth of vegetation in other areas, it is reasonable to conclude that the high level walls have had their vegetation deliberately removed, though there are no indications of other repairs.

When visited, in 2005, some natural re-colonisation was evident. At the west end, outwith the church, there was sporadic scattering of occasional Mountain Sorrel, Ivy-leaved Toadflax and Smooth Meadow Grass Rare. On the high church wall (observed from ground) there was a scattered open cover of Fescue species, with Autumn Hawkbit rare.

On the gables at either end of church (west side to north) there was occasional patchy Ivy-leaved Toadflax; to the south patches of dense grassy mix of Fescue spp and Smooth Meadow Grass; on the east side only very rare Ivy-leaved Toadflax. In addition on this east side there was a small ledge with patches of Ivy-leaved Toadflax.</td></tr>
<tr><td>4.1.2</td><td>Area 2: The North Aisle West Gable.</td><td colspan="4">This wall slopes at ~40degrees, with a rough rubble head. In 1775 this has a covering along its full length, in the centre of the wall. By 1888 it has a complete capping, apparently mixed species, but with a mass of fine grasses. This section can be consistently charted through the record of photographs to the date of our inspection as an example of a naturally established capping, dating back several hundred years.

This capping, ~125mm thick, seems to be a mature and stable mixture of species forming a dense and thick matt that effectively binds and protects the wallhead stones, dominated by Red Fescue interspersed with frequent Ribwort Plantain and Dandelion. The edges in particular show a dominance of mosses and lichens, the centre has more fine grasses. There are a fair number of dandelions, but they do not appear to be thriving. The root system is dense, about 75mm thick and well established. The soil was fine textured.</td></tr>
</table>

4.1.3	Area 3: The South-west Cloister Walls.	These walls are complete to a rubble wallhead at ~4.5m above ground level. They are ~600mm thick. The limited archival information shows an apparently mature, mainly grass capping in 1981 and 1997. This area was not inspected closely, but appears to have a consistent, mature, flatly domed capping, rising to perhaps 150mm. Fine grasses apparently dominate, but there are wild flowers and some dandelions. When surveyed, the west wall and western half of the south wall had a dense mat of abundant Red Fescue interspersed with frequent Smooth Meadow Grass and occasional Sweet Vernal Grass; a small amount of Lady's Bedstraw on edges. Dandelion was frequent throughout. On the south wall, east end, there were several roses (30-40cm high) and also one *Cotoneaster Simonsii* (30-50cm high). All these shrubs appeared well established and rooted into the wall. There were also frequent patches of Lady's Bedstraw. Beneath these lay a thin grassy mat with frequent Red Fescue and occasional Smooth Meadow Grass. Dandelion is frequent throughout.
4.1.4	Area 4 : Refectory Walls, excluding test sections.	This section comprises one flat rubble wallhead at ~4.5m and two gables, which retain their skew stones and are well pointed, rise at ~50 degrees. The walls are ~800mm thick. This area is not well recorded in the archive images. In 1981 the flat wallhead had inconsistent and clumpy vegetation, while the gables had occasional clumps. The vegetation on the flat south wallhead shows a bare area towards the east gable, suggesting local wind action. Otherwise there is a consistent capping of grasses and wild flowers covering to ~50mm from the edge. The cappings have been badly invaded by woody shrubs, especially roses from the amenity planting. The gables have occasional clumps in the rubble joints. When surveyed, the flat wallheads had Dandelion abundant throughout. Adjacent to Area 5 there are two established roses (with hips) and another rose 2m further east (30-40cm high); There was also one large, well established and rooted perennial plant (yet to be identified) (50cm+ high). Polypody fern and Autumn Hawkbit were occasional; beneath lay an open grassy mat dominated by Red and Sheep's Fescue. The vegetation becomes more sparse towards the eastern end of the wall. On the west gable, the north side was clear apart from abundant well established Dandelion and occasional Autumn Hawkbit. The west gable south side was also clear apart from frequent Dandelion. The east gable, north side, was clear with dense patches of Ivy-leaved Toadflax above, and very occasional Dandelion below, as well as one small patch of Yorkshire Fog. The south side was clear except for one patch of Ivy-leaved Toadflax at the top and rarely Dandelions.
4.1.5	Area 5: The Test Sections. *(Note: There was some difficulty in establishing the exact boundaries of each test area)*	*Test A* had a close matt of grass, though it had evidently lost some soil, as this was thin. The species were dominated by grasses and the capping managed to reach a little nearer the edge of the masonry than the natural cappings. It was inspected by John Renshaw after eleven months, when it was described as having been adversely affected by drought, patchy and thin, but that the soil stabilisation was helping prevent erosion. In 2005 it seemed well established, though was a little yellower than Test B. This section had very little invasion by other species, which was a problem on nearby areas. Mix of frequent Clover cultivar, Dandelion and patches of Lady's Bedstraw; Ribwort Plantain is rare. Beneath is some patchy Red Fescue. There was also Yarrow (in flower). *Test B* was in good condition, with greater species diversity and less thickly matted grasses and roots than test A. This also reached nearer the edge than the naturally established caps, non-grass species reaching the edge and even projecting 40mm or so over one side. The cap on the domed section was a little less well established. This was a very uniform area, overwhelmingly dominated by Fescue spp with very occasional Poa sp. Other species were rare. There were two small holes in the grass mat, one possibly the result of Ribwort Plantain dying, assumed due to dry conditions. *Test C* had not established well, with little density of grass or root, considerable invasion by rooty shrubs and areas of exposed soil and vulnerable masonry. It was less protective than the natural cappings. This area had mixed dominance of frequent Dandelion interspersed with frequent Clover cultivar; one dense patch of Common Bird's Foot Trefoil on north side of wall. Ribwort Plantain was frequent throughout.

4.1.6	Area 6: Low Walls.	The low walls seem to be well established with dense rooted benign species in many locations. Old photographs would indicate that the walls were previously consolidated. On the east lower walls, there was a relatively dense, grassy mat (mown recently) – mix of abundant Red Fescue, some Sheep's Fescue interspersed with frequent, well established Red Clover, together with some Lady's Bedstraw (generally on the edges). Dandelion and Ribwort Plantain were scattered throughout. On the northern edge, were two well established Geranium sp (garden escape). In places, occasional mosses beneath where relatively open grassy mat. There was one Ragwort, though the taproot did not appear to be penetrating into wall. On the south lower walls there was a dense, grassy mat, a mix of abundant Red Fescue interspersed by frequent Red Clover, with occasional small patches of Snow-in-Summer on edges. On the gable sloping to south, there was sporadic vegetation in cracks and ledges. The lower section had abundant Dandelion with occasional Ivy-leaved Toadflax and Red Fescue. The upper section had a small amount of White Stonecrop together with Mouse Ear Hawkweed. The narrow section of high wall adjacent to the gable had a grassy mat dominated by Red Fescue, some Sheep's Fescue, occasional Dandelion and also White Stonecrop rare.
4.2	Surrounding Vegetation:	The ruin grounds include mown lawns and ameniety gardens. These and the village gardens contain a variety of native and exotic species. Beyond the village is sheep grazed grassland.

4.3 Species Survey. *Site Assessment by HL, 20.08.05*

D=Dominant, **A**=Abundant, **F**=Frequent, **O**=Occasional, **R**=Rare, **VR**=Very Rare, *****=Present

Flora on Cappings

1=Area 1, lower walls to west side; 2=Area 1, main higher wall (seen from distance); 3=Area 1, gables (seen from distance); 4=Area 2; 5=Area 3, west side and part south; 6=Area 3, south adjacent to area 4; 7=Area 4, wall; 8=Area 4, gables; 9=Area 5, test A; 10=Area 5, test B; 11=Area 5, test C; 12=Area 6, lower wall east; 13=Area 6, lower wall south; 14=Area 6, slopes above; 15=Area 6, top

Common Name	*Latin Name*	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9 A**	**10 B**	**11 C**	**12**	**13**	**14**	**15**
Grasses:																
Cock's Foot	*Dactylis glomerata*												**R**			
Red Fescue	*Festuca rubra*		**O**	**O**	**D**	**A**	**F**	**F**	**R**	**O**	**D**		**A**	**A**	**O**	**D**
Sheep's Fescue	*Festuca ovina*		**O**			**F**	**O**	**O**					**O**			**R**
Smooth Meadow Grass	*Poa pratensis*	**R**		**O**							**R**		**R (e)**	**R**		
Sweet Vernal Grass	*Anthoxanthum odoratum*					**O**										
Yorkshire Fog	*Holcus lanatus*								**R**							
Ruderals/Herbs:																
Autumn Hawkbit	*Leontodon autumnalis*		**R**			**R**		**O**	**R**							
Bloody Cranesbill	*Geranium sanguineum*												**O**			
Broadleaved Willowherb	*Epilobium montanum*							**R**								
Buck's Horn Plantain	*Plantago coronopus*										**R**					
Common Bird's Foot Trefoil	*Lotus corniculatus*											**F**				
Dandelion	*Taraxacum officinale*				**F**	**F**	**F**	**A**	**A**	**F**	**R**	**F**	**O**	**O**	**A**	**O**

Ivy-leaved Toadflax	*Cymbalaria muralis*	**O**		**O**	**R**	**VR (e)**			**O**		**R**				**O**	
Lady's Bedstraw	*Galium verum*					**R**	**F**	**R**		**F**	**VR**		**O**			
Mountain Sorrel	*Oxyria digyna*	**R**														
Mouse Ear Hawkweed	*Hieracium pilosella*												**R**		**R**	**R**
Orpine	*Sedum telephium*					**R**										
Ragwort	*Senecio jacobaea*												**R**			
Red Clover	*Trifolium pratense*												**A**	**A**	**R**	
Red Valarian	*Centranthus ruber*							**VR**								
Ribwort Plantain	*Plantago lanceolata*				**F**	**F**				**R**	**R**	**F**	**O**			
Snow in summer (exotic garden escape)	*Cerastium biebersteinii*													**O**		
White Clover Cultivar (commercial)	*Trifolium repens*									**F**	**VR**	**F**				
White Stonecrop	*Sedum alba*														**O**	**R**
Yarrow	*Achillea millefolium*									**R**		**R**				
Ferns and Mosses:																
Mosses	*Unknown*				**R**	**R**		**R**					**R**			**R (e)**
Maidenhair Spleenwort	*Asplenium trichomanes*				**R**	**R**									**R**	
Polypody	*Polypodium vulgaris agg*				**R**	**R**		**O**								
Shrubs:																
Cotoneaster	*Cotoneaster simonsii*						**R**									
Rose sp. (30-40 cm high)	*Rosa canina agg*						**F**	**3 x**								

Flora on Surrounding Vegetation			
Common Name #= exotic garden plant	Latin Name	Surrounding Vegetation	Comment
Grasses:			
Common Bent	*Agrostis capillaris*	**O**	Lawn
Couch Grass	*Elymus repens*	**R**	Beds
Perennial Ryegrass	*Lolium perenne*	**D**	Larges areas of mown grass
Red Fescue	*Festuca rubra agg.*	**F**	Beds/Rocks on edge of beds

	Ruderals/Herbs:			
	Autumn Hawkbit	*Leontodon autumnalis*	**R**	Beds
	Azorella #	*Azorella trifucata*	**R**	Beds
	Broadleaved Willowherb	*Epilobium montanum*	**R**	Beds
	Cleavers	*Galium aparine*	**R**	Beds
	Common Sorrel	*Rumex acetosa*	**R**	Beds
	Daisy	*Bellis perennis*	**O**	Lawn
	Dandelion	*Taraxacum officinale agg.*	**O**	Lawn and Beds
	Cranesbill #	*Geranium spp*	**O**	Beds. Several garden sepcies
	Granny's Bonnet #	*Aquilegia sp.*	**R**	Beds
	Ground Elder	*Aegopodium podagraria*	**O**	Beds
	Hedge Bindweed	*Calystegia sepium*	**R**	Beds. Invasive.
	Hollyhock #	*Althaea sp*	**R**	Beds
	Lady's Bedstraw	*Galium verum*	**O**	Beds
	Lady's Mantle	*Alchemilla glabra*	**R**	Lawn
	Mouse Ear Hawkweed	*Hieracium pilosella*	**R**	Rocks on edge of beds
	Nettles	*Urtica doica*	**O**	By shed
	Orpine	*Sedum telephium*	**R**	Beds
	Roses #	*Rosa spp.*	**O**	Beds. Various shrub rose spp.
	Smooth Sow Thistle	*Sonchus oleraceus*	**R**	Beds
	Snow in Summer #	*Cerastium biebersteinii*	**O**	Beds
	Stonecrop sp.#	*Sedum spathulifolium*	**R**	Beds
	Ivy-leaved Toadflax	*Cymbalaria muralis*	**O**	Beds
	Tutsan	*Hypericum androsaemum*	**R**	Beds
	Trees/Shrubs:			
	Escallonia #	*Escallonia*	**O**	By shed
	Fuchsia #	*Fuchsia sp*	**R**	Beds
	Hebe #	*Hebe*	**O**	By shed
	Mosses/Ferns:			
	Maidenhair Spleenwort	*Asplenium trichomanes*	**R**	Rocks on edge of beds
4.4	Fauna:	None noted		

5.0	**Technique**	
5.1	Source of Technique:	
5.2	Season of Work:	September
5.3	Preliminary Repairs to Structure:	It had been anticipated that the core mortar on the wallhead would have decayed and that significant rebuilding would be necessary, but when it was exposed, the mortar was found to be sound and only minor consolidation of top stones was required. There had also been some local areas of washed out mortar, which were repaired. It was on this basis that the wallhead masonry generally was considered to be in good condition and that the rest of the natural capping therefore did not merit removal.
5.4	Treatment of Existing Vegetation:	The naturally established caps were removed and any deep roots cut out.
5.5	Soft Capping Technique:	The tests are three adjacent sections on the roughly flat Refectory south wallhead, ~800mm wide. The tests were applied in 1994 and inspected eleven months later. The tests were designed, supervised and inspected by John Renshaw. *Test A.* The jute mesh was fastened to the wallhead core masonry on one side, followed by a shallow dome of soil, finishing 50mm from the stone edge. The grass seeds were sown by hand and two layers of jute mesh was then laid over and pegged. *Test B.* The jute mesh was fastened to the wallhead core masonry on one side, followed by a shallow dome of soil, which partly rose to about 300mm following the underlying masonry profile, finishing 50mm from the stone edge. The turf was laid over and two layers of jute mesh were then laid over and pegged. T*est C.* The jute mesh was fastened to the wallhead core masonry on one side, followed by a shallow dome of soil, which rose to about 300mm following the underlying masonry profile, finishing 50mm from the stone edge. The grass seeds were sown by hand and two layers of jute mesh were then laid over and pegged.
5.6	Vegetation: Source and Description	*Test A.* Test A is recorded to have been seeded with a proprietary grass seed mix (British Seed Houses Ltd, A16, 20% Tournament Hard Fescue, 20% Sheep's Fescue, 35% Boreal Creeping Red Fescue, 15% Reubens Flattened Meadow Grass, 7.5% Highland Browntop Bent, 2.5% NZ Huia White Clover) and the soil fixed with a jute scrim. However GR said that it was gathered by local children in the nearby fields. *Test B.* Test B used local turf cut from rocky outcrops. T*est C.* Test C was seeded with the same mix as Test A.
5.7	Soil: Source and Description	*Test A.* This test was onto a slightly cambered wallhead. It had 75mm of soil applied, described as humus rich and believed to be a mixture of local soil and well composted seaweed, which had been mixed with a proprietary agricultural polymer (Broadleaf P4) to improve its stability. *Test B.* This test used the same soil as Test A. *Test C.* This test used the same soil as Test A.
5.8	DPC:	None
5.9	Defining Membrane:	None
5.10	Fixing:	Jute 25mm mesh cover, fixed with plastic pegs to masonry
5.11	Aftercare:	None
5.12	Maintenance:	No maintenance to test cappings.

6.0	**Performance Assessment**	
6.1	General Performance:	*Area 1* GR was not aware of these walls having been cleared of plants and attributed their lack of plants to local wind severity. He did report that the wall to the south-west of the west gable had been extensively rebuilt with cement mortar and the wallhead had been consolidated at that time. It seems clear that these walls have been cleared of naturally colonising vegetation on several occasions and that it will naturally try to re-colonise. The south elevation of the arcaded wall has a lot of vegetation growing in the cracks and this seems more extensive than that on comparable soft-capped walls. A tentative inference could be that the lack of cap and cement mortar are promoting growth in damp cracks. *Area 2* This natural capping is mature, very stable and works in a model fashion, binding the head masonry with a dense mat of fine grasses, which also prevents more damaging plants from colonising. The vulnerable edges are stabilised by mosses. *Area 3* This wall seemed to be in good condition, with healthy vegetation over a sound wallhead. It seems likely that this is a naturally established flat capping comparable in age and lack of interference to the sloping section in Area 2. *Area 4* In comparing these walls with the others, it seems likely that these walls have been cleared at some point, perhaps during repairs in the early 20thC and that since then natural cappings have struggled to re-establish themselves in a satisfactory manner. Certainly these walls are the most exposed to winds. *Area 5* The use of grass seeds seemed to be effective in producing a tight matt of grass that repelled invasive species on the flat wallhead (Test A, Fig. 28.19). However it failed to establish on the sloped wallhead (Test C, Fig. 28.21). The section of local turf generally performed well on both surfaces, but was less tight (Test B, Fig. 28.20). The use of the polymer seemed to have retarded initial erosion sufficiently for the seed to establish on the flat wall, but not on the sloping. The manufacturer's information indicates an effective life for the material of five years, which would be enough time for the grass to establish if conditions were appropriate.
6.2	Effect of Climate:	The tests are exposed to the prevailing wind, which will encourage soil erosion, though the two layers of jute mesh and polymer would give some initial protection. The exposure to rain and sun are significant, but not extreme.
6.3	Effect of Birds:	None noted
6.4	Effect of Animals:	None noted
6.5	Aesthetic Performance:	The public enjoy the planted and sheltered setting that the Nunnery ruins provide and the condition of the building contrasts markedly with the restored Abbey buildings. The natural mural vegetation contrasts uncomfortably with the areas of cleared walls and the amenity planting around the cloister. Therefore although the site has great charm and individual areas of vegetation are beautiful, the overall role of plants in the presentation of the ruin is somewhat confused and unsatisfactory.
6.6	Public Reaction:	None noted
6.7	Team Reaction:	None noted

6.8	Comments:	While GR associated the variation in amount of mural vegetation on the walls to local wind exposure, this is not backed up by the archival images. Eilean Mor (CS1) and Eynhallow (CS18) show the scouring effect of wind, but this is usually quite localised and these sites are more severely exposed. It is reasonable to conclude that it would have been preferable if all the natural cappings had been retained on all the wallheads. Maintenance might then have been limited to selective removal of damaging species (though these would be very rare) and local masonry repairs. The evidence indicates that where natural cappings were removed, the mortar is exposed to erosion of the mortar core and damage by colonisation by damaging species. A higher level of maintenance is thereby required. The tests are a rare and valuable experiment in technique. A reasonable conclusion is that simply seeding soil is not a viable technique in anything other than a flat and sheltered situation, where there is little danger of colonisation by damaging species. Nonetheless seeding of appropriate species can help promote a dense and fine root mass. While use of suitable local turf was simplest and most effective in these test conditions, use of seeding, on its own or with turfing, might be a useful technique where suitable turf is difficult to obtain, for example for archaeological reasons as on St. Kilda (CS7) or where the turf might fail because of its poor quality or because access require summer installation and little aftercare, such as at Eynhallow (CS18).
7.0	**References:**	
	Interviews: John Renshaw, *Architect* Gordon Rutherford, *Historic Scotland foreman* Sources: RCAMHS photos ref. AGD/24/104, AG/7103, AG/6069, AG/512 http://www.metoffice.gov.uk/climate/uk/averages/19712000/mapped.html	

Fig. 28.2: Aerial view from the west.

Fig. 28.3: The south view is the most naturalistic.

Fig. 28.4: North-east view, 1775.

Fig. 28.5: Church north gable, 2005, with natural vegetation.

Fig. 28.6: View from the north-east, 1973.

Fig. 28.7: Church north gable, detail.

Fig. 28.9: Face vegetation is undisturbed, while the cappings have been removed.

Fig. 28.8: View of low walls, showing mixed treatment.

Fig. 28.10: The turfed low walls have a dense root mat.

Fig. 28.12: The masonry joints are exposed to wind-driven rain and root penetration.

Fig. 28.11: The Refectory south wall. Vegetation has re-colonised wallheads cleared of natural cappings, probably in the early 20th C.

Fig. 28.13: Chapel west end. The vegetation-free masonry presents an abstracted image.

Fig. 28.14: Refectory west end. The naturally capped masonry appears more related to its setting.

Fig. 28.15: View North. The Nunnery is valued as a public space that has a different character from the fully restored Abbey, seen behind.

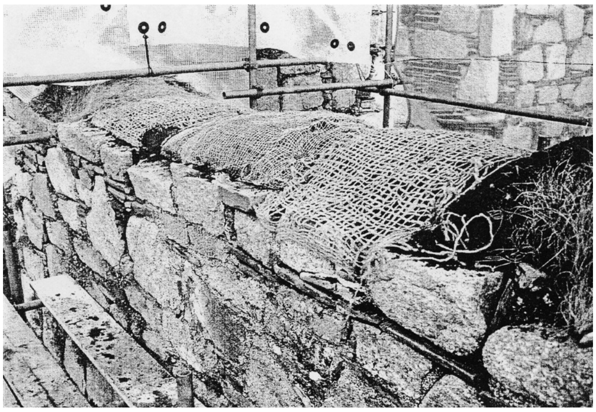


Fig. 28.16: The three test cappings after installation.

Fig. 28.17: Test A, sowing grass seed.

Fig. 28.18: The Refectory from the north-east.

Fig. 28.19: Test A, 2005.

Fig. 28.20: Test B, 2005.

Fig. 28.21: Test C, 2005.

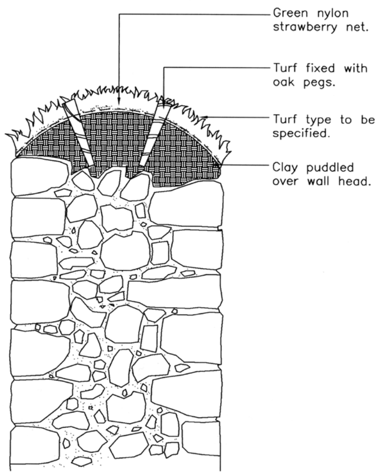
Case Study 29: NUNTON STEADINGS, Benbecula, Outer Hebrides

This case study is an interesting example of capping using machair turf and clay.

Fig. 29.1: Nunton Steadings, the west side of the wall. The capping has set naturally into the uneven wallhead.

1.0	**Background**				
1.1	Location:	Near the west coast of Benbecula, Western Isles			
1.2	Grid Reference:	NF 7650 5369			
1.3	Date of Works:	1999			
1.4	Client:	Uist Building Preservation Trust			
1.5	Contractor:	UBC			
1.6	Architect:	Simpson & Brown Architects			
1.7	Access:	The wall is adjacent to a public road. The Steadings contains a visitor centre focusing on local history.			
1.8	Visit Record:	Date:	By:		
		19.08.03	TM		
2.0	**Building**				
2.1	Type:	Barn, ruined, isolated wall fragment			
2.2	Classification:	Category B listed, 05.07.1996			
2.3	Chronology:	Built:	In two phases, mid 18thC and 19thC.		
		Ruined:	The rest of the barn is thought to have been demolished in the early 20th C.		
		Repairs:	1999, the wall was repaired prior to soft capping		
2.4	Construction and Form:	The wall is a linear fragment, ~1.5m high x 10m long x 0.6m thick, constructed of local rubble stone in lime mortar.			
3.0	**Site**				
3.1	Setting:	Description:	The wall forms the eastern wall of a steadings enclosure on the west coast of a low-lying island.		
		Altitude:	< 10 m		
		Distance from Coast:	~400 m		
3.2	Classifications:	None known			
3.3	Microclimate: * Data source: Met. Office, Annual Averages 1971 – 2000 *(Numbers in brackets give data as a % of national average)*	The area generally is very exposed to wind, though the adjacent buildings provide significant shelter in an otherwise very open landscape. The wall is exposed to the sun, though the wall faces east-west.			
		Rainfall*	~1630mm (107%)	Days of Rain >= 1mm*	~230 (124%)
		Min Temp*	~6.4°C (160%)	Max Temp*	~10.8°C (102%)
		Days Ground Frost*	~15	Hours sunshine*	~1280 (110%)
		Prevailing Wind Direction:		South-west	
4.0	**Flora and Fauna**				
4.1	Vegetation on Wall:	The capping has a limited species variety, significantly less than the assumed source area (Fig. 29.4).			
4.2	Surrounding Vegetation:	The steading is surrounded by rough grazing, which turns to machair grassland towards the shore.			

4.3	Species Survey. *Assessment by HL from photos* **D**=Dominant, **A**=Abundant, **F**=Frequent, **O**=Occasional, **R**=Rare, **VR**=Very Rare, *****=Present				
	Common Name	Latin Name	Capping	Surrounding Vegetation	Comment
	Grasses:				
	Cock's Foot	*Dactylis glomerata*	**R**		
	Red Fescue	*Festuca rubra agg*	**D**		
	Ruderals/Herbs:				
	Ribwort Plantain	*Plantago lanceolata*	**O**		
	Yarrow	*Achillea millefolium*	**O**		
	Trees/Shrubs: None				
	Mosses/Ferns: None				
4.4	Fauna:	None recorded			

5.0	**Technique**	
5.1	Source of Technique:	There may have been consultations with SPAB, Historic Scotland and a mason with experience of soft capping.
5.2	Season of Work:	Autumn
5.3	Preliminary Repairs to Structure:	The wallhead was reasonably complete, needing little consolidation
5.4	Treatment of Existing Vegetation:	There was little natural vegetation on the wallhead (Fig. 29.2).
5.5	Soft Capping Technique:	A curved cap of clay soil was applied over the stone, followed by a single layer of turf.
5.6	Sketch Section:	 *29.2: Section of capping.*
5.7	Vegetation: Source and Description	The turf was cut from the local machair, grazed diverse grassland on sandy coastal soil. This would have a dense root mat and very free draining soil.
5.8	Soil: Source and Description	The source of the clay soil is not known.
5.9	DPC:	None used
5.10	Defining Membrane:	None used
5.11	Fixing:	Oak pegs, set in at an angle

5.12	Aftercare:	None known
5.13	Maintenance:	None known
6.0	**Performance Assessment**	
6.1	General Performance:	The cap has performed well, reducing the exposure of the vulnerable open wallhead and settling in to give a naturalistic appearance.
6.2	Effect of Climate:	The climate does not seem to have had a significant effect, other than to limit species diversity through dry summer conditions.
6.3	Effect of Birds:	None known
6.4	Effect of Animals:	None known
6.5	Aesthetic Performance:	The appearance of the capping is entirely appropriate, with the flora reflecting that in the surrounding landscape.
6.6	Public Reaction:	None known
6.7	Team Reaction:	The architect is content that the cappings have survived.
6.8	Comments:	The sandy machair soil is very different to the clay beneath, perhaps allowing enough moisture through to keep the clay damp all the year round. The turf's strong root system will have significantly helped to sustain it.
7.0	**References:**	
	Interview: John Sanders, *Simpson & Brown Architects* Data: http://www.metoffice.gov.uk/climate/uk/averages/19712000/mapped.html	

Fig. 29.3: The wall prior to intervention, approx 1997, showing little apparent natural colonisation, though this may have been removed.

Fig. 29.4: Four years after the capping was applied, it looks healthy and natural, if somewhat lost amid tarmacadam.

Fig. 29.5: There is limited species diversity, related to microclimatic conditions. The caps will endure fairly strong peak drought conditions.

Case Study 30: THE OLD MILL, Ardkinglas, Argyll

This case study presents one of the most benign conditions of soft cappings, with considerable colonisation pressures from diverse species and where repair works preserved the natural impression of the ruin.

Fig. 30.1: South view, the ruin sits as a romantic feature along a footpath through mature woodland.

1.0	**Background**		
1.1	Location:	Ardkinglas Estate, Argyll, near A815	
1.2	Grid Reference:	NN 175 101	
1.3	Date of Works:	June 2001, with repairs in March 2003	
1.4	Client:	Ardkinglas Estate	
1.5	Contractor:	Rebecca Little Construction	
1.6	Architect:	N/A	
1.7	Access:	Unrestricted access, adjacent to a public footpath.	
1.8	Visit Record:	Date:	By:
		28/07/05	TM, RL

2.0	**Building**		
2.1	Type:	Water Mill, ruinous	
2.2	Classification:	None known, unlisted	
2.3	Chronology:	Built:	c.1795
		Ruined:	c.1830. Thought to have been destroyed by fire.
		Repairs:	2001 (main), 2003 (to soft cappings).
2.4	Construction and Form:	This is a single storey building, with two standing gables rising to ~5m and other wallheads at ~2m. The walls are built mainly of basalt rubble in lime mortar. Most walls stand to full height, though most of the south wall is ruinous.	

3.0	**Site**				
3.1	Setting:	Description:	The ruin sits in a small clearing in sloping woodland, adjacent to a burn. The area is very damp and sheltered, with abundant lush vegetation. A public footpath passes close to the building as part of an estate woodland walk.		
		Altitude:	40m		
		Distance inland:	~30km, sea loch ~1km		
3.2	Classifications:	None.			
3.3	Microclimate: * Data source: Met. Office, Annual Averages 1971 – 2000 *(Numbers in brackets give data as a % of national average)*	Description: Though sheltered and damp, the building gets a good amount of high angle sunshine.			
		Rainfall*	~350mm (230%)	Days of Rain >= 1mm*	~250 (135%)
		Min Temp*	~3°C (75%)	Max Temp*	~10°C (95%)
		Days Ground Frost*	~112	Hours sunshine*	~1300 (112%)
		Prevailing wind direction:		Assumed south-west	

4.0	**Flora and Fauna**					
4.1	Vegetation on Building	The vegetation is lush and healthy, with the walls displaying a wide range of species, supported on almost every surface or cleft. A wide number of species have naturally seeded onto the ruin from the surrounding bio-diverse woodland.				
4.2	Surrounding Vegetation:	The structure is surrounded by lush, mature woodland, with a wide variety of species.				
4.3	Species Survey. *Assessment by HL from photographs* D= Dominant, A=Abundant, F= Frequent, O= Occasional, R=Rare, VR= Very Rare, *= Present					
	Common Name	Latin Name	Gables	Flat Wall Heads	Other Remnant	Surrounding Vegetation
	Grasses:					
	Cock's Foot	*Dactylis glomerata*		**R**		
	Common Bent	*Agrostis capillaris*		**R**		
	Creeping Soft Grass	*Holcus mollis*	**A**	**A**	**O**	**F**
	Red Fescue	*Festuca rubra agg.*	**O**	**O**		**O**
	Tufted Hair Grass	*Deschampsia cespitosa*	**O**	**R**		**O**
	Sweet Vernal Grass	*Anthoxanthum odorata*	**R**			
	Ruderals/Herbs:					
	Bramble	*Rubus fruticosus agg*		**R**		**O**
	Broadleaved Willowherb	*Epilobium montanum*		**R**		**O**
	Cleavers	*Galium aparine*		**R**		
	Creeping Buttercup	*Ranunculus repens*				**R**
	Figwort	*Scrophularia nodosa*	**R**	**R**		
	Foxglove	*Digitalis purpurea*				**R**
	Great Woodrush	*Luzula sylvatica*				**O**
	Herb Robert	*Geranium robertianum*		**R**		**R**
	Meadowsweet	*Filipendula ulmaria*				**F**
	Ragwort	*Senecio jacobaea*		**R**		**VR**
	Raspberry	*Rubus idaeus*	**R**	**R**		
	Rosebay Willowherb	*Chamerion angustifolium*				**R**
	Soft Rush	*Juncus effusus*				**O**
	Valarian	*Valariana officinalis*		**O**		**O**
	Wild Strawberry	*Fragaria vesca*		**F**	**O**	**O**
	Trees/Shrubs:					
	Ash	*Fraxinus excelsior*		**R**		*
	Beech	*Fagus sylvatica*				*
	Common Alder	*Alnus glutinosa*				*
	Elm Sapling/Seedling	*Ulmus glabra*	*	**R**		
	Goat Willow	*Salix caprea*				*
	Hazel	*Corylus avellana*				*
	Norway Spruce	*Picea abies*				*
	Oak	*Quercus robur*				*

	Rhododendron	*Rhododendron ponticum*				*
	Rowan	*Sorbus aucuparia*				*
	Sycamore	*Acer pseudoplatanus*				*
	Ferns/Mosses:					
	Broad Buckler Fern	*Dryopteris dilatata*		**O**		**R**
	Golden Scaly Male	*Dryopteris affinis*		**R**		
	Maidenhair Spleenwort	*Asplenium trichomanes*	*			
	Male Fern	*Dryopteris filix-mas*		**R**		**F**
	Moss	*Rhytidiadelphus squarrosus*		**F**		
	Moss	*Hylocomium splendens*		**F**		
	Moss, General				**D**	
	Polypody	*Polypodium vulgare agg.*		**R**		
4.4	Fauna:	None recorded				
5.0	**Technique**					
5.1	Source of Technique:	Rebecca Little Construction, a development of their previous work. By this time BL had come to the conclusion that good quality turf was more important than a thick clay layer.				
5.2	Season of Work:	Summer				
5.3	Preliminary Repairs to Structure:	Selected areas of wall were consolidated with lime mortar.				
5.4	Treatment of Existing Vegetation:	The existing vegetation was removed from the areas selected for masonry repairs, with trees and other damaging plants cut out as far as possible. Most capping vegetation was kept alive and damp so that it could be reapplied.				
5.5	Soft Capping Technique:	A 100mm thick, shallow curved, tempered clay cap was applied to the wallhead and existing vegetation reinstated, with some limited areas of new turf applied in two layers, root to root.				
5.6	Vegetation: Source and Description	Vegetation that had been removed in order to consolidate the wallhead masonry was re-used, supplemented with some locally cut turf. This turf was high quality, rough pasture grazed turf with a strong root mat.				
5.7	Soil: Source and Description	Errol clay was used. Little importance was given to this layer and it was used mainly as a bonding agent.				
5.8	DPC:	None used				
5.9	Defining Membrane:	None used				
5.10	Fixing:	Timber pegs				
5.11	Aftercare:	The turf was watered while RLC remained on site, approximately two weeks.				
5.12	Maintenance:	There was a maintenance plan established at the time of the work, to control natural colonisation by trees and ruderals, but to what extent this has been implemented is unkown. In November 2002, the client reported patches of dead turf on the west gable and these were repaired with two layers of commercial turf in March 2003.				

6.0	**Performance Assessment**	
6.1	General Performance:	The masonry and lime repairs below the caps are in good condition, with no sign of lime runs or other damage from high moisture levels. In general the capping has blended with the original vegetation to form a dense, thick cover to the wallheads, though there have been some minor local areas of failure. On the accessible east gable the clay layer was soft and malleable, like plasticine (Fig. 30.13). There was a good root mass layer and deep penetration of fine roots, with the turf so well bonded that it was inseparable from the clay layer. On the west gable, the 2003 repairs have taken well, but a strip of dieback has gradually developed on the west side of the north slope, where the original masonry is exposed in good condition, the clay and turf having both disappeared (Figs. 30.10 and 11). This may have been because it presented a relatively poor mechanical key and was exposed to the sun, though the comparable south slope had abundant growth. On the south lower stack, a dense carpet of moss had been lifted and re-applied during the works and this had survived well on the clay cap (Figs. 30.6 and 7). The clay had a similar consistency and there was some deep penetration of fine roots. On the adjacent higher ruined walls the more biodiverse original vegetation had re-established well on the clay caps.
6.2	Effect of Climate:	The mild, sheltered conditions were key to the successful growth on steep narrow gables, especially as the work was carried out in early summer.
6.3	Effect of Birds:	None recorded
6.4	Effect of Animals:	None recorded
6.5	Aesthetic Performance:	The capping has performed well and it is difficult to differentiate between the repaired and un-repaired walls. The biodiversity of the species growing on the ruin gives it a romantic quality, appropriate to its woodland setting.
6.6	Public Reaction:	None recorded
6.7	Team Reaction:	The technique has worked well and is also suitable aesthetically. The vegetation looks very natural mainly because of its species diversity. (RL)
6.8	Analysis:	Although the contractor was unsure about how well the caps would survive, they have successfully protected the lime repairs from heavy rain and strong sun far beyond the critical early period. This site and others, such as Kilmorie Chapel (CS23), demonstrate that summer applications can be very successful in appropriately damp climatic conditions. The thin layer of clay has generally performed well, both as an adhesive for the turf, and as a moisture reservoir, maintaining a plastic consistency through the height of summer. The local openness of this site means it never stays as damp as the clay caps on Doune Castle Mill (CS15) though this received lower rainfall. The clay layer's relative thinness and flat profile may have inhibited seeding by larger plants to some degree, but in the long term, because of the mild conditions and rich local seed-bank, this site will require periodic removal of ruderals and tree saplings to avoid damage to the underlying masonry. With such a strong colonising setting, a root barrier might have been considered to reduce such maintenance, but this would have been difficult to apply on the rough, relatively small wall sections. The short-term failure of a small area on the gable, the success of the subsequent repairs and the slow development of dieback on one edge confirm that narrow sloping surfaces, such as gables, present stressful conditions for vegetation where microclimate, slope and surface texture combine to affect the viability of soft caps in a manner that is difficult to predict. The fact that poorer quality commercial turf succeeded and became rapidly indistinguishable shows that this, although very different from the original vegetation, can be an appropriate material under such strong colonising conditions (Figs. 30.10 and 11).
7.0	**References:**	
	Interview: Rebecca Little Data: http://www.metoffice.gov.uk/climate/uk/averages/19712000/mapped.html	

Fig. 30.2: South-west view showing the river which once powered the mill. Doune Castle Mill (CS15) is in a similarly damp situation.

Fig. 30.3: West view, the mill sits in a clearing within the woods.

Fig. 30.4: North view, March 2003.

Fig. 30.5: North view, July, 2005.

The new turf caps on the main building seem better able to repel tall invasive species, such as ferns, in summer, compared to the moss-rich natural caps on the foreground walls. This allows them to be more clearly distinguished throughout the year, when the form of the naturally capped walls becomes lost in surrounding tall vegetation.

Fig. 30.6: Thick moss blankets were carefully removed and later reinstated to the foreground stub.

Fig. 30.7: The additional clay layer on the stub does not seem to have led to increased colonisation compared to the unaltered wallheads in the background.

Fig. 30.8: East view, March 2003, showing patches of failure on the west gable.

Fig. 30.9: East view, July 2005, showing significant colonisation amid lush summer growth.

Fig. 30.10: West gable, March 2003, repairs in progress.

Fig. 30.11: West gable, July 2005, the repairs are indistinguishable.

Fig. 30.12: Species retained through the works include wild strawberries.

Fig. 30.13: Four years after application, the clay remained soft and malleable.

Fig. 30.14: A strip of edge dieback on the north slope of the west gable contrasts with the projecting drip provided on the south slope.

Case Study 31: TOWN WALL, Peebles, Peeblesshire

This case study is an interesting example of a conservation capping where thin commercial turf has succeeded well, if a little monotonously, in an urban setting with benign climatic conditions.

Fig. 31.1. Peebles Town Wall, north view. The cap generally maintains good cover, though in places the sward is thin.

1.0	**Background**				
1.1	Location:	Peebles, central Scottish Borders			
1.2	Grid Reference:	NT253406			
1.3	Date of Works:	Late September - mid October 2003			
1.4	Client:	Scottish Borders Council			
1.5	Contractor:	Sandy MacLean & Co.			
1.6	Architect:	None involved			
1.7	Access:	Unrestricted access to the public east and north, with private property to the west.			
1.8	Visit Record:	Date:	By:		
		16.06.05	TM, Alun Tarr		
2.0	**Building**				
2.1	Type:	Fortified Town Walls, large fragment			
2.2	Classification:	Scheduled Ancient Monument			
2.3	Chronology:	Built:	c. 1570-74		
		Ruined:	The wall was maintained in good repair until at least the 1720s, but it had generally disappeared by c.1800, leaving only a few fragments.		
		Repairs:	None known		
2.4	Construction and Form:	The wall is built of basalt rubble masonry in lime mortar, and stands ~0.9m wide and 3m tall. The wall comprises a south section, ~24m long, and a west section, ~50m long, linked by the wall of a round corner tower.			
3.0	**Site**				
3.1	Setting:	Description:	The south section has a public car park on the east side and private gardens and office parking to the west. The west wall faces the side of a supermarket and its car park to the north and office parking to the south.		
		Altitude:	170m		
		Distance inland:	36 km		
3.2	Classifications:	None			
3.3	Microclimate: * Data source: Met. Office, Annual Averages 1971 – 2000 *(Numbers in brackets give data as a % of national average)*				
		Rainfall*	~950mm (63%)	Days of Rain >= 1mm*	~170 (91%)
		Min Temp*	~4.1°C (103%)	Max Temp*	~10.8°C (102%)
		Days Ground Frost*	~135	Hours sunshine *	~1190 (103%)
		Prevailing Wind Direction:		Assumed south-west	
4.0	**Flora and Fauna**				
4.1	Vegetation on Wall:	The capping appeared generally lush and healthy with a sward about 300mm tall. The taller grass was growing from the sides, rather than from the crown. There was consistent edge dieback of 25-50mm and two larger local patches of dieback under trees. The species appeared remarkably monotonous, with no colonisation evident. The Common Bent was probably still present, but declining in competition to the Fescues and not identifiable in photographs because they had not yet flowered. The turf seemed to be a thin layer on top of the clay with a moderate root mat. Fine roots could be found to penetrate ~125mm into the clay.			
4.2	Surrounding Vegetation:	There was a range of trees in the vicinity of the wall, including birch, as well as domestic and commercially landscaped garden plants. However most of the immediate surroundings are hard landscaped.			

4.3	Species Survey. *Assessment by HL from photos* **D**=Dominant, **A**=Abundant, **F**=Frequent, **O**=Occasional, **R**=Rare, **VR**=Very Rare, *=Present					
	Common Name	Latin Name	Source Turf	Capping	Surrounding Vegetation	Comment
	Grasses:					
	Red Fescue	*Festuca rubra agg*	**60%**	**D**		Source turf was a mix of Strong Creeping Fescue and Slender Creeping Fescue
	Common Bent	*Agrostis capillaris*		**O**		
	Annual meadow Grass	*Poa annua*			*	in nearby gutters
	Perennial Rye Grass		**40%**	**F**		
	Ruderals/Herbs:					
	Foxgloves	*Digitalis purpurea*			*	
	Trees/Shrubs:					
	Larch sp.	*Larix sp*.			*	
	Lawson's Cypress				*	
	Birch sp.	*Betula sp*.			*	
	Broom	*Cytisus scoparius*			*	
4.4	Fauna:	None recorded				

5.0	**Technique**	
5.1	Source of Technique:	Advised by Historic Scotland
5.2	Season of Work:	Autumn
5.3	Preliminary Repairs to Structure:	The rubble masonry was consolidated with lime mortar, and the flat slate string course cope repaired and reinstated. This projected ~40mm beyond the rubble face and was intended to act as a root barrier.
5.4	Treatment of Existing Vegetation:	The considerable naturally established cap, comprising grasses, shrubs and tree saplings, was removed (Fig. 30.6).
5.5	Soft Capping Technique:	The clay was laid on the consolidated wallhead, hand moulded to form a domed section, ~200mm tall. Turves were laid across the wall, doubled up under the edges 150mm. The turf was fixed with timber pegs into the clay and green plastic mesh, ~ 20mm sq, laid over the top.
5.6	Vegetation: Source and Description	The capping material was supplied by Stewarts, a commercial turf producer, type 'SS6', described by the contractor as a special mix of very fine grasses, and by the client as a drought resistant mix. It was eighteen months old, of commercial cultivars probably grown in East Lothian and supplied in 0.5m x 2m rolls, 40mm thick.
5.7	Soil: Source and Description	Clay was sourced from a local farm and used as dug. It was a sticky grey clay with a large coarse fraction of sharp stones up to 25mm. The contractor described that *'if it dries out it becomes as hard as a brick and won't take water again'*.
5.8	DPC:	None
5.9	Defining Membrane:	None
5.10	Fixing:	Timber pegs and fine plastic mesh
5.11	Aftercare:	None
5.12	Maintenance:	None known

6.0	**Performance Assessment**	
6.1	General Performance: May 2005	Photographs from soon after completion (Fig. 31.7) show some edge dieback on the south edge of the west wall with apparently some associated clay staining, but no dieback on the north edge of the same wall. The masonry was in good condition, though lime runs were extensive, up to about 600mm below the slate cap, indicating that this formed an effective dpc. There were no indications that roots had penetrated through the joints in the string course, though a few clumps appeared in cracks on the wall face. The vegetation seemed to be generally in healthy condition, with the combination of complete grass cover, dense clay soil and surrounding hard landscaping strongly inhibiting colonisation from surrounding vegetation. There was consistent edge dieback of 25-50mm, with the worst being at the exposed south end. There was local dieback beneath the branches of a yew tree, and comparable dieback beneath a lelandea indicated that this was from rain shadowing, rather than poisoning by dropped foliage (Fig. 31.10). The clay was a continuous mass of homogenous, dense and slightly damp material. The turf largely formed a distinct layer on top of this, ~30mm thick, but occasional fine roots could be seen to penetrate ~125mm into the clay layer.
6.2	Effect of Climate:	The climate is relatively sheltered and fairly evenly damp and this suits the capping.
6.3	Effect of Birds:	None recorded
6.4	Effect of Animals:	None recorded
6.5	Aesthetic Performance:	The general aesthetic performance is good. Although it lacks the diversity of the natural capping, the uncontrolled natural growth was both damaging to the wall and unsuited to the urban location. In time, more bio-diversity can be expected to lift the cap's monotony. However, it is clear that the wall has lost some of its ancient character with the removal of its natural cap.
6.6	Public Reaction:	One of the neighbouring supermarket's staff commented that the capping could do with cutting to tidy it up.
6.7	Team Reaction:	The capping was considered very successful.

6.8	Analysis:	In comparison to the natural cap on nearby Cessford Castle (CS2), it can be seen that the sheltered urban setting of Peebles facilitated colonisation by more damaging shrubs and trees, while exposed, isolated and rural Cessford had few damaging species. This is the only example with an intentional root barrier and it seems likely to be successful. The dense clay would also inhibit root penetration were it not for the sharp stone fraction, which effectively breaks up the mass of clay. The combination of clay and slate dpm seem a strong defence against colonisation by trees and shrubs that dominated the natural cap. The fact that the clay has remained damp and that the turf has survived with a relatively shallow root system indicates that the rainfall pattern is particularly benign, with many days experiencing little rain, rather than occasional heavy downpours and significant periods of drought. The penetration of deep fine roots would allow the turf to tap more moisture during dry periods. It was notable that the apparent limited nutrition was not apparently a problem. This was echoed in the verdant grass growth in nearby gutters. It is not yet possible to determine whether the relatively mild edge dieback will stabilise or be the start of progressive decay, but stabilisation seems more likely. The fact that the tallest growth is on the sloping sides rather than the top, suggests that the doubling up of turf 150mm on the edges was effective in increasing the density of grass. The lack of a cut edge will also have inhibited edge dieback. This project demonstrated probably the most successful use of commercial turf and this can be primarily attributed to the benign climatic conditions, although appropriate season of application, a folded turf edge and the quality of the clay were also contributory factors. It can only be assumed that an appropriate natural turf would have been even more successful. The root mat of Common Bent may have given the turf a good coherence during cutting, transport and application, but it is less suited to conditions in the long term and could be expected to be out-competed by the Fescues. This seems to be happening and is in line with guidance given in Sweden in the early 20thC. regarding the role of Common Bent. The use of a biodegradable mesh would have improved the aesthetic success, while the inclusion of some soil from the natural capping would have assisted root penetration and aided bio-diversity through seeds, although there would be the danger of undesirable seeding. More bio-diversity through the re-use of some of the appropriate natural flora, together with a more varied profile, would have perhaps appeared more naturalistic and sat more gracefully on this ancient wall.
7.0	**References:**	
	Interviews: John Pollitt, *Scottish Borders Council, Client* Stuart Witten, *Contractor* William Napier, *NTS* Stewarts, *turf supplier* Sources: (1967 a) The Royal Commission on the Ancient and Historical Monuments of Scotland. Peeblesshire: an inventory of the ancient monuments, 2v, Edinburgh, p 280, No. 544 RCAHMS Photographs: ref PB/434	

Fig. 31.2: View of the corner tower and south section.

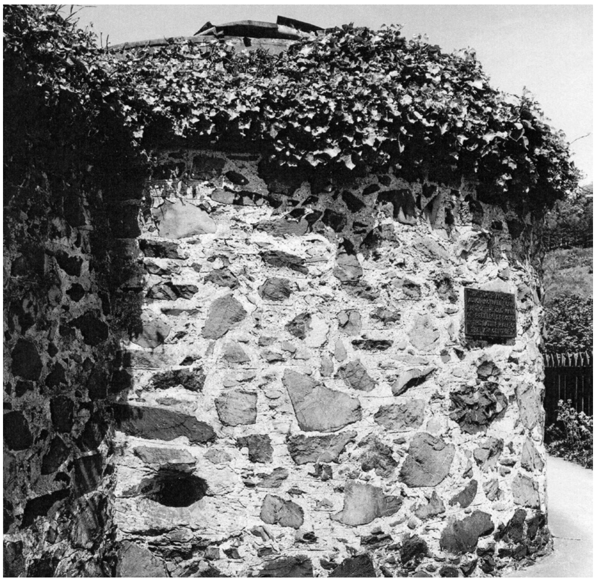


Fig. 31.3: View before works, c.1963.

Fig. 31.4: The west section, north side.

Fig. 31.5 Edge dieback was worst at the south end.

Fig. 31.6: The natural capping, prior to repairs.

Fig. 31.7: The new capping, soon after application.

Fig. 31.8: The new capping, two years after application.

Fig. 31.9: The turf formed a thin layer, poorly rooted in.

Fig. 31.10: Dieback beneath a yew tree.

Fig. 31.11: The green plastic mesh is unsightly.

Case Study 32: RUINED HOUSE, Cottown, Perthshire

The case study is the only example of use of soft capping as an emergency measure to protect decaying masonry.

Fig. 32.1: A view of the soft-capped walls from the west, seven years after installation.

1.0	**Background**				
1.1	Location:	Cottown, near St. Madoes, ~5miles east of Perth, in the grounds of the Old Schoolhouse			
1.2	Grid Reference:	NO 2057 2102			
1.3	Date of Works:	August 1999			
1.4	Client:	National Trust for Scotland (NTS)			
1.5	Contractor:	Rebecca Little Construction			
1.6	Architect:	Historic Scotland			
1.7	Access:	The site is open to the public			
1.8	Visit Record:	Date:	By:		
		30.7.03	TM		
		30.7.04	TM		
		19.5.06	TM		
2.0	**Building**				
2.1	Type:	Dwelling, ruinous			
2.2	Classification:	Category A Listed			
2.3	Chronology:	Built:	c.1745		
		Ruined:	c.1950		
		Repairs:	1999		
2.4	Construction and Form:	The ruined walls are the remains of a rectilinear dwelling house. They are mainly rubble stone in clay mortar, but there are also a number of single skin brick walls in lime mortar. The walls are in an advanced state of decay.			
3.0	**Site**				
3.1	Setting:	Description:	The building was part of a cluster of vernacular buildings, one of which, the schoolhouse, has been conserved. The ruined walls now stand in the ground of the schoolhouse, with adjacent modern housing.		
		Altitude:	25m		
		Distance from Coast:	3 km		
3.2	Classifications:	None known			
3.3	Microclimate: * Data source: Met. Office, Annual Averages 1971 – 2000 *(Numbers in brackets give data as a % of national average)*	Description: the site has fairly typical east coast weather, relatively low rainfall and high solar radiation. Due to its low height, it is moderately sheltered.			
		Rainfall*	~820mm (54%)	Days of Rain >= 1mm*	~130 (70%)
		Min Temp*	~4.7°C (118%)	Max Temp*	~12.9°C (123%)
		Days Ground Frost*	~120	Hours sunshine*	~1390 (120%)
		Prevailing Wind Direction:		South-west	
4.0	**Flora and Fauna**				
4.1	Vegetation on Wall:	The cap vegetation is sparse and dominated by Festuca rubra grass, with some invasion by Willowherb. There is a clear pattern of dieback from the south edges.			
4.2	Surrounding Vegetation:	The immediate surroundings are a mixture of well-maintained domestic gardens containing exotic species and mown lawns, and overgrown wilderness areas, surrounded by agricultural land.			

4.3	Species Survey. *Assessment from photos by HL* **D**=Dominant, **A**=Abundant, **F**=Frequent, **O**=Occasional, **R**=Rare, **VR**=Very Rare, *=Present					
	Common Name	Latin Name	Wall	Roof Ridge	Surrounding Vegetation	Comment
	Grasses:					
	False Oat Grass	*Arrhenatherum elatius*			*	
	Red Fescue	*Festuca rubra agg*	**D**	*		
	Yorkshire Fog	*Holcus lanatus*			*	
	Ruderals/Herbs:					
	Bramble	*Rubus fruticosus agg*			*	
	Broadleaved Willowherb	*Epilobium montanum*	**R**			
	Creeping Thistle	*Cirsium arvense*			*	
	Daisy	*Bellis perennis*			*	
	Nettles	*Urtica dioica*			*	
	Trees/Shrubs:					
	Broom	*Cytisus scoparius*		*		Uncertain
	Mosses/Ferns:					
	N/A					
4.4	Fauna:	None noted				

5.0	**Technique**	
5.1	Source of Technique:	The technique was developed as a temporary measure, following the use of a clay/turf cap on the ridge of the schoolhouse thatched roof.
5.2	Season of Work:	Late summer
5.3	Preliminary Repairs to Structure:	No major consolidation work was carried out and the walls were dismantled to a safe, reasonably sound level. The clay mortar had decayed and the rubble stonework was quite loose in places. It was hoped that there would be a programme of repairs within two years, but this was not realised.
5.4	Treatment of Existing Vegetation:	Vegetation was removed
5.5	Soft Capping Technique:	A clay/sand mix was applied to the wall heads in a rounded profile, with a single layer of turf laid over, pegged at the edges.
5.6	Vegetation: Source and Description	Commercial lawn turf was used.
5.7	Soil: Source and Description	A clay mixture of 1Errol clay:2 coarse, sharp sand was used. This clay is the local subsoil.
5.8	DPC:	None used
5.9	Defining Membrane:	None used
5.10	Fixing:	Timber pegs were pushed through the turf and into the earth layer at a slight angle along the bottom edge of the turfs. Vertical pegging was avoided as it was thought this would channel water into the caps.
5.11	Aftercare:	The turf was watered for a couple of days after fitting but no continued aftercare was given.
5.12	Maintenance:	None

6.0	**Performance Assessment**	
6.1	General Performance:	The cappings performed well for their intended purpose of providing short-term protection to the walls beneath. As an emergency measure they had the benefits of retarding the decay mechanisms of thermal flux, moisture and freeze/thaw, while being fully reversible. As there have been no subsequent further conservation works, the cappings have been exposed over a much longer period than was intended. In this respect, they have not proved very successful. There are large areas of failure and shrinkage, with small and steep sections of capping performing worst (Figs. 32.2 to 32.5).
6.2	Effect of Climate:	The relatively long drought periods in the summer had a significant effect. It is known that there was some early dieback, directly attributable to the warm, dry season of application. This may have been significant in reducing rooting in and growth in the first autumn, leaving the caps vulnerable to dieback the following summer. Despite having been in situ for seven years, there has been little subsequent colonisation.
6.3	Effect of Birds:	None noted
6.4	Effect of Animals:	None noted
6.5	Aesthetic Performance:	The caps now look in poor condition
6.6	Public Reaction:	None noted
6.7	Team Reaction:	RL thought the caps had performed well as a short-term measure and that they would have waited until the autumn and varied the technique if it had been a long-term solution.
6.8	Comments:	These cappings demonstrate that soft capping can prove an effective emergency temporary repair technique to conserve exposed wallheads. It is notable that even where the vegetation has died, the clay cap has survived and maintained a protective cover, reminiscent of the walls at Gordon Castle Estate (CS4). East coast sites clearly require more care regarding drought conditions than in the west, such as Kilmorie Chapel (CS23), where works were also carried out in summer. In this respect the dieback at Cottown is very comparable to that at Aberuthven (CS38). It is interesting that the clay and turf ridge to the thatched schoolhouse roof has performed only a little better (Fig. 32.6). This cap was installed in the autumn, using natural rather than commercial turf, and flourished early on, but subsequently suffered significant dieback, shrinkage, failure to root in and has required several repairs. The ridge fared best on the north side, with the south suffering most dieback and shrinkage. There was a comparable correlation of performance to orientation in the wall cappings and this is clearly linked to peak solar radiation. It is notable that at sites where there is comparable low rainfall, but some shade, such as at Hugh Millar's Cottage (CS20), the caps perform much better. The ridge suffered significant cracking of the clay layer, with repairs using a less clay rich mix, akin to the mix used on the wallheads, proving more resilient when the earth became exposed through plant dieback. This raises the debate of how much these clay caps can act as a moisture reservoir in dry sites, when a clay mix designed for durability, once exposed will be difficult for roots to penetrate.

7.0	**References:**
	Interviews: Rebecca Little Sources: http://www.pkht.org.uk/Events.asp?id=4 Data: http://www.metoffice.gov.uk/climate/uk/averages/19712000/mapped.html

Fig. 32.2: Summer conditions with the Festuca rubra surviving, but with a dry sward.

Fig. 32.3: Isolated small caps fared worst, being most vulnerable to drying out.

Fig. 32.4: The narrow brick wall caps struggled to survive, though the clay mortar caps continue to provide wallhead protection.

Fig. 32.5: The south facing edges were most vulnerable to drying out under the influence of solar radiation, with grass retreating to the northern sides.

Fig. 32.6: The south side of the schoolhouse clay/turf ridge capping. Despite repairs and a better quality turf, the ridge is still vulnerable to dieback and decay, though the north side fares better. This ridge has since been re-done in 2008.

Case Study 33: RUINED HOUSE, Pabbaigh, Outer Hebrides

This case study is an interesting example of an exposed site, where working conditions were very challenging.

Fig. 33.1: View from the east during works. The site conditions were difficult, with an exposed site and all materials, equipment and personnel brought in and out by helicopter.

1.0	**Background**				
1.1	Location:	Island of Pabbaigh (aka Pabbay), south of Barra, Western Isles			
1.2	Grid Reference:	NL 6072 8745			
1.3	Date of Works:	August 2003			
1.4	Client:	The National Trust for Scotland			
1.5	Contractor:	Rebecca Little Construction			
1.6	Architect:	Tom Morton Associates advised the contractor			
1.7	Access:	Unrestricted access, though it is difficult to reach. There are no inhabited dwellings on the island and access is only possible by boat, Barra having the nearest harbour, or helicopter.			
1.8	Visit Record:	Date:	By:		
		19.02.02	TM		
		16.08.03	TM during works		
		27.07.05	Susan Bain, NTS		
2.0	**Building**				
2.1	Type:	House, ruined, said to be the last inhabited house on the island.			
2.2	Classification:	Scheduled Ancient Monument			
2.3	Chronology:	Built:	Mid to late 19thC.		
		Ruined:	Mid 20thC.		
		Repairs:	2003		
2.4	Construction and Form:	Ruins of a building standing to roof height, measuring 12m by 5.5m.			
3.0	**Site**				
3.1	Setting:	Description:	The building stands on the west side of the island, on rough grassland, which originally contained cultivated areas.		
		Altitude:	~20m		
		Distance from Coast:	200m		
3.2	Classifications:	None known			
3.3	Microclimate: * Estimated from Met. Office, Annual Averages 1971 – 2000 *(Numbers in brackets give data as a % of national average)*	The island is open and severely exposed, at the southern end of the Outer Hebrides, though the ruin itself is somewhat sheltered by rising ground to the west.			
		Rainfall*	~1600mm (105%)	Days of Rain >= 1mm*	~240 (130%)
		Min Temp*	~6.4°C (160%)	Max Temp*	~18°C (76%)
		Days Ground Frost*	~15	Hours sunshine*	~1280 (110%)
		Prevailing Wind Direction:		Assumed south-west	

<table>
<tr><th>4.0</th><th colspan="5">Flora and Fauna</th></tr>
<tr><td>4.1</td><td>Vegetation on Wall:</td><td colspan="4">The natural cappings were dominated by fine grasses, which formed a dense sward on many areas, though cover on the gables was incomplete. The surviving new cappings have a similar dense grassy character.</td></tr>
<tr><td>4.2</td><td>Surrounding Vegetation:</td><td colspan="4">The immediate surroundings of the ruin are ungrazed fine grasses. Further away there is more diversity. There are no trees</td></tr>
<tr><td rowspan="6">4.3</td><td colspan="5">Species Survey. Assessment by HL from photographs
D= Dominant, A=Abundant, F= Frequent, O= Occasional, R=Rare, VR= Very Rare, *= Present</td></tr>
<tr><td>Common Name</td><td>Latin Name</td><td>Capping</td><td>Surrounding Vegetation</td><td>Comment</td></tr>
<tr><td colspan="5">Grasses: No information</td></tr>
<tr><td colspan="5">Ruderals/Herbs: No information</td></tr>
<tr><td colspan="5">Trees/Shrubs: No information</td></tr>
<tr><td colspan="5">Mosses/Ferns: No information</td></tr>
<tr><td>4.4</td><td>Fauna:</td><td colspan="4">None noted</td></tr>
<tr><td colspan="6"></td></tr>
<tr><th>5.0</th><th colspan="5">Technique</th></tr>
<tr><td>5.1</td><td>Source of Technique:</td><td colspan="4">The technique was a development of previous work by Rebecca Little Construction.</td></tr>
<tr><td>5.2</td><td>Season of Work:</td><td colspan="4">Summer (August). The timing of the work was very restricted by limited window for work and access in reasonable weather.</td></tr>
<tr><td>5.3</td><td>Preliminary Repairs to Structure:</td><td colspan="4">The wallheads were consolidated in lime mortar, set, as far as possible, to shed water. The flat wallheads have a complex geometry created by the many rafter end sockets. Much of the upper masonry was loose and the natural capping served to bind it (Figs. 32.4 and 5).
The gable wallheads had an external raised edge, but were otherwise repaired to a flat sloping face.</td></tr>
<tr><td>5.4</td><td>Treatment of Existing Vegetation:</td><td colspan="4">The existing vegetation was discarded.</td></tr>
<tr><td>5.5</td><td>Soft Capping Technique:</td><td colspan="4">A protective turf capping was applied in two layers, root to root, over a geotextile membrane. The soft capping was seen as less important than the lime consolidation. It was thought climatic conditions would make survival difficult, but that natural colonisation might gradually be reinstated. There was insufficient time to consolidate all the wallheads.</td></tr>
<tr><td>5.6</td><td>Vegetation: Source and Description</td><td colspan="4">The turf was removed in long strips, 600 and 400mm wide to suit the wallheads (Fig. 33.8). The strips were sourced from the ground to the south of the site, near the accommodation buildings. The grass was scythed by hand, prior to lifting. The strips were spaced apart to encourage regrowth.</td></tr>
<tr><td>5.7</td><td>Soil: Source and Description</td><td colspan="4">There was no soil layer.</td></tr>
<tr><td>5.8</td><td>DPC:</td><td colspan="4">None used</td></tr>
<tr><td>5.9</td><td>Defining Membrane:</td><td colspan="4">A geotextile membrane was laid under the turf as a defining layer.</td></tr>
<tr><td>5.10</td><td>Fixing:</td><td colspan="4">The turf was temporarily secured against wind uplift with twine, tied to timber dooks.</td></tr>
<tr><td>5.11</td><td>Aftercare:</td><td colspan="4">None</td></tr>
<tr><td>5.12</td><td>Maintenance:</td><td colspan="4">None</td></tr>
</table>

6.0	**Performance Assessment**	
6.1	General Performance:	The cappings performed well in giving temporary protection to the lime repairs in the severe climatic conditions, mainly wind-driven rain rather than frost. Several areas have been lost to wind uplift, despite the twine restraints. The two turf layers were still clearly defined and the geotextile layer could be seen in several places. The turf seemed to have coped well with the undulation of the masonry, despite the lack of a soil layer to even its geometry.
6.2	Effect of Climate:	The turf had been subject to severe winds, which caused some loss. Otherwise, two years after installation, there seemed to be little edge dieback and the turf that survived was healthy, suggesting that the summers were not too stressful.
6.3	Effect of Birds:	None known
6.4	Effect of Animals:	None known
6.5	Aesthetic Performance:	While, overall the naturalistic cappings are attractive in reinstating the impression of the previous natural vegetation in a site surrounded by similar grasses, there are several points that detract from this. The full cappings in some areas contrast sharply with the bare masonry in others (Fig. 33.12). The two layers of turf will give an unnatural impression until they thoroughly root together. The defining layer can be clearly seen in some places, which detracts from the cappings appeal (Fig. 33.10).
6.6	Public Reaction:	None known
6.7	Team Reaction:	The contractor was pleased with the condition of the turf that survived and not surprised by the wind-damaged areas.
6.8	Comments:	The condition of the surviving caps is impressive, given the strong winds, solar exposure and summer installation. It also demonstrates the viability of turf only cappings, though the high quality and root mass of the turf was clearly important. While its moisture or fertility is not apparently needed a clay layer might have helped to even the geometry of the flat wallheads. Nonetheless, as the cappings mature they should present an even impression, with the wallhead sockets clearly expressed.
7.0	**References:**	
	Interviews: Rebecca Little, *contractor* Tom Morton, *Architect* Susan Bain, *NTS*	

Fig. 33.2: The site gets some shelter by rising ground to the west.

Fig. 33.3: South view.

Fig. 33.4: The natural cappings, east wall.

Fig. 33.5: Removing the naturally established vegetation revealed loose masonry.

Fig. 33.6: North view, showing accommo-dation building.

Fig. 33.7: Mortar repairs to the gable.

Fig. 33.8: Cutting the turf.

Fig. 33.9: Cappings being applied.

Fig. 33.10: Two years after application, dieback reveals the defining membrane.

Fig. 33.11: The naturalistic cappings match the unmown and ungrazed site.

Fig. 33.12: East view two years after application, showing lost cappings on right.

Case Study 34: SALT WORKS, Preston Island, Fife

This case study describes work by volunteers on an exposed site.

Fig. 34.1: The Salt Pan Houses. The soft cappings survive well on the chimney and wallheads.

1.0	**Background**		
1.1	Location:	Preston Island (not now an island) in the Firth of Forth, by Torryburn, Fife.	
1.2	Grid Reference:	NT 007 852	
1.3	Date of Works:	August/September 1998	
1.4	Client:	Scottish Power in partnership with Historic Scotland and Fife Regional Council.	
1.5	Contractor:	Action Environment Limited, a work experience organisation.	
1.6	Architect:	Bob Heath	
1.7	Access:	A fence encloses the site and direct access is by arrangement with Logan Power only. However a public path circles the wire fence, from which the ruins are visible at a distance of approximately 10m.	
1.8	Visit Record:	Date:	By:
		23.06.05	EP, IM
2.0	**Building**		
2.1	Type:	Industrial Buildings associated with Salt Pans and Coal Mine, ruined.	
2.2	Classification:	Scheduled Ancient Monument	
2.3	Chronology:	Built:	The mineshafts were built in 1800 and the pan house and accommodation block were built in 1811.
		Ruined:	The island was abandoned by the mid 1850s and it is thought they were ruined shortly afterwards.
		Repairs:	1998
2.4	Construction and Form:	There are a number of ruinous structures, clustered in the centre of the original island (Fig. 34.2). There were originally three Salt Pan Houses. Two remain with the walls and chimneys intact (Fig. 34.4). The walls remain to between 1.4m and 2.3m high, and 0.4m wide. The chimneys are ~5-6m tall and also of sandstone; but the top sections are of red brick, which appear to be a latter addition. The third Salt Pan House, the one furthest west, has partially collapsed and is only visible as a mound as earth has built up around it. The Accommodation Block is a rectangular building ~20m by 5m (Fig. 34.5). The walls have remained in most places to their full heights and the original copingstones are visible. The walls stand at a height of ~4m with the apex of the gable ends ~6m. The walls are 0.4m wide. The George Pit Winding Engine House is the most dominating structure on the island, the walls are ~8m tall, and 0.5m wide and the chimney is 9-10m tall (Fig. 34.3). The Lady Pit Winding Engine House is smaller and more ruinous. The walls vary in height from ground level to ~4m tall and 0.5m wide. All the structures are built of locally quarried squared sandstone rubble in lime mortar; with the repairs having been carried out using sandstone quarried from the same area, but cut with a flatter profile.	

3.0	**Site**				
3.1	Setting:	Description:	The Salt Pan Houses lie to the north-east of the island, the Accommodation Block to the south-west, the George Pit Engine House to the west and the Lady Pit Engine House to the south-east. When the buildings were first constructed Preston Island was a very exposed, isolated rocky outcrop in the Firth of Forth estuary, subject to severe wind, rain, and sea spray. However, the sea surrounding Preston Island has been reclaimed over the past twenty-five years with ash from Longannet power station. The buildings have gained a great deal more shelter from the new surrounding landmass and vegetation.The structures are situated directly in an area of well-maintained, regularly mowed grass; metal wire fencing encloses this area.		
		Altitude:	~0m		
		Distance from Coast:	~0.5km		
3.2	Classifications:	SSSI area Local Nature Reserve Firth of Forth Special Protection Area (SPA)			
3.3	Microclimate: * Estimated from Met. Office, Annual Averages 1971 – 2000 *(Numbers in brackets give data as a % of national average)*				
		Rainfall*	~700mm (46%)	Days of Rain >= 1mm*	~130 (70%)
		Min Temp*	~5.5°C(137%)	Max Temp*	~12.0C° (114%)
		Days Ground Frost*	~40	Hours sunshine*	~1360(117%)
		Prevailing Wind Direction:		South-west	

4.0	**Flora and Fauna**	
4.1	Vegetation on Wall:	The amount of vegetation sustained on the wallheads is very varied. Generally where the turf has survived it is quite dense, consisting mainly of a variety of grasses, dominated by Red Fescue, although there are also a number of other colonised species. The Salt Pan Houses have the densest vegetation, forming a thick even coverage, with only approximately 20% of the capping material eroded. The Accommodation Block has sustained the least amount of vegetation, with only a patchy covering of long grass growing on the wallheads. Approximately 95% of the turf has eroded.
4.2	Surrounding Vegetation:	The immediate surrounding vegetation (i.e. within the enclosure) comprises well-tended grass, which is mown regularly. However the interiors of the structures are not mown and, as the ruins provide shelter, these areas are very overgrown, with a number of semi-mature trees, large shrubs and ruderals (Fig. 34.8). Outside the enclosure the reclaimed land is dominated by Indian Meliot (sour clover), nettles and grasses. There are also many trees, predominantly ash and beech, these are known to self-seed well in this area.

4.3	Species Survey. *Assessment by HL from photos* **D**=Dominant, **A**=Abundant, **F**=Frequent, **O**=Occasional, **R**=Rare, **VR**=Very Rare, *=Present				
	Common Name	Latin Name	Capping	Surrounding Vegetation	Comments
	Grasses:				
	Common Bent	*Agrostis capillaris*	**R**	**O**	
	False Oat Grass	*Arrhenatherum elatius*		**R**	
	Red Fescue	*Festuca rubra agg.*	**A**	**O**	C- Dominant in places, more patchy elsewhere
	Sheep's Fescue	*Festuca ovina*	**O**		More patchy areas
	Yorkshire Fog	*Holcus lanatus*		**F**	
	Ruderals/Herbs:				
	Autumn Hawkbit	*Leontodon autumnalis*		**R**	
	Cleavers	*Galium aparine*	*		Bottom edge
	Creeping Buttercup	*Ranunculus repens*		**R**	
	Creeping Thistle	*Cirsium arvense*	*		Lower level - ruins
	Dandelion	*Taraxacum officinale agg.*	*	**R**	Tops - patchy mix with grasses
	Mouse Ear Hawkweed	*Hieracium pilosella*	*		Tops - Patchy mix with grasses
	Ragwort	*Senecio jacobaea*	*		Lower level - ruins
	Nettle	*Urtica dioica*		**R**	
	Ribbed Melilot	*Mellotus officinalis*		**R**	
	Ribwort Plantain	*Plantago lanceolata*	*	**F**	Tops - patchy mix with grasses
	Scentless Mayweed	*Tripleurospermum inordorum*	*	**R**	Lower level - ruins
	Smooth Sow Thistle	*Sonchus oleraceus*	*		Lower level - ruins - edge
	White Clover	*Trifolium repens*	**R**	**F**	On lower level
	Trees/Shrubs:				
	Elderflower	*Sambucus nigra*	**R**		Lower level - ruins - edge
	Hawthorn	*Crataegus monogyna*	**R**		Lower level - ruins - edge
	Rose sp.	*Rosa canina agg.*	**R**	**R**	C-Lower level - ruins - edge
	Mosses/Ferns:				
	Mosses etc.		**R**		Lower level - ruins
4.3	Fauna:	The bird population is quite extensive: Skylark, Meadow Pipit, Grey Partridge, Willow Warbler, Water Rail, Chaffinch inhabit the woodland areas and Shelduck, Wigeon, Curlew, Redshank, Sandwich Tern and Dunlin on the more costal areas.			

5.0	**Technique**	
5.1	Source of Technique:	The architect had visited the work being undertaken on the Isle of May (CS36) and thought that a similar technique would work well on Preston Island
5.2	Season of Work:	Late summer/ Early autumn
5.3	Preliminary Repairs to Structure:	The walls were re-pointed in areas with a hydraulic lime mortar that was mixed on site and carefully matched to the original. Where the walls were considered structurally unstable, thin sandstone slabs were used to infill voids or replace broken or defective stones.
5.4	Treatment of Existing Vegetation:	There was quite a lot of vegetation growing on the walls before they were consolidated. All of this was removed and discarded.
5.5	Soft Capping Technique:	A single layer of turf was applied to the wall head.
5.6	Vegetation: Source and Description	The turf was cut from the existing ground cover of the island.
5.7	Soil: Source and Description	No earth layer was used as the turf was applied directly to the masonry.
5.8	DPC:	None used
5.9	Defining Membrane:	None used
5.10	Fixing:	None used
5.11	Aftercare:	None given
5.12	Maintenance:	No regular maintenance
6.0	**Performance Assessment**	
6.1	General Performance:	*Accommodation Block:* In general there has been complete failure of the capping, especially on the most exposed walls, where in some sections there is even very little earth remaining and the masonry is completely exposed. The grass growing on the wallheads is sparse and a great deal of it is yellow. There is even less vegetation growing on the gable ends of the walls, and where there is growth it appears to be due to a small ledge or step in the wall, providing shelter. The more sheltered north walls have a slightly denser coverage, but it is not comprehensive and a great deal of earth is exposed. There is growth on a number of internal sills. *George Pit Engine House:* The vegetation on the tallest wallheads is quite sparse, however the smaller projecting walls have healthy lush vegetation growing on them. The lower walls have a well-matted root system with a variety of plants and grasses growing on them and the earth is damp. *Lady Pit Engine House:* The vegetation provides a sparse covering to the wallheads, in areas the stone is visible where the soil layer has been eroded away. In most areas there is erosion around the edges of the walls where the grass has died back and the soil is dry and crumbly to touch. There appears to be quite healthy growth on top of the chimney but this was only possible to assess from the ground, the grass appeared quite tall and green. There is extreme erosion of the stone and mortar in areas of the remaining standing walls. *Salt Pan Houses:* On wider walls, or areas where the floor level is sloped upwards towards the wallhead due to collapsed masonry, the vegetation is thick and well established. It appears generally healthy and provides a thick mat over the masonry. However on the walls that stand upright the vegetation is quite sparse and no root system exists, in parts the masonry wallhead is totally exposed. The soil layer is visible where there has been some dieback around the edges, particularly on the most westerly, isolated wall. Here the soil is quite crumbly and brushes off easily. This is in contrast to those parts of the wall where the vegetation is thick, where it is very difficult to even reach the soil layer, which is damp and well meshed.

6.2	Effect of Climate:	Wind exposure plays a large role in the condition of the cappings. The Salt Pan Houses have the most comprehensive cappings and they are the most sheltered, where as the complete failure of the capping on the Accommodation Block can be attributed to its extremely exposed position.
6.3	Effect of Birds:	No known problems
6.4	Effect of Animals:	No known problems
6.5	Aesthetic Performance:	Generally, the cappings are successful in giving a naturalistic impression to the ruins. The setting, which contrasts dramatically between the close mown lawns of the fenced enclosure and the wild overgrown ruin interiors, is perhaps less balanced.
6.6	Public Reaction:	None recorded
6.7	Team Reaction:	None recorded
6.8	Analysis	The soft cappings technique on this site was at its simplest, in laying turf cut from nearby on the wallheads, without soil or fixings. On an exposed site with low rainfall and no aftercare, it not surprising that there has been considerable dieback and that the distribution relates to local climatic exposure. The best areas suggest that such simple techniques can be successful in sheltered conditions. Comparison with the Isle of May (CS36) suggests that the use of a soil layer would have reduced dieback. In both cases fixings would have reduced loss. In terms of protecting the masonry, the capping will have had a temporary benefit in protecting the mortar repairs from rain and frost, and in that respect the lost cappings are comparable in performance to the emergency cappings at Cottown (CS32) which were a temporary measure. The long-term benefits of moisture reduction will be felt mainly by the broader areas of masonry, such as the chimneys, where the size has also encouraged capping survival.
7.0	**References:**	
	Sources: Ewart, G, *A Man Worth His Salt, Fife Council, 1997* Interviews: Bob Heath, *Architect* Iain McNair, *Longannet Power* Data: http://www.metoffice.gov.uk/climate/uk/averages/19712000/mapped.html	

Fig. 34.2: Aerial view from the west, before the works, 1988.

Fig. 34.3: The George Pit House.

Fig. 34.4: The Salt Pan Houses.

Fig. 34.5: The Accommodation Block.

Fig. 34.6: Grass clings to locally-sheltered places.

Fig. 34.7: Cover is very sparse on exposed wallheads.

Fig. 34.8: Inside the ruins, there is no maintenance and a profusion of plants thrive sheltered from the wind.

Fig. 34.9: Low level caps show re-growth after drought dieback and possible grazing by rabbits.

Fig. 34.10: The most exposed caps, on the chimneys, perform well.

Case Study 35: SKIPNESS CASTLE, Kintyre, Argyll

This case study presents ongoing work by Historic Scotland on a monument in Argyll, which raises interesting issues regarding the role of soft capping in the presentation of ruined masonry.

Fig. 35.1: Skipness Castle from the north.

1.0	**Background**		
1.1	Location:	Skipness, Mull of Kintyre	
1.2	Grid Ref.:	NR 9078 5778	
1.3	Date of Works:	Annually in winter, 2002-06	
1.4	Client:	Historic Scotland	
1.5	Contractor:	Historic Scotland, Lochgilphead squad	
1.6	Architect:	Historic Scotland, Michael Burgoyne	
1.7	Access:	Public access to ground level, wallheads can be overlooked from the tower	
1.8	Visit Record:	Date:	By:
		04.12.05	TM, soft capping in progress
2.0	**Building**		
2.1	Type:	Castle, ruined	
2.2	Classification:	Category A Listed Scheduled Ancient Monument.	
2.3	Chronology:	Built:	The site was first occupied at the beginning of 13thC. with the construction of a hall-house and chapel. The curtain wall was not built until the beginning of the 14thC. and the tower at the beginning of the 16thC.
		Ruined:	Late 1600s. A sketch of 1898 shows vegetation on the wallheads.
		Repairs:	There were apparently repairs soon after the monument was taken into guardianship, c.1930s, which included clearing naturally established vegetation from the wallheads. A dense grassy sward had re-established by 1965, but was largely, if not completely, removed for rough racking consolidation in cement and lime c.1980. Subsequently, soft cappings have been applied as winter work since 2001, with natural vegetation again being removed.
2.4	Construction:	The surviving structure comprises a rectilinear courtyard, ~27m x 35m, with a tower house in the north-east corner. The courtyard is enclosed by walls, ~10m high and 2.1m thick. The masonry is roughly coursed, locally quarried mica-schist rubble with red sandstone dressings. The mortar is *"made up of a composition of lime, sea-shell, and earth of a dunnish colour, so exceedingly firm that it were easier to quarry a whin-stone"* (Statistical Account of Scotland). The wallheads present a variety of conditions. The east wall includes remains of a parapet walkway, sitting low in the middle of the wallhead between rough racking (soft capped 2002). The southeast and south walls were part of a building and incorporate bayed features between rough racking (not soft capped). The west wall is rough racked, sloping inward with traces of a parapet upstand (soft capped 2003, 2004 and 2006). The north wall is flat and rough racked (soft capped 2005).	
3.0	**Site**		
3.1	Setting:	Description:	The castle is situated on the west shore of Loch Fyne, amid rough pasture with deciduous trees to the west. It is very exposed to the prevailing south-west.
		Altitude:	~2m
		Distance from Coast:	~ 200m
3.2	Classifications:	None known	

3.3	Microclimate: * Estimated from Met. Office, Annual Averages 1971 – 2000 *(Numbers in brackets give data as a % of national average)*	The site has a mild, but wet and windy climate. Close to the sea loch shore, it has no protection from rain driven in from the Atlantic on the prevailing southwest. Proximity to the loch means there is little frost.			
		Rainfall *	~1700mm (111%)	Days of Rain >= 1mm *	~185 (100%)
		Min Temp*	~6.2°C (155%)	Max Temp*	~11.8°C (112%)
		Days Ground Frost*	~40	Hours sunshine*	~1340 (115%)
		Prevailing Wind Direction:		South-west	

4.0	Flora and Fauna	
4.1	Vegetation on Wall:	The wall cappings generally present a healthy and dense sward, dominated by fine grasses. Mosses and other plants generally congregate on areas of edge dieback.
4.2	Surrounding Vegetation:	Sparsely distributed across the uncapped wallheads there are a variety of unidentified grasses and other plants. Mown grasses, whose species are unidentifiable, dominate the immediate surrounding area. The castle grounds are surrounded by grazed fields, with deciduous woodlands ~100m to the west.
4.3	Species Survey. *Assessment from photographs by HL, 24.1.07* **D**=Dominant, **A**=Abundant, **F**=Frequent, **O**=Occasional, **R**=Rare, **VR**=Very Rare, *=Present	

Common Name	Latin Name	Capping	Surrounding Vegetation	Comment
Grasses:				
Common bent	*Agrostis capillaris*	**A**		
Red Fescue	*Festuca rubra agg*	**O**		Locally dominant and well established in places
Species unidentifiable		**A**		Bare areas and dying grasses
Ruderals/Herbs:				
Daisy	*Bellis perennis*	**VR**		
Broadleaved Willowherb	*Epilobium montanum*		*	
Trees/Shrubs: None noted				
Mosses/Ferns:				
Moss sp		**VR**		Unidentified; on exposed soils

4.4	Fauna:	None noted

5.0	**Technique**	
5.1	Source of Technique:	The technique was carried forward from the experimental work by Historic Scotland at Doune Castle Mill (CS15), but with some modifications and improvements.
5.2	Season of Work:	Winter (September – March)
5.3	Preliminary Repairs to Structure:	No mortar repairs were undertaken, there having been extensive wallhead consolidation twenty-five years previously. The mortar had cracked, allowing water ingress, but the wallheads were not pointed, in order to give a mechanical key.
5.4	Treatment of Existing Vegetation:	A considerable quantity of naturally established vegetation was removed, comprising mainly grass.

5.5	Soft Capping Technique:	The clay is stiff from storage under cover and is worked up on boards by foot into blocks. This requires great effort and considerable time. This is laid over the bare masonry to achieve a roughly uniform section (Fig. 34.5 and 34.6) to a min. 75mm and max. 450mm thick. Hessian is used as a temporary cover to prevent drying out. Over this, nom 75mm topsoil is laid, sufficiently damp to be homogenous, followed by one layer of turf, with staggered joints, as one process in day sections. The turf is pegged against wind uplift.
5.6	Vegetation: Source & Description	Turf was mainly fresh and cut from an adjacent field, grazed by sheep. The area where the turf was cut was damp, being at the bottom of a slope and the soil poorly draining. One section used three week old commercial turf.
5.7	Soil: Source & Description	Topsoil was sourced form the local Kilmartin Quarry, riddled to remove stones. The clay was excess Errol clay from Doune Castle Mill mixed with sand (1:4, Gallowflat red clay:sharp sand).
5.8	DPC:	Clay cap, see above
5.9	Defining Membrane:	None
5.10	Fixing:	Turf pegged at edges: twigs or metal hoops (Fig. 35.7).
5.11	Aftercare:	None
5.12	Maintenance:	None
6.0	**Performance Assessment**	
6.1	General Performance:	The caps have performed well in reducing moisture ingress into the wallheads, with water dripping from the underside of arched openings in the walls beneath having been halted (Fig. 35.9). The turf, apart from exposed edges, was well established, with a healthy dense sward and root system. The roots have not penetrated into the clay layer, which has a slightly plastic consistency (Fig. 35.10 and 13). Some short-term clay staining after the works is reported. There is also minor, local, long-term clay staining where edges are not stable. There is consistent evidence of edge decay, which seems to correlate with wind exposure. The soft cap profile, of which there is significant variation, does not seem to affect performance, with a healthy sward generally away from decaying edges (Figs. 35.11 and 12). There seems to be very little invasive seeding, with only occasional dandelions, etc. The exception is the decayed edges, where there are mosses some secondary grass growth and other plants. There is no evidence of trees seeding from the adjacent woodland. There has been some natural seeding onto the uncapped masonry.
6.2	Effect of Climate:	The effects of wind exposure are clearly the principal factor contributing to the decay of the edges, which is general and progressive, and most affects the edges with greatest wind exposure. It is fairly clear that the turf dies first and then there is erosion of the topsoil and clay, with some secondary colonisation of the exposed soil by moss, grass and other species, most successful on the more sheltered edges (Fig. 35.14). It seems unlikely that these edges would dry out excessively, killing the grass, as there is a good quantity of soil and a wet climate. Heavy rainfall might cause occasional saturation of the soil, especially on the flatter wallheads.
6.3	Effect of Birds:	None noted
6.4	Effect of Animals:	None noted

6.5	Aesthetic Performance:	The aesthetic performance of the cappings is mixed and raises interesting issues about how to treat differing wallhead conditions. The edge decay will need to be resolved as a progressive technical problem before its aesthetic impact becomes very significant. The consequential minor clay staining is unsightly, but barely noticeable to the untrained eye. The different wallhead conditions have been treated in different ways and there has been obvious aesthetic consideration in the design of the soft cappings and their effect on the presentation of the monument when publicly viewed from the tower. On the east wallhead the capping defines the walkway surface clearly, between areas of exposed rough racking. On the west and north walls the rough racking has all been soft capped. Neither the paved surfaces nor rough racking on the south and south-west wallheads have been soft capped. Therefore, while the soft cappings work well aesthetically on the individual wallheads, there is an overall inconsistency in presentational approach that is slightly confusing. Further seasons of work may remedy this, but there is clearly a dilemma between conservation and preservation interests. If all the wallheads were soft capped, this would give maximum protection to the masonry and present the ruin in its natural condition. The history of rapid re-colonisation, related to the mild climate, evidences this. However full soft capping would obscure the complexity of wallhead conditions that are a clear visual expression the different built elements that form the monument as it stands today. If only rough racked areas were to be capped, the paved surfaces would clearly define these characteristics, but, being flat and of more porous stone, they would be left vulnerable to decay and natural colonisation.
6.6	Public Reaction:	None noted
6.7	Team Reaction:	Those involved from Historic Scotland agree that the soft capping work has worked very well.
6.8	Comments:	This is a fascinating example of soft capping in several respects. On a technical level, the use of a topsoil layer over the clay seems to be an improvement on the Doune Castle Mill (CS15) precedent, in avoiding deterioration of the turf through saturation of the clay. However, comparison with Kilmorie Chapel (CS23) suggests that profile and microclimate may be equally important factors. With the high wind exposure on this site, a rolled edge detail may have prevented edge decay establishing. More generally, there does not seem to be a need for double turf on these mild sites, with the soil layer assisting in creating a good root mass, minimising the quantity of turf required. The use of local turf is again shown to be more successful than commercial turf in achieving a dense sward. However, it would perhaps have been ideal if the turf, which was removed from the wallheads prior to the works, could have been reinstated over the clay and soil layers. The difference in species and root structure between that turf and the turf sourced from a damp pasture might have improved edge resistance to wind damage. Certainly the natural caps displayed a robust edge condition. This monument demonstrates the same potential for rapid and dense natural colonisation in the mild climatic conditions found in Argyll that are demonstrated at Eilean Mor (CS1). This poses a question over long-term maintenance. The soft cappings appear to perform well, with no need for significant intervention, assuming that the edge decay can be stabilised by remedial work. However, the uncapped wallheads will have more rapid colonisation because of the proximity of these plants and they will suffer the normal decay processes of exposed mortar and stone. This highlights the fact that in complex individual cases, such as this monument, a clear balance between fabric conservation, presentation and efficient maintenance can be difficult to achieve.
7.0	**References:**	
	Sources: *Statistical Account of Scotland*, XII (1794) p.485. *Inventories of Ancient Monuments, Vol. 23 (1971) Argyll, Vol. I Kintyre*, RCAHMS, The University Press, Glasgow. RCAHMS photographs: 1898 sketch AGD/81/15P, AG/753, 720, 743 & 745, A/65631 Interviews: Michael Burgoyne, *Historic Scotland Architect* Lawrence Begg, *Historic Scotland Works Manager* Robbie Wilson, *Historic Scotland Foreman*	

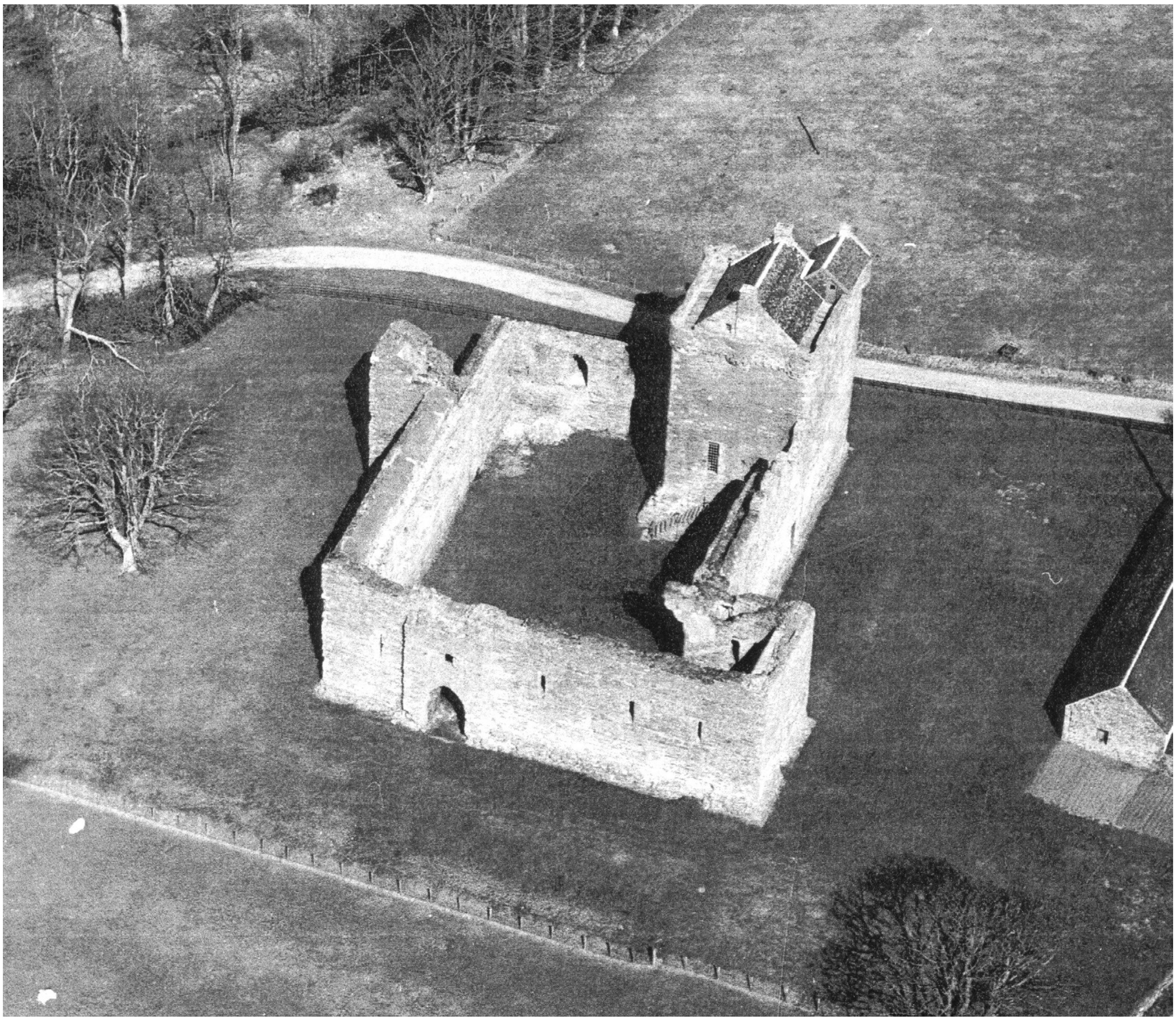


Fig. 35.2: Aerial view from the south in 1984.

Fig. 35.3: The east and south walls in 1965 prior to capping.

Fig. 35.4: The east and south walls in 2006.

Fig. 35.5: Application of capping.

Fig. 35.6: Application of capping.

Fig. 35.7: Metal pinnings.

Fig. 35.8: The west wall. A division between two seasons' work is discernable in the middle.

Fig.35.9: Moisture reduction under arch.

Fig. 35.10: Edge dieback on last season's capping. The outside of this section is in the foreground of Fig. 35.11.

Fig. 35.11: Variation in profile. The east wall in the foreground has a much flatter profile than the north wall in the background.

Fig. 35.12: The west wall. The more recent work has a less stable edge than the previous years.

Fig. 35.13: New growth in edge dieback.

Fig. 35.14: Natural colonisation of the south wall.

Fig. 35.15: The south end of the east wall.

Case Study 36: ST. ADRIAN'S CHAPEL AND MONASTERY, Isle of May, Fife

This case study documents cappings on a sensitive archaeological site on an east coast island, where climatic and working conditions proved difficult.

Fig. 36.1: The masonry ruins stand amid rolling grassland and rocky outcrops.

1.0	**Background**		
1.1	Location:	Isle of May, at the mouth of the Firth of Forth	
1.2	Grid Reference:	NT 6586 9902	
1.3	Date of Works:	November 2002	
1.4	Client:	Fife Regional Council in partnership with SNH	
1.5	Contractor:	Matthew White	
1.6	Architect:	John Sanders, Simpson & Brown Architects	
1.7	Access:	Limited public access. There are daily trips by boat during the summer months, from Anstruther, weather dependant.	
1.8	Visit Record:	Date:	By:
		20.06.05	EP

2.0	**Building**		
2.1	Type:	Chapel, ruin and monastery, post excavation remains	
2.2	Classification:	Scheduled Ancient Monument	
2.3	Chronology:	Built:	c. 1000 –1200, converted to fortified house c. 1500
		Ruined:	c. 1700
		Repairs:	Excavations began in 1992 and were undertaken during the summer months in six seasons until 1997. For financial, practical and administrative reasons the consolidation and capping of the walls took longer than expected and was not completed until 2002.
2.4	Construction and Form:	The ruined walls of the small chapel are built of random rubble in lime mortar and rough racked at heights approximately 1.4 – 3m above the surrounding ground. The corners and openings are detailed in a pale sandstone ashlar. Only the east wall, about 4m long, is soft capped and this stands at 1.4 –2.2m above ground level. The excavated remains of the monastery walls stand approximately 0.2m above the path level and contain an excavated interior approx 0.6m deep. The walls form a rectilinear plan, approx. 6m by 8m.	

3.0	**Site**				
3.1	Setting:	Description:	The chapel is situated on the south-east of the Isle of May, an island 1.5 km long and 0.5km wide, approximately 8 km south-east of the Fife coast. The island slopes gradually up from sea level on the east to 50m cliffs on the west side.		
		Altitude:	2m		
		Distance inland:	30m		
3.2	Classifications:	Site of Special Scientific Interest Special Protection Area National Nature Reserve Special Area of Conservation			
3.3	Microclimate: * Data source: Met. Office, Annual Averages 1971 – 2000 *(Numbers in brackets give data as a % of national average)*	The site is very exposed to wind, rain and salt spray, especially to the east. However the walls benefit from a degree of shelter from adjacent higher walls.			
		Rainfall (mm)*	~550mm (36%)	Days of Rain >= 1mm*	~110 (168%)
		Min Temp*	~ 6°C? (150%)	Max Temp *	~ 6°C? (57%)
		Days Ground Frost*	40?	Hours sunshine*	~1600 (138%)
		Prevailing Wind Direction:		Assumed south-west	

4.0	**Flora & Fauna**					
4.1	Vegetation on Wall:	The capping applied to the high level chapel wall is patchy and dry. It has decayed back to isolated patches, where the grass seems reasonably healthy and grew to 350mm high. In general there is dieback around all of the edges and the vegetation is confined to a central strip and a number of niches formed by the rough racking. There is evidence of a number of ruderals, which are thought to have been imported with the turf, rather than naturally seeded. However, in general they have not survived. The capping applied to the low level excavated walls was in poor condition, with a great deal of erosion. Very heavy browsing by rabbits allowed the grass only a short growth of about 5mm, which provided little protection.				
4.2	Surrounding Vegetation:	The island vegetation is fairly consistent natural grassland of limited species with rocky outcrops and no large plants or trees.				
4.3	Species Survey. *Assessment by HL from photographs* **D**=Dominant, **A**=Abundant, **F**=Frequent, **O**=Occasional, **R**=Rare, **VR**=Very Rare, *=Present					
	Common Name	Latin Name	Low-Level Capping	High-Level Capping	Surrounding Vegetation	Comments
	Grasses:					
	Common Bent	*Agrostis capillaris*	**O**	**R**		
	Fescue sp.	*Festuca sp.*	**A**	**D**		Very heavily browsed at LL.
	Ruderals/Herbs:					
	Common Mouse Ear	*Cerastium fontanum*			*	
	Creeping Buttercup	*Ranunculus repens*	**R**		*	
	Creeping Thistle	*Cirsium arvense*	**R**			
	Daisy	*Bellis perennis*			*	
	Forget-me-not sp.	*Myosotis sp.*			*	
	Greater Plantain	*Plantago major*			*	
	Hogweed	*Heracleum sphondylium*			*	
	Lesser Burdock	*Arctium minus agg.*			*	
	Mallow sp.	*Althaea sp.*		**R**		
	Nettles	*Urtica dioica*			*	
	Procumbent Pearlwort	*Sagina procumbens*	**F**			
	Ragwort	*Senecio jacobaea*	**R**			
	Sea Campion	*Silene vulgaris ssp maritima*			*	Large clumps throughout
	Spear Thistle	*Cirsium vulgare*	**R**			
	Thrift	*Armeria maritima*		**R**		
4.4	Fauna:	Large numbers of birds inhabit the island, including razorbills, kittiwakes, fulmars, guillemots, puffins, terns and shags. The island also has a large rabbit population.				

5.0	**Technique**	
5.1	Source of Technique:	The architects were aware of this as a conservation technique, having used it three years before at Nunton Steadings (CS 29).
5.2	Season of Work:	Late autumn
5.3	Preliminary Repairs to Structure:	The chapel walls were repointed with a hydraulic lime mortar. A capping of hydraulic mortar ~50mm thick was applied to the wallhead to form a water shedding surface. The low monastery walls were partially rebuilt and consolidated with lime mortar.
5.4	Treatment of Existing Vegetation:	The existing naturally established caps on the chapel walls were removed to allow the consolidation work. The existing vegetation and soil covering on the monastery walls was stripped away during initial excavation work. Nettles quickly colonised the disturbed area but these were also removed.
5.5	Soft Capping Technique:	A layer of earth ~100-150mm thick was applied to the wallhead in a shallow domed profile. One layer of turf was then applied, roots down.
5.6	Vegetation: Source & Description	The turf was sourced from the mainland, reported as having been locally produced in Fife. The turf was delivered to the site one to two weeks before it was applied and, although it was watered during this period, it dried out considerably, with brown patches apparent.
5.7	Soil: Source & Description	Assumed to be from the island, possible spoil from the excavations. The soil does not seem to have a significant clay or humus content. It is fine grained, with significant quantities of sand and round stones.
5.8	DPC:	None used
5.9	Defining Membrane:	None used
5.10	Fixing:	It is thought that no fixings were used. Wind, created by the helicopter used to transport materials to and from the site, partially lifted the turves from the wallhead during the works (Fig 36.4).
5.11	Aftercare:	None known
5.12	Maintenance:	None known
6.0	**Performance Assessment**	
6.1	General Performance:	The caps have suffered consistent severe edge dieback, min 50mm, leaving grass in isolated sections along the wallheads, giving ~60-70% cover. The surviving turf seems well established and has a uniform appearance. The vegetation on the lower walls is in worse condition than that at higher levels, and this appears to be due to aggressive grazing by rabbits. The exposed soil is dry, very friable and rapidly erodes. The large stones within the earth layer encourage erosion when exposed, as the earth erodes sacrificially around them, loosening them until they fall out, exposing deeper material. It is important to note that the appearance of the cappings was comparable to the surrounding turf, except there was little of the white flowering sea campion. This is an extremely harsh environment and the vegetation is neither lush nor extensive. In this context, the cappings have had limited success.
6.2	Effect of Climate:	The turf was applied late in the year, when it was extremely windy, with gale force seven or eight winds not unusual. The turf is exposed to a great deal of sea spray.
6.3	Effect of Birds:	Turf was removed by birds, particularly kittiwakes, to build nests during the nesting period in late spring (April/May).
6.4	Effect of Animals:	The island's large rabbit population heavily graze the accessible turf, which keeps it extremely short, leaving it more vulnerable to climate related erosion.
6.5	Aesthetic Performance:	The capping has not been successful in aesthetic terms. Where the grass is alive, it appears naturalistic, but the decay and erosion is unsightly.
6.6	Public Reaction:	None noted.

6.7	Team Reaction:	The capping is not considered by the client to have been very successful. The initial feeling that it 'looked awful' was linked to early loss due to birds and edge dieback, but more recently, as the turf has stabilised, it is felt to be partially successful. It is hoped that the surviving caps will be colonised by island species, especially the Thrift. It is thought that the technique *'works well on sites that are well maintained but not on unmaintained sites such as this'*, (DS). In addition, the inclement weather and the logistics of helicopter transport caused problems, delays and led to high costs. These combined to leave the team members with a negative experience.
6.8	Comments:	The cappings have had limited success in providing a durable finish to the wallheads. Whether this stabilises to form a better capping in the long term remains to be seen. It may be that conditions are too severe and all cappings will gradually fail, as happens at Eynhallow, but the fact that the core of the cappings has survived and that naturally established cappings existed before the works, suggests that the capping will gradually recover. The isolation of this island site meant that there was no means of aftercare, and this is comparable to the situations of Pabbaigh (CS33) and Eynhallow (CS18). The need to carry out work outside the bird-breeding season presented practical difficulties again similar to Eynhallow, though that site lacked the aggressive assaults of the birds. The heavy grazing by rabbits was more damaging than grazing at other sites, such as Dun Carloway Blackhouse (CS3) and St. Kilda (CS7), which are predominantly by sheep. The sites exposure is comparable to other coastal and island sites, though the drying conditions are more severe than on the west coast, while Eynhallow has much less solar radiation. The most comparable site is probably Skara Brae (CS10), where grass cutting mimics the effect of the rabbits and the soil has a similar poor structure. Despite these harsh site conditions, the caps were certainly successful in providing initial protection of the consolidated wallheads against climatic exposure during the first year, when mortar repairs are particularly vulnerable. It also suggests that capping with turf could be a useful temporary measure on sites with ongoing excavations to protect exposed areas over winter between excavation seasons. The case study suggests measures that can be taken to optimise the likelihood of success in this type of site. The turf was apparently of good quality, but it could have been laid sooner after lifting. Applying the turf in two layers would also have inhibited dieback. Although the turf was relatively local, it would have been ideal to re-use the vegetation that had been removed during the excavations, either that from the natural wallhead cappings or turf lifted from ground surfaces at the start of the excavations. This would have had the optimum species mix for survival in the site conditions. The cost of watering this until it was needed would perhaps have been less than the cost of transporting turf by helicopter. The caps could have been pegged and netted against wind uplift. This would also have deterred theft by birds. The use of a better structured soil may have retained more moisture and been less susceptible to wind erosion when exposed.

7.0	**References:**
	Interviews: Douglas Speirs, *Fife Council Archaeology Service* Darren Helmsley, *reserve warden, Scottish Natural Heritage* Sources: RCAHMS, Fife Kinross and Clackmannan, No.39, p. 25-6, 1933 Yeoman P, *Secrets of Fife's Holy Island, The Archaeology of the Isle of May* RCAHMS Photographs: E/81767/CN/PO, E/81772/CN/PO, E/81775/CN/PO, E/81771/CN/PO, E/81792/CN/PO, E/81776/CN/PO

Fig. 36.2: The ruins prior to works, showing naturally established wallhead vegetation.

Fig. 36.3: After completion of the works, with the excavated walls in the foreground.

Fig. 36.4: Damage caused by wind from the helicopter.

Fig. 36.5: Lime capping to consolidated wallheads.

Fig. 36.6: East wall of ruined chapel. Patchy vegetation and dieback.

Fig. 36.7: The central section shows healthy growth.

Fig. 36.8: Edge dieback on the high walls.

Fig. 36.9: The large pebbles are exposed by erosion.

Fig. 36.10: Failure on sections of the low-lying walls. The surviving cap condition is comparable to the surrounding area.

Case Study 37: ST. CLEMENT'S CHURCH, Roghadal, Harris, Outer Hebrides

This fascinating case study reveals some of the complexity of repairing walls with mature cappings on a sensitive site.

Fig. 37.1: View from the north-east, 2005. A rebuilt section of wall is behind the cars.

1.0	**Background**				
1.1	Location:	Roghadal (Rodel), on the south-eastern tip of Harris, Western Isles			
1.2	Grid Reference:	NG 0477 8318			
1.3	Date of Works:	North roadside wall rebuilt in 2003 with soft caps applied, the west wall and the west end of the south wall in 2006.			
1.4	Client:	N/A			
1.5	Contractor:	Historic Scotland			
1.6	Architect:	Historic Scotland			
1.7	Access:	Un-restricted access, public graveyard.			
1.8	Visit Record:	Date:	By:		
		22.08.03	TM. BL		
		06.09.05	TM		
		15.09.06	TM		
2.0	**Building**				
2.1	Type:	Graveyard enclosure walls			
2.2	Classification:	Scheduled Ancient Monument			
2.3	Chronology:	Built:	The date of the enclosure walls is uncertain. The church is thought to date from the 16thC, but has been heavily restored on several occasions. Walls are recorded on the early OS maps, suggesting they were built in the early 19thc. or before.		
		Ruined:	The walls are not ruined as such, being generally stable, but locally dilapidated.		
		Repairs:	The north roadside wall was taken down and rebuilt in 2003. The west wall was similarly rebuilt 2005-06.		
2.4	Construction and Form:	These walls seem to have been originally constructed with turf caps over drywall rubble masonry in the local tradition, as illustrated in other nearby field walls (CS5). They stand to approx. 1m.			
3.0	**Site**				
3.1	Setting:	Description:	The site sits on the south-eastern corner of Harris. The island is exposed to the south-west, though crucially the graveyard walls are partly in the lee of a small hill.		
		Altitude:	20m		
		Distance from Coast:	200m		
3.2	Classifications:	None known			
3.3	Microclimate:	The site is exposed to strong winds.			
	* Data source: Met. Office, Annual Averages 1971 – 2000	Rainfall*	~3000?mm (197%)	Days of Rain >= 1mm*	~250? (135%)
	(Numbers in brackets give data as a % of national average)	Min Temp*	~6°C (150%)	Max Temp*	~7°C (67%)
		Days Ground Frost*	~30	Hours sunshine*	~1200 (103%)
		Prevailing Wind Direction:		Assumed south-west	

4.0	**Flora and Fauna**	
4.1	Vegetation on Wall:	*Old Cappings:* Generally the old cappings have developed caps of dense fine grasses, with wild flowers and mosses, especially at the edges. The caps are obviously drier than the surrounding vegetation. There is commonly some edge dieback, though the degree varies considerably and it is most common on the windward side. This is also the southern side, so there may also be some effect from solar radiation. Soil thickness is on average 100mm, with the roughness of the wallhead providing a good mechanical key. *North Wallhead:* The north roadside wall was rebuilt in 2003 with soft caps applied, in turvess 50mm thick, x 300mm wide x 600mm flat across the wallhead. The vegetation is almost entirely grass, though some moss and other species had started to colonise by year three.
4.2	Surrounding Vegetation:	The graveyard has generally close mown lawn, with rough grazing surrounding the enclosure walls. One nearby ruin has wallheads that have been naturally colonised. Here the amount of soil is very small and the species are largely grasses.

4.3	Species Survey. *Assessment by HL from photos* **D**=Dominant; **A**=Abundant; **F**=Frequent; **O**=Occasional; **R**=Rare; **VR**=Very Rare; *=Present					
	Common Name	Latin Name	North wall	Other walls	Surrounding Vegetation	Comment
	Grasses:					
	Common Bent	*Agrostis capillaris*	**O**		*	
	Creeping soft grass	*Holcus mollis*			*	
	Crested Dogstail	*Cynosurus cristatus*	**F**			
	Early Hair Grass	*Aira praecox*	**O**			North edges
	Perennial Rye Grass	*Lolium perenne*	**O**		*	
	Red Fescue	*Festuca rubra agg*	**F**		*	
	Sheep's Fescue	*Festuca ovina*			*	
	Velvet Bent	*Agrostis canina*		**A**		
	Yorkshire Fog	*Holcus lanatus*	**R**			
	Ruderals/Herbs:					
	Broadleaved Dock	*Rumex obtusifolius*			*	
	Common Chickweed	*Stellaria media*			*	
	Common Mouse Ear	*Cerastium fontanum*			*	
	Common Sorrel	*Rumex acetosa*			*	
	Creeping Buttercup	*Ranunculus repens*			*	
	Heath Bedstraw	*Galium saxatile*		**R**		
	Iris	*Iris pseudacorus*			*	Adjacent to "other walls"
	Lady's Mantle	*Alchemilla glabra*			*	
	Nettle	*Urtica dioica*			*	
	Ribwort Plantain	*Plantago lanceolata*	**R**			
	Soft Rush	*Juncus effusus*			*	
	Spear Thistle	*Cirsium vulgare*			*	
	White Clover	*Trifolium repens*	**R**			
	Trees/Shrubs:					
	Sycamore	*Acer pseudoplatanus*			*	
	Gorse	*Ulex europaeus*			*	
	Fuschia	*Fuschia sp*			*	
	Hazel	*Corylus avellana*			*	
	Mosses/Ferns:					
	Bracken	*Pteridium aquilinum*			*	Adjacent to "other walls"
	Lichens	*Cladonia spp*		**O**		
4.4	Fauna:	None noted				

5.0	**Technique**	
5.1	Source of Technique:	Uncertain
5.2	Season of Work:	Thought to be summer
5.3	Preliminary Repairs to Structure:	The drystone walls were taken down and reconstructed before capping.
5.4	Treatment of Existing Vegetation:	The existing vegetation cappings were discarded.
5.5	Soft Capping Technique:	The walls originally seem to have had a soft capping following the local vernacular, of a layer of soil, followed by a layer of turf, though the soil layer is less clear and consistent than on the nearby field walls (CS5). On top of the flat drystone wallheads, sections of turf, 50mm thick, x 300mm wide x 600mm flat were laid across.
5.6	Vegetation: Source & Description	Not known, apparently fairly local, though not from the immediate vicinity.
5.7	Soil: Source & Description	There is no separate soil layer. The soil included in the turf is somewhat peaty.
5.8	DPC:	None used
5.9	Defining Membrane:	None used
5.10	Fixing:	None used
5.11	Aftercare:	None apparent
5.12	Maintenance:	None apparent
6.0	**Performance Assessment**	
6.1	General Performance:	*The Old Cappings* The old cappings are very mature and show considerable variation, apparently relating to wind exposure, with mosses, sedums, lichens and other species all colonising where the grass struggles to survive (Figs. 37.10 and 11). The result is a dense matt giving good wallhead cover in most areas (Fig. 37.5). There is not a large amount of soil, but the root mat binds the head stones together well, contributing to their stability, while not having deep and potentially damaging tap roots that penetrate into the masonry. Relatively small areas have not sustained cappings and these seem to be associated with areas of masonry in worst condition, including partial collapse. In the best locations, the walls have a full and lush topping of predominantly grass species, with soil 125-150mm thick and cover to the edges (Figs. 37.4 and 6). One of the small enclosures within the graveyard has a rough masonry cope that has been partially colonised by plants. In the main these are sparse and ineffective, but where one corner is sheltered by a stunted tree, there is good grass cover, clearly indicating the importance of wind exposure on this site (Fig. 37.8). *New Cappings* The soft caps on the north wallhead, which was rebuilt in 2003, have had varied success, with some areas struggling and others becoming reasonably well established. There was clearly a period of initial dieback from the exposed cut edges, as well as shrinkage of the joints between the relatively small turf blocks (Fig. 37.14). The south edge commonly died back ~25mm, while the north remained to its original line. In the worst areas, the turf dies right across the wallhead. In dead areas the dense rotted turf suffered little erosion, though there was some minor association of turf edge decay with joints in the masonry below. By the third year there was evidence of new plant growth on the cut edge (Figs. 37.17 and 18).
6.2	Effect of Climate:	Though the site has some shelter from rising ground to the south-west, the south edges are still significantly affected by wind, apparently causing dieback through drying out of the edge, likely with some assistance from solar radiation.
6.3	Effect of Birds:	None noted
6.4	Effect of Animals:	None noted

6.5	Aesthetic Performance:	Generally the old cappings are a good example of local vernacular traditions, where the materials merge with the landscape from which they were sourced. The age of the old cappings also have subtler resonances, as their species diversity and physical size and shape respond to microclimatic conditions. Both the old and rebuilt boundary walls have metal angle post and wire fences on top, which are presumably intended to deter sheep. These significantly detract from the walls' visual appearance. The rebuilt walls are not a good match to the old walls, lacking their physical and species complexity. Their lines are also straight and overall they lack the subtle grace, which the old ones have attained. They are then, an example of repairing in the original style, rather than building to replicate an aged appearance. It is hard to know if old walls originally looked like rebuilt ones, or whether the new ones have been built with more care and desire to achieve a uniform appearance. In 100 years it may be impossible to distinguish any difference as the new masonry settles in and the vegetation gains complexity. Nonetheless, in the short term the visual impression of the rebuilt walls is rather too 'tidied up' and it would be unfortunate if all the landscape character and sense of place that the old walls bring, is lost through rebuilding of all the walls. One simple means of retaining some of that character through the repairs would be to re-use some of the old vegetation. The old stone is re-used to rebuild the masonry and it is logical to extend the same principle to the other walling material – the plant cap.
6.6	Public Reaction:	None known
6.7	Team Reaction:	None known
6.8	Comments:	This case study demonstrates how much soft cappings can contribute to the character of a site and the setting of a historic monument and how important that repairs be fully considered. It highlights the repairs context for vernacular cappings, such as Gordon Castle Estate (CS4) as well as other walls in the Western Isles, as illustrated by walls near this site in CS5. It demonstrates that a sensitivity to local vernacular soft capping traditions survives, though it suggests that the skills and knowledge of the detail of local traditions could be further developed.
7.0	**References:**	
	http://www.metoffice.gov.uk/climate/uk/averages/19712000/mapped.html	

Fig. 37.2: Aerial view from the south, 1966. The varied condition of the walls implies construction at different times.

Fig. 37.3: East view. The wall materials of stone and turf echo the surrounding landscape of rough grazing with rocky outcrops.

Fig. 37.4: The mature turf capped drystone walls are only one of a complex range of plant/stone relationships on the site.

Fig. 37.5: The old cappings all have dense root mats, which tie together the un-mortared stones, without damaging them.

Fig. 37.6: East wall. Many of the old cappings have a broad and full sward.

Fig. 37.7: South wall. Some exposed caps are sparse.

Fig. 37.8: Vegetation cover relates to wind shelter.

Fig. 37.9: Evidence of stones to hold down turf, akin to St. Kilda.

Fig. 37.10: Sedums and mosses provide stability in exposed areas.

Fig. 37.11: Lichen growth can be significant.

Fig. 37.12: The new cappings.

Fig. 37.13: The finished wall.

Fig. 37.14: Early dieback and joint shrinkage.

Fig. 37.15: North wall. After two years dieback is considerable.

Fig. 37.16: North wall. After three years initial dieback seems to have stopped.

Fig. 37.17: North wall. After three years, there is some new growth from the cut edges.

Fig. 37.18: Moss and grass colonisation helps to stabilise decay of dead areas.

Fig. 37.19: North and east walls. The visual contrast between the old and reconstructed walls is significant.

Case Study 38: ST. KATTAN'S CHAPEL, Aberuthven, Perthshire

This case study illustrates the most severe dieback on a permanent conservation capping.

Fig. 38.1: View from the east showing the wallhead sheltered from wind-driven rain by buildings and partially from vertical rain by trees, but exposed to high angle summer solar radiation.

<table>
<tr><td>1.0</td><td colspan="5">Background</td></tr>
<tr><td>1.1</td><td>Location:</td><td colspan="4">Aberuthven, Perthshire</td></tr>
<tr><td>1.2</td><td>Grid Reference:</td><td colspan="4">NN 9734 1510</td></tr>
<tr><td>1.3</td><td>Date of Works:</td><td colspan="4">March 2001</td></tr>
<tr><td>1.4</td><td>Client:</td><td colspan="4">Perth and Kinross Heritage Trust</td></tr>
<tr><td>1.5</td><td>Contractor:</td><td colspan="4">Rebecca Little Construction</td></tr>
<tr><td>1.6</td><td>Architect:</td><td colspan="4">N/A</td></tr>
<tr><td>1.7</td><td>Access:</td><td colspan="4">Un-restricted access, in public graveyard.</td></tr>
<tr><td rowspan="3">1.8</td><td rowspan="3">Visit Record:</td><td>Date:</td><td colspan="3">By:</td></tr>
<tr><td>Spring 2002</td><td colspan="3">RL</td></tr>
<tr><td>27.07.05</td><td colspan="3">TM, RL, HL, EP</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>2.0</td><td colspan="5">Building</td></tr>
<tr><td>2.1</td><td>Type:</td><td colspan="4">Freestanding wall, adjoining church</td></tr>
<tr><td>2.2</td><td>Classification:</td><td colspan="4">Category B Listed, 05.10.1971</td></tr>
<tr><td rowspan="3">2.3</td><td rowspan="3">Chronology:</td><td>Built:</td><td colspan="3">Uncertain, post 1600, probably 17thC.</td></tr>
<tr><td>Ruined:</td><td colspan="3">Uncertain, photographs show it roofless and ivy clad c.1875.</td></tr>
<tr><td>Repairs:</td><td colspan="3">None known</td></tr>
<tr><td>2.4</td><td>Construction and Form:</td><td colspan="4">The wall is built of random rubble in lime mortar and survives complete to the wallhead. It is ~2m high, 0.4m wide at the head and 6m long. It is linear and runs east-west between two gables.</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>3.0</td><td colspan="5">Site</td></tr>
<tr><td rowspan="3">3.1</td><td rowspan="3">Setting:</td><td>Description:</td><td colspan="3">The chapel is set within the well-maintained grounds of a small cemetery. It is surrounded by arable farming land to the north, south and west and the small village of Aberuthven to the east.</td></tr>
<tr><td>Altitude:</td><td colspan="3">40m</td></tr>
<tr><td>Distance inland:</td><td colspan="3">56 km</td></tr>
<tr><td>3.2</td><td>Classifications:</td><td colspan="4">None</td></tr>
<tr><td rowspan="5">3.3</td><td rowspan="5">Microclimate:
* Data source:
Met. Office, Annual Averages 1971 – 2000
(Numbers in brackets give data as a %of national average)</td><td colspan="4">Although the site is exposed to the prevailing south-west wind, the wall is sheltered and partially shaded on all sides, both by taller walls and a mature tree, which overhangs the wall from the north.</td></tr>
<tr><td>Rainfall*</td><td>~870mm (57%)</td><td>Days of Rain >= 1mm*</td><td>~132 (71%)</td></tr>
<tr><td>Min Temp*</td><td>~4.7°C (118%)</td><td>Max Temp*</td><td>~12.0°C (114%)</td></tr>
<tr><td>Days Ground Frost*</td><td>~134</td><td>Hours sunshine*</td><td>~1280 (110%)</td></tr>
<tr><td colspan="2">Prevailing Wind Direction:</td><td colspan="2">South-west</td></tr>
</table>

4.0	**Flora and Fauna**				
4.1	Vegetation on Wall:	The vegetation was dry and appeared quite dead, with coverage even and thin across the top and the sides generally bare. The grass appeared slightly healthier on the north side and was ~ 0.3m high. There were some colonised ruderals and a number of tree saplings, though these also looked quite dead. There were small patches of moss.			
4.2	Surrounding Vegetation:	The graveyard has been well kept, regularly mown grass, and is largely surrounded by cereal fields. There are a number of mature trees in the graveyard adjacent to the wall, the closest being a large elm tree whose branches overhang it. Several other masonry walls and monuments within the graveyard support naturally established grasses.			
4.3	Species Survey. *Site Assessment by HL, 27.7.05* **D**=Dominant; **A**=Abundant; **F**=Frequent; **O**=Occasional; **R**=Rare; **VR**=Very Rare; *****=Present				
	Common Name	Latin Name	Capping	Surrounding Vegetation	Comment
	Grasses:				
	Perennial Rye Grass	*Lolium perenne*	**A**		Not drought tolerant
	Red Fescue	*Festuca rubra agg*	**F**		Colonised?
	Smooth Meadow Grass	*Poa pratensis*	**O**		Colonised?
	Ruderals/Herbs:				
	Germander Speedwell	*Veronica chamaedrys*	**R**		
	Broadleaved Dock	*Rumex obtusifolius*		**O**	
	Broadleaved Willowherb	*Epilobium montanum*	**R**		
	Creeping Thistle	*Cirsium arvense*		**O**	
	Lesser Burdock	*Arctium minus agg*		**R**	
	Ribwort Plantain	*Plantago lanceolata*	**R**		
	Rosebay Willowherb	*Chamerion angustifolium*		**O**	
	Smooth Sow Thistle	*Sonchus oleraceus*	**VR**		
	Trees/Shrubs:				
	Ash	*Fraxinus excelsior*		**F**	
	Elder	*Sambucus nigra*		**O**	
	Hawthorn	*Crataegus monogyna*		**R**	
	Sycamore	*Acer pseudoplatanus*	**R**	**F**	
	Wild Rose	*Rosa canina*		**R**	
	Mosses/Ferns:				
	Mosses, general		**R**		
4.4	Fauna:	There is evidence of spiders, bees and other insects.			

5.0	**Technique**	
5.1	Source of Technique:	Rebecca Little Construction, a development of earlier techniques.
5.2	Season of Work:	Spring
5.3	Preliminary Repairs to Structure:	The wallheads were consolidated with moderately hydraulic lime mortar and the wall selectively re-pointed.
5.4	Treatment of Existing Vegetation:	Prior to work being carried out the walls were stripped of a large amount of ivy.
5.5	Soft Capping Technique:	One layer of turf was applied to the wallhead over a shallow dome of clay, max. ~150mm thick.
5.6	Vegetation: Source and Description	Commercially produced, poor quality turf was used. Species not known. It had a poor, un-matted root system.
5.7	Soil: Source and Description	The mix was 1:2, Errol clay:coarse sharp sand.
5.8	DPC:	None used
5.9	Defining Membrane:	None used
5.10	Fixing:	The turf was fixed into the clay with hazel pegs at 45 degrees.
5.11	Aftercare:	The turf was watered for the first week.
5.12	Maintenance:	No known maintenance plan.
6.0	**Performance Assessment**	
6.1	General Performance:	In 2002, RL visited the site one year after application, when the turf looked well established and lush. In 2005, the soft capping was in poor condition. The grass had died back completely from the sloping edges, with a strip of yellow and seemingly dead grass in the centre of the cap. In the east section even this central strip became very thin. There was also greater dieback under the tree, which may be linked to shading, rain shadowing and/or abrasion from the foliage (Fig. 38.3). However, at the ends, where it abutted gables, there was some green grass (Fig. 38.4). While the surviving grass may have been less dead than it appeared, as the site was visited in high summer, the conditions were clearly very stressed. Where the vegetation had died, the exposed soil appeared to be washing away and there was staining of the masonry. The soil was crumbly, friable, very dry and sandy. In some sections, particularly on the south side, the soil has completely eroded away, exposing the clay cap, which was dry, hard and decaying at a slower rate. On the north side there had been some colonisation of the exposed soil by mosses and grasses (Fig. 38.8). The masonry wall showed no deterioration, other than some superficial staining.
6.2	Effect of Climate:	The surroundings seem to provide shelter from wind-driven rain coming across the strath to the south-west, but little shade from peak summer sunshine. The greater exposure of the east section of wall seems to be reflected in more advanced decay. The north side seemed marginally more stable than the south.
6.3	Effect of Birds:	No recorded problems
6.4	Effect of Animals:	No recorded problems
6.5	Aesthetic Performance:	The capping does not add to the aesthetic appeal of the graveyard.
6.6	Public Reaction:	None recorded
6.7	Team Reaction:	RL attributed the failure to the spring application and commercial turf.

6.8	Comments	This was the driest capping surveyed which had been intended as a permanent cap. However, it should be noted that the survey was carried out in high summer and the capping would have appeared less dry at other times of the year. By comparison Black Castle (CS13) was visited the same day. The critical climatic factor seemed to be low levels of moisture, and this related primarily to precipitation levels rather than solar or wind exposure. The sloping edges could not sustain plant cover, but decay of the soil was slow because of the shelter from wind-driven rain. There had been an increasing prevalence of drought tolerant species, but not sufficient to achieve a stable cover. It is unclear whether the capping will stabilise over time, or progressively decay to complete failure. Using more drought tolerant grass species in the capping turf may well have significantly improved survival, while two layers of turf would have improved resistance against dieback in the initial summers. The clay did not seem able to perform as a moisture reservoir and a different mix may have been more successful. A shallower profile may have reduced stress conditions on the edges. It is interesting that growth was lush after one year, indicating that the spring installation in a dry site was not a problem. It could be that the watered and turf-covered clay retained enough initial moisture through the first summer to sustain the grasses, but that over three years it gradually dried out. The fact that Perennial Rye Grass was still abundant after three years suggests that conditions for grass viability are marginal rather than prohibitive and that Red Fescue and Smooth Meadow Grass should be able to maintain better coverage in the long term. With the establishment of mosses and other drought tolerant species, there are signs that the capping may be in slow transition to a stable state.
7.0	**References:**	
	Interviews: Rebecca Little, *RLC, contractor* Rachel Tilling, *PKHT, client* McGibbon & Ross, The Ecclesiastical Architecture of Scotland, Vol. 3, p.485-6, 1896-7 RCAHMS Photographs: G813295PO & G813296PO, C. 1876	

Fig. 38.2: The south side, with the capping in unattractive summer condition.

Fig 38.3: North side. Abrasion by the tree, blown in the wind, may be an additional factor in decay of the capping.

Fig. 38.4: The east section, with greatest dieback and soil staining, but some green grass adjacent to the gable.

Fig. 38.5: The north face, with progressive decay of the exposed soil and clay layers, but also some secondary growth of mosses and grass. It may be the cap is simply in long-term transition to more suitable species.

Fig. 38.6: The centre of the cap has good cover.

Fig. 38.7: Natural colonisation of another graveyard wall.

Fig. 38.8: Moss and a spider's home.

Fig. 38.9: Damaging colonisation nearby by trees and willow-herb.

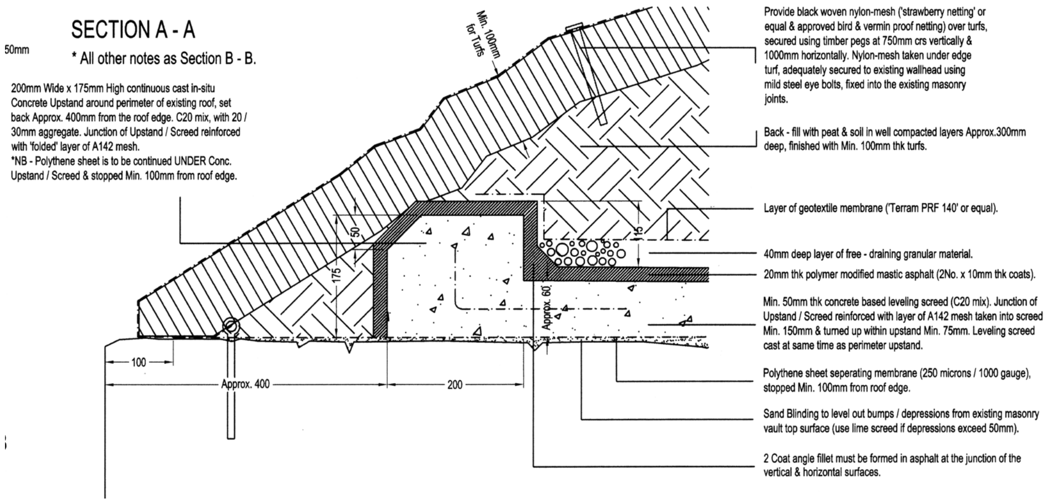
Case Study 39: THE WINE TOWER, Fraserburgh, Aberdeenshire

This case study presents an interesting building where a clay/turf soft capping failed and was replaced by a much more successful turf capping over an asphalt membrane.

Fig. 39.1: The Wine Tower, south view on a day of normal weather.

1.0	**Background**				
1.1	Location:	Beside the Lighthouse Museum, Kinnaird's Head, Fraserburgh, Aberdeenshire			
1.2	Grid Reference:	NJ 999 675			
1.3	Date of Works:	1st capping, late 1980s 2nd capping, 2003			
1.4	Client:	1st capping, unknown 2nd capping, Historic Scotland			
1.5	Contractor:	1st capping, unknown 2nd capping, unknown local contractor			
1.6	Architect:	1st capping, Leslie F Hunter 2nd capping, Historic Scotland			
1.7	Access:	There is restricted public access. The exterior of the tower can be seen from the open public shoreside, but the inside is only open as part of the Fraserburgh Lighthouse Museum. Opening times vary throughout the year			
1.8	Visit Record:	Date:	By:		
		26.10.06	TM		
2.0	**Building**				
2.1	Type:	Use unknown, possibly a chapel. Thought to have been temporarily acted as a residence. The origin of its name is unknown.			
2.2	Classification:	Scheduled Ancient Monument Category A Listed			
2.3	Chronology:	Built:	1570		
		Ruined:	Unknown		
		Repairs:	Uncertain, apart from capping works described above		
2.4	Construction and Form:	The Wine Tower is a small, three-storey truncated tower, built of random rubble masonry in lime mortar. The building is rectilinear and measures 8m by 6.4m, reaching a height of 8.3m. The walls are ~ 1.5m thick and the upper room has a vaulted ceiling, with delicate carved sandstone decoration.			
3.0	**Site**				
3.1	Setting:	Description:	The tower is built on the bare foreshore rocks in a very exposed situation onto the North Sea.		
		Altitude:	~10m		
		Distance from Coast:	5 - 30m, depending on tide		
3.2	Classifications:	May be within a scheduled area			
3.3	Microclimate: * Estimated from Met. Office, Annual Averages 1971–2000. *Numbers in brackets give data as a % of national average.*	The site has the typical east coast low rainfall and high solar radiation. However its location, jutting out into the North Sea means it is frequently exposed to severe winds, often cold, and a high level of airborne salts.			
		Rainfall*	~810mm (53%)	Days of Rain >= 1mm*	~150 (81%)
		Min Temp*	~6°C (150%)	Max Temp*	~10.9°C (104%)
		Days Ground Frost*	~40?	Hours sunshine*	~1400 (120%)
		Prevailing Wind Direction:		South-west, though strong north- easterlies are also prevalent.	

4.0	**Flora and Fauna**				
4.1	Vegetation on Wall:	The capping is dominated by typical capping grass species, with a few other benign species.			
4.2	Surrounding Vegetation:	The immediate areas are a mixture of tended and untended amenity grassland, though there are also typical foreshore plants nearby.			
4.3	Species Survey. *Assessment by HL from Photographs* **D**=Dominant, **A**=Abundant, **F**=Frequent, **O**=Occasional, **R**=Rare, **VR**=Very Rare, *****=Present				
	Common Name	Latin Name	Capping	Surrounding Vegetation	Comment
	Grasses:				
	Common Bent	*Agrostis capillaris*	**A**		
	Red Fescue	*Festuca rubra*	**F**		
	Ruderals/Herbs:				
	Ribwort Plantation	*Plantago lanceolata*	**A**		
	White Clover	*Trifolium arvense*	**R**		
	Yarrow	*Achillea millefolium*	**R**		
	Broadleaved Dock	*Rumex obtusifolius*		*	
	Trees/Shrubs: None				
	Mosses/Ferns: None noted				
4.4	Fauna:	None noted			
5.0	**Technique**				
5.1	Source of Technique:	Uncertain. The Fort George Historic Scotland office was responsible for maintaining a number of soft-capped monuments including Eynhallow (CS18), Skara Brae (CS10), as well as Fort George itself, which has its clay and turf capped embrasures replaced by turfed bitumen cappings.			
5.2	Season of Work:	1st Capping, unknown 2nd Capping, summer			
5.3	Preliminary Repairs to Structure:	*1st Capping:* The extent of any masonry consolidation in the first capping is uncertain. *2nd Capping:* The previous capping was entirely removed, but there are not thought to have been any other associated repairs.			
5.4	Treatment of Existing Vegetation:	*1st Capping:* It is assumed that any naturally colonised vegetation was removed. *2nd Capping:* The existing vegetation was removed with the intention of re-use			
5.5	Soft Capping Technique:	*1st Capping:* A layer of clay was set directly onto the top of the masonry roof, with turf laid over. *2nd Capping:* Existing vegetation and soil/clay layer was removed. Masonry was cleaned and dried and a thin layer of sand blinding was used to level out bumps and depressions. A thin layer, ~50mm thick, of C20 mix concrete was cast over the whole roof, with an up stand around the perimeter and falling to a water spout. The upstand was approximately 175mm high and set back 400mm from the edge. A layer of asphalt capping was applied to the concrete, followed by a 40mm layer of 18mm dia. gravel. The roof was then backfilled with a layer of peat and topsoil, to a height of ~550mm. This was applied in two layers that were well compacted and shaped to form a convex profile to shed water collection. A capping of 100mm thick turf was then pegged on top.			

5.6	Sketch Section: 2nd capping,  *Fig. 39.2: Section through the second capping.*	
5.7	Vegetation: Source and Description	*1st Capping:* Unknown *2nd Capping:* Turves to be cut into as large sections as possible to allow handling without tearing and taken from grass that has recently been mown. The turves were of a standard thickness (100mm) to ensure a level surface and the joints were angled away from the flow of water. It is unknown whether any of the old turf was re-used as intended.
5.8	Soil: Source and Description	*1st Capping:* Uncertain. Photographs from the second capping downtakings indicate that there was a layer of red clay, ~150mm thick, tapering to nothing at the roof edge. This was covered by a thicker layer of dark soil (Fig. 39.3). *2nd Capping:* The single soil layer varies in thickness related to its distance from the edge of the tower. In the centre it reaches a maximum thickness of 450mm. It consists of 60% fibrous peat and 40% topsoil.
5.9	DPC:	*1st Capping:* The clay layer was intended to act as a waterproofing layer. *2nd Capping:* A 20mm thick, polymer-modified mastic asphalt layer was applied above the concrete screed.
5.10	Defining Membrane:	*1st Capping:* None apparent *2nd Capping* A polythene sheet separating membrane was used between the initial sand blinding and the concrete capping.
5.11	Fixing:	*1st Capping:* Metal hoops to edge (Fig. 39.4). *2nd Capping:* A black woven nylon mesh was applied over the turf and fixed at 750mm centres vertically and 1m horizontally with timber pegs. At the edges, the mesh was taken under the edge of the turf and secured directly to the wallhead using mild steel eye bolts.
5.12	Aftercare:	Unknown
5.13	Maintenance:	None

6.0	**Performance Assessment**	
6.1	General Performance:	*1st Capping:* The clay/turf capping failed to keep the masonry waterproof, with significant ingress of water to the vault, saturating the decorative dressings and leaving extensive deposits of leached clay on the surface (Figs 37.5 and 37.6). When it was removed, it was apparent that the clay had cracked through cycles of swelling and shrinkage. The vegetation was apparently healthy, but may have had edge decay. *2nd Capping:* Since the application of the second capping, the vault masonry has dried out and it seems to perform well in waterproofing the roof (Fig. 39.7). The vegetation appears generally healthy (Fig. 39.8), though there is consistent edge dieback, ~100mm, which exposes the soil beneath to erosion. Decay is worst at the corners and turf joints are clearly visible, confirming that the turf never rooted in at the edges (Fig. 39.10).
6.2	Effect of Climate:	The severity of winds, together with the low rainfall and high solar exposure, contribute to the edge dieback.
6.3	Effect of Birds:	None noted
6.4	Effect of Animals:	None noted
6.5	Aesthetic Performance:	The capping appears as a fairly naturalistic vegetation cover, though the edge dieback, minor soil staining of the masonry and plastic netting detract from this impression.
6.6	Public Reaction:	None noted
6.7	Team Reaction:	The second capping is regarded as successful.
6.8	Comments:	The failure of the clay capping is interesting and echoes the performance of the capping on the vault at Monimail (CS27), where the clay layer was thinner. The ingress of water was much more than through the vault at Eilean Mor (CS1), despite the much higher rainfall and thinness of soil on that site. The fact that this roof is essentially flat, with an upstand edge means that it retains much more moisture than Eilean Mor, which effectively sheds rainwater. The cap at Monimail was also pretty flat. The colour indicates that the type of clay was probably an illite, which has low expansiveness and is therefore less waterproof than, for example, the oily grey clay used at the Arnol Blackhouse (CS9). The edge decay can be attributed to the site's exposure to strong drying conditions and it is possible that measures could have been taken to improve the edge performance, including a different edge detail and non-summer application. The shape and size of the capping should ensure good long-term plant viability, though the edges may struggle to stabilise under aggressive wind conditions and with growth suppressed by salts. The first capping showed some edge stress, stabilised with mosses and the original natural turf capping has a very low profile, set back from the masonry edge. The edge decay is unlikely to be affected by saturation as an effect of the membrane as it falls to a water spout. However, the membrane may heighten peak drying conditions where the turf thins down to the masonry edge, as happened over shallow covered bitumen membranes at Melgund Castle (CS26). Overall though the depth of capping and drainage arrangement seem to have avoided any detrimental effect on plant viability by having a membrane. The plastic netting has prevented wind uplift damaging the turf, though did not prevent it dying. In the long term, it will prove a visual distraction and could be a hazard to birds, as happened at Black Castle (CS13).

7.0	**References:**
	Interviews: Leslie F Hunter, *Architect* Mike Penderey, *Historic Scotland Architect* Sources: MacGibbon and Ross, D and T (1887-92) The castellated and domestic architecture of Scotland from the twelfth to the eighteenth centuries, 5v, Edinburgh, Vol. ?, 31-34, http://www.metoffice.gov.uk/climate/uk/averages/19712000/mapped.html

Fig. 39.3: Section through the first capping. Note the edge cover and moss growth on the right.

Fig. 39.4: Metal fixings from the first capping.

Fig. 39.5: Interior of the vault under the first capping, water staining to limewash.

Fig. 39.6: Water dripping from the ceiling under the first capping.

Fig. 39.7: Interior view, second capping.

Fig. 39.8: Thick sward on the second capping.

Fig. 39.9: North view, two years after the second capping.

Fig. 39.10: Detail of edge decay.

GLOSSARY

batter: slight incline on the face of a wall

broch: a round drystone tower

coverband: large fat stones placed across the top of the wall, as a base for cope stones

CS: Case Study

dieback: dying back of vegetation from its edges

illite: a common type of clay

kaolin: a type of clay

ledumite: a proprietary bitumen-coated lead damp-proof course

limecrete: concrete type material using lime as a binder instead of cement

machair: bio-diverse grassland, commonly on raised beaches

RCAHMS: Royal Commission on Ancient and Historic Monuments in Scotland

rough racked: masonry finished to a broken face

shielings: vernacular seasonally occupied dwellings, commonly associated with summer hill pasture

shuttering: boarding used to provide a temporary support to facework during construction

SSSI: Site of Special Scientific Interest

stolon: a plant that takes root along its length to form a new plant

thermal flux: range of temperature experienced by a material

thermal blanketing: thermally insulating effect

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