Northern Periphery and Arctic Programme 2014–2020
EUROPEAN UNION
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European Regional Development Fund

Climate Risk Management Plan

to assess historic places for climate change impacts and associated adaptation planning

☒ Group of historic place

Name of group

The Historic Town of Inveraray

Figure 1Looking over the calm waters of Loch Fyne to Inveraray, a small town and fishing port on the west shore of the loch, Argyll & Bute.

Image © Visit Scotland

Assessment details	
Names and affiliations of assessors	Mark Lodge (Argyll & Bute Council) Kim deBuiteleir (Argyll & Bute Council) Carsten Hermann & Vanessa Glindmeier (Historic Environment Scotland)
Version number of assessment	V1.0 DRAFT
Date of completion of assessment	29 May 2020
Assessment type	☐ Advanced Level ☒ Standard Level
Comments on assessment process	Thank you to all attendees of the workshops in Inveraray in the summers of 2018 and 2019 and all other contributors to and reviewers of this Climate Risk Management Plan.

EXECUTIVE SUMMARY

Overview Historic Place/Group of Historic Places/Place Categories

☒ Group of historic places

Geographic information (group of historic places)			
ID	Name of place	Place's address	Place's extent
1	Aray Bridge	Inveraray, Argyll & Bute, Scotland	Bridge at mouth of river Aray, Arrochar Road
2	Inveraray Cross	Inveraray, Argyll & Bute, Scotland	Free-standing, carved stone cross in Front Street, Inveraray
3	The avenue screen wall	Inveraray, Argyll & Bute, Scotland	Stone segmental arches along West Front Street, Inveraray
	Inveraray sea wall	Inveraray, Argyll & Bute, Scotland	Natural stone wall along Loch Fyne west shore and A83
Summary of assessment of group of historic places			

Name of historic place / place category to be analysed	ID where applicable
Aray Bridge	1

Description of historic place / place category and its wider surroundings	
Brief description of historic place / place category	vital transportation route coming in and out of Inveraray via A83 road, built in 1775; 2 segmental spans. Rubble; dressed face-work. Partly balustraded parapet; central spandrel pierced by oculus; angular pier. Approach walls: weathered projecting copes; small posts at ends; Category A-listed structure
Brief description of place's immediate surroundings	Loch Fyne to east, view of historic town of Inveraray along old Military Road to south, view onto woodlands and river Aray running along Inveraray Castle estate to north, single traffic road (Arrochar trunk road) operating over bridge, controlled by traffic lights.
Brief description of places' wider environs	Aray Bridge is located outside the Inveraray Conservation Area, in the west of mainland Scotland.

Cultural heritage designations	
Designation	Title
Category A listed	Aray Bridge, Mouth of river Aray, Arrochar Road

Key cultural significance values	
Key value	Rating
Forming part of the A83, the bridge represents a major access route to the historic town of Inveraray, connecting the town to the rest of Scotland and allowing goods/local produce to be transported across the country	3

Overview Risk Assessment

Summary of Risk Register (incl. Advanced Level)	☒ Standard level: **Risks ratings are 0-16 (inherent risk)** ☐ Advanced level: **Risk ratings are 0-64 (heritage risk)**

List of unacceptable risks

state risks consider as unacceptable at the respective time horizons
ranked by decreasing risk rating

Impact ID	Description	Risk rating *Time horizon 1* Today	*Time horizon 2* 2070	*Time horizon 3* n.a.
3	Damage by flowing debris in river, such as tree trunks	9	12	n.a.

Highest-ranked acceptable risks
(state multiple if of the same rating at time horizon #1)

Impact ID	Description	Risk rating *Time horizon 1* Today	*Time horizon 2* 2070	*Time horizon 3* n.a.
1	Dislocation of stones on adjacent sea wall	6	12	n.a.
6	Vegetation growth on bridge bases and joints	6	12	n.a.
2	Increased pressure on foundations and bridge bases by heavy river flow	4	16	n.a.
4	Weathering of stone faces and masonry	3	12	n.a.
5	Freeze-thaw spalling of surfaces of parapet, arch edge stones and bridge joints	2	1	n.a.

Summary of increasing risks

Risk of damage from wave action is increasing due to water currents changing, as well as increased precipitation.

Risk of damage from heavy river flow and tree uprooting on land is increasing due to increased precipitation, windspeed in combination with a change in tidal currents and sea level rise.

Risk of damage from wind & rain weathering as well as physical damage by growth of plant roots is increasing due to an increase is windspeed, precipitation and temperature.

Summary of decreasing risks

Risk of damage from frost weathering is decreasing as the number of days with frost occurrence are decreasing, and winters are projected to be warmer in general.

Effect of occurrence of impacts on key cultural heritage values			
Key values	Current rating	Revised rating	Comments
Forming part of the A83, the bridge represents a major access route to the historic town of Inveraray, connecting the town to the rest of Scotland and allowing goods/local produce to be transported across the country	3	2 1	If bridge foundations are damaged slightly If bridge foundations are damaged significantly

Conclusions

Today, only one risk is considered as unacceptable, namely

- #3 Damage by flowing debris in river, such as tree trunks

However, by 2070 four more risks will be considered as unacceptable, namely

- #1 Dislocation of stones on adjacent sea wall
- #6 Vegetation growth on bridge bases and joints
- #2 Increased pressure on foundations and bridge bases by heavy river flow
- #4 Weathering of stone faces and masonry

Overview Adaptation Planning

Summary of Adaptation Measures Register				
Impact / Measure ID	**Adaptation measure** (short title)	**Adaptation type**	**Location** where measure would be installed	**Potential effect on cultural significance** including mitigation example
Impact investigated	Damage by flowing debris in river, such as tree trunks		**Impact ID**	3
3/P1	Build new structure	Protect	At calculated distance to bridge pillars. Investigation has to be carried out to determine the best possible location.	beneficial
3/S1	Reinforce bridge pillars	Strengthen	Bridge pillars	beneficial
3/D1	Frequent maintenance	Respond to Damage	Whole structure	neutral
3/L1	Monitoring	Managing Loss	Whole structure	neutral
3/P1	Build new structure	Protect	At calculated distance to bridge pillars. Investigation has to be carried out to determine the best possible location.	beneficial
3/I1	Replicate bridge in model format	Manage Uncertainty	Whole structure	beneficial

Name of historic place / place category to be analysed	ID where applicable
Inveraray Cross	2

Description of historic place / place category and its wider surroundings	
Brief description of historic place / place category	Scheduled monument, free-standing carved stone, 15th century, fenced
Brief description of place's immediate surroundings	Loch Fyne to north and east, Inveraray main street to south-west
Brief description of places' wider environs	Located within Inveraray Conservation Area, in the west of mainland Scotland

Cultural heritage designations	
Designation	**Title**
Scheduled monument	Inveraray cross
Conservation Area	Inveraray Conservation Area

Key cultural significance values	
Key value	**Rating**
The cross was formerly used as the Mercat (Market) Cross in the old town and is believed to be of ecclesiastical origin	3

Overview Risk Assessment

Summary of Risk Register (incl. Advanced Level)	☒ Standard level: **Risks ratings are 0-16 (inherent risk)** ☐ Advanced level: **Risk ratings are 0-64 (heritage risk)**

List of unacceptable risks

state risks consider as unacceptable at the respective time horizons
ranked by decreasing risk rating

Impact ID	Description	Risk rating *Time horizon 1* Today	*Time horizon 2* 2070	*Time horizon 3* n.a.
1	Impact damage due to wave force to cross	3	12	n.a.
2	Surface abrasion of stonework and platform joints on which cross is erected	4	9	n.a.
4	Vegetation growth on cross and platform on which cross is erecetd	2	9	n.a.

Highest-ranked acceptable risks
(state multiple if of the same rating at time horizon #1)

Impact ID	Description	Risk rating *Time horizon 1* Today	*Time horizon 2* 2070	*Time horizon 3* n.a.
3	Spalling of stone surfaces damaging the mouldings and detailing	6	3	n.a.
5	Discolouration of surface in a mostly cosmetic form without causing harm	0	4	n.a.

Summary of increasing risks

Risk of damage from wave overtopping during storms, is increasing due to sea level rise and increased storminess.

Risk of damage from wind & rain weathering, growth of plant roots and fungus and moss growth on stone surface is increasing, due to increased temperatures and precipitation.

Summary of decreasing risks

Risk of damage from frost weathering is decreasing as the number of days with frost occurrence are decreasing, and winters are projected to be warmer in general.

Effect of occurrence of impacts on key cultural heritage values			
Key values	Current rating	Revised rating	Comments
Forming part of the A83, the bridge represents a major access route to the historic town of Inveraray, connecting the town to the rest of Scotland and allowing goods/local produce to be transported across the country	3	2 1	If bridge foundations are damaged slightly If bridge foundations are damaged significantly

Conclusions

Today, only one risk is considered as unacceptable, namely

- #3 Damage by flowing debris in river, such as tree trunks

However, by 2070 four more risks will be considered as unacceptable, namely

- #1 Dislocation of stones on adjacent sea wall
- #6 Vegetation growth on bridge bases and joints
- #2 Increased pressure on foundations and bridge bases by heavy river flow
- #4 Weathering of stone faces and masonry

Overview Adaptation Planning

Summary of Adaptation Measures Register				
Impact / Measure ID	**Adaptation measure** (short title)	**Adaptation type**	**Location** where measure would be installed	**Potential effect on cultural significance** including mitigation example
Impact investigated	Surface abrasion of stonework and platform joints on which cross is erected		**Impact ID**	2
2/S1	Repairs	Strengthen	Stone pedestal at base of cross	beneficial
2/R1	Move to Inverary Castle or Museum	Relocate	Whole cross	acceptably adverse without mitigation
2/D1	Heritage Value	Respond to Damage	n.a.	neutral
2/L1	Deterioration	Managing Loss	n.a.	neutral
2/I1	LiDAR survey	Investigation	Whole cross	beneficial

APPENDED ASSESSMENTS

Historic Places and Cultural Significance

Singular place, group of places or place categories

☒ Group of historic places

Geographic information (group of historic places)	
Name of group	The Historic Town of Inveraray
Description of group	The historic town of Inveraray lies near the head of Loch Fyne, a sea water inlet in the council area of Argyll & Bute, in western Scotland. Dating from the 18th century, the planned town of Inveraray is, for the Argyll region, a traditional county town, located on a natural promontory on the loch, and became later a model for urban developments on Scotland's west coast. The town is also an integral part of the wider historic landscape, which forms part of the Argyll Estate, including a nearby designed landscape with the Duke of Argyll's castle. Most of the historic town is designated today as cultural heritage, in the form of an urban ensemble (conservation area), singular built structures (listed buildings) and a cultural landscape (designated garden and designed landscape).

Historic places of the group			
Place ID	Name of place	Place's address	Place's extent
1	Aray Bridge	Inveraray, Argyll & Bute, Scotland	Bridge at mouth of river Aray, Arrochar Road
2	Inveraray Cross	Inveraray, Argyll & Bute, Scotland	Free-standing, carved stone cross in Front Street, Inveraray
3	The avenue screen wall	Inveraray, Argyll & Bute, Scotland	Stone segmental arches along West Front Street, Inveraray
	Inveraray sea wall	Inveraray, Argyll & Bute, Scotland	Natural stone wall along Loch Fyne west shore and A83

Historic place overview

Name of historic place to be analysed	Place ID if applicable
Aray Bridge	1

Description of historic place and its wider surroundings	
Brief description of historic place	vital transportation route coming in and out of Inveraray via A83 road, built in 1775; 2 segmental spans. Rubble; dressed face-work. Partly balustraded parapet; central spandrel pierced by oculus; angular pier. Approach walls: weathered projecting copes; small posts at ends; Category A-listed structure
Brief description of place's immediate surroundings	Loch Fyne to east, view of historic town of Inveraray along old Military Road to south, view onto woodlands and river Aray running along Inveraray Castle estate to north, single traffic road (Arrochar trunk road) operating over bridge, controlled by traffic lights.
Brief description of places' wider environs	Aray Bridge is located outside the Inveraray Conservation Area, in the west of mainland Scotland.

Cultural significance

Conservation policies				
ID	Document title	Author(s)	Version	Date
1	National Transport Strategy	Transport Scotland		2020
2	Transport Scotland Asset Management Framework	Transport Scotland		

Cultural heritage designations			
Designation	Title	Reference	Comments
Category A listed	Aray Bridge, Mouth of river Aray, Arrochar Road	LB11545	

Rating of key cultural significance values		
Key value	**Rating**	**Comments / reasons**
Forming part of the A83, the bridge represents a major access route to the historic town of Inveraray, connecting the town to the rest of Scotland and allowing goods/local produce to be transported across the country	3	

Site observations, hazards and climate drivers (optional)

Observed damages and deterioration			
Damage and deterioration observed at historic place	**Impact type**	**Environmental hazard** associated with observations	**Climate drivers**
Dislocation of stones on adjacent sea wall	☒ damage ☐ deterioration	Wave action	Water currents, wind speed
Increased pressure on foundations and bridge bases	☐ damage ☒ deterioration	Heavy river flow	Tidal currents, precipitation
Damage by flowing debris in river, such as tree trunks	☒ damage ☐ deterioration	Tree uprooting on land	Storm, wind speed
Weathering of stone faces and masonry	☐ damage ☒ deterioration	Wind & rain weathering	Wind speed, precipitation
Freeze-thaw spalling of surfaces of parapet, arch edge stones and bridge joints	☐ damage ☒ deterioration	Frost weathering	Precipitation, temperature fluctuation at freezing point
Vegetation growth on bridge bases and joints	☒ damage ☐ deterioration	Physical damage by growth of plant roots	Precipitation, temperature

Hazard register

Hazard Register							
Climate drivers	**Climate trends**		**Environmental hazards**			**Impact on historic place**	
Description of variables	*Observed trends*	*Projected trends*	*Description of observed or potential hazard*	*Change in relevance observed*	*projected*	*Description of observed or potential impacts*	*Impact types*
Water currents			Wave action	☒ increase ☐ decrease ☐ no change	☒ increase ☐ decrease ☐ no change	Dislocation of stones on adjacent sea wall	☒ damage ☐ deterioration
Tidal currents, precipitation	• Fluctuation observed, but no great changes in overall annual precipitation levels • Summer average precipitation has decreased • Winter average precipitation has increased	• Annual average precipitation projected to increase • Summer average precipitation projected to decrease -> drier summers • Winter average precipitation projected to increase -> wetter winters	Heavy river flow	☒ increase ☐ decrease ☐ no change	☒ increase ☐ decrease ☐ no change	Increased pressure on foundations and bridge bases	☐ damage ☒ deterioration
Storm (wind speed) sea level	• Storm events appear to have increased in intensity and frequency • Mean sea level rise of about 16cm since start of 20th century	• Mean sea level rise projected to continue under all emission scenarios, but substantially varying based on success of reducing GHG emissions	Tree uprooting on land	☒ increase ☐ decrease ☐ no change	☒ increase ☐ decrease ☐ no change	Damage by flowing debris in river, such as tree trunks	☒ damage ☐ deterioration
Wind speed, precipitation, temperature (fluctuation at freezing point)	• Fluctuation observed, but no great changes in overall annual precipitation levels • Summer average precipitation has decreased • Winter average precipitation has increased • Mean annual temperature has increased • Mean seasonal temperatures have increased • Annual minimum air temperature has increased • Winter minimum air temperature has increased	• Annual average precipitation projected to increase • Summer average precipitation projected to decrease -> drier summers • Winter average precipitation projected to increase -> wetter winters • Mean annual temperature projected to increase • Mean seasonal temperatures projected to increase • Annual minimum air temperate projected to increase • Winter minimum air temperature projected to increase	Wind & rain weathering	☒ increase ☐ decrease ☐ no change	☒ increase ☐ decrease ☐ no change	Weathering of stone faces and masonry	☐ damage ☒ deterioration
			Frost weathering	☒ increase ☐ decrease ☐ no change	☒ increase ☐ decrease ☐ no change	Freeze-thaw spalling of surfaces of parapet, arch edge stones and bridge joints	☐ damage ☒ deterioration
			Physical damage by growth of plant roots	☒ increase ☐ decrease ☐ no change	☒ increase ☐ decrease ☐ no change	Vegetation growth on bridge bases and joints	☒ damage ☐ deterioration

Risk register

Risk register for multiple time horizons														
Impact		**Time horizon #1: Today**						**Time horizon #2: 5** 2070						
Impact ID and description		Likelihood rating	Severity rating	Inherent risk rating	Inherent risk rating definition	Acceptability of risk	Recommendations for action	Likelihood rating	Severity rating	Inherent risk rating	Inherent risk rating definition	Acceptability of risk	Recommendations for action	
1	Dislocation of stones on adjacent sea wall	2	3	6	Minor risk	Acceptable risk level subject to monitoring	consider active risk monitoring	3	4	12	Extreme risk	Unacceptable level of risk requiring immediate attention	consider immediate adaptation action	
2	Increased pressure on foundations and bridge bases	2	2	4	Minor risk	Acceptable risk level subject to monitoring	consider active risk monitoring	4	4	16	Extreme risk	Unacceptable level of risk requiring immediate attention	consider immediate adaptation action	
3	Damage by flowing debris in river, such as tree trunks	3	3	9	Minor risk	Unacceptable level of risk	consider timely adaptation action	4	3	12	Extreme risk	Unacceptable level of risk requiring immediate attention	consider immediate adaptation action	
4	Weathering of stone faces and masonry	3	1	3	Insignificant risk	Acceptable risk level	No action required	4	3	12	Extreme risk	Unacceptable level of risk requiring immediate attention	consider immediate adaptation action	
5	Freeze-thaw spalling of surfaces of parapet, arch edge stones and bridge joints	2	1	2	Insignificant risk	Acceptable risk level	No action required	1	1	1	Insignificant risk	Acceptable risk level	No action required	
6	Vegetation growth on bridge bases and joints	3	2	6	Minor risk	Acceptable risk level subject to monitoring	consider active risk monitoring	4	3	12	Extreme risk	Unacceptable level of risk requiring immediate attention	consider immediate adaptation action	

Summary of risk register

Summary of Risk Register (incl. Advanced Level)	☒ Standard level: **Risks ratings are 0-16 (inherent risk)** ☐ Advanced level: **Risk ratings are 0-64 (heritage risk)**

List of unacceptable risks

state risks consider as unacceptable at the respective time horizons
ranked by decreasing risk rating

Impact ID	Description	Risk rating *Time horizon 1* Today	*Time horizon 2* 2070	*Time horizon 3* n.a.
3	Damage by flowing debris in river, such as tree trunks	9	12	n.a.

Highest-ranked acceptable risks
(state multiple if of the same rating at time horizon #1)

Impact ID	Description	Risk rating *Time horizon 1* Today	*Time horizon 2* 2070	*Time horizon 3* n.a.
1	Dislocation of stones on adjacent sea wall	6	12	n.a.
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2	Increased pressure on foundations and bridge bases by heavy river flow	4	16	n.a.
4	Weathering of stone faces and masonry	3	12	n.a.
5	Freeze-thaw spalling of surfaces of parapet, arch edge stones and bridge joints	2	1	n.a.

Summary of increasing risks

Risk of damage from wave action is increasing due to water currents changing, as well as increased precipitation.

Risk of damage from heavy river flow and tree uprooting on land is increasing due to increased precipitation, windspeed in combination with a change in tidal currents and sea level rise.

Risk of damage from wind & rain weathering as well as physical damage by growth of plant roots is increasing due to an increase is windspeed, precipitation and temperature.

Summary of decreasing risks

Risk of damage from frost weathering is decreasing as the number of days with frost occurrence are decreasing, and winters are projected to be warmer in general.

Effect of occurrence of impacts on key cultural heritage values			
Key values	Current rating	Revised rating	Comments
Forming part of the A83, the bridge represents a major access route to the historic town of Inveraray, connecting the town to the rest of Scotland and allowing goods/local produce to be transported across the country	3	2 1	If bridge foundations are damaged slightly If bridge foundations are damaged significantly
Conclusions			
Today, only one risk is considered as unacceptable, namely • #3 Damage by flowing debris in river, such as tree trunks However, by 2070 four more risks will be considered as unacceptable, namely • #1 Dislocation of stones on adjacent sea wall • #6 Vegetation growth on bridge bases and joints • #2 Increased pressure on foundations and bridge bases by heavy river flow • #4 Weathering of stone faces and masonry			

Adaptation Planning

Impact to be investigated	
Impact description	Damage by flowing debris in river, such as tree trunks
Associated hazard	Wave action
Risk rating	9
Impact ID	3
Longlist of adaptation measures	
PROTECT	
P1	Build new structure
STRENGTHEN	
S1	Reinforce bridge pillars and primary points of impacts
RELOCATE	
R1	Not possible
RESPOND TO DAMAGE	
D1	Maintenance
MANAGING LOSS	
L1	Record/analyse
MANAGE UNCERTAINTY	
I1	Create model of bridge

Adaptation measure appraisal	
Impact / Measure ID	3/P1
Adaptation measure (short title)	Necessary structures
Details of measure (brief description)	Build new structure around the base level and add structure further upstream to catch debris
Adaptation type	Protect
Location where measure would be installed (If working at Advanced Level, use *place elements*.)	At calculated distance to bridge pillars. Investigation has to be carried out to determine the best possible location.

If adaptation type is Protect, Strengthen, Relocate *or* Respond to Damage, *use below table:*

Adaptation measures appraisal: Adjustment of severity rating (Standard Level only)	
Effect of measure on risk *The risk would be...* Complete sentence by using answer from **Error! Reference source not found.**7	
Associated effect on severity rating *Severity rating would ...*	

If the answer to the first query is left unchanged *or* increased, *stop the appraisal of the measure concerned.*

Regardless of adaptation type, continue with the table below:

Potential effects on cultural significance	
Descriptive rating of effect on cultural significance of the place	☐ unacceptably adverse ☐ acceptably adverse subject to mitigation ☐ acceptably adverse without mitigation ☐ neutral ☒ beneficial
If the response above was "subject to mitigation", name examples for how this might be achieved.	n.a.

If the answer to the first query was unacceptably adverse or was acceptably adverse subject to mitigation, with no suitable example identified in the second query, top the appraisal of the measure concerned.

Adaptation measure appraisal	
Impact / Measure ID	3/S1
Adaptation measure (short title)	Reinforce bridge pillars
Details of measure (brief description)	Reinforce the bridge pillars and primary points of impacts with fibre concrete
Adaptation type	Strengthen
Location where measure would be installed (If working at Advanced Level, use *place elements*.)	Bridge pillars

If adaptation type is Protect, Strengthen, Relocate *or* Respond to Damage, *use below table:*

Adaptation measures appraisal: Adjustment of severity rating (Standard Level only)	
Effect of measure on risk *The risk would be...* Complete sentence by using answer from **Error! Reference source not found.**7	
Associated effect on severity rating *Severity rating would ...*	

If the answer to the first query is left unchanged *or* increased, *stop the appraisal of the measure concerned.*

Regardless of adaptation type, continue with the table below:

Potential effects on cultural significance	
Descriptive rating of effect on cultural significance of the place	☐ unacceptably adverse ☐ acceptably adverse subject to mitigation ☐ acceptably adverse without mitigation ☐ neutral ☒ beneficial
If the response above was "subject to mitigation", name examples for how this might be achieved.	n.a.

If the answer to the first query was unacceptably adverse or was acceptably adverse subject to mitigation, with no suitable example identified in the second query, top the appraisal of the measure concerned.

Adaptation measure appraisal	
Impact / Measure ID	3/D1
Adaptation measure (short title)	Frequent maintenance
Details of measure (brief description)	Increase maintenance frequency, particularly as reaction to inspection
Adaptation type	Respond to Damage
Location where measure would be installed (If working at Advanced Level, use *place elements*.)	Whole structure

If adaptation type is Protect, Strengthen, Relocate *or* Respond to Damage, *use below table:*

Adaptation measures appraisal: Adjustment of severity rating (Standard Level only)	
Effect of measure on risk *The risk would be...* Complete sentence by using answer from **Error! Reference source not found.**7	
Associated effect on severity rating *Severity rating would ...*	

If the answer to the first query is left unchanged *or* increased, *stop the appraisal of the measure concerned.*

Regardless of adaptation type, continue with the table below:

Potential effects on cultural significance	
Descriptive rating of effect on cultural significance of the place	☐ unacceptably adverse ☐ acceptably adverse subject to mitigation ☐ acceptably adverse without mitigation ☒ neutral ☐ beneficial
If the response above was "subject to mitigation", name examples for how this might be achieved.	n.a.

If the answer to the first query was unacceptably adverse or was acceptably adverse subject to mitigation, with no suitable example identified in the second query, top the appraisal of the measure concerned.

Adaptation measure appraisal	
Impact / Measure ID	3/L1
Adaptation measure (short title)	Monitoring
Details of measure (brief description)	Monitor wear down by recording and analysing the degradation of foundation
Adaptation type	Managing Loss
Location where measure would be installed (If working at Advanced Level, use *place elements*.)	Whole structure

If adaptation type is Managing Loss*, use below table:*

Managing Loss appraisal	
How would the measure support communities?	
Which specific communities would be supported?	
Are the answers to the two questions above considered sufficiently relevant to explore measure further?	☒ Yes, explore this adaptation measure further ☐ No, file this idea of an adaption measure and proceed to next measure on long-list

If the answer to the last question was no, stop the appraisal of the measure concerned.

Regardless of adaptation type, continue with the table below:

Potential effects on cultural significance	
Descriptive rating of effect on cultural significance of the place	☐ unacceptably adverse ☐ acceptably adverse subject to mitigation ☐ acceptably adverse without mitigation ☒ neutral ☐ beneficial
If the response above was "subject to mitigation", name examples for how this might be achieved.	

If the answer to the first query was unacceptably adverse or was acceptably adverse subject to mitigation, with no suitable example identified in the second query, top the appraisal of the measure concerned.

Adaptation measure appraisal	
Impact / Measure ID	3/I1
Adaptation measure (short title)	Replicate bridge in model format
Details of measure (brief description)	Create models of the bridge to increase the understanding of damage and adaptation potential
Adaptation type	Manage Uncertainty
Location where measure would be installed (If working at Advanced Level, use *place elements*.)	Whole structure

If adaptation type is Manage Uncertainty*, use below table:*

Manage Uncertainty appraisal	
How would the considered measure reduce uncertainty?	
How would the considered measure support other relevant measures?	
Are the answers to the two questions above considered sufficiently relevant to explore measure further?	☒ Yes, explore this adaptation measure further ☐ No, file this idea of an adaption measure and proceed to next measure on long-list

If the answer to the last question was no, stop the appraisal of the measure concerned.

Regardless of adaptation type, continue with the table below:

Potential effects on cultural significance	
Descriptive rating of effect on cultural significance of the place	☐ unacceptably adverse ☐ acceptably adverse subject to mitigation ☐ acceptably adverse without mitigation ☐ neutral ☒ beneficial
If the response above was "subject to mitigation", name examples for how this might be achieved.	

If the answer to the first query was unacceptably adverse or was acceptably adverse subject to mitigation, with no suitable example identified in the second query, top the appraisal of the measure concerned.

Adaptation Measures Register

Adaptation Measures Register					
Impact investigated	Damage by flowing debris in river, such as tree trunks			**Impact ID**	3
Impact / Measure ID	**Adaptation measure** (short title)	**Adaptation type**	**Location** where measure would be installed	**Potential effect on cultural significance** including mitigation example	**Include in summary**
3/P1	Build new structure	Protect	At calculated distance to bridge pillars. Investigation has to be carried out to determine the best possible location.	beneficial	☒ include
3/S1	Reinforce bridge pillars	Strengthen	Bridge pillars	beneficial	☒ include
3/D1	Frequent maintenance	Respond to Damage	Whole structure	neutral	☒ include
3/L1	Monitoring	Managing Loss	Whole structure	neutral	☒ include
3/I1	Replicate bridge in model format	Manage Uncertainty	Whole structure	beneficial	☒ include

Summarising the adaptation measures

Summary of Adaptation Measures Register				
Impact investigated	Damage by flowing debris in river, such as tree trunks		**Impact ID**	3
Impact / Measure ID	**Adaptation measure** (short title)	**Adaptation type**	**Location** where measure would be installed	**Potential effect on cultural significance** including mitigation example
3/P1	Build new structure	Protect	At calculated distance to bridge pillars. Investigation has to be carried out to determine the best possible location.	beneficial
3/S1	Reinforce bridge pillars	Strengthen	Bridge pillars	beneficial
3/D1	Frequent maintenance	Respond to Damage	Whole structure	neutral
3/L1	Monitoring	Managing Loss	Whole structure	neutral
3/I1	Replicate bridge in model format	Manage Uncertainty	Whole structure	beneficial

Historic place overview

Name of historic place to be analysed	Place ID if applicable
Inveraray Cross	2

Description of historic place and its wider surroundings	
Brief description of historic place	Scheduled monument, free-standing carved stone, 15th century, fenced
Brief description of place's immediate surroundings	Loch Fyne to north and east, Inveraray main street to south-west
Brief description of places' wider environs	Located within Inveraray Conservation Area, in the west of mainland Scotland

Cultural significance

Conservation policies				
ID	Document title	Author(s)	Version	Date
1	Conservation Area Appraisal & Management Plan - Inveraray	Scottish Civic Trust		2017

Cultural heritage designations			
Designation	Title	Reference	Comments
Scheduled monument	Inveraray cross	SM254	
Conservation Area	Inveraray Conservation Area		

Rating of key cultural significance values		
Key value	Rating	Comments / reasons
The cross was formerly used as the Mercat (Market) Cross in the old town and is believed to be of ecclesiastical origin	3	

Site observations, hazards and climate drivers (optional)

Observed damages and deterioration			
Damage and deterioration observed at historic place	**Impact type**	**Environmental hazard** associated with observations	**Climate drivers**
Impact damage due to wave force to cross	☒ damage ☐ deterioration	Wave overtopping during storm	Storm (wind speed, tidal currents) sea level
Surface abrasion of stonework and platform joints on which cross is erected	☐ damage ☒ deterioration	Wind & rain weathering	Wind speed, precipitation
Spalling of stone surfaces damaging the mouldings and detailing	☐ damage ☒ deterioration	Frost weathering	Precipitation, temperature fluctuation at freezing point
Vegetation growth on cross and platform on which cross is erecetd	☒ damage ☐ deterioration	Physical damage by growth of plant roots Fungus and moss growth on stone surface	Precipitation, temperature

Hazard register

Hazard Register							
Climate drivers	**Climate trends**		**Environmental hazards**			**Impact on historic place**	
Description of variables	*Observed trends*	*Projected trends*	*Description of observed or potential effect*	*Change in relevance observed*	*projected*	*Description of observed or potential impacts*	*Impact types*
Storm (wind speed, tidal currents) sea level	• Mean sea level rise of about 16cm since start of 20th century	• Mean sea level rise projected to continue under all emission scenarios, but substantially varying based on success of reducing GHG emissions	Wave overtopping during storm	☒ increase ☐ decrease ☐ no change	☒ increase ☐ decrease ☐ no change	Impact damage due to wave force to cross	☒ damage ☐ deterioration
Wind speed, precipitation, temperature (fluctuation at freezing point)	• Fluctuation observed, but no great changes in overall annual precipitation levels • Summer average precipitation has decreased • Winter average precipitation has increased • Mean annual temperature has increased • Mean seasonal temperatures have increased • Annual minimum air temperature has increased • Winter minimum air temperature has increased	• Annual average precipitation projected to increase • Summer average precipitation projected to decrease -> drier summers • Winter average precipitation projected to increase -> wetter winters • Mean annual temperature projected to increase • Mean seasonal temperatures projected to increase • Annual minimum air temperate projected to increase • Winter minimum air temperature projected to increase	Wind & rain weathering	☒ increase ☐ decrease ☐ no change	☒ increase ☐ decrease ☐ no change	Surface abrasion of stonework and platform joints on which cross is erected	☐ damage ☒ deterioration
			Frost weathering	☒ increase ☐ decrease ☐ no change	☒ increase ☐ decrease ☐ no change	Spalling of stone surfaces damaging the mouldings and detailing	☐ damage ☒ deterioration
			Physical damage by growth of plant roots	☒ increase ☐ decrease ☐ no change	☒ increase ☐ decrease ☐ no change	Vegetation growth on cross and platform on which cross is erecetd	☒ damage ☐ deterioration
			Fungus and moss growth on stone surface	☒ increase ☐ decrease ☐ no change	☒ increase ☐ decrease ☐ no change	Discolouration of surface in a mostly cosmetic form without causing harm	☐ damage ☒ deterioration

Risk register

Risk register for multiple time horizons														
Impact		Time horizon #1: Today						Time horizon #2: 2070						
Impact ID and description		Likelihood rating	Severity rating	Inherent risk rating	Inherent risk rating definition	Acceptability of risk	Recommendations for action	Likelihood rating	Severity rating	Inherent risk rating	Inherent risk rating definition	Acceptability of risk	Recommendations for action	
1	Impact damage due to wave force to cross	1	3	3	Insignificant risk	Acceptable risk level	No action required	3	4	12	Extreme risk	Unacceptable level of risk requiring immediate attention	consider immediate adaptation action	
2	Surface abrasion of stonework and platform joints on which cross is erected	2	2	4	Minor risk	Acceptable risk level subject to monitoring	Consider active risk monitoring	3	3	9	Major risk	Unacceptable level of risk	consider timely adaptation action	
3	Spalling of stone surfaces damaging the mouldings and detailing	3	2	6	Minor risk	Acceptable risk level subject to monitoring	Consider active risk monitoring	1	3	3	Insignificant risk	Acceptable risk level	no action required	
4	Vegetation growth on cross and platform on which cross is erecetd	2	1	2	Insignificant risk	Acceptable risk level	No action required	3	3	9	Major risk	Unacceptable level of risk	consider timely adaptation action	
5	Discolouration of surface in a mostly cosmetic form without causing harm	3	0	0	Insignificant risk	Acceptable risk level	No action required	4	1	4	Minor risk	Acceptable risk level subject to monitoring	Consider active risk monitoring	

Summary of risk register

Summary of Risk Register (incl. Advanced Level)	☒ Standard level: **Risks ratings are 0-16 (inherent risk)** ☐ Advanced level: **Risk ratings are 0-64 (heritage risk)**

List of unacceptable risks

state risks consider as unacceptable at the respective time horizons
ranked by decreasing risk rating

Impact ID	Description	Risk rating *Time horizon 1* Today	*Time horizon 2* 2070	*Time horizon 3* n.a.
1	Impact damage due to wave force to cross	3	12	n.a.
2	Surface abrasion of stonework and platform joints on which cross is erected	4	9	n.a.
4	Vegetation growth on cross and platform on which cross is erecetd	2	9	n.a.

Highest-ranked acceptable risks
(state multiple if of the same rating at time horizon #1)

Impact ID	Description	Risk rating *Time horizon 1* Today	*Time horizon 2* 2070	*Time horizon 3* n.a.
3	Spalling of stone surfaces damaging the mouldings and detailing	6	3	n.a.
5	Discolouration of surface in a mostly cosmetic form without causing harm	0	4	n.a.

Summary of increasing risks

Risk of damage from wave overtopping during storms, is increasing due to sea level rise and increased storminess.

Risk of damage from wind & rain weathering, growth of plant roots and fungus and moss growth on stone surface is increasing, due to increased temperatures and precipitation.

Summary of decreasing risks

Risk of damage from frost weathering is decreasing as the number of days with frost occurrence are decreasing, and winters are projected to be warmer in general.

Effect of occurrence of impacts on key cultural heritage values			
Key values	Current rating	Revised rating	Comments
The cross was formerly used as the Mercat (Market) Cross in the old town and is believed to be of ecclesiastical origin	3	2 1	If the cross is slightly damaged If the cross is significantly damaged
Conclusions			
No risks are currently considered unacceptable, however, with projected changes to the local climate, three risks are anticipated to be considered as unacceptable, namely • #1 Impact damage due to wave force to cross • #2 Surface abrasion of stonework and platform joints on which cross is erected • #4 Vegetation growth on cross and platform on which cross is erecetd			

Adaptation Planning

Impact to be investigated	
Impact description	Surface abrasion of stonework and platform joints on which cross is erected
Associated hazard	Wind & rain weathering
Risk rating	4
Impact ID	2

Longlist of adaptation measures	
PROTECT	
P1	Build a protecting structure, such as glass box
STRENGTHEN	
S1	structure restoration
RELOCATE	
R1	Move to Inveraray Castle or a museum
RESPOND TO DAMAGE	
D1	Conserving Heritage
MANAGING LOSS	
L1	Acknowledgement of deterioration
MANAGE UNCERTAINTY	
I1	LiDAR survey

Adaptation measure appraisal	
Impact / Measure ID	2/P1
Adaptation measure (short title)	Structure to preserve cross
Details of measure (brief description)	Build a structure around this e.g. a glass house, however, it would have a big impact on aesthetics and the Inveraray community
Adaptation type	Protect
Location where measure would be installed (If working at Advanced Level, use *place elements*.)	Around cross

If adaptation type is Protect, Strengthen, Relocate *or* Respond to Damage, *use below table:*

Adaptation measures appraisal: Adjustment of severity rating (Standard Level only)	
Effect of measure on risk *The risk would be...* Complete sentence by using answer from **Error! Reference source not found.**7	Substantially reduced
Associated effect on severity rating *Severity rating would ...*	Reduced by 5 points

If the answer to the first query is left unchanged *or* increased, *stop the appraisal of the measure concerned.*

Regardless of adaptation type, continue with the table below:

Potential effects on cultural significance	
Descriptive rating of effect on cultural significance of the place	☒ unacceptably adverse ☐ acceptably adverse subject to mitigation ☐ acceptably adverse without mitigation ☐ neutral ☐ beneficial
If the response above was "subject to mitigation", name examples for how this might be achieved.	n.a.

If the answer to the first query was unacceptably adverse or was acceptably adverse subject to mitigation, with no suitable example identified in the second query, top the appraisal of the measure concerned.

Adaptation measure appraisal	
Impact / Measure ID	2/S1
Adaptation measure (short title)	Structure restoration
Details of measure (brief description)	Repair to base and mouldings to protect from erosion. Repoint gaps in the base's mortar to ensure stability of overall structure.
Adaptation type	Strengthen
Location where measure would be installed (If working at Advanced Level, use *place elements*.)	Stone pedestal at base of cross

If adaptation type is Protect, Strengthen, Relocate *or* Respond to Damage, *use below table:*

Adaptation measures appraisal: Adjustment of severity rating (Standard Level only)	
Effect of measure on risk *The risk would be...* Complete sentence by using answer from **Error! Reference source not found.**7	Slightly reduced
Associated effect on severity rating *Severity rating would ...*	Reduced by 2 points

If the answer to the first query is left unchanged *or* increased, *stop the appraisal of the measure concerned.*

Regardless of adaptation type, continue with the table below:

Potential effects on cultural significance	
Descriptive rating of effect on cultural significance of the place	☐ unacceptably adverse ☐ acceptably adverse subject to mitigation ☐ acceptably adverse without mitigation ☐ neutral ☒ beneficial
If the response above was "subject to mitigation", name examples for how this might be achieved.	n.a.

If the answer to the first query was unacceptably adverse or was acceptably adverse subject to mitigation, with no suitable example identified in the second query, top the appraisal of the measure concerned.

Adaptation measure appraisal	
Impact / Measure ID	2/R1
Adaptation measure (short title)	Local relocation
Details of measure (brief description)	Could move to Inveraray castle, but this is already full of interesting things. Move to a museum, either in Glasgow or somewhere Local. Potential to renovate a local building to become a museum. A replica of concrete stone could replace it on the current site.
Adaptation type	Relocate
Location where measure would be installed (If working at Advanced Level, use *place elements*.)	Whole cross

If adaptation type is Protect, Strengthen, Relocate *or* Respond to Damage, *use below table:*

Adaptation measures appraisal: Adjustment of severity rating (Standard Level only)	
Effect of measure on risk *The risk would be...* Complete sentence by using answer from **Error! Reference source not found.**7	Completely eliminated
Associated effect on severity rating *Severity rating would ...*	Set to nil

If the answer to the first query is left unchanged *or* increased, *stop the appraisal of the measure concerned.*

Regardless of adaptation type, continue with the table below:

Potential effects on cultural significance	
Descriptive rating of effect on cultural significance of the place	☐ unacceptably adverse ☐ acceptably adverse subject to mitigation ☒ acceptably adverse without mitigation ☐ neutral ☐ beneficial
If the response above was "subject to mitigation", name examples for how this might be achieved.	n.a.

If the answer to the first query was unacceptably adverse or was acceptably adverse subject to mitigation, with no suitable example identified in the second query, top the appraisal of the measure concerned.

Adaptation measure appraisal	
Impact / Measure ID	2/D1
Adaptation measure (short title)	Conserving Heritage
Details of measure (brief description)	Accept that the cross' current location holds maximum heritage value
Adaptation type	Respond to Damage
Location where measure would be installed (If working at Advanced Level, use *place elements*.)	n.a.

If adaptation type is Protect, Strengthen, Relocate *or* Respond to Damage, *use below table:*

Adaptation measures appraisal: Adjustment of severity rating (Standard Level only)	
Effect of measure on risk *The risk would be...* Complete sentence by using answer from **Error! Reference source not found.**7	
Associated effect on severity rating *Severity rating would ...*	

If the answer to the first query is left unchanged *or* increased, *stop the appraisal of the measure concerned.*

Regardless of adaptation type, continue with the table below:

Potential effects on cultural significance	
Descriptive rating of effect on cultural significance of the place	☐ unacceptably adverse ☐ acceptably adverse subject to mitigation ☐ acceptably adverse without mitigation ☒ neutral ☐ beneficial
If the response above was "subject to mitigation", name examples for how this might be achieved.	n.a.

If the answer to the first query was unacceptably adverse or was acceptably adverse subject to mitigation, with no suitable example identified in the second query, top the appraisal of the measure concerned.

Adaptation measure appraisal	
Impact / Measure ID	2/L1
Adaptation measure (short title)	Acknowledgment of deterioration
Details of measure (brief description)	Acceptance of deterioration process
Adaptation type	Managing Loss
Location where measure would be installed (If working at Advanced Level, use *place elements*.)	n.a.

If adaptation type is Protect, Strengthen, Relocate *or* Respond to Damage, *use below table:*

Adaptation measures appraisal: Adjustment of severity rating (Standard Level only)	
Effect of measure on risk *The risk would be...* Complete sentence by using answer from **Error! Reference source not found.**7	
Associated effect on severity rating *Severity rating would ...*	

If the answer to the first query is left unchanged *or* increased, *stop the appraisal of the measure concerned.*

If adaptation type is Managing Loss, *use below table:*

Managing Loss appraisal	
How would the measure support communities?	
Which specific communities would be supported?	
Are the answers to the two questions above considered sufficiently relevant to explore measure further?	☐ Yes, explore this adaptation measure further ☐ No, file this idea of an adaption measure and proceed to next measure on long-list

If the answer to the last question was no, stop the appraisal of the measure concerned.

Regardless of adaptation type, continue with the table below:

Potential effects on cultural significance	
Descriptive rating of effect on cultural significance of the place	☐ unacceptably adverse ☐ acceptably adverse subject to mitigation ☐ acceptably adverse without mitigation ☒ neutral ☐ beneficial
If the response above was "subject to mitigation", name examples for how this might be achieved.	n.a.
If the answer to the first query was unacceptably adverse or was acceptably adverse subject to mitigation, with no suitable example identified in the second query, top the appraisal of the measure concerned.	

Adaptation measure appraisal	
Impact / Measure ID	2/I1
Adaptation measure (short title)	Damage replication
Details of measure (brief description)	LiDAR survey to get precise image of deterioration
Adaptation type	Manage Uncertainty
Location where measure would be installed (If working at Advanced Level, use *place elements*.)	Whole cross
If adaptation type is Protect, Strengthen, Relocate *or* Respond to Damage, *use below table:*	
Adaptation measures appraisal: Adjustment of severity rating (Standard Level only)	
Effect of measure on risk *The risk would be...* Complete sentence by using answer from **Error! Reference source not found.**7	
Associated effect on severity rating *Severity rating would ...*	
If the answer to the first query is left unchanged *or* increased, *stop the appraisal of the measure concerned.*	
If adaptation type is Manage Uncertainty, *use below table:*	

Manage Uncertainty appraisal	
How would the considered measure reduce uncertainty?	
How would the considered measure support other relevant measures?	
Are the answers to the two questions above considered sufficiently relevant to explore measure further?	☐ Yes, explore this adaptation measure further ☐ No, file this idea of an adaption measure and proceed to next measure on long-list
If the answer to the last question was no, stop the appraisal of the measure concerned.	
Regardless of adaptation type, continue with the table below:	
Potential effects on cultural significance	
Descriptive rating of effect on cultural significance of the place	☐ unacceptably adverse ☐ acceptably adverse subject to mitigation ☐ acceptably adverse without mitigation ☐ neutral ☒ beneficial
If the response above was "subject to mitigation", name examples for how this might be achieved.	n.a.
If the answer to the first query was unacceptably adverse or was acceptably adverse subject to mitigation, with no suitable example identified in the second query, top the appraisal of the measure concerned.	

Adaptation Measures Register

Adaptation Measures Register					
Impact investigated	Surface abrasion of stonework and platform joints on which cross is erected			**Impact ID**	2
Impact / Measure ID	**Adaptation measure** (short title)	**Adaptation type**	**Location** where measure would be installed	**Potential effect on cultural significance** including mitigation example	**Include in summary**
P1	Build a structure	Protect	Around cross	unacceptably adverse	☐ include
S1	Repairs	Strengthen	Stone pedestal at base of cross	beneficial	☒ include
R1	Move to Inverary Castle or Museum	Relocate	Whole cross	acceptably adverse without mitigation	☒ include
D1	Heritage Value	Respond to Damage	n.a.	neutral	☒ include
L1	Deterioration	Managing Loss	n.a.	neutral	☒ include
I1	LiDAR survey	Manage Uncertainty	Whole cross	beneficial	☒ include

Summarising the adaptation measures

Summary of Adaptation Measures Register					
Impact / Measure ID	**Adaptation measure** (short title)	**Adaptation type**	**Location** where measure would be installed	**Potential effect on cultural significance** including mitigation example	
Impact investigated	Surface abrasion of stonework and platform joints on which cross is erected			**Impact ID**	2
S1	Repairs	Strengthen	Stone pedestal at base of cross	beneficial	
R1	Move to Inverary Castle or Museum	Relocate	Whole cross	acceptably adverse without mitigation	
D1	Heritage Value	Respond to Damage	n.a.	neutral	
L1	Deterioration	Managing Loss	n.a.	neutral	
I1	LiDAR survey	Manage Uncertainty	Whole cross	beneficial	