Lochgilphead Flood Study

Options Screening Report

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Quality information

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1. Introduction

1.1 Purpose of the report

Argyll and Bute Council (ABC) are looking to address flood risk in the town of Lochgilphead in accordance with the Highland and Argyll Local Flood Risk Management Plan (2016). The Flood Risk Management (FRM) Act (Scotland 2009) provides the necessary statutory powers and potential funding to address this risk and also allows any measures promoted to enhance the local area. AECOM was commissioned to undertake a Flood Study (FS) for Lochgilphead in Spring 2018. The study will propose new flood mitigation measures for coastal and fluvial flooding. This will enable ABC to make an informed decision moving forward on the most economically, environmentally and socially viable options to alleviate flooding in Lochgilphead.

At this point in the study, significant work has been carried out to understand the flood mechanisms affecting Lochgilphead and to identify constraints and opportunities with regard to potential flood mitigation options. The purpose of this report is to summarise the work that has been undertaken to inform the optioneering process. This includes developing a long list of potential solutions and screening this to a short list of feasible options which will be developed in more detail.

The scope of the report includes:

- Summarising the process to date
- Summary of baseline modelling results
- Mitigation options – Long list
- Option screening
- Preliminary Environmental Appraisal
- Baseline Damage Assessment
- Public consultation event summary
- Mitigation options - Short list
- Next steps

1.2 The process

The project is being carried out in a phased approach in line with Scottish Environment Protection Agency (SEPA) and Scottish Government Guidance[1][2]. The study is split into the following phases:

- Phase 1 – Data gathering and gap analysis
- Phase 2 – Baseline modelling
- Phase 3 – Long list to Short List
- Phase 4 – Option appraisal

Figure 1-1 provides a high level overview of the study development process.

[1] Options appraisal for flood risk management: Guidance to support SEPA and the responsible authorities, Scottish Government, May 2016.
[2] Local Authority flood study checklist, Version 2, SEPA, June 2017.

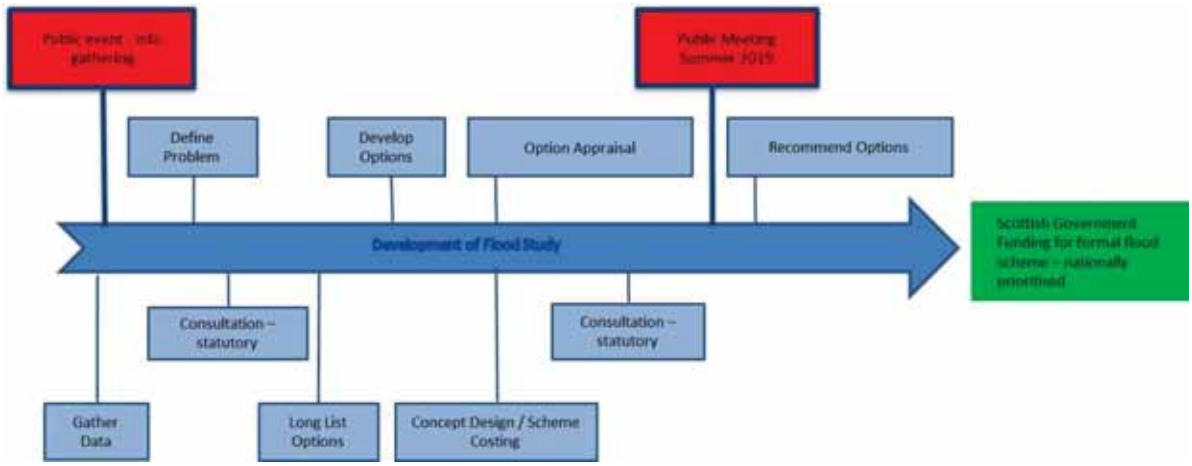


Figure 1-1: The study process

Significant work has been carried out to understand the flood sources and mechanisms affecting Lochgilphead. During Phase 1 (Lochgilphead Flood Study, Phase 1 report, Data gap analysis) the existing available information was collated, and a gap analysis undertaken to determine the quality of the data and what additional information was needed in order to undertake the assessment of flood risk.

At the start of the flood study process a public consultation was carried out with the residents of Lochgilphead, to understand their experience of flooding in the area and to identify hotspots. This information was then be used to sense check any modelling outputs generated. Further public consultation events will be held during this phase, Phase 3, to present the findings of this report. The community will be invited to provide feedback and comment on options identified to manage the flood risk identified.

The flood mechanisms and extents currently experienced in Lochgilphead were confirmed in Phase 2. Flooding from coastal and fluvial sources were assessed through long-term wave transformation modelling, joint probability and wave overtopping analyses. Catchment hydrology was undertaken to form the fluvial inflows to the two watercourses in the study area. In addition to this, a high-level model of the Crinan Canal was also constructed to understand how this influenced fluvial flows. These sources of flooding were then combined in a computer model to establish an overall representation of flooding in Lochgilphead. The findings of this stage are summarised in Section 2 of this report (Lochgilphead Flood Study, Phase 2 report, Baseline modelling).

The study is currently at Phase 3; where the drivers of flooding and the scale of the problem are understood and options to mitigate flood risk can be proposed. The process has been informed by additional assessments including; ecological and environmental, and planning desk studies to identify constraints to and opportunities for flood alleviation options.

Consultation has been a key part of the Phase 3 process. Statutory stakeholders such as SEPA, Scottish Canals and Scottish Water have been involved through technical workshops.

This information has then been layered up to drive decision making in the optioneering process. The purpose of this report is to summarise the work that has been done to inform the optioneering and the next steps to develop the options.

The Scottish Government Guidance on Options Appraisal for Flood Risk Management sets out a clear approach to identify and prioritise mitigation measures. The following steps are highlighted:

- Define the purpose of the appraisal and set objectives.
- Identify “long list” of potential flood measures
- Screen to create a “short list” of flood measures
- High level appraisal of short listed flood measures

AECOM have adopted this approach for Phase 3 of this study. A long list of potential measures to mitigate against the causes of flooding were identified. This report sets out the decision making behind the long list of options and also details how the short list has been created based on known feasibility issues. This approach ensures resources are expended on assessing the most suitable options which are most likely to give a return in flood risk benefit.

At the end of Phase 3, a short list of potential options will be established and will be further developed through detailed modelling, outline design and cost benefit appraisal in Phase 4. The way forward will then be dependent on the option recommendations. If a formal scheme is determined to be the best option, the finding of this study would be passed to SEPA for inclusion in the next round of SEPA FRM Strategies. The Strategies set out a prioritised list of actions for flood risk on national scale.

If successful, the FS will then be submitted for approval to Scottish Government and the scheme details presented to the public for comment. Following this, detailed design will commence with funding statements compiled and approved prior to tender and construction.

2. Baseline Modelling Results - Summary

Lochgilphead is located in a wider Potentially Vulnerable Area (PVA) that has identified properties both at risk of fluvial and pluvial flooding. Coastal flooding was not identified as a source of flooding that causes damages in the wider PVA in the last cycle of PVA documentation, however, it is included in the latest SEPA National Flood Risk Assessment 2018 assessment.

The town of Lochgilphead is identified as being at possible risk of flooding from fluvial, surface water and canal sources in SEPA's 2015 Flood Risk Management (FRM) PVA documentation. The 2018 version of the 2021 FRM Strategies, which is yet to be finally completed, also identifies coastal sources of flood risk. Actions outlined in the 2015 PVA documentation focus around identifying fluvial flood risk from the Badden Burn, coastal flood risk and possible flooding from the Crinan Canal. The FRM Strategies PVA sets out a requirement for a Flood Study to assess the complex interactions between these three sources. These sources and their interactions have formed the basis of the baseline assessment undertaken in Phase 2 (Lochgilphead Flood Study, Phase 2 report, Baseline modelling), where full details of the below summaries can be found.

To assess these flooding interactions, a 1D/2D model was constructed, with inflows representing the coastal conditions, fluvial subcatchments and Crinan Canal.

2.1 Model Inflows

Inflows from the three flood sources were established by undertaking hydraulic modelling and hydrological analysis. A summary of the assessment undertaken for each source is presented below.

2.1.1 Coastal

The main objective of the coastal modelling exercise is to establish the nearshore extreme sea level and wave characteristics along the frontage at Lochgilphead. In order to achieve this, AECOM has undertaken a numerical modelling study to investigate the existing and future (up to the year 2100) wave climate. The information on wave conditions and extreme sea levels was used to assess still water levels and provide wave overtopping volumes which were used as inflows into a linked 1D/2D hydraulic model that included all sources of flooding.

A regional wave model was run to establish the offshore wave heights at Lochgilphead under present day conditions. The regional modelling results show that the wave climate at the entrance to Lochgilphead is moderate (< 3 m) although a maximum significant wave height of 3.5 m was predicted over the available 38 year hindcast period. A joint probability analysis of wave heights and water levels was undertaken for present day condition and a future (2100) epoch. The results from this extremes analysis were then used as boundary conditions for a local high resolution model of Loch Gilp.

The findings from the local model for the present day scenario show that wave conditions within Lochgilphead are small, with a 1% AEP event producing wave heights in the region of 0.8 m. The small waves can be attributed to the extensive shallow bathymetry within Loch Gilp.

Due to the small wave heights, and topography of the frontage at Lochgilphead, wave overtopping is not considered a significant issue. Increases in still water levels, as predicted in climate change scenarios, represent the greatest source of flooding to the lower lying areas of the town.

The extreme sea level established in this coastal modelling exercise was therefore applied as the tidal boundary to the 1D/2D linked model.

2.1.2 Crinan Canal

The Crinan Canal discharges into the Badden Burn catchment via waste Weir 3 in between Cairnbaan and Lochgilphead. There is also the potential for the canal to overtop its embankment should levels build sufficiently. Both sources will contribute to flood risk in and around Lochgilphead and require to be added into the 1D/2D model.

A simplified 1D model of the Crinan Canal, including: sluice gates; waste weirs; and controlled and uncontrolled feeders was constructed to establish likely flows from the canal into the Badden Burn catchment.

It was found that waste Weir 3, downstream of Cairnbaan, discharged into the Badden Burn from the 50% AEP event, and spill over the canal embankment occurred from the 20% AEP event. These flows contributed to the total flows in the Badden Burn and were applied to the linked 1D/2D model as point inflows.

It is worth noting that the model of the Crinan Canal is a simplification of the system and operations and was used to establish likely flows into the fluvial catchment rather than to fully replicate the canal functioning.

2.1.3 Fluvial

The Badden Burn that runs through Lochgilphead is made up of numerous sub catchments, which were to be represented in the 1D element of the model separately at their inflow location to best replicate timings and flood volumes at specific locations. The Cuilarstich Burn joins the Badden Burn in town but contains no notable subcatchments in the modelled reach.

However, there are inherent issues with small catchment hydrology, and for this reason, peak flow for the total larger catchment at the tidal limit of the watercourse was calculated so that the sub-catchment flow could be reconciled to a flow estimate that held more confidence.

Each sub-catchment was delineated using FEH Web Service information where available. Given the difference in sub catchment size, critical storm durations (the storm duration that gives the highest peak flow) were found to vary. To establish one critical duration for the entire catchment, a range of durations were run through the 1D/2D model to establish the duration that produced the greatest flooding at key receptors.

Catchment descriptors for the total catchment were downloaded from the FEH Web Service and amended where appropriate based on site walkovers and Scottish Canal's Water Control Manual which details modification to natural watercourses as a result of the canal. These descriptors were then used to undertake a Statistical analysis and ReFH2 for comparison before selecting the preferred method. The Statistical method was deemed to be the most appropriate method for the size of the catchment and produced the largest flows. These flow estimates were taken forward as the downstream peak flows. Sub-catchments were then scaled until the downstream flow matched the flow establish in the Statistical Analysis.

When undertaking the reconciliation, it was found that the uplift factors of the sub-catchments would have to be very high to achieve a match at the downstream boundary. Sensitivity checks were undertaken to establish whether these uplifts were realistic and if the downloaded catchment descriptors were correct. It was found that the catchment descriptors were accurate, and the uplifts were unrealistic due to the functioning of the floodplain around the Meadows area. Flows were not reconciled to the Statistic peaks for this reason and instead uplifted by between 1.18 and 1.24, based on the ratio of the downstream Statistical Analysis flows to the ReFh2 peak flow estimates. Full details of this analysis can be found in the Phase 2 report.

Climate change uplifts used within this study were based on the SEPA commissioned CEH report which utilised UKCP09 data. The medium emission scenario, 50th percentile uplift of 37% was applied, with the medium emission, 90th percentile of 60% assessed as a sensitivity test.

These inflows, with the standardised critical storm duration and flow reconciliation uplift were applied to the 1D inflows into the 1D/2D model.

2.1.4 Joint probability

Once the coastal and fluvial conditions had been established, a joint probability assessment was undertaken to establish the likelihood of fluvial and coastal interactions.

There is no local fluvial or tidal gauged data from the surrounding areas that could be used to establish joint probability likelihood. Therefore, the most appropriate way to determine joint probability is through sensitivity testing.

The sensitivity testing involved running a high AEP fluvial event with a range of coastal levels to identify if there were any key areas where flooding was worse during a combined event (i.e. $Q_{05\%}$ $T_{10\%}$) than from a single source event ($Q_{0.5\%}$ T_{MHWS}). The same combinations were run for a tidal event, with a high tide of 0.5% AEP with a range of fluvial flows. This analysis was also undertaken for climate change scenarios. For the single source simulations, a tide level of the Mean High Water Spring (MHWS) level was applied to the high fluvial flows, and a flow equating to QMED (median flow) / 2 (half QMED) was applied to the high tidal levels.

It was found that the two sources of flooding were largely independent of each other, with fluvial sources causing the greatest flood risk to areas upstream of Bishopton Road bridge and tidal sources causing the greatest flood risk to areas downstream of Bishopton Road.

Given the independence of flood sources, a set of fluvial runs with a MHWS boundary and a set of tidal runs, with a QMED / 2 fluvial flow were used in the baseline model.

2.2 Flood Risk

Given the mechanisms found in the joint probability analysis, where some areas were tidally dominated and some were fluvial dominated, a full suite of fluvial simulations and a full suite of tidal simulations were undertaken. This was to establish the maximum flood depths and extents at all locations across the study area. Full details of the assessment and flood maps can be found in the Phase 2 report.

2.2.1 Fluvial

During the 0.5% AEP fluvial event, which includes any spill from the canal, flooding first occurs from the overflow Weir 3 on the canal and from overtopping of the culvert at the junction near Cairnbaan on the Badden Burn (location 1, Figure 2-1). Out of bank spill then occurs upstream of the Meadows area into the grazing land on either side of the watercourse (location 2, Figure 2-1). Flooding from these spill locations combines with spill from the canal and causes much of the land and the A816 between Lochgilphead and Cairnbaan to become inundated. Whilst flooding continues to spread upstream of Lochgilphead, out of bank flow is first noted at the confluence of the Badden Burn and Cuilarstich Burn (location 3, Figure 2-1) and at the caravan park (location 4, Figure 2-1). Flood waters build in the caravan site before flowing over the A83 and out to sea. Later in the event, an additional area of flooding is observed around the junction of Bishopton Road and the A816 around the ABC plant yard (location 5, Figure 2-1).

No coastal flooding is observed as a result of a MHWS sea level as the tide levels do not reach the top of the coastal defences along the Front Green.

The 0.5% AEP event plus climate change follows the same flood mechanism as the 0.5% AEP present day event, albeit with an increase in flood depths. Additional areas of flooding on both banks originate from the Cuilarstich Burn at the Bishopton Road crossing (location 6, Figure 2-1) which occurs slightly later in the event than spill into the caravan park.

During the climate change scenario, as with the present day, no flooding is observed as a result of a MHWS sea level as the tide levels do not reach the top of the coastal defences along the Front Green.

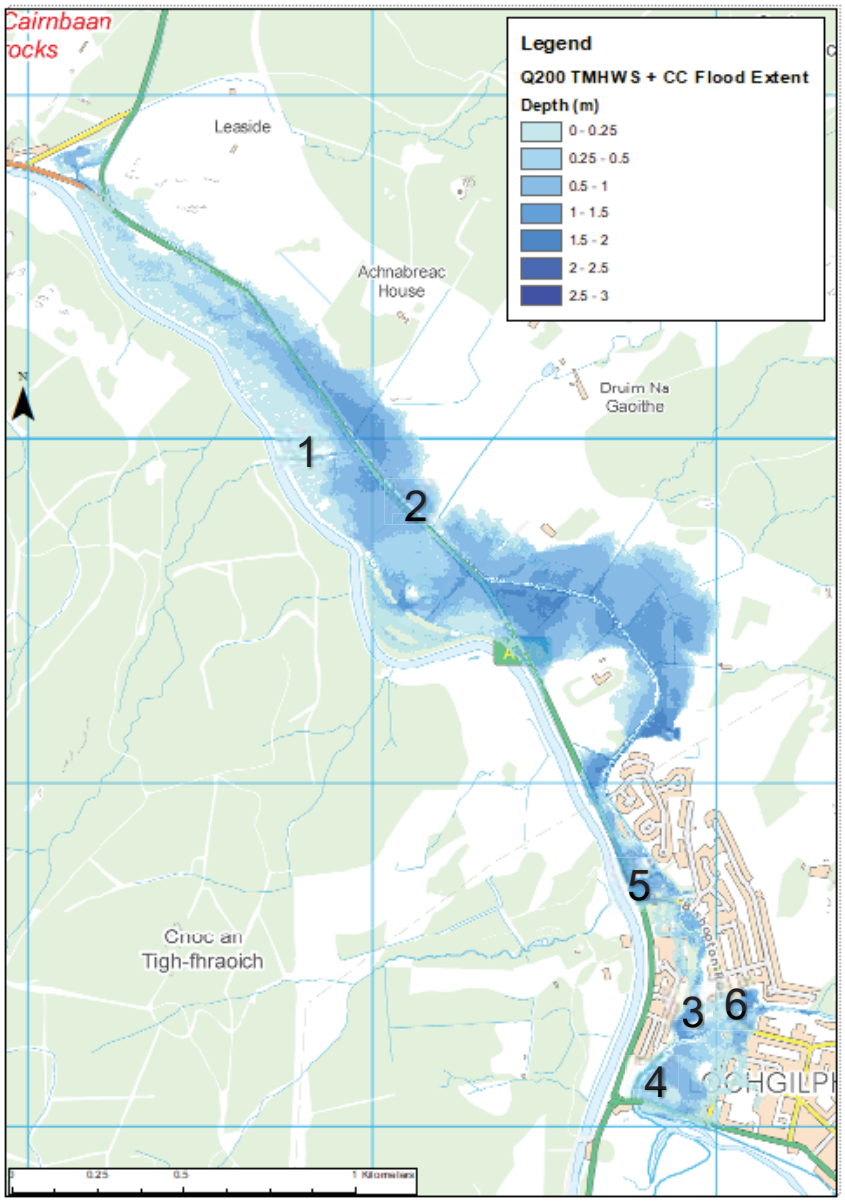


Figure 2-1: Fluvial flooding $Q_{0.5}$ T_{MHWS} + CC

During higher frequency events, flooding first occurs on the floodplain surrounding the A816 and at the confluence of the Badden Burn and Cuilarstich Burn from the 50% AEP event. More notable flooding is experienced upstream of the Meadows area from the 10% AEP event. By the 2% AEP event, a large portion of the floodplain upstream of the Meadows is inundated, and spill into the caravan park from the Badden Burn commences. By the 1% AEP event, a large percentage of the caravan park is inundated.

2.2.2 Tidal

During the 0.5% AEP tidal event, with a low fluvial flow, flooding first occurs around the confluence of the Badden and Cuilarstich Burn due to tidal levels backing up in the channel. The entire Front Green up to Poltalloch Street becomes flooded before peak tide where tidal waters are also seen to spill over the A83 and over the left bank of the watercourse into the caravan park. Tidal floodwaters begin to encroach onto properties along the A83, before spreading up Argyll Street.

Some minor flooding is noted on the A816 from the canal overflow weir and from overtopping of the culvert at Cairnbaan.

The 0.5% AEP event plus climate change follows the same flood mechanism as the 0.5% AEP present day event, albeit with an increase in flood depths in the caravan site and on the Front Green.

A larger portion of the urban area of Lochgilphead is affected in the climate change scenario, with floodwaters reaching Lorne Street and Union Street, again producing greater flood depths.

Some minor flooding is noted around the A816 from the canal overflow weir and from overtopping of the culvert at Cairnbaan.

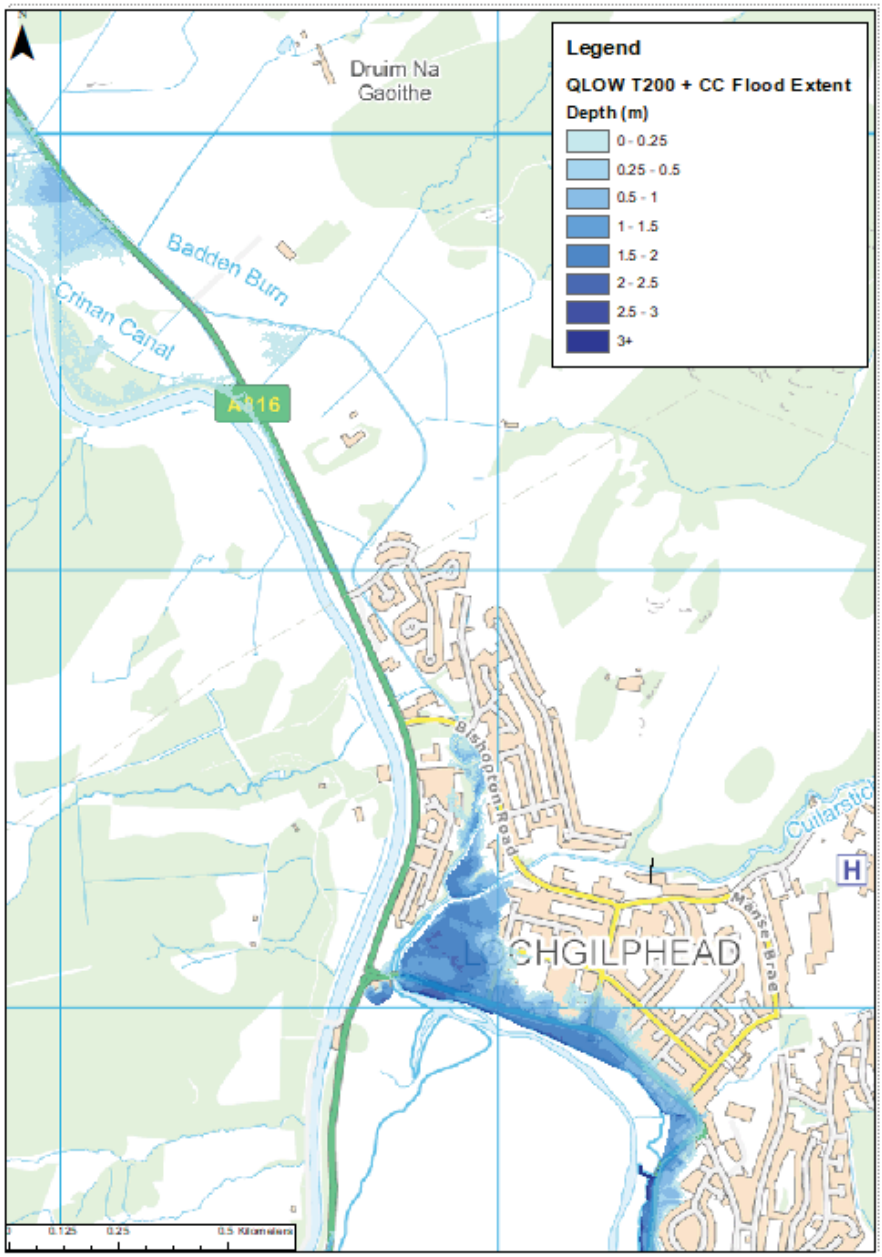


Figure 2-2: Tidal flooding Q_{LOW} $T_{0.5\%}$ + CC

During higher frequency present day events, flooding occurs on the Front Green from the 50% AEP event. By the 20% AEP event, the whole Front Green is inundated, and tidal levels have exceeded the levels on Poltalloch Street and overflowed into the caravan park, causing inundation across approximately 60% of the site. Properties along Poltalloch Street are seen to be affected from the 10% AEP onwards, with flooding becoming more widespread through Lochgilphead by the 2% AEP event.

3. Long list – flood protection mitigation options

Flood risk objectives provide a common goal and shared ambition for managing floods. As a PVA in the first round of SEPA FRM Strategies, flood risk objectives for the area have been set. As such this study has attempted to set objectives based on assessment of the underlying evidence of the causes and impacts of flooding.

The objectives for the Lochgilphead area are:

- Avoid an overall increase in flood risk
- Reduce flood risk in Lochgilphead from the Badden Burn
- Reduce coastal flood risk

Using the results of the baseline modelling, a range of structural and non-structural flood mitigation measures have been identified to achieve the objectives of the study in a way that is most sustainable. Measures look to address both coastal and fluvial flooding at source, along its pathways and protect key receptors of the flooding.

Natural Flood Management (NFM) measures include:

  - Re-meandering of watercourses
  - Provision of 2 stage channel
  - Tree planting
  - Wetland creation
  - Reduction of sediment transport
  - Intertidal recharge to provide wave dissipation, primarily to reduce sea debris on the Front Green
  - Saltmarsh creation

Structural measures include:

- Upstream storage on the Auchoish Burn and Cuilarstich Burn
- Direct defences
  - Raising of the A816
  - Embankment along the left bank at the caravan park
  - Flood wall or embankment along existing defence line at Front Green
  - Flood wall or embankment set back from existing defence line closer to Poltalloch Street
  - Flood wall along A83 on approach to Lochgilphead
  - Combination wall/ embankment based on traditional/demountable/embankment to provide a custom design
  - Wall along left bank of Cuilarstich Burn
  - Wall along right bank of Cuilarstich Burn
  - Wall along right bank of Badden Burn around the swimming pool and ABC plant yard
  - Tidal barrage structure at the entrance to the natural harbour.
- Wave dissipation – breakwater, primarily to reduce sea debris on the Front Green
- Bridge and culvert upgrades
  - Upgrade of culvert under A816 at Cairnbaan
  - Upgrade of the bridges at Bishopton Road on the Cuilarstich Burn
  - Upgrade of the Poltalloch Street Road bridge
  - Upgrade of the bridge at the Auchoish Burn confluence

- Land reclamation
  - Infilling of intertidal area for flood defence purposes
  - Infilling of small section behind wall at police station for flood defence purposes
- Canal management – changing levels of waste weirs

Non-structural measures include:

- Individual Property Flood Protection
- Flood resilience
- Improved flood warning
- Self help
- Managed retreat
- Canal management
  - Alternative operation of the canal
  - Storage of more water in the upstream reservoirs

A summary of all options considered and the flood receptor they would benefit along with a unique ID is set out in Table 3-1.

Table 3-1: Long list of flood mitigation measures

Category	Measure	ID	Flood receptor (location)
	Fluvial measure - Re-meandering of the Badden Burn away from the A816 between Cairnbaan and The Meadows to improve channel sinuosity and habitats	1.1	This measure aims to address flooding on the A816 and potentially within Lochgilphead.
	Fluvial measure - Provision of a 2-stage channel in the current burn alignment (re-shaping existing channel) to improve habitats and improve capacity/ flood mechanisms.	1.2	This measure aims to address flooding on the A816 and potentially within Lochgilphead.
	Fluvial measure - Tree planting in the upper catchment to reduce surface water run off – increase lag in catchment	1.3	This measure aims to address flooding on the A816 and within Lochgilphead.
	Fluvial measure - Wetland creation and ditch blocking. Reduce risk of blockage and provide small scale attenuation in areas upstream of the Meadows	1.4	This measure aims to address flooding on the A816 and within Lochgilphead.
	Fluvial measure - In channel improvements on the Badden Burn to reduce sediment transport. This could include dredging or installation of features to encourage pools and riffles	1.5	This measure aims to reduce issues caused by sediment such as blockage which aims to address flooding on the A816 and within Lochgilphead
	Coastal measure - Intertidal recharge to provide wave dissipation	1.6	This measure aims to dissipate wave energy and therefore reduce flooding from wave overtopping around the front green and southern sections of Lochgilphead.
	Tidal measure - Saltmarsh/managed realignment to provide wave dissipation	1.7	This measure aims to dissipate wave energy and therefore reduce flooding from wave overtopping around the front green and southern sections of Lochgilphead.
	Fluvial measure - Tree planting in the upper catchment and ditch blocking to reduce surface water run off – increase lag in catchment	1.8	This measure aims to reduce runoff into the Cularstich Burn to reduce flooding and increase capacity for flood flows in the Badden Burn within Lochgilphead centre.
	Fluvial measure - forestry management including elements such as efficient tree planting, appropriate drainage and tree spacing as well as consideration of appropriate tree felling etc	1.9	This measure aims to address flooding on the A816 and potentially within Lochgilphead.
Upstream storage	Fluvial measure - Storage provision on the Auchoish burn	2.1	This measure aims to reduce overall flows into the Badden Burn from the Auchoish Burn
	Fluvial measure - Storage provision on the Cularstich burn	2.2	This measure aims to reduce overall flows into the Badden Burn from the Cularstich burn
Direct defences	Fluvial measure - Raising of the A816 so that a higher standard of flood protection can be provided	3.1	This measure aims to reduce flooding on the A816
	Fluvial measure - Increasing the height of the left-hand bank along the caravan park	3.2	This measure aims to reduce flooding at the caravan park

Category	Measure	ID	Flood receptor (location)
	Coastal measure - Coastal flood wall along existing coastal defences	3.3	This measure aims to reduce flooding to the front green and the southern sections of Lochgilphead
	Coastal measure - Coastal flood wall set along Poltalloch Street	3.4	This measure aims to reduce flooding to the southern sections of Lochgilphead
	Coastal measure - Coastal flood embankment along existing coastal defences	3.5	This measure aims to reduce flooding to the front green and the southern sections of Lochgilphead
	Coastal measure - Coastal flood embankment set back within front green area	3.6	This measure aims to reduce flooding to some parts of the front green and the southern sections of Lochgilphead
	Coastal measure - Coastal defence wall along A83 on approach to Lochgilphead	3.7	This measure aims to address coastal flooding on the A83 on the approach to Lochgilphead
	Coastal measure - Combination of direct defences such as wall/ embankment/coping stones/ flood gates etc along the length of affected area	3.8	This measure aims to reduce flooding to the front green and the southern sections of Lochgilphead
	Fluvial measure - flood wall along the left-hand bank of the Cuilarstich Burn from upstream of Bishopton Road to confluence with Badden Burn	3.9	This measure aims to address flooding in the areas around the bowling green, caravan park and Bishopton Road and Poltalloch Street
	Fluvial measure - flood wall along the right-hand bank of the Cuilarstich Burn from upstream of Bishopton Road to confluence with Badden Burn	3.10	This measure aims to address flooding in the areas around the SSE power distribution facility and Bishopton Road – it should be noted that the SSE site has recently constructed flood defences around the perimeter
	Fluvial measure – flood wall along the right-hand bank of the Badden Burn between Meadows Road and Bishopton Road.	3.11	This measure aims to address flooding in the area around the swimming pool, Riverside petrol station and the ABC plant yard.
	Tidal measure - Tidal barrage to stop high sea levels entering the front green area. This would likely run between pier to the west and existing wall to the east. Provision for boat access may also be required.	3.12	This measure aims to reduce flooding to the front green and the southern sections of Lochgilphead
Property flood protection	Small scale property interventions that could be employed when high sea levels are predicted and as fluvial protection. This would include measures such as flood doors and flood-proof airbricks. Appropriate for flood levels up to 0.6m in depth.	4.1	All affected properties
Flood resilience	Coastal and fluvial measure -The measure would aim to improve building resilience to flooding making clear up easier and cheaper. This could include waterproof render and lifting of electrical sockets in properties at risk of flooding	5.1	This measure aims to improve community resilience for all affected properties
Bridge/culvert	Fluvial measure - Upgrade of culvert under the A816 at Cairnbaan	6.1	This measure aims to address flooding on the A816 near Cairnbaan

Category	Measure	ID	Flood receptor (location)
upgrades	Fluvial measure --Upgrade of the 2 bridges on the Cuilarstich Burn at Bishopton Road to increase conveyance	6.2	This measure aims to reduce flooding of the Cuilarstich Burn around Bishoptop Road
	Fluvial measure - Upgrade of the Poltalloch Street bridge to increase conveyance	6.3	This measure aims to address flooding to the caravan site
	Fluvial measure - Upgrade of the bridge at the Auchoish Burn to increase conveyance	6.4	This measure aims to address flooding on the A816
Wave dissipation	Coastal measure - Breakwater placed in the intertidal areas to dissipate waves and reduce overall wave height.	7.1	This measure aims to dissipate waves and reduce overtopping along the frontage
Improved flood warning	Coastal measure - This measure would aim to provide earlier warning of high sea levels so that residents could be more prepared. Likely to be either based on Met Office data or other tidal gauges on the Firth of Clyde.	8.1	This measure aims to improve community resilience for all affected properties
Self help	Coastal and fluvial measure - The measure would aim to improve understanding of flooding issues and how to cope better.	9.1	This measure aims to improve community resilience for all affected properties
Managed retreat	Coastal measure - Setting up of a long-term plan to move properties away from the southern section of Lochgilphead	10.1	This measure aims to reduce those at flood risk by relocating away from flood areas – all affected properties
Land reclamation	Coastal measure - Infilling of an area of the intertidal mudflats in front of the front green, to create more space to install the most suitable defence to protect Lochgilphead – the main purpose of this land raising would be for coastal flood protection purposes	11.1	This measure aims to address flooding to the southern sections of Lochgilphead and the front green.
	Coastal measure - Infilling of an area of back of houses east of front green and at Police Station– the main purpose of this land raising would be for coastal flood protection purposes	11.2	This measure aims to address flooding to the eastern sections of Lochgilphead
Canal management	Fluvial measure - Raising of the invert level at weir 3 – potential lowering of weir 1 and 2 invert levels so that little or no flow enters the Badden Burn from the canal	12.1	This measure aims to address flooding on the A816 and areas around the caravan park
	Fluvial measure - Alternative operation of canal – changes to trigger levels and operations.	12.2	This measure aims to address flooding on the A816 and areas around the caravan park
	Store more water in upstream reservoirs that feed the summit pound	12.3	This would aim to reduce flow into the summit pound and therefore into the eastern reach
Do nothing	This scenario assumes no future maintenance of flood defences or flood warning.	13.1	

4. Long List Screening

The long list of options has been screened for technical, financial, legal and environmental feasibility. The purpose of this was to remove any potential measures that are clearly unfeasible or unrealistic at an early stage. Table 4-1 sets out the criteria that were used for screening out unfeasible or unrealistic options. The guidance of screening from long list to short list is set out within the Flood Risk Management (Scotland) Act 2009.

Table 4-1: Screening criteria

Feasibility	Description	Metric
Technical	Removal of any measures that are not technically feasible. E.g. is land available for above ground storage	Categorical – Y/N based on scoring Expert Judgement
Legal	Removal of any measures that represent insurmountable legal issues including health and safety.	Categorical – Y/N based on scoring Expert Judgement
Financial	At this stage, is there evidence that the costs will be disproportionate compared to the benefits? Rapid assessment of cost estimates against key economic and social benefits. Please note this should not be a detailed cost benefit analysis.	Categorical – Y/N based on scoring Estimated build and maintenance costs of measure vs benefits to economy and key social impacts (risk to life/human health)
Environmental	Removal of any measure than had clear negative environmental impacts E.g. required construction on protected areas or reduced amenity and visual value	Categorical – Y/N based on scoring Expert Judgement and additional study findings

Expert judgement is used within this process to score each option for each criterion and as such will open option selection up to a degree of subjectivity. During this process consultation events with ABC, Scottish Canals, Scottish Water and SEPA have been held in order to gather as many opinions as possible to inform the decision making process. These events are detailed in **Section 4.1**. Additional assessments were also carried out to help inform the optioneering process and ensure all the information was available that was reasonably possible, to identify opportunities and constraints at this early stage. These studies are detailed in **Section 4.2**.

4.1 Stakeholder engagement

4.1.1 Argyll and Bute Council

Following completion of the baseline studies and site walkovers, the long list was created by AECOM. To review the feasibility of the long list, ABC and AECOM held a workshop, which enabled all the relevant client personnel to input into the screening process. ABC technical and policy staff were in attendance, and AECOM were able to gather feedback from the session. AECOM specifically asked ABC to comment on the technical, legal and financial feasibility of all options presented. All comments made were noted and are summarised in **Section 8.1.**

4.1.2 Scottish Canals, SEPA and Scottish Water

Having gained ABC's input to the long list, Scottish Canals, ERZ (landscape architects undertaking Front Green regeneration plans), Transport Scotland, SNH, Historic Scotland and SEPA were then

invited to attend a stakeholder workshop. The consultation took the form of a half day workshop where AECOM sought to bring all the parties up to date on the project and then summarised the long list of options. The outputs from consultation with ABC were discussed and any additional points highlighted within the workshop event were noted and are summarised in **Section 8.2.**

4.2 Additional studies

During this stage a broader consideration was made in terms of environmental considerations (human and natural) impacts. This has been addressed through our public consultation summarised in **Section 8** and through our Preliminary Ecological Appraisal and Planning screening exercise, the findings of which are summarised in **Section 5 and Section 6** of this report. A baseline Damages Impact Assessment has been undertaken and is provided in **Section 7** and **Appendix C** of this report.

These studies have provided more information on opportunities and constraints with regards to the environmental and economic impacts of the potential options and helped inform the appraisal of options to progress from the long list to the short list. The studies are summarised in the sections noted above and the full reports are within the appendices.

5. Ecological Preliminary Appraisal - Recommendations

Below are the recommendations taken from the Preliminary Ecological Appraisal. The full report can be found in **Appendix B**.

As the long list of options are only at pre-feasability stage, specific ecological recommendations cannot be made. Ecological receptors considered to be potentially relevant, and which may represent a high level of constraint to any of the options, are identified below.

5.1 Nature conservation designations

5.1.1 Moine Mhor SAC, SSSI, NNR

The site holds various designations based on the presence of several qualifying interests such as raised bogs, Atlantic salt meadows, otter and breeding bird assemblages. The SAC and SSSI consist of multiple parts, all located close to one another. The part nearest to the site is located 1.4 km to the north-east and is separated from the site by a mix of broadleaved woodland, conifer plantation, moorland with heather and grass fields. The NNR occupies a strip to the south of the site and is 1.6 km away.

As the site is designated in part due to the presence of otter and marsh fritillary butterfly, there is the potential for otter associated with these SACs to use suitable habitat in the study area at times. It is recommended that the scheme is subject to a Habitats Regulations Appraisal (HRA) so that appropriate mitigation measures can be put in place.

5.1.2 Knapdale Loch SPA/SSSI

The site holds the most southerly regular breeding population of black-throated diver in Britain and is of high productivity and European importance. This SPA/SSSI consists of multiple sites, the closest of which can be found 3.4 km east of the Scheme. The study area may be used as “functional land” for foraging by birds from the SPA/SSSI. Black-throated diver move to the coast in winter and feed on fish, therefore Loch Gilp may provide suitable habitat for these birds as multiple fish species have been recorded within the area. There is a risk of pollution from any scheme to Loch Gilp which could have a direct negative effect on the birds themselves and the suitable prey within the loch which could affect the integrity of the SPA/SSSI. Therefore, it is recommended that an HRA Screening assessment is carried out in relation to any proposed scheme. SNH should be involved throughout the Screening process and approached for any relevant data they may hold. Mitigation such as strict pollution prevention measures would have to be put in place during construction of the scheme to avoid such pollution events arising in the first instance.

5.2 Notable habitats

Woodland within 2 km of the study area includes large areas of coniferous and deciduous woodland to the east and west. Although these areas of broadleaved woodland are not notable, all broadleaved woodland has ecological value and there is a general presumption in planning policy against its removal without significant public benefit. Removal of any trees to facilitate the scheme should consequently be minimised.

Scheme-specific surveys will be required to determine the presence of protected or notable habitats. These surveys can only be conducted once the location and extent of the planned works has been identified.

5.3 Protected and notable species

5.3.1 Bird species

Greenland white-fronted goose, black grouse, hen-harriers, common crossbill, curlew and redshank have all been assessed as potentially using the study area. Further survey for these species may be required as part of any future Scheme.

5.3.2 Protected mammals

Red squirrel, pine marten, wildcat, bat species, badger, otter beaver and water vole are assessed as being potentially present within the study area and therefore posing a medium to high level constraint to a future scheme. Additional survey will be required to inform this and protected species licences may be necessary.

5.3.3 Great Crested Newt

Suitable habitat for great crested newt may be present within the study area and therefore further surveys may be required as part of any future scheme to confirm their presence/absence. It is recommended that survey be carried out on all watercourses 250m from any scheme elements.

5.3.4 Invasive Non-Native Species (INNS)

There is potential for any future scheme to impact the distribution of INNS and therefore further information should be gathered to identify the specific risks so that they can be mitigated.

5.3.5 Summary

A number of protected species including European Protected Species, those protected under the WCA and other notable species including those which are non-native with the potential to be invasive have been recorded within the search area or have the potential to be present.

Given the above, a full suite of protected species and habitat surveys, including for the survey of non-native species, will be required to inform future stages of the project. As noted previously, given the nature of the flood scheme options, protected and invasive species associated with watercourses are likely to be of particular relevance. The scope for future surveys should be informed by this report but refined based on the specific locations and design of any option taken forward and should take the form of a full Preliminary Ecological Appraisal, involving site survey, and/or an Ecological Impact Assessment (EcIA) in accordance with CIEEM guidance.

5.4 General recommendations

Detailed mitigation measures will be based on the results of the surveys recommended above and the final design of the proposed works. Local planning policy requires that all development must be designed with cognisance of minimising impact on biodiversity and the natural environment.

For information, other general measures are likely to include the following:

- SEPA guidance should be strictly adhered to (and this will likely be a requirement as part of the necessary Water Environment (Controlled Activities) (Scotland) Regulations 2011 ('CAR') licence applications). SEPA Pollution Prevention Guidelines (PPGs) and Guidelines for Pollution Prevention (GPPs, which have now replaced some PPGs) should be strictly adhered to.
- Undertaking scrub and vegetation clearance outside the breeding bird season (March to August, inclusive) to avoid illegal obstruction/destruction of bird nests.

Production of a Construction Environmental Management Document (CEMD) and Construction Method Statements will be required (CMS, produced by the contractor and agreed with the relevant authority in advance of construction). This will detail site specific environmental effects, mitigation measures, timescales and responsibilities.

5.5 Enhancement

National planning policy outlines that the planning system should seek biodiversity benefits from new development where possible. Any future Scheme could incorporate a number of ecological enhancement measures and this concept should be built-in from an early stage and refined as the scheme progresses. Suggestions for potential enhancement measure are outlined below:

- The burns within the study area may have a number of modifications such as culverts which may affect the presence of protected and notable species. Removing obstacles to migration (for both

fish and mammals such as otter) and improving the immediate riparian habitat to improve connectivity could constitute significant ecological enhancement as part of the scheme.

- Vegetation planting upstream to attenuate and store water flow before it reaches the flood risk area could increase ecologically valuable habitat and could constitute significant ecological enhancement. Areas of proposed planting would have to be carefully selected to ensure a net gain in biodiversity is achieved, and that the natural function of ecologically valuable habitats is maintained (including land which may be functional to specially protected sites as noted above).
- If non-native species are found to be present these will need to be managed, most likely through the production of an Invasive Species Biosecurity Management Plan (BMP). If such plans are required these would constitute an ecological benefit in themselves by cataloguing the species present and avoiding the further spread of such species. There is potential to widen the ecological benefit of such plans by increasing their scope to the entire catchment(s) (which in this area is not particularly large). A catchment-wide approach will have far-reaching ecological benefit and may help to address the risk of invasive-non-native species spreading back into the scheme area in the future.

6. Planning and Environmental Constraints

A high level desk study of any potential planning and environmental constraints was carried out. This was to inform the optioneering process by highlighting any areas of significance but also to potentially identify opportunities.

6.1 Environmental constraints

The desk study has highlighted several key environmental aspects that could impact of the proposed options and should be considered when screening the long list of options. See **Figure 1 and 2, Appendix A** for the extents and location of these. The main constraints and opportunities to consider include:

- Conservation Area – much of Lochgilphead is within a Conservation Area. The area extends up Argyll Street and along the Front Green. This designation is assigned in order to protect the setting of the village around the Front Green. Any future Scheme within this area "must seek to preserve or enhance the character of the area" (ABC [3]).
- Scheduled Monuments – The Crinan Canal, Loch a'Bharain canal feeder is designated as a scheduled monument and is located just out with the study area.
- Woodland – areas of long established and ancient (semi natural) woodland have been identified around Lochgilphead. Ideally any options would look to avoid these areas.
- Listed Buildings – there are a number of Grade B and C listed buildings in Lochgilphead. The flood study is aiming to reduce flood risk to these properties however works that directly impact these buildings should be avoided.

6.2 Planning constraints

Several key planning constraints have been highlighted, that should be taken into account when screening the proposed long list of options; see **Figure 2, Appendix A**. The Local Development Plan for Argyll and Bute Council [4] was consulted and the main planning constraints and opportunities are summarised below:

- Open Space Protected Areas – These areas are set aside and are not to be developed. These include the Front Green, playing field at Dewar Avenue and the bowling green.
- Area for action – "areas which, subject to resource availability during the plan-period, will be the focus for partnership or community action. Area remits for these AFAs are being worked up in the Supplementary Information and Guidance report; these area remits may include investment and funding packages, land assembly and asset management programmes, development and redevelopment proposals, infrastructure provision and environmental enhancement proposals. Depending on circumstances, AFAs may coincide with other categories of sites such as potential development areas." For Lochgilphead the areas for actions are shown as:
  - AFA 12/1 Lochgilphead Town Centre/Waterfront – environmental enhancements and flood prevention
- Potential Development Area – these are sites that have been identified as having potential to be developed for specified uses and those listed for Lochgilphead are outlined in Table 6-1 below
- The Lochgilphead Regeneration Project is currently undertaking a regeneration exercise within the Front Green. This proposal involves play park improvements, landscaping and creation of improved communal areas. It is worth noting that this has the potential to be a constraint within the area if a scheme is identified.

[3] https://www.argyll-bute.gov.uk/conservation-areas Accessed 04.09.2019
[4] Argyll and Bute Local Development Plan Written Statement, (Adopted March 2015). https://www.argyll-bute.gov.uk/sites/default/files/written_statement_0.pdf Accessed 04.09.2019

Table 6-1 Lochgilphead potential development areas

LDP Code	Site	Type
PDA 12/23	Cairnbaan – south of lock 5	N/A
PDA3009	Baddens	N/A
PDA 12/3	County yard	Mixed
PDA3008	Lochgilphead Hospital	N/A
PDA3013	Clock Lodge	N/A

Source: Argyll and Bute Local Development Plan

- Allocated Sites – sites within Lochgilphead which have been allocated for housing and business are outlined in Table 6-2 below.

Table 6-2 Lochgilphead development allocations

LDP Code	Site	No. Houses	Area (Ha)
BI-AL 12/2	Achnabreck		4.29
H3005	Moneydrain Road	44	
H3002	Fernoch Farm	60	
H-AL 12/1	Fernoch Crescent	8	
H3006	High School	160	

Source: Argyll and Bute Local Development Plan

- Town Centre – Lochgilphead town centre is listed as a Main Town Centre within the LDP.

7. Baseline Damages Impact Assessment

7.1 Introduction

Flooding can have economic, social and environmental impacts. The aim of this section is to set out the results of the baseline impact assessment. The full results and methods are presented in the technical report in **Appendix C**.

7.2 Methods

The assessment process used here follows the Scottish Government guidance[5] and, as such, will be compatible with the aims of the Flood Risk Management (Scotland) 2009 Act. Whilst the Scottish Government guidance covers the main principles of the assessment set out below, the Multi-Coloured Manual (MCM)[6] and Multi-Coloured Handbook (MCH)[7] cover the detailed procedure and standard data used for the assessment.

The baseline damage assessment is based on a "do minimum" scenario, however no current maintenance costs have been included at this stage. This allows for the benefits of "doing something" to be assessed at a later stage. Damages were estimated using the flood extents and depths from the hydraulic model. **Table 7-1** sets out the approach used for each component. A more detailed description of the proposed approach taken for selected receptors is included within the technical report.

Table 7-1 - Summary of economic damage assessment components

Receptor	Damage assessment approach
Economic impacts	
Residential properties	Included. Properties classified by type, age and regional social grading
Non-residential properties	Included. Properties classified by MCM code.
Vehicles	Included. Based on number of properties at risk (detailed information on number of vehicles within the study area is not readily available).
Evacuation	Included. Evacuation costs based on property type and flood depth (detailed local data is not readily available)
Distributional impacts (DIA)	Included. Based on 2011 census data for Lochgilphead
Indirect impacts on non-residential properties	Applied as basic 3% uplift to direct damages
Local authority, emergency and recovery costs	Included. Uplift factor from MCM data.
Infrastructure	
Electricity and gas	Described
Water and waste water	Described
Telecommunications	n/a – no vulnerable infrastructure present within study area
Schools	Described
Hospitals	n/a – no infrastructure present within study area
Transport	
Road disruption	Described
Rail disruption	n/a – no infrastructure present within study area

[5] Scottish Government, 2016. Options appraisal for flood risk management: Guidance to support SEPA and the responsible authorities. Edinburgh: Scottish Government.
[6] Penning-Rowsell et al. (2013). Flood and Coastal Erosion Risk Management. A Manual for Economic Appraisal. Oxon: Routledge.
[7] Penning-Rowsell et al. (2017). Flood and Coastal Erosion Risk Management. A Handbook for Economic Appraisal. [Online] London: Middlesex University

Receptor	Damage assessment approach
Agriculture	n/a – not the focus of this study
Social impacts	
Risk to life	Quantified based on flood hazard, number of properties and likelihood
Health	Monetised based on standard of protection provided
Social vulnerability	Described
Recreation, community and way of life	Described
Environmental impacts	
Water environment	Described
Biodiversity, flora and fauna	Described
Air and soil	Described
Climatic factors	Described
Landscape	Described
Cultural heritage	Described

7.3 Results

The number of properties affected by flooding during a 'do nothing' scenario in the study area are shown in **Table 7-2** and **Table 7-3**. The effect of climate change for coastal and fluvial flooding are incorporated into the assessment differently, full details can be found in the technical report in **Appendix C**. The corresponding damages are shown in **Table 7-4** and **Table 7-5**. These results do not include the impact of capping or write-offs, as those factors only get taken into account when damages are discounted over the appraisal period.

Table 7-2 - Number of properties affected by coastal flooding in the study area

			Return period (years)							
Scenario	**Property Type**	2	5	10	20	50	100	200	1000
Present Day	Residential	0	19	29	35	48	52	60	92
	Non-Residential (NRP)	0	2	4	6	9	13	23	51
Climate Change	Residential	45	52	53	66	88	93	99	148
	Non-Residential (NRP)	7	13	19	33	50	56	66	97
Total no. of properties affected by flooding (incl CC)		52	65	72	99	138	149	165	245

* Damages for residential properties start to be accrued when the water is within 300mm of the floor level as water enters the sub-floor area.

Table 7-3 - Number of properties affected by fluvial flooding in the study area

		Return period (years)							
Scenario	**Property Type**	**2**	**5**	**10**	**20**	**50**	**100**	**200**	**1000**
Present Day	Residential	0	0	0	0	11	22	29	61
	Non-Residential (NRP)	0	0	0	0	0	2	6	23
Total no. of properties affected by flooding		0	0	0	0	11	24	35	84

* Damages for residential properties start to be accrued when the water is within 300mm of the floor level as water enters the sub-floor area.

** climate change counts are not listed separately for fluvial simulations due to the difference in approach. See Economics report in Appendix C.

Table 7-4 - Baseline monetised coastal flood damages by present day return period (i.e. excl. CC)

		Return period (years)							
Category		**2**	**5**	**10**	**20**	**50**	**100**	**200**	**1000**
Residential	Direct	£0	£21,467	£58,341	£134,791	£442,971	£585,646	£802,723	£1,777,658
	Vehicles	£0	£5,739	£28,694	£54,518	£117,644	£123,382	£149,207	£229,549
	Indirect	£0	£5,248	£18,656	£48,361	£106,768	£141,639	£173,292	£305,575
	DIA	£0	£3,897	£10,590	£24,467	£80,406	£106,304	£145,706	£322,672
	Subtotal	**£0**	**£36,351**	**£116,281**	**£262,136**	**£747,789**	**£956,972**	**£1,270,927**	**£2,635,454**
NRP	Direct	£1,169	£13,264	£87,717	£164,971	£444,330	£665,918	£1,036,025	£2,667,073
	Indirect	£35	£398	£2,632	£4,949	£13,330	£19,978	£31,081	£80,012
	Subtotal	**£1,205**	**£13,662**	**£90,349**	**£169,920**	**£457,660**	**£685,895**	**£1,067,106**	**£2,747,085**
Other	Emergency	£125	£3,716	£15,628	£32,075	£94,941	£133,917	£196,746	£475,586
	Health	£0	£3,026	£12,103	£22,188	£42,360	£44,377	£52,445	£82,702
	Subtotal	**£125**	**£6,742**	**£27,731**	**£54,263**	**£137,301**	**£178,294**	**£249,191**	**£558,288**
Total		**£1,330**	**£56,754**	**£234,360**	**£486,319**	**£1,342,749**	**£1,821,161**	**£2,587,224**	**£5,940,828**

Table 7-5 - Baseline monetised fluvial flood damages by present day return period (i.e. excl. CC)

		Return period (years)							
Category		**2**	**5**	**10**	**20**	**50**	**100**	**200**	**1000**
Residential	Direct	£0	£0	£0	£0	£16,891	£50,469	£105,526	£1,084,824
	Vehicles	£0	£0	£0	£0	£2,882	£5,764	£25,939	£109,518
	Indirect	£0	£0	£0	£0	£832	£5,592	£19,968	£124,955
	DIA	£0	£0	£0	£0	£3,066	£9,161	£19,155	£196,912
	Subtotal	**£0**	**£0**	**£0**	**£0**	**£23,671**	**£70,986**	**£170,588**	**£1,516,210**
NRP	Direct	£0	£0	£0	£0	£1,861	£20,259	£207,970	£1,781,375
	Indirect	£0	£0	£0	£0	£56	£608	£6,239	£53,441
	Subtotal	**£0**	**£0**	**£0**	**£0**	**£1,917**	**£20,867**	**£214,209**	**£1,834,817**
Other	Emergency	£0	£0	£0	£0	£2,006	£7,568	£33,544	£306,683
	Health	£0	£0	£0	£0	£1,013	£6,078	£12,156	£43,560
	Subtotal	**£0**	**£0**	**£0**	**£0**	**£3,020**	**£13,646**	**£45,700**	**£350,243**
Total		**£0**	**£0**	**£0**	**£0**	**£28,607**	**£105,499**	**£430,497**	**£3,701,271**

Average Annual Damage (AAD) is the expected value of damages within a typical year: ∑*Damages x Probability.* AAD is shown below calculated from current value damages and probability; and for future probability for the climate change horizons. Due to the frequency of flooding, one property was considered to be written off (and were not included in the AAD total). The increased frequency of flooding with climate change means that the ADD does not increase linearly. **Table 7-6** shows the AAD for the assessed climate change scenarios.

Table 7-6 - Baseline average annual damages

		Average Annual Damage- Coastal		Average Annual Damage- Fluvial	
Category		**Current**	**Climate Change**	**Current**	**Climate Change**
Residential	Direct	£36,379	£67,356	£4,568	£20,354
	Vehicles	£10,119	£7,549	£546	£2,319
	Indirect	£9,294	£7,319	£536	£2,401
	DIA	£6,603	£86,048	£829	£3,695
	Subtotal	**£62,396**	**£168,273**	**£6,480**	**£28,768**
NRP	Direct	£37,336	£172,186	£6,666	£31,102
	Indirect	£1,120	£5,166	£200	£933
	Subtotal	**£38,456**	**£177,351**	**£6,866**	**£32,035**
Other	Emergency	£7,888	£25,631	£1,202	£5,506
	Health	£4,064	£2,786	£251	£1,029
	Subtotal	**£11,952**	**£28,417**	£1,453	£6,534
Total		**£112,804**	**£374,042**	**£14,799**	**£67,337**

Present Value Damage (PVD) represents the damages expected to be accumulated over the appraisal period (100 years). The total damages accrued are also “discounted” to a Present Value (see the full report in **Appendix C**). PVD is derived from the sum of all probability damages accrued, capped and discounted: ∑ (Damages x Probability) capped x discount rate. Where required, properties were written off in the year that the flood frequency is expected to exceed once every three years, with a discount factor applied where necessary. Table 7-7 the present value damage per type for Lochgilphead and Table 7-8 shows a summary of these results.

Table 7-7: Baseline present value damages

Category		PVD- Coastal	PVD CC- Coastal	PVD- Fluvial	PVD CC- Fluvial
Residential	Direct	£852,956	£1,587,752	£136,187	£702,753
	Vehicles	£66,424	£95,406	£16,282	£40,803
	Indirect	£60,666	£89,458	£15,992	£51,151
	DIA	£78,588	£211,965	£24,720	£98,972
	Subtotal	£1,058,635	£1,984,581	£193,181	£893,679
NRP	Direct	£657,255	£1,414,664	£190,463	£895,067
	Indirect	£17,146	£39,697	£5,714	£14,209
	Subtotal	£674,401	£1,454,361	£196,177	£909,276
Other	Emergency	£161,593	£342,261	£34,952	£168,393
	Health	£24,355	£35,081	£7,490	£18,410
	Subtotal	£185,947	£377,342	£42,441	£186,803
Total		£1,918,983	£3,816,284	£431,799	£1,989,759

Table 7-8: Summary of PVD

Totals	Total PVD	Total PVD (CC)
Coastal	£1.92M	£3.82M
Fluvial	£432K	£1.99M
Lochgilphead Combined	£2.35M	£5.81M

The study area was split into ‘flood cells’ – areas which flood from the same location(s) and which could potentially be protected independently. This allows for further investigations to focus on those areas which are most affected. A plan showing the location of the flood cells is included in Figure 7-1. **Table 7-9** shows the present value damage (PVD) for each flood cell.

Table 7-9 - Baseline combined present value damages by cell

Flood cell	Residential	Non-residential	All Non-Property	Total	Proportion of total	Main flood mechanism
1	£1,813,004	£1,461,232	£880,252	£4,154,488	71.55%	Coastal
2	£26,948	£639,150	£89,109	£755,207	13.01%	Fluvial
3	£24,691	£11,253	£14,244	£50,188	0.86%	Mixed
4	£179,007	£2,183	£85,493	£266,683	4.59%	Mixed
5	£246,856	£195,913	£136,707	£579,476	9.98%	Fluvial
Total	**£2,290,506**	**£2,309,731**	**£1,205,806**	**£5,806,043**	100.00%	

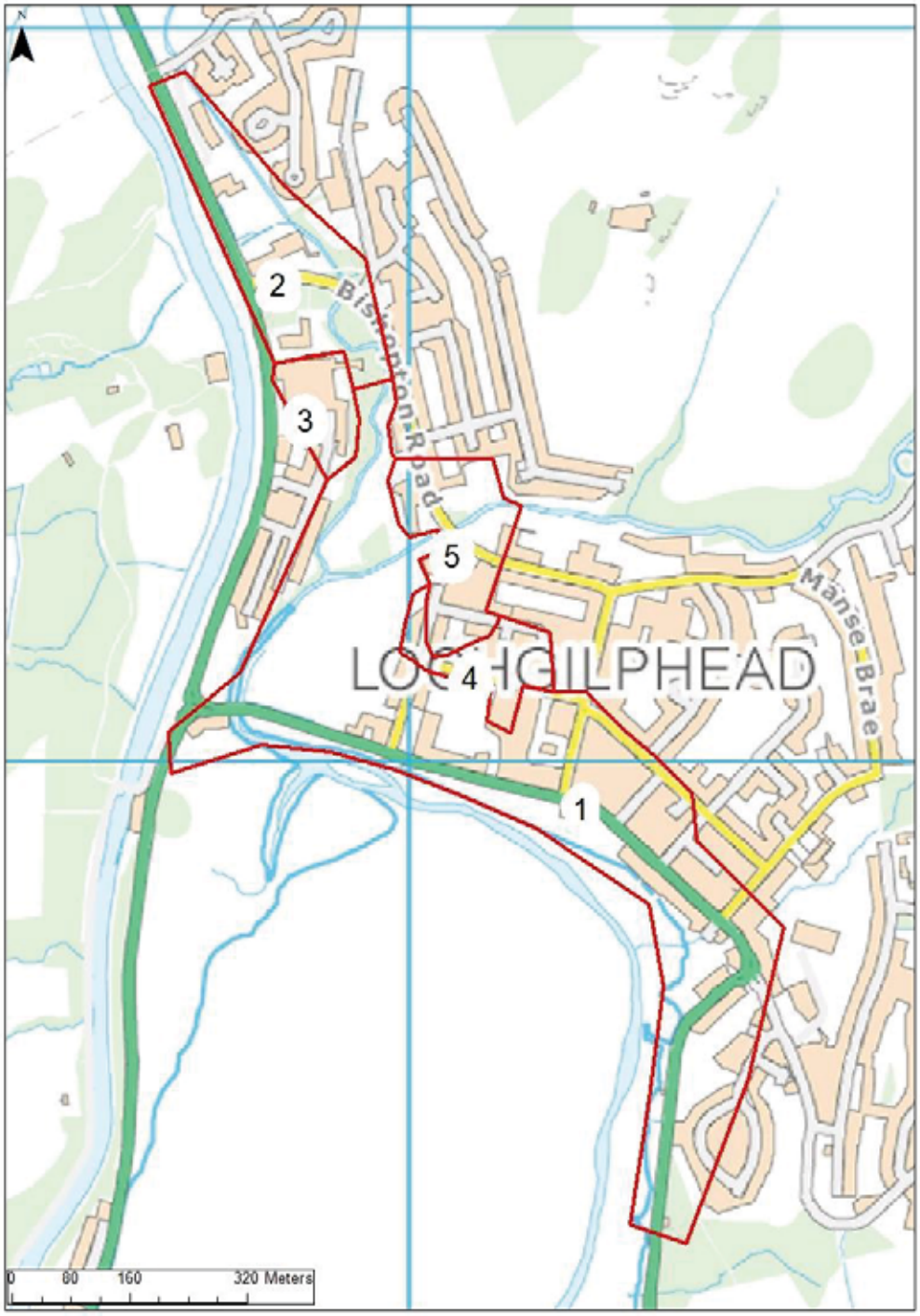


Figure 7-1: Lochgilphead flood cells

The flooding impacts assessed in this report are broadly in line with the impacts experienced during historical flood events; the greatest impacts are located in those areas that have flooded most frequently in recent years. Key non-monetised impacts include flooding of roads and associated disruption, risk to life, damage to key community assets and pollution of watercourses. The frequency of such an events are expected to increase as a result of climate change.

The non-monetised impacts should also be taken into account as part of any appraisals and decision-making. Many properties within the Lochgilphead Conservation Area are at risk of flooding.

7.4 Sensitivity analysis

Uncertainty is an inherent quality in economic damages assessments, given the process involves layering together different datasets with their own individual uncertainties and simplifying assumptions

across areas. MCM guidance recommends the use of sensitivity analysis to be aware of these uncertainties. The chosen method is in line with best practise and industry standard approaches which aim to provide a managed, efficient and conservative method to economic damages assessment.

The sensitivity analyses have shown there to be some uncertainty in flood damages, particularly the reliance on the modelling results and the climate change scenario, there is therefore a degree uncertainty in flood depths for this study. This is typical of a study of this kind.

The damages presented here are based on a best estimate of each of the variables; however, the potential for variation in the total damages (both positive and negative) needs to be borne in mind in any decision-making.

Full details of the sensitivity assessment can be found in the Baseline economic report in Appendix C.

8. Consultation events

8.1 Public information Gathering Event

A canvassing event was undertaken on the 7th of July 2018 to further verify the baseline model results and establish any additional flood history. Flood history from the information gathering event included:

- High sea levels reach the Front Green yearly, with still water levels reaching Poltalloch Street every 1-2 years;
- Recollections of tidal flooding coming up Union Street and also around the Fyneside petrol station;
- Houses along Poltalloch Street regularly have sand bags out;
- The A816 is frequently flooded from the Badden Burn and is closed approximately once every 1-2 years.

8.2 Stakeholder workshop

A workshop was undertaken on the 5th of July 2019 to gather information and concerns from the key stakeholders in relation to the long list of options. This would help to inform the short listing process. Comments received during this event are as follows:

- Generally agreed that set back defences on the Front Green would be more problematic from a visual and amenity perspective;
- Concerns over how the Front Green redevelopment will tie in with any flood protection measures;
- Flooding shown and described in the Phase 2 report was said to seem reasonable and tied in with previous events;
- Flood mitigation options should not increase flood risk elsewhere;
- A managed adaptive approach should be taken including consideration of delaying investment and setting out how an option may change in the future;
- Supportive of natural methods that could also have biodiversity improvements.

9. Scoring the Long List

To quantify the reasoning behind selection of the short list from the long list, a high-level scoring system was developed. This considered stakeholder views and expert judgement on feasibility of technical, legal, financial and environmental aspects of the proposals. **Section 4** sets out the criteria used for screening out unfeasible or unrealistic options. Expert judgement was involved in making these decisions, which involved elements of subjectivity. However, by consulting main stakeholders and being transparent in our approach, we have been able to appraise each measure fairly.

Each criterion, of which there were 4, was scored out of 5, with 5 being the highest available score and 1 being the lowest. The total available score is 20. A score of 5 was given to options that categorically had no obstacles whereas a score of 1 was given to options that had many obstacles already apparent that are thought to be substantially prohibitive. Where there were no real positives or negatives against an option, or a neutral effect was anticipated, it has been given a score of 3.

For example, if an option is clearly technically feasible it would score 5, and if legally there was no known obstacles such as land ownership it would also score a 5. If the option was going to be extremely costly and the expert's opinion was the impact on flood risk would be limited, the score for cost would be 1. Finally, if the option had a neutral impact on environmental factors it would score 3 giving a total score of 14, which could then be ranked against other options.

Figure 9-1 and Figure 9-2 displays the locations of the long list options.

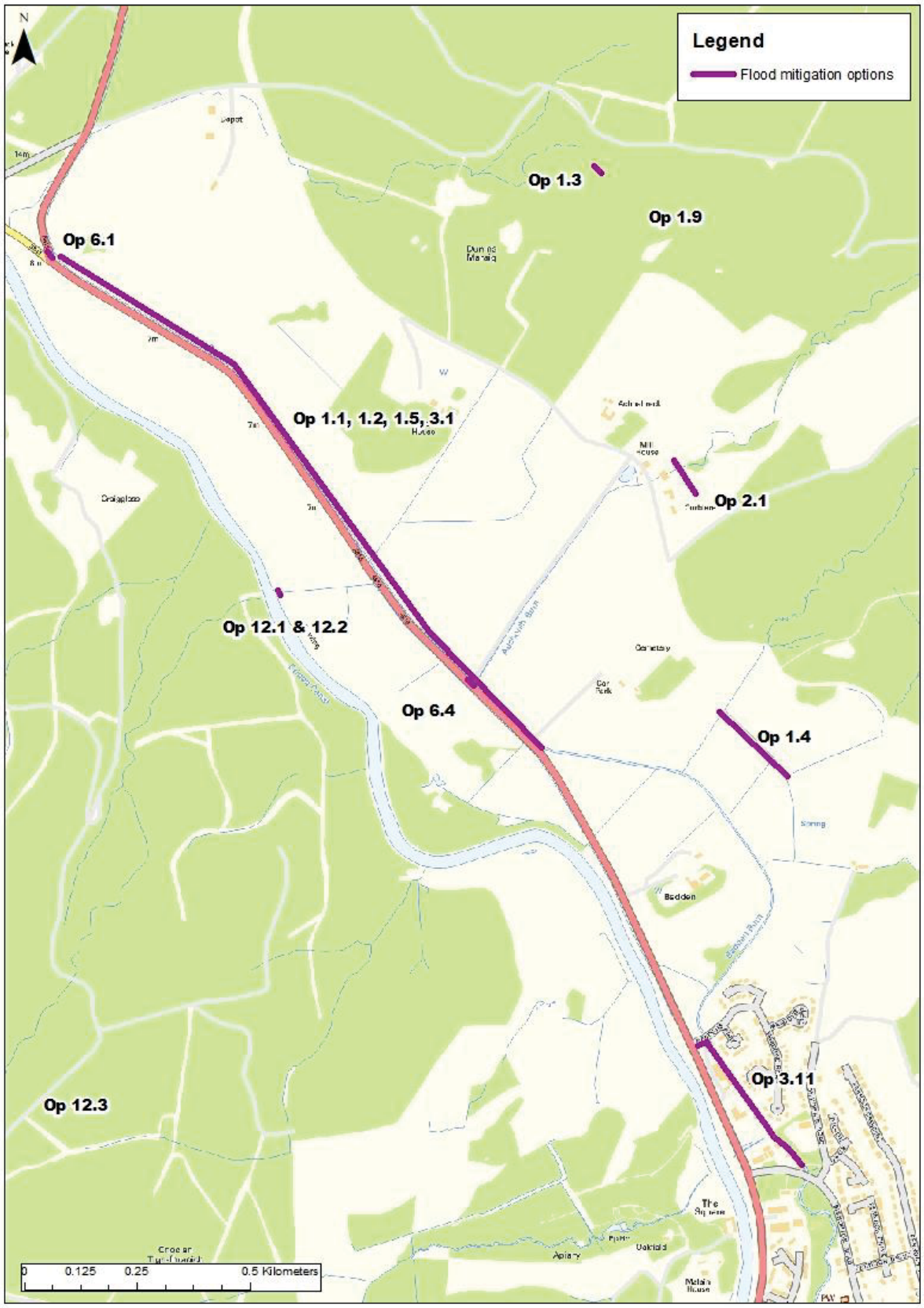


Figure 9-1: Long list option locations

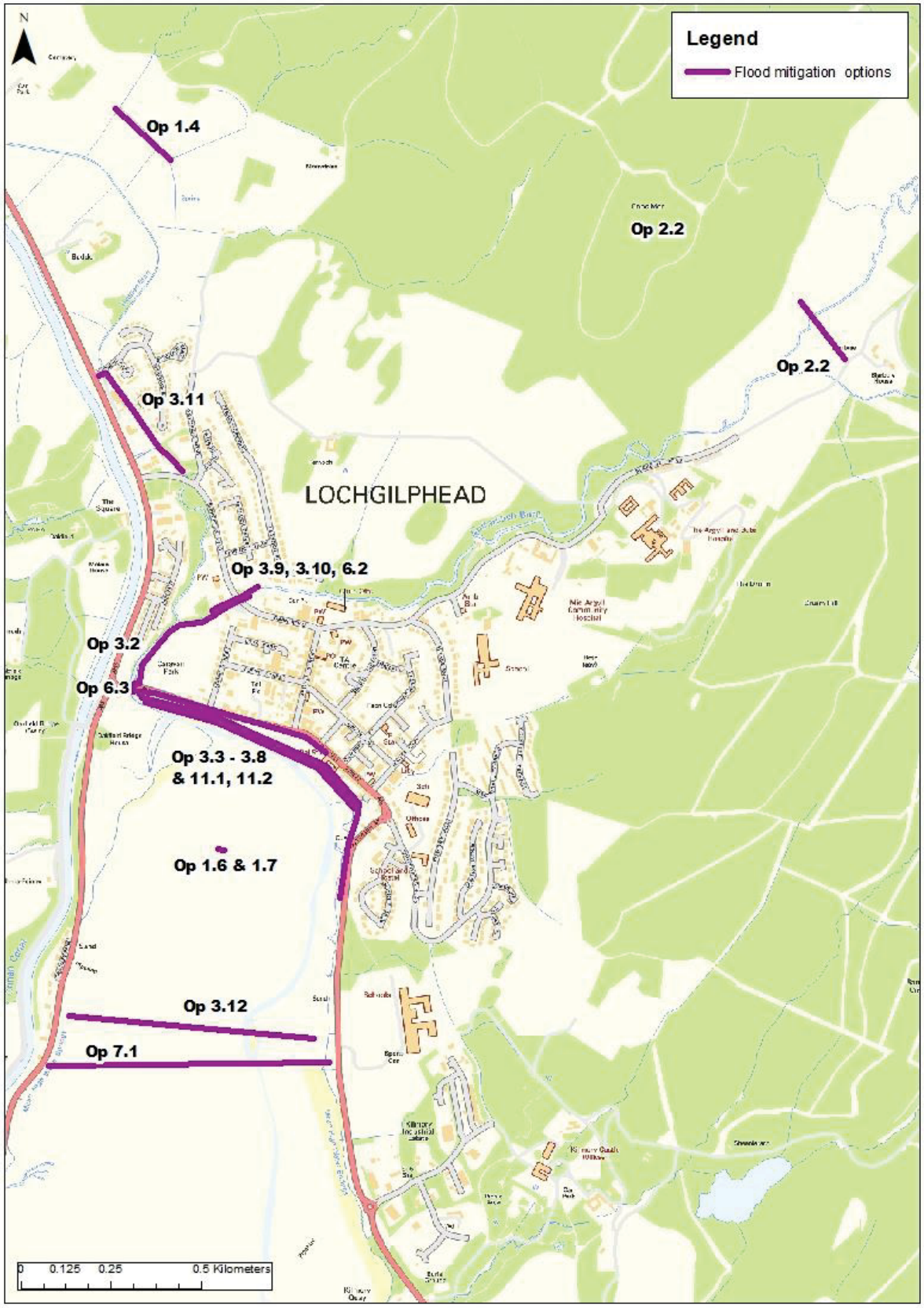


Figure 9-2: Long list option locations

The scoring of the options is set out in Table 9-1 along with the key decision points raised by ABC, Scottish Canals, SEPA, ERZ and the public noted. For options to be taken forward, a score of 12 of more was deemed to be an appropriate cut off. This meant that options, in general, would achieve a 3 or more per criteria and therefore have an above average score. Options with a score of 12 or more were taken forward to the short list for more detailed assessment and appraisal during Phase 4. A summary table has also been provided (Table 10-1). Options highlighted in green in this table have been taken forward whilst those in red have been discounted and discussed in **Section 10.1.**

Table 9-1 Long list screening & scoring

Category	Measure	ID	Flood receptor (location)	Feasibility – Technical	Feasibility - Legal	Feasibility - Cost	Feasibility – Environmental	Total Score
NFM Options	Fluvial measure - Re-meandering of the Badden Burn away from the A816 between Cairnbaan and The Meadows to improve channel sinuosity and habitats	1.1	This measure aims to address flooding on the A816 and potentially within Lochgilphead.	• Feasible • Topography is relatively flat in and around the burn – could be moved • Unlikely to have significant effects at larger events • Open areas around the watercourse do not appear to be utilised • May take a while to establish and realise benefits • Potentially problematic to quantify effect • Few properties affected by fluvial flooding -Road authority could benefit from this so should be passed on as recommendation for them to consider. • Currently canalised and SEPA have noted that the Roy Maps show a more sinuous channel but that it may be difficult to implement • Limited impact on reducing downstream urban flooding 2	• Potential for land owner issues – perhaps multiple • Land take / compensation required 2	• Could be relatively inexpensive compared to engineered options • Land take / compensation costs • Long term maintenance likely to be relatively low • Limited return for NFM options as damages offset locally are low and limited positive knock on effect for LGH centre. • Other sources of funding may be available such as Water Environment fund. 3	• Habitat improvement • Watercourse functioning improvements • Sediment transport could be improved and made more natural 4	11
	Fluvial measure - Provision of a 2-stage channel in the current burn alignment (re-shaping existing channel) to improve habitats and improve capacity/ flood mechanisms.	1.2	This measure aims to address flooding on the A816 and potentially within Lochgilphead.	• Feasible • Good access for works • Unlikely to have significant effects at larger events • Open areas around the watercourse do not appear to be utilised • May take a while to establish and realise benefits • Increasing channel capacity can cause issues further downstream and would have to be investigated thoroughly • Few properties affected by fluvial flooding • Good access • Currently canalised and SEPA have noted that the Roy Maps show a more sinuous channel but that it may be difficult to implement • Burn in close proximity to existing road structure • Limited impact on reducing downstream urban flooding 2	• Potential for land owner issues – perhaps multiple • Land take / compensation likely to be very minimal 2	• Could be relatively inexpensive compared to engineered options • Land take / compensation costs likely to be low • Long term maintenance likely to be relatively low • Significant length of Burn to access and re-shape – costs could creep up • Other sources of funding may be available such as the Water Environment fund. 3	• Habitat improvement • Watercourse functioning improvements • Sediment transport could be improved and made more natural 4	11
	Fluvial measure - Tree planting in the upper catchment to reduce surface water run off – increase lag in catchment	1.3	This measure aims to address flooding on the A816 and within Lochgilphead.	• Unlikely to be feasible due to large area required to be planted for meaningful effect - Catchment already heavily planted so limited benefit • Unlikely to have significant effects at larger events • Few properties affected by fluvial flooding at low return periods • Reduced run off from planting takes years to realise. 1	• Potential for significant landowner issues • Land take/ compensation required • Change of existing land use 1	• Significant land take/ compensation costs • Costs likely to be significant due to extensive area required limiting likelihood of positive cost benefit ratio 2	• Potential to improve habitats – may depend on species of tree • Large portion of the catchment already planted which limits environmental benefit of additional planting • Preferable to plant slower growing species so deforestation isn't an issue – this extends the timeframes of benefits 3	7
	Fluvial measure - Wetland creation and ditch blocking. Reduce risk of	1.4	This measure aims to address flooding on the A816 and within Lochgilphead.	• Feasible • Land is relatively flat and wetland creation could be achieved with small interventions • Increasing back up effects in meadows	• Storage without reservoir implications • Potential for significant landowner issues • Land take/ compensation required	• Relatively inexpensive when compared to engineering solutions • Land purchase /compensation required • long term maintenance requirements are	• Opportunity to create wetland habitats to improve biodiversity • Highly unlikely to have a negative impact as enhancing current land condition	11

Category	Measure	ID	Flood receptor (location)	Feasibility – Technical	Feasibility - Legal	Feasibility - Cost	Feasibility – Environmental	Total Score
	blockage and provide small scale attenuation in areas upstream of the Meadows			due to climate change sea level rise may limit wetland effectiveness • Few properties affected by fluvial flooding • Attenuation is limited without engineering solutions • May take a certain amount of time to realise benefits whilst wetland is establishing • Limited attenuation provision • Unlikely to provide significant flood risk reduction at higher events – without more formalised storage depth of water is limited, reducing benefits. • Limited impact on reducing downstream urban flooding 2	2	relatively minimal once established 3	4	
	Fluvial measure - In channel improvements on the Badden Burn to aid in sediment transport reduction. This could include dredging or installation of features to encourage pools and riffles	1.5	This measure aims to reduce issues caused by sediment such as blockage which aims to address flooding on the A816 and within Lochgilphead	• Feasible • Small scale and unlikely to significantly alter flooding – especially at higher events • Few properties affected by fluvial flooding at low return periods • Good access • If sediment is shown to be an issue, frequent maintenance may be required. ABC will likely carry out some maintenance (dredging) as required in future along the length of the A816 – this could be modelled to show it is necessary and if it affects flood risk. • Vegetation growth rather than sedimentation is main issue so positive impact is limited • SEPA highlighted aspects such as dredging would require modelling to demonstrate the benefits on flood risk • Limited impact on reducing downstream urban flooding 1	• Minimal land owner concerns as works would be in channel • Unlikely to be compensation requirements • Potential access issues / permissions whilst work is being undertaken 4	• Relatively inexpensive when compared to engineering solutions • Small land take costs, if any • Maintenance would be minimal • Unlikely to have enough positive impact to be cost beneficial 3	• Opportunity to improve channel habitats – creation of pools and riffles etc • Very unlikely to have negative impacts • Returning to a more natural transport regime could negatively affect some species 3	11
	Coastal measure - Intertidal recharge to provide wave dissipation	1.6	This measure aims to dissipate wave energy and therefore reduce flooding from wave overtopping around the front green and southern sections of Lochgilphead.	• Feasible • May take time to establish and realise any benefits • A large intertidal area already exists to the south of Lochgilphead and beach depletion is not known to be an issue – likely minimal impact • Limited benefit against extreme water levels • Wave heights not shown to be significant • Material deposition by sea barge in intertidal area may be impractical 1	• Potential land owner issues – likely only 1 • Crown Estates ownership of sea bed to 12 nautical miles to be aware of 2	• Material costs likely to be relatively low – although will vary depending on type of transport • Likely relatively low ongoing maintenance - added uncertainty as replenishment requirements are dictated by natural processes 3	• Could provide more connectivity with the sea • May impact habitats in the intertidal area – this could be positive or negative depending on design • Ecological constraint – changing conditions for species identified • Rich area of ecology, shell collection is a common activity here so this should be protected • Change in character of intertidal area 3	9
	Coastal measure - Saltmarsh/managed realignment to provide wave dissipation	1.7	This measure aims to dissipate wave energy and therefore reduce flooding from wave overtopping around the front green and southern sections of Lochgilphead.	• Feasible but difficult to implement as some properties close to existing wave return wall and the burn channel • May take time to establish and realise any benefits • Existing extensive areas of marsh, intertidal area – likely limited impact • Limited benefit against extreme water	• Potential land owner issues – likely only 1 • Crown Estates ownership of sea bed to 12 nautical miles to be aware of	• Material costs likely to be relatively low – although will vary depending on transport type • Likely relatively low ongoing maintenance - added uncertainty as management requirements dictated by natural processes	• Could provide more connectivity with the sea • May impact habitats in the intertidal area – this could be positive or negative depending on design • Ecological constraint – changing conditions for species identified • Change in character of intertidal area	8

Category	Measure	ID	Flood receptor (location)	Feasibility – Technical	Feasibility - Legal	Feasibility - Cost	Feasibility – Environmental	Total Score
				levels • Wave heights not shown to be significant • Material deposition by sea barge in intertidal area may be impractical 1	2	3	2	
	Fluvial measure - Tree planting in the upper catchment and ditch blocking to reduce surface water run off – increase lag in catchment	1.8	This measure aims to reduce runoff into the Cularstich Burn to reduce flooding and increase capacity for flood flows in the Badden Burn within Lochgilphead centre.	• Feasible but unlikely to have a significant impact due to the heavily forested nature of the existing catchment • Limited opportunities to plant further so likely minimal impact. • No real space for meaningful wetland area to provide suitable storage due to tree coverage • Reduced run off from planting could take decades to fully realise 1	• Highly likely to have multiple landowners to deal with • May impact commercial forestry and farming practices 2	• Low cost but also likely to have very limited impact • May be contrary to grants in place • Potential to speak to commercial forestry manager to see if any further improvements could be made 2	• Potential to improve habitats – may depend on species of tree • Large portion of the catchment already planted which limits environmental benefit of additional planting • Water quality, air quality, carbon storage benefits but will be small given limited area available for planting 4	9
	Fluvial measure - forestry management including elements such as efficient tree planting, appropriate drainage and tree spacing as well as consideration of appropriate tree felling etc	1.9	This measure aims to address flooding on the A816 and potentially within Lochgilphead.	• Feasible but may be problematic to quantify • Unlikely to have a significant impact at higher return periods • Managed forests should already be following good management practices which again would limit effects. • Small benefits could be realised • Reduced runoff from planting could take decades to fully realise 2	• Highly likely to have multiple landowners to deal with • May impact commercial forestry and farming practices 2	• Low cost but also likely to have very limited impact • Ongoing maintenance to ensure correct functioning 2	• Could improve surface water runoff and reduce soil loss • Potential to somewhat improve habitats if forestry management was improved 3	9
Upstream storage	Fluvial measure - Storage provision on the Auchoish burn	2.1	This measure aims to reduce overall flows into the Badden Burn from the Auchoish Burn.	• Feasible • Appreciable engineering required to provide dam/ storage structure • Limited availability of suitable locations • Close proximity to housing downstream • Relatively straightforward access • Sufficient space in valley • Relatively small number of properties would be protected • Already significant storage in Meadows area • Long term maintenance and reservoir inspections to consider 2	• Land ownership and access permission issues • Maintenance on private land or land purchase • May fall under the Reservoirs Act – having multiple dams rather than one large dam could avoid this • Access via private land • Compensation requirements • Potential increase in risk to properties requiring further protection 2	• Significant construction costs • Temporary and permanent access • Land take costs; potentially multiple owners which can increase costs • Considerable length of dam required • Maintenance costs associated with the outfall structures 2	• Potential to disrupt habitats in the immediate area • Could impact on sediment transport – this would have to be fully investigated • Large embankment may change the feel of the area • Environmental improvements could be built into the design – creating new habitats/planting etc • Impact on sediment and fish migration would need to be assessed if any in channel structure was proposed 2	8
	Fluvial measure - Storage provision on the Cularstich burn	2.2	This measure aims to reduce overall flows into the Badden Burn from the Cularstich burn	• Feasible but likely to highly challenging • Less flood risk contribution from this Burn therefore would likely be cost and effort prohibitive • Would not solve main issues on Badden Burn • Limited suitable areas in catchment due to heavy forest cover. Only suitable space is on left hand bank of Burn upstream of golf course in land adjacent to Blarbuie House - this is fairly limited in terms of area. • Significant impoundment structure would be needed to tie in with topography (150m	• Land ownership and access permission issues • Maintenance on private land or land purchase • May fall under the Reservoirs Act – having multiple dams rather than one large dam could avoid this • Access via private land • Compensation requirements • Likely single landowner • Land looks to be actively farmed given ditching in place	• Significant construction costs which would be highly unlikely to offset damages • Temporary and permanent access • Land take costs; • Considerable length of dam required • Maintenance costs associated with the outfall structures	• Potential to disrupt habitats in the immediate area • Could impact on sediment transport – this would have to be fully investigated • Large embankment may change the feel of the area • Environmental improvements could be built into the design – creating new habitats/planting etc • Impact on sediment and fish migration would need to be assessed if any in channel structure was proposed.	7

Category	Measure	ID	Flood receptor (location)	Feasibility – Technical	Feasibility - Legal	Feasibility - Cost	Feasibility – Environmental	Total Score
				long and 4m high) • Numerous pylons in vicinity would be challenging to construct around • Long term maintenance and reservoir inspections to consider 1	2	2	2	
Direct Defences	Fluvial measure - Raising the A816 so that a higher standard of flood protection can be provided	3.1	This measure aims to reduce flooding on the A816	• Feasible • Access is reasonable • Wouldn't protect any properties • Potential to impact flow mechanisms and increase flooding downstream which would need to be fully investigated. • Resurfacing to be investigated by ABC roads team separately. • Large stretch or road would need to be resurfaced • Underlying ground conditions result in long term settlement which has been infilled previously. This settlement appears to have slowed recently. Raising could however exacerbate settlement 1	• Land ownership and access permission issues – unlikely to be significant • Relatively minimal permanent land take • Unlikely to be compensation requirements 4	• Likely to be costly as significant length would be lifted (~2km) • Land take costs unlikely to be significant • Maintenance costs – depends on underlying material • Low potential for damages offset – unlikely to be cost beneficial • Continual and regular maintenance cost due to settlement • Unlikely to be a sustainable use of funds 2	• Potential to disrupt habitats depending on the height of road lift • Could impact the flood mechanisms causing areas to be cut off/flood that had not previously flooded 2	9
	Fluvial measure - Increasing the height of the left-hand bank along the caravan park	3.2	This measure aims to reduce flooding at the caravan park	• Feasible • Reasonable access • Utilities unlikely to be a significant issue • Limited number of permanent properties affected • Would not offer protection from coastal events which is dominant mechanism so would need to be done in tandem. This is feasible and would provide a dual benefit 2	• Land ownership and access permissions – likely only 1 owner (caravan park) • Relatively minimal permanent land take and largely undeveloped • Compensation requirements 4	• Relatively short length of defences required • Land take costs unlikely to be significant • Maintenance requirements unlikely to be significant 4	• Has the potential to impact on river bank habitats depending on proximity of defence to watercourse • Depending on height, the character of the area may be affected • Habitats could however be improved with planting etc. 3	13
	Coastal measure - Coastal flood wall along existing coastal defences Indicative heights required: A 2% AEP present day scenario would be a 1 50% AEP with climate change considered. – 1000mm +FB defence level required A 0.5% AEP present day scenario would be a 10% AEP with climate change considered – 1.35 +FB defence level required	3.3	This measure aims to reduce flooding to the front green and the southern sections of Lochgilphead	• Feasible • The condition of the existing wall may affect how the defences can be constructed • Access to working area is good • Any works that raise defences could block flow (either wave overtopping or pluvial) from re-entering the channel – significant no. of flapped culverts required to maintain flow path – sea levels rise may impact drainage on the landward side of defence • Unlikely to be significant issues with existing services • Level required is challenging whilst maintaining views – potential for glass topped defences etc • Would not stop flooding to and from Paterson Street and wider flooding due to coastal SWL beyond end of existing wall if done in isolation. • Potential interface with Lochgilphead Regeneration Project needs to be considered	• Potential land owner and land take issues however front green is likely ABC owned. This is to be queried with regeneration team. • Maintenance would land with the council for survey. • Other sources of funding available though this is likely to minimal • Crown Estates ownership of sea bed to 12 nautical miles to be aware of • Potential issues relating to blockage of views from Front Green and properties • Potential planning issue as it is a conservation area	• Costly - a significant length of defences (700m) is required • Significant height also required to protect to climate change which also increases costs • Potential cost for surface water pumping / back of wall drainage • Potential land take costs though unlikely • Works to existing structures may be required	• Further cuts off the land from the sea • Wall height may have to be limited so as not to provide a barrier to the sea or be too intrusive- this will minimise standard of protection • Habitats could be affected - surveys will reveal if this is a significant risk • Depending on height, the character of the area may be affected • Elements to encourage habitats and biodiversity could be included in the wall structure • Potential impact on noted ecological constraints including otter, vole and Aquatic & invertebrate species. 3	13

Category	Measure	ID	Flood receptor (location)	Feasibility – Technical	Feasibility - Legal	Feasibility - Cost	Feasibility – Environmental	Total Score
				4	4	2		
	Coastal measure - Coastal flood wall set along Poltalloch Street Indicative heights required: A 2% AEP present day scenario would a 50% AEP with climate change considered. 2% present day /50% AEP + CC – 730mm +FB defence level required A 0.5% AEP present day scenario would be a 10% AEP with climate change considered – 1.05 +FB defence level required	3.4	This measure aims to reduce flooding to the southern sections of Lochgilphead	• Feasible • Access to working area is more constricted on landward side – however potential to set back into Front Green a little • Any works that raise defences could block flow (either wave overtopping or pluvial) from re-entering the channel – significant no. of flapped culverts required to maintain flow path – sea levels rise may impact drainage on the landward side of defence • Potential issues with existing services • Level required is challenging whilst maintaining views – potential for glass topped defences etc • Would not protect properties on Lochnell Street • Would not stop flooding to and from Paterson Street and wider flooding due to coastal SWL beyond end of existing wall if done in isolation. • Potential interface with Regeneration Project needs to be considered 4	• Road closures may be required but can likely be limited due to good working space on Front Green • Potential land owner and land take issues. Front green is likely ABC owned. This is to be queried with regeneration team. • Future maintenance would land with council for survey, repair works etc. • Potential issues relating to blockage of views from Front Green and properties • Potential planning issue as it is a conservation area 4	• Costly - a significant length of defences (550m) is required – however less than 2.1 • Significant height also required to protect to climate change which also increases costs • Potential cost for surface water pumping / back of wall drainage • Potential land take costs. Majority in ABC ownership so not likely to be massive issue 2	• Further cuts off the Front Green from the town • Wall height may have to be limited so as not to provide a barrier to the sea or be too intrusive- this will minimise standard of protection • Habitats could be affected - surveys will reveal if this is a significant risk • Depending on height, the character of the area may be affected • Would allow Front Green to remain linked to sea • Potential impact on noted ecological constraints including otter, vole and Aquatic & invertebrate species. • Having the wall at the back of the front green would have more environmental and social impact, as it's not connected to the town i.e. effectively 'giving up' this space 2	12
	Coastal measure - Coastal flood embankment along existing coastal defences Indicative heights required: A 2% AEP present day scenario would be a 50% AEP with climate change considered. – 1000mm +FB defence level required A 0.5% AEP present day scenario would be a 10% AEP with climate change considered – 1.35m +FB defence level required	3.5	This measure aims to reduce flooding to the front green and the southern sections of Lochgilphead	• Feasible • Embankment height may have to be limited so as not to provide a barrier to the sea or be too intrusive- this will minimise standard of protection • Access to working area is good • Any works that raise defences could block flow from re-entering the channel – significant no. of flapped culverts required to maintain flow path – sea levels rise may impact drainage on the landward side of defence • Likely minimal issues with existing services • Would not stop flooding to and from Paterson Street and wider flooding due to coastal SWL beyond end of existing wall if done in isolation. • Potential interface with Regeneration Project needs to be considered 4	• Potential land owner and land take issues • Maintenance would land with the council for survey etc • Crown Estates ownership of sea bed to 12 nautical miles to be aware of • Potential issues relating to blockage of views from Front Green and properties • Potential planning issue as it is a conservation area 4	• Costly - a significant length of defences (700m) is required – however these will be reduced from option 2.1 • Significant height also required to protect to climate change which also increases costs • Potential cost for surface water pumping / back of wall drainage • Potential land take costs 2	• Further cuts off the Front Green from the town • Habitats could be affected - surveys will reveal if this is a significant risk • Depending on height, the character of the area may be affected • Could be designed to be a lot less intrusive than a traditional wall with landscaped features and pathways • Potential impact on noted ecological constraints including otter, vole and Aquatic & invertebrate species. 3	13
	Coastal measure - Coastal flood embankment set back within front green area Indicative heights required: A 2% AEP present	3.6	This measure aims to reduce flooding to some parts of the front green and the southern sections of Lochgilphead	• Feasible • Embankment height may have to be limited so as not to provide a barrier to the sea or be too intrusive- this will minimise standard of protection • Access to working area is good • Any works that raise defences could block flow from re-entering the channel – significant no. of flapped culverts	• Potential land owner and land take issues • Maintenance would land with the council for survey etc • Potential issues relating to blockage of views from Front Green and properties • Potential planning issue as it is a conservation area	• Costly - a significant length of defences (550m) is required – however these will be reduced from option 2.1 • Significant height also required to protect to climate change which also increases costs • Potential cost for surface water pumping / back of wall drainage • Potential land take costs	• Habitats could be affected - surveys will reveal if this is a significant risk • Depending on height, the character of the area may be affected • Could be designed to be a lot less intrusive than a traditional wall • May cut off part of the Front Green from the sea and town • Potential impact on noted ecological	12

Category	Measure	ID	Flood receptor (location)	Feasibility – Technical	Feasibility - Legal	Feasibility - Cost	Feasibility – Environmental	Total Score
	day scenario would a 50% AEP with climate change considered. – 900mm +FB defence level required A 0.5% AEP present day scenario would be a 10% AEP with climate change considered – 1.25m +FB defence level required			required to maintain flow path – sea levels rise may impact drainage on the landward side of defence • Likely minimal issues with existing services • Would not protect properties on Lochnell Street • Would not stop flooding to and from Paterson Street and wider flooding due to coastal SWL beyond end of existing wall if done in isolation. • Potential interface with Regeneration Project needs to be considered 4	3	3	constraints including otter, vole and Aquatic & invertebrate species. • Having the embankment set back in the front green would have more environmental and social impact as it would minimise useable space and potentially cut more of the town from the sea 2	
	Coastal measure - Coastal defence wall along A83 on approach to Lochgilphead	3.7	This measure aims to address coastal flooding on the A83 on the approach to Lochgilphead	• Feasible • Access to working area is limited in some areas which adds complexity • Any works that raise defences could block flow from re-entering the channel – significant no. of flapped culverts required to maintain flow path – sea levels rise may impact drainage on the landward side of defence • Potential issues with existing services • Level required is challenging whilst maintaining views – potential for glass topped defences etc – this may be less of an issue than defences at the front green • Wouldn't not protect many properties – primarily for the road • Would not stop flooding to the Front green area and nearby properties if done in isolation. • Could add amenity to the area if designed in the right way Limited benefit on its own 2	• Potential land owner and land take issues • Maintenance would land with the council for survey etc • Crown Estates ownership of sea bed to 12 nautical miles to be aware of • Potential issues relating to blockage of views from properties but limited along this length 4	• Costly - a significant length of defences is required to fully protect this road as flooding occurs along 1.3km stretch • Significant height also required to protect to climate change which also increases costs • Potential cost for surface water pumping / back of wall drainage • Potential land take costs • Works to existing structures and road may be required • Limited properties would be protected which may result in low cost benefit. 2	• Further cuts off the land from the sea • Habitats could be affected - surveys will reveal if this is a significant risk • Depending on height, the character of the area may be affected – perhaps less of a problem than along the front • Elements to encourage habitats and biodiversity could be included in the wall structure • Potential impact on noted ecological constraints including otter, vole and Aquatic & invertebrate species. 2	10
	Coastal measure - Combination of direct defences such as wall/ embankment/coping stones/ flood gates etc along the length of affected area	3.8	This measure aims to reduce flooding to the front green and the southern sections of Lochgilphead	• Feasible • The condition of the existing wall may impact how any wall can be constructed • Access to working area may be constricted in some areas but issues could be minimised by selecting most appropriate option at each location • Varying defence type could address specific issues • Potential issues with existing services but again could likely be minimised when compared to traditional defences • Potential interface with Regeneration Project needs to be considered • Challenges along Lochnell St as properties bound to seawall in some cases 4	• Road closures may be required • Potential land owner and land take issues • Crown Estates ownership of sea bed to 12 nautical miles to be aware of 3	• Costly as significant length required (850m) • Costs could however be reduced depending on combination of defences i.e. embankment where there is sufficient space to reduce costs • Significant height still required to protect to climate change which increases costs • Potential cost for surface water pumping / back of wall drainage • Potential land take costs 3	• Potential to further cuts off the land from the sea but could be tailored to provide best solution • Depending on height, the character of the area may be affected • Elements to encourage habitats and biodiversity could be included in the wall structure • Potential impact on noted ecological constraints including otter, vole and Aquatic & invertebrate species. • Options could be tailored to produce best result at specific location. I.e. a gate could be used to maintain links with the sea rather than a wall across the whole of the front green. 3	13
	Fluvial measure - flood wall along the	3.9	This measure aims to address flooding in the	• Feasible • Wall height is relatively minor	• Potential land take and land owner issues • Partial road closures may be required	• Relatively short length required • Wall height is not significant	• Has the potential to impact on river bank habitats depending on proximity of	11

Category	Measure	ID	Flood receptor (location)	Feasibility – Technical	Feasibility - Legal	Feasibility - Cost	Feasibility – Environmental	Total Score
	left-hand bank of the Cuilarstich Burn from upstream of Bishopton Road to confluence with Badden Burn		areas around the bowling green, caravan park and Bishopton Road and Poltalloch Street	• Access to working area is constricted due to roads and properties • Any works that raise defences could block flow from re-entering the channel • Works within private properties • Potential issues with existing services • Protection of relatively few properties – and only at high return periods • Cutting off floodplain will affect flood mechanisms downstream which would require investigation • Given interlinkage of flood mechanism should not be done in isolation but as part of a coastal solution required • Compensatory storage would be required 2	• Maintenance may land with the council for survey etc 3	• Potential land take costs • Potential cost for surface water pumping / back of wall drainage • Difficult access could increase costs 3	defence to watercourse • Habitats could however be improved with planting etc • Depending on height, the character of the area may be affected • Could impact the flood mechanisms causing areas to be cut off/flood that had not previously flooded – this would need investigated fully 3	
	Fluvial measure - flood wall along the right-hand bank of the Cuilarstich Burn from upstream of Bishopton Road to confluence with Badden Burn	3.10	This measure aims to address flooding in the areas around the SSE power distribution facility and Bishopton Road – it should be noted that the SSE site has recently constructed flood defences around the perimeter	• Feasible • Wall height is relatively minor • Access to working area is constricted due to roads and properties • Any works that raise defences could block flow from re-entering the channel • Potential issues with existing services • Protection of relatively few properties – and only at high return periods – especially given the SSE flood protection walls • Cutting off floodplain will affect flood mechanisms downstream which would require investigation • Given interlinkage of flood mechanism should not be done in isolation but as part of a coastal solution required • Compensatory storage would be required for lost floodplain 2	• Potential land take and land owner issues – may be minimal as few landowners • Partial road closures may be required • Maintenance may land with the council for survey etc • Works within private properties 2	• Relatively short length required • Wall height is not significant • Potential land take costs • Potential cost for surface water pumping / back of wall drainage • Difficult access could increase costs • Limited number of properties would be protected 3	• Has the potential to impact on river bank habitats depending on proximity of defence to watercourse • Habitats could however be improved with planting etc • Depending on height, the character of the area may be affected • Could impact the flood mechanisms causing areas to be cut off/flood that had not previously flooded – this would need investigated fully 3	10
	Fluvial measure – flood wall along the right-hand bank of the Badden Burn from Meadows Road to Bishopton Road	3.11	This measure aims to address flooding in the areas around the swimming pool, Riverside petrol station and ABC plant yard.	• Feasible • Wall height is relatively minor • Access to working area is constricted due to roads and properties • Difficulties around defences at Meadow Road • Any works that raise defences could block flow from re-entering the channel • Potential issues with existing services • Protection of relatively few properties – and only at high return periods – 0.1% (2%+CC) onwards • Cutting off floodplain will affect flood mechanisms downstream which would require investigation to ensure no increase in flood risk elsewhere • Compensatory storage would be required for lost floodplain 2	• Potential land take and land owner issues – may be minimal as few landowners and several are council owned • Partial road closures may be required • Maintenance may land with the council for survey etc • Works within private properties	• Reasonable length required • Wall height is not significant • Potential land take costs • Potential cost for surface water pumping / back of wall drainage • Difficult access could increase costs • Limited number of properties would be protected 3	• Has the potential to impact on river bank habitats depending on proximity of defence to watercourse – they are likely to be close dur to existing buildings • Habitats could however be improved with planting etc • Depending on height, the character of the area may be affected - behind building so may be minimal • Could impact the flood mechanisms causing areas to be cut off/flood that had not previously flooded – this would need investigated fully	10

Category	Measure	ID	Flood receptor (location)	Feasibility – Technical	Feasibility - Legal	Feasibility - Cost	Feasibility – Environmental	Total Score
					2		3	
	Tidal measure - Tidal barrage to stop high sea levels entering the front green area. This would likely run between pier to the west and existing wall to the east. Provision for boat access may also be required.	3.12	This measure aims to reduce flooding to the front green and the southern sections of Lochgilphead	• Would be quite extensive width given wide inlet to Lochgilphead (1km) challenging to construct • Likely to be a complex design process • Offering a high standard of protection would result in an intrusive structure • Additional measures required to dictate when barrage would be employed. • Protection relies on defences being operated correctly 2	• Issues relating to commercial usage at the quay and access • Will be in crown estates ownership • Issues relating to deployment of the barrage and liability associated with this 2	• Significant length and height required - likely to be extremely costly • High maintenance costs 1	• Character of the area and view will be impacted • Potential for free flow of water to be impacted causing standing water • Disruption of marine habitats during and post construction 2	7
Property Flood Protection	Small scale property interventions that could be employed when high sea levels are predicted and as fluvial protection. This would include measures such as flood doors and flood-proof airbricks. May be particularly appropriate at Brackley Park. Appropriate for flood levels up to 0.6m in depth.	4.1	All affected properties	• Feasible for some properties • Less feasible for depths over 0.6m which includes climate change scenarios • Relies on people to employ defences in advance • Properties are all unique so would require surveys to understand requirements • Resilience measure rather than prevention • Could be a quick win in short term before CC impacts come into play -For example – protection could be provided for 25 years, then go back and assess the new flood risk • Many listed properties with non-standard requirements i.e. flood doors would be v difficult due to misshapen door opens etc. 4	• Liability issues surrounding deployment • No council policy but could implement as part of a scheme if shown to be most cost-effective solution • Owners responsible for maintenance • Minimal land take or owner issues 3	• Relatively inexpensive when compared to direct defence options • May achieve reasonable cost benefit at higher frequency events • Social cost in terms of stress associated with larger events in which PFP will not protect and with a lack of confidence in the reliability of these measures 3	• No real positive or negative impacts 3	13
Flood resilience	Coastal and fluvial measure -The measure would aim to improve building resilience to flooding making clear up easier and cheaper. This could include waterproof render and lifting of electrical sockets in properties at risk of flooding from either source	5.1	This measure aims to improve community resilience for all affected properties	• Technically feasible • Will not reduce flooding but may reduce damage and risk • Resilience measure rather than prevention • Feeling this is a sensible option given Climate Change implications • Would need to be bespoke given uniqueness of property • Only small number of properties may be applicable • Scottish Government has done recent studies on this so there is an evidence base. • Could be carried out in tandem with PLP interventions 4	• Minimal land take or owner issues • All affected properties would need to be retrofitted to achieve maximum benefits • Would be provided on a grant basis – difficult to force property owners to take up and ensure 100% coverage • Any minor maintenance responsibilities would remain with house owner. 3	• Relatively inexpensive when compared to direct defence options • May achieve reasonable cost benefit at higher frequency events • Social cost in terms of stress associated with flooding as this option does not reduce flood occurrence 4	• No real positive or negative impacts 3	14
Bridge/culvert upgrades	Fluvial measure - Upgrade of culvert under the A816 at Cairnbaan	6.1	This measure aims to address flooding on the A816 near Cairnbaan	• Feasible • Works required on main access road • Good access to culvert • Few constructability issues • Flooding from this source does not affect any properties and therefore offers limited	• Land owner and access permissions • Maintenance would likely land with the Council • Potential for small land take for headwalls and screens etc if required • Potential road closure – minor diversion	• Costs likely to be relatively low due to short length • Minimal requirement for large temporary works • Small land take costs, if any • Unlikely to be significant costs attributed	• Has the potential to impact on river bank habitats – this would be temporary • Sediment transport could be altered if culvert capacity was increased • Limited impact on mammal and fish passage	11

Category	Measure	ID	Flood receptor (location)	Feasibility – Technical	Feasibility - Legal	Feasibility - Cost	Feasibility – Environmental	Total Score
				benefit • Utilities are unlikely to be a significant issue • Would not affect flooding of the road further downstream and therefore not solve any significant flooding issues • Already on ABC operations list of proposed upgrades to look at in coming months. Indicative pipe size would help understand requirements for information purposes – minor intervention for ABC and unlikely to be a viable FPS measure • Challenging levels – shallow and need to ensure a suitable cover. 2	3	to utilities • Road closure • If works are suitable could come from council maintenance budget given it is on radar as a priority • Limited benefit so unlikely to gain funding – minor intervention for ABC roads team 3	• Small local improvements could be made as part of the works. 3	
	Fluvial measure -- Upgrade of the 2 bridges on the Cuilarstich Burn at Bishopton Road to increase conveyance	6.2	This measure aims to reduce flooding of the Cuilarstich Burn around Bishoptop Road	• Feasible • Works required on main road • Access is somewhat limited • Utilities have the potential to cause restrictions • Access constraints due to steep sided channel and properties • Significant works • Relatively few properties affected and only at higher events. 1	• Potential land owner issues • Significant road closures • Access agreements and permissions required 2	• Large bridges and upgrades are likely to be expensive • Construction work in close proximity to buildings adds to costs – access issues • Small permanent land take costs, if any 1	• Has the potential to impact on river bank habitats – this would be temporary • Sediment transport could be altered if culvert capacity was increased • Limited impact on mammal and fish passage • Small local improvements could be made as part of the works. 2	6
	Fluvial measure - Upgrade of the Poltalloch Street bridge to increase conveyance	6.3	This measure aims to address flooding to the caravan site	• Feasible • Works required on main access road – although diversion would not be significant • Open space either side is reasonable for access • Utilities have the potential to cause restrictions • Flooding from this source is not seen to affect a large number of properties • Increasing capacity of this bridge could increase flooding from coastal source • Transport Scotland owned - they may have designs in place to upgrade this bridge already – discussion would be worthwhile 2	• Potential land owner issues – transport Scotland owned • Significant road closure • Access agreements and permissions required 2	• Large bridge to upgrade – possibility of upgrading both structures at this location which adds to costs • Small land take costs, if any 2	• Has the potential to impact on river bank habitats – this would be temporary • Sediment transport could be altered if culvert capacity was increased • Limited impact on mammal and fish passage • Small local improvements could be made as part of the works. 3	9
	Fluvial measure - Upgrade of the bridge at the Auchoish Burn to increase conveyance	6.4	This measure aims to address flooding on the A816	• Feasible • Works would be on road leading off the A816 so less frequently used – less disruption • Significant temporary works to maintain access to properties • Open space either side provides good access • Unlikely to be significant issues with utilities • Would not provide protection to properties in Lochgilphead • May provide localised betterment but does not solve all flooding on the A816	• Potential land owner issues • Access agreements and permissions required • Temporary access requirements	• Small bridge replacement – shouldn't hold significant costs • Small land take costs, if any	• Has the potential to impact on river bank habitats – this would be temporary • Sediment transport could be altered if culvert capacity was increased • Limited impact on mammal and fish passage • Small local improvements could be made as part of the works.	11

Category	Measure	ID	Flood receptor (location)	Feasibility – Technical	Feasibility - Legal	Feasibility - Cost	Feasibility – Environmental	Total Score
				2	3	3	3	
Wave dissipation	Coastal measure - Breakwater placed in the intertidal areas to dissipate waves and reduce overall wave height.	7.1	This measure aims to dissipate waves and reduce overtopping along the frontage	• Feasible • Would only protect against waves and not high-water levels - limited impact in relation to flood risk • Adequate space although bathymetry would need to be inspected to determine if depths were appropriate – depths don't appear to be too great • Does not address the main flood driver of high standing water levels 2	• Potential land owner issues • Crown Estates ownership up to 12 nautical miles is something to be aware of 3	• Costs could be significant enough as reasonable length required • Low maintenance costs 3	• Potential disruption of marine habitats • Potential to be visible at low or normal tides • Ecological constraint – changing conditions for species identified in PEA 2	10
Improved flood warning	Coastal measure - This measure would aim to provide earlier warning of high sea levels so that residents could be more prepared. Likely to be either based on Met Office data or other tidal gauges on the Firth of Clyde.	8.1	This measure aims to improve community resilience for all affected properties	• Feasible if implemented in tandem with PFP – limited use by itself • Does not alleviate or reduce flooding but may reduce damage and risk • Would not require large scale monitoring or instrumentation • SEPA Flood warning in place – would be useful to know if this is well used and if we can engage people more during consultation • Generally felt residents have a good understanding of tidal conditions • Flood warning already in place and well publicised which reduces benefits 3	• Issues relating to liability and confidence in warnings • Distribution of warnings can be problematic and impact on any benefits 2	• Relatively inexpensive costs of instrumentation and monitoring • Costs associated with distributing warnings • Does not solve flooding and associated costs with clean up still in place 3	• No real positive or negative impacts 3	11
Self help	Coastal and fluvial measure - The measure would aim to improve understanding of flooding issues and how to cope better.	9.1	This measure aims to improve community resilience for all affected properties	• Technically feasible • Could reduce damage and risk if residents are better prepared • Will not alleviate or reduce flooding but may reduce damage and risk • Measures would be part of a wider strategy of reducing flood risk rather than a standalone measure 3	• Legalities of funding and ownership of local groups could be complex • Relatively low ongoing maintenance and running costs for the council 4	• Minimal costs relating to awareness and Community Action Group set up 4	• No real positive or negative impacts 3	14
Managed retreat	Coastal measure - Setting up of a long-term plan to move properties away from the southern section of Lochgilphead	10.1	This measure aims to reduce those at flood risk by relocating away from flood areas – all affected properties	• Technically feasible • Issues relating to character of town meaning relocation is unlikely to be accepted • Large number of properties in Lochgilphead affected • Establishing criteria for relocation is complex 1	• Complexity around relocation – emotive topic and likely to have significant legal issues • Relatively low ongoing maintenance and running costs for the council • Compulsory purchase is time consuming and complex • There are no set ABC policies– potential issues regarding how many properties could be purchased, relocation ability etc. 1	• Large number of properties affected with significant costs associated with land and property purchase • Large costs associate with purchase of land for relocation • Industries such as tourism would be negatively affected and causes associated issues. 2	• Previously built up areas would have to be demolished and managed appropriately to create new habitats etc • Existing greenfield sites required for relocation • Potential for reconnection with the sea 3	7
Land reclamation	Coastal measure - Infilling of an area of the intertidal mudflats in front of the existing front green, to create more space to install the most suitable	11.1	This measure aims to address flooding to the southern sections of Lochgilphead and the front green.	• Feasible • Not a standard approach • Access and space are likely already sufficient on the Front Green so land reclamation for flood purposes unlikely to be required • Wall height may still need to be limited so it is not overly intrusive	• Marine Scotland would be consulted • Crown estate ownership of land	• Material would be required for bringing new land up to appropriate level likely to be large volume of material and costly to import • Wall would still need to be constructed largely to same level as other traditional defence options • Likely small land take costs	• Ecological constraint – changing conditions for species identified in PEA • Chance to incorporate better connectivity with the sea and create habitats	9

Category	Measure	ID	Flood receptor (location)	Feasibility – Technical	Feasibility - Legal	Feasibility - Cost	Feasibility – Environmental	Total Score
	defence to protect Lochgilphead – the main purpose of this land raising would be for coastal flood protection purposes			• Stabilisation of land raising may be problematic given underlying material • Land raising more appropriate in coastal than fluvial situations • Could impact fluvial watercourse ability to discharge 2	3	2	2	
	Coastal measure - Infilling of an area of back of houses east of front green and at Police Station– the main purpose of this land raising would be for coastal flood protection purposes	11.2	This measure aims to address flooding to the eastern sections of Lochgilphead	• Feasible • Not a standard approach • Stabilisation of land raising may be problematic given underlying material • Land raising more appropriate in coastal than fluvial situations • Would give added protection to vulnerable receptors • Impact on coastal processes would need to be understood – dynamic coast indicates fairly stable coastline here so may be sustainable in long-term without needs for substantial protection 3	• Marine Scotland would be consulted • Crown estate ownership of land 3	• Material would be required for bringing new land up to appropriate level likely to be relatively small volume of material, reducing costs to import • Wall would still need to be constructed largely to same level as other traditional defence options • Likely small land take costs 3	• Ecological constraint – changing conditions for species identified in PEA • Relatively small area would reduce any environmental impact • Chance to incorporate better connectivity with the sea and create habitats 3	12
Canal management	Fluvial measure - Raising of the invert level at weir 3 – potential lowering of weir 1 and 2 invert levels so that little or no flow enters the Badden Burn from the canal	12.1	This measure aims to address flooding on the A816 and areas around the caravan park	• Feasible • Canal depth required to be maintained for boat passage • Access is reasonable • Utilities unlikely to be an issue • May require temporary lowering of canal levels which could impact usage • Limited number of properties affected by fluvial flooding • Hydraulic gradient is an issue • Not suitable as flood scheme option but should be taken forward for discussion with SC and to identify proposed changes to WCM say to reflect better management on the ground • Known low freeboard at Badden bends. Could increase the amount you have to raise embankment 2	• Land owner issues – minimal as likely only 1 • Has the potential to impact tourism on the canal if levels are altered • Relatively low ongoing maintenance and running costs for the council • Minimal land take, if any • Out with ABC remit 2	• Relatively small-scale works required which keeps costs lower • Small, if any, land take and compensation costs 3	• Potential for habitats downstream of weir 3 to be impacted • Canal levels should vary little so minimal impact on canal habitats after construction • Canal levels may need to be lowered during construction which could have temporary impacts • Temporarily local impacts to channel and overflow structure whilst work is undertaken 3	10
	Fluvial measure - Alternative operation of canal – changes to trigger levels and operations.	12.2	This measure aims to address flooding on the A816 and areas around the caravan park	• Feasible • Non-engineered option • Canal depth required to be maintained for boat passage • Limited number of properties affected by fluvial flooding • Is the canal operational in Winter? Potential to close the canal Oct – March and draw it down for storage – advance active management 3	• No land owner issues • Has the potential to impact tourism on the canal if levels are altered • Little/ no maintenance and running costs – may need monitoring • No land take requirements • Out with ABC remit 3	• No engineering works which keep costs low • No land take or compensation costs 3	• Canal levels should vary little so minimal impact on canal habitats after implementation 3	12
	Store more water in upstream reservoirs	12.3	This would aim to reduce flow into the summit	• Technically feasible • Majority of reservoirs are currently uncontrolled, so control structures would	• The category of a reservoir could be impacted if the dimensions of storage capacity were to be changed	• Installing control structures could be expensive depending on type • Unlikely to provide a reasonable cost	• May change habitats • Fish migration could be impacted by in channel structures	9

Category	Measure	ID	Flood receptor (location)	Feasibility – Technical	Feasibility - Legal	Feasibility - Cost	Feasibility – Environmental	Total Score
	that feed the summit pound		pound and therefore into the eastern reach	likely be required. • Likely limited benefit as there are already measures in place to reduce flow from the reservoirs into the summit pound 2	• Potential for multiple land owners 2	benefit 2	• Potential to improve reservoir habitats. 3	
Do nothing	This scenario assumes no future maintenance of flood defences or flood warning.	13.1		• Unfeasible – frequency of flooding in the future will become unsustainable 1	• Council has a duty to implement and maintain flood protection actions 1	• Costly in terms of clear up, repairs and road closures 1	• Frequent flooding could impact the ecological and environmental aspects in Lochgilphead 1	4

9.1 Long list scoring summary

A summary of the long list scoring is provided in Table 9-1 below. Options in green indicate those being carried forward to the short list, having a combined score of 12 or more; options in red are discounted with reasoning given in **Section 10.1**.

Table 9-2 Long list score summary table

Option Category	Measure	ID	Feasibility				Total Score
			Technical	Legal	Cost	Environmental	
NFM options	Fluvial measure - Re-meandering of the Badden Burn	1.1	2	2	3	4	11
	Fluvial measure - Provision of a 2-stage channel	1.2	2	2	3	4	11
	Fluvial measure - Tree planting in the upper catchment of Badden Burn	1.3	1	1	2	3	7
	Fluvial measure - Wetland creation and ditch blocking.	1.4	2	2	3	4	11
	Fluvial measure - In channel improvements on the Badden Burn	1.5	1	4	3	3	11
	Coastal measure - Intertidal recharge	1.6	1	2	3	3	9
	Coastal measure - Saltmarsh/managed realignment	1.7	1	2	3	2	8
	Fluvial measure - Tree planting/ ditch blocking on Cuilarstich Burn	1.8	1	2	2	4	9
	Fluvial measure - forestry management	1.9	2	2	2	3	9
Upstream storage	Fluvial measure - Storage provision on the Auchoish burn	2.1	2	2	2	2	8
	Fluvial measure - Storage provision on the Culastich burn	2.2	1	2	2	2	7
Direct defences	Fluvial measure - Raising the A816	3.1	1	4	2	2	9
	Fluvial measure - Increasing left bank along the caravan park	3.2	2	4	4	3	13
	Coastal measure - Coastal flood wall along existing coastal defences	3.3	4	4	2	3	13
	Coastal measure - Coastal flood wall set along Poltalloch Street	3.4	4	4	2	2	12

Option Category	Measure	ID	Feasibility				Total Score
			Technical	Legal	Cost	Environmental	
	Coastal measure - Flood embankment along existing coastal defences	3.5	4	4	2	3	13
	Coastal measure - Flood embankment set back within front green area	3.6	4	3	3	2	12
	Coastal measure - Flood wall along A83 on approach to Lochgilphead	3.7	2	4	2	2	10
	Coastal measure - Combination of direct defences	3.8	4	3	3	3	13
	Fluvial measure - flood wall along the left-hand bank of the Cuilarstich Burn	3.9	3	3	3	3	11
	Fluvial measure - flood wall along the right-hand bank of the Cuilarstich Burn	3.10	2	2	3	3	10
	Fluvial measure – flood wall along right-hand bank at Meadows Road	3.11	2	2	3	3	10
	Tidal measure - Tidal barrage	3.12	2	2	1	2	7
Property flood protection	Coastal and fluvial measure - Small scale property interventions	4.1	4	3	3	3	13
Flood resilience	Coastal and fluvial measure - improve building resilience	5.1	4	3	4	3	14
Bridge/culvert upgrades	Fluvial measure - Upgrade of culvert under the A816 at Cairnbaan	6.1	2	3	3	3	11
	Fluvial measure -- Upgrade Cuilarstich Burn bridges at Bishopton Road	6.2	1	2	1	2	6
	Fluvial measure - Upgrade of the Poltalloch Street bridge	6.3	2	2	2	3	9
	Fluvial measure - Upgrade of the bridge at the Auchoish Burn	6.4	2	3	3	3	11
Wave dissipation	Coastal measure - Breakwater placed in	7.1	2	3	3	2	10

Option Category	Measure	ID	Feasibility				Total Score
			Technical	Legal	Cost	Environmental	
	the intertidal area						
Improved flood warning	Coastal measure - earlier warning of high sea levels	8.1	3	4	4	3	11
Selp help	Coastal and fluvial measure - improve understanding of flooding issues and how to cope better.	9.1	3	4	4	3	14
Managed retreat	Coastal measure - move properties away from the southern section of Lochgilphead	10.1	1	1	2	3	7
Land reclamation	Coastal measure - Infilling of an area of the intertidal mudflats in front of the existing front green	11.1	2	3	2	2	9
	Coastal measure - Infilling of an area of back of houses east of front green and at Police Station	11.2	3	3	3	3	12
Canal management	Fluvial measure - Raising of the invert level at weir 3	12.1	2	2	3	3	10
	Fluvial measure - Alternative operation of canal	12.2	3	3	3	3	12
	Store more water in upstream reservoirs that feed the summit pound	12.3	2	2	2	3	9
Do nothing	This scenario assumes no future maintenance of flood defences or flood warning.	13.1	1	1	1	1	4

10. Short Listing

Following the screening exercise, the short listed options are set out in Table 10-1. A more detailed discussion of reasons for removing options is set out in **Section 10.1**.

The remaining short list has discounted options which are not considered to be technically, economically, environmentally or legally feasible. The performance of those which remain will be investigated more thoroughly with regard to flood risk which will be informed through detailed modelling and the benefits to be gained in terms of economic damages avoided, environmental benefit from human and natural impacts and social benefits. A full options appraisal will be carried out following more detailed modelling of the short list so that options can be ranked and prioritised to find the most suitable solution considering all aspects.

10.1 Discounted options – justification

10.1.1 Remeandering of the Badden Burn

Unlikely to provide sufficient additional storage to stop flooding at higher events. This option also does not address the main source of flooding to Lochgilphead, which is tidal.

10.1.2 Two stage channel

Unlikely to provide sufficient additional storage to stop flooding at higher events. This option also does not address the main source of flooding to Lochgilphead, which is tidal.

10.1.3 Tree planning in Badden Burn catchment

Large percentage of catchment already planted which reduces any benefit of this measure. It is also likely that this option would take a long time to realise benefits. This option also does not address the main source of flooding to Lochgilphead, which is tidal.

10.1.4 Wetland creation

Unlikely to provide significant flood risk reduction at higher events without more formalised storage. This option also does not address the main source of flooding to Lochgilphead, which is tidal.

10.1.5 Channel improvements to reduce sediment transport

Limited impact at higher events and measures such as dredging would require frequent maintenance. This option also does not address the main source of flooding to Lochgilphead, which is tidal.

10.1.6 Intertidal recharge

A large intertidal areas already exists at Lochgilphead which reduces any benefits of this measure. It also would not address the main source of flooding which is extreme water levels, not wave overtopping.

10.1.7 Saltmarsh/managed realignment

A large marsh/ intertidal area already exists at Lochgilphead which reduces any benefits of this measure. It also would not address the main source of flooding which is extreme water levels, not wave overtopping.

10.1.8 Tree planning in Cuilarstich Burn catchment

Large percentage of catchment already planted which reduces any benefit of this measure. It is also likely that this option would take a long time to realise benefits. This option also does not address the main source of flooding to Lochgilphead, which is tidal.

10.1.9 Forestry management

Likely small benefits as a result of this measure which could take decades to realise. This option also does not address the main source of flooding to Lochgilphead, which is tidal

10.1.10 Storage provision on Auchoish Burn

Appreciable engineering required and potentially high land take and maintenance costs. This option would not address the main source of flooding in Lochgilphead and is therefore unlikely to achieve a good cost benefit.

10.1.11 Storage provision on Cuilarstich Burn

Appreciable engineering required and potentially high land take and maintenance costs. Also limited suitable locations. This option would not address the main source of flooding in Lochgilphead and is therefore unlikely to achieve a good cost benefit.

10.1.12 Raising the A816

A significant stretch of road would require to be resurfaced which is likely to be costly. Given that this measure would only address flooding of the road, it is unlikely to achieve a favourable cost benefit. It does not address the main source of flooding in Lochgilphead, which is tidal.

10.1.13 Flood wall along A83 on approach to Lochgilphead

This measure would not protect many properties, with the primary focus being the road. The large stretch of road, and minimal property protection means that it is unlikely to achieve a reasonable cost benefit. It would also not stop flooding to the Front Green and the southern parts of Lochgilphead.

10.1.14 Flood wall along left bank of Cuilarstich Burn

Likely small benefits as the majority the majority of properties already have a high standard of protection, it is primarily open space that is affected. Complex issues relating to access and required compensatory storage which would be extremely problematic to provide.

10.1.15 Flood wall along right bank of Cuilarstich Burn

Likely small benefits as the majority of the right bank is protected by the SSE flood wall. Complex issues relating to access and required compensatory storage which would be extremely problematic to provide.

10.1.16 Flood wall along right bank of Badden Burn

Likely small benefits as only a handful of properties will be protected by this measure which already have a high standard of protection (0.1% AEP/ 2%AEP + CC). Complex issues relating to access and required compensatory storage which would be extremely problematic to provide.

10.1.17 Tidal barrage

Significant height and length required and likely to be extremely costly and would therefore struggle to achieve a reasonable cost benefit. Other complex issues relating to environmental, ecological, social and visual elements.

10.1.18 Upgrade of culvert under A816 at Cairnbaan

Does not solve main source of flooding, which is tidal. This measure also would not affect flooding further downstream on the A816 and would therefore offer limited benefit. This is something that Argyll and Bute Council Roads team may take forward in the future.

10.1.19 Upgrade of bridges at Bishopton Road on Cuilarstich Burn

Complex and significant works which are likely to carry high costs. Relatively few properties would be protected through this measure and only at higher return periods. It would be unlikely to achieve a reasonable cost benefit and does not protect Lochgilphead from the main source of flooding, which is tidal.

10.1.20 Upgrade of bridge at Poltalloch Street

Significant works on a main access road. Relatively few properties are affected by fluvial flooding caused by this structure and upgrading the bridge may in fact increase coastal flooding in the caravan park during high tides.

10.1.21 Upgrade of bridge at Auchoish Burn confluence

This option would offer no protection to properties in Lochgilphead and is unlikely to significantly change the flood mechanism in the area. Limited overall benefit to the A816.

10.1.22 Wave dissipation

Limited benefit as this measure would only address wave overtopping which was found to be minimal. It would not address the main source of tidal flooding which is extreme water levels.

10.1.23 Improved flood warning

Complex issues relating to liability and confidence in warnings. Flood warning is also currently in place and it was considered unlikely that improvements would provide any real benefits. This option would also not reduce flooding but may reduce damages as residents could implement flood preparation measures.

10.1.24 Managed retreat

At this time, this is not considered a viable option for flood protection due to the number of properties and complex legalities. A managed retreat would effectively destroy the character of the town which would be difficult to re-establish This may however be reconsidered in the future.

10.1.25 Land reclamation – infilling portion of intertidal area

Land reclamation is generally only acceptable for flood defence purposes where there is insufficient land. The Front Green provides sufficient space for defences and reclaiming land on a large scale is likely to be considered an expensive and unrequired option.

10.1.26 Canal management – raising of weir 3 invert

Unlikely to provide sufficient additional storage to stop flooding at higher events given the gradient on the canal. This option also does not address the main source of flooding to Lochgilphead, which is tidal. Option could be considered further by Scottish Canals and Argyll and Bute Council roads department to improve flooding on the A816.

10.1.27 Canal management – increasing storage in upstream reservoirs

Significant works likely required to provide control structures on the reservoirs. Given the current operation of the canal, whereby feeders are already cut off and diverted from Summit Pound, it is unlikely this would realise any real benefits.

10.1.28 Do nothing

This is not considered an option given the scale and likely increased frequency of flooding events predicted to occur over the next 100 years.

10.2 Shortlisted options

Table 10-1. Short List

Type of Measure	ID	Flood receptor (location)	Measure	Total Score
Direct defences	3.2	This measure aims to reduce flooding at the caravan park	Fluvial measure - Increasing left bank along the caravan park	13
	3.3	This measure aims to reduce flooding to the front green and the southern sections of Lochgilphead	Coastal measure - Coastal flood wall along existing coastal defences	13
	3.4	This measure aims to reduce flooding to the southern sections of Lochgilphead	Coastal measure - Coastal flood wall set along Poltalloch Street	12
	3.5	This measure aims to reduce flooding to the front green and the southern sections of Lochgilphead	Coastal measure - Flood embankment along existing coastal defences	13
	3.6	This measure aims to reduce flooding to some parts of the front green and the southern sections of Lochgilphead	Coastal measure - Flood embankment set back within front green area	12
	3.8	This measure aims to reduce flooding to the front green and the southern sections of Lochgilphead	Coastal measure - Combination of direct defences	13
Property flood protection	4.1	All affected properties	Coastal and fluvial measure - Small scale property interventions	13
Flood resilience	5.1	This measure aims to improve community resilience for all affected properties	Coastal and fluvial measure - improve building resilience	14
Self help	9.1	This measure aims to improve community resilience for all affected properties	Coastal and fluvial measure - improve understanding of flooding issues and how to cope better.	14
Land reclamation	11.2	This measure aims to address flooding to the eastern sections of Lochgilphead	Coastal measure - Infilling of an area of back of houses east of front green and at Police Station	12
Canal management	12.2	This measure aims to address flooding on the A816 and areas around the caravan park	Fluvial measure - Alternative operation of canal	12

11. Summary and Next Steps

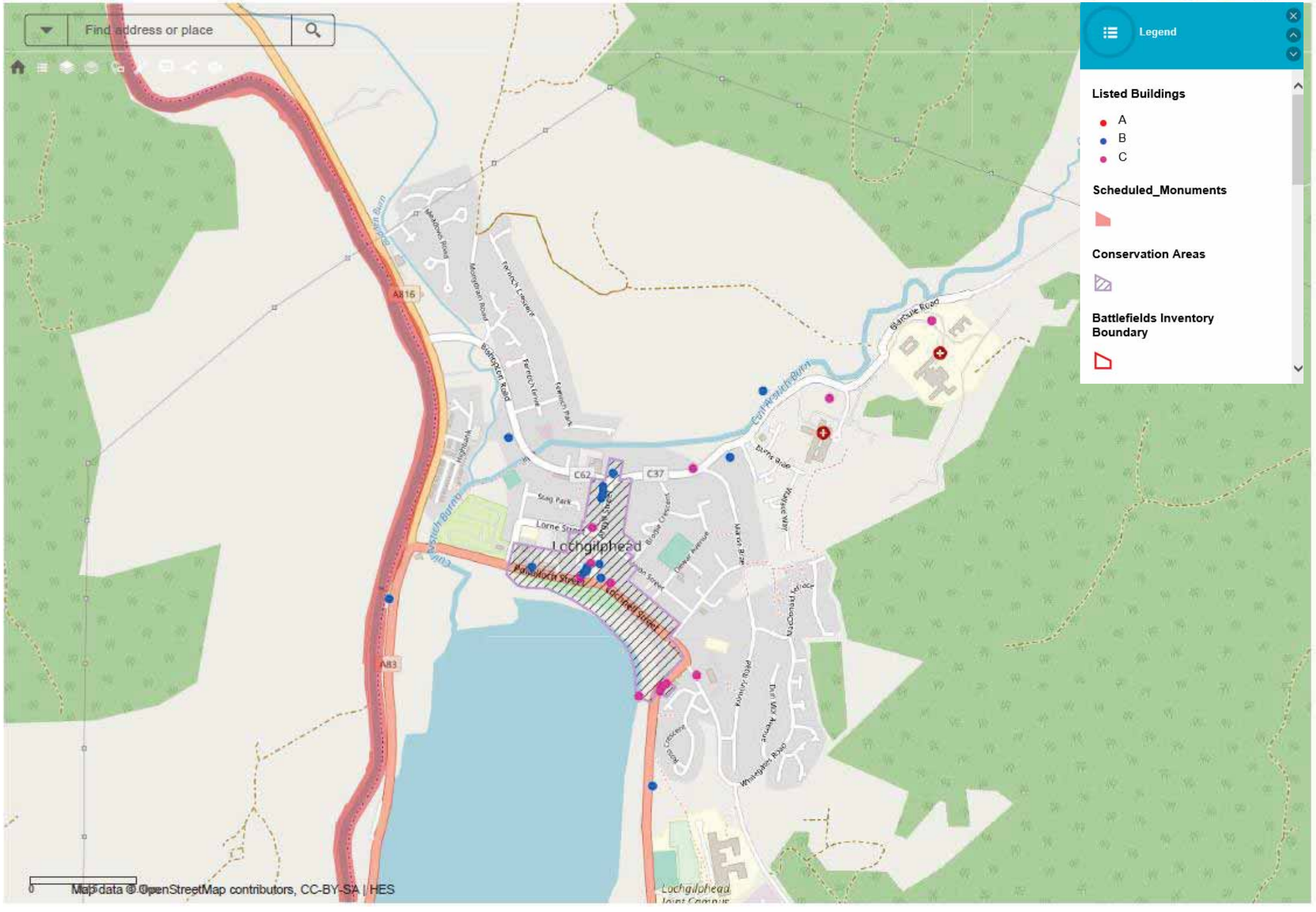
A long list of options was created that looked at different ways to mitigate fluvial and coastal flood risk within Lochgilphead. The long list was brought before key stakeholders including ABC, SW, SEPA and SC. This was to identify any possible reasons for the listed options to not be feasible and identify any missed opportunities at this stage. Input from these bodies along with desk studies to understand environmental, planning and ecological opportunities and constraints were used to inform the screening process.

The options identified above could be proposed as standalone options or could be used in combination with multiple options. The next phase will look to take the short list and group options where appropriate and develop more detail to enable the high level costs to be established, assessment of the benefit and ranking of these final options.

Next steps are detailed below:

- Group options if appropriate in consultation with ABC,
- Model short listed options/group of options,
- Concept design of options,
- Cost options,
- Damage assessment post options,
- Cost benefit analysis – including economic, environmental and social appraisals,
- Produce appraisal summary tables,
- Report on findings in report and through public consultation; and,
- Identify preferred option

Appendix A – Figures


Find address or place
Legend
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A
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Scheduled_Monuments
Conservation Areas
Battlefields Inventory Boundary
A816
A83
C62
C37
Lochgilphead
Lochgilphead Joint Campus
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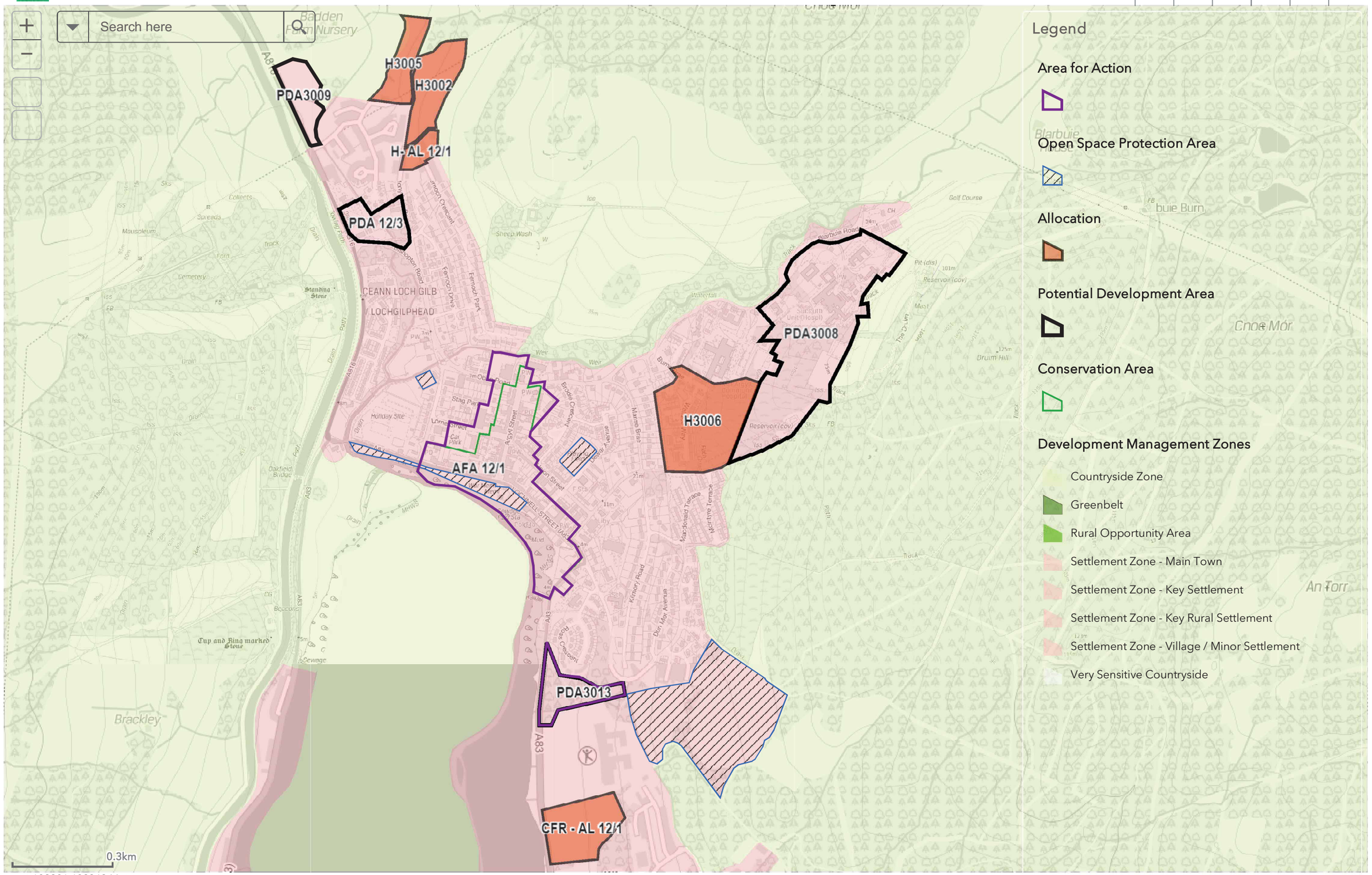
Argyll and Bute Local Development Plan 2015 App

Click here for more information on the LDP



Appendix B – Ecology and Environmental Preliminary Appraisal

Lochgilphead Flood Study

Desk-based Preliminary Ecological Appraisal

Argyll and Bute Council

Project number: 60578115

22 March 2019

Quality information

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Table of contents

1. Introduction

AECOM was commissioned by Argyll and Bute Council (ABC) to undertake a Flood Study for the town of Lochgilphead (hereafter referred to as the 'Scheme').

The Study is in the early stages of development and detailed design of works required to alleviate flooding are not yet known. Therefore, this Report refers to a general proposed scheme area (hereafter referred to as the 'Site') as defined on Figure 1. This area (central grid reference NR 86 88) encompasses an area of approximately 500 ha consisting of the Badden and Cuilarstich Burns, the Crinan Canal and adjacent tidal zone.

The purpose of this Report is to provide a high-level, desk-based Preliminary Ecological Appraisal assessing the potential ecological risks and opportunities associated with the Scheme. The Report identifies the scope of further work that would be required to progress the project including the submission of a planning application. High-level recommendations are made on Scheme options for the avoidance or minimisation of the potential impacts of the Scheme on identified ecological features, and of potential enhancements to biodiversity and/or ecosystem services.

The approach applied when undertaking this appraisal accords with the Guidelines for Preliminary Ecological Appraisal published by the Chartered Institute of Ecology and Environmental Management (CIEEM) (CIEEM, 2017).

The purpose of the PEA was to:

- identify general habitat types present within the Scheme area and any areas immediately outside of the Scheme where there may be potential for direct or indirect effects (the "zone of influence");
- carry out an appraisal of the potential of the habitat types identified to support protected or notable species of fauna and flora; and,
- provide advice on any potential ecological constraints and opportunities, including providing recommendations for further field survey which may be required to inform the detailed design of the Scheme.

2. Wildlife legislation and planning policy

Wildlife legislation

The following wildlife legislation is potentially relevant to the proposed works:

- Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (the 'Habitats Directive');
- Directive 2009/147/EC on the conservation of wild birds (the 'Birds Directive');
- Directive 2000/60/EC establishing a framework for Community action in the field of water policy (the 'Water Framework Directive' (WFD));
- Regulation (EU) No 1143/2014 on the prevention and management of the introduction and spread of invasive alien species ('Invasive Alien Species Regulation');
- Conservation (Natural Habitats, &c.) Regulations 1994 (as amended in Scotland) (the 'Habitats Regulations');
- Wildlife & Countryside Act 1981 (as amended in Scotland) ('WCA');
- Nature Conservation (Scotland) Act 2004 (as amended);
- Wildlife & Natural Environment (Scotland) Act 2011 (as amended) ('WANE Act');
- Protection of Badgers Act 1992 (as amended in Scotland); and,
- Conservation of Salmon (Scotland) Regulations 2016 ('Salmon Regulations').

The above legislation has been considered when planning and undertaking this PEA using the methods described in Section 3, when identifying potential constraints to the Scheme, and when making recommendations for further survey, design options and mitigation, as discussed in Section 5. Compliance with legislation may require the attainment of relevant protected species licences prior to the implementation of the Scheme.

Further information on the requirements of the above legislation is provided as Appendix A.

National planning policy

Scottish Planning Policy (SPP) 2014 recognises the environment as a national asset offering opportunities for enjoyment, recreation and sustainable economic activity. In summary, the policy principles most relevant to nature conservation state that the planning system should:

- facilitate positive change while maintaining / enhancing distinctive landscape character;
- conserve and enhance protected sites and species, maintaining healthy ecosystems and the natural processes which provide important services to communities;
- protect and improve the water environment and soil;
- protect and enhance ancient woodland, hedgerows and trees with high ecology/landscape value; and,
- seek biodiversity benefits from new development where possible.

SPP also sets out the biodiversity duty of public bodies and the legislative requirements for protected sites and species.

It is also Scottish Government policy to treat Wetlands of International Importance (Ramsar sites) in the same way as Natura 2000 sites (Special Areas of Conservation (SACs) and Special Protection Areas (SPAs)), and to treat candidate, potential or proposed Natura 2000 / Ramsar sites, as well as areas identified as compensation sites for adverse effects on these designations, as if they were fully designated.

Local planning policy

Relevant local planning policies for ABC are included in the Argyll and Bute Local Development Plan (LDP), adopted March 2015. This LDP includes the following policies relevant to nature conservation:

- Policy LDP STRAT 1 – Sustainable Development: states that in preparation of new development proposals, developers should seek to conserve and enhance the natural and built environment and avoid significant adverse impacts on biodiversity, natural and built heritage resources. They should also avoid having significant adverse impacts on land, air and water environment;
- Policy LDP 3 – Supporting the Protection, Conservation and Enhancement of our Environment: in all development management zones, Argyll and Bute Council will assess applications for planning permission with the aim of protecting, conserving and, where possible, enhancing the built, human and natural environment. There is extensive supporting guidance detailing the mechanism of this policy delivery;
- Policy LDP 5 – Supporting the Sustainable Growth of Our Economy: this policy in part aims to help deliver sustainable growth through focussing on regeneration activity and promoting environmental enhancement; and,
- Policy LDP 10 – Maximising our Resources and Reducing Our Consumption: ABC will support development proposals which seek to maximise resources and reduce consumption where they accord with (amongst others) minimising impact on the water environment, minimising impact on biodiversity and the natural environment, avoiding the loss of trees and woodland and avoiding the disturbance of carbon rich soils.

ABC has also produced a technical note for planners and developers to provide guidance and ensure that development meets the requirement to address and protect biodiversity in the planning and development process.

The Argyll and Bute Biodiversity Action Plan (BAP) (2010 to 2015) contributes to the biodiversity conservation aims, objectives and actions described at a national level and to the delivery of a number of other strategies and plans relevant to the biodiversity of the Council area. Specifically it details six ecosystem works programmes to be delivered by the plan and lists habitats and species selected for action. Habitats selected for action that may be relevant to the Development include upland oak *Quercus* woodland, lowland mixed deciduous woodland, rivers and blanket bog. Priority species for conservation action include Greenland white-fronted goose *Anser albifrons* ssp. *flavirostris,* black grouse *Tetrao tetrix,* osprey *Pandion haliatetus,* red squirrel *Scurius vulgaris,* otter *Lutra lutra* and soprano pipistrelle *Pipistrellus pygmaeus*. The 2010 to 2015 BAP has not yet been superseded but is currently being re-drafted.

The above planning policy has been considered when assessing potential ecological constraints and opportunities identified by the desk study and when assessing requirements for further survey, design options and ecological mitigation, as described in Section 5.

3. Methods

This PEA was limited to desk-based study and no field survey was carried out to inform the assessment.

A desk study was carried out to identify nature conservation designations, and protected and notable habitats and species potentially relevant to the Scheme.

A stratified approach was taken during the desk study, based on the likely zone of influence of the various options for the Scheme on different ecological features and the maximum distances typically considered by statutory consultees. Accordingly, the desk study sought to identify:

- any international nature conservation designations within 10 km of the Site;
- other statutory nature conservations designations within 2 km of the Site;
- local non-statutory nature conservation designations within 1 km of the Site; and,
- protected / notable habitats and species within 2 km of the Site.

Combined, these areas are referred to as the 'Desk Study Area'. Statutory designations further afield were also considered if impacts were possible, such as on water-related features of interest via connecting watercourses, or if the features of interest included mobile species for which Scottish Natural Heritage (SNH) require wider search distances (such as geese).

Greenland white-fronted goose *Anser albifrons* ssp. *flavirostris* is known to utilise the Kintyre area, to the south of Lochgilphead, during the non-breeding season. To define the Desk Study Area in relation to this species, its local range was examined. In a report commissioned by SNH, Pendlebury *et al* (2011) identified that the core foraging range of Greenland white-fronted geese in Kintyre is between 5 – 8 km from roost sites. It was therefore considered reasonable to adopt a 10 km Desk Study Area in relation to SPAs designated for this species.

The desk study was carried out using the data sources detailed in Table 1. For the purposes of this PEA protected and notable habitats and species included:

- all species listed on Schedules 2 and 4 of the Habitats Regulations;
- all species listed on Schedules 1, 5 and 8 of the WCA;
- all species of birds listed on Annex I of the Birds Directive;
- all qualifying features of European designated sites within 10 km of the Site;
- species and habitats considered of principal importance for nature conservation in Scotland through inclusion on the Scottish Biodiversity List (SBL);
- priority habitats and key species in the Argyll and Bute BAP;
- species that are Nationally Rare, Nationally Scarce or listed in national or local Red Data Lists;
- bird species on the Red List of Birds of Conservation Concern (BoCC, Eaton *et al,* 2015); and,
- invasive non-native species of UK concern, such as those identified on Schedule 9 of the WCA (although this no longer legally applies in Scotland) and those considered species of EU concern under the EU Invasive Alien Species Regulation.

Table 1. Desk study data sources

Data source	Accessed	Data obtained
Argyll and Bute Council website	08/02/2019	• LDP policies relevant to nature conservation. • Biodiversity Action Plan information. • Local non-statutory nature conservation designations within 1 km of the Site.
Google	26/02/2019	• Aerial imagery and Street view
NBN Atlas Scotland (commercially-available records only)	26/02/2019	• Recent biological records, defined as being from the year 2000 onwards (inclusive).
Ordnance Survey (OS) 1:25,000 maps	26/02/2019	• Habitats and connectivity relevant to interpretation of

and aerial photography		planning policy and potential protected / notable species constraints.
Scotland Environment webpage	26/02/2019	• Habitat Map of Scotland dataset. • Native Woodland Survey of Scotland.
Scottish Environment Protection Agency (SEPA) River Basin Management Plan (RBMP)	26/02/2019	• Status of waterbodies / watercourses.
SNH Natural Spaces webpage	26/02/2019	• Dataset for Ancient Woodland in Scotland.
SNH SiteLink webpage	26/02/2019	• International statutory designations within 10 km. • Other statutory designations within 2 km.

Limitations

Aerial photography and Google Street View imagery were utilised to glean an overview of habitats (and species) present within the Site. Google Street View Imagery was from 2016/2015 and aerial photography is from an unknown date. It is possible that habitats / conditions on Site have changed since these photos were taken. Furthermore, given the level of detail available from these sources, it is likely that some features on could not be viewed at all, or viewed in sufficient detail for robust appraisal.

Data used from the Scotland's Environment webpage to distinguish the main habitat types within the Desk Study Area is made up of the best available national data classified according to the European Nature Information System (EUNIS). Consequently, smaller habitat areas may not have been recorded. As such, a lack of habitat records does not necessarily mean they are absent and could still occur within the Desk Study Area.

Biological records information is dependent on records having been submitted for the area of interest. As such, a lack of records for particular habitats or species does not necessarily mean they are absent from the area of interest. Similarly, the presence of records for particular habitats and species does not automatically mean they still occur within the area of interest or are relevant. No specific data request was made to the local records centre (Argyll Biological Records Centre (ABRC)), however all records collated by this centre are available for commercial use on the NBN Atlas Scotland.

4. Results

Nature conservation designations

Statutory designations

Table 2 details the statutory nature conservation designations of sites identified by the desk study, based on the method given in Section 3 of this Report. The designations are listed in descending order, with those closest to the Site listed first. The locations of all sites described in Table 2 are illustrated on Figures 2 (internationally designated sites) and 3 (nationally designated sites).

Table 2. Sites with statutory designations for nature conservation

Designation	Reason(s) for designation	Relationship to the Site
Moine Mhor SAC, Site of Special Scientific Interest (SSSI) and National Nature Reserve (NNR)	Qualifying interests for which the site is designated as a SAC are active raised bogs, Atlantic salt meadows, degraded raised bogs, marsh fritillary butterfly *Euphydryas aurinia*, otter *Lutra lutra*, intertidal mudflats and sandflats and western acidic oak woodland. The site is designated as a SSSI for some features mentioned above and the breeding bird assemblage which includes hen harrier *Circus cyaneus*, short-eared owl *Asio flammeus*, red-breasted merganser *Mergus serrator*, redshank *Tringa totanus*, curlew *Numenius arquata* and snipe *Gallinago gallinago.* The presence of dragonfly species, osprey and hen harrier *Circus cyaneus* are mentioned in descriptions of the NNR. In winter the site is visited by Greenland white-fronted geese and greylag geese *Anser anser.*	The SAC and SSSI consist of multiple parts, all located close to one another. The part nearest to the Site is located 1.4 km to the north-east, and is separated from the Site by a mix of broadleaved woodland, conifer plantation, moorland with heather and grass fields. The NNR occupies a strip to the south of the largest part of the Site and is 1.6 km away.
Upper Loch Fyne and Loch Goil Marine Protected Area (MPA)	Designated due to the presence of burrowed mud, horse mussel *Modiolus modiolus* beds, flame shell *Limaria hians* beds, ocean quahog *Arctica islandica* aggregations and sublittoral mud and specific mixed sediment communities.	2.8 km east of the Site and connected to the Site by 3.7 km of coastline. Intervening land use is conifer plantation, moorland and semi-improved fields.
Knapdale Lochs SPA and SSSI	This site qualifies due to supporting a breeding population of European importance of black-throated diver *Gavia arctica.*	A multi-part Site of which three parts are within the Study Area. Loch Clachaig is located 3.4 km east of the Site, Loch Fuar-Bheinne is located 7.4 km to the south-east and Dubh Loch is located 9.5 km south-east. The intervening habitat appears to be a mix of broadleaved woodland, conifer plantation, moorland with heather and semi-improved grazed fields. The SPA and SSSI are coincident.
Taynish and Knapdale Woods SAC	Designated due to the presence of marsh fritillary butterfly, otter, western acidic oak woodland and clear- water lakes or lochs with aquatic vegetation and poor to moderate nutrient levels.	3.4 km west of the Site. The intervening habitat appears to be mainly broadleaved woodland, conifer plantation and moorland.
Loch Sween MPA	Designated due to the presence of burrowed mud, maerl beds, native oysters and sublittoral mud and mixed sediment communities.	6.3 km west of the Site on the opposite (west) coast, and separated by more than 100 km of coastline. The intervening terrestrial habitat appears to be mainly conifer plantation and moorland.
Tarbert Woods SAC	The primary reason for the designation of this site is the presence of western acidic oak woodland with holly *Ilex aquifolium* and hard fern *Blechnum* spp. The site comprises coastal strips of fragmented broad-leaved woodland with good stands of old sessile oak *Quercus petraea* woods, which are important for oceanic bryophyte communities.	This SAC is a multi-part site, of which one part is present within the Desk Study Area. This is 7.5 km south of the Site and is separated by conifer plantation, moorland with heather and semi-improved fields.
Inner Hebrides and	Considered to be the one of the best areas in the	Located 7.8 km west of the Site on the opposite

Designation	Reason(s) for designation	Relationship to the Site
the Minches SAC	United Kingdom for harbour porpoise *Phocoena phocoena.*	(west) coast and separated by moorland. Over 100 km of coastline separates the Site and the SAC.
Loch Sunart to the Sound of Jura MPA	Designated due to the presence of flame shell beds, northern feather star *Leptometra celtica* aggregation on mixed substrata and serpulid aggregations.	7.9 km north west of the Site on the opposite (west) coast and separated by more than 100 km of coastline. The intervening terrestrial habitat appears to be mainly conifer plantation and moorland.
Firth of Lorne SAC	Designated due to the presence of marine reefs.	The SAC is located 11.5 km north west of the Site, with its nearest part at Craignish Point. Over 200 km of coastline separates the Site and the SAC.

Non-statutory designations

Non-statutory designated sites (along with SSSIs and NNRs) are shown in Figure 2.2.

Local Nature Conservation Sites

A single Local Nature Conservation Site (LNCS) is present within 1 km of the Site, the location of which was found on the Argyll and Bute Local Development Plan 2015 Interactive Map. Lochgilphead LNCS is located within the Site boundary, covering the tidal area between Lochgilphead town and Loch Gilp. No further detail of this site could be found, however, based on an inspection of aerial photography and records provided by the NBN Atlas Scotland, it may be designated due to the presence of intertidal habitats and wading birds.

Ancient Woodland and Native Woodland Survey of Scotland

Numerous areas of woodland that appear on the Ancient Woodland Inventory are present within the Desk Study Area. Several areas of ancient woodland are located adjacent to the Crinan Canal on the west bank, with a small patch on the east.

The native woodland survey shows woodland to the west of the Crinan Canal to be a mixture of native woodland and (non-native) plantation woodland on ancient woodland sites (PAWS). However Google Streetview suggests that at least a thin strip adjacent to the canal within this area comprises mature broadleaved trees, with a non-native exotic conifer beyond (to which the PAWS probably refers).

Habitats

The following assessment of the habitats likely to be present on Site is based on a review of OS mapping and available aerial images only, and no verification has been carried out through field survey.

The Site comprises the tidal northern part of Loch Gilp, and three watercourses – the Crinan Canal, the Cuilarstich Burn and the Baddan Burn. At low tide, a large expanse of apparent intertidal mudflat is present in the area between Loch Gilp and Lochgilphead. To the north-west of this tidal area is a small area of woodland, grassland and scrub, with the potential for saltmarsh to occur around the watercourse in the north. Also to the north-east of the tidal area is the mouth of the Cuilarstich Burn.

The Cuilarstich Burn is crossed by Portalloch Street (the A83) and extends into the town of Lochgilphead where it passes through amenity land and is bordered by a thin strip of native woodland. The burn is also crossed by the Bishopton Road and above this enters a larger area of ancient and native woodland to the eastern extent of the Site.

The Badden Burn joins the Cuilarstich Burn approximately 200 m north of Portalloch Street. North of this, the Badden Burn flows through a wider area of grassland and woodland until a crossing on Bishopton Road. Beyond this, the burn takes on a more canalised character with only a thin strip of woodland and adjacent industrial and residential areas. From here, the Badden Burn exits the town, enters marshy grassland fields and is bordered by thin strips of woodland and scrub including gorse *Ulex europaeus*. North of the Badden Nursery, the Badden Burn swings round to meet the A816, which it follows for the remainder of its length. Here there burn is highly artificial and more similar to a slow-flowing drain. In places artificial banks are visible from Google Streetview. Adjacent vegetation is a grassy road verge to the west and ruderal vegetation to the east with occasional trees. The Badden Burn remains similar north of this, to the extent of the Site.

Both the Cuilarstich and Badden Burns were classed as having overall “Moderate” status from the SEPA River Basin Management Plan in 2016 and 2017 with “Moderate” ratings for invertebrate fauna. Prior to these years, ratings for macroinvertebrates had been consistently “Good”. “High” ratings were awarded to both burns for fish, including for fish access.

Works seen on Google Streetview appeared to show the digging of another drain-like watercourse parallel to the west of the A816.

The Crinan Canal is joined to Loch Gilp via locks in the village of Ardrishaig at the southern-most extent of the Site. The Canal passes through the village of Ardrishaig and then Lochgilphead, with bank vegetation consisting of amenity grassland and tall ruderal vegetation. North of this, the canal is bordered to the west by mixed woodland, including ancient woodland and woodland listed as Native on the Native Woodland for Scotland Survey, with semi-improved fields and conifer plantation beyond. To the east are houses, gardens and Loch Gilp. North of Lochgilphead, habitat on the western bank remains similar, with the eastern bank running adjacent to marshy grassland and occasional scrub. An area of potential wet woodland (an SBL habitat) is present between the canal and the A816, east of Achnabreac Cemetery. Google Streetview from the canals’ tow path shows an area of dense woodland in a depression. OS Mapping shows this area as a mix of wetland and woodland with a pond present, and records from the NBN Atlas Scotland describe the area as “willow carr”. This area is listed as ancient woodland and native woodland on the Ancient Woodland Inventory and Native Woodland Survey for Scotland, respectively.

The Crinan Canal was listed as having “Good ecological potential” on the SEPA River Basin Management Plan, but no information was given regarding fish or invertebrates. Objectives for 2021 include “High” ratings for fish migration, water quality and freedom from invasive species.

Protected and notable species

A list of protected and/or notable species for which records are held by the NBN Atlas Scotland, along with source accreditation, is provided in Appendix 2. Where records are referred to below, accreditation to the organisation which supplied the data (if known) is provided in brackets.

Mammals

Badger

Suitable habitat for sett creation is present on the wooded slopes in the wider area and associated farmland offers foraging opportunities. Marshy grassland adjacent to the Badden Burn is likely to be too damp for sett creation.

NBN Atlas Scotland, returned two records of badger, both killed on the road (ABRC and Highland Biological Records Centre (HBRC)). One of these from 2011 was found on Tarbert Road, between 400 m and 1.3 km south-west of the Site. The other was from 2016, but detailed location information was not provided.

Bats

Numerous buildings adjacent to the Site have the potential to support roosting bats, as do mature trees present throughout, for example adjacent to Bishopton Road and on the west bank of the canal. Tree lined areas of the Badden Burn within Lochgilphead and along the Crinan Canal offer opportunities for commuting and foraging bats.

NBN Atlas Scotland returned 22 recent records of four species of bats (Wild Surveys and Bat Conservation Trust (BCT)). Common pipistrelle *Pipistrellus pipistrellus* and brown long-eared bat *Plecotus auritus* were recorded to the north of the Site, at a minimum distance of 220 m west of the site boundary. The relevant 1 km grid square contains a section of the canal outwith the Site and what appears to be mixed plantation woodland and large areas of scrub. Additional records of brown long-eared bat were provided, but to 10 km accuracy only. Two common pipistrelle roosts were also recorded in 2013 and 2017 likely within the town, but precise locations were not provided. Single records of Natterer’s bat *Myotis nattereri* and Daubenton’s bat *Myotis daubentonii* from 2015 and 2007, respectively, were also identified, but these were to 10 km accuracy only.

Beaver

The site of the Scottish Beaver Trial in Knapdale Forest is located approximately 5 km to the west of the Site. Beavers *Castor fiber* from this site have been known to occasionally visit the Crinan Canal, and given the introduction of legislation giving beavers European Protected Species status, to come into force in Scotland in

May 2019, it is unclear how the species will continue to spread in this area. However, the Crinan Canal does not offer suitable habitat for beaver to make refuges or dams. The suitability of the Badden Burn is reduced in part by a lack of shading from trees and a high level of disturbance from roads and built up areas. However the suitability of those areas not directly adjacent to roads could not be assessed during this desk-based study.

No records of beaver were returned by the NBN Atlas Scotland.

Otter

The three watercourses and the tidal area offer suitable habitat for otter. Numerous opportunities for holt or lie up creation are present in woodland at the mouth of the Cuilarstich Burn, adjacent to Bishopton Road, on the west bank of the Crinan Canal and within wetland between the canal and Badden Burn, west of Achnabreac Cemetery.

Two SACs designated for otter are present to the west of the Site, and directly connected by the Crinan Canal. Moine Mhor SAC is located 3 km from the northern-most part of the Crinan Canal within the Site, and Taynish and Knapdale Woods SAC is 3.9 km north-west. Kruuk and Moorhouse (1991) suggest that the home range of otters can cover up to 16 km of a watercourse, thus if a suitable food source is present, it is feasible that otters from the SACs may use watercourses on Site at times.

No recent records of otter were returned by the NBN Atlas Scotland.

Pine marten and red squirrel

Suitable woodland habitat for pine marten and red squirrel is present along the western bank of the Crinan Canal, and in more isolated patches to the north east of the Badden Burn. Numerous opportunities for these species exist in woodland in the wider area.

A single 2014 record of pine marten was returned by the NBN Atlas Scotland (ABRC) from the northern-most part of the Site. A total of 56 recent records of red squirrel were returned (ABRC, Scottish Beavers and Scottish Wildlife Trust (SWT)). Records were spread throughout the area surrounding the Site, but concentrated in woodland along the banks of the loch, and to the north and east of the Site.

Water vole

The Crinan Canal and Badden Burn both have the potential to provide suitable open and slow flowing water habitats for water vole *Arvicola amphibius*. The Badden Burn alongside the A816 appears to have the necessary grassy banks and suitable slopes for burrow creation. The character of the banks of the Crinan Canal could not be determined, and if man-made (very likely) this may reduce the suitability for burrow creation by the species.

No records of water vole were returned by the NBN Atlas Scotland.

Wildcat

The mosaic of woodland, farmland and moorland in the wider area, for example to the west of the Crinan Canal near Craigglass, offers suitable habitat for hunting and sheltering wildcat *Felis silvestris*. The Site is located within the southern extent of the wildcats known range (Harris & Yalden, 2008); however it is not located near any of the Scottish Wildcat Action Priority Areas as listed on the Scottish Wildcat Action website.

Although suitable habitat does exist adjacent to the Site, the presence of human habitation has been shown to reduce wildcat activity, with Klar *et al* (2008) demonstrating displacement of 200 m around single houses and 900 m around settlements. The presence of the town of Lochgilphead and surrounding dwellings, roads and forestry operations therefore reduces the likelihood of wildcat presence.

No records of wildcat were returned by the NBN Atlas Scotland. The Scottish Wildcat Action website provided records of two hybrid cats and one pure wildcat from the Taynish peninsula, approximately 10 km west of the Site, although no date was attached to these.

Birds

A number of agricultural fields are present adjacent to the watercourses on Site which may offer potential foraging opportunities for species including Greenland white-fronted goose, which are known to over-winter on the Kintyre Peninsula, south of Lochgilphead.

The area surrounding the Site contains a mosaic of woodland and open moorland suitable for black grouse *Tetrao tetrix*. The NBN Atlas Scotland returned 26 records of black grouse, all from a 10 km grid square

overlapping a most of the Site, the most recent from 2011. The habitat present is also potentially suitable for hen harriers during the breeding and non-breeding seasons. Coniferous woodland adjacent to the Site also provides habitat for species such as common crossbill *Loxia curvirostra*. Single records of this species (from 1999) were returned by the NBN Atlas Scotland (provided by Royal Society for the Protection of Birds (RSPB)).

The combination of tidal mudflat and nearby farmland offers nesting and foraging opportunities for species such as curlew and redshank. The NBN database returned six records of curlew from 2016 (RSPB/ABRC), and ten records of redshank (RSPB) from 2003 – 2005. Records of the two species were concentrated around the tidal area to the south of the Site.

The Site is within the core breeding range of black-throated diver, and although no lochs suitable for breeding are present on Site, the shallow and sandy bottomed tidal inlet provides habitat for foraging. The NBN Atlas returned three records from May 2006 of black-throated diver in the tidal area (RSPB). Black-throated diver are known to use sea lochs to display, and breeding individuals commonly fly between breeding lochs and the coast to feed (Forrester and Andrews, 2007). Thus there is the potential for black-throated diver breeding within the Knapdale Lochs SPA and SSSI to use the Site.

Habitats throughout the Site offer suitable foraging and nesting opportunities for a range of common bird species.

Reptiles and amphibians

The mosaic of woodland and grassland habitats on Site and in the wider area is suitable for reptile species including adder *Vipera berus*.

The NBN Atlas Scotland returned a single 2015 record of adder (ABRC). This was from a 1 km grid square north east of the Site, 35 m from the Badden Burn at its nearest point.

A single pond and several areas of wetland with the potential to support amphibian species could be identified from aerial photography. The pond is located between the Crinan Canal and A816, and wetland is located on the opposite bank of the canal, as well as to the east of the Badden Burn near Achnabreac House. A second pond may be present on the opposite bank of the canal, south of the first pond, although this could not be seen from aerial photography. The Amphibian and Reptile Group UK (ArgUK) Advice Note 5 indicates that the Site is located in a zone unsuitable for great crested newt *Triturus cristatus*; however the JNCC website suggests that the species has been recorded on the Kintyre Peninsula, south of Lochgilphead.

A single record of common toad *Bufo bufo* (2009) was returned by the NBN Atlas Scotland.

Fish

Both the Cuilarstich and Badden Burns have received “High” ratings in regards to fish access since 2012. From Streetview and aerial photography, suitable habitat for spawning Atlantic salmon *Salmo salar* and sea/brown trout *Salmo trutta* appears to be present and there is the potential for both species to occur. No information regarding the status of fish in the Crinan Canal was given, however, as access to the sea would be through locks at Crinan and Ardrishaig, it is unlikely that Atlantic salmon and sea trout can gain access, and suitable spawning habitat is likely to be absent. However there is the potential for resident brown trout and European eel *Anguila anguila* to occur within the canal.

There is the potential for depositions of sediment to be present offering habitat for lamprey species; however this could not be assessed during the desk study.

No recent records of freshwater fish species were returned by the NBN Atlas Scotland. However, Atlantic salmon, European eel and brown/sea trout were recorded (by ABRC) at the mouth of the Cuilarstich Burn where Poltalloch Street crosses in 1990. Records of common marine species including viviparous blenny *Zoarces viviparous* and dogfish *Scyliorhinus canicula* were also returned from Loch Gilp (SNH).

Invertebrates

Butterflies

Habitats throughout the Site have the potential to support notable butterfly species. For example, the marshy and tussocky grassland adjacent to the Badden Burn is suitable for marsh fritillary, and the combination of marshy grassland, woodland and heathland in the wider area offers opportunities for small pearl-bordered fritillary *Boloria selene*, both listed on Schedule 5 of the Wildlife and Countryside act and the Scottish Biodiversity List.

The NBN Atlas returned a single record of small pearl-bordered fritillary from 2016 (ABRC), in conifer plantation to the east of Lochgilphead.

Freshwater invertebrates

Records of thirteen species of dragonfly and damselfly were returned (all British Dragonfly Society Recording Scheme) from the Crinan Canal between 2001 and 2014. Seven species were recorded at the pond within the potential wet woodland west of Achnabreac Cemetery. The large diversity of species indicates an unpolluted waterbody.

The NBN Atlas Scotland returned data from freshwater invertebrate surveys undertaken across numerous sites on the Cuilarstich Burn, Badden Burn and Crinan Canal by SEPA in 2005 and 2006. A range of invertebrates were found including numerous species of aquatic beetle, stonefly, caddisfly, mayfly, true-fly and freshwater snail, and this biodiversity indicates good water quality.

Marine invertebrates

The coastal area 1 km to the west of the Site has the potential to support numerous marine species. For example, the NBN Atlas Scotland returned records of several polychaete worms, anemones, starfish, crabs and mollusc species (Seasearch) and the notable ocean quahog for which the nearby Upper Loch Fyne and Loch Goil MPA is designated.

Lichens and bryophytes

No recent records of notable lichen species were returned by the NBN Atlas Scotland. However, two SBL species of lichen, *Cladonia norvenica,* which is Nationally Rare, and *Bactrospora homalotropa,* which is Nationally Scarce, were returned from 1991, approximately 1 km north of the Site. These species both grow on trees and dead or decaying wood.

No bryophyte records were found on the NBN Atlas Scotland, however particular broadleaved woodland habitat in this geographical location is known to support notable bryophyte (moss and liverwort) communities. The Cuilarstich Burn is included in the SNH commissioned project 'Bryological assessment for hydroelectric schemes[1] in the West Highlands' (Averis *et al*, 2012). It was categorised as not surveyed but not likely to be important for notable oceanic bryophyte communities based on factors such as topography and habitat.

Invasive non-native species

Sika deer *Cervus nippon*, are known to be present in the region and may be present in the wooded areas on Site. NBN Atlas Scotland returned recent records of this species from woodland adjacent to the east and west of the Site.

Records of New Zealand flatworm *Arthurdendyus triangulatus* were provided by the NBN Atlas Scotland (SNH) from Ardrishaig in 2004 and Lochgilphead in 2002 and 2011.

The NBN Atlas Scotland returned records of several invasive non-native plant species (all ABRC). Records of Himalayan balsam *Impatiens glandulifera*, Japanese knotweed *Reynoutria japonica* and salmonberry *Rubus spectabilis* were returned from within Lochgilphead itself, with specific records of Japanese knotweed and Himalayan balsam from 2016 at the mouth of the Cuilarstich Burn. Further 2016 records of Himalayan balsam, Japanese knotweed, salmonberry and rhododendron *Rhododendron ponticum* were returned from east of the tidal area, in the Kilmory area. A single 2015 record of pirri-pirri burr *Acaena novae-zelandiae* was returned from north-west of the Site along the Crinan Canal. New Zealand willowherb *Epilobium brunnescens*, a commonly occurring non-native species, was also recorded within Lochgilphead and immediately east and west of the northernmost point of the Site. Given the proximity to the town of Lochgilphead, and connectivity provided by travel along the A816 and Crinan Canal, there is the potential for other non-native (potentially invasive) plants, including garden escapes, to occur.

[1] Although this assessment related specifically to hydro-electric schemes, flood schemes have the potential to result in changes in hydrology and therefore similar impacts.

5. Ecological constraints and recommendations

Approach to the identification of ecological constraints

Relevant ecological features that may represent constraints to the Scheme, or that provide opportunities to deliver ecological enhancement in accordance with planning policy, are identified in Section 4 of this Report.

Scottish Planning Policy and local planning policy (summarised in Section 2 of this Report) specify requirements for the protection of features of importance for biodiversity, and requirements for the protection of sites of conservation importance. Planning policy is a material consideration when determining planning applications.

Compliance with planning policy requires that the proposed works considers and engages the following mitigation hierarchy where there is potential for impacts on relevant ecological receptors:

1. avoid features where possible;
2. minimise impact by design, method of working or other measures; and,
3. compensate for significant residual impacts, for example by providing suitable habitats.

This hierarchy requires the highest level to be applied where possible. The rationale for the proposed mitigation and/or compensation should be provided with planning applications, including sufficient detail to show that these measures are feasible and would be provided.

The likelihood of the relevant ecological features constraining the proposed works has been assessed with reference to the scale described in Table 3. The higher the importance of the ecological receptor for the conservation of biodiversity at national and local scales, the more likely it is to be a material consideration during determination of the planning application for the proposed works.

In pursuance of the objective within Scottish Planning Policy of providing biodiversity benefits where possible, consideration should be given (where appropriate) to scope for enhancement as part of the proposed works. This should represent biodiversity gain over and above that achieved through mitigation and compensation. Enhancement could be achieved on and/or off the Site.

Table 3. Scale of constraint to development

Likelihood	Definition
High	An actual or potential constraint that is subject to relevant legal protection and is likely to be a material consideration in determining the planning application (e.g. statutory nature conservation designations and European/nationally protected species). Further survey likely to be required (as detailed in this report) to support a planning application.
Medium	An actual or potential constraint that is covered by national or local planning policy and, depending on the level of the potential impact as a result of the proposed works, may be a material consideration in determining the planning application. Further survey may be required (as detailed in this report) to support a planning application.
Low	Unlikely to be a constraint to works or require further survey prior to submission of a planning application. Mitigation is likely to be covered under Construction Environmental Management Plan (CEMP) or precautionary working method statement (e.g. generic requirements for the management of nesting bird risks).

Constraints and recommendations: designations

Statutory designations

Moine Mhor SAC (and SSSI / NNR) and Taynish and Knapdale Woods SAC are designated in part due to the presence of otter. As mentioned in Section 4.3.1.4, there is the potential for otter associated with these SACs to use suitable habitat on the Site at times.

Furthermore, both SACs are also designated for the presence of marsh fritillary butterfly. Although adults of this species are described as being relatively sedentary, habitat on Site is suitable for the species (see Section 4.3.5.1) and it is possible that outlier populations may be present on Site and these could contribute to the SAC population.

Both SACs are also designated due to the presence of habitats including western acidic oak woodland. The distance from the Scheme is considered sufficient to mean there will be no impacts on these habitats.

Knapdale Lochs SPA (and SSSI) is designated solely for supporting breeding black-throated diver. The tidal area on Site is considered suitable for this species and they have been recorded there during the breeding season. Thus there is the potential for breeding black-throated diver to travel to the Site to feed.

The above three European protected sites qualify for populations of species which may utilise land within the Scheme area. Such land may therefore be functional to the SAC/SPA and effects upon it may negatively affect the integrity of the SAC/SPA. Therefore, if potential pathways for impacts are identified between the Scheme and the sites cannot be ruled out (in the absence of mitigation), it is recommended that the Scheme is subject to a Habitats Regulations Appraisal (HRA). The purpose of HRA is to formally establish whether construction of the Scheme, in the absence of any mitigation, will have Likely Significant Effects (LSE) on the European sites identified. There is a high likelihood that, given the nature of the Scheme and the probable works associated with it, embedded mitigation can be designed to remove the potential for LSE on the European sites identified.

Given the above, the Moine Mhor SAC, Taynish and Knapdale Woods SAC and Knapdale Lochs SPA (including all national designations also) are considered to pose a **Medium** constraint to the Scheme.

Other European designated sites are present some distance from the Site. Tarbert Woods SAC, Inner Hebrides and the Minches SAC and Firth of Lorne SAC are located 7.5 km, 7.8 km and 11.5 km distant, respectively. None are directly connected to the Site, however indirect connectivity via coastal waters exists which may facilitate pollution effects. However the very large distances involves render this pathway unviable. Given this lack of connectivity and the qualifying interests for which the sites are designated, these protected sites are considered to pose **No** constraint to the Scheme.

Loch Sween MPA and Loch Sunart to the Sound of Jura MPA are separated from the sites by over 100 km of coastline. Upper Loch Fyne and Loch Goil MPA is separated from the Site by 3.7 km of coastline. Under the legislation by which MPAs are protected (the Marine (Scotland) Act), Scottish Ministers must be notified by a public authority if “the exercise of any of the authority’s functions, or an activity that the authority intends to carry out, will significantly hinder the conservation objectives of a MPA – unless guidance has been given previously”. Pollution prevention measures will form an integral part of the Scheme during both construction and operation, as required by law. Due to these strict requirements, the very large distances between the Scheme and these MPAs and the dilution effects involved, no impacts upon them as a result of the Scheme are anticipated. Therefore they are considered to pose **No** constraint to the Scheme and consultation under the Marine (Scotland) Act is not considered necessary.

Non statutory designations

Lochgilphead LNCS

Lochgilphead LNCS is located within the Site and comprises the intertidal area. The Site is potentially designated due to the presence of intertidal habitat and wading birds, however this could not be confirmed. Thus there is the potential for the LNCS to be negatively affected, depending on the scope of works. LNCS do not receive any specific legal protection, but have been highlighted as important to local nature conservation / biodiversity. If this site will be affected by works, further survey may be required to assess if it hosts notable habitats or species (likely to be the case, by virtue of its designation), and mitigation relating to these may be required.

Lochgilphead LNCS is therefor considered to pose a **Medium** level constraint to the Scheme.

Ancient Woodland

Large areas of ancient woodland are present on Site, with the majority adjacent to the west of the Crinan Canal. Other areas are present including the potential wet woodland east of the canal, and on the Cuilarstich Burn to the eastern extent of the Site.

National planning policy states that ancient woodland should be protected and enhanced (along with other native and long-established woodlands with high nature conservation value). If woodland habitat is likely to be affected by works (during construction or operation) either directly or indirectly (i.e. via pollution via watercourses) further survey is recommended to collect data on woodland types present. These may take the form of either Phase 1 habitat survey, and/or National Vegetation Classification (NVC) survey in areas of particularly diverse vegetation or where there may be groundwater dependent terrestrial ecosystems (GWDTE) (a SEPA requirement). If ancient woodland is lost to the Scheme, this would constitute a permanent adverse effect, i.e. it cannot be mitigated (replaced) in the long term.

Ancient woodland therefore poses a **Medium** constraint.

Constraints and recommendations: habitats

The Badden and Cuilarstich burns have the potential to qualify as SBL river and stream habitats if they support six or more species listed under Criterion B of the Priority Habitat Description. These species could include Atlantic salmon, brown / sea trout, European eel, water vole, otter, three lamprey species and soprano pipistrelle, several of which may potentially be present. As mentioned in Section 4.2, both burns received a Moderate overall status on the SEPA River Basin Management Water Environment Hub due to invertebrate fauna for the years 2017/2016. Furthermore, rivers are a priority habitat in the LBAP and may support several notable species such as otter and fish.

Woodland not included within the AWI, but which may have comparable ecological value, is present on Site. There is also the potential for wet woodland, an SBL habitat, to be present adjacent to the east of the canal, west of Achnabreac cemetery.

There is the potential for saltmarsh, an SBL habitat, to be present to the north west of the intertidal area.

Other habitats which are not notable are likely to be present on Site including conifer plantation and species-poor grassland. These habitats may support notable species, although they have limited ecological value themselves.

Habitats could not be fully assessed using aerial imagery, however it is considered likely that notable habitats (such as ancient woodland) are present on Site. It is recommended that where habitats may be affected by the Scheme, a Phase 1 habitat survey is carried out to identify the habitat types present. It may also be necessary to carry out NVC survey in areas of particularly diverse vegetation or where there may be GWDTE (a SEPA requirement). Where river / stream habitat may be affected, appropriate aquatic habitat surveys (such as River Habitat Survey (RHS)) may be required.

If notable habitats are affected by the Scheme, following biodiversity best practice these should be remediated / replaced like-for-like. Notable habitats therefore pose a **Medium** constraint to the Scheme.

Constraints and recommendations: species

Mammals

Badger

Suitable habitat for badger is present on Site. Badger are specially protected by the Protection of Badgers Act, thus survey for this species should take place if works will affect suitable habitat. If badger refuges are present and may be disturbed / destroyed during works, mitigation (including obtaining licences from SNH) will be required.

Badger is considered to be a **Medium** level constraint to the Scheme.

Bats

Bats are European Protected Species and receive strict legal protection under the WCA.

Suitable habitat and roosting opportunities for bats are present across the Site, especially within Lochgilphead and in woodland west of the canal. If trees or buildings are to be impacted by the Scheme (during preliminary works, construction or operation) they should be subject to assessment of their suitability to roosting bats. Depending on the results of this assessment, further surveys may be required and this could take several forms. Surveys could include further ground-based investigations using an endoscope, survey of the features at height (using a ladder or climbing techniques) and / or dusk emergence / dawn re-entry surveys during the bat activity season. Activity surveys would also be beneficial in investigating the use of habitat present by bats. A suitable survey programme should be devised and surveys should follow the guidelines published by the Bat Conservation Trust (BCT) in Collins (2016). If bat roosts are found to be present and may be disturbed / destroyed during works, mitigation (including obtaining licences from SNH) will be required.

Bat species have the potential to pose a **Medium** level constraint to the Scheme.

Beaver

Beaver will be subject to full legal protection from May 2019.

If works affect habitat suitable for this species, survey for beaver should be undertaken. If beaver refuges are present and may be disturbed / destroyed during works, mitigation (including obtaining licences from SNH) will be required. Beavers have the potential to present a **Medium** level constraint to the Scheme.

Otter

Watercourses, waterbodies and wetlands across the Site are suitable for otter and it is considered likely that the species is present. Otter are EPS and it is therefore recommended that survey for this species be carried out in areas of watercourse which will be disturbed. Furthermore, there is the potential for otter from the nearby SACs to use the Site.

If otter refuges are present and may be disturbed / destroyed during works, mitigation (including obtaining licences from SNH) will be required. Given their protection and close association of this species and the Scheme with watercourses, otter has the potential to present a **High** level constraint to the Scheme.

Pine marten and red squirrel

Suitable woodland habitat is available for both pine marten and red squirrel throughout the Site, especially to the west of the canal. Both species are protected under the WCA, and if the Scheme involves disturbing suitable habitat, it would be necessary to conduct surveys for both species.

If pine marten / squirrel refuges are present and may be disturbed / destroyed during works, mitigation (including obtaining licences from SNH) will be required. These species are considered likely to be present and may present a **Medium** level constraint to the Scheme.

Water vole

Some suitable habitat is present on Site for water vole. Water vole burrows are protected by the WCA, thus it is suggested that surveys for the species are undertaken if suitable habitat will be disturbed.

If water vole refuges are present and may be disturbed / destroyed during works, mitigation (including obtaining licences from SNH) will be required. Given their protection and close association of this species and the Scheme with watercourses, water vole is considered to present a **Medium** level constraint to the Scheme.

Wildcat

The mosaic of habitats required by wildcat is present in the wider area, and the Site is within the known range of the species (although proximity of the Scheme to human habitation reduces their potential to be present). Wildcat are EPS and it is therefore recommended that wildcat surveys be undertaken if suitable habitat for this species will be disturbed.

If wild cat refuges are present and may be disturbed / destroyed during works, mitigation (including obtaining licences from SNH) will be required. Wildcat is therefore considered to present a **Medium** level constraint to the Scheme.

Birds

Black-throated diver (a Schedule 1 (WCA) species and qualifying interest of the Knapdale Loch SPA) has previously been recorded in the intertidal area of Lochgilphead within the Site. Birds from the SPA (located 3.4

km east) may feed in this area. Records of barn owl (Schedule 1 (WCA)) were returned and potentially suitable roosting and foraging habitat for this species is present within the Site.

In the wider area of the Scheme there is a suitable mosaic of woodland and heather moorland suitable for black grouse (an SBL and LBAP species), and on site there is marshy grassland habitat suitable for hen harrier (WCA Schedule 1). Coniferous woodland adjacent to the Site may support populations of common crossbill (WCA Schedule 1).

Tidal mudflats within the Site offer nesting and foraging habitat for curlew (included on the SBL, LBAP and BoCC red list), and redshank. (LBAP).

Given the above, the Scheme may affect notable bird species and specific bird surveys may be required, notable bird species therefore represent a **Medium** constraint to the Scheme.

There is potential for common breeding bird species to be present throughout the Site, assemblages of which may be important locally and require specific mitigation. If suitable habitat for such assemblages of breeding birds will be affected, it is recommended that a programme of breeding bird surveys be undertaken to identify the species present and any mitigation required, Furthermore, active nests of all wild birds are protected under the WCA, this should be noted during preparations for pre-construction or construction works.

Common breeding birds are considered to be a **Medium** level constraint to the Scheme.

Reptiles and amphibians

Habitat potentially suitable for adder (and other notable reptiles such as slow worm *Anguis fragilis*) is present on Site. All native reptiles are protected from intentional or reckless killing or injury under the WCA, and both adder and slow worm are SBL species.

If suitable habitat for notable reptile species may be affected by the Scheme, further survey and mitigation may be required. Notable reptiles therefore present a **Low** level constraint to the Scheme.

Habitat potentially suitable for great crested newt (EPS) is present on Site, and given the nature of the Scheme there is higher risk of impacts upon the aquatic environment (on which this species depends). It is therefore recommended that Habitat Suitability Index (HSI) surveys of all waterbodies within 250 m of the Scheme are carried out. If waterbodies are found to be suitable for great crested newt, and may be affected by works, further surveys potentially consisting of eDNA analysis and subsequent trapping and torching may be required to investigate their presence and inform mitigation requirements. If great crested newt are present and may be disturbed / habitats destroyed during works, mitigation (including obtaining licences from SNH) will be required.

Other notable amphibians may be present (e.g. common toad, an SBL species), however such species are common and widespread and their presence is only likely to require standard mitigation measures to avoid direct harm.

Therefore notable amphibians (including great crested newt) have the potential to be a **Medium** level constraint to the Scheme.

Fish

Both Badden and Cuilarstich Burns were assessed as having “High” accessibility to fish (based on assessment data available between 20112 and 2017), and habitat for Atlantic salmon and trout appears to be present. Suitability for lamprey specie could not be assessed. It is important for local fish populations that accessibility is maintained.

It is recommended that the local fisheries group is consulted to investigate the potential presence of notable fish species in the burns and canal, to understand the local fisheries ecology such as timings of runs / spawning periods and in regards to barriers to fish migration.

As the Scheme works are inherently associated with watercourses, the works could have adverse effects on notable fish species (if found to be present following the investigations described above), either directly or indirectly and during construction or operation.

If notable fish species or their habitats may be affected by the Scheme, further survey will be required.

Given the close association of both fish species and the Scheme with watercourses, fish are considered a **Medium** level constraint to the Scheme.

Invertebrates

Given the habitats present, there is the potential for notable butterfly species such as marsh fritillary and small pearl-bordered fritillary to occur on Site. The pond within wetland to the east of the canal also has the potential to support a range of dragonflies and damselflies, as would any slower flowing sections of watercourses within the Site. Notable macrophytic invertebrates may also be present within both freshwater and marine habitats.

If terrestrial or aquatic habitats will be affected by the Scheme, invertebrate surveys are recommended. These may inform appropriate detailed design of the Scheme, or inform habitat mitigation recommendations.

Notable invertebrates are considered to pose a **Low** level constraint to the Scheme.

Lichens and bryophytes

Notable lichen species were recorded near to the Site, and it is known that notable species / assemblages of lichens and bryophytes exist within the general Scheme area. Certain bryophyte species are closely associated with watercourses and highly dependent on specific micro-habitats and can be affected by minor changes in inundation / splashing / humidity). Such species, if present within the Scheme area, may be significantly affected by any changes to watercourses and associated hydrology. The Cuilarstich Burn is included in the SNH commissioned project 'Bryological assessment for hydroelectric schemes in the West Highlands' (Averis *et al*, 2012). It was categorised as not surveyed but not likely to be important based on factors such as topography and habitat. Consequently the assessment recommends that a bryologist be consulted to advise if a bryological survey is required regarding hydro-electric schemes on this watercourse.

If the Scheme affects habitats with the potential to host notable lichen / bryophyte communities, further survey (or consultation regarding survey requirements) for these species is recommended. Results of these surveys may inform the detailed design of the Scheme, or inform mitigation requirements. Therefore, notable species / assemblages of lichens and bryophytes are considered to pose a **Low** level constraint to the Scheme.

Invasive non-native species

Sika deer are non-native to the UK and as such (under the WANE Act) it is an offence to release this species or allow it to escape from captivity – such actions are not relevant to the Scheme and as such this species is not considered further.

Six non-native, potentially invasive species have been recorded within the Scheme area. These are rhododendron and Japanese knotweed (considered high risk species given their inclusion on Schedule 9 of the WCA (although this no longer applies in Scotland)), Himalayan balsam (high risk - included on Schedule 9 of WCA and EU IAS), salmonberry, pirri-pirri burr and New Zealand willowherb. It is also possible that other non-native, potentially invasive, plant species are present. The non-native invertebrate New Zealand flat worm was recorded as present in the desk study.

It is an offence under the Wildlife and Natural Environment Act (Scotland) Act 2011 (as amended) to plant, or otherwise cause to grow, any plant in the wild at a location outside its native range. There are therefore considered to be two primary risks regarding the Scheme and invasive non-native species: the potential movement of invasive plant material during construction (i.e. a direct effect), and effects associated with the nature of the Scheme which will involve amendments to watercourses, culverts and discharge locations which could facilitate new movement / increased movement of such species indirectly.

With regard to non-native species, if charged with committing an offence, it is a defence against prosecution to prove that all reasonable steps were taken and all due diligence exercised in attempting to avoid committing the offence. Therefore, to demonstrate due diligence and avoid the accidental spread of the non-native species, they should be subject to specific survey (where possible, i.e. not feasible for New Zealand flat worm) at an appropriate time of the year, and encompassed within a Biosecurity Management Plan (BMP). This document will record the known locations of relevant species (both terrestrial and aquatic), assess the risk they pose to the project (once a detailed design is chosen) and set out proportionate measures to be implemented to control these risks. Construction and operational risks should be considered. Careful consideration of species-specific management is also required as all non-native species have differing methods and timings of dispersal. Where possible, works should aim to avoid invasive non-native species (plus a suitable buffer) entirely and appropriate

biosecurity (cleaning of machinery etc.) must be described in the BMP and fully employed. The BMP must be strictly adhered to and inform all stages of the work proposed, including preliminary tasks such as ground investigation.

Non-native invasive plant species are deemed to pose a **Medium** constraint to Scheme.

6. Summary

Several ecological features may be present on Site, as described in this Report. If present, notable ecological features may to pose constraints to the Scheme and these have been discussed in Section 5 and are summarised in Table 6, below. Where potential constraints have been identified, high-level recommendations for further ecological survey work and possible requirements for mitigation have been provided. Features discussed above and assessed as being likely to pose no constraint to the Scheme are not included in Table 6.

Table 6. Summary of potential ecological constraints and recommended further action

Receptor	Scale of constraint	Further action, including surveys and potential mitigation	Primary driver	When is action likely to be required		
				To inform design	Before planning application	Pre-construction onwards
Moine Mhor SAC/ SSSI/NNR,Taynish and Knapdale Woods SAC and Knapdale Lochs SPA/SSSI	Medium	HRA to formally assess potential for likely significant effects on the SPA/SAC Potential field work required to inform HRA.	Legislation	✓	✓	
Lochgilphead LNCS	Medium	If affected further survey for notable habitats / species and consequent mitigation may be required.	Planning policy	✓	✓	
Ancient Woodland	Medium	Avoid ancient woodland removal (and removal of other woodland with high nature conservation value). Further survey to identify ancient woodland areas which may be affected. If removed mitigation is not possible.	Planning policy	✓	✓	
Notable habitats	Medium	Avoid adversely affecting notable habitats such as streams, woodland and saltmarsh. Survey will be required to assess if notable habitats are present within the Scheme area. If notable habitats are adversely affected, these must be remediated / replaced.	Legislation	✓	✓	
Badger	Medium	Survey of suitable habitat within zone of influence of Scheme. If refuges are located within disturbance distance mitigation / licensing will be required.	Legislation	✓	✓	✓
Bat species	Medium	Survey of suitable habitat within zone of influence of Scheme for roost suitability and activity. If structures/trees suitable as roosts are located within disturbance distance, further survey will be required alongside potential mitigation / licensing.	Legislation	✓	✓	✓
Beaver	Medium	Survey of suitable habitat within zone of influence of Scheme. If refuges are located within disturbance distance mitigation / licensing will be required.		✓	✓	✓
Otter	High	Survey of suitable habitat within zone of influence of Scheme. If refuges are located within disturbance distance mitigation / licensing will be required.	Legislation	✓	✓	✓

Receptor	Scale of constraint	Further action, including surveys and potential mitigation	Primary driver	When is action likely to be required		
				To inform design	Before planning application	Pre-construction onwards
Pine marten and red squirrel	Medium	Survey of suitable habitat within zone of influence of Scheme. If refuges are located within disturbance distance mitigation / licensing will be required.	Legislation	✓	✓	✓
Watervole	Medium	Survey of suitable habitat within zone of influence of Scheme. If refuges are located within disturbance distance mitigation / licensing will be required	Legislation	✓	✓	✓
Wildcat	Medium	Survey of suitable habitat within zone of influence of Scheme. If refuges are located within disturbance distance mitigation / licensing will be required	Legislation	✓	✓	✓
Notable bird species	Medium	Species specific survey if relevant habitats will be affected. Implementation of specific mitigation.	Legislation	✓	✓	✓
Common breeding bird species	Medium	Although not notable, assemblages of common bird species may be affected. Survey may be required depending on habitat affected. Mitigation to avoid offences regarding disturbance / obstruction / destruction of active bird nests.	Legislation	✓	✓	✓
Notable reptiles	Low	Survey / mitigation if suitable retile habitat will be affected.	Legislation	✓	✓	✓
Notable amphibians (including great crested newt)	Medium	HSI surveys required for waterbodies within 250 m of the Scheme. If waterbodies are found to be suitable, and likely to be affected by the Scheme, further surveys to investigate the presence / absence of this species may be required. If great crested newt are located within disturbance distance mitigation / licensing will be required. Standard mitigation required for common amphibians.	Legislation	✓	✓	✓
Fish	Medium	Consultation with local fisheries trusts to investigate presence of notable species, local ecology and barriers to fish migration. Survey of suitable habitat within zone of influence of Scheme. Implementation of specific mitigation.	Legislation	✓	✓	✓
Notable invertebrates	Low	Survey for terrestrial / aquatic invertebrates if suitable habitat will be affected.	Legislation	✓	✓	✓

Receptor	Scale of constraint	Further action, including surveys and potential mitigation	Primary driver	When is action likely to be required		
				To inform design	Before planning application	Pre-construction onwards
		Implementation of specific mitigation if required.				
Notable lichens and bryophytes	Low	If suitable habitat for these species will be affected, consultation / further survey required. If significant assemblages present, specific mitigation to be implemented.	Planning policy	✓	✓	✓
Invasive non-native species	Medium	Dedicated survey for terrestrial and aquatic species within Scheme area. If present (highly likely) production of a Biosecurity Management Plan (BMP) to be strictly adhered to.	Legislation	✓	✓	✓

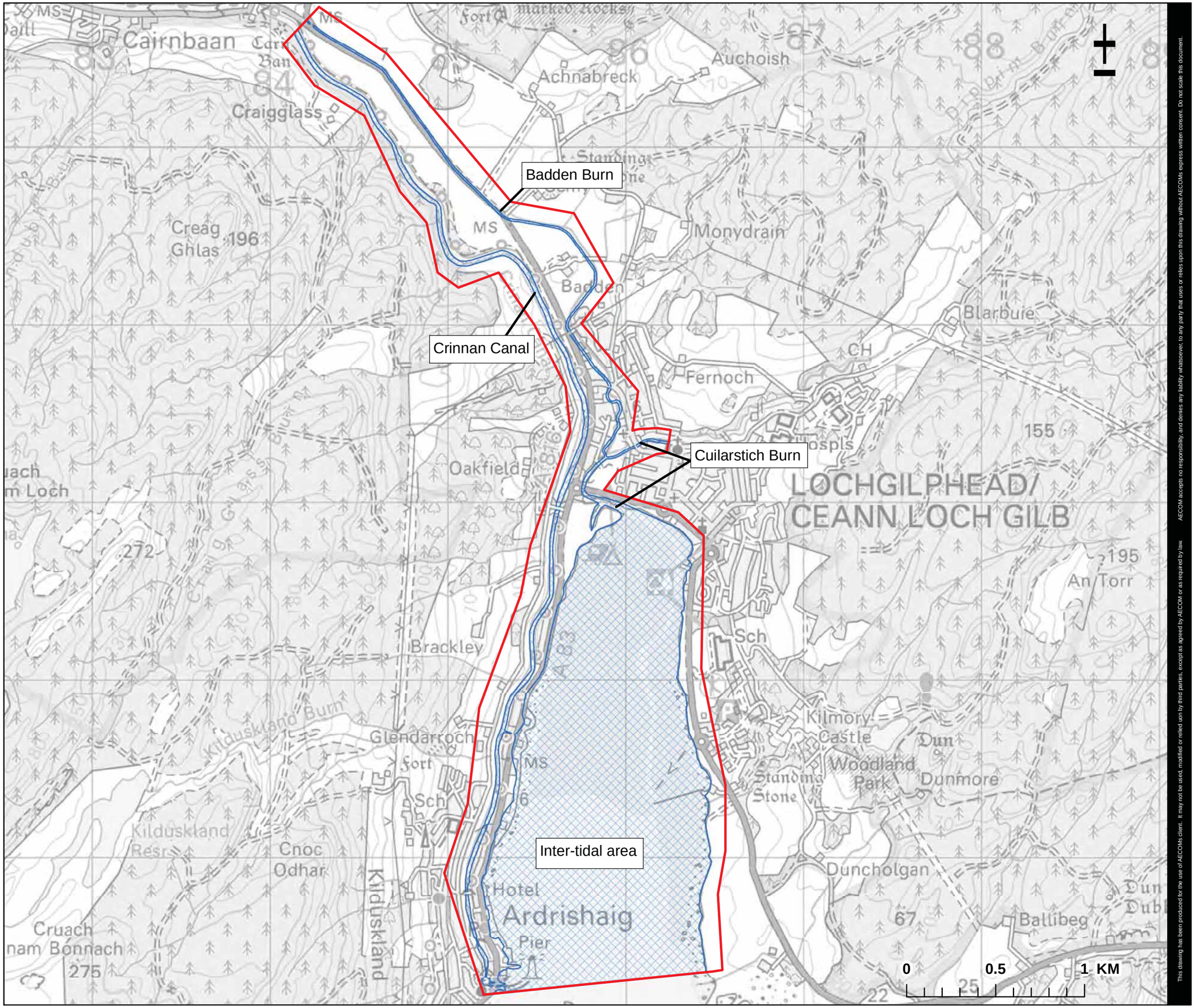
7. Enhancement

National planning policy outlines that the planning system should seek biodiversity benefits from new development where possible. The proposed Scheme could incorporate a number of ecological enhancement measures and this concept should be built-in to the Scheme from an early stage and refined as the Scheme progresses. Suggestions for potential enhancement measure are outlined below:

- The burns within the Scheme area may have a number of modifications such as culverts which may affect the presence of protected and notable species. Removing obstacles to migration (for both fish and mammals such as otter) and improving the immediate riparian habitat to improve connectivity could constitute significant ecological enhancement as part of the scheme.
- Vegetation planting upstream to attenuate and store water flow before it reaches the flood risk area could increase ecologically valuable habitat and could constitute significant ecological enhancement. Areas of proposed planting would have to be carefully selected to ensure a net gain in biodiversity is achieved, and that the natural function of ecologically valuable habitats is maintained (including land which may be functional to specially protected sites as noted above).
- If non-native species are found to be present these will need to be managed, most likely through the production of an Invasive Species Biosecurity Management Plan (BMP). If such plans are required these would constitute an ecological benefit in themselves by cataloguing the species present and avoiding the further spread of such species. There is potential to widen the ecological benefit of such plans by increasing their scope to the entire catchment(s) (which in this area is not particularly large). A catchment-wide approach will have far-reaching ecological benefit and may help to address the risk of invasive-non-native species spreading back into the Scheme area in the future.

8. Figures

Project Management Initials: SH Designer: JD Checked: SM Approved: TM



AECOM

PROJECT

Lochgilphead Flood Study

CLIENT

Argyll and Bute Council

KEY:

Approximate Site boundary

Water courses and bodies of interest

Scale: 1:20,000 @ A3

PROJECT NUMBER

60578115

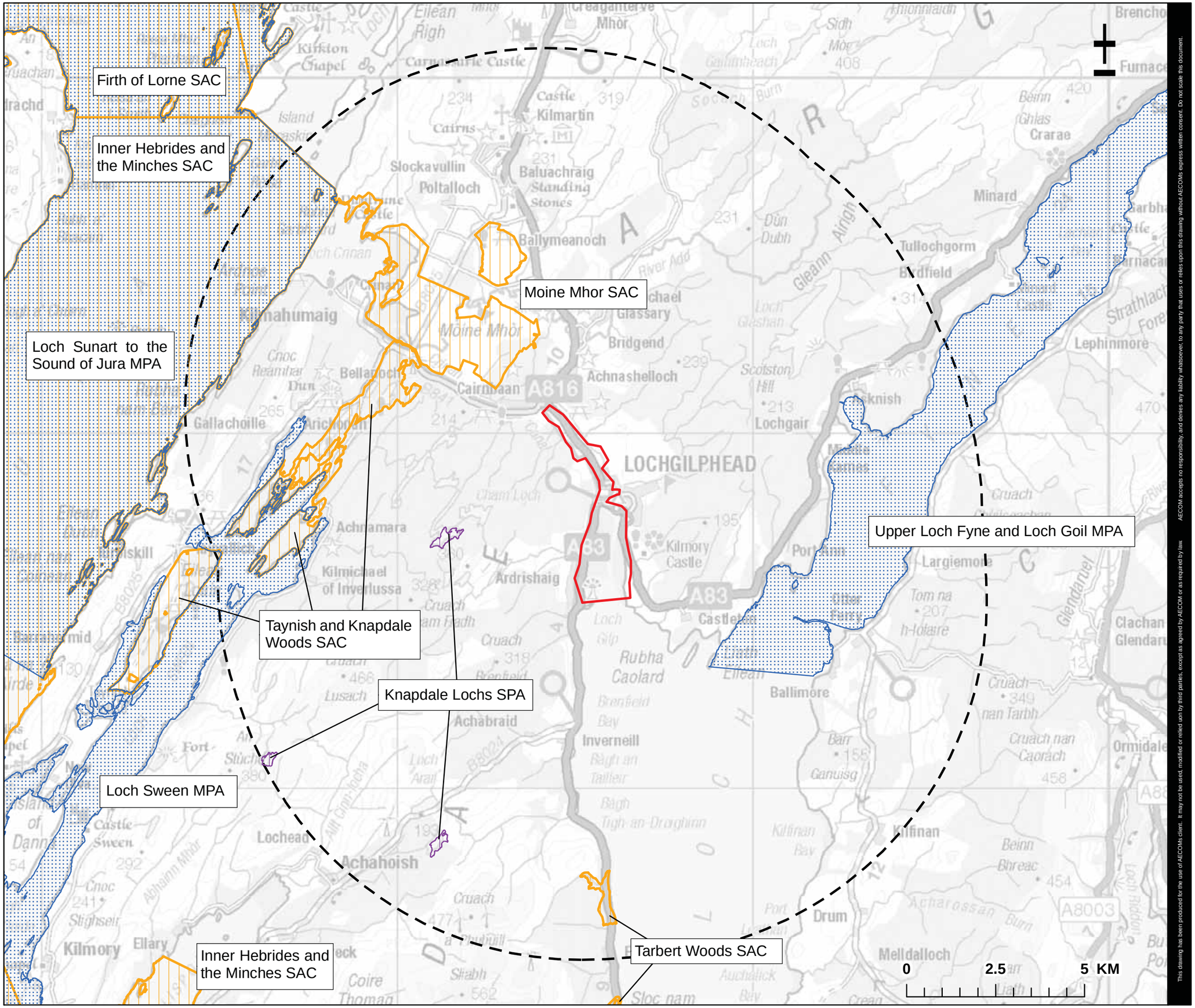
SHEET TITLE

Figure 1 - Site overview

SHEET NUMBER

1 of 1

Project Management Initials: SH Designer: JD Checked: SM Approved: TM



Scale: 1:100,000 @ A3

AECOM

PROJECT

Lochgilphead Flood Study

CLIENT

Argyll and Bute Council

KEY:

- Approximate Site boundary
- 10 km buffer
- Special Protection Area (SPA)
- Special Area of Conservation (SAC)
- Marine Protected Area (MPA)

PROJECT NUMBER

60578115

SHEET TITLE

Figure 2 - International designations and Marine Protected Areas

SHEET NUMBER

1 of 1

Project Management Initials: SH Designer: JD Checked: SM Approved: TM

Moine Mhor SSSI and NNR

Knapdale Lochs

Lochgilphead LNCS

0 1 2 KM

Scale: 1:40,000 @ A3

AECOM

PROJECT

Lochgilphead Flood Study

CLIENT

Argyll and Bute Council

KEY:

- Approximate Site boundary
- 2 km buffer
- Special Site of Scientific Interest
- National Nature Reserve
- Local Nature Conservation Site
- Ancient Woodland

PROJECT NUMBER

60578115

SHEET TITLE

Figure 3 - National designations (excluding MPAs)

SHEET NUMBER

1 of 1

9. References

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Kruuk, H. & Moorhouse, A. (1991). The spatial organization of otters (Lutra lutra) in Shetland. *Journal of Zoology* 224, **1**; pp 41-57.

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SNH SiteLink website: http://gateway.snh.gov.uk/sitelink/index.jsp

Scottish Wildcat Action website: http://www.scottishwildcataction.org/how-you-can-help

Appendix A Legislation and Planning Policy

This Appendix provides only a summary of relevant legislation and policy, covering only the most relevant aspects.

Conservation (Natural Habitats, &c.) Regulations 1994 (as amended in Scotland)

These Regulations ('the Habitats Regulations') implement *Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora* (the 'Habitats Directive'), designating and protecting European Protected Species (EPS) and Natura 2000 sites. The latter comprise Special Protection Areas (SPAs) for birds, and Special Areas of Conservation (SACs) for other taxa and habitats. For EPS (including all bats, otter *Lutra lutra*, great crested newt *Triturus cristatus* and natterjack toad *Bufo calamita*) it is an offence to:

- Deliberately or recklessly kill, injure or take an EPS (or its eggs where applicable);
- Deliberately or recklessly disturb an EPS at a place of shelter, or elsewhere if this could impair its ability to breed or affect its local distribution; or,
- Damage, destroy or obstruct access to an EPS place of shelter (whether occupied or not).

Places of shelter include all bat roosts, otter holts and laying-up areas, and great crested newt foraging/hibernation habitat up to 500m from breeding ponds where connective habitat exists.

Actions which would be EPS offences can be licensed, if a) the reason is one of the specified purposes in Regulation 44(2), b) there is no satisfactory alternative, and c) the 'favourable conservation status' of the species is not compromised. Developments affecting Natura 2000 sites must be subject to a Habitats Regulations Appraisal (HRA), and site integrity must be maintained.

Wildlife & Countryside Act 1981 (as amended in Scotland) (WCA)
Nature Conservation (Scotland) Act 2004 (as amended)
Wildlife & Natural Environment (Scotland) Act 2011 (as amended) (WANE Act)

These Acts work together to protect birds and certain animals and plants, regulate non-native species, protect Sites of Special Scientific Interest (SSSIs) and place a duty on public bodies to further the conservation of biodiversity. The WCA implements *Directive 2009/147/EC on the conservation of wild birds* (the 'Birds Directive') and the *Convention on the Conservation of European Wildlife and Natural Habitats* (Bern Convention). For Schedule 5 animals (e.g. red squirrel *Sciurus vulgaris*, water vole *Arvicola amphibius*, pine marten *Martes martes* and wildcat *Felis sylvestris*) it is an offence to intentionally or recklessly (or knowingly cause or permit another person to):

- Kill, injure or take the animal (not currently applicable to water vole in Scotland);
- Damage, destroy or obstruct access to the animal's places of shelter; or,
- Disturb the animal whilst at a place of shelter.

Common reptiles are protected from intentional or reckless killing and injury.

For birds it is an offence to intentionally or recklessly:

- Kill, injure or take any wild bird or its eggs;
- Take, damage, destroy or interfere with the nest of any wild bird whilst in use or being built (or at any time for eagles), or obstruct/prevent any wild bird from using its nest; or,
- Disturb Schedule 1 birds at or near an active nest or lek, or their dependent young (or harass eagles, hen harrier or red kite at any time).

Actions which would be offences regarding wild birds cannot be licensed for development purposes. Some actions which would be offences affecting Schedule 5 species can be licensed for development purposes if there is a) significant social, economic or environmental benefit and b) no satisfactory alternative. Developments affecting SSSIs are generally only allowed if there are reasons of national importance and site integrity will be

maintained. Under the WANE Act it is an offence in Scotland to spread any non-native species in the wild (not only those on Schedule 9 of the WCA).

Protection of Badgers Act 1992 (as amended in Scotland)

It is an offence to: wilfully kill, injure or take a badger; intentionally or recklessly damage, destroy or obstruct a badger sett; or disturb a badger in a sett (or allow someone to do these things). A sett is any structure or place with signs of current use by badger. Some actions which would be offences can be licensed, but direct removal or killing of badgers cannot be licensed for development purposes.

EU Directive 2000/60/EC Water Framework Directive (WFD)

The WFD requires that water catchments are managed so that waterbodies and watercourses meet required standards. A consequence is that SEPA normally require developers to identify groundwater-dependent terrestrial ecosystems (GWDTEs) within 100m of roads/trenches or 250m of substantial constructions, and to avoid degradation of GWDTEs and surface waters. If avoidance is not possible, SEPA will require mitigation to minimise impacts, and may request planning conditions to guarantee it.

Regulation (EU) No 1143/2014 on the prevention and management of the introduction and spread of invasive alien species ('Invasive Alien Species Regulation')

This lists invasive non-native species of EU concern and sets out requirements for their management. EU regulations are applicable to member states without implementation through national legislation.

Conservation of Salmon (Scotland) Regulations 2016 ('Salmon Regulations').

These Regulations require the conservation status of salmon populations on catchments supporting them to be assessed yearly, and the numbers of salmon that may be killed (if any) to be determined. They also state that conservation plans may be agreed for conservation and management of salmon.

Scottish Planning Policy (SPP) 2014

SPP recognises the environment as a national asset offering opportunities for enjoyment, recreation and sustainable economic activity. In summary, the policy principles most relevant to nature conservation state that the planning system should:

- facilitate positive change while maintaining and enhancing distinctive landscape character;
- conserve and enhance protected sites and species, maintaining healthy ecosystems and natural processes which provide important services to communities;
- protect and improve the water environment and soil;
- protect and enhance ancient woodland, hedgerows and trees with high ecology/landscape value; and,
- seek biodiversity benefits from new development where possible.

SPP also sets out the biodiversity duty of public bodies and legislative requirements for protected sites and species. Note also that it is government policy to treat Ramsar sites in the same way as Natura 2000 sites (SACs and SPAs), and to treat candidate, potential or proposed Natura 2000 / Ramsar sites, and areas identified as compensation sites for adverse effects on these designations, as if they are fully designated.

Appendix B Protected and notable species records from within 2 km

Table B1. Notable Species Records within 2 km as accessed through NBN Atlas Scotland website

Type	Species	Scientific name	Legislation	Data source
Mammal	Common pipistrelle	Pipistrellus pipistrellus	EPS, WCA Sch5	Records provided by Wild Surveys, accessed through NBN Atlas website.
Mammal	Brown long-eared bat	Plecotus auritus	EPS, WCA Sch5, SBL, LBAP	Records provided by Bat Conservation Trust, accessed through NBN Atlas website.
Mammal	Daubenton's bat	Myotis daubentonii	EPS, WCA Sch5, SBL	Records provided by Bat Conservation Trust, accessed through NBN Atlas website.
Mammal	Natterers bat	Myotis nattereri	EPS, WCA Sch5, SBL	Records provided by Bat Conservation Trust, accessed through NBN Atlas website.
Mammal	Badger	Meles meles	Protection of Badgers Act 1992	Records provided by Argyll Biological Records Centre and Highland Biological Recording Group, accessed through NBN Atlas website.
Mammal	Pine marten	Martes martes	WCA Sch5, SBL	Records provided by Argyll Biological Records Centre, accessed through NBN Atlas website.
Mammal	Red squirrel	Sciurus vulgaris	WCA Sch5, SBL, LBAP	Records provided by Argyll Biological Records Centre, Scottish Beavers and Scottish Wildlife Trust, accessed through NBN Atlas website.
Amphibian	Common Toad	Bufo bufo	SBL	Records provided by Argyll Biological Records Centre, accessed through NBN Atlas website.
Reptile	Adder	Vipera berus	WCA Sch5, SBL, LBAP	Records provided by Argyll Biological Records Centre, accessed through NBN Atlas website.
Bird	Barn owl	Tyto alba	WCA Sch1, SBL	Records provided by Royal Society for the Protection of Birds, accessed through NBN Atlas website.
Bird	Black grouse	Tetrao tetrix	Red BoCC, SBL, LBAP	Records provided by Royal Society for the Protection of Birds, accessed through NBN Atlas website.
Bird	Black-headed gull	Chroicocephalus ridibundus	BoCC Amber List	Records provided by Royal Society for the Protection of Birds and Argyll Biological Records Centre accessed through NBN Atlas website.
Bird	Black-throated diver	Gavia arctica	WCA Sch1, BoCC Amber List, LBAP	Records provided by Royal Society for the Protection of Birds, accessed through NBN Atlas website.
Bird	Common gull	Larus canus	BoCC Amber List	Records provided by Royal Society for the Protection of Birds and Argyll Biological Records Centre accessed through NBN Atlas website.
Bird	Common swift	Apus apus	BoCC Amber List, LBAP	Records provided by Royal Society for the Protection of Birds, accessed through NBN Atlas website.
Bird	Crossbill	Loxia curvirostra	WCA Sch1	Records provided by Royal Society for the Protection of Birds, accessed through NBN Atlas website.
Bird	Curlew	Numenius arquata	Red BoCC, SBL, LBAP	Records provided by Royal Society for the Protection of Birds and Argyll Biological Records Centre accessed through NBN Atlas website.
Bird	Dunnock	Prunella modularis	Amber BoCC	Records provided by Royal Society for the Protection of Birds, accessed through NBN Atlas website.
Bird	Grasshopper	Locustella naevia	Red BoCC, SBL,	Records provided by Royal Society for the

Type	Species	Scientific name	Legislation	Data source
	warbler		LBAP	Protection of Birds, accessed through NBN Atlas website.
Bird	Herring gull	Larus argentatus	BoCC Red List, LBAP	Records provided by Royal Society for the Protection of Birds, accessed through NBN Atlas website.
Bird	House martin	Delichon urbicum	BoCC Amber List	Records provided by Argyll Biological Records Centre, accessed through NBN Atlas website.
Bird	House sparrow	Passer domesticus	Red BoCC, SBL	Records provided by Royal Society for the Protection of Birds and Argyll Biological Records Centre accessed through NBN Atlas website.
Bird	Lesser black-backed gull	Larus fuscus	BoCC Amber List	Records provided by Argyll Biological Records Centre, accessed through NBN Atlas website.
Bird	Lesser redpoll	Acanthis cabaret	Red BoCC, SBL	Records provided by Royal Society for the Protection of Birds, accessed through NBN Atlas website.
Bird	Linnet	Linaria cannabina	BoCC Red List	Records provided by Argyll Biological Records Centre, accessed through NBN Atlas website.
Bird	Mute swan	Cygnus olor	BoCC Amber List	Records provided by Royal Society for the Protection of Birds, accessed through NBN Atlas website.
Bird	Oystercatcher	Haematopus ostralegus	BoCC Amber List	Records provided by Argyll Biological Records Centre, accessed through NBN Atlas website.
Bird	Redshank	Tringa totanus	Amber BoCC, LBAP	Records provided by Royal Society for the Protection of Birds, accessed through NBN Atlas website.
Bird	Redstart	Phoenicurus phoenicurus	BoCC Amber List, LBAP	Records provided by Royal Society for the Protection of Birds, accessed through NBN Atlas website.
Bird	Reed bunting	Emberiza schoeniclus	Amber BoCC, SBL, LBAP	Records provided by Royal Society for the Protection of Birds, accessed through NBN Atlas website.
Bird	Snipe	Gallinago gallinago	Amber BoCC	Records provided by Royal Society for the Protection of Birds, accessed through NBN Atlas website.
Bird	Song thrush	Turdus philomelos	Red BoCC, SBL	Records provided by Royal Society for the Protection of Birds, accessed through NBN Atlas website.
Bird	Spotted flycatcher	Muscicapa striata	Red BoCC, SBL, LBAP	Records provided by Royal Society for the Protection of Birds, accessed through NBN Atlas website.
Bird	Starling	Sturnus vulgaris	Red BoCC	Records provided by Royal Society for the Protection of Birds, accessed through NBN Atlas website.
Bird	Tree pipit	Anthus trivialis	Red BoCC, SBL	Records provided by Royal Society for the Protection of Birds, accessed through NBN Atlas website.
Bird	Whinchat	Saxicola rubetra	Red BoCC	Records provided by Royal Society for the Protection of Birds, accessed through NBN Atlas website.
Bird	Willow warbler	Phylloscopus trochilus	BoCC Amber List	Records provided by Argyll Biological Records Centre, accessed through NBN Atlas website.
Bird	Wood warbler	Phylloscopus sibilatrix	Red BoCC, SBL	Records provided by Royal Society for the Protection of Birds, accessed through NBN Atlas website.
Bird	Yellowhammer	Emberiza citrinella	Red BoCC, SBL, LBAP	Records provided by Royal Society for the Protection of Birds, accessed through NBN Atlas website.

Type	Species	Scientific name	Legislation	Data source
Butterfly	Small pearl-bordered fritillary	*Boloria selene*	SBL, BAP	Records provided by Argyll Biological Records Centre, accessed through NBN Atlas website.
Moth	Garden tiger	*Arctia caja*	SBL	Records provided by Argyll Biological Records Centre and Highland Biological Recording Group, accessed through NBN Atlas website.
Moth	Broom moth	*Ceramica pisi*	SBL	Records provided by Argyll Biological Records Centre, accessed through NBN Atlas website.
Mollusc	Icelandic cyprine	*Arctica islandica*	OSPAR threatened /declining species	Records provided by Scottish Natural Heritage, accessed through NBN Atlas website.
Plant	Charlock	*Sinapis arvensis*	SBL	Records provided by Argyll Biological Records Centre, accessed through NBN Atlas website.
Plant	Welsh poppy	*Meconopsis cambrica*	Nationally scarce	Records provided by Argyll Biological Records Centre, accessed through NBN Atlas website.
Plant	Corn marigold	*Glebionis segetum*	Vulnerable	Records provided by Argyll Biological Records Centre, accessed through NBN Atlas website.
Plant	Large-flowered hemp-nettle	*Galeopsis speciosa*	Vulnerable, SBL	Records provided by Argyll Biological Records Centre, accessed through NBN Atlas website.
Plant	Bluebell	*Hyacinthoides non-scripta*	WCA Schedual 8	Records provided by Argyll Biological Records Centre, accessed through NBN Atlas website.
Plant	Touch-me-not	*Impatiens noli-tangere*	Nationally scarce	Records provided by Argyll Biological Records Centre, accessed through NBN Atlas website.
Plant	Rock stonecrop	*Sedum forsterianum*	Nationally scarce	Records provided by Argyll Biological Records Centre, accessed through NBN Atlas website.
Plant	Corn spurrey	*Spergula arvensis*	Vulnerable	Records provided by Argyll Biological Records Centre, accessed through NBN Atlas website.
Plant	Common maerl	*Phymatolithon calcareum*	Annex 5 of Habitat Directive, SBL	Records provided by Scottish Natural Heritage, accessed through NBN Atlas website.
INNS (Mammal)	Sika deer	*Cervus nippon*		Records provided by Argyll Biological Records Centre, accessed through NBN Atlas website.
INNS (invertebrate)	New Zealand flat worm	*Arthurdendyus triangulates*		Records provided by Scottish Natural Heritage, accessed through NBN Atlas website.
INNS (Plant)	Salmonberry	*Rubus spectabilis*		Records provided by Argyll Biological Records Centre, accessed through NBN Atlas website.
INNS (Plant)	Indian Balsam	*Impatiens glandulifera*		Records provided by Argyll Biological Records Centre, accessed through NBN Atlas website.
INNS (Plant)	Japanese Knotweed	*Fallopia japonica*		Records provided by Argyll Biological Records Centre, accessed through NBN Atlas website.
INNS (Plant)	Pirri-Pirri-Bur	*Acaena novae-zelandiae*		Records provided by Argyll Biological Records Centre, accessed through NBN Atlas website.
INNS (Plant)	New Zealand Willowherb	*Epilobium brunnescens*		Records provided by Argyll Biological Records Centre, accessed through NBN Atlas website.
INNS (Plant)	Rhododendron	*Rhododendron ponticum*		Records provided by Argyll Biological Records Centre, accessed through NBN Atlas website.

Nationally scarce refers to species occurring in 16 – 100 hectads in Great Britain.

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Appendix C – Baseline Damage Assessment

Lochgilphead Flood Study

Baseline Economic, Social and Environmental Impact Assessment- Technical Report

Project number: 60578115

December 2019

Quality information

Prepared by	Checked by	Verified by	Approved by
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Revision History

Revision	Revision date	Details	Authorized by	Position
1	August 2019	Draft for client comment		
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Table of Contents

Figures

Tables

1. Introduction

1.1 Background

AECOM is working to explore options for managing flood risk within Lochgilphead on behalf of Argyll and Bute Council (ABC). An understanding of expected flooding impacts under the baseline scenario is required to enable screening of options and support further option development. This study concerns the fluvial and coastal flood risk within Lochgilphead.

The aims of this assessment are to:

1. identify the areas of highest economic impacts and any points where there is a disproportional change in economic impacts relative to the change in probability (to determine where interventions should be focussed);
2. quantify the economic impacts of flooding expected over the appraisal period (to inform the scale of intervention that should be considered); and
3. provide a basis for identifying the potential benefits and impacts of any proposed options

This assessment covers economic, social and environmental impacts of flooding under the baseline scenario. It is not an Environmental Impact Assessment associated with any Flood Protection Scheme or other development. This document should be read in conjunction with the baseline modelling report[1] and preliminary ecological appraisal[2].

[1] Phase 2 Report - Baseline Conditions, AECOM.
[2] Preliminary Ecological Appraisal Report Lochgilphead, AECOM.

1.2 Study Area

The study area is shown in **Figure 1** below.

Lochgilphead is a town in North Kintyre in the west of Scotland, on the bank of the Crinan Canal. In the 2011 census Lochgilphead had a recorded population of 2300. The town is an important link across the Kintyre peninsula, due to its central location.

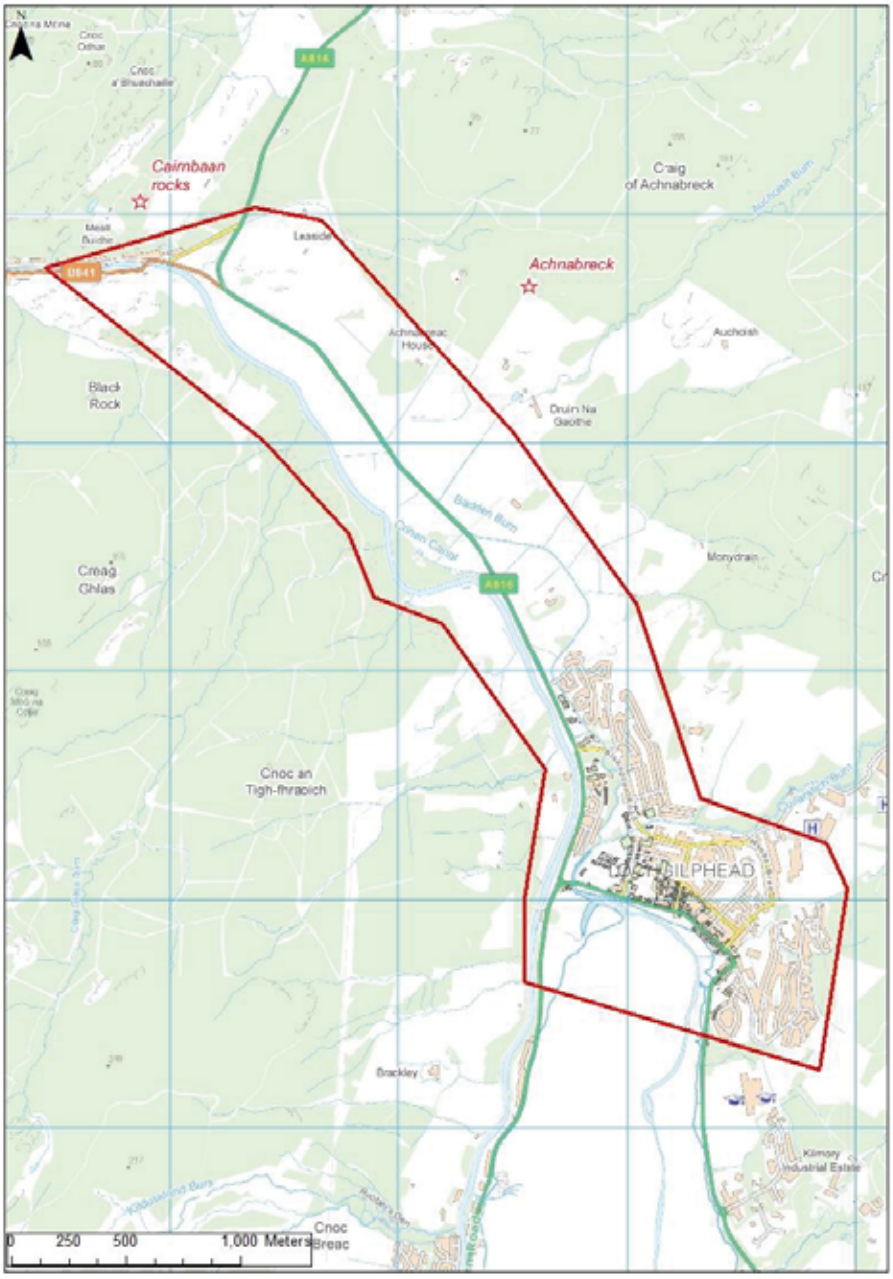


Figure 1. Study area

2. Methodology

2.1 General

2.1.1 Available Information

The following data sources were used for this assessment.

Table 1. Available data

Data name	Source	Data description
SEPA receptor datasets (properties)	ABC	GIS dataset of assets within the study area, 2011 data
Google Streetview and aerial imagery	Google	-
OS MasterMap	ABC	Ordnance Survey vector mapping
OS 50k mapping	AECOM	Ordnance Survey 1:50,000 scale raster mapping
Scottish Gov LiDAR	ABC	LiDAR
Threshold level survey	ABC	Threshold level survey of vulnerable property thresholds and ground levels

2.1.2 Legislation and Guidance

Flood risk management is governed by the Flood Risk Management (Scotland) 2009 Act. The Scottish Government has produced a guidance document describing the responsibilities of SEPA, local authorities and Scottish Water under the Act[3]. The document states that responsible authorities should “act with a view to reducing overall flood risk” (probability and consequence) in a sustainable way. ABC has included the development of a flood study for Lochgilphead in its Local Flood Risk Management Plan.

The process for developing flood study appraisals is outlined in Scottish Government appraisal guidance[4].This covers the economic, environmental and social aspects to be considered when promoting schemes under the Act. The Environment Agency has produced similar guidance[5] for England and Wales and is also a useful reference document. The assessment process used here follows the Scottish Government guidance and, as such, will be compatible with the aims of the Act.

Whilst the Scottish Government guidance covers the main principles of the assessment set out below, the Multi-Coloured Manual (MCM)[6] and Multi-Coloured Handbook (MCH)[7] cover the detailed procedure and standard data used for the assessment.

2.1.3 Proportionate Approach

The Scottish Government guidance requires that the level of detail in the assessment is proportionate to the stage of appraisal and the level of detail needed to differentiate between options. For low-cost flood risk management options, a full-scale assessment may not be justified.

[3] Scottish Government, 2011. Delivering Sustainable Flood Risk Management. Edinburgh: Scottish Government
[4] Scottish Government, 2016. Options appraisal for flood risk management: Guidance to support SEPA and the responsible authorities. Edinburgh: Scottish Government.
[5] Environment Agency, 2010. Flood and Coastal Erosion Risk Management Appraisal Guidance Appraisal Guidance. Bristol: Environment Agency
[6] Penning-Rowsell et al. (2013). Flood and Coastal Erosion Risk Management. A Manual for Economic Appraisal. Oxon: Routledge.
[7] Penning-Rowsell et al. (2017). Flood and Coastal Erosion Risk Management. A Handbook for Economic Appraisal. [Online] London: Middlesex University

2.1.4 Scenarios

The appraisal process requires consideration of the following scenarios:

- 'Do Nothing': walk away and cease all maintenance, repairs and similar activities. This may not be an acceptable option for Local Authorities due to their statutory obligations under the Act. In this case, the 'do minimum' option should be considered as the baseline.
- 'Do Minimum': this involves maintaining the existing situation. This can include general maintenance, repairs and watercourse clearance. The costs of the 'do minimum' option can be significant in areas with a high maintenance burden
- At a later stage of this project - 'Do Something': this involves the provision and maintenance of a flood risk management option. This includes both structural and non-structural measures.

2.1.5 Valuation of Costs and Benefits

All values should be in economic terms rather than financial:

- Financial takes situation from an individual's point of view whereas economic looks at the impact on the nation as a whole, noting that one person's loss can be another's gain. If, for example, a 10-year old TV is lost in a flood the financial cost would be the cost of replacing it with an equivalent new TV, whereas the economic cost would be the value of a 10-year old TV.
- VAT and other indirect taxes are included in financial costs, whereas they are not included in the economic case as they are simply transfers of money within the economy.

All benefits and costs over the entire life of the scheme require to be brought to a present value (PV). The current discount rates specified in the HM Treasury Green Book are 3.5% for years 0-30, 3% for years 31-75 and 2.5% thereafter. An appraisal period of 100 years is used to ensure all costs and benefits can be compared in an equitable manner. The choice of a 100-year period reflects the typical design life of the longest-lasting scheme elements. Some elements, such as mechanical and electrical components, may have a shorter lifespan and would therefore need to be replaced during the appraisal period.

Any historical valuations or costs are brought to a present-day value using an appropriate index. For example, historical property sales are converted to a current valuation using the House Price Index (HPI). Depth-damage data is brought to a present value using the Consumer Price Index (CPI).

2.1.6 Return Periods

The choice of return periods is an important factor in the assessment of damages. The aim of selecting return periods is to reasonably represent the "true" loss-probability curve (that is the loss-probability curve that would be generated if an infinite number of events were modelled). Higher-frequency events contribute the greatest proportion of damages, and it is therefore vital that there is good resolution of data for the lower return periods. A range of return periods were included in this assessment, ranging from more frequent flood events (2-year return period) up to low frequency flood events (1000-year return period). This provides a good representation of the loss-probability curve.

2.1.7 Capping of Damages and Write-offs

2.1.7.1 General Guidance

Scottish Government guidance (as for the other guidance referred to in this report) states that economic property losses should not exceed the current capital value of the property. Where damages exceed the market value, a cap is applied. Capping values should be the regional risk-free values of the property in question (i.e. the value of the property if there was no flood risk).

The MCM states that properties should be written off where the flood frequency exceeds, on average, once every three years. Since the modelling did not include the 3-year return period, a property was considered to be written off if the flood frequency was once every 2 years. Properties were written off at the cap values described below.

2.1.7.2 Residential Property

The MCM states that the risk-free regional (i.e. Scottish) average value should be used for capping residential property damages. For this assessment, residential property valuations were obtained from Registers of Scotland. It should be noted that this dataset is highly likely to include properties at risk of flooding; however, the presence of a large number of additional properties should moderate their impact. Static caravans were capped at the average value for replacing a second-hand static caravan home as outlined in the MCM. Threshold survey was not available for caravan, LiDAR level with average 0.3m step height was applied.

Table 2. Residential property values, Q3 2018

Property Type	Scotland Average (RoS)	Comment
Detached	£263,541	
Semi-detached	£168,221	
Terraced	£145,962	
Flat	£143,303	
Bungalow*	No data	£200,000 was used as an approximate valuation
Static Caravan	£17,500	

**Data for bungalows is not specifically included by RoS; presumably bungalows are classified in terms of whether they are detached, semi-detached etc.*

2.1.7.3 Non-Residential Property

For non-residential properties, the MCH recommends rateable values are multiplied by 10 to derive approximate valuations. More detailed valuations can be estimated by multiplying the rateable values by (100 / rental yield).

Rateable values were obtained from the Scottish Assessors Association website (www.saa.gov.uk). Yields were obtained from CBRE. Where rateable values were not available via the Scottish Assessors Association an average rateable value was applied. There is likely to be some uncertainty associated with these estimates, but this is considered to be a proportionate approach at this stage.

Yield data is reported as a Scottish average and broken down by sector. The “all property” yield was used for all non-residential properties in this study. This is similar to the values reported in the MCH. Where the influence of this valuation is significant site surveys can be carried out to improve confidence. It should be noted that there are fluctuations in rates both in time and location; 7% is considered to be representative of recent years.

Table 3. Property yields, 2017

Sector	Yield (2017)
All property	7%
Offices	8.6%
Industrial	8.4%
Retail	4%

Source: CBRE Scotland Market view Q3 2017

2.1.7.4 Other Property / Infrastructure

The MCH does not set out procedures to follow for capping non-property damages such as utilities. The Scottish Government guidance suggests that the maximum economic benefit should be limited to the cost of reconstructing the asset to avoid the flood risk (e.g. by raising or relocating). The cost should be depreciated to allow for the age of the existing asset. The guidance notes that the cost of raising or relocating these types of assets is likely to be extremely high and rarely less than the expected damages.

2.1.8 Climate Change

Climate change is expected to increase the incidence of severe weather events. Scottish Government guidance on the Act[8] encourages the development of flood risk management solutions that are adaptable to future changes in the climate. The Scottish Government appraisal guidance recommends the use of judgement and up to date evidence to estimate the impacts of climate change on flood risk.

2.1.8.1 Fluvial

An assessment of the vulnerability of Scottish river catchments to climate change was published by the CEH in 2011[9] based on UKCP09 data. Some of the results are summarised by SEPA in their 2016 flood modelling guidance for responsible authorities. Three periods are covered by the UKCP09: the 2020s (2010-2039), the 2050s (2040-2069) and the 2080s (2070-2099). There are also three emissions scenarios (low, medium and high) and, due to the probabilistic nature of climate change modelling, there is a range of possible change factors depending on the confidence interval for each emissions scenario. For example, for the 2050s medium emissions scenario, there is a 50% chance that the change in flood peak will exceed 26% in Argyll. The CEH research also indicated that the change factors vary with the magnitude of the flood.

It is clear that there is significant uncertainty in estimating the impact of climate change on future flood risk. For the purposes of this assessment, the medium emissions scenario, 50th percentile, was used. This is expected to give a middle value of climate change. It should be noted that the emissions scenarios do not take into account any current or future measures to limit emissions. Sensitivity testing was used to better understand the influence of this decision.

Table 4. % change in peak flow for medium emissions scenario, 50th percentile, for Argyll

Period	Peak river flow change factor
2020s	14%
2050s	26%
2080s	37%

Source: Kay et al. (2011).

The effect of climate change was incorporated into the assessment by increasing the frequency of damages over the 100-year appraisal period. The change in frequency was determined by the change factors noted above.

2.1.8.2 Coastal

Coastal climate change has been considered based on the current UKCP09 / Defra guidance on changes to relative sea levels, wind and wave climate in the future. The UKCP18 data was published after the climate change modelling had been undertaken. All data was downloaded from the Defra website (http://ukclimateprojections-ui.metoffice.gov.uk/ui/).

The guidance highlights that recent studies suggest that a medium emission 50th percentile UKCP09 should not be considered a central estimate. It is stated that a risk-based approach should be undertaken. The high emissions 95th percentile adopted in this study is therefore considered to be a high estimate for sea level rise, but should give an indication of the possible effects of climate change.

[8] Scottish Government, 2011. Delivering Sustainable Flood Risk Management. Edinburgh: Scottish Government

[9] Kay, Crooks, Davies & Reynard (2011). An Assessment of the vulnerability of Scotland's river catchments and coasts to the impacts of climate change. Wallingford: CEH.

The damages assessment therefore represents a high-end estimate of expected damages. This should be taken into account during decision-making. The choice of emission scenario is in line with the approach for the national flood risk assessment maps as noted in SEPAs 'Flood Modelling Guidance for Responsible Authorities'.

The effect of climate change was incorporated into the assessment by running the hydraulic models with climate change included.

2.1.9 Existing Property-Level Flood Mitigation Measures

No information relating to existing property-level measures was made available by ABC and no measures were observed during AECOM's site visits to the area. No property-level flood mitigation measures were therefore included in this study.

2.2 Overview of Appraisal Approach

The table below sets out the approach used for each component. A more detailed description of the proposed approach taken for selected receptors is included below.

Table 5. Summary of Damage Assessment Components

Receptor	Damage assessment approach
Economic impacts	
Residential properties	Included. Properties classified by type, age and regional social grading
Non-residential properties	Included. Properties classified by MCM code
Vehicles	Included. Based on number of properties at risk (detailed information on number of vehicles within the study area is not readily available)
Evacuation	Included. Evacuation costs based on property type and flood depth (detailed local data is not readily available)
Distributional impacts	Included. Based on 2011 census data for Lochgilphead
Indirect impacts on non-residential properties	Applied as basic 3% uplift to direct damages
Local authority, emergency and recovery costs	Included. Uplift factor from MCM data
Infrastructure	
Electricity and gas	Described
Water and waste water	Described
Telecommunications	n/a – no vulnerable infrastructure present within study area
Schools	Described
Hospitals	n/a – no infrastructure present within study area
Transport	
Road disruption	Described
Rail disruption	n/a – no infrastructure present within study area
Agriculture	n/a – not the focus of this study
Social impacts	
Risk to life	Quantified based on flood hazard, number of properties and likelihood
Health	Monetised based on standard of protection provided
Social vulnerability	Described
Recreation, community and way of life	Described
Environmental impacts	
Water environment	Described
Biodiversity, flora and fauna	Described
Air and soil	Described
Climatic factors	Described
Landscape	Described
Cultural heritage	Described

2.3 Economic Impacts

2.3.1 Residential and Non-Residential Properties

The property dataset was created using Potentially Vulnerable Area (PVA) data provided by ABC, a number of alterations were made to better represent the area. Additional fields were added to contain data for this assessment:

- **Flood cells**. The study area was divided into smaller zones that flood independently. This allows for the spatial distribution of damages to be understood and flood mitigation measures to be optimised to target those areas most at risk.
- **MCM code**. The basis of MCM codes was OS mapping, Google StreetView and survey photos. Residential properties were categorised based on type and age. Non-residential properties were categorised based on their MCM category.
- **Floor areas**. These are only required for non-residential properties and were derived using OS mapping.
- **Floor levels**. Surveyed floor levels were applied.
- **Flood levels**. Flood levels for properties were extracted from the hydraulic model based on the maximum water level within the property boundary.

Depth-damage data was taken from the MCH for the relevant flood duration (fluvial long, coastal short), water types (storm and salt) and warning (coastal only). For residential property, the depth-damage data for individual social classes were aggregated into a single weighted average.

A static caravan site is located to the west of Lochgilphead town centre. Guidance from the MCM handbook was used assess these properties. Average rates for static homes were applied based on the number of caravan plots observed. It is not proportionate to undertake a detailed site-specific assessment at this stage. Should options be considered in detail for the caravan park, further site surveys may be required.

2.3.2 Distributional Impacts Analysis

Distributional impacts analysis reflects how reducing flood risk affects individuals depending on their socio-economic group. The principle is that an extra pound is worth more to a person who has a lower income than someone who has a higher income. Distributional impacts require to be applied where necessary and practical.

The distribution of residents within each approximated social grade in Lochgilphead is not significantly different from the Scottish national average. In line with the detailed approach taken for this study, distributional impacts analysis has been included. However it is unlikely to provide significantly different results had the social grade averaged depth-damage data been used.

Table 6. Census data and distributional impacts analysis factors

	AB	C1	C2	DE
Proportion of people aged 16 – 64 in Scotland	19%	31%	24%	26%
Proportion of people aged 16 – 64 in Lochgilphead	19%	32%	28%	21%
Weighted factor	0.74	1.12	1.22	1.64

Total weighted factor	1.18

Source: http://www.scotlandscensus.gov.uk/

2.3.3 Infrastructure and Transport – General

There are three types of losses associated with infrastructure: direct damages; wider economic impacts and wider less tangible impacts. The direct damages to all buildings affected are calculated within the non-residential property section. Additional losses and direct damages for infrastructure not associated with properties are explored in this section. Categories identified in the MCM are: electricity and gas; water and waste water; telecommunications; schools; hospitals; roads; and rail.

The MCM states that assessments should be proportional to the impact of flooding on the asset and the significance of the asset. Although it may be *feasible* to assess the potential losses to a number of assets it may not be *cost-effective or necessary* to do so. The 5 step prioritisation process was followed for all identified infrastructure.

1. Identify those assets at risk of flooding
2. Determine the likelihood of flooding assets
3. Determine the criticality of the assets to flooding
4. Utilise a risk matrix for prioritisation (**Table 7**)
5. Assess the impact of resistance and resilience

Table 7. Risk Matrix

Impact	**Significant**	Medium Risk	High Risk	Very High Risk
	Moderate	Low Risk	Medium Risk	High Risk
	Low	Negligible Risk	Low Risk	Medium Risk
		Very low	**Low**	**Medium/High**
		Likelihood		

2.3.4 Electricity and Gas

Several small substations are included within the study area, these have been included within the data set. A larger substation is located on Bishopton Road, due to the size of the substation, specific site surveys would be required to understand its vulnerability to flood risk. At this stage of the assessment these have not been carried out however should flood mitigation options be considered in the area site surveys are recommended.

Low-medium likelihood, moderate impact. Overall risk: high

2.3.5 Water and Wastewater

No water or waste water treatment works were included within the asset dataset. A Scottish Water pumping station is located on the front green and has been included within the data set. It is at risk from the 10-year return period. At this stage of the assessment site specific survey and consultation has not been carried out. This is recommended at detail design stage.

Medium/high likelihood, low impact. Overall risk: medium

2.3.6 Telecommunications

A British Telecom office is included within the property dataset; flooding of this office is unlikely to affect telecommunications infrastructure. No telephone exchanges were included in the asset database used for this assessment. No further investigation was therefore warranted.

Overall risk: n/a

2.3.7 Schools

Lochgilphead has a joint primary and secondary school, called Lochgilphead Joint Campus, located to the south of the town just off the A83. Opened in the 2007, the building is located on high ground and is out with the area of flood risk.

The road accessing the school, the A83, is at risk and included within the study. Further investigation is possible at future stages of the study, particularly if there are records of the school being disrupted as a result of flooding.

Argyll College has two sites in Lochgilphead, one of which is within the area of flood risk and has been included within the assessment through the property assessment.

Very low likelihood, moderate impact. Overall risk: low.

2.3.8 Hospitals

There are two hospitals located in Lochgilphead, The Argyll and Bute Hospital and the Mid Argyll Community Hospital. Both are located out with the study area and have therefore not been included in this assessment. However, both are accessed via the key Lochgilphead roads and therefore further investigation is possible at future stages of the study, particularly if there are records of the hospitals being disrupted as a result of flooding.

Overall risk: n/a

2.3.9 Road Disruption

Several roads within the study area are at risk of flooding. The key factors for estimating traffic damage and disruption costs include flood duration, the number of roads likely to be impacted and the importance of those roads affected (i.e. whether a flood causes a significant knock-on effect to other parts of the network).

Of particular note are the A816 and the A83 which is the main road for Lochgilphead and the through road for the Kintyre Peninsula. Due to the importance of this road locally further investigation is required.

Medium / high likelihood, moderate impact. Overall risk: high risk.

2.3.10 Rail disruption

There are no railways in the study area.

Overall risk: n/a

2.3.11 Agriculture

Although there are areas of agriculture just outside the edge of Lochgilphead, these are not the focus of this study.

Overall risk: n/a

2.4 Social Impacts

2.4.1 Risk to Life

The hazard associated with flooding is based on the depth and velocity of water. This, paired with the probability of flooding, can be used to assess the risk to life. Whilst it is possible to monetise this risk, at this stage of the study it was considered appropriate to describe the risk based on hazard, probability and key properties affected.

2.4.2 Health

Flooding can have a wide range of impacts on health including stress and anxiety associated with flooding, physical health effects from contact with flood water and worry about future flooding. This is an area of active research and there is uncertainty associated with any methods used to quantify these impacts. The Scottish Government appraisal guidance refers to a 2004 Defra study[10]. This has since been superseded with research from 2012[11], which was used for this assessment.

2.4.3 Social Vulnerability

The effects of flooding will be felt differently by different people depending on a range of factors (e.g. age, health, income, home ownership) – this is known as social vulnerability. Flood disadvantage is the combination of social vulnerability and flood risk. The Scottish Government has produced maps showing the social vulnerability and flood disadvantage across Scotland. These were used for this study to describe the social vulnerability to flooding in Lochgilphead.

2.4.4 Recreation, Community and Way of Life

Similar to health, flooding can have wide-ranging effects on the local community by disrupting recreational opportunities (e.g. football grounds, sports centres), causing flood damages to community facilities (e.g. town halls, libraries) and affecting day-to-day life (e.g. employment and shopping). There is insufficient evidence available to allow such impacts to be readily monetised and in any case the impact is not likely to be significant for Lochgilphead. These impacts will therefore be assessed based on a description of impacts.

2.5 Environmental Impacts

The Scottish Government appraisal guidance describes the key categories against which flooding impacts can be assessed as follows (although other methods, such as ecosystem services, are also possible):

- Water environment
- Biodiversity, flora and fauna
- Air and soil
- Climatic factors
- Landscape
- Cultural heritage

It is understood that there are currently no pressing environmental issues associated with flooding at the site. The primary requirements for environmental appraisal are therefore to identify opportunities for environmental enhancement and assess environmental impacts associated with any flood mitigation options (thus allowing for impacts to be mitigated). For this appraisal, the environmental impacts are described unless there is an indication that impacts will be significant (in which case a formal Environmental Impact Assessment may be required).

[10] Defra (2004). Flood and coastal defence appraisal guidance. Supplementary note to operating authorities. Revisions to economic appraisal on: reflecting socio-economic equity in appraisal and appraisal of human-related intangible impacts of flooding. Defra: London.
[11] Ramsbottom et al. (2012). Climate change risk assessment for the floods and coastal erosion sector. Defra: London. Discussion also in Frontier Economics (2013). The economics of climate resilience: appraising interventions to diminish the mental health effects of flooding – a case study of Hull. Frontier Economics Ltd: London.

3. Results

3.1 Baseline Monetised Damages

The number of properties affected by flooding during in the study area is shown in **Table 8** and **Table 9**. The corresponding damages are shown in **Table 10** and **Table 11**. These results do not include the impact of capping or write-offs, as those factors only get taken into account when damages are discounted over the appraisal period.

Table 8. Number of properties affected by coastal flooding in the study area

		Return period (years)							
Scenario	**Property Type**	**2**	**5**	**10**	**20**	**50**	**100**	**200**	**1000**
Present Day	Residential*	0	19	29	35	48	52	60	92
	Non-Residential (NRP)	0	2	4	6	9	13	23	51
Climate Change	Residential*	45	52	53	66	88	93	99	148
	Non-Residential (NRP)	7	13	19	33	50	56	66	97
Total no. of properties affected by flooding (incl CC)		52	65	72	99	138	149	165	245

* Damages for residential properties start to be accrued when the water is within 300mm of the floor level as water enters the sub-floor area.

Table 9. Number of properties affected by fluvial flooding in the study area

		Return period (years)							
Scenario	**Property Type**	**2**	**5**	**10**	**20**	**50**	**100**	**200**	**1000**
Present Day	Residential*	0	0	0	0	11	22	29	61
	Non-Residential (NRP)	0	0	0	0	0	2	6	23
Total no. of properties affected by flooding		0	0	0	0	11	24	35	84

* Damages for residential properties start to be accrued when the water is within 300mm of the floor level as water enters the sub-floor area.

Table 10. Baseline monetised coastal flood damages by present day return period (excl. CC)

		Return period (years)							
Category		**2**	**5**	**10**	**20**	**50**	**100**	**200**	**1000**
Residential	Direct	£0	£21,467	£58,341	£134,791	£442,971	£585,646	£802,723	£1,777,658
	Vehicles	£0	£5,739	£28,694	£54,518	£117,644	£123,382	£149,207	£229,549
	Indirect	£0	£5,248	£18,656	£48,361	£106,768	£141,639	£173,292	£305,575
	DIA	£0	£3,897	£10,590	£24,467	£80,406	£106,304	£145,706	£322,672
	Subtotal	**£0**	**£36,351**	**£116,281**	**£262,136**	**£747,789**	**£956,972**	**£1,270,927**	**£2,635,454**
NRP	Direct	£1,169	£13,264	£87,717	£164,971	£444,330	£665,918	£1,036,025	£2,667,073
	Indirect	£35	£398	£2,632	£4,949	£13,330	£19,978	£31,081	£80,012
	Subtotal	**£1,205**	**£13,662**	**£90,349**	**£169,920**	**£457,660**	**£685,895**	**£1,067,106**	**£2,747,085**
Other	Emergency	£125	£3,716	£15,628	£32,075	£94,941	£133,917	£196,746	£475,586
	Health	£0	£3,026	£12,103	£22,188	£42,360	£44,377	£52,445	£82,702
	Subtotal	**£125**	**£6,742**	**£27,731**	**£54,263**	**£137,301**	**£178,294**	**£249,191**	**£558,288**
Total		**£1,330**	**£56,754**	**£234,360**	**£486,319**	**£1,342,749**	**£1,821,161**	**£2,587,224**	**£5,940,828**

Table 11. Baseline monetised fluvial flood damages by present day return period (excl. CC)

Category		Return period (years)							
		2	5	10	20	50	100	200	1000
Residential	Direct	£0	£0	£0	£0	£16,891	£50,469	£105,526	£1,084,824
	Vehicles	£0	£0	£0	£0	£2,882	£5,764	£25,939	£109,518
	Indirect	£0	£0	£0	£0	£832	£5,592	£19,968	£124,955
	DIA	£0	£0	£0	£0	£3,066	£9,161	£19,155	£196,912
	Subtotal	**£0**	**£0**	**£0**	**£0**	**£23,671**	**£70,986**	**£170,588**	**£1,516,210**
NRP	Direct	£0	£0	£0	£0	£1,861	£20,259	£207,970	£1,781,375
	Indirect	£0	£0	£0	£0	£56	£608	£6,239	£53,441
	Subtotal	**£0**	**£0**	**£0**	**£0**	**£1,917**	**£20,867**	**£214,209**	**£1,834,817**
Other	Emergency	£0	£0	£0	£0	£2,006	£7,568	£33,544	£306,683
	Health	£0	£0	£0	£0	£1,013	£6,078	£12,156	£43,560
	Subtotal	**£0**	**£0**	**£0**	**£0**	**£3,020**	**£13,646**	**£45,700**	**£350,243**
Total		**£0**	**£0**	**£0**	**£0**	**£28,607**	**£105,499**	**£430,497**	**£3,701,271**

Average Annual Damage (AAD) is the expected value of damages within a typical year: ∑*Damages x Probability.* AAD is shown below calculated from current value damages and probability alongside future AAD based on the increased probability of flooding with climate change. Due to the frequency of flooding, one property was considered to be written off and was not included in the AAD total. The increased frequency of flooding with climate change means that more properties are written off; it is therefore possible that AAD reduces with time and that the ADD does not increase linearly. **Table 12** shows the AAD for the assessed climate change scenarios.

Table 12. Baseline average annual damages

Category		Average Annual Damage- Coastal		Average Annual Damage- Fluvial	
		Current	Future (with Climate Change)	Current	Future (with Climate Change)
Residential	Direct	£36,379	£67,356	£4,568	£20,354
	Vehicles	£10,119	£7,549	£546	£2,319
	Indirect	£9,294	£7,319	£536	£2,401
	DIA	£6,603	£86,048	£829	£3,695
	Subtotal	**£62,396**	**£168,273**	**£6,480**	**£28,768**
NRP	Direct	£37,336	£172,186	£6,666	£31,102
	Indirect	£1,120	£5,166	£200	£933
	Subtotal	**£38,456**	**£177,351**	**£6,866**	**£32,035**
Other	Emergency	£7,888	£25,631	£1,202	£5,506
	Health	£4,064	£2,786	£251	£1,029
	Subtotal	**£11,952**	**£28,417**	£1,453	£6,534
Total		**£112,804**	**£374,042**	**£14,799**	**£67,337**

Present Value Damage (PVD) represents the damages expected to be accumulated over the appraisal period (100 years). The total damages accrued are also “discounted” to a Present Value (see **Section 2.1.5**). PVD is derived from the sum of all probability damages accrued, capped and discounted: ∑ (Damages x Probability) capped x discount rate. Where required, properties were written off in the year that the flood frequency is expected to exceed once every three years, with a discount factor applied where necessary.

The study area was split into ‘flood cells’ – areas which flood from the same location(s) and which could potentially be protected independently. This allows for further investigations to focus on those areas which are most affected. A plan showing the location of the flood cells is included in **Appendix A.1**. **Table 13** shows the present value damage by type and Table 14 presents a summary

of the present value damage, both with and without climate change. **Table 15, Table 16** and **Table 17** shows the coastal, fluvial and combined present value damage (PVD) for each flood cell.

Table 13. Baseline present value damages by type

Category		PVD- Coastal	PVD CC- Coastal	PVD- Fluvial	PVD CC- Fluvial
Residential	Direct	£852,956	£1,587,752	£136,187	£702,753
	Vehicles	£66,424	£95,406	£16,282	£40,803
	Indirect	£60,666	£89,458	£15,992	£51,151
	DIA	£78,588	£211,965	£24,720	£98,972
	Subtotal	£1,058,635	£1,984,581	£193,181	£893,679
NRP	Direct	£657,255	£1,414,664	£190,463	£895,067
	Indirect	£17,146	£39,697	£5,714	£14,209
	Subtotal	£674,401	£1,454,361	£196,177	£909,276
Other	Emergency	£161,593	£342,261	£34,952	£168,393
	Health	£24,355	£35,081	£7,490	£18,410
	Subtotal	£185,947	£377,342	£42,441	£186,803
Total		£1,918,983	£3,816,284	£431,799	£1,989,759

Table 14. Summary of PVD

Totals	Total PVD	Total PVD (CC)
Coastal	£1.92M	£3.82M
Fluvial	£432K	£1.99M
Lochgilphead Combined	£2.35M	£5.81M

Table 15. Baseline coastal present value damages by cell

Flood cell	Residential	Non-residential	All non-property	Total	Proportion of total
1	£1,580,749	£1,412,413	£809,094	£3,802,256	99.63%
2	£0	£0	£0	£0	0.00%
3	£1,997	£311	£1,471	£3,779	0.10%
4	£5,007	£1,940	£3,302	£10,249	0.27%
5	£0	£0	£0	£0	0.00%
Total	**£1,587,752**	**£1,414,664**	**£813,868**	**£3,816,284**	100.00%

Table 16. Baseline fluvial present value damages by cell

Flood cell	Residential	Non-residential	All non-property	Total	Proportion of total
1	£232,255	£48,820	£71,158	£352,233	17.70%
2	£26,948	£639,150	£89,109	£755,207	37.95%
3	£22,694	£10,942	£12,773	£46,410	2.33%
4	£174,001	£243	£82,191	£256,434	12.89%
5	£246,856	£195,913	£136,707	£579,476	29.12%
Total	**£702,753**	**£895,067**	**£391,938**	**£1,989,759**	100.00%

Table 17. Baseline combined present value damages by cell

Flood cell	Residential	Non-residential	All non-property	Total	Proportion of total
1	£1,813,004	£1,461,232	£880,252	£4,154,488	71.55%
2	£26,948	£639,150	£89,109	£755,207	13.01%
3	£24,691	£11,253	£14,244	£50,188	0.86%
4	£179,007	£2,183	£85,493	£266,683	4.59%
5	£246,856	£195,913	£136,707	£579,476	9.98%
Total	**£2,290,506**	**£2,309,731**	**£1,205,806**	**£5,806,043**	100.00%

3.2 Baseline Non-Monetised Damages

3.2.1 Economic - Road Disruption

The A83 is the main road through Lochgilphead and provides access to the rest of the Kintyre peninsula. The road is at risk of shallow flooding from the 2-year event. More extreme events could necessitate in road closures.

There are two aspects of damages to roads which can be accounted for: direct damage to road infrastructure and losses due to road traffic disruption.

Direct damages to road infrastructure vary depending on the type and scale of the damage, the type of road and the location of the required repair. Estimates are available from the MCM of unit costs for resurfacing roads from £15/m² for quiet roads to £50/m² for busier roads. Direct damages can occur if flooding causes lasting damage to the road. However, for flooding to cause lasting damage water would have to remain on the road for long periods of time (the MCM considers a long period of time to be ‘days’ rather than hours) or high velocities would have to be present. This is found not to be the case in Lochgilphead and therefore direct damages have not been assessed at this stage of the study. Should any mitigation options considered be found to provide significant benefits to the road infrastructure, further assessment may be warranted.

The MCM provides a framework to value traffic disruption. This is based on the additional distance travelled as a result of a diversion.

- A816/A83 – potentially closed during a 10-year return period event or greater. There is no known diversion route available to the south of the Kintyre peninsula.

Due to the core route provided by the A816/A83 economic losses may be experienced. Should any flood mitigation options considered be found to provide significant benefits to the road infrastructure, further assessment would be warranted.

Property damages can be affected by the waves caused by vehicles being driven along flooded roads. This impact has not been included in the hydraulic model and therefore has not been quantified in the assessment, however it could lead to further justification for road closures.

Figure 2. A816 and A83 through Lochgilphead

3.2.2 Social – Risk to Life

Due to the shallow and localised nature of flooding, the flood hazards are generally not significant. The locations of maximum hazard are similar to the roads at risk of flooding. No detailed analysis was carried out. Flood hazard ratings were estimated using the equation *hazard = d x (v + 0.5)*. The following table summarises maximum flood hazards.

Table 18. Flood hazard

Return period (years)	Maximum flood hazard	Hazard description	Affected locations
Fluvial 200	0.3 (Low)	**Caution** – flood zone with shallow flowing water or deep standing water	A816, petrol station
Coastal 50	0.9 (Moderate)	**Dangerous for some** (i.e. children) – flood zone with deep or fast flowing water	A83, Caravan Park
Coastal 200	0.9 (Moderate)	**Dangerous for some** (i.e. children) – flood zone with deep or fast flowing water	A83, Caravan Park

In addition to the locations identified in Table 18, any watercourses are likely to be a moderate hazard or greater during a flood event.

The hazard caused by wave overtopping is not fully assessed within the simple assessment above. It should be noted that during extreme coastal events wave overtopping can be highly dangerous and can result in loss of life.

3.2.3 Social – Social Vulnerability

The key areas in Lochgilphead at risk of flooding are a combination of non-residential and residential properties. The Scottish Government maps identify Lochgilphead, as having an average social vulnerability. Flooding would therefore have a similar impact in this area as other parts of the country. The Scottish Government maps categorise Lochgilphead as having average flood disadvantage for coastal flood and relatively low for fluvial. Flood disadvantage categorisation is based on SEPA's national scale flood mapping, not the outputs from this study. The modelling and damage results prepared for this study show that if flood risk were to continue to increase with climate change the flood disadvantage would increase.

3.2.4 Social – Recreation, Community and Way of Life

The following is a list of community features that are affected by flooding to provide an indication of the range of social impacts of flooding. For the avoidance of doubt, this is not a site-specific flood risk assessment for each of the features noted.

It should be noted that as Lochgilphead is a village, any flooding of the village centre would seriously impact the recreation, community and way of life for the majority of residents.

Table 19. Community features at risk of flooding

Feature	Onset of flooding (indicative return period in years)
Riverside Filling Station	200 fluvial
Mid Argyll Community Pool	200 fluvial
Riverside Rascals Nursery	200 fluvial
Lochgilphead Caravan Park	10 coastal
Bank of Scotland	50 coastal
Tesco Express	1000 coastal

3.2.5 Environmental

Separate ecological assessments[12] have been carried out in order to identify constraints and opportunities relevant to the development of a flood protection scheme. A summary of key issues in terms of flooding impacts is provided here.

Water environment

Both the Cuilarstich and Badden Burns were classed as having overall "Moderate" status from the SEPA River Basin Management Plan in 2017. The Loch Fyne outer basin has a coastal overall classification of 'good'. The current level of flood risk is not considered to be affecting the water environment. The increased frequency of flooding could increase the likelihood of pollutants entering the natural environment.

Biodiversity, flora and fauna

The presence of a range of species, including protected species, should be expected within the study area. Further detail can be found in the Lochgilphead Flood Study Preliminary Ecological Appraisal.

The current level of flood risk is not considered to be affecting biodiversity, flora and fauna however there are always opportunities for environmental enhancement as part of any flood mitigation proposals.

Air and soil

The current level of flood risk is not considered to be affecting air and soil.

Climatic factors

Flooding leads to greenhouse gas emissions through the following:

- Emissions during the flood response (vehicle movements, pumping etc.)
- Emissions embedded in replacement goods
- Emissions embedded in repair materials
- Emissions associated with additional energy use to dry out properties following a flood

Cultural heritage

A section of Lochgilphead is a Conservation Area; this includes Argyll Street through the town centre and Poltaloch Street and Lochnell Street along the coastal frontage. Lochgilphead is home to a number of grade B and C Listed Buildings. Some of these are directly affected by flooding. It is possible that repeated flooding would discourage investment in maintaining these properties and lead to an overall degradation of the area. This does not appear to be an issue at present.

Landscape

The current level of flood risk is not considered to be affecting the local landscape other than those issues discussed under cultural heritage.

3.3 Sensitivity Analysis

3.3.1 Single Large Damage Sources

The damage assessment is dependent on a large number of variables, each with its own level of reliability. Sensitivity testing is used to improve understanding of the potential variation of the damage values, and the influence this could have on the overall study outcome.

The total damages are distributed amongst 259 properties, both residential (148) and non-residential (111). Around 55% of property damages are associated with non-residential properties. There is a

[12] Preliminary Ecological Appraisal Report Lochgilphead, AECOM.

relatively even spread of damages across the properties, with one property contributing the highest percentage of 7%, which is the Riverside petrol station. Considering the location and size of this property this is considered reasonable and it was deemed at this stage that site surveys are not necessary. This also means that total damages would not be sensitive to uncertainty in the assumptions for any one property (such as property type, age or floor level). Instead, damages will be sensitive to any inherent uncertainty in the general MCM methodology such as climate change and translating model results into flood levels within properties.

Closer inspection of many of the highest contributors shows that the high proportion of damages is justified as many of the buildings and surrounding areas have experienced flooding in the past. Where possible many of the highest contributing properties have been sense checked to ensure the results are appropriate.

3.3.2 Modelling Tolerance

There are always uncertainties when quantifying physical processes using mathematical models, and economic damages are sensitive to these uncertainties. As such, many of the uncertainties highlighted within the modelling report continue to apply to this assessment. As discussed within the modelling report the approach is based on best practice and best available research/data and is therefore acceptable. Sensitivity testing has been carried out and is detailed in the baseline modelling report to understand potential changes to model results due to different parameters. For details on potential sensitivity to changes in model results see the following section on flood depths.

The hydraulic modelling included several sensitivity tests to the joint probability of coastal and fluvial flooding. It was found that areas were either critically influenced by either coastal or fluvial flooding, i.e. they are independent. There was an exception in cell 3 where a combination scenario was found to have the potential to be modestly correlated. The baseline model for the whole of Lochgilphead area applied the independent correlation of coastal and fluvial flooding. Further details can be found in the baseline modelling report.

A sensitivity test was applied to the cell 3 properties to determine the influence that the modestly correlated combination would have had on property damages. The difference in depth between the baseline and the sensitivity test were 10mm with no change in the flood extent. The largest PVD for any property in the baseline assessment was approximately £650. Based on this small depth increase the resultant PVD increase would be nominal. This nominal change would not affect the outcome of option development.

3.3.3 Flood Depths within Properties

Flood depths are based on the difference between modelled water levels and the property floor level. The majority of floor levels within Lochgilphead have been surveyed and should therefore have a high degree of accuracy. Floor levels for some of the properties were estimated based on adjacent surveyed properties. Both levels have some level inherent uncertainty based on the methods used to derive them. A flood depth increases of just 100mm would increase total PV flood damages from £6.3M to £7.8M; an increase of 21%. Although in flood level terms 100mm is a large increase, there is more uncertainty in model results and an error of 100mm is possible. It is expected, however, that model results are broadly representative of actual flood events. Methods follow best practice using the best available data, so there is little scope for increasing confidence further. The possible variation in damages should therefore be taking into account in any decision-making.

3.3.4 Future Flood Risk

The increase in future flood risk associated with climate change was included in this assessment. There is significant uncertainty in the effects of climate change. If there was no change in flood frequency, then total PV flood damages would be £2.35M, a reduction of 63%.

3.3.5 Capping and Write Offs

Depending on the frequency of flooding, damages for some propertieswere capped; and one property was considered to be written off. There is a reasonable degree of confidence in both the residential property valuations and non-residential property valuations, which used standard methods. However,

there is less confidence in the properties that had no rateable value data and therefore had an averaged value applied. This is in line with the recommendations made by Chatterton[13], but reduces confidence in the results.

The effects of capping and write-offs are amplified by the effect of climate change. Overall within Lochgilphead there is a reasonable occurrence of capping and write off and therefore the overall results are thought to be representative.

3.3.6 Summary

Uncertainty is an inherent factor in economic damages assessments, given the process involves a range of datasets each with its own individual uncertainties and simplifying assumptions. MCM guidance recommends the use of sensitivity analysis to be aware of these uncertainties.

The sensitivity analyses have shown there to be some uncertainty in flood damages for example the reliance on the modelling results and the climate change scenario. There is therefore a degree uncertainty in flood damages for this study.

The chosen damage assessment method is in line with best practice and industry standard approaches which aim to provide a managed, efficient and proportional method to economic damages assessment. The damages presented here are based on a best estimate of each of the variables; however, the potential for variation in the total damages (both positive and negative) needs to be borne in mind in any decision-making. As shown in the sensitivity analysis above, variations would not be unexpected. This is typical of a study of this kind.

[13] Chatterton (2016). National receptor dataset: property codes with prefix “9”. Published by Flood Hazard Research Centre, Middlesex University.

4. Conclusions

This assessment of economic, social and environmental impacts of flooding was carried out in accordance with Scottish Government guidance, using data from the Multi-Coloured Manual and other sources. Impacts covered the next 100 years if no intervention takes place to reduce the risk of flooding. This is a baseline scenario against which options can be evaluated.

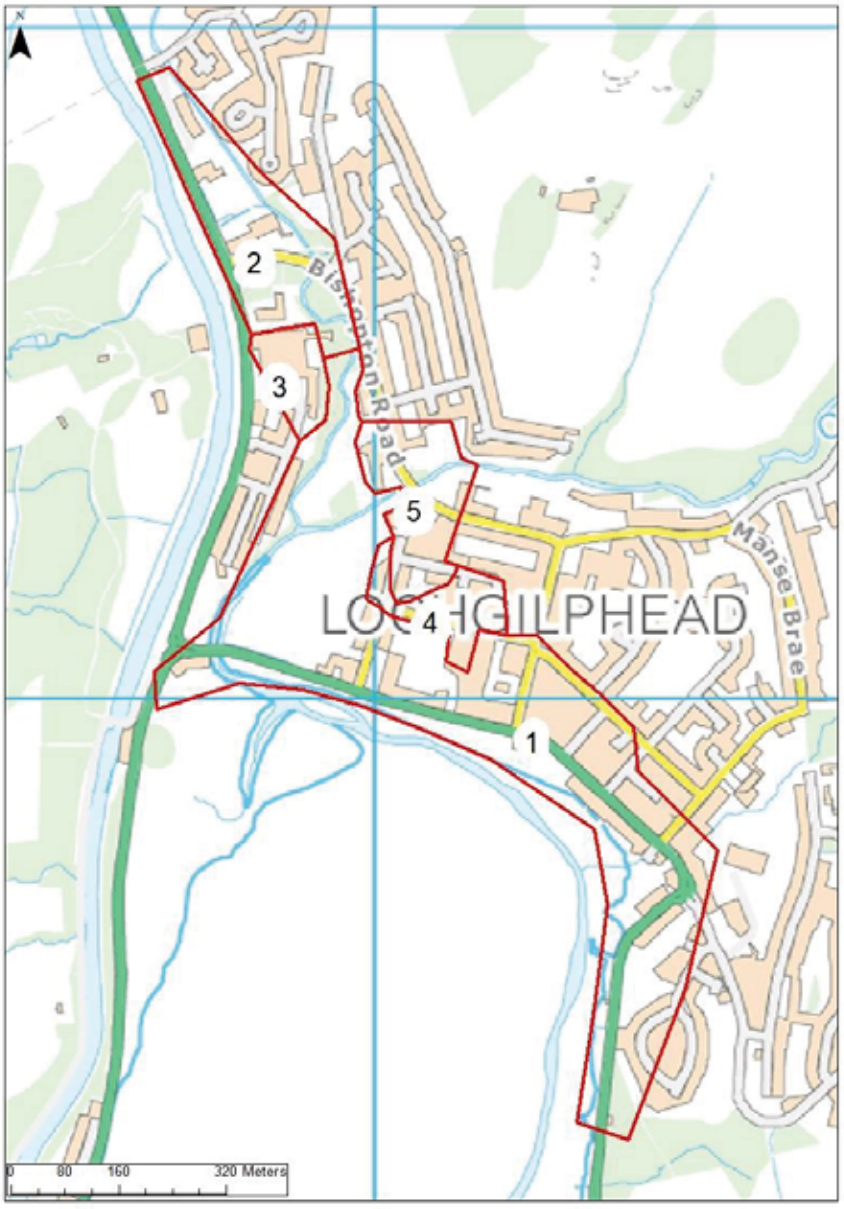
The flooding impacts assessed in this report are broadly in line with the impacts experienced during historical flood events; the greatest impacts are located in those areas that have flooded most frequently in recent years. A total of 143 properties are expected to be flooded during a coastal present day 1000-year return period flood event; 92 residential and 51 non-residential. This increases to 245 properties during a climate change 1000yr event. The total monetised damages associated with a 1000-year coastal event were estimated to be around £5.9M. A total of 84 properties are expected to be flooded during a fluvial 1000-year return period flood event; 92 residential and 51 non-residential. The total monetised damages associated with a 1000-year fluvial event were estimated to be around £3.7M.

Key non-monetised impacts include flooding of roads and associated disruption, , damage to key community assets and impacts on key employers. The frequency of such an event is expected to increase as a result of climate change.

The present value of monetised flood damages over the next 100 years was estimated to be £5.8M; this includes annual average damages of around £370k for coastal and the value of properties written off due to the high frequency of flooding in the future. The damages presented here are based on a best estimate of each of the variables; however the potential for variation in the total damages (both positive and negative) needs to be borne in mind in any decision-making. The aforementioned non-monetised impacts should also be taken into account as part of any appraisals and decision-making.

The findings from this assessment will be used in the in the decision-making process for selecting a preferred scheme option for Lochgilphead.

Appendix A .1 – Flood Cells



n.b. any areas not contained within flood cells were either not within the study area or were not at risk of flooding during a 1000 year return period event.

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