
Argyll
Bute
COUNCIL

Nicci Buckley BSc MSc CSci MCIWEM C.WEM
Unit 2.1 Quantum Court
Research Avenue South
Heriot Watt Research Park
Riccarton
Edinburgh
EH14 4AP

Draft 11/12/18	-	G Whyte, Argyll & Bute Council
Draft 26/02/19	Comments addressed	G Whyte, Argyll & Bute Council
27/11/19	Comments addressed	G Whyte, Argyll & Bute Council
Final 27/11/19	Street names changes	G Whyte, Argyll & Bute Council

This report describes work commissioned by Grant Whyte on behalf of Argyll & Bute Council by Purchase Order number AB315359. Argyll Bute Council's representative for the contract was Grant Whyte. Steven Thomson of JBA Consulting carried out this work.

Prepared by ..... Steven Thomson BSc (Hons) MSc GMICE
Senior Engineer

Reviewed by ..... Rene Dobson BEng CEng MICE
Associate Director

A printed copy of the main text in this document will result in a carbon footprint of 58g if 100% post-consumer recycled paper is used and 73g if primary-source paper is used. These figures assume the report is printed in black and white on A4 paper and in duplex.

JBA is aiming to reduce its per capita carbon emissions.

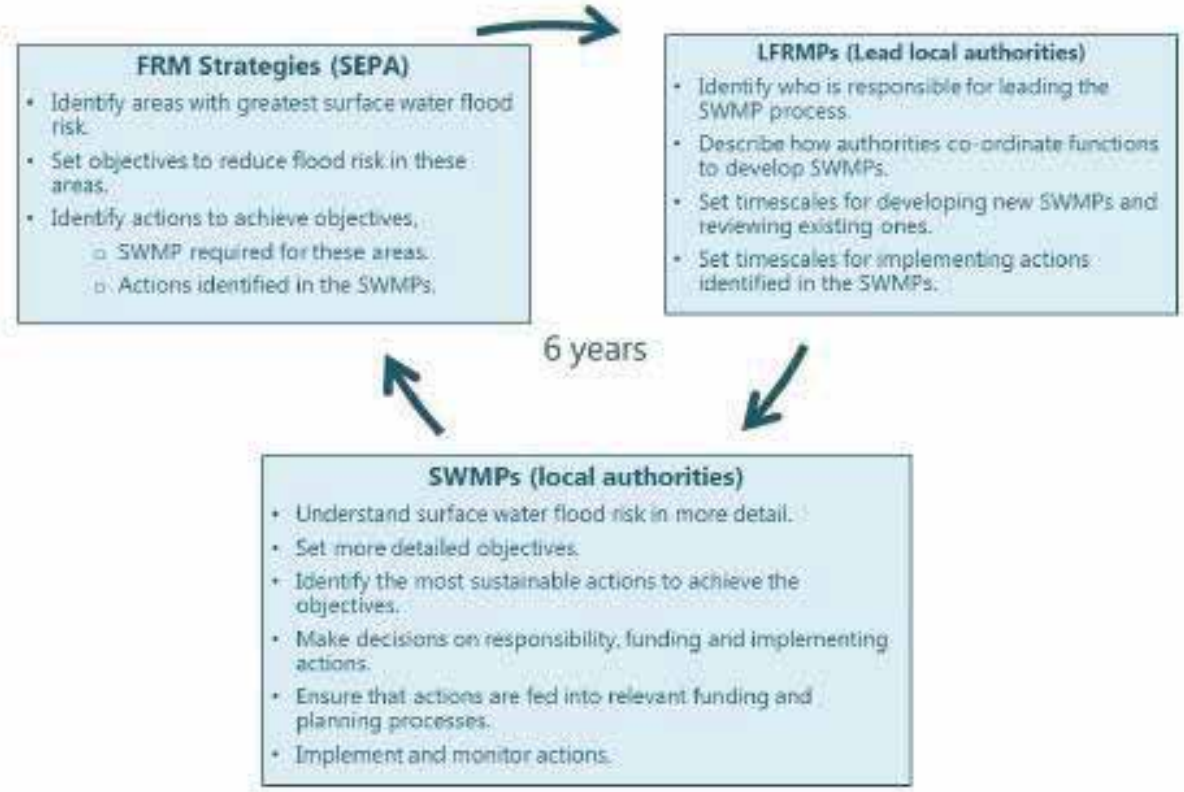
AAD	Annual Average Damages
DTM	Digital Terrain Model
FEH	Flood Estimation Handbook
FRM	Flood Risk Management
GIS	Graphical Information System
LDP	Local Development Plan
LFRMP	Local Flood Risk Management Plan
LiDAR	Light Detection and Ranging
LPD	Local Planning District
mAOD	Meters Above Ordnance Datum
MCA	Multi-criteria assessment
NFM	Natural Flood Management
OS	Ordnance Survey
PLP	Property Level Protection
PLR	Property Level Resistance
PVA	Potentially Vulnerable Area
RBMP	River Basin Management Plan
SAIFF	Scottish Advisory and Implementation Forum for Flooding
SDP	Strategic Development Plan
SEPA	Scottish Environmental Protection Agency
SPAADE	Scottish Pluvial Average Annual Damages Estimates
SuDS	Sustainable Urban Drainage System
SWMP	Surface Water Management Plan
WFD	Water Framework Directive
WWTW	Waste Water Treatment Works

In 2009 the Scottish Government introduced the Flood Risk Management (FRM) Act which established a 6 year planning cycle for assessing and sustainably managing flood risk in Scotland. The FRM act was created to reduce the negative impact of all types of flooding including from surface water.

The key FRM strategies that relate to surface water are to:

- Identify areas at greatest risk.
- Set objectives to reduce risk in those areas.
- Identify actions to achieve the objectives:
    - Inform the responsible authorities to develop and implement SWMPs to reduce the risk of surface water flooding for areas with greatest risk.
    - Describe the relevant actions that have been identified through the SWMP process to reduce surface water flood risk.

The locations requiring a SWMP were identified by the FRM strategies published by SEPA in 2015[1]. The FRM strategies lead to the creation of Local Flood Risk Management Plans (LFRMPs) which set out who will lead the SWMP process, timescales for developing the SWMPs and timescales for implanting actions identified in the SWMPs.



[1] Flood Risk Management Strategies: http://apps.sepa.org.uk/FRMStrategies/

[2] SAIFF, Surface Water Management Planning Guidance – 2nd Edition – May 2017

The aim of a surface water management plan is to reduce the risk of surface water flooding in the most sustainable way as required by the FRM Act. It is a plan which outlines the preferred surface water management strategy in a given location. In this context surface water flooding describes flooding from artificial drainage networks (sewers & drains), groundwater, runoff from land (pluvial), small watercourses and ditches (including culverts) that occurs as a result of heavy rainfall.

Surface water flooding accounts for 23% of all annual flood damages in Scotland with estimated annual damages of approximately £58 million[3]. Surface water flooding is expected to increase in the future due to climate change and the effects of urban creep (loss of greenspace due to urbanisation). The effects of climate change alone are predicated to increase the properties and businesses at risk by 45% by 2080.

The organisations which need to be involved in SWMPs will vary as with location depending on the local environment and type of problems encountered. Three partners have been identified as part of this study Argyll and Bute Council and Scottish Water. Due to the high-level assessment it is necessary to restrict stakeholders initially in order to progress the consultation and engagement process efficiently. Should more detailed studies be required as part of the SWMP potential additional stakeholders will be identified. Each of the three organisations are integral to managing flood risk. The following section outlines their roles and responsibilities in the SWMP and how the SWMP will be used by each organisation.

[3] SEPA 2013 Flood Risk Data

Argyll and Bute Council are the Lead Partner and has the overall responsibility of the SWMP. Three separate departments of the council are involved and can influence the SWMP process

Argyll and Bute Council have general powers to manage flood risk (from all sources, including surface water flooding) in their area under the FRM Act. This includes implementing actions described in the LFRMPs, flood protection schemes or any other flood protection work.

Argyll and Bute Council (as a roads authority) have a requirement to maintain and manage public roads under the Roads (Scotland) Act 1984. As such they have the powers to drain roads and where drains (including SuDS) are constructed they are also required to maintain them.

Argyll and Bute Council (as a planning authority) have powers to grant or refuse planning applications of which flood risk assessments form an important consideration. As well as planning application the council also creates Strategic Development Plans and Local Development Plans which includes infrastructure investments required as well as the drainage associated.

Scottish planning policy generally takes a precautionary approach to flood risk and promotes SuDS as a way of limiting the effect of the increase in impermeable areas often associated with new developments. Planning policy requires that any new development is designed to withstand surface water flooding at the 1:200yr storm event and that surface water discharge is limited to the equivalent greenfield runoff rate.

As well as planning the council is also responsible for building standards. Building standards have duties to ensure that surface water management infrastructure (drainage and flooding) is designed to appropriate standards, where that infrastructure is owned by the land / home owners rather than vested by Scottish Water or a local authority (as roads authority). Section 3.6 of the Building (Scotland) Regulations 2004 sets out the requirements for surface water drainage.

Outputs from the SWMP will be used by Argyll and Bute Council to carry out other activities such as emergency planning, control drainage, review LDP land allocations, and Strategic Development Plans (SDP), at the same time as satisfying the requirements of the FRM Act.

Scottish Water has duties under the Sewerage (Scotland) Act 1968 to provide and maintain public sewers that can effectively drain surface water from the curtilage of properties under 'usual' rainfall events (1:30 year rainfall event). The definition of flooding under the FRM Act does not include flooding solely from a sewerage system (which falls under Scottish Water duties). The Sewerage (Scotland) Act sets out vesting process for new infrastructure draining the curtilage of properties. They also have the duty to receive water from adopted SuDS systems.

Scottish Water is an essential partner in the SWMP. The outputs from the SWMP will be used by Scottish Water to prepare for emergencies, undertake their Drainage Area and Sewerage Management Plans, plan their investment and respond to climate and population change in addition to development pressures.

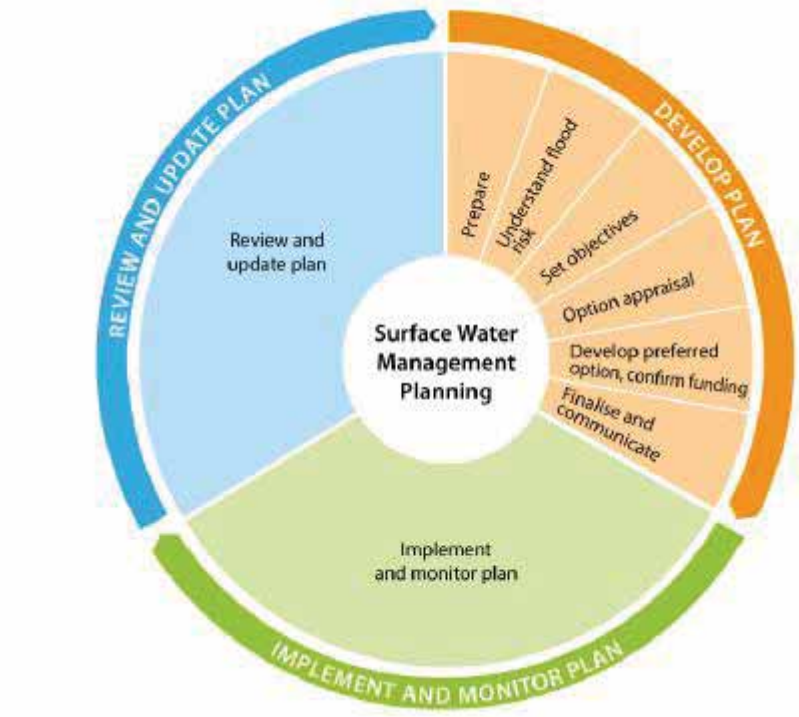
SEPA has responsibilities under the FRM Act to map and assess flood risk (including surface water flood risk), produce FRM Strategies (that take into account surface water flooding), provide a flood warning service and issue flood risk advice to planning authorities.

SEPA is an essential Partner in the SWMP. The outputs from the SWMP will be issued to the SEPA to review and assess existing and new emergency plans, communicate with local residents on flood risk issues, and finalise asset management plans (investment, operations and maintenance).

From a planning perspective SWMPs can provide a framework to alleviate surface water flooding for new developments, whilst contributing to improving the water quality of our water networks and achieving the requirements of the Water Framework Directive (WFD).

The SWMP consists of 3 key areas:

- Developing the plan
    - Prepare – Gather and collate existing flooding information, allocate resource, validate existing information and identify the geographical extent of the SWMP area.
    - Understand flood risk – analyse, interrogate and interoperate available information to understand surface water flood hazard and risk. Use this information to identify areas with the greatest risk and communicate the findings to key stakeholders.
    - Set Objectives – Using the objectives specified from FRM strategies to set more detailed objectives for areas with greatest risk. Once the objectives are identified they can be prioritised and shared with key stakeholders for potential future collaborative efforts to reduce flood risk.
    - Options Appraisal – A high level appraisal for all objectives and a more detailed appraisal and design for priority objectives. Developing and comparing proposed options in order to select a preferred option. This stage also includes consulting and co-ordination of the preferred options with stakeholders.
    - Develop preferred option, confirm funding – This step involves developing the preferred option in more detail, confirming responsibility of the stakeholders and identify how the project could be funded.
    - Finalise and communicate plan – the final step of the Development Process is to produce a SWMP that summarises the key findings and outputs and includes proposals for monitoring, implementing, reviewing and updating the SWMP.
- Implement and monitor plan
    - Implementing the action identified in the SWMP and monitoring the success of the action to determine if objectives have been achieved.
- Review and update plan
    - The SWMP is a long-term process subject to the cyclic nature of the flood risk management planning circle. When SWMP are updated the development stage is revisited to account for any changes during the implementation period.



To help manage flood risk and reduce impacts of flooding on communities SEPA developed it's first Flood Risk Management Strategies published in December 2015. Scotland has been separated into 14 Local Plan Districts (LPDs), these districts being based on river catchments across administrative and institutional boundaries. Each LPD has a bespoke overarching strategy in place to manage flood risk.

Argyll and Bute Council, as an authority responsible for flood risk management, is a member of The Clyde and Loch Lomond LPDs and has had detailed involvement in the preparation and agreement of the LPD strategies and local plans.

[4] SAIFF, Surface Water Management Planning Guidance – 2nd Edition – May 2017

The flowing section contains a brief synopsis of the works undertaken to create the SWMP. The full report for each subject can be found in appendix A to D.

The first step in the SWMP is to gather all of the available existing data on surface water flooding provided by the key stakeholders:

- Regional Pluvial Flood Hazard Mapping
- National Pluvial Flood Hazard Mapping
- Natural Flood Management Data
- Flooding Receptors
- Strategic Appraisal Baseline

- GIS network
- Anonymised Flood Records Spreadsheet
- Drainage Network Model

- Flood records database
- Local development plan
- Photographic records

- Information on settlements and localities – National Records of Scotland
- Catchment descriptors - Flood Estimation Handbook
- Social vulnerability to flooding and flood disadvantage – Scottish Government

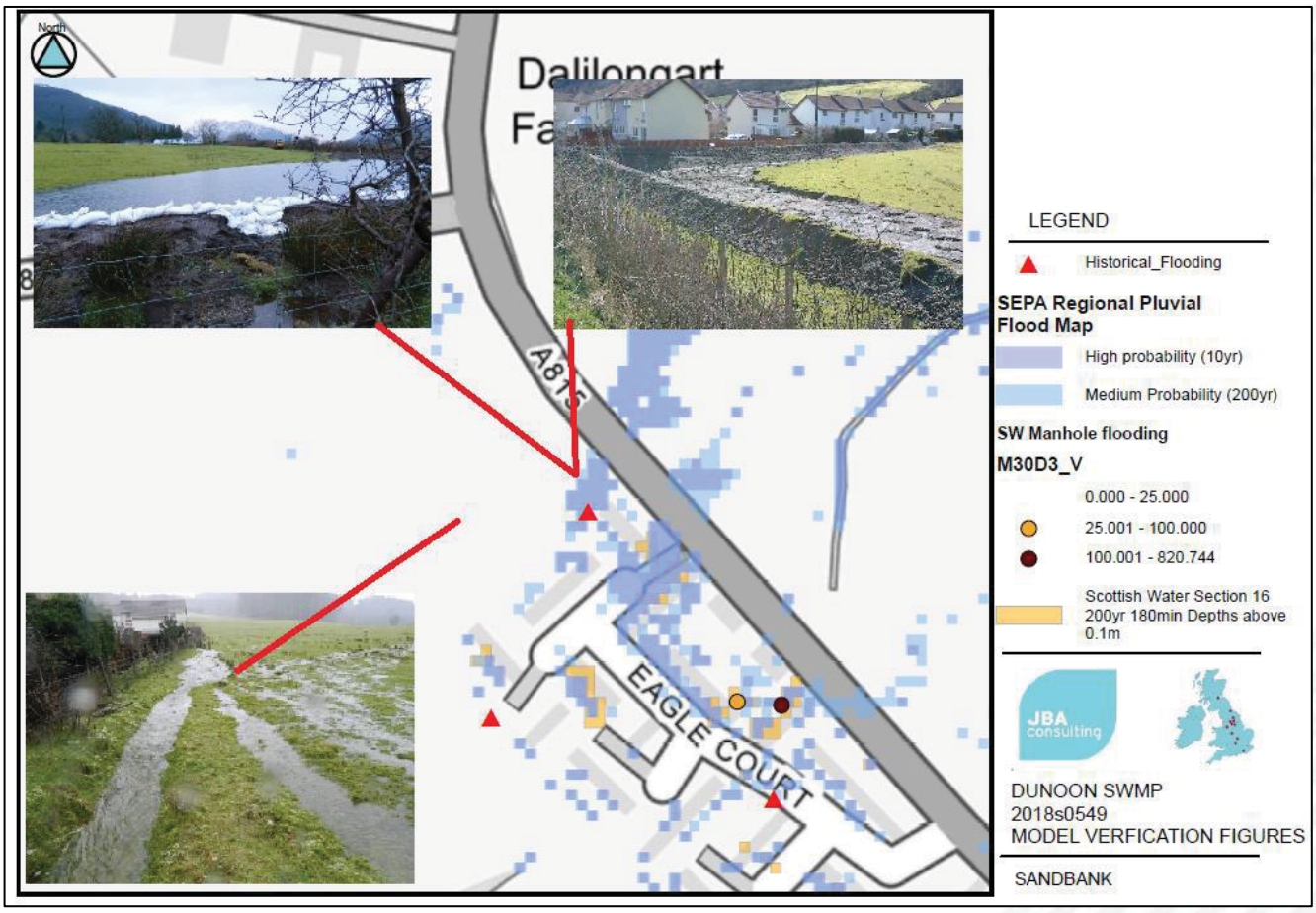
To understand the current flood risk it is necessary to take in to account all of the pluvial & fluvial management activities that are in place. The activities could either increase or decrease surface water flood risk. Data supplied included information on:

- Argyll and Bute Council's maintenance and inspection regime.
- The Milton Burn Flood Protection Scheme was completed in 2012 which consists of a 1.4m bypass pipe, flood wall improvements and the raising of a pedestrian bridge. This scheme reduces the impact of flooding in Dunoon and provides a standard of protection to a 1 in 100 year flood plus climate change in the St Mun's area. These defences will be maintained, and will continue to manage flooding according to the design standard at the time of construction. Unless actions are put in place to enhance the standard of protection, levels of flood risk are likely to increase over time as a consequence of climate change.
- The Kilbride Road, Dunoon Flood Prevention Scheme 2007 was confirmed on January 29, 2008. Flooding in the Kilbride Road area from the Crochan Burn regularly causes substantial damages to businesses and properties in the area. The flood prevention scheme comprises a new culvert along Kilbride Road together with ancillary drainage improvements to protect businesses and properties against flooding up to a 1 in 100 year event, taking into account the effects of climate change. Argyll & Bute Council has awarded the construction contract with completion planned for summer 2009.

The natural catchment characterises watercourses in each of the SWMP areas are described fully in appendix A. The catchment area and other catchment descriptors have been extracted from FEH handbook or from a hydrological assessment undertaken by Grontmij in 2010 on behalf of Argyll and Bute Council. The description of the catchment can be used to get an idea of how the watercourses are likely to behave during a flood event. For example, debris load and the type of debris will affect the likelihood of blockages at downstream constrictions e.g. culverts and bridges.

Although the SWMP is a pluvial study the guidance documents require it to also consider fluvial events where watercourses have small catchments ($3km^2$) or are predominantly urban.

Verification of all the collated data is undertaken using the GIS data to compare the modelled hazard and risk data against observed events. The purpose of the verification process is to identify areas where good alignment between modelled and observed flooding occurs and that the mechanisms of flooding are identifiable. These areas will be deemed suitable for assessing the consequences of flooding. The process also identifies where poor calibration exists between modelled data and observed flood events. This could be a location where flooding is predicted, but has not occurred, or conversely a location where flooding has occurred, but is not predicted by the model. The section below provides a summary of the model verification for each of the SWMP areas. Further details on this process can be found in appendix A.



The modelled and observed data has shown that this area is considered to be at significant risk of surface water flooding. There is a strong correlation between the model and observed data, particularly in high risk areas. However, the model does not account for mitigation measures installed by the council which are known to have lowered the flood risk in particular areas. Overall, the model confidence is moderate in this SWMP area.

The model verification process has highlighted a variance in model confidence that can differ substantially across the PVA area as well as within each SWMP area. The SEPA regional pluvial mapping and Scottish Water flood spreading assessment forms the basis of the model as it is the most accurate data available. Due to the scale of the regional pluvial mapping there will always be areas that are not well represented. Small drainage ditches, minor channel and multiple culverted section require more detailed modelling to determine the flooding mechanisms.

Phase 2 of the SWMP focuses on understanding surface water flood risk with each of the SWMP areas identified in Phase 1 of the report.

It is well documented that Dunoon has a history of surface water flooding. The purpose of this phase of the report is to take a closer look at the flooding within these areas, to understand the flooding mechanisms at work as well as the associated hazard and risk.

Understanding the causes and consequences of flooding is crucial for making well informed decisions on how to manage flood risk. This will be done by analysing available information to gain an appreciation of the sources, pathways, receptors, flood risk and flood hazard.

In order to understand surface water flood risk, it is necessary to break down each of the surface water management areas into smaller flooding "hotspots". The flooding hotspots are defined by the flooding mechanism. Flooding mechanisms within a hotspot may be singular or linked with multiple different mechanisms causing flooding in one area. An example of this could be where hillside runoff floods properties before passing into the drainage network which subsequently surcharges effecting nearby properties.

Before defining the hotspots an analysis of key information within each SWMP area is undertaken to identify catchment wide factors that may influence the definition of the flooding hotspot. This analysis includes:

- Significant surface water flood events
- Natural drainage features
- Artificial drainage features
- Interactions between the natural and artificial drainage systems
- Existing surface water management infrastructure

Defining flood risk hotspots is a manual process which involves analysing all of the information available. However, initially to define the geographical area the primary focus is on the SEPA regional pluvial flood hazard mapping, Scottish Water flood spreading assessment results and also the historic flood database. At this stage it is also important to refer back to the model verification step to incorporate the model confidence when defining the hotspot.

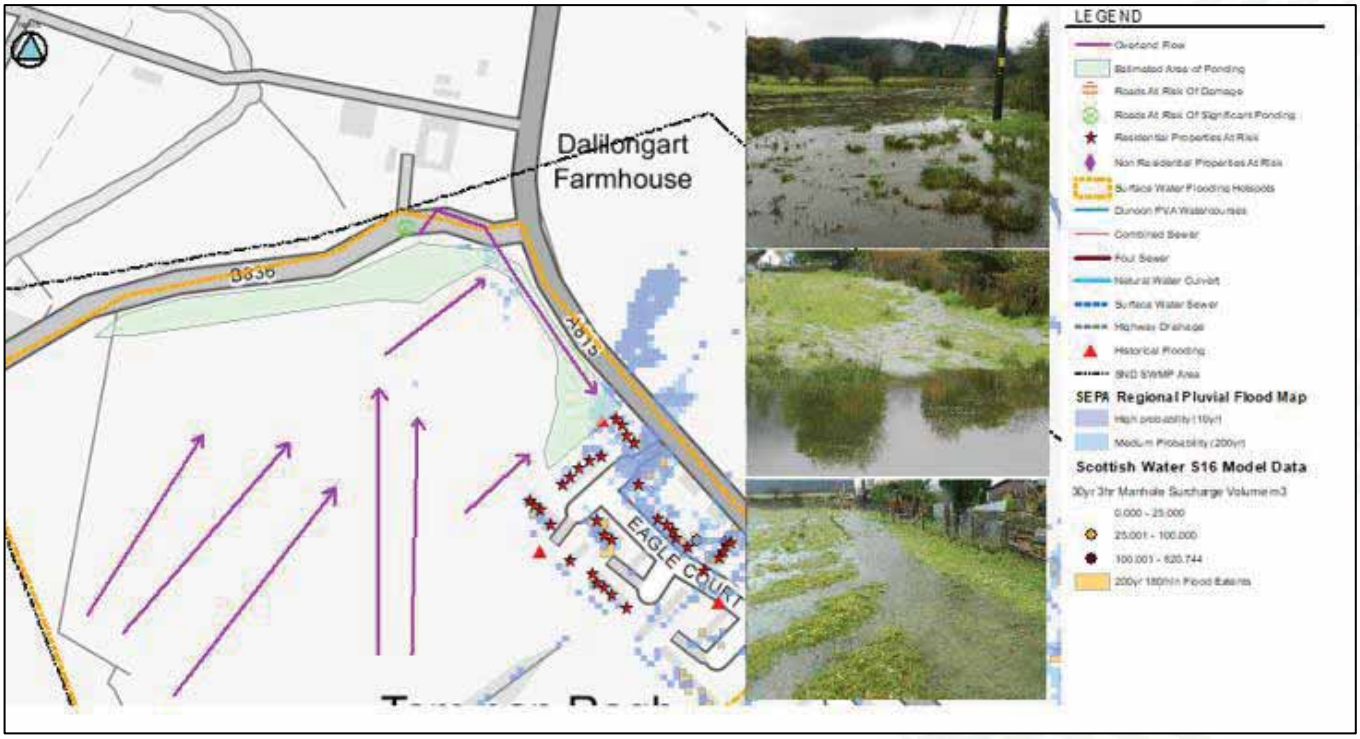
A site visit was also undertaken, where engineers visited the hotspots where model confidence was low or there was uncertainty over the flooding mechanism.

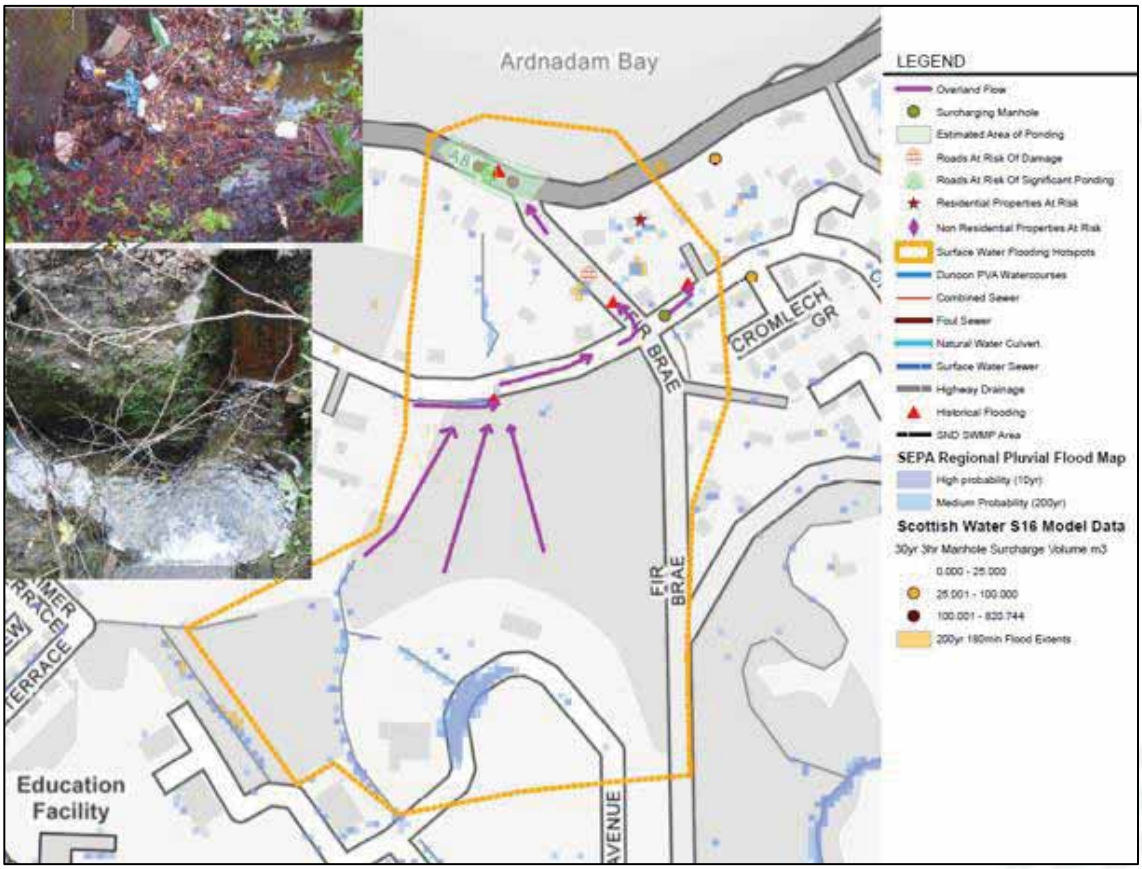
When analysing the hotspots, it is important to consider not only the current flood risk but also the future flood risk. The future flood risk looks at factors such as climate change, urban creep, demographic change as well as potential development sites. Future developments can provide an opportunity to not only manage surface water within the site but to the areas connected to the site.

Once the hotspots have been identified and damages have been assigned, it is necessary to prioritise the hotspots so that efforts can be focused where there is the most benefit. The factors that influence the ranking are as follows:

- The value of the average annual damages within each hotspot.
- The number of residential properties assessed to be at risk for the 1:200 year event.
- The number of non-residential properties assessed to be at risk for the 1:200 year event.
- Where the management of the risk lies within the powers of the SWMP stakeholders.
- The number and presence of vulnerable facilities.
- Where existing schemes are already operating hence reducing the benefit of implementing additional measures and allowing non-protected areas to be addressed.
- Social vulnerability to flooding dataset, published by the Scottish Government.

The figures below are examples of the analysis from the hotspot creation phase. A total of 16 surface water flooding hotspots were derived during the study. Each hotspot is covered in substantial detail in appendix B.





It is estimated that surface water flooding accounts for 20% of annual average flood damages in the Dunoon PVA (based on SEPA modelled data).

Dunoon PVA	£74,000	£406,000

A summary of the surface water flood risk for each of the SWMP areas below. For details on the surface water flood risk and information on how these number were derived see section 4.

Dunoon	0	122	0	£1,930
				£171,988

The Flood Risk Management Strategy for LPD 11 contains high-level objectives for surface water management within the PVAs. The FRM document also identifies priority areas for the SWMPs which have been further broken down into hotspots as discussed in Phase 2. The high-level objectives are:

- To avoid an increase in surface water flood risk (applies everywhere including SWMP areas).
- To reduce surface water flood risk (applies to SWMP areas at the town and city scale).

More detailed and localised objectives for reducing surface water flood risk are based on the understanding of flood risk and the assessment of responsible authorises (stakeholders). The objectives available to be used in the SWMP are described in the table below.

Reduce surface water flood risk	Areas where the greatest risk of surface water flooding (hotspots) has been identified in phase 2 through analysis of the model and historic events. Areas where there are critical facilities or infrastructure that carry a risk i.e. schools, hospitals, main roads.
Accept flood risk and maintain existing actions	Areas where there are already surface water management feature/schemes in place to reduce flood risk i.e. surface water storage, pumping stations.
Improve understanding of surface water flood risk	Areas where, from the analysis undertaken in Phase 2, it is not clear how or why flooding is occurring or how to remediate the flooding. This can be applied to individual hotspots or larger areas depending on the outcome of the model verification undertaken in Phase 1.

In order to develop the initial objectives identified by SEPA in the LPD Strategies a 2 part process is required:

1. The initial objectives proposed in the FRM strategies have been updated following the results of the Understanding Surface Water Flood Risk section (Phase 2). This process creates targeted objectives for each of the hotspots identified. The objectives are also assigned a draft priority at this stage.
2. The objectives are then subject to stakeholder consultation where they will be appraised, selected and prioritise for implementation based in the knowledge of upcoming projects and funding opportunities.

Once the objectives have been assigned it is necessary to prioritise the various objectives. An accurate timeline is not given at this stage as it is more an indication of which objectives could be possible in the long and short term.

When considering the priority of the objectives there is no prescriptive method to do so however, factors to consider are:

- Surface water flood risk (using information on impacts of flooding).
- Surface water flood risk to priority receptor groups, e.g. schools, hospitals, homes at risk in socially vulnerable areas.
- Locations with a history of flooding.
- Areas where there is no history of flooding but are predicted to flood and should therefore be treated with caution, particularly where more detailed models are not available. It is sensible to balance predicted and actual flooding information when prioritising.
- Locations where there are opportunities for joint working (e.g. making management more cost-effective and delivering multiple benefits).

The initial objectives have been set for each of the hotspots identified. Details can be found in Appendix C.

The options appraisal stage of the SWMP is key to ensure the most sustainable and feasible actions are identified and implemented as required by the FRM Act. The SWMP guidance shows that the most sustainable options for managing surface water flood risk will be identified using the process in the figure below focusing on the assessment of costs, flood risk mitigation benefits as well as other associated benefits.

Before undertaking the long list of potential actions, it is necessary to conduct a high level assessment for all the objectives identified in Phase 3 - Setting Initial Objectives. To enable focussed effort on surface water flood risk management within the SWMP cycle, the identified hotspots have been prioritised. The highest-ranking hotspots have been assessed further to identify options for implementation. The hotspots not being taken through to the next stage will be reassessed in the next SWMP cycle. This initial appraisal has been conducted to remove hotspots which are either:

- Predominantly fluvial flood events from which secondary surface water flooding is a minor factor and would not have occurred without the fluvial event. A fluvial study may be required for these areas which is outwith the scope of the SWMP.
- Have existing flood protection/mitigation measures where maintaining the asset provides a suitable level of protection.

The hotspots which are not being taken through to the next stage are identified in the table within appendix D. The table also identifies possible options that have been identified to aid the development of the next SWMP.

A long list of potential actions has been developed against each of the verified remaining flooding hotspots. Following the SWMP guidance, broad categories of actions were identified including structural and non-structural options. A total of 25 actions have been considered against each hotspot. The available actions are listed in a table in Appendix D. The long list actions are designed to identify and screen potential options and are not developed in detail.

It is necessary to screen the long list of actions to remove any actions which are clearly unfeasible leaving a smaller number to be taken through to the next step of the appraisal process. Here sustainability is a key issue with unsustainable actions disregarded.

During this process actions are screened against 3 main criteria – technical, legal and economic. Each action is attributed a score of 1, 2 or 3. A score of 1 represents an action that is to be taken forward into the options appraisal stage. A score of 2 represents an action that only partially addresses pluvial flood risk. A score of 2 could also be used where there is an action that would mitigate flood risk but is subject to substantial constraints that may make the action unattractive and potentially unfeasible. A score of 3 was attributed where actions are clearly unfeasible or unlikely to reduce surface water flood risk.

	Adhere to existing planning policy	2	2	2	2	2	3
	Implement more stringent land use policies	1	2	2	1	3	3
	Clarify new Surface Water infrastructure responsibility	3	3	3	3	3	3
	Clarify existing Surface Water infrastructure responsibility	3	3	3	3	3	3
	Emergency response plans	2	2	2	2	2	2
	Improve understanding of flood mechanisms	1	1	1	1	1	1
	Options appraisal and design	2	2	2	2	1	2
	Improve information on Surface Water flooding	2	2	2	2	2	2
	Business continuity planning	2	2	2	2	2	2
	Community action group	2	2	2	2	2	2
	Flood insurance	2	2	2	2	2	2
	Raise awareness	2	2	2	2	2	2
	Property Level Protection (PLP)	1	2	1	1	2	1
	Property Level Resilience	1	2	1	1	2	1
	Flood forecasting and warning	3	3	3	3	3	3
	Asset management and maintenance	1	1	1	2	1	2
	Watercourse management and maintenance	2	2	1	3	1	2
	Relocation	3	3	3	3	3	3
	Infiltration/evapotranspiration	3	3	3	3	1	3
	Conveyance	2	1	2	2	2	1
	Storage	1	3	1	3	3	3
	Restoring urban watercourses	3	2	1	3	3	3
	Urban watercourse engineering/ direct defences	3	2	1	3	3	1
	Run-off reduction strategy	3	3	3	3	3	3
	Reducing surface water in the sewer	3	3	3	1	2	3
	Land management	1	2	2	1	3	2
	Underground storage	3	3	3	2	1	3
	Underground conveyance	3	3	3	2	2	3
	Modification of culverted watercourses	1	1	1	3	3	1

The following section contains information on each of the high priority hotspots selected for options appraisal. Each surface water flood risk hotspot is described before a Multi-Criteria Assessment is undertaken on the viable actions identified in table above using the procedure described in Section 3.3 of Appendix D. The multi-criteria assessment is similar to the scoring mechanism used for the long list of actions but with more criteria and a more complex scoring method.

The actions identified as viable from the Multi-Criteria Assessment have been taken forward as options.

The proposed options listed below were created by JBA Consulting before being reviewed by representatives of Argyll and Bute Council and Scottish Water at a stakeholder workshop on 22nd November 2018.

Details of the options presented to the stakeholders can be found in appendix D.

A stakeholder workshop was held at Argyll and Bute Council's office in Helensburgh on Thursday 22nd November 2018. JBA presented the findings of the SWMP to members of Argyll and Bute Council and Scottish Water.

The presentation started with a recap of how the SWMP had progressed and the techniques/methods used in each of the preceding reports. JBA then presented each of the hotspots explaining the flooding mechanisms as well as the current and future flood risk. JBA discussed how the short list of actions had been derived and how these subsequently formed options.

Once the preferred option is chosen it will probably need to be developed and assessed in more detail. The level of detail required will depend on the flood risk and scale of the action (e.g. enough detail should be provided to have high confidence in the effectiveness of the action, and to inform and have high confidence in funding decisions).

Timings for confirming funding and assigning responsibilities for implementation, and for further development and design of the preferred option, are likely to vary (e.g. depending on the scale of option, source of funding and so on).

Good design is essential to ensure that surface water management infrastructure is able to realise multiple benefits, including integrating with and enhancing the urban landscape. It is therefore important that multidisciplinary teams include landscape architects, as well as flood management and drainage engineers.

The outcome of this stage should be an agreed set of feasible and sustainable actions to manage the risk of surface water flooding in an area.

Following open discussions, the following consensuses was agreed for the 6 remaining priority hotspots. Graphical representations of the preferred options can be found in Appendix D.

This option was seen as the best option in order to be in a position to develop an appropriate flood mitigation solution.

Other options discussed included:

- Infiltration (formalising current storage method).
- Conveyance (improving capture of runoff and conveying it below the A815.
- Land management.
- Storage (with a flow control/outlet)

  It was agreed that at present there is not sufficient data to be able to determine a favourable option hence, the next step is to prioritise the study of flooding mechanisms which will help identify the most suitable mitigation measures.

The study may consist of 2 phases, a data gathering exercise and modelling exercise.

The data gathering will include a review of Scottish Water's network GIS format) and a topographical survey. The Scottish Water data review will focus on the drainage layout of the Eagle Court development which is expected to have a separate surface water network, with a particular focus on the discharge locations of the pipes. A topographical survey will be used to establish:

- The topography of the contributing area including the hillside (overland flow).
- Property threshold levels.
- Drainage ditch cross sections (including the culvert and downstream of the culvert).
- The locations of Scottish Waters assets in the area.
- The topography of the area to the east of the A815 including any channels or culvert/pipe outfalls which may be utilised in the design.

The second phase will involve creating a 1D/2D hydraulic model which can represent the flooding mechanisms in this area. This will be used to determine the current flood risk in terms of storm return period i.e. 1 in 10-year rainfall event.

The model created can then be used to assess the risk and determine any further interventions.

This option was seen as the best option in order to be in a position to develop an appropriate flood mitigation solution. It was agreed that at present there is not sufficient data to be able to determine a favourable option hence, the next step is to prioritise the study of flooding mechanisms which will help identify the most suitable mitigation measures and also to reconsider asset management and maintenance activities.

The study may consist of 3 phases, a site walkover data gathering exercise, topographical survey and modelling exercise.

Undertake an initial site walkover to better understand the route of the water coming down the hillside through the wooded area, the headwall arrangement and the route of the flood water (including road gullies).

This information may be sufficient to inform suitable mitigation options or can be used specify a topographical survey.

Using the information from the site walkover a topographical survey may be specified for use in a hydraulic model. The topographical survey will include:

- The topography of the contributing area including the hillside (overland flow).
- Property threshold levels.
- Drainage ditch/channel cross sections throughout the slope and upstream area (including the culvert and downstream of the culvert).
- The locations of Scottish Waters assets in the area.

The third phase will involve creating a 1D/2D hydraulic model which can represent the flooding mechanisms in this area. This will be used to determine the current flood risk in terms of storm return period i.e. 1 in 10-year rainfall event.

The model created can then be used to appraise the various mitigation options to find the most suitable.

–

Following discussion of the various options presented and the work undertaken in the Grontmij assessment, asset management and maintenance was selected as the preferred option.

The flood history of this reach is limited with the only major event occurring due to a substantial blockage within a culvert. As such it was agreed that the most appropriate option at this time is to focus on maintaining the asset and preventing future blockage which may include improving screens and headwalls as well as reassessing inspection frequencies.

–

This option was seen as the best option in order to be in a position to develop an appropriate flood mitigation solution.

The initial step in this process would be to undertake a hydrological assessment of the watercourse to understand the extent of the catchment and flows which are currently entering the sewer network. This is likely to require a topographical survey of the drainage ditch system.

Once the flows into the network have been identified an assessment can be made on the cost benefit of a new surface water pipe on John Street. This work may also provide an opportunity to improve the headwall and upstream channel in order to prevent excess sediment and debris entering the new pipe.

Throughout the process of the study and implantation of removing the surface water from the sewer network, planning restrictions may also be utilised to prevent excess surface water entering the sewer network from the proposed development north of Alexander Street. This may include limiting the peak flow of the surface water rather than the volume of surface water.

–

This option was seen as the best option in order to be in a position to develop an appropriate flood mitigation solution.

The initial step in this process would be to undertake a hydrological assessment of the catchment to understand the extent of the catchment and flows which are currently flowing towards the south west of the park. This is possible using a 2D hydraulic model which utilises the available LiDAR data.

Once the flows are identified then works to determine the location and sizing of the infiltration test can proceed. At this stage it will be necessary to research possible discharge locations. It is likely that several possible routes will be identified and appraised against the damages to determine the most cost-effective solution.

By introducing the new drainage, it may be possible to decommission the existing pumping station and regrade or infill the associated drainage channels.

After discussion of the potential flooding mechanisms in the Arran park area of Innellan it was decided to lower the priority of the hotspot to low. This was due to the majority of the flood risk lying within the boundary of a single property. At this location the flooding mechanism comes under the responsibility of the riparian owner in which case the stakeholders have very little influence.

.

Hotspot	Preferred Option	Final Objective	Final Priority	Responsibility	Potential Funding Route	Target Implement ation Date	Target Standard of protection	Number of homes and businesses better protected
SND_HS01: Eagle Court	*Improve understanding of flooding mechanism*	*Improve understanding of surface water flood risk*	*High*	*Argyll and Bute Council*	*LA capital via FRM strategies*	*2022-2028*	*1 in 200 year*	*34*
DUN_HS04: Alexander Street	Improve understanding of flooding mechanism, more stringent land use policy and removing surface water from the sewer	*Reduce surface water flood risk*	*High*	*Argyll and Bute Council and Scottish Water*	*LA capital via FRM strategies / Scottish Water Capital*	*2022-2028*	*1 in 200 year*	*21 (+reduction in dry weather flow in sewer network)*
DUN_HS09: Black Park	Improve understanding of flooding mechanism, watercourse management and maintenance and infiltration and evaporation	*Reduce surface water flood risk*	*High*	*Argyll and Bute Council*	*LA revenue*	*2022-2028*	*1 in 200 year*	*5*
SND_HS03: Fir Brae	*Improve understanding of flooding mechanism and asset management and maintenance*	*Improve understanding of surface water flood risk*	*Medium*	*Argyll and Bute Council*	*LA capital via FRM strategies*	*2022-2028*	*1 in 200 year*	*1 (+ponding on Shore Road)*
DUN_HS01: Fairhaven	*Asset management and maintenance*	*Accept risk and maintain existing assets*	*On-going*	*Argyll and Bute Council*	*LA revenue*	-	-	-
TOW_HS03: Arran Park	*Change to low priority to be reassessed in the next SWMP cycle.*	*Accept risk and maintain existing assets*	*On-going*	*Argyll and Bute Council*	*LA revenue*	-	-	-

Now that the preferred option has been selected it will need to be developed and assessed in more detail. The level of detail required will depend on the flood risk and scale of the action (e.g. enough detail should be provided to have high confidence in the effectiveness of the action, and to inform and have high confidence in funding decisions).

Timings for confirming funding are likely to be inline with the FRM funding cycle with application for funding due in late 2019 for the next cycle 2022-2028.

Good design is essential to ensure that surface water management infrastructure is able to realise multiple benefits, including integrating with and enhancing the urban landscape. It is therefore important that multidisciplinary teams include landscape architects, as well as flood management and drainage engineers.

Once implemented, actions can be monitored to determine progress towards achieving objectives. Monitoring can also determine how effective actions are at managing surface water and realising multiple benefits. As more information is gathered, over time, other actions can be implemented and improved.

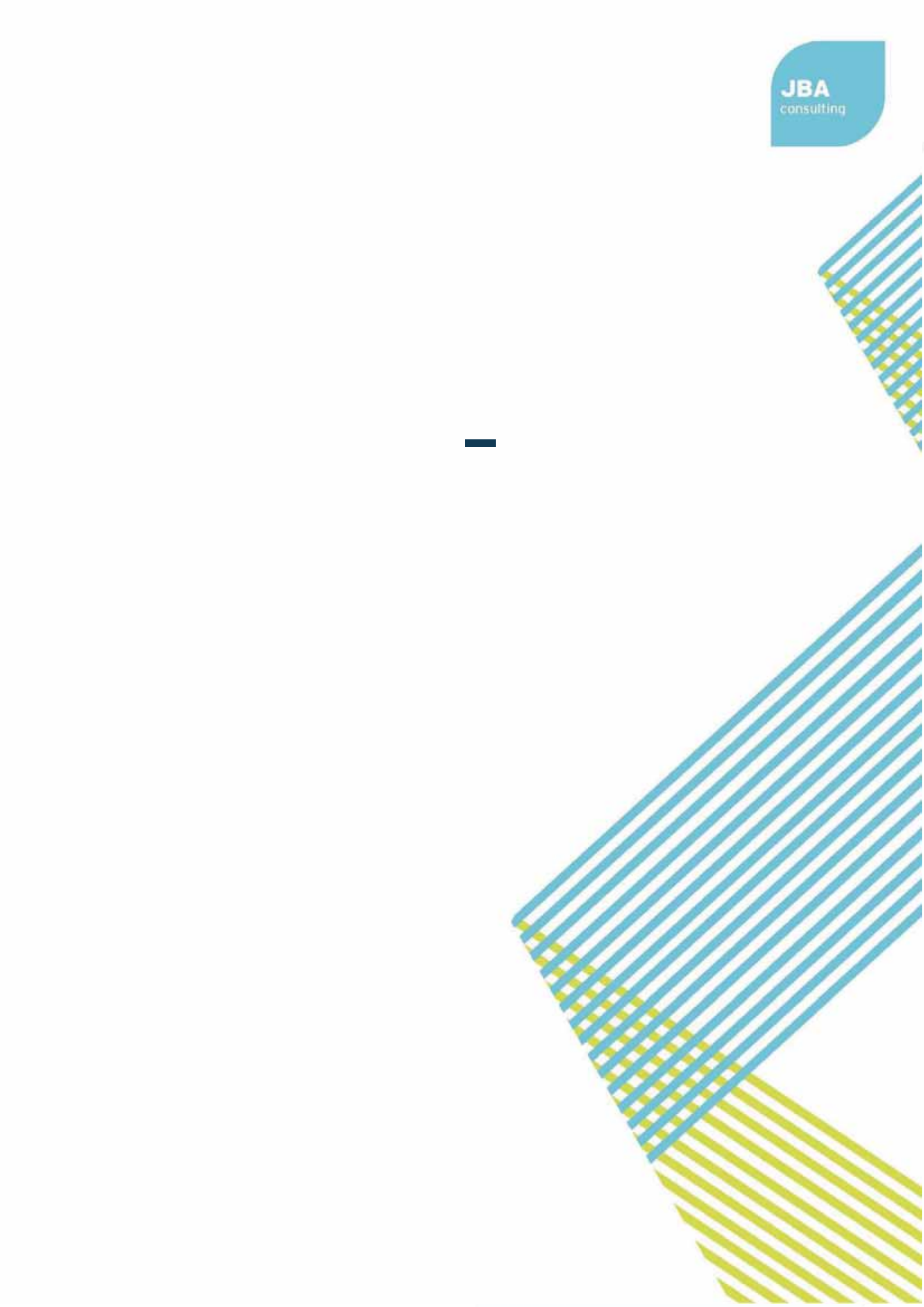
Updated summaries of all actions and their status e.g. 'live implementation plan') should be maintained to help co-ordination and communication. The summaries should confirm when an action has been completed and capture key information about that action. Key data (e.g. standard of protection, number of properties protected etc.) on completed structural actions in particular should be collected and shared with stakeholders, including SEPA and Argyll and Bute Council. This will help to confirm the status of any relevant actions that are in the LFRMP and FRM Strategy and also allow reduction in flood risk to be collated, quantified and communicated to monitor progress against the objectives of reducing flood risk.

Flood risk management planning follows a six-year cycle, with stages covering understanding flood risk, setting objectives and implementing actions to achieve objectives. SWMPs should be reviewed and updated with LFRMP and FRM Strategy timescales in mind.

When reviewing and updating a SWMP, the development process should be repeated and any required changes made, e.g. to update understanding of flood risk, objectives and actions.

Key drivers of a review may include:

- Updated flood hazard and risk information.
- The occurrence of a flood.
- FRM Strategy publications (containing updated SWMP areas and confirmed funding of actions).
- Outcome of investment decisions by partner agencies that deviate from the preferred plan.
- Monitoring of the implementation of actions, e.g. indicating where changes can be made to replicate success and / or improve outcomes where actions have not been successful.
- New development or other changes in the area that affect surface water flooding.



The National Flood Risk Assessment (2011) has identified a Potentially Vulnerable Area 11/07 within Argyll & Bute.

This SWMP covers the eastern half of the headland and is centred on the main settlement of Dunoon. The aim is to collect broad scale and detailed data to identify proportionate flood hazard and risk.

During this stage consultation was limited to Argyll & Bute Council, SEPA and Scottish Water.

The spatial scale of the SWMP extends over eastern half of the headland from Sandbank in the north to Toward in the south covering an area of approximately 47.5km^2. The SWMP area is predominantly rural with several urban areas including Innellan, Toward, Sandbank, Kirn, Ardnadam and the main settlement Dunoon. Given the broadscale of the SWMP it is necessary to produce multiple SWMP areas in order to understand the flood risk and flooding mechanisms at work.

The areas have been selected by considering the following:

- The areas of greatest impact of surface water flooding, using the SEPA pluvial flood maps, Scottish Water model data and historical flooding records (SEPA, Scottish Water, & Argyll and Bute Council).
- The extent of urban areas.
- The size and extent of natural drainage features.
- The size and extent of artificial drainage networks.

Using the information above the SWMP has been divided into 3 areas:

1. Sandbank and Ardnadam (north).
2. Dunoon and Kirn (centre).
3. Innellan and Toward (south).

The geographical areas can be seen in the SWMP drawings presented in Appendix A.

A project specific data register has been created for the Argyll and Bute SWMP and can be viewed in Appendix D. The data register records all sources of information used to develop the SWMP and specifically identifies the following;

- What data and information is available
- Who owns the data / information
- Licensing information and limitations on use
- Data format
- Level of confidence and suitability for use

The Regional Pluvial Dataset consists of high quality shapefiles showing flood depth, extent and velocity. Three return periods have been provided:

- low probability = 1000-year return period
- Medium probability = 200-year return period
- High probability = 10-year return period

The DTM is derived from predominantly good quality LiDAR data which has been edited to prevent false blockage at culverts and bridges. The dataset is a combination of the regional pluvial hazard and Scottish Water data (and national pluvial where there is no regional). These are still a good basis for validating the SEPA pluvial hazard data. The regional pluvial flood hazard dataset is the primary model-based source of flooding information for this SWMP.

SEPA have also provided the detailed regional pluvial hazard maps. These have been developed for the purposes of surface water management planning. There maps show pluvial flood extent, depth and flow direction, for a range of rainfall return periods (10, 30, 50, 100, 200, 200+cc). This dataset will be used during analysis of the surface water flooding "hotspots."

The National Pluvial Dataset is suitable for high level studies and contains shapefiles showing flood extent, depth and velocity. This has since been superseded with the Regional Pluvial dataset which will be used in its place where available. Confidence in this data set is poor and only used if regional maps are not available. However, the regional pluvial dataset included all SWMP areas hence the National dataset was not used.

Contains shapefiles with information on floodplain storage, runoff likelihoods and information on sediment transport. There is an error in the data which has made it only visible a very high scales, this has made the data difficult to use. As a result, a medium level of confidence is appropriate.

Available throughout the SWMP area contains shapefiles for a comprehensive range of receptors useful for determining flood hazard and risk. The dataset ties in well with the background mapping hence confidence is high. This data was produced for the 1st FRM Strategies in 2015. A new dataset has been developed as part of the National Flood Risk Assessment (2018).

Contains appraisal baseline outputs for the regional and national pluvial datasets as well as the Average Annual Damages (AAD) grids which are a vital part of determining and prioritise flood risk. The dataset is produced by SEPA and derived from various receptor datasets and the regional pluvial mapping. The data is consistent with the SEPA flood depths and the Scottish Water Flood Spread Assessment. As a result, there is a high level of confidence in the appraisal baseline dataset. As the dataset is based on the regional pluvial flood hazard maps the confidence in the data will vary in line with the model confidence.

Under Section 16 of the FRM (Scotland) Act 2009 Scottish Water have a duty to assess flood risk from sewerage systems. As such Scottish Water have provided the following data:

Scottish Water have provided a detailed GIS sewer network for Dunoon to Hunter's Quay. The GIS networks are either compiled by GIS points or polylines. The very high volume of points makes the dataset very difficult to use and interoperate. Given the detailed nature of the data provided the level of confidence is high. However, in its raw state, its suitability for use is moderate due to it being difficult to use. To improve the usefulness within the SWMP study, the data has been rationalised to include the following:

- Manholes, pipes and outfalls. The data has been stripped back to the essential components only.
- Networks have been coloured according to the type of sewer i.e. red for combined, blue for surface water, brown for foul etc.

This information was not available at the time of writing this Surface Water Management Plan.

Scottish Water have undertaken a flooding spreading assessment for the Dunoon, Kirn and Sandbank catchment in line with Section 16 of the Flood Risk Management (Scotland) Act 2009.

In September 2012, Scottish Water appointed MWH to fulfil an Infiltration Study for the Dunoon Sewered Area (SA). The purpose of this was to highlight any infiltration issues and the significant inflow areas and recommend potential solutions to address these issues. Situated on the Firth of Clyde, Dunoon is a resort town with a population of 8,251 with a total of 6,535 properties in its catchment. Dunoon's sewer network is old and mainly consists of combined sewers with a small number of separate systems for the newer developments. The town has seven pumping stations which are located along the banks of the Firth of Clyde. The report highlights the problems in the Dunoon SA and suggests requirements for improvement.

The LDP dataset consists of shapefiles used to in the creation of the Local Development Plan and indicates sites earmarked for future uses such as housing or business. These files are vital in assessing future flood risk and opportunities for surface water management in future developments. The data was used to create the LDP reports, confidence is high.

Records of observed flooding in the Argyll and Bute Council have been included in the SEPA flood database. This data is very important and is required to validate the model. The level of detail in the data entries is adequate and includes a description of flood origins and damages. However, within the same database there are a lot of entries which appear to be logged calls by concerned residents or works orders for operatives. There were also substantial inaccuracies in the location of the GIS file. All of the historical data has been analysed and moved to the correct location. To streamline the dataset the following entries were removed:

- Any entries that referred to coastal or fluvial flooding from a significant watercourse e.g. Milton Burn, Blagaidh Burn.
- Any entries that were instructions to operatives
- Any entries which referred to blocked road drainage which was not recurring.
- Any entries which referred to burst watermains.
- Any entries that were to vague to be located.

The database was reviewed inline with substantial volumes of historic documents on flooding in specific areas. This information included detailed descriptions of flooding mechanisms, sketches, diagrams, photographs and information from home owners.

Historic flood photographs were provided. This data is crucial as it conveys the scale and damage of the surface water flooding in this area.

The council have provided a GIS file which contains the locations of all assets that are prone to flooding such as culverts, screens and drainage ditches.

Argyll and Bute Council are responsible for managing and maintaining road drainage. This extends from road gullies to their connection to the local drainage system. It has been assumed that road gullies/drainage are connected to the combined sewer unless shown otherwise in the GIS drainage networks provided. Responsibility for open drainage ditches/channels varies depending on the watercourse and ownership such as Argyll and Bute Council and Riparian Owners, SEPA undertakes a regulatory role. The responsibility for culverted watercourses also varies and can include Argyll and Bute Council, Scottish Water as well Riparian Owners. Responsibility for the sewer network and operation of the associated pumping stations falls with Scottish Water.

- − The National Records of Scotland provide GIS files for information regarding settlements including settlement boundaries. There is a high level of confidence in the data.
- − Social vulnerability to flooding is understood as the varying degree to which people's health and well-being would be negatively affected if they came into contact with flooding. The higher the vulnerability, the greater the negative effect of flooding. There is a high level of confidence in the data.
- − Catchments of influential watercourses have also been digitised as part of this SWMP. The Catchment boundaries and a description of the catchment characteristics can be found in Section 4 below. There is a high level of confidence in the data.

Argyll and Bute Council undertake a proactive inspection and maintenance regime to allow for efficient and effective flood management (all sources) within the Local Authority area. When flooding is forecast teams are sent out to ensure that key surface water infrastructure such as trash screens are clear. This work is undertaken and managed by the Road, Traffic and Transportation department. This department are responsible for maintaining public roads, including drainage, as well as clearing debris and potential blockages from watercourses and structures which are deemed a flood risk. It is the responsibility of the riparian owners to maintain the bed and banks of a watercourse and also for protecting individual properties.

The council have already implemented and maintain a number of local measures to alleviate the risk of surface water flooding. There are also a number of SuDS in operation within Argyll and Bute. The council provided a SuDS report which contained up to date information on operational SuDS schemes as well as other council operated surface water management assets.

A summary of the surface water alleviation measures (not including SuDS) which have been implemented are listed below:

- The Milton Burn Flood Protection Scheme was completed in 2012 which consists of a 1.4m bypass pipe, flood wall improvements and the raising of a pedestrian bridge. This scheme reduces the impact of flooding in Dunoon and provides a standard of protection to a 1 in 100 year flood plus climate change in the St Mun's area. These defences will be maintained, and will continue to manage flooding according to the design standard at the time of construction. Unless actions are put in place to enhance the standard of protection, levels of flood risk are likely to increase over time as a consequence of climate change.
- The Kilbride Road, Dunoon Flood Prevention Scheme 2007 was confirmed on January 29, 2008. Flooding in the Kilbride Road area from the Crochan Burn regularly causes substantial damages to businesses and properties in the area. The flood prevention scheme comprises a new culvert along Kilbride Road together with ancillary drainage improvements to protect businesses and properties against flooding up to a 1 in 100 year event, taking into account the effects of climate change. Argyll & Bute Council has awarded the construction contract with completion planned for summer 2009.

Flood warning systems only operate on large watercourses/catchments, there are no such watercourses in the SWMP area.

The remaining areas are covered by the Flood Alert Service. The Scottish Flood Forecasting Service provides daily flood guidance statements at a national level to Category 1 and 2 agencies including emergency services and Local Authorities. This service provides a 5-day forecast of surface water flood risk.

All new developments are required to limit surface water run off to greenfield runoff rates. This is achieved by using various SuDS to attenuate runoff therefore avoiding an increase in runoff which is often associated with new developments. The issue of non-adoption of SuDS and the failure to manage facilities properly is a potential concern to local authorities.

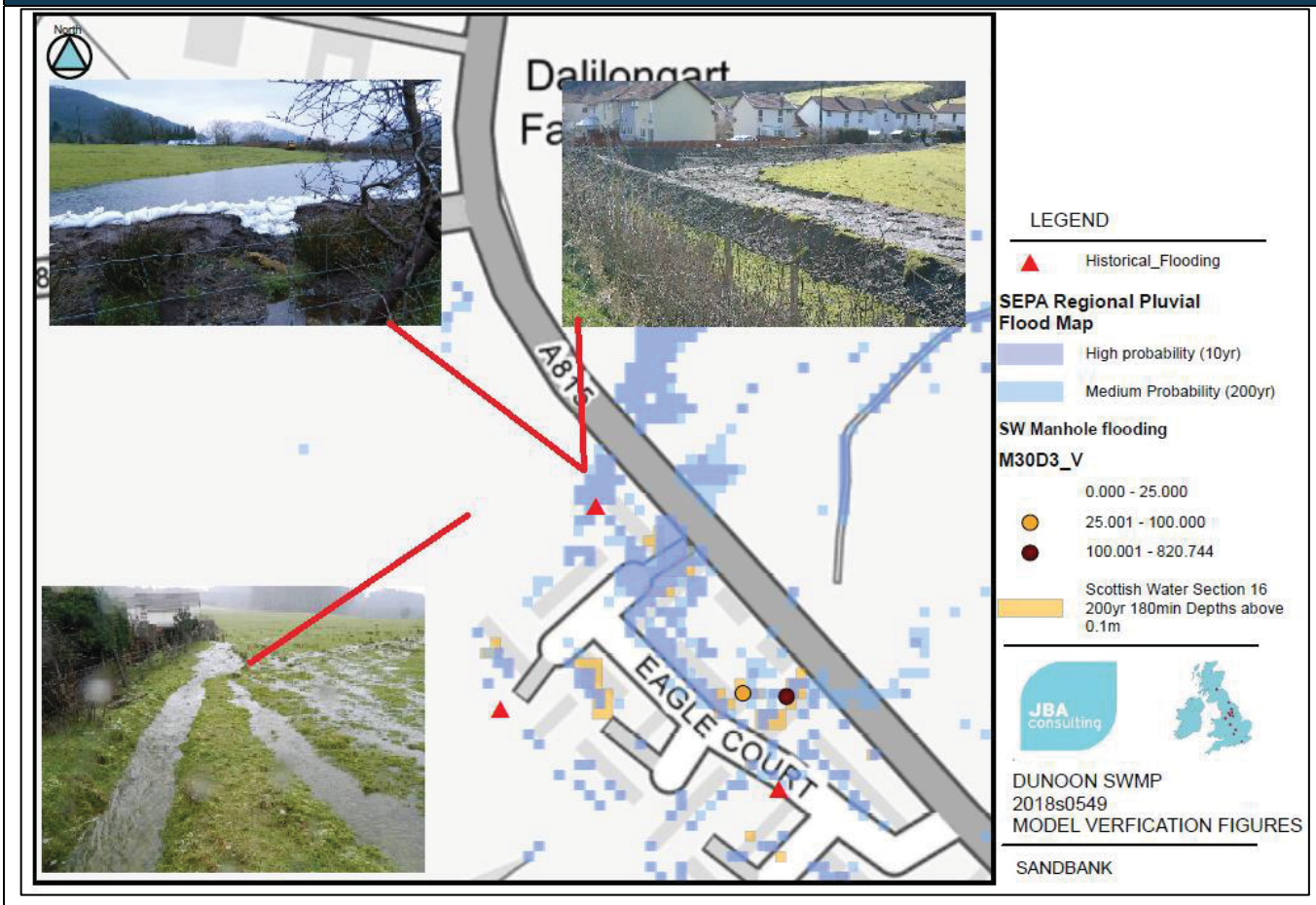
Verification of all the collated data was undertaken using the GIS data to compare the modelled hazard and risk data against observed events. The purpose of the verification process is to identify areas where good alignment between modelled and observed flooding occurs and the mechanisms of flooding are well understood. These areas will be deemed suitable for assessing the consequences of flooding. The process also identifies where poor calibration exists between modelled data and observed flood events. This could be a location where flooding is predicted, but has not occurred, or conversely a location where flooding has occurred, but is not predicted by the model.

A precautionary approach has been used in developing the SWMP i.e. where flooding is predicted in the model, but has not been observed, the predicted flooding will be taken forward in the SWMP. Where flooding is not predicted in the model but has been observed indicates that further information is likely to be required. Model confidence has been classed as high, moderate or low where:

- High confidence represents good correlation between observed historic data and modelled data such as SEPA pluvial mapping or Scottish Water flood spreading mapping.
- Moderate confidence represents areas where there are some model results but they do not tie in perfectly with the observed data but there is a clear link. Areas where the model has shown flooding with no historic data could be due to SuDS or other drainage infrastructure preventing ponding, here the model confidence could be moderate.

  Moderate confidence can also be used to describe overall model confidence where there is mix of low and high model confidence within one SWMP area.
- Low model confidence is used when there is a poor correlation between observed historic data and model data or where the model is inaccurate. An example of low model confidence is where minor watercourses are poorly defined causing water to come out of bank where there are no records of this occurring.

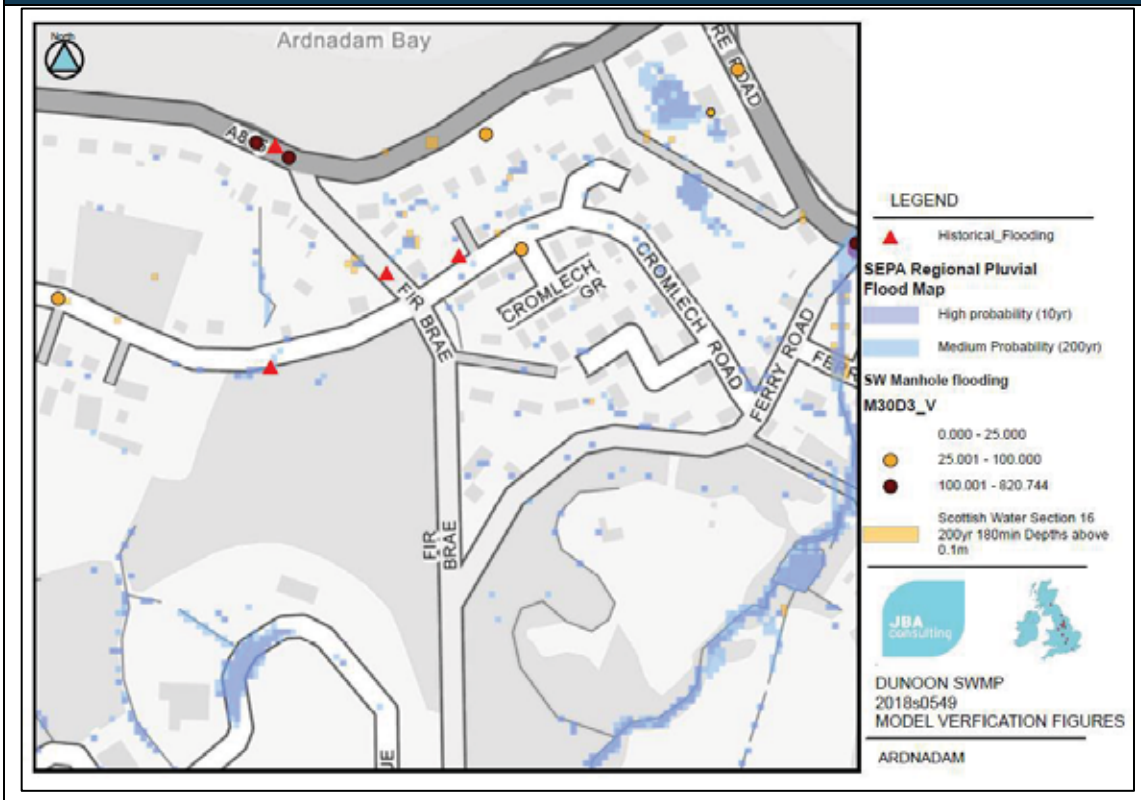
The following section presents figures from the model highlighting areas of good and bad correlation with recorded flood events records and photographs where available. Full details of correlations with all historic events can be found in the SWMP model results and confidence table in the appendix.



There are 2 related flood mechanisms that effect Eagle Court. Surface runoff from the grassed hillside to the south west often overtops drainage infrastructure resulting in nuisance flooding of gardens to the properties on the western extent of the development. Similarly, overland flow from the hillside effects properties at the northern extent of the development. Here, hillside runoff is combined with flows from a blocked drain. All flows are directed to the south eastern corner of the field adjacent to properties. Damages typically include interior flooding of multiple properties. An informal flood bund has been constructed to help retain the flood water. Flood water is known to have breached the bund since it was constructed.

The model does not represent the nuisance flooding of the gardens to the west due to the water not ponding and just flows over the gardens. However, the model does show ponding in the field to the north east and highlights the low-lying properties of Eagle Court that could be affected.

There is a good correlation between modelled pluvial data and historic flooding data therefore the alignment with the model is good and confidence at this location is high.



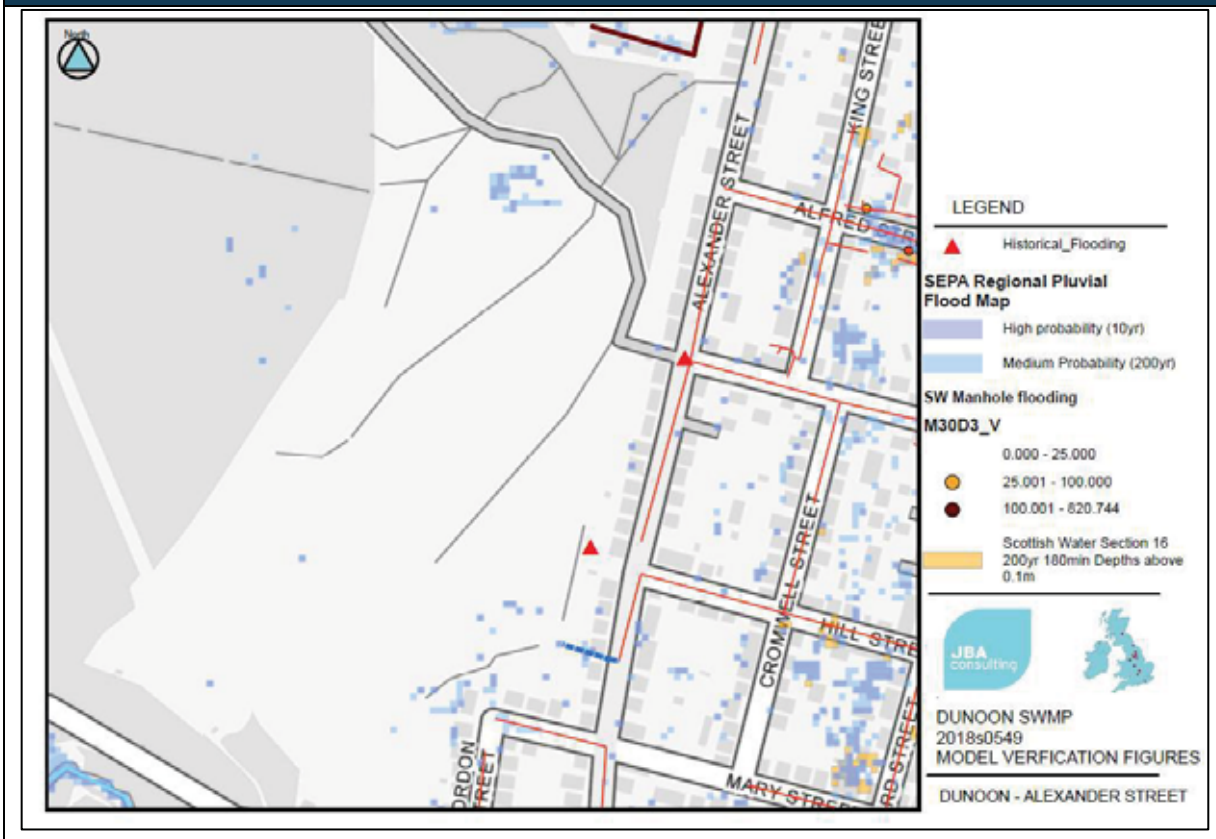
There are 2 flooding mechanisms at work at this location both coming from an unnamed watercourse to the south west of the junction of Cromlech Road and Fir Brae. At this location the watercourse enters a culvert which is prone to blockage. When the culvert is blocked flows spill down Fir Brae to the north east. Due to the steepness of the road, flows have caused delamination in the past resulting in remedial resurfacing.

Also, flows often enter the culvert at the junction with Fir Brae but then surcharge at a downstream manhole sending floodwaters through the garden of a property on Cromlech Road. It is not known if the property is damaged when flood water flows through the garden.

There are also records of ponding on Shore Road west of the junction with Fir Brae, it has been assumed that the incidents are linked to those above.

At this location there is very little modelled flooding however it has been highlighted by historic observed data hence the confidence in the model data at this location is low as the model alignment is poor. The scale of the watercourse and nature of the surcharging is too localised to be represented by the regional scale mapping.

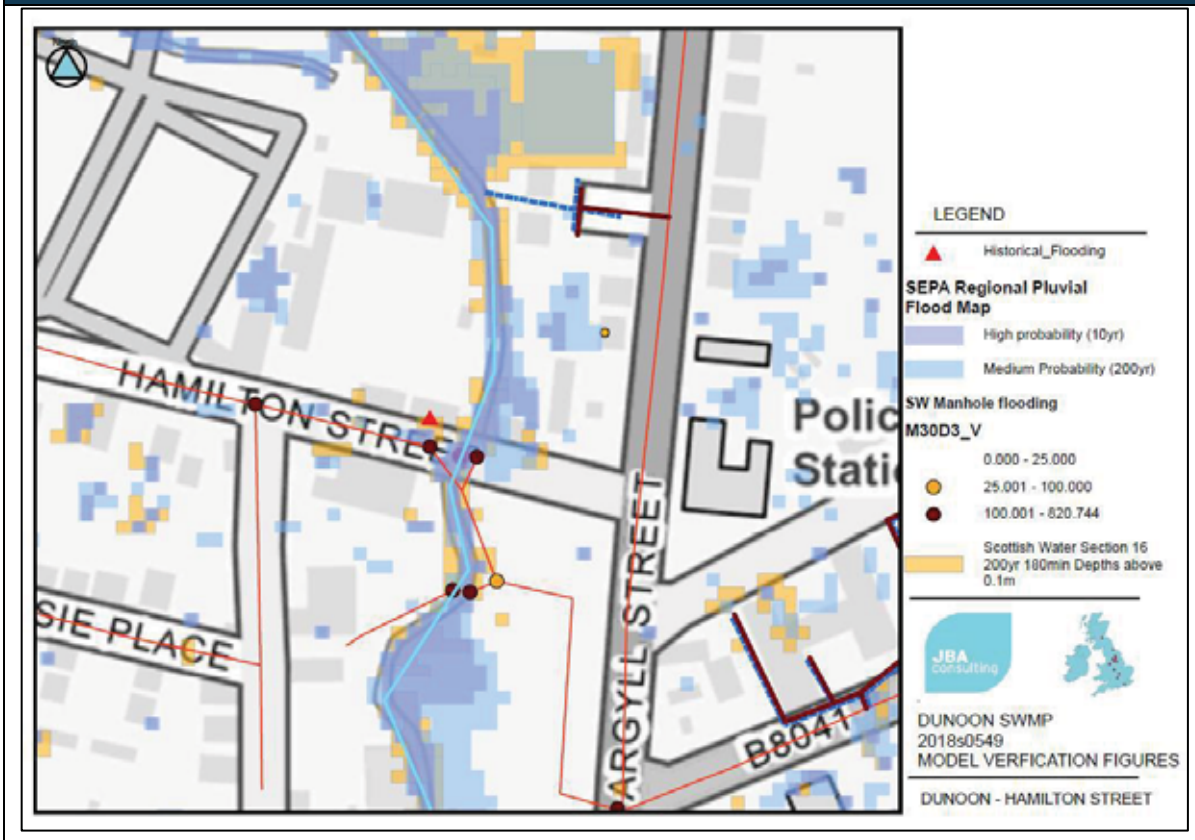
The modelled and observed data has shown that this area is at significant risk of surface water flooding. There is a good correlation between the model and observed data, although there are some discrepancies in some locations. Overall however, the confidence in the model is still moderate in this area.



The hillside to the west of Alexander is the source of 2 flooding mechanism. Firstly, hillside runoff is known to overtop existing drainage ditches, a cause nuisance flooding to the rear gardens that border the hillside. The second mechanism is due to the network of the hillside ditches and drains which collect and discharge in to a culvert at the junction with John Street.

The watercourse is prone to blockage at the headwall causing flood water to overtop which forces flows onto Alexander Street. The road camber in this area directs flows south along Alexander Street where it enters the drainage system of a low-lying residential property causing substantial interior damage.

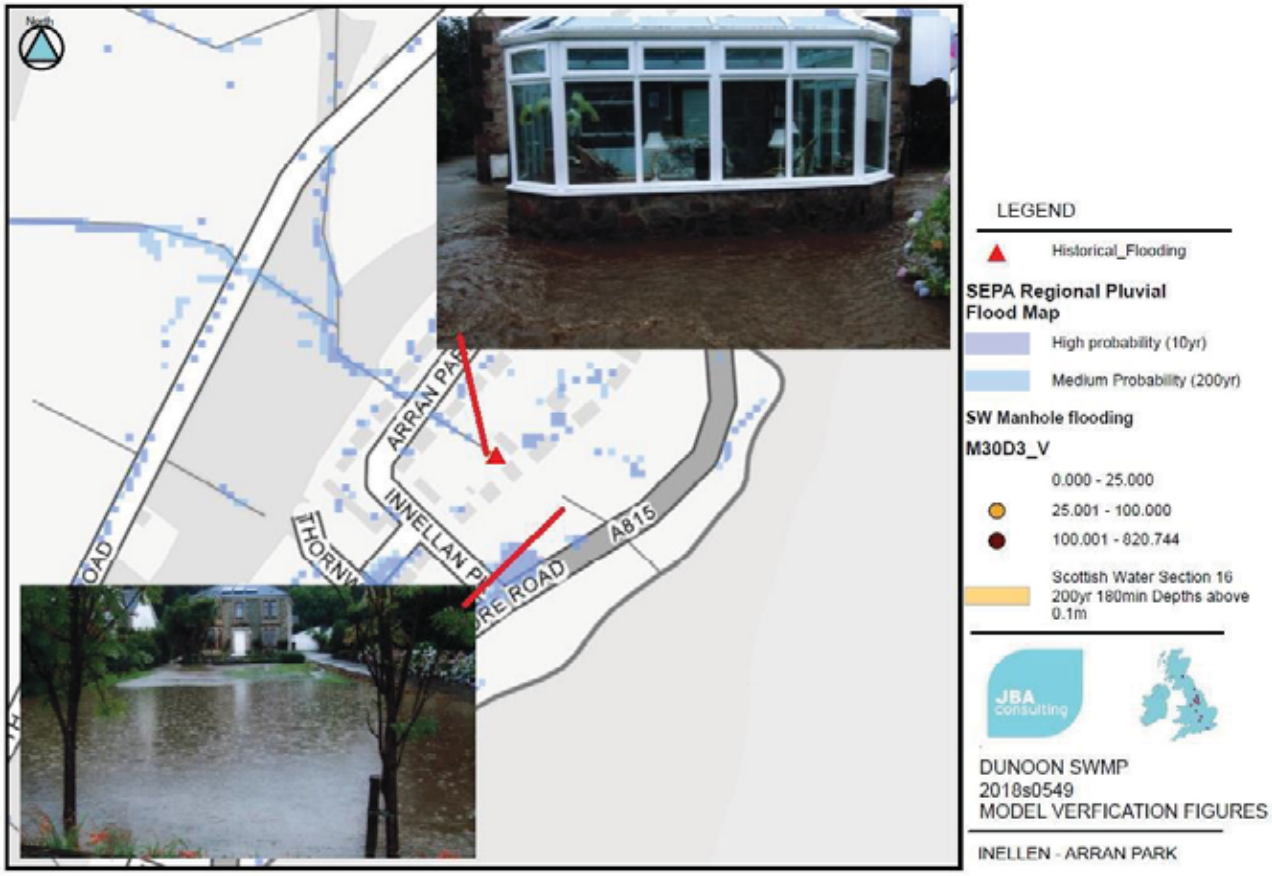
At this location there is very little modelled flooding however it has been highlighted by historic observed data hence the confidence in the model data at this location is low as the model alignment is poor. However, the regional scale of the mapping would not be able to represent the drainage ditch system due to small scale of the ditch network.



Flooding of 2 properties occurred due to the overtopping of the adjacent Milton Burn. It has been assumed that over topping was due to the partial blockage of the culvert under Hamilton Street. However, the model also shows significant manhole surcharging in this area which could be related to the watercourse overtopping. Damages were thought to include both external and internal damages.

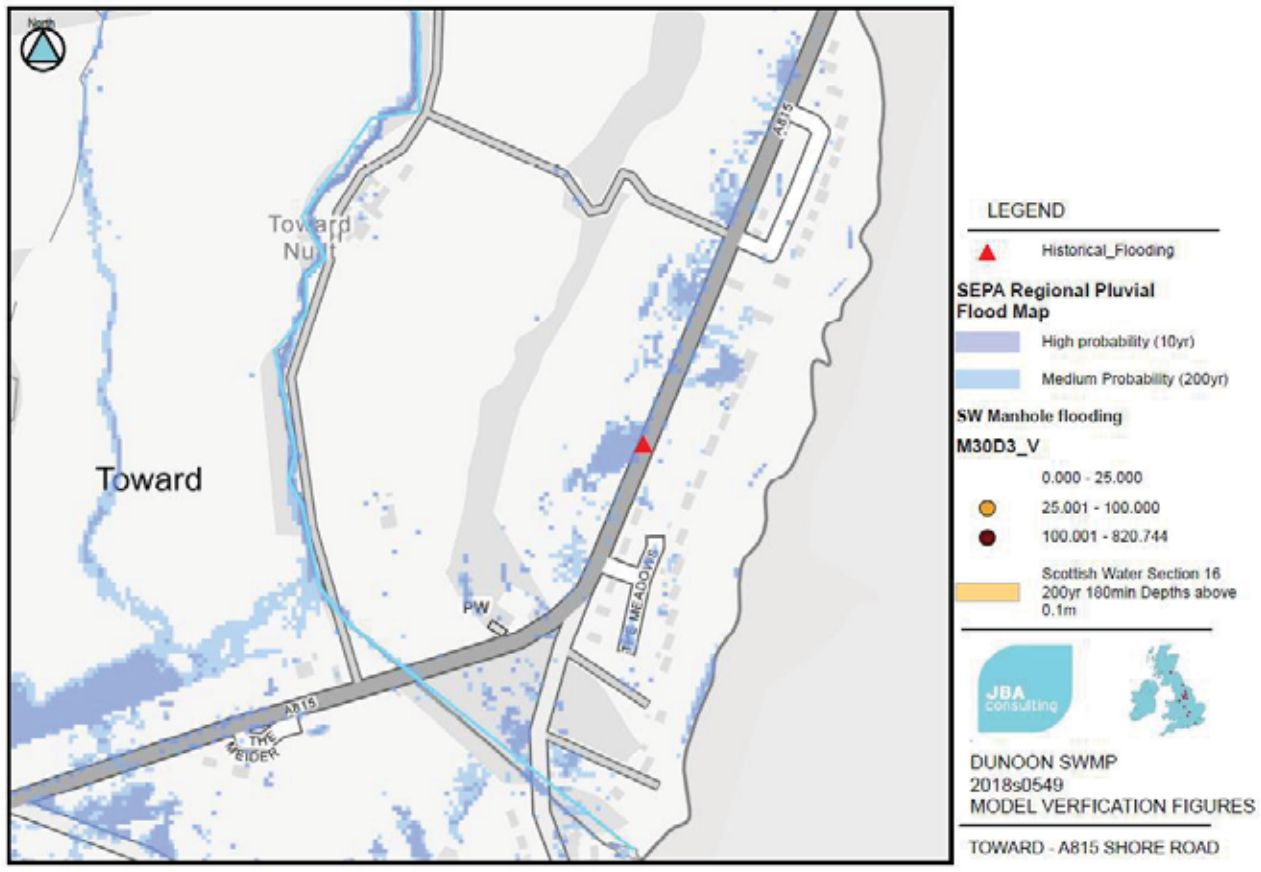
There is a good correlation between modelled pluvial data and historic flooding data therefore the alignment with the model is good and confidence at this location is high.

The modelled and observed data has shown that this area is at significant risk of surface water flooding. There is a good correlation between the model and observed data, although there are some discrepancies in particular locations. Overall however, the confidence in the model is still moderate to high in this area.



A minor watercourse which drains the steep hillside to the west is culverted below Arran Park (Road) then briefly flows openly before being culverted as it passes below a property on Shore Road and Shore Road itself. There is a significant history of blockages and out of bank flow causing damages to gardens and significant interior property damage.

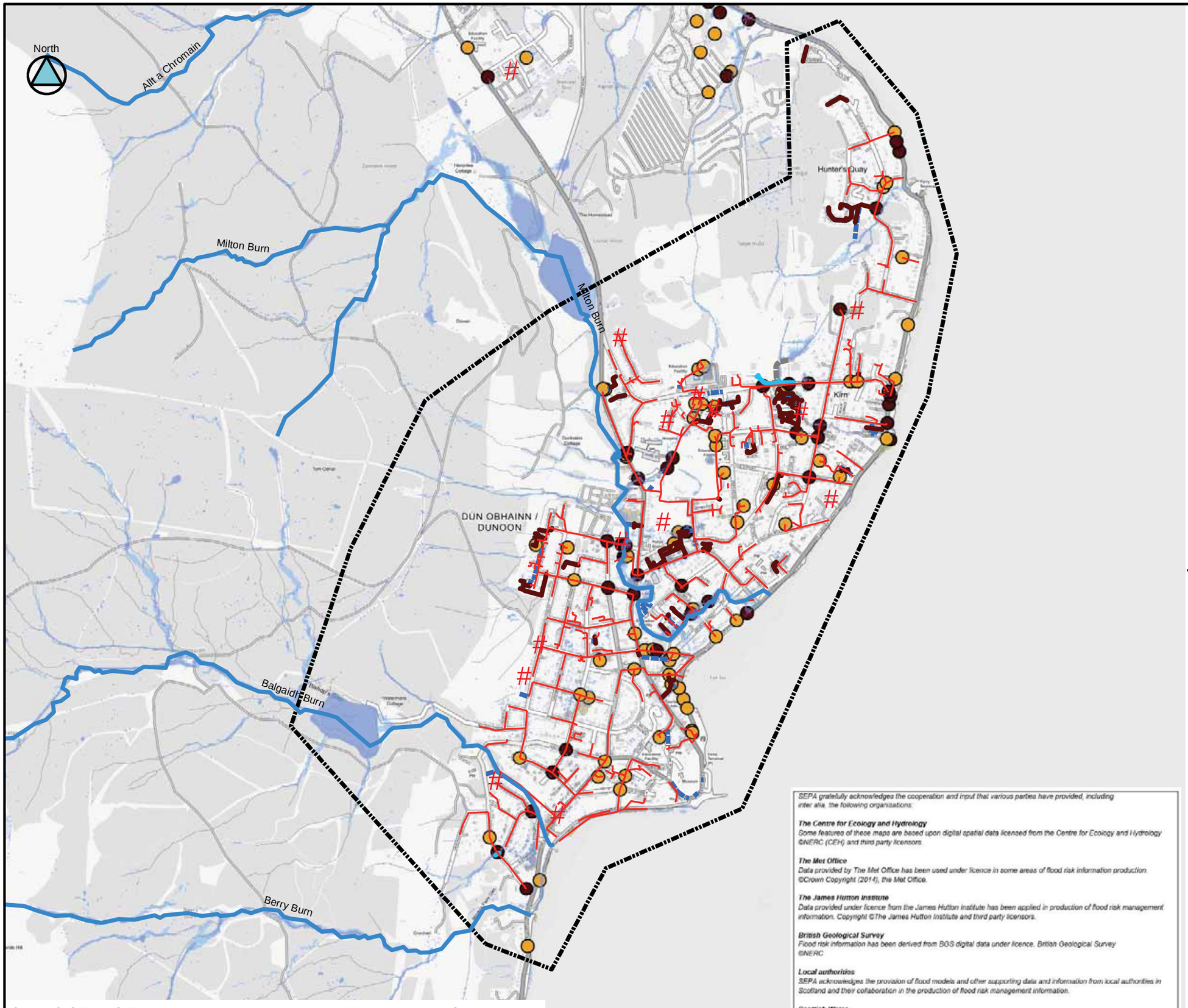
There is a moderate correlation between modelled pluvial data and historic flooding data therefore the alignment with the model is fair and confidence at this location is moderate.



The drainage ditch/area of bog to the west of the road is prone to overtopping and flooding the road. Damages are reported to be restricted to the road which can become impassable to small vehicles.

There is a good correlation between modelled pluvial data and historic flooding data therefore the alignment with the model is good and confidence at this location is high.

The model verification process has highlighted a variance in model confidence that can differ substantially across the PVA area as well as within each SWMP area. The SEPA regional pluvial mapping and Scottish Water flood spreading assessment forms the basis of the model as it is the most accurate data available. Due to the scale of the regional pluvial mapping there will always be areas that are not well represented. Small drainage ditches, minor channel and multiple culverted section require more detailed modelling to determine the flooding mechanisms.



LEGEND

- Historical_Flooding
- DUN_SWMP_Boundary
- Dunoon PVA Watercourses
- Combined
- Foul
- Natural Water
- Surface Water
- Highway Drainage

SEPA Regional Pluvial Flood Map

- High probability (10yr)
- Medium Probability (200yr)

Scottish Water S16 Model Data

M30D3_V4

Manhole Surcharge Volume m3

- 0.000 - 25.000
- 25.001 - 100.000
- 100.001 - 820.744

- 200yr 180min Flood Extents

SEPA gratefully acknowledges the cooperation and input that various parties have provided, including inter alia, the following organisations:

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licensed from the Centre for Ecology and Hydrology ©NERC (CEH) and third party licensors.

The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2014), the Met Office.

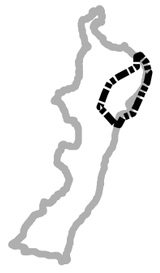
The James Hutton Institute
Data provided under licence from the James Hutton Institute has been applied in production of flood risk management information. Copyright ©The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC

Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

DUNOON PVA KEYPLAN



JBA consulting

DUNOON AND KIRN SWMP AREA

2018S0549_DUN_D01

Historic Surface Water Flooding	
	Eagle court
	Multiple occurrences
	There are 2 related flood mechanisms that effect Eagle Court. Surface runoff from the bare hillside to the south west often overtops drainage infrastructure resulting in nuisance flooding of gardens to the properties on the western extent of the development. Similarly, overland flow from the hillside effects properties at the northern extent of the development. Here hillside runoff is combined with flows from a blocked hillside drain. All flows are directed to the south eastern extent of the field adjacent to properties. Damages typically include interior flooding of multiple properties. An informal flood bund has been constructed to help retain the flows. Flood water is said to have come close to over topping the bund since it was constructed.
	The model does not represent the nuisance flooding of the gardens to the west due to the water not ponding and just flowing over the gardens. The model does show ponding in the field to the north east and highlights the low-lying properties of Eagle Court that could be affected. *There is a good correlation between modelled pluvial data and historic flooding data therefore the alignment with the model is good and confidence at this location is high.*

Historic Surface Water Flooding	
	A815 Sandbank
	2
	At 2 sperate locations there are recorded incidents where flood water has entered the road and ponds in the carriageway or adjacent to properties. This is thought to be due to small hillside runoff watercourses overtopping due to blocked culverts under the A815. No damages have been associated to the incidents.
	At this location there is very little modelled flooding however it has been highlighted by historic observed data hence the confidence in the model data at this location is low as the model alignment is poor.

Historic Surface Water Flooding	
	Cromlech Road
	1
	An unnamed watercourse over tops due to blockages at the Cromlech Road culvert causing flows to back up in the adjacent property. This is known to have happened on several occasions with one occurrence resulting in flooding to a garden and garage.
	There is a good correlation between modelled pluvial data and historic flooding data therefore the alignment with the model is good and confidence at this location is high.

Historic Surface Water Flooding	
	Fir Brae
	Multiple
	There are 2 flooding mechanisms at work at this location both coming from an unnamed watercourse to the south west of the junction of Cromlech Road and Fir Brae. Here the watercourse enters a culvert which is prone to blockage. When the culvert is blocked flows spill down Fir Brae to the north. Due to the steepness of the road, flows have caused delamination in the past resulting in remedial resurfacing. *If the culvert is not blocked flows often enter the culvert but then surcharge at a downstream manhole sending floodwaters through the garden of a property on Cromlech Road. It is not known if the property is damaged when flood water flows through the garden.* *There are also records of ponding on Shore Road west of the junction with Fir Brae, it has been assumed that the incidents are linked to those above.*
	At this location there is very little modelled flooding however it has been highlighted by historic observed data hence the confidence in the model data at this location is low as the model alignment is poor. The scale of the watercourse and nature of the surcharging is too localised to be represented by the regional scale mapping.

Historic Surface Water Flooding	
	Libraries Headquarters (Highland Avenue)
	1
	There is a record of flooding at the libraries headquarter in the Highland Avenue Industrial Estate. There are no details of damages or the cause of the flooding. Given the flat nature of the location is assumed flooding was due to sewer surcharging or a blockage within the road gully network.
	There is a moderate correlation between modelled pluvial data and historic flooding data therefore the alignment with the model is fair and confidence at this location is moderate.

Future Surface Water Flooding
Properties at risk: *20-30 residential dwellings, 1 business*
Sandbank Community Councils, Sandbank Development Trust
Potential developments sites at surface water risk are taken from the Bute and Cowal Local Development Plan 2015 *2 Business sites:* *BI-AL 2/1 and BI-AL 2/2* *2 Housing site:* *H-AL 2/11and H 1001* The potential housing development H1001 is located north west of Eagle Court in an area subject to significant hillside runoff flows and also features an informal bund which protects properties in the north west of the estate. The proposed development offers significant opportunities to manage surface water on site and mitigate flooding at Eagle Court. The potential housing development H-AL 2/11 Ardnadam Farm may also offer opportunities to improve the unnamed watercourse which flows through the site. Any improvements should be aimed at limiting the debris/sediment load which can pass downstream. This may help lower the risk of flooding at the Cromlech Road culvert which is 150m downstream of the site. Other than meeting existing planning requirements there for surface water there are no additional opportunities for the 2 proposed business sites.
The modelled and observed data has shown that this area is considered to be at significant risk of surface water flooding. As a result, this area shall continue on to the Options Phase of the SWMP process.

North

Holy Loch

Kilmun

Strone

Sandbank

Ardnadam

Hunter's Quay

Milton Burn

Milton Burn

Allt a Chromain

0 0.25 0.5 1 1.5 2 Kilometers

LEGEND

- Historical_Flooding
- SND_SWMP_Area
- Dunoon PVA Watercourses
- Combined
- Foul
- Natural Water
- Surface Water
- Highway Drainage

SEPA Regional Pluvial Flood Map

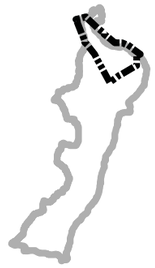
- High probability (10yr)
- Medium Probability (200yr)

Scottish Water S16 Model Data

30yr 3hr Manhole Surcharge Volume m3

- 0.000 - 25.000
- 25.001 - 100.000
- 100.001 - 820.744
- 200yr 180min Flood Extents

DUNOON PVA KEYPLAN



SEPA gratefully acknowledges the cooperation and input that various parties have provided, including inter alia, the following organisations:

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licensed from the Centre for Ecology and Hydrology ©NERC (CEH) and third party licensors.

The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2014), the Met Office.

The James Hutton Institute
Data provided under licence from the James Hutton institute has been applied in production of flood risk management information. Copyright ©The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC

Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

JBA consulting

SANDBANK AND ARDNADAM SWMP AREA

2018S0549_SND_D01

Historic Surface Water Flooding	
	Lochan Avenue
	Multiple occurrences
	Hillside runoff causes the rear gardens of Lochan Avenue to be permanently damp/boggy. Some home owners have resorted to digging trenches around the perimeter of their gardens to intercept the surface water and divert it away. Field drains and drainage trenches upslope on the hill are known to be silted up and barely functional. There is also a small channel located toward the northern extent of Lochan Avenue which is prone to overtopping at the culvert beneath the road. This sends surface water onto the road, into the gullies which are subsequently connected to the combined sewer.
	At this location there is very little modelled flooding however it has been highlighted by historic observed data hence the confidence in the model data at this location is low as the model alignment is poor.

Historic Surface Water Flooding	
	Ardenslate Road
	2
	Reports of rear gardens being flooded by sewer material. Damages are thought to have been restricted to the garden area.
	There is a moderate correlation between modelled pluvial data and historic flooding data therefore the alignment with the model is fair and confidence at this location is moderate.

Historic Surface Water Flooding	
	Ardenslate Crescent
	1
	Reports of ponding water on the road reaching the footpath. There are no recorded damages associated with this event. The source of the flooding is not known the model shows that drainage in this area is likely to surcharge however it is also possible that road drainage did not perform as expected.
	There is a moderate correlation between modelled pluvial data and historic flooding data therefore the alignment with the model is fair and confidence at this location is moderate.

Historic Surface Water Flooding	
	Fairhaven
	1
	An unnamed watercourse flows open along the eastern extent of the development for approximately 50m. The watercourse is culverted both up and downstream of this. It has been assumed that the downstream culvert was at least partially blocked during an event in which the channel was reportedly close to over topping.
	At this location there is very little modelled flooding however it has been highlighted by historic observed data hence the confidence in the model data at this location is low as the model alignment is poor. However, the regional scale of the mapping would not be able to represent a localised issue such as this.

Historic Surface Water Flooding	
	Corner of Hunter Street approximately 50m south of James Street
	1
	Reports of significant ponding on the road where buses struggled to pass. There are no reported damages in this area and the event is not known to have reoccurred hence it is assumed that this was down to blocked road gullies.
	There is a good correlation between modelled pluvial data and historic flooding data therefore the alignment with the model is good and confidence at this location is high.

Historic Surface Water Flooding	
	Erichtbank Drive
	1
	Reports of flooding to gardens due to the camber in the road. Flooding is thought to be restricted to houses on the south of the street with damaged restricted to the front of the gardens. Water is likely to be shallow and moving as the whole street slopes towards Shore Road.
	There is a good correlation between modelled pluvial data and historic flooding data therefore the alignment with the model is good and confidence at this location is high.

Historic Surface Water Flooding	
	McCall Terrace
	1
	Flooding of 2 properties occurred due to the overtopping of an adjacent minor unnamed watercourse. It has been assumed that over topping was due to the partial blockage of the culvert under Hamilton Street. However, the model also shows significant manhole surcharging in this area. Damages were thought to include both external and internal damages.
	There is a good correlation between modelled pluvial data and historic flooding data therefore the alignment with the model is good and confidence at this location is high.

Historic Surface Water Flooding	
	Alexander Street
	Multiple
	The hillside to the west of Alexander Street is the source of 2 flooding mechanism. Firstly, hillside runoff is known to overtop existing drainage ditches and cause nuisance flooding to the rear gardens bordering the hillside. The second mechanism is due to the collection of the hillside ditches and drains which collect and discharge in to a culvert at the junction with John Street. *The watercourse is prone to blockages at the headwall causing flood water to overtop which forces flows onto Alexander Street. Due to the road camber in this area this directs flows south along the street where it enters the ground of a low-lying residential property causing substantial interior damage. It is also understood that manholes downstream of the headwall are prone to surcharging.*
	At this location there is very little modelled flooding however it has been highlighted by historic observed data hence the confidence in the model data at this location is low as the model alignment is poor. However, the regional scale of the mapping would not be able to represent the drainage ditch system due to small scale of the ditch network.

Historic Surface Water Flooding	
	Broomfield Drive
	2
	Reports of flooding to the rear garden of the property at the north western extent of the street. The rear garden slopes up to Kilbride Road from which it is thought the flood water comes from. Drainage installed during the redevelopment of a landslide on this road is thought to be under capacity resulting in flows heading towards to the property.
	At this location there is very little modelled flooding however it has been highlighted by historic observed data hence the confidence in the model data at this location is low as the model alignment is poor. However, the regional scale of the mapping does not take into account localised road drainage issues.

Historic Surface Water Flooding	
	Wellington Street
	1
	Reports of surface water accumulating at the low point in the road. There are no further reports of this occurring hence it is thought this has occurred due to blockages in road gullies or lack of capacity in the road drainage network.
	At this location there is very little modelled flooding however it has been highlighted by historic observed data hence the confidence in the model data at this location is low as the model alignment is poor. However, the regional scale of the mapping does not take into account localised road drainage issues.

Historic Surface Water Flooding	
	Kilbride Road
	Multiple
	There are reports of a drain over flowing at the base of Kilbride Road. There are no damages associated with this report. It is not known what the source of is i.e. road gullies or sewer surcharging however, the model shows significant manhole surcharging in this area.
	There is a good correlation between modelled pluvial data and historic flooding data therefore the alignment with the model is good and confidence at this location is high.

Historic Surface Water Flooding	
	Black Park
	Multiple
	Overland flow from grassed slopes, football pitches, athletics stadium and parking area drain toward the south west corner of Black Park. Flood waters either flow directly into the rear gardens of properties on Argyll Street or via a ditch and pumping station system which affects a property on Argyll Road.
	There is a good correlation between modelled pluvial data and historic flooding data therefore the alignment with the model is good and confidence at this location is high.

Future Surface Water Flooding
Properties at risk: *50-100 residential dwellings, 0 business*
Dunoon Community Council
Potential developments sites at surface water risk are taken from the Bute and Cowal Local Development Plan 2015 *3 Housing site:* *H-AL 2/2, H-AL 2/3, H-AL 2/4, H-AL 2/5* The potential housing development H-AL 2/3 Gordon Street offers a substantial opportunity to manage hillside runoff which contributes to flooding issues on Alexander Street. By managing the surface water on this development this will likely reduce the volume of surface water entering the combined sewer network at John Street. Other than meeting existing planning requirements there for surface water there are no additional opportunities for the other 3 proposed housing sites.
The modelled and observed data has shown that this area is considered to be at significant risk of surface water flooding. As a result, this area shall continue on to the Options Phase of the SWMP process.

North

Unnamed (Dalmoak burn)

Unnamed (Dalmoak burn)

Toward Nulit

Toward

0 0.25 0.5 1 1.5 2 Kilometers

LEGEND

- Historical_Flooding
- TOW_SWMP_Boundary
- Dunoon PVA Watercourses
- Combined
- Foul
- Natural Water
- Surface Water
- Highway Drainage

SEPA Regional Pluvial Flood Map

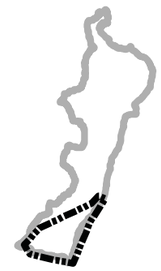
- High probability (10yr)
- Medium Probability (200yr)

Scottish Water S16 Model Data

30yr 3hr Manhole Surcharge Volume m3

- 0.000 - 25.000
- 25.001 - 100.000
- 100.001 - 820.744
- 200yr 180min Flood Extents

DUNOON PVA KEYPLAN



SEPA gratefully acknowledges the cooperation and input that various parties have provided, including inter alia, the following organisations:

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licenced from the Centre for Ecology and Hydrology ©NERC (CEH) and third party licensors.

The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2014), the Met Office.

The James Hutton Institute
Data provided under licence from the James Hutton institute has been applied in production of flood risk management information. Copyright ©The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC

Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

JBA consulting

TOWARD AND INELLEN SWMP AREA

2018S0549_TOW_D01

Historic Surface Water Flooding	
	Wyndham Road
	Multiple occurrences
	The drainage ditch to the north of the Wyndham Road was reported to have over topped on numerous occasions although no damages have been reported.
	At this location there is very little modelled flooding however it has been highlighted by historic observed data hence the confidence in the model data at this location is low as the model alignment is poor. The drainage ditch is too small to be suitably represented by regional scale mapping.

Historic Surface Water Flooding	
	Matheson Lane
	1
	Reports of flooding causing damage to steps on Matheson Lane. The exact location of the steps is unknown but are assumed to be at the junction with Wyndham Road. The flooding mechanism was not identified in the report however there is a minor watercourse which is culverted to the north of Wyndham Road which is known to be sensitive to flooding.
	At this location there is very little modelled flooding however it has been highlighted by historic observed data hence the confidence in the model data at this location is low as the model alignment is poor.

Historic Surface Water Flooding	
	Arran Park
	Multiple
	A minor watercourse which drains the steep hillside to the west is culverted below Arran Park (Road) then briefly culverted as it passes between the Arran Park and Shore Road properties. There is a significant history of blockages and out of bank flow causing damages to gardens and significant interior property damage.
	There is a moderate correlation between modelled pluvial data and historic flooding data therefore the alignment with the model is fair and confidence at this location is moderate.

Historic Surface Water Flooding	
	A815 Shore Road (Toward)
	multiple
	The drainage ditch/area of bog to the west of the road is prone to overtopping and flooding the road. Damages are reported to be restricted to the road which can become in passable to small vehicles.
	There is a good correlation between modelled pluvial data and historic flooding data therefore the alignment with the model is good and confidence at this location is high.

Historic Surface Water Flooding	
	Toward Community Centre Car Park
	1
	Reports suggest this area is prone to flooding. Flooding is thought to be minor and related to low points in the informal carpark.
	At this location there is very little modelled flooding however it has been highlighted by historic observed data hence the confidence in the model data at this location is low as the model alignment is poor.

Historic Surface Water Flooding	
	Erichtbank Drive
	1
	Reports of flooding to gardens due to the camber in the road. Flooding is thought to be restricted to houses on the south of the street with damaged restricted to the front of the gardens. Water is likely to be shallow and moving as the whole street slopes towards Shore Road.
	There is a good correlation between modelled pluvial data and historic flooding data therefore the alignment with the model is good and confidence at this location is high.

Future Surface Water Flooding
Properties at risk: *<10 residential dwellings, 0 business*
South Cowal Community Council
Potential developments sites at surface water risk are taken from the Bute and Cowal Local Development Plan 2015 *3 Housing site:* *H-AL 2/19, H-AL 2/20* Both proposed housing sites present an opportunity to manage surface water within the sites themselves as both sites have modelled ponding water. The H-AL2/20 site also represents an opportunity to manage surface water to the north which features a significant area of ponding immediately to the north of the site.
The modelled and observed data has shown that this area is considered to be at significant risk of surface water flooding. As a result, this area shall continue on to the Options Phase of the SWMP process.

PROJECT DATA REGISTER

Project name:	Dunoon SSWMP
Project number:	2018s0549
Data manager:	Nicci Buckley
Client:	Argyll & Bute Council

Owner	Description	Transfer type	Data format	Received from	Licenced to JBA? (yes / no)	Licence expiry date	Comment on level of confidence / suitability for use
SEPA	Regional Pluvial Hazard Mapping (website dataset)	Jbarn	Various GIS	ABC: Grant Whyte	yes	End of project	Regional pluvial flood hazard (website) dataset is one of the primary model based source of flooding information. High quality detailed originally created by JBA. This SWMP will use SEPA Regional Pluvial Mapping V1.3 which is the latest dataset hence confidence is high. The "website" data set includes Scottish Water flooding information and incorporates SEPA's National dataset where there is a data gap.
SEPA	NFM Data	Jbarn	Various GIS	ABC: Grant Whyte	yes	End of project	The ABC_CLIP dataset supplied is only visible from a scale of 1:500,000 or above. The AandB unclipped datasets are visible meaning these can be integrated and are of particular use in the Sandhaven Road and South Campbell Road areas where runoff is a documented problem in the Dunoon PVA.
SEPA	Risk Receptor Datasets	Jbarn	Various GIS	ABC: Grant Whyte	yes	End of project	Available throughout the SWMP areas contains shapefiles for a comprehensive range of receptors useful for determining flood risk. The dataset produce by SEPA ties in well with the background mapping hence confidence is high.
SEPA	SEPA Flood Risk Management Strategic Appraisal Baseline (RECEPTOR DATASETS, GUIDANCE, APPRAISAL BASELINE OUTPUTS, AAD GRIDS)	Jbarn	Various GIS	ABC: Grant Whyte	yes	End of project	ADD point datasets are a vital part of determining and prioritise flood risk. High level of confidence.
Scottish Water	GIS Sewer Network	Jbarn	Various GIS	ABC: Grant Whyte	yes	End of project	Scottish Water have provided a detailed GIS sewer network for all of the SWMP areas. The GIS networks are either compiled by GIS points or polylines. The very high volume of points makes the dataset very difficult to use and interoperate. Given the detailed nature of the data provided the level of confidence is high however its suitability for use is moderate until it is processed to only contain the required information.
Scottish Water	Section 16 model outputs	Jbarn	Various GIS	ABC: Grant Whyte	yes	End of project	Scottish Water have provided model outputs identifying the extent and depths of flooding from the sewerage system for a range of return periods and storm durations. Depths not contained in the attribute table making data of limited use.
ABC Council	Dunoon background info: flood history, photographs, emails, drawings, flooding reports	Jbarn	GIS, jpeg, Outlook Item, MS Word, pdf	ABC: Grant Whyte	yes	End of project	This data is very important and is required to validate the model. The level of detail in the data entries includes a description of flood origins and damages. Confidence is high.

Offices at

Coleshill
Doncaster
Dublin
Edinburgh
Exeter
Glasgow
Haywards Heath
Isle of Man
Limerick
Newcastle upon Tyne
Newport
Peterborough
Saltaire
Skipton
Tadcaster
Thirsk
Wallingford
Warrington

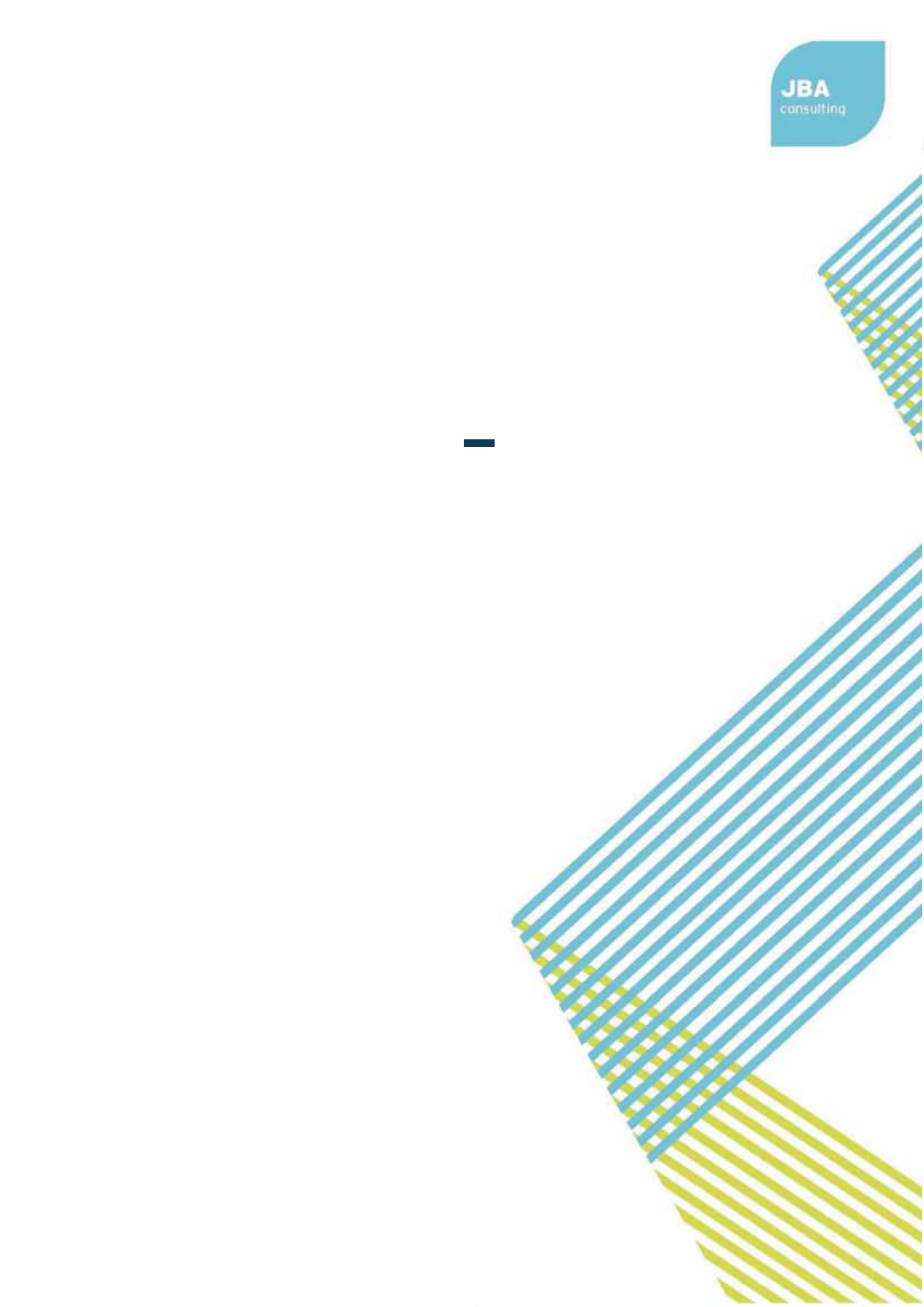
Registered Office
South Barn
Broughton Hall
SKIPTON
North Yorkshire
BD23 3AE
United Kingdom

+44(0)1756 799919
info@jbaconsulting.com
www.jbaconsulting.com
Follow us:

Jeremy Benn Associates Limited

Registered in England 3246693

JBA Group Ltd is certified to:
ISO 9001:2015
ISO 14001:2015
OHSAS 18001:2007



Phase 2 of the SWMP focuses on understanding surface water flood risk with each of the SWMP areas identified in Phase 1 of the report. The SWMP areas identified are:

- Sandbank and Ardnadam (north).
- Dunoon and Kirn (centre).
- Innellan and Toward (south).

The Dunoon PVA has a substantial history of surface water flooding. The purpose of this phase of the report is to take a closer look at the flooding within these areas, to understand the flooding mechanisms at work as well as the associated hazard and risk.

Understanding the causes and consequences of flooding is crucial for making well informed decisions on how to manage flood risk. This will be done by analysing available information to gain an appreciation of the sources, pathways, receptors, flood risk and flood hazard.

In order to understand surface water flood risk, it is necessary to break down each of the surface water management areas into smaller flooding "hotspots". The flooding hotspots are defined by the flooding mechanism. Flooding mechanisms within a hotspot may be singular or linked with multiple different mechanisms causing flooding in one area. An example of this could be where hillside runoff floods properties before passing into the drainage network which subsequently surcharges effecting nearby properties.

The size of the hotspot will also vary between town, neighbourhood and street level again, depending on the flooding mechanism and the extent of flooding. Analysing data at this scale will allow for objectives and actions to be more focused which, will in turn allow flood risk to be summarised and monitored over time to determine the effectiveness of implemented actions.

Before defining the hotspots an analysis of key information within each SWMP area is undertaken to identify catchment wide factors that may influence the definition of the flooding hotspot. This analysis includes:

- Significant surface water flood events – this is a brief summary of historic surface water flood events which will describe flooding in terms of where it took place, who or what was affected and level of damages.
- Natural drainage features – This is a description of existing significant watercourse within each SWMP area.
- Artificial drainage features – this is a description of the sewer catchments within the SWMP area including where separated systems operate and where the catchment drains to.
- Interactions between the natural and artificial drainage systems – this is a summary of where the two networks crossover including features such as outfalls in to channels, combined sewer overflows and in particular where surface water enters the combined sewer.
- Existing surface water management – this is a brief summary of all current surface water management infrastructure. This includes SuDS, Council operated surface water drainage, Council operated flood protection/alleviation measures and Scottish Water capacity improvement schemes.

Defining flood risk hotspots is a manual process which involves analysing all of the information available. However, initially to define the geographical area the primary focus is on the SEPA regional pluvial flood hazard mapping and the historic flood database. At this stage it is also important to refer back to the model verification stage to incorporate the model confidence when defining the hotspot.

For the SEPA Regional Pluvial Flood hazard data the 1:10 year and 1:200 year flood events have been used in the hotspot analysis. The majority of the analysis is undertaken using the 200 year event with the 10 year event used to highlight areas more prone to flooding and where flood depths are likely to be greater.

The Scottish Water Flood spreading assessment results focus on the 30 year rainfall event. In the UK new drainage systems are typically designed to convey the 1:30 year event however much of the network in Dunoon is significantly older and is expected to have a lower capacity. The extents of 1:200 year flood spreading assessment are included to correlate with the SEPA regional model. The Scottish Water model only covers the Dunoon and Kirn SWMP area.

Using the SEPA Risk Receptor Dataset the number of receptors effected by the flooding can be determined. As the receptor dataset consists of points only, it is typically necessary to apply a level of engineering judgement to determine whether a property is likely to be affected. For example, a house is represented by a single point typically found within the boundary of the building, without applying judgement the property would only be at risk if flood water came into contact with the point by which point flood water may already have encroached on the building footprint. This would also not account for damages to gardens, garages and other out buildings. Other receptors such as utilities and infrastructure have been accounted for in the damages assessment.

The SEPA regional pluvial damages data has been utilised to provide a monitory value for the damages accrued in each hot spot. The damages are presented in average annual damages (AAD) which are based on the SEPA regional pluvial mapping and SEPA Risk Receptor Dataset. The data is available as a $1km^2$ grid tile and also point data sets. The grid tiles are the sum of the point values with in each grid square. Due to the variable nature of the hotspots there are occasions where multiple exist within a single grid tile or where hotspots cross into multiple grid tiles. To most accurately assess damages the sum of the point data set was used for each hotspot.

As this is the case SEPA's Scottish Pluvial Annual Average Damage Estimate (SPAADEs) dataset shall be used. SPAADEs are not based on observed pluvial flood damages; instead they are derived from strategic national modelling. The SPAADE values derived in 2013 are £1,100 for a residential property and £1,700 for non-residential property. An uplift has been applied on these figures based on the Retail Price Index (RPI) from the Office of National Statistics. The uplifted values to be used in this SWMP are £1,387 for residential properties and £2,133 for non-residential properties.

Where SEPA AAD datasets are available and model confidence is good then the ADD values take precedence over the SPAADE dataset. Given the records of the observed flood events available known damages will also be used where possible.

A site visit was undertaken at the start of the project. JBA met with staff from the Argyll and Bute Council in Dunoon. The site walkover multiple sites which were photographed, and the flooding mechanisms/consequences were discussed. The site visit has formed an important part of the generation of hotspots due to the limited model data available in certain areas.

The future flood risk has been assessed during the analysis of each hotspot. There are 3 main areas associated with future flood risk, any of these items could increase the likelihood of future flooding.

Climate change – Using SEPA's 1:1000 year event pluvial flood hazard map it is possible to gain an appreciation for the effects of climate change. While all areas are likely to see flows increase and rainfall intensify, this will have a greater effect on some areas than others, typically this is related to the topography.

Urban Creep – Refers to the trend of replacing permeable ground with impermeable surfaces e.g. gardens replaced with driveways or areas re-developed with higher density buildings. Rates of urban creep vary, and no data has been supplied in order to assess this. However, this is not thought to be a significant issue in Dunoon.

Demographics – The local development plan has been used when assessing the flooding hotspots to determine how future expansion may affect flood risk at each hotspot. New developments will be subject to factors such as planning policy, development planning and development management which will interact with demographic change to influence flood risk. Scottish Planning Policy seeks to ensure that new developments are not at risk from surface water flooding and do not increase surface water flood risk elsewhere. No new developments are planned within the vicinity of the hotspots selected.

Development creep has the same impact as climate change and the 1000 year maps are considered to represent these influences.

Once the hotspots have been identified and damages have been assigned, it is necessary to prioritise the hotspots so that efforts can be focused where there is the most benefit. The factors that influence the ranking are as follows:

- The value of the average annual damages within each hotspot.
- The number of residential properties assessed to be at risk for the 1:200 year event.
- The number of non-residential properties assessed to be at risk for the 1:200 year event.
- Where the management of the risk lies within the powers of the SWMP stakeholders.
- The number and presence of vulnerable facilities.
- Where existing schemes are already operating hence reducing the benefit of implementing additional measures and allowing non-protected areas to be addressed.
- Social vulnerability to flooding dataset, published by the Scottish Government.

The prioritisation is a manual process using engineering judgement in the first instance. The initial ranking is then communicated to the SWMP stakeholders to gain their knowledge and experience before a final ranking is agreement.

It is estimated that surface water flooding accounts for 20% of annual average flood damages in the Dunoon area (based on SEPA modelled data).

The SEPA PVA report for Dunoon provides the following statement which is to be used as an indicator when monitoring any SWMP objectives:

"This objective will be monitored using surface water flood risk across the Potentially Vulnerable Area. For 11/07 there are 40 residential properties at risk and Annual Average Damages of £74,000."

A summary of the surface water flood risk for the SWMP area is presented in the table below. For details on the surface water flood risk and information on how these number were derived see section 4.

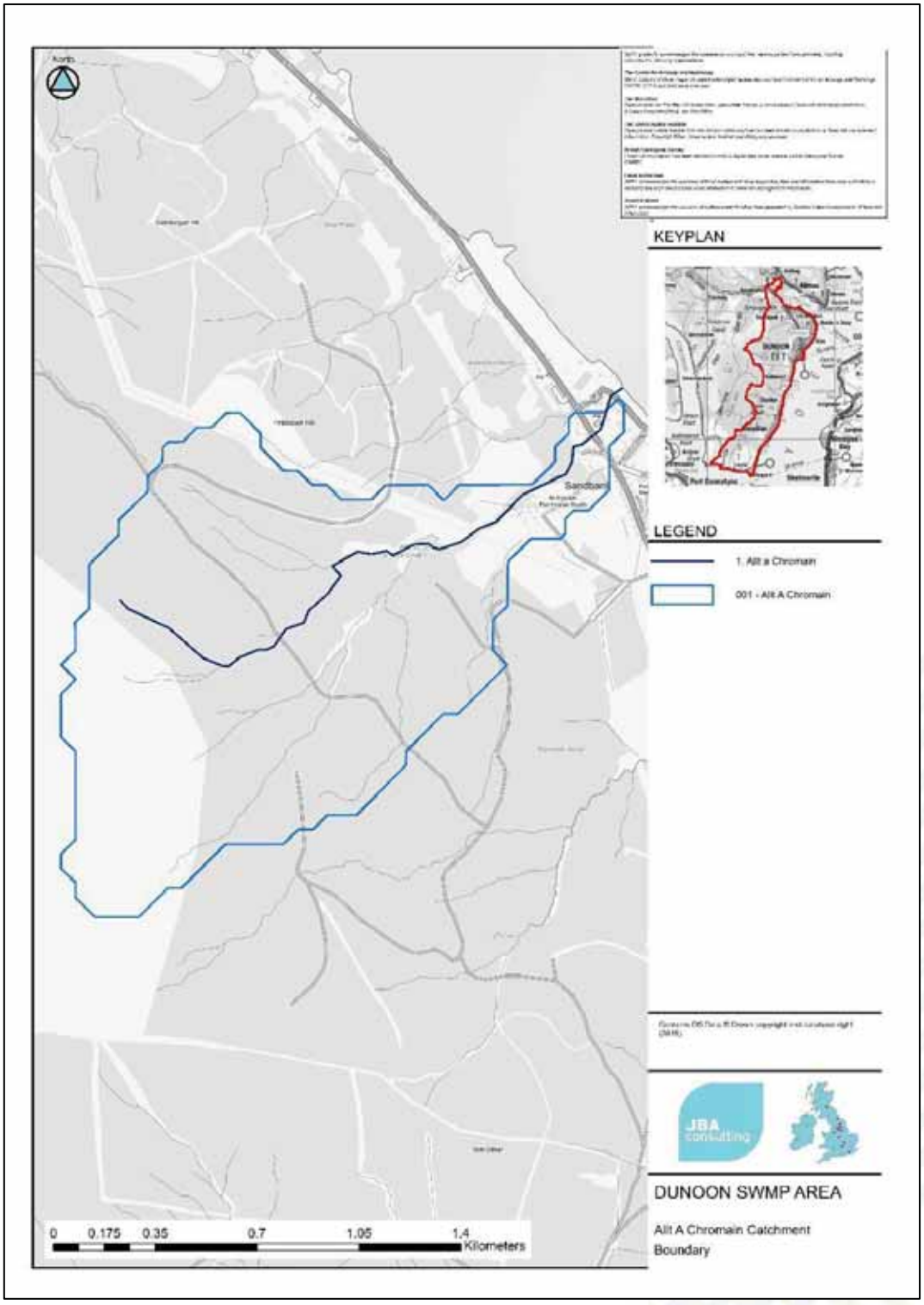
Dunoon	0	117	0	£1930.84 (SPAADE Data £165,053)

Sandbank and Ardnadam have several recurring issues with surface water flooding which are often related to the numerous small watercourses that drain the hillside to the west.

Flooding in the Eagle Court area is substantial and has previously resulted in exterior and interior damages of multiple properties. Here a combination of hillside runoff and out of bank flow from a natural drainage channel combine and flow over a field to a topographical low point adjacent to the Eagle Court development. An informal bund has been constructed to retain the flood water in the corner of the field although this has been breached in the past.

There is also a history of minor flooding at multiple locations in the area. This is primarily due to small unnamed watercourses and drainage ditches overtopping at culverts due to blockages or general capacity issues. Damages range from exterior damage to property and significant ponding on roads.

The catchment of the Allt a Chromain covers approximately 1.9km^2 in the Sandbank area. The catchment is relatively steep with average gradient of approximately 1:7. The upper catchment consists of commercial forestry with the lower reaches lined by woodland before the watercourse is culverted beneath Sandbank itself.


North
KEYPLAN
LEGEND
1. Allt a Chromain
001 - Allt A Chromain
0 0.175 0.35 0.7 1.05 1.4
Kilometers
DUNOON SWMP AREA
Allt A Chromain Catchment Boundary

No information on the sewer network was available from Scottish Water at the time of writing this SWMP.

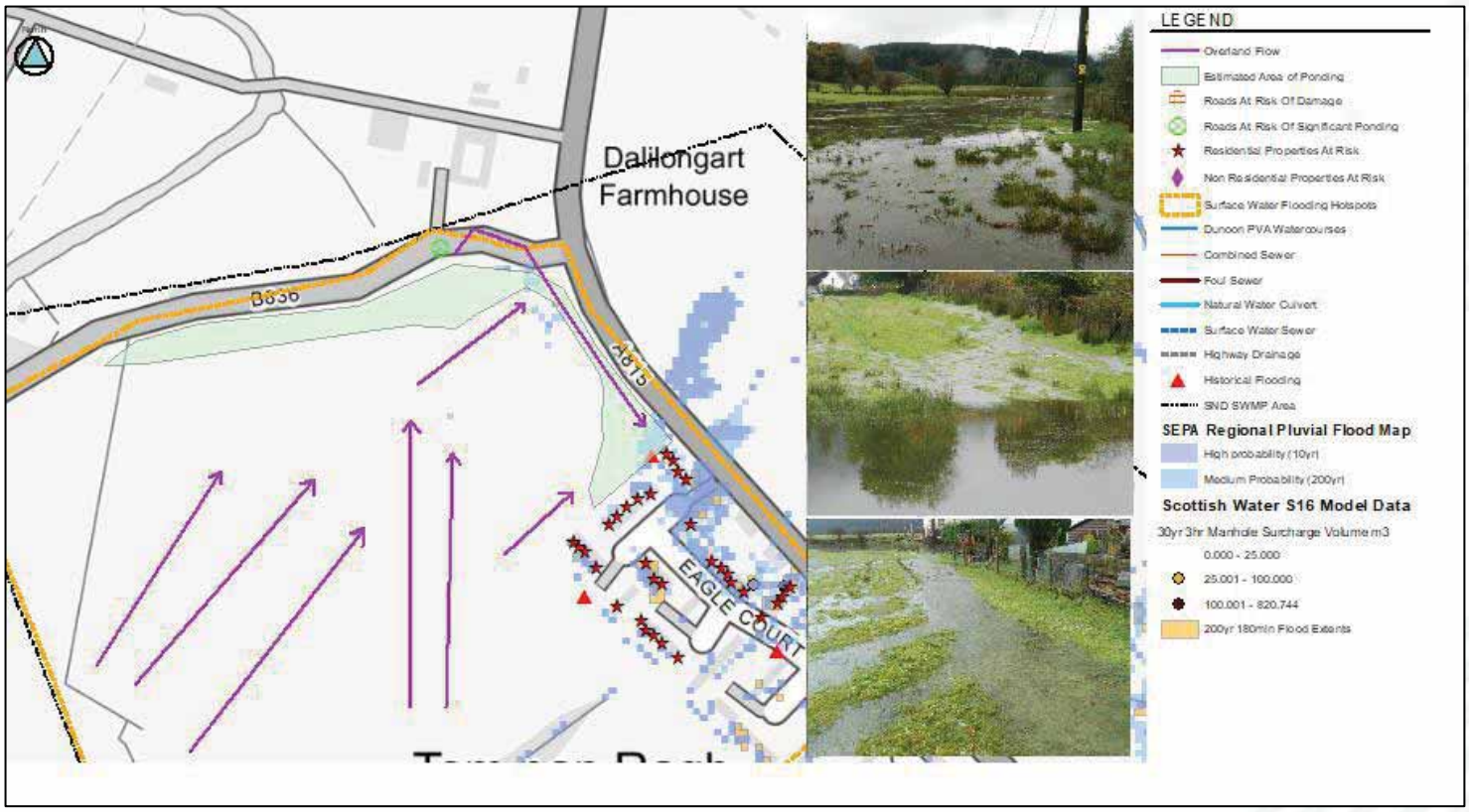
An informal L shaped bund has been constructed in the corner of the field adjacent to Eagle Court. The bund is thought to consist of the insitu soil which has been scraped and shaped to form the bund. The bund is known to have breached on at least one occasion.

For the purpose of this study it has been assumed that road gullies are connected to the combined sewer.

There are 2 flooding mechanisms at work in this area which results in surface water ponding against an informal bund in the corner of a field to the north of Eagle Court. Hillside runoff from the west is either collected in a drainage ditch and flows toward the B836 or flows overland directly to the north east corner of the field.

Under normal conditions the drainage ditch flows east adjacent to the road before passing under the road toward Dalilongart Farmhouse. It is understood that this area is prone to blockage which flows onto the road causing significant volumes of ponding water. The ponding water then flows into the field adjacent to the A815 and flow south east to the informal bund area. The informal bund is a recent creation, thought to consist of scraped site won material with little to no compaction. The bund has breached in the past and came close to over topping on several occasions. The properties to south west of Eagle Terrace also receive nuisance flooding to their gardens due to hillside runoff overwhelming the drainage network which surrounds the development.

Damages in Eagle Court are significant including interior and exterior flooding of multiple properties. Ponding on the B836 is also known to have closed the road at times. The current flood risk is high as the flooding is known to be recurring and the informal defences have failed to mitigate flood risk. The flood hazard is also high due to the damages caused and a significant breach of the informal structure could cause high velocities. There is an opportunity to mitigate or partially mitigate future flood risk through a potential housing development for the site. The future flood risk is likely to increase as a result of more frequent intense rainfall events associated with climate change which will further increase the depth of flood water and potentially increase the flood extent.

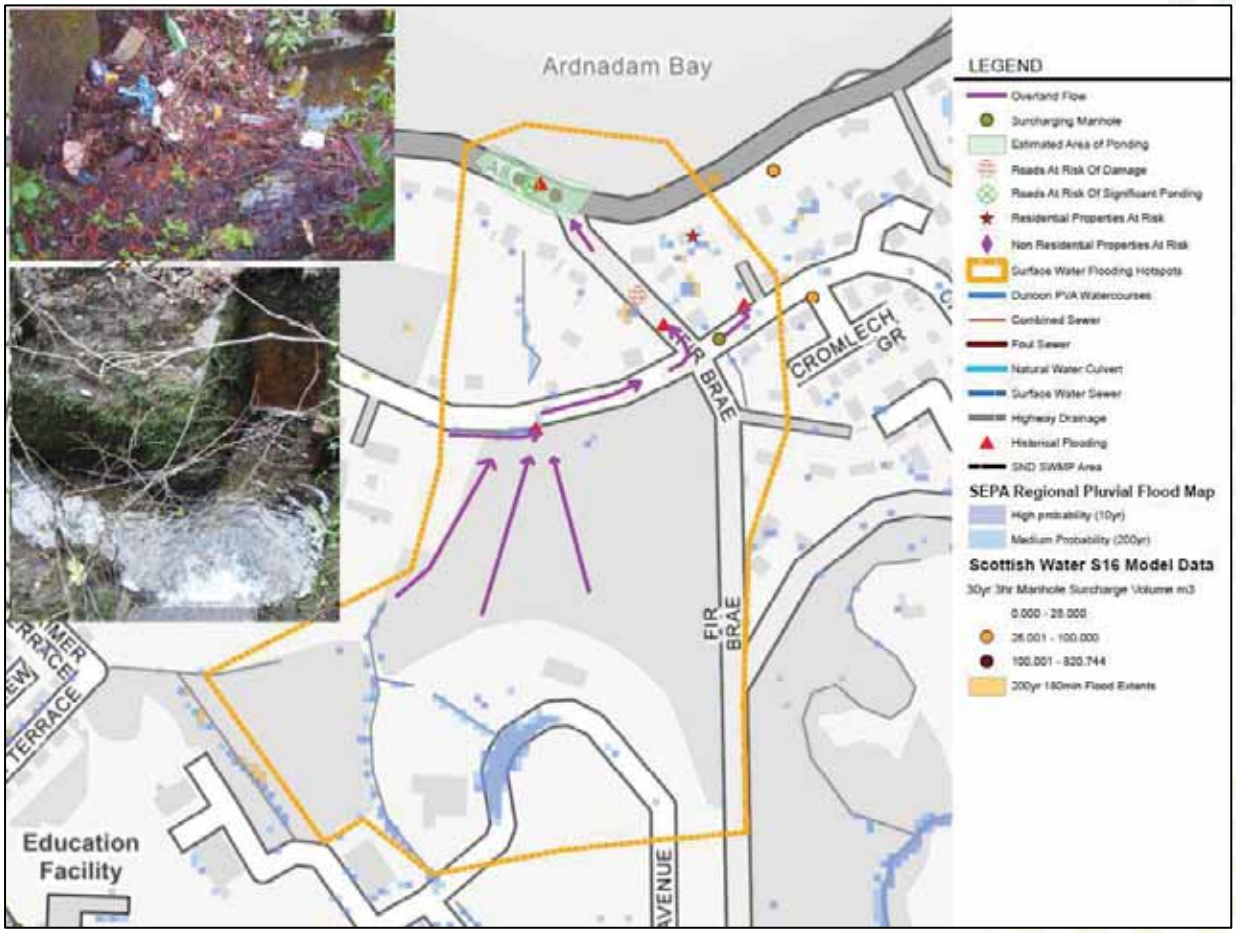

Dalilongart
Farmhouse
B836
A815
EAGLE COURT
LEGEND
Overland Flow
Estimated Area of Ponding
Roads At Risk Of Damage
Roads At Risk Of Significant Ponding
Residential Properties At Risk
Non Residential Properties At Risk
Surface Water Flooding Hotspots
Dunoon PVA Watercourses
Combined Sewer
Foul Sewer
Natural Water Culvert
Surface Water Sewer
Highway Drainage
Historical Flooding
SND SWMP Area
SEPA Regional Pluvial Flood Map
High probability (10yr)
Medium Probability (200yr)
Scottish Water S16 Model Data
30yr 3hr Manhole Surcharge Volume m3
0.000 - 25.000
25.001 - 100.000
100.001 - 820.744
200yr 180min Flood Extents

This hotspot features 3 separate minor watercourses which flow down the eastern slope of Finbracken Hill through Sandbank. Each of the watercourses are steep and entrenched with catchments consisting of commercial forestry. As such they are flashy and prone to blockages at the culverts which convey the watercourse below the road. Two of the watercourses have spilled on to the A885 in the past causing ponding on the road and threatening nearby properties. The third watercourse blocks at Cromlech Road culvert which has resulted in flooding of a garage at a property adjacent to the culvert.

The current flood risk is high as the flooding is known to be recurring. The flood hazard is also high due to the anticipated high velocities when the channels are in spate. There are no developments planned in this area however future flood risk is likely to increase as a result of more frequent intense rainfall events associated with climate change.

Flows from a minor watercourse and SuDS from Highland Avenue flow down a wooded hillside to the north of Highland Avenue. The watercourse and hillside runoff collects in drainage ditches and channels flowing adjacent to Cromlech Road. Several of the drainage ditches drain to a single culvert which conveys flows south under the road and into a private property. This culvert is prone to substantial blockage at the headwall which causes water to over top on to Cromlech Road. Once on Cromlech Road flows head east before turning north and flowing down Fir Brae. There are reports of ponding on Shore Road approximately adjacent to the junction with Fir Brae. It is possible that flood water from Fir Brae ponds here however, the model also shows substantial manhole surcharging volumes. A manhole to the east of the Fir Brae and Cromlech Road junction is also prone to surcharging sending flows into the garden of a neighbouring property and out onto Shore Road. It is assumed the surcharging is linked to the surface water issues discussed above. Damages to the property as a result of surcharging are understood to be restricted the garden only. Fir Brae has also suffered damages to the road surface course due to the high velocity of flood water.

The current flood risk is high as the flooding is known to be recurring. The flood hazard is also high due to the damages caused and the velocity floodwater. The Highland Avenue business park area is zoned for future development. This could provide an opportunity to restrict flows which are passed downstream which may help to lower flood risk. Without intervention future flood risk is likely to increase as a result of more frequent intense rainfall events associated with climate change.



Rank	Hotspot name and location		Total Annual Average Damage (AAD)	Non Residential Properties	Residential Properties	Community facilities	Listed buildings	Infrastructure
		Return Period (yr)	**200**	**200**	**200**	**200**	**200**	**200**
		History of flooding Confidence in data						
1	**SND_HS01: Eagle Terrace**	*History of surface water flooding due to extensive volume hillside runoff and over topped watercourse ponding in the corner of the field adjacent to the development Good confidence in model data*	*£1773.14 (£47, 158 SPAADE data)*	*0*	*34*	*-*	*-*	*Significant ponding on B836*
2	**SND_HS03: Fir Brae**	*History of surface water flooding caused by blocked culverts causing high velocity overland flow, ponding on the carriageway and manhole surcharging. Low confidence in model data.*	*£0 (£1,387 SPAADE data)*	*0*	*1*	*-*	*-*	*Fir Brae damaged Significant ponding on Shore Road*
3	**SND_HS02: A885 High Road**	*History of surface water flooding due to blocked culverts resulting in flooding of adjacent road or property. Low confidence in model data*	*£0 (£1,387 SPAADE data)*	*0*	*1*	*-*	*-*	*Minor ponding to A885*

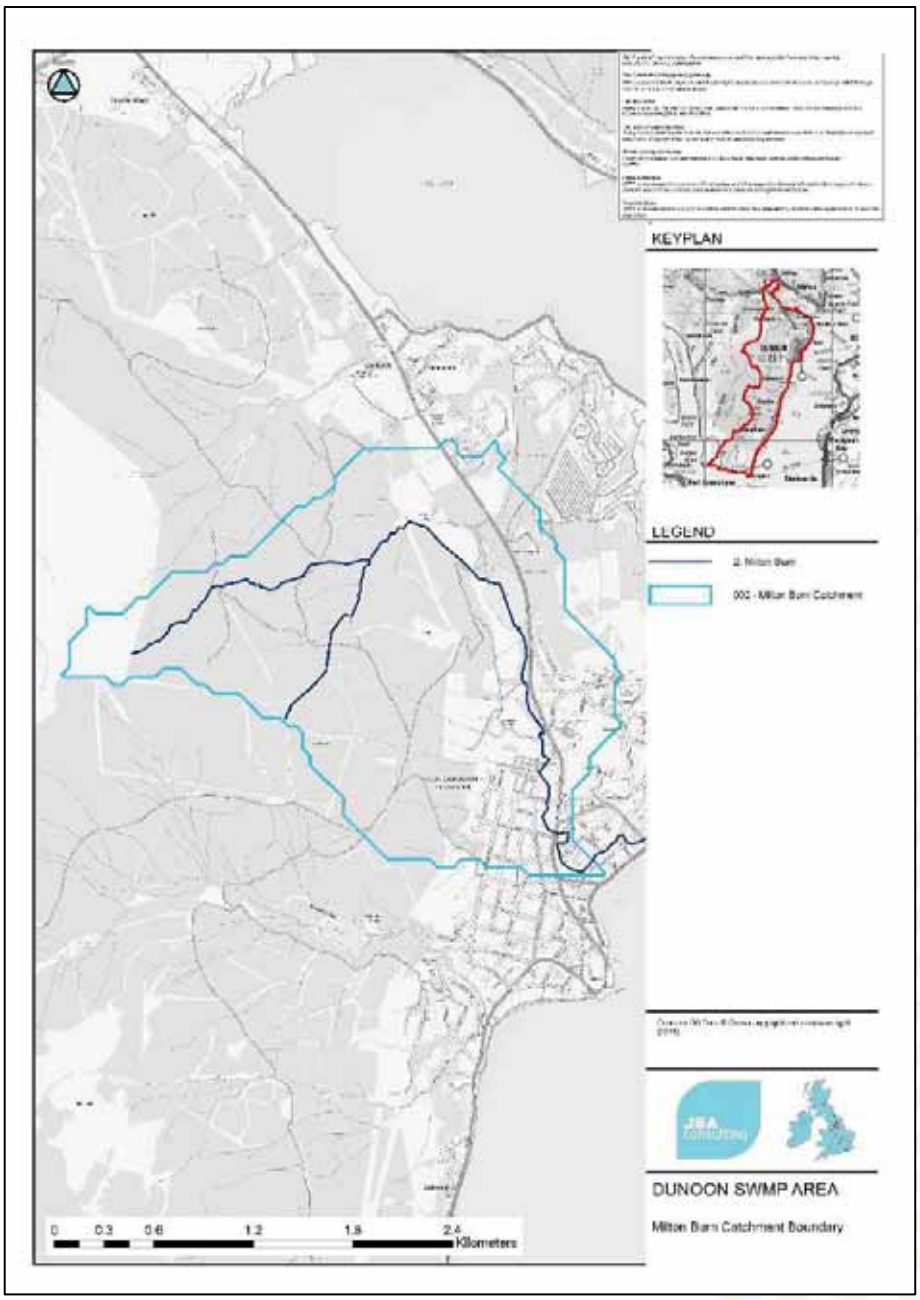
The majority of severe flood events in Dunoon are a result of coastal or fluvial actions nonetheless there are still multiple areas which suffer from pluvial flooding.

There are numerous flooding mechanisms at work within the Dunoon SWMP area. Hillside runoff has contributed to nuisance flooding of gardens in Lochan Avenue, Alexander Street and Broomfield Road. Small watercourses and drainage channels are another common issue as they enter the urbanised areas where they are constrained in channels and culverts. Culverts are prone to blockages resulting in a reduction in capacity and out of bank flows. This has occurred in Alexander Street, McCall Terrace and the Fairhaven development. Damages have included extensive interior flooding of properties in the past.

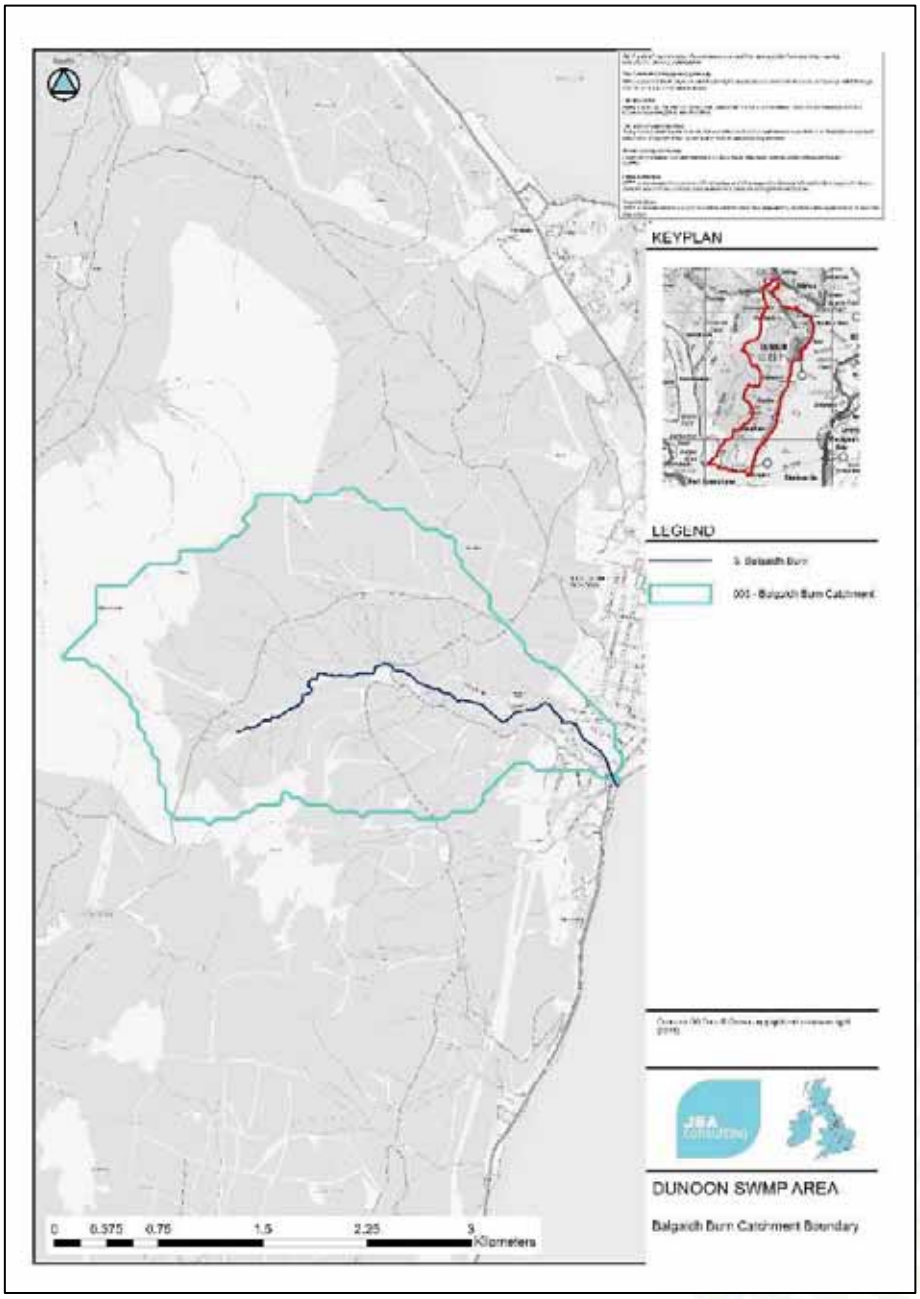
Both the Scottish Water model results and the flooding database provided by the council suggest there are issues with drainage throughout the Dunoon area. The council flooding database has demonstrated that there is an issue with road gullies becoming blocked causing water to pond at multiple locations throughout the area. These reports are typically isolated incidents which are not geographically linked. This would suggest this is more of a maintenance issue than a specific problem.

The Scottish Water model shows that there are a number of manholes throughout the catchment that may surcharge significant volumes of material (>500m^3) during a 30 year storm event. A separate study into the sewer network has also indicated that the network takes on significant volumes of water via infiltration which further reduces network capacity. There is a record of sewer surcharging in the Ardenslate Crescent area which caused damage to gardens.

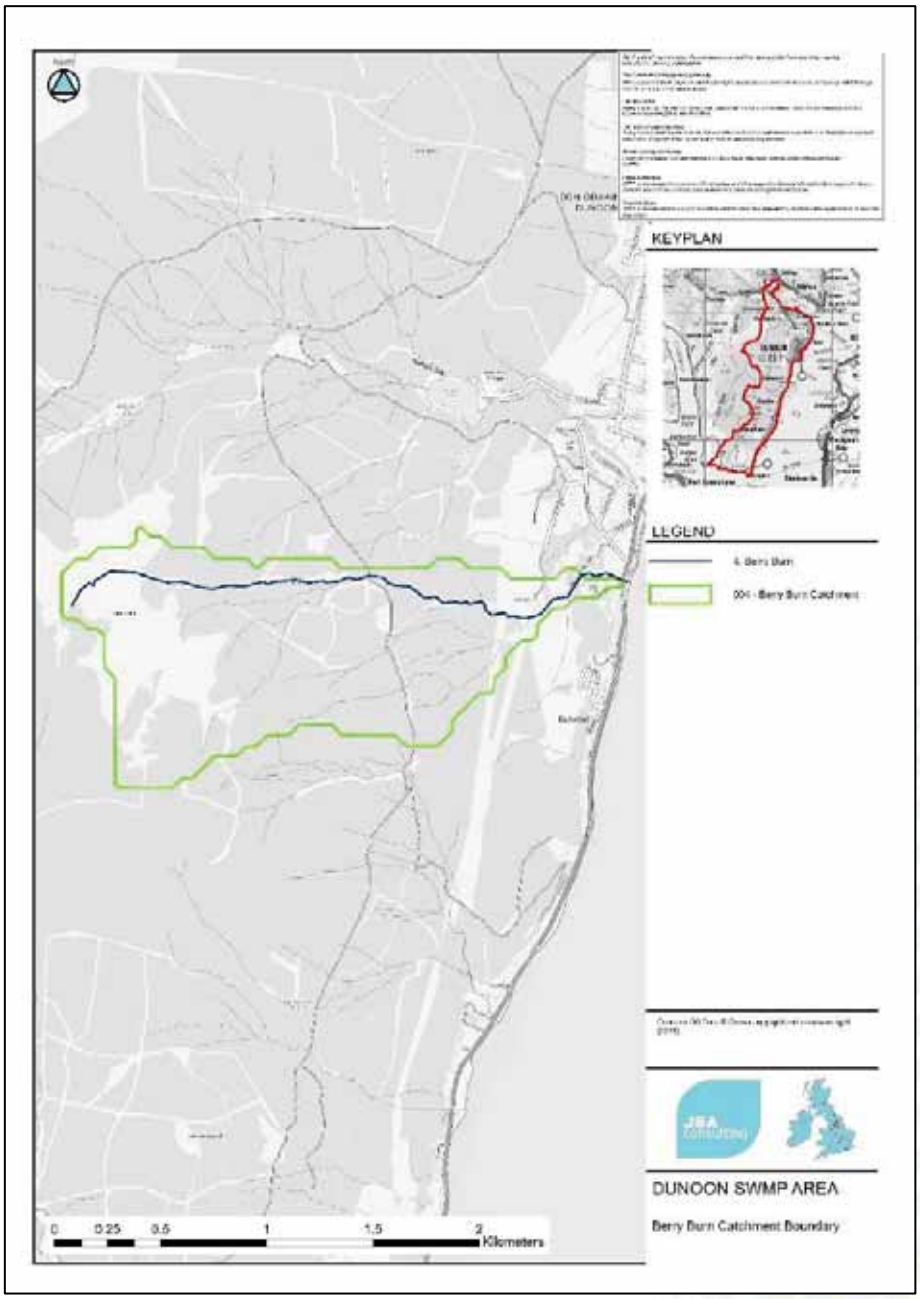
The Milton Burn catchment covers approximately 5km^2. The watercourse is effectively split in half by Loch Loskin situated north west of Dunoon. The upper reaches consist of steep hillside where the land cover is entirely commercial forestry. Downstream of Loch Loskin the watercourse flows through Dunoon in a mixture of urbanised open channels and culverts. The bed slope of the lower reach is considerably slacker than the upper reach.



The Balgaidh Burn drains a catchment area of approximately 6.1km^2. Runoff from the catchment is heavily influence by Bishop's Glen Reservoir. The catchment is relatively steep with an average gradient of approximately 1:6. The watercourse originates on the upper slopes of Kilbride Hill to the south west of Dunoon. The catchment is dominated by commercial forestry. Beyond the reservoir the watercourse falls steeply in a wooded valley before flattening as it passes through a residential area.



The Berry Burn catchment area is approximately 1.8km^2 which, like many of the catchments, is dominated by commercial forestry. The catchment is relatively steep with an average gradient of approximately 1:6. The watercourse flattens as it reaches the coast flowing open in a wooded valley before being culverted under Bullwood Road at its confluence with the Firth of Clyde.



There is a combined sewer network which covers the majority of Dunoon with very few separated systems present only at the newer developments.

All combined sewers are collected by an arterial combined sewer which is a pumped beneath the A815 toward a treatment plant in Bullwood to the south of Dunoon. This intercepts a total of 21 outfalls which previously discharged directly to the sea. A Scottish Water Study into infiltration of the Dunoon network found that infiltration into the network was substantial problem which further reduces capacity.

There are no known surface water management features in the Dunoon SWMP area.

Throughout the SWMP area road drainage is predominantly connected to the combined sewer. There is also suspected to be a significant volume of rural runoff and hillside drainage that is intercepted on the urban fringe. For example, the data provided indicates that the hillside ditch drainage network above Alexander Street collects at a single culvert at the top of John Street which connects to a combined sewer.

An unnamed watercourse flows openly along the eastern extent of the Fairhaven development for approximately 50m. The watercourse is culverted both up and downstream of this. There are 2 recorded incidents of flooding occurring. During the first incident the watercourse was reported to be close to overtopping while a second incident involved interior flooding of a property in which the fire service was in attendance. Following the interior flooding the culvert was cleared of debris which included substantial woody debris and a car tyre. The interior damage to the property was thought to be extensive.

The current flood risk is high as the flooding known to be recurring and the culverts are susceptible to blockage. The flood hazard is also high due to the damages caused and potential for significant velocities in the vicinity of the channel when overtopping. The future flood risk is likely to increase as a result of more frequent intense rainfall events associated with climate change which will further increase the depth of flood water and potentially increase the flood extent.

Hillside runoff from a wooded area causes the rear gardens of Lochan Avenue to be permanently damp/boggy particularly those toward the north of the street. Some home owners have resorted to digging trenches around the perimeter of their gardens to intercept the surface water and divert it away. Field drains and drainage trenches upslope on the hill are known to be silted up and barely functional. There is also a small channel located toward the northern extent of Lochan Avenue which is prone to overtopping at the culvert beneath the road. This sends surface water onto the road, into the gullies which are subsequently connected to the combined sewer. Damages are thought to be restricted to gardens however, there is report of damage to a masonry wall which collapsed due to the surface water pressure.

The current flood risk is high as the flooding known to be recurring/consistent. The flood hazard is also low as flood depths are shallow and damages are limited. The future flood risk is likely to increase as a result of more frequent intense rainfall events associated with climate change which may further increase the volume of flood water and potentially increase the flood extent.

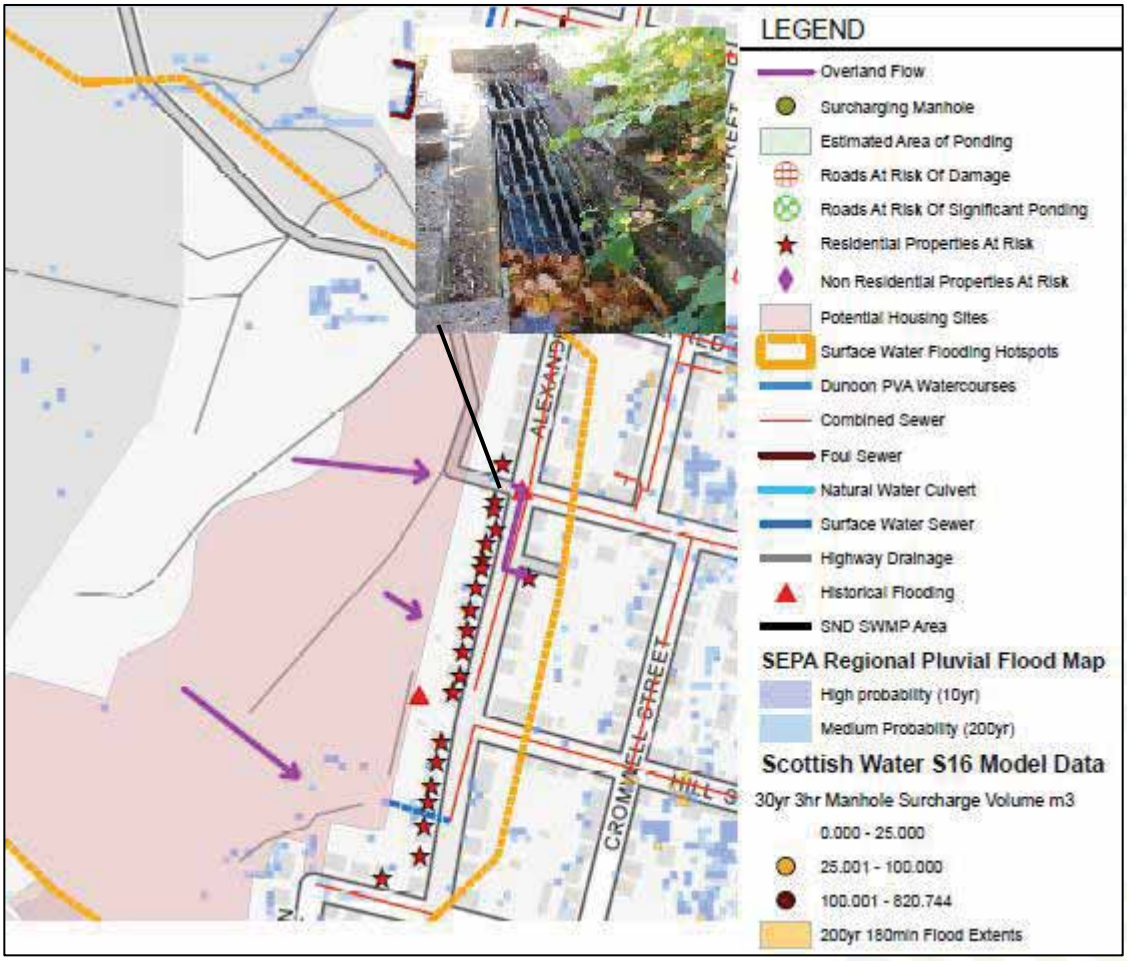
There are 2 recorded flooding incidents in this area. There is a report of ponding water on the Ardenslate Crescent reaching the footpath. The second incident relates to sewer surcharging in the rear garden of a property on Ardenslate Road. The source of the flooding to Ardenslate Crescent is not known however, it is thought that the road drainage is connected to the combined sewer. It has therefore been assumed that both incidents were a function of the performance of the sewer network.

The current flood risk is moderate as the flooding is known to be recurring however the sewer system in the area is thought to be underperforming. The flood hazard is also moderate as flood velocity is likely to be low however, flows may contain foul material. The future flood risk is likely to increase as a result of more frequent intense rainfall events associated with climate change which may further increase the volume of flood water entering the sewer.

The hillside to the west of Alexander Street is the source of 2 flooding mechanisms. Firstly, hillside runoff is known to overtop existing drainage ditches a cause nuisance flooding to the rear gardens border the hillside. The second mechanism relates to the collection of the hillside ditches and drains which collect and discharge in to a culvert at the junction with John Street.

The watercourse is prone to blockages at the headwall causing flood water to overtop onto Alexander Street. Due to the road camber in this area this directs flows south along the street where it enters the ground of a low-lying residential property causing substantial interior damage. It is also understood that manholes downstream of the headwall are prone to surcharging. Damages vary from nuisance garden flooding to interior property damage.

The current flood risk is high as the flooding is known to be recurring. The flood hazard is moderate as flood velocity is likely to vary however, flood depth is likely to be low. There is the potential to mitigate future flood risk by managing surface water on the proposed housing development on the hillside to the west of Alexander Street. The future flood risk is likely to increase as a result of more frequent intense rainfall events associated with climate change which may further increase the volume of flood water entering the culvert.



There is one recorded flooding incident in this area. There is a report of flooding to 2 properties however, there is no record of the flooding mechanism or the level of damage sustained. The model data available indicates that the flooding mechanisms are either due to the Milton Burn becoming blocked at the culvert which conveys flow beneath Hamilton Street, or surcharging manholes adjacent to the properties. It is also possible that both mechanisms could be linked. The manholes adjacent to the properties show surcharge volumes well in excess of 500m^3 for various return periods below the 1 in 30-year event.

The current flood risk is moderate as the flooding is not known to be recurring however the potential damage could be significant. The flood hazard is high as the model data shows that flood depths could be up to 1m and also potentially contains foul material. The future flood risk is likely to increase as a result of more frequent intense rainfall events associated with climate change which may further increase the volume of flood water entering the sewer.

There is a report of minor garden flooding to the properties on the south of Erichtbank Drive. Overland flow from the vegetated hillside to the west enters the street and due to the camber of the road, flows are directed towards the properties. Although flooding is restricted to gardens and paths this has frozen in the past making access hazardous for residents.

The current flood risk is moderate as the flooding is thought to be to be recurring but is limited in extent and depth. The flood hazard is moderate as the surface water is unlikely to pond due to the gradient of the street. The hazard presented is due to the freezing of the flood water. The future flood risk is likely to remain the same as the catchment for the surface water is very limited and its flow path is defined.

There is a report of minor garden flooding to a property at the north western extent of Broomfield Drive. The flooding mechanism is unknown but thought to be as a result of remediation of a landslip above on Kilbride Road which has affected drainage forcing flows through the garden.

The current flood risk is low as the flooding is not thought to be recurring. The flood hazard is also low as the surface water is unlikely to pond due to the gradient of the garden and no damages have been recorded. The future flood risk is likely to remain the same as the catchment for the surface water is very limited and its flow path is defined.

There is a substantial number of reports in the council flooding database which refer to ineffective or blocked road drainage causing flooding of path and roads.

The current flood risk is moderate as the flooding as it is not thought to be recurring at specific locations although there are a substantial number of recorded incidents. The flood hazard is low to moderate as depths are known to vary but velocities are very low.

Black Park in Dunoon is located between East Argyll Street, Argyll Road and Park Road. The park features an athletics stadium, rugby pitch, all-weather football facilities and large gravel carparking area to the south. The topography generally falls to the south west with all rainfall falling within the catchment flowing towards this point. As such, the overland flow in the carpark and south west of the park is substantial.

The overland flow floods the gardens of neighbouring properties up to 0.3m deep multiple times per month. At least 4 properties are badly affected with others likely to be affected by nuisance flooding. Flows have not yet entered the properties but are reported to have been close.

After speaking to local residents, it is understood that a drainage ditch system used to intercept flows and channel it to a headwall which then connected to the combined sewer. The headwall was removed when the Miller Court development was constructed circa 1990s when it was replaced with a small pumping station. Little is known about the pumping station and its onward connection. However, following the results of the site walkover, it has been assumed that the pumped water flows to a surface water manhole within Miller Court's separated sewer network. The separated sewer network in Miller Court then appears to connect to the combined sewer.

Unfortunately, the drainage channel has not been maintained and is understood to have been shortened as the gravel car park has expanded over the years. As such it only intercepts a small portion of the flows entering the park. Flows which do enter the heavily silted and vegetated channel slowly flow toward the pumping station. The pumping station is known to be unreliable and has been maintained by a local resident on an ad-hoc basis for 20 years. The pump was not functional on the day of the site visit. The pump itself is very small with an unknown capacity, the outlet pipe from the pump is approximately 50mm ∅. Residents also state the flooding has increased substantially since the construction of the all-weather football pitches.

The flood hazard is low to moderate as depths are known to vary but velocities are very low.

The current flood risk is high as the flooding is recurring. The flood hazard is also high as the surface water is ponding over significant areas during low return period events which suggests that inundation to properties is likely during more significant storm events. The future flood risk is likely to remain the same as the catchment for the surface water is very limited and its flow path is defined.

The future flood risk is likely to increase as a result of more frequent intense rainfall events associated with climate change which may further increase the volume of flood water reaching the south west corner of Black Park.

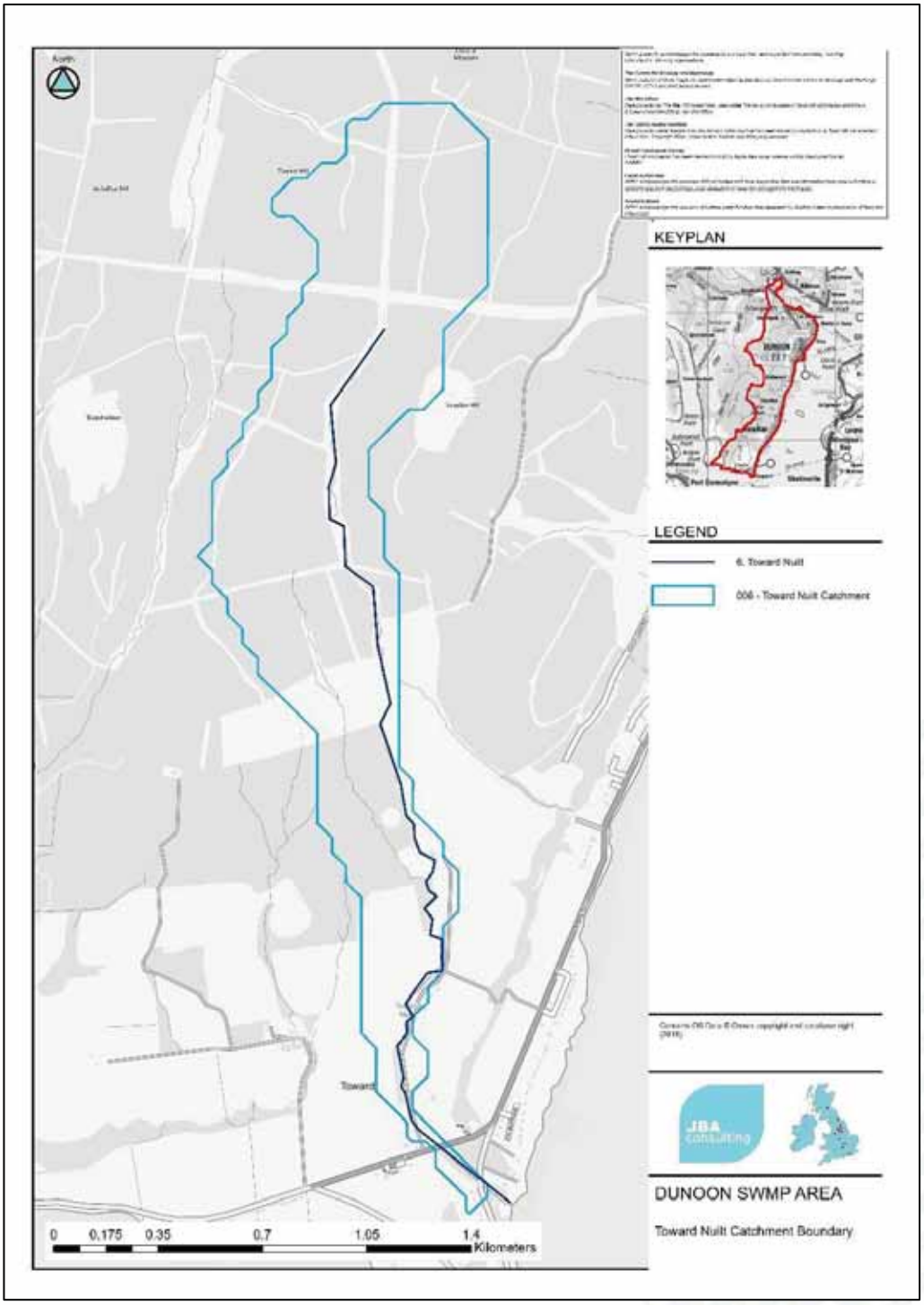
Rank	Hotspot name and location		Total Annual Average Damage (AAD)	Non Residential Properties	Residential Properties	Community facilities	Listed buildings	Infrastructure
		Return Period (yr)	**200**	**200**	**200**	**200**	**200**	**200**
		History of flooding Confidence in data						
1	**DUN_HS04: Alexander Street**	*Hillside runoff to the west of Alexander Street causes nuisance flooding to the rear gardens as well as out of bank flows at a culvert send flows along the road and into a low-lying residential property. Low confidence in model data.*	*£0 (£29,127 SPAADE data)*	-	*21*	-	-	-
2	**DUN_HS09: Black Park**	*Overland flow from an area of open ground gathers in the south west corner of Black Park overwhelming existing infrastructure affecting low-lying residential properties. Good confidence in model data.*	*£0 (£6,935 SPAADE data)*	-	*5*	-	-	-
3	**DUN_HS05: McCall Terrace**	*History of flooding at 2 properties caused by overtopping Milton Burn and/or surcharging manholes. Good confidence in model data.*	*£1300.70 (£5,548 SPAADE data)*	-	*4*	-	-	-
4	**DUN_HS01: Fairhaven**	*Culverted section of urban watercourse prone to blockages causing out of bank flows in the Fairhaven area. Low confidence in model data*	*£0 (£5,548 SPAADE data)*	-	*4*	-	-	-
5	**DUN_HS03: Ardenslate Crescent Area**	*History of suspected sewer surcharging and ponding in residential gardens and streets. moderate confidence in model data.*	*£0 (£27,740 SPAADE data)*	-	*20*	-	-	-

Rank	Hotspot name and location		Total Annual Average Damage (AAD)	Non Residential Properties	Residential Properties	Community facilities	Listed buildings	Infrastructure
		Return Period (yr)	**200**	**200**	**200**	**200**	**200**	**200**
		History of flooding Confidence in data						
6	**DUN_HS02: Lochan Avenue**	*Hillside runoff causing rear gardens of properties along Lochan Avenue to be permanently saturated. Low confidence in model data.*	*£0 (£15,257 SPAADE data)*	-	*11*	-	-	-
7	**DUN_HS06: Ericht Bank Drive**	*History of flooding to gardens caused by overland flow from small hillside being directed by the camber in the road. Low confidence in model data.*	*£0 (£11,096 SPAADE data)*	-	*8*	-	-	-
8	**DUN_HS07: Broomfield Drive**	*Nuisance garden flooding caused by overland flow from road drainage on Kilbride Road at a former landslip. Low confidence in model data.*	*£0 (£2774 SPAADE data)*	-	*2*	-	-	-
9	**DUN_HS08: Road Drainage**	*Problems with road drainage due to blocked/ineffective gullies throughout the SWMP area. Low confidence in model data.*	*£0 (£2774 SPAADE data)*	-	-	-	-	*Multiple roads with deep ponded water*

The primary flood risk within the Toward and Innellan area is in Allan Park, Innellan. Here a steep watercourse enters the residential estate and passes through multiple culverts on its route to the shore. Flooding has occurred at 2 of the 3 culverts due to blockages sending flood water on to roads and into adjacent properties causing exterior and interior damage.

Other incidents of flooding are localised often restricted to single properties where out of bank flows are typically caused by a lack of capacity or blockages in culverts. Damages range from interior property damage to significant ponding on roads.

The Toward Nuilt drains approximately 1.6km^2 of the Innellan area. It flows across the top of Innellan Hill and falls down the rocky hillside south towards the Toward area. Toward Nuilt descends with an average gradient of approximately 1:10 through a catchment of commercial forestry.


KEYPLAN
LEGEND
6. Toward Nuilt
006 - Toward Nuilt Catchment
0 0.175 0.35 0.7 1.05 1.4
Kilometers
DUNOON SWMP AREA
Toward Nuilt Catchment Boundary

No information on the sewer network was available from Scottish Water at the time of writing this SWMP.

No known surface water management features are present in this area.

For the purpose of this study it has been assumed that road gullies are connected to the combined sewer.

There is a report of pluvial flood water causing damage to a set of stairs on Matheson Lane. There are no details on the flooding mechanism or the extent of the damage. There is also no information on the construction of the stairs, it has been assumed that these were timber board steps. The flooding is thought to have been caused by a drainage ditch which runs parallel to Knockamillie Road over topping at the culvert which conveys flow below Wyndham Road.

The current flood risk is low as the flooding is not thought to be recurring. The flood hazard is moderate as the flood water had enough force to damage stairs, but depth is likely to be very shallow. The future flood risk is likely to increase as a result of more frequent intense rainfall events associated with climate change which will further increase the volume of flood water.

It is reported that groundwater flowing beneath North Campbell Road springs in the garden of a bungalow and causes internal flooding the property. There is no modelled flooding at this location.

The current flood risk is moderate as the flooding is not thought to be recurring. The flood hazard is high as it causes internal damage to a property with a vulnerable resident. The future flood risk is likely to remain at a similar level to the existing flood risk.

Two unnamed watercourses flow down a wooded hillside to the west of Arran Park and converge approximately 60m upstream of the estate. The watercourse flows through a twin culvert under Arran Park Road before flowing openly through gardens. There is a constriction on the channel as the watercourse passes through a boundary wall into the ground of another residential dwelling on Shore Road. Once in the boundary of the Shore Road property the channel changes to a cemented U-shaped masonry channel before entering a culvert which conveys flows under the property. Flows are known to have come out of bank at all 3 constrictions. Works to improve the screens on the Arran Park Road culvert are known to have reduce blockage at this culvert. Downstream of the culvert the channel sits in a deep V-shaped channel located in the side and rear garden of a residential property on Arran Park. Due to the constriction at the boundary wall flood waters have reportedly came close to overtopping the bank.

Substantial flooding has occurred at the property on Shore Road due to out of bank flows at the culvert located in the back garden of this property. It is not known if this

is due to the culvert being under capacity or if it is prone to blockages. Damages include both internal and external flooding of properties.

The current flood risk is high as the flooding thought to be recurring and potential damages are extensive. The flood hazard is high as it the depth of flood water could be significant in places and velocity of the flood water is also expected to be fast close to the channel. The future flood risk is likely to increase as a result of more frequent intense rainfall events associated with climate change which will further increase the volume of flood water.

Interior and exterior damage was caused to a property on Fern Lane in 2009 when a culvert under "the Velvet Path" ,which runs perpendicular and upslope of the property, overtopped sending flows down the hillside and into the property. The watercourse flows steeply through a commercially forested area before flowing under the path which has a substandard and damaged screen prone to creating blockages.

The current flood risk is moderate as the flooding is not thought to be recurring. The flood hazard is high as it causes internal damage to a property. The future flood risk is likely to increase as a result of more frequent intense rainfall events associated with climate change which will further increase the volume of flood water.

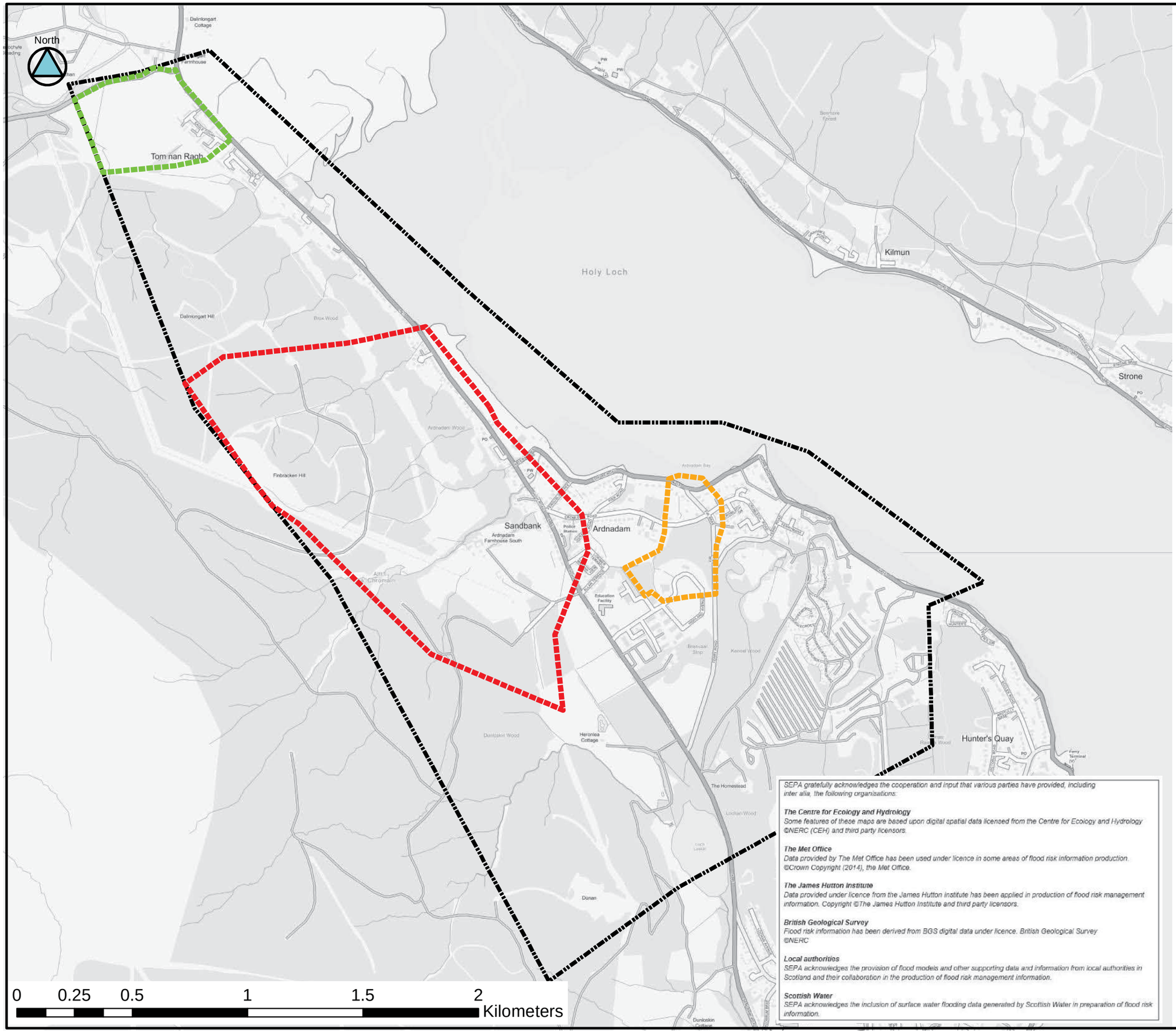
: Inlet screen to culvert under the "Velvet Path"

A drainage ditch which runs parallel with the A815 Shore Road in Toward is prone to overtopping causing flood water to pond on the road. Reports suggest that the depth of water may make the road unpassable for cars. There are also additional concerns as the flood water is situated on a blind bend in the road.

The current flood risk is high as the flooding is known to be recurring. The flood hazard is moderate as it may cause smaller vehicles to use an alternative route. The future flood risk is likely to increase as a result of more frequent intense rainfall events associated with climate change which will further increase the volume of flood water.

Rank	Hotspot name and location		Total Annual Average Damage (AAD)	Non Residential Properties	Residential Properties	Community facilities	Listed buildings	Infrastructure
		Return Period (yr)	**200**	**200**	**200**	**200**	**200**	**200**
		History of flooding Confidence in data						
1	**TOW_HS03: Arran Park**	*Watercourse is constricted by culverts in residential area, history of over topping and flood properties. Low confidence in model data.*	*£0 (£13,870 SPAADE data)*	-	*10*	-	-	-
2	**TOW_HS02: North Campbell Street**	*Suspected ground water flooding causes interior damage to a single property. Low confidence in model data.*	*£0 (£1,387 SPAADE data)*	-	*1*	-	-	-
3	**TOW_HS04: Ferns Lane**	*Blocked culvert on access track causes flood water to spill down the hillside toward a residential property causing interior and exterior damage. Low confidence in model data.*	*£0 (£1,387 SPAADE data)*	-	*1*	-	-	-
4	**TOW_HS05: A815 Shore Road**	*History of flood water ponding on the road due to overtopping drainage ditch. Moderate confidence in model data.*	*£0 (£0 SPAADE data)*	-	-	-	-	*A815 blocked due to ponding water*
5	**TOW_HS01: Matheson Lane**	*Overtopping culvert cause damage to a set of stairs Low confidence in model data*	*£0 (£0 SPAADE data)*	-	-	-	-	*Damage to stairs on school access route.*

This page is intentionally left blank.



SEPA gratefully acknowledges the cooperation and input that various parties have provided, including inter alia, the following organisations:

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licensed from the Centre for Ecology and Hydrology ©NERC (CEH) and third party licensors.

The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2014), the Met Office.

The James Hutton Institute
Data provided under licence from the James Hutton Institute has been applied in production of flood risk management information. Copyright ©The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC

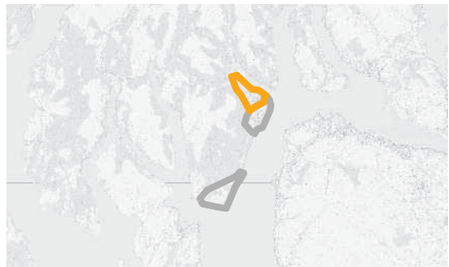
Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

LEGEND

- SND_HS01
- SND_HS02
- SND_HS03
- SND SWMP Area

DUNOON SWMP KEYPLAN



JBA consulting

SND D02

HOTSPOT SUMMARY

North

Dalilongart Farmhouse

B836

A815

EAGLE COURT

Tom nan Ragh

0 37.5 75 150 225 300 Meters

SEPA gratefully acknowledges the cooperation and input that various parties have provided, including inter alia, the following organisations:

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licensed from the Centre for Ecology and Hydrology ©NERC (CEH) and third party licensors.

The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2014), the Met Office.

The James Hutton Institute
Data provided under licence from the James Hutton institute has been applied in production of flood risk management information. Copyright ©The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC

Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

LEGEND

- Overland Flow
- Estimated Area of Ponding
- @ Roads At Risk Of Damage
- ? Roads At Risk Of Significant Ponding
- ^ Residential Properties At Risk
- X Non Residential Properties At Risk
- Potential Housing Sites
- Surface Water Flooding Hotspots
- Dunoon PVA Watercourses
- Combined Sewer
- Foul Sewer
- Natural Water Culvert
- Surface Water Sewer
- Highway Drainage
- # Historical Flooding
- SND SWMP Area

SEPA Regional Pluvial Flood Map

- High probability (10yr)
- Medium Probability (200yr)

Scottish Water S16 Model Data

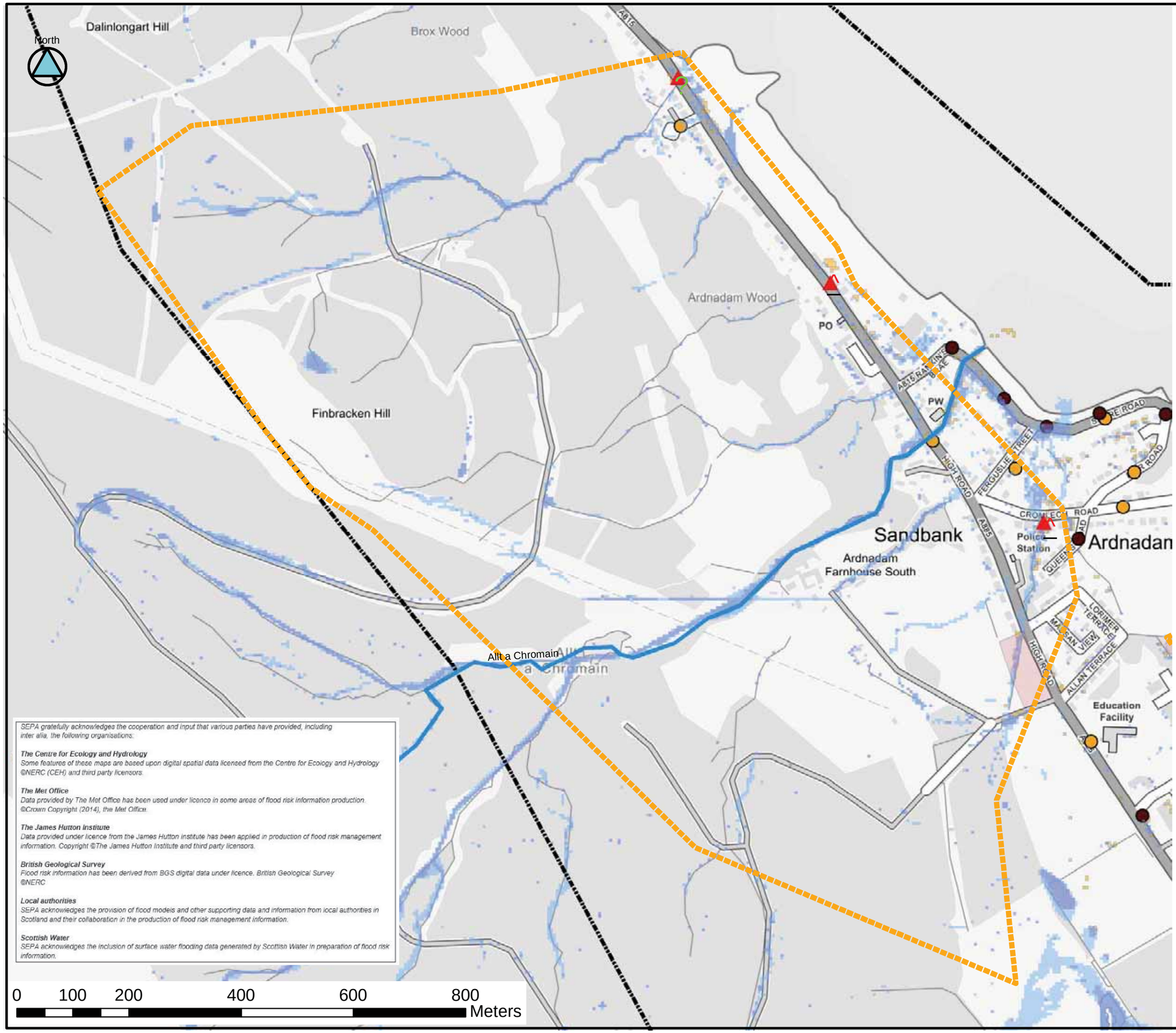
30yr 3hr Manhole Surcharge Volume m3

- 0.000 - 25.000
- 25.001 - 100.000
- 100.001 - 820.744
- 200yr 180min Flood Extents

JBA consulting

SND_HS01

EAGLE COURT



SEPA gratefully acknowledges the cooperation and input that various parties have provided, including inter alia, the following organisations:

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licensed from the Centre for Ecology and Hydrology ©NERC (CEH) and third party licensors.

The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2014), the Met Office.

The James Hutton Institute
Data provided under licence from the James Hutton institute has been applied in production of flood risk management information. Copyright ©The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC

Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

LEGEND

- # Historical Flooding
- ^ Residential Properties At Risk
- X Non Residential Properties At Risk
- @ Roads At Risk Of Damage
- ? Roads At Risk Of Significant Ponding
- Surface Water Flooding Hotspots
- Potential Housing Sites
- Dunoon PVA Watercourses
- Combined Sewer
- Foul Sewer
- Natural Water Culvert
- Surface Water Sewer
- Highway Drainage
- SND SWMP Area

SEPA Regional Pluvial Flood Map

- High probability (10yr)
- Medium Probability (200yr)

Scottish Water S16 Model Data

30yr 3hr Manhole Surcharge Volume m3

- 0.000 - 25.000
- 25.001 - 100.000
- 100.001 - 820.744
- 200yr 180min Flood Extents

SANDBANK SWMP KEYPLAN

JBA consulting

SND HS02

A885 HIGH ROAD

Ardnadam Bay

SHORE ROAD

A8

FIR BRAE

CROMLECH GR

CROMLECH ROAD

FERRY ROAD

FIR BRAE

HIGHLAND AVENUE

Education Facility

0 37.5 75 150 225 300 Meters

LEGEND

- Overland Flow
- Surcharging Manhole
- Estimated Area of Ponding
- @ Roads At Risk Of Damage
- ? Roads At Risk Of Significant Ponding
- ^ Residential Properties At Risk
- X Non Residential Properties At Risk
- Surface Water Flooding Hotspots
- Dunoon PVA Watercourses
- Combined Sewer
- Foul Sewer
- Natural Water Culvert
- Surface Water Sewer
- Highway Drainage
- # Historical Flooding

SEPA Regional Pluvial Flood Map

- High probability (10yr)
- Medium Probability (200yr)

Scottish Water S16 Model Data

30yr 3hr Manhole Surcharge Volume m3

- 0.000 - 25.000
- 25.001 - 100.000
- 100.001 - 820.744
- 200yr 180min Flood Extents

SEPA gratefully acknowledges the cooperation and input that various parties have provided, including inter alia, the following organisations:

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licensed from the Centre for Ecology and Hydrology ©NERC (CEH) and third party licensors.

The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2014), the Met Office.

The James Hutton Institute
Data provided under licence from the James Hutton Institute has been applied in production of flood risk management information. Copyright ©The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC

Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

JBA consulting

SND_HS03

FIR BRAE

North

DÙN OBHAINN / DUNOON

Hunter's Quay

Kirn

0 0.25 0.5 1 1.5 2 Kilometers

LEGEND

- DUN_HS01
- DUN_HS02
- DUN_HS03
- DUN_HS04
- DUN_HS05
- DUN_HS06
- DUN_HS07
- DUN_HS09
- DUN_SWMP_Boundary

DUNOON SWMP KEYPLAN

SEPA gratefully acknowledges the cooperation and input that various parties have provided, including inter alia, the following organisations:

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licensed from the Centre for Ecology and Hydrology ©NERC (CEH) and third party licensors.

The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2014), the Met Office.

The James Hutton Institute
Data provided under licence from the James Hutton Institute has been applied in production of flood risk management information. Copyright ©The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC

Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

JBA consulting

DUN D02

HOTSPOT SUMMARY

North

0 37.5 75 150 225 300 Meters

LEGEND

- # Historical Flooding
- ^ Residential Properties At Risk
- X Non Residential Properties At Risk
- @ Roads At Risk Of Damage
- ? Roads At Risk Of Significant Ponding
- Surface Water Flooding Hotspots
- Potential Housing Sites
- Dunoon PVA Watercourses
- Combined Sewer
- Foul Sewer
- Natural Water Culvert
- Surface Water Sewer
- Highway Drainage
- SND SWMP Area

SEPA Regional Pluvial Flood Map

- High probability (10yr)
- Medium Probability (200yr)

Scottish Water S16 Model Data

30yr 3hr Manhole Surcharge Volume m3

- 0.000 - 25.000
- 25.001 - 100.000
- 100.001 - 820.744
- 200yr 180min Flood Extents

DUNOON SWMP KEYPLAN

JBA consulting

DUN HS01

FAIR HAVEN

SEPA gratefully acknowledges the cooperation and input that various parties have provided, including inter alia, the following organisations:

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licensed from the Centre for Ecology and Hydrology ©NERC (CEH) and third party licensors.

The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2014), the Met Office.

The James Hutton Institute
Data provided under licence from the James Hutton Institute has been applied in production of flood risk management information. Copyright ©The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC

Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

North

LOCHLAN AVENUE

0 25 50 100 150 200 Meters

LEGEND

- # Historical Flooding
- ^ Residential Properties At Risk
- X Non Residential Properties At Risk
- @ Roads At Risk Of Damage
- ? Roads At Risk Of Significant Ponding
- Surface Water Flooding Hotspots
- Potential Business Sites
- Dunoon PVA Watercourses
- Combined Sewer
- Foul Sewer
- Natural Water Culvert
- Surface Water Sewer
- Highway Drainage
- SND SWMP Area

SEPA Regional Pluvial Flood Map

- High probability (10yr)
- Medium Probability (200yr)

Scottish Water S16 Model Data

30yr 3hr Manhole Surcharge Volume m3

- 0.000 - 25.000
- 25.001 - 100.000
- 100.001 - 820.744
- 200yr 180min Flood Extents

DUNOON SWMP KEYPLAN

JBA consulting

DUN_HS02

LOCHLAN AVENUE

SEPA gratefully acknowledges the cooperation and input that various parties have provided, including inter alia, the following organisations:

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licensed from the Centre for Ecology and Hydrology ©NERC (CEH) and third party licensors.

The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2014), the Met Office.

The James Hutton Institute
Data provided under licence from the James Hutton Institute has been applied in production of flood risk management information. Copyright ©The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC

Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

North

ARDENSLATE ROAD

ARDENSLATE CRESCENT

ELIZABETH AVENUE

DIXON AVE

DR

0 12.5 25 50 75 100 Meters

LEGEND

- Historical Flooding
- Residential Properties At Risk
- Non Residential Properties At Risk
- Roads At Risk Of Damage
- Roads At Risk Of Significant Ponding
- Surface Water Flooding Hotspots
- Potential Housing Sites
- Dunoon PVA Watercourses
- Combined Sewer
- Foul Sewer
- Natural Water Culvert
- Surface Water Sewer
- Highway Drainage
- SND SWMP Area

SEPA Regional Pluvial Flood Map

- High probability (10yr)
- Medium Probability (200yr)

Scottish Water S16 Model Data

30yr 3hr Manhole Surcharge Volume m3

- 0.000 - 25.000
- 25.001 - 100.000
- 100.001 - 820.744

- 200yr 180min Flood Extents

DUNOON SWMP KEYPLAN

SEPA gratefully acknowledges the cooperation and input that various parties have provided, including inter alia, the following organisations:

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licensed from the Centre for Ecology and Hydrology ©NERC (CEH) and third party licensors.

The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2014), the Met Office.

The James Hutton Institute
Data provided under licence from the James Hutton Institute has been applied in production of flood risk management information. Copyright ©The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC

Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

JBA consulting

DUN HS03

ARDENSLATE CRESCENT AREA

North

Watermans Cottage

Balgaidh Burn

Milton Burn

COWAN PLACE

JESSIE PLACE

MCARTHUR STREET

KING STREET

ALEXANDER STREET

ALFRED STREET

JOHN STREET

CROMWELL STREET

HILL STREET

VICTORIA ROAD

GORDON STREET

NELSON STREET

B86

HANOVE

0 37.5 75 150 225 300 Meters

LEGEND

- # Historical Flooding
- ^ Residential Properties At Risk
- X Non Residential Properties At Risk
- @ Roads At Risk Of Damage
- ? Roads At Risk Of Significant Ponding
- Surface Water Flooding Hotspots
- Potential Housing Sites
- Dunoon PVA Watercourses
- Combined Sewer
- Foul Sewer
- Natural Water Culvert
- Surface Water Sewer
- Highway Drainage
- SND SWMP Area

SEPA Regional Pluvial Flood Map

- High probability (10yr)
- Medium Probability (200yr)

Scottish Water S16 Model Data

30yr 3hr Manhole Surcharge Volume m3

- 0.000 - 25.000
- 25.001 - 100.000
- 100.001 - 820.744
- 200yr 180min Flood Extents

DUNOON SWMP KEYPLAN

JBA consulting

DUN_HS04

ALEXANDER STREET

SEPA gratefully acknowledges the cooperation and input that various parties have provided, including inter alia, the following organisations:

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licensed from the Centre for Ecology and Hydrology ©NERC (CEH) and third party licensors.

The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2014), the Met Office.

The James Hutton Institute
Data provided under licence from the James Hutton Institute has been applied in production of flood risk management information. Copyright ©The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC

Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

North

HAMILTON STREET

IE PLACE

Milton Burn

Poli
Stat
TREET

0 12.5 25 50 75 100
Meters

LEGEND

- # Historical Flooding
- ^ Residential Properties At Risk
- X Non Residential Properties At Risk
- @ Roads At Risk Of Damage
- ? Roads At Risk Of Significant Ponding
- Surface Water Flooding Hotspots
- Potential Housing Sites
- Dunoon PVA Watercourses
- Combined Sewer
- Foul Sewer
- Natural Water Culvert
- Surface Water Sewer
- Highway Drainage

SEPA Regional Pluvial Flood Map

- High probability (10yr)
- Medium Probability (200yr)

Scottish Water S16 Model Data

30yr 3hr Manhole Surcharge Volume m3

- 0.000 - 25.000
- 25.001 - 100.000
- 100.001 - 820.744
- 200yr 180min Flood Extents

DUNOON SWMP KEYPLAN

JBA consulting

DUN_HS05

McCALL TERRACE

SEPA gratefully acknowledges the cooperation and input that various parties have provided, including inter alia, the following organisations:

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licensed from the Centre for Ecology and Hydrology ©NERC (CEH) and third party licensors.

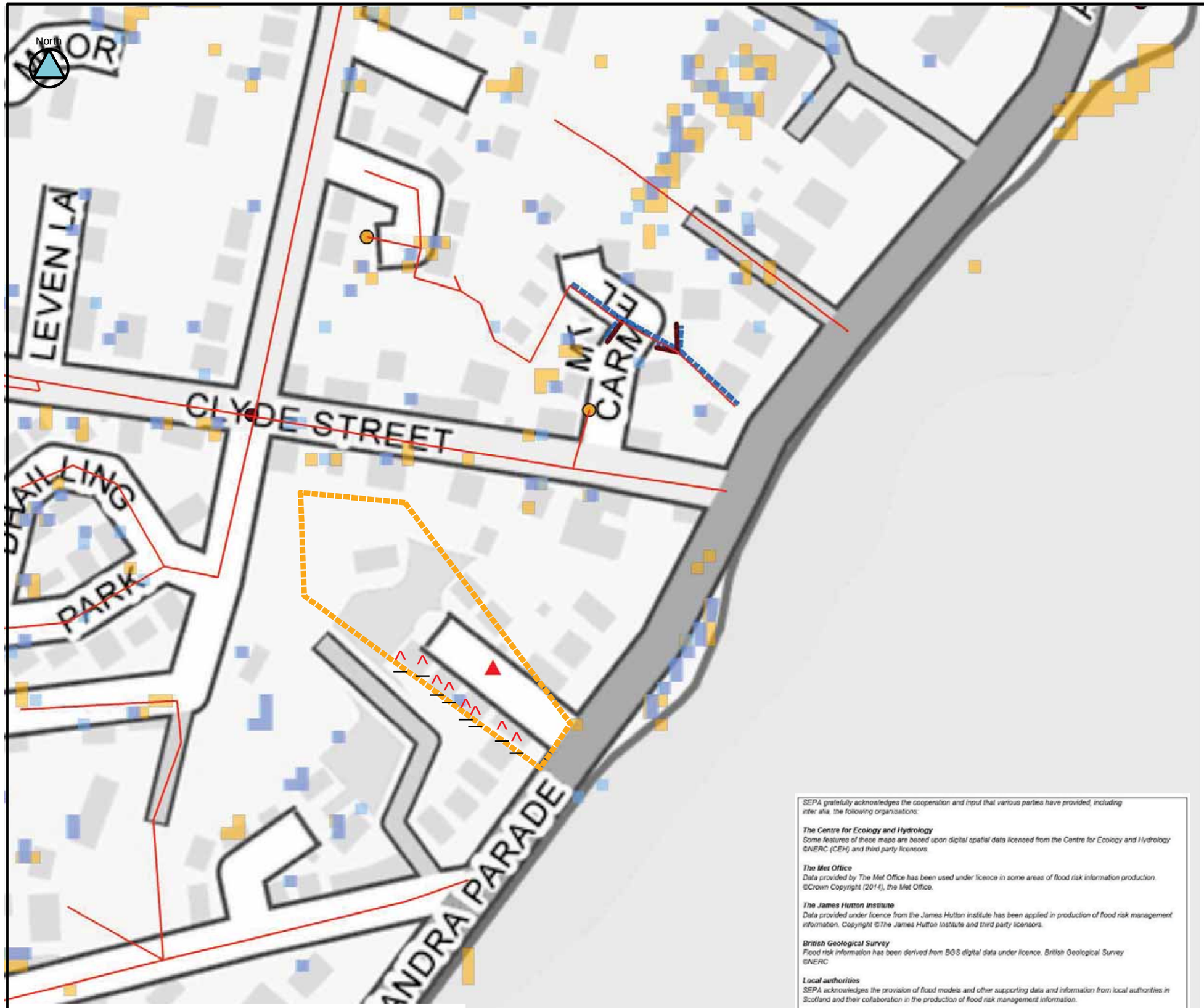
The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2014), the Met Office.

The James Hutton Institute
Data provided under licence from the James Hutton Institute has been applied in production of flood risk management information. Copyright ©The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC

Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.



LEGEND

- # Historical Flooding
- ^ Residential Properties At Risk
- X Non Residential Properties At Risk
- @ Roads At Risk Of Damage
- ? Roads At Risk Of Significant Ponding
- Surface Water Flooding Hotspots
- Potential Housing Sites
- Dunoon PVA Watercourses
- Combined Sewer
- Foul Sewer
- Natural Water Culvert
- Surface Water Sewer
- Highway Drainage

SEPA Regional Pluvial Flood Map

- High probability (10yr)
- Medium Probability (200yr)

Scottish Water S16 Model Data

30yr 3hr Manhole Surcharge Volume m3

- 0.000 - 25.000
- 25.001 - 100.000
- 100.001 - 820.744

- 200yr 180min Flood Extents

DUNOON SWMP KEYPLAN

JBA consulting

DUN_HS06

ERICHTBANK DRIVE

SEPA gratefully acknowledges the cooperation and input that various parties have provided, including inter alia, the following organisations:

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licensed from the Centre for Ecology and Hydrology ©NERC (CEH) and third party licensors.

The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2014), the Met Office.

The James Hutton Institute
Data provided under licence from the James Hutton Institute has been applied in production of flood risk management information. Copyright ©The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC

Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

North

PW

Balgaidh Burn

WILLIAM

BROOMFIELD

0 15 30 60 90 120 Meters

LEGEND

- # Historical Flooding
- ^ Residential Properties At Risk
- X Non Residential Properties At Risk
- @ Roads At Risk Of Damage
- ? Roads At Risk Of Significant Ponding
- Surface Water Flooding Hotspots
- Potential Housing Sites
- Dunoon PVA Watercourses
- Combined Sewer
- Foul Sewer
- Natural Water Culvert
- Surface Water Sewer
- Highway Drainage

SEPA Regional Pluvial Flood Map

- High probability (10yr)
- Medium Probability (200yr)

Scottish Water S16 Model Data

30yr 3hr Manhole Surcharge Volume m3

- 0.000 - 25.000
- 25.001 - 100.000
- 100.001 - 820.744
- 200yr 180min Flood Extents

DUNOON SWMP KEYPLAN

JBA consulting

DUN_HS07

BROOMFIELD DRIVE

SEPA gratefully acknowledges the cooperation and input that various parties have provided, including inter alia, the following organisations.

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licensed from the Centre for Ecology and Hydrology ©NERC (CEH) and third party licensors.

The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2014), the Met Office.

The James Hutton Institute
Data provided under licence from the James Hutton Institute has been applied in production of flood risk management information. Copyright ©The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC

Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

North

Hospital

Education Facility

Fire Station

Police Station

Milton Burn

SANDBANK ROAD

BENCORRUM BRAE

SANDERSON DR

ARDENSIDE

DIXON CRESCENT

DIXON PLACE

ARGYLL STREET

PARK ROAD

DHALLING AVENUE

JOHNSTON TERRACE

JOHNSTON STREET

W STREET

HAMILTON STREET

ARGYLL

B8041

0 20 40 80 120 160 Meters

LEGEND

- Roads At Risk Of Damage
- Roads At Risk Of Significant Ponding
- Residential Properties At Risk
- Non Residential Properties At Risk
- Potential Business Sites
- Surface Water Flooding Hotspots
- Dunoon PVA Watercourses
- Combined Sewer
- Foul Sewer
- Natural Water Culvert
- Surface Water Sewer
- Highway Drainage
- Historical Flooding
- SND SWMP Area

SEPA Regional Pluvial Flood Map

- High probability (10yr)
- Medium Probability (200yr)

Scottish Water S16 Model Data

30yr 3hr Manhole Surcharge Volume m3

- 0.000 - 25.000
- 25.001 - 100.000
- 100.001 - 820.744
- 200yr 180min Flood Extents

DUNOON SWMP KEYPLAN

SEPA gratefully acknowledges the cooperation and input that various parties have provided, including inter alia, the following organisations:

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licensed from the Centre for Ecology and Hydrology ©NERC (CEH) and third party licensors.

The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2014), the Met Office.

The James Hutton Institute
Data provided under licence from the James Hutton Institute has been applied in production of flood risk management information. Copyright ©The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC

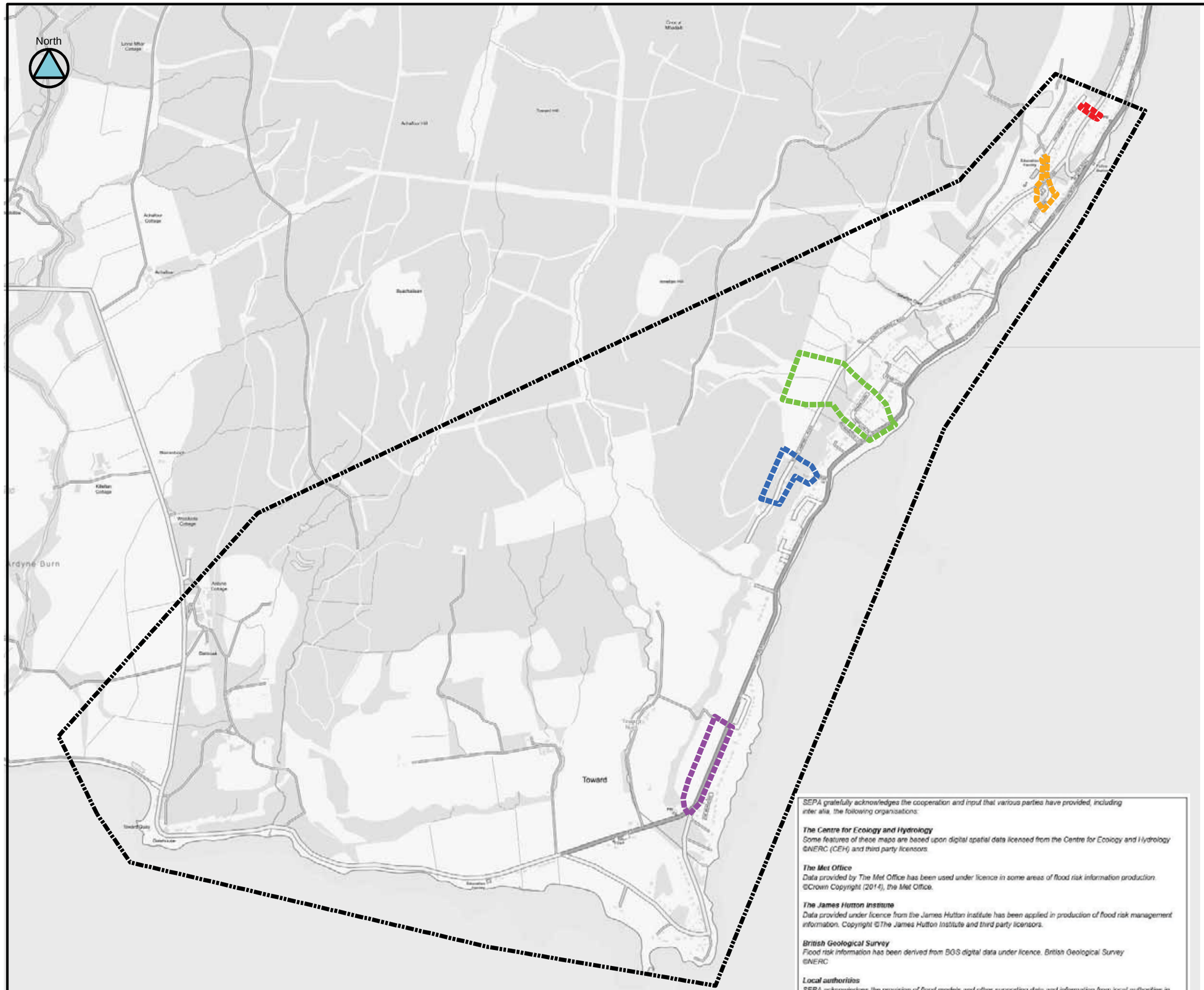
Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

JBA consulting

DUN_HS09

BLACK PARK



LEGEND

- TOW_HS01
- TOW_HS02
- TOW_HS03
- TOW_HS04
- TOW_HS05
- TOW_SWMP_Boundary

DUNOON SWMP KEYPLAN

SEPA gratefully acknowledges the cooperation and input that various parties have provided, including inter alia, the following organisations:

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licensed from the Centre for Ecology and Hydrology ©NERC (CEH) and third party licensors.

The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2014), the Met Office.

The James Hutton institute
Data provided under licence from the James Hutton Institute has been applied in production of flood risk management information. Copyright ©The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC

Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

JBA consulting

TOW D02

HOTSPOT SUMMARY

North

Education Facility

KNOCKAMILLIE ROAD

WYNDHAM ROAD

PIER

PO

RE ROAD

PW

N LANE

0 12.5 25 50 75 100 Meters

SEPA gratefully acknowledges the cooperation and input that various parties have provided, including inter alia, the following organisations:

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licensed from the Centre for Ecology and Hydrology ©NERC (CEH) and third party licensors.

The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2014), the Met Office.

The James Hutton Institute
Data provided under licence from the James Hutton Institute has been applied in production of flood risk management information. Copyright ©The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC

Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

LEGEND

- Historical Flooding
- Residential Properties At Risk
- Non Residential Properties At Risk
- Roads At Risk Of Damage
- Roads At Risk Of Significant Ponding
- Surface Water Flooding Hotspots
- Potential Housing Sites
- Dunoon PVA Watercourses
- Combined Sewer
- Foul Sewer
- Natural Water Culvert
- Surface Water Sewer
- Highway Drainage

SEPA Regional Pluvial Flood Map

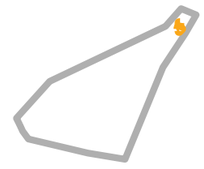
- High probability (10yr)
- Medium Probability (200yr)

Scottish Water S16 Model Data

30yr 3hr Manhole Surcharge Volume m3

- 0.000 - 25.000
- 25.001 - 100.000
- 100.001 - 820.744
- 200yr 180min Flood Extents

TOWARD SWMP KEYPLAN



JBA consulting

TOW_HS01

MATHESON LANE

North

NORTH CAMPBELL

SHORE ROAD

A815

KNOCKAMILLIE TERRACE

PO

0 25 50 100 150 200 Meters

LEGEND

- Historical Flooding
- Residential Properties At Risk
- Non Residential Properties At Risk
- Roads At Risk Of Damage
- Roads At Risk Of Significant Ponding
- Surface Water Flooding Hotspots
- Potential Housing Sites
- Dunoon PVA Watercourses
- Combined Sewer
- Foul Sewer
- Natural Water Culvert
- Surface Water Sewer
- Highway Drainage

SEPA Regional Pluvial Flood Map

- High probability (10yr)
- Medium Probability (200yr)

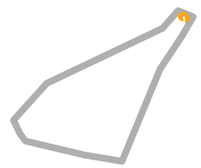
Scottish Water S16 Model Data

30yr 3hr Manhole Surcharge Volume m3

- 0.000 - 25.000
- 25.001 - 100.000
- 100.001 - 820.744

- 200yr 180min Flood Extents

TOWARD SWMP KEYPLAN



SEPA gratefully acknowledges the cooperation and input that various parties have provided, including inter alia, the following organisations:

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licensed from the Centre for Ecology and Hydrology ©NERC (CEH) and third party licensors.

The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2014), the Met Office.

The James Hutton Institute
Data provided under licence from the James Hutton Institute has been applied in production of flood risk management information. Copyright ©The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC

Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

JBA consulting

TOW_HS02

NORTH CAMPBELL ROAD

North

FERRY LANE

ARRAN PARK

INNELLAN PK

THORNWOOD LA

SHORE ROAD

A815

SOUTH CAMPBELL ROAD

0 25 50 100 150 200 Meters

LEGEND

- Historical Flooding
- Residential Properties At Risk
- Non Residential Properties At Risk
- Roads At Risk Of Damage
- Roads At Risk Of Significant Ponding
- Surface Water Flooding Hotspots
- Potential Housing Sites
- Dunoon PVA Watercourses
- Combined Sewer
- Foul Sewer
- Natural Water Culvert
- Surface Water Sewer
- Highway Drainage

SEPA Regional Pluvial Flood Map

- High probability (10yr)
- Medium Probability (200yr)

Scottish Water S16 Model Data

30yr 3hr Manhole Surcharge Volume m3

- 0.000 - 25.000
- 25.001 - 100.000
- 100.001 - 820.744
- 200yr 180min Flood Extents

TOWARD SWMP KEYPLAN

SEPA gratefully acknowledges the cooperation and input that various parties have provided, including inter alia, the following organisations:

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licensed from the Centre for Ecology and Hydrology ©NERC (CEH) and third party licensors.

The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2014), the Met Office.

The James Hutton Institute
Data provided under licence from the James Hutton Institute has been applied in production of flood risk management information. Copyright ©The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC

Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

JBA consulting

TOW_HS03

ARRAN PARK

North

SOUTH CAMPBELL ROA

FERNS LA

0 25 50 100 150 200 Meters

LEGEND

- Historical Flooding
- Residential Properties At Risk
- Non Residential Properties At Risk
- Roads At Risk Of Damage
- Roads At Risk Of Significant Ponding
- Surface Water Flooding Hotspots
- Potential Housing Sites
- Dunoon PVA Watercourses
- Combined Sewer
- Foul Sewer
- Natural Water Culvert
- Surface Water Sewer
- Highway Drainage

SEPA Regional Pluvial Flood Map

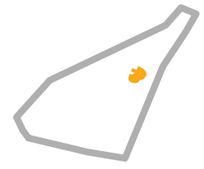
- High probability (10yr)
- Medium Probability (200yr)

Scottish Water S16 Model Data

30yr 3hr Manhole Surcharge Volume m3

- 0.000 - 25.000
- 25.001 - 100.000
- 100.001 - 820.744
- 200yr 180min Flood Extents

TOWARD SWMP KEYPLAN



JBA consulting

TOW_HS04

FERNS LANE

SEPA gratefully acknowledges the cooperation and input that various parties have provided, including inter alia, the following organisations:

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licensed from the Centre for Ecology and Hydrology ©NERC (CEH) and third party licensors.

The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2014), the Met Office.

The James Hutton Institute
Data provided under licence from the James Hutton Institute has been applied in production of flood risk management information. Copyright ©The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC

Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

North

PW

THE MEADOWS

0 25 50 100 150 200
Meters

LEGEND

- # Historical Flooding
- ^ Residential Properties At Risk
- X Non Residential Properties At Risk
- @ Roads At Risk Of Damage
- ? Roads At Risk Of Significant Ponding
- Surface Water Flooding Hotspots
- Potential Housing Sites
- Dunoon PVA Watercourses
- Combined Sewer
- Foul Sewer
- Natural Water Culvert
- Surface Water Sewer
- Highway Drainage

SEPA Regional Pluvial Flood Map

- High probability (10yr)
- Medium Probability (200yr)

Scottish Water S16 Model Data

30yr 3hr Manhole Surcharge Volume m3

- 0.000 - 25.000
- 25.001 - 100.000
- 100.001 - 820.744
- 200yr 180min Flood Extents

TOWARD SWMP KEYPLAN

SEPA gratefully acknowledges the cooperation and input that various parties have provided, including inter alia, the following organisations:

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licensed from the Centre for Ecology and Hydrology ©NERC (CEH) and third party licensors.

The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2014), the Met Office.

The James Hutton Institute
Data provided under licence from the James Hutton Institute has been applied in production of flood risk management information. Copyright ©The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC

Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

JBA consulting

TOW_HS05

A815 SHORE ROAD

Offices at

Coleshill
Doncaster
Dublin
Edinburgh
Exeter
Glasgow
Haywards Heath
Isle of Man
Limerick
Newcastle upon Tyne
Newport
Peterborough
Saltaire
Skipton
Tadcaster
Thirsk
Wallingford
Warrington

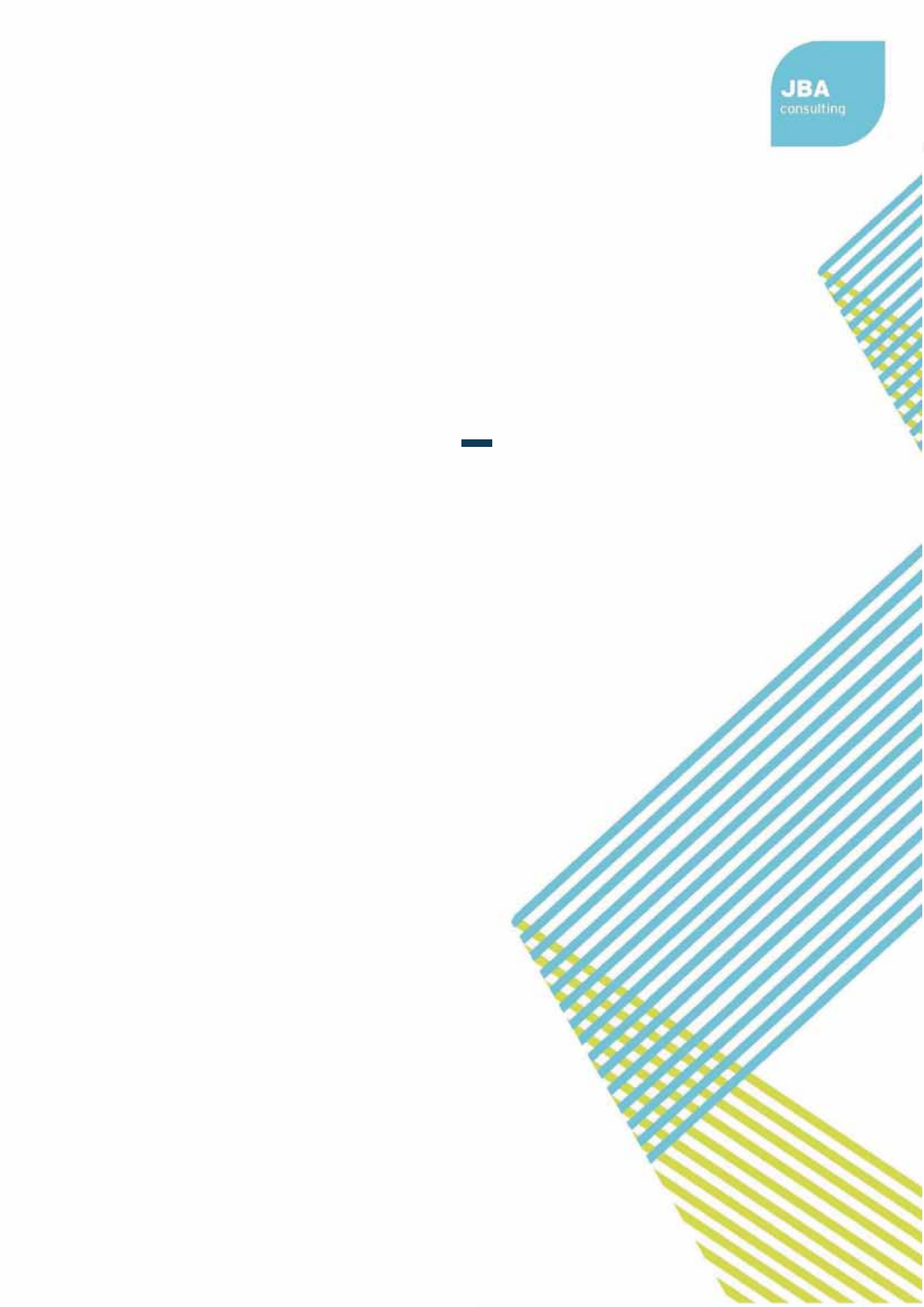
Registered Office
South Barn
Broughton Hall
SKIPTON
North Yorkshire
BD23 3AE
United Kingdom

+44(0)1756 799919
info@jbaconsulting.com
www.jbaconsulting.com
Follow us:

Jeremy Benn Associates Limited

Registered in England 3246693

JBA Group Ltd is certified to:
ISO 9001:2015
ISO 14001:2015
OHSAS 18001:2007



The Flood Risk Management Strategy for LPD11 contains high-level objectives for surface water management within the PVAs. The FRM document also identifies priority areas for the SWMPs which have been further broken down into hotspots as discussed in Phase 2. The high-level objectives are:

- To avoid an increase in surface water flood risk (applies everywhere including SWMP areas).
- To reduce surface water flood risk (applies to SWMP areas at the town and city scale).

The Local Flood Risk Management Plans have identified objectives that are in line with the objectives set in the Strategies. The Clyde and Loch Lomond LPD has the following objectives:

Applies across Clyde and Loch Lomond Plan District	Avoid an overall increase in flood risk	11127	70 residential properties £390,000,000 Annual Average Damages
Applies across Clyde and Loch Lomond Plan District	Reduce overall flood risk	11132	

Within the Clyde and Loch Lomond LPD objectives were also set for each PVA.

Dunoon	Reduce the economic damages and risk to people from surface water flooding in Dunoon.	11083	• 40 residential properties • £74,000 Annual Average Damages

[1] Flood Risk Management Strategy, Forth LPD 9, SEPA 2015

More detailed and localised objectives for reducing surface water flood risk are based on the understanding of flood risk and the assessment of responsible authorises (stakeholders). The objectives available to be used in the SWMP are described in the table below.

Reduce surface water flood risk	Areas where the greatest risk of surface water flooding (hotspots) has been identified in phase 2 (Appendix B) through analysis of the model and historic events. Areas where there are critical facilities or infrastructure that carry a risk i.e. schools, hospitals, main roads.
Accept flood risk and maintain existing actions	Areas where there are already surface water management feature/schemes in place to reduce flood risk i.e. surface water storage, pumping stations.
Improve understanding of surface water flood risk	Areas where, from the analysis undertaken in Phase 2 (Appendix B), it is not clear how or why flooding is occurring or how to remediate the flooding. This can be applied to individual hotspots or larger areas depending on the outcome of the model verification undertaken in Phase 1 (Appendix A).

In order to manage objectives and gauge their success it is necessary to use a number of indicators. The indicators used are the receptors which are at risk from surface water flooding e.g. Number of properties effected, annual average damages.

In order to develop the initial objectives identified by SEPA in the LPD Strategies a 2 part process is required:

1. The initial objectives proposed in the FRM strategies have been updated following the results of the Understanding Surface Water Flood Risk section (Phase 2). This process creates targeted objectives for each of the hotspots identified. The objectives are also assigned a draft priority at this stage.
2. The objectives are then subject to stakeholder consultation where they will be appraised, selected and prioritise for implementation based in the knowledge of upcoming projects and funding opportunities.

Once the objectives have been assigned it is necessary to prioritise the various objectives. An accurate timeline is not given at this stage as it is more an indication of which objectives could be possible in the long and short term.

When considering the priority of the objectives there is no prescriptive method to do so however, factors to consider are:

- Surface water flood risk (using information on impacts of flooding).
- Surface water flood risk to priority receptor groups, e.g. schools, hospitals, homes at risk in socially vulnerable areas.
- Locations with a history of flooding.
- Areas where there is no history of flooding but are predicted to flood and should therefore be treated with caution, particularly where more detailed models are not available. It is sensible to balance predicted and actual flooding information when prioritising.
- Locations where there are opportunities for joint working (e.g. making management more cost-effective and delivering multiple benefits).

Consultation with key stakeholders is vital at this stage in order to ensure that all parties are accepting of the hotspots identified and understand the flooding mechanisms at work. Consultation with stakeholders is vital at the Objectives stage in order to identify links with other projects and initiatives, prioritise area according to other investment taking place in these areas and to ensure co-ordinated approaches or joint implementation. This would improve efficiencies and potentially deliver multiple benefits. Through consultation it is hoped that other projects will be identified that may be co-ordinated or implemented jointly with surface water flood management. It is important that the stakeholders involved have input into the proposed objectives and the prioritisation process.

Information requested from stakeholders includes:

- Scottish Water planned work
- Local Authority roads department planned work
- Local Authority land use planning areas identified for development or regeneration.
    - Information on green space
    - Proposals to enhance existing or develop new open / green space (e.g. open space strategies, local biodiversity actions plans, 'green and blue' network development, footpath and cycle path development, urban watercourse restoration, park development, climate change adaptation plans).
- SEPA RBMP and proposals for river restoration.
- Any other projects that might influence surface water management such as community initiatives and flood studies.
- Any other planned work in vicinity of the surface water flooding hotspots in which the stakeholders can influence.

Argyll and Bute Council	New hotspot added, Black Park in Dunoon.
Scottish Water	Scottish water explained how they are experiencing network capacity issues due to significant infiltration into their network including during dry weather (high infiltration / rural contributions).
SEPA	No new data.

Hotspot name and location	History of flooding Confidence in data	Initial Objective	Initial Priority	Objective Indicators					Timescale
				Annual Average Damages (ADD) (all return periods)	Non-Residential (1:200yr)	Residential (1:200yr)	Community facilities (1:200yr)	Infrastructure (1:200yr)	
SND_HS01: Eagle Terrace	*History of surface water flooding due to extensive volume hillside runoff and over topped watercourse ponding in the corner of the field adjacent to the development* *Good confidence in model data*	*Reduce surface water flood risk*	*High*	*£1773.14* *(£47, 158 SPAADE data)*	*0*	*34*	*-*	*Significant ponding on B836*	*2022-2028*
SND_HS03: Fir Brae	*History of surface water flooding caused by blocked culverts causing high velocity overland flow, ponding on the carriageway and manhole surcharging.* *Low confidence in model data.*	*Improve understanding of flood risk*	*Medium*	*£0* *(£1,387 SPAADE data)*	*0*	*1*	*-*	*Fir Brae damaged Significant ponding on Shore Road*	*2028-2034*
SND_HS02: A885 High Road	*History of surface water flooding due to blocked culverts resulting in flooding of adjacent road or property.* *Low confidence in model data*	*Reduce surface water flood risk*	*Low*	*£0* *(£1,387 SPAADE data)*	*0*	*1*	*-*	*Minor ponding to A885*	*2034-2040*

Hotspot name and location	History of flooding Confidence in data	Initial Objective	Initial Priority	Objective Indicators					Timescale
				Annual Average Damages (ADD) (all return periods)	Non-Residential (1:200yr)	Residential (1:200yr)	Community facilities (1:200yr)	Infrastructure (1:200yr)	
DUN_HS04: Alexander Street	*Hillside runoff to the west of Alexander Street causes nuisance flooding to the rear gardens as well as out of bank flows at a culvert send flows along the road and into a low-lying residential property. Low confidence in model data.*	*Reduce surface water flood risk*	*High*	*£0 (£29,127 SPAADE data)*	-	*21*	-	-	*2022-2028*
DUN_HS09: Black Park	*Overland flow from an area of open ground gathers in the south west corner of Black Park overwhelming existing infrastructure affecting low-lying residential properties. Good confidence in model data.*	*Reduce surface water flood risk*	*High*	*£0 (£6,935 SPAADE data)*	-	*5*	-	-	*2022-2028*
DUN_HS05: McCall Terrace	*History of flooding at 2 properties caused by overtopping Milton Burn and/or surcharging manholes. Good confidence in model data.*	*Reduce surface water flood risk*	*Medium*	*£1300.70 (£5,548 SPAADE data)*	-	*4*	-	-	*2034-2040*
DUN_HS01: Fairhaven	*Culverted section of urban watercourse prone to blockages causing out of bank flows in the Fairhaven area. Low confidence in model data*	*Reduce surface water flood risk*	*Medium*	*£0 (£5,548 SPAADE data)*	-	*4*	-	-	*2034-2040*

Hotspot name and location	History of flooding Confidence in data	Initial Objective	Initial Priority	Objective Indicators					Timescale
				Annual Average Damages (ADD) (all return periods)	Non-Residential (1:200yr)	Residential (1:200yr)	Community facilities (1:200yr)	Infrastructure (1:200yr)	
DUN_HS08: Road Drainage	*Problems with road drainage due to blocked/ineffective gullies throughout the SWMP area. Low confidence in model data.*	*Reduce surface water flood risk*	*Low*	*£0 (£0 SPAADE data)*	-	-	-	*Ponding on various road often at significant depths*	*On going*
DUN_HS03: Ardenslate Crescent Area	*History of suspected sewer surcharging and ponding in residential gardens and streets. moderate confidence in model data.*	*Improve understanding of flooding mechanism*	*Low*	*£0 (£27,740 SPAADE data)*	-	*20*	-	-	*2034-2040*
DUN_HS02: Lochan Avenue	*Hillside runoff causing rear gardens of properties along Lochan Avenue to be permanently saturated. Low confidence in model data.*	*Reduce surface water flood risk*	*Low*	*£0 (£15,257 SPAADE data)*	-	*11*	-	-	*2034-2040*
DUN_HS06: Ericht Bank Drive	*History of flooding to gardens caused by overland flow from small hillside being directed by the camber in the road. Low confidence in model data.*	*Reduce surface water flood risk*	*Low*	*£0 (£11,096 SPAADE data)*	-	*8*	-	-	*2034-2040*
DUN_HS07: Broomfield Drive	*Nuisance garden flooding caused by overland flow from road drainage on Kilbride Road at a former landslip. Low confidence in model data.*	*Improve understanding of flooding mechanism*	*Low*	*£0 (£2774 SPAADE data)*	-	*2*	-	-	*2034-2040*

Hotspot name and location	History of flooding Confidence in data	Initial Objective	Initial Priority	Objective Indicators					Timescale
				Annual Average Damages (ADD) (all return periods)	Non-Residential (1:200yr)	Residential (1:200yr)	Community facilities (1:200yr)	Infrastructure (1:200yr)	
TOW_HS03: Arran Park	*Watercourse is constricted by culverts in residential area, history of over topping and flood properties. Low confidence in model data.*	*Reduce surface water flood risk*	*High*	*£0 (£13,870 SPAADE data)*	-	*10*	-	-	*2022-2028*
TOW_HS02: North Campbell Road	*Suspected ground water flooding causes interior damage to a single property. Low confidence in model data.*	*Improve understanding of flooding mechanism*	*Medium*	*£0 (£1,387 SPAADE data)*	-	*1*	-	-	*2034-2040*
TOW_HS04: Ferns Lane	*Blocked culvert on access track causes flood water to spill down the hillside toward a residential property causing interior and exterior damage. Low confidence in model data.*	*Reduce surface water flood risk*	*Low*	*£0 (£1,387 SPAADE data)*	-	*1*	-	-	*2034-2040*
TOW_HS05: A815 Shore Road	*History of flood water ponding on the road due to overtopping drainage ditch. Moderate confidence in model data.*	*Reduce surface water flood risk*	*Low*	*£0 (£0 SPAADE data)*	-	-	-	*A815 blocked due to ponding water*	*2034-2040*
TOW_HS01: Matheson Lane	*Overtopping culvert cause damage to a set of stairs Low confidence in model data*	*Improve understanding of flooding mechanism*	*Low*	*£0 (£0 SPAADE data)*	-	-	-	*Damage to stairs on school access route.*	*2034-2040*

North

SND_HS01

SND_HS02

SND_HS03

Holy Loch

Kilmun

Ardnadam

Sandbank

Hunter's Quay

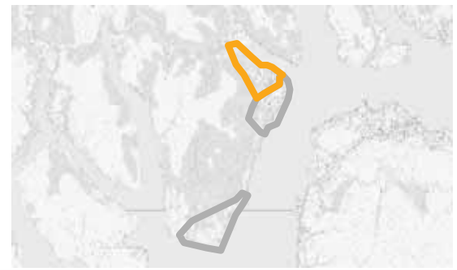
Tom nan Rash

0 0.25 0.5 1 1.5 2 Kilometers

LEGEND

- HIGH PRIORITY
- MEDIUM PRIORITY
- LOW PRIORITY
- SND SWMP Area

DUNOON SWMP KEYPLAN



SEPA gratefully acknowledges the cooperation and input that various parties have provided, including inter alia, the following organisations:

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licensed from the Centre for Ecology and Hydrology ©NERC (CEH) and third party licensors.

The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2014), the Met Office.

The James Hutton Institute
Data provided under licence from the James Hutton Institute has been applied in production of flood risk management information. Copyright ©The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC

Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

JBA consulting

SND D03

SURFACE WATER FLOOD RISK PRIORITIES

North

DUN_HS08 (Entire Hotspot)

DUN_HS02

DUN_HS01

DUN_HS03

DUN_HS06

DUN_HS05

DUN_HS09

DUN_HS04

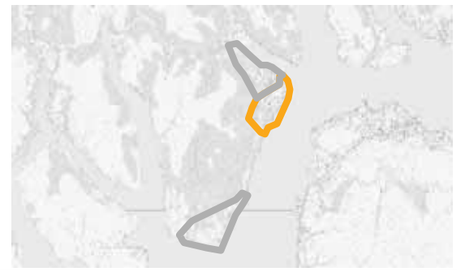
DUN_HS07

0 0.25 0.5 1 1.5 2 Kilometers

LEGEND

- HIGH PRIORITY
- MEDIUM PRIORITY
- LOW PRIORITY
- DUN_SWMP_Boundary

DUNOON SWMP KEYPLAN



SEPA gratefully acknowledges the cooperation and input that various parties have provided, including inter alia, the following organisations:

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licensed from the Centre for Ecology and Hydrology ©NERC (CEH) and third party licensors.

The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2014), the Met Office.

The James Hutton Institute
Data provided under licence from the James Hutton Institute has been applied in production of flood risk management information. Copyright ©The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC

Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

JBA consulting

DUN D03

SURFACE WATER FLOOD RISK PRIORITIES

North

TOW_HS01

TOW_HS02

TOW_HS03

TOW_HS04

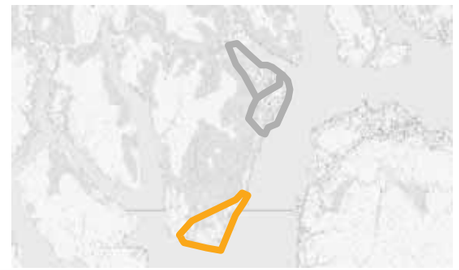
TOW_HS05

0 0.25 0.5 1 1.5 2 Kilometers

LEGEND

- HIGH PRIORITY
- MEDIUM PRIORITY
- LOW PRIORITY
- TOW_SWMP_Boundary

DUNOON SWMP KEYPLAN



SEPA gratefully acknowledges the cooperation and input that various parties have provided, including inter alia, the following organisations:

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licensed from the Centre for Ecology and Hydrology ©NERC (CEH) and third party licensors.

The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2014), the Met Office.

The James Hutton Institute
Data provided under licence from the James Hutton Institute has been applied in production of flood risk management information. Copyright ©The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC

Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

JBA consulting

TOW D03

SURFACE WATER FLOOD RISK PRIORITIES

Offices at

Coleshill
Doncaster
Dublin
Edinburgh
Exeter
Glasgow
Haywards Heath
Isle of Man
Limerick
Newcastle upon Tyne
Newport
Peterborough
Saltaire
Skipton
Tadcaster
Thirsk
Wallingford
Warrington

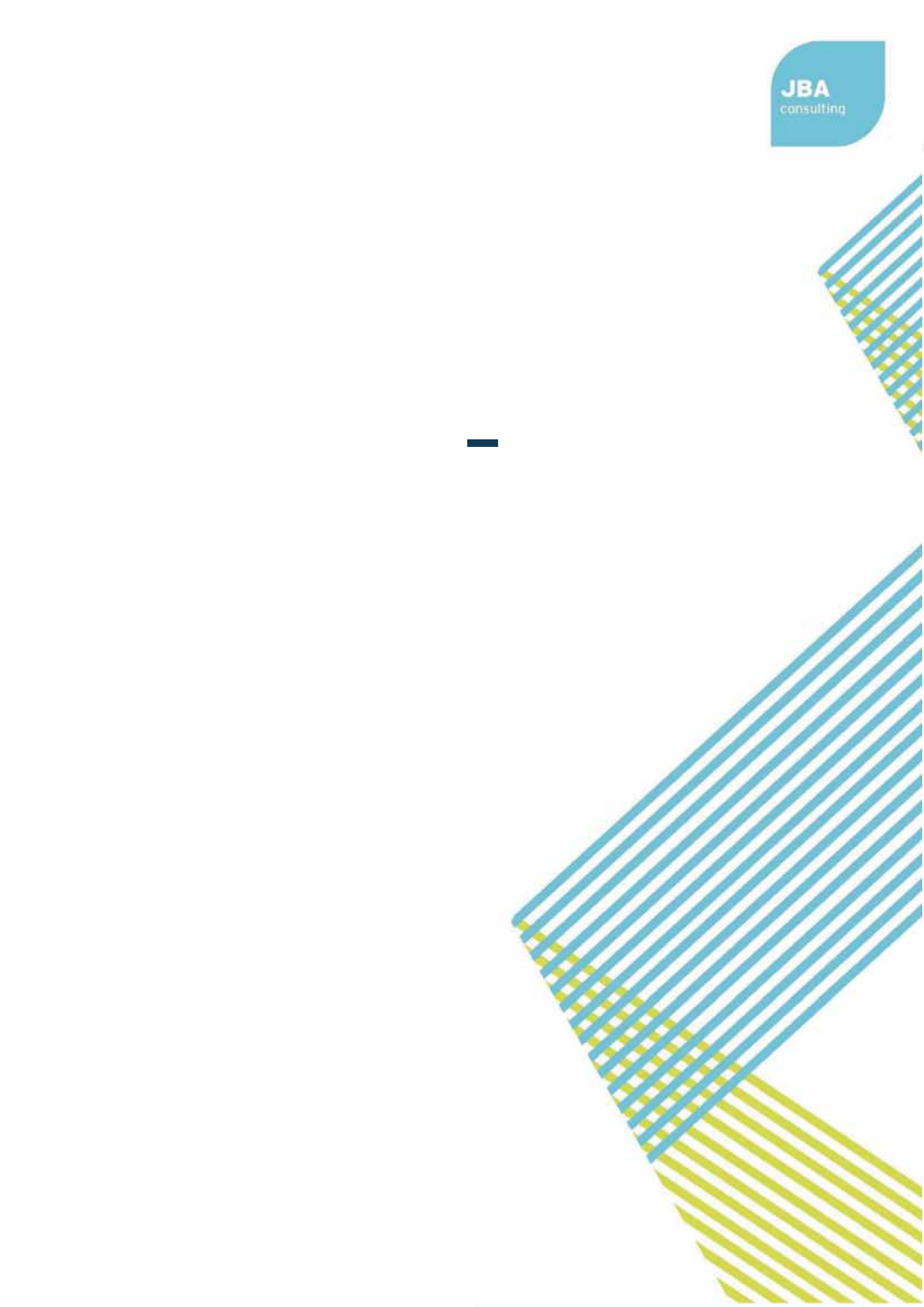
Registered Office
South Barn
Broughton Hall
SKIPTON
North Yorkshire
BD23 3AE
United Kingdom

+44(0)1756 799919
info@jbaconsulting.com
www.jbaconsulting.com
Follow us:

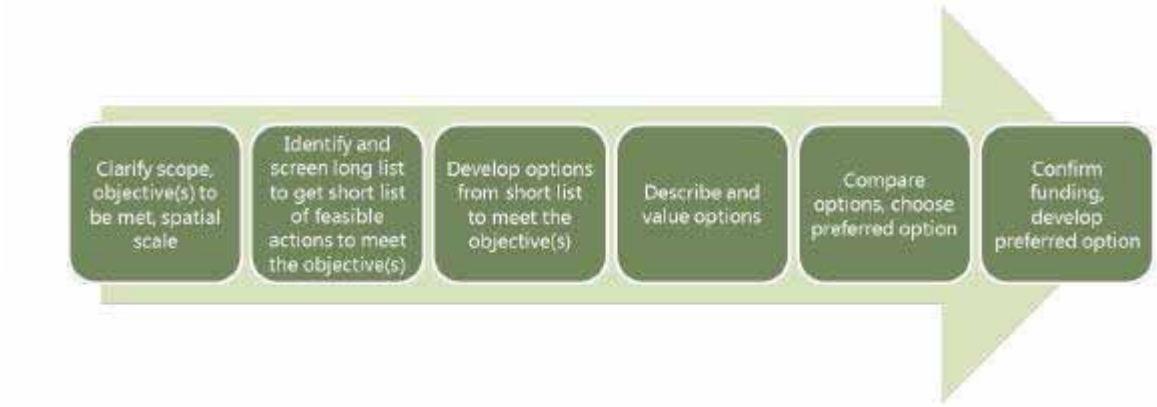
Jeremy Benn Associates Limited

Registered in England 3246693

JBA Group Ltd is certified to:
ISO 9001:2015
ISO 14001:2015
OHSAS 18001:2007



The options appraisal stage of the SWMP is key to ensure the most sustainable and feasible actions are identified and implemented as required by the FRM Act. The SWMP guidance shows that the most sustainable options for managing surface water flood risk will be identified using the process in the figure below focusing on the assessment of costs, flood risk mitigation benefits as well as other associated benefits.



The options selected will be compiled of one or more actions designed to mitigate surface water flood risk. Actions can be both structural or non-structural, a full list of potential actions can be found in Section 3.1. The guidance documents listed below have been followed in order to generate and appraise options:

- The Green Book: Appraisal and Evaluation in Central Government (HM Treasury, 2014);
- Public Finance Manual (Scottish Government, 2011);
- Sustainable Flood Risk Management – Principles of appraisal: a policy statement (Scottish Government, 2011);
- Surface Water Management Planning Guidance (SEPA, Scottish Water, Scottish Government, 2017);
- Flood Protection Appraisals: Guidance for SEPA and Responsible Authorities;
- Delivering Sustainable Flood Risk Management (Scottish Government, 2011);
- Flood Protection Schemes – Guidance for Local Authorities Chapter 5 Project Appraisal (Scottish Government, 2012);
- Cost Benefit Analysis of Options to Manage Surface Water Flooding; Guidance to replace chapter 6 of Surface Water Management Planning Guidance (SEPA & SAIFF, December 2014)
- Appraisal Method for Flood Risk Management Strategies (SEPA, 2013).

[1] SWMP Guidance, SAIFF, 2017

Before undertaking the long list of potential actions, it is necessary to conduct a high level assessment for all the objectives identified in Phase 3 (Appendix C) - Setting Initial Objectives. Due to the small size of this SWMP only 3 hotspots have been identified. To enable focussed effort on surface water flood risk management within the SWMP cycle, the identified hotspots have been prioritised. The highest-ranking hotspots have been assessed further to identify options for implementation. The hotspots not being taken through to the next stage will be reassessed in the next SWMP cycle. This initial appraisal has been conducted to remove hotspots which are either:

- Predominantly fluvial flood events from which secondary surface water flooding is a minor factor and would not have occurred without the fluvial event. A fluvial study may be required for these areas which is out with the scope of the SWMP.
- Have existing flood protection/mitigation measures where maintaining the asset provides a suitable level of protection.
- Have been assigned a low priority.

The hotspots which are not being taken through to the next stage are identified in the table below. Possible options have been identified to aid the development of the next SWMP.

Hotspot name and location	History of flooding Confidence in data	Initial Objective	Initial Priority	Include in options appraisal
SND_HS02: A885 High Road	*History of surface water flooding due to blocked culverts resulting in flooding of adjacent road or property.* *Low confidence in model data*	*Reduce surface water flood risk*	*Low*	Not at this time – the risk to receptors and associated damages are not sufficient enough to warrant a high priority rating when compared to other high-risk hotspots. Actions can be identified in future SWMP options appraisals. *Options likely to include: Improving headwalls and debris screens and reassess asset management strategy.*
DUN_HS03: Ardenslate Crescent Area	*History of suspected sewer surcharging and ponding in residential gardens and streets.* *moderate confidence in model data.*	*Improve understanding of flooding mechanism*	*Low*	Not at this time – the risk to receptors and associated damages are not sufficient enough to warrant a high priority rating when compared to other high-risk hotspots. Actions can be identified in future SWMP options appraisals. *Options likely to include: CCTV inspection of sewer network, further sewer modelling to inform options appraisal.*
DUN_HS02: Lochan Avenue	*Hillside runoff causing rear gardens of properties along Lochan Avenue to be permanently saturated.* *Low confidence in model data.*	*Reduce surface water flood risk*	*Low*	Not at this time – the risk to receptors and associated damages are not sufficient enough to warrant a high priority rating when compared to other high-risk hotspots. Actions can be identified in future SWMP options appraisals. *Options likely to include: Managing surface water upslope by reinstating hillside drainage network.*
DUN_HS05: McCall Terrace	*History of flooding at 2 properties caused by overtopping Milton Burn and/or surcharging manholes. Good confidence in model data.*	*Reduce surface water flood risk*	*Medium*	Primary flooding mechanism is thought to be fluvial with potential secondary pluvial flooding from surcharging manholes. Fluvial study required.
DUN_HS06: Ericht Bank Drive	*History of flooding to gardens caused by overland flow from small hillside being directed by the camber in the road.* *Low confidence in model data.*	*Reduce surface water flood risk*	*Low*	Not at this time – the risk to receptors and associated damages are not sufficient enough to warrant a high priority rating when compared to other high-risk hotspots. Actions can be identified in future SWMP options appraisals. *Options likely to include: Managing surface water upslope by installing hillside drainage, install kerbs to direct flow or installing road gullies.*

Hotspot name and location	History of flooding Confidence in data	Initial Objective	Initial Priority	Include in options appraisal
DUN_HS07: Broomfield Drive	*Nuisance garden flooding caused by overland flow from road drainage on Kilbride Road at a former landslip. Low confidence in model data.*	*Improve understanding of flooding mechanism*	*Low*	Not at this time – the risk to receptors and associated damages are not sufficient enough to warrant a high priority rating when compared to other high-risk hotspots. Actions can be identified in future SWMP options appraisals. *Review road drainage and as built drawings of landslide remediation to determine flooding mechanism which can inform an options appraisal*
DUN_HS08: Road Drainage	*Problems with road drainage due to blocked/ineffective gullies throughout the SWMP area. Low confidence in model data.*	*Reduce surface water flood risk*	*Low*	Not at this time – the risk to receptors and associated damages are not sufficient enough to warrant a high priority rating when compared to other high-risk hotspots. Actions can be identified in future SWMP options appraisals. *Review road gully cleaning and inspection regime. Long term goal of removing gullies from the sewer network.*
TOW_HS02: North Campbell Road	*Suspected groundwater flooding causes interior damage to a single property. Low confidence in model data.*	*Improve understanding of flooding mechanism*	*Low*	Not at this time – the risk to receptors and associated damages are not sufficient enough to warrant a high priority rating when compared to other high-risk hotspots. Actions can be identified in future SWMP options appraisals. *Review possible flooding mechanisms – unlikely to be groundwater as flooding has only occurred once.*
TOW_HS04: Ferns Lane	*Blocked culvert on access track causes flood water to spill down the hillside toward a residential property causing interior and exterior damage. Low confidence in model data.*	*Reduce surface water flood risk*	*Low*	Not at this time – the risk to receptors and associated damages are not sufficient enough to warrant a high priority rating when compared to other high-risk hotspots. Actions can be identified in future SWMP options appraisals. *Options likely to include: Improving headwalls and debris screens and reassess asset management strategy.*
TOW_HS05: A815 Shore Road	*History of flood water ponding on the road due to overtopping drainage ditch. Moderate confidence in model data.*	*Reduce surface water flood risk*	*Low*	Not at this time – the risk to receptors and associated damages are not sufficient enough to warrant a high priority rating when compared to other high-risk hotspots. Actions can be identified in future SWMP options appraisals. *Options likely to include: Increase channel capacity and conveyance, create a storage area in the field adjacent to the road.*
TOW_HS01: Matheson Lane	*Overtopping culvert cause damage to a set of stairs Low confidence in model data*	*Improve understanding of flooding mechanism*	*Low*	Not at this time – the risk to receptors and associated damages are not sufficient enough to warrant a high priority rating when compared to other high-risk hotspots. Actions can be identified in future SWMP options appraisals. *Options likely to include: Undertake a site visit to investigate possible flooding mechanisms.*

A long list of potential actions has been developed against each of the verified flooding hotspots. Following the SWMP guidance, broad categories of actions were identified including structural and non-structural options. A total of 25 actions have been considered against each hotspot. The available actions are listed in the table below. The long list actions are designed to identify and screen potential options and are not developed in detail.

The long list of actions has been assessed with the following points in mind:

– All actions that are structural or non-structural that could at least partially complete the objectives regardless of the implementation scale i.e. property, neighbourhood or strategic level, shall be considered. Actions with varying implementation timelines should be considered including those which are aspirational. Consider whether there are opportunities to help meet objectives for reducing fluvial flood risk and improving river quality.

– should be promoted where possible considering the impact of actions on surface water flood risk now and in the future. Actions which deliver multiple sustainable goals such as increasing community amenities, improving biodiversity and reducing the costs associated with waste water treatment should be actively encouraged.

– actions are identified that would be undertaken by the full range of stakeholders, judgement should not be influenced by responsibilities, funding concerns or delivery method.

	Adhere to existing planning policy
	Implement more stringent land use policies
	Clarify new Surface Water infrastructure responsibility
	Clarify existing Surface Water infrastructure responsibility
	Emergency response plans
	Improve understanding of flood mechanisms
	Options appraisal and design
	Improve information on Surface Water flooding
	Business continuity planning
	Community action group
	Flood insurance
	Raise awareness
	Property Level Protection (PLP)
	Property Level Resilience
	Flood forecasting and warning
	Asset management and maintenance
	Watercourse management and maintenance
	Relocation
	Infiltration/evapotranspiration
	Conveyance
	Storage
	Restoring urban watercourses
	Urban watercourse engineering
	Run-off reduction strategy
	Reducing surface water in the sewer
	Land management
	Underground storage
	Underground conveyance
	Modification of culverted watercourses

It is necessary to screen the long list of actions to remove any actions which are clearly unfeasible leaving a smaller number to be taken through to the next step of the appraisal process. Here sustainability is a key issue with unsustainable actions disregarded.

During this process actions are screened against 3 main criteria – technical, legal and economic.

– is it technically achievable?

Removing actions which are not technically feasible. An example could be that the infiltration action could not be implemented due naturally low permeability ground or perhaps the estimated storage space required cannot physically fit into the available space.

– is it legal and safe to implement?

Removing actions which will require insurmountable legal challenges including health and safety and land purchasing. This will also include how the action legally affects environmental or cultural sites.

– is it economically viable?

Consider costs at a very high level and remove actions which are likely to be disproportionately high compared to the associated benefits.

An initial screening was undertaken using engineering judgement in order to produce a series of options to present at a stakeholder workshop. The screening is subject to change during stakeholder consultation as new information is shared. In the table below the 6 hotspots are assessed using a simple numeric marking scheme. Each action is attributed a score of 1, 2 or 3. A score of 1 represents an action that is to be taken forward into the options appraisal stage. A score of 2 represents an action that only partially addresses pluvial flood risk. A score of 2 could also be used where there is an action that would mitigate flood risk but is subject to substantial constraints that may make the action unattractive and potentially unfeasible. A score of 3 was attributed where actions are clearly unfeasible or unlikely to reduce surface water flood risk.

Adhere to existing planning policy	2	2	2	2	2	3
Implement more stringent land use policies	1	2	2	1	3	3
Clarify new Surface Water infrastructure responsibility	3	3	3	3	3	3
Clarify existing Surface Water infrastructure responsibility	3	3	3	3	3	3
Emergency response plans	2	2	2	2	2	2
Improve understanding of flood mechanisms	1	1	1	1	1	1
Options appraisal and design	2	2	2	2	1	2
Improve information on Surface Water flooding	2	2	2	2	2	2
Business continuity planning	2	2	2	2	2	2
Community action group	2	2	2	2	2	2
Flood insurance	2	2	2	2	2	2
Raise awareness	2	2	2	2	2	2
Property Level Protection (PLP)	1	2	1	1	2	1
Property Level Resilience	1	2	1	1	2	1
Flood forecasting and warning	3	3	3	3	3	3
Asset management and maintenance	1	1	1	2	1	2
Watercourse management and maintenance	2	2	1	3	1	2
Relocation	3	3	3	3	3	3
Infiltration/evapotranspiration	3	3	3	3	1	3
Conveyance	2	1	2	2	2	1
Storage	1	3	1	3	3	3
Restoring urban watercourses	3	2	1	3	3	3
Urban watercourse engineering/ direct defences	3	2	1	3	3	1
Run-off reduction strategy	3	3	3	3	3	3
Reducing surface water in the sewer	3	3	3	1	2	3
Land management	1	2	2	1	3	2
Underground storage	3	3	3	2	1	3
Underground conveyance	3	3	3	2	2	3
Modification of culverted watercourses	1	1	1	3	3	1

The assessment process aims to scope measures that will achieve multiple objectives in the context of site constraints and future development. We will complete a Multi-Criteria Assessment (MCA) screening exercise to consider the relative merits of each measure. JBA have experience of reviewing a range of flood mitigation options. It is recognised that it is important to ensure options are compared thoroughly, consistently and carefully reviewing options against the following criteria:

- Technical Feasibility – is it easily implemented?
- Relative Cost – how expensive is it in comparison to other measures?
- Economic Viability – is it expensive to implement?
- Social Impact and Acceptability – how will it impact on residents?
- Environmental – how will it impact the environment?
- Sustainability – is it a sustainable approach?

Detailed cost estimates have not been prepared as the funding and delivery mechanisms are not yet known. Each management option will be scored against each of the criteria set out above using relative indicator, in line with UK guidance:

- **U** - not applicable or unacceptable outcome
- **-2** - severely negative outcome
- **-1** - moderately negative outcome
- **0** - neutral outcome
- **+1** - moderately positive outcome, or
- **+2** - strongly positive outcome

The measures with the lowest overall combined scores from the MCA will be screened out to produce a short list of preferred options. The short-listed mitigation measures provide the starting point for a more detailed economic assessment should the Partners wish to take any of the sites further and implement surface water management measures.

The following section contains information on each of the high priority hotspots selected for options appraisal. Each surface water flood risk hotspot is described before a Multi-Criteria Assessment is undertaken on the viable actions identified in table 3-2 using the procedure described in Section 3.3.

The proposed options listed below were created by JBA Consulting before being reviewed by representatives of Argyll and Bute Council and Scottish Water at a stakeholder workshop on 22nd November 2018.

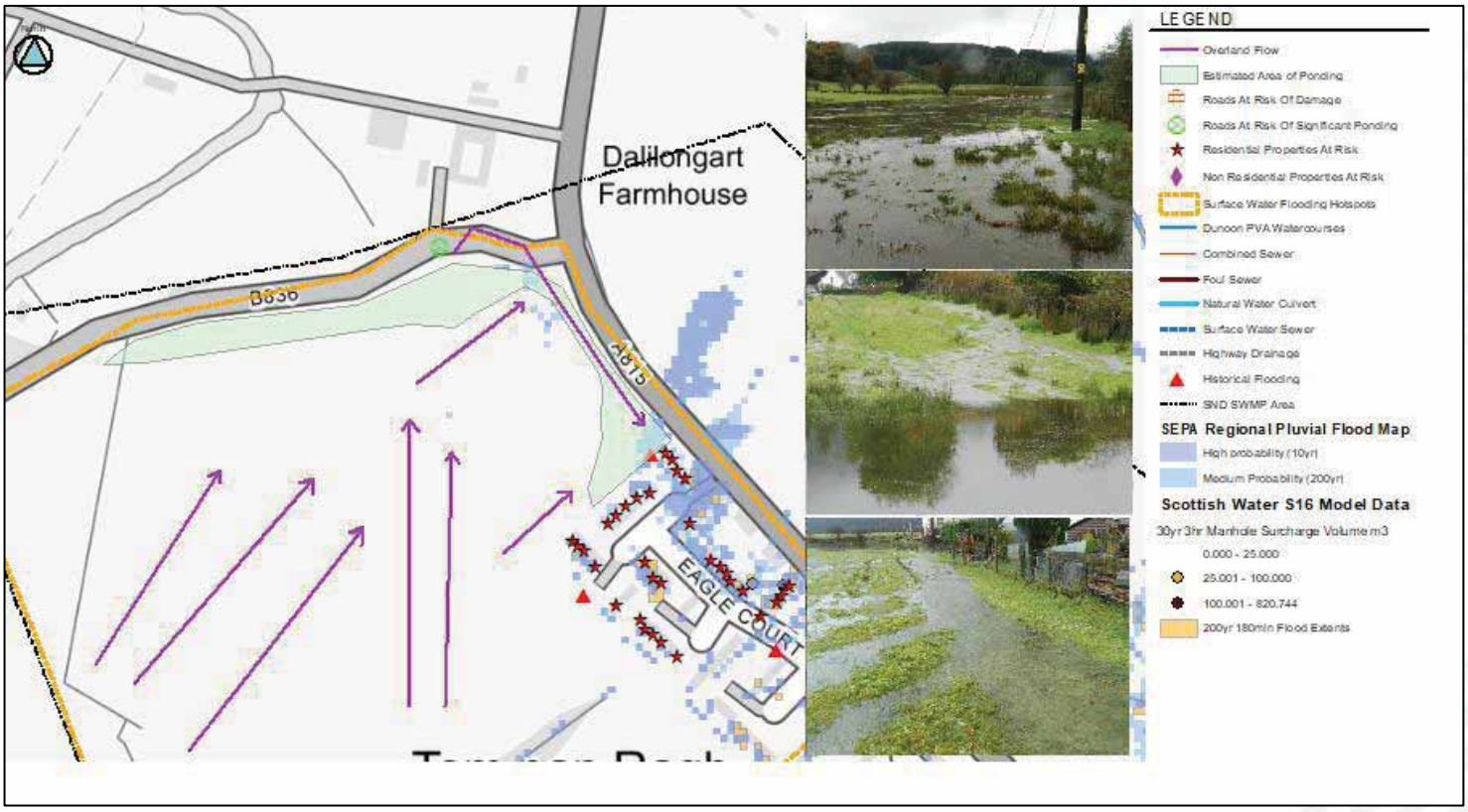
A series of figures have been produced to accompany the results of the MCA assessment, the figures can be found in Appendix A.

There are 2 flooding mechanisms at work in this area which results in surface water ponding against an informal bund in the corner of a field to the north of Eagle Court. Hillside runoff from the west is either collected in a drainage ditch and flows toward the B836 or flows overland directly to the north east corner of the field.

Under normal conditions the drainage ditch flows east adjacent to the road before passing under the road toward Dalilongart Farmhouse. It is understood that this area is prone to blockages which sends flows onto the road causing significant volumes of ponding water. The ponding water then flows into the field adjacent to the A815 and flows south east to the informal bund area. The informal bund is a recent creation, thought to consist of scraped site won material with little to no compaction. The bund does not have a discharge point and effectively stores the water allowing it to infiltrate into the ground. The bund has breached in the past and came close to over topping on several occasions. The properties to south west of Eagle Court also receive nuisance flooding to their gardens due to hillside runoff overwhelming the drainage network which surrounds the development.

Damages in Eagle Court are significant including interior and exterior flooding of multiple properties. Ponding on the B836 is also known to have closed the road at times. The current flood risk is high as the flooding known to be recurring and the informal defences have failed to mitigate flood risk. The flood hazard is also high due to the damages caused and that a significant breach of the informal structure could cause high velocities. There is an opportunity to mitigate or partially mitigate future flood risk through a potential housing development earmarked for the site. The future flood risk is likely to increase as a result of more frequent intense rainfall events associated with climate change which will further increase the depth of flood water and potentially increase the flood extent.

Using SEPAs Scottish Pluvial Annual Average Damages Estimates (SPAADE) dataset the estimated damages for this hotspot are £47,158.



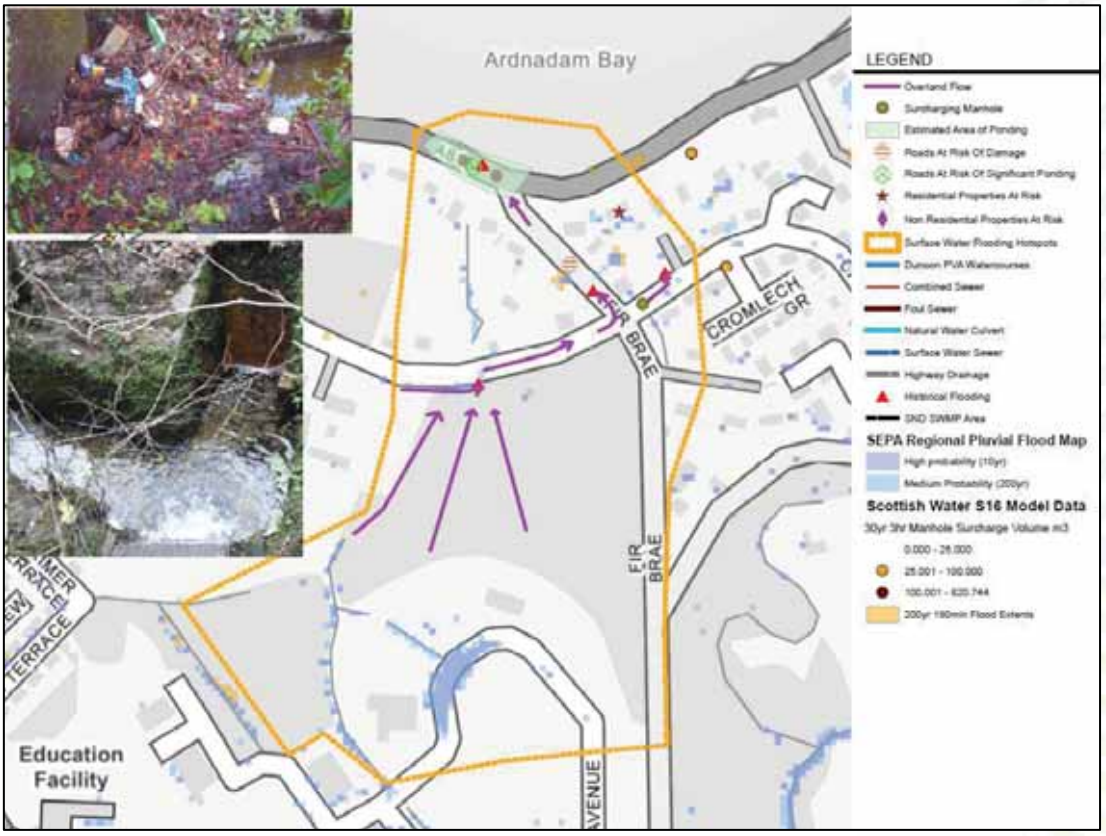
Implement more stringent land use policies	+2	+2	+2	0	0	0	+6	Yes
Improve understanding of flooding mechanisms	+2	+1	+1	0	0	0	+4	Yes
Property Level Protection/Resistance (PLP/PLR)	+2	+1	-1	-1	0	-1	0	No
Asset management and maintenance	+2	0	0	+1	0	0	+3	Maybe
Storage	+1	-1	+1	+2	+1	+2	+6	Yes
Land management	+1	-1	-1	+1	+2	+2	+4	Yes
Modification of culverted watercourses	+1	-1	-1	+2	-1	-1	-1	No

Do minimum	Current situation for comparison, includes maintaining existing drainage, pipes, channels and culverts.
Option 1	This option will involve gathering further information on the flooding mechanisms within this hotspot before implementing further actions. This may include: • Topographical survey to establish overland flow paths, existing defence level and property thresholds. Will also include the drainage channel and culvert adjacent to the B836. • Further information on the Scottish Water network in the area, particularly the separate network within Eagle Court and where the surface water discharges to. • 1D/2D hydraulic model of the area including the unnamed drainage channel to indicate existing capacity and volume of over flow, culvert under the B836, overland flow with and without the current defence. The land to the north of Eagle Court has been identified in the LDP as a potential future housing development. This may provide an opportunity to manage surface water within the site using SuDS hence mitigating the flood risk to the properties at Eagle Court.
Option 2	This option would involve constructing a formal flood storage basin in place of the existing informal defences. The studies in Option 1 will inform volume requirements to achieve the required standard of protection. The storage will likely consist of an L-shaped embankment with flow control structure limiting discharge downstream. The utilities in this area are unknown as such the flow control may discharge to the Scottish Water network if a suitable connection is available or will require land drainage to be laid beneath Shore road after which the watercourse would flow openly through fields to its confluence with the Firth of Clyde.
Option 3	To limit the volume of water reaching the problem area there is the potential to use NFM techniques to minimise runoff such as woodland plantations, introducing hedge rows, changing crop type. It would also be prudent to increase the drainage ditch network. Examine other funding streams available to implement NFM including forestry and Water Environment sources.

Flows from a minor watercourse and SuDS from Highland Avenue flow down a wooded hillside to the north of Highland Avenue. The watercourse and hillside runoff collects in drainage ditches and channels which flow adjacent to Cromlech Road. Several of the drainage ditches drain to a single culvert which conveys flows south under the road and into a private property. This culvert is understood to be approximately 300mm in diameter with its invert approximately 2.3m below road level, as such there is a substantial drop from the upstream channel to the culvert invert at the headwall. This culvert is prone to substantial blockages at the headwall which causes water to over top on to Cromlech Road. Once on Cromlech Road flows head east before turning north and flowing down Fir Brae. There are reports of ponding on Shore Road approximately adjacent to the junction with Fir Brae. It is possible that flood water from Fir Brae ponds here however, the model also shows substantial manhole surcharging volumes. A manhole to the east of the Fir Brae and Cromlech Road junction is also prone to surcharging sending flows into the garden of a property (loch View) and out onto Shore Road. It is assumed the surcharging is linked to the surface water issues discussed above. Damages to the property as a result of surcharging are understood to be restricted the garden only. Fir Brae has also suffered damages to the surface course due to the high velocity flood of flood water.

The current flood risk is high as the flooding is known to be recurring. The flood hazard is also high due to the damages caused and the velocity of floodwater. The Highland Avenue business park area is earmarked for future development. This could provide an opportunity to restrict flows which are passed downstream which may help to lower flood risk. Without intervention future flood risk is likely to increase as a result of more frequent intense rainfall events associated with climate change.

Using SEPAs Scottish Pluvial Annual Average Damages Estimates (SPAADE) dataset the estimated damages for this hotspot are £1,378.



Improve understanding of flooding mechanisms	+2	+1	+1	0	0	0	+4	Yes
Asset management and maintenance	+2	+1	0	+1	0	0	+4	Yes
Conveyance	+1	-1	-1	+1	+2	+2	+4	Yes
Modification of culverted watercourses – Headwall/screen improvements	+1	-1	-1	+1	+2	+2	+4	Yes
Modification of culverted watercourses – capacity improvements	+1	-2	-2	+1	-1	-1	-4	No

Do minimum	Current situation for comparison, includes maintaining existing drainage, headwalls, channels and culverts.
Option 1	This option will involve gathering further information on the flooding mechanisms within this hotspot before implementing further actions. This may include: • Topographical survey to establish overland flow paths, existing channels, culverts and property thresholds. • 1D hydraulic model of the unnamed drainage channels present on the hillside to indicate existing capacity and volume of over flow. • Consider increasing the inspections and clearing works at the culvert headwall to help ensure flows are able to enter the culvert effectively.
Option 2	This option will build on the knowledge gained in Option 1 to improve channel capacity within the sloped wooded area. Some of the flow from this area is known to be caused by a drainage ditch being diverted due to a development. This option will create formal drainage channels on the hillside using erosion resistant materials. This will help to prevent the build up of sediment at the culvert.
Option 3	This option will improve the culverts resilience to blockages further by improving the headwall arrangement and introducing trash screens. This may involve: • Modifying the headwall arrangement to allow for trash screens to be constructed to limit debris entering the site. • Creation of a working area to allow operatives to clear screens effectively and safely. • Creating a course debris screen upstream of the culvert headwall with suitable access for operatives.

An unnamed watercourse flows openly along the eastern extent of the Fairhaven development for approximately 50m. The watercourse is culverted both up and downstream of this. There are 2 recorded incidents of flooding occurring. During the first incident the watercourse was reported to be close to overtopping while a second incident involved interior flooding of a property in which the fire service was in attendance. Following the interior flooding the culvert was cleared of debris which included substantial wooded debris and also a car tyre. The interior damage to the property was thought to be extensive.

The hydrology of this catchment was assessed by Grontmij in August 2010 as part of a Flood Management Programme for Argyll and Bute Council. The report shows that the catchment is split in 2; the area upstream of Ardenslate Road comprising mostly of a golf course, and the area south of Ardenslate Road which consists sole of residential developments. The Study then undertook a 1D hydraulic model of the watercourse and assessed the current flood risk as well as culvert upsizing as a potential solution. The study shows that the channel will be inundated at the open section with flood depths up to 0.71m for the 200 year plus climate change scenario. The study concludes that "upsizing culverts will not alleviate flooding along the Ardenslate Road watercourse".

The current flood risk is high as the flooding known to be recurring and the culverts are susceptible to blockages. The flood hazard is also high due to the damages caused and potential for significant velocities in the vicinity of the channel when overtopping. The future flood risk is likely to increase as a result of more frequent intense rainfall events associated with climate change which will further increase the depth of flood water and potentially increase the flood extent.

Using SEPAs Scottish Pluvial Annual Average Damages Estimates (SPAADE) dataset the estimated damages for this hotspot are £1,378.

[2] Argyll and Bute Council Flood Management Programme – Hydrology Summary Report, Grontmij, 2010

Asset/watercourse management and maintenance	+2	+1	0	+1	0	0	+4	Yes
Property level protection / Property level resistance (PLP/PLR)	+2	+1	-1	-1	0	-1	0	No
Restoring Urban Watercourses	+1	-1	0	+1	+2	+2	+5	Yes
Storage	0	-1	-1	+2	+2	+2	+4	Yes
Direct defences	0	-1	-1	-1	-1	-1	-5	No
Modification of culverted watercourses – capacity improvements	-1	-2	-2	+1	-1	-1	-4	No

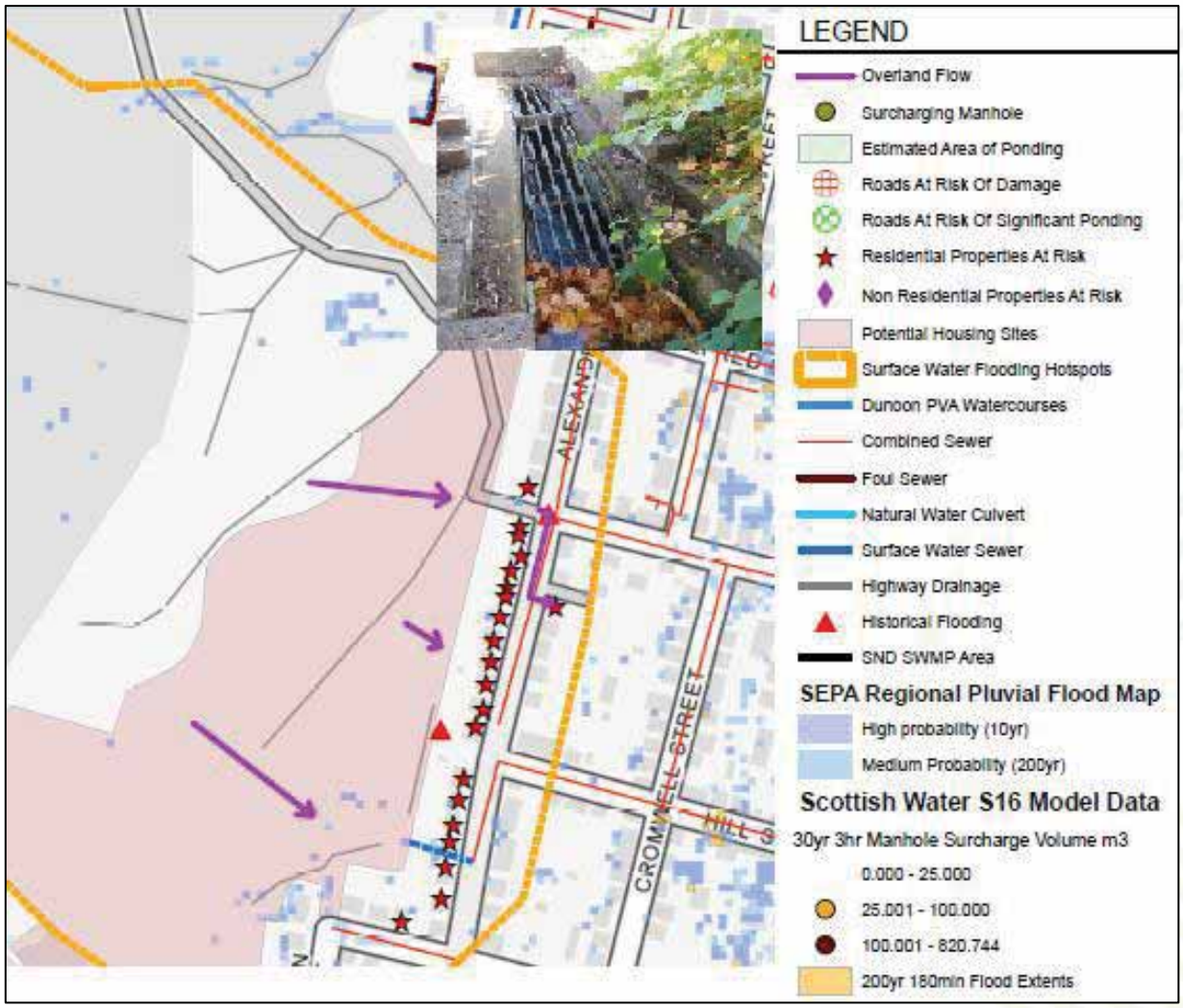
Do minimum	Current situation for comparison, includes maintaining existing drainage, headwalls, channels and culverts.
Option 1	Consider increasing the inspections and clearing works at the culvert headwalls to help ensure flows are able to enter the culverts effectively.
Option 2	As shown by the Grontmij hydraulic study upsizing culverts will not mitigate flood risk in this area. Where the watercourse is open, consideration should be given to modifying the channel to create floodplains where possible to increase the channel capacity. This would also include improvements to headwalls and screens within the reach to limit blockage risk.
Option 3	The most significant contributing area shown in Grontmij's hydrology report is the upstream catchment which is predominantly formed of a golf course. The best chance of reducing flood risk is to limit the flows which enter the downstream culverted system. Formal storage could potentially be created in the area to the west of the bowling green. From mapping and information available this appears to be a disused area, potentially belong to the neighbouring golf course. This above ground storage would likely involve the creation of a basin with impounding embankments. This would require a flow control unit to limit downstream flows into the existing culvert network below Ardenslate Road. This could also potentially provide added amenity benefits by introducing a wetland habitat.

The hillside to the west of Alexander Street is the source of 2 flooding mechanisms. Firstly, hillside runoff is known to overtop existing drainage ditches a cause nuisance flooding to the rear gardens border the hillside. The second mechanism relates to the collection of the hillside ditches and drains which collect and discharge in to a culvert at the junction with John Street.

The watercourse is prone to blockages at the headwall causing flood water to overtop onto Alexander Street. Due to the road camber in this area this directs flows south along the street where it enters the ground of a low-lying residential property causing substantial interior damage. It is also understood that manholes downstream of the headwall are prone to surcharging. Damages vary from nuisance garden flooding to interior property damage.

The current flood risk is high as the flooding is known to be recurring. The flood hazard is moderate as flood velocity is likely to vary however, flood depth is likely to be low. There is the potential to mitigate future flood risk by managing surface water on the proposed housing development on the hillside to the west of Alexander Street. The future flood risk is likely to increase as a result of more frequent intense rainfall events associated with climate change which may further increase the volume of flood water entering the culvert.

Using SEPAs Scottish Pluvial Annual Average Damages Estimates (SPAADE) dataset the estimated damages for this hotspot are £29,127.



Implement more stringent land use policy	+2	+2	+2	0	0	0	+6	Yes
Improve understanding of flooding mechanisms	+2	+1	+1	0	0	0	+4	Yes
Property level protection / Property level resistance (PLP/PLR)	+2	+1	+1	+1	0	-1	+4	Yes
Reducing surface water in the sewer – Separate surface water pipe	0	-1	-1	+2	+2	+2	+4	Yes
Land management	0	-1	-1	+1	+2	+2	+3	Maybe
Urban Watercourse Engineering – headwall improvements and debris management	+1	+1	+1	+2	+2	+1	+8	Yes

Do minimum	Current situation for comparison, includes maintaining existing drainage, headwalls, channels and culverts.
Option 1	This option will involve gathering further information on the flooding mechanisms within this hotspot before implementing further actions. This may include: • Topographical survey to establish overland ditch network, flow paths, existing defence level and property thresholds. • 1D hydraulic model of the unnamed drainage channel to indicate existing capacity and volume of over flow. • Detailed 2D hydraulic model of the area if required after 1D modelling. Will show overland flow paths and opportunities to improve the drainage ditch network. The land to the north of Alexander Street has been identified in the LDP as a potential future housing development. This may provide an opportunity to manage surface water within the site using SuDS hence mitigating the flood risk to the properties on Alexander Street.
Option 2	This option would build on the information from option 1 and involve fitting PLP/PLR to the properties effected. For example the property which experienced flooding to the basement via the sanitary system could be fitted with non-return valves.
Option 3	The main issue with the current drainage arrangement is the debris load which blocks the headwall at the top of John Street. The headwall is fitted with a screen however due to the headwall being very narrow the screen has limited surface area in which to collect debris. This will causes the screen to block quickly which would be difficult to manage even with a proactive maintenance scheme. There are multiple approaches to manage the debris load: • Limit vegetation type adjacent to the watercourse. By creating a grassed buffer this will limit the volume of wooded debris entering the watercourse. • Install a coarse debris screens upstream to limit the volume of large debris reaching the headwall. • Move the location of the headwall upstream to an area with sufficient space to construct a headwall with a large screen and working area. By increasing the surface area of the screen more debris could accumulate whilst allowing water to pass through. Providing a screen that meets SEPA guidance with

	a working area will allow operatives to clear debris safely. • A formal overland flow path could be created adjacent to the new headwall to allow any over topping water to be direct towards the existing headwall. The current headwall could be replaced by another inlet into the piped system such as series of gullies or linear drain.
Option 4	The flooding risk in this location relates to a relatively small number of properties. However, the watercourse in question is suspected to drain 30-40 hectares of steep hillside, part of which is commercial forestry. It is understood the Dunoon sewer network has substantial dry weather flows resulting in storage tank operating at capacity. The surface water can be removed from the network by creating a pipe which flows down John Street and into the Firth of Clyde. Although this would be an expensive exercise it may prove cost beneficial when compared to increasing storage capacity or improving capacity at the WWTW.

Black Park in Dunoon is located between East Argyll Street, Argyll Road and Park Road. The park features an athletics stadium, rugby pitch, all-weather football facilities and large gravel carparking area to the south. The topography generally falls to the south west with all rainfall falling within the catchment flowing towards this point. As such, the overland flow in the carpark and south west of the park is substantial.

The overland flow floods the gardens of neighbouring properties up to 0.3m deep multiple times per month. At least 4 properties are badly affected with others likely to be affected by nuisance flooding. Flows have not yet entered the properties but are reported to have been close.

After speaking to local residents, it is understood that a drainage ditch system used to intercept flows and channel it to a headwall which then connected to the combined sewer. The headwall was removed when the Miller Court development was constructed circa 1990s when it was replaced with a small pumping station. Little is known about the pumping station and its onward connection. However, following the results of the site walkover, it has been assumed that the pumped water flows to a surface water manhole within Miller Court's separated sewer network. The separated sewer network in Miller Court then appears to connect to the combined sewer.

Unfortunately, the drainage channel has not been maintained and is understood to have been shortened as the gravel car park has expanded over the years. As such it only intercepts a small portion of the flows entering the park. Flows which do enter the heavily silted and vegetated channel slowly flow toward the pumping station. The pumping station is known to be unreliable and has been maintained by a local resident on an ad-hoc basis for 20 years. The pump was not functional on the day of the site visit. The pump itself is very small with an unknown capacity, the outlet pipe from the pump is approximately 50mm ∅. Residents also state the flooding has increased substantially since the construction of the all-weather football pitches.

The flood hazard is low to moderate as depths are known to vary but velocities are very low.

The current flood risk is high as the flooding is recurring. The flood hazard is also high as the surface water is ponding over significant areas during low return period events which suggests that inundation to properties is likely during more significant storm events. The future flood risk is likely to remain the same as the catchment for the surface water is very limited and its flow path is defined.

The future flood risk is likely to increase as a result of more frequent intense rainfall events associated with climate change which may further increase the volume of flood water reaching the south west corner of Black Park.

Using SEPAs Scottish Pluvial Annual Average Damages Estimates (SPAADE) dataset the estimated damages for this hotspot are £29,127.

Improve understanding of flooding mechanisms	+2	+2	+1	0	0	0	+5	Yes
Asset management and maintenance (pump)	+1	0	-1	+1	0	-1	0	No
Watercourse management and maintenance (ditches)	+2	0	0	+1	+1	+1	+5	Yes
Infiltration and evaporation	+1	+1	0	+2	+2	+1	+7	Yes
Underground storage	+1	-1	-2	+2	-2	-1	-3	No

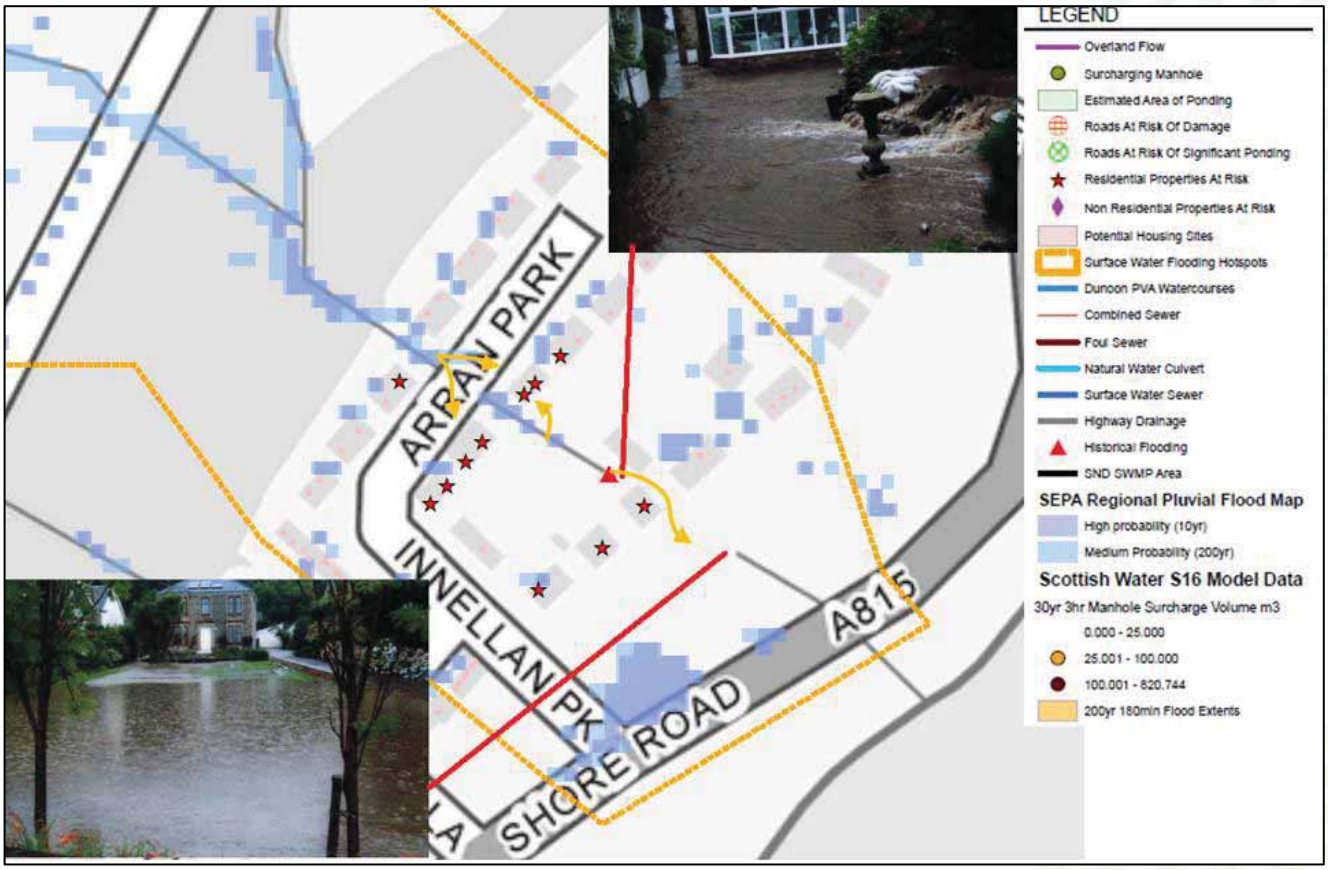
Do minimum	Current situation for comparison, includes maintaining existing drainage, pumping station, headwalls, channels and culverts.
Option 1	This option will involve gathering further information on the flooding mechanisms within this hotspot before implementing further actions. This may include: • Topographical survey to establish overland ditch network, flow paths, existing defence level and property thresholds. • Detailed 2D hydraulic model of the area if required. Will show overland flow paths, flow volumes and opportunities to improve the drainage ditch network.
Option 2	This option would build on the information from option 1 and involve clearing out the existing drainage channels in the south west of the park and schedule on-going maintenance as required.
Option 3	This option would build on the information from option 1 and involve constructing new infiltration trenches in the car park area to intercept flows before they can reach the houses in the south west. This would then connect into the existing drainage network. By incepting the flow before it reaches the corner it will be possible to convey the flows by gravity which could lead to the decommissioning of the pump station. There does not appear to be any feasible options for discharging to a surface water sewer or natural watercourse.

Two unnamed watercourses flow down a wooded hillside to the west of Arran Park and converge approximately 60m upstream of the estate. The watercourse flows through a twin culvert under Arran Park road before flowing openly through gardens. There is a constriction on the channel as the watercourse passes through a boundary wall into the ground of another residential dwelling on Shore Road. Once in the boundary of the Shore Road property the channel changes to a cemented U-shaped masonry channel before entering a culvert which conveys flows under the property. Flows are known to have come out of bank at all 3 constrictions. Works to improve the screens on the Arran Park Road culvert are known to have reduce blockage at this culvert. Downstream of the culvert the channel sits in a deep V-shaped channel located in the side and rear garden of a residential property on Arran Park. Due to the constriction at the boundary wall flood waters have reportedly came close to overtopping the bank.

Substantial flooding has occurred at the property on Shore Road due to out of bank flows at the culvert located in the back garden of this property. It is not known if this is due to the culvert being under capacity or if it is prone to blockages. Damages include both internal and external flooding of properties.

The current flood risk is high as the flooding thought to be recurring and potential damages are extensive. The flood hazard is high as it the depth of flood water could be significant in places and velocity of the flood water is also expected to be fast close to the channel. The future flood risk is likely to increase as a result of more frequent intense rainfall events associated with climate change which will further increase the volume of flood water.

Using SEPAs Scottish Pluvial Annual Average Damages Estimates (SPAADE) dataset the estimated damages for this hotspot are £13,870.



Improve understanding of flooding mechanisms	+2	+1	+1	0	0	0	+4	Yes
Property level protection / Property level resistance (PLP/PLR)	+2	+1	0	-1	0	-1	+1	No
Conveyance Shore Road/ Allan Park Wall	+2	+1	+1	+1	+1	+1	+7	Yes
Urban watercourse engineering – Direct Defences	+1	-1	-1	+1	-1	-1	-2	No
Modification of culverted watercourses - Shore Road	+1	-1	0	+2	+1	+1	+4	Yes
Modification of culverted watercourses Allan Park Screen	+2	-1	+1	+1	+1	+1	+5	Yes

Do minimum	Current situation for comparison, includes maintaining existing drainage, headwalls, channels and culverts.
Option 1	This option will involve gathering further information on the flooding mechanisms within this hotspot before implementing further actions. This may include: • Topographical survey to establish channel dimensions, overland flow paths and property thresholds. Will also include a cross sectional survey of the watercourse up and downstream of Arran Park. • 1D hydraulic model of the unnamed drainage channel to indicate existing capacity and volume of over flow at the various constrictions.
Option 2	There are reports of flood water backing up in the channel upstream of the boundary wall between Shore Road and Arran Park. The current orifice in the wall is very small particularly when compare the to the twin culvert upstream under Arran Park road. In order to increase channel conveyance there is a need to increase the capacity through the boundary wall. A substantially larger orifice could be constructed for little cost. This should at least match the capacity of the downstream channel. This would help to mitigate flood risk for the property upstream of the wall and reduce the pressure on the wall caused by flood waters lowering the risk of damage.
Option 3	The property at Shore Road features a masonry lined channel from the boundary wall to a culvert which conveys the unnamed watercourse beneath the house. The watercourse then briefly reappears in the front garden before entering a second culvert which conveys flows below Shore Road and into the Firth of Clyde. To reduce flood risk the following actions could be taken: • Create a new large diameter culvert which channels flows around the side of the house instead of under it. The existing culvert should remain in situ and act as a secondary culvert for high flows. • Modify the masonry channel upstream to match the capacity of the new culvert arrangement. • If the hydraulic modelling shows that it is required a similar arrangement could be constructed for the culvert beneath Shore Road. • Depending on the design security screens may be added to the culverts. Debris screens are not required due to the screens at the Arran Park culvert.

Option 4	Improvements to the headwall and culvert at Arran Park are known to have taken place which has increased the capacity available. To reduce the risk of blockages a new screen arrangement could be constructed to increase the surface area of the screen. The arrangement could consist of 1-2 stages each with safe working area. It is expected a screen of this kind could increase the available screen surface are by 2. Modifications to the headwall be may required to under this work.

A stakeholder workshop was held at Argyll and Bute Council's office in Helensburgh on Thursday 22nd November 2018. JBA presented the findings of the SWMP to representatives of Argyll and Bute Council and Scottish Water.

The presentation started with a recap of how the SWMP had progressed and the techniques/methods used in each of the preceding reports. JBA then presented each of the hotspots explaining the flooding mechanisms as well as the current and future flood risk. JBA discussed how the short list of actions had been derived and how these subsequently formed options.

Following open discussions, the following consensuses was agreed for the 5 remaining priority hotspots. Graphical representations of the preferred options can be found in Appendix A.

–

This option was seen as the best option in order to be in a position to develop an appropriate flood mitigation solution.

Other options discussed included:

- Infiltration (formalising current storage method).
- Conveyance (improving capture of runoff and conveying it below the A815.
- Land management.
- Storage (with a flow control/outlet)

  It was agreed that at present there is not sufficient data to be able to determine a favourable option hence, the next step is to prioritise the study of flooding mechanisms which will help identify the most suitable mitigation measures.

The study may consist of 2 phases, a data gathering exercise and modelling exercise.

The data gathering will include a review of Scottish Water's network (GIS format) and a topographical survey. The Scottish Water data review will focus on the drainage layout of the Eagle Court development which is expected to have a separate surface water network, with a particular focus on the discharge locations of the pipes. A topographical survey will be used to establish:

- The topography of the contributing area including the hillside (overland flow).
- Property threshold levels.
- Drainage ditch cross sections (including the culvert and downstream of the culvert).
- The locations of Scottish Waters assets in the area.
- The topography of the area to the east of the A815 including any channels or culvert/pipe outfalls which may be utilised in the design.

The second phase will involve creating a 1D/2D hydraulic model which can represent the flooding mechanisms in this area. This will be used to determine the current flood risk in terms of storm return period i.e. 1 in 10-year rainfall event.

The model created can then be used to appraise the various mitigation options to find the most suitable for implementation.

This option was seen as the best option in order to be in a position to develop an appropriate flood mitigation solution. It was agreed that at present there is not sufficient data to be able to determine a favourable option hence, the next step is to prioritise the study of flooding mechanisms which will help identify the most suitable mitigation measures and also to reconsider asset management and maintenance activities.

The study may consist of 3 phases, a site walkover data gathering exercise, topographical survey and modelling exercise.

Undertake an initial site walkover to better understand the route of the water coming down the hillside through the wooded area, the headwall arrangement and the route of the flood water (including road gullies).

This information may be sufficient to inform suitable mitigation options or can be used specify a topographical survey.

Using the information from the site walkover a topographical survey may be specified for use in a hydraulic model. The topographical survey will include:

- The topography of the contributing area including the hillside (overland flow).
- Property threshold levels.
- Drainage ditch/channel cross sections throughout the slope and upstream area (including the culvert and downstream of the culvert).
- The locations of Scottish Waters assets in the area.

The third phase will involve creating a 1D/2D hydraulic model which can represent the flooding mechanisms in this area. This will be used to determine the current flood risk in terms of storm return period i.e. 1 in 10-year rainfall event.

The model created can then be used to appraise the various mitigation options to find the most suitable.

–

Following discussion of the various options presented and the work undertaken in the Grontmij assessment, asset management and maintenance was selected as the preferred option.

The flood history of this reach is limited with the only major event occurring due to a substantial blockage within a culvert. As such it was agreed that the most appropriate option at this time is to focus on maintaining the asset and preventing future blockage which may include improving screens and headwalls as well as reassessing inspection frequencies.

–

This option was seen as the best option in order to be in a position to develop an appropriate flood mitigation solution.

The initial step in this process would be to undertake a hydrological assessment of the watercourse to understand the extent of the catchment and flows which are currently entering the sewer network. This is likely to require a topographical survey of the drainage ditch system.

Once the flows into the network have been identified an assessment can be made on the cost benefit of a new surface water pipe on John Street. This work may also provide an opportunity to improve the headwall and upstream channel in order to prevent excess sediment and debris entering the new pipe.

Throughout the process of the study and implantation of removing the surface water from the sewer network, planning restrictions may also be utilised to prevent excess surface water entering the sewer network from the proposed development north of Alexander Street. This may include limiting the peak flow of the surface water rather than the volume of surface water.

–

This option was seen as the best option in order to be in a position to develop an appropriate flood mitigation solution.

The initial step in this process would be to undertake a hydrological assessment of the catchment to understand the extent of the catchment and flows which are currently flowing towards the south west of the park. This is possible using a 2D hydraulic model which utilises the available LiDAR data.

Once the flows are identified then works to determine the location and sizing of the infiltration test can proceed. At this stage it will be necessary to research possible discharge locations. It is likely that several possible routes will be identified and appraised against the damages to determine the most cost-effective solution.

By introducing the new drainage, it may be possible to decommission the existing pumping station and regrade or infill the associated drainage channels.

After discussion of the potential flooding mechanisms in the Arran park area of Innellan it was decided to lower the priority of the hotspot to low. This was due to the majority of the flood risk lying within the boundary of a single property. At this location the flooding mechanism comes under the responsibility of the riparian owner in which case the stakeholders have very little influence.

Given the varied preferred options selected during the stakeholder workshop there are several potential funding routes available. There will need to be a level of co-ordination on most options as they are to be jointly delivered. Ultimately sources of funding will depend on who is responsible for implementation, the scale of the action required, and type of work involved. When different authorities are jointly implementing actions, funding may need to be aligned. This should be taken into account when planning implementation. Stakeholders should bear in mind that the funding cut off for SEPA's FRM cycle 2022-2028 is quarter 4 of 2019. Funding options may include:

- Local authority revenue
- Local authority capital via FRM Strategy prioritisation
- Scottish Water maintenance
- Scottish Water capital via quality and standards process
- SEPA's Water Environment Fund
- Private funding (e.g. developer contributions, forestry)
- Other sources e.g. EU funding, or if joint projects are being taken forward other funding sources may be available.

Hotspot	Preferred Option	Final Objective	Final Priority	Responsibility	Potential Funding Route	Target Implement ation Date	Target Standard of protection	Number of homes and businesses better protected
SND_HS01: Eagle Court	*Improve understanding of flooding mechanism*	*Improve understanding of surface water flood risk*	*High*	*Argyll and Bute Council*	*LA capital via FRM strategies*	*2022-2028*	*1 in 200 year*	*34*
DUN_HS04: Alexander Street	Improve understanding of flooding mechanism, more stringent land use policy and removing surface water from the sewer	*Reduce surface water flood risk*	*High*	*Argyll and Bute Council and Scottish Water*	*LA capital via FRM strategies / Scottish Water Capital*	*2022-2028*	*1 in 200 year*	*21 (+reduction in dry weather flow in sewer network)*
DUN_HS09: Black Park	Improve understanding of flooding mechanism, watercourse management and maintenance and infiltration and evaporation	*Reduce surface water flood risk*	*High*	*Argyll and Bute Council*	*LA revenue*	*2022-2028*	*1 in 200 year*	*5*
SND_HS03: Fir Brae	*Improve understanding of flooding mechanism and asset management and maintenance*	*Improve understanding of surface water flood risk*	*Medium*	*Argyll and Bute Council*	*LA capital via FRM strategies*	*2022-2028*	*1 in 200 year*	*1 (+ponding on Shore Road)*
DUN_HS01: Fairhaven	*Asset management and maintenance*	*Accept risk and maintain existing assets*	*On-going*	*Argyll and Bute Council*	*LA revenue*	-	-	-
TOW_HS03: Arran Park	*Change to low priority to be reassessed in the next SWMP cycle.*	*Accept risk and maintain existing assets*	*On-going*	*Argyll and Bute Council*	*LA revenue*	-	-	-

North

Improve Understanding of Flooding Mechanism

Dalilongart Farmhouse

B836

A815

EAGLE COURT

Tom nan Ragh

?

LEGEND

- Overland Flow
- Estimated Area of Ponding
- @ Roads At Risk Of Damage
- ? Roads At Risk Of Significant Ponding
- ^ Residential Properties At Risk
- X Non Residential Properties At Risk
- Potential Housing Sites
- Surface Water Flooding Hotspots
- Dunoon PVA Watercourses
- Combined Sewer
- Foul Sewer
- Natural Water Culvert
- Surface Water Sewer
- Highway Drainage
- # Historical Flooding
- SND SWMP Area

SEPA Regional Pluvial Flood Map

- High probability (10yr)
- Medium Probability (200yr)

Scottish Water S16 Model Data

30yr 3hr Manhole Surcharge Volume m3

- 0.000 - 25.000
- 25.001 - 100.000
- 100.001 - 820.744

200yr 180min Flood Extents

0 37.5 75 150 225 300 Meters

SEPA gratefully acknowledges the cooperation and input that various parties have provided, including inter alia, the following organisations:

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licensed from the Centre for Ecology and Hydrology ©NERC (CEH) and third party licensors.

The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2014), the Met Office.

The James Hutton Institute
Data provided under licence from the James Hutton institute has been applied in production of flood risk management information. Copyright ©The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC

Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

JBA consulting

SND_HS01
OPTION 1

EAGLE COURT

Ardnadam Bay

A8

CROMLECH GR

FIR BRAE

FERRY ROAD

FIR BRAE

HIGHLAND AVENUE

Education Facility

0 37.5 75 150 225 300 Meters

Improve understanding of flooding mechanism

Asset management and maintenance

LEGEND

- Overland Flow
- Surcharging Manhole
- Estimated Area of Ponding
- @ Roads At Risk Of Damage
- ? Roads At Risk Of Significant Ponding
- ^ Residential Properties At Risk
- X Non Residential Properties At Risk
- Surface Water Flooding Hotspots
- Dunoon PVA Watercourses
- Combined Sewer
- Foul Sewer
- Natural Water Culvert
- Surface Water Sewer
- Highway Drainage
- # Historical Flooding

SEPA Regional Pluvial Flood Map

- High probability (10yr)
- Medium Probability (200yr)

Scottish Water S16 Model Data

30yr 3hr Manhole Surcharge Volume m3

- 0.000 - 25.000
- 25.001 - 100.000
- 100.001 - 820.744
- 200yr 180min Flood Extents

SEPA gratefully acknowledges the cooperation and input that various parties have provided, including inter alia, the following organisations:

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licensed from the Centre for Ecology and Hydrology ©NERC (CEH) and third party licensors.

The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2014), the Met Office.

The James Hutton Institute
Data provided under licence from the James Hutton Institute has been applied in production of flood risk management information. Copyright ©The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC

Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

JBA consulting

SND_HS03
OPTION 1

FIR BRAE

North

Asset management and maintenance

Kirn

KIRN BRAE

KIRN GARDENS

ASH GARDENS

HUNTER STREET

DUNCLUTHA LANE

ARGYLL TERRACE

ATE CRESCENT

PW

0 37.5 75 150 225 300 Meters

LEGEND

- # Historical Flooding
- ^ Residential Properties At Risk
- X Non Residential Properties At Risk
- @ Roads At Risk Of Damage
- ? Roads At Risk Of Significant Ponding
- Surface Water Flooding Hotspots
- Potential Housing Sites
- Dunoon PVA Watercourses
- Combined Sewer
- Foul Sewer
- Natural Water Culvert
- Surface Water Sewer
- Highway Drainage
- SND SWMP Area

SEPA Regional Pluvial Flood Map

- High probability (10yr)
- Medium Probability (200yr)

Scottish Water S16 Model Data

30yr 3hr Manhole Surcharge Volume m3

- 0.000 - 25.000
- 25.001 - 100.000
- 100.001 - 820.744

- 200yr 180min Flood Extents

DUNOON SWMP KEYPLAN

SEPA gratefully acknowledges the cooperation and input that various parties have provided, including inter alia, the following organisations:

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licensed from the Centre for Ecology and Hydrology ©NERC (CEH) and third party licensors.

The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2014), the Met Office.

The James Hutton Institute
Data provided under licence from the James Hutton Institute has been applied in production of flood risk management information. Copyright ©The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC

Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

JBA consulting

DUN HS01
Option 1

FAIR HAVEN

North

Improve understanding of flooding mechanism

Implement more stringent land use policy

Removing surface water from the sewer

Watermans Cottage

Balgaidh Burn

Milton Burn

COWAN PLACE

ALEXANDER STREET

GORDON STREET

NELSON STREET

CROMWELL ST

HILL STREET

VICTORIA ROAD

0 37.5 75 150 225 300 Meters

LEGEND

- # Historical Flooding
- ^ Residential Properties At Risk
- X Non Residential Properties At Risk
- @ Roads At Risk Of Damage
- ? Roads At Risk Of Significant Ponding
- Surface Water Flooding Hotspots
- Potential Housing Sites
- Dunoon PVA Watercourses
- Combined Sewer
- Foul Sewer
- Natural Water Culvert
- Surface Water Sewer
- Highway Drainage
- SND SWMP Area

SEPA Regional Pluvial Flood Map

- High probability (10yr)
- Medium Probability (200yr)

Scottish Water S16 Model Data

30yr 3hr Manhole Surcharge Volume m3

- 0.000 - 25.000
- 25.001 - 100.000
- 100.001 - 820.744
- 200yr 180min Flood Extents

DUNOON SWMP KEYPLAN

SEPA gratefully acknowledges the cooperation and input that various parties have provided, including inter alia, the following organisations:

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licensed from the Centre for Ecology and Hydrology ©NERC (CEH) and third party licensors.

The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2014), the Met Office.

The James Hutton Institute
Data provided under licence from the James Hutton Institute has been applied in production of flood risk management information. Copyright ©The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC

Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

JBA consulting

DUN_HS04
Option 4

ALEXANDER STREET

North

SANDBANK ROAD

BENCORRUM BRAE

SANDERSON DR

AVENUE

ARDENSIDE

Hospital

Education Facility

Improve understanding of flooding mechanism

Watercourse management and maintenance

Infiltration and evapouration

Fire Station

Milton Burn

ARGYLL STREET

PARK ROAD

UNION STREET

JOHNSTON TERRACE

W STREET

Police Station

HAMILTON STREET

ARGYLL

B8041

PW

0 20 40 80 120 160 Meters

LEGEND

- Roads At Risk Of Damage
- Roads At Risk Of Significant Ponding
- Residential Properties At Risk
- Non Residential Properties At Risk
- Potential Business Sites
- Surface Water Flooding Hotspots
- Dunoon PVA Watercourses
- Combined Sewer
- Foul Sewer
- Natural Water Culvert
- Surface Water Sewer
- Highway Drainage
- Historical Flooding
- SND SWMP Area

SEPA Regional Pluvial Flood Map

- High probability (10yr)
- Medium Probability (200yr)

Scottish Water S16 Model Data

30yr 3hr Manhole Surcharge Volume m3

- 0.000 - 25.000
- 25.001 - 100.000
- 100.001 - 820.744
- 200yr 180min Flood Extents

DUNOON SWMP KEYPLAN

SEPA gratefully acknowledges the cooperation and input that various parties have provided, including inter alia, the following organisations:

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licensed from the Centre for Ecology and Hydrology ©NERC (CEH) and third party licensors.

The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2014), the Met Office.

The James Hutton Institute
Data provided under licence from the James Hutton Institute has been applied in production of flood risk management information. Copyright ©The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC

Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

JBA consulting

DUN_HS09
Option 3

BLACK PARK

Offices at

Coleshill
Doncaster
Dublin
Edinburgh
Exeter
Glasgow
Haywards Heath
Isle of Man
Limerick
Newcastle upon Tyne
Newport
Peterborough
Saltaire
Skipton
Tadcaster
Thirsk
Wallingford
Warrington

Registered Office
South Barn
Broughton Hall
SKIPTON
North Yorkshire
BD23 3AE
United Kingdom

+44(0)1756 799919
info@jbaconsulting.com
www.jbaconsulting.com
Follow us:

Jeremy Benn Associates Limited

Registered in England 3246693

JBA Group Ltd is certified to:
ISO 9001:2015
ISO 14001:2015
OHSAS 18001:2007