



Flood Warning Strategy 2012 to 2016

Foreword



SEPA recognises the important benefits that flood forecasting and warning can provide for the people of Scotland. As flood warning authority under the Flood Risk Management (Scotland) Act 2009, and in undertaking our Civil Contingencies Act 2004 Category 1 duties, we aim to develop and improve our flood forecasting and warning service to reduce the impact of flooding on our most vulnerable communities.

The first *National Flood Risk Assessment* published by SEPA in December 2011 highlighted that one in 22 homes and one in 13 businesses are at risk of flooding in Scotland and with climate change we can expect the frequency and severity of extreme events to increase. The Scottish Government guidance on *Delivering Sustainable Flood Risk Management* (June 2011) highlighted the actions needed in preparing to reduce the impacts of flooding, including raising awareness, increasing property-level resilience and having effective flood warning systems.

This **Flood Warning Strategy** covers the period 2012 to 2016; the first planning cycle set out in the Flood Risk Management (Scotland) Act 2009. It explains to our flood risk management partners and other stakeholders how we will maintain and develop our flood warning service over the next four years, assuming funding from the Scottish Government continues.

Prioritising our public expenditure by targeting our efforts where the benefits of investment are greatest is an important consideration in this strategy. With the support of the Scottish Government, SEPA has developed an approach which will ensure prioritised investment in our flood forecasting and warning service over this period.

Delivering the measures identified within the strategy will help our emergency services and the public prepare for, and respond to, flood events. Effective action based on accurate and timely flood forecasts and warnings can result in a significant reduction in risk to life, social impacts, residential property damage, business and agriculture damage and infrastructure disruption.

In summary, this strategy sets out how we will develop our flood forecasting and warning service over the next four years – a key contribution to building a more resilient Scotland.

David Pirie
Director of Science and Strategy

1 Introduction

1.1 Legislative drivers for Flood Warning

In 2004 the Scottish Environment Protection Agency (SEPA) was designated as a Category 1 responder under the Civil Contingencies Act. This Act aimed to ensure effective arrangements are in place for planning for emergencies, responding to emergencies and the continued delivery of services. This gave SEPA duties in relation to flood warning services, including: risk assessment; maintaining emergency and business continuity plans; communicating with the public; sharing information; and co-operation.

The Flood Risk Management (Scotland) Act 2009 (the FRM Act) has created a new framework for the management of flood risk in Scotland, which is supported by new responsibilities for SEPA. Under the FRM Act, SEPA's flood warning responsibilities have been further formalised and given a strengthened statutory basis.

In 2010 SEPA stated how it intended to transpose these new responsibilities and a number of objectives were set as part of our Statement of Intent (SEPA, 2010). Specifically, we committed to reduce the impact of flooding through the provision of actively disseminated, reliable and timely flood warnings to registered users of a national flood warning service, by:

- Providing actively disseminated flood warning messages to registered users of the Floodline direct warning service
- Offering direct flood warning service for all formal flood warning schemes that SEPA operates and for more generalised region-wide Flood Alerts
- Providing live flooding information and advice through Floodline
- Providing the necessary flood forecasting and monitoring capabilities to support these flood warning activities.

As the designated flood warning authority under the FRM Act and assuming funding from the Scottish Government continues, SEPA is committed to providing an effective flood warning service and to reduce the impact of flooding from all sources. We are also committed to work with communities to improve their response through:

- Developing a national flood warning strategy (this strategy)
- Reviewing and, where necessary, upgrading flood forecasting and monitoring capabilities for existing flood warning schemes to ensure that they continue to offer accurate and effective warning
- Prioritising the expansion of flood warning schemes to cover other areas of Scotland at high risk of fluvial and coastal flooding, subject to cost benefit analyses and availability of funding
- Liaising with the Met Office to further develop methods of working more closely together with the aim of improving our technical capability to forecast, model and warn against all sources of flooding in Scotland
- Continuing to work with the public and responder communities to improve the understanding of flood risk with the aim of improving their preparedness and response to flooding and thereby reducing the adverse consequences.

SEPA is also committed to maintaining effective relationships with responsible authorities and strategic and professional partners to ensure their needs for flood warning are being met and are aligned with Scotland's flood risk management priorities.

1.2 What will the Strategy achieve?

The Strategy has been produced to help deliver our strategic vision of the flood warning service over the coming four years. Specifically the service vision is:

SEPA will provide a flood warning service which helps Scottish communities and responders to take action, tackle flooding together and reduce the impact that

flooding could have on lives through maintaining and increasing our capabilities as a respected and influential flood warning authority.

This is aligned to SEPA's corporate outcomes in that Scotland's environment is understood; SEPA is an influential and respected authority; and that SEPA is a high performance organisation.

In addition, with the acknowledged threat of climate change, we can expect the frequency and severity of extreme events to increase. This Strategy aligns to SEPA's Flood Risk and Climate Change Strategy and our corporate objectives for preparing for a sustainable future and taking steps to limit climate change.

1.3 How this Strategy is structured

The Strategy has been developed around seven strategic areas defined to maintain and strengthen SEPA's flood warning service:

1. Flood detection and monitoring

This addresses requirements to support our monitoring network (rain and flow gauges, radar).

2. Surface water flooding

3. Coastal/tidal flooding

4. River flooding

Strategic areas No. 2 to 4 address the science requirements for the three main sources of flooding in Scotland.

5. Uncertainty in flood predictions

This addresses the science and communication requirements to manage uncertainty in forecasting.

6. Flood warning service development

This identifies where we intend to provide new or improved flood warning schemes.

7. Skills, expertise and knowledge

This addresses training and exercise requirements for our staff and engagement with our partners.

For each strategic area, the subsequent sections of this Strategy define the expected outcomes and the required activities supporting the maintenance and development of our service.

1.4 Link to other developments under SEPA Flood Risk Management programme

This strategy is being published to establish what we want to achieve by 2016 in terms of flood warning service capability and delivery and links to other key flood risk management activities. Under the **National Flood Risk Assessment** (published in December 2011) and the **Flood Risk Management Planning in Scotland: Arrangements for 2012 – 2016** (published in February 2012), SEPA has outlined areas in Scotland where the potential impact of flooding is sufficient to justify further assessment and appraisal of flood risk management measures, of which flood warning is an important measure.

In addition, SEPA is also developing a **Flood Risk Mapping Strategy** for the co-ordination and management of all our map-based data and products to support flood risk management planning and the delivery and implementation of flood risk management plans and strategies to sustainably manage flood risk in Scotland. There will be linkages established between the Flood Risk Mapping Strategy and flood warning maps and data.

This flood warning strategy outlines what capabilities SEPA will deliver for river, coastal and surface water forecasting and warning by 2016. Further development beyond 2016 will be driven by the outcomes of Flood Management Strategies and Plans, which will be published in 2015/16.

2 Background to flood warning

SEPA inherited 41 flood warning schemes at inception in 1996 and all schemes currently operated to provide targeted flood warning are listed in Appendix B. The following section outlines the progress of flood warning development since SEPA's Policy 34 was published in 1998. The major milestones within this recent period are:

- In 2001 Floodline was introduced by SEPA in Scotland and for the first time provided a national passive flood warning information system.
- In 2006, SEPA introduced the Flood Early Warning System (FEWS) and new flood warning schemes for the Clyde, Kelvin and Irvine catchments.
- In 2011, the introduction of the Floodline direct warning service in Scotland provided an active dissemination system for the first time in Scotland.

2.1 Flood Warning Developments (1998 to 2010)

The Strathclyde flood of January 1994 was one of the most devastating floods in recent history in Scotland. Following this major event, the concerned local authorities pursued various flood risk management options to mitigate future flooding impacts, including the Kelvin and White Cart Flood Prevention Schemes and River Clyde Flood Management strategy. Flood warning was a key element supporting these measures and in 2007 SEPA launched formal flood warning schemes for the main rivers in the Strathclyde area. As part of the project, SEPA also invested in its flood forecasting capabilities with the development of the Flood Early Warning System (FEWS) Scotland. The introduction of this flood forecasting platform has greatly helped SEPA to deliver a nationwide programme of improvements in its forecasting capabilities which has included:

- The introduction of forecasting models and flood warning threshold improvements for the rapid response catchments in Edinburgh (Water of Leith and Braid Burn) in 2008
- The development and launch of the North East flood warning schemes for the rivers Deveron, Dee, Don and North Esk in 2010
- The introduction of a flood warning scheme for the River Devon catchment based on improved flood forecasting in 2010
- The improvement and integration within the FEWS platform of pre-existing flood warning schemes, in particular for the White Cart catchment (2007) and the Firth of Clyde coastal scheme (2009)
- Flood warning improvements incorporating threshold review, catchment model forecasting developments and upgrades to monitoring networks in the Findhorn, Burn of Mosset, Lossie, South Esk, Brothock and Tweed catchments between 2009 and 2011.

2.2 Scottish Parliament Flooding Inquiry (2008)

The Scottish Parliament Rural Affairs and Environment Committee established a Flooding and Flood Management Inquiry in 2008. Consultations were sought from a wide range of responders and flood risk management specialists. One such response outlined the challenge for flood warning in Scotland:

"Public expectations around flood warning systems can never be fully met."
Association of Chief Police Officers of Scotland. 2008

As part of the inquiry, the Scottish Parliament committee recommendations for flood warning included:

- The development of a national flood warning strategy

- Giving SEPA the ability to disseminate flood warnings directly to end users
- Upgrading existing flood warning systems and expansion into currently uncovered area
- Filling the void that exists with regard to pluvial flood warnings
- The development of flood warning systems in other areas of Scotland at risk of coastal flooding

Since the publication of the Committee recommendations, a number of significant developments have been driven forward by SEPA to address the points raised and are referred to in this section. Any outstanding recommendations such as the development of a service for pluvial (surface water) flooding form part of this strategy.

2.3 Flood Warning Dissemination Programme (2008-2011)

The programme successfully delivered and launched a new direct and targeted warning service through Floodline in April 2011. This has been a key step change in SEPA's flood warning capabilities offering active flood warning information to those at risk of flooding in Scotland and meeting one of the objectives of the Scottish Parliament recommendations. By September 2011 over 12,000 customers were registered for the service as part of a successful marketing and registration drive and this subsequently increased to over 14,000 customers by Dec 2012 (Figure 1)

In parallel to the implementation of direct warnings, a number of other significant improvements to flood warning were achieved. These included:

- The introduction of the Scottish Flood Forecasting Service; a working partnership with the Met Office to develop methods of working more closely together with the aim of improving our technical capability to forecast, model and warn against all sources of flooding in Scotland. The service now delivers a daily Flood Guidance Statement and is developing improved methods of flood forecasting to inform Category 1 and 2 Responders.
- Improved working relationships with SEPA's strategic partners around flood events through joint development of community-based flood warning areas.
- The introduction of new flood warning codes aligned with those used by the Environment Agency.
- A number of flood warning improvement projects with the aim of providing reliable and timely flood warnings to high risk locations.

2.4 Going Forward – Prioritisation of Flood Warning Developments

A prioritised approach to the development of flood warning is key to this strategy. A new methodology for assessing the benefits of flood warning was developed which assessed both the tangible and intangible benefits of flood warning (SNIFFER, 2008). The method appraises the benefits of flood warning through the reduction of risk to life and injury, social impacts, residential property damage, business and agriculture damage, infrastructure disruption and activation of property-level flood resilience measures. Since 2008, SEPA has applied this method to all new schemes requested by local authorities.

In addition, in 2009 a study was commissioned to assist in the prioritisation of future investment in coastal flood forecasting. A coastal flood vulnerability index was developed, based on exposure to wave and storm surge, number of properties at risk, historical flooding and flood defence availability.

Both the new methodology for assessing the benefits of flood warning and the coastal flood vulnerability index have been used to define the priority areas for flood warning development included in this Strategy.

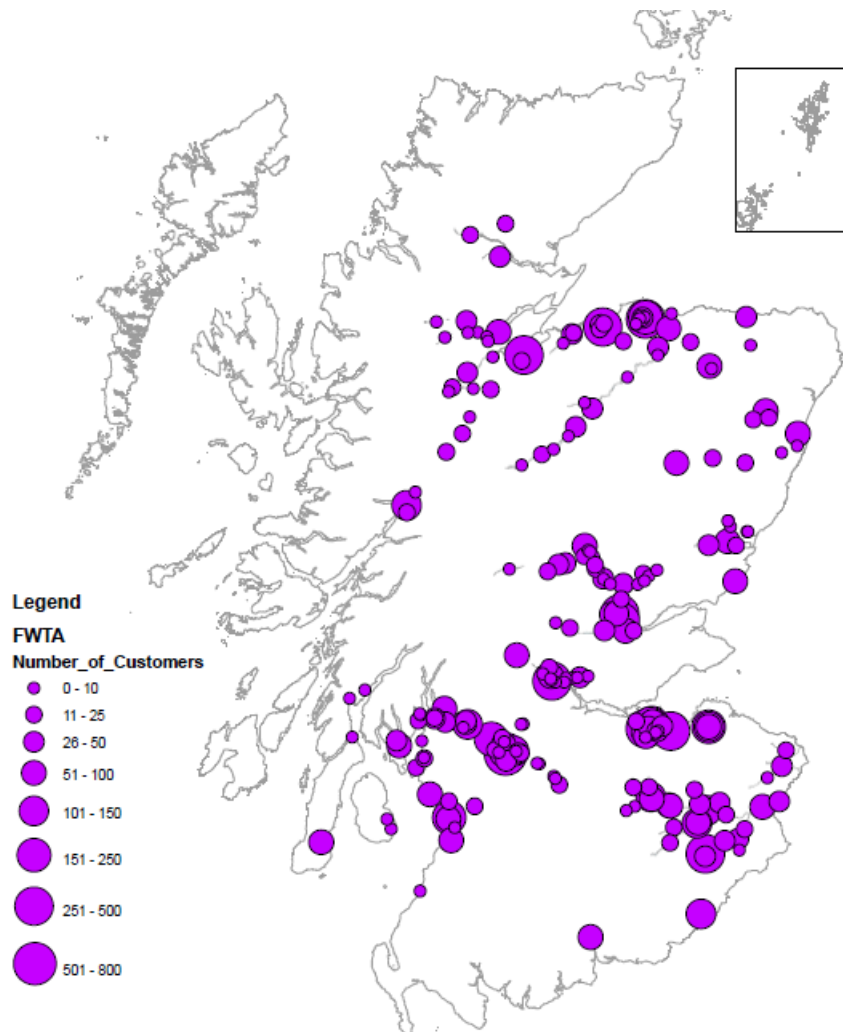


Figure 1: Map illustrating registered customers of the Floodline service per flood warning target area (August 2012)

3 Flood Detection and Monitoring

Strategic Area 1: SEPA will develop the necessary flood detection and monitoring capabilities required to deliver the flood warning service

3.1 Outcomes

SEPA will:

- Maintain and increase the quality and coverage of our monitoring capabilities in the river and coastal environment in support of the flood warning service; and
- Increase our understanding of the spatial representation and real time measurement of rainfall, maintaining the best use of SEPA's hydrometric network.

3.2 Activities

To deliver this, SEPA will:

- Ensure that the hydrometric monitoring networks (precipitation and temperature as well as loch, river and tidal water levels) are sufficient to support flood warning; make improvements where required and expand in support of service developments (Link to SEPA's Hydrometric Monitoring Network Strategy);
- Ensure that the quality of riverflow measurement (specifically high flows) is sufficient to support flood forecasting;
- Maximise the use and benefit of real time hydrometric monitoring (GPRS) in flood forecasting;
- Review the current weather radar network and its suitability for flood warning provision and make recommendations for improvements (including new and temporary installations); and
- Ensure best use of the precipitation monitoring network in combination with the radar network.

4 Surface Water Flooding

Strategic Area 2: Working with the Met Office, SEPA will develop approaches in forecasting pluvial¹ flooding

4.1 Outcomes

SEPA will:

- Increase our understanding of surface water flooding mechanisms;
- Create surface water forecasting capabilities that are at the forefront of science developments; and
- Increase the surface water forecasting and warning capabilities.

4.2 Activities

To deliver this, SEPA will:

- Understand the rainfall mechanisms behind surface water flooding and determine short range rainfall depth-duration estimates for flooding impacts;
- Work with others involved in weather science developments to capitalise on latest technology in surface water flood prediction;
- Develop a coarse resolution surface water guidance tool; and
- Undertake a scoping study for the development of hydrological modelling capabilities in urban areas to predict in real time surface water flooding potential.

¹ “Flooding as a result of rainfall when water ponds or flows over ground before it enters a natural or man-made drainage system or watercourse, or when it cannot enter because the system is already full to capacity.” SEPA, ‘Improved Understanding of Pluvial Flood Risk in Scotland, June 2009.

5 Coastal/Tidal Flooding

Strategic Area 3: SEPA will aim to reduce the impact of coastal flooding through the provision of reliable and timely flood warnings

5.1 Outcomes

SEPA will:

- Increase SEPA's coastal flood forecasting capabilities on a national scale by the use of the latest coastal flooding science developments; and
- Increase the reliability and timeliness of flood warnings to customers.

5.2 Activities

To deliver this, SEPA will:

- Maintain robustness, and increase coverage, of flood forecasting systems in support of flood warning;
- Work as a partner with the UK Coastal Monitoring and Forecasting Service to provide a comprehensive coastal flood risk forecast service in Scotland;
- Improve approaches to wind and wave forecasting in coastal and tidal/estuarial waters through further development of the Coastal Flood Alert Tool; and
- Continue to develop and enhance coastal flood forecasting through modelling and improved understanding of coastal flooding processes.

Note: The development of specific coastal flood warning schemes is included in Strategic Area 6 - Flood Warning Service Development.

6 Fluvial Flooding

Strategic Area 4: SEPA will aim to reduce the impact of river flooding through the provision of reliable and timely flood warnings

6.1 Outcomes

SEPA will:

- Create a flood forecasting capability on a national and catchment scale by utilising latest science developments; and
- Increase the reliability and timeliness of flood warnings to customers.

6.2 Activities

To deliver this, SEPA will:

- Maintain robust and appropriate flood forecasting systems in support of flood warning;
- Work alongside the Flood Forecasting Centre and Environment Agency for England and Wales and other European forecasting agencies to improve approaches to forecasting;
- Provide countrywide river flood forecasting information through the development of a national hydrological model;
- Develop methods for forecasting in rapid response and flashy catchments; and
- Improve approaches to flood forecasting for snowmelt and within reservoir or hydro-electric influenced catchments.

Note: The development of specific fluvial flood warning schemes is included in Strategic Area 6 - Flood Warning Service Development.

7 Uncertainty in Flood Predictions

Strategic Area 5: SEPA will aim to maximise the performance of its flood predictions and manage uncertainty in forecasting through risk-based communication

7.1 Outcomes

SEPA will:

- Increase our understanding of uncertainties in flooding predictions; and
- Create risk-based communication of flooding.

7.2 Activities

To deliver this, SEPA will:

- Undertake a feasibility study to introduce probabilistic approaches to river and coastal flood forecasting;
- Develop options and methods for risk-based communication to responders;
- Develop real time flood visualisation tools linked to flood forecasting; and
- Undertake post-flood event analysis to measure and improve performance of flooding predictions.

8 Flood Warning Service Development

Strategic Area 6: SEPA will provide an effective flood warning service and reduce the impact of flooding from all sources and work with communities and responders to improve their preparedness and response to flooding

8.1 Outcomes

SEPA will:

- Maintain the provision of reliable and timely flood warnings to customers;
- Maintain flood vigilance and guidance for the whole country up to 5 days ahead;
- Increase, and ensure currency of, the flood warning service customer base;
- Increase real time awareness of the risk of flooding from river, coastal and surface water risk in areas not served by community based warning schemes; and
- Increase the response and preparedness to flooding through improved reach and communication of flood warnings.

8.2 Activities

To deliver this and assuming funding from the Scottish Government continues, SEPA will:

- Continue to operate the flood warning service for those benefiting from community-based flood warnings (see Figure 2 below showing the areas currently covered by targeted flood warning schemes);
- Maintain effective flood warning dissemination, flood forecasting and telemetry systems;
- Continue to operate the Scottish Flood Forecasting Service for emergency responders;
- Deliver new coastal and tidal flood warning schemes: Firth of Forth and Tay (by 2012); Loch Linnhe (by 2013); Moray Firth and Ness tidal (by 2014); Solway Firth (by 2015) and other at-risk locations through our existing Coastal Flood Alerting Tool (CFAT) by 2016; and consider alterations to existing schemes where required and feasible;
- Deliver new fluvial flood warning schemes: Stonehaven (by 2013); Loch Lomond and River Leven (by 2016); Garnock (by 2016); and consider alterations to existing schemes where required and feasible;
- Continue to review and refine flood warning areas and thresholds using new and emerging flood risk management information and tools (developed through the implementation of the Flood Risk Management Act in particular) (Link to SEPA's Flood Risk Mapping Strategy);
- Ensure that flood warning provision is fit for purpose and is a key element of sustainable approaches to flood risk management in Scotland and that flood warning meet the needs of other flood risk management measures (Link to SEPA's Flood Risk Planning Process);
- Consider the service delivery options for those not served by specific flood warning areas (i.e. wider Flood Alerts) or for surface water alerting; and consider the introduction of a general public daily Flood Guidance product;

- Work with the public and responder communities to improve understanding of flood risk and warning service (Link to SEPA's Flooding Communications Strategy); and
- Utilise emerging digital technologies linked to Floodline (social media) and FEWS (publicly available forecasts) (Link to SEPA's Flooding Communications Strategy).

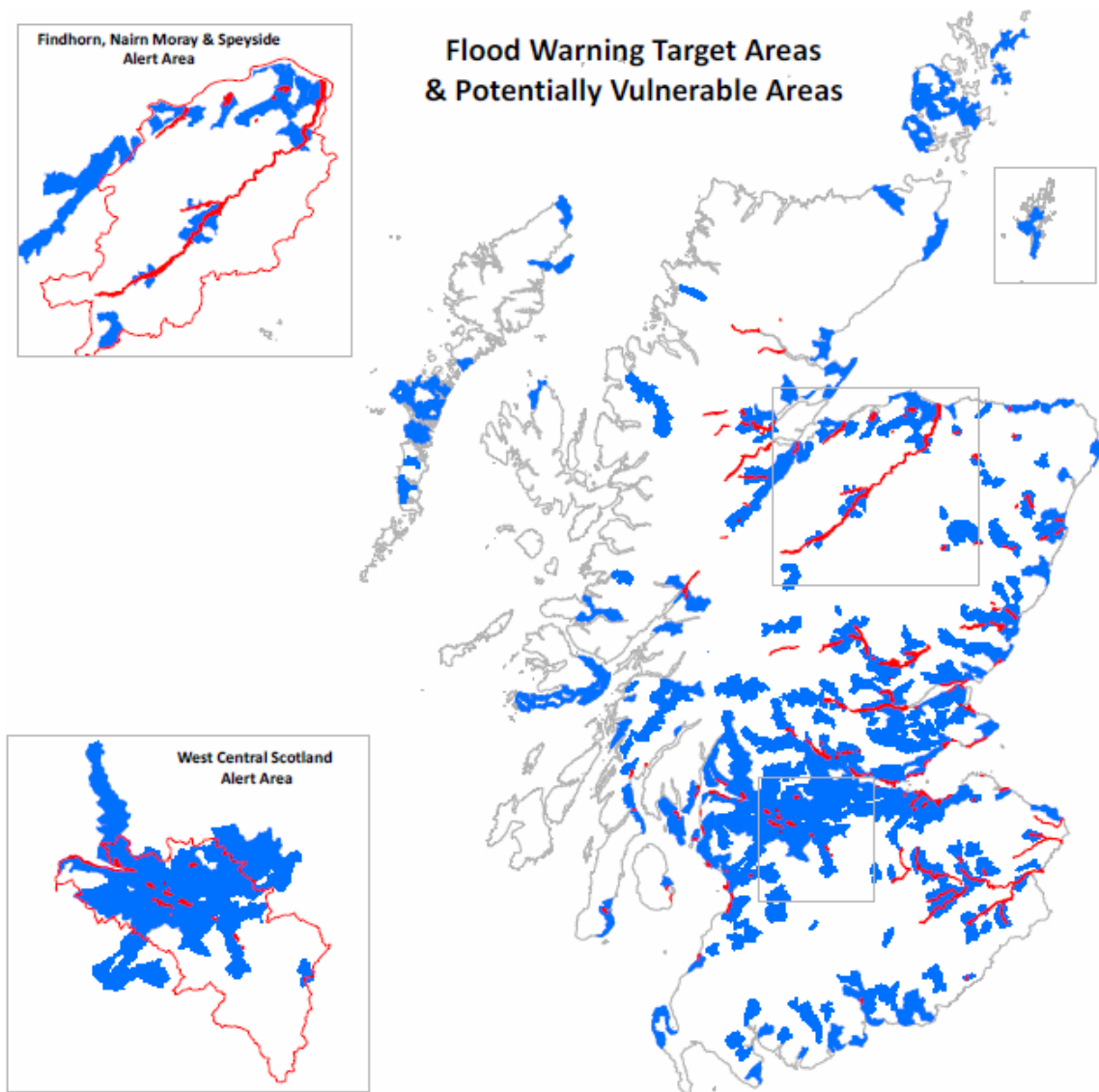


Figure 2: Map illustrating potentially vulnerable areas (blue) and areas currently covered by flood warning schemes (red)

9 Skills, Expertise and Knowledge

Strategic Area 7: SEPA will ensure that it has the required skills, expertise and knowledge to provide an effective flood warning service

9.1 Outcomes

SEPA will:

- Maintain operational readiness to flooding events and work in partnership with responders; and
- Maintain a skilled and competent staff resource involved in all flood forecasting and warning activities.

9.2 Activities

To deliver this, SEPA will:

- Ensure that all staff involved in flood forecasting, warning and response meet a minimum set of training and experience competencies;
- Ensure the best possible use of emerging weather prediction science through the development of a hydrometeorological skills capability;
- Deliver an annual flood warning exercise to test the readiness of its systems, procedures and staff; and
- Promote the 'science behind the service' through responder workshops and visits to area flood warning centres and the flood forecasting centre operations.

10 Flood Warning Strategy – Key Milestones

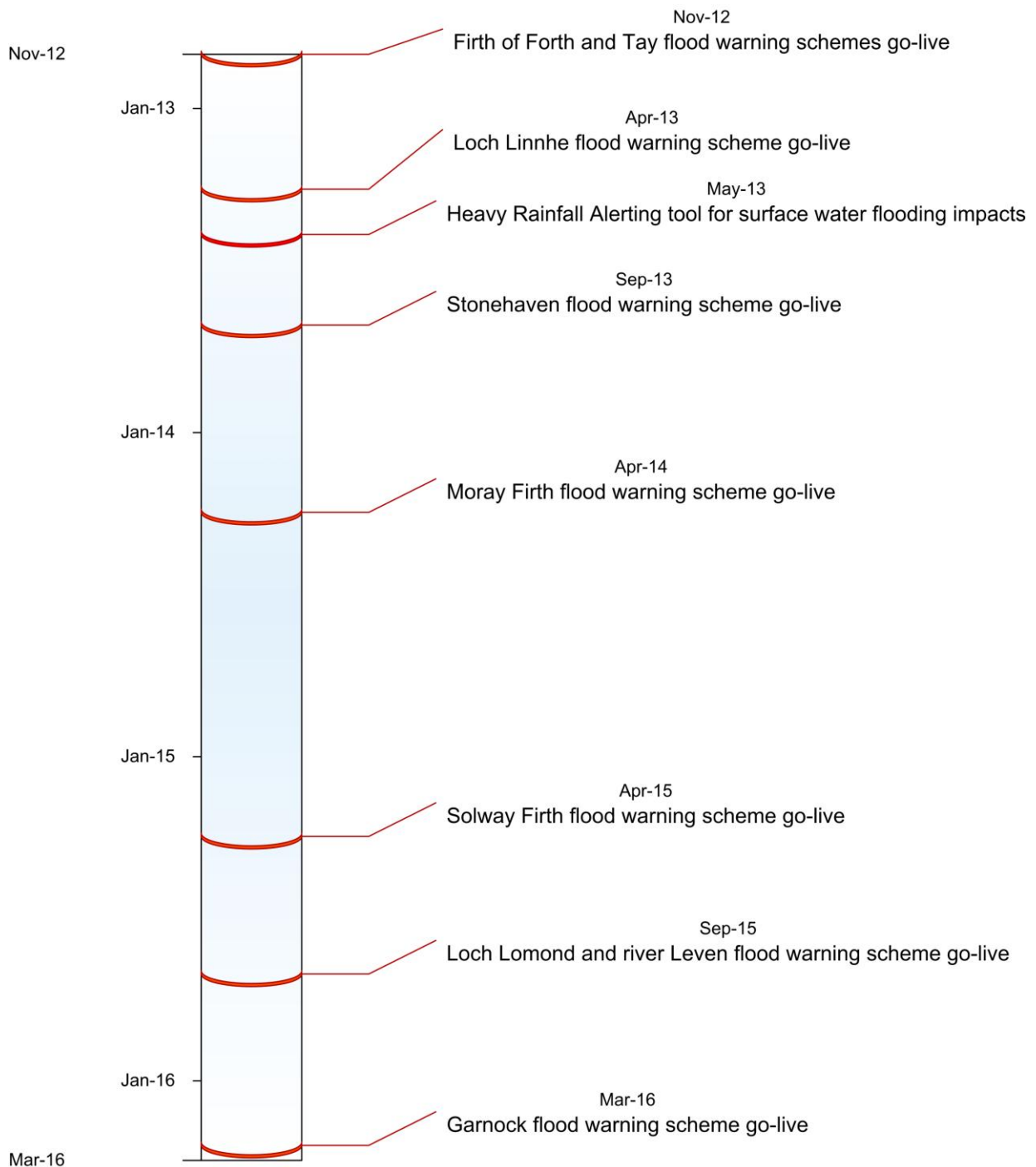


Figure 3: Overview of the key milestones for implementation of the flood warning strategy

Appendix A Contributors

This strategy has been developed and produced with the input of a number of key individuals.

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Scottish Government: Judith Tracey (Head of Managing Flood Risk Team).

Appendix B Flood Warning Schemes Coverage

The following areas are where SEPA operates targeted flood warning schemes (as of April 2012):

- Highlands and Islands: Rivers Shin, Oykel, Conon, Ness, Lochy, Nairn and Beaully.
- Moray: Rivers Findhorn, Spey and Lossie.
- Aberdeenshire: Rivers Deveron, Dee and Don.
- Angus and Dundee: North and South Esk and Brothock.
- Tayside: Rivers Tay, Lyon, Tummel, Almond, Isla, Erich and Earn.
- Central Region: Rivers Forth, Teith and Devon.
- Edinburgh and Lothians: Water of Leith, Braid Burn, Rivers Almond, Tyne and Esk.
- Scottish Borders: River Tweed and main tributaries (Ettrick, Yarrow, Teviot, Blackadder, Whiteadder, Eye, Gala, Leader, Liddel, Jed, Eddlestone, Lyne and Leithen).
- Dumfries and Galloway: River Nith.
- Strathclyde: White Cart, Kelvin, Clyde, Irvine and Firth of Clyde.