



Scotland's centre of expertise for waters

Scotland Rural Development Programme (SRDP) 2014-2020: Recommendations for targeting support to deliver maximum benefit for the water environment





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This document was produced by:

[Ioanna Akoumianaki](#), [Kit \(C.J.A.\) Macleod](#), [Ade Ibiyemi](#) and [Jannette MacDonald](#)

James Hutton Institute
Craigiebuckler
Aberdeen
AB15 8QH

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Acronyms

CREW	Centre of Expertise for Waters
CxC	Centre of Expertise for Climate Change
DPMAG	Diffuse Pollution Management Advisory Group
EAFRD	European Agricultural Fund for Rural Development
EC	European Commission
EU	European Union
FRM Act	Flood Risk Management (Scotland) Act 2009
FRMP	Flood Risk Management Plans
GhG emissions	Green-house Gas emissions
GIS	Geographic Information Systems
JHI	James Hutton Institute
NFRA	National Flood Risk Assessment
PVAs	Potentially Vulnerable Areas
RBMP cycle	River Basin Management Planning cycle
RBMP	River Basin Management Plans
SEPA	Scottish Environment Protection Agency
SRDP	Scotland Rural Development Programme
SSSIs	Special Sites of Scientific Interest
WFD	Water Framework Directive

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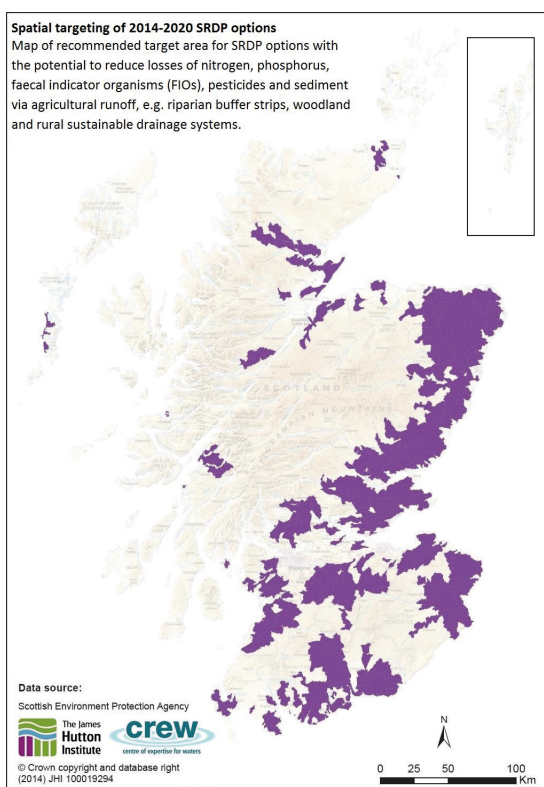
Executive Summary

The Questions

Where should the agri-environment options funded by the 2014-2020 Scotland Rural Development Programme (SRDP) be targeted to help control diffuse pollution and contribute to flood risk management? What criteria could be applied when selecting applications for SRDP support to help deliver the maximum benefit?

Key Findings

- A simple, catchment-based method was developed to enable SRDP options with the potential to benefit the water environment to be available for farmers' applications where the impacts and risk from diffuse pollution and flooding are greatest.
- Transparent scoring criteria were also laid down to help prioritise applications that address national and EU policy priorities and have the potential to deliver multiple objectives and maximise benefits.
- The methods targets options with the potential to benefit water quality by reducing and controlling agricultural diffuse pollution to priority catchments.
- The method also targets options with the potential to contribute to natural flood risk management (e.g. management of floodplains following removal of embankments, and riparian buffer strips) to catchments with areas at significant risk from river and/or coastal flooding.
- Maximising benefits for water quality involves prioritising options with the potential to tackle multiple diffuse pollution pressures, such as riparian buffer strips.
- Delivery of multiple benefits entails prioritising options with the potential to improve water and soil quality, increase resilience to flooding, enhance biodiversity, connect habitats and contribute to natural carbon storage, such as riparian buffer strips, woodlands and rural sustainable drainage systems.



- Target areas, options and scoring criteria could easily be updated to align spatial targeting with policy- and evidence-driven revisions.

Background

Achieving the objectives of the Water Framework Directive and contributing to natural flood management are key priorities in the agri-environment payment scheme offered by the 2014-2020 SRDP. Spatial targeting of SRDP payments will help Scotland cost-effectively meet these priorities by matching the spatial distribution of local and regional issues of diffuse pollution and flood risk.

Research undertaken

The list of options with the potential to improve and protect water quality was partly built upon SEPA's recommendations and partly on the evidence-base about their benefits compiled in an earlier CREW report. These benefits were linked to the spatial information gathered by SEPA about diffuse pollution pressures. The list of options with the potential to contribute to natural flood risk management was built upon SEPA's recommendations following the national spatial screening of opportunities for natural flood management. Options with the potential to reduce the losses of one or a combination of pollutants were targeted to the catchments taken forward for the priority catchment approach in line with the priorities set out in the second river basin planning cycle. Options with the potential to mitigate flood risk were targeted to catchments with areas at significant risk from river and/or coastal flooding (called potentially vulnerable areas, PVAs). The target catchments identified in this project were then integrated with the target areas identified in parallel projects for preserving biodiversity and carbon stores, to inform the Scottish Government.

Recommendations

1. Applications involving farmers' collaboration should be promoted to help maximise delivery of multiple benefits at the landscape or catchment scale and to manage hydrological connectivity.
2. A farm plan identifying diffuse pollution risks and how these can be addressed at the farm holding scale (beyond regulatory compliance) should be a pre-requisite for funding.
3. Training should be available for farmers, case officers and facilitators to enable them to ensure that the right option is targeted and properly maintained at the right place.
4. Areas out with the priority catchment approach, where previous SRDP payments delivered benefits for water quality, e.g. Loch Leven, should be targeted with the 2014-20 SRDP payments.
5. Certain options should be encouraged to tackle site-specific issues, e.g. fencing in bathing water protected areas, and riparian woodland upstream of potentially vulnerable areas.



Creation of riparian buffer strips in permanent grassland fields.

1.0 INTRODUCTION

The Scotland Rural Development Programme (SRDP), part-funded by the European Agricultural Fund for Rural Development (EAFRD), supports Scottish objectives that match the priorities of the European Union (EU) Rural Development Programme (RDP). A key requirement in the 2014 - 20 SRDP is to address the EU 2014-2020 RDP priorities for (i) restoring and preserving biodiversity, (ii) improving water and soil management, and (iii) reducing green-house gas (GhG) emissions, through agri-environment payments. In this context, the Scottish Government (SG) asked the Scottish Centre of Expertise for Waters (CREW) to develop recommendations for the spatial targeting of agri-environment options in the 2014-20 SRDP. The aim is to ensure cost-effective delivery of benefits for the water environment and to help Scotland meet the objectives of the Water Framework Directive (European Union 2000) and the Flood Directive (European Union 2007).

The Water Framework Directive sets out the overarching legislative framework for the protection and improvement of water quality. It requires that EU Member States achieve good status for all waterbodies by 2015, 2021 or 2027, through six-year cycles of river basin management plans. For example, in Scotland water quality is generally good and the overall objective is for 98% of waterbodies to be at good status by 2027 (Scottish Government 2010). In 2012, however, approximately 35 % of waterbodies in the Scotland river basin district and 55% of waterbodies in the Solway-Tweed river basin district were at less than the good status (SEPA 2014a; b). Diffuse pollution from agricultural land use was the main pressure causing the majority of these waterbodies to fail the good status required by the Water Framework Directive.

The Rural Diffuse Pollution Plan was launched in 2011 by the Diffuse Pollution Management Advisory Group (DPMAG) to help to control diffuse pollution sources and to deliver the objectives set in the River Basin Management Plans (DPMAG 2011). The Diffuse Pollution Plan includes a "national awareness-raising campaign" and the "priority catchment approach" for catchments where tackling diffuse pollution requires a more focused intervention. The priority catchment approach takes targeted action through a sequential process of assessing pressures, raising awareness, providing advice to land managers on compliance with the Diffuse Pollution General Binding Rules and delivering guidance on options available via SRDP support to improve and protect water quality, beyond compliance with regulations (Figure 1). If properly targeted, the agri-environment options offered by the 2014-20 SRDP have the potential to contribute to the objectives set in the river basin management plans.

The Flood Risk Management Scotland (2009) Act sets objectives and measures for sustainably tackling flood risk through six-year cycles of flood risk management plans from 2015 onwards. A

key objective is to consider "a set of techniques that aim to work with natural processes, features and characteristics to manage the sources and pathways of flood waters", i.e. natural flood risk management. Strategic action is being prioritised in the 243 areas identified by SEPA as vulnerable to river and/or coastal flooding, also known as potentially vulnerable areas (SEPA 2011). Natural flood management needs to be targeted to the potentially vulnerable areas but also to "opportunity areas", i.e. areas where natural features provide potential for alteration and restoration that could enhance storage of flood waters and slow down flow, thus reducing risk at the potentially vulnerable areas.

Taking a targeted approach to implementing measures is increasingly considered as more effective than having all options open to all. Some agri-environment payments in EU countries have been generally 'broad and shallow' with 'open to all' eligibility and modest demands on farmers' practices (Uthes et al. 2010). The 'narrow and deep' approach (or spatial targeting), on the other hand, aims to ensure that the distribution of payments matches the spatial distribution of environmental issues. These issues can be targeted at the local scale, e.g. farm holding, or the regional scale, e.g. landscape, zones, catchment, or for the whole country (Finn et al. 2009). In addition, many agri-environment options (including creation of buffer strips, tree shelter belts and wetlands) have the potential, if properly managed and targeted on a landscape scale, to deliver multiple benefits, for example improve water and soil quality; increase resilience to climate change and flooding; preserve biodiversity; and generally augment rural amenities (e.g. Boatman et al. 2008; Macleod et al. 2013).

The effectiveness of the 'narrow and deep' approaches has been demonstrated, in term of both environmental and financial benefits, in a number of cases. For example, targeting agri-environment options with the potential to benefit water quality, to areas failing good status under the Water Framework Directive, resulted in reductions in soil erosion and nitrogen losses (e.g. Uthes et al. 2010). Similarly, improvements in water quality were shown when agri-environment payments were targeted to designated sites for conservation (Hodge et al. 2010; Boatman et al. 2008). The major factors contributing to the effectiveness of the 'narrow and deep' approach include: focusing on measurable outcomes in vulnerable-impacted areas; gathering site-specific, baseline data to inform targeting, and; defining potential benefits on a spatial basis (see Baylis et al. 2008 and literature cited therein). For example, van der Host (2007) and Naden (2013) showed that a GIS-based spatial analysis can inform the process of designing an agri-environment targeting approach that is at the most appropriate geographic scale for policy intervention and integration.

The specific objectives-deliverables of this project were to deliver:

- 1) A list of agri-environment options to be targeted to address priorities for the water environment from water quality and flood risk management perspectives.
- 2) Maps showing the target areas to benefit the water environment.
- 3) A list of criteria for use when scoring and selecting applications for SRDP support.

¹ Macleod, CJA, Holmes, B, Vinten, A & MacDonald, J 2013, Scotland Rural Development Programme 2014-20 – assessing potential water and soil quality options, their evidence base and potential to deliver multiple benefits, CRW2012/12, Available at: <crew.ac.uk/publications>. Accessed: October 2014.

² A sequential process of assessing pressures, raising awareness, providing advice to land managers on compliance with the Diffuse Pollution General Binding Rules and providing guidance on options available via SRDP support to help deliver good status under the Water Framework Directive.organisms (Hedrick et al., 2013 and literature cited therein).

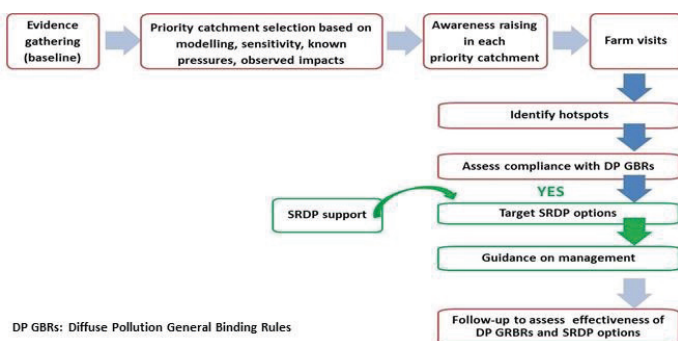


Figure 1. The priority catchment approach and its relation to SRDP support (source: DPMAG, 2011).

The target areas and criteria to benefit the water environment will be integrated with those to benefit biodiversity and carbon storage in the run up to the Scottish Government's final proposal for the 2014-2020 SRDP Targeting Project to the CAP Pillar 2 Implementation Group.

2.0 Methodology

2.1 General approach

The targeting recommendations were developed in close collaboration with SEPA staff and in consultation with the Scottish Government and experts from the James Hutton Institute. A series of meetings took place during the course of the project to ensure the timely delivery of the three deliverables of the project by mid-February 2014 (Figure 2). The steps taken are detailed in sections 2.2; 2.3; and 2.4.

2.2 Selecting options for water quality and natural flood management (Deliverable 1)

The list of agri-environment options with the potential to improve and protect water quality was partly built upon SEPA's recommendations and partly on the evidence-base compiled in an earlier CREW report (Macleod et al., 2013). This evidence related to the benefits of agri-environment options funded by previous rural development programmes across EU. The options selected, if properly managed, have the potential to reduce agricultural losses to watercourses via runoff of one or a combination of the following pollutants: nitrogen (N); phosphorus (P); faecal indicator organisms (FIOs); pesticides; and suspended solids. Options with the potential to deliver additional benefits for biodiversity, flood management and soil quality were also included in the list.

The list of agri-environment options with the potential to contribute to natural flood risk management was built upon SEPA's recommendations following the national screening of opportunities for natural flood management (e.g. Nutt, 2012). The selection of options for flood risk management was also informed by consultations with a number of organisations and stakeholders, including the Scottish Advisory and Implementation Forum for Flooding (SAIFF). Options with the potential to deliver objectives for biodiversity, climate change mitigation, and water quality were also taken forward.

2.3 Spatial targeting (Deliverable 2)

2.3.1 Selecting target areas to benefit water quality

The options selected in Deliverable 1 were targeted to areas where impacts and risks from agricultural land use were greatest.

Options with the potential to improve and protect water quality were targeted to the catchments taken forward for the priority catchment approach and the second river basin management planning cycle. These catchments included groundwater and surface waterbodies impacted by agricultural diffuse pollution, and areas important for public health such as bathing, drinking and shellfish water protected areas, as well as Natura 2000 sites. Spatial data were provided by SEPA to enable targeting to focus on the "operational area" within each priority catchment, i.e. where farm visits are planned to ensure compliance with the Diffuse Pollution General Binding Rules.

SEPA provided information on the ongoing consultation process for the preparation of the second river basin management planning cycle (2015-2021). At the time of developing this project, 59 catchments have been found to be applicable for the priority catchment approach through the second cycle (Figure 3), which includes the fourteen priority catchments that were taken forward during the first cycle (2009-2015). Action in the 59 catchments may be phased over the second and third river basin management planning cycles following consultations later in 2014. The 59 catchments shown in Figure 3 are recommended as targets for 2014-2020 SRDP support to reduce the impacts and risks from agricultural diffuse pollution, hereafter reported as "target areas for water quality".

Targeting of options to reduce a specific pollutant was tailored to the Water Framework Directive objectives applicable to each waterbody type, as shown in Table 1. SEPA provided spreadsheets showing which waterbodies within the operational areas of the target areas for water quality fail the standards under the Water Framework Directive for nitrates, ammonia, phosphorus, pesticides and faecal indicator organisms. Where possible, and to ensure that all degrees of pressures were taken into account, evidence included: waterbodies failing the ecological quality ratios for diatoms and macrophytes (indicating phosphorus pressures); waterbodies failing the SPEAR_{pesticides} indicator (insect SPEcies At Risk) (indicating pesticide pressures); and waterbodies failing the provisional standard for Scotland for the Proportion of Sediment-sensitive (benthic) Invertebrates (PSI).

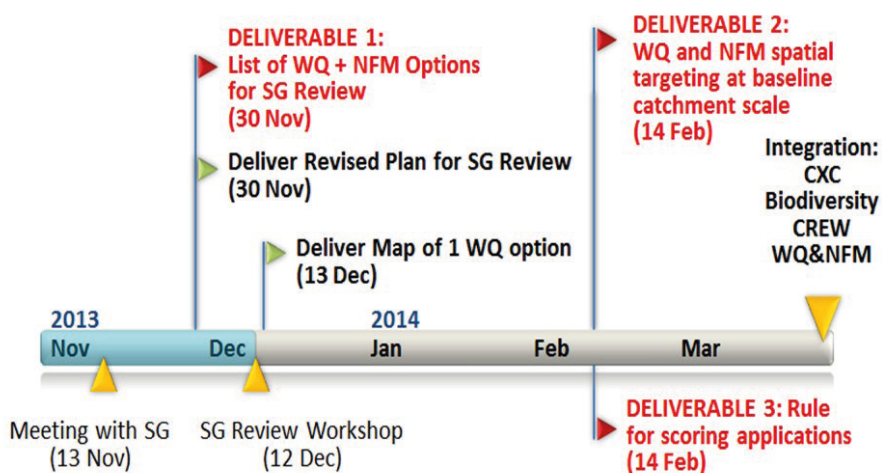


Figure 2. Initial timeline suggested for the CREW targeting project. SG: Scottish Government; WQ: Water Quality; NFM: Natural Flood Management; CXC: Centre of Expertise for Climate Change.

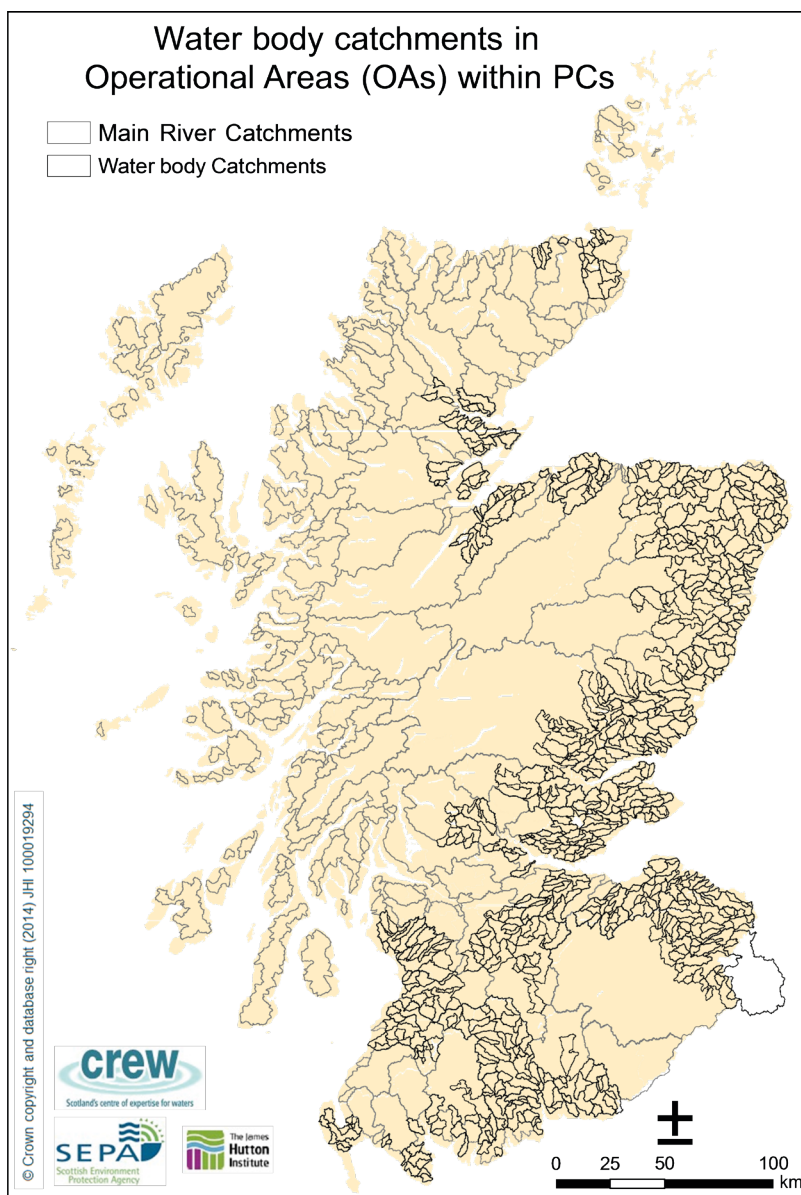


Figure 3. Waterbodies (no=725) within the operational areas (OAs) of the priority catchments selected for the second river basin management planning cycle. These waterbodies are recommended as target areas for water quality in the 2014 – 2020 SRDP. PCs: priority catchments.

Table 1. List of pollutants potentially linked to agricultural diffuse pollution pressures and for which the Water Framework Directive sets out standards (according to waterbody type) that must be met to support good ecological status.

Pollutant	Waterbody type
Nitrogen (Nitrates; ammonium)	<ul style="list-style-type: none"> • Drinking water protected areas • Rivers • Transitional waters
Phosphorus (dissolved; particulate; total)	<ul style="list-style-type: none"> • Drinking water protected areas • Natura 2000 sites • Rivers • Lakes • Transitional waters
Faecal Indicator Organisms (FIOs)	<ul style="list-style-type: none"> • Drinking water protected areas • Bathing water protected areas • Shellfish water and freshwater fisheries protected areas
Pesticides	<ul style="list-style-type: none"> • Drinking water protected areas • Natura 2000 sites
Suspended solids*	<ul style="list-style-type: none"> • Natura 2000 sites

*There are concerns about the impacts of suspended solids in drinking water, shellfish water and freshwater fisheries protected areas and transitional waters but there is no standard under the Water Framework Directive.

More specifically:

- Options with the potential to reduce nitrogen losses were targeted to catchments with drinking water protected areas and to river waterbodies failing the ammonium standard.
- Options with the potential to reduce phosphorus losses were targeted to river waterbodies failing the standard for dissolved phosphorus as well as the diatom standard and also to catchments with drinking water and Natura 2000 protected areas.
- Options with the potential to reduce losses of faecal indicator organisms to watercourses were targeted to catchments with protected areas for bathing, drinking, shellfish and freshwater fisheries waters.
- Options with the potential to reduce pesticide losses were targeted to: drinking water protected areas; catchments draining to Natura 2000 sites; waterbodies failing pesticide standards; and waterbodies failing the SPEAR indicator.
- Options with the potential to reduce suspended solids were targeted to waterbodies failing the provisional PSI standard and in priority catchments draining to Natura 2000 sites to ensure protection of flagship species for aquatic nature conservation (e.g. pearl mussels) from high turbidity and sediment deposition.

Before applying this targeting method to all water quality options identified as described in section 2.2, we tested the robustness and simplicity of the approach by targeting one option (i.e. winter stubbles) in mid-December 2013 (Annex 1). Following approval by the Scottish Government, we identified the target areas for water quality for each option with the potential to reduce one or a combination of pollutants. The steps followed to define the target areas for each “water quality” option identified in section 2.2 are described in detail in Annex 2.

2.3.2 Selecting target areas to contribute to natural flood management

Ideally, options with the potential to control flood risk should be targeted to two types of areas.

- The “opportunity areas for natural flood management”, identified by Nutt et al. (2012) for SEPA, to enable flood risk to be reduced downstream by slowing flow and enhancing floodplain storage.
- The 243 potentially vulnerable areas (PVAs) to flooding and sediment deposition, identified by SEPA during the National Flood Risk Assessment (NFRA 2011). Flood risk in these areas may be generated by: high tides and stormy conditions (i.e. “coastal flooding”); excessive rainfall causing rivers to burst their banks (i.e. river flooding, also known as “fluvial flooding”); or a combination of coastal and river processes (“coastal & fluvial flooding”).

Nevertheless, a number of uncertainties are associated with the currently identified potential target areas for natural flood risk management (SEPA 2013). Firstly, these areas have been identified on the basis of a relatively gross spatial resolution (e.g. 250m X 250m) that may be incompatible with the concept of spatial targeting. Secondly, the top or bottom reaches of the catchments within these areas have been classed as having “no data available” for sediment management, making it difficult to identify both the sources of sediments and where deposition could be addressed or influenced by changes in land management practices. Thirdly, the precise links of flood risk with land use and management have not been identified yet on a site-specific basis.

Options with the potential to contribute to natural flood management were targeted to the main river catchments draining into potentially vulnerable areas at risk from “fluvial flooding”

and to potentially vulnerable areas at risk from “coastal” and/or “coastal & fluvial flooding”, hereafter reported as target areas for natural flood management. The potentially vulnerable areas nested in the main river catchments were classified according to the source of flood risk, as shown in Figure 4, to enable each flood risk type and the opportunities for reducing them to be addressed in the targeting approach. The steps followed to define target areas for each “flood” option identified in section 2.2 are described in detail in Annex 3.

2.4 Criteria for scoring farm applications (Deliverable 3)

Simple criteria to help score and prioritise applications were built to help address national and EU priorities for rural development and align the prioritisation of applications with SEPA’s strategies to deliver the objectives of the Water Framework Directive and the Flood Risk Management Act (2009). Specifically we addressed the following questions:

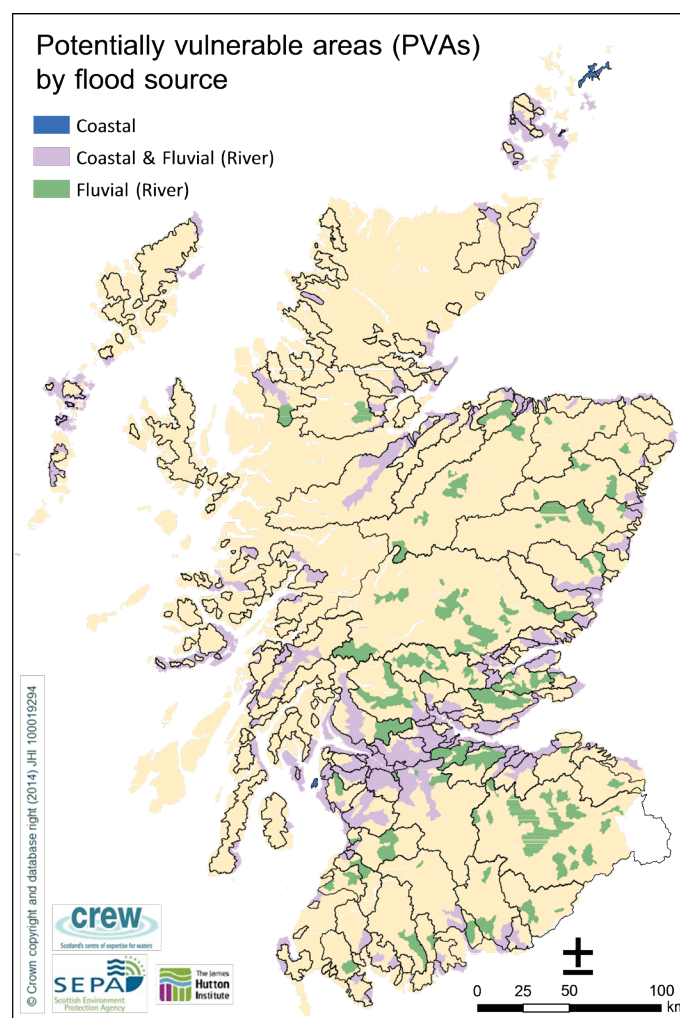


Figure 4. Target areas for natural flood management showing the distribution of the potentially vulnerable areas (PVAs) by source of flooding: “fluvial” (river), “coastal & fluvial”, or exclusively “coastal flooding”. All PVAs were also at risk from pluvial flooding (i.e. ponding). Shetland is not shown here but contains PVAs at risk from “coastal & fluvial flooding”.

Question 1: How can we prioritise the delivery of measurable outcomes when selecting applications for SRDP support?

Priorities for action (prioritisation scenarios) within priority catchments have been outlined in the consultation process towards the publication of the second river basin management plans under the Water Framework Directive. These scenarios are shown in Figure 5 and indicate where action can be prioritised within the target areas for water quality. Addressing the river basin management planning priorities in the SRDP selection process involves allocating a higher score to applications referring to land within priority catchments assigned as "Category 1" (i.e. priority catchments in the first river basin management cycle and bathing, drinking, shellfish water protected areas) and "Category 2" (i.e. catchments draining to Natura 2000 sites), as shown in Figure 5.

Prioritising options within the target areas for natural flood management involves considering whether the application refers to land within the potentially vulnerable areas and/or land within opportunity areas for natural flood management according to currently available spatial evidence.

Question 2: What criteria can be used for aligning policy priorities for water quality and flood risk management with other national priorities and EU directives, such as those preserving biodiversity, reducing and capturing GhG emissions from soils and ecosystems, and preserving cultural heritage monuments?

Prioritising options to help deliver multiple policy priorities involves taking into account whether the application refers to designated sites and their spatial overlaps within the target areas for water quality and natural flood management. More specifically, the target areas for water quality, i.e. the priority catchments to be taken forward in line with the prioritisation scenarios shown in Figure 5, already include drinking (including groundwater), shellfish, freshwater fish, bathing water, aquatic Sites of Special Scientific Interest (SSSIs) and Natura 2000 protected areas under the Water Framework Directive. In addition, both the target areas for water quality and natural flood management include terrestrial parts of Natura 2000 sites and SSSIs. The flood risk management plans (NFRA, 2011) will target areas with low potential of recovery from flooding within designated sites for conservation and the preservation of natural heritage.

Also, applications referring to potentially vulnerable areas located within the target area for water quality satisfy the criterion for prioritising areas with overlapping policy priorities. In general, prioritising applications for land where designated sites and potentially vulnerable areas overlap could help achieve multiple benefits in keeping with the integrated resource management supported in the Land Use Strategy (Scottish Government 2011).

Question 3: How can we account for the multiple benefits that can potentially be delivered by an application?

Certain options have the potential to deliver a wide range of benefits, for example water and soil quality improvements, increased resilience to flooding, enhanced biodiversity, habitat connectivity and carbon sequestration, as shown in the assessment of the evidence base carried out by Macleod et al. (2013). Prioritising applications for such options can enhance effectiveness at the landscape scale.

Question 4: How can we prioritise the delivery of benefits at the catchment scale?

Synergies in the uptake of SRDP options have the potential to deliver benefits at a wider scale, such as habitat connectivity and floodplain management at the landscape scale. Therefore, including, or not, partnerships and collaborations in an

application, provides a criterion for the scale of the delivery of benefits.

Question 5: How can we address site-specific issues and incentivise uptake under the principle of "the right option at the right place"?

Site-specific evidence and mapping about areas suitable for the uptake of a certain option, either within a farm plot or a catchment i.e. "opportunity mapping", has the potential to enable SRDP support to be tailored to what needs to be done and where. In addition, training for farmers, case officers and facilitators has the potential to help with targeting and implementing the right option at the right place. Appropriate guidance on maintenance and installation of SRDP options is also a key component of determining the effectiveness of SRDP support for the water environment.

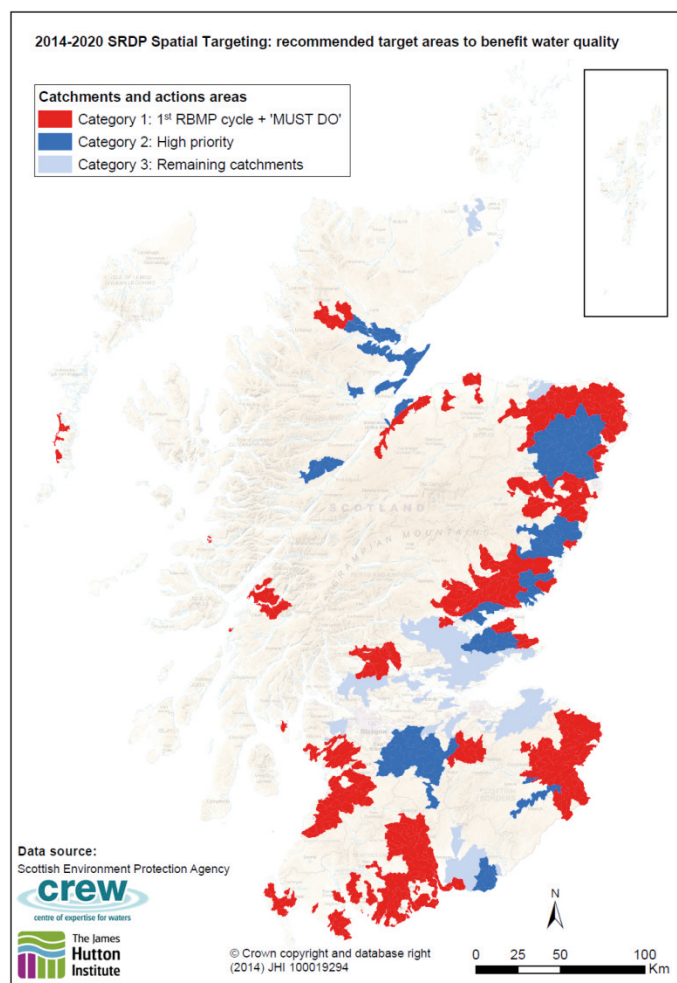


Figure 5. Scenarios for prioritising action (including uptake of SRDP options) during the second river basin management planning (RBMP) cycle. Category 1: priority catchments selected in the first RBMP cycle and 'must do' catchments, i.e. bathing, drinking and shellfish water protected areas; Category 2: high priority catchments, i.e. catchments draining into Natura 2000 designated sites; Category 3: remaining catchments taken forward for the second RBMP cycle.

3.0 RESULTS

3.1 List of options (Deliverable 1)

Eight annual recurrent (management) options were recommended to be targeted in the 2014-20 SRDP for their potential to deliver benefits for water quality (Table 2). In addition, 14 capital items with the potential to prevent or mitigate diffuse pollution from steading and in-field agricultural practices were recommended for consideration in the 2014-20 SRDP (Table 3). 'Irrigation lagoons' is the only water quantity protection measure in these lists.

Table 2. List of annual recurrent (management) options to benefit water quality recommended for the next SRDP.

Hedgerow restoration and management
Retention of winter stubbles for wildlife
Stubbles followed by green manure in an arable rotation
Beetle banks
Creation or management of grass buffers in arable fields
Creation or management of riparian buffers in permanent grassland fields
Removing livestock from fields with watercourses during the bathing water season
Converting arable at risk of flooding or erosion to grassland

Table 3. List of "stand-alone" capital items with potential water quality benefits recommended for the next SRDP. SuDS: Sustainable Drainage Systems.

Managing steading drainage: roof drainage, surface/underground drainage, rural SuDS (swales, retention ponds, wetlands)
Slurry storage
Pesticide handling facilities
Tramline management
Woodland for water
Alternative watering
Hotspot management: hard standings for troughs and gateways
Hotspot management: livestock access tracks
Hotspot management: livestock crossings
In-field rural SuDS: traps & bunds
In-field rural SuDS: swales
In-field rural SuDS: retention ponds
In-field rural SuDS: constructed wetlands
Water use efficiency: creation of off-line irrigation lagoon

Ten annual recurrent (management) options with the potential to contribute to natural flood management were recommended for consideration in the 2014-20 SRDP (Table 4). "Floodplain management" and "restoration of intertidal habitats" were specifically included in the list to address objectives of the Flood Risk Management Act (2009). In addition, eight capital items with the potential to contribute to natural flood management were

also recommended for consideration in the 2014-20 SRDP (Table 5). With the exception of "in-ditch wetlands" and "restoration of river banks", the remainder of natural flood management capital items were also taken forward to address impacts on water quality.

Table 4. List of annual recurrent (management) options with the potential to contribute to natural flood risk management recommended for consideration in the 2014-2020 SRDP.

Creation or management of grass buffers in arable fields
Creation or management of riparian buffers in permanent grassland fields
Converting arable at risk of flooding or erosion to grassland
Floodplain management
Management of species-rich grassland and wetland habitats
Management and restoration of lowland raised bogs
Buffer areas for lowland raised bogs and fens
Restoration of intertidal habitats
Hedgerow restoration and management
Moorland management

Table 5. List of capital items with the potential to contribute to natural flood risk management recommended for consideration in the 2014-2020 SRDP.

In-field rural SuDS: traps & bunds
In-field rural SuDS: swales
In-field rural SuDS: retention ponds
In-field rural SuDS: constructed wetlands
In-field rural SuDS: wetlands (in-ditch)
Woodland for water
Restore river banks
Tramline management

Certain options were also included in the list of options compiled by the Biodiversity and Climate Change Targeting Groups, as follows:

- "Hedgerows", "winter stubbles", "winter stubbles-green manure", "beetle banks", and "grass buffers" were targeted for their potential to deliver benefits for biodiversity.
- "Grass buffers" and "converting arable to grassland" were targeted for their potential to benefit water quality and contribute to natural flood management.
- Certain options such as 'riparian buffers in permanent grassland' were targeted for water quality, natural flood management, biodiversity and climate change.
- 'Woodland for water', 'tramline management', and 'in-field rural SuDS' have been included in the lists of options for water quality and natural flood management.
- Options targeting lowland bog habitats and the creation of buffer areas for bogs and fens have also been taken forward to increase resilience to flood risk and climate change.
- With the exception of 'in-ditch wetlands' and 'restoration of river banks', the remainder of capital items with the potential to contribute to natural flood management (Table 5) were also taken forward to address diffuse pollution from agricultural land use.

3.2 Target areas (Deliverable 2)

3.2.1 Target areas for water quality

Overall, six different maps are recommended indicating the availability of the eight annual recurrent options and the 14 capital items within the target areas for water quality. Matching combinations of potential benefits with observed diffuse pollution impacts resulted in six groups of options sharing the same target area.

- **Water quality target area 1** shows availability of 15 options (annual recurrent and “stand-alone” capital items), which have the potential to reduce all of the observed diffuse pollution impacts: “steading drainage and rural suds”; “woodlands for water”; “in-field rural suds: swales”; “in-field rural suds: traps & bunds”; “in-field rural SuDS: constructed farm wetlands”; “in-field rural SuDS: retention ponds”; “water use efficiency: irrigation lagoons”; “hotspot management: hard standing for troughs and gateways”; “hedgerows”; “beetle banks”; “removing livestock from fields with watercourses during the bathing water season”; “grass buffers in arable fields”; “riparian grass buffers in permanent grassland”; “converting arable at risk of flooding or erosion to grassland”.

Therefore, these options are available at all catchments within the target area for water quality (Figure 6).

- **Water quality target area 2** shows availability of two options, “winter stubbles” and “winter stubbles followed by green manure”, which have the potential to reduce nitrogen, phosphorus, pesticide and sediment losses into groundwater and surface waters but have no effect on FIO losses; therefore, these two options were not targeted to catchments where FIOs losses into groundwater and surface water were the only observed impact or projected risk (Figure 7).
- **Water quality target area 3** is for “slurry storage”, which is targeted to catchments where nitrogen, phosphorus and FIO losses have the potential to cause or have caused failure of the good status under the Water Framework Directive (Figure 8).
- **Water quality target area 4** is for “pesticide handling facilities”, which is targeted to catchments needing protection from losses of pesticide into groundwater and surface waters (Figure 9);
- **Water quality target area 5** is for “tramline management”, which is targeted to catchments at risk from phosphorus, pesticide and sediment losses into surface waters (Figure 10); and
- **Water quality target area 6** shows availability of two capital items related to hotspot management, i.e. “livestock tracks” and “livestock crossings”, which are available to all catchments within the target area for water quality except for one catchment with pesticide pressures exclusively (Figure 11)

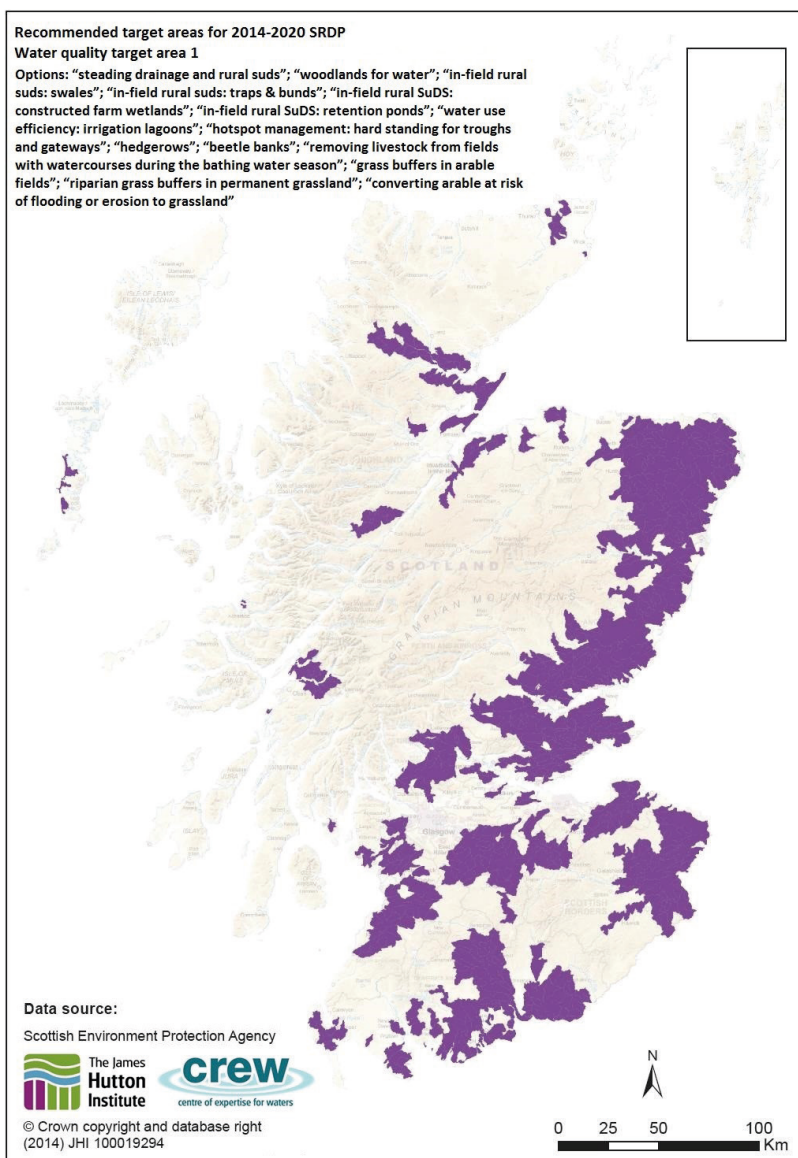


Figure 6. Water quality target area 1 (recommended) for 15 options: “steading drainage and rural suds”; “woodlands for water”; “in-field rural suds: swales”; “in-field rural suds: traps & bunds”; “in-field rural SuDS: constructed farm wetlands”; “in-field rural SuDS: retention ponds”; “water use efficiency: irrigation lagoons”; “hotspot management: hard standing for troughs and gateways”; “hedgerows”; “beetle banks”; “removing livestock from fields with watercourses during the bathing water season”; “grass buffers in arable fields”; “riparian grass buffers in permanent grassland”; “converting arable at risk of flooding or erosion to grassland”. Number of waterbodies within target area: 725.

**Recommended target areas for 2014-2020 SRDP
Water quality target area 2**

**Options: "retention of winter stubble";
"winter stubble followed by green manure"**

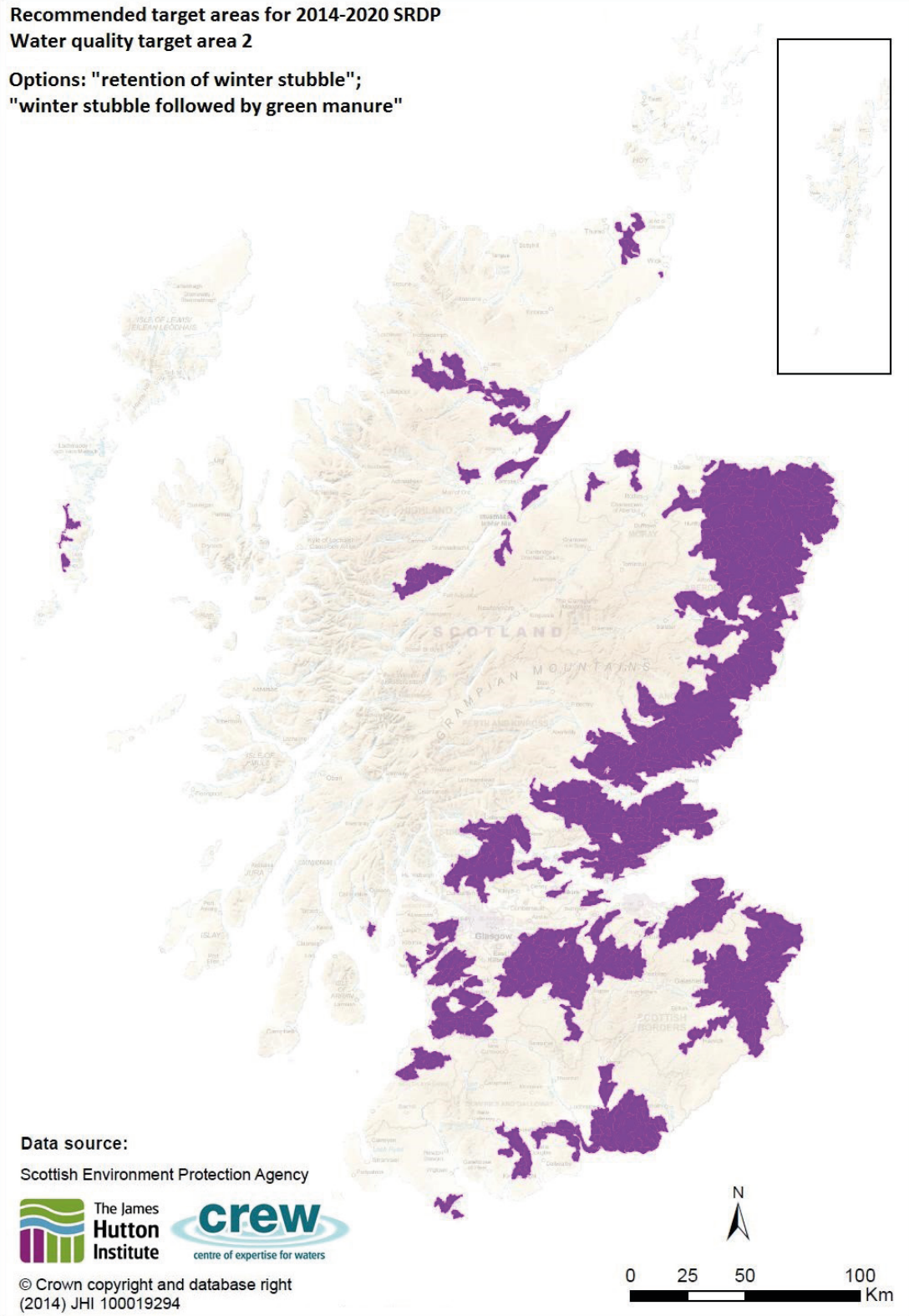


Figure 7. Water quality target area 2 (recommended) for “retention of winter stubbles” and “winter stubbles followed by green manure”. Number of waterbodies within target area: 603.

Recommended target areas for 2014-2020 SRDP
Water quality target area 3
Option : "slurry storage"

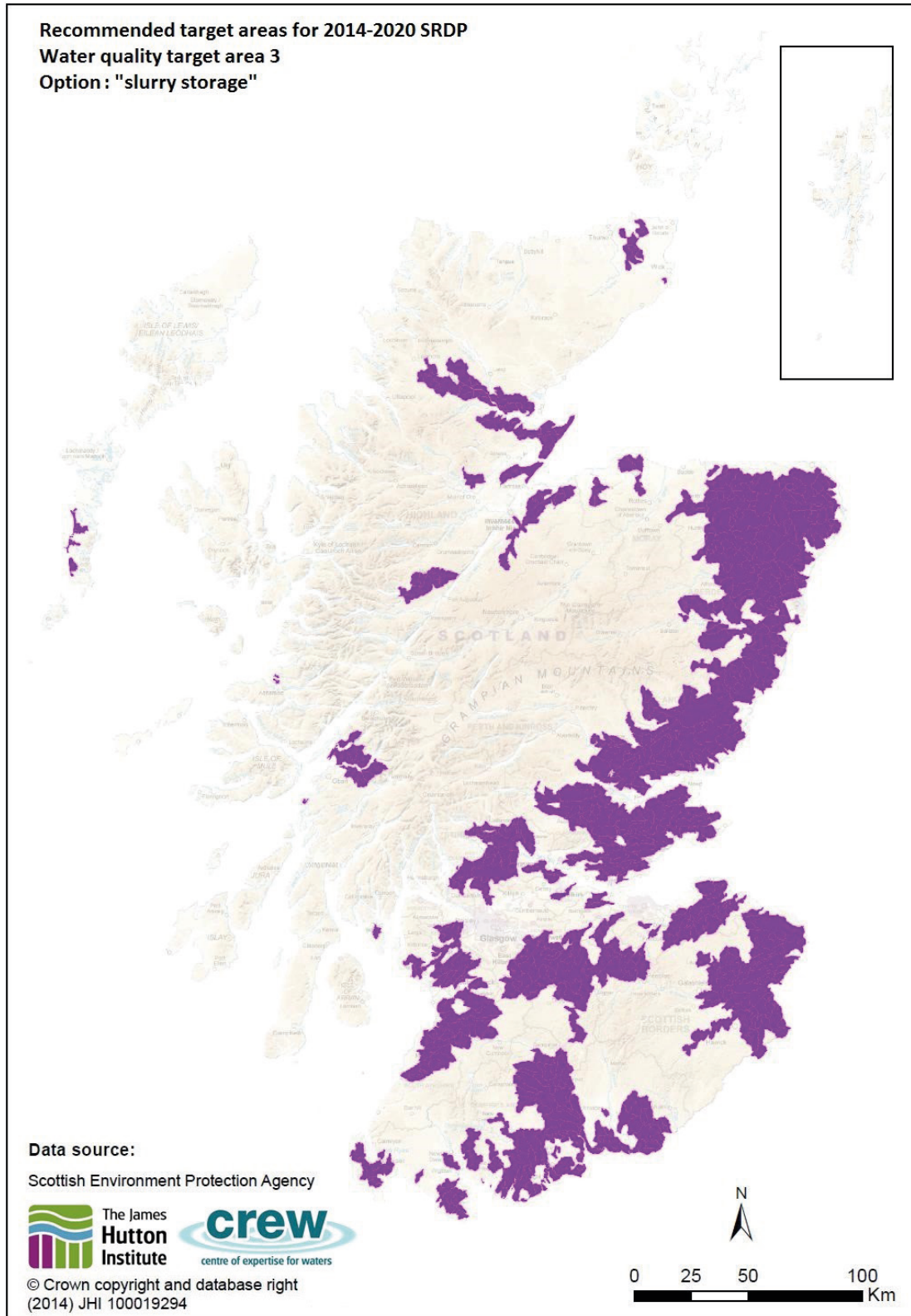


Figure 8. Water quality target area 3 (recommended) for "slurry storage". Number of waterbodies within target area: 721.

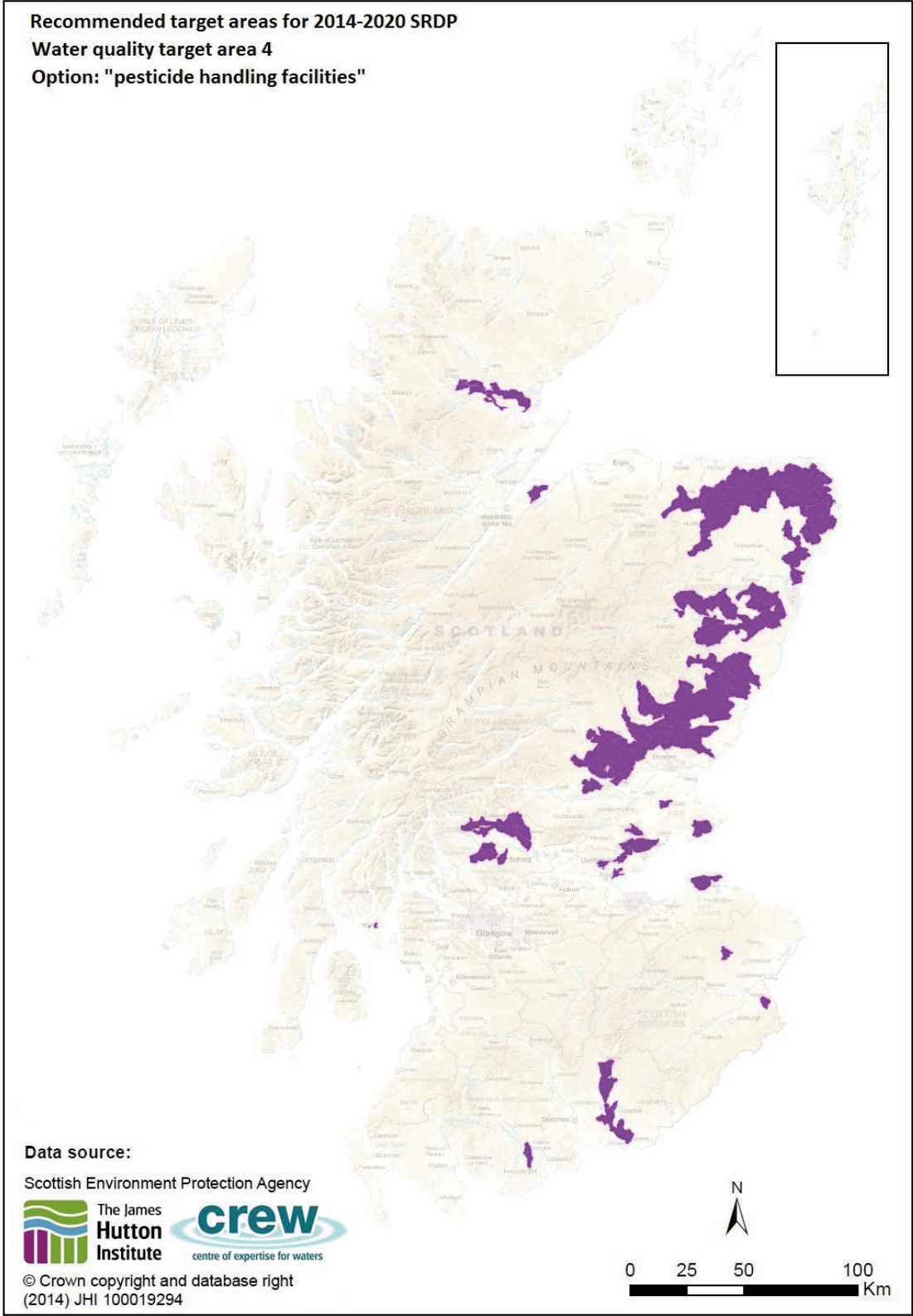


Figure 9. Water quality target area 4 (recommended) for “pesticide handling facilities”. Number of waterbodies within target area: 197.

Recommended target areas for 2014-2020 SRDP
Water quality target area 5
Option: "tramline management"

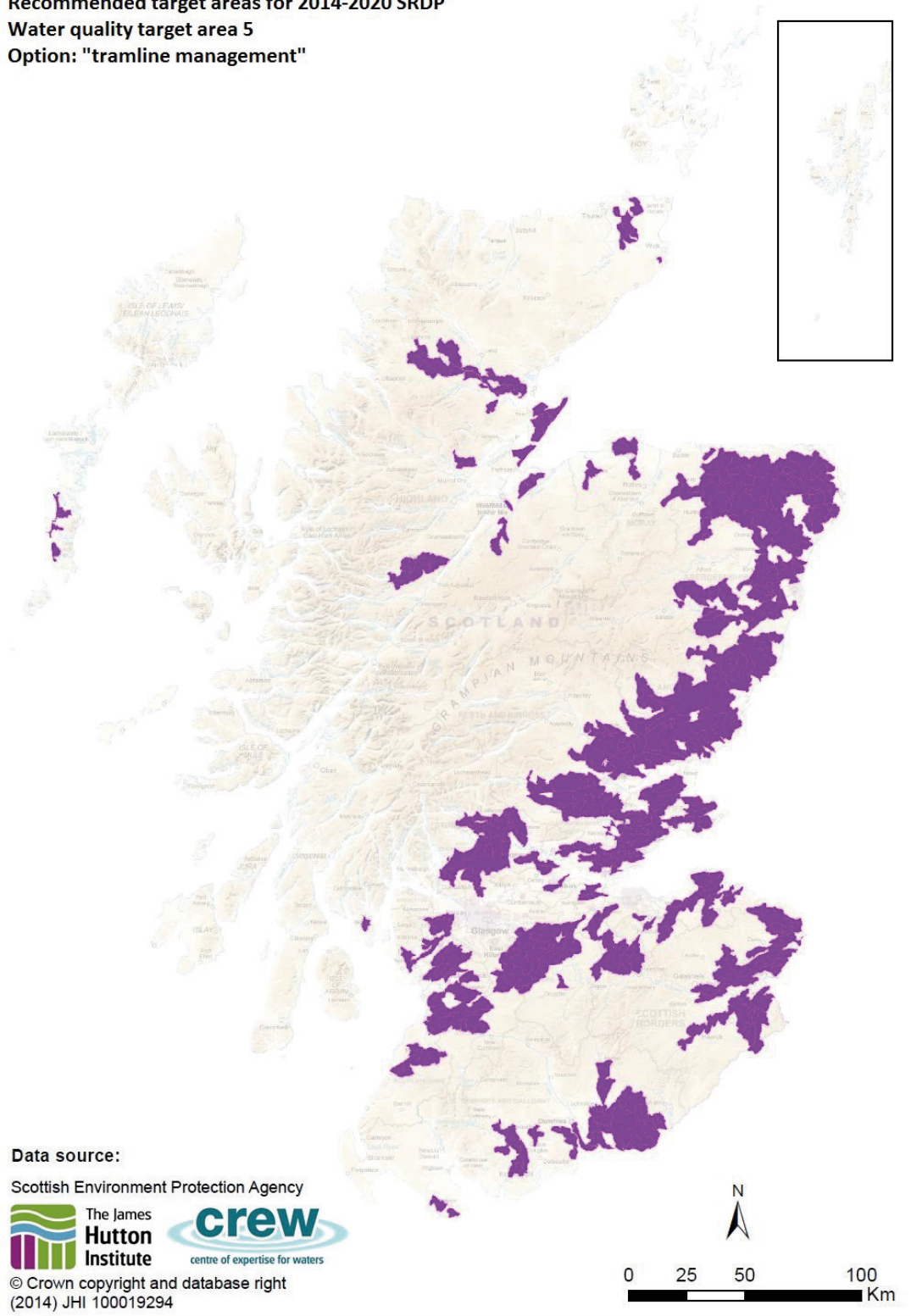


Figure 10. Water quality target area 5 (recommended) for "tramline management". Number of waterbodies within target area: 528.

Recommended target areas for 2014-2020 SRDP
Water quality target area 6
Options: "hotspot management: livestock tracks"
"hotspot management: livestock crossings"

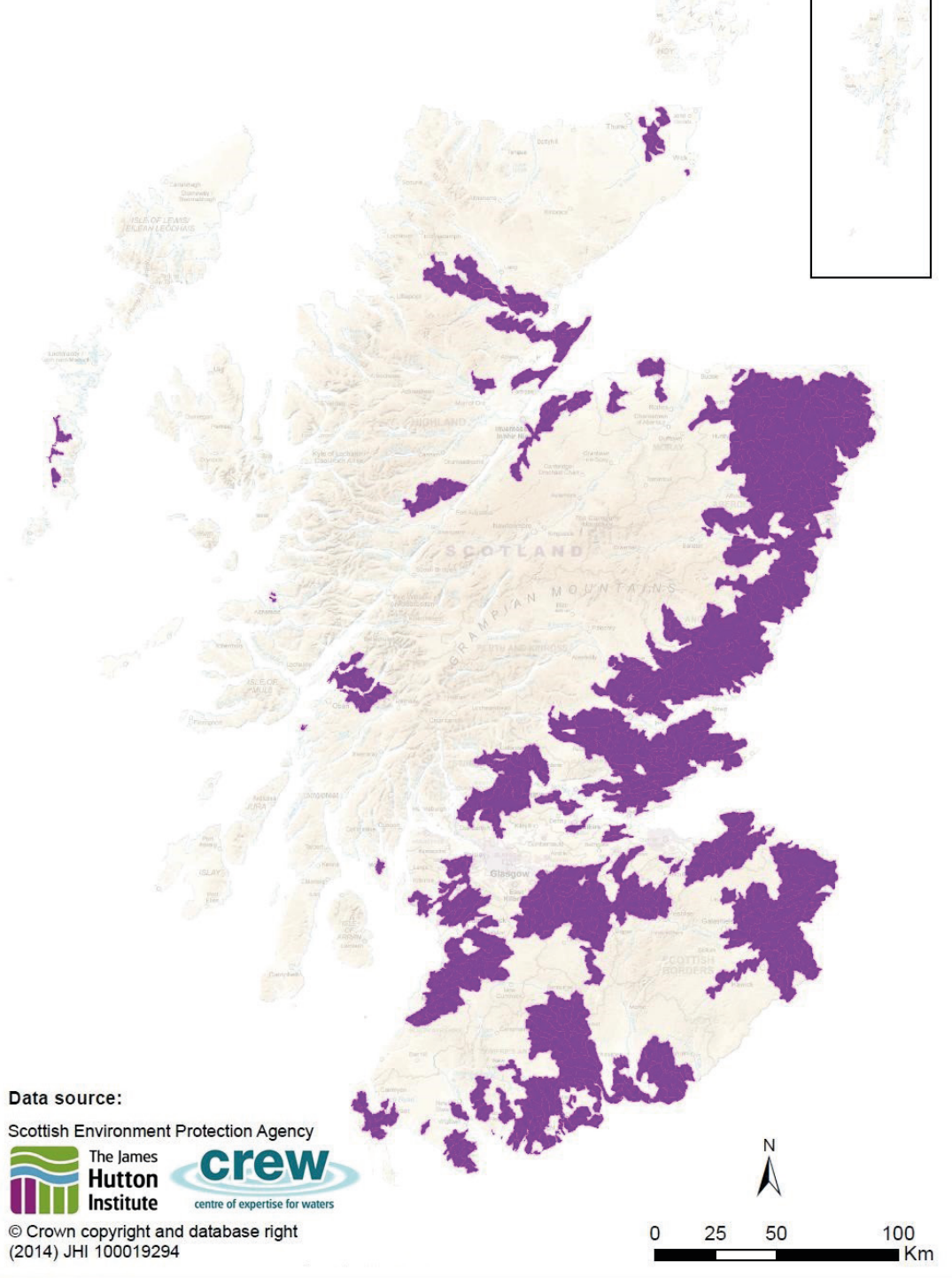


Figure 11. Water quality target area 6 (recommended) for "Hotspot management: livestock tracks" and "Hotspot management: livestock crossings". Number of waterbodies within target area: 723.

3.2.2 Target areas for natural flood management

Overall, two targeting maps are recommended to indicate availability of options within the target area for natural flood management.

- **Natural flood management target area 1** indicates availability of options with a potential to reduce fluvial (river) flooding in catchments draining into “fluvial” and / or “coastal & fluvial” potentially vulnerable areas (Figure 12). These options are: “grass buffers in arable fields”; “riparian buffers in permanent grassland fields”; “converting arable at risk of flooding or erosion to grassland”; “floodplain management”; “management of species rich grassland and wetland habitats”;

wetland habitats”; “lowland raised bogs”; “buffer areas for lowland raised bogs and fens”; “hedgerows”; “moorland management” “in-field rural SuDS: traps & bunds”; “in-field rural SuDS: swales”; “in-field rural SuDS: retention ponds”; “in-field rural SuDS: constructed wet lands”; “in-field rural SuDS: wetlands (in-ditch)”; “woodland for water”; “restore river banks”; “tramline management”.

- **Natural flood management target area 2** shows the availability of “restoration of intertidal habitats” in “coastal’ and “coastal & fluvial” potentially vulnerable areas and in catchments with “coastal & fluvial” potentially vulnerable areas to ensure an integrated catchment approach to combined sources of flood risk (Figure 13).

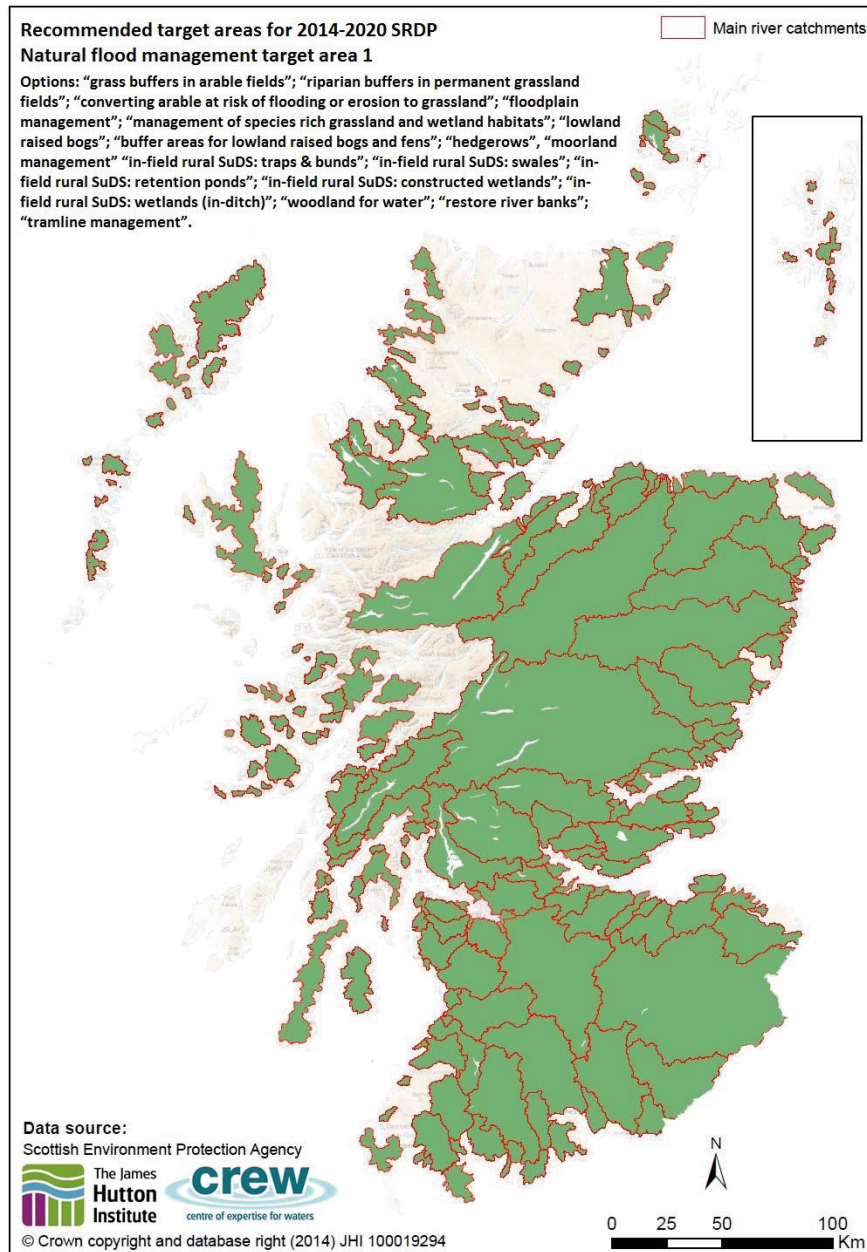


Figure 12. Natural flood management target area 1 (recommended) for 17 options (annual recurrent and “stand-alone” capital items) with the potential to mitigate fluvial flooding: “grass buffers in arable fields”; “riparian buffers in permanent grassland fields”; “converting arable at risk of flooding or erosion to grassland”; “floodplain management”; “management of species rich grassland and wetland habitats”; “lowland raised bogs”; “buffer areas for lowland raised bogs and fens”; “hedgerows”; “moorland management” “in-field rural SuDS: traps & bunds”; “in-field rural SuDS: swales”; “in-field rural SuDS: retention ponds”; “in-field rural SuDS: constructed wetlands”; “in-field rural SuDS: wetlands (in-ditch)”; “woodland for water”; “restore river banks”; “tramline management”.

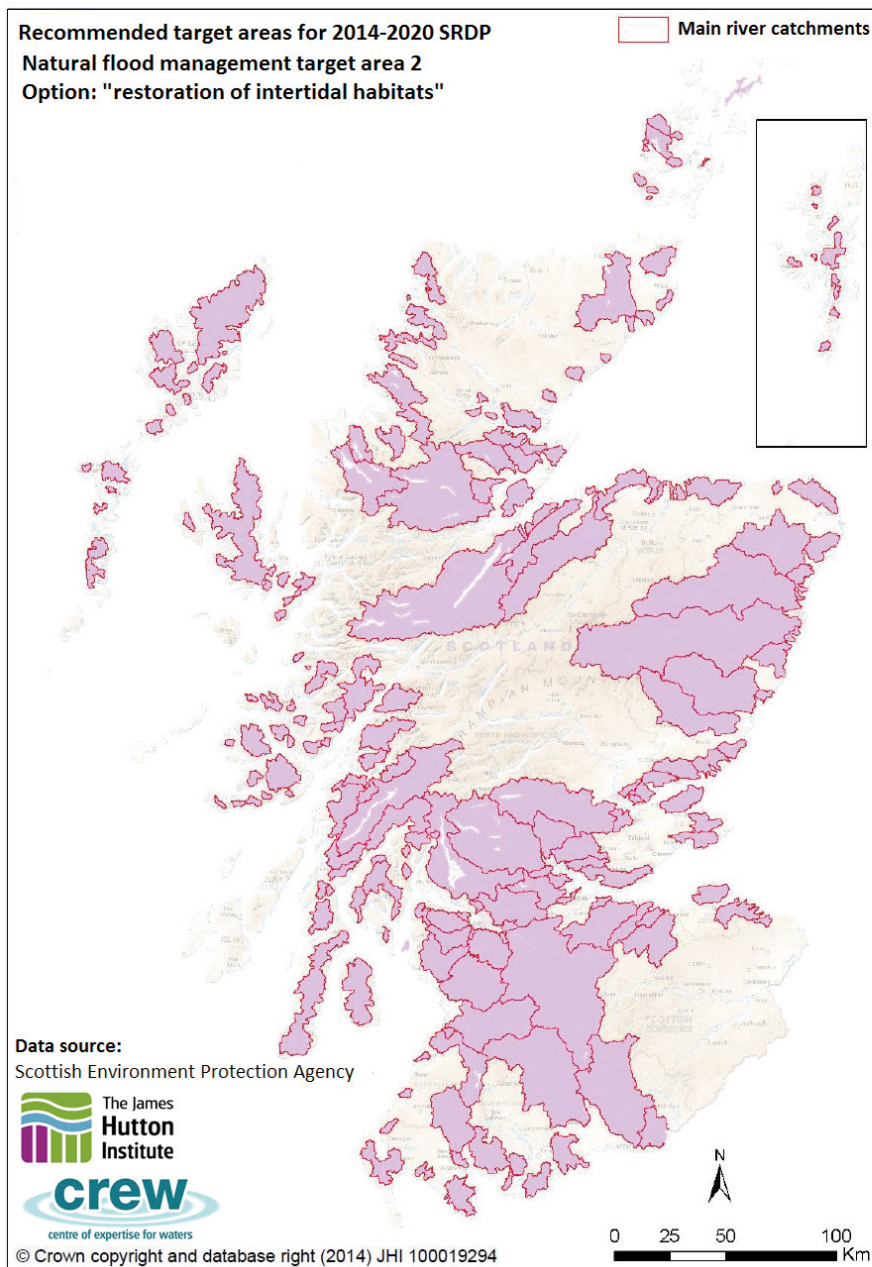


Figure 13. Natural flood management target area 2 for "restoration of intertidal habitats".

3.3 Scoring criteria when selecting applications (Deliverable 3)

The aim of the scoring recommendations presented in Tables 6 and 7 is to enable a higher score to be allocated to applications with the potential to address national and EU policy priorities; deliver multiple benefits; and maximise benefits. The major criteria for prioritising applications include:

- Alignment with the priorities set in the river basin and flood risk management plans.
- Implementation within designated sites and their spatial overlaps to help to deliver national and EU policy priorities.
- Potential of options to deliver multiple benefits at the landscape scale.
- Potential of options to tackle multiple pressures and risks.
- Implementation through partnerships and collaborations.
- Justification of uptake on the basis of farm-specific opportunity mapping.
- Training for farmers, case officers and facilitators.
- Expert guidance.
- Site-specific issues.

Table 6. List of criteria recommended for prioritising and scoring applications in the 2014-2020 SRDP from a water quality perspective. Depending on SRDP budget, target catchments may be refined according to scoring prioritisation. RBMP: River basin management planning. RPID: Rural payments and inspections division. FAS: Farm advisory service.

Scoring criteria for water quality	Higher score to be allocated to applications referring to
Alignment with the priorities set in the 2nd RBMP cycle	Farm holdings within: <ul style="list-style-type: none"> ✓ Catchments selected for 1st RBMP + protected areas for bathing, drinking, shellfish, and fishing waters (Category 1 in Figure 5). ✓ Catchments with high priority areas (i.e. aquatic Natura 2000 sites) (Category 2 in Figure 5). ✓ Remaining catchments (Category 3 in Figure 5).
Delivery of national/EU policy priorities	Farm holdings within or adjacent to: <ul style="list-style-type: none"> ✓ Designated (terrestrial) sites under the Habitats and the Wild Birds Directive and Sites of Special Scientific Interest (SSSIs). ✓ Potentially vulnerable areas and “opportunity areas” in line with the flood risk management plans. ✓ Sites identified for their potential to enhance carbon stores under the Land Use Strategy. ✓ Sites identified as iconic landscapes and cultural heritage.
Multiple benefits	Options with the potential to deliver additional benefits such as: <ul style="list-style-type: none"> ✓ Improve soil quality; increase resilience to flooding; enhance biodiversity; contribute to carbon sequestration; connect habitats.
Range of diffuse pollution pressures	Farm holdings within: <ul style="list-style-type: none"> ✓ Priority catchments with a variety of diffuse pollution pressures.
Collaboration	Collaborative schemes: <ul style="list-style-type: none"> ✓ With the potential to benefit water quality at a landscape or waterbody scale.
Opportunity mapping	Options targeted to: <ul style="list-style-type: none"> ✓ High risk areas for diffuse pollution within a farm holding where greatest benefits could be delivered.
Farm plan*	Options justified by: <ul style="list-style-type: none"> ✓ A survey; farmer self-audits; SEPA's 1:1 surveys in the priority catchment approach; guidance from RPID or FAS.
Farmer's training	Options for which farmers have received training for proper implementation and maintenance.
Pollutant transport**	Options that, if properly grouped across a catchment, have the potential to reduce pollutants at source, intercept pollutants during transport, and protect the receiving waters
Site-specific needs	Options that have been shown to address specific pressures e.g. livestock fencing in catchments draining to bathing waters.

*This could be part of the eligibility criteria. **Guidance must be provided to case officers.

Table 7. List of criteria recommended for prioritising and scoring applications to add value to natural flood management (NFM) in the 2014-2020 SRDP. FRMPs: Flood risk management plans. RPID: Rural payments and inspections division. FAS: Farm advisory Service.

Scoring criteria for water quality	Higher score to be allocated to applications referring to
FRMPs priorities	Farm holdings within: <ul style="list-style-type: none"> ✓ Potentially vulnerable areas ✓ “Opportunity areas” for natural flood management upstream of potentially vulnerable areas
Collaboration – management of hydrological connectivity*	Options: <ul style="list-style-type: none"> ✓ Submitted as part of collaborative schemes to ensure reduction of flow generation (source), slowing down and storage (transport) and mitigation of flood risk within potentially vulnerable areas (receptors).
Delivery of national/EU policy priorities	Farm holdings within or adjacent to: <ul style="list-style-type: none"> ✓ Priority catchments ✓ Designated (terrestrial) sites under the Habitats and the Wild Birds Directive and as Sites of Special Scientific Interest (SSSIs). ✓ Sites identified for their potential to enhance carbon stores under the Land Use Strategy. ✓ Sites identified as iconic landscapes and cultural heritage.
Multiple benefits	Options with the potential to deliver additional benefits such as: <ul style="list-style-type: none"> ✓ Improve water and soil quality; increase resilience to climate change; enhance biodiversity; connect habitats.

Table 7.Continued	
Scoring criteria for water quality	Higher score to be allocated to applications referring to
Opportunity mapping	Options targeted to: ✓ Areas at risk from flooding within a farm holding where greatest benefits could be delivered.
Farm plan**	Options justified by: ✓ A survey; farmer self-audits; SEPA's 1:1 surveys; guidance from RPID or FAS.
Farmer's training	Options for which farmers have received training for proper implementation and maintenance.
Site-specific needs	Options that have been shown to address specific pressures e.g. woodland for water in riparian areas upstream of selected potentially vulnerable areas.

*Guidance to be prepared for case officers and facilitators. **Guidance must be provided to case officers.

4.0 Policy implications of the targeting approach

4.1 Opportunities

Aligning 2014 – 20 SRDP support with Scotland's and EU's policy priorities will help to deliver policy objectives and multiple benefits for rural development. The targeting approach and scoring criteria developed here open up a range of opportunities for cost-effectiveness, as follows:

- Making an option available where it can deliver measurable water quality benefits or contribute to natural flood management is a form of SRDP uptake optimisation.
- Matching potential water quality benefits with observed impacts in priority catchments adds value to SEPA's efforts to meet good status under the Water Framework Directive.
- Targeting SRDP payments to areas at significant risk from flooding and "opportunity areas" for natural flood management is a way of promoting the implementation of natural flood management techniques by farmers.
- Prioritising policy goals with public interest (e.g. protection and recovery of bathing and drinking waters from diffuse pollution and flood risk mitigation in potentially vulnerable areas) contributes to the delivery of long-term multiple benefits for rural areas.
- Endorsing a catchment-wide approach and prioritising partnerships and overlaps of target areas with designated areas for conservation, cultural heritage and carbon storage, is in line with the Ecosystem Services approach (Scottish Government, 2011).

In addition, the method is:

- Flexible, as target areas, options and scoring criteria can be updated without affecting the scope of targeting, i.e. the right option at the right place.
- Robust, as it is based on a detailed baseline dataset (i.e. SEPA's assessments to inform the river basin management plans and the flood risk management plans) and a growing body of evidence on the benefits of options.
- Transparent, as the scoring criteria are based on evidence and the steps for targeting are described in detail. Therefore, the method could easily be repeated in the future or elsewhere.

Finally, it must be also recognised that certain options, such as those contributing to natural flood management, may be broadly offered rather than spatially targeted to enable emerging site-specific pressures to be tackled without the need to update the whole targeting approach.

4.2 Limitations

Targeting agri-environment schemes to areas with known agricultural pressures and observed impacts is not new in Scotland, as demonstrated by the priority catchment approach. However, it raises significant challenges. In particular:

- There is a significant body of evidence on the effectiveness of most options when considered individually and at the farm holding scale; however, little monitoring evidence is currently available on the effectiveness of these options in combination and at a catchment/waterbody scale. Gathering quantitative data on the benefits of the options to be taken forward in the 2014 - 2020 SRDP is stipulated in the Rural Development Regulation .
- The actual effect of individual options, as opposed to the potential effect, is determined by site-specific factors, such as slope or proximity to a watercourse. Therefore, although this targeting approach is catchment-based, identifying high risk areas for the installation of options at the farm holding scale can be as important as uptake of the options themselves in achieving objectives.
- To enable measureable outcomes, uptake of options to deliver benefits at a landscape or catchment scale requires quantitative assessment of the appropriate scale of the uptake of SRDP options. For example, it would be useful in the future to identify how many kilometres of riparian buffers and associated SRDP payments are required in each catchment.
- Consideration of where collaborative schemes for water quality improvement or natural flood management can deliver catchment-wide and measurable benefits would greatly increase cost-effectiveness.
- Ensuring water quality is protected in areas at risk, e.g. from future land use pressures, needs further consideration. Protection is likely to be more cost-effective than restoration. For example, removing SRDP support from areas out with priority catchments where previous SRDP spend delivered benefits, e.g. Loch Leven, would result in a decline in water quality.

⁴ A draft report can be accessed on line at:

<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:347:0487:0548:EN:PDF>

5.0 Concluding remarks

This report describes the policy drivers of, and the evidence base for, the spatial targeting of 2014 – 2020 SRDP support and the application selection process, to help mitigate diffuse pollution and flood risk. Close collaboration of CREW with SEPA, Scottish Government staff and JHI experts was instrumental in the development of a robust and transparent method to enhance the implementation of river basin and flood risk management plans. Emphasis has been placed on explaining how water quality issues in priority catchments have been matched with the options that could tackle these issues; and how flood risk in potentially vulnerable areas could be reduced by targeting “opportunity areas” upstream. Thorough analyses of available data provided by SEPA, and consultation with JHI experts has enabled the delivery of lists of options with the potential to help achieve good status under the Water Framework Directive and to contribute to natural flood management under the Flood Risk Management Act (2009). The report identifies target areas where the potential benefits and effectiveness of each option are maximised, and provides recommendations on scoring criteria to help the application selection process.

The key findings can be summarised as follows:

- A simple, catchment-based method was developed to enable SRDP options with the potential to benefit the water environment to be available for farmer applications where the impacts and risk from diffuse pollution and flooding are greatest.
- Scoring criteria were also laid down to help prioritise applications that address national policy priorities and have the potential to deliver multiple objectives and maximise benefits.
- The method targets options with the potential to reduce and control agricultural diffuse pollution, such as grass strips in arable land and riparian buffer strips, to priority catchments.
- The method targets options with the potential to mitigate and control flooding, such as management of floodplains following removal of embankments to help store flood waters, to catchments with areas assessed by SEPA as vulnerable to river and/or coastal flooding.
- Addressing policy priorities requires that applications include land on or adjacent to:
 - Protected areas for drinking, bathing, shellfish and freshwater fishing waters and aquatic Natura 2000 sites in line with the objectives set in the 2nd river basin management planning cycle.
 - Potentially vulnerable areas to flooding (PVAs) and/or areas providing opportunities for natural flood management in line with the objectives set in flood risk management plans.
 - Areas designated under the Habitats and Wild Birds Directive and SSSIs.
 - Areas designated as sites for enhancing carbon stores under the Land Use Strategy.
- Delivery of multiple benefits entails prioritising options such as riparian buffer strips in grassland and arable land and woodland for water, which can improve water and soil quality, increase resilience to flooding, enhance biodiversity, connect habitats and contribute to carbon sequestration.
- Maximising benefits involves prioritising options with the potential to tackle multiple diffuse pollution pressures, such as rural sustainable drainage systems, which can reduce losses of nitrogen, phosphorus, faecal indicator organisms (FIOs), pesticides, and sediment to watercourses.
- Target areas could easily be updated to align targeting with policy- and evidence-driven revisions.

The following **additional recommendations** are made to help enhance the cost-effectiveness of the targeting approach developed here.

Firstly, scoring should prioritise applications involving farmers' collaboration to help maximise delivery of multiple benefits at the

landscape scale, enhance habitat connectivity and control hydrological to mitigate transfer of pollutants and flood risk.

Secondly, a farm plan identifying diffuse pollution risks and how these can be addressed at the farm holding scale (beyond regulatory compliance) should be a pre-requisite for funding.

Thirdly, training should be available for farmers, case officers and facilitators to enable them ensure that the right option is targeted and properly maintained at the right place. Also, areas out with the priority catchment approach, where previous SRDP payments delivered benefits for water quality, e.g. Loch Leven, should be targeted with 2014-20 SRDP payments.

Finally, certain options should be encouraged to tackle site-specific issues, e.g. fencing in bathing water protected areas and woodland for water in riparian areas upstream potentially vulnerable areas.

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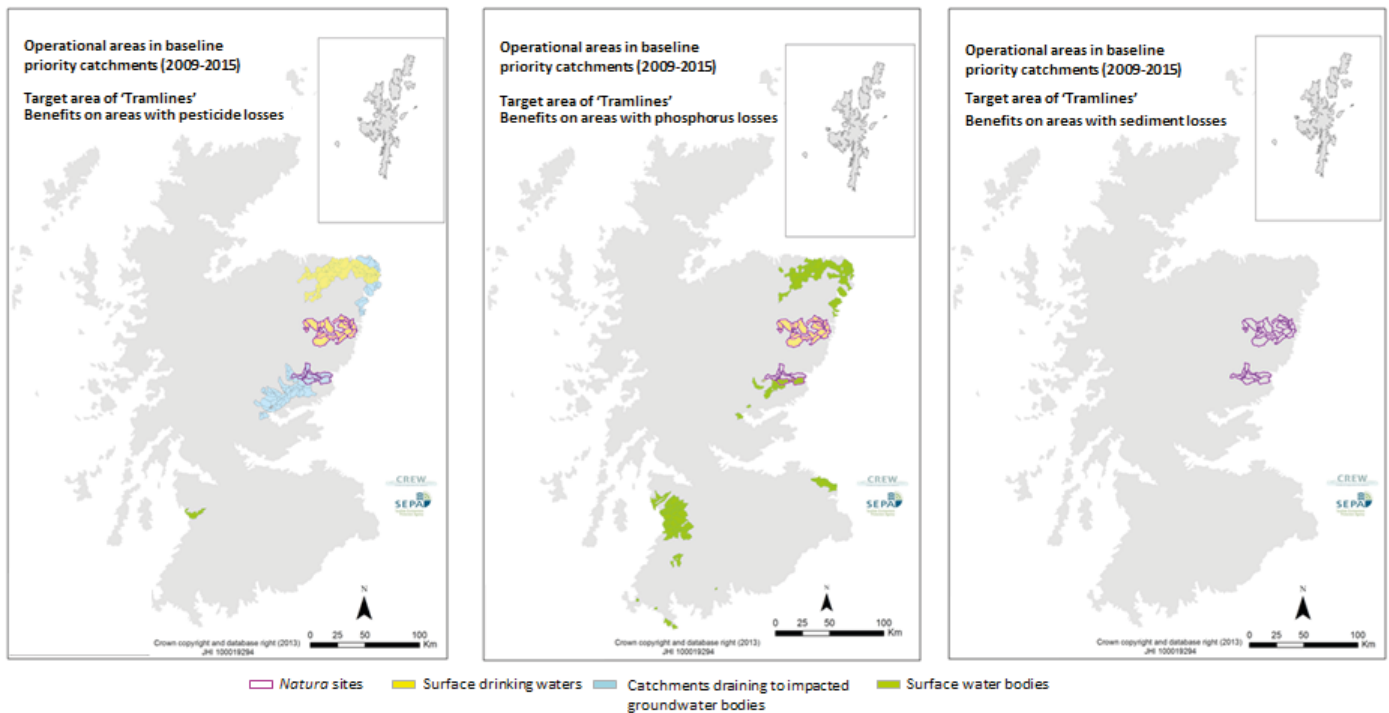
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Annex

Annex 1: Trial maps

Trial map delivered to the Scottish Government in December 2013 to showcase how our targeting approach addressed policy objectives using SEPA's priority catchments selected for the 2009-2015 river basin management planning cycle.



Annex 2: Description of the nine sequential steps to identify target areas for each water quality option

The method proposed here included the following steps:

1. Reviewing the agri-environment benefits on water quality detailed in an earlier CREW project (Macleod et al., 2013).
2. Extracting a sub-set of potential benefits to water quality from the wider set of benefits on water quality and soil quality detailed by Macleod et al., 2013. For targeting purposes, we considered the potential benefits on reducing losses to surface waters and groundwater of:

- ✓ Nitrogen (N), referring to nitrates (NO₃⁻) and ammonium (NH₄⁺);
- ✓ Phosphorus (P), referring to soluble reactive (SRP) and particulate phosphorus (PP);
- ✓ Plant protection products (PPP), referring to pesticides;

- ✓ Faecal indicator organisms (FIOs); and
 - ✓ Suspended solids, referring to sediments.
3. Extracting the scoring of the potential effectiveness of each option and capital item to deliver the potential benefits. In Macleod et al. (2013), scores of potential effectiveness ranged from -1 (some potential to decrease benefit) to 2 (large potential to increase benefit).
 4. Simplifying the scoring of potential effectiveness adopted in Macleod et al. (2013) by transforming it to a simple yes/no scoring: 'yes' representing low or large potential for benefit; 'no' representing lack of evidence or potential to decrease benefit, i.e. increase losses to watercourses.
 5. Matching the agri-environment options assessed in Macleod et al. (2013) with the options taken forward for the 2014-20 SRDP (Deliverable 1). Examples of this matching are presented in Annex 3: Table I and Table II.

6. Matching the benefits of each option with the observed impacts at each catchment within the operational areas of priority catchments (Annex 2: Table III and Table IV). For example, options with the potential to benefit N losses (i.e. reduce N losses) will be available for uptake by farmers in catchments with observed N losses or at risk of waterbody status deterioration related to N losses.
7. Using a GIS layer for each digitised catchment boundary (georeferenced by SEPA at a 1:50,000 scale) as follows:
 - ✓ Catchments draining to water bodies
 - ✓ Operational areas
 - ✓ 59 priority catchments selected for the second river basin management planning cycles.
8. Creating a GIS layer for each combination of impacts matched to the benefits delivered by each option and capital item observed at a waterbody scale, as produced in Step 5.
9. Mapping availability of each option and capital item across priority catchments using SEPA's geodatabase and the layer of impacts-benefits per option and capital item.

Table 1. Matching the agri-environment options assessed in Macleod et al. (2013) with the water quality options (annual recurrent) recommended for targeting in the next SRDP: extract from the working spreadsheet.

annual recurrent Options included in Deliverable 1	from "CREW potential benefits" worksheet	
	unique code (UID)	"SRDP Options" from Macleod <i>et al.</i> (2013)
1. Hedgerow restoration and management	531	New hedges/ dry stone dyke
2. Retention of winter stubbles for wildlife	394	Overwintered stubble
	401	Reduced-herbicide cereal crops followed by overwintered stubble
	402	Extended overwintered stubble
3. Stubbles followed by green manure in an arable rotation	480	Retain winter stubbles
	17	Catch crops and Cover crops/Establish cover crops in the autumn
4. Beetle banks	278	Floristically enhanced grass buffer strips (non-rotational)
5. Management of grass margins in arable fields	75	Establish in-field grass buffer strips on tillage land
6. Management of water margins	53	Maintain and /or manage riparian wetlands
	96	Establish riparian buffer strips
	156	Dry Riparian Buffer Zone (or Strip) - 1 - (protection from machinery operations and livestock)
	157	Riparian buffer strip (dry)
	158	Riparian buffer strip (wet)
	621	Water margins and enhanced riparian buffer areas
7. Converting arable at risk of flooding or erosion to grassland	775	Vegetated buffer strips (including riparian buffer strips)
	159	Intercept flow at the bottom of a slope by a dry, grass buffer
	406	In-field grass areas to prevent erosion and run-off
8. Removing livestock from fields with watercourses during the bathing water season	477	Fixed rough grass margins on arable land
		Method 76: Fence off rivers and streams from livestock
	569	Construct water troughs with a firm but permeable base

Annex 2 (cont'd)

Table II. Matching the agri-environment options assessed by Macleod et al. (2013) with the water quality options (capital items) recommended for targeting in the 2014 - 20 SRDP. This table was discussed in the sense-checking meeting held in Aberdeen on 24th February 2014. The review concluded 'soil testing' and 'slurry application' should be removed, and 'water use efficiency: irrigation lagoons' should be added.

stand-alone Capital Items included in Deliverable 1	from "CREW potential benefits" worksheet	
	unique identification code	" SRDP Options" from Macleod <i>et al.</i> (2013)
1. Managing Steading Drainage: Roof Drainage	87 107	Minimise the volume of dirty water (and slurry) produced and contain all that is produced Clean and dirty water separation - roofs
2. Managing Steading Drainage: Roofing of storage/handling areas	582	Install covers on slurry stores
4. Managing Steading drainage: Surface/Underground Drainage	539	Cross-drains
	543	Soak away
3. Slurry Storage	88	Adopt batch storage of slurry
	581	Increase the capacity of farm manure (slurry) stores to improve timing of slurry applications
	588	Use liquid/ solid manure to slurry handling system
	616	Manure/slurry treatment
	801	Increased slurry storage capacity
	582	Install covers on slurry stores
	4. SUDS for steading Runoff: Constructed Farm Wetland	797
97		Establish and maintain artificial (constructed) wetlands
537		Artificial/ restored wetland (Constructed wetlands/wetland rest)
618		Treat run-off of pollutants - farm wetlands
5. SUDS for steading Runoff: Swales	199	Grassed Waterways (swales)
	151	Swales and grassed waterways (also known as grassed or conveyance swales)
6. SUDS for steading Runoff: Retention Pond	529	Retention (ponds)
7. Pesticide handling	179	Biobeds
	617	Treat run-off of pollutants - biobeds
8. Tramlines	552;37	Manage over-winter tramlines; tillage to avoid tramlines
9. Slurry application	591	Use slurry band spreading application techniques
	592	Use slurry injection application techniques
10. Soil testing	3	Use a fertiliser recommendation system with soil testing
	6	Reduce P-application based on soil P status
	1	P Index - a tool to evaluate risk of P runoff
11. Alternative Watering	569	Construct water troughs with a firm but permeable base
12. Hotspot management:Field Bases	569	Construct water troughs with a firm but permeable base
	57	Re-site gateways away from high risk areas
13. Hotspot management:Livestock field access tracks	94	Construct bridges for livestock crossing rivers and streams
14. Hotspot management: Livestock Crossings	164	Stream crossing - control of
15. Rural SuDS: Sediment Traps and Bunds	145	Contour bund
	111	Soil erosion and sediment control plans
	525	Barriers & traps (basic)
		Swales and grassed waterways (also known as grassed or conveyance swales)
16. Rural SuDS: Swales	151	Swales and grassed waterways (also known as grassed or conveyance swales)
17. Rural SuDS: Retention Ponds	529	Retention (ponds)
18. Rural SuDS: Constructed Wetland	97	Establish and maintain artificial (constructed) wetlands
19. Woodland for Water	530	Woodland shelter belts

Annex 2 (cont'd)

Table III. Benefits of each water quality (annual recurrent management) option. This table was discussed in the sense-checking meeting held in Aberdeen on 24th February 2014. The review concluded pesticide benefits for 'stubbles followed by green manure' and FIO benefits for 'grass buffers' should be added.

WQ Options (annual recurrent items)	WQ Benefits (✓) and Conflicts (✗)					Comments
	N	P	FIOs	Pests	S. Solids	
1. Hedgerow restoration and management	✓	✓	✓	✓	✓	Ioanna Akoumianaki: Nitrates or ammonium
2. Retention of winter stubbles for wildlife	✓	✓		✓	✓	
3. Stubbles followed by green manure in an arable rotation	✓	✓			✓	
4. Beetle banks	✓	✓	✓	✓	✓	
5. Removing livestock from fields with watercourses during the bathing water season	✓	✓	✓	✓	✓	
6. Management of grass margins in arable fields	✓	✓		✓	✓	Ioanna Akoumianaki: SRP or TP or both
7. Management of water margins	✓	✓	✓	✓	✓	
8. Converting arable at risk of flooding or erosion to grassland	✓	✓	✓	✓	✓	

Annex 2 (cont'd)

Table IV. Benefits of each water quality (capital items) option. This table was discussed in the sense-checking meeting held in Aberdeen on 24th February 2014. The review concluded FIO benefits for 'swales' and nitrogen and pesticide benefits for 'traps & bunds' should be added.

"Stand Alone" Capital Items	WQ Benefits (✓) and Conflicts (✗)					Comments
	N	P	FIOs	Pests	SS	
1. Managing steading drainage: roof drainage	✓	✓	✓	✓		
2. Managing steading drainage: surface / underground drainage (Surface drainage interception; concrete apron remediation; Underground clean water drainage; Underground drainage pipework)	✓	✓	✓	✓	✓	
3. Slurry Storage (storage covers; above ground tanks; transfer pumps; reception tanks; lined lagoons)	✓	✓	✓			
4. SuDS for steading runoff: constructed farm wetlands	✓	✓	✓	✓	✓	
5. SuDS for steading runoff: swales	✓	✓		✓	✓	
6. SuDS for steading runoff: retention ponds	✓	✓	✓	✓	✓	
7. Pesticide Handling (biobeds; biofilters; drip trays/portable bunds; concrete bunded area; roofing)				✓		
8. Tramlines		✓		✓	✓	Ioanna Akoumianaki: No benefits but if implemented in conjunction with "Slurry Storage" it has N, P, FIOs benefits and as such it has been mapped
9. Slurry application	✗					
10. Soil testing	✓	✓			✓	
11. Alternative Watering (Abstraction; Pumped with Solar Power; Pumped with external power supply; Stock/Water Powered; Gravity/Mains Supplied; Trough)	✓	✓	✓	✓	✓	
12. Hotspot management: field bases	✓	✓	✓	✓	✓	
13. Hotspot management: livestock tracks	✓	✓	✓		✓	
14. Hotspot management: livestock crossings	✓	✓	✓		✓	
15. In-field rural SuDS: traps & bunds		✓	✓		✓	
16. In-field rural SuDS: swales	✓	✓		✓	✓	
17. In-field rural SuDS: retention ponds	✓	✓	✓	✓	✓	
18. In-field rural SuDS: constructed wetlands	✓	✓	✓	✓	✓	
19. Woodland for water	✓	✓	✓	✓	✓	

Annex 3. Steps followed to identify target areas of the NFM options in the 2014-20 SRDP.

Identifying target areas for natural flood management involved the following steps:

1. Identifying flood source using a spreadsheet provided by SEPA for the needs of the CREW targeting project. Hereafter potentially vulnerable areas will be termed "fluvial", "coastal & fluvial", and "coastal", accordingly.
2. Identifying the main river catchment containing each potentially vulnerable area (PVA).
3. Matching the benefits of natural flood management - suggested by SEPA and based on Nutt (2012) for alleviating fluvial and coastal flooding - with the options in Deliverable 1.
4. Targeting agri-environment options with potential benefits for areas at risk from fluvial and pluvial flooding to main river catchments containing "fluvial", "coastal & fluvial" PVAs.
5. Targeting options and capital items with potential benefits for areas at risk from coastal flooding to main river catchments containing "coastal" and "coastal & fluvial" PVAs.



Scotland's centre of expertise for waters

CREW Facilitation Team

James Hutton Institute

Craigiebuckler

Aberdeen AB15 8QH

Scotland UK

Tel: +44 (0)1224 395 395

Email: enquiries@crew.ac.uk

www.crew.ac.uk



The James
Hutton
Institute



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