

# Flood Risk Management Strategy

## Solway Local Plan District

This section provides supplementary information on the characteristics and impacts of river, coastal and surface water flooding. Future impacts due to climate change, the potential for natural flood management and links to river basin management are also described within these chapters.

Detailed information about the objectives and actions to manage flooding are provided in Section 2.

### Section 3: Supporting information

3.1	Introduction .....	311
3.2	River flooding .....	312
	• Esk (Dumfriesshire) catchment group .....	313
	• Annan catchment group .....	321
	• Nith catchment group .....	327
	• Dee (Galloway) catchment group .....	335
	• Cree catchment group.....	342
3.3	Coastal flooding.....	349
3.4	Surface water flooding.....	359

## 3.1 Introduction

In the Solway Local Plan District, river flooding is reported across five distinct river catchments. Coastal flooding and surface water flooding are reported across the whole Local Plan District.

A summary of the number of properties and Annual Average Damages from river, coastal and surface water flooding is outlined in Table 1.

	Total number of properties at risk <sup>1</sup>	Annual Average Damages	Local authority
<b>River catchments</b>			
Esk (Dumfriesshire) catchment group	400	£870,000	Carlisle City Council Cumbria Council Dumfries and Galloway Council Scottish Borders Council
Annan catchment group	600	£1.5 million	Dumfries and Galloway Council Scottish Borders Council South Ayrshire Council South Lanarkshire Council
Nith catchment group	1,100	£4.3 million	Dumfries and Galloway Council, East Ayrshire council South Lanarkshire Council
Dee (Galloway) catchment group	630	£1.4 million	Dumfries and Galloway Council East Ayrshire council
Cree catchment group	740	£1.7 million	Dumfries and Galloway Council South Ayrshire Council
<b>Coastal flooding</b>			
Solway coastal area	840	£2.7 million	Dumfries and Galloway Council South Ayrshire Council
<b>Surface water flooding</b>			
Solway Local Plan District	830	£1.2 million	Dumfries and Galloway Council East Ayrshire council Scottish Borders Council South Ayrshire Council South Lanarkshire Council

**Table 1:** Summary of flood risk from various sources within the Solway Local Plan District

<sup>1</sup> Total number of residential and non-residential properties at risk of flooding.

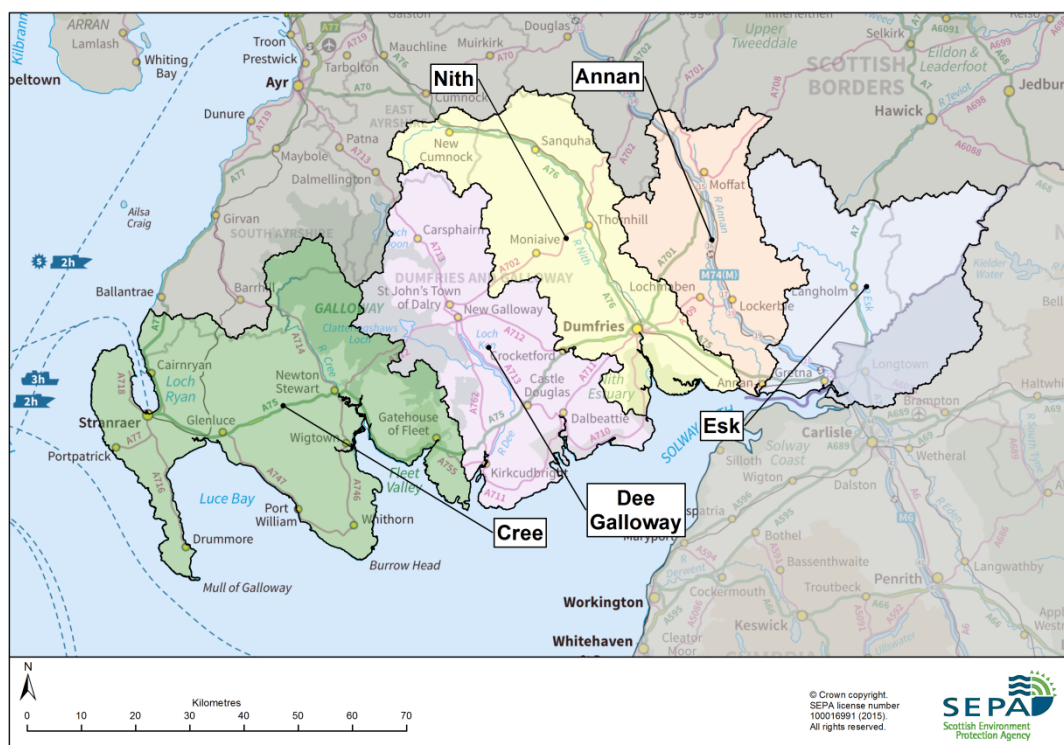
## 3.2 RIVER FLOODING

### Solway Local Plan District

This section provides supplementary information on river flooding at the catchment level. It provides an overview of the catchment's natural characteristics, flood risk and the existing actions to manage flooding. It outlines the likely impact of climate change and the potential for natural flood management.

Detailed information about the objectives and actions to manage flooding are provided in Section 2.

In the Solway Local Plan District, river flooding is reported across five distinct river catchments, shown below in Figure 1.



**Figure 1:** River catchments within the Solway Local Plan District

## River flooding Esk (Dumfriesshire) catchment group

### Catchment overview

The Esk catchment group is located within the Solway Local Plan District covering an area of over 1,360km<sup>2</sup>. The catchment group is over 99% rural with less than 1% urban and a population of approximately 16,000. This area includes parts of two local authorities; Dumfries and Galloway Council and Scottish Borders Council.

The River Esk is the main river within the Esk catchment group and originates in the hills to the east of Moffat. Its main tributaries are the Black Esk and the White Esk, which merge south of Castle O'er Forest. Langholm has an approximate elevation of 100m and is surrounded by steep hills on all sides with elevations of around 300m. It is located at the confluence of three rivers, the River Esk, Wauchope Water and Ewes Water.

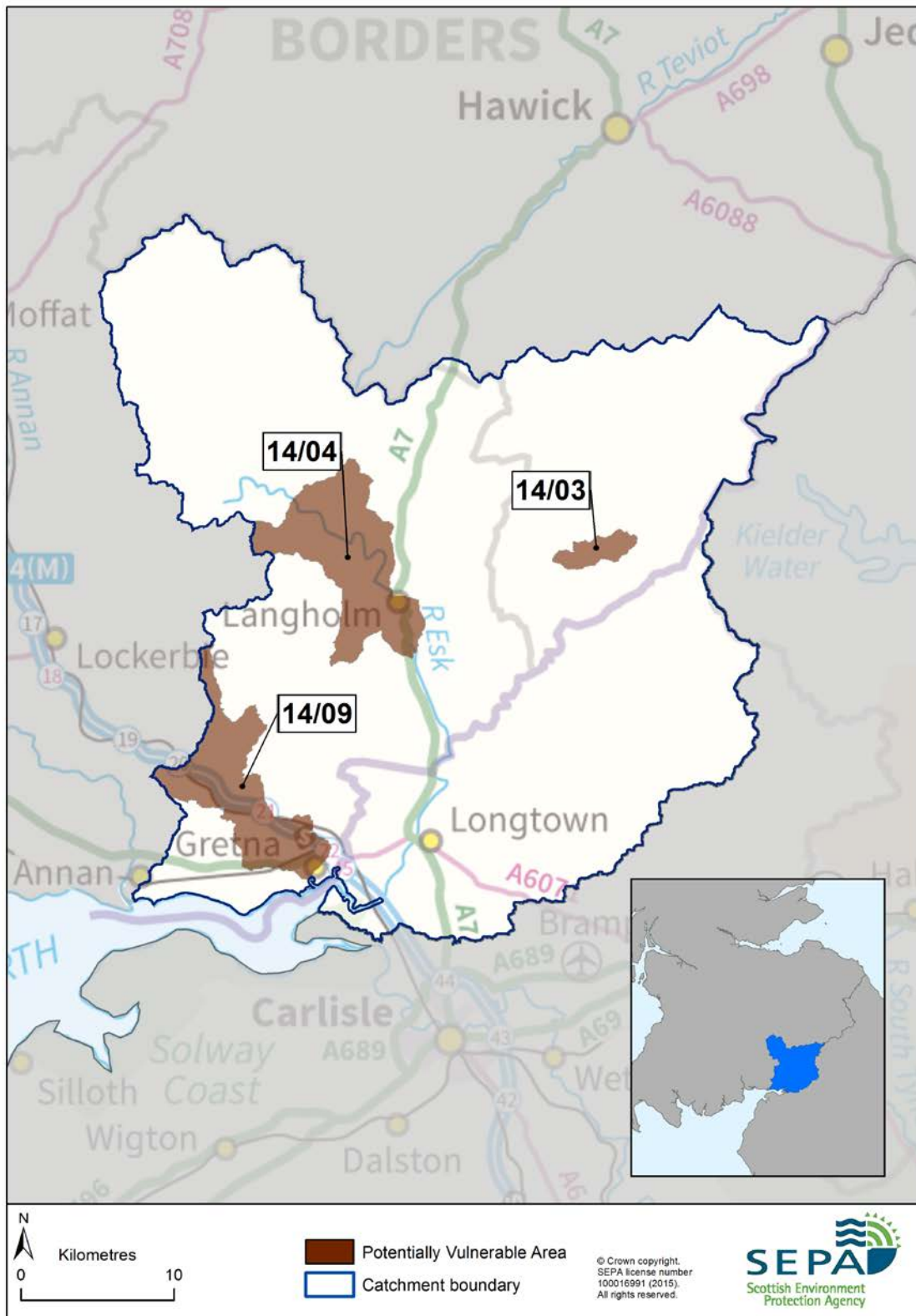
The Liddel Water flows from the north east of the catchment group, passing through Newcastleton after the confluence with the Hermitage Water. The Liddel Water forms the boundary between Scotland and England, before joining the River Esk between Canonbie and Longtown. The River Esk continues southwest and enters the Solway Firth to the east of Gretna.

The annual average rainfall is 1,366mm, which is broadly typical for Scotland. The annual average rainfall ranges between 1,298mm and 1,532mm in the upper parts of the catchment and 1,297mm and 1,427mm in the lower parts.

### Flood risk in the catchment

Approximately 360 residential properties are at risk of river flooding, 88% of which are located within Potentially Vulnerable Areas. There are approximately 40 non-residential properties predicted to be at risk of river flooding, 72% of which are located within Potentially Vulnerable Areas. There are three Potentially Vulnerable Areas within this catchment group as shown in Figure 1:

- Newcastleton (14/03)
- Langholm (14/04)
- Kirtle Water (14/09).



**Figure 1:** River catchment for the Esk (Dumfriesshire) catchment group

## Main areas at risk

The main areas with a risk of river flooding can be seen in Table 1 which shows the number of properties at risk and the Annual Average Damages caused by river flooding. This includes damages to residential and non-residential properties, transport and agriculture. Langholm and Newcastleton are the main areas at risk of river flooding.

	Residential and non-residential properties at risk of river flooding	Annual Average Damages
Langholm	190	£270,000
Newcastleton	130	£150,000
Waterbeck	<10	£40,000
Dornock	<10	£20,000
Davington	<10	£20,000

**Table 1:** Main areas at risk of river flooding

### Economic activity and infrastructure at risk

The Annual Average Damages caused by river flooding in the Esk (Dumfriesshire) group catchment are approximately £870,000 which accounts for approximately 9% of the estimated Annual Average Damages from river flooding within the Solway Local Plan District. This consists of:

- 57% residential properties (£500,000)
- 19% non-residential properties (£160,000)
- 10% roads (£87,000)
- 7% emergency services (£60,000)
- 4% agriculture (£38,000)
- 3% vehicles (£23,000).

Figure 2 shows the distribution of Annual Average Damages throughout the area. The greatest concentration of damages is in Langholm, Newcastleton and Kirtlebridge.

Please note that economic damages to rail were not assessed as information on damages at a strategic scale is not available.

Table 2 shows further information about infrastructure and agricultural land at risk of flooding within this catchment.

	Number at risk	Further detail
Community facilities	<10	Includes: educational buildings and emergency services.
Utility assets	<10	Includes: electricity substations.
Roads (km)	5.5	Notably: M6 south east of Gretna A74(M) at Kirtlebridge A7 (Langholme to Longtown) There are also a number of locally important B roads at risk
Railway routes (km)	0.5	Railway between Kirtlebridge, Gretna, Carlisle, Annan and Longtown.
Agricultural land (km <sup>2</sup> )	21	

**Table 2:** Infrastructure and agricultural land at risk of river flooding

### Designated environmental and cultural heritage sites at risk

Within the catchment it is estimated that 28 designated cultural heritage sites are at risk of river flooding. These sites include; scheduled monuments and listed buildings.

Approximately 1.5 km<sup>2</sup> of environmental designated area is at risk of river flooding. This includes Special Areas of Conservation, Special Protection Areas and Sites of Special Scientific Interest.

### History of flooding

There has been a long history of flooding within the area, with a number of these floods impacting properties. The most significant flooding was experienced in Newcastleton with flooding in February 1997, January 2001 and October 2005. The flood on 12 October 2005 was reported by local residents as the 'worst in living memory', causing damage to around 30 houses.

The most recent flood occurred in 2012 which resulted in community facilities flooding in Eskdalemuir. Other recent reports of river flooding include Langholm by the River Esk which rose to street level in January 2009.

The earliest recorded flooding in the area occurred in 1846 with flooding from the Liddel Water, River Esk and Whitrope Burn, with two further regional flood events before 1900.

Further detail about the history of flooding in this area is available in the relevant Potentially Vulnerable Area chapters of this document.

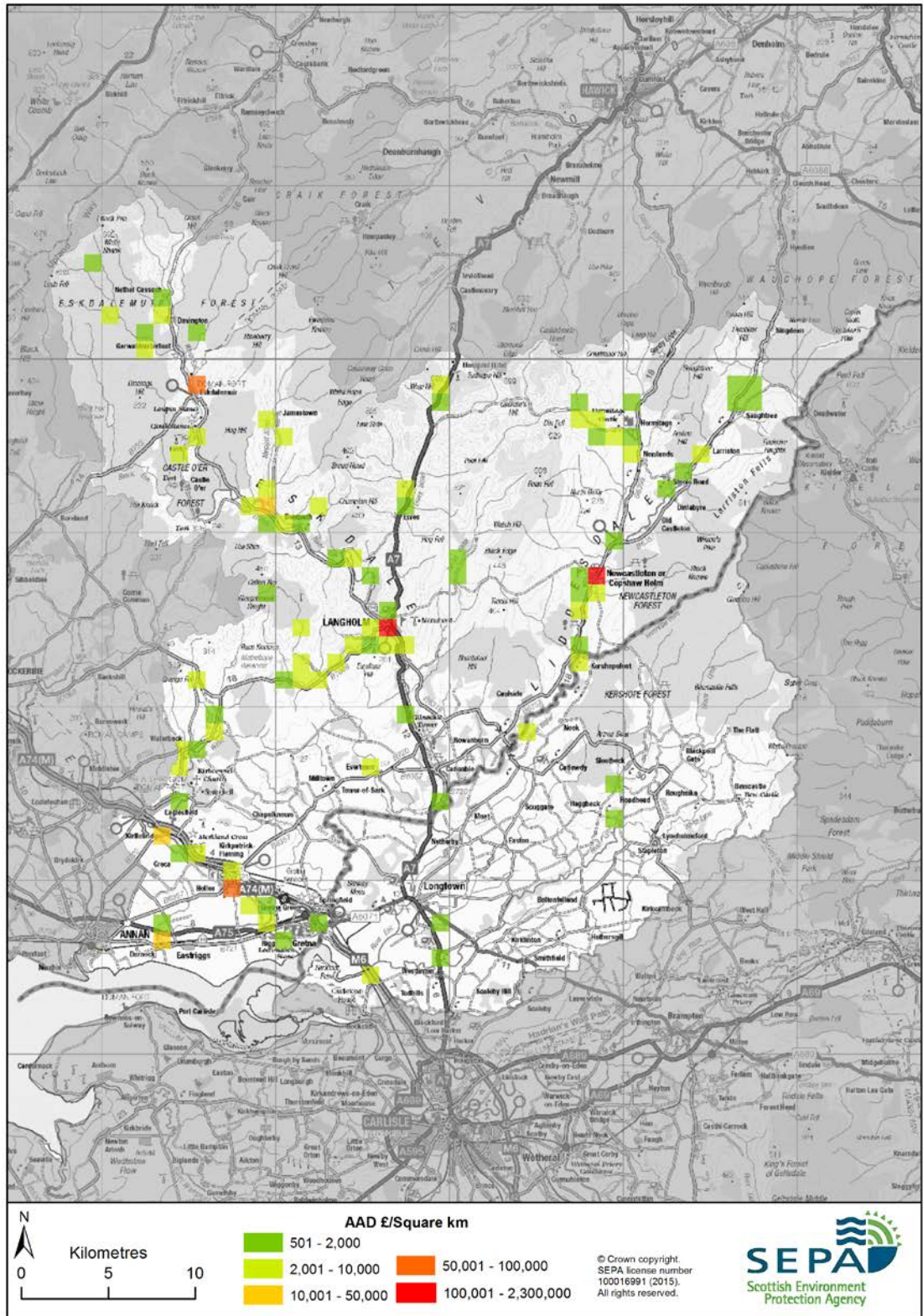


Figure 2: Annual Average Damages from river flooding



## Managing flood risk

A range of public bodies have responsibility for managing flood risk in Scotland and they are working closer than ever before to target action in the areas where the greatest benefit can be gained. Members of the public also have a role to play and are the first line of defence against flooding by taking action to protect themselves and their property from flooding. Further information about roles and responsibilities is provided in Section 1.

This section describes the existing actions that are in place to manage flood risk and are in addition to the information presented in the relevant Potentially Vulnerable Area chapter of this document

### River flood warning schemes

SEPA operates a flood warning scheme for Newcastleton in the Scottish Borders. Flood Warnings are issued when river flooding is forecast for the flood warning areas. There is one river flood warning area in this catchment as shown in Figure 3 and Table 3. Table 3 shows the total number of properties in the flood warning area and the percentage of those properties that have signed up to receive flood warnings. Note that this is not the number of properties at risk of flooding.

Flood warning area (FWA)	River	Properties within FWA	% of properties registered May 2014
Newcastleton Village	Liddel Water	230	49%

**Table 3:** Flood warning areas

Work has started on a Flood Early Warning System (FEWS) system for Langholm, which aims to be operational for 2016.



Figure 3: Flood warning area

## Climate change and future flood risk

The UK Climate Projections (UKCP09) predicts that climate change may lead to warmer and drier summers, warmer and wetter winters with less snow, and more extreme temperature and rainfall. The predicted increase in rainfall and river flows may increase the potential for river flooding.

Under the UKCP09 high emissions scenario for 2080, average peak river flows for the Esk (Dumfriesshire) catchment group may increase by 44%<sup>1</sup>. This would potentially increase in the number of residential properties at risk of river flooding from approximately 360 to 750, and the number of non-residential properties from approximately 40 to 80.

The predicted increases in flood risk are solely based on the impact of a changing climate on the magnitude of flooding; they do not take into account any potential increase due to population change, development pressures or urban creep, nor do they take into account any mitigation as a result of actions contained in this or future Flood Risk Management Strategies.

## Potential for natural flood management

The assessment of the potential for natural flood management is shown on SEPA's flood maps (<http://www.sepa.org.uk/environment/water/flooding/flood-maps/>). The maps indicate the potential for wave attenuation and estuarine surge attenuation. They show areas where natural flood management could be effective and where further detailed assessment should take place. This information was used to identify where local authorities could include natural flood management as part of flood risk management schemes and studies. The proposed schemes and studies are listed in the relevant Potentially Vulnerable Area chapters of this document.

### Runoff reduction

The assessment shows that many parts of the River Esk and Liddel Water catchments have the potential for runoff reduction.

### Floodplain storage

The River Esk between Georgefield and Craigcleuch, as well as the Ewes Water between Arkleton and Terrona, are also shown to have potential for floodplain storage.

Further areas are identified as having medium potential for floodplain storage are identified along the Hermitage Water and Liddel Water, upstream of Newcastleton.

### Sediment management

The River Esk has lengths of high erosion and deposition. Implementing natural flood management measures in these areas may have the potential of attenuating flows in the watercourses which contribute to flood risk in areas such as Langholm. Dumfries & Galloway Council is currently investigating the benefits of gravel removal through Langholm on the Esk.

---

<sup>1</sup> From the study 'An assessment of the vulnerability of Scotland's river catchments and coasts to the impacts of climate change' (CEH, 2011)

## River flooding Annan catchment group

### Catchment overview

The Annan catchment group is located within the Solway Local Plan District, covering an area of over 960km<sup>2</sup>. The region is over 98% rural, with less than 2% of the area identified as urban and an approximate population of 25,000. This area includes parts of three local authorities; Dumfries and Galloway Council, Scottish Borders Council and South Lanarkshire Council.

The River Annan is the main river catchment in this area. It originates from Annanhead Hill in the north and flows south through steep hills past Moffat. Downstream of Moffat, the catchment is relatively flat, with the River Annan flowing parallel to the A74. The river has three main tributaries, the Kinnel Water, the Dryfe Water and the Water of Milk. The River Annan flows into the Solway Firth at Annan.

The rainfall for the catchment group is broadly typical for Scotland, ranging between 1,349mm in the lower parts of the area and 1,575mm in the upper parts.

### Flood risk in the catchment

There are approximately 540 residential properties at risk of river flooding, 81% of which are located within a Potentially Vulnerable Area. There are approximately 60 non-residential properties at risk of river flooding, 62% of which are located within a Potentially Vulnerable Area. There are three Potentially Vulnerable Areas situated within this catchment group as shown in Figure 1:

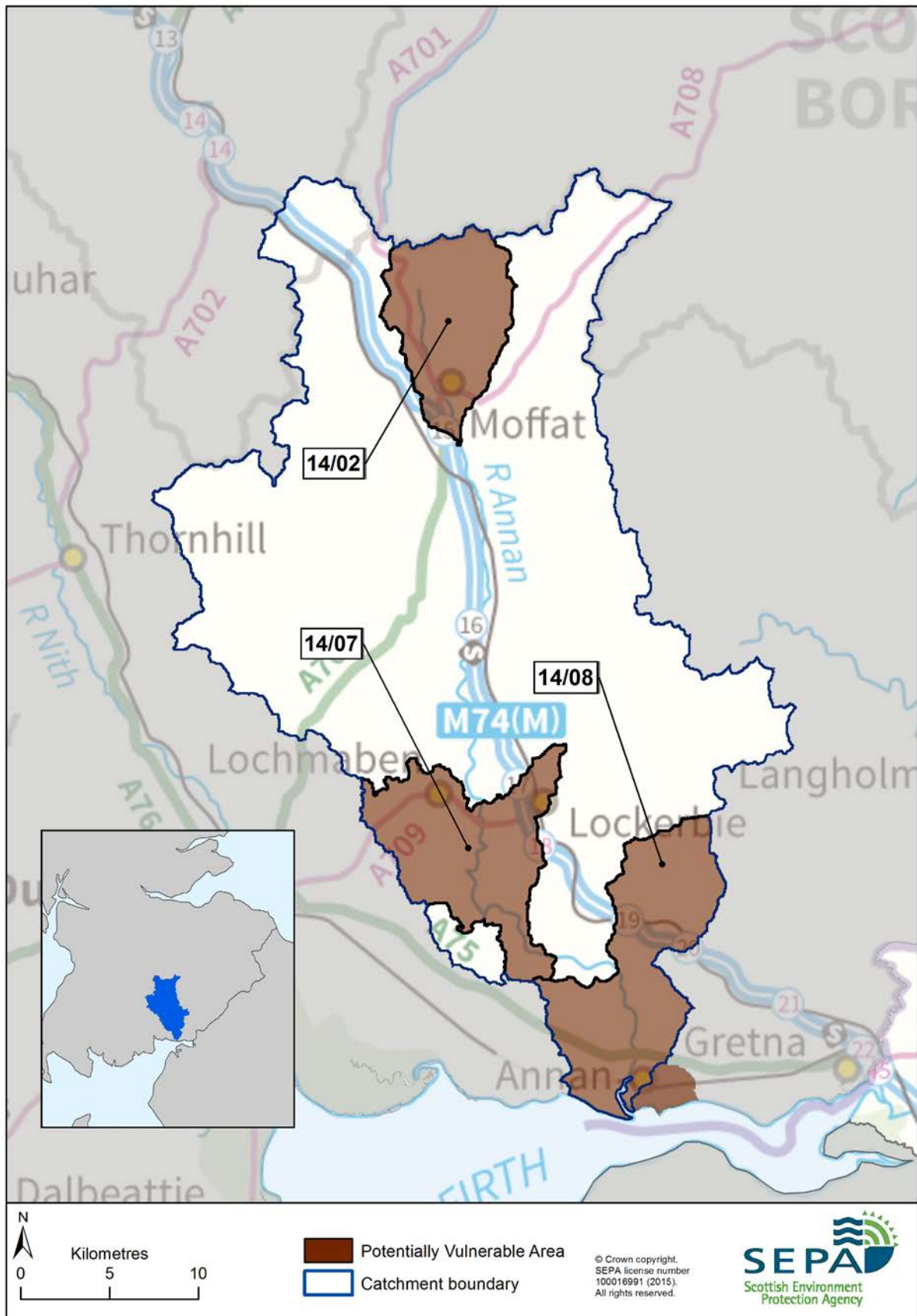
- Moffat (14/02)
- Lochmaben to Locherbie (14/07)
- Ecclefechan – Annan (14/08).

### Main areas at risk

The main areas at risk of river flooding can be seen in Table 1, which shows the number of properties at risk and the Annual Average Damages caused by river flooding. This includes damages to residential and non-residential properties, transport and agriculture. Moffat is the main town at risk of river flooding.

	Residential and non-residential properties at risk of river flooding	Annual Average Damages
Moffat	340	£470,000
Annan	50	£110,000
Ecclefechan	50	£87,000
Lochmaben	10	£45,000
Hightae	10	£31,000
Ae	10	£19,000

**Table 1:** Main areas at risk of river flooding



**Figure 1:** River catchment for the Annan catchment group

## Economic activity and infrastructure at risk

The Annual Average Damages caused by river flooding in the Annan catchment group are approximately £1.5 million, which accounts for almost 15% of the estimated Annual Average Damages from river flooding within the Solway Local Plan District. The damages are distributed as follows:

- 64% residential properties (£920,000)
- 11% roads (£160,000)
- 9% non-residential properties (£140,000)
- 7% agriculture (£100,000)
- 7% emergency services (£100,000)
- 2% vehicles (£36,000).

Figure 2 shows the distribution of Annual Average Damages throughout the catchment. The figure shows that the highest concentration of damages is in Moffat, with Ecclefechan, Lochmaben and Annan also having high damages

Please note that economic damages to rail were not assessed as information on damages at a strategic scale is not available.

Table 2 shows further information about infrastructure and agricultural land at risk of flooding within this catchment.

	Number at risk	Further detail
<b>Community facilities</b>	<10	Includes: educational building and emergency services
<b>Utility assets</b>	10	Includes: electricity substations, Scottish Water assets and telecommunications sites
<b>Roads (km)</b>	10.2km	Notably: A74(M) at Kirtlebridge A701 Moffat to Dumfries (particularly the area known as 'Hidden Corner' A708 east of Moffat A709 Lockerbie to Lochmaben (particularly at Castle loch)
<b>Railway routes</b>	3.4km	Railway between Kirkton and Newton.
<b>Agricultural land (km<sup>2</sup>)</b>	47	Notably: adjacent to the Moffat Water and land along the course of the River Annan between Lockerbie and Lochmaben

**Table 2:** Infrastructure and agricultural land at risk of flooding

## Designated environmental and cultural heritage sites at risk

Within the catchment group it is estimated that approximately 32 designated cultural heritage sites are at risk of river flooding. These sites include; scheduled monuments, designed gardens and landscapes and listed buildings.

Approximately 3km<sup>2</sup> of environmental designated area are is risk of river flooding. This includes Special Areas of Conservation, Special Protection Areas and Sites of Special Scientific Interest.

## History of flooding

There is a long history of flooding in this catchment group with most of the flooding impacting fields and roads. The most recent river flooding occurred in Moffat in December 2013, with regular flooding recorded in the town, over the last 15 years linked to both surface water and rivers. Other areas in the region have also suffered recent flooding including Applegarthtown, Nethermill, Heck and Kettleholm, which were impacted on 21 August 2009, mainly affecting roads. In 2005 a culvert upstream of Wamphray became blocked during a high flow event, leading to flooding of a number of properties, and damage to roads infrastructure. In December 2008 the Kinnel Water burst its banks and impacted the area of Millhousebridge.

One of the most significant floods in the area occurred in 1977. This caused damage to properties, railway lines and fields, with Newton Whampray, Annan and Brydekirk flooded by the River Annan and Moffat from both the River Annan and Birnock Water.

The earliest reported flooding in the area was in 1767 with flooding on the River Annan in part due to snow melt. It is reported that the flooding caused a large amount of damage in Lochmaben and destroyed housing and crops.

Further detail about the history of flooding in this area is available in the relevant Potentially Vulnerable Area chapters of this document.

## Managing flood risk

A range of public bodies have responsibility for managing flood risk in Scotland and they are working closer than ever before to target action in the areas where the greatest benefit can be gained. Members of the public also have a role to play and are the first line of defence against flooding by taking action to protect themselves and their property from flooding. Further information about roles and responsibilities is provided in Section 1.

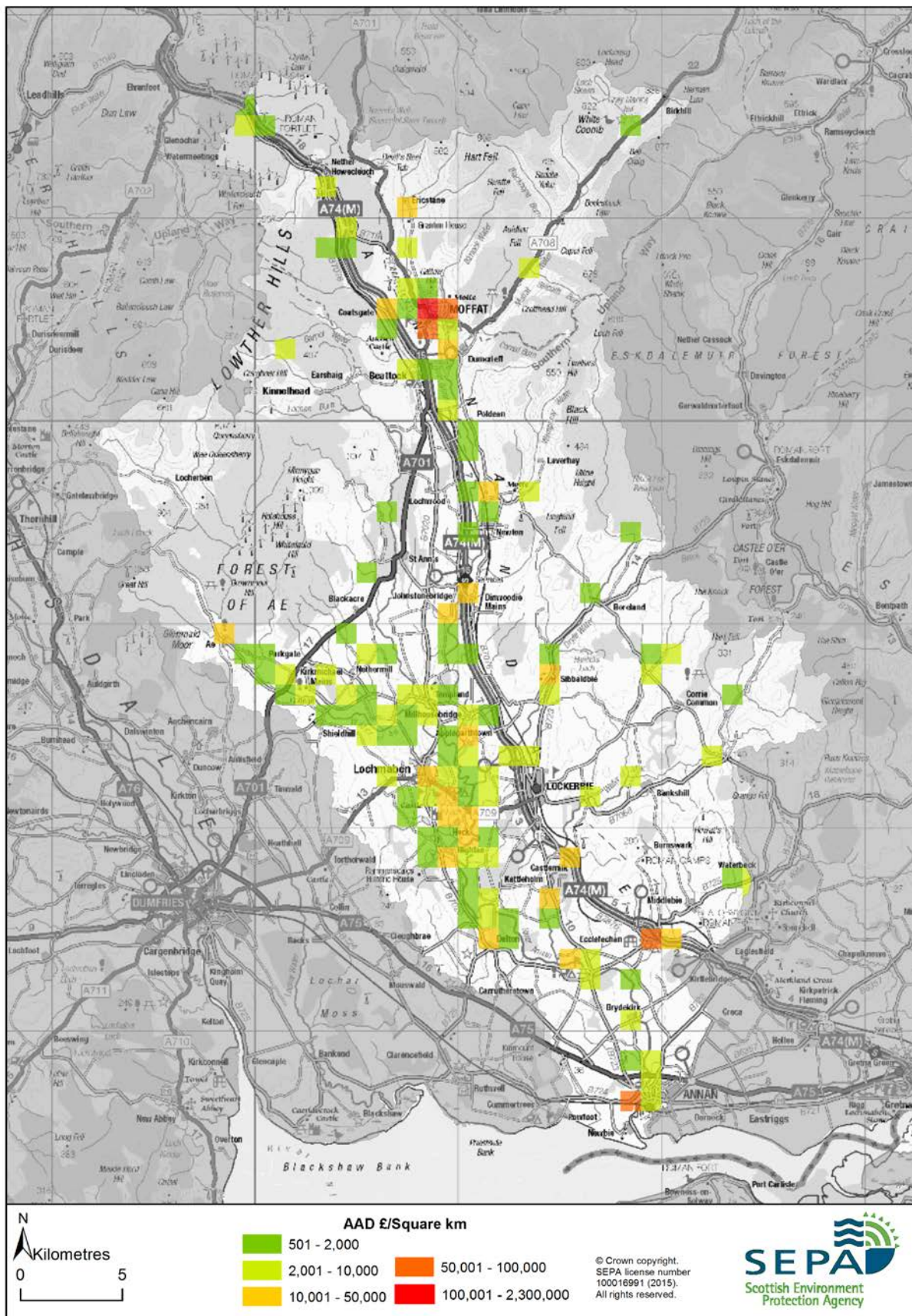
This section describes the existing actions that are in place to manage flood risk and are in addition to the information presented in the relevant Potentially Vulnerable Area chapter of this document.

### Flood protection schemes

A flood protection scheme was constructed in 1989 on the Well Road in Moffat. The scheme included channel improvements and the construction of culverts on an unnamed tributary of the Birnock Water.

### Awareness raising campaigns and community groups

The Moffat Flood Action Group is known to be active in this catchment group and covers the watercourses in Moffat and the upper River Annan. Since it was established in 2010 the group has promoted a flood product subsidy scheme and reports on issues associated with road drainage, culverts and watercourse condition.



**Figure 2: Annual Average Damages from river flooding**



## Climate change and future flood risk

The UK Climate Projections (UKCP09) predicts that climate change may lead to warmer and drier summers, warmer and wetter winters with less snow, and more extreme temperature and rainfall. The predicted increase in rainfall and river flows may increase the potential for river flooding.

Under the UKCP09 high emissions scenario for 2080, average peak river flows for the Annan catchment group may increase by 44%<sup>1</sup>. This would potentially increase in the number of residential properties at risk of river flooding from approximately 540 to 690 and the number of non-residential properties from approximately 60 to 90

The predicted increases in flood risk are solely based on the impact of a changing climate on the magnitude of flooding; they do not take into account any potential increase due to population change, development pressures or urban creep, nor do they take into account any mitigation as a result of actions contained in this or future Flood Risk Management Strategies.

## Potential for natural flood management

The assessment of the potential for natural flood management is shown on SEPA's flood maps (<http://www.sepa.org.uk/environment/water/flooding/flood-maps/>). The maps indicate the potential for wave attenuation and estuarine surge attenuation. They show areas where natural flood management could be effective and where further detailed assessment should take place. This information was used to identify where local authorities could include natural flood management as part of flood risk management schemes and studies. The proposed schemes and studies are listed in the relevant Potentially Vulnerable Area chapters of this document.

### Runoff reduction

The assessment identifies an area with medium potential for runoff reduction in the Birnock Water catchment, which contributes to flooding in Moffat, and further areas in proximity to the Water of Ae, which converges with the River Annan. Some areas with high potential for runoff reduction are also identified to the south east near Waterbeck, within the catchment of the Mein Water, which contributes to flooding in Ecclefechan further downstream.

### Floodplain storage

The assessment shows that tributaries to the north of the Water of Ae, such as the Garrel Water, Kinnel Water and the Kirkland Burn, have the potential for floodplain storage. If large storage areas were available there may be potential to reduce flooding in areas at risk further downstream, such as Lochmaben. There may be potential for floodplain storage areas in Lochwood and Johnstonebridge, which may also help to reduce flooding in Johnstonebridge, as well as Lochmaben, Heck and Dalton further downstream.

### Sediment management

Lengths along the River Annan and the Water of Ae alternate between high erosion and high deposition in proximity to areas which are known to flood such as Heck and Hightae. Incorporating sediment management measures in these rivers may potentially reduce flood risk downstream.

---

<sup>1</sup> From the study 'An assessment of the vulnerability of Scotland's river catchments and coasts to the impacts of climate change' (CEH, 2011)

## River flooding Nith catchment group

### Catchment overview

The Nith catchment group is located within the Solway Local Plan District and covers an area of over 1,480 km<sup>2</sup>. The catchment group is over 98% rural, with less than 2% urban, and an approximate population of 64,000. This area includes part of three local authorities; Dumfries and Galloway Council, East Ayrshire council and South Lanarkshire Council.

The main river catchment within this area is the River Nith. The River Nith catchment originates in the Carsphairn Hills of East Ayrshire. It initially flows in an easterly direction through New Cumnock and Kirkconnel before turning south and continuing to Dumfries, where it flows into the Solway Firth. The Nith is generally contained within steep valley sides as far south as Thornhill, where the landscape begins to flatten. The majority of tributaries of the River Nith are upstream of Thornhill and drain the hills of the southern uplands. The largest of these tributaries is the Cluden Water.

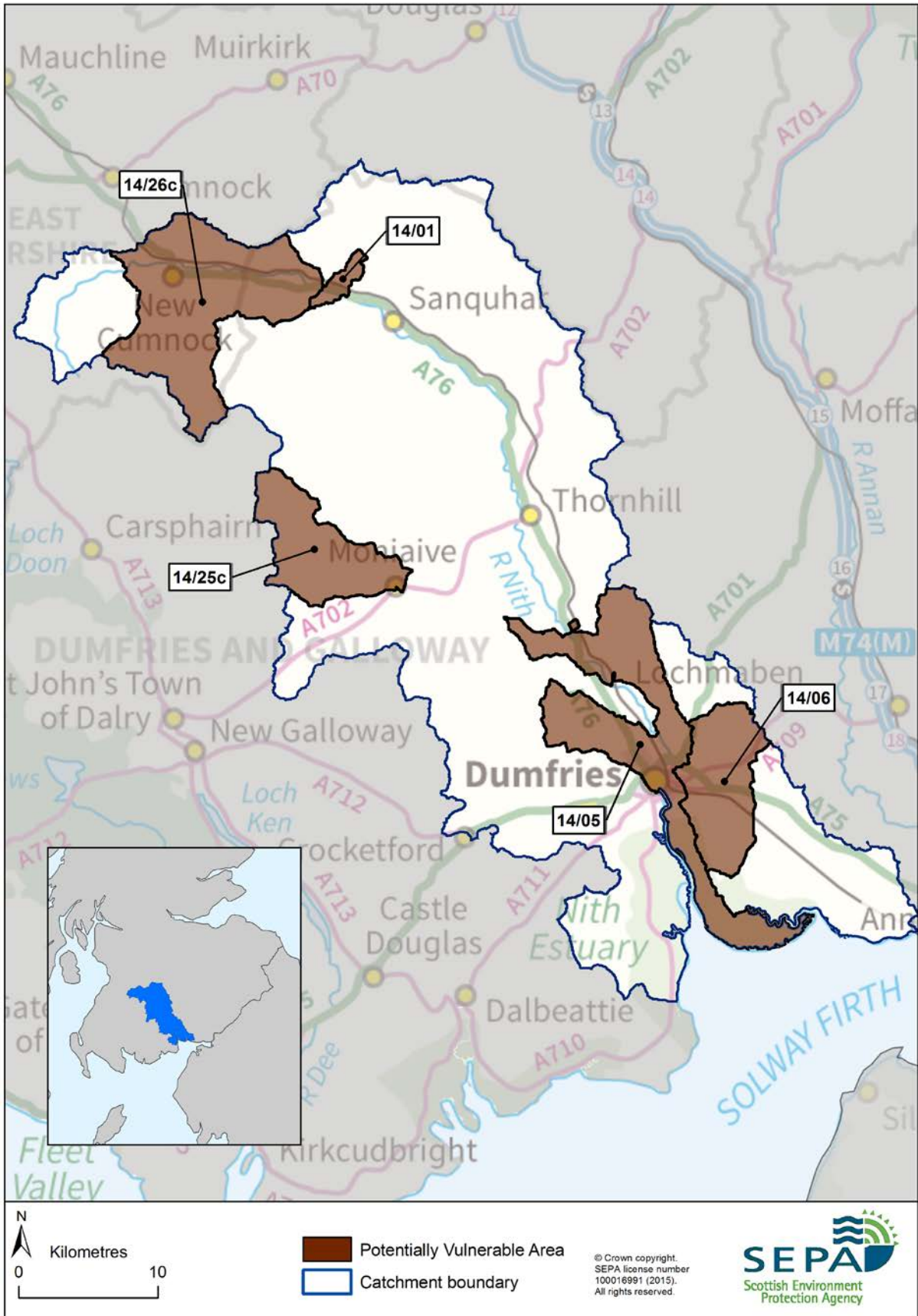
The Lochar Water is the second river catchment within the area and is significantly smaller than the Nith. Located in the south east, it flows approximately parallel to the River Nith and discharges to the Solway Firth.

The annual average rainfall for the Nith catchment group is broadly typical for Scotland, ranging between 1,438mm in the lower parts of the catchment to 1,527mm in the upper parts.

### Flood risk in the catchment

There are approximately 850 residential properties at risk of river flooding, 54% of which are located within Potentially Vulnerable Areas, with an additional 30% located within candidate Potentially Vulnerable Areas. There are also an estimated 220 non-residential properties at risk of river flooding, 65% of which are located within Potentially Vulnerable Areas and an additional 28% within candidate Potentially Vulnerable Areas. There are three Potentially Vulnerable Areas situated within this catchment group and there are also two candidate Potentially Vulnerable Areas (Figure 1):

- Kirkconnel (14/01)
- Dumfries Nith (14/05)
- Dumfries east (14/06)
- Moniaive (14/25c)
- New Cumnock (14/26c).



**Figure 1:** River catchment for the Nith catchment group

## Main areas at risk

The main areas at risk of river flooding can be seen in Table 1, which shows the number of properties at risk and the Annual Average Damages caused by river flooding. This includes damages to residential and non-residential properties, transport and agriculture. Dumfries and New Cumnock are the main areas at risk of river flooding.

	Residential and non-residential properties at risk of river flooding	Annual Average Damages
Dumfries	390	£2.6 million
New Cumnock (including Mansfield)	290	£490,000
Kirkconnel	100	£170,000
Kirkton	20	£100,000
Moniaive	20	£50,000
Lincluden	10	£10,000

**Table 1:** Main areas at risk of river flooding

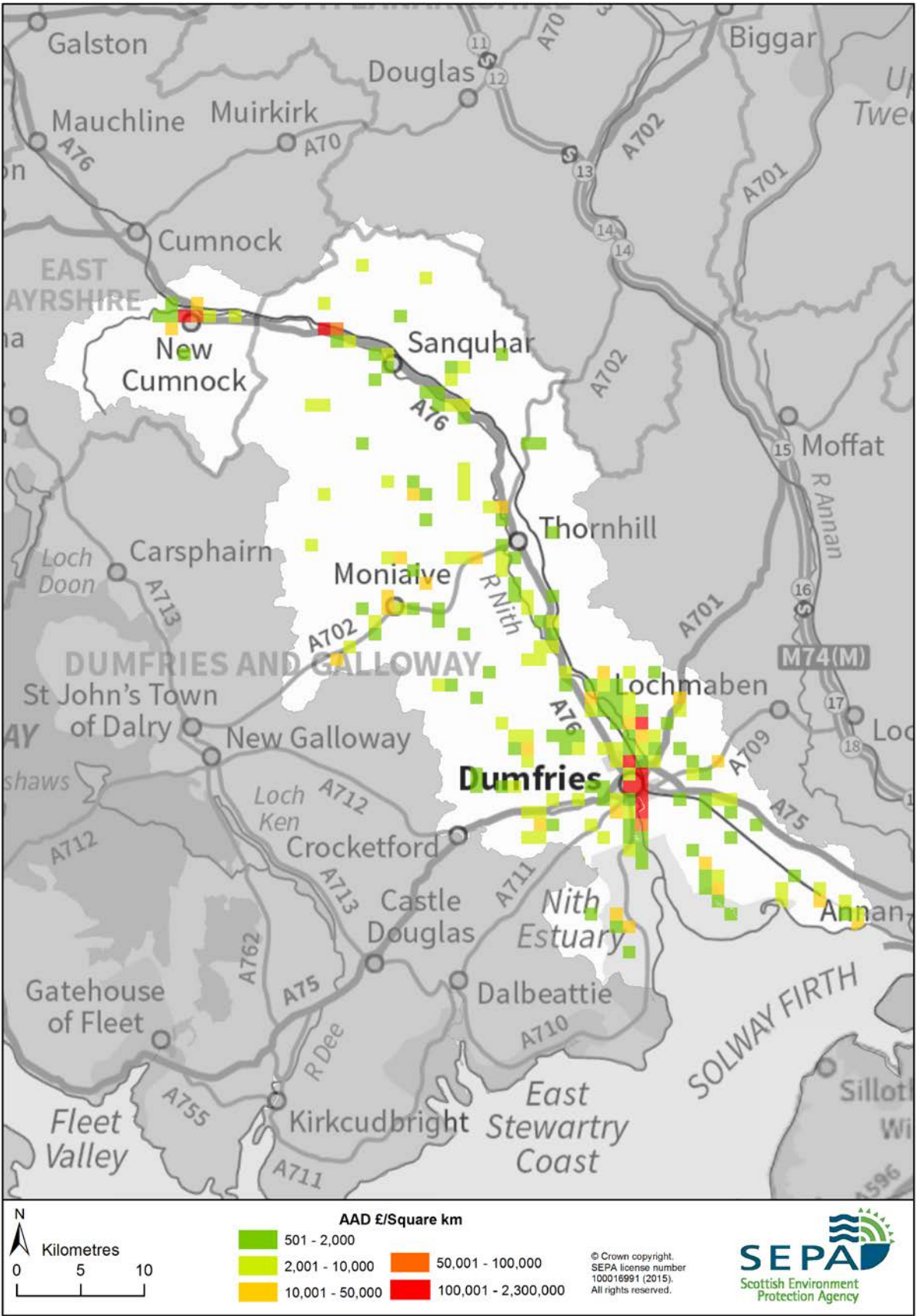
## Economic activity and infrastructure at risk

The total Annual Average Damages caused by river flooding in the Nith catchment group are approximately £4.3 million, which accounts for almost 44% of the estimated Annual Average Damages from river flooding within the Solway Local Plan District. The damages are distributed as follows:

- 44% residential properties (£1.9 million)
- 40% non-residential properties (£1.7 million)
- 7% emergency services (£250,000)
- 4% roads (£190,000)
- 3% agriculture (£140,000)
- 2% vehicles (£98,000).

Figure 2 shows the distribution of Annual Average Damages throughout the catchment group. It shows that the highest concentration of damages are in Dumfries and New Cumnock.

Please note that economic damages to rail were not assessed as information on damages at a strategic scale is not available.



**Figure 2:** Annual Average Damages from river flooding

Table 2 shows further information about infrastructure and agricultural land at risk of flooding within this catchment.

	Number at risk	Further detail
<b>Community facilities</b>	<10	Includes: educational buildings.
<b>Utility assets</b>	30	Includes: electricity substations, Scottish Water assets and telecommunication sites.
<b>Roads (km)</b>	8.8	Notably: A76 New Cumnock to Dumfries A701 at Tinwald A75 Dumfries
<b>Railway routes (km)</b>	4.4	Railway between New Cumnock and Dumfries
<b>Agricultural land (km<sup>2</sup>)</b>	67	The most extensive areas of land are located to the north of Dumfries and extend north along the River Nith to Thornhill, Sanquhar and west of New Cumnock.

**Table 2:** Infrastructure and agricultural land at risk of river flooding

### Designated environmental and cultural heritage sites at risk

Within the catchment it is estimated that 28 designated cultural heritage sites are at risk of river flooding. These sites include; scheduled monuments, designed gardens and landscapes and listed buildings.

Approximately 12 km<sup>2</sup> of environmental designated area is at risk of river flooding. This includes Special Areas of Conservation (3km<sup>2</sup>), Special Protection Areas (5km<sup>2</sup>), and Sites of Special Scientific Interest (4km<sup>2</sup>).

### History of river flooding

There has been a long history of flooding within the catchment with a number of recent flood events.

Flooding occurred on 11 December 1994 near Auldgirth, north of Dumfries, which resulted in one fatality. On the same date there was flooding in Dumfries causing serious disruption to transport and damaged residential and commercial properties in Whitesands, Brewery Street and Friars Vennel.

Dumfries is known to be affected by floods from the River Nith almost every year since 1891 with the earliest flooding reported in 1785.

Flooding occurred on 31 December 2013 which affected properties and businesses in New Cumnock, Kirkconnel, Sanquhar and Moniaive. The areas worst affected were in New Cumnock, St. Conal's Square and Riverside Terrace in Kirkconnel, as well as parts of Sanquhar.

Significant flooding occurred in the Nith catchment on November 2009 which resulted in flooding to properties in Dumfries and the surrounding areas.

Further detail about the history of flooding in this area is available in the relevant Potentially Vulnerable Area chapters of this document.

## Managing flood risk

A range of public bodies have responsibility for managing flood risk in Scotland and they are working closer than ever before to target action in the areas where the greatest benefit can be gained. Members of the public also have a role to play and are the first line of defence against flooding by taking action to protect themselves and their property from flooding. Further information about roles and responsibilities is provided in Section 1.

This section describes the existing actions that are in place to manage flood risk and are in addition to the information presented in the relevant Potentially Vulnerable Area chapter of this document.

### Flood protection schemes

Dumfries and Galloway Council constructed a flood protection scheme in Kirkconnel in 1984. This consisted of re-grading 330m of the Glenwharrie Burn (Polbower Burn), construction of concrete retaining walls and reinforcing gabions to the rear of Kirkconnel Activity and Resource Centre. It also included 120m of culvert and two surface water interceptor cattle grids at Fauldhead Farm.

### River flood warning schemes

SEPA operates a flood warning scheme in the Nith catchment group. Flood Warnings are issued when river flooding is forecast for the flood warning areas. There is one river flood warning area within the catchment, at Whitesands in Dumfries, as shown in Figure 3 and Table 3. Table 3 shows the total number of properties in the flood warning area and the percentage of those properties that have signed up to receive flood warnings. Note that this is not the number of properties at risk of flooding.

Flood warning area (FWA)	River	Properties within FWA	% of properties registered May 2014
Whitesands (Dumfries)	Nith	349	36%

**Table 3:** Flood warning areas



Figure 3: Flood warning area



## Climate Change and future flood risk

The UK Climate Projections (UKCP09) predicts that climate change may lead to warmer and drier summers, warmer and wetter winters with less snow, and more extreme temperature and rainfall. The predicted increase in rainfall and river flows may increase the potential for river flooding.

Under the UKCP09 high emissions scenario for 2080, average peak river flows for the Nith catchment group may increase by 44%<sup>1</sup>. This would potentially increase in the number of residential properties at risk of river flooding from approximately 850 to 1,200 and the number of non-residential properties from approximately 220 to 300.

The predicted increases in flood risk are solely based on the impact of a changing climate on the magnitude of flooding; they do not take into account any potential increase due to population change, development pressures or urban creep, nor do they take into account any mitigation as a result of actions contained in this or future Flood Risk Management Strategies.

## Potential for natural flood management

The assessment of the potential for natural flood management is shown on SEPA online maps (<http://www.sepa.org.uk/environment/water/flooding/flood-maps/>). The maps indicates the potential for runoff reduction, floodplain storage and sediment management. They show areas where natural flood management could be effective and where further detailed assessment should take place. This information was used to help identify where local authorities could include natural flood management as part of flood risk management schemes and studies. The proposed schemes and studies are listed in the relevant Potentially Vulnerable Area chapters of this document.

SEPA is currently carrying out a natural flood management pilot study in the Upper Nith catchment, which also looks at way to improve the ecological status of water bodies in the catchment and may help to reduce local flooding.

### Runoff reduction

The assessment shows that a large area in the north of the catchment group has the potential for runoff reduction. This area is situated within the River Nith catchment, upstream of New Cumnock, Kirconnel and Sanquhar.

### Floodplain storage

Downstream on the River Nith there are several areas with the potential for flood storage both upstream of Dumfries town centre.

### Sediment management

Moderate erosion occurs upstream of Kirconnel along lengths of the River Nith and the Glenwharrie Burn.

---

<sup>1</sup> From the study 'An assessment of the vulnerability of Scotland's river catchments and coasts to the impacts of climate change' (CEH, 2011)

## River flooding Dee (Galloway) catchment group

### Catchment overview

The Dee catchment group is located within the Solway Local Plan District and covers an area of over 1,530km<sup>2</sup>. The catchment is over 98% rural and almost 2% urban with a population of approximately 24,000. This area includes part of two local authorities; Dumfries and Galloway Council and East Ayrshire Council.

The area comprises two main catchments, the River Dee and the Urr Water. The River Dee catchment has two main river stems: the Water of Ken, which flows in a southerly direction from the north of the catchment group, and the River Dee, which flows in an easterly direction before the two join at Loch Ken when the River Dee flows south discharging to the Solway Firth at Castle Douglas. The Urr Water is the significantly smaller catchment. It flows mostly southwards from Loch Urr then runs parallel to the B794 to the west of Dalbeattie, eventually discharging to the Solway Firth.

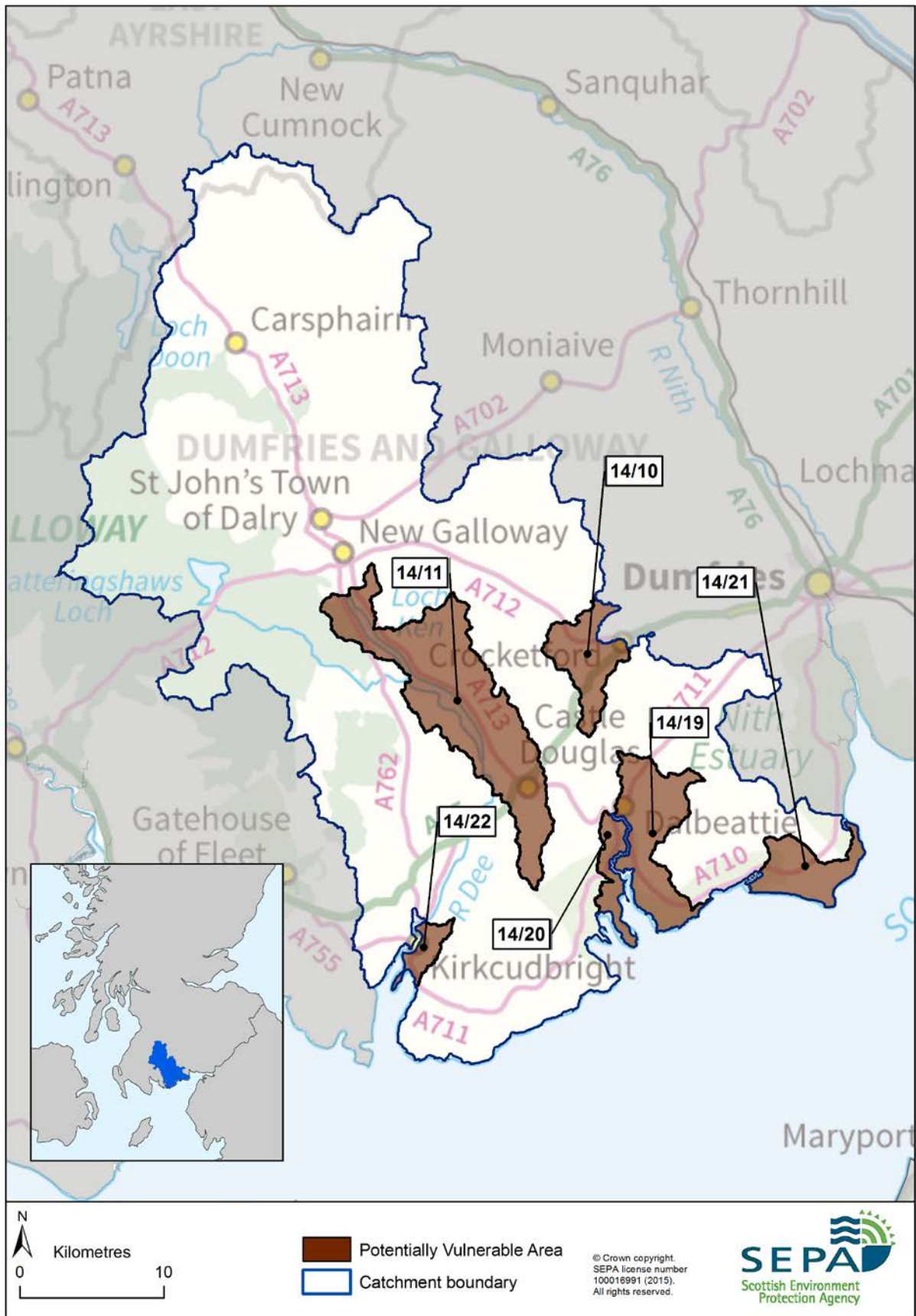
The catchment experiences higher than average rainfall ranging between 1,709mm in the lower part of the catchment and 1,821mm in the upper part.

The area is heavily modified by the Galloway hydro scheme, completed in the 1930s, which incorporates 1,344km<sup>2</sup> of catchment. Whilst the scheme's reservoirs provide some flood storage, they were not built as flood defence structures. Scottish Power is licensed to use water for power generation under regulations which include conditions to ensure flooding is not exacerbated by its operation. This includes restrictions on water release for electricity generation during flood conditions to avoid sending more water downstream. However, the reservoirs release excess flow when the water level rises above the appropriate levels.

### Flood risk in the catchment

There are approximately 530 residential properties predicted to be at risk of river flooding, 46% of which are located within Potentially Vulnerable Areas. Approximately 110 non-residential properties are predicted to be at risk of river flooding, 85% of which are located within Potentially Vulnerable Areas. There are five Potentially Vulnerable Areas at risk of river flooding situated within this catchment group as shown in Figure 1:

- Springholm (14/10)
- Castle Douglas (14/11)
- Dalbeattie (14/19)
- Palnackie (14/20)
- Southernness and Carsethorn (14/21).



**Figure 1:** River catchment for the Dee (Galloway) catchment group

## Main areas at risk

The main areas at risk of river flooding can be seen in Table 1, which shows the number of properties at risk and the Annual Average Damages caused by river flooding. This includes damages to residential and non-residential properties, transport and agriculture. The property count for Carsphairn comes from a local authority study, while all other values are from a SEPA study.

	Residential and non-residential properties at risk of river flooding	Annual Average Damages
Dalbeattie	270	£260,000
Castle Douglas	120	£280,000
Carsphairn	30	£18,000
Springholm	20	£70,000
New Galloway	20	£47,000
Bridge of Dee	20	£36,000

**Table 1:** Main areas at risk of river flooding

## Economic activity and infrastructure at risk

The Annual Average Damages caused by river flooding in the Dee (Galloway) catchment group are approximately £1.4 million which accounts for almost 14% of the estimated Annual Average Damages from river flooding within the Solway Local Plan District. The damages are distributed as follows:

- 68% residential properties (£1.0 million)
- 9% roads (£130,000)
- 8% emergency services (£95,000)
- 6% non-residential properties (£80,000)
- 6% agriculture (£80,000)
- 3% vehicles (£50,000).

Figure 2 shows the distribution of Annual Average Damages throughout the catchment group. Table 2 shows further information about infrastructure and agricultural land at risk of flooding within this catchment.

	Number at risk	Further detail
<b>Community facilities</b>	<10	Includes: educational buildings and healthcare facilities
<b>Utility assets</b>	20	Includes: electricity substations and Scottish Water assets
<b>Roads (km)</b>	14.7	Notably: A713 between Carsphairn and Knocknalling A711 between Dalbeattie and Dumfries A75 between Springholm and Crockettford A762 at Glenlee north-west of New Galloway
<b>Agricultural land (km<sup>2</sup>)</b>	46	Generally located along the main watercourses but flood plains are more extensive to the west of Castle Douglas and north of New Galloway

**Table 2:** Infrastructure and agricultural land at risk of river flooding

## Designated environmental and cultural heritage sites at risk

Within the catchment it is estimated that approximately 29 designated cultural heritage sites are at risk of river flooding. These sites include; scheduled monuments, designed gardens and landscapes and listed buildings.

Approximately 22 km<sup>2</sup> of environmental designated areas are at risk of river flooding. This includes Special Areas of Conservation (<1km<sup>2</sup>), Special Protection Areas (8km<sup>2</sup>) and Sites of Special Scientific Interest (14km<sup>2</sup>).

## History of flooding

Recent major river flooding was experienced in December 2013, Carsphairn, Ken Bridge, New Galloway, with local residents identifying the flooding as the worst they have experienced in 40 years. A number of properties were affected along with sections of the A713.

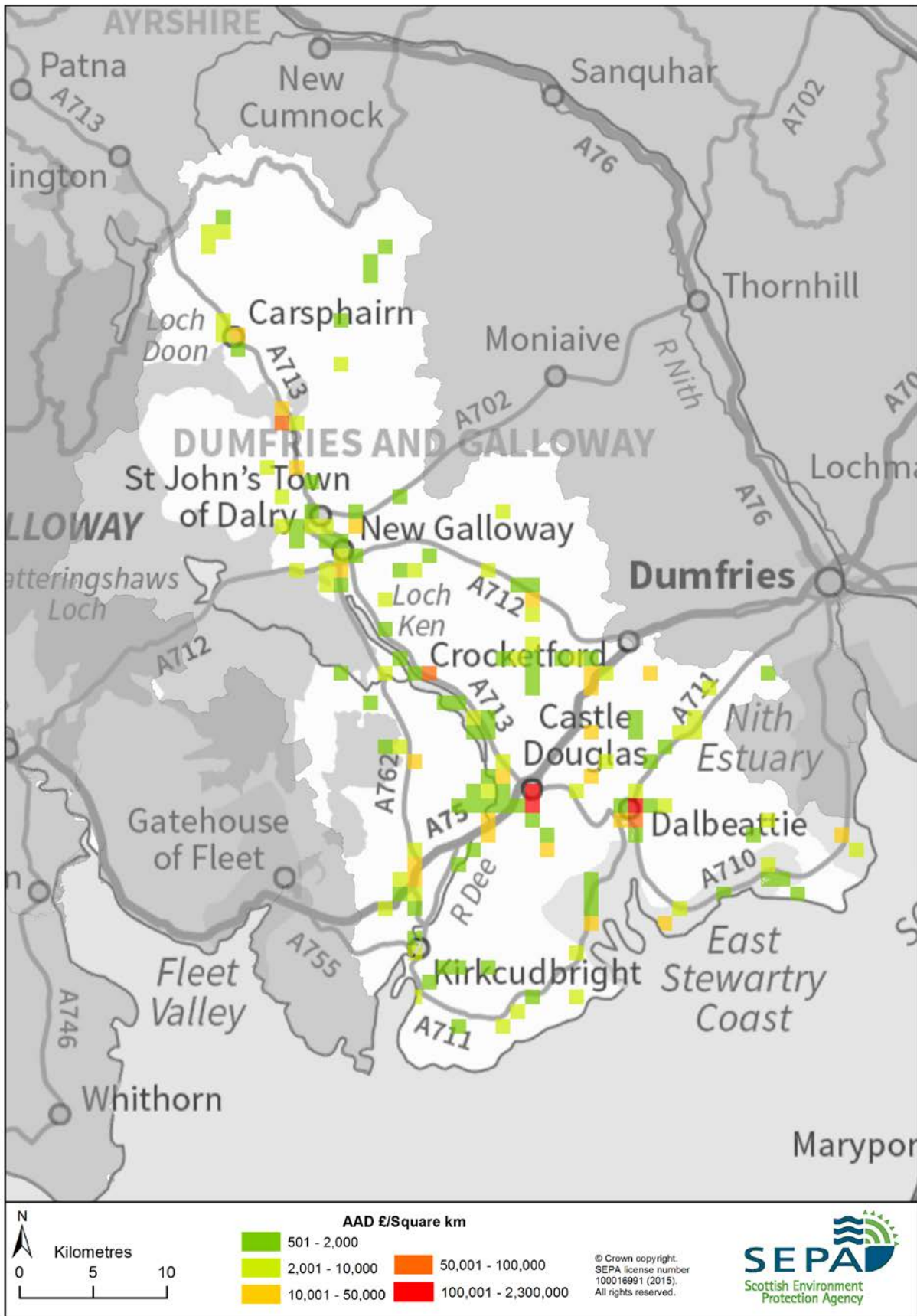
In late 2008 river flooding occurred in the areas of Beeswing, Dalbeattie, Kirkcudbright, Crossmichael and Parton mainly affecting roads and properties.

In December 2006 the Water of Ken flooded causing substantial damage to the A762 and road surface. On the same date flood water overspilled the banks of Loch Ken and flooded through fields onto the A713 road in Parton Village.

In January 2005 the Mill Burn flooded roads and school playground. On the same day the Palnackie Burn and Greenlaw Burn flooded and endangered nearby properties.

Wider impacts due to flooding, occurred on 31 October 1977 in Dalbeattie, when the gas supply was cut off for two days, during the flood a nearby footbridge was washed away.

Further detail about the history of flooding in this area is available in the relevant Potentially Vulnerable Area chapters of this document.



**Figure 2:** Annual Average Damages from river flooding

## Managing flood risk

A range of public bodies have responsibility for managing flood risk in Scotland and they are working closer than ever before to target action in the areas where the greatest benefit can be gained. Members of the public also have a role to play and are the first line of defence against flooding by taking action to protect themselves and their property from flooding. Further information about roles and responsibilities is provided in Section 1.

This section describes the existing actions that are in place to manage flood risk and are in addition to the information presented in the relevant Potentially Vulnerable Area chapter of this document.

### Flood protection schemes

Dumfries and Galloway Council has a number of flood protection schemes throughout this catchment group including the following:

- Dalbeattie Flood Protection Scheme (1981). The scheme covered the Kirkgunzeon Lane, Dalbeattie Burn and Drumjohn Burn and involved channel improvements, construction of banks and walls and culvert replacements.
- Craigieknowe Burn Flood Protection Scheme (1980)
- The Springholm Flood Protection Scheme (1990) consisted of the installation of a water gate, channel improvements and replacement culverts on the Culsharn Burn.
- Grange Burn Flood Protection Scheme (1972) in Bridge of Urr.

## Climate change and future flood risk

The UK Climate Projections (UKCP09) predicts that climate change may lead to warmer and drier summers, warmer and wetter winters with less snow, and more extreme temperature and rainfall. The predicted increase in rainfall and river flows may increase the potential for river flooding.

Under the UKCP09 high emissions scenario for 2080, average peak river flows for the Dee (Galloway) catchment group may increase by 44%<sup>1</sup>. This would potentially increase in the number of residential properties at risk of river flooding from approximately 530 to 830 and the number of non-residential properties from approximately 110 to 150.

The predicted increases in flood risk are solely based on the impact of a changing climate on the magnitude of flooding; they do not take into account any potential increase due to population change, development pressures or urban creep, nor do they take into account any mitigation as a result of actions contained in this or future Flood Risk Management Strategies.

## Potential for natural flood management

The assessment of the potential for natural flood management is shown on SEPA's flood maps (<http://www.sepa.org.uk/environment/water/flooding/flood-maps/>). The maps indicate the potential for wave attenuation and estuarine surge attenuation. They show areas where natural flood management could be effective and where further detailed assessment should take place. This information was used to identify where local authorities could include natural flood management as part of flood risk management schemes and studies. The proposed

---

<sup>1</sup> From the study 'An assessment of the vulnerability of Scotland's river catchments and coasts to the impacts of climate change' (CEH, 2011)

schemes and studies are listed in the relevant Potentially Vulnerable Area chapters of this document.

Dumfries and Galloway Council are to carry out further assessment of the potential for natural flood management to reduce flood risk in the Dee catchment.

### **Runoff reduction**

The Loch Ken catchment has large areas of high and medium potential for runoff reduction. These are situated in the east of the catchment group, mainly covering the area between the Water of Deugh and Shaw Hill. Incorporating runoff reduction measures in this area may reduce risk along Loch Ken and the River Dee further downstream. Another notable area exists to the north of the River Deugh, which contributes to significant flood risk in Carsphairn. Other sizable areas designated as having medium potential for runoff reduction are scattered through the catchment group, particularly along the east and in the south east of the area, upstream of Potentially Vulnerable Areas Springholm (14/10), Dalbeattie (14/19) and Southernness and Caresthorn (14/21).

### **Floodplain storage**

There are substantial areas of potential flood storage throughout the catchment group. There is scope for additional storage at several lochs, including but not limited to Loch Grannoch, Lock Skerrow, Clatteringshaws Loch, Stroan Loch and most notably Loch Ken. As Loch Ken is controlled to an extent by the barrage at Glenloch, therefore any potential flood storage may be governed by the operational controls at this structure. Loch Ken also contributes to flood risk in some nearby areas, so additional storage in this area may not be suitable as it may exacerbate flood problems.

Floodplain storage in the catchment group has already been greatly influenced by Scottish Power's incorporation of water storage areas. There are 10 dams within the Galloway hydro scheme, which provide additional storage in reservoirs such as Loch Doon, Clatteringshaws and Lock Ken to supply the six power stations that form the Galloway hydro scheme. The flow of water to the turbines can be shut off by closing intake gates and valves, according to customer demand and available water, which will alter water levels downstream. There are restrictions on water release for electricity generation during flood conditions, which have been put in place to avoid increased flooding downstream.

Further information on the Galloway hydro scheme can be found on the Scottish Power website<sup>2</sup>.

### **Sediment management**

Watercourses contributing to Lock Ken, such as the Water of Ken and Black Water of Dee, have distinct lengths of erosion and deposition. The River Dee, south of Loch Ken, has alternating high levels of erosion and deposition upstream of Kircudbright, which experiences flooding from the river. Opportunities for balancing the river sediment movement also exist along watercourses in Potentially Vulnerable Areas 14/10 (Spottes Burn) and 14/19 (Kirkgunzeon Lane).

---

<sup>2</sup> [http://www.scottishpower.com/pages/galloway\\_and\\_lanark\\_hydro\\_schemes.asp](http://www.scottishpower.com/pages/galloway_and_lanark_hydro_schemes.asp)



## River flooding Cree catchment group

### Catchment overview

The Cree catchment group is located within Solway Local Plan District and covers an area of over 2,000km<sup>2</sup>. The region is over 98% rural with less than 2% of the area identified as urban, with an approximate population of 34,000. This area includes part of two local authorities; Dumfries and Galloway Council and South Ayrshire Council.

There are three main river catchments which are the Water of Luce, the River Bladnoch and the River Cree. The River Cree originates in the South Ayrshire Hills. The main tributaries of the Cree are the Minnoch, Trool and Penkiln Burns. The Water of Luce originates from Milljoan Hill in South Ayrshire and flows south into New Luce, where it is joined by the Cross Water of Luce. It continues south towards Glenluce before flowing into the Solway Firth at Luce Bay. The River Bladnoch headwaters are in Loch Maberry in the north, it continues in a south-easterly direction until it passes Wigtown harbour and enters the sea at Wigtown Bay.

The annual average rainfall in the area is relatively high for Scotland, ranging between 1,366mm and 2,026mm in the upper parts of the catchments, to between 1,342mm and 1,756mm in the lower parts.

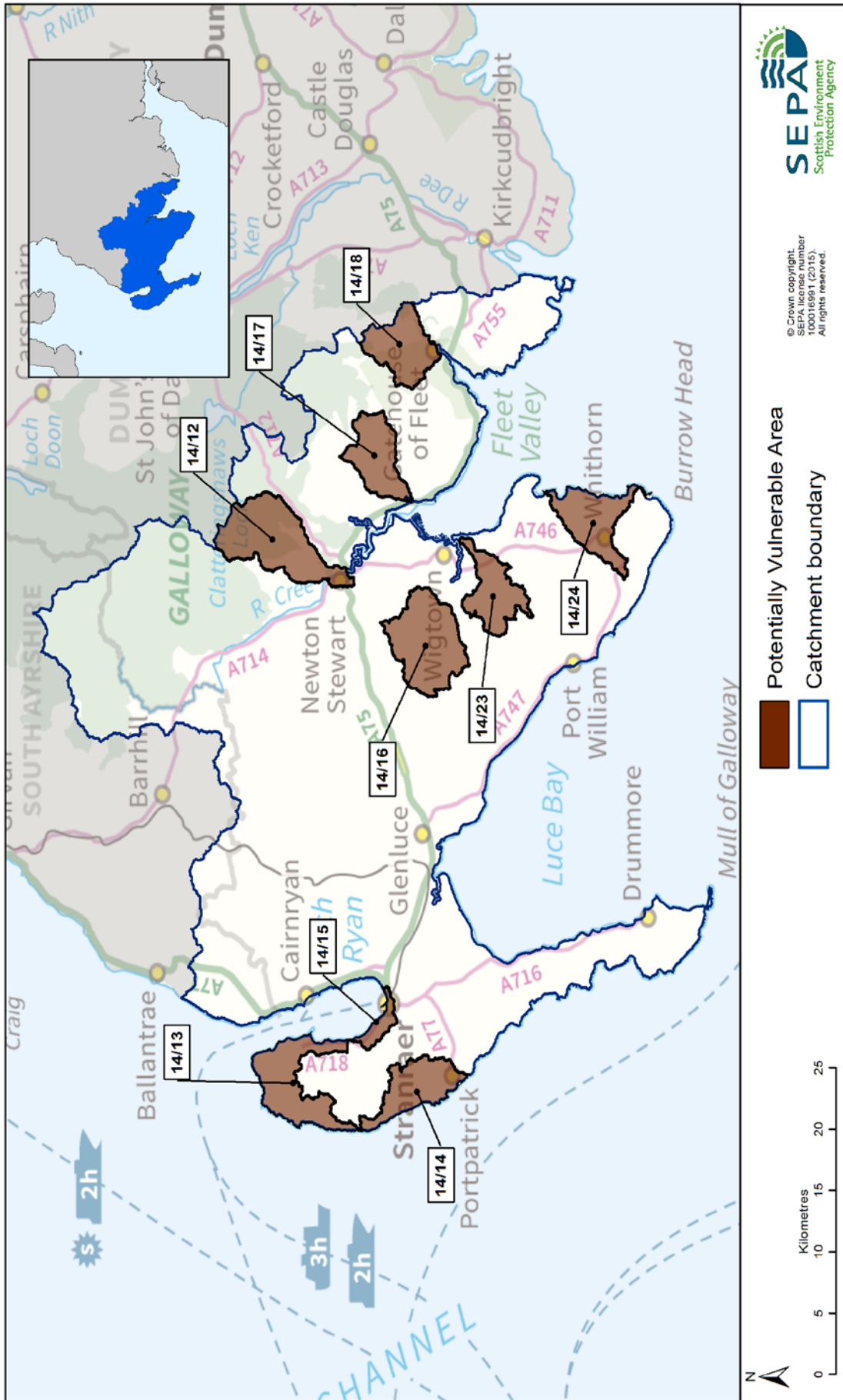
### Flood risk in the catchment

There are approximately 580 residential properties at risk of river flooding, 78% of which are located within Potentially Vulnerable Areas. There are also approximately 160 non-residential properties at risk of river flooding, 80% of which are located within Potentially Vulnerable Areas. There are nine Potentially Vulnerable Areas in this catchment group as shown in Figure 1:

- Newton Stewart (14/12)
- Kirkcolm (14/13)
- Portpatrick (14/14)
- Stranraer (14/15)
- Spittal (14/16)
- Creetown (14/17)
- Gatehouse of Fleet (14/18)
- Braehead and Whauphill (14/23)
- Isle of Whithorn and Garlieston (14/24).

### Main areas at risk

The main areas at risk of river flooding can be seen in Table 1, which shows the number of properties at risk and the Annual Average Damages caused by river flooding. This includes damages to residential and non-residential properties, transport and agriculture. Newton Stewart and Stranraer are the main areas at risk of flooding.



**Figure 1:** River catchment for the Cree catchment group

	Residential and non-residential properties at risk of river flooding	Annual Average Damages
Newton Stewart	270	£520,000
Stranraer	200	£160,000
Garlieston	80	£200,000
Creetown	60	£130,000
Isle of Whithorn	10	£35,000
Sorbie	10	£34,000
Port William	10	£30,000

**Table 1:** Main areas at risk of river flooding

### Economic activity and infrastructure at risk

The Annual Average Damages caused by river flooding in the Cree catchment group are approximately £1.7 million, which accounts for almost 18% of the estimated Annual Average Damages from river flooding within the Solway Local Plan District. The damages are distributed as follows:

- 59% residential properties (£1.0 million)
- 18% non-residential properties (£300,000)
- 7% emergency services (£120,000)
- 7% roads (£110,000)
- 6% agriculture (£96,000)
- 3% vehicles (£47,000).

Figure 2 shows the distribution of Annual Average Damages throughout the catchment group. The figure shows that the highest concentration of damages is in Newton Stewart and Garlieston.

Please note that economic damages to rail were not assessed as information on damages at a strategic scale is not available.

Table 2 shows further information about infrastructure and agricultural land at risk of flooding within this catchment.

	Number at risk	Further detail
<b>Community facilities</b>	<10	Includes: educational buildings and healthcare facilities
<b>Utility assets</b>	10	Includes: electricity substations and telecommunications sites
<b>Roads (km)</b>	10.2km	Notably: A77 along the shore of Loch Ryan heading north from Stranraer to Ballantrae A75 Stranraer to Newton Stewart and south of Gatehouse of Fleet A714 north of Newton Stewart
<b>Railway routes (km)</b>	1.4km	Stranraer
<b>Agricultural land (km<sup>2</sup>)</b>	50	Located mainly along the main watercourses

**Table 2:** Infrastructure and agricultural land at risk of flooding

## Designated environmental and cultural heritage sites at risk

Within the catchment it is estimated that 48 designated cultural heritage sites are at risk of river flooding. These sites include; scheduled monuments, gardens and designed landscapes and listed buildings.

Approximately 11 km<sup>2</sup> of environmental designated area is at risk of river flooding. This includes Special Areas of Conservation (4km<sup>2</sup>), Special Protection Areas (1km<sup>2</sup>) and Sites of Special Scientific Interest (6km<sup>2</sup>).

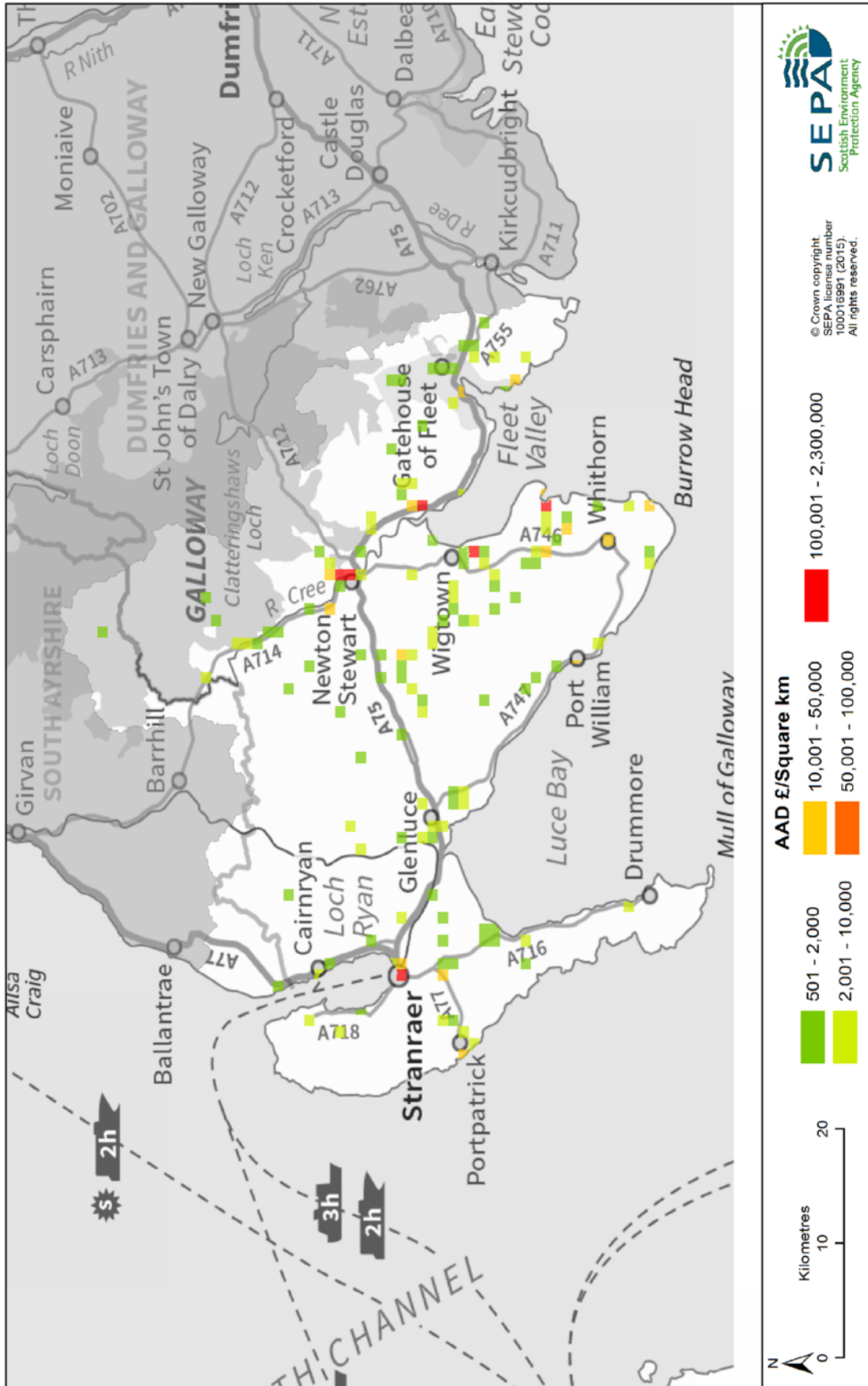
## History of flooding

There have been a number of floods in the area, which have impacted people and properties. The largest impacts have been along the River Cree and Penkiln Burn, where many river floods have affected Newton Stewart and Minnigaff. The first recorded flooding was in 1851, with the most recent flood occurring on 19 November 2012. Flooding in 2012 was the highest observed water level in the River Cree, which resulted in approximately 50 properties being flooded. The most recent flooding on the River Cree occurred on July 2015 when flash flooding caused flooding to properties Creetown.

A major river flood occurred in Portpatrick on October 2000 causing extensive damage to shops, hotels and houses. This flood ultimately led to the construction of the Portpatrick Flood Protection Scheme in 2004.

River floods have also impacted Mayfield. In 1970 and 1971 the ferry terminal marshalling yard flooded from Black Stank/Bishop Burn. The earliest recorded flood took place in October 1926 with a number of recent floods here in August 1999 and across September and October 2002.

Further detail about the history of flooding in this area is available in the relevant Potentially Vulnerable Area chapters of this document.



**Figure 2:** Annual Average Damages from river flooding

## Managing flood risk

A range of public bodies have responsibility for managing flood risk in Scotland and they are working closer than ever before to target action in the areas where the greatest benefit can be gained. Members of the public also have a role to play and are the first line of defence against flooding by taking action to protect themselves and their property from flooding. Further information about roles and responsibilities is provided in Section 1.

This section describes the existing actions that are in place to manage flood risk and are in addition to the information presented in the relevant Potentially Vulnerable Area chapter of this document.

### Flood protection schemes

Dumfries and Galloway Council has a number of flood protection schemes throughout this catchment group including:

- The Creetown Flood Protection Scheme that consists of embankments and a diversion channel.
- The Kirkcolm Flood Protection Scheme (1991) involved channel improvements and culvert up-grades.
- Kirkinner Flood Protection Scheme (1991) involved channel improvements and culvert replacements.
- Whithorn Flood Protection Scheme (1991) involved channel improvements and culvert replacement.
- Mochrum Flood Protection Scheme (1991) on the Druchtag Burn involved the burn being culverted through the village.
- Port Logan Flood Protection Scheme (1991) consisted of the culverting of an unnamed tributary through the Shore Road to mitigate flooding of properties along Laigh Row.
- The Portpatrick Flood Protection Scheme (2004) consisted of upstream attenuation areas, channel improvements, bridge raising, a storm bypass pipe and walls.
- Stranraer Flood Protection Scheme is partially completed. The scheme is being undertaken as a number of different work packages which includes: diversion of part of the Sheuchan Burn and trash screens, culverting, new culvert inlet and silt trap, culvert replacement, flow control, formalisation of storage within agricultural land and masonry wall re-build, as well as property level protection installations such as automatic air bricks. Dumfries and Galloway Council will maintain the works with periodic inspection.

### River flood warning schemes

There is no current river flood warning schemes within the Cree catchment group but it is proposed that a Flood Early Warning System (FEWS) for Newton Stewart will be put in place before the end of 2016.

## Awareness raising and community groups

The Cree Valley Flood Action Group covers the watercourses in Newton Stewart and a section of the River Cree. It was established in 2013 following flooding in November 2012.

## Climate change and future flood risk

The UK Climate Projections (UKCP09) predicts that climate change may lead to warmer and drier summers, warmer and wetter winters with less snow, and more extreme temperature and rainfall. The predicted increase in rainfall and river flows may increase the potential for river flooding.

Under the UKCP09 high emissions scenario for 2080, average peak river flows for the Cree catchment group may increase by 44%<sup>1</sup>. This would potentially increase in the number of residential properties at risk of river flooding from approximately 580 to over 790 and the number of non-residential properties from approximately 160 to 190.

The predicted increases in flood risk are solely based on the impact of a changing climate on the magnitude of flooding; they do not take into account any potential increase due to population change, development pressures or urban creep, nor do they take into account any mitigation as a result of actions contained in this or future Flood Risk Management Strategies.

## Potential for natural flood management

The assessment of the potential for natural flood management is shown on SEPA's flood maps (<http://www.sepa.org.uk/environment/water/flooding/flood-maps/>). The maps indicate the potential for wave attenuation and estuarine surge attenuation. They show areas where natural flood management could be effective and where further detailed assessment should take place. This information was used to identify where local authorities could include natural flood management as part of flood risk management schemes and studies. The proposed schemes and studies are listed in the relevant Potentially Vulnerable Area chapters of this document.

## Runoff reduction and floodplain storage

The assessment indicates that a significant area of the catchment shows high and medium potential for runoff reduction. The main areas are in the north of the River Cree and Water of Minnoch catchments. There is also an area to the north of Newton Stewart with high potential for runoff reduction. This area is also shown to have high potential for additional floodplain storage with sections as far as Bargrennan.

## Sediment management

Watercourses within the catchment are generally balanced, with some shorter lengths alternating between high erosion and high deposition. Lengths of high erosion and high deposition occur upstream of Newton Stewart, with predominantly high deposition occurring downstream, therefore natural flood management actions in the upstream catchment may offer some potential to reduce flooding risk.

---

<sup>1</sup> From the study 'An assessment of the vulnerability of Scotland's river catchments and coasts to the impacts of climate change' (CEH, 2011)

## 3.3 Coastal flooding

### Solway Local Plan District

This chapter provides supplementary information on flooding for coastal areas. It provides an overview of the natural characteristics of the coast, a summary of flood risk within the coastal area and a brief history of flooding. It also outlines the likely impact of climate change and the potential for natural flood management.

Information about the objectives and actions to manage flood risk are provided in in Section 2.

#### Coastal overview

This coastal area of the Solway Local Plan District covers approximately 625km of coastline. There are several coastal communities in this coastal area including Stranraer, Annan, Creetown, Kirkcudbright and Portpatrick.

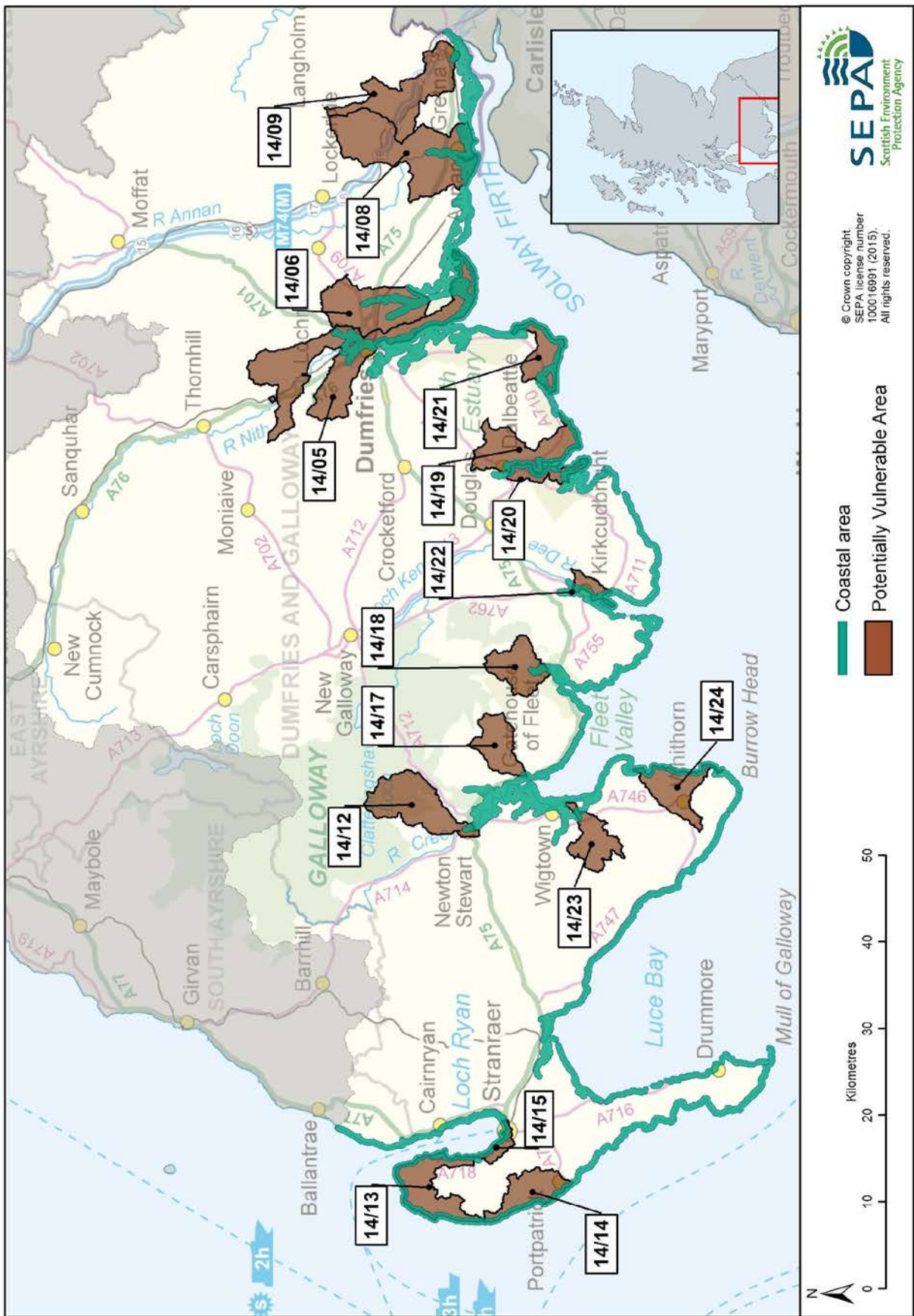
This area spans two local authorities; Dumfries and Galloway Council and South Ayrshire Council.

#### Flood risk

Within this area there are estimated to be approximately 670 residential properties and approximately 170 non-residential at risk of coastal flooding. This risk has been calculated from the inland projection of still water levels. Additionally there are potential impacts from locally generated wave mechanisms affecting the coastline. The Potentially Vulnerable Areas in this Local Plan District at risk of coastal flooding are listed below. Potentially Vulnerable Areas 14/06 and 14/12 are near the coast although have no damage from coastal flooding (Figure 1).

- Dumfries Nith (14/05)
- Ecclefechan-Annan (14/08)
- Kirtle Water catchment (14/09)
- Kirkcolm (14/13)
- Portpatrick (14/14)
- Stranraer (14/15)
- Creetown (14/17)
- Gatehouse of Fleet (14/18)
- Dalbeattie (14/19)
- Palnackie (14/20)
- Southernness and Carsethorn (14/21)
- Kirkcudbright (14/22)
- Braehead and Whauphill (14/23)
- Isle of Whithorn and Garlieston (14/24).





**Figure 1:** Local Plan District coastal area and Potentially Vulnerable Areas with a risk of coastal flooding

## Main areas at risk

The main areas at risk of coastal flooding can be seen in Table 1. This shows the number of properties at risk and the total Annual Average Damages caused by coastal flooding for each of these areas. This includes damages to residential and non-residential properties, transport and agriculture.

	Residential and non-residential properties at risk of coastal flooding	Annual Average Damages
Stranraer	150	£220,000
Annan	130	£240,000
Kirkcudbright	90	£200,000
Isle of Whithorn	50	£260,000
Powfoot	60	£230,000
Creetown	40	£200,000
Garlieston	40	£160,000
Dalbeattie	30	£180,000
Southernness	30	£120,000
Portpatrick	10	£30,000

**Table 1:** Main areas at risk of coastal flooding

## Economic activity and infrastructure at risk

The Annual Average Damages caused by coastal flooding within this coastal area are approximately £2.7 million. The damages are distributed as follows:

- 56% residential properties (£1.5 million)
- 15% non-residential properties (£410,000)
- 14% roads (£390,000)
- 6% Emergency services (£180,000)
- 4% vehicles (£120,000)
- 2% agriculture (£60,000).

There is potential for damages all along the Solway coastline, although the highest damages are predicted to occur around the main coastal areas, with potential impacts to properties, shops and services in these areas. Figure 2 shows the Annual Average Damages throughout the coastal area.

Please note that economic damages to rail were not assessed as information on damages at a strategic scale is not available.

Table 2 shows further information about infrastructure and agricultural land at risk of coastal flooding.

	Number at risk	Further detail
<b>Community facilities</b>	<10	Includes; emergency services and educational buildings
<b>Utility assets</b>	20	Includes; electricity substations and fuel extraction sites
<b>Roads (km)</b>	23.4	Notably: A77 and A75
<b>Railway routes (km)</b>	2.9	Section of Glasgow South Western line
<b>Agricultural land (km<sup>2</sup>)</b>	30.6	

**Table 2:** Infrastructure and agricultural land at risk of coastal flooding

### **Designated environmental and cultural heritage sites at risk**

Within the catchment it is estimated that approximately 42 designated cultural heritage sites are at risk of coastal flooding. These sites include; scheduled monuments, gardens and designed landscapes and listed buildings.

Approximately 32 environmental designated areas are at risk of coastal flooding. This includes four Special Areas of Conservation, four Special Protection Areas and 24 Sites of Special Scientific Interest. These include the Luce Bay and Sands, Isle of Whithorn Bay, Cree Estuary, Borgue coast, Upper Solway flats and marshes and Solway Firth.

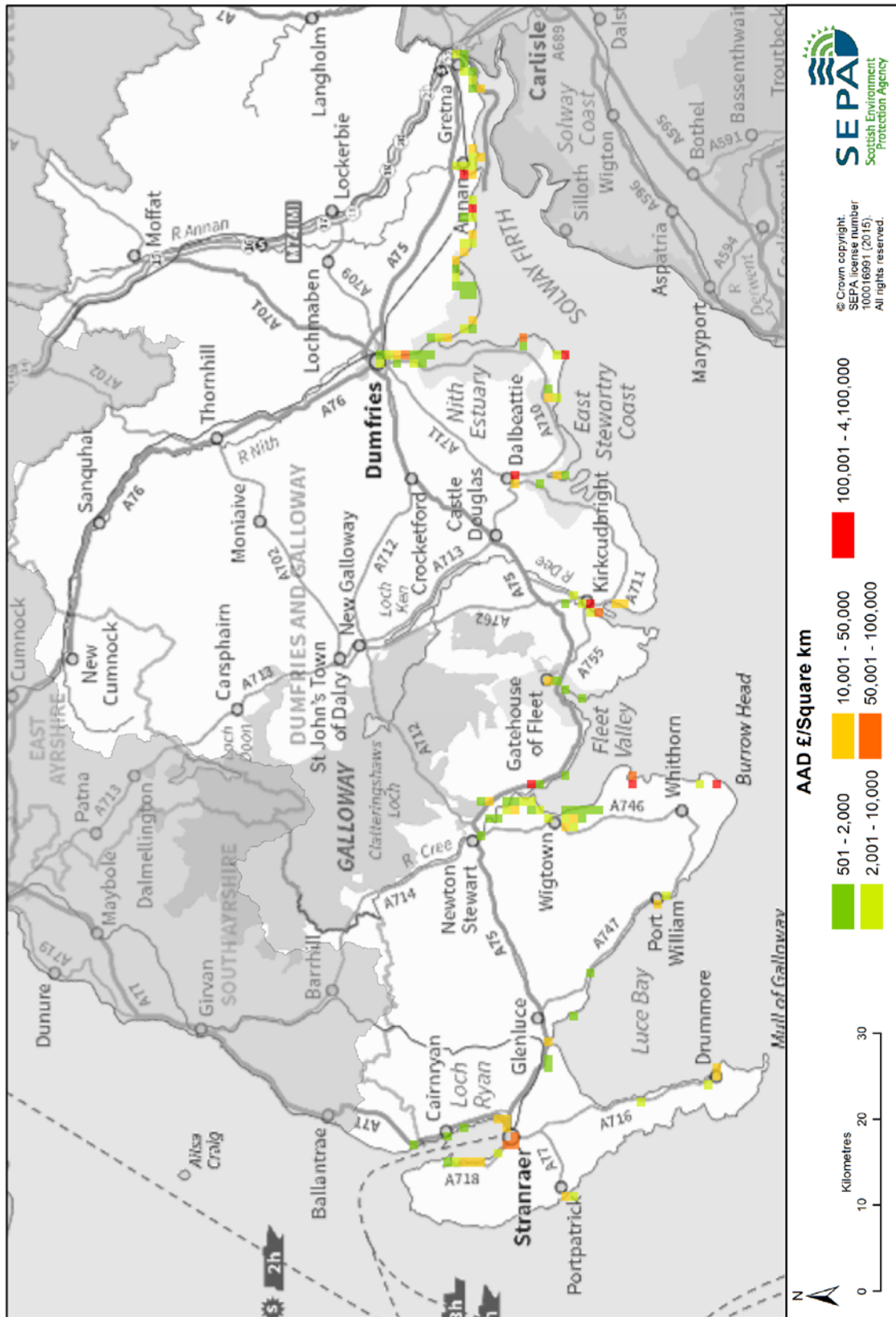


Figure 2: Annual Average Damages from coastal flooding

## History of flooding

The most recent and notable coastal flooding along the Solway coastline occurred in January 2014. The January 2014 flooding also affected several locations across the area including:

- Annan: approximately 30 properties were affected by flooding
- Creetown: more than 10 residential properties were affected.
- Dumfries: a few business properties were flooded.
- Glencaple and Kelton approximately 10 properties were affected and a road was closed due to flooding.
- Isle of Whithorn: approximately 40 residential properties and a few business properties flooded.
- Kirkcudbright: approximately 10 residential properties and business properties flooded.
- Port Logan fewer than 10 residential properties were flooded.
- Portpatrick there was damage to coastal defence structures
- Port William waves destroyed part of the sea wall and the A747 was damaged.
- Powfoot: roads and public space flooded and three families were evacuated from Queensberry Caravan Park.
- Southernness: approximately 10 residential properties flooded and there was damage to private coastal defence.

On the 1 February 2014 coastal flooding in the Isle of Whithorn resulted in fire and rescue crews pumping water from properties on Harbour Row and Main Street. Furthermore, on the 1 February 2014 huge waves overtopped the harbour wall in Port William which caused residential properties to flood and a coastal road to close at a number of locations.

The earliest recorded floods date back to the late 19 century. However, these had limited impacts to people and properties.

Further detail about the history of flooding in this area is available in the relevant Potentially Vulnerable Area chapters of this document.

## Managing flood risk

A range of public bodies have responsibility for managing flood risk in Scotland and they are working closer than ever before to target action in the areas where the greatest benefit can be gained. Members of the public also have a role to play and are the first line of defence against flooding by taking action to protect themselves and their property from flooding. Further information about roles and responsibilities is provided in Section 1.

This section describes the existing actions that are in place to manage flood risk and are in addition to the information presented in the relevant Potentially Vulnerable Area chapter of this document.

## Flood protection schemes

There are coastal defence assets throughout this Local Plan District which are not formal flood protection schemes but do provide protection against both flooding and erosion.

Common types of shoreline defence along this coastline are:

- **Hard Shoreline Reinforcement:** Reinforcement structures use materials such as rock armour, man-made armour, revetments, retaining walls, gabion baskets, seawalls and sheet piling to protect vulnerable coastlines or harbours from erosion.
- **Flood Defence Embankment:** This is a length of flood embankment, such as an artificial bank of earth and stone created to prevent inundation of estuarine and coastal floodplains.

The location and type of existing coastal defences in this Local Plan District are shown in Figure 4.

## Coastal flood warning schemes

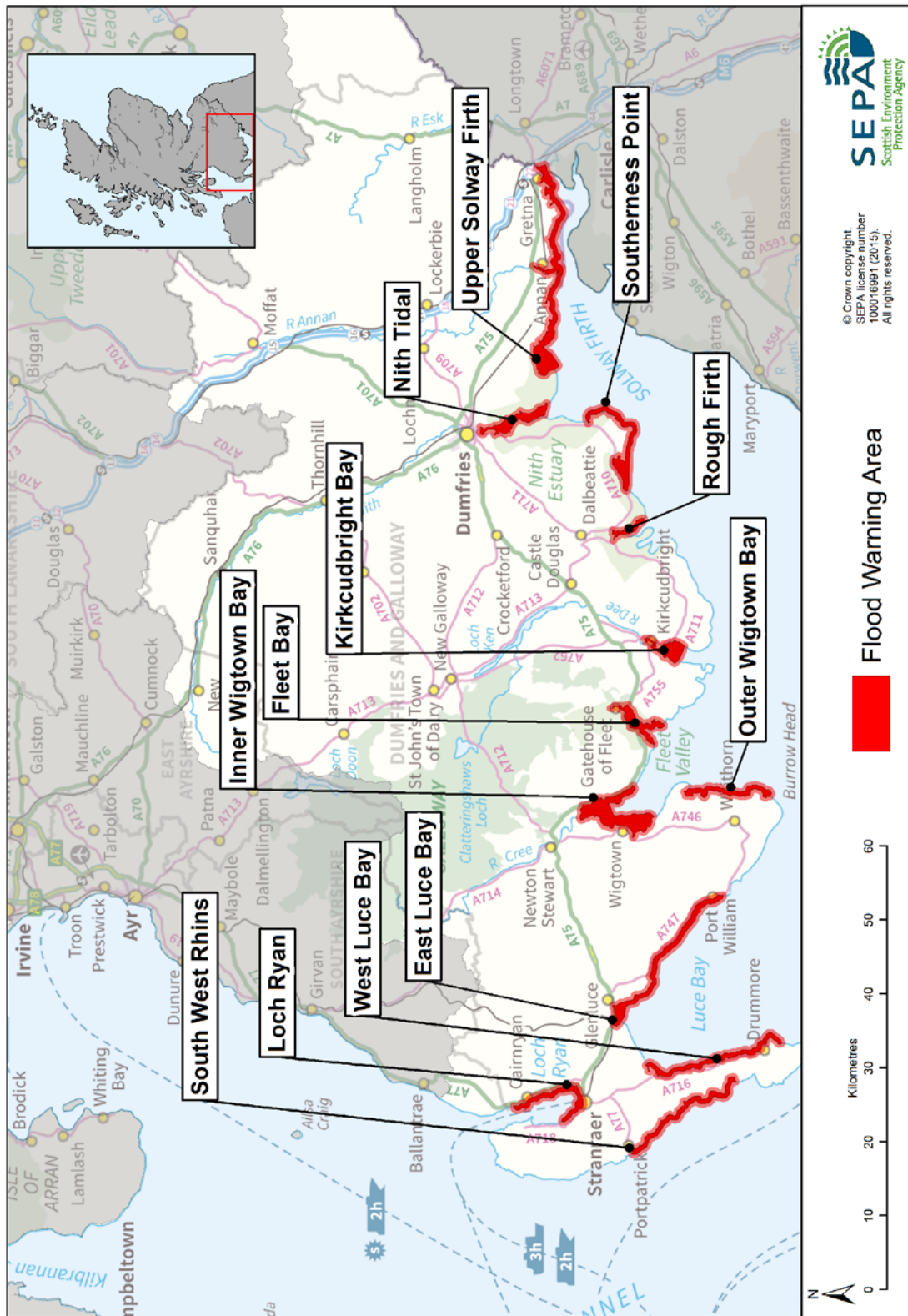
A flood warning scheme for the Solway Firth was launched in October 2015. The warning areas within this scheme are shown in Figure 3.

## Climate change and future flood risk

UK Climate Projections (UKCP09) predicts that climate change may increase sea levels. The magnitude of sea level rise varies around the coastline.

For the UKCP09 high emissions scenario, the predicted average sea level increase for the Solway Local Plan District is between 0.48m-0.50m by 2080. This may increase the number of residential properties at risk of coastal flooding from approximately 680 to 1,700 and the number of non-residential from approximately 170 to 230. Coastal flood modelling by SEPA has not taken into account the impacts of future climate change on wave overtopping or storminess, which could increase the number of people affected by coastal flooding.

The predicted increases in flood risk are solely based on the impact of a changing climate on the magnitude of flooding; they do not take into account any potential increase due to population change, development pressures or urban creep, nor do they take into account any mitigation as a result of actions contained in this or future Flood Risk Management Strategies.



**Figure 3: Flood warning areas**

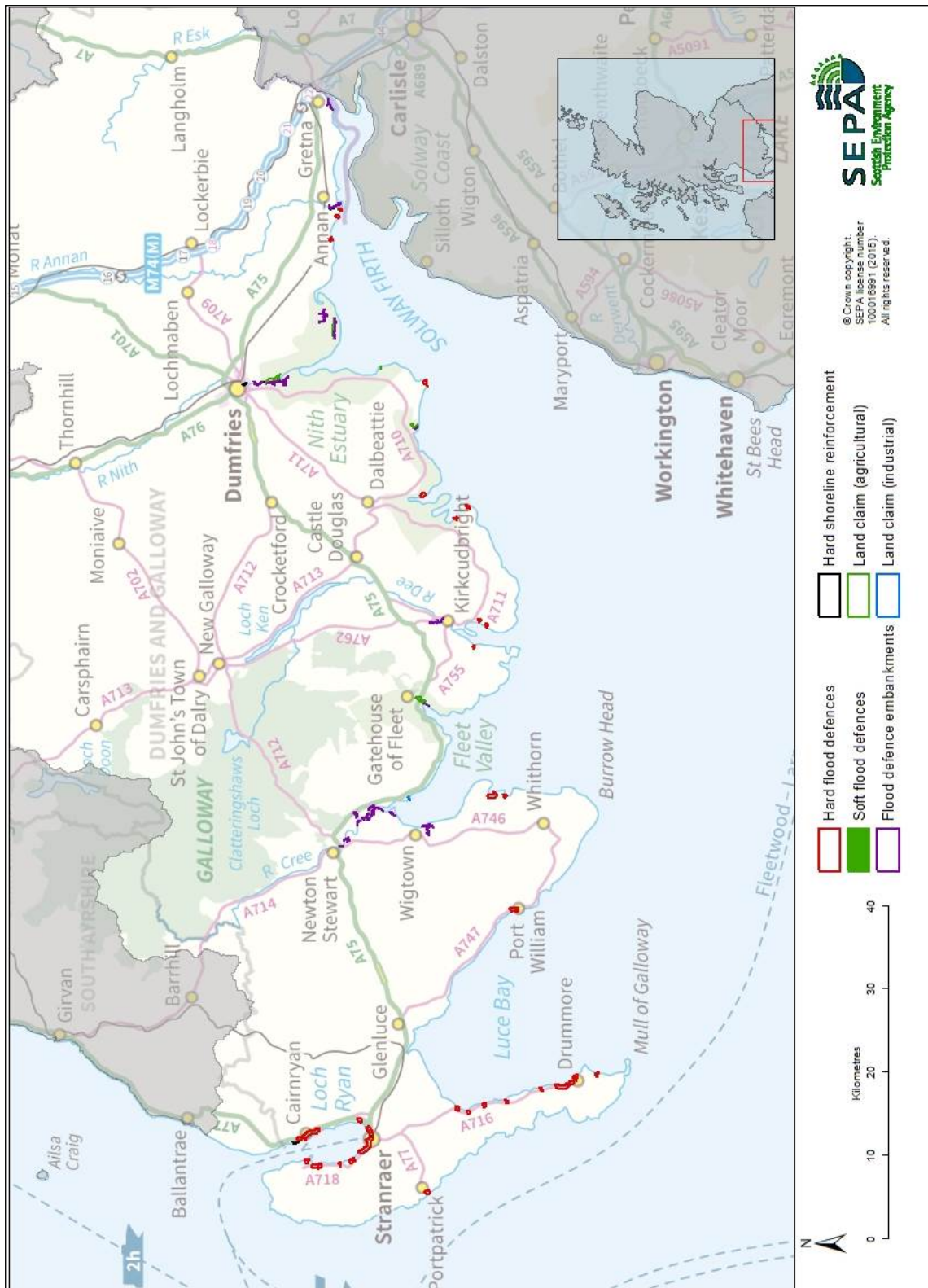


Figure 4: Coastal protection for coastal area



## Potential for natural flood management

The assessment of the potential for natural flood management is shown on SEPA's flood maps (<http://www.sepa.org.uk/environment/water/flooding/flood-maps/>). The maps indicate the potential for wave attenuation and estuarine surge attenuation. They show areas where natural flood management could be effective and where further detailed assessment should take place. This information was used to identify where local authorities could include natural flood management as part of flood risk management schemes and studies. The proposed schemes and studies are listed in the relevant Potentially Vulnerable Area chapters of this document.

### Wave energy dissipation

There are a number of areas along the majority of the coastline that show potential for wave energy dissipation. Some of these areas are:

- Loch Ryan, between Leffnoll Point and Kirkcolm
- Broadsea Bay to Black Head
- Port of Spittal Bay
- Mull of Galloway to Burrow Head
- Innerwell Port and Ravenshall Point
- Southernness Point
- Kirkcudbright Bay
- Carsethorn.

### Estuarine surge

There are a number of areas showing high potential for estuarine surge attenuation. Most notable are:

- Auchencairn Bay
- Rough Firth
- along Mersehead Sands
- Blackshaw Bank
- Sarkfoot Point
- Wigtown Sands.

## 3.4 Surface water flooding

### Solway Local Plan District

This chapter provides supplementary information on surface water flooding across the Solway Local Plan District. It provides an overview of the main areas at risk and the history of surface water flooding. The predicted impacts on infrastructure are also identified. The impacts on environmental sites and agricultural land have not been assessed.

Information about the objectives and actions to manage flood risk are provided in Section 2.

#### Flood risk

Within Solway Local Plan District there are approximately 590 residential properties and 240 non-residential properties at risk of surface water flooding. It is estimated that 85% of these properties are located within Potentially Vulnerable Areas.

#### Main areas at risk

Table 1 provides a list of the areas with the greatest number of properties at risk. The damages include impacts to residential and non-residential properties, vehicles, emergency services and roads.

	Residential and non-residential properties at risk of surface water flooding	Annual Average Damages
Dumfries	380	£370,000
Moffat	70	£160,000
Annan	50	£75,000
Castle Douglas	40	£29,000
Lincluden	40	£25,000
Dalbeattie	30	£54,000
Heathall	20	£13,000

**Table 1:** Main areas at risk of surface water flooding

#### Economic activity and infrastructure at risk

The Annual Average Damages caused by surface water flooding within this catchment are approximately £1.2 million. The damages are distributed as follows:

- 53% residential properties (£630,000)
- 30% non-residential properties (£360,000)
- 11% roads (£130,000)
- 5% Emergency services (£60,000).
- 1% vehicles (£15,000)

Figure 1 shows the distribution of Annual Average Damages from surface water flooding across the Local Plan District. The greatest concentration of potential damages is in Dumfries. Annan, Moffat and Gatehouse of Fleet also have areas of high damages.

Please note that economic damages to rail were not assessed as information on damages at a strategic scale is not available. Table 2 shows the approximate numbers of further infrastructure assets which are at risk of flooding within this Local Plan District.

	Number at risk	Further detail
<b>Community facilities</b>	<10	Includes; educational buildings and emergency services.
<b>Utility assets</b>	70	Includes; electricity substations, electricity generation and fuel extraction sites.
<b>Roads (km)</b>	751	Includes; A710, A75 and A76
<b>Railway routes (km)</b>	6.5	Section of Glasgow South Western line

**Table 2:** Infrastructure at risk of surface water flooding

### Designated environmental and cultural heritage sites at risk

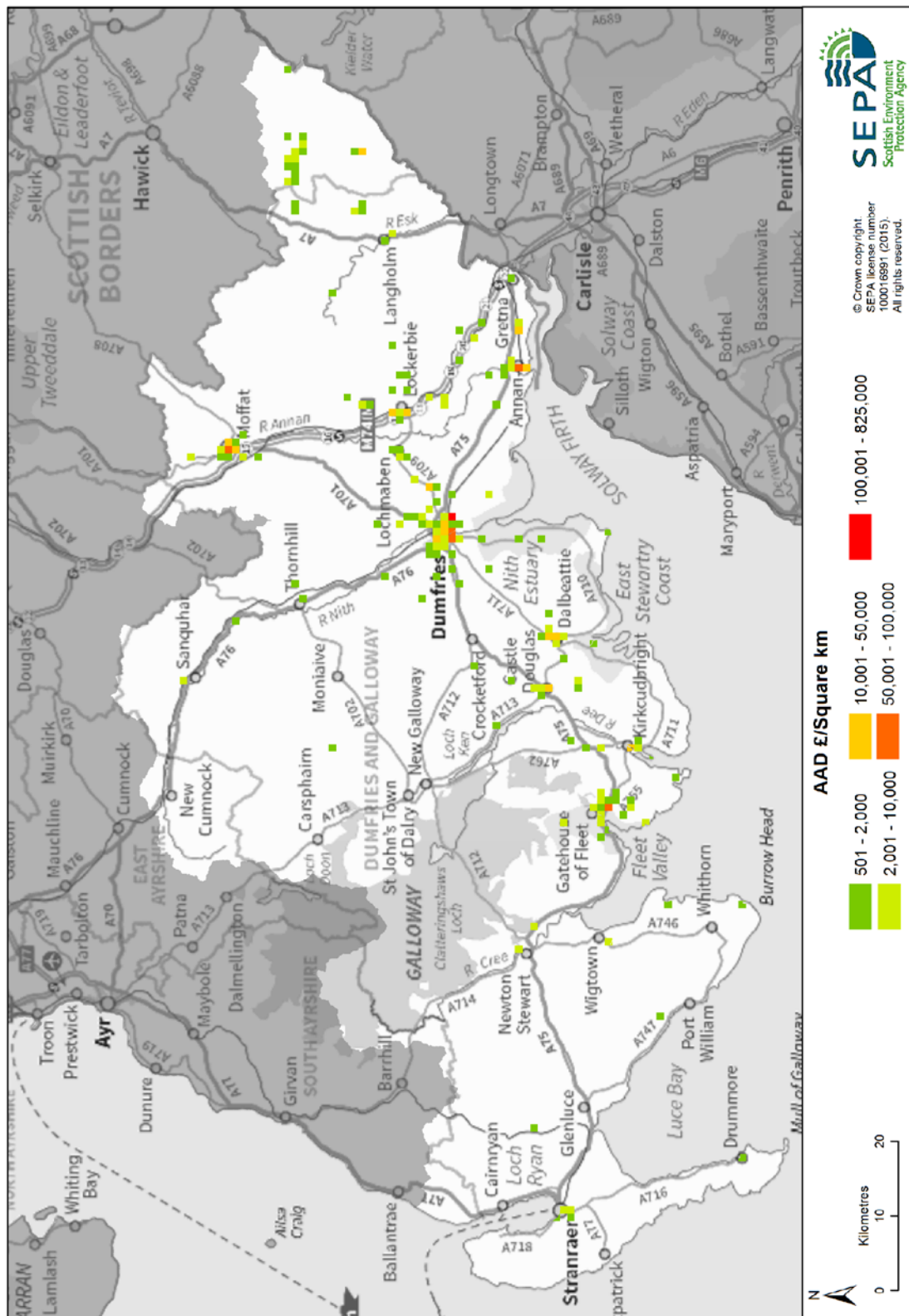
Within the Local Plan District it is estimated that 144 designated cultural heritage sites have a risk of surface water flooding. These sites include; scheduled monuments, gardens and designed landscapes and listed buildings.

The impact of surface water flooding on environmental sites has not been assessed and is assumed to be relatively low.

### History of surface water flooding

Since surface water flooding was first reported in Dumfries, Moffat and Newton Stewart during the 1870's, there have been few reports of surface water flooding to properties with most related to ponding on agricultural land. The most notable surface water flood occurred in January 1942 in the town of Stranraer, which caused flooding to a large number of residential and non-residential properties. Roads were also blocked, with an evacuation and rescue required.

More recently, minor flooding was reported to impact roads and properties in Nithsdale and Annandale and Eskdale in January and August 2009. There was also flooding between September and December 2008, which had minor impacts on many roads and properties throughout the district.



**Figure 1: Annual Average Damages from surface water flooding**

## Managing flood risk

### Surface water management priority areas

The areas at highest risk from surface water flooding have been prioritised. These priority areas were identified using SEPA flood models, supplemented with historical flood information and, where available, more detailed modelling from local authorities. These priority areas require the preparation of surface water management plans, the details of which can be found in Section 2.

A range of public bodies have responsibility for managing flood risk in Scotland and they are working closer than ever before to target action in the areas where the greatest benefit can be gained. Members of the public also have a role to play and are the first line of defence against flooding by taking action to protect themselves and their property from flooding. Further information about roles and responsibilities is provided in Section 1.

### Flood protection schemes

There are two surface water flood protection schemes within Solway Local Plan District:

- The scheme at Southernness was completed in 1983 by Dumfries and Galloway Council and consists of two culverts and four manholes.
- A surface water drain was installed in 2009 in Newcastleton by the Scottish Borders Council.

## Climate Change and Future Flood Risk

UK Climate Projections (UKCP09) predicts that climate change may lead to warmer and drier summers, warmer and wetter winters with less snow, and more extreme temperature and rainfall. The pluvial modelling undertaken considered climate change scenarios with a 20% increase in rainfall intensity.

Under these conditions it is estimated that the number of residential properties at risk of surface water flooding may increase from approximately 590 to 830 and the number of non-residential properties from approximately 240 to 300.

The predicted increases in flood risk are solely based on the impact of a changing climate on the magnitude of flooding; they do not take into account any potential increase due to population change, development pressures or urban creep, nor do they take into account any mitigation as a result of actions contained in this or future Flood Risk Management Strategies.