The river basin management plan for the Solway Tweed river basin district 2009–2015

Chapter 1:
State of the water environment

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*Appendices for this document are available on the SEPA website at:
www.sepa.org.uk/water/river_basin_planning.aspx

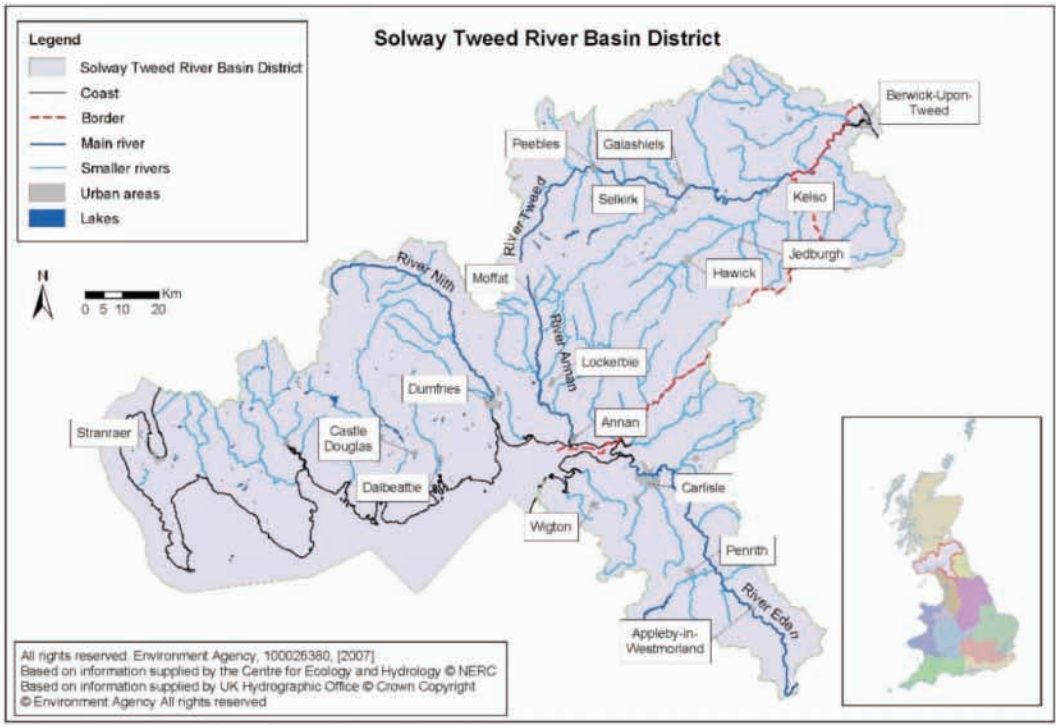
1. About the Solway Tweed river basin district

The Solway Tweed river basin district (see Map 1) incorporates the catchments that feed into the Solway Firth and Tweed estuaries, the estuaries themselves and the groundwater that underlies the river basin district. The river basin district has an area of around 17,500km^2 and incorporates the Scottish Borders, Dumfries and Galloway, small parts of Ayrshire in Scotland and parts of Northumbria and Cumbria in England. The main river catchments include the rivers Tweed, Eden, Esk, Annan, Nith, Dee-Ken, Bladnoch, Cree and their associated wetlands.

The river basin district is largely rural and supports a wide range of internationally important habitats and wildlife, with many of the water bodies designated Special Areas of Conservation (SACs) and Special Protection Areas (SPAs). There are also many excellent salmon and sea trout rivers in the river basin district.

The area is home to approximately 450,000 people and important economic activities including tourism, agriculture, forestry and manufacturing.

Map 1: Solway Tweed river basin district



1.1 Water and our economy

The water environment in the Solway Tweed is an important economic, social and environmental asset. The reputation of this river basin district as a clean and healthy place gives people the confidence to live here, to start up businesses and to visit on holiday.

Several of the sectors considered to be of strategic importance in Solway Tweed have close links with the water environment. These include:

- renewable energy generation (particularly through hydropower generation);
- food and drink (including fish processing);
- tourism;
- services;
- textiles and clothing;
- agriculture, forestry and fishing;
- food and drink.

The services sector is the most important contributor to the Solway Tweed economy and includes tourism and recreation related businesses. These businesses are an important part of the Solway Tweed economy; in 2004, tourism-related jobs accounted for 11.4% of all employment in Dumfries and Galloway and 7.3% in the Scottish Borders compared with 8.8% for Scotland as a whole.[1]

Parts of the Lake District National Park, the Northumberland National Park, Northumberland Coast Area of Outstanding Natural Beauty (AONB) and the Berwickshire and North Northumberland Coast European Marine site are within the Solway Tweed river basin district and are all major tourist attractions. According to ONE North East[2], tourists visiting the Northumberland National Park spent over £40 million (equivalent to over 2 million visitor days) and in the coastal AONB over £72 million (4.9 million visitor days) in 2003.

The River Tweed is considered one of the most important salmon rivers in Scotland and England; a recent study commissioned by the River Tweed Commission estimated that it generates just under £18 million per year and supports 487 full-time jobs[3]. The River Eden and the rivers in Dumfries and Galloway are also important resources for employment and income.

Agriculture is a significant industry in the area; when combined with fisheries and forestry, the sector contributes around 6% to regional output, compared with less than 2% for Scotland as a whole. Farming in the area is mixed. Dumfries and Galloway has 37% of all dairy cows in Scotland, while around 45% of all farmed land in both the Scottish Borders and Dumfries and Galloway is managed crops or grass and the remaining 55% is rough grazing[4]. This indicates relatively intensive farming in the area compared with the rest of Scotland, for which 65% of the farm land is rough grazing. Northumberland and Cumbria have a relatively high proportion of rough grazing: 24% compared with 5.9% for England as a whole[5].

1.2 Water and our wildlife

The value of the Solway Tweed river basin district is also reflected in the range and number of natural heritage sites and species designated under both the Habitats and Birds directives. The Solway Firth European Marine Site and the Berwickshire and North Northumberland Coast European Marine Site both cross the border between Scotland and England and the River Tweed Special Area of Conservation also includes Scottish and English water bodies. The Solway Mosses Special Area of Conservation incorporates lowland raised mires in both north Cumbria and Dumfriesshire. In all, there are 46 water-dependent Special Areas of Conservation or Special Protection Areas in the Solway Tweed river basin district (Table 1).

Table 1: Number of sites designated under the Habitats and Birds directives in the Solway Tweed river basin district

Type	Number
Special Area of Conservation (SAC)	33
Special Protection Area (SPA)	13
Total	**46**

The Water Framework Directive also requires a number of other economically important protected areas, such as shellfish growing waters, to be taken into account. These are discussed in more detail in Chapter 5: www.sepa.org.uk/water/river_basin_planning.aspx

The Solway Tweed river basin district often contains species at the limit of their distribution. For example, the rare natterjack toad (*Bufo calamita*) is found at its north western limits in the Solway Tweed river basin district. This amphibian lives in the brackish waters along the edge of the north Cumbria and Solway coast. By contrast, the rare water plant slender naiad (*Najas flexilis*) has its southern limits in this district. These distribution patterns may also be affected by climate change in the future.

[1] *South of Scotland Labour Market and Economic Intelligence Project*, 2007 www.southlmi.org
[2] *The Economic Value of Protected Landscapes in the North East of England*, August 2004.
[3] Tweed Economic Survey undertaken by SQV Ltd, 2007 www.rtc.org.uk/About_/Tweed_Economic_Survey/tweed_economic_survey.html
[4] *Scottish Agricultural census Summary Sheets by Geographic Area: June 2007*, Scottish Government, 2008 www.scotland.gov.uk/Publications/2008/03/11093631/0
[5] *June 2007 Agricultural and Horticultural Survey – England*, Defra, 2008 www.defra.gov.uk/esg/work_htm/publications/cs/farmstats_web/default.htm

1.3 Water and our well-being

Water is one of the basic requirements for life and good quality water requires less treatment before it enters the public supply network.

Water is an important part of the landscape of this district and a major attraction in places such as the Lake District. Bathing waters (as identified under the revised Bathing Waters Directive 2006) are also an asset for tourism. These high profile sites provide a focus for water quality issues due to the more stringent standard for bacterial levels. In the Solway Tweed river basin district there are eight bathing waters.

Where to find additional information

The economic importance of water in the Solway Tweed river basin district was described in the economic characterisation report published in 2005[6]. Several important documents have been published since then which provide strategic frameworks, goals and targets to help secure economic prosperity in Solway Tweed. These documents include:

- UK Shared Framework for Sustainable Development[7];
- Government Economic Strategy[8];
- draft National Planning Framework 2.

All recognise the importance of ensuring that the Scottish and English economies grow within environmental limits.

1.4 Climate change

The water environment is particularly vulnerable to the effects of climate change. It is already possible to detect trends that are affecting the water environment. An example of how the change in rainfall patterns can be detected can be seen in records from the Crichton Hospital, south of Dumfries, which began in 1857. These records show that since the 1920's the weather has become increasingly wet, with a marked increase in rainfall in the last 20 years. When the annual records for each year are looked at in more detail it is clear that higher rainfall levels can be attributed to an increase in winter rain.

It is inevitable that these climate changes will affect the conditions and pressures on the water environment. Climate change impacts may not be strongly felt during the first plan period up to 2015. However, decisions and investments or modifications to existing infrastructure may last more than one plan cycle when the impacts of climate change may be more evident.

This river basin management plan needs to be able to adapt to changes. Higher water temperatures and changes in precipitation patterns are of particular importance to surface water ecosystems. Such changes are likely to affect how ecosystems function, especially in combination with changes in water chemistry.

Significant changes in average temperature, precipitation and soil moisture are likely to affect water availability and demand in most sectors – especially agriculture, forestry and for public supply. Demand for water for irrigation is likely to increase across the east of the river basin district.

Groundwater supplies are less susceptible than surface water to short-term climate variability; they are influenced more by long-term trends. However, less reliability of surface water flows in summer may lead to greater pressure on groundwater sources and levels may fall. Lowering of groundwater levels will have knock-on consequences for river flows and the possibility of salt water moving into freshwater aquifers near coasts. Surface water temperatures may change more quickly if there is less water, which will have direct impacts on fish populations and indirect consequences such as worsening the effects of pollution.

[6] www.sepa.org.uk/water/water_publications/characterisation_reports.aspx
[7] *One Future – Different Paths. The UK's shared framework for sustainable development*, Defra, 2005.
[8] The Government Economic Strategy, Scottish Government, November 2007

2. The current condition of the water environment

The current condition of the water environment in the Solway Tweed river basin district is the starting point for this plan. Understanding where and why the water environment is in good condition and where improvements are necessary ensures that the most appropriate actions and resources are put in place.

The condition of the water environment is determined through a process called classification (see Section 2.1 and Appendix A). This process determines the status of a water body – ranging from high to poor – and groundwater as either good or poor. The Water Framework Directive requires the aim for all water bodies to be in good condition. The five possible statuses for surface water bodies are shown in Figure 1.

Figure 1: Status classification for surface water bodies

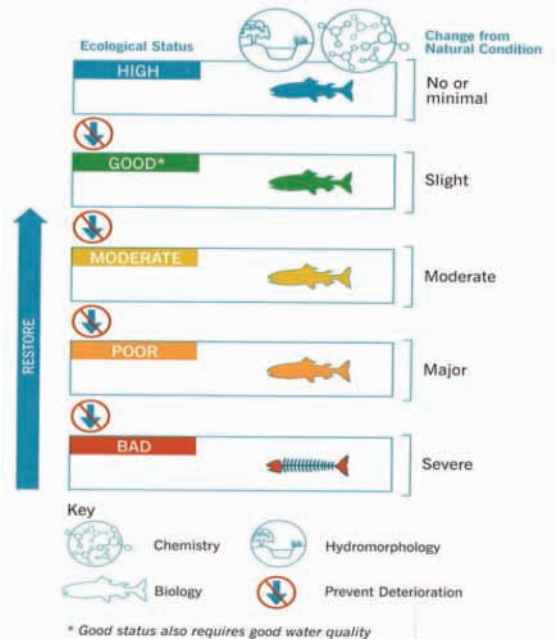


Table 2 and Map 2 summarise the classification results for rivers, lochs/lakes, estuaries and coastal waters in the Solway Tweed river basin district, where 45% of the surface water bodies are in a good or better status.

Water bodies vary in size and this means that a particular number of water bodies does not correspond to a given area or length of surface water. For completeness, Table 2 and other tables in this river basin management plan provide information on both the number of water bodies and the corresponding length or area of surface water they represent.

Table 2: Overall status of surface waters in the Solway Tweed river basin district, 2008

	Rivers		Lochs/lakes		Estuaries		Coastal waters	
Status	Number of water bodies	Length (km)	Number of water bodies	Area (km²)	Number of water bodies	Area (km²)	Number of water bodies	Area (km²)
High/maximum	5	39	0	0	5	57	0	0
Good	230	2487	7	5	5	27	7	1871
Moderate	203	2583	20	32	1	306	1	42
Poor	65	777	4	5	0	0	0	0
Bad	23	296	4	3	0	0	0	0
Total	526	6182	35	45	11	390	8	1913

Map 2: Status of surface waters in the Solway Tweed river basin district, 2008

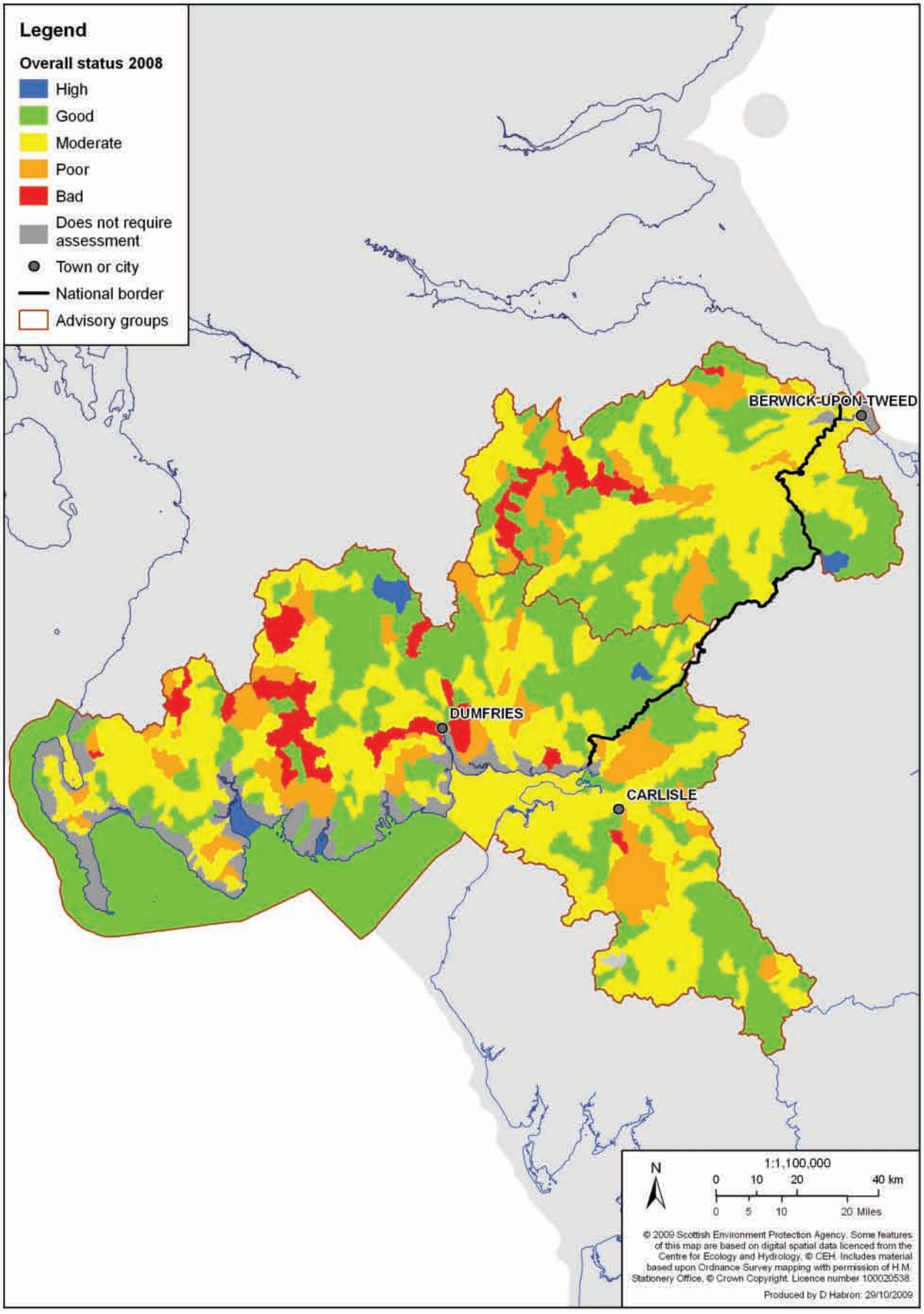
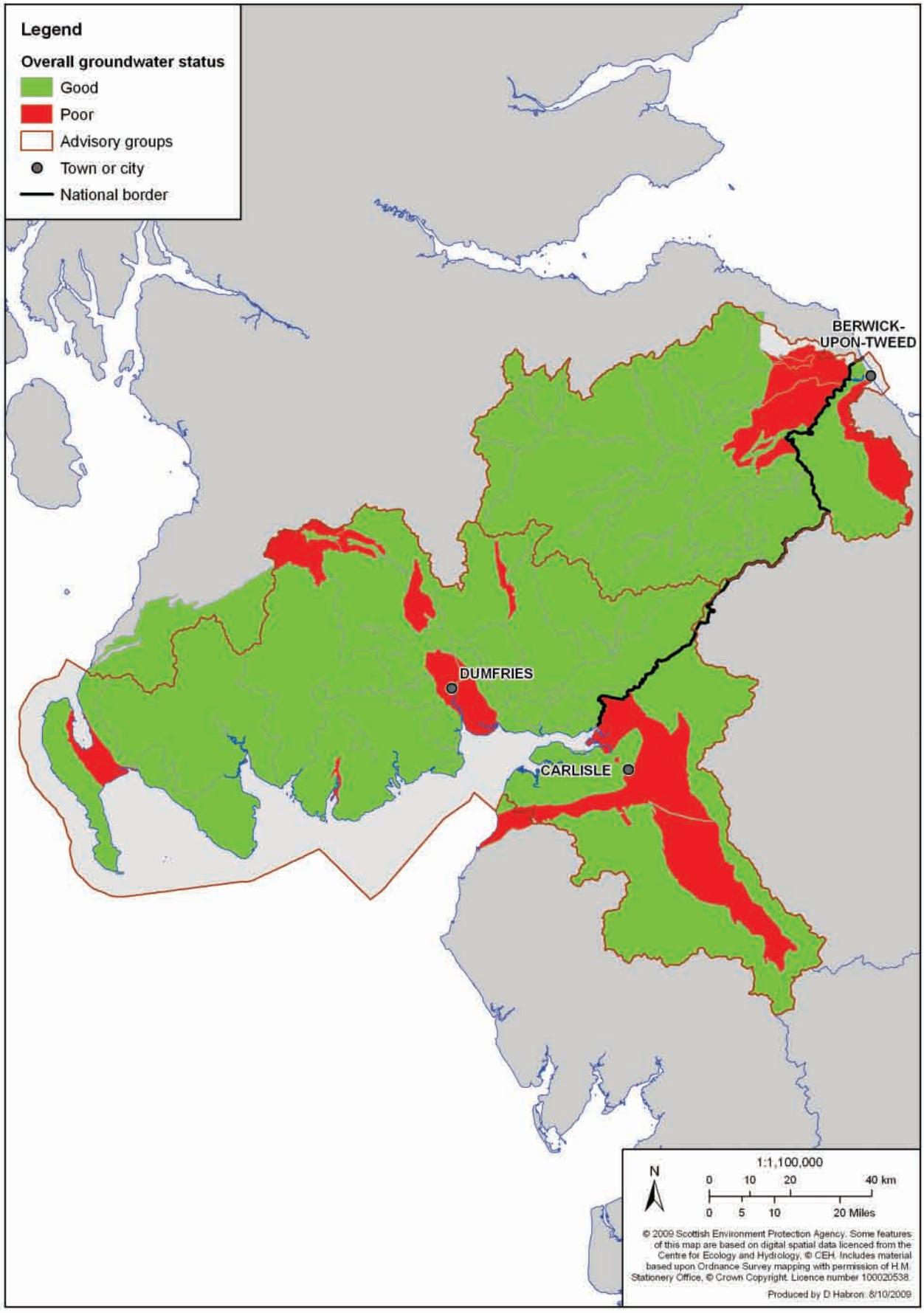


Table 3 and Map 3 below summarise the overall classification results for groundwater. These distinguish whether bodies of groundwater are in a good or poor condition. The classification takes account of whether or not the water bodies are polluted and whether the amount of water being abstracted from them is sustainable. The test of sustainability includes assessing any impacts on rivers or wetlands that depend on the groundwater. Nearly 82% of groundwater bodies in the Solway Tweed river basin district are at good status.

Table 3: Status of groundwater in the Solway Tweed river basin district, 2008

Status	Groundwater status	
	Number of water bodies	Area (km^2)
Good	60	13,445
Poor	13	2238

Map 3: Status of groundwater in the Solway Tweed river basin district, 2008



2.1 How are water bodies monitored and classified?

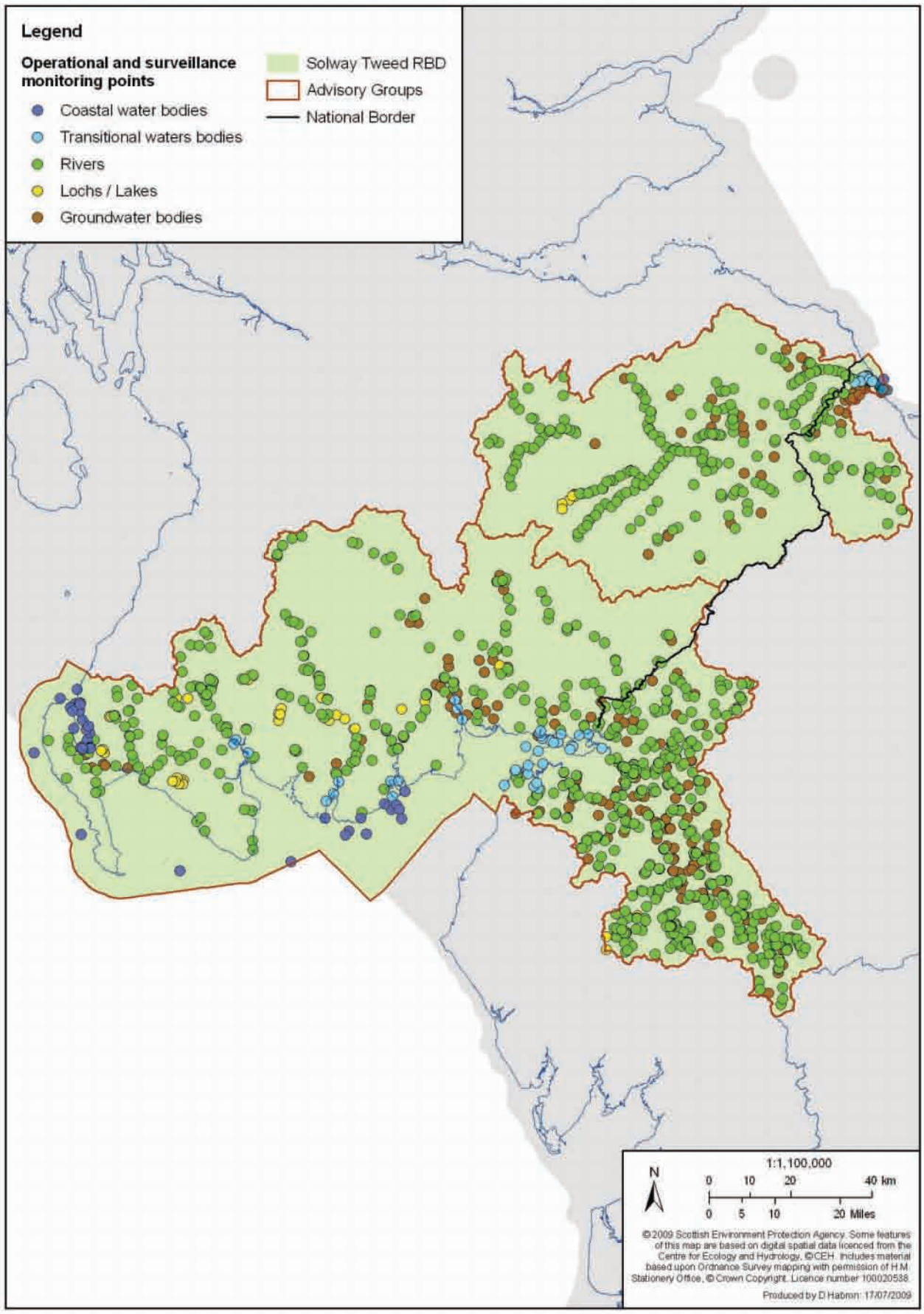
The monitoring scheme assesses impacts on the:

- quantity of water;
- condition of the habitats within the water and at its edge;
- plants and animals living within the water environment.

The assessment methods used in the monitoring programme were developed jointly with the rest of the UK. A number were also checked against those used by other countries across Europe. All are based on environmental quality criteria set out in European legislation. As a result, for the first time the water environment of the Solway Tweed has been classified to the same standards as the rest of the UK and Europe. This is particularly important in the Solway Tweed river basin district as it incorporates both Scottish and English water bodies. SEPA and the Environment Agency therefore agreed a monitoring strategy which can be found on SEPA's website:
www.sepa.org.uk/water/monitoring_and_classification/scottish_monitoring_strategy.aspx

Map 4 shows the monitoring network used to collect the information for the 2008 classification scheme.

Map 4: Monitoring network in the Solway Tweed river basin district



Data from monitoring also includes information collected and assessments carried out by other organisations. Information from the monitoring programme is used to determine the status of each water body.

This classification scheme is a complex process using many different tests and results. In addition to the overall status, the classification scheme can separate out ecological status (see Section 3.2) and chemical status (see Section 3.3). A further level of detail can be obtained for each of the parameters that make up the classification scheme. Appendix A describes the main parameters and Appendix B presents a summary of classification information by parameter.

You can find information on the classification results for individual water bodies, including information on the confidence in those results, using the interactive map on SEPA's website:
www.sepa.org.uk/water/river_basin_planning.aspx

2.2 Ecological status of surface water bodies

Surface waters support a great variety of plants and animal communities, each adapted to the different natural characteristics of the waters in which they occur. Ecological status refers to the health of the water environment as reflected by the mix and abundance of a range of plants and animals.

The classification scheme assesses the amount of change from the natural characteristics expected in the water body. These changes can be caused by such things as:

- pollution;
- changes to water flows and levels;
- physical changes to beds and banks;
- presence of invasive non-native species.

Further information on how ecological quality is assessed can be found can be found in Appendix A.

There are 235 surface water bodies (47%) in the Solway Tweed river basin district at good or high ecological status (see Table 4), which means that they are at almost natural condition. However, 265 surface water bodies (53%) are currently at less than good ecological status.

Table 4: Ecological status of bodies of surface water (other than heavily modified and artificial water bodies) in the Solway Tweed river basin district, 2008

Ecological status class	Rivers		Lochs/lakes		Estuaries		Coastal waters	
	Number of water bodies	Length (km)	Number of water bodies	Area (km²)	Number of water bodies	Area (km²)	Number of water bodies	Area (km²)
High	5	39	0	0	5	57	0	0
Good	211	2362	3	1	4	26	7	1871
Moderate	172	2168	13	17	1	306	1	42
Poor	60	735	3	2	0	0	0	0
Bad	15	206	0		0	0	0	0
Total	463	5510	19	20	10	389	8	1913

2.3 Chemical status of water bodies

The chemical status of water bodies in the Solway Tweed is generally excellent, with over 98% of river water bodies monitored passing chemical status and no failures in loch/lake, estuary or coastal water bodies. For example, there is only one failure for priority substances (toxic pollutants – see Appendix A for more information) in the Solway Tweed river basin district. Failures for specific pollutants (which includes metals such as iron and chemicals such as ammonium) are similarly few in number, with 97% of river water bodies at passing and no failures in lochs/lake, estuary or coastal water bodies. Map 8 shows the water bodies failing due to specific pollutants.

2.4 Ecological potential of surface water bodies

Ecological potential applies to artificial or heavily modified water bodies. These are water bodies that:

- have been substantially changed in character as a result of physical alterations;
- could not be restored to good ecological status without significant adverse impacts on the wider environment or on activities dependent on the alterations (eg flood protection, water storage for drinking water supply and hydropower generation).

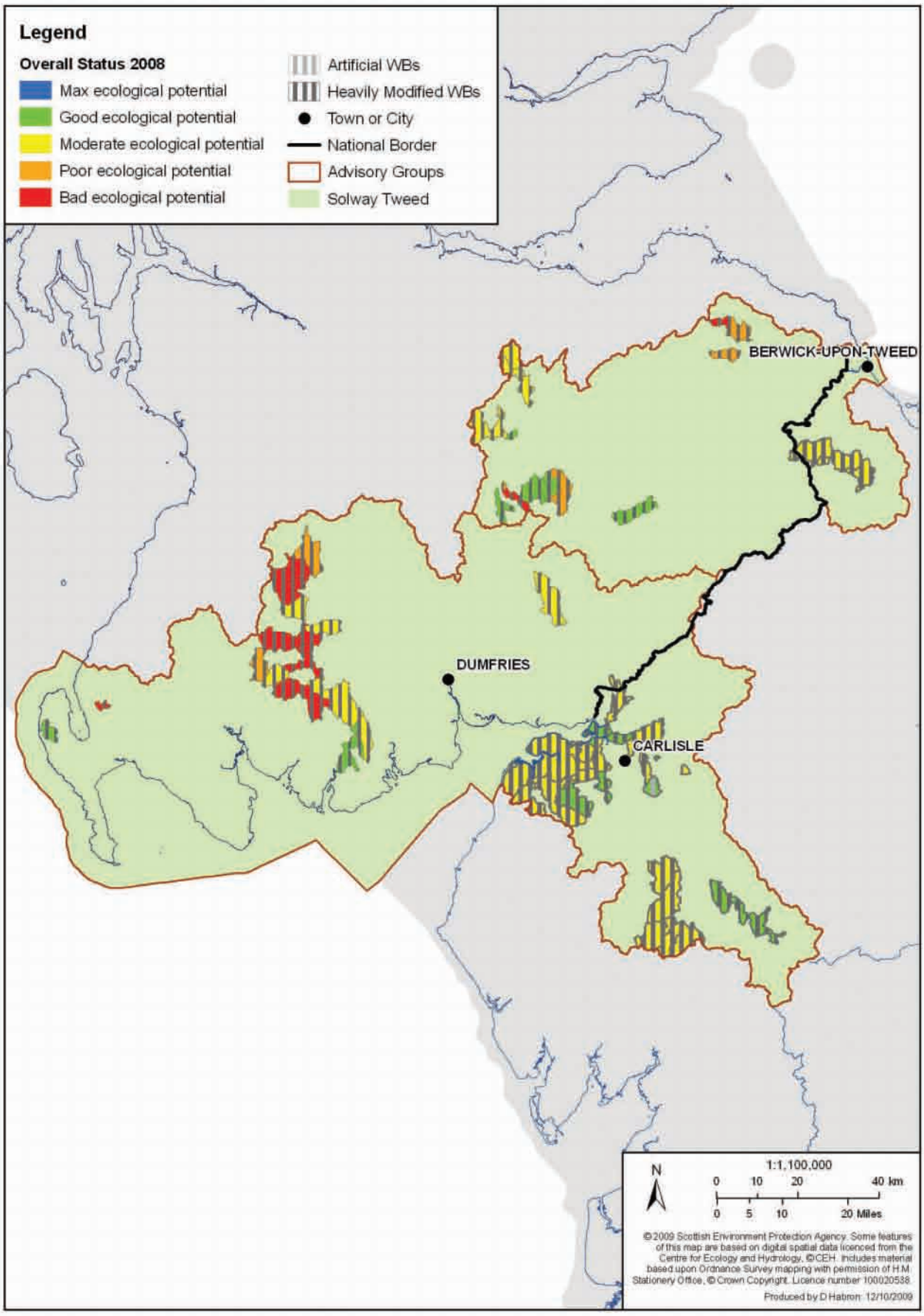
There are 80 heavily modified or artificial water bodies in the Solway Tweed river basin district. For these bodies, classification describes a water body's 'ecological potential'. This is a measure of the extent to which a water body's ecological quality has been maximised, given the limits imposed by the physical modifications necessary for its use(s) or for the wider environment (eg conservation of biodiversity or built heritage). For more information on heavily modified and artificial water bodies, see Chapter 4: www.sepa.org.uk/water/river_basin_planning.aspx

Table 5 summarises the ecological potential of heavily modified and artificial water bodies in the Solway Tweed river basin district. Map 5 shows how ecological status and potential vary across the district.

Table 5: Ecological potential of heavily modified and artificial surface water bodies in the Solway Tweed river basin district, 2008

Ecological potential class	Rivers		Loch/lake		Estuaries		Coastal waters		Artificial (canals)		Artificial (others)	
	Number	Length (km)	Number	Area (km^2)	Number	Area (km^2)	Number	Area (km^2)	Number	Length (km)	Number	Length (km)
Good or better	15	156	4	4	0	0	0	0	0	0	6	7
Moderate or worse	42	514	12	21	1	1.5	0	0	0	0	0	0
Total	57	670	16	25	1	2	0	0	0	0	6	7

Map 5: Ecological potential of surface water bodies in the Solway Tweed river basin district, 2008



3. What is affecting the condition of our water environment?

The water environment is a valuable resource for everyone to use and enjoy but our activities can also create problems, for example by polluting the water or by damaging the natural habitat.

In order to reduce the impact of our actions we need to understand the pressures or risks associated with those actions. This will help ensure that the water environment is managed sustainably.

3.1 How have the pressures and impacts been assessed?

The first assessment of the pressures and impacts on the water environment was carried out in 2004 as part of the development of the characterisation report for the Solway Tweed river basin district[9]. This work was used to help prioritise the monitoring network as part of a risk-based assessment.

Information relating to the pressures and impacts on water bodies is an important method of predicting where a water body may fail to meet the Water Framework Directive requirements and the broad reasons why this might be the case.

SEPA has improved its knowledge of the impacts on water quantity as a result of the requirements of the Water Environment (Controlled Activities) (Scotland) Regulations 2005. These require operators of any sizeable discharges, abstractions and impoundment works (eg dams) to obtain authorisation from SEPA. Combining the detailed information on pressures controlled by the regulations with its classification results has allowed SEPA to identify where these pressures are causing water bodies to be in a less than good state.

The Environment Agency has a considerable amount of historical information on the pressures on the water environment, given that permitting regimes have been in place for discharges to and abstractions from the water environment for several decades.

3.2 Significant water management issues

The significant water management issues report for the Solway Tweed river basin district[10] was produced in 2007 and looked at those impacts that were most likely to cause water bodies to fail the Water Framework Directive objective of being at good status in 2015. The report identified the most common problems affecting the Solway Tweed's water environment as:

- Water quality issues
  - from agriculture
  - from forestry
  - from sewage disposal activities
  - from acidification
- Water quantity issues
  - for water supply
  - for agriculture
  - for hydropower
- Habitat changes
  - for agriculture
  - for forestry
  - for water supply
- Invasive non-native species.

[9] www.sepa.org.uk/water/water_publications/characterisation_reports.aspx
[10] www.sepa.org.uk/water/water_publications/swmi.aspx

3.3 What are the significant pressures in 2008?

Using the information on significant pressures and their impacts together with the 2008 classification results, it is possible to identify the most significant pressures currently preventing the Solway Tweed's water environment from meeting good status. Table 6 shows the proportion of water bodies significantly adversely affected by the different pressures.

Table 6: Significant pressures on water bodies in the Solway Tweed river basin district in 2008

	Proportion of water bodies caused to be less than good status (%)					
Pressure	Rivers	Lochs/lakes	Estuaries	Coastal waters	Groundwaters	All
Water quality	28	40	9	13	11	32
Water quality worked out as area/length proportion	29	43	78	0	13	12
Alterations to water flows and levels	13	23			14	13
Modification of beds, banks and shores	19	31	9	0		19
Barriers to fish migration*	9	20				9
Impact of invasive non-native species*	1	3	0	0		1

*Scotland data only.
Please note: where cells are shaded this pressure does not apply.

3.4 Water quality

The presence of pollutants can reduce the quality of the water environment. Pollution may be in the form of chemicals such as pesticides, herbicides or metals, or an increase in nutrients.

Pollution is the most well-known issue affecting the water environment. It can threaten the quality of all parts of the water cycle from groundwater to rivers, lochs/lakes, estuaries and coastal waters.

Pollution is detected either directly by the presence of a nutrient or chemical compound in a water sample, or indirectly through a reduction or change in plant and animal species such as an increase (a bloom) of algae. Further information on the links between the reasons for failure and their potential impacts can be found in Table C1 in Appendix C.

Soluble reactive phosphorus is found in detergents, sewage, animal waste and fertilisers. Elevated levels of phosphorus lead to eutrophication (an undesirable growth of plants and depletion of oxygen). In the Solway Tweed, water bodies that are failing as a result of increased phosphorus levels are generally found in areas where the main pressure on the water environment is intensive agriculture (Map 6).

Microscopic plants called diatoms respond to changes in nutrient concentrations, including phosphorus. In the Solway Tweed river basin district 730km of rivers (16% of total river length) are at less than good status, based on the assessment using diatoms. Diatom failures contribute to the greatest length of rivers at less than good and are found where the main pressures on the water environment are from high intensity agriculture and sewage inputs (Map 7).

Specific pollutants are generally substances that occur naturally in the environment but which are damaging at higher levels. Very few water bodies have been downgraded as a result of pressures from specific pollutants (Map 8). The most common specific pollutant downgrading rivers in the Solway Tweed is ammonium compounds. This is commonly associated with organic pollution such as that from sewage or animal waste. There are also a small number of water bodies with specific problems. For example, one water body, Glenridding Beck in the Lake District, is failing due to pollution from mine water.

An additional impact on water quality is caused by acidification. This is due to a combination of poor air quality caused by atmospheric pollutants, an acidic (non-buffering) geology and planting of conifer forests. Conifer trees 'scavenge' acid pollutants out of the air. After rainfall these acid pollutants are washed off the trees and into the adjacent surface waters. A total of 25 water bodies in the Solway sub-basin are affected by acidification. These include parts of the Bladnoch, Cree, Dee–Ken and Fleet catchments.

The results from the monitoring of fish species and numbers show that 45 river water bodies (521km) are at less than good status. Fish are sensitive to a number of different pressures including acidification, pollution and alterations to flows and habitats.

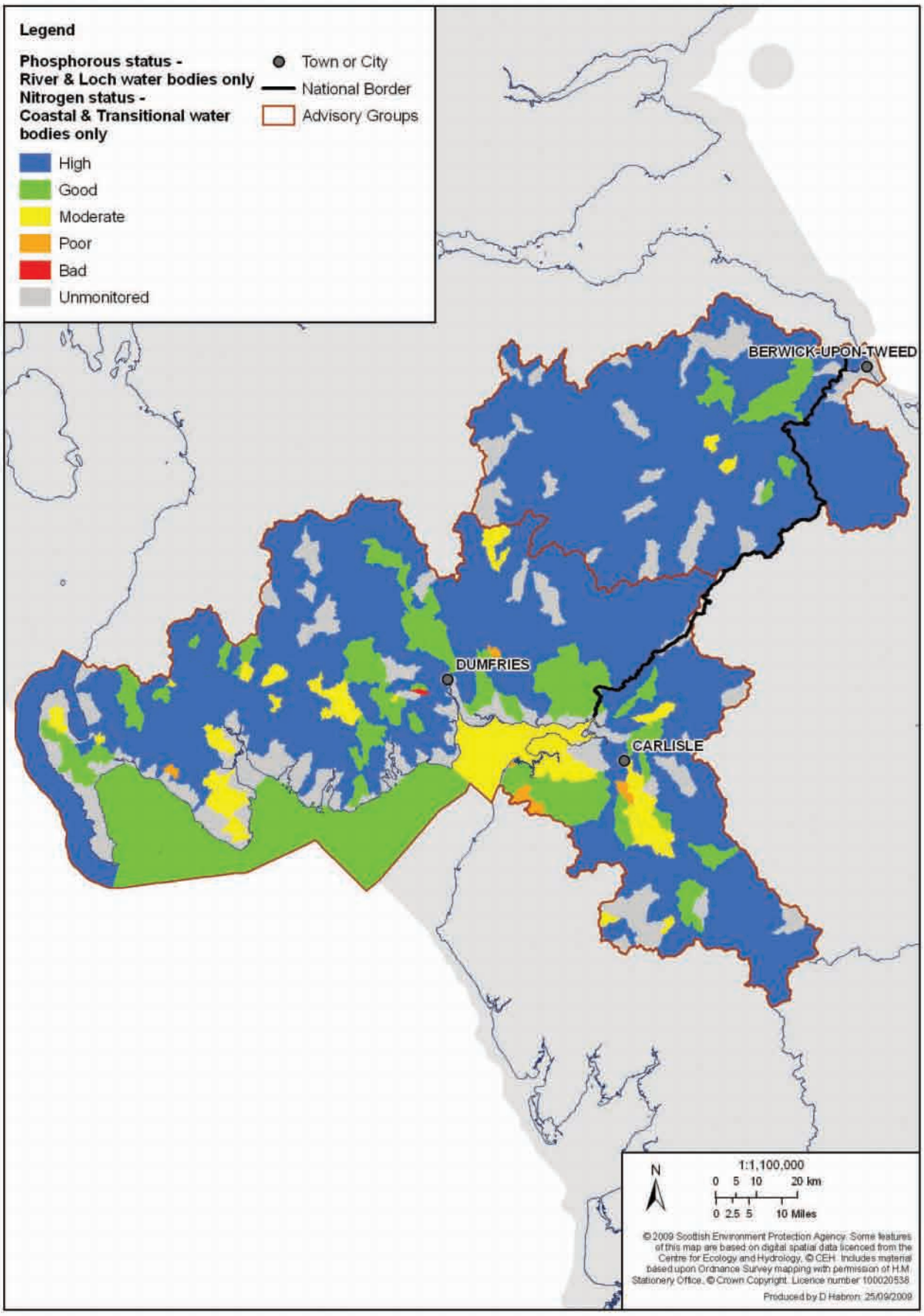
There is only one estuary (the Solway estuary) and one coastal water body (Loch Ryan) not at good status in the Solway Tweed river basin district. However, since the estuary water body covers an area of 305 km^2, this represents a significant portion of the total estuary area. This water body is failing for pollution related reasons.

The groundwater in the Solway Tweed is generally in good condition. However, the two main reasons why a small number of water bodies are at poor status are:

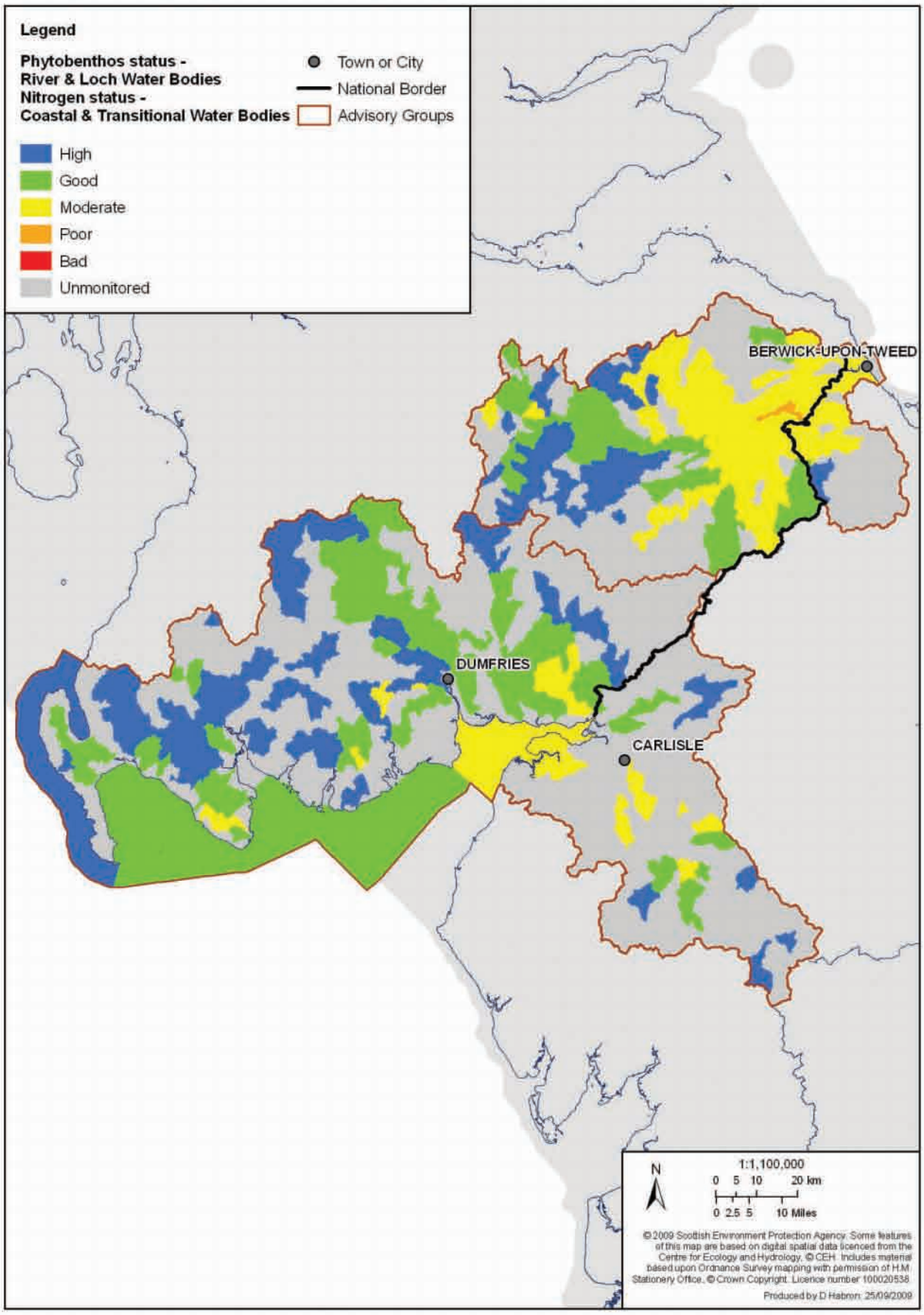
- inputs from agriculture, primarily nitrate pollutants;
- impacts from mining.

Once polluted, restoration of groundwater is difficult and likely to take many years to achieve. This is because pollutants tend to be flushed out of groundwater bodies only very slowly. The long natural lag-time for groundwater replenishment means that identifying and tackling potential problems, before they cause long-term damage, is important. A monitoring and assessment programme has been set up to identify significant and sustained upward trends in the concentration of pollutants in groundwater. These are trends that, if unaddressed, would lead to deterioration of the chemical status of groundwater. Map 9 shows the chemical status of groundwater bodies and upward trends in pollutant concentrations in 2008.

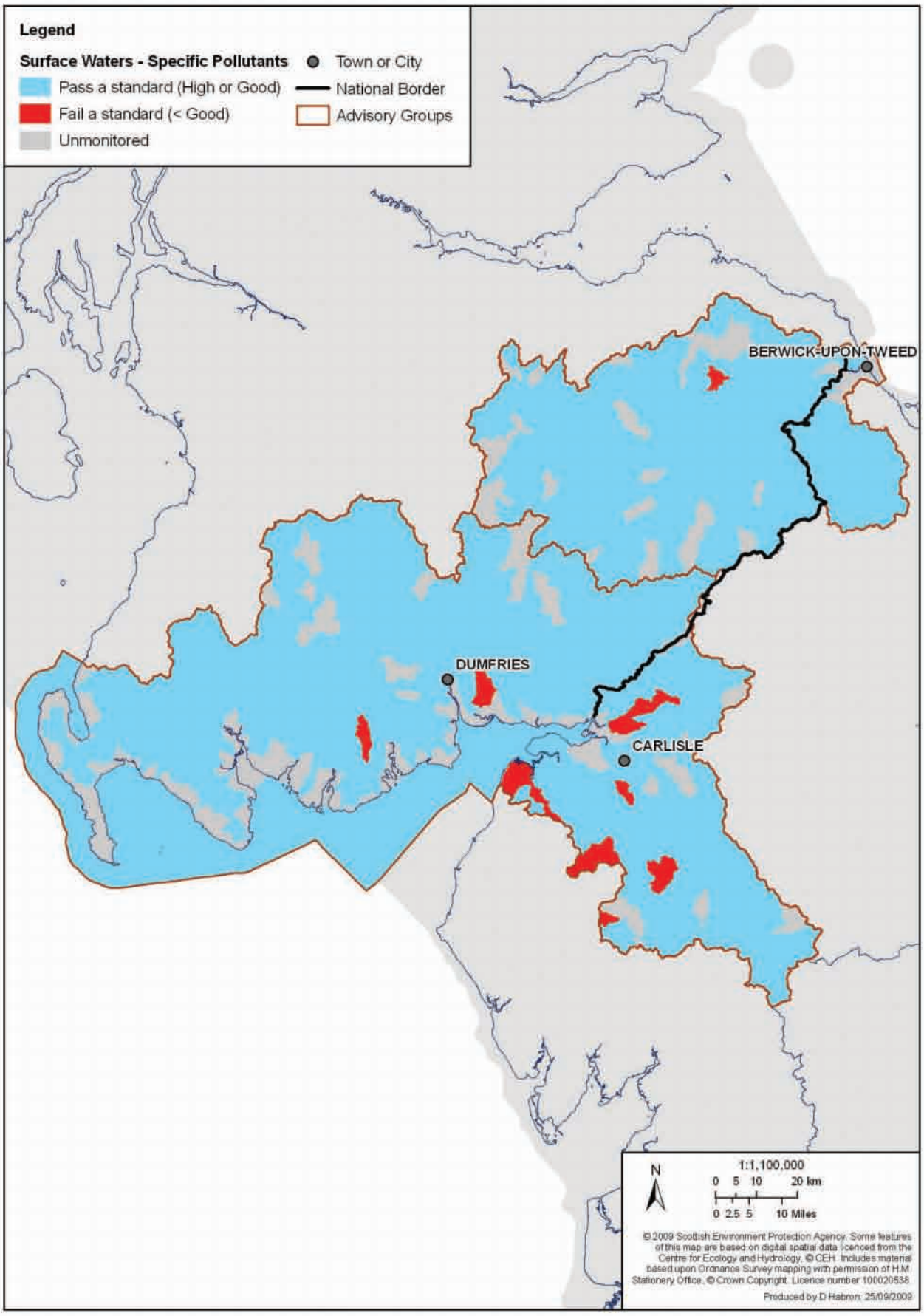
Map 6: Status of phosphorus in rivers and lochs/lakes and nitrogen in coastal water bodies and estuaries in the Solway Tweed river basin district, 2008



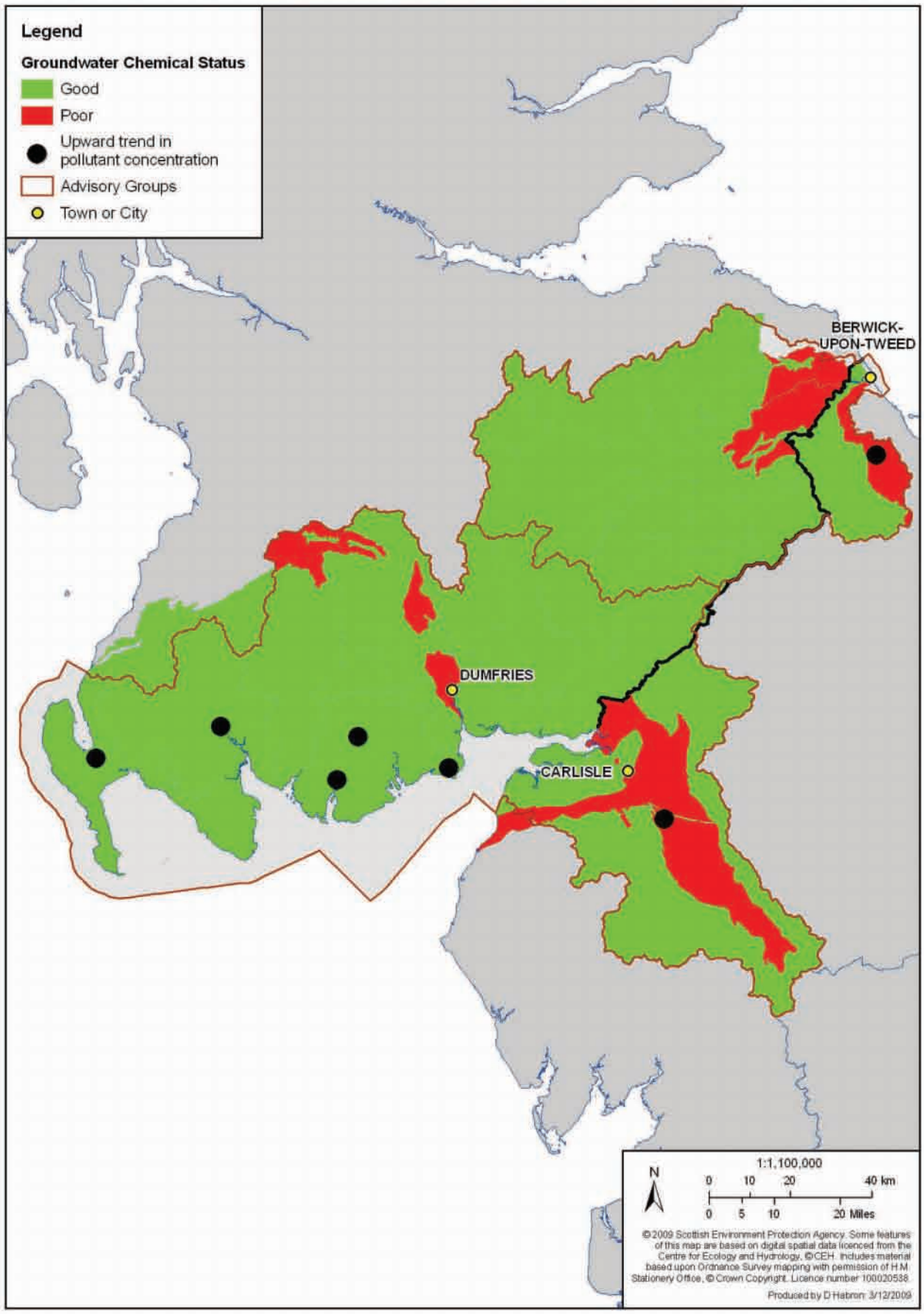
Map 7: Status of diatoms in rivers and lochs/lakes and nitrogen in coastal water bodies and estuaries in the Solway Tweed river basin district, 2008



Map 8: Status of specific pollutants in surface waters in the Solway Tweed river basin district



Map 9: Status of groundwater chemistry with trend information in the Solway Tweed river basin district



4. Water quantity

Changes in the amount of water present in a water body may be part of the natural process of that water environment, for example, the ebb and flow of the tides in the estuaries and periods of high flow in rivers which salmon use to migrate upstream. These changes in water level also change the amount of energy in a water body – shifting sand, silt or gravel through the system. This is important as it creates and recreates the different kinds of habitat required by water-dwelling creatures such as silt for lamprey or gravel beds for spawning salmon.

However, the effect of low flows may continue for longer periods or be more severe when the water body already has high levels of abstraction for public water supply, industry, agriculture or domestic use. Unsustainable abstraction from groundwater can lower groundwater levels and affect dependent river flows or wetlands, or can allow the intrusion of salty water from under the sea. Sudden increases in the amount of water can also have a detrimental effect. Water entering a surface water body from the land around may bring pollutants with it.

Changes in rainfall patterns are predicted to occur under current climate change scenarios. There are likely to be increased environmental impacts associated with changes in the amount of water from more rainfall in winter and more sudden storm events through to low water levels in drier summers.

More information on the potential impacts of the water quantity pressure, including which types of protected area may be affected, is given in Table C2 in Appendix C.

Of the rivers and lochs/lakes in the Solway Tweed river basin district, 86% are at high or good status for water quality issues (Map 10). The main reasons for not reaching good status are:

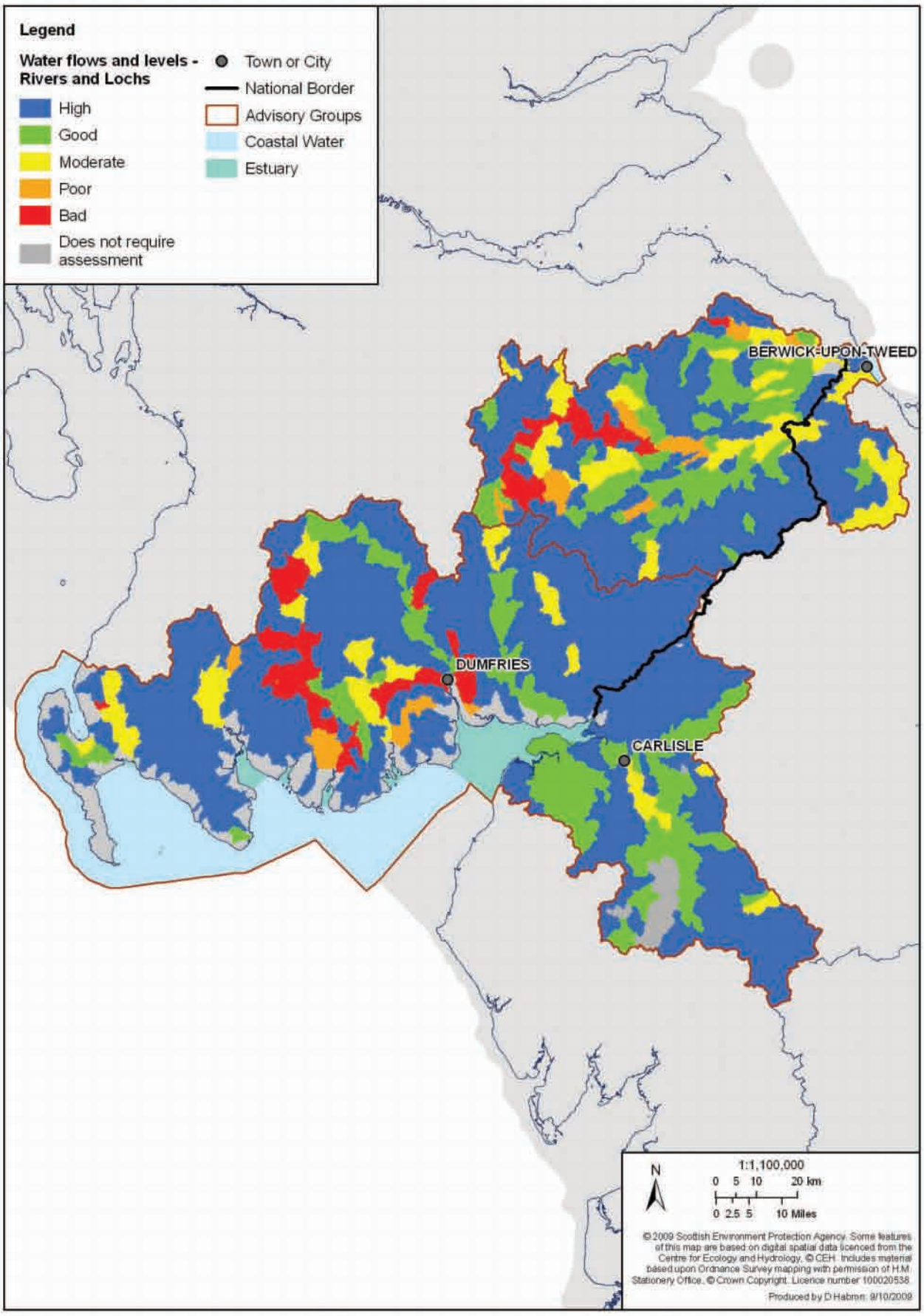
- impoundments to provide drinking water and hydropower;
- abstraction for farming.

Alterations to the environment due to impoundments, which change the natural flow of water, are associated with water supply and electricity generation. Water supply reservoirs in the Solway Tweed include Haweswater, which supplies a significant proportion of Manchester's water.

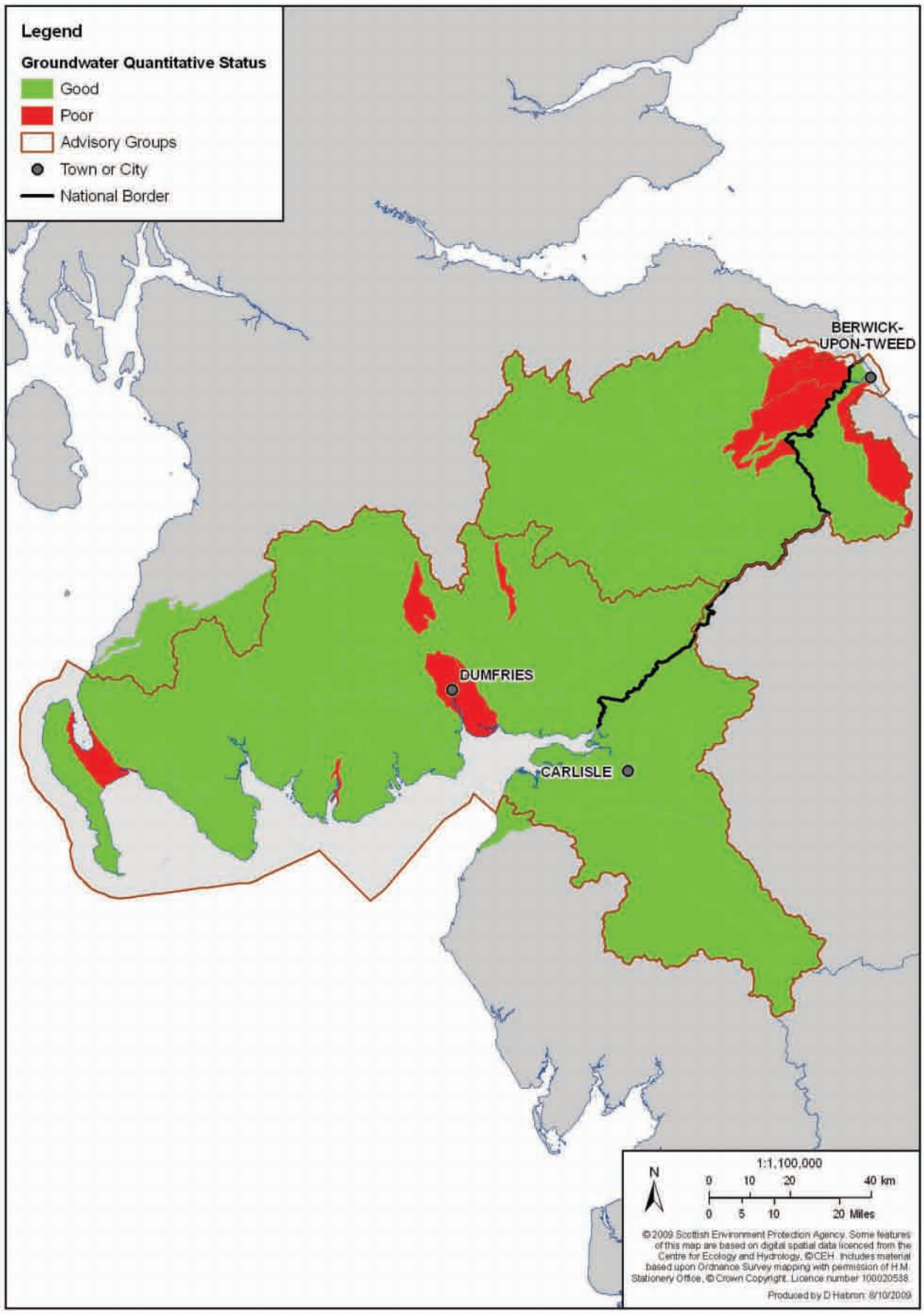
The Galloway Hydropower scheme operated by Scottish Power has modified many of the major rivers and lochs in the River Dee catchment. In most cases, these modifications have resulted in the water body being considered to be heavily modified.

Abstraction of water for agriculture is an issue in parts of the east, particularly in the Tweed where the main farming practice is arable. Groundwater abstraction from boreholes is showing to have an impact on river flows in a small number of cases. Groundwater is also abstracted for public water supply and this is also causing a number of groundwater bodies to not be at good status (Map 11).

Map 10: Status of water flow and levels in the Solway Tweed river basin district, 2008



Map 11: Groundwater quantitative status in the Solway Tweed river basin district, 2008



5. Habitats

There are very few truly natural water bodies in the Solway Tweed river basin district; only 3% are at high status. This reflects the long history of management of the structure and habitat of water bodies for agriculture, forestry, transport and industry, and to protect people and properties. Types of management include:

- straightening rivers;
- deepening rivers, lochs/lakes, estuaries and coastal waters;
- engineering structures (eg dams) within rivers, lochs and lakes that become barriers to fish and gravel movement.

The link between environmental quality and these types of management is complex. Our understanding of the impacts is still developing, though there are some good examples of where improvements to habitats or changes in practices have made significant differences to the overall health of a water body.

One of the most frequent impacts on the classification of water bodies is the presence of barriers to fish passage. In Scotland, approximately 520km of rivers and 10km^2 of catchment/lochs lie upstream of structures which create a barrier to fish migration. The distribution of these barriers aligns with the presence of impoundments (for water supply, electricity generation and weirs), as well as with urban areas and areas of intensive forestry or agriculture (eg culverts and badly designed road bridges).

Changes to the beds and banks can also be due to alterations in the water levels of lochs/lakes resulting from damming and flow regulation. Regulating the flow inappropriately can cause drawdown scars (like the rings on the side of a bath), which prevent animals and plants living in those areas. Some lochs/lakes, estuaries and coasts are affected by engineering to protect roads, paths and railways from flooding.

Forestry is a major land use in the Solway Tweed river basin district. Some forests designed before the publication of the Forestry Commission's *Forest & Water Guidelines*[11] included the planting of conifers up to and across the water course. This had a negative impact on the water environment through shading and an increase in the risk of siltation as well as the physical change to the structure of the watercourse.

5.1 Wetlands

As well as assessing the habitats of surface water bodies and groundwater bodies, it is important to assess the status of all wetlands that depend on surface or groundwater for their water needs.

The assessment of the status of the beds, banks and shores of surface water bodies already takes account of whether wetlands are present. Groundwater takes into account the potential impacts of groundwater abstraction on wetland.

SEPA is developing an inventory of all wetlands in the Solway Tweed river basin district and the potential risks to them. It will present its first full assessment of the status of the district's wetland resource in 2013.

The Environment Agency has compiled an inventory of groundwater-dependent wetlands in England. It has used this list in assessing any negative impacts caused by associated groundwater bodies and has downgraded the groundwater body status where necessary.

[11] www.forestry.gov.uk/pdf/FCGL002.pdf/$FILE/FCGL002.pdf

6. Invasive non-native species

Invasive non-native species are plants and animals from other parts of the world that have successfully established themselves in areas where they would not naturally occur. Away from their normal water environment and often free from their usual predators, these species can thrive at the expense of our own wildlife.

Table 7 shows the extent to which surface waters in the Solway Tweed river basin district were affected by this problem in 2008.

Table 7: Surface waters known to be adversely affected by invasive non-native species in the Solway Tweed river basin district, 2008

Adverse impact of invasive non-native species	Rivers		Lochs/lakes		Estuaries		Coastal waters	
	Number of water bodies	Length (km)	Number of water bodies	Area (km²)	Number of water bodies	Area (km²)	Number of water bodies	Area (km²)
Causing ecological quality to be moderate	5	87	1	7	0	0	0	0
Causing ecological quality to be poor	0	0	0	0	0	0	0	0
Causing ecological quality to be bad	0	0	0	0	0	0	0	0

In England, the presence of invasive non-native species in and around the water environment is reflected in the overall ecological classification results where the invasive species have a direct impact on the environments in which they occur. The presence of these species has not been identified as a direct reason for failure in any of England's water bodies, but they are likely to be a contributing factor in some water bodies that are not at good status. Water bodies that are at high status are assessed for the presence of problem invasive species and can be downgraded as a result, although no Solway Tweed water bodies met these criteria.

In Scotland, six water bodies are at moderate status due to the presence of American signal crayfish. More general information can be found in Table C4 in Appendix C.

American signal crayfish

In the Solway Tweed river basin district, six water bodies are at moderate status due to the presence of American signal crayfish. These water bodies include the Leithen Burn in the Tweed and Water of Ken in the Solway. The Dee contains the largest Scottish population of American signal crayfish.

Crayfish may prey on both salmon eggs and young fish, and compete with salmon for available habitat and food resources. Their burrowing behaviour leads to modification in the in-stream and bankside habitat and may lead to erosion problems. Anglers may also have their baits eaten by crayfish, particularly when using dead fish.