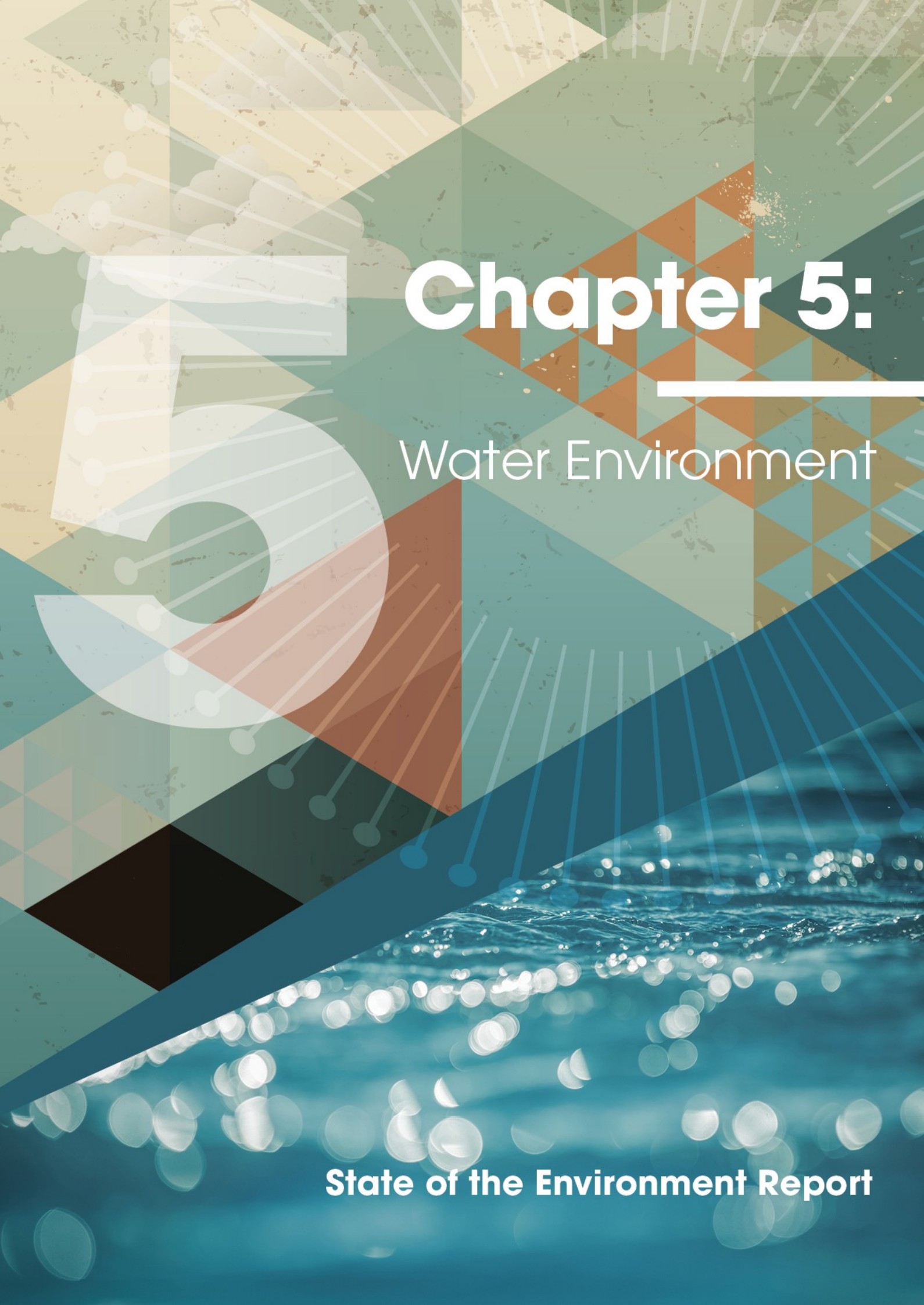
Chapter 5:

Water Environment



State of the Environment Report

EAST AYRSHIRE COUNCIL
STATE OF THE ENVIRONMENT REPORT
CHAPTER 5 – WATER ENVIRONMENT

SUMMARY

Key Messages

Water is a valuable resource, which has multiple uses, e.g. potable water supply, waste water disposal, and water for agriculture and industry, ecology and conservation, recreation, sport and transport. There is robust regulation in Scotland which regulates activities to protect the water environment and has led to an improvement in water quality across Scotland and East Ayrshire. In respect of East Ayrshire's water resources:

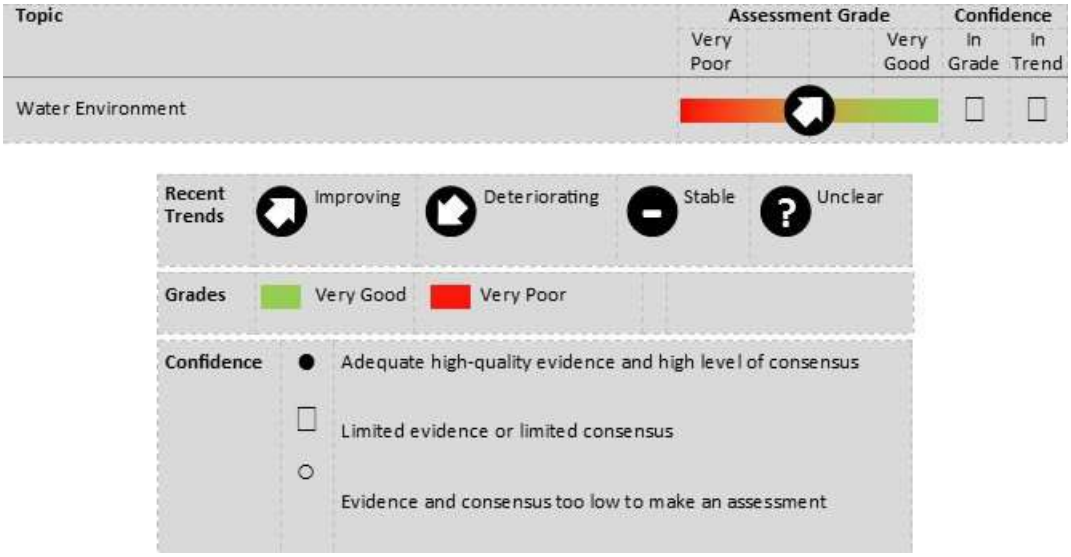
- There are no estuaries or coastal waters.
- All surface water bodies are within either the Clyde or Solway sub basins. Nine catchments have been identified within or partially within East Ayrshire, i.e. River Ayr, River Clyde, River Dee (Solway), River Doon, River Garnock, River Irvine, River Nith, Water of Girvan and White Cart Water.
- There are 64 identified surface water bodies including some water bodies with only part of their catchments within East Ayrshire, such as rivers and lochs at the region's boundary. These comprise a total of 58 river water bodies and 6 lochs.
- Most of the rivers are mid-altitude or lowland, calcareous or siliceous and medium or small in scale. The lakes, 4 of which are reservoirs (Lochgoin Reservoir, Loch Riecawr, Loch Finlas and Loch Doon) are mid-altitude low or medium alkalinity, deep and large.
- Compared with the whole of Scotland, East Ayrshire has proportionately less rivers and lochs of good status.
- Although groundwater in East Ayrshire tended to be of lower quality than Scotland-wide, the new system has noted that since 2012 there are proportionately more groundwater bodies of good status in East Ayrshire than Scotland-wide.
- Of the 21 bedrock aquifers underlying East Ayrshire, in 2013, 4 were assessed as Poor status and 17 Good status, i.e. 81% are Good status. On an area basis, compared with the area of East Ayrshire (1270km^2), the approximate areas of the 4 Poor status aquifers underlying east Ayrshire are 283km^2, 248km^2, 192km^2, and 87.6km^2 respectively which gives a total area of poor status groundwater of approximately 811.5km^2. This represents approximately 64% of the East Ayrshire area. On an area basis East Ayrshire has significantly higher proportion of the underlying aquifer areas of Poor status than Scotland as a whole.
- The Flood Risk Management (Scotland) Act, 2009 introduced new duties for the Council in relation to assessing and managing flood risk. Flood Risk Management Strategies for each of the 14 National Local Plan Districts (LPDs) were published in December 2015. The strategy for the majority of watercourses in East Ayrshire is contained in LPD 12 - Ayrshire, with the strategy for New Cumnock (River Nith) is contained in LPD 14 – Solway. Local Flood Risk Management Plans which provide additional local detail on the funding and delivery timetable for actions between 2016 and 2021 will be published in June 2016.

Trends

Recent annual trends (based on latest available data from 2013) show more improvements in status and fewer degradations in East Ayrshire than across Scotland for rivers and lochs. However there is more degradation of groundwater body status in East Ayrshire than Scotland-wide. Comparison with the bedrock geology indicates that these poor status aquifers (Cumnock, Kilmarnock, Ayr and Upper Nithsdale) are associated with Scottish coal measures (a geological formation in midland valley of Scotland including Ayrshire coalfields which includes mudstone, siltstone and sandstone with common coal seams present at some levels).

- The percentage of river water bodies in East Ayrshire of Good status or better in 2013 was 33% (19 out of 58), compared with 55% (1318 out of 2406) in Scotland.
- The percentage of lochs in East Ayrshire of Good status or better in 2013 was 17% (1 out of 6) compared with 67% (224 out of 334) in Scotland.
- The percentage of superficial and bedrock groundwater bodies combined of Good status in East Ayrshire is 84% (21 out of 25) compared with 78% (314 out of 403) in Scotland.
- The Met Office (see Chapter 6 Climate Change) projections do not include extreme weather events but there appears to be widespread consensus that these are likely to increase in frequency. In addition to an increased risk of future storms and flooding, there is also an increased risk of future drought. Areas of East Ayrshire were affected by flooding in December 2015 as a result of 'Storm Frank' and illustrates the importance of forward looking actions to address areas of potential risk. The Flood Risk Management Strategy for Ayrshire identified lists of Works and Studies within East Ayrshire: Studies identified through the FRM Strategies are expected to be funded by Local Authorities; however it is anticipated that the Scottish Government may contribute to some studies in the future. Work has already commenced on the River Irvine study following the flooding event of December 2015.

State and Trend



OVERVIEW

Water is an essential requirement for life and Scotland benefits from a significant water based resource. East Ayrshire includes a total of 58 river water bodies and 6 lochs.

1.1 Water Environment in Scotland

All of the water bodies in Scotland are within either the Scotland or the Solway Tweed River Basins. There are 10 sub basin districts and 155 catchments.

Surface water – rivers
There are 2406 river water bodies in Scotland and there is a wide range in typology assigned to these, each characterised as one of 20 typologies[1]. Most of the (39%) river water bodies in Scotland are mid-altitude siliceous and small; with the second and third most common types being lowland calcareous small (16%) or lowland siliceous small (14%).

Surface water – lochs
There are 334 lochs (or lakes) in Scotland and there is a wide range in typology assigned to the loch water bodies, each characterised as one of 16 typologies[1]. As shown in the bar chart, most (24%) loch water bodies in Scotland are lowland medium alkalinity deep and large; with the second and third most common being lowland low alkalinity deep and large (23%) or mid altitude low alkalinity deep and large (19%).

Groundwater – superficial aquifers
There are 103 superficial groundwater bodies in Scotland, all within either the Scotland or the Solway Tweed River Basins. These are all characterised as weakly to moderately mineralised, oxygenated, neutral, shallow and local (CCCF extracted/ viewed November 2014). They tend to be sands and gravels and/ or are associated with river valleys orcoasts.

Groundwater – bedrock aquifers
There are 300 bedrock groundwater bodies in Scotland, all within either the Scotland or the Solway Tweed River Basins (CCCF extracted/ viewed November 2014). These are all characterised as one of five typologies as shown in the following table.

Table 1 - Bedrock Groundwater Body Typologies in Scotland (SEPA, 2014)

Typology	% of each typology
Moderately mineralised, oxygenated, neutral to slightly alkaline, moderate and intermediate.	76
Moderately to highly mineralised, potentially reducing, neutral to alkaline, layered and regional.	84
Weakly mineralised, oxygenated, neutral to slightly acidic, shallow and local.	121
Weakly to moderately mineralised, oxygenated, neutral, moderate and mineralised.	16
Weakly to moderately mineralised, oxygenated, neutral, shallow and local.	3

[1] 'Current condition and challenges for the future' (CCCF)

STATE AND TREND – DETAILED ANALYSIS

2.1 Scotland – State and Trend

State

Table 2 presents the number of loch waterbodies, river waterbodies and groundwater bodies in Scotland in each class (Bad to High) for 2013.

Table 2 – Number (and Percentage) of Water Bodies in Each Class of Overall Status in 2013 for the Whole of Scotland.

Class of Overall Status	2013 Status		
	River Waterbodies	Loch Waterbodies	Groundwater Bodies
High	151 (6%)	59 (18%)	N/A
Good	1167 (49%)	165 (49%)	314 (78%)
Moderate	616 (26%)	69 (21%)	N/A
Poor	378 (16%)	34 (10%)	89 (22%)
Bad	91 (4%)	7 (2%)	N/A
Total	2406	334	403

The Nathan Critchlow-Watton Report for SEPA[2] noted that in 2012 most of Scotland's water environment was in a good condition and subject to fewer pressures than most other European waters. The main Scottish environmental problems relate to the water environment associated with the larger population centres, i.e. Glasgow and Edinburgh, and the productive agricultural areas along the east coast.

SEPA records that typically impacts are caused by a number of pressures, including diffuse source pollution, point source pollution, morphological alterations to beds, banks and shores, alterations to water levels and flows and the presence of invasive non-native species.

Trend

In 2012 there was a major change in how SEPA reported the composition and number of groundwater bodies, so that direct comparison of number of groundwater bodies in each class between 2008-2011 and 2012-2013 cannot be made.

The **percentage** of water bodies in each class for 2008 to 2013 is shown in Table 3 along with the overall percentage at high or good status.

[2] Nathan Critchlow-Watton Aquatic Classification Results and Comparison to Previous Years, 12/12/2013 – SEPA

Table 3- Classification Results for Rivers, Lochs and Groundwater Bodies in Scotland (Percentage of Number of Water Bodies)

Water Body	Status	Percentage of the Number of Water Bodies in Each Status Class in Scotland (%)					
		2008	2009	2010	2011	2012	2013
Rivers	High/ maximum	8	7	8	8	8	6
	Good	46	47	46	46	48	49
	Moderate	23	24	23	23	21	26
	Poor	15	15	15	15	15	16
	Bad	8	8	8	8	8	4
	% Good or Better	54	54	54	54	56	55
	No. of rivers (and %) improved between 2012 and 2013						**335 (14%)**
	No. of rivers (and %) degraded between 2012 and 2013						**315 (13%)**
Lochs	High/ maximum	18	17	16	19	21	18
	Good	44	46	47	44	42	49
	Moderate	18	19	21	23	23	21
	Poor	13	12	13	11	10	10
	Bad	7	7	3	4	3	2
	% Good or Better	62	63	63	62	63	67
	No. (and %) improved between 2012 and 2013						**32 (10%)**
	No. (and %) degraded between 2012 and 2013						**30 (9%)**
Ground water	Good	77	79	79	80	76	78
	Poor	23	21	21	20	24	22
	No. (and %) of groundwater bodies improved between 2012 and 2013						**17 (4%)**
	No. (and %) of groundwater bodies degraded between 2012 and 2013						**9 (2%)**

Between 2008 and 2013, there was a minor improvement (1%) in the proportion of Scottish rivers classed as Good or High (54% to 55%) and a slight improvement (5%) for lochs (62% to 67%).

Comparison of the same set of groundwater bodies across Scotland between 2008 and 2011 shows an improvement in the percentage of the total number at Good status from 77% to 80%. The apparent decrease in the percentage of the total number of groundwater bodies at Good between 2011 and 2012 from 80% to 76% is due to the reporting system change. SEPA notes that on an area basis the percentage area of groundwater bodies at Good increased from 81% to 86% between 2011 and 2012[3].

Scotland-wide, the most recent annual change (2012 to 2013) has shown 14% improvement and 13% degradation in rivers status; 10% improvement and 9% degradation in loch status and 4% improvement and 2% degradation in the status of groundwater bodies.

2.2 East Ayrshire

2.2.1 Surface Water Bodies

State

Surface Water bodies - Rivers and Lochs (Figure 3, 4, 5)
All surface water bodies within East Ayrshire are within either the Clyde or Solway sub basins. Nine catchments have been identified within or partially within East Ayrshire, these are the River Ayr, River Clyde, River Dee (Solway), River Doon, River Garnock, River Irvine, River Nith, Water of Girvan and White Cart Water.

[3] SEPA's report 2012 Aquatic Classification Results and Comparison to Previous Years, 12/12/2013 by Nathan Critchlow-Watton

There are 64 identified surface water bodies including some water bodies with only part of their catchments within East Ayrshire, such as rivers and lochs at the region's boundary. These 64 water bodies comprise a total of 58 river water bodies and 6 lochs[4]. Most of the rivers are of typology mid-altitude or lowland, calcareous or siliceous, medium or small. The lakes, 4 of which are reservoirs (Lochgoin Reservoir, Loch Riecawr, Loch Finlas and Loch Doon) are mid-altitude low or medium alkalinity, deep and large.

Compared with the whole of Scotland, East Ayrshire has proportionately less rivers and lochs of good status.

Since 2008 there has been more improvement and increase in the number of Good status rivers, lochs in East Ayrshire than Scotland-wide.

The overall status of the rivers and loch water bodies in East Ayrshire in 2013 has been assessed by SEPA and ranges from bad to good as shown in Table 4.

Table 4 – Overall status in 2013 of the surface water bodies in East Ayrshire

Number in status class in 2013	EAC Rivers	EAC Lochs	EAC Total surface water bodies
No. High	4	0	4
No. Good	15	1	16
No. Moderate	22	3	25
No. Poor	16	2	18
No. Bad	1	0	1
Total	58	6	64

Bad Status Waterbodies
The only surface water body in East Ayrshire with bad status in 2013 was the Gala Lane (waterbody 10448) and was noted as being affected by diffuse pollution resulting from non-renewable energy / acidification.

Poor Status Waterbodies
The 18 surface water bodies with poor status in 2013 were subject to impacts from diffuse pollution or point source pollution and physical changes as shown in Table 5.

Table 5 – Poor status surface water bodies in East Ayrshire and associated pressures

Poor Status Water body – River or Loch	Pressures*
10383 - Lugton Water	DP, MA (impounding – weir/ dam), PP (sewage disposal, livestock farming)
10399 - Kingswell Burn/Fenwick Water/Kilmarnock Water	DP, PP (sewage), MA (impounding – weir/ dam)
10400 - Craufurdland Water (Fenwick Water to Hareshawmuir Water)	DP (livestock farming), MA, FR (water collection, purification, distribution; impounding)
10401 - Craufurdland Water/Dunton Water(u/s Hareshawmuir Water)	DP (livestock farming), MA (impounding – weir/ dam), A (renewable energy, water collection, purification, distribution), FR (water collection, purification, distribution; impounding)

[4]https://www.sepa.org.uk/data-visualisation/water-classification-hub/

Poor Status Water body – River or Loch	Pressures*
10402 - Hareshawmuir Water/Gawkshaw Burn	DP (livestock farming), MA
10412 - Avon Water (u/s Glengavel Water conf)	MA (Impounding – weir/ dam)
10413 - Calder Water	MA (Impounding – weir/ dam)
10421 - River Ayr (u/s Greenock Water)	PP (sewage disposal), MA (fish barrier)
10425 - Glenstang Burn/Trabboch Burn	DP (livestock farming)
10442 – Purchlewan Burn	DP (livestock farming)
10444 - Muck Water	MA (water collection, purification, distribution; impounding), A (mining & quarrying of coal)
10447 - Pollcrayvie Burn	MA (water collection, purification, distribution; impounding), DP (production of non-renewable electricity)
10450 - un-named trib of Loch Slochy	MA (water collection, purification, distribution; impounding)
10563 - Water of Deugh (u/s of Carsphairn Lane)	MA (forestry), A (production of renewable energy), MA & FR (production of renewable energy; impounding – weir/ dam)
10564 – Pochriegavin Burn	MA (production of renewable energy; impounding – weir/ dam)
10611 – River Nith (Sanquhar – New Cumnock)	DP, PP (sewage disposal), MA
100305 – Lochgoin Reservoir	MA (water collection, purification, distribution; impounding – weir/dam)
100314 – Loch Doon	MA & A (production of renewable energy; impounding – weir/ dam), DP (Forestry)(phosphorous)

*DP = Diffuse Source Pollution; MA = Morphological Alteration; A = Abstraction; PP = Point Source Pollution; FR = Flow Regulation

Moderate Status Waterbodies

There were 22 river water bodies and 3 lochs with **Moderate Status** in 2013. The recorded pressures on these included diffuse source pollution, point source pollution, morphological alterations, abstraction, flow rate and/ or alien species from livestock farming, forestry, sewage disposal, water collection, purification and distribution, mining and quarrying of coal, production of non-renewable electricity and/ or production of renewable electricity.

Trend

The overall status of the rivers and loch water bodies between 2009 and 2013 has been assessed by SEPA and ranges from Bad to Good as follows:

Table 6 - Classification Results for Rivers and Lakes in East Ayrshire

Water Body	Status	Number in status class				
		2009	2010	2011	2012	2013
Rivers	High	-	-	-	-	4
	Good	17	17	18	21	15
	Moderate	21	21	22	16	22

Water Body	Status	Number in status class				
		2009	2010	2011	2012	2013
	Poor	14	17	15	19	16
	Bad	6	3	3	2	1
	% Good & High	29%	29%	31%	36%	33%
	No. of river water bodies in East Ayrshire improved between 2012 to 2013					13 (22%)
	No. of river water bodies in East Ayrshire with no change between 2012 to 2013					39 (67%)
	No. of river water bodies in East Ayrshire degraded between 2012 to 2013					6 (10%)
Lochs	Good	0	1	1	1	1
	Moderate	4	2	2	2	3
	Poor	1	2	2	2	2
	Bad	1	1	1	1	0
	% Good	0%	17%	17%	17%	17%
	No. of lochs in East Ayrshire improved between 2012 to 2013					1 (17%)
	No. of lochs in East Ayrshire with no change between 2012 to 2013					5 (83%)
	No. of lochs in East Ayrshire degraded between 2012 to 2013					0

Of the East Ayrshire surface water bodies, the percentage of river water bodies which improved between 2012 and 2013 was 22% (13 out of 58). There was one improved loch. The improved river water bodies were:

- 10394 - Annick Water (Poor to Moderate)
- 10395 - Glazert Burn(Poor to Moderate)
- 10397 – Garrier Burn(Poor to Moderate)
- 10398 – Carmel Water(Poor to Moderate)
- 10405 - Logan Burn(Good to High)
- 10406 – Glen Water(Good to High)
- 10420 – River Ayr (d/s Greenock Water) (Poor to Moderate)
- 10436 – Burn O'Need (Good to High)
- 10446 – Garpel Burn (Bad to Moderate)
- 10563 – Water of Deugh (u/s Carsphain Lane)(Bad to Poor)
- 10614 - Afton Water (Poor to Moderate)
- 10726 – Whitehaugh Water/ Polbeith Burn (Good to High)
- 10927 – Cessnock Water (Poor to Moderate)

There were 6 river water bodies out of 58 (i.e. 10%) and no lochs which degraded between 2012 and 2013. The pressures on the degraded rivers related to diffuse source pollution, point source pollution and/ or morphological changes from various sources:

- 10442 – Purclewan Burn (Moderate to Poor) (Diffuse source pollution from livestock farming: phosphorous, dissolved O2)

- 10448 – Gala Lane (Moderate to Bad) (Diffuse source pollution from production of non-renewable electricity (pH)
- 10462 – Dyrock Burn (Good to Moderate) (no identified pressures)
- 10564 Pochriegavin Burn (Moderate to Poor) (Morphological alterations from production of renewable electricity)
- 10611 – River Nith (Sanquhar – New Cumnock) (Moderate to Poor) (Point source pollution from sewage disposal and diffuse source pollution and morphological alterations from unidentified source.)
- 10925 – River Doon (u/s Muck Water) (Good to Moderate) (Diffuse source pollution from mixed farming and flow regulation from production of renewable electricity).

Recent annual trends show more improvements in status and fewer degradations in East Ayrshire than across Scotland for rivers and lochs.

- The percentage number of river water bodies in East Ayrshire of Good status or better in 2013 was 33% (19 out of 58), compared with 55% (1318 out of 2406) in Scotland.
- The percentage number of lochs in East Ayrshire of Good status or better in 2013 was 17% (1 out of 6) compared with 67% (224 out of 334) in Scotland.

The following waterbodies are Heavily Modified and therefore their overall status will only be Moderate to Good Ecological Potential:

- 10446 – Garpel Burn (Bad to Moderate)
- 10563 – Water of Deugh (u/s Carsphairn Lane) (Bad to Poor)
- 10614 - Afton Water (Poor to Moderate)
- 10925 – River Doon (u/s Muck Water) (Good to Moderate)
- 10449 - Whitespout Lane (Moderate)
- 100319 – Loch Riecawr (Moderate to Good)

Future Trends
SEPA ('Current condition and challenges for the future') has considered potential impacts and trends in water body status in terms of whether or not there is a risk of not meeting the 2015 status target and risks of deterioration in status before 2015, 2021 and 2027.

Surface Water bodies – Rivers and Lochs
The risk to the status of rivers and lochs across Scotland are presented in the following table.

Table 7 - Risks to status of rivers and lochs in Scotland

Risks to status	No. of rivers in Scotland	No. rivers at risk from Mining and quarrying	No. rivers at risk from production of non-renewable electricity	No. of lochs in Scotland	No. lochs at risk from Mining and quarrying	No. lochs at risk from production of non-renewable electricity
Risk of not meeting 2015 target status						
At risk	361	12	23	43	1	3
Possibly at risk	61	4	0	6	0	0
Not at risk	1984	32	43	285	0	4
Most common pressures	Farming, sewage disposal, forestry, no assigned industry	Diffuse source pollution, abstraction and point source pollution	Diffuse source pollution	Farming, forestry sewage, water collection/ purification/ distribution, no assigned industry	Morphological alterations	Diffuse Source pollution

Risks to status	No. of rivers in Scotland	No. rivers at risk from Mining and quarrying	No. rivers at risk from production of non-renewable electricity	No. of lochs in Scotland	No. lochs at risk from Mining and quarrying	No. lochs at risk from production of non-renewable electricity
Risk of deterioration in status before 2015						
At risk	298	7	2	11	0	0
Possibly at risk	72	0	0	8	0	0
Not at risk	2036	0	0	315	0	0
Most common pressures	Farming, sewage disposal, forestry, no assigned industry	Point source pollution and diffuse source pollution	Diffuse source pollution	Farming, sewage disposal, forestry, no assigned industry, aquaculture	N/A	N/A
Risk of deterioration in status before 2021 or 2027						
At risk	357	7	2	18	0	0
Possibly at risk	52	0	0	2	0	0
Not at risk	1997	0	0	314	0	0
Most common pressures	Farming, sewage disposal, forestry, no assigned industry	Point source pollution, diffuse source pollution	Diffuse source pollution	Farming, sewage disposal, forestry, no assigned industry, aquaculture	N/A	N/A

For rivers in Scotland the risks to 2015 status and potential deterioration in 2015, 2021 or 2027 status tend to be related to agriculture, sewage disposal and forestry or to industry. Only 3% (12 out of 361) of rivers have been highlighted as at risk of not meeting the 2015 target status and 2% at risk of a deterioration in status before 2015, 2021 or 2027 due to mining and quarrying.

For lochs in Scotland, only one loch is anticipated to be at risk of not meeting the 2015 status due to mining and quarrying while this industry group is not considered to present a risk of future deterioration in loch status.

2.2.2 Groundwater

State

Groundwater – superficial aquifers (Figure 6)
There are 4 superficial groundwater bodies within East Ayrshire Council area some of which only slightly underlie East Ayrshire, all of which are characterised as weakly to moderately mineralised, oxygenated, neutral, shallow and local.

The percentage number of superficial and bedrock groundwater bodies combined of Good status in East Ayrshire is 84% (21 out of 25) compared with 78% (314 out of 403) in Scotland.

Table 6 – Superficial groundwater Bodies in East Ayrshire

River Basin District	Sub Basin District	Water body ID	Name	Overall Status 2013	Total Aquifer Area (km^2)	Approximate % area in EAC area
Scotland	Clyde	150719	Drumclog	Good	13.30	<5%

			sand and gravel			
Scotland	Clyde	150756	Irvine Valley	Good	16.38	100%
Scotland	Clyde	150802	Prestwick & Irvine Coastal	Good	78.71	<10%
Solway Tweed	Solway	150771	Upper Nith Valley	Good	26.21	~50%

Groundwater – bedrock aquifers *(Figure 6)*
Underlying East Ayrshire, there are 18 bedrock groundwater bodies within Clyde Sub basin district, some of which only slightly underlie East Ayrshire and 3 bedrock aquifers within Solway Sub basin district. These are listed in Table 8 with the total area of each groundwater body. The areas underlying East Ayrshire *per se* are given in Figure 6.

Table 8 - Bedrock aquifers under East Ayrshire in 2013[5]

Water Body ID and Name	Overall Status 2013	Total Aquifer Area (km^2)	Typology Summary
Clyde Sub Basin District			
150445 Priestland	Good	13.60	Weakly mineralised, oxygenated, neutral to slightly acidic. Shallow. Local
150489 Wardlaw Hill	Good	36.95	Moderately to highly mineralised, potentially reducing, neutral to alkaline. Layered. Regional
150497 Slouch Moss	Good	40.08	Moderately to highly mineralised, potentially reducing, neutral to alkaline. Layered. Regional
150502 Mauchline	Good	43.99	Weakly to moderately mineralised, oxygenated, neutral. Moderate. Intermediate
150521 Dalrymple	Good	53.46	Moderately to highly mineralised, potentially reducing, neutral to alkaline. Layered. Regional
150541 South Glengavel	Good	64.44	Weakly mineralised, oxygenated, neutral to slightly acidic. Shallow. Local
150559 Carrick Forest	Good	78.95	Weakly mineralised, oxygenated, neutral to slightly acidic. Shallow. Local
150566 Crosshill*	Good	86.75	Moderately to highly mineralised, potentially reducing, neutral to alkaline. Layered. Regional
150575 North Glengavel*	Good	95.6	Weakly mineralised, oxygenated, neutral to slightly acidic. Shallow. Local
150587 Strathaven*	Good	109.5	Weakly mineralised, oxygenated, neutral to slightly acidic. Shallow. Local
150588 Beith*	Good	111.98	Weakly mineralised, oxygenated, neutral to slightly acidic. Shallow. Local
150599 Whitelee	Good	125.84	Weakly mineralised, oxygenated, neutral to slightly acidic. Shallow. Local
150607 Girvan*	Good	139.62	Moderately to highly mineralised, potentially reducing, neutral to alkaline. Layered. Regional
150622 Newton Mearns*	Good	166.66	Weakly mineralised, oxygenated, neutral to slightly acidic. Shallow. Local
150646 Cumnock	Poor	288.10	Moderately to highly mineralised, potentially reducing, neutral to alkaline. Layered. Regional
150662 Kilmarnock	Poor	372.34	Moderately to highly mineralised, potentially reducing, neutral to alkaline. Layered. Regional
150669 Ayr	Poor	406.86	Moderately to highly mineralised, potentially reducing, neutral to alkaline. Layered. Regional
150673 Lesmahagow	Good	453.47	Moderately to highly mineralised, potentially reducing, neutral to alkaline. Layered. Regional

[5]https://www.sepa.org.uk/data-visualisation/water-environment-hub/

Water Body ID and Name	Overall Status 2013	Total Aquifer Area (km^2)	Typology Summary
Solway Sub Basin District			
150660 South Ayrshire Hills	Good	367.63	Weakly mineralised, oxygenated, neutral to slightly acidic. Shallow. Local
150663 Upper Nithsdale	Poor	377.76	Weakly mineralised, oxygenated, neutral to slightly acidic. Shallow. Local
150694 Galloway	Good	2108.03	Weakly mineralised, oxygenated, neutral to slightly acidic. Shallow. Local

#Area is for whole aquifer from water body datasheets, not area of the aquifer within East Ayrshire
*****Aquifers only impinge on East Ayrshire

Of the 21 bedrock aquifers underlying East Ayrshire, in 2013, 4 were assessed as Poor status and 17 Good status, i.e. 81% are Good status. On an area basis, compared with the area of East Ayrshire (1270km^2), the approximate areas of the 4 Poor status aquifers underlying East Ayrshire are 283km^2, 248km^2, 192km^2, and 87.6km^2 respectively which gives a total area of poor status groundwater of approximately 811.5km^2. This represents approximately 64% of the East Ayrshire area. These Poor status aquifers are located in the northwest, central and southeast areas. In terms of overall area, East Ayrshire has significantly higher proportion of the underlying aquifer areas of Poor status than Scotland as a whole.

Pressures Associated with Poor Status Groundwater Bodies
The Poor status in 2013 noted above for 3 of the bedrock aquifers in East Ayrshire (Cumnock, Ayr, and Kilmarnock) is related to poor groundwater chemistry in respect of the chemical tests for mining. In addition, for Cumnock the quantitative status is Poor. The Poor status of Upper Nithsdale groundwater is related to point source impacts on the chemistry but there are no identified pressures in the SEPA datasheet. The 2013 water body datasheets for the other three Poor status groundwater bodies identified the pressures to be diffuse source pollution as a result of mining and quarrying of coal with an additional abstraction pressure on Cumnock.

Comparison with the bedrock geology indicates that these poor status aquifers are associated with Scottish coal measures (a geological formation in midland valley of Scotland including Ayrshire coalfields which includes mudstone, siltstone and sandstone with common coal seams present at some levels). The aquifers in the south are associated with wackes (sedimentary rock composed of sand-sized grains), those in the north with igneous rocks while the small aquifer at the centre-west is sandstone, breccia and conglomerate.

Trend

There is a difference in SEPA's identification and characterisation of the groundwater bodies from 2012 and those between 2008 and 2011 which prevents a review of longer trends. The ten 2008-2011 identified groundwater bodies in East Ayrshire are listed in Table 5.14 with the status in 2008 and 2011 presented in respect of quality and quantity. Changes in the status in 2012 and 2013 for groundwaters under the 2012 system are discussed below.

Table 8 - Classification results for bedrock and superficial groundwater bodies under East Ayrshire in 2008 and 2011

Water Body ID and Name	Overall Status 2008	Overall Status 2011	Total Aquifer Area (km^2)*	Pressures in 2008
Clyde Sub Basin District				
150197 Cumnock bedrock & localised sands and gravel aquifers	Poor, poor	Poor, poor	398	DP and A - Mining and quarrying of coal (Poor chemical test (mining))

150194 Girvan bedrock & localised sands and gravel aquifers	Poor, poor	Poor, poor	501.5	DP and A - Mining and quarrying of coal (Poor chemical test (mining))
150196 Ayr bedrock & localised sands and gravel aquifers	Poor quality, good quantity	Poor quality, good quantity	166.2	DP - Mining and quarrying of coal (Poor chemical test (mining))
150107 Mauchline bedrock & localised sands and gravel aquifers	Poor quantity, good chemistry	Good, good	50.6	A – water collection, purification, distribution
150198 Kilmarnock bedrock & localised sands and gravel aquifers	Good quantity, poor quality	Good quantity, poor quality	294.6	DP - Mining and quarrying of coal (Poor chemical test (mining))
150200 Clyde Plateau West bedrock & localised sands and gravel aquifers	Good, good	Good, good	173	N/A
Solway Sub Basin District				
150174 New Cumnock bedrock & localised sands and gravel aquifers	Good quantity, Poor quality	Good quantity, Poor quality	148.9	DP - Mining and quarrying of coal (Poor chemical test (mining))
150176 New Cumnock sand and gravel	Good, good	Good, good	10.8	N/A
150181 New Galloway bedrock & localised sands and gravel aquifers	Good, good	Good, good	928.1	N/A
150189 Newton Stewart bedrock & localised sands and gravel aquifers	Good, good	Good, good	1574.7	N/A

* Total aquifer area can include areas outwith East Ayrshire; Pressures as above

In 2008 the East Ayrshire groundwaters were classed as 40% Good (4 out of 10) and 60% Poor (6 out of 10), while in 2011 these improved to 50% Good (5 out of 10) and 50% Poor (5 out of 10). The 2012 classifications (using the updated groundwater identities) show an even greater improvement in that there were 85% Good status (17 out of 20) and 15% (3 out of 20) were Poor.

For the groundwater bodies identified under the 2012 system, there was no change in superficial groundwater status between 2012 and 2013, i.e. the 4 superficial groundwater bodies remained of Good Status.

For the bedrock groundwaters, 17 out of 21 were Good in 2013 (Table 5.8) whereas 18 out of 21 were Good in 2012. The only change in groundwater status between 2012 and 2013 occurred for Upper Nithsdale (150663) which degraded from Good to Poor with no identified pressures. Hence 4% (1 out of 25) of the total (superficial and bedrock) groundwater bodies degraded in the year from 2012 to 2013.

Future Trends

Groundwater – Superficial and Bedrock
Superficial groundwater: No superficial groundwater bodies in East Ayrshire have been identified as being at risk of not meeting the 2015 target status or at risk of deterioration in status before 2015, 2021 or 2027. Hence mining and quarrying and the production of non-renewable electricity are not predicted to present future risks to status.

Bedrock Groundwater:
Only one East Ayrshire bedrock groundwater body (Cumnock ID 150646) has been identified as being at risk of meeting the 2015 target status and this has been highlighted as due to mining and quarrying. No East Ayrshire bedrock groundwaters have been identified as being

at risk of deterioration of status by 2015, 2021 and 2027. Hence mining and quarrying and the production of non-renewable electricity are not predicted to present future risks to status.

2.2.3 Flooding

State

The UK Climate Projections (UKCP09) report predicts that climate change may lead to warmer and drier summers, warmer and wetter winters with less snow, and more extreme temperature and rainfall events. The Met Office (see Chapter 6 Climate Change) projections do not include extreme weather events but there appears to be widespread consensus that these are likely to increase in frequency. In addition to an increased risk of future storms and flooding, there is also an increased risk of future drought. The increased threat of flooding can potentially cause further damage to East Ayrshire's economy and society, disruption to transport links, the public water supply and increased vulnerability to personal and commercial property.

The Flood Risk Management (Scotland) Act, 2009[6] introduced new duties for the Council in relation to assessing and managing flood risk.

The Ayrshire Flood Steering Group (East Ayrshire Council, North Ayrshire Council (lead local authority) and South Ayrshire Council; Scottish Water; and, SEPA) was established on the 11 September 2013 to oversee and support the development of the draft Flood Risk Management Strategy for Ayrshire and the Local Flood Risk Management Plans which provide additional local detail on the funding and delivery timetable for actions between 2016 and 2021.

The draft Flood Risk Management Strategy for Ayrshire was produced by SEPA, and in November 2015 they submitted the Flood Risk Management Strategies for each of the fourteen National Local Plan Districts to Scottish Ministers. These were formally published in December 2015[7]. The strategy for the majority of watercourses in East Ayrshire is contained in LPD 12 - Ayrshire, with the strategy for New Cumnock (River Nith) is contained in LPD 14 – Solway.

The Flood Risk Management Strategies for each District set out the "short to long term" ambitions for flood risk management in Scotland. They state the objectives for tackling floods in the areas identified as being at high risk of flooding, the Potentially Vulnerable Areas (PVAs). Each PVA is considered in the document with appropriate actions identified to deliver the objectives along with indicative timescales prioritised in six year planning cycles. There are 3 Potentially Vulnerable Areas in East Ayrshire as shown in Table 9 below. These objectives and action plans shall be developed into the Local Flood Risk Management Plans to be prepared by each Local Authority by June 2016.

Table 9 – Extracts from SEPA's Flood Risk Management Strategies relevant to East Ayrshire[8]

Potentially Vulnerable Area (PVA)	Local Plan District	Main River Catchment	Local Authority	Summary (Extract from SEPA
12/6	12 - Ayrshire	River Irvine	East Ayrshire South Ayrshire North Ayrshire East Renfrewshire	Assessment of future flood risk and past events shows fluvial and coastal sources presents: potential impact to a large number of residential

[6] https://www.legislation.gov.uk/asp/2009/6/contents
[7] http://apps.sepa.org.uk/FRMStrategies/
[8] http://apps.sepa.org.uk/FRMStrategies/ayrshire.html and http://apps.sepa.org.uk/FRMStrategies/solway.html

Potentially Vulnerable Area (PVA)	Local Plan District	Main River Catchment	Local Authority	Summary (Extract from SEPA
				properties; limited impact to low category community facilities; potential impact to a large number of commercial properties; potential impact to minor transport links and limited impact to less resilient designated sites, with frequent reports of flooding in the area between 1907 and 2008.
12/14	12 - Ayrshire	River Ayr	East Ayrshire	Assessment of future flood risk and past events shows that River Ayr, Lugar Water and their tributaries present: potential impact to a large number of residential properties; limited impact to low category community facilities; potential impact to a large number of commercial properties; limited impact to transport links; potential impact to high grade agricultural land; limited impact to less resilient environmental designation and potential impact to sensitive designated sites, with infrequent reports of flooding in the area.
12/15	12 - Ayrshire	River Doon	South Ayrshire East Ayrshire	Assessment of future flood risk and past events shows that River Doon presents: potential impact to a large number of residential properties and potential impact to sensitive designated sites, with infrequent reports of flooding in the area between 1814 and 2009.
New Cumnock (Candidate Potentially Vulnerable Area 14/26c)	14-Solway	River Nith	Dumfries and Galloway Council East Ayrshire Council	Included as a candidate Potentially Vulnerable Area due to the risk to people and properties. River flooding presents the greatest risk to residential properties in New Cumnock as well as to transport links, notably the A76 and B741. Within this Potentially Vulnerable Area it is estimated that climate change will increase the number of residential properties at risk of flooding from approximately

Potentially Vulnerable Area (PVA)	Local Plan District	Main River Catchment	Local Authority	Summary (Extract from SEPA
				240 to 290 and the number of non-residential properties from approximately 60 to 70.

The Ayrshire and Solway Flood Risk Management Strategies identifies a range of infrastructure and agricultural land at risk of flooding including:

- Property - residential and non-residential
- Community facilities - educational buildings, emergency services and healthcare facilities
- Utility assets - electricity substations and Utilities assets
- Roads and Railway routes
- Agricultural land

The Flood Risk Management Act, Flood Risk Management Strategies and Scottish Government Guidance follows a hierarchy of avoid, reduce and accept in relation to flood management. There are a range of suggested actions included within the Ayrshire Flood which will assist with adaptation to flood events including:

- River flood warning schemes, forecasting and awareness raising
- Runoff reduction – sustainable urban drainage
- Floodplain storage
- Sediment management
- Flood protection schemes - East Ayrshire Council has completed a number of flood protection schemes within the catchment group area including:
    - Formal flood defences in Galston consisting of clad sheet pile walls and earth embankments on the River Irvine in Crookedholm and the Burn Anne (2008)
    - Kilmarnock is defended by clad sheet pile walls, constructed on the Kilmarnock Water, 1998, and on the River Irvine in 2000;
    - Attenuation ponds at Milton and Galston were constructed to relieve localised flooding issues.

East Ayrshire Flood Response Plan[9]

East Ayrshire Council have a Flood Response Plan which sets out its roles and responsibilities in relation to flooding which may arise as a result of adverse weather and severe storms. The aim of the Plan is to provide a structure for an inter-agency response to a flood emergency within East Ayrshire. The plan is maintained and reviewed by the Ayrshire Civil Contingencies Team.

The objectives of the plan are:

- to develop a corporate and co-ordinated response to flooding incidents and mitigation measures
- to develop and produce proactive contingency measures for dealing with flooding affecting Council property, non-Council property (commercial and residential), transport routes, villages isolated by flood waters and care of the displaced
- to provide recognised and agreed procedures for obtaining assistance from Central Government, the military forces and any other organisations

[9]https://www.east-ayrshire.gov.uk/Resources/PDF/F/EAC-Flood-Plan---September-2015.pdf

Trend

The Met Office have confirmed that December 2015 broke the record for the wettest month, since records began in 1910 with almost twice as much rain as normal[10]. Climate change predictions indicate a potential risk of increased flood incidents. Areas of East Ayrshire were affected by flooding in December 2015 as a result of 'Storm Frank' and illustrates the importance of forward looking actions to address areas of potential risk. The Flood Risk Management Strategy for Ayrshire identified lists of Works and Studies within East Ayrshire:

Works in East Ayrshire Council Area:

- New Cumnock FPS - £3.3 m

Studies in East Ayrshire Council Area:

- Irvine Valley Flood Study - £30,000 - 50,000
- Catrine Flood Study - £30,000 - 50,000
- Dalmellington Flood Study - £30,000 - 50,000
- Dalrymple Flood Study - £30,000 - 50,000

Surface Water Management Plans:

- Ayrshire ICS/Option Report East (Cumulative costs) - £180,000 -200,000

Studies identified through the FRM Strategies are expected to be funded by Local Authorities; however it is anticipated that the Scottish Government may contribute to some studies in the future. Work has already commenced on the River Irvine study following the flooding event of December 2015.

PRESSURES

3.1 Development

Development can lead to a range of changes to the water environment during construction and operation for example:

Construction

- Earthworks and construction (track, machinery, borrow pits) may pollute nearby watercourses with sedimentary material or construction materials (grout, bentonite, concrete, tarmac, lubricants, timber treatments, paint)
- Increased loadings of suspended solids can smother the natural substrate of watercourses and adversely affect spawning ground and invertebrate communities
- Earthworks may mobilise pollutants in soil and allow them to contaminate water resources through surface water run-off and percolation to groundwater
- Earthworks/ realignment of watercourses/ creation of new ponds/ drainage systems/ culverts/ crossings/ temporary bunding or material stockpiles may alter runoff, hydrology or morphology of nearby water features resulting in changes to flood risk or habitats
- Accidental physical damage to banks/ stream beds/ culverts may affect flow characteristics
- Pollution from accidental spillage of fuels, hydraulic fluids and lubricants
- Pollution due to vandalism of stores or plant
- Foul drainage from washroom facilities, wheel washing, etc. impacts on receiving waters
- Water abstraction/ dewatering or change in groundwater level may alter hydrological regime
- Disturbance/ damage to existing foul drainage systems.

[10] http://www.metoffice.gov.uk/mobile/news/article/news/releases/archive/2016/december-records

Operation

- Changes in volume and rate of surface runoff from impermeable surfaces such as roofs, driveways, access roads affecting flow characteristics or causing soil erosion
- Pollution of groundwater (and eventually receiving watercourses) from accumulated contaminants in runoff from these surfaces and from garden/ landscaped areas, e.g. debris from plant litter, fuel, dust, surfactants, pesticides and herbicides, salt
- Changes to the permeability of surface cover may impact on the underlying hydraulic regime and groundwater recharge
- Surface drainage schemes may alter the flow characteristics of nearby watercourses and flooding characteristics
- Safety issues associated with the creation of new open water bodies
- Physical disturbance to surface water features from increased use of the area
- Enhancement of amenity/ ecology

3.2 Pollution

In addition to potential for pollution through development, there are a range of sources of pollutants which can enter the water environment through human activity. These are typically split into two main types - point source pollution or diffuse pollution:

- **Point source pollution** can originate from industrial processes and includes sewage treatment works, factories and input from fish farms. These discharges are controlled and regulated by the Scottish Environment Protection Agency through the Water Environment (Controlled Activities) (Scotland) Regulations 2011[11].
- **Diffuse source pollution** is typically associated with sources such as run-off of soil, nutrients and pesticides caused by farming and forestry, contaminated run-off from urban areas, and deposition of acid pollutants from air pollution.

3.3 Abstractions and Engineering Works

Water abstraction for water supply and renewable energy and engineering works such as culverting, straightening, bridging etc can impact on water volumes, flood capacity and channel morphology with resulting increases in erosion, flood risk and flows. Activities such as abstractions and works that would involve engineering in watercourses are regulated under the Water Environment (Controlled Activities) (Scotland) Regulations 2011[5]. The Flood Risk Management Act, Flood Risk Management Strategies and Scottish Government Guidance follows a hierarchy of avoid, reduce and accept in relation to flood management. Engineering activities that could increase flood risk potential directly or indirectly with impacts need to be assessed and carefully considered.

3.4 Specific Pressures – East Ayrshire

The data available shows that most of the principal watercourses within East Ayrshire, including parts of the River Ayr, River Irvine, Kilmarnock/Fenwick Waters, Black Water and Water of Coyle are considered at risk to some degree from the pressures discussed above.

Groundwater is also subject to these same pressures. In terms of abstraction of drinking water in East Ayrshire the primary sources are from tributaries of the River Irvine.

There are risks from morphological pressures i.e. effects on river profiles, banking, geometry exists within certain parts of the surface water system due to a range of development pressures including increased run-off from deforestation and other riparian commercial development activities.

[11] http://www.sepa.org.uk/regulations/water/

Flood attenuation works include those completed along the River Irvine and may include other schemes under Flood Risk Strategies once studies have been concluded (see section 2.2.3 above).

Mineral extraction has impacted on quality and morphology of the water environment in particular locations which is discussed in section 5.

CONCLUSIONS

4.1 Conclusion

Water is a valuable resource, which has multiple uses, e.g. potable water supply, waste water disposal, water for agriculture and industry, ecology and conservation, recreation, sport and transport. There is robust regulation in Scotland which regulates activities to protect the water environment and has led to an improvement in water quality across Scotland and East Ayrshire. This legislation seeks to:

- Prevent deterioration and enhance status of aquatic ecosystems, including groundwater;
- Promote sustainable water use;
- Reduce pollution; and
- Contribute to the mitigation of floods and droughts via the Flood Risk Management (FRM) Act.

Recent annual trends show more improvements in status and fewer degradations in East Ayrshire than across Scotland for rivers and lochs. However there is more degradation of groundwater body status in East Ayrshire than Scotland-wide. Comparison with the bedrock geology indicates that these poor status aquifers are associated with Scottish coal measures (a geological formation in midland valley of Scotland including Ayrshire coalfields which includes mudstone, siltstone and sandstone with common coal seams present at some levels).

- The percentage number of river water bodies in East Ayrshire of Good status or better in 2013 is 33% (19 out of 58), compared with 55% (1318 out of 2406) in Scotland.
- The percentage number of lochs in East Ayrshire of Good status or better in 2013 is 17% (1 out of 6) compared with 67% (224 out of 334) in Scotland.
- The percentage number of superficial and bedrock groundwater bodies combined of Good status in East Ayrshire is 84% (21 out of 25) compared with 78% (314 out of 403) in Scotland.

Recent weather events (Winter 2015) have resulted in significant levels of flooding across Scotland and in parts of East Ayrshire and highlight the impact from flooding on people and property and also the importance of planning in relation to mitigating flooding risks. There appears to be widespread consensus that extreme weather events will increase in frequency with corresponding flood risk.

MINERALS – IMPACTS ON THE WATER ENIRONMENT FROM MINERAL EXTRACTION

5.1 Summary

East Ayrshire has a significant history of mineral extraction including opencast coal industry and quarrying activity and this has affected the water environment in the past through both point source and diffuse pollution, alterations to watercourses and creation of water filled voids which require long term management.

5.2 Understanding the Impacts from Mineral Activity

In general, the potential impacts on the water environment which might occur include alterations of and/or to the:

- Ecological and Chemical quality of surface waters and groundwater
- Quantity of water flows/ ecology potential and abstractions
- Groundwater supply to surface waters and to Groundwater dependent terrestrial ecosystems.
- The quantity and/ or quality of groundwater as a resource (drinking water, water conveyance, cooling etc.)

In conventional deep mining, surface or open cast mining, contamination-related impacts on water quality relate to the production of acid mine water, the introduction of minerals/ metals into water and impacts related to surface activities e.g. extraction, blasting, processing. In relation to quarry operations the main potential impact relates to sedimentation from poor surface water management together with fuel/hydrocarbon spillages. These, and the potential impacts from unconventional oil and gas, are discussed below.

5.2.1 Identified Pressures from Mineral Activity

SEPA has identified on the water body information sheets for 2013 where there are pressures on surface waters which are due to mining and quarrying and/ or to the production of non-renewable electricity production (i.e. which includes production by coal, gas, nuclear or pumped hydro). SEPA notes on the water body information sheets that the measures, pressures and objectives may not align to the 2013 classification results.

SEPA has also identified the pressures on East Ayrshire surface waters and groundwater bodies from these activities which present risks to the 2015 target status and/or risks of deterioration in status before 2015, 2021 and 2027.

Although for some water bodies there can be multiple pressures, pressures identified in 2013 from mining and quarrying of coal on surface waters have been recorded for 6 river water bodies and no lochs, as shown in Table 10.

No pressures have been identified by SEPA on any of the 4 superficial groundwater bodies or on any of the Good status bedrock groundwater bodies in 2013. Three of the Poor status groundwater bodies (all bedrock), i.e. Cumnock, Ayr, and Kilmarnock, had pressures in 2013 identified as diffuse source pollution as result of **mining and quarrying of coal.**

Table 10 - Identified mining and quarrying pressures on East Ayrshire surface waters

Water body – River or Loch with Mining and Quarrying Pressure	2013 Overall Status	Mining and Quarrying Pressure and Assessment Parameter	Comment
10422 – Water of Coyle (d/s Taiglum Burn)	Moderate (Ecological Moderate; Chemical Pass)	Diffuse Source Pollution - UK Specific Pollutants (Annex 8)	Specific Pollutants has **Pass** status in 2013, however, several have Pass with low confidence. **Moderate** water quality seems to relate to phosphorous and biological elements from diffuse source pollution from farming and sewage disposal.
10424 – Taiglum Burn	Moderate (Ecological Moderate; Chemical Pass)	Diffuse Source Pollution - UK Specific Pollutants (Annex 8)	Specific Pollutants have **Fail** status in 2013, in respect of ammonium, however, several have Pass with low confidence. The ammonium relates to diffuse source pollution from livestock farming.
10430 – Lugar/ Glenmuir Water	Good (Ecological Good; Chemical Pass)	Abstraction - Depletion of base flow from groundwater body	Despite pressures from mining and quarrying and from forestry, the overall status is good.
10443 – Cumnock Water	Good (Ecological Good; Chemical Pass)	Abstraction - Depletion of base flow from groundwater body	Despite pressures from mining and quarrying and from forestry, the overall status is good.
10444 – Muck Water	Poor (Ecological Poor; Chemical Pass)	Abstraction - Depletion of base flow from groundwater body	The **Poor** status seems to relate to morphological pressures and fish barriers.
10612 – River Nith (u/s New Cumnock)	Moderate (Ecological Moderate; Chemical Pass)	Morphological Alterations and Diffuse Source Pollution - UK Specific Pollutants (Annex 8)	Specific Pollutants have **Pass** status in 2013, however, several have **Pass** with low confidence. The **moderate** status relates to physical condition and morphology.

From SEPA's 2013 water body information sheets, for data current on 3/12/2014.

The UK Specific Pollutants are listed in SEPA's Environmental Quality Standards and Standards for Discharges to Surface Waters[12]. Specific Pollutants are defined as substances that can have a harmful effect on biological quality, and which may be identified by EU Member States as being discharged to water in "significant quantities". The Water Framework Directive (Annex VIII) provides an indicative list of such pollutants.

For East Ayrshire rivers, lochs and superficial groundwater, mining and quarrying of coal are not predicted to present a risk to the 2015 target status. Only one bedrock groundwater body (Cumnock ID 150646) has been identified as having a risk from mining and quarrying pressures to its 2015 status target. No East Ayrshire surface water bodies or groundwater bodies are at risk of deterioration in status before 2015, 2021 and 2027 caused by mining or quarrying. Potential impacts from extraction can be controlled through appropriate controls in planning such as control of surface water runoff.

5.2.2 Identified Pressures from Production of Non-Renewable Electricity

Pressures from production of non-renewable electricity (which includes production by coal, gas, nuclear or pumped hydro) on surface waters have been recorded for 8 river water bodies and 2 lochs in East Ayrshire, as shown in Table 11.

[12]WAT-SG-53 version 5.1, July 2014 https://www.sepa.org.uk/media/152957/wat-sg-53-environmental-quality-standards-for-discharges-to-surface-waters.pdf

Table 11 – Identified Pressures from Production of Non-Renewable Energy on Surface Waters in East Ayrshire (SEPA)

River or Loch with Non-Renewable Electricity Production Pressure	2013 Overall Status	Non-Renewable Electricity Pressure and Assessment Parameter	Comment
10439 – Carrick Lane	Moderate (Ecological Moderate; Chemical Pass)	Diffuse Source Pollution - pH	Status of pH and acidification recorded as **Moderate** and acid neutralising capacity as High in 2013. Diffuse source pollution from forestry also contributes to the pH.
10446 – Garpel Burn	Moderate (Ecological Poor; Chemical Pass)	Diffuse Source Pollution - pH	pH status recorded as **Good** in 2013 and acidification as **Moderate**. Poor status seems to be in respect of hydrology (impoundment, abstraction and flow regulation) due to water collection, purification and distribution.
10447 – Pollcrayvie Burn	Poor (Ecological Poor; Chemical Pass)	Diffuse Source Pollution - pH	Status of pH and acid neutralising capacity recorded as **High** and acidification as **Moderate** in 2013. The **Poor** status seems to relate to morphological pressures and fish barriers due to water collection, purification and distribution and impounding – weir/ dam.
10448 – Gala Lane	Bad (Ecological Bad; Chemical Pass)	Diffuse Source Pollution - pH	Status of pH and acidity recorded as **Moderate** and acid neutralisation capacity as **High** but with low confidence in 2013 while acidification is **Bad.**
10449 – Whitespout Lane	Moderate (Ecological Moderate; Chemical Pass)	Diffuse Source Pollution - pH	pH status and acidification recorded as **Moderate** in 2013 with low and medium confidence respectively. Diffuse source pollution from forestry also contributes to the pH. Fish ecology, macro-invertebrates and hydrology (abstraction) also recorded as **Moderate** due to water collection, purification and distribution. This river is heavily modified.
10451 – Black Garpel	Moderate (Ecological Moderate; Chemical Pass)	Diffuse Source Pollution - pH	Status of pH and acid neutralising capacity recorded as **High** in 2013 with low confidence while acidification is **moderate** with medium confidence. The **moderate** status also relates to macro-invertebrates (acid).
10452 - Tunskeen Lane	Moderate (Ecological Moderate; Chemical Pass)	Diffuse Source Pollution - pH	Status of pH and acid neutralising capacity recorded as **High** in 2013 with low confidence while acidification is **moderate** with medium confidence. The **moderate** status seems to relate to macro-invertebrates (acid).
100317 – Loch Riecawr (reservoir)	Moderate (Ecological Poor; Chemical Pass)	Diffuse Source Pollution - acidification	This reservoir is heavily modified. Acid neutralising capacity and acidification in 2013 are of **High** status. **Moderate** status seems to relate to phosphorous (due to diffuse source pollution from forestry), abstraction & morphological alterations (at shore for water collection, purification and distribution) and water quality due to Fish barriers and morphological pressures have **Poor** status.
100320 – Loch Enoch	Good (Ecological	Diffuse Source Pollution -	Acid neutralising capacity and acidification in 2013 are of **High** status.

River or Loch with Non-Renewable Electricity Production Pressure	2013 Overall Status	Non-Renewable Electricity Pressure and Assessment Parameter	Comment
	Good; Chemical Pass)	acidification	

For East Ayrshire, the production of non-renewable electricity is predicted to present a risk of meeting the 2015 target status for three rivers (Garpel Burn, Pollcravie Burn and Gala Lane), all located in the southernmost area of the region.

There is no risk to the 2015 status target for East Ayrshire lochs, superficial groundwaters or bedrock groundwaters from the production of non-renewable electricity.

For East Ayrshire rivers, lochs, superficial groundwater and bedrock groundwater, the production of non-renewable electricity is not predicted to cause a deterioration in status before 2015, 2021 and 2027.

5.2.3 Impacts on water - Shallow and deep mining

Shallow coal mining is defined by the Coal Authority as '*lying at a depth of up to 10 x the thickness of coal seam extraction down to a maximum depth of 30 metres (30 metres is the height of a 10 storey building). This definition is typically extended to 50 metres in one or two areas where the coal is particularly thick.*' Deep (>200m below ground level) mining ended in 1988 in East Ayrshire with the closure of Barony mine, Auchinleck (BGS)**.**

Hence given the depth of operations, both shallow mining (which can be extracted by open cast methods) and deep mining have the potential to impact on the water environment. A distinction between open cast coal mining and other surface mining is that waste rock is immediately backfilled into the recently-worked void rather than being stored.

The geological processes responsible for pollutant release and attenuation have been presented in '*Assessing the impact of opencast coal mining on water quality (Groundwater Regulations 1998), prepared for SEPA by PL Younger and DJ Sapsford, March 2004*. These include the oxidation of coal-bearing strata and pyrite weathering, the role of iron-rich carbonate minerals and neutralisation reactions. The report considers that '*there is very little risk of List I substances being released from strata disturbed by opencast mining in Scotland'* and that *'the risk of occurrence of List II substances is more tangible'*. Substances deemed likely to leach from disturbed geological materials include zinc, nickel, fluorides, ammonia, iron, manganese, aluminium and sulphate.

Minewater Treatment

The Coal Authority notes in 'Understanding Mine Water Treatment' that:
'As coal mining in the UK has reduced, some arrangements to pump water out of the mines have stopped. This has allowed iron, found in the rocks within mine workings, to mix with underground water. As this mine water reaches the surface it comes into contact with the air and a chemical reaction takes place. The iron in the water changes state (from ferrous to ferric) which creates an acidic solution known as acid mine drainage.

*In the UK, many of the coalfields contain a significant amount of limestone which counterbalances much of this acidity, resulting in a typical neutral mine water. Small particles of iron (ferric hydroxide) then form in the solution, which drop out of the water to create what is known as ochre. It is this material that causes affected streams, rivers and other watercourses to appear a red / orange colour and could pollute water supplies.***'**

The Coal Authority had no responsibility for dealing with mine water pollution from abandoned coal mines when it was established in 1994. It soon became clear to government however, that the Coal Authority was the public body best equipped to deal with mine water. Working with the Environment Agency and the Scottish Environment Protection Agency, the Coal Authority formed a mine water remediation programme. Schemes to clean and protect the nation's water courses and sources of drinking water continue to be delivered by this programme.'

*'The success of the Coal Authority's coal mine water treatment programme has resulted in an extension of their powers, under the Energy Act 2011, to deal with pollution from metal mines.***'**

The Coal Authority has published a Code of Practice for Mine Water Treatment Schemes (2012) and notes that planning applications may be required, with or without a requirement for an Environmental Statement.

There are 12 operated minewater treatment schemes in Scotland, 1 of which is in East Ayrshire, listed by the Coal Authority and shown in the following table.

Table 12 – Mine Water treatment Scheme in East Ayrshire

Mine water scheme name	Location	Treatment Type
Kames	**Land adj. A70, near Kames Farm, Muirkirk, Cumnock, East Ayrshire**	**Passive Mine Water Treatment Schemes & Gravity Overflows**

Case study – Mine Water Treatment

The above table records one operated minewater treatment schemes in East Ayrshire, i.e. Kames, Cumnock. The Coal Authority Report taken from the National Archive on 06/05/2009 notes the following about the site and the treatment:

Case Study – Minewater Treatment in East Ayrshire
'*Site History -The receiving watercourse (Garpel Water/ River Ayr) has been impacted by mine water since the early 1970s and the current treatment scheme at Kames was constructed in 2000. There are two shafts, one is capped and has four pipes to allow outflow of water. The other is a former air shaft and has been backfilled. The capping and pipes were installed by the Coal Authority a year or so before the main treatment scheme was constructed.'*

'Water Chemistry - The minewater at Kames is net alkaline and is issuing from deep underground coal mine workings. Iron concentration is in the region of 12 milligrams per litre. The flow is up to 25 litres/second; the design specification for the flow at the site is 36 litres/second. The average inflow value for pH is 7.1.'
'Site Design - The required treatment scheme at Kames involves aeration and settlement, followed by surface flow aerobic wetland, with re-aeration between the in-series wetland cells.'

'The minewater flows from the capped shaft straight into a stepped aeration cascade. The water flows from this into two concrete settling tanks working in parallel. The water (still split) flows into the first of two sets of wetland cells in series. There are concrete weir/cascade structures in between the wetland cells. Straw bunds in the wetland cells encourage the water to flow around the system and utilise the full area of the cell. The cells are planted with Typha and Phragmites, however Reed Canary Grass initially smothered these, but the plants have shown signs of regeneration. A grassed bank separates the two parallel wetland systems.'

It is estimated that the cells will need to be cleaned annually. The parallel system along with sludge drying beds allows this to happen without disruption to the system **'**

5.2.4 Unconventional Gas – Particularly Hydraulic Fracturing

Potential water environment issues that have been highlighted are in relation to the quantities of water required for pumping to create the fractures, the chemicals included in the fracking fluid, the wastewater returned to the surface and surface activities.

Water Source
The volume of water required for fracking is approximately 800m^3/ fracture which can translate to approximately 9000m^3 to 43,000m^3/ well over a lifetime of possibly a decade. However this is in the order of the volume required to water a golf course for a month, run a 1000MW coal-fired power plant for 12 hours or lost in leaks in United Utilities region in the North West of England every hour (*Gas works? Shale gas and its policy implications, Policy Exchange, Moore (2012)*).

The availability (and sustainability) of such a source, quantitative impacts on the water environment (in respect of the groundwater resource and its importance in supplying surface waters and GWDTEs), and the logistics of supply (and transport) should be taken into consideration.

Quality of Water Added/ Injected

The typical composition of fracking fluid is 94.6% water with the secondary component sand constituting 5.23% and 0.17% other minor additives[13]. The sand acts as 'proppant' to keep the fractures open to allow gas flow. The additives have various uses including scale inhibitor to prevent build-up of scale on the well walls, acid to help initiate fractures, biocide to kill the production of corrosive H_2S, friction reducers and surfactants to reduce the fluid's viscosity.

Some of the additives are proprietary so that their composition is not widely available. However in the UK, legislation is in place to demand disclosure. FracFocus has published a list of 60 chemicals most commonly used in fracking in the USA[14]. In the UK, Cuadrilla have added polyacrylamide friction reducers (0.04%), hydrochloric acid (0.125%) or a biocide (0.005%)[15].

Quantity and Quality of Wastewater

Approximately 30% of the added water is recovered in the first 30 days of fracking with the remainder spread over the well lifetime. The quality of the initial water recovered is better than that during later operation as the latter is more concentrated and is saline with the returned chemicals, hydrocarbons, minerals and NORMs (naturally occurring radioactive materials**)**. The waste water will require appropriate storage and treatment in accordance with the Controlled Activities Regulations prior to discharge.

NORMS

The NORMs associated with the oil and gas industry are of the Uranium-238 and Thorium-232 decay series where in decay products flow with the oil, gas and water during the production process and accumulate in scale, sludge and scrapings. (Guidelines for the Management of Naturally Occurring Radioactive Material (NORM) in the Oil & Gas Industry, International Association of Oil & Gas Producers, Report No. 412, September 2008.

The UK Government have developed a Strategy for dealing with NORMs[16].

The SEA consultation document notes that: '*NORM wastes generated by off-shore oil and gas industry have been re-injected into the sea bed (solid and water-based wastes). Liquid waste containing contaminants which preclude off shore disposal (oil/ metals) must be sent for onshore treatment and disposal. This is largely conventional treatment, including removal of oil and radionuclides with disposal via the drainage system (in accordance with dilute and disperse). Most onshore solid NORM wastes are disposed to landfill as exempt radioactive waste. There is uncertainty over future quantities of NORM wastes due to potential decommissioning of off-shore installations and the potential development of on-shore gas/oil industries. Uncertainty in NORM waste management could result in insufficient capacity for efficient and effective storage, treatment and disposal of the waste.'*

'*The primary concern for water in relation to NORM management likely lies in the potential for inappropriate management of these wastes, and particularly in the potential risk of managing emerging liquid waste streams for both water and soil (e.g. contamination of surface and groundwater)*'. This includes '*the development of waste management facilities and potential spillage of liquid NORM waste'*.

[13] Shale gas extraction in the UK: a review of hydraulic fracturing, June 2012
[14] www.fracfocus.org/chemical-use/what-chemicals-are-used)
[15] Shale gas and fracking, House of Commons Standard Note SN/SC/6073, October 2014
[16] https://www.webarchive.org.uk/wayback/archive/20170110012420/http://www.gov.scot/Publications/2014/07/5552

Surface Activities
Potential impacts on the water environment can also arise from activities at the surface. These could include spills and leaks of fracking fluid, its individual components, fuel/ oil storage, diesel from HGVs, rest-rooms, disturbed soils during the construction of the aboveground site compound, from the wastewater treatment etc. There is potential for leakage from storage tanks or pipes required to ensure the treatment of the contaminated water. It is likely in some bigger fracking sites that the contaminated water is pumped to an above ground central location for treatment and will need to be disposed of off-site. Mitigation measures and guidance to minimise such impacts (including SEPA's Pollution Prevention Guidelines) are established.

Potential Contamination Issues related to the drilling of a fracking well
Potential issues relate to the variable aquifer vertical stratigraphy, concrete attack by acid groundwater, casing joints not sealed, poorly formed seals between casing and host rock and gas migration. These can be managed by the installation of good and appropriate well design and construction. Construction quality assurance is required.

It is in the Contractors' interest to maintain well integrity to prevent loss of gas and/or productivity and to prevent impacts on the water environment.

Impacts on Water Volume
The abstraction of water will only be allowed if the applicant can demonstrate there is sufficient capacity and an application would need to be made to SEPA for a Controlled Activities Regulation (CAR) Licence.

5.3 Existing Regulations and Guidance

Regulatory mechanisms are in place for safeguarding against most of the potential issues including those associated with Planning Applications and Environmental Impact Assessments. However it has been pointed out[17] that only the design of wells is regulated and that more regulation is recommended for the construction of the wells at a national level.

Existing Regulations and guidance include *inter alia*:

- The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended) in respect of water abstraction and discharges.
- Waste Management Regulations (with respect to storage, re-use and disposal of waste)
- Mining Waste Directive (2006/21/EC)
- Planning Advice Notes (e.g. PAN 50 Controlling the Environmental Effects of Surface Mineral Workings).
- Mineral Extraction: Code of Practice for the Owners and Operators of Quarries and other Extraction Sites, Scottish Government, June 2005.
- Petroleum Exploration and Development licences (PEDLs).
- SEPA's Pollution Prevention Guidelines and Guidance Notes.

[17] ICE seminar on 'UK Shale Gas: Frack on, frack off or frack well?' on 11.11.2014 by Prof. Zoe Shipton

5.4 Conclusions

Water pollution from historical minerals extraction will have had a detrimental impact on the water environment and the health of surface water and groundwater resources. Scotland has some of the most robust environmental legislation with respect to water quality and this has resulted in year on year improvements in water quality, with similar trends seen in East Ayrshire. There have been some challenges as a result of the demise of Scottish Coal and ATH Resources and the abandonment of some minerals sites in East Ayrshire and associated issues such as their respective abandoned voids filling with water. The Council continues to work closely with SEPA and land owners to address these issues. Current minerals sites are operated in accordance with relevant permits and Licences – and compliance monitoring is undertaken by planning monitoring officers on behalf of East Ayrshire Council. This should safeguard the water resource in accordance with the relevant legislation in the longer term.

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Flood Risk Management Strategies – Ayrshire and Solway	http://apps.sepa.org.uk/frmstrategies/ayrshire.html http://apps.sepa.org.uk/frmstrategies/solway.html	March 2019

GLOSSARY

Abstraction – the removal of that water, permanently or temporarily, from rivers, lakes, canals, reservoirs or from groundwater

Aquifer – a subsurface layer or layers of rock or other geological strata of sufficient porosity and permeability to allow either a significant flow of groundwater or the abstraction of significant quantities of groundwater.

Bedrock Aquifer - solid permeable formations e.g. sandstone, chalk and limestone

Catchment – area of land bounded by watersheds draining into a river, basin, or reservoir

Climate Change - world-wide, long term change in weather patterns and/or average temperatures of the planet caused by human activity

Controlled Activities Regulation (CAR) - The Water Environment (Controlled Activities) (Scotland) Regulations 2011 which are referred to as the Controlled Activity Regulations (CAR) apply regulatory controls over activities which may affect Scotland's water environment.

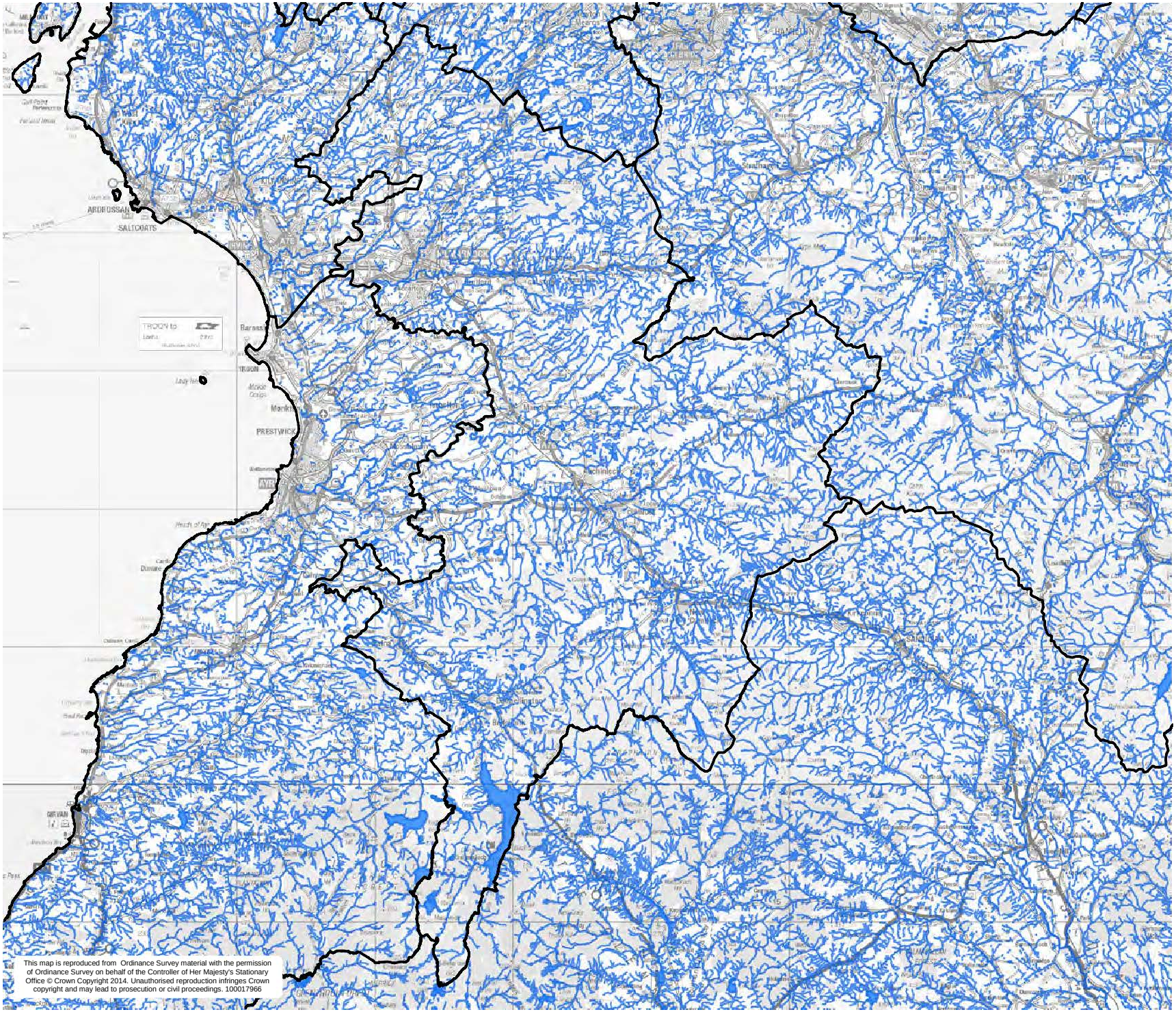
Groundwater – water which is below the surface of the ground in the saturated zone and in direct contact with the ground or subsoil.

Morphology – shape of a river channel

Scottish coal measures - a geological formation in midland valley of Scotland including Ayrshire coalfields which includes mudstone, siltstone and sandstone with common coal seams present at some levels)

Superficial Aquifer - permeable unconsolidated deposits e.g. sands and gravels.

Unconventional gas - The term unconventional gas refers to natural gas held in rocks that cannot be exploited using traditional methods. Shale and coal are source rocks for unconventional gas.



Legend

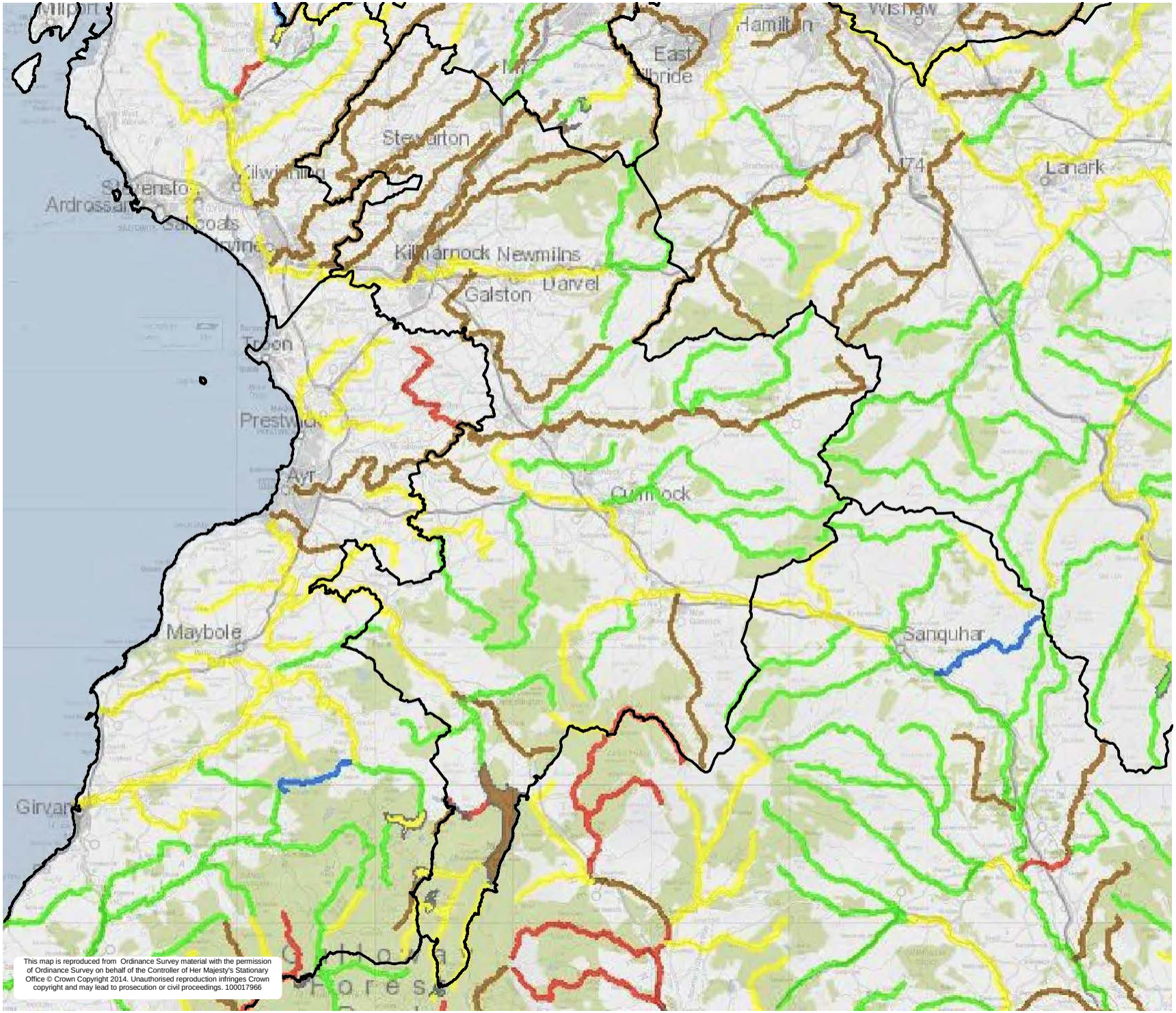
- Scottish Local Authority Boundaries
- Surface Water

0 2.25 4.5 9 Km

N

Figure 5.3

Surface Water Bodies



Legend

Scottish Local Authority Boundaries

Loch classification

- High Status / Potential
- Good Status / Potential
- Moderate Status / Potential
- Poor Status / Potential
- Bad Status / Potential

River classification

- High Status / Potential
- Good Status / Potential
- Moderate Status / Potential
- Poor Status / Potential
- Bad Status / Potential

0 2.5 5 10 Km

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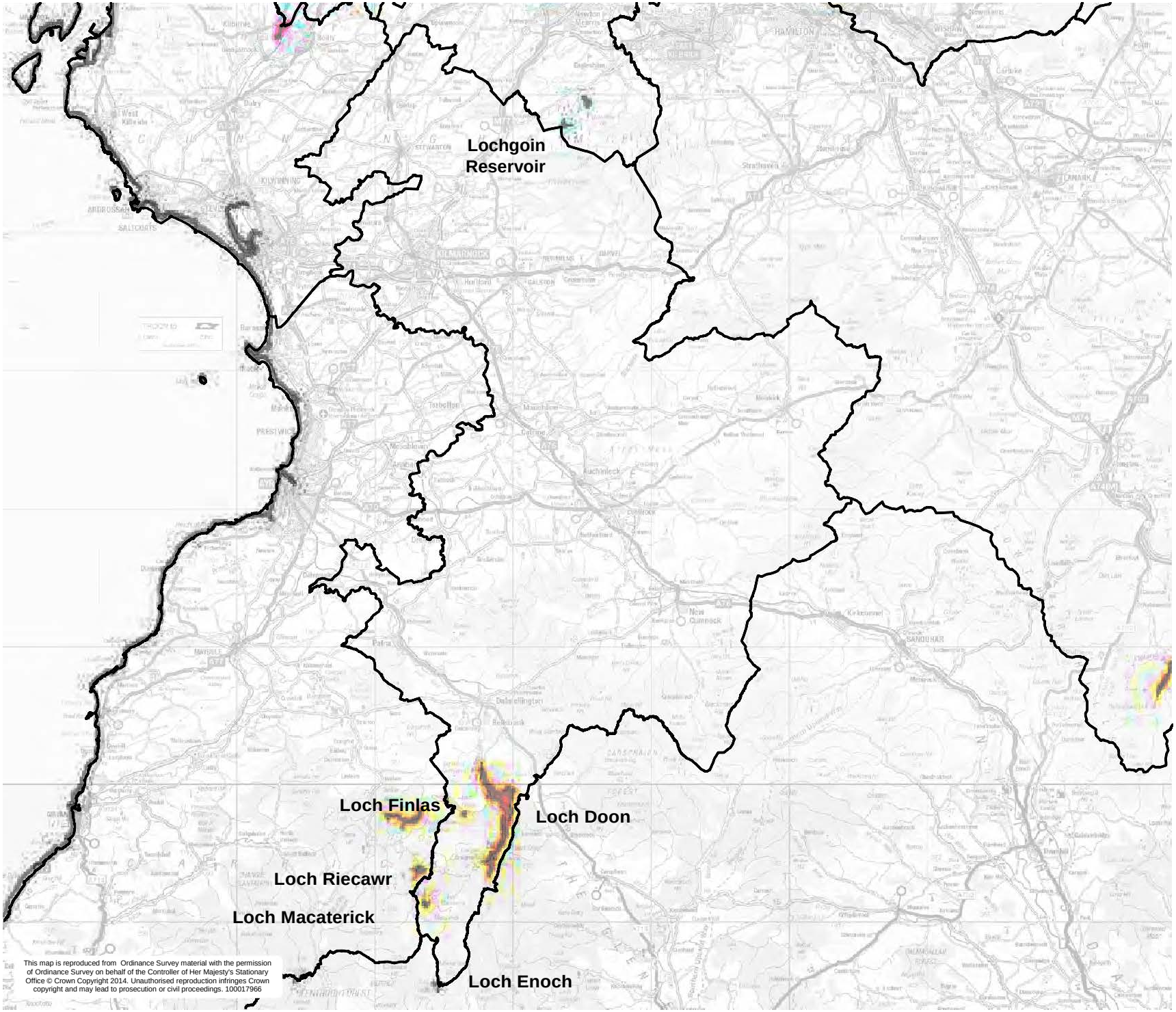
Figure 5.4

Rivers and Lochs 2012 Status



Legend

Scottish Local Authority Boundaries

0 2.25 4.5 9 Km

Figure 5.5

Surface Water Lakes

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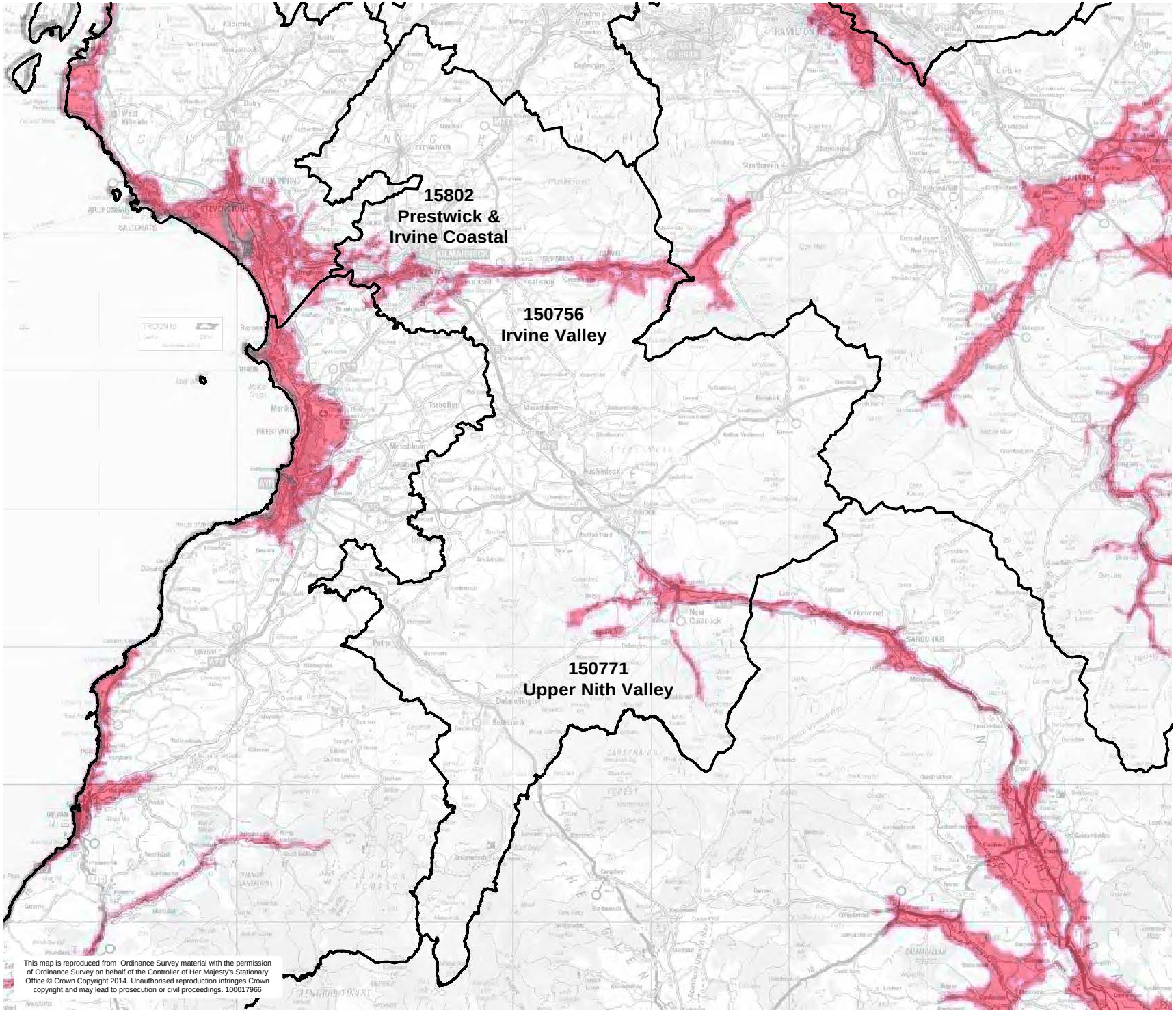

Legend

Scottish Local Authority Boundaries

0 2.25 4.5 9 Km

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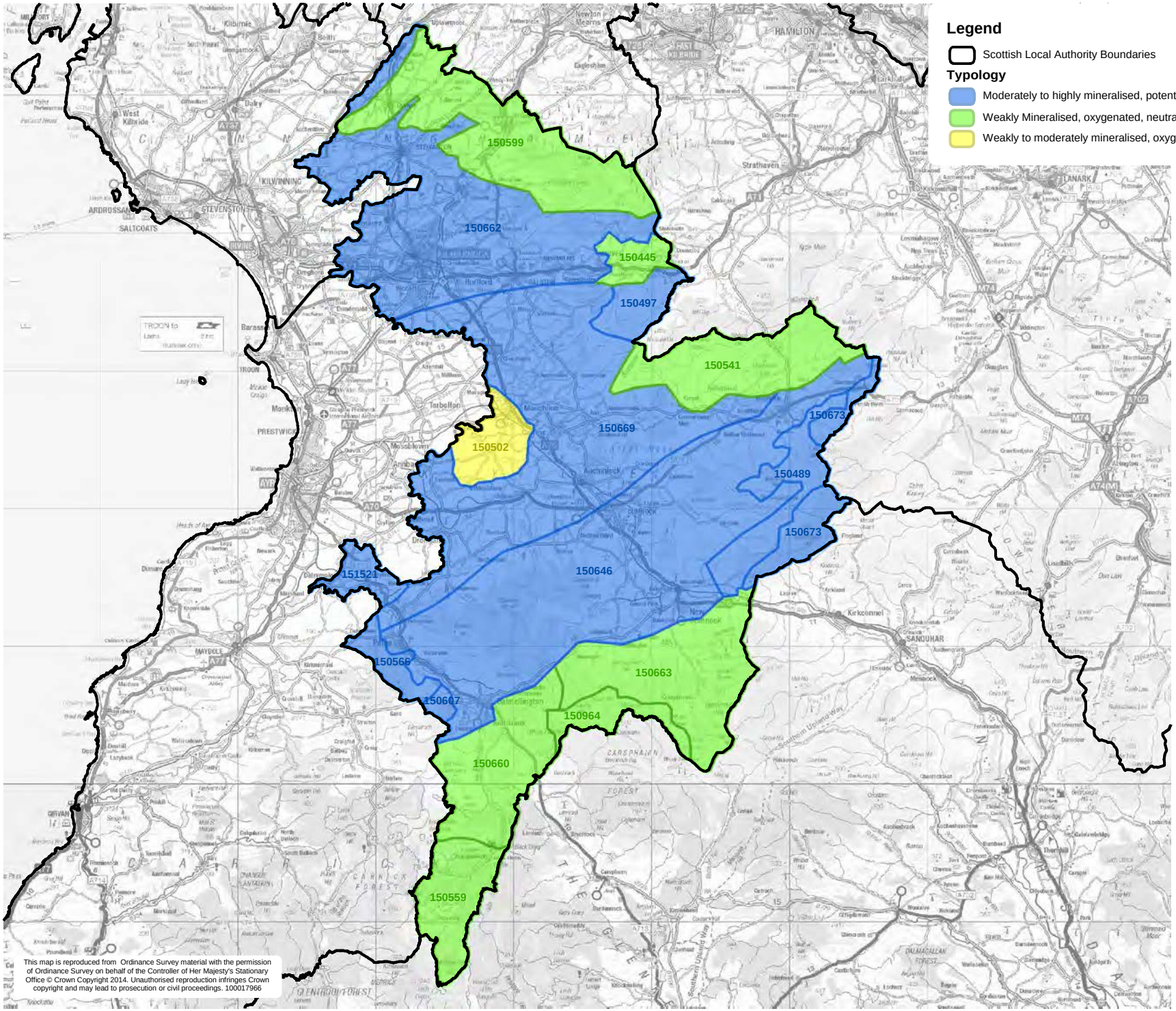
Figure 5.6

2012 Superficial Aquifer



Ref No.	Name	Area (Ha)
150559	Carrick Forrest	3900
150694	Galloway	1889
150660	South Ayrshire Hills	6790
150663	Upper Nithsdale	8762
150673	Lesmahagow	2910
150489	Wardlaw Hill	3767
150646	Cumnock	28363
150607	Girvan @ SW	368
150566	Crosshill @ SW	1366
151521	Darymple	1431
150502	Mauchline	2609
150669	Ayr	24812
150541	South Glen Gavel	6659
150497	Slouch Moss	1993
150445	Priestland	1464
150662	Kilmarnock	19218
150599	Whitelee	10731

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Figure 5.7

2012 Bedrock Aquifer Typologies

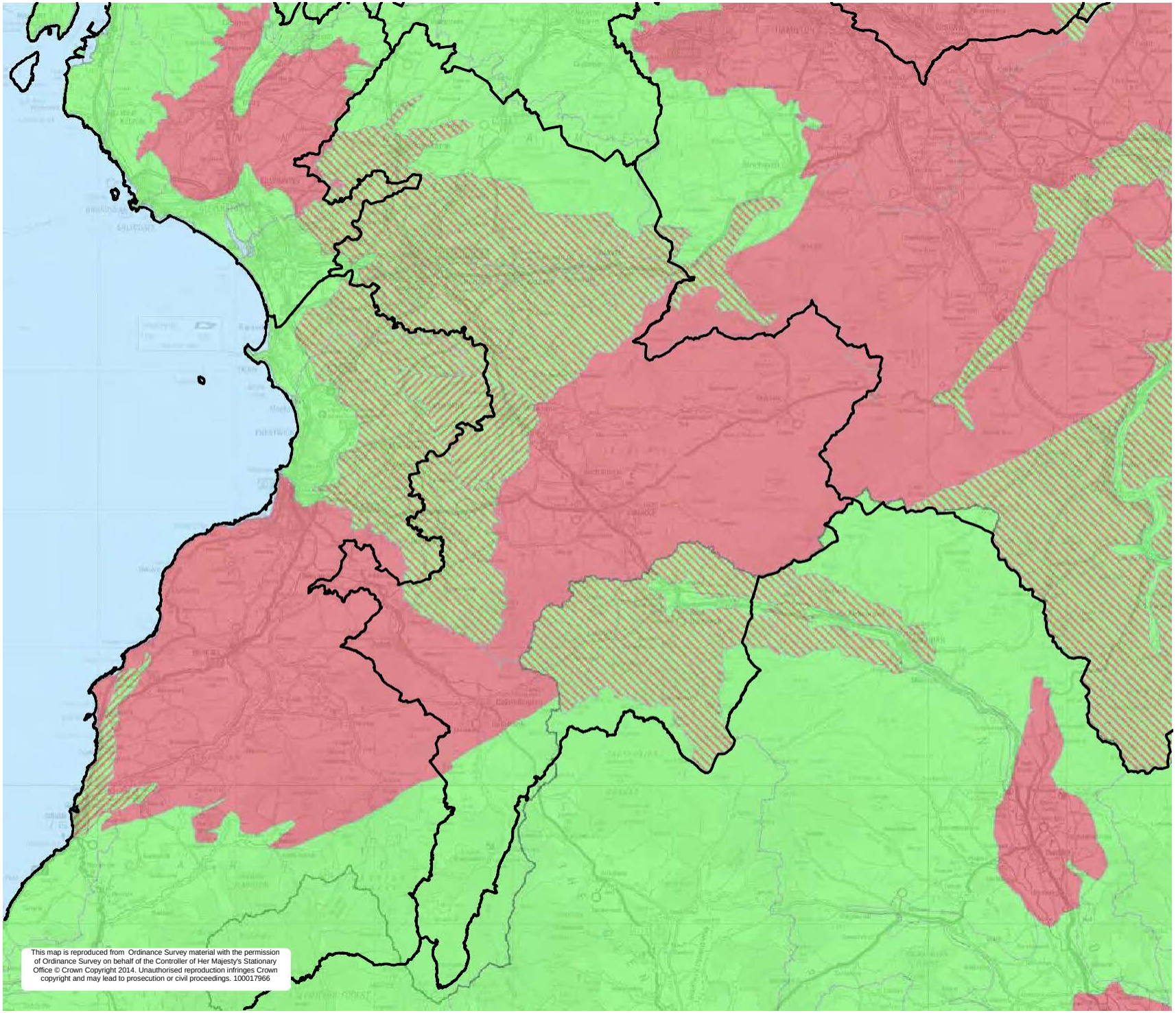

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Figure 5.8

2008 Groundwater Bodies Classification

East Ayrshire Council
Comhairle Shiorrachd Inbhir Àir an Ear

Planning & Economic Development
The Johnnie Walker Bond, 15 Strand Street
Kilmarnock, East Ayrshire KA1 1HU

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