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Local Authority Waters Programme

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Sheen Control Catchment

Desk Study

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Summary

The Sheen catchment is one of six catchments selected by the Waters of LIFE Project. The Waters of LIFE is an EU LIFE Integrated Project which aims to help reverse the deterioration of Ireland's most pristine waters. There are five **demonstration** catchments. The Sheen, was selected to act as a **control** catchment and a location for the trialling of soft protection measures, since is has mostly maintained high status.

The Sheen Control Catchment is based on subcatchment Sheen_SC_010, located in the Beara peninsula in Co.Kerry. It comprises four river waterbodies, Sheen_010, Coomeelan Stream_010, Sheen_020 and Sheen_030. The river flows in a northerly direction, veering southwest before it discharges to the transitional waters of the Kenmare River. The subcatchment covers a total area of 100.5km^2.

Of the four waterbodies in the control catchment, three are high status objective waterbodies (HSOWB): Sheen_010, Coomeelan Stream_010 and Sheen_020. Currently Coomeelan Stream_010 and Sheen_020 are meeting their Water Framework Directive (WFD) objectives of high ecological status and are *Not At Risk* of failing to achieve their WFD objective by 2027. Sheen_010 is currently at Good ecological status and its risk status is "review". Sheen_030 (not monitored under WFD) is at High ecological status (based on EPA modelling) and is *Not at Risk*.

Topography across the control catchment is mountain and river valley landscape. Bedrock is either outcropping on high exposed rocky peaks or close to the surface with shallow soil cover on slopes leading to the river valleys. Soil type is predominantly wet poorly draining peat, alluvium around the main river channel and some pockets of either poor or moderate to well-draining sandstone tills that are found in more peripheral areas. Subsoils are moderate to poorly draining acid mineral tills mainly, but well drained tills are present within the Sheen River valley on the mid slopes to the lower lying areas in all four waterbodies.

Over half of the land area in the Sheen Control Catchment is described as peat bog. Land use is mainly agriculture with forestry covering just under 10% of the total area. Residential rural settlement is of low density and scattered throughout with a larger concentration in Sheen_030 closer to the transitional and coastal shores of the Kenmare River and in close proximity to Kenmare town.

Potential pressures associated with agriculture in the control catchment could include sheep overgrazing, disposal of sheep dip, sediment losses to water where land has been drained, and the movement of phosphate in poor drained scenarios. However agricultural intensity in the control catchment is low and extensive with pollution potential mapping (PIP) showing only relatively few high risk critical source areas (CSA) for phosphate and nitrate. Potential nutrient impacts from agriculture are likely to be localised in the higher risk critical source areas close to the main Sheen river channel.

Pressures around forestry are associated with the legacy sites, those planted prior to Best Forest Practice and are a risk for sediment and nutrient run-off to water especially when planted in peat and on sloping lands, which is the case for much of the forestry here.

Hydromorphology, which has been identified as one of the significant pressures on High status objective waterbodies, is also a potential pressure in the control catchment. However, the River Hydromorphological Assessment Technique (RHAT) carried out for all three HSOWBs in Sheen_SC_010 in 2015, were found to be in the high-status class.

Sheen_010

This waterbody covers approx. 17.1km^2. It contains headwaters of the Sheen River, called the Baurearagh River, draining very steep slopes going up to a height of just over 600m OD. The river is therefore expected to be very fast in high flow conditions. A WFD operational monitoring point is located at the waterbody outlet, Releagh Br. 21S010100. Biological quality at this site had been continual high (Q4-5) until it deteriorated to Q4 in 2018. It improved again to High in 2019 but dropped to Q4 in 2020 and 2021. There is no WFD operational chemistry monitoring for this site, so the overall ecological status (currently Good) is driven by the biology. Hydromorphology (Bank erosion) is identified as being the likely pressure at this site (from WFD APP) but there is no further information available on this to date.

Agriculture enterprise in Sheen_010 are expected mainly to be sheep farming due to the nature of the terrain here although land improvement appears to have been carried out in places especially in peaty and poorly draining areas where cattle may also be kept. Forestry takes up approx. 19% of the total land area with much of it planted prior to best forest practice. Forestry is planted on peat and on steep slopes which increases the risk of sediment and nutrient loss to water during forestry operations.

Coomeelan Stream_010

The waterbody covers an area of approx. 24.5km^2 and contains headwaters of the Sheen River draining mountainous terrain up to a height of just over 700m OD. A WFD operational monitoring point located at the outlet of Coomeelan Stream_010 at Br. u/s of Sheen River confluence 21C140200 has consistently been at High biological status and drives the High ecological status for the waterbody. There is no WFD operational chemistry monitoring site for this waterbody. As for Sheen_010, sheep farming is likely to be the main agricultural enterprise here. Forestry coverage is very low accounting for 1.5% coverage of the total area of the sub basin. However, the location of legacy forestry close to and at the WFD operational monitoring point could potentially impact status when forestry activities are carried out.

Sheen_020

This waterbody makes up the mid-section of the Sheen Control Catchment with an area of 36.2km2. It is the largest of the waterbodies in the control catchment. It contains some of the Sheen's headwaters coming from the Esk River in the southwest and receives tributaries of the Feabunaun, Glassagarriv and Glashanaglaragh streams. The WFD operational monitoring point at the outlet at Dromanassig Br 21S010600 is at High biological status, driving the High ecological status for Sheen_020. Biological monitoring results fluctuated between Q4-5 and Q4 between 1997 and 2006, indicating a pressure impacting on water quality during that period. However, it has remained at High biological status (Q4-5) since 2009. There is no WFD chemistry monitoring site in Sheen_020. As this site is the most downstream point of all the high-status objective waterbodies, any cumulative pressures upstream have the potential to significantly impact at this point.

As for the two upstream waterbodies, agricultural intensity in Sheen_020 is low although there are some higher risk CSAs for phosphate and nitrate located in this waterbody particularly in the lower valley areas close to the main Sheen River. Forestry coverage is about 10% of the total sub basin area..

Sheen_030

This waterbody is downstream of the three HSOWBs and is approx. 22.7km^2 in size. It too has a Glassagarriv Stream which rises in the Killaha and Barraduff mountains in the west. The waterbody is not monitored under WFD but preWFD biology monitoring site at 1.1km u/s of Sheen Br 21S010700 shows the last Q value recorded in 2003 as Q4. The WFD app shows that status in Sheen_030 was unassigned up to 2013-2018 when EPA assigned Good status based on grouping. Status for 2016-2021 is High, based on EPA modelling. Land use is similar to that in the upstream sub basins although there are some higher risk CSAs for both phosphate and nitrate in the lower lying valley of the Sheen River. Forestry covers 11% of its overall land area.

While Sheen_010 has recently experienced a deterioration in status, for the most part the Sheen Control Catchment is not currently considered to be under threat of significant impacts. The desk study attempts to highlight potential pressures associated with land use in the HSOWBs, for the Waters of LIFE project. Future impacts are potentially most likely from forestry activities in legacy sites and from agricultural practices if they change, such as intensification or through land improvement or development by reclamation.

The desk study proposes monitoring for both biology and chemistry, and assessments of hydromorphological and habitat quality to establish a baseline and further characterise and understand the control catchment.

1 Introduction

1.1 Background to Catchment

The Waters of LIFE is an EU LIFE Integrated Project (IP) which aims to help reverse the deterioration of Ireland's most pristine waters. The Project will operate in five demonstration catchments nationally to test measures for the protection and restoration of High Status in Blue Dot rivers. The five demonstration catchments were selected from WFD subcatchments defined by the EPA. The selection process considered a number of criteria, including number and extent of significant pressures, status history and Q value amongst others. The project also includes one control catchment (the Sheen), which was selected on the basis that some of its waterbodies consistently demonstrated High Status in the past and, at the time of selection, were *Not at Risk* of failing to meet their WFD objectives. See Demonstration Catchment Selection Report for further information on the catchment selection process.

The Sheen Control Catchment is based on subcatchment Sheen_SC_010, located in the Beara peninsula in Co. Kerry. It comprises four river waterbodies, Sheen_010, Coomeelan Stream_010, Sheen_020 and Sheen_030. The subcatchment covers a total area of 100.5km2.

Of the four waterbodies in the control catchment, three are high status objective: Sheen_010, Coomeelan Stream_010 and Sheen_020. Currently Coomeelan Stream_010 and Sheen_020 are meeting their High status objective and are *Not At Risk*. Sheen_010 is currently at Good ecological status and risk is at *Review*. Sheen_030 (not monitored under WFD) is at High ecological status (based on EPA modelling) and *Not at Risk*.

1.2 Summary Information

A schematic layout of the Sheen Control Catchment, showing current WFD status and risk, is provided in **Figure 1**. **Figure 2** shows location of the catchment, waterbodies within, WFD monitoring locations and the latest ecological status. Summary information on WFD risk, objectives, ecological status, known pressures and associated significance for the waterbodies in the catchment is presented in **Table** 1.

This is further summarised in the 'Receptor information and assessment' section.

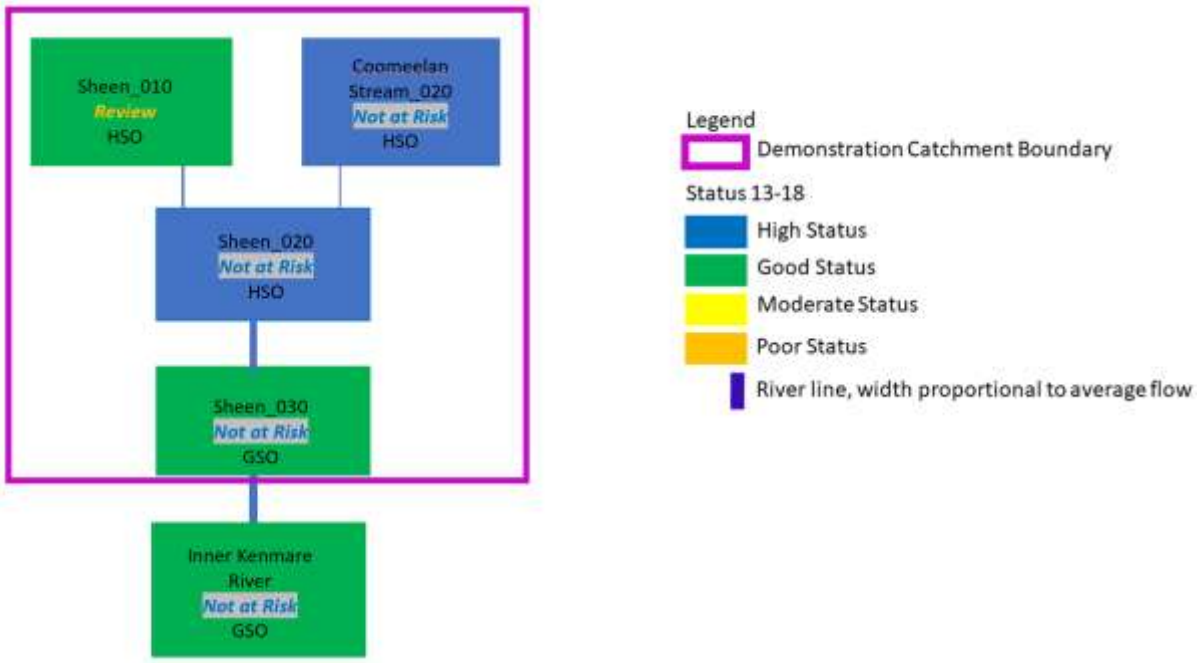


Figure 1 Schematic drawing of the control catchment.
2013-2018 ecological status is represented by the box colour

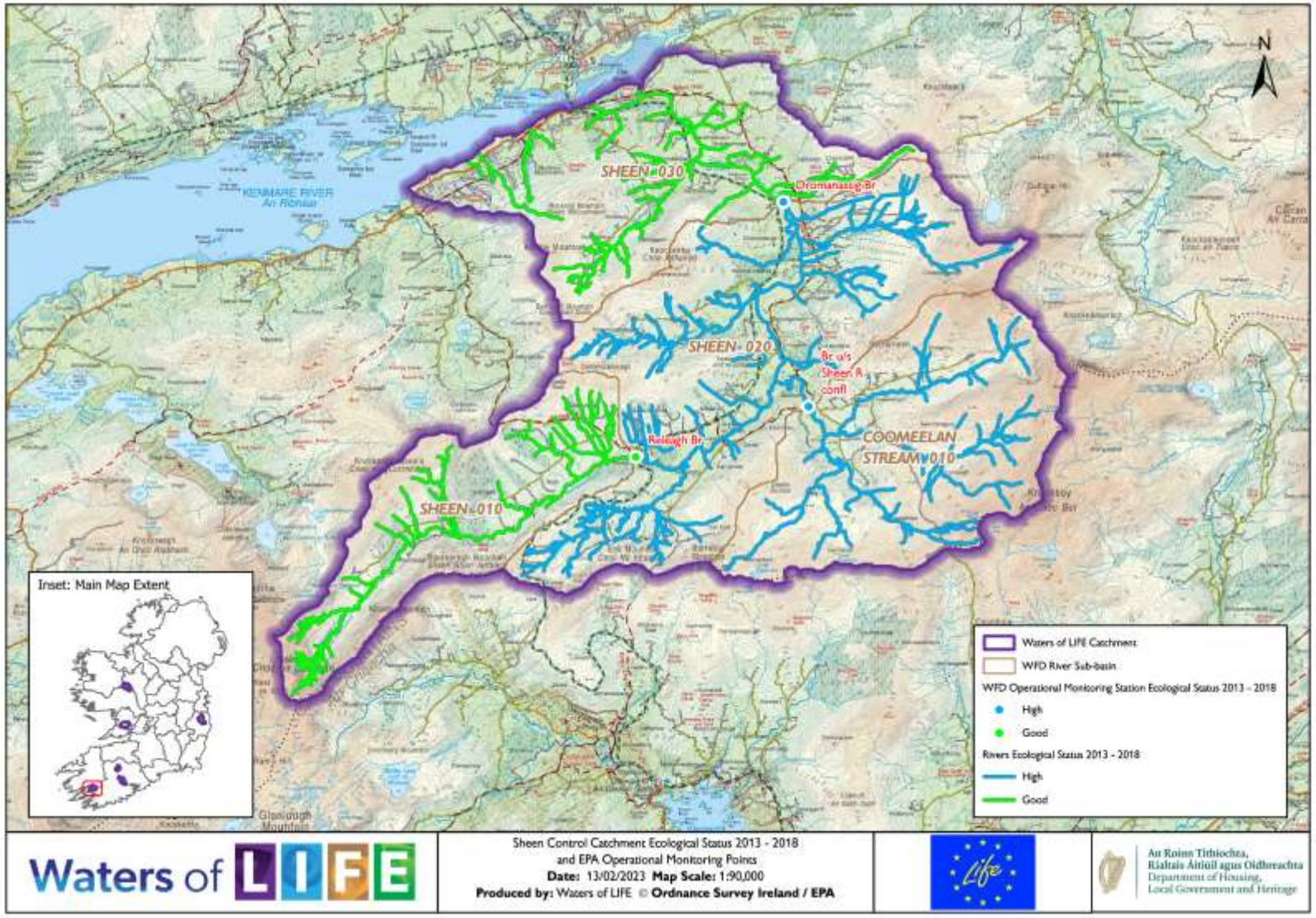


Figure 2: Map of the Sheen catchment showing current ecological status (2013-2018), WFD monitoring points and most recent biological status results

Table 1 Summary table of individual waterbodies within the Sheen Control Catchment

Waterbody Code	Waterbody Name	Risk (3rd cycle)	WFD Obj.	Ecological Status			Pressures		
				2010 - 2012	2010 - 2015	2013 - 2018	Category	Sub-category	Sig? (Y/N)
SW21S010100	Sheen_010	**Review*	High	High	High	Good	Hydro-morphology	River Bank Erosion	Y
SW21S010600	Sheen_020	*Not at Risk*	High	High	High	High	None listed		
SW21C140200	Coomeelan Stream_010	*Not at Risk*	High	High	High	High	None listed		
SW21S010700	Sheen_030	*Not at Risk*	Good	Unassigned	Unassigned	Good, based on grouping for 2013-2018.	None listed		

2 Receptor information & assessment

2.1 Context and Setting

The Waters of LIFE is an EU LIFE Integrated Project (IP) which aims to help reverse the deterioration of Ireland's most pristine waters. The Project will operate in six demonstration catchments nationally to test measures for the protection and restoration of High Status in Blue Dot rivers.

Demonstration catchments were selected from subcatchments identified by the EPA using a variety of criteria such as, size, pressures present among others (see: Demonstration Catchment Selection Report for more information on the selection process). The Sheen, which had consistently maintained High ecological status, was selected to act as a control catchment and a location for the trialling of soft protection measures.

The Sheen Control Catchment is based on subcatchment Sheen_SC_010, located in the Beara peninsula in Co. Kerry. It comprises four river waterbodies, Sheen_010, Coomeelan Stream_010, Sheen_020 and Sheen_030. The catchment covers a total area of 100.5km2.

Of the four waterbodies in the control catchment, three are High status objective: Sheen_010, Coomeelan Stream_010 and Sheen_020. For the 2013-2018 reporting period, Coomeelan Stream_010 and Sheen_020 are meeting their High status objective and are *Not At Risk*. Sheen_010 is at Good ecological status and risk is at *Review*. Sheen_030 (not monitored under WFD) is at High ecological status (based on EPA modelling) and *Not at Risk*.

Topography across the control catchment is mountain and river valley landscape. Bedrock is either outcropping on high exposed rocky peaks or close to the surface with shallow soil cover on slopes leading to into the river valleys. Soil type across the control catchment is predominantly wet poorly draining peat, alluvium around the main river channel and some pockets of either poor or moderate to well-draining sandstone tills that are found in more peripheral areas. Subsoils are moderate to poorly draining acid mineral tills mainly, but well drained tills are present within the Sheen River valley on the mid slopes to the lower lying areas in all four waterbodies.

Over half of the land area in the Sheen Control Catchment is described as peat bog. Land use is mainly agriculture with forestry covering just under 10% of the total area. Residential rural settlement is of low density and scattered throughout with a larger concentration in Sheen_030 closer to the transitional and coastal shores of the Kenmare River and in close proximity to Kenmare town.

2.2 WFD Information

Water quality information has been reviewed and summary information on ecological status, biological conditions, and nutrient chemistry for the Sheen catchment river waterbodies are provided in Table 2 and 3.

Table 2 Summary of Q-values and physico-chemical data for the control catchment

		Figures Tables	Sheen_010 (Baurearagh River)	Coomeelan Stream_010	Sheen_020	Sheen_030
Risk Category		**Figure 1**Figure 1	*Review*	*Not at Risk*	*Not at Risk*	*Not at Risk*
Waterbody Monitoring Point			**Releagh Br**	**Br. u/s Sheen River confluence**	**Dromanassig Br**	**1.1km u/s Sheen Br**
Station Type		**Figure 2**	Operational	Operational	Operational	preWFD
Biological Status	**2013-2015**	**Table 3**	High (Q4-5)	High (Q4-5)	High (Q4-5)	Unassigned
	2016-2018		Good (Q4)	High (Q4-5)	High (Q4-5)	Unassigned
	2019-2020		Good (Q4-5 in 2019, Q4 in 2020)	High (Q4-5)	High (Q4-5)	Unassigned
	trends in Q values	**Figure 3 to 5**	Deteriorating trend; fluctuating between Q4-5 and Q4 since 2018, had been consistently Q4-5 from 1994 to 2015 (Q5 in 2003)	Stable site, consistently at Q4-5 since 1994 when monitoring started	Stable site at Q4-5 since 2009, but had fluctuated between Q4-5 and Q4 previous to that 1994-2006	Good status as extrapolated by EPA in 2021 (Derreendarragh_010 used)
	2016-2018 Q value data					
	Fish status (where rel)					
Hydrochemistry Data			**No**	**No**	**No**	**No**
Ortho-P (mg/l P)	**Baseline**		No data	No data	No data	No data
	indicative quality					
	Trends - significant?					
	Dist to threshold					
NH4-N (mg/l N)	**Baseline**		No data	No data	No data	No data
	indicative quality					
	Trends - significant?					
	Dist to threshold					
TON (mg/l N)	**Baseline**		No data	No data	No data	No data
	indicative quality					
	Trends - significant?					
	Dist to threshold					

	Figures Tables	Sheen_010 (Baurearagh River)	Coomeelan Stream_010	Sheen_020	Sheen_030
Supporting Conditions • **Chemical conditions** • **Oxygenation Conditions** • **Acidification Conditions**		No data	No data	No data	No data
Hydromorphology					
RHAT score **Evidence of Arterial drainage**	**Table 4**	0.906 None No OPW or LA DD	0.953 None No OPW or LA DD	0.984 None No OPW or LA DD	n/a None No OPW or LA DD
Ecological Status (2013–2018) **Elements driving status**	**Figure 2**	Good Invertebrate Status	High n/a	High n/a	Good (extrapolated) n/a
Protected Areas	**Fig A6-1**	• Caha Mountains SAC 000093 • Maulagowna Bog SAC 001881	• Derryclogher (Knockboy) Bog SAC	• DW abstraction at Bunane – private supply, PE 450	• Borders Kenmare River SAC 002158 • Doughill Bog NHA 001948 • d/s receptor at Outer Kenmare River (coastal wb) Designated Shellfish Area
WFD Objective		High	High	High	Good
EPA biologist notes (if any)					
Other info					Abstraction point for hydroelectric
Significant or potentially significant issue/impact for receptor		Hydromorphology (bank erosion)	n/a	n/a	n/a

Biological Monitoring Results

Table 3 Biological quality record for waterbodies in Sheen Control Catchment

	Sheen_SC_010 Sub-Catchment				Q Values											
	Station Name	Code	Waterbody	Type	1987	1994	1997	2000	2003	2006	2009	2012	2015	2018	2019	2020
Headwaters	Releagh Br	RS21S010100	Sheen_010	Operational	4	4-5	4-5	4-5	5	4-5	4-5	4-5	4-5	4	4-5	4
	Br u/s Sheen River conflu	RS21C140200	Coomeelan Stream_010	Operational		4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5		4-5
Mid-section	Bunane Br	RS21S010200	Sheen_020	preWFD	4											
	Dromagorteen Br	RS21S010300	Sheen_020	preWFD												
	Ford u/s Dromagorteen Br	RS21S010400	Sheen_020	preWFD	4	4-5	4-5	4-5	4-5							
	Dromanassig Br	RS21S010600	Sheen_020	Operational	4-5	4-5	4	4	4-5	4	4-5	4-5	4-5	4-5		4-5
Lower	1.1km u/s Sheen Br	RS21S010700	Sheen_030	preWFD		4	4	4	4							
	Sheen Br	RS21S010800	Sheen_030	preWFD	4											

Source: EPA Qvalue data

No data available

Sheen_010

This waterbody holds headwaters of the Sheen River situated in the southwest of the control catchment. The river here is called the Baurearagh river, rising in the Caha Mountains and flowing northeast into Sheen_020.

The WFD objective for Sheen_010 is High ecological status. Sheen_010 is not meeting its objective as it is currently at Good ecological status. The risk category for Sheen_010 is *Review* for the third cycle, having been updated from *Not at Risk* during the second cycle.

'Releagh Br' operational monitoring station (21S010100) is located at the outlet of Sheen_010 (refer to map Fig 2). **Figure 3** below shows the biological monitoring record for Releagh Br. The site saw a drop to Q4 in 2018 while prior to that, results had been consistently stable at Q4-5 since 1994 (Q5 in 2003). The site improved back to Q4-5 in 2019 but subsequently deteriorated again to Q4 in 2020.

Source EPA data

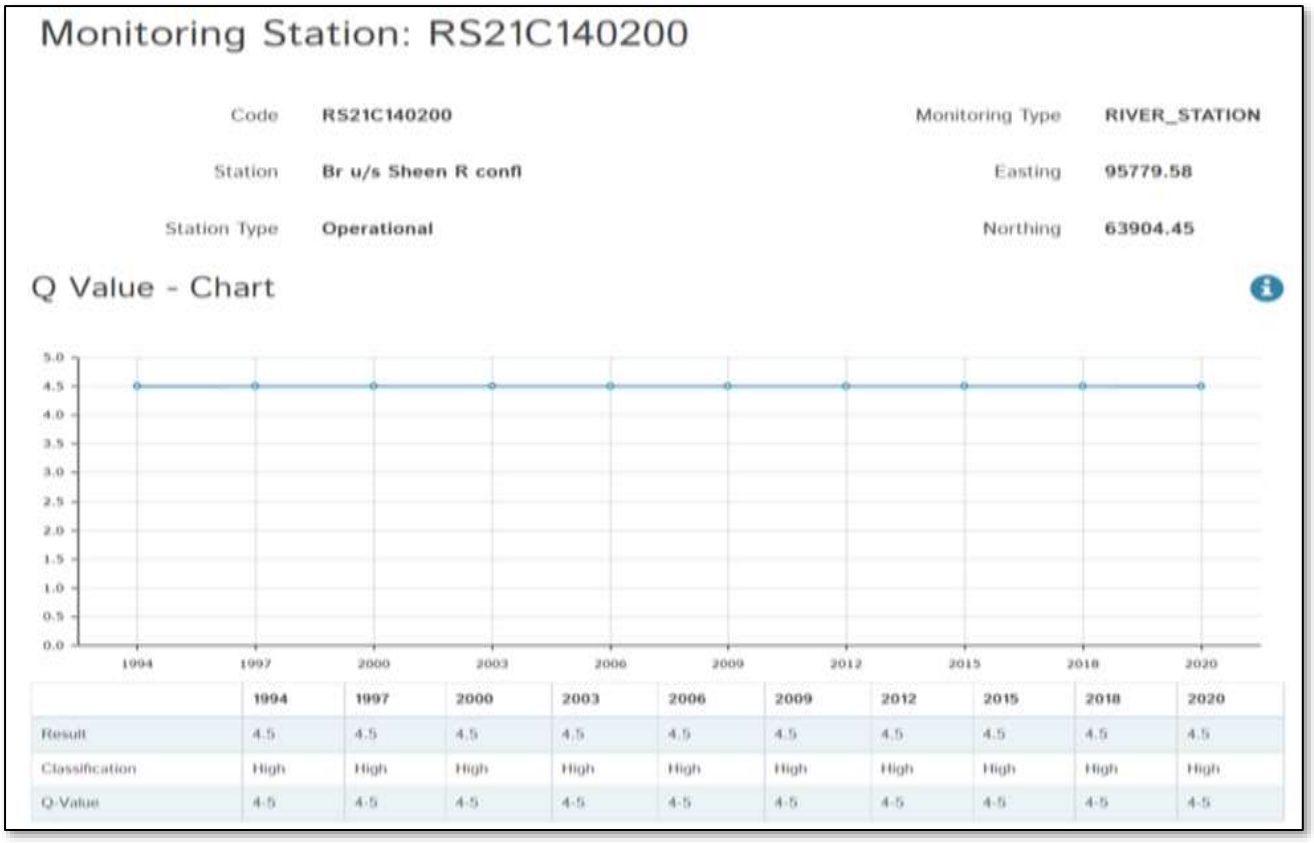
Figure 3: Biological monitoring at Releagh Br., outlet of Sheen_010

Coomeelan Stream_010

The Coomeelan Stream rises in the Knockboy and Barraboy Mountains in the south and southeast of the control catchment. These headwaters flow in a northwest direction into Sheen_020.

Coomeelan Stream_010 is meeting its WFD objective of High ecological status and therefore is *Not at Risk* for the third cycle.

Operational monitoring station 'Br. u/s Sheen River confluence' 21C140200 is situated at the outlet of Coomeelan Stream_010 (refer to Fig 2 above). The biological status for this site is High at Q4-5 and has consistently remained stable at Q4-5 since records began in 1994, refer to **Figure 4** below.



	1994	1997	2000	2003	2006	2009	2012	2015	2018	2020
Result	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5
Classification	High	High	High	High	High	High	High	High	High	High
Q-Value	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5

Source EPA data

Figure 4: Biological monitoring data at Br. u/s Sheen River confluence, outlet of Coomeelan Stream_010

Sheen_020

The Sheen River flows generally in a northerly direction through Sheen_020. This is the mid-section of the river and subcatchment. Sheen_020 takes in tributary streams of the Esk, Feabunaun and Glashanaglaragh.

Sheen_020 is meeting its WFD objective of High ecological status and is *Not at Risk* for the third cycle.

An operational monitoring station at 'Dromanassig Br' 21S010600 at the outlet of Sheen_020 is currently at High biological quality at Q4-5 (2020). The biological record for this site shows that there have been deteriorations in the past with the Q value dropping to Q4 at times during the period between 1997 to 2006. However, the site has remained consistently stable at Q4-5 since 2009 to the present as can be seen in **Figure 5**.

There are three pre-WFD monitoring sites in Sheen_020, refer to Table 4. There are no recent biological data for any of these sites. The most recent data for 'Ford d/s of Dromagorteen Br' 21S010400 is Q4-5 (2003).

Monitoring Station: RS21S010600

Code	RS21S010600	Monitoring Type	RIVER_STATION
Station	Dromanassig Br	Easting	95281.71
Station Type	Operational	Northing	67962.84

Q Value - Chart

	1987	1994	1997	2000	2003	2006	2009	2012	2015	2018	2020
Result	4.5	4.5	4	4	4.5	4	4.5	4.5	4.5	4.5	4.5
Classification	High	High	Good	Good	High	Good	High	High	High	High	High
Q-Value	4-5	4-5	4	4	4-5	4	4-5	4-5	4-5	4-5	4-5

Source: EPA data
Figure 5: Biological monitoring data at Dromanassig Br., outlet of Sheen_020

Sheen_030

This waterbody is not monitored under WFD. . Two pre-WFD sites are located in the north of Sheen_030 near the outlet to the transitional waters of Kenmare River. They are '1.1km u/s of Sheen Br.' 21S010700 and 'Sheen Br.' 21S010800. There are no recent Q data available for either site. The most recent Q value for 1.1km u/s of Sheen Br was Q4 in 2006. See Table 4 for data at this site covering the years 1994 to 2003. Refer to **Figure 2** for site locations.

The WFD objective for Sheen_030 is Good. Status was unassigned until the EPA assigned Good status here (assessment technique, grouping) for the 2013-2018 period.

Hydrochemistry

- There are no operational chemistry monitoring sites in the control catchment.
- There are recent data available however for one site at the outlet of Sheen_010 at Releagh Br. 21S010100, carried out in 2021 across five sampling occasions. Some of these data are summarised in Appendix 2, Table A2-1.
- Kerry County Council has supplied monitoring data for the period 2000-2002, for four sites from each of the waterbodies in the Sheen_SC_010 subcatchment. A summary of these data is included in Appendix 2, Tables A2-2 to A2-5. The location of these sites is shown on the map in Appendix I.

To note, these data were taken into consideration by the EPA in determining the WFD risk category for Sheen_030 during the 2nd cycle.

- The more recent chemistry monitoring data for Releagh Br. in Sheen_010 (2021) is useful as there has been a recent deterioration in the biological quality at this site, dropping from Q4-5 to Q4 in 2018 and currently at Q4 (2020 and 2021). While the 2021 data are limited to 5 samples, it shows that mean values for nutrients were generally below their high status EQS. Comparing this to the older data from 2000 – 2002 for Releagh Br, shows no significant change in mean annual values at this site between the two periods. However, data are too limited for nutrient issues (perhaps intermittent) to be ruled out.

- The 2000-2002 data, particularly for the sites in the High-status objective waterbodies indicate that at that time annual mean nutrient and other parameters would have met their respective high status EQS values. However, again while the data are limited, some spikes were observed that occurred more notably in Sheen_020 at site Dromagorteen Br 21S010350 with a BOD spike of 2.1 mg/l (March 2001) and MRP of 0.048 mg/l (June 2001). These suggest a nearby organic pollution source and/or a diffuse nutrient run-off pressure. It is interesting to note that biological quality dropped at Dromanassig Br. located at the outlet of Sheen_020 (approx. 4km d/s of the chemistry site) going from Q4-5 to Q4 in monitoring years 1997 and 2000 before improving again to Q4-5 in 2003.

- Annual mean values for MRP in Sheen_030 for the period 2000 – 2002 were all well below the good status EQS (in fact well below high status EQS of 0.025mg/l-P) although a low-level spike in June 2001 of 0.037mg/l exceeded the mean EQS, a significant increase compared to other MRP results for this site. This high result is most likely a reflection of the high MRP result on the same sampling occasion for the upstream site at Dromagorteen Br. in Sheen_020, discussed above.

- Total phosphorus (TP) results are available for Sheen_010, Sheen_020 and Sheen_030 for 2000 and 2001 only. These data are included in Table A2-6, Appendix 2. While there is no EQS for total phosphorus in rivers, levels can indicate a sediment issue as particulate phosphorus. Taking 0.025mg/l TP EQS (good status) used for lakes as an indicator in this case, data shows levels increased in June 2001 with much higher levels in the latter part of 2001 (Aug and Nov) for all waterbodies. The headwaters waterbody of Sheen_010 saw increased TP up to 0.063 and 0.055 for respective months, reaching 0.142mg/l in November 2001 at Dromanassig Br in Sheen_020.

- Considering the spikes and elevated levels of certain parameters such as MRP, TP and BOD in June 2001, this suggests that the Sheen River was impacted by one or more pressures at that time, which affected biological quality in High-Status Objective waterbody (HSOWB) Sheen_020. The source of the pressure is not known but may have originated from upstream in the contributing catchment. As the upper Sheen river drains mountainous terrain, the river is very fast flowing and likely to be highly flashy at times, so pressure impacts from the headwaters may have been transported to the mid and lower sections of the control catchment i.e. Sheen_020 and Sheen_030.

- Mean alkalinity values for all waterbodies in the subcatchment are generally low at <10mg/l (indicator level used by EPA for acid sensitivity along with pH <5.5units), indicative of poor buffering capacity. As stated above the data are limited but of all 32 results for alkalinity 81% are <10mg/l $CaCO_3$.

    - Both Sheen_010 and Coomeelan Stream_010 (containing headwaters) have average alkalinity values of 7mg/l $CaCO_3$ with a range of between 2 – 12mg/l.
    - Sheen_020 (mid-section) similarly has an average alkalinity of 8mg/l $CaCO_3$ with a range of 3 – 13mg/l.
    - Sheen_030 (lower section) is up slightly to an average of 9mg/l $CaCO_3$ with a range of 3 – 13mg/l.
    - The pH range across all waterbodies is mid-scale at 6.1 – 7.8.

  Low alkalinity is relevant especially for the high-status objective waterbodies in understanding the potential for catchment acidity and the potential risk of impacts associated with acidification particularly to invertebrates and other aquatic elements. It shows that if the pH were to drop there is very little buffering capacity to negate its potential effects.

- Another parameter highlighted in the data which should be considered, particularly with the potential for acid sensitive conditions, is copper that was recorded at 15ug/l at Releagh Br in Sheen_010 in 2021. There is a prescribed copper limit under the Codified Fresh Water Fish Directive/Salmonid Regulations where a limit value of 5ug/l Cu applies where hardness is <10mg/l CaCO3 (as is this case see Table A2-1 in Appendix 1). There are only 5 results for copper, the rest are below the limit value. A high copper level in acidified conditions could create toxicity to aquatic biological elements.

2.2.3 Hydromorphology

RHAT

River Hydromorphological Assessment Technique (RHAT) surveys were undertaken for the three high status objective waterbodies in Sheen_SC_010 subcatchment in July 2015, see Table 4.

Table 4 RHAT scores for Sheen Control Catchment High Status Objective waterbodies

Waterbody Name	Station Name	Station Code	RHAT Score	RHAT Class
Sheen_010	Releagh Br.	21S010100	0.906	High
Coomeelan Stream_010	Br. u/s Sheen river confluence	21C140200	0.953	High
Sheen_020	Dromanassig Br.	21S010600	0.984	High

MQI

MQI data for the catchment show that channels are in either high or good class. One small stretch is moderate, located upstream of Releagh Br in Sheen_010. See **Figure 6** below.

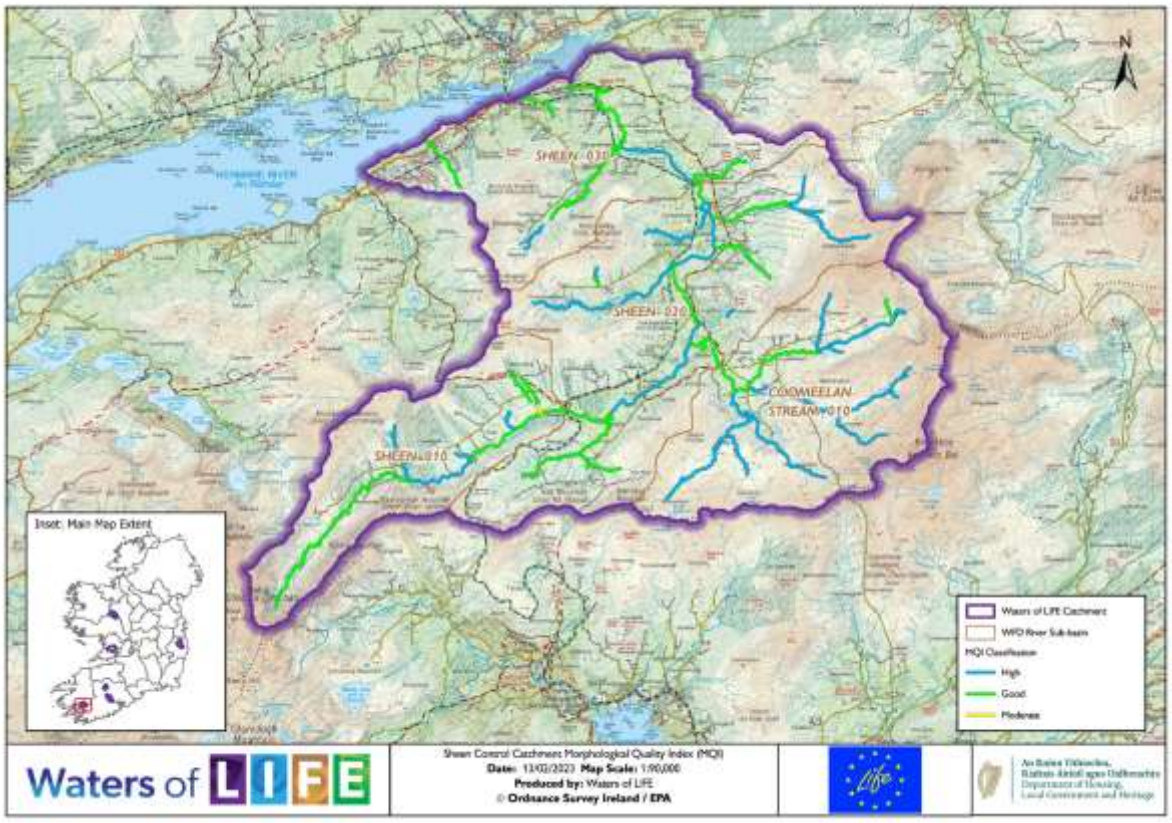


Figure 6: MQI map for Sheen control catchment

Natural Sediment Accumulation

The substrate zoning for risk of natural sediment accumulation for the control catchment is shown in **Figure 7** below. The high to extensive areas are associated with peat and variable areas are mixed substrate/tills. However, the assessed risk of natural sediment accumulation in channels in the catchment all fall into the low category and confined to some smaller tributary streams (see **Figure 8**) mainly in Coomeelan Stream_010 and Sheen_020.

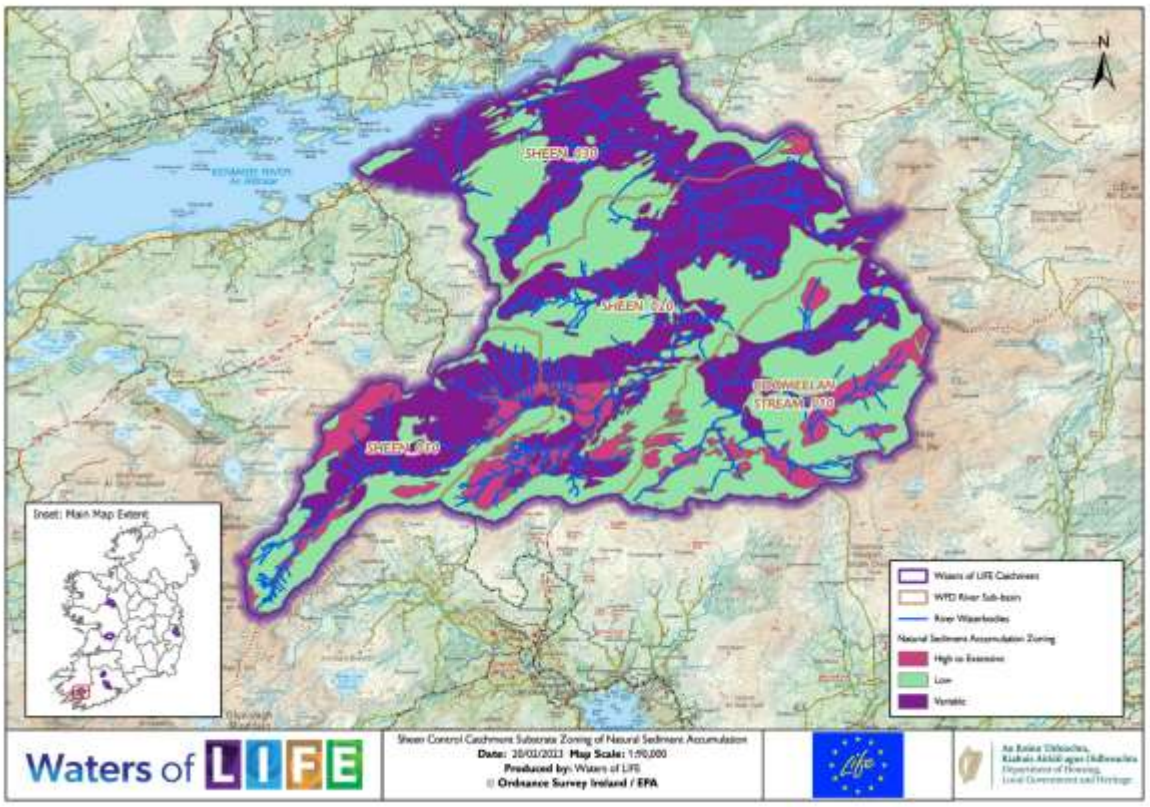


Figure 7: Substrate zoning of natural sediment accumulation

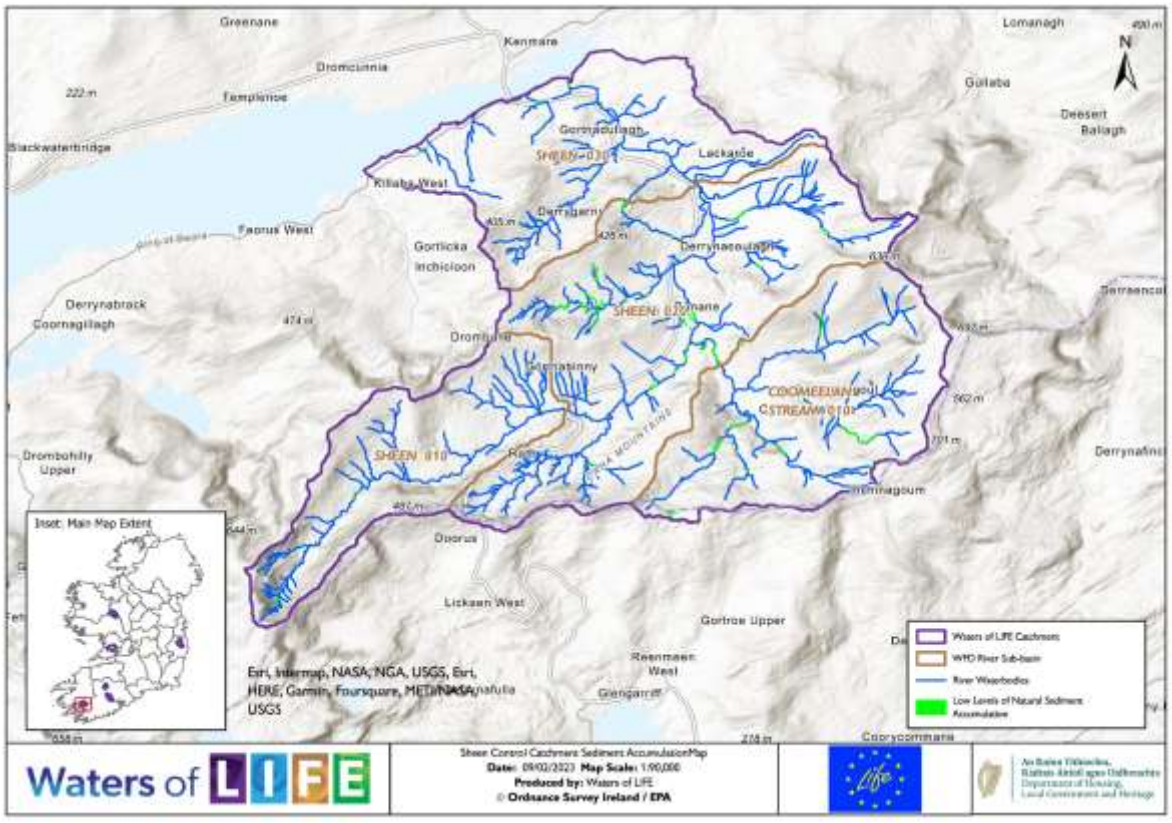


Figure 8: Natural sediment accumulation risk, Sheen control catchment

3 Significant pressure information

3.1 Initial Characterisation

A summary of the pressures identified during the WFD initial characterisation process is shown in Table 5. During EPA characterisation for the 2nd cycle of the River Basin Management Plan, the three High status waterbodies Sheen_010, Coomeelan Stream_010 and Sheen_020 were all at High status and all *Not at Risk* of not achieving their WFD objective. No pressures were assigned against them. For the 3rd cycle, the EPA have identified Hydromorphology in their Pressures assessment for Sheen_010. This waterbody dropped in ecological status from High (2010 – 2015) to Good (2015 – 2018) based on the biological quality element. Risk is currently at *review*.

Table 5 Pressures identified by EPA initial characterisation in the Sheen control catchment

WB Code	WB name	Pressure category	Pressure subcategory	Significant pressure (Y/N)	Pressure & Impact details	Further characterisation (desk study/ LCA)	
						2nd cycle pressure Sign.?	New 3rd cycle Pressure
IE_SW_21S010100	Sheen_010	Hydro-morphology	River bank erosion	Y	Altered habitats due to morphological changes	No	Y
IE_SW_21C140200	Coomeelan Stream_010	No Pressure Impacts data available					
IE_SW_21S010600	Sheen_020	No Pressure Impacts data available					
IE_SW_21S010700	Sheen_030	No Pressure Impacts data available					

3.2 Catchment Setting and Land Use

The following is a review of potential/future pressures across the control catchment, particularly for the three high status objective waterbodies.

Sheen Control Catchment Setting

The topography of the Sheen Control Catchment is that of mountains and valleys. The outer boundary of the catchment is very steep throughout reaching heights of 608m OD in the southwest at the Caha Mountains and 706m OD in the southeast at Knockboy. These mountains are part of the Caha and Sheehy Mountain ranges that are situated at the start of the Beara Peninsula. Headwaters of the Sheen River in Sheen_010 and Coomeelan Stream_010 both exit their respective waterbodies at a height of 100m OD with the main river valley in Sheen_020 lying at a height of approx. 40-50m OD.

This makes for a fast-flowing river with waterfalls and cascades featuring. The valley widens out in Sheen_030 where the river flows at 30m – 10m OD before meeting the transitional waters of Kenmare River.

To a fairly large extent rock is either at or close to the surface over much of the control catchment particularly on the mountain peaks and their upper slopes. Otherwise, soil type is predominantly wet poorly draining soils of peat and poorly draining sandstone derived till subsoils. Moderate to well drained loams and tills are found particularly in the mid and lower sections of the catchment on lower slopes and within the Sheen River valley. Alluvium soils are present in the mid and lower sections bordering both sides of the main channel and appear to be poor draining (see Figures A3-1 and A3-2, Appendix 3). Subsoils are either peat or till with variable drainage capabilities and generally appear to be quite shallow as groundwater vulnerability is nearly entirely at the upper end of the scale, i.e. 'X' and 'E' and 'H'. The alluvium soils found bordering the main river channel as in Sheen_020 and Sheen_030 display a moderate groundwater vulnerability an indicator of their poor drainage but also possibly their greater depth (see Figures A3-3 and A3-9, Appendix 3).

To date, the Blue Dot programme has found that the main significant pressures impacting high status waterbodies in Ireland are agriculture, hydromorphology and forestry (source: LAWPRO Blue Dot Programme). These pressure categories are most relevant in the Sheen Control Catchment and are discussed below.

Land-use in Sheen Control Catchment

The Sheen catchment covers an area of 100.5km^2. Main land type/use is shown in Figure 9 below which is based on the Corine 2018 dataset. A breakdown of area (km^2) and % land type/use is set out in **Table 6** and shows that over half the land area within the catchment is peat bog and just over a quarter is used principally in agriculture with significant areas of natural vegetation.

Land used principally for agriculture in the Corine 2018 map indicates approx. 25.94km^2 or 26% and natural grassland 2.03km^2 or 2%. Agricultural data show a larger extent of lands for agriculture including upland peat bog areas and while an exact land area is not derived it would appear that agriculture is of low intensity and extensive, with sheep and bovine as the main enterprises. This is displayed in **Figure 10** overlying the Corine 2018 map. Pollution Potential Impact (PIP) maps for phosphate show relatively small areas of the higher ranks (1-2) in the mid and lower sections of the Sheen Control Catchment in Sheen_020 and Sheen_030. There are some areas of rank 3 in the headwaters of Sheen_010 and the southwest of Sheen_020. (PIP information is discussed further below and in Section 4. PIP maps can be found in Appendix 3).

Corrine 2018 data indicate that forestry covers approx. 6.8km^2 or 6.7% of the control catchment area with 4.3km^2 or 5.5% land coverage within the HSO WBs. The Forest Service dataset shows possibly a better reflection with a higher land area as forested at 9.6km^2 or 9.5% of the overall control catchment with 7.1km^2 or 9.2% forestry coverage in the HSO WBs. Figure**Figure 11**: Lands forested in the Sheen Control Catchment maps the areas under forestry in the control catchment and **Table 7** sets out the areas forested across the catchment and within each waterbody (HSOWBs are highlighted).

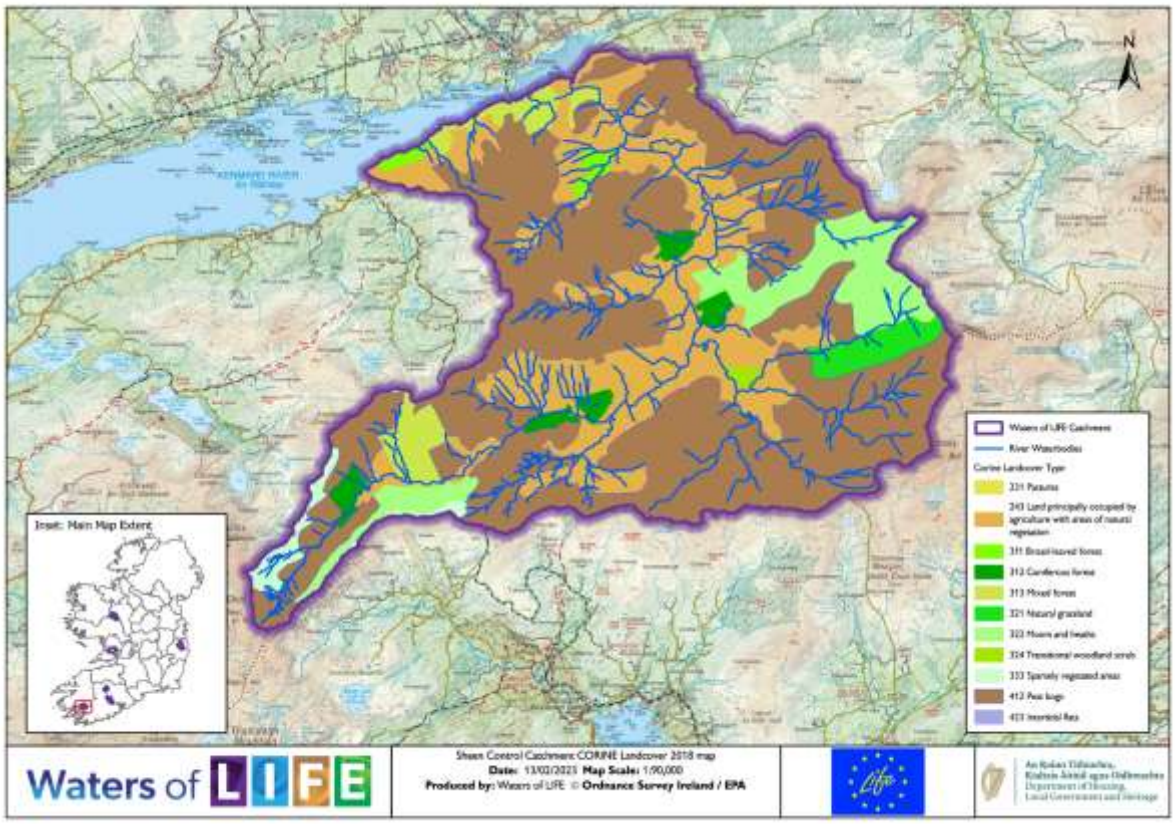


Figure 9: Land type and use in Sheen Control Catchment (from Corine 2018 data)

Table 6: Land type and use in Sheen Control Catchment (from Corine 2018 data)

	Sub-catchment Sheen_SC_010		High Status Objective WBs		Sheen_010		Coomeelan Stream_010		Sheen_020		Sheen_030	
	km²	%	km2	%	km²	%	km²	%	km²	%	km²	%
TOTAL land area	100.5		77.8		17.1		24.5		36.2		22.7	
Coniferous	2.12	2	2.12	3	0.83	**5**			1.29	4		
Mixed forest	3.58	4	1.92	2	1.92	**11**					1.67	7
Broad-leaves	0.76	1									0.76	3
Transitional woodland	0.31	0.3	0.27	0.3			0.27	1			0.04	0.2
Land principally occupied by agriculture with sig area of nat veg	25.94	**26**	18.09	**23**	2.81	**16**	2.51	10	12.77	**35**	7.8	**34**
Natural grassland	2.03	2	2.04	3			2.04	8				
Peat bogs	55.93	**56**	43.49	**56**	8.36	**49**	17.35	**71**	17.78	**49**	12.37	**55**
Moors and heathland	8.1	8	8.1	10	1.61	9	2.28	9	4.21	12		
Sparsley veg areas	1.68	2	1.68	2	1.57	9			0.11	0.3		

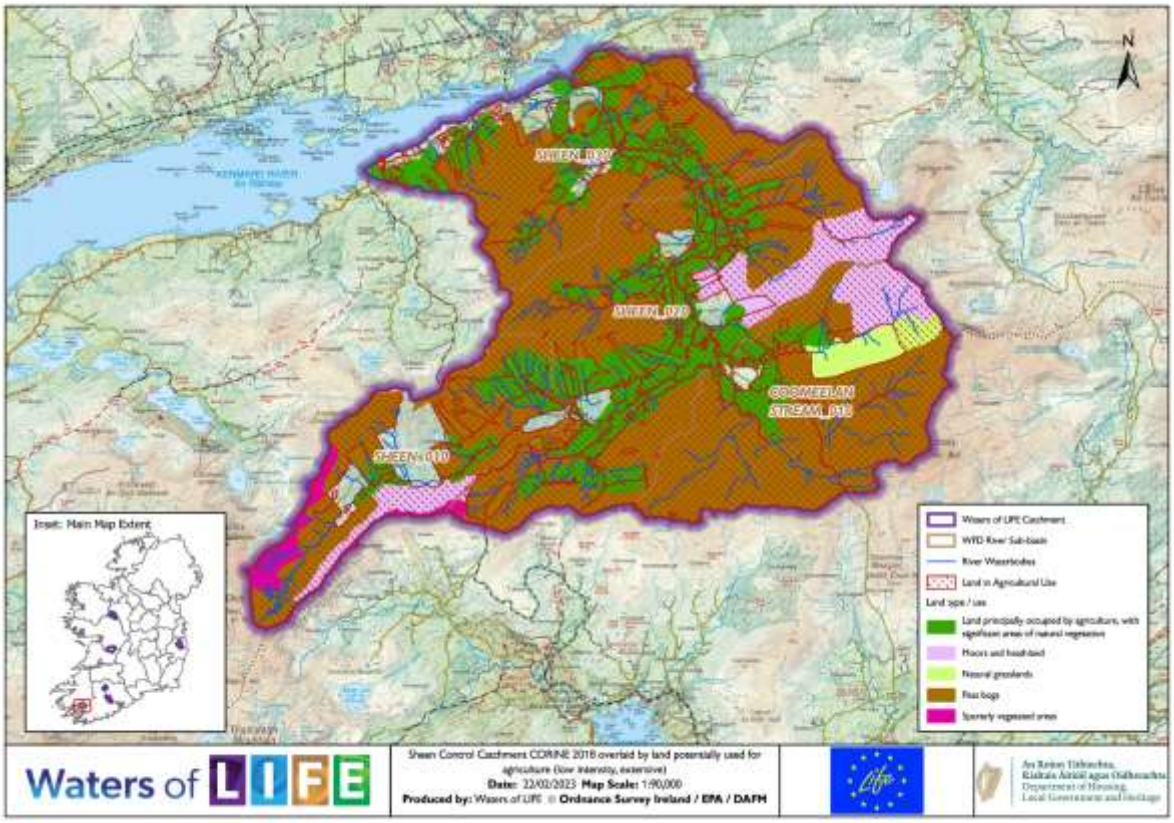


Figure 10: Corine 2018 overlaid by land potentially used for agriculture (low intensity, extensive)

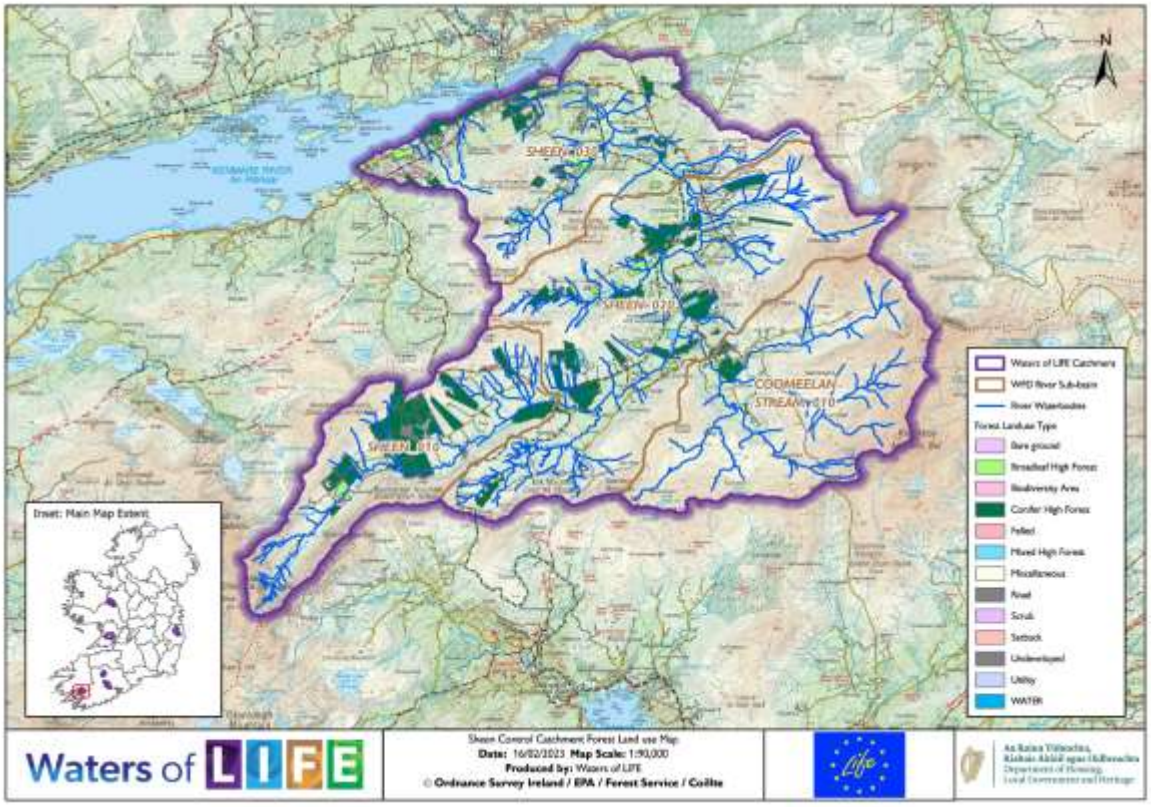


Figure 11: Lands forested in the Sheen Control Catchment

Table 7 Forested lands in Sheen Control Catchment

	Sub-catchment Sheen_SC_010		High Status Objective WBs		Sheen_010		Coomeelan Stream_010		Sheen_020		Sheen_030	
	km²	%	km2	%	km²	%	km²	%	km²	%	km²	%
Total land area	100.5		77.8		17.1		24.5		36.2		22.7	
Area in forestry/%coverage of total land area	9.59	9.5	7.14	9.2	3.33	19	0.37	1.5	3.44	10	2.45	11
%coverage of total forested area in HSOWBs						46.6		5.18		48.2		

3.3 Potential Significant Pressures in the Sheen Control Catchment

3.4 Agriculture

As described above, soil cover in the Sheen catchment is mainly peat with some areas of till in the east in Coomeelan Stream_010 and Sheen_020. Till subsoils extend across a somewhat large area throughout the control catchment with varying drainage characteristics some are moderately to poorly drained while others are well draining. These are found along the valleys of the Sheen River

and its tributaries. In Sheen_010 agricultural land has been developed in areas with well drained and poorly drained subsoils. In the poorly draining soils and subsoils setting, including river alluvium soils, dominant nutrient pathways are via overland flow and through open drainage channels favouring the movement of phosphate and ammonium. The susceptibility map shows this, where most of the control catchment has a high-risk potential for phosphate pathways to surface waters being at rank 2 and 3 (refer to Figure A3-10, Appendix 3).

Drainage characteristics of the till soils/subsoils is varied with well-draining subsoils situated closer to the main Sheen channel along the river valley in Sheen_020 and Sheen_030 (Figure A3-1 and A3-4, Appendix 3). In this case the susceptibility map for nitrate movement via near surface pathways to surface waters (Figure A3-11, Appendix 3) shows a high-risk potential with ranks 1 to 3. In the HSOWBs rank 1 is found in the upper part of Sheen_020 and the lower Coomeelan Stream.

Both susceptibility maps show the locations of the high risk areas close to the main Sheen River channel and the WFD monitoring points which are located at each waterbody outlet for Sheen_010, Coomeelan Stream_010 and Sheen_020.

Agricultural intensity appears to be quite low in the HSO WBs as shown by the PIP maps in Appendix 3, Figures A3-5 to A3-8.

- The critical source areas (CSAs) for phosphate pathways to surface water in poorly draining soils/subsoils are few, located mainly in the lower section of Sheen_010, the headwaters of the Esk Stream in Sheen_020 and the lower section of Sheen_020. The highest risk ranks of 1 and 2 are found in the lower section of Sheen_020 close to its outlet.
- The CSA for nitrate via near surface pathways to surface water in the well-drained areas are located mostly throughout the Sheen_020 waterbody and also in Coomeelan Stream_010 close to the outlet. The highest and only risk rank here is 3.

CSAs for both phosphate and nitrate for Sheen_030 are included in the aforementioned figures in Appendix 3. Again, agriculture is low intensity here with similar distribution of few areas with high risk potential. It is unlikely that nutrient issues are arising from these potential critical source areas because biological monitoring records for the three HSOWBs have been indicative of High status for a long period of time (aside from the recent decline in Sheen_010). However, if agriculture were to intensify, especially on lands close to the river channel and its main tributaries, this could result in increased nutrient losses to the river. Chemistry sampling would be of benefit to develop an understanding of baseline conditions in each of the High status objective river waterbodies in the control catchment.

The most likely significant issues that could potentially impact water quality in the control catchment in the future are nutrients (particularly phosphate), sediment and sheep dip. Sediment sources associated with agricultural practices could arise as a result of over-grazing when the green cover is stripped, exposing soils to a higher degree of erosion, causing sediment loss to waters. Sediment is also lost from natural bank erosion, stream and river channel works (straightening, deepening, etc),

land drainage and land reclamation. Further monitoring for sediment is important to identify any current issues. Sheep dip is a chemical used in the treatment for ectoparasites in sheep. If disposed of incorrectly/illegally to streams and rivers, it is highly toxic to aquatic invertebrates, fish and other aquatic life. It is usually made up of organophosphates and cypermethrin.

There is potential for agricultural point sources, e.g. from farm yards, direct discharges, etc. to impact on water quality. This can cause organic and nutrient pollution with elevated BOD, ammonium and ortho-phosphate in receiving waters.

To note, the Sheen River would typically be fast flowing as the upper section/headwaters of the control catchment (i.e. Sheen_010, southern part of Sheen_020 and Coomeelan Stream_010) drains mountainous topography which could possibly send any potential nutrient and sediment issues further downstream to Sheen_020 which lies across a more moderate slope.

3.5 Forestry

As stated above and referring to **Table 7** and **Figure 11**: Lands forested in the Sheen Control Catchment forestry covers 9.59km^2 or 9.5% of the total land area in the control catchment (100.5km^2).

Of the HSO WBs which account for 77.8km^2 of the total catchment area, 7.1km^2 of that land area is forested (9.2%). Of the lands under forestry, most of it is situated in Sheen_010 and Sheen_020 both with similar coverage at 47% and 48% respectively. Coomeelan Stream_010 has the least coverage at 5.2%.

Distribution of forestry in the HSOWBs appears to be mainly on the lower level slopes and lower ground within the Sheen valley in Sheen_020 except for where it is situated in the steeper upland areas in the headwaters of the tributary streams of Esk and Feabunaun. In Sheen_010, forestry is situated mainly on higher upland levels including at >300m in places on very steep slopes. Present forestry standards for the west of Ireland do not allow afforestation over 300m OD. Forestry in Coomeelan Stream_010 is on lower, less steep ground at the outlet of the waterbody.

Forestry development within the HSOWBs dates back to the late 1960's in Sheen_010 but most forestry appears to have been planted subsequently from the late 1980's/early 1990's to mid-2000's across all HSOWBs. There is recent afforestation approval for Sheen_010 and Coomeelan Stream_010. There has been no recent afforestation in Sheen_020.

Pressures associated with forestry relate more to legacy forestry stands planted prior to best practice. These stands can be planted up to the edge of streams and rivers with their drainage regime directly connected to those watercourses, making forest management activities high risk for sediment and nutrient run-off to waters. Mitigation measures to abate potential impacts can be difficult to implement because space is often unavailable and retrofitting drainage flow pathways from these sites is not easily achievable. The risk of impact is increased where the legacy stands are on peat, a highly erodible material that does not hold phosphorus resulting in very high risk of sedimentation

and nutrients entering the receiving waters during clear-fell, thinning, re-establishment and forest road development (associated drainage). Sloping sites increase the difficulty in controlling surface water run-off in these scenarios. High intensity rainfall events greatly increase the potential for high levels of sediment and nutrient run-off from clear-felled sites (including the period post clearfell while soils remain bare). Brash (tree debris, twigs, bark, needles etc), if not managed on site appropriately, can accumulate in drains and streams. When this material breaks down, it can release nutrients to waters.

Forestry pressures can have a greater impact on High status sites, reducing or wiping out sensitive taxa, with considerable time required for recovery.

Current forest standards apply to sites post clear-fell where surface water management and forestry layout (including appropriate setbacks etc) mean that receiving waters benefit from best forestry practice so future impacts should be much reduced.

While the Sheen Control Catchment is not designated as an acid sensitive area, the limited data available as discussed in section 2 indicate that this issue should be considered, based on the low alkalinity levels found across the catchment. pH and alkalinity are used by the EPA to determine whether an area is acid sensitive (buffering capacity). A pH of <5.5 units and alkalinity of 10mg/l $CaCO_3$ are considered indicative of an acid sensitive environment. The overall pH range in the control catchment is 6.1 – 7.8 and mean alkalinity is 7 – 9mg/l CaCO3. The Sodium Dominance Index (SDI) for this location in Kerry is >70 (Source: EPA ERDTI doc), indicating a risk of acid sensitivity. An SDI of 50-60 is considered an indicative threshold of sensitivity with >60 regarded as being at risk.

A low buffering capacity results from the lack of availability of base cations in the system due to the type of underlying geology and where peat is the primary land cover material. Trees tend to take up base cations during their initial growth stage until better canopy and leaf development, further depleting the water environment of buffering capacity. This means that there is little to effectively negate the impact of higher acidity levels or during an episodic acidification event where pH levels decrease. This can occur in a few ways but peat disturbance, e.g. during clear felling, site preparation for afforestation, drainage, etc. can enhance the oxidation process of organic matter causing greater and more concentrated leaching of organic acids, dissolved organic carbon, sulphates, nitrates and aluminium, lowering the ph. Where deeper acidic mineral subsoils are drained, aluminium can be mobilised resulting in the potential for toxicity to aquatic biota and fish.

While acid sensitivity generally is somewhat complex and includes several variables its relevance in terms of potential impacts to the freshwater biota and other aquatic elements is worth further consideration in the Sheen Control Catchment. This is particularly important for the three HSOWBs, if future forestry development and percentage cover in the catchment were to increase.

3.6 Hydromorphology

A hydromorphological pressure is where a river and the land adjacent to it have been physically changed from its natural condition. This includes straightening and deepening of the river channel and land drainage. Impacts can be numerous and interlinked but basically affect the river by modifying flow conditions, releasing more sediment into the river and altering habitat. Excess sediment on the bed of a river can damage habitat for aquatic life such as invertebrates (aquatic insects) and fish and can provide substrate for excessive macrophyte growth. Removal of riparian vegetation can impact the aquatic biological community by depleting the habitat for emerging fly larvae. It can also cause bank erosion, releasing sediment to the river, and destabilisation, potentially causing bank collapse.

Hydromorphology pressure in the Sheen Control Catchment could include land reclamation, land drainage, removal of riparian vegetation and straightening of tributary stream channels.

- Land reclamation: The practice of land reclamation for agricultural productivity has increased in recent years. It can involve the removal of peat, scrub/natural vegetation across a field parcel, often including the riparian margin, and the installation of land drains to create productive pasture. Land reclamation remove habitat for biodiversity and can create a significant source of sediment during the development phase. This sediment becomes mobilised through run-off and can travel to drains, streams and ultimately in rivers and other downstream receptors. The extent of land reclamation in the Sheen Control Catchment is presently unknown. Aerial imagery suggests that there has been reclamation in Sheen_010 and in the upper and eastern part of the Sheen_020 sub basin. Aerial imagery also indicates dense drainage patterns which are not comprehensively captured in existing GIS datasets. Walk over surveys would be useful in the catchment to establish a baseline and to identify where reclamation works are undertaken during the life of the project.
- Draining agricultural lands can cause sediment to be mobilised and lost to rivers and streams, particularly during drain excavation and where drain maintenance is undertaken. Draining peaty areas can result in high dissolved iron in runoff and baseflow, particularly during periods of low river flow. This iron becomes oxidised when it reaches surface water, creating an iron sludge which deposits on the stream bed and can be toxic to invertebrates in low river flow conditions. Figure A5-1 Appendix 5 shows the OSI waters layer mapping with drainage channels included. This map, combined with aerial imagery, shows areas with a higher density of drainage, particularly in the lower Sheen_010, upper Sheen_020 and along the moderate and poorly draining areas in the the lower Coomeelan Stream_010 and the eastern section of Sheen_020. It would be useful to undertake stream walks to determine the extent of this activity in the catchment, including areas drained for forestry and where forestry activity such as afforestation or clear felling has been carried out.
- Channel straightening either of natural streams or purposed drainage channels connecting into lower order streams or to the main river channel amends flow dynamics by increasing the velocity and change sediment distribution patterns away from natural conditions. This scenario is more relevant to lower lying poorly drained settings and can affect habitat for macroinvertebrates and other freshwater biota. Straightened channels are observed in Figure A5-1, Appendix 5.

3.7 Other potential pressures

Domestic wastewater treatment systems (DWWTS)

There is low density rural settlement in the HSO WBs in the control catchment, with higher numbers in Sheen_030 especially along the coastal area. Where dwellings are in close proximity to rivers and streams in poorly draining soils and subsoils in the catchment, there is a risk of phosphate loss to waters, and equally a risk of nitrate loss in the well drained soils. The low DWWTS density across much of the catchment suggests that DWWTSs are unlikely to cause water quality issues at a waterbody scale. However faulty, inadequate or poorly maintained systems, particularly in poorly draining areas, can discharge partially treated effluent to waters, causing localised organic and nutrient pollution. If one of these systems is discharging effluent a short distance upstream of a WFD monitoring point, the impact can be significant. Future walk over surveys/monitoring/local catchment assessment should bear in mind the nature of localised impacts in this regard. EPA Sanicose maps can be used to identify higher risk areas in the control catchment for focusing walkover surveys.

Section 4 Licences

There are two facilities licensed under section 4 of the Water Pollution Act (1977 to 1990) located in the lower part of the control catchment, in Sheen_030. There are no licensed facilities in the HSOWBs.

Extractive Industry – Quarries

There are two registered quarries in Sheen_020. Quarries may be a potential source of sediment loss to nearby surface water receptors which can impact the aquatic habitat. The level of activity of both facilities is unknown but aerial views suggest they are not highly productive and may not be in current operation. Regardless, even disused quarries can pose a risk of sediment loss, depending on surface water management regimes and degree of direct connectivity to surface waters. A walk over survey and sediment assessment of the downstream receptor should provide useful information on the degree of risk, if any, associated with this pressure. The larger quarry is located directly adjacent to a tributary called the Glashanaglaragh Stream which joins the main Sheen River approximately 815m upstream of the WFD operational monitoring point Dromanassig bridge at the outlet of Sheen_020.

Invasive Species

Invasive terrestrial plant species can impact habitat. It would be useful to record their presence and extent, as part of the catchment walkover surveys.

4 Pathways information & analysis

4.1 Conceptual Model

Table 8 Pathways information

Factor	Map	Compartment 1	Compartment 2				Compartment 3		Compartment 4	
Topography description		Located in mountainous uplands manly in Sheen_010, the sw of Sheen_020 and Coomelan Stream_010	These areas are distributed in all waterbodies of the control catchment found in the mountainous uplands and slopes but particularly in the river valleys. Includes the alluvium found in the mid-lower Sheen_020 and Sheen_030.				Covering most of Sheen_010 and distributed around Sheen_020 and Sheen_030 as too the lower section of CoomeelanStream_010		Found in all waterbodies of the control catchment but particularly flows the river and tributary corridors. Found in upland and the lower valley settings	
Bedrock unit	Y	Devonian Old Red Sandstone (Sandstone and Siltstone)								
Aquifer type		PI (mainly) and LI	PI and LI				PI and LI	PI	PI and LI	PI
Groundwater body	N	Beara Sneem IE_SW_G019 (low recharge throughout)								
Groundwater vulnerability	Y	E, H	X	H, M	X, E		X	E, H, M		E, H, M
Subsoil type	Y	Peat	Rock	Alluvium	TDSs	Rock	TDSs	TDSs		TDSs
Subsoil permeability	Y	v. Poor	Poor	Poor	Mod/ Poor	n/a	Mod/ Poor	Mod/Poor		Well
Soil type	Y	Peat	Peat	Alluvium	TDSs (Loam drift)		None	Peat (if removed)	TDSs (coarse Loam)	Peat (if removed)	TDSs (coarse Loam)
Hydrology – • Drainage • Drainage density	Y	v. Poor	Poor					Moderate /poor		Well	

Susceptibility:					
PO4 near surface pathway to SW	A3-10	**High –** **rank 2 and 3**	**High – rank 2 and 3**	**High** to moderate – rank 2 to 4	Low – rank 4
NO3 subsurface to GW	N	Low – rank 5	Low – rank 5	Low – rank 5	Low – rank 5
NO3 near surface to SW	A3-11	Low – rank 4	Low – rank 4	Low – rank 4	**High – rank 1 to 3**
PIP:					
PIP CSA PO4 to SW	Fig A3-5	**High – rank 3** (areas in Sheen_010 and upper Sheen_020 HSOWBs) Low – rank 5 (everywhere else in the control catchment)	**High – rank 1 – 3** (areas in lower Sheen_020 HSOWB, and Sheen_030) Low – rank 5 to 7 (everywhere else in control catchment)	**High – rank 1 – 3** (areas in lower Sheen_020 HSOWB, and Sheen_030) Low – rank 4 to 5 (everywhere else in control catchment)	Low - rank 6 and 7
PIP CSA NO3 to GW/SW	Fig A3-7	Low – rank 7	Low – rank 6 and 7	Low – rank 6 and 7	**High – rank 1 to 5**
Likely main pathway(s)		Overland flow and via drainage channels	Overland flow and via drainage channels	Overland and via drainage channels (tending to be more poorly draining but with more variability than in compartment 2)	Shallow groundwater (upper bedrock zone) to surface water
CSAs description	FigureFigure 13 and 14	Lower section of Sheen_010 and Esk Stream in sw of Sheen_020 (HSOWBs)	Lower Sheen_020 close to main river channel (in alluvium) and along tributary streams west of the river (HSOWB). In Sheen_030 close to main river channel (in alluvium) and along tributary streams west of the river.	Lower Sheen_020 close to main river channel (HSOWB) In Sheen_030 close to main river channel and along tributary streams west of the river	Distributed around Sheen-020 (HSOWB) mainly close to lower order tributary streams

					Sheen_030 close to lower order tributary streams

(From *Desk Studies for Areas for Action, EPA Recommendations. Version 3, LAWPRO January 2019*)

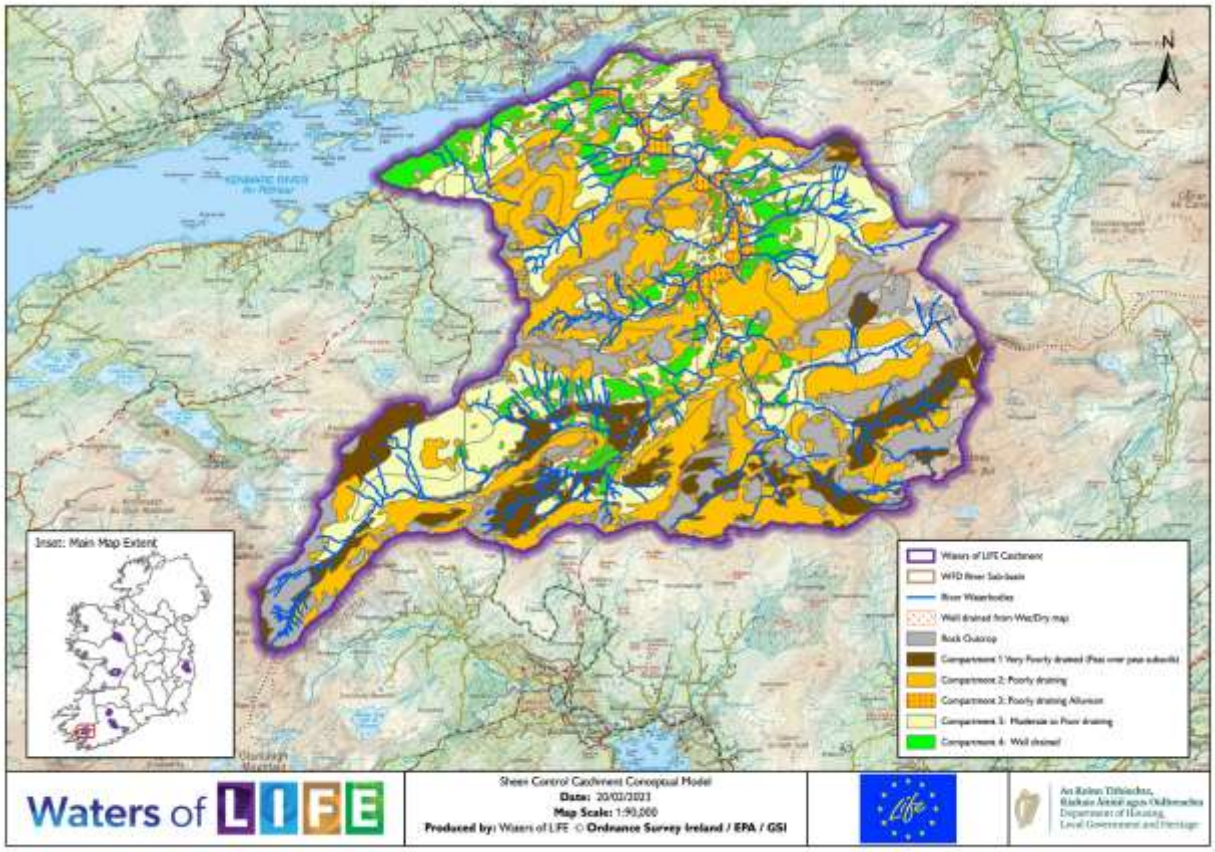


Figure 12: Conceptual model for Sheen Control Catchment

Compartment 1 is very poorly draining with peat as soil and subsoil. Found mainly in higher upland mountain areas around the southwest, south and southeast of the control catchment and therefore mainly in the HSO WBs. Land use is fairly limited here most likely under sheep grazing although in Sheen_010 and the southwest of Sheen_020, around the headwaters of the Esk Stream, some of this compartment is under forestry and agricultural use. Figure 13 shows some areas at rank 3 for PIP phosphate CSAs in this compartment. While agriculture intensity appears to be low, proximity of these high ranked areas to high status sites carry a high risk of impact if there is an issue. The potential issues here are sediment and diffuse phosphate with key pathways by overland flow and via drainage channels. Where land is in forestry and agricultural use, they are very likely to have undergone drainage works, straightened drainage channels are evident. Natural drainage density is high in this compartment as expected.

Compartment 2 is poorly draining with peat or sandstone derived till soils. In some cases peat is overlying sandstone bedrock but mostly there is underlying moderate to poorly draining till subsoils. Alluvium soils are included in this compartment and found mainly along the Sheen River valley in Sheen_020 and Sheen_030 and are regarded as typically poorly draining.

Of interest in this compartment is where there is peat is over bedrock, the susceptibility maps show these areas as high rank 1 for nitrate pathways to surface water (via near surface pathways) but also appear as a high rank at 2 and 3 in the phosphate susceptibility maps. Alluvium is similar where it is shown as a high rank 2 in both susceptibility maps. Both these particular areas are depicted as 'well drained' in the Wet/Dry (EPA) drainage map. It is therefore concluded that where these scenarios occur that caution is advised, and that on-the-ground validation is sought as to their actual drainage capabilities. It is suggested that these lands may likely have been amended/improved for use hence, the conflicting information. They can be seen in Figure 12 near the main Sheen River channel in Sheen_020 and are overlaid by green hatching which is the 'well drained' GIS layer from the Wet/Dry mapping. In the conceptual model these areas are included in compartment 2, as poorly draining.

High rank PIP CSAs for P pathways (rank 1 and 2) in this compartment are found in lower Sheen_020 around the main Sheen River channel, in alluvium soils and in small areas around tributary streams west of the main river. Also in Sheen_030 again close to the main Sheen River channel and in small areas around tributary streams west of the main river. Compartment 2 carries a higher risk potential for land reclamation (discussed in Section 3 under Potential Significant Pressures) and tend to have high drainage density (natural and human-made).

Compartment 3 is also poorly draining although there is likely some variability to moderate drainage due to subsoils (moderate to poor tills). The compartment includes areas where the upper soils of peat may have been removed or are of a peat mineral soil mix with underlying moderate to poorly draining subsoils. Coarse loam soils present in Sheen_030 are included in this compartment.

Some few high rank PIP CSAs for P (rank 2) in this compartment are found in lower Sheen_020 near the main Sheen River channel. Rank 1 and 2 area are found in Sheen_030.

Compartment 4 is based on areas with well-draining sub-soils which are located throughout the control catchment and found mainly in the river and tributary valleys. While some of these well drained sub-soils are overlaid with poorer draining peat, they are indicative of lands at higher risk of the movement of N via subsurface pathways to surface waters particularly where the over burden may have been removed for land improvement.

PIP maps for N near surface pathways show rank 3 nearly all in Sheen_020, see Figure A4-3, Appendix 4. These rank 3 areas are not all entirely within compartment 4. In the conceptual model, some of the PIP-N rank 3 overlaps with compartment 2, specifically in areas where peat soil is over rock. As mentioned above susceptibility mapping has defined those areas (i.e. peat over bedrock) as at high risk for diffuse N movement through near surface pathways but also high rank for PIP P pathways to surface water. As peat is typically poorly draining it is more prudent to assume a poorer drainage capability in these areas unless land has undergone reclamation and improvement to allow for better access to underlying interflow pathways in the upper part of the aquifer. As indicated above under the description for Compartment 2, ground truthing is required here for determining most dominant pathway. Coarse well drained Loam in Sheen_030 is included in this compartment. PIP N near surface pathways at rank 1 and 3 are located here.

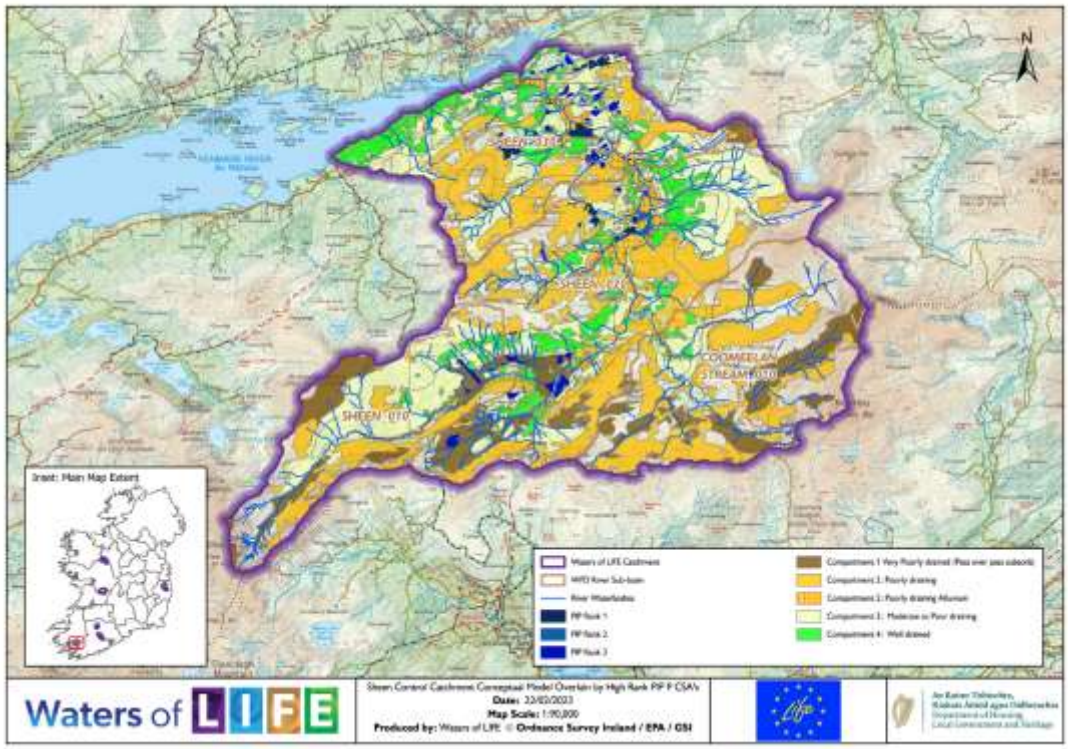


Figure 13: Conceptual model overlaid by high rank PIP map for phosphate to surface waters

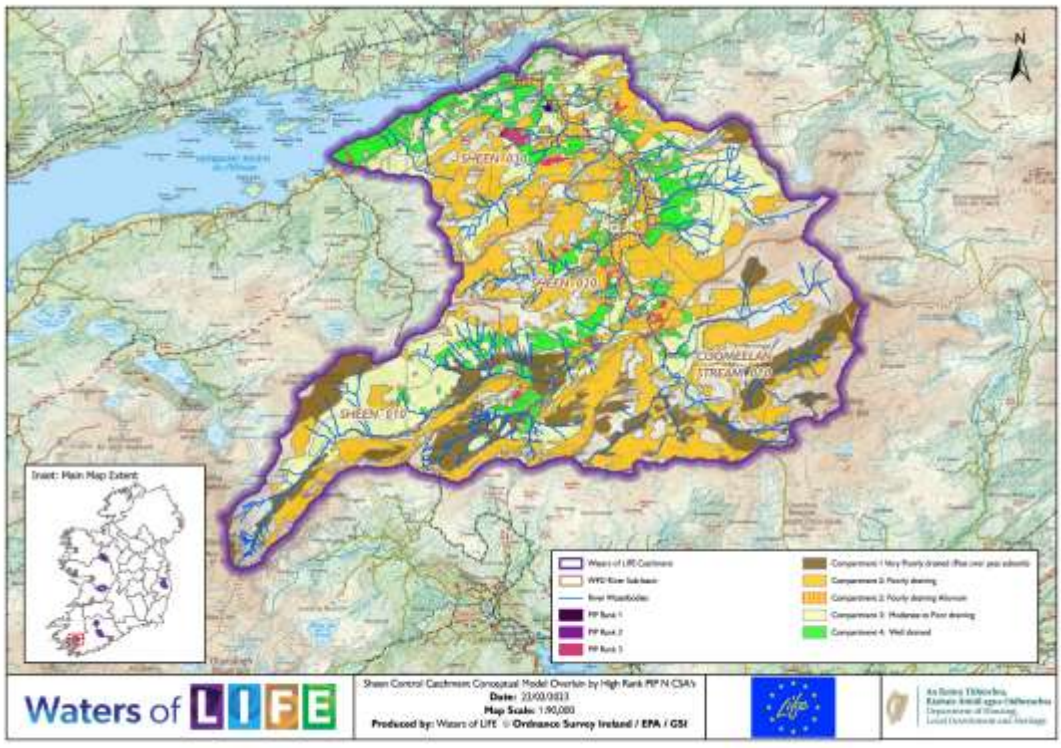


Figure 14: Conceptual model overlaid by high rank PIP for N pathways critical source areas

5 Interim story of the Sheen Control Catchment

The Sheen Control Catchment comprises four waterbodies, three of which are High Status Objective Waterbodies (HSOWBs) (Sheen_010, Coomeelan Stream_010 and Sheen_020). Sheen_030 (Good status objective) is the final waterbody before the Sheen River discharges to the transitional waters of Kenmare River (IE_SW_190_0300).

5.1 Sheen_010

- The WFD objective for Sheen_010 is High ecological status. Sheen_010 is not meeting this objective as it is currently at Good ecological status. The risk category is *Review* for the third cycle, having been updated from *Not at Risk* for cycle 2.
- Ecological status in Sheen_010 is driven by biological status at the WFD operational monitoring point at 'Releagh Br.' (21S010100) situated at the outlet of the waterbody. This site saw a drop to Q4 in 2018 while prior to that the site had been consistently stable at Q4-5 since 1994 (Q5 in 2003). The site improved back to Q4-5 in 2019 but subsequently deteriorated again to Q4 in 2020.
- The Releagh Br. site is not monitored for chemistry. Limited chemistry data from samples collected in 2021 (and earlier data from 2000 to 2002) indicate that nutrients are not an issue here. The reason for the recent deterioration in biological status is not yet known.
- There is no information available on sediment levels at this site although historic chemistry data shows that TP results for Aug and Nov 2001 were at 0.063mg/l and 0.055mg/l respectively, indicating potentially high sediment mobilisation at that time.
- A RHAT assessment undertaken at Releagh Br in 2015 places the site into a *high* class with a score of 0.906. The MQI data for the control catchment shows that channels are in either high or good class except for one small moderate stretch, located upstream of Releagh Br on a tributary stream.
- Rock outcrops make up the higher mountain peaks and the very steep slopes of Caha Mountain in the headwaters of the Baurearagh River. Peat covers the entire waterbody with either bedrock underlying, particularly on the upper and mid slopes, or with underlying sandstone till soils covering the lower slopes and river valley. The Till subsoils are mostly moderately to poorly draining but pockets of well drained are situated in the lower part of the waterbody along tributaries north of the main river channel. Alluvium soils are found close to the main river channel.
- Dominant pathways in Sheen_010 are overland flow and via drainage channels in the peat and mod/poorly drained till areas which favours the movement of phosphate and sediment. In the well-drained pockets near-surface pathways for nitrate movement dominate.
- Land use in Sheen_010 is mainly agriculture and forestry with some scattered rural dwellings. Potential pressures in this waterbody driving the recent deterioration are agriculture, forestry and hydromorphology.

- In Sheen_010 agricultural intensity is low with only some small areas at rank 3 PIP-P critical source areas (CSAs) in the waterbody. Sheep grazing is likely to be the main enterprise in the upland mountainous areas with bovine also likely on lower slopes and in the valley. Pressures around sheep can include overgrazing which increases risk of sediment loss to waters and toxic impacts if sheep dip is disposal (illegally) to surface waters. There is a potential pressure from diffuse run-off of phosphate to surface water where the rank 3 PIP CSAs are located close to the main channel and tributary streams. Sediment from land drainage is also a potential pressure especially in the poorly draining areas of peat and wet Till soils.
- Of the total land area in Sheen_010, 19% is under forestry which accounts for nearly 47% of the total area under forestry in the HSOWBs of the control catchment. Forestry is a potential pressure at legacy sites (lands forested pre-best forest practice) which are being thinned or clear-felled, with risk of impact to receiving waters through sediment and nutrient loss. Most of the forestry in this waterbody was planted in the late '80's/early '90's to the mid-2000's. Felling would have a high-risk potential to the high status at the WFD monitoring point due to proximity and legacy issues.
- Acidification is a potential issue here due to low buffering capacity. It should be considered in assessing applications for future forestry development in this waterbody. Potential acidity impacts to biology should be considered where clear-felling on peat occurs close to the WFD operational monitoring site at Releagh Br.
- Potential hydromorphological pressures here could arise from over grazing, land drainage or drainage channel maintenance.

5.2 Coomeelan Stream_010

- Coomeelan Stream_010 is meeting its WFD objective of High ecological status and therefore is *Not at Risk* for the third cycle.
- Operational monitoring station 'Br. u/s Sheen River confluence' 21C140200 is situated at the outlet of Coomeelan Stream_010. The biological status for this site is High at Q4-5 and has consistently remained stable at Q4-5 since records began in 1994.
- There is no operational chemistry monitoring site for Coomeelan Stream_010. Limited data are available for three years (2000-2003) for the site at Br. u/s of Sheen River confluence 21C140200. Results indicate that there was no significant nutrient issue at that time, with annua means below current EQSs. There is no information available on sediment levels at the site. As biological status at this site is consistently High, this suggests that supporting chemistry conditions have remained satisfactory here.
- A RHAT assessment undertaken at 'Br. u/s Sheen River confluence' in 2015 places the site into a *high* class with a score of 0.953. The MQI data for the control catchment shows that channels are in either high or good class.
- Rock outcrops are found on several mountain peaks within CoomeelanStream_010. Peat covers the entire waterbody with either bedrock underlying, particularly on the upper and

mid slopes, or underlying sandstone till soils covering the much lower slopes and the river valley. The Till subsoils are for the most part poorly draining, including the alluvium soils, with more moderate to poorly draining subsoils in the river valley near to the main channel of the Coomeelan Stream. There are very few pockets of well drained subsoils found closer to the outlet of the waterbody.

- Dominant pathways in Coomeelan Stream_010 are overland flow and through drainage channels. This favours the movement for diffuse nutrient (phosphate) and to surface water. As this waterbody is mostly mountainous and drained by Coomeelan Stream and its tributaries, flows are expected to be very fast during winter high flow conditions.
- Land use is mainly agriculture with a little forestry.
- In Coomeelan Stream_010 agricultural intensity is very low, mostly in phosphate PIP rank 4 to 5 areas, so risk of diffuse phosphate loss to surface waters is low. Sheep farming is likely to be the main enterprise here although the lower lands in the river valley may have cattle. Potential pressures around sheep include overgrazing which increases risk of sediment loss to waters and toxic impacts if sheep dip is disposal (illegally) to surface waters. Sediment from land drainage could also be a potential pressure especially in the poorly draining areas of peat and wet Till soils.
- Forestry covers 1.5% of the total land area in Coomeelan Stream_010, accounting for about 5% of the total area under forestry in the HSOWBs of the control catchment. Forestry is a potential pressure at legacy sites (lands forested pre-best forest practice) which are being thinned or clear-felled, with risk of sediment and nutrient loss to waters. The forestry established in this waterbody dates to the late 1980's with more recent afforestation in the mid 2010's. Forestry is located close to the waterbody outlet and WFD monitoring site on the eastern side of the main channel. Forestry felling is a potential future pressure here due to proximity and legacy issues.
- Acidification is a potential future issue due to low buffering capacity. It should be factored into consideration in any future afforestation applications in this waterbody.
- Rural dwellings are low in number in the sub basin. Where dwellings are in close proximity to WFD operational monitoring points, there is a higher risk of potential impact from domestic wastewater treatment systems if the systems are faulty, inadequate or poorly maintained.
- Potential future hydromorphological pressures could arise from land drainage, drain clearing, maintenance or land reclamation.

5.3 Sheen_020

- Sheen_020 is meeting its WFD objective of High ecological status and is *Not at Risk* for the third WFD cycle.
- An operational monitoring station at 'Dromanassig Br' 21S010600 at the outlet of Sheen_020 is currently at high biological quality at Q4-5 (2020). The biological record for this site shows that there has been deterioration in the past with the Q value dropping to Q4 at times during

the period between 1997 to 2006. However, the site has remained consistently stable at Q4-5 from 2009 to the present. There is no information on sediment at the site.

- There is no operational chemistry monitoring at this site. Limited data are available for three years, 2000-2003 for Dromagorteen Br. and indicates overall that there was no significant nutrient issue at that time, with annual means in keeping with current EQSs. However, the data shows spikes on occasion, with a BOD result of 2.1 mg/l in March 2001, MRP of 0.048 mg/l in June 2001 and a TP result of 0.142mg/l in Nov 2001. As mentioned above, with fluctuating biological quality between 1997 and 2006, it appears likely that there was a significant pressure impacting the site during that period, potentially associated with a sediment issue.
- A RHAT assessment undertaken at Dromanassig Br. in 2015 places the site into a *high* class with a score of 0.984. MQI data shows that channels are in either high or good class.
- Rock outcrops are found on several upland and mountain peaks within Sheen_020 particularly in the west of the waterbody but also around its border at the south and east. Peat is found across the waterbody with mostly poor draining subsoils found throughout on the higher and mid-slopes areas. Moderate to poorly draining soils are present particularly along the river and tributaries valleys and in the northeast of the waterbody. Alluvium soils are distributed along either side of the main Sheen River channel. Well drained subsoils feature along a corridor through the centre of Sheen_020 on the lower lying valley areas.
- Dominant flow pathways are overland flow and through drainage channels allowing for the movement of diffuse nutrient (phosphate) and sediment run-off. In well drained area movement of nutrients such as nitrate will be via near surface pathways to surface waters.
- Land use is mainly agriculture and forestry.
- Agricultural intensity in Sheen_020 is generally very low with phosphate PIP maps showing mainly rank 4 and 5 areas. Higher PIP areas (rank 3) are located in the upper headwaters in Esk Stream and at the lower reaches of the waterbody in the lower valley, with some areas close to the main channel at rank 1 and 2. While intensity is low, very PIP high ranks at 1 and 2 in close proximity to the main channel carry a higher risk of potential impact to high status waters from diffuse source phosphate run-off.
- As with the upstream waterbodies, sheep and bovine enterprises are most likely here. Potential pressures around sheep can include overgrazing which increases risk of sediment loss to waters and toxic impacts if sheep dip is disposal (illegally) to surface waters. Sediment from land drainage is also a potential pressure especially in the poorly draining areas of peat and wet Till soils.
- Forestry cover in Sheen_020 is 10% of total lands in the sub basin. This accounts for 48% of the total area forested across the three HSOWBs. Forestry is a potential pressure at legacy sites (lands forested pre-best forest practice) which are being thinned or clear-felled, with risk of impact to receiving waters through sediment and nutrient losses. The forestry established in this waterbody dates to the late 1980's. Forestry in Sheen_020 is situated in peat and poorly drained soils on steep slopes in some places, increasing the risk of impact to water.

- Acidification is a potential future issue here due to low buffering capacity in the water and should be factored in for consideration in any future afforestation in this waterbody. Acidity impacts to the biology should be considered if clear-felling on peat occurs close to the main channel such as in the upper headwaters in Sheen_020 at the Esk Stream.
- Potential future hydromorphological pressures could result from activities such as drain clearing, drain maintenance and land reclamation.

5.4 Sheen_030

- There are no WFD operational monitoring points in this waterbody. Two pre-WFD sites are located in the north of Sheen_030 near the outlet to the transitional waters of Kenmare River. They are '1.1km u/s of Sheen Br.' 21S010700 and 'Sheen Br.' 21S010800. There are no recent Q data available for either site. The most recent Q value for 1.1km u/s of Sheen Br was Q4 in 2006.
- The WFD objective for Sheen_030 is Good. It had been 'unassigned' for all status iterations since 2007. Its extrapolated status for 2013-2018 is Good, based on grouping and it is *Not at Risk* for cycle 3.
- Chemistry data for Sheen_030 are limited to three years, 2000-2001. Generally, overall nutrient data showed no issues in this period. However elevated levels of MRP and TP were observed in June 2001, possibly reflecting pressure from further upstream in the catchment.
- There are no RHAT data available for this waterbody as it is not a HSOWB. MQI data shows that channels are in either high or good class.
- Mountainous peaks and upland slopes of rock at the surface lie in the west, south west and along the eastern border of this waterbody. Lower lying rock outcrops are found all along the northern sector bordering the transitional waters of the Kenmare River. Peat is the dominant land cover in more upland areas while the lower slopes and lower lying valley have moderate to poorly draining mineral soils including alluvium found bordering either side of the Sheen River. Well drained soils are pocketed in amongst these soils along the valley.
- Dominant flow pathways are overland flow and through drainage channels, potentially allowing for movement of diffuse phosphate and sediment run-off. In the well-drained areas, movement of nitrate is via near surface pathways to surface waters.
- Land use is under agriculture with a larger number of rural dwellings in this sub basin in comparison to the rest of the control catchment. Forestry coverage is very low.
- Agricultural intensity is low with some small areas of high PIP CSAs for phosphate and nitrate along the Sheen valley. Sheep and cattle are mainly farmed here with potential pressures around sheep including overgrazing, with resultant risk of sediment loss to waters. Toxic impacts can result if sheep dip is disposed of (illegally) to surface waters. Sediment from land drainage is also a potential pressure especially in the poorly draining areas of peat and wet Till soils.

- Much of the settlement is located near the northern border with the transitional waters but also close to tributaries of the lower Sheen. A cluster of high risk domestic wastewater treatment systems are located in the lower Sheen upstream of pre- WFD monitoring point 1.1km upstream of Sheen Br.
- Forestry coverage is low in Sheen_030 at 11% of the total land area here. As with the other waterbodies upstream, acidification is a potential issue due to low buffering capacity in the water and should be factored in for consideration in any future afforestation in this waterbody.

6 Work plan

6.1 Walk over survey/ monitoring and assessment

Locations for initial catchment assessment are shown in Figure 15 to Figure 18. The purpose of local catchment assessment (LCA) in Sheen_020, Sheen_030 and Coomeelan Stream_010 is to establish baseline water quality information and to develop knowledge of the catchment. In the event of future deterioration in any of the waterbodies in the control catchment, this baseline information will assist in identifying the significant issues and the significant pressures driving the deterioration. The following is a starting point for proposed monitoring sites which may be expanded or amended during field work.

- Field parameters/measurements at all monitoring sites to be undertaken (pH, conductivity, D.O. Total dissolved solids (TDS) and temperature.
- Chemistry sampling at low, mean and high flow conditions -see Table 9 below for parameters to include.
- Sediment assessments to determine whether sediment is an issue at the WFD operational monitoring points and also to determine if there are sources of excess sediment coming from upstream in the control catchment.
- RHAT assessment should be updated. Particularly relevant where there may have been changes since 2015.
- Biological assessment (SSIS or RA) at all locations depending on habitat.
- Q assessment at the outlet of Sheen_030 to confirm Good status here
- Note pressure information in the vicinity of all sites e.g. presence of sewage fungus (odour), drainage outlets from forestry/agriculture, cattle access points, road discharges, drainage density and outputs to river/stream, etc
- Assess upstream and downstream of point sources (eg licensed facilities and quarries).
- Note hydromorphology information at all sites. Ideally full hydromorphological assessments should be conducted along the main channel sites.
- Identify, note details and record location of invasive species

Table 9: Chemistry parameters proposed for inclusion

Parameter	units	Limit of Detection	Reason
MRP	mg/l-P	0.02	EQS
Total Phosphorus	mg/l-P	0.02	Sediment
Total Ammonia	mg/l-N	0.01	EQS
TON	mg/l- N		
Nitrate	mg/l -N		
Alkalinity	mg/l CaCO3	10	Adds to information on buffering capacity
Copper	ug/l Cu	5	FF Directive, adds to existing data
Zinc	ug/l Zn		FF Directive, adds to existing data
Iron	ug/l Fe		Associated with peat and drainage

Full LCA is now required on Sheen_010 because of the drop to Good biological status here. Assessments should commence at the WFD monitoring point, Releagh Bridge. Suggested upstream main channel LCA locations are shown on the map in Figure 15. The catchment is quite remote and these locations were selected based on likely access to the river. However, many of the points shown on the map are accessible only through private lands so strong engagement with landowners will be very important before significant fieldwork can commence here.

If sediment appears to be a significant issue at Releagh Bridge, undertake stream walks to identify upstream sediment sources. Stream walks along forested areas wll be useful to identify locations of unmapped drains connecting these stands to the river main channel or its tributaries.

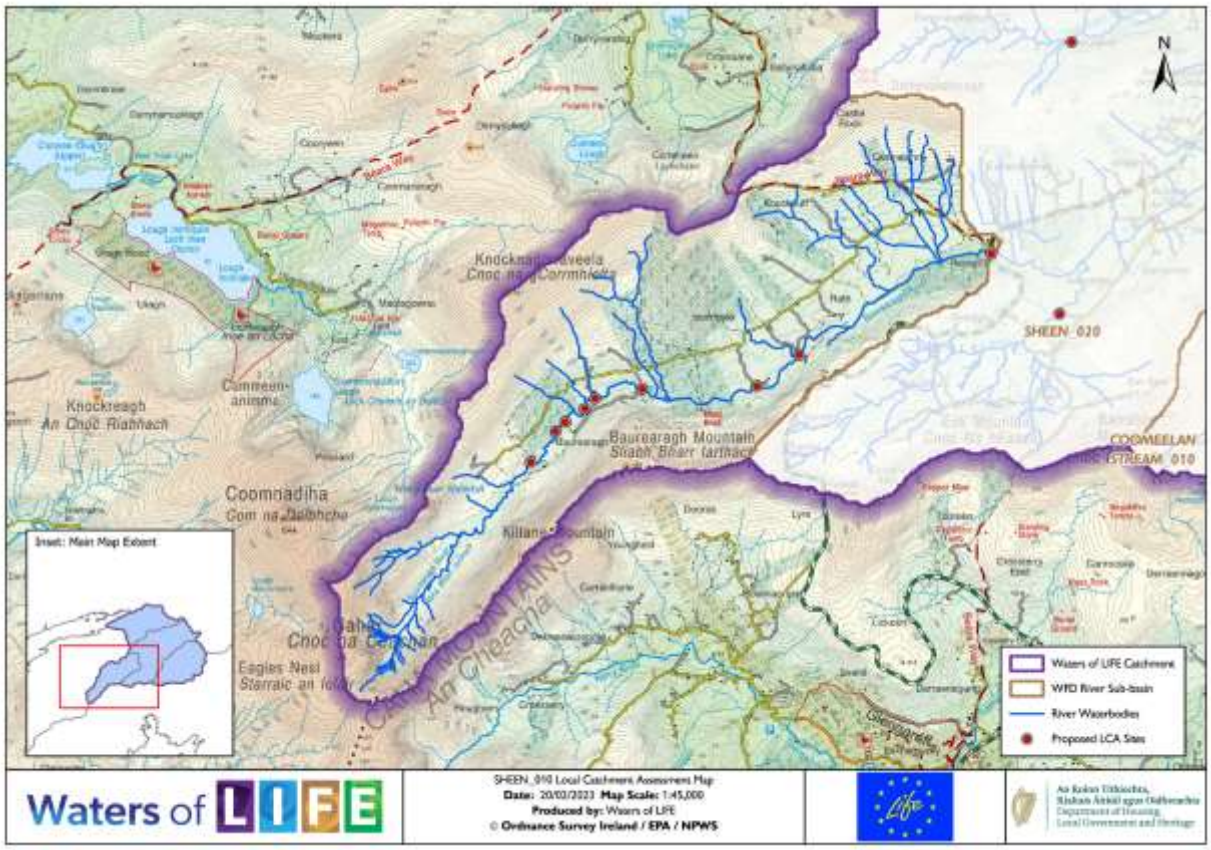


Figure 15: Initial LCA locations, Sheen_010

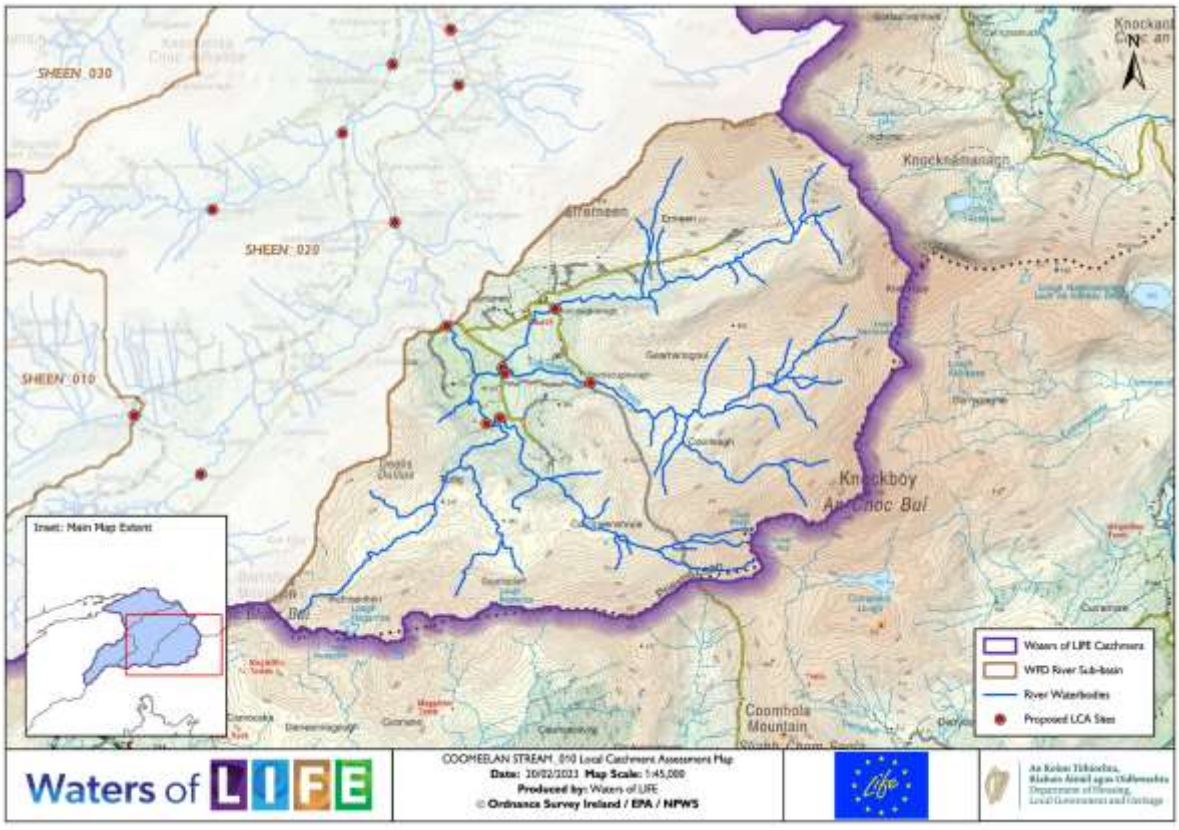


Figure 16: Initial LCA locations, Coomeelan Stream_010

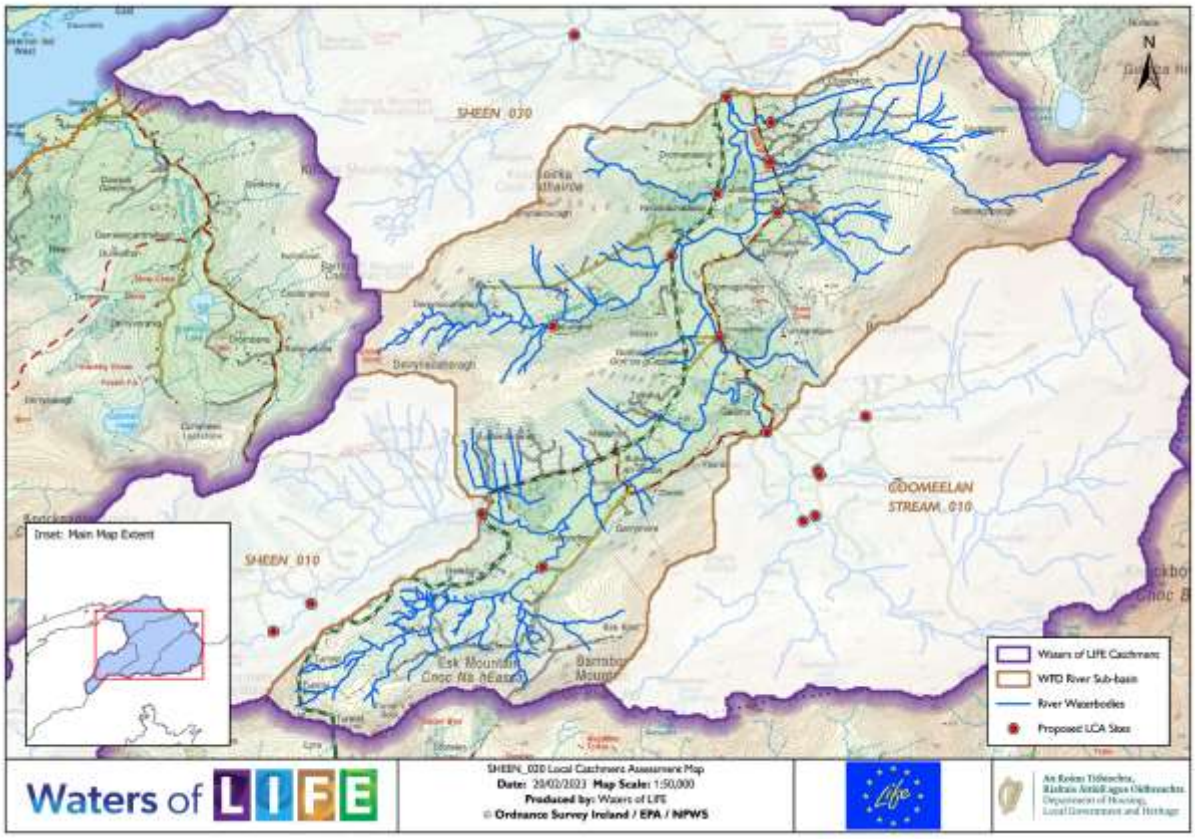


Figure 17: Initial LCA locations, Sheen_020

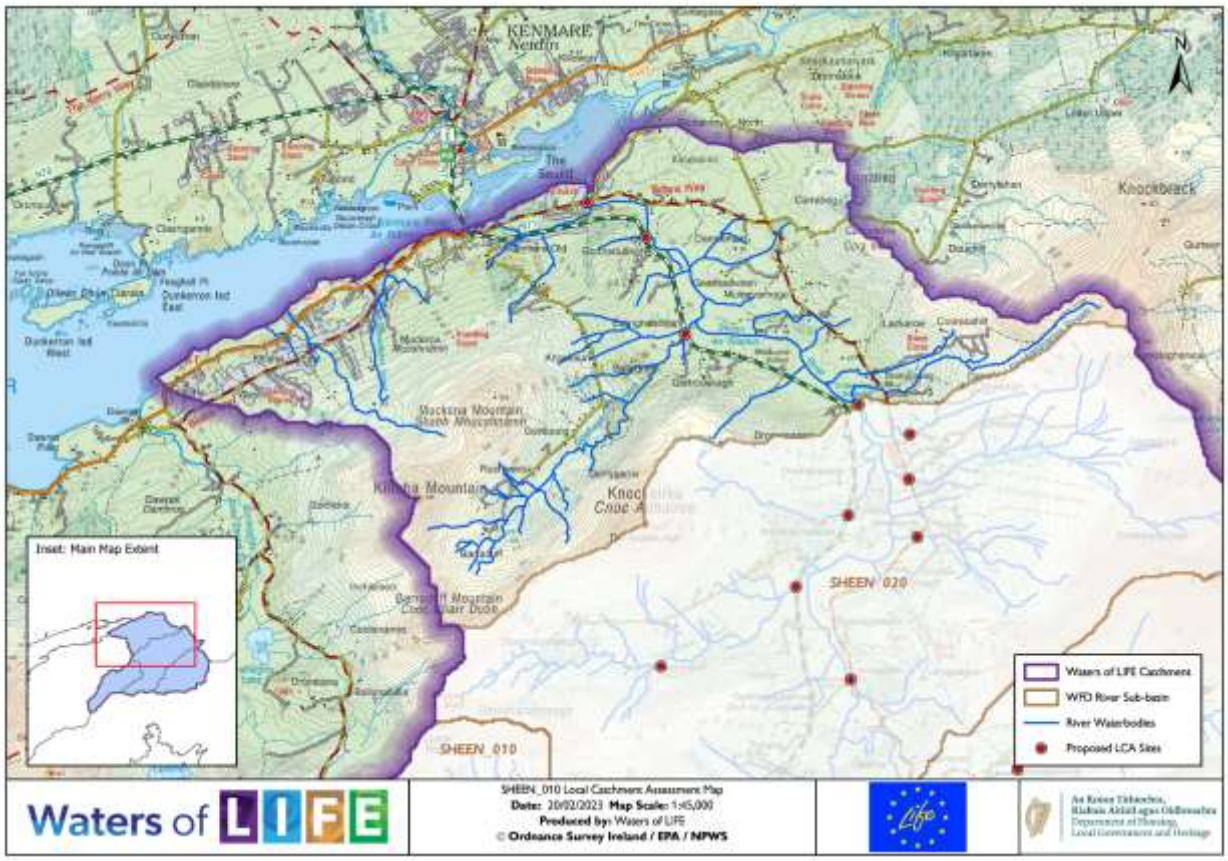


Figure 18: Initial LCA locations, Sheen_030

7 Review of mitigation options

The Sheen catchment is a control catchment. The only measures proposed for the catchment, over and above the basic measures driven by the relevant statutory bodies, are awareness raising on water quality and High status sites, for communities and landowners. Education and awareness raising will focus on the importance of High status and on the risk to waters posed by agriculture, forestry, hydromorphology and domestic wastewater, including DWWTSs. Education and awareness raising will also be provided for farmers and landowners on invasive species, current best practice and how to prevent spread, especially in and around watercourses.

Appendix 1: Monitoring point locations, Sheen Control Catchment

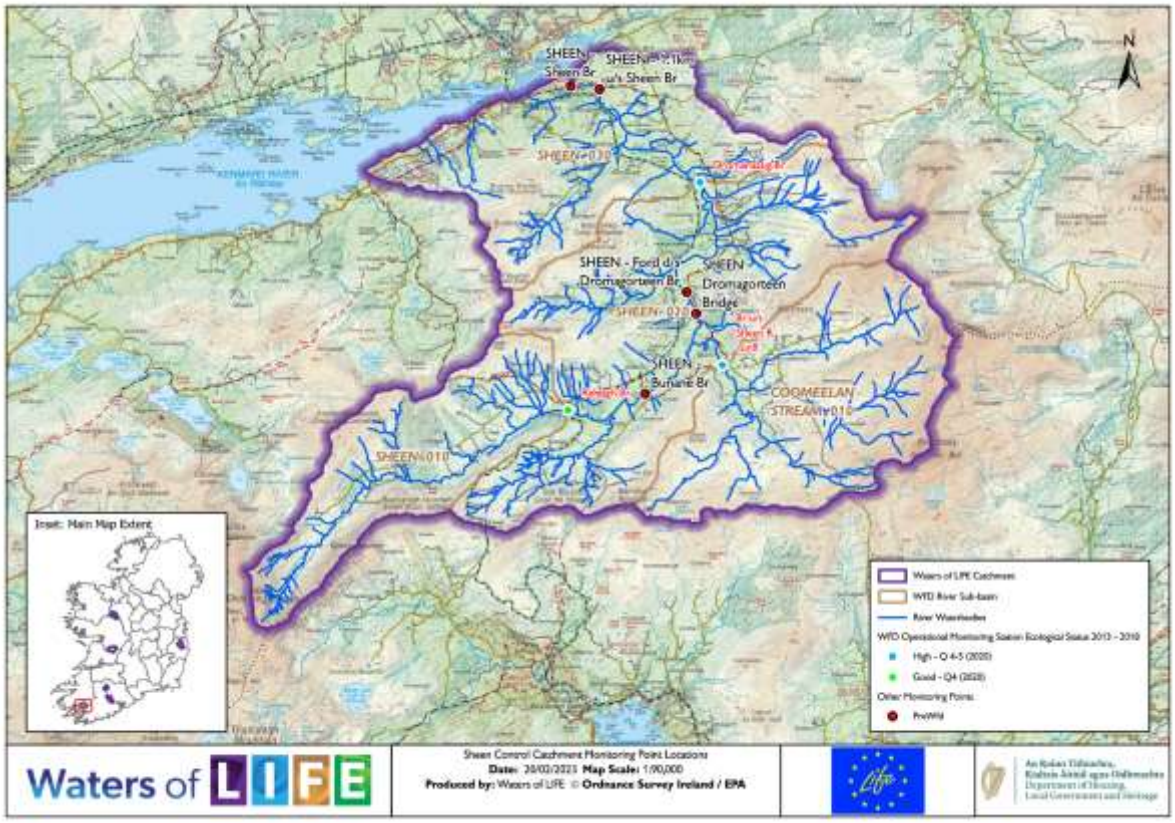


Figure A-1 Map of all monitoring sites (operational and pre-WFD) in the Sheen Control Catchment

Appendix 2: Chemistry monitoring data for pre-WFD sites, Sheen Control Catchment

- Below is a summary of data for pre -WFD sites in the Sheen Control Catchment, supplied by Kerry County Council.
- Three sites are in High status objective waterbodies, Releagh Br. in Sheen_010, Br. u/s of Sheen River confluence in Coomeelan Stream_010 and Dromagorteen Br. in Sheen_020.
- High status (mean) EQSs are included in the tables for High status objective waterbodies
- Sheen_030 (site 1.1km u/s of Sheen Br) is a good status objective waterbody so good status (mean) EQSs are shown here.
- Results exceeding their respective EQS are highlighted in red.
- Generally, all sites show that mean values for nutrients and other supporting parameters were within their relevant EQS.

Table A2-1

Sheen_010: Releagh Br., 21S010100. Data 2001

Year	ph	Conductivity uS/cm @25°C range	D.O. mg/l range	B.O.D. mg/l	MRP mg/l -P	Ammonia mg/l-N	T.O.N mg/l-N	Alkalinity mg/l CaCO3	Hardness mg/l	Copper mg/l
Feb-21	6.5	57	99	0.5	0.005	0.01	0.1	6.8	11	0.5
Mar-21	7.3	72	101	0.5	0.01	0.023	0.1	8	12	3
May-21	6.7	64	100	0.5	0.005	0.01	0.1	4.4	5	0.5
Sep-21	7	69	99	0.5	0.005	0.01	0.1	12.5	15	0.5
Nov-21	6.6	47	94	0.5	0.005	0.01	1.9	5.5	5	15
mean	6.8	62	99	0.5	0.01	0.013	0.46	7.4	9.6	3.9
EQS HS (mean)	4.5 - 9.0 units (soft water)	n/a	80 - 120% sat	≤1.3	0.025 mg/l-P	0.04 mg/l-N	3-4 mg/l NO3	n/a	n/a	5 ug/l @ 10mg/l hardness

Table A2-2

Sheen_010: Releagh Br., 21S010100. Data 2000 - 2002

	results range			mean annual values				
Year	**ph range**	**Conductivity uS/cm @25°C range**	**D.O. mg/l range**	**B.O.D. mg/l**	**MRP mg/l -P**	**Ammonia mg/l-N**	**T.O.N mg/l-N**	**Alkalinity mg/l CaCO3**
2000	6.1 - 7.8	56 - 71	*11.3	<1.0	0.006	<0.016	0.43	no data
2001	6.8 - 7.0	49 - 64	9.8 - 13.0	1	0.009	<0.016	0.52	no data
2002	6.1 - 7.2	40 - 75	10.5 - 12.7	<1.0	0.01	<0.016	0.57	6.7
overall mean	6.9	60		<1.0	<0.010	<0.016	0.51	6.7
Min	6.1	40	9.8	<1.0	<0.005		0.24	2.3
Max	7.8	75	13	1.1	0.021		1.21	9.4
EQS HS (mean)	4.5 - 9.0 (soft water)	n/a		≤1.3	0.025 mg/l-P	0.04 mg/l-N	3-4 mg/l NO3	n/a

*single result

Table A2-3

Coomeelan Stream_010: Br. u/s of Sheen River confluence, 21C140200. Data 2000 - 2002

	results range			mean annual values				
Year	ph range	Conductivity uS/cm @25°C range	D.O. mg/l range	B.O.D. mg/l	MRP mg/l -P	Ammonia mg/l-N	T.O.N mg/l-N	Alkalinity mg/l CaCO3
2000	no data	no data	no data	no data	no data	no data	no data	no data
2001	no data	no data	no data	no data	no data	no data	no data	no data
2002	6.8	55	10.0 - 12.3	*<1	0.01	*<0.016	0.55	6.8
Min	6.2	26	10		0.005		0.22	2
Max	7.1	74	12.3		0.029		1.01	11.9
EQS HS (mean)	4.5 - 9.0 units (soft water)	n/a		≤1.3	0.025 mg/l-P	0.04 mg/l-N	3-4 mg/l NO3	n/a

*single result

Table A2-4

Sheen_020: Dromagorteen Br., 21S010350. Data 2000 - 2002

	results range			mean annual values				
Year	ph range	Conductivity uS/cm @25°C range	D.O. mg/l range	B.O.D. mg/l	MRP mg/l -P	Ammonia mg/l-N	T.O.N mg/l-N	Alkalinity mg/l CaCO3
2000	6.3 - 7.3	53 - 72	11.5	1.0	<0.005	<0.016	0.74	no data
2001	6.7 - 7.0	45 - 61	10.1 - 13.0	1.3	0.017	<0.016	0.69	no data
2002	6.4 - 7.4	33 - 80	10.1 - 12.8	<1.0	0.010	<0.016	0.79	7.8
overall Mean	6.9	60		1.1	0.011	<0.016	0.75	
Min	6.3	33	10.1	<1.0	<0.005		0.25	3
Max	7.4	80	13	2.1	0.048		1.8	13
EQS HS (mean)	4.5 - 9.0 units (soft water)	n/a		≤1.3	0.025 mg/l-P	0.04 mg/l-N	3-4 mg/l NO3	n/a

Table A2-5

Sheen_030: 1.1km u/s of Sheen Br 21S010700. Data 2000 - 2002

	results range			mean annual values				
Year	**ph range**	**Conductivity uS/cm @25°C range**	**D.O. mg/l range**	**B.O.D. mg/l**	**MRP mg/l -P**	**Ammonia mg/l-N**	**T.O.N mg/l-N**	**Alkalinity mg/l CaCO3**
2000	6.3 - 7.3	54 - 79	*11.4	1.1	0.006	<0.016	0.85	no data
2001	6.7 - 7.0	54 - 71	10.0 - 13.0	1.4	0.016	<0.016	0.81	no data
2002	6.4 - 7.2	38 - 87	10.0 - 12.8	<1	0.009	<0.016	0.97	8.7
overall Mean	6.9	65		1.2	0.01	<0.016	0.87	
Min	6.3	38	10	<1	0.005		0.39	3.1
Max	7.3	87	13	2.0	0.037		2.1	12.6
EQS GS (mean)	4.5 - 9.0 units (soft water)	n/a		≤1.5	0.025 mg/l-P	0.065 mg/l-N	3-4 mg/l NO3	n/a

*single result

Table A2-6 Total Phosphorus results 2000 – 2001

		HSOWBs		
Year	**Month**	Sheen_010	Sheen_020	Sheen_030
2000	March	0.013	0.014	0.022
	May	0.012	< 0.01	0.012
	Nov	< 0.01	< 0.01	< 0.01
2001	Feb	0.01	0.01	0.014
	May	< 0.01	< 0.01	0.01
	June	0.016	0.011	0.025
	Aug	0.063	0.027	0.036
	Nov	0.055	0.142	0.079

Appendix 3. Conceptual model maps, Sheen Control Catchment

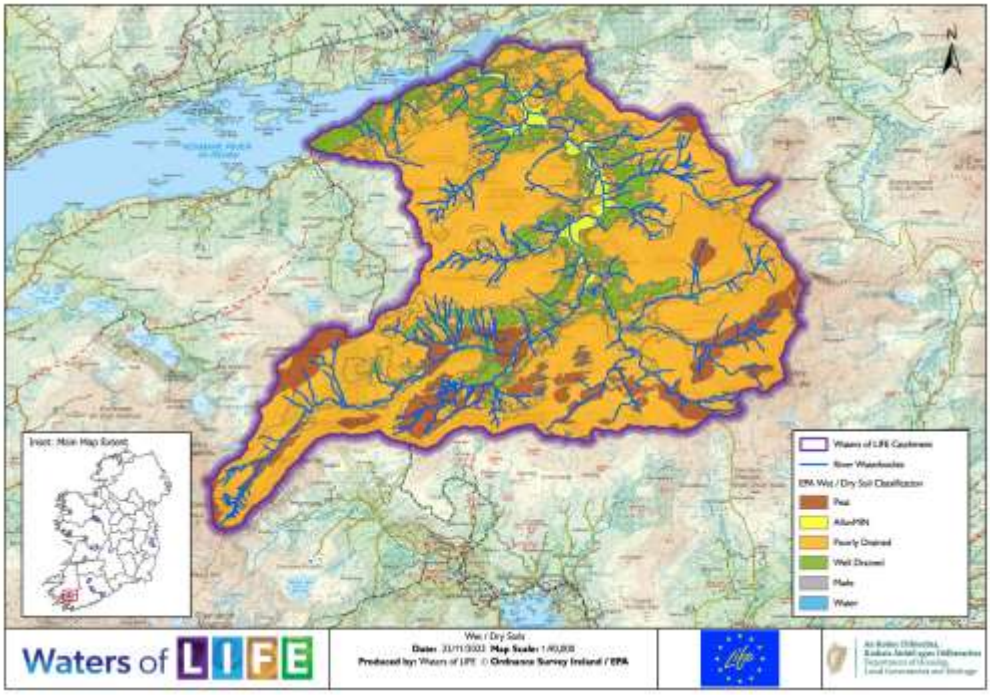


Figure A3-1 Wet/dry soils map, Sheen Control Catchment

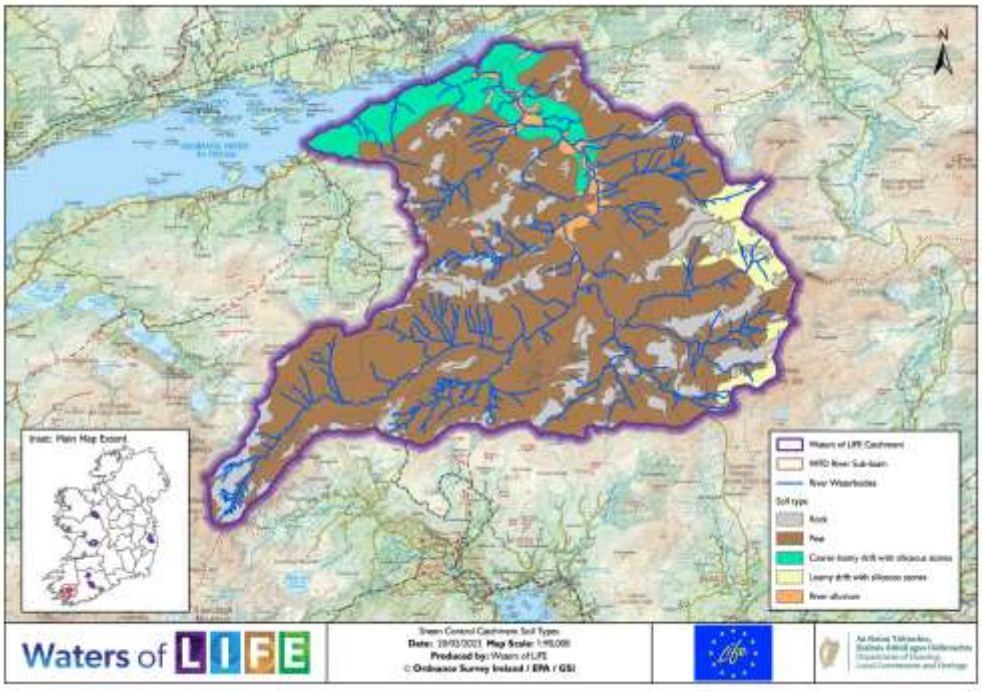


Figure A3-2 Soil Type, Sheen Control Catchment

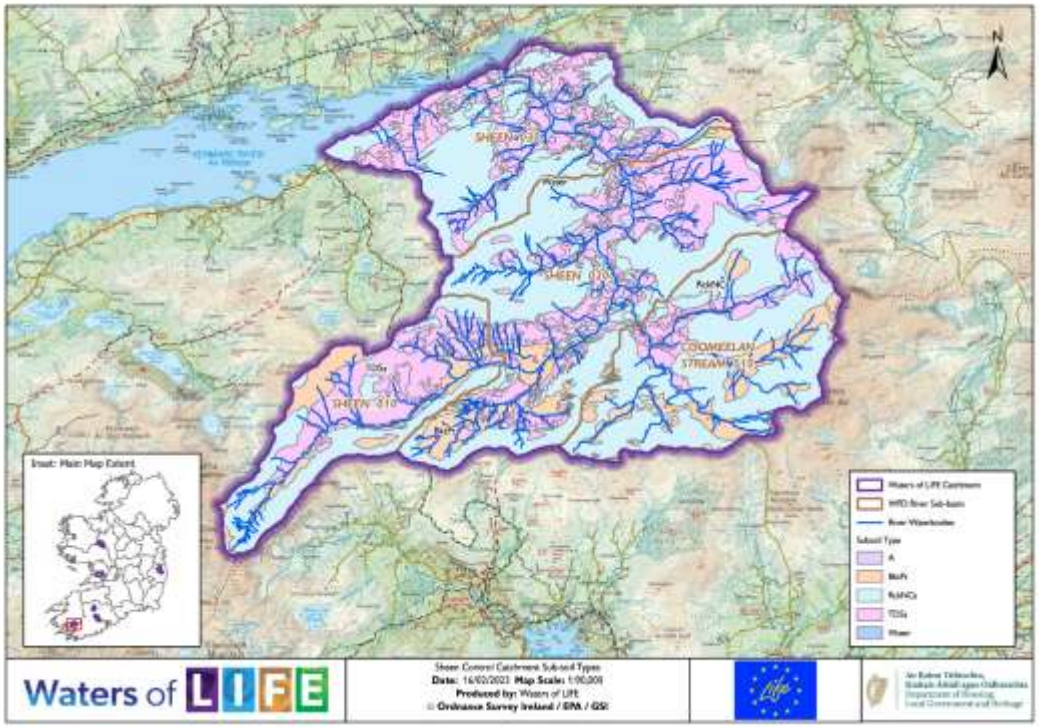


Figure A3-3: Subsoil type, Sheen Control Catchment

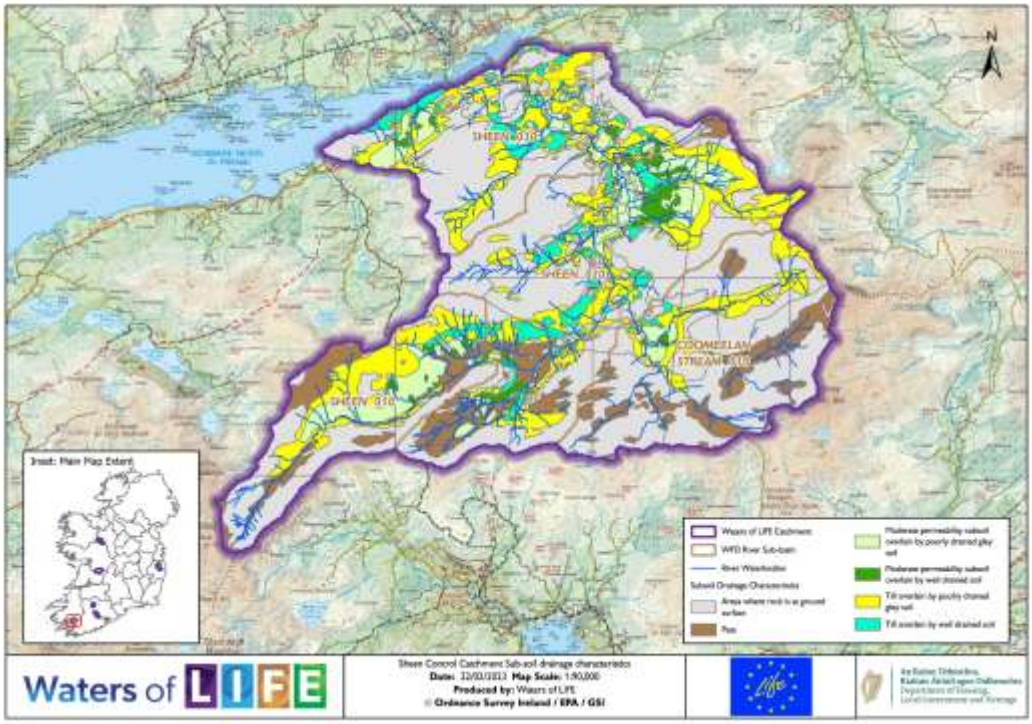


Figure A3-4: Subsoil drainage characteristics, Sheen Control Catchment

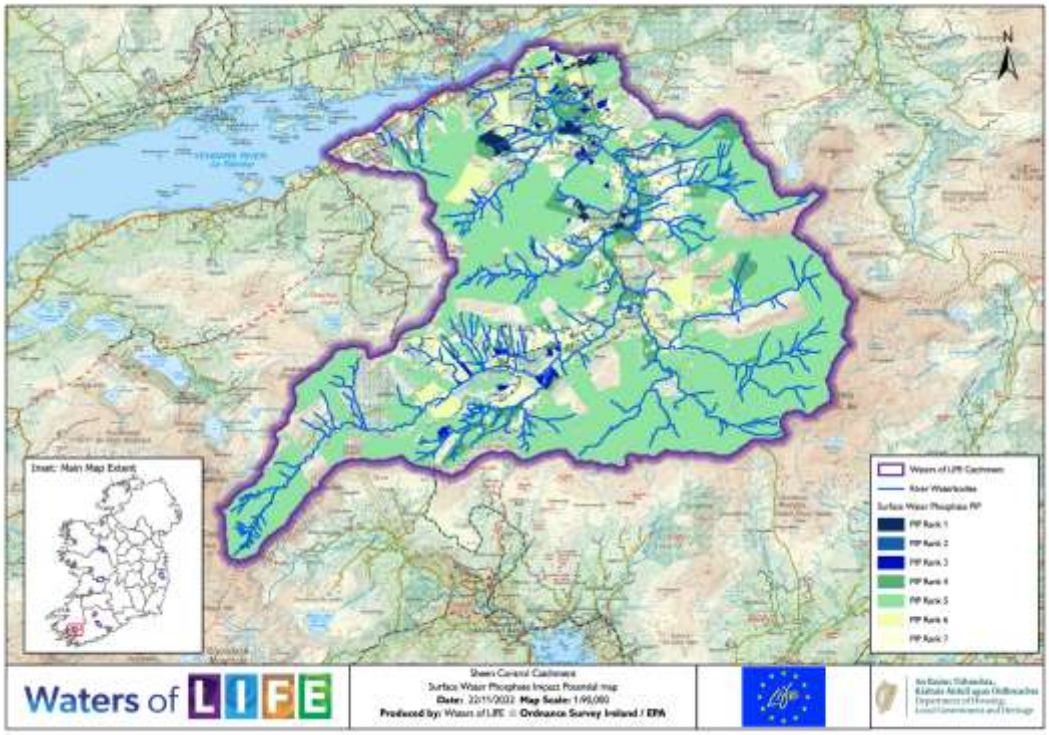


Figure A3-5: PIP map, phosphate critical source areas/pathways to surface waters

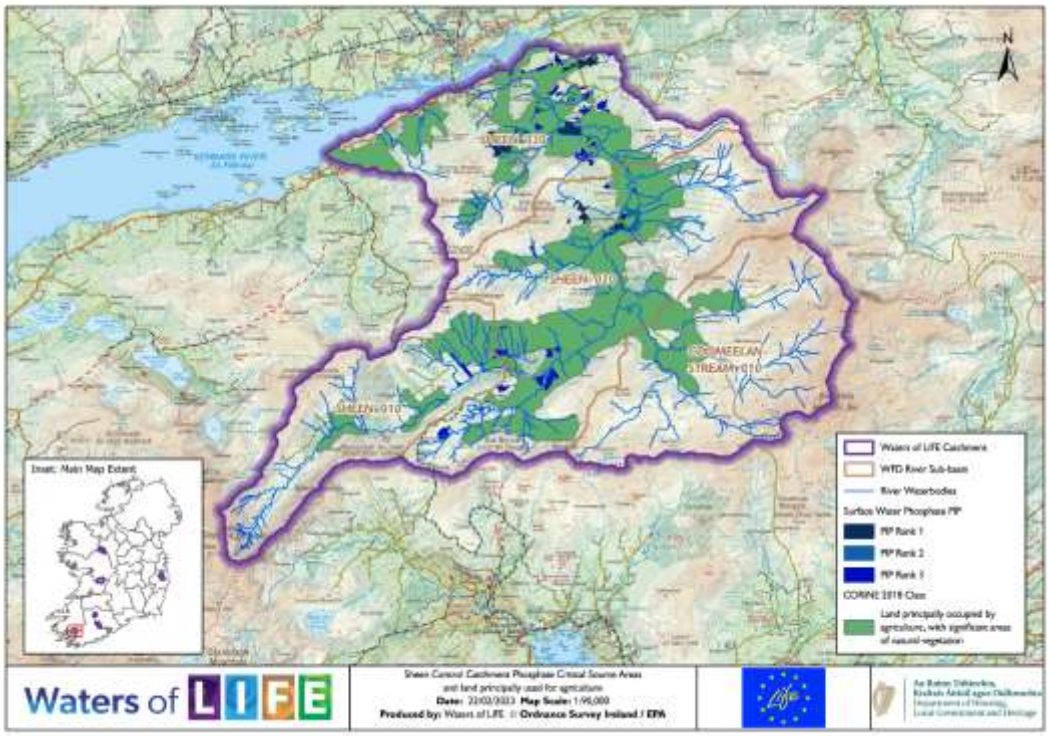


Figure A3-6: Phosphate critical source areas and land principally used for agriculture

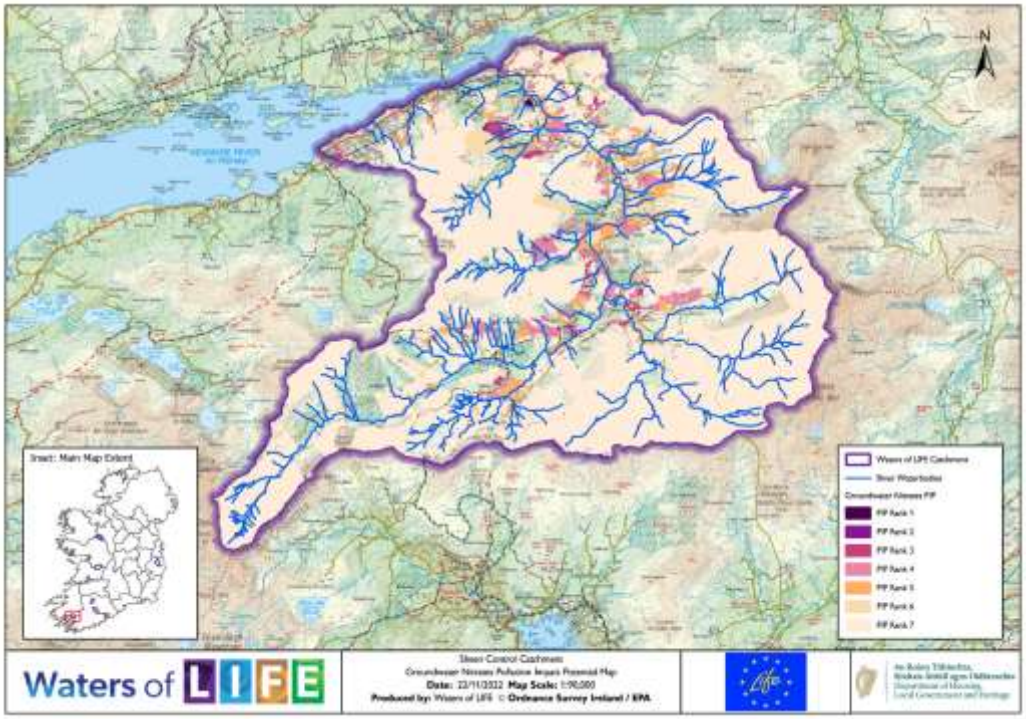


Figure A3-7: PIP map, nitrate critical source areas

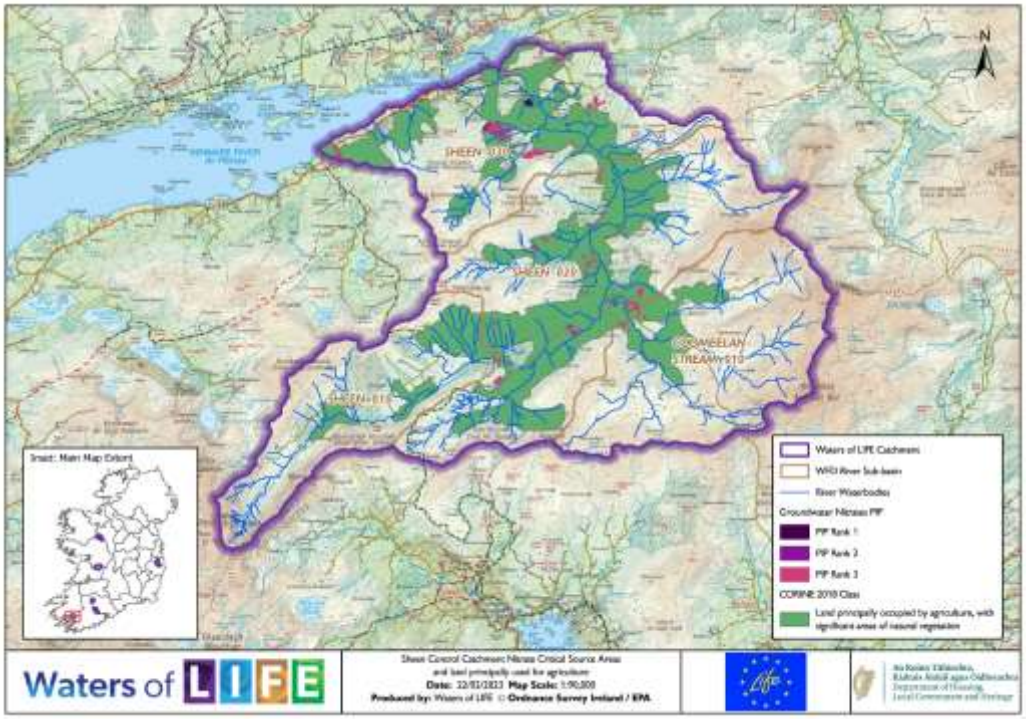


Figure A3-8: Nitrate critical source areas and land principally used for agriculture

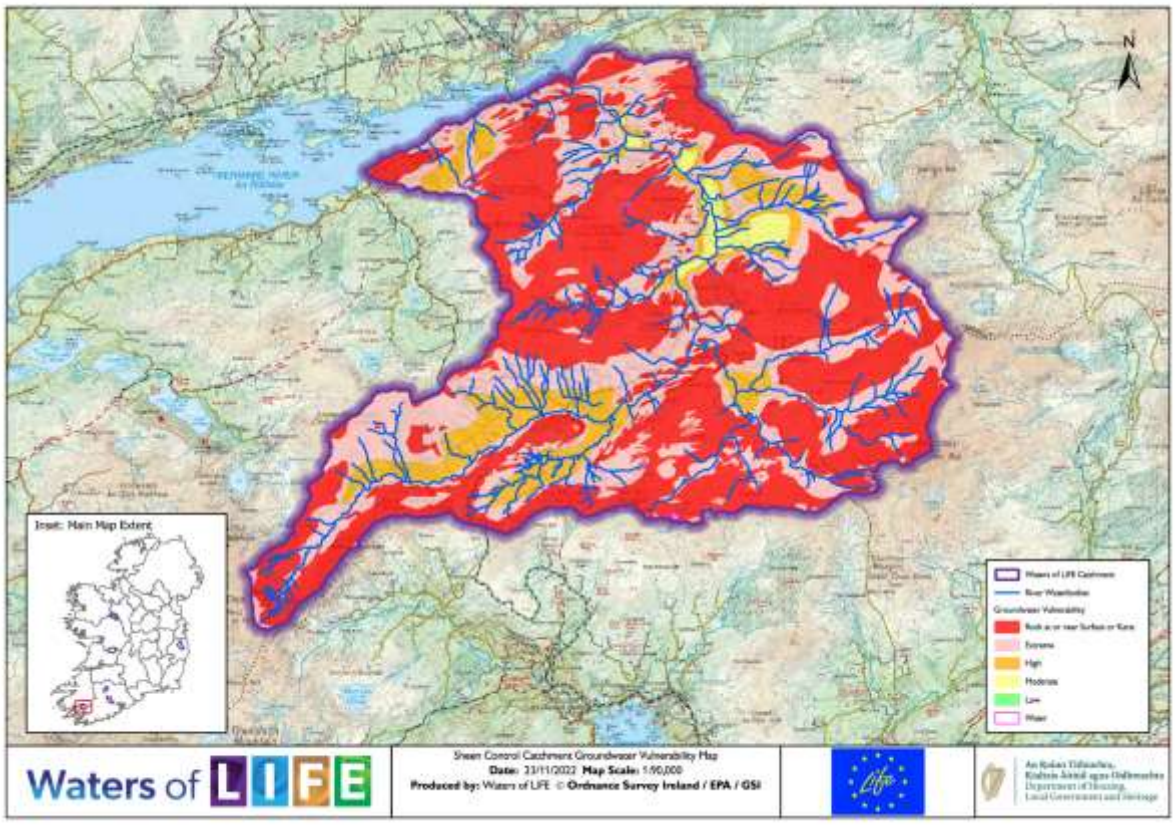


Figure A3-9 Groundwater vulnerability map, Sheen Control Catchment

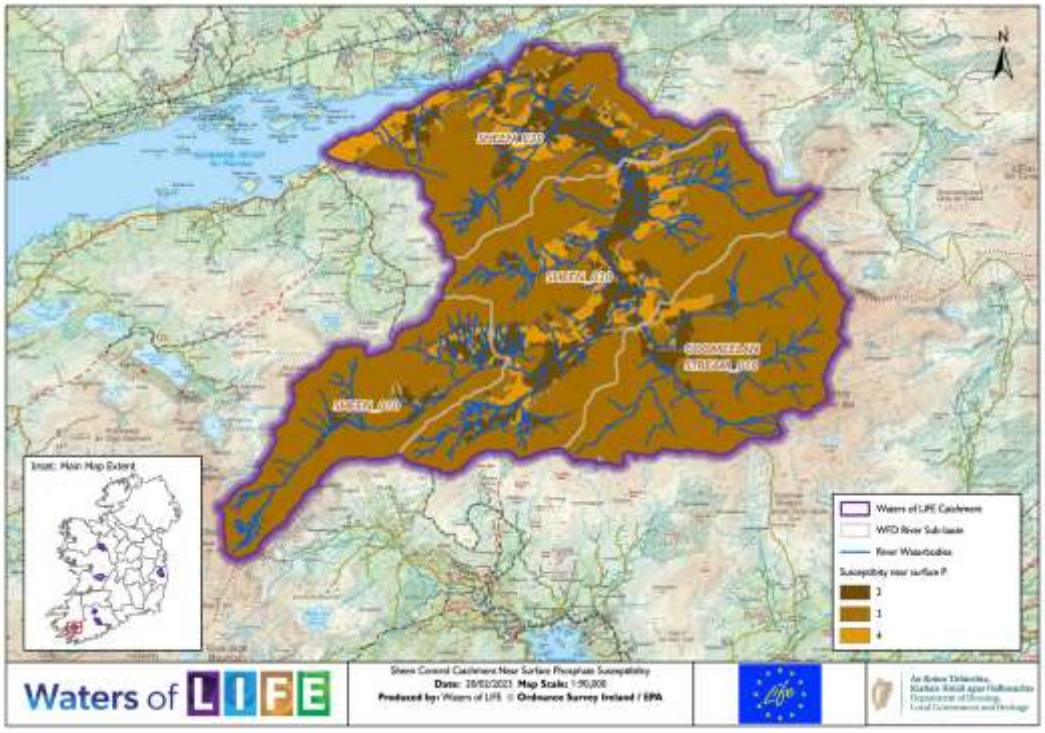


Figure A3-10 Susceptibility map for risk of phosphate loss to surface waters, Sheen Control Catchment

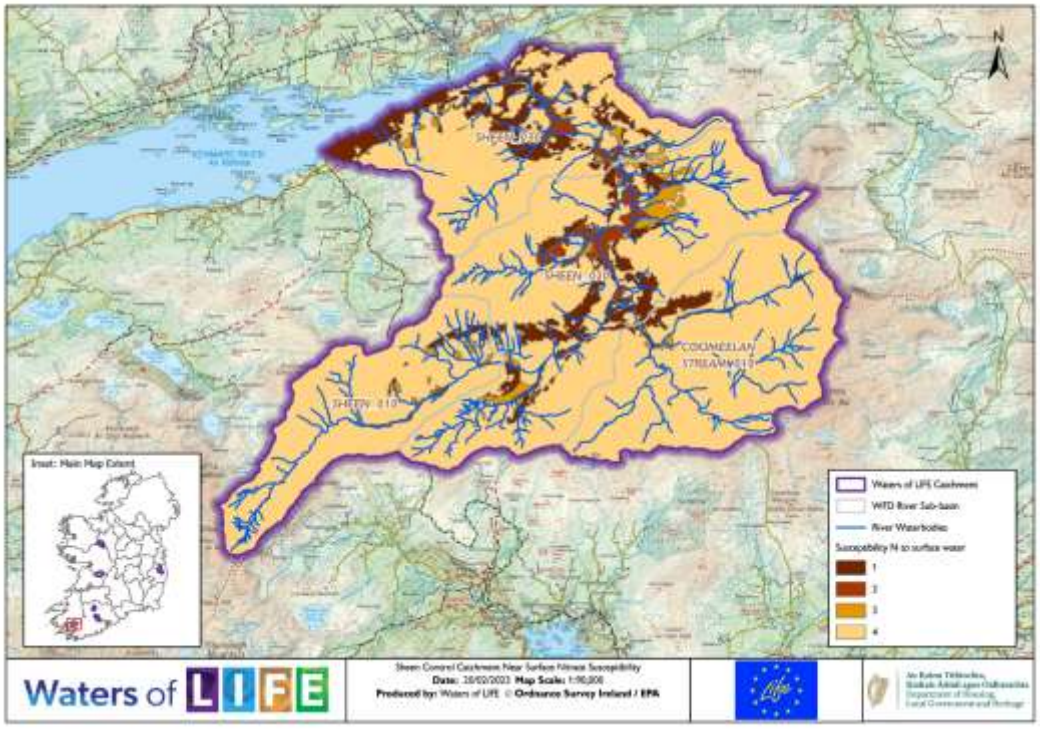


Figure A3-11 Susceptibility map for risk of nitrate loss to surface water, Sheen Control Catchment

Appendix 4: Settlement distribution and licensed facilities, Sheen Control Catchment

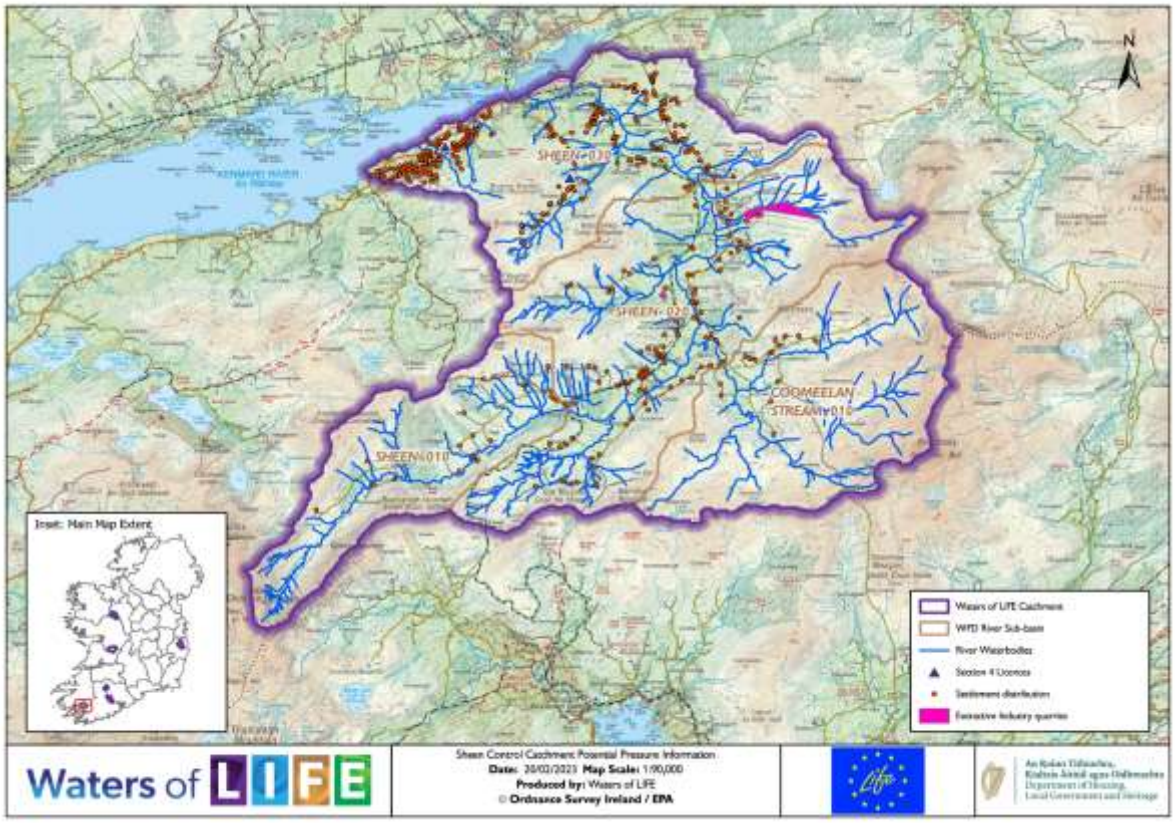


Figure A4-1 Settlement distribution and Section 4 licensed facilities, Sheen Control Catchment

Appendix 5: Drainage map, Sheen Control Catchment

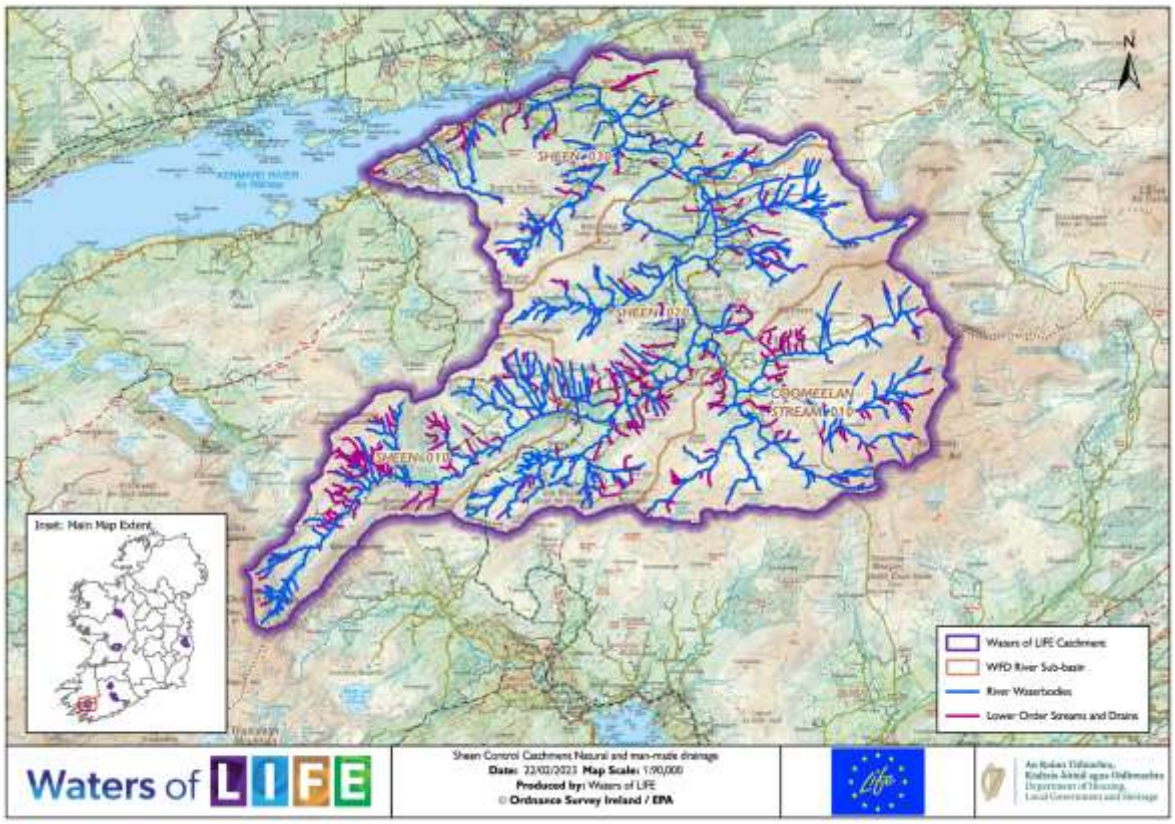


Figure A5-1 Natural and man-made drainage in the Sheen Control Catchment

Appendix 6: Protected sites, Sheen Control Catchment

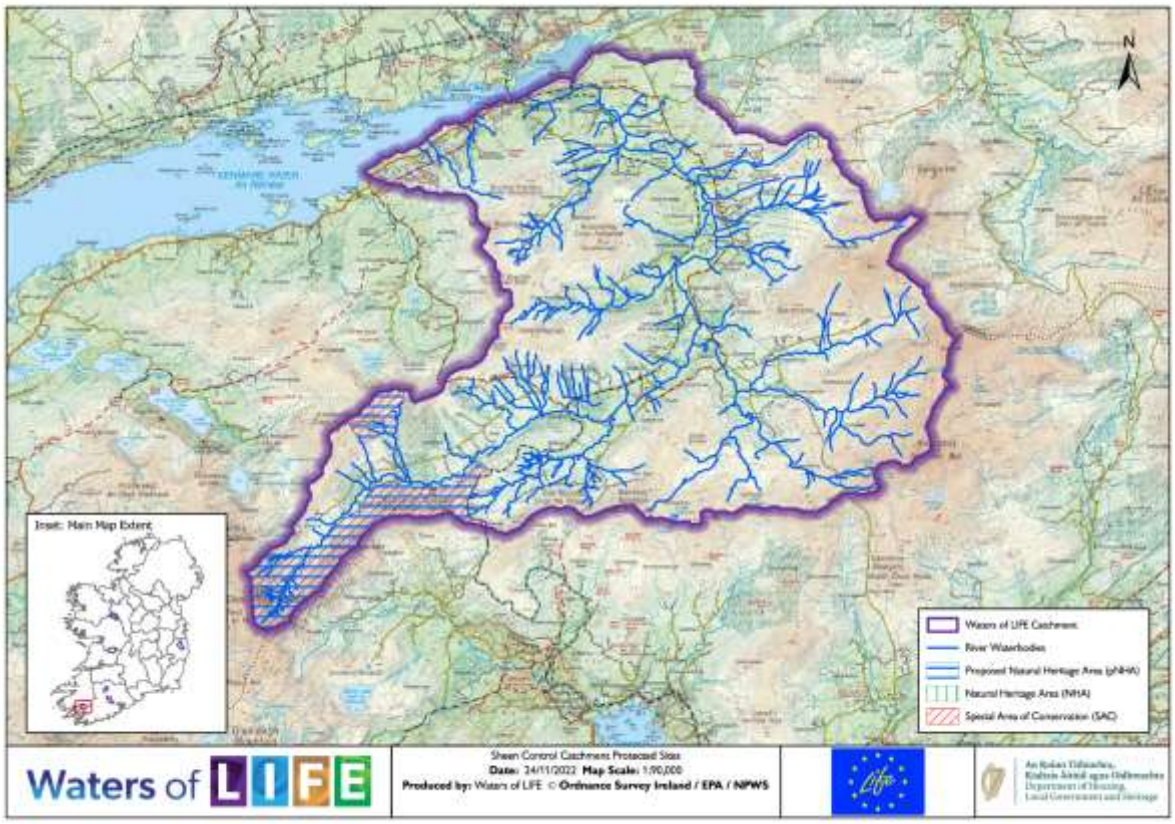


Figure A6-1 Protected sites in the Sheen Control Catchment