Sanitary Survey Report and Sampling Plan for

Kilmakilloge Harbour, Co. Kerry

Produced by

AQUAFACT - APEM Group

In conjunction with

The Sea Fisheries Protection Authority (SFPA)

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Statement of use:

Under EU Regulation 2019/627 which lays down uniform practical arrangements for the performance of official controls on products of animal origin intended for human consumption, a sanitary survey relevant to bivalve mollusc production in Kilmakilloge was undertaken in 2023. This report provides an appropriate hygiene classification zoning and monitoring plan based on the best available information with detailed supporting evidence. AQUAFACT undertook the desktop component of the work on behalf of the SFPA.

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Glossary, Acronyms, and Abbreviations

ADCP	Acoustic doppler current profiler
BMPA	Bivalve mollusc production area
Cefas	Centre for Environment, Fisheries and Aquaculture Science
cfu	colony forming unit
CPA	Classified Production Area
CRS	coordinate reference system
CSO	Central Statistics Office
Depuration	The process of purification or removal of impurities
DSW	Designated Shellfish Waters
E. coli	*Escherichia coli*
ED	Electoral Divisions
EU	European Union
GIS	Geographical Information Systems
GPS	Global Positioning System
Industry	Relates to shellfish producers, BIM (Bord Iascaigh Mhara) and any relevant shellfish production stakeholder.
kn	knots (kilometres per hour [km.h] is equal to 0.54 knots
MPN	Most Probable Number
NBDC	National Biodiversity Data Centre
Pollution	Encompasses *E. coli* contamination only for the purposes of this sanitary survey report.
RMP	Representative Monitoring Point
SAC	Special Area of Conservation
SFPA	Sea Fisheries Protection Authority
SI	Statutory Instrument
SPA	Special Protection Area
WGS84	World Geodetic System 1984 – datum featuring coordinates that change with time.

1. Executive Summary

Under Regulation (EU) 2017/625 and its subsequent Implementing Regulation (EU) 2019/627, there is a requirement for competent authorities intending to classify bivalve production and relaying areas to undertake a sanitary survey. The purpose of a sanitary survey is to determine the extent to which potential sources of pollution may impact a production area and ultimately inform the sampling plan for the National Microbiological Sampling Programme, as operated by the Sea Fisheries Protection Authority (SFPA); the results of which determine the annual classification for Bivalve Mollusc Production Areas (BMPAs). In the context of this sanitary survey report, pollution encompasses *E. coli* contamination only. In accordance with the European Union Reference Laboratory (EURL) Guide to Good Practice on the microbiological monitoring of bivalve mollusc harvesting areas, a re-evaluation of pollution sources and the sampling plan (primary sanitary survey) should be undertaken if a time trigger (six years or more since the last survey) or a change in the environment has occurred. The production of Pacific oyster (*Magallana gigas*) in Kilmakilloge Harbour ceased a number of years ago. The shellfish industry in Kilmakilloge Harbour have submitted a request to recommence production of Pacific oyster. Additionally, the current representative monitoring points (RMPs) for mussels in Kilmakilloge Harbour were not initially chosen based on a sanitary survey. Consequently, a sanitary survey must be undertaken to determine species-specific RMPs. This report identifies the sources and types of faecal, *i.e.*, *E. coli*, contamination discharging into Kilmakilloge Harbour and assess whether or not these sources are likely to affect the microbiological concentration in the production area.

Kilmakilloge Harbour is approximately 5.64 km^2 in area, located on the south shore of Kenmare Bay, Co. Kerry. It is part of the Southwestern River Basin District and is entirely covered by Water Framework Directive (WFD) designated shellfish waters. There are two licensed salmon sites and one licensed scallop site within Kilmakilloge Harbour, though only the latter is currently active. Licensed aquaculture is dominated by production of blue mussel in Kilmakilloge Harbour, and there is one licensed Pacific oyster production site.

Upon the reviewed classification of the production area in Kilmakilloge Harbour, the sampling plan recommends a minimum of 15 individual blue mussels of market size (minimum length of 4 cm) and a minimum of 10 individual Pacific oysters (minimum 8 cm in length) be collected (CEFAS[1]; European Commission[2]) on a monthly basis year-round.

This report endeavours to document and quantify all known sources of pollution entering Kilmakilloge Harbour. The investigation concluded that the primary sources of pollution in Kilmakilloge Harbour are the Lauragh River and associated Owenshagh river water body, the population density in permanent households on private septic tanks may also influence the *E. coli* levels in Kilmakilloge Harbour. Nevertheless, 2016-2021 WFD ecological status for river sub-basins discharging into Kilmakilloge Harbour was Good, and Kilmakilloge Harbour transitional water body was assigned a High ecological status (EPA Catchments[28]). The Owenshagh

river water body is expected to channel diffuse agricultural pollutants as it flows through agricultural land, along with domestic and urban wastewater contamination since this water body primarily occurs within the Glanmore Electoral Division (ED), the ED with the highest calculated population in the contributing catchment. Therefore, this river water body, the tributaries of which ultimately funnel into the Lauragh River, is potentially the main driver for contamination levels in the production area. However, it should be noted that the bacteriological survey results from near the Lauragh River discharge point had low levels of *E. coli*. The highest *E. coli* result from the bacteriological survey was obtained from a sample taken on the southwestern shoreline of Kilmakilloge Harbour (**section 9.2.2**). Furthermore, there may be seasonal differences in contamination levels. For example, increased numbers of lambs within the contributing catchment are expected during the spring/summer seasons. Additionally, Met Éireann rainfall data show higher volumes of rainfall from October to January; both of the aforementioned may result in increased *E. coli* levels.

In accordance with Regulation 627/2019 concerning Live Bivalve Mollusc Sanitary Surveys, this report mandates significant updates to the classification sampling for Kilmakilloge Harbour. Specifically, there is a transition from three to two RMPs designated for blue mussels with alternate locations, and one RMP has been designated for Pacific oysters (**Figure 6-1** and **Figure 6-2,** respectively). These changes are imperative for meeting legislative requirements and essential for the accurate monitoring and classification of shellfish production areas and safe harvesting practices. The mussel RMPs for monitoring *E. coli* levels have been strategically chosen based on a range of hydrodynamic and spatial features that include areas of similar depth, tidal currents, suspended sediment levels, and freshwater influence. Interpretation of current data indicates that, on the ebbing tide, the flow of water splits when it meets Spanish Island (**Figure 8-1**) so the two blue mussel RMPs have been assigned accordingly. As there is only one licensed Pacific oyster site in Kilmakilloge Harbour, the Pacific oyster RMP has been located on this site. Data on discharge points from the desktop and shoreline surveys influenced the positioning of this RMP. Therefore, the current mussel RMPs (**Figure 5-1**) in Kilmakilloge Harbour will be discontinued and replaced with the proposed RMPs as set out in this report.

2. Introduction

Consumption of raw or lightly cooked bivalve molluscs can result in illness due to the presence of microorganisms, many of which are derived from faecal contamination of the marine environment. Shellfish contaminated with pathogenic microorganisms may cause infectious disease in humans and such outbreaks are more likely to occur close to our coasts where production areas are impacted by sources of human and animal faecal contamination; referred to as pollution for the purposes of this report. The risk of contamination of bivalve molluscs with pathogenic microorganisms is assessed through microbiological monitoring programmes. This assessment results in the classification of bivalve mollusc production areas (BMPA), which in turn governs the level of treatment required before human consumption of the shellfish.

Under European Union (EU) regulations sanitary surveys of bivalve mollusc production areas and their associated hydrological catchments and coastal waters are required to establish the appropriate representative monitoring points (RMPs) for these monitoring programmes. Specifically, under regulation (EU) 2017/625 and its subsequent implementing regulation (EU) 2019/627, there is a requirement to carry out a sanitary survey before classifying any shellfish production or relaying area. Article 56 of Implementing Regulation 627 of 2019 states:

1. Before classifying a production or relaying area, the competent authorities shall carry out a sanitary survey that includes:
    a. An inventory of the sources of pollution of human or animal origin likely to be a source of contamination for the production area,
    b. An examination of the quantities of organic pollutants released during the different periods of the year, according to the seasonal variations of human and animal populations in the catchment area, rainfall readings, wastewater treatment, *etc*. and
    c. Determination of the characteristics of the circulation of pollutants by virtue of current patterns, bathymetry and the tidal cycle in the production area.
2. The competent authorities shall carry out a sanitary survey fulfilling the requirements set out in paragraph one in all classified production and relaying areas, unless carried out previously.
3. The competent authorities may be assisted by other official bodies or food business operators under conditions established by the competent authorities in relation to the performance of this survey.

In addition, Article 57 of the same regulation requires competent authorities to establish a monitoring programme for live bivalve mollusc production areas that is based on an examination of the sanitary survey described above. Currently, the Sea Fisheries Protection Authority (SFPA) in conjunction with AQUAFACT - APEM Group (AQUAFACT) are conducting sanitary surveys for new bivalve mollusc production areas and for those existing classified production areas which were previously not surveyed. This report contains the

documents relevant to the sanitary survey of the bivalve mollusc production area at Kilmakilloge Harbour, County Kerry. It identifies the representative monitoring points and supporting sampling plan for mussels and oysters in Kilmakilloge Harbour. It also sets out the production area boundaries in the bay.

3. Overview of the Fishery/Production Area

3.1. Description of the Area

Kilmakilloge Harbour is located on the south shore of Kenmare Bay, Co. Kerry (**Figure 3-1**). Kenmare Bay is a long, narrow southwest facing bay bordered by both Counties Cork and Kerry. At *c.* 5.64 km^2 Kilmakilloge harbour is part of the Southwestern River Basin District. The Water framework Directive (WFD) designated shellfish waters (DSW) area is 5.7 km^2 while the contributing catchment to these shellfish waters spans an area of approximately 75.6 km^2. Directly adjacent is the Kenmare River/Sneem/Ardgroom DSW which has a larger contributing catchment[3].

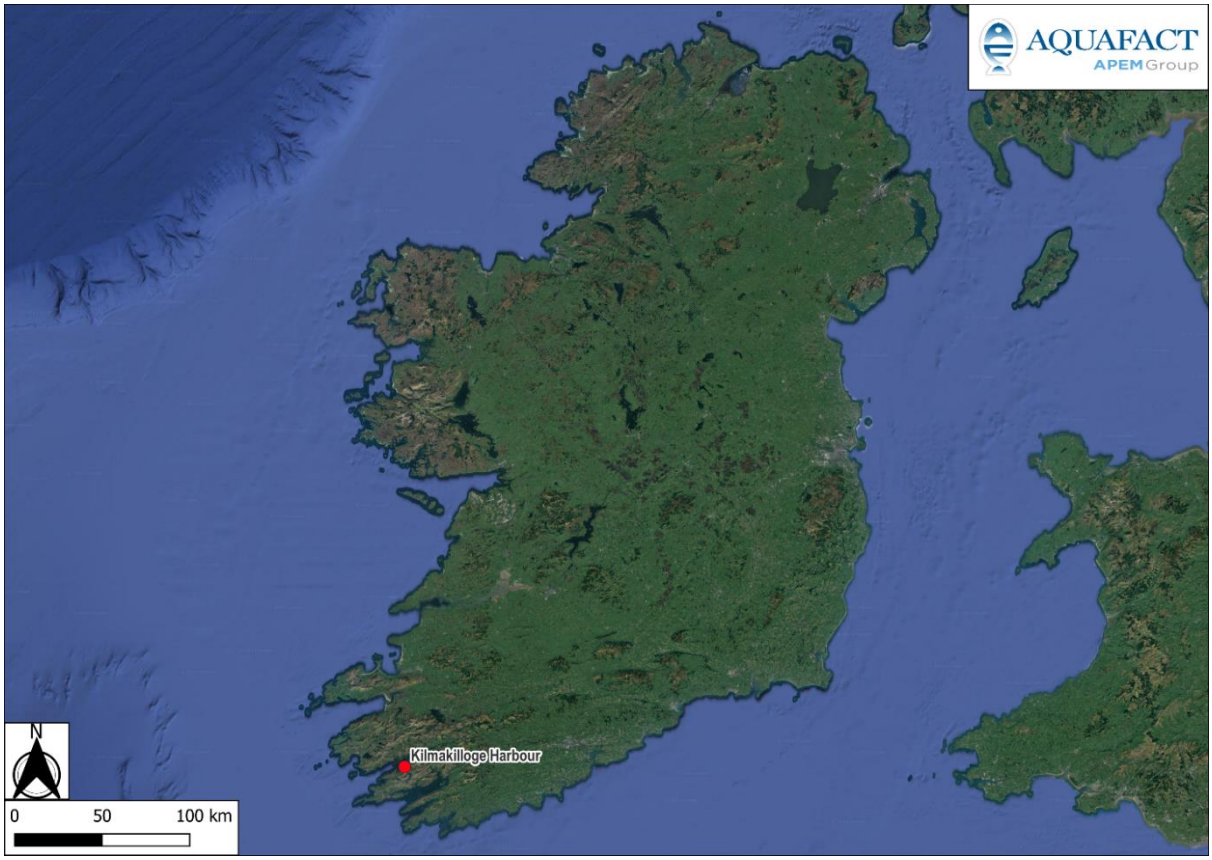


Figure 3-1: Location of Kilmakilloge Harbour, Co. Kerry.

The Owenshagh sub-catchment within the Dunmanus-Bantry-Kenmare Water Framework Directive (WFD) catchment covers the land surrounding Kilmakilloge Harbour (**Figure 3-2**). As defined on EPA Catchments[4], regarding water "a catchment is simply defined as an area of land around a river, lake or other body of water". The Owenshagh sub-catchment is comprised of six river sub-basins, five of which (partially or fully) discharge into Kilmakilloge Harbour. It is necessary to note that WFD river water bodies were established for hydrological purposes and not bacteriological, which is what is required for this sanitary survey. Kilmakilloge Harbour contributing catchment has been determined accordingly by amending the boundaries of these five river sub-basins for the purposes of this sanitary survey report only. AQUAFACT has determined a boundary line based

on the river waterbodies that flow into Kilmakilloge Harbour and simultaneously the Designated Shellfish Waters (DSW) within this bay (see Figure 3-2 for river water bodies and boundary line). According to Article 2(10) of Directive 2000/60/EC a "body of surface water means a discrete and significant element of surface water such as a lake, a reservoir, a stream, river or canal, part of a stream, river or canal, a transitional water or a stretch of coastal water." As rivers are defined under the same directive as mainly being on the surface, a river waterbody can therefore be described based on the definition of a "body of surface water". The area within this boundary line will be hereafter referred to as Kilmakilloge Harbour contributing catchment/the contributing catchment. Kilmakilloge Harbour contributing catchment covers an area of *c*. 75.6 km^2. The contributing catchment is dominated by the Lauragh River, the river into which the Owenshagh river water body converges, and which drains *c*. 46.3% of the contributing catchment.

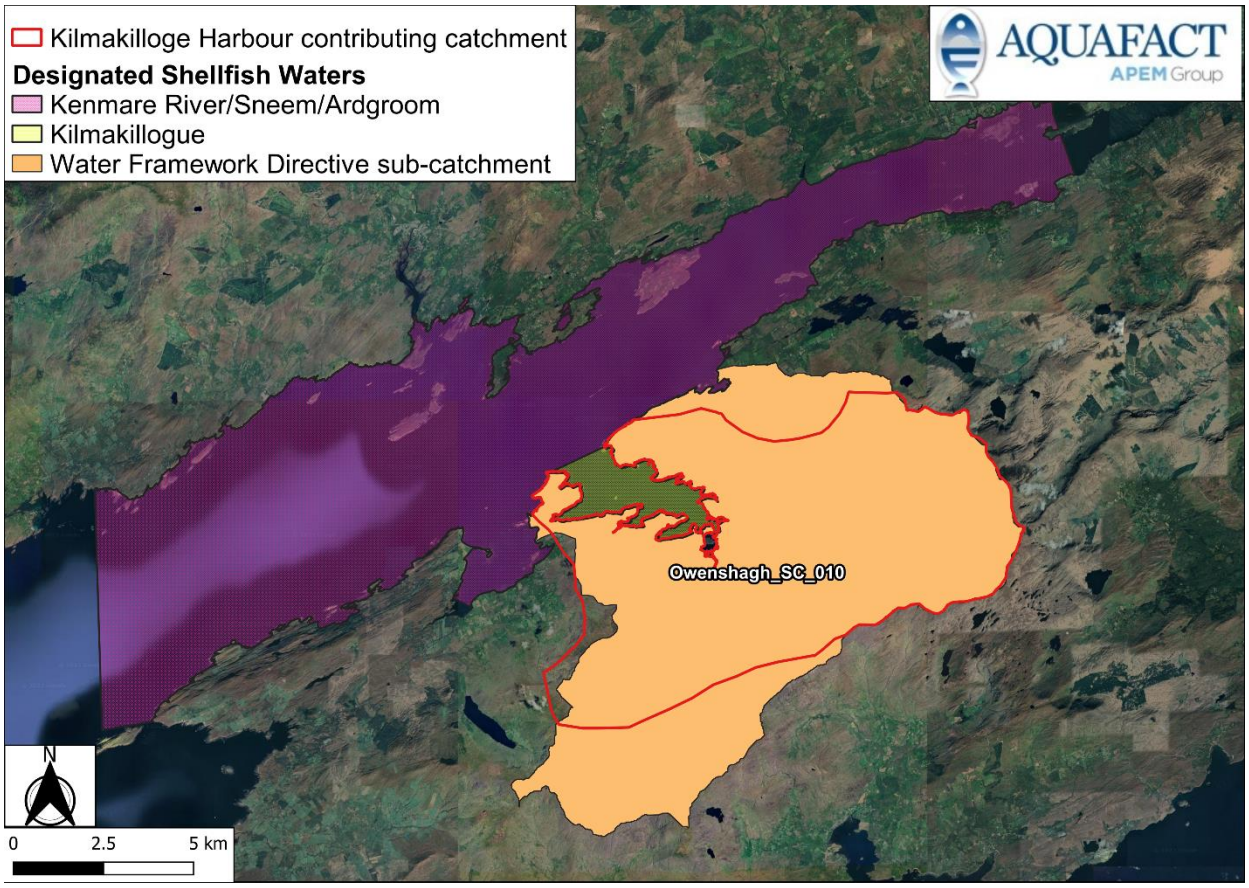


Figure 3-2: Water Framework Directive Owenshagh sub-catchment surrounding Kilmakilloge Harbour with specific areas of the sub-catchment that contribute to Kilmakilloge Harbour outlined in red. Only those Designated Shellfish Waters that are relevant to Kilmakilloge Harbour are displayed in this map.

Kilmakilloge Harbour is part of the Kenmare River Special Area of Conservation (SAC). This SAC is designated for the presence of a number of important Annex I/II habitats and species[5]. Kenmare River SAC is a deep, drowned glacial valley with old red sandstone as bedrock forming reefs. Numerous islands and inlets along the SAC contribute to the diversity of marine communities and habitats. In exposed areas the sublittoral sediment is composed of coarse shelly sand and gravel, whereas muddy sand primarily comprises the more sheltered

areas. Maërl occurs in sheltered bays of the Kenmare River SAC. Salt meadows occur in the sheltered area of Kilmakilloge Harbour supporting a diversity of species[5].

The Corine land cover within Kilmakilloge Harbour contributing catchment is largely made up of peat bogs (41%) and to a lesser extent a mixture of moors and heathland, sparsely vegetated areas and land principally occupied by agriculture. A small percentage of land (<11%) in the contributing catchment consists of pastures, natural grasslands, mixed forest, coniferous forest, broad-leaved forest, bare rocks, sea and ocean, and water bodies (**Figure 7-6**).

3.2. Kilmakilloge Harbour Shellfish Fisheries

3.2.1. Location/Extent of Growing/Harvesting Area

Kilmakilloge Harbour is almost entirely covered by DSW but is not currently a classified production area (CPA) (**Figure 3-2**). **Figure 3-3** shows the current locations of licensed aquaculture sites within Kilmakilloge Harbour. Sites coloured aqua blue are licensed blue mussel (*Mytilus edulis*) sites, these sites are further detailed in **section 3.2.2.1** and are colour coded by licence in **Figure 3-4**. Site T06/024 (dark orange) is licensed for blue mussel with a total area of *c.* 0.095 km^2. Site T06/033A (pink) is licensed for blue mussel with a total area of *c*. 0.053 km^2. Site T06/035A (green) is licensed for blue mussel with a total area of *c*. 0.026 km^2. Site T06/106 (lilac) is licensed for blue mussel with a total area of *c.* 0.055 km^2. Site T06/114 (purple) is licensed for blue mussel with a total area of *c.* 0.04 km^2. T06/131 (light orange) is licensed for blue mussel with a total area of *c*. 0.04 km^2. Site T06/149B (red) is licensed for blue mussel with a total area of *c*. 0.085 km^2. Site T06/154 (dark blue) is licensed for blue mussel with a total area of *c*. 0.044 km^2. Site T06/190 (light blue) is licensed for blue mussel with a total area of *c*. 0.039 km^2. Site T06/390A as detailed in **Figure 3-5** is licensed for Pacific oyster (*Magallana gigas*) and European flat oyster (*Ostrea edulis*) with a total area of *c*. 0.022 km^2, however only Pacific oyster are being grown there currently. Site T06/327A (**Figure 3-3**; yellow) is licensed for Great Atlantic scallop, however this site is not active at present. Should producers wish to initiate operations for these additional shellfish species, they are required to contact the SFPA, and a further sanitary survey may be required.

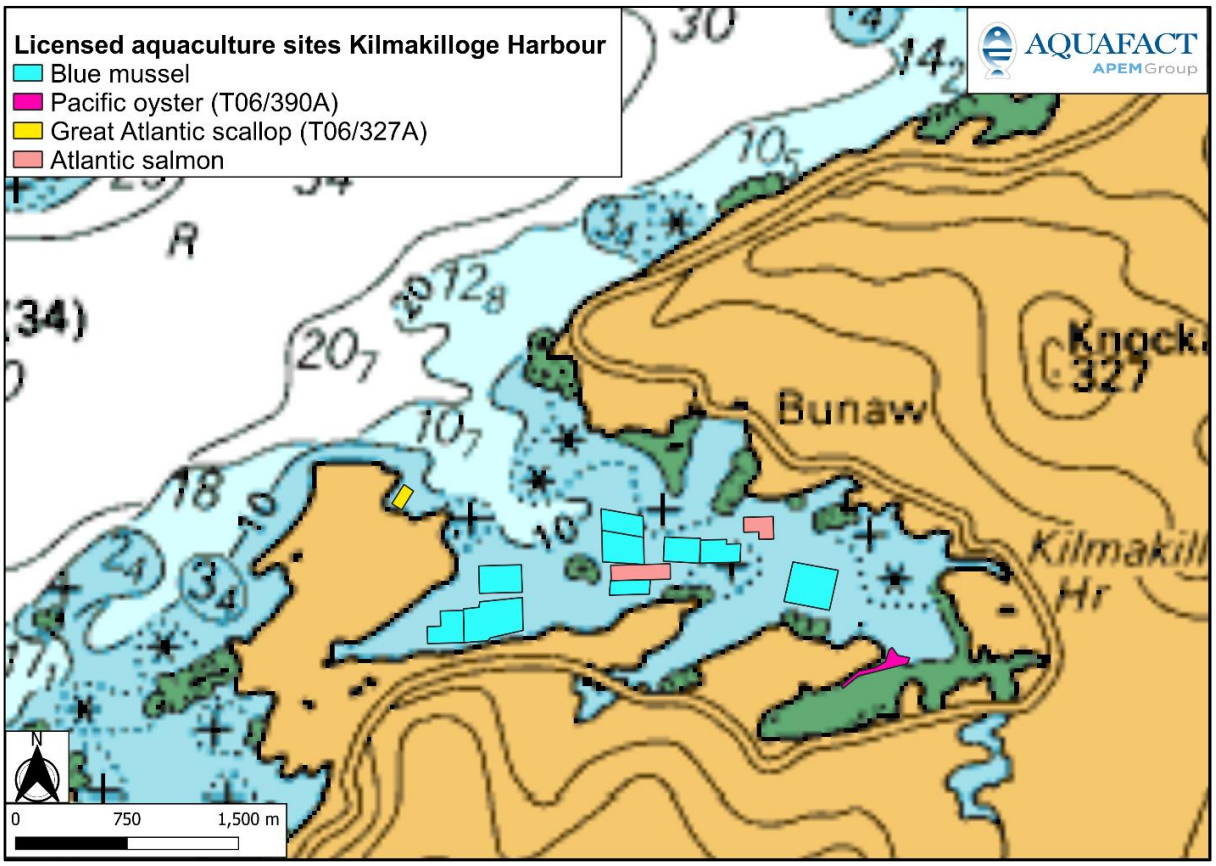


Figure 3-3: Licensed aquaculture sites within Kilmakilloge Harbour, Co. Kerry.

3.2.2. Description of Bivalve Species

3.2.2.1. Mussels (Mytilus edulis)

Distribution

Figure 3-4 shows the locations of the licensed mussel sites in Kilmakilloge Harbour which cover an area of 0.477 km^2. Each licensed site in **Figure 3-4** is colour coded to distinguish the licensed boundaries.

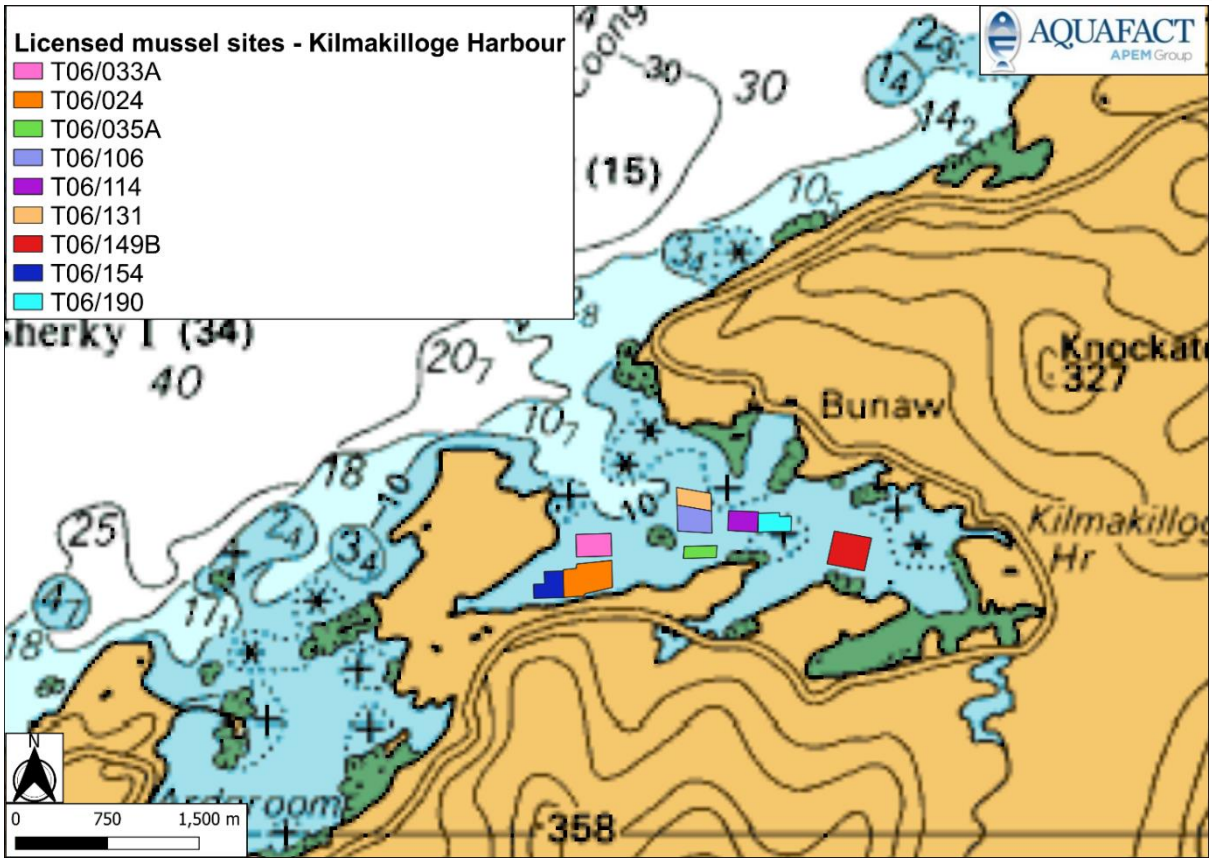


Figure 3-4: Licensed blue mussel sites within Kilmakilloge Harbour.

Fishery

Mussels (*M. edulis*) have been produced in Kilmakilloge Harbour since the early 1980s, using the longline method (BIM, 2023 *unpubl.*), and continue to be produced currently with longlines using natural spatfall. The mussel seed is on-grown for 18-24 months, until the mussels reach market size, and can then be harvested (Marine Institute, 2019). The annual average tonnage of mussels produced in this area varies from year to year (BIM, 2023 *unpubl.*). The 5-year (2018-2022) average tonnage of mussels produced is 809.6 tonnes (**Table 3.1**). Mussels are also licensed for production at other sites throughout Kenmare River.

Table 3.1: Annual Mussel (*Mytilus edulis*) production from 2018-2022 (source: BIM, 2023 *unpubl.*).

Year	Tonnes produced
2022	950.8
2021	900.2
2020	684
2019	649
2018	864
5-year average	809.6

*note this is all rope mussel. There is no record of recent scallop or oyster production up to and including 2022.

3.2.2.2. Pacific Oysters (*Magallana gigas*)

Distribution

Figure 3-5 shows the location of the licensed oyster site in Kilmakilloge Harbour which covers an area of 0.022 km^2.

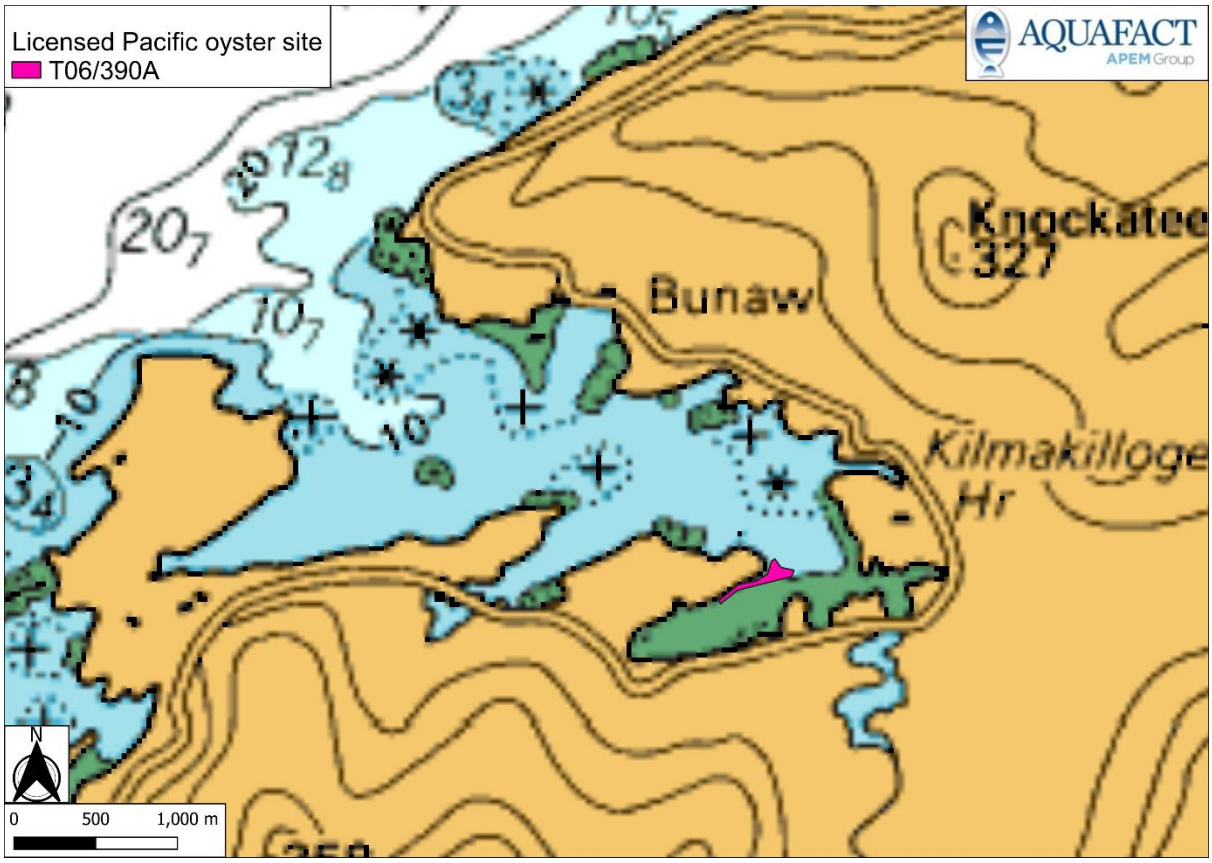


Figure 3-5: Licensed Pacific oyster site within Kilmakilloge Harbour.

Pacific oysters (*M. gigas*) were cultivated in Kilmakilloge Harbour in the past, with production between 2000 – 2002 approximately 4.3 tonnes/annum[6]. The site is also licensed for European flat oyster (*Ostrea edulis*) although this species has never been commercially produced here. Bags and trestles will be used at the licensed site for cultivation, with seed stocked according to the Department of Agriculture, Food and the Marine.

4. Overall Assessment of Pollution Sources Likely to be a Source of Contamination for Shellfish

This section endeavours to summarise the potential pollution sources impacting Kilmakilloge Harbour and the associated DSW; in the context of this report, pollution refers to *Escherichia coli* (*E. coli*) contamination only. For that reason, details on the local human population, boating activities, and sewage discharges are provided. Agricultural operations, as potential contamination sources, the contributions of rivers and streams, and how contaminants move throughout the bay based on currents, tidal data, and the bathymetry of Kilmakilloge Harbour are also discussed. Additional potential pollution sources including changes in tourism numbers and activities, yearly variations in agricultural practices, and seasonal precipitation are detailed. Notably, this section incorporates a detailed inventory of pollution sources observed during the shoreline survey, complemented by a discussion on the bacteriological sampling results acquired concurrently. Details of Special Protected Areas (SPAs) and SACs near the bay are also provided.

4.1. Human population

The population of Kilmakilloge Harbour contributing catchment is estimated at 289 people with no towns or large urban areas. The population of the contributing catchment falls well below the average density for rural Ireland with 3.8 people per km^2 compared to 27 people per km^2 nationally in rural areas and is very low in comparison to the population density of Ireland (70 people per km^2)[7]. The census recorded 974 households across the three Electoral Divisions (EDs), of which 16.7% are vacant and 31.6% are unoccupied holiday homes. Of the estimated 265 households within the contributing catchment, 13.9% are vacant, 49% are permanent households and 38.4% are unoccupied holiday homes. Sewage and wastewater levels are likely to increase during the summer season when holiday homes are more frequently used, therefore potentially increasing the *E. coli* discharged into Kilmakilloge Harbour.

4.2. Boating

Nine potential piers/slipways/boat access points were identified during the desktop survey, however the shoreline survey validated only three of these (**Figure 7-19**, **Table 7.7**, map ID 9, 36, 59). No comment was made on boating in the harbour by the shoreline survey. Boat activity in the harbour is expected to be low, with increased levels due to operational vessel deployment during October-April for harvesting season.

4.3. Sewage Discharges

This report presents a focused summary of potential *E. coli* contamination sources in Kilmakilloge Harbour, based on observations and data collected during the desktop and shoreline surveys at the time of reporting. It is important to note that these findings are specific to the conditions observed at that particular time and should be considered as a snapshot, not an exhaustive representation of ongoing conditions. At the time of writing this report, there were no wastewater treatment works within Kilmakilloge Harbour contributing

catchment. There were also no rainfall dependent or emergency sewage discharges within the contributing catchment. Of the 115 permanent households within the contributing catchment, sewage from the majority (92.3%) of households is treated by individual septic tanks or other individual treatment, and a small number (1.8%) are on the public sewage scheme. However, without definitive data on the location of these septic tanks it is challenging to use these data in the selection of specific RMP locations. There is a high percentage of households on private treatment systems, however the overall population of Kilmakilloge Harbour contributing catchment is low compared to the rest of Ireland. The settlement pattern is not well dispersed over the EDs, with a higher estimated population in Glanmore, more than double that of Ardea, the next highest estimated population. The Glanmore ED dominates the contributing catchment in terms of area and borders the entire southern shore of the harbour.

There are no industrial discharges within Kilmakilloge Harbour contributing catchment that have emissions to water. There is one Section 4 discharge in the contributing catchment, but it has no emissions to water; therefore, it is highly unlikely to add to faecal contamination loading in Kilmakilloge Harbour.

The shoreline survey revealed a number of potential *E. coli* inputs via more than 24 streams, four culverts and nine drains/pipe discharges (**Figure 7-36**). Water quality of river water bodies within the contributing catchment were of High status during the 2016-2022 monitoring period according to the EPA[4;22] (**Figure 8-3**) and this coincides with the findings of the shoreline survey where all culverts and streams, where noted, were reported as running clear. Turbidity can affect water clarity as high concentrations of particulate matter can have effects on light penetration and habitat quality and particles provide attachment for pollutants such as bacteria[8]. However, the shoreline survey noted that occasionally there was a stream draining an area where slurry spreading was observed, and this could potentially lead to a decrease in water quality.

4.4. Agricultural Sources

Land use within the contributing catchment is principally peat bogs (41%), moors and heathland (19%), and sparsely vegetated areas (17%). Agricultural land (pastures 2% and land principally occupied by agriculture 11%) accounts for 13% of Kilmakilloge Harbour contributing catchment. As agriculture is anticipated to be a source of *E. coli* pollution, it is notable that land principally occupied by agriculture occurs mainly along the coast of the contributing catchment, overlapping with multiple rivers and discharges entering Kilmakilloge Harbour.

According to the Census of Agriculture 2020[7], there are 2,434 cattle in the EDs that overlap with the contributing catchment, with the highest number of total cattle occurring in Kilcatherine (1,457). However, Kilcatherine has the smallest overlap with the contributing catchment, and the estimated number of total cattle actually within the contributing catchment in Kilcatherine is 37 cattle. The density of total cattle in the contributing catchment is low at *c.* 0.18 cattle/ha of farmland, compared to 1.31 LSU/ha, the 2022 average

stocking rate for Ireland (Teagasc, 2023). While Teagasc uses different criteria compared to the CSO to define cattle and cows, dairy cows are considered separately under both definitions (Teagasc, 2023).

There are 13,173 sheep in the contributing catchment, with the largest number occurring in Glanmore (9,796). This is of particular importance to note as the Glanmore ED coincides with much of the shoreline within the contributing catchment, and therefore provides a direct route for *E. coli* pollution to discharge into the BMPA. The stocking density for sheep in the contributing catchment (*c.* 3.7 sheep/ha of farmland) is higher when compared to 1.12 LSU/ha, the average total stocking density for sheep in 2022 (Teagasc, 2023). The high number of sheep is consistent with the 2021 census of sheep which reports Kerry as falling under the top-five counties with the largest populations of sheep in Ireland[9]. Considering this high number of sheep compared to other livestock, sheep likely account for the majority of agricultural pollution in the contributing catchment, particularly after periods of elevated rainfall when the surface water runoff may bring more faecal contamination into the harbour. One location with sheep and one with cattle were noted during the shoreline survey (**Table 7.7, Figure 7-19**, map ID. 51 and 52, respectively); the number of sheep or cattle observed at these locations was not noted.

Water sampling during the shoreline survey showed evidence of contamination at all nine stations sampled (**Table 9.6**). Currently, there are no guideline values for *E. coli* in DSW, however, apart from station 8, the water samples from Kilmakilloge Harbour are not considered to have high *E. coli* levels. Station 8 is thought to have moderate levels of *E. coli* (426 cfu/100 ml).

4.5. Rivers and Streams

Kilmakilloge Harbour drains a catchment of *c.* 75.61 km^2 and is dominated by the Owenshagh and Croanshagh river water bodies which combined drain 74.1% of the contributing catchment (46.2% and 27.9%, respectively) (**Figure 8-3**). The 2016-2021 WFD status for all waterbodies within the contributing catchment is High[4]. The adjacent coastal waterbody, Outer Kenmare River (**Figure 8-3**), is also of High status.

River water bodies are defined by the EPA and are the units being used in this report to determine how Kilmakilloge Harbour contributing catchment is drained rather than considering individual rivers and streams. The Owenshagh River water body enters Kilmakilloge *c.* 1 km from the nearest licensed aquaculture site (T06/390A)[1]. Land use overlapping with the Owenshagh River water body is dominated by peat bogs, however the river flows over areas of pasture and land principally occupied by agriculture which may increase levels of contamination (**Figure 7-6**). Kerry County Council advise that intensive agriculture does not occur on the land

[1] Distance was measured as the shortest linear distance, *i.e.,* 'as the crow flies'.

overlapping the Owenshagh River water body and therefore agricultural land is unlikely to be a significant pressure (Kerry County Council[10]). The Croanshagh River water body drains 27.9% of the contributing catchment and discharges the furthest away from the licensed aquaculture sites. It flows into an inlet that connects to the main harbour through a narrow passage. Other river water bodies in the area, namely the Lahid and the Cashelkeelty, drain a smaller percent of the contributing catchment (13.8% and 12.1%, respectively). While these water bodies, when combined, drain only 25.9% of the contributing catchment, they may transport higher concentrations of *E. coli* into Kilmakilloge Harbour because they flow over agricultural land and have multiple discharge points into the harbour. The Owenshagh River water body will likely be the main transporter of contamination into the DSW due to the high percentage of the contributing catchment it drains; however, the effects of the Lehid and Cashelkeelty River water bodies should not be overlooked due to their proximity to the licensed aquaculture sites and that they also flow over agricultural land.

It was noted during the shoreline survey that there were 24 streams and five rivers draining into the production area (**Figure 7-36**), eight of these freshwater discharges being close to the licensed sites and having the potential for more localised impacts. Water sampling during the shoreline survey showed evidence of contamination at all nine stations sampled (**Figure 9-1**). Station 8 which returned the highest *E. coli* concentration is situated on agricultural land in brackish water adjacent to a culvert and a stream which discharge into the BMPA (**Table 7.9, Figure 7-36**; map ID 40 and 41, respectively. Currently, there are no guideline values for *E. coli* in DSW. At 426 cfu/100 ml, Station 8 is considered to have moderate levels of contamination, however the remaining water samples are not considered to have high *E. coli* levels (**Table 9.6**).

4.6. Movement of Contaminants

Kilmakilloge Harbour is a relatively shallow bay at *c.* 10 m, reaching depths of 20 m near the mouth of the bay as it borders Kenmare River. Based on ADCP data (BIM, 2017 *unpubl.*), on an ebbing tide, water flows in a north-westerly direction until it meets Spanish Island, at which point the flow splits into two trajectories. One flow passes along the eastern side of the island, while the second flow travels southwest of the island before wrapping around and flowing out of the bay between Spanish Island and licensed sites T06/024 and T06/033A. The mussel longline structures located on these licensed sites direct the flow from the southwest to travel west of Spanish Island. ADCP data recorded moderate current speeds throughout Kilmakilloge Harbour, except for south-southwest of Spanish Island where current velocities were notably higher. According to Falconer *et al*. (2019 *unpubl.*), particles were more concentrated in the inner bay on a spring tide. This is noteworthy as it indicates the likelihood of *E. coli* levels being higher in the inner bay and subsequently effecting site T06/390A and T06/149B on an ebbing tide.

On a neap tide, residence times were *c.* 4.5 days and particles flushed faster on the southern shores of the harbour and tended to concentrate on the north-eastern shores, with few particles in the inner harbour. On a

spring tide, residence times were *c.* 4 days, and particles were more concentrated in the inner harbour compared to neap tidal cycles. Particles dissipated in a relatively uniform pattern in the outer parts of the harbour during spring tides. As the prevailing wind blows from the south-southwest, wind-induced currents may cause contaminants in the surface waters to be pushed over the T06/154, T06,024, and T06/033A licensed sites.

4.7. Wildlife

There is no overlap between Kilmakilloge Harbour contributing catchment and any Special Protected Areas (SPAs). The BMPA is within the foraging/breeding range of several bird species within the following SPAs: Iveragh Peninsula SPA, Beara Peninsula SPA, and Sheep's Head to Toe Head SPA, and there is a large diversity of bird species found in these areas. The bird species for which these SPAs are designated are listed in **section 7.1.6.2**. These bird species are unlikely to visit the shellfish production area as the habitat type is not particularly conducive to the presence of these birds. However, the structures present at bivalve mollusc and finfish licensed sites provide suitable area for birds to perch. Gulls (supported by all three SPAs), cormorants, and shags (Iveragh Peninsula SPA) are likely to perch on the floating mussel longlines (Roycroft *et al*., 2007). The potential use of the longlines by these birds suggests they may defaecate while present in the area which would add to the *E. coli* levels in the surrounding water. The Killarney National Park SPA situated inland supports bird species which may occur in the contributing catchment if their flight paths overlap with the contributing catchment boundary.

Kenmare River SAC overlaps Kilmakilloge Harbour contributing catchment and is designated for the species otter (*Lutra lutra*) and harbour seal (*Phoca vitulina*), protected under Annex II of the Habitats Directive. Kilmakilloge Harbour is noted as an area where seals generally occur[5], and in 2013, 350 harbour seals were recorded in inner Kilmakilloge Harbour[12]. Harbour seals are also documented in the adjacent Sneem and Ardgroom Harbours, which is relevant considering harbour seals foraging range can be extensive; the furthest foraging trip recorded was 220 km (Sharples *et al*., 2012). A number of harbour seal moulting sites are documented in Kilmakilloge Harbour, predominantly in the inner harbour. One breeding, one moulting and one resting site were noted between the licensed mussel sites T06/190 and T06/064B[11]. Otters have been noted in Kilmakilloge Harbour[5]. Other marine mammals such as bottlenose dolphin (*Tursiops truncates*) and grey seal (*Halichoerus grypus*) have been sighted in Kenmare River and may occur in Kilmakilloge Harbour[12].

The bird and marine mammal populations that visit the site may contribute to the background bacteriological levels within the bay, but their impacts will be largely diffuse. Calambokidis and McLaughlin (1987) found that a population of up to 230 harbour seals had the potential to be significant contributors to the high faecal coliform levels reported in Quilcene Bay, Washington, US which resulted in the cessation of commercial shellfisheries in the area. Harbour seals in Kilmakilloge Harbour are likely to increase bacteriological levels and this information may influence where the RMP is located.

4.8. Seasonality

In 2019, more than 4.6m tourists visited the southwest region of Ireland (Fáilte Ireland, 2019). This figure was made up of 2,335,000 overseas tourists, 2,316,000 domestic tourists, and 38,000 Northern Irish tourists. Of the domestic tourists in 2022, a total of 1,207,000 visited Co. Kerry, with 3,679,000 overnights and an average length of stay of three nights (Fáilte Ireland, 2023). Out of 29 participating tourist attractions, the main tourist attractions in Kerry in 2021 were Muckross House Gardens, Derrynane Parklands, Tralee Bay Wetlands Centre, Dingle Oceanworld, and Gallarus Castle and Oratory (Fáilte Ireland, 2022).

There are three tourist attractions/activities located inside the contributing catchment area that are documented: Derreen Gardens, The Rosa Sea Fishing and Scenic Tours, and Kilmakilloge Wild Atlantic Way Discovery Point. Derreen gardens had 24,500 visitors in 2021 and 10,000 in 2022[13]. These tourist attractions do not appear in the top visitor attractions for Co. Kerry[14], however the tourism potential of Derreen Gardens results in a substantial number of visitors to a small region which may impact contamination levels in the area. The number of holiday homes accounts for 38.4% of the contributing catchment. The number of domestic trips by Irish residents in 2022 was highest over the 2nd yearly quarter (April, May, and June) followed by quarter 3 (July, August, and September)[15]. This may indicate an increase in the use of holiday homes over these periods. For Ireland as a whole, in 2019 most tourists visited between June and August (32%), followed by October to December (22%), January to March (19%) and 9% in each of April, May and September. This trend may differ from the southwest region due to weather, the number of attractions and the level of demand for those attractions. Based on the visitor numbers alone for Derreen Gardens from the past two years, tourism numbers in the area are presumed to be reasonably high for a small geographical area, therefore it is likely that there will be a seasonal impact on the shellfish area from tourism.

In terms of agriculture, the number of sheep would be expected to be higher in spring/summer when lambs are present; also, at that time of the year there may be more extensive grazing in the hills and thus bacterial impacts would be more widely spread. In Co. Kerry, the spreading of slurry is prohibited between October 1st and January 15th [16]. Statutory Instrument (S.I.) No. 113/202221 sets out guidelines relating to the environmental conditions that should be avoided when spreading slurry or fertiliser. Particular guidelines are also in place for slurry spreading near watercourses, with recommended buffer strip distances provided, *e.g.*, 20 m from lakes and main river channels[17]. Much of the land in the contributing catchment is peat bogs, and moors and heathland, however there is agricultural land bordering the shoreline, so there is a potential risk associated with contamination resulting from slurry spreading if the guidelines are not adhered to.

Analysis of rainfall data for the contributing catchment has shown that the highest rainfall occurs in October to February. During this period of time, faecal contamination may enter the bay in run-off from the land. Though, notably this largely coincides with the prohibited period for slurry spreading. The highest bacterial loading from the land is expected to occur in August and September as faecal biomass may accumulate over

the dryer period of April to July. As significant rainfall events can occur throughout the year it is not just during the winter months that a risk of increased contamination is present. A seasonal trend was observed over the 30-year period in which summer was the driest season and winter was the wettest, however the five-year trend from 2018 to 2022 found autumn to be the wettest season; summer remained the driest.

4.9. Shoreline Survey

Inventory of Pollution Sources

In total 63 features were identified (see **Appendix 4**: Shoreline Survey Images), 24 of which were streams, five rivers, four culverts, seven drains, and two pipes. There were two areas of rough grazing, one location with cows and one location with sheep. Seven bridges, two boating shelter locations, three boat access points (namely Kilmakilloge pier, landing pier, and boat marina), and one freshwater lough. Also observed was one picnic area, one location with two cormorants, and one otter. The majority of discharges flow directly into the DSW, except for one drain and one stream (See **Figure 7-36**, map ID 10 and 7, respectively). The drain is adjacent to the Lauragh river water body and likely discharges to the contributing catchment via the Lauragh River.

Bacteriological Sampling Results

Water sampling was undertaken as part of the shoreline survey with nine water samples taken from four rivers, two from areas of rough grazing, two from areas of brackish water, and one adjacent to a freshwater lough. Currently, there are no guideline values for *E. coli* levels in DSW. Station 3 was anticipated to have the highest *E. coli* levels as the Owenshagh River water body drains 46.2% of the contributing catchment, and so was presumed to be the main source of bacterial contamination due to run-off from the land. However, bacteriological sampling has shown in reality that this is not the case. The highest *E. coli* levels were measured at Station 8 at 426 cfu/100 ml (**Figure 9-1**) which was an area of brackish water. Levels of *E. coli* measured at Stations 1 and 3 were the next highest (Loughanacreen and Owenshagh Rivers, respectively; **Figure 9-1**) and the lowest concentration recorded was at Station 5 (**Figure 9-1**).

Of the discharges noted during the shoreline survey, 14 out of 45 were man-made discharges or pipes. As such the impact due to human activities is likely to be relatively low, however as no water samples were taken from these discharge points, a definitive evaluation cannot be made at this time. There are no wastewater treatment works within the contributing catchment. No commercial facilities discharge into the harbour. There is one Section 4 discharge in the contributing catchment.

5. Recommended Amendments

Currently, there are two RMPs in Kilmakilloge Harbour for blue mussel (**Figure 5-1**; B3 and B5); the third RMP marked on **Figure 5-1** has not been in use in recent years. A sanitary survey was not employed in assigning these RMPs and, therefore, they do not necessarily capture the worst-case scenario in terms of contamination entering the bay. Following a review of up-to-date data and assessment of the current environmental conditions, these RMPs will be discontinued. Additionally, Pacific oysters have not been produced in Kilmakilloge Harbour for a number of years, so there is no RMP assigned.

Two new RMPs have been determined for blue mussel and one RMP for Pacific oysters in Kilmakilloge Harbour, in order to detect the highest levels of *E. coli* contamination in the bay as per legislative requirements; comparison of the previous versus the proposed RMPs can be seen in **Figure 5-2**.

Table 5.1: Coordinates of previous/current representative monitoring points (RMPs) for *E. coli* in Kilmakilloge Harbour.

RMP	Site Name	Site code	Species	Longitude	Latitude	Easting	Northing
B3	Derreen	KY-KE-KE	*M. edulis*	51.7683	-9.7967	76020.5726	58794.2932
B5	Collorus	KY-KE-KE	*M. edulis*	51.7683	-9.8303	73701.2855	58851.9636
RMP	Spanish Island		*M. edulis*	51.7728	-9.8180	74561.9511	59335.1541

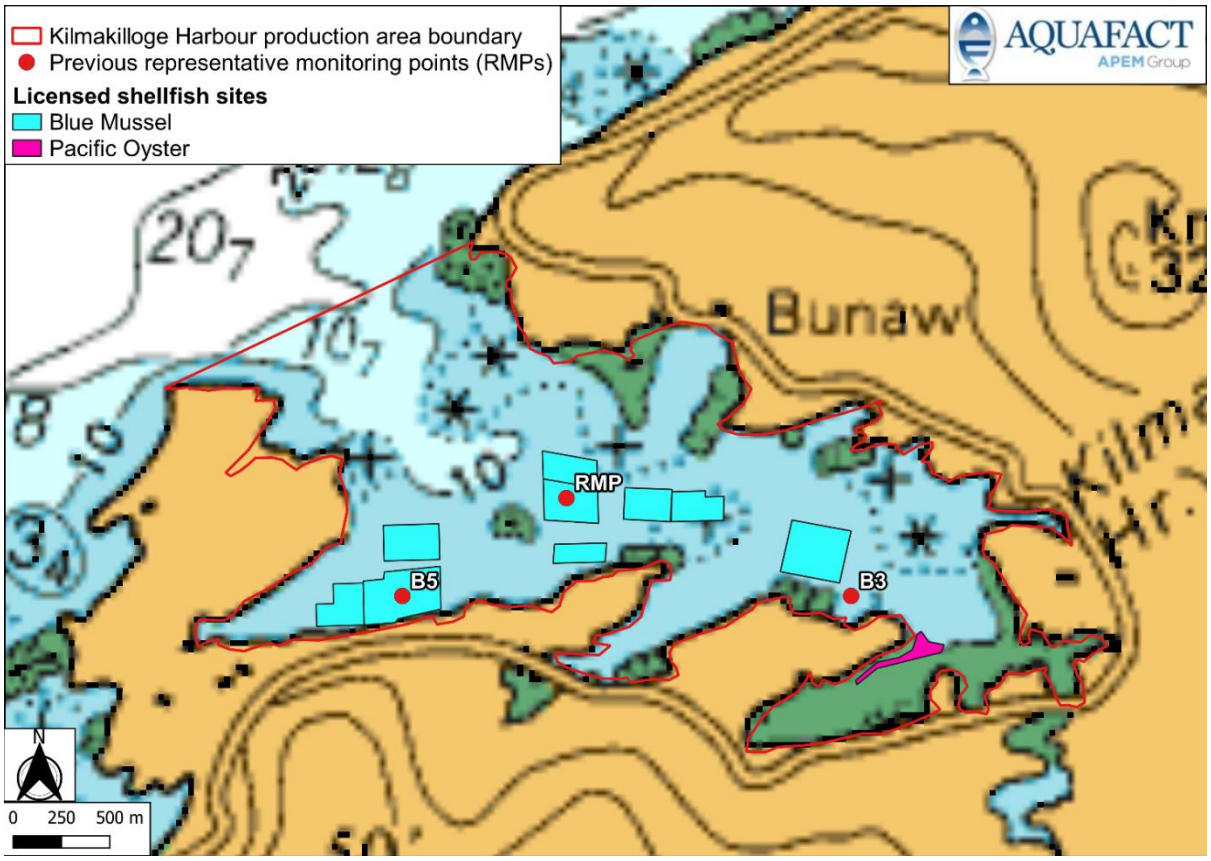


Figure 5-1: Previous representative monitoring points (RMPs) for blue mussel (*Mytilus edulis*) in Kilmakilloge Harbour.

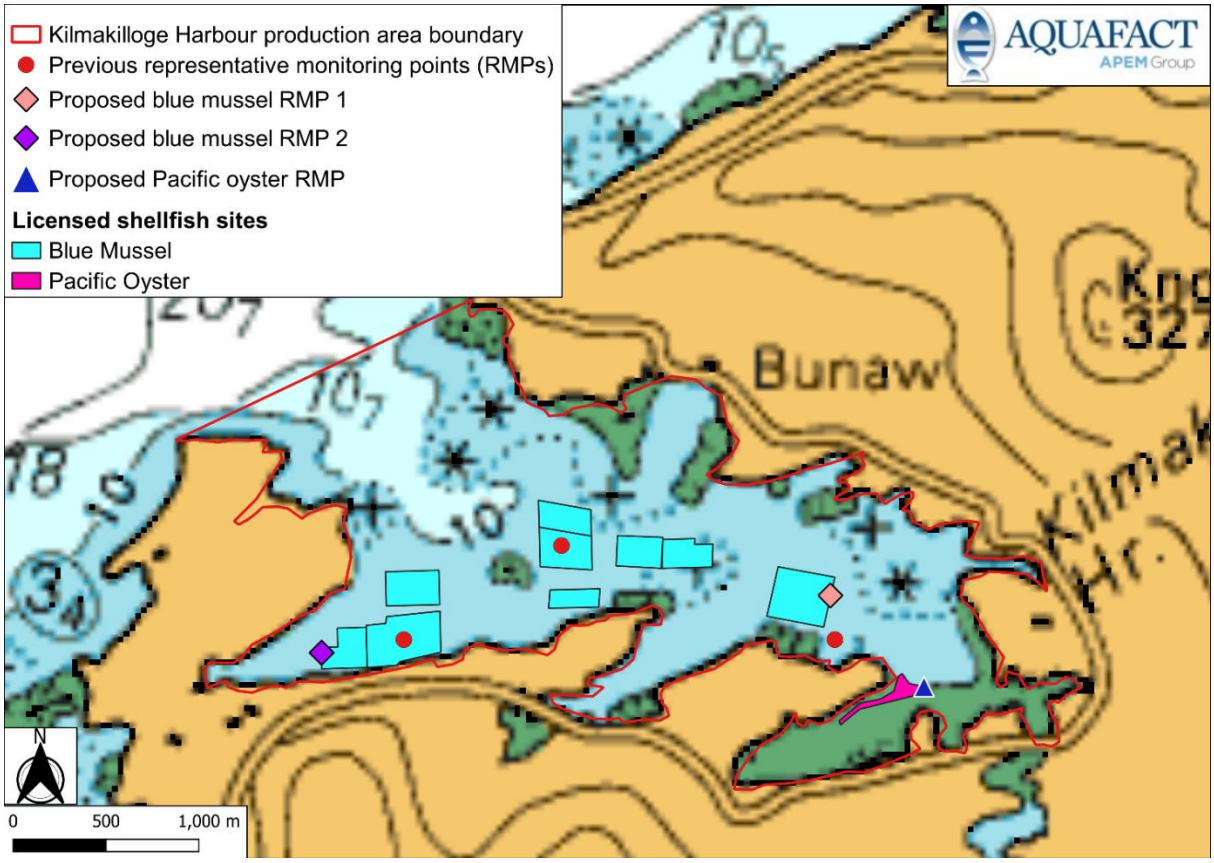


Figure 5-2: Previous representative monitoring points (RMPs) for blue mussel (*Mytilus edulis*) and proposed RMPs for blue mussel and Pacific oyster (*Magallana gigas*) in Kilmakilloge Harbour.

6. Representative Monitoring Points and Sampling Plan

As there are two different licensed shellfish species (blue mussels and Pacific oysters) in active production in Kilmakilloge Harbour, species-specific RMPs are determined in the following sections.

See **Appendix 7: Annex: Kilmakilloge RMP changes** for SFPA amendments to the RMPs at Kilmakilloge Harbour. Note that **Appendix 7: Annex: Kilmakilloge RMP changes** was authored by the SFPA and added as an addendum to this report in August 2024.

6.1. RMP for Mussels (*M. edulis*)

Two RMPs for mussels are recommended within Kilmakilloge Harbour due to the hydrodynamics of the bay and locations of discharges.

RMP 1 for mussels is located in the middle to inner section of the bay, situated on the north-eastern side of the T06/149B licensed site (**Figure 6-1** and **Table 6.1**). This RMP will adequately capture *E. coli* contamination emanating from the Lauragh River and wider Owenshagh river water body, the river water bodies with primary drainage capacity in the contributing catchment. In the inner bay, the desktop and shoreline surveys recorded a high number of features with potential to contribute to *E. coli* concentrations in the DSW. At the time of sampling, the water samples taken in this area had low to moderate *E. coli* concentrations (**Table 9.6**, Stations 3-6; see **section 9.2.2** for further details). Nevertheless, some of these features and the Station 3 water sample overlap with agricultural land (**Figure 7-6**) and so the RMP is located accordingly to detect *E. coli* from these potential sources as a precautionary approach, should the bacterial levels increase. Additionally, the cumulative waters from a high number of other streams/rivers and culverts/drains identified during the desktop and shoreline surveys will be carried over RMP 1 on an ebbing tide and due to the hydrodynamics of the bay. According to ADCP data (BIM, 2017 *unpubl.*) on an ebbing tide, water flows from the inner bay in a north-westerly direction until it hits Spanish Island at which points it splits in two, with one flow heading north-northwest. On spring tide, particles tended to be more concentrated in the inner bay compared to the outer bay. Therefore, the location of RMP 1 should account for *E. coli* levels surrounding sites T06/149B, T06/190, T06/114, T06/035A, T06,106, and T06/131.

RMP 2 for mussels is located in the south-western part of Kilmakilloge Harbour, in an inlet close to the mouth of the bay, situated on the western side of the T06/154 licensed site (**Figure 6-1** and **Table 6.1**). The ADCP data (BIM, 2017 *unpubl.*) shows that, on an ebbing tide, the second flow of water that results from the splitting at Spanish Island, initially tracks south-southwest before flowing north-northwest along the T06/024 and T06/033A licensed sites. This direction of flow indicates that contamination from features along the inlet to the south of the Collorus headland would not likely impact the licensed mussel sites to the east of Spanish Island. However, the water sample taken from Station 8, coinciding with an area of brackish water, returned a moderate level of *E. coli* (**Table 9.6**) and the prevailing wind coming from a south to south-westerly direction

may push contaminants in surface waters of these licensed sites. Therefore, RMP 2 is situated to capture *E. coli* contamination entering Kilmakilloge Harbour from the shoreline of this inlet. Additionally, much of the land surrounding this inlet is agricultural in nature and therefore is likely to be a potential source of *E. coli*.

The RMPs have been located so as to reflect the effect of any contamination from the abovementioned discharges. Accordingly, samples should be taken at the RMPs within the top one metre of water as freshwater discharges are the primary *E. coli* source in Kilmakilloge Harbour, and as freshwater is less dense than seawater it tends to sit on top of saltwater until mixing occurs.

6.2. Microbiological Sampling Plan

A minimum of 15 individual blue mussels of market size (minimum 4 cm shellfish length) are required to be sampled monthly[18;19]. Flesh samples should be taken within the top one metre of the water column and as close to the surface as possible, to obtain a representative sample of the *E. coli* levels in the bay. Flesh samples should be taken within a maximum of 100 m from RMP 1 and 2, respectively[19]. Upon the reviewed classification of the production area for blue mussels and considering that harvesting can potentially take place year-round, the minimum sampling frequency for ongoing monitoring should be at least monthly at each RMP on a year-round basis. The SFPA is the competent authority responsible for implementing this sampling plan.

Table 6.1: Coordinates of the representative monitoring points (RMP) for mussels in Kilmakilloge Harbour. Note: the coordinate reference system is Irish National Grid.

RMP	Site code	Species	Longitude	Latitude	Easting	Northing
RMP 1	KY-KE-KE	*M. edulis*	51.7704304985	-9.7970489060	76002.3288	59031.9136
RMP 2	KY-KE-KE	*M. edulis*	51.7676677813	-9.8367120485	73256.9143	58792.7543

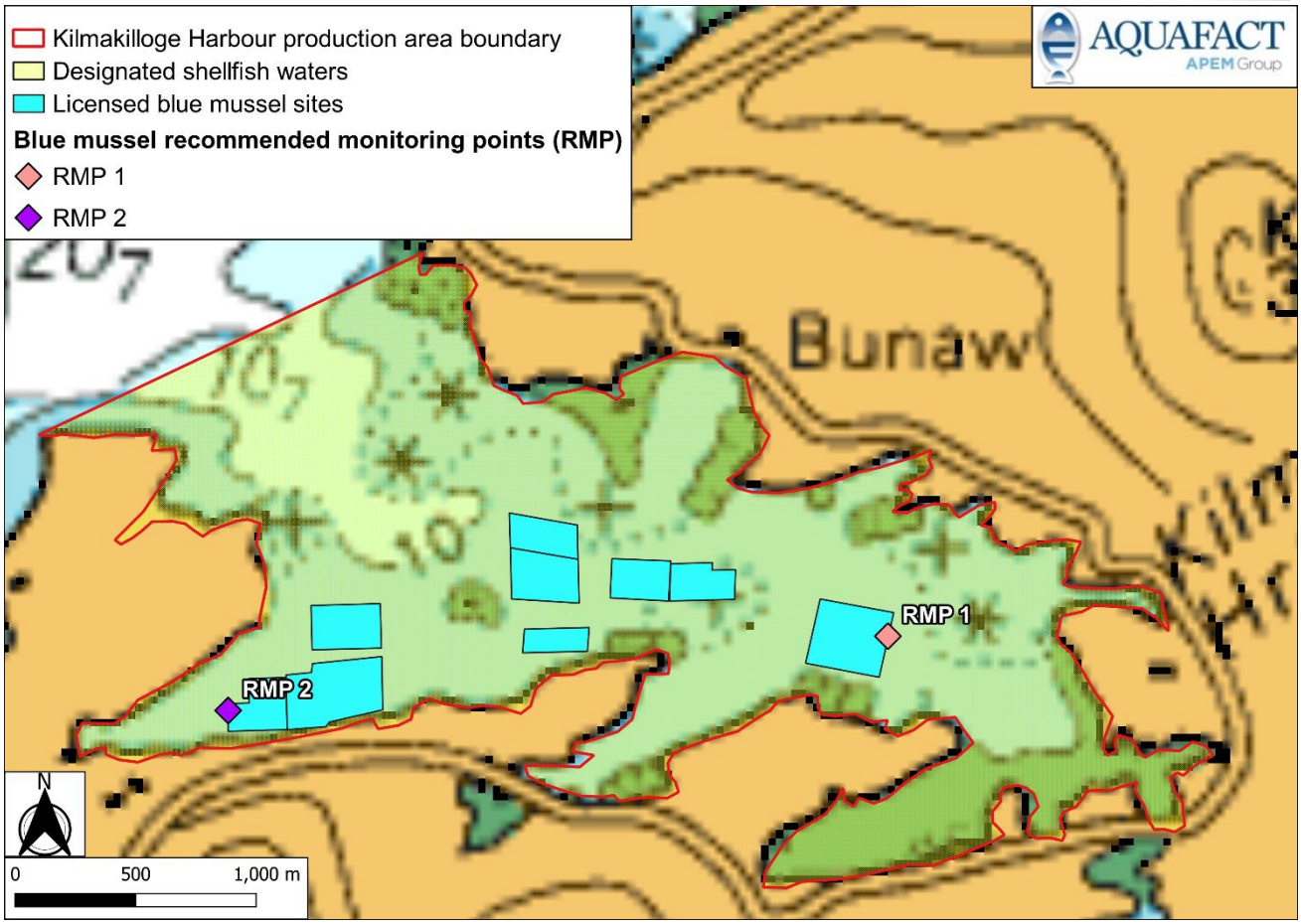


Figure 6-1: Kilmakilloge Harbour production area boundary with proposed representative monitoring points (RMPs) for blue mussel (*Mytilus edulis*).

6.3. RMP for Pacific Oysters (*M. gigas*)

One RMP for Pacific oysters is recommended for Kilmakilloge Harbour, located in the inner bay on the north-eastern boundary of the T06/390A licensed site (**Figure 6-2** and **Table 6.2**).

The motivation for locating the Pacific oyster RMP is the same as that discussed for RMP 1 for mussels in **section 6.1** above. To reiterate, RMP 1 for Pacific oysters will account for *E. coli* contamination coming from the main sources as identified in this report, *i.e.*, agricultural land, the Lauragh River and associated Owenshagh river water body, streams/rivers and culverts/pipes identified in the shoreline survey, and water sample results from the bacteriological survey (**Figure 7-6**, **Figure 8-4**, **Figure 7-36**, and **Figure 9-1**, respectively). On a spring tide, concentrations of particles were higher in the inner than the outer bay (Falconer *et al*., 2019 *unpubl.*), and on an ebbing tide, the water flows in a north-westerly direction, therefore the location of RMP 1 for Pacific oysters should detect *E. coli* levels across site T06/390A.

6.4. Microbiological Sampling Plan

A minimum of 10 individual Pacific oysters of market size (minimum 8 cm shellfish length) are required to be sampled monthly[18;19]. Flesh samples should be taken within the top one metre of the water column and as close to the surface as possible, to obtain a representative sample of the *E. coli* levels in the bay. Flesh samples

should be taken within a maximum of 100 m from RMP 1[19]. Upon the reviewed classification of the production area for Pacific oysters, the minimum sampling frequency for ongoing monitoring should be at least monthly at each RMP on a year-round basis. The SFPA is the competent authority responsible for implementing this sampling plan.

Table 6.2: Coordinates of the representative monitoring point (RMP) for Pacific oysters in Kilmakilloge Harbour. Note: the coordinate reference system is Irish National Grid.

RMP	Site code	Species	Longitude	Latitude	Easting	Northing
RMP 1	KY-KE-KE	*M. gigas*	51.7660334414	-9.7897493283	76494.1654	58530.3327

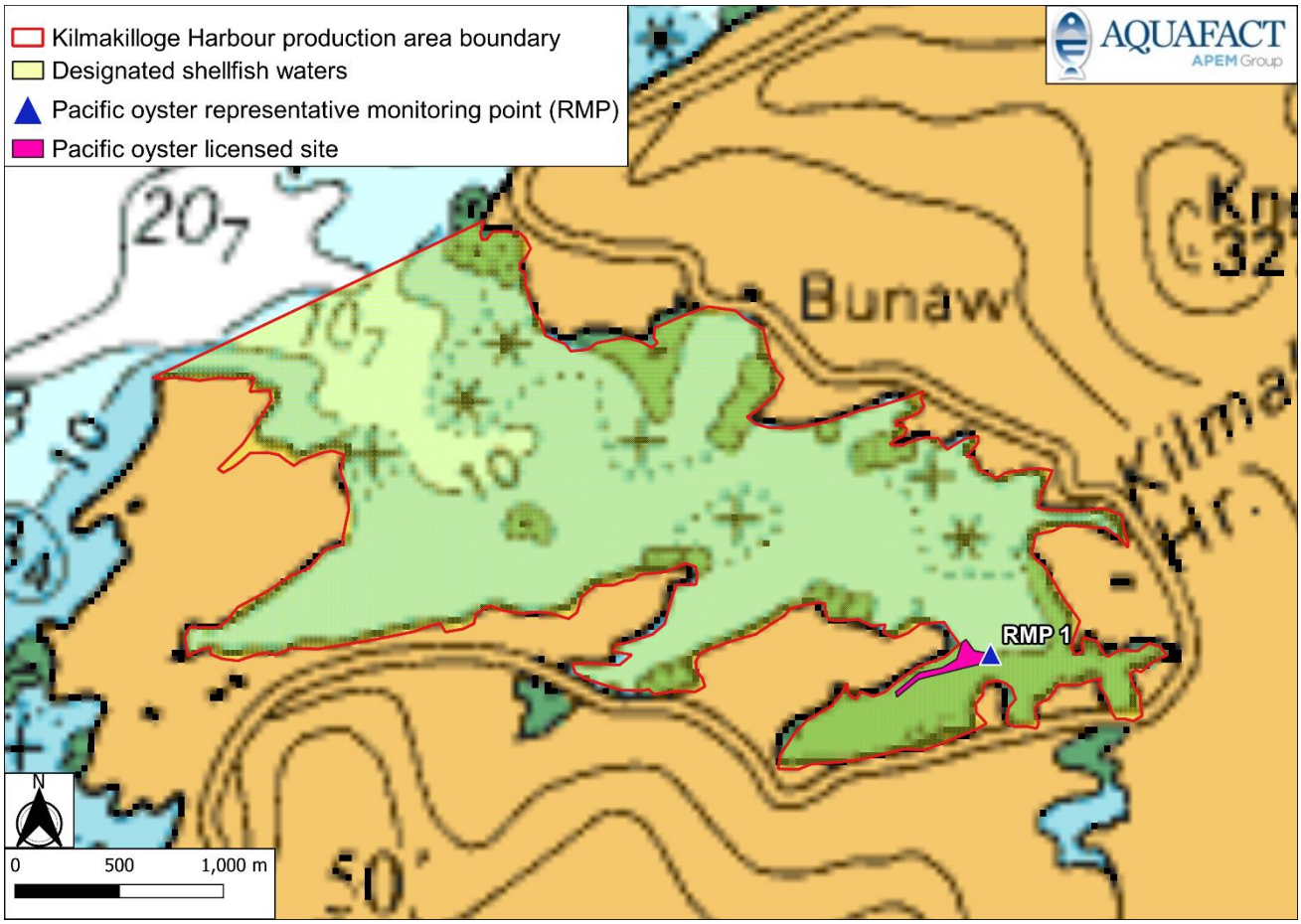


Figure 6-2: Kilmakilloge Harbour production area boundary with proposed representative monitoring point (RMP) for Pacific oyster (*Magallana gigas*).

6.5. General Sampling Method

All collection and transport of shellfish samples for *E. coli* testing under the sampling plan identified as part of the Kilmakilloge Harbour Sanitary Survey should adhere to the Code of Practice for the Microbiological Monitoring of Bivalve Mollusc Production Areas[19]. The sampling procedure and guidance notes are found in Appendix 9.2 of that document.

7. Appendix 1: Identification of Pollution Sources

This section documents all pollution sources identified during the desktop and shoreline survey within Kilmakilloge Harbour contributing catchment. **Figure 7-1** shows the contributing catchment which spans an approximate area of 75.61 km^2.

7.1. Desktop Survey

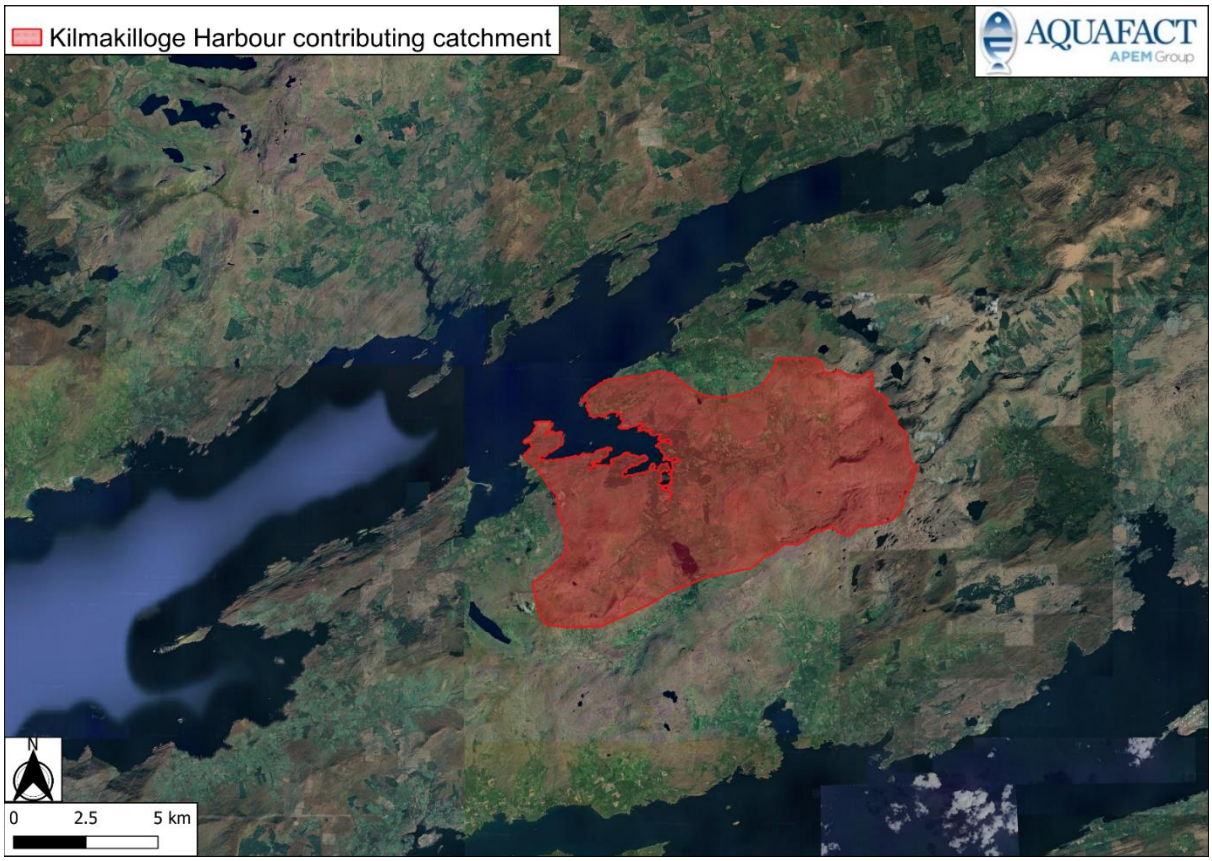


Figure 7-1: Kilmakilloge Harbour contributing catchment used for assessment of pollution sources.

7.1.1. Human Population

Population census data documented by the Central Statistics Office (CSO) is given in units of Eds[24]. **Figure 7-2** shows the EDs within the contributing catchment. These data were obtained through the CSO Small Area Population MAP (SAPMAP[7]), an interactive mapping tool, for the year 2016 as the more recent 2022 results are still to be fully published. **Figure 7-3** shows the human population within Kilmakilloge Harbour contributing catchment and **Table 7.1** shows these data in tabular form.

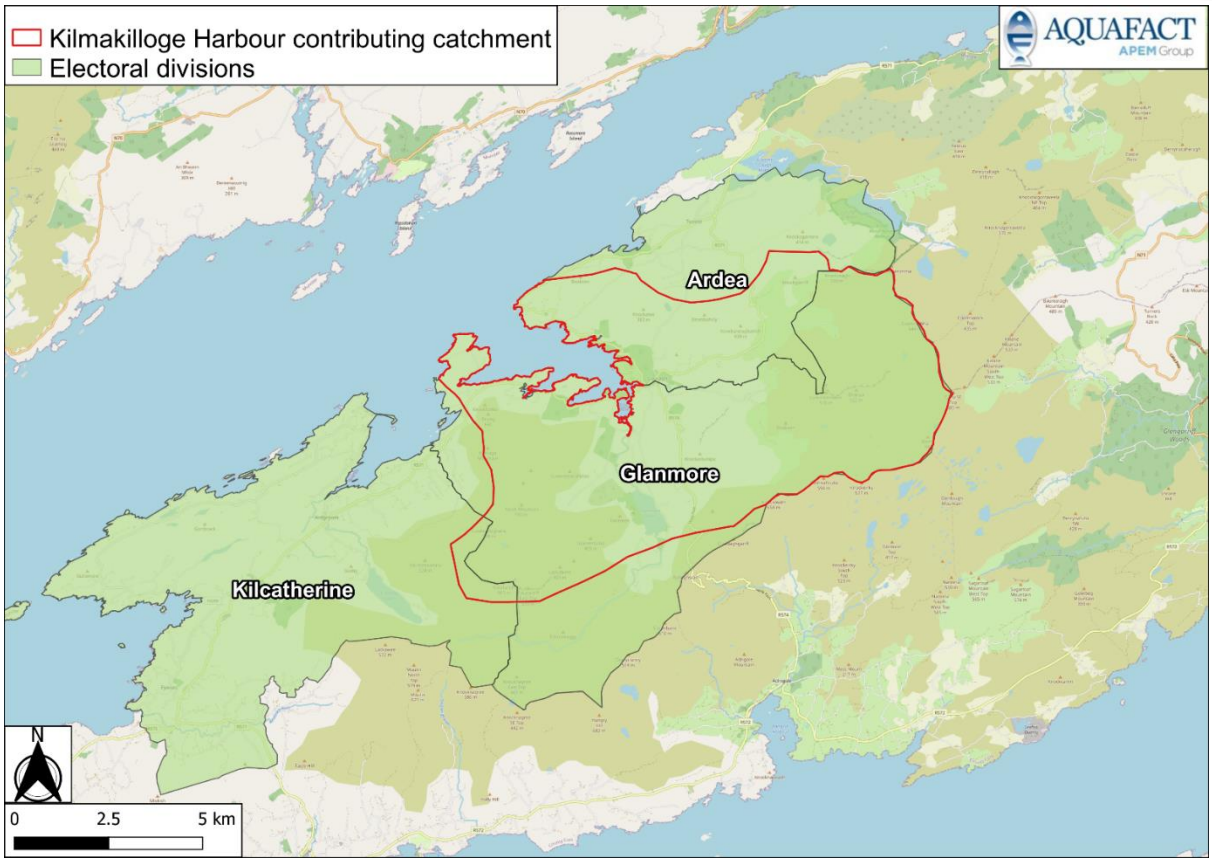


Figure 7-2: Electoral divisions within Kilmakilloge Harbour contributing catchment.

Kilmakilloge Harbour contributing catchment partially overlaps three EDs; the majority of Ardea and Glanmore (both in Co. Kerry) are encapsulated by the contributing catchment boundary, and only a small segment of Kilcatherine, Co. Cork lies inside the boundary. These three EDs accommodate a total population of 1,214 people. An attempt was made to estimate the actual population within the contributing catchment by calculating the extent of each ED lying within the contributing catchment using QGIS software and then converting to a percentage of the overall area (km^2) of the ED in Microsoft Excel. From this value the population size was calculated, *e.g.*, if 50% of the ED lies within the contributing catchment then 50% of the total population was taken to be the population size of the area within the contributing catchment. It is of note that the values calculated in **Table 7.1** are decimal numbers and are rounded to the nearest whole number in the text for ease of understanding. Using this method, the population of the contributing catchment is estimated at 289 people. Glanmore contains the largest population within the contributing catchment (179), Ardea has a considerably lower population (89) and Kilcatherine hosts the smallest population within the contributing catchment (21). There are no towns/urban centres within the contributing catchment.

There are 974 households across the three EDs, of which 16.7% are vacant (163) and 31.6% are holiday homes (308) and 51.6% are occupied. Of the approximated 265 households within the contributing catchment (based on the percentage of each ED within the contributing catchment), 13.9% are vacant (37) and 38.4% are holiday

homes (102) and 49% are occupied (130). **Table 7.2** shows the number of households in each ED and the approximate proportion within the contributing catchment.

Human population in given areas is obtainable from census data; however, relating this information to the level of microbial contamination in coastal waters is difficult and is constrained by the geographic boundaries used. Nonetheless, it can be deduced that areas with a higher population will have higher levels of sewage and wastewater entering the Kilmakilloge Harbour system. Therefore, the highest levels of sewage and waste would be expected to enter from the Glanmore ED. As holiday homes account for approximately 38% of the dwellings in the contributing catchment, and permanent households account for 49%, it is likely that sewage and wastewater levels increase notably when tourism increases, relative to the permanent population. Therefore, this may increase *E. coli* discharged into Kilmakilloge Harbour in the summer season when holiday homes are typically more frequently used.

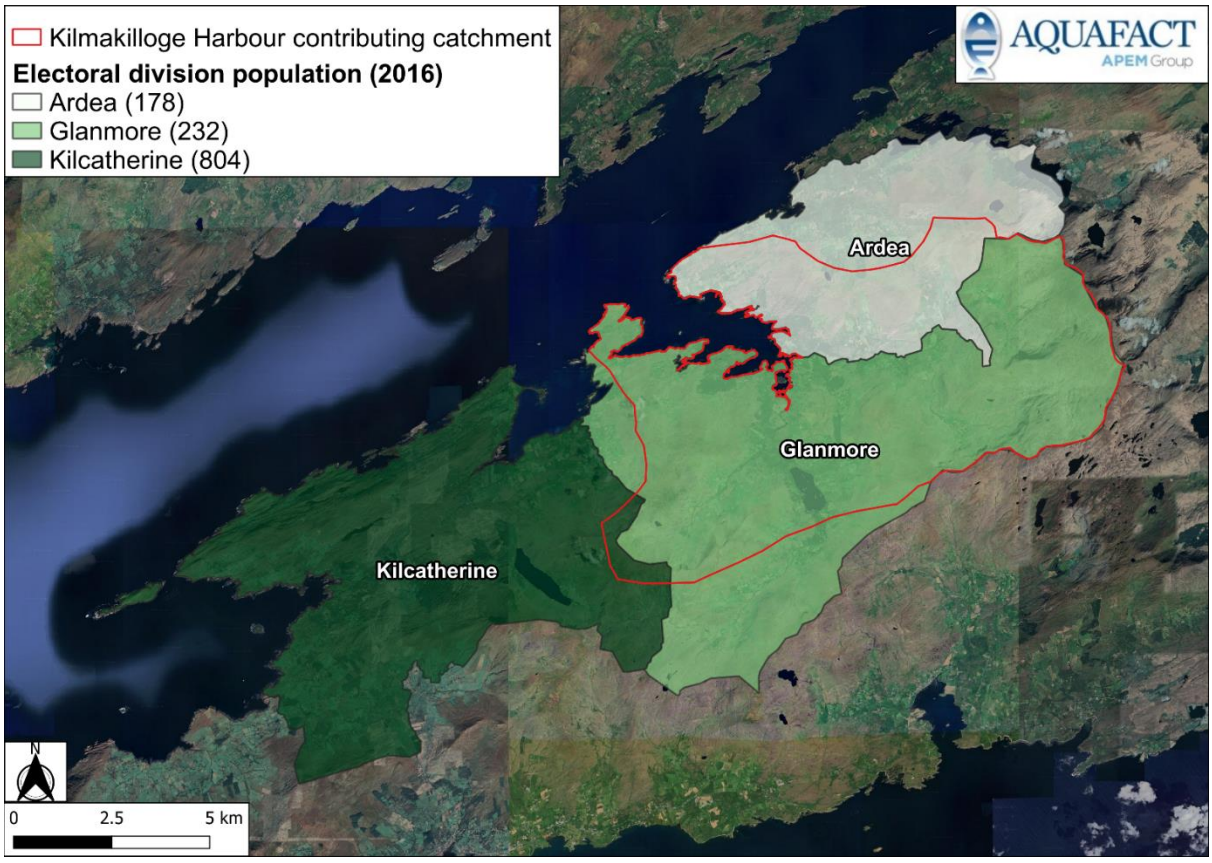


Figure 7-3: Human population within Kilmakilloge Harbour contributing catchment (source: CSO[7]).

Table 7.1: Human population within Kilmakilloge Harbour contributing catchment (source: CSO[7]).

Electoral Division	Population (2016)	% ED in Contributing Catchment	Estimated Population
Ardea (Co. Kerry)	178	50.17	89.3
Glanmore (Co. Kerry)	232	77.25	179.2
Kilcatherine (Co. Cork)	804	2.56	20.6

Table 7.2: Households within the Electoral Divisions within Kilmakilloge Harbour contributing catchment and surrounds (source: CSO[7]).

Electoral Division	Entire Electoral Division				Contributing Catchment %			
	Total Households	No. Occupied*	Unoccupied holiday homes	Vacant houses	Total Households	No. Occupied*	Unoccupied holiday homes	Vacant houses
Ardea (Co. Kerry)	199	85	86	28	99.8	42.5	43.1	14.0
Glanmore (Co. Kerry)	195	98	71	26	150.6	79.7	54.8	20.1
Kilcatherine (Co. Cork)	580	320	151	109	14.8	8.2	3.9	2.8

*This figure includes those houses temporarily unoccupied on census night.

7.1.2. Tourism

In 2019, more than 4.6m tourists visited the Southwest region of Ireland (Fáilte Ireland, 2019). This figure was made up of 2,335,000 overseas tourists, 2,316,000 domestic tourists, and 38,000 Northern Irish tourists. Of the domestic tourists in 2022, a total of 1,207,000 visited Co. Kerry with 3,679,000 overnights and an average length of stay of three nights (Failte Ireland, 2023). Out of 29 participating tourist attractions, the main tourist attractions in the area in 2021 were Muckross House Gardens, Derrynane Parklands, Tralee Bay Wetlands Centre, Dingle Oceanworld, and Gallarus Castle and Oratory (Fáilte Ireland, 2022). Tourism data from different years has been referenced in this section in order to use the most recent data where available.

There are three tourist attractions/activities located inside the contributing catchment that are documented, Derreen Gardens, The Rosa Sea Fishing and Scenic Tours, and Kilmakilloge Wild Atlantic Way Discovery Point (**Figure 7-4**) and one accommodation facility is listed. The Rosa Tours operate daily from May to the end of September and limit the number of people per trip to five. However, this does not necessarily account for all of the tourist attractions, activities, and available accommodation within the contributing catchment as others may exist which are not part of the database being used; the Discover Ireland website[20] lists an additional two accommodation options, one being a caravan and camping park.

Derreen Beach is the only publicly listed beach within the contributing catchment, however there is a shingle beach near the Kilmakilloge Wild Atlantic Way Discovery Point and likely other beaches around the bay. None of these beaches are monitored for their bathing water quality[21]. Papadakis *et al.* (1997) found significant correlations between the number of swimmers present on beaches and the presence of pathogenic bacteria in Greece. In 2007, Elmir *et al.* (2007) showed the role of human skin as an intermediate mechanism of pathogen transmission to the water column. However, as there are no monitored beaches or bathing water locations within the bay the numbers of swimmers and subsequently the bacteriological quality of the bay cannot be estimated.

For Ireland as a whole, in 2019 most tourists visited between June and August (32%), followed by October to December (22%), January to March (19%), and 9% in each of April, May, and September. This trend may vary for the contributing catchment due to weather conditions, number of attractions in the area, and the level of demand for particular attractions.

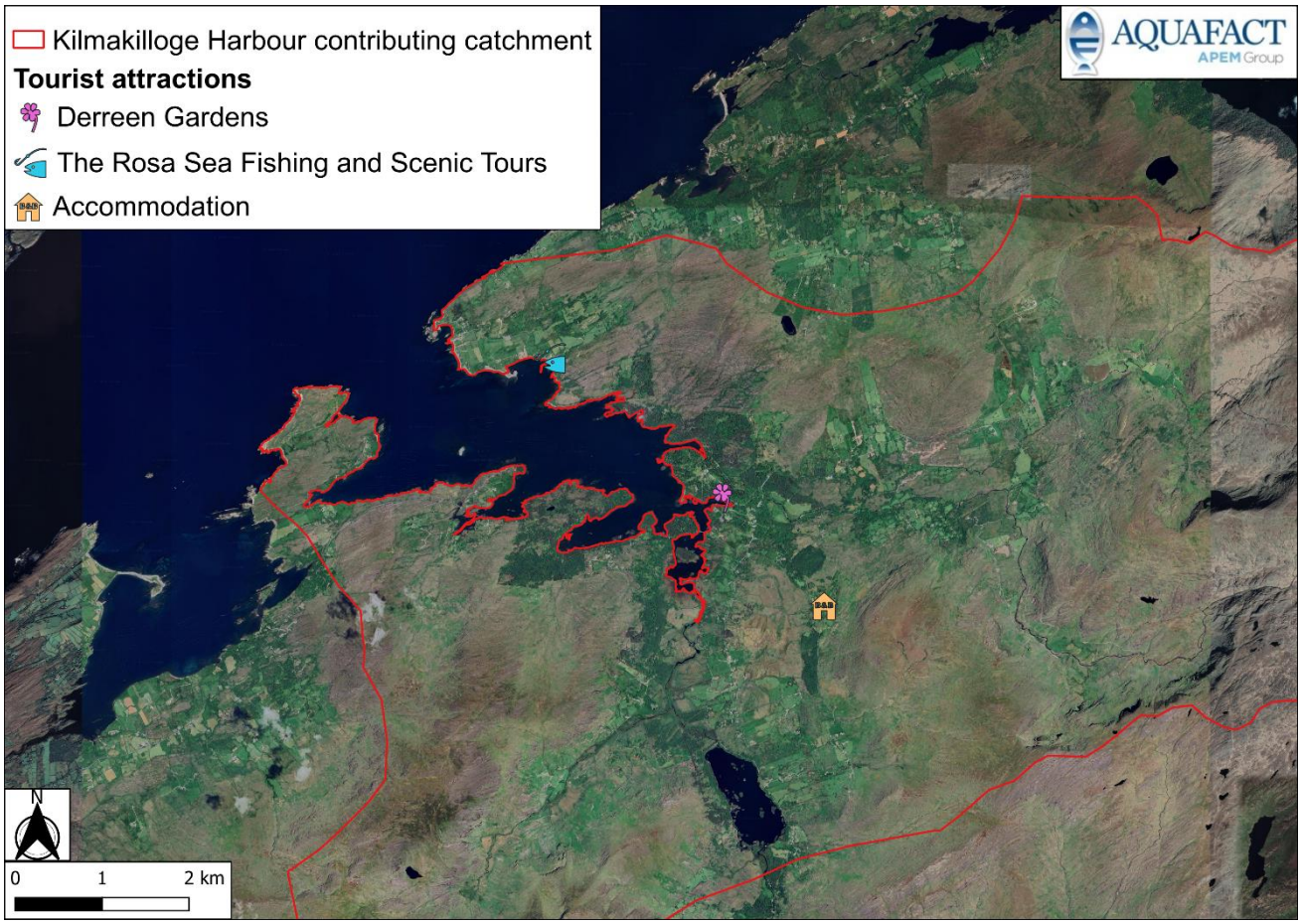


Figure 7-4: Documented attractions and accommodation within Kilmakilloge Harbour contributing catchment.

7.1.3. Sewage Discharges

Sewage effluent can vary in nature depending on the degree to which the sewage has been treated. Discharges of sewage effluent can arise from a number of different sources and be continuous or intermittent in nature:

- treated effluent from urban sewage treatment plants (continuous).
- storm discharges from urban sewage treatment plants (intermittent).
- effluent from 'package' sewage treatment plants serving small populations (continuous).
- combined sewer and emergency overflows from sewerage systems (intermittent).
- septic tanks (intermittent).
- crude sewage discharges at some estuarine and coastal locations (continuous).

Treatment of sewage ranges from:

- none (crude sewage).
- preliminary (screening and/or maceration to remove/disguise solid matter).

- primary (settling to remove suspended solids as sewage sludge). Typically removes 40% of BOD (Biochemical Oxygen Demand), 60% of suspended solids; 17% of nitrogen and 20% of phosphorus from the untreated sewage.
- secondary (settling and biological treatment to reduce the organic matter content). Typically removes 95% of BOD, 95% of suspended solids, 29% of nitrogen, and 35% of phosphorus from the untreated sewage. Nutrient removal steps can be incorporated into secondary treatment which can reduce ammonia - N down to 5 mg/l and phosphorus to 2mg/l.
- tertiary (settling, biological treatment and an effluent polishing step which may involve a reed bed (unlikely for coastal works) or a treatment to reduce the load of micro-organisms in the effluent). Typically removes 100% of BOD, 100% of suspended solids, 33% of nitrogen and 38% of phosphorus from the untreated sewage.

7.1.3.1. Water Treatment Works

There were no wastewater treatment works within Kilmakilloge Harbour contributing catchment at the time of writing this report.

7.1.3.2. Continuous Discharges

Table 7.3 lists the sewage facilities per ED and estimated numbers per the contributing catchment. It was estimated that the majority of households are serviced by individual septic tanks and potentially only two households have no septic tank; a small proportion of households either did not disclose their sewage facilities or used another treatment system.

7.1.3.3. Rainfall Dependent/Emergency Sewage Discharges

There were no rainfall dependent or emergency sewage discharges found within the contributing catchment at the time of writing this report.

Table 7.3: Sewage facilities at permanent households per ED within Kilmakilloge Harbour contributing catchment and surrounding area (CSO[7]).

Electoral Division (ED)	Entire ED						Contributing Catchment %					
	Permanent Private Household	Public Sewage Scheme	Individual Septic Tank	Other individual treatment	Other/ Not Stated	No sewage facility	Permanent Private Households	Public Sewage Scheme	Individual Septic Tank	Other individual treatment	Other/Not Stated	No sewage facility
Ardea (Co. Kerry)	79	1	69	4	4	1	61.0	0.8	53.3	3.1	3.1	0.8
Glanmore (Co. Kerry)	92	0	75	12	3	2	46.2	0	37.6	6.0	1.5	1
Kilcatherine (Co. Cork)	308	51	223	20	13	1	7.9	1.3	5.7	0.5	0.4	0

7.1.4. Industrial Discharges

There are no industrial discharges within Kilmakilloge Harbour contributing catchment that have emissions to water[22]. There is one Section 4 discharge in the contributing catchment, located in Clogherane, Lauragh, reference number W67 (**Figure 7-5**).

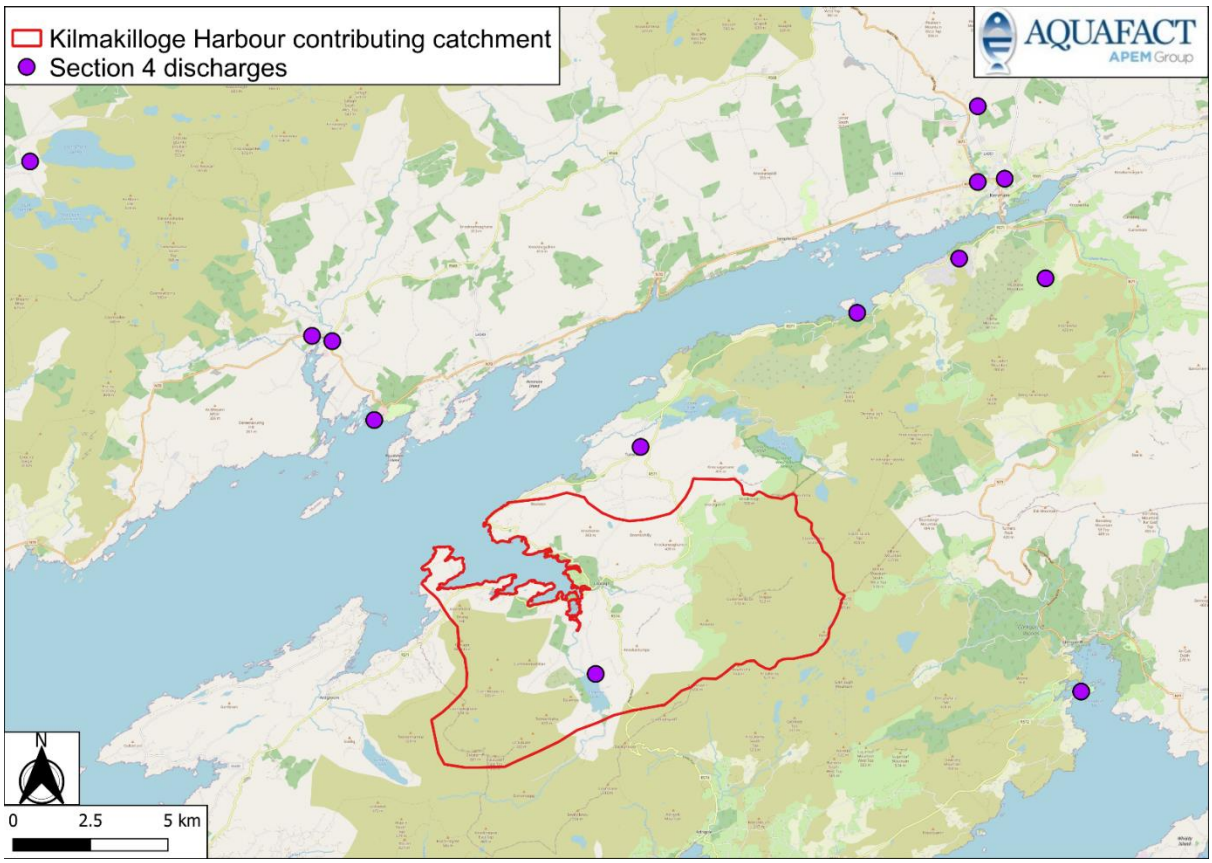


Figure 7-5: Location of Section 4 discharges within and outside of Kilmakilloge Harbour contributing catchment (source: EPA Geoportal[22]).

7.1.5. Land Use Discharges

Figure 7-6 shows the 2018 Corine land use within Kilmakilloge Harbour contributing catchment[23]. **Figure 8-4** shows all river water bodies within the contributing catchment. Within the contributing catchment, land use is dominated by peat bogs (31 km^2; 41%). Other land use is attributed to moors and heathland (14 km^2; 19%) and sparsely vegetated areas (13 km^2; 17%). The remaining 11% of land cover is comprised of a mixture of other land use types (**Figure 7-7**).

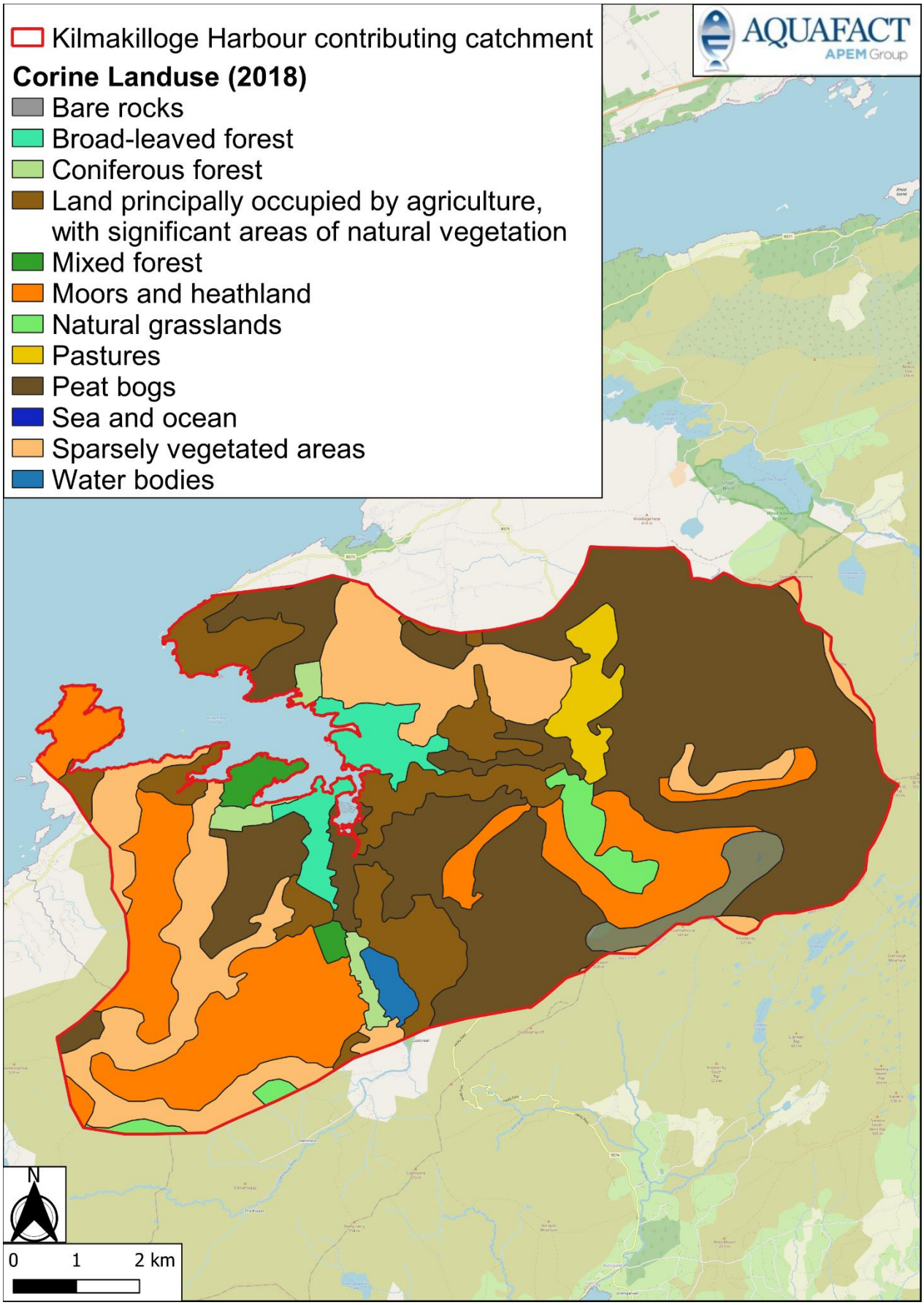


Figure 7-6: 2018 Corine land use within Kilmakilloge Harbour contributing catchment (source: EPA Geo portal[23]).

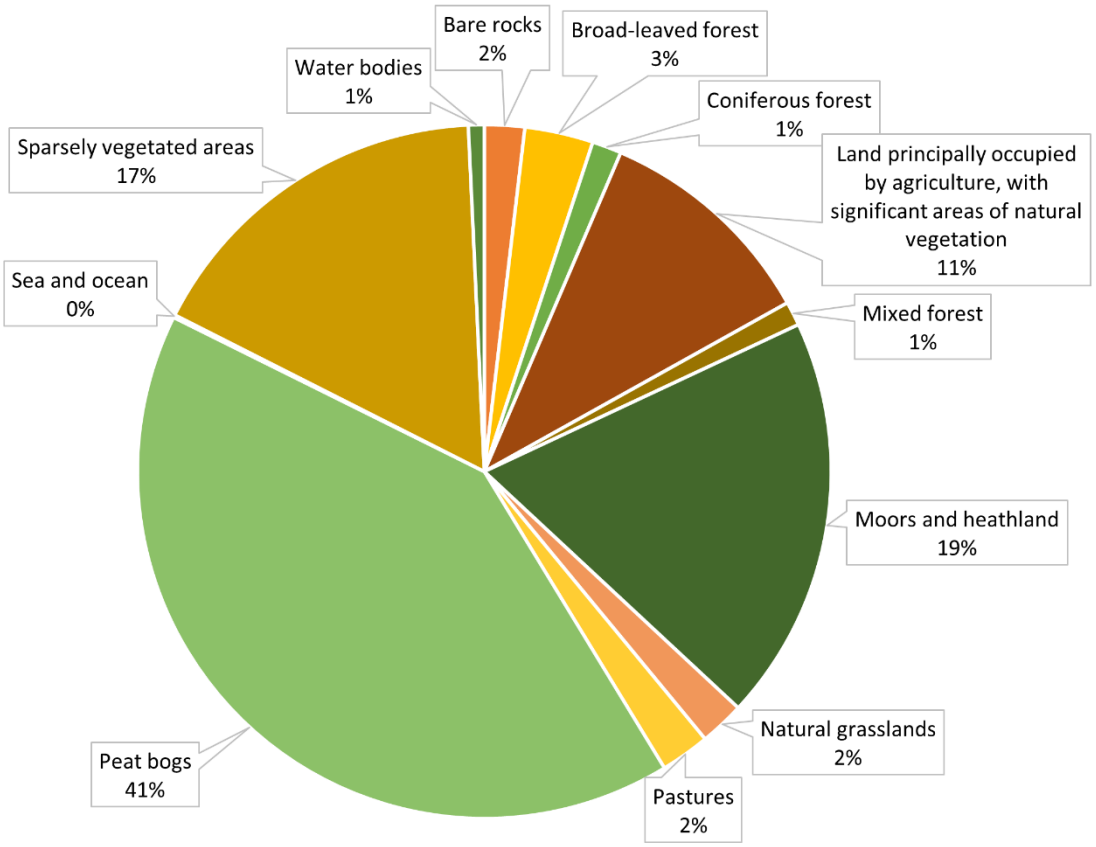


Figure 7-7: Percentage breakdown of Corine land use (2018) within Kilmakilloge Harbour contributing catchment.

Data from the Census of Agriculture 2020[24] is displayed in **Table 7.5** below. Thematic maps for each category in **Table 7.5** are shown in **Figure 7-9** to **Figure 7-15**. The total area farmed across the three EDs of interest is 8,033.6 ha (*c.* 80.34 km^2) **Figure 7-8**. However, as with the data per ED on households and sewage treatment systems, an estimate was made of the number of farms and other agricultural data in **Table 7.5** based on the percentage overlap with Kilmakilloge Harbour contributing catchment. The estimated total number of farms within the contributing catchment is 78, with the majority falling inside of Glanmore ED. The estimated area farmed is 3,552 ha (*c.* 35.5 km^2) covering approximately 44% of the entire contributing catchment. The estimated grassland cover is 3,559 ha, *i.e.*, the majority of agricultural landcover. The estimated number of total cattle is similar in Ardea and Glanmore, though there are more non-dairy cows in Glanmore (136) than the other two EDs.; total cattle refers to female and male cattle, dairy cows, and non-dairy/other cows. There is a considerably higher estimated number of sheep in Glanmore (9,797) compared to the other EDs.

A number of studies have reported a strong association between intensive livestock farming areas and faecal indicator concentrations of microorganisms in streams and coastal waters due to run-off from manure, especially during high flow conditions, both from point and non-point sources of contamination (*e.g.,* Crowther *et al.,* 2002). **Table 7.4** shows the potential daily loading of *E. coli* from livestock (compared to humans and

birds). Sheep rank the highest in terms of potential *E. coli* load, followed by pigs, cows, birds, humans, and poultry. Sheep numbers would be expected to increase in spring following the birth of lambs and decrease in the autumn as they are sent to market. Therefore, larger quantities of livestock droppings will be deposited during this period, though it may not impact the DSW until washed into the sea during and/or after periods of heavy rainfall unless deposited directly on the shoreline.

Table 7.4: Potential daily loading of *E. coli* (Jones & White, 1984).

Source	Faecal Production (g/day)	Average Number (*E. coli*/g)	Daily Load (*E. coli*)	Rank
Man	150	13×10^6	1.9×10^9	5
Cows	23600	0.23×10^6	5.4×10^9	3
Sheep	1130	16×10^6	18.1×10^9	1
Chicken	182	1.3×10^6	0.24×10^9	6
Pig	2700	3.3×10^6	8.9×10^9	2
Gull	15.3	131.2×10^6	2×10^9	4

Table 7.5: Agricultural census data for all Electoral Divisions within and surrounding Kilmakilloge Harbour contributing catchment[24].

Electoral Division Name	Electoral Divisions								Contributing Catchment %							
	No. Farms	Area Farmed (ha)	Avg. Farm Size (ha)	Total Grass & Rough Grazing (ha)*	Total Cattle ***	Sheep	Cows	Other cows **	No. Farms	Area Farmed (ha)	Avg. Farm Size (ha)	Total Grass & Rough Grazing (ha)*	Total Cattle ***	Sheep	Cows	Other cows **
Ardea	47	1,945.3	41.4	1,944.1	583	6,250	0	166	24	976	21	975	292	3136	0	83
Glanmore	67	3,240.1	48.4	3,250.1	394	12,681	0	176	52	2503	37	2511	304	9796	0	136
Kilcatherine	112	2,848.2	25.4	2,847.0	1,457	9,403	0	601	3	73	1	73	37	241	0	15

* Total grass and Rough Grazing taken to be the sum of Total Pasture, Total Silage, Total Hay, and Rough Grazing.

** Other cows as defined by the CSO are female beef cattle

*** Total cattle is comprised of all male and female cattle under two years, dairy cows, and non-dairy/other cows.

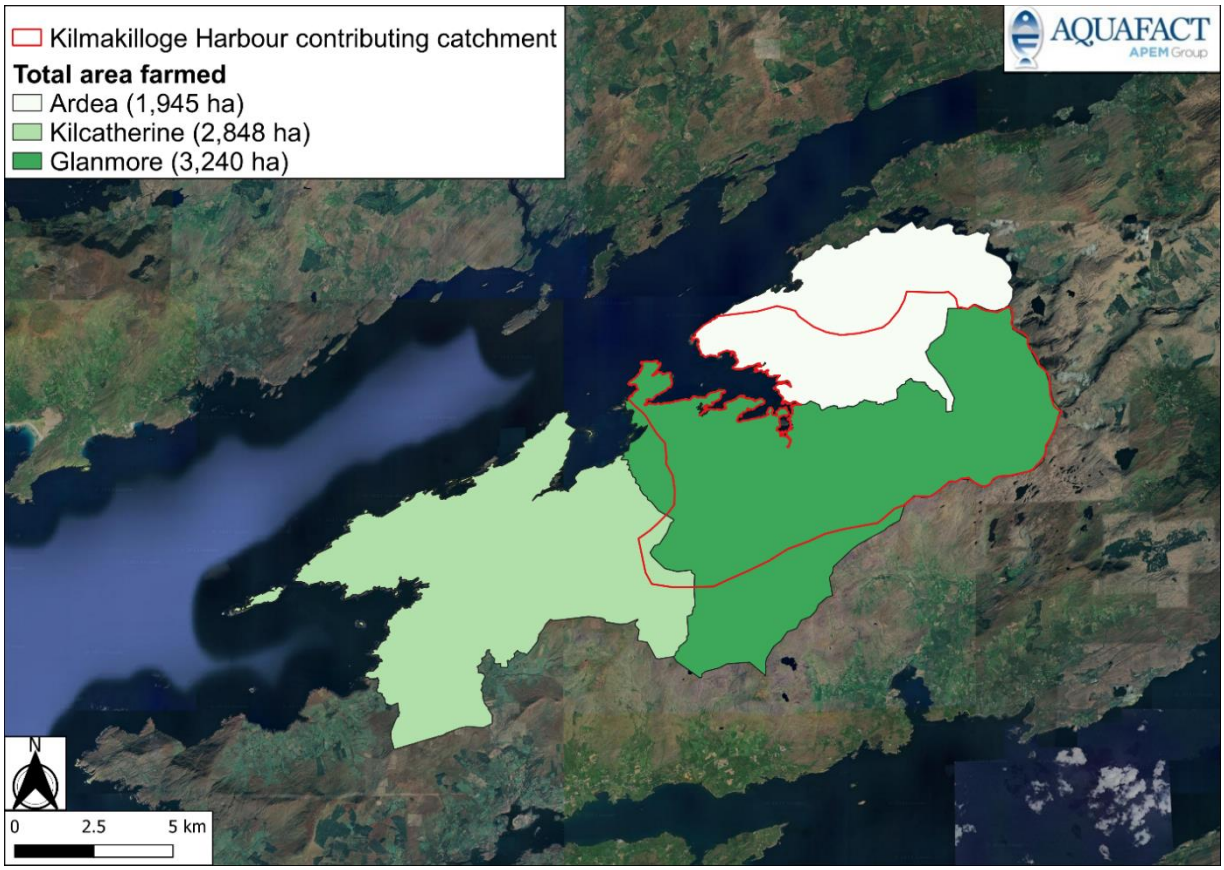


Figure 7-8: Total farmed area per electoral division overlapping with Kilmakilloge Harbour contributing catchment.

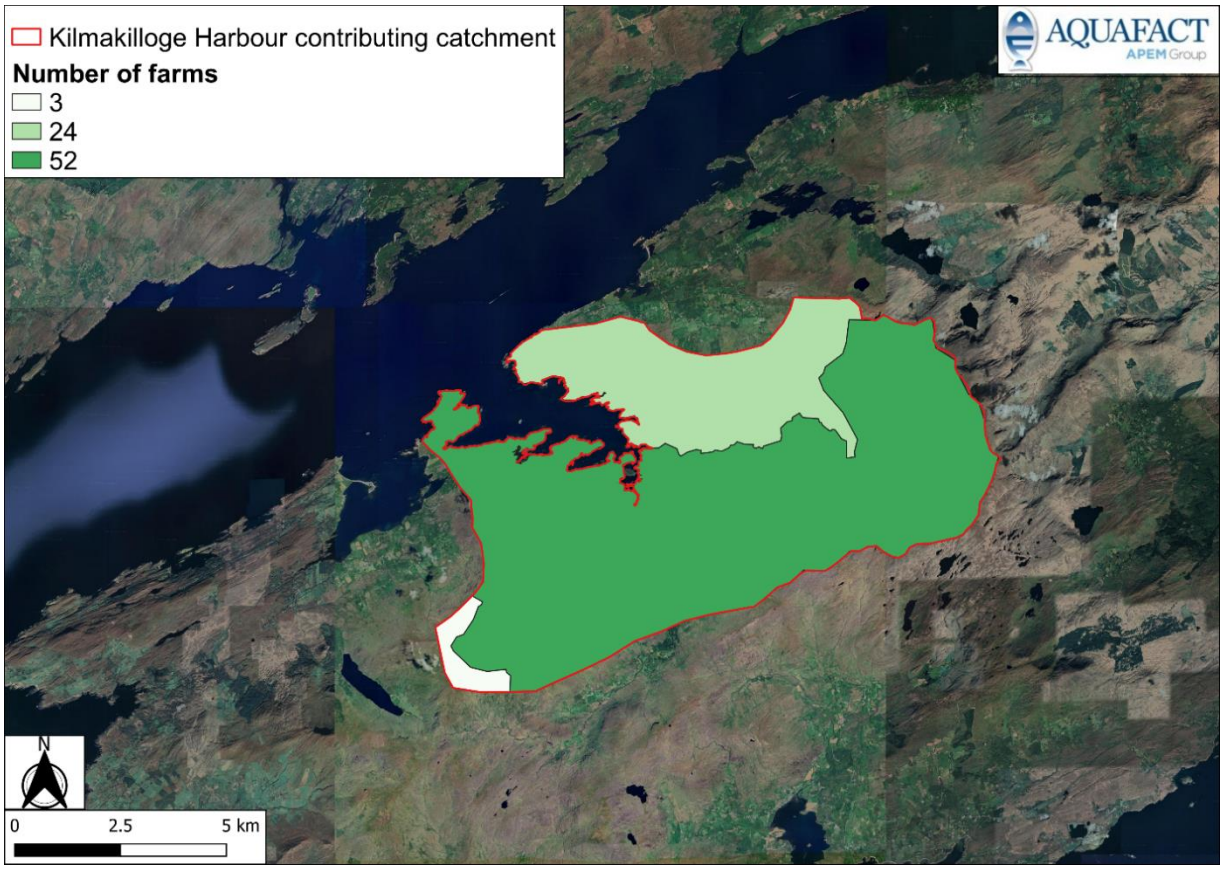


Figure 7-9: Estimated number of farms per electoral division within Kilmakilloge Harbour contributing catchment.

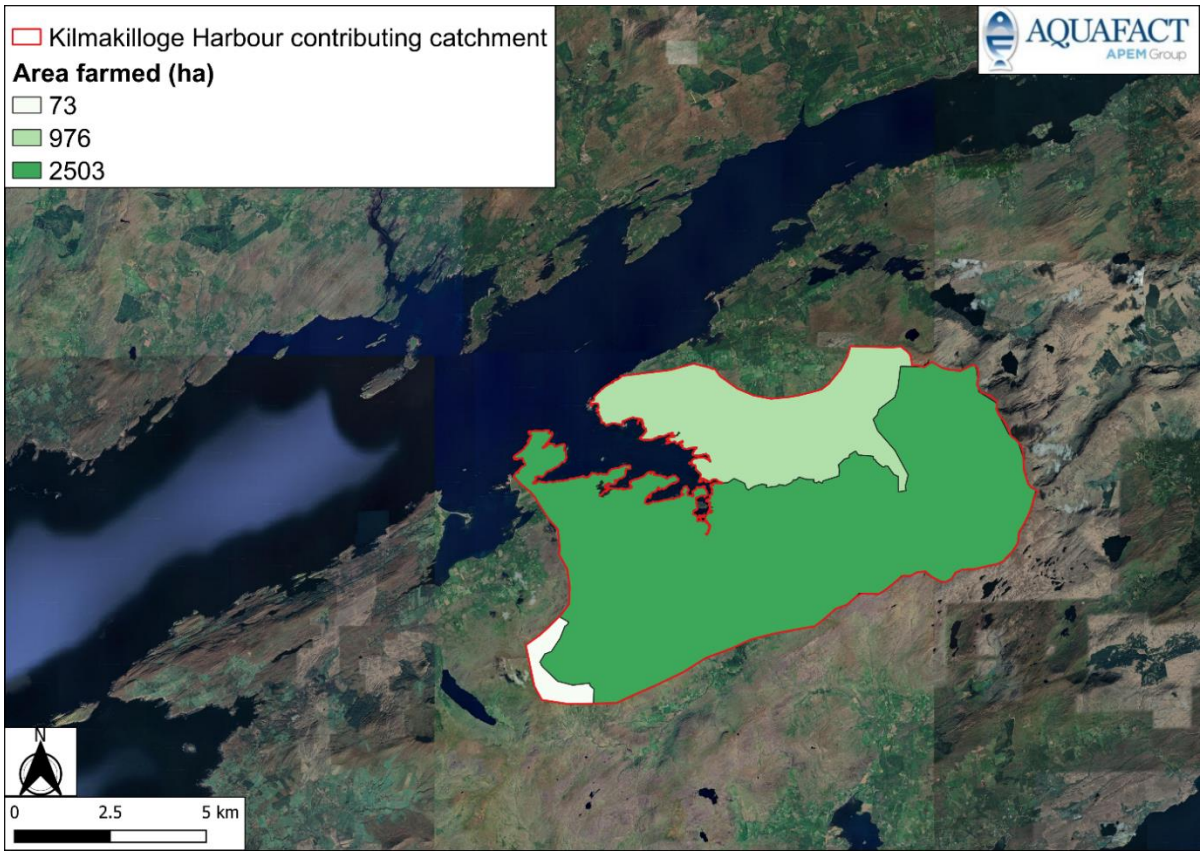


Figure 7-10: Estimated area farmed (ha) within Kilmakilloge Harbour contributing catchment.

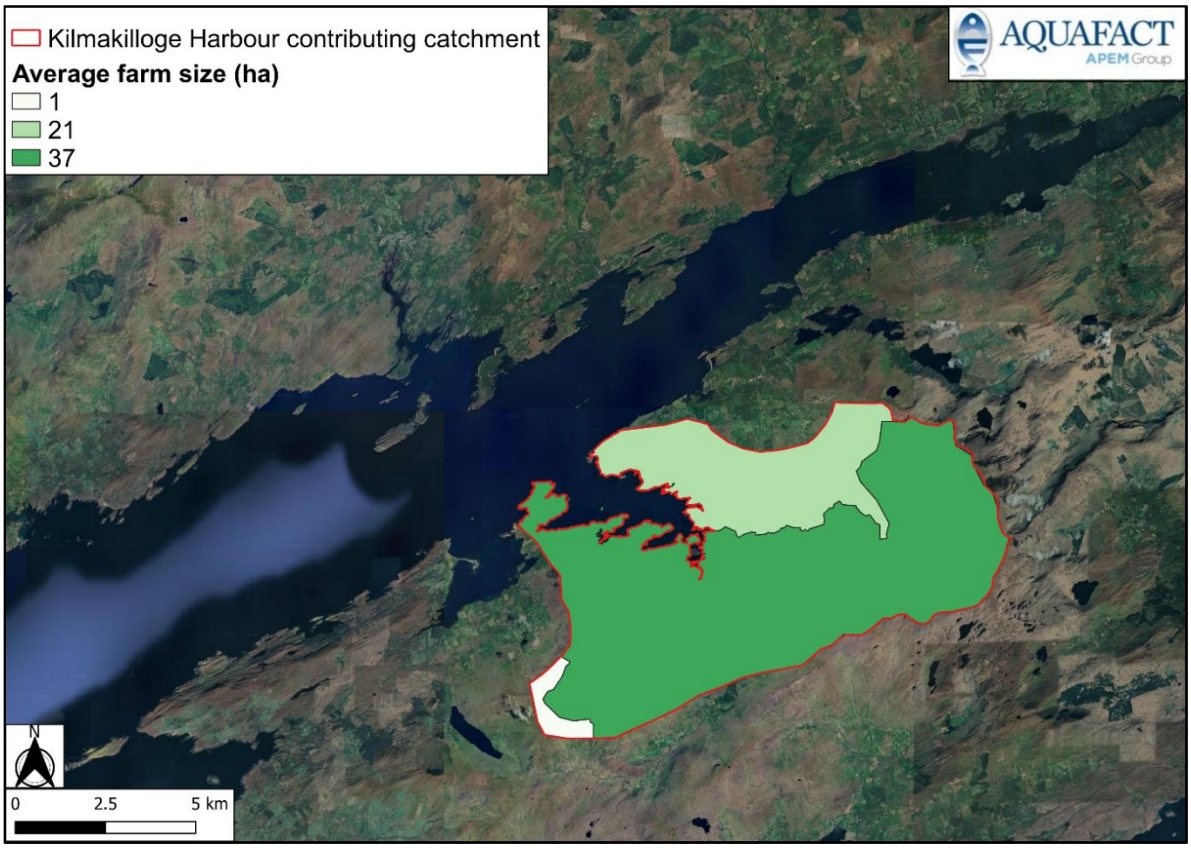


Figure 7-11: Average farm size (ha) based on estimated area of farm within Kilmakilloge Harbour contributing catchment.

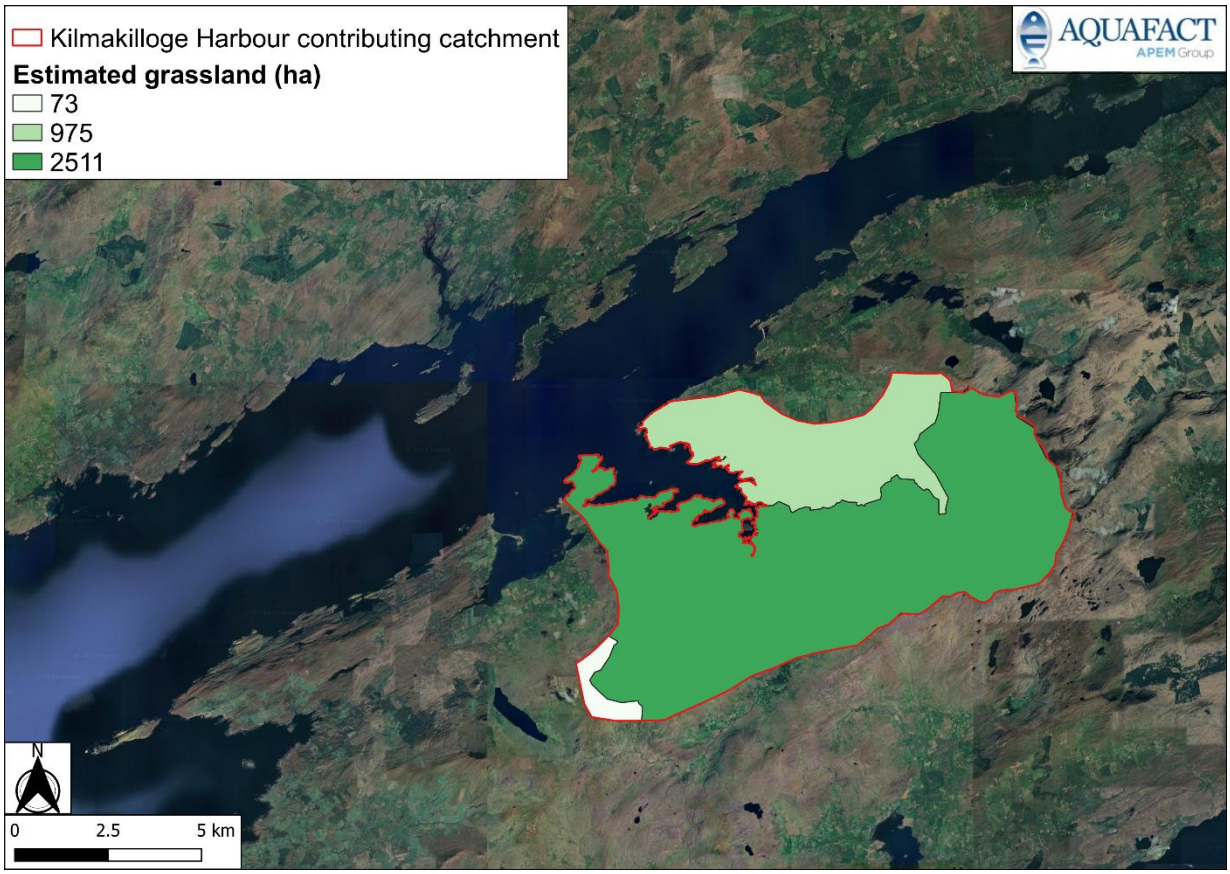


Figure 7-12: Estimated grassland area (ha) within Kilmakilloge Harbour contributing catchment.

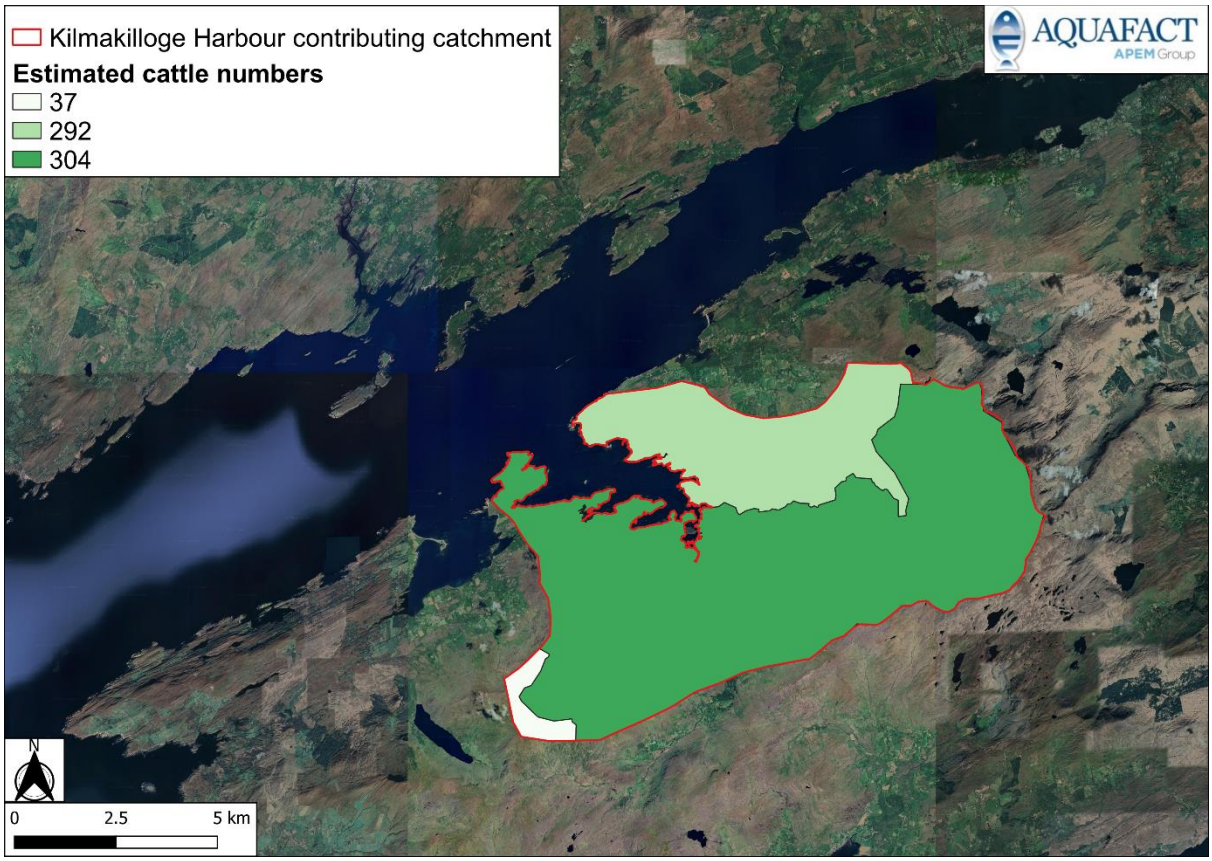


Figure 7-13: Estimated number of cattle within Kilmakilloge Harbour contributing catchment.

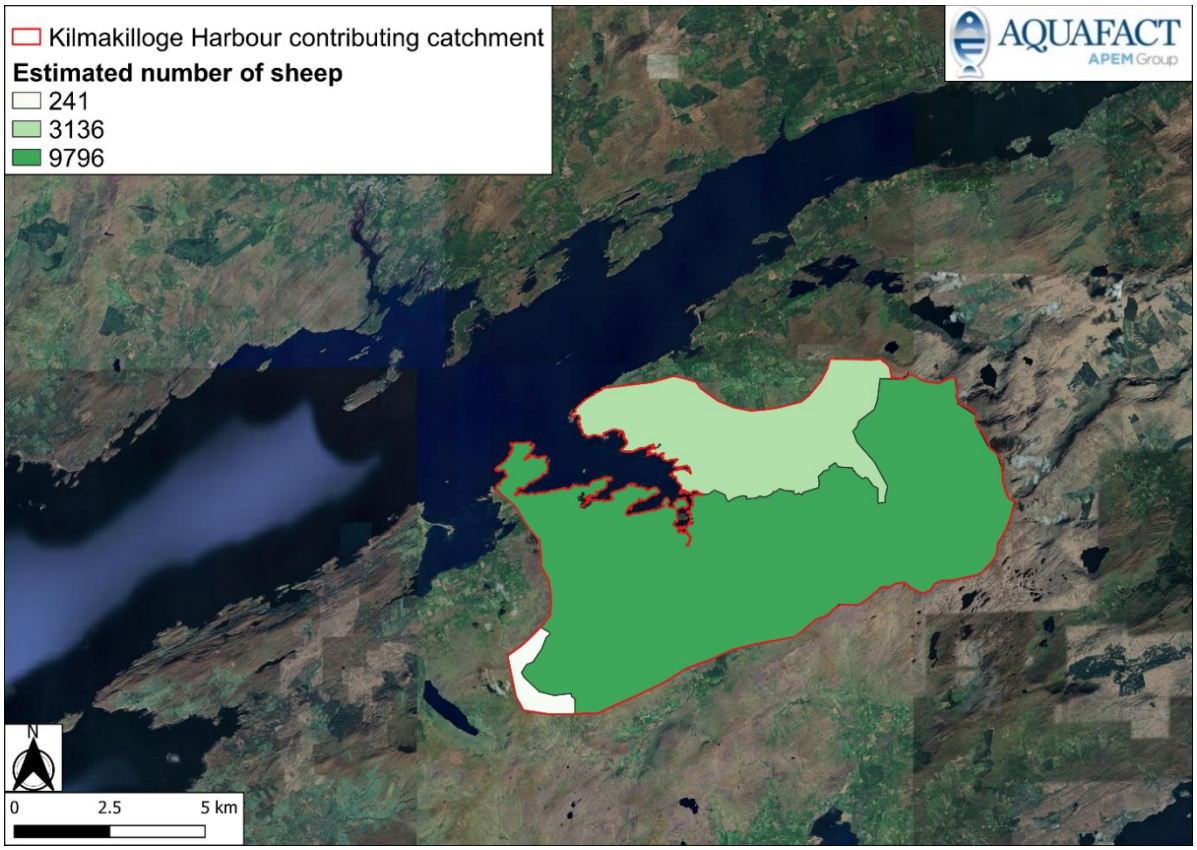


Figure 7-14: Estimated number of sheep per electoral division within Kilmakilloge Harbour contributing catchment.

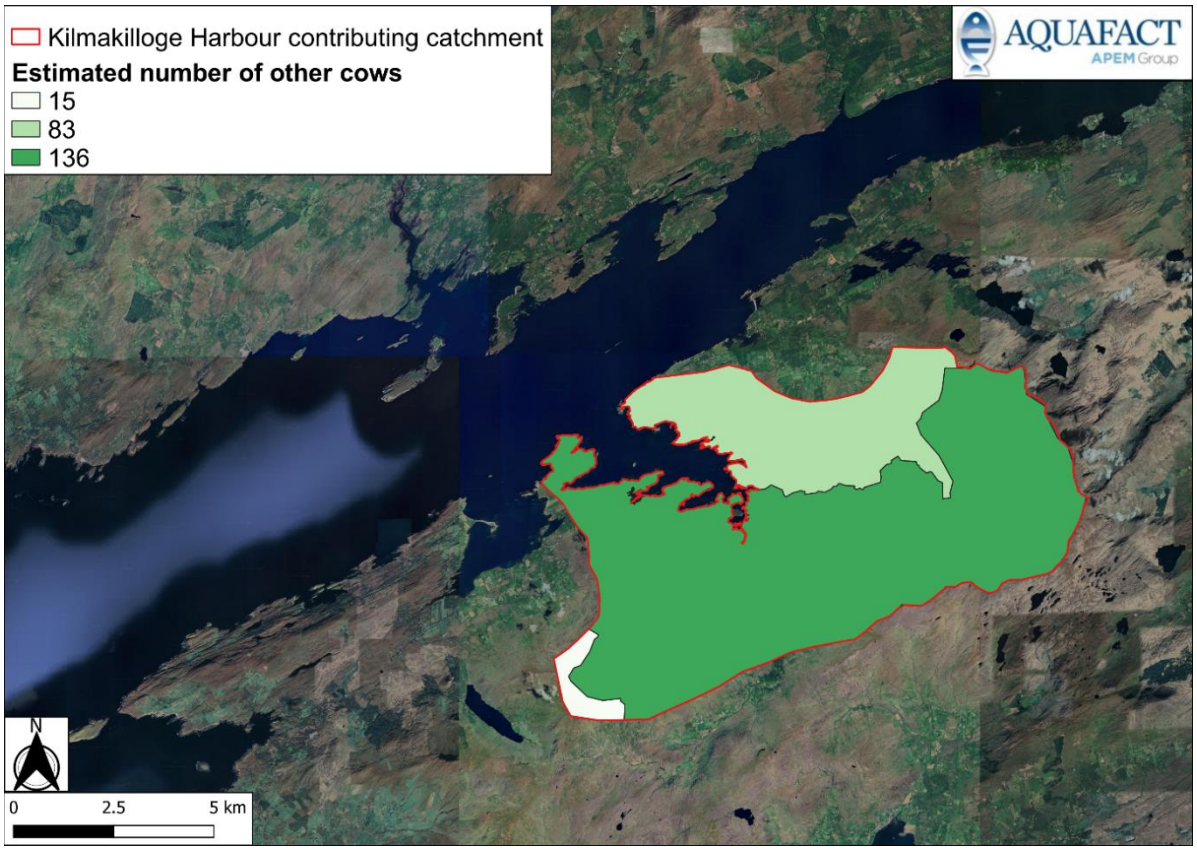


Figure 7-15: Estimated number of other cows in the electoral divisions within Kilmakilloge Harbour contributing catchment.

Statutory Instrument (S.I.) No. 113/2022[25] sets out regulations on the application of slurry and organic fertilisers, notably the method by which it is spread, the amount, the environmental conditions and the required distance from water courses. The aim of the Nitrates Action Programme is to prevent water pollution resulting from agricultural practices as well as to protect and improve water quality. The Fifth Nitrates Action Programme 2022-2025, given effect by S.I. No. 113 of 2022, restricts the spreading of slurry to before October 1st of a given year. The Programme prohibits the spreading of soiled water between December 1st and 31st, effective from January 1st, 2024 (see publication on overview of the programme for exceptions[26]). From January 1st, 2024, the use of low emission slurry spreading equipment is compulsory for farmers operating above 130 kg livestock N/ha for the purposes of air quality.

Rainfall levels and drainage and adsorption capacity of different soil types are factored into these regulations and also allow for exceptions under certain circumstances. While the levels of slurry and soiled water spreading were not readily available for Kilmakilloge Harbour contributing catchment at the time of writing, that *c.* 13% of the land is comprised of pastures and agricultural land gives an indication of the potential levels of spreading in the vicinity and potential discharge levels to groundwater and subsequently the DSW in the bay.

The bedrock within Kilmakilloge Harbour contributing catchment is primarily old red sandstone[27]. In terms of groundwater vulnerability, the contributing catchment is dominated by 'rock at or near surface or karst' according to the Geological Survey of Ireland groundwater data[27] (**Figure 7-16**). There are some extensive patches of high to extreme groundwater vulnerability areas occurring within the contributing catchment (**Figure 7-16**) and these primarily coincide with peat bogs. These are areas of high vulnerability but also overlap with pastures, broad-leaved forest and agricultural land. The contributing catchment occurs within the Beara Sneem ground water body which is described as having poorly productive bedrock. This indicates that the bedrock is not a good water source and could act as a route for water and associated pollutants to enter rivers and streams (Moe *et al*., 2010). Nonetheless, the Beara Sneem ground waterbody status was reported as 'good' in the 2016-2021 monitoring period[28].

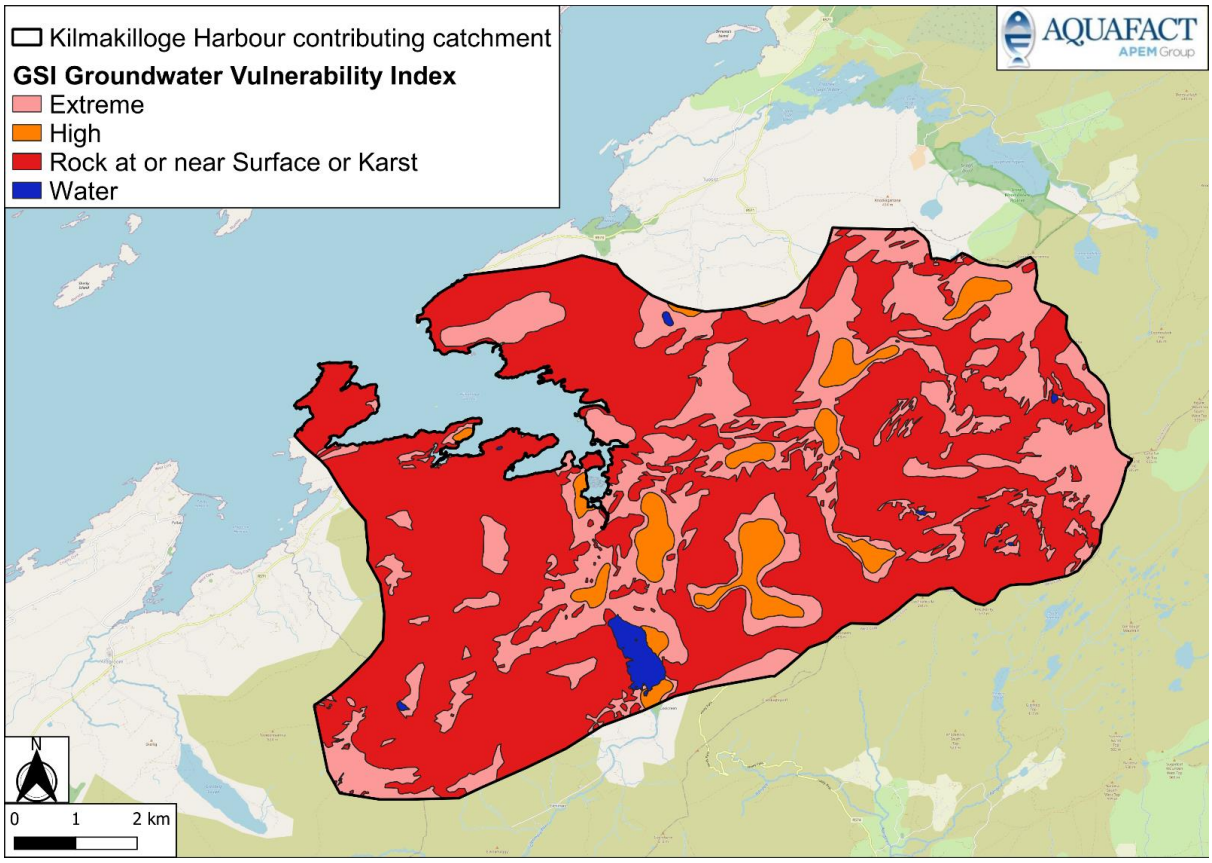


Figure 7-16: Geological Survey Ireland groundwater vulnerability within Kilmakilloge Harbour contributing catchment. Contains Irish Public Sector Data (Geological Survey Ireland) licensed under a Creative Commons Attribution 4.0 International (CC BY 4.0) licence.

7.1.6. Other Pollution Sources

7.1.6.1. Shipping

Operational waste from vessels, if not properly managed, can end up in the sea where the potential for contamination or pollution occurs. Wastes generated or landed in ports and harbours can be broadly divided into a) operational and domestic waste from ships and boats, b) waste from commercial cargo activities and c) waste generated from maintenance activities and associated maritime industry activities.

Marpol Annex IV defines sewage as “drainage from medical premises, toilets, urinals, spaces containing live animals and other waste waters when mixed with sewage waste streams”. Although adopted in 1973, the Annex did not come into effect internationally until September 2003, with subsequent amendments entered into force in August 2005. Annex IV requires ships to be equipped with either a sewage treatment plant, a sewage comminuting and disinfecting system or a sewage holding tank. Within 3 miles of shore, Annex IV requires that sewage discharges be treated by a certified Marine Sanitation Device (MSD) prior to discharge into the ocean. Sewage discharges made between 3 and 12 miles offshore must be treated by no less than maceration and chlorination, and sewage discharged greater than 12 miles from shore is unrestricted. Annex IV also established certain sewage reception facility standards and responsibilities for ports and contracting parties.

Ship sewage originates from water-borne human waste, wastewaters generated in preparing food, washing dishes, laundries, showers, toilets, and medical facilities. However, as waste enters the marine environment from many sources, it makes the identification of specific impacts from ship/boat waste very difficult. It is widely recognised that the majority of pollution entering the marine environment comes from land-based sources and atmospheric inputs from land-based industrial activities, with only an estimated 12% originating from shipping activities (GESAMP [Joint Group of Experts on the Scientific Aspects of Marine environmental Pollution], 1990).

Figure 7-17 shows all potential boat facilities and activities, namely slipways, piers and ports within Kilmakilloge Harbour contributing catchment; **Table 7.6** details these facilities. There were nine slipways/piers noted from the desktop survey within Kilmakilloge Harbour. However, the shoreline survey only verified three of these piers/slipways in Kilmakilloge Harbour, namely Kilmakilloge Pier, unnamed boat marina and unnamed landing pier (**Figure 7-17**; map ID 2, 5, and 8, respectively). These three piers/slipways correspond to map ID 9, 61 and 37, respectively, in **Figure 7-19**). On the Collorus headland on the northwestern shore of the harbour, between map ID 56-63 in **Figure 7-19**, the shoreline survey noted that there are a number of houses along the shoreline, most of which have little used private jetties or slipways.

The piers/slipways noted during the shoreline survey are small piers/slipways. During harvesting season (October-April) two 30 ft vessels and a small number of <10 ft fishing vessels will be deployed. Outside of this time period, boat activity in the bay is expected to be moderate to low and mostly made up of small fishing craft and shellfish farm service boats.

While data on sewage discharge levels from boating activities in the area were not available at the time of writing, it is unlikely that pollution occurs; disposal of sewage at sea governed by S.I. No. 492/2012 ensures this. Therefore, it is highly unlikely that any vessels in the area would have any negative impacts on *E. coli* contamination levels in the production area.

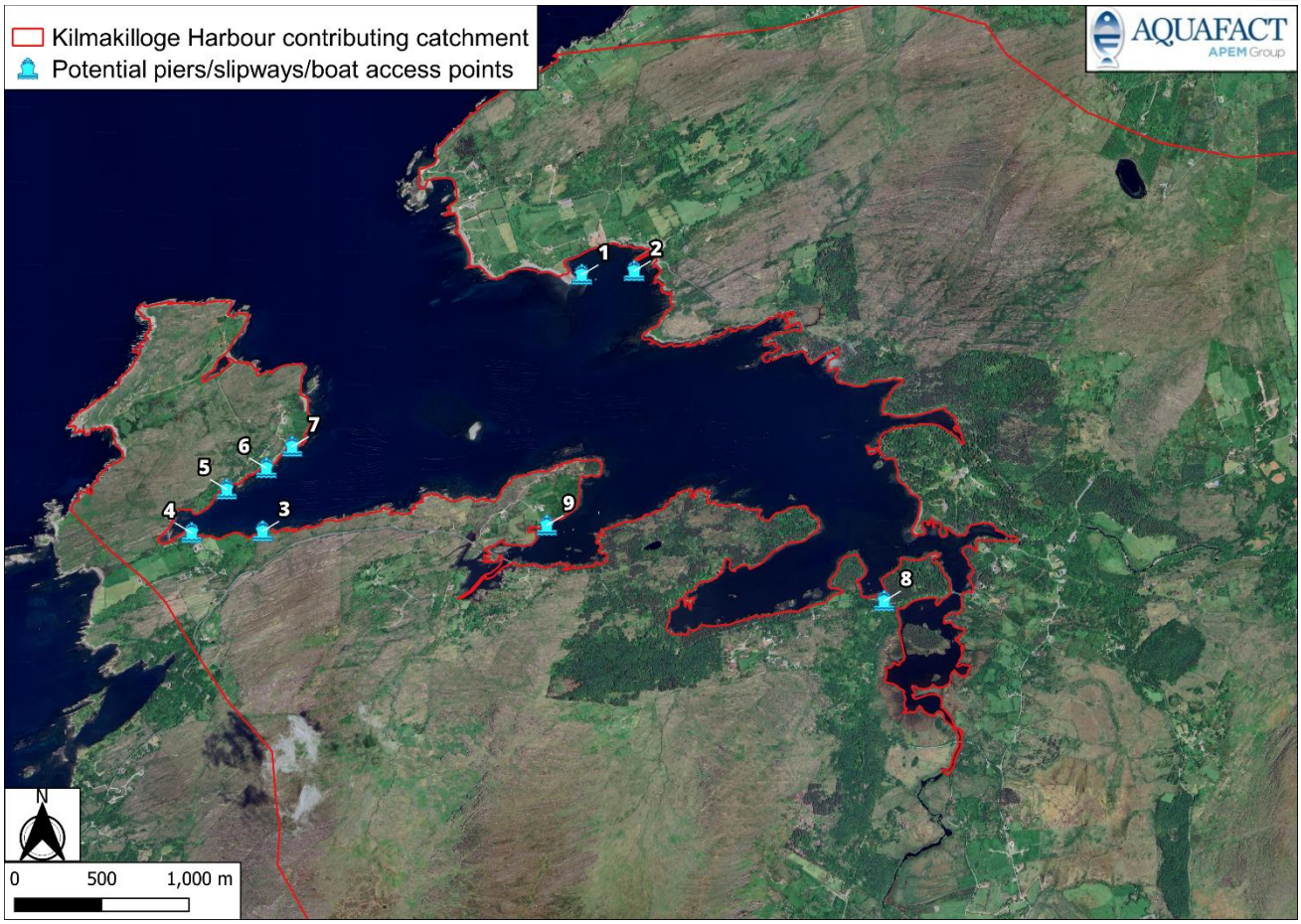


Figure 7-17: Potential piers/slipways/boat access points within Kilmakilloge Harbour contributing catchment identified during the desktop survey.

Table 7.6: Approximate coordinates for potential piers, slipways and boat access points within Kilmakilloge Harbour contributing catchment. Coordinate reference system (CRS) EPSG:4326 - WGS 84.

ID	Potential boat access points	Latitude	Longitude
1	Port	51.7791	-9.8117
2	Pier	51.7793	-9.8073
3	Slipway	51.7659	-9.8382
4	Slipway	51.7658	-9.8441
5	Slipway	51.7681	-9.8411
6	Slipway	51.7692	-9.8379
7	Slipway	51.7703	-9.8357
8	Slipway	51.7623	-9.7865
9	Slipway	51.7662	-9.8146

7.1.6.2. Wildlife

Birds

It is important to document the bird populations in the Kilmakilloge Harbour area as bird faeces are rich in faecal bacteria (Oshira & Fujioka, 1995) and have been shown to be a source of faecal contamination in the marine environment (Jones *et al.,* 1978; Standridge *et al.,* 1979; Levesque *et al.,* 1993, Alderisio & DeLuca 1999, Levesque *et al.,* 2000, Ishii *et al.,* 2007). There is no overlap between Kilmakilloge Harbour contributing

catchment and any SPAs. However, a number of SPAs in the vicinity of Kilmakilloge Harbour contributing catchment have been considered as potential sources of *E. coli* based on the protected species for which they are designated and the species these SPAs support. While there are other SPAs in the vicinity, they have not been factored in due to the unlikeliness that the bird species for which they are designated and/or support would occur in the contributing catchment and, more specifically, in Kilmakilloge Harbour itself. Lack of suitable habitat is the primary reason for not considering these SPAs.

The following SPAs, which have been designated under Annex I of the Birds Directive, are noted due to the potential for bird species to occur within the contributing catchment and subsequently contribute to the *E. coli* levels in the shellfish waters. The Iveragh Peninsula SPA, Beara Peninsula SPA and Sheep's Head to Toe Head SPA are located to the northwest, west and southwest of the contributing catchment respectively, along the coast of counties Kerry and Cork. They are designated for bird species which utilise cliff habitats so it would be unlikely for these species to occur within the contributing catchment. However, all three SPAs support other bird species which have the potential to occur within the contributing catchment, such as various gull species. The Killarney National Park SPA is located inland, northeast of the contributing catchment and supports bird species which may occur in the contributing catchment if their flight paths overlap with the contributing catchment.

Aquatic Animals

Kilmakilloge Harbour contributing catchment overlaps with three SACs and closely borders another SAC, however only one of these, Kenmare River SAC, is designated for aquatic mammals. Otter (*L. lutra*) and the harbour seal (*P. vitulina*) are protected species under Annex II of the Habitats Directive.

Harbour seal presence was documented 391 times in Kenmare River SAC during 2003, with Kilmakilloge Harbour being specifically noted as an area where the seals occurred; otter were also noted as occurring here[5]. During the 2010 Harbour Seal Pilot Monitoring Project, the maximum harbour seal count was 324, compared to 310 the previous year. The most recent monitoring survey in 2013 returned a count of 350 seals in inner Kilmakilloge Harbour[12]. Harbour seals have also been documented in Sneem Harbour to the northeast of Kilmakilloge Harbour and in Ardgroom Harbour to the southwest. Kenmare Bay, including Kilmakilloge Harbour, is a designated harbour seal habitat. There are a number of harbour seal moulting sites documented in Kilmakilloge Harbour, predominantly in the inner harbour. One of these moulting sites along with one breeding and one resting site were noted in the middle of the harbour between two licensed mussel sites[11] (**Figure 7-18**).

The most recent recorded sighting of otter within the contributing catchment on the National Biodiversity Data Centre (NBDC[12]) website is from 2017, when one otter was sighted on the eastern side of the Collorus headland, near the entrance to Kilmakilloge Harbour. In 2015 one otter was sighted in the Glanmore River and

in 2013 one otter was recorded in outer Kilmakilloge harbour on the northern side of the harbour entrance[12]. Other marine mammals such as bottlenose dolphin and grey seal have been sighted in Kenmare River[12].

No estimates of the volumes of seal or otter faeces are available although it is reasonable to assume that what is ingested and not assimilated in the gut must be defecated. The concentration of *E. coli* and other faecal indicator bacteria contained in seal faeces has been reported as being similar to that found in raw sewage, with counts showing up to 1.21 x 104 cfu *E. coli* per gram dry weight of faeces (Lisle *et al.,* 2004). *Salmonella* and *Campylobacter* spp. Have also been found in wild seals (Stoddard *et al.,* 2005).

All aquatic mammals that occur within Kilmakilloge Harbour contributing catchment are likely to add to background levels of faecal contamination within the area particularly during the haul-out periods for seals.

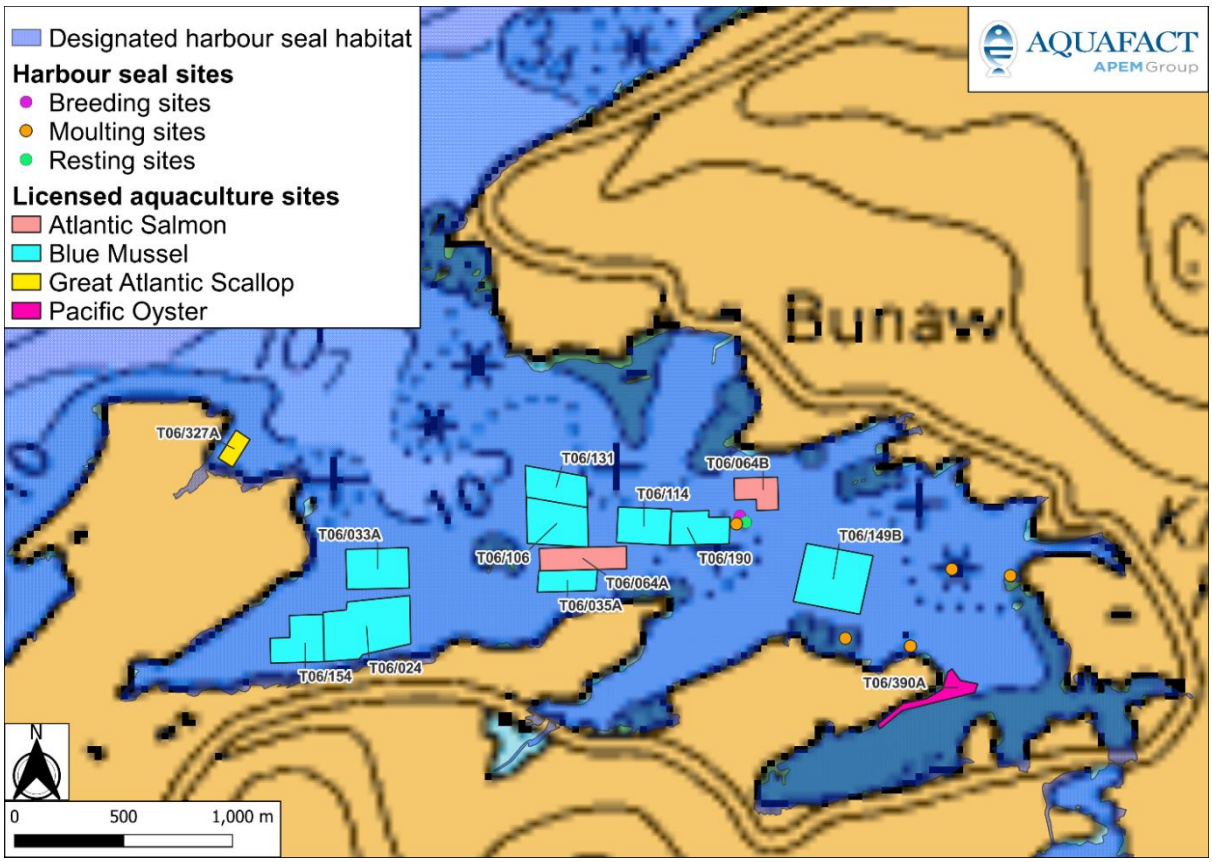


Figure 7-18: Harbour seal habitat and site use in reference to Kilmakilloge Harbour and licensed aquaculture sites.

7.2. Shoreline Survey

7.2.1. Shoreline Survey Report

A shoreline survey was carried out by the SFPA. **Figure 7-19** shows the GPS (Global Positioning System) locations of 63 sites which were photographed over four survey days between August and October 2023. All of the Kilmakilloge Harbour shoreline was walked, where practical. The area along the Doorus Loop walk

between map ID 45 and 46 (**Figure 7-19**) was not surveyed due to thick foliage and forestry. The Eskadour headland was not surveyed due to access issues.

The aim of this shoreline survey was to identify/confirm and mark all discharges, pollution sources, waterways, and marinas along the shoreline. GPS coordinates were recorded for all features and marked on a map. In addition, all features were photographed digitally (where possible). Notes were made on the numbers and types of farm animals visible from the shoreline and on wild fowl/populations of wild animals with an estimation of their numbers.

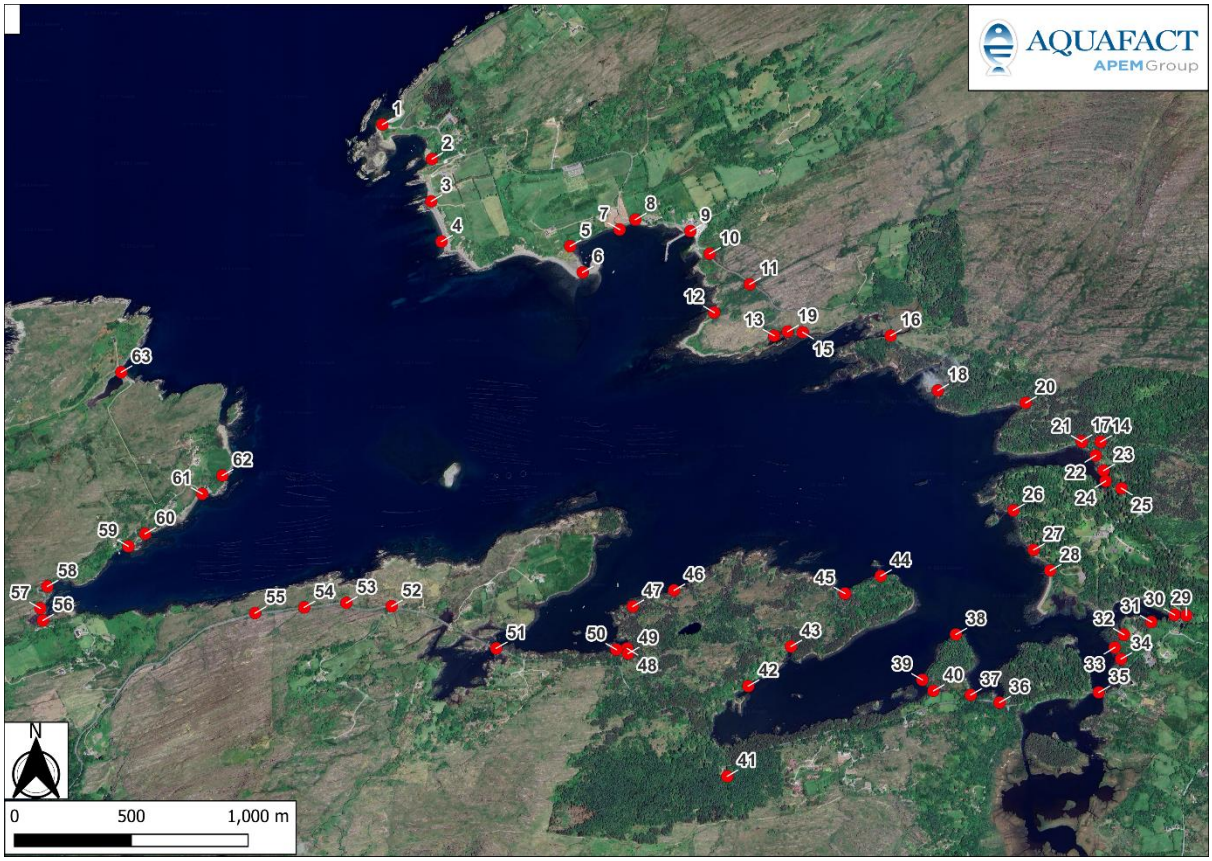


Figure 7-19: Locations of GPS and photograph sites from the shoreline survey (numbering cross-referenced to Table 7.7).

Figure 7-19 shows the location of all features observed during the shoreline survey. In total 63 features were identified (see **Appendix 4**: Shoreline Survey Images), of which 24 were streams, five rivers, four culverts, seven drains, and two pipes. There were seven bridges, two boating shelter locations, three boat access points (namely Kilmakilloge pier, landing pier, and boat marina), and one freshwater lough. Two areas of rough grazing were noted, one location with cows and one location with sheep. Additionally, one picnic area, and one location with two cormorants and an otter were observed. **Figure 7-20** to **Figure 7-34** show the locations of these features. **Table 7.7** details all features identified, and the numbering used is cross-referenced to **Figure 7-20** to **Figure 7-34**.

Table 7.7: Features identified during the shoreline survey. Latitude and longitude values are in coordinate reference system (CRS) WGS84, easting and northing values are in CRS Irish Transverse Mercator[29]. Refer to Figure 7-20 to Figure 7-34 for locations and Appendix 4: Shoreline Survey Images for photographs.

Map Point	Observation	Comments	Picture Number	Latitude	Longitude	Easting	Northing
1	2 x cormorants, 1 x otter	Start point.	1, 2	51.7845	-9.82483	474101	560709.8
2	Picnic Area	Hot tub next to picnic area with hut, very boggy, fishing spot, private dwelling on headland opposite this area, private dwelling bordering beach, swimming location.	3, 4, 5	51.78318	-9.82175	474309.9	560557.7
3	Pipe	Runoff pipe in beach area near private dwelling and picnic area.	6	51.78156	-9.8218	474301.9	560377.6
4	Streams	Rough grazing and big gullies in land from runoff. Multiple streams, freshwater runoff from land, on beach directly across from private dwelling on opposite headland.	7, 8	51.78002	-9.82116	474341.8	560205.2
5	Stream	Brackish pond, with tidal influence, silty bottom, freshwater stream.	9	51.77984	-9.81319	474891.2	560171.5
6	Boat Shelter	Strand opposite Kilmakilloge pier where boats shelter.	10	51.77884	-9.81241	474942.2	560058.9
7	River	River entering into Kilmakilloge harbour.	11	51.78048	-9.81012	475104.7	560237.4
8	Pipe/Freshwater Runoff	Freshwater well with freshwater runoff from well. House to right of well, 2 sets of houses, water pipe from freshwater runoff pipes from road x2.	12,13	51.78086	-9.80914	475173.4	560278
9	Kilmakilloge Pier	Old drain that has its outlet blocked with stones, rope and tyres.	14	51.78042	-9.80573	475407.5	560223.2
10	Stream	Stream running clear.	15	51.77955	-9.80454	475487.2	560124.4
11	Stream	Slightly large stream running clear.	16	51.77838	-9.80205	475655.7	559990
12	Stream	Small clear stream.	17	51.7773	-9.80426	475500.3	559873.7
13	Drain	Very narrow slow flowing drain.	18	51.77641	-9.80054	475754.5	559768.3
14	Drain	Wide drain.	19	51.77234	-9.78029	477140.7	559281.3
15	Stream	Small stream running clear.	20	51.77654	-9.79877	475877	559779.8
16	River with bridge	(Bridge main) major river running clear.	21	51.77641	-9.79332	476252.7	559756
17	Stream	Small stream running clear fast flowing.	22	51.77237	-9.78149	477058	559286.7
18	Stream	Wide stream running clear.	23	51.77431	-9.79039	476449.1	559517.5
19	Stream	Small stream — running clear.	24	51.77657	-9.7997	475812.9	559784.7
20	Stream	Small stream running clear — onto beach.	25	51.77384	-9.78494	476823.9	559456

Map Point	Observation	Comments	Picture Number	Latitude	Longitude	Easting	Northing
21	Stream	Small stream clear running into mud flat estuary.	26	51.77234	-9.78145	477060.6	559283.3
22	Derreen River	Main river — Bridge point, clear running.	27	51.77182	-9.7806	477117.9	559224
23	Culvert	Clear running – Culvert.	28	51.77124	-9.78011	477150.1	559158.6
24	Stream	Clear running — small stream.	29	51.77084	-9.77998	477158	559113.9
25	Stream	Stream running clear onto mud flats.	30	51.77056	-9.779	477224.9	559081.1
26	Boat House with Pipe	Boat house Derreen woods — Drainage pipe.	31	51.76972	-9.7857	476760.2	558999
27	Culvert/drain	Culvert/Land drain 18" pipe concrete flowing clear into estuary.	32	51.7682	-9.78445	476842.4	558827.8
28	Culvert	Location under main Derreen house culvert from woods — clear into estuary/beach.	33	51.76741	-9.78342	476911.3	558738.2
29	Owenshagh River Bridge (upstream)	Derreen Garden entrance Owenshagh river bridge.	34	51.76569	-9.77498	477489.1	558532.7
30	Owenshagh River Entry Point	Start Point, Lauragh Bridge.	35	51.76571	-9.77571	477438.8	558536.1
31	Field Drain	Moderate Flow field drain.	36	51.76544	-9.77715	477338.7	558508.5
32	Stream	Bridge.	37	51.76495	-9.77885	477220	558456.9
33	Drain	Small Field Drain.	38	51.76446	-9.77942	477179.3	558403.3
34	Drain	Small Field Drain.	39	51.76402	-9.77903	477205.1	558353.7
35	Bridge/road	Bridge/Road +river (summary sheet).	40, 41	51.76274	-9.78041	477106.3	558213.7
36	Landing pier	Area between Map ID 6 & 7 heavily wooded.	42	51.76235	-9.78656	476680.8	558180.7
37	Drain	Field drain draining woodland.	43	51.76264	-9.78835	476558	558216
38	Point of Turn	Doorus Point.	44	51.76496	-9.78927	476500.9	558475.6
39	Next Point	No Comments.	45	51.76322	-9.79135	476352.6	558285.6
40	Rough Grazing	Point of return, rough grazing between here and road.	46, 47	51.7628	-9.79066	476399	558237.7
41	Stream with waterfall	Freshwater stream and waterfall entering into Kilmakilloge Harbour. Empty out by stone circle sign.	No Picture	51.75952	-9.80345	475507.3	557894.6
42	Stream	Small stream run off from woodland.	No Picture	51.76298	-9.80215	475606.7	558277.2
43	Stream	Stream run off from woodland.	No Picture	51.7645	-9.7995	475793.6	558441.8
44	Next Point	Doorus Loop Walk — photo looking North.	48	51.7672	-9.79393	476185.4	558732.7
45	Stream	Stream running off from woodland.	No Picture	51.76653	-9.79615	476030.3	558661.9
46	Next Point	Looking East to Bunaw Pier.	49	51.76665	-9.80675	475299.5	558693.3

Map Point	Observation	Comments	Picture Number	Latitude	Longitude	Easting	Northing
47	Shore	Along shore from north side Doorus loop.	50, 51, 52	51.76603	-9.8093	475121.4	558629.2
48	Stream	Stream 1.	No Picture	51.76442	-9.80964	475093.2	558450.2
49	Stream	Eskadour / Doorus stream no. 2.	53	51.76423	-9.80959	475096.2	558429
50	Next Point	Looking west to Eskadour bridge.	54	51.76438	-9.81032	475046.5	558446.9
51	Eskadour Bridge with sheep	Sheep grazing on land both sides of Eskadour bridge. Rough grazing.	No Picture	51.76443	-9.81777	474532.4	558465.3
52	Cows	Rough grazing ground across from road entrance to number of houses, ground very boggy and stoney, house on headland. Cows grazing.	55	51.76604	-9.82425	474089.7	558655.5
53	Rough Grazing	Rough grazing, boggy ground.	56	51.76617	-9.82706	473896.1	558674.9
54	Stream	Freshwater stream entering into harbour under old oak tree.	57	51.766	-9.82967	473715.5	558660.5
55	Next Point	Point taken in lay-by directly across from green shed and houses on opposite headland.	58	51.76578	-9.83272	473504.4	558641.3
56	Culvert	Culvert.	59	51.7655	-9.84588	472595.4	558632.7
57	Stream	Freshwater stream to left of house next to big stone boulder.	60	51.76596	-9.84604	472585.6	558684.5
58	Brackish water	Brackish Water.	61	51.7668	-9.8456	472618.4	558777.2
59	Boat marina	Boat marina.	62	51.76834	-9.84058	472969.1	558939.7
60	Stream	Stream (small) running clear.	63	51.76882	-9.83954	473042.2	558991.3
61	Stream	Stream (small) running clear.	64	51.77035	-9.836	473290.8	559155.3
62	Drain	Land drain from good agricultural ground (Cattle grazing field) clear water.	65	51.77105	-9.83475	473379.1	559231
63	Freshwater Lough	Freshwater lough.	66	51.77501	-9.84102	472957.5	559682.4

Figure 7-20: Features 1-4 identified during the shoreline survey (numbering cross-reference to Table 7.7).

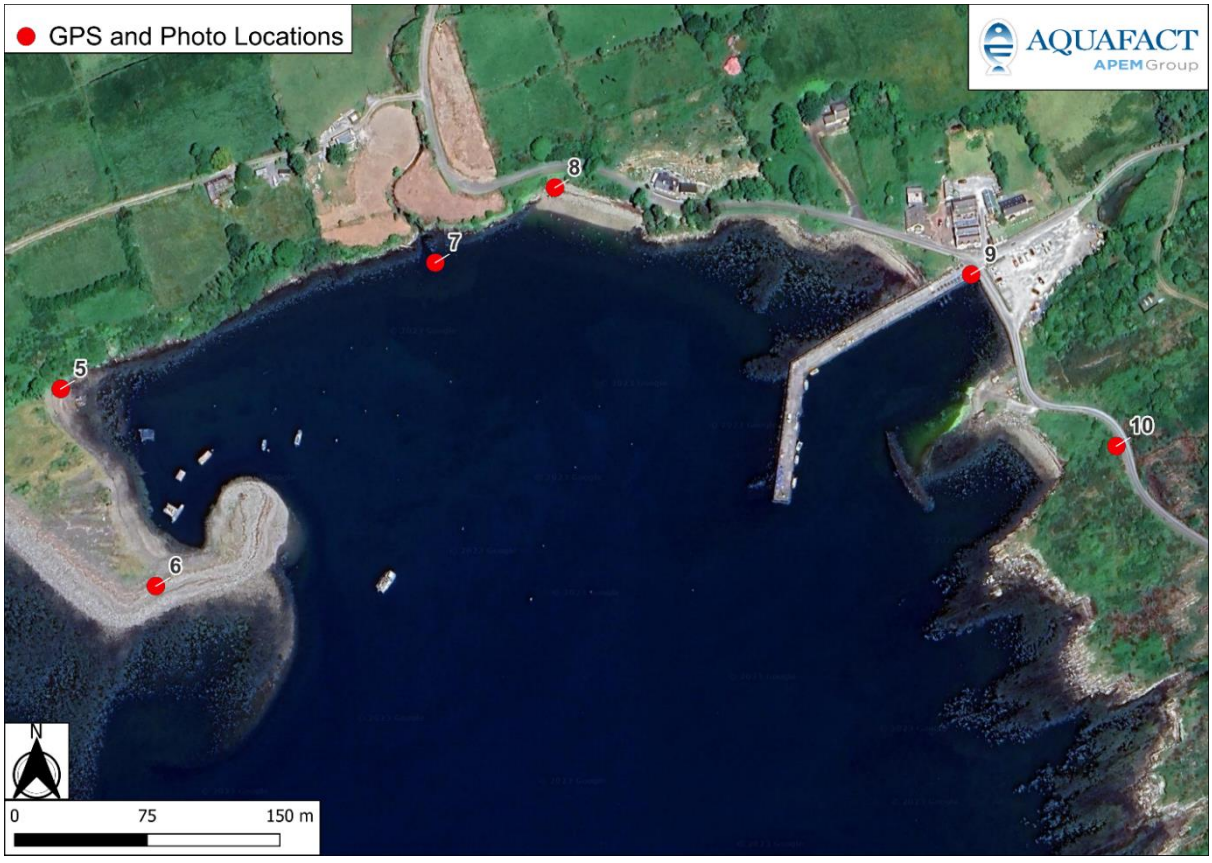


Figure 7-21: Features 5-10 identified during the shoreline survey (numbering cross-reference to Table 7.7).

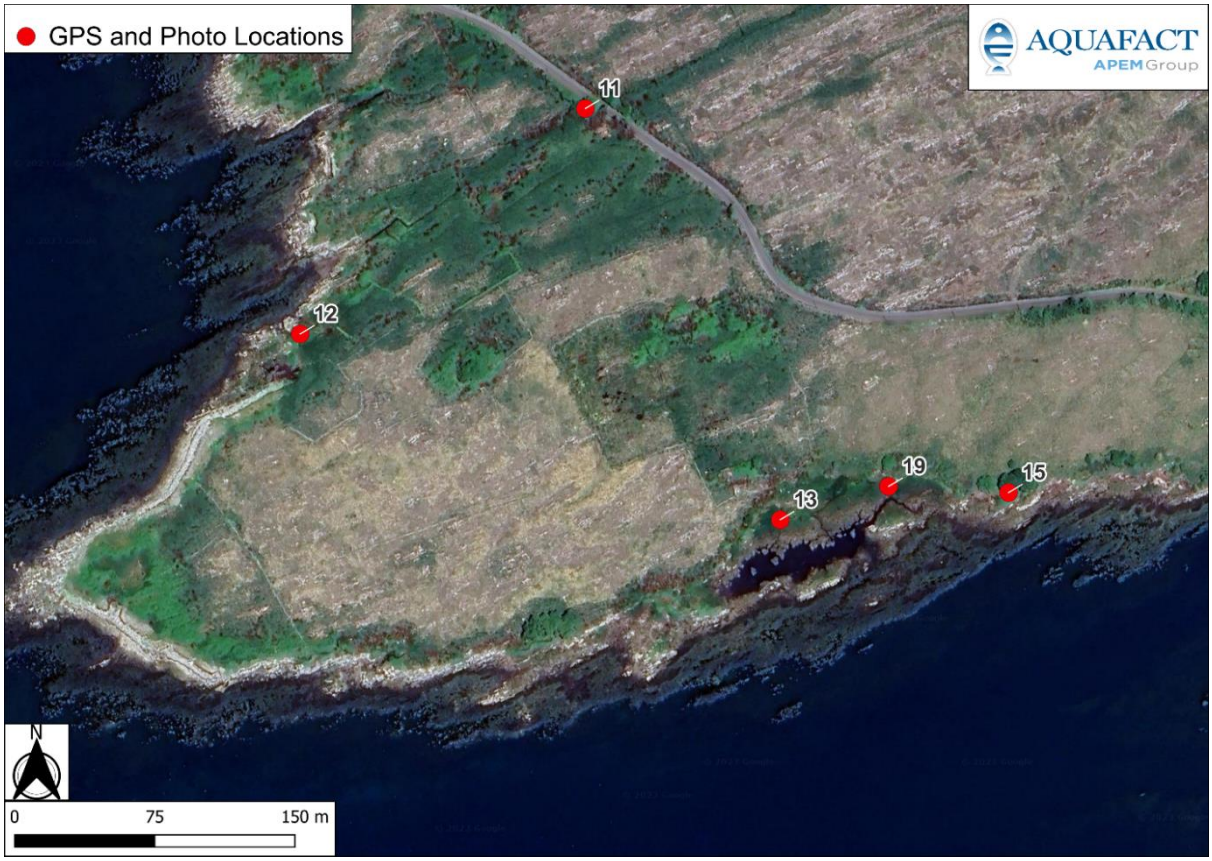


Figure 7-22: Features 11-15 and 19 identified during the shoreline survey (numbering cross-reference to Table 7.7).

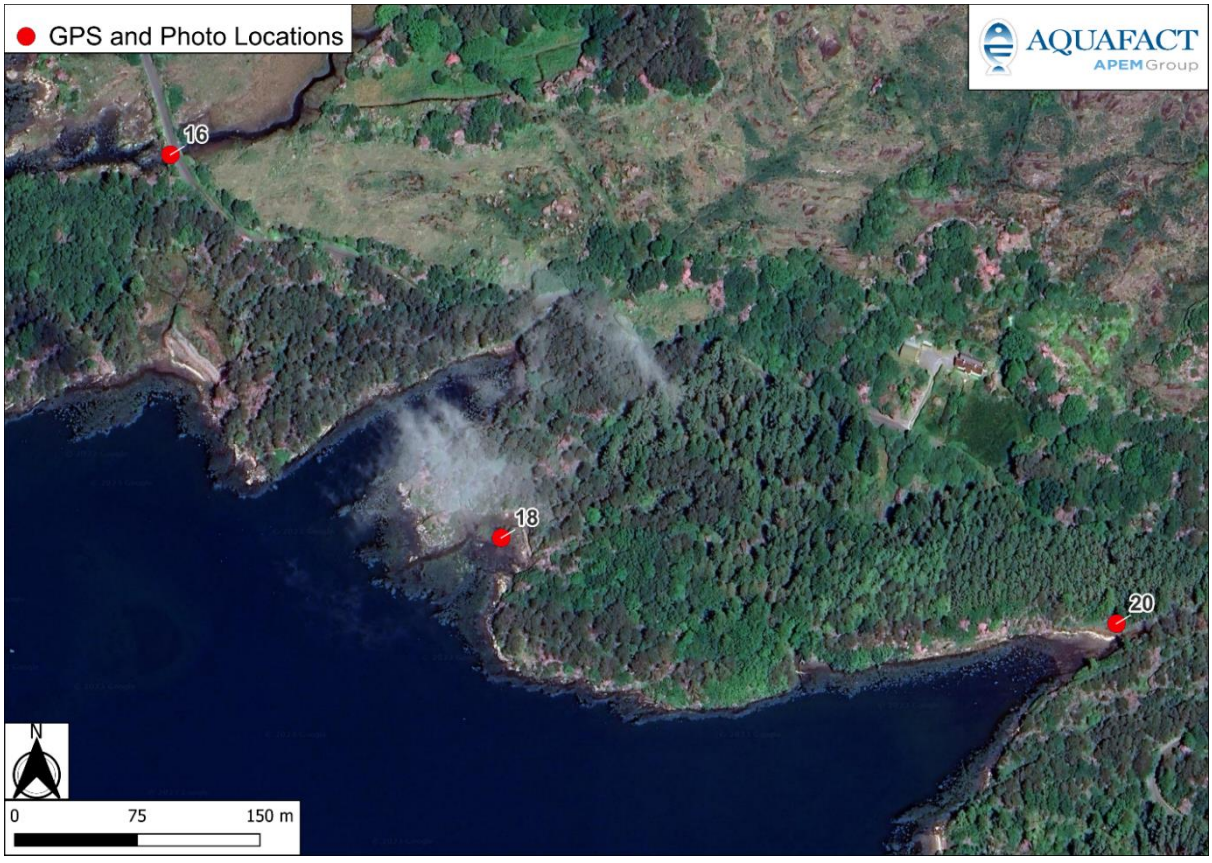


Figure 7-23: Features 16, 18 and 20 identified during the shoreline survey (numbering cross-reference to Table 7.7).

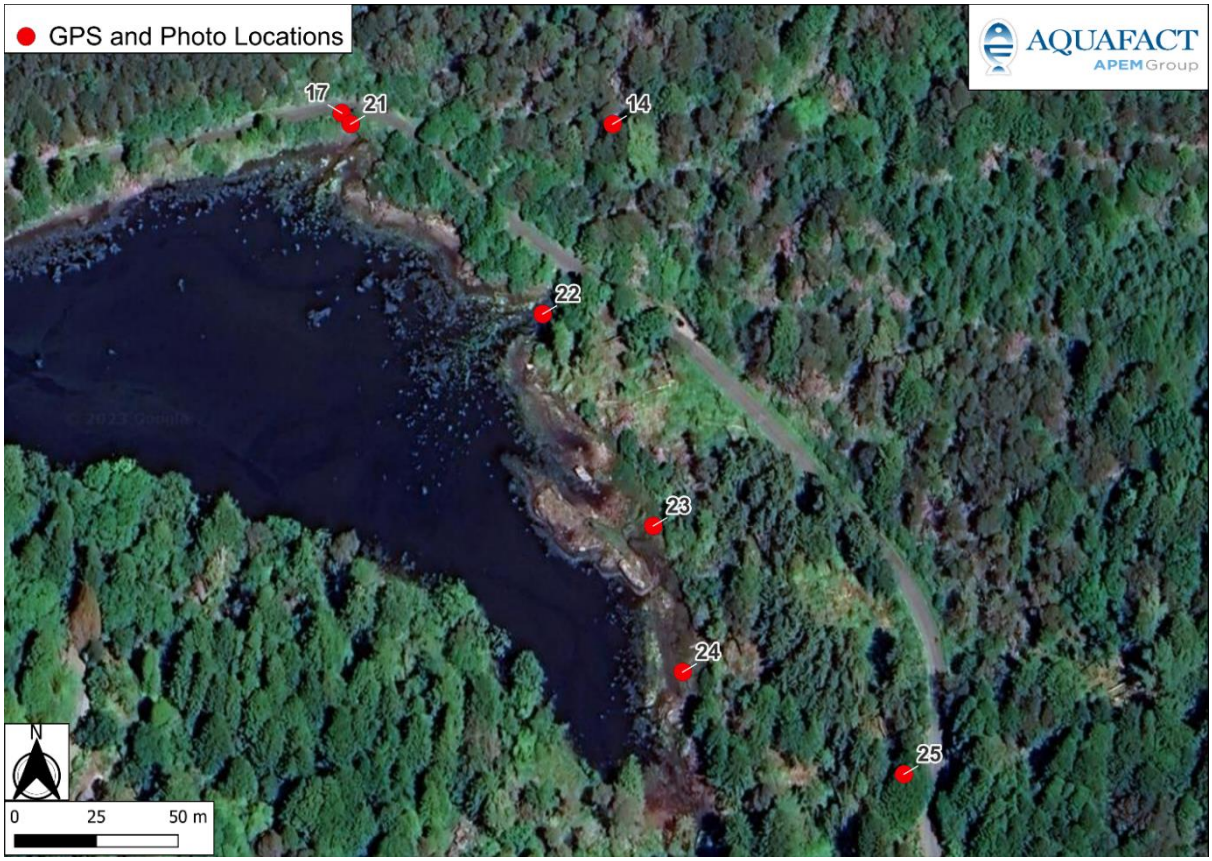


Figure 7-24: Features 14, 17, and 21-25 identified during the shoreline survey (numbering cross-reference to Table 7.7).

Figure 7-25: Features 26-28 identified during the shoreline survey (numbering cross-reference to Table 7.7).

Figure 7-26: Features 29-35 identified during the shoreline survey (numbering cross-reference to Table 7.7).

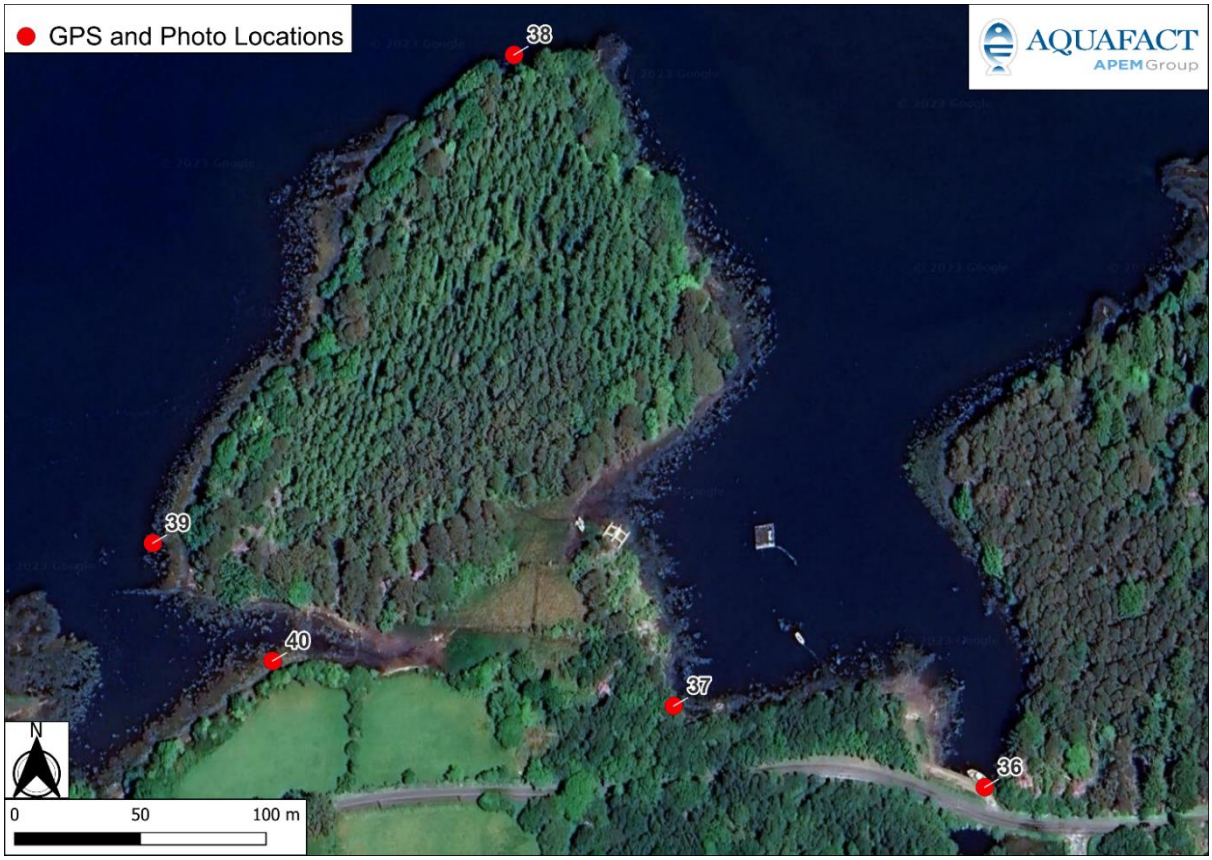


Figure 7-27: Features 36-40 identified during the shoreline survey (numbering cross-reference to Table 7.7).

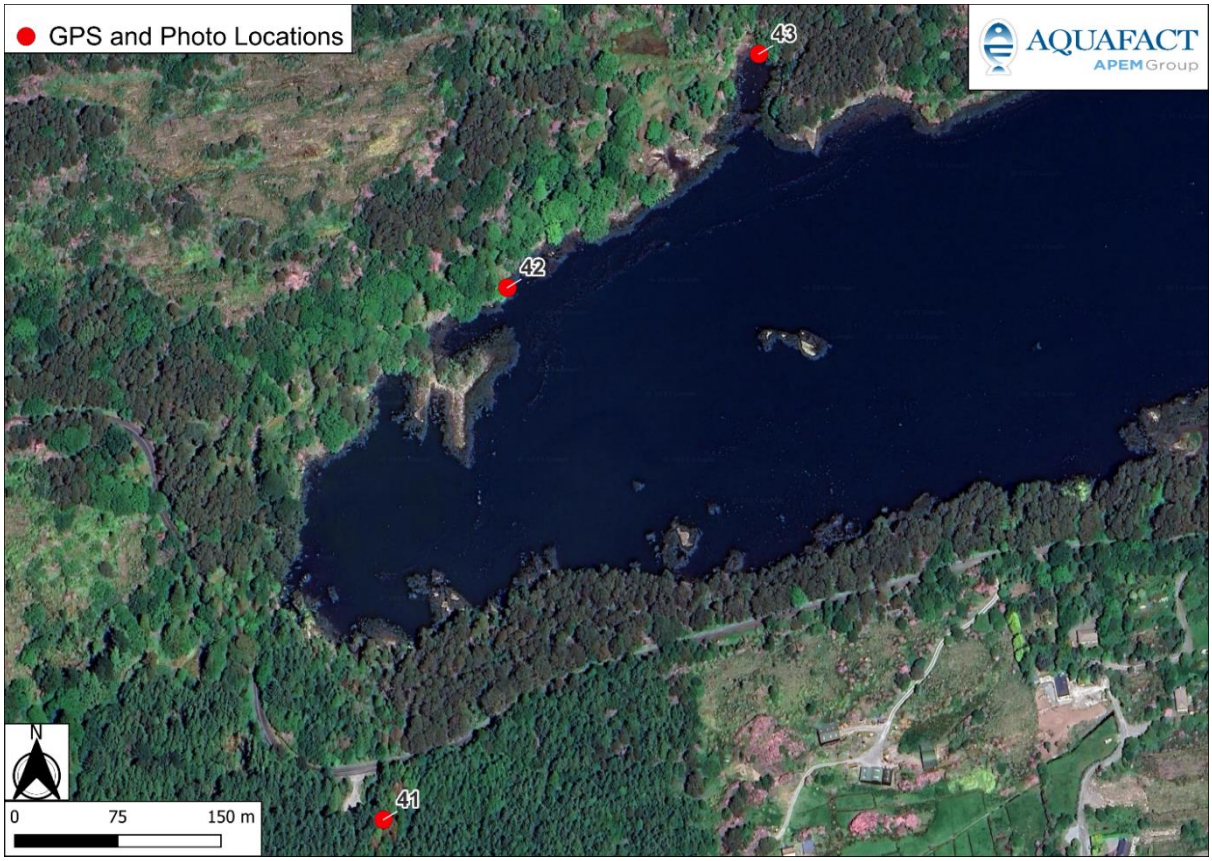


Figure 7-28: Features 41-43 identified during the shoreline survey (numbering cross-reference to Table 7.7).

Figure 7-29: Features 44-45 identified during the shoreline survey (numbering cross-reference to Table 7.7).

Figure 7-30: Features 46-50 identified during the shoreline survey (numbering cross-reference to Table 7.7).

Figure 7-31: Features 51-55 identified during the shoreline survey (numbering cross-reference to Table 7.7).

Figure 7-32: Features 56-58 identified during the shoreline survey (numbering cross-reference to Table 7.7).

Figure 7-33: Features 59-62 identified during the shoreline survey (numbering cross-reference to Table 7.7).

Figure 7-34: Feature 63 identified during the shoreline survey (numbering cross-reference to Table 7.7).

7.2.2. Locations of Sources

Figure 7-35 shows all rivers/streams that discharge into Kilmakilloge Harbour and **Table 7.8** provides cross-referenced details for this map. **Figure 7-36** shows all discharges into Kilmakilloge Harbour contributing catchment and **Table 7.9** provides cross-referenced details for industrial discharges, drains, pipes, rivers, and stream discharges.

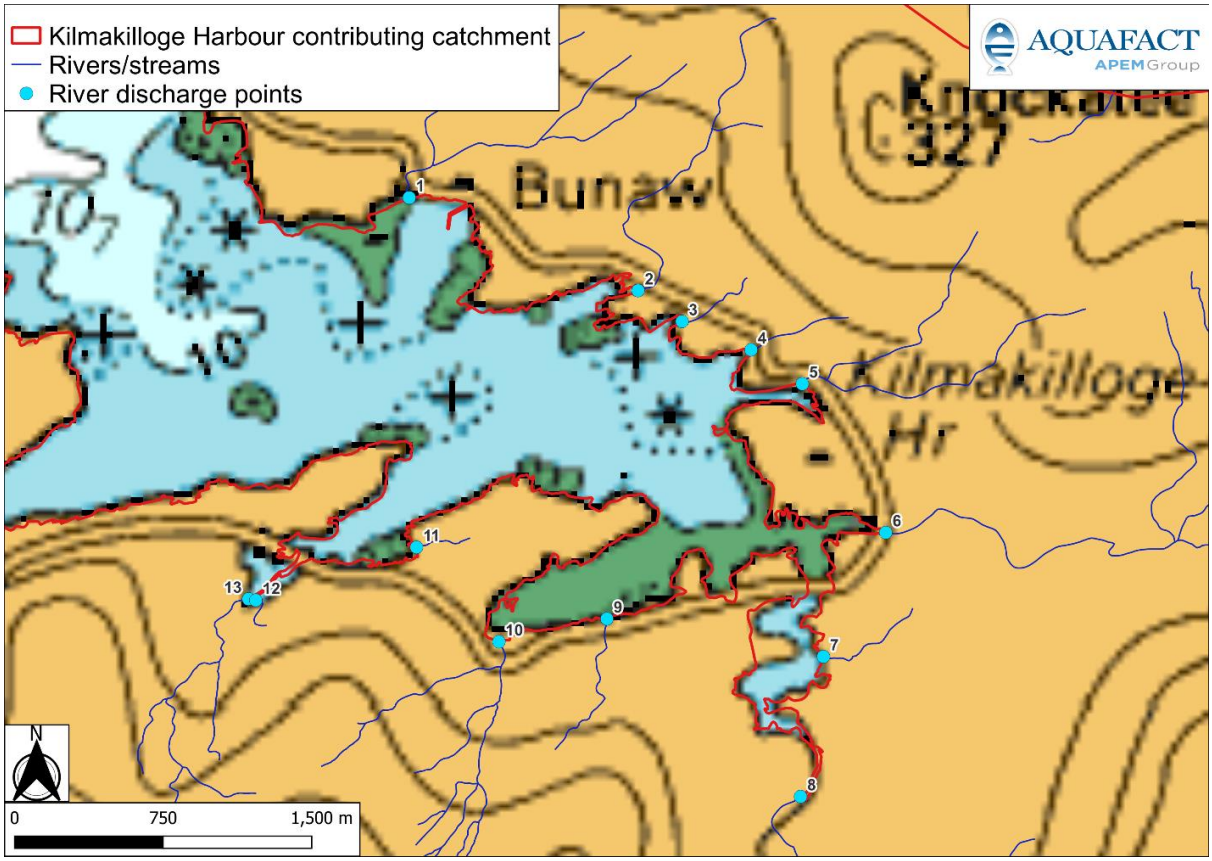


Figure 7-35: Locations of all river/stream discharge points into Kilmakilloge Harbour.

Table 7.8: Cross-referenced table for Figure 7 35 river/stream discharge points.

Map ID	River/stream
1	Loughanacreen
2	Lehid 21
3	Unnamed
4	Unnamed
5	Lauragh
6	Owenshagh
7	Lauragh Lower
8	Croanshagh
9	Reenkilla 21
10	Cashelkeelty 21
11	Unnamed
12	Unnamed
13	Eskadour 21

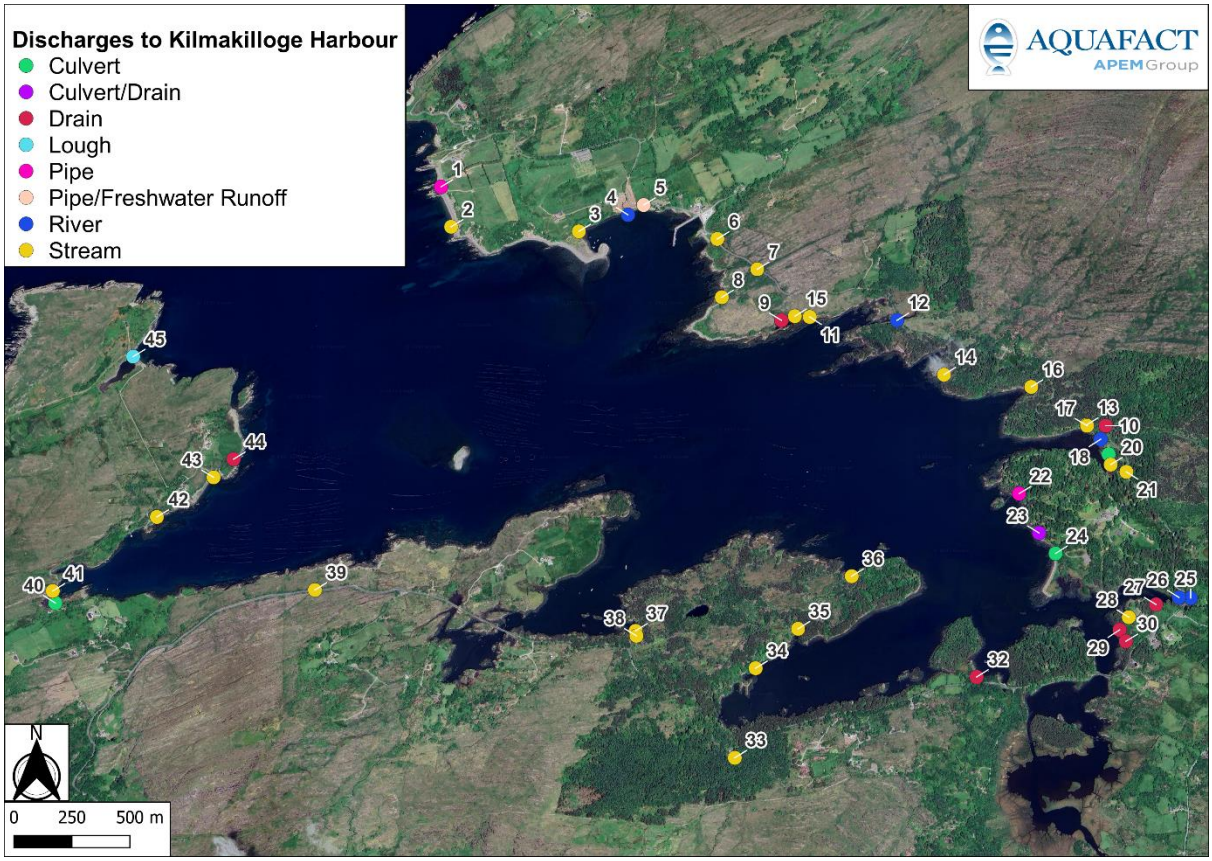


Figure 7-36: Locations of all discharges into Kilmakilloge Harbour contributing catchment.

Table 7.9: Cross-referenced table for Figure 7-36 discharges. Latitude and longitude values are in CRS WGS84, easting and northing values are in CRS Irish Transverse Mercator[29].

Map Point	Observation	Comments	Picture Number	Latitude	Longitude	Easting	Northing
1	Pipe	Runoff pipe.	6	51.78156	-9.8218	474301.9	560377.6
2	Streams	Rough grazing and big gullies in land from runoff. Multiple streams, freshwater runoff from land, directly across from private dwelling on opposite headland.	7,8	51.78002	-9.82116	474341.8	560205.2
3	Stream	Brackish pond, with tidal influence, silty bottom, freshwater stream.	9	51.77984	-9.81319	474891.2	560171.5
4	River	No comments.	11	51.78048	-9.81012	475104.7	560237.4
5	Pipe/Freshwater Runoff	Freshwater well with freshwater runoff from well. House to right of well, 2 sets of houses, water pipe from freshwater runoff pipes from road x2.	12 + 13	51.78086	-9.80914	475173.4	560278
6	Stream	Stream running clear.	15	51.77955	-9.80454	475487.2	560124.4
7	Stream	Slightly large stream running clear.	16	51.77838	-9.80205	475655.7	559990
8	Stream	Small clear stream.	17	51.7773	-9.80426	475500.3	559873.7
9	Drain	Very narrow slow flowing drain.	18	51.77641	-9.80054	475754.5	559768.3
10	Drain	Wide drain.	19	51.77234	-9.78029	477140.7	559281.3
11	Stream	Small stream running clear.	20	51.77654	-9.79877	475877	559779.8
12	River with bridge	(Bridge main) major river running clear.	21	51.77641	-9.79332	476252.7	559756
13	Stream	Small stream running clear fast flowing.	22	51.77237	-9.78149	477058	559286.7
14	Stream	Wide stream running clear.	23	51.77431	-9.79039	476449.1	559517.5
15	Stream	Small stream — running clear.	24	51.77657	-9.7997	475812.9	559784.7
16	Stream	Small stream running clear — onto beach.	25	51.77384	-9.78494	476823.9	559456
17	Stream	Small stream clear running into mud flat estuary.	26	51.77234	-9.78145	477060.6	559283.3
18	Derreen River	Main river — Bridge point, clear running.	27	51.77182	-9.7806	477117.9	559224
19	Culvert	Clear running — Culvert.	28	51.77124	-9.78011	477150.1	559158.6
20	Stream	Clear running — small stream.	29	51.77084	-9.77998	477158	559113.9
21	Stream	Stream running clear onto mud flats.	30	51.77056	-9.779	477224.9	559081.1
22	Boat House with Pipe	Boat house Derreen woods — Drainage pipe.	31	51.76972	-9.7857	476760.2	558999
23	Culvert/drain	Culvert/Land drain 18” pipe concrete flowing clear into estuary.	32	51.7682	-9.78445	476842.4	558827.8

Map Point	Observation	Comments	Picture Number	Latitude	Longitude	Easting	Northing
24	Culvert	Location under main Derreen house culvert from woods — clear into estuary/beach.	33	51.76741	-9.78342	476911.3	558738.2
25	Owenshagh River Bridge (upstream)	Derreen Garden entrance Owenshagh River bridge.	34	51.76569	-9.77498	477489.1	558532.7
26	Owenshagh River Entry Point	Start Point.	35	51.76571	-9.77571	477438.8	558536.1
27	Drain	Moderate Flow.	36	51.76544	-9.77715	477338.7	558508.5
28	Stream	Bridge.	37	51.76495	-9.77885	477220	558456.9
29	Drain	No Comments.	38	51.76446	-9.77942	477179.3	558403.3
30	Drain	No Comments.	39	51.76402	-9.77903	477205.1	558353.7
32	Drain	Draining woodland.	43	51.76264	-9.78835	476558	558216
33	Stream with waterfall	Freshwater stream and waterfall entering into Kilmakilloge bay. Empty out by stone circle sign.	No Picture	51.75952	-9.80345	475507.3	557894.6
34	Stream	Small stream run off from woodland.	No Picture	51.76298	-9.80215	475606.7	558277.2
35	Stream	Stream run off from woodland.	No Picture	51.7645	-9.7995	475793.6	558441.8
36	Stream	Stream run off from woodland.	No Picture	51.76653	-9.79615	476030.3	558661.9
37	Stream	No Comments.	No Picture	51.76442	-9.80964	475093.2	558450.2
38	Stream	No Comments.	55	51.76423	-9.80959	475096.2	558429
39	Stream	Freshwater stream entering into bay under old oak tree.	59	51.766	-9.82967	473715.5	558660.5
40	Culvert	Culvert.	61	51.7655	-9.84588	472595.4	558632.7
41	Stream	Freshwater stream to left of house next to big stone boulder.	62	51.76596	-9.84604	472585.6	558684.5
42	Stream	Stream (small) running clear.	65	51.76882	-9.83954	473042.2	558991.3
43	Stream	Stream (small running clear.	66	51.77035	-9.836	473290.8	559155.3
44	Drain	Land drain from good agricultural ground (Cattle grazing field) clear water.	67	51.77105	-9.83475	473379.1	559231
45	Freshwater Lough	Freshwater lough.	68	51.77501	-9.84102	472957.5	559682.4

8. Appendix 2: Hydrography/Hydrodynamics

8.1. Simple/Complex Models

A three-dimensional hydrodynamic model was developed as part of the European Union Horizon 2020 TAPAS (Tools for Assessment and Planning of Aquaculture Sustainability) project, an element of which used Kilmakilloge Harbour to assess the carrying capacity of a coastal bay in Ireland (Falconer *et al*., 2019, *unpubl.*). This model has 40 m resolution and was built using high resolution bathymetric data.

8.2. Depth

Kilmakilloge Harbour is generally shallow at 10 m or less and increases to 10.7 m at the mouth of the bay, reaching 20 m at the mouth of the harbour into Kenmare Bay. Bathymetry in the harbour is complex due to narrow, deep channels occurring, noted especially at the mouth of the bay and west of Spanish Island. **Figure 8-1** illustrates the bathymetry of Kilmakilloge Harbour.

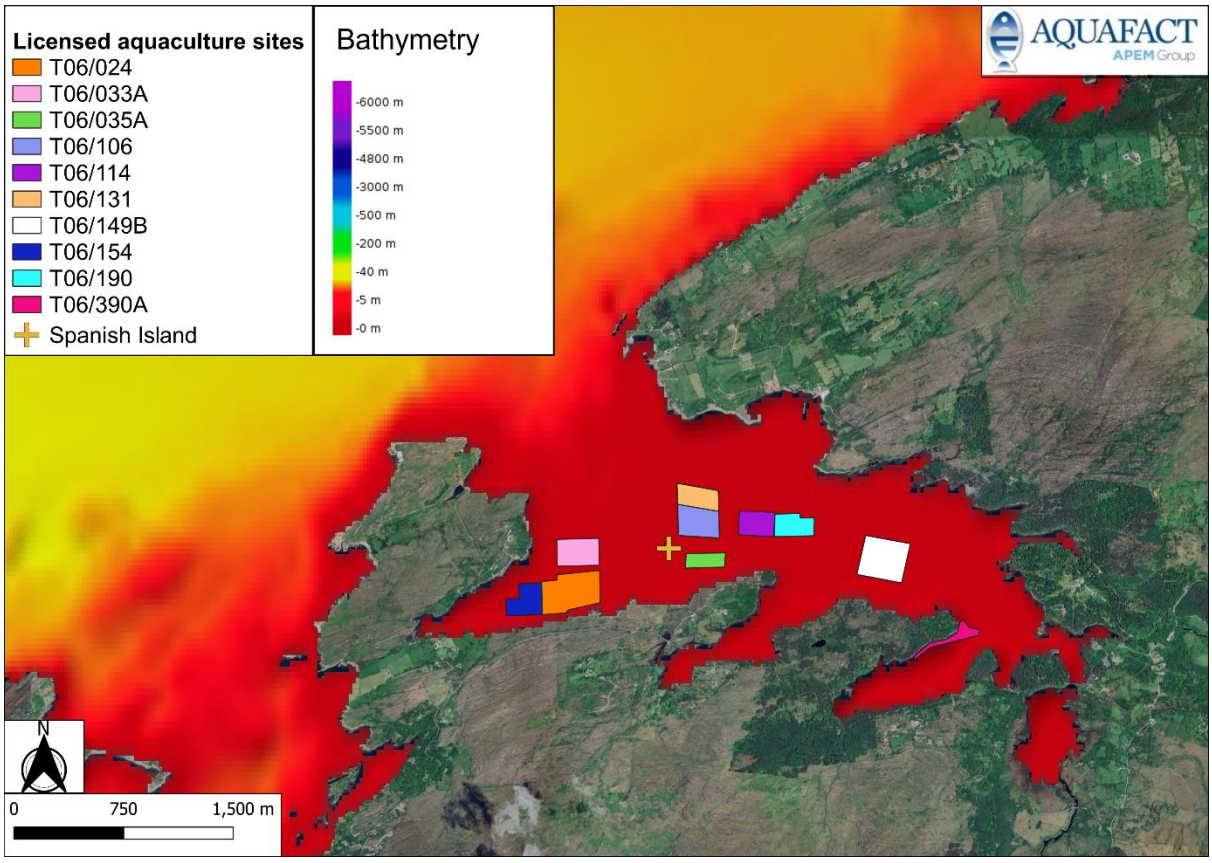


Figure 8-1: Kilmakilloge Harbour bathymetry (source: EMODnet; licensed under a Creative Commons Attribution 4.0 International (CC BY 4.0) licence).

8.3. Tides and Currents

In 2017, five Acoustic Doppler Current Profilers (ADCPs) were deployed by Bord Iascaigh Mhara in Kilmakilloge Harbour; at the mouth of the harbour, behind Spanish Island, in the inner harbour, and two were deployed to the west of Spanish Island. From the data gathered during this study it was reported that the main current

flows into the harbour in the middle and upper water columns on the incoming tide from a north-westerly direction. Entering the harbour, the water flow immediately hits a shallow shelf on the western side of Spanish Island and is forced into two channels. One flow travels east to the inner bay past sites T06/131 and T06/106 and the other flow is forced south through two shallow water channels west of Spanish Island passing sites T06/033A, T06/154 and T06/154 & 154/1.

On the outgoing tide, the flow passes over sites T06/149B, T06/190, and T06/114. The flow is split into two when it meets Spanish Island; one flow remains on a south-westerly trajectory, flowing along the west to the north of the island and the second flow moves quickly southwest of the island. Mussel longline structures associated with T06/024 and T06/033A cause the flow to swing up from the southwest through deep, narrow channels on the west of the island and leave the bay from this direction.

The highest average speeds at bottom and middle water columns ranged from 0.041 to 0.064 m/s for all ADCP locations except at the mouth of the harbour which recorded higher velocities of 0.111 and 0.099 m/s at the bottom and middle water column, respectively. This is likely due to the complex bathymetry at the harbour mouth. The highest average surface current speeds ranged from 0.223 to 0.351 m/s except for the ADCP located at the mouth of the harbour which recorded a very low velocity of 0.082 m/s in comparison to the other ADCP locations. Highest average surface current speeds were recorded behind Spanish Island.

Current flow and velocity in Kilmakilloge Harbour are generally predictable but varies in areas of complicated bathymetric features such as channels at the seabed (mouth of harbour and west of Spanish Island) and due to mussel longline structures in surface waters which create unpredictability in the flows, as seen around sites T06/033A, T06/024 and T06/035A (BIM, 2017, *unpubl.*).

8.4. Wind and Waves

Wind data from 2018 to 2022 from Valentia Observatory Met Éireann station, Co. Kerry[30] are displayed in **Table 8.1** below and wind roses for each corresponding year can be seen in **Figure 8-2**.

In 2018, *c.* 17% of the wind came from the south, *c.* 12% came from the west; the strongest winds came from the west. In 2019, *c.* 13% of the winds came from the south, with *c.* 11% coming from the west and *c.* 8% coming from the northwest; the strongest winds came from the west-northwest. In 2020, *c.* 13% of the wind came from the west, *c.* 12% came from the south and *c.* 7% came from the southwest and north, respectively; the strongest winds came from the west-southwest. In 2021, *c.* 16% of the wind came from the south and *c.* 14% came from the west; the strongest winds came from the west. In 2022, *c.* 14% of the wind came from the south, *c.* 10% came from the west and *c.* 9% came from the southwest and northeast; the strongest winds came from the west-southwest. In 2019, 2020 and 2022 wind directions were more variable than in 2018 and 2021. The prevailing wind over the 2018 to 2022 time period came from a south-southwest direction. **Table 8.2** shows the seasonal averages from 2018 to 2022. Seasons were selected by grouping the results from the

following periods: spring (March-May), summer (June-August), autumn (September-November), and winter (December-February). Seasonal averages over the past five years indicate that winds are typically strongest in the winter months (11.6 kn), followed by autumn (9.6 kn), spring (9.0kn), and 7.9 kn in summer.

Wind conditions affect the hydrodynamic conditions in Kilmakilloge Harbour by generating wind-induced currents and waves. Of these phenomena, wind-induced waves are an important factor in the process of sediment resuspension and transport. Wind waves are produced by the local prevailing wind. They travel in the direction of the prevailing wind, *i.e.,* a south-westerly wind will produce northeasterly moving waves. The height of wind waves depends on:

- the strength of the wind,
- the time the wind has been blowing and
- the fetch.

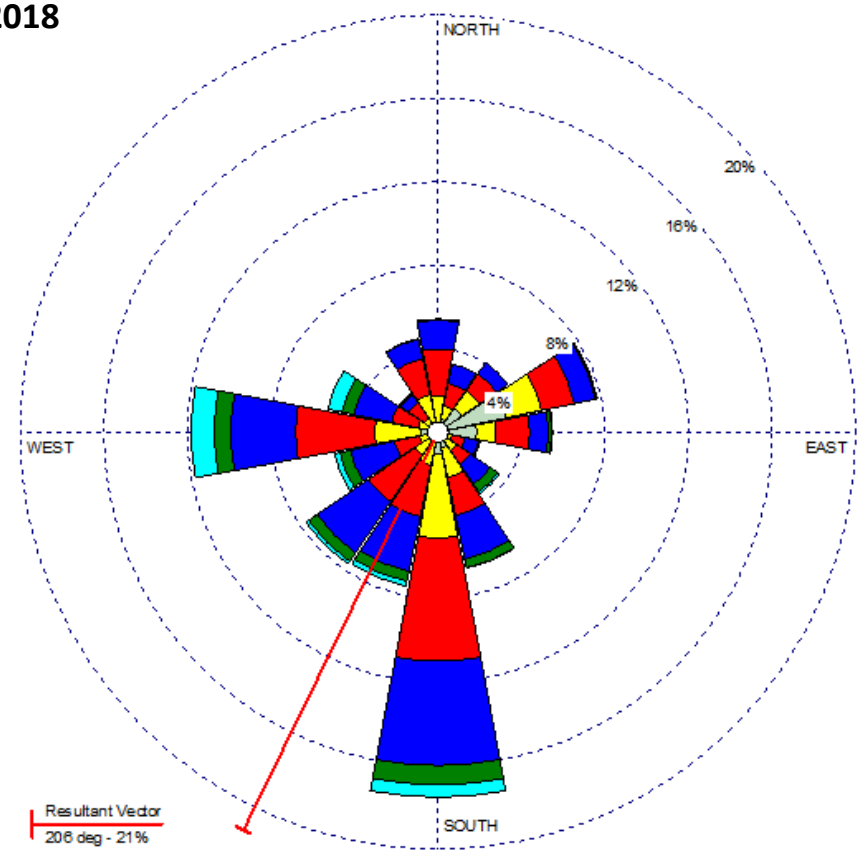
Table 8.1: Wind speed and direction for Valentia Observatory, Co. Kerry from 2018-2022 (source: Met Éireann[30]).

	2018		2019		2020		2021		2022	
Month	Mean Speed (knots)	Max 10-min Mean Direction (°)	Mean Speed (knots)	Max 10-min Mean Direction (°)	Mean Speed (knots)	Max 10-min Mean Direction (°)	Mean Speed (knots)	Max 10-min Mean Direction (°)	Mean Speed (knots)	Max 10-min Mean Direction (°)
January	13.7	212	9.2	240	11.1	190	8.3	180	9	169
February		211	12.9	197	17.2	243	12.5	178	14.4	248
March	8.7	175	11.4	227	11.3	185	10.2	208	8.4	155
April	9.5	183	10.3	186	6.4	191	7.6	185	8.5	194
May	7.9	183	8.2	213	8.8	184	9.2	221	9.2	226
June	6.8	243	8.6	194	9	230	7.6	182	9.2	216
July	6.9	245	7.8	244	9.3	246	6.3	243	7	248
August	8.4	236	10.1	225	8	209	7.1	229	6.3	214
September	8.9	229	9.2	216	8.1	216	6.9	213	7.7	178
October	8.6	213	9.7	177	11.6	200	9.2	210	10.8	198
November	11.1	165	10	153	10.3	194	8.6	189	13	209
December	11.4	197	12	208	11.9	200	11	193	9.2	148

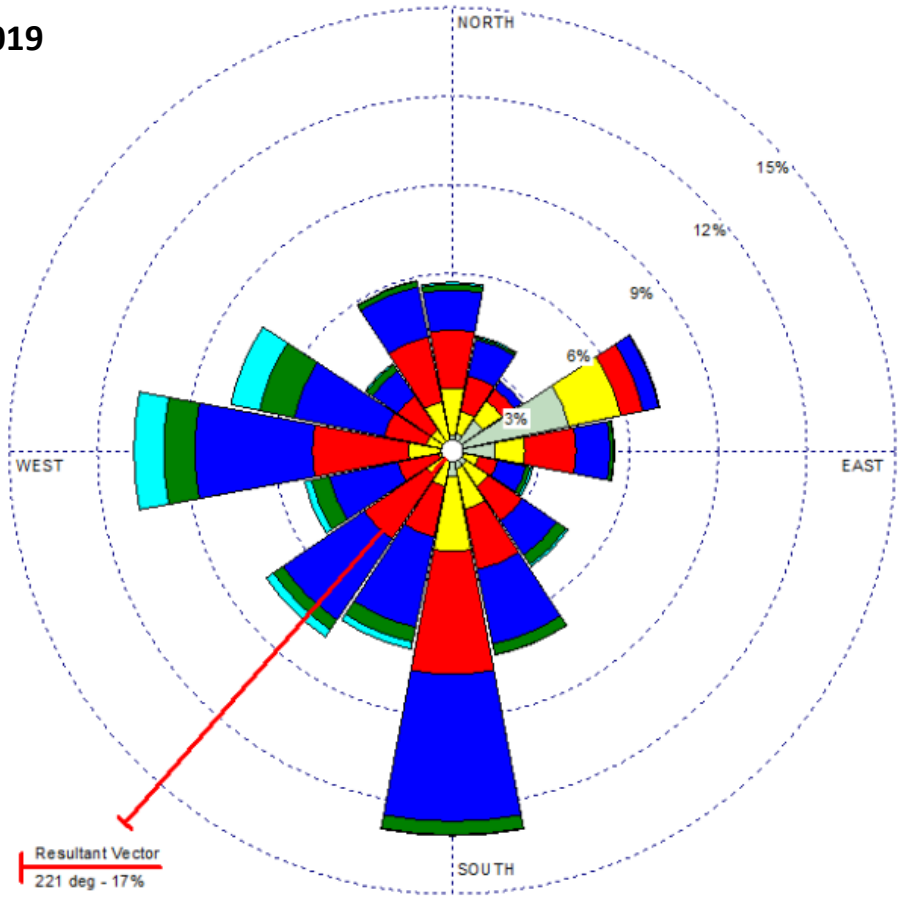
Table 8.2: Seasonal average wind speed (knots) for Valentia Observatory, Co. Kerry wind data (source: Met Éireann[30]).

Season	2018	2019	2020	2021	2022	5-year average
Winter	12.4	10.7	12.9	9.8	12.1	11.6
Spring	8.7	10.0	8.8	9.0	8.7	9.0
Summer	7.4	8.8	8.8	7.0	7.5	7.9
Autumn	9.5	9.6	10.0	8.2	10.5	9.6

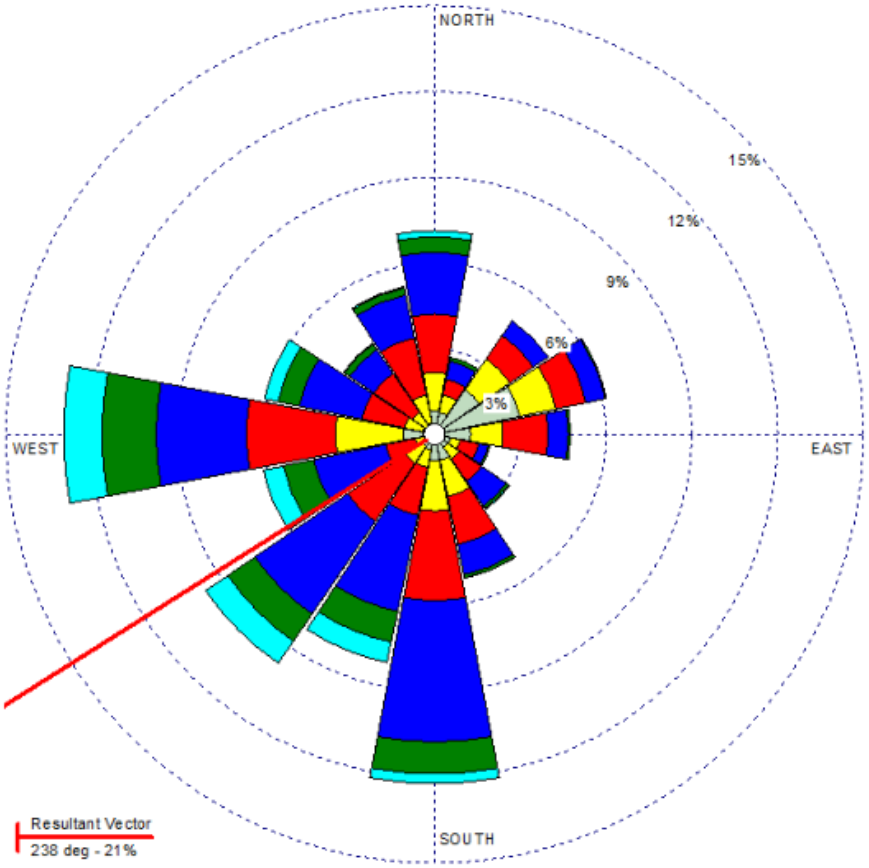
2018


NORTH
20%
16%
12%
8%
4%
WEST
EAST
SOUTH
Resultant Vector
206 deg - 21%

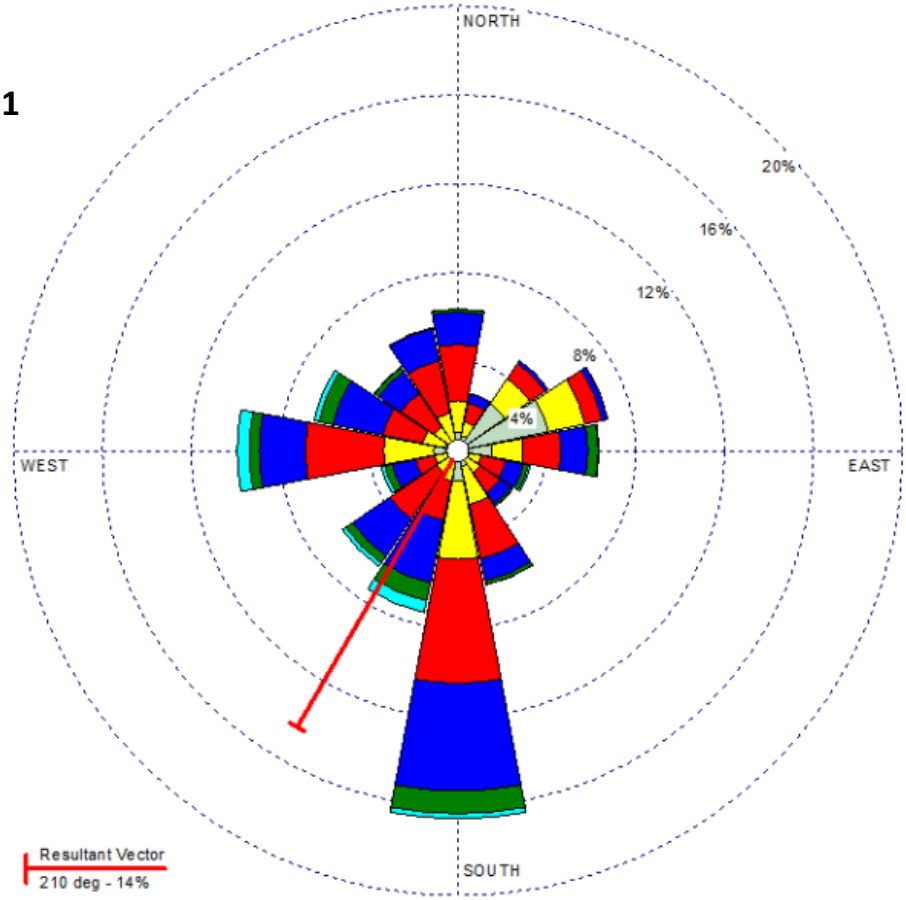
2019

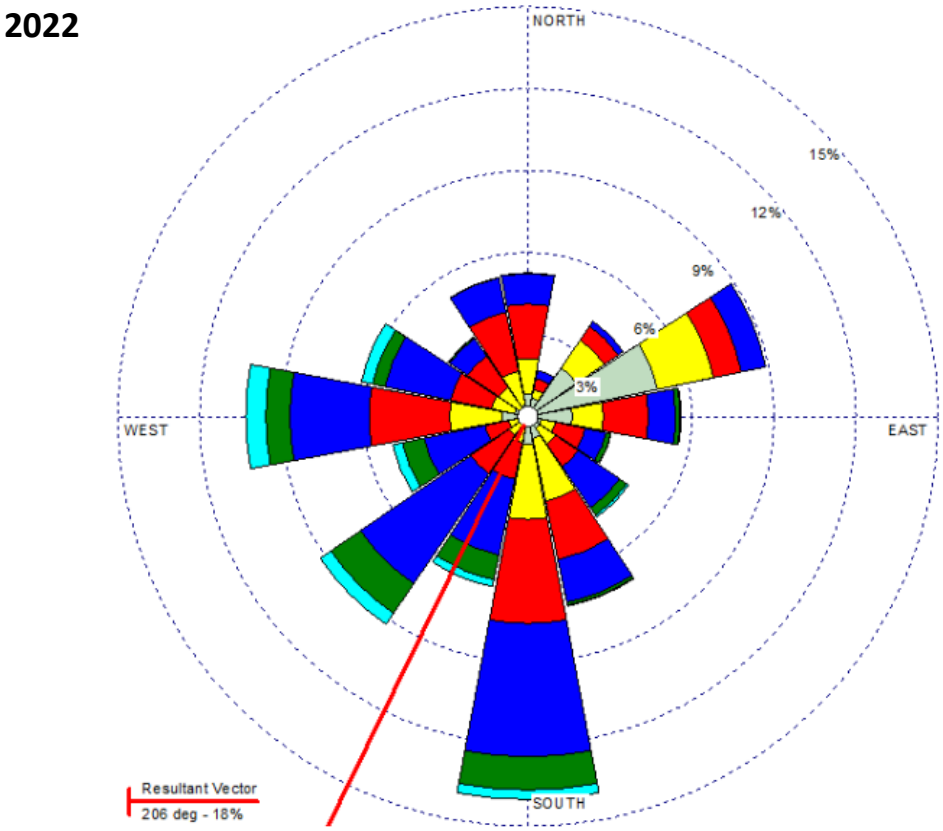

NORTH
15%
12%
9%
6%
3%
WEST
EAST
SOUTH
Resultant Vector
221 deg - 17%

2020


NORTH
15%
12%
9%
6%
3%
WEST
EAST
SOUTH
Resultant Vector
238 deg - 21%

2021


NORTH
20%
16%
12%
8%
4%
WEST
EAST
SOUTH
Resultant Vector
210 deg - 14%



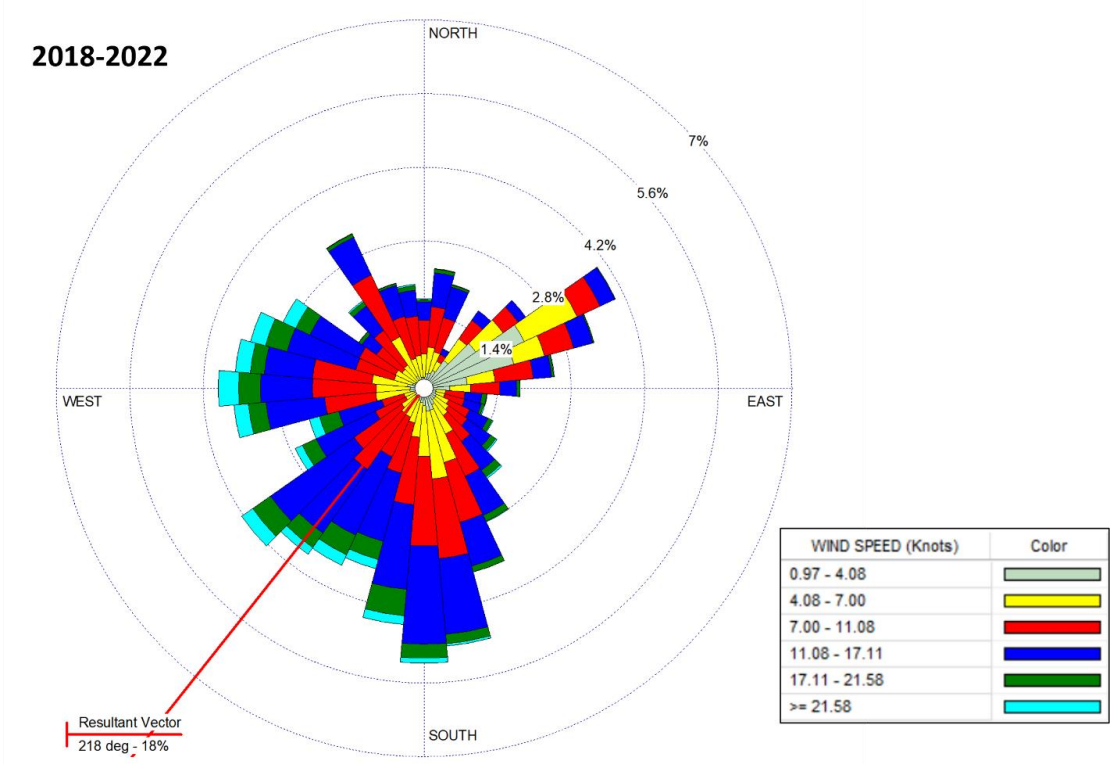


Figure 8-2: Wind rose data from Valentia Observatory Met Éireann station 2018-2022 (source: Met Éireann[30]).

8.5. River Discharges

There are five designated WFD river water bodies which drain into Kilmakilloge Harbour, three of which only partially drain into the bay, totalling an area of 81.05 km^2; within these river sub-basins are five corresponding river water bodies (see **Figure 8-3** for river sub-basins and **Figure 8-4** for river water bodies). As this value incorporates river water bodies which discharge outside Kilmakilloge Harbour, an approximation of the area which drains into Kilmakilloge Harbour was made using QGIS 3.28.12 to avoid an over-estimation of the area, returning a value of 70.83 km^2. The contributing catchment is dominated by the WFD river basin Owenshagh which drains 46.3% of the contributing catchment. The Croanshagh_020 and Drimminboy_010 water bodies which form the Croanshagh river basin drain a combined 27.9% of the contributing catchment. The Castelkeelty_010 river water body drains 12.1% and Lehid_010 drains 13.8% of the contributing catchment.

The 2016-2021 WFD status of Kilmakilloge Harbour and its associated freshwater sources can be seen in **Figure 8-3**. Of the river systems flowing directly into Kilmakilloge Harbour, all water bodies were of Good status[28]. The outer Kenmare River coastal water body was of Good status. Kilmakilloge Harbour transitional water body obtained a High ecological status for the 2016-2021 monitoring period. Flow and water level measurements were not available at the time of writing this report for the relevant water bodies.

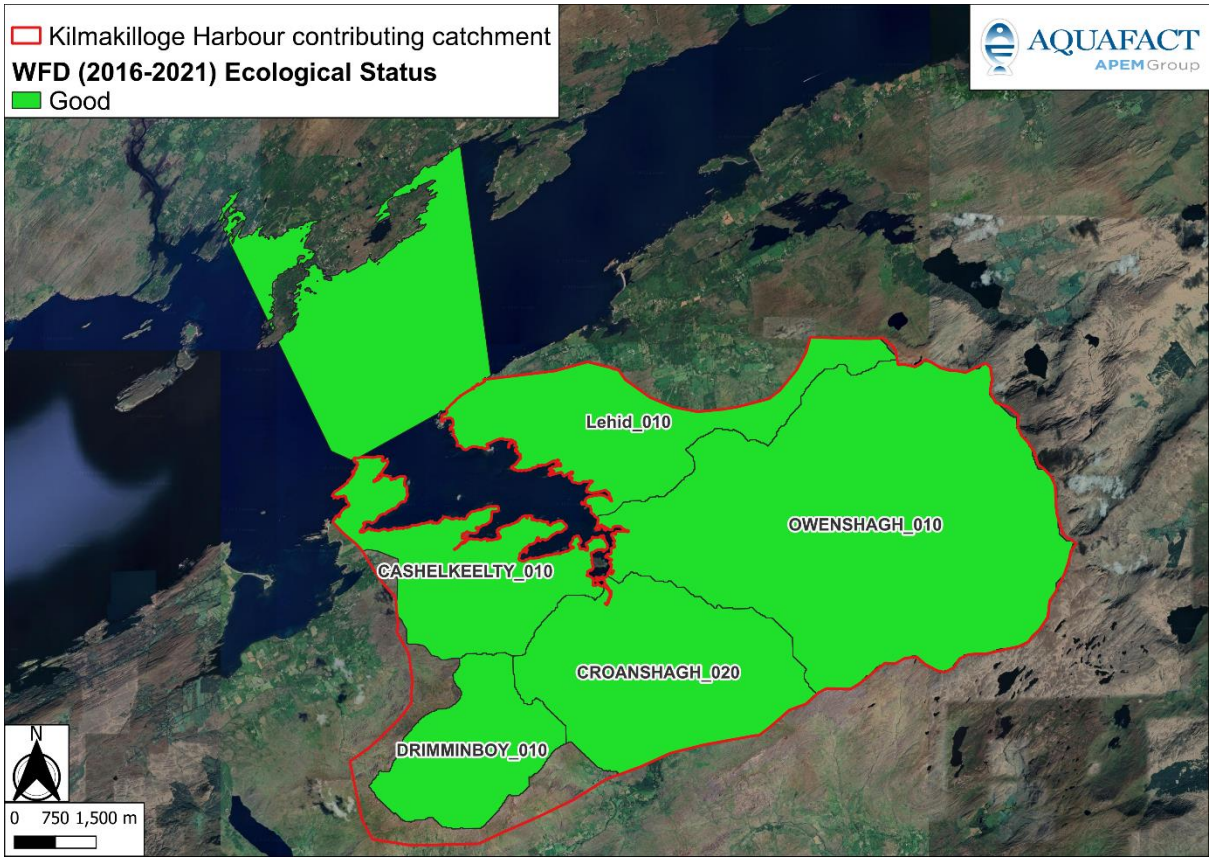


Figure 8-3: Water Framework Directive (WFD) 2016-2021 ecological status of river sub-basins and coastal water bodies within Kilmakilloge Harbour contributing catchment (source: EPA[4;22]).

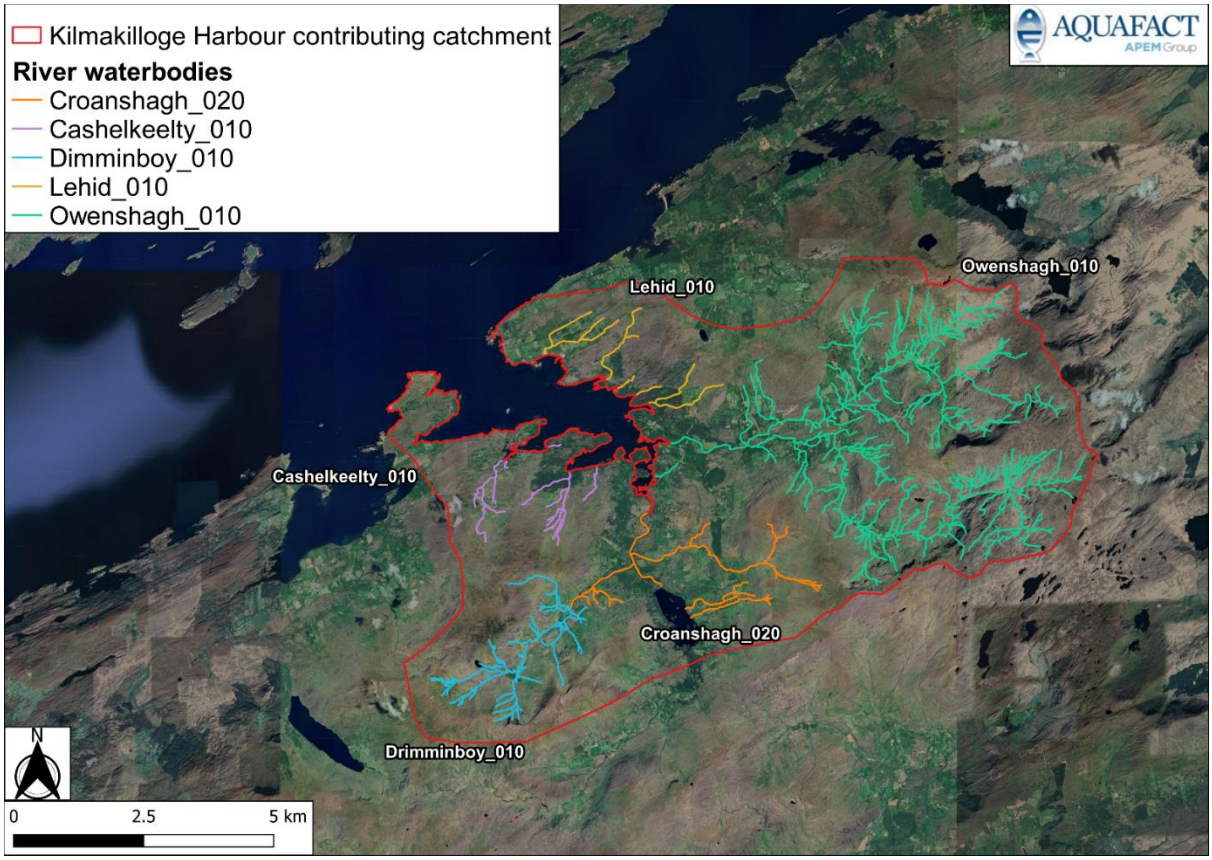


Figure 8-4: River water bodies within Kilmakilloge Harbour contributing catchment (source: EPA[4;22]).

8.6. Rainfall Data

8.6.1. Amount and Time of Year

In this section, data from the Kenmare (Derreen) Met Éireann Station, situated at the head of Kilmakilloge Harbour (**Figure 8-6**) is used to investigate long term rainfall patterns, *i.e.,* 30-year period, and rainfall patterns over a recent 5-year period, *i.e.,* 2018-2022. Kenmare (Derreen) Met Éireann Station is located in the Derreen Gardens, near Lauragh, Co. Kerry. **Figure 8-5** shows the average monthly rainfall data for Ireland (Curley *et al.*, 2023) from 1991 to 2020. The wettest months overall during this period were October-January.

Table 8.3 shows the 30-year average monthly rainfall at the Kenmare (Derreen) Met Éireann station (**Figure 8-7**). During the period 1992 to 2022, average rainfall at Kenmare (Derreen) was lowest in June (114.4 mm) and highest in December (253.6 mm). The greatest daily total ranged from a low of 27.8 in August to a high of 45.7 mm in November; note that data for both average rainfall and greatest daily total rainfall (mm) was missing for some years which may bias the month determined to have the lowest rainfall amounts. **Table 8.4** shows the seasonal averages at Kenmare (Derreen) from 1992 to 2022. Lowest average rainfall over the 30-year period was in summer (123.8 mm) with the highest average rainfall experienced in winter (23.5 mm).

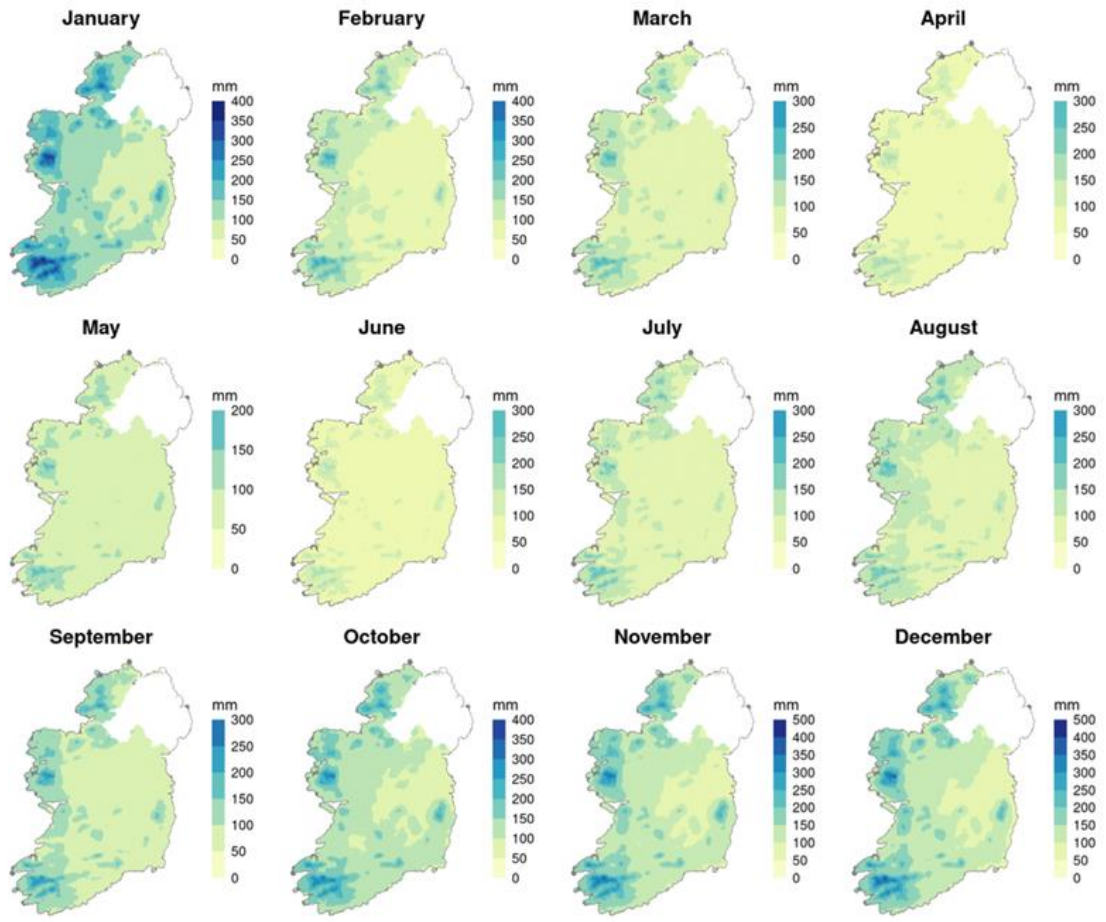


Figure 8-5: Average monthly rainfall (mm) data from 1991 to 2020 for Ireland (source: Curley *et al.*, 2023).

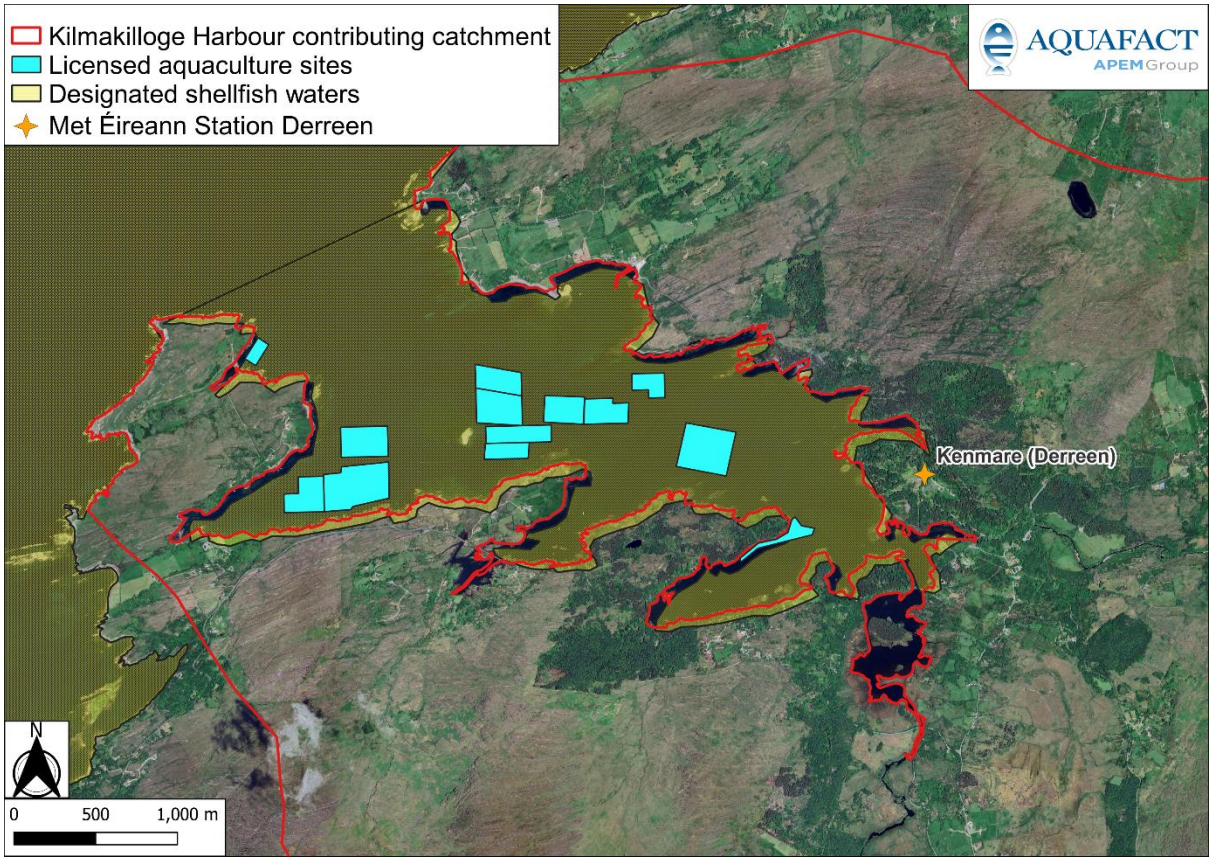


Figure 8-6: Location of Kenmare (Derreen) Met Éireann weather station in relation to the Kilmakilloge Harbour production area.

Table 8.3: Average monthly rainfall at Kenmare (Derreen), Co. Kerry from 1992 to 2022 (source: Met Éireann[30]).

Average Rainfall (mm)	Month	Greatest Daily Total (mm)
244.3	January	43.2
199.7	February	37.6
148.4	March	35.7*
135.4	April	36.9*
121.3	May	28.3
114.4	June	32.3*
126.8	July	31.4
130.2*	August	27.8*
160.6	September	41.3
223.7	October	45.5
241.1	November	45.7
253.6	December	44.5*
2099.5	**Year**	450.2

*Data was missing for some years

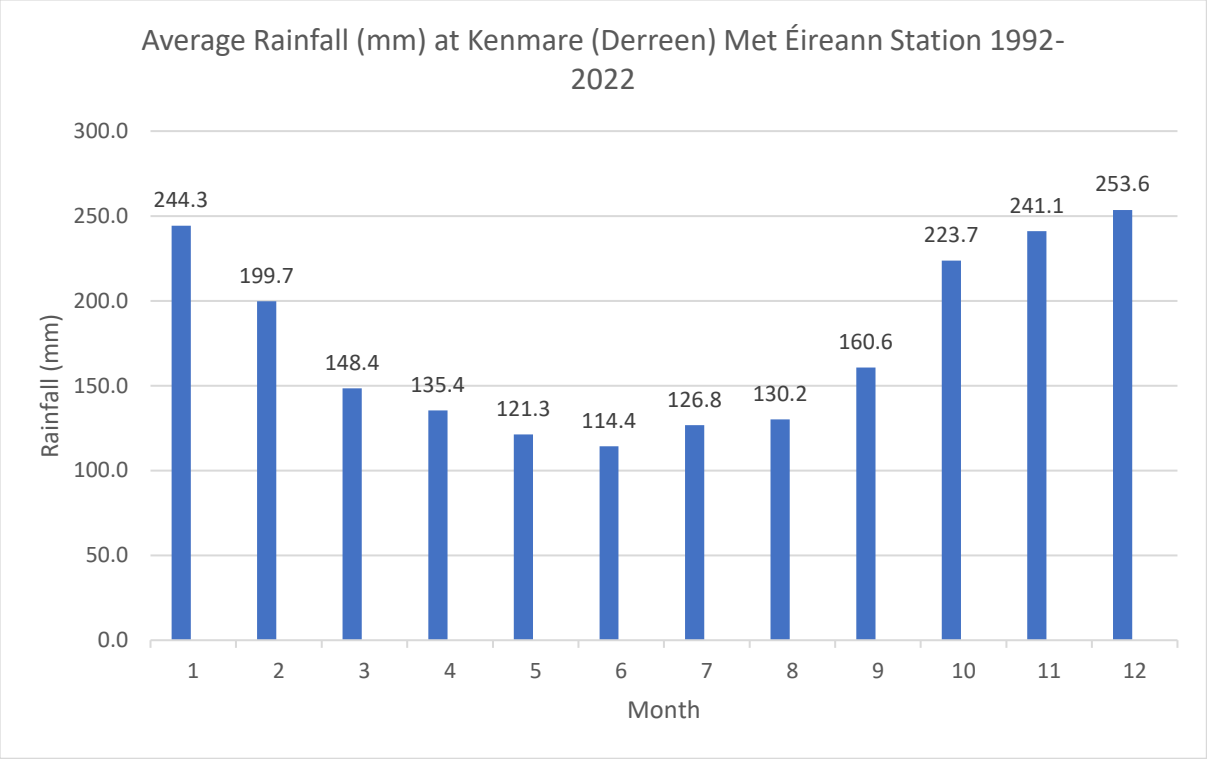


Figure 8-7: Average monthly rainfall (mm) at Kenmare (Derreen) Met Éireann Station, Co. Kerry from 1992 to 2022 (source: Met Éireann[30]).

Table 8.4: Average seasonal rainfall values (mm) from 1992 to 2022 at Kenmare (Derreen), Co. Kerry (source: Met Éireann[30]).

Season	Average
Spring	135.1
Summer	123.8
Autumn	208.5
Winter	232.5

Figure 8-8 and **Table 8.5** shows average monthly rainfall at the Kenmare (Derreen) Met Éireann station from 2018 to 2022[30]. Maximum monthly rainfall was in November 2018 (452.4 mm) and the lowest monthly rainfall was April 2021 (30.0 mm). The 5-year average monthly rainfall ranged from a low of 98.2 mm in June to a high of 295.3 mm in November. Annual averages ranged from 160.1 mm in 2021 to 202.0 mm in 2020.

Table 8.6 shows the total seasonal rainfall at Kenmare (Derreen) from 2018-2022[30]. The following seasonal fluctuations were observed: in 2018, summer was the driest and autumn was the wettest season. In 2019, spring was the driest and winter was the wettest. In 2020, summer was the driest and winter was the wettest. In 2021, summer was the driest and autumn was the wettest and in 2022, summer was the driest and autumn was the wettest. Over the five years, summer 2018 was the driest season and autumn 2022 was the wettest season.

Table 8.5: Total monthly rainfall data (mm) at Kenmare (Derreen), Co. Kerry from 2018 to 2022 (source: Met Éireann[30]).

Year	2018	2019	2020	2021	2022	Monthly 5-yr Average
January	326.7	128.7	179.4	190.2	84.1	181.8
February	143.6	216.9	301	393.3	206.7	252.3
March	179.4	179.6	118.4	96.6	132.8	141.4
April	315.7	203	81.7	30	136.5	153.4
May	107	61.6	71.7	233.2	84.3	111.6
June	32.4	104.8	149	44.4	160.5	98.2
July	79.6	83.7	237.3	69.8	47.5	103.6
August	76.1	188.4	325.7	39.9	47.8	135.6
September	124.8	199.7	117	133.2	183.7	151.7
October	100.7	226.5	283.6	332.9	337.7	256.3
November	452.4	210.6	278.3	88.4	447	295.3
December	322.2	284	281.4	269.6	207.4	272.9
Annual Average	188.3	174.0	202.0	160.1	173.0	

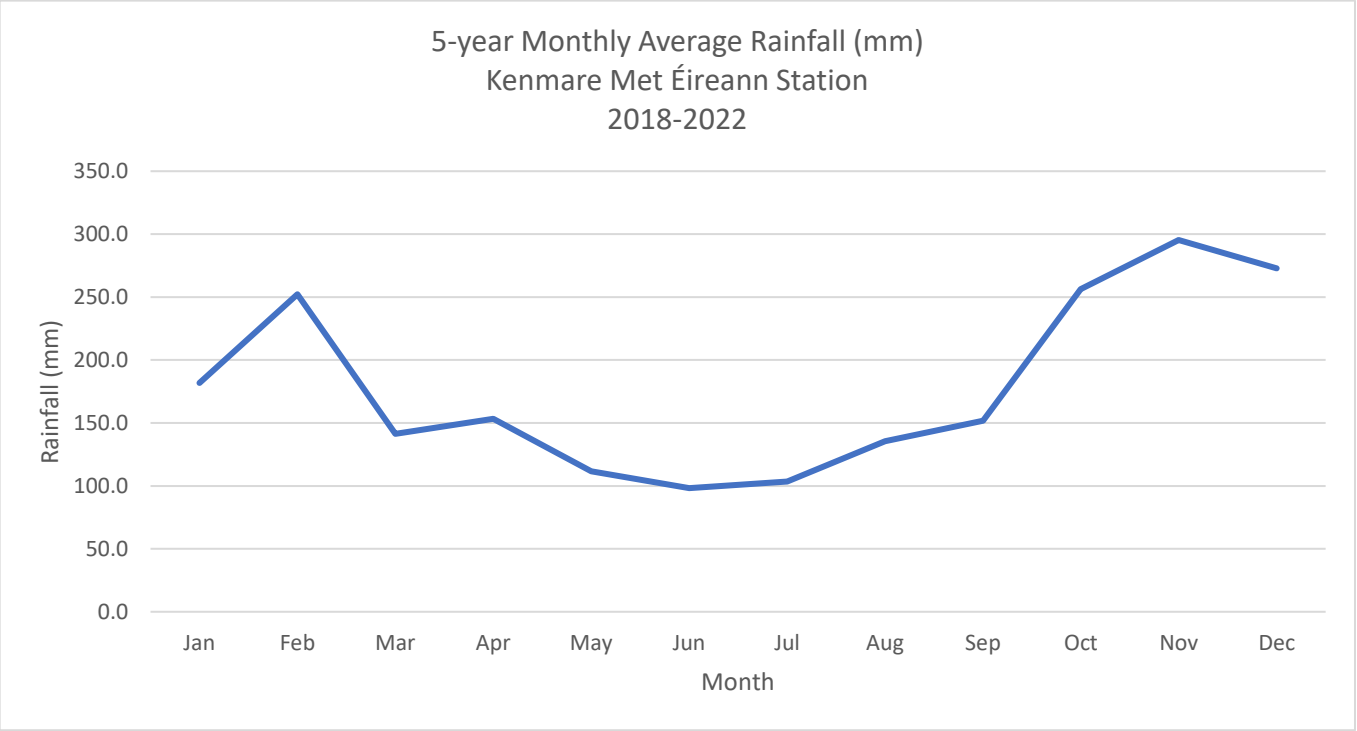


Figure 8-8: 5-year average monthly rainfall (mm) at Kenmare (Derreen) Met Éireann Station from 2018 to 2022 (source: Met Éireann[30]).

Table 8.6: Total seasonal rainfall (mm) at Kenmare (Derreen) Met Éireann Station from 2018 to 2022 (source: Met Éireann[30]).

Station	Season/Year	2018	2019	2020	2021	2022
Kenmare (Derreen)	Spring	200.7	148.1	90.6	119.9	117.9
	Summer	62.7	125.6	237.3	51.4	85.3
	Autumn	226.0	212.3	226.3	184.8	322.8
	Winter	264.2	209.9	253.9	284.4	166.1

8.6.2. Frequency of Significant Rainfalls

Met Éireann has developed a depth duration frequency model for the estimation of point rainfall frequencies (Fitzgerald, 2007). For a 1 in 100-year return period, 40.4 mm of rain would be expected over a 1-hour period and 107.0 mm over 24 hours. While these would be extremely uncommon events, the model predicts that once a year 11.5 mm of rain would fall in 1 hour and 38.8 mm over a 24-hour period. Data from Kenmare (Derreen) Met Éireann station show that there have been 223 24-hour periods within which more than 38.88 mm of rain fell over the 30-year period 1992-2022. For this same period, November had the greatest daily rainfall with 241.1 mm. Over the 5-year period 2018-2022, data from Kenmare (Derreen) Met Éireann station show that there have been 34 24-hour periods within which more than 38.88 mm of rain fell. A significant rainfall is considered to be ≥ 120 mm of rain within a 24-hour time period (Tony Cawley, Hydroenvironmental Ltd., *pers. comm*).

Increased faecal contamination of coastal waters is typically associated with high rainfall and storm events through surface water run-off from livestock or other animals present and through sewer and wastewater treatment plant overflows (Mallin *et al.*, 2001; Lee & Morgan, 2003). It is therefore expected that run-off due to rainfall will be higher during the October to January period. However, as can be seen in the rainfall data in **Table 8.7**, heavy rainfall events leading to episodes of high run-off can occur in most months of the year and it is therefore not just the winter months that are at risk of increased contamination. When these occur during generally drier periods in spring and summer months, they are likely to carry higher loadings of faecal material which has accumulated on pastures where greater numbers of livestock are present.

Table 8.7: Rainfall events > 38.88 mm within a 24-hour period, recorded at the Kenmare (Derreen) Met Éireann Station 2018-2022 (source: Met Éireann[30]).

Date	Rainfall (mm)	Date	Rainfall (mm)	Date	Rainfall (mm)
25-Nov-22	52.1	19-Oct-20	49.8	14-Dec-18	45.7
06-Sep-22	49	18-Oct-20	43.2	12-Dec-18	58.4
27-Jun-22	44.2	29-Sep-20	41.4	04-Dec-18	39.1
08-Mar-22	39.4	24-Aug-20	77.5	26-Nov-18	50.8
06-Dec-21	41.4	20-Aug-20	50.3	14-Nov-18	40.9
23-Oct-21	39.6	19-Aug-20	44.5	13-Nov-18	72.6
07-Oct-21	63.5	14-Aug-20	51.6	16-Apr-18	59.4
19-May-21	51.6	29-Jul-20	58.4	05-Apr-18	67.6
22-Feb-21	86.4	20-Jun-20	64.5	13-Mar-18	42.7
18-Feb-21	74.2	08-Feb-20	43.2	12-Jan-18	88.9
12-Feb-21	71.4	17-Dec-19	39.4		
10-Nov-20	64.3	13-Apr-19	59.7		

8.7. Salinity

As part of the national WFD monitoring programme for transitional and coastal waters, the EPA monitored salinity in Kilmakilloge Harbour at four stations (**Figure 8-9**). Data spanning a ten-year period (February 2013-September 2023) were analysed to characterise the salinity in the bay; these data can be requested from the EPA. Based on the annual median salinity, all four stations are mostly marine (euhaline) in nature with an annual median salinity above 30. Although, the inner site (KG020) appears to experience periods of reduced salinity near the surface particularly during periods of increased freshwater input.

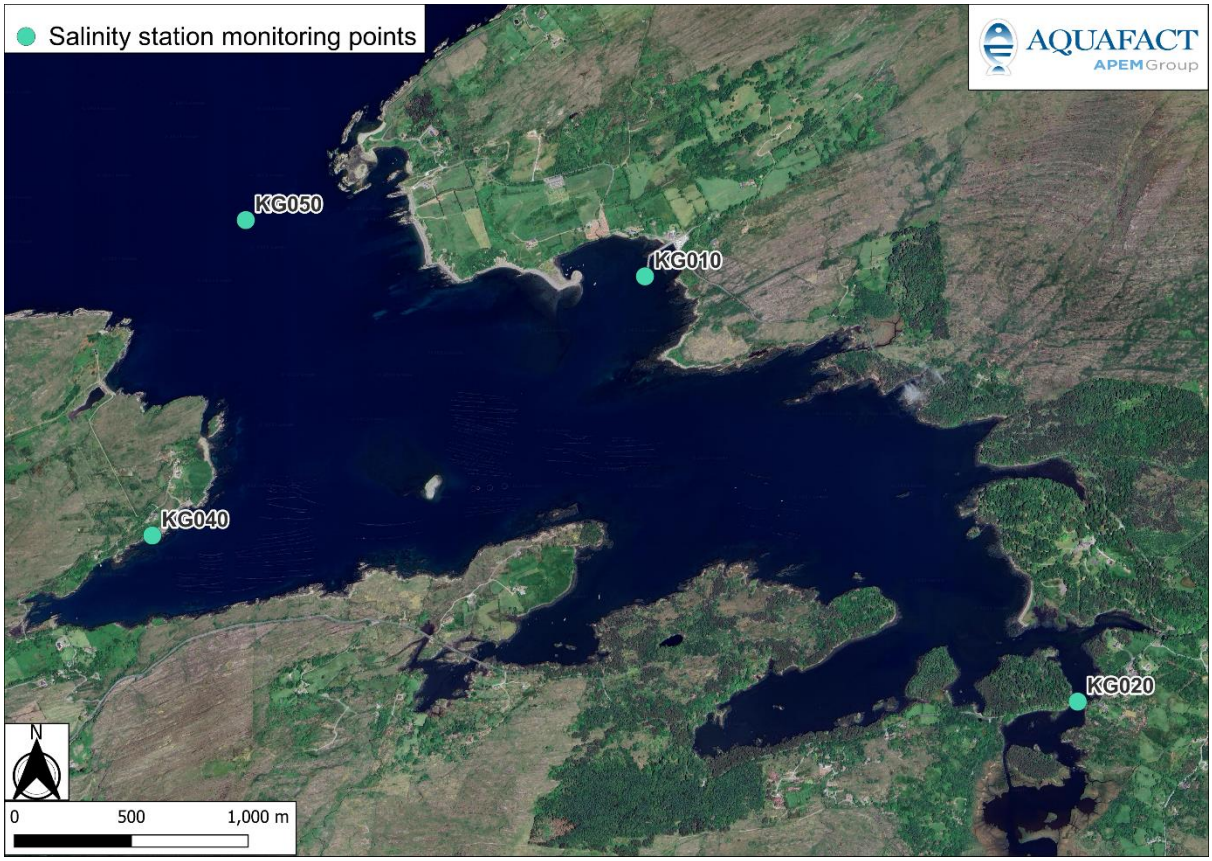


Figure 8-9: Salinity monitoring stations in Kilmakilloge Harbour.

8.8. Turbidity

Turbidity is a measure of water clarity, including suspended particulate matter. Measurements were taken by the EPA at the four stations as shown in **Figure 8-9**, between 2013 and 2021. Based on an analysis of these data, turbidity in Kilmakilloge Harbour can be classified as being low (Keogh *et al.*, 2020). High turbidity values in areas can indicate a high organic load associated with nutrient and bacteriological elevation. However, this is not a direct relationship, and other parameters should be considered to interpret high turbidity data appropriately.

8.9. Flushing time

Residence times for Kilmakilloge Harbour were taken from Falconer *et al.* (2019) unpublished hydrodynamic model report. On a neap tide, residence times were *c*. 4.5 days (9 tidal flushes), and 4 days (8 tidal flushes) on a spring tide, both of which are considered relatively short residence/flushing times. On a neap tide, particles flushed faster on the southern shores of Kilmakilloge Harbour and tended to concentrate on the north-eastern shores, with fewer particles noted in the inner harbour. The inner harbour was the opposite on the spring tide, with particles being more concentrated here compared to the outer harbour. Otherwise, flushing patterns were similar on a spring tide just further upstream as may be expected. Particles dissipated in a fairly uniform pattern in the outer part of the harbour during spring tides, perhaps due to the gyre that forms there during a spring tide (Falconer *et al.,* 2019).

8.10. Discussion

Kilmakilloge Harbour is a small bay on the southern bank of Kenmare Bay and forms the north shore of the Beara Peninsula. Sediment is dominated by muddy sand in sheltered regions and by coarse shelly sand and gravel in exposed regions. Maërl occurs in sheltered inlets in the bay and salt meadows occur in the sheltered areas of Kilmakilloge Harbour. Of the three islands within the harbour, Spanish Island is the largest and influences flow and current patterns within the harbour; the other islands are Green and Grinneen. The harbour is largely subtidal however some of the inlets are intertidal. Depth in the harbour is generally 10 m or less but ranges from 0 m to 20 m at the mouth of the harbour. The main current flows into the harbour from a northwest/north-northwest direction and is split into two channels by Spanish Island and flow past licensed sites. On the outgoing tide, the current is once again split by Spanish Island. Mussel longline structures cause the flow to swing up south through deep channels on the west of the island and leaves the harbour from an east/east-southeast direction. Highest average current speeds were recorded at the mouth of the harbour for the middle and bottom water columns but had the lowest average surface speeds. Highest average surface speeds were recorded behind Spanish Island. The prevailing wind blows from a south-southwest direction. Drainage of the contributing catchment is dominated by the Owenshagh river water body. All water bodies flowing into Kilmakilloge Harbour were of High status for the 2016-2021 period. Highest average rainfall over a 30-year period was in winter and the lowest was in summer. It is expected that run-off due to rainfall will be higher during the October to January period. Kilmakilloge Harbour is mostly marine in nature, with an annual median salinity above 30. The inner site at which salinity was measured (KG020) experiences a greater freshwater input as reflected in the lower salinity values recorded at this site. Fluctuations in salinity levels in surface waters are likely due to freshwater inputs and rainfall. Turbidity measurements were low at the four sample stations in Kilmakilloge Harbour. Residence time in the harbour is considered relatively short, with 9 tidal flushes on a neap tide and 8 tidal flushes on a spring tide.

9. Appendix 3: Shellfish and Water Sampling

9.1. Historical Data

9.1.1. Shellfish Flesh Quality

In accordance with Regulation (EU) 2017/625 and the subsequent implementing regulation (EU) 2019/627 the SFPA is required to classify bivalve mollusc production areas and to fix the boundaries thereof. The process involved regular sampling of shellfish from each area to be classified in order to establish levels of microbiological contamination which subsequently determines which classification should be awarded for that particular area.

The regulations stipulate that the competent authority must monitor the levels of *E. coli* within the harvesting area and that according to the sample results, must classify the area as being one of three categories: **A**, **B**, or **C**. An **A** classification allows for the product to be placed directly on the market, whereas **B** or **C** classification requires the product to go through a process of depuration, heat treatment or relaying before it can be placed on the market. **Table 9.1** summarises this system[19].

Table 9.1: Classification system for shellfish harvesting areas.

Classification			Permitted Levels	Outcome
	A	<230	Not exceeding 230 *E. coli* 100 g flesh/liquid in 80% of samples. Not exceeding 700 *E. coli* 100 g in remaining 20% of samples.	May go direct for human consumption if end product standard met.
	B	<4600	Not exceeding 4,600 *E. coli* 100 g flesh/liquid in 90% of samples. Not exceeding 46,000 *E. coli* 100 g in remaining 10% of samples.	Must be subject to purification, relaying in Class A area (to meet Category A requirements) or cooked by an approved method.
	C	<46000	Not exceeding 46,000 *E. coli* 100 g flesh in all samples.	Must be subject to relaying for a period of at least 2 months in a Class A or B area or cooked by an approved method.
	Above 46,000 *E. coli* per 100 g flesh/liquid.			Prohibited. Harvesting not permitted

Table 9.2 lists the *E. coli* results for mussels in Kilmakilloge Harbour from January 2011 to July 2023 and **Table 9.3** lists the *E. coli* results for Oysters from December 2022 to May 2023. **Table 9.4** shows the historical classification of shellfish beds in Kilmakilloge Harbour (2011-2023). The classification status has varied in Kilmakilloge Harbour from 2011 to date. Between 2011-2015, Kilmakilloge Harbour had a **B** classification for mussels, however in 2016 the classification was upgraded to an **A** classification on seasonal terms, whereby it reverts to **B** at other times. Kilmakilloge has been class **A** from 2016-2023.

Table 9.2: Historical *E. coli* results from Kilmakilloge Harbour mussels from January 2011 to July 2023 (source: SFPA); colour coded per Table 9.1.

Sampling Date	Sample Position	MPN *E. coli*/100 g	Category	Sampling Date	Sample Position	MPN *E. coli* /100g	Category
10-Jan-11	DIREEN	20	A	29-May-17	COLLORUS	20	A
10-Jan-11	SPANISH ISLAND	20	A	29-May-17	DIREEN	18	A
10-Feb-11	COLLORUS	220	A	04-Jul-17	DIREEN	18	A
10-Feb-11	SPANISH ISLAND	20	A	04-Jul-17	COLLORUS	18	A
08-Mar-11	DIRREEN	20	A	18-Jul-17	DIREEN	18	A
08-Mar-11	COLLORUS	20	A	18-Jul-17	COLLORUS	18	A
07-Apr-11	DIRREEN	50	A	29-Aug-17	COLLORUS	18	A
07-Apr-11	COLLORUS	170	A	29-Aug-17	DIREEN	18	A
03-May-11	DIREEN	**1300**	B	05-Oct-17	COLLORUS	20	A
03-May-11	COLLORUS	110	A	05-Oct-17	DIREEN	20	A
14-Jun-11	DIREEN	20	A	26-Oct-17	DIREEN	**330**	B
14-Jun-11	SPANISH ISLAND	20	A	26-Oct-17	COLLORUS	230	A
27-Jul-11	COLLORUS	20	A	05-Dec-17	COLLORUS	18	A
27-Jul-11	SPANISH ISLAND	50	A	05-Dec-17	DIREEN	18	A
27-Jul-11	DIREEN	230	A	18-Dec-17	DIREEN	20	A
01-Aug-11	SPANISH ISLAND	20	A	18-Dec-17	COLLORUS	45	A
15-Sep-11	DIREEN	**490**	B	05-Feb-18	DIREEN	18	A
15-Sep-11	COLLORUS	**5400**	C	05-Feb-18	COLLORUS	18	A
25-Oct-11	COLLORUS	**1300**	B	19-Feb-18	COLLORUS	18	A
25-Oct-11	DIREEN	**490**	B	19-Feb-18	DIRREEN	18	A
16-Nov-11	COLLORUS	50	A	26-Mar-18	DIREEN	18	A
16-Nov-11	DIREEN	20	A	26-Mar-18	COLLORUS	18	A
15-Dec-11	DIREEN	**1300**	B	30-Apr-18	COLLORUS	18	A
15-Dec-11	COLLORUS	220	A	30-Apr-18	DIREEN	18	A
19-Jan-12	COLLORUS	130	A	29-May-18	DIREEN	45	A
19-Jan-12	DIREEN	**2400**	B	29-May-18	COLLORUS	20	A
08-Feb-12	DIREEN	20	A	12-Jun-18	COLLORUS	18	A
08-Feb-12	COLLORUS	20	A	12-Jun-18	DIREEN	18	A
08-Mar-12	DIREEN	50	A	23-Jul-18	COLLORUS	18	A
08-Mar-12	COLLORUS	20	A	23-Jul-18	DIREEN	18	A

Sampling Date	Sample Position	MPN *E. coli*/100 g	Category	Sampling Date	Sample Position	MPN *E. coli* /100g	Category
02-Apr-12	COLLORUS	20	A	28-Aug-18	DIREEN	20	A
02-Apr-12	DIREEN	20	A	28-Aug-18	COLLORUS	20	A
14-May-12	COLLORUS	20	A	04-Sep-18	DIREEN	18	A
14-May-12	DIREEN	20	A	04-Sep-18	COLLORUS	20	A
11-Jun-12	DIREEN	**700**	B	03-Oct-18	DIREEN	18	A
11-Jun-12	COLLORUS	**1700**	B	03-Oct-18	COLLORUS	18	A
30-Jul-12	N/A	20	A	18-Dec-18	DIREEN	18	A
30-Jul-12	DIREEN	70	A	18-Dec-18	COLLORUS	18	A
27-Aug-12	DIREEN	**920000**	C	14-Jan-19	COLLORUS	18	A
27-Aug-12	COLLORUS	20	A	14-Jan-19	DIREEN	18	A
03-Sep-12	DIREEN	20	A	18-Feb-19	COLLORUS	20	A
03-Sep-12	COLLORUS	110	A	25-Feb-19	COLLORUS	18	A
04-Oct-12	DIREEN	**3500**	B	25-Feb-19	DIREEN	18	A
04-Oct-12	COLLORUS	**330**	B	27-Mar-19	DIREEN	18	A
12-Nov-12	DIREEN	50	A	27-Mar-19	COLLORUS	18	A
12-Nov-12	COLLORUS	50	A	08-Apr-19	DIREEN	18	A
05-Dec-12	DIREEN	20	A	08-Apr-19	COLLORUS	18	A
05-Dec-12	COLLORUS	20	A	07-May-19	COLLORUS	18	A
24-Jan-13	COLLORUS	20	A	07-May-19	DIREEN	18	A
24-Jan-13	DIREEN	20	A	28-May-19	DIREEN	18	A
19-Feb-13	DIREEN	20	A	28-May-19	COLLORUS	93	A
19-Feb-13	COLLORUS	20	A	22-Jul-19	COLLORUS	18	A
25-Mar-13	DIREEN	20	A	22-Jul-19	DIREEN	18	A
25-Mar-13	COLLORUS	20	A	28-Aug-19	DIREEN	**940**	B
01-May-13	COLLORUS	20	A	28-Aug-19	COLLORUS	230	A
01-May-13	DIREEN	20	A	05-Sep-19	COLLORUS	45	A
16-May-13	COLLORUS	130	A	05-Sep-19	DIREEN	45	A
16-May-13	DIREEN	20	A	29-Oct-19	COLLORUS	45	A
17-Jun-13	DIREEN	**490**	B	29-Oct-19	DIREEN	18	A
17-Jun-13	COLLORUS	**330**	B	25-Nov-19	COLLORUS	18	A
23-Jul-13	DIRREEN	130	A	25-Nov-19	DIREEN	68	A
23-Jul-13	COLLORUS	20	A	17-Dec-19	COLLORUS	18	A
25-Sep-13	DIREEN	20	A	17-Dec-19	DIREEN	40	A
25-Sep-13	COLLORUS	20	A	21-Jan-20	DIREEN	18	A
05-Nov-13	COLLORUS	170	A	21-Jan-20	COLLORUS	18	A

Sampling Date	Sample Position	MPN *E. coli*/100 g	Category	Sampling Date	Sample Position	MPN *E. coli* /100g	Category
05-Nov-13	DIRREEN	230	A	24-Feb-20	DIREEN	18	A
09-Dec-13	SPANISH ISLAND	20	A	24-Feb-20	COLLORUS	78	A
09-Dec-13	COLLORUS	20	A	23-Mar-20	COLLORUS	18	A
09-Dec-13	DIRREEN	20	A	23-Mar-20	DIREEN	18	A
28-Jan-14	DIRREEN	130	A	23-Apr-20	COLLORUS	18	A
28-Jan-14	COLLORUS	230	A	23-Apr-20	DIREEN	18	A
05-Mar-14	DIRREEN	20	A	12-May-20	COLLORUS	18	A
05-Mar-14	COLLORUS	20	A	12-May-20	DIREEN	18	A
29-Apr-14	DIRREEN	**790**	B	18-Jun-20	COLLORUS	18	A
29-Apr-14	COLLORUS	**700**	B	18-Jun-20	DIREEN	18	A
29-Apr-14	SPANISH ISLAND	**790**	B	29-Jul-20	DIREEN	230	A
18-Jun-14	SPANISH ISLAND	20	A	29-Jul-20	COLLORUS	**490**	B
01-Jul-14	N/A	20	A	31-Aug-20	DIREEN	170	A
24-Jul-14	N/A	80	A	31-Aug-20	COLLORUS	230	A
25-Aug-14	N/A	**330**	B	28-Sep-20	COLLORUS	110	A
24-Sep-14	SPANISH ISLAND	18	A	28-Sep-20	DIREEN	18	A
29-Oct-14	DIREEN	**1300**	B	14-Oct-20	COLLORUS	18	A
29-Oct-14	COLLORUS	**2400**	B	14-Oct-20	DIREEN	18	A
24-Nov-14	DIRREEN	**2400**	B	03-Dec-20	DIREEN	18	A
24-Nov-14	COLLORUS	130	A	03-Dec-20	COLLORUS	20	A
15-Dec-14	DIREEN	20	A	20-Jan-21	DIREEN	20	A
15-Dec-14	COLLORUS	18	A	20-Jan-21	COLLORUS	20	A
13-Jan-15	DIREEN	230	A	02-Mar-21	COLLORUS	18	A
13-Jan-15	COLLORUS	78	A	02-Mar-21	DIREEN	18	A
16-Feb-15	DIREEN	45	A	12-Apr-21	COLLORUS	18	A
16-Feb-15	COLLORUS	18	A	12-Apr-21	DIREEN	18	A
03-Mar-15	DIRREEN	68	A	31-May-21	COLLORUS	20	A
03-Mar-15	COLLORUS	45	A	31-May-21	DIREEN	20	A
02-Apr-15	DIREEN	78	A	21-Jun-21	DIREEN	18	A
02-Apr-15	COLLORUS	130	A	21-Jun-21	COLLORUS	18	A
30-Apr-15	DIREEN	18	A	15-Jul-21	COLLORUS	18	A
30-Apr-15	COLLORUS	18	A	15-Jul-21	DIREEN	18	A

Sampling Date	Sample Position	MPN *E. coli*/100 g	Category	Sampling Date	Sample Position	MPN *E. coli* /100g	Category
16-Jun-15	DIREEN	18	A	31-Aug-21	DIREEN	18	A
16-Jun-15	SPANISH ISLAND	20	A	31-Aug-21	COLLORUS	20	A
29-Jul-15	DIREEN	110	A	20-Sep-21	DIREEN	**330**	B
29-Jul-15	COLLORUS	78	A	20-Sep-21	COLLORUS	**490**	B
17-Aug-15	DIREEN	20	A	11-Oct-21	DIREEN	45	A
17-Aug-15	COLLORUS	18	A	11-Oct-21	COLLORUS	20	A
08-Sep-15	COLLORUS	18	A	16-Nov-21	DIREEN	18	A
08-Sep-15	DIREEN	18	A	16-Nov-21	COLLORUS	18	A
20-Oct-15	COLLORUS	18	A	17-Jan-22	COLLORUS	18	A
20-Oct-15	DIREEN	18	A	17-Jan-22	DIREEN	18	A
24-Nov-15	DIREEN	45	A	28-Feb-22	DIREEN	130	A
24-Nov-15	COLLORUS	18	A	28-Feb-22	COLLORUS	18	A
02-Dec-15	COLLORUS	20	A	22-Mar-22	DIREEN	18	A
02-Dec-15	DIREEN	18	A	22-Mar-22	COLLORUS	18	A
06-Jan-16	DINEEN	230	A	25-Apr-22	DIREEN	18	A
06-Jan-16	COLLORUS	45	A	25-Apr-22	COLLORUS	18	A
22-Feb-16	DIREEN	18	A	25-May-22	DIREEN	18	A
22-Feb-16	COLLORUS	18	A	25-May-22	COLLORUS	18	A
23-Mar-16	DINEEN	18	A	20-Jul-22	DIREEN	18	A
23-Mar-16	COLLORUS	18	A	20-Jul-22	COLLORUS	18	A
14-Apr-16	COLLORUS	18	A	17-Aug-22	DIREEN	18	A
14-Apr-16	DINEEN	45	A	17-Aug-22	COLLORUS	20	A
30-May-16	DIREEN	18	A	19-Sep-22	DIREEN	18	A
30-May-16	COLLORUS	18	A	19-Sep-22	COLLORUS	130	A
21-Jun-16	DINEEN	230	A	25-Oct-22	DIREEN	**2400**	B
21-Jun-16	COLLORUS	**1300**	B	25-Oct-22	COLLORUS	**790**	B
27-Jul-16	COLLORUS	20	A	29-Nov-22	COLLORUS	18	A
27-Jul-16	DIREEN	18	A	29-Nov-22	DIREEN	78	A
22-Aug-16	DIREEN	**1700**	B	19-Dec-22	COLLORUS	20	A
22-Aug-16	COLLORUS	**5400**	C	19-Dec-22	DIREEN	18	A
21-Sep-16	DIREEN	130	A	30-Jan-23	COLLORUS	18	A
21-Sep-16	COLLORUS	18	A	30-Jan-23	DIREEN	18	A
26-Oct-16	DIREEN	40	A	21-Feb-23	DIREEN	18	A
26-Oct-16	COLLORUS	18	A	21-Feb-23	COLLORUS	18	A

Sampling Date	Sample Position	MPN *E. coli*/100 g	Category	Sampling Date	Sample Position	MPN *E. coli* /100g	Category
14-Nov-16	DIREEN	110	A	27-Apr-23	DIREEN	18	A
14-Nov-16	COLLORUS	170	A	27-Apr-23	COLLORUS	18	A
06-Dec-16	SPANISH ISLAND	18	A	29-May-23	COLLORUS	18	A
06-Dec-16	DIREEN	18	A	29-May-23	DIREEN	18	A
30-Jan-17	DIRREEN	20	A	25-Jul-23	COLLORUS	18	A
30-Jan-17	COLLORUS	18	A	25-Jul-23	DIREEN	18	A
28-Feb-17	COLLORUS	45	A				
28-Feb-17	DIREEN	40	A				
13-Mar-17	COLLORUS	18	A				
13-Mar-17	DIREEN	18	A				
18-Apr-17	COLLORUS	18	A				
18-Apr-17	DINEEN	18	A				
18-Apr-17	SPANISH ISLAND	18	A				

Values in bold and highlighted yellow are particularly high levels of *E. coli*. Values in bold and red font are extremely high levels of *E. coli*.

Table 9.3: Historical *E. coli* results from Kilmakilloge Harbour Pacific oysters from December 2022 to May 2023 (source: SFPA); colour coded per Table 9.1.

Sample Position	Sample Date	MNP *E. coli* /100g
EAST	08-Dec-22	110
EAST	07-Feb-23	20
EAST	08-Mar-23	230
EAST	23-Mar-23	230
EAST	05-Apr-23	68
EAST	19-Apr-23	78
N/A	15-May-23	790

Table 9.4: Historical classification of shellfish beds in Kilmakilloge Harbour (2011-2023) (source: SFPA).

Boundaries	Bed Name	Species	Classification	
			2011-2015	2016-2023
Kilmakilloge Harbour	All beds	Mussels	B	A*

*Seasonal classification – 1st December to 1st June, reverts to Class **B** at other times.

9.1.2. Norovirus (NoV)

The Kilmakilloge Harbour production area has to date not been subject to any norovirus sampling programme or baseline studies of norovirus levels.

9.2. Current Data

9.2.1. Sampling Sites and Methodology

Nine water samples were taken within Kilmakilloge Harbour. The locations of these sites can be seen in **Figure 9-1** and **Table 9.5** shows the station coordinates.

Table 9.5: Water sample coordinates with date of sampling.

Station	Feature	Name	Latitude	Longitude	Sampling Date
1	Loughanacreen River	Bunaw Goleen	51.7806465	-9.8105	16/10/2023
2	Lehid River	Kilmackilloge Bridge	51.77641	-9.79332	16/10/2023
3	Owenshagh River	Lauragh Bridge	51.7655705	-9.77551	16/10/2023
4	Drumminboy Bridge	Durnminboy bridge	51.7625732	-9.78024	16/10/2023
5	Coastal	End Point Survey Day 1	51.7628	-9.79066	16/10/2023
6	Adjacent Cashelkeelty River	Lauragh Stone Circle	51.760727	-9.80325	16/10/2023
7	Eskadour Bridge	Eskadour Bridge	51.76443	-9.81777	16/10/2023
8	Coastal	Colorus	51.7668181	-9.84561	16/10/2023
9	Coastal (adjacent Freshwater Lough)	Colorus Point	51.77501	-9.84102	16/10/2023

9.2.2. Bacteriological Analysis Results

Table 9.6 shows the water sample analysis results and **Figure 9-1** shows the magnitude of the *E. coli* results. Station 1 was located at the mouth of the Loughanacreen River and corresponds to map ID 7 in **Figure 7-19**. The Station 2 sample was taken at the mouth of the Lehid River and corresponds to map ID 16 (**Figure 7-19**), where the river was reported running clear adjacent to a bridge. Station 3 was located at the mouth of the Owenshagh River (map ID 30; **Figure 7-19**). The Station 4 sample was measured at the Drumminboy Bridge in an area of brackish water. The bridge is situated over an inlet within Kilmakilloge Harbour into which the Croanshagh River discharges and marks the point this inlet connects to the main bay (map ID 35; **Figure 7-19**). The Station 5 sample was taken in an area of rough grazing (map ID 40; **Figure 7-19**). Station 6 was located adjacent to where the Cashelkeelty River discharges into the harbour, downstream from map ID 41 in **Figure 7-19**. Station 7 was located at Eskadour Bridge and sheep were reported grazing on both sides adjacent to the bridge (map ID 51; **Figure 7-19**). Station 8 was located at Collorus, on the southwestern shore of the harbour in an area of brackish water (map ID 58; **Figure 7-19**). Station 9 was located at Collorus Point adjacent to a freshwater lough (map ID 63; **Figure 7-19**). Guidelines on acceptable levels of *E. coli* in DSW have not yet been established, nevertheless, and excluding Station 8, the water sample results (**Table 9.6**) are not considered to

have high *E. coli* levels; Station 8 returned a value of 426 cfu/100 ml, more than double the next highest station at 179 cfu/100 ml. The minimum mandatory standard for bathing waters requires *E. coli* levels <500/100 ml for coastal areas and <900/100 ml for freshwater areas[31].

Table 9.6: Kilmakilloge Harbour water sampling results.

Station No.	*E. coli* (cfu/100 ml)	Latitude	Longitude
1	179	51.7806	-9.8105
2	70	51.7764	-9.7933
3	179	51.7656	-9.7755
4	63	51.7626	-9.7802
5	< 1	51.7628	-9.7907
6	3	51.7607	-9.8033
7	11	51.7644	-9.8178
8	426	51.7668	-9.8456
9	108	51.775	-9.841

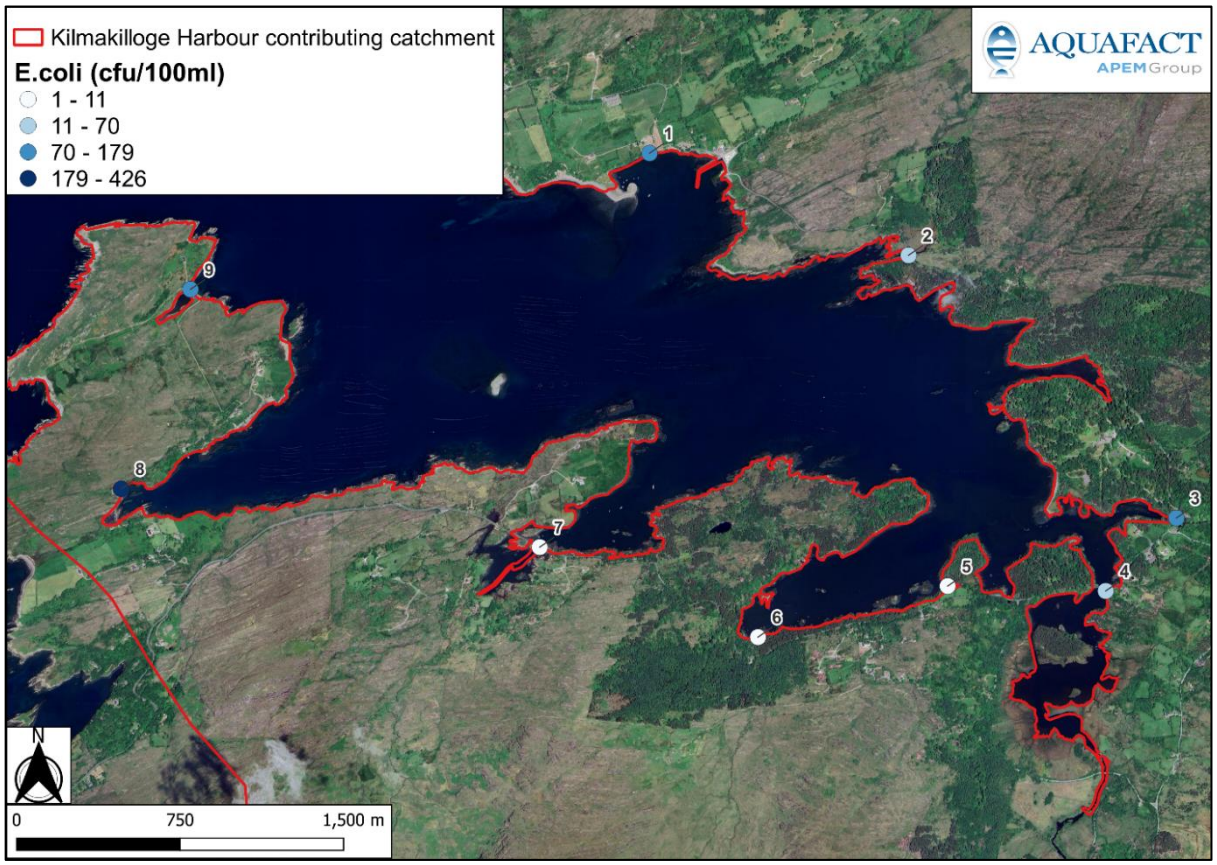


Figure 9-1: Location and magnitude of *E. coli* results from water samples taken during the shoreline survey (numbering cross-referenced to Table 9.6).

10. Appendix 4: Shoreline Survey Images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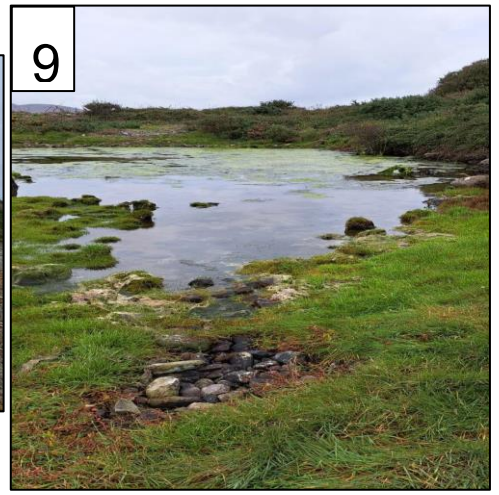
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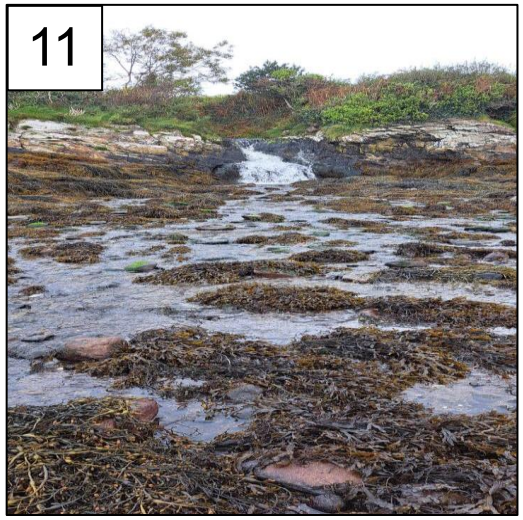
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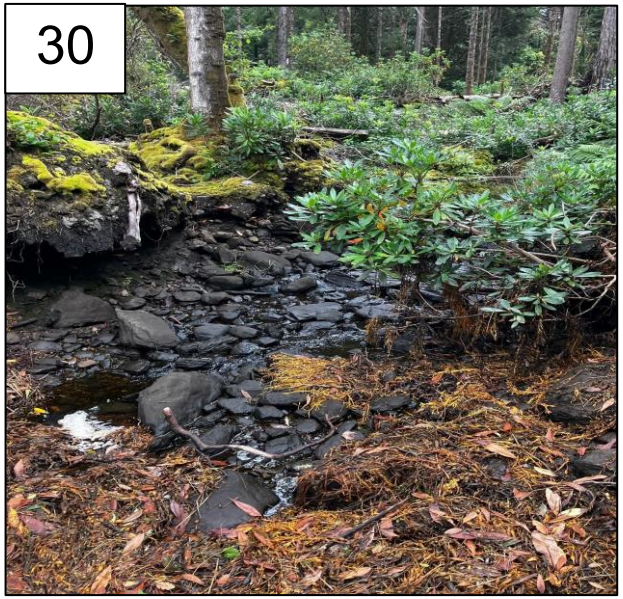
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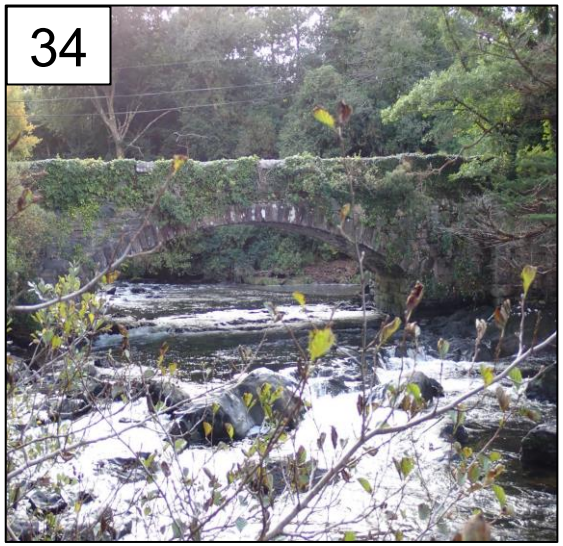
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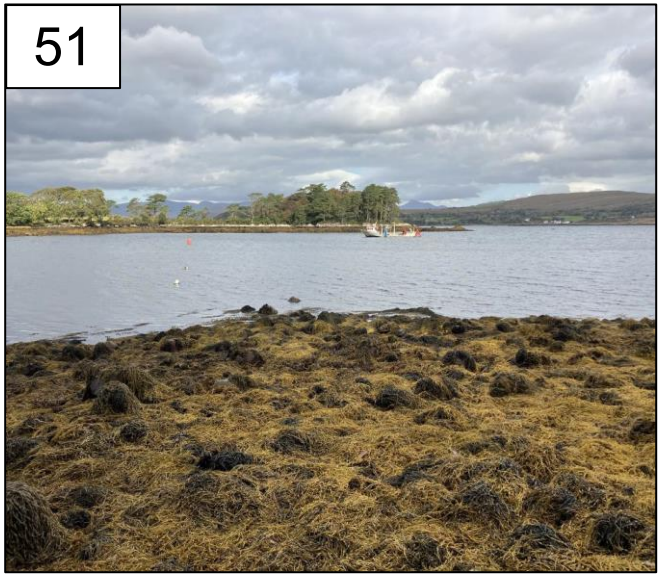
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11. Appendix 5: Blue Mussel Monitoring Information

Kilmakilloge Harbour Production Area

Site Name: Kilmakilloge Harbour

Site Identifier: KY-KE-KE

Monitoring Point Coordinates:

RMP 1 **Latitude:** -9.7970 **Longitude:** 51.7704

RMP 2 **Latitude:** -9.8367 **Longitude:** 51.7677

Species: *Mytilus edulis*

Sample Depth: Samples should be taken within the first one metre of surface water.

Sample Frequency: Monthly

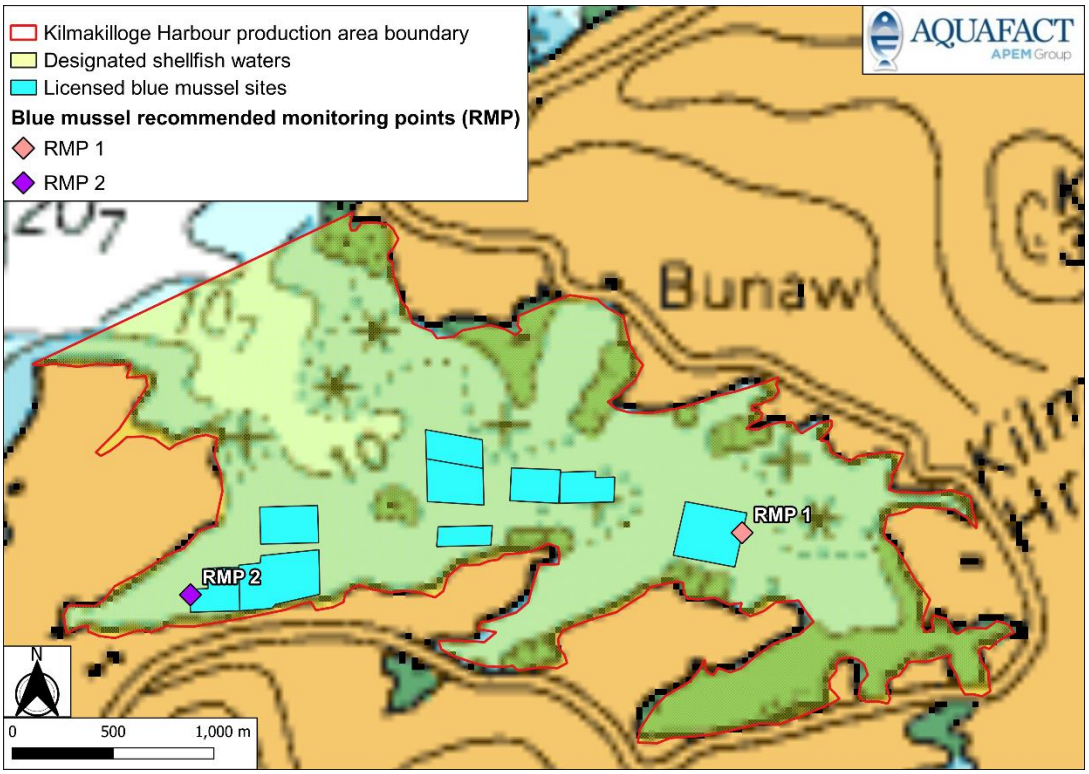
Responsible Authority: Sea Fisheries Protection Authority

Authorised Samplers: SFPA Castletownbere Port Office

Maximum Allowed Distance from Sampling Point: The sample must be taken from within 100 m of the sampling point.

Sampling Size: Minimum 15 market sized shellfish

Sampling Method: Taken from rope at point.



12. Appendix 6: Pacific Oyster Monitoring Information

Kilmakilloge Harbour Production Area

Site Name: Kilmakilloge Harbour

Site Identifier: KY-KE-KE

Monitoring Point Coordinates **Latitude:** -9.7897 **Longitude:** 51.7660

Species: *Magallana gigas*

Sample Depth: Samples should be taken within the first one metre of surface water.

Sample Frequency: Monthly

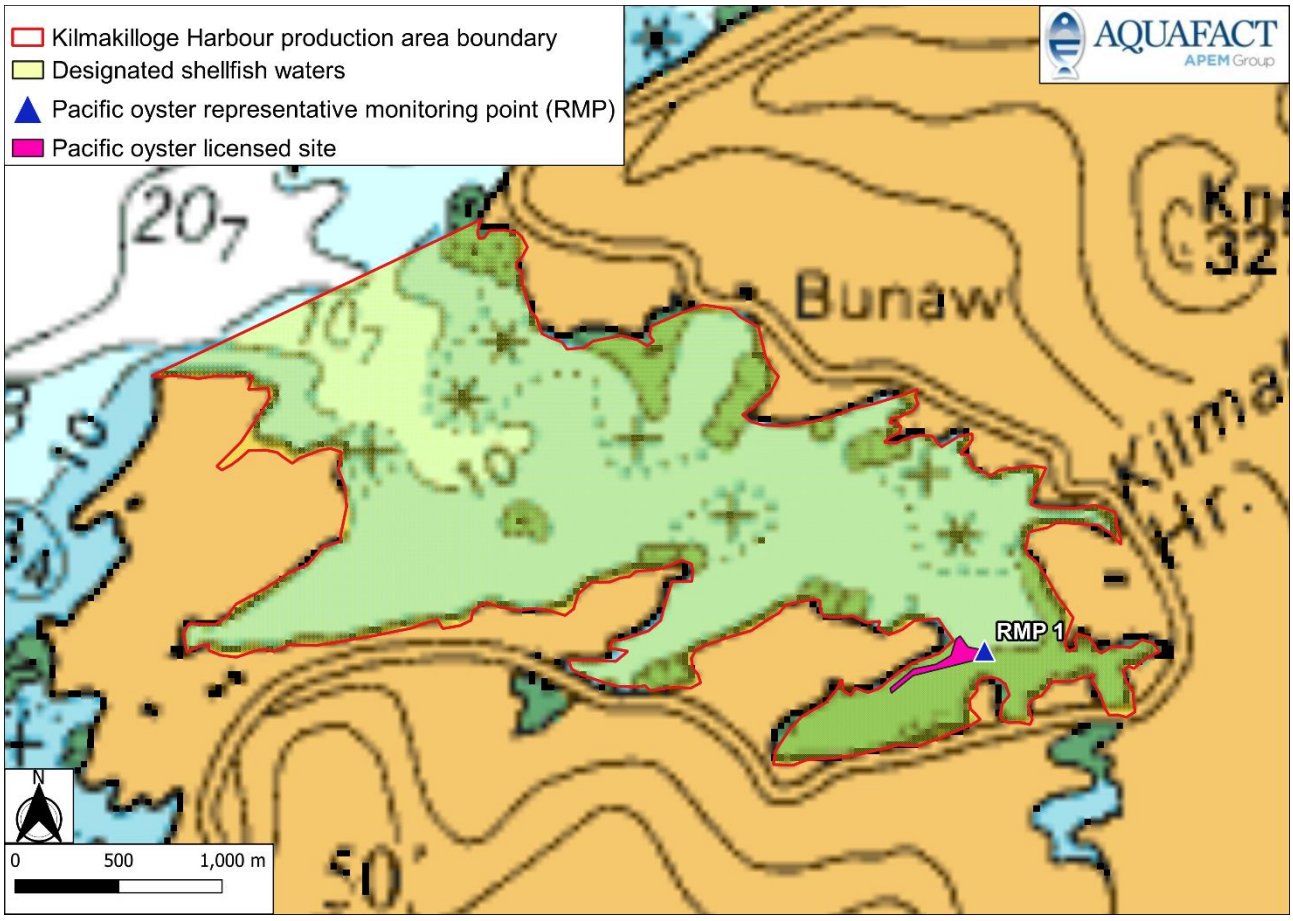
Responsible Authority: Sea Fisheries Protection Authority

Authorised Samplers: SFPA Castletownbere Port Office

Maximum Allowed Distance from Sampling Point: The sample must be taken from within 100 m of the sampling point.

Sampling Size: Minimum 10 market sized shellfish

Sampling Method: Taken from trestles at point.



13. Appendix 7: Annex: Kilmakilloge RMP changes

The purpose of this annex is to explain the changes in RMP locations determined by the sanitary survey. The Kilmakilloge Harbour sanitary survey was completed on the 13.02.24. The purpose of this Annex is to outline the reasons for a change in the sampling plan, specifically Representative Monitoring Point (RMP) 1.

Please let it be noted that this Annex is an SFPA document and Aquafact had no part the drafting of the document.

Regarding the RMPs for Blue Mussels:

The sanitary survey determined that two new RMPs have been determined for blue mussels in Kilmakilloge Harbour, in order to detect the highest levels of E. coli contamination in the bay as per legislative requirements.

However, due to the lack of available stock/samples at the recommended RMP1 in the sanitary survey, the SFPA had to create an additional interim RMP3 and a protocol, the full details of the decision and sampling plan are specified below:

RMP 1: located at a fallow site with no stock available for sampling.

RMP 2: located at a site with limited stock during parts of the year.

According to the Code of Practice for the Classification and Microbiological Monitoring of Bivalve Mollusc Production Areas in Ireland, the SFPA can adjust the sampling location in the event that samples are not present in at the Representative Monitoring Point (RMP), “a new point may be identified in consultation with local industry. The old point should then be discontinued.”

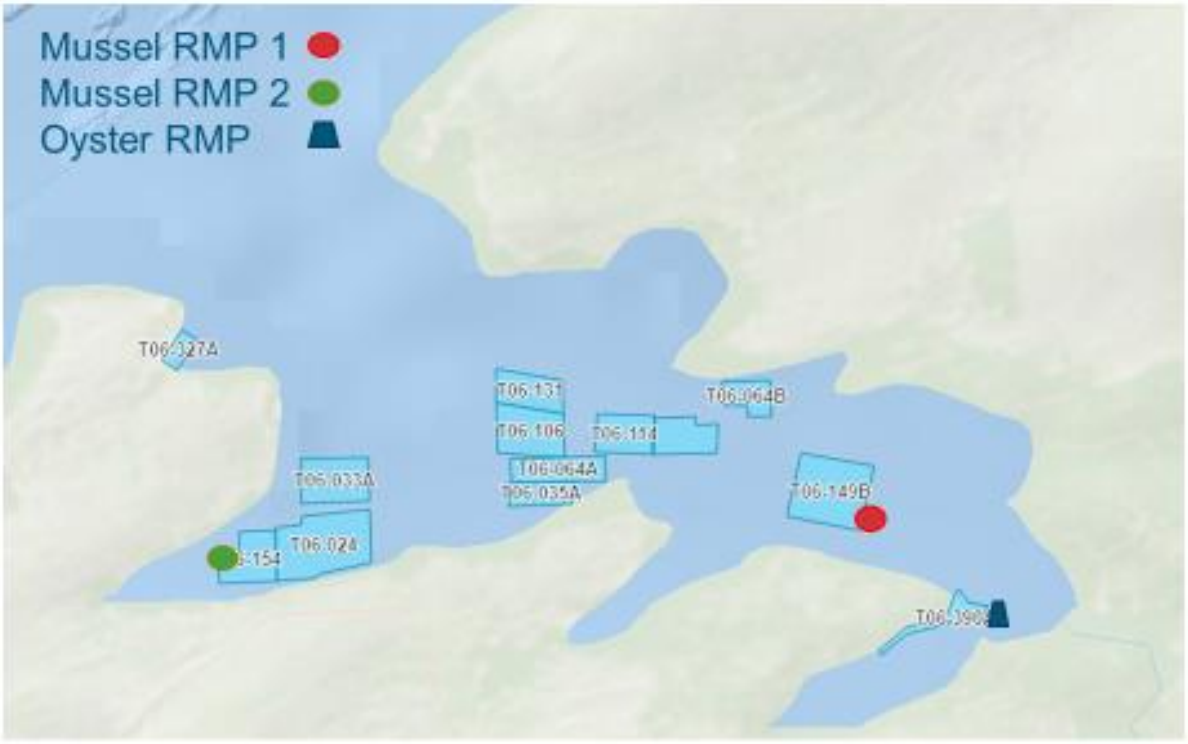


Fig 1: Representative Monitoring Points (RMPs) for blue mussel (*Mytillus edulis*) and pacific oysters (*Magallana gigas*) in Kilmakilloge Harbour detailed in the sanitary survey

SFPA decision regarding RMPs status

1. The classification boundary should not be reduced in the event producers holding aquaculture licences wishes to recommence production.
   The SFPA propose an interim RMP (RMP 3) be established until stock/samples are available at RMP 1. If production resumes in the inner harbour, sampling at RMP 1 shall be recommenced and the interim RMP 3 will be discontinued.
2. RMP 2 remains in place as outlined in the sanitary survey. If samples are unavailable from RMP 2, samples can be taken from the closest available area with available stock/samples.

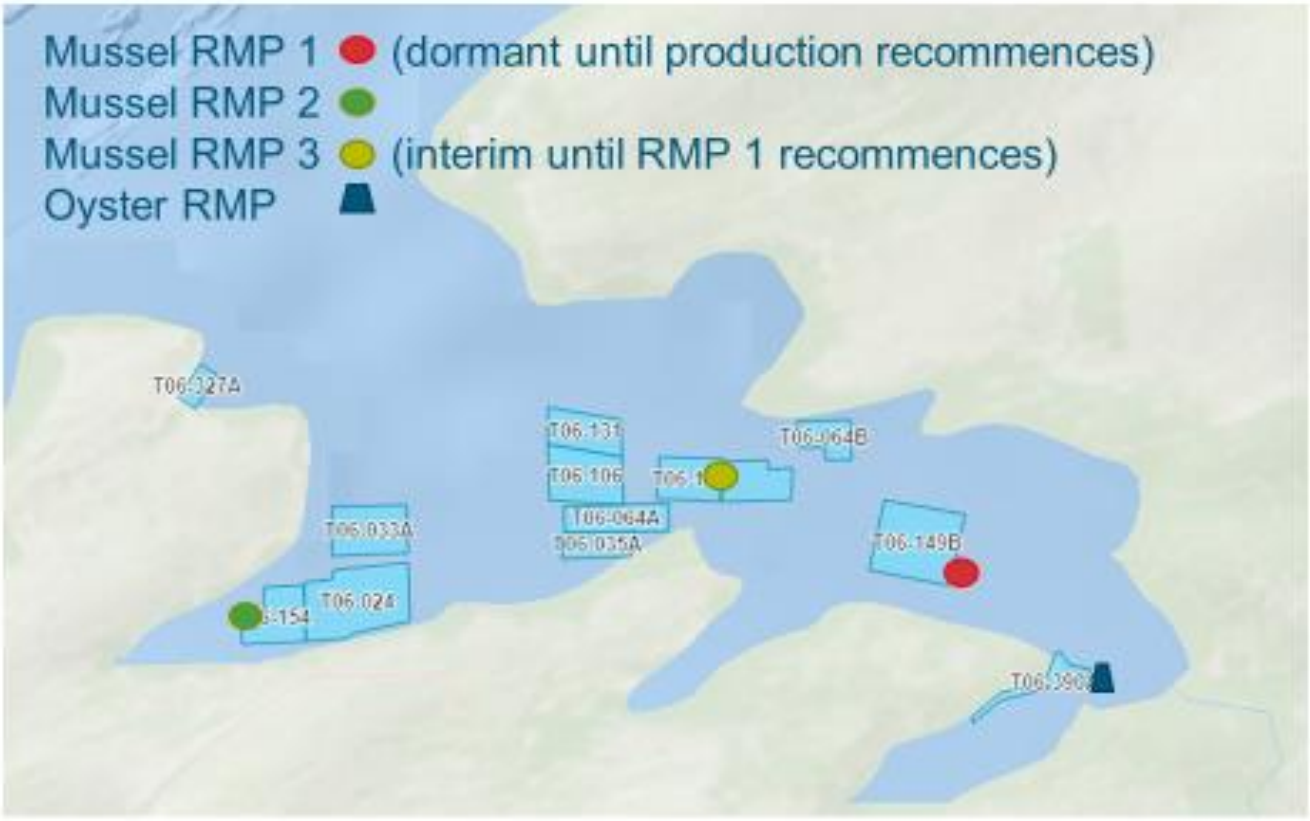


Fig 2: Final Representative Monitoring Points (RMPs) for blue mussel (*Mytillus edulis*) and pacific oysters (*Magallana gigas*) in Kilmakilloge Harbour

Kilmakilloge Harbour Sampling Plan & Representative Monitoring Points for Blue Mussels

Site Name: Kilmakilloge Harbour

Site Identifier: KY-KE-KE

Monitoring Point Coordinates:

RMP 1

Longitude: 51.7704304985

Latitude: -9.7970489060

RMP 2

Longitude: 51.7676677813

Latitude: -9.8367120485

RMP 3 (Interim RMP for RMP 1)

Longitude: 51.772214

Latitude: -9.810728

Species: *Mytilus edulis*

Sample Depth: Samples should be taken within the first one metre of surface water.

Sample Frequency: Monthly

Responsible Authority: Sea Fisheries Protection Authority

Authorised Samplers: SFPA Castletownbere Port Office

Maximum Allowed Distance from Sampling Point: The sample must be taken from within 100 m of the sampling point.

Sampling Size: Minimum 15 market sized shellfish

Sampling Method: Taken from rope at point.

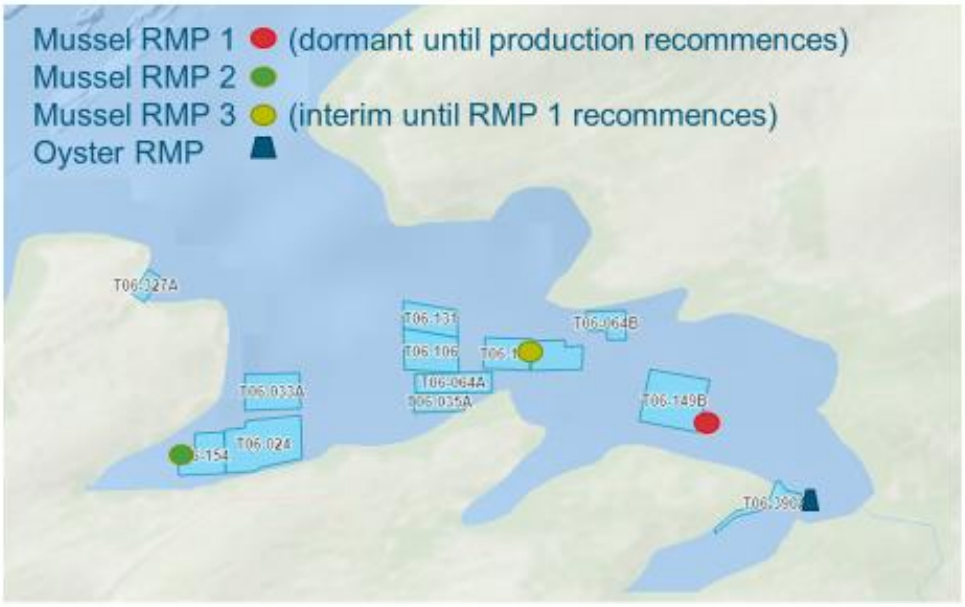


Fig 3: Final Representative Monitoring Points (RMPs) for blue mussel (*Mytillus edulis*) and pacific oysters (*Magallana gigas*) in Kilmakilloge Harbour

14. References

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15. List of Endnotes

[1] Microbiological Monitoring of Bivalve Mollusc Harvesting Areas – Guide to Good Practice: Technical Application: https://www.cefas.co.uk/media/jyzhl1si/good-practice-guide-issue-6.pdf

[2] European Commission 2017: Community Guide to the Principles of Good Practice Microbiological Classification and Monitoring of Bivalve Mollusc Production

[3] https://www.gov.ie/en/publication/e261b-shellfish-waters/

[4] https://www.catchments.ie/

[5] See the 'Protected Sites' tab on the NPWS website for all conservation objectives, site synopsises and lists of conservation features for each SAC and SPA listed in this report: https://www.npws.ie/protected-sites

[6] Designated shellfish waters Clare-Kerry: https://alab.ie/media/alab/2022%2008%2009%20Kilmakilloge%20Alab%20FINAL%20draft.pdf

[7] See statistics tab on CSO website for census of population 2016 & 2022; see census interactive map for small area population statistics & agricultural data: https://www.cso.ie/en/

[8] Turbidity and water: Turbidity and Water | U.S. Geological Survey (usgs.gov)

[9] See gov.ie webpage for National Sheep and Goat Census Report 2021: https://www.gov.ie/en/collection/3afc7-national-sheep-and-goat-census-report-2021/

[10] Kerry County Council: https://alab.ie/media/alab/2022%2008%2009%20Kilmakilloge%20Alab%20FINAL%20draft.pdf

[11] See site-specific conservation objectives shapefiles: https://www.npws.ie/maps-and-data/habitat-and-species-data

[12] National Biodiversity Data Centre: https://maps.biodiversityireland.ie/Map

[13] Fáilte Ireland Visitor Numbers to Attractions Dashboard: https://www.failteireland.ie/Research-Insights/Activities/visitor-numbers-to-attractions-dashboard.aspx

[14] Discover Kerry: Tourist Attractions in Kerry, Things to do in Kerry |Discover Kerry

[15] See Travel by Irish Residents: https://data.cso.ie/

[16]DAFM – Nitrates Explanatory Handbook: https://assets.gov.ie/234709/3a78e71c-411a-49f7-90b5-1fc87d75d08b.pdf

[17] https://www.irishstatutebook.ie/eli/statutory.html

[18] European Commission 2017: Community Guide to the Principles of Good Practice Microbiological Classification and Monitoring of Bivalve Mollusc Production

[19] See publications tab for SFPA code of practice: https://www.sfpa.ie/

[20] https://www.discoverireland.ie/

[21] https://www.beaches.ie/

[22] https://gis.epa.ie/EPAMaps/

[23] EPA Geoportal: https://gis.epa.ie/

[24] https://www.cso.ie/en/

[25] https://www.irishstatutebook.ie/eli/statutory.html

[26] See 'Publications' tab on gov.ie website for Fifth Nitrates Action Programme Overview document: https://www.gov.ie/en/publication/f1d01-fifth-nitrates-action-programme-2022-2025/

[27] https://www.gsi.ie/en-ie/Pages/default.aspx

[28] https://www.catchments.ie/

[29] FieldenMaps.info / Co-ordinate Converter / Ireland

[30] See climate tab for current and historical data: https://www.met.ie/

[31] Bathing Water Quality in Ireland: https://www.beaches.ie/wp-content/uploads/2017/06/BW_Report_2015.pdf