Scottish Sanitary Survey Report

Sanitary Survey Report
South Ford
UB-259
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	Name	**Position**	**Date**
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Partner Organisations

The hydrographic assessment and the shoreline survey and its associated report were undertaken by SRSL, Oban.

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Appendices

I. Executive Summary

Under (EC) Regulation 854/2004, which sets forth specific rules for the organisation of official controls on products of animal origin intended for human consumption, sanitary surveys of production areas and their associated hydrological catchments and coastal waters are required in order to establish the appropriate representative monitoring points (RMPs) for the monitoring programme.

The purpose of the sanitary survey is to demonstrate compliance with the requirements stated in Annex II (Chapter II Paragraph 6) of Regulation (EC) 854/2004. The sanitary survey results in recommendations on the location of RMPs, the frequency of sampling for microbiological monitoring, and the boundaries of the production areas deemed to be represented by the RMPs. A sanitary survey was undertaken on the classified common cockle fishery at South Ford on the basis recommended in the European Union Reference Laboratory publication: "Microbiological Monitoring of Bivalve Mollusc Harvesting Area Guide to Good Practice: Technical Application" (https://eurlcefas.org/media/13831/gpg_issue-5_final_all.pdf).

South Ford is a large intertidal area separating the island of Benbecula from the island of South Uist in the Outer Hebrides.

The principal sources of faecal contamination to the fishery are point source discharges of human sewage and diffuse contamination from human, livestock and wildlife sources. There is likely to be seasonal variation in inputs, and significant seasonal variation was found in *E. coli* monitoring results, which were higher in summer than in either spring or winter.

The RMP is currently located well away from the main identified sources of faecal contamination and therefore may not adequately reflect contamination levels at the shellfish bed west of the causeway.

As the area is intertidal, contaminants are expected to be carried over most of the intertidal area within a single tide. Contaminants arising from the west side of the causeway may under certain conditions be transported to the east side.

Due to the number of sewage discharges to the west side of the causeway, it is recommended that the production area be curtailed to exclude this area. It is recommended that the RMP be moved to NF 8042 4739, near the northwest extent of the production area.

II. Sampling Plan

Production Area	South Ford
Site Name	South Ford
SIN	UB-259-162-04
Species	Common cockles
Type of Fishery	Hand-raked
NGR of RMP	NF 8042 4739
East	80420
North	847390
Tolerance (m)	100
Depth (m)	not applicable
Method of Sampling	Hand raked
Frequency of Sampling	Monthly
Local Authority	Comhairle nan Eilean Siar
Authorised Sampler(s)	Samantha Muir
Local Authority Liaison Officer	Colm Fraser
Production Area Boundaries	The area bounded by lines drawn between NF 8100 4545 and NF 8252 4673 and between NF 8265 4682 and NF 8300 4712, extending to the causeway at the western boundary and to MHWS elsewhere.

III. Report

1. General Description

South Ford is a large intertidal area separating the island of Benbecula from the island of South Uist in the Outer Hebrides. It is part of the Nan Eilean Siar council area.

The intertidal area of the ford is divided by a road causeway. There is a 15 m long bridge at the northern end of the causeway and the gap spanned by the bridge allows water to flow between the two sides. The intertidal area extends 4.2 km to the northwest of the causeway and 2.8 km to the south-east.

There are no large settlements in the area surrounding South Ford, however there are a number of small hamlets and individual houses along connecting roads. A Ministry of Defence Missile Range is located on the northwest coast of South Uist and includes the adjacent waters.

This sanitary survey was undertaken on the classified fishery at South Ford on the basis recommended in the European Union Reference Laboratory publication: “Microbiological Monitoring of Bivalve Mollusc Harvesting Area Guide to Good Practice: Technical Application” (https://eurlcefas.org/media/13831/gpg_issue-5_final_all.pdf). This production area was selected for survey at this time based on a risk-based ranking of the area amongst those in Scotland that have yet to receive sanitary surveys.

Note on Gaelic place names

Many of the names given to places and infrastructure throughout this area are Gaelic in origin and spelled in two or more ways. Typically a Gaelic spelling and an alternate phonetic spelling are used interchangeably. This makes establishing consistent ways of identifying features or places difficult. Where possible, spellings of places used in this report are consistent with the spellings used on the Ordnance Survey 1:25000 maps. Please note that spellings may be different on other OS maps. Common examples used in this report include Iochdar - Eochar, Lionacleit - Liniclate, Creag Ghoraidh - Creagorry, Haclait - Hacklet, and Griomasaigh - Grimsay.

Names used to denote specific features in data supplied to us by other agencies, such as Scottish Water or SEPA, will be used as designated by the supplier.

Figure 1.1 Location of South Ford

2. Fishery

Wild common cockles (*Cerastoderma edule*) are harvested at South Ford. A summary of the site is presented in Table 2.1.

Table 2.1 Area shellfish farms

Production area	Site	SIN	Species	RMP
South Ford	South Ford	UB-259-162-04	Common cockles	NF 8050 4655

The production area is defined as the area bounded by lines drawn between NF 7919 4727 to NF 7990 4804 and NF 8100 4545 to NF 8300 4712.

Cockles are hand-raked by numerous harvesters. Both the north and south sides of the area are harvested, although locals state that the majority of harvesters work the north side of the area.

As there is no cockle distribution data the estimated extent shown in Figure 2.1 is based upon the preferred habitat of the species. In this case the entirety of the intertidal area could be considered suitable.

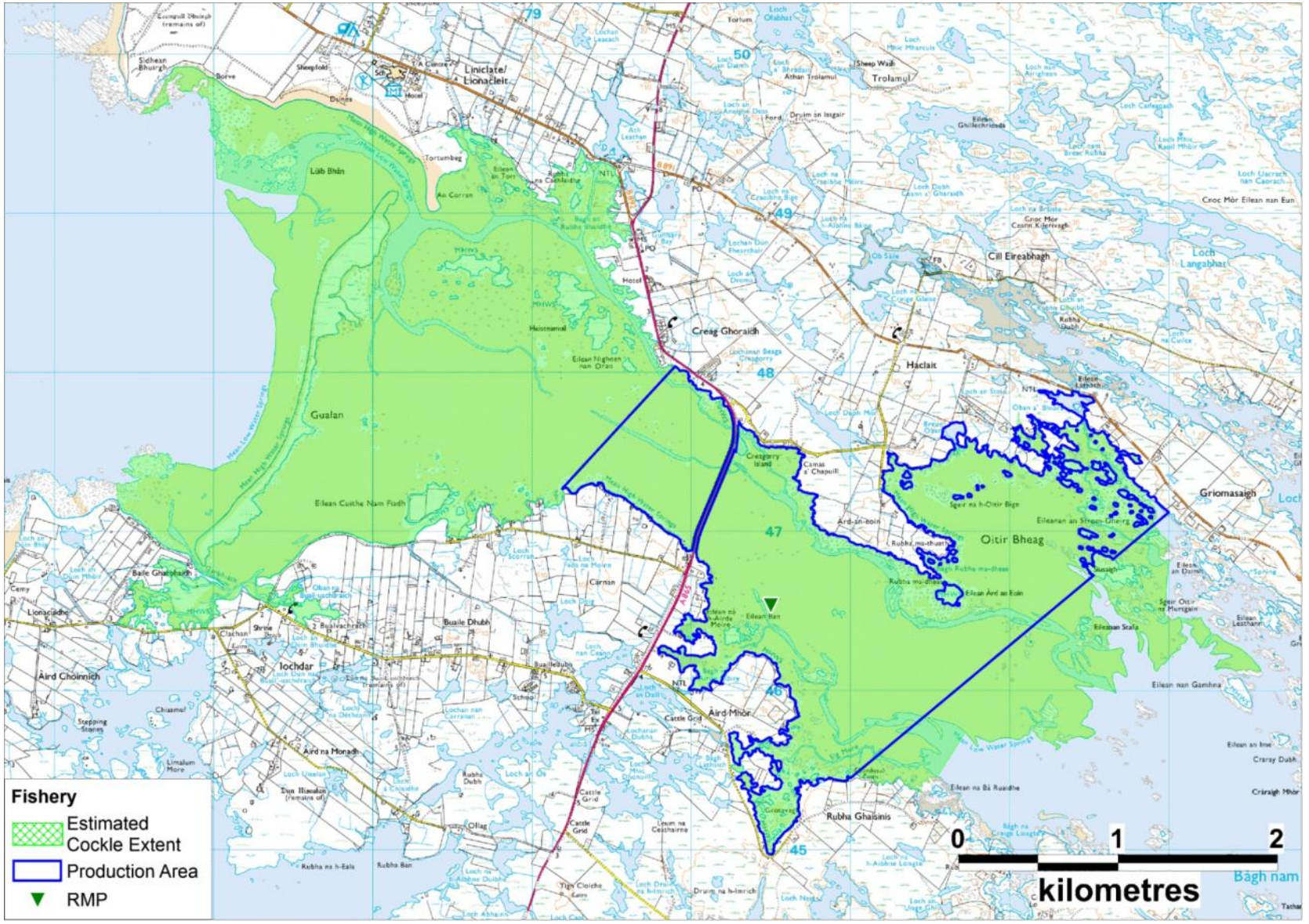


Figure 2.1 South Ford Fishery

3. Human Population

Information was obtained on the population within the vicinity of the South Ford production area from the General Register Office for Scotland. The last census was undertaken in 2011. The census output areas surrounding South Ford are shown in Figure 3.1 thematically mapped by the 2011 population densities. The census output areas differ in size and the population within each area will not be evenly distributed.

Table 3.1 Census output area and population – South Ford

Census Output Area ID	Population	Area (km^2)	Density (Persons/km^2)
S00072823	89	3	30
S00072948	144	8	18
S00072766	70	4	18
S00072907	127	2	64
S00072839	103	16	6
S00072816	92	24	4

Population in the area is diffuse, with individual homes located along the roads in the area. On the north side of the ford, population is centred around the settlements of Torlum, Lionacleit, Greag Ghoraidh, Haclait, and Griomasaigh. Lionacleit has a secondary school and tourist accommodation including a hotel and a B&B. There is further visitor accommodation north of Greag Ghoraidh. A small regional airport is located on the north side of the island of Benbecula. The Lionacleit school complex also serves as a community hub and incorporates a public library, sports centre, cafe, and museum. A camping and caravan site is noted to the west of the Lionacleit school on the OS 1:10000 map.

Population along the south side of the ford is located mainly around the settlement of Iochadar, where there is also a primary school. There is further holiday accommodation on this side of the ford. It should be noted that there may be further tourist accommodation not identified during an internet search on the area. During the shoreline survey it was noted that all anchorages in the area are tidal. At the time of the survey, no boats were observed navigating the waterway. A leisure boat was observed moored in Bagh Nam Faoileann on the south east coast of Benbecula and a small private tidal harbour was seen at Bagh na h-Airde Moire on the northeast coast of South Uist. Locations of the schools, identified accommodation, and the mooring and private harbour are shown in Figure 3.1

Overall, areas of the cockle bed adjacent to the settlements are more likely to be more impacted by human-related sources of faecal contamination. The amount of tourist accommodation is high compared to the resident population and thus there is likely to be significant seasonal variation in human population in the area.

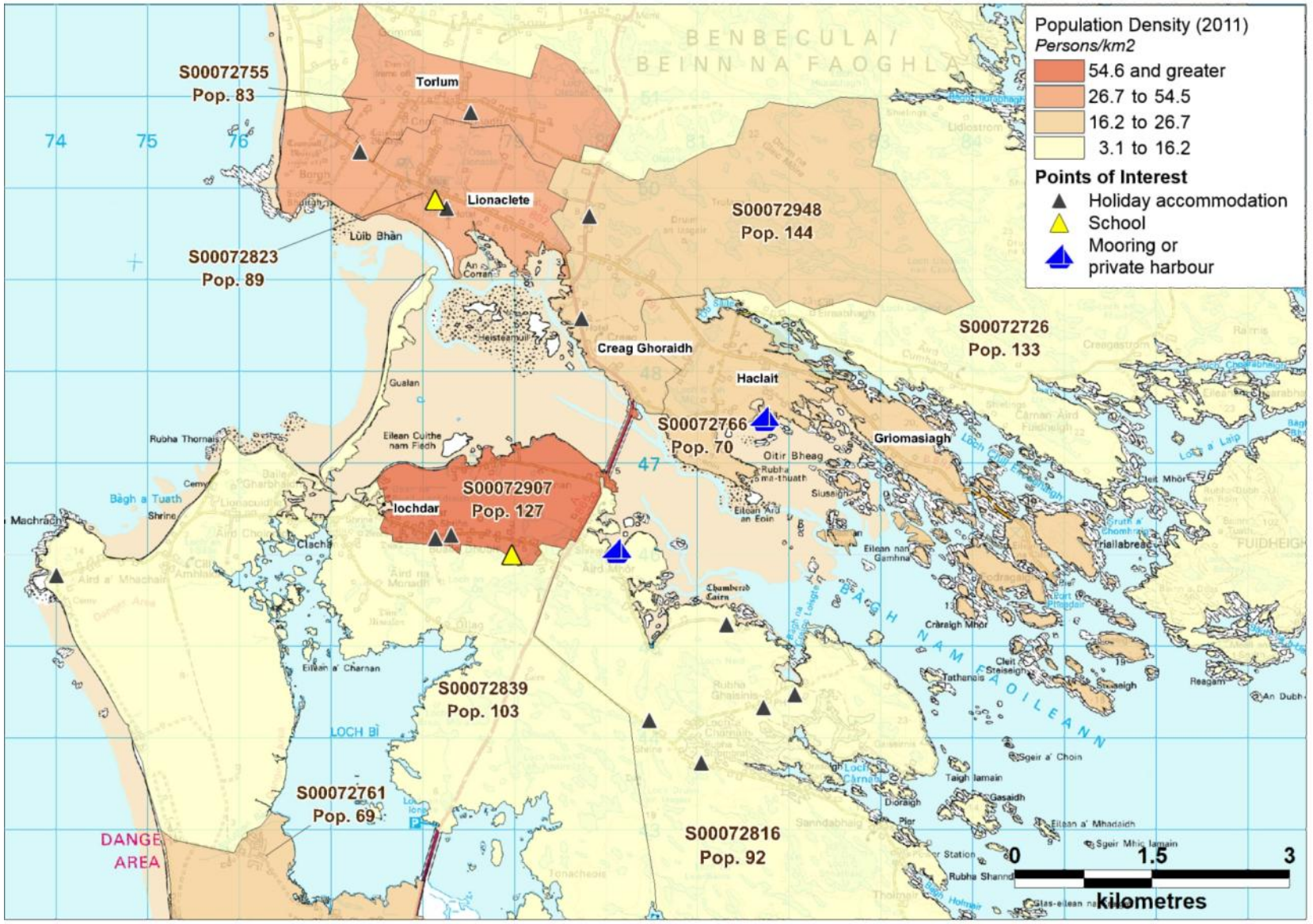


Figure 3.1 Population map for the area around South Ford

4. Sewage Discharges

Information on sewage discharges within 4 km around grid reference NF 8050 4655, the location of the RMP, was sought from Scottish Water and the Scottish Environment Protection Agency (SEPA). Data requested included the name, location, type, size (in either flow or population equivalent), level of treatment, sanitary or bacteriological data, spill frequency, discharge destination (to land, watercourse or sea), any available dispersion or dilution modelling studies, and whether improvements were in work or planned. No information was provided on sanitary or bacteriological quality, spill frequency, dispersion or modelling studies, or whether improvements were being undertaken or planned.

4.1 Community Discharges

Several community discharges were identified by both SEPA and Scottish Water, and this information is summarised in Table 4.1.

Scottish Water provided information on eight septic tanks (continuous discharges) and four overflows (intermittent discharges). SEPA provided information on seven septic tanks only.

The largest of the reported discharges is from the Liniclate septic tank, with a PE of 500. This discharges to reed bed, which provides secondary treatment to the effluent stream. There is an EO associated with the pumping station for this tank.

SEPA and Scottish Water records were broadly in agreement with regard to flow and location information for the seven assets which were reported by both. Scottish Water and SEPA both provided information on the septic tank covered by licence CAR/L/1002876. However, each spelled the name differently, and Scottish Water identified another septic tank as Iochdar. Scottish Water did not have a licence number in their database for this septic tank, however they noted that an application has been submitted to register this discharge . Both the Scottish Water Iochdar septic tank and Eochar WWPS discharge to Loch nan Ceann. Langabhat septic tank discharges to the head of Loch Chearabhaigh, which lies to the northeast of the ford.

Discharges of greatest significance to the cockle fishery at South Ford are those septic tanks discharging along the northwest shoreline (Liniclate School, Strome Cottages, and Creagarry 1 and 2) and the Eochar septic tank, on the southwest shore.

Information on locations where sewage sludge is applied to land had been requested from SEPA: it was identified that little data was held on this and that the data that was held could not be made available for assessment within the sanitary survey programme.

Table 4.1 Community sewage discharges - South Ford

Scottish Water					SEPA				
Discharge Name	**Licence number**	**Location**	**Treatment Level**	**PE**	**Discharge Name**	**Licence number**	**Location**	**Treatment Level**	**PE**
Strome Cottages SEP 1980	WPC/N/60938	NF 7934 4932	Septic Tank	76	Strome Cottages Septic Tank	WPC/N/60938	NF 7934 4932	Primary	76
Cuidhe Na Gamhna SEP 1980	CAR/L/1001830	NF 7961 4626	Septic Tank	25	Cuidhe Na Gamhna STW	CAR/L/1001830	NF 79611 46264	Primary	25
Iochdar SEP 1980	Not in database	NF 7930 4613	Septic Tank	9	*	*	*	*	*
Eochar SEP 1980	CAR/L/1002876	NF 7734 4657	Septic Tank	59	Iochdar Septic Tank	CAR/L/1002876	NF 77300 46600	Primary	59
Creagorry SEP 1 1980	WPC/N/60944	NF 8021 4783	Septic Tank	196	Ford Council Houses	WPC/N/60944	NF 8021 4783	Primary	196
Creagorry SEP 2 1980	WPC/N/60943	NF 7970 4850	Septic Tank	148	Straid a' Phrionsa Council Houses	WPC/N/60943	NF 7970 4850	Primary	148
Langabhat SEP 1980	WPC/N/61227	NF 8192 4859	Septic Tank	10	Lagavat Council Houses	WPC/N/61227	NF 8192 4859	Primary	10
Liniclate Septic Tank & Reed Bed	CAR/L/1001801	NF 7840 4990	Septic Tank & Reed Bed	500	Liniclate School WwTW	CAR/L/1001801	NF 78536 49552	Secondary	500
Liniclate Inlet PS and EO	WPC/N/62100	NF 7840 4990	EO	*	*	*	*	*	*
Eochar WWPS 1 1997	Not in database	NF 7802 4622	CSO/EO	*	*	*	*	*	*
Eochar WWPS 2 1997	Not in database	NF 7760 4638	CSO/EO	*	*	*	*	*	*
Eochar WWPS 1960	Not in database	NF 7930 4613	EO	*	*	*	*	*	*

* Data not provided, EO=emergency overflow only, CSO/EO- combined sewer overflow plus emergency overflow, WWPS=wastewater pumping station, STW=sewage treatment works, WwTW=wastewater treatment works, PE= population equivalent.

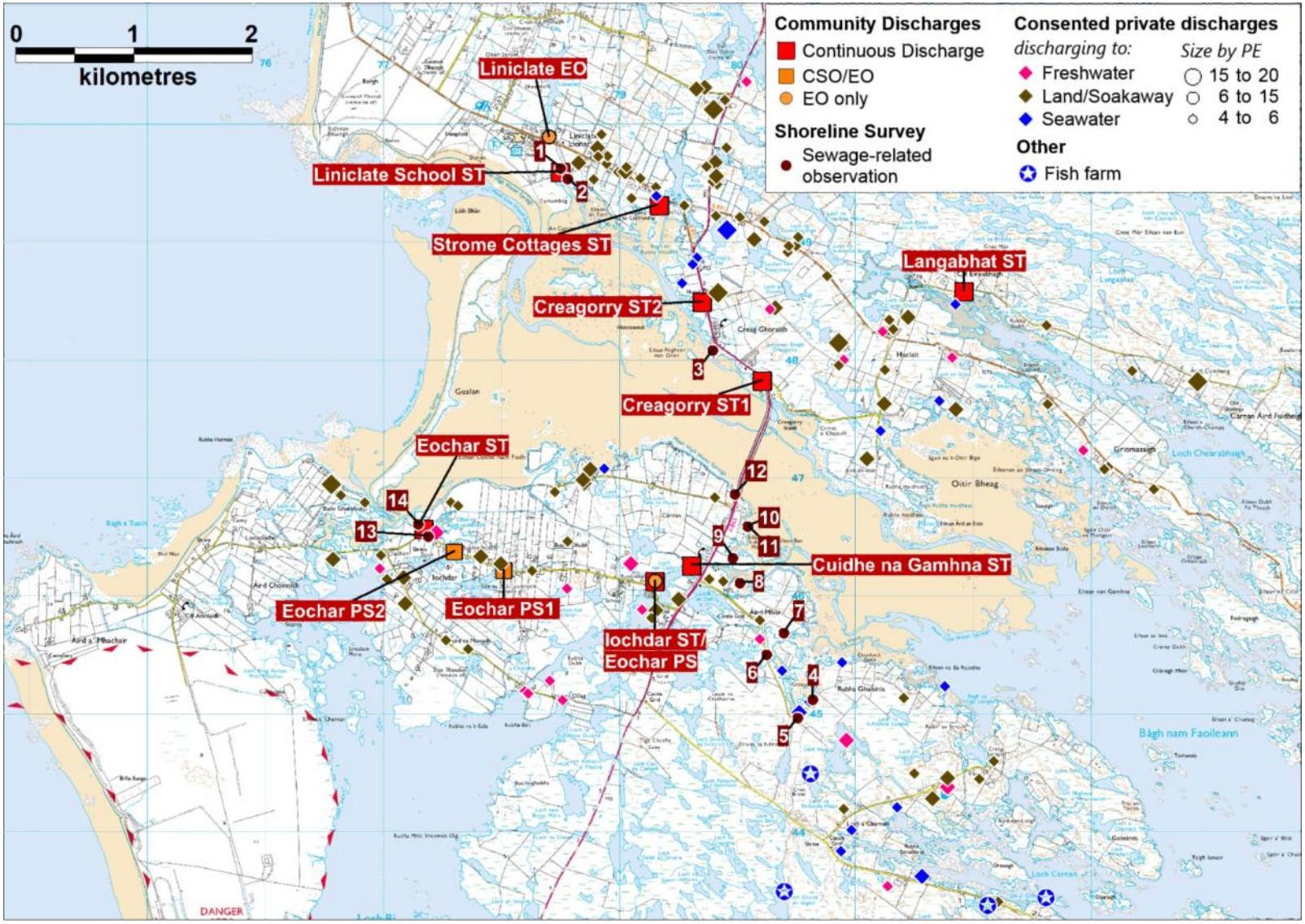


Figure 4.1 Map of discharges for South Ford

4.2 Private Discharge Consents – SEPA

SEPA provided information regarding a large number of consented discharges within the specified request area. Consents for discharges that should not contribute to any faecal input to the area, such as abstraction, engineering works, etc were excluded from assessment.

Consent information was received for 128 private sewage discharges from dwellings and businesses. Details of these consents, along with consents for fish farms, water treatment works and other pertinent consents are given in Appendix 6.

Groups of private discharges to sea are located between Strome Cottages ST and Creagorry ST 2, northwest of the causeway and along the southeast side of the ford.

Four consents related to fish farms: two freshwater cage fish farms, one marine cage fish farm and a fish hatchery. All of these are located along the outer south shore of the sound. As with the trade discharge, the activities themselves are not likely to contribute faecal indicator organisms to the sea. However, if these facilities include staff toilets, discharges may have some septic content.

The majority of private discharges are consented to discharge to land. SEPA have identified previously that in remote areas, consents originally registered as discharging to land may have been diverted to sea or to watercourses upon failure of the soakaway fields and therefore at least some of the reported discharges to soakaway may actually be to water.

The land around this area is very low lying, and most of the reported soakaway discharges lie less than 10m above sea level. It is therefore not clear how effective the soakaway systems will be, particularly for those that are located very near the shoreline. Parts of the area are at high risk of flooding from coastal, river and/or surface water sources. This is particularly an issue in and around Iochdar and on the lowest parts of the north shore (Comhairle nan Eilean Siar, 2014), and therefore soakaways in these areas might be expected to contribute to faecal contamination at the fishery after heavy rainfall or coastal flooding.

Registration of septic tanks is required for all new properties and upon sale of existing properties. Therefore, there may be additional discharges that have not yet been registered with SEPA.

Shoreline Survey Discharge Observations

Sewage infrastructure was noted during the shoreline survey undertaken in autumn 2014. These are listed in Table 4.2 and shown in Figure 4.1.

Table 4.2 Discharge-associated observations made during the shoreline survey

No.	Date	NGR	Associated Photograph (Appendix 5)	*E. coli* (cfu/100ml)	Description
1	27/07/2014	NF 78498 49632	Figs.3&4	-	Public Sewage Discharge: Three metal covers on earthwork mound summit. Labels "Linaclete Reed Bed". Final, fourth cover, near stream.
2	27/07/2014	NF 78561 49547		-	Suspected Public Sewage Discharge point.
3	28/07/2014	NF 79788 48087		-	Septic tank with no visible outfall but apparent seepage from top of tank.
4	29/07/2014	NF 80639 45128		-	Septic tank, concrete, observed about 30 m from waypoint 58. Outfall not observed.
5	29/07/2014	NF 80510 44972	Fig. 16	-	Septic tank observed from waypoint 57 with outfall pipe (right angle joint, 100 mm standard soil pipe) ending in air at tank. Property notice indicated that it was a holiday house at the time of the survey.
6	29/07/2014	NF 80246 45508		-	Plastic 100 mm standard soil pipe outfall onto beach seen from road. No flow observed but appeared to be in use by dwelling above shore.
7	29/07/2014	NF 80395 45689		-	Plastic 100 mm standard soil pipe outfall onto beach. No flow but appeared to be in use.
8	29/07/2014	NF 80020 46115	Fig. 12		Septic tank and apparent soakaway outside garden ground of new house.
9	29/07/2014	NF 79959 46328		-	Septic tank with dry outfall pipe emerging and ending about 100 mm from tank end. Dwelling above appears unoccupied.
10	29/07/2014	NF 80087 46593	Fig. 10	7.2×10^6	Outfall pipe with slow flow emerging from garden ground. Standard 100 mm plastic soil drain pipe.
11	29/07/2014	NF 80087 46595		-	Two septic tanks in close proximity. Both appearing disused with dry outfall pipes protruding about 30 cm from each tank and long grass below.
12	29/07/2014	NF 79979 46867		-	Overgrown slipway and probable septic tank associated with premises at waypoint 31. No outfall pipe observed.
13	27/07/2014	NF 77377 46512	Fig. 5	-	Location of visible steel pipe east of road.
14	27/07/2014	NF 77294 46615		-	Public Sewage Discharge (PSD) on south shore of South Ford: Iochdar pipe, metal, 200 mm diameter, seen east side of road but no visible end observed to the west of the road.

Observations 1 and 2 probably relate to Liniclate School WwTW (CAR/L/1001801) which has a PE of 500.

Observation 3 probably relates to CAR/R/1059657 which has a PE of 5.

Observation 4 may relate to CAR/R/1057094 which discharges to sea and has a PE of 5.

Observation 7 probably relates to CAR/R/1059454 which has a PE of 5.

Observation 10 relates to an outfall pipe with a small flow. A sample taken from this returned a value of 7200000 *E. coli* (cfu/100ml) Observations 13 and 14 refer to a

steel pipe : no outfall was observed. They relate to Iochdar septic tank (CAR/L/1002876) which has a PE of 59.

Summary

The area around South Ford is served by a mixture of community sewage systems and small private sewage systems. Four community septic tanks discharge to the north side of South Ford, all to the west of the causeway, with a combined consented PE of 920 The largest of these septic tanks serves the Lionacleit school and community centre, and will serve a significant transient population, particularly in summer when tourists are likely to visit the area in larger numbers. One septic tank with a small PE of 10 discharges to Loch Chearabhaigh northeast of the ford, and is considered unlikely to have a significant impact on the South Ford shellfishery.

Three community septic tanks are located on the south side of the ford. Cuidhe Na Gamhna ST discharges to freshwater just to the west of the A865. Iochdar ST (Scottish Water) also discharges to the same water body as Cuidhe Na Gamhna.

Two CSOs are associated with pumping stations located between the Eochar and Iochdar septic tanks. It is not clear where spills from these actually discharge. This system lies in an area that is identified as being prone to flooding.

Private septic tanks and/or outfalls were observed along the shore southeast of the causeway. However, the greatest area of sewage input is likely to be the northwest side of the ford given the relatively high number of both private and community sewage discharges. Private discharges are likely to be the most significant sources of sewage to the southeast shore of the ford, although their impact is likely to be more local.

List of Acronyms

NGR=	National Grid Reference	EO	Emergency Overflow
PE=	Population Equivalent	CSO=	Combined Sewer Overflow
DWF=	Dry Weather Flow	U/T	Unnamed Tributary

5. Agriculture

Information on the spatial distribution of animals on land adjacent to or near the fishery can provide an indication of the potential amount of organic pollution from livestock entering the shellfish farm area. Agricultural census data to parish level was requested from the Scottish Government Rural Environment, Research and Analysis Directorate (RERAD) for the North Uist and South Uist parishes. Reported livestock populations for the parishes in 2013 are listed in Table 5.1. RERAD withheld data for reasons of confidentiality where the small number of holdings reporting would have made it possible to discern individual farm data. Any entries which relate to fewer than five holdings, or where two or fewer holdings account for 85% or more of the information, are replaced with an asterisk.

Table 5.1 Livestock numbers in the North Uist and South Uist agricultural parish 2014

	North Uist		South Uist	
	431 km^2		431 km^2	
	Holdings	Numbers	Holdings	Numbers
Pigs	*	*	5	34
Poultry	40	614	70	1153
Cattle	78	2023	146	1998
Sheep	197	22098	358	24771
Horses used in Agriculture	0	-	*	*
Other horses and ponies	7	12	17	44

* data withheld

The livestock census numbers for North Uist and South Uist relate to very large parish areas, therefore it is not possible to determine the spatial distribution of the livestock on the shoreline adjacent to the survey area or to identify how many animals are likely to impact the catchment around the shellfish bed. Although the figures are of little use in assessing the potential impact of livestock contamination to the shellfishery they do give an idea of the total numbers of livestock over the broader area. Sheep were kept in moderate numbers and poultry, cattle and other horses and ponies were kept in small numbers and. No pigs were reported for the North Uist parish due the small number of holdings and there were small numbers of pigs in the South Uist parish. A source of spatially relevant information on livestock population in the area was the shoreline survey (see Appendix 5) which only relates to the time of the site visit on the 27th – 29th July 2014. Observations made during the survey are dependent upon the viewpoint of the observer some animals may have been obscured by the terrain.

During the shoreline survey sheep, cattle and horses were all observed by the team during their transit around the area but only sheep were observed and recorded

during the shoreline walks. Approximately 34 sheep were recorded on the northwestern side of South Ford and two sheep were also recorded on the beach near the northern end of the causeway. Four sheep and 3 lambs were observed on the southeastern side of South Ford. Horse faeces were noted on grass above the shoreline on the southeast side of the causeway.

The OS 1:25,000 map showed 2 sheepfolds on the north side of South Ford.

Information on locations where animal slurry is stored and/or applied to land had been requested from SEPA: it was identified that little data was held on this and that the data that was held could not be made available for assessment within the sanitary survey programme.

Numbers of sheep are expected to be approximately double during the spring and summer months when lambs are present.

Contributions of faecal contamination from livestock are expected to be mainly associated with sheep, with additional contributions from cattle and horses. From the observations recorded during the shoreline survey, the impacts would be likely to be greatest on the northwest side of the cockle bed. However, the other identified areas of improved pasture around the area may also be used for livestock grazing and, if so, contribute to faecal contamination of the fishery.

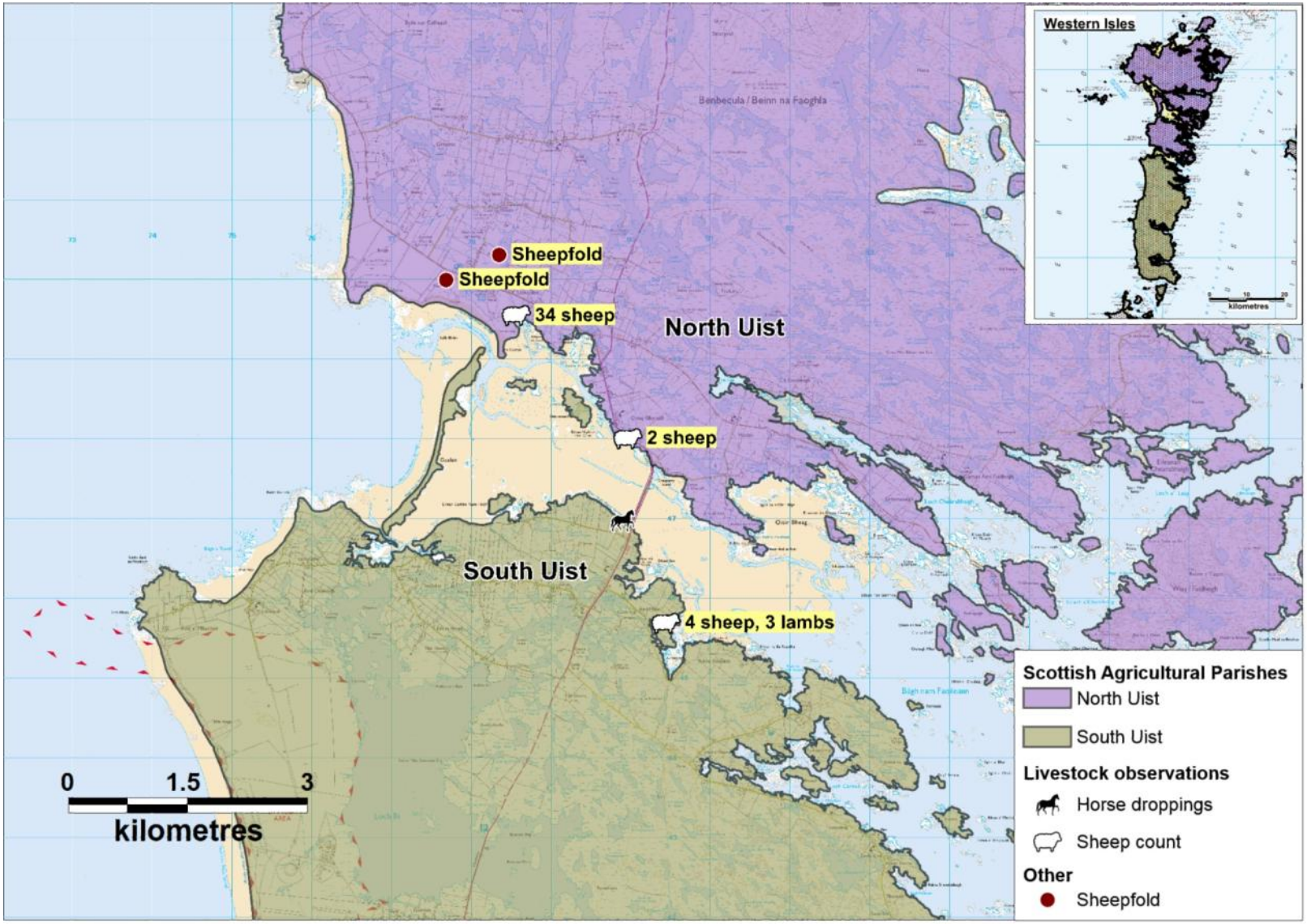


Figure 5.1 Livestock observations at South Ford

6. Wildlife

Wildlife species present in and around the production area will contribute to background levels of faecal contamination at the fishery, and large concentrations of animals may constitute significant sources when they are present. Seals (pinnipeds), whales (cetaceans) and some seabirds may deposit faecal wastes directly into the sea, whilst birds and mammals present on land will contribute a proportion of any faecal indicator loading carried in diffuse runoff or watercourses.

The species for which information was potentially available and which could contribute to faecal indicator levels at South Ford are considered below.

Pinnipeds

The Special Committee on Seals 2013 report indicated that both harbour seals and grey seals are found within the Outer Hebrides (SCOS, 2013). Harbour seal populations have been shown to have recovered significantly since a 35% decrease between 1996 and 2008, with 2,739 harbour seals observed within the Outer Hebrides between 2007 and 2012. No population estimates are available for grey seals, though the Outer Hebrides are known to contain one of two main UK breeding grey seal colonies. Pup production was noted to remain stable, with 12,900 pups recorded in 2010. During the shoreline survey one grey seal was observed to the northwest of the area.

Cetaceans

There are no specific reports of cetaceans such as whales, dolphins or porpoise at areas around South Ford on the main sightings website (Hebridean Whale and Dolphin Trust, 2014). No cetaceans were observed during the shoreline survey.

Seabirds

Seabird data was downloaded from the collated JNCC dataset from the website (JNCC, 2014) in March 2014. The dataset was then manipulated to show the most recent data where repetitions of counts were present. It should be appreciated that the sources of this data are varied, with some recorded as unknown or estimated, whilst some come from reliable detailed surveys such as those carried out for the Seabird 2000 report by Mitchell *et al.*, (2004). Data applicable for the 5 km area around the wild cockle bed are listed in Table 6.1.

Table 6.1 Seabird counts within 5 km of South Ford

Common name	Species name	Count*	Method	Accuracy
Herring Gull	*Larus argentatus*	84	Occupied sites, nests, territory and individuals on land	One estimate, the remaining are accurate
Common Gull	*Larus canus*	130	Occupied nests, sites, territory and individuals on land	One estimate, the remaining are accurate
Great Black-Backed Gull	*Larus marinus*	8	Occupied territory and nests	Accurate
Black-Headed Gull	*Chroicocephalus ridibundus*	44	Occupied nests and sites	Accurate
Fulmar	*Fulmarus glacialis*	562	Occupied sites	Unknown
Arctic Tern	*Sterna paradisaea*	24	Occupied territory and individuals on land	Accurate
Common Tern	*Sterna hirundo*	36	Occupied nests, territory and individuals on land	Accurate
'Comic' tern	*Unidentified tern species*	10	Individuals on land	Accurate

*The counts have been adjusted where the method used was occupied nests/sites/territory to reflect the probable number of individual birds (i.e. counts of nests were doubled).

The areas around the wild cockle bed contain a large number of occupied fulmar sites. This included a significantly sized site to the eastern of the cockle bed, around the small group of islands Eileanan Stafa. The main breeding season for fulmars is May to October. Other species in the area include gulls with common gulls most common in the area, and terns.

Birds were the main wildlife observed during the shoreline survey. Oystercatchers were the most commonly observed, with approximately 105 individuals seen during the survey. Common gulls, a heron and tawny owls were also observed.

Otters

The Outer Hebrides are known to support a large population of the Eurasian otter (*Lutra lutra*) (Outer Hebrides Tourism Industry Association, 2014). Although there are no specific reports of otters around the shores of South Ford, there are anecdotal accounts of otters in the area (Davies & MacKinnon, 2014). No otters were observed during the shoreline survey.

Deer

Red deer are known to be present in large numbers within the Outer Hebrides (Visit Scotland, 2014). It is known that red deer usually inhabit hillside moorland during summer months and lowland areas, particularly woodland during winter months. No deer were observed during the shoreline survey.

Overall

The main wildlife species contributing to contamination sources at South Ford wild cockle bed will be seabirds and seals. The largest contamination impact is expected on the northeastern side of the cockle bed during May to October, when fulmars will be nesting in their sites at Eileanan Stafa.

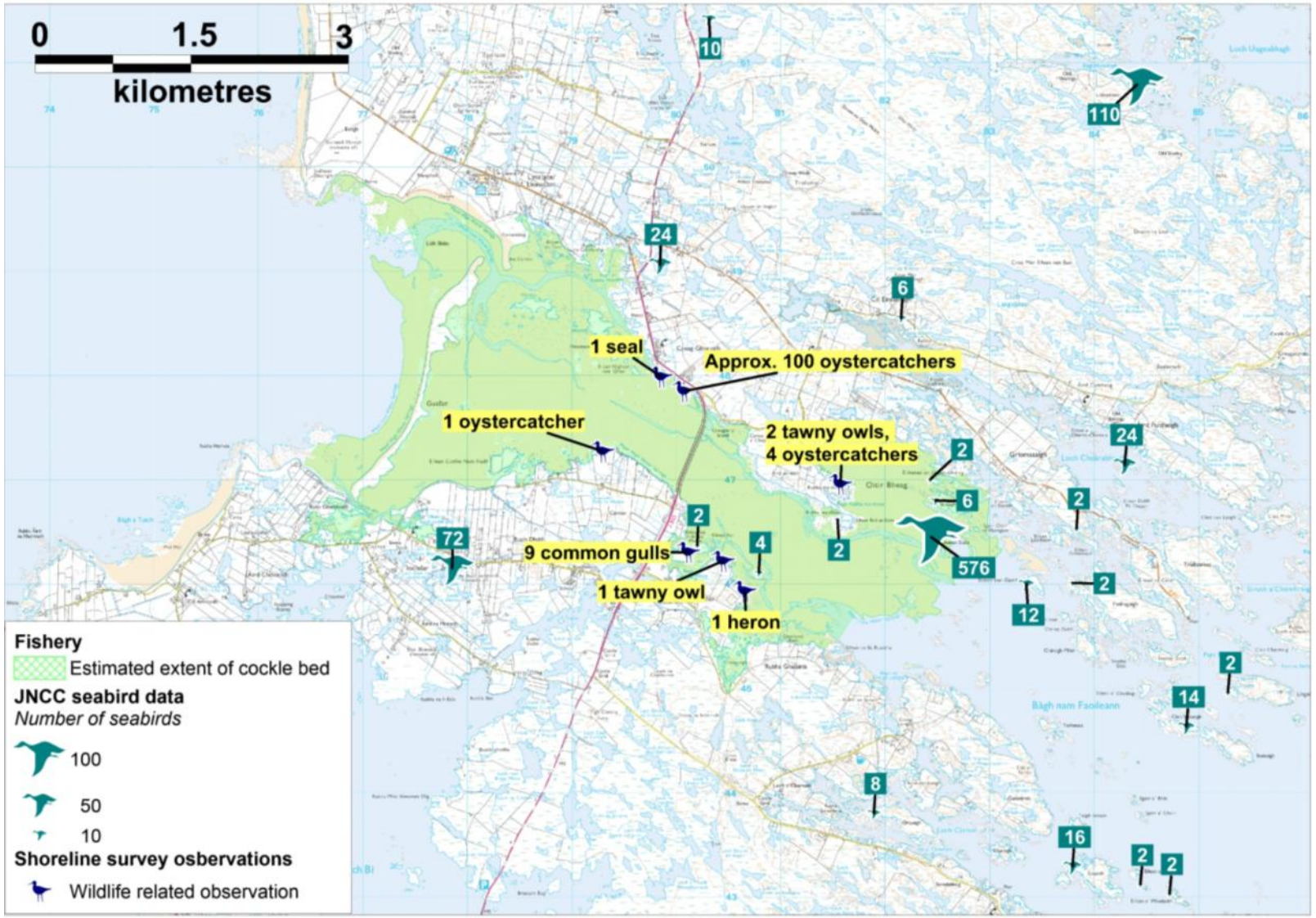


Figure 6.1 Map of wildlife distributions around South Ford

7. Land Cover

The Land Cover Map 2007 data for the area is shown in Figure 7.1. The predominant land cover types adjacent to the shellfish bed are rough grassland, improved grassland, bog and dwarf shrub heath. There are also scattered areas of coniferous woodland. The shellfish bed is categorised as littoral or supra-littoral sediment.

Five small built-up areas are represented in the data, one of which appears to correspond with the school at Lionacleit. The others, however, appear to be classified in error as they do not appear to correspond with any built up areas in satellite imagery. A large part of the land to the southwest of the ford has also been classified as supralittoral and sublittoral sediment, although much of the area lies above sea level appears to be covered in vegetation. Therefore, caution must be exercised is assessing the land cover based solely on this information. During the shoreline survey, it was observed that almost all of the land surveyed was used for rough grazing.

Faecal indicator organism export coefficients for faecal coliform bacteria have been found to be approximately 1.2 – 2.8x10^{9} cfu km^{-2} hr^{-1} for urban catchment areas, approximately 8.3x10^{8} cfu km^{-2} hr^{-1} for areas of improved grassland and approximately 2.5x10^{8} cfu km^{-2} hr^{-1} for rough grazing (Kay, et al., 2008a). The contributions from all land cover types would be expected to increase significantly after rainfall events, however this effect would be particularly marked from improved grassland areas (roughly 1000-fold) (Kay, et al., 2008a).

The potential contribution of contaminated run-off to the shellfish bed is likely to be moderate due to areas of improved grassland close to the shoreline and large areas of rough grassland.. Contributions would be greatest near to shore over the cockle bed to the west of the causeway. Contamination would be expected to increase after rainfall events.

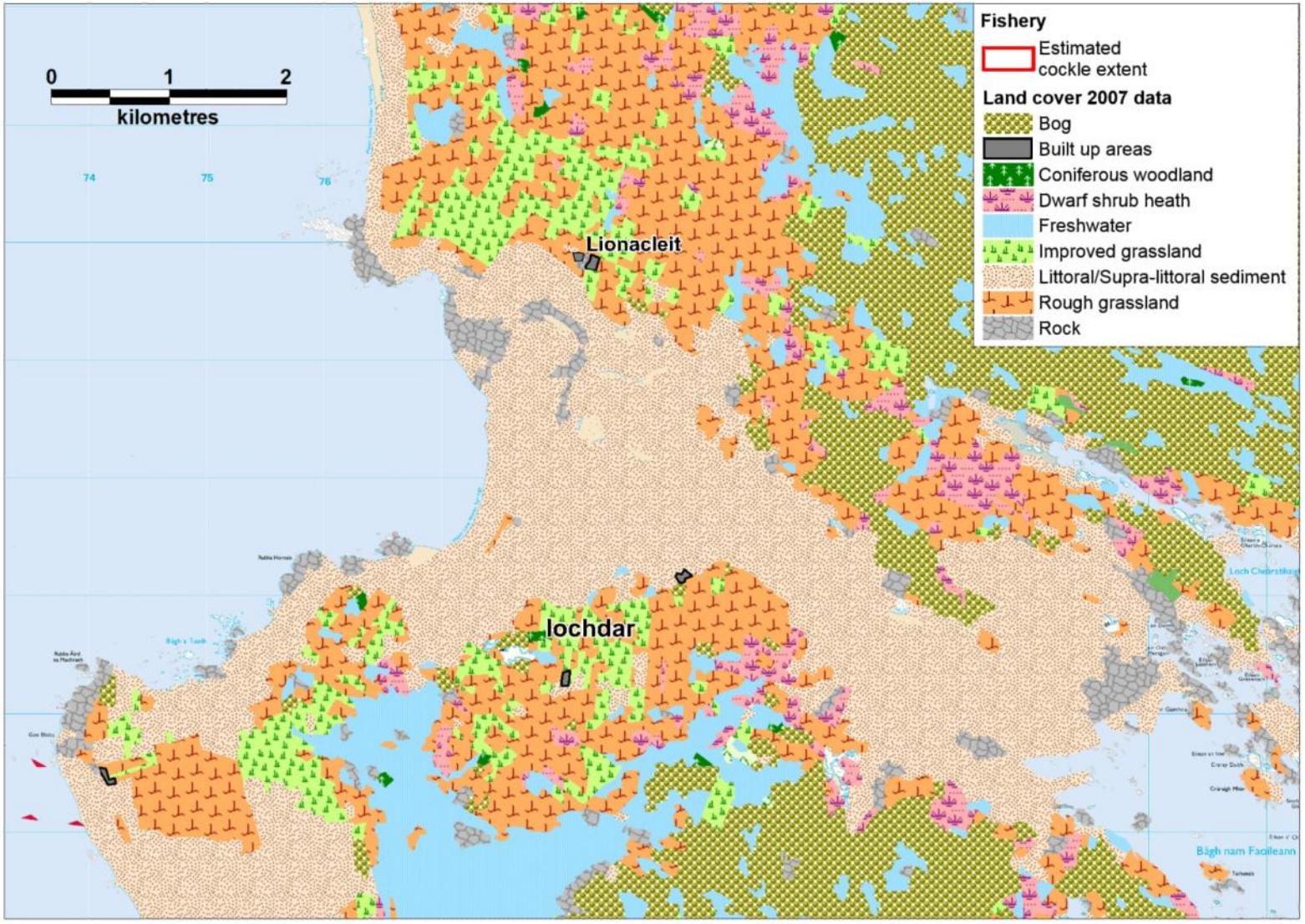


Figure 7.1 LCM2007 land cover data for the area around South Ford

8. Watercourses

There are no gauging stations on watercourses entering South Ford. Spot measurements of flow and microbial content were obtained during the shoreline survey conducted on the 27th - 29th July 2014. Dry and exceptionally warm weather was recorded in the 48 hrs prior to the survey. The watercourses and drainage listed in Table 8.1 are those recorded during the shoreline survey. The locations and loadings of measured watercourses are shown in Figure 8.1.

Table 8.1 Watercourses entering South Ford

No.	Eastings	Northings	Description	Width (m)	Depth (m)	Flow (m^3/d)	Loading (*E. coli* per day)
1	78561	849547	Watercourse	Not measured or sampled			
2	79431	849314	Watercourse	0.22	0.85	30500	1.5×10^{10}
3	80623	847530	Drainage	NA	NA	17*	9×10^{6}
4	81738	847526	Drainage	0.60	0.10	809	8.1×10^{7}
5	80510	844970	Drainage	Not measured or sampled			
6	80267	845449	Drainage	0.49	0.14	2560	5.1×10^{8}
7	80245	845658	Watercourse	0.26[1] 0.13[2]	0.14[1] 0.10[2]	1360[1] 210[2]	1.6×10^{8}
8	79944	845993	Drainage	1.8	0.14	7210	$<7.2 \times 10^{8}$**

*Flow rate recorded using a jug [1] Branch 1 [2] Branch 2 (The watercourse had two branches. Loadings for each branch were estimated separately and then combined to give the overall loading.)
** Where *E. coli* values were less than the limit of detection, that value was used to estimate the upper limit for the loading.

At the time of the shoreline survey there were only three substantial flowing watercourses recorded by the survey team. Watercourse no.1 located south of Linaclate was noted to be a watercourse draining from the Oban Lionacleit loch and adjacent to a public outfall: it was not sampled or measured by the survey team. The highest estimated loading (1.5×10^{10} *E. coli*/day) was associated with a watercourse (No. 2) located approximately one kilometre to the east of Linaclate. Two other watercourses (Nos. 3 and 4) were observed along the northern shore to the east of the causeway. These both had low estimated loadings. A cluster of watercourses (Nos. 5 to 8) with undetermined or low estimated loadings were observed on the southern shore to the east of the causeway. The combined loading from these would be moderate.

Overall, freshwater inputs are expected to provide low to moderate levels of contamination to the shellfish bed in South Ford, with the highest impact expected on the northern shore around Lionacleit and on the southern shore to the east of the causeway. Contamination would be expected to increase after rainfall.

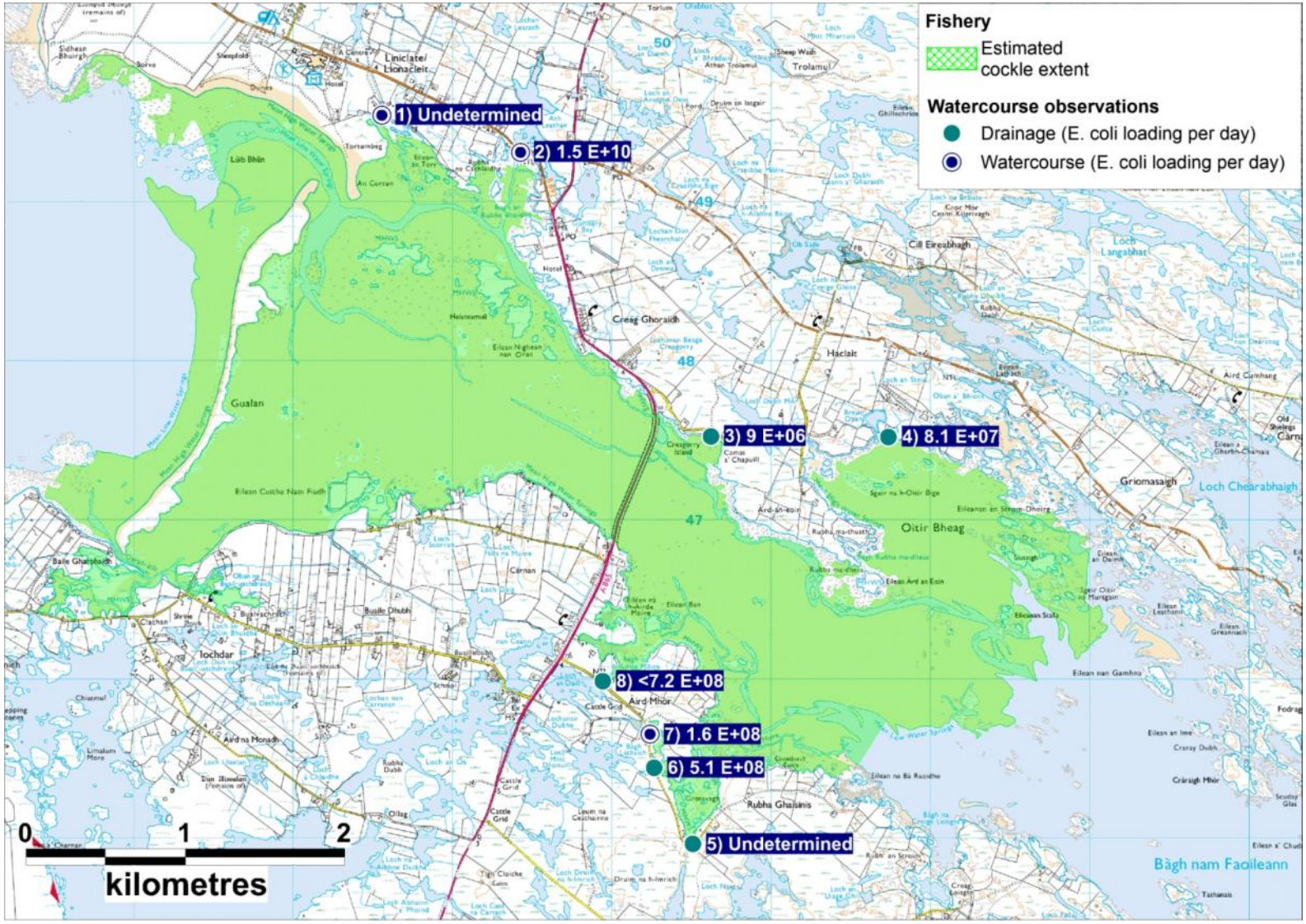


Figure 8.1 Map of watercourse loadings at South Ford

9. Meteorological Data

The nearest weather station for which a nearly complete rainfall data set was available is located at South Uist Range, situated approximately 40 km south west of the production area. Rainfall data was available for January 2008 – December 2013. Values for 01-29/02/2008, 13-14/09/2008 and 04/11/2008 were either not recorded or were accumulated values so have been omitted from this assessment. The nearest wind station is also situated at South Uist Range. Conditions may differ between this station and the fisheries due to the distances between them. However, this data is still shown as it can be useful in identifying seasonal variation in wind patterns.

Data for these stations was purchased from the Meteorological Office. Unless otherwise identified, the content of this section (e.g. graphs) is based on further analysis of this data undertaken by Cefas. This section aims to describe the local rain and wind patterns in the context of the bacterial quality of shellfish at South Ford.

9.1 Rainfall

High rainfall and storm events are commonly associated with increased faecal contamination of coastal waters through surface water run-off from land where livestock or other animals are present, and through sewer and waste water treatment plant overflows (Mallin, et al., 2001; Lee & Morgan, 2003). The box and whisker plots in Figures 9.1 and 9.2, present a summary of the distribution of individual daily rainfall values by year and by month. The grey box represents the middle 50% of the observations, with the median at the midline. The whiskers extend to the largest or smallest observations up to 1.5 times the box height above or below the box. Individual observations falling outside the box and whiskers are represented by the symbol *.

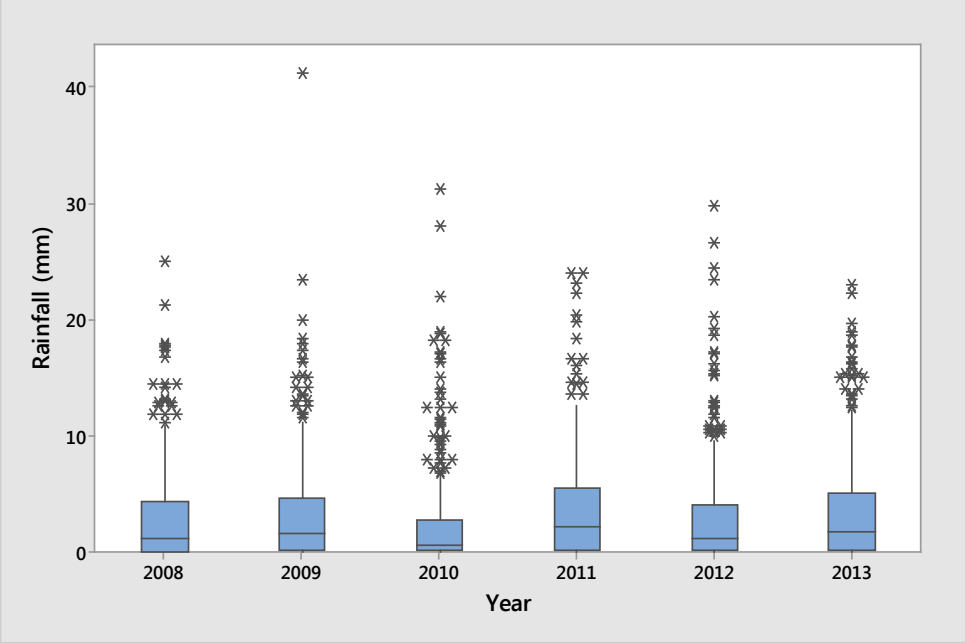


Figure 9.1 Box plot of daily rainfall values by year at South Uist Range (2008 – 2013)

Daily rainfall values varied from year to year, with 2010 being the driest year (915 mm). The wettest year was 2011 (1343 mm). High rainfall values exceeding 30 mm/d occurred in 2009, 2010 and 2012 with one day exceeding 40 mm/d occurring in 2009.

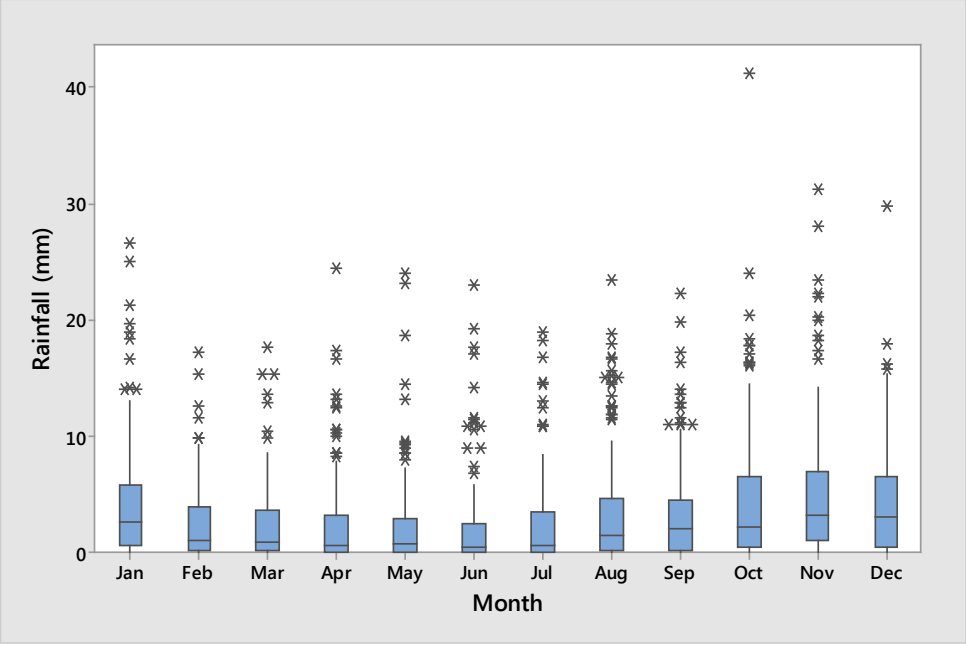


Figure 9.2 Box plot of daily rainfall values by month at South Uist Range (2008 – 2013)

Daily rainfall values were higher during the autumn and winter. Rainfall was highest in November (855 mm) and lowest in June (351 mm). Rainfall values exceeding 30 mm/d were observed in October, November and December with the event in October exceeding 40 mm/d. It should be noted that data was missing for February 2008. This will reduce the respective annual and monthly rainfall totals.

For the period considered here (2008 – 2013) 44 % of days received daily rainfall of less than 1 mm and 8 % of days received daily rainfall of over 10 mm.

It is therefore expected that run-off due to rainfall will be higher during the autumn and winter months. However, extreme rainfall events leading to episodes of high runoff can occur in most months and when these occur during generally drier periods in late spring and summer, they are likely to carry higher loadings of faecal material that has accumulated on pastures when greater numbers of livestock were present.

9.2 Wind

Wind data was collected from South Uist: Range and summarised in seasonal wind roses in Figure 9.3 and annually in Figure 9.4.

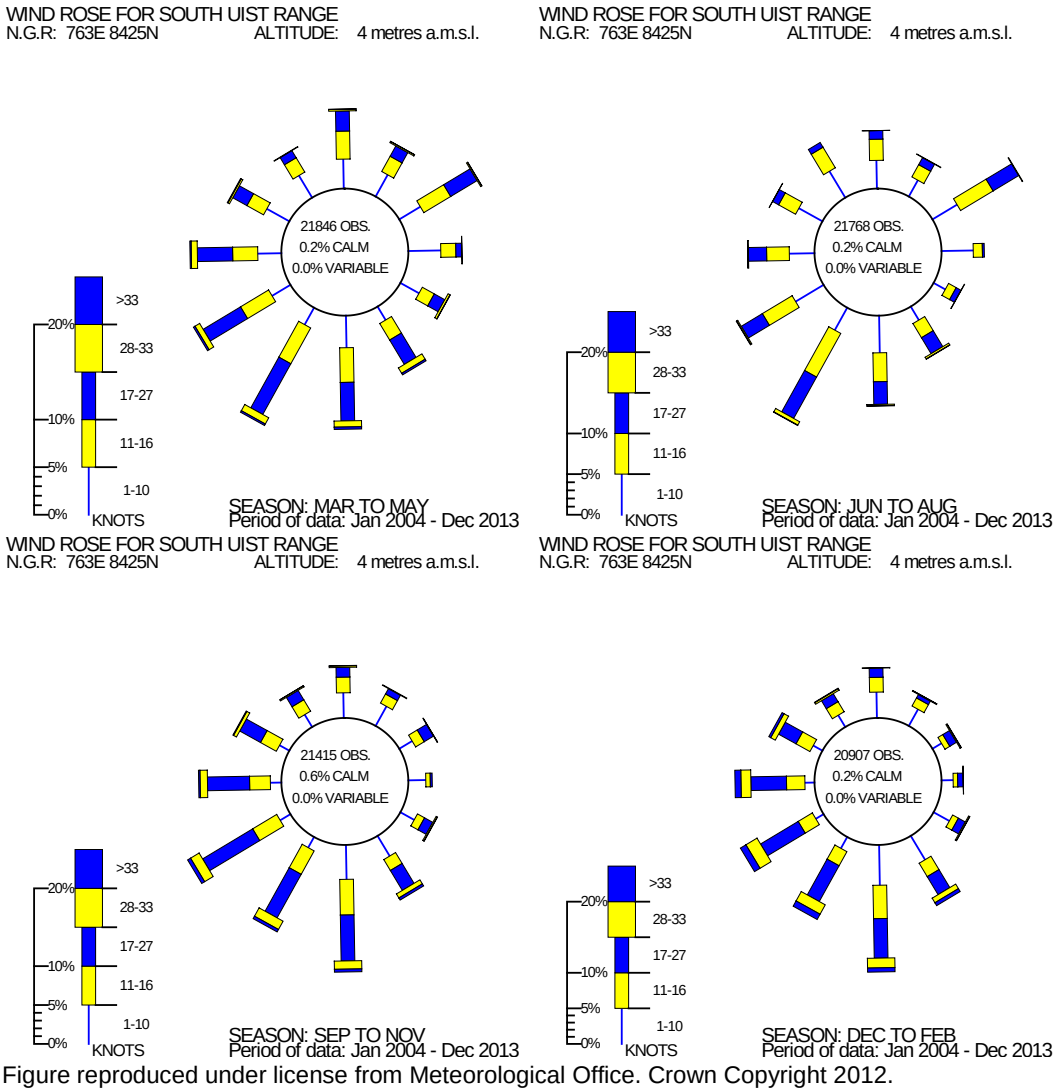


Figure 9.3 Seasonal wind roses for South Uist: Range

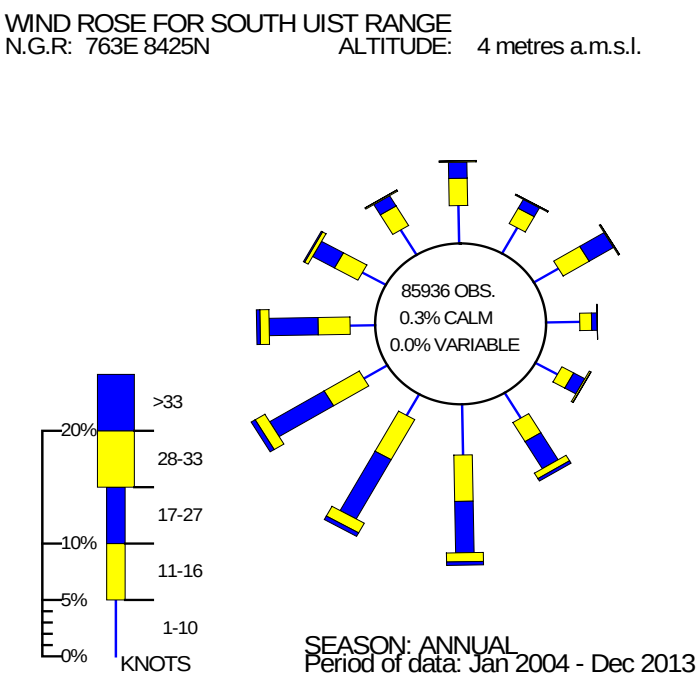


Figure 9.4 Annual wind rose for South Uist: Range

Overall, the strongest winds tended to come from the southwest quarter. Seasonally the strongest winds occurred during the autumn and winter. Typically, the wind came from around the south and the west throughout the year but the spring and summer also see winds coming from east-northeast.

Wind is an important factor in the spread of contamination as it has the ability to drive surface water at about (3%) of the wind speed (Brown, 1991) so a gale force wind (34 knots or 17.2 m/s) would drive a surface water current of about 1 knot or 0.5 m/s. Therefore, strong winds can significantly alter the pattern of surface currents. Strong winds also have the potential to affect tide height depending on wind direction and local hydrodynamics of the site. A strong wind combined with a spring tide may result in higher than usual tides, which will carry any accumulated faecal matter at and above the normal high water mark into the production area.

10. Classification Information

South Ford is classified for production of common cockles (*Cerastoderma edule*). The classification history since 2006 is listed in Table 10.1 below. It was declassified for a year in 2007-2008.

Table 10.1 South Ford: (common cockle) classification history

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2006	A	A	A	A	A	A	A	A	A	A	A	A
2007	A	A	A									
2008				A	A	A	A	B	B	B	B	B
2009	A	A	A	A	A	A	A	A	A	A	A	A
2010	A	A	A	A	A	A	A	A	A	A	A	A
2011	A	A	A	A	A	A	A	A	A	A	A	A
2012	A	A	A	A	A	A	A	A	A	A	A	A
2013	A	A	A	A	A	A	A	A	A	A	A	A
2014	A	A	A	A	A	A	A	A	A	A	A	A
2015	A	A	A									

The area has been given a year round A classification since 2009. It was declassified for a 12 months in 2007-2008.

11. Historical *E. coli* Data

11.1 Validation of historical data

Results for all samples assigned against South Ford production area for the period 01/01/2009 to the 28/10/2014 were extracted from the FSAS database and validated according to the criteria described in the standard protocol for validation of historical *E. coli* data. The data was on 28/10/2014. All *E. coli* results were reported as most probable number (MPN) per 100 g of shellfish flesh and intravalvular fluid.

Nine sample results reported as <18 or <20 were reassigned a value of 10 *E. coli* MPN/100 g for the purposes of statistical evaluation and graphical representation.

Two samples were stated as rejected and were omitted from the dataset for this report. The reported location for one sample lay 41 km southwest of the production area and was also omitted from this dataset. The remaining 67 samples were received at the laboratory within 48 hours since collection and had box temperatures of ≤8^{o}C.

11.2 Summary of microbiological results

Sampling and results summaries for results at South Ford between 2009 and 2014 are listed in Table 11.1.

Table 11.1 Summary of historical sampling and results

Sampling Summary	
Production area	South Ford
Site	South Ford
Species	Common cockles
SIN	UB-259-162-04
Location	Various
Total no of samples	67
No. 2009	12
No. 2010	10
No. 2011	12
No. 2012	10
No. 2013	12
No. 2014	11
Results Summary	
Minimum	<18
Maximum	3500
Median	70
Geometric mean	60
90 percentile	246
95 percentile	670
No. exceeding 230/100g	6 (9%)
No. exceeding 1000/100g	2 (3%)
No. exceeding 4600/100g	0
No. exceeding 18000/100g	0

Sampling frequency has been even across years. Two samples yielded results >1000 *E. coli* MPN/100 g.

11.3 Overall geographical pattern of results

The geographical locations of all 67 samples assigned to South Ford are shown in Figure 11.1 with the symbol size proportional to the *E. coli* result. Thirty-two samples were reported to have been taken at the current RMP location of NF 8050 4655 and all 67 samples plot within 500 m of the RMP. The highest result (3500 *E. coli* MPN/100 g) was from a sample reported to have been taken at the RMP.

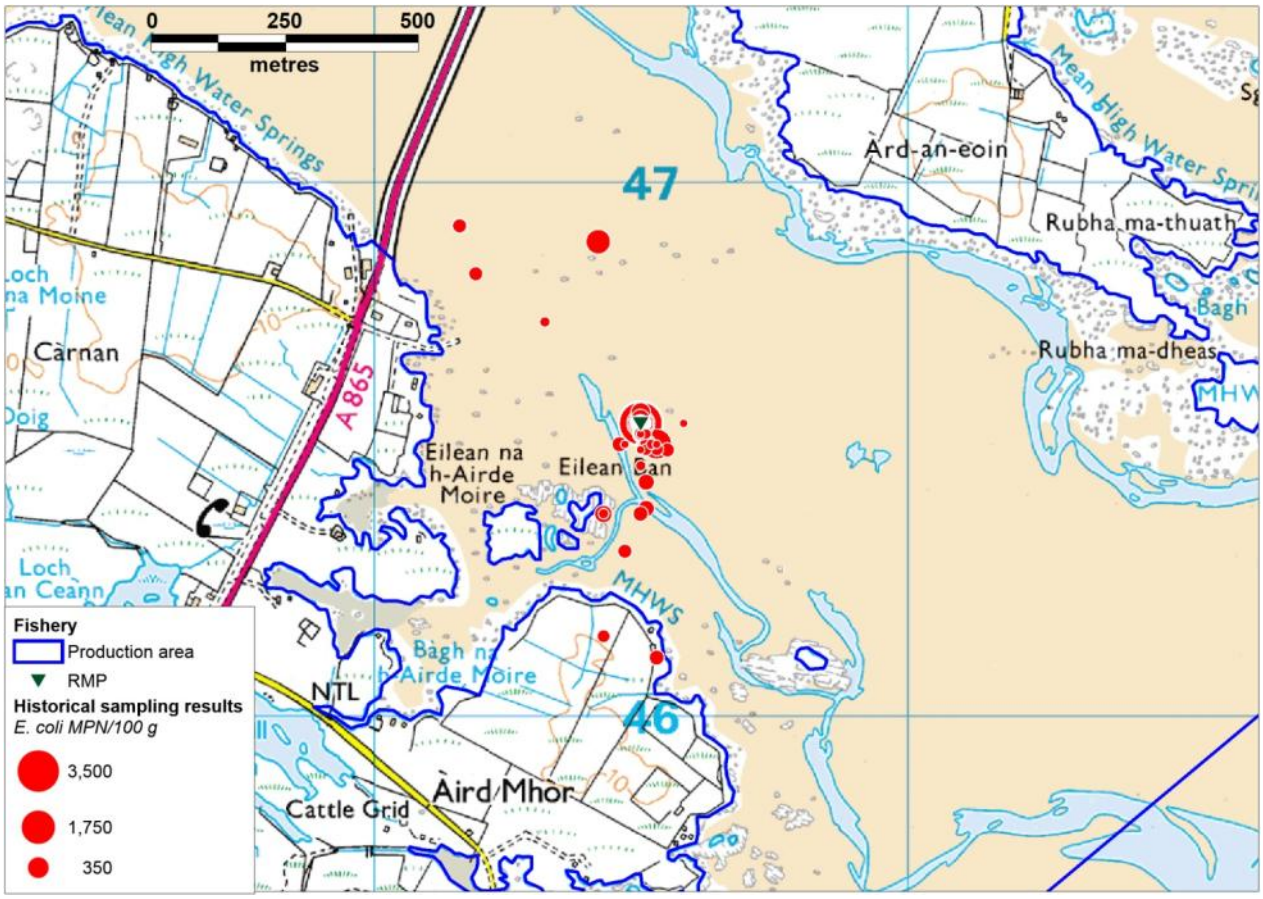


Figure 11.1 Map of reported sampling locations for common cockles at South Ford

11.4 Overall temporal pattern of results

A scatterplot of *E. coli* results against date for South Ford is presented in Figure 11.2. The dataset is fitted with a lowess trend line. Lowess trendlines allow for locally weighted regression scatter plot smoothing. At each point in the dataset an estimated value is fitted to a subset of the data, using weighted least squares. The approach gives more weight to points near to the x-value where the estimate is being made and less weight to points further away. In terms of the monitoring data, this means that any point on the lowess line is influenced more by the data close to it (in time) and less by the data further away. A trend line helps to highlight any apparent underlying trends or cycles.

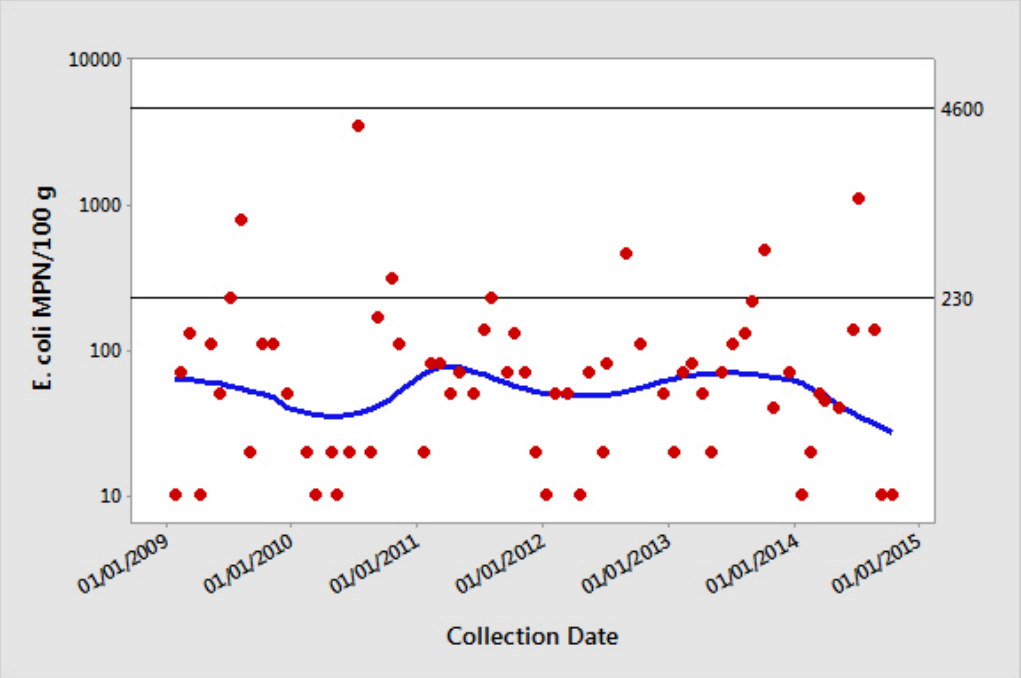


Figure 11.2 Scatterplot of *E. coli* results by collection date at South Ford, fitted with a lowess line

Shellfish *E. coli* levels have stayed approximately the same over time.

11.5 Seasonal pattern of results

Season dictates not only weather patterns and water temperature, but livestock numbers and movements, presence of wild animals and patterns in human distribution. All of these can affect levels of microbial contamination, causing seasonal patterns in results. A scatterplot of *E. coli* results by month, overlaid by a lowess line to highlight trends for South Ford is displayed in Figure 11.3. Jittering was applied to points at 0.02 (x-axis) and 0.001 (y-axis) respectively.

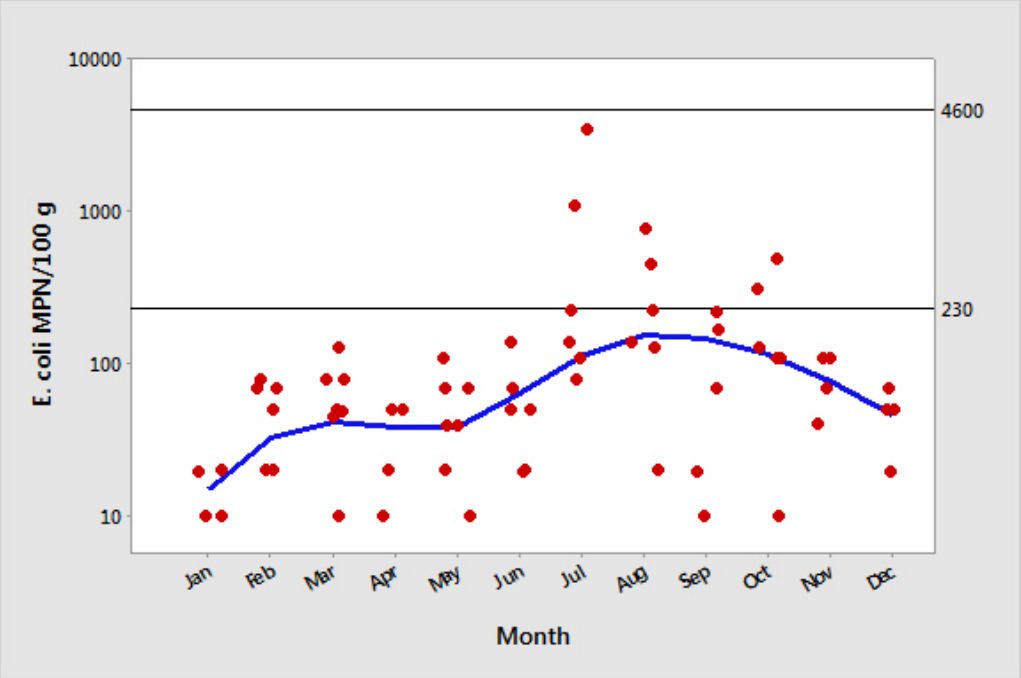


Figure 11.3 Scatterplot of *E. coli* results by month at South Ford, fitted with a lowess line

E. coli levels were lowest in January and highest between July and October. The two highest results were from samples taken in July.

For statistical evaluation, seasons were split into spring (March-May), summer (June-August), autumn (September-November) and winter (December-February). A boxplot of *E. coli* results by season for South Ford is presented in Figure 11.4.

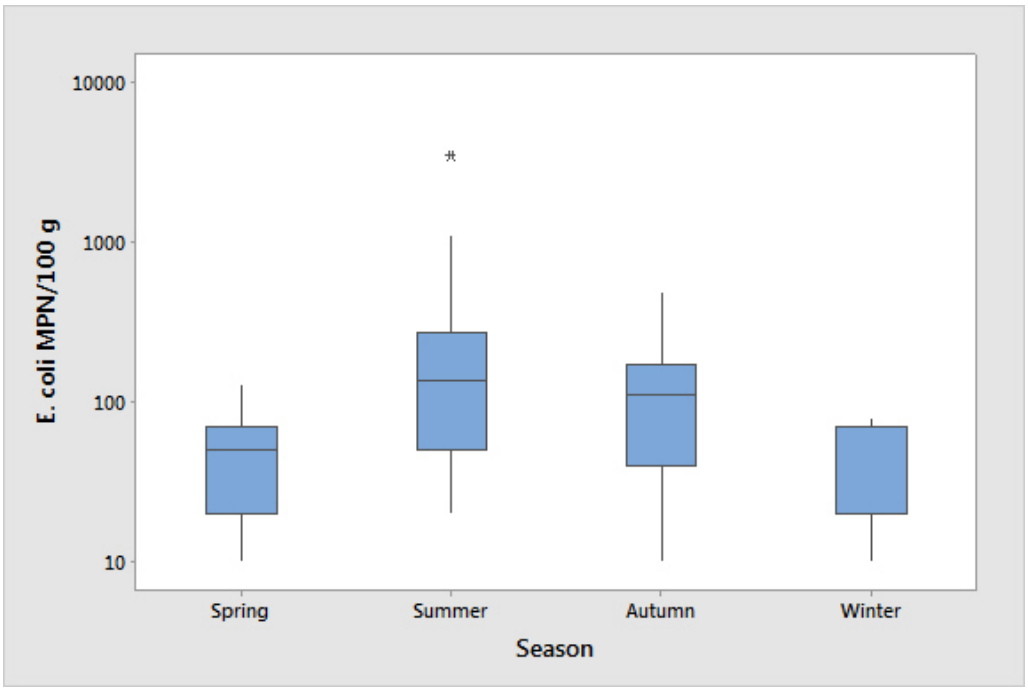


Figure 11.4 Boxplot of *E. coli* results by season at South Ford

A very highly significant difference was found between *E. coli* results for South Ford by season (one-way ANOVA, p = 0.000) (Appendix 4). Average *E. coli* levels in summer were significantly higher than those in spring and winter.

11.6 Analysis of results against environmental factors

Environmental factors such as rainfall, tides, wind, sunshine and temperature can all influence the flux of faecal contamination into growing waters (Mallin, et al., 2001; Lee & Morgan, 2003). The effects of these influences can be complex and difficult to interpret. This section aims to investigate and describe the influence of these factors individually (where appropriate environmental data is available) on the sample results using basic statistical techniques.

11.6.1 Analysis of results by recent rainfall

The nearest weather station with available rainfall data was at South Uist Range approximately 40km southwest of South Ford. Rainfall data was purchased from the Meteorological Office for the period of 01/01/09 - 31/12/2013 (total daily rainfall in mm). Data was extracted from this for all sample results at South Ford between 01/01/2009 - 31/12/2013.

Two-day rainfall

Rainfall data was available for 54 out of the 67 samples. A scatterplot of *E. coli* results against total rainfall recorded on the two days prior to sampling for South Ford is displayed in Figure 11.5. Jittering was applied to points at 0.02 (x-axis) and 0.001 (y-axis) respectively.

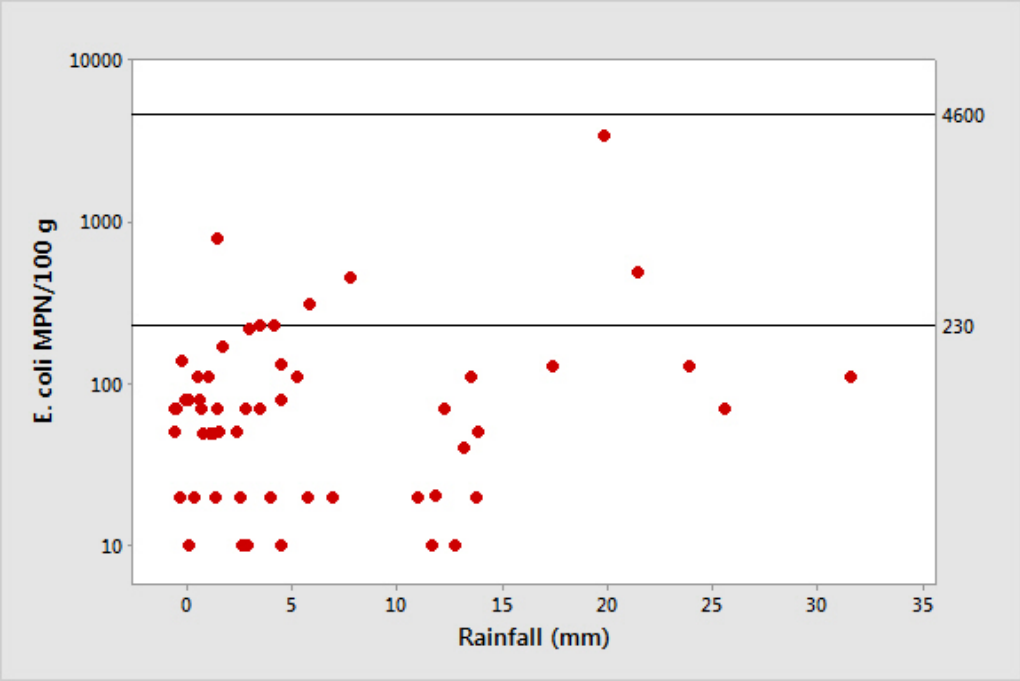


Figure 11.5 Scatterplot of *E. coli* results against rainfall in the previous two days at South Ford

No significant correlation was found between *E. coli* results and the previous two day rainfall (Spearman's rank correlation r = 0.093, p = 0.503). However, no results <70 *E. coli* MPN/100 g were seen following two day rainfall values of >15 mm.

Seven-day rainfall

The effects of heavy rainfall may take differing amounts of time to be reflected in shellfish sample results in different systems. Tthe relationship between rainfall in the previous seven days and sample results was investigated in an identical manner to the above. Rainfall data was available for 51 out of the 67 samples. A scatterplot of *E. coli* results against total rainfall recorded for the seven days prior to sampling at South Ford is shown in Figure 11.6. Jittering was applied to points at 0.02 (x-axis) and 0.001 (y-axis) respectively.

No significant correlation was found between *E. coli* results and the previous seven day rainfall (Spearman's rank correlation r = 0.036, p = 0.803).

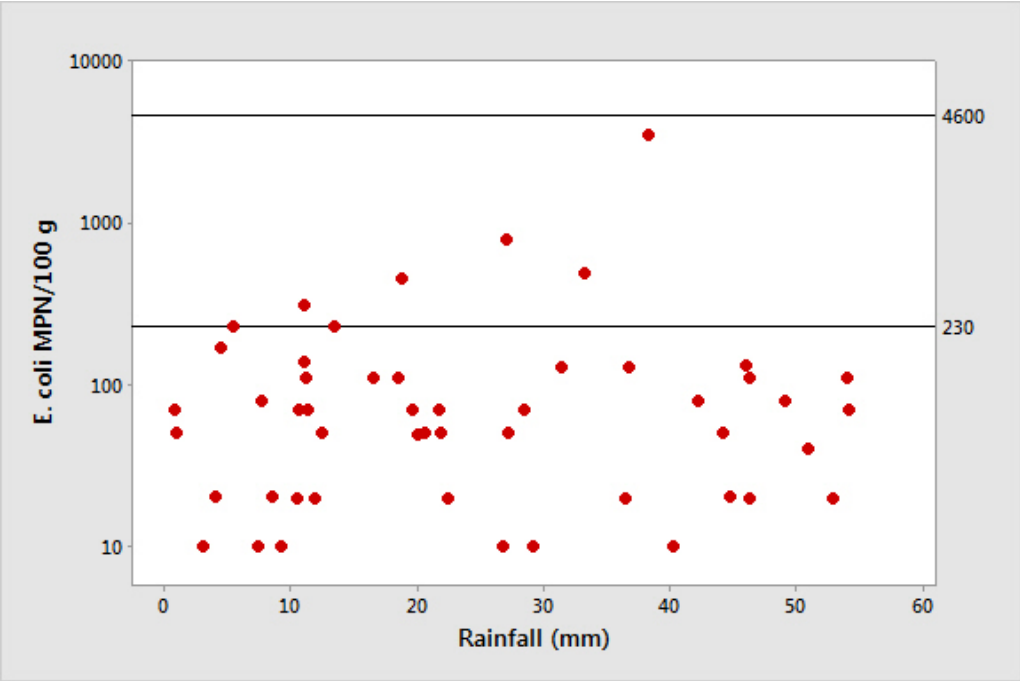


Figure 11.6 Scatterplot of *E. coli* results against rainfall in the previous seven days at South Ford

11.6.2 Analysis of results by tidal height

Spring/neap tidal cycle

Spring tides are large tides that occur fortnightly and are influenced by the state of the lunar cycle. They reach above the mean high water mark, potentially reaching additional contamination on the shoreline, as well as increasing circulation and particle transport distances . The largest (spring) tides occur approximately two days after the full/new moon, at about 45º on a polar plot. The tides then decrease to the smallest (neap) tides, at about 225º, before increasing back to spring tides. A polar

plot of *E. coli* results against the lunar cycle is shown for South Ford in Figure 11.7. It should be noted that local meteorological conditions (e.g. wind strength and direction) can also influence tide height, but are not taken into account in this section.

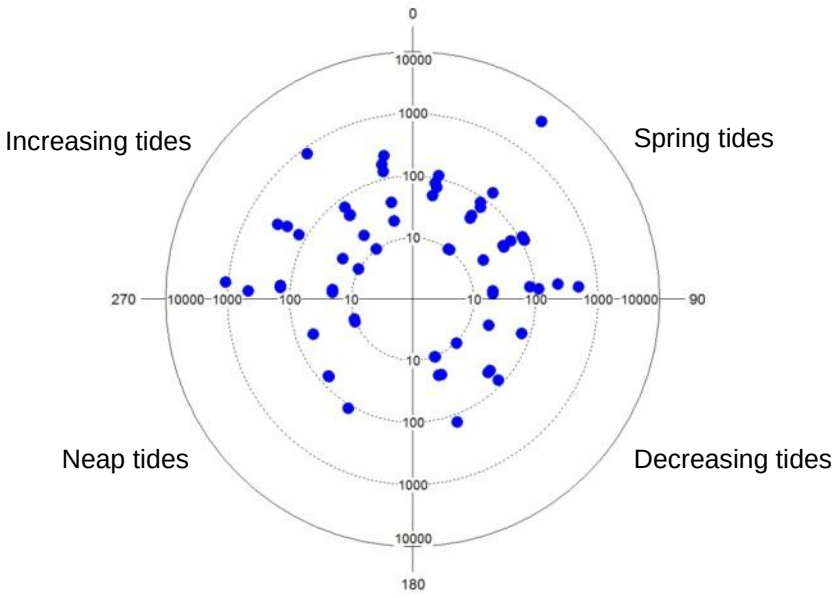


Figure 11.7 Polar plots of *E. coli* results on the spring/neap tidal cycle at South Ford

No significant correlation was found between *E. coli* results and the spring/neap tidal cycle (circular-linear correlation r = 0.208, p = 0.063). The highest results were predominantly taken on increasing and spring tides, however the majority of samples were also taken under these conditions

High/low tidal cycle

Tidal state (high/low tide) changes the direction and strength of water flow around production areas. Depending on the location of contamination sources, tidal state may cause marked changes in water quality near the vicinity of the farms. Shellfish species response time to *E. coli* levels can vary from within an hour to a few hours. High and low water data from Balivanich was extracted from POLTIPS-3 in October 2014. This site was the closest to the production area (approximately 9 km to the southwest) and it is assumed that the tidal state will be similar between sites.

A polar plot of *E. coli* results against the high/low tidal cycle for South Ford is shown in Figure 11.8. High water is located at 0^{o} on the polar plot and low water at 180^{o}.

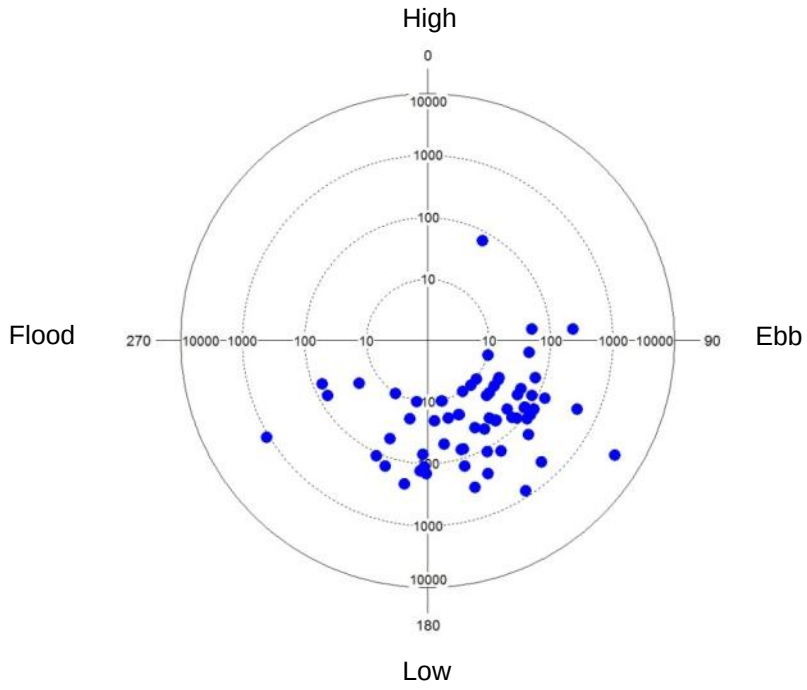


Figure 11.8 Polar plots of *E. coli* results on the high/low tidal cycle at South Ford

No significant correlation was found between *E. coli* results and the high/low tidal cycle (circular-linear correlation r = 0.108, p = 0.477). The majority of samples were reported as having been taken on ebb and low tides. This is to be expected given the intertidal nature of the fishery.

11.6.3 Analysis of results by water temperature

Water temperature can affect survival time of bacteria in seawater (Burkhardt, et al., 2000). It can also affect the feeding and elimination rates in shellfish and therefore may be an important predictor of *E. coli* levels in shellfish flesh. Water temperature is obviously closely related to season. Any correlation between temperatures and *E. coli* levels in shellfish flesh may therefore not be directly attributable to temperature, but to the other factors e.g. seasonal differences in livestock grazing patterns. A scatterplot of *E. coli* results against water temperature for South Ford is shown in Figure 11.9. Water temperature was recorded for 44 out of the 67 South Ford samples. Jittering was applied to points at 0.02 (x-axis) and 0.001 (y-axis) respectively.

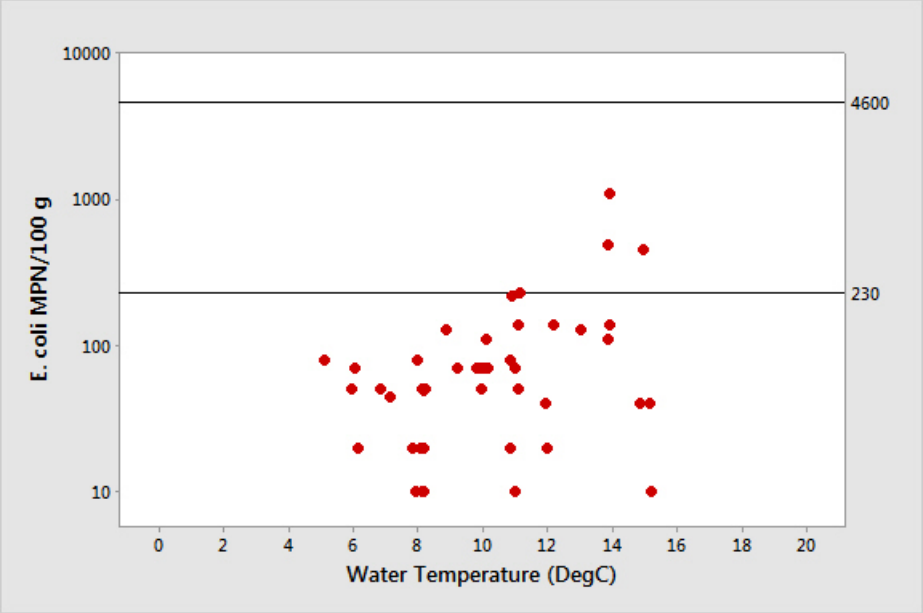


Figure 11.9 Scatterplot of *E. coli* results against water temperature at South Ford

A statistically significant correlation was found between *E. coli* results and water temperature (Spearman's rank correlation r = 0.324, p = 0.032), with the highest sample results associated with water temperatures 14 - 15^{o}C.

11.6.4 Analysis of results by salinity

Salinity will give a direct measure of freshwater influence and hence freshwater borne contamination at a site. A scatterplot of *E. coli* results against salinity for South Ford are shown in Figure 11.10. Salinity was recorded for 35 out of the 67 of the South Ford samples and jittering of results was applied at 0.02 (x-axis) and 0.001 (y-axis) respectively.

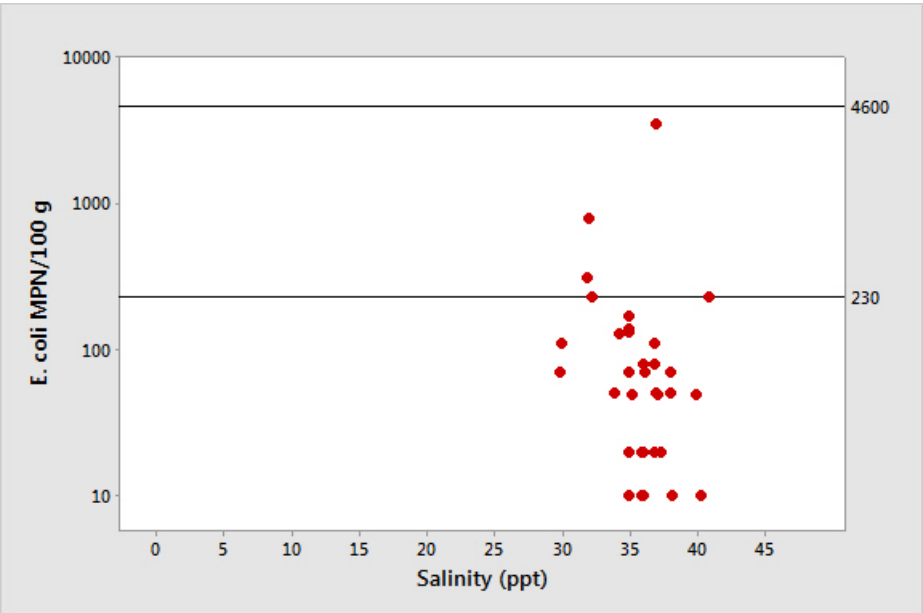


Figure 11.10 Scatterplot of *E. coli* results against salinity at South Ford

No statistically significant correlation was found between common cockle *E. coli* results and salinity (Spearman's rank correlation r = -0.314, p = 0.066). Reported salinity values ranged up to 40 ppt: maximum salinity of full strength seawater around the UK is usually approximately 35 ppt.

11.7 Evaluation of results over 1000 *E. coli* MPN/100 g

In the results from South Ford, two common cockles samples had results >1000 *E. coli* MPN/100 g and are listed below in Table 11.2.

Table 11.2 South Ford historic *E. coli* sampling results over 1000 *E. coli* MPN/100 g

Collection Date	*E. coli* (MPN/100g)	Location	2 day rainfall (mm)	7 day rainfall (mm)	Water Temp (°C)	Salinity (ppt)	Tidal state (spring/neap)	Tidal State (high/low)
12/07/2010	3500	NF 8050 4655	20.2	37.4	-	37	Spring	Ebb
08/07/2014	1100	NF 8053 4651	-	-	14	-	Increasing	Low

-No data available

The two highest results were both associated with samples taken in July. Sampling locations varied; the highest result was from a sample taken at the RMP, whilst the other elevated results was from a sample taken 50 m southeast of the RMP.

Previous two and seven day rainfall was only available for the sample with the highest result and appeared to be relatively high at 20.2 and 37.4 mm respectively. Salinity was similarly only available for this sample and was above normal seawater salinity at 37 ppt. Water temperature was only stated for the other sample and was at 14°C. Tidal states regarding high water indicated both samples were taken on ebb/low tidal states as expected from a fishery on an intertidal area. Tidal states regarding spring tides, indicated spring and increasing tides were used.

11.8 Summary and conclusions

Regular sampling has taken place at South Ford, with a large proportion of samples reported as having been taken at the RMP. As the fishery is a wild cockle bed, stock is unlikely to have always been present at the RMP. The highest result was from a sample reported to have been taken at this location. No conclusions could be made as to potential spatial variation in *E. coli* results.

Sample results have generally been low, with only six results >230 *E. coli* MPN/100g. The highest result was 3500 *E. coli*. *E. coli* levels have stayed approximately constant over time. Seasonally, results tend to be highest between July and October and average *E. coli* levels in summer were significantly greater than those in spring and winter.

No statistically significant correlation was found between results and previous two day or results and previous seven day rainfall or between results and salinity. A statistically significant correlation was found between results and water temperature, with results >230 *E. coli* MPN/100 g from samples taken at water temperatures between 14 and 15^{o}C.

No statistically significant correlation was found between results and spring/neap or high/low tidal state.

12. Designated Waters Data

Shellfish Water Protected Areas

There are no designated shellfish water protected areas in or nearby to South Ford.

Bathing Waters

There are no designated bathing waters within South Ford.

13. Bathymetry and Hydrodynamics

13.1 Introduction

13.1.1 The Study Area

The South Ford assessment area is situated in the Outer Hebrides area of Scotland, between the islands of Benbecula and South Uist. The landscape around the assessment area is relatively flat, and is characterised by numerous small freshwater lochs. Many small streams flow into the assessment area from these lochs. The assessment area comprises the tidally submerged area between Benbecula and North Uist, and contains numerous islands and tidally exposed rocks. A map of the assessment area can be found in Figure 13.1.

The assessment area is split by the A865 road causeway. To the west of the causeway the assessment area extends to Rubha Hornais in the south and Sidhean Bhuirgh in the north. West of the causeway lies a large area of intertidal sand, Bàgh nam Faoileann, bounded by the narrow, long island, Gualan. Only a small gap exists between Gualan and Benbecula in the north, approximately 245 m wide. The gap between the southernmost point of Gualan and South Uist is even smaller, at approximately 30 m wide. This island acts as a barrier island to the western part of the South Ford assessment area and restricts wave energy and erosion within the area (Comhairle nan Eilean Siar, 2012).

To the east of the causeway there is also a substantial intertidal area, and waters beyond this area to the east are characterised by many small islands and tidally exposed rocks. The eastern portion of the assessment area includes Loch Càrnan, and extends from Reagam, in the north, to the westernmost tip of Caltinish in the south, adjacent to Loch Sheileabhaig.

The assessment area extends 4.2 km to the west-northwest of the causeway and 7.3 km to the south-east of the causeway. The causeway is located at the narrowest part of the assessment area, at 725 m, while the assessment area widens in both directions toward the western and eastern boundaries.

The causeway has a single aperture to allow water flow between the eastern and western sides of the assessment area.

Coordinates for South Ford (coordinates for the road causeway):

57.401573°N 007.327986°W
OS GB36 801113 847128

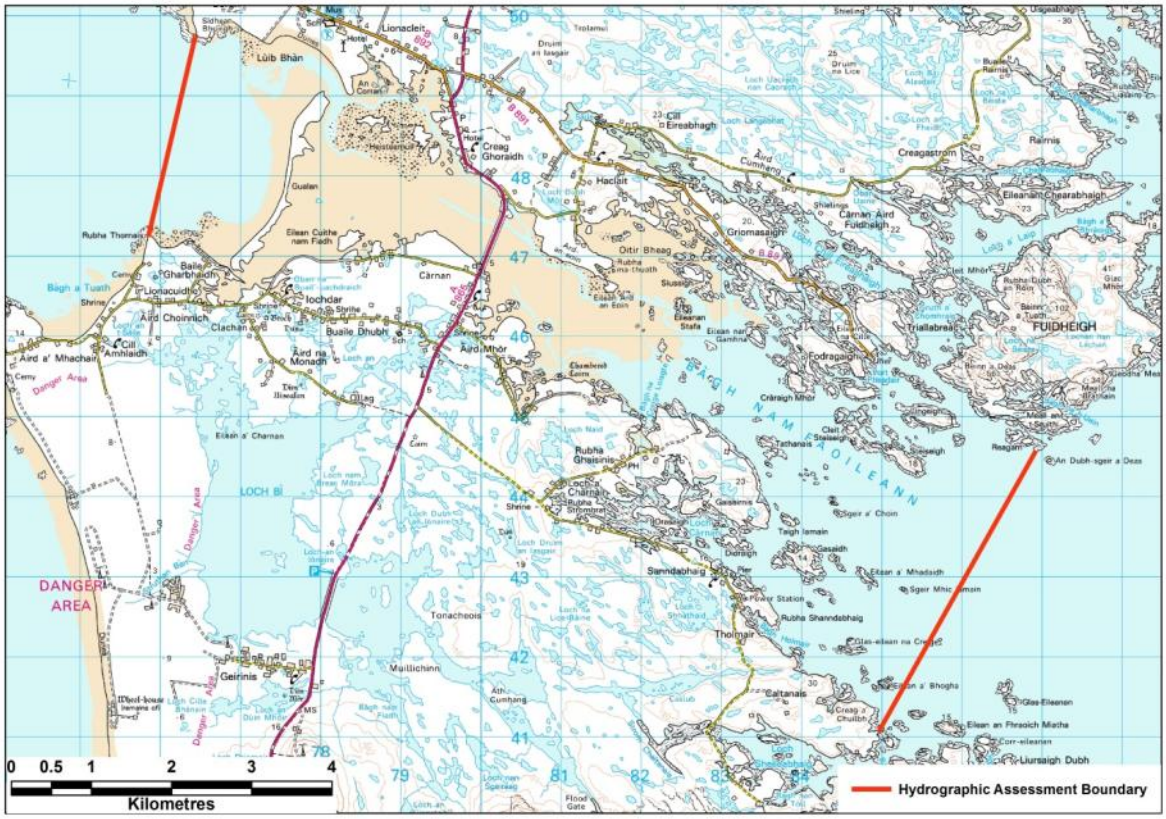


Figure 13.1 Extent of the hydrographic study area

13.2 Bathymetry and Hydrodynamics

13.2.1 Bathymetry

Figure 13.2 shows the bathymetry of the assessment area to the east of the causeway. The extensive intertidal area adjacent to the causeway covers 4.5 km^2 to the east of the causeway. There are no sills in the east of the assessment area, which instead gradually deepens in a south-easterly direction, towards the Minch. A narrow, deep channel extends from the northwest to southeast of the assessment area, reaching a maximum depth of 41 m. The remainder of the assessment area to the east of the causeway is approximately 5 m in depth, and is punctuated by many islands and tidally exposed rocks.

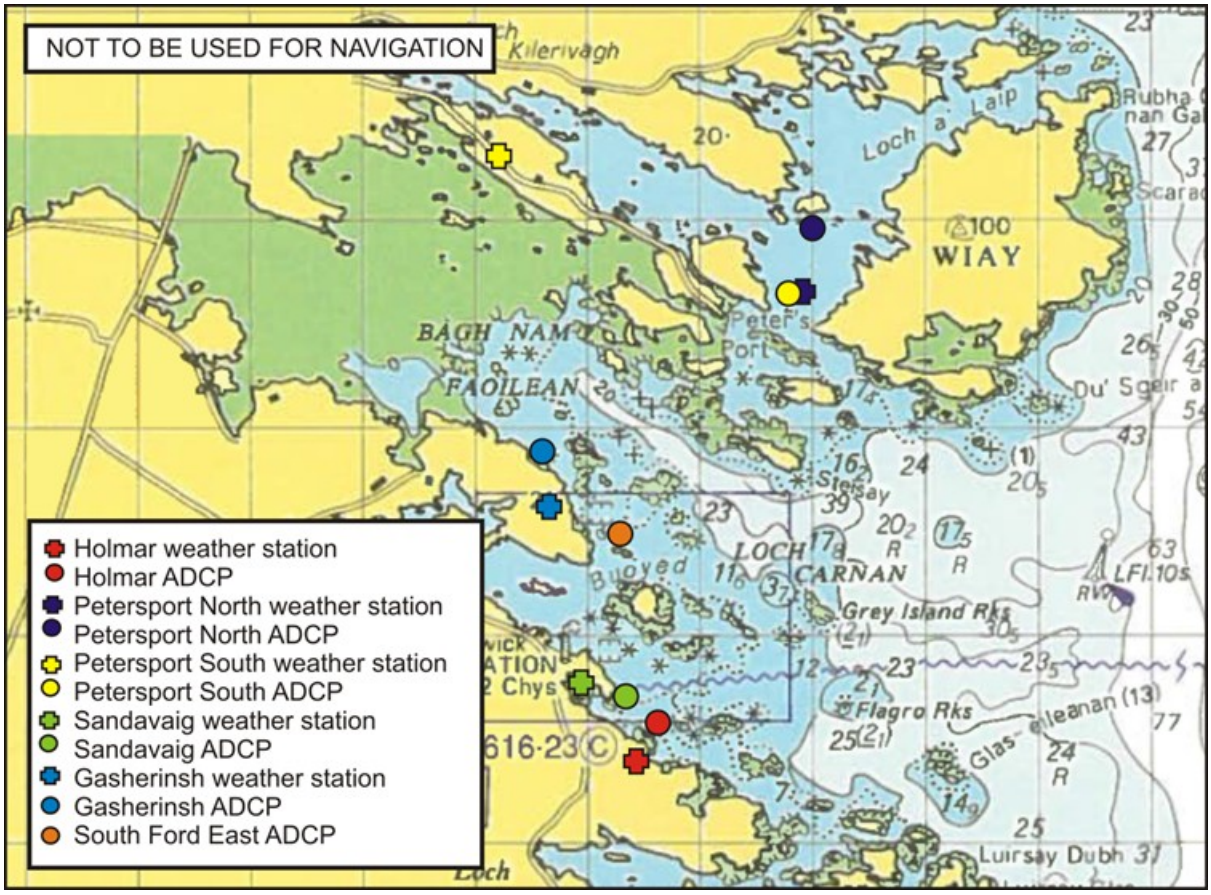


Figure 13.2 Admiralty chart (2904) extract for South Ford, eastern portion of the assessment area.

Locations of ADCPs and weather stations within assessment area are shown. Note that the weather station for South Ford East is located outside the assessment area to the northwest, on the island of Benbecula.

Figure 13.3 shows the bathymetry of the assessment area to the west of the causeway between Benbecula and South Uist. This part of the assessment area is predominantly comprised of intertidal sand, occupying 6.4 km^2. To the west of this intertidal area, depths increase, reaching approximately 5 m in depth at the assessment area boundary.

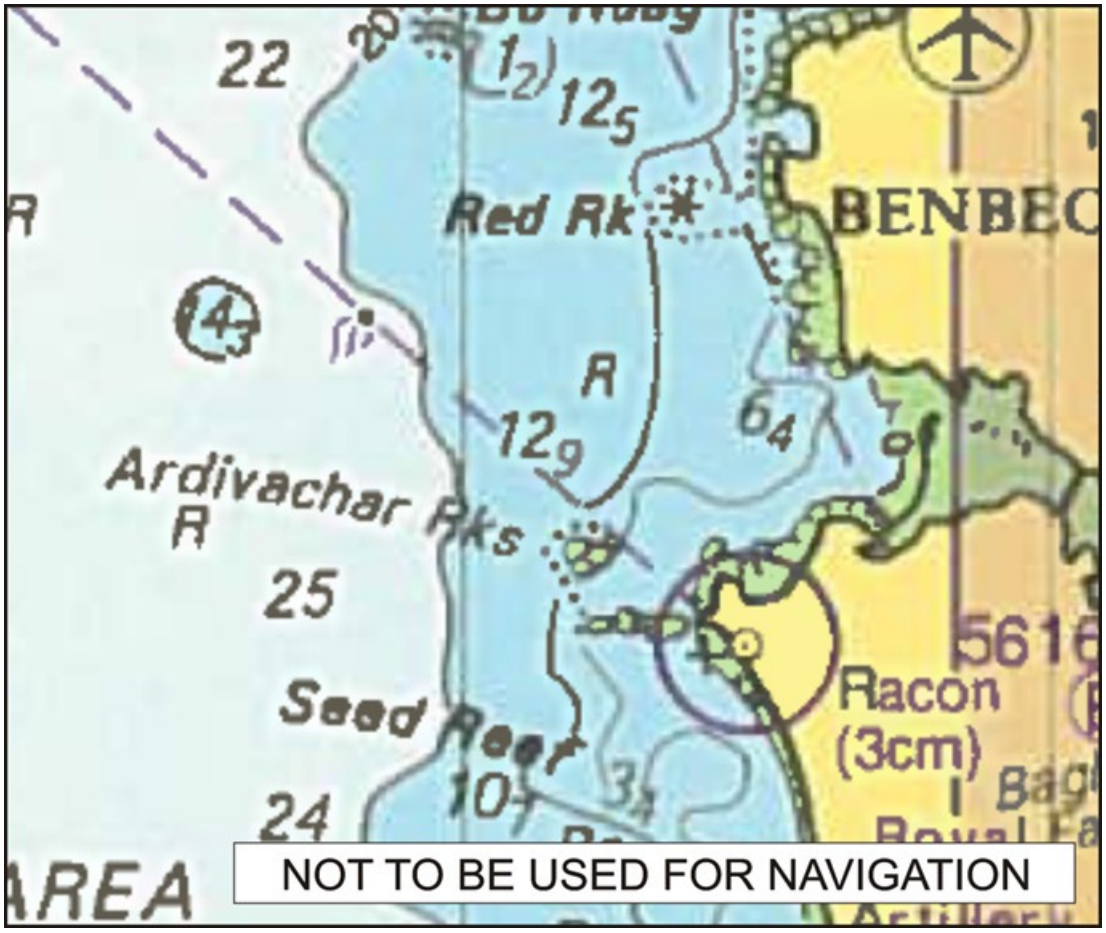


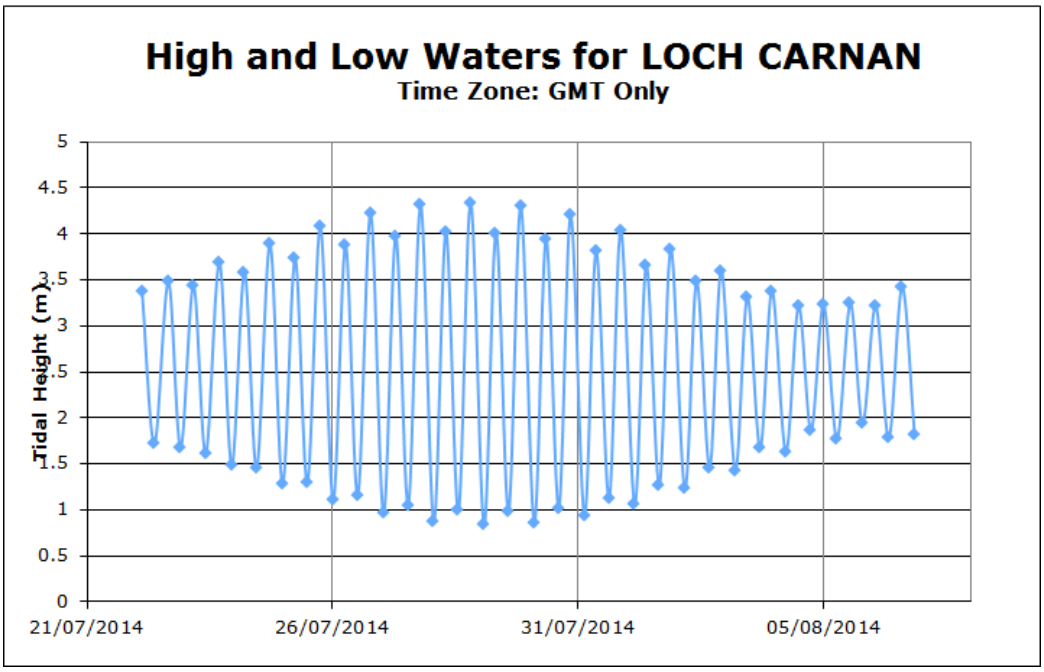
Figure 13.3 Admiralty chart (Chart 2722) extract for South Ford, western portion of the assessment area.

No ADCPs or weather stations are found within this portion of the assessment area.

The mean depth of the assessment area at low water is approximately 5 m, while the estimated low water volume is 9.04×10^7 m^3.

13.2.2 Tides

Standard tidal data for Loch Carnan, centred around the survey date of 30th July 2014, are shown in Figure 13.4. Tidal predictions for Loch Carnan indicate that in this region the tidal characteristics are semi-diurnal, with a well-developed spring-neap cycle.



Reproduced from Poltips3 [www.pol.ac.uk/appl/poltips3]

Figure 13.4 Two week tidal curve for Loch Carnan.

Tidal heights in Loch Carnan, data from Poltips3 [www.pol.ac.uk/appl/poltips3]:

Mean High Water Springs	=	4.50 m
Mean Low Water Springs	=	0.60 m
Mean High Water Neaps	=	3.20 m
Mean Low Water Neaps	=	1.90 m

This gives an approximate tidal volume of water within the assessment area during each tidal cycle of:

Springs: 7.05×10^7 m^3
Neaps: 2.35×10^7 m^3

Note that the spring tidal volume is almost half of the low water volume, indicating a significant exchange of water on each tide.

13.2.3 Tidal Streams and Currents

There are no published tidal diamonds for this area. Enhancement of the speed of the tidal streams caused by the many channels between islands and the numerous shallow areas will be important within this assessment area. The effect will be highly localised flow directions and speeds. The causeway will also be important, particularly if it restricts water flow between the eastern and western components of the assessment area. However, the precise impact of the causeway will be hard to determine given that most of the current meter data is from the outer part of the assessment area.

Current meter data were available at six specified sites within the assessment area: Holmar, Petersport North, Petersport South, Sandavaig, Gasherinsh, and South Ford East. Data were obtained from SEPA for the six sites, whose locations are shown in Figure 13.2.

Each survey spanned a period of at least fifteen days, focussing on a half-lunar period in order to capture a spring-neap cycle:

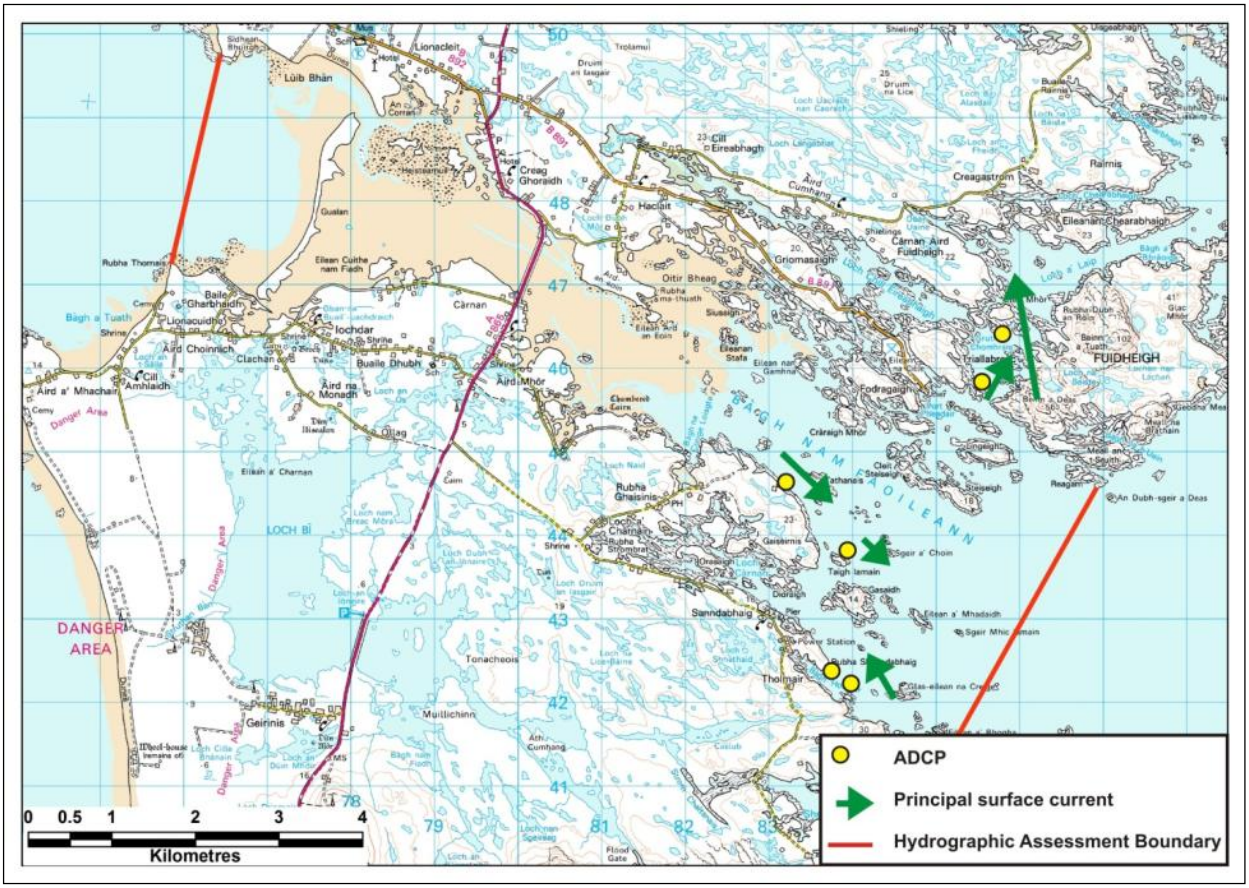


Figure 13.5 Map showing South Ford ADP sample sites within the assessment area.

Using the surface principal current amplitude and the assumption of a uniform sinusoidal tide, the cumulative transport distance and direction that might be expected during each phase of the tide is shown above. No cumulative transport is shown for the Sandavaig site, as the principal current direction could not be calculated from associated ADP data. The cumulative transport distance at Sandavaig was calculated to be 0.8 km, and is expected to be in a similar direction to the adjacent site at Holmar.

Table 13.1: Hydrographic survey sites, survey dates, and citations for data provided by SEPA form six sites within the assessment area.

Survey site	Survey Dates	Citation
Holmar	23/12/08 – 07/01/2009	Namara Projects 2009
Petersport North	02/06/07 - 22/06/07	Xodus Aurora 2007
Petersport South	12/06/02 – 30/06/02	MacKenzie 2002

Sandavaig	01/11/00 – 17/11/00	MacKenzie Marine Ltd. 2000a
Gasherinsh	30/06/00 – 17/07/00	MacKenzie Marine Ltd. 2000b
South Fort East	14/05/09 – 04/06/09	Namara Aquaculture Ltd. 2012

Data from Holmar, 57.36037°N, 7.25669°W were collected between 23/12/08 and 07/01/09 and are summarised in Table 13.2. The average water depth recorded for the duration of the survey was 15 m.

Mean current speeds suggest that flow speeds are relatively similar throughout the water column and rather moderate in magnitude. Currents are generally characterised by flows along a south-easterly to north-westerly axis, parallel to the adjacent shoreline. Residual currents are strongest near the seabed, and flow in a south-easterly direction at near-bed and mid-water depths. No distinct pattern was observed in tidal flows across the spring-neap cycle, and it is suggested that this site is weakly flushed (Namara Projects, 2009).

Table 13.2 Holmar current data measured in 2008-2009

Average Depth	Near-bed (2.8 m above seabed)	Mid-water (6.8 m above seabed)	Sub-surface (10.8 m from seabed)
Mean Speed (ms-1)	0.038	0.033	0.037
Maximum Speed (ms-1)	0.100	0.100	0.120
Principal Axis Amp & Dir (ms-1) & (°Grid)	0.031 (125)	0.035 (135)	0.04 (330)
Residual speed (ms-1)	0.016	0.010	0.004
Residual direction (ºGrid)	127	139	293

A weather station was also deployed during the Holmar survey. Wind speeds were relatively low during the weather station deployment, and the greatest recorded daily wind speed reached 8 m/s on only one occasion. Winds came from all directions, though the strongest winds have a westerly component.

Data were collected from Petersport North, 57°23.828' N 7°14.118' W (OS Ref: 85634.687 E, 846203.490 N), between 02/06/07 and 22/06/07 and are summarised in Table 13.3. The average water depth recorded during the survey was 16.6 m.

Mean current speeds suggest that currents are slightly stronger at the seabed than near the surface, and predominantly flow in a north to south direction. While currents near the seabed had a somewhat persistent northerly flow, current directions were more evenly split across the tidal cycle at the sea surface, flowing in northerly and southerly directions with similar frequency. Both mean and residual current speeds were strongest near the sea bed and weakest near the sea surface, and were stronger at all depths that at the Holmar site.

Table 13.3 Petersport North current data measured in 2007

Average Depth	Near-bed (3 m above seabed)	Mid-water (9 m above seabed)	Sub-surface (13 m from seabed)
Mean Speed(ms^{-1})	0.093	0.077	0.074
Maximum Speed (ms^{-1})	0.31	0.27	0.24
Principal Axis Amp & Dir (ms^{-1}) & (^oM)	0.125 (360)	0.105 (360)	0.109 (350)
Residual speed (ms^{-1})	0.067	0.045	0.016
Residual direction (^oM)	0.1	2.1	6.5

A weather station was also deployed during the Petersport North survey, and winds during the deployment averaged approximately 5.5 m/s. The maximum recorded wind speed was 11 m/s. While winds most frequently came from the northeast, winds were recorded from all directions during the deployment.

Data were collected at Petersport South, N 57.393873 W 007.236261', between 12/06/02 and 30/06/02 and are summarised in Table 13.4. The average recorded water depth during the survey was 14 m.

Table 13.4 Petersport South current data measured in 2002

Average Depth	Near-bed (3 m above seabed)	Sub-surface (3 m below surface)
Mean Speed (ms-1)	0.063	0.074
Maximum Speed (ms-1)	0.240	0.231
Principal Axis Amp & Dir (ms-1) & (^oM)	0.043 (075)	0.084 (029)
Residual speed (ms-1)	0.020	0.028
Residual direction (^oM)	097	170

Mean current speeds at Petersport South are similar to those measured at Petersport North, though mean current speeds are more similar at the seabed and sea surface. Both principal and residual currents were strongest at the surface.

Surface flows at Petersport South are predominantly along an east-west axis. At the seabed current directions are more variable, but most frequently flow in an easterly direction, though flows with southerly components are also common. The strongest surface currents at Petersport South are generally oriented northeast to southwest. Stronger currents are also oriented northeast to southwest at the seabed, but greater current velocities also flow in a northerly direction.

A weather station was deployed during the assessment period at Petersport South, and recorded a maximum wind speed of 16.4 m/s. Generally, however, wind speeds varied between 1.5 m/s and 10 m/s. Winds came from all quarters, but most frequently from the southwest.

Data were collected from Sandavaig, 57°21.785' N 007°15.669' W, between 01/11/00 and 17/11/00 and are summarised in Table 13.5. An ADCP was deployed in a water depth of 14.1 m at low tide.

Table 13.5 Sandavaig current data measured in 2000

Average Depth	Near-bed (3 m above seabed)	Sub-surface (3 m below sea surface)
Mean Speed (ms^{-1})	0.061	0.056
Maximum Speed **(**ms^{-1})	0.175	0.240

The dataset provided for Sandavaig did not allow for independent calculation of the principal current or residual characteristics at this location, as the correspondence between ADCP depths and reported values was not clear. However, it is suggested that the tide at this site flows in a northwest – southeast direction, with similar velocities on ebb and flood tides (MacKenzie Marine Ltd. 2000a). Residual flows at all depths occurred in a north-westerly direction. Current speeds varied with the spring-neap tidal cycle, with strongest flows occurring on a spring tide.

A weather station was also deployed during the Sandavaig survey, and winds during the deployment averaged approximately 4.5 m/s. The maximum recorded wind speed was 11 m/s. Winds were most frequently recorded from a north-easterly direction during this deployment.

Data were collected from South Ford East, 57.37459 N 7.25802 W, between 15/05/09 and 04/06/09 and are summarised in Table 13.6. The average water depth recorded during the survey was 18.2 m.

Mean current speeds suggest that currents are stronger near the sea surface, and decrease with depth. Currents predominantly flow along a south-easterly to north-westerly axis at all depths. Near the seabed this axis of flow becomes less distinct, and the direction of flow is more variable. Residual current speeds were greatest at midwater depths, and residual currents tend to flow in a north-westerly direction at all depths. Current speeds are greater at spring tides than at neaps at both near-surface and midwater depths, though current speeds are more similar throughout the tidal cycle at the seabed (Namara Aquaculture Ltd. , 2012).

Table 13.6 South Ford East current data measured in 2009

Average Depth	Near-bed (2.8 m above seabed)	Mid-water (10.8 m above seabed)	Sub-surface (14.8 m from seabed)
Mean Speed (ms-1)	0.034	0.045	0.049
Maximum Speed (ms-1)	0.120	0.176	0.154
Principal Axis Amp & Dir (ms-1) & (^{o}M)	0.023 (156)	0.054 (136)	0.060(134)
Residual speed (ms-1)	0.014	0.019	0.015
Residual direction (^{o}M)	308	288	290

A weather station was also deployed during the South Ford East survey, and winds during the deployment averaged approximately 4.0 m/s. The maximum recorded wind speed was 6.0 m/s. Winds came most frequently from a south-westerly direction and were recorded from all directions during this deployment.

Data were collected from Gasherinsh, 57°22'51 N 7°15.89' W, between 30/06/00 and 17/07/00 and are summarised in Table 13.7. The average water depth recorded during the survey was 14.6 m.

Table 13.7 Gasherinsh current data measured in 2000

Average Depth	Near-bed (3 m above seabed)	Sub-surface (3 m below sea surface)
Mean Speed (ms-1)	0.054	0.055
Maximum Speed (ms-1)	0.167	0.197
Principal Axis Amp & Dir (ms-1) & (ºM)	0.045 (139)	0.031 (134)
Residual speed (ms-1)	0.014	0.037
Residual direction (ºM)	207	162

Some inconsistencies in the collected and reported data for this site were found but independent analysis of the tidal flow was possible. Mean current speeds suggest that currents flow at similar speeds at the surface and near the seabed. Currents predominantly flow along a southeast – northwest axis (MacKenzie Marine Ltd , 2000b), though there is greater variability in direction of flow near the surface. Residual current speeds were stronger near the sea surface, oriented in a south south-easterly direction, while near the seabed residual flows were weaker and oriented with a westerly component, in a south southwesterly direction. Current speeds at this location are slower than those at the Petersport sites, but are similar to those at other locations within the assessment area.

A weather station was also deployed during the Gasherinsh survey, and winds during the deployment averaged approximately 4 m/s. The maximum recorded wind speed was approximately 8 m/s. Winds most frequently had a northerly component, coming from a north easterly through to north westerly directions. Strongest winds came from a north northwesterly direction.

In general, the current meter data from the above sites suggests that the assessment area of South Ford is moderately quiescent, though current speeds do vary throughout the water column and across the area as anticipated.

Using recorded mean surface principal currents and assuming a uniform sinusoidal tide, the cumulative transport that might be expected during each phase of the tide (approximately 6 hours) is illustrated in Figure 13.5. No distinction is made here for springs and neaps. A summary of cumulative transport distances can be found in table 13.8:

Table 13.8 Summary of surface principal current speeds for the 6 sites across South Ford assessment area and the corresponding cumulative transport.

Site	Surface Principal Current (ms^{-1})	Cumulative Transport (km)
Holmar	0.040	0.6
Petersport North	0.109	1.5
Petersport South	0.043	0.6
Sandavaig	0.056	0.8
Gasherinsh	0.060	0.8
South Fort East	0.031	0.4

Dispersion is an important property of a water body with respect to redistribution of contaminants over time. There are no measurements or published data relating to dispersion in the assessment area. Without such data it is difficult to judge what the dispersive environment might be like. However, dispersion in this area is likely to be greatly enhanced by flows around the numerous islands and tidally exposed rocks throughout the assessment area.

Dispersion of surface contaminants may be enhanced by wave energy within the assessment area. Sources of wave energy are from both short period waves generated within the area itself and longer period swells originating from the waters to the east, which are open to the Minch, and to the west, which are open to the North Atlantic Ocean. Even so, the inner portions of the loch will relatively be sheltered by islands and rocky reefs which characterise the area.

13.2.4 River/Freshwater Inflow

No major rivers flow into the assessment area, though many small streams flow into the area from the numerous freshwater lochs which characterise the surrounding landscape. These include Loch an Os to the west of the road causeway and Loch Dubh Mòr, Loch na Beiste, Loch Naid and Loch Shnathaid to the east of the causeway. Loch Bì, to the west of the causeway, is a brackish loch with a small opening to the sea, but following construction of the causeway the size of the opening has decreased as a result of sediment accretion (Comhairle nan Eilean Siar, 2012).

13.2.5 Meteorology

The nearest weather station for which a continuous rainfall dataset is available is located on South Uist: Range. This station is situated approximately 40 km to the southwest of the assessment area. Rainfall records are available from January 2008 to December 2013, though it must be noted that some data was missing from the April 2008 record, which will have affected annual and monthly rainfall totals.

While 2010 generally had the lowest daily rainfall, the highest rainfall for this time period was recorded in 2011 (1343 mm). Rainfall values of > 30 mm d^{-1} only occurred in 3 years: 2009, 2010, and 2012, and a single rainfall event of > 40 mm d^{-1} occurred in 2009. Rainfall events of > 30 mm d^{-1} occurred only in October, November, and December, while the rainfall event of >40 mm d^{-1} occurred in

October. Daily rainfall varied seasonally, from lower values in February and March to higher values in autumn and winter (October – January). Mean rainfall at South Uist Range peaks in November. For the duration of the dataset, daily rainfall of below 1 mm occurred on 44% of days, while daily rainfall above 10 mm occurred on 8% of days.

Run-off due to rainfall is expected to be highest in the autumn and winter months. However, it must also be noted that moderate rainfall events occurred in most months and consequently that periods of elevated run-off can occur throughout the year.

Wind data were obtained from the same station as rainfall data, South Uist: Range. Given the distance between this location and the assessment area, and varying topography, wind statistics may not be directly transferrable to the specific production area at South Ford. They are, however, valuable in providing the general pattern of the seasonal wind conditions. Data collected between January 2004 and December 2013 indicate that the predominant wind direction is from the southwest. Seasonally the strongest winds occurred during the winter and came from this quarter. Typically the wind came from around the south and west throughout the year but spring and summer also saw winds from the north and northeast. These two directions lie perpendicular to the axis of the assessment area. Nevertheless, local wind direction in the assessment area is likely to be somewhat influenced by the surrounding topography.

13.2.6 Model Assessment

The complexity of the possible exchanges within the assessment area (notably the passage of water through the causeway and to the northeast of the area around Wiay) are such that it was not considered appropriate to set up a box model run for the assessment area. However, an estimate using the tidal prism method gives a flushing time of around 2 – 3 days (Edwards & Sharples, 1986).

13.3 Hydrographic Assessment

13.3.1 Surface Flow

The assessment area does not have a significant point source of freshwater but has numerous smaller rivers discharging from lochs around the perimeter. The meteorological data indicate a moderate seasonal variation in freshwater discharge which will create seasonal variation in any freshwater stratification or weak, localised estuarine circulation.

It is unlikely that freshwater contributes strongly to the exchange characteristics of the site. Nevertheless, there may be combinations of conditions that give rise to a distinct fresh surface layer that can be more easily influenced by winds giving rise to current flow that can vary with depth. However, it is likely that these layers will

become rather quickly mixed during periods of strong wind and due to the rather shallow nature of the site.

South Ford is rather complex in terms of the topography of the loch with numerous islands, inlets, shoals and adjoining lochs and sounds. Further, tidal flows are found to be relative weak or moderate. From the current meter records located in the eastern part of South Ford it is clear that the flow of water is rather complex and variable in both speed and direction across the assessment area. Nevertheless, the general characteristic is that the flood tide will tend to flow west and north whilst the ebb tide will flow south and east. The cumulative transport distance on each phase (flood/ebb) of the tide has been estimated to be typically between 0.5 and 1.0 km within the assessment area though in the vicinity of narrows may be higher.

The residual flows during the period of measurement are typically weak. Surface residual flows in the eastern part of South Ford would be enhanced by winds blowing out of the loch with the statistically more likely westerly winds. Clearly, in the western part of South Ford this would create suppression of surface flow in the area.

Net transport of contaminants is related to the residual flow. The net transport over a tidal cycle of approximately 12 hours would be around a similar order of magnitude to the tidal flow, at 1.0 km or less.

From the current meter measurements in South Ford it is likely that any surface contaminant in the eastern part of the assessment area would be transported along rather complex pathways.

13.3.2 Exchange Properties

Due to the rather complex nature of the assessment area and its split over two sites separated by the causeway, it is not possible to provide a fully quantitative measure of exchange. However, it is anticipated that South Ford will have a relatively short flushing time, on the order of a few days. Further, due to the tidal flow through the area, it is expected that the study site will be a moderately flushed system throughout most of the year with surface contaminants being dispersed in any surface residual flow that will be enhanced by westerly winds.

Current flow has been measured in the eastern part of South Ford at numerous locations. This provides a good spread in terms of distribution, yet each current meter is only deployed for a relatively short period of the year, limiting detailed seasonal analysis. Nevertheless, the tidal flows are generally weak or moderate and residual flows that are also moderate. There is rather little descriptive literature on exchange properties for the area. However, it was possible to make a broad assessment of the likely exchange rates. Consequently, the confidence level of this assessment is MEDIUM.

14. Shoreline Survey Overview

The shoreline survey at South Ford was conducted between the 27th and 29th July 2014. All three days were reported to be dry and mild, with light winds broadly from the northwest quadrant.

The fishery consisted of a wild common cockle bed. Local people indicated harvesting was usually conducted on the north side of South Ford, whilst the south side is used for harvesters to park vehicles for fishing the South side. Rakes and collecting baskets were seen stored above shore along the south side, and stacks of baskets were also seen on the north side. Three shellfish samples were taken along the north shore and returned results of 2500, 270 and 68 *E. coli* MPN/100 g. Seawater samples yielded results ranging from 4 to 62 *E. coli* cfu/100 ml with three of the highest being from locations along the southern shore.

The largest concentration of human population was at Lionacleit where there was a school, library and museum as well as a large and busy hotel and a campsite. There was a further hotel at Creag Ghoraidh. Several B&B's were observed along the south side of the ford.

Two commercial premises were observed at each end of the causeway. The site on the north end was used to store nephrops and lobsters. Several 100 mm diameter hoses were observed leading to and from the shed to the sea: an employee stated that these were used for re-circulating seawater. On the south side, there were large sheds used to store general supplies and although a ST was observed, no outfall pipe was noted.

Community septic tanks were seen at Lionacleit, Iochdar and in the vicinity of Cuidhe na Gamhna STW.

A septic tank observed on the north side of the area appeared to be seeping from the top. The remaining septic tanks were observed along the southeast side of the ford. One outfall was found to be discharging a low flow, a sample of which confirmed it had a high septic content (7.2×10^6 *E. coli* cfu/100 ml).

A leisure boat was moored along the north side and a small private tidal harbour and disused slipway were seen on the south side.

Sheep, beef cattle and horses were all observed in the survey area. A few sheep were observed on the beach/area directly above the shore at the northwest and horse droppings were seen on grass above the beach along the southeast shore. A large number of horses and ponies were also noted inland of the shoreline. A notice for holiday equestrian activities was also observed.

Rough grassland dominated the area on both sides, with patches of bracken and peat bog also noted in a several areas above and set back from the shoreline. Trees and shrubs were only observed in gardens.

Freshwater sample results from land drainage and watercourses were low between <10 and 120 *E. coli* cfu/100 ml.

Birds were the most common wildlife observed. Oystercatchers were the most frequently seen, with a total of approximately 105 birds. A grey seal seen to the northwest.

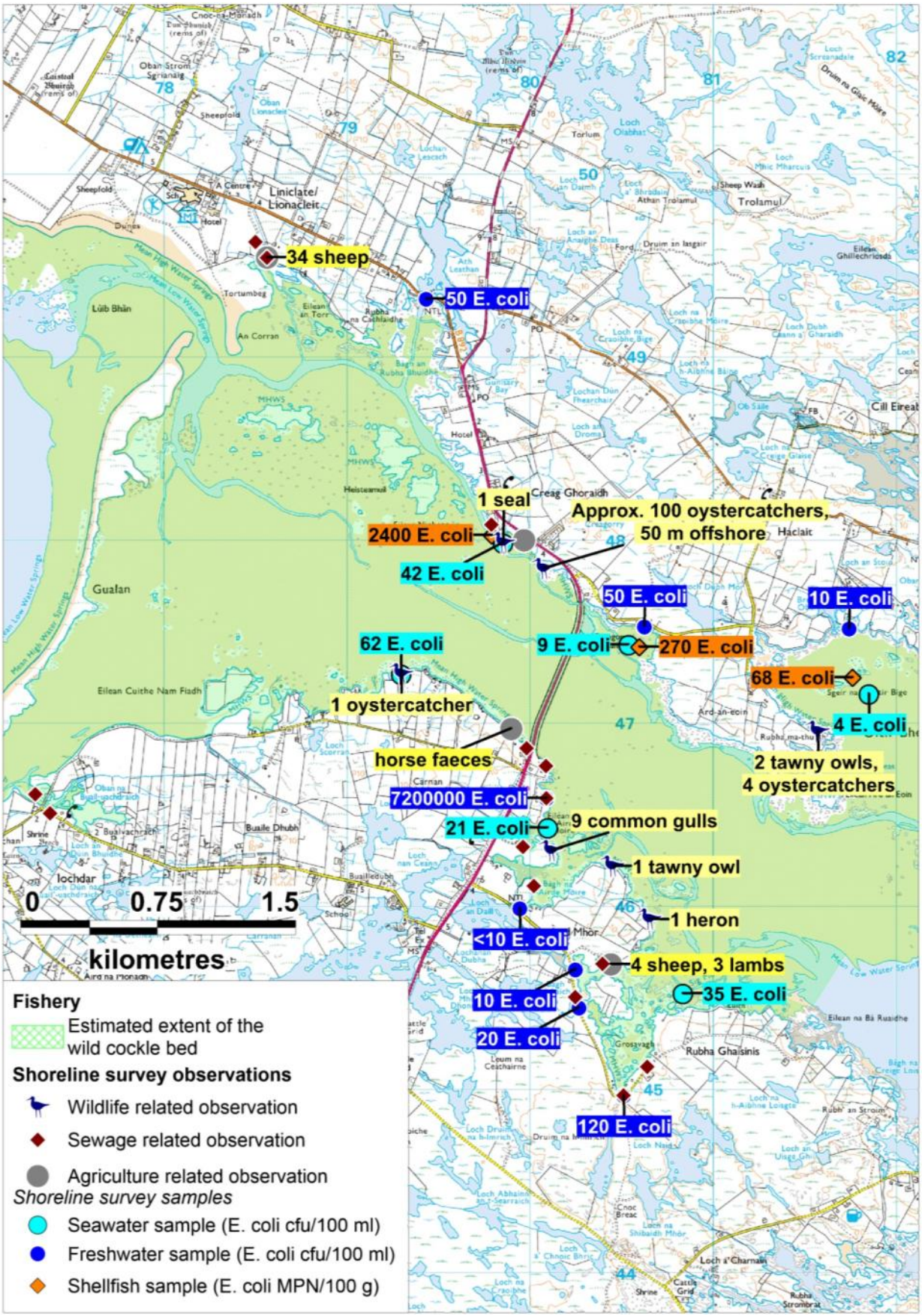


Figure 14.1 Map of shoreline survey observations at South Ford

15. Bacteriological Survey

A bacteriological survey was undertaken at South Ford to help inform the assessment of spatial impacts from potential sources of contamination in the area. Sampling was undertaken by hand-raking on two occasions at three locations that had been sampled during the shoreline survey. The locations are shown in the map in Figure 15.1. The results, together with the geometric mean and maximum values for these at each site, are given in Table 15.1.

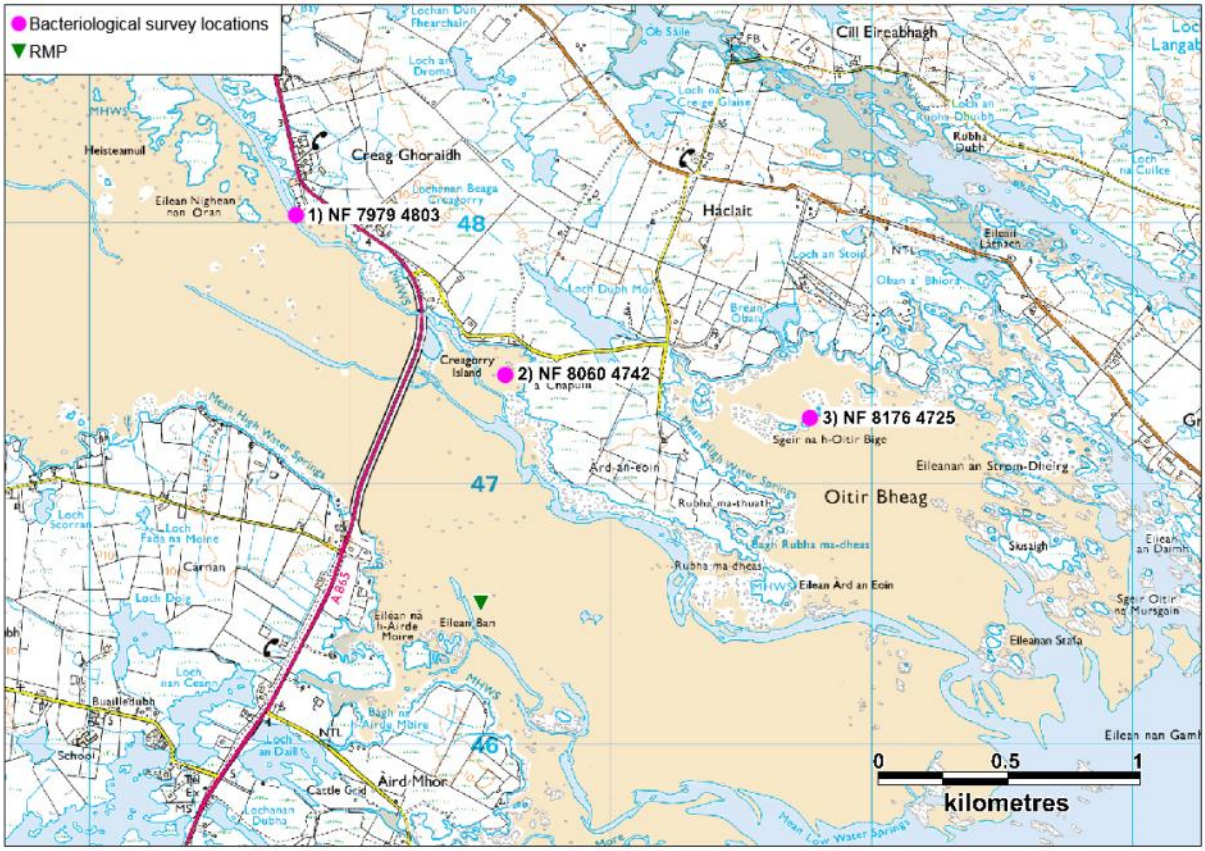


Figure 15.1 Bacteriological survey sampling locations

Table 15.1. Bacteriological survey results

Sample point	NGR	*E. coli* MPN/100 g				
		28/07/14	08/09/2014	23/09/14	Geometric mean	Maximum
1	NF 7979 4803	2400	330	330	639	2400
2	NF 8060 4742	270	20	78	75	270
3	NF 8176 4725	68	230	45	89	230

The highest geometric mean and maximum *E. coli* values from the three sets of samples were seen at sample point 1 located near Creagorry.

16. Overall Assessment

Human sewage impacts

There are a number of sewage discharges to the area, the largest of which are associated with the settlements of Lionacleit and Creag Goraidh and discharge to sea along the north shore of the ford, to the west of the causeway. These include community septic tanks and a small number of private septic tanks. There are in addition a large number of septic tanks consented to discharge to soakaway along this side of the ford, and any of these not functioning efficiently or rerouted to sea will add to the impact on water quality on this side of the causeway.

On the south side of the ford, the population is concentrated on the west side of the causeway around the settlement of Iochdar, where there are three septic tanks, as well as two CSOs. There are also private septic tanks in this area, which is very low lying and prone to flooding, which would increase the risk of sewage contamination to the coastal and freshwater environment.

Fewer people live east of the causeway, and there is only one very small community septic tank discharging to the northeast of the ford. The remaining discharges are from individual private septic tanks, which were slightly more numerous on the south shore than the north. Impacts from human sewage are therefore expected to be significantly higher on the west side of the causeway than on the east side. Highest impacts to the west side are expected along the north shore, particularly around the sewage outfalls for Liniclate School, Strome Cottages, Creagorry 1 and Creagorry 2 septic tanks. Impacts may be higher around the latter 3, which receive lower level treatment than the Liniclate School discharge. However, it should be noted that the efficiency of the reed bed treatment provided for the Liniclate discharge could be affected by coastal flooding.

Impacts to the east side are expected to be relatively local to the small private discharges near the shore, and there appear to be more of these along the south shore. There may also be higher sewage impacts where water flows under the causeway from the west side of the ford.

Agricultural impacts

Most of the land around the fishery was reported to be used for rough grazing, mainly of sheep but also cattle and horses Sheep were reported in very large numbers for both South Uist parish and North Uist parish (including Benbecula). Sheep were observed mainly along the northwest shore of the ford, where there were also two sheep folds noted on the OS map. Two sheep were also seen on the shoreline in this area. Although it is likely that sheep will be present along most, if not all, of the shoreline at times, the presence of sheepfolds on the northwest

shore suggests that the animals are gathered there periodically and therefore the impact may be higher on this side of the fishery.

Wildlife impacts

Relatively little information was found on specific wildlife populations in the area. Seals are known to be present in the area, and one was seen during the shoreline survey however there was no clear information on overall numbers of animals and their spatial distribution around the ford.

Seabird count data showed large numbers of breeding seabirds, particularly around the eastern side of the ford. There was a large colony of fulmars noted on an island near the northeast end of the cockle bed, and this would be expected to constitute a potentially significant point source of faecal contamination during the May to October breeding season.

Wading birds, such as oystercatchers, are likely to use the area for both breeding and for feeding during migrations. A large number of oystercatchers were seen to the west of the causeway during the shoreline survey, however wading birds are likely to utilise the large intertidal areas on both sides of the causeway. Due to the large intertidal area available, there is potential for very large numbers of these birds to be present particularly during spring and autumn migrations. There was insufficient evidence to suggest that any one part of the fishery would be more impacted than another.

Seasonal variation

Significant seasonal variation is anticipated in human, livestock and wildlife populations in the area. The significant amount of tourist accommodation in the area, including camping facilities, suggests that the human population in area is likely to be higher during the peak summer holiday months. Livestock numbers are likely to be higher when lambs are present in late spring and summer. Seasonal variation in wildlife numbers depends on the species. Breeding seabirds are present in summer, whereas wading birds may be more numerous during spring and autumn migrations.

Investigation of historical shellfish *E. coli* data showed that results were very significantly higher in summer than in spring or winter and the highest results were obtained from samples collected from July to October.

Seasonal variation was also seen in historical rainfall data, with highest daily rainfall occurring from October to January.

A statistically significant correlation was found between results and water temperature, with results >230 *E. coli* MPN/100 g from samples taken at water temperatures between 14 and 15^{o}C. This coincides with the summer season.

Watercourses

Few watercourses were found to flow into the South Ford area. Those that were identified and sampled during the shoreline survey showed only low to moderate levels of faecal contamination. with the highest impact expected on the northern shore around Lionacleit and on the southern shore to the east of the causeway.

Contaminants are expected to be carried over most of the intertidal area. Contaminants arising from the west side of the causeway may under certain conditions be transported to the east side.

Contamination would be expected to increase after rainfall. However, no statistically significant correlation was found between results and previous two day or results and previous seven day rainfall or between results and salinity. Therefore, rainfall-dependent runoff did not appear to be a significant driver of faecal contamination at the sampling location.

Movement of contaminants

The cumulative transport distance on each phase (flood/ebb) of the tide has been estimated to be typically between 0.5 and 1.0 km within the assessment area though in the vicinity of narrows it may be higher. This suggests that contamination levels would be highest in the vicinity of sources. There is potential for contamination arising to the west of the causeway to pass through to the eastern side at the narrows between them.

As the area is intertidal, contaminants could be expected to be carried over most of the intertidal area within a single tide.

No statistically significant correlation was found between results and spring/neap or high/low tidal state at the sampling location.

Temporal and geographical patterns of sampling results

There has been no apparent change in results over the sampling period assessed, from 2006 to 2014.

Nearly half of all samples, including the one with the highest result, were reported to have been taken at the RMP, which is located near the southeast shore of the ford. All samples were reported to have been taken within 500 m of the RMP. The RMP location lies relatively distant from the majority of identified sources of faecal contamination in the area.

A bacteriological survey undertaken at three locations within the classified production area showed significantly higher results at the northwestern end of the shellfishery than at the two sampling locations east of the causeway.

Conclusions

The principal sources of faecal contamination to the fishery are point source discharges of human sewage and diffuse contamination from human, livestock and wildlife sources. There is likely to be seasonal variation in inputs, and significant seasonal variation was found in *E. coli* monitoring results, which were higher in summer than in either spring or winter.

The RMP is currently located well away from the main identified sources of faecal contamination and therefore may not adequately reflect contamination levels at the shellfish bed west of the causeway.

17. Recommendations

Production area

It is recommended that the production area be curtailed to just the east side of the causeway in order to exclude identified point sources of sewage effluent. The recommended production area boundaries are:

The area bounded by lines drawn between NF 8100 4545 and NF 8252 4673 and between NF 8265 4682 and NF 8300 4712, extending to the causeway at the western boundary and to MHWS elsewhere.

RMP

It is recommended that the RMP be moved NF 8042 4739, at the northwest end of the production area near where water flows under the causeway. This will better reflect contamination arising from the community septic tanks on the west side of the causeway.

Tolerance

A tolerance of 100 m is recommended to allow sufficient scope for obtaining hand raked samples. The actual location of each sample should be recorded to the nearest 10 m using GPS equipment.

Depth of sampling

Not applicable

Frequency

Monthly sampling is recommended.

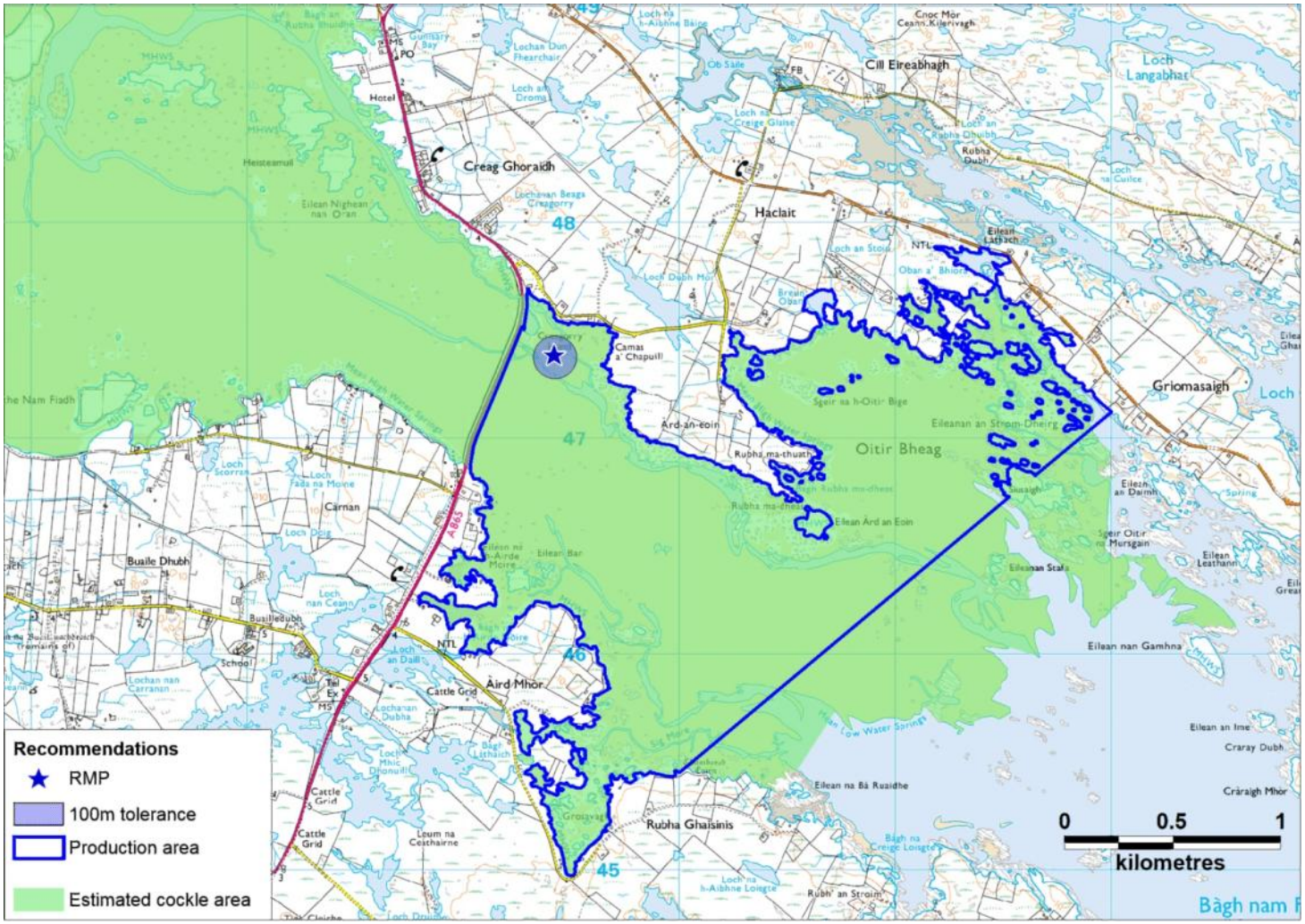


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Figure 17.1 Map of recommendations at South Ford

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4. **Hydrographic Section Glossary**
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1. General Information on Wildlife Impacts

Pinnipeds

Two species of pinniped (seals, sea lions, walruses) are commonly found around the coasts of Scotland: These are the European harbour, or common, seal (*Phoca vitulina vitulina*) and the grey seal (*Halichoerus grypus*). Both species can be found along the west coast of Scotland.

Common seal surveys are conducted every 5 years and an estimate of minimum numbers is available through Scottish Natural Heritage.

According to the Scottish Executive, in 2001 there were approximately 119,000 grey seals in Scottish waters, the majority of which were found in breeding colonies in Orkney and the Outer Hebrides.

Adult Grey seals weigh 150-220 kg and adult common seals 50-170 kg. They are estimated to consume between 4 and 8% of their body weight per day in fish, squid, molluscs and crustaceans. No estimates of the volume of seal faeces passed per day were available, though it is reasonable to assume that what is ingested and not assimilated in the gut must also pass. Assuming 6% of a median body weight for harbour seals of 110kg, that would equate to 6.6kg consumed per day and probably very nearly that 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 1.21×10^4 CFU (colony forming units) *E. coli* per gram dry weight of faeces (Lisle *et al* 2004).

Both bacterial and viral pathogens affecting humans and livestock have been found in wild and captive seals. *Salmonella* and *Campylobacter* spp., some of which were antibiotic-resistant, were isolated from juvenile Northern elephant seals (*Mirounga angustirostris*) with *Salmonella* found in 36.9% of animals stranded on the California coast (Stoddard, et al., 2005) *Salmonella* and *Campylobacter* are both enteric pathogens that can cause acute illness in humans and it is postulated that the elephant seals were picking up resistant bacteria from exposure to human sewage waste.

One of the *Salmonella* species isolated from the elephant seals, *Salmonella typhimurium*, is carried by a number of animal species and has been isolated from cattle, pigs, sheep, poultry, ducks, geese and game birds in England and Wales. Serovar DT104, also associated with a wide variety of animal species, can cause severe disease in humans and is multi-drug resistant (Poppe, et al., 1998)

Cetaceans

As mammals, whales and dolphins would be expected to have resident populations of *E. coli* and other faecal indicator bacteria in the gut. Little is known about the concentration of indicator bacteria in whale or dolphin faeces, in large part because the animals are widely dispersed and sample collection difficult.

A variety of cetacean species are routinely observed around the west coast of Scotland. Where possible, information regarding recent sightings or surveys is gathered for the production area. As whales and dolphins are broadly free ranging, this is not usually possible to such fine detail. Most survey data is supplied by the Hebridean Whale and Dolphin Trust or the Shetland Sea Mammal Group and applies to very broad areas of the coastal seas.

It is reasonable to expect that whales would not routinely affect shellfisheries located in shallow coastal areas. It is more likely that dolphins and harbour porpoises would be found in or near fisheries due to their smaller physical size and the larger numbers of sightings near the coast.

Birds

Seabird populations were surveyed all over Britain as part of the SeaBird 2000 census. These counts are investigated using GIS to give the numbers observed within a 5 km radius of the production area. This gives a rough idea of how many birds may be present either on nests or feeding near the shellfish farm or bed.

Further information is gathered where available related to shorebird surveys at local bird reserves when present. Surveys of overwintering geese are queried to see whether significant populations may be resident in the area for part of the year. In many areas, at least some geese may be present year round. The most common species of goose observed during shoreline surveys has been the Greylag goose. Geese can be found grazing on grassy areas adjacent to the shoreline during the day and leave substantial faecal deposits. Geese and ducks can deposit large amounts of faeces in the water, on docks and on the shoreline.

A study conducted on both gulls and geese in the northeast United States found that Canada geese (*Branta canadiensis*) contributed approximately 1.28×10^5 faecal coliforms (FC) per faecal deposit and ring-billed gulls (*Larus delawarensis*) approximately 1.77×10^8 FC per faecal deposit to a local reservoir (Alderisio & DeLuca, 1999). An earlier study found that geese averaged from 5.23 to 18.79 defecations per hour while feeding, though it did not specify how many hours per day they typically (Gauthier & Bedard, 1986)

Waterfowl can be a significant source of pathogens as well as indicator organisms. Gulls frequently feed in human waste bins and it is likely that they carry some human pathogens.

Deer

Deer are present throughout much of Scotland in significant numbers. The Deer Commission of Scotland (DCS) conducts counts and undertakes culls of deer in areas that have large deer populations.

Four species of deer are routinely recorded in Scotland, with Red deer (*Cervus elaphus*) being the most numerous, followed by Roe deer (*Capreolus capreolus*), Sika deer (*Cervus nippon*) and Fallow deer (*Dama dama*).

Accurate counts of populations are not available, though estimates of the total populations are >200,000 Roe deer, >350,000 Red deer, < 8,000 Fallow deer and an unknown number of Sika deer. Where Sika deer and Red deer populations overlap, the two species interbreed further complicating counts.

Deer will be present particularly in wooded areas where the habitat is best suited for them. Deer, like cattle and other ruminants, shed *E. coli*, *Salmonella* and other potentially pathogenic bacteria via their faeces.

Otters

The European otter (*Lutra lutra*) is present around Scotland with some areas hosting populations of international significance. Coastal otters tend to be more active during the day, feeding on bottom-dwelling fish and crustaceans among the seaweed found on rocky inshore areas. An otter will occupy a home range extending along 4-5km of coastline, though these ranges may sometimes overlap (Scottish National Heritage, n.d.). Otters primarily forage within the 10 m depth contour and feed on a variety of fish, crustaceans and shellfish (Paul Harvey, Shetland Sea Mammal Group, personal communication).

Otters leave faeces (also known as spraint) along the shoreline or along streams, which may be washed into the water during periods of rain.

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2. Tables of Typical Faecal Bacteria Concentrations

Summary of faecal coliform concentrations (cfu $100ml^{-1}$) for different treatment levels and individual types of sewage-related effluents under different flow conditions: geometric means (GMs), 95% confidence intervals (CIs), and results of t-tests comparing base- and high-flow GMs for each group and type.

Indicator organism	**Base-flow conditions**				**High-flow conditions**			
Treatment levels and specific types: Faecal coliforms	*n*[c]	Geometric mean	Lower 95% CI	Upper 95% CI	*n*[c]	Geometric mean	Lower 95% CI	Upper 95% CI
Untreated	252	1.7×10^{7} * (+)	1.4×10^{7}	2.0×10^{7}	282	2.8×10^{6} * (-)	2.3×10^{6}	3.2×10^{6}
Crude sewage discharges	252	1.7×10^{7} * (+)	1.4×10^{7}	2.0×10^{7}	79	3.5×10^{6} * (-)	2.6×10^{6}	4.7×10^{6}
Storm sewage overflows					203	2.5×10^{6}	2.0×10^{6}	2.9×10^{6}
Primary	127	1.0×10^{7} * (+)	8.4×10^{6}	1.3×10^{7}	14	4.6×10^{6} (-)	2.1×10^{6}	1.0×10^{7}
Primary settled sewage	60	1.8×10^{7}	1.4×10^{7}	2.1×10^{7}	8	5.7×10^{6}		
Stored settled sewage	25	5.6×10^{6}	3.2×10^{6}	9.7×10^{6}	1	8.0×10^{5}		
Settled septic tank	42	7.2×10^{6}	4.4×10^{6}	1.1×10^{7}	5	4.8×10^{6}		
Secondary	864	3.3×10^{5} * (-)	2.9×10^{5}	3.7×10^{5}	184	5.0×10^{5} * (+)	3.7×10^{5}	6.8×10^{5}
Trickling filter	477	4.3×10^{5}	3.6×10^{5}	5.0×10^{5}	76	5.5×10^{5}	3.8×10^{5}	8.0×10^{5}
Activated sludge	261	2.8×10^{5} * (-)	2.2×10^{5}	3.5×10^{5}	93	5.1×10^{5} * (+)	3.1×10^{5}	8.5×10^{5}
Oxidation ditch	35	2.0×10^{5}	1.1×10^{5}	3.7×10^{5}	5	5.6×10^{5}		
Trickling/sand filter	11	2.1×10^{5}	9.0×10^{4}	6.0×10^{5}	8	1.3×10^{5}		
Rotating biological contactor	80	1.6×10^{5}	1.1×10^{5}	2.3×10^{5}	2	6.7×10^{5}		
Tertiary	179	1.3×10^{3}	7.5×10^{2}	2.2×10^{3}	8	9.1×10^{2}		
Reed bed/grass plot	71	1.3×10^{4}	5.4×10^{3}	3.4×10^{4}	2	1.5×10^{4}		
Ultraviolet disinfection	108	2.8×10^{2}	1.7×10^{2}	4.4×10^{2}	6	3.6×10^{2}		

Source: (Kay, et al., 2008b)

Table 3 – Geometric mean (GM) and 95% confidence intervals (CIs) of the GM faecal indicator organism (FIO) concentrations (cfu/100ml) under base- and high-flow conditions at the 205 sampling points and for various subsets, and results of paired t-tests to establish whether there are significant elevations at high flow compared with base flow

FIO	*n*	**Base Flow**			**High Flow**		
Subcatchment land use		Geometric mean	Lower 95% CI	Upper 95% CI	Geometric mean[a]	Lower 95% CI	Upper 95% CI
Total coliforms							
All subcatchments	205	5.8×10^{3}	4.5×10^{3}	7.4×10^{3}	7.3×10^{4}**	5.9×10^{4}	9.1×10^{4}
Degree of urbanisation							
Urban	20	3.0×10^{4}	1.4×10^{4}	6.4×10^{4}	3.2×10^{5}**	1.7×10^{5}	5.9×10^{5}
Semi-urban	60	1.6×10^{4}	1.1×10^{4}	2.2×10^{4}	1.4×10^{5}**	1.0×10^{5}	2.0×10^{5}
Rural	125	2.8×10^{3}	2.1×10^{3}	3.7×10^{3}	4.2×10^{4}**	3.2×10^{4}	5.4×10^{4}
Rural subcatchments with different dominant land uses							
≥75% Imp pasture	15	6.6×10^{3}	3.7×10^{3}	1.2×10^{4}	1.3×10^{5}**	1.0×10^{5}	1.7×10^{5}
≥75% Rough Grazing	13	1.0×10^{3}	4.8×10^{2}	2.1×10^{3}	1.8×10^{4}**	1.1×10^{4}	3.1×10^{4}
≥75% Woodland	6	5.8×10^{2}	2.2×10^{2}	1.5×10^{3}	6.3×10^{3}*	4.0×10^{3}	9.9×10^{3}
Faecal coliform							
All subcatchments	205	1.8×10^{3}	1.4×10^{3}	2.3×10^{3}	2.8×10^{4}**	2.2×10^{4}	3.4×10^{4}
Degree of urbanisation							
Urban	20	9.7×10^{3}	4.6×10^{3}	2.0×10^{4}	1.0×10^{5}**	5.3×10^{4}	2.0×10^{5}
Semi-urban	60	4.4×10^{3}	3.2×10^{3}	6.1×10^{3}	4.5×10^{4}**	3.2×10^{4}	6.3×10^{4}
Rural	125	8.7×10^{2}	6.3×10^{2}	1.2×10^{3}	1.8×10^{4}**	1.3×10^{4}	2.3×10^{4}
Rural subcatchments with different dominant land uses							
≥75% Imp pasture	15	1.9×10^{3}	1.1×10^{3}	3.2×10^{3}	5.7×10^{4}**	4.1×10^{4}	7.9×10^{4}
≥75% Rough Grazing	13	3.6×10^{2}	1.6×10^{2}	7.8×10^{2}	8.6×10^{3}**	5.0×10^{3}	1.5×10^{4}
≥75% Woodland	6	3.7×10	1.2×10	1.2×10^{2}	1.5×10^{3}**	6.3×10^{2}	3.4×10^{3}
Enterococci							
All subcatchments	205	2.7×10^{2}	2.2×10^{2}	3.3×10^{2}	5.5×10^{3}**	4.4×10^{3}	6.8×10^{3}
Degree of urbanisation							
Urban	20	1.4×10^{3}	9.1×10^{2}	2.1×10^{3}	2.1×10^{4}**	1.3×10^{4}	3.3×10^{4}
Semi-urban	60	5.5×10^{2}	4.1×10^{2}	7.3×10^{2}	1.0×10^{4}**	7.6×10^{3}	1.4×10^{4}
Rural	125	1.5×10^{2}	1.1×10^{2}	1.9×10^{2}	3.3×10^{3}**	2.4×10^{3}	4.3×10^{3}
Rural subcatchments with different dominant land uses							
≥75% Imp. pasture	15	2.2×10^{2}	1.4×10^{2}	3.5×10^{2}	1.0×10^{4}**	7.9×10^{3}	1.4×10^{4}
≥75% Rough Grazing	13	4.7×10	1.7×10	1.3×10^{2}	1.2×10^{3}**	5.8×10^{2}	2.7×10^{3}
≥75% Woodland	6	1.6×10	7.4	3.5×10	1.7×10^{2}**	5.5×10	5.2×10^{2}
[a] Significant elevations in concentrations at high flow are indicated: **po0.001, *po0.05.							
[b] Degree of urbanisation categorised according to percentage built-up land: 'Urban' (X10.0%), 'Semi-urban' (2.5–9.9%) and 'Rural' (o2.5%).							

Source: (Kay, et al., 2008a)

Table 4 - Comparison of faecal indicator concentrations (average numbers/g wet weight) excreted in the faeces of warm-blooded animals

Animal	Faecal coliforms (FC) number	Excretion (g/day)	FC Load (numbers/day)
Chicken	1,300,000	182	2.3×10^8
Cow	230,000	23,600	5.4×10^9
Duck	33,000,000	336	1.1×10^{10}
Horse	12,600	20,000	2.5×10^8
Pig	3,300,000	2,700	8.9×10^8
Sheep	16,000,000	1,130	1.8×10^{10}
Turkey	290,000	448	1.3×10^8
Human	13,000,000	150	1.9×10^9

Source: (Gauthier & Bedard, 1986)

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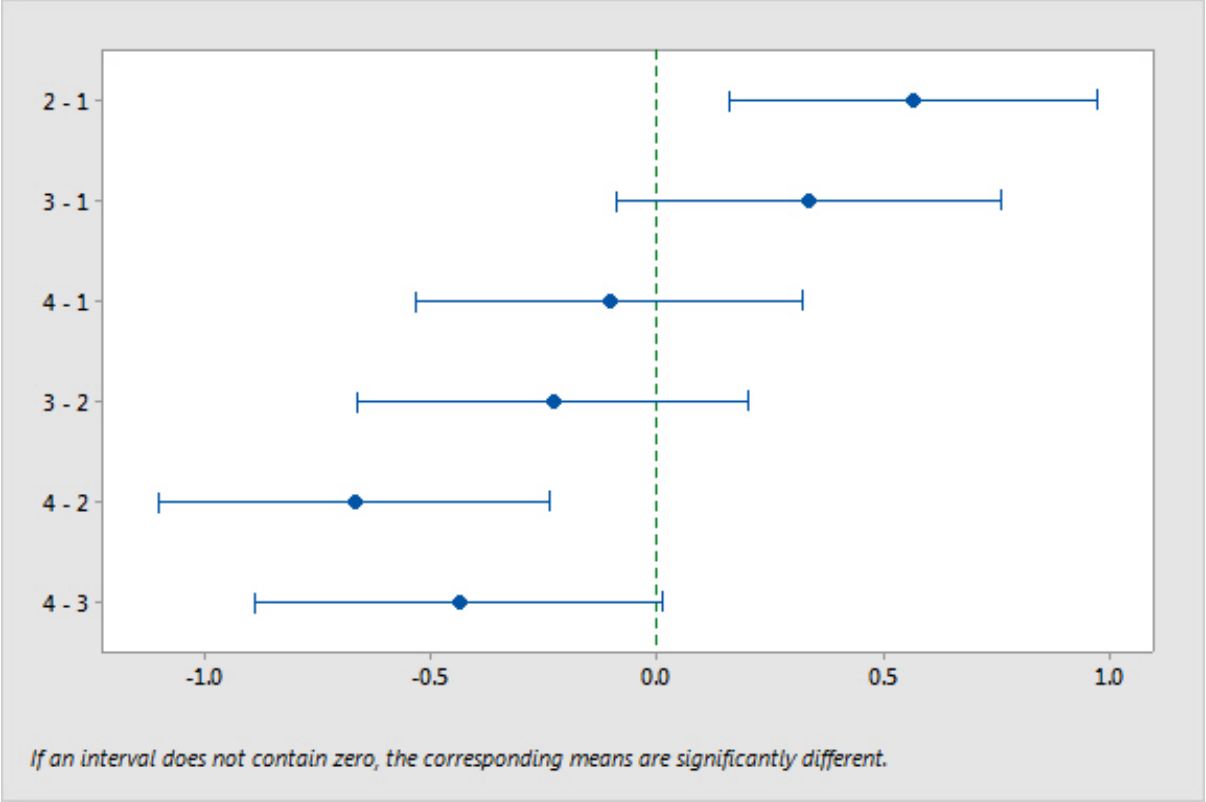
3. Statistical Data

One-way ANOVA: logec versus Season

```
Method
Null hypothesis         All means are equal
Alternative hypothesis  At least one mean is different
Significance level      α = 0.05
Equal variances were assumed for the analysis.
Factor Information
Factor  Levels  Values
Season       4  1, 2, 3, 4
Analysis of Variance
Source  DF  Adj SS  Adj MS  F-Value  P-Value
Season   3   4.828  1.6092     7.32    0.000
Error   63  13.844  0.2197
Total   66  18.672
Model Summary
       S    R-sq  R-sq(adj)  R-sq(pred)
0.468775  25.86%     22.32%      16.24%
Means
Season   N    Mean   StDev       95% CI
1       19  1.5741  0.3660  (1.3591, 1.7890)
2       18   2.140   0.613  ( 1.919,  2.360)
3       15   1.908   0.498  ( 1.667,  2.150)
4       15  1.4694  0.3351  (1.2275, 1.7112)
Pooled StDev = 0.468775
```

Tukey Pairwise Comparisons

```
Grouping Information Using the Tukey Method and 95% Confidence
Season   N    Mean  Grouping
2       18   2.140  A
3       15   1.908  A B
1       19  1.5741    B
4       15  1.4694    B
Means that do not share a letter are significantly different.
```


2 - 1
3 - 1
4 - 1
3 - 2
4 - 2
4 - 3
-1.0
-0.5
0.0
0.5
1.0
If an interval does not contain zero, the corresponding means are significantly different.

4. Hydrographic Assessment Glossary

The following technical terms may appear in the hydrographic assessment.

Bathymetry. The underwater topography given as depths relative to some fixed reference level e.g. mean sea level.

Hydrography. Study of the movement of water in navigable waters e.g. along coasts, rivers, lochs, estuaries.

MHW. Mean High Water, The highest level that tides reach on average.

MHWN. Mean High Water Neap, The highest level that tides reach on average during neap tides.

MHWS. Mean High Water Spring, The highest level that tides reach on average during spring tides

MLW. Mean Low Water, The lowest level that tides reach on average.

MLWN. Mean Low Water Neap, The lowest level that tides reach on average during neap tides.

MLWS. Mean Low Water Spring, The lowest level that tides reach on average during spring tides.

Tidal period. The dominant tide around the UK is the twice daily one generated by the moon. It has a period of 12.42 hours. For near shore so-called rectilinear tidal currents then roughly speaking water will flow one way for 6.2 hours then back the other way for 6.2 hours.

Tidal range. The difference in height between low and high water. Will change over a month.

Tidal excursion. The distance travelled by a particle over one half of a tidal cycle (roughly~6.2 hours). Over the other half of the tidal cycle the particle will move in the opposite direction leading to a small net movement related to the tidal residual. The excursion will be largest at Spring tides.

Tidal residual. For the purposes of these documents it is taken to be the tidal current averaged over a complete tidal cycle. Very roughly it gives an idea of the general speed and direction of travel due to tides for a particle over a period of several days.

Tidal prism. The volume of water brought into an estuary or sea loch during half a tidal cycle. Equal to the difference in estuary/sea loch volume at high and low water.

Spring/Neap Tides. Spring tides occur during or just after new moon and full moon when the tide-generating force of the sun acts in the same direction as that of the moon, reinforcing it. The tidal range is greatest and tidal currents strongest during spring tides.

Neap tides occur during the first or last quarter of the moon when the tide-generating forces of the sun and moon oppose each other. The tidal range is smallest and tidal currents are weakest during neap tides.

Tidal diamonds. The tidal velocities measured and printed on admiralty charts at specific locations are called tidal diamonds.

Wind driven shear/surface layer. The top metre or so of the surface that generally moves in the rough direction of the wind typically at a speed that is a few percent (~3%) of the wind speed.

Return flow. A surface flow at the surface may be accompanied by a compensating flow in the opposite direction at the bed.

Stratification. The splitting of the water into two layers of different density with the less dense layer on top of the denser one. Due to either temperature or salinity differences or a combination of both.

5. Shoreline Survey Report

Production area: South Ford
Site name: South Ford
SIN: UB-259-162-04
Species: Common cockles
Harvester: Various harvesters, non-contacted
Local Authority: Comhairle nan Eilean: Uist & Barra
Status: Existing area
Date Surveyed: 27th – 29th July 2014
Surveyed by: Alison Clarke, Peter Lamont
Existing RMP: NF 8050 4655
Area Surveyed:
On the north shore: from the last shoreline dwelling close by the Cooperative store on the northwest of the A865 Causeway, to the shoreline southeast of Haclait (waypoint 7 to just east of waypoint 21). The last part of the planned north section, to north-northeast of the small uninhabited Island of Siusaigh, was not completed.

On the south shore: from nearly 1 km west of the south end of the causeway to the shore just west of the onshore chambered cairn north of Rubha Ghaisnis, southeast of the south end of the causeway (waypoints 26 to 59).

Weather

In the week before the survey, the Western Isles experienced dry and exceptionally warm weather with the temperature reaching 27 degrees Celsius.

Sunday 27th July 2014 – Dry and mild, 100% cloud cover, wind direction W speed 11 knots, temperature 15°C.

Monday 28th July 2014 – Dry and mild, 100% cloud cover, wind direction N/NW speed 5.2 knots, temperature 5.2°C.

Tuesday 29th July 2014 – Dry and mild with slight gusts in the morning, 95% cloud cover, wind direction NW speed 8 knots, temperature 22.8°C.

Stakeholder engagement during the survey

The fishery is a naturally occurring wild stock with numerous harvesters. On one occasion the team did observe a van and three harvesters arrive to start work in the bay, Oitir Beag, near the road end at Ard an eoin on the north side. No harvesters were contacted prior to or during the survey.

The sampling officer, Samantha Muir was very helpful during planning and attempted to meet up with the team on Monday 28th July, but poor mobile reception and time constraints prevented a meeting as the team were engaged on the shore walk and were constrained by the low tide duration.

Fishery

Local information regarding the fishery was not readily available and the team were not able to meet the Sampling Officer. Casual information obtained locally was that most harvesters work the north side of South Ford and that cockles are the predominant species sought. On the south side, the old ferry slipway at the southeast end of the causeway is used by harvesters to park vehicles for fishing the south side. A collection of cockle rakes and collecting baskets were seen on the south side stored above the shore and two stacks of plastic collecting baskets were also seen stored on the shore on the north side at different locations.

Sewage Sources

There are a small number of municipal sewage facilities in the area and while the majority of dwellings are evenly dispersed with private drainage, it would appear that some, at least, are linked to communal public sewage schemes.

Three public sewage discharge facilities were designated on the survey plan and visited by the team of which evidence for two were confirmed.

The first was identified as Linaclete Reed Bed according to labelling on the inspection covers (Figs. 3&4). This was situated near a large and busy hotel (The Dark Island Hotel), Linaclete School and museum and a concentration of housing.

The second was only observed by the team as an exposed section of steel pipe, Fig. 5, the outfall of which could not be seen. The team located the precise position indicated on the survey plan but no sign of the outfall or any other installation could be seen. The land and shore thereabouts is very flat with shallow sandy and muddy sandbanks.

The team could not confirm the third public scheme. At the position indicated in the plan there was what appeared to be concrete covers in the grass, flush with the ground but the team were unable to get close to verify the facility because of fencing and no waypoint was taken.

Situated on the northwest side of the fishery there are two hotels, The Isle of Benbecula House Hotel and the Dark Island Hotel. At the southwest end of the causeway are some large sheds. Signage on the exterior indicated a

general supplies store. The slipway below these premises appeared to be no longer in use. No outfall pipe was observed below the septic tank.

All other outfall pipes found are described as in Table 1.

Seasonal Population

The area immediately north of South Ford in the vicinity of the fishery is comparatively well served with hotel accommodation comprising the Dark Island Hotel and its sister hotel, the Isle of Benbecula House Hotel. The former is adjacent to Lionacleit School, library and museum.

The team identified a small number of B&Bs in the area and a campsite was located to the west of the Dark Island Hotel on the north side of the ford. Although observed in the area, the B&Bs and the campsite both lay just outside the survey route therefore no waypoints were taken. Most dwellings appeared to be permanent habitations and the team observed only a few, mainly on the south side, that appeared to be holiday homes. No caravan parks were observed.

Boats/Shipping

Along the shores around the fishery anchorages are all tidal. The fishery dries to large areas of sand and muddy sand at low tide and since the team were present only at low tide no boats were observed navigating the waterway. One well maintained wooden clinker leisure boat was seen moored in Bagh Nam Faoileann (southwest of waypoint 20) on the north side and a small private tidal harbour was seen at Bagh na h-Airde Moire, Aird Mhor (waypoint 44) on the south side. These were the only boats and boat facilities observed during the survey.

Farming and Livestock

Sheep, cattle and horses were all observed by the team in the vicinity of South Ford but of these livestock only a few sheep were observed either on the beach or on ground directly above the shore. Cattle observed were all beef breeds. The team observed many horses and ponies from the road, inland from the nearest shores, while in transit around South Ford and one notice advertised holiday equestrian activities. One set of horse droppings were seen on the grass above the beach at the southeast side of the causeway (waypoint 30, NF 79895 46972) but no livestock was observed in the fields adjacent to the shore near that location.

Land Use

Most land adjacent to the shore on both sides of South Ford appeared to be rough grazing. Signs of a limited amount of peat cutting were also seen. However, these were inland and away from the survey route, resulting in the location not being recorded. The team did not observe any cultivated land outside of private garden grounds.

There are commercial premises at each end of the causeway. At the northeast end is a shellfish plant storing prawns (*Nephrops norvegicus*) and lobsters (*Homarus vulgaris*) on onshore tanks in sheds (Fig. 7, waypoint 12). The team observed several 100 mm diameter hoses leading to and from the shed to the sea, Fig. 8, and were informed by one of four staff that the flowing water was recirculating seawater for the live stored shellfish.

Land Cover

The only trees and shrubs present were in private gardens. Rough grazing grasslands predominated above the beaches with almost no bracken. Many places farther inland from the immediate shore are peat bog.

Watercourses

The land is low-lying and the only significant flowing watercourses encountered by the team were all fed by small lochs farther inshore. The planned freshwater sample just east of Lionacleit (Fig. 9, waypoint 25) was tidal and sampled at low tide. A watercourse beside the Public Outfall, Linaclete Reed Bed, east of the Dark Island Hotel draining from a loch called Oban Lionacleit (waypoint 2), and another on the south side draining from Loch Mhic Dhonuill (waypoint 50, Fig. 13), were the only substantial flowing watercourses encountered by the team.

Wildlife/Birds

Gulls were few in number and ranged throughout the area. The maximum the team observed in one place was 9 birds at waypoint 40. Oyster catchers were frequently seen as single birds and in pairs and on one occasion a large group of about 100 birds was encountered (waypoint 11). A pair of roosting tawny owls was seen by the team on the first day on the north side and a single tawny owl on the second day on the south side (waypoints 17 and 46 respectively). One heron was seen at Aird Mhor on the south side (waypoint 47). One Atlantic grey seal was seen swimming at the start of the shore walk on the north side (waypoint 8, Fig. 6).

Specific observations made during the survey are mapped in Figure 1 and listed in Table 1. Water and shellfish samples were collected at the locations marked on Figure 2. Bacteriology results are given in Tables 2 and 3. Photographs are presented in Figures 3-17.

Shoreline Survey Maps

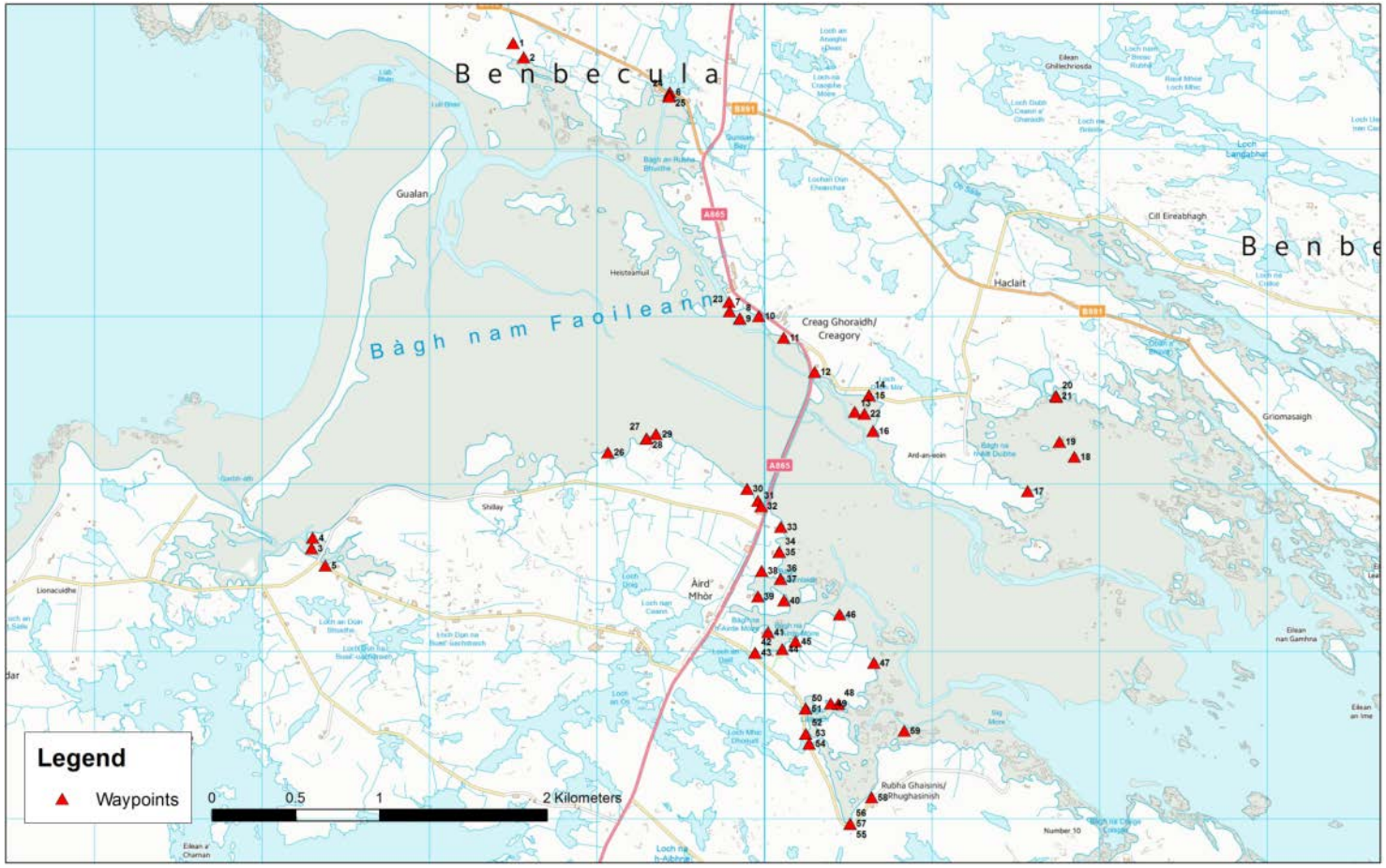


Figure 1. South Ford, Benbecula waypoints

Figure 2. South Ford, Benbecula samples

Table 1 Shoreline Observations

No.	Date	Time	NGR	East	North	Associated photograph	Associated sample	Description
1	27/07/2014	18:03	NF 78498 49632	78499	849633	Figs.3&4		Public Sewage Discharge: Three metal covers on earthwork mound summit. Labels "Linaclete Reed Bed". Final, fourth cover, near stream.
2	27/07/2014	18:16	NF 78561 49547	78561	849547			Suspected Public Sewage Discharge point at the westernmost point on survey map. Several metal inspection covers were installed in a field southeast from Lionacleit school and Dark Island Hotel, appearing to end at pile of rocks on the bank of watercourse draining from Oban Lionacleit loch. Adjoining field with 34 sheep.
3	27/07/2014	19:31	NF 77294 46615	77295	846616			Public Sewage Discharge (PSD) on south shore of South Ford: Iochdar pipe, metal, 200 mm diameter, seen east side of road but no visible end observed to the west of the road.
4	27/07/2014	19:35	NF 77302 46679	77302	846679			East of road grid point given in survey plan for Iochdar PSD facility. Mudbank, no outfall pipe or any other installation visible (Iochdar Septic Tank)
5	27/07/2014	19:40	NF 77377 46512	77377	846513	Fig. 5		Location of visible steel pipe east of road.
6	28/07/2014	8:38	NF 79433 49339	79434	849339			Site of freshwater sample. Tide coming in, sampling and flow measurements deferred to low tide.
7	28/07/2014	9:21	NF 79788 48087	79788	848088			Start of north side South Ford shorewalk at the west end of survey route. Septic tank with no visible outfall but apparent seepage from top of tank.
8	28/07/2014	9:55	NF 79851 47987	79852	847988	Fig.6	SFSW1	Planned seawater sample. Seal (Atlantic Grey) swimming just off the shore.
9	28/07/2014	9:55	NF 79852 47988	79853	847989			Cockle and razor shells seen at seawater sample site.
10	28/07/2014	10:10	NF 79966 48003	79966	848003			Two sheep observed on beach.

No.	Date	Time	NGR	East	North	Associated photograph	Associated sample	Description
11	28/07/2014	10:16	NF 80114 47874	80114	847874			Sound of trickling water heard from deep grass above shore but only stagnant pools observed onshore. Dwellings above shore. Approximately 100 oystercatchers on rocks just off the shore about 50 metres from waypoint 11.
12	28/07/2014	10:33	NF 80298 47669	80298	847670	Fig. 7&8		Commercial shellfish premises above shore. "Sutherland Game and Shellfish". Holding facility for prawns and lobsters with recirculating seawater intake and outfall pipes.
13	28/07/2014	11:01	NF 80537 47431	80538	847432		SFSW2	Planned seawater sample east of Creagorry Island (now part of the causeway).
14	28/07/2014	11:13	NF 80623 47530	80623	847530		SFFW1	Unplanned freshwater sample.
15	28/07/2014	11:14	NF 80623 47529	80623	847530			Sample associated with waypoint 14 appears to be land drainage and emanates from private ground. Flow rate 12 L/min (1 litre measured in 5 sec).
16	28/07/2014	11:28	NF 80647 47317	80647	847317			Power cable observed.
17	28/07/2014	12:02	NF 81571 46957	81571	846958			One pair of tawny owls disturbed. Four oyster catchers seen.
18	28/07/2014	12:35	NF 81849 47162	81850	847162		SFSW3	Planned seawater sample.
19	28/07/2014	12:40	NF 81761 47252	81761	847252		SFSF1	Planned shellfish sample of cockles collected.
20	28/07/2014	13:02	NF 81742 47520	81743	847520		SFFW2	Unplanned freshwater sample.
21	28/07/2014	13:09	NF 81738 47526	81738	847526			Freshwater flow associated with waypoint 20 appears to be run-off from fields. Flow 0.156 m/sec, SD 0.011, dimensions 0.6 m wide by 0.1 m deep. South Ford north side, easternmost extent of shore walk. Team return west to collect samples.
22	28/07/2014	14:06	NF 80595 47420	80596	847420		SFSF2	Planned shellfish sample of cockles collected (associated with site of earlier seawater sample at waypoint 13).

No.	Date	Time	NGR	East	North	Associated photograph	Associated sample	Description
23	28/07/2014	14:58	NF 79790 48030	79790	848031		SFSF3	Planned shellfish sample of cockles collected (associated with site of earlier seawater sample at waypoint 8).
24	28/07/2014	15:14	NF 79430 49320	79431	849320		SFFW3	Planned freshwater sample (associated with waypoint 6).
25	28/07/2014	16:03	NF 79431 49313	79431	849314	Fig. 9		Flow associated with waypoint 24 is tidal. Flow rate 1.887 m/sec, dimensions 0.85 m wide by 0.22 m depth in middle of concrete pipe of internal diameter 1.15 m.
26	29/07/2014	9:15	NF 79064 47189	79065	847189			Start of shorewalk, south side of South Ford, westernmost end of survey route. Derelict thatched dwelling. Concrete covers in garden ground assumed to be septic tank. No outfall pipe to sea observed.
27	29/07/2014	9:29	NF 79294 47271	79294	847272		SFSW4	Planned seawater sample 4.
28	29/07/2014	9:29	NF 79294 47272	79295	847272			One oystercatcher observed.
29	29/07/2014	9:33	NF 79352 47297	79352	847298			Rubbish observed on shore (jetsam).
30	29/07/2014	9:47	NF 79895 46972	79895	846972			Horse droppings observed in the grass above the shore.
31	29/07/2014	9:50	NF 79960 46900	79961	846901			Retail premises, "Carnan Stores", above shore. General hardware supplies.
32	29/07/2014	9:53	NF 79979 46867	79979	846868			Overgrown slipway and probable septic tank associated with premises at waypoint 31. No outfall pipe observed.
33	29/07/2014	10:09	NF 80097 46743	80097	846740			Two septic tanks in close proximity. Both appearing disused with dry outfall pipes protruding about 30 cm from each tank and long grass below each outfall.
34	29/07/2014	10:11	NF 80087 46593	80087	846593		SFFW4	Unplanned freshwater sample 4 marked as contaminated.

No.	Date	Time	NGR	East	North	Associated photograph	Associated sample	Description
35	29/07/2014	10:11	NF 80087 46593	80088	846594	Fig. 10		Outfall pipe with slow flow emerging from garden ground. Standard 100 mm plastic soil drain pipe. Associated with sample at waypoint 34. Flow rate 0.171 L/min (20 ml in 7 sec using 30 ml universal tube as measure).
36	29/07/2014	10:30	NF 80095 46432	80096	846432		SFSW5	Planned seawater sample 5.
37	29/07/2014	10:30	NF 80096 46433	80096	846433	Fig. 11		Site of seawater sample associated with waypoint 36, NW of Eilean na h Airde Moire.
38	29/07/2014	10:42	NF 79983 46481	79983	846481			Stagnant pools from land drainage.
39	29/07/2014	10:49	NF 79959 46328	79960	846329			Septic tank with dry outfall pipe emerging and ending about 100 mm from tank end. Dwelling above appears unoccupied.
40	29/07/2014	10:56	NF 80115 46304	80115	846305			Nine common gulls observed from waypoint.
41	29/07/2014	11:10	NF 80020 46115	80020	846115	Fig. 12		Septic tank and apparent soakaway outside garden ground of new house.
42	29/07/2014	11:27	NF 79943 45991	79944	845992		SFFW5	Unplanned freshwater sample 5.
43	29/07/2014	11:28	NF 79943 45992	79944	845993			Drainage associated with unplanned freshwater sample 5, waypoint 42, emanates from pools ending at Loch an Daill to the south side of the road. Flow 0.5 m/sec, SD 0.003 at 18 cm deep and 0.162 m/sec, SD 0.003 at 10 cm depth, total watercourse width 1.8 m.
44	29/07/2014	11:39	NF 80106 46013	80106	846014			No outfall pipes observed from dwellings above shore. Small private tidal harbour with no boats.
45	29/07/2014	11:43	NF 80183 46060	80184	846060			Stagnant watercourse emerging from fields.
46	29/07/2014	11:51	NF 80448 46221	80448	846221			Roosting tawny owl disturbed by team.
47	29/07/2014	12:01	NF 80651 45931	80652	845932			Heron disturbed by team.
48	29/07/2014	12:15	NF 80440 45686	80440	845686			Sheep observed, four adults and three grown lambs.
49	29/07/2014	12:17	NF 80395 45689	80395	845690			Plastic 100 mm standard soil pipe outfall onto beach. No flow but appeared to be in use.
50	29/07/2014	12:29	NF 80245 45658	80246	845659		SFFW6	Unplanned freshwater sample 6.

No.	Date	Time	NGR	East	North	Associated photograph	Associated sample	Description
51	29/07/2014	12:37	NF 80244 45658	80245	845658	Fig. 13		Watercourse associated with waypoint 50 draining under road from Loch Mhic Dhonuill. Flow split in two by rock: 0.431 m/sec, SD 0.010, depth 14 cm by width 26 cm and 0.187 m/sec, SD 0.004, depth10 cm by width 13 cm.
52	29/07/2014	12:45	NF 80246 45508	80246	845508			Plastic 100 mm standard soil pipe outfall onto beach seen from road. No flow observed but appeared to be in use by dwelling above shore.
53	29/07/2014	12:52	NF 80266 45449	80267	845449		SFFW7	Unplanned freshwater sample from slow flowing watercourse (drain).
54	29/07/2014	12:52	NF 80266 45449	80267	845449	Fig. 14		Under road drain associated with waypoint 54 formed from corrugated iron cast around with concrete. Flow 0.431 m/sec, SD 0.006, width 49 cm, depth in middle 14 cm, pipe diameter 59 cm.
55	29/07/2014	13:11	NF 80510 44970	80511	844970		SFFW8	Unplanned freshwater sample 8.
56	29/07/2014	13:12	NF 80510 44970	80511	844970	Fig. 15		Under road drain associated with waypoint 55 formed from corrugated iron cast around with concrete, 0.87 m diameter. Negligible flow.
57	29/07/2014	13:18	NF 80510 44972	80511	844972	Fig. 16		Septic tank observed from waypoint 57 with outfall pipe (right angle joint, 100 mm standard soil pipe) ending in air at tank. Property notice indicated that it was a holiday house at the time of the survey.
58	29/07/2014	13:25	NF 80639 45128	80640	845128			Septic tank, concrete, observed about 30 m from waypoint 58. Outfall not observed.
59	29/07/2014	13:50	NF 80833 45526	80834	845527	Fig. 17	SFSW6	Planned seawater sample 6. End of South Ford shoreline walk south side, southeast corner of fishery.

Photographs referenced in the table can be found attached as Figures 3 to 17.

Sampling

Seawater and freshwater samples were collected at the sites marked in Figure 2. The team were unable to complete just under the last kilometre of the easternmost section of the planned shoreline walk on the north side of South Ford from about NF 821,475 eastwards.

All freshwater and all seawater samples on the survey plan were acquired.

In addition three cockle samples were taken as well as the seawater samples from the north side of South Ford although either seawater or shellfish had been stipulated in the plan. Cockle sample SFSF3 was collected in a low water channel within 50 m of a house close by the Cooperative store, west of the north end of the causeway. The onshore tank for this house had overflow seepage marks.

All the samples were transferred to Biotherm 30 boxes with ice packs and shipped by air (Benbecula and Stornoway airports respectively) to Glasgow Scientific Services (GSS) for *E. coli*. analysis. Three seawater, three freshwater and three shellfish (cockle) samples were collected and sent to the laboratory on the 28th July, the temperature on arrival at the laboratory was recorded as 1.7°C. Three seawater and five freshwater samples were collected and sent to the laboratory on the 29th July the temperature on arrival at the laboratory was recorded as 4.8°C.

Seawater samples were tested for salinity by GSS and the results were reported in mg Chloride per litre. These results have been converted to parts per thousand (ppt) using the following formula:

$$\text{Salinity (ppt)} = 0.0018066 \times Cl^{-} \text{ (mg/L)}$$

Table 2. Water Sample Results

No.	Date	Sample	Grid Ref	Type	E. coli (cfu/100ml)	Salinity (ppt)
1	28/07/2014	SFFW1	NF 80623 47530	Freshwater	50	
2	28/07/2014	SFFW2	NF 81742 47520	Freshwater	10	
3	28/07/2014	SFFW3	NF 79430 49320	Freshwater	50	
4	28/07/2014	SFSW1	NF 79851 47987	Seawater	42	35.59
5	28/07/2014	SFSW2	NF 80537 47431	Seawater	9	35.95
6	28/07/2014	SFSW3	NF 81849 47162	Seawater	4	35.59
7	29/07/2014	SFFW4	NF 80087 46593	Freshwater	7200000	
8	29/07/2014	SFFW5	NF 79943 45991	Freshwater	<10	
9	29/07/2014	SFFW6	NF 80245 45658	Freshwater	10	
10	29/07/2014	SFFW7	NF 80266 45449	Freshwater	20	
11	29/07/2014	SFFW8	NF 80510 44970	Freshwater	120	
12	29/07/2014	SFSW4	NF 79294 47271	Seawater	62	35.59
13	29/07/2014	SFSW5	NF 80095 46432	Seawater	21	35.41
14	29/07/2014	SFSW6	NF 80833 45526	Seawater	35	35.59

Table 3. Shellfish Sample Results

No.	Date	Sample	Grid Ref	Type	E. coli (MPN/100g)
1	28/07/2014	SFSF1	NF 81761 47252	Common cockles	68
2	28/07/2014	SFSF2	NF 80595 47420	Common cockles	270
3	28/07/2014	SFSF3	NF 79790 48030	Common cockles	2400

Salinity Profiles

No CTD salinity profiles were taken because no boat work was required.

Photographs – Times recorded on photographs are BST

Figure 3. Linaclete reed bed situated northwest of the survey site. Waypoint 1.

Fig. 4 Labelling on inspection cover at municipal PSO, Linaclete. Waypoint 1.

Figure 5. Lochdar septic tank pipe falling towards the shoreline, situated southwest of the survey site. Waypoint 5.

Fig. 6 Atlantic grey seal (near waypoint 8).

Fig. 7 “Sutherland Game and Shellfish” commercial shellfish processing and storage plant. Waypoint 12.

Fig. 8 Seawater intake and outfall pipes at “Sutherland Game and Shellfish” plant. Waypoint 12.

Fig. 9 Tidal freshwater outlet drain under roadway sampled at low tide. Site of planned freshwater sample SFFW3. Waypoint 25.

Figure 10. Septic tank discharge onto the shore, south east of the causeway. Site of unplanned freshwater (contaminated) sample SSFW4. Waypoint 35.

Fig. 11 Site of planned seawater sample SFSW5, waypoint 37, with the small islet of Eilean na h-Airde Moire in the distant centre of the photograph.

Fig. 12 Septic tank and apparent soakaway in garden ground of new house. Waypoint 41.

Fig. 13 Freshwater outflow from inland Loch Mhic Dhonuill. Roadway on the left. Site of unplanned freshwater sample SFFW6, waypoint 51.

Fig. 14 Drain under roadway with slow flowing watercourse. Site of unplanned freshwater sample SFFW7, waypoint 54.

Fig. 15 Drain under roadway with almost no flow. Site of unplanned freshwater sample SFFW8, waypoint 56.

Fig. 16 Septic tank from holiday house with outfall pipe ending in air above shore. No flow observed. Photograph taken from waypoint 57.

Fig. 17 Site of planned seawater sample SFSW6, north of Rubha Ghaisinis, at the SE of South Ford, associated with waypoint 59.

6. SEPA Private Discharge Consents

Licence No.	NGR	Site Name	Discharge Type	Discharges to	MDF (m3/d)	DMF (m3/d)	PE
CAR/R/1012663	NF 78750 47080	Dwelling, Carnan, South Uist	Sewage (Private) Primary	Soakaway			6
CAR/R/1012683	NF 80499 48973	Dwelling, Liniclate, Benbecula	Sewage (Private) Primary	Soakaway			5
CAR/R/1014544	NF 77443 46544	Dwelling, Eochar, South Uist	Sewage (Private) Primary	Oban na Buail-uachdraich			6
CAR/R/1020703	NF 76970 46240	Dwelling, South Uist	Sewage (Private) Primary	Loch Bee			5
CAR/R/1020957	NF 80320 48450	Dwelling, Creagorry, Benbecula	Sewage (Private) Primary	Soakaway			6
CAR/R/1025554	NF 78780 49540	Dwelling, Liniclate, Benbecula	Sewage (Private) Primary	Soakaway			5
CAR/R/1029175	NF 78810 49810	Dwelling, Liniclate, Benbecula	Sewage (Private) Primary	Soakaway			6
CAR/R/1041545	NF 79308 49476	Dwelling,Liniclate	Sewage (Private) Primary	Land			5
CAR/R/1041860	NF 80189 45800	Dwelling	Sewage (Private) Primary	Land			5
CAR/R/1042031	NF 81820 48030	Dwelling, Creagorry, Benbecula	Sewage (Private) Primary	U/T of Loch an Stoip			5
CAR/R/1042032	NF 81710 47660	Dwelling, Creagorry, Benbecula	Sewage (Private) Primary	Breun Oban			5
CAR/R/1042293	NF 80140 49030	Dwelling, Liniclate	Sewage (Private) Primary	Soakaway			7
CAR/R/1042648	NF 79305 45885	Dwelling, South Uist	Sewage (Private) Primary	Soakaway			6
CAR/R/1042724	NF 77530 45630	Dwelling, Iochdar, South Uist	Sewage (Private) Primary	Soakaway			5
CAR/R/1042727	NF 77030 46150	Dwelling, Iochdar, South Uist	Sewage (Private) Primary	Land			5
CAR/R/1042808	NF 79810 49688	Dwelling, Lionacleit, Benbecula	Sewage (Private) Primary	Soakaway			6
CAR/R/1043138	NF 81320 48270	Dwelling, Hacklett, Benbecula	Sewage (Private) Primary	Soakaway			5
CAR/R/1043277	NF 80896 48007	Dwelling, Hacklet, Benbecula	Sewage (Private) Primary	Loch Dubh Beag			5
CAR/R/1044173	NF 81444 48373	Dwelling, Hacklet, Benbecula	Sewage (Private) Primary	Soakaway			7
CAR/R/1044385	NF 81850 47590	Dwelling, Hacklett, Benbecula	Sewage (Private) Primary	Land			6
CAR/R/1047141	NF 81850 48480	Dwelling, Kilerivagh, Benebecula	Sewage (Private) Primary	Loch Chill Eireadhaigh			5
CAR/R/1047183	NF 80877 43839	Dwelling, Loch Carnan, South Uist	Sewage (Private) Primary	Tidal Pond			5
CAR/R/1047627	NF 80900 48010	Dwelling, Benbecula	Sewage (Private) Primary	Loch Dubh Beag			5
CAR/R/1047649	NF 81410 45140	Dwelling, Rhughasinish, South Uist	Sewage (Private) Primary	Soakaway			5
CAR/R/1048218	NF 80760 48720	Dwelling, Hacklett, Benbecula,	Sewage (Private) Primary	Soakaway			5
CAR/R/1048516	NF 80426 48923	Dwelling,Liniclate, Benbecula	Sewage (Private) Primary	Soakaway			5
CAR/R/1049108	NF 80434 48973	Dwelling, Liniclate, Benbecula	Sewage (Private) Primary	Soakaway			5
CAR/R/1049232	NF 79814 49548	Dwelling, Liniclate, Benbecula,	Sewage (Private) Primary	Land			5
CAR/R/1049678	NF 80860 47960	Dwelling, Hacklett, Benbecula	Sewage (Private) Primary	Soakaway			5
CAR/R/1050151	NF 81780 44384	Dwelling, Rhugashinish, Lochcarnan	Sewage (Private) Primary	U/N watercourse			6
CAR/R/1050282	NF 77820 46340	Dwelling, Bualadubh, South Uist	Sewage (Private) Primary	Soakaway			7

Licence No.	NGR	Site Name	Discharge Type	Discharges to	MDF (m3/d)	DMF (m3/d)	PE
CAR/R/1051752	NF 79656 48877	Dwelling, Creagorry, Benbecula	Sewage (Private) Primary	Bagh na Rubha Bhuidne			5
CAR/R/1052056	NF 77716 45554	Dwelling, Ardnamonie, South Uist	Sewage (Private) Primary	Soakaway			5
CAR/R/1052681	NF 79193 45890	Dwelling, Clachan, South Uist	Sewage (Private) Primary	Loch Ose			5
CAR/R/1052693	NF 79270 45820	Dwelling, Clachan, Eochdar	Sewage (Private) Primary	Soakaway			5
CAR/R/1052874	NF 79810 46841	Dwelling, Carnan, Isle Of South Uist	Sewage (Private) Primary	Soakaway			5
CAR/R/1054331	NF 79740 49650	Dwelling, Linclate, Benbecula	Sewage (Private) Primary	Soakaway			5
CAR/R/1054782	NF 81286 48347	Dwelling, Hacklett, Benbecula	Sewage (Private) Primary	Soakaway			5
CAR/R/1054799	NF 80970 44020	Dwelling, Lochcarnan, South Uist	Sewage (Private) Primary	Loch Carnan			5
CAR/R/1055609	NF 76980 46350	Dwelling, Clachan, Eochar, South Uist	Sewage (Private) Primary	Soakaway			5
CAR/R/1055759	NF 79314 49400	Dwelling, Liniclate, Benbecula	Sewage (Private) Primary	Sound of Monach			5
CAR/R/1055787	NF 79620 48820	Dwelling, Creagorry, Benbecula	Sewage (Private) Primary	Bagh Nam Faoilean			5
CAR/R/1055789	NF 80020 49220	Dwelling, Liniclate, Benbecula	Sewage (Private) Primary	Soakaway			5
CAR/R/1055822	NF 79800 50130	Dwelling, Liniclate, Benbecula	Sewage (Private) Primary	Land			15
CAR/R/1055868	NF 78990 49600	Dwelling, Benbecula	Sewage (Private) Primary	Soakaway			5
CAR/R/1056398	NF 80277 48437	Dwelling, Red Bank, Benbecula	Sewage (Private) Primary	U/N watercourse			5
CAR/R/1056481	NF 79720 50320	Dwelling, Torlum, Benbecula	Sewage (Private) Secondary	Soakaway			6
CAR/R/1056496	NF 79913 49108	Dwelling, Liniclate Muir, Benbecula	Sewage (Private) Primary	Gunisary Bay			15
CAR/R/1056514	NF 81233 48248	Dwelling, Hacklet, Benbecula	Sewage (Private) Primary	Loch na Creige Glaise			5
CAR/R/1056573	NF 77140 46171	Dwelling, Ardnamonie, Iochdar, South Uist	Sewage (Private) Primary	Soakaway			5
CAR/R/1056578	NF 76559 46948	2 Dwellings, Uist	Sewage (Private) Primary	Soakaway			15
CAR/R/1056580	NF 78260 46220	Dwelling, Iochdar	Sewage (Private) Primary	Soakaway			5
CAR/R/1056710	NF 81094 47170	Dwelling, Creagorry, Benbecula	Sewage (Private) Primary	Soakaway			6
CAR/R/1056774	NF 79894 50214	Dwelling, Linilate, Bennecula.	Sewage (Private) Primary	Soakaway			5
CAR/R/1057071	NF 78411 45284	Dwelling, Eochar, Isle of Lewis	Sewage (Private) Primary	Loch an Os			5
CAR/R/1057094	NF 80608 45108	Dwelling, Rhugashinish, Lochcarnan	Sewage (Private) Primary	Grosavagh			5
CAR/R/1057208	NF 79820 49230	Dwelling, Liniclete Moor, Benbecula	Sewage (Private) Primary	Land			5
CAR/R/1057227	NF 78520 45120	Dwelling, Ardnamonie, Isle of South Uist	Sewage (Private) Primary	Loch Bi			5
CAR/R/1057671	NF 79048 49607	Dwelling, Liniclate, Benbecula	Sewage (Private) Primary	Soakaway			9
CAR/R/1057676	NF 80900 44200	Dwelling, Lochcarnan, Uist	Sewage (Private) Primary	Soakaway			5
CAR/R/1057744	NF 80922 44780	Dwelling, Rhugashinish, South Uist	Sewage (Private) Primary	Bagh na Creigh Loisgre			6
CAR/R/1057878	NF 80379 45370	Dwelling, Ardmore, South Uist	Sewage (Private) Primary	Bagh Nam Faoilean			5
CAR/R/1057885	NF 80521 45019	Dwelling, Rhigashinish, South Uist	Sewage (Private) Primary	Bagh na Faoilean			6
CAR/R/1057900	NF 83901 47820	Dwelling, Creagorry, Benbecula	Sewage (Private) Primary	Soakaway			15

Licence No.	NGR	Site Name	Discharge Type	Discharges to	MDF (m3/d)	DMF (m3/d)	PE
CAR/R/1058011	NF 77991 46280	Dwelling, Iochdar, South Uist	Sewage (Private) Secondary	Soakaway			6
CAR/R/1058420	NF 79095 46282	Dwelling, Bualadubh, South Uist	Sewage (Private) Primary	Loch Doig			7
CAR/R/1059454	NF 80390 45690	Dwelling, Ardmore, South Uist	Sewage (Private) Primary	Bagh Lathaich			5
CAR/R/1059500	NF 79100 49380	Dwelling, Liniclate, Benbecula	Sewage (Private) Primary	Soakaway			5
CAR/R/1059615	NF 80230 49180	Dwelling, Liniclate, Benbecula	Sewage (Private) Primary	Soakaway			5
CAR/R/1059657	NF 79793 48066	Dwelling, Creagorry, Benbecula	Sewage (Private) Primary	Bagn Nam Faoilean			5
CAR/R/1059702	NF 79790 49520	Dwelling, Liniclate, Benbecula	Sewage (Private) Primary	Land			5
CAR/R/1059706	NF 79830 49500	Dwelling, Liniclate, Benbecula	Sewage (Private) Primary	Land			5
CAR/R/1059711	NF 79820 49570	Dwelling, Liniclate, Benbecula	Sewage (Private) Primary	Land			8
CAR/R/1059712	NF 80890 45440	Dwelling, Rhugashinish, South Uist	Sewage (Private) Primary	Bagh Nam Faoilean			5
CAR/R/1059719	NF 79532 48658	Dwelling, Creagorry, Benbecula	Sewage (Private) Primary	Bahn Nam Faoilean			5
CAR/R/1059763	NF 79835 48572	Hotel, Benbecula	Sewage (Private) Primary	Soakaway			15
CAR/R/1059952	NF 82050 44450	Dwelling, Rhugashinish, South Uist	Sewage (Private) Primary	Soakaway			5
CAR/R/1059969	NF 78890 49670	Dwelling, Liniclate	Sewage (Private) Primary	Soakaway			5
CAR/R/1060055	NF 79500 45980	Dwelling, Ardmore, South Uist	Sewage (Private) Primary	Land			7
CAR/R/1060062	NF 80190 45640	Dwelling, Ardmore, South Uist	Sewage (Private) Primary	Bagh Lathaich			5
CAR/R/1060080	NF 80860 48150	Dwelling, Hacklett, Benbecula	Sewage (Private) Primary	Land			15
CAR/R/1060122	NF 82931 47241	Dwelling, Grimsay Island	Sewage (Private) Primary	U/N watercourse			5
CAR/R/1060129	NF 79550 49320	Dwelling, Benbecula	Sewage (Private) Primary	Land			5
CAR/R/1060131	NF 78850 49920	Dwelling, Liniclate, Benbecula	Sewage (Private) Primary	Land			5
CAR/R/1060960	NF 81241 47636	Dwelling, Hacklett, Benbecula	Sewage (Private) Primary	Soakaway			7
CAR/R/1061471	NF 82630 47630	Dwelling, Grimsay, Benbecula	Sewage (Private) Primary	Soakaway			5
CAR/R/1061556	NF 78554 46067	Dwelling, Iochdar, South Uist	Sewage (Private) Primary	Loch nan Carranan			5
CAR/R/1061682	NF 81500 44500	Dwelling, Lochcarnan, South Uist	Sewage (Private) Primary	Soakaway			5
CAR/R/1062152	NF 79650 50310	Dwelling, Torlum, Benbecula	Sewage (Private) Primary	Land			6
CAR/R/1062938	NF 79180 49550	Dwelling, Liniclate, Benbecula	Sewage (Private) Primary	Soakaway			5
CAR/R/1064582	NF 79060 49645	Dwelling, Liniclate, Benbecula	Sewage (Private) Primary	Soakaway			5
CAR/R/1064819	NF 82172 44603	Dwelling, Rhughashinish, South Uist	Sewage (Private) Primary	Soakaway			5
CAR/R/1064835	NF 81652 44288	Dwelling, Lochcarnan, South Uist	Sewage (Private) Primary	Soakaway			7
CAR/R/1064948	NF 80076 50367	Dwelling,Torlum, Benbecula	Sewage (Private) Primary	U/T of Loch Olabhat			5
CAR/R/1066215	NF 79910 49810	Dwelling, Liniclate, Benbecula	Sewage (Private) Primary	Soakaway			5
CAR/R/1066280	NF 79880 46130	Dwelling, Ardmore, South Uist	Sewage (Private) Primary	Soakaway			5
CAR/R/1066353	NF 80516 49050	Dwelling, Liniclate, Benbecula	Sewage (Private) Primary	Soakaway			5

Licence No.	NGR	Site Name	Discharge Type	Discharges to	MDF (m3/d)	DMF (m3/d)	PE
CAR/R/1066442	NF 78871 47085	Dwelling, Iochdar, South Uist	Sewage (Private) Primary	Bagh nam Faoilean			5
CAR/R/1066486	NF 76640 46860	Dwelling, Balgarva, Iochdar, South Uist	Sewage (Private) Primary	Soakaway			5
CAR/R/1066650	NF 81250 47926	Dwelling, Hacklete, Benbecula	Sewage (Private) Primary	Land			5
CAR/R/1066658	NF 76840 46800	Dwelling, Balgarva, South Uist	Sewage (Private) Primary	Land			5
CAR/R/1068569	NF 83530 46910	Dwelling, Grimsay Island, Benbecula	Sewage (Private) Primary	Land			5
CAR/R/1069497	NF 81760 45240	Dwelling, Rhughuinish, South Uist	Sewage (Private) Primary	Bagh nam Faoilean			5
CAR/R/1069773	NF 78698 46965	Dwelling, Iochdar, South Uist	Sewage (Private) Primary	Soakaway			6
CAR/R/1070662	NF 81272 43541	Dwelling, Lochboisdale, South Uist	Sewage (Private) Primary	U/N Loch			5
CAR/R/1071234	NF 77180 45940	Dwelling, Eochari, South Uist	Sewage (Private) Primary	Soakaway			6
CAR/R/1076083	NF 77165 46163	Dwelling, Iochdar, South Uist	Sewage (Private) Primary	Soakaway			7
CAR/R/1076103	NF 81352 44210	Dwelling, Loch Caravan, South Uist	Sewage (Private) Primary	Loch Carnan			5
CAR/R/1076157	NF 83349 47914	Dwelling, Grimsay Island, Benbecula	Sewage (Private) Primary	Soakaway			5
CAR/R/1076164	NF 82620 48300	Dwelling, Uiskevagh, Benbecula	Sewage (Private) Primary	Soakaway			5
CAR/R/1076262	NF 81779 44460	Dwelling, Rhughasinish, South Uist	Sewage (Private) Primary	Soakaway			6
CAR/R/1076937	NF 76570 46320	Dwelling, Iochdar, South Uist	Sewage (Private) Primary	Soakaway			6
CAR/R/1077000	NF 77572 46796	Dwelling, Iochdar, South Uist	Sewage (Private) Primary	Soakaway			5
CAR/R/1077065	NF 77634 46770	Dwelling, Eochar, South Uist	Sewage (Private) Primary	Soakaway			5
CAR/R/1077729	NF 78900 49740	Dwelling, Liniclate, Benbecula	Sewage (Private) Primary	Soakaway			5
CAR/R/1077803	NF 83146 47098	Dwelling, Grimsay, Benbecula	Sewage (Private) Primary	Soakaway			5
CAR/R/1077922	NF 78198 45195	Dwelling, Eaochar, South Uist	Sewage (Private) Primary	Loch Bi			5
CAR/R/1078499	NF 78450 46890	Dwelling, Carnan, Eochar, South Uist	Sewage (Private) Primary	Soakaway			5
CAR/R/1078521	NF 81214 47407	Dwelling, Hacklett, Benbecula	Sewage (Private) Primary	Bagh n hAilt Duibhe			5
CAR/R/1079156	NF 78224 45176	Dwelling, Eochar, South Uist	Sewage (Private) Primary	U/T of Loch Bi			5
CAR/R/1080390	NF 78688 46991	Dwelling, Carnan, Eochar, South Uist	Sewage (Private) Primary	Soakaway			7
CAR/R/1095091	NF 82210 43410	Dwelling, Lochcarnan, South Uist	Sewage (Private) Primary	Soakaway			5
CAR/R/1095638	NF 79760 46150	Dwelling,Ardmore, South Uist	Sewage (Private) Primary	Soakaway			5
CAR/R/1102239	NF 78822 49735	Dwelling, Liniclate, Benbecula	Sewage (Private) Primary	Soakaway			5
CAR/R/1109397	NF 78650 49680	Dwelling, Liniclate, Benbecula	Sewage (Private) Primary	Soakaway			8
CAR/R/1111367	NF 81560 43630	Dwelling, Lochcarnan, South Uist	Sewage (Private) Primary	Loch CarnanIsle			6
CAR/R/1111484	NF 78560 46470	Dwelling, Bualadubh, South Uist	Sewage (Private) Primary	Soakaway			5
CAR/R/1117579	NF 83110 47080	Dwelling, Grimsay Island, Benbecula	Sewage (Private) Primary	Land			5

LS=Land/Soakaway, SW= Seawater Body, FW= Freshwater Body, PE= Population Equivalent, - = Not applicable