Scottish Sanitary Survey Programme

Sanitary Survey Report

Bay of Backaskail

OI 453

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Cefas

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Report Distribution – Bay of Backaskail

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Table of Contents

I. Executive Summary

A sanitary survey was undertaken at Bay of Backaskail at the request of the Food Standards Agency in Scotland. Backaskail Bay is located on the south side of the island of Sanday, in the northern Orkney Isles. The survey included Kettletoft Bay, which lies adjacent to Backaskail Bay. The surrounding area is rugged and sparsely populated.

Wild razor clams (*Ensis* sp.) are collected by diving at Backaskail Bay by two harvesters. One operates year-round, while the other only operates in Orkney during the winter. The fishery at Backaskail Bay is in actual fact likely to stretch across both Backaskail and Kettletoft Bays, though these areas may be exploited by different harvesters. Although the sanitary survey did not set out to systematically survey stocking levels, very few empty razor clam shells were observed in Backaskail Bay. There appeared to be more evidence of razor clams within Kettletoft Bay, though empty shells were not present in large numbers.

The most significant sources of faecal contamination to the bay are the Kettletoft septic tank discharge from Bea Ness and potentially diffuse agricultural contamination from livestock. Water draining from Bea Loch is likely to carry diffuse faecal contamination from the livestock surrounding the loch. Any overland flow of rainfall runoff is likely to carry faecal contamination to the bay. Risk is higher at the head of Backaskail Bay, where large numbers of cattle were seen and the outflow from Bea Loch is found and also along the head of Kettletoft Bay. Few direct pathways were found for transport of diffuse pollution to the bay, however.

Wildlife is likely to contribute to background levels of contamination throughout the bay, and may contribute to more locally significant contamination around Kettletoft Bay in particular.

Seawater samples taken during the shoreline survey indicated highest contamination levels at the end of Bea Ness near the outfall, and toward the centre of the head of Backaskail Bay. At the time of sampling, the tide was flooding, or moving up the shore and toward the northeast. There did not appear to be any significant sources of contamination west of the sampling point. Therefore it may be presumed that the interaction of sources and movement of contaminants is more complex and dependent upon factors beyond simple predicted tidal flows.

Recommendations:
The boundaries of the production area were expanded to include more of the potential fishery, and an exclusion zone was recommended around the Kettletoft ST outfall at Bea Ness. A fuller description of the recommended boundaries of both the production area and the exclusion zone can be found in Section 17.

Due to the nature of the fishery, a representative monitoring zone was recommended for razor clams, extending 300 metres southward and 200

metres eastward from HY 6500 3900. As it has not always been possible to get samples of razor clams for monitoring purposes, an alternative RMP was recommended at HY 6600 3841 for the sampling of bagged mussels as a sentinel species. It was recommended that parallel monitoring be undertaken on both species for one year to establish whether continued use of the alternative RMP is adequately protective of public health in the case of this fishery.

II. Sampling Plan

PRODUCTION AREA	Bay of Backaskail	Bay of Backaskail
SITE NAME	Backaskail razors	Backaskail Alternative RMP
SIN	OI 453	OI 453
SPECIES	Razor clam	Common mussels
TYPE OF FISHERY	Wild	sentinel
NGR OF RMP	-	HY 6600 3841
EAST	-	366000
NORTH	-	1038410
BOUNDARIES OF RMZ	Area bounded by lines drawn between HY 6500 3900 to HY 6520 3900 to HY 6520 3850 to HY 6500 3850 to HY 6500 3900	-
TOLERANCE (M)	0	20
DEPTH (M)	NA	1-3m
METHOD OF SAMPLING	Hand	Hand
FREQUENCY OF SAMPLING	Monthly	Monthly
LOCAL AUTHORITY	Orkney Island Council	Orkney Island Council
AUTHORISED SAMPLER(S)		
LOCAL AUTHORITY LIAISON OFFICER		

III. Report

1. General Description

The Bay of Backaskail fishery is located on the southern side of the island of Sanday, in the Northern Orkney Islands (see Figure 1.1). The bay is approximately 2.0 km at its widest point and 0.6 km from the beach to the end of the Kettletoft headland. The bay is located in Sanday Sound and is open to the south.

This sanitary survey was undertaken at the request of Food Standards Agency Scotland.

Figure 1.1 Location of Backaskail Bay

2. Fishery

Wild razor clams (*Ensis* sp.) are reported to be hand dived at Backaskail Bay by two harvesters. One operates year-round, while the other only operates in Orkney during the winter. The bay has not been harvested since June 2011.

Few empty razor shells were found at the tideline in Backaskail Bay. More were observed in Kettletoft Bay, although still only in small numbers.

An attempt was made to collect razor clams from Backaskail Bay at the lowest tide of the survey (0.4 m on 27 September 2011), however no likely burrows or razor clams were found. Anecdotal evidence suggested that the razor clams were only likely to be accessible on the larger spring tides that occur in March. A report from the Sanday Ranger for January to March 2010 indicated that razor clams were collected at low spring tide in Kettletoft Bay in March 2010. This suggests that the beds lie well below MLWS.

The production area boundary is defined by the area bounded by lines drawn between HY 6555 3828 to HY 6352 3828 extending to MHWS. There is currently no defined RMP. Samples of razor clams have been supplied intermittently by the harvester.

Commercial diving for razor clams is likely to be confined to depths of less than 10 metres (Breen *et al* 2011). Surveys for commercially exploitable bivalve species undertaken in Orkney in 1989 did not include the waters around Sanday (McKay 1991) and therefore did not provide information useful for establishing the extent or density of razor clam beds at Backaskail. Therefore, the exploitable bed is presumed to extend from below MLWS to at least the 10 metre depth curve across both bays. The estimated potential bed area, based on depth areas given in Admiralty chart 2562 (UKHO 2010), is identified in Figure 2.1. There are further areas of potentially exploitable depth in Sanday Sound to the south of the island, though these are not shown in the figure.

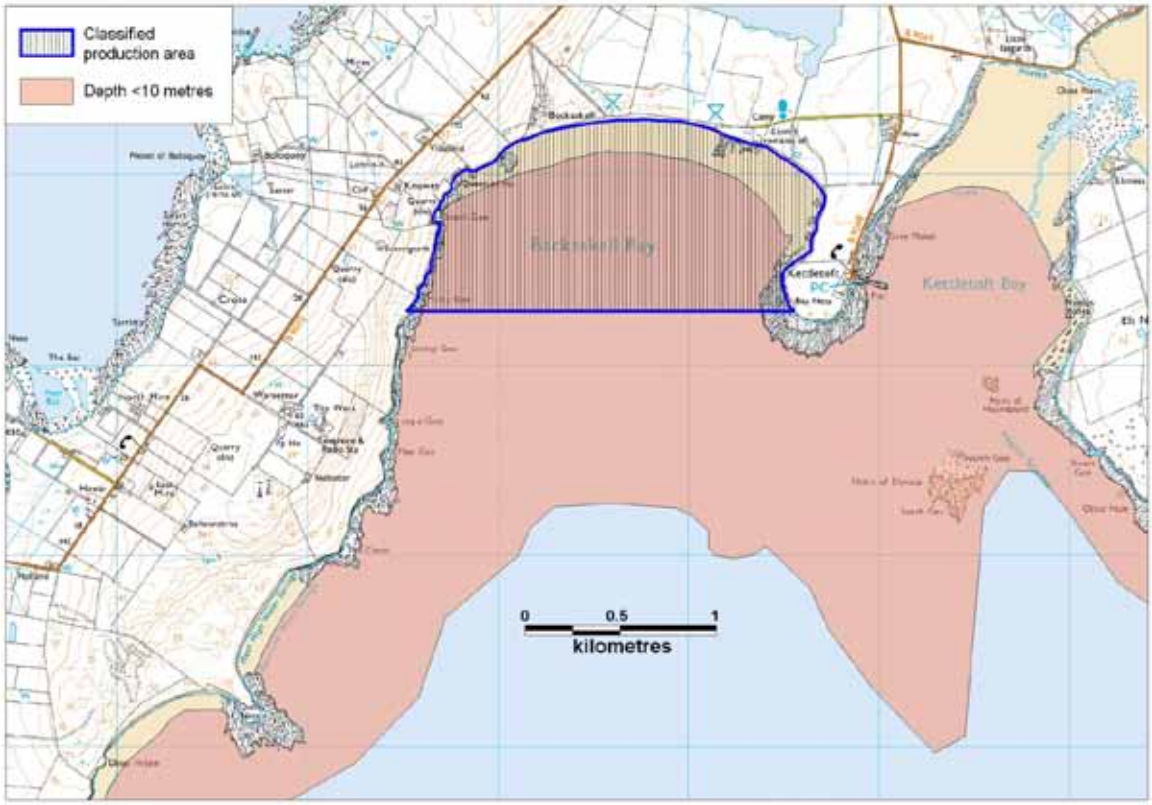

Figure 2.1 Backaskail Bay Fishery

3. Human Population

Information on the population in the vicinity of the Bay of Backaskail at the 2001 census was obtained from the General Register Office for Scotland.

Figure 3.1 Population map of Backaskail Bay

The population of the island of Sanday is split between four census output areas. The shoreline adjacent to Backaskail Bay and Kettletoft Bay lies in a single output area with a population of 135. The majority of the population of this area resides along the main roads. The settlement of Kettletoft is the largest centre of population on the immediate vicinity of the fishery.

Table 3.1 Census output areas: Backaskail Bay

Output area	Population
60RA000020	135
60RA000022	99
Total	**234**

The pier at Kettletoft has public conveniences and a shower block, as well as a mooring area for a small number of boats. The island attracts tourists mainly during the summer season. It was not clear at the time of shoreline survey whether the small hotel at Kettletoft was still in business. There was a B&B at Backaskail, a small car park and picnic areas along the shore of Backaskail Bay. There is further accommodation elsewhere on the island. Therefore, it is likely that the island population is higher during the summer tourist season.

4. Sewage Discharges

Information on sewage discharges to the area was sought from Scottish Water and the Scottish Environment Protection Agency (SEPA). Only one Scottish Water discharge was reported to the southern shore of the island. This is identified in Table 4.1.

Table 4.1 Discharges identified by Scottish Water

Consent Ref No.	NGR of discharge	Discharge Name	Discharge Type	Level of Treatment	Consented flow m^3/day	Consented Design PE
CAR/L/1020381	HY 6592 3843	Kettletoft Septic Tank	Continuous	Septic tank	-	-

No sanitary or microbiological data were available for this discharge. No information on consented flow or design population equivalent (PE) was provided by Scottish Water for this discharge.

Discharge consents provided by SEPA are identified in Table 4.2. The majority serve single dwellings. Only those consented discharges that lie within the catchment of Backaskail and Kettletoft bays are considered below.

Table 4.2 Discharge consents identified by SEPA

No.	Ref No.	NGR of discharge	Discharge Type	Level of Treatment	Consented/ design PE	Discharges to
1	CAR/R/1070936	HY 6237 3714	Sewage (Private)	Septic tank	5	Soakaway
2	CAR/R/1044710	HY 6349 3892	Sewage (Private)	Septic tank	6	Land
3	CAR/R/1065836	HY 6360 3919	Sewage (Private)	Septic tank	6	Soakaway
4	CAR/R/1010753	HY 6414 3931	Sewage (Private)	Septic tank	6	Soakaway
5	CAR/R/1053222	HY 6477 4047	Sewage (Private)	Septic tank	5	Soakaway
6	CAR/R/1057340	HY 6484 4053	Sewage (Private)	Septic tank	5	Land
7	CAR/R/1043297	HY 6496 4064	Sewage (Private)	Septic tank	5	Land
8	CAR/R/1043296	HY 6495 4051	Sewage (Private)	Septic tank	5	Soakaway
9	CAR/R/1040988	HY 6530 4063	Sewage (Private)	Septic tank	5	Soakaway
10	CAR/R/1047973	HY 6530 4029	Sewage (Private)	Septic tank	5	Soakaway
11	CAR/R/1024061	HY 6583 4072	Sewage (Private)	Septic tank	5	Soakaway
12	CAR/R/1070032	HY 6589 4063	Sewage (Private)	Septic tank	5	Soakaway
13	CAR/R/1049611	HY 6580 4019	Sewage (Private)	Septic tank	5	Soakaway
14	CAR/R/1040552	HY 6642 4078	Sewage (Private)	Septic tank	6	Soakaway
15	CAR/R/1045013	HY 6652 4050	Sewage (Private)	Septic tank	6	Soakaway
16	CAR/R/1044163	HY 6654 4054	Sewage (Public)	Septic tank	5	Soakaway
17	CAR/R/1012617	HY 6663 3963	Sewage (Private)	Septic tank	5	Soakaway
18	CAR/R/1049935	HY 6710 3976	Sewage (Private)	Septic tank	5	Soakaway
19	CAR/R/1060395	HY 6724 3982	Sewage (Private)	Septic tank	5	Little Sea
20	CAR/R/1045052	HY 6729 3984	Sewage (Private)	Septic tank	10	Little Sea
21	CAR/R/1045109	HY 6755 4036	Sewage (Private)	Septic tank	5	Soakaway
22	CAR/R/1041851	HY 6750 4019	Sewage (Private)	Septic tank	8	Land
23	CAR/R/1044162	HY 6762 3888	Sewage (Private)	Septic tank	5	Soakaway
24	CAR/R/1043765	HY 6725 3905	Sewage (Private)	Septic tank	5	Kettletoft Bay
25	CAR/R/1014948	HY 6583 3852	Sewage (Private)	Septic tank	5	Land
26	CAR/L/1020381	HY 6548 3811	Sewage (Public) STW	Septic tank	72*	Backaskail Bay
27	CAR/L/1020381	HY 6592 3843	EO	6mm screen	-	Kettletoft Bay

* Consented flow not to exceed 19m^3/day

The majority of the population around Backaskail and Kettletoft Bays are not connected to mains sewerage and instead have private septic tank systems. Table 4.2, No. 25 refers to a septic tank at Kettletoft. Given the location, it is unlikely to discharge to land and more likely that it has either been connected to the public sewerage system or discharges to shore in Kettletoft Bay. Soakaway systems, if properly maintained, would not be expected to materially affect water quality in either of the two bays. However, poorly maintained or malfunctioning septic systems may lead to contaminated runoff overland to the nearest water body.

Shoreline survey observations related to sewage infrastructure are listed in Table 4.3.

Table 4.3 Discharges and septic tanks observed during shoreline surveys

No.	Date	NGR	Description
1	27/09/2011	HY 6590 3842	Public conveniences
2	27/09/2011	HY 6585 3846	Scottish Water pumping station
3	27/09/2011	HY 65883 38480	Old septic pipes, look dry, no odour
4	27/09/2011	HY 65904 38622	Outfall pipe blocked up with wood
5	27/09/2011	HY 65941 38707	Septic pipe, goes under shore
6	27/09/2011	HY 65942 38718	2 septic pipes, both dribbling. Sewage fungus below pipe. End of pipe over 5 feet above shore (above head height)
7	27/09/2011	HY 65973 38765	Old ceramic septic pipe, dry
8	27/09/2011	HY 65502 38129	Ridge of rock running off shore from point, approximately in line with SW tank further north. No pipe visible
9	27/09/2011	HY 65613 38241	Manhole cover in line with raised rock ridge
10	27/09/2011	HY 65911 38422	Pipe running from behind toilets along jetty, unknown purpose, does not appear to run when toilets flushed.
11	27/09/2011	HY 66073 39127	1 septic tank to west
12	28/09/2011	HY 63945 39476	B&B, septic tank on the corner of lot

All discharges or observations identified in Tables 4.1 to 4.3 are shown mapped in Figure 4.1.

The only direct discharge to Backaskail Bay is from the Scottish Water septic tank, which discharges off the end of Bea Ness. The discharge consent identifies that the maximum consented flow is 19m^3 per day, and that an emergency overflow discharges adjacent to Kettletoft pier. It is likely that the pipe observed along the jetty (Table 4.3, No. 10) is the emergency overflow pipe. No evidence of recent flow from this pipe was seen during the shoreline survey. As this should only flow in emergency, it is not expected to affect the bacteriological water quality in the area on a regular basis.

The nearest other septic tank to Backaskail Bay was associated with a B&B at the west end of the bay. This septic tank discharges to soakaway over 100 m uphill from the shoreline and should the tank and soakaway field be in good working order, no appreciable contamination should enter Backaskail Bay. The B&B caters for resident guests and also provides evening meals for non-residents. The discharge consent is for a population equivalent of 6, however

considering the restaurant use on top of the B&B, it may exceed this capacity particularly when the B&B rooms are occupied.

The sewage pumping station at Kettletoft was observed during the survey, and though evidence of the outfall pipe was observed, the pipe itself was not seen. A seawater sample taken from the location suggested moderate faecal contamination.

A number of discharge pipes were observed along the shore of Kettletoft, some of which were active. These appeared to relate to caravans interspersed among the homes along the shore. Other outfall pipes appeared to be out of use and may relate either to homes that were only occupied seasonally or that had been connected to the Scottish Water tank at Kettletoft, making the older discharge pipes redundant.

Observation 11 relates to the septic tank for How Farm. No discharge pipe was found on the shore side of the tank, therefore it is presumed to drain to soakaway. Although SEPA identified a consented discharge to Little Sea at the farm on the north end of Els Ness, no septic tank or evident discharge was found during the shoreline survey.

Discharges along Kettletoft Bay, and any further discharges along Els Ness or Little Sea would be most likely to affect water quality within Kettletoft Bay itself. Discharge from the Scottish Water septic tank at Kettletoft could potentially affect water in both bays, depending on local hydrodynamics. There were no direct discharges to the head of Backaskail Bay.

Figure 4.1 Map of discharges for Backaskail Bay

5. Geology and Soils

Geology and soil types were assessed following the method described in Appendix 2. A map of the resulting soil drainage classes is shown in Figure 5.1. Areas shaded pink and yellow indicate poorly draining soils while areas shaded blue indicate more freely draining soils.

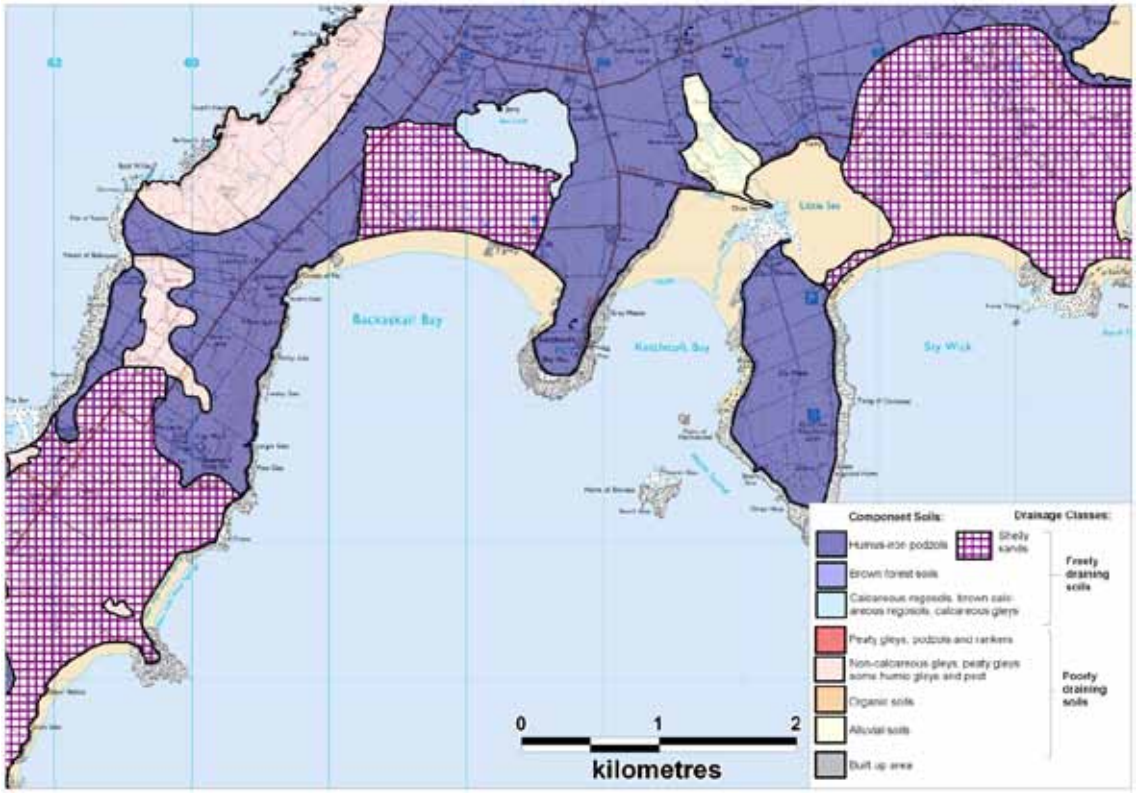

Figure 5.1 Component soils and drainage classes for Backaskail Bay

Four types of component soil can be found in this area. The most predominant is composed of well-drained humus-iron podzols. This soil type (shown in blue or purple) is found on the shores to the east and west of Backaskail Bay extending inland and on Els Ness. Large areas of shelly sands cover the shoreline north and south west of Backaskail Bay and east of Little Sea.

Only one area of poorly-drained soil type was identified adjacent to Backaskail Bay and Kettletoft Bay. This is an area of alluvial soils located at the northern end of Kettletoft Bay.

The potential for contaminated runoff attributable to soil drainage is low along the shore of the Backaskail Bay and slightly higher for the northern end of Kettletoft Bay.

6. Land Cover

The Land Cover Map 2000 data for the area is shown in Figure 6.1 below:

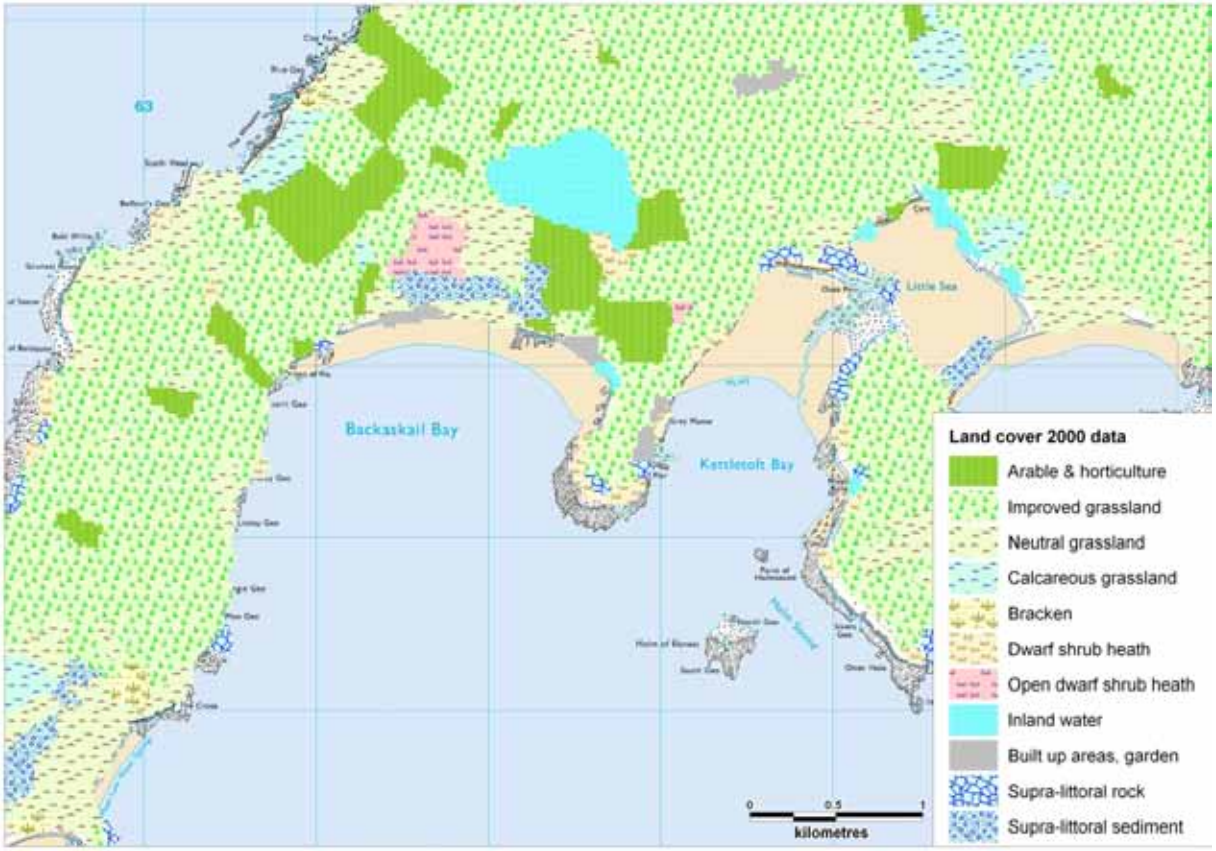

Figure 6.1 LCM2000 class land cover data for Backaskail Bay

Improved grassland is found along parts of the shoreline of Backaskail Bay and around Bea Loch, which drains into Backaskail Bay. In addition to improved grassland there are areas classed as arable to the northeast of Backaskail Bay. Kettletoft is represented as a built up area. Other small built-up areas and an area of supra-littoral rock are identified along the shore of Backaskail Bay. These do not concur with the shoreline survey observations, which indicated the area is farmed.

Studies undertaken by Kay et al (2008) found that faecal indicator organism export coefficients for faecal coliform bacteria were highest for urban catchment areas (approx 1.2 – 2.8x10^{9} cfu km^{-2} hr^{-1}) and lower for areas of improved grassland (approximately 8.3x10^{8} cfu km^{-2} hr^{-1}) and rough grazing (approximately 2.5x10^{8} cfu km^{-2} hr^{-1}) areas. Lowest contributions would be expected from areas of woodland (approximately 2.0x10^{7} cfu km^{-2} hr^{-1}) (Kay *et al*. 2008). 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*. 2008).

The potential for contribution of faecal coliform bacteria attributable to land cover type is therefore significant along the majority of the shoreline of both Kettletoft Bay and Backaskail Bay. In Backaskail Bay, any effect would be greatest where Bea Loch flows to the bay and in Kettletoft Bay the effect would be greatest along the built-up area of Kettletoft.

7. Farm Animals

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 production area. Agricultural census data to parish level was requested from the Scottish Government Rural Environment, Research and Analysis Directorate (RERAD) for Cross & Burness and Lady parishes. Reported livestock populations for the parishes in 2009 and 2010 are listed in Table 7.1. 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 less than five holdings, or where two or fewer holdings account for 85% or more of the information, are replaced with an asterisk.

Table 7.1 Livestock numbers in Cross & Burness and Lady parishes 2009- 2010

	628 – Cross & Burness (34.5 km^2)				629 - Lady (23.2 km^2)			
	2009		2010		2009		2010	
	Holdings	Numbers	Holdings	Numbers	Holdings	Numbers	Holdings	Numbers
Pigs	*	*	*	*	*	*	*	*
Poultry	21	376	22	382	24	514	22	421
Cattle	21	3692	20	3659	15	2671	15	2624
Sheep	38	4625	35	4446	21	1947	21	2002
Horses-ag	*	*	*	*	*	*	*	*
Horses and ponies	9	31	10	35	11	33	11	39

* Data withheld for reasons of confidentiality

The parish of Cross & Burness covers the west half of Sanday as well as the island of North Ronaldsay, which lies 4 km north of Sanday. Both parishes cover significant land areas, only a small part of which lies adjacent or near to Backaskail Bay. Therefore, the parish level data is not sufficient for identifying the numbers of animals likely to be present within the catchment area of the bay. The only spatially relevant information was therefore that obtained during the shoreline survey (see Appendix), which only relates to the dates of the site visit on 27th – 28th September 2011. The spatial distribution of animals observed and noted during the shoreline survey is illustrated in Figure 7.1.

Sanday is largely agricultural, with cattle production higher than sheep production. Large numbers of cattle and sheep were observed on land around both bays and around Bea Loch, as shown in Table 7.2 and Figure 7.1. A small number of pigs and horses were seen on land adjacent to Bea Loch.

Table 7.2 Livestock observed during shoreline survey

	Backaskail Bay	*Kettletoft Bay*	*Bea Loch*
Cattle	77	160	35
Sheep	76	105	38
Pigs			8
Horses/ponies		2	10

Silage is produced on some of the land around the fishery and silage clamps were seen near the shore at Backaskail Bay and draining to the shoreline at Kettletoft Bay. A sample taken of silage effluent draining from a clamp on Els Ness was found to contain no detectable *E. coli*.

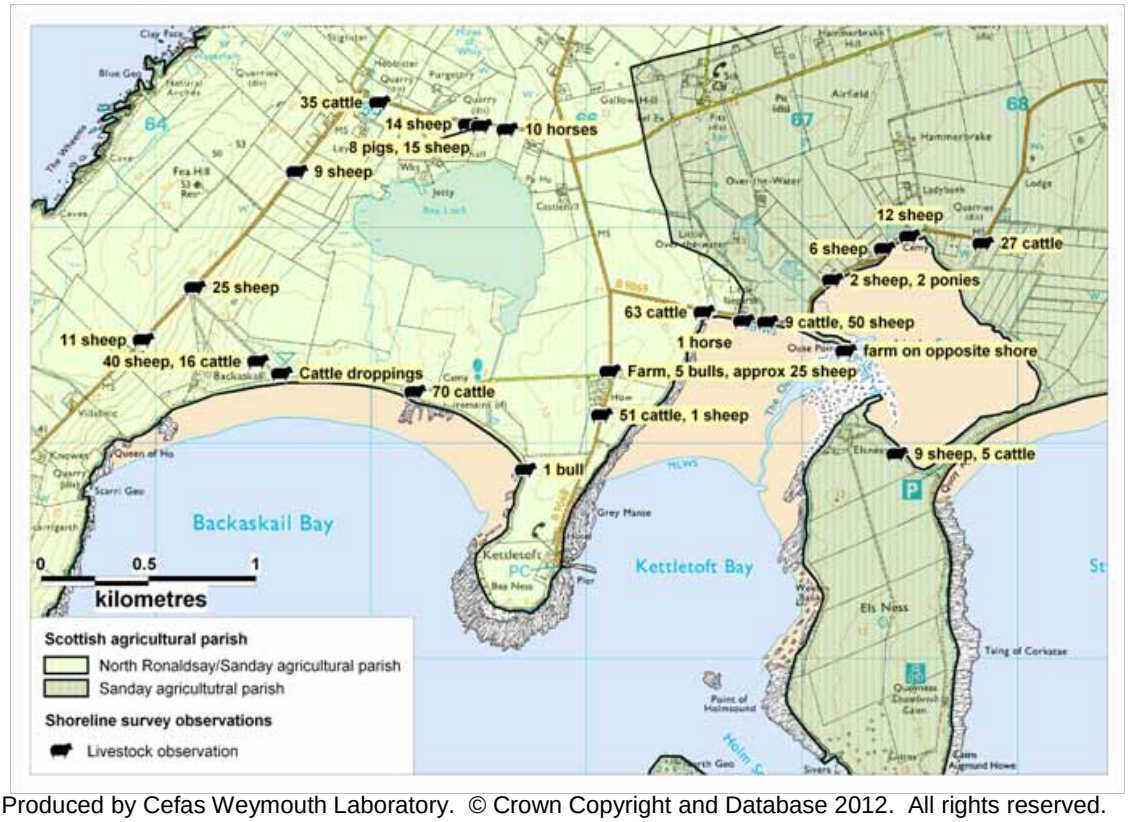

Figure 7.1 Livestock observations at Backaskail Bay

Rainfall runoff from land adjacent to inland areas of Little Sea and Bea Loch is likely to carry faecal contamination from livestock which will drain to the sea at Kettletoft and Backaskail Bays, respectively. Given the large numbers of livestock animals observed, agricultural source diffuse pollution is likely to be the primary source of faecal contamination to the waters of both bays.

8. Wildlife

Wildlife may also contribute to faecal contamination observed at fisheries. General information on the impacts of wildlife species can be found in Appendix 2.

Part of Backaskail Bay and Kettletoft Bay lie within the Sanday Special Area of Conservation, which was designated for its subtidal reef, sandbank, and intertidal mud and sand flat habitats, as well as for its population of Common seals.(http://jncc.defra.gov.uk/protectedsites/sacselection/sac.asp?EUCode=UK0030069.)

The northernmost part of Kettletoft Bay and Little Sea fall within the East Sanday Coast Ramsar site.

Birds
Seabirds

Seabird 2000 data has been provided for a 5 km radius of the Backaskail Bay production area and is shown in Table 8.1 below.

Table 8.1 Seabird counts within 5km of the site.

Common name	Species	Count	Method
Arctic Tern	*Sterna paradisaea*	216	Individuals on land
Northern Fulmar	*Fulmarus glacialis*	4196	Occupied sites
Herring Gull	*Larus argentatus*	79	Individuals on land/Occupied sites
Common Gull	*Larus canus*	365	Individuals on land/Occupied nests
Black Guillemot	*Cepphus grylle*	147	Individuals on land
Great Black-backed Gull	*Larus marinus*	24	Individuals on land/Occupied territory
Lesser Black-backed Gull	*Larus fuscus*	10	Individuals on land
Black-headed Gull	*Larus ridibundus*	86	Individuals on land
Black-legged Kittiwake	*Rissa tridactyla*	134	Occupied nests
European Shag	*Phalacrocorax aristotelis*	70	Occupied nests
Arctic Skua	*Stercorarius parasiticus*	8	Occupied territory

The count in Table 8.1 was adjusted from the survey data to give a total number of likely individuals. Where survey counts were given as occupied sites, nests or territories, the count was multiplied by two. Records of individuals were counted as one. This count does not take into account chicks on the nest, as these numbers may vary and not all pairs of adults will successfully rear young every season. The majority of recorded seabirds were identified along the western shore of the island and are less likely to impact water quality in Backaskail Bay. The largest concentrations of birds bordering on the bay are found along the western shore of Backaskail Bay and on the southern end of Els Ness. Droppings deposited around the nests during summer will be washed into the surrounding land and sea after rainfall and therefore any impact on water quality may linger beyond the summer months.

Waders and Wildfowl

Records of bird counts undertaken by the Royal Society for the Protection of Birds (RSPB) were reported on the Visit Orkney website (http://www.visitorkney.com/birdreports/november2011.asp). Swans, geese and ducks have been reported on Bea Loch from September – November, with the loch sometimes hosting very large numbers of pink-footed geese and wigeon. Highest counts noted on Bea Loch were 2500 wigeon in 2007 and 3500 pink-footed geese in 2009. The Sanday Community website notes that large numbers of greylag geese are present on the island generally during the winter months (http://www.sanday.co.uk/sanday/natural-history).

Seals

Both grey seals (*Halichoerus grypus*) and common or harbour seals (*Phoca vitulina vitulina*) are recorded in Orkney. A survey carried out in August 2010 for harbour seals, during which grey seal numbers were also recorded, showed modest seal numbers in the vicinity of the fishery (Duck and Morris, 2011).

Table 8.2 Seal counts within Backaskail and Kettletoft bays.

	Common Seals	*Grey Seals*
All Sanday	121	107
Stove to Lang Taing*	25	32

*including Kettletoft and Backaskail

These numbers represent a single count date of animals hauled out on shore. Therefore, it may be an underestimate of the total number of seals present, particularly of grey seals. These animals are present in the area year-round and forage widely for food. Therefore, they are presumed to be present in or around the waters of the fishery at least part of the time and are likely to contribute to background levels of faecal contamination in the areas where they are found.

Otters

Otters are known to occur throughout Orkney. Otters typically defecate in established latrines adjacent to freshwater courses. However, there are no permanent water courses suitable for otters discharging to Backaskail Bay.

Whales/dolphins

Harbour porpoises are reported to be commonly found in Orkney waters throughout the year, while other dolphin species are more likely to be present in summer only (http://www.orkney.com/porpoise). No data on the likely distribution and numbers of animals in the area of Backaskail Bay was found. However, it should be presumed that these animals may contribute to background levels of contamination within the bay from time to time.

Overall, the risk of faecal contamination to the waters around the fishery is mainly from seabirds breeding on Els Ness and along the west shore of Backaskail Bay during summer, geese and ducks using Bea Loch in autumn, and from wading birds and seals in Kettletoft Bay. The extent of

contamination from birds is likely to be affected by their seasonal presence but there is likely to be some contribution from these animals throughout the year. Highest impact is likely to be at the outlet of Bea Loch, along the northeast shore of Backaskail Bay, and within the Little Sea. Contamination from seals may be highest where they routinely haul out, and this was observed along the shore at Kettletoft.

Figure 8.1 Map of seabird distributions at Backaskail Bay

9. Meteorological data

The nearest rain station for which weather data was available from was Shapinsay, Balfour Castle which is located 27.6 km south west of the fishery. Rainfall data was available largely complete, however data was missing for 2 days in December 2006 and 2 days in November 2009. Reported rainfall was accumulated over 2 days on 4 occasions in November 2008, one in December 2008 and 2 occasions in 2010. The cumulative data were removed from prior to analysis. The nearest station for which wind data was available was Kirkwall, which is situated 35km south of the fishery. It should be noted that conditions may differ between the weather station and the site due to the distances between them and the differences in topography of the surrounding land.

Data for the station was purchased from the meteorological office and unless stated otherwise further analysis of this section e.g. graphs were undertaken by Cefas. This section aims to describe how the rain and wind patterns may affect bacterial quality of shellfish at the Bay of Backaskail.

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 (e.g. Mallin et al, 2001; Lee & Morgan, 2003). Figures 9.1 and 9.2 depict box and whisker plots that show the distribution of 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 *.

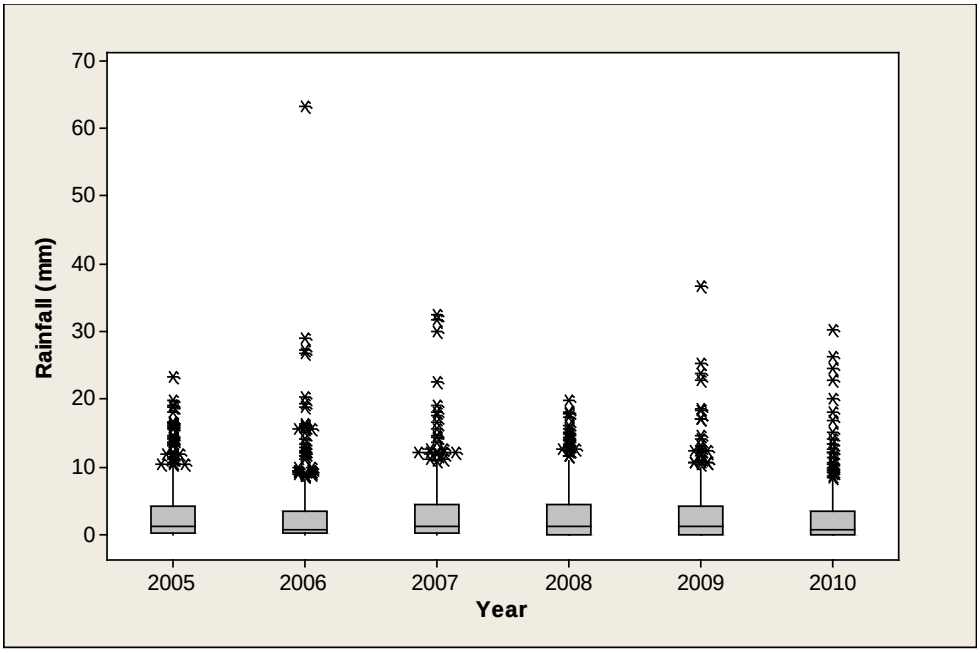

Figure 9.1 Box plots of daily rainfall values by year at Shapinsay (2005 – 2010)

Rainfall varied relatively little from year to year for the period considered, though 2006 was drier than the other years. Peak rainfall events exceeded 30mm on only 5 days over the period.

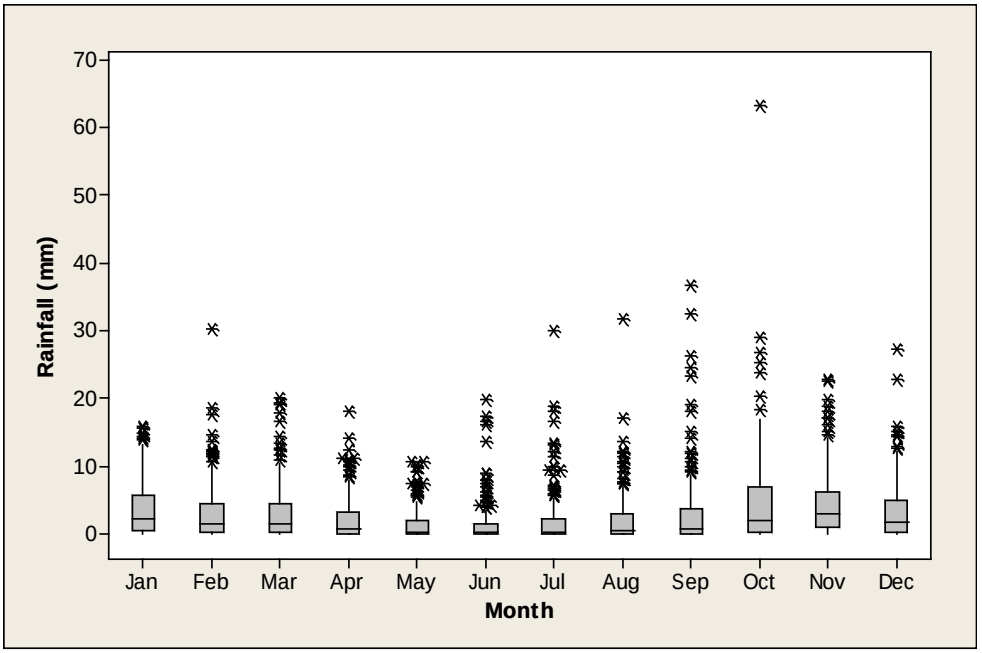

Figure 9.2 Box plots of daily rainfall values by month at Shapinsay (2005 – 2010)

Weather was generally found to be wettest in October and November, with the driest months occurring in May and June. For the period considered here, 49% of days received rainfall of less than 1mm and 7% of days received rainfall of more than 10mm. Rainfall exceeding 30 mm per day occurred in February and July-October. It would be expected that runoff levels will be greater during the periods of higher rainfall as grounds become permanently saturated and overflow systems cannot cope with demand. However, faecal matter can accumulate on pastures during the drier summer months and sporadic high rainfall events during this period can lead to high levels of faecal contamination in runoff.

9.2 Wind

Wind data was collected from Kirkwall and is summarised by seasonal wind roses shown in Figure 9.3 and annually in Figure 9.4.

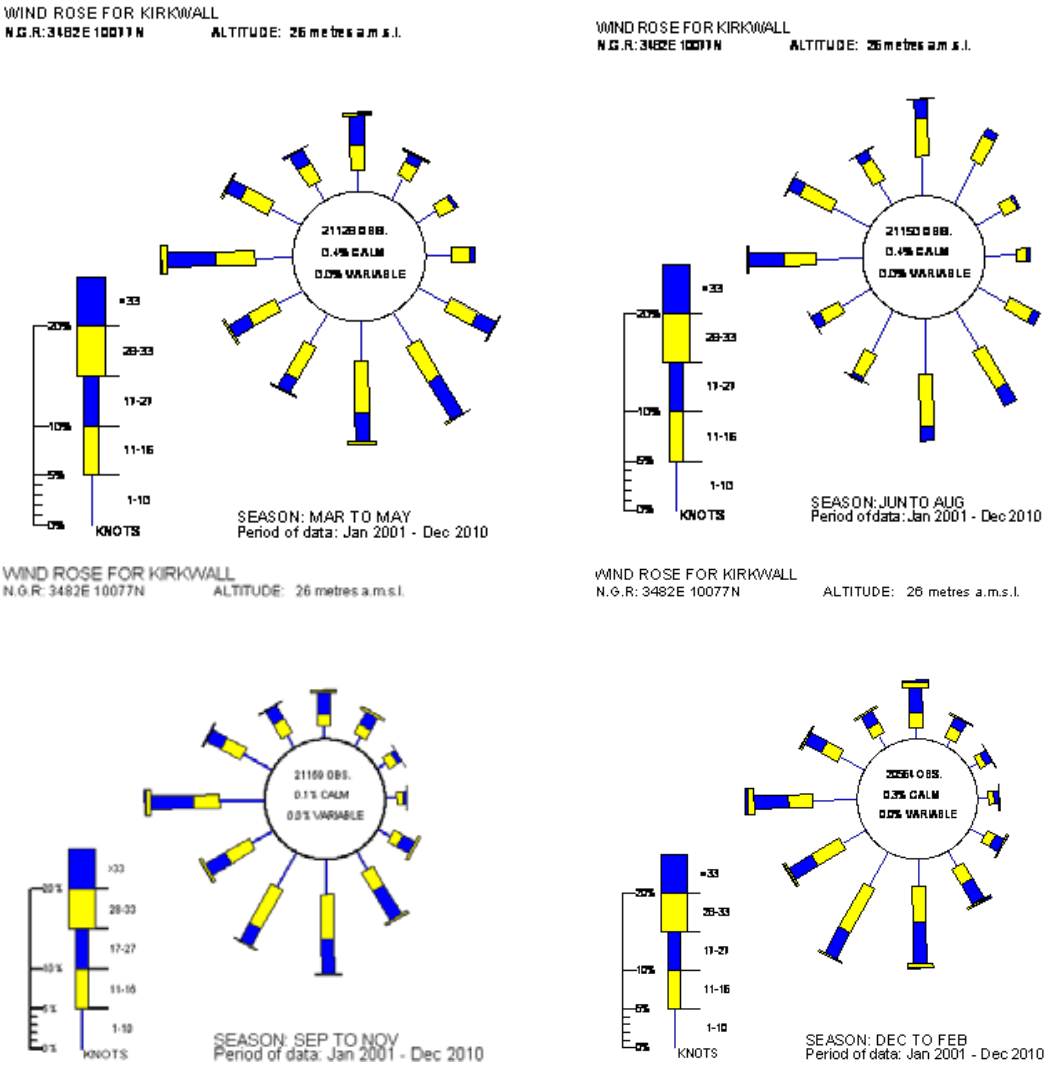

Figure 9.3 Seasonal wind roses for Kirkwall

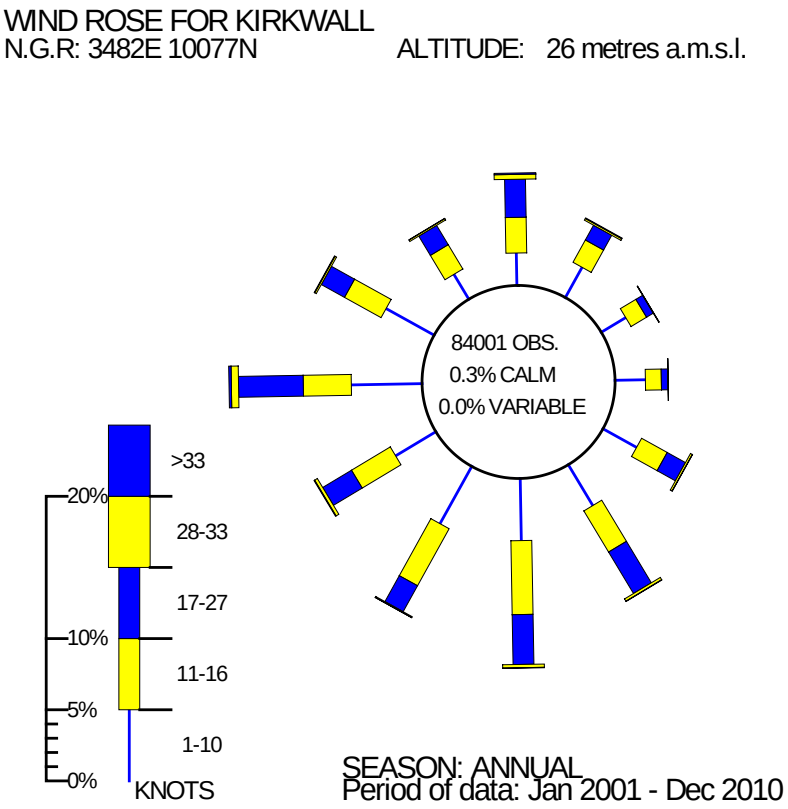

Figure 9.4 Annual wind rose for Kirkwall

Overall, the prevailing winds at Kirkwall airport are from the south and west. In general, winds tend to be slightly lighter in the summer than during the rest of the year. During spring, winds blow more often from the southeast than during other seasons.

Winds typically drive surface waters 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 0.5m/s. Strong winds may affect tide height and significantly alter surface currents depending on wind direction and local hydrodynamics of the site. Strong easterly or southeasterly winds may drive contaminants discharging from the Kettletoft septic tank across Backaskail Bay while strong winds from the west would tend to move contaminants across Kettletoft Bay. Strong southerly winds would be likely to set up complex circulation patterns within each bay, and may tend to keep contaminants arising from the shoreline circulating within the bay in which they arose.

10. Current and historical classification status

The classification status is shown in Table 10.1. Bay of Backaskail is currently classed as a seasonal A/B.

Table 10.1 Classification history, Bay of Backaskail

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2011				A	A	B	B	B	B	B	B	A
2012	A	A	A									

11. Historical *E. coli* data

11.1 Validation of historical data

Data for all razor clam samples taken at Bay of Backaskail up to the end of 2011 were extracted from the database and validated according to the criteria described in the standard protocol for validation of historical *E. coli* data. The samples included those recorded as being taken for the purposes of fast track classification.

No sample was noted as rejected by FSAS. The location for one sample was noted as not verified and no grid reference was given.

Twelve of the thirteen samples were received at the laboratory between 19 and 28 hours after collection. The lab received date/time for the other sample was recorded as being before the collection date/time. The recorded coolbox temperatures were all 8°C or less.

All *E. coli* results are reported in most probable number per 100 g of shellfish flesh and intravalvular fluid. Five samples had the result reported as <20, and were assigned a nominal value of 10 for statistical assessment and graphical presentation. No sample had the result reported as >18000.

11.2 Summary of microbiological results

Table 11.1 Summary of historical sampling and results

Sampling Summary	
Production area	Bay of Backaskail
Site	Backaskail Razors
Species	Razor clams
SIN	OI-453-857-16 (OI-559-1027-16 for fast track samples)
Location	3 (See Figure 11.1)
Total no of samples	13
No. 2010	7
No. 2011	6
Results Summary	
Minimum	<20
Maximum	80
Median	20
Geometric mean	20
90 percentile	80
95 percentile	80
No. exceeding 230/100g	0
No. exceeding 1000/100g	0
No. exceeding 4600/100g	0
No. exceeding 18000/100g	0

11.3 Overall geographical pattern of results

The locations of nine samples were recorded against one grid reference, recorded to 100 m accuracy. This plotted towards the centre of the presently defined production area. The locations of three other samples were reported to 10 m accuracy: two samples were reported against one of these and one sample against the other. Both of these locations plotted at the southern edge of the present production area. The location of one sample was recorded as not verified and no grid reference was given in the database. The locations of the three identified sampling locations are shown on the map in Figure 11.1.

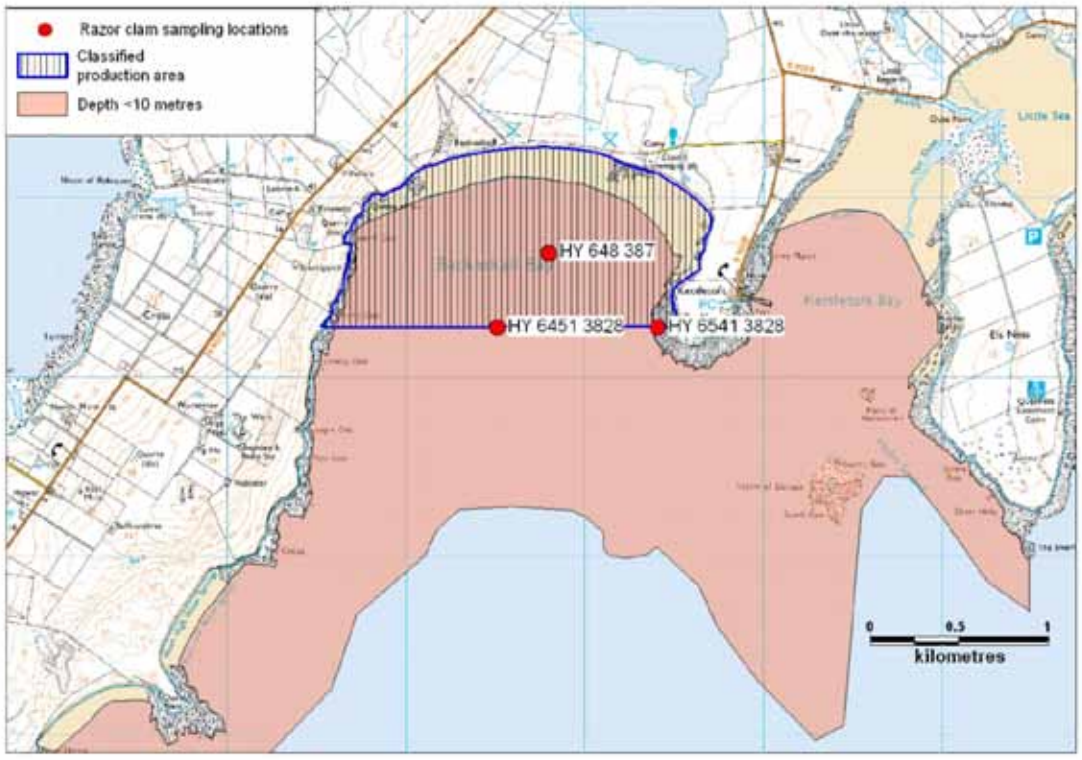

Figure 11.1 Map of razor clam sampling locations

The two highest results of 80 *E. coli* MPN/100 g were recorded against the location plotting towards the middle of the present production area (HY 648 387).

11.4 Overall temporal pattern of results

Figure 11.2 presents a scatter plot of individual *E. coli* results against date. Given the small number of samples, no attempt has been made to fit a smoother or trend line to the data. There is an impression of higher results towards the earlier part of 2010. However, given the intermittent nature of the sampling, together with the low number of results available, it is not possible to determine whether this trend is significant.

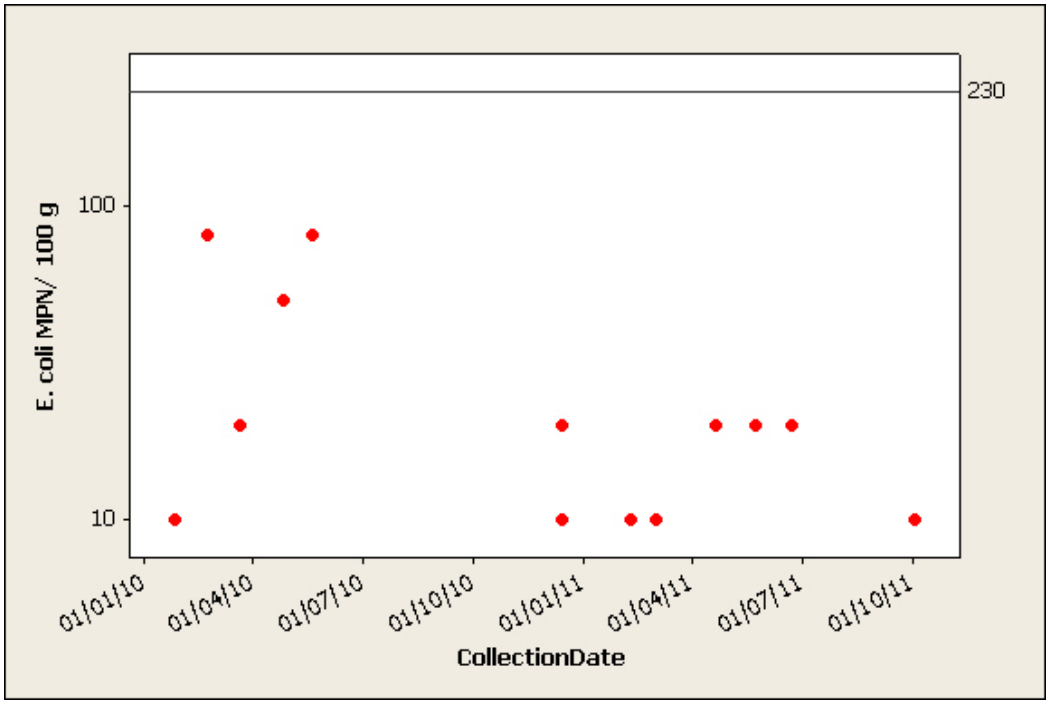

Figure 11.2 Scatterplot of *E. coli* results by date

11.5 Seasonal pattern of results

The very small number of results, together with the intermittent nature of sampling, means that it is not possible to undertake an assessment of the results by season.

11.6 Analysis of results against environmental factors

Environmental factors such as rainfall, tides, winds, sunshine and temperatures can all influence the flux of faecal contamination into growing waters (e.g. 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.

The very small number of results available from the Bay of Backaskail means that it is not possible to undertake an assessment of the magnitude of the *E. coli* levels against environmental factors.

11.7 Evaluation of results over 230 *E. coli* MPN/100g

No results greater than 230 *E. coli* MPN/ 100g have been seen in the monitoring undertaken up to the end of 2011.

11.8 Summary and conclusions

Only thirteen *E. coli* results from razor clams were available from the production area. The maximum result was 80 *E. coli* MPN/100 g. The number of results was insufficient to allow for assessment of time trend or seasonal effects or to allow analysis against environmental factors. The two highest results were reported against a location, recorded to 100 m accuracy, which plotted towards the centre of the present production area. As most of the samples had been reported against that location, it is not possible to make an assessment of spatial variability.

11.9 Sampling frequency

When a production area holds a non-seasonal classification, and where at least 24 results are available over the past 3 years, and the geometric mean of those results falls within a certain range, consideration can be given to reducing the sampling frequency from monthly to bimonthly. Insufficient results are available for the Bay of Backaskail to allow assessment against those criteria.

12. Designated Waters Data

The waters of Backaskail Bay are not currently designated under the either the European Community Shellfish Waters Directive (2006/113/EC) or the EC Bathing Water Directive (2006/7/EC).

13. River Flow

No significant streams were observed during the shoreline survey. Bea Loch overflows to the sea. However, this passes through a large sand berm and although water was observed pooled on either side of the berm, there was insufficient flow across the sand at the time of shoreline survey to measure and sample.

14. Bathymetry and Hydrodynamics

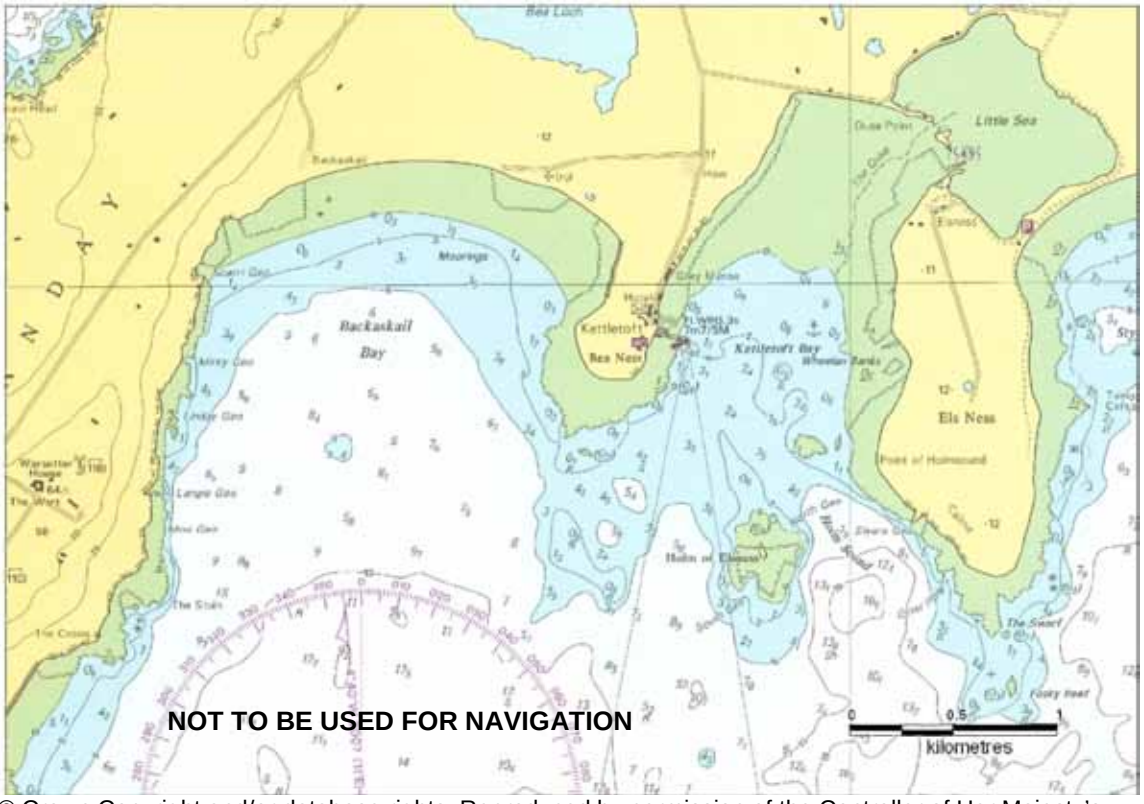

Figure 14.1 Bathymetry at Backaskail Bay

Backaskail Bay is located on the southern side of the island of Sanday. Kettletoft Bay is located immediately to the east of Backaskail Bay and the two are separated by a short promontory, Bea Ness. The western side of Backaskail Bay is formed by the south-western end of Sanday. Sanday Sound lies to the south. There is a large drying area in Backskaill Bay: below this, the seabed slopes fairly gently and the depth (at chart datum) only reaches 10 m at the outer extent of the bay. There is an even greater extent of drying area within Kettletoft Bay and this extends into the Little Sea, a large drying area almost cut off from the rest of Kettletoft Bay by land. The Ouse is a channel that drains the Little Sea. Much of the intertidal area in both bays is sandy, although there are rocky outcrops along the western side of Backaskail Bay, around Bea Ness and along the eastern shore of Kettletoft Bay. Backaskail Bay has been identified as having an area of sandy shingle in the area around the outlet stream of Bea Loch (Barne, *et al*., 1997).

Moorings are identified in Backaskail Bay on the chart, together with an anchorage in Kettletoft Bay. The Clyde Crusing Club guide for the area identifies Kettletoft Bay as a mooring area (Clyde Cruising Club, 2007). No moorings were observed in either bay during the shoreline survey.

14.1 Tidal Curve and Description

The two tidal curves shown in Figure 14.2 are for Kettletoft Pier, on the western side of Kettletoft Bay. The tidal curves have been output from UKHO TotalTide. The first is for seven days beginning 00.00 BST on 27/09/11 and the second is for seven days beginning 00.00 BST on 04/10/11. This two-week period covers the date of the shoreline survey. Together they show the predicted tidal heights over high/low water for a full neap/spring tidal cycle.

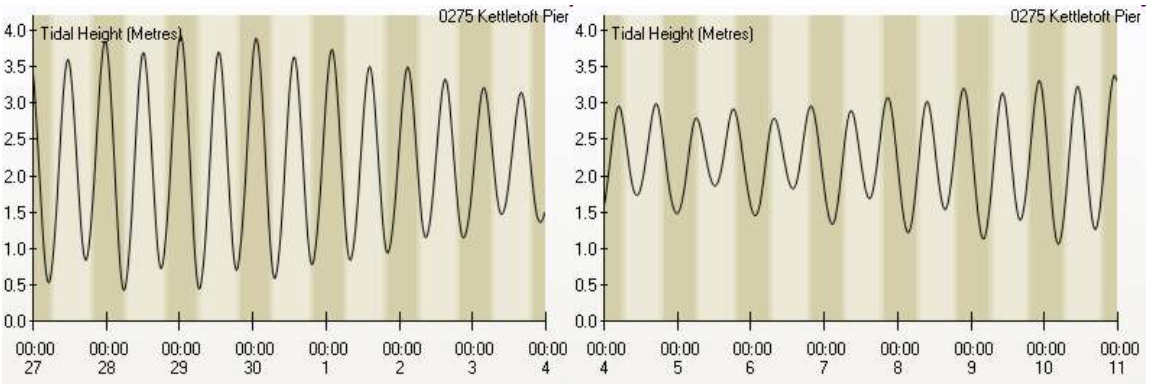

Figure 14.2 Tidal curves for Kettletoft Pier

The following is the summary description for Kettletoft Pier from TotalTide:

0275 Kettletoft Pier is a Secondary Non-Harmonic port.
The tide type is Semi-Diurnal.

HAT	4.0 m
MHWS	3.5 m
MHWN	2.8 m
MSL	2.18 m
MLWN	1.6 m
MLWS	0.9 m
LAT	0.3 m

Predicted heights are in metres above Chart Datum. The average tidal range at springs is 2.6 m and at neap is 1.2 m and so the tidal range is moderate (mesotidal).

14.2 Currents

Tidal stream information was available for a number of stations south and west of the south-west tip of Sanday. The location of these stations and the tidal stream arrows at peak spring flood and neap tide are shown in Figures 14.3 and 14.4. The tidal diamond for SN027R, located in Spurness Sound between Sanday and Stronsay, is shown in Table 14.1. The Clyde Cruising Club guide indicates that although tidal streams are strong in Spurness Sound, as indicated by the figures and the tidal diamond, they are weak in

Sanday Sound. The latter situation will be more applicable to Backaskail Bay. Lawrence *et al*. (2009) modelled current flows around Orkney and predicted currents in the Backaskail Bay area of less than 0.25 m/s. They did predict onshore wave action and simulated wave heights ranged from 1.4 to 2.6 m. The predicted wave heights in Kettletoft Bay were less than 1 m. Reference to the Admiralty Tidal Stream Atlas for Orkney and Shetland Islands shows that tidal streams in the area flow generally easterly on the flood tide up to approximately 1 hour before high water after which the direction veers round to west-south-westerly for most of the ebb tide (Hydrographic Office, 1986). This general direction will be modified by the curve of Backaskail Bay and the promontory of Bea Ness. Over the drying areas, the flow will obviously, in general, be towards the land on the flooding tide and away from it on the ebbing tide: in Backaskail Bay this will be superimposed on the general current flow while in Kettletoft Bay the landward and seaward flows will predominate.

At a peak current flow of 0.25 m/s. Contaminants would be taken a maximum of approximately 3.5 km over a flood or ebb tidal cycle, ignoring any effects from dilution or dispersion. It is expected that the distance that contaminants will be carried by the currents will be less than this for much of the time.

Prevailing south-westerly winds will enhance flows into the two bays and will reduce ebbs flows out of them.

Table 14.1 Tidal streams for station SN027R (59°09.97'N 2°41.60'W) (taken from Totaltide)

Time	Direction	Spring rate (m/s)	Neap rate (m/s)
-06h	071°	1.20	0.46
-05h	085°	0.67	0.26
-04h	125°	0.36	0.15
-03h	195°	0.72	0.26
-02h	244°	1.70	0.67
-01h	240°	1.70	0.67
HW	230°	0.82	0.31
+01h	234°	0.57	0.21
+02h	247°	0.51	0.21
+03h	255°	0.15	0.05
+04h	052°	0.87	0.31
+05h	058°	1.80	0.72
+06h	069°	1.30	0.51

Figure 14.3 Spring flood tide off Sanday

Figure 14.4 Spring ebb tide off Sanday

14.3 Conclusions

Tidal streams in the area of the two bays are expected to be low. In general, on the flood tide, flows will travel towards Backaskail Bay from Spurness Sound on the flood tide and away from it on the ebb. Superimposed on this will be the movement of water over the drying areas. Prevailing south-westerly winds will markedly affect the flows. Contamination arising from within Backaskail Bay will impact across the western part of the fishery on the ebb tide and that arising from within Kettletoft Bay will impact on the eastern part of the fishery, also on the ebb tide. Any contamination arising from the western side of Backskail Bay will be taken across the fishery on the flood tide. Depths in the area are restricted and so there will be limited dilution of any contamination. However, wave action will tend to disperse contaminants.

15. Shoreline Survey Overview

The shoreline survey was conducted on 27-28 September 2011 under rainy conditions. The area surveyed extended from the west end of the beach at Backaskail Bay to the north end of Els Ness on the east side of Kettletoft Bay. Few empty razor shells were found along Backaskail Bay. More razor shells were seen in Kettletoft Bay and Little Sea. An attempt to collect a razor clam sample from Backaskail Bay at low tide during the survey was not successful.

The nearest potential source of human faecal contamination to the Backaskail Bay fishery was the B&B on the west end of the beach. The septic tank for the B&B discharged to soakaway. No other discharges were observed along Backaskail Bay. At Bea Ness, south of Kettletoft, a line of rocks was observed extending off shore in a line from an inspection cover. A seawater sample taken at the line of rocks was found to contain 42 *E. coli* cfu/100ml, which indicated some faecal contamination. A pipe behind the public conveniences and showers at Kettletoft Pier appeared to not be connected to the toilets but appeared to be active though not discharging at the time. The Scottish Water septic tank was observed near the head of the pier. Along the seawall at Kettletoft, several pipes were observed though the majority were dry and did not appear to be septic in nature. Active septic pipes to the shore were observed behind a small number of caravans. A small number of boats were observed at Kettletoft pier and fishing boats normally present were away at the time.

One large farm was seen at Backaskail Bay and two at Kettletoft Bay, and smaller farms were seen around Bea Loch. Large numbers of livestock were observed, with cattle and sheep present in similar numbers. A small number of pigs and horses were also seen around Bea Loch. No animals appeared to have access to the shoreline. Silage was grown on fields not used for grazing. Silage clamps were seen near the shore at Backaskail and Els Ness. The clamp at Els Ness had drains to the shore, and a sample taken on the effluent was found to have no detectable *E. coli*.

A small number of seals were seen in Kettletoft Bay, approximately 300 gulls and waders were seen on mud north of Els Ness, and 40 geese were seen flying over the north end of Kettletoft Bay.

Seawater samples taken during the survey showed low to moderate levels of contamination. The highest contamination levels were observed at mid Backaskail Bay (51 *E. coli* cfu/100ml) and at the end of Bea Ness (42 *E. coli* cfu/100ml). The samples with the lowest *E. coli* concentrations were taken from Little Sea and The Ouse (<1 and 4 *E. coli*, respectively). No shellfish samples were collected during the shoreline survey. The sampling officer collected a mussel sample from a sampling bag at Kettletoft Pier for *E. coli* analysis on 4 October 2011, and it returned a result of 20 *E. coli* MPN/100g.

No permanent water courses were seen, although there appeared to be drainage from Bea Loch to Kettletoft Bay though flow was not sufficient to measure and sample.

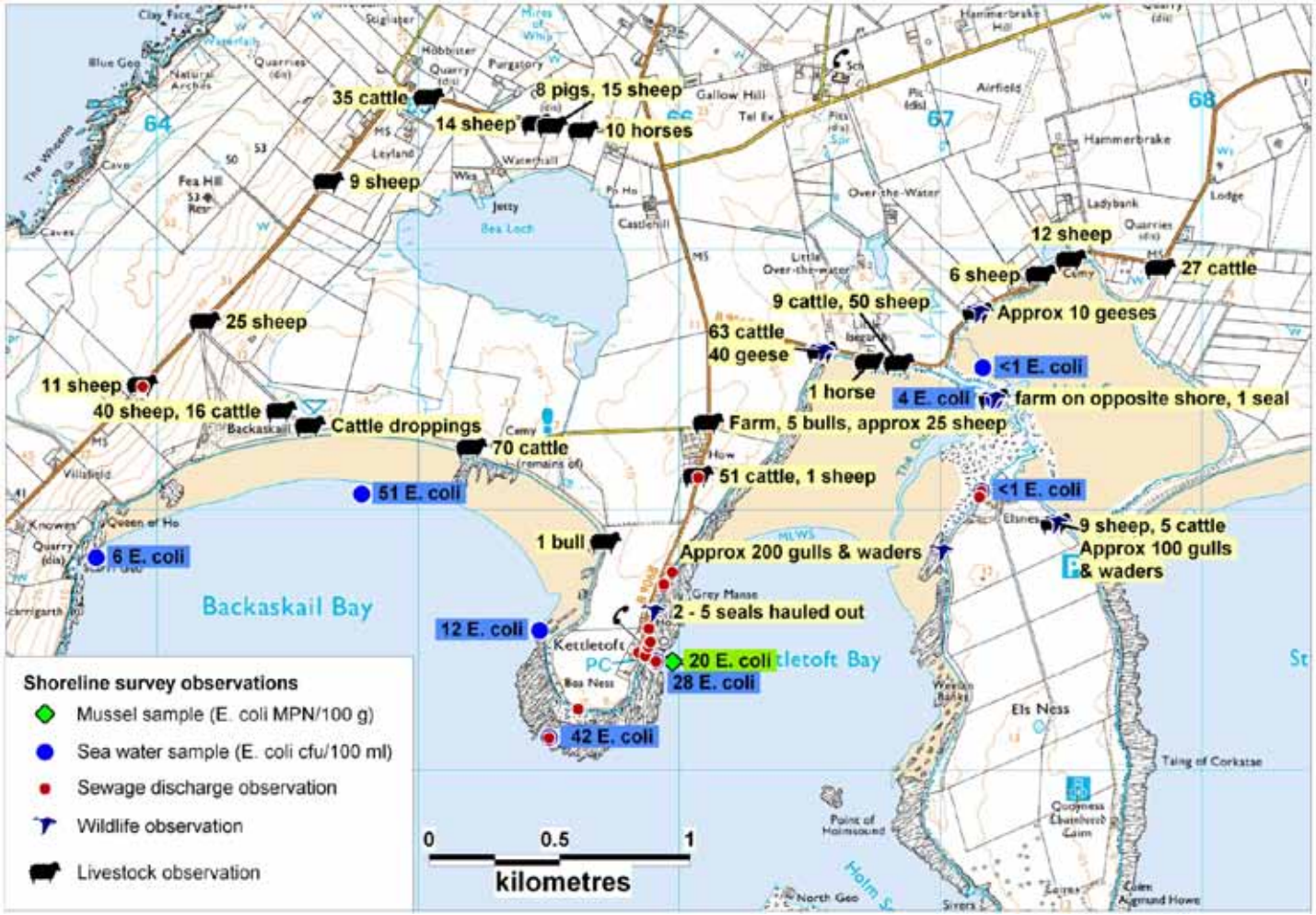

Figure 15.1 Summary of shoreline survey findings for Backaskail Bay

16. Overall Assessment

Human sewage impacts

The most significant discharge of human sewage to the fishery is the septic tank at Kettletoft, which discharges off Bea Ness on the east end of Backaskail Bay. The tank is consented to serve a maximum population of 72, and the pumping station has an emergency overflow that discharges to Kettletoft Bay.

Both the hotel and the public toilets at Kettletoft Pier are presumed to discharge to the public sewerage system. A water sample taken during the shoreline survey near the point of discharge contained an *E. coli* concentration consistent with faecal input; however it was not possible to conclude whether this was due entirely to the septic tank discharge. Discharges from the further individual discharges to Kettletoft Bay from caravans are likely to lead to localised degradation of water quality along the west shore of Kettletoft Bay.

Fishing boats use the pier and are presumed to have on-board toilets. If these are discharged either on return to the pier or within the bay, it could have a deleterious effect on water quality in the vicinity.

Overall, the risk to the fishery from sewage contamination is highest at the end of Bea Ness.

Agricultural impacts

Diffuse agricultural pollution is likely to be a significant source of contaminants to the water of the bay. Water draining from Bea Loch is likely to carry diffuse faecal contamination from the livestock surrounding the loch. This appears to drain through a sand berm and to the waters of Backaskail Bay. Any other overland flow of rainfall runoff is likely to carry faecal contamination to the bay. Risk is higher at the head of Backaskail Bay, where large numbers of cattle were seen and the outflow from Bea Loch is found and also along the head of Kettletoft Bay.

Wildlife impacts

Wildlife impacts on the bacteriological water quality in the area are expected to be affected by the seasonal movements and presences of animals. Geese and ducks are present on Bea Loch in autumn and gulls and wading birds at Little Sea in winter. These are likely to contribute faecal contamination to the head of Backaskail and Kettletoft Bays respectively. Breeding seabirds use the west shore of Backaskail Bay and Els Ness during the summer and impacts from these is most likely near shore along the outer parts of the bay. Seals hauled out along any part of the shoreline may have a localised impact on water quality and these were observed along the shore at Kettletoft.

Seasonal variation

Seasonal variation occurs in the number of human visitors to the island, the presence of wildlife, agricultural practices and rainfall levels. While the number of visitors to the island is likely to be higher during the summer months, the numbers of geese and shorebirds are likely to be higher in winter. Rainfall, which can lead to runoff of contaminants from land, is highest in autumn, while the numbers of sheep present around the area are likely to be higher in summer. There was insufficient *E. coli* monitoring history available on which to base an assessment of any likely corresponding seasonal variation in contamination levels in shellfish flesh.

Rivers and streams

Only one potentially permanent watercourse to Backaskail Bay was identified during the shoreline survey. This discharged from Bea Loch. The catchment for the loch contained a significant number of livestock and during the autumn, large numbers of geese and ducks. However, during the shoreline survey the outflow observed was flowing through a sand berm and flow across the sand was insufficient to measure and sample. Therefore, contamination levels likely to be present in this outflow could not be confirmed.

Movement of contaminants

Movement of contaminants within the bay is expected to be low, with flows moving toward the northeast on the flood tide and the southwest on the ebb. Strong winds would be expected to markedly affect the flows, with the effect complicated by any swell running into the bays. Sewage discharged from the outfall at the end of Bea Ness would be expected to affect the western side of the fishery on the ebb tide and then be carried across the eastern side on the flood tide. Water depths in the bay are shallow, offering limited opportunity for dilution of contaminants, however waves driven from the prevailing wind direction would aid in dispersal.

Predicted particle transport distances suggest that contamination arising in either bay would potentially affect water across the span of both bays over a tidal cycle. Depths are shallower in Kettletoft Bay; therefore there would be less opportunity for dilution of contaminants arising locally than would be possible in the deeper area of Backaskail Bay.

Temporal and geographical patterns of sampling results

Of 13 samples available for analysis, 9 were reported as having been taken at a single grid reference set near the centre of the bay. This was recorded to 100 metre accuracy, however it is not clear whether all the samples came from within 100m of this point or whether samples taken anywhere within the bay were attributed to the centre point of the bay. Therefore it is not possible

to draw any meaningful conclusions regarding the geographic distribution of sampling results from this data.

Samples were taken intermittently over the last two years; therefore it was not possible to assess any trends over that time or by seasons within that period. Due to the expected seasonal variation in factors likely to affect contamination levels, it is anticipated there may be some seasonal variation in contamination levels present within the shellfish.

Conclusions

The fishery at Backaskail Bay in actual fact is likely to stretch across both Backaskail and Kettletoft Bays. Although the sanitary survey did not set out to systematically survey stocking levels, very few empty razor clam shells were observed in Backaskail Bay. There appeared to be more evidence of razor clams within Kettletoft Bay, though empty shells were also not present in large numbers.

The most significant sources of faecal contamination to the bay are the Kettletoft septic tank discharge from Bea Ness and potentially diffuse agricultural contamination from livestock. Few direct pathways were found for transport of diffuse pollution to the bay, however. Wildlife is likely to contribute to background levels of contamination throughout the bay, and may contribute to more locally significant contamination around Kettletoft Bay in particular.

Seawater samples taken during the shoreline survey indicated highest contamination levels at the end of Bea Ness near the outfall, and toward the centre of the head of Backaskail Bay. At the time of sampling, the tide was flooding, or moving up the shore and toward the northeast. There did not appear to be any significant sources of contamination west of the sampling point. Therefore it may be presumed that the interaction of sources and movement of contaminants is more complex and dependent upon factors beyond simple tidal flows.

17. Recommendations

Production area

It is recommended that the classified production area be extended to incorporate more of the probable shellfish bed. The northern boundary has been curtailed at Kettletoft Pier to exclude discharges to the shoreline north of the pier. The southern boundary has been extended to cover most of the 10 metre depth area of the bay and to allow for convenient visual points of reference.

Recommended production area boundaries are the area contained within lines drawn between HY 6315 3700 to HY 6750 3700 and HY 6750 3700 to HY 6750 3725 and between HY 6588 3846 to HY 6702 3844 and extending to MHWS.

Exclusion zone

Due to the presence of a continuous sewage discharge within the production area, it is recommended that an exclusion zone be established around the Scottish Water discharge at HY 6548 3811. The exclusion zone is described as the area bounded by lines drawn between HY 6549 3841 to HY 6517 3841 and HY 6517 3841 to HY 6517 3781 and HY 6517 3781 to HY 6578 3781 and HY 6578 3781 and HY 6577 3824 and extending to MHWS.

RMZ

Due to the nature of the fishery, it is recommended that a representative monitoring zone be established for monitoring of razor clams. The recommended zone extends 200 metres eastward and 500 metres southward of HY 6500 3900 (the area bounded by lines drawn between HY 6500 3900 to HY 6520 3900 to HY 6520 3850 to HY 6500 3850 to HY 6500 3900). All razor clam samples submitted for classification purposes must come from within this boundary and collection location recorded to within 10 metres. As the use of a zone already allows scope for movement to ensure sufficient animals are found for sampling purposes, no further sampling tolerance is recommended.

Sampling depth is not applicable.

Alternative RMP

It is recognised that there may be difficulties in obtaining samples of razor clams for classification monitoring purposes. Therefore, an alternative RMP is recommended for use in monitoring bagged mussels as a sentinel species. The recommended sampling point is HY 6600 3841, on the south side of Kettletoft pier. This is to allow for exposure to any contamination moving east and north from the sewage discharge at Bea Ness. A tolerance of 20m is recommended to allow for a suitable location to hang the bag and to allow some scope for relocating the bag should conditions require.

Bagged mussels should be put in place no less than 2 weeks prior to sampling to ensure time for the shellfish to equilibrate to local conditions. Sampling bags should be hung such that they remain immersed at 1-3 metres below the surface.

Frequency

It is recommended that parallel monitoring be undertaken for one year in order to establish whether the use of the mussel sentinels is adequately protective of public health at the fishery. It is recommended that monthly monitoring be undertaken.

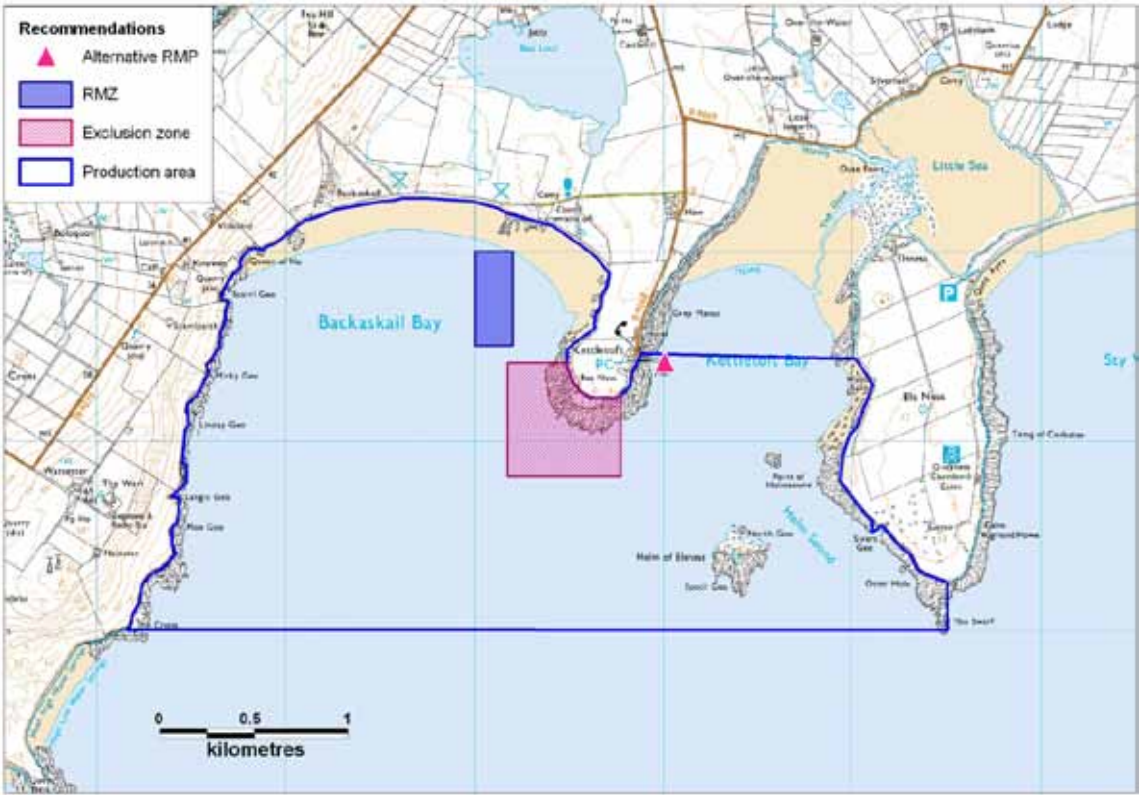

Figure 17.1 Map of recommendations at Backaskail Bay

18. References

Barne, J.H., Robson, C.F., Kaznowska, S.S., Doody, J.P., Davidson, N.C., & Buck, A.L., eds. (1997). Coasts and seas of the United Kingdom. Region 2: Orkney. Peterborough, Joint Nature Conservation Committee. (Coastal Directories Series.).

Breen, M., Howell, T., and Copland, P. (2011) A report on electrical fishing for razor clams (Ensis sp.) and its likely effects on the marine environment. Marine Scotland Science Report Number 03/11. 120pp.

Brown J. (1991). The final voyage of the Rapaiti. A measure of surface drift velocity in relation to the surface wind. *Marine Pollution Bulletin*, 22, 37-40.

Clyde Cruising Club (2007). Sailing Directions and Anchorages: N & NE Scotland and Orkney Islands. Glasgow: Clyde Cruising Club Publications Ltd.

Duck, C. and Morris, C. (2011). Report title*.* Surveys of harbour (common) seals inOrkney in August 2010. *Scottish Natural Heritage Commissioned Report No.439*

Hydrographic Office (1986). Tidal Stream Atlas: Orkney and Shetland Islands. Taunton: Hydrographic Office.

Kay, D, Crowther, J., Stapleton, C.M., Wyler, M.D., Fewtrell, L., Anthony, S.G., Bradford, M., Edwards, A., Francis, C.A., Hopkins, M. Kay, C., McDonald, A.T., Watkins, J., Wilkinson, J. (2008). Faecal indicator organism concentrations and catchment export coefficients in the UK. *Water Research* 42, 442-454.

Lawrence J., Kofoed-Hansen H. and Chevalier C. (2009). High-resolution metocean modelling at EMEC's (UK) marine energy test sites. Proceedings of the 8th European Wave and Tidal Energy Conference, Uppsala, Sweden, 2009.

Lee, R.J., Morgan, O.C. (2003). Environmental factors influencing the microbial contamination of commercially harvested shellfish. *Water Science and Technology* 47, 65-70.

Mallin, M.A., Ensign, S.H., McIver, M.R., Shank, G.C., Fowler, P.K. (2001). Demographic, landscape, and meteorological factors controlling the microbial pollution of coastal waters. *Hydrobiologia* 460, 185-193.

McKay, D.W. (1992) Report on a survey around Scotland of potentially exploitable burrowing bivalve molluscs. Marine Laboratory, Aberdeen Report Number: 1/92. 70pp.

19. List of Figures and Tables

Figures

Tables

Appendices

1. **Geology and Soils Assessment Method**
2. **General Information on Wildlife Impacts**
3. **Tables of Typical Faecal Bacteria Concentrations**
4. **Hydrographic Methods**
5. **Shoreline Survey Report**

Geology and Soils Assessment Method

Component soils and their associations were identified using uncoloured soil maps (scale 1:50,000) obtained from the Macaulay Institute. The relevant soils associations and component soils were then investigated to establish basic characteristics. From the maps seven main soil types were identified: 1) humus-iron podzols, 2) brown forest soils, 3) calcareous regosols, brown calcareous regosols, calcareous gleys, 4) peaty gleys, podzols, rankers, 5) non-calcareous gleys, peaty gleys: some humic gleys, peat, 6) organic soils and 7) alluvial soils.

Humus-iron podzols are generally infertile and physically limiting soils for productive use. In terms of drainage, depending on the related soil association they generally have a low surface % runoff, of between 14.5 – 48.4%, indicating that they are generally freely draining.

Brown forest soils are characteristically well drained with their occurrence being restricted to warmer drier climates, and under natural conditions they often form beneath broadleaf woodland. With a very low surface % runoff of between 2 – 29.2%, brown forest soils can be categorised as freely draining (Macaulay Institute, 2007).

Calcareous regosols, brown regosols and calcareous gleys are all characteristically freely draining soils containing free calcium carbonate within their profiles. These soil types have a very low surface % runoff at 14.5%.

Peaty gleys, peaty podzols and peaty rankers contribute to a large percentage of the soil composition of Scotland. They are all characteristically acidic, nutrient deficient and poorly draining. They have a very high surface % runoff of between 48.4 – 60%.

Non-calcareous gleys, peaty gleys and humic gleys are generally developed under conditions of intermittent or permanent water logging. In Scotland, non-calcareous gleys within the Arkaig association are most common and have an average surface % runoff of 48.4%, indicating that they are generally poorly draining.

Organic soils often referred to as peat deposits and are composed of greater than 60% organic matter. Organic soils have a surface % runoff of 25.3% and although low, due to their water logged nature, results in them being poorly draining.

Alluvial soils are confined to principal river valleys and stream channels, with a wide soil textural range and variable drainage. However, the alluvial soils encountered within this region have an average surface % runoff of 44.3%, so it is likely that in this case they would be poorly draining.

These component soils were classed broadly into two groups based on whether they are freely or poorly draining. Drainage classes were created based on information obtained from the both the Macaulay Institute website

and personal communication with Dr. Alan Lilly. GIS map layers were created for each class with poorly draining classes shaded red, pink or orange and freely draining classes coloured blue or grey. These maps were then used to assess the spatial variation in soil permeability across a survey area and it's potential impact on runoff.

Glossary of Soil Terminology

Calcareous: Containing free calcium carbonate.

Gley: A sticky, bluish-grey subsurface layer of clay developed under intermittent or permanent water logging.

Podzol: Infertile, non-productive soils. Formed in cool, humid climates, generally freely draining.

Rankers: Soils developed over noncalcareous material, usually rock, also called 'topsoil'.

Regosol: coarse-textured, unconsolidated soil lacking distinct horizons. In Scotland, it is formed from either quartzose or shelly sands.

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 50-170kg. 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 and 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 feed (Bedard and Gauthier, 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.

Other

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 Natural Heritage website). 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.

References:

Alderisio, K.A. and N. DeLuca (1999). Seasonal enumeration of fecal coliform bacteria from the feces of Ring-billed gulls (*Larus delawarensis*) and Canada geese (*Branta canadensis*). *Applied and Environmental Microbiology*, 65:5628-5630.

Bedard, J. and Gauthier, G. (1986) Assessment of faecal output in geese. *Journal of Applied Ecology*, 23:77-90.

Lisle, J.T., Smith, J.J., Edwards, D.D., andd McFeters, G.A. (2004). Occurrence of microbial indicators and *Clostridium perfringens* in wastewater, water column samples, sediments, drinking water and Weddell Seal feces collected at McMurdo Station, Antarctica. *Applied and Environmental Microbiology*, 70:7269-7276.

Scottish Natural Heritage. http://www.snh.org.uk/publications/on-line/wildlife/otters/biology.asp. Accessed October 2007.

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}		
Reedbed/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, D. et al (2008) Faecal indicator organism concentrations in sewage and treated effluents. *Water Research* 42, 442-454.

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: Adapted from Geldreich 1978 by Ashbolt et al in World Health Organisation (WHO) Guidelines, Standards and Health. 2001. Ed. by Fewtrell and Bartram. IWA Publishing, London.

Hydrographic Methods

The new EU regulations require an appreciation of the hydrography and currents within a region classified for shellfish production with the aim to “determine the characteristics of the circulation of pollution, appreciating current patterns, bathymetry and the tidal cycle.” This document outlines the methodology used by Cefas to fulfil the requirements of the sanitary survey procedure with regard to hydrographic evaluation of shellfish production areas. It is written as far as possible to be understandable by someone who is not an expert in oceanography or computer modelling. A glossary at the end of the document defines commonly used hydrographic terms e.g. tidal excursion, residual flow, spring-neap cycle etc.

The hydrography at most sites will be assessed on the basis of bathymetry and tidal flow software only. Selected sites will be assessed in more detail using either: 1) a hydrodynamic model, or 2) an extended consideration of sources, available field studies and expert assessment. This document will consider the more basic hydrographic processes and describes the common methodology applied to all sites.

Background processes

Currents in estuarine and coastal waters are generally driven by one of three mechanisms: 1) Tides, 2) Winds, 3) Density differences.

Tidal flows often dominate water movement over the short term (approximately 12 hours) and move material over the length of the *tidal excursion*. Tides move water back and forth over the tidal period often leading to only a small net movement over the 12 hours tidal cycle. This small net movement is partly associated with the *tidal residual* flow and over a period of days gives rise to persistent movement in a preferred direction. The direction will depend on a number of factors including the bathymetry and direction of propagation of the main tidal wave.

Wind and density driven current also lead to persistent movement of water and are particular important in regions of relatively low tidal velocities characteristic of many of the water bodies in Scottish waters. Whilst tidal flows generally move material in more or less the same direction at all depths, wind and density driven flows often move material in different directions at the surface and at the bed. Typical vertical profiles are depicted in Figure 1. However, it should be understood that in a given water body, movement will often be the sum of all three processes.

In sea lochs, mechanisms such as “wind rows” can transport sources of contamination at the edge of the loch to production areas further offshore. Wind rows are generated by winds directed along the main length of the loch. An illustration of the waters movements generated in this way is given in Figure 2. As can be seen the water circulates in a series of cell that draw material across the loch at right angles to the wind direction. This is a particularly common situation for lochs with high land on either side as these tend to act as a steering mechanism to align winds along the water body.

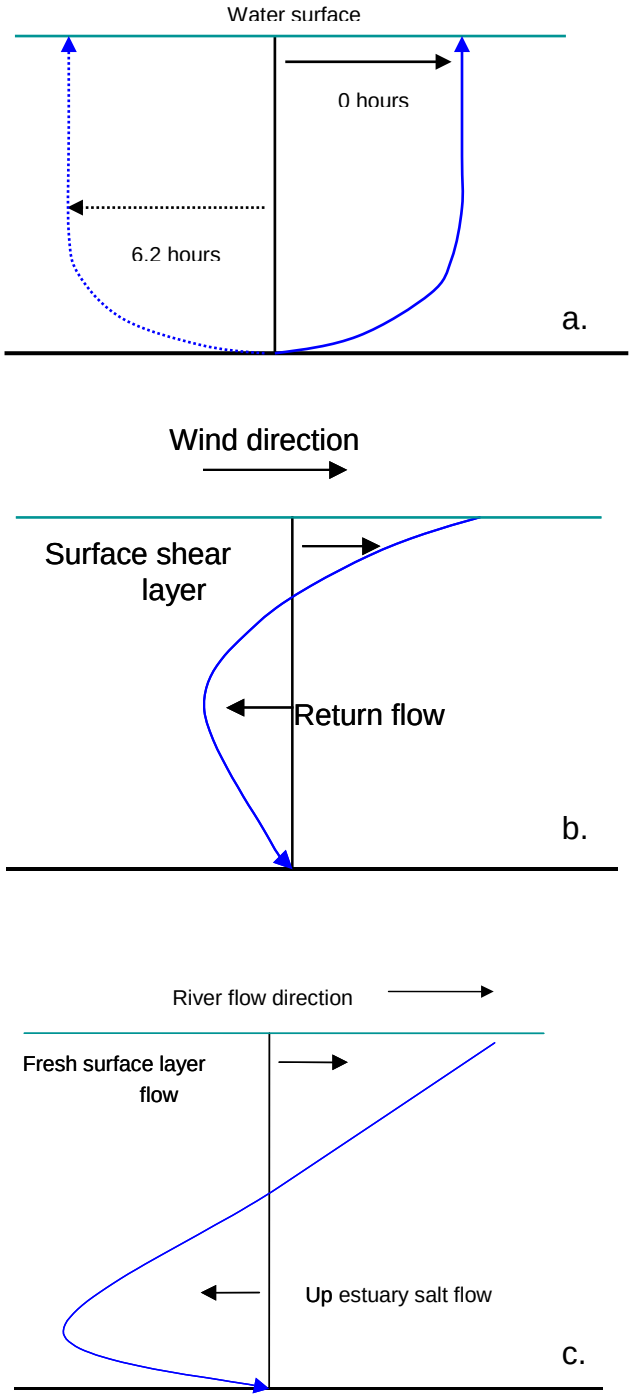

Figure 1. Typical vertical profiles for water currents. The black vertical line indicates zero velocity so portions of the profile to the left and right indicate flow moving in opposite directions. a) Peak tidal flow profiles. Profiles are shown 6.2 hours apart as the main tidal current reverses direction over a period of 6.2 hours. b) wind driven current profile, c) density driven current profile.

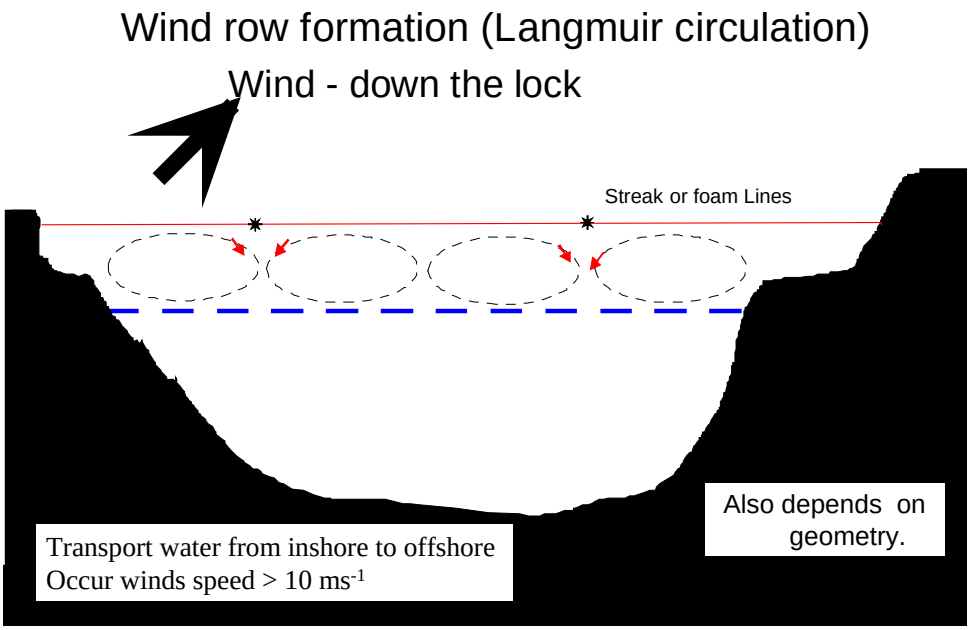

Figure 2. Schematic of wind driven 'wind row' currents. The dotted blue line indicates the depth of the surface fresh(er) water layer usually found in sea lochs.

Non-modelling Assessment

In this approach the assessment requires a certain amount of expert judgment and subjectivity enters in. For all production areas, the following general guidelines are used:

1. Near-shore flows will generally align parallel to the shore.
2. Tidal flows are bi-directional, thus sources on either side of a production area are potentially polluting.
3. For tidal flows, the tidal excursion gives an idea of the likely main 'region of influence' around an identified pollutant source.
4. Wind driven flows can drive material from any direction depending on the wind direction. Wind driven current speeds are usually at a maximum when the wind direction is aligned with the principle axis of the loch.
5. Density driven flows generally have a preferred direction.
6. Material will be drawn out in the direction of current, often forming long thin 'plumes'.

Many Scottish shellfish production areas occur within sea lochs. These are fjord-like water bodies consisting of one or more basins, deepened by glacial activity and having relatively shallow sills that control the mixing and flushing processes. The sills are often regions of relatively high currents, while the basins are much more tranquil often containing higher density water trapped below a fresh lower density surface layer. Tidal mixing primarily occurs at the sills.

The catalogue of Scottish Sea Loch produced by the SMBA is used to quantify sills, volume fluxes and likely flow velocities. Because the flow is so constrained by the rapidly varying bathymetry, care has to be used in the extrapolation of direct measurements of current flow. Mean flow velocities can be estimated at the sills by using estimates of the sill area and the volume change through a tidal cycle. This in turn can be used to estimate the maximum distance travelled in a tidal cycle in the sill area. Away from the sill area, tidal velocities are general low and transport events are dominated by wind or density effects. Sea Lochs

generally have a surface layer of fresher water; the extent of this depends on freshwater input, sill depth and quantity of mixing.

In addition to movement of particles by currents, dilution is also an important consideration. Dilution reduces the effect of an individual point source although at the expense of potentially contaminating a larger area. Thus class A production areas can be achieved in water bodies with significant faecal coliform inputs if no transport pathway exists and little mixing can occur. Conversely a poor classification might occur where high mixing causes high and permanent background concentrations arising from many weak diffuse sources.

References

European Commission 1996. Report on the equivalence of EU and US legislation for the Sanitary Production of Live Bivalve Molluscs for Human Consumption. EU Scientific Veterinary Committee Working Group on Faecal Coliforms in Shellfish, August 1996.

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.

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. The strongest tides in a month are called spring tides and the weakest are called neap tides. Spring tides occur every 14 days with neaps tides occurring 7 days after springs. Both tidal range and tidal currents are strongest at Spring 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. Often a surface flow at the surface is accompanied by a compensating flow in the opposite direction at the bed (see figure 1).

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.

Shoreline Survey Report

Prod. area:	Bay of Backaskail
Site name:	Backaskail razors
Species:	Razor clam
Harvester:	Various
Local Authority:	Orkney Island Council
Status:	Existing
Date Surveyed:	27-28 September 2011
Surveyed by:	Michelle Price-Hayward, Jenni Kakkonen
Nominal RMP:	
Area Surveyed:	Backaskail Bay and Kettletoft Bay

Weather observations

27 September – Rain. Winds South, F5-6. Temperature 14.8 C.
28 September – Dry, partly cloudy. Winds South F4. Temperature 15 C

Fishery

The bay was not being harvested during the survey. Few empty razor shells were found at tideline in Backaskail Bay. More were observed in Kettletoft Bay and Little Sea, although still not in large numbers.

An attempt was made to collect razor clams from Backaskail Bay at the lowest tide of the survey (0.4 m on 27 September), however no likely burrows or razor clams were found. The harvester provided a razor clam sample that was submitted for *E. coli* analysis on 3/10/2011 and the sampling officer collected a mussel sample from the Kettletoft pier on 4/10/2011.

Sewage/Faecal Sources

At Backaskail Bay, there was a B&B near to the shore with a septic tank that discharges to soakaway. No further direct discharges to Backaskail beach were observed. The Scottish Water septic tank at Kettletoft appears to discharge via an outfall off Bea Ness. Inspection covers and a line of mounded rocks running from southwest from the shore at the point and extending beyond the low water mark were observed, though it was not possible to see the outfall. At Kettletoft pier was a public conveniences and shower block. There was a discharge pipe behind the facilities, which ran along the jetty wall and did not appear to be actively discharging at the time of survey. This did not appear to be connected to the toilets, but may have been associated with the shower block.

Along the seawall at Kettletoft, several pipes were observed though the majority were dry and did not appear to be septic in nature. Active septic pipes to the shore were observed behind a small number of caravans. Two of these discharged near or slightly above the high water mark, and were observed to be dribbling. It was not possible to access these for sampling due to their height above the shore. A third pipe extended below the vegetation on the shore and therefore it was not possible to confirm whether it was active.

A small number of boats were tied up at Kettletoft pier, and the sampling officer noted that there were additional fishing boats out that would normally be kept at the pier. None of these appeared to be permanently occupied.

A septic tank was observed to the south and west of How Farm, north of Kettletoft. As this was >150 m from the shore it was presumed to discharge to soakaway.

Farming and livestock
Three large farms were observed, one at Backaskail and two others near Kettletoft. Further smaller farms were located further inland from the area and around Bea Loch, which appears to discharges to Backaskail Bay when it receives sufficient rainfall. Large numbers of cattle and sheep were observed. Silage was grown in fields not used for grazing, and silage stores were observed near the shore at Backaskail and at Elsness.

Livestock were consistently kept fenced away from the shore, and no livestock droppings or animals were observed on the shore.

Seasonal Population
The island is served by regular ferry from Kirkwall and has archaeological sites of tourist interest. There is accommodation at Backaskail as well as a hotel and B&B at Kettletoft.

Boats/Shipping
A small number of boats were present at Kettletoft pier, which is used as a base for local fishermen.

Land Use
Land use around both bays is predominantly agricultural. Most of the area is improved grassland or sown to crops, mainly silage.

Watercourses
There were no significant permanent streams observed. Bea Loch overflows to the sea, however this passes through a large sand berm and water was observed pooled on either side of the burn, but there was insufficient flow across the sand to measure or sample.

Wildlife/Birds
Five seals were observed hauled out on the shore at Kettletoft, and a further seal was observed off Ouse Point. Approximately 300 gulls and wading birds were observed on the intertidal mud off the north shore of Els Ness. A flock of 40 geese were observed flying overhead at the north end of Kettletoft Bay.

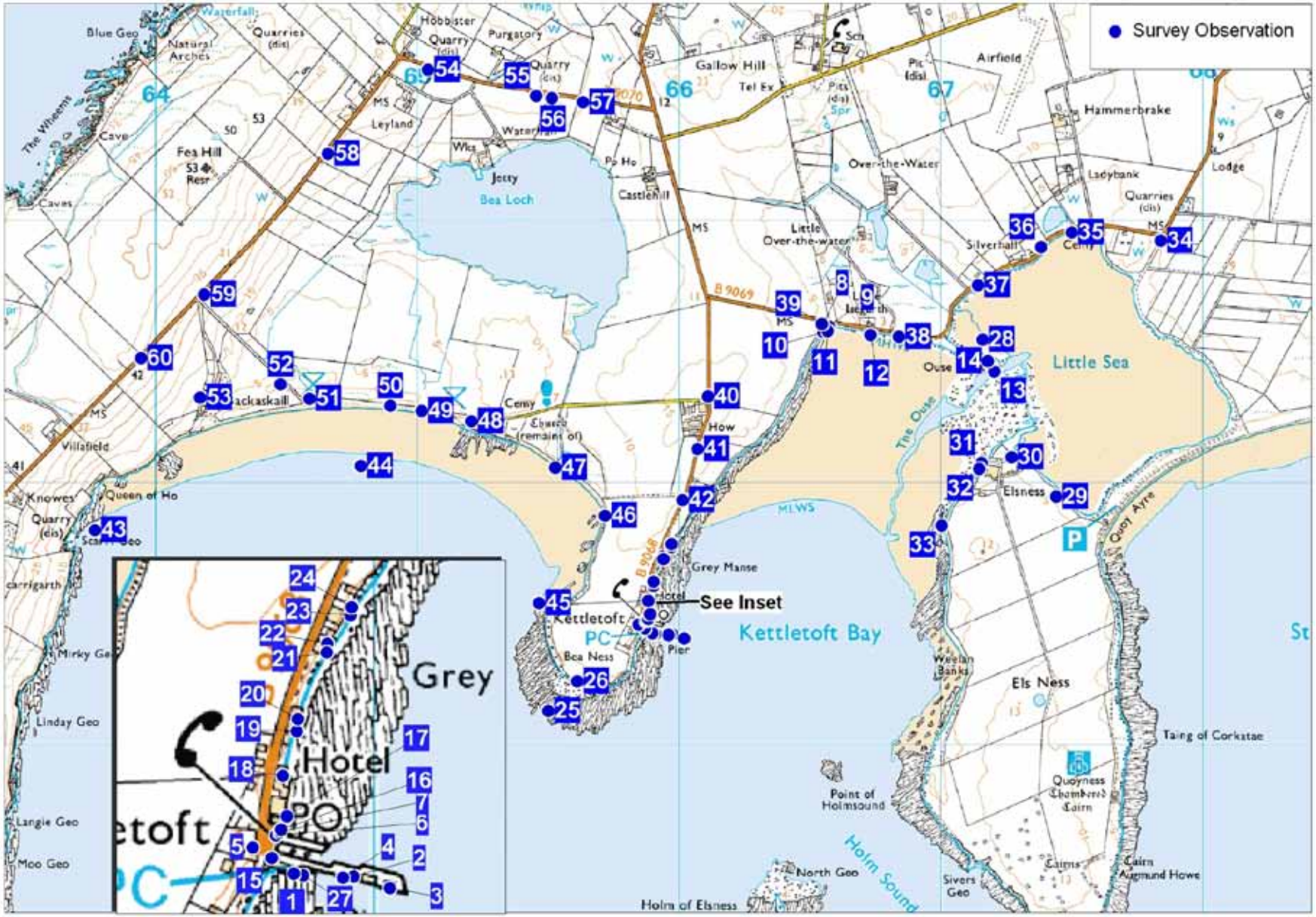

Figure 1. Map of Shoreline Observations

Table 1. Shoreline Observations

No.	Date	Time (GMT)	NGR	East	North	Sample	Photograph	Description
1	27/09/2011	11:04:21	HY 65899 38424	365899	1038424			Public conveniences
2	27/09/2011	11:08:07	HY 65975 38420	365975	1038420			RMP – Sample bag location
3	27/09/2011	11:11:25	HY 66022 38405	366022	1038405			Fisherman's storage shed on pier
4	27/09/2011	11:12:50	HY 65962 38419	365962	1038419		Figure 3	2 cars on pier, 1 large boat normally here but must be out, 3 small fishing boats, 1 small sailing yacht
5	27/09/2011	11:15:35	HY 65846 38457	365846	1038457		Figure 4	Scottish Water septic tank
6	27/09/2011	11:18:32	HY 65876 38473	365876	1038473			Pipe, appears to drain rain water from roofs
7	27/09/2011	11:19:34	HY 65881 38477	365881	1038477			Pipe, again draining rain water
8	27/09/2011	13:45:29	HY 66551 39601	366551	1039601			Entrance to field, 23 cattle, silage recently cut on shore side of road
9	27/09/2011	13:47:16	HY 66574 39597	366574	1039597			Occupied house on shore side of road
10	27/09/2011	13:49:04	HY 66555 39574	366555	1039574			End walk
11	27/09/2011	13:50:27	HY 66570 39579	366570	1039579			Discarded pipe and other rubbish
12	27/09/2011	13:54:44	HY 66733 39563	366733	1039563			House on opposite side of road above shore, no pipe apparent. One of two houses along road, 1 horse next to house.
13	27/09/2011	14:15:57	HY 67206 39425	367206	1039425	OIB1		Odd green patch, no apparent drainage from shore, 1 seal, farm visible on opposite shore. Green continues around point, water flow rapid through gap between shore and small shoal
14	27/09/2011	14:20:28	HY 67182 39464	367182	1039464			Cockle shells on shore
15	27/09/2011	14:42:25	HY 65871 38444	365871	1038444			Pipes through rock, not flowing, no evidence of septic discharge
16	27/09/2011	14:45:21	HY 65883 38480	365883	1038480			Old septic pipes, look dry, no odour
17	27/09/2011	14:47:40	HY 65890 38497	365890	1038497		Figure 5	Drainage pipe, 10 cm inner diameter, unknown purpose. Does not appear to be septic, no flow. Pipe appears new. Some algal patches on shore below pipe
18	27/09/2011	14:57:27	HY 65885 38549	365885	1038549			Water drainage pipe, dribbling
19	27/09/2011	15:00:40	HY 65903 38606	365903	1038606			2 seals hauled out approximately 50 m out (5 seen at this location later in day)
20	27/09/2011	15:02:19	HY 65904 38622	365904	1038622			Outfall pipe blocked up with wood
21	27/09/2011	15:07:18	HY 65941 38707	365941	1038707		Figure 6	Septic pipe, goes under shore
22	27/09/2011	15:10:31	HY 65942 38718	365942	1038718			2 septic pipes, both dribbling. Sewage fungus below pipe. End of pipe over 5 feet above shore (above my head height)
23	27/09/2011	15:17:16	HY 65972 38755	365972	1038755			Pipe through wall, dripping but no odour or other evidence of septic content. >6 ft up wall
24	27/09/2011	15:19:32	HY 65973 38765	365973	1038765			Old ceramic septic pipe, dry
25	27/09/2011	15:54:07	HY 65502 38129	365502	1038129	OIB2		Ridge of rock running off shore from point, approximately in line with SW tank further north. No pipe visible
26	27/09/2011	16:12:10	HY 65613 38241	365613	1038241			Manhole cover in line with raised rock ridge

No.	Date	Time (GMT)	NGR	East	North	Sample	Photograph	Description
27	27/09/2011	16:24:01	HY 65911 38422	365911	1038422	OIB3	Figure 7	Pipe running from behind toilets along jetty, unknown purpose, does not appear to run when toilets flushed. Possibly from showers?
28	27/09/2011	16:56:48	HY 67163 39547	367163	1039547	OIB4	Figure 8	Water sample OIB4
29	27/09/2011	17:28:09	HY 67444 38947	367444	1038947			9 sheep, 5 cattle and approximately 100 gulls and waders
30	27/09/2011	17:33:19	HY 67272 39098	367272	1039098			Drainage ditch, odourous, stagnant
31	27/09/2011	17:38:32	HY 67157 39075	367157	1039075	OIB5	Figure 9	Drainage pipe from silage pit, dribbling, silage effluent
32	27/09/2011	17:43:45	HY 67149 39053	367149	1039053			Second drainage pipe from silage pit, also dribbling
33	27/09/2011	17:52:20	HY 67005 38837	367005	1038837			Approximately 200 gulls and waders
34	27/09/2011	18:14:45	HY 67843 39924	367843	1039924			12 cattle to the east, 15 to the north across road junction
35	27/09/2011	18:16:18	HY 67502 39956	367502	1039956			12 sheep
36	27/09/2011	18:16:32	HY 67386 39899	367386	1039899			6 sheep
37	27/09/2011	18:17:03	HY 67145 39754	367145	1039754			2 sheep, 2 ponies, approx 10 geese
38	27/09/2011	18:19:24	HY 66842 39558	366842	1039558			9 cattle, 50 sheep visible in distance
39	27/09/2011	18:21:47	HY 66548 39605	366548	1039605			40 cattle (marked previously, but a smaller number were counted earlier). At least 100 cattle in distance away from shore, approx 40 geese flying overhead
40	27/09/2011	18:26:03	HY 66112 39330	366112	1039330			Farm, 5 bulls, approx 25 sheep
41	27/09/2011	18:26:20	HY 66073 39127	366073	1039127			51 cattle, 1 sheep, 1 septic tank to west.
42	28/09/2011	05:26:18	HY 63768 38819	363768	1038819	OIB6		Backaskail bay, west side at low tide
43	28/09/2011	06:04:11	HY 64784 39063	364784	1039063	OIB7		Seawater sample OIB7, no shells, no siphon holes, few worm casts
44	28/09/2011	06:26:35	HY 65465 38540	365465	1038540	OIB8		Seawater sample OIB8
45	28/09/2011	06:54:42	HY 65719 38874	365719	1038874			1 bull in field
46	28/09/2011	07:06:17	HY 65527 39057	365527	1039057		Figure 10	Water puddle both sides of a sand berm, doesn't appear to be flowing, shallow flow seen further along sand, no sample
47	28/09/2011	07:22:19	HY 65207 39235	365207	1039235		Figure 11	Car park, approximately 70 cattle/calves
48	28/09/2011	07:31:29	HY 65016 39274	365016	1039274			Entrance to beach, no evidence of livestock
49	28/09/2011	07:36:16	HY 64897 39293	364897	1039293			Stable waste at edge of field
50	28/09/2011	07:43:25	HY 64587 39320	364587	1039320			Dry gulley, probably runs after heavy rainfall, old cattle droppings
51	28/09/2011	07:47:57	HY 64477 39376	364477	1039376		Figure 12	Silage pit, car park, approximately 40 sheep on hill above road to North, approximately 16 cattle on farm this side of road
52	28/09/2011	09:31:59	HY 64171 39325	364171	1039325			No record
53	28/09/2011	11:05:28	HY 65042 40577	365042	1040577			35 cattle north side of lake
54	28/09/2011	11:06:49	HY 65455 40477	365455	1040477			14 sheep north side of lake
55	28/09/2011	11:07:27	HY 65515 40468	365515	1040468			8 pigs, 15 sheep south side of road
56	28/09/2011	11:08:39	HY 65635 40452	365635	1040452			10 horses north side of lake
57	28/09/2011	11:12:11	HY 64658 40256	364658	1040256			9 sheep west of lake

No.	Date	Time (GMT)	NGR	East	North	Sample	Photograph	Description
58	28/09/2011	11:13:37	HY 64185 39719	364185	1039719			25 sheep west of B&B
59	28/09/2011	11:14:44	HY 63945 39476	363945	1039476			11 sheep west of B&B, septic tank on the corner

Photographs referenced in the table can be found attached as Figures 3-12.

Sampling

Water samples were collected at sites marked on the map. Samples were transferred to a Biotherm 10 box with ice packs and shipped to SSQC on 29 September for *E. coli* analysis. Samples were received by the laboratory on 29 September. A subsequent mussel sample was collected by the sampling officer on 4 October and sent to SSQC for *E. coli* analysis. The sample temperatures on arrival were within the recommended temperature range of 2-8C.

All results are shown in Tables 2 and 3, and shown mapped in Figure 2.

All but one of the seawater samples were tested for salinity by the laboratory and results reported in parts per thousand (ppt). The remaining sample had been submitted in a smaller container and therefore was treated as a freshwater sample. The sample result and reported salinity for that sample area subject to query and may be amended pending further investigation.

At the time of reporting, no result was available for the harvester-provided razor clam sample.

Table 2. Water Sample Results

No.	Date	Sample	Grid Ref	Type	E. coli (cfu/100ml)	Salinity (ppt)
1	27/09/2011	OIB1	HY 67206 39425	Seawater	4	34.52
2	27/09/2011	OIB2	HY 65502 38129	Seawater	42	34.98
3	27/09/2011	OIB3	HY 65911 38422	Seawater	28	34.92
4	27/09/2011	OIB4	HY 67163 39547	Seawater (15ml only)	<1	26.10
5	27/09/2011	OIB5	HY 67157 39075	Silage effluent	<1	6.60
6	28/09/2011	OIB6	HY 63768 38819	Seawater	6	34.91
7	28/09/2011	OIB7	HY 64784 39063	Seawater	51	34.63
8	28/09/2011	OIB8	HY 65465 38540	Seawater	12	34.92

Table 3. Shellfish Sample Results

No.	Date	Sample	Grid Ref	Type	E. coli (MPN/100g)
1	4/10/2011	Kettletoft pier1	HY 65975 38420	Mussel	20

Figure 2. Sample results map

Photographs

Figure 3. Kettletoft pier

Figure 4. Scottish Water ST and pumping station

Figure 5. New drainage pipe along seawall at Kettletoft.

Figure 6. Plastic pipe to ground at upper shore

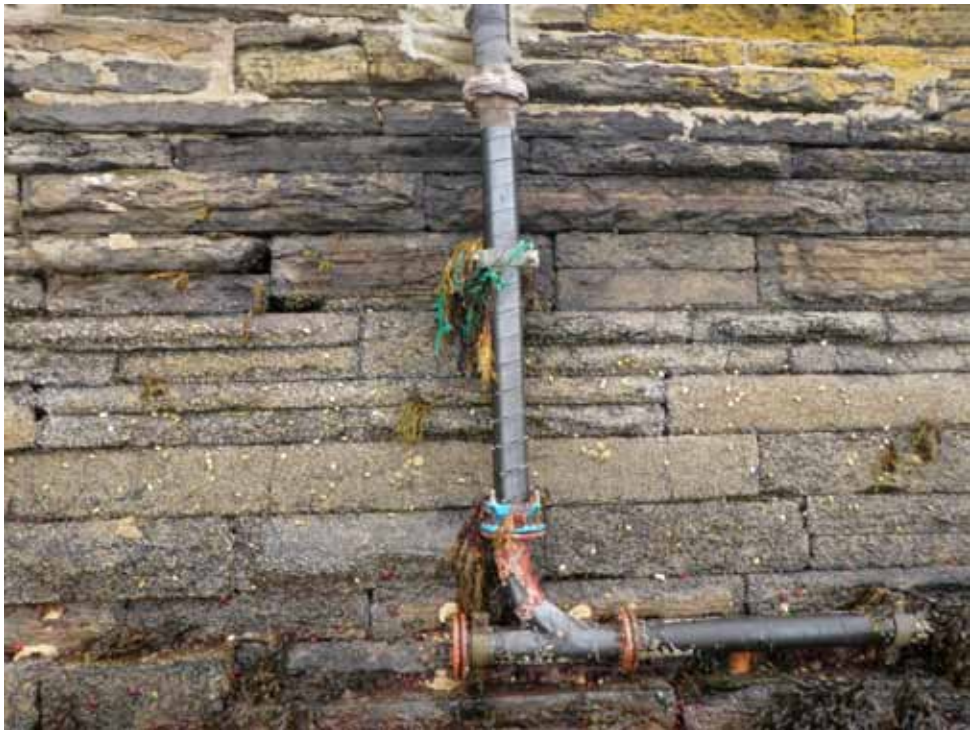

Figure 7. Pipe behind facilities at Kettletoft pier

Figure 8. Sample point – Ouse at low tide

Figure 9. Silage effluent pipe at Elsness

Figure 10. Water puddled next to sand berm

Figure 11. Calves near cemetery car park above Backaskail Bay

Figure 12. Silage at Backaskail car park