Scottish Sanitary Survey Report

Sanitary Survey Report
East Burwick
SI-583-1060-08
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Partner Organisations

The hydrographic assessment and the shoreline survey and its associated report were undertaken by Shetland Seafood Quality Control, Scalloway.

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Appendices

I. Executive Summary

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

The purpose of the sanitary survey is to demonstrate compliance with the requirements stated in Annex II (Chapter II Paragraph 6) of Regulation (EC) 854/2004. The sanitary survey results in recommendations on the location of RMPs, the frequency of sampling for microbiological monitoring, and the boundaries of the production areas deemed to be represented by the RMPs. A sanitary survey was undertaken on the classified mussel fishery at East Burwick on the basis recommended in the European Union Reference Laboratory publication: "Microbiological Monitoring of Bivalve Mollusc Harvesting Area Guide to Good Practice: Technical Application" (http://www.cefas.defra.gov.uk/nrl/information-centre/eu-good-practice-guide.aspx). This area was selected for survey at this at it is a newly classified area.

Bur Wick is a small inlet formed by the Burwick peninsula, a short distance northwest of Scalloway on the west coast of Mainland in the Shetland Islands.

The fishery is comprised of a single long-line mussel farm with 9 long-lines and 8-10 metre droppers. The area was subject to a fast track classification in summer 2014.

The main sources of contamination to the Bur Wick fishery are:

- A community septic tank discharge from Maa Ness STW, which serves the population of Scalloway.
- Intermittent discharges from the Maa Ness works to the same outfall as above.
- Diffuse pollution from livestock, primarily sheep, grazed on the north shore of Bur Wick.
- Diffuse wildlife source contamination.

The Scalloway outfall discharges within 1 km south of the mussel farm. A bacteriological survey showed higher *E. coli* results in mussel samples taken from the southern end of the mussel farm, indicating that southern end of the farm was more impacted by faecal contamination than the northern or western extents of the farm.

The main pathway of contamination is via wind-driven current movement, particularly during winds from the east, south or southwest. These would drive contamination northward along the coast and into Bur Wick.

No changes are recommended to the provisional production area boundaries, however it is recommended that the RMP be moved from its provisional location to HU 3906 4012, which lies on the southeast corner of the mussel farm.

II. Sampling Plan

Production Area	East Burwick Mussels
Site Name	East Burwick Mussels
SIN	SI-583-1060-08
Species	Common mussel
Type of Fishery	Long line aquaculture
NGR of RMP	HU 3906 4012
East	439060
North	1140120
Tolerance (m)	40
Depth (m)	1-3
Method of Sampling	Hand
Frequency of Sampling	Monthly
Local Authority	Shetland Islands Council
Authorised Sampler(s)	Sean Williamson Marion Anderson Agnes Smith Alan Harpin
Production area boundary	The area within a line drawn between HU 3889 4061 to HU 3874 4023 to HU 3904 3985 extending to mean high water springs

III. Report

1. General Description

Bur Wick is a small inlet formed by the Burwick peninsula, on the west coast of Mainland in the Shetland Islands. The inlet opens to the southwest and is partially sheltered by the small islet of Burwick Holm. Further offshore is the small island of Langa. To the southeast, and on the other side of the peninsula, lies Scalloway, the second largest settlement in Shetland with a population of just over 1000.

Bur Wick is approximately 650 m in width and 750 m in length, with a maximum depth of 22 m.

A sanitary survey was undertaken on the classified fishery at East Burwick on the basis recommended in the European Union Reference Laboratory publication: “Microbiological Monitoring of Bivalve Mollusc Harvesting Area Guide to Good Practice: Technical Application” (https://eurlcefas.org/). This production area was selected for survey at this time due to the submission of an application for classification of a common mussel fishery.

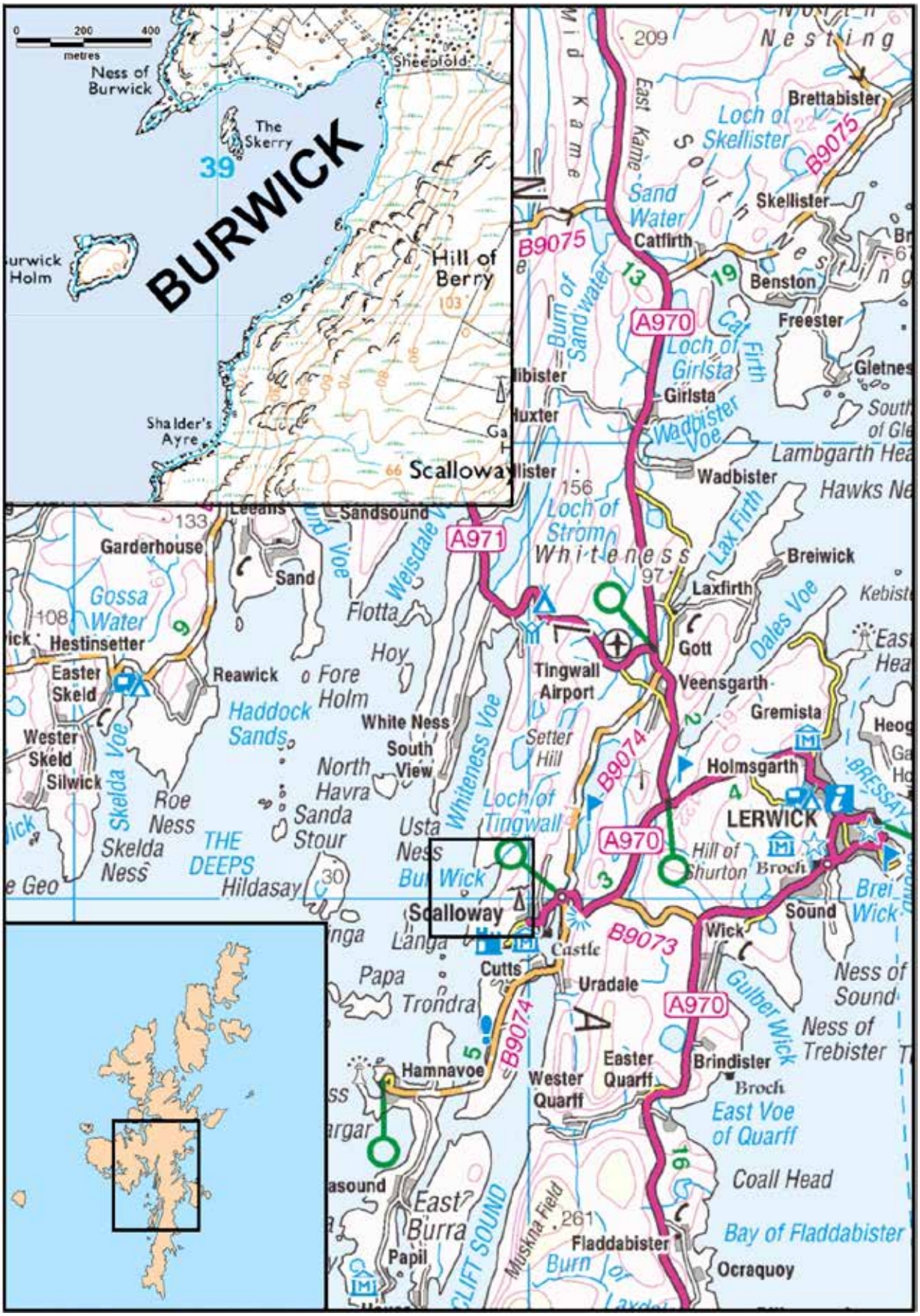


Figure 1.1 Location of East Burwick

2. Fishery

East Burwick is a new common mussel (*Mytilus edulis*) fishery.

Table 2.1 Area shellfish farms

Production area	Site	SIN	Species
East Burwick Mussels	East Burwick Mussels	SI-583-1060-08	Common mussels

A provisional RMP assessment was conducted in 2014 and recommended a provisional RMP be located at HU 3929 4035 with the provisional production area to be confined to the area within a line drawn between HU 3889 4061 to HU 3874 4023 to HU 3904 3985 extending to mean high water.

At the time of the shoreline survey the site consisted of nine double-headed longlines with 8-10 meter droppers The longlines ran parallel to the eastern shoreline. The site is licensed for nine, 220-metre, double-headed longlines. This site is currently holds a fast track classification, however harvest under this classification is only intended if the harvester's other sites are closed due to biotoxin levels.

The fishery location identified during the shoreline survey, together with the provisional RMP location and production area boundaries, are shown in Figure 2.1.

The provisional RMP was assigned based on the location of the seabed lease and permitted mooring containment area for the site. However, based on the shoreline survey, the mussel farm is actually positioned at the southwestern end of the area.

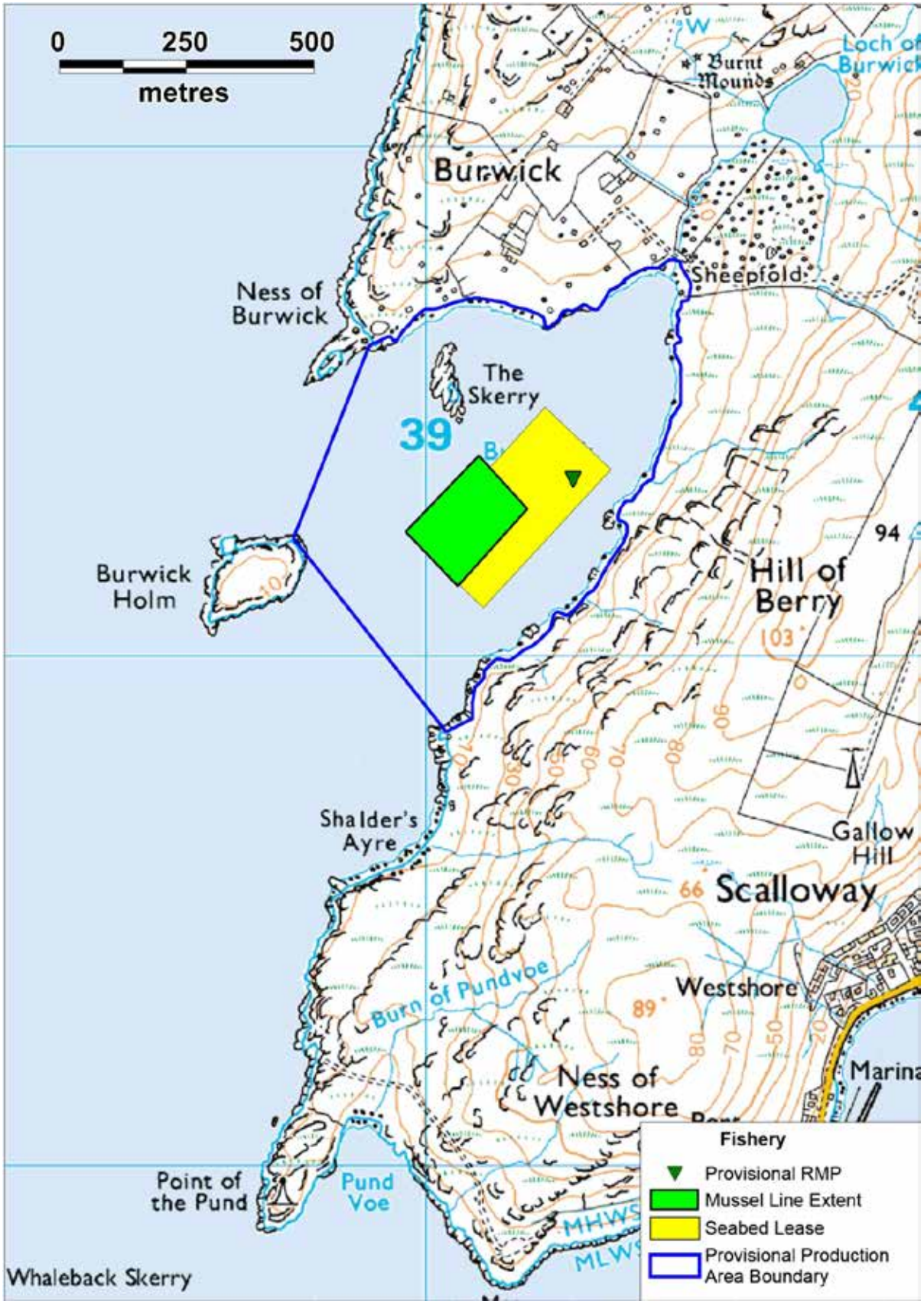


Figure 2.1 East Burwick Fishery

3. Human Population

Information was obtained from the General Register Office for Scotland on the population within the vicinity of the East Burwick production area. The last census was undertaken in 2011. The census output areas surrounding East Burwick are shown thematically mapped by the 2011 population densities in Figure 3.1. The census output area adjacent to the fishery has a low population density (<9 people per km^2), however the town of Scalloway is located 3 km south along the coastline and the overall population density in this area is high.

Table 3.1 Census output areas and populations – surrounding Scalloway

Census Output Area	Population
S00059498	85
S00059561	199
S00059560	61
S00059444	99
S00059500	135
S00059449	147
S00059558	202

The shoreline directly adjacent to the shellfish farm is largely inaccessible and uninhabited apart from a track linking the two dwellings along the shore north of the mussel farm to the town of Scalloway. Scalloway is the second largest town in Shetland with an estimated population of 1,100 (mid-2012) and has primary school with 145 pupils (Scalloway Junior High School, 2008), tourist accommodation, NAFC Marine Centre and University (with accommodation), a harbour, two marinas and a boating club. Scalloway is linked to the rest of the island via the A 970 and B 9074 roads. Tourist accommodation in Scalloway includes a 22 bedroom hotel (Scalloway Hotel, 2014), and a small number of B&Bs and self catering units. There are a further self-catering accomodation at Easterhoull, located east of Scalloway and at the time of the shoreline survey, a 280-room accommodation barge for construction workers was berthed at the pier on the east side of Scalloway harbour.

Scalloway harbour is a busy area for commercial, leisure and fishing vessels. Berths are located at the boating club, Port Arthur marina (58 berths) and at East Voe Marina (55 berths). There is an anchorage (Clyde Cruising Club, 2005) in the middle of Scalloway harbour and there are also numerous piers in the area. At the time of the shoreline survey, there were approximately six workboats berthed and nine vessels of mixed type ashore for servicing at the pier on the eastern side of the harbour. A slipway in the harbour also had three vessels present for maintenance. Boat traffic in the East Burwick production area is largely associated with the fishery

and leisure activities. During the survey a small workboat was observed at the shellfish farm.

Overall, impacts from human sources to the water quality at the mussel farm are likely to be low to moderate due to the low population density of the immediate area but higher population density around Scalloway. Any impact from visiting boats is most likely to be low as the majority of boat activity is concentrated in and around Scalloway harbour.

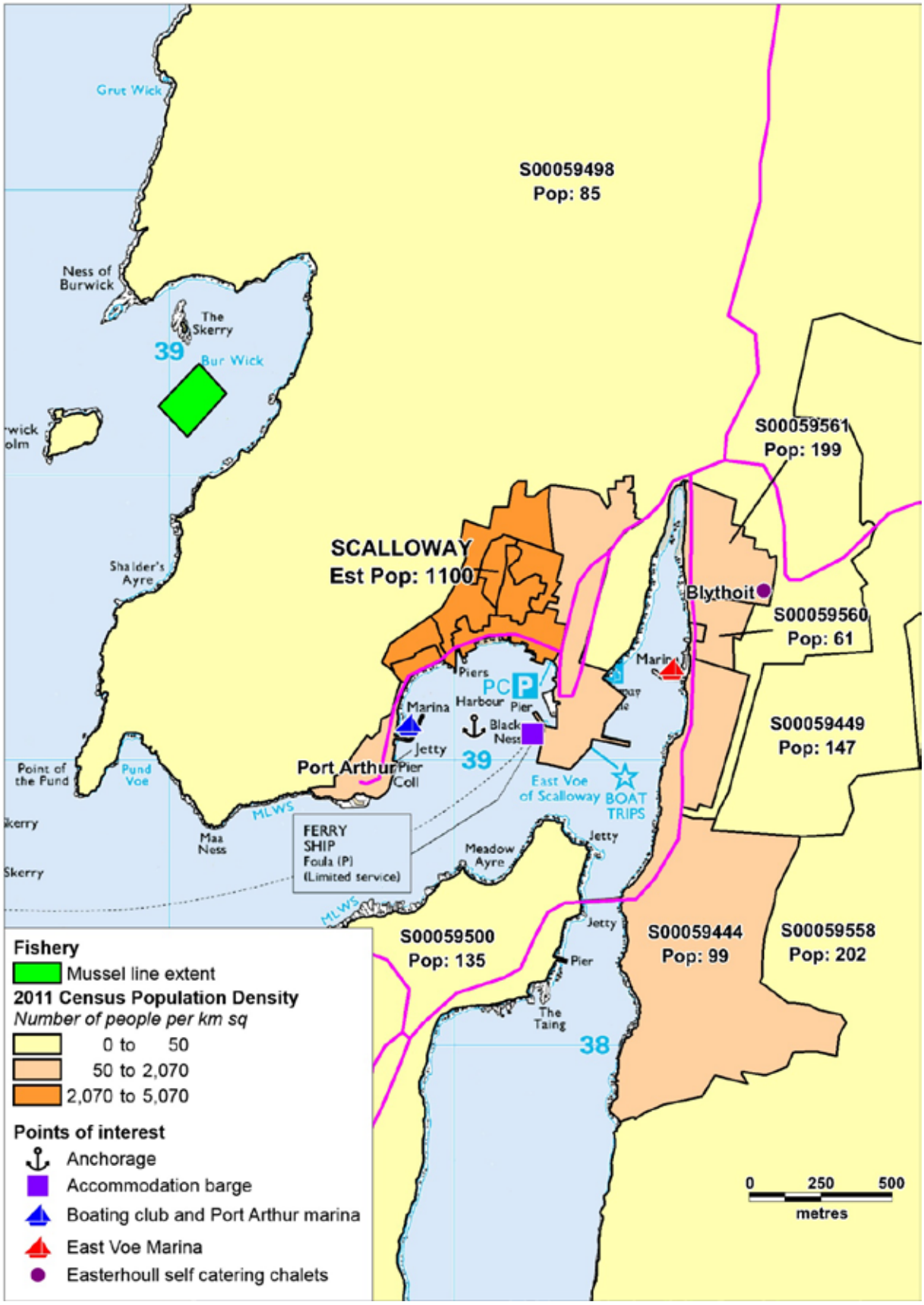


Figure 3.1 Population map for the vicinity of East Burwick

4. Sewage Discharges

Information on sewage discharges was sought from Scottish Water and the Scottish Environment Protection Agency (SEPA) for an area around Bur Wick, including Whiteness Voe, Scalloway, Trondra and the northern end of West Burra. Data requested included the name, location, type, size (in either flow or population equivalent), level of treatment, sanitary or bacteriological data, spill frequency, discharge destination (to land, watercourse or sea), any available dispersion or dilution modelling studies, and whether improvements were in work or planned.

A sanitary survey was conducted in March 2009 for a mussel farm to the south of the current fishery at Shalders Ayre. Observations and data from that report was used to support cross checking of data.

4.1 Community Discharges

SEPA provided information on four community final effluent (FE) discharges and eight intermittent discharges. These are listed in Table 4.1 and shown in Figure 4.1. The information agreed with that supplied by Scottish Water.

The largest discharge is that from the Maa Ness wastewater treatment works (WWTW), which serves Scalloway, Port Arthur, and the smaller communities along the East Voe of Scalloway, including Blythoit. The works discharges primary treated effluent to an outfall located approximately 1.5 km to the south of the fishery and has a consented dry weather flow of 625 m^3/day. A CSO discharges at the same location. A temporary housing barge has been sited at Scalloway (see Section 3: Population). This barge does have a built in sewage treatment system (Bibby Maritime, 2009) but probably uses Scalloway sewage system for sewage treatment as this seems to be preferable (Sludgehammer Group Ltd., 2007). The consented population equivalent (PE) for the tank is 2850, which allows a substantial buffer above the likely connected population.

Seven intermittent discharges are associated with the Scalloway sewage network, two combined sewer overflows (CSOs) and five emergency overflows (EOs).These discharge to either Scalloway Harbour or the East Voe of Scalloway.

Three other continuous discharges were reported; two located at Hamnavoe on the island of West Burra approximately 5 km south of the fishery. One, Hamnavoe STW has a permitted dry weather flow (DWF) of 80 m^3/d and the other, Hulsidale STW has a PE of 80. The other, Nesbister STW, discharges approximately 5 km north of the production area and has a mean daily flow (MDF) of 60 m^3/d. An associated CSO is located at the head of Whiteness Voe.

Table 4.1 Community Discharges

Licence	Name	Location	Discharge Type	Discharging to	DWF/ MDF (m^3/day)	PE***	Overflow (l/s)
CAR/L/1001965	Nesbister STW, FE to Whiteness Voe, Whiteness, Shetland	HU 39684 44808	Sewage (Public) Primary	Whiteness Voe	60*	-	-
CAR/L/1001966	Wormadale CSO to Whiteness Voe, Whiteness, Shetland	HU 3985 4585	Combined Sewer Overflow	Whiteness Voe	-	-	
CAR/L/1004025	Maa Ness WWTW	HU 38700 39300	Sewage (Public) Primary	Bur Wick	625**	2850	-
CAR/L/1004025	Maa Ness WWTW	HU 38700 39300	Combined Sewer Overflow	Bur Wick			34
CAR/L/1002258	Westshore PS, EO to East Voe, Scalloway, Shetland	HU 39900 39300	Combined Sewer Overflow	Scalloway Harbour	-	-	75
CAR/L/1002258	Westshore PS, EO to East Voe, Scalloway, Shetland	HU 39900 39300	Emergency Overflow	Scalloway Harbour	-	-	-
CAR/L/1002259	Burn Beach Pumping Station CSO	HU 40300 39300	Combined Sewer Overflow	Scalloway Harbour	-	-	67
CAR/L/1002262	Seachest PS, EO to East Voe of Scalloway, Shetland	HU 40700 38800	Emergency Overflow	Scalloway Harbour	-	-	-
CAR/L/1002259	Burn Beach PS, Scalloway, EO to East Voe of Scalloway	HU 40295 39345	Emergency Overflow	East Voe of Scalloway	-	-	-
CAR/L/1002260	Blacksness STW, EO to East Voe of Scalloway	HU 40517 39054	Emergency Overflow	East Voe of Scalloway	-	-	-
CAR/L/1002261	Blydoit STW, EO to EAst Voe of Scalloway	HU 40800 39600	Emergency Overflow	East Voe of Scalloway	-	-	-
CAR/L/1002299	Hamnavoe STW, FE to Atla Ness, Hamnavoe, Shetland	HU 37100 36194	Sewage (Public) Primary	Alta Ness	80**	-	-
CAR/L/1005013	Hulsidale STW, FE to Atlantic Ocean, Hamnavoe, Shetland	HU 37358 35853	Sewage (Public) Primary	Atlantic Ocean	17	80	-

Notes: *flow as Mean Daily Flow (MDF); **flow as Dry Weather Flow (DWF); ***Population Equivalent; For comparison of values an approximate conversion factor of 1 PE = 200 l/day (0.2 m^3/day) may be used.

4.2 Consented Private Discharges

Information provided by SEPA on sewage consents north and west and of the Whiteness peninsula have been excluded from assessment as has information on consents for septic tanks which discharge in catchments terminating over 6 km from the fishery.

Discharges relating to abstraction or engineering works have been excluded from assessment, as they should not contribute to any faecal input to the area. Details of the other consented discharges are given in Appendix 6.

SEPA provided information on trade effluent discharges for a quarry (CAR/L/1001923) and a shipbuilder (CAR/L/1004075). It is not known whether these have a septic component: They are not shown in Figure 4.1, but are included in Appendix 6.

This left information on seventy-four sewage-related consents that were assessed in this report. These are located mainly along the east side of Whiteness peninsula and at the north shores of the islands of Tronda and West Burra. Two septic tanks (CAR/R/1058919 & CAR/R/1058914) are reported as discharging to soakaway approximately 125 m and 175 m inland from Bur Wick. These have relatively small PEs of 6 and 5 respectively.

The large majority of consents were for discharge to soakaway. The effectiveness of soakaway systems depends on location and maintenance, and SEPA have identified previously that in remote areas, consents originally registered as discharging to land may have been diverted to sea or watercourses.

Registration is required for all new properties and upon sale of existing properties. Information provided by SEPA is considered to be correct at the time of writing, however there may be additional discharges that are not yet registered with SEPA.

Many consents for fish farms were recorded in the area around East Burwick. While it is not explicitly stated if any of these discharge sewage some fish farms may have service barges with toilet facilities that result in faecal contamination. These have not been shown in Figure 4.1 but are included in Appendix 6.

Shoreline Survey Discharge Observations

Fifteen sewage-related observations were noted during the shoreline survey. These are listed in Table 4.2.

Table 4.2 Discharge-associated observations made during the shoreline survey

No.	Date	NGR	Associated Photograph (Appendix 5)	Sample result E. coli cfu/100ml	Description
1	17/06/2014	HU 39326 40778	Figure 6		Concrete septic tank at the top of the field below a house. Wet area below the tank.
2	17/06/2014	HU 39320 40691			Possible soakaway area for the above septic tank, green grass area leading to the shore. Wet area at the shore.
3	17/06/2014	HU 38703 39295		5	Seawater sample collected near Scalloway's main outfall.
4	17/06/2014	HU 39853 39310	Figure 7		West Shore pumping station. Pipe leading to the water under the road.
5	17/06/2014	HU 40359 39350			Public toilets at the shore.
6	18/06/2014	HU 40816 39544	Figure 8		Blydoit discharge pipe from the pumping station leading to the water.
7	18/06/2014	HU 40838 39554			Blydoit pumping station.
8	18/06/2014	HU 40740 38818			Sea Chest pumping station.
9	18/06/2014	HU 39937 38449	Figure 9		Plastic septic tank below two new houses at the top of the field.
10	18/06/2014	HU 39908 38439	Figure 10		Plastic septic tank below a new house at the top of the field.
11	18/06/2014	HU 39813 38415	Figure 11		Plastic septic tank below houses at the top of the field.
12	18/06/2014	HU 39750 38437	Figure 12		Large concrete septic tank near the shore below houses.
13	18/06/2014	HU 39507 38343	Figure 13		Large concrete septic tank near the shore below houses.
14	18/06/2014	HU 39496 38363	Figure 14	92,000	Pipe associated with the septic tank mentioned above leading to the water.

Observation 1 related to a septic tank, (probably CAR/R/1058919) with a possible soakaway (observation 2). A green grass area was reported leading to the shore. Lush plant growth on soakaway fields can be an indicator of a failing sewage system (Michigan State University Extension, 2003; Woodstock Conservation Commission, 2014), indicating that effluent is not being properly treated. This coupled with the close proximity to the mussel lines (<400 m) means this discharge has the potential to impact significantly on the fishery.

A seawater sample taken close to the Maa Ness outfall returned a result of 5 *E. coli* MPN/100ml (observation 3) which does not indicate significant sewage contamination. However, the sampling location may not have been within the effluent plume.

Observations 4 and 6-8 related to sewage assets while Observation 5 related to public toilets at Scalloway.

Observations 9-14, all located around the north of the island of Tronda, relate to several observed septic tanks.

Observation 14 which returned a value of 92,000 *E. coli* MPN/ 100ml, most likely relates to the Cauldhame Septic Tank (CAR/S/1081637) which has a PE of 60.

Summary

The area around Bur Wick is served by a combination of both community and private discharges. The Maa Ness outfall, which discharges approximately 1 km south of the mussel lines, poses the greatest risk of contamination to the fishery. Additional contamination will arise after heavy rain from the operation of the associated CSO. If the soakaways for either of the two septic tanks located inland from Bur Wick fail, they may pose additional local sources of contamination. One soakaway was observed during the shoreline survey and did show some sign of failure .

List of Acronyms

MDF=	Mean daily flow	DWF=	Dry weather flow
PE=	Population Equivalent	ST=	Septic Tank
WWTW=	Wastewater Treatment Work	CSO=	Combined Sewer Overflow

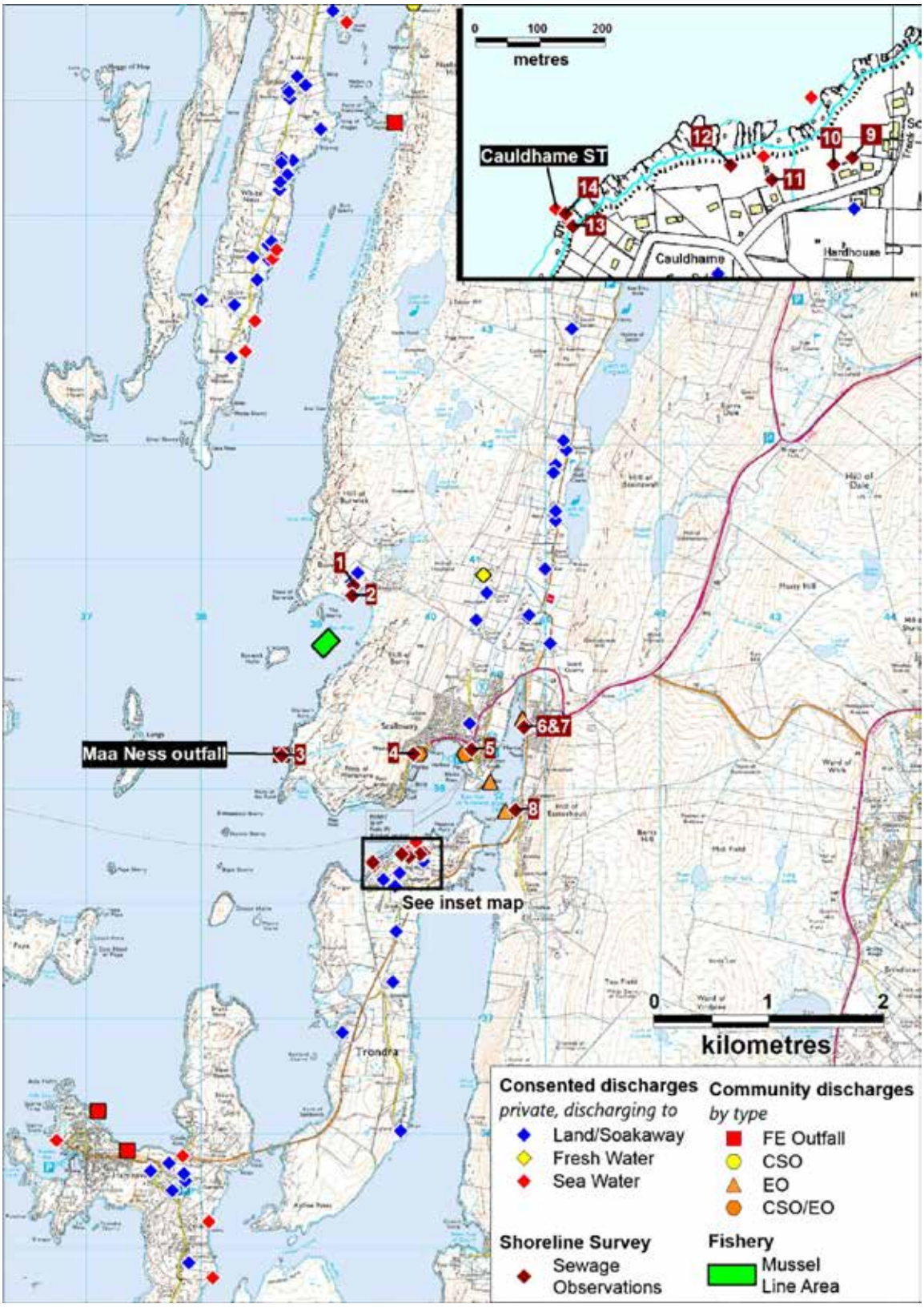


Figure 4.1 Map of discharges for East Burwick

5. Agriculture

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

Table 5.1 Livestock numbers in the Tingwall and Whiteness agricultural parishes 2013

	Tingwall		**Whiteness**	
	65 km^2		62 km^2	
	Holdings	Numbers	Holdings	Numbers
Pigs	*	*	*	*
Poultry	16	335	7	118
Cattle	10	368	*	*
Sheep	41	13,650	20	3856
Other horses and ponies	14	134	*	*

* data withheld

The livestock numbers indicated that sheep predominated with poultry present in small numbers. The majority of animals recorded were in Tingwall parish. Tingwall also had a small number of cattle and horses and ponies. There were fewer than five holdings of pigs for both parishes and also horses and ponies in the Whiteness parish, indicating that these animals were present. However, the Tingwall and Whiteness parishes extend beyond the immediate vicinity of the East Burwick area and it is therefore not possible to determine the proportion of livestock within the parish areas that may contribute to faecal impacts at Bur Wick.

A source of spatially relevant information on livestock population in the area was the shoreline survey (see Appendix 5) which only relates to the time of the site visit on the 17th and 18th June 2014. Observations made during the survey are dependent upon the viewpoint of the observer and some animals may have been obscured by the terrain. The spatial distribution of animals observed and noted during the shoreline survey is illustrated in Figure 5.1.

During the shoreline survey, flocks of sheep, often with lambs, were observed grazing along much of the shoreline directly north and east of the mussel farm. Ducks and chickens were also observed in a field on the northern shoreline. No livestock were observed on the western shoreline adjacent to the mussel farm. Additional livestock were

observed grazing along the shoreline southeast of Scalloway. These included numerous sheep and also two Shetland ponies and several ducks. The majority of the animals had access to the shoreline and sheep faeces were found along much of the shore.

Review of publicly available aerial images (taken in 2012) found that areas likely to be improved pasture were located adjacent to the shoreline north of the mussel farm and also adjacent to the coastline and inland around Scalloway (Bing Maps, accessed 05/08/2014). These areas are shown in Figure 5.1. Ordnance Survey maps contained reference to several cattle grids and sheep dips inland north and west of Scalloway.

Numbers of sheep are expected to be approximately double during the spring and summer months when lambs are present. Any contributions of faecal contamination from livestock grazing in the area would potentially affect those shellfish grown on the northern long lines closest to the shore. The largest concentration of livestock were observed on the shoreline adjacent to the mussel farm and would be expected to potentially impact at the lines closest to those shores.

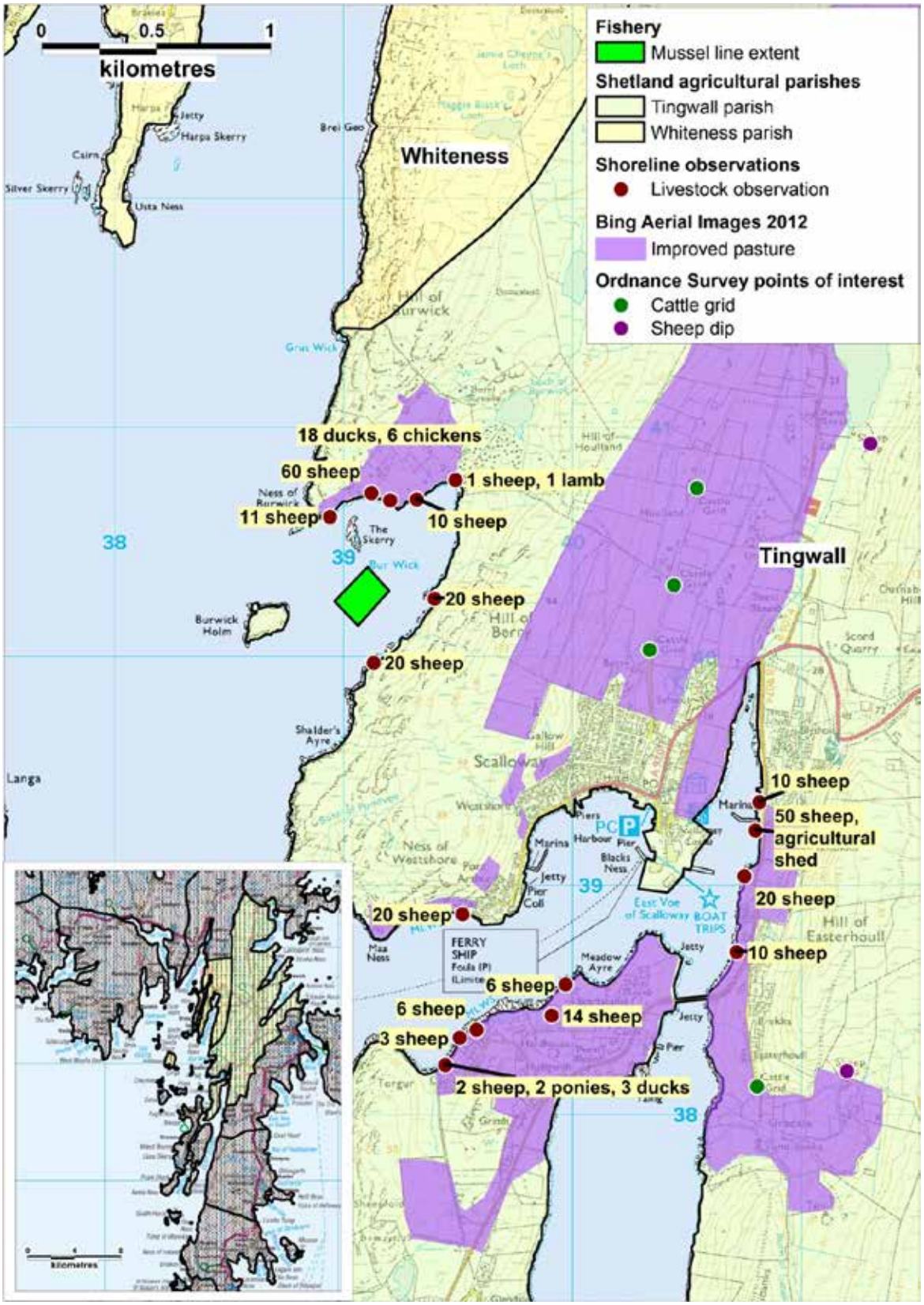


Figure 5.1 Livestock observations at East Burwick

6. Wildlife

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

The species most likely to contribute to faecal indicator levels around the common mussel fishery at East Burwick are considered below.

Pinnipeds

The Special Committee on Seals Report (SCOS, 2013) identified that August surveys undertaken between 2007 and 2011 showed harbour seals (*Phoca vitulina*) widely distributed around Mainland. However, reported counts relate to 10 km squares and it is therefore not possible to determine from the published report the number seen in the vicinity of Bur Wick. Grey seals are also found around Shetland, though in smaller numbers than common seals. No seals were observed during the shoreline survey.

Cetaceans

Shetland is known to support a large variety of cetaceans in its surrounding waters. The Atlantic white-sided dolphin and white beaked dolphin were the most frequently observed cetaceans along the west coast of Shetland (Scottish Natural Heritage, 2009), with reported sightings of the common dolphin at Scalloway (SeaWatch Foundation, 2013). Porpoise have also been recorded the vicinity of Scalloway Harbour and West Burra Island (Nature in Shetland, 2014). No cetaceans were observed during the shoreline survey.

Birds

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

Table 6.1 Seabird counts within 5 km of the East Burwick

Common name	Species name	Count*	Method	Accuracy
Black Guillemot	*Cepphus grylle*	48	Individuals on land	Accurate
Fulmar	*Fulmarus glacialis*	702	Occupied sites	Accurate
Herring Gull	*Larus argentatus*	278	Individuals on land and occupied nests	Accurate
Black-Headed Gull	*Chroicocephalus ridibundus*	138	Occupied nests	One accurate, two unknown
Lesser Black-Backed Gull	*Larus fuscus*	22	Individuals on land	Accurate
Great Black-Backed Gull	*Larus marinus*	54	Individuals on land, occupied nests and territory	Accurate
Common Gull	*Larus canus*	108	Individuals on land and occupied territory	Accurate
Arctic Skua	Stercorarius parasiticus	2	Occupied territory	Accurate
Great Skua	*Stercorarius skua*	12	Occupied territory	Accurate
Arctic Tern	*Sterna paradisaea*	218	Individuals on land and occupied nests	Accurate

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

The JNCC dataset indicates that fulmars are the most common seabird species within 5 km of the East Burwick fishery, whilst herring gulls, Arctic terns, and common gulls are also numerous. The most concentrated aggregations of seabirds were noted on the island of Langa (to the southwest of the fishery) and on the island of Green Horr (to the south). Arctic terns and fulmar were most common species respectively at those locations.

Data from the Marine and Spatial Plan for Shetland (NAFC, 2012), highlights that nearby areas host eider ducks, mainly to the west and south of the fishery. Birds were the only wildlife observed during the shoreline survey, with gulls, oystercatchers, Arctic terns, eider ducks and a plover noted. Arctic terns were the most numerous, with a potential nesting colony observed on the shoreline approximately 300 m north of the fishery. Shellfish shells and sea urchin tests were noted along the shoreline at several locations and it was considered that these could be bird feeding areas.

Otters

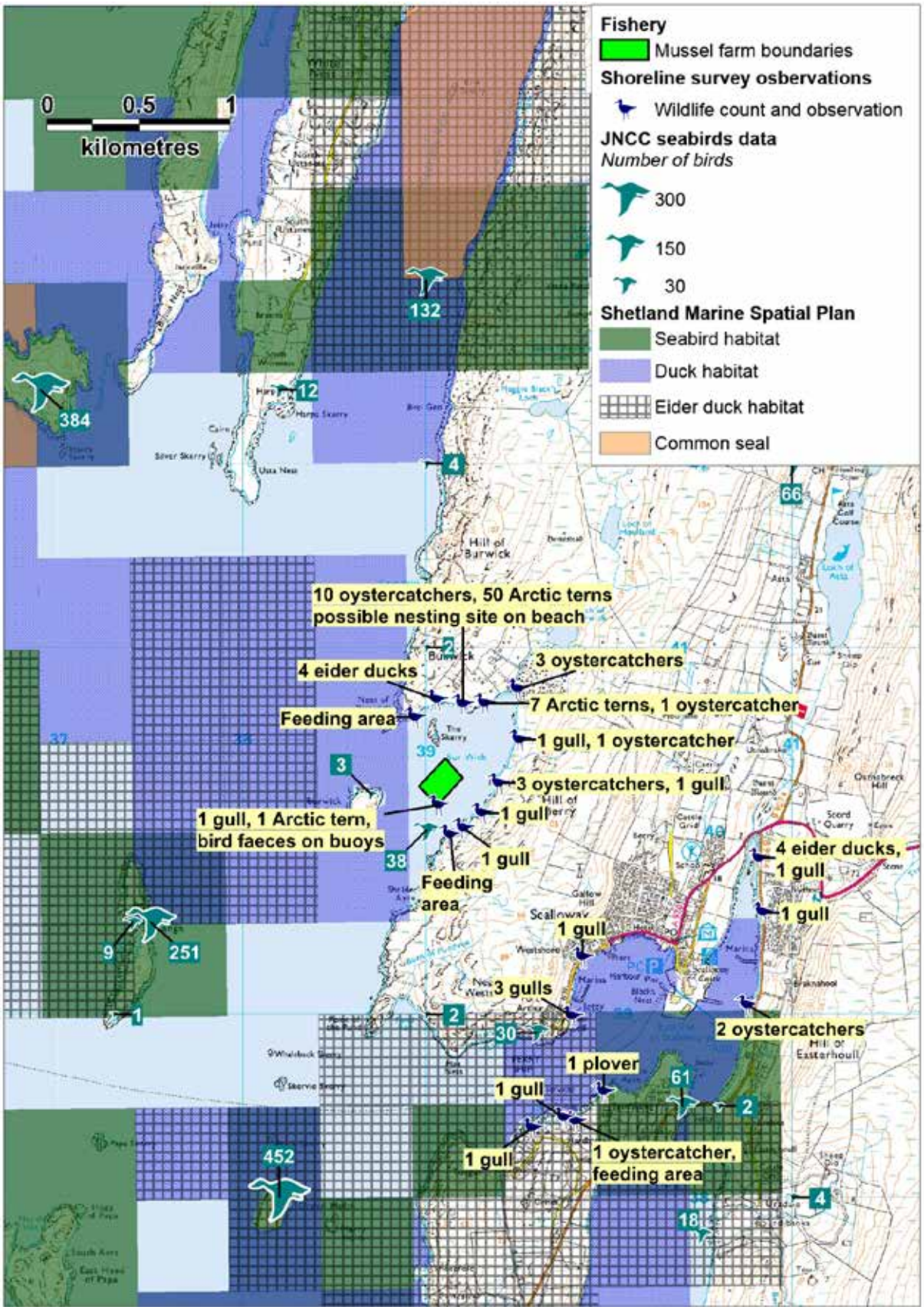
Shetland is estimated to host 12% of the UK Eurasian otter (*Lutra lutra*) population (Shetland Otters, 2014). There are no reports or anecdotal accounts of otters in the

East Burwick area. Marine and Spatial Plan for Shetland (NAFC, 2012)indicated that otter habitat was present around the islands of Hildasay and Linga, which are situated approximately 3 km west-southwest of the fishery, as well as around the islands of Papa and Oxna >3 km southwest of the fishery.

Overall

Birds are anticipated to be the most significant wildlife contamination source to the East Burwick mussel fishery. In particular, eider ducks are anticipated to be present during much of the year, with eider habitat noted west and south of the fishery. Seabirds such as herring gulls, common gulls, guillemots, cormorants and Arctic terns are also found in the area, with available habitat also present. Faecal contamination from marine mammals may also impact sporadically. Impacts are assumed to be approximately even across the fishery, given its small extent.

The locations of recorded wildlife habitat and seabird breeding areas, as well as wildlife observations from the shoreline survey, are displayed in Figure 6.1.



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Ordnance Survey licence number [GD100035675]

Figure 6.1 Map of wildlife around East Burwick

7. Land Cover

The Land Cover Map 2007 data for the area is shown in Figure 7.1. The predominant land cover types adjacent to East Burwick are dwarf shrub heath and rough grassland. There is a small area of improved grassland inshore north east of the fishery. The built up areas shown in the map represent the town of Scalloway. Faecal indicator organism export coefficients for faecal coliform bacteria have been found to be approximately 1.2 – $2.8x10^{9}$ cfu km^{-2} hr^{-1} for urban catchment areas, approximately $8.3x10^{8}$ cfu km^{-2} hr^{-1} for areas of improved grassland and approximately $2.5x10^{8}$ cfu km^{-2} hr^{-1} for rough grazing (Kay, et al., 2008a). The contributions from all land cover types would be expected to increase significantly after rainfall events, however this effect would be particularly marked from improved grassland areas (roughly 1000-fold) (Kay, et al., 2008a).

The highest potential contribution of contaminated runoff to the East Burwick mussel farm is from the area of improved grassland north east of the fishery. The potential contribution of contaminated runoff to the shellfish farm would be highest along the northern end of the long lines. Areas utilised for rough grazing would be expected to contribute significantly to faecal contaminant loading carried in watercourses and overland flow draining the area during rainfall.

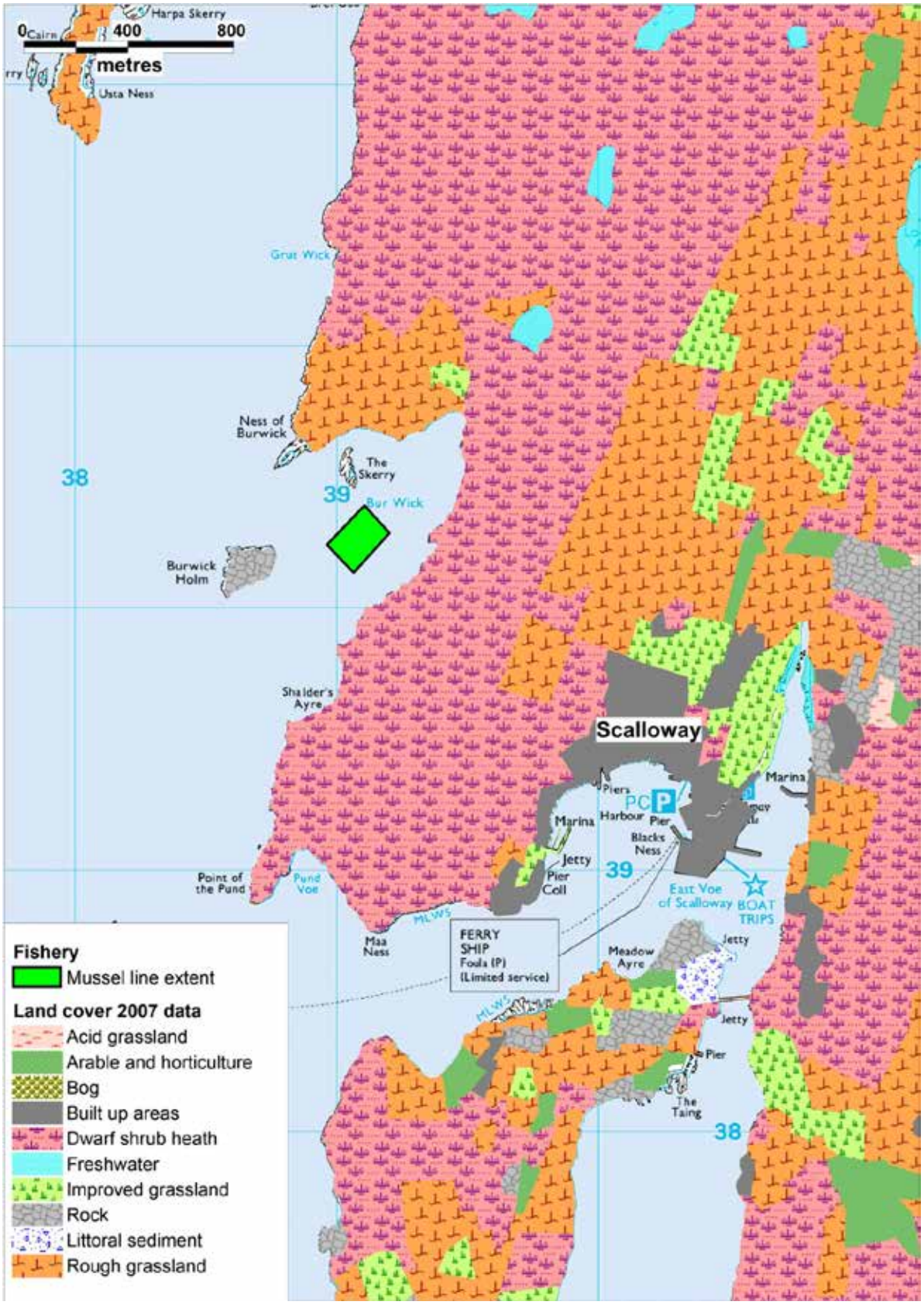


Figure 7.1 LCM2007 land cover data for the area around East Burwick

8. Watercourses

There are no gauging stations on watercourses entering Bur Wick.

Spot measurements of flow and microbial content were obtained during the shoreline survey conducted on the 17th and 18th June 2014. No precipitation was recorded in the 48 hrs prior to the survey. The watercourses listed in Table 8.1 are those recorded during the shoreline survey. Three of the watercourses did not have sufficient flow at the time of the survey to take measurements. The locations and loadings of measured watercourses are shown in Figure 8.1.

Table 8.1 Watercourses entering East Burwick

No.	Eastings	Northings	Description	Width (m)	Depth (m)	Flow (m^3/d)	Loading (*E. coli* per day)
1	439489	1140776	Tributary of Loch of Burwick	0.25	0.06	381	5.3×10^7
2	439171	1140741	Spring	Not measured		8*	1.9×10^8
3	439204	1140012	Small watercourse	Not measured			Not determined
4	439306	1140096	Small watercourse	Not measured			Not determined
5	439508	1140495	Small watercourse	Not measured			Not determined

* Flow measured using a 350 ml jug, average taken from three measurements

Estimated loadings for watercourses 1 and 2 were low. The small watercourses numbered 3 to 5, which could not be measured, contained moderate concentrations of *E. coli* of between 100 to 600 cfu/100 ml. All of the recorded watercourses were within 500 m of the mussel farm and would potentially impact on the lines closest to the northern and eastern shorelines. Any loadings would be likely to be greater after significant rainfall. Other watercourses are shown on the Ordnance Survey map as being located outside of Bur Wick but these are relatively small and are not thought to materially affect the microbiological quality at the fishery.

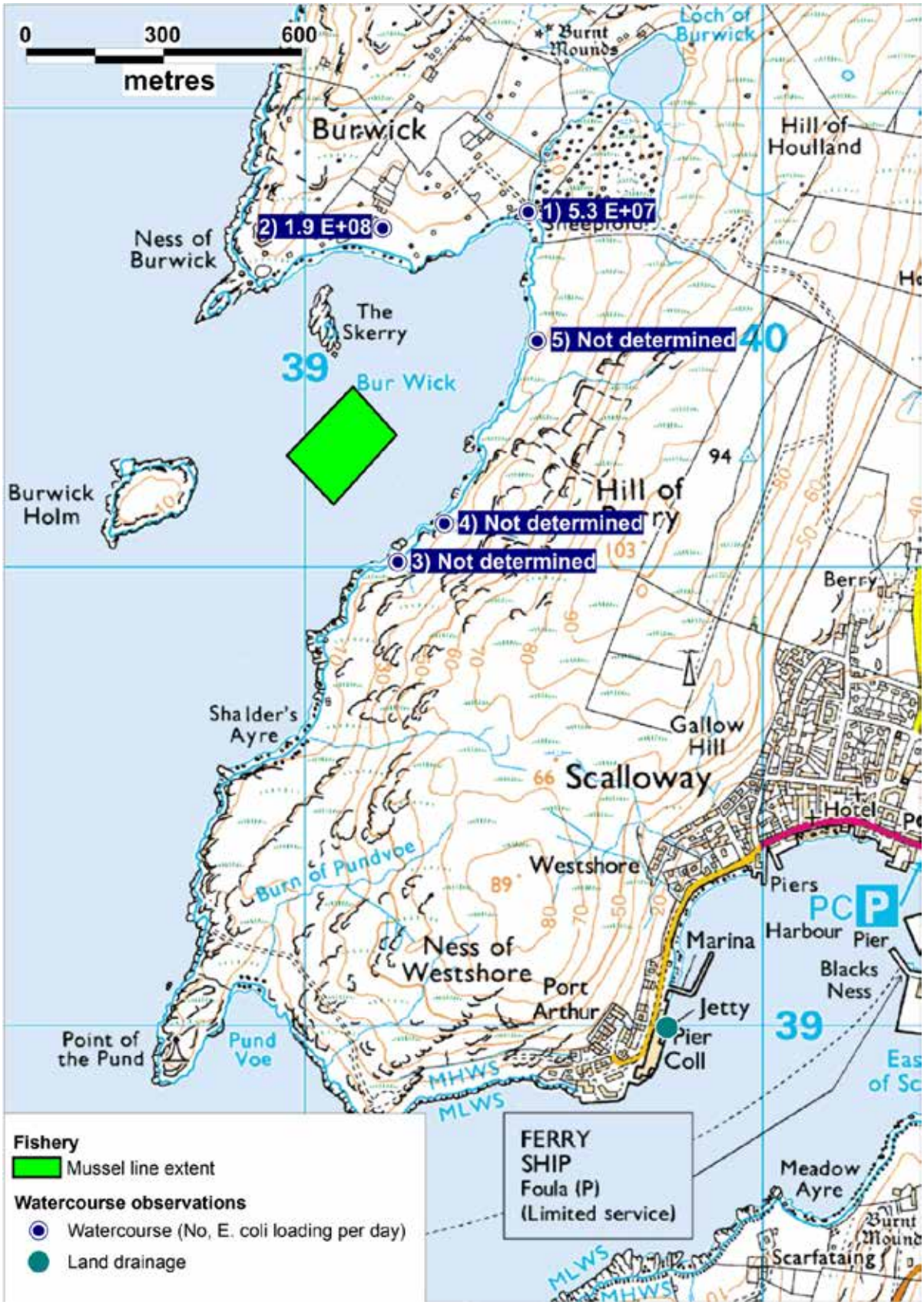


Figure 8.1 Map of watercourse loadings at East Burwick

9. Meteorological Data

The nearest weather station for which a complete rainfall data set was available is located at Lerwick, situated approximately 6 km to the east of the production area. Rainfall data was available for January 2008 – December 2013. The nearest wind station is also situated in Lerwick. Conditions may differ between this station and the fisheries due to the distances between them. However, this data is still shown as it can be useful in identifying seasonal variation in wind patterns.

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

9.1 Rainfall

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

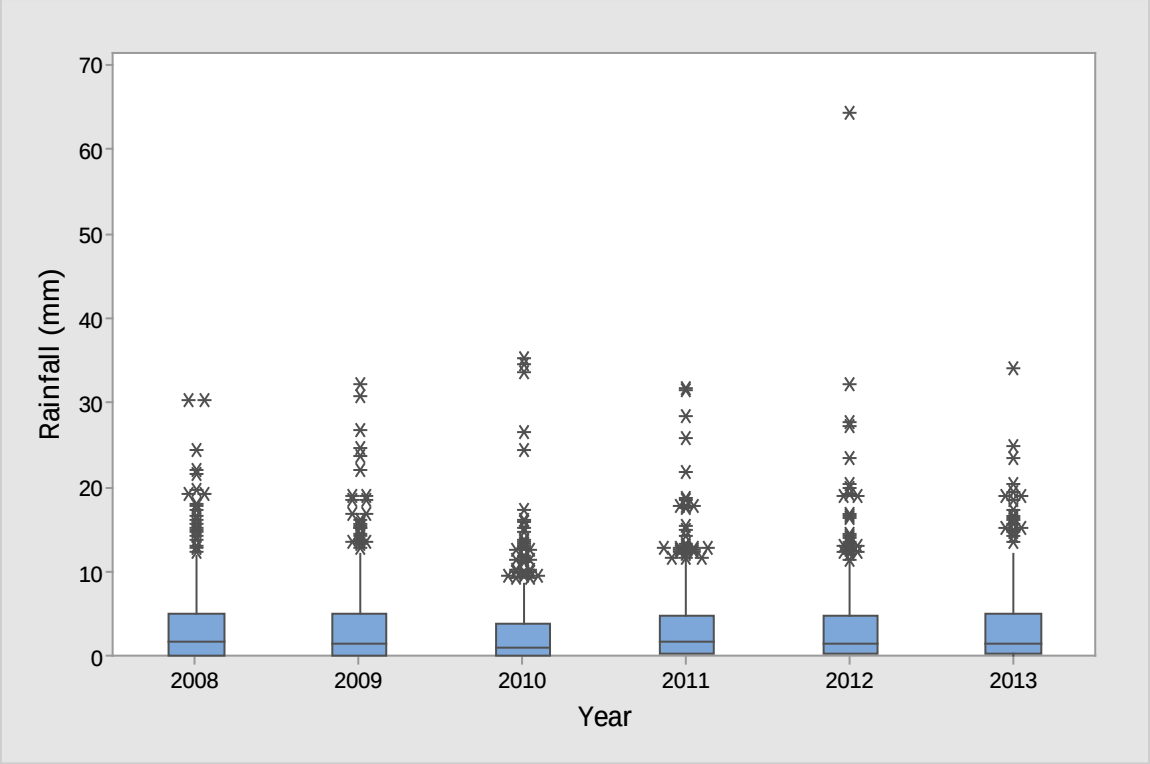


Figure 9.1 Box plot of daily rainfall values by year at Lerwick (2008 – 2013)

Rainfall values varied from year to year, with 2010 being the driest year (annual total: 1085 mm). The wettest year was 2012 (1296 mm). High rainfall values of more than 30 mm/d occurred in all years but an extreme rainfall event of over 60 mm/d was seen in 2012.

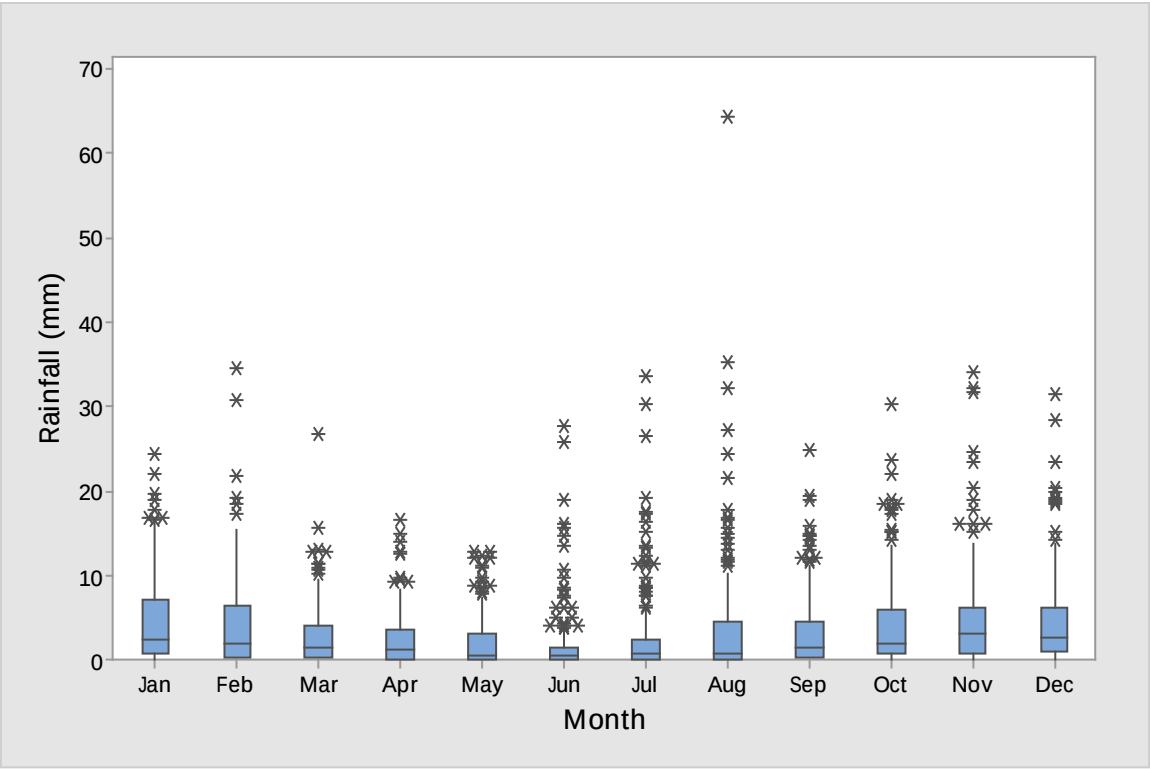


Figure 9.2 Box plot of daily rainfall values by month at Lerwick (2008 – 2013)

Daily rainfall values were higher during the autumn and winter. Rainfall was highest in December (860 mm) and lowest in June (330 mm). Rainfall values exceeding 30 mm/d occurred in February, July, August, October, November and December while the extreme rainfall event took place in August.

For the period considered here (2008 – 2013) 47 % of days received daily rainfall of less than 1 mm and 9 % of days received daily rainfall of over 10 mm.

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

9.2 Wind

Wind data was collected from Lerwick and summarised in seasonal wind roses in Figure 9.3 and annually in Figure 9.4.

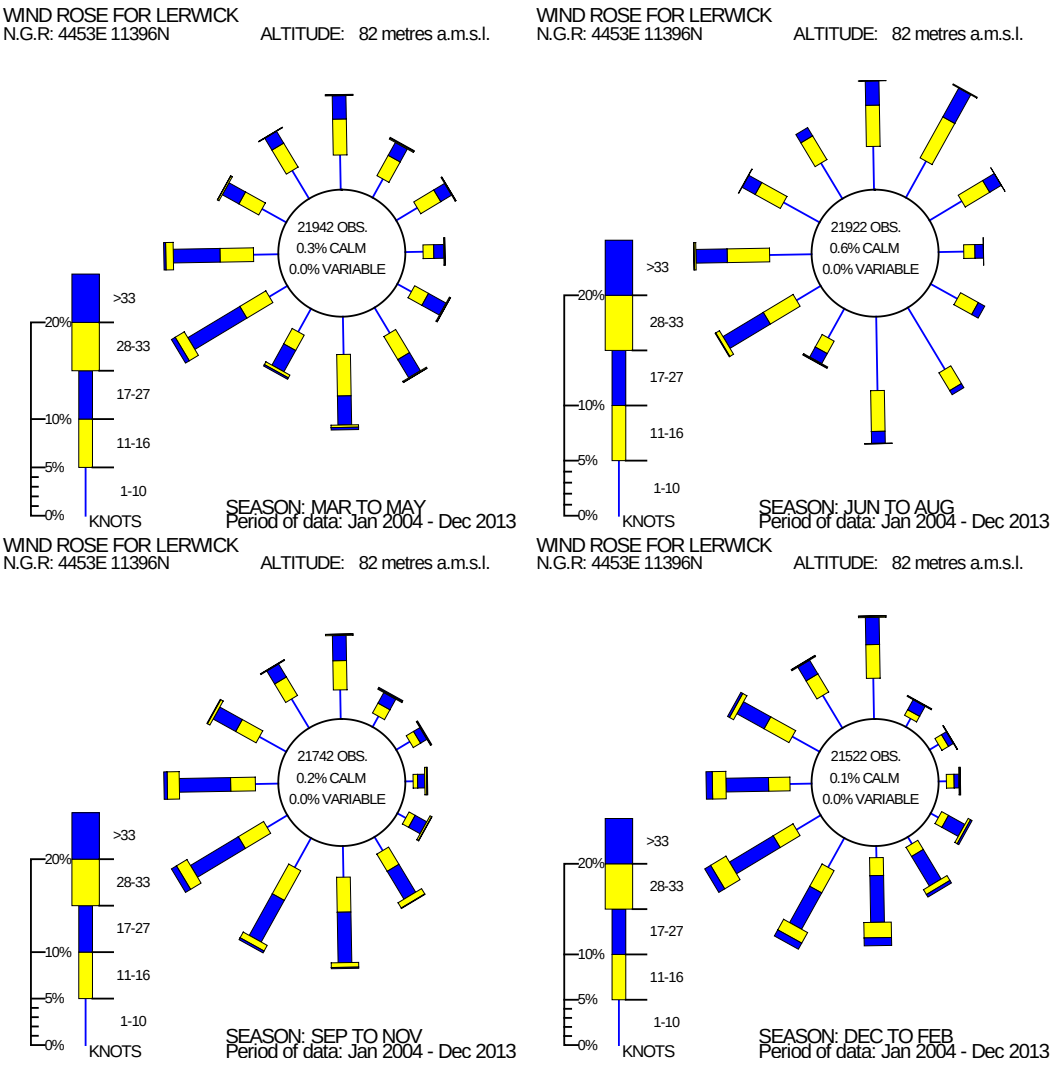


Figure 9.3 Seasonal wind roses for Lerwick

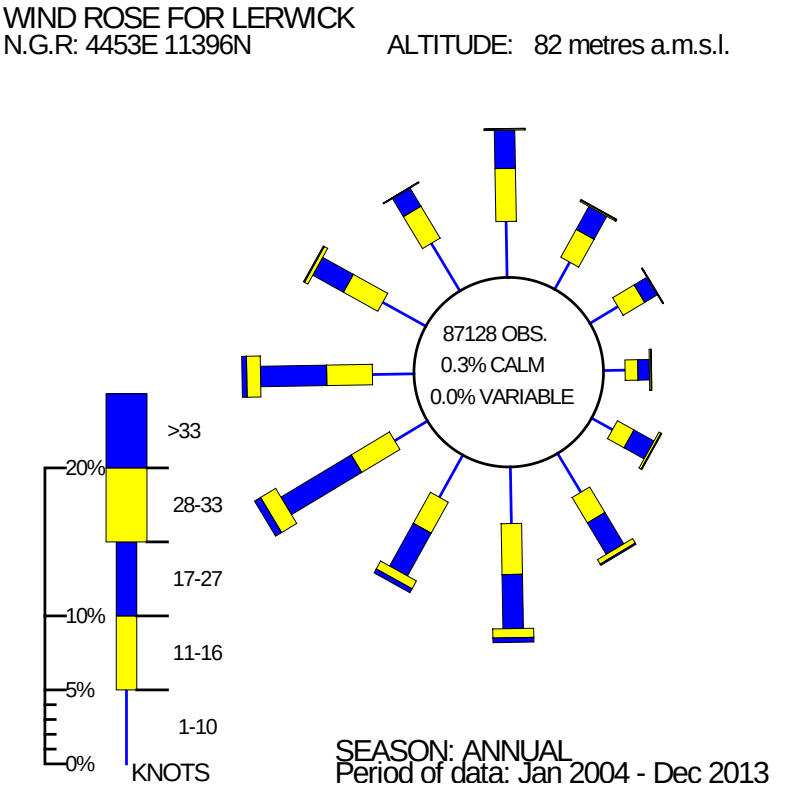


Figure 9.4 Annual wind rose for Lerwick

Overall the annual wind direction showed that wind was stronger when coming from the west than the east, and winds from the southerly direction were stronger than those from the north. The strongest winds tended to come to from the southwest quarter although winds from the north occurred relatively frequently. During the summer, winds were also often seen from the northnortheast. Winds were strongest during the winter and were weakest during the summer.

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

10. Classification Information

East Burwick is a new production area for common mussels (*Mytilus edulis*). Samples are currently being submitted towards standard classification.

12. Historical *E. coli* Data

12.1 Validation of historical data

Results for all samples assigned against East Burwick Mussels for the period 01/01/2009 to the 29/07/2014 were extracted from the FSAS database and validated according to the criteria described in the standard protocol for validation of historical *E. coli* data. The data was extracted from the database on 29/07/2014. All *E. coli* results were reported as most probable number (MPN) per 100 g of shellfish flesh and intravalvular fluid.

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

All nine samples were reported as valid, were received at the laboratory within 48 hours of collection and had box temperatures of <8^{o}C. Reported sampling locations for all nine samples lay within the production area boundaries.

12.2 Summary of microbiological results

Sampling and results summaries for East Burwick are displayed in Table 11.1.

Table 12.1 Summary of historical sampling and results from East Burwick

Sampling Summary	
Production area	East Burwick Mussels
Site	East Burwick Mussels
Species	common mussels
SIN	SI-583-1060-08
Location	Various
Total no of samples	9
No. 2014	9
Results Summary	
Minimum	<18
Maximum	790
Median	220
Geometric mean	108
90 percentile	790
95 percentile	790
No. exceeding 230/100g	2 (22%)
No. exceeding 1000/100g	0
No. exceeding 4600/100g	0
No. exceeding 18000/100g	0

12.3 Overall geographical pattern of results

The geographical locations of all sample results assigned to East Burwick are shown in Figure 11.1 with the symbol sizes graduated proportional to the magnitude of the *E. coli* result.

The nine East Burwick sample results were all taken from the northeast corner of the mussel farm. The highest result was associated with a sample taken slightly to the north and west of the other sampling locations.

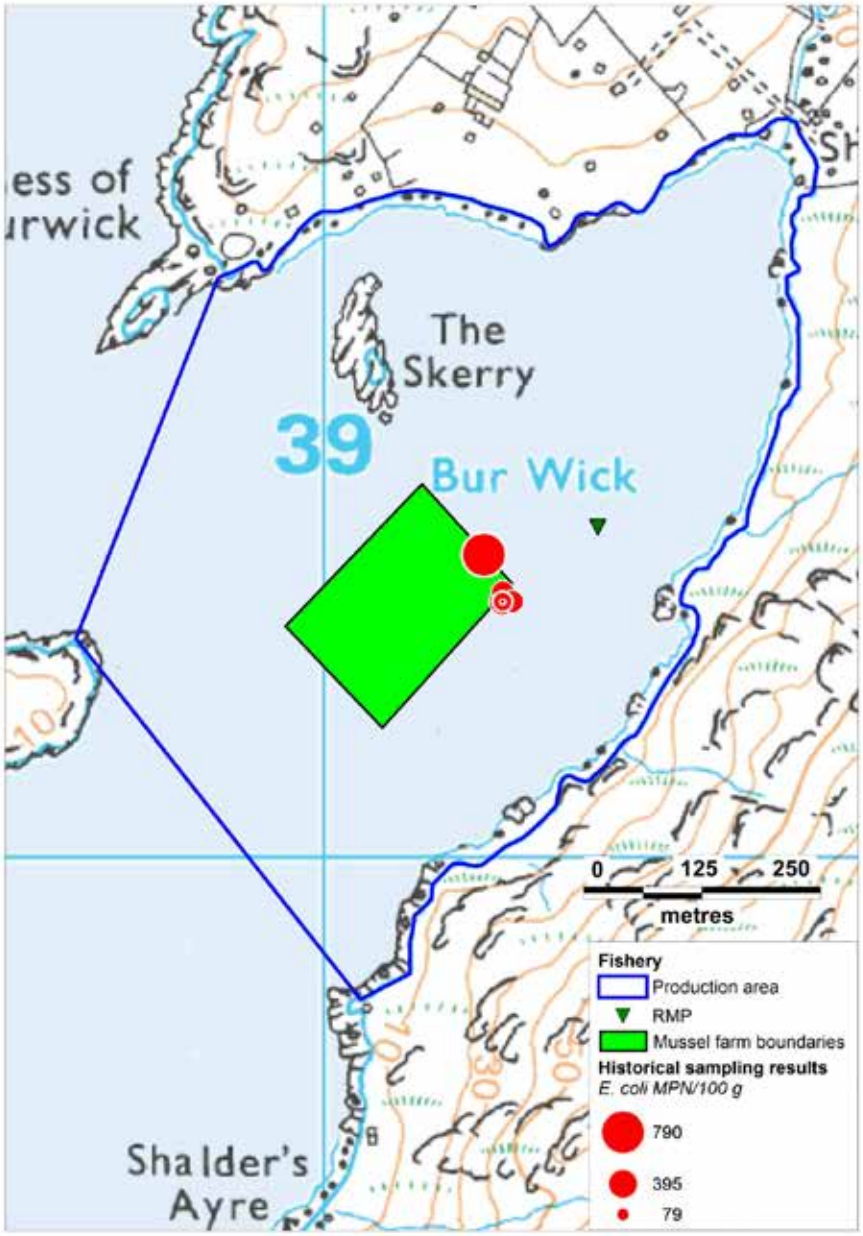


Figure 12.1 Map of reported sampling locations for common mussels at East Burwick

12.4 Overall temporal pattern of results

A scatterplot of *E. coli* results against date for East Burwick is presented in Figure 11.2.

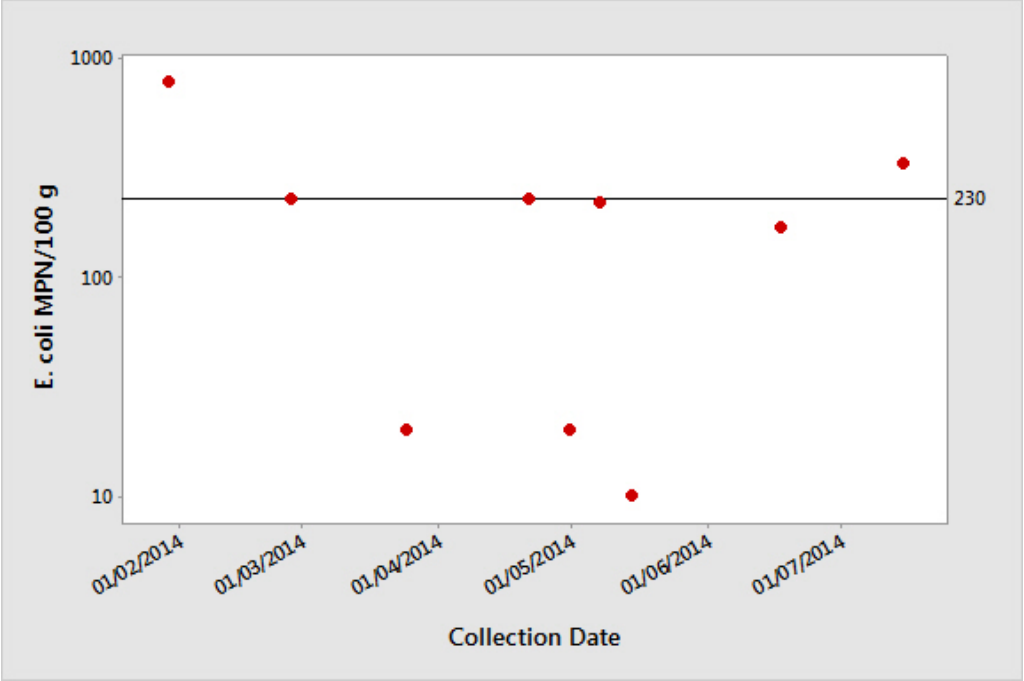


Figure 12.2 Scatterplot of *E. coli* results by collection date at East Burwick, fitted with a lowess line

The highest result was from a sample taken in January 2014.

12.5 11.4 Effect of environmental factors

No analyses were undertaken with respect to the possible effects of environmental factors on the magnitude of the mussel *E. coli* results due to the very limited number of results available at the time of assessment.

12.6 Summary and conclusions

Sampling at East Burwick began in 2014 and too few results are available to date to draw any conclusions with regard to spatial or temporal trends.

13. Designated Waters Data

Shellfish Water Protected Areas

The Shellfish Waters Directive (2006/113/EC) has been repealed (as at 31 December 2013) and equivalent protection for areas previously designated under that Directive is given by The Water Environment (Shellfish Water Protected Areas: Environmental Objectives etc.) (Scotland) Regulations 2013. The West of Scalloway Shellfish Water Protected Area (SWPA) was a new designation in 2013. The SWPA designation is a 3.6 km^2 area covering Bur Wick, the isle of Langa to the west and Whaleback Skerry and Skervie Skerry to the south. The designated SWPA for West of Scalloway is shown in Figure 12.1. No site report was available on the SEPA website.

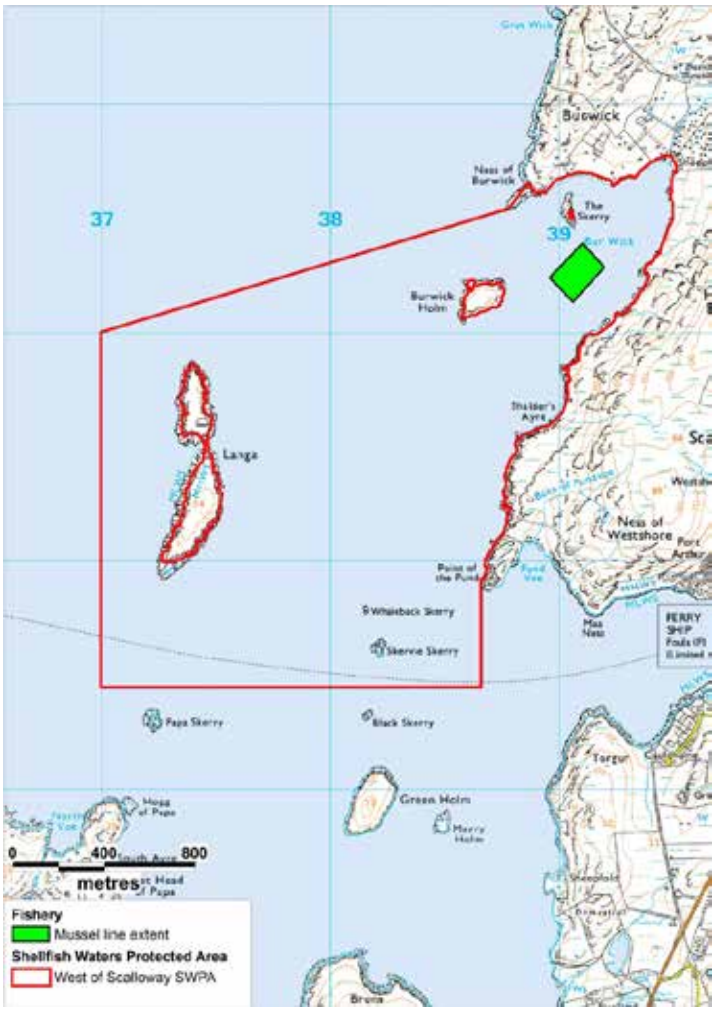


Figure 13.1 Designated shellfish water protected area – East Burwick

Bathing Waters

There are no designated bathing waters within the vicinity of East Burwick.

14. Bathymetry and Hydrodynamics

14.1 Introduction

The study area is located on the west Shetland mainland and comprises all waters contained within a boundary defined between the Point of the Pund (HU 387 389) and the southern tip of the island of Langa (HU 373 389), between the northern point of Langa (HU 374 399) and Usta Ness (HU 380 418), and finally across the southern extent of Weisdale Voe between Usta Ness and the shore below the Hill of Burwick (HU 391 418). This includes the body of water known as Bur Wick and the approaches thereto. Bur Wick is a small inlet on this section of coastline which opens to the waters around the Scalloway archipelago. The inlet is orientated roughly north-east/south-west and is characterised by a broad mouth tapering to a point at the head.

14.2 Bathymetry

Extracts from Admiralty chart BA3294 (1:25,000) annotated with the limits of the study area, production area and the location of the mussel farm mooring containment area is given in Figure 13.1.

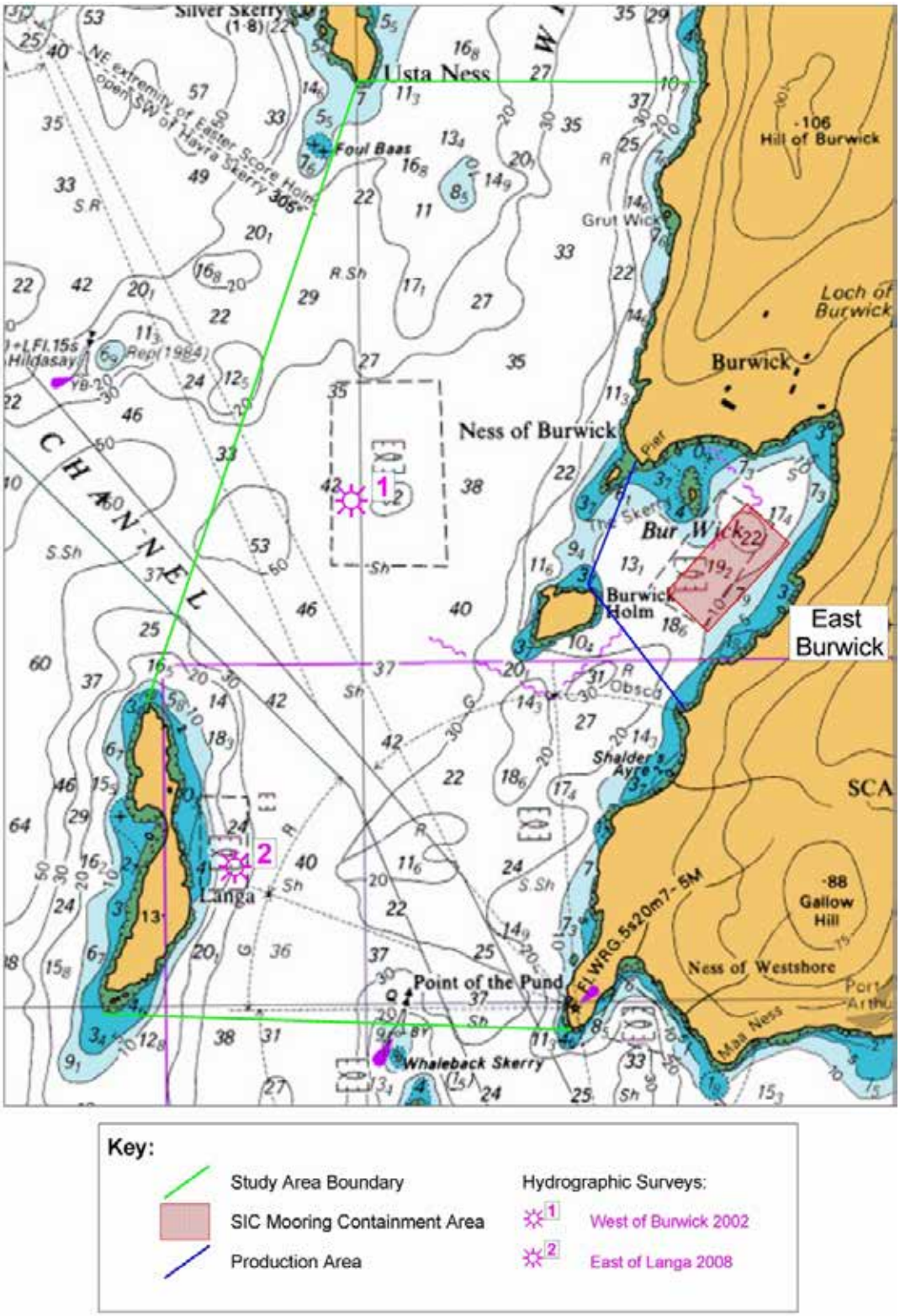
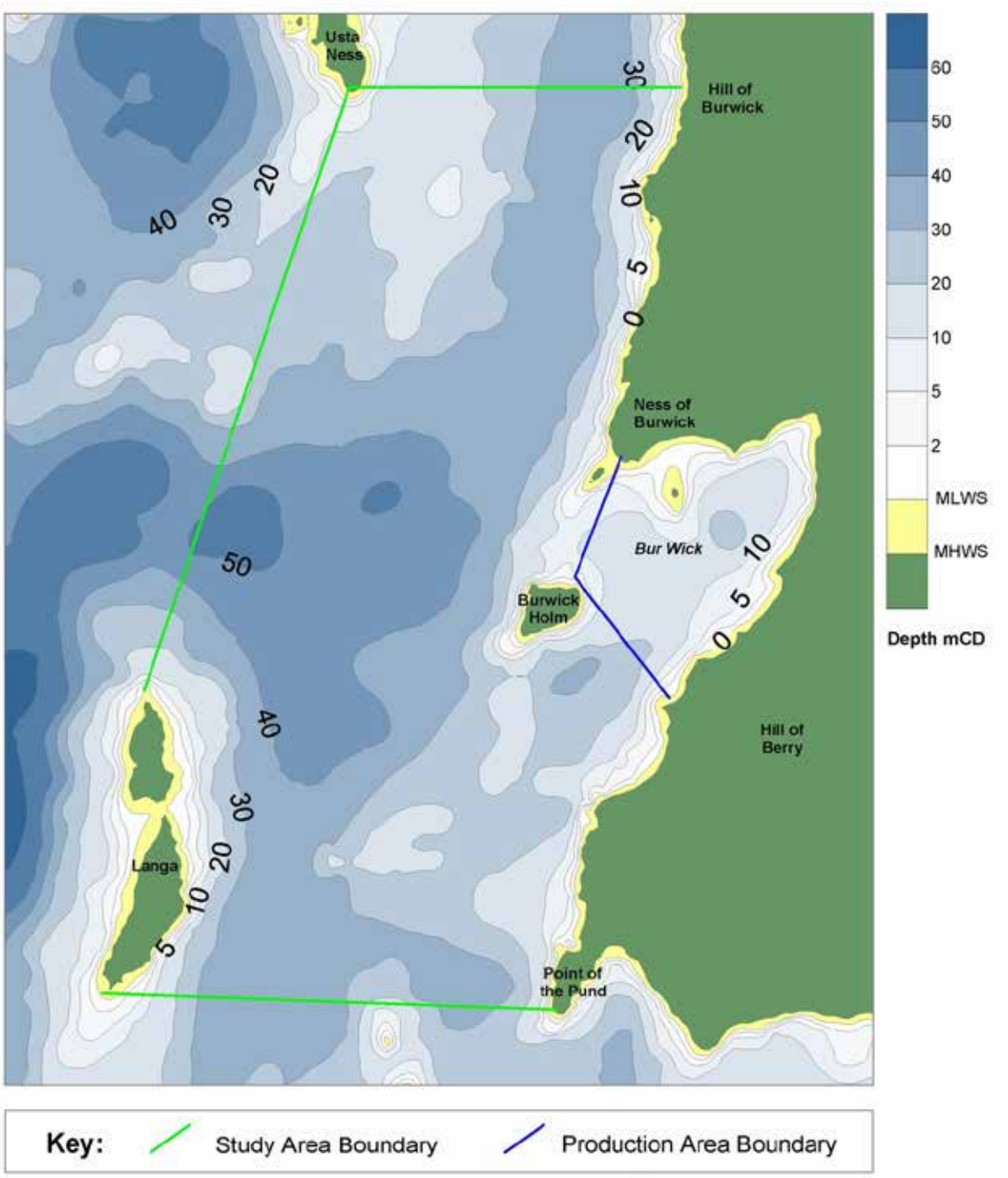


Figure 14.1 Admiralty chart extract

Vector data from an electronic version of this chart was extracted and contoured using Golden Software Surfer 8 (Figure 13.2).



Depths given as metres chart datum.

Figure 14.2 Bathymetry of East Burwick Study Area.

The contour plot illustrates:

- There is a deep area of water to the west of Langa that extends to the north of this island and curves then east into the study area.
- There are two approaches to Bur Wick either side of Burwick Holm. A minor sill is present to the north of the island (<10 metres) while the channel to the south has deeper water (20 to 30 metres).
- The depth of the production area is largely between 10 and 20 metres with a gentle gradient from the shore.
- Within the production area there is a small isolated area of deeper water near the head of the inlet reaching 22 metres.

Grid volume computations in Surfer allow for the estimation of the surface area and volume. Positional information is related to the British National Grid to give Eastings as the “x” coordinate and Northings as the “y” coordinate in a three dimensional grid. The values presented in Table 13.1 represent the area and volume at chart datum by defining the surface “z” as zero.

Table 14.1 Area and volume estimations of the study area using Surfer

Parameter*	Study Area	Production Area
Area (km^2)	3.92	0.37
Volume (Mm^3)	104.61	3.76
Mean depth (m)	26.7	10.1
Maximum depth (m)	62.0	22.0

* All values at chart datum

No part of the study area is included in the *Scottish Sea Lochs catalogue* (Edwards & Sharples, 1986)) or the *Catalogue of Voes, Firths and Sounds in Shetland* (Dixon, 1987).

14.3 Tidal Information

Information pertaining to predicted tide height is derived from the UKHO TotalTide prediction for Scalloway, the nearest secondary port which is located in the neighbouring inlet to the south-east of the study area boundary. Figures 13.3 and 13.4 show tidal curves for a fifteen day period starting on the 17 June 2014 and therefore includes the date of the shoreline survey (17 & 18 June 2014).

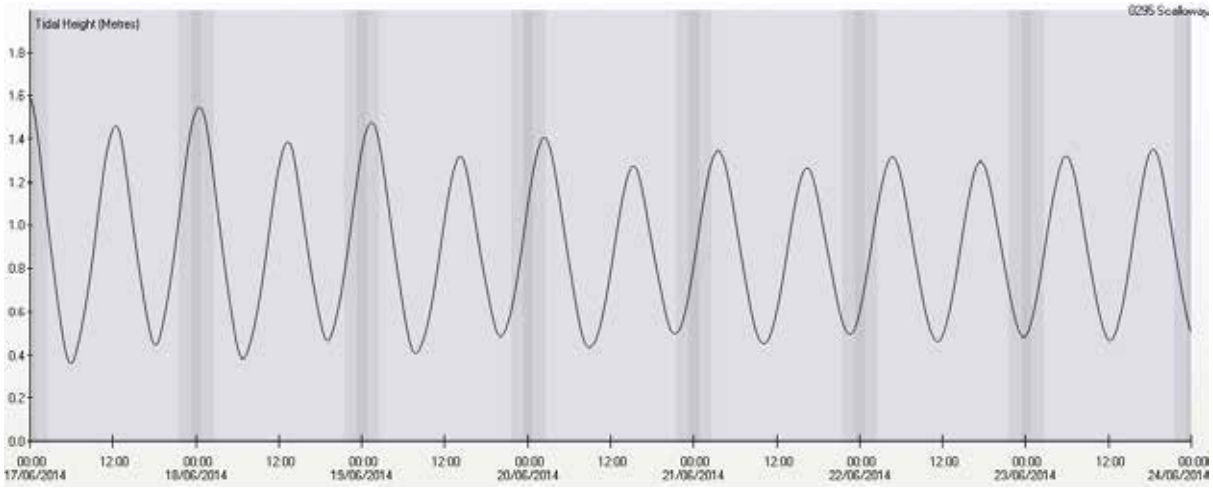


Figure 14.3 Tidal Curve Scalloway 17 to 24 June 2014

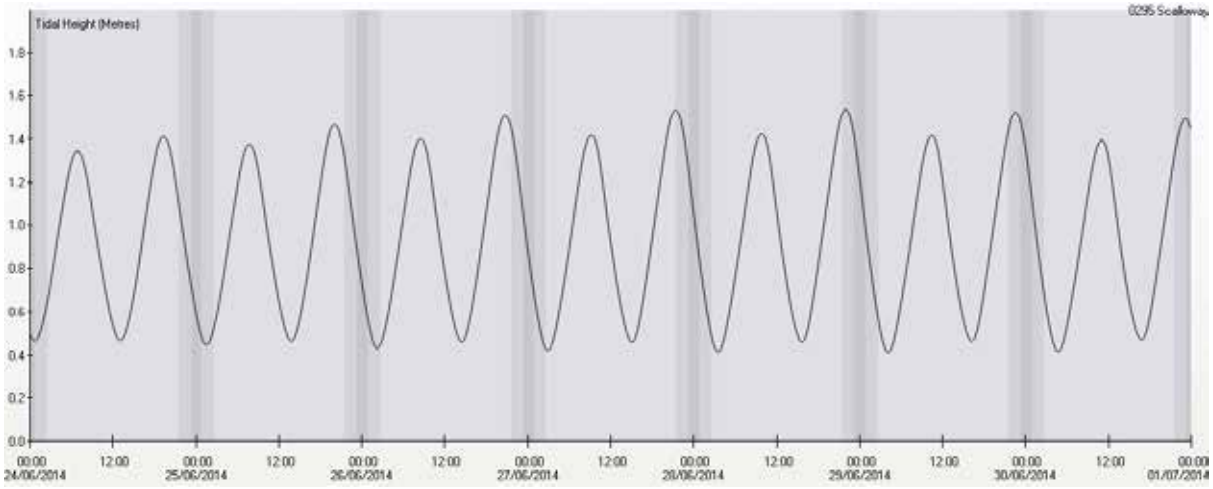


Figure 14.4 Tidal Curve Scalloway 24 June to 1 July 2014

Tide level information from TotalTide is summarised below. Predicted heights are in metres above chart datum.

0295 Scalloway is a Secondary Non-Harmonic port.

The tide type is Semi-Diurnal.

HAT	1.9 m
MHWS	1.6 m
MHWN	1.3 m
MLWN	0.6 m
MLWS	0.5 m
LAT	0.3 m

Based on the above Scalloway would be classified as micro-tidal with a low tidal range of 1.1 m for springs and 0.7 m for neaps. Comparable conditions are likely to

be found within the study region on account of similar topography and geographic proximity. Limited validation of this assumption is possible through pressure data collected from *in situ* measurements at the hydrographic survey locations in the area, described in Section 4.

14.3.1 Timing

Pressure data were recorded by current meters deployed at West of Burwick and East of Langa (0.8 and 1.4 km from the production area boundary respectively). These data were compared to the Scalloway TotalTide prediction for the equivalent survey periods. There was no discernible difference found between the timing of high and low water at Scalloway and at these locations, therefore there is unlikely to be a significant departure from the prediction throughout the study area.

14.3.2 Range

The range of three tides around the spring tide and three tides around the neap tide for the deployment at East of Langa 2008 were compared to that predicted for the corresponding tides at Scalloway. The East of Langa data was selected as this was considered of higher quality than the West of Burwick data; a faulty pressure sensor on the meter used for the latter survey warranted the use of an independent pressure logger resulting in records with a poorer resolution than the East of Langa data. The observed tidal range during spring tides is comparable to the prediction (observed range 1.26 dBar, predicted range 1.20 m). Neap tidal range was also similar although not as close as the prediction (observed range 0.41 dBar, predicted range 0.6 m). Atmospheric pressure is not accounted for in the survey data.

14.3.3 Tidal Volume

The volume of water entering and leaving a given area on each tide is estimated by two methods. The first is a simple box model based on a “tidal prism” method (Edwards & Sharples, 1986):

$$T_f \text{ (days)} = 0.52V/0.7A.R$$

where V is the volume of the loch basin (m^3), A is the surface area of the loch (m^2) and R is the spring tidal range (m). The factor 0.52 is the number of days per tidal cycle, and the factor 0.7 approximates the mean tidal range from the spring tidal range, R. As the spring tidal range is used, inputs for volume and area pertain to those calculated for MLWS for the study area. Based on this method estimates of flushing time (T_f) and flushing rate (Q) for both the study and production areas are given below in Table 13.2.

Table 14.2 Estimate of flushing rate and tidal volume for the study and production areas using the tidal prism method.

Input:		Study Area	Production Area
Volume* (V)	Mm^3	106.60	3.95
Area* (A)	km^2	3.95	0.38
Tidal range (R)	m	1.1	1.1
Output:			
Flushing Time (T_f)	days	18.22	6.96
Flushing Rate (Q)	Mm^3/year	2,136	207
Flushing Rate (Q)	Mm^3/day	5.85	0.57
Flushing Rate (Q)	Mm^3/tidal cycle	3.04	0.29

*Calculated for MLWS.

The tidal prism method indicates that 2.9 % and 7.5 % of the low water volume of the study and production areas respectively are exchanged during each tidal cycle and that total exchange would take eighteen days for the study area seven days for the production area.

The second method again utilises Surfer grid computations to estimate the volume of each area at different tidal states by defining the “z” surface according to the tidal level and subtracting low water from high water (Table 13.3).

Table 14.3 Estimate of flushing rate and tidal volume of the study and production areas using Surfer grid volume calculation.

Tide	Z (m)	Study Area Volume (Mm^3)	Production Area Volume (Mm^3)
MLWS	0.5	106.60	3.95
MHWS	1.6	111.02	4.39
Difference (spring tide)		4.43	0.44
MLWN	0.6	107.00	3.99
MHWN	1.3	109.81	4.27
Difference (Neap tide)		2.81	0.28
Average Difference		**3.62**	**0.36**

The estimate of the flushing rate is below the average tidal volume. Both estimations of the exchange rate given should be interpreted cautiously as both employ a gross simplification of hydrodynamic properties in a topographically complex area. In particular this applies to the study area which is not typical of a semi-enclosed water body for which the tidal prism calculation is suited with exchange occurring through three large boundaries. Sill and basin features will restrict exchange at depth and lead to longer residency times while wind forcing may serve to enhance or compound exchange depending on the direction. Such interactions are beyond the scope of simple box modelling techniques.

14.4 Currents

Admiralty charts provide no tidal stream information within the study area. The Admiralty Tidal Stream Atlas for Orkney and Shetland (UKHO, 1986) also does not

detail tidal flow within the study area however the currents to be expected to the west of the Scalloway islands is given. Flow is generally to the north from approximately five hours after high water Scalloway to three hours before high water, and to the south from two hours before high water to four hours after.

14.4.1 Field Data

Historically there have been two field studies which give an insight into the current flow patterns of the study area. Summary information of the deployments is given in Appendix 1 while their locations are included at Figure 13.2. Data from these hydrographic studies were provided to Cefas by SEPA which archive information concerning fish farm licencing on their Public Register. Both were evaluated and re-processed to the requirements outlined by SEPA in the *Regulation and Monitoring of Marine Cage Fish Farming (Scotland) Attachment VIII* (2008) to standardise analysis. The quality of the data collect is assessed against Attachment VIII to determine if each survey suitably represents the hydrographic conditions at each site. Both surveys produced data that is considered acceptable to the standards defined in Attachment VII and are therefore considered reliable representations.

14.4.2 Survey Data Assessment

An assessment of the hydrographic data collected at the West of Burwick and East of Langa fish farms was undertaken with detailed summary statistics tabulated in Appendix 4. Figure 13.5 illustrates the frequency of currents by vector and the pertinent summary statistics for near-surface waters.

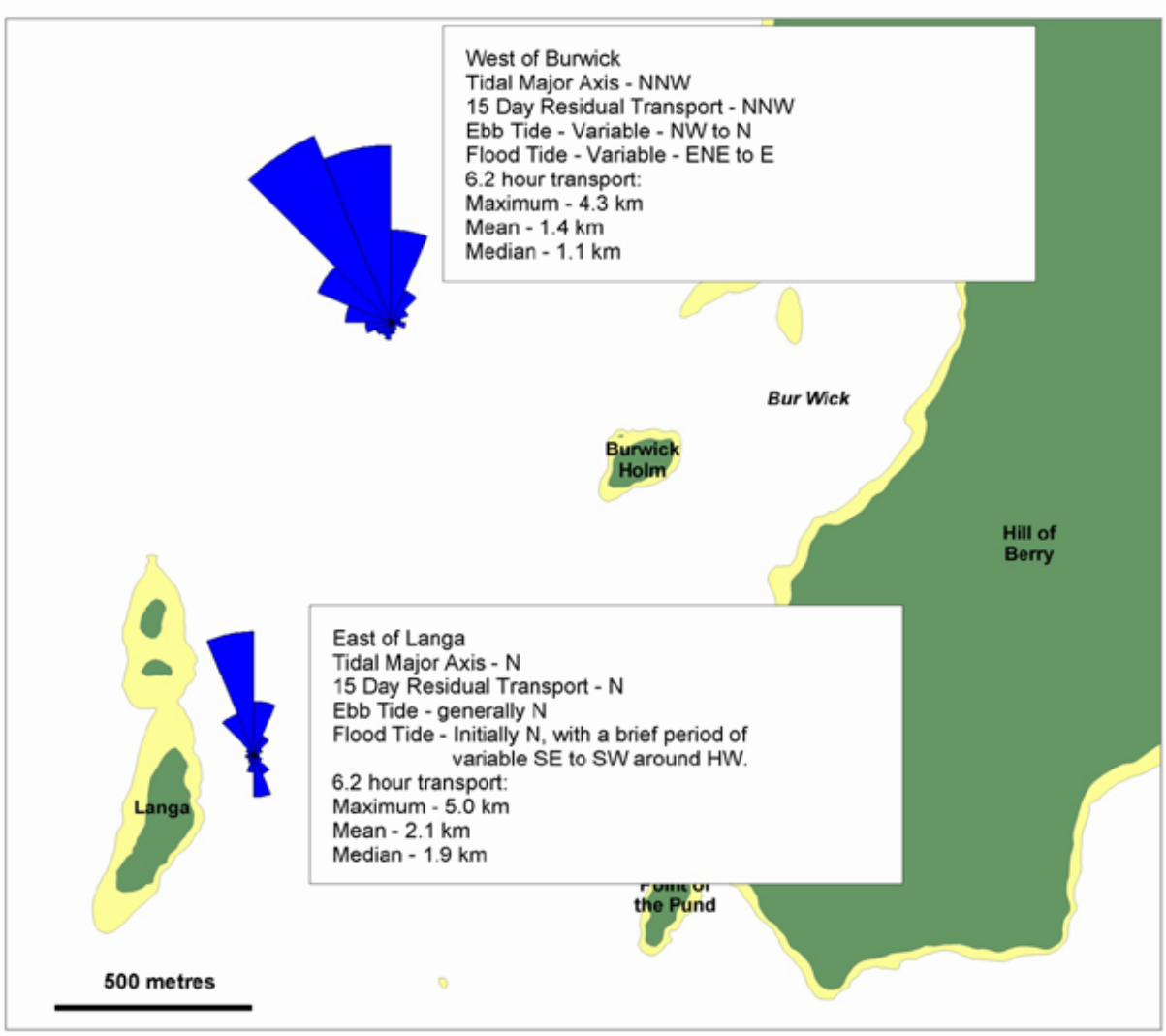


Chart based on data extracted from Admiralty Chart BA3294-2 © Crown Copyright and/or database rights. Reproduced by permission of the Controller of Her Majesty's Stationery Office and the UK Hydrographic Office (www.ukho.gov.uk).

Figure 14.5 Near-surface current direction frequency (bin size 22.5°) for the surveys at West of Burwick and East of Langa, including a summary of residual and tidal transport at each location.

The hydrographic data collected at West of Burwick in 2002 indicates that the influence from tidal currents is relatively low. Current velocities are greater nearer the surface than they are near the seabed and there is a corresponding variation in the residual transport away from the survey location over the 41 metres of water in which the instrument was deployed. It is apparent through assessment of the near-surface record that wind forcing has a strong influence on the currents observed during the fifteen day survey period. Meteorological data shows breezy conditions on average with winds rarely falling below Beaufort Force 4 until the last three days of the survey, and instances of stronger winds on four occasions between F6 and F8. This airflow originated from the south-east becoming east north-east for the last three days of the survey, with the only variation from this recorded during the two brief instances of calm conditions. Current flow in the near-surface record is characterised

by near unidirectional flow to the north-west, with some instances transport to the north and north-east, lasting for several tidal cycles. The survey location is moderately exposed with large fetches (4 km or more) from several directions (north-east, north-west, south-west, south south-east and south).

With respect to patterns of tidal movement data from the near seabed record was examined where there is the least influence of wind forcing. There is little evidence of periodicity in current velocity corresponding to the semi-diurnal tidal cycle, although in some instances early on in the survey period there is a recurring quiescent period at around low water. Peak speeds recorded are coincidental with a current flow to the east north-east. Regarding tidal direction, the only evidence is present during the spring tides as during neap tides a near unidirectional flow was observed. The pattern observed is not synchronous with the timing of high and low water. For the latter part of the flood tide, at high water and the early part of the ebb tide currents shows a variable flow to the east north-east or east. For the remaining time there is a variable flow to the north-west or north.

Periods of greatest transport during a 6.2 hour period (up to 4.3 km) occur in a cluster on a single flood tide, which is coincidental with the strongest winds recorded during the survey period.

The data collected during the East of Langa survey in 2008 would indicate that a more energetic current regime is present at this location than that observed at West of Burwick. Throughout the water column the majority of currents recorded are along a north-west/south-east axis with overall transport to the north.

The tidal cycle is discernible in the time series of the current data throughout the water column both in terms of speed and direction, although both demonstrate some variability from one tide to the next and this appears to be linked to the spring/neap cycle. Peak velocities frequently occur towards the end of the ebb tide, or at low water and lowest currents speeds are present at high water, although this pattern is not discernible during the neaps phase of the tidal cycle. Regarding tidal direction again the pattern observed is not synchronous with the timing of high and low water. From after high water and through low water to just prior to the subsequent high water currents are generally flowing to the north with a bias to the north north-west, while at around high water the general flow is to the south, anywhere between south-east and south-west. Therefore currents flowing towards the north last considerably longer than the more short lived counter flow. Again this pattern is less apparent during neaps with considerably more variation present, including periods of near unidirectional flow across adjacent tidal cycles.

As at the West of Burwick survey location, wind forcing can influence current speed and direction. The survey period was characterised by winds from the south and breezy conditions, rarely falling below F4 with six instances where speeds exceeded

F6. During spring tides strong winds from the south appear to increase the velocity of currents on the tidal stream flowing to the north, although the flow in the reciprocal direction at around high water is still present. During neap tides strong winds from the south-east or the north-west produced near-surface current flow in the opposite direction that persisted over multiple tidal cycles. Current speeds are also elevated during these periods. The survey location is moderately exposed to a fetch of 3.5 km to both the north and south.

Periods of greatest transport during a 6.2 hour period (up to 5.0 km) mostly occurred during a strong wind event from the south-east, although there is evidence of a regular increase in excursion associated with the strongest part of the tide flowing north at low water.

In summary tidal currents in the study area are relatively weak and subject to influence from wind forcing. Strong airflows can serve to enhance a particular tidal flow or dominate it altogether producing prolonged periods of unidirectional flow. Both surveys were conducted in winter and both were characterised by breezy conditions originating from the south-east, south or south-west which resulted in a net movement of near-surface waters to the north. Regarding tidal flow alone, in generally terms the ebb tide flows from south to north which is consistent with the Admiralty Tidal Stream Atlas for the currents present off the south-west Shetland mainland. Tidal flow to the south may be underrepresented in the survey data due to the dominance of wind generated currents from this direction.

Both surveys were conducted beyond the East Burwick production area boundary. While more sheltered and in shallower water than the survey locations the fishery is still exposed to a fetch of approximately 3.5 km from the south-west and 5.2 km from the north-west and with the potential for wind generated transport demonstrated it is not unreasonable to assume that the near-surface waters of the production area will be subject to the same influence.

14.5 Stratification

Salinity and temperature profiles were collected at three locations in the production area during the shoreline survey in June 2014. These locations corresponded to the extents of the mussel lines of the fishery. At all three locations the observed change was within the accuracy for the instrument used (± 0.35 ppt), illustrating near-uniform salinity levels typical of normal seawater over a depth of 10 metres. The three surface seawater samples collected at each of these locations also showed nominal levels. Surface seawater samples were collected at five additional locations to the south of the production area during the shoreline survey. All five also showed typical levels for seawater, although these were marginally depressed compared to those collected at East Burwick. Temperature profiles at the fishery showed minor variation with depth, a decrease of 0.1°C at the southern end of the site, with the greatest

difference at the northern end of the lines where the surface reading was 0.7 °C greater than that recorded at 10 metres. Complete salinity and temperature profile data and water sample analysis are available in the shoreline survey report.

During the summer months there is the potential that thermal stratification may occur. With a layer of warmer water above cold dense water the potential also exists for the formation of density driven currents. However, there was no evidence of this phenomenon during the fieldwork conducted in June 2014 at the locations sampled.

A total of five watercourses were recorded draining into the production area during the shoreline survey, the largest of which was at the head of the inlet. Annual rainfall patterns could therefore have an effect on surface salinity. Figure 13.6 illustrates the monthly total rainfall and the 24 hour average rainfall from the Lerwick Meteorological Office from 2007 to 2012. During the autumn and winter months reduced salinity in near surface waters may occur with higher fresh water input, however the timing of the fieldwork precluded any further study of this phenomenon.

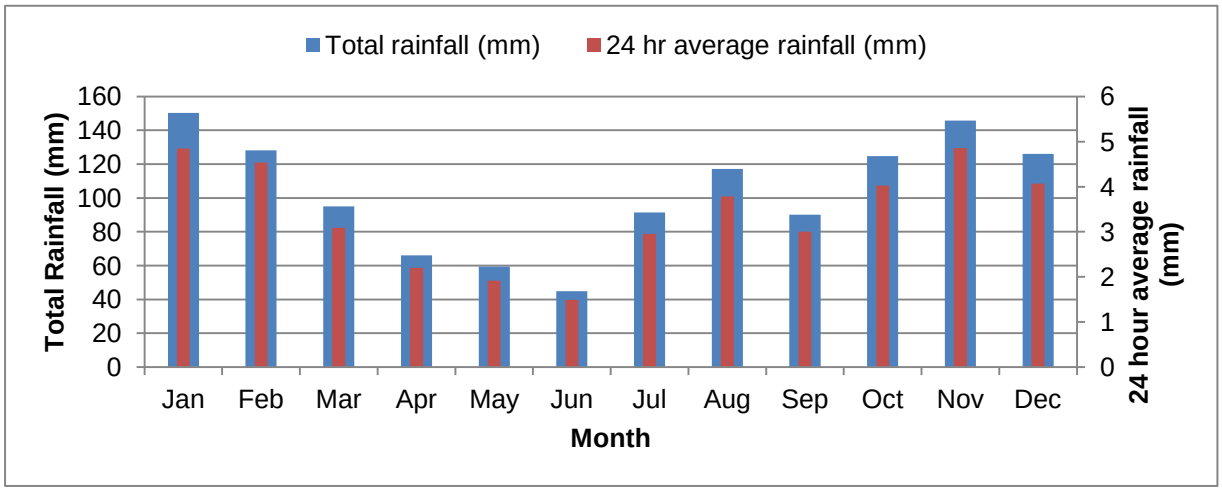


Figure 14.6 Total monthly and mean 24 hour rainfall for the period 2007 to 2012

As no part of the study area is included in the available water body catalogues (Edwards & Sharples, 1986; Dixon, 1987) various parameters pertaining to freshwater input for the production area have been calculated using the same methodology as used in these publications and are detailed in Table 13.4 below.

Table 14.4 Estimated freshwater runoff parameters for the East Burwick production area

Watershed km^2	Annual rainfall (mm)	Runoff (Million Mm^3/yr)	Fresh tide per thousand	Salinity reduction (ppt)	Runoff/Width m^3/d
3.1	1,223*	3.0	14.3	0.5	20.2

*Annual average 2007-2011. Source Met Office, rainfall data for Lerwick.

These parameters would indicate that freshwater input has the potential to have an influence on the production area. When compared to others collated in the water body catalogues, Bur Wick would be in the top five of sites ranked in order of greatest freshwater to tidal water supply ratio and resultant salinity reduction. This is a reflection of the fact that Bur Wick has a relatively large watershed for a small body of water.

The predicted salinity reduction was not observed during the shoreline survey however the figure calculated relates to Bur Wick over the whole year. The figure must be considered in the context of seasonal variations in runoff and the likely salinity gradient relating to the sources of the freshwater input. The observed readings may be attributed to low rainfall on the days preceding the survey; June is on record the driest month of the year according to meteorological records for Shetland.

14.6 Summary

- The tidal prediction for Scalloway is applicable to the study area in terms of timing and range.

- Figures for tidal exchange derived from the two methods indicate that between 7.5 % to 9.1 % of the low water volume of the production area is exchanged during the tidal cycle leading to a flushing time of approximately seven days. It is acknowledged that the same calculations for the complete study area are not likely to be representative due to the open nature of the region.

- Field observations from the study area indicate that tidal currents are relatively weak and variable. In general terms the ebb tide flows northerly and the flood tide is southerly or easterly which roughly conforms to the pattern of tidal steams offshore. Wind forcing dominates the tidal flow, particularly in near surface waters, and can either enhance a given tidal flow if winds are blowing along the tidal axis, or overpower the tidal current entirely with a period of unidirectional flow over sequential tidal cycles.

- The greatest transport events during a 6.2 hour (tidal) period of 4 to 5 km are generally associated with elevated wind forcing, and occasionally coincidental with the ebb tide.

- Neither hydrographic survey was in the production area, however with evidence for wind influence on surface water movement in the region is apparent, and therefore similar conditions are likely here. The production area is exposed to 3.5 km fetch to the south-west and a 5.2 km fetch to the north-west.

- Salinity profiles collected during the June 2014 shoreline survey showed no indication of freshwater influence in the surface waters of the production area, however the timing of the survey in the driest month of the year may have been a factor. Freshwater runoff calculations based on the watershed and bathymetric properties of the production area would suggest that there is potential for influence, although however the estimated change would be comparatively low with respect to sea lochs on the Scottish Mainland, where a difference in the order of 20 ppt may be seen between bottom and surface waters.

15. Shoreline Survey Overview

The East Burwick shoreline survey was conducted on the 17th and 18th June 2014. No rain was reported in the 48 hrs prior to the survey, though light rain fell on the morning of the first survey day.

The fishery consisted of a common mussel farm, comprised of nine double-headed long-lines with 8-10 m droppers and lay parallel to the east shore. Shellfish samples were taken at the surface and at 8 m depth at the eastern, southern and western extents of the mussel farm. Highest results were obtained from samples taken at the southern extent of the fishery (near surface: 790 *E. coli* MPN/100 g; 8 m: 490 *E. coli* MPN/100 g). Subsurface seawater samples were taken at the same locations as shellfish samples, with the highest result also obtained from a sample taken at the south of the fishery (5 *E. coli* cfu/100 ml).

Only two houses were noted on the land immediately adjacent to the fishery. Human population was mostly concentrated to the south and southeast, at Scalloway and at the smaller settlements of Scarfataing and Cauldhame on the north side of the island of Trondra.

Six private discharges were noted, one on the shore north of the fishery and five in Scarfataing and Cauldhame. A seawater sample taken from the end of a submerged pipe associated with a concrete ST serving several houses in Cauldhame returned a result of 92,000 *E. coli* cfu/100 ml. Maa Ness WWTW was observed in Port Arthur. A seawater sample taken at its main outfall location between Shalder's Ayre and the Point of the Pund returned a result of 5 *E. coli* cfu/100 ml, whilst the seawater sample taken at Shalder's Ayre returned a result of 19 *E. coli* cfu/100 ml. Discharge pipes to sea were noted from the West Shore, Blydoit, and Seachest pumping stations.

Visitor accommodation was mostly situated in Scalloway, with nine self catering chalets also noted at Easterhoull in East Voe. A 280 room accommodation barge was also berthed on the west side of Blackness Pier during the survey. It is for the use of workers refurbishing the Sullom Voe Oil Terminal and constructing the new gas plant in Shetland. However the influx in workers was also noted to have caused a high year- round demand in accommodation in the vicinity of Scalloway.

A workboat was noted at the fishery during the survey, with a small pier also observed at Ness of Burwick. Boating activity was mostly centred in Scalloway Harbour.

Most of the land around the fishery was used for rough grazing. In total, 253 sheep were observed. These were seen at a number of locations along the shoreline route

with approximately half being recorded along the shores of Bur Wick. Sheep faeces were observed at a number of locations on the shore.

Five watercourses around the fishery were sampled, though low flow rates prevented flow measurements being taken at three of them. Freshwater samples taken from watercourses yielded results ranged from 14 to 2400 *E. coli* cfu/100.

Birds were the only wildlife observed during the survey, with highest numbers noted around the fishery. Arctic terns were the most frequently observed, with a potential breeding colony was noted on the beach north of the fishery. Shell debris along the shoreline suggesting possible bird feeding areas were noted north and south of the fishery, and between Scarfataing and Cauldhame.

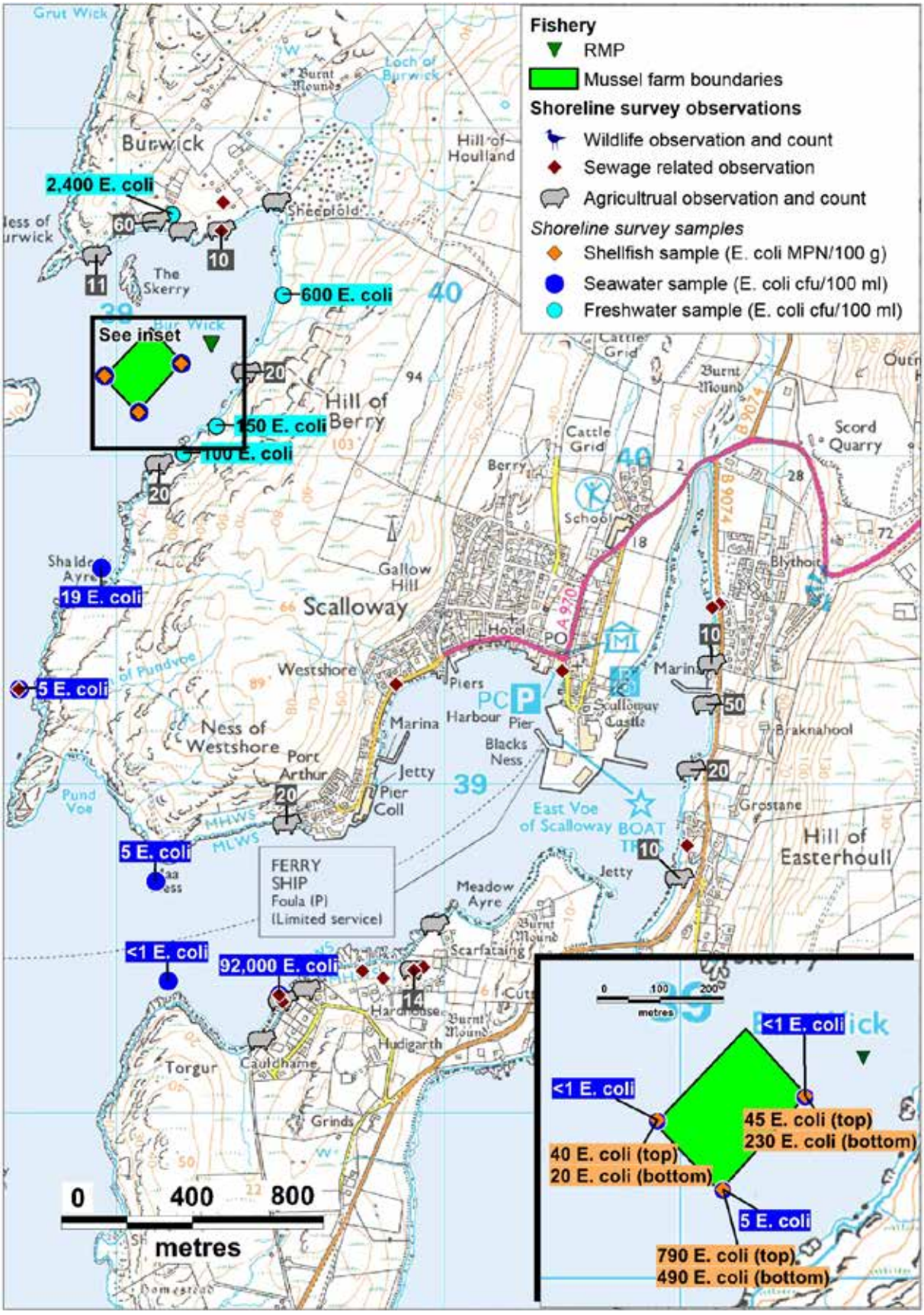


Figure 15.1 Map of shoreline survey observations at East Burwick

16. Bacteriological Survey

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

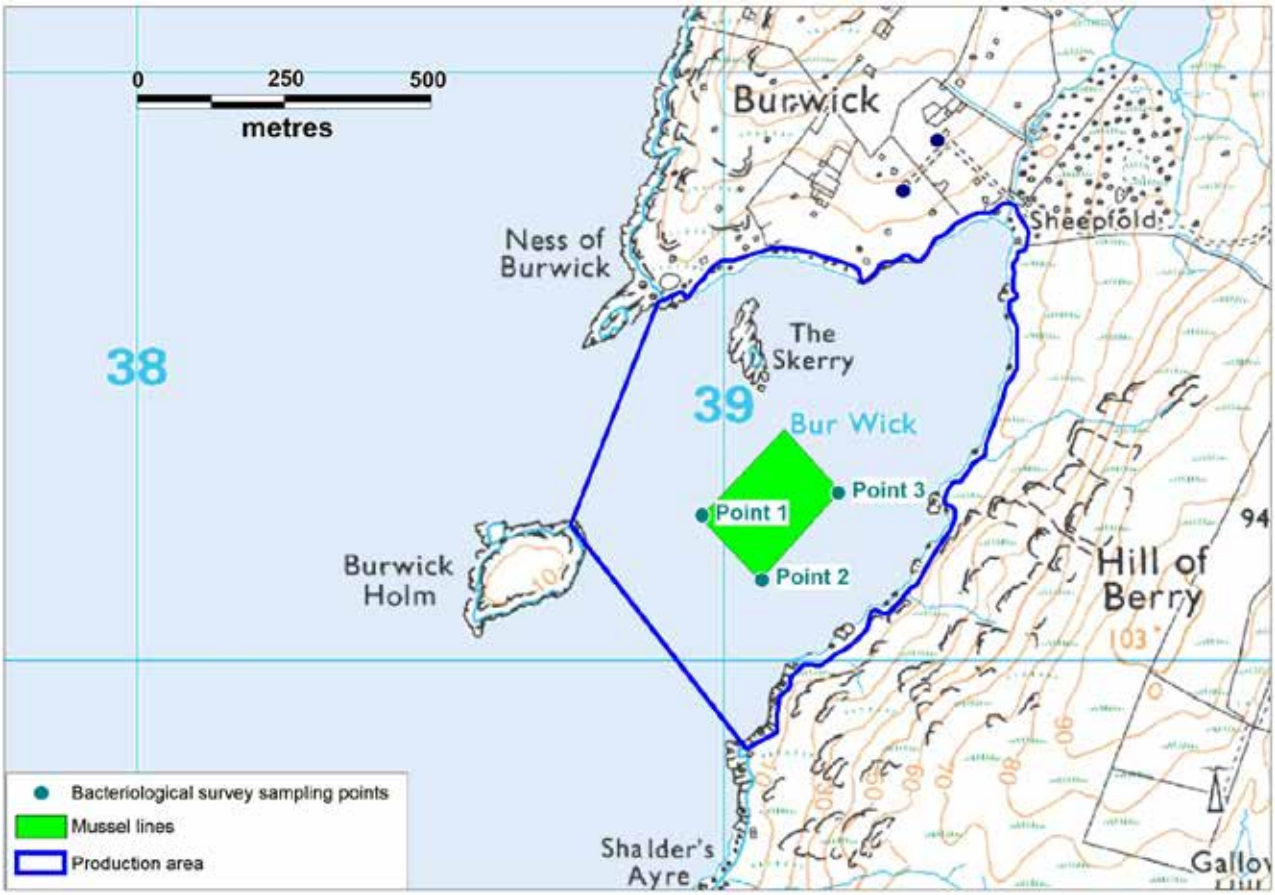


Figure 16.1 Bacteriological survey sampling locations

Table 15.1. Bacteriological survey results

Sample point	NGR	*E. coli* MPN/100 g				
		17/06/2014	01/07/2014	15/07/2014	Geometric mean	Maximum
1	HU 3895 4023	40	<18	330	51	330
2	HU 3906 4012	790	2200	790	1110	2200
3	HU 3919 4027	45	20	78	41	78

[1]< values were assigned a nominal value of 10 for the determination of the geometric mean

The highest geometric mean and maximum *E. coli* values from the three sets of samples were seen at sample point 2.

17. Overall Assessment

Human sewage impacts

The primary sewage impacts to the fishery come from the Maa Ness treatment works outfall, which discharges within 1km of the mussel farm. This outfall also serves as the discharge point for an associated CSO and therefore additional contamination would be expected to arise after heavy rainfall. Two properties to the north of the fishery both have septic tanks discharging to soakaway systems. Should either of these fail, it could pose an additional local source of contamination and at the time of shoreline survey there was indication that one of the tanks was potentially failing. Impacts from this source would be most likely to affect the northern extent of the mussel farm, however the impact is expected to be relatively minor compared to that of the larger outfall from Maa Ness to the south.

Agricultural impacts

Much of the area surrounding Bur Wick is used for extensive livestock grazing, particularly of sheep. A significant number of animals were seen along the north shore of Burwick, where there was a large area of improved pasture. Sheep had access to the shoreline, and therefore direct deposition of sheep droppings to the intertidal shore is likely. Sheep were found to graze widely around the area and therefore at least some contribution from livestock sources is likely around much of the fishery, however impacts are likely to be highest to the north of the fishery where there is a farm.

Wildlife impacts

Birds, seals, dophins and otters are all likely to contribute to background levels of faecal contamination found in the area. However, contributions from birds are expected to be the most significant in terms of contamination at the mussel farm. Eider ducks, gulls and cormorants are likely to be present throughout the year and are most likely to be present on and around the mussel farm itself. Due to the small size of the mussel farm, impacts are presumed to be evenly distributed.

Seasonal variation

Insufficient monitoring history was available to support assessment of seasonal variation in E. coli results at this site. There is likely to be a significant seasonal variation in livestock inputs, as more sheep will be present in spring and summer when there are lambs. No significant seasonal increase in human population is expected, as though there is some tourist accommodation in Scalloway it does not accommodate large numbers relative to the resident population of the area.

Rivers and streams

There were only a very small number of watercourses discharging to the area, and none of these was large. All recorded watercourses were located to the north or east of the mussel farm. Loadings estimated based on shoreline survey results were relatively low, and any impacts would be most likely to affect the north and east sides of the fishery.

Movement of contaminants

The hydrographic assessment indicated that tidal currents were weak and variable and that wind-driven flows were likely to predominate. Winds from the south, southeast or southwest would tend to drive contamination arising from sources to the south of Bur Wick northwards toward the mussel farm. Transport of up to 5 km over a single tide was associated with strong winds, particularly from the southeast. Therefore, it is likely that contaminants arising from the Maa Ness septic tank discharge will be transported across the fishery under prevailing wind conditions, and under certain conditions the discharges at Huisdale and Hamnavoe may also add to contaminant levels at Bur Wick.

Temporal and geographical patterns of sampling results

There is insufficient historical monitoring data on which to base an assessment of the temporal and geographical variations in sampling results. Shoreline survey sampling showed higher results in both shellfish and seawater at the southern end of the mussel farm. A bacteriological survey confirmed this observation, with samples taken from the southern end of the mussel farm returning higher *E. coli* results on all three sampling occasions.

Conclusions

The mussel fishery at Bur Wick is impacted by sewage discharges from the Maa Ness septic tank, as well as by diffuse human and agricultural source contamination arising from a farm and houses located on the north shore of Bur Wick. Wildlife sources are likely to contribute to background levels of contamination across the fishery. Diffuse sources are concentrated around the north and east sides of the mussel farm, however the contribution from Maa Ness is expected to be more significant under prevailing wind conditions. In light of the population served by the Maa Ness tank, which is comprised of a permanent resident community of more than 1100 as well as approximately 300 visiting workers, the risk from human viruses is not likely to be adequately represented by *E. coli* results.

18. Recommendations

Production area

No change is recommended to the boundaries of the provisional production area, which are:

> The area within a line drawn between HU 3889 4061 to HU 3874 4023 to HU 3904 3985 extending to mean high water springs.

RMP

In light of the risk from the continuous sewage discharge to the south of the mussel farm, it is recommended that the RMP be moved to the southern end of the mussel farm, at HU 3906 4012.

Frequency

It is recommended that a monthly sampling frequency be retained.

Depth of sampling

As higher results were seen nearer the surface, it is recommended that samples be taken from a depth of 1-3 metres.

Tolerance

It is recommended that a sampling tolerance of 40 metres be applied to allow scope for movement of the mussel lines.

The locations of the production area, recommended RMP and mussel farm area are shown in Figure 18.1.

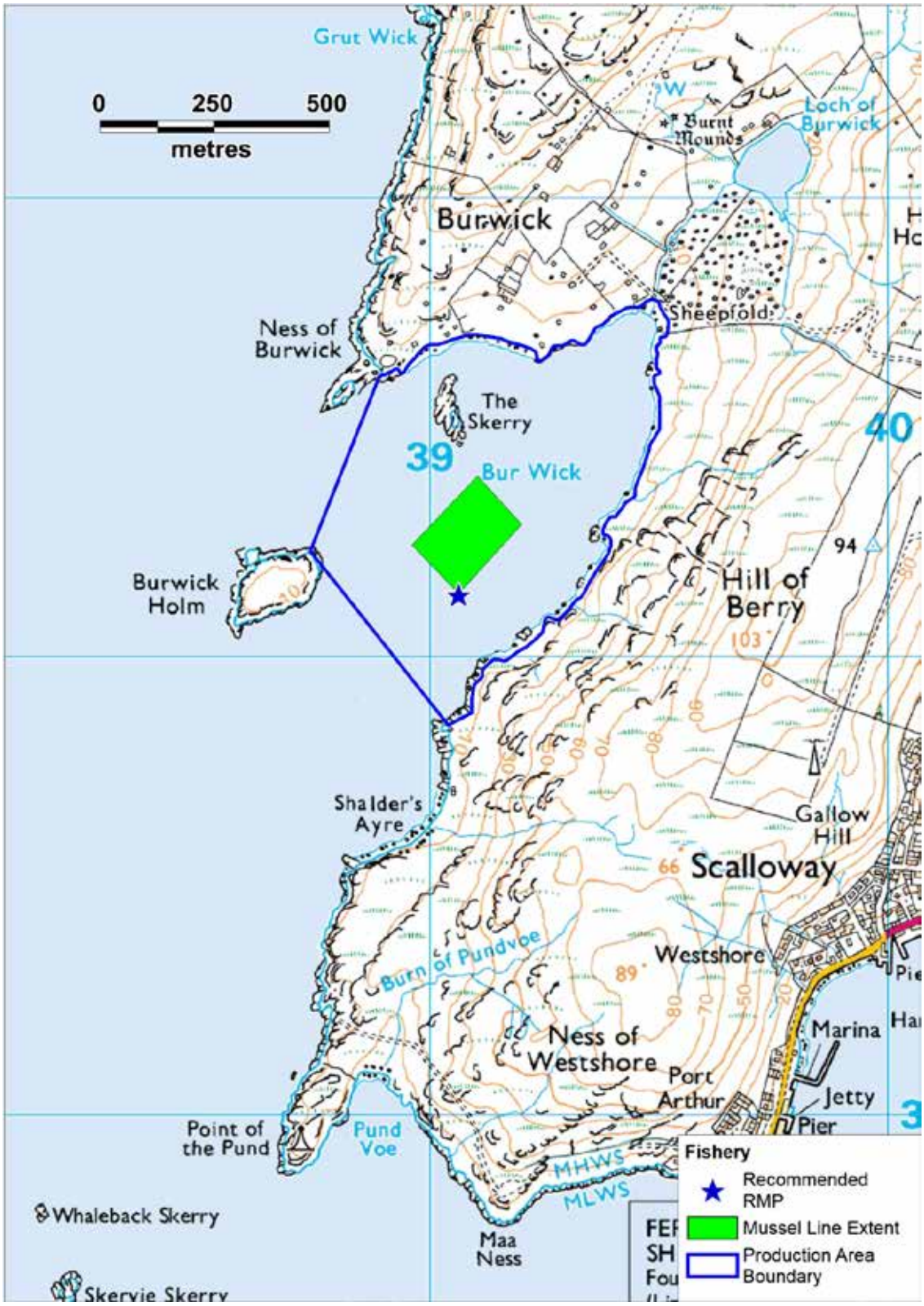


Figure 18.1 Map of recommendations at East Burwick

19. References

Bibby Maritime, 2009. *Bibby Challenger Sales Brochure.* [Online] Available at: http://www.bibbymaritime.com/media/10084/bibby_challenge_brochure.pdf [Accessed 06 08 2014].

Brown, J., 1991. The final Voyage of Rapaiti:A measure of surface drift velocity in relation to the surface wind. *Marine Pollution Bulletin,* 22(1), pp. 37-40.

Clyde Cruising Club, 2005. *Sailing Directions and Anchorages- Part 6 Shetland Islands.* Glasgow: Clyde Cruising Club Publications Ltd.

Dixon, I., 1987. *Catalogue of Voes, Firths and Sounds in Shetland.* s.l.:Nature Conservancy Council.

Edwards, A. & Sharples, F., 1986. *Scottish Sea Lochs: a Catalogue,* Oban: Scottish Marine Biological Association/Nature Conservancy Council.

JNCC, 2014. *Seabird colony data.* [Online] Available at: http://jncc.defra.gov.uk/page-4460 [Accessed 23 05 2014].

Kay, D. et al., 2008a. Faecal indicator organism concentrations and catchment export coefficients in the UK. *Water Research,* 42(10/11), pp. 2649-2661.

Ladysmith House, 2014. *Ladysmith House.* [Online] Available at: http://www.ladysmithhouse.co.uk/accommodation.html [Accessed 06 08 2014].

Lee, R. J. & Morgan, O. C., 2003. Envrionmental factors influencing the microbial contamination of commercially harvested shellfish.. *Water Science and Technology,* Issue 47, pp. 65-70.

Mallin, M. A. et al., 2001. Demographis, landscape and meterological factors controlling the microbial pollution of coastal waters. *Hydrobiologica,* Issue 460, pp. 185-193.

Michigan State University Extension, 2003. *What is Septic System Failure.* [Online] Available at: http://www.msue.msu.edu/objects/content_revision/download.cfm/revision_id.499684/workspace_id.-4/01500606.html/ [Accessed 05 08 2014].

National Records of Scotland, 2014. *2011 Census: Aggregate data (Scotland) [computer file].UK Data Service Census Support. Downloaded from: http://infuse.mimas.ac.uk. This information is licensed under the terms of the Open Government Licence [http://www.nationalarchives.gov.uk/doc/open-gov,* s.l.: s.n.

Nature in Shetland , 2014. *Whales and Dolphins in Shetland Waters.* [Online] Available at: http://www.nature-shetland.co.uk/seamammal/cetaceans.htm [Accessed 27 08 2014].

Scalloway Hotel, 2014. *Scalloway Hotel.* [Online] Available at: http://www.scallowayhotel.com/rooms.htm [Accessed 06 08 2014].

Scalloway Junior High School, 2008. *Welcome to Scalloway Primary School.* [Online] Available at: http://www.scalloway.shetland.sch.uk/ [Accessed 06 08 2014].

Scottish Natural Heritage, 2009. *Whales, Dolphins & Porpoises; Naturally Scottish,* Perth: Scottish Natural Heritage.

SeaWatch Foundation, 2013. *Shetland.* [Online] Available at: http://seawatchfoundation.org.uk/legacy_tools/region.php?output_region=1 [Accessed 2 12 2013].

SEPA, 2008. *Regulation and monitoring of Marine Cage Fish Farming in Scotland,* Stirling: Scottish Environmental Protection Agency.

Shetland Otters, 2014. *Shetland's Otters.* [Online] Available at: http://www.shetlandotters.com/shetlands-otters.php [Accessed 27 08 2014].

Sludgehammer Group Ltd., 2007. *The Bibby Progress.* [Online] Available at: http://www.sludgehammer.net/portfolio/the-bibby-progress/ [Accessed 06 08 2014].

UKHO, 1986. Taunton: Admiralty Charts and Publications.

Windward B&B Shetland, 2008. *Windward B&B Shetland.* [Online] Available at: http://www.accommodation-shetland.co.uk/products-/ [Accessed 06 08 2014].

Woodstock Conservation Commission, 2014. *Septic Systes.* [Online] Available at: http://www.woodstockconservation.org/Septic_System_Dos_and_Donts.htm [Accessed 05 08 2014].

20. List of Figures and Tables

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3. **Hydrographic Assessment Glossary**
4. **Hydrographic Section Appendix**
5. **Shoreline Survey Report**
6. **Consented discharges**

1. General Information on Wildlife Impacts

Pinnipeds

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

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

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

Adult Grey seals weigh 150-220 kg and adult common seals 50-170 kg. They are estimated to consume between 4 and 8% of their body weight per day in fish, squid, molluscs and crustaceans. No estimates of the volume of seal faeces passed per day were available, though it is reasonable to assume that what is ingested and not assimilated in the gut must also pass. Assuming 6% of a median body weight for harbour seals of 110kg, that would equate to 6.6kg consumed per day and probably very nearly that defecated.

The concentration of *E. coli* and other faecal indicator bacteria contained in seal faeces has been reported as being similar to that found in raw sewage, with counts showing up to 1.21×10^4 CFU (colony forming units) *E. coli* per gram dry weight of faeces (Lisle *et al* 2004).

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

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

Cetaceans

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

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

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

Birds

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

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

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

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

Deer

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

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

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

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

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 National Heritage, n.d.). Otters primarily forage within the 10 m depth contour and feed on a variety of fish, crustaceans and shellfish (Paul Harvey, Shetland Sea Mammal Group, personal communication).

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

References

Alderisio, K. A. & DeLuca, N., 1999. Seasonal enumeration of fecal coliform bacretia from the feces of ring-billed gulls (Larus delawerensis) and Canada geese (Branta canadensis). *Applied and Environmental Microbiology,* 65(12), pp. 5628-5630.

Gauthier, G. & Bedard, J., 1986. Assessment of faecal output in geese. *Journal of Applied Ecology,* 23(1), pp. 77-90.

Lisle, J. T., Smith, J. J., Edwards, D. D. & McFeters, G. A., 2004. Occurence of microbial indicators and Clostridium perfringens in wastewater, water coloum samples, sediments, drinking water and weddel seal faeces collected at McMurdo Station, Antarctica. *Applied and Environmental Microbiology,* 70(12), pp. 7269-7276.

Poppe, C. et al., 1998. Salmonella typhimurium DT104: a virulent and drug-resistant pathogen. *The Canadian Veterinary Journal,* 39(9), pp. 559-565.

Scottish National Heritage, n.d. *Otters and Development.* [Online] Available at: http://www.snh.org.uk/publications/on-line/wildlife/otters/biology.asp [Accessed 10 10 2012].

Stoddard, R. A. et al., 2005. Salmonella and Campylobacter spp. in Northern Elephant Seals, California. *Emerging Infections Diseases,* 11(12), pp. 1967-1969.

2. Tables of Typical Faecal Bacteria Concentrations

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

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

comparing base- and high-flow GMs for each group and type.

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

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

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

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

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

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

Source: (Gauthier & Bedard, 1986)

References

Gauthier, G. & Bedard, J., 1986. Assessment of faecal output in geese. *Journal of Applied Ecology,* 23(1), pp. 77-90.

Kay, D. et al., 2008a. Faecal indicator organism concentrations and catchment export coefficients in the UK. *Water Research,* 42(10/11), pp. 2649-2661.

Kay, D. et al., 2008b. Faecal indicator organism in concentration sewage and treated effluents. *Water Research,* 42(1/2), pp. 442-454.

3. Hydrographic Assessment Glossary

The following technical terms may appear in the hydrographic assessment.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

4. Hydrographic Section Appendix

Appendix 1: Hydrographic survey details

Site Name	NGR	Survey Period	Equipment
West of Burwick	HU 38019 40497	25/11/02 – 13/12/02	Nortek 500 kHz ADCP
East of Langa	HU 37661 39372	07/01/08 – 14/02/08	Aquadopp 600 kHz ADP

Appendix 2: Hydrographic survey summary statistics

Parameter	Units	Near-surface / Mid-depth / Near-bottom	West of Burwick	East of Langa
Mean speed	m/s		0.069	0.100
			0.044	0.082
			0.050	0.075
Tidal major axis	°Grid		330	350
			310	345
			245	340
Amplitude anisotropy	-		1.99	3.11
			1.20	3.40
			1.54	2.09
Residual speed	m/s		0.056	0.052
			0.022	0.046
			0.008	0.035
Residual direction	°Grid		329	353
			332	338
			275	342
Vector averaged residual	-		0.027 m/s at 325° Grid	0.044 m/s at 344° Grid
Tidal excursion	km		1.15	2.05
			0.74	1.73
			0.96	1.49

The tidal major axis is the long axis of the predominant tidal direction. Amplitude anisotropy is a measure of the relative scale of the currents along the tidal major axis relative to those across it. Residual speed and direction represent the net transport away from survey position during the fifteen-day assessment period and this is resolved over the three layers in the value reported as vector averaged residual. Finally, the tidal excursion is an estimate based on the amplitude of tidal currents along the tidal major axis.

5. Shoreline Survey Report

Shoreline Survey Report

Production Area:	East Burwick
Site Name:	East Burwick
SIN:	SI-583-1060-08
Harvesters:	**Shetland Mussels**: Michael Tait
Local Authority:	Shetland Islands Council
Status:	Existing area
Date surveyed:	17 & 18 June 2014
Surveyed by:	Sean Williamson (Hall Mark Meat Hygiene Ltd.) Vicki Smith (SSQC Ltd.) We are grateful to Shetland Mussels for providing assistance during the marine survey work.
Existing RMP:	HU 3929 4035 *(E.coli)*
Area Surveyed:	See Figure 1

Specific observations made on site are mapped in Figure 1 and listed in Table 1. Water and shellfish samples were collected at the locations marked on Figures 2 and 3. Bacteriology results are given in Tables 2 and 3. Salinity profiles are presented in Table 4 with profile locations marked on Figure 2. Photographs are presented in Figures 4-20.

Weather

Tuesday 17 June 2014

Foggy conditions with some drizzle in the morning lifted to overcast cloud cover during the site visit and following shoreline walk. An F3/F4 westerly wind persisted throughout the day.

Wednesday 18 June 2014

Similar conditions on the following survey day; mostly cloudy with some foggy spells. Light F2 westerly wind increasing to F4 through the day.

Preceding the shoreline survey, Sunday 15 June was mostly cloudy with a F3 north westerly breeze and Monday 16 June began with scattered cloud becoming mostly cloudy during the day. Light F2/F3 north westerly winds became westerly by the evening. There was no recorded rainfall on either day.

Fishery

The location of the mussel lines for the fishery is mapped in Figure 1. The fishery had stocked mussel lines on site.

The East Burwick fishery consisted of nine mussel lines running parallel to the eastern shoreline (Figures 4 and 5). All lines were double-headed longlines with 8 to 10 metre droppers. The site is licenced for nine 220 metre twin-headline longlines. The harvester has a fast track application in progress to allow them to harvest the site in the near term if required, although they state this would only be if their sites in other production areas are closed due to biotoxin levels.

Sewage/Faecal Sources

Burwick is sparsely populated with two houses at the end of the track that links these properties to the village of Scalloway. Located near the head of the voe on the northern shore one septic tank with a soakaway was identified below the house closest to the fishery (Figure 6). Other properties in the area surveyed are associated with settlements at Scalloway, East Voe and Cauldhame on the island of Trondra.

The largest settlement in the area is the village of Scalloway with the majority of the properties here linked to the Maa Ness Waste Water Treatment Works at Port Arthur. The outfall for this WWTW is located to the south of the East Burwick production area between Shalder's Ayre and the Point of the Pund.

Scalloway has a number of local amenities to serve both the community and visitors with a large proportion of these to be found along Main Street which follows the waterfront to Port Arthur. There are public toilets and several businesses based along the street including two shops, a nursery, a hairdressers, a chemist, a care home, a hotel, two engineering businesses, a gym and a public house. At Port Arthur is the Scalloway Boating Club and the NAFC Marine Centre. Five pipes discharging to sea were recorded in the village. One was at the West Shore Sewage Pumping Station (Figure 7). A second pipe with a clear discharge appeared to be associated with land drainage at the Scalloway Boating Club. A large pipe was observed at the northern end of the NAFC Marine Centre campus which was confirmed not to be in use, while at the southern end there were three pipes associated with the Marine Hatchery buildings and filtration system.

No septic tanks were recorded in both sections of the East Voe shoreline route. A discharge pipe was present from the Blydoit Sewage Pumping Station (Figure 8).

Between Scarfataing and Cauldhame on the island of Trondra approximately 18 houses are located on the seaward side of the road serving these properties. Five septic tanks were observed along the survey route, all located in the fields between the properties and the shoreline. The first two plastic septic tanks appeared to serve three recently built properties at Scarfataing (Figures 9 and 10) and a third plastic tank was adjacent to a newly built house which was part of a group of four properties (Figure 11). A large concrete septic tank was present close to the shore below these houses (Figure 12). At Cauldhame a large concrete septic tank was observed below

a group of houses (Figure 13). A pipe from this led to the shore with the end of the pipe not visible below the water (Figure 14). An old plastic pipe was also observed at the shore during this section of the survey and while the end was not visible there was no audible sound of flowing water.

Sample analysis

Five freshwater samples were obtained from watercourses around the East Burwick production area, two on the northern shore and three from the southern shore. Four sampling points were outlined in the survey plan and three of these were collected. At one location defined near northern end of the East Burwick fishery a sample was not collected in favour of sampling a more significant watercourse which was identified just to the north. An additional sample was obtained from the northern shore near the head of the voe. Three of the five watercourses sampled were found to have *E.coli* levels between 14-150 cfu/100 ml. Of the two samples with the highest *E.coli* counts, one was from the additional sample collected from a small watercourse leading to the beach that was not on the survey plan (2,400 cfu/100 ml). This originated from a spring in a field containing domestic ducks and chickens, (Figure 15). The second was from the watercourse on the southern shore which was identified as a more suitable alternative to the neighbouring one highlighted in the survey plan (600 cfu/100 ml, Figure 16).

Seawater samples obtained from three locations on the East Burwick fishery; at either end of the line closest to the shore and at the southern end of the outermost line. *E.coli* levels were between <1 to 5 cfu/100ml. Away from the fishery five seawater samples were collected, four of which were on the sample plan. For the planned sampling points *E.coli* levels were between 1 to 19 cfu/100ml with the highest level at Shalders Ayre to the south of the production area boundary. An additional sample was collected during the shoreline walk at Cauldhame from the water's edge near a discharge pipe associated with the septic tank here (*E.coli* levels at 92,000 cfu/100ml)

Mussel samples were obtained from the same three locations on the East Burwick fishery as the seawater samples. Two samples were collected at each location, one from the top of a mussel dropper and one from the bottom of the dropper. The sample from the northern end of the line closest to the shore line returned results of 45 *E.coli* MPN/100g and 230 *E.coli* MPN/100g for the top and bottom samples respectively. At the southern end of this line levels were 790 *E.coli* MPN/100g and 490 *E.coli* MPN/100g for the top and bottom respectively. At the southern end of the line furthest from the shore counts were 40 *E.coli* MPN/100g and 20 *E.coli* MPN/100g for the top and bottom samples respectively.

Salinity profiles were obtained from the East Burwick fishery again at the three locations described above. In all cases observed variation in salinity measurements with depth did not exceed the accuracy value of the probe used (± 0.35 ppt). Surface salinity ranged from 34.98 ppt to 35.16 ppt at each location.

Temperature profiles were also obtained from these locations. All three profiles showed a slight increase in temperature from 10 metres to the surface, in particular

at the northern end of the fishery (0.7°C difference). Surface temperature ranged from 11.9°C to 12.1°C.

Salinities of the seawater samples analysed at the laboratory showed salinities ranging from 35.18 PSU present at the sampling point to the north of Torgur to 35.77 PSU present at the northern end of the East Burwick fishery.

Seasonal population

There is no guest house accommodation adjacent to the East Burwick Fishery. In the village of Scalloway the 22 room Scalloway Hotel is located on Main Street. Other guest houses in the village include the Windward Bed and Breakfast (sleeps six) and Ladysmith House self-catering accommodation (sleeps four). At East Voe there are nine self-catering chalets at Easterhoull. Shetland has recently seen a large influx of workers from the British mainland to support the refurbishment of the Sullom Voe Oil Terminal and the construction of a new Gas Plant. This has meant that accommodation in the islands is often in high demand throughout the year. The 280 room accommodation barge *Bibby Challenge* is presently berthed on the East Voe side of Blacksness Pier for workers associated with this construction.

At the NAFC Marine Centre campus, the 25 room Port Arthur House provides accommodation for visiting students.

Boats/Shipping

Boat traffic within the East Burwick production area is largely associated with the fishery, creel fishing and leisure activities. A small workboat was observed at the lines during the survey. On the northern shore at the Ness of Burwick there is a small stone pier (Figure 17).

There is significant shipping and boating activity in Scalloway Harbour largely based at Blacksness Pier which provides berthing and services for oil industry related vessels and fishing boats operating to the west of Shetland. The pier also serves as a shorebase for salmon companies operating fish farms around the Scalloway islands (Figure 18). Six workboats were berthed at the time of the survey and nine workboats and leisure vessels were ashore for servicing. Malakoff Limited operates a slipway in the village for vessel maintenance and repairs and there were three vessels present during the survey. At the Scalloway Boating Club there is a pontoon for visiting yachts which also supports leisure fishing activities, with two moored vessels recorded. There are two marinas in the harbour, one at Port Arthur with 58 berths (Figure 19) and one at East Voe with around 55 berths. East Voe shellfish operate a shorebase with a jetty for their workboats. Several small leisure boats were recorded ashore on small beaches at various locations in the village, at East Voe and at Trondra during the shoreline walk. Private piers, pontoons and a mooring were also observed.

Farming and Livestock

The majority of the land observed during the survey around the production area was rough grazing. At the dwellings near the head of the voe 18 ducks and 6 chickens were present in a field which had access to the shore (Figure 20). A total of 82 sheep were observed on the northern shore and 40 sheep were observed on the southern shore during the East Burwick section of the shoreline walk. All of these animals had access to the shore, and sheep faeces were recorded throughout the walk. Areas where there were steeper escarpments on the southern shore may have restricted access to some parts of the shore adjacent to the fishery by these animals.

Elsewhere during the shoreline walk, around 20 sheep with access to the shore were recorded on the hillside beyond Port Arthur. At East Voe in fenced fields above the road 80 sheep would not have had access to the shore. An agricultural shed was also observed here. During the Trondra section of the shore 31 sheep were recorded and the majority had access to the shore; again faeces were noted all the way along the survey route. In a fenced enclosure at Cauldhame two Shetland ponies and three ducks were present.

Land Use and Land Cover

The northern shoreline of the East Burwick production was characterised as rough grass with wild iris and stony beaches. The southern shoreline was dominated by rough grassland with heather and buttercups, and boggy areas with cottongrass on lower ground above the rocky shore.

The village of Scalloway is a typical urbanised area with a developed waterfront which became rough grassing land beyond Port Arthur. East Voe was characterised by housing estates in the north with more agricultural land use around the properties found to the south, and this was typically improved grazing enclosed by fencing. On Trondra fields of rough grazing were present between the properties there and the shoreline

Watercourses

Five watercourses were sampled during the shoreline survey, three of which were outlined on the sample plan with one sampling point exchanged for one from a nearby stream and an additional sample collected from a small watercourse flowing from a spring in a field of ducks and chickens. Flow rate was recorded at two of the five watercourses sampled. Flow rate was not recorded at three of the watercourses as there was insufficient water flow due to the stagnant nature of the watercourse.

Wildlife/Birds

Birds were observed in all areas surveyed. At East Burwick Arctic terns were frequently observed with approximately 58 recorded in total. A potential breeding colony was identified on a beach on the northern shore of the production area mid-way along the survey route. Oystercatchers were also common, particularly along the southern shoreline (17 recorded). Gulls and eider ducks were also recorded. Shell debris was observed on two occasions which could indicate areas where birds may have been feeding, present on both shorelines. Bird faeces were observed on buoys of the mussel lines.

Beyond the production area gulls, eider ducks and oystercatchers were also present, as well as a crow and a ringed plover, although fewer birds were recorded overall. Shell debris was observed between Scarfataing and Cauldhame which again could indicate an area which birds have used for feeding.

General observations

Recorded observations apply to the date of survey only. Animal numbers were recorded on the day from the observer's point of view. This does not necessarily equate to total numbers present as natural features may obscure individuals and small groups of animals from view.

Dimensions and flows of watercourses are estimated at the most convenient point of access and not necessarily at the point at which the watercourse enters the voe.

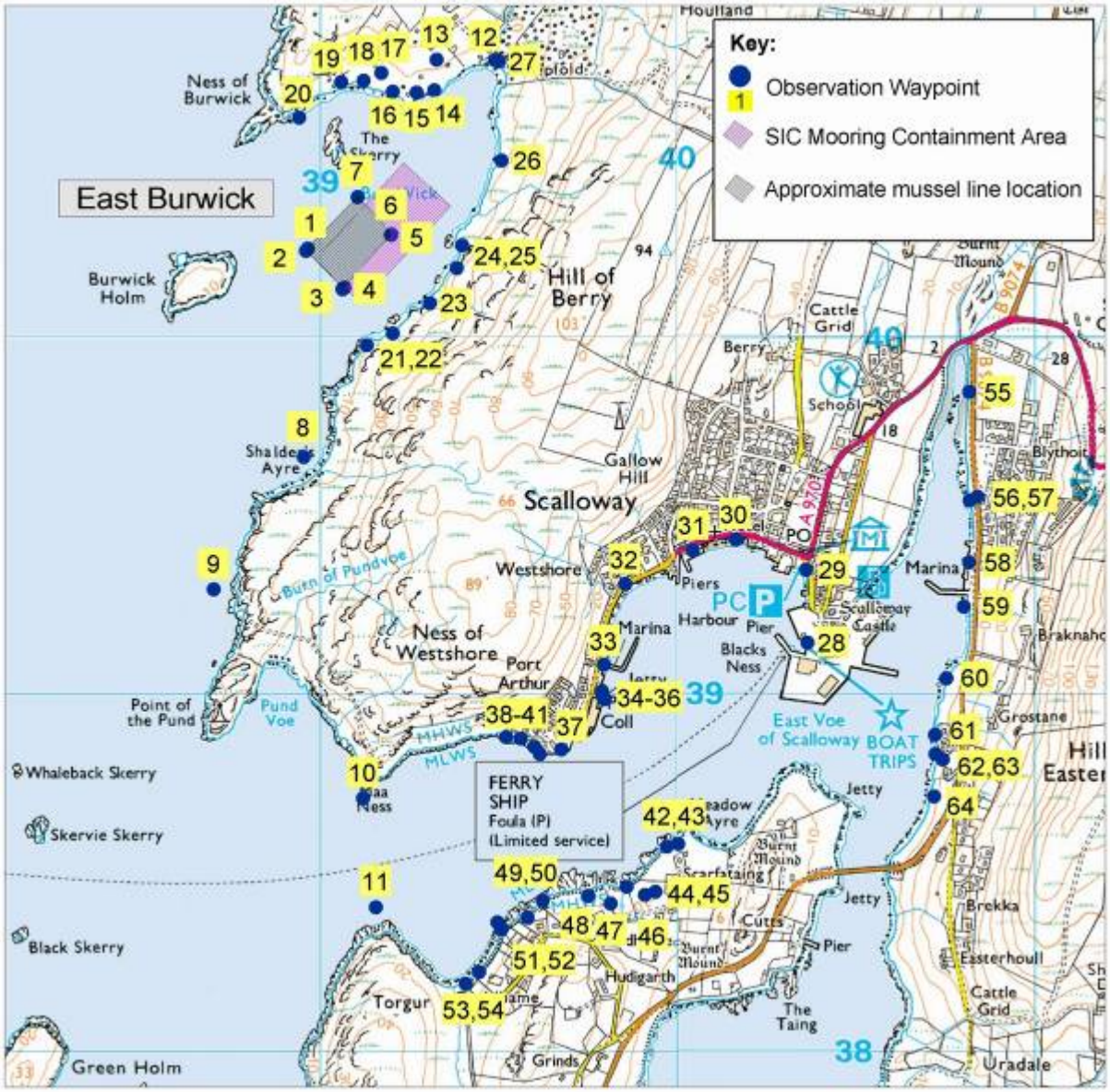

Figure 1 Map of shoreline observations East Burwick.

Table 1 Shoreline Observations

No.	Date/Time (UT)	NGR	Easting	Northing	Associated Photograph	Associated Sample	Description
1	17/06/2014 07:44	HU 38965 40249	438965	1140249		EB-MUSS01 (Top), EB-MUSS02 (Bottom) & EB-SW01	East Burwick shoreline survey - boat work. Weather: Foggy, light breeze. Sea state: large wavelets, no white caps. East Burwick fishery. 9x double headed longlines, 8-10m droppers. Two mussel samples collected from the south end of the East Burwick fishery from the furthest west line, just north of the SW corner. Surface sample collected from the top of a mussel dropper, bottom sample collected from bottom of a mussel dropper. Salinity Profile 1 collected (ppt/°C): 10m 35.06/11.8, 5m 35.01/11.9, 3m 35.00/11.9, surface 34.98/11.9. Seawater sample collected.
2	17/06/2014 07:55	HU 38961 40243	438961	1140243			SW corner of the East Burwick fishery.
3	17/06/2014 07:57	HU 39063 40136	439063	1140136			SE corner of the East Burwick fishery.

No.	Date/Time (UT)	NGR	Easting	Northing	Associated Photograph	Associated Sample	Description
4	17/06/2014 08:02	HU 39068 40139	439068	1140139	Figure 4	EB-MUSS03 (Top), EB-MUSS04 (Bottom) & EB-SW02	Two mussel samples collected from the south end of the East Burwick fishery from the furthest east line, just north of the SE corner. Surface sample collected from the top of a mussel dropper, bottom sample collected from bottom of a mussel dropper. Salinity Profile 2 collected (ppt/°C): 10m 35.18/11.9, 5m 35.17/12.0, 3m 35.16/12.0, surface 35.16/12.0. Seawater sample collected. One gull and one Artic tern in flight. Some bird faeces on the buoys at the fishery.
5	17/06/2014 08:15	HU 39200 40288	439200	1140288			NE corner of the East Burwick fishery.
6	17/06/2014 08:17	HU 39198 40287	439198	1140287		EB-MUSS05 (Top), EB-MUSS06 (Bottom) & EB-SW03	Two mussel samples collected from the north end of the East Burwick fishery from the furthest east line, just south of the NE corner. Surface sample collected from the top of a mussel dropper, bottom sample collected from bottom of a mussel dropper. Salinity Profile 3 collected (ppt/°C): 10m 35.14/11.4, 5m 35.16/12.0, 3m 35.16/12.1, surface 35.15/12.1. Seawater sample collected.
7	17/06/2014 08:33	HU 39105 40393	439105	1140393			NW corner of the East Burwick fishery.
8	17/06/2014 08:38	HU 38954 39665	438954	1139665		EB-SW04	Seawater sample collected from Shalder's Ayre.
9	17/06/2014 08:43	HU 38703 39295	438703	1139295		EB-SW05	Seawater sample collected near Scalloway's main outfall.
10	17/06/2014 08:48	HU 39120 38710	439120	1138710		EB-SW06	Seawater sample collected south of Maa Ness.

No.	Date/Time (UT)	NGR	Easting	Northing	Associated Photograph	Associated Sample	Description
11	17/06/2014 08:51	HU 39157 38405	439157	1138405		EB-SW07	Seawater sample collected north of Torgur.
12	17/06/2014 12:01	HU 39489 40776	439489	1140776		EB-FW01	Shoreline walk - Burwick (north shore). Head of the voe to Ness of Burwick. Overcast, light breeze. Lowland area with rough grassland above a small stony beach. Watercourse coming down from the hill under the road leading to the beach. Wild iris beside the watercourse. Freshwater sample obtained and flow rate measured; width 25 cm, depth 6 cm, flow 0.294 m/s, st. dev. 0.008 m/s. One sheep and one lamb observed. Sheep faeces present, no fences animals would have access to the shore. Two houses on the hill. Old boat above the beach, and small disused shed.
13	17/06/2014 12:09	HU 39326 40778	439326	1140778	Figure 6		Concrete septic tank at the top of the field below a house. Wet area below the tank. Steeper escarpments present. Sheep faeces noted.
14	17/06/2014 12:13	HU 39320 40691	439320	1140691			Possible soakaway area for the above septic tank, green grass area leading to the shore. Wet area at the shore. Ten sheep observed. Seven Artic terns and one oystercatcher in flight.
15	17/06/2014 12:15	HU 39270 40685	439270	1140685			Two dead sheep at the shore.
16	17/06/2014 12:18	HU 39203 40688	439203	1140688	Figure 20		Stony beach. Ten oystercatchers and fifty Artic terns in flight. Artic terns thought to be nesting on the beach. Eighteen ducks and six chickens in the field.

No.	Date/Time (UT)	NGR	Easting	Northing	Associated Photograph	Associated Sample	Description
17	17/06/2014 12:22	HU 39171 40741	439171	1140741	Figure 15	EB-FW02	Spring leading to the beach. Water iris present. Large stagnant pool up the hill where the spring originates. Freshwater sample collected. Flow rate measured, time taken to fill 350ml jug - 3.7s/4.1s/3.9s.
18	17/06/2014 12:24	HU 39122 40719	439122	1140719			Old boat at the shore. Lowland stony beach area. Flat grassland areas above the beach increasing to hills. Old disused house and outbuildings up the hill. Sixty sheep above the beach no fences so they have access to the shore.
19	17/06/2014 12:33	HU 39060 40714	439060	1140714			Old disused hut and boat. Four eider ducks in the water. East Burwick fishery, small workboat taking a look around the site. Trailer at the shore. Two house ruins.
20	17/06/2014 12:39	HU 38941 40615	438941	1140615	Figure 17		Small pier. Sea urchin carcasses and shells, possibly feeding area for birds. Two creels present at the pier. Eleven sheep observed above the shore.

No.	Date/Time (UT)	NGR	Easting	Northing	Associated Photograph	Associated Sample	Description
21	17/06/2014 13:19	HU 39131 39978	439131	1139978			Shoreline walk - Burwick (south shore). Shalder's Ayre to head of the voe. Steep escarpments, rough grassland with heather and buttercups with a stony shore. Steep hills at the back with grass and stones. Twenty sheep on the hills, no fences but animals would have difficulty accessing the shore. Sheep faeces present all the way along the shore. Sea urchin carcasses where birds may have been feeding. Boggy area.
22	17/06/2014 13:22	HU 39204 40012	439204	1140012		EB-FW03	Small watercourse leading to the shore through vegetation. No flow stagnant pools. Brown algae/oily sheen on the rocks at the shore. One gull in flight. Freshwater sample obtained, unable to measure flow rate.
23	17/06/2014 13:30	HU 39306 40096	439306	1140096		EB-FW04	Small watercourse leading to the shore through rocks and vegetation. No flow small stagnant pools, brown/green algae on the rocks at the shore. One gull in flight. Freshwater sample obtained, unable to measure flow rate.
24	17/06/2014 13:37	HU 39382 40194	439382	1140194	Figure 5		East Burwick fishery. Very steep escarpments.
25	17/06/2014 13:39	HU 39397 40258	439397	1140258			Lowland area, small stony beach. Lots of rubbish washed up, nettles present. 20 sheep observed on the hill. 3 oystercatchers and one gull in flight. Boggy area above beach, bog cotton present.

No.	Date/Time (UT)	NGR	Easting	Northing	Associated Photograph	Associated Sample	Description
26	17/06/2014 13:48	HU 39508 40495	439508	1140495	Figure 16	EB-FW05	Small watercourse leading to the shore through rocks. No flow small stagnant pools. One gull and one oystercatcher in flight. Freshwater sample obtained, unable to measure flow rate.
27	17/06/2014 13:57	HU 39499 40772	439499	1140772			Lowland stony beach area at head of voe. Three oystercatchers on the beach. End of the survey walk.
28	17/06/2014 14:40	HU 40363 39146	440363	1139146	Figure 18		Shoreline walk - Scalloway pier to NAFC Marine Centre. Scalloway Harbour. Three Scottish Sea Farms workboats, one NAFC workboat and two other workboats present. Nine boats out of the water on the pier. Nine houses observed near the shore to the north of the harbour.
29	17/06/2014 14:47	HU 40359 39350	440359	1139350			Public toilets at the shore. Scalloway's main street with two shops, a care centre, hairdressers, an engineering business, chemist, hotel and public house, bank and gym.
30	17/06/2014 14:52	HU 40162 39435	440162	1139435			Small stony beach with two boats on the shore.
31	17/06/2014 14:54	HU 40042 39404	440042	1139404			Malakoff marine engineering business. Pier with three boats in the water and two boats on the pier. Large number of houses in the Scalloway area.
32	17/06/2014 14:58	HU 39853 39310	439853	1139310	Figure 7		West Shore pumping station. Pipe leading to the water under the road. One gull in flight.

No.	Date/Time (UT)	NGR	Easting	Northing	Associated Photograph	Associated Sample	Description
33	17/06/2014 15:03	HU 39794 39084	439794	1139084	Figure 19		Port Arthur marina (58 berths). 39 boats present in the marina at the time of the survey, 11 boats observed on the shore or on trailers.
34	17/06/2014 15:04	HU 39789 39010	439789	1139010			Scalloway Boating Club. Three boats on shore. Pontoon with two yachts and one small motorboat present.
35	17/06/2014 15:06	HU 39790 38997	439790	1138997			Pipe with a small clear water discharge, no smell, to the south of the boating club. Most likely land drainage. Algae present inside the pipe.
36	17/06/2014 15:07	HU 39796 38988	439796	1138988			Large blue pipe entering the water at the north end of the NAFC Marine Centre building (not in use). Concrete tank at the top of the rocky shore where pipe originates. Three gulls in flight.
37	17/06/2014 15:16	HU 39674 38847	439674	1138847			NAFC Marine Centre, John Goodlad Centre, Hatchery and storage areas behind the John Goodlad Centre. Scottish Sea Farms large workboat and a yacht heading in towards Scalloway harbour.
38	17/06/2014 15:20	HU 39615 38834	439615	1138834			Large filtration system associated with the NAFC hatchery installed due to dredging activity in the harbour. Two pipes leading to the water.
39	17/06/2014 15:22	HU 39599 38854	439599	1138854			Pipe discharging to the sea, associated with the hatchery. Clear water discharge.

No.	Date/Time (UT)	NGR	Easting	Northing	Associated Photograph	Associated Sample	Description
40	17/06/2014 15:25	HU 39560 38878	439560	1138878			Three houses above the shore. Steep escarpments with stony beach below. Sheep faeces present. One crow observed in flight.
41	17/06/2014 15:27	HU 39520 38882	439520	1138882			Twenty sheep not in fenced areas with access to the shore, however steep escarpments may have prevented the animals accessing the shore. Sheep faeces present. End of shoreline walk.
42	18/06/2014 10:04	HU 40001 38583	440001	1138583			Shoreline walk: Scarfataing-Cauldhame. Medium to high escarpments, stony beaches at the shore. Rough grassland. One house at the top of the field. Sheep faeces present.
43	18/06/2014 10:07	HU 39970 38575	439970	1138575			Old pipe not in use leading to the shore. Six sheep not in fenced areas with access to the shore. One plover observed in flight.
44	18/06/2014 10:10	HU 39937 38449	439937	1138449	Figure 9		Plastic septic tank below two new houses at the top of the field.
45	18/06/2014 10:11	HU 39908 38439	439908	1138439	Figure 10		Plastic septic tank below a new house at the top of the field. Fourteen sheep in the field with access to the shore. Sheep faeces present.
46	18/06/2014 10:13	HU 39857 38463	439857	1138463			Wooden rowing boat at the shore.
47	18/06/2014 10:14	HU 39813 38415	439813	1138415	Figure 11		Plastic septic tank below houses at the top of the field. Large boat leaving Scalloway harbour. One oystercatcher in flight. Sea urchin and crab carcasses present near the shore where birds may have been feeding.

No.	Date/Time (UT)	NGR	Easting	Northing	Associated Photograph	Associated Sample	Description
48	18/06/2014 10:17	HU 39750 38437	439750	1138437	Figure 12		Large concrete septic tank near the shore below houses. One gull observed in the water.
49	18/06/2014 10:22	HU 39622 38424	439622	1138424			Old disused plastic pipe leading to a small stony beach at the shore, end of pipe not visible but no running water heard coming from the pipe.
50	18/06/2014 10:25	HU 39580 38377	439580	1138377			Two rowing boats and one motor boat at the shore. Creels and buoys present around the boats. 6 sheep not in fenced area with access to the shore. Sheep faeces present. 1 gull in flight.
51	18/06/2014 10:27	HU 39507 38343	439507	1138343	Figure 13		Large concrete septic tank near the shore below houses. Three sheep in a fenced area, no access to the shore. Sheep faeces present inside and outside the fenced area.
52	18/06/2014 10:32	HU 39496 38363	439496	1138363	Figure 14	EB-SW08	Pipe associated with the septic tank mentioned above leading to the water. End of the pipe not visible. Seawater sample obtained where the pipe enters the water.
53	18/06/2014 10:37	HU 39444 38224	439444	1138224			Two sheep observed on the beach. Two Shetland ponies in a fenced area below a house. Three ducks in a fenced area below a house.
54	18/06/2014 10:38	HU 39408 38191	439408	1138191			Two rowing boats on a stony beach. One boat on a mooring. Small pontoon. Sheep faeces present. End of shoreline walk.

No.	Date/Time (UT)	NGR	Easting	Northing	Associated Photograph	Associated Sample	Description
55	18/06/2014 10:52	HU 40815 39848	440815	1139848			Shoreline walk: East Voe. Large housing scheme across the road from the shore. Four eider ducks in the water and one gull in flight.
56	18/06/2014 10:56	HU 40816 39544	440816	1139544	Figure 8		Blydoit discharge pipe from the pumping station leading to the water.
57	18/06/2014 10:57	HU 40838 39554	440838	1139554			Blydoit pumping station. One gull in flight. Motorboat on a trailer beside a house south of the pumping station.
58	18/06/2014 11:00	HU 40815 39370	440815	1139370			East Voe marina. 55 boats in the marina, 3 boats on moorings. Ten sheep in the field above the road.

No.	Date/Time (UT)	NGR	Easting	Northing	Associated Photograph	Associated Sample	Description
59	18/06/2014 11:03	HU 40799 39247	440799	1139247			Small pier and shorebase used by East Voe Shellfish. One workboat in the water and one workboat on the pier, other workboats are known to operate from this shorebase. One yacht also present. Buoys, pegs, ropes and other fishery equipment present. Large shed and lorry and trailers at the shorebase. Agricultural shed and fifty sheep observed

							above the road.
60	18/06/2014 11:14	HU 40751 39047	440751	113904 7			Rough grassland and stony beach at the shore. Twenty sheep observed above the road. Scalloway harbour across the voe, accommodation barge and four boats berthed at the pier. Sheep faeces above the shore no fences so sheep would have access to the shore. Two oystercatchers in flight.
61	18/06/2014 11:21	HU 40719 38888	440719	113888 8			House and small pier at the shore. Animal faeces dumped at the top of the pier.
62	18/06/2014 11:24	HU 40720 38834	440720	113883 4			House and old pier at the shore. Stony beach below. Small boat present on the beach.
63	18/06/2014 11:25	HU 40740 38818	440740	113881 8			Sea Chest pumping station. Steep escarpments, sheep faeces present.

64	18/06/2014 11:28	HU 40716 38716	440716	1138716			Ten sheep observed, no fences but animals would have difficulty accessing the shore. End of shoreline walk.

Sampling

Water and shellfish samples were collected at the locations indicated in Figures 2 and 3. three of the four freshwater samples detailed in the survey plan were obtained from watercourses, as well as one additional freshwater sample which was collected from a small watercourse on the northern shore of the East Burwick production area. All samples were transported initially by a cool backpack and then in a cool box to SSQC Ltd. for analysis within 24 hours of sample collection.

Bacteriology results are present in Table 2 and 3 and mapped in Figures 2 and 3.

Seawater samples were also tested for salinity at SSQC Ltd. In the field salinity profiles were collected using a YSI Professional Plus handheld meter and CT probe which had an accuracy of (± 0.35 ppt). Results are presented in Table 4 and locations of the profiles are mapped in Figure 2.

Table 2 Water sample *E.coli* results

No.	Sample Ref.	Date/Time (UT)	Position	Type	*E.coli* (cfu/100ml)	Salinity*
1	EB-SW01	17/06/2014 07:44	HU 38965 40249	SW	<1	35.47
2	EB-SW02	17/06/2014 08:02	HU 39068 40139	SW	5	35.67
3	EB-SW03	17/06/2014 08:17	HU 39198 40287	SW	<1	35.77
4	EB-SW04	17/06/2014 08:38	HU 38954 39665	SW	19	35.73
5	EB-SW05	17/06/2014 08:43	HU 38703 39295	SW	5	35.21
6	EB-SW06	17/06/2014 08:48	HU 39120 38710	SW	5	35.22
7	EB-SW07	17/06/2014 08:51	HU 39157 38405	SW	<1	35.18
8	EB-FW01	17/06/2014 12:01	HU 39489 40776	FW	14	-
9	EB-FW02	17/06/2014 12:22	HU 39171 40741	FW	2,400	-
10	EB-FW03	17/06/2014 13:22	HU 39204 40012	FW	100	-
11	EB-FW04	17/06/2014 13:30	HU 39306 40096	FW	150	-
12	EB-FW05	17/06/2014 13:48	HU 39508 40495	FW	600	-
13	EB-SW08	18/06/2014 10:32	HU 39496 38363	SW	92,000	35.27

*Practical Salinity Scale 1978 (PSS-78)

Table 3 Shellfish sample *E.coli* results

No.	Sample Ref.	Date/Time (UT)	Position	Type	Depth	*E.coli* (MPN/100g)
1	EB-MUSS01	17/06/2014 07:44	HU 38965 40249	Common Mussel	Top	40
2	EB-MUSS02	17/06/2014 07:44	HU 38965 40249	Common Mussel	Bottom	20
3	EB-MUSS03	17/06/2014 08:02	HU 39068 40139	Common Mussel	Top	790
4	EB-MUSS04	17/06/2014 08:02	HU 39068 40139	Common Mussel	Bottom	490
5	EB-MUSS05	17/06/2014 08:17	HU 39198 40287	Common Mussel	Top	45
6	EB-MUSS06	17/06/2014 08:17	HU 39198 40287	Common Mussel	Bottom	230

Table 4 Salinity profiles

Profile	Date/Time (UT)	Position	Depth (m)	Salinity (ppt) (± 0.35 ppt)	Temperature (°C)
1	17/06/2014 07:44	HU 38965 40249	surface	34.98	11.9
			3	35.00	11.9
			5	35.01	11.9
			10	35.06	11.8
2	17/06/2014 08:02	HU 39068 40139	surface	35.16	12
			3	35.16	12
			5	35.17	12
			10	35.18	11.9
3	17/06/2014 08:17	HU 39198 40287	surface	35.15	12.1
			3	35.16	12.1
			5	35.16	12
			10	35.14	11.4

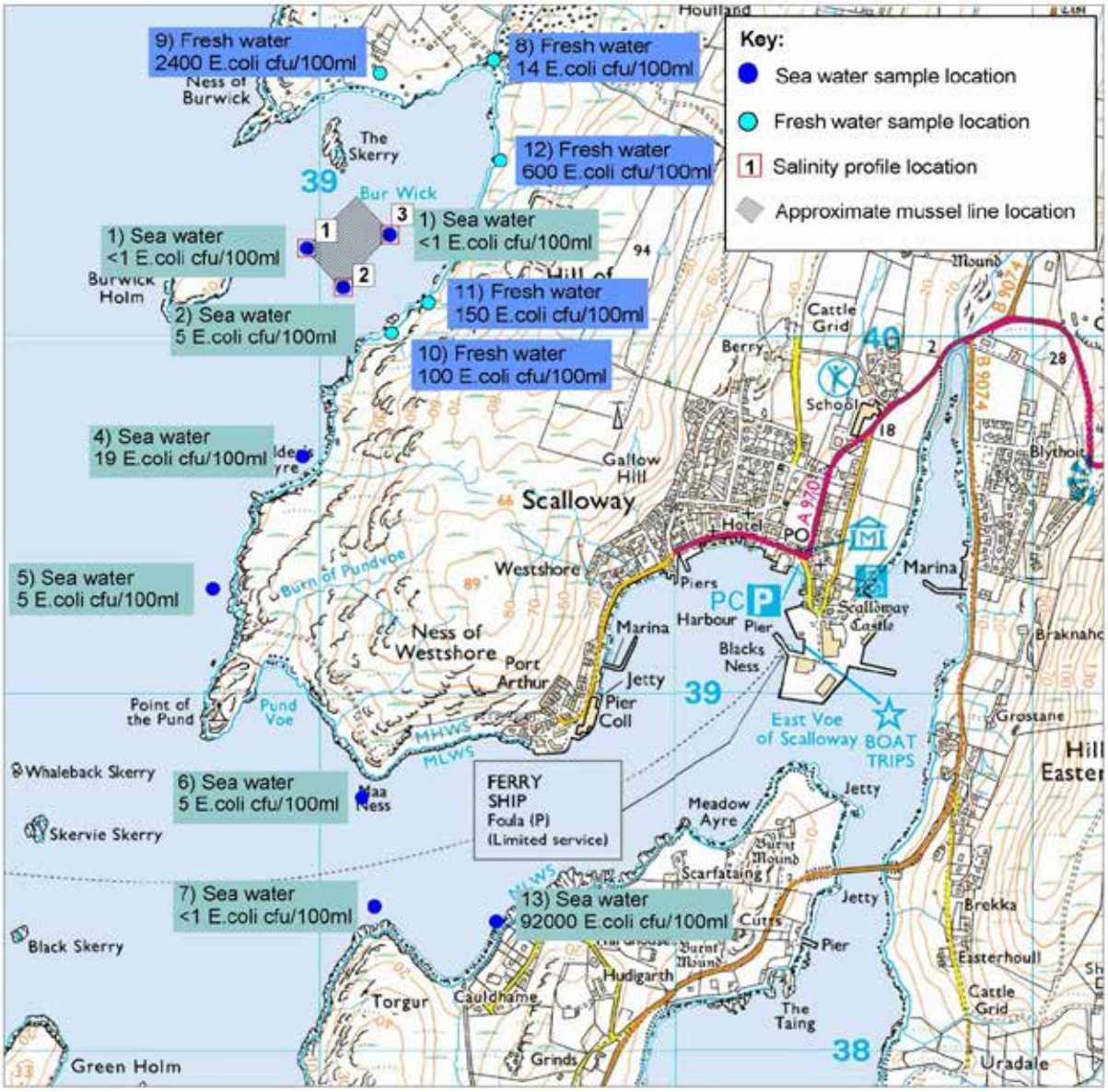

Figure 2 Map of water sample results and salinity profile locations East Burwick.

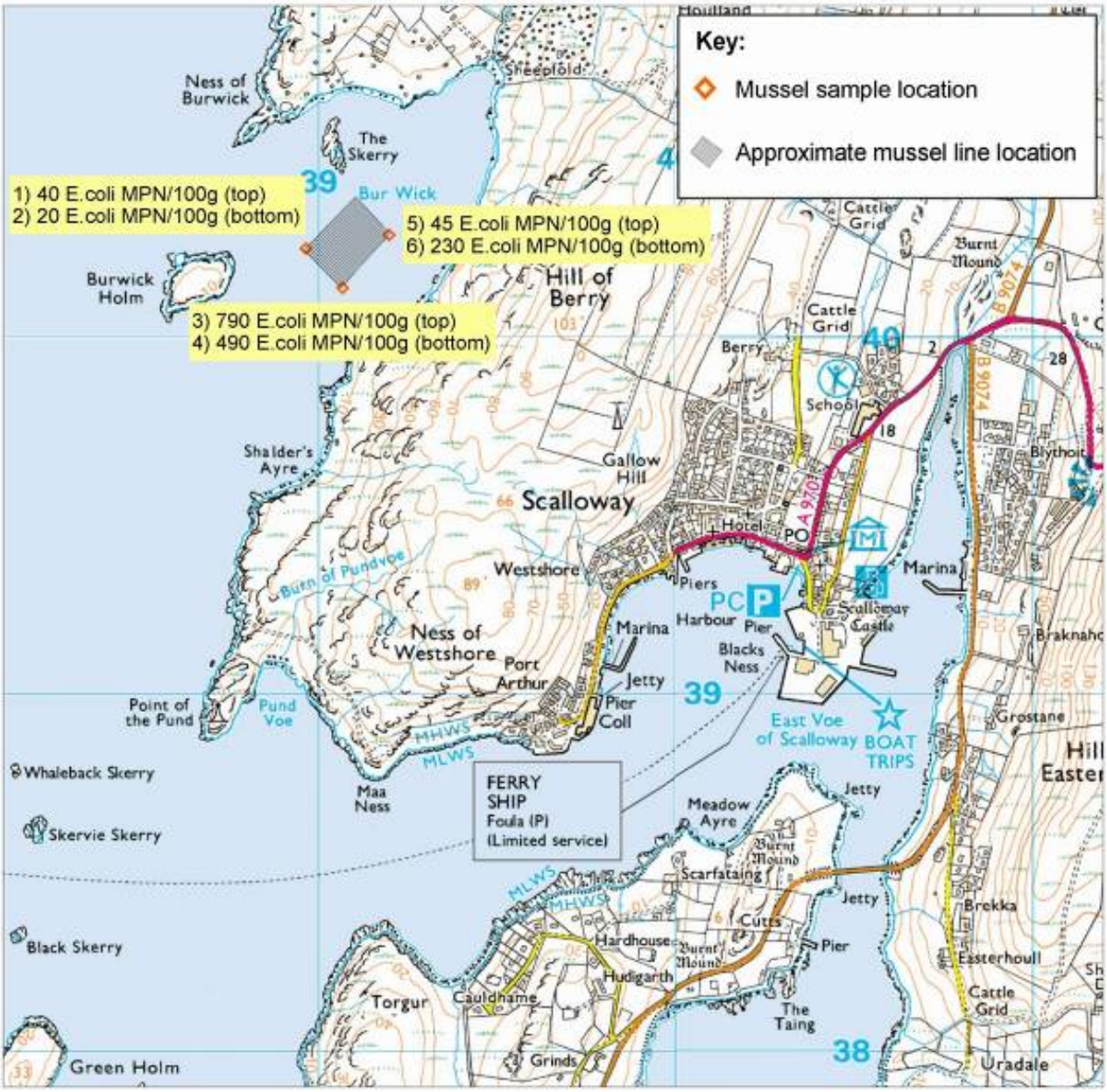

Figure 3 Map of shellfish sample results East Burwick.

Photographs

Figure 4 – Mussel lines at the East Burwick fishery looking North.

Figure 5 – East Burwick fishery from the southern shore of the production area looking west.

Figure 6 – Septic tank associated with a house at Burwick

Figure 7 – Pipe associated with the West Shore Sewage Pumping Station

Figure 8 – Pipe associated with the Blydoit Sewage Pumping Station

Figure 9 – Septic tank associated with houses at Scarfataing

Figure 10 – A second septic tank associated with houses at Scarfataing

Figure 11 – Septic tank associated with a new house near Scarfataing.

Figure 12 – Concrete septic tank below a group of houses near Cauldhame.

Figure 13 – Concrete septic at Cauldhame.

Figure 14 – Discharge pipe from septic tank in Figure 13. Seawater sample obtained from shore.

Figure 15 – Additional freshwater sample obtained from a watercourse on the northern shore of the East Burwick production area.

Figure 16 – Small watercourse sampled north of the East Burwick fishery.

Figure 17 – Small stone pier at the Ness of Burwick

Figure 18 – Workboats berthed at Blacksness Pier

Figure 19 – Port Arthur marina

Figure 20 – Domestic animals in a field above the shore at Burwick

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6. Consented discharges

Licence No.	NGR	Site Name	Treatment type	Discharges to	MDF (m3/d)	PE
CAR/L/1001965	HU 39684 44808	Nesbister	Sewage (Public) Primary	Whiteness Voe	60	
CAR/L/1002281	HU 38800 48400	Clach-na-Strom Outfall, Clach-na-Strom, White	Sewage (Public) Untreated	Weisdale Voe		250
CAR/R/1009165	HU 3970 3776	Dwelling, Tronda, Shetland	Sewage (Private) Primary	Land		5
CAR/R/1014567	HU 38580 43740	Dwelling, Whiteness, Shetland	Sewage (Private) Primary	Land		5
CAR/R/1016138	HU 3994 3837	Dwelling, Scarfataing, Trondra	Sewage (Private) Primary	Land		5
CAR/R/1025577	HU 39110 45950	Dwelling, Whiteness, Shetland	Sewage (Private) Primary	Soakaway		5
CAR/R/1025761	HU 38590 43610	Dwelling, North House, Shetland	Sewage (Private) Primary	Land		6
CAR/R/1029123	HU 38492 43435	Dwelling, South Ustaness, South Whiteness	Sewage (Private) Primary	Soakaway		15
CAR/R/1030326	HU 43600 42700	Dwelling, Gott, Shetland	Sewage (Private) Primary	Soakaway		5
CAR/R/1033150	HU 38705 44498	Dwelling, Whiteness, Shetland	Sewage (Private) Primary	Soakaway		5
CAR/R/1033872	HU 39100 49350	Dwelling, Weisdale, Shetland	Sewage (Private) Primary	Soakaway		5
CAR/R/1035235	HU 38990 46910	Dwelling, Whiteness, Shetland	Sewage (Private) Primary	Stromness Voe		6
CAR/R/1036077	HU 38625 43619	Dwelling, Whiteness, Shetland	Sewage (Private) Primary	Whiteness Voe		5
CAR/R/1036280	HU 39150 45780	Dwelling, Whiteness, Shetland	Sewage (Private) Primary	Soakaway		6
CAR/R/1036519	HU 39240 46460	Dwelling, Whitecairns, Shetland	Sewage (Private) Primary	Land		5
CAR/R/1036961	HU 39372 46787	Dwelling, Whiteness, Shetland	Sewage (Private) Primary	Loch of Strom		10
CAR/R/1037694	HU 39260 47180	Dwelling, Whiteness, Shetland	Sewage (Private) Primary	Strom Loch		5
CAR/R/1038356	HU 42647 43804	Dwelling, Shetland	Sewage (Private) Primary	Soakaway		12
CAR/R/1038384	HU 41090 41824	Dwelling, Asta, Scalloway, Shetland	Sewage (Private) Preliminary	Land		5
CAR/R/1038725	HU 39840 48480	Dwelling, Whiteness, Shetland	Sewage (Private) Primary	Land		6
CAR/R/1038726	HU 39395 46601	Dwelling, Whiteness, Shetland	Sewage (Private) Primary	Land		5
CAR/R/1038727	HU 39780 48410	Dwelling, Whiteness, Shetland	Sewage (Private) Primary	Land		5
CAR/R/1038736	HU 41072 41757	Dwelling, Asta, Scalloway, Shetland	Sewage (Private) Primary	Land		5

Licence No.	NGR	Site Name	Treatment type	Discharges to	MDF (m3/d)	PE
CAR/R/1038739	HU 38650 48210	Dwelling, Whiteness, Shetland	Sewage (Private) Primary	Soakaway		6
CAR/R/1038794	HU 41181 41955	Dwelling, Asta, Scalloway, Shetland	Sewage (Private) Primary	Soakaway		50
CAR/R/1038805	HU 41158 42037	Dwelling, Asta, Scalloway, Shetland	Sewage (Private) Primary	Soakaway		5
CAR/R/1039084	HU 38850 48180	Dwelling, Whiteness, Shetland	Sewage (Private) Primary	Land		5
CAR/R/1039562	HU 42950 46320	Dwelling, Upper Strand, Tingwall, Shetland	Sewage (Private) Primary	Land		5
CAR/R/1039670	HU 41090 41420	Asra House, Scalloway, Shetland	Sewage (Public) Primary	Soakaway		5
CAR/R/1039737	HU 42590 43720	Dwelling, Tingwall, Shetland	Sewage (Private) Primary	Soakaway		10
CAR/R/1039778	HU 38260 42760	Dwelling, South Whiteness, Shetland	Sewage (Private) Primary	Soakaway		5
CAR/R/1039819	HU 42510 44090	Dwelling, Gott, Shetland	Sewage (Private) Primary	Soakaway		5
CAR/R/1039849	HU 41650 43660	Dwelling, Gott, Shetland	Sewage (Private) Primary	Soakaway		5
CAR/R/1039850	HU 41590 43683	Dwelling, Grimsta, Tingwall	Sewage (Private) Primary	Soakaway		5
CAR/R/1039872	HU 40460 40865	Dwelling, Scalloway, Shetland	Sewage (Private) Primary	U/N W/C		5
CAR/R/1039894	HU 38390 42810	Dwelling, South Whiteness, Shetlan	Sewage (Private) Primary	The Deeps		10
CAR/R/1039940	HU 41091 41341	Dwelling, Asta, Scalloway, Shetland	Sewage (Private) Primary	Soakaway		10
CAR/R/1040150	HU 41650 45450	Dwelling,Gott Shetland	Sewage (Private) Primary	Soakaway		5
CAR/R/1040176	HU 42556 45377	Kingdom Hall & Meetint Hall, Tingwall	Sewage (Public) Primary	Soakaway		5
CAR/R/1040740	HU 38800 44480	Dwelling, South Whiteness, Shetland	Sewage (Private) Primary	Soakaway		5
CAR/R/1042577	HU 38755 45105	Dwelling, Whiteness, Shetland, ZE2 9LL	Sewage (Private) Primary	Soakaway		10
CAR/R/1042654	HU 38840 45210	Dwelling, South Whiteness, Shetland	Sewage (Private) Primary	Soakaway		5
CAR/R/1045030	HU 41000 40920	Dwelling, Scalloway, Shetland	Sewage (Private) Primary	Soakaway		5
CAR/R/1046389	HU 38774 45016	Dwelling, Whiteness, Shetland	Sewage (Private) Primary	Land		6
CAR/R/1053809	HU 38618 43772	Dwelling, Fitch.Shetland	Sewage (Private) Primary	Soakaway		5
CAR/R/1057792	HU 38750 44350	Dwelling, Shetland	Sewage (Private) Primary	Soakaway		5
CAR/R/1058189	HU 38696 44457	Dwelling, South Whiteness, Shetland	Sewage (Private) Primary	Soakaway		7
CAR/R/1058709	HU 39181 47671	Dwelling, Whiteness, Shetland	Sewage (Private) Primary	Soakaway		15
CAR/R/1058914	HU 39367 40886	Dwelling, Burwick, Shetland	Sewage (Private) Primary	Soakaway		5

Licence No.	NGR	Site Name	Treatment type	Discharges to	MDF (m3/d)	PE
CAR/R/1058919	HU 39308 40800	Dwelling, Burwick, Shetland	Sewage (Private) Primary	Soakaway		6
CAR/R/1059021	HU 38767 45075	Dwelling, Whiteness, Shetland	Sewage (Private) Primary	Soakaway		5
CAR/R/1059209	HU 38004 43263	Dwelling, South Whiteness, Shetland	Sewage (Private) Primary	Soakaway		5
CAR/R/1061077	HU 42750 43970	Dwelling,Tingwall Shetland	Sewage (Private) Primary	Soakaway		10
CAR/R/1072271	HU 38700 44230	Dwelling, South Wuitness, Shetland	Sewage (Private) Primary	Soakaway		11
CAR/R/1075797	HU 39143 46838	Dwelling, Whiteness, Shetland	Sewage (Private) Primary	Soakaway		5
CAR/R/1076586	HU 40400 40470	Dwelling, Berry, Scalloway, Shetland	Sewage (Private) Primary	Soakaway		5
CAR/R/1077068	HU 39040 44750	Dwelling, South Whiteness, Shetland	Sewage (Private) Primary	Soakaway		5
CAR/R/1077071	HU 38684 44219	Dwelling,South Whiteness, Shetland	Sewage (Private) Primary	Soakaway		5
CAR/R/1078022	HU 40490 40710	Dwelling, Berry, Scalloway, Shetland	Sewage (Private) Primary	Soakaway		5
CAR/R/1078227	HU 38911 45134	Dwelling, South Whiteness, Shetland	Sewage (Private) Primary	Soakaway		15
CAR/R/1078318	HU 39270 45680	Dwelling, Hoove, South Whiteness, Shetland	Sewage (Private) Primary	Whiteness Voe		5
CAR/R/1078321	HU 39234 46802	Dwelling, Whiteness, Shetland	Sewage (Private) Primary	Loch of Strom		15
CAR/R/1078325	HU 39214 46815	Dwelling, Whiteness, Shetland	Sewage (Private) Primary	Loch of Strom		15
CAR/R/1078337	HU 41550 44170	Dwelling, Griesta, Gott, Shetland	Sewage (Private) Primary	Soakaway		7
CAR/R/1078455	HU 38450 43630	Dwelling, South Whiteness, Shetlands Isles	Sewage (Private) Primary	Soakaway		6
CAR/R/1078669	HU 38590 48070	The Rock, Whiteness, Shetland	Sewage (Private) Primary	Soakaway		7
CAR/R/1079709	HU 39220 46790	Dwelling, Whiteness, Shetland	Sewage (Private) Primary	Loch of Strom		11
CAR/R/1080194	HU 38690 44290	Dwelling, South Whiteness, Shetland	Sewage (Private) Primary	Soakaway		5
CAR/R/1086363	HU 41950 45250	Dwelling, Tingwall, Gott, Shetland	Sewage (Private) Secondary	Soakaway		14
CAR/R/1086787	HU 38470 43080	Dwelling, Whiteness, Shetland	Sewage (Private) Untreated	Whiteness Voe		6
CAR/R/1089611	HU 39130 47750	Dwelling, Whiteness, Shetland	Sewage (Private) Primary	Soakaway		10
CAR/R/1098359	HU 38290 43220	Dwelling, South Ustaness, Shetland	Sewage (Private) Primary	Soakaway		9
CAR/R/1098919	HU 41232 43009	Dwelling, Scalloway, Shetland	Sewage (Private) Primary	Soakaway		7
CAR/R/1098985	HU 41040 40270	Dwelling, Scalloway, Shetland	Sewage (Private) Secondary	Soakaway		5

Licence No.	NGR	Site Name	Treatment type	Discharges to	MDF (m3/d)	PE
CAR/R/1101986	HU 39100 47180	Dwelling, Olligarth, Shetland	Sewage (Private) Primary	River Whiteness		6
CAR/R/1110338	HU 40850 40490	Dwelling, Scalloway	Sewage (Private) Primary	Soakaway		5
CAR/R/1110339	HU 40856 40514	Dwelling, Scalloway, Shetland	Sewage (Private) Primary	Soakaway		5
CAR/R/1119045	HU 38660 43700	Dwelling, Shetland	Sewage (Private) Primary	Whiteness Voe		15
CAR/L/1004025	HU 38700 39300	Scalloway Main Outfall	Sewage (Public) Primary	Bur Wick		2850
CAR/L/1002299	HU 37100 36194	Hamnavoe Septic Tank, Atla Ness, Hamnavoe	Sewage (Public) Primary	Alta Ness		
CAR/L/1004025	HU 38698 39210	Scalloway main outfall septic tank effluent	Sewage (Public) Primary	Bur Wick		2850
CAR/L/1005013	HU 37358 35853	Hulsidale Septic Tank, Hamnavoe, Burra Isle	Sewage (Public) Primary	Atlantic Ocean	17	80
CAR/R/1009165	HU 39700 37760	Dwelling, Trondra, Shetland	Sewage (Private) Primary	Land		5
CAR/R/1016138	HU 39940 38370	Dwelling, Scarfataing, Trondra	Sewage (Private) Primary	Land		5
CAR/R/1020324	HU 37843 35805	Dwelling, Brake, Shetland	Sewage (Private) Primary	Coastal Waters		20
CAR/R/1036623	HU 37560 35690	Dwelling, Meal, Shetland	Sewage (Private) Primary	Soakaway		5
CAR/R/1036662	HU 37560 35670	Dwelling, Hamnavoe, Shetland	Sewage (Private) Primary	Soakaway		5
CAR/R/1038231	HU 37850 35650	Dwelling, Burra Isle, Shetland	Sewage (Private) Primary	Soakaway		5
CAR/R/1038241	HU 37863 35585	Dwelling, Utterabrake, Burra Isle, Shetland	Sewage (Private) Primary	Soakaway		5
CAR/R/1038346	HU 39230 36880	Dwelling, Trondra, Scalloway, Shetland	Sewage (Private) Primary	Soakaway		5
CAR/R/1038435	HU 39690 38150	Dwelling, Trondra, Scalloway	Sewage (Private) Primary	Soakaway		5
CAR/R/1038753	HU 37750 35500	2 Dwellings, Meal, Hamnavoe, Shetland	Sewage (Private) Primary	Soakaway		13
CAR/R/1039604	HU 38070 35230	Dwelling, Hamnavoe, Shetland	Sewage (Private) Primary	Lang Sound		5
CAR/R/1039608	HU 38070 35230	Dwelling, Hamnavoe, Shetland	Sewage (Private) Primary	Lang Sound		5
CAR/R/1039614	HU 38070 35230	Dwelling, Brake, Hamnavoe, Shetland	Sewage (Private) Primary	Stream Sound		7
CAR/R/1039724	HU 37720 35740	2 Dwellings, Hamnavoe, Burra, Shetland	Sewage (Private) Primary	Soakaway		12
CAR/R/1039867	HU 39730 38270	Dwelling, Trondra, Scalloway, Shetland	Sewage (Private) Primary	Soakaway		5
CAR/R/1039869	HU 39500 38350	11 Dwellings	Sewage (Private) Primary	East Voe of Scalloway		50

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CAR/R/1053522	HU 39590 38210	Dwelling,Trondra,Shetland	Sewage (Private) Primary	Land		5
CAR/R/1058914	HU 39367 40886	Dwelling, Burwick, Shetland	Sewage (Private) Primary	Soakaway		5
CAR/R/1058919	HU 39308 40800	Dwelling, Burwick, Shetland	Sewage (Private) Primary	Soakaway		6
CAR/R/1061259	HU 38102 34740	Dwelling, Southerhouse, Hamnavoe, Burra	Sewage (Private) Primary	Lang Sound		5
CAR/R/1069341	HU 37892 34875	Dwelling, Hamnavoe, Shetland	Sewage (Private) Primary	Soakaway		5
CAR/R/1077059	HU 39670 37320	Dwelling, Tronda, Shetland	Sewage (Private) Primary	Soakaway		5
CAR/R/1089904	HU 36740 35940	Dwelling, Altaness, Shetland	Sewage (Private) Primary	Atlantic Ocean		11
CAR/R/1108020	HU 40340 39570	Dwelling, Berry Road, Shetland	Sewage (Private) Primary	Land		5
CAR/R/1109421	HU 39740 36020	Dwelling, Trondra, Scalloway, Shetland	Sewage (Private) Primary	Land		6
CAR/R/1109613	HU 39874 38541	Dwelling, Trondra, Shetland	Sewage (Private) Primary	East Voe of Scalloway		5
CAR/R/1119833	HU 39800 38450	Dwelling, Trondra, Shetland	Sewage (Private) Primary	East Voe of Scalloway		6
CAR/S/1081637	HU 39480 38370	Dwelling,, Trondra, Shetland	Sewage (Private) Primary	East Voe of Scalloway		60
CAR/R/1061647	HU 38735 44367	Dwelling, Finstown, Orkney	Sewage (Private) Primary	Land		5
CAR/L/1001966	HU 3985 4585	Wormadale	Sewage (Public) Combined Sewer Overflow (CSO)	Whiteness Voe		
CAR/L/1002258	HU 39900 39300	Westshore Pumping Station CSO	Combined Sewer Overflow	Scalloway Harbour		
CAR/L/1002260	HU 40300 39300	Burn Beach Pumping Station CSO	Combined Sewer Overflow	Scalloway Harbour		
CAR/L/1002229	HU 43158 46130	Strand Pumping Station, Gott	Sewage (Public) Emergency Overflow (EO)	Burn of Strand		1
CAR/L/1002230	HU 42633 44625	Veensgarth Pumping Station, Veensgarth	Sewage (Public) Emergency Overflow (EO)	Burra Burn		
CAR/L/1002244	HU 43513 46416	Strand Pumping Station, Strand, Gott	Sewage (Public) Emergency Overflow (EO)	Lax Firth		
CAR/L/1002258	HU 39900 39300	Westshore Pumping Station EO	Emergency Overflow	Scalloway Harbour		
CAR/L/1002259	HU 44400 39100	Blackness Pumping Station EO	Emergency Overflow	Scalloway Harbour		
CAR/L/1002260	HU 40300 39300	Burn Beach Pumping Station EO	Emergency Overflow	Scalloway Harbour		

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CAR/L/1002261	HU 40800 39600	Blydoit Pumping Station EO	Emergency Overflow	Scalloway Harbour		
CAR/L/1002262	HU 40700 38800	Seachest Pumping Station EO	Emergency Overflow	Scalloway Harbour		
CAR/L/1002258	HU 39885 39313	Westshore PS, EO to East Voe, Scalloway	Sewage (Public) Emergency Overflow (EO)	East Voe of Scalloway		
CAR/L/1002259	HU 40295 39345	Burn Beach PS, EO to East Voe of Scalloway	Sewage (Public) Emergency Overflow (EO)	East Voe of Scalloway		
CAR/L/1002260	HU 40517 39054	Blacksness STW, EO to East Voe of Scalloway	Sewage (Public) Emergency Overflow (EO)	East Voe of Scalloway		
CAR/L/1002261	HU 40800 39600	Blydoit STW, EO to EAst Voe of Scalloway	Sewage (Public) Emergency Overflow (EO)	East Voe of Scalloway		
CAR/L/1002262	HU 40649 38794	Seachest PS, EO to East Voe of Scalloway	Sewage (Public) Emergency Overflow (EO)	East Voe of Scalloway		
CAR/L/1001818	HU 35700 46500	Brei Geo Offshore MCFF, Sandsound Voe	Fish Farm Marine Cage			
CAR/L/1003058	HU 37100 46300	Flotta West MCFF, Weisdale Voe	Fish Farm Marine Cage			
CAR/L/1003059	HU 38140 40604	Burwick West MCFF, Bur Wick	Fish Farm Marine Cage			
CAR/L/1003070	HU 36900 43000	North Havra MCFF, Sound of Havra	Fish Farm Marine Cage			
CAR/L/1003114	HU 37700 45000	Sound Of Hoy MCFF, Weisdale Voe	Fish Farm Marine Cage			
CAR/L/1003865	HU 40290 48800	Loch of Strom Site, Loch of Strom, Shetland	Fish Farm Freshwater Cage			
CAR/L/1003898	HU 37499 45434	North of Hoy MCFF, Weisdale Voe	Fish Farm Marine Cage			
CAR/L/1004068	HU 37724 45959	Binna Ness MCFF, Stromness Voe	Fish Farm Marine Cage			
CAR/L/1004156	HU 35750 47350	Brei Geo Inshore MCFF, Sandsound Voe	Fish Farm Marine Cage			
CAR/L/1004206	HU 35510 45000	Fore Holm MCFF, Haddock Sands	Fish Farm Marine Cage			
CAR/L/1004217	HU 35300 43400	Easter Score Holm MCFF, Haddock Sands	Fish Farm Marine Cage			
CAR/L/1008980	HU 39195 40398	Burwick East MCFF, Bur Wick	Fish Farm Marine Cage			
CAR/L/1009820	HU 35111 41837	Sanda Stour MCFF, The Deeps	Fish Farm Marine Cage			
CAR/L/1011656	HU 36500 40500	Hildasay East MCFF, Bur Wick	Fish Farm Marine Cage			
CAR/L/1002864	HU 38333 35494	Lang Sound MCFF, Off Langa	Fish Farm Marine Cage	Lang Sound		
CAR/L/1002868	HU 39950 36870	Lea of Trondra MCFF, Clift Sound	Fish Farm Marine Cage	Clift Sound		

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CAR/L/1002920	HU 35149 38170	Spoose Holm MCFF, The Deeps	Fish Farm Marine Cage	Spoose Holm		
CAR/L/1002983	HU 36600 38374	North of Papa MCFF, North Voe	Fish Farm Marine Cage	North Voe		
CAR/L/1002987	HU 39380 35384	Kallee Ness MCFF, Clift Sound	Fish Farm Marine Cage	Clift Sound		
CAR/L/1003056	HU 37490 36210	Setter Voe MCFF, West Burra	Fish Farm Marine Cage			
CAR/L/1003059	HU 38140 40604	Burwick West MCFF, Bur Wick	Fish Farm Marine Cage	Bur Wick		
CAR/L/1004039	HU 38900 38894	Pund Voe MCFF, Scalloway	Fish Farm Marine Cage	Pund Voe		
CAR/L/1004040	HU 37600 39494	East of Langa SIte	Fish Farm Marine Cage	Bur Wick		
CAR/L/1004046	HU 40200 35794	Wester Quarff MCFF, Clift Sound	Fish Farm Marine Cage	Clift Sound		
CAR/L/1005048	HU 37143 37726	East Head of Papa MCFF, East Voe	Fish Farm Marine Cage	North Voe		
CAR/L/1008980	HU 39195 40398	Burwick East MCFF, Bur Wick	Fish Farm Marine Cage	Bur Wick		
CAR/L/1009007	HU 39535 38855	Marine Hatchery	Fish Farm Marine Tank	East Voe of Scalloway		
CAR/L/1009907	HU 38569 34860	Whalsies Ayre MCFF, Stream Sound	Fish Farm Marine Cage	Whalsies Ayre		
CAR/L/1010455	HU 37600 39494	East of Langa MCFF, Bur Wick	Fish Farm Marine Cage	Bur Wick		
CAR/L/1011237	HU 38882 37783	East of Merry Holm MCFF, The Deeps	Fish Farm Marine Cage			
CAR/L/1011656	HU 36500 40500	Hildasay East MCFF, Bur Wick	Fish Farm Marine Cage			
CAR/L/1011980	HU 38406 36644	Bruna Ness MCFF, Lang Sound	Fish Farm Marine Cage			
CAR/L/1019424	HU 40812 37862	Burra Isles MCFF, Lang Sound	Fish Farm Marine Cage			
CAR/L/1001923	HU 40994 40050	Shetland Islands Council, Scord Quarry	Other Effluent	U/N W/C		
CAR/S/1085670	HU 41900 45170	Tingwall Airport, Tingwall, Shetland	Surface Water (Other) Commercial, Ind & Other			
CAR/L/1004075	HU 40008 39282	Malakoff and Wm Moore	Other Effluent	Scalloway Harbour		