Isle of Man Government
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Summary of Peel Bay and river catchment Sediment Monitoring Results

This document is a collection of sampling work and in some cases commentary, which has been undertaken by DEFA either for its own use, or for that of other parties.

The reports were originally produced between September 2013 and February 2017.

For the sake of easy reference, the pages are numbers sequentially, though the documents are discreet and separate report.

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This version is published on the DEFA website on 28th November 2017, replacing a less structured version of the same collection of reports.

Summary of analysis undertaken September 2013 – December 2014

This document was originally dated 16th April 2015

Context

This summary of sediment sampling results is assembled from analysis of sample taken in September 2013, June 2014, August 2104, September 2014 and December 2014, to accompany the trial disposal at sea of approximately 4,000 tonnes of dredged sediment from Peel Marina, in May 2014.

Summary

The results presented here have clearly identified that the dumping signature in sediment concentration is found in Peel Bay, following the trial disposal of 4,000 tonnes of dredged material from Peel Marina.

It is also clear that Peel Bay itself had significant contamination issues prior to the disposal of dredged material from Peel inner Harbour. This was in most noticeable in sediments in the southern part of the bay.

Results

Offshore Sediment Analysis

Sediments analysed from the bay and licenced dump site show that prior to disposal of the dredged material the bay had some heavy metal contamination, with arsenic, nickel and lead exceeding OSPAR level 1 limits at certain sites. However, the average values for all metals prior to deposition of the dredged material were below OSPAR level 1 criteria. Post-dredge disposal results indicate that levels of all heavy metals have steadily increased in the offshore waters of the bay and licenced dump site and with the exception of nickel all metals analysed now exceed OSPAR level 1 criteria (see table 1).

In order to aid the assessment of the data several indicative values have been used. For sediments (beach and offshore surveys) the OSPAR guidance has been followed, which provides a two-tier evaluation for sediments with the lower tier (level 1) indicating that sediments are contaminated and that disposal to sea would come under scrutiny. OSPAR level 2 would indicate that sediments are beyond acceptable limits for dumping at sea. Whilst these criteria are primarily intended for the assessment of contaminated sediments they are used here to indicate impacts of heavy metal contamination in Peel Bay.

To aid the interpretation of the data a ‘traffic light system’ of coding is given in the following tables:

- Yellow indicates that heavy metal concentration are at or above 50% of the OSPAR level 1 limit, suggesting heavy metals are above background levels and indicate a degree of heavy-metal contamination.
- Red boxes indicate that sediment heavy metal concentrations exceed OSPAR level 1 and the sediment would be classed as contaminated.

	As	Cd	Cr	Cu	Ni	Pb	Zn	Heavy Metal impact
Pre dump Sept 2013 average	17.26	0.25	28.64	9.82	22.22	46.72	85.24	Yes
Range(mg/kg)	10.9-33.8	0.23-0.28	20-38	4.6-13.5	16-31	31-82	63-109	Yes
Survey 1 post- dump average 3/6/14	13.81	0.45	24.11	8.67	18.13	57.36	94.36	Yes
Range(mg/kg)	9.0-17	0.27-0.87	17-28	3.9-28.9	11.5-20	27-146	60-176	Yes
Survey 2 post- dump average 3/8/14	12.24	0.302	22.02	6.96	19.32	32.62	76.98	Yes
Range (mg/kg)	9.8-13.8	0.2-0.4	16-24.6	4.6-9.4	16.7-20.60	22.4-38.6	53-108	Yes
Survey 3 post- dump Average 29/9/14	17.43	0.47	24.57	15.8	22.2	58.36	145.7	Yes
Range (mg/kg)	15.2-20.9	0.39-0.57	0.32-38.7	11.8-23.5	19.3-23.9	42.3-79.4	124-174	Yes
Survey 4 post-dump Average 4/12/14	26.2	0.86	52.2	26.6	20	76.5	180	Yes
Range mg/kg	15-42.8	0.64-1.0	32-90	15-36	18-22	52-121	150-203	Yes
OSPAR Action Level 1	20	0.4	50	30	30	50	130	
OSPAR Action Level 2	70	4	370	300	150	400	600	

Table 1. Offshore sediment heavy metal concentration averages and concentration ranges for the pre-dump survey and four subsequent post-dump surveys (all expressed as mg/kg dry weight). OSPAR action level concentrations are given for comparison purposes. Red indicates that the value exceeds OSPAR action level 1, yellow indicates heavy metal concentrations are at or above 50% of the OSPAR action level 1.

Average metal concentrations in the offshore environment of Peel Bay and licenced dump sites have increased between pre-dumping and current levels. Average cadmium concentrations have increased by approximately 240% between pre and post dredging activities, similarly lead concentrations have increased by 64%, arsenic by 51%, chromium by 83%, zinc by 110% and copper by 170%.

Comparison of the heavy metal concentrations between the pre and post dredge disposal operation shows that concentrations of both lead and cadmium increased significantly immediately following the discharge of sediment from the breakwater. The concentrations of metals in the vicinity of the breakwater initially decreased, but have subsequently shown a marked increase over the course of the study. Cadmium concentrations remain elevated and are still significantly higher than those recorded before sediment disposal. Both cadmium and lead concentrations at this locality remain above OSPAR action level 1.

Peel Marina and Poortown temporary storage facility - Questions and Answers

This document was originally dated Thursday 16th April 2015

Q1 Why did you decide to remove 18,000 tonnes of silt from Peel Marina now?

A1 Silt from the River Neb has been accumulating in the Marina at such a rate that parts of the Marina are now dry. The DOI is under a statutory obligation to dredge harbours and keep them open to navigation. If no action had been taken Peel marina would have lost even more berths, resulting in significant harm to the local and national economy. Boat owners have highlighted the urgent need for dredging to prevent the imminent closure of the marina. The DOI estimates that the Marina will be completely dry in 3 years if nothing is done. DOI undertook 3 separate dredging operations last year but the amount of silt removed was only slightly more than the amount that is deposited annually.

The Marina has transformed Peel harbour since it was built, and helped make the town such and attractive place to live, work and visit. The Marina and Harbour are a key part of the local economy and are vital to the success of the Island's fishing industry. The loss of the Marina would be a major blow to the local and national economy. Whilst the amount of silt deposited each year varies with the weather conditions, it is a certainty that silt will come down the river and so doing nothing is not an option. Small scale dredging would have been environmentally acceptable but cannot solve the problem so DOI decided that the only thing to do was to clear the accumulation of silt in a single project.

Q2 Why were the dredgings not deposited at sea?

A2 Marine organisms such as scallops, crabs and lobsters are either filter feeders or they feed in close proximity to the sediments on the sea bed. Disposing of 18,000 tonnes of contaminated sediments from the marina directly to the sea bed would have had a negative impact on the species involved. Testing carried out by DEFA officers had already identified the likelihood that earlier disposal of 4,000 tonnes into the sea had contributed to rises in contaminants within commercial fisheries species to levels approaching EU food safety standards.

The processed value of Queen Scallops from the fishing area earmarked for marine disposal is approximately £2.4 million pounds per annum. It is worth remembering that the £2.4 million represents the value of one species. Closure of the area to fishing due to contamination could have affected more species and the losses could have been greater.

Importantly, once sediments are deposited directly into the sea, all control over the material is lost and the nature of some of the contaminants is such that valuable fisheries could need to be closed for more than one year.

The Isle of Man is a signatory to the Oslo-Paris Convention for the Protection of the Marine Environment for the North East Atlantic (OSPAR). The Convention specifies maximum levels

of marine contaminants. In the case of the Peel Marina sediments, the worst areas were approximately four times the OSPAR threshold.

The Isle of Man is currently bidding to become the first entire jurisdiction to achieve UNESCO Biosphere status. This accolade could be extremely valuable to the people of the Island and it is probable that disposing of 18,000 tonnes of contaminated silt into important and bio-diverse waters would have a serious negative impact on that bid.

Q3 Why did you decide to create a temporary store for the dredged silt?

A3 Extensive work over a ten month period had identified that disposing of the sediments at sea would have a damaging impact on our international reputation as an environmentally responsible nation. It was also highly likely that it would cause the closure of valuable commercial fisheries and have an adverse effect on the marine environment for a significant period of time.

While disposal at sea was the cheapest option, it was known to be potentially the most damaging in terms of public health as analysis carried out through 2014 indicated that disposal of unusually large quantities at sea could have raised contamination levels in human food species to above EU food safety standards.

DEFA and DOI officers also considered a wide range of land based options, including smelting to reclaim the metals or storing the silt in large textile tubes to protect against coastal erosion. None of the re-use options were found to be viable, so disposal on land was assessed. There are a number of landfill facilities in the Isle of Man but none of these were found to be suitable. The Wrights Pit North landfill site at the Point of Ayre, the disused quarry on Peel hillside overlooking Fenella Beach, former mines and mining spoil sites and two privately operated landfill facilities were all ruled out based on currently available information because of issues such as lack of capacity, land ownership, legislative restrictions, or environmental considerations.

DOI decided that, as the Marina had to be dredged, disposal on land was the best environmental option and there were no suitable landfill sites on the Island, the only option was to create a temporary store whilst a permanent disposal site could be found.

Q4 What legislation allows emergency developments of this nature?

A4 Section 64 of the Public Health Act 1990 allows DEFA (the Department with responsibility for environmental health and environmental protection issues) to provide clearance to DOI to allow it to store materials at premises it (DOI) owns in the event of urgent public health concerns. No other land or property can be considered under the powers of this Act.

Section 64 allows for work to commence on projects of this type providing that appropriate control measures have been agreed and that a Direction (a form of licence) has been issued.

In this case a Direction was issued to DOI by DEFA on the 1st April 2015. The Act also stipulates that it is appropriate to follow up the design ratification and the issue of a Direction with a public notice of intent and a 21 day period during which interested parties can submit comments on the development. An advert has been placed and appropriate notice allowed.

The reputational and economic damage that would have accompanied closure of the Marina when considered alongside the health implications of marine disposal and the lack of available land based options, required urgent action and a decision was taken to identify suitable temporary storage solutions using emergency powers under Public Health legislation which allowed work to commence before the need to apply for planning permission.

Q5 Why was the Poortown location selected?

A5 Poortown and the adjacent land at Rockmount is owned by DOI and used as part of its quarry operations. Only 2 miles from Peel, access to the site is already in place and is suited to receiving heavy vehicles. The land and its profile is suited to the engineering adaptations that would be required to allow safe storage of the dredged material and the adjacent stream runs directly into the Neb so that water leaving the storage site from the settlement tanks will return to the river system which transported the sediments to the marina in the first place.

In addition to this, a water sample taken from the stream before any work commenced demonstrated pre-existing high concentrations of metal contaminants. These are probably the consequence of the local geology or historic mineral workings. Any trace of contaminants remaining in the water after it leaves the on-site controls would therefore be less likely to have an adverse impact on the quality of the water flowing down the stream.

Q6 Why are the sediments classified as hazardous waste?

A6 Metals are present in the Island's geology and sediments containing them have been transported by river systems to the sea for centuries. When the flow of a river slows down – as is the case when the River Neb reaches Peel Marina - sediments settle to the bottom and over time become increasingly concentrated. If such sediments are made available for human or animal ingestion the concentrations of metals can build up in tissues and over a period of time they can result in health issues.

As an example the vast majority of the lead content in water is bound to solid particles. The transporting water itself contains only a small percentage of the metal. Water therefore needs to be consumed in much greater quantities to build up potentially harmful concentrations in body tissues.

Conversely sediments deposited into the marine environment can be ingested directly by edible marine animals and can build up relatively quickly to concentrations which can lead to health issues in humans if they consume this seafood in sufficient quantities.

Q7 What are the harmful contaminants in the silt?

A7 If present in high enough quantities lead, cadmium and Polycyclic Aromatic Hydrocarbons (PAH's) can have an impact on health.

These three contaminants are present in the sediment but it is important to point out that the risks they present to health are normally associated with exposure to the solid forms of the materials such as dust or inhalable fractions such as vapours.

Contaminants dissolved in water are not thought to be as hazardous unless they are present in very high concentrations and consumed over a significant period of time.

In this case the contaminants are expected to be securely held within the bunded area of the facility. Water outflows will be monitored carefully.

The contaminants in the silt are naturally occurring on the Island and can be found in the soils and old mine workings in the Foxdale area. The attached table (see appendix) provides data for the levels of key contaminants in both the Foxdale former mine working area and Peel Marina. A comparison of the data shows that silt from the Marina is safer than soil in the vicinity of former mine workings. Samples from the 'deads' show significantly higher levels again and these areas have been used for recreation for many years without any known adverse health effects.

Q8 What measures are in place to manage risks from the Poortown facility?

A8 The measures designed into the Poortown facility include a retaining bund, an impermeable polythene membrane to prevent contaminated water leaching into the ground, a bank of settlement lagoons and a filter system to catch PAHs.

The vast majority of the solid fraction is therefore retained and not available to the environment.

Water which does run off from the stored deposits will contain only a small quantity of the contaminants and this water will pass through a bank of settlement lagoons which will allow the majority of any solid material contained in it to sink to the bottom and be retained. Contaminants are therefore greatly reduced and released into the environment at a much slower rate than they would be at sea.

The bund and delivery vehicle access arrangements have been designed to prevent direct run off onto adjacent land.

Measures will be adopted as the sediment is extracted from the Marina to allow much of the water to drain back into the basin, thereby minimising the volume and salinity of any water transported to the Poortown location.

Further to this, analysis of the water quality in the stream adjacent to the facility at Poortown has identified pre-existing, naturally high, concentrations of some metal contaminants which will form the basis of a discharge licence against which any possible changes to pollutant levels can be measured as the deposition of the materials progresses. The levels to be specified in the licence are in alignment with UK statutory Environmental Quality Standards and therefore not likely to pose any risk to livestock reared in the fields adjacent to the watercourse.

Regular sampling of run-off and leachates will be undertaken.

Q9 What will happen if the control measures are not effective?

A9 A regular sampling regime will identify any problems should they arise and DEFA and DOI officers will work together to ensure that appropriate measures are implemented should they be required.

Additional controls could include, enhanced filtering measures such as reed beds and shell screens (both proven techniques) or using tankers to remove run-off in the event that prolonged periods of heavy rain stretch the capacity of the settlement lagoons.

Q10 Why did you commence work on the Poortown site without first going through the planning process?

A10 Although the DOI could have deposited all 18,000 tonnes of silt at sea in a short period, it recognised that although that would have been legal on the Island, it would have been environmentally irresponsible, economically damaging and internationally unacceptable. Once it became clear that disposal on land was the best environmental option the DOI considered all the existing landfill sites on the Island but found that none were suitable.

As DOI is obliged to dredge harbours and as the Public Health Act contains specific provisions for emergency developments, the Department could have done the works without seeking permission. The Minister decided that it would be better if the Department made a planning application so that everyone can see what is being planned and why. The planning process was started at the same time that the Public Health Act Direction was being considered; the application will be submitted within a week of the start of operations.

The Department's planning enforcement policy has for many years made this option clearly available to those who find themselves in similar difficulty. Copies of this document are freely available on the Department's website.

Q11 Why was there no public consultation or notification before the work at Poortown commenced?

A11 The Poortown location was only identified as the main option for further consideration in mid-March 2015. Prior to that, the efforts of DOI and DEFA officers had focussed on pre-existing disposal sites or locations closer to Peel.

Once it became clear that the only option to avoid a situation in which public health might be put at risk, the Poortown possibility was further explored.

Feasibility and design work progressed quickly and in parallel and it became clear that the location was viable as a temporary storage solution towards the end of March.

Under the terms of the Public Health Act work can commence before any public consultation period but in this case it would have been preferable to give the German Commissioners a few days advanced warning, as was provided to the Peel Commissioners. While this omission was not deliberate, this opportunity was missed and Minister Gawne has personally apologised to the German Commissioners for this.

Q12 What is happening about a permanent solution?

A12 DOI has promised German Commissioners that the Poortown site will not be used as a permanent waste disposal site. DOI wants to use the temporary store for no more than 5 years and will start work immediately on identifying a long term solution to the need for a new problematic waste disposal site. It is unlikely that a new site can be open before 2018 at the earliest but the dredged silt will be removed from Poortown as soon as a new site is available.

Q13 How will the silting problem in Peel be dealt with or avoided in future?

A13 DOI engineers are currently working to assess the viability of options which could be used to control the amount of silt entering into the marina. However, it is likely that a small amount of material will be dredged from the Marina each year and disposed of at sea in compliance with relevant environmental standards

Q14 Does the legislation need to be reviewed?

A14 Manx legislation is under regular review to ensure that it is fit for purpose. In this case it appears to have functioned well as planning and environmental protection laws acted as deterrents to inappropriate choices regarding deposition of the silt. The emergency provisions of the Public Health Act allowed the development of a pragmatic temporary storage option once all other alternatives had been thoroughly considered.

Q15 Could the Government have handled this better?

A15 Yes. With hindsight the original design of the marina was flawed and work on removing silt should have been carried out as part of a regular maintenance regime. In future, appropriate environmental impact assessments will be used to identify such issues and guard against such problems. The Government response over the past year has however been much more positive and responsible.

DOI and DEFA have worked together to identify and develop a good temporary solution which gives them control of the situation. They will continue to work together to use the time gained to develop permanent solutions and ideally to put the material to good use.

Importantly, the Island will be viewed by its neighbours as a responsible jurisdiction which deals with its own problems rather than disposing of its potentially harmful waste into a sea which is shared by all.

Q16 Has the recent testing identified any food safety issues?

A16 The monitoring continues to show that the commercially fished sea food is safe for human consumption. However, we would advise again that the mussels from the entrance to Peel harbour should not be used for human consumption as a consequence of the naturally high levels of metal contaminants in the river sediments which have been present for generations.

In the light of what has been learnt from the recent monitoring, DEFA intends to continue the sampling process in order to ensure the impacts are fully understood.

Heavy Metals in Foxdale former mine-working area, and Peel Marina

This document was originally dated 16th April 2015

Important note: The analytical results from which these data are extracted relate only to the samples tested, which had been taken for specific investigatory purposes in locations where mine contamination was suspected – no inference regarding heavy metal content in soils not similarly contaminated by residues from mine workings is implied nor should be inferred.

	Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc
Peel Marina sediment (5 samples taken by DEFA in 2013)	40 - 49	3 - 6	34 - 41	75 - 126	1,570 – 2,480	29 - 34	870 – 1,420
Soils from Foxdale area in vicinity of mines (range of majority) excluding obviously mine spoil	20 - 200	1 - 13	10 - 60	10 - 260	400 – 6,500	8 - 80	250 – 5,000
Mine spoil from 'deads' area	up to 460	up to 17	up to 30	up to 670	up to 70,000	up to 35	up to 1,900
Sample taken from road spillage outside Highwayman Pub – Monday 13th April 2015	27.5	5.6	29.3	118	1,866	23.1	1,307

All results in milligrams per kilogram (mg/kg) dry weight

70,000 mg/kg corresponds to 7% lead, which may indicate some un-extracted lead ore.
The above data are from analysis carried out by the Government Laboratory.

Mr Lenartowicz, Government Analyst, has quantified these results with regard to the 8-hour workplace exposure limits. If the silt dried and became suspended in the air in the form of inhalable dust, in visibly dusty atmosphere, none of the metals present would exceed the 8-hour work place exposure limits.

In addition the Government Laboratory has analysed water from the river downstream of the Poortown site

	Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc
River water from downstream of field adjacent to Poortown Quarry, 5/03/15	<5	<0.5	<5	25.8	57.9	12.1	85.8

All results in micrograms per litre (µg/l) N.B 1000 µg/l = 1 mg/l

January / February 2017 Peel Marina Sediment Sampling

Sediments from Peel Marina were sampled on two occasions in early 2017 in order to assess the suitability of disposal to sea. In January sediments from the marina and turning basin (marina side of flap gate) were taken using a vibro-coring device. Nine cores in total were collected and analysed for contaminants (see Figure 1 for map and Table 1 for results).

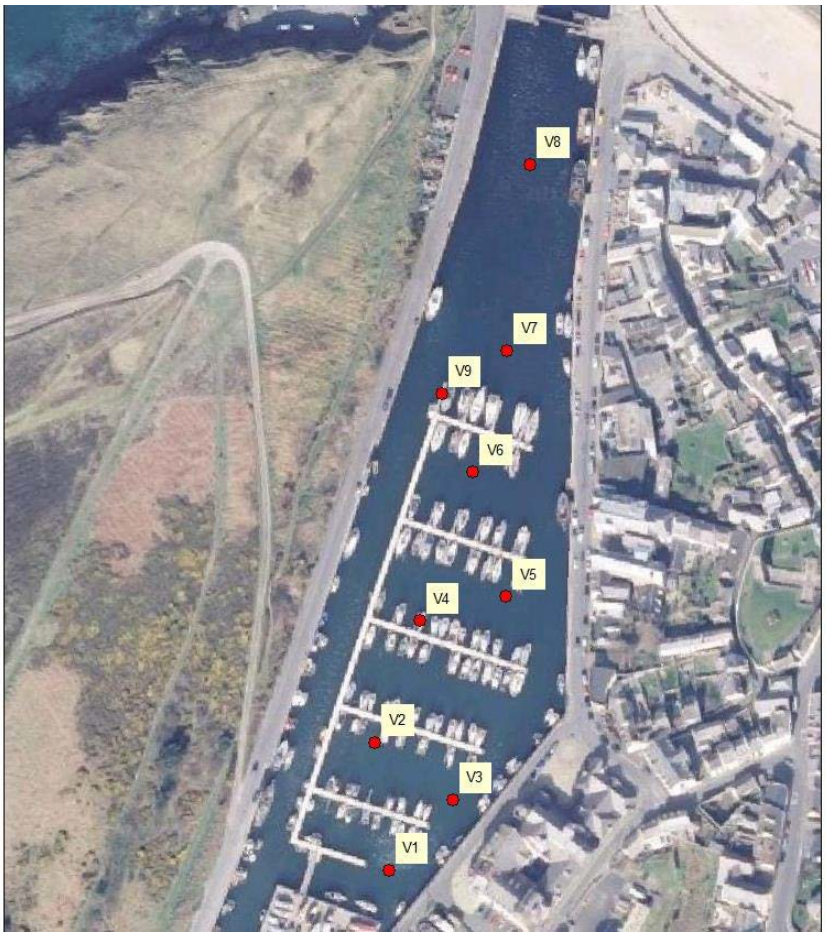


Figure 1. Location of cores collected in January 2017 Table 1.

Results of samples from Peel Marina. January 2017 (mg/kg dry weight).

sample name	Column1	Sample depth	As	Cd	Cr	Cu	Ni	Pb	Zn
kk 387	core 1 surface	0-15	47.6	4.33	29.5	76.3	32.1	1085	835
kk 388	core 1 bottom	80-210	7.84	0.29	17.8	6.76	19.0	36.0	47.6
kk 389	core 2 surface	0-20	52.2	5.50	31.2	76.4	34.0	1179	938
kk 390	core 2 30-50	30-50	6.37	0.15	35.1	71.8	33.8	17.2	62.3
kk 391	core 3 surface	0-40	43.2	5.64	31.6	99.6	34.3	1438	1070
kk 392	core 3 40	40-80	13.0	11.2	18.1	146	17.7	2462	2514
kk 393	core 3 80-100	80-100	7.09	0.30	34.2	17.7	35.3	50.3	80.1
kk 394	core 4 surface	0-50	52.1	4.88	30.9	75.0	34.4	1138	860
kk 395	core 4 50-80	50-80	7.14	0.38	33.4	18.2	33.8	122	109
kk 396	core 4 100	100	6.94	0.25	42.6	20.1	40.7	27.7	78.7
kk 397	core 5 surface	0-30	42.6	4.62	34.0	85.5	32.3	1625	859
kk 398	core 5 60cm	60-140	13.4	3.71	25.1	67.9	20.6	1047	837
kk 399	core 5 180	140-180	5.81	0.21	33.2	18.4	32.1	32.6	64.5
kk 400	core 6 surface	0-15	48.7	4.90	33.5	85.5	34.8	1550	875
kk 401	core 6 bottom	25-40	12.5	0.40	46.3	28.5	46.6	48.4	103
kk 402	core 7 surface	0-35	54.8	6.00	30.1	93.6	36.6	1670	981
kk 403	core 7 50	35-70	79.7	10.0	33.6	275	38.1	5024	2972
kk 404	core 7 100	70-130	49.3	20.3	32.8	202	33.0	6128	3786
kk 405	core 8 30	15-30	20.3	1.89	26.7	56.6	29.0	644	425
kk 406	core 9 surface	0-20	74.3	6.65	32.9	120	39.8	1906	1121

In February 2017 further sampling was undertaken at six sites (see Figure 2) along the main River Neb channel adjacent to the marina. The coarse nature of this sediment precluded penetration so samples were collected utilising a long reach excavator.

Figure 2. Location of sampling sites February 2017

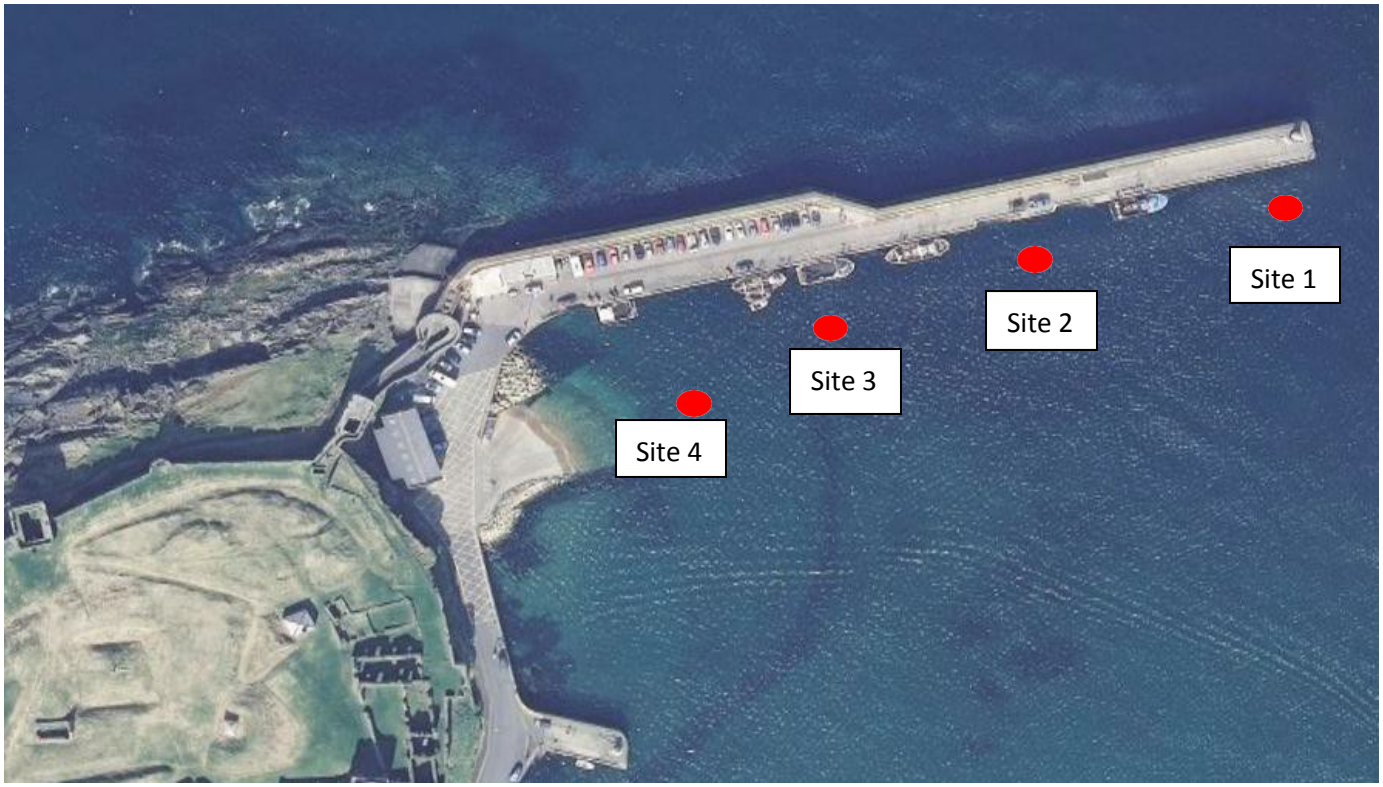
Table 2. Results of samples from Marina (river side) February 2017 (mg/kg dry weight)

Site	Lab number	As	Cd	Cr	Cu	Ni	Pb	Zn
Site 1 Surface	kk 1562	65.6	11.4	50.9	260	50.2	4080	2082
Site 2 Surface	kk 1563	36.1	3.73	35.6	182	37.7	2381	1032
Site 3 surface	kk 1564	35.6	4.86	32.7	94.0	31.5	1525	881
Site 3 1-2m	kk 1566	47.9	8.03	33.5	145	36.7	4043	1911
Site 3 2m	kk 1567	36.5	5.51	36.1	133	30.7	1966	912
Site 4 surface	kk 1568	48.9	4.26	30.5	78.8	32.9	1676	923
Site 4 1-2m	kk 1569	53.8	4.73	38.9	96.0	34.0	2163	1013
Site 5 Surface	kk 1570	50.5	4.34	35.7	89.3	35.3	1905	933
Site 5 2m	kk 1571	69.8	5.23	41.6	360	43.2	4002	1858
Site 6 surface	kk 1572	48.4	4.70	34.3	73.8	34.5	1955	1127
Site 6 1-2m	kk 1573	50.7	4.65	31.0	61.7	33.0	1287	847

Peel Outer Breakwater Sediment Surface Heavy Metal Analysis

Introduction

Four Van-Veen grab samples were taken from Peel outer harbour on the 19th January 2017. The sediments were analysed for heavy metals.



Locations of Sampling Sites

Results

		As	Cd	Cr	Cu	Ni	Pb	Zn
Site 1 total		16.99	0.29	23.53	18.78	24.40	58.05	100.04
Site 2 total		9.72	0.23	15.43	9.38	16.24	40.70	114.01
Site 3 total		8.56	0.37	13.32	15.49	14.85	69.60	115.23
Site 4 total		11.88	0.79	12.70	52.24	13.28	256.65	308.29
Average 4 sites		11.8	0.4	16.2	24.0	11.1	106.2	159.4
CEFAS/OSPAR	AL1	20.0	0.40	50.0	30.0	30.0	50	130
CEFAS/OSPAR	AL2	70.0	4.00	370.0	300.0	150.0	400	600

Brief Conclusions

1) All samples below CEFAS/OSPAR level 2

2) Site 1, 3 & 4 have Pb above CEFAS/OSPAR level 1

3) Site 4 (impacted by River Neb/inner harbour) has highest overall concentrations.

4) Site 1 impacted by cutter suction deposits?

5) Concentration gradient towards River Neb for most metals (except Ni & Cr)

6) Samples below CEFAS/OSPAR level 2 – deposition at sea should be allowed (especially if taken as an average of all four sites).

This section of the document was amended 24th November 2017, to replace three typos.