Provision of Statutory Shellfish Monitoring Services for Scotland- Chemical Contaminant Analysis of Shellfish from Classified Harvesting Areas (2020)

Report to Food Standards Scotland

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Chemical Contaminant Analysis of Shellfish from Classified Harvesting Areas (2020)

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Contents

Glossary of Main Terms

Term or Acronym	General Meaning of Term
µg/kg	Microgram per kilogram (part per billion)
EC	European Commission
EU	European Union
FAPAS	Food Analysis Proficiency Assurance Scheme
fat weight	Values based on the assessed fat content of the sample
FSA	Food Standards Agency
FSS	Food Standards Scotland
GC-HRMS	Gas chromatography - high resolution mass spectrometry
GC-MS	Gas chromatography - unit resolution mass spectrometry
Heavy Metals	A loosely defined subset of naturally occurring metallic elements than have a high atomic weight and a density of 5g/mL or more.
ICP-MS	Inductively coupled plasma-mass spectrometry
LIMS	Laboratory Information Management System
LOD	Limit of Detection
LOQ	Limit of Quantification
Lower bound (lb)	assumes values at less than the limit of detection are zero (e.g.<0.07 = 0)
mg/kg	Milligram per kilogram (part per million)
MPL	Maximum permitted level
ng/kg	Nanogram per kilogram (part per trillion)
Non-ortho-PCB	Non-ortho-substituted PCB (co-planar)
Ortho-PCB	Ortho-substituted PCB (non-planar)
EU PAH 4	4 PAHs covered by the EU food regulations (benzo[a]pyrene, benzo[a]anthracene, benzo[b]fluoranthene, chrysene)
PAHs	Polycyclic aromatic hydrocarbons
PCB	Polychlorinated biphenyl
PCDD/F	Polychlorinated dibenzo-*p*-dioxin/ polychlorinated dibenzofuran (dioxins)
ICES-6	International Council for Exploration of the Sea (ICES) six marker PCBs (PCB 28, PCB 52, PCB 101, PCB 138, PCB 153 and PCB 180)
TEF	Toxic Equivalency Factor – toxicity expressed for each dioxin-like compound relative to 2,3,7,8-TCDD (TEF = 1).
TEQ	Toxic Equivalence – product of the congener concentration and the TEF
Total TEQ	Total of the Sum of all the Toxic Equivalences (TEQs) for each group of compounds
Trace Element	An element in a sample that has an average concentration of less than 100 parts per million (< 100 mg/kg)
Upper bound (ub)	assumes values at less than the limit of detection are equal to the limit of detection (e.g. <0.07 = 0.07)
whole weight	Values based on the sample as received (wet weight)
WHO	World Health Organisation
WHO-TEQ 2005	World Health Organisation TEQ based on TEF values as set in 2005

Executive Summary

This study on chemical contaminants in shellfish from Scottish classified shellfish production areas fulfils part of the requirements of EU member states [1, 2] to adopt appropriate monitoring measures and carry out compliance checks on shellfish produced for human consumption. Marine shellfish bio-accumulate environmental contaminants because of their inability to metabolise them to easily excreted compounds. The study determines concentrations of regulated environmental contaminants in the flesh of edible species with a view to determine current levels of occurrence and to allow estimation of consumer exposure.

The study analysed 18 samples of shellfish including Common mussels, Pacific oysters, Common cockles, surf clams and razor clams for polycyclic aromatic hydrocarbons (PAHs), trace elements, polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs) and polychlorinated biphenyls (PCBs). The methodologies used for the analyses were UKAS accredited to the ISO 17025 standard and follow EU commission regulations for data quality criteria.

The highest levels for both benzo[a]pyrene and for the sum of PAH4 all fall below the maximum permitted levels (MPL), of 5 µg/kg and 30 µg/kg respectively [2]. PCDD/Fs and PCBs in the samples tested were below the maximum regulatory levels [2]. Concentrations of the regulated heavy metals, mercury, cadmium and lead were all below the set maximum limits [2]. Contaminant profiles from the 2020 study are similar to the previous year's data.

1. Background to Study

Marine shellfish are an excellent source of protein, are high in essential minerals and low in fat. In many parts of the UK and in Scotland in particular, the shellfish industry makes a significant contribution to the local economy. Shellfish have a recognised potential for bio-accumulating contaminants and some bivalve species such as mussels, are commonly used as early indicators of local pollution. Bivalves feed by filtering plankton from the surrounding water. This feeding mechanism leads to the bio-accumulation of pollutants of biogenic and anthropogenic origin such as polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs) collectively referred to as dioxins, polychlorinated biphenyls (PCBs), trace elements and polycyclic aromatic hydrocarbons (PAHs) from the surrounding waters. The bio-accumulation potential of the shellfish species used for food is particularly relevant in the case of environmental contaminants with long biological half-lives such as PCDD/Fs and PCBs. These contaminants have been the subject of several studies [3, 4, 5, 6, 7] relating to the occurrence and bio-accumulation in marine species and the resulting potential for human exposure arising from the consumption of the edible species.

In recognising the requirements of food safety, the EU has defined limits for the control of these contaminants in a range of foods including shellfish [2]. EU member states are required to adopt appropriate monitoring measures and carry out compliance checks regarding the occurrence of these contaminants in shellfish produced for human consumption.

PCDD/Fs and PCBs are recognised environmental and food contaminants that are known to bio-accumulate in fish and shellfish. The extent of this accumulation is evident by the levels of these contaminants detected in various studies. Total Diet Studies (TDS) conducted in the UK over the last two decades [8] have shown fish (including shellfish) to be one of the highest PCDD/F and PCB containing food groups. Human dietary exposure can therefore be significantly influenced by the fish and shellfish component of the diet, particularly in high level consumers and low body-weight individuals.

Although metabolised in many fish species, PAHs persist in shellfish as filter feeding species appear unable to affect bio-transformation of these contaminants. Other than this bio-accumulation pathway, PAHs can also arise in fish and shellfish through some food preparation and processing methods – e.g. smoked fish are known to contain elevated levels of PAHs. Some PAH compounds have been shown to be genotoxic and carcinogenic, the most studied of which benzo[a]pyrene (BaP) is regulated in a range of foods including shellfish, within the EU [9, 10]. However, more recent evaluation by the European Food Safety Authority (EFSA) CONTAM panel, concluded that a set of 4 compounds; benzo[a]pyrene, chrysene, benzo[a]anthracene

and benzo[b]fluoranthene (collectively referred to as PAH4) were more suitable indicators of PAH toxicity in food [11]. These four compounds were subsequently included in the updated Commission Regulation [12].

Some trace elements e.g. cadmium, mercury and lead, are established toxic contaminants. Others, such as copper, chromium, selenium and zinc are essential to health but may be toxic at high levels of exposure. These elements may enter marine and aquatic environments and bio-accumulate in some species. Some potentially toxic elements occur naturally as part of the local geology, but others may also be found in the location of certain industries, as a result of unauthorised discharge, or as a result of other anthropogenic activity.

As part of its monitoring requirements in support of EU regulations, Food Standards Scotland (FSS) has overseen the collection of shellfish each year from classified shellfish production areas within relevant local authority areas. Sampling officers were requested to obtain suitable shellfish samples from designated sampling points within classified shellfish production areas, as defined by the FSS. The collection of shellfish and transport logistics were co-ordinated by Cefas. Samples were taken and live shellfish sent to Fera, with the edible tissues analysed for the contaminants described above. The analysis was carried out at Fera Science Limited in York. Sampling and analysis were conducted in accordance with EU regulations [13, 14].

Fera has generated environmental contaminant data on shellfish collected from new and existing shellfish production areas in Scotland since 2007. This report collates the results of the individual analyses for dioxins, PAHs and heavy metals in samples of shellfish collected from classified Scottish production areas in the first quarter of 2020.

2. Methods

2.1 Sample Collection and Preparation

Eighteen samples of shellfish, including species of Common mussels (8 samples), Pacific oysters (3), Common cockles (1), surf clams (2), and razor clams (4) were collected between January and March 2020. The sampling period was timed to coincide with the period of optimal contaminant concentrations in the shellfish which relates to the period before annual spawning.

Details on the locations, with descriptions of the samples and identification are given in Table 1.

On receipt at the laboratory, each sample was given a unique laboratory reference number and the sample details were logged into a Nautilus LIMS database. The samples were stored frozen prior to analysis. Sample preparation consisted of shelling followed by thorough homogenisation. Aliquots were then taken for PAH, trace element and dioxin analysis as requested by FSS. Dioxin sample aliquots underwent additional freeze-drying and were re-homogenised prior to analysis.

2.2 Contaminants measured – Specific Analytes

Maximum permitted levels (MPL) for chemical contaminants listed below:

MPLs relevant for live bivalve molluscs

	Maximum levels (Whole weight)		
Lead	1.5 mg/kg		
Cadmium	1.0 mg/kg		
Mercury	0.50 mg/kg		
Dioxins and PCBs	Sum of dioxins (WHO PCDD/F TEQ)	Sum of dioxins and dioxin-like PCBs (WHO PCDD/F + PCB TEQ)	Sum of ICES-6
	3.5 pg/g	6.5 pg/g	75 ng/g
PAHs	Benzo[a]pyrene	Sum of EU PAH 4	
	5.0 µg/kg	30 µg/kg	

The compounds analysed are listed below, with regulated contaminants highlighted in **bold** type.

Dioxins **- all 17, 2378-Cl substituted PCDDs and PCDFs.**

Dioxin-like PCBs **- IUPAC no. 77, 81, 105, 114, 118, 123, 126, 156, 157, 167, 169 and 189.**

Non dioxin-like PCBs - IUPAC numbers 18, **28**, 31, 47, 49, 51, **52**, 99, **101**, 128, **138**, **153** and **180**.

PAHs - acenaphthene, acenaphthylene, fluorene, phenanthrene, anthracene, fluoranthene, benzo[c]fluorene, pyrene, benzo[e]pyrene, benzo[b]naptho[2,1-d]thiophene, anthanthrene, coronene, benzo[ghi]fluoranthene, **benzo[a]anthracene**, **chrysene**, **benzo[b]fluoranthene**, benzo[j]fluoranthene,

benzo[k]fluoranthene, **benzo[a]pyrene**, cyclopenta[cd]pyrene, indeno[1,2,3-cd]pyrene, dibenzo[a,h]anthracene, benzo[ghi]perylene, dibenzo[a,l]pyrene, dibenzo[a,e]pyrene, dibenzo[a,i]pyrene, dibenzo[a,h]pyrene and the alkylated PAH, 5-methylchrysene.

Trace elements – Chromium (Cr), Manganese (Mn), Cobalt (Co), Nickel (Ni), Copper (Cu), Zinc (Zn), Arsenic (As), Selenium (Se), Silver (Ag), **Cadmium** (**Cd), Mercury (Hg), Lead (Pb)**

2.3 PCDD/F and PCB - Analytical Methodology

(Fera SOPs FSG 401-414)

The method used for the preparation, extraction and analysis of samples has been reported previously [15] and is part of the CEN EN16215:2012 standard. In brief, samples were fortified with ^{13}C-labelled analogues of target compounds and exhaustively extracted using mixed organic solvents. Ortho substituted PCBs were separated from non-ortho substituted PCBs and PCDD/Fs by fractionation on activated carbon. The two fractions were further purified using adsorption chromatography on alumina. Analytical measurement was carried out using GC-HRMS for the seventeen, 2,3,7,8-Cl substituted PCDD/F congeners and non-ortho substituted PCBs. GC-MS was used for the measurement of the ortho substituted PCBs.

All analyses were UKAS accredited to ISO 17025 standards, with the inclusion of in-house reference material, (LIMS No. S11-018695 crude cod liver oil) and method blanks which were evaluated prior to reporting. Further quality assurance measures included the successful participation in international inter-comparison exercises such as the Norwegian Institute of Public Health's "Dioxins in Food" on an annual basis [16, 17]. In addition, as the National Reference Laboratory (NRL) for dioxins and halogenated contaminants, Fera participates in proficiency testing (PT) exercises and other inter-laboratory exercises as organised by the European Union Reference Laboratory for Halogenated Persistent Organic Pollutants (EURL-POPs) and achieves consistently good results. Accreditation is audited regularly as required by the current ISO 17025 standard.

2.4 Polycyclic Aromatic Hydrocarbons (PAH) - Analytical Methodology

(Fera SOP FSG 410)

The analytical methodology for the PAHs has been reported before [18] and is based on internal standardisation with GC-MS measurement. An aliquot of the homogenised sample was fortified with ^{13}C-labelled analogues of target compounds and saponified with methanolic potassium hydroxide. The extracted PAH solutions were purified in two stages with a DMF/cyclohexane partition followed by adsorption chromatography on activated silica. Purified extracts were sensitivity standardised and measured using GC-MS.

The analytical procedure for PAHs is UKAS accredited to the ISO 17025 standard and includes the assessment of method blanks and reference materials, (e.g. T0658, PAHs in cocoa butter) for compliance with established

accreditation criteria [19]. The methodology also meets the criteria required for evaluating data against the maximum permitted limits for benzo[a]pyrene as specified in EU Commission Regulations. Fera regularly participates in FAPAS PT exercises for PAHs in food. In addition, as NRL for PAHs, Fera participates in PT exercises and other inter-laboratory exercises as organised by the European Union Reference Laboratory for PAHs and Process Contaminants (EURL-PC) and achieves consistently good results.

2.5 Trace Elements - Analytical Methodology

(Fera SOP FSG 461 and 457)

Aliquots of the homogenised sample were weighed into allotted digestion vessels and a mixture (4:1) of nitric acid and hydrochloric acid added. The vessels were capped and the contents digested using a high-pressure microwave digestion system. Reagent blanks, certified reference materials and a spiked sample were also taken through the procedure. The resulting solutions were transferred to pre-marked acid-clean plastic test tubes and diluted to 10 ml with deionised water. The digest solutions, together with a set of standards covering the expected concentration range, were internally standardised with indium and rhodium in dilute nitric acid (1 %v/v). Measurements were made using an Agilent 7700x ICP-MS with collision cell.

In common with the other two sets of analyses, the analytical procedure is accredited to the ISO 17025 standard. The criteria used to assess data included checks on instrument drift, spike recovery, replicate agreement, limits of detection and certified reference material (e.g. CE 278K mussel tissue) values. Regular, successful participation in FAPAS inter-comparison exercises provides further confidence in the data. In addition, as NRL for trace elements, Fera participates in PT exercises and other inter-laboratory exercises as organised by the European Union Reference Laboratory for Heavy Metals and Nitrogenous Compounds (EURL-MN), achieving consistently good results.

2.6 Fat analysis

For samples requiring dioxin and PCB analysis, total fat determinations were sub-contracted to West Yorkshire Analytical Services and Aberdeen Scientific Services. Both laboratories are UKAS accredited for fat analysis.

3. Results

Analyte concentrations are presented in Tables 3 to 6. Concentration units reflect current convention as required by regulation, and data were rounded to two decimal places or as appropriate. The reporting limits (quoted as "<") for dioxins, PCBs and PAHs are calculated as a dynamic parameter and therefore represent the limits of determination that prevail during the specific measurement. For PCDD/Fs, PCBs, metals and PAHs, the reporting limits are consistent with the requirements of EU regulations. Data on the reference materials that were analysed concurrently with the samples were within established acceptable limits and are available on request. Measurement uncertainty (MU) was calculated and applied to data following guidelines and principals set out in Measurement Uncertainty for Persistent Organic Pollutants By Isotope-Dilution Mass Spectrometry [20]. MU and reference material data are also available on request.

In addition to the concentration of individual congeners, the dioxin-like toxicity of the samples arising from PCDD/Fs and dioxin-like PCBs has also been reported as a toxic equivalents (WHO-TEQ) in tables 3a and 3b, which are calculated by multiplying the concentration of each congener of interest by its toxicity equivalency factor (WHO-TEF). The TEQs are presented in terms of the 2005 TEFs [21]. Additionally, as per the requirements of Regulation No. 1259/2011 [22] the sum of the ICES-6 PCBs is also provided in tables 3a and 3b. The regulations for shellfish are based on whole weight concentrations; however, in keeping with previous reports to Food Standards Scotland, the results for PCDD/Fs and PCBs have also been reported on a fat weight basis.

In general, the patterns and levels of the three contaminant classes were consistent with those recorded last year or from previous years.

Five samples were tested for PCDD/Fs and PCBs. All samples contained PCDD/Fs and PCBs above the LOQ. Levels found were well within the regulatory limits. The range for total TEQ (PCDD/F + PCB) on a whole weight, upper bound basis was 0.06 ng TEQ/kg. to 0.13 ng TEQ/kg. On average, PCDD/Fs contributed to least half of the total TEQ.

The concentration of ICES-6 PCBs on an upper bound whole weight basis ranged from 0.09 µg/kg to 0.20 µg/kg. Tables 3a and 3b summarise TEQ and ICES-6 data, while Tables 4a and 4b presents results for analyte concentrations on a whole and fat weight basis respectively.

PAHs were detected in all 18 samples analysed. All samples showed levels below MRL for BaP (5 µg/kg) and PAH4 (30 µg/kg). Benzo[a]pyrene concentrations ranged from 0.10 µg/kg to 2.14 µg/kg and the sum of PAH4 concentrations ranged from 0.61 µg/kg to 12.75 µg/kg. The single highest concentration for the regulated compounds was benzo[b]fluoranthene at 4.09 µg/kg in a sample of common mussels (S20-002177) collected from Loch Leven Upper.

The sample with the highest concentration of benzo[a]anthracene at 3.40 µg/kg was a sample of razor clams (S20-001898) collected from North Bay: Barassie. It also had the highest benzo[a]pyrene (2.14 µg/kg), chrysene (3.39 µg/kg) and sum of PAH 4 concentrations (12.75 µg/kg). This is nearly twice as high as than observed in razor clams sampled from the same site last year. Table 5 shows PAH data in µg/kg whole weight.

Sixteen samples were analysed for heavy metals, results of which are detailed in Table 6. Concentrations of the regulated heavy metals (Cd, Hg, Pb) were all below the regulatory limit (Commission Regulation EC No. 1881/2006, as amended). The concentration ranges for Hg, Cd and Pb were <0.007 mg/kg to 0.023 mg/kg, 0.018 mg/kg to 0.218 mg/kg and 0.035 mg/kg to 0.142 mg/kg respectively. The highest concentration of Cd was found in a sample of Pacific oysters (0.218 mg/kg, S20-011829, Loch Fyne - Otter Ferry, Balliemore). The 3 most abundant heavy metals were zinc, manganese and copper, with zinc present at the highest concentration.

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Table 1: Overview of all Samples*

Local Authority	Production Area	Sample Site Name	Site Identification No.	Grid Reference	Species	Date Sample Taken	Date Received at Fera	FERA LIMS No.
Argyll & Bute	Castle Stalker	Port Appin	AB-492-909-04	NM91884712	Common cockles	22/01/2020	24/01/2020	S20-001897
Argyll & Bute	Loch A Chumhainn: Outer	Outer	AB-113-018-13	NM40645460	Pacific Oysters	25/02/2020	26/02/2020	S20-013522
Argyll & Bute	Loch Fyne: Otter Ferry	Balliemore	AB-151-039-13	NR92188351	Pacific Oysters	11/02/2020	12/02/2020	S20-011829
Argyll & Bute	Sound of Gigha Leim	Leim	AB-856-2309-16	NR65504890	Razor Clams	20/01/2020	23/01/2020	S20-001776
Argyll & Bute	West Loch Tarbert	Loup Bay	AB-299-084-13	NR76805850	Pacific Oysters	14/01/2020	15/01/2020	S20-001360
Comhairle nan Eilean Siar: Lewis & Harris	Loch Leurbost	Loch Leurbost	LH-168-114-08	NB37292480	Common Mussels	19/02/2020	20/02/2020	S20-012712
Comhairle nan Eilean Siar: Lewis & Harris	Loch Roag: Eilean Chearstaigh	Eilean Scarastaigh	LH-344-697-08	NB19033302	Common Mussels	04/02/2020	05/02/2020	S20-011288
Comhairle nan Eilean Siar: Lewis & Harris	Loch Roag: Linngeam	Linngeam	LH-187-122-08	NB14793345	Common Mussels	04/02/2020	05/02/2020	S20-011287
Comhairle nan Eilean Siar: Lewis & Harris	West Loch Roag - Gob Sgrithir	Gob Sgrithir	LH-829-2215-08	NB12203270	Common Mussels	11/02/2020	17/02/2020	S20-012159
Fife	Fife Ness Surf Clams	Kingsbarns	FF-771-1974-19	NO63301146	Surf Clams	21/01/2020	23/01/2020	S20-001774
Fife	Firth of Forth: North	Anstruther	FF-068-184-19	NO59380474	Surf Clams	21/01/2020	23/01/2020	S20-001775
Fife	Forth Estuary: Largo Bay	Largo bay	FF-072-118-16	NO44180107	Razor clams	19/01/2020	21/01/2020	S20-001579
Highland - Lochaber	Loch Leven: Lower	Lower	HL-170-222-08	NN07165905	Common Mussels	28/01/2020	29/01/2020	S20-002176
Highland - Lochaber	Loch Leven: Upper	Upper	HL-171-223-08	NN14806168	Common Mussels	28/01/2020	29/01/2020	S20-002177
Highland - Sutherland	Loch Laxford	Sgeir Fhadha	HS-167-319-08	NC21184938	Common mussels	07/01/2020	09/01/2020	S20-001196
Highland Council: Skye & Lochalsh	Sound of Sleat	Glenelg Bay	SL-833-2242-16	NG71740124	Razor Clams	02/02/2020	04/02/2020	S20-011256
Shetlands	Vaila Sound - East Ward	Brandy Ayre	SI-858-2312-08	HU24214630	Common Mussels	19/02/2020	20/02/2020	S20-012713
South Ayrshire	North Bay	Barassie	SA-337-719-16	NS31193167	Razor Clams	23/01/2020	24/01/2020	S20-001898

**Quality statement: Information relating to the origin of the samples (place, date of collection and GR/NGR details) is as provided by sampling staff and has not undergone verification checks by Fera/Cefas*

Table 2: Samples: Chemical contaminant testing

Local Authority	Production Area	Sample Site Name	Site Identification Number (SIN)	Species	PAHs	Trace Elements	DXN/ PCBs	FERA LIMS No.
Argyll & Bute	Castle Stalker	Port Appin	AB-492-909-04	Common cockles	X	X	-	S20-001897
Argyll & Bute	Loch A Chumhainn: Outer	Outer	AB-113-018-13	Pacific oysters	X	X	-	S20-013522
Argyll & Bute	Loch Fyne: Otter Ferry	Balliemore	AB-151-039-13	Pacific oysters	X	X	-	S20-011829
Argyll & Bute	Sound of Gigha Leim	Leim	AB-856-2309-16	Razor clams	X	X	X	S20-001776
Argyll & Bute	West Loch Tarbert	Loup Bay	AB-299-084-13	Pacific oysters	X	X	X	S20-001360
Comhairle nan Eilean Siar: Lewis & Harris	Loch Leurbost	Loch Leurbost	LH-168-114-08	Common mussels	X	X	-	S20-012712
Comhairle nan Eilean Siar: Lewis & Harris	Loch Roag: Eilean Chearstaigh	Eilean Scarastaigh	LH-344-697-08	Common mussels	X	X	-	S20-011288
Comhairle nan Eilean Siar: Lewis & Harris	Loch Roag: Linngeam	Linngeam	LH-187-122-08	Common mussels	X	X	-	S20-011287
Comhairle nan Eilean Siar: Lewis & Harris	West Loch Roag - Gob Sgrithir	Gob Sgrithir	LH-829-2215-08	Common mussels	X	X	X	S20-012159
Fife	Fife Ness Surf Clams	Kingsbarns	FF-771-1974-19	Surf clams	X	X	-	S20-001774
Fife	Firth of Forth: North	Pittenweem	FF-068-189-19	Surf clams	X	X	-	S20-001775
Fife	Forth Estuary: Largo Bay	Largo Bay	FF-072-188-16	Razor clams	X	X	-	S20-001579
Highland Council: Skye & Lochalsh	Sound of Sleat	Glenelg Bay	SL-833-2242-16	Razor clams	X	X	X	S20-011256
Highlands - Lochaber	Loch Leven: Lower	Lower	HL-170-222-08	Common Mussels	X	-	-	S20-002176
Highlands - Lochaber	Loch Leven: Upper	Upper	HL-171-223-08	Common mussels	X	-	-	S20-002177
Highlands - Sutherland	Loch Laxford	Sgeir Fhadha	HS-167-319-08	Common mussels	X	X	-	S20-001196
Shetlands	Vaila Sound - East Ward	Brandy Ayre	SI-858-2312-08	Common Mussels	X	X	X	S20-012713
South Ayrshire	North Bay	Barassie	SA-337-719-16	Razor clams	X	X	-	S20-001898

Table 3a: PCDD/Fs and PCB - TEQ and ICES6 summary, Whole weight

				TEQs in ng/kg								Σ ICES6 in µg/kg	
Fera LIMS No.	Species	Production Area	Site Name	o-PCB WHO-TEQ 2005 lb	o-PCB WHO-TEQ 2005 ub	Planar PCB TEQ 2005 lb	Planar PCB TEQ 2005 ub	PCDD/F TEQ 2005 lb	PCDD/F TEQ 2005 ub	**Tota l (PCDD/F+ PCB) TEQ 2005 lb**	**Tota l (PCDD/F+ PCB) TEQ 2005 ub**	**ICES6 lb**	**ICES6 ub**
S20-001360	Pacific oysters	West Loch Tarbert	Loup Bay	0.00	<0.01	0.04	0.04	0.06	0.08	**0.10**	**0.13**	**0.18**	**0.20**
S20-001776	Razor clams	Sound of Gigha Leim	Leim	0.00	<0.01	0.04	0.04	0.06	0.08	**0.10**	**0.13**	**0.19**	**0.20**
S20-011256	Razor clams	Sound of Sleat	Glenelg Bay	0.00	<0.01	0.02	0.02	0.02	0.05	**0.04**	**0.08**	**0.16**	**0.17**
S20-012713	Common mussels	Vaila Sound - East Ward	Brandy Ayre	0.00	<0.01	0.04	0.04	0.03	0.04	**0.07**	**0.09**	**0.05**	**0.09**
S20-012159	Common mussels	West Loch Roag - Gob Sgrithir	Gob Sgrithir	0.00	<0.01	0.01	0.01	0.01	0.04	**0.02**	**0.06**	**0.09**	**0.12**

Table 3b: PCDD/Fs and PCB - TEQ and ICES6 summary, Fat weight

					TEQs in ng/kg									Σ ICES6 in µg/kg	
Fera LIMS No.	Species	Production Area	Site Name	% Fat	o-PCB WHO-TEQ 2005 lb	o-PCB WHO-TEQ 2005 ub	Planar PCB TEQ 2005 lb	Planar PCB TEQ 2005 ub	PCDD/F TEQ 2005 lb	PCDD/F TEQ 2005 ub	**Tota l (PCDD/F+ PCB) TEQ 2005 lb**	**Tota l (PCDD/F+ PCB) TEQ 2005 ub**	**ICES6 lb**	**ICES6 ub**
S20-001360	Pacific oysters	West Loch Tarbert	Loup Bay	0.86	0.15	0.15	4.24	4.24	9.06	9.1	**13.45**	**13.49**	**23.36**	**23.36**
S20-001776	Razor clams	Sound of Gigha Leim	Leim	0.69	0.23	0.25	5.59	5.59	10.66	10.69	**16.48**	**16.53**	**29.62**	**29.79**
S20-011256	Razor clams	Sound of Sleat	Glenelg Bay	0.87	0.12	0.13	13.38	13.38	21.22	25.06	**34.72**	**38.57**	**17.16**	**17.28**
S20-012713	Common mussels	Vaila Sound - East Ward	Brandy Ayre	0.32	0.11	0.16	7.99	7.99	8.17	8.17	**16.27**	**16.32**	**23.55**	**23.55**
S20-012159	Common mussels	West Loch Roag - Gob Sgrithir	Gob Sgrithir	0.47	0.11	0.16	3.29	3.29	7.13	7.66	**10.53**	**11.11**	**24.77**	**24.77**

Table 4a: PCDD/F & PCB concentrations, Whole weight

	FERA LIMS No.	S20-001360	S20-001776	S20-011256	S20-012159	S20-012713
	Species	Pacific oysters	Razor clams	Razor clams	Common mussels	Common mussels
	Production Area	West Loch Tarbert	Sound of Gigha Leim	Sound of Sleat	West Loch Roag - Gob Sgrithir	Vaila Sound - East Ward
	Sample Site Name	Loup Bay	Leim	Glenelg Bay	Gob Sgrithir	Brandy Ayre
ortho-PCBs, µg/kg	PCB 18	<0.01	<0.01	<0.01	<0.01	<0.01
	PCB 28	<0.01	0.01	0.01	<0.01	<0.01
	PCB 31	<0.01	0.01	<0.01	<0.02	<0.02
	PCB 47	<0.01	<0.01	<0.01	<0.01	<0.01
	PCB 49	<0.01	<0.01	<0.01	<0.01	<0.01
	PCB 51	<0.01	<0.01	<0.01	<0.01	<0.01
	PCB 52	0.01	0.01	0.01	<0.01	<0.01
	PCB 99	0.02	0.02	0.02	<0.01	<0.01
	PCB 101	0.03	0.03	0.03	<0.01	0.01
	PCB 105	<0.01	0.01	<0.01	<0.01	<0.01
	PCB 114	<0.01	<0.01	<0.01	<0.01	<0.01
	PCB 118	0.03	0.04	0.02	<0.01	0.01
	PCB 123	<0.01	<0.01	<0.01	<0.01	<0.01
	PCB 128	<0.01	0.01	<0.01	<0.01	<0.01
	PCB 138	0.05	0.06	0.05	0.02	0.03
	PCB 153	0.09	0.08	0.06	0.03	0.05
	PCB 156	<0.01	<0.01	<0.01	<0.01	<0.01
	PCB 157	<0.01	<0.01	<0.01	<0.01	<0.01
	PCB 167	<0.01	<0.01	<0.01	<0.01	<0.01
	PCB 180	<0.01	<0.01	<0.01	<0.01	<0.01
	PCB 189	<0.01	<0.01	<0.01	<0.01	<0.01
non-ortho-PCBs, ng/kg	PCB 77	1.61	3.04	1.70	0.35	1.18
	PCB 81	0.11	0.17	0.10	<0.03	0.08
	PCB 126	0.34	0.35	0.20	0.09	0.34
	PCB 169	0.08	0.09	0.05	0.04	0.12
PCDD/Fs, ng/kg	2378TCDD	<0.01	<0.01	<0.01	<0.01	<0.01
	12378PeCDD	0.02	0.02	<0.01	<0.01	0.01
	123478HxCDD	<0.01	<0.01	<0.01	<0.01	<0.01
	123678HxCDD	0.02	0.02	<0.01	0.01	0.01
	123789HxCDD	<0.01	<0.01	<0.01	<0.01	<0.01
	1234678HpCDD	0.03	0.09	0.05	0.08	0.06
	OCDD	0.06	0.64	0.21	0.56	0.15
	2378TCDF	0.17	0.20	0.11	0.04	0.06
	12378PeCDF	0.02	0.01	<0.01	<0.01	0.01
	23478PeCDF	0.07	0.06	0.03	0.02	0.03
	123478HxCDF	<0.01	0.01	<0.01	<0.01	<0.01
	123678HxCDF	<0.01	<0.01	<0.01	<0.01	<0.01
	123789HxCDF	<0.01	<0.01	<0.01	<0.01	<0.01
	234678HxCDF	0.02	0.01	<0.01	<0.01	0.01
	1234678HpCDF	<0.01	0.04	0.02	0.02	0.02
	1234789HpCDF	<0.01	<0.01	<0.01	<0.01	<0.01
	OCDF	<0.01	0.03	0.02	0.01	0.02

Table 4b: PCDD/F & PCB concentrations, Fat weight

	FERA LIMS No.	S20-001360	S20-001776	S20-011256	S20-012159	S20-012713
	Species	Pacific oysters	Razor clams	Razor clams	Common mussels	Common mussels
	Production Area	West Loch Tarbert	Sound of Gigha Leim	Sound of Sleat	West Loch Roag - Gob Sgrithir	Vaila Sound - East Ward
	Sample Site Name	Loup Bay	Leim	Glenelg Bay	Gob Sgrithir	Brandy Ayre
ortho-PCBs, µg/kg	PCB 18	0.59	1.10	<0.84	<1.75	<1.47
	PCB 28	0.80	1.88	1.19	1.99	2.01
	PCB 31	0.81	1.72	1.14	<5.62	<4.72
	PCB 47	0.52	0.80	0.53	<0.70	0.60
	PCB 49	0.82	1.25	0.78	<0.85	0.72
	PCB 51	0.07	<0.12	0.12	<0.07	<0.10
	PCB 52	1.34	2.17	1.36	1.33	1.42
	PCB 99	2.45	3.03	1.97	1.56	1.21
	PCB 101	3.98	5.02	2.92	2.67	3.08
	PCB 105	0.93	1.70	0.81	0.75	<0.84
	PCB 114	<0.04	<0.11	<0.06	<0.11	<0.11
	PCB 118	3.51	5.14	2.64	2.82	2.99
	PCB 123	0.13	0.15	0.10	<0.20	<0.17
	PCB 128	0.52	1.50	0.81	0.84	0.96
	PCB 138	6.10	9.38	5.23	6.40	7.17
	PCB 153	10.63	11.17	6.46	10.62	10.46
	PCB 156	0.14	0.30	0.12	<0.28	0.29
	PCB 157	0.11	0.14	0.07	<0.26	<0.22
	PCB 167	0.26	0.25	0.11	0.25	0.31
	PCB 180	0.51	<0.17	<0.12	0.54	0.63
	PCB 189	<0.03	<0.63	<0.36	<0.51	<0.43
non-ortho-PCBs, ng/kg	PCB 77	186.18	441.97	1057.82	108.03	249.9
	PCB 81	12.48	24.27	64.61	<10.65	17.07
	PCB 126	39.47	51.43	123.63	29.09	71.85
	PCB 169	8.89	13.19	29.58	12.33	25.9
PCDD/Fs, ng/kg	2378TCDD	1.04	1.25	<3.73	<0.46	0.78
	12378PeCDD	2.84i	2.7i	5.60	2.19i	2.59
	123478HxCDD	0.72	0.95	2.58	1.87	1.31
	123678HxCDD	1.88	2.50	4.02	3.16	2.66
	123789HxCDD	0.84	1.41	4.02	2.6i	1.84
	1234678HpCDD	3.15	13.35	31.45	25.60	13.42
	OCDD	6.96	92.63	131.81	173.43	32.71
	2378TCDF	20.01	28.61	70.07	11.52	12.57
	12378PeCDF	2.28	1.61	4.31	2.43	2.43
	23478PeCDF	8.27	8.68	18.38	7.03	6.70
	123478HxCDF	<0.17	1.97	6.03	1.46	2.00
	123678HxCDF	0.70	1.32	3.02	1.08	1.33
	123789HxCDF	<0.08	<0.2	<1.01	<0.59	0.71
	234678HxCDF	1.86	1.71i	5.03	2.27	2.75
	1234678HpCDF	<0.59	5.20	14.07	5.73i	4.98
	1234789HpCDF	<0.07	<0.2	<0.7	<0.65	<0.6
	OCDF	0.46	3.85	9.76	4.51	4.52

NOTE: *where shown i = indicative*

Table 5: PAH concentrations (µg/kg Whole weight)

FERA LIMS No.	S20-001196	S20-001360	S20-001579	S20-001774	S20-001775	S20-001776
Species	Mussels	Pacific oysters	Razor clams	Surf clams	Surf clams	Razor clams
Production Area	Loch Laxford	West Loch Tarbert	Forth Estuary: Largo Bay	Fife Ness Surf Clams	Firth of Forth: North	Sound of Gigha Leim
Sample Site Name	Sgeir Fhadha	Loup Bay	Largo bay	Kingsbarns	Anstruther	Leim
acenaphthylene	<0.08	0.08	0.25	0.25	0.23	0.21
acenaphthene	<0.56	<0.55	<0.55	<0.56	<0.56	<0.56
fluorene	<0.49	<0.48	0.58	<0.49	<0.49	0.51
phenanthrene	0.99	1.38	1.24	1.30	1.18	1.44
anthracene	0.06	0.11	0.40	0.35	0.23	0.17
fluoranthene	0.60	2.72	3.50	1.65	1.42	2.37
benzo[c]fluorene	0.03	0.14	0.20	0.13	0.10	0.13
pyrene	0.58	1.83	2.71	1.52	1.47	1.47
benzo[ghi]fluoranthene	0.32	0.87	1.32	0.64	0.54	1.08
Benzo[a]anthracene	**0.15**	**0.45**	**1.61**	**0.82**	**0.70**	**0.79**
benzo[b]naphtho[2,1-d]thiophene	<0.06	0.19	0.23	0.13	0.11	0.23
cyclopenta[cd]pyrene	<0.01	0.03	<0.03	0.02	<0.02	0.02
chrysene	**0.19**	**0.89**	**1.50**	**0.79**	**0.71**	**1.07**
5-methylchrysene	<0.01	0.02	0.07	0.04	0.03	0.04
benzo[b]fluoranthene	**0.60**	**1.05**	**1.59**	**1.16**	**0.97**	**1.95**
benzo[j]fluoranthene	0.20	0.24	0.68	0.50	0.42	0.68
benzo[k]fluoranthene	0.24	0.44	0.82	0.61	0.51	0.89
benzo[e]pyrene	0.78	1.25	2.15	1.86	1.52	2.54
benzo[a]pyrene	**0.14**	**0.22**	**1.02**	**0.76**	**0.65**	**0.62**
indeno[1,2,3-cd]pyrene	0.29	0.17	0.56	0.78	0.66	0.52
dibenz[a,h]anthracene	<0.05	<0.06	0.13	0.14	0.12	0.10
benzo[ghi]perylene	0.43	0.22	0.74	1.10	1.08	0.58
anthanthrene	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
dibenzo[a,l]pyrene	<0.11	<0.11	<0.15	<0.22	<0.21	<0.13
dibenzo[a,e]pyrene	<0.10	<0.10	0.12	0.17	0.14	<0.10
dibenzo[a,i]pyrene	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
dibenzo[a,h]pyrene	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
coronene	0.14	<0.10	0.19	0.40	0.47	0.13
PAH 4 Sum lb	**1.08**	**2.61**	**5.72**	**3.53**	**3.03**	**4.43**
PAH 4 Sum ub	**1.08**	**2.61**	**5.72**	**3.53**	**3.03**	**4.43**

NOTE: *where shown i= indicative*

FERA LIMS No.	S20-011256	S20-001897	S20-001898	S20-002176	S20-002177	S20-011287
Species	Razor clams	Common cockles	Razor clams	Common mussels	Common mussels	Common mussels
Production Area	Sound of Sleat	Castle Stalker	North Bay	Loch Leven: Lower	Loch Leven: Upper	Loch Roag: Linngeam
Sample Site Name	Glenelg Bay	Port Appin	Barassie	Lower	Upper	Linngeam
acenaphthylene	0.31	<0.08	0.68	0.19	0.21	<0.22
acenaphthene	<0.60	<0.56	<0.55	<0.56	<0.56	<0.62
fluorene	<0.43	<0.49	0.88	<0.49	<0.49	<0.45
phenanthrene	1.82	<0.65	3.39	1.12	0.98	<0.55
anthracene	0.20	<0.04	0.96	0.21	0.22	<0.04
fluoranthene	1.90	0.65	7.51	1.63	1.72	0.38
benzo[c]fluorene	0.10	0.04	0.39	0.11	0.13	0.02
pyrene	1.44	0.58	5.58	1.63	1.76	<0.35
benzo[ghi]fluoranthene	0.65	0.41	2.38	0.99	1.10	0.22
Benzo[a]anthracene	**0.68**	**0.33**	**3.40**	**0.75**	**0.84**	**0.12**
benzo[b]naphtho[2,1-d]thiophene	0.25	0.18	0.49	0.33	0.39	0.04
cyclopenta[cd]pyrene	0.02	0.04	0.05	0.06	0.10	<0.01
chrysene	**0.92**	**0.64**	**3.39**	**1.21**	**1.47**	**0.23**
5-methylchrysene	0.02	0.02	0.13	0.04	0.05	<0.01
benzo[b]fluoranthene	**1.06**	**0.74**	**3.82**	**3.44**	**4.09**	**0.48**
benzo[j]fluoranthene	0.42	0.40	1.57	1.00	1.12	0.19
benzo[k]fluoranthene	0.40	0.46	1.99	1.35	1.54	0.18
benzo[e]pyrene	2.16	1.20	5.81	5.89	5.71	0.57
benzo[a]pyrene	**0.39**	**0.44**	**2.14**	**0.84**	**0.99**	**0.14**
indeno[1,2,3-cd]pyrene	0.42	0.45	0.87	0.87	0.95	0.24
dibenzo[ah]anthracene	0.11	0.11	0.20	0.17	0.23	<0.06
benzo[ghi]perylene	0.59	0.46	1.06	1.71	1.81	0.28
anthanthrene	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
dibenzo[a,l]pyrene	<0.13	<0.11	<0.15	<0.16	<0.18	<0.12
dibenzo[a,e]pyrene	<0.12	<0.10	0.12	0.13	0.15	<0.10
dibenzo[a,i]pyrene	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
dibenzo[a,h]pyrene	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
coronene	0.17	0.12	0.14	0.23	0.24	0.12
PAH 4 Sum lb	**3.05**	**2.15**	**12.75**	**6.24**	**7.39**	**0.97**
PAH 4 Sum ub	**3.05**	**2.15**	**12.75**	**6.24**	**7.39**	**0.97**

FERA LIMS No.	S20-011288	S20-011829	S20-012159	S20-012712	S20-012713	S20-013522
Species	Common mussels	Pacific oysters	Common mussels	Common mussels	Common mussels	Pacific oysters
Production Area	Loch Roag: Eilean Chearstaigh	Loch Fyne: Otter Ferry	West Loch Roag - Gob Sgrithir	Loch Leurbost	Vaila Sound - East Ward	Loch A Chumhainn: Outer
Sample Site Name	Eilean Scarastaigh	Balliemore	Gob Sgrithir	Loch Leurbost	Brandy Ayre	Outer
acenaphthylene	0.39	<0.22	<0.22	<0.88	<0.30	<0.18
acenaphthene	<0.63	<0.63	<0.63	<0.63	0.99	<0.62
fluorene	<0.46	<0.45	<0.45	0.74	0.65	0.63
phenanthrene	1.57	<0.55	0.72	1.85	1.61	1.91
anthracene	0.37	<0.04	<0.04	<0.08	<0.08	0.04
fluoranthene	4.00	<0.36	<0.36	0.56	0.41	0.78
benzo[c]fluorene	0.20	0.02	0.01	0.02	0.01	0.02
pyrene	3.59	<0.36	<0.36	0.51	<0.36	0.56
benzo[ghi]fluoranthene	2.00	0.19	0.14	0.19	0.09	0.19
Benzo[a]anthracene	**1.34**	**0.09**	**0.09**	**0.17**	**0.07**	**0.15**
benzo[b]naphtho[2,1-d]thiophene	0.40	0.04	0.04	0.04	0.02	0.05
cyclopenta[cd]pyrene	0.04	<0.01	<0.01	<0.01	<0.01	<0.01
chrysene	**1.99**	**0.18**	**0.17**	**0.23**	**0.14**	**0.26**
5-methylchrysene	0.06	<0.01	<0.01	<0.01	<0.01	<0.01
benzo[b]fluoranthene	**3.10**	**0.37**	**0.32**	**0.53**	**0.30**	**0.65**
benzo[j]fluoranthene	0.79	0.15	0.13	0.22	0.12	0.17
benzo[k]fluoranthene	1.34	0.15	0.13	0.21	0.11	0.26
benzo[e]pyrene	4.95	0.55	0.40	0.63	0.45	0.66
benzo[a]pyrene	**0.54**	**0.12**	**0.12**	**0.17**	**0.10**	**0.14**
indeno[1,2,3-cd]pyrene	0.39	0.22	0.18	0.24	0.18	0.15
dibenzo[ah]anthracene	0.15	<0.06	<0.05	<0.05	<0.05	<0.05
benzo[ghi]perylene	0.65	0.26	0.26	0.32	0.20	0.16
anthanthrene	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
dibenzo[a,l]pyrene	<0.12	<0.12	<0.12	<0.13	<0.13	<0.13
dibenzo[a,e]pyrene	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
dibenzo[a,i]pyrene	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
dibenzo[a,h]pyrene	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
coronene	<0.10	0.13	0.11	0.13	0.10	<0.10
PAH 4 Sum Lower µg/kg	**6.97**	**0.76**	**0.70**	**1.10**	**0.61**	**1.20**
PAH 4 Sum Upper µg/kg	**6.97**	**0.76**	**0.70**	**1.10**	**0.61**	**1.20**

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Table 6: Trace Element Concentrations (mg/kg whole weight)

FERA LIMS No.	S20-001196	S20-001360	S20-001579	S20-001774	S20-001775	S20-001776
Species	Common mussels	Pacific oysters	Razor clams	Surf clams	Surf clams	Razor Ccams
Production Area	Loch Laxford	West Loch Tarbert	Forth Estuary: Largo Bay	Fife Ness Surf Clams	Firth of Forth: North	Sound of Gigha Leim
Sample Site Name	Sgeir Fhadha	Loup Bay	Largo bay	Kingsbarns	Anstruther	Leim
Chromium	0.13	<0.1	0.13	0.23	0.18	0.12
Manganese	1.29	3.26	1.15	3.87	15.0	1.2
Cobalt	0.026	0.033	0.075	0.159	0.173	0.067
Nickel	0.16	<0.1	<0.1	0.31	0.32	<0.1
Copper	0.75	4.8	0.92	1.1	0.99	0.94
Zinc	10.8	145.0	16.3	10.4	9.63	14.7
Arsenic	1.47	1.56	1.37	1.63	1.71	1.54
Selenium	0.394	0.238	0.253	0.422	0.466	0.318
Silver	<0.01	0.254	0.088	0.373	0.423	0.274
Cadmium	0.06	0.14	0.018	0.097	0.1	0.023
Mercury	0.008	0.016	0.013	0.016	0.018	0.023
Lead	0.106	0.046	0.083	0.142	0.135	0.06

FERA LIMS No.	S20-001897	S20-001898	S20-011256	S20-011287	S20-011288	S20-011829
Species	Common cockles	Razor clams	Razor clams	Common mussels	Common mussels	Pacific oysters
Production Area	Castle Stalker	North Bay	Sound of Sleat	Loch Roag: Linngeam	Loch Roag: Eilean Chearstaigh	Loch Fyne: Otter Ferry
Sample Site Name	Port Appin	Barassie	Glenelg Bay	Linngeam	Eilean Scarastaigh	Balliemore
Chromium	0.14	0.13	<0.1	0.14	0.13	<0.1
Manganese	1.24	1.11	1.26	0.84	0.67	3.0
Cobalt	0.168	0.055	0.032	0.027	0.026	0.022
Nickel	2.71	<0.1	<0.1	0.12	0.11	<0.1
Copper	0.42	1.34	1.01	0.62	0.61	6.64
Zinc	7.54	16.1	14.8	12.3	15.2	92.7
Arsenic	1.2	1.46	1.69	1.08	1.45	1.37
Selenium	0.263	0.281	0.324	0.305	0.361	0.216
Silver	0.013	0.069	0.078	<0.01	<0.01	0.332
Cadmium	0.037	0.029	0.027	0.061	0.08	0.218
Mercury	0.013	0.015	0.008	0.008	0.013	0.009
Lead	0.068	0.081	0.05	0.096	0.112	0.035

FERA LIMS No.	S20-012159	S20-012712	S20-012713	S20-013522
Species	Common mussels	Common mussels	Common mussels	Pacific oysters
Production Area	West Loch Roag - Gob Sgrithir	Loch Leurbost	Vaila Sound - East Ward	Loch A Chumhainn: Outer
Sample Site Name	Gob Sgrithir	Loch Leurbost	Brandy Ayre	Outer
Chromium	0.16	0.18	0.1	0.14
Manganese	0.78	1.7	0.84	1.9
Cobalt	0.027	0.036	0.023	0.026
Nickel	0.13	0.13	0.1	<0.1
Copper	0.59	0.57	0.68	6.55
Zinc	12.5	13.1	14.5	138.0
Arsenic	1.27	1.44	1.18	1.35
Selenium	0.336	0.286	0.283	0.176
Silver	<0.01	<0.01	<0.01	0.494
Cadmium	0.074	0.06	0.169	0.1
Mercury	0.01	0.008	<0.007	0.012
Lead	0.106	0.141	0.113	0.05

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