Appendix 17.4 Sediment Sample Analytical Report

Report Number: 2021-30787

James Hutton Limited

ANALYTICAL LABORATORY SERVICES
Assured Analytical Excellence

Analytical Report

on Various Analyses in Coastal Sediment Samples

For:
David Custer, David Hannon, Gemma Tait, John Bleach
Orkney Islands Council
Development and Environmental Services
Council Offices, School Place
Kirkwall
Orkney
KW15 1NY

REPORT AUTHOR

Douglas Kindness, BSc (Hons)
Analytical Chemist

Douglas.Kindness@hutton.ac.uk

REPORT AUTHORISER & ISSUE DATE

Valid report must contain authorised signature above

Report Number: 2021-30787

Job and Sample Information:	
Client Order No/Reference:	PO 002012785
Date Sample(s) Received:	25/03/2021
Hutton ID	**Client sample ID**
1342636	Location 1
1342637	Location 2
1342638	Location 3
1342639	Location 4 Slipway

Methods

Methods	Accreditation Reference	Date Analysis Completed
Sample Preparation	n/a	Various
Tributyl Tin by GC-MS	n/a	21/04/2021
PAH Analysis by GC-MS	n/a	09/04/2021
ICES 7 PCB's by GC-MS	n/a	17/04/2021
Total Petroleum Hydrocarbons by GC-MS	n/a	13/04/2021
BM015-04 Flexible scope As, Cd, Cr, Cu, Hg, Ni, Pb and Zn by ICP-MS	n/a	29/04/2021
Elemental C&N (UKAS Method DM001)	n/a	14/04/2021
Gravel % by sieving	n/a	15/04/2021
Particle Size Analysis by Laser Diffraction (UKAS Method DM011)	n/a	15/04/2021
Organochlorine/Organophosphorus pesticide screen	n/a	15/04/2021
Density following drying at 30°C	n/a	23/04/2021

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Analytical Methods

Heavy metals by ICP-MS
The samples were air dried at 30°C and ball-milled. This fraction was subjected to a strong acid digestion and the digests analysed for selected heavy metals by ICP-MS.

Tributyl and Dibutyltins by GC-MS
The samples were freeze-dried and ball-milled. TBT was extracted after addition of an internal standard. The extract was derivatised using Grignard reagent and the TBT derivative analysed by GC-MS in the selected ion mode. TBT and DBT were quantified using response factors obtained from derivatised standards.

ICES 7 PCBs
Samples were freeze dried and sieved to <2mm. After addition of internal standard, the analytes were extracted into an organic solvent. Following clean-up and concentration the extract was analysed for ICES 7 PCBs by GC-MS in the selected ion mode. PCB congeners were quantified using response factor obtained from calibration standards.

US EPA 16 PAHs
The samples were freeze dried and sieved to <2mm. After addition of deuterated PAH standards, this fraction was extracted, and the extract analysed for the US EPA 16 PAHs by GC-MS in the selected ion mode. PAHs were quantified using response factor obtained from calibration standards.

Total Petroleum Hydrocarbons
The samples were freeze dried and sieved to <2mm. Squalene was added as an internal standard and extracted into Isohexane. The extracts were subjected to Florisil clean-up, concentrated and analysed by GC-MS in selective ion mode (m/z 57,85).

Gravel %
Samples were sieved and fraction > 2 mm fraction was reported as Gravel fraction.

Particle Size Analysis by Laser Diffraction (Mastersizer 3000)
Particle size distribution was determined on the samples after sieving to pass a 2 mm aperture (<2mm fraction) using a laser diffractometry (Mastersizer 3000).

Organochlorine/Organophosphorus pesticide screen (Qualitative Analysis) -
Sample was extracted into DCM and concentrated. Sample was then run on a GC-MS scan against the NIST02 and RTLPest2 Libraries on the GC-MS.

Density following drying at 30°C
Samples were air dried at 30°C, then were added to a vessel of known volume. All samples were added in 3 stages with tapping to ensure the sediment was 'settled' within the vessel. The final weights were recorded and used to calculate density.

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Results

Table 1. Gravel Percentage by Sieving

Customer identity	Laboratory Code	Gravel (%)
Location 1	**1342636**	Not Detected
Location 2	**1342637**	Not Detected
Location 3	**1342638**	Not Detected
Location 4 Slipway	**1342639**	Not Detected

Table 2. Sample Density

Customer identity	Laboratory Code	Density g/cm³
Location 1	**1342636**	1.418
Location 2	**1342637**	1.203
Location 3	**1342638**	1.180
Location 4 Slipway	**1342639**	1.360

Table 3. Total Organic Carbon

Customer identity	Laboratory Code	Organic Carbon (%/w)
Location 1	**1342636**	3.29
Location 2	**1342637**	5.33
Location 3	**1342638**	4.57
Location 4 Slipway	**1342639**	4.38

Table 4. Tributyltin and Dibutyltin analysis by GCMS

Customer identity	Laboratory Code	TBT (µg/kg dry weight)	DBT (µg/kg dry weight)
Location 1	**1342636**	<10	<10
Location 2	**1342637**	<10	<10
Location 3	**1342638**	<10	<10
Location 4 Slipway	**1342639**	<10	<10

Table 5. Total Petroleum hydrocarbons by GCMS

Customer identity	Laboratory Code	TPH (dry weight mg/kg)
Location 1	1342636	1.6
Location 2	1342637	<1
Location 3	1342638	<1
Location 4 Slipway	1342639	<1

Table 6. Polyaromatic Hydrocarbons by GCMS

	Concentration (µg/kg dry weight)			
Laboratory Code	1342636	1342637	1342638	1342639
Customer identity	Location 1	Location 2	Location 3	Location 4 slipway
Naphthalene	<3	4	9	<3
Acenaphthylene	<2	<2	<2	<2
Acenaphthene	<4	<4	<4	<4
Fluorene	<3	<3	<3	<3
Phenanthrene	<2	<2	5	<2
Anthracene	<5	<5	<5	<5
Fluoranthene	<3	<3	<3	<3
Pyrene	<3	<3	<3	<3
Benz[a]anthracene	<2	<2	<2	<2
Chrysene	<2	<2	<2	<2
Benzo(b)fluoranthrene	<1	<1	<1	<1
Benzo(k)fluoranthrene	<1	<1	<1	<1
Benzo(a)pyrene	<1	<1	<1	<1
Indeno(1,2,3-cd) pyrene	<1	<1	<1	<1
Dibenzo(a,h)anthracene	<1	<1	<1	<1
Benzo(g,h,i)perylene	<1	<1	<1	<1
Total PAH	0	4	14	0

Table 7. Polychlorinated biphenyls by GCMS

	Concentration (µg/kg dry weight)			
Laboratory Code	1342636	1342637	1342638	1342639
Customer identity	Location 1	Location 2	Location 3	Location 4 slipway
PCB-28	<0.1	<0.1	<0.1	<0.1
PCB-52	<0.1	<0.1	<0.1	<0.1
PCB-101	<0.1	<0.1	<0.1	<0.1
PCB-118	<0.1	<0.1	<0.1	<0.1
PCB-138	<0.1	<0.1	<0.1	<0.1
PCB-153	<0.1	<0.1	<0.1	<0.1
PCB-180	<0.1	<0.1	<0.1	<0.1

Table 8. ICP-MS for Arsenic, Cadmium, Chromium, Copper, Mercury, Nickel , Lead and Zinc in Aqua Regia matrix

		(mg/kg)							
Customer identity	**Laboratory Code**	**Arsenic**	**Cadmium**	**Chromium**	**Copper**	**Mercury**	**Nickel**	**Lead**	**Zinc**
Location 1	**1342636**	1.80	<0.0015	4.65	0.82	<0.045	2.57	0.71	3.28
Location 2	**1342637**	1.66	<0.0015	5.34	0.82	<0.045	2.83	0.96	3.64
Location 3	**1342638**	2.17	0.045	6.14	0.99	<0.045	3.17	1.05	4.25
Location 4 Slipway	**1342639**	0.90	<0.0015	5.66	0.70	<0.045	2.72	0.97	4.74

Organochlorine/Organophosphorus pesticide screen (Qualitative Analysis) - detection by GC-MS scan of DCM extract against NIST02 and RTLPest2 Libraries:

Overall, samples were not found to contain detectable pesticides. A small (<0.2% of peak percentages) peak of tributylamine was detected in sample 1342636 (Location 1). This compound is reported to be used as an insecticide besides having other uses.

Appendix 1: Particle Size Analysis by Laser Diffraction on following pages:

Analysis - Std Report - Sediments

James Hutton Institute

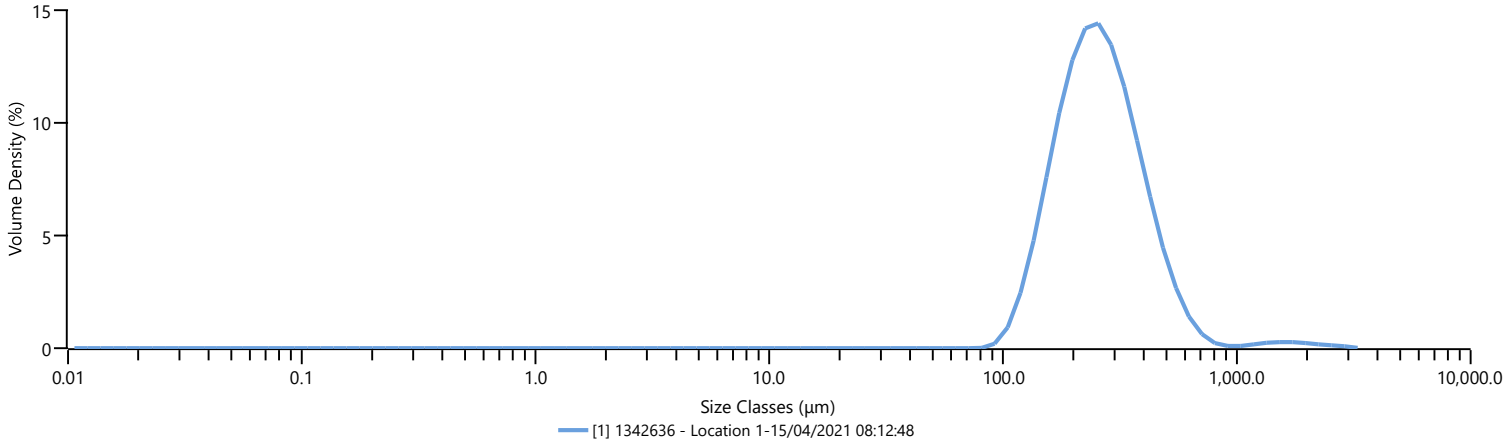
Measurement Details	
Client	Orkney Islands Council
Sample Name	1342636 - Location 1
Job No	2021-30787
Operator Name	CD40093
SOP File Name	HydroLV.cfg

Measurement Details	
Analysis Date Time	15/04/2021 08:12:48
Measurement Date Time	15/04/2021 08:12:48
Result Source	Measurement

Analysis	
Particle Name	Silica
Particle Refractive Index	1.520
Particle Absorption Index	0.100
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.54 %
Laser Obscuration	9.82 %

Result	
Concentration	0.3206 %
Span	1.147
Uniformity	0.416
Specific Surface Area	25.03 m^2/kg
D [3,2]	240 µm
D [4,3]	297 µm
Dv (10)	154 µm
Dv (50)	254 µm
Dv (90)	445 µm

Frequency (compatible)



Result

Size (µm)	% Volume In	Size (µm)	% Volume In	Size (µm)	% Volume In	Size (µm)	% Volume In	Size (µm)	% Volume In	Size (µm)	% Volume In	Size (µm)	% Volume In	Size (µm)	% Volume In
0.0100	0.00	0.0597	0.00	0.357	0.00	2.13	0.00	12.7	0.00	76.0	0.00	454	3.69	2710	0.07
0.0114	0.00	0.0679	0.00	0.405	0.00	2.42	0.00	14.5	0.00	86.4	0.12	516	2.19	3080	0.00
0.0129	0.00	0.0771	0.00	0.460	0.00	2.75	0.00	16.4	0.00	98.1	0.72	586	1.13	3500	
0.0147	0.00	0.0876	0.00	0.523	0.00	3.12	0.00	18.7	0.00	111	2.00	666	0.49		
0.0167	0.00	0.0995	0.00	0.594	0.00	3.55	0.00	21.2	0.00	127	3.95	756	0.18		
0.0189	0.00	0.113	0.00	0.675	0.00	4.03	0.00	24.1	0.00	144	6.33	859	0.07		
0.0215	0.00	0.128	0.00	0.767	0.00	4.58	0.00	27.4	0.00	163	8.73	976	0.08		
0.0244	0.00	0.146	0.00	0.872	0.00	5.21	0.00	31.1	0.00	186	10.72	1110	0.14		
0.0278	0.00	0.166	0.00	0.991	0.00	5.92	0.00	35.3	0.00	211	11.91	1260	0.20		
0.0315	0.00	0.188	0.00	1.13	0.00	6.72	0.00	40.1	0.00	240	12.10	1430	0.23		
0.0358	0.00	0.214	0.00	1.28	0.00	7.64	0.00	45.6	0.00	272	11.29	1630	0.22		
0.0407	0.00	0.243	0.00	1.45	0.00	8.68	0.00	51.8	0.00	310	9.71	1850	0.19		
0.0463	0.00	0.276	0.00	1.65	0.00	9.86	0.00	58.9	0.00	352	7.69	2100	0.15		
0.0526	0.00	0.314	0.00	1.88	0.00	11.2	0.00	66.9	0.00	400	5.59	2390	0.11		

Analysis - Std Report - Sediments

James Hutton Institute

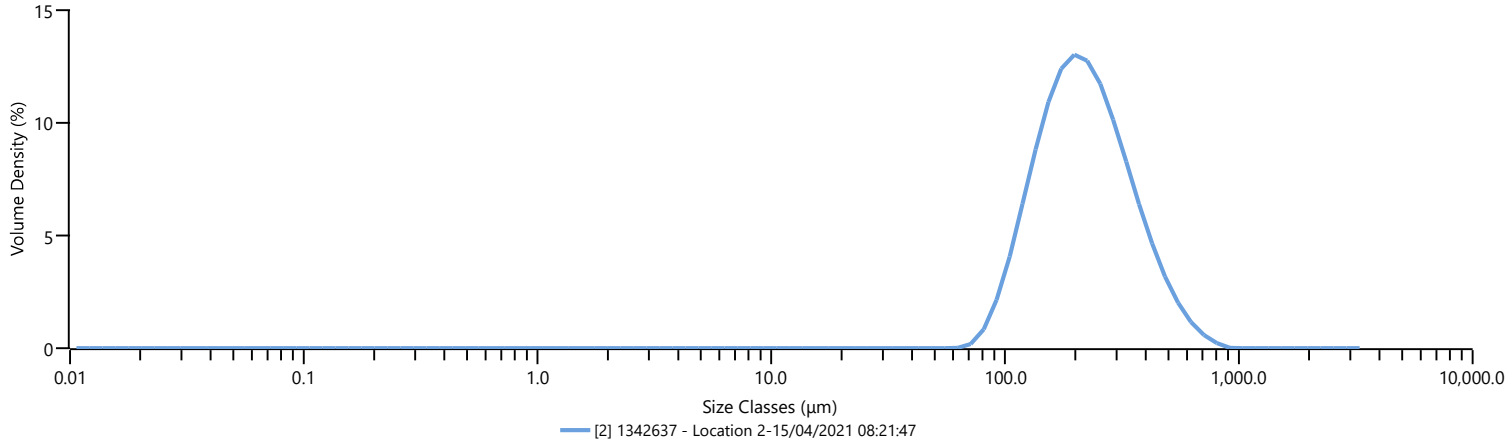
Measurement Details	
Client	Orkney Islands Council
Sample Name	1342637 - Location 2
Job No	2021-30787
Operator Name	CD40093
SOP File Name	HydroLV.cfg

Measurement Details	
Analysis Date Time	15/04/2021 08:21:47
Measurement Date Time	15/04/2021 08:21:47
Result Source	Measurement

Analysis	
Particle Name	Silica
Particle Refractive Index	1.520
Particle Absorption Index	0.100
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.48 %
Laser Obscuration	9.36 %

Result	
Concentration	0.2521 %
Span	1.284
Uniformity	0.401
Specific Surface Area	30.30 m^2/kg
D [3,2]	198 µm
D [4,3]	241 µm
Dv (10)	123 µm
Dv (50)	213 µm
Dv (90)	397 µm

Frequency (compatible)



Result

Size (µm)	% Volume In	Size (µm)	% Volume In	Size (µm)	% Volume In	Size (µm)	% Volume In	Size (µm)	% Volume In	Size (µm)	% Volume In	Size (µm)	% Volume In	Size (µm)	% Volume In
0.0100	0.00	0.0597	0.00	0.357	0.00	2.13	0.00	12.7	0.00	76.0	0.66	454	2.63	2710	0.00
0.0114	0.00	0.0679	0.00	0.405	0.00	2.42	0.00	14.5	0.00	86.4	1.74	516	1.66	3080	0.00
0.0129	0.00	0.0771	0.00	0.460	0.00	2.75	0.00	16.4	0.00	98.1	3.36	586	0.95	3500	
0.0147	0.00	0.0876	0.00	0.523	0.00	3.12	0.00	18.7	0.00	111	5.33	666	0.47		
0.0167	0.00	0.0995	0.00	0.594	0.00	3.55	0.00	21.2	0.00	127	7.37	756	0.18		
0.0189	0.00	0.113	0.00	0.675	0.00	4.03	0.00	24.1	0.00	144	9.15	859	0.00		
0.0215	0.00	0.128	0.00	0.767	0.00	4.58	0.00	27.4	0.00	163	10.39	976	0.00		
0.0244	0.00	0.146	0.00	0.872	0.00	5.21	0.00	31.1	0.00	186	10.92	1110	0.00		
0.0278	0.00	0.166	0.00	0.991	0.00	5.92	0.00	35.3	0.00	211	10.69	1260	0.00		
0.0315	0.00	0.188	0.00	1.13	0.00	6.72	0.00	40.1	0.00	240	9.81	1430	0.00		
0.0358	0.00	0.214	0.00	1.28	0.00	7.64	0.00	45.6	0.00	272	8.48	1630	0.00		
0.0407	0.00	0.243	0.00	1.45	0.00	8.68	0.00	51.8	0.00	310	6.91	1850	0.00		
0.0463	0.00	0.276	0.00	1.65	0.00	9.86	0.00	58.9	0.00	352	5.31	2100	0.00		
0.0526	0.00	0.314	0.00	1.88	0.00	11.2	0.00	66.9	0.13	400	3.86	2390	0.00		

Analysis - Std Report - Sediments

James Hutton Institute

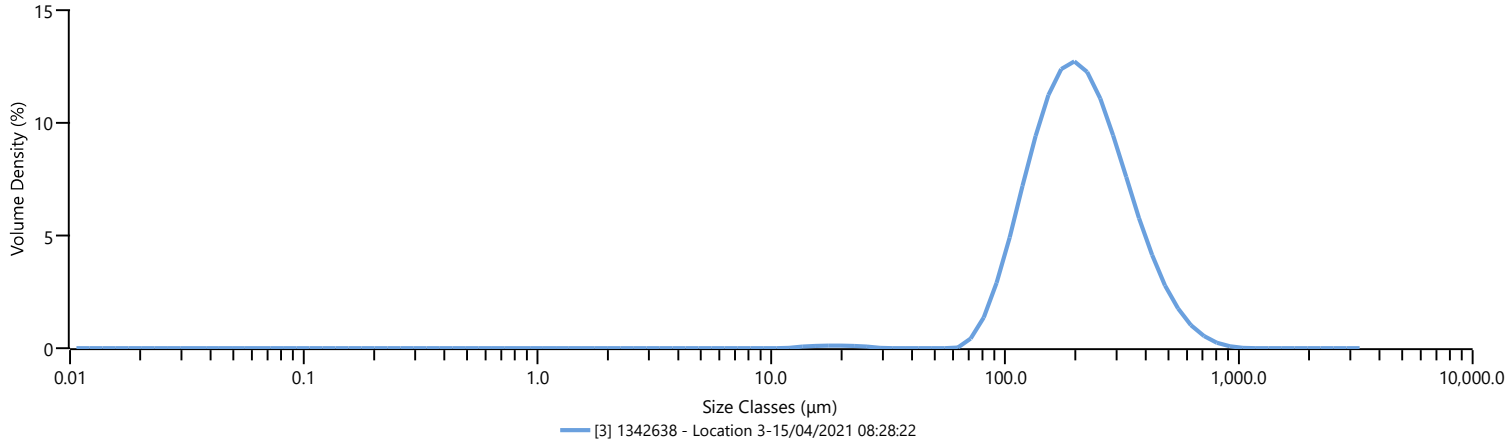
Measurement Details	
Client	Orkney Islands Council
Sample Name	1342638 - Location 3
Job No	2021-30787
Operator Name	CD40093
SOP File Name	HydroLV.cfg

Measurement Details	
Analysis Date Time	15/04/2021 08:28:22
Measurement Date Time	15/04/2021 08:28:22
Result Source	Measurement

Analysis	
Particle Name	Silica
Particle Refractive Index	1.520
Particle Absorption Index	0.100
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.45 %
Laser Obscuration	13.85 %

Result	
Concentration	0.3485 %
Span	1.326
Uniformity	0.416
Specific Surface Area	33.18 m^2/kg
D [3,2]	181 µm
D [4,3]	232 µm
Dv (10)	115 µm
Dv (50)	204 µm
Dv (90)	386 µm

Frequency (compatible)



Result

Size (µm)	% Volume In	Size (µm)	% Volume In	Size (µm)	% Volume In	Size (µm)	% Volume In	Size (µm)	% Volume In	Size (µm)	% Volume In	Size (µm)	% Volume In	Size (µm)	% Volume In
0.0100	0.00	0.0597	0.00	0.357	0.00	2.13	0.00	12.7	0.07	76.0	1.10	454	2.30	2710	0.00
0.0114	0.00	0.0679	0.00	0.405	0.00	2.42	0.00	14.5	0.08	86.4	2.38	516	1.45	3080	0.00
0.0129	0.00	0.0771	0.00	0.460	0.00	2.75	0.00	16.4	0.10	98.1	4.08	586	0.84	3500	
0.0147	0.00	0.0876	0.00	0.523	0.00	3.12	0.00	18.7	0.10	111	6.00	666	0.44		
0.0167	0.00	0.0995	0.00	0.594	0.00	3.55	0.00	21.2	0.09	127	7.87	756	0.20		
0.0189	0.00	0.113	0.00	0.675	0.00	4.03	0.00	24.1	0.07	144	9.41	859	0.07		
0.0215	0.00	0.128	0.00	0.767	0.00	4.58	0.00	27.4	0.00	163	10.39	976	0.00		
0.0244	0.00	0.146	0.00	0.872	0.00	5.21	0.00	31.1	0.00	186	10.67	1110	0.00		
0.0278	0.00	0.166	0.00	0.991	0.00	5.92	0.00	35.3	0.00	211	10.26	1260	0.00		
0.0315	0.00	0.188	0.00	1.13	0.00	6.72	0.00	40.1	0.00	240	9.27	1430	0.00		
0.0358	0.00	0.214	0.00	1.28	0.00	7.64	0.00	45.6	0.00	272	7.89	1630	0.00		
0.0407	0.00	0.243	0.00	1.45	0.00	8.68	0.00	51.8	0.00	310	6.33	1850	0.00		
0.0463	0.00	0.276	0.00	1.65	0.00	9.86	0.00	58.9	0.00	352	4.79	2100	0.00		
0.0526	0.00	0.314	0.00	1.88	0.00	11.2	0.00	66.9	0.32	400	3.42	2390	0.00		

Analysis - Std Report - Sediments

James Hutton Institute

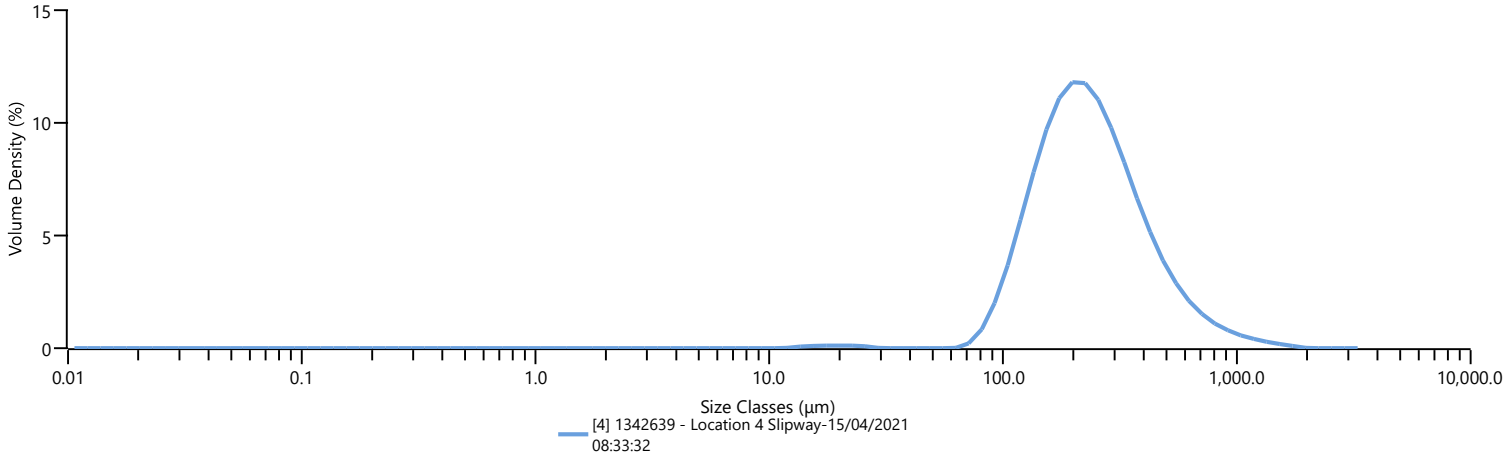
Measurement Details	
Client	Orkney Islands Council
Sample Name	1342639 - Location 4 Slipway
Job No	2021-30787
Operator Name	CD40093
SOP File Name	HydroLV.cfg

Measurement Details	
Analysis Date Time	15/04/2021 08:33:32
Measurement Date Time	15/04/2021 08:33:32
Result Source	Measurement

Analysis	
Particle Name	Silica
Particle Refractive Index	1.520
Particle Absorption Index	0.100
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.46 %
Laser Obscuration	11.26 %

Result	
Concentration	0.3080 %
Span	1.576
Uniformity	0.515
Specific Surface Area	30.09 m^2/kg
D [3,2]	199 µm
D [4,3]	277 µm
Dv (10)	124 µm
Dv (50)	226 µm
Dv (90)	481 µm

Frequency (compatible)



Result

Size (µm)	% Volume In	Size (µm)	% Volume In	Size (µm)	% Volume In	Size (µm)	% Volume In	Size (µm)	% Volume In	Size (µm)	% Volume In	Size (µm)	% Volume In	Size (µm)	% Volume In
0.0100	0.00	0.0597	0.00	0.357	0.00	2.13	0.00	12.7	0.06	76.0	0.67	454	3.23	2710	0.00
0.0114	0.00	0.0679	0.00	0.405	0.00	2.42	0.00	14.5	0.08	86.4	1.64	516	2.38	3080	0.00
0.0129	0.00	0.0771	0.00	0.460	0.00	2.75	0.00	16.4	0.09	98.1	3.04	586	1.74	3500	
0.0147	0.00	0.0876	0.00	0.523	0.00	3.12	0.00	18.7	0.10	111	4.74	666	1.26		
0.0167	0.00	0.0995	0.00	0.594	0.00	3.55	0.00	21.2	0.09	127	6.52	756	0.91		
0.0189	0.00	0.113	0.00	0.675	0.00	4.03	0.00	24.1	0.08	144	8.12	859	0.65		
0.0215	0.00	0.128	0.00	0.767	0.00	4.58	0.00	27.4	0.00	163	9.30	976	0.47		
0.0244	0.00	0.146	0.00	0.872	0.00	5.21	0.00	31.1	0.00	186	9.89	1110	0.34		
0.0278	0.00	0.166	0.00	0.991	0.00	5.92	0.00	35.3	0.00	211	9.85	1260	0.24		
0.0315	0.00	0.188	0.00	1.13	0.00	6.72	0.00	40.1	0.00	240	9.23	1430	0.15		
0.0358	0.00	0.214	0.00	1.28	0.00	7.64	0.00	45.6	0.00	272	8.17	1630	0.08		
0.0407	0.00	0.243	0.00	1.45	0.00	8.68	0.00	51.8	0.00	310	6.88	1850	0.00		
0.0463	0.00	0.276	0.00	1.65	0.00	9.86	0.00	58.9	0.00	352	5.53	2100	0.00		
0.0526	0.00	0.314	0.00	1.88	0.00	11.2	0.00	66.9	0.15	400	4.29	2390	0.00		

Samples will be stored for a period of eight weeks following completion of analysis and acceptance of analytical report(s) at no extra cost after which samples will be disposed of unless a specific instruction is given (with the sample analysis request/order) to store the sample beyond this period. Extended storage charges will apply.

END OF REPORT