A Short Brief on Carcinogenic Silica Dust

Summary

Ultra-fine silica dust particles at a size of 10 µm or less (known as PM10 particles) are absorbed by the lining of the lungs and, as a consequence, silica dust has been classified as a grade 1 carcinogen. The World Health Organisation 24 hour limit for exposure to PM10 particles of carcinogenic silica dust is 50 µg/m^3 and HSE's limit is 100 µg/m^3.

HQPL's consultants (ACS Testing Limited) report dated 29 November 2018 have confirmed that the Freeth Farm sand represents the finest sand classification where around 3% of the sand by weight passes through a 63µm sieve. If all the fine particles were 63µm in diameter, this would mean that a 1kg sample of sand would contain up to 30g of fines which would equate to around 70 million fine particles for every kilogram of sand.

However, the Freeth Farm sand contains sand particles much finer than 63µm, as has previously been confirmed by light microscopy. Consequently, a detailed measurement of the actual particle sizes has recently been carried out by Lawson Scientific Limited using a laser based Particle Size Analyser. The analysis of 2 separate samples taken close to the Phase 5 excavation area showed that 13% of the particles (Sample 1) and 38% (Sample 2) were below 9.817 µm. This means that the number of PM10 particles per kilogram is over 103 billion (Sample 1) and over 264 billion (Sample 2).

The results from a study of airborne respirable silica near a sand and gravel facility in central California show that PM10 particles were measured at concentrations of 60.6 µg/m^3 at a distance of 22m and 62.4 µg/m^3 at 62m.

HQPL's dust mitigation strategy for the extraction of 307,200 te of ultra-fine sand containing billions of PM10 particles per kilogram relies on a 35m buffer zone; 4m high x 19m wide bunds and the sand remaining damp at all times. HQPL also have an option to deploy a water bowser under dry conditions at the discretion of the site manager.

This is wholly inadequate. The surface layers of the ultra-fine sand will dry out in less than 15 minutes; PM10 particles will lift from the surface in light winds; are invisible to the naked eye and will only be reliably detected by continuous dust monitoring.

A buffer zone of 35m is not in line with the normal UK planning authority practice (100m); does not meet the DoE planning guidance (100m); does not meet the Institute of Air Quality Management (IAQM) guidance (100m); and, in the absence of any continuous dust monitoring, is inadequate to keep levels of PM10 particles to within acceptable 24 hour health limits.

It is strongly recommended that a sensible buffer zone of at least 100m in line with UK norms together with continuous dust monitoring (which can be achieved using inexpensive equipment) be included as part of the planning conditions for HQPL's sand extraction proposal in order to provide appropriate environmental protection for local residents.

Background

The present proposal involves a buffer zone of 35m and the construction and removal of noise attenuation bunds that are 4m high and 19m wide and starting 26m from the Freeth Farm Cottage property boundaries. The 4m x 19m bunds will require 27,000 te of sandy topsoil to be piled up and then removed using the long reach Volvo excavating shovel shown below.

The proposal involves the extraction of 307,200 te of very fine silica sand over a 4-5 year period using the Volvo excavators and loading shovels shown below.


HPQL's submissions admit the potential for dust formation during top soil removal and bund formation and states that:

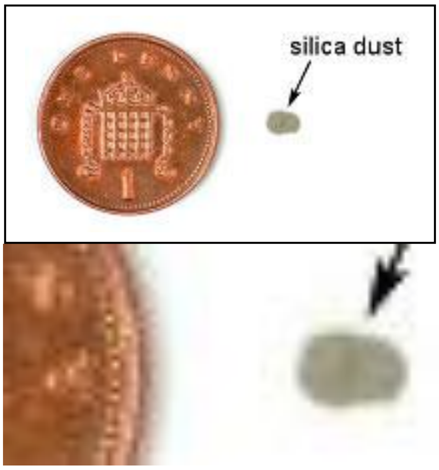
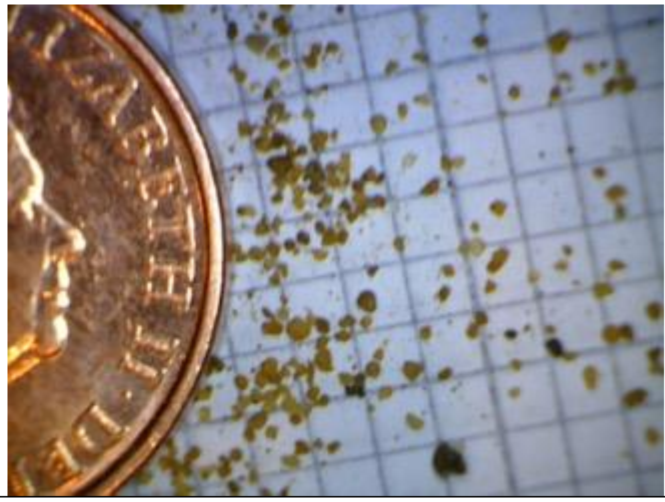
> *"there are receptors to the west which would be within 200m of these potentially dusty operations, particularly bund formation. Freeth Farm Cottages in particular have the potential to be affected when the wind is blowing from the north, east and south (depending on the stage of bund construction)."*

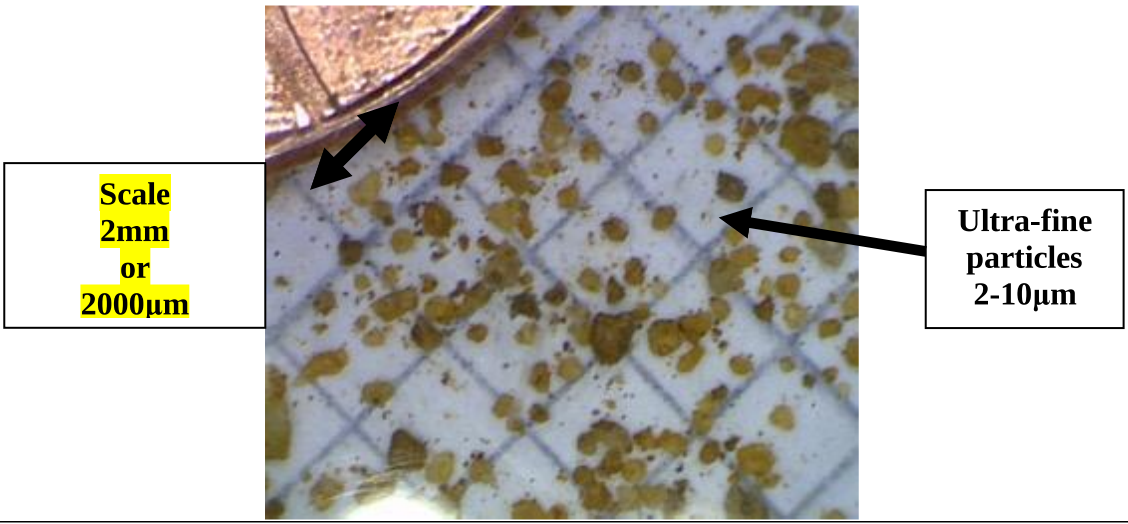
HQPL's argument that a reduced level of environmental protection should be allowed based on the argument that an increased buffer zone would render the proposed development commercially non-viable has been exposed as a misrepresentation of the true position.

By itself, silica dust is not toxic. The health risk arises when silica particles are small enough to get into the deepest parts of the lungs, especially the alveoli where inhaled air passes into the bloodstream. Chronic or long-term exposure to fine silica particles can lead to lung inflammation and produce a severe lung disease known as silicosis. This has prompted government and international health agencies to declare silica to be a human carcinogen (IARC, 2012; NTP, 2011; Steenland, 2014).

The Health and Safety Executive (HSE) advice on is that the daily amounts of silica needed to cause adverse health effects are small (0.1 mg/m^3 or 100 μg/m^3, see Annex 2), as shown in the picture below, taken from a HSE publication, with acknowledgements to HSE. The recommended World Health Organisation limit is 50 μg/m^3 over a 24 hour period.

A representative sample of the Freeth Farm sand has been examined under a microscope to determine the distribution of sand particle sizes, as shown below.

HSE Silica Dust Particle	Freeth Farm sand particle sizes
	



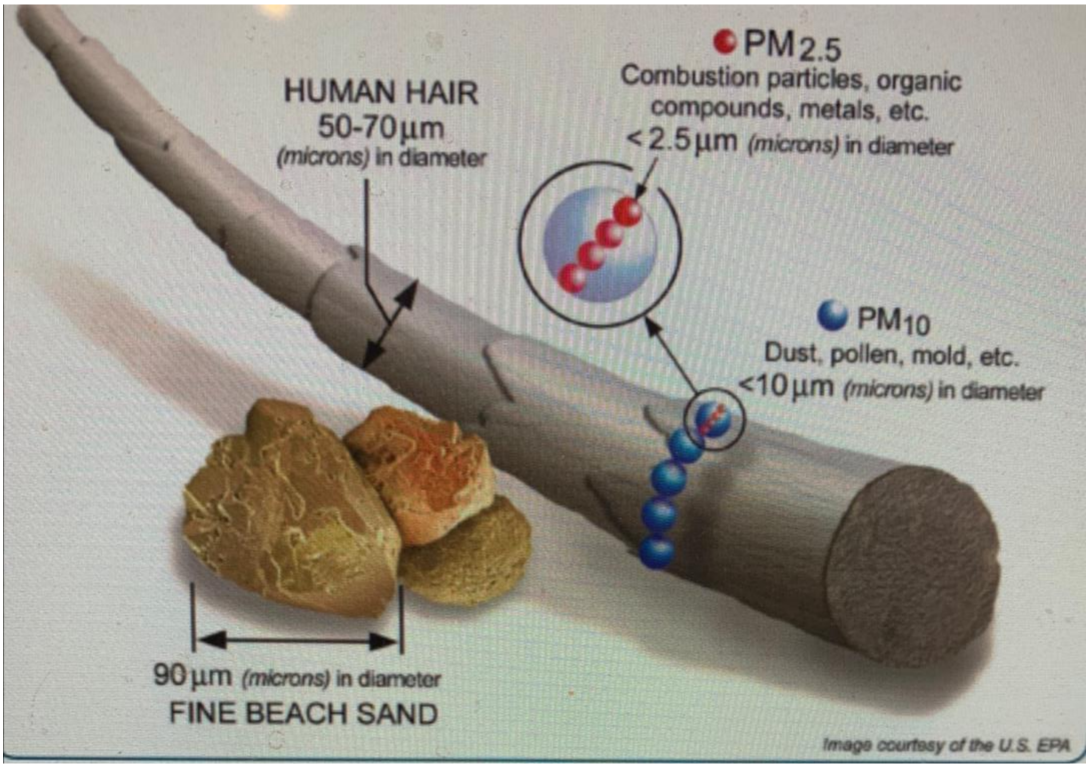
The Freeth Farm silica sand has also been investigated by HQPL's consultants ACS Testing Limited. Their evaluation dated 29 November 2018 states that *"We have estimated the likely average grading in accordance with the ISO 656 sieve apertures"* as a *"0/2mm FP Cat f_3 fine concreting sand"*.

The 0/2mm FP Cat f_3 classification is the finest sand classification that means that up to 3% of the content by weight will pass through a 63μm sieve, as shown below.

Line	Particle size fractions *d/D*	Fines content	Category
	mm	% m/m	
1	0/2 to 0/5	≤ 3	f_3
2	0/2 to 0/5	≤ 16	f_{16}
3	0/2 to 0/5	> 16	$F_{declared}$
4	2/4 to 32/63	≤ 0.5	$f_{0.5}$
5	2/4 to 32/63	≤ 1	f_1
6	2/4 to 32/63	≤ 2	f_2
7	2/4 to 32/63	≤ 3	f_3
8	2/4 to 32/63	≤ 4	f_4
9	2/4 to 32/63	> 4	$F_{declared}$
Note: For special areas of application, the particle size fraction/grade of delivered particles 1/3 mm in category $f_{0.5}$, f_1 *or* f_3 *may be used.*			

If it assumed that the largest particles are all 63μm, this would mean that each spherical particle would weigh around 0.433 x 10^{-6} g, so that a 1kg sample of sand would contain up to 30g of fines which would equate to around 70 million fine particles for every kilogram of sand.

To put this into perspective, the diameter of a human hair is around 50-70 μm and fine beach sand has a typical diameter of around 90 μm. Pollen grains have a diameter of around 10 μm (see blue balls below) and PM2.5 particles have a diameter of 2.5 μm as shown by the very tiny red dots superimposed onto the blue pollen balls below. These PM2.5 and PM10 particles are so fine that they weigh almost nothing, are invisible to the naked eye and are dangerous as they are blown about even in light winds and absorbed by the lining of the lungs if breathed in.



The actual particle size distributions for 2 samples taken from close to Phase 5 have been analysed by Lawson Scientific Limited using a Beckman Coulter Particle Size Analyser on 27 May 2021. The full details are given in Annex 2.

The results below show that the maximum particle size for Sample 1 was 948 μm (1mm) with 4.3% of the particles being 2.5 μm or less (known as PM2.5 particles) and 13% of the particles being 10 μm or less (known as PM10 particles). For Sample 2 the maximum particle size was 340 μm (0.3mm) with 11% of the particles being PM2.5 and 38% of the particles being PM10.

	Percentage of Particles less than 2.5 μm (PM2.5)	**Percentage of Particles less than 10 μm (PM10)**	**PM10 particles per kilogram**	**Maximum Particle Size**
Sample 1	**4.3%**	**13%**	**103,000,000,000**	**948 μm**
Sample 2	**11%**	**38%**	**264,000,000,000**	**340 μm**

Sample 1 would have over 103 billion PM10 particles per kilogram.

Sample 2 would have over 264 billion PM10 particles per kilogram.

The results from a study of airborne respirable silica near a sand and gravel facility in central California (Environ Sci Technol., December 2002 by Shiraki & Holmen) show that PM10 samples were measured as 60.6 $\mu g/m^3$ at a distance of 22m and 62.4 $\mu g/m^3$ at 62m. The World Health Organisation 24 hour limit on PM10 particles is 50 $\mu g/m^3$.

The 27,000 te of sandy top-soil needed to build the 4m high x 19m wide noise attenuation bunds will contain trillions of ultra-fine particles that will form the basis of a significant carcinogenic health risk due to their close proximity (42m) from the occupied Freeth Farm Cottage buildings during the 24 weeks when the bunds are being constructed and removed.

Similarly, the extraction of 307,200 te of ultra-fine sand over a 4-5 year period will also many trillions of ultra-fine particles that are invisible to the naked eye and can be transported long distances in dry light wind conditions. This is why an increased buffer zone is essential to provide adequate environmental protection.

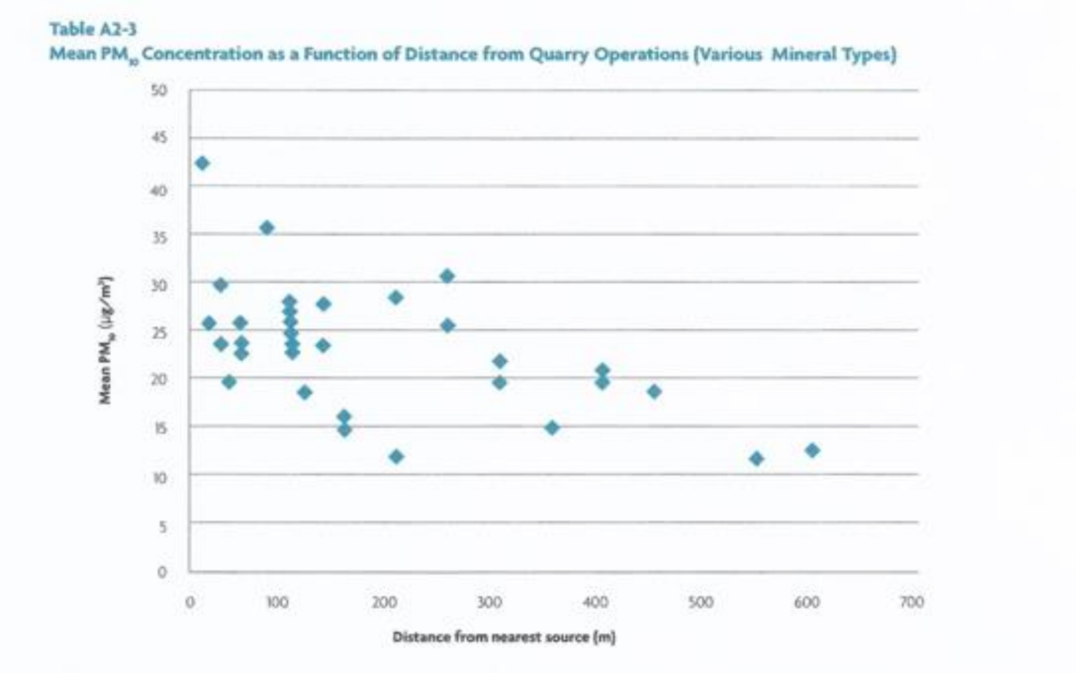
The Department of the Environment Planning Guide, Section 5.3 states that:

> *"Residents living in proximity to quarries can potentially be affected by dust up to 0.5km from the source, although continual or severe concerns about dust are most likely to be experienced within about 100m of the dust source. The main potential impacts of dust are visual impacts, coating/soiling of property (including housing, washing and cars), coating of vegetation, contamination of soils, water pollution, change in plant species composition, loss of sensitive plant species, increased inputs of mineral nutrients and altered pH balances. Respirable particles, i.e. those less than 10 micrometres (10μm) in diameter, have the potential to cause effects on human health, depending on exposure levels".*

The Institute of Air Quality Management (IAQM) Guidance on Mineral Dust states that:

> *"Smaller dust particles remain airborne for longer, dispersing widely and depositing more slowly over a wider area. Large dust particles (greater than 30 µm), which make up the greatest proportion of dust emitted from mineral workings, will largely deposit within 100m of sources. Intermediate-sized particles (10–30 µm) are likely to travel up to 200–500m. Smaller particles (less than 10µm) which make up a small proportion of the dust emitted from most mineral workings, are only deposited slowly but may travel 1000m or more"*

The IAQM guidance for Mineral Dust considers the effects of 10µm particles (PM_{10}) as a function of distance from quarry operations as shown below:



The best practice exclusion zones adopted by various planning authorities to keep noise and dust levels to within statutory limits are shown below:

Planning Authority	Exclusion Zone or Stand-off Distance
Buckinghamshire	**200m (or 100m with a 5m bund)**
Durham	**250m**
Hampshire	**250m**
Lancashire	**100m**
Somerset	**200m**
West Dorset	**100-250m**
Wales	**100m**

In relation to quarry dust, the Department of Environment issued a detailed technical report on buffer zones in 1995 which states:

> *"The DoE study concluded that severe or persistent concerns about dust are most likely to be experienced near to significant dust sources (generally within 100m). In practice, standoff distances are often incorporated into local planning policy, with distances of 250-500 metres typically adopted"*

The Control of Substances Hazardous to Health Regulations 2002 (COSHH), as amended, requires a formal risk assessment to be carried out to control exposure to respirable crystalline silica (RCS).

Rather than carry out a formal risk assessment as required under the COSSH regulations, HQPL have simply claimed that there is always a dust risk to local residents during farming activities such as ploughing.

However, ploughing does not often penetrate the top soil layers into the sand deposits below and ploughing only usually occurs around twice a year. That is in the Winter months before planting, usually 1-2 days and again in late Autumn after harvesting. The ploughing takes place generally at distances much greater than 16m from Freeth Farm Cottages. In addition, although the topsoil is sandy the ground is invariably wet in late Autumn and Winter, so the dust risk from ploughing is minimal and not at all similar to heaping and removing 27,000 te of sandy top soil at 16m from the Freeth Farm Cottages property boundaries over a 24 week period during Phases 5, 6 and 7.

HQPL's dust mitigation strategy for the main sand extraction activities is that the sand will remain permanently wet which will reduce any dust and they have the option of deploying a water bowser at the discretion of the site manager under dry conditions, with no continuous dust monitoring being proposed.

Since the fine dust particles are invisible to the naked eye and the surface layers will dry out in around 15 minutes, any light winds will lead to a dust lift that is invisible to the operators who will have a vested interest to keep working. With no sensible buffer zone or continuous dust monitoring in place, local residents are clearly at risk.

Continuous dust monitoring equipment such as the one shown below are inexpensive and easy to use and are routinely used in Wiltshire for air quality particle monitoring in AQMAs and should be imposed as a planning condition to provide adequate environmental protection.

Annex 1

HSE Guidance on Carcinogenic Silica Dust Exposure

(0.1 mg/m^3 or 100 μg/m^3)

SILICA: How WEL are you managing the risk?

Dust is generated in many quarry processes, from overburden stripping through extraction of the target mineral resource, through processing and loading the end product. Silica is a naturally occurring mineral, which is very common on the earth's surface and occurs in its crystalline form in many different rock types.

Lung X-ray showing scarring caused by exposure to RCS

Breathing in dust of any sort is potentially harmful, and exposure to dust in the workplace must be controlled under the requirements of the Control of Substances Hazardous to Health Regulations 2002 (COSHH). Under COSHH there is a Workplace Exposure Limit or WEL for inhalable general dust of 10 mg/m^3, or 4 mg/m^3 for the finest or *respirable* dust, ie that which is in such small particles it can be breathed deep into the lungs. However, particular dusts, including respirable crystalline silica (RCS) carry a greater risk of ill health, due to the nature of their reaction with the body. These more harmful dusts have their own WELs. Since 2002 the WEL for RCS has been 0.3 mg/m^3.

If RCS enters the lungs, it causes a particular recognisable disease known as silicosis. Scar tissue develops which impairs lung function and leads to chronic bronchitis and shortness of breath. Silicosis normally develops over a long period and often only becomes apparent after retirement; however with intense daily exposure to RCS it can develop much more quickly.

Recent research has revealed that there is significant risk of developing silicosis even where RCS is controlled at the WEL. For this reason HSC is considering a recommendation from the Advisory Committee on Toxic Substances (ACTS) that the WEL be reduced to 0.1 mg/m^3. This change is likely to take effect in the autumn. If exposures to RCS are controlled to below 0.1 mg/m3 there should be a very low risk of developing silicosis. Once exposure is 0.1 mg/m^3 or greater, the risk increases significantly.

Silicosis is a completely preventable disease if control measures are properly designed, implemented and maintained. To control risk from RCS, employers must apply the principles of COSHH.*

In a quarry environment where silica is a constituent of the rock, practical control of RCS exposure will depend on establishing and maintaining management systems (eg to ensure dust from vehicle movements is minimised by maintaining road surfaces and sufficiently regular trips by water bowser), as well as suitably designed and maintained plant and equipment to contain dusty processes and remove dust from enclosed work areas. The use of personal protective equipment is a last resort – do not rely on this as the sole means of protecting workers from dust exposure.

To coincide with the new WEL later this year, HSE is publishing a series of silica information sheets, an addition to the existing series of *COSHH Essentials* guidance (www.coshh-essentials.org.uk). These have been developed in consultation with industry to provide practical guidance on workplace control measures for certain processes. HSE's guidance is similar to that being produced by Eurosil, which represents at European level the industries with an interest in processes and products containing silica. British quarry operators can implement either set of guidance to help them comply with COSHH.

A further important development at European level is the *European Social Dialogue Agreement* on silica, which representatives of the British quarry industry have been very significantly involved with. By signing up to the agreement, organisations commit to standards of control, recording and reporting. Actions detailed in the *European Social Dialogue Agreement* address employers' duties.

Inspectors will be using *COSHH essentials* in assessing compliance. If, on a quarry visit, they believe exposure to RCS has not been prevented, or where prevention was not reasonably practicable it was not being 'adequately controlled', they will consider enforcement

Dust spillage should be contained and vacuumed, not swept with a broom

action. 'Adequate control' for RCS means applying the principles of good practice for the control of exposure to RCS, eg implementing the guidance in *COSHH essentials*, and ensuring that the WEL is not exceeded.

The QNJAC's guidance on *Occupational health management in the quarry industry*, published in 2004, (www.hse.gov.uk/aboutus/meetings/qnjac/qnjac-ohg.pdf) is likely to be revised soon to reflect changes to good industry practice in controlling exposure to silica and other health risks in quarrying.

* Further information is available in HSE's free leaflet, *COSHH a brief guide to the Regulations: What you need to know about the Control of Substances Hazardous to Health Regulations 2002 (COSHH)* Leaflet INDG136(rev3) HSE Books 2005 (single copy free or priced packs of 10 ISBN 0 7176 2982 1) Web version: www.hse.gov.uk/pubns/indg136.pdf.

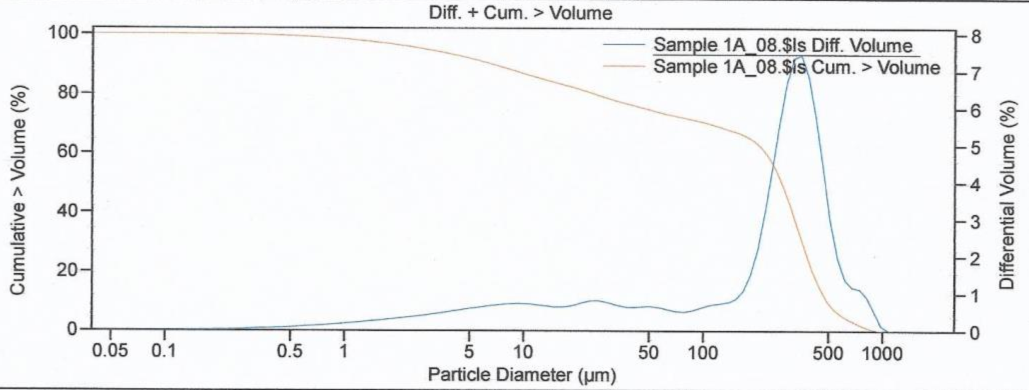
Annex 2

LS Particle Size Analyzer

27 May 2021 14:56

Beckman Coulter LS 13 320

File name:	E:\Peter Alberry\Sample 1A_08.$ls Sample 1A_08.$ls
File ID:	Sample 1A
Sample ID:	Sample 1
Operator:	MERITICS3
Run number:	8
Comment 2:	Dispersion, Direct
Optical model:	Fraunhofer.rfd PIDS included
Residual:	1.02%
LS 13 320	Aqueous Liquid Module
Start time:	10:49 27 May 2021 — Run length: 64 seconds
Pump speed:	72
Obscuration:	5% — PIDS Obscur: 46%
Fluid:	Water
Software:	6.03 — Firmware: 2.02



Volume Statistics (Arithmetic) Sample 1A_08.$ls

Calculations from 0.040 μm to 2000 μm

Volume:	100%		
Mean:	261.2 μm	S.D.:	200.0 μm
Median:	276.0 μm	Variance:	40013 μm^2
Mean/Median ratio:	0.946	C.V.:	76.6%
Mode:	356.1 μm	Skewness:	0.528 Right skewed
		Kurtosis:	0.135 Leptokurtic

d_{10}: 6.660 μm d_{50}: 276.0 μm d_{90}: 496.9 μm

<10%	<25%	<50%	<75%	<90%
6.660 μm	48.30 μm	276.0 μm	384.5 μm	496.9 μm
>10%	>25%	>50%	>75%	>90%
496.9 μm	384.5 μm	276.0 μm	48.30 μm	6.660 μm

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LS Particle Size Analyzer

27 May 2021 14:56

Beckman Coulter LS 13 320

Sample 1A_08.$ls

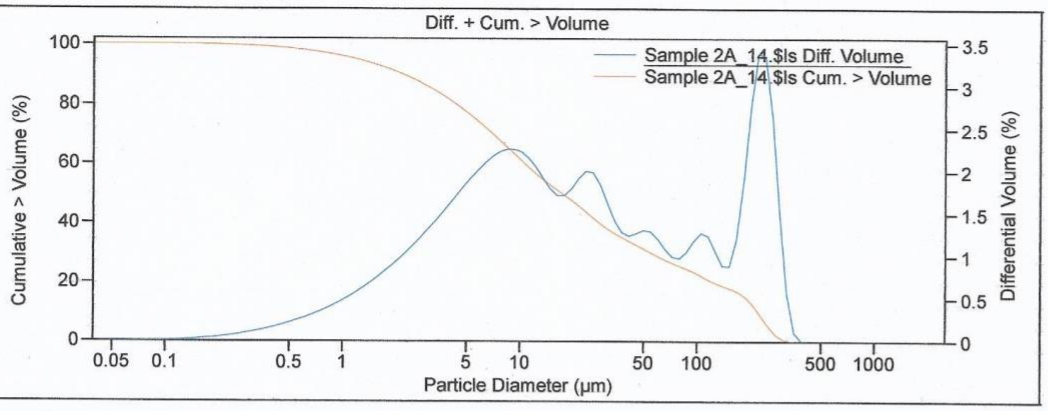
Channel Diameter (Lower) µm	Diff. Volume %	Cum. > Volume %
0.040	0.000020	100
0.044	0.000037	100
0.048	0.000078	100
0.053	0.00017	100
0.058	0.00032	100
0.064	0.00060	99.999
0.070	0.0011	99.999
0.077	0.0017	99.998
0.084	0.0025	99.996
0.093	0.0035	99.99
0.102	0.0048	99.99
0.112	0.0063	99.99
0.122	0.0079	99.98
0.134	0.0098	99.97
0.148	0.012	99.96
0.162	0.015	99.9
0.178	0.018	99.9
0.195	0.022	99.9
0.214	0.026	99.9
0.235	0.032	99.9
0.258	0.038	99.8
0.284	0.044	99.8
0.311	0.051	99.8
0.342	0.059	99.7
0.375	0.067	99.6
0.412	0.076	99.6
0.452	0.086	99.5
0.496	0.096	99.4
0.545	0.11	99.3
0.598	0.12	99.2
0.656	0.13	99.1
0.721	0.15	99.0
0.791	0.16	98.8
0.868	0.18	98.7
0.953	0.19	98.5
1.047	0.21	98.3
1.149	0.23	98.1
1.261	0.25	97.9
1.385	0.26	97.6
1.520	0.28	97.3
1.668	0.31	97.1
1.832	0.33	96.8
2.011	0.35	96.4
2.207	0.37	96.1
2.423	0.39	95.7
2.660	0.42	95.3
2.920	0.44	94.9
3.205	0.47	94.5
3.519	0.50	94.0
3.863	0.53	93.5
4.240	0.56	93.0
4.655	0.59	92.4
5.110	0.62	91.8
5.610	0.65	91.2
6.158	0.67	90.6
6.760	0.70	89.9
7.421	0.72	89.2
8.147	0.73	88.5
8.943	0.73	87.7
9.817	0.73	87.0
10.78	0.72	86.3
11.83	0.69	85.6
12.99	0.67	84.9
14.26	0.64	84.2
15.65	0.64	83.6
17.18	0.66	82.9
18.86	0.71	82.3
20.70	0.77	81.6
22.73	0.81	80.8
24.95	0.82	80.0
27.39	0.78	79.2
30.07	0.73	78.4
33.01	0.67	77.6
36.24	0.64	77.0
39.78	0.64	76.3
43.67	0.65	75.7
47.94	0.66	75.1
52.62	0.64	74.4
57.77	0.60	73.7
63.41	0.55	73.1
69.61	0.52	72.6
76.42	0.51	72.1
83.89	0.55	71.6
92.09	0.61	71.0
101.1	0.67	70.4
111.0	0.72	69.7
121.8	0.74	69.0
133.7	0.77	68.3
146.8	0.86	67.5
161.2	1.07	66.6
176.9	1.50	65.6
194.2	2.20	64.1
213.2	3.19	61.9
234.1	4.39	58.7
256.9	5.64	54.3
282.1	6.72	48.6
309.6	7.37	41.9
339.9	7.43	34.6
373.1	6.85	27.1
409.6	5.74	20.3
449.7	4.34	14.5
493.6	2.97	10.2
541.9	1.96	7.23
594.9	1.38	5.27
653.0	1.17	3.88
716.8	1.13	2.71
786.9	0.92	1.58
863.9	0.52	0.67
948.3	0.13	0.15
1041	0.015	0.015
1143	0	0
1255	0	0
1377	0	0
1512	0	0
1660	0	0
1822	0	0
2000		0

LS Particle Size Analyzer

27 May 2021 14:56

Beckman Coulter LS 13 320

File name:	E:\Peter Alberry\Sample 2A_14.$ls
	Sample 2A_14.$ls
File ID:	Sample 2A
Sample ID:	Sample 2A
Operator:	MERITICS3
Run number:	14
Comment 2:	Dispersion, Direct
Optical model:	Fraunhofer.rfd PIDS included
Residual:	1.08%
LS 13 320	Aqueous Liquid Module
Start time:	11:18 27 May 2021 — Run length: 65 seconds
Pump speed:	72
Obscuration:	6% — PIDS Obscur: 50%
Fluid:	Water
Software:	6.03 — Firmware: 2.02



Volume Statistics (Arithmetic) Sample 2A_14.$ls

Calculations from 0.040 µm to 2000 µm

Volume:	100%		
Mean:	62.57 µm	S.D.:	86.48 µm
Median:	17.38 µm	Variance:	7479 µm^2
Mean/Median ratio:	3.601	C.V.:	138%
Mode:	223.4 µm	Skewness:	1.470 Right skewed
		Kurtosis:	0.794 Leptokurtic

d_{10}: 2.214 µm d_{50}: 17.38 µm d_{90}: 223.1 µm

<10%	<25%	<50%	<75%	<90%
2.214 µm	5.670 µm	17.38 µm	84.73 µm	223.1 µm

>10%	>25%	>50%	>75%	>90%
223.1 µm	84.73 µm	17.38 µm	5.670 µm	2.214 µm

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LS Particle Size Analyzer

Beckman Coulter LS 13 320

27 May 2021 14:56

Sample 2A_14.$ls

Channel Diameter (Lower) µm	Diff. Volume %	Cum. > Volume %
0.040	0.000002	100
0.044	0.000019	100
0.048	0.000070	100
0.053	0.00017	100
0.058	0.00032	100
0.064	0.00057	99.999
0.070	0.0011	99.999
0.077	0.0021	99.998
0.084	0.0036	99.996
0.093	0.0055	99.99
0.102	0.0081	99.99
0.112	0.011	99.98
0.122	0.015	99.97
0.134	0.019	99.95
0.148	0.024	99.9
0.162	0.031	99.9
0.178	0.038	99.9
0.195	0.046	99.8
0.214	0.057	99.8
0.235	0.070	99.7
0.258	0.084	99.7
0.284	0.100	99.6
0.311	0.12	99.5
0.342	0.14	99.4
0.375	0.16	99.2
0.412	0.18	99.1
0.452	0.20	98.9
0.496	0.23	98.7
0.545	0.25	98.5
0.598	0.28	98.2
0.656	0.32	97.9
0.721	0.35	97.6
0.791	0.39	97.3
0.868	0.43	96.9
0.953	0.48	96.4
1.047	0.53	96.0
1.149	0.58	95.4
1.261	0.64	94.9
1.385	0.70	94.2
1.520	0.76	93.5
1.668	0.83	92.8
1.832	0.90	91.9
2.011	0.98	91.0
2.207	1.06	90.0
2.423	1.14	89.0
2.660	1.23	87.8
2.920	1.32	86.6
3.205	1.42	85.3
3.519	1.52	83.9
3.863	1.62	82.3
4.240	1.73	80.7
4.655	1.83	79.0
5.110	1.93	77.2
5.610	2.03	75.2
6.158	2.11	73.2
6.760	2.18	71.1
7.421	2.24	68.9
8.147	2.27	66.7
8.943	2.27	64.4
9.817	2.24	62.1
10.78	2.17	59.9
11.83	2.06	57.7
12.99	1.93	55.7
14.26	1.80	53.7
15.65	1.72	51.9
17.18	1.72	50.2

Channel Diameter (Lower) µm	Diff. Volume %	Cum. > Volume %
18.86	1.81	48.5
20.70	1.93	46.7
22.73	2.01	44.7
24.95	1.99	42.7
27.39	1.85	40.7
30.07	1.63	38.9
33.01	1.42	37.3
36.24	1.29	35.8
39.78	1.25	34.5
43.67	1.28	33.3
47.94	1.31	32.0
52.62	1.30	30.7
57.77	1.21	29.4
63.41	1.09	28.2
69.61	1.00	27.1
76.42	0.98	26.1
83.89	1.06	25.1
92.09	1.19	24.1
101.1	1.28	22.9
111.0	1.24	21.6
121.8	1.07	20.3
133.7	0.89	19.3
146.8	0.89	18.4
161.2	1.21	17.5
176.9	1.90	16.3
194.2	2.78	14.4
213.2	3.40	11.6
234.1	3.37	8.22
256.9	2.65	4.85
282.1	1.51	2.20
309.6	0.57	0.68
339.9	0.11	0.11
373.1	0.0077	0.0077
409.6	0	0
449.7	0	0
493.6	0	0
541.9	0	0
594.9	0	0
653.0	0	0
716.8	0	0
786.9	0	0
863.9	0	0
948.3	0	0
1041	0	0
1143	0	0
1255	0	0
1377	0	0
1512	0	0
1660	0	0
1822	0	0
2000		0